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FINAL REPORT

AQUEOUS MINERAL CARBONATION

Mineral Availability, Pretreatment, Reaction Parametrics, And Process Studies

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By

W.K. O'Connor, D.C. Dahlin, G.E. Rush, S.J. Gerdemann,
L.R. Penner, and D.N. Nilsen

Office of Process Development
National Energy Technology Laboratory
(formerly Albany Research Center)
Office of Fossil Energy, US DOE

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ABSTRACT

Aqueous mineral carbonation has been studied at the Albany Research Center as a potential option for CO_2 sequestration. The research has included fundamental studies, resource evaluation, and process development. Studies have focused on the reaction of Ca-, Fe-, and Mg-silicate minerals with gaseous CO_2 to form geologically stable, naturally occurring solid carbonate minerals. Process development has progressed in parallel with an economic evaluation, with an initial overall cost estimate of ~$69/ton CO_2. Improved mineral pretreatment and reactor design indicate that costs could be reduced. However, the scale of ex-situ operations, requiring ~55 kt mineral/day to carbonate 100% of the CO_2 emissions from a 1 GW coal-fired power plant, may favor an in-situ methodology. Laboratory studies of in-situ mineral carbonation show promise.

INTRODUCTION

Carbon dioxide sequestration by mineral carbonation has been investigated for the past five years at the Albany Research Center (ARC), in collaboration with the Office of Fossil Energy - Mineral Carbonation Study Group. This work has focused on the development of an *ex situ* aqueous process to convert magnesium silicate-rich ultramafic rocks and minerals, such as olivine and serpentine, to magnesium carbonates by contact with gaseous CO_2 in an aqueous solution. Studies within the last year have been expanded to include alternative mineral feed stocks, including calcium- and ferrous iron-rich rocks and minerals, including wollastonite and basalt. Initial studies using ultramafic rocks simplified the reaction sequence by providing high-purity mineral reactants with high concentrations of the primary cations (Ca, Fe^{2+}, Mg) necessary for precipitation of stable carbonate compounds, such as calcite ($CaCO_3$), siderite ($FeCO_3$), and magnesite ($MgCO_3$). Emphasis has been placed on the energy consumption for the overall process, which is impacted most significantly by reaction kinetics, parametrics, and efficiency. Because all three are dependent upon the mineral reactants used, some discussion of these reactants is warranted.

MINERAL CHEMISTRY

Carbonation Reactions

The alteration of Mg-bearing ultramafic rocks by natural hydrothermal fluids is known as serpentinization, and produces hydrated Mg-silicate minerals (serpentine) and, when CO_2 is available, magnesite (eq. 1). Increasing the activity of CO_2 can by-pass the formation of the hydrated species to form the carbonates and silicic acid and/or free silica (eq. 2). Because this reaction occurs in nature and is thermodynamically favored, it became the basis for the aqueous mineral carbonation process. Studies demonstrated that the list of primary mineral reactants could be expanded beyond the Mg-rich silicates to include the Ca- and Fe^{2+}-rich silicates as well. The theoretical carbonation reactions for the Ca-, Fe^{2+}-, and Mg-silicates are included below for reference (eq. 1-5).

$$2Mg_2SiO_4 + CO_2 + 2H_2O \Rightarrow Mg_3Si_2O_5(OH)_4 + MgCO_3 \quad \text{Eq. 1}$$

$$Mg_2SiO_4 + 2CO_2 + 2H_2O \Rightarrow 2MgCO_3 + H_4SiO_4 \quad \text{Eq. 2}$$

$$Mg_3Si_2O_5(OH)_4 + 3CO_2 + 2H_2O \Rightarrow 3MgCO_3 + 2H_4SiO_4 \quad \text{Eq. 3}$$

$$Fe_2SiO_4 + 2CO_2 + 2H_2O \Rightarrow 2FeCO_3 + H_4SiO_4 \quad \text{Eq. 4}$$

$$CaSiO_3 + CO_2 + 2H_2O \Rightarrow CaCO_3 + H_4SiO_4 \quad \text{Eq. 5}$$

Carbonation Potential

A key theoretical yardstick for the value of a particular mineral reactant for mineral carbonation is its carbonation potential. The carbonation potential for a rock or mineral was described by Goff et al. (2000) regarding the hydrated magnesium silicate serpentine [$Mg_3Si_2O_5(OH)_4$]. Goff used the molar concentration of Mg in a serpentine sample to calculate the theoretical number of moles of CO_2 that could be converted to magnesite ($MgCO_3$) by reaction with the serpentine. This method was modified for the current study to include the cations Ca and Fe^{2+} in the calculation, because all three cations can potentially form stable carbonate compounds. The modified method thus permits the calculation of the carbonation potential for the alternative mineral feed stocks studied (Table I). The carbonation potential, R_{CO2}, was calculated from the total molar concentration of Ca, Fe^{2+}, and Mg in the feed, and is defined here as the mass ratio of rock or mineral necessary to convert a unit mass of CO_2 to the solid carbonate (eq. 6). By this definition, a low R_{CO2} is preferable to a high R_{CO2}.

$$R_{CO2} = \frac{100}{\left(\sum Ca^{2+} + Fe^{2+} + Mg^{2+}\right) MW_{CO2}} \quad \text{Eq. 6}$$

Where:
$\sum Ca^{2+} + Fe^{2+} + Mg^{2+}$ = The sum of the molar concentrations for the specified cations.
MW_{CO2} = Molecular weight of CO_2.

Carbonation Reactivity

While the R_{CO2} is an inherent property of a rock or mineral, based strictly on its chemical composition, the carbonation reactivity of that rock or mineral is dependent on numerous factors, including the mineral composition, pretreatment, and solubility at the specific carbonation conditions of time, temperature, and pressure.

An evaluation of the relative sequestration reactivity for the specific mineral feed stocks studied is also included in Table I. The reactivity of the various feed materials was measured as the extent of reaction, R_X, or the percent stoichiometric conversion of the Ca-, Fe^{2+}-, and Mg-silicates to their carbonate counterparts (eq. 7).

Table I. Mineral chemistry, carbonation potential, and reactivity.[1]

Rock/mineral group	Mineral	Formula	Concentration, wt pct				R_{CO2}[2]	ε_A, %	R_x[3], %
			Feed			Prod.			
			Ca	Fe^{2+}	Mg	CO_2			
Feldspar	Anorthite (An)	$CaAl_2Si_2O_8$	10.3	3.1	4.8	1.9	4.4	23	9
Serpentine	Antigorite (Ant)	$Mg_3Si_2O_5(OH)_4$	<0.1	2.4	24.6	24.2	2.1	47	92
Pyroxene	Augite (Aug)	$CaMgSi_2O_6$ + (Fe,Al)	15.6	9.6	6.9	11.1	2.7	37	33
Basalt	An, Aug, Mt, Ol		6.7	6.7	4.3	2.9	4.9	37	15
Olivine (Ol)	Fayalite (Fa)	Fe_2SiO_4	0.6	44.3	0.3	19.2	2.8	36	66
Olivine (Ol)	Forsterite (Fo)	Mg_2SiO_4	0.1	6.1	27.9	29.7	1.8	56	81
Serpentine	Lizardite (Liz)	$Mg_3Si_2O_5(OH)_4$	0.3	1.5	20.7	16.0	2.5	39	40
Oxide	Magnetite (Mt)	Fe_3O_4	0.6	21.9	0.3	1.5	5.5	18	08
Ultramafic	Talc	$Mg_3Si_4O_{10}(OH)_2$	2.2	9.2	15.7	5.2	2.8	36	15
Ultramafic	Wollastonite (Wo)	$CaSiO_3$	31.6	0.5	0.3	22.9	2.8	36	82

[1] Carbonation test conditions: 80% -37 μm feed; 1 hour; 185˚C; P_{CO2}=150 atm; 15% solids; 0.64 *M* $NaHCO_3$, 1 *M* NaCl.
[2] Mass ratio of ore necessary to carbonate unit mass of CO_2.
[3] Reaction efficiency, percent stoichiometric conversion of Ca, Fe^{2+}, and Mg cations in silicate feed to carbonate.

$$R_X = \frac{X_{CO2}}{\varepsilon_A\left(1 - X_{CO2}\right)} \quad \text{Eq. 7}$$

Where:
X_{CO2} = CO_2 concentration in the solid products in weight percent.
ε_A = Percent weight gain assuming 100% stoichiometric conversion of the available cations to the carbonates.

Due to the variability in mineral solubility, partial pressure of CO_2 (P_{CO2}) sensitivity, and precipitation kinetics, it was not practical to conduct all tests at a standardized set of pretreatment and carbonation conditions. Thus, the R_X values reported in Table I generally represent the best results achieved for each mineral reactant to date. The standardized test conditions are included as a footnote to the table. Variations from the standard conditions are noted below. For example, the wollastonite and forsterite exhibit comparable R_X, but both required an ultra-fine grinding pretreatment stage to achieve those reaction efficiencies. In addition, the P_{CO2} for the wollastonite carbonation is much lower than that for the forsterite, at 40 atm versus 150 atm, respectively. Countering the reduced P_{CO2} for wollastonite, however, is its higher R_{CO2} relative to forsterite. Because Ca is a much heavier element than Mg, the Ca-bearing silicates have a lower molar concentration of cations suitable for carbonation, and thus a higher R_{CO2}. Both these factors have a significant impact on the process economics, which are discussed in greater detail in a later section.

Antigorite serpentine has the second lowest R_{CO2} and the highest R_X of the minerals investigated. However, a heat pretreatment stage was necessary to achieve this degree of reactivity. Lizardite serpentine underwent an identical heat treatment stage to achieve the reported R_X, although to less effect. The lower reactivity of the non-heat treated hydrated magnesium silicates is evident in the R_X of 15% reported for talc. Heat treatment proved an effective activation methodology for the hydrated minerals. However, as with the ultra-fine grinding used to activate olivine and wollastonite, heat treatment has a significant impact on the process economics and CO_2 balance.

Finally, the mafic rocks and/or minerals, including basalt, which is comprised in part of varying concentrations of anorthite, augite, magnetite, and olivine, all tended to exhibit the lowest R_X and the highest R_{CO2}. The anorthite and augite tests included the ultra-fine grinding stage, but were conducted for longer carbonation times (6 hours) than the standard 1 hour carbonation time, thus the R_X for 1 hour for both would be lower than shown. Although the fayalite and magnetite tests were also conducted for 6 hours rather than the standard time, their R_X are believed to be comparable to the others because neither underwent the ultra-fine grinding stage.

MINERAL AVAILABILITY

Ultramafic Mineral Carbonation Regions

The ultramafic minerals investigated for mineral carbonation generally occur within large ophiolite complexes that are described as remnants of oceanic crust that have been compressed and folded along convergent continental margins. In North America, these ultramafic belts occur along both coasts, rather than the interior, which places limitations on the application of the mineral carbonation technology. The large tonnage of ore required for mineral sequestration makes it necessary to locate the mineral carbonation plant at the mine mouth, rather than at the CO_2 point source. As part of the mineral carbonation studies conducted at ARC, an evaluation of the scale of major CO_2 point sources and

their proximity to the potential mineral sources was conducted, resulting in the identification of 7 primary ultramafic mineral carbonation regions within the conterminous U.S. (Figure 1).

Figure 1. Ultramafic mineral carbonation regions.

Coal Consumption and Ore Tonnage To determine the potential scale for mineral sequestration, it was necessary to derive the total CO_2 point source emissions within a specified distance of the mineral sources within these 7 regions. To simplify this determination, CO_2 point sources were limited to coal-fired power plants that occur within 100- and 200-mile radii of the geographic center of the specific mining district or mineral deposit. Total CO_2 emissions were calculated from total regional coal consumption derived from Platts (2001), and carbon content of the coal used in that region after Babcock & Wilcox (1998). Assumptions for coal use by region include sub-bituminous/lignite Washington coal in Region 1, sub-bituminous Wyoming coal in regions 2 and 3, Texas lignite in region 4, and bituminous Pennsylvania coal in regions 5-7 (Table II). The total calculated CO_2 emissions for all 7 regions (604 Mt) represents ~30% of the total annual CO_2 emissions from U.S. coal-fired power plants, as reported by the EIA (2003).

Total ore demand in Table II was calculated assuming sequestration of 100% of the CO_2 emissions in each region, at the R_{CO2} of the various mineral reactants, and the demonstrated extent of reaction (R_X). Experimental results were used for the latter at two levels of mineral pretreatment. Standard pretreatment for all minerals is defined as size reduction to 80% minus 400 mesh (37 μm). Activated pretreatment is specific to the mineral type: olivine and wollastonite were mechanically activated by the addition of an ultra-fine grinding stage; serpentine minerals were activated by the addition of a heat-treatment stage. The impact of the mineral pretreatment operations is dramatic, reducing the total ore tonnage by over 75%. However, as stated previously, these activation steps also impact process economics and the CO_2 balance. These latter two factors are discussed further in later sections.

Ultramafic Mineral Resources The regional ore demand totals included in Table II are very large, even for the activated mineral reactants. However, with two exceptions, the ultramafic mineral resources far exceed these demands. Roskill (1990) reported reserves of 1.8 Gt of unaltered dunite (>90% olivine) at the Twin Sisters deposit in NW Washington. This represents a 33-year supply for current Region 1 CO_2 emissions.

Coleman and Irwin (1977) and Goff et al. (1997) described the vast belts of serpentine in SW Oregon and the California Coast Ranges, which dwarf the annual estimated ore demands for both Regions 2 and 3. Less certain is the availability of serpentine from the Llano Uplift to meet the estimated ore demand of ~200-400 Mt/year for mineral sequestration in Region 4. A resource of over 1 Gt of serpentine is inferred after Barnes et al. (1950), which may be a 5-10 year supply at full-scale mineral sequestration. In contrast, the serpentine resource in Region 6, the State Line district along the Maryland-Pennsylvania border, is vast, as described by Pearre and Heyl (1960). However, the 300-600 Mt/year ore demand would require 20-40 50-kt/day open pit mines.

Hunter (1941) provided a detailed description of the olivine deposits in western North Carolina, and Roskill (1990) reported ~200 Mt of reserves. These reserve estimates indicate that the olivine supply in Region 5 could meet the ore demand for only 1-2 years, assuming ~120 Mt/year within the more limited 100-mile radius. Serpentine resources would have to substitute for olivine in Region 5. Virta (2001) reported wollastonite reserves in Region 7 at ~14 Mt, roughly a 6-month supply for the 100-mile radius ore demand. Alternatives to wollastonite would be needed, although increased demand could spur exploration that might extend the wollastonite supply.

Mafic Mineral Carbonation Regions

The most likely targets for mafic mineral exploitation are the three massive flood basalt provinces that occur within the conterminous U.S. (Figure 2).

Figure 2. Mafic mineral carbonation regions.

Table II. Annual coal consumption, CO_2 emissions, and ore demand by ultramafic mineral carbonation region.

Region	Mining district/deposit	Mineral	R_{CO2}	R_X, %		Radius, miles	Coal, Mt	C, wt pct	CO_2, Mt	Ore, Mt	
				Std.	Act.					Std.	Act.
1	Twins Sisters, WA	Olivine	1.8	61	81	100 100-200	5 2	70 70	13 5	38 15	29 11
2	Trinity-Siskiyou Mtn, CA-OR	Serpentine (lizardite)	2.5	9	40	100 100-200	4 0	70 70	10 0	303 0	64 0
3	Coast Range, Southern CA	Serpentine (lizardite)	2.5	9	36	100 100-200	4 0	70 70	10 0	303 0	71 0
4	Llano Uplift, TX	Serpentine (lizardite)	2.5	9	40	100 100-200	13 18	63 63	30 42	888 1229	187 259
5	Asheville, NC	Olivine	1.8	61	81	100 100-200	20 49	74 74	54 133	160 392	121 295
6	State Line, MD-PA	Serpentine (antigorite)	2.1	12	92	100 100-200	39 46	74 74	106 125	1822 2149	242 285
7	Willsboro, NY	Wollastonite	2.8	43	82	100 100-200	4 24	74 74	11 65	70 422	37 222
Total	Region 1-7, ultramafic ores						228		604	7790	1823

These flood basalt provinces contain vast amounts of material for mineral sequestration, although experimental studies indicate that reaction efficiencies are low and R_{CO2} high compared to the ultramafic minerals (Table I). Mafic regions 8 and 10 overlap ultramafic regions 1 and 6, respectively. The CO_2 emissions and ore demand totals were calculated separately, but by the same methods, with the results included in Table III.

The Columbia River Basalt Group (CRBG) of Region 8 has been described by Reidel et al. (1989), among other authors. The CRBG covers over 200,000 km^2 at an average thickness of 1 km. Green (1972) described the geology of the Keweenawan Rift System Basalts (KRSB) in Region 9, while Olsen et al. (1996) provided similar discussion of the Newark Basin Basalts (NBB) of Region 10. In each case, the tremendous tonnages required for *ex situ* mineral sequestration and the layered structure of each flood basalt province suggest they may hold greater promise for *in situ* mineral sequestration rather than as sources of mafic mineral reactants for the *ex situ* process. Reidel et al. (2002) reported on the potential for natural gas storage within anticlinal structures in the CRBG and speculated on the potential for CO_2 injection into deep saline aquifers hosted by the CRBG. Initial laboratory pressure-leach studies conducted at ARC on core from the CRBG were reported by O'Connor et al. (2003). The favorable basalt mineralogy for mineral carbonation could make these flood basalt provinces attractive targets for geological sequestration.

Table III. Annual coal consumption, CO_2 emissions, and ore demand by mafic mineral carbonation region

Region	Mining district/deposit	Mineral	R_{CO2}	R_X, %	Radius, miles	Coal, Mt	C, wt pct	CO_2, Mt	Ore, Mt
8	CRBG, WA-OR	Basalt	4.9	15	100 100-200	2 5	70 70	5 13	170 420
9	KRSB, MN-WI-IA	Basalt	4.9	15	100 100-200	13 18	69 69	33 46	8100 1500
10	NBB, NJ-NY-PA	Basalt	4.9	15	100 100-200	23 34	74 74	62 92	2000 3000
Total	Region 8-10, mafic ores					95		251	15200

MINERAL PRETREATMENT

Activation of the mineral reactants has been achieved by both thermal and mechanical means, although the mechanism for this activation is not clearly understood. Because most mineral dissolution reactions are surface controlled, it is possible that the two pretreatment methods proved successful primarily due to increased surface area. Mechanical pretreatment reduces the mean particle size of the minerals, while thermal pretreatment removes chemically-bound water, which may increase the porosity and the resulting surface area. Zhang et al. (1996) provided some discussion of the enhancement of Mg silicate solubility by mechanical means, while McKelvy et al. (2002) and Chizmeshya et al. (2002) described thermal activation and computational modeling studies, respectively, conducted at Arizona State University, a collaborating laboratory with ARC. All

suggest that the activation is due to destruction or disordering of the mineral lattice. It is likely that both phenomena are responsible to some degree for the improvements in mineral reactivity achieved by pretreatment. However, because the energy penalty necessary to achieve such activation is most critical to the viability of any mineral-carbonation process, the following discussion focuses on the energy consumption for the various mineral pretreatment options, rather than the root causes for enhanced reactivity.

Mechanical Activation

Mechanical activation was investigated by use of conventional rod and ball milling techniques, as well as ultra-fine grinding using a scalable stirred-media detritor (SMD) mill. The Work Index (grinding energy) necessary for specific size reduction was calculated for olivine and the two serpentine minerals, using data derived from pilot-scale comminution tests conducted on the ores and the formula described by Bond (1952). Energy consumption for ultra-fine grinding was determined by direct measurement from the SMD mill. Four test series were conducted on the primary mineral reactants to evaluate the sensitivity of mineral reactivity (R_X) to grinding energy (Figure 3).

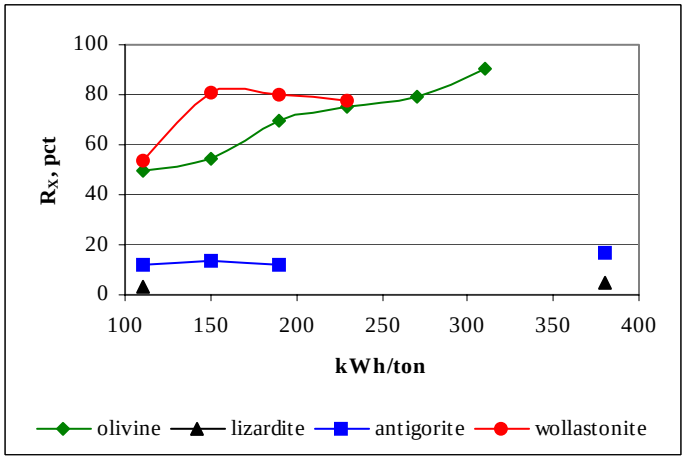


Figure 3. Grinding energy versus Rx.

The carbonation test conditions varied by mineral, using the best demonstrated reaction parametrics: 1 hour duration (all minerals); 185°C (olivine), 155°C (serpentines), 200°C (wollastonite); P_{CO2} of 150 atm (olivine and serpentines), 40 atm (wollastonite); carrier solution of 1 *M* NaCL, 0.64 *M* $NaHCO_3$ (olivine and serpentines), distilled water (wollastonite). While olivine showed a nearly linear relationship between mechanical energy input and R_X, wollastonite activation peaked at a much lower energy input, with no gain at higher energies. In contrast, both serpentine minerals show virtually no increase in R_X at energies up to nearly 400 kW•h/ton. Additional studies using a laboratory-scale attrition-grinding mill showed significant activation of the serpentines, but the estimated energy consumption was extremely high, and activation of serpentine by mechanical means alone appears impractical.

The relationship between particle size and surface area versus mechanical energy input was also examined for the olivine ground products (Figure 4). Particle size is represented by the D_{50} (50% finer than specified diameter) as determined by an X-ray absoption sedimentation method. Not surprising is the fact that olivine particle size decreases while reactivity increases with increasing grinding energy. Surface area measurements by BET N_2 adsorption increase from 2.6 to 10.2 m^2/g over this same series. Because all carbonation tests were conducted for 1 hour, reaction rates cannot be derived from these data, but it is likely that the increased surface area accelerated the dissolution rate of the mineral, leading to further extent of reaction within the 1-hour test time.

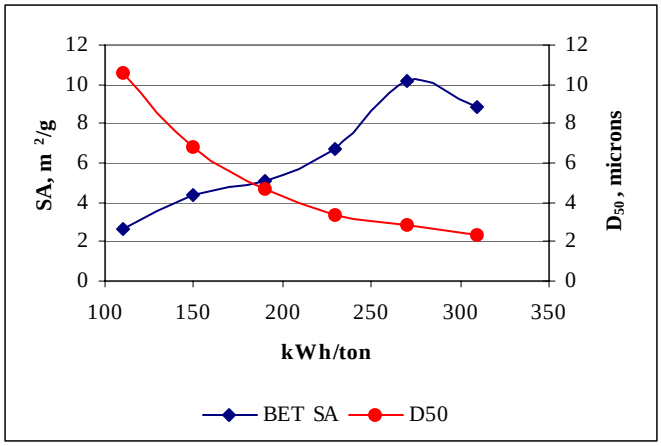


Figure 4. Olivine grinding energy versus particle size and surface area.

Thermal Activation

Thermal activation of the hydrated Mg-silicate species was accomplished by the addition of a heat treatment stage in the mineral pretreatment process. An effective heat treatment methodology was developed experimentally and confirmed by differential thermal analysis and thermal gravimetric analysis (DTA/TGA) of the antigorite serpentine ore sample (Figure 5).

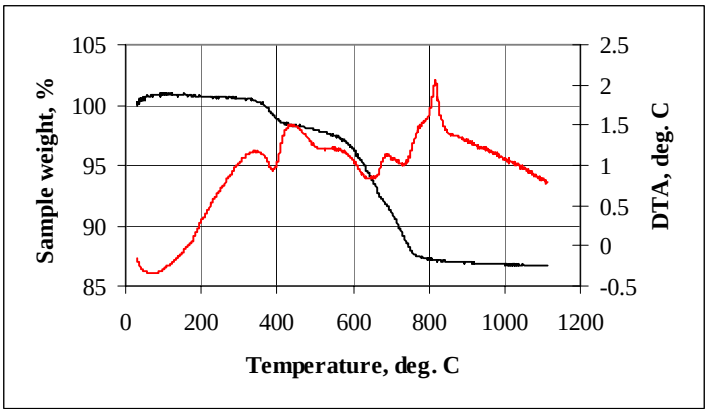


Figure 5. DTA (red) & TGA (black) for antigorite

The most effective heat-treatment temperature determined experimentally was approximately 630°C. This is reflected in the TGA plot, which shows the most significant weight loss, due to dehydroxylation or removal of the chemically-bound water, initiating at about 600°C. The DTA plot shows an endotherm in this temperature range centered on approximately 650°C, which corroborates the experimental data derived from bulk heat treatment of the ore. A second endotherm evident on the DTA plot occurs at about 390°C, coinciding with a weight loss of roughly 2% based on the TGA. This may be indicative of brucite [$Mg(OH)_2$] dehydroxylation, which occurs at roughly 375°C. X-ray diffraction (XRD) analysis of the same sample identified brucite as a minor phase (1-10%). DTA/TGA of the lizardite samples showed no similar weight loss or endotherm around 400°C, suggesting that brucite is absent from those ores. Because Mg-hydroxide species are far more reactive than Mg silicate, the presence of brucite in the antigorite sample may help explain the higher R_x achieved for that serpentine compared to the lizardite variety.

A great deal of study has focused on serpentine activation, both recently within the DOE Mineral Carbonation Study Group, and prior to the current research. Barnes et al. (1950) described extensive studies on the utilization and heat activation of Texas serpentine. Zhang et al. (1997) reported on the enhancement of acid extraction of Mg and Si from serpentine by mechanochemical treatment, although the 6-hour grinding times utilized likely make the methodology extremely energy-intensive. From a process standpoint, the energy consumption required for activation is more significant than the methodologies themselves, which led to an effort to determine the relative energies for thermal activation of the serpentine minerals used in the current study.

The theoretical energy required for the heat activation process must include the energy to heat the mineral to the specified temperature and the enthalpy of dehydroxylation. The latter includes the energy to decompose the serpentine, removing the hydroxyl molecule and producing a pseudo-amorphous silicate phase. Thermodynamic data reported by King et al. (1967) was used to calculate the effective heat capacities at temperature for antigorite serpentine. The theoretical energy required to heating the mineral to the specified temperature was calculated by equation 8.

$$Q = C_P \Delta T \qquad \text{Eq. 8}$$

Where:
Q = heat, cal/mol
C_P = cal/K•mol @ temperature T_1, (K)
$\Delta T = T_1 - T_0$ (298K)

Quantitative DTA analysis was utilized to determine the dehydroxylation energies (E_d) for antigorite and lizardite serpentine, which were reported by Govier and Arnold (2004) to be approximately 95 and 131 kJ/mol, respectively. Combining the C_P data derived for antigorite serpentine coupled with these mineral-specific E_d values results in the total theoretical energy requirement for the heat-activation process. For example, heat treatment of the serpentine at 630°C (C_P = 89.26 cal/K mol) requires 206 kW•h/ton to heat the mineral, while dehydroxylation of the antigorite and lizardite requires an additional 87 and 120 kW•h/ton, respectively. Total energy consumption for the heat treatment process is thus 293 and 326 kW•h/ton, for antigorite and lizardite, respectively.

A series of heat treatment tests was conducted over a range of 200-1,000°C at 200°C intervals to evaluate the effect of heat-treatment temperature on antigorite serpentine reactivity. The reported energy values for the heat-treatment process represent the thermal energies required at each temperature as calculated by the method described above (Figure 6). The energies at the 200°C and 400°C heat treatment temperatures do not include the E_d because dehydroxylation does not occur at temperatures below approximately 600°C.

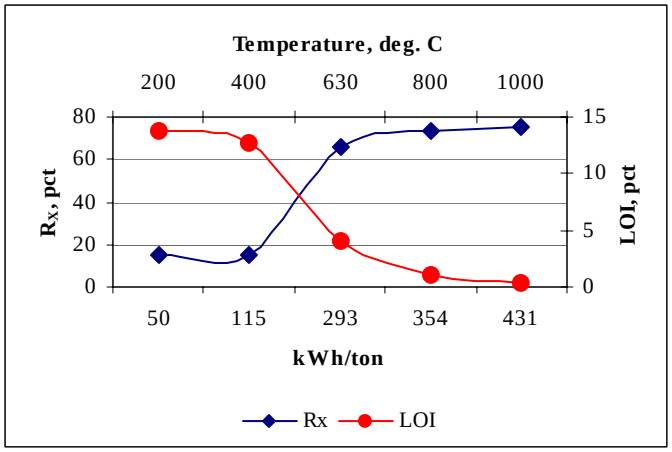


Figure 6. Antigorite heat treatment energy versus Rx.

The Loss-on-Ignition (LOI) curve was added to Figure 6 to emphasize the relationship between carbonation reactivity and effective removal of bound water. The LOI continues to decrease at temperatures above 630°C, although R_X increases only slightly, thus the added energy is not considered cost-effective. Barnes et al. (1950) identified an effective zone for activation that ranges from roughly 600-725°C, distinguished by an amorphous XRD pattern of the activated serpentine. McKelvy et al. (2001) described a meta-stable serpentine phase that forms in roughly the same temperature range, and suggested that heating above 800°C is undesirable, because this leads to a phase transformation to the non-hydrated Mg-silicate phases, forsterite and enstatite. This phase transformation is marked by an exotherm at just over 800°C (Figure 5).

Energy Consumption

Using the energy data compiled during the mechanical and thermal activation studies, a compilation of comparative energy consumption values was prepared for each of the 7 ultramafic mineral carbonation regions (Table IV). The feed material histories are summarized in the first three columns of the table, with a code specific to each material included in column 4. This code is used in subsequent tables to conserve space. The rest of the table includes the energy consumption values determined for the various mineral pretreatment methodologies by stage.

For example, crushing energy for all materials is estimated at 2 kW•h/ton, based on mining cost data produced by the U.S. Bureau of Mines (1987). Ore grade is assumed to be 100% for the Twin Sisters olivine and all serpentine mineral districts (Regions 1-4, 6), based on first-hand observation of several of the mining operations, which are essentially open-pit quarries that require no concentration steps. However, laboratory analysis of olivine samples collected from the Asheville Mining District (Region 5) identified alteration minerals, serpentine and talc, with an estimated ore grade of 70% olivine. Bench-scale tests conducted on the Region 5 olivine ore indicated that gravity separation could be an effective beneficiation process, with an energy penalty of approximately 2 kW•h/ton. It is assumed that the beneficiation step would be conducted following the first grinding stage, which appears to provide sufficient liberation of the olivine from the alteration products based on the laboratory studies. Thus, the grinding energy for the stage 1 grind is based on the tonnage of raw ore processed, while subsequent pretreatment energies are based on processing the olivine concentrate.

Table IV. Energy consumption by feed material and specific pretreatment methodology.

Feed Material History				Pretreatment Energy Consumption, kW•h/ton						
						Grinding			Heat	
Region	Ore mineral & grade	Pretreatment methodology	Code	Crush.	Bene.	Stage 1	Stage 2	Stage 3	treatment	Total
1	Olivine, 100%	Ball mill (-200 mesh)	1A	2		11				13
		Ball mill (-400 mesh)	1B	2		11	70			83
		SMD mill	1C	2		11	70	150		233
2-4	Serpentine, 100% (lizardite)	Ball mill (-200 mesh)	2-4A	2		11				13
		Heat treatment (-200)	2-4B	2		11			326	339
5	Olivine, 70%	Ball mill (-200 mesh)	5A	2	2	15				19
		Ball mill (-400 mesh)	5B	2	2	15	70			89
		SMD mill	5C	2	2	15	70	150		239
6	Serpentine, 100% (antigorite)	Ball mill (-200 mesh)	6A	2		11				13
		Heat treatment (-200)	6B	2		11			293	306
		Heat treatment (-400)	6C	2		11	70		293	376
7	Wollastonite, 50%	Ball mill (-400 mesh)	7A	2	4	21	70			97
		SMD mill	7B	2	4	21	70	70		167

Virta (2001) reported wollastonite grade in the Region 7 deposits at 40-60%. Information provided with samples from the largest wollastonite mining operation in Region 7 described a two-stage concentration process, including size separation to remove calcite and magnetic separation to remove garnet. The wollastonite ore grade was assumed to be 50% for the subject calculations, and a beneficiation energy penalty of 4 kW•h/ton was added to the overall pretreatment energy consumption figure. As with the Region 5 olivine beneficiation, the size and gravity separation steps would be conducted on the raw wollastonite ore following the first-stage grind, which increases the grinding energy for that stage accordingly, compared to the non-beneficiated ore materials. Subsequent pretreatment energies are based on processing the wollastonite concentrate.

This compilation was used to calculate the theoretical parasitic energy loss from the power plant, based on the measured mechanical/thermal activation energies and experimental carbonation data. The basis for this calculation was a 1 GW coal-fired power plant, burning coal with an as-fired heat value of 12,500 Btu/lb and carbon content of 74%, at 35% plant efficiency. The CO_2 emissions of 25.4 kt/day were then used to calculate the daily ore requirement to sequester 100% of the CO_2 emissions at the R_{CO2} and demonstrated R_X of each mineral reactant in a single pass through the carbonation reactor. The results are included in Table V.

Table V. Parasitic energy loss by pretreatment.

Feed Code	R_{CO2}	R_X, %	Ore/conc., kt/day	Pct total plant energy
1A	1.8	16	286	15
1B	1.8	61	75	26
1C	1.8	81	56	55
2-4A	2.5	9	706	37
2-4B	2.5	40	158	222
5A	1.8	16	286	22
5B	1.8	61	75	28
5C	1.8	81	56	56
6A	2.1	12	445	24
6B	2.1	62	86	110
6C	2.1	92	58	90
7A	2.8	43	165	67
7B	2.8	82	87	61

While the daily ore requirements decrease dramatically with increased mineral activation, the coincident parasitic energy loss on the power plant becomes problematic. The latter is critical because it provides an estimate of the CO_2 balance, based on the pretreatment energies only. For example, the 15% of total plant energy necessary for pretreatment methodology 1A (minus 200-mesh Twin Sisters olivine) indicates that the CO_2 avoided is approximately 85% for that feed material at that degree of pretreatment. This assumes that the energy required for the pretreatment operation is generated by burning the same coal at the same efficiency as stated for the power plant. Adding the sequestration plant energy requirement decreases the CO_2 avoided even further. Parasitic energy losses exceeding unity (1.0) indicate that the CO_2 avoided is negative, meaning that more CO_2 is emitted by the pretreatment operation than is sequestered. These problems are most acute for the thermal-activation operations on the serpentine minerals, but the high energy consumption for the mechanical activation operations on the olivine and wollastonite minerals are also problematic.

The improved reactivity achieved by the additional pretreatment operations is negated for the most part by the higher energy demand. However, the higher ore requirements at the lower pretreatment energies require massive increases in mining output, exceeding the available resources in some regions. These calculations assume a single pass of the mineral through the carbonation plant; the successful addition of a recycle stream could reduce the virgin ore demand significantly. This issue is discussed further under the Process Development section later in this report.

Physical Properties

Several physical properties of the specific pretreatment products were measured for comparison. The results included in Table VI provide some insight into the mechanisms impacting the activation phenomena.

Table VI. Physical properties of the pretreatment products.

Feed Code	D_{80}, μm	D_{50}, μm	BET SA, m^2/g
1A	75	20	5
1B	37	14	NA
1C	10	3	7
2-4A	75	19	32
2-4B	NA	22	11
5A	NA	NA	NA
5B	NA	NA	NA
5C	NA	NA	NA
6A	75	13	9
6B	NA	NA	NA
6C	37	17	19
7A	NA	NA	NA
7B	NA	NA	NA

The D_{80} values correspond with the size reduction targets for the stage-1 grinding operations. The minus 200-mesh ball mill product from pretreatment methodology 1A represents material that is 80% finer than 75 μm, and so on. The further reduction in particle diameter with each succeeding stage of grinding is reflected in both the D_{80} and D_{50} values. Particle diameters below 10 μm may significantly reduce if not eliminate diffusion limitations at the mineral specific carbonation reaction conditions, while coincident increases in surface area improve the mineral dissolution kinetics. Both phenomena improve R_X, although at significant energy penalty, as specified in Table IV.

The heat-activation process on the serpentine minerals tended to increase the mean particle diameter for both minerals, but with opposite impacts on the surface areas. Lizardite (2-4B) surface area decreased by nearly 300% after heat treatment, while antigorite (6B and C) surface area increased by over 200%. These variations in surface area may help to explain the much higher reactivity of the heat-activated antigorite compared to that of the heat-activated lizardite. The reason for the variable surface areas after removal of the bound water is likely tied to the different lattice structures of the two minerals a discussion beyond the scope of this paper.

REACTION PARAMETRICS

Experimental Procedure and Apparatus

Series of laboratory experiments were conducted at ARC to define the optimum carbonation reaction conditions specific to each mineral investigated. Foremost in this process was the development of an effective experimental apparatus and procedure, both of which can have a significant impact on the R_X. For example, initial tests were conducted in a batch autoclave system with continuous agitation but did not include gas dispersion or a means to maintain constant P_{CO2}. The stirred-tank-reactor (STR) was prepared for operation by the following procedure:

1. 100 g olivine weighed and placed in the STR;
2. 400 ml distilled water poured into the STR;
3. STR sealed, evacuated, weighed (tare weight), and placed into an ice bath;
4. liquid CO_2 introduced into the STR;
5. STR placed back on scale, weight of CO_2 determined;
6. pressure bled off while STR on scale until proper weight of CO_2 remained;
7. STR heated to final process P and T;
8. after specified test time, STR cooled, pressure bled off, slurry removed;
9. slurry filtered, solids dried, weighed, and sampled for analysis, solution sampled for analysis.

The proper weight of CO_2 was calculated in advance using the compressibility factor equation of state (equation 9).

$$P\hat{V} = zRT \qquad \text{Eq. 9}$$

Where:
P = pressure, *atm*
V = molar volume, *moles/liter*
z = compressibility factor for CO_2
R = gas constant, $liter \bullet atm \bullet mole^{-1} \bullet K^{-1}$
T = temperature, K

The CO_2 compressibility factor was initially interpolated from the available literature and then modified based on the empirical results. The solubility of CO_2 in water at the desired P-T conditions was also included in the final calculation.

This procedure was simplified dramatically by the development of a new batch autoclave system that included a CO_2 gas booster pump controlled by a pressure transducer on the autoclave (Figure 7).

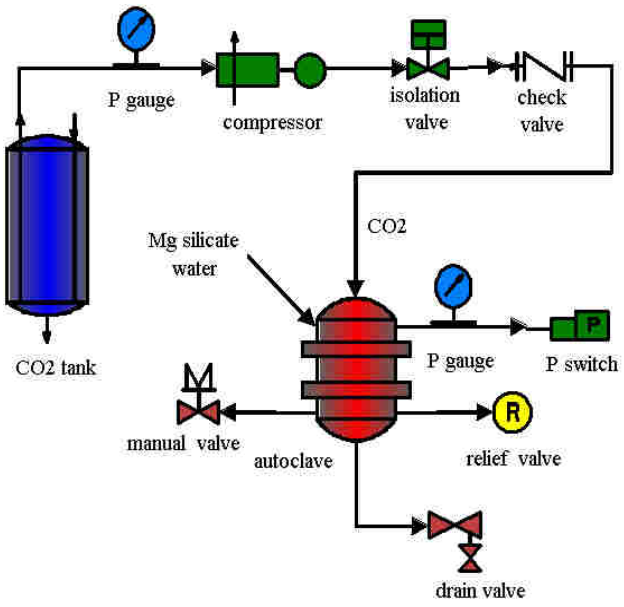


Figure 7. Schematic of laboratory apparatus.

All subsequent tests conducted in the new system followed a simplified test procedure. The pre- and post-test solids and solution handling procedures were not changed, but the inclusion of the gas booster pump permitted operation under relatively constant P_{CO2}, which was not possible in the former system. This minimized the impact of decreasing P_{CO2} due to carbonation and/or system leaks on the final R_X. In addition, the use of a gas-dispersion agitator dramatically improved three-phase mixing in the reactor, which ultimately improved R_X without changing P and T conditions or residence time. The modified test procedure follows.

1. 167 g of mineral reactant and 950 g carrier solution (distilled water or bicarbonate/salt solution) poured into STR;
2. STR sealed, purged with CO_2;
3. STR heated to test T;
4. CO_2 injected to test P;
5. additional CO_2 injected as system pressure decreases due to reaction and/or leaks;
6. after specified test time, STR cooled, pressure bled off, slurry removed;
7. slurry filtered, solids dried, weighed, and sampled for analysis, solution sampled for analysis.

In the new system, the autoclave was sealed and purged with CO_2 following the addition of the slurry. This left a residual atmosphere of about 10 atm P_{CO2} during the heat-up interval, which was standardized to 1 hour. To discern the extent of reaction that had occurred during the heat-up interval, zero-time tests were conducted for each mineral reactant. These tests were terminated once the system had reached the desired temperature, but prior to CO_2 injection to the final elevated pressure. Results showed that R_X was mineral-specific, being negligible for the olivine and non-heat-treated serpentine minerals, but much more significant for the wollastonite and heat-treated serpentines.

The zero-time R_X measurements for the heat-treated antigorite, heat-treated lizardite, and wollastonite were roughly 18, 34, and 45 pct, respectively. The reported test times are designated only for time at the test P and T conditions; the 1-hour heat-up times were neglected. The results from the zero-time tests indicate that the true test times should account for the heat-up interval, at least for the more highly reactive mineral species. However, for the purpose of this report, it was assumed that the highly reactive portion of these mineral species would also react within the 1-hour test time at the final P and T conditions if the system permitted introduction of the slurry into the reactor at these conditions. Perhaps more significant is the relatively high R_X for these activated minerals at much-reduced P_{CO2} and reduced temperature during the heat-up interval.

Carbonation Carrier Solution

Carbonic Acid System: The original aqueous mineral carbonation process investigated at ARC used distilled water (pH = 5.8) as the carbonation carrier solution, and was thus considered the carbonic-acid route. Hem (1985) pointed out that, while carbonic acid (H_2CO_3) is conventionally used to represent all the dissolved undissociated CO_2 in natural waters, only about 0.01 pct of the dissolved CO_2 is actually present in this form. Thus, the H_2CO_3 convention used to describe the process has no practical effect on the results. These initial tests were exploratory in nature and intended to provide a baseline regarding the impact of solution chemistry on the overall mineral-carbonation process. One possible reaction sequence for the carbonic-acid route includes several simultaneous reactions. In this sequence, bicarbonate formation within the solution occurs by hydration of CO_2 to form carbonic acid, which dissociates to the separate hydrogen and bicarbonate ions (equation 10).

$$H_2O + CO_2 \overset{\text{I}}{\Rightarrow} H_2CO_3 \overset{\text{II}}{\Rightarrow} H^+ + HCO_3^- \quad \text{Eq.10}$$

$$Mg_2SiO_4 + 4H^+ \Rightarrow 2Mg^{2+} + H_4SiO_4 \quad \text{Eq.11}$$

$$Mg^{2+} + HCO_3^- \Rightarrow MgCO_3 + H^+ \quad \text{Eq.12}$$

Mineral hydrolysis liberates Mg^{2+} cations from the forsterite olivine, with co-production of silicic acid and/or free silica and water (equation 11). Carbonation of the Mg^{2+} cations would then occur by reaction with the HCO_3^- to produce the solid carbonate and additional H^+ for further mineral hydrolysis (equation 12). Regarding equation 10, Nguyen et al. (1984) stated that while equilibrium with the bicarbonate ion is very fast (rreaction II), the formation of carbonic acid (reaction I) is the rate-determining step. This is likely due to the slow dissolution rate of CO_2 in water, as described by Sherwood and Pigford (1952). Reaction I may also be rate-limiting for the overall mineral carbonation process in the carbonic-acid system, although forsterite dissolution and magnesite precipitation kinetics also play significant roles. The positive impact of the modified experimental apparatus, which included gas dispersion for improved three-phase mixing, on the overall reaction efficiency is likely due in part to improved rates for equation 10. A complete discussion of the CO_2 hydration reaction kinetics is beyond the scope of this paper. However, it is readily seen that finding a means to facilitate aqueous bicarbonate formation would help overcome this rate-limiting step.

Bicarbonate System: Based on the results from the initial test series, it was theorized that solution pH plays a conflicting role in the two-stage reaction process. While acidic solutions should favor mineral hydrolysis and improve silicate dissolution rates, carbonate precipitation likely requires alkaline solutions. Thus, a buffered solution chemistry was formulated that permits simultaneous silicate dissolution and carbonate precipitation. In this new system, $NaHCO_3$ was added to the solution, serving the dual purpose of modifying the solution to slightly alkaline pH while acting as an effective CO_2 carrier. The impact of this addition was immediately apparent, reducing the required residence times to achieve an R_X of approximately 80% from 24 to 6 hours, all other carbonation conditions being constant. One interpretation of the modified reaction sequence includes direct reaction between the forsterite olivine and bicarbonate ion (equation 13), followed by immediate bicarbonate regeneration due to reaction of CO_2 with the hydroxide ion (equation 14).

$$Mg_2SiO_4 + 2HCO_3^- \Rightarrow 2MgCO_3 + SiO_2 + 2OH^- \quad \text{Eq.13}$$

$$OH^- + CO_2 \Rightarrow HCO_3^- \quad \text{Eq.14}$$

The actual ionic species present at the carbonation P and T conditions are not known, thus speculation on whether OH^- could exist in this system is tenuous, but at the pH of the buffered solution (~7.9), typical silicate hydrolysis does not occur. Characterization of the reaction products tends to support this assertion, with identification of a silica-rich outer layer on the coarser, partially-reacted silicate grains. These zones are depleted of Mg^{2+} cations, suggesting that the cation is mobilized rather than the silica, the latter being the expected path for typical mineral hydrolysis.

Regardless of the actual reaction pathway, the bicarbonate carrier solution was refined experimentally by using various concentrations of $NaHCO_3$, with and without NaCl. The NaCl addition improved R_X at constant $NaHCO_3$ concentration and P and T. The additional Na^+ ions may modify the surface charge of the silicate particles, aiding in the ion exchange at the solid/liquid interface. The Cl^- ions may provide a means to complex the Mg^{2+} cations, at least temporarily, increasing the Mg^{2+} solubility. The combination of $NaHCO_3$ and NaCl was found to be most effective, with the optimum concentrations based on the demands of an industrial process utilizing solution recycle. The final combination of 0.64 *M* $NaHCO_3$ and 1 *M* NaCl is the maximum solubility of the two compounds in water at ambient conditions. Although higher concentrations were demonstrated to be technically feasible at the elevated P and T utilized, excessive losses of the dissolved salts to the solids would likely occur during post-carbonation gas/solid/liquid separation. The latter must occur at temperatures well below 100°C to permit recycle of a water-vapor-free CO_2 stream, which would lead to precipitation of some portion of the salts. Conservative solution concentrations were used in these tests, recognizing that room was available for further refinement of the carrier solution.

Carrier Solution pH: To further investigate the impact of pH on the complex mineral-dissolution and carbonate-precipitation sequence, a series of tests was conducted over a pH range of 2.4 to 12.3. The pre- and post-test solution pH and descriptions of the various carrier solutions for several tests are included in Table VII.

Table VII. Carrier solution, pH and R_X[1].

Solution pH		Carrier solution	R_X
Initial	Final		
2.36	7.08	1 *M* NaCl (1 ml 100 g/L HCl)	45
5.89	7.22	1 *M* NaCl	47
7.88	7.99	0.64 *M* $NaHCO_3$, 1 *M* NaCl	83
9.49	8.04	0.25 *M* $NaHCO_3$, 0.25 *M* Na_2CO_3, 1 *M* NaCL	80
11.02	7.79	0.5 *M* Na_2CO_3, 1 *M* NaCl	79
12.25	7.26	4.5 g/L NaOH, 1 *M* NaCl	49

[1] Test conditions: heat treated antigorite serpentine; T = 185°C, pCO_2 = 115 atm, 3 hours.

In each case, solution pH migrated toward that of the buffered solution (initial pH = 7.88). Solutions with the most extreme initial pH achieved the lowest R_X. In the current system, HCO_3^- appears to be the dominant dissolved CO_2 species. The essentially infinite supply of CO_2 made available to the solution by continuous three-phase mixing in the reactor apparently makes pH migration from the extremes unavoidable. Hem (1985) described the relationships among the dissolved CO_2 species and pH in a CO_2 species distribution diagram (Figure 8). Superimposed on the diagram are data points corresponding with the final solution pH versus R_X for the tests reported in Table VII. The combined diagram illustrates that in all cases the final solutions fall within the HCO_3^- region, and suggests that R_X is highest for solutions with the highest HCO_3^- concentration. For example, a final solution with a pH = 8.0 is comprised of roughly 2% H_2CO_3 (aq) [CO_2 (aq)] and 98% HCO_3^-. Because reagent make-up to maintain a more acidic or alkaline starting solution would become problematic, any benefit due to enhanced mineral dissolution rate by use of the more aggressive solution is lost.

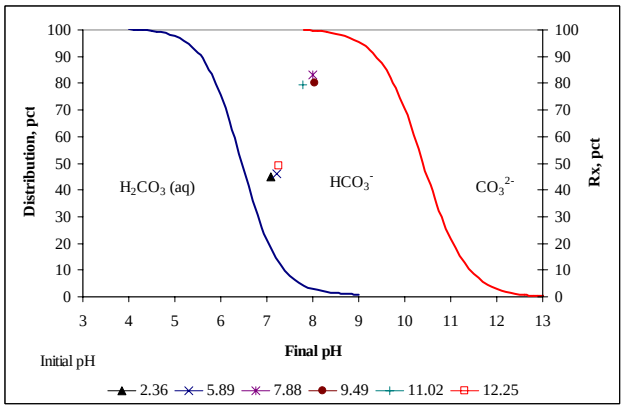


Figure 8. Carbon dioxide species distribution diagram.

Thermodynamics: To better understand the improved overall carbonation rate in the bicarbonate system, the theoretical free energies of formation for a set of stoichiometric carbonation equations were determined. These equations represent the combined mineral dissolution and carbonate precipitation reactions in the carbonic-acid (equation 15) and bicarbonate (equation 16) systems. Equation 17 shows regeneration of the $NaHCO_3$ by absorption of CO_2 and water.

$$Mg_2SiO_4 + 2CO_{2(g)} + H_2O \Rightarrow 2MgCO_3 + H_2O + SiO_2 \quad \text{Eq.15}$$

$$Mg_2SiO_4 + 4NaHCO_3 \Rightarrow 2MgCO_3 + 2Na_2CO_3 + 2H_2O + SiO_2 \quad \text{Eq.16}$$

$$2Na_2CO_3 + 2H_2O + 2CO_{2(g)} \Rightarrow 4NaHCO_3 \quad \text{Eq.17}$$

The theoretical free energies of formation were determined at 1 atm CO_2 and various temperatures using HSC thermodynamics software (1995), with the respective trends included in Figure 9. The ΔG_f for equation 16 becomes negative at roughly 150°C, which corresponds well with the favored temperature range (~150-200°C) identified for Mg-silicate carbonation. In contrast, the ΔG_f for equation 15 becomes positive at precisely the same temperature, which may help explain the dramatic improvement in overall carbonation rate in the bicarbonate-based system.

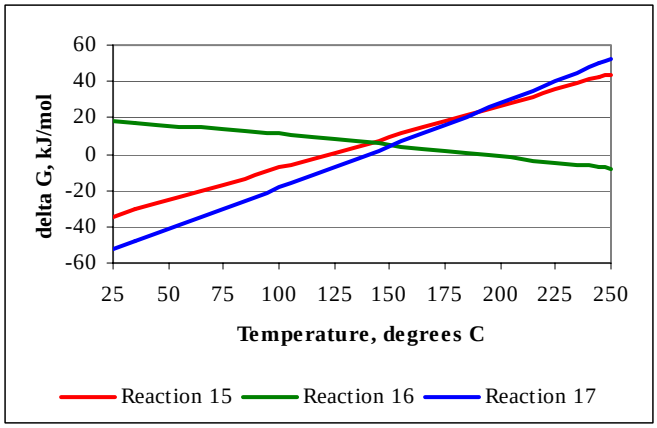


Figure 9. Gibbs free energy of formation for a selection of carbonation reactions, @ 1 atm CO_2.

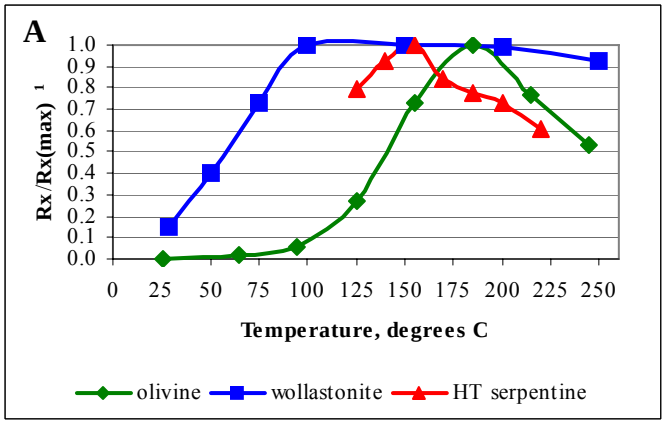
Although both equation 15 and equation 17 exhibit positive and thus unfavorable ΔG_f in the favored carbonation temperature range, it is likely that elevated P_{CO2} drives those reactions to the right. Thus, the P and T conditions used for Mg silicate carbonation may represent a favorable thermodynamic window for both the mineral carbonation and bicarbonate regeneration reactions, particularly in the bicarbonate system.

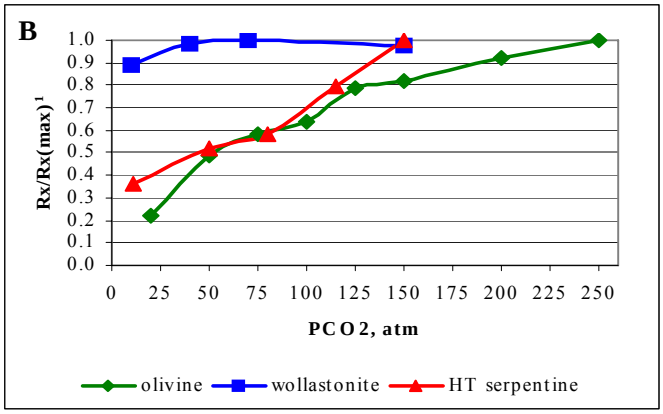
Ca-Silicate Carrier Solution: The discussion of carrier solutions thus far has referred exclusively to Mg-silicate carbonation. Tests using the Ca-silicate, wollastonite, quickly revealed a significant change in carrier-solution requirements, compared to those for the Mg-silicates. Experimental results demonstrated that Ca-silicate carbonation was not as sensitive to solution dynamics, with equivalent R_X achieved in both the carbonic acid and bicarbonate systems. This may be indicative of a relatively higher solubility for wollastonite compared to the Mg silicates used, but is more likely due to the much higher precipitation rate for calcium carbonate compared to magnesium carbonate. Pokrovsky et al. (1999) reported that magnesite ($MgCO_3$) precipitation rates are at least 4 orders of magnitude lower than those of calcite ($CaCO_3$). Thus, wollastonite carbonation may not require the ionic concentrations or CO_2 activity necessary for Mg-silicate carbonation.

Carbonation Temperature and Pressure

To better define the optimum carbonation conditions, several test series were conducted to investigate carbonation sensitivity to both temperature and P_{CO2}. Each test series was conducted at a mineral-specific set of constant carbonation conditions, while varying the critical variable of temperature or pressure, respectively. Discrepancies in the carbonation conditions were ignored where they do not impact the relative trends. For example, the carbonation tests were conducted for 3 hours on the heat-treated (HT) antigorite serpentine, but for only 1 hour on the olivine and wollastonite; this was necessary to achieve distinguishable reaction efficiencies at the lower P and T conditions. The relative R_X trends exhibited for each mineral series are most critical, rather than comparisons of the maximum achieved R_X between minerals. Thus, the R_X values were normalized by dividing the measured R_X by the maximum R_X achieved in that series, to eliminate mineral-specific variations due in part to differing pretreatment methodologies, carbonation carrier solutions, and/or P and T. The normalized carbonation temperature and P_{CO2} sensitivity diagrams are included in Figures 10A and 10B. Actual R_X values test parameters are included in the complete compilation of results in Appendices A through F.

Perhaps most striking about the sensitivity diagrams is the different trends exhibited by the Mg-silicate minerals compared to the Ca-silicate mineral. In Figure 10A, both the olivine and heat-treated serpentine show a sharp peak in R_X at specific carbonation temperatures, 185°C and 155°C, respectively. In contrast, the wollastonite R_X increases at a similar rate until a minimum threshold temperature (100°C) is reached, above which the R_X remains nearly constant over a broad temperature range. Because the carbonation process includes two distinct reactions, mineral dissolution followed by carbonate precipitation, temperature plays a complex role. Dissolution kinetics improve with increasing temperature,





[1] *$R_{X\,(max)}$ for each mineral was achieved at specific conditions used for each series, which were not optimized.*

Figure 10A. Carbonation temperature sensitivity diagram.

Figure 10B. Carbonation P_{CO2} sensitivity diagram.

but carbonate precipitation is retarded at higher temperatures due to reduced CO_2 activity. Bischoff and Rosenbauer (1996) described a similar phenomenon regarding wallrock alteration in CO_2-charged waters as the "unreactivity of CO_2 at higher temperatures." The fact that the wollastonite is much less affected by changes in temperature is likely indicative of the much higher rate of calcite precipitation relative to magnesite.

Similarly, the mineral-specific trend plots in Figure 10B show that the Mg-silicate minerals exhibit a nearly linear increase in R_X with increasing P_{CO2}, while the wollastonite appears nearly independent of P_{CO2} above about 40 atm. These differences can again be traced to the much higher rate of calcite precipitation relative to magnesite, making wollastonite much less dependent on P_{CO2} than the Mg-silicate minerals. These trends were inferred by the mineral-specific carrier solutions as well. The best R_X for the Mg silicates was achieved in the bicarbonate system, while that for wollastonite was achieved in the carbonic-acid system. Because the former contains dramatically higher concentrations of CO_2 relative to the latter, the improved R_X for Mg-silicate

carbonation may suggest that CO_2 activity plays a role in the Mg-silicate mineral-dissolution reaction as well.

Carbonation Material Balances

In the determination of the R_X for each of the carbonation tests, the mass of CO_2 present in the feed was subtracted from that in the product solids, and the net CO_2 reporting to the product solids was assumed to originate from carbonation of the silicate feed mineral. This method provided a highly accurate evaluation of the stoichiometric conversion of the silicate to the carbonate. However, it did ignore the possibility that some of the CO_2 in the product solids did not originate from the feed or from conversion of the silicate, but from the $NaHCO_3$ salts added to the carrier solution. While the amount of salt losses to the product solids was considered minimal, based on the filtration and washing methods used, some evaluation of the potential for such losses was warranted.

Following each carbonation test, the slurry was drained from the autoclave under gravity flow, then underwent pressure filtration to produce an uncontaminated solution sample for post-test analysis. The autoclave was then flushed with tap water, and the residual solids and flush water were added to the filter press for a second round of pressure filtration. The flush water acted as an effective wash for the product solids during the second filtration, but the potential existed for some carrier solution salts to remain in the filter cake, and contribute some portion of CO_2 in the solids. To investigate the potential for salt losses to the product solids during post-test solid/liquid separation, Cl was added to the analyte list for the solid feed and products for a selection of carbonation tests. The inclusion of Cl made a complete material balance over the carbonation test possible, because it could be used as a marker for salt pick-up in the product solids.

The carbonation tests selected represented each of the primary mineral reactants investigated, at varying degrees of conversion efficiency. Material balances were then calculated over each test, including the total elemental masses contributed by both the solid and liquid constituents in the slurry. The complete balances are included in Appendix G, with an explanation to follow. The results of the balances and their impact on conversion efficiencies are summarized in Table VIII below.

Table VIII. Corrected R_X for a selection of tests.[1]

Test No.	Mineral	Original R_X	Corrected R_X
SC-80	Antigorite	68.9	67.0
SC-92	Antigorite	23.5	22.2
SC-169	Lizardite	38.7	36.1
SC-387	Olivine	67.4	67.0
SC-564	Wollastonite	33.2	31.9

[1] Complete tests parameters included in Appendices A-E.

Appendix G includes the solids and solution chemistry for the feed and products from each test, as well as the material balance for each test. For simplification, test SC-387, which used the Twin sisters olivine as the silicate reactant, is used as an example. Table G7 includes the chemistry data for the feed and products. The concentrations reported in Table G7 were used to calculate the mass of each element in the feed and product components, based on the total mass of feed solids, solution, and product solids and solution. Table G8 reports the concentrations and masses for each element in the feed and product components, including oxygen, which was calculated by difference. The mass of the elements in the solids was based on the 167 g of feed used, and the total recovered solids following the test. The mass of the elements in the solutions were determined based on the total volume of the solution and the concentrations for the elements in the solution.

Summing the masses for each element in the feed solids and feed solution results in the total mass of each element in the feed slurry, which was the basis for the closure determined for each element over the test. Total mass of each element in the product solids and solution is divided by the mass for each element in the feed slurry, with the result reported in the final column of Table G8 as "Closure." Closure for the major elemental components in the solids, such as Fe, Mg, and Si, was excellent at 96.4%, 101.6%, and 97.2%, respectively. Closure for the minor constituents of the solids, such as Al, Ca, Cr, and K vary widely, at 120.2%, 245.0%, 120.7%, and 184.7%, respectively. These variations from closure (100%) are primarily due to the extremely low concentrations for these elements, and are thus not considered significant. High closure for CO_2 (348.8%) is obviously due to the addition of gaseous CO_2 to the product solids by successful carbonation. High closure for water of dehydration (201.6%) is due to incomplete drying of the filter cake. Overall, the closure for the elemental constituents is considered quite good.

The weight gains in the product solids for Cl and Na were assumed to originate from the carrier solution. Their molar concentrations were then used to determine the amount of salts from the carrier solution reporting to the product solids, based on several assumptions: (1) all Cl reporting to the solids from the solution originated as NaCl; (2) additional Na reporting to the solids (beyond that as NaCl) originated as Na_2CO_3; (3) the molar concentration of Na_2CO_3 reporting to the solids was used to calculate CO_2 reporting to the solids originating from the carrier solution. The mass of CO_2 calculated to have originated from the solution was subtracted from the total mass of CO_2 in the solids, just as the mass of CO_2 originating from the feed was subtracted from the total CO_2. Thus a modified net CO_2 mass in the solids was used to calculate the corrected conversion efficiency (R_X), which is reported in Table VIII. This exercise confirms that salt losses to the solids are minimal, and suggest that make-up to the carrier solution can be minimized.

Optimized Carbonation Conditions

Based on the empirical data presented thus far, the optimum mineral-specific carbonation conditions were derived and are reported in Table IX. These conditions are meant to represent the best-demonstrated reaction parametric space to date and not to preclude future advancements. Process considerations were also used in the evaluation. For example, although olivine R_X increases with increasing P_{CO2}, pressures above 150 atm were considered impractical, due to the limited improvement in R_X at higher P_{CO2}. The highest R_X should be achieved at these conditions and depends on the mineral pretreatment intensity. Mineral activation by more aggressive pretreatment should improve absolute R_X at these optimum carbonation conditions.

Table IX. Optimum carbonation conditions, by mineral.

Mineral	Carbonation conditions		
	T, °C	P_{CO2}, atm	Carrier solution
Olivine	185	150	0.64 *M* $NaHCO_3$, 1 *M* NaCl
Wollastonite	100	40	Distilled water
HT serpentine	155	115	0.64 *M* $NaHCO_3$, 1 *M* NaCl

PROCESS DEVELOPMENT

Mineral Carbonation History

Lackner et al. (1997a,b, 1998) provided some of the earliest discussion of mineral sequestration of anthropogenic CO_2 emissions. Together with colleagues from the Las Alamos National Laboraotry (LANL), he proposed the LANL aqueous process for mineral carbonation of serpentine ores. The LANL process is a derivation from an earlier technology developed during World War II by the Tennessee Valley Authority and U.S. Bureau of Mines for production of Mg metal from olivine. Houston and Rankin (1942) and Houston and Kerr (1945) described an HCl acid-leach process for Mg extraction, followed by electrolysis of the $MgCl_2$ leach product for metal recovery and acid regeneration. Silica gel formation during pH adjustment following the leach step was recognized as a challenge to the process, which was otherwise technically feasible but not economically favored.

The LANL process substituted a complex $MgCl_2$ dehydration and crystallization operation for the electrolytic stage of the TVA/USBM process. The crystallized $MgCl_2$ is converted to $Mg(OH)_2$ during an acid recovery step, which is followed by carbonation of the $Mg(OH)_2$. Nilsen and Hundley (1999) conducted a preliminary feasibility study of the LANL process to quantify the energy-intensive dehydration and crystallization steps. Power requirements for the sequestration operation result in a negative CO_2 balance, such that CO_2 produced by generating the energy to run the process far exceeds the CO_2 sequestered by the process. These results led to investigation of the ARC aqueous process as an alternative method for *ex situ* mineral carbonation.

Reactor Design

The ARC aqueous mineral-carbonation process has been demonstrated using a batch autoclave with continuous stirring and constant temperature and P_{CO2} capability. An industrial-scale process clearly requires continuous processing, and the elevated P and T conditions make reactor design a critical issue. Because required wall thickness for a pressure vessel is directly related to pressure and diameter, large-scale conventional autoclave reactors operating at 150 atm would be extremely thick-walled and very capital intensive. An ideal reactor design would entail minimal diameter to limit wall thickness without limiting scale. A continuous pipeline reactor meets these criteria for the current aqueous mineral carbonation process; a conceptualized view of such a reactor is shown in Figure 11.

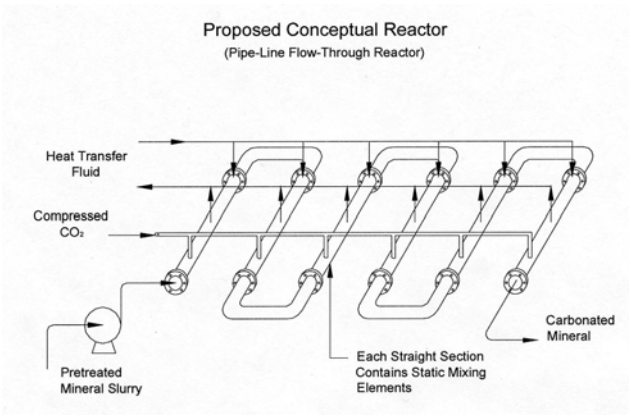


Figure 11. Conceptual pipeline reactor.

As a proof-of-concept of the pipeline reactor, a loop reactor was conceived that would permit operation in the pipeline design without the need to build a full-scale reactor. Figure 12 shows the loop reactor constructed at ARC prior to installation of insulation.

Figure 12. Laboratory-scale flow loop reactor.

Slurry is circulated for specified residence times while critical performance parameters such as three-phase mixing with static mixers, fluid flow at supercritical CO_2 pressures, and pre- and post-test slurry injection and removal are evaluated. Engineering data acquired by operation of the flow-loop reactor may be used for the design and construction of a pilot-scale continuous pipeline reactor. However, before any discussion of construction of a second-generation pipeline reactor was warranted, a feasibility study of the current aqueous mineral carbonation process was necessary.

Process Feasibility Study

The feasibility of mineral carbonation as a method for CO_2 storage has been the subject of several previous studies. The EIA (1999) commissioned an exhaustive study of several methods proposed by LANL, including the original LANL aqueous process, and several molten salt processes described by Wendt et al. (1998a,b,c). Sequestration costs were estimated at \$60-80 per ton CO_2 for the favored molten salt process, which is yet to be demonstrated, to over \$200 per ton CO_2 for the LANL aqueous process. Both methods were found to be currently untenable, due to the excessive energy demand for the aqueous process, and excessive chemical make-up volumes for the molten salt process. Energy demand for the former was determined by both the EIA study and by Nilsen and Hundley (1999) to be over 4 times the energy produced by the power plant for which the process was designed to accommodate. The latter was estimated to use nearly 1/3 of annual world HCl production for sequestration of 100% of the CO_2 emissions from a single 500-MW power station.

A second feasibility study was conducted by NEXANT (2000) for an anaerobic hydrogen/electric power generation plant with CO_2 disposal by mineral carbonation. This was the first study to include the ARC aqueous process for the mineral-carbonation step, in this case applied to serpentine carbonation. Sequestration costs were estimated at \$70 per ton CO_2, including a heat-activation step. The estimated energy demand for the heat- treatment step was much lower than that reported here, at 153 kW•h/ton compared to 293 kW•h/ton (antigorite) or 326 kW•h/ton (lizardite). The sequestration cost was calculated assuming a plant efficiency of 65% for the anaerobic hydrogen/electric power production technology, compared to a typical coal-fired power plant efficiency of 35%. Sequestration costs applied to conventional coal-fired technology were roughly \$130 per ton CO_2.

A third mineral carbonation feasibility study was commissioned by the National Energy Technology Laboratory (NETL) and completed by Lyons et al. (2003), using a preliminary process design and basis developed at ARC by Nilsen and Penner (2001). A steady-state simulation of the process was created in Aspen® process simulation software, from which capital- and operating-cost estimates were generated. This study evaluated an olivine-based mineral-carbonation process scaled for the sequestration of 100% of the CO_2 emissions from a 1.3 GW coal-fired power plant. Olivine was selected as the mineral reactant in part to simplify the process by eliminating the heat-pretreatment stage. The process flow diagram is shown in Figure 13.

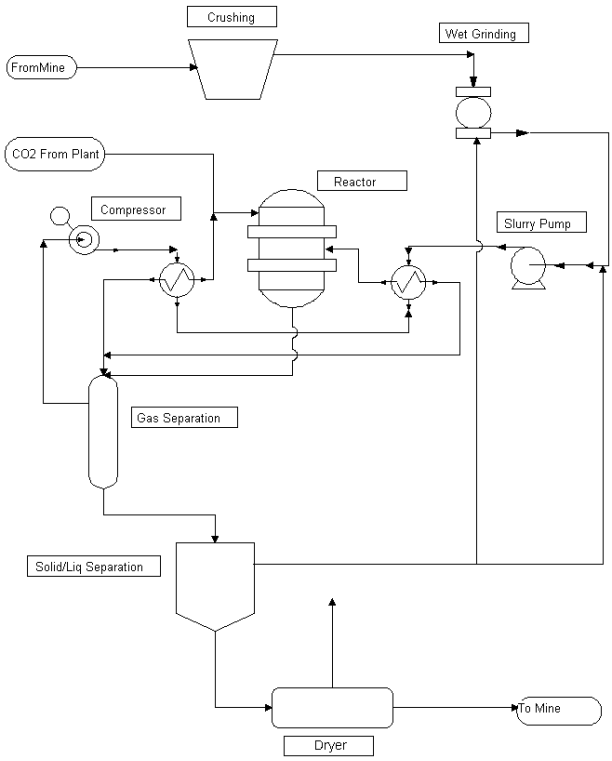


Figure 13. Aqueous mineral carbonation process flow diagram.

Because the proposed pipeline reactor design referred to above was unproven at the time, a conservative approach was adopted and conventional continuous-flow leach-type autoclave reactors were selected for the study (Figure 14).

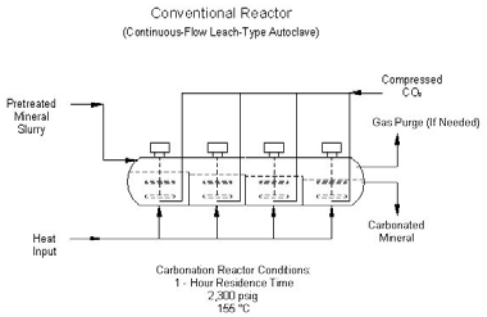


Figure 14. Conventional reactor design used in feasibility study.

The impact of the conventional reactor design on the process economics is significant. The design required 12-foot diameter vessels with 14-inch thick walls, which accounted for roughly 50% of total capital costs. Additional assumptions and selected bases for the feasibility study follow:

- Olivine is the mineral reactant, with an ore grade of 100% and MgO concentration of 49 wt pct;
- Olivine ore is ground to 80% minus 400 mesh (37 microns);
- 65% reaction efficiency (R_X) with each pass through the process;
- 60% of the unreacted olivine from the products is separated at 20 μm size and recycled;
- Twin Sisters olivine (Region 1) is utilized for the process, with the sequestration plant located next to the mine site;
- The mining operation is open pit, and the process products re-deposited in the depleted pits;
- CO_2 is transported to the plant via pipeline (CO_2 separation costs are not included in mineral sequestration cost estimates);
- Carbonation conditions include: 2 hour residence time; T = 185°C; P_{CO2} = 150 atm; P_{H2O} = 6.5 atm; 30% solids; carrier solution = 0.64 *M* $NaHCO_3$, 1 *M* NaCl.

The NETL study evaluated sequestration of approximately 1,100 tons of CO_2 per hour, requiring roughly 2,500 tons of virgin olivine ore plus an additional 800 tons of olivine from an unreacted product recycle loop every hour. Power requirements total 352 MW, with nearly 75% of the total power required for the ore-grinding operations. This power represents a 27% energy penalty on the power plant for which the sequestration operation was designed. Sensitivity analyses were conducted to evaluate the impact of reduced reactor residence time and P_{CO2} on the overall sequestration cost and energy demand. These results were used to derive the carbonation costs for the alternative mineral feedstocks described in this report, as well as the overall carbonation costs and CO_2 balance by mineral-carbonation region.

Carbonation Costs

The final carbonation cost determined in the NETL feasibility study was $69 per ton CO_2 sequestered for the baseline olivine process described above. This baseline process applies directly to ultramafic mineral carbonation in Region 1, as described in Table II. However, the R_X reported in the subject study were achieved in 1-hour reactor residence times rather than the 2-hour residence time assumed for the NETL study. Thus, the sequestration cost was lowered to $54 per ton CO_2, based on the reactor residence-time sensitivity analysis. Dividing the modified sequestration cost of $54 per ton CO_2 by the ore demand value (R_{CO2}/R_X) for the ore in Region 1 results in a cost of ~$18 per ton ore. It was necessary to derive the sequestration cost per ton of ore in order to account for variations in the pretreatment operations, which are mineral-specific and are reported as an energy cost per ton of ore in Table IV. This made it possible to determine an adjusted carbonation cost, including the pretreatment and sequestration costs, for each of the ultramafic mineral-carbonation regions defined in Table II. Multiplying the final adjusted cost per ton of ore by the calculated total ore demand (Table II) provides the total carbonation cost for each region. Dividing the total calculated regional CO_2 emissions (Table II) by the total carbonation costs provides the carbonation cost per ton of CO_2 sequestered. Using this method, the estimated carbonation costs were determined for each ultramafic mineral carbonation region and are reported in Table X. Several key parameters for each region are repeated from Table II for reference. The adjustments made to account for variations in ore grade, grinding intensity, and carbonation conditions were mineral- and/or region-specific and are described below.

The sequestration costs for wollastonite ore in Region 7 were reduced by $5 per ton ore (to $13 per ton ore) due to the lower P_{CO2} (40 atm) utilized in the reactor, based on the P_{CO2} sensitivity analysis included in the NETL study. However, the pretreatment costs for the wollastonite ore were adjusted for the beneficiation process required due to the lower grade of ore. The size and magnetic separation processes used to produce a wollastonite concentrate were estimated to incur an energy penalty of 4 kW•h/ton ore. Because the beneficiation processes were assumed to be conducted at minus 200-mesh (75 μm) particle size, the grinding costs to that stage increase accordingly, adding 10 kW•h /ton ore to the pretreatment costs. Using the electricity cost of $0.054 per kW•h cited in the NETL study as a basis, the final adjusted carbonation cost is approximately $14 per ton ore. For simplicity, this adjustment ignores capital costs for the beneficiation operation. Similar adjustments due to lower ore grade and the required beneficiation costs were made for the olivine ores in Region 5, for a final adjusted sequestration cost of $19 per ton ore.

The non-heat-treated serpentine ores (Regions 2-4, 6) were ground to 80% minus 200-mesh (75 μm), a savings of approximately 70 kW•h/ton of ore compared to the finer grind assumed for the NETL study. Thus, the final adjusted sequestration cost for the non-heat-treated serpentine ores is roughly $15 per ton ore.

Table X includes two sets of carbonation costs. The first set is for what has been termed standard pretreatment, with the associated costs described above. The second set of carbonation costs refers to the activated pretreatment methodologies, which were defined previously in the discussion for Table II. Ultrafine grinding was utilized for activation of the olivine and wollastonite ores and/or concentrates, while heat-

Table X. Annual coal consumption, energy generation, CO_2 emissions, ore requirements, and carbonation costs by ultramafic mineral carbonation Region.

Region	Coal, Mt	Heat value, Btu/lb[1]	Energy, GW•h (x 1000)	CO_2 seq., Mt[2]	Ore demand, Mt		Sequestration costs							
							$/ton ore[3]		$, billions		$/ton CO_2 seq.		$/kW•h	
					std.	act.	std.	act.	std.	act.	std.	act.	std.	act.
1	7	12300	18	18	53	40	18	26	1.0	1.1	54	59	0.06	0.06
2	4	11030	9	10	302	64	15	44	4.4	2.0	427	199	0.49	0.23
3	4	11030	9	10	303	71	15	44	4.4	2.3	427	222	0.49	0.25
4	31	11360	72	72	2117	446	15	44	30.7	14.3	427	199	0.43	0.20
5	69	13080	184	187	552	416	19	27	10.3	11.1	55	59	0.06	0.06
6	85	13080	220	231	3971	527	15	48	57.7	17.9	250	78	0.26	0.08
7	28	13080	75	76	492	259	14	19	6.9	4.8	91	64	0.09	0.06
Total	228		587	604	7790	1823	15	37	115.4	53.7	191	89	0.20	0.09

[1] As-fired coal heat value based on primary coal used in each Region, after Babcock & Wilcox (1998).
[2] Total CO_2 emissions based on coal consumption and carbon content by region (Table II); CO_2 sequestered assumes sequestration of 100% of emissions.
[3] Carbonation cost per ton of ore, derived from NETL feasibility by Lyons et al. (2003), with adjustments described in text.

treatment was utilized for activation of the serpentine ores. The grinding energy necessary to grind beyond the 400-mesh (37 μm) size assumed in the NETL study, or the energy required to add a heat-treatment step for the serpentine ores, was reported in Table IV. Using these energies and the $0.054 per kW•h basis from the NETL study, the adjusted carbonation costs per ton ore and per ton CO_2 were calculated. As described above, the adjustments to the pretreatment costs ignore capital costs for the processing equipment, thus the costs here are lower than would be expected. While it is recognized that these costs could be significant, perhaps as high as the operating costs, proper scaling of equipment would require separate feasibility studies for each Region that are not considered practical at this time. They may not be necessary, because the estimated values included in Table X are intended to provide a relative comparison of carbonation costs between mineral reactants and carbonation Regions, rather than absolute carbonation costs.

DISCUSSION

Carbonation Costs

The carbonation cost summary in Table XI illustrates the complex relationship between mineral reactivity, degree of pretreatment, ore demand, and ultimate costs. For example, the ore demand is decreased by roughly 75% for all seven Regions with the addition of the activation step, which more than doubles the cost per ton of ore but reduces the total sequestration cost by over half. The addition of the activation step also reduces the mean sequestration cost for all seven Regions, from $191 to $89 per ton CO_2 sequestered, and cut the cost per kW•h in half to $0.09 per kW•h.

The lowest costs were found for the standard pretreatment olivine ores from Regions 1 and 5, at $54 and $55 per ton CO_2 sequestered, respectively. These costs increased by roughly $5 per ton CO_2 with the addition of the activation step. Considering the mineral resources described previously for each region, the activation step would only be recommended for the Region-5 olivine ore, due to its limited availability.

The wollastonite ore from Region 7 that was activated by ultrafine grinding has the second lowest carbonation cost, at $64 per ton CO_2 sequestered. The wollastonite exhibited greater reactivity than any of the other minerals, but its higher R_{CO2} value and lower ore grade, and the ultrafine grinding activation step resulted in slightly higher costs than the olivine ores. However, even with the activation step, the limited wollastonite resource in Region 7 makes it unlikely that the ore could support an *ex situ* mineral-carbonation operation without a significant increase in proven ore reserves.

Of the four regions utilizing serpentine as the mineral reactant, only the antigorite ore from Region 6 has carbonation costs reasonably close to those for the olivine and wollastonite ores. The heat-activated antigorite ore has a carbonation cost of $78 per ton CO_2 sequestered. This is roughly 35-40% of the cost for the heat-activated lizardite ores from Regions 2-4, and suggests that only the Region 6 serpentine could be reasonably considered for mineral carbonation, with the current process developments, based on economics alone.

CO_2 Balance

The total energy generation by region reported in Table XI was included for calculation of the carbonation cost per kW·h, and it was also necessary to determine the net CO_2 avoided by the mineral-carbonation process. The NETL study determined a total energy demand of 352 MW for the baseline process. This baseline value was adjusted to account for the lower energy consumption required for the 1-hour carbonation residence times (all minerals), lower P_{CO2} utilized for wollastonite

carbonation, and the coarser particle size used for the non-heat-treated serpentine ores. The adjusted energy-consumption figures are reported by region in Table XI, in GW·h per Mt CO_2 sequestered. The energy consumption required for the mineral-specific pretreatment activation steps is also reported in Table XI. The sum of the two is the total mineral carbonation energy consumption for the activated ores.

Assuming the energy required for the mineral-carbonation process was supplied by the same coal-fired power plants generating the CO_2 to be sequestered, the CO_2 generated by the mineral-carbonation process can be calculated. Subtracting the latter from the total CO_2 sequestered results in the net CO_2 avoided (Table XI). The CO_2 avoided with the standard pretreatment methodology for all seven regions, is roughly 76% of the total CO_2 sequestered. Carbonation costs increase accordingly, to roughly \$80 and \$112 per ton of CO_2 avoided for the two olivine ores and the wollastonite ore, respectively. Carbonation costs for the non-heat-activated antigorite and lizardite serpentine ores increase to roughly \$300 and \$500 per ton CO_2 avoided.

Table XI. Energy consumption for the mineral carbonation process, with derived CO_2 avoided.

Region	Energy, GW•h (x1000)	CO_2 seq., Mt[1]	Energy consumption, GW•h/Mt CO_2 seq.			CO_2 avoided, Mt		Carbonation cost, \$/t CO_2 avoided	
			std.[2]	act.[3]	Total	std.	act.	std.	act.
1	18	18	300	333	633	13	7	78	167
2	9	10	180	2022	2202	8	0	537	NC
3	9	10	180	2251	2431	8	0	538	NC
4	72	72	180	2022	2202	59	0	521	NC
5	184	187	320	333	653	126	63	81	173
6	220	231	180	829	1009	187	0	309	NC
7	75	76	190	239	429	62	43	112	110
Total	587	604				463	112	249	479

[1] Total CO_2 emissions based on coal consumption and carbon content by Region (Table II), CO_2 sequestered assumes sequestration of 100% of said emissions.
[2] Energy consumption for complete sequestration operation, including energy for standard pretreatment methodology and carbonation energy derived from White (2003).
[3] Energy for activated pretreatment methodology, mechanical or thermal (from Table IV).

Inclusion of the activation steps dramatically lowers the CO_2 avoided and essentially eliminates the heat-activated serpentine ores from consideration. Inclusion of the heat-activation step results in negative CO_2 avoided, which means more CO_2 is generated than sequestered by the process. The ultrafine grinding step used to activate the olivine and wollastonite more than doubles the olivine carbonation cost, but has little impact on that of the wollastonite. The reason for the latter lies in the lower total energy consumption required for the activated wollastonite compared to the activated olivine. Because the two activated minerals have nearly identical R_X, the lower energy consumption for the activated wollastonite outweighs its higher R_{CO2} and results in a lower carbonation cost compared to the olivine ores. These results suggest that inclusion of an activation step may be warranted for the wollastonite ore but not recommended for the olivine ores, while heat activation of the serpentine ores is not tenable.

Recoverable Values

During the pilot-scale comminution tests conducted on the olivine and serpentine ores, a wet magnetic-separation step was successfully demonstrated on the minus 200-mesh (75 µm) ground product. A magnetic concentrate representing approximately 5% of the total ground product, with a total iron-oxide grade of roughly 55 wt pct, was produced from each of the serpentine ores. Using the ore demand figures for Regions 2-4 and 6 and the demonstrated magnetic fraction from the pilot-scale tests, the total iron-ore tonnage was calculated and reported in Table XII. Assuming an iron-ore value of approximately \$30 per ton, the by-product iron concentrate represents an annual revenue value of approximately \$10 billion for the non-heat-activated serpentine ores, and nearly \$2 billion for the activated ores, which would be mined at significantly lower tonnages. This results in modest savings of about \$0.01 per kW•h for the carbonation cost of the serpentine ores, but does little to offset the unfavorable CO_2 balance resulting from the low reactivity of the non-heat activated ores, or the excessive energy consumption required for the heat- activation step.

Table XII. By-product iron ore value.

Region	Iron ore, Mt		\$, billions[1]		\$/kW•h	
	std.	act.	std.	act.	std.	act.
1	-	-	-	-	-	-
2	15	3	0.5	0.1	0.44	0.22
3	15	4	0.5	0.1	0.44	0.24
4	105	22	3.1	0.7	0.39	0.19
5	-	-	-	-	-	-
6	198	26	5.9	0.8	0.24	0.08
7	-	-	-	-	-	-
Total	335	55	10.0	1.7		

[1] Iron ore value based on \$30 per ton.

CONCLUSION

Carbon dioxide sequestration by an aqueous mineral carbonation process was demonstrated in laboratory-scale batch autoclave tests, using three primary silicate-mineral reactants. These reactants, generally characterized from most reactive to least reactive, include the Ca-silicate wollastonite, Mg-silicate olivine, and hydrated Mg-silicate serpentine. The studies conducted on the Mg-silicate olivine provided the basis for a process feasibility study, which determined a carbonation cost of $69 per ton of CO_2 sequestered. The study included sensitivity analyses for carbonation reactor residence time and P_{CO2}, which were utilized to adjust the carbonation costs for more recently developed mineral-specific process improvements. The adjusted carbonation cost for the baseline olivine process is $54 per ton of CO_2 sequestered.

An energy requirement of 352 MW was determined for a process scaled for the sequestration of 100% of the CO_2 emissions from a 1.3-GW coal-fired electric generation plant (1,100 tons CO_2 per hour). After accounting for the sequestration energy demand, CO_2 avoided was 72% of the total CO_2 sequestered, at a cost of $78 per ton of CO_2 avoided.

Seven ultramafic mineral carbonation regions, located primarily along both coasts of the conterminous U.S, were identified in the course of the studies. Carbonation costs for the seven regions ranged from $89 to $191 per ton of CO_2 sequestered, at an energy cost of $0.09 to $0.20 per kW•h, depending on the intensity of mineral-pretreatment operations. The CO_2 avoided for all seven Regions was 76% of the CO_2 sequestered, when using standard pretreatment methodologies.

The studies included an investigation of mineral availability in the seven carbonation regions identified. Total coal-fired electric generation CO_2 emissions within these regions account for roughly ⅓ of the U.S. total, and would require 1.8 to 7.8 Gt per year of silicate ore to carbonate 100% of the emissions, depending on the degree of mineral pretreatment utilized. Two regions utilized olivine, four utilized serpentine, and one utilized wollastonite as the mineral reactant. However, mineral availability followed a reverse trend compared to reactivity, with the order from most abundant to least abundant being serpentine, olivine, and finally wollastonite. Based on ore demand calculations made as part of the study, current resource estimates for wollastonite could not support the regional ore demand, and only one of the regions utilizing olivine could meet the demand for a significant time. Serpentine resources likely exceed the ore demands in three of the four regions but would require dozens of mines on the scale of 50 kt per day to meet the regional demand.

Effective thermal and mechanical mineral activation methodologies were identified that could decrease ore demand by up to 75%. However, energy-consumption determinations for both activation methodologies dramatically impact the process economics and CO_2 balance. Mechanical activation of olivine is not recommended, primarily because it reduces the CO_2 avoided by nearly 50%, and sufficient mineral resources are available in the one region to meet the ore demand without the activation step. However, mechanical activation of wollastonite is recommended, due to its limited availability and the improvement in process economics and minimal impact on CO_2 avoided by inclusion of the activation step. Serpentine carbonation costs were reduced to roughly $78 per ton of CO_2 sequestered, at an energy cost of $0.08 per kW•h, with inclusion of a heat-treatment step. However, thermal activation of serpentine, while extremely effective, results in more CO_2 generated than is sequestered by the process, making it an impractical methodology. These calculations assume no heat recovery from the thermal activation step, but plausible heat recovery would be unlikely to dramatically alter the CO_2 balance.

Based on the results of these studies, olivine and wollastonite exhibit the best potential for utilization in an industrial mineral-carbonation process. Current mineral-resource estimates indicate that only olivine could meet the regional ore demands. While serpentine availability makes it the most attractive mineral reactant, having the broadest occurrence and the greatest abundance, current process developments have been unsuccessful at activating the serpentine without a heat-treatment step. The latter can not be supported due to excessive energy demands. Utilization of serpentine may yet find promise as a reactive matrix for geological sequestration, where reaction rate would be defined on the order of years rather than minutes. Preliminary studies of simulated in situ mineral carbonation of serpentine minerals show promise, and may point to viable application of the experience gained from the *ex situ* studies.

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Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-1	FGO	screened commercial product	106x75	
SC-2	FGO	screened commercial product	106x75	
SC-3	FGO	screened commercial product	106x75	
SC-4	FGO	screened commercial product	53x37	
SC-5	FGO	screened commercial product	106x75	
SC-6	FGO	screened commercial product	106x75	
SC-7	FGO	screened commercial product	106x75	
SC-8	FGO	screened commercial product	106x75	
SC-9	FGO	screened commercial product	106x75	
SC-10	FGO	screened commercial product	53x37	
SC-11	FGO	screened commercial product	53x37	
SC-12	FGO	screened commercial product	53x37	
SC-13	FGO	screened commercial product	53x37	
SC-14	FGO	screened commercial product	106x75	
SC-15	Syn. Mg2SiO4		-45	99-P363
SC-16	FGO	screened commercial product	-37	
SC-17	FGO	screened commercial product	53x37	
SC-18	Syn. Mg2SiO4		-45	99-P363
SC-19	FGO	screened commercial product	-37	
SC-20	FGO	screened commercial product	-37	
SC-21	FGO	screened commercial product	-37	
SC-22	FGO	screened commercial product	-37	
SC-23	FGO	screened commercial product	-37	
SC-24	FGO	screened commercial product	53x37	
SC-25	FGO	screened commercial product	-37	
SC-26	FGO	screened commercial product	-37	
SC-27	FGO	screened commercial product	-37	
SC-28	FGO	screened commercial product	-37	
SC-29	FGO	screened commercial product	-37	
SC-30	FGO	screened commercial product	150x106	99-T601
SC-31	FGO	screened commercial product	150x106	99-T601
SC-32	CHA		-37	99-T2094
SC-33	CHA		-37	99-T2094
SC-34	CHA		-37	99-T2161

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-35	CHA		-37	99-T2189
SC-36	CHA		-37	99-T2189
SC-37	CHA		-37	99-T2206
SC-38	CHA		-37	99-T2206
SC-39	CHA		-37	99-T2206
SC-40	FGO	screened commercial product	-37	
SC-41	CHA		-37	
SC-42	FGO		-37	
SC-43	FGO		-37	
SC-44	CHA		-37	
SC-45	CHA		-37	
SC-46	CHA		-37	
SC-47	CHA		-37	
SC-48	CHA		-37	
SC-49	CHA		-37	
SC-50	CHA		-37	00-T171
SC-51	DBO		-37	00-T177
SC-52	DBO		-37	00-T177
SC-53	CHA		-37	00-T171
SC-54	CHA		-37	00-T171
SC-55	Mg(OH)2		-37	00-T202
SC-56	Mg(OH)2		-37	00-T202
SC-57	FGO		-75	00-T224
SC-58	CHA		-37	00-T171
SC-59	CHA		-37	00-T171
SC-60	DBO		-37	00-T177
SC-61	DBO		-37	00-T177
SC-62	SWOL NM		-37	
SC-63	CHA		-37	00-T171
SC-64	CHA		-37	00-T171
SC-65	CHA		-37	00-T171
SC-66	CHA		-37	00-T171
SC-67	CHA		-37	00-T171
SC-68	CHA		-37	00-T171

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-69	CHA		-37	00-T171
SC-70	CHA		-37	00-T171
SC-71	CHA		-37	00-T171
SC-72	CHA		-37	00-T171
SC-73	CHA		-37	00-T171
SC-74	CHA		-37	00-T171
SC-75	CHA		-37	00-T171
SC-76	CHA		-37	00-T171
SC-77	CHA		-37	00-T171
SC-78	CHA		-37	00-T171
SC-79	CHA		-37	00-T171
SC-80	CHA		-37	00-T171
SC-81	CHA		-37	00-T728
SC-82	CHA		-37	00-T728
SC-83	CHA		-37	00-T728
SC-84	CHA		-37	00-T728
SC-85	CHA		-37	00-T728
SC-86	CHA		-37	00-T728
SC-87	CHA		-37	00-T728
SC-88	CHA		-37	00-T728
SC-89	CHA		-37	00-T728
SC-90	CHA		-37	00-T728
SC-91	CHA		-37	00-T728
SC-92	CHA		-37	00-T728
SC-93	CHA		-37	00-T728
SC-94	CHA		-37	00-T728
SC-95	CHA		-37	00-T728
SC-96	CHA		-37	00-T728
SC-97	CHA		-37	00-T728
SC-98	CHA		-37	00-T728
SC-99	CHA NM		-37	
SC-100	CHA NM		-37	
SC-101	CHA		-37	00-T728
SC-102	CHA		-37	00-T728

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-103	CHA NM		-37	00-T956
SC-104	CHA NM		-37	00-T956
SC-105	CHA		-37	00-T728
SC-106	CHA		-37	00-T728
SC-107	CHA		-37	00-T728
SC-108	CHA		-37	00-T728
SC-109	CHA		-37	00-T1088
SC-110	Transite		-850	00-T1160
SC-111	FGO		53x37	00-T1247
SC-112	FGO		53x37	00-T1247
SC-113	FGO		53x37	00-T1247
SC-114	FGO		-37	
SC-115	CHA NM		-150	
SC-116	CHA NM		-75	
SC-117	UM98-01A1 Serp			
SC-118	CHA NM		-37	
SC-119	CHA NM		-37	
SC-120	CHA NM		-37	
SC-121	CHA NM		-37	
SC-122	CHA NM		-37	
SC-123	CHA NM		-37	
SC-124	CHA NM		-75	
SC-125	CHA NM		-75	
SC-126	CHA NM		-150	
SC-127	CHA NM		-150	
SC-128	CHA NM		-75	
SC-129	FGO NM		-37	
SC-130	CHA NM PP	pilot plant circuit w/mag sep	-75	00-T1739
SC-131	CHA NM PP	pilot plant circuit w/mag sep	-75	00-T1739
SC-132	CHA NM PP	pilot plant circuit w/mag sep	-75	00-T1739
SC-133	CHA NM PP	pilot plant circuit w/mag sep	-75	00-T1739
SC-134	FGO		-75	00-T2017
SC-135	FGO		-75	00-T2017
SC-136	FGO		-75	00-T2017

Appendix A1: Sample ID and Grinding History - Stage 1

Test	Material	Size Reduction - Stage 1		
		Stage 1	Particle size, um	LIMS No.
SC-137	FGO		-75	00-T2017
SC-138	FGO		-75	00-T2017
SC-139	FGO		-75	00-T2017
SC-140	FGO		-75	00-T2017
SC-141	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-142	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-143	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-144	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-145	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-146	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-147	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-148	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-149	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-150	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-151	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-152	FGO		-25	00-T2184
SC-153	CHA B2 NM	pilot plant circuit w/mag sep	-25	00-T2188
SC-154	SWOL NM		-25	00-T1737
SC-155	FGO		-75	00-T2017
SC-156	FGO		-75	00-T2017
SC-157	FGO		-75	00-T2017
SC-158	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-159	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-160	FGO		-75	00-T2017
SC-161	FGO		-75	00-T2017
SC-162	FGO		-75	00-T2017
SC-163	SWOL NM		-75	00-T1737
SC-164	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-165	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-166	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-167	SWOL NM		-75	00-T1737
SC-168	SWOL NM		-75	00-T1737
SC-169	SWOL NM		-75	00-T1737
SC-170	SWOL NM		-75	00-T1737

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-171	SWOL NM		-75	00-T1737
SC-172	TSO		-75; D50 = 22	01-T264
SC-173	TSO		-75; D50 = 22	01-T264
SC-174	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-175	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-176	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-177	FGO		-75	00-T2017
SC-178	SWOL NM		-75	00-T1737
SC-179	SWOL NM		-75	00-T1737
SC-180	FGO		-75	00-T2017
SC-181	TSO		-75; D50 = 22	01-T264
SC-182	FGO		-75	00-T2017
SC-183	FGO		-75	00-T2017
SC-184	FGO		-75	00-T2017
SC-185	FGO		-75	00-T2017
SC-186	FGO		-75	00-T2017
SC-187	FGO		-75	00-T2017
SC-188	FGO		-75	00-T2017
SC-189	FGO		-75	00-T2017
SC-190	FGO		-75	00-T2017
SC-191	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-192	FGO		-75	00-T2017
SC-193	FGO		-75	00-T2017
SC-194	LANL CA Serp		-75	01-T544
SC-195	FGO		-75	00-T2017
SC-196	FGO		-75	00-T2017
SC-197	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-198	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-199	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-200	SWOL NM		-75	00-T1737
SC-201	LANL CA Serp		-75	01-T544
SC-202	CHA B2 NM	pilot plant circuit w/mag sep	-75	01-T663
SC-203	CHA B2 NM	pilot plant circuit w/mag sep	-75	01-T663
SC-204	CHA B2 NM	pilot plant circuit w/mag sep	-75	01-T663

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-205	CHA B2 NM	pilot plant circuit w/mag sep	-75	01-T663
SC-206	SWOL NM		-75	00-T1737
SC-207	CHA B2 NM	pilot plant circuit w/mag sep	-75	01-T663
SC-208	SWOL NM		-75	00-T1737
SC-209	FGO		-75	00-T2017
SC-210	FGO	composite product from SC-183 - SC-186	+20	01-T755
SC-211	FGO	composite product from SC-183 - SC-186	+20	01-T755
SC-212	FGO	composite product from SC-183 - SC-186	-20	01-T756
SC-213	FGO		-75	00-T2017
SC-214	FGO		-75	00-T2017
SC-215	SWOL NM		-75	00-T1737
SC-216	FGO		-75	00-T2017
SC-217	SWOL NM		-75	00-T1737
SC-218	FGO		-75	00-T2017
SC-219	FGO		-75	00-T2017
SC-220	FGO		-75	00-T2017
SC-221	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-222	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-223	CHA B2 NM	pilot plant circuit w/mag sep	-75	00-T1739
SC-224	FGO		-75	00-T2017
SC-225	FGO		-75	00-T2017
SC-226	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-227	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-228	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-229	CHA B2 NM		-75	01-T663
SC-230	DBO		-38	00-T177
SC-231	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-232	TSO - CS		-75	01-T1334
SC-233	DBO		-38	00-T177
SC-234	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-235	TSO - CS		-75	01-T1334
SC-236	TSO - CS		-75	01-T1334
SC-237	TSO - CS		-75	01-T1334
SC-238	TSO - CS		-75	01-T1334

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-239	TSO - CS		-75	01-T1334
SC-240	TSO - CS		-75	01-T1334
SC-241	TSO - CS		-75	01-T1334
SC-242	TSO - CS		-75	01-T1334
SC-243	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-244	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-245	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-246	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-247	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-248	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-249	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-250	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-251	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-252	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-253	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-254	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-255	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-256	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-257	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-258	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-259	FGO		-75	01-T1971
SC-260	FGO		-75	01-T1971
SC-261	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-262	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-263	FGO		-38	01-T1984
SC-264	FGO		-38	01-T1984
SC-265	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-266	FGO		-38	01-T1997
SC-267	FGO		-38	01-T1997
SC-268	FGO		-38	01-T1997
SC-269	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-270	FGO	composite +20 um product from SC-263-264, 266-268	+20	01-T2185
SC-271	FGO	composite +20 um product from SC-263-264, 266-268		01-T2185
SC-272	TSO - PP NM	pilot plant circuit w/mag sep	-75	

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-273	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-274	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-275	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-276	DBO		-38	
SC-277	DBO		-38	
SC-278	SWOL NM		-75	
SC-279	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-280	CHA B2 NM	pilot plant circuit w/mag sep	-75	
SC-281	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-282	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-283	SWOL NM		-75	
SC-284	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-285	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-286	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-287	FGO		-75	00-T2017
SC-288	FGO		-75	00-T2017
SC-289	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-290	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-291	FGO		-75	00-T2017
SC-292	Ivtek magnetite		-75	01-T2388
SC-293	SWOL NM		-75	00-T1737
SC-294	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-295	TSO		-75	
SC-296	TSO		-75	
SC-297	TSO		-75	
SC-298	TSO		-75	
SC-299	TSO		-75	
SC-300	TSO		-75	
SC-301	TSO		-75	
SC-302	TSO		-75	
SC-303	TSO		-75	
SC-304	Siletz basalt		-75	01-T2314
SC-305	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-306	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-307	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-308	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-309	PennMD Serp		-75	
SC-310	PennMD Serp		-75	00-T777
SC-311	FGO		-25	
SC-312	SWOL NM		-25	
SC-313	CHA B2 NM	pilot plant circuit w/mag sep	-25	
SC-314	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-315	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-316	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-317	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-318	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-319	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-320	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-321	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-322	TSO		not sized	02-T172
SC-323	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-324	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-325	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-326	SWOL NM		-75	
SC-327	SWOL NM		-75	
SC-328	SWOL NM		-75	
SC-329	TSO		-75	
SC-330	TSO		-75	
SC-331	TSO		-75	
SC-332	TSO		-75	
SC-333	TSO		-75	
SC-334	TSO		-75	
SC-335	TSO		-75	
SC-336	TSO		-75	
SC-337	TSO		-75	
SC-338	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-339	TSO - PP NM	pilot plant circuit w/mag sep	-75	
SC-340	TSO		-75	

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-341	TSO		screened 6x10m	
SC-342	TSO		screened 6x10m	
SC-343	TSO		screened -20m	
SC-344	TSO		screened -20m	
SC-345	TSO		screened 10x14m	
SC-346	TSO		screened 14x20m	
SC-347	TSO		screened 10x14m	
SC-348	TSO		screened 14x20m	
SC-349	TSO - METSO			
SC-350	TSO - METSO			
SC-351	TSO - METSO			
SC-352	TSO - METSO			
SC-353	TSO - METSO			
SC-354	TSO - METSO			
SC-355	TSO - METSO			
SC-356	TSO - METSO			
SC-357	TSO - METSO			
SC-358	TSO - METSO			
SC-359	TSO - METSO			
SC-360	TSO - METSO			
SC-361	TSO			
SC-362	TSO			
SC-363	TSO - METSO	Metso Test 2 Product, as-received		02-T523
SC-364	TSO - METSO	Metso Test 3 Product, as-received		02-T531
SC-365	SW	as-received		02-T540
SC-366	SW	as-received		02-T540
SC-367	SW	as-received		02-T540
SC-368	SW	as-received		02-T540
SC-369	SW	as-received		02-T540
SC-370	SW	as-received		02-T540
SC-371	SW	as-received		02-T540
SC-372	SW	as-received		02-T540
SC-373	SW	as-received		02-T540
SC-374	SW	as-received		02-T540

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-375	SW	as-received		02-T540
SC-376	SWOL - HM			
SC-377	SWOL - HM			
SC-378	SW	as-received		02-T540
SC-379	SW	as-received		02-T540
SC-380	SW	as-received		02-T540
SC-381	SW	as-received		02-T540
SC-382	SWOL - HM			
SC-383	CHA - HM			
SC-384	TSO - HM			
SC-385	TSO - HM			
SC-386	SWOL - HM			
SC-387	TSO - HM			
SC-388	SWOL - HM			
SC-389	TSO - HM			
SC-390	TSO - HM			
SC-391	SWOL - HM			
SC-392	SWOL - HM			
SC-393	SWOL - HM			
SC-394	TSO - HM			
SC-395	TSO - HM			
SC-396	SWOL - HM			
SC-397	SWOL - HM			
SC-398	SWOL - HM			
SC-399	SWOL - HM			
SC-400	SWOL - HM			
SC-401	SWOL - HM			
SC-402	SWOL - HM			
SC-403	SWOL - HM			
SC-404	SWOL - HM			
SC-405	SWOL - HM			
SC-406	SWOL - HM			
SC-407	SWOL - HM			
SC-408	SWOL - HM			

Appendix A1: Sample ID and Grinding History - Stage 1

Test	Material	Size Reduction - Stage 1		
		Stage 1	Particle size, um	LIMS No.
SC-409	TSO			
SC-410	TSO			
SC-411	TSO - METSO			
SC-412	CRB 18			
SC-413	CRB 18			
SC-414	CRB 18			
SC-415	CRB 18			
SC-416	Sumpter Talc			
SC-417	Sumpter Talc			
SC-418	SWOL - HM			
SC-419	SWOL - HM			
SC-420	SWOL - HM			
SC-421	SWOL - HM			
SC-422	Syn. Fe2SiO4			
SC-423	TSO - HM			
SC-424	Syn. Fe2SiO4			
SC-425	TSO - HM			
SC-426	SWOL - HM			
SC-427	CRB 6			
SC-428	Labradorite			
SC-429	TSO - HM			
SC-430	TSO - HM			
SC-431	TSO - HM			
SC-432	Augite (Wards)			
SC-433	Augite (Wards)			
SC-434	Anorthite (Wards)			
SC-435	CRB 7			
SC-436	TSO - HM			
SC-437	CRB 7			
SC-438	TSO - HM			
SC-439	TSO - HM			
SC-440	SWOL - HM			
SC-441	SWOL - HM			
SC-442	SWOL - HM			

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-443	TSO - HM			
SC-444	SWOL - HM			
SC-445	SWOL - HM			
SC-446	SWOL - HM			
SC-447	SWOL - HM			
SC-448	SWOL - HM			
SC-449	SWOL - HM			
SC-450	SWOL - HM			
SC-451	SWOL - HM			
SC-452	SWOL - HM			
SC-453	SWOL - HM			
SC-454	SWOL - HM			
SC-455	SWOL - HM			
SC-456	SWOL - HM			
SC-457	SWOL - HM			
SC-458	SWOL - HM			
SC-459	SWOL - HM			
SC-460	SWOL - HM			
SC-461	SWOL - HM			
SC-462	TSO - HM			
SC-463	TSO - HM			
SC-464	TSO - HM			
SC-465	TSO - HM			
SC-466	TSO - HM			
SC-467	TSO - HM			
SC-468	TSO - HM			
SC-469	TSO - HM			
SC-470	TSO - HM			
SC-471	TSO - HM			
SC-472	TSO - HM			
SC-473	SWOL - HM			
SC-474	TSO - HM			
SC-475	TSO - HM			
SC-476	TSO - HM			

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-477	TSO - HM			
SC-478	TSO - HM			
SC-479	TSO - HM			
SC-480	TSO - HM			
SC-481	TSO - HM			
SC-482	TSO - HM			
SC-483	TSO - HM			
SC-484	TSO - HM			
SC-485	TSO - HM			
SC-486	TSO - HM			
SC-487	TSO - HM			
SC-488	TSO(HM) + Syn. Fe2SiO4	50% 02-T683 + 50% 02-T1028		
SC-489	TSO(HM) + Syn. Fe2SiO4	75% 02-T683 + 25% 02-T1028		
SC-490	TSO(HM) + Syn. Fe2SiO4	25% 02-T683 + 75% 02-T1028		
SC-491	TSO(HM) + Syn. Fe2SiO4	25% 02-T683 + 75% 02-T1028		
SC-492	TSO - HM			
SC-493	TSO - HM			
SC-494	TSO - HM			
SC-495	TSO - HM			
SC-496	TSO - HM			
SC-497	TSO - HM			
SC-498	TSO - HM			
SC-499	TSO - HM			
SC-500	TSO - HM			
SC-501	TSO - 03			
SC-502	TSO(HM) + Syn. Fe2SiO4	25% 02-T683 + 75% 02-T1028		
SC-503	TSO - 03			
SC-504	TSO - 03			
SC-505	TSO - 03			
SC-506	TSO - 03			
SC-507	TX Serp			
SC-508	TSO - 03			
SC-509	SWOL NM		-75	
SC-510	TSO - 03B			

Appendix A1: Sample ID and Grinding History - Stage 1

Test	Material	Size Reduction - Stage 1		
		Stage 1	Particle size, um	LIMS No.
SC-511	TSO - 03B			
SC-512	TSO - 03B			
SC-513	TSO - 03B			
SC-514	TSO - 03B			
SC-515	TSO - 03B			
SC-516	CRB 7			
SC-517	CRB 7			
SC-518	CRB 7			
SC-519	Anorthite (Wards)			
SC-520	Augite (Wards)			
SC-521	Syn. Fe2SiO4			
SC-522	Yellowstone Mine Talc			
SC-523	Ivtek magnetite		-75	01-T2388
SC-524	TSO - 03B			
SC-525	TSO - 03B			
SC-526	TSO - 03B			
SC-527	TSO - 03B			
SC-528	TX Serp			
SC-529	TSO - 03			
SC-530	TSO - 03			
SC-531	TSO - 03B			
SC-532	TSO - 03B			
SC-533	TSO - 03B			
SC-534	TSO - 03B			
SC-535	TSO - 03B			
SC-536	TSO - 03B			
SC-537	TSO - 03B			
SC-538	TSO - 03B			
SC-539	TSO - 03B			
SC-540	TSO - 03B			
SC-541	TSO - 03B			
SC-542	TSO - 03B			
SC-543	TSO - 03B			
SC-544	TSO - 03B			

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-545	TSO - 03B			
SC-546	TSO - 03B			
SC-547	TSO - 03B			
SC-548	TSO - 03B			
SC-549	TSO - 03B			
SC-550	TSO - 03B			
SC-551	TSO - 03B			
SC-552	SW	as-received		02-T540
SC-553	TSO - 03B			
SC-554	TSO - 03B			
SC-555	TSO - 03B			
SC-556	TSO - 03C			
SC-557	NW Tails	as-received		03-T595
SC-558	TSO - 03B			
SC-559	TSO - 03B			
SC-560	NW Dust DC101	as-received		03-T600
SC-561	NW Dust DC101	as-received		03-T600
SC-562	NW Dust DC101	as-received		03-T600
SC-563	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-564	NW 100	as-received		03-T599
SC-565	TSO - PP NM	pilot plant circuit w/mag sep	-75; D50 = 21	01-T1241
SC-566	NW 100	as-received		03-T599
SC-567	TSO - 03C			
SC-568	NW 100	as-received		03-T599
SC-569	NW 100	as-received		03-T599
SC-570	NW 100	as-received		03-T599
SC-571	NW 100	as-received		03-T599
SC-572	NW 100	as-received		03-T599
SC-573	NW 100	as-received		03-T599
SC-574	NW 100	as-received		03-T599
SC-575	NW 100	as-received		03-T599
SC-576	NW 100	as-received		03-T599
SC-577	SW	as-received		02-T540
SC-578	CHA		-150; D50 = 25	03-T751

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-579	SW	as-received		02-T540
SC-580	SW	as-received		02-T540
SC-581	SW	as-received		02-T540
SC-582	SW	as-received		02-T540
SC-583	SW	as-received		02-T540
SC-584	SW	as-received		02-T540
SC-585	SW	as-received		02-T540
SC-586	SW	as-received		02-T540
SC-587	NW 100	as-received		
SC-588	SWOL		-150	03-T883
SC-589	SWOL		-150	03-T883
SC-590	CHA		-150; D50 = 25	03-T751
SC-591	CHA		-150; D50 = 25	03-T751
SC-592	NW 100	as-received		
SC-593	SWOL		-150	03-T883
SC-594	NW 100	as-received		03-T599
SC-595	NW 100	as-received		03-T599
SC-596	NW 100	as-received		03-T599
SC-597	NW 100	as-received		03-T599
SC-598	NW 100	as-received		03-T599
SC-599	NW 100	as-received		03-T599
SC-600	CHA		-150; D50 = 25	03-T751
SC-601	NW 100	as-received		03-T599
SC-602	NW 100	as-received		03-T599
SC-603	NW 100	as-received		03-T599
SC-604	NW 100	as-received		03-T599
SC-605	NW 100	as-received		03-T599
SC-606	NW 100	as-received		03-T599
SC-607	NW 100	as-received		03-T599
SC-608	NW 100	as-received		03-T599
SC-609	NW 100	as-received		03-T599
SC-610	NW 100	as-received		03-T599
SC-611	NW 100	as-received		03-T599
SC-612	NW 100	as-received		03-T599

Appendix A1: Sample ID and Grinding History - Stage 1

		Size Reduction - Stage 1		
Test	Material	Stage 1	Particle size, um	LIMS No.
SC-613	NW 100	as-received		03-T599
SC-614	NW 100	as-received		03-T599
SC-615	NW 100	as-received		03-T599
SC-616	NW 100	as-received		03-T599
SC-617	NW 100	as-received		03-T599
SC-618	NW 100	as-received		03-T599
SC-619	NW 100	as-received		03-T599
SC-620	NW 100	as-received		03-T599
SC-621	NW 100	as-received		03-T599
SC-622	NW 100	as-received		03-T599
SC-623	NW Tails	as-received		03-T595
SC-624	TSO - 03B			
SC-625	TSO - 03B			
SC-626	TSO - 03B			
SC-627	TSO - 03C			
SC-628	Gabbro			

TSO - Twin Sisters Olivine
CHA - Cedar Hill Antigorite
SWOL - SW Oregon Lizardite
NW - Nycoi Wollastonite
SW - Shell Wollastonite
DBO - Day Book Olivine
FGO - Foundry Grade Olivine

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-1										
SC-2										
SC-3										
SC-4										
SC-5										
SC-6										
SC-7										
SC-8										
SC-9										
SC-10										
SC-11										
SC-12										
SC-13										
SC-14										
SC-15										
SC-16										
SC-17										
SC-18										
SC-19										
SC-20										
SC-21										
SC-22										
SC-23										
SC-24										
SC-25										
SC-26										
SC-27										
SC-28										
SC-29										
SC-30										
SC-31										
SC-32										
SC-33										
SC-34										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-35										
SC-36										
SC-37										
SC-38										
SC-39										
SC-40										
SC-41										
SC-42										
SC-43										
SC-44										
SC-45										
SC-46										
SC-47										
SC-48										
SC-49										
SC-50										
SC-51										
SC-52										
SC-53										
SC-54										
SC-55										
SC-56										
SC-57										
SC-58										
SC-59										
SC-60										
SC-61										
SC-62										
SC-63										
SC-64										
SC-65										
SC-66										
SC-67										
SC-68										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-69										
SC-70										
SC-71										
SC-72										
SC-73										
SC-74										
SC-75										
SC-76										
SC-77										
SC-78										
SC-79										
SC-80										
SC-81										
SC-82										
SC-83										
SC-84										
SC-85										
SC-86										
SC-87										
SC-88										
SC-89										
SC-90										
SC-91										
SC-92										
SC-93										
SC-94										
SC-95										
SC-96										
SC-97										
SC-98										
SC-99										
SC-100										
SC-101										
SC-102										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-103										
SC-104										
SC-105										
SC-106										
SC-107										
SC-108										
SC-109										
SC-110										
SC-111										
SC-112		ground 30 min				0.5				
SC-113										
SC-114										
SC-115										
SC-116										
SC-117										
SC-118										
SC-119										
SC-120										
SC-121										
SC-122										
SC-123										
SC-124										
SC-125										
SC-126										
SC-127										
SC-128										
SC-129										
SC-130										
SC-131										
SC-132										
SC-133										
SC-134										
SC-135										
SC-136										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-137										
SC-138										
SC-139										
SC-140										
SC-141										
SC-142										
SC-143										
SC-144										
SC-145										
SC-146										
SC-147										
SC-148										
SC-149										
SC-150										
SC-151										
SC-152										
SC-153										
SC-154										
SC-155										
SC-156										
SC-157										
SC-158										
SC-159										
SC-160										
SC-161										
SC-162										
SC-163										
SC-164										
SC-165										
SC-166										
SC-167										
SC-168										
SC-169										
SC-170										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-171										
SC-172										
SC-173										
SC-174										
SC-175										
SC-176										
SC-177										
SC-178										
SC-179										
SC-180										
SC-181										
SC-182										
SC-183										
SC-184										
SC-185										
SC-186										
SC-187										
SC-188										
SC-189										
SC-190										
SC-191										
SC-192										
SC-193										
SC-194										
SC-195										
SC-196										
SC-197										
SC-198										
SC-199										
SC-200										
SC-201										
SC-202										
SC-203										
SC-204										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-205										
SC-206										
SC-207										
SC-208										
SC-209										
SC-210										
SC-211		BM	W		50	0.083			21% -20 um	01-T760
SC-212										
SC-213										
SC-214										
SC-215										
SC-216										
SC-217										
SC-218										
SC-219										
SC-220										
SC-221										
SC-222										
SC-223										
SC-224										
SC-225										
SC-226										
SC-227										
SC-228										
SC-229										
SC-230										
SC-231										
SC-232										
SC-233										
SC-234										
SC-235										
SC-236										
SC-237										
SC-238										

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-239										
SC-240										
SC-241										
SC-242										
SC-243										
SC-244										
SC-245		B3A	D			24				01-T1555
SC-246		B3A	D			24				01-T1555
SC-247		B3A	D			24				01-T1556
SC-248		B3A	D			24				01-T1556
SC-249										
SC-250		B3A	D			24				01-T1694
SC-251		B3A	D			24				01-T1694
SC-252		B3A	D			24				01-T1694
SC-253		B3A	D			24				01-T1694
SC-254		B3A	D			0.083				01-T1752
SC-255		B3A	D			24				01-T1694
SC-256		B3A	D			0.083				01-T1827
SC-257		B3A	D			1				01-T1833
SC-258		B3A	D			2				01-T1836
SC-259										
SC-260										
SC-261		B3A	D			4				-
SC-262		B3A	D			1				01-T1987
SC-263										
SC-264										
SC-265		B3A	W		H2O	1				01-T1993
SC-266										
SC-267										
SC-268										
SC-269		B3A	W		H2O	1				01-T1993
SC-270										
SC-271		BM							95% -20	01-T2204
SC-272		B3A	W		H2O	1				01-T1993

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-273		B3A	D			2				01-T2273
SC-274		B3A	W		H2O	2				01-T2276
SC-275		B3A	W		H2O	2				01-T2276
SC-276		B3A	D			1				01-T2283
SC-277		B3A	D			1				01-T2283
SC-278		B3A	D			1				01-T2289
SC-279		B3A	D			1				01-T2298
SC-280		B3A	D			1				01-T2298
SC-281		B3A	W	30	Carb. Solution	1				01-T2315
SC-282		B3A	W	30	Carb. Solution	1				01-T2315
SC-283		attrited dry 1h	D			1				01-T2289
SC-284		B3A	W	30	Carb. Solution	1				01-T2353
SC-285		B17A	W	70	H2O	1				01-T2356
SC-286		B3A	W	30	Carb. Solution	1				01-T2353
SC-287		B17A	W	50	Carb. Solution	1				01-T2365
SC-288		B17A	W	50	Carb. Solution	4				01-T2368
SC-289		B3A	W	30	Carb. Solution	1				01-T2353
SC-290		B3A	W	30	Carb. Solution	1				01-T2353
SC-291		B17A	W	50	Carb. Solution	1				01-T2384
SC-292										
SC-293		B3A	W	30	Carb. Solution	1				01-T2414
SC-294		B17A	W	50	Carb. Solution	1				01-T2418
SC-295		BM	D			1				01-T2421
SC-296		BM	D			1				01-T2421
SC-297		BM	D			1				01-T2421
SC-298		BM	D			1				01-T2421
SC-299		BM	D			1				01-T2421
SC-300		BM	D			1				01-T2421
SC-301		BM	D			1				01-T2421
SC-302		BM	D			1				01-T2421
SC-303		BM	D			1				01-T2421
SC-304										
SC-305		attrited wet 1h	W	30	Carb. Solution	1				02-T24
SC-306		attrited wet 1h	W	30	Carb. Solution	1				02-T24

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-307		attrited wet 1h	W	30	Carb. Solution	1				02-T24
SC-308		attrited wet 1h	W	30	Carb. Solution	1				02-T24
SC-309		BM	D			1				02-T40
SC-310										
SC-311		BM	W			7				02-T64
SC-312		BM	W			8				02-T68
SC-313		BM	W			6				02-T83
SC-314		BM	D			2				02-T115
SC-315		BM	D			2				02-T115
SC-316										
SC-317										
SC-318										
SC-319		BM	D			2				02-T115
SC-320		B3A	W			24				02-T171
SC-321		attrited dry 4h	D			4				02-T173
SC-322		BM	D			1				
SC-323		attrited dry 15 min	D			0.25				02-T181
SC-324		attrited dry 5 min	D			0.083				02-T185
SC-325		attrited dry 30 min	D			0.5				02-T198
SC-326		B3A	D			24				02-T244
SC-327		B3A	D			24				02-T244
SC-328		attrited dry 4h	D			4				02-T252
SC-329		BM	D			1				02-T255
SC-330		BM	D			1				02-T255
SC-331		BM	D			1				02-T255
SC-332		BM	D			1				02-T255
SC-333		BM	D			1				02-T255
SC-334		BM	D			1				02-T255
SC-335		BM	D			1				02-T255
SC-336		BM	D			1				02-T255
SC-337		BM	D			1				02-T255
SC-338		attrited dry 1h	D			1				02-T292
SC-339		attrited wet 1h	W			1				02-T295
SC-340		BM	D			1				02-T255

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-341		BM	D			1				02-T302
SC-342		BM	W			1				02-T310
SC-343		BM	W			1				02-T318
SC-344		BM	D			1				02-T325
SC-345		BM	W			1				02-T328
SC-346		BM	W			1				02-T332
SC-347		BM	D			1				02-T335
SC-348		BM	D			1				02-T341
SC-349		RM	D						screened thru 106	02-T368
SC-350		RM	D						screened thru 106	02-T368
SC-351		RM	D						screened thru 106	02-T368
SC-352		RM	D						screened thru 106	02-T368
SC-353		RM	D						screened thru 106	02-T368
SC-354		RM	D						screened thru 106	02-T368
SC-355		RM	D						screened thru 106	02-T368
SC-356		RM	D						screened thru 106	02-T368
SC-357		RM	D						screened thru 106	02-T368
SC-358		RM	D						screened thru 106	02-T368
SC-359		RM	D						screened thru 106	02-T368
SC-360		RM	D						screened thru 106	02-T368
SC-361		BMed, attrited dry 1h	D/D			1; 1				02-T499
SC-362		BMed, attrited dry 1h				1; 1				02-T499
SC-363										
SC-364										
SC-365										
SC-366										
SC-367										
SC-368		BM	D			1				02-T554
SC-369		BM	D			1				02-T554
SC-370		BM	D			1				02-T565
SC-371		B3A	D			1			D50 = 15	02-T568
SC-372		B3A	D			1			D50 = 15	02-T568
SC-373		B3A	D			1			D50 = 15	02-T568
SC-374		B3A	D			1			D50 = 15	02-T568

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-375		BM	D			1				02-T565
SC-376		RM	D			2				02-T587
SC-377		RM	D			2				02-T587
SC-378		BM	D			1				02-T625
SC-379		BM	D			1				02-T625
SC-380		BM	D			1				02-T625
SC-381		BM	D			1				02-T625
SC-382		RM	D			2				02-T587
SC-383		RM	D			2				02-T586
SC-384		RM	D			2				02-T678
SC-385		RM	D			2				02-T678
SC-386		RM	D			2				02-T587
SC-387		RM	D			2				02-T678
SC-388		RM	D			2				02-T587
SC-389		RM	D			2				02-T678
SC-390		RM	D			2				02-T678
SC-391		RM	D			2				02-T587
SC-392		RM	D			2				02-T587
SC-393		RM	D			2				02-T587
SC-394		RM	D			2				02-T678
SC-395		RM	D			2				02-T678
SC-396		RM	D			2				02-T587
SC-397		RM	D			2				02-T587
SC-398		RM	D			2				02-T587
SC-399		RM	D			2				02-T587
SC-400		RM	D			2				02-T587
SC-401		RM	D			2				02-T587
SC-402		RM	D			2				02-T587
SC-403		RM	D			2				02-T587
SC-404		RM	D			2				02-T587
SC-405		RM	D			2				02-T587
SC-406		RM	D			2				02-T587
SC-407		RM	D			2				02-T587
SC-408		RM	D			2				02-T587

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-409		BM, B3A	D			1; 1				02-T499
SC-410		BM, B3A	D			1; 1				02-T499
SC-411		RM	D						screened thru 106	02-T368
SC-412		RM	D			2				02-T656
SC-413		RM	D			2				02-T656
SC-414		RM	D			2				02-T656
SC-415		RM	D			2				02-T656
SC-416		RM	D			2				01-T525
SC-417		RM	D			2				01-T525
SC-418		RM	D			2				02-T587
SC-419		RM	D			2				02-T587
SC-420		RM	D			2				02-T587
SC-421		RM	D			2				02-T587
SC-422		RM; BM	D			2; 1				02-T1028
SC-423		RM	D			2				02-T678
SC-424		RM; BM	D			2; 1				02-T1028
SC-425		RM	D			2				02-T678
SC-426		RM	D			2				02-T587
SC-427		RM	D			2				02-T644
SC-428		RM	D			2				02-T1092
SC-429		RM	D			2				02-T678
SC-430		RM	D			2				02-T678
SC-431		RM	D			2				02-T678
SC-432		RM; BM	D			1; 1				02-T1110
SC-433		RM; BM	D			1; 1				02-T1110
SC-434		RM; BM	D			1; 1				02-T?
SC-435		RM; BM	D			2; 1				02-T645
SC-436		RM	D			2				02-T678
SC-437		RM; BM	D			2; 1				02-T645
SC-438		RM	D			2				02-T678
SC-439		RM	D			2				02-T678
SC-440		RM	D			2				02-T587
SC-441		RM	D			2				02-T587
SC-442		RM	D			2				02-T587

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-443		RM	D			2				02-T678
SC-444		RM	D			2				02-T587
SC-445		RM	D			2				02-T587
SC-446		RM	D			2				02-T587
SC-447		RM	D			2				02-T587
SC-448		RM	D			2				02-T587
SC-449		RM	D			2				02-T587
SC-450		RM	D			2				02-T587
SC-451		RM	D			2				02-T587
SC-452		RM	D			2				02-T587
SC-453		RM	D			2				02-T587
SC-454		RM	D			2				02-T587
SC-455		RM	D			2				02-T587
SC-456		RM	D			2				02-T587
SC-457		RM	D			2				02-T587
SC-458		RM	D			2				02-T587
SC-459		RM	D			2				02-T587
SC-460		RM	D			2				02-T587
SC-461		RM	D			2				02-T587
SC-462		RM	D			2				02-T678
SC-463		RM	D			2				02-T678
SC-464		RM	D			2				02-T678
SC-465		RM	D			2				02-T678
SC-466		RM	D			2				02-T678
SC-467		RM	D			2				02-T678
SC-468		RM	D			2				02-T678
SC-469		RM	D			2				02-T678
SC-470		RM	D			2				02-T678
SC-471		RM	D			2				02-T678
SC-472		RM	D			2				02-T678
SC-473		RM	D			2				02-T587
SC-474		RM	D			2				02-T678
SC-475		RM	D			2				02-T678
SC-476		RM	D			2				02-T678

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-477		RM	D			2				02-T678
SC-478		RM	D			2				02-T678
SC-479		RM	D			2				02-T678
SC-480		RM	D			2				02-T678
SC-481		RM	D			2				02-T678
SC-482		RM	D			2				02-T678
SC-483		RM	D			2				02-T678
SC-484		RM	D			2				02-T678
SC-485		RM	D			2				02-T678
SC-486		RM	D			2				02-T678
SC-487		RM	D			2				02-T678
SC-488										
SC-489										
SC-490										
SC-491										
SC-492		RM	D			2				02-T678
SC-493		RM	D			2				02-T678
SC-494		RM	D			2				02-T678
SC-495		RM	D			2				02-T678
SC-496		RM	D			2				02-T678
SC-497		RM	D			2				02-T678
SC-498		RM	D			2				02-T678
SC-499		RM	D			2				02-T678
SC-500		RM	D			2				02-T678
SC-501	G02-03	RM	D			2				03-T25
SC-502										
SC-503	G02-03	RM	D			2				03-T25
SC-504	G02-03	RM	D			2				03-T25
SC-505	G02-03	RM	D			2				03-T25
SC-506	G02-03	RM	D			2				03-T25
SC-507		RM	D			2				03-T163
SC-508	G02-03	RM	D			2				03-T25
SC-509		B3A	D			24				02-T244
SC-510	G02-03 + G06-03	RM	D			2				03-T206

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-511	G02-03 + G06-03	RM	D			2				03-T206
SC-512	G02-03 + G06-03	RM	D			2				03-T206
SC-513	G02-03 + G06-03	RM	D			2				03-T206
SC-514	G02-03 + G06-03	RM	D			2				03-T206
SC-515	G02-03 + G06-03	RM	D			2				03-T206
SC-516		RM; BM	D			2; 1				02-T645
SC-517		RM; BM	D			2; 1				02-T645
SC-518		RM; BM	D			2; 1				02-T645
SC-519		RM; BM	D			1; 1				02-T?
SC-520		RM; BM	D			1; 1				02-T1110
SC-521		RM; BM	D			2; 1				02-T1028
SC-522	G16-03	RM	D			2				03-T289
SC-523	G18-03	B3A	D			1	55:1			03-T295
SC-524	G02-03 + G06-03	RM	D			2				03-T206
SC-525	G02-03 + G06-03	RM	D			2				03-T206
SC-526	G02-03 + G06-03	RM	D			2				03-T206
SC-527	G02-03 + G06-03	RM	D			2				03-T206
SC-528		RM	D			2				03-T163
SC-529	G02-03	RM	D			2				03-T25
SC-530	G02-03	RM	D			2				03-T25
SC-531	G02-03 + G06-03	RM	D			2				03-T206
SC-532	G02-03 + G06-03	RM	D			2				03-T206
SC-533	G02-03 + G06-03	RM	D			2				03-T206
SC-534	G02-03 + G06-03	RM	D			2				03-T206
SC-535	G02-03 + G06-03	RM	D			2				03-T206
SC-536	G02-03 + G06-03	RM	D			2				03-T206
SC-537	G02-03 + G06-03	RM	D			2				03-T206
SC-538	G02-03 + G06-03	RM	D			2				03-T206
SC-539	G02-03 + G06-03	RM	D			2				03-T206
SC-540	G02-03 + G06-03	RM	D			2				03-T206
SC-541	G02-03 + G06-03	RM	D			2				03-T206
SC-542	G02-03 + G06-03	RM	D			2				03-T206
SC-543	G02-03 + G06-03	RM	D			2				03-T206
SC-544	G02-03 + G06-03	RM	D			2				03-T206

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-545	G02-03 + G06-03	RM	D			2				03-T206
SC-546	G02-03 + G06-03	RM	D			2				03-T206
SC-547	G02-03 + G06-03	RM	D			2				03-T206
SC-548	G02-03 + G06-03	RM	D			2				03-T206
SC-549	G02-03 + G06-03	RM	D			2				03-T206
SC-550	G02-03 + G06-03	RM	D			2				03-T206
SC-551	G02-03 + G06-03	RM	D			2				03-T206
SC-552										
SC-553	G02-03 + G06-03	RM	D			2				03-T206
SC-554	G02-03 + G06-03	RM	D			2				03-T206
SC-555	G02-03 + G06-03	RM	D			2				03-T206
SC-556		RM	D			2				03-T569
SC-557	G41-03	RM	D			1				03-T596
SC-558	G02-03 + G06-03	RM	D			2				03-T206
SC-559	G02-03 + G06-03	RM	D			2				03-T206
SC-560										
SC-561										
SC-562										
SC-563		BM	D						screened thru 37; D50 = 14	03-T649
SC-564	G43-03 + G45-03	RM	D			1				03-T679
SC-565		BM	D						screened thru 37; D50 = 14	03-T649
SC-566	G43-03 + G45-03	RM	D			1				03-T679
SC-567		RM	D			2				03-T569
SC-568	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-569	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-570	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-571	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-572	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-573	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-574	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-575	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-576	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-577	G56-03	MD	W	50	H2O	0.4025	3.5:1	110	D50 = 4	03-T809
SC-578	G53-03	MD	W	50	H2O	0.4114	3.5:1	110	D50 = 3	03-T752

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-579	G55-03	MD	W	50	H2O	0.2547	3.5:1	70	D50 = 5	03-T748
SC-580	G55-03	MD	W	50	H2O	0.2547	3.5:1	70	D50 = 5	03-T748
SC-581	G54-03	MD	W	50	H2O	0.1075	3.5:1	30		03-T788
SC-582	G54-03	MD	W	50	H2O	0.1075	3.5:1	30		03-T788
SC-583	G54-03	MD	W	50	H2O	0.1075	3.5:1	30		03-T788
SC-584	G56-03	MD	W	50	H2O	0.4025	3.5:1	110	D50 = 4	03-T809
SC-585	G56-03	MD	W	50	H2O	0.4025	3.5:1	110	D50 = 4	03-T809
SC-586	G55-03	MD	W	50	H2O	0.2547	3.5:1	70	D50 = 5	03-T748
SC-587	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-588	G57-03	MD	W	50	H2O	0.1164	3.5:1	30		03-T884
SC-589	G58-03	MD	W	50	H2O	0.2706	3.5:1	70		03-T896
SC-590	G52-03	MD	W	50	H2O	0.2636	3.5:1	70		03-T933
SC-591	G51-03	MD	W	50	H2O	0.1178	3.5:1	30		03-T952
SC-592	G43-03 + G45-03 + G46-03	RM	D			1				03-T706
SC-593	G59-03	MD	W	50	H2O	2.02	3.5:1	300	D50 = 2	03-T980
SC-594	G60-03	RM	D			1				03-T985
SC-595	G60-03	RM	D			1				03-T985
SC-596	G60-03	RM	D			1				03-T985
SC-597	G60-03	RM	D			1				03-T985
SC-598	G60-03	RM	D			1				03-T985
SC-599	G60-03	RM	D			1				03-T985
SC-600	G62-03	MD	W	50	H2O	1.6136	3.5:1	300	D50 = 2	03-T1058
SC-601	G60-03	RM	D			1				03-T985
SC-602	G60-03	RM	D			1				03-T985
SC-603	G60-03	RM	D			1				03-T985
SC-604	G60-03	RM	D			1				03-T985
SC-605	G60-03	RM	D			1				03-T985
SC-606	G60-03	RM	D			1				03-T985
SC-607	G60-03	RM	D			1				03-T985
SC-608	G60-03	RM	D			1				03-T985
SC-609	G60-03	RM	D			1				03-T985
SC-610	G60-03	RM	D			1				03-T985
SC-611	G60-03	RM	D			1				03-T985
SC-612	G60-03	RM	D			1				03-T985

Appendix A2: Sample ID and Grinding History - Stage 2

	Size Reduction - Stage 2									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-613	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened thru 25; D50 = 8	03-T1135
SC-614	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened 38x25; D50 = 32	03-T1140
SC-615	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened thru 25; D50 = 8	03-T1135
SC-616	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened 53x38	03-T1157
SC-617	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened thru 25; D50 = 8	03-T1135
SC-618	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened thru 25; D50 = 8	03-T1135
SC-619	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened 75x53	03-T1178
SC-620	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened 106x75	03-T1185
SC-621	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened 150x106	03-T1195
SC-622	G63-03 + G64-03	(RM; BM) + RM	D			(1; 1) + 1			screened +150	03-T1198
SC-623	G41-03	RM	D			1				03-T596
SC-624	G02-03 + G06-03	RM	D			2				03-T206
SC-625	G02-03 + G06-03	RM	D			2				03-T206
SC-626	G02-03 + G06-03	RM	D			2				03-T206
SC-627	G65-03	RM	D			2				03-T569
SC-628	G67-03	RM; BM	D			1; 1				03-T1259

TSO - Twin Sisters Olivine
CHA - Cedar Hill Antigorite
SWOL - SW Oregon Lizardite
NW - Nycoi Wollastonite
SW - Shell Wollastonite
DBO - Day Book Olivine
FGO - Foundry Grade Olivine

RM - rod mill
BM - ball mill
HBM - hot ball mill
MD - Metso detritor
B3A - Bldg. 3 attritor
B17A - Bldg. 17 attritor
PS - paint shaker

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-1										
SC-2										
SC-3										
SC-4										
SC-5										
SC-6										
SC-7										
SC-8										
SC-9										
SC-10										
SC-11										
SC-12										
SC-13										
SC-14										
SC-15										
SC-16										
SC-17										
SC-18										
SC-19										
SC-20										
SC-21										
SC-22										
SC-23										
SC-24										
SC-25										
SC-26										
SC-27										
SC-28										
SC-29										
SC-30										
SC-31										
SC-32										
SC-33										
SC-34										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-35										
SC-36										
SC-37										
SC-38										
SC-39										
SC-40										
SC-41										
SC-42										
SC-43										
SC-44										
SC-45										
SC-46										
SC-47										
SC-48										
SC-49										
SC-50										
SC-51										
SC-52										
SC-53										
SC-54										
SC-55										
SC-56										
SC-57										
SC-58										
SC-59										
SC-60										
SC-61										
SC-62										
SC-63										
SC-64										
SC-65										
SC-66										
SC-67										
SC-68										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-69										
SC-70										
SC-71										
SC-72										
SC-73										
SC-74										
SC-75										
SC-76										
SC-77										
SC-78										
SC-79										
SC-80										
SC-81										
SC-82										
SC-83										
SC-84										
SC-85										
SC-86										
SC-87										
SC-88										
SC-89										
SC-90										
SC-91										
SC-92										
SC-93										
SC-94										
SC-95										
SC-96										
SC-97										
SC-98										
SC-99										
SC-100										
SC-101										
SC-102										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-103										
SC-104										
SC-105										
SC-106										
SC-107										
SC-108										
SC-109										
SC-110										
SC-111										
SC-112										
SC-113										
SC-114										
SC-115										
SC-116										
SC-117										
SC-118										
SC-119										
SC-120										
SC-121										
SC-122										
SC-123										
SC-124										
SC-125										
SC-126										
SC-127										
SC-128										
SC-129										
SC-130										
SC-131										
SC-132										
SC-133										
SC-134										
SC-135										
SC-136										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-137										
SC-138										
SC-139										
SC-140										
SC-141										
SC-142										
SC-143										
SC-144										
SC-145										
SC-146										
SC-147										
SC-148										
SC-149										
SC-150										
SC-151										
SC-152										
SC-153										
SC-154										
SC-155										
SC-156										
SC-157										
SC-158										
SC-159										
SC-160										
SC-161										
SC-162										
SC-163										
SC-164										
SC-165										
SC-166										
SC-167										
SC-168										
SC-169										
SC-170										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-171										
SC-172										
SC-173										
SC-174										
SC-175										
SC-176										
SC-177										
SC-178										
SC-179										
SC-180										
SC-181										
SC-182										
SC-183										
SC-184										
SC-185										
SC-186										
SC-187										
SC-188										
SC-189										
SC-190										
SC-191										
SC-192										
SC-193										
SC-194										
SC-195										
SC-196										
SC-197										
SC-198										
SC-199										
SC-200										
SC-201										
SC-202										
SC-203										
SC-204										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-205										
SC-206										
SC-207										
SC-208										
SC-209										
SC-210										
SC-211										
SC-212										
SC-213										
SC-214										
SC-215										
SC-216										
SC-217										
SC-218										
SC-219										
SC-220										
SC-221										
SC-222										
SC-223										
SC-224										
SC-225										
SC-226										
SC-227										
SC-228										
SC-229										
SC-230										
SC-231										
SC-232										
SC-233										
SC-234										
SC-235										
SC-236										
SC-237										
SC-238										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-239										
SC-240										
SC-241										
SC-242										
SC-243										
SC-244										
SC-245										
SC-246										
SC-247										
SC-248										
SC-249										
SC-250										
SC-251										
SC-252										
SC-253										
SC-254										
SC-255										
SC-256										
SC-257										
SC-258										
SC-259										
SC-260										
SC-261										
SC-262										
SC-263										
SC-264										
SC-265										
SC-266										
SC-267										
SC-268										
SC-269										
SC-270										
SC-271										
SC-272										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-273										
SC-274										
SC-275										
SC-276										
SC-277										
SC-278										
SC-279										
SC-280										
SC-281										
SC-282										
SC-283										
SC-284										
SC-285										
SC-286										
SC-287										
SC-288										
SC-289										
SC-290										
SC-291										
SC-292										
SC-293										
SC-294										
SC-295										
SC-296										
SC-297										
SC-298										
SC-299										
SC-300										
SC-301										
SC-302										
SC-303										
SC-304										
SC-305										
SC-306										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-307										
SC-308										
SC-309										
SC-310										
SC-311										
SC-312										
SC-313										
SC-314										
SC-315										
SC-316										
SC-317										
SC-318										
SC-319										
SC-320										
SC-321										
SC-322										
SC-323										
SC-324										
SC-325										
SC-326										
SC-327										
SC-328										
SC-329										
SC-330										
SC-331										
SC-332										
SC-333										
SC-334										
SC-335										
SC-336										
SC-337										
SC-338										
SC-339										
SC-340										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-341										
SC-342										
SC-343										
SC-344										
SC-345										
SC-346										
SC-347										
SC-348										
SC-349										
SC-350		BM	D			1				02-T425
SC-351		BM	W			1				02-T428
SC-352		attrited dry 1h	D			1				02-T432
SC-353		attrited wet 1h	W			1				02-T435
SC-354		attrited wet 1h	W			1				02-T435
SC-355		BM	D			1				02-T425
SC-356		BM	D			1				02-T425
SC-357		B3A	D			1				02-T456
SC-358		B3A	D			1				02-T456
SC-359		B3A	D			1				02-T456
SC-360		B3A	D			1				02-T456
SC-361										
SC-362										
SC-363										
SC-364										
SC-365										
SC-366										
SC-367										
SC-368										
SC-369										
SC-370										
SC-371										
SC-372										
SC-373										
SC-374										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-375										
SC-376										
SC-377	HM-1	HBM	D			4				02-T603
SC-378										
SC-379										
SC-380										
SC-381										
SC-382	HM-2	HBM	D			4				02-T657
SC-383										
SC-384										
SC-385		BM	D			1				02-T683
SC-386	HM-3	HBM	D			4				02-T691
SC-387		BM	D			1				02-T683
SC-388	HM-4	HBM	D			4				02-T700
SC-389		BM	D			1				02-T683
SC-390		BM	D			1				02-T683
SC-391	HM-5	HBM	D			4				02-T712
SC-392	A1B	B3A	D			1				02-T716
SC-393	A2	B3A	D			1				02-T722
SC-394		BM	D			1				02-T683
SC-395		BM	D			1				02-T683
SC-396	A3	B3A	D			1				02-T744
SC-397	A4	B3A	D			1				02-T762
SC-398	HM-6	HBM	D			4				02-T771
SC-399	HM-7	HBM	D			4				02-T791
SC-400	A5	B3A	D			1				02-T794
SC-401	HM-8	HBM	D			4				02-T799
SC-402	A6	B3A	D			1				02-T802
SC-403	A7A	B3A	D			1				02-T810
SC-404	A7B	B3A	D			1				02-T823
SC-405	HM-9	HBM	D			4				02-T828
SC-406	HM-10	HBM	D			4				02-T835
SC-407	A8	B3A	D			1				02-T883
SC-408	A9	B3A	D			1				02-T900

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-409										
SC-410										
SC-411										
SC-412										
SC-413		BM	D			1				02-T947
SC-414		attrited dry 1h, 300 rpm	D			1				02-T951
SC-415										
SC-416										
SC-417		attrited dry 1h, 300 rpm	D			1				02-T977
SC-418	A10B	B3A	D			1				02-T989
SC-419	HM-11	HBM	D			4				02-T995
SC-420	A11	B3A	D			1				02-T1001
SC-421		BM	D			1				02-T1011
SC-422										
SC-423		B17A	D			1	10:1			02-T1036
SC-424										
SC-425		B17A	W	40	H2O	1	10:1			
SC-426	A12	B3A	D			1				02-T1060
SC-427										
SC-428										
SC-429		B17A	D			1	20:1			02-T1096
SC-430		B17A	D			1	5:1			02-T1100
SC-431		PS	D			0.083				02-T1106
SC-432										
SC-433		attrited dry 4h	D			4				02-T1124
SC-434		attrited dry 4h	D			4				02-T1134
SC-435		attrited dry 4h	D			4				02-T1139
SC-436	G37-02	B3A	D			1	10:1			02-T1154
SC-437										
SC-438	G38-02	B17A	D			0.5				02-T1163
SC-439	G39-02	B17A	D			1				02-T1176
SC-440	A13	B3A	D			1				02-T1186
SC-441	A14	B3A	D			1				02-T1208
SC-442	A15	B3A	D			1				02-T1223

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-443	G40-02	B17A	D			0.667	10:1			02-T1226
SC-444	A16	B3A	D			1				02-T1235
SC-445	A17	B3A	D			0.5				02-T1238
SC-446	A18	B3A	D			0.25				02-T1246
SC-447	A19	B3A	D			0.125				02-T1249
SC-448	A22	B3A	D			1				02-T1259
SC-449	A24	B3A	D			0.25				02-T1265
SC-450	A22	B3A	D			1				02-T1259
SC-451	A26	B3A	D			0.125				02-T1276
SC-452	A27	B3A	D			0.125				02-T1280
SC-453	A28	B3A	D			0.125				02-T1284
SC-454	A30	B3A	D			0.125				02-T1294
SC-455	A29	B3A	D			0.125				02-T1297
SC-456	A25	B3A	D			1				02-T1302
SC-457	A23	B3A	D			0.5				02-T1306
SC-458	A20	B3A	D			0.5				02-T1324
SC-459	A21	B3A	D			0.25				02-T1357
SC-460	A31	B3A	D			0.125				02-T1366
SC-461	A32	B3A	D			0.125				02-T1404
SC-462	G41-02	B3A	D			1	40:1			02-T1408
SC-463	G44-02	B3A	D			1	30:1		D50 = 10	02-T1411
SC-464	G43-02	B3A	D			1	20:1		D50 = 8	02-T1415
SC-465	G42-02	B3A	D			1	5:1		D50 = 11	02-T1424
SC-466	G45-02	B17A	D			1	30:1			02-T1432
SC-467	G37-02	B3A	D			1	10:1			02-T1154
SC-468	G46-02	B17A	D			1	40:1		D50 = 10	02-T1494
SC-469	G47-02	B17A	W	50	H2O	1	10:1			02-T1533
SC-470	G37-02	B3A	D			1	10:1			02-T1154
SC-471	G37-02	B3A	D			1	10:1			02-T1154
SC-472	G37-02	B3A	D			1	10:1			02-T1154
SC-473	G49-02	B17A	W	50	H2O	1	10:1			02-T1582
SC-474	G42-02	B3A	D			1			D50 = 11	02-T1424
SC-475	G51-02	B3A	W		H2O	1	10:1		D50 = 6	02-T1597
SC-476	G52-02	B3A; BM	D; W	50	H2O	1; 0.083	10:1		D50 = 3	02-T1154

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-477	G53-02	B3A	D			1	10:1			02-T1607
SC-478	G54-02	B3A; BM	D			1; 0.083	10:1			02-T1614
SC-479	G55-02	B17A	W	50	H2O	0.083	10:1			02-T1621
SC-480	G56-02	B17A	W	50	H2O	1				02-T1635
SC-481	G58-02	B17A	W	50	H2O	0.25	10:1			02-T1643
SC-482	G57-02	B17A	D			1	10:1		D50 = 11	02-T1655
SC-483	G59-02	BM	W	33	H2O	0.25			D50 = 7	02-T1661
SC-484	G60-02	BM	W	33	H2O	0.5			D50 = 6	02-T1665
SC-485	G61-02	BM	W	33	H2O	0.75			D50 = 6	02-T1670
SC-486	G62-02	BM	W	33	H2O	1			D50 = 5	02-T1695
SC-487	G63-02	B17A	W	50	H2O	0.5	10:1			02-T1698
SC-488										
SC-489										
SC-490										
SC-491										
SC-492	G61-02	BM	W	33	H2O	0.75				02-T1670
SC-493	G42-02	B3A	D			1	5:1		D50 = 11	02-T1424
SC-494	G42-02	B3A	D			1	5:1		D50 = 11	02-T1424
SC-495	G51-02	B3A	W		H2O	1	10:1		D50 = 6	02-T1597
SC-496	G42-02	B3A	D			1	5:1		D50 = 11	02-T1424
SC-497	G42-02	B3A	D			1	5:1		D50 = 11	02-T1424
SC-498	G43-02	B3A	D			1	20:1		D50 = 8	02-T1415
SC-499		B17A	D			1	5:1			02-T1100
SC-500	G01-03	B17A	D			1	5:1			03-T19
SC-501	G03-03	B3A	W		H2O	1	20:1			03-T26
SC-502										
SC-503	G03-03	B3A	W		H2O	1	20:1		D50 = 6	03-T26
SC-504	G03-03	B3A	W		H2O	1	20:1			03-T26
SC-505	G04-03	B3A	W		H2O	1	5:1		D50 = 4	03-T72
SC-506	G04-03	B3A	W		H2O	1	5:1			03-T72
SC-507	G05-03	B17A	D			1	10:1			03-T164
SC-508	G04-03	B3A	W		H2O	1	5:1			03-T72
SC-509										
SC-510	G07-03	MD	W	50	H2O	0.4833	3.5:1	110		03-T207

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-511	G08-03	MD	W	50	H2O	1	3.5:1	234		03-T210
SC-512	G08-03	MD	W	50	H2O	1	3.5:1	234		03-T210
SC-513	G09-03	MD	W	65	H2O	0.1875	2.3:1	30		03-T226
SC-514	G10-03	MD	W	32	H2O	0.1028	5:1	30		03-T230
SC-515	G11-03	MD	W	65	H2O	0.0733	5:1	30		03-T242
SC-516	G12-03	B17A	W	50	H2O	1	10:1			03-T252
SC-517	G12-03	B17A	W	50	H2O	1	10:1			03-T252
SC-518	G12-03	B17A	W	50	H2O	1	10:1			03-T252
SC-519	G13-03	B3A	D			1	55:1			03-T270
SC-520	G14-03	B3A	D			1	55:1			03-T275
SC-521	G15-03	B3A	D			1	55:1			03-T281
SC-522	G17-03	B3A	D			1	55:1			03-T290
SC-523										
SC-524	G19-03	MD	W	50	H2O	0.3295	3.5:1	110		03-T298
SC-525	G20-03	B17A	W	50	H2O	0.7417	3.5:1	110		03-T309
SC-526	G21-03	B17A	W	50	H2O	1.0750	3.5:1	110		03-T313
SC-527	G22-03	B17A	W	50	H2O	1	10:1	334		03-T321
SC-528										
SC-529	G04-03	B3A	W		H2O	1	5:1			03-T333
SC-530	G04-03	B3A	W		H2O	1	5:1			03-T364
SC-531	G24-03	MD	W	50	H2O	0.3258	3.5:1	70		03-T370
SC-532	G24-03	MD	W	50	H2O	0.3258	3.5:1	70		03-T370
SC-533	G24-03	MD	W	50	H2O	0.3258	3.5:1	70		03-T370
SC-534	G25-03	MD	W	50	H2O	0.6287	3.5:1	150		03-T383
SC-535	G26-03	MD	W	50	H2O	0.4122	3.5:1	110		03-T390
SC-536	G28-03	MD	W	50	H2O	0.7461	3.5:1	190		03-T397
SC-537	G27-03	MD	W	50	H2O	0.1372	3.5:1	30		03-T409
SC-538	G29-03	B3A	W		H2O	1	5:1			03-T413
SC-539	G30-03	MD	W	50	H2O	0.4181	3.5:1	110	D50 = 5	03-T422
SC-540	G30-03	MD	W	50	H2O	0.4181	3.5:1	110	D50 = 5	03-T422
SC-541	G31-03	MD	W	50	H2O	0.9581	3.5:1	230		03-T485
SC-542	G32-03	MD	W	50	H2O	0.2650	3.5:1	70		03-T499
SC-543										
SC-544	G34-03	MD	W	65	H2O	0.3586	3.5:1	110		03-T513

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-545	G35-03	MD	W	65	H2O	0.4672	3.5:1	150		03-T517
SC-546	G33-03	MD	W	65	H2O	0.2194	3.5:1	70		03-T526
SC-547	G34-03	MD	W	65	H2O	0.3586	3.5:1	110		03-T513
SC-548	G35-03	MD	W	65	H2O	0.4672	3.5:1	150		03-T517
SC-549	G36-03	MD	W	65	Carb. Solution	0.3906	3.5:1	110		03-T540
SC-550	G36-03	MD	W	65	Carb. Solution	0.3906	3.5:1	110		03-T540
SC-551	G37-03	MD	W	50	H2O	0.1189	3.5:1	30		03-T563
SC-552										
SC-553	G38-03	MD	W	50	H2O	0.2633	3.5:1	70		03-T570
SC-554	G38-03	MD	W	50	H2O	0.2633	3.5:1	70		03-T570
SC-555	G38-03	MD	W	50	H2O	0.2633	3.5:1	70		03-T570
SC-556	G39-03	B3A	W		H2O	1	5:1		D50 = 4	03-T577
SC-557										
SC-558	G40-03	MD	W	50	H2O	0.4589	3.5:1	110	D50 = 8	03-T601
SC-559	G42-03	MD	W	50	H2O	0.5439	3.5:1	150	D50 = 7	03-T627
SC-560										
SC-561										
SC-562										
SC-563										
SC-564										
SC-565										
SC-566										
SC-567	G44-03	B3A	W		H2O	1	5:1			03-T697
SC-568	G47-03	MD	W	50	H2O	0.0919	3.5:1	30		03-T707
SC-569	G48-03	MD	W	50	H2O	0.2989	3.5:1	70		03-T725
SC-570	G49-03	MD	W	50	H2O	0.3967	3.5:1	110		03-T728
SC-571	G49-03	MD	W	50	H2O	0.3967	3.5:1	110		03-T728
SC-572	G48-03	MD	W	50	H2O	0.2989	3.5:1	70		03-T725
SC-573	G50-03	MD	W	50	H2O	0.5008	3.5:1	150		03-T735
SC-574	G47-03	MD	W	50	H2O	0.0919	3.5:1	30		03-T707
SC-575	G48-03	MD	W	50	H2O	0.2989	3.5:1	70		03-T725
SC-576	G49-03	MD	W	50	H2O	0.3967	3.5:1	110		03-T728
SC-577										
SC-578										

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-579										
SC-580										
SC-581										
SC-582										
SC-583										
SC-584										
SC-585										
SC-586										
SC-587	G47-03	MD	W	50	H2O	0.0919	3.5:1	30		03-T707
SC-588										
SC-589										
SC-590										
SC-591										
SC-592	G50-03	MD	W	50	H2O	0.5008	3.5:1	150		03-T735
SC-593										
SC-594	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-595	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-596	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-597	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-598	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-599	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-600										
SC-601	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-602	G61-03	MD	W	50	H2O	0.2657	3.5:1	70		03-T986
SC-603	G63-03	BM	D			1				03-T1090
SC-604	G63-03	BM	D			1				03-T1090
SC-605	G63-03	BM	D			1				03-T1090
SC-606	G63-03	BM	D			1				03-T1090
SC-607	G63-03	BM	D			1				03-T1090
SC-608	G63-03	BM	D			1				03-T1090
SC-609	G61-03	MD	W	50		0.2657	3.5:1	70		03-T986
SC-610	G61-03	MD	W	50		0.2657	3.5:1	70		03-T986
SC-611	G61-03	MD	W	50		0.2657	3.5:1	70		03-T986
SC-612	G61-03	MD	W	50		0.2657	3.5:1	70		03-T986

Appendix A3: Sample ID and Grinding History - Stage 3

	Size Reduction - Stage 3									
Test	Grind No.	Mill	Dry/Wet	% Solids	Grind Solution	Time, h	Media: Charge	Energy, kWh/t	Particle size, um	LIMS No.
SC-613										
SC-614										
SC-615										
SC-616										
SC-617										
SC-618										
SC-619										
SC-620										
SC-621										
SC-622										
SC-623										
SC-624									screened thru 25 um	03-T1208
SC-625									screened 38x25 um	03-T1215
SC-626									screened 53x38 um	03-T1228
SC-627	G65-03	B3A	W	50		0.1	5:1			03-T1233
SC-628										

TSO - Twin Sisters Olivine
CHA - Cedar Hill Antigorite
SWOL - SW Oregon Lizardite
NW - Nycoi Wollastonite
SW - Shell Wollastonite
DBO - Day Book Olivine
FGO - Foundry Grade Olivine

RM - rod mill
BM - ball mill
HBM - hot ball mill
MD - Metso detritor
B3A - Bldg. 3 attritor
B17A - Bldg. 17 attritor
PS - paint shaker

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-1			none						
SC-2			none						
SC-3			none						
SC-4			none						
SC-5			none						
SC-6			none						
SC-7			none						
SC-8			none						
SC-9			none						
SC-10			none						
SC-11			none						
SC-12			none						
SC-13			none						
SC-14			none						
SC-15			none						
SC-16			none						
SC-17			none						
SC-18			none						
SC-19			none						
SC-20			none						
SC-21	383C, 244 atm H2O, 518 rpm, 1h	none	none						
SC-22			none						
SC-23	SC-22 product solids + 1 g make-up	none	none						
SC-24			none						
SC-25			none						
SC-26			none						
SC-27	385C, 274 atm H2O, 2000 rpm, 1h	none	none						
SC-28	385C, 271 atm H2O, 2000 rpm, 1h	none	none						
SC-29			none						
SC-30	1M NaOH, 1M NaCl, 90C, 24h	99-T656	none						
SC-31			none						
SC-32			none						
SC-33			none						
SC-34				12	700	air	11.1	1.23	99-T2162
SC-35	385C, 296 atm H2O, 2000 rpm, 1h	none							
SC-36	1M NaOH, 70C, 12h	99-T2200		2	700	air	11	1.8	99-T2201
SC-37				2	650	air	11.5		
SC-38				2	650	air	12.2	2.97	00-T15
SC-39				3	700	CO2	12	2.27	00-T20
SC-40			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-41			2	2	567	CO2	10	6.02	00-T38
SC-42			none						
SC-43			none						
SC-44			none						
SC-45			5	2	650	air	7	8.41	00-T131
SC-46			3	2	550	CO2	12	4.45	00-T142
SC-47			4	2	650	CO2	11.2	5.65	00-T153
SC-48	1M NaOH, 1M NaCl, 90C, 24h	00-T44	none						
SC-49	10% HCl, 70C, 144h	00-T146	none						
SC-50			5	2	650	CO2	10.6	5.84	00-T172
SC-51			none						
SC-52			none						
SC-53			2	2	650	argon	11	5.62	00-T189
SC-54			6	2	650	CO2	11.4	4.45	00-T197
SC-55			none						
SC-56				2	480	air	30.2	24.4	00-T216
SC-57			none						
SC-58			15	3	650	CO2	13.6	2.31	00-T232
SC-59			15	3	650	CO2	13.6	2.31	00-T232
SC-60	1M NaOH, 1M NaCl, 90C, 24h	00-T266	none						
SC-61	10% HCl, 70C, 168h	00-T264	none						
SC-62			19	2	700	CO2	14	2.55	00-T274
SC-63			18	2	630	CO2	10.4	4.98	00-T281
SC-64			18	2	630	CO2	10.4	4.98	00-T281
SC-65			20	2	650	CO2	10.7	4.4	00-T304
SC-66			20	2	650	CO2	10.7	4.4	00-T304
SC-67			22	2	650	CO2	10.5	4.5	00-T315
SC-68			21	2	630	CO2	11.5	4.32	00-T323
SC-69			21	2	630	CO2	11.5	4.32	00-T323
SC-70			24	3	630	CO2	9.5	5.97	00-T389
SC-71			26	2	640	CO2	11.2	3.96	00-T392
SC-72			26	2	640	CO2	11.2	3.96	00-T392
SC-73			30	2	650	CO2	11.4	4.16	00-T405
SC-74			30	2	630	CO2	11.4	4.16	00-T405
SC-75			29	2	630	CO2	10.5	4.53	00-T421
SC-76			29	2	630	CO2	10.5	4.53	00-T421
SC-77			31	2	630	CO2	11.2	4.26	00-T458
SC-78			31	2	630	CO2	11.2	4.26	00-T458
SC-79	1M NaOH, 1M NaCl, 90C, 24h		23	2	630	CO2	9.9		
SC-80			24	3	630	CO2	9.5	5.97	00-T389

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-81			32	2	630	CO2	11.1	4.3	00-T729
SC-82			32	2	630	CO2	11.1	4.3	00-T729
SC-83			33	2	630	CO2	12.6	3.42	00-T750
SC-84			33	2	630	CO2	12.6	3.42	00-T750
SC-85			34	2	630	CO2	11.6	4.19	00-T757
SC-86			34	2	630	CO2	11.6	4.19	00-T757
SC-87			35	2	630	CO2	11.9	3.92	00-T765
SC-88			35	2	630	CO2	11.9	3.92	00-T765
SC-89			36	2	630	CO2	11	4.82	00-T772
SC-90			36	2	630	CO2	11	4.82	00-T772
SC-91	SC-86 product solids	00-T761							
SC-92			38	2	630	CO2	11.6	4.43	00-T785
SC-93			37	2	630	CO2	12	4.01	00-T792
SC-94			38	2	630	CO2	11.6	4.43	00-T785
SC-95			43	2	200	CO2	1.6	13.8	00-T826
SC-96			44	2	400	CO2	4.3	12.7	00-T837
SC-97			45	2	800	CO2	13.8	1.09	00-T840
SC-98			40	2	630	air	11.9	4.59	00-T922
SC-99			47	2	630	CO2	13	2.88	00-T926
SC-100			48	2	630	air	13	3.31	00-T929
SC-101			40	2	630	air	11.9	4.59	00-T922
SC-102			49	2	1000	CO2	14.1	0.3	00-T939
SC-103			50	2	630	air	11.4	6.03	00-T1036
SC-104			50	2	630	air	11.4	6.03	00-T1036
SC-105			41	2	630	CO2	11.4	4.43	00-T1055
SC-106			41	2	630	CO2	11.4	4.43	00-T1055
SC-107			46			CO2	11.3	4.91	00-T1065
SC-108			46			CO2	11.3	4.91	00-T1065
SC-109			none						
SC-110			none						
SC-111			none						
SC-112			none						
SC-113	ground thru 37 um in NaOH/NaCl	00-T1254	none						
SC-114	NaOH/NaCl, 90C, 24h		none						
SC-115			52	2	630	air	11.4		00-T1383
SC-116			54	2	630	air	11.3		00-T1384
SC-117				3	630	CO2			
SC-118			56	2	630	air	11.7		00-T1385
SC-119			57	2	630	air	11.5		00-T1386
SC-120			57	2	630	air	11.5		00-T1386

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-121			58	2	630	air	13.1		00-T1387
SC-122			59	2	630	air	12.4		00-T1388
SC-123			59	2	630	air	12.4		00-T1388
SC-124			60	2	630	air	11	4.98	00-T1626
SC-125			60	2	630	air	11	4.98	00-T1626
SC-126			61	2	630	air	12.3	5.03	00-T1627
SC-127			61	2	630	air	12.3	5.03	00-T1627
SC-128			62	2	630	air	12.4	5.22	00-T1628
SC-129	NaOH/NaCl, 90C, 24h		none		amb.	air			none
SC-130			64	1	630	air	11.7	4.99	00-T1762
SC-131			64	1	630	air	11.7	4.99	00-T1762
SC-132			64	1	630	air	11.7	4.99	00-T1762
SC-133			64	1	630	air	11.7	4.99	00-T1762
SC-134			none						
SC-135			none						
SC-136			none						
SC-137			none						
SC-138			none						
SC-139			none						
SC-140			none						
SC-141			65	1	630	air	12.3	4.82	00-T2028
SC-142			65	1	630	air	12.3	4.82	00-T2028
SC-143			65	1	630	air	12.3	4.82	00-T2028
SC-144			65	1	630	air	12.3	4.82	00-T2028
SC-145			65	1	630	air	12.3	4.82	00-T2028
SC-146			65	1	630	air	12.3	4.82	00-T2028
SC-147			65	1	630	air	12.3	4.82	00-T2028
SC-148			65	1	630	air	12.3	4.82	00-T2028
SC-149			65	1	630	air	12.3	4.82	00-T2028
SC-150			71	1	630	CO2	12.2	4.66	00-T2116
SC-151			none						
SC-152			none						
SC-153			none						
SC-154			none						
SC-155			none						
SC-156			none						
SC-157			none						
SC-158			72				9.1	7.57	01-T94
SC-159			73				3.7	3.75	01-T112
SC-160	citric acid/NaCl grind	01-T128	none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-161	NaOH/NaCl grind	01-T140	none						
SC-162	NaOH/NaCl grind	01-T140	none						
SC-163			74-76					4.18	01-T178
SC-164			70A-C				11.3	5.29	01-T184
SC-165			70A-C				11.3	5.29	01-T184
SC-166			70A-C				11.3	5.29	01-T184
SC-167			74-76					4.18	01-T178
SC-168			74-76					4.18	01-T178
SC-169			74-76					4.18	01-T178
SC-170			74-76					4.18	01-T178
SC-171			74-76					4.18	01-T178
SC-172			none						
SC-173			none						
SC-174	plus 5% Fe3O4	none	77			CO2	12	3.55	01-T280
SC-175	plus 5% Fe3O4	none	77			CO2	12	3.55	01-T280
SC-176			70A-C						01-T184
SC-177			none						
SC-178			78			air	11.8	3.85	01-T331
SC-179			78			air	11.8	3.85	01-T331
SC-180			none						
SC-181			none						
SC-182			none						
SC-183			none						
SC-184			none						
SC-185			none						
SC-186			none						
SC-187			none						
SC-188			none						
SC-189			none						
SC-190			none						
SC-191			79A-C			air		5.48	01-T596
SC-192			none						
SC-193			none						
SC-194			81A&B			CO2		5.24	01-T611
SC-195	plus 5% MgO	none	none						
SC-196	plus 5% Fe3O4	none	none						
SC-197			79A-C			air		5.48	01-T596
SC-198			79A-C			air		5.48	01-T596
SC-199			79A-C			air		5.48	01-T596
SC-200			83A-C			air		5.17	01-T644

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-201			81A&B			CO2		5.24	01-T611
SC-202			none						
SC-203			none						
SC-204			none						
SC-205			none						
SC-206			none		amb.	air		14.1	none
SC-207			none						
SC-208			none						
SC-209			none						
SC-210			none		amb.	air		2.22	none
SC-211			none		amb.	air		2.25	none
SC-212			none		amb.	air		35.8	none
SC-213			none						
SC-214			none						
SC-215			83A-C			air		5.17	01-T644
SC-216			none						
SC-217			83A-C			air		5.17	01-T644
SC-218			none						
SC-219			none						
SC-220			none						
SC-221			79A-C			air		5.48	01-T596
SC-222			K-III			air		4.91	01-T934
SC-223			K-III			air		4.91	01-T934
SC-224			none						
SC-225			none						
SC-226	plus 5% MgO	none	none						
SC-227			none						
SC-228			none						
SC-229			K-III			air		4.91	01-T934
SC-230			none						
SC-231			none						
SC-232			none						
SC-233			none						
SC-234			none						
SC-235			none						
SC-236			none						
SC-237			none						
SC-238	plus 5% MgO	none	none						
SC-239	1M NaOH/1M NaCl grind	01-T1489	none						
SC-240	1M NaOH/1M NaCl grind	01-T1489	none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-241			none						
SC-242	Liquid Sonification Process	01-T1502	none						
SC-243			none						
SC-244			none						
SC-245			none						
SC-246			none						
SC-247			none						
SC-248			none						
SC-249			none						
SC-250			none						
SC-251			none						
SC-252			none						
SC-253			none						
SC-254			none						
SC-255			none						
SC-256			none						
SC-257			none						
SC-258			none						
SC-259			none						
SC-260			none						
SC-261			none						
SC-262			none						
SC-263			none						
SC-264			none						
SC-265			none						
SC-266			none						
SC-267			none						
SC-268			none						
SC-269			none						
SC-270	composite +20 um product from SC-263-264, 266-268	01-T2185	none						
SC-271	same as SC-270, ground to 95% -20um*	01-T2204	none						
SC-272			none						
SC-273			none						
SC-274			none						
SC-275			none						
SC-276			none						
SC-277			none						
SC-278			none						
SC-279			none						
SC-280			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-281			none						
SC-282			none						
SC-283			none						
SC-284			none						
SC-285			none						
SC-286			none						
SC-287			none						
SC-288			none						
SC-289			none						
SC-290			none						
SC-291			none						
SC-292			none						
SC-293			none						
SC-294			none						
SC-295			none						
SC-296			none						
SC-297			none						
SC-298			none						
SC-299			none						
SC-300			none						
SC-301			none						
SC-302			none						
SC-303			none						
SC-304			none						
SC-305			none						
SC-306			none						
SC-307			none						
SC-308			none						
SC-309			none						
SC-310			none						
SC-311			none						
SC-312			none						
SC-313			none						
SC-314			none						
SC-315			none						
SC-316			none						
SC-317			none						
SC-318			none						
SC-319			none						
SC-320			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-321			none						
SC-322			none						
SC-323			none						
SC-324			none						
SC-325			none						
SC-326			none						
SC-327			none						
SC-328			none						
SC-329			none						
SC-330			none						
SC-331			none						
SC-332			none						
SC-333			none						
SC-334			none						
SC-335			none						
SC-336			none						
SC-337			none						
SC-338			none						
SC-339			none						
SC-340			none						
SC-341			none						
SC-342			none						
SC-343			none						
SC-344			none						
SC-345			none						
SC-346			none						
SC-347			none						
SC-348			none						
SC-349			none						
SC-350			none						
SC-351			none						
SC-352			none						
SC-353			none						
SC-354			none						
SC-355			none						
SC-356			none						
SC-357			none						
SC-358			none						
SC-359			none						
SC-360			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-361			none						
SC-362			none						
SC-363			none						
SC-364			none						
SC-365			none						
SC-366			none						
SC-367			none						
SC-368			none						
SC-369			none						
SC-370			none						
SC-371			none						
SC-372			none						
SC-373			none						
SC-374			none						
SC-375			none						
SC-376			none						
SC-377									
SC-378			none		amb.	air			none
SC-379			none		amb.	air			none
SC-380			none		amb.	air			none
SC-381			none		amb.	air			none
SC-382						air			
SC-383			none		amb.	air			none
SC-384			none		amb.	air			none
SC-385			none		amb.	air			none
SC-386									
SC-387			none		amb.	air			none
SC-388						Ar			
SC-389			none		amb.	air			none
SC-390			none		amb.	air			none
SC-391					amb.	Ar			
SC-392					amb.	Ar			
SC-393					amb.	Ar			
SC-394			none		amb.	air			none
SC-395			none		amb.	air			none
SC-396					amb.	Ar			
SC-397					amb.	Ar			
SC-398						Ar			
SC-399						Ar			
SC-400					amb.	Ar			

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-401						Ar			
SC-402					amb.	Ar			
SC-403					amb.	Ar			
SC-404					amb.	Ar			
SC-405						Ar			
SC-406						Ar			
SC-407					amb.	Ar			
SC-408					amb.	air			
SC-409	+ 10 g CaCO3	none							
SC-410	+ 10 g CaCO3	none							
SC-411	+ 0.9 g MgCO3	none							
SC-412									
SC-413									
SC-414									
SC-415									
SC-416									
SC-417									
SC-418						Ar			
SC-419					amb.	Ar			
SC-420						Ar			
SC-421					amb.	air			
SC-422			none						
SC-423			none						
SC-424			none						
SC-425			none						
SC-426									
SC-427			none						
SC-428			none						
SC-429			none		amb.	air			none
SC-430			none		amb.	air			none
SC-431			none		amb.	air			none
SC-432			none						
SC-433			none						
SC-434			none						
SC-435			none						
SC-436			none		amb.	air			none
SC-437			none						
SC-438			none		amb.	air			none
SC-439			none		amb.	air			none
SC-440						Ar			

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-441						Ar			
SC-442						Ar			
SC-443			none		amb.	air			none
SC-444					amb.	Ar			
SC-445					amb.	Ar			
SC-446					amb.	Ar			
SC-447					amb.	Ar			
SC-448					amb.	Ar			
SC-449					amb.	Ar			
SC-450					amb.	Ar			
SC-451					amb.	Ar			
SC-452						Ar			
SC-453						Ar			
SC-454						Ar			
SC-455						Ar			
SC-456					amb.	Ar			
SC-457					amb.	Ar			
SC-458					amb.	Ar			
SC-459					amb.	Ar			
SC-460					amb.	Ar			
SC-461						Ar			
SC-462			none		amb.	air			none
SC-463			none		amb.	air			none
SC-464			none		amb.	air			none
SC-465			none		amb.	air			none
SC-466			none		amb.	air			none
SC-467			none		amb.	air			none
SC-468			none		amb.	air			none
SC-469			none		amb.	air			none
SC-470			none		amb.	air			none
SC-471			none		amb.	air			none
SC-472			none		amb.	air			none
SC-473			none		amb.	air			none
SC-474			none		amb.	air			none
SC-475			none		amb.	air			none
SC-476			none		amb.	air			none
SC-477			none		amb.	air			none
SC-478			none		amb.	air			none
SC-479			none		amb.	air			none
SC-480			none		amb.	air			none

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-481			none		amb.	air			none
SC-482			none		amb.	air			none
SC-483			none		amb.	air			none
SC-484			none		amb.	air			none
SC-485			none		amb.	air			none
SC-486			none		amb.	air			none
SC-487			none		amb.	air			none
SC-488			none		amb.	air			none
SC-489			none		amb.	air			none
SC-490			none		amb.	air			none
SC-491			none		amb.	air			none
SC-492			none		amb.	air			none
SC-493			none		amb.	air			none
SC-494			none		amb.	air			none
SC-495			none		amb.	air			none
SC-496			none		amb.	air			none
SC-497			none		amb.	air			none
SC-498			none		amb.	air			none
SC-499			none		amb.	air			none
SC-500			none		amb.	air			none
SC-501			none		amb.	air			none
SC-502			none		amb.	air			none
SC-503			none						
SC-504			none						
SC-505			none						
SC-506			none						
SC-507			none						
SC-508			none						
SC-509			none						
SC-510			none						
SC-511			none						
SC-512			none						
SC-513			none						
SC-514			none						
SC-515			none						
SC-516			none						
SC-517			none						
SC-518			none						
SC-519			none						
SC-520			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-521			none						
SC-522			none						
SC-523			none						
SC-524			none						
SC-525			none						
SC-526			none						
SC-527			none						
SC-528			none						
SC-529			none						
SC-530			none						
SC-531			none						
SC-532			none						
SC-533			none						
SC-534			none						
SC-535			none						
SC-536			none						
SC-537			none						
SC-538			none						
SC-539			none						
SC-540			none						
SC-541			none						
SC-542			none						
SC-543			none						
SC-544			none						
SC-545			none						
SC-546			none						
SC-547			none						
SC-548			none						
SC-549			none						
SC-550			none						
SC-551			none						
SC-552			none						
SC-553			none						
SC-554			none						
SC-555			none						
SC-556			none						
SC-557			none						
SC-558			none						
SC-559			none						
SC-560			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-561			none						
SC-562			none						
SC-563			none						
SC-564			none						
SC-565			none						
SC-566			none						
SC-567			none						
SC-568			none						
SC-569			none						
SC-570			none						
SC-571			none						
SC-572			none						
SC-573			none						
SC-574			none						
SC-575			none						
SC-576			none						
SC-577			none						
SC-578			none						
SC-579			none						
SC-580			none						
SC-581			none						
SC-582			none						
SC-583			none						
SC-584			none						
SC-585			none						
SC-586			none						
SC-587			none						
SC-588			none						
SC-589			none						
SC-590			none						
SC-591			none						
SC-592			none						
SC-593			none						
SC-594			none						
SC-595			none						
SC-596			none						
SC-597			none						
SC-598			none						
SC-599			none						
SC-600			none						

Appendix B: Pretreatment History

	Chemical pretreatment		Heat Pretreatment						
Test	Description	LIMS No.	HT No.	Time, h	Temp., C	Atm	Wt loss, pct	LOI	LIMS No.
SC-601			none						
SC-602			none						
SC-603			none						
SC-604			none						
SC-605			none						
SC-606			none						
SC-607			none						
SC-608			none						
SC-609			none						
SC-610			none						
SC-611			none						
SC-612			none						
SC-613			none						
SC-614			none						
SC-615			none						
SC-616			none						
SC-617			none						
SC-618			none						
SC-619			none						
SC-620			none						
SC-621			none						
SC-622			none						
SC-623			none						
SC-624			none						
SC-625			none						
SC-626			none						
SC-627			none						
SC-628			none						

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-1	24	158	87-79	20	480	distilled H2O	98-P2256
SC-2	24	136	128-123	20	480	distilled H2O	98-P2301
SC-3	24	188	126-117	20	480	distilled H2O	98-S2351
SC-4	24	185	129-120	20	480	distilled H2O	98-S2389
SC-5	24	250	118-41	25	480	distilled H2O	98-S2566
SC-6	-	250	126	20	470	distilled H2O	none
SC-7	-	250	126	20	465	distilled H2O	none
SC-8	-	250	126	20	480	distilled H2O	none
SC-9	24	250	82	20	475	distilled H2O	98-S2616
SC-10	6	186	128-122	20	475	distilled H2O	99-S176
SC-11	48	186	130-68	20	475	distilled H2O	99-S318
SC-12	3	186	131-101	20	465	distilled H2O	99-T326
SC-13	12	186	132-124	20	470	distilled H2O	99-T333
SC-14	144	150	51	20	470	distilled H2O	99-T384
SC-15	3	186	126-107	20	460	distilled H2O	99-T387
SC-16	3	186	130-125	20	470	distilled H2O	99-T389
SC-17	-	385	99	20	550	distilled H2O	99-T631
SC-18	3	186	125-107	20	465	distilled H2O	99-T634
SC-19	-	385	99	20	580	distilled H2O	99-T658
SC-20	3	383	99	20	553	distilled H2O	99-S671
SC-21	3	250	299	20	540	distilled H2O	99-T688
SC-22	-	250	299	20	540	distilled H2O	none
SC-23	3	185	329	20	516	distilled H2O	99-T694
SC-24	24	185	115	20	543	distilled H2O	99-T800
SC-25	24	185	115	15	2000	distilled H2O	99-T968
SC-26	24	185	115	15	2000	seawater	99-T1003
SC-27		250	163	15	2000	distilled H20	99-T1007
SC-28	24	185	115	15	2000	distilled H20	99-T1540
SC-29	24	300	255	15	2000	distilled H20	99-T1552
SC-30	24	185	115	15	2000	distilled H20	99-T2072
SC-31	24	185	115	15	2000	distilled H20	99-T2088
SC-32	24	185	115	15	2000	distilled H20	99-T2095
SC-33	24	185	115	15	2000	distilled H20	99-T2147
SC-34		185	115	15	2000	distilled H20	99-T2163
SC-35	24	185	115	15	2000	distilled H20	99-T2190
SC-36	24	185	115	15	2000	distilled H20	99-T2202
SC-37	24	185	115	15	2000	0.5M NaHCO3	99-T2207
SC-38	24	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T16
SC-39	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T21
SC-40	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T30
SC-41	24	185	115	15	2000	distilled H20	00-T39
SC-42	4	115	80	15	2000	0.5M NaHCO3/1M NaCl	00-T120
SC-43	6	185	80	15	2000	0.5M NaHCO3/1M NaCl	00-T125
SC-44	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T129
SC-45	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T132
SC-46	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T143
SC-47	3	220	115	15	2000	0.5M NaHCO3/1M NaCl	00-T154
SC-48	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T160
SC-49	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T162
SC-50	3	220	150	15	2000	0.5M NaHCO3/1M NaCl	00-T173
SC-51	3	255	115	15	2000	0.5M NaHCO3/1M NaCl	00-T178
SC-52	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T183
SC-53	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T190
SC-54	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T198
SC-55	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T203
SC-56	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T217

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-57	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T225
SC-58	3	185	115	15	2000	0.64M NaHCO3/1M NaCl	00-T233
SC-59	3	185	115	15	2000	0.5M NaHCO3/1.5M NaCl	00-T251
SC-60	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T255
SC-61	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T259
SC-62	3	185	115	15	2000	0.64M NaHCO3/1M NaCl	00-T275
SC-63	3	185	115	15	2000	0.75M NaHCO3/0.5M NaCl	00-T282
SC-64	3	200	115	15	2000	0.75M NaHCO3/0.5M NaCl	00-T297
SC-65	3	170	115	15	2000	0.75M NaHCO3/0.5M NaCl	00-T305
SC-66	3	155	115	15	2000	0.75M NaHCO3/0.5M NaCl	00-T309
SC-67	3	185	80	15	2000	0.64M NaHCO3/1M NaCl	00-T316
SC-68	3	185	50	15	2000	0.64M NaHCO3/1M NaCl	00-T324
SC-69	1	185	115	15	2000	0.64M NaHCO3/1M NaCl	00-T326
SC-70	2	155	115	15	2000	0.64M NaHCO3/1M NaCl	00-T390
SC-71	3	185	115	15	2000	0.36M NaHCO3/2M NaCl	00-T393
SC-72	3	185	115	15	2000	0.25M NaHCO3/0.25M Na2CO3/1M NaCl	00-T402
SC-73	3	185	115	15	2000	0.5M NaHCO3/1M NaCl	00-T406
SC-74	3	185	115	15	2000	4.5g/L NaOH	00-T409
SC-75	3	185	115	15	2000	1 ml 100g/L HCl/1M NaCl	00-T422
SC-76	2	185	115	15	2000	4.5g/L NaOH/1M NaCl	00-T430
SC-77	3	185	115	15	2000	1M NaCl	00-T459
SC-78	1	185	115	15	2000	1.2M NaHCO3/1M NaCl (50C)	00-T500
SC-79	1	185	115	15	2000	0.64M NaHCO3/1M NaCl	00-T719
SC-80	3	155	115	15	2000	0.64M NaHCO3/1M NaCl	00-T723
SC-81	3	140	115	15	2000	0.64M NaHCO3/1M NaCl	00-T730
SC-82	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T747
SC-83	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T751
SC-84	0.5	155	185	15	2000	0.64M NaHCO3/1M NaCl	00-T754
SC-85	0.5	155	220	15	2000	0.64M NaHCO3/1M NaCl	00-T758
SC-86	0.5	155	11	15	2000	0.64M NaHCO3/1M NaCl	00-T761
SC-87	0	155	4	15	2000	0.64M NaHCO3/1M NaCl	00-T766
SC-88	0.5	115	4	15	2000	0.64M NaHCO3/1M NaCl	00-T769
SC-89	0.5	155	185	15	2000	0.64M NaHCO3/1M NaCl	00-T774
SC-90	0.5	155	185	15	2000	0.64M NaHCO3/1M NaCl	00-T778
SC-91	0	155	10	15	1000	0.64M NaHCO3/1M NaCl	00-T782
SC-92	0.5	155	11	15	2000	0.64M NaHCO3/1M NaCl	00-T786
SC-93	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T793
SC-94	3	155	11	15	2000	0.64M NaHCO3/1M NaCl	00-T816
SC-95	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T827
SC-96	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T838
SC-97	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T841
SC-98	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T923
SC-99	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T927
SC-100	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T930
SC-101	1	155	115	15	2000	0.64M NaHCO3/1M NaCl	00-T937
SC-102	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T940
SC-103	0.5	155	185	15	2000	0.64M NaHCO3/1M NaCl	00-T1037
SC-104	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1039
SC-105	1	125	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1056
SC-106	1	185	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1058
SC-107	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1066
SC-108	1	155	150	15	2000	1.2M KHCO3/1M KCl	00-T1071
SC-109	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1089
SC-110	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1161
SC-111	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1248
SC-112	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1250

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-113	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1255
SC-114	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1344
SC-115	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1390
SC-116	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1391
SC-117	2	155	150	12	1500	0.64M NaHCO3/1M NaCl	00-T1392
SC-118	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1393
SC-119	1		150	15	2000	0.64M NaHCO3/1M NaCl	00-T1394
SC-120	1		150	15	1500	0.64M NaHCO3/1M NaCl	00-T1395
SC-121	1	155	150	26	2000	0.64M NaHCO3/1M NaCl	00-T1396
SC-122	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T1397
SC-123	1	155	150	15	500	0.64M NaHCO3/1M NaCl	00-T1629
SC-124	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T1630
SC-125	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1631
SC-126	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T1632
SC-127	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1633
SC-128	1	155	150	26	1000	0.64M NaHCO3/1M NaCl	00-T1634
SC-129	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T1674
SC-130	1	155	150	25	1000	0.64M NaHCO3/1M NaCl	00-T1763
SC-131	1	155	22.5	25	1000	0.64M NaHCO3/1M NaCl	00-T1819
SC-132	1	155	150	25	1000	0.64M NaHCO3/1M NaCl	00-T1822
SC-133	1	155	75	25	1000	0.64M NaHCO3/1M NaCl	00-T1824
SC-134	0	155	10	15	1000	0.64M NaHCO3/1M NaCl	00-T2018
SC-135	0.5	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2020
SC-136	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2023
SC-137	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2025
SC-138	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2030
SC-139	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	00-T2038
SC-140	12	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2055
SC-141	0.5	155	185	30	2000	0.64M NaHCO3/1M NaCl	00-T2057
SC-142	0	155	10	15	1000	0.64M NaHCO3/1M NaCl	00-T2060
SC-143	0.5	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2062
SC-144	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2065
SC-145	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2067
SC-146	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2074
SC-147	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2097
SC-148	12	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2103
SC-149	1	155	150	15	1000	1M NH4HCO3/ 1M NH4Cl	00-T2105
SC-150	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2117
SC-151	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2135
SC-152	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2185
SC-153	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T2189
SC-154	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2
SC-155	3	155	150	15	2000	0.64M NaHCO3/1M NaCl	01-T7
SC-156	6	155	150	15	2000	0.64M NaHCO3/1M NaCl	01-T20
SC-157	12	155	150	15	2000	0.64M NaHCO3/1M NaCl	01-T31
SC-158	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T95
SC-159	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T113
SC-160	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	01-T129
SC-161	1	155	150	15	2000	0.64M NaHCO3/1M NaCl	01-T141
SC-162	1	155	150	15	2000	1M NaOH/1M NaCl	01-T155
SC-163	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T179
SC-164	1	155	150	15	1000	0.64M NaHCO3/1M NaCl/0.5M Na2SO4	01-T185
SC-165	1	155	150	15	1000	0.64M NaHCO3/1M NaCl/0.5M Na2SO3	01-T193
SC-166	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T199
SC-167	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T210
SC-168	0	155	10	15	1000	0.64M NaHCO3/1M NaCl	01-T213

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-169	0.5	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T215
SC-170	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T220
SC-171	12	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T244
SC-172	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	00-T265
SC-173	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T275
SC-174	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T281
SC-175	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T303
SC-176	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T314
SC-177	1	300	150	15	1000	0.64M NaHCO3/1M NaCl	01-T318
SC-178	0	155	24	15	1000	0.64M NaHCO3/1M NaCl	01-T332
SC-179	1	155	20	15	1000	0.64M NaHCO3/1M NaCl	01-T334
SC-180	52 min	300	150	15	1000	0.64M NaHCO3/1M NaCl	01-T337
SC-181	1	250	150	15	1000	0.64M NaHCO3/1M NaCl	01-T381
SC-182	3	300	150	15	1000	0.64M NaHCO3/1M NaCl	01-T398
SC-183	6	155	150	30	1000	0.64M NaHCO3/1M NaCl	01-T694
SC-184	6	155	150	30	1000	0.64M NaHCO3/1M NaCl	01-T698
SC-185	6	155	150	30	1000	0.64M NaHCO3/1M NaCl	01-T702
SC-186	6	155	150	30	1000	0.64M NaHCO3/1M NaCl	01-T709
SC-187	6	155	20	15	1000	0.64M NaHCO3/1M NaCl	01-T580
SC-188	6	185	20	15	1000	0.64M NaHCO3/1M NaCl	01-T587
SC-189	6	215	20	15	1000	0.64M NaHCO3/1M NaCl	01-T591
SC-190	6	125	20	15	1000	0.64M NaHCO3/1M NaCl	01-T594
SC-191	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T597
SC-192	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T604
SC-193	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T609
SC-194	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T612
SC-195	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T620
SC-196	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T623
SC-197	1	155	20	15	1000	0.64M NaHCO3/1M NaCl	01-T630
SC-198	1	50	20	15	1000	0.64M NaHCO3/1M NaCl	01-T638
SC-199	1	24	20	15	1000	0.64M NaHCO3/1M NaCl	01-T641
SC-200	1	50	20	15	1000	0.64M NaHCO3/1M NaCl	01-T645
SC-201	1	50	20	15	1000	0.64M NaHCO3/1M NaCl	01-T655
SC-202	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T664
SC-203	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T668
SC-204	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T680
SC-205	24	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T711
SC-206	24	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T731
SC-207	24	155	150	15	1000	distilled H20	01-T738
SC-208	24	155	150	15	1000	distilled H20	01-T740
SC-209	1	155	150	15	1000	0.64M NaHCO3/1M NaCl (acidified)	01-T744
SC-210	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T757
SC-211	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T761
SC-212	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T795
SC-213	6	155	150	15	1000	recyc soln from ol tests 155-57,161,187-88	01-T798
SC-214	24	155	150	15	1000	recyc soln from ol tests 155-57,161,187-88	01-T822
SC-215	1	155	150	15	1000	recyc soln from serp tests 163,167-71	01-T830
SC-216	6	155	150	15	1000	recyc soln from serp tests 163,167-71	01-T836
SC-217	24	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T842
SC-218	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T847
SC-219	6	155	150	15	1000	recyc soln from SC218 + fresh makeup	01-T853
SC-220	6	185	125	15	2000	0.5M NaHCO3/1M NaCl	01-T878
SC-221	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T891
SC-222	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T935
SC-223	1	155	150	15	1000	0.64M NaHCO3/0.75M NaCl/0.12M MgCl2	01-T944
SC-224	3	155	150	15	1000	0.64M NaHCO3/0.75M NaCl/0.12M MgCl2	01-T947

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-225	6	185	115	15	2000	0.5M NaHCO3/1M NaCl	01-T951
SC-226	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1242
SC-227	1	155	150	15	1000	0.64M NaHCO3/0.75M NaCl/0.12M MgCl2	01-T1249
SC-228	24	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1263
SC-229	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1267
SC-230	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1283
SC-231	3	155	150	15	1000	Utah salt sol'n	01-T1325
SC-232	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1335
SC-233	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1338
SC-234	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1379
SC-235	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1382
SC-236	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1384
SC-237	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1391
SC-238	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1473
SC-239	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1490
SC-240	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1495
SC-241	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1498
SC-242	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1503
SC-243	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1505
SC-244	1	185	150	15	1000	Utah salt sol'n	01-T1575
SC-245	3	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1576
SC-246	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1601
SC-247	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1606
SC-248	1	35	10	15	1000	0.64M NaHCO3/1M NaCl	01-T1621
SC-249	1	215	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1690
SC-250	1	40	10	15	1000	0.64M NaHCO3/1M NaCl	01-T1695
SC-251	0.5	38	10	15	1000	0.64M NaHCO3/1M NaCl	01-T1703
SC-252	0.25	39	10	15	1000	0.64M NaHCO3/1M NaCl	01-T1739
SC-253	0.25	42	57	15	2000	0.64M NaHCO3/1M NaCl	01-T1748
SC-254	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1753
SC-255	0.5	48	10	15	1000	distilled H20	01-T1760
SC-256	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1828
SC-257	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1834
SC-258	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1837
SC-259	2	185	150	30	1000	0.64M NaHCO3/1M NaCl	01-T1972
SC-260	2	185	115	30	1000	0.64M NaHCO3/1M NaCl	01-T1974
SC-261	1	18	1	15	1800	0.64M NaHCO3/1M NaCl	01-T1977
SC-262	1	24	1	15	1800	0.64M NaHCO3/1M NaCl	01-T1979
SC-263	2	185	115	30	1000	0.64M NaHCO3/1M NaCl	01-T1985
SC-264	2	185	150	30	1000	0.64M NaHCO3/1M NaCl	01-T1988
SC-265	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T1994
SC-266	2	185	150	24	1000	0.64M NaHCO3/1M NaCl	01-T1998
SC-267	2	185	150	30	1000	0.64M NaHCO3/1M NaCl	01-T2009
SC-268	2	185	115	30	1000	0.64M NaHCO3/1M NaCl	01-T2014
SC-269	1	22	10	15	1000	0.64M NaHCO3/1M NaCl	01-T2025
SC-270	2	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2186
SC-271	2	185	150	30	1000	0.64M NaHCO3/1M NaCl	01-T2205
SC-272	1	185	150	15	1000	distilled H20	01-T2239
SC-273	1	185	150	15	1000	distilled H20	01-T2274
SC-274	6	185	150	15	1000	distilled H20	01-T2277
SC-275	1	185	150	15	1000	distilled H20	01-T2279
SC-276	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2284
SC-277	1	26	10	15	1000	0.64M NaHCO3/1M NaCl	01-T2287
SC-278	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2290
SC-279	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2299
SC-280	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2311

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-281	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2316
SC-282	1	20	10	15	1000	0.64M NaHCO3/1M NaCl	01-T2320
SC-283	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2342
SC-284	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2354
SC-285	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2357
SC-286	1	185	~23	15	1000	0.64M NaHCO3/1M NaCl	01-T2360
SC-287	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2366
SC-288	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2369
SC-289	0.5	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2376
SC-290	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2382
SC-291	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2385
SC-292	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2389
SC-293	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2415
SC-294	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2419
SC-295	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	01-T2424
SC-296	1	185	20	15	1000	0.64M NaHCO3/1M NaCl	01-T2425
SC-297	1	185	100	15	1000	0.64M NaHCO3/1M NaCl	01-T2428
SC-298	1	185	250	15	1000	0.64M NaHCO3/1M NaCl	01-T2450
SC-299	1	185	75	15	1000	0.64M NaHCO3/1M NaCl	02-T1
SC-300	1	185	50	15	1000	0.64M NaHCO3/1M NaCl	02-T3
SC-301	1	185	125	15	1000	0.64M NaHCO3/1M NaCl	02-T6
SC-302	1	185	200	15	1000	0.64M NaHCO3/1M NaCl	02-T8
SC-303	1	185	125	15	1000	0.64M NaHCO3/1M NaCl	02-T11
SC-304	1	185	145	15	1000	0.64M NaHCO3/1M NaCl	02-T20
SC-305	0.5	185	145	15	1000	0.64M NaHCO3/1M NaCl	02-T25
SC-306	0.5	185	200	15	1000	0.64M NaHCO3/1M NaCl	02-T31
SC-307	0.5	185	48	15	1000	0.64M NaHCO3/1M NaCl	02-T35
SC-308	0.5	185	100	15	1000	0.64M NaHCO3/1M NaCl	02-T37
SC-309	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T41
SC-310	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T58
SC-311	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T65
SC-312	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T69
SC-313	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T84
SC-314	3	20	1	13	-	0.64M NaHCO3/1M NaCl	02-T125
SC-315	3	20	1	13	-	0.64M NaHCO3/1M NaCl	02-T127
SC-316	3	185	150	30	1500	0.64M NaHCO3/1M NaCl	02-T150
SC-317	3	185	150	40	1500	0.64M NaHCO3/1M NaCl	02-T152
SC-318	3	185	150	50	1500	0.64M NaHCO3/1M NaCl	02-T155
SC-319	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T165
SC-320	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T169
SC-321	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T174
SC-322	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T177
SC-323	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T182
SC-324	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T186
SC-325	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T199
SC-326	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T245
SC-327	0.25	30	10	15	1000	0.64M NaHCO3/1M NaCl	02-T248
SC-328	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T253
SC-329	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T256
SC-330	1	26	150	15	1000	0.64M NaHCO3/1M NaCl	02-T259
SC-331	1	26	150	15	1000	0.64M NaHCO3/1M NaCl	02-T261
SC-332	1	65	150	15	1000	0.64M NaHCO3/1M NaCl	02-T264
SC-333	1	95	150	15	1000	0.64M NaHCO3/1M NaCl	02-T272
SC-334	1	125	150	15	1000	0.64M NaHCO3/1M NaCl	02-T275
SC-335	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T277
SC-336	1	215	150	15	1000	0.64M NaHCO3/1M NaCl	02-T286

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-337	1	245	150	15	1000	0.64M NaHCO3/1M NaCl	02-T289
SC-338	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T293
SC-339	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T296
SC-340	1	125	150	15	1000	0.64M NaHCO3/1M NaCl	02-T300
SC-341	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T303
SC-342	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T311
SC-343	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T319
SC-344	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T326
SC-345	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T329
SC-346	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T333
SC-347	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T336
SC-348	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T342
SC-349	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T369
SC-350	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T426
SC-351	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T429
SC-352	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T433
SC-353	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T436
SC-354	1	185	150	15	1000	recycle	02-T441
SC-355	1	185	150	15	1000	recycle	02-T444
SC-356	1	185	150	15	1000	distilled H20	02-T446
SC-357	1	185	150	15	1000	distilled H20	02-T457
SC-358	1	185	150	15	1000	distilled H20	02-T474
SC-359	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T477
SC-360	1	24	10	15	1000	0.64M NaHCO3/1M NaCl	02-T492
SC-361	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T500
SC-362	1	185	150	15	1000	distilled H20	02-T504
SC-363	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T524
SC-364	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T532
SC-365	1	185	147	15	1000	0.64M NaHCO3/1M NaCl	02-T541
SC-366	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T548
SC-367	1	200	40	15	1000	0.64M NaHCO3/1M NaCl	02-T551
SC-368	1	200	40	15	1000	0.64M NaHCO3/1M NaCl	02-T555
SC-369	1	21	10	15	1000	0.64M NaHCO3/1M NaCl	02-T558
SC-370	1	185	150	15	1000	distilled H20	02-T566
SC-371	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T569
SC-372	1	185	150	15	1000	distilled H20	02-T571
SC-373	1	26	10	15	1000	distilled H20	02-T582
SC-374	1	200	40	15	1000	distilled H20	02-T589
SC-375	1	200	40	15	1000	distilled H20	02-T601
SC-376	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T608
SC-377	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T620
SC-378	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T626
SC-379	1	200	150	15	1000	0.64M NaHCO3/1M NaCl	02-T634
SC-380	1	230	150	15	1000	0.64M NaHCO3/1M NaCl	02-T636
SC-381	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T662
SC-382	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T671
SC-383	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T674
SC-384	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T679
SC-385	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T684
SC-386	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T692
SC-387	3	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T696
SC-388	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T701
SC-389	0.5	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T704
SC-390	0	185	10	15	1000	0.64M NaHCO3/1M NaCl	02-T709
SC-391	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T713
SC-392	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T717

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-393	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T723
SC-394	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T731
SC-395	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T734
SC-396	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T745
SC-397	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T763
SC-398	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T772
SC-399	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T792
SC-400	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T795
SC-401	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T800
SC-402	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T803
SC-403	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T811
SC-404	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T824
SC-405	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T829
SC-406	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T836
SC-407	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T884
SC-408	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T901
SC-409	1	185	150	15.7	1000	distilled H20	02-T914
SC-410	1	185	150	15.7	1000	0.64M NaHCO3/1M NaCl	02-T917
SC-411	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T934
SC-412	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T940
SC-413	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T948
SC-414	1	185	150	12	1000	0.64M NaHCO3/1M NaCl	02-T952
SC-415	24	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T968
SC-416	2	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T971
SC-417	0.5	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T978
SC-418	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T990
SC-419	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T996
SC-420	1	155	150	14	1000	0.64M NaHCO3/1M NaCl	02-T1002
SC-421	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1012
SC-422	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1029
SC-423	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1037
SC-424	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1047
SC-425	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1053
SC-426	1	155	150	14.4	1000	0.64M NaHCO3/1M NaCl	02-T1061
SC-427	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1063
SC-428	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1093
SC-429	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1097
SC-430	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1101
SC-431	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1107
SC-432	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1111
SC-433	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1125
SC-434	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1135
SC-435	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1140
SC-436	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1155
SC-437	6	185	150	15	1000	distilled H20	02-T1158
SC-438	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1164
SC-439	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1177
SC-440	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1187
SC-441	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1209
SC-442	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1224
SC-443	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1227
SC-444	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1236
SC-445	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1239
SC-446	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1247
SC-447	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1250
SC-448	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1260

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-449	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1266
SC-450	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1269
SC-451	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1277
SC-452	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1281
SC-453	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1285
SC-454	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1295
SC-455	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1298
SC-456	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1303
SC-457	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1307
SC-458	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1325
SC-459	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1358
SC-460	1	155	150	6.4	1000	0.64M NaHCO3/1M NaCl	02-T1367
SC-461	1	155	150	7.5	1000	0.64M NaHCO3/1M NaCl	02-T1405
SC-462	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1409
SC-463	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1412
SC-464	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1416
SC-465	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1425
SC-466	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1433
SC-467	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	see note
SC-468	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1495
SC-469	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1534
SC-470	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1538
SC-471	1	185	100	15	1000	0.64M NaHCO3/1M NaCl	02-T1567
SC-472	1	185	50	15	1000	0.64M NaHCO3/1M NaCl	02-T1580
SC-473	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1583
SC-474	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1595
SC-475	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1598
SC-476	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1604
SC-477	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1608
SC-478	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1615
SC-479	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1622
SC-480	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1636
SC-481	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1644
SC-482	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1656
SC-483	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1662
SC-484	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1666
SC-485	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1671
SC-486	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1696
SC-487	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1699
SC-488	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1706
SC-489	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1708
SC-490	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1717
SC-491	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1731
SC-492	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1734
SC-493	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1737
SC-494	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1748
SC-495	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1750
SC-496	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1754
SC-497	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	02-T1756
SC-498	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T11
SC-499	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T16
SC-500	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T20
SC-501	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T27
SC-502	6	185	150	13	1000	0.64M NaHCO3/1M NaCl	03-T41
SC-503	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T43
SC-504	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T70

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-505	1	175	150	10	1000	0.64M NaHCO3/1M NaCl	03-T141
SC-506	0	175	150	10	1000	0.64M NaHCO3/1M NaCl	03-T147
SC-507	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T165
SC-508	1	175	150	15	1000	0.64M NaHCO3/1M NaCl	03-T168
SC-509	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T176
SC-510	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T208
SC-511	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T211
SC-512	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T219
SC-513	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T227
SC-514	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T231
SC-515	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T242
SC-516	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T253
SC-517	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T257
SC-518	6	185	150	15	1000	Simulated Basalt Aquifer	03-T260
SC-519	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T271
SC-520	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T276
SC-521	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T282
SC-522	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T291
SC-523	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T296
SC-524	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T299
SC-525	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T310
SC-526	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T314
SC-527	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T322
SC-528	6	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T329
SC-529	1	175	150	15	1000	0.64M NaHCO3/1M NaCl	03-T334
SC-530	1	175	150	15	1000	0.64M NaHCO3/1M NaCl	03-T365
SC-531	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T371
SC-532	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T375
SC-533	1	185	150	14	1000	0.64M NaHCO3/1M NaCl	03-T380
SC-534	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T384
SC-535	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T391
SC-536	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T398
SC-537	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T410
SC-538	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T414
SC-539	1	185	145	15	1000	0.64M NaHCO3/1M NaCl	03-T423
SC-540	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T488
SC-541	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T486
SC-542	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T500
SC-543	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T511
SC-544	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T514
SC-545	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T518
SC-546	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T527
SC-547	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T531
SC-548	0.25	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T535
SC-549	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T541
SC-550	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T550
SC-551	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T564
SC-552	1	185	150	15	1000	distilled H20	03-T567
SC-553	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T571
SC-554	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T574
SC-555	1	185	150	14	1000	0.64M NaHCO3/1M NaCl	03-T586
SC-556	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T590
SC-557	1	185	150	15	1000	distilled H20	03-T597
SC-558	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T602
SC-559	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T628
SC-560	1	185	150	15	1000	distilled H20	03-T634

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-561	1	200	40	15	1000	distilled H20	03-T642
SC-562	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T645
SC-563	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T650
SC-564	1	185	150	15	1000	distilled H20	03-T680
SC-565	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T686
SC-566	1	200	40	15	1000	distilled H20	03-T695
SC-567	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T698
SC-568	1	200	40	15	1000	distilled H20	03-T708
SC-569	1	200	40	15	1000	distilled H20	03-T726
SC-570	1	200	40	15	1000	distilled H20	03-T729
SC-571	0.5	200	40	15	1000	distilled H20	03-T731
SC-572	0.5	200	40	15	1000	distilled H20	03-T733
SC-573	1	200	40	15	1000	distilled H20	03-T736
SC-574	0.5	200	40	15	1000	distilled H20	03-T738
SC-575	0.25	200	40	14.8	1000	distilled H20	03-T740
SC-576	0	200	10	15	1000	distilled H20	03-T746
SC-577	0.5	24	10	15	1000	distilled H20	03-T749
SC-578	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T753
SC-579	0	100	10	15	1000	distilled H20	03-T763
SC-580	0	150	10	15	1000	distilled H20	03-T778
SC-581	0	200	10	15	1000	distilled H20	03-T789
SC-582	0	150	10	15	1000	distilled H20	03-T793
SC-583	0	116	10	14.9	1000	distilled H20	03-T799
SC-584	0	150	10	15	1000	distilled H20	03-T810
SC-585	0	200	10	15	1000	distilled H20	03-T812
SC-586	0	200	10	15	1000	distilled H20	03-T816
SC-587	0	200	10	14.1	1000	distilled H20	03-T818
SC-588	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T885
SC-589	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T897
SC-590	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T934
SC-591	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T953
SC-592	1	200	40	30	1000	distilled H20	03-T973
SC-593	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T981
SC-594	1	200	40	15	1000	0.64M NaHCO3/1M NaCl	03-T987
SC-595	1	150	40	15	1000	distilled H20	03-T1002
SC-596	1	200	10	15	1000	distilled H20	03-T1004
SC-597	1	100	40	15	1000	distilled H20	03-T1021
SC-598	1	250	40	15	1000	distilled H20	03-T1033
SC-599	1	200	40	15	1000	distilled H20	03-T1056
SC-600	1	155	150	15	1000	0.64M NaHCO3/1M NaCl	03-T1059
SC-601	1	100	10	15	1000	distilled H20	03-T1062
SC-602	1	150	10	15	1000	distilled H20	03-T1068
SC-603	1	200	40	15	1000	distilled H20	03-T1091
SC-604	1	150	40	15	1000	distilled H20	03-T1093
SC-605	1	100	40	15	1000	distilled H20	03-T1099
SC-606	1	200	70	15	1000	distilled H20	03-T1101
SC-607	1	200	10	15	1000	distilled H20	03-T1108
SC-608	1	200	150	15	1000	distilled H20	03-T1110
SC-609	1	75	40	15	1000	distilled H20	03-T1113
SC-610	1	29	40	15	1000	distilled H20	03-T1120
SC-611	1	50	40	15	1000	distilled H20	03-T1127
SC-612	1	200	40	15	1000	tap H2O	03-T1129
SC-613	1	200	40	15	1000	distilled H20	03-T1136
SC-614	1	200	40	15	1500	distilled H20	03-T1141
SC-615	1	200	40	15	1000	distilled H20	03-T1152
SC-616	1	200	40	13.7	1500	distilled H20	03-T1158

Appendix C: Carbonation Parametric Space Conditions

Test	Carbonation Conditions						Product Solids
	Time, h	Temp., C	PCO2, atm	Solids, pct	rpm	Starting Solution	LIMS No.
SC-617	1	200	40	15	1500	distilled H20	03-T1162
SC-618	1	200	40	15	1500	distilled H20	03-T1174
SC-619	1	200	40	15	1500	distilled H20	03-T1179
SC-620	1	200	40	15	1500	distilled H20	03-T1186
SC-621	1	200	40	15	1500	distilled H20	03-T1196
SC-622	1	200	40	15	1500	distilled H20	03-T1199
SC-623	1	200	40	15	1500	distilled H20	03-T1203
SC-624	1	185	150	15	1500	0.64M NaHCO3/1M NaCl	03-T1209
SC-625	1	185	150	15	1500	0.64M NaHCO3/1M NaCl	03-T1216
SC-626	1	185	150	15	1500	0.64M NaHCO3/1M NaCl	03-T1229
SC-627	1	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T1233
SC-628	6	185	150	15	1000	0.64M NaHCO3/1M NaCl	03-T1260

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, %				Wt Gain CO2 @ 100% Conversion	Conversion, pct	
		Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)		By Wt Gain	By Stoichiometry
SC-1	98-P2256				6.9	0.0	-	--
SC-2	98-P2301				2.27	0.0	-	--
SC-3	98-S2351				18.3	0.0	-	--
SC-4	98-S2389				17.7	0.0	-	--
SC-5	98-S2566				1.45	0.0	-	--
SC-6	none			-	-	--	-	--
SC-7	none			-	-	--	-	--
SC-8	none			-	-	--	-	--
SC-9	98-S2616				0.07	0.0	-	--
SC-10	99-S176				1.25	0.0	2	--
SC-11	99-S318				19.8	0.0	43	--
SC-12	99-T326				0.33	0.0	1	--
SC-13	99-T333				6.58	0.0	12	--
SC-14	99-T384				6.21	0.0	12	--
SC-15	99-T387	0.47		34.7	32.5	63.3	77	76.0
SC-16	99-T389				0.58	0.0	1	--
SC-17	99-T631				0.14	0.0	0	--
SC-18	99-T634	0.47		34.7	31.7	63.3	-	73.3
SC-19	99-T658				0.12	0.0	-	--
SC-20	99-S671				0.2	0.0	-	--
SC-21	99-T688				0.83	0.0	18	--
SC-22	none			-	-	--	-	--
SC-23	99-T694				0.8	0.0	-	--
SC-24	99-T800				0.7	0.0	-	--
SC-25	99-T968				32.3	0.0	90	--
SC-26	99-T1003				31.7	0.0	96	--
SC-27	99-T1007				1.75	0.0	6	--
SC-28	99-T1540				33.5	0.0	93	--
SC-29	99-T1552				25.6	0.0	72	--
SC-30	99-T2072			31.6	13.4	57.2	38	27.1
SC-31	99-T2088	0.09		31.6	3.74	57.3	11	6.8
SC-32	99-T2095	0.11	3.62	27.2	11.4	52.2	34	24.6
SC-33	99-T2147	0.11	3.62	27.2	11.5	52.2	-	24.9
SC-34	99-T2163	0.15	0.71	30.2	20.3	55.4	58	46.0
SC-35	99-T2190	0.20	3.43	24.0	6.93	46.4	7	16.1
SC-36	99-T2202	0.33	0.34	30.7	19.2	56.2	53	42.3
SC-37	99-T2207			22.2	22.6	40.2	67	72.7
SC-38	00-T16	0.25	0.31	28.9	25.6	52.8	76	65.1
SC-39	00-T21	0.31	0.56	28.0	28.2	51.5	84	76.3
SC-40	00-T30				29.8	0.0	75	--
SC-41	00-T39	0.27	1.89	27.5	19.5	51.6	55	47.0
SC-42	00-T120				0.56	0.0	-	--
SC-43	00-T125				26.1	0.0	68	--
SC-44	00-T129				6.04	0.0	7	--
SC-45	00-T132	0.28	0.46	27.8	13.7	51.0	41	31.1
SC-46	00-T143	0.29	2.01	29.1	24.8	54.6	71	60.4
SC-47	00-T154	0.24	1.73	28.6	18.8	53.4	60	43.4
SC-48	00-T160			24.8	4.83	44.9	7	11.3
SC-49	00-T162			25.7	2.89	46.5	2	6.4
SC-50	00-T173	0.13	2.44	29.1	18.4	54.7	60	41.2
SC-51	00-T178	0.15	7.40	30.9	1.41	61.9	6	2.3
SC-52	00-T183	0.15	7.40	30.9	13	61.9	35	24.1
SC-53	00-T190	0.11	2.62	28.9	21.4	54.5	66	50.0
SC-54	00-T198	0.20	2.75	27.6	23.4	52.3	70	58.4
SC-55	00-T203	0.50	0.18	40.4	50.3	73.8	117	137.1
SC-56	00-T217	0.58	0.18	47.7	50.2	87.1	-	115.7

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, %				Wt Gain CO2 @ 100% Conversion	Conversion, pct	
		Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)		By Wt Gain	By Stoichiometry
SC-57	00-T225	0.10	6.02	30.2	6.62	59.5	13	11.9
SC-58	00-T233	0.15	2.73	27.1	27.1	51.4	83	72.4
SC-59	00-T251	0.15	2.73	27.1	26.3	51.4	81	69.5
SC-60	00-T255			23.1	1.62	41.8	1	3.9
SC-61	00-T259			26.2	0.05	47.4	-	0.1
SC-62	00-T275	0.22	3.76	30.2	14.3	57.9	49	28.8
SC-63	00-T282	0.13	2.60	29.3	23.3	55.2	72	55.0
SC-64	00-T297	0.13	2.60	29.3	22.2	55.2	69	51.7
SC-65	00-T305	0.23	2.64	28.2	24	53.4	72	59.2
SC-66	00-T309	0.23	2.64	28.2	24.3	53.4	73	60.1
SC-67	00-T316	0.14	2.54	29.4	22.3	55.4	67	51.8
SC-68	00-T324	0.14	2.42	29.1	20.3	54.7	62	46.5
SC-69	00-T326	0.14	2.42	29.1	19.2	54.7	58	43.4
SC-70	00-T390	0.08	2.64	28.2	20.3	53.2	59	47.9
SC-71	00-T393	0.14	2.69	29.3	22.8	55.3	71	53.4
SC-72	00-T402	0.14	2.69	29.3	24.1	55.3	80	57.4
SC-73	00-T406	0.10	2.85	29.5	23.9	55.7	79	56.3
SC-74	00-T409	0.10	2.85	29.5	14.4	55.7	41	30.2
SC-75	00-T422	0.12	2.76	28.7	15.7	54.3	45	34.3
SC-76	00-T430	0.12	2.76	28.7	16.7	54.3	49	37.0
SC-77	00-T459	0.14	2.82	28.6	16.4	54.1	47	36.2
SC-78	00-T500	0.14	2.82	28.6	21.8	54.1	65	51.5
SC-79	00-T719				17.2	0.0	42	--
SC-80	00-T723	0.08	2.64	28.2	27.3	53.2	82	70.6
SC-81	00-T730	0.02	2.72	28.7	26	54.1	77	64.9
SC-82	00-T747	0.02	2.72	28.7	24.2	54.1	72	59.0
SC-83	00-T751	0.02	2.87	25.3	26.1	48.1	79	73.5
SC-84	00-T754	0.02	2.87	25.3	24.7	48.1	75	68.2
SC-85	00-T758	0.10	2.64	27.4	24.1	51.8	72	61.3
SC-86	00-T761	0.10	2.64	27.4	8.97	51.8	25	19.0
SC-87	00-T766	0.05	2.76	24.7	6.35	46.9	20	14.4
SC-88	00-T769	0.05	2.76	24.7	5.73	46.9	18	13.0
SC-89	00-T774	0.06	2.71	28.6	19.6	54.0	61	45.2
SC-90	00-T778	0.06	2.71	28.6	23	54.0	69	55.4
SC-91	00-T782	0.02	2.28	21.1	9.49	40.0	-	26.2
SC-92	00-T786	0.07	2.53	28.7	11.5	54.0	38	24.1
SC-93	00-T793	0.05	2.69	29.4	26	55.4	78	63.4
SC-94	00-T816	0.07	2.53	28.7	14.7	54.0	57	31.9
SC-95	00-T827	0.07	2.76	25.9	6.49	49.1	14	14.1
SC-96	00-T838	0.09	2.55	26.3	6.59	49.7	15	14.2
SC-97	00-T841	0.03	3.03	29.6	28.2	56.0	85	70.1
SC-98	00-T923	0.06	0.66	29.0	24.1	53.1	75	59.8
SC-99	00-T927	0.02	1.76	30.0	28.4	55.7	84	71.2
SC-100	00-T930	0.11	1.72	29.8	27.8	55.4	84	69.5
SC-101	00-T937	0.06	0.66	29.0	23.5	53.1	72	57.9
SC-102	00-T940	0.03	4.17	29.6	28.7	56.9	86	70.7
SC-103	00-T1037	0.06	0.58	28.6	21.4	52.3	61	52.1
SC-104	00-T1039	0.06	0.58	28.6	23.1	52.3	66	57.5
SC-105	00-T1056	<0.02	3.18	27.9	22.7	--	68	--
SC-106	00-T1058	<0.02	3.18	27.9	24	--	73	--
SC-107	00-T1066	0.05	2.64	28.4	16.5	53.5	51	36.9
SC-108	00-T1071	0.05	2.64	28.4	18.2	53.5	57	41.6
SC-109	00-T1089	0.19	2.34	25.3	4.8	47.8	-	10.5
SC-110	00-T1161	19.90	1.10	8.8	21.2	38.6	-	69.8
SC-111	00-T1248	0.12	5.59	31.1	4.6	60.8	10	7.9
SC-112	00-T1250	0.12	5.59	31.1	12.5	60.8	33	23.5

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-113	00-T1255	0.15	6.76	33.6	14.5	66.3	52	25.6
SC-114	00-T1344				5.53	0.0	13	--
SC-115	00-T1390	0.07	0.52	24.6	19.1	45.0	65	52.5
SC-116	00-T1391	0.06	0.43	27.6	21.3	50.4	67	53.7
SC-117	00-T1392				12.1	0.0	45	--
SC-118	00-T1393	0.13	0.37	27.2	21.9	49.7	71	56.5
SC-119	00-T1394	0.13	0.53	29.4	22.2	53.8	71	53.1
SC-120	00-T1395	0.13	0.53	29.4	21.9	53.8	71	52.2
SC-121	00-T1396	0.19	0.48	30.0	23.5	54.9	74	56.0
SC-122	00-T1397	0.09	0.63	26.8	22.6	49.1	73	59.5
SC-123	00-T1629	0.09	0.63	26.8	18.5	49.1	70	46.2
SC-124	00-T1630	0.15	0.56	29.8	21.1	54.5	73	49.0
SC-125	00-T1631	0.15	0.56	29.8	21.2	54.5	68	49.3
SC-126	00-T1632	0.06	0.68	25.5	19.1	46.8	62	50.5
SC-127	00-T1633	0.06	0.68	25.5	19.5	46.8	58	51.8
SC-128	00-T1634	0.04	0.56	23.1	19.5	42.3	62	57.3
SC-129	00-T1674				1.03	0.0	-	--
SC-130	00-T1763	0.08	0.57	29.2	20.5	53.4	63	48.3
SC-131	00-T1819	0.08	0.57	29.2	7.41	53.4	29	15.0
SC-132	00-T1822	0.08	0.57	29.2	20.4	53.4	61	48.0
SC-133	00-T1824	0.08	0.57	29.2	11.1	53.4	41	23.4
SC-134	00-T2018	0.11	6.00	31.1	0.22	61.1	-	0.4
SC-135	00-T2020	0.11	6.00	31.1	0.38	61.1	-	0.6
SC-136	00-T2023	0.11	6.00	31.1	13	61.1	42	24.4
SC-137	00-T2025	0.11	6.00	31.1	0.39	61.1	-	0.6
SC-138	00-T2030	0.11	6.00	31.1	19	61.1	58	38.4
SC-139	00-T2038	0.11	6.00	31.1	5	61.1	13	8.6
SC-140	00-T2055	0.11	6.00	31.1	30.5	61.1	86	71.8
SC-141	00-T2057	0.12	0.58	29.5	19.2	54.0	59	44.0
SC-142	00-T2060	0.12	0.58	29.5	9.18	54.0	31	18.7
SC-143	00-T2062	0.12	0.58	29.5	18.9	54.0	58	43.2
SC-144	00-T2065	0.12	0.58	29.5	24.3	54.0	72	59.5
SC-145	00-T2067	0.12	0.58	29.5	21.3	54.0	64	50.1
SC-146	00-T2074	0.12	0.58	29.5	25.3	54.0	76	62.7
SC-147	00-T2097	0.12	0.58	29.5	21	54.0	63	49.2
SC-148	00-T2103	0.12	0.58	29.5	26	54.0	77	65.1
SC-149	00-T2105	0.12	0.58	29.5	16.8	54.0	52	37.4
SC-150	00-T2117	0.11	1.48	29.9	21.9	55.4	70	50.6
SC-151	00-T2135	0.03	1.46	27.1	5.49	50.2	9	11.6
SC-152	00-T2185	0.12	6.50	30.1	0.7	59.7	-	1.2
SC-153	00-T2189	0.02	2.61	26.1	7	49.3	10	15.3
SC-154	01-T2	0.23	2.12	23.7	1.72	44.8	-	3.9
SC-155	01-T7	0.11	6.00	31.1	8.56	61.1	22	15.3
SC-156	01-T20	0.11	6.00	31.1	22.2	61.1	59	46.7
SC-157	01-T31	0.11	6.00	31.1	33.4	61.1	73	82.0
SC-158	01-T95	0.15	0.71	28.0	16.7	51.4	55	39.0
SC-159	01-T113	0.14	0.78	29.9	20.8	54.9	67	47.8
SC-160	01-T129	0.15	6.19	30.3	2	59.9	3	3.4
SC-161	01-T141	0.14	7.76	30.1	7.66	60.7	20	13.7
SC-162	01-T155	0.14	7.76	30.1	3.93	60.7	9	6.7
SC-163	01-T179	0.35	<0.01	25.8	15.2	--	49	--
SC-164	01-T185	0.09	0.66	29.8	19.9	54.6	62	45.5
SC-165	01-T193	0.09	0.66	29.8	20.8	54.6	66	48.1
SC-166	01-T199	0.09	0.66	29.8	20.1	54.6	59	46.1
SC-167	01-T210	0.35	<0.01	25.8	17	--	59	--
SC-168	01-T213	0.35	<0.01	25.8	13.6	--	49	--

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, %				Wt Gain CO2 @ 100% Conversion	Conversion, pct	
		Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)		By Wt Gain	By Stoichiometry
SC-169	01-T215	0.35	<0.01	25.8	15.5	--	54	--
SC-170	01-T220	0.35	<0.01	25.8	18.2	--	62	--
SC-171	01-T244	0.35	<0.01	25.8	19	--	64	--
SC-172	00-T265	0.14	6.03	29.9	0.67	59.0	0	1.1
SC-173	01-T275	0.14	6.03	29.9	4.88	59.0	12	8.7
SC-174	01-T281	0.09	2.56	28.4	23.8	53.5	73	58.4
SC-175	01-T303	0.09	2.56	28.4	27.4	53.5	82	70.5
SC-176	01-T314	0.09	0.66	29.8	23	54.6	68	54.8
SC-177	01-T318	0.11	6.00	31.1	6.4	61.1	-	11.2
SC-178	01-T332	0.30	0.05	26.2	13.7	47.8	51	33.2
SC-179	01-T334	0.30	0.05	26.2	13.4	47.8	51	32.4
SC-180	01-T337	0.11	6.00	31.1	6.69	61.1	-	11.7
SC-181	01-T381	0.14	6.03	29.9	6.21	59.0	8	11.2
SC-182	01-T398	0.11	6.00	31.1	9.11	61.1	-	16.4
SC-183	01-T694	0.11	6.00	31.1	25	61.1	-	54.5
SC-184	01-T698	0.11	6.00	31.1	23	61.1	-	48.9
SC-185	01-T702	0.11	6.00	31.1	23.3	61.1	-	49.7
SC-186	01-T709	0.11	6.00	31.1	24.1	61.1	-	51.9
SC-187	01-T580	0.11	6.00	31.1	8.21	61.1	23	14.6
SC-188	01-T587	0.11	6.00	31.1	5.39	61.1	18	9.3
SC-189	01-T591	0.11	6.00	31.1	0.85	61.1	16	1.4
SC-190	01-T594	0.11	6.00	31.1	0.39	61.1	1	0.6
SC-191	01-T597	0.10	0.43	28.8	20.9	52.6	64	50.3
SC-192	01-T604	0.11	6.00	31.1	4.26	61.1	11	7.3
SC-193	01-T609	0.11	6.00	31.1	-	61.1	39	--
SC-194	01-T612	0.68	2.19	21.0	12.1	40.5	43	34.0
SC-195	01-T620			34.1	11.3	61.7	30*	20.6
SC-196	01-T623			-	1.89	--	3	--
SC-197	01-T630	0.10	0.43	28.8	12.4	52.6	39	26.9
SC-198	01-T638	0.10	0.43	28.8	7.14	52.6	22	14.6
SC-199	01-T641	0.10	0.43	28.8	0.22	52.6	-	0.4
SC-200	01-T645	0.32	<0.01	26.1	8.26	--	37	--
SC-201	01-T655	0.68	2.19	21.0	0.83	40.5	-	2.1
SC-202	01-T664	0.09	1.52	27.2	6.14	50.5	12	12.9
SC-203	01-T668	0.09	1.52	27.2	6.74	50.5	13	14.3
SC-204	01-T680	0.09	1.52	27.2	5.67	50.5	5	11.9
SC-205	01-T711	0.09	1.52	27.2	8.44	50.5	18	18.2
SC-206	01-T731	0.32	<0.01	26.1	2.27	--	1	--
SC-207	01-T738	0.09	1.52	27.2	7.92	50.5	10	17.0
SC-208	01-T740	0.32	<0.01	26.1	1.63	--	-	--
SC-209	01-T744	0.11	6.00	31.1	<0.1	61.1	-	--
SC-210	01-T757	0.08	5.08	28.3	2.12	55.3	0	3.9
SC-211	01-T761	0.17	4.88	28.2	1.67	55.1	-	3.1
SC-212	01-T795	0.02	4.39	21.8	35.3	42.9	-	127.1
SC-213	01-T798	0.11	6.00	31.1	0.72	61.1	-	1.2
SC-214	01-T822	0.11	6.00	31.1	33.4	61.1	90	82.0
SC-215	01-T830	0.32	<0.01	26.1	16	--	54	--
SC-216	01-T836	0.11	6.00	31.1	0.25	61.1	-	0.4
SC-217	01-T842	0.32	<0.01	26.1	19.6	--	65	--
SC-218	01-T847	0.11	6.00	31.1	6.52	61.1	17	11.4
SC-219	01-T853	0.11	6.00	31.1	0.43	61.1	0	0.7
SC-220	01-T878	0.11	6.00	31.1	1.05	61.1	2	1.7
SC-221	01-T891	0.10	0.43	28.8	20.6	52.6	61	49.3
SC-222	01-T935	0.13	0.67	29.1	21	53.3	67	49.8
SC-223	01-T944	0.13	0.67	29.1	22.1	53.3	74*	53.2
SC-224	01-T947	0.11	6.00	31.1	4.1	61.1	18*	7.0

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-225	01-T951	0.11	6.00	31.1	1.08	61.1	2	1.8
SC-226	01-T1242			32.8	6.09	59.4	16*	10.9
SC-227	01-T1249	0.15	5.94	30.4	3.35	59.9	13*	5.8
SC-228	01-T1263	0.15	5.94	30.4	6.65	59.9	12	11.9
SC-229	01-T1267	0.13	0.67	29.1	21.1	53.3	66	50.1
SC-230	01-T1283	0.15	7.40	30.9	2.1	61.9	1	3.5
SC-231	01-T1325	0.15	5.94	30.4	0.56	59.9	-	0.9
SC-232	01-T1335	0.16	5.89	28.3	1.42	56.0	3	2.6
SC-233	01-T1338	0.15	7.40	30.9	17.4	61.9	47	34.0
SC-234	01-T1379	0.15	5.94	30.4	16.3	59.9	45	32.5
SC-235	01-T1382	0.16	5.89	28.3	22.1	56.0	40	50.6
SC-236	01-T1384	0.16	5.89	28.3	21.2	56.0	59	48.0
SC-237	01-T1391	0.16	5.89	28.3	18.1	56.0	53	39.4
SC-238	01-T1473			31.3	23.2	56.7	68	53.3
SC-239	01-T1490	0.17	6.43	29.7	23.8	59.0	66	52.9
SC-240	01-T1495	0.17	6.43	29.7	11.8	59.0	33	22.7
SC-241	01-T1498	0.16	5.89	28.3	7.56	56.0	21	14.6
SC-242	01-T1503	0.16	5.74	30.0	6.33	59.0	16	11.5
SC-243	01-T1505	0.15	5.94	30.4	2.7	59.9	6	4.6
SC-244	01-T1575	0.15	5.94	30.4	1.91	59.9	2	3.3
SC-245	01-T1576	0.13	1.34	20.8	21.1	38.8	59	68.8
SC-246	01-T1601	0.13	1.34	20.8	20.6	38.8	57	66.8
SC-247	01-T1606	0.13	6.81	25.4	29	51.5	93	79.3
SC-248	01-T1621	0.13	6.81	25.4	12.3	51.5	48	27.2
SC-249	01-T1690	0.15	5.94	30.4	4.53	59.9	17	7.9
SC-250	01-T1695	0.05	1.55	23.2	19.7	43.3	57	56.7
SC-251	01-T1703	0.05	1.55	23.2	19.4	43.3	68	55.6
SC-252	01-T1739	0.05	1.55	23.2	19.2	43.3	70	54.9
SC-253	01-T1748	0.05	1.55	23.2	17.2	43.3	-	48.0
SC-254	01-T1753	0.12	6.44	29.0	27.3	57.7	106	65.1
SC-255	01-T1760	0.05	1.55	23.2	18.6	43.3	66	52.8
SC-256	01-T1828	0.19	5.63	29.5	2.1	58.0	6	3.7
SC-257	01-T1834	0.14	5.75	30.1	27.8	59.2	82	65.1
SC-258	01-T1837	0.18	5.73	30.1	28.8	59.2	89	68.3
SC-259	01-T1972	0.09	4.76	31.7	10.8	61.2	32	19.8
SC-260	01-T1974	0.09	4.76	31.7	13.9	61.2	39	26.4
SC-261	01-T1977			-	6.22	--	26	--
SC-262	01-T1979	0.06	5.38	28.6	1.97	56.1	-	3.6
SC-263	01-T1985	0.06	5.18	31.5	19.6	61.2	56	39.9
SC-264	01-T1988	0.06	5.18	31.5	22.3	61.2	62	46.9
SC-265	01-T1994	0.15	7.42	28.4	31.6	57.4	90	80.5
SC-266	01-T1998	0.10	5.93	31.2	22.3	61.3	64	46.9
SC-267	01-T2009	0.10	5.93	31.2	22.4	61.3	62	47.1
SC-268	01-T2014	0.10	5.93	31.2	19.2	61.3	54	38.8
SC-269	01-T2025	0.15	7.42	28.4	0.79	57.4	-	1.4
SC-270	01-T2186	0.12	5.58	29.2	11.8	57.4	19	23.3
SC-271	01-T2205	0.14	5.50	28.7	27.6	56.4	67	67.6
SC-272	01-T2239	0.15	7.42	28.4	3.12	57.4	-	5.6
SC-273	01-T2274	0.22	6.52	29.0	14.8	57.9	41	30.0
SC-274	01-T2277	0.15	8.85	25.8	15.1	53.8	37	33.0
SC-275	01-T2279	0.15	8.85	25.8	17.4	53.8	39	39.1
SC-276	01-T2284	0.05	6.43	24.2	29.4	48.9	89	85.1
SC-277	01-T2287	0.05	6.43	24.2	0.66	48.9	-	1.4
SC-278	01-T2290	0.28	1.46	22.5	14	42.2	38	38.6
SC-279	01-T2299	0.11	1.42	25.9	16.9	48.1	38	42.3
SC-280	01-T2311	0.11	1.42	25.9	18.1	48.1	50	45.9

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-281	01-T2316	0.16	8.79	27.6	31.4	57.1	98	80.2
SC-282	01-T2320	0.16	8.79	27.6	0.56	57.1	2	1.0
SC-283	01-T2342	0.28	1.46	22.5	14.4	42.2	38	39.9
SC-284	01-T2354	0.19	8.80	27.6	32.4	57.1	94	83.9
SC-285	01-T2357	0.14	5.97	27.3	3.98	54.3	11	7.6
SC-286	01-T2360	0.19	8.80	27.6	19.6	57.1	70	42.7
SC-287	01-T2366	0.11	6.01	29.3	16.3	57.9	46	33.6
SC-288	01-T2369	0.19	6.59	31.0	21.2	61.5	59	43.7
SC-289	01-T2376	0.19	8.80	27.6	27.7	57.1	87	67.1
SC-290	01-T2382	0.19	8.80	27.6	13.5	57.1	42	27.3
SC-291	01-T2385	0.11	5.69	28.3	8.87	55.8	24	17.4
SC-292	01-T2389	0.58	21.90	0.3	1.45	18.3	-	8.0
SC-293	01-T2415	0.28	2.17	21.6	1.47	41.1	-	3.6
SC-294	01-T2419	0.14	6.35	30.1	2.57	59.6	5	4.4
SC-295	01-T2424	0.18	6.34	30.4	21.8	60.2	60	46.3
SC-296	01-T2425	0.18	6.34	30.4	6.92	60.2	18	12.3
SC-297	01-T2428	0.18	6.34	30.4	17.8	60.2	49	36.0
SC-298	01-T2450	0.18	6.34	30.4	25.4	60.2	71	56.5
SC-299	02-T1	0.18	6.34	30.4	16.5	60.2	46	32.8
SC-300	02-T3	0.18	6.34	30.4	14.3	60.2	38	27.7
SC-301	02-T6	0.18	6.34	30.4	22.8	60.2	62	49.0
SC-302	02-T8	0.18	6.34	30.4	23.8	60.2	67	51.9
SC-303	02-T11	0.18	6.34	30.4	21.2	60.2	58	44.7
SC-304	02-T20	7.26	5.28	4.8	1.43	20.8		7.0
SC-305	02-T25	0.14	9.04	29.0	23.2	59.8	75	50.5
SC-306	02-T31	0.14	9.04	29.0	26.3	59.8	81	59.7
SC-307	02-T35	0.14	9.04	29.0	6.88	59.8	22	12.4
SC-308	02-T37	0.14	9.04	29.0	16.1	59.8	52	32.1
SC-309	02-T41	0.17	2.43	25.2	4.66	47.7	4	10.2
SC-310	02-T58	0.28	2.49	25.9	4.73	49.1	4	10.1
SC-311	02-T65	0.15	5.55	30.6	21.8	59.9	59	46.5
SC-312	02-T69	0.32	2.19	23.4	1.56	44.4	-	3.6
SC-313	02-T84	0.10	2.59	26.7	6.76	50.5	16	14.4
SC-314	02-T125	0.12	6.31	30.3	0.26	59.9	-	0.4
SC-315	02-T127	0.12	6.31	30.3	<0.1	59.9	-	--
SC-316	02-T150	0.15	5.94	30.4	16.7	59.9	45	33.5
SC-317	02-T152	0.15	5.94	30.4	17	59.9	45	34.2
SC-318	02-T155	0.15	5.94	30.4	17.1	59.9	46	34.5
SC-319	02-T165	0.12	6.31	30.3	10.5	59.9	31	19.6
SC-320	02-T169	0.11	11.40	22.6	10.9	50.0	32	24.5
SC-321	02-T174	0.14	6.36	28.3	30.3	56.4	99	77.1
SC-322	02-T177	0.40		31.9	7.62	58.2	21	14.2
SC-323	02-T182	0.15	6.41	29.5	27.7	58.6	73	65.4
SC-324	02-T186	0.18	6.53	30.5	26.1	60.5	74	58.3
SC-325	02-T199	0.15	6.50	30.1	28.8	59.8	82	67.7
SC-326	02-T245	0.35	1.34	24.2	27.9	45.2	75	85.5
SC-327	02-T248	0.35	1.34	24.2	15.1	45.2	22	39.3
SC-328	02-T253	0.31	1.27	22.7	25.3	42.4	75	79.8
SC-329	02-T256	0.13	6.42	31.0	21.8	61.3	62	45.5
SC-330	02-T259	0.13	6.42	31.0	<0.1	61.3	-	--
SC-331	02-T261	0.13	6.42	31.0	<0.1	61.3	-	--
SC-332	02-T264	0.13	6.42	31.0	0.52	61.3	-	0.9
SC-333	02-T272	0.13	6.42	31.0	1.48	61.3	0	2.5
SC-334	02-T275	0.13	6.42	31.0	5.62	61.3	14	9.7
SC-335	02-T277	0.13	6.42	31.0	16.8	61.3	46	32.9
SC-336	02-T286	0.13	6.42	31.0	17.7	61.3	49	35.1

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, %				Wt Gain CO2 @ 100% Conversion	Conversion, pct	
		Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)		By Wt Gain	By Stoichiometry
SC-337	02-T289	0.13	6.42	31.0	13	61.3	42	24.4
SC-338	02-T293	0.12	8.45	32.1	26.8	64.9	77	56.4
SC-339	02-T296	0.22	10.10	28.3	29.3	59.4	80	69.7
SC-340	02-T300	0.13	6.42	31.0	7.11	61.3	18	12.5
SC-341	02-T303	0.11	5.34	31.3	14.5	61.0	30	27.8
SC-342	02-T311	0.13	5.78	30.1	23.5	59.2	55	51.9
SC-343	02-T319	0.09	6.92	29.9	16.3	59.7	35	32.6
SC-344	02-T326	0.09	6.38	29.5	15.2	58.5	32	30.6
SC-345	02-T329	0.11	6.99	30.5	25.3	60.8	59	55.7
SC-346	02-T333	0.11	6.55	30.6	18.2	60.7	38	36.7
SC-347	02-T336	0.14	4.93	30.6	7.16	59.4	13	13.0
SC-348	02-T342	0.11	6.52	30.4	10.5	60.3	20	19.5
SC-349	02-T369	0.12	5.79	30.4	13	59.7	24	25.0
SC-350	02-T426	0.07	5.68	30.5	13.9	59.8	29	27.0
SC-351	02-T429	0.10	6.47	30.1	19	59.7	42	39.3
SC-352	02-T433	0.05	6.13	29.6	30.7	58.5	77	75.8
SC-353	02-T436	0.12	6.92	28.4	32.6	57.0	83	84.9
SC-354	02-T441	0.12	6.92	28.4	32.6	57.0	80	84.9
SC-355	02-T444	0.07	5.68	30.5	15.8	59.8	32	31.4
SC-356	02-T446	0.07	5.68	30.5	1.88	59.8	0	3.2
SC-357	02-T457	0.13	6.09	30.2	10.3	59.6	27	19.3
SC-358	02-T474	0.13	6.09	30.2	7.56	59.6	11	13.7
SC-359	02-T477	0.13	6.09	30.2	33.8	59.6	85	85.7
SC-360	02-T492	0.13	6.09	30.2	0.58	59.6	-	1.0
SC-361	02-T500	0.07	6.17	30.3	31.9	59.8	84	78.4
SC-362	02-T504	0.07	6.17	30.3	9.1	59.8	11	16.7
SC-363	02-T524	0.11	6.05	29.9	28.1	59.0	57	66.2
SC-364	02-T532	0.10	5.97	30.4	19.4	59.8	41	40.2
SC-365	02-T541	32.90	0.53	0.3	10.5	37.0	24	24.4
SC-366	02-T548	32.90	0.53	0.3	10.8	37.0	26	25.5
SC-367	02-T551	32.90	0.53	0.3	12.1	37.0	29	30.1
SC-368	02-T555	31.60	0.67	0.3	18.9	35.8	59	60.1
SC-369	02-T558	31.60	0.67	0.3	4.04	35.8	-	3.9
SC-370	02-T566	33.00	0.60	0.3	21.1	37.2	69	66.9
SC-371	02-T569	31.60	0.52	0.3	23.8	35.6	93	85.9
SC-372	02-T571	31.60	0.52	0.3	24.8	35.6	90	89.4
SC-373	02-T582	31.60	0.52	0.3	16.9	35.6	49	50.0
SC-374	02-T589	31.60	0.52	0.3	25.5	35.6	88	91.7
SC-375	02-T601	33.00	0.60	0.3	20	37.2	64	61.9
SC-376	02-T608		2.44	23.1	1.05	43.7	-	2.4
SC-377	02-T620	0.28	1.46	23.6	2.36	44.2	5	5.5
SC-378	02-T626	32.20	0.67	0.3	17.5	36.4	56	52.9
SC-379	02-T634	32.20	0.67	0.3	18	36.4	58	55.0
SC-380	02-T636	32.20	0.67	0.3	18.8	36.4	61	58.6
SC-381	02-T662	32.20	0.67	0.3	17.2	36.4	55	51.7
SC-382	02-T671	0.27	1.17	22.1	2.65	41.2	6	6.6
SC-383	02-T674		2.37	25.6	5.61	48.2	9	12.3
SC-384	02-T679	0.08	5.92	30.7	12.6	60.3	25	23.9
SC-385	02-T684	0.05	6.11	29.2	18	57.7	38	38.0
SC-386	02-T692	0.28	1.19	23.7	2.53	44.1	5	5.9
SC-387	02-T696	0.05	6.11	29.2	28	57.7	68	67.4
SC-388	02-T701	0.28	1.86	23.3	2.42	43.9	5	5.6
SC-389	02-T704	0.05	6.11	29.2	12	57.7	23	23.6
SC-390	02-T709	0.05	6.11	29.2	1.63	57.7	3	2.9
SC-391	02-T713	0.27	1.80	22.6	1.55	42.6	-	3.7
SC-392	02-T717	0.25	1.09	22.3	10.6	41.5	15	28.6

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-393	02-T723	0.23	1.49	21.1	22.1	39.6	54	71.6
SC-394	02-T731	0.05	6.11	29.2	32.9	57.7	85	85.0
SC-395	02-T734	0.05	6.11	29.2	17.9	57.7	38	37.8
SC-396	02-T745	0.29	1.15	22.1	12.6	41.2	26	35.0
SC-397	02-T763	0.35	1.46	22.1	22.8	41.5	60	71.1
SC-398	02-T772	0.48	1.88	22.3	4.02	42.4	7	9.9
SC-399	02-T792	0.21	1.81	21.0	6.31	39.7	12	17.0
SC-400	02-T795	0.22	0.75	20.7	22	38.3	58	73.6
SC-401	02-T800	0.21	1.98	20.6	3.86	39.1	8	10.3
SC-402	02-T803	0.16	1.20	20.0	21.1	37.3	52	71.7
SC-403	02-T811	0.18	1.78	21.3	6.7	40.1	10	17.9
SC-404	02-T824	0.29	1.70	21.2	6.31	40.0	9	16.8
SC-405	02-T829	0.22	2.00	23.0	5.2	43.4	11	12.6
SC-406	02-T836	0.21	2.02	21.1	6.15	40.0	14	16.4
SC-407	02-T884	0.22	1.50	21.4	15.8	40.2	36	46.7
SC-408	02-T901	0.19	0.88	21.0	21.1	38.9	54	68.7
SC-409	02-T914			30.3*	9.37	--	17	--
SC-410	02-T917			30.3*	31.1	--	103	--
SC-411	02-T934			30.4*	8.39	--	15	--
SC-412	02-T940	6.72	6.67	4.3	0.58	20.4	2	2.9
SC-413	02-T948	6.80	7.46	4.3	1.12	21.1	6	5.4
SC-414	02-T952	7.21	7.56	4.5	2.93	22.0	23	13.7
SC-415	02-T968	6.72	6.67	4.3	3.89	20.4	18	19.8
SC-416	02-T971	2.39	4.92	19.1	1.86	41.1	-	4.6
SC-417	02-T978	2.19	9.23	15.7	5.24	38.1	21	14.5
SC-418	02-T990	0.27	1.53	23.2	19.7	43.5	65	56.4
SC-419	02-T996	0.25	2.03	22.4	2.99	42.4	1	7.3
SC-420	02-T1002	0.29	1.71	20.9	16.7	39.5	59	50.8
SC-421	02-T1012	0.23	1.77	23.4	2.94	44.0	-	6.9
SC-422	02-T1029	0.60	44.30	0.3	11.1	36.0	30	34.7
SC-423	02-T1037	0.19	6.23	28.7	22.2	57.1	50	50.0
SC-424	02-T1047	0.60	44.30	0.3	19.2	36.0	56	65.9
SC-425	02-T1053	0.08	5.92	30.7	27.9	60.3	58	64.2
SC-426	02-T1061	0.38	1.50	22.6	14.3	42.5	45	39.3
SC-427	02-T1063	5.33	8.14	2.6	0.93	17.0	-	5.5
SC-428	02-T1093	8.03	1.30	0.2	0.7	10.2	11	6.9
SC-429	02-T1097	0.15	6.31	29.8	25.1	59.1	59	56.7
SC-430	02-T1101	0.22	6.07	30.3	19.7	59.9	43	41.0
SC-431	02-T1107	0.36	6.17	29.8	15.2	59.2	32	30.3
SC-432	02-T1111	16.10	4.22	7.1	0.82	33.8	-	2.4
SC-433	02-T1125	15.60	9.62	6.9	11.1	37.2	39	33.5
SC-434	02-T1135	10.30	3.05	4.8	1.94	22.4	15	8.8
SC-435	02-T1140	4.85	7.97	2.3	1.76	15.7	14	11.4
SC-436	02-T1155	0.16	6.23	29.2	22.8	57.9	53	51.0
SC-437	02-T1158	5.51	7.34	2.9	0	17.2	-	0.0
SC-438	02-T1164	0.19	6.28	28.5	10.5	56.7	22	20.7
SC-439	02-T1177	0.15	6.27	30.3	14.4	59.9	31	28.1
SC-440	02-T1187	0.31	1.28	22.9	12.9	42.8	31	34.6
SC-441	02-T1209	0.37	1.42	23.7	15.1	44.4	46	40.0
SC-442	02-T1224	0.27	1.41	23.2	11.7	43.4	21	30.5
SC-443	02-T1227	0.18	6.01	29.6	15.1	58.5	33	30.4
SC-444	02-T1236	0.38	1.44	22.5	21.1	42.3	57	63.3
SC-445	02-T1239	0.38	1.68	22.9	16.6	43.2	38	46.1
SC-446	02-T1247	0.38	1.53	22.6	11.4	42.5	25	30.3
SC-447	02-T1250	0.39	1.59	21.7	7.09	41.0	11	18.6
SC-448	02-T1260	0.35	1.24	20.6	20.3	38.6	47	65.9

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-449	02-T1266	0.35	1.56	22.7	16.5	42.7	40	46.3
SC-450	02-T1269	0.35	1.24	20.6	20.4	38.6	49	66.3
SC-451	02-T1277	0.37	1.59	22.0	13.6	41.5	33	38.0
SC-452	02-T1281	0.36	1.59	22.2	13.3	41.8	32	36.7
SC-453	02-T1285	0.37	1.55	22.5	12.1	42.4	25	32.5
SC-454	02-T1295	0.36	1.69	23.7	12.8	44.6	32	32.9
SC-455	02-T1298	0.37	1.56	21.7	13	40.9	28	36.5
SC-456	02-T1303	0.36	1.79	22.7	25.8	42.9	64	81.1
SC-457	02-T1307	0.43	1.64	22.5	22.9	42.5	56	69.9
SC-458	02-T1325	0.35	1.22	21.0	9.11	39.4	18	25.5
SC-459	02-T1358	0.30	1.58	18.1	6.88	34.3	7	21.5
SC-460	02-T1367	0.35	1.74	18.5	7.2	35.2	13	22.0
SC-461	02-T1405	0.38	1.52	22.6	8.01	42.5	17	20.5
SC-462	02-T1409	0.15	5.83	27.9	29.7	55.3	79	76.5
SC-463	02-T1412	0.15	6.00	29.3	30.2	57.9	79	74.7
SC-464	02-T1416	0.20	6.05	28.9	28.7	57.3	72	70.3
SC-465	02-T1425	0.12	6.23	26.3	24.7	52.6	60	62.3
SC-466	02-T1433	0.12	6.03	25.9	24.7	51.8	69	63.4
SC-467	see note	0.16	6.23	29.2		57.9	61	0.0
SC-468	02-T1495	0.24	6.01	28.5	26.5	56.6	73	63.7
SC-469	02-T1534	0.20	6.93	29.8	31	59.6	84	75.4
SC-470	02-T1538	0.16	6.23	29.2	23	57.9	52	51.6
SC-471	02-T1567	0.16	6.23	29.2	19.7	57.9	45	42.3
SC-472	02-T1580	0.16	6.23	29.2	18.1	57.9	45	38.1
SC-473	02-T1583	0.40	2.09	22.9	1.56	43.5	0	3.6
SC-474	02-T1595	0.12	6.23	26.3	25.2	52.6	60	64.0
SC-475	02-T1598	0.16	8.21	27.4	31.9	56.2	85	83.3
SC-476	02-T1604	0.16	6.23	29.2	25.4	57.9	58	58.8
SC-477	02-T1608	0.11	6.27	27.7	26.2	55.2	63	64.3
SC-478	02-T1615	0.14	6.07	28.0	27	55.6	64	66.5
SC-479	02-T1622	0.16	6.06	28.9	19.3	57.3	42	41.8
SC-480	02-T1636	0.17	6.68	29.6	27.9	59.0	70	65.6
SC-481	02-T1644	0.17	6.36	29.8	23.8	59.1	57	52.8
SC-482	02-T1656	0.14	6.17	29.7	23.1	58.8	54	51.1
SC-483	02-T1662	0.16	6.36	29.4	22.5	58.4	52	49.7
SC-484	02-T1666	0.15	6.51	30.0	23.7	59.6	55	52.1
SC-485	02-T1671	0.14	6.73	29.4	21	58.7	43	45.3
SC-486	02-T1696	0.17	6.51	29.2	27	58.2	67	63.6
SC-487	02-T1699	0.16	6.70	29.2	28.2	58.3	72	67.4
SC-488	02-T1706				24.4	0.0	69	--
SC-489	02-T1708				27.1	0.0	74	--
SC-490	02-T1717				3.3	0.0	7	--
SC-491	02-T1731				13.7	0.0	43	--
SC-492	02-T1734	0.14	6.73	29.4	7.04	58.7	12	12.9
SC-493	02-T1737	0.12	6.23	26.3	6.69	52.6	13	13.6
SC-494	02-T1748	0.12	6.23	26.3	7.59	52.6	17	15.6
SC-495	02-T1750	0.16	8.21	27.4	31	56.2	79	79.9
SC-496	02-T1754	0.12	6.23	26.3	8.19	52.6	16	16.9
SC-497	02-T1756	0.12	6.23	26.3	7.73	52.6	15	15.9
SC-498	03-T11	0.20	6.05	28.9	26.7	57.3	65	63.6
SC-499	03-T16	0.22	6.07	30.3	4.53	59.9	7	7.9
SC-500	03-T20	0.12	6.05	29.7	6.78	58.7	12	12.4
SC-501	03-T27	0.15	9.56	26.5	32.5	55.7	83	86.5
SC-502	03-T41				20.6	0.0	63	--
SC-503	03-T43	0.15	9.56	26.5	30.8	55.7	91	80.0
SC-504	03-T70	0.15	9.56	26.5	24.6	55.7	68	58.6

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-505	03-T141	0.14	6.94	29.1	29.7	58.3	74	72.5
SC-506	03-T147	0.14	6.94	29.1	6.89	58.3	14	12.7
SC-507	03-T165	0.07	1.04	23.4	2.66	43.3	3	6.3
SC-508	03-T168	0.14	6.94	29.1	22.9	58.3	51	51.0
SC-509	03-T176	0.35	1.34	24.2	23.3	45.2	75	67.1
SC-510	03-T208	0.22	5.93	30.2	18	59.6	40	36.8
SC-511	03-T211	0.15	5.95	29.2	24.2	57.7	55	55.3
SC-512	03-T219	0.15	5.95	29.2	5.54	57.7	12	10.2
SC-513	03-T227	0.14	5.84	28.9	8.67	57.1	16	16.6
SC-514	03-T231	0.16	6.02	29.1	3.04	57.6	5	5.4
SC-515	03-T242	0.17	6.11	29.7	5.58	58.8	9	10.1
SC-516	03-T253	5.84	8.06	3.0	1.83	18.2	12	10.5
SC-517	03-T257	5.84	8.06	3.0	2.39	18.2	19	13.9
SC-518	03-T260	5.84	8.06	3.0	<0.1	18.2	0	0.6
SC-519	03-T271	10.00	5.85	4.4	0.22	23.6	58	0.9
SC-520	03-T276	15.90	5.94	7.0	4.69	34.8	16	14.1
SC-521	03-T282	0.76	28.40	0.3	6.56	23.7	36	29.6
SC-522	03-T291	0.10	1.60	17.1	14.9	32.3	47	54.2
SC-523	03-T296	0.68	11.40	0.4	1.21	10.4	7	11.8
SC-524	03-T299	0.13	6.39	29.5	21.6	58.6	51	47.0
SC-525	03-T310	0.10	5.97	28.8	20.5	56.9	46	45.3
SC-526	03-T314	0.13	6.27	29.8	18.9	59.0	43	39.5
SC-527	03-T322	0.16	6.54	29.1	27.9	58.0	72	66.7
SC-528	03-T329	0.04	0.96	22.3	1.71	41.2	0	4.2
SC-529	03-T334	0.14	6.90	29.4	3.38	58.8	6	5.9
SC-530	03-T365	0.14	7.00	29.2	3.02	58.5	5	5.3
SC-531	03-T371	0.10	6.02	29.0	3.02	57.3	4	5.4
SC-532	03-T375	0.10	6.02	29.0	20.9	57.3	45	46.1
SC-533	03-T380	0.10	6.02	29.0	2.89	57.3	3	5.2
SC-534	03-T384	0.14	5.96	29.1	28.3	57.5	70	68.6
SC-535	03-T391	0.20	6.47	28.2	24.4	56.4	59	57.3
SC-536	03-T398	0.15	6.00	29.0	29.4	57.4	73	72.6
SC-537	03-T410	0.13	6.02	28.7	20.4	56.8	45	45.1
SC-538	03-T414	0.15	6.81	28.6	30.4	57.3	79	76.2
SC-539	03-T423	0.12	6.09	27.2	23.4	54.2	56	56.4
SC-540	03-T488	0.12	6.09	27.2	25.6	54.2	60	63.5
SC-541	03-T486	0.15	5.92	27.8	31.3	55.1	80	82.6
SC-542	03-T500	0.03	5.89	24.6	22.8	49.2	51	60.0
SC-543	03-T511	0.22	5.93	30.5	13.6	60.1	27	26.2
SC-544	03-T514	0.17	6.02	29.8	27.9	58.9	68	65.7
SC-545	03-T518	0.12	5.97	28.8	29.7	57.0	75	74.2
SC-546	03-T527	0.13	5.93	29.0	23	57.3	52	52.1
SC-547	03-T531	0.17	6.02	29.8	12.6	58.9	24	24.5
SC-548	03-T535	0.12	5.97	28.8	12.9	57.0	27	26.0
SC-549	03-T541	0.14	6.10	28.7	26.4	56.9	69	63.0
SC-550	03-T550	0.14	6.10	28.7	24.7	56.9	57	57.6
SC-551	03-T564	0.12	6.33	29.8	16.7	59.1	35	33.9
SC-552	03-T567	32.90	0.53	0.3	13.5	37.0	36	35.5
SC-553	03-T571	0.16	6.80	29.1	19.2	58.2	43	40.8
SC-554	03-T574	0.16	6.80	29.1	23.3	58.2	52	52.2
SC-555	03-T586	0.16	6.80	29.1	6.31	58.2	11	11.6
SC-556	03-T590	0.18	6.97	28.6	32.7	57.5	85	84.6
SC-557	03-T597	24.40	3.14	1.4	6.32	31.8	18	19.7
SC-558	03-T602	0.13	7.35	29.1	26	58.6	62	60.0
SC-559	03-T628	0.14	7.59	28.9	27.2	58.4	66	63.9
SC-560	03-T634	28.10	1.29	0.7	14.6	33.2	47	46.6

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, %				Wt Gain CO2 @ 100% Conversion	Conversion, pct	
		Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)		By Wt Gain	By Stoichiometry
SC-561	03-T642	28.10	1.29	0.7	12.8	33.2	37	38.6
SC-562	03-T645	28.10	1.29	0.7	11.6	33.2	34	34.0
SC-563	03-T650	0.14	6.21	28.8	1.36	57.2	2	2.4
SC-564	03-T680	31.90	0.63	0.1	10.9	35.7	32	33.2
SC-565	03-T686	0.14	6.21	28.8	2.34	57.2	3	4.2
SC-566	03-T695	31.90	0.63	0.1	10.5	35.7	31	31.9
SC-567	03-T698	0.12	7.10	28.1	29.8	56.6	76	75.0
SC-568	03-T708	32.70	0.68	0.2	16.8	36.7	57	53.9
SC-569	03-T726	33.00	1.09	0.1	23.2	37.3	87	81.1
SC-570	03-T729	33.40	0.63	0.1	23.3	37.4	83	80.4
SC-571	03-T731	33.40	0.63	0.1	23.3	37.4	87	81.2
SC-572	03-T733	33.00	1.09	0.1	22	37.3	79	75.1
SC-573	03-T736	32.60	0.64	0.1	22.1	36.5	83	78.0
SC-574	03-T738	32.70	0.68	0.2	16.5	36.7	44	50.9
SC-575	03-T740	33.00	1.09	0.1	22.1	37.3	84	76.7
SC-576	03-T746	33.40	0.63	0.1	20.1	37.4	71	66.5
SC-577	03-T749	32.10	0.55	0.3	4.41	36.1	2	3.9
SC-578	03-T753	0.12	1.85	25.2	5.35	47.2	6	12.0
SC-579	03-T763	32.70	0.56	0.3	15.5	36.8	40	43.0
SC-580	03-T778	32.70	0.56	0.3	20.5	36.8	68	65.5
SC-581	03-T789	33.30	0.59	0.3	15.8	37.5	43	43.7
SC-582	03-T793	33.30	0.59	0.3	16.7	37.5	50	47.9
SC-583	03-T799	33.30	0.59	0.3	15.8	37.5	46	44.2
SC-584	03-T810	32.10	0.55	0.3	22.6	36.1	83	77.6
SC-585	03-T812	32.10	0.55	0.3	21.5	36.1	74	71.6
SC-586	03-T816	32.70	0.56	0.3	20.2	36.8	64	63.7
SC-587	03-T818	32.70	0.68	0.2	14.4	36.7	45	44.7
SC-588	03-T885	0.44	2.06	22.4	1.31	42.6	1	3.1
SC-589	03-T897	0.34	1.93	22.1	1.17	41.9	-	2.8
SC-590	03-T934	0.16	1.60	25.0	5.71	46.7	10	13.0
SC-591	03-T953	0.05	2.25	25.2	5.25	47.4	5	11.7
SC-592	03-T973	32.60	0.64	0.1	20.8	36.5	70	70.8
SC-593	03-T981	0.37	2.25	21.9	1.95	41.8	9	4.8
SC-594	03-T987	32.70	0.67	0.1	20.3	36.7	75	70.1
SC-595	03-T1002	32.70	0.67	0.1	22.9	36.7	87	82.1
SC-596	03-T1004	32.70	0.67	0.1	20.2	36.7	71	68.9
SC-597	03-T1021	32.70	0.67	0.1	22.9	36.7	86	81.8
SC-598	03-T1033	32.70	0.67	0.1	21.8	36.7	76	75.7
SC-599	03-T1056	32.70	0.67	0.1	19.1	36.7	64	63.8
SC-600	03-T1059	0.22	1.84	24.9	6.47	46.8	14	14.8
SC-601	03-T1062	32.70	0.67	0.1	21.3	36.7	84	75.5
SC-602	03-T1068	32.70	0.67	0.1	20.6	36.7	80	72.1
SC-603	03-T1091	33.00	0.98	0.1	13.1	37.2	42	39.8
SC-604	03-T1093	33.00	0.98	0.1	14.1	37.2	44	43.2
SC-605	03-T1099	33.00	0.98	0.1	14	37.2	44	42.9
SC-606	03-T1101	33.00	0.98	0.1	13.4	37.2	40	40.5
SC-607	03-T1108	33.00	0.98	0.1	12.1	37.2	37	36.0
SC-608	03-T1110	33.00	0.98	0.1	13.1	37.2	39	39.5
SC-609	03-T1113	32.70	0.67	0.1	17.9	36.7	64	59.7
SC-610	03-T1120	32.70	0.67	0.1	4.84	36.7	9	12.3
SC-611	03-T1127	32.70	0.67	0.1	11.1	36.7	37	33.3
SC-612	03-T1129	32.70	0.67	0.1	22.8	36.7	80	80.1
SC-613	03-T1136	33.00	0.66	0.1	19	36.9	64	62.7
SC-614	03-T1141	32.60	0.69	0.1	12.4	36.5	37	38.1
SC-615	03-T1152	33.00	0.66	0.1	16	36.9	52	50.5
SC-616	03-T1158	32.60	0.73	0.1	8.76	36.6	23	25.3

Appendix D: Carbonation Results

Test	Product Solids LIMS No.	Analyses, % Ca (feed)	Fe+2 (feed)	Mg (feed)	CO2 (product)	Wt Gain CO2 @ 100% Conversion	Conversion, pct By Wt Gain	By Stoichiometry
SC-617	03-T1162	33.00	0.66	0.1	16.4	36.9	54	52.1
SC-618	03-T1174	33.00	0.66	0.1	16.3	36.9	53	51.7
SC-619	03-T1179	33.30	0.86	0.1	8.12	37.4	23	23.0
SC-620	03-T1186	33.40	0.80	0.1	7.26	37.6	20	20.2
SC-621	03-T1196	33.40	0.75	0.2	6.16	37.5	18	16.9
SC-622	03-T1199	32.30	0.95	0.2	5.65	36.5	15	15.8
SC-623	03-T1203	24.40	3.14	1.4	6.65	31.8	19	20.8
SC-624	03-T1209	0.27	6.68	28.3	13	56.8	26	26.3
SC-625	03-T1216	0.05	5.61	30.5	2.64	59.7	4	4.5
SC-626	03-T1229	0.13	5.69	30.0	4.67	58.9	7	8.3
SC-627	03-T1233	0.12	6.27	30.0	20	59.4	43	42.1
SC-628	03-T1260	4.88	11.80	4.7	6.97	23.1		32.4

Appendix E: Comments and Observations

SC-1	
SC-2	
SC-3	
SC-4	
SC-5	
SC-6	rupture disk failure, test terminated
SC-7	rupture disk failure, test terminated
SC-8	rupture disk failure, test terminated
SC-9	
SC-10	
SC-11	
SC-12	
SC-13	
SC-14	
SC-15	
SC-16	
SC-17	test terminated early
SC-18	
SC-19	test terminated early
SC-20	
SC-21	
SC-22	test terminated early
SC-23	
SC-24	
SC-25	
SC-26	
SC-27	test terminated after pretreatment
SC-28	
SC-29	
SC-30	
SC-31	
SC-32	
SC-33	
SC-34	
SC-35	
SC-36	
SC-37	
SC-38	
SC-39	
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SC-41	
SC-42	

SC-43	
SC-44	
SC-45	
SC-46	
SC-47	
SC-48	
SC-49	
SC-50	
SC-51	
SC-52	
SC-53	
SC-54	
SC-55	
SC-56	spilled sample
SC-57	
SC-58	
SC-59	
SC-60	
SC-61	
SC-62	
SC-63	
SC-64	
SC-65	
SC-66	
SC-67	
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SC-121
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SC-123
SC-124
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SC-126

SC-127	
SC-128	
SC-129	
SC-130	
SC-131	gas composition: 15% CO2, 5% O2, balance N2
SC-132	
SC-133	gas composition: 50% CO2, 8% O2, balance N2
SC-134	
SC-135	
SC-136	
SC-137	
SC-138	
SC-139	
SC-140	
SC-141	
SC-142	
SC-143	
SC-144	
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SC-167	
SC-168	

SC-169	
SC-170	
SC-171	
SC-172	
SC-173	
SC-174	
SC-175	
SC-176	
SC-177	spilled sample
SC-178	
SC-179	
SC-180	spilled sample
SC-181	
SC-182	spilled sample
SC-183	test for feasibility study
SC-184	test for feasibility study
SC-185	test for feasibility study
SC-186	test for feasibility study
SC-187	
SC-188	
SC-189	
SC-190	
SC-191	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-192	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-193	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-194	
SC-195	added 3% to 31.1% (00-T2017 Mg analysis)
SC-196	
SC-197	
SC-198	
SC-199	unexplained wt loss; 29g ppte in liquor
SC-200	
SC-201	unexplained wt loss; 28g ppte in liquor
SC-202	
SC-203	
SC-204	
SC-205	
SC-206	
SC-207	
SC-208	
SC-209	
SC-210	

SC-211	
SC-212	
SC-213	
SC-214	
SC-215	
SC-216	
SC-217	
SC-218	
SC-219	
SC-220	
SC-221	
SC-222	
SC-223	
SC-224	
SC-225	
SC-226	added 3% to 29.8% (01-T1241 Mg analysis)
SC-227	
SC-228	
SC-229	
SC-230	
SC-231	
SC-232	
SC-233	
SC-234	
SC-235	spilled sample
SC-236	
SC-237	
SC-238	added 3% to 28.3% (01-T1334 Mg analysis)
SC-239	
SC-240	
SC-241	
SC-242	
SC-243	
SC-244	
SC-245	repeat Mg analysis
SC-246	repeat Mg analysis
SC-247	
SC-248	
SC-249	
SC-250	spilled sample
SC-251	
SC-252	

SC-253	
SC-254	
SC-255	
SC-256	
SC-257	
SC-258	
SC-259	
SC-260	
SC-261	flotation cell test 1
SC-262	flotation cell test 2
SC-263	
SC-264	solenoid stuck - low pressure for 1/2 test
SC-265	
SC-266	misweighed feed - low pct solids
SC-267	
SC-268	compare SC-263
SC-269	
SC-270	
SC-271	stage ground: S1: 20 min; S2: 25 min; S3: 25 min
SC-272	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-273	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-274	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-275	
SC-276	
SC-277	
SC-278	
SC-279	
SC-280	
SC-281	
SC-282	
SC-283	
SC-284	repeat of SC-281
SC-285	Test 1: SiO2 grinding media
SC-286	
SC-287	Test 2: SiO2 grinding media
SC-288	Test 3: 10x14m olivine grinding media
SC-289	
SC-290	
SC-291	Test 4: 10x20m olivine grinding media
SC-292	
SC-293	
SC-294	Test 5: 10x20m olivine grinding media

SC-295	
SC-296	
SC-297	
SC-298	
SC-299	
SC-300	
SC-301	
SC-302	
SC-303	
SC-304	
SC-305	compare SC-289
SC-306	
SC-307	
SC-308	
SC-309	
SC-310	
SC-311	
SC-312	
SC-313	
SC-314	CO2 bubbled into sol'n; magnetic mixer, plexiglass vessel
SC-315	CO2 bubbled into sol'n; 24V DC, 1.8 amp, magnetic mixer, plexiglass vessel
SC-316	compare SC-234
SC-317	
SC-318	
SC-319	
SC-320	
SC-321	
SC-322	vitrified and granualted prior to stage-2 reduction
SC-323	slight solids loss due to small spill
SC-324	
SC-325	
SC-326	
SC-327	
SC-328	
SC-329	
SC-330	no "incubation" time
SC-331	1h "incubation" to accomodate heat-up time for high-temp tests
SC-332	no "incubation" time
SC-333	no "incubation" time
SC-334	no "incubation" time; pressure gauge questionable
SC-335	no "incubation" time; new pressure gauge
SC-336	no "incubation" time

SC-337	no "incubation" time
SC-338	
SC-339	
SC-340	1h "incubation" to accomodate heat-up time for high-temp tests
SC-341	Begin Thadeus method of calculation of extent of reaction by wt gain
SC-342	
SC-343	
SC-344	
SC-345	
SC-346	
SC-347	
SC-348	
SC-349	
SC-350	
SC-351	
SC-352	
SC-353	
SC-354	composited product sol'ns from SC-295, SC-298, SC-301, SC-302, SC-329, SC-338, SC-339, and SC-352
SC-355	composited product sol'ns from SC-295, SC-298, SC-301, SC-302, SC-329, SC-338, SC-339, and SC-352
SC-356	
SC-357	base test for SO2 tests to follow
SC-358	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-359	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-360	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-361	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-362	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-363	
SC-364	
SC-365	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-366	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-367	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-368	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-369	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-370	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-371	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-372	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-373	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-374	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-375	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-376	
SC-377	250C
SC-378	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained

SC-379	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-380	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-381	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-382	nonmag from mag sep'n (02-T632), 250C
SC-383	1/2 rod milled additional 30 min
SC-384	
SC-385	
SC-386	nonmag from mag sep'n (02-T632), 250C in Ar
SC-387	
SC-388	nonmag from mag sep'n (02-T632), 250C in Ar
SC-389	
SC-390	
SC-391	nonmag from mag sep'n - batch 2, bag 1 (02-T698), 500 g, in Ar
SC-392	nonmag from mag sep'n - batch 2, bag 1 (02-T698), 200 g, in Ar, 300 rpm
SC-393	nonmag from mag sep'n - batch 2, bag 1 (02-T698), 200 g, in Ar, 500 rpm
SC-394	
SC-395	compare SC-385
SC-396	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 300 rpm; compare SC-392
SC-397	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm; compare SC-393
SC-398	nonmag from mag sep'n - batch 3 (02-T736), 250 g, 250C in Ar; compare SC-391
SC-399	nonmag from mag sep'n - batch 3 (02-T736), 250 g, 250C in Ar, 100 rpm
SC-400	nonmag from mag sep'n - batch 2, bag 1 (02-T698), 200 g, in Ar, 500 rpm; copmpare SC-393, SC-397
SC-401	nonmag from mag sep'n - batch 3 (02-T736), 250 g, 250C in Ar, 60 rpm, mixed balls; compare SC-398
SC-402	nonmag from mag sep'n - batch 3 (02-T736), 100 g x 2, in Ar, 300 rpm; compare SC-392, SC-396
SC-403	nonmag from mag sep'n - batch 3 (02-T736), 400 g, in Ar, 300 rpm ("free half" to carb.)
SC-404	nonmag from mag sep'n - batch 3 (02-T736), 400 g, in Ar, 300 rpm ("caked half" to carb.)
SC-405	nonmag from mag sep'n - batch 3 (02-T736), 250 g, 250C in Ar, 100 rpm, mixed balls
SC-406	nonmag from mag sep'n - batch 3 (02-T736), 250 g, 250C in Ar, 135 rpm, mixed balls
SC-407	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 400 rpm
SC-408	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 500 rpm
SC-409	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-410	gas composition: 1.5%SO2, 0.05%He, balance CO2
SC-411	
SC-412	
SC-413	
SC-414	
SC-415	
SC-416	unaccounted weight loss
SC-417	severe leak, terminated test early
SC-418	nonmag from mag sep'n - batch 3 (02-T736), 200 g x 2, >200C (final T) in Ar, 500 rpm
SC-419	nonmag from mag sep'n - batch 3 (02-T736), 250 g, in Ar, 135 rpm, mixed balls
SC-420	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 244C (init. T) in Ar, 300 rpm

SC-421	nonmag from mag sep'n - batch 3 (02-T736), 100 g x 2
SC-422	fayalite to siderite
SC-423	Test 6: 500 rpm
SC-424	fayalite to siderite
SC-425	Test 7: 500 rpm; attrited product not dried prior to carbonation; estimated carbonation by weight gain
SC-426	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 150C (init. T) in Ar, 300 rpm
SC-427	
SC-428	based on Ca: assumed 60 anorthite/40 albite w/~12.1% CaO (B = 15.84) for wt basis
SC-429	Test 8: 100 g x 2, 500 rpm; compare SC-423
SC-430	Test 9: 400 g, 500 rpm; compare SC-423, SC-429
SC-431	1/4" balls
SC-432	
SC-433	
SC-434	
SC-435	
SC-436	1100 g, 500 rpm
SC-437	
SC-438	500 rpm, pin impeller
SC-439	500 rpm, pin impeller
SC-440	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 100C (init. T) in Ar, 300 rpm
SC-441	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 200C (init. T) in Ar, 300 rpm
SC-442	nonmag from mag sep'n - batch 3 (02-T736), 200 g, 50C (init. T) in Ar, 300 rpm
SC-443	
SC-444	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm
SC-445	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm
SC-446	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm
SC-447	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm
SC-448	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm
SC-449	nonmag from mag sep'n - batch 3 (02-T736), 100 g, in Ar, 500 rpm
SC-450	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 500 rpm; compare SC-448
SC-451	nonmag from mag sep'n - batch 3 (02-T736), 100 g, in Ar, 500 rpm
SC-452	nonmag from mag sep'n - batch 3 (02-T736), 100 g, 100C (init. T) in Ar, 500 rpm
SC-453	nonmag from mag sep'n - batch 3 (02-T736), 100 g, 60C (init. T) in Ar, 500 rpm
SC-454	nonmag from mag sep'n - batch 3 (02-T736), 100 g, 200C (init. T) in Ar, 500 rpm
SC-455	nonmag from mag sep'n - batch 3 (02-T736), 100 g, 150C (init. T) in Ar, 500 rpm
SC-456	nonmag from mag sep'n - batch 3 (02-T736), 100 g, in Ar, 500 rpm
SC-457	nonmag from mag sep'n - batch 3 (02-T736), 100 g, in Ar, 500 rpm
SC-458	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 400 rpm
SC-459	nonmag from mag sep'n - batch 3 (02-T736), 200 g, in Ar, 400 rpm
SC-460	nonmag from mag sep'n - batch 3 (02-T736), 100 g, in Ar, 300 rpm
SC-461	nonmag from mag sep'n - batch 3 (02-T736), 100 g, 200C (init. T) in Ar, 300 rpm
SC-462	275 g, 500 rpm

SC-463	367 g, 500 rpm
SC-464	550 g, 500 rpm
SC-465	2200 g, 500 rpm
SC-466	100 g x 2, 500 rpm
SC-467	1100 g, 500 rpm; product (02-T1463) and rinse solids (02-T1464) kept separate for analysis
SC-468	75 g x 3, 500 rpm
SC-469	300 g, 500 rpm
SC-470	1100 g, 500 rpm
SC-471	1100 g, 500 rpm
SC-472	1100 g, 500 rpm
SC-473	nonmag from mag sep'n - batch 3 (02-T736), 500 rpm
SC-474	2200 g, 500 rpm
SC-475	1100 g, 500 rpm
SC-476	1100 g; attritor, 500 rpm; ball mill 50%s, large balls
SC-477	1100 g; 500 rpm
SC-478	1100 g; attritor, 500 rpm; ball mill 50%s, small balls
SC-479	300 g, 500 rpm
SC-480	600 g, 500 rpm
SC-481	300 g, 500 rpm
SC-482	300 g, 500 rpm; composite 7 batches
SC-483	G57-02 composite (02-T1655), 400 g, 500 rpm
SC-484	G57-02 composite (02-T1655), 400 g, 500 rpm
SC-485	G57-02 composite (02-T1655), 400 g, 500 rpm
SC-486	G57-02 composite (02-T1655), 400 g, 500 rpm
SC-487	300 g, 500 rpm
SC-488	
SC-489	
SC-490	
SC-491	repeat SC-490
SC-492	G57-02 composite (02-T1655), 400 g, 500 rpm
SC-493	2200 g, 500 rpm; compare SC-465, SC-474
SC-494	2200 g, 500 rpm; compare SC-465, SC-474, SC-493
SC-495	1100 g, 500 rpm; compare SC-475
SC-496	2200 g, 500 rpm; compare SC-465, SC-474, SC-493, SC-494
SC-497	2200 g, 500 rpm; compare SC-465, SC-474, SC-493, SC-494, SC-496
SC-498	550 g, 500 rpm
SC-499	Test 9: 400 g, 500 rpm
SC-500	400 g, 500 rpm; compare SC-430, SC-499
SC-501	550 g
SC-502	repeat SC-490, SC-491
SC-503	550 g; repeat SC-501
SC-504	550 g; compare SC-503

SC-505	2200 g; compare FL-1
SC-506	2200 g; "0" test for Flow Loop conditons on warm-up
SC-507	300 g
SC-508	2200 g; aged 2 weeks in air; compare SC-505
SC-509	compare SC-326
SC-510	SMD-1: 537 g, kaolin balls
SC-511	SMD-2: 537 g, kaolin balls
SC-512	SMD-2: 537 g, kaolin balls
SC-513	SMD-3: 832 g, kaolin balls
SC-514	SMD-4: 405 g, kaolin balls
SC-515	SMD-5: 405 g, kaolin balls
SC-516	300 g x 2, 500 rpm; baseline for CO2/SO2 tests on basalt
SC-517	300 g x 2, 500 rpm; gas composition: 1.5% SO2, 0.05% He, balance CO2
SC-518	300 g x 2, 500 rpm; 1.5% SO2, 0.05% He, balance CO2; sol'n (mg/L): 97 NaHCO3, 30 Na2CO3, 207 Na2SO4, 410 NaCl, 110 NaF, 11.2 KCl, pH = 9.297 @ 20.2C
SC-519	200 g
SC-520	200 g
SC-521	200 g
SC-522	200 g
SC-523	200 g
SC-524	SMD-6: 537 g, 1/4" steel balls
SC-525	537 g, kaolin balls
SC-526	537 g, 1/4" steel balls
SC-527	300 g, 1/4" steel balls
SC-528	
SC-529	03-T72 aged 8 weeks in air, 2200 g; Ca analysis from 03-T72; compare FL-1, SC-505, SC-508
SC-530	03-T72 aged 8 weeks in Ar, 2200 g; Ca analysis from 03-T72; compare FL-1, SC-505, SC-508, SC-529
SC-531	SMD-7: 537 g, kaolin balls; CO2 Lot M27219, Cyl. 275-000606
SC-532	SMD-7: 537 g, kaolin balls; CO2 Lot E10210, Cyl. 000265; compare SC-531, SC-364
SC-533	SMD-7: 537 g, kaolin balls; same CO2 cylinder as SC-531; compare SC-531, SC-532, SC-364
SC-534	SMD-8: 537 g, kaolin balls
SC-535	SMD-9: 537 g, 3mm steel balls
SC-536	SMD-11: 537 g, kaolin balls
SC-537	SMD-10: 537 g, kaolin balls
SC-538	2200 g, 500 rpm; compare SC-505
SC-539	SMD-12: 537 g, kaolin balls; pressure set low by accident; compare SC-510
SC-540	SMD-12: 537 g, kaolin balls; compare SC-539
SC-541	SMD-13: 537 g, kaolin balls
SC-542	SMD-14: 537 g, kaolin balls; compare SC-532
SC-543	compare SC-384
SC-544	SMD-16: 587 g, kaolin balls; compare SC-540
SC-545	SMD-17: 587 g, kaolin balls; compare SC-534
SC-546	SMD-15: 587 g, kaolin balls; compare SC-542

SC-547	SMD-16: 587 g, kaolin balls; compare SC-544
SC-548	SMD-17: 587 g, kaolin balls; compare SC-545
SC-549	SMD-18: 629.5 g, kaolin balls; direct from autoclave to carbonation; estimated weight and % solids
SC-550	SMD-18: 629.5 g, kaolin balls; dried; compare SC-549
SC-551	SMD-19: 537 g, 1/8" SS balls
SC-552	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-553	SMD-20: 537 g, 1/8" SS balls; Coleman grade CO2 (99.99%)
SC-554	SMD-20: 537 g, 1/8" SS balls; anaerobic CO2 (99.99%)
SC-555	SMD-20: 537 g, 1/8" SS balls; Bone Dry CO2 (99.99%) - Lab 10B
SC-556	2200 g, 500 rpm; anaerobic CO2 (99.99%)
SC-557	1000 g, small mill; anaerobic CO2 (99.99%)
SC-558	SMD-21: 537 g, 1/8" SS balls; anaerobic CO2 (99.99%)
SC-559	SMD-22: 537 g, 1/8" SS balls; anaerobic CO2 (99.99%)
SC-560	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-561	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-562	CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-563	Anaerobic CO2 (99.99%)
SC-564	1000 g x 2, small mill; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-565	Anaerobic CO2 (99.99%); warm-up 2.75 hr, normal cool-down (simulate flow loop)
SC-566	1000 g x 2, small mill; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-567	2200 g, 500 rpm; anaerobic CO2 (99.99%)
SC-568	SMD-23: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-569	SMD-24: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-570	SMD-25: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-571	SMD-25: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-572	SMD-24: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-573	SMD-26: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-574	SMD-23: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-575	SMD-24: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-576	SMD-25: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-577	SMD-32: 534 g, kaolin balls; new CO2 cylinder; no warm-up period
SC-578	SMD-29: 522 g, kaolin balls; anaerobic CO2 (99.99%)
SC-579	SMD-31:534 g, kaolin balls; 30 min warm-up and end test; severe leak in bottom valve
SC-580	SMD-31: 534 g, kaolin balls; 60 min warm-up and end test
SC-581	SMD-30: 534 g, kaolin balls; 60 min warm-up and end test
SC-582	SMD-30: 534 g, kaolin balls; 60 min warm-up and hold, and end test
SC-583	SMD-30: 534 g, kaolin balls; 60 min warm-up and hold, and end test
SC-584	SMD-32: 534 g, kaolin balls; 60 min warm-up and hold, and end test
SC-585	SMD-32: 534 g, kaolin balls; 60 min warm-up and hold, and end test
SC-586	SMD-31: 534 g, kaolin balls; 60 min warm-up and end test
SC-587	SMD-23: 534 g, kaolin balls; 60 min warm-up and end test
SC-588	SMD-33: 522 g, kaolin balls

SC-589	SMD-34: 522 g, kaolin balls
SC-590	SMD-28: 522 g, kaolin balls
SC-591	SMD-27: 522 g, kaolin balls
SC-592	SMD-26: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-593	SMD-35: 522 g, kaolin balls
SC-594	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-595	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-596	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-597	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-598	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-599	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-600	SMD-37: 522 g, kaolin balls
SC-601	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-602	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-603	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-604	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-605	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-606	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-607	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-608	7x9 mill, ~1000 g x 2, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-609	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-610	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-611	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-612	SMD-36: 534 g, kaolin balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-613	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-614	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-615	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-616	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-617	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-618	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-619	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-620	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-621	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-622	7x9 mill, ~1000 g x 2 each, mixed rods, mixed balls; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-623	1000 g, small mill; CaSiO3 basis: net Ca + Fe+2 + Mg available and net CO2 gained
SC-624	
SC-625	loss of extreme fines through filter paper
SC-626	168.0g coarse filter solids, 5.8g fine filter solids (passed through paper, 03-T1230); analyzed separately
SC-627	2200 g
SC-628	1000 g

Appendix F: Feed and Product Chemistry

Carbonation test #SC-1 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.166	Cl	na	na
CaO	0.178	0.220	Cr	na	na
Cr_2O_3	0.044	na	Fe	<0.0001	0.0007
FeO	7.83	6.37	Mg	<0.0001	0.1320
Fe_2O_3	na	na	Ni	na	na
MgO	49.4	47.3	K	na	na
NiO	na	na	Si	<0.0005	0.5960
K_2O	0.007	na	Na	na	na
SiO_2	41.3	38.3	CO_2	<0.1	0.53
Na_2O	0.099	na	HCO_3	na	na
CO_2	<0.3	6.90			
C, noncarbonate	0.021	0.047	pH	5.50	na
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.359	na			
Total	99.443	99.250			
LOI, total[3]	0.38	na			
Extent of carbonation, %[4]		12.6			

Carbonation test #SC-2 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.179	Cl	na	na
CaO	0.178	0.185	Cr	na	na
Cr_2O_3	0.044	na	Fe	<0.0001	0.0006
FeO	7.83	6.93	Mg	<0.0001	0.3160
Fe_2O_3	na	na	Ni	na	na
MgO	49.4	47.3	K	na	na
NiO	na	na	Si	<0.0005	0.405
K_2O	0.007	na	Na	na	na
SiO_2	41.3	40.0	CO_2	<0.1	1.27
Na_2O	0.099	na	HCO_3	na	na
CO_2	<0.3	2.270			
C, noncarbonate	0.021	0.053	pH	5.50	na
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.359	na			
Total	99.443	96.882			
LOI, total[3]	0.38	na			
Extent of carbonation, %[4]		3.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-3 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.155	Cl	na	na
CaO	0.178	0.124	Cr	na	na
Cr_2O_3	0.044	na	Fe	<0.0001	0.0022
FeO	7.83	6.06	Mg	<0.0001	0.0622
Fe_2O_3	na	na	Ni	na	na
MgO	49.4	43.9	K	na	na
NiO	na	na	Si	<0.0005	0.563
K_2O	0.007	na	Na	na	na
SiO_2	41.3	32.7	CO_2	<0.1	0.40
Na_2O	0.099	na	HCO_3	na	na
CO_2	<0.3	18.3			
C, noncarbonate	0.021	0.036	pH	5.50	5.65
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.359	na			
Total	99.443	101.344			
LOI, total[3]	0.38	na			
Extent of carbonation, %[4]		38.0			

Carbonation test #SC-4 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.171	Cl	na	na
CaO	0.169	0.155	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0017
FeO	6.63	5.96	Mg	<0.0001	0.056
Fe_2O_3	0.629	na	Ni	na	na
MgO	51.6	41.5	K	na	na
NiO	na	na	Si	<0.0005	0.586
K_2O	0.016	na	Na	na	na
SiO_2	40.9	33.2	CO_2	<0.1	0.360
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	17.7			
C, noncarbonate	0.031	0.029	pH	5.50	5.10
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	98.623			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		35.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-5 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.197	Cl	na	na
CaO	0.178	0.206	Cr	na	na
Cr_2O_3	0.044	na	Fe	<0.0001	0.0005
FeO	7.83	6.65	Mg	<0.0001	0.028
Fe_2O_3	na	na	Ni	na	na
MgO	49.4	49.6	K	na	na
NiO	na	na	Si	<0.0005	0.0867
K_2O	0.007	na	Na	na	na
SiO_2	41.3	40.2	CO_2	<0.1	0.50
Na_2O	0.099	na	HCO_3	na	na
CO_2	<0.3	1.45			
C, noncarbonate	0.021	0.188	pH	5.50	5.34
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.359	na			
Total	99.443	98.487			
LOI, total[3]	0.38	na			
Extent of carbonation, %[4]		2.5			

Carbonation test #SC-6 [aborted test FG olivine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202		Cl		
CaO	0.178		Cr		
Cr_2O_3	0.044		Fe		
FeO	7.83		Mg		
Fe_2O_3	na		Ni		
MgO	49.4		K		
NiO	na		Si		
K_2O	0.007		Na		
SiO_2	41.3		CO_2		
Na_2O	0.099		HCO_3		
CO_2	<0.3				
C, noncarbonate	0.078		pH		
H_2O, dehyd.[1]	na				
H_2O, chem.[2]	0.380				
Total	99.521				
LOI, total[3]	0.38				
Extent of carbonation, %[4]					

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-7 [aborted test FG olivine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202		Cl		
CaO	0.178		Cr		
Cr_2O_3	0.044		Fe		
FeO	7.83		Mg		
Fe_2O_3	na		Ni		
MgO	49.4		K		
NiO	na		Si		
K_2O	0.007		Na		
SiO_2	41.3		CO_2		
Na_2O	0.099		HCO_3		
CO_2	<0.3				
C, noncarbonate	0.078		pH		
H_2O, dehyd.[1]	na				
H_2O, chem.[2]	0.380				
Total	99.521				
LOI, total[3]	0.38				
Extent of carbonation, %[4]					

Carbonation test #SC-8 [aborted test FG olivine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202		Cl		
CaO	0.178		Cr		
Cr_2O_3	0.044		Fe		
FeO	7.83		Mg		
Fe_2O_3	na		Ni		
MgO	49.4		K		
NiO	na		Si		
K_2O	0.007		Na		
SiO_2	41.3		CO_2		
Na_2O	0.099		HCO_3		
CO_2	<0.3				
C, noncarbonate	0.078		pH		
H_2O, dehyd.[1]	na				
H_2O, chem.[2]	0.380				
Total	99.521				
LOI, total[3]	0.38				
Extent of carbonation, %[4]					

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-9 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.259	Cl	na	na
CaO	0.178	0.114	Cr	na	na
Cr_2O_3	0.044	na	Fe	<0.0001	0.0002
FeO	7.83	7.55	Mg	<0.0001	0.0231
Fe_2O_3	na	na	Ni	na	na
MgO	49.4	49.4	K	na	na
NiO	na	na	Si	<0.0005	0.2170
K_2O	0.007	na	Na	na	na
SiO_2	41.3	40.9	CO_2	<0.1	0.25
Na_2O	0.099	na	HCO_3	na	na
CO_2	<0.3	0.070			
C, noncarbonate	0.021	0.041	pH	5.50	5.25
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.359	na			
Total	99.443	98.307			
LOI, total[3]	0.38	na			
Extent of carbonation, %[4]		0.1			

Carbonation test #SC-10 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.158	Cl	na	na
CaO	0.169	0.224	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0010
FeO	6.63	6.77	Mg	<0.0001	0.0556
Fe_2O_3	0.629	na	Ni	na	na
MgO	51.6	46.1	K	na	na
NiO	na	na	Si	<0.0005	0.5270
K_2O	0.016	na	Na	na	na
SiO_2	40.9	31.4	CO_2	<0.1	0.44
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	1.25			
C, noncarbonate	0.031	0.030	pH	na	na
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	85.971			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		2.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-11 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.149	Cl	na	na
CaO	0.169	0.155	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0015
FeO	6.63	6.20	Mg	<0.0001	0.0481
Fe_2O_3	0.629	0.029	Ni	na	na
MgO	51.6	40.3	K	na	na
NiO	na	na	Si	<0.0005	0.4720
K_2O	0.016	na	Na	na	na
SiO_2	40.9	32.5	CO_2	<0.1	0.43
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	19.8			
C, noncarbonate	0.031	0.056	pH	5.50	5.89
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	99.199			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		40.6			

Carbonation test #SC-12 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.227	Cl	na	na
CaO	0.169	0.129	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0006
FeO	6.63	6.11	Mg	<0.0001	0.0629
Fe_2O_3	0.629	0.801	Ni	na	na
MgO	51.6	52.4	K	na	na
NiO	na	na	Si	<0.0005	0.2910
K_2O	0.016	na	Na	na	na
SiO_2	40.9	40.4	CO_2	<0.1	0.26
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	0.330			
C, noncarbonate	0.031	0.022	pH	5.50	5.85
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	100.447			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		0.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-13 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.259	Cl	na	na
CaO	0.169	0.137	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0030
FeO	6.63	7.00	Mg	<0.0001	0.0824
Fe_2O_3	0.629	<0.01	Ni	na	na
MgO	51.6	48.1	K	na	na
NiO	na	na	Si	<0.0005	0.57
K_2O	0.016	na	Na	na	na
SiO_2	40.9	37.4	CO_2	<0.1	0.52
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	6.58			
C, noncarbonate	0.031	0.000	pH	5.50	5.70
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	99.496			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		11.6			

Carbonation test #SC-14 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.189	Cl	na	na
CaO	0.169	0.252	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.001
FeO	6.63	7.83	Mg	<0.0001	0.144
Fe_2O_3	0.629	<0.01	Ni	na	na
MgO	51.6	46.8	K	na	na
NiO	na	na	Si	<0.0005	0.369
K_2O	0.016	na	Na	na	na
SiO_2	40.9	36.4	CO_2	<0.1	0.64
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	6.21			
C, noncarbonate	0.031	1.785	pH	5.50	5.90
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	99.397			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		10.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-15 **Reag. Mg2SiO4**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.204	Cl	na	na
CaO	0.660	0.491	Cr	na	na
Cr_2O_3	0.012	na	Fe	<0.0001	<0.0001
FeO	0.009	0.051	Mg	<0.0001	0.440
Fe_2O_3	na	na	Ni	na	na
MgO	57.5	37.5	K	na	na
NiO	na	na	Si	<0.0005	0.084
K_2O	0.019	na	Na	na	na
SiO_2	37.9	27.8	CO_2	<0.1	2.19
Na_2O	0.101	na	HCO_3	na	na
CO_2	na	32.5			
C, noncarbonate	0.063	0.400	pH	5.50	7.19
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	na	na			
Total	96.590	98.930			
LOI, total[3]	na	na			
Extent of carbonation, %[4]		76.0			

Carbonation test #SC-16 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.242	Cl	na	na
CaO	0.182	0.227	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.000
FeO	8.58	7.53	Mg	<0.0001	0.089
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	50.7	K	na	na
NiO	0.331	na	Si	<0.0005	0.330
K_2O	0.011	na	Na	na	na
SiO_2	40.4	39.8	CO_2	<0.1	0.52
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	0.580			
C, noncarbonate	0.039	0.010	pH	5.50	6.15
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	99.112			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		1.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-17 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.208	Cl	na	na
CaO	0.169	0.175	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.042
FeO	6.63	6.68	Mg	<0.0001	0.555
Fe_2O_3	0.629	0.329	Ni	na	na
MgO	51.6	51.6	K	na	na
NiO	na	na	Si	<0.0005	0.244
K_2O	0.016	na	Na	na	na
SiO_2	40.9	40.4	CO_2	<0.1	2.01
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	0.140			
C, noncarbonate	0.031	0.011	pH	5.50	na
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	99.539			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		0.2			

Carbonation test #SC-18 **Syn. Mg2SiO4**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.163	Cl	na	na
CaO	0.660	0.400	Cr	na	na
Cr_2O_3	0.012	na	Fe	<0.0001	<0.0001
FeO	0.009	<0.02	Mg	<0.0001	0.584
Fe_2O_3	na	na	Ni	na	na
MgO	57.5	36.8	K	na	na
NiO	na	na	Si	<0.0005	0.242
K_2O	0.019	na	Na	na	na
SiO_2	37.9	27.6	CO_2	<0.1	2.49
Na_2O	0.101	na	HCO_3	na	na
CO_2	na	31.7			
C, noncarbonate	0.063	0.058	pH	5.50	6.70
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	na	na			
Total	96.590	96.728			
LOI, total[3]	na	na			
Extent of carbonation, %[4]		73.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-19 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.249	Cl	na	na
CaO	0.182	0.075	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	na
FeO	8.58	9.58	Mg	<0.0001	na
Fe_2O_3	<0.01	na	Ni	na	na
MgO	48.4	50.2	K	na	na
NiO	0.331	na	Si	<0.0005	na
K_2O	0.011	na	Na	na	na
SiO_2	40.4	40.2	CO_2	<0.1	na
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	0.120			
C, noncarbonate	0.039	0.056	pH	5.50	na
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	100.543			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		0.2			

Carbonation test #SC-20 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.274	Cl	na	na
CaO	0.182	0.190	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.000
FeO	8.58	10.45	Mg	<0.0001	0.419
Fe_2O_3	<0.01	na	Ni	na	na
MgO	48.4	50.7	K	na	na
NiO	0.331	na	Si	<0.0005	0.113
K_2O	0.011	na	Na	na	na
SiO_2	40.4	40.4	CO_2	<0.1	1.71
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	0.200			
C, noncarbonate	0.039	0.032	pH	5.50	na
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	102.312			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		0.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-21 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.272	Cl	na	na
CaO	0.182	0.201	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.00
FeO	8.58	7.89	Mg	<0.0001	0.26
Fe_2O_3	<0.01	na	Ni	na	na
MgO	48.4	50.1	K	na	na
NiO	0.331	na	Si	<0.0005	0.16
K_2O	0.011	na	Na	na	na
SiO_2	40.4	39.8	CO_2	<0.1	1.01
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	0.830			
C, noncarbonate	0.039	0.022	pH	5.50	7.32
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	99.077			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		1.4			

Carbonation test #SC-22 [test aborted - no samples] **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180		Cl		
CaO	0.182		Cr		
Cr_2O_3	0.247		Fe		
FeO	8.581		Mg		
Fe_2O_3	<0.01		Ni		
MgO	48.4		K		
NiO	0.331		Si		
K_2O	0.011		Na		
SiO_2	40.4		CO_2		
Na_2O	0.030		HCO_3		
CO_2	<0.01				
C, noncarbonate	0.144		pH		
H_2O, dehyd.[1]	0.060				
H_2O, chem.[2]	0.390				
Total	99.004				
LOI, total[3]	0.39				
Extent of carbonation, %[4]					

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-23 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.266	Cl	na	na
CaO	0.182	0.222	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.001
FeO	8.58	8.08	Mg	<0.0001	0.215
Fe_2O_3	<0.01	na	Ni	na	na
MgO	48.4	51.4	K	na	na
NiO	0.331	na	Si	<0.0005	0.189
K_2O	0.011	na	Na	na	na
SiO_2	40.4	39.6	CO_2	<0.1	0.80
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	0.800			
C, noncarbonate	0.039	0.052	pH	5.50	na
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	100.397			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		1.4			

Carbonation test #SC-24 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.242	Cl	na	na
CaO	0.169	0.252	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.000
FeO	6.63	7.71	Mg	<0.0001	0.115
Fe_2O_3	0.629	na	Ni	na	na
MgO	51.6	53.4	K	na	na
NiO	na	na	Si	<0.0005	0.195
K_2O	0.016	na	Na	na	na
SiO_2	40.9	40.2	CO_2	<0.1	0.47
Na_2O	0.024	na	HCO_3	na	na
CO_2	<0.01	0.700			
C, noncarbonate	0.031	0.042	pH	5.50	7.67
H_2O, dehyd.[1]	<0.01	na			
H_2O, chem.[2]	0.580	na			
Total	100.711	102.551			
LOI, total[3]	0.61	na			
Extent of carbonation, %[4]		1.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-25 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.171	Cl	na	na
CaO	0.182	0.229	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	<0.0001
FeO	8.58	5.27	Mg	<0.0001	0.067
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	35.3	K	na	na
NiO	0.331	na	Si	<0.0005	0.168
K_2O	0.011	na	Na	na	na
SiO_2	40.4	26.7	CO_2	<0.1	0.66
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	32.3			
C, noncarbonate	0.039	3.68	pH	5.50	7.15
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	103.718			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		81.9			

Carbonation test #SC-26 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.089	Cl	7.2	6.6
CaO	0.182	0.290	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0002	0.001
FeO	8.58	4.91	Mg	1.2800	0.172
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	33.3	K	0.3730	0.4180
NiO	0.331	0.337	Si	0.0011	0.036
K_2O	0.011	0.008	Na	9.52	9.30
SiO_2	40.4	25.2	CO_2	0.01	0.85
Na_2O	0.030	0.051	HCO_3	na	na
CO_2	<0.01	31.700			
C, noncarbonate	0.039	0.908	pH	7.74	7.20
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	96.868			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		79.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-27 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.189	Cl	na	na
CaO	0.182	0.132	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.00
FeO	8.58	6.88	Mg	<0.0001	0.346
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	47.4	K	na	na
NiO	0.331	na	Si	<0.0005	0.047
K_2O	0.011	na	Na	na	na
SiO_2	40.4	40.2	CO_2	<0.1	1.45
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	1.75			
C, noncarbonate	0.039	0.167	pH	5.50	na
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	96.761			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		3.1			

Carbonation test #SC-28 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.210	Cl	na	na
CaO	0.182	0.088	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.000
FeO	8.58	5.17	Mg	<0.0001	0.102
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	33.8	K	na	na
NiO	0.331	na	Si	<0.0005	0.172
K_2O	0.011	na	Na	na	na
SiO_2	40.4	25.9	CO_2	<0.1	0.49
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	33.5			
C, noncarbonate	0.039	0.097	pH	5.50	6.80
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	98.777			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		86.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-29 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.173	Cl	na	na
CaO	0.182	0.168	Cr	na	na
Cr_2O_3	0.247	na	Fe	<0.0001	0.0001
FeO	8.58	5.89	Mg	<0.0001	0.206
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	35.5	K	na	na
NiO	0.331	na	Si	<0.0005	0.115
K_2O	0.011	na	Na	na	na
SiO_2	40.4	27.0	CO_2	<0.1	0.94
Na_2O	0.030	na	HCO_3	na	na
CO_2	<0.01	25.6			
C, noncarbonate	0.039	0.053	pH	5.50	na
H_2O, dehyd.[1]	0.060	na			
H_2O, chem.[2]	0.291	na			
Total	98.800	94.324			
LOI, total[3]	0.39	na			
Extent of carbonation, %[4]		59.1			

Carbonation test #SC-30 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.234	0.198	Cl	na	na
CaO	0.070	0.096	Cr	na	na
Cr_2O_3	0.070	na	Fe	<0.0001	0.0002
FeO	4.55	3.90	Mg	<0.0001	0.139
Fe_2O_3	1.801	3.346	Ni	na	na
MgO	49.9	45.4	K	na	na
NiO	na	na	Si	<0.0005	0.196
K_2O	0.009	na	Na	na	na
SiO_2	41.1	35.1	CO_2	<0.1	0.65
Na_2O	0.102	na	HCO_3	na	na
CO_2	<0.3	13.4			
C, noncarbonate	0.000	0.000	pH	5.50	7.26
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.330	na			
Total	98.153	101.454			
LOI, total[3]	0.33	na			
Extent of carbonation, %[4]		26.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-31 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.234	0.295	Cl	na	na
CaO	0.070	0.222	Cr	na	na
Cr_2O_3	0.070	na	Fe	<0.0001	0.0002
FeO	4.55	5.34	Mg	<0.0001	0.153
Fe_2O_3	1.801	1.215	Ni	na	na
MgO	49.9	50.7	K	na	na
NiO	na	na	Si	<0.0005	0.192
K_2O	0.009	na	Na	na	na
SiO_2	41.1	38.7	CO_2	<0.1	0.64
Na_2O	0.102	na	HCO_3	na	na
CO_2	<0.01	3.74			
C, noncarbonate	0.022	0.309	pH	5.50	7.38
H_2O, dehyd.[1]	na	na			
H_2O, chem.[2]	0.308	na			
Total	98.153	100.579			
LOI, total[3]	0.33	na			
Extent of carbonation, %[4]		6.7			

Carbonation test #SC-32 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.157	1.568	Cl	na	na
CaO	0.028	0.127	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0001
FeO	4.68	3.19	Mg	<0.0001	0.1
Fe_2O_3	2.17	2.93	Ni	na	na
MgO	45.6	41.0	K	na	na
NiO	na	na	Si	<0.0005	0.2
K_2O	<0.002	na	Na	na	na
SiO_2	37.4	32.9	CO_2	<0.100	0.52
Na_2O	<0.002	na	HCO_3	na	na
CO_2	0.380	11.4			
C, noncarbonate	0.027	0.119	pH	5.50	6.84
H_2O, dehyd.[1]	0.150	na			
H_2O, chem.[2]	10.94	na			
Total	101.576	93.236			
LOI, total[3]	11.50	na			
Extent of carbonation, %[4]		23.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-33 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.234	Cl	na	na
CaO	0.128	0.147	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0003
FeO	4.68	3.45	Mg	<0.0001	0.108
Fe_2O_3	2.17	1.80	Ni	na	na
MgO	45.6	40.5	K	na	na
NiO	na	na	Si	<0.0005	0.145
K_2O	na	na	Na	na	na
SiO_2	37.2	33.2	CO_2	<0.100	0.45
Na_2O	na	na	HCO_3	na	na
CO_2	0.400	11.5			
C, noncarbonate	0.070	0.141	pH	5.50	6.46
H_2O, dehyd.[1]	0.110	na			
H_2O, chem.[2]	10.12	na			
Total	100.753	90.888			
LOI, total[3]	10.70	na			
Extent of carbonation, %[4]		23.8			

Carbonation test #SC-34 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.293	0.246	Cl	na	na
CaO	0.214	0.140	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0001
FeO	0.91	0.798	Mg	<0.0001	0.237
Fe_2O_3	7.35	5.73	Ni	na	na
MgO	50.1	38.8	K	na	na
NiO	na	na	Si	<0.0005	0.111
K_2O	na	na	Na	na	na
SiO_2	40.9	31.9	CO_2	<0.100	0.86
Na_2O	na	na	HCO_3	na	na
CO_2	0.090	20.3			
C, noncarbonate	0.010	0.070	pH	5.50	6.75
H_2O, dehyd.[1]	0.230	0.670			
H_2O, chem.[2]	0.9	1.86			
Total	100.934	100.491			
LOI, total[3]	1.23	22.9			
Extent of carbonation, %[4]		45.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-35 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.285	0.300	Cl	na	na
CaO	0.277	0.372	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0001
FeO	4.41	4.40	Mg	<0.0001	0.186
Fe_2O_3	<0.001	<0.001	Ni	na	na
MgO	39.8	42.9	K	na	na
NiO	na	na	Si	<0.0005	0.139
K_2O	0.014	0.004	Na	na	na
SiO_2	36.4	34.9	CO_2	<0.100	0.80
Na_2O	0.013	0.005	HCO_3	na	na
CO_2	0.660	6.930			
C, noncarbonate	0.086	0.279	pH	6.74	5.50
H_2O, dehyd.[1]	0.120	0.050			
H_2O, chem.[2]	13.5	10.141			
Total	95.565	100.296			
LOI, total[3]	14.40	17.40			
Extent of carbonation, %[4]		14.6			

Carbonation test #SC-36 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.333	0.219	Cl	na	na
CaO	0.467	0.278	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0001
FeO	0.44	0.399	Mg	<0.0001	0.103
Fe_2O_3	6.62	5.23	Ni	na	na
MgO	50.9	34.7	K	na	na
NiO	na	na	Si	<0.0005	0.120
K_2O	0.013	0.006	Na	na	1.20
SiO_2	41.7	32.5	CO_2	<0.100	2.64
Na_2O	0.795	0.189	HCO_3	na	na
CO_2	0.210	19.200			
C, noncarbonate	0.030	0.080	pH	5.50	7.80
H_2O, dehyd.[1]	0.190	0.190			
H_2O, chem.[2]	1.4	3.130			
Total	103.085	96.095			
LOI, total[3]	1.80	22.6			
Extent of carbonation, %[4]		41.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-37 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.253	Cl	na	na
CaO	0.355	0.217	Cr	na	na
Cr_2O_3	na	na	Fe	<0.001	0.0005
FeO	0.40	0.540	Mg	0.0030	0.0154
Fe_2O_3	6.89	5.05	Ni	na	na
MgO	47.9	34.2	K	0.0001	0.0064
NiO	na	na	Si	0.0007	0.099
K_2O	0.014	0.006	Na	16.3	8.4
SiO_2	41.3	29.7	CO_2	21.8	18.9
Na_2O	0.010	0.501	HCO_3	na	na
CO_2	0.260	22.6			
C, noncarbonate	0.012	0.132	pH	8.51	8.21
H_2O, dehyd.[1]	0.200	0.430			
H_2O, chem.[2]	2.5	5.2			
Total	100.123	98.858			
LOI, total[3]	2.97	28.40			
Extent of carbonation, %[4]		54.7			

Carbonation test #SC-38 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.142	Cl	38.3	35.9
CaO	0.355	0.330	Cr	na	na
Cr_2O_3	na	na	Fe	0.0010	0.0007
FeO	0.40	0.386	Mg	0.0080	0.0584
Fe_2O_3	6.89	4.79	Ni	na	na
MgO	47.9	33.7	K	0.0060	0.0076
NiO	na	na	Si	0.0011	0.0270
K_2O	0.014	0.011	Na	26.0	23.8
SiO_2	41.3	28.9	CO_2	19.5	18.6
Na_2O	0.010	0.890	HCO_3	na	na
CO_2	0.260	25.6			
C, noncarbonate	0.012	0.063	pH	7.75	7.61
H_2O, dehyd.[1]	0.200	0.600			
H_2O, chem.[2]	2.498	4.137			
Total	100.123	99.488			
LOI, total[3]	2.97	30.4			
Extent of carbonation, %[4]		64.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-39 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.261	0.197	Cl	38.3	35.9
CaO	0.432	0.355	Cr	na	na
Cr_2O_3	na	na	Fe	0.0010	0.0007
FeO	0.72	0.386	Mg	0.0080	0.0126
Fe_2O_3	6.56	4.98	Ni	na	na
MgO	46.4	33.5	K	0.0060	0.0076
NiO	na	na	Si	0.0011	0.0245
K_2O	0.010	0.006	Na	26.0	24.0
SiO_2	41.5	28.0	CO_2	19.5	19.8
Na_2O	0.009	0.414	HCO_3	na	na
CO_2	0.340	28.2			
C, noncarbonate	0.059	0.154	pH	7.75	8.12
H_2O, dehyd.[1]	0.210	0.200			
H_2O, chem.[2]	1.7	1.95			
Total	98.194	98.351			
LOI, total[3]	2.27	30.50			
Extent of carbonation, %[4]		75.5			

Carbonation test #SC-40 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.132	Cl	37.9	37.2
CaO	0.182	0.231	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0009	0.0008
FeO	8.58	2.02	Mg	0.0046	0.0372
Fe_2O_3	<0.01	4.06	Ni	na	na
MgO	48.4	36.6	K	0.0030	0.0034
NiO	0.331	na	Si	0.0013	0.0216
K_2O	0.011	0.005	Na	25.5	24.7
SiO_2	40.4	26.3	CO_2	22.0	20.8
Na_2O	0.030	0.144	HCO_3	na	na
CO_2	<0.01	29.8			
C, noncarbonate	0.039	0.207	pH	na	8.12
H_2O, dehyd.[1]	0.060	<0.05			
H_2O, chem.[2]	0.291	0.693			
Total	98.800	100.249			
LOI, total[3]	0.39	30.7			
Extent of carbonation, %[4]		72.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-41 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.291	0.223	Cl	na	0.2
CaO	0.375	0.362	Cr	na	na
Cr_2O_3	na	na	Fe	<0.0001	0.0001
FeO	2.43	1.685	Mg	<0.0001	0.1420
Fe_2O_3	4.55	3.52	Ni	na	na
MgO	45.6	37.0	K	na	0.0028
NiO	na	na	Si	<0.0005	0.0917
K_2O	0.010	0.006	Na	na	0.2
SiO_2	40.0	31.9	CO_2	<0.100	1.0
Na_2O	0.012	0.015	HCO_3	na	na
CO_2	0.870	19.5			
C, noncarbonate	0.061	0.178	pH	5.50	6.98
H_2O, dehyd.[1]	0.930	1.490			
H_2O, chem.[2]	4.2	3.83			
Total	99.288	99.659			
LOI, total[3]	6.02	25.00			
Extent of carbonation, %[4]		45.2			

Carbonation test #SC-42 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.234	Cl	37.9	35.2
CaO	0.182	0.199	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0009	0.0006
FeO	8.58	5.89	Mg	0.0046	0.085
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	52.2	K	0.0030	0.0048
NiO	0.331	na	Si	0.0013	0.0189
K_2O	0.011	0.018	Na	25.5	36.6
SiO_2	40.4	40.2	CO_2	22.0	21.9
Na_2O	0.030	0.039	HCO_3	na	na
CO_2	<0.01	0.6			
C, noncarbonate	0.039	0.082	pH	na	7.89
H_2O, dehyd.[1]	0.060	0.130			
H_2O, chem.[2]	0.3	0.6			
Total	98.800	100.200			
LOI, total[3]	0.39	1.4			
Extent of carbonation, %[4]		1.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-43 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.182	Cl	34.1	33.8
CaO	0.182	0.174	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0007	0.0005
FeO	8.58	6.27	Mg	0.0050	0.0252
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	38.0	K	0.0024	0.0042
NiO	0.331	na	Si	0.0013	0.0177
K_2O	0.011	0.007	Na	32.7	32.1
SiO_2	40.4	28.5	CO_2	21.2	20.2
Na_2O	0.030	0.171	HCO_3	na	na
CO_2	<0.01	26.1			
C, noncarbonate	0.039	0.177	pH	na	7.99
H_2O, dehyd.[1]	0.060	0.080			
H_2O, chem.[2]	0.3	0.74			
Total	98.800	100.321			
LOI, total[3]	0.39	27.10			
Extent of carbonation, %[4]		60.6			

Carbonation test #SC-44 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.278	Cl	34.1	34.1
CaO	0.277	0.204	Cr	<0.0005	na
Cr_2O_3	na	na	Fe	0.0007	0.0006
FeO	2.25	2.21	Mg	0.0050	0.017
Fe_2O_3	4.00	3.93	Ni	<0.0005	na
MgO	41.8	34.2	K	0.0024	0.0072
NiO	na	na	Si	0.0013	0.0159
K_2O	0.008	0.008	Na	32.7	32.0
SiO_2	35.9	35.5	CO_2	21.2	19.7
Na_2O	0.011	0.256	HCO_3	<0.0001	na
CO_2	0.730	6.0			
C, noncarbonate	0.063	0.112	pH	7.76	7.91
H_2O, dehyd.[1]	0.060	1.490			
H_2O, chem.[2]	13.8	9.36			
Total	99.222	93.560			
LOI, total[3]	14.70	17.0			
Extent of carbonation, %[4]		12.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-45 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.238	Cl	34.2	34.2
CaO	0.388	0.242	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0006
FeO	0.59	0.656	Mg	0.005	0.028
Fe_2O_3	6.31	5.28	Ni	na	na
MgO	46.1	35.0	K	0.0026	0.0070
NiO	na	na	Si	0.0012	0.0168
K_2O	0.010	0.007	Na	32.9	31.8
SiO_2	38.5	35.5	CO_2	21.6	18.7
Na_2O	0.010	0.700	HCO_3	na	na
CO_2	0.450	13.7			
C, noncarbonate	0.000	0.071	pH	7.82	7.83
H_2O, dehyd.[1]	0.550	1.24			
H_2O, chem.[2]	7.4	7.59			
Total	100.592	100.217			
LOI, total[3]	8.41	22.60			
Extent of carbonation, %[4]		30.2			

Carbonation test #SC-46 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.310	0.248	Cl	34.2	33.6
CaO	0.411	0.288	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0007
FeO	2.59	1.90	Mg	0.00500	0.032
Fe_2O_3	4.30	3.33	Ni	na	na
MgO	48.2	35.8	K	0.0026	0.0082
NiO	na	na	Si	0.0012	0.0260
K_2O	0.035	0.011	Na	32.9	31.2
SiO_2	40.9	29.7	CO_2	21.6	19.2
Na_2O	0.027	0.392	HCO_3	na	na
CO_2	0.480	24.8			
C, noncarbonate	0.064	0.152	pH	7.82	7.93
H_2O, dehyd.[1]	0.490	1.240			
H_2O, chem.[2]	3.4	2.4			
Total	101.234	100.325			
LOI, total[3]	4.45	28.6			
Extent of carbonation, %[4]		59.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-47 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.316	0.244	Cl	34.0	31.8
CaO	0.337	0.294	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0007
FeO	2.23	1.698	Mg	0.0054	0.0578
Fe_2O_3	4.37	3.86	Ni	na	na
MgO	47.4	36.5	K	0.0028	0.0062
NiO	na	na	Si	0.0013	0.0278
K_2O	0.011	0.010	Na	32.3	29.2
SiO_2	39.8	39.8	CO_2	21.0	17.5
Na_2O	0.007	0.910	HCO_3	na	na
CO_2	0.540	18.8			
C, noncarbonate	0.033	0.219	pH	7.75	7.88
H_2O, dehyd.[1]	0.690	1.740			
H_2O, chem.[2]	4.4	4.74			
Total	100.134	108.784			
LOI, total[3]	5.65	25.50			
Extent of carbonation, %[4]		42.3			

Carbonation test #SC-48 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.231	Cl	34.0	34.1
CaO	0.277	0.309	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0007
FeO	2.25	2.07	Mg	0.0054	0.010
Fe_2O_3	4.00	3.99	Ni	na	na
MgO	41.8	40.8	K	0.0028	0.0044
NiO	na	na	Si	0.0013	0.0334
K_2O	0.008	0.005	Na	32.3	31.0
SiO_2	35.9	36.2	CO_2	21.0	18.5
Na_2O	0.011	0.213	HCO_3	na	na
CO_2	0.730	4.8			
C, noncarbonate	0.063	0.282	pH	7.75	7.93
H_2O, dehyd.[1]	0.060	0.430			
H_2O, chem.[2]	13.8	11.4			
Total	99.222	100.661			
LOI, total[3]	14.70	16.9			
Extent of carbonation, %[4]		9.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-49 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.317	Cl	34.1	33.4
CaO	0.277	0.155	Cr	na	na
Cr_2O_3	na	na	Fe	0.0005	0.0007
FeO	2.25	2.033	Mg	0.0011	0.0138
Fe_2O_3	4.00	4.23	Ni	na	na
MgO	41.8	41.8	K	0.0005	0.0048
NiO	na	na	Si	0.0012	0.0187
K_2O	0.008	0.017	Na	33.8	31.2
SiO_2	35.9	37.9	CO_2	21.6	18.4
Na_2O	0.011	0.248	HCO_3	na	na
CO_2	0.730	2.9			
C, noncarbonate	0.063	0.105	pH	7.77	7.92
H_2O, dehyd.[1]	0.060	0.380			
H_2O, chem.[2]	13.8	11.22			
Total	99.222	101.252			
LOI, total[3]	14.70	14.60			
Extent of carbonation, %[4]		4.7			

Carbonation test #SC-50 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.334	0.238	Cl	34.1	34.3
CaO	0.175	0.164	Cr	na	na
Cr_2O_3	na	na	Fe	0.0005	0.0007
FeO	3.14	2.26	Mg	0.0011	0.067
Fe_2O_3	3.59	3.42	Ni	na	na
MgO	48.2	36.3	K	0.0005	0.0017
NiO	na	na	Si	0.0012	0.0440
K_2O	0.008	0.007	Na	33.8	31.9
SiO_2	40.0	30.6	CO_2	21.6	18.9
Na_2O	0.029	1.299	HCO_3	na	na
CO_2	0.450	18.4			
C, noncarbonate	0.054	0.008	pH	7.77	7.82
H_2O, dehyd.[1]	0.610	2.130			
H_2O, chem.[2]	4.7	5.2			
Total	101.369	99.994			
LOI, total[3]	5.84	25.7			
Extent of carbonation, %[4]		40.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-51 **Day Book olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.238	Cl	33.8	33.7
CaO	0.215	0.165	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0005
FeO	9.52	6.97	Mg	0.0009	0.0308
Fe_2O_3	2.72	<0.01	Ni	na	na
MgO	51.2	48.2	K	0.0006	0.0056
NiO	na	na	Si	0.0013	0.0184
K_2O	0.009	0.004	Na	32.8	32.5
SiO_2	40.4	40.4	CO_2	21.0	19.9
Na_2O	0.014	0.037	HCO_3	na	na
CO_2	0.310	1.4			
C, noncarbonate	0.047	0.099	pH	7.78	7.98
H_2O, dehyd.[1]	0.140	0.150			
H_2O, chem.[2]	2.8	2.51			
Total	107.640	100.270			
LOI, total[3]	3.26	4.17			
Extent of carbonation, %[4]		1.8			

Carbonation test #SC-52 **Day Book olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.223	Cl	33.8	38.8
CaO	0.215	0.171	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0007
FeO	9.52	5.85	Mg	0.0009	0.042
Fe_2O_3	2.72	<0.01	Ni	na	na
MgO	51.2	43.1	K	0.0006	0.0036
NiO	na	na	Si	0.0013	0.0173
K_2O	0.009	0.004	Na	32.8	34.5
SiO_2	40.4	34.9	CO_2	21.0	21.6
Na_2O	0.014	0.159	HCO_3	na	na
CO_2	0.310	13.0			
C, noncarbonate	0.047	0.082	pH	7.78	7.89
H_2O, dehyd.[1]	0.140	0.130			
H_2O, chem.[2]	2.8	2.2			
Total	107.640	99.791			
LOI, total[3]	3.26	15.4			
Extent of carbonation, %[4]		23.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-53 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.376	0.291	Cl	33.9	33.9
CaO	0.154	0.162	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0007
FeO	3.37	2.28	Mg	0.0008	0.0184
Fe_2O_3	3.90	2.60	Ni	na	na
MgO	47.9	35.2	K	0.0004	0.0036
NiO	na	na	Si	0.0013	0.0591
K_2O	0.003	0.002	Na	32.9	30.2
SiO_2	40.0	30.2	CO_2	21.0	18.4
Na_2O	0.005	0.692	HCO_3	na	na
CO_2	0.270	21.4			
C, noncarbonate	0.030	0.000	pH	7.81	8.01
H_2O, dehyd.[1]	0.720	1.48			
H_2O, chem.[2]	4.6	4.42			
Total	101.356	98.642			
LOI, total[3]	5.62	27.30			
Extent of carbonation, %[4]		49.4			

Carbonation test #SC-54 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.312	0.217	Cl	33.9	34.1
CaO	0.277	0.220	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0005
FeO	3.54	2.20	Mg	0.0008	0.037
Fe_2O_3	3.903	3.46	Ni	na	na
MgO	45.8	34.8	K	0.0004	0.0015
NiO	na	na	Si	0.0013	0.0189
K_2O	0.013	0.007	Na	32.9	30.6
SiO_2	40.4	30.0	CO_2	21.0	18.8
Na_2O	0.491	0.658	HCO_3	na	na
CO_2	0.330	23.4			
C, noncarbonate	0.037	0.000	pH	7.81	7.99
H_2O, dehyd.[1]	0.700	1.23			
H_2O, chem.[2]	3.4	3.4			
Total	99.179	99.532			
LOI, total[3]	4.45	28.0			
Extent of carbonation, %[4]		57.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-55 **Mg(OH)2**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.089	0.070	Cl	34.8	32.5
CaO	0.705	0.540	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0005
FeO	0.23	0.232	Mg	0.0009	0.0222
Fe_2O_3	<0.010	<0.010	Ni	na	na
MgO	67.0	47.8	K	0.0005	0.0044
NiO	na	na	Si	0.0012	0.0196
K_2O	0.005	0.005	Na	31.9	28.0
SiO_2	0.1	0.2	CO_2	21.2	15.5
Na_2O	0.020	1.779	HCO_3	na	na
CO_2	1.10	50.3			
C, noncarbonate	0.022	0.000	pH	7.80	7.83
H_2O, dehyd.[1]	0.240	0.100			
H_2O, chem.[2]	30.0	1.70			
Total	99.580	102.643			
LOI, total[3]	31.40	52.10			
Extent of carbonation, %[4]		133.1			

Carbonation test #SC-56 **Mg(OH)2**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.117	0.087	Cl	34.8	28.3
CaO	0.810	0.411	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0005
FeO	0.23	0.23	Mg	0.0009	0.052
Fe_2O_3	<0.010	<0.010	Ni	na	na
MgO	79.1	47.8	K	0.0005	0.0066
NiO	na	na	Si	0.0012	0.0351
K_2O	0.007	0.002	Na	31.9	23.9
SiO_2	0.2	0.1	CO_2	21.2	11.0
Na_2O	0.023	1.429	HCO_3	na	na
CO_2	8.28	50.2			
C, noncarbonate	0.530	0.000	pH	7.80	8.22
H_2O, dehyd.[1]	3.520	0.110			
H_2O, chem.[2]	12.1	1.7			
Total	104.871	102.046			
LOI, total[3]	24.40	52.0			
Extent of carbonation, %[4]		91.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-57 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.231	0.236	Cl	34.1	33.7
CaO	0.146	0.141	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0004
FeO	7.74	6.304	Mg	0.0008	0.0352
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	50.1	47.3	K	0.0005	0.0054
NiO	na	na	Si	0.0028	0.0195
K_2O	0.007	0.005	Na	33.0	33.8
SiO_2	40.9	37.9	CO_2	20.8	19.7
Na_2O	0.208	0.162	HCO_3	27.9	27.5
CO_2	0.100	6.6			
C, noncarbonate	0.067	0.093	pH	7.76	7.99
H_2O, dehyd.[1]	0.080	0.110			
H_2O, chem.[2]	0.9	1.03			
Total	100.430	99.819			
LOI, total[3]	1.16	7.85			
Extent of carbonation, %[4]		11.7			

Carbonation test #SC-58 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.310	0.242	Cl	35.1	34.4
CaO	0.213	0.130	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0008
FeO	3.51	2.41	Mg	0.0015	0.019
Fe_2O_3	3.65	2.39	Ni	na	na
MgO	44.9	27.7	K	0.0006	0.0019
NiO	na	na	Si	0.0016	0.0182
K_2O	0.012	0.006	Na	37.8	32.6
SiO_2	41.1	28.9	CO_2	27.2	23.7
Na_2O	0.017	0.603	HCO_3	35.2	29.7
CO_2	0.280	27.1			
C, noncarbonate	0.033	0.074	pH	7.88	7.99
H_2O, dehyd.[1]	0.580	0.950			
H_2O, chem.[2]	1.4	1.8			
Total	96.029	92.244			
LOI, total[3]	2.31	29.9			
Extent of carbonation, %[4]		71.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-59 **CH serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.310	0.206	Cl	51.3	50.9
CaO	0.213	0.174	Cr	na	na
Cr_2O_3	na	na	Fe	0.0012	0.0011
FeO	3.51	2.42	Mg	0.0008	0.0698
Fe_2O_3	3.65	3.35	Ni	na	na
MgO	44.9	28.2	K	0.0006	0.0015
NiO	na	na	Si	0.0023	0.0203
K_2O	0.012	0.005	Na	41.7	38.3
SiO_2	41.1	29.3	CO_2	19.2	16.9
Na_2O	0.017	0.627	HCO_3	25.60	18.30
CO_2	0.280	26.3			
C, noncarbonate	0.033	0.092	pH	7.69	7.72
H_2O, dehyd.[1]	0.580	1.130			
H_2O, chem.[2]	1.4	1.98			
Total	96.029	93.771			
LOI, total[3]	2.31	29.50			
Extent of carbonation, %[4]		68.8			

Carbonation test #SC-60 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.229	Cl	35.1	34.1
CaO	0.182	0.221	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0007	0.0007
FeO	8.58	5.93	Mg	0.0015	0.023
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	44.8	K	0.0006	0.0016
NiO	0.331	na	Si	0.0016	0.0196
K_2O	0.011	0.005	Na	37.8	31.0
SiO_2	40.4	40.2	CO_2	27.2	19.8
Na_2O	0.03	0.077	HCO_3	35.2	25.1
CO_2	<0.01	1.62			
C, noncarbonate	0.039	0.069	pH	7.76	8.06
H_2O, dehyd.[1]	0.060	0.240			
H_2O, chem.[2]	0.3	2.3			
Total	98.800	95.679			
LOI, total[3]	0.39	4.2			
Extent of carbonation, %[4]		2.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-61 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.206	Cl	34.1	34.6
CaO	0.182	0.148	Cr	na	na
Cr_2O_3	0.247	na	Fe	0.0008	0.0006
FeO	8.58	6.86	Mg	0.0009	0.0206
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	43.3	K	0.0005	0.0015
NiO	0.331	na	Si	0.0017	0.0255
K_2O	0.011	0.005	Na	30.5	30.8
SiO_2	40.4	42.1	CO_2	19.9	18.7
Na_2O	0.030	0.070	HCO_3	24.3	21.4
CO_2	<0.01	0.1			
C, noncarbonate	0.039	0.063	pH	7.82	7.76
H_2O, dehyd.[1]	0.060	0.230			
H_2O, chem.[2]	0.3	2.03			
Total	98.800	95.076			
LOI, total[3]	0.39	2.37			
Extent of carbonation, %[4]		0.1			

Carbonation test #SC-62 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.20	0.178	Cl	35.1	35.2
CaO	0.312	0.390	Cr	na	na
Cr_2O_3	0.092	na	Fe	0.0007	0.0009
FeO	4.84	3.47	Mg	0.0015	0.032
Fe_2O_3	3.20	3.17	Ni	na	na
MgO	50.1	47.8	K	0.0006	0.0100
NiO	0.070	na	Si	0.0016	0.0196
K_2O	0.009	0.007	Na	37.8	33.6
SiO_2	42.6	34.7	CO_2	27.2	24.0
Na_2O	0.015	0.950	HCO_3	35.2	29.9
CO_2	0.150	14.3			
C, noncarbonate	0.055	0.117	pH	7.88	7.92
H_2O, dehyd.[1]	0.350	1.20			
H_2O, chem.[2]	2.1	3.78			
Total	104.080	109.982			
LOI, total[3]	2.55	19.4			
Extent of carbonation, %[4]		28.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-63 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.255	0.178	Cl	17.2	17.0
CaO	0.175	0.185	Cr	na	na
Cr_2O_3	na	na	Fe	0.0004	0.0007
FeO	3.34	2.354	Mg	0.0013	0.0216
Fe_2O_3	3.92	3.12	Ni	na	na
MgO	48.9	30.2	K	0.0005	0.0014
NiO	na	na	Si	0.0012	0.0312
K_2O	0.016	0.008	Na	26.3	25.9
SiO_2	40.2	30.0	CO_2	30.0	28.9
Na_2O	0.020	0.709	HCO_3	37.90	36.30
CO_2	0.370	23.3			
C, noncarbonate	0.029	0.021	pH	7.95	8.16
H_2O, dehyd.[1]	0.660	1.150			
H_2O, chem.[2]	3.9	3.73			
Total	101.841	94.878			
LOI, total[3]	4.98	28.20			
Extent of carbonation, %[4]		53.9			

Carbonation test #SC-64 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.255	0.195	Cl	17.2	17
CaO	0.175	0.344	Cr	na	na
Cr_2O_3	na	na	Fe	0.0004	0.0008
FeO	3.34	2.42	Mg	0.0013	0.041
Fe_2O_3	3.92	3.25	Ni	na	na
MgO	48.9	35.2	K	0.0005	0.0013
NiO	na	na	Si	0.0012	0.0284
K_2O	0.016	0.005	Na	26.3	25.4
SiO_2	40.2	30.2	CO_2	30.0	29.4
Na_2O	0.020	1.29	HCO_3	37.9	40.3
CO_2	0.370	22.2			
C, noncarbonate	0.029	0.000	pH	7.95	8.07
H_2O, dehyd.[1]	0.660	1.540			
H_2O, chem.[2]	3.9	3.6			
Total	101.841	100.112			
LOI, total[3]	4.98	27.3			
Extent of carbonation, %[4]		50.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-65 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.187	Cl	17.0	16.9
CaO	0.323	0.243	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0007
FeO	3.40	2.35	Mg	0.0016	0.0236
Fe_2O_3	3.70	3.25	Ni	na	na
MgO	46.8	34.0	K	0.0003	0.0015
NiO	na	na	Si	0.0009	0.0308
K_2O	0.005	0.004	Na	27.4	26.1
SiO_2	40.4	29.5	CO_2	31.1	28.9
Na_2O	0.011	0.609	HCO_3	39.7	37.5
CO_2	0.320	24.0			
C, noncarbonate	0.026	0.130	pH	7.91	8.18
H_2O, dehyd.[1]	0.660	0.930			
H_2O, chem.[2]	3.4	3.24			
Total	99.305	98.456			
LOI, total[3]	4.40	28.30			
Extent of carbonation, %[4]		58.5			

Carbonation test #SC-66 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.212	Cl	17.0	17.0
CaO	0.323	0.164	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0009
FeO	3.40	2.35	Mg	0.0016	0.026
Fe_2O_3	3.70	2.36	Ni	na	na
MgO	46.8	33.3	K	na	na
NiO	na	na	Si	0.0009	0.037
K_2O	0.005	0.004	Na	27.4	26.4
SiO_2	40.4	29.7	CO_2	31.1	29.4
Na_2O	0.011	0.631	HCO_3	39.7	39.6
CO_2	0.320	24.3			
C, noncarbonate	0.026	0.078	pH	7.91	8.07
H_2O, dehyd.[1]	0.660	0.780			
H_2O, chem.[2]	3.4	3.3			
Total	99.305	97.287			
LOI, total[3]	4.40	28.5			
Extent of carbonation, %[4]		59.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-67 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.314	0.215	Cl	34.1	33.8
CaO	0.201	0.200	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0007
FeO	3.27	2.35	Mg	0.0012	0.0320
Fe_2O_3	3.50	1.66	Ni	na	na
MgO	48.7	35.6	K	0.0007	0.0019
NiO	na	na	Si	0.0012	0.0213
K_2O	0.014	0.011	Na	35.4	34.2
SiO_2	40.0	30.6	CO_2	27.0	24.7
Na_2O	0.023	0.693	HCO_3	36.0	32.8
CO_2	0.280	22.3			
C, noncarbonate	0.030	0.134	pH	7.80	7.95
H_2O, dehyd.[1]	0.520	0.890			
H_2O, chem.[2]	3.7	3.58			
Total	100.575	98.273			
LOI, total[3]	4.50	26.90			
Extent of carbonation, %[4]		51.2			

Carbonation test #SC-68 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.306	0.215	Cl	34.1	34.0
CaO	0.196	0.135	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0006
FeO	3.11	2.20	Mg	0.0012	0.010
Fe_2O_3	4.261	2.83	Ni	na	na
MgO	48.2	36.1	K	0.0007	0.0014
NiO	na	na	Si	0.0012	0.0397
K_2O	0.009	0.004	Na	35.4	33.6
SiO_2	40.4	31.2	CO_2	27.0	23.9
Na_2O	0.013	0.663	HCO_3	36.0	31.1
CO_2	0.300	20.3			
C, noncarbonate	0.038	0.160	pH	7.80	8.16
H_2O, dehyd.[1]	0.500	0.810			
H_2O, chem.[2]	3.5	3.6			
Total	100.901	98.329			
LOI, total[3]	4.32	24.9			
Extent of carbonation, %[4]		45.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-69 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.306	0.251	Cl	33.5	33.2
CaO	0.196	0.158	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0008
FeO	3.11	2.21	Mg	0.0010	0.0834
Fe_2O_3	4.26	3.43	Ni	na	na
MgO	48.2	37.0	K	0.0007	0.0013
NiO	na	na	Si	0.0013	0.0215
K_2O	0.009	0.005	Na	34.5	35.0
SiO_2	40.4	32.1	CO_2	26.7	24.5
Na_2O	0.013	0.586	HCO_3	35.0	32.3
CO_2	0.300	19.2			
C, noncarbonate	0.038	0.100	pH	7.81	7.91
H_2O, dehyd.[1]	0.500	0.870			
H_2O, chem.[2]	3.5	3.83			
Total	100.901	99.709			
LOI, total[3]	4.32	24.00			
Extent of carbonation, %[4]		42.8			

Carbonation test #SC-70 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.289	0.212	Cl	33.5	36.2
CaO	0.108	0.154	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0010
FeO	3.40	2.60	Mg	0.0010	0.033
Fe_2O_3	3.60	2.90	Ni	na	na
MgO	46.8	36.1	K	0.0007	0.0026
NiO	na	na	Si	0.0013	0.0371
K_2O	0.007	0.006	Na	34.5	35.6
SiO_2	39.8	30.8	CO_2	26.7	25.4
Na_2O	0.013	0.553	HCO_3	35.0	33.3
CO_2	0.470	20.3			
C, noncarbonate	0.016	0.040	pH	7.81	8.00
H_2O, dehyd.[1]	0.420	0.560			
H_2O, chem.[2]	5.1	4.6			
Total	99.936	98.877			
LOI, total[3]	5.97	25.5			
Extent of carbonation, %[4]		46.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-71 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.334	0.246	Cl	72.9	73.0
CaO	0.200	0.143	Cr	na	na
Cr_2O_3	na	na	Fe	0.0015	0.0017
FeO	3.46	2.38	Mg	0.0007	0.0482
Fe_2O_3	3.70	3.09	Ni	na	na
MgO	48.6	35.2	K	0.0008	0.0016
NiO	na	na	Si	0.0022	0.0336
K_2O	0.003	na	Na	50.0	47.9
SiO_2	40.2	29.5	CO_2	14.5	13.5
Na_2O	0.008	0.789	HCO_3	18.5	17.4
CO_2	0.150	22.8			
C, noncarbonate	0.032	0.077	pH	7.77	7.78
H_2O, dehyd.[1]	0.420	0.710			
H_2O, chem.[2]	3.4	3.41			
Total	100.470	98.319			
LOI, total[3]	3.96	27.00			
Extent of carbonation, %[4]		53.1			

Carbonation test #SC-72 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.334	0.185	Cl	37.3	37.0
CaO	0.200	0.143	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0010
FeO	3.46	2.30	Mg	0.0011	0.032
Fe_2O_3	3.70	3.37	Ni	na	na
MgO	48.6	33.3	K	0.0010	0.0016
NiO	na	na	Si	0.0015	0.0279
K_2O	0.003	0.010	Na	39.8	38.8
SiO_2	40.2	28.7	CO_2	21.4	28.9
Na_2O	0.008	0.922	HCO_3	14.4	37.9
CO_2	0.150	24.1			
C, noncarbonate	0.032	0.113	pH	9.49	8.04
H_2O, dehyd.[1]	0.420	0.740			
H_2O, chem.[2]	3.4	3.5			
Total	100.470	97.430			
LOI, total[3]	3.96	28.5			
Extent of carbonation, %[4]		57.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-73 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.189	0.302	Cl	37.5	37.3
CaO	0.137	0.161	Cr	na	na
Cr_2O_3	na	na	Fe	0.0010	0.0010
FeO	3.67	3.24	Mg	0.0006	0.0550
Fe_2O_3	3.77	3.26	Ni	na	na
MgO	48.9	33.2	K	0.0003	0.0012
NiO	na	na	Si	0.0009	0.0300
K_2O	0.005	0.005	Na	42.7	40.6
SiO_2	40.9	29.1	CO_2	21.9	30.0
Na_2O	0.015	2.14	HCO_3	<0.0001	42.90
CO_2	0.160	23.9			
C, noncarbonate	0.032	0.187	pH	11.02	7.79
H_2O, dehyd.[1]	0.360	0.910			
H_2O, chem.[2]	3.6	4.40			
Total	101.721	100.770			
LOI, total[3]	4.16	29.40			
Extent of carbonation, %[4]		56.0			

Carbonation test #SC-74 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.189	0.244	Cl	0.0	0.3
CaO	0.137	0.105	Cr	na	na
Cr_2O_3	na	na	Fe	0.0002	0.0006
FeO	3.67	2.91	Mg	<0.0001	0.262
Fe_2O_3	3.77	2.46	Ni	na	na
MgO	48.9	40.3	K	0.0027	0.0026
NiO	na	na	Si	0.0006	0.0832
K_2O	0.005	0.009	Na	2.3	2.4
SiO_2	40.9	32.9	CO_2	<0.0001	5.3
Na_2O	0.015	0.078	HCO_3	<0.0001	7.12
CO_2	0.160	14.4			
C, noncarbonate	0.032	0.100	pH	12.66	7.90
H_2O, dehyd.[1]	0.360	0.780			
H_2O, chem.[2]	3.6	3.6			
Total	101.721	97.940			
LOI, total[3]	4.16	18.9			
Extent of carbonation, %[4]		29.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-75 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.331	0.232	Cl	36.4	35.8
CaO	0.169	0.086	Cr	na	na
Cr_2O_3	na	na	Fe	0.0007	0.0007
FeO	3.55	2.856	Mg	0.0001	0.736
Fe_2O_3	3.97	3.36	Ni	na	na
MgO	47.6	38.1	K	0.0006	0.0018
NiO	na	na	Si	0.0015	0.0224
K_2O	0.011	0.006	Na	22.0	21.4
SiO_2	40.2	33.4	CO_2	<0.0001	2.0
Na_2O	0.018	0.083	HCO_3	<0.0001	2.84
CO_2	0.120	15.7			
C, noncarbonate	0.031	0.095	pH	2.36	7.08
H_2O, dehyd.[1]	0.350	0.720			
H_2O, chem.[2]	4.0	3.98			
Total	100.390	98.632			
LOI, total[3]	4.53	20.50			
Extent of carbonation, %[4]		34.1			

Carbonation test #SC-76 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.331	0.248	Cl	36.3	35.4
CaO	0.169	0.182	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0007
FeO	3.55	2.84	Mg	0.0001	0.220
Fe_2O_3	3.97	3.32	Ni	na	na
MgO	47.6	38.0	K	0.0024	0.0032
NiO	na	na	Si	0.0002	0.0405
K_2O	0.011	0.013	Na	25.5	25.0
SiO_2	40.2	32.7	CO_2	<0.0001	4.4
Na_2O	0.018	0.248	HCO_3	<0.0001	6.36
CO_2	0.120	16.7			
C, noncarbonate	0.031	0.082	pH	12.25	7.26
H_2O, dehyd.[1]	0.350	0.610			
H_2O, chem.[2]	4.0	3.9			
Total	100.390	98.852			
LOI, total[3]	4.53	21.3			
Extent of carbonation, %[4]		36.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-77 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.351	0.272	Cl	36.5	35.6
CaO	0.189	0.178	Cr	na	na
Cr_2O_3	na	na	Fe	0.0006	0.0005
FeO	3.63	2.920	Mg	0.0001	0.6970
Fe_2O_3	3.76	3.32	Ni	na	na
MgO	47.4	38.6	K	0.0006	0.0020
NiO	na	na	Si	<0.0002	0.0220
K_2O	0.008	0.006	Na	20.4	21.2
SiO_2	40.6	32.9	CO_2	<0.00005	1.8
Na_2O	0.023	0.139	HCO_3	<0.0001	2.66
CO_2	0.140	16.4			
C, noncarbonate	0.025	0.084	pH	7.77	7.78
H_2O, dehyd.[1]	0.400	0.610			
H_2O, chem.[2]	3.7	0.00			
Total	100.288	95.504			
LOI, total[3]	4.26	4.26			
Extent of carbonation, %[4]		35.9			

Carbonation test #SC-78 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.351	0.202	Cl	37.6	37.6
CaO	0.189	0.153	Cr	na	na
Cr_2O_3	na	na	Fe	0.0009	0.0011
FeO	3.63	2.71	Mg	0.0018	0.009
Fe_2O_3	3.76	3.17	Ni	na	na
MgO	47.4	35.0	K	0.0007	0.0016
NiO	na	na	Si	0.0010	0.0294
K_2O	0.008	0.004	Na	44.8	44.0
SiO_2	40.6	31.0	CO_2	46.9	47.9
Na_2O	0.023	0.561	HCO_3	56.7	59.6
CO_2	0.140	21.8			
C, noncarbonate	0.025	0.050	pH	8.16	8.34
H_2O, dehyd.[1]	0.400	0.650			
H_2O, chem.[2]	3.7	3.6			
Total	100.288	98.913			
LOI, total[3]	4.26	26.1			
Extent of carbonation, %[4]		51.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-79 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.289	0.304	Cl	37.1	37.0
CaO	0.108	0.210	Cr	na	na
Cr_2O_3	na	na	Fe	0.0010	0.0012
FeO	3.40	2.15	Mg	0.0011	0.0320
Fe_2O_3	3.60	3.87	Ni	na	na
MgO	43.6	33.2	K	0.0010	0.0072
NiO	na	na	Si	0.0015	0.0244
K_2O	0.007	0.015	Na	34.2	33.2
SiO_2	38.1	31.2	CO_2	22.7	25.0
Na_2O	0.013	0.903	HCO_3	23.5	33.6
CO_2	0.530	17.2			
C, noncarbonate	0.000	0.106	pH	7.79	8.12
H_2O, dehyd.[1]	0.420	1.630			
H_2O, chem.[2]	5.0	5.56			
Total	95.074	96.350			
LOI, total[3]	5.97	24.50			
Extent of carbonation, %[4]		40.6			

Carbonation test #SC-80 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.289	0.221	Cl	37.1	36.4
CaO	0.108	0.235	Cr	na	na
Cr_2O_3	na	na	Fe	0.0010	0.0013
FeO	3.56	2.29	Mg	0.0011	0.019
Fe_2O_3	4.19	3.26	Ni	na	na
MgO	46.8	33.0	K	0.0010	0.0018
NiO	na	na	Si	0.0015	0.0244
K_2O	0.007	0.007	Na	34.2	32.2
SiO_2	39.8	29.5	CO_2	22.7	23.7
Na_2O	0.013	0.535	HCO_3	23.5	32.6
CO_2	0.470	27.3			
C, noncarbonate	0.016	0.049	pH	7.79	8.01
H_2O, dehyd.[1]	0.430	0.750			
H_2O, chem.[2]	1.2	1.6			
Total	96.789	98.766			
LOI, total[3]	2.07	29.7			
Extent of carbonation, %[4]		69.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-81 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.186	0.116	Cl	36.1	36.3
CaO	0.025	0.099	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0016
FeO	7.13	2.43	Mg	0.0011	0.0274
Fe_2O_3	4.03	3.19	Ni	na	na
MgO	47.6	32.8	K	0.0006	0.0010
NiO	na	na	Si	0.0016	0.0253
K_2O	0.003	<0.002	Na	33.0	32.3
SiO_2	40.0	28.7	CO_2	26.1	24.0
Na_2O	0.007	0.499	HCO_3	35.4	31.2
CO_2	0.230	26.0			
C, noncarbonate	0.013	0.000	pH	7.72	8.08
H_2O, dehyd.[1]	0.430	0.540			
H_2O, chem.[2]	3.6	3.26			
Total	103.272	97.630			
LOI, total[3]	4.30	29.80			
Extent of carbonation, %[4]		61.9			

Carbonation test #SC-82 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.186	0.125	Cl	36.1	36.1
CaO	0.025	0.072	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0017
FeO	7.13	2.51	Mg	0.0011	0.071
Fe_2O_3	4.03	3.27	Ni	na	na
MgO	47.6	32.8	K	0.0006	0.0011
NiO	na	na	Si	0.0016	0.0237
K_2O	0.003	0.003	Na	33.0	32.4
SiO_2	40.0	29.7	CO_2	26.1	24.6
Na_2O	0.007	0.398	HCO_3	35.4	32.0
CO_2	0.230	24.2			
C, noncarbonate	0.013	0.000	pH	7.72	7.97
H_2O, dehyd.[1]	0.430	0.560			
H_2O, chem.[2]	3.6	3.8			
Total	103.272	97.546			
LOI, total[3]	4.30	28.6			
Extent of carbonation, %[4]		56.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-83 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.268	0.191	Cl	37.3	36.1
CaO	0.025	0.023	Cr	na	na
Cr_2O_3	na	na	Fe	0.0008	0.0010
FeO	3.69	2.57	Mg	0.0012	0.0844
Fe_2O_3	4.23	3.36	Ni	na	na
MgO	46.6	29.3	K	0.0007	0.0012
NiO	na	na	Si	0.0026	0.0275
K_2O	0.010	0.007	Na	33.9	32.0
SiO_2	40.9	29.3	CO_2	26.1	24.1
Na_2O	0.018	0.535	HCO_3	34.5	32.2
CO_2	0.250	26.1			
C, noncarbonate	0.014	0.087	pH	7.78	7.97
H_2O, dehyd.[1]	0.480	0.710			
H_2O, chem.[2]	2.7	2.90			
Total	99.119	95.145			
LOI, total[3]	3.4	29.8			
Extent of carbonation, %[4]		65.9			

Carbonation test #SC-84 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.268	0.180	Cl	37.3	36.2
CaO	0.025	0.022	Cr	na	na
Cr_2O_3	na	na	Fe	0.0008	0.0012
FeO	3.69	2.65	Mg	0.0012	0.064
Fe_2O_3	4.232	3.30	Ni	na	na
MgO	46.6	34.7	K	0.0007	0.0009
NiO	na	na	Si	0.0026	0.0269
K_2O	0.010	0.006	Na	33.9	32.4
SiO_2	40.9	29.7	CO_2	26.1	24.3
Na_2O	0.018	0.492	HCO_3	34.5	31.9
CO_2	0.250	24.7			
C, noncarbonate	0.014	0.009	pH	7.78	7.98
H_2O, dehyd.[1]	0.480	0.700			
H_2O, chem.[2]	2.7	2.9			
Total	99.119	99.343			
LOI, total[3]	3.4	28.3			
Extent of carbonation, %[4]		61.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-85 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.270	0.180	Cl	36.2	35.8
CaO	0.146	0.109	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0015
FeO	3.40	2.43	Mg	0.0010	0.0410
Fe_2O_3	4.55	3.42	Ni	na	na
MgO	45.4	31.3	K	0.0005	0.0008
NiO	na	na	Si	0.0027	0.0248
K_2O	0.004	0.004	Na	33.9	31.8
SiO_2	40.4	29.7	CO_2	25.6	23.4
Na_2O	0.010	0.586	HCO_3	33.0	30.3
CO_2	0.290	24.1			
C, noncarbonate	0.017	0.000	pH	7.79	8.06
H_2O, dehyd.[1]	0.680	1.030			
H_2O, chem.[2]	3.2	3.17			
Total	98.427	96.102			
LOI, total[3]	4.2	28.3			
Extent of carbonation, %[4]		60.7			

Carbonation test #SC-86 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.270	0.246	Cl	36.2	36.2
CaO	0.146	0.025	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0018
FeO	3.40	2.93	Mg	0.0010	0.098
Fe_2O_3	4.547	4.15	Ni	na	na
MgO	45.4	35.0	K	0.0005	0.0008
NiO	na	na	Si	0.0027	0.0242
K_2O	0.004	0.003	Na	33.9	32.4
SiO_2	40.4	40.6	CO_2	25.6	24.6
Na_2O	0.010	0.530	HCO_3	33.0	33.3
CO_2	0.290	9.0			
C, noncarbonate	0.017	0.022	pH	7.79	7.98
H_2O, dehyd.[1]	0.680	1.120			
H_2O, chem.[2]	3.2	4.1			
Total	98.427	97.715			
LOI, total[3]	4.19	14.2			
Extent of carbonation, %[4]		18.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-87 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.183	Cl	37.0	36.2
CaO	0.071	0.153	Cr	na	na
Cr_2O_3	na	na	Fe	0.0015	0.0147
FeO	3.55	2.93	Mg	0.0015	0.0298
Fe_2O_3	4.22	4.19	Ni	na	na
MgO	45.4	41.5	K	0.0006	0.0036
NiO	na	na	Si	0.0027	0.0318
K_2O	0.015	0.015	Na	34.8	32.2
SiO_2	40.2	36.8	CO_2	25.9	24.2
Na_2O	0.029	0.632	HCO_3	35.6	32.1
CO_2	0.290	6.4			
C, noncarbonate	0.024	0.057	pH	7.86	8.08
H_2O, dehyd.[1]	0.610	1.780			
H_2O, chem.[2]	3.0	4.61			
Total	97.660	99.153			
LOI, total[3]	3.9	12.8			
Extent of carbonation, %[4]		12.5			

Carbonation test #SC-88 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.204	Cl	37.0	36.7
CaO	0.071	0.036	Cr	na	na
Cr_2O_3	na	na	Fe	0.0015	0.0023
FeO	3.55	2.92	Mg	0.0015	0.038
Fe_2O_3	4.22	4.29	Ni	na	na
MgO	45.4	38.1	K	0.0006	0.0013
NiO	na	na	Si	0.0027	0.0228
K_2O	0.015	0.010	Na	34.8	32.8
SiO_2	40.2	36.6	CO_2	25.9	23.4
Na_2O	0.029	0.491	HCO_3	35.6	32.2
CO_2	0.290	5.7			
C, noncarbonate	0.024	0.036	pH	7.86	8.09
H_2O, dehyd.[1]	0.610	2.210			
H_2O, chem.[2]	3.0	4.8			
Total	97.660	95.469			
LOI, total[3]	3.92	12.8			
Extent of carbonation, %[4]		11.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-89 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.217	0.131	Cl	36.3	35.2
CaO	0.078	0.126	Cr	na	na
Cr_2O_3	na	na	Fe	0.0014	0.0013
FeO	3.49	2.44	Mg	0.0013	0.0154
Fe_2O_3	4.35	3.79	Ni	na	na
MgO	47.4	36.6	K	0.0005	0.0007
NiO	na	na	Si	0.0031	0.0176
K_2O	0.007	0.005	Na	33.2	31.0
SiO_2	40.4	31.0	CO_2	26.2	23.7
Na_2O	0.020	0.512	HCO_3	35.8	31.8
CO_2	0.360	19.6			
C, noncarbonate	0.022	0.021	pH	7.79	7.89
H_2O, dehyd.[1]	0.680	1.88			
H_2O, chem.[2]	3.8	4.20			
Total	100.829	100.371			
LOI, total[3]	4.8	25.7			
Extent of carbonation, %[4]		44.4			

Carbonation test #SC-90 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.217	0.146	Cl	36.3	35.4
CaO	0.078	0.250	Cr	na	na
Cr_2O_3	na	na	Fe	0.0014	0.0019
FeO	3.49	2.65	Mg	0.0013	0.088
Fe_2O_3	4.35	3.25	Ni	na	na
MgO	47.4	34.8	K	0.0005	0.0008
NiO	na	na	Si	0.0031	0.0172
K_2O	0.007	0.003	Na	33.2	32.0
SiO_2	40.4	30.6	CO_2	26.2	24.6
Na_2O	0.020	0.462	HCO_3	35.8	33.6
CO_2	0.360	23.0			
C, noncarbonate	0.022	0.063	pH	7.79	7.88
H_2O, dehyd.[1]	0.680	0.870			
H_2O, chem.[2]	3.8	3.6			
Total	100.829	99.669			
LOI, total[3]	4.8	27.5			
Extent of carbonation, %[4]		54.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-91 **SC-86 Product Solids**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.246	0.149	Cl	36.4	36.1
CaO	0.025	0.078	Cr	na	na
Cr_2O_3	na	na	Fe	0.0021	0.0027
FeO	2.93	2.80	Mg	0.0012	0.012
Fe_2O_3	4.15	3.46	Ni	na	na
MgO	35.0	40.6	K	0.0006	0.0013
NiO	na	na	Si	0.0014	0.0233
K_2O	0.003	0.014	Na	33.9	32.8
SiO_2	40.6	36.2	CO_2	26.2	22.8
Na_2O	0.530	0.511	HCO_3	36.9	25.1
CO_2	8.970	9.5			
C, noncarbonate	0.022	0.040	pH	7.76	8.19
H_2O, dehyd.[1]	1.120	1.070			
H_2O, chem.[2]	4.1	3.80			
Total	97.715	98.193			
LOI, total[3]	14.2	14.40			
Extent of carbonation, %[4]		1.7			

Carbonation test #SC-92 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.188	0.147	Cl	36.4	36.5
CaO	0.095	0.062	Cr	na	na
Cr_2O_3	na	na	Fe	0.0021	0.0024
FeO	3.25	2.74	Mg	0.0012	0.025
Fe_2O_3	4.60	4.86	Ni	na	na
MgO	47.6	39.0	K	0.0006	0.0009
NiO	na	na	Si	0.0014	0.0194
K_2O	0.007	0.003	Na	33.9	33.4
SiO_2	40.9	34.9	CO_2	26.2	24.8
Na_2O	0.009	0.717	HCO_3	36.9	32.3
CO_2	0.270	11.5			
C, noncarbonate	0.019	0.051	pH	7.76	8.00
H_2O, dehyd.[1]	0.65	1.41			
H_2O, chem.[2]	3.5	4.1			
Total	101.035	99.466			
LOI, total[3]	4.4	17.1			
Extent of carbonation, %[4]		23.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-93 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.111	Cl	36.1	35.9
CaO	0.066	0.062	Cr	na	na
Cr_2O_3	na	na	Fe	0.0032	0.0032
FeO	3.46	2.59	Mg	0.0010	0.0714
Fe_2O_3	4.45	3.32	Ni	na	na
MgO	48.7	33.2	K	0.0005	0.0009
NiO	na	na	Si	0.0020	0.0234
K_2O	0.003	<0.002	Na	33.6	32.4
SiO_2	40.9	29.5	CO_2	25.6	24.8
Na_2O	0.008	0.400	HCO_3	34.4	32.6
CO_2	0.240	26.0			
C, noncarbonate	0.040	0.024	pH	7.86	7.96
H_2O, dehyd.[1]	0.650	0.780			
H_2O, chem.[2]	3.1	3.00			
Total	101.746	98.961			
LOI, total[3]	4.0	29.8			
Extent of carbonation, %[4]		62.9			

Carbonation test #SC-94 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.188	0.099	Cl	36.1	35.5
CaO	0.095	0.041	Cr	na	na
Cr_2O_3	na	na	Fe	0.0032	0.0033
FeO	3.25	2.93	Mg	0.0010	0.015
Fe_2O_3	4.60	3.19	Ni	na	na
MgO	47.6	33.2	K	0.0005	0.0024
NiO	na	na	Si	0.0020	0.0220
K_2O	0.007	<0.002	Na	33.6	31.2
SiO_2	40.9	31.2	CO_2	25.6	22.6
Na_2O	0.009	1.658	HCO_3	34.4	30.4
CO_2	0.270	14.7			
C, noncarbonate	0.019	0.000	pH	7.86	8.10
H_2O, dehyd.[1]	0.650	3.57			
H_2O, chem.[2]	3.5	6.0			
Total	101.035	96.615			
LOI, total[3]	4.4	24.3			
Extent of carbonation, %[4]		31.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-95 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.189	0.172	Cl	37.6	36.8
CaO	0.095	0.111	Cr	na	na
Cr_2O_3	na	na	Fe	0.0008	0.0006
FeO	3.55	3.09	Mg	0.0012	0.0336
Fe_2O_3	3.56	3.57	Ni	na	na
MgO	42.9	41.0	K	0.0006	0.0010
NiO	na	na	Si	0.0017	0.0208
K_2O	0.007	0.004	Na	35.4	34.0
SiO_2	36.4	34.2	CO_2	26.5	25.6
Na_2O	0.014	0.960	HCO_3	35.9	34.4
CO_2	0.530	6.49			
C, noncarbonate	0.020	0.079	pH	7.80	7.86
H_2O, dehyd.[1]	0.370	0.410			
H_2O, chem.[2]	12.9	11.12			
Total	100.527	101.191			
LOI, total[3]	13.8	18.1			
Extent of carbonation, %[4]		13.0			

Carbonation test #SC-96 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.229	0.165	Cl	37.6	37.2
CaO	0.127	0.052	Cr	na	na
Cr_2O_3	na	na	Fe	0.0008	0.0008
FeO	3.28	2.82	Mg	0.0012	0.047
Fe_2O_3	3.93	4.09	Ni	na	na
MgO	43.6	41.6	K	0.0006	0.0001
NiO	na	na	Si	0.0017	0.0324
K_2O	<0.002	<0.002	Na	35.4	33.2
SiO_2	36.8	34.7	CO_2	26.5	25.9
Na_2O	0.006	0.253	HCO_3	35.9	33.2
CO_2	0.890	6.6			
C, noncarbonate	0.021	0.000	pH	7.80	8.07
H_2O, dehyd.[1]	0.540	0.310			
H_2O, chem.[2]	11.2	10.3			
Total	100.677	100.851			
LOI, total[3]	12.7	17.2			
Extent of carbonation, %[4]		12.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-97 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.158	0.156	Cl	36.7	36.0
CaO	0.042	0.037	Cr	na	<0.001
Cr_2O_3	na	na	Fe	0.0007	0.0008
FeO	3.90	2.71	Mg	0.0012	0.0262
Fe_2O_3	4.00	3.06	Ni	na	<0.001
MgO	49.1	32.3	K	0.0005	0.0010
NiO	na	na	Si	0.0021	0.0234
K_2O	0.002	<0.002	Na	33.8	32.5
SiO_2	41.9	29.3	CO_2	25.5	24.3
Na_2O	0.005	0.431	HCO_3	35.4	33.0
CO_2	0.180	28.2			
C, noncarbonate	0.002	0.004	pH	7.82	
H_2O, dehyd.[1]	0.490	0.500			
H_2O, chem.[2]	0.4	1.10			
Total	100.208	97.839			
LOI, total[3]	1.1	29.8			
Extent of carbonation, %[4]		69.7			

Carbonation test #SC-98 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.100	Cl	36.8	36.3
CaO	0.089	0.113	Cr	na	na
Cr_2O_3	na	na	Fe	0.0018	0.0018
FeO	0.85	0.84	Mg	0.0013	0.038
Fe_2O_3	7.31	4.83	Ni	na	na
MgO	48.1	28.7	K	0.0006	0.0012
NiO	na	na	Si	0.0021	0.0283
K_2O	0.005	0.003	Na	29.8	28.7
SiO_2	40.4	29.5	CO_2	23.4	23.3
Na_2O	0.006	0.651	HCO_3	27.7	31.7
CO_2	0.240	24.1			
C, noncarbonate	0.009	0.083	pH	7.80	8.07
H_2O, dehyd.[1]	0.750	1.090			
H_2O, chem.[2]	3.6	3.7			
Total	101.565	93.743			
LOI, total[3]	4.6	29.0			
Extent of carbonation, %[4]		59.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-99 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.120	Cl	36.8	36.2
CaO	0.031	0.316	Cr	na	na
Cr_2O_3	na	na	Fe	0.0018	0.0020
FeO	1.75	0.489	Mg	0.0013	0.0212
Fe_2O_3	1.94	2.62	Ni	na	na
MgO	49.7	31.8	K	0.0006	0.0008
NiO	na	na	Si	0.0021	0.0260
K_2O	<0.002	<0.002	Na	29.8	28.8
SiO_2	42.8	29.5	CO_2	23.4	23.4
Na_2O	0.005	0.469	HCO_3	27.7	30.8
CO_2	0.210	28.4			
C, noncarbonate	0.014	0.000	pH	7.80	8.10
H_2O, dehyd.[1]	0.770	1.24			
H_2O, chem.[2]	1.9	2.16			
Total	99.306	97.168			
LOI, total[3]	2.9	31.8			
Extent of carbonation, %[4]		71.1			

Carbonation test #SC-100 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.255	0.158	Cl	36.6	36.3
CaO	0.151	0.093	Cr	na	na
Cr_2O_3	na	na	Fe	0.0016	0.0123
FeO	2.21	1.47	Mg	0.0011	0.055
Fe_2O_3	1.92	1.43	Ni	na	na
MgO	49.4	33.8	K	0.0005	0.0012
NiO	na	na	Si	0.0019	0.0027
K_2O	<0.002	1.4	Na	29.9	28.4
SiO_2	42.6	29.5	CO_2	25.9	23.0
Na_2O	<0.002	0.647	HCO_3	33.4	30.0
CO_2	0.190	27.8			
C, noncarbonate	0.015	0.000	pH	7.99	8.03
H_2O, dehyd.[1]	0.890	1.36			
H_2O, chem.[2]	2.2	0.0			
Total	99.828	97.731			
LOI, total[3]	3.3	3.3			
Extent of carbonation, %[4]		69.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-101 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.166	Cl	36.6	35.9
CaO	0.089	0.073	Cr	na	na
Cr_2O_3	na	na	Fe	0.0016	0.0024
FeO	0.85	0.630	Mg	0.0011	0.0614
Fe_2O_3	7.31	5.48	Ni	na	na
MgO	48.1	31.7	K	0.0005	0.006
NiO	na	na	Si	0.0019	30.4
K_2O	0.005	0.003	Na	29.9	28.8
SiO_2	40.4	29.7	CO_2	25.9	23.1
Na_2O	0.006	0.483	HCO_3	33.4	31.6
CO_2	0.240	23.5			
C, noncarbonate	0.009	0.000	pH	7.99	8.02
H_2O, dehyd.[1]	0.750	1.07			
H_2O, chem.[2]	3.6	3.63			
Total	101.565	96.436			
LOI, total[3]	4.6	28.2			
Extent of carbonation, %[4]		57.3			

Carbonation test #SC-102 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.171	0.119	Cl	37.4	36.3
CaO	0.048	0.035	Cr	na	na
Cr_2O_3	na	na	Fe	0.0011	0.0012
FeO	5.36	3.59	Mg	0.0012	0.097
Fe_2O_3	2.56	2.04	Ni	na	na
MgO	49.1	32.5	K	0.0006	0.0011
NiO	na	na	Si	0.0010	0.0272
K_2O	<0.002	<0.002	Na	31.8	32.2
SiO_2	42.1	29.3	CO_2	26.0	25.2
Na_2O	0.009	0.336	HCO_3	34.9	32.7
CO_2	<0.01	28.7			
C, noncarbonate	0.043	0.017	pH	7.79	7.86
H_2O, dehyd.[1]	0.130	0.320			
H_2O, chem.[2]	0.2	1.0			
Total	99.719	97.931			
LOI, total[3]	0.3	30.0			
Extent of carbonation, %[4]		70.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-103 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.221	0.124	Cl	37.4	36.5
CaO	0.079	0.093	Cr	na	na
Cr_2O_3	na	na	Fe	0.0011	0.0006
FeO	0.75	0.527	Mg	0.0012	0.0140
Fe_2O_3	3.69	2.97	Ni	na	na
MgO	47.4	35.0	K	0.0006	0.0015
NiO	na	na	Si	0.0010	19.2
K_2O	0.011	0.007	Na	31.8	28.6
SiO_2	41.5	31.9	CO_2	26.0	24.2
Na_2O	0.009	0.674	HCO_3	34.9	28.0
CO_2	0.310	21.4			
C, noncarbonate	0.007	0.030	pH	7.79	8.08
H_2O, dehyd.[1]	0.850	1.330			
H_2O, chem.[2]	4.9	4.44			
Total	99.709	98.460			
LOI, total[3]	6.0	27.2			
Extent of carbonation, %[4]		51.4			

Carbonation test #SC-104 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.221	0.295	Cl	36.3	36.7
CaO	0.079	0.095	Cr	na	na
Cr_2O_3	na	na	Fe	0.0009	0.0010
FeO	0.75	0.53	Mg	0.0010	0.086
Fe_2O_3	3.69	2.95	Ni	na	na
MgO	47.4	35.2	K	0.0007	0.0009
NiO	na	na	Si	0.0016	0.0154
K_2O	0.011	0.004	Na	29.4	29.0
SiO_2	41.5	30.8	CO_2	26.3	23.4
Na_2O	0.009	0.692	HCO_3	32.5	30.3
CO_2	0.310	23.1			
C, noncarbonate	0.007	0.016	pH	7.78	7.94
H_2O, dehyd.[1]	0.850	1.38			
H_2O, chem.[2]	4.9	4.3			
Total	99.709	99.315			
LOI, total[3]	6.0	28.8			
Extent of carbonation, %[4]		56.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-105 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.208	0.189	Cl	36.3	36.4
CaO	<0.020	<0.020	Cr	na	na
Cr_2O_3	na	na	Fe	0.0009	0.0006
FeO	4.09	2.419	Mg	0.0010	0.0880
Fe_2O_3	3.49	3.33	Ni	na	na
MgO	46.3	33.0	K	0.0007	0.0013
NiO	na	na	Si	0.0016	0.0286
K_2O	0.017	na	Na	29.4	37.0
SiO_2	40.4	30.2	CO_2	26.3	25.5
Na_2O	0.022	0.310	HCO_3	32.5	33.3
CO_2	0.250	22.7			
C, noncarbonate	0.020	0.025	pH	7.78	7.91
H_2O, dehyd.[1]	0.650	1.28			
H_2O, chem.[2]	3.5	3.50			
Total	98.949	96.909			
LOI, total[3]	4.4	27.50			
Extent of carbonation, %[4]		54.9			

Carbonation test #SC-106 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.208	0.151	Cl	36.8	36.6
CaO	<0.020	0.028	Cr	na	na
Cr_2O_3	na	na	Fe	0.0004	0.0004
FeO	4.09	2.35	Mg	0.0010	0.070
Fe_2O_3	3.49	2.69	Ni	na	na
MgO	46.3	34.7	K	0.0006	0.0010
NiO	na	na	Si	0.0011	0.0214
K_2O	0.017	<0.004	Na	43.6	39.2
SiO_2	40.4	29.7	CO_2	20.7	25.2
Na_2O	0.022	0.337	HCO_3	20.6	33.1
CO_2	0.250	24.0			
C, noncarbonate	0.020	0.140	pH	7.75	7.94
H_2O, dehyd.[1]	0.650	1.310			
H_2O, chem.[2]	3.5	3.3			
Total	98.949	98.648			
LOI, total[3]	4.4	28.7			
Extent of carbonation, %[4]		59.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-107 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.151	0.132	Cl	36.9	35.8
CaO	0.074	0.034	Cr	na	na
Cr_2O_3	na	na	Fe	0.0018	0.0020
FeO	3.40	2.573	Mg	0.0001	0.1880
Fe_2O_3	4.23	3.67	Ni	na	na
MgO	47.1	37.5	K	45.2	42.0
NiO	na	na	Si	0.0020	0.0264
K_2O	<0.004	0.434	Na	0.0	0.2
SiO_2	40.2	32.3	CO_2	26.3	25.5
Na_2O	0.019	0.019	HCO_3	34.3	34.0
CO_2	0.300	16.5			
C, noncarbonate	0.005	0.127	pH	8.22	8.23
H_2O, dehyd.[1]	0.530	1.45			
H_2O, chem.[2]	4.1	4.82			
Total	100.091	99.542			
LOI, total[3]	4.9	22.9			
Extent of carbonation, %[4]		36.3			

Carbonation test #SC-108 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.151	0.151	Cl	36.3	35.2
CaO	0.074	0.066	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0010
FeO	3.40	2.52	Mg	0.0002	0.243
Fe_2O_3	4.23	3.83	Ni	na	na
MgO	47.1	36.6	K	70.8	67.2
NiO	na	na	Si	0.0025	0.0336
K_2O	<0.004	0.458	Na	0.0	0.1
SiO_2	40.2	31.9	CO_2	50.6	47.7
Na_2O	0.019	0.023	HCO_3	69.6	62.6
CO_2	0.300	18.2			
C, noncarbonate	0.005	0.073	pH	8.12	8.34
H_2O, dehyd.[1]	0.530	1.310			
H_2O, chem.[2]	4.1	4.3			
Total	100.091	99.470			
LOI, total[3]	4.9	23.9			
Extent of carbonation, %[4]		40.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-109 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.302	0.283	Cl	36.8	35.1
CaO	0.266	0.252	Cr	na	na
Cr_2O_3	na	na	Fe	0.0004	0.0004
FeO	3.01	2.933	Mg	0.0010	0.0254
Fe_2O_3	3.72	3.80	Ni	na	na
MgO	41.9	40.8	K	0.0006	0.3760
NiO	na	na	Si	0.0011	0.0282
K_2O	0.007	0.027	Na	43.6	38.0
SiO_2	37.9	36.6	CO_2	20.7	26.5
Na_2O	0.020	0.318	HCO_3	20.6	32.8
CO_2	0.560	4.8			
C, noncarbonate	0.061	0.080	pH	7.75	7.81
H_2O, dehyd.[1]	0.360	0.330			
H_2O, chem.[2]	13.2	11.1			
Total	101.338	101.287			
LOI, total[3]	14.2	16.3			
Extent of carbonation, %[4]		9.4			

Carbonation test #SC-110 **Transite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.42	2.02	Cl		37.2
CaO	27.8	25.6	Cr		na
Cr_2O_3	na	na	Fe		0.0012
FeO	1.42	1.38	Mg		0.051
Fe_2O_3	1.77	1.64	Ni		na
MgO	14.5	13.9	K		0.2110
NiO	na	na	Si		0.0277
K_2O	0.186	0.092	Na		36.5
SiO_2	23.3	21.4	CO_2		24.1
Na_2O	0.102	1.139	HCO_3		32.50
CO_2	13.9	21.2			
C, noncarbonate	0.000	0.094	pH	7.79	7.58
H_2O, dehyd.[1]	2.70	1.890			
H_2O, chem.[2]	9.0	5.9			
Total	97.182	96.266			
LOI, total[3]	25.60	29.1			
Extent of carbonation, %[4]		31.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-111 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.188	Cl		0.1
CaO	0.169	0.269	Cr		<0.020
Cr_2O_3	na	na	Fe		na
FeO	7.19	6.96	Mg		1.88
Fe_2O_3	0.63	0.61	Ni		2.33
MgO	51.6	54.6	K		19.9
NiO	na	na	Si		na
K_2O	0.016	0.007	Na		<0.004
SiO_2	40.9	38.7	CO_2		14.1
Na_2O	0.024	0.093	HCO_3		0.23
CO_2	<0.01	4.6			
C, noncarbonate	0.031	0.075	pH	7.85	27.5
H_2O, dehyd.[1]	<0.01	<0.01			
H_2O, chem.[2]	0.6	0.65			
Total	101.277	106.723			
LOI, total[3]	0.61	5.32			
Extent of carbonation, %[4]		7.9			

Carbonation test #SC-112 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.167	Cl	36.4	35.3
CaO	0.169	0.192	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0012
FeO	7.19	6.92	Mg	0.0015	0.074
Fe_2O_3	0.629	0.06	Ni	na	na
MgO	51.6	48.7	K	0.0008	0.0058
NiO	na	na	Si	0.0018	0.0252
K_2O	0.016	0.007	Na	36.4	35.4
SiO_2	40.9	35.1	CO_2	25.9	25.8
Na_2O	0.024	0.181	HCO_3	35.1	33.2
CO_2	<0.01	12.5			
C, noncarbonate	0.031	0.029	pH	7.72	7.95
H_2O, dehyd.[1]	#VALUE!	0.180			
H_2O, chem.[2]	#VALUE!	0.7			
Total	#VALUE!	104.756			
LOI, total[3]	0.61	13.4			
Extent of carbonation, %[4]		23.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-113 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.184	Cl	36.4	35.0
CaO	0.169	0.228	Cr	na	na
Cr_2O_3	na	na	Fe	0.0013	0.0012
FeO	7.19	7.590	Mg	0.0015	0.0940
Fe_2O_3	0.63	<0.01	Ni	na	na
MgO	51.6	46.8	K	0.0008	0.0027
NiO	na	na	Si	0.0018	0.0264
K_2O	0.016	0.006	Na	36.4	35.3
SiO_2	40.9	33.8	CO_2	25.9	23.6
Na_2O	0.024	0.201	HCO_3	35.1	31.1
CO_2	<0.01	14.5			
C, noncarbonate	0.031	0.053	pH	7.72	7.99
H_2O, dehyd.[1]	<0.01	0.190			
H_2O, chem.[2]	0.6	0.56			
Total	101.277	104.068			
LOI, total[3]	0.61	15.30			
Extent of carbonation, %[4]		27.9			

Carbonation test #SC-114 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.143	Cl	36.0	26.3
CaO	0.182	0.103	Cr	na	na
Cr_2O_3	0.247	0.066	Fe	0.0014	0.0008
FeO	8.58	7.23	Mg	0.0064	0.082
Fe_2O_3	<0.01	<0.01	Ni	na	na
MgO	48.4	47.8	K	0.0007	0.0024
NiO	0.331	0.267	Si	0.0016	0.0310
K_2O	0.011	0.004	Na	36.1	26.8
SiO_2	40.4	38.3	CO_2	26.6	18.6
Na_2O	0.030	0.166	HCO_3	34.7	25.3
CO_2	<0.01	5.5			
C, noncarbonate	0.039	0.071	pH	7.84	8.00
H_2O, dehyd.[1]	0.06	0.13			
H_2O, chem.[2]	0.3	0.6			
Total	98.800	100.376			
LOI, total[3]	0.39	6.4			
Extent of carbonation, %[4]		10.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-115 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.091	Cl	36.0	35.9
CaO	0.096	0.252	Cr	na	0.0042
Cr_2O_3	0.015	0.018	Fe	0.0014	0.0008
FeO	0.67	0.746	Mg	0.0064	0.1560
Fe_2O_3	3.45	2.32	Ni	na	<0.001
MgO	45.8	37.1	K	0.0007	0.0034
NiO	0.204	0.165	Si	0.0016	0.0238
K_2O	0.006	0.003	Na	36.1	35.0
SiO_2	42.4	32.1	CO_2	26.6	25.1
Na_2O	0.008	1.698	HCO_3	34.7	33.2
CO_2	0.240	19.1			
C, noncarbonate	0.016	0.000	pH	7.84	7.72
H_2O, dehyd.[1]	0.600	1.530			
H_2O, chem.[2]	4.9	5.77			
Total	98.537	100.920			
LOI, total[3]	5.8	26.4			
Extent of carbonation, %[4]		46.3			

Carbonation test #SC-116 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.251	0.130	Cl	35.9	33.7
CaO	0.081	0.207	Cr	<0.001	0.0062
Cr_2O_3	0.017	0.291	Fe	0.0009	0.0009
FeO	0.55	0.60	Mg	0.0038	0.133
Fe_2O_3	3.45	2.40	Ni	<0.001	<0.001
MgO	45.8	36.5	K	0.0006	0.0023
NiO	0.204	0.197	Si	0.0012	0.0266
K_2O	0.004	0.010	Na	36.8	32.9
SiO_2	42.4	31.7	CO_2	26.0	22.5
Na_2O	0.008	1.685	HCO_3	34.40	28.70
CO_2	0.240	21.3			
C, noncarbonate	0.016	0.007	pH	7.79	7.81
H_2O, dehyd.[1]	0.60	1.29			
H_2O, chem.[2]	4.9	4.7			
Total	98.456	100.966			
LOI, total[3]	5.77	27.3			
Extent of carbonation, %[4]		53.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-117 LANL

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.80	2.36	Cl	35.9	34.5
CaO	0.189	0.175	Cr	<0.001	<0.001
Cr_2O_3	0.314	0.021	Fe	0.0009	0.0009
FeO	2.80	2.10	Mg	0.0038	0.0334
Fe_2O_3	6.21	5.49	Ni	<0.001	<0.001
MgO	40.3	37.5	K	0.0006	0.0033
NiO	0.229	0.165	Si	0.0012	0.0243
K_2O	0.008	0.005	Na	36.8	33.0
SiO_2	40.6	33.6	CO_2	26.0	23.1
Na_2O	0.013	0.910	HCO_3	34.4	30.1
CO_2	na	12.1			
C, noncarbonate	0.124	0.000	pH	7.79	7.95
H_2O, dehyd.[1]	1.48	2.27			
H_2O, chem.[2]	6.2	6.53			
Total	101.277	103.185			
LOI, total[3]	7.78	20.9			
Extent of carbonation, %[4]		30.0			

Carbonation test #SC-118 Cedar Hill serpentine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.153	0.067	Cl	35.6	35.6
CaO	0.176	0.178	Cr	<0.001	0.0050
Cr_2O_3	0.020	0.031	Fe	0.0010	0.0010
FeO	0.48	0.55	Mg	0.0038	0.049
Fe_2O_3	3.65	2.72	Ni	<0.001	<0.001
MgO	45.1	36.1	K	0.0006	0.0019
NiO	0.204	0.165	Si	0.0015	0.0260
K_2O	0.005	0.007	Na	36.0	34.0
SiO_2	42.6	31.7	CO_2	26.5	24.2
Na_2O	0.010	0.871	HCO_3	35.3	30.5
CO_2	0.170	21.9			
C, noncarbonate	0.011	0.043	pH	7.72	7.97
H_2O, dehyd.[1]	0.500	1.070			
H_2O, chem.[2]	4.1	4.3			
Total	97.131	99.696			
LOI, total[3]	4.8	27.3			
Extent of carbonation, %[4]		56.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-119 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.092	Cl	35.6	35.8
CaO	0.176	0.178	Cr	<0.001	0.0041
Cr_2O_3	0.044	0.056	Fe	0.0010	0.0009
FeO	0.68	0.720	Mg	0.0038	0.0622
Fe_2O_3	4.42	3.05	Ni	<0.001	<0.001
MgO	48.7	36.0	K	0.0006	0.0032
NiO	0.229	0.178	Si	0.0015	0.0252
K_2O	0.004	0.009	Na	36.0	33.4
SiO_2	41.9	30.8	CO_2	26.5	21.3
Na_2O	0.010	0.922	HCO_3	35.3	24.2
CO_2	0.160	22.2			
C, noncarbonate	0.019	0.051	pH	7.72	7.89
H_2O, dehyd.[1]	0.750	1.100			
H_2O, chem.[2]	3.6	3.95			
Total	100.919	99.287			
LOI, total[3]	4.5	27.3			
Extent of carbonation, %[4]		52.7			

Carbonation test #SC-120 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.098	Cl	36.7	36.0
CaO	0.176	0.182	Cr	<0.001	0.0049
Cr_2O_3	0.044	0.051	Fe	0.0009	0.0011
FeO	0.68	0.68	Mg	0.0040	0.052
Fe_2O_3	4.42	3.23	Ni	<0.001	<0.001
MgO	48.7	35.6	K	0.0005	0.0016
NiO	0.229	0.172	Si	0.0016	0.0226
K_2O	0.004	0.005	Na	36.2	34.4
SiO_2	41.9	31.2	CO_2	26.9	24.0
Na_2O	0.010	0.946	HCO_3	35.7	31.3
CO_2	0.160	21.9			
C, noncarbonate	0.019	0.063	pH	7.93	8.02
H_2O, dehyd.[1]	0.75	1.13			
H_2O, chem.[2]	3.6	3.9			
Total	100.919	99.250			
LOI, total[3]	4.5	27.0			
Extent of carbonation, %[4]		51.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-121 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.157	0.085	Cl	36.7	35.7
CaO	0.270	0.151	Cr	<0.001	0.0120
Cr_2O_3	0.044	0.044	Fe	0.0009	0.0008
FeO	0.62	0.656	Mg	0.0040	0.0620
Fe_2O_3	4.45	3.09	Ni	<0.001	<0.001
MgO	49.7	35.0	K	0.0005	0.0021
NiO	0.229	0.178	Si	0.0016	0.0250
K_2O	0.005	0.005	Na	36.2	32.4
SiO_2	41.9	30.4	CO_2	26.9	20.3
Na_2O	0.011	1.06	HCO_3	35.7	25.1
CO_2	0.200	23.5			
C, noncarbonate	0.016	0.000	pH	7.93	7.85
H_2O, dehyd.[1]	0.830	1.30			
H_2O, chem.[2]	3.6	3.50			
Total	102.072	98.933			
LOI, total[3]	4.6	28.3			
Extent of carbonation, %[4]		55.5			

Carbonation test #SC-122 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.137	0.086	Cl	37.1	36.2
CaO	0.130	0.225	Cr	<0.001	0.0075
Cr_2O_3	0.044	0.057	Fe	0.0009	0.0009
FeO	0.81	0.68	Mg	0.0032	0.078
Fe_2O_3	4.25	3.32	Ni	<0.001	<0.001
MgO	44.4	35.5	K	0.0005	0.0018
NiO	0.229	0.178	Si	0.0012	0.0230
K_2O	0.004	0.004	Na	36.6	33.4
SiO_2	41.7	30.4	CO_2	26.8	23.6
Na_2O	0.010	1.03	HCO_3	35.4	30.9
CO_2	0.230	22.6			
C, noncarbonate	0.018	0.052	pH	7.87	7.98
H_2O, dehyd.[1]	0.820	1.20			
H_2O, chem.[2]	3.9	4.4			
Total	96.725	99.739			
LOI, total[3]	5.0	28.3			
Extent of carbonation, %[4]		58.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-123 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.137	0.180	Cl	37.1	36.0
CaO	0.130	0.072	Cr	<0.001	na
Cr_2O_3	0.044	0.032	Fe	0.0009	0.0012
FeO	0.81	0.553	Mg	0.0032	0.0592
Fe_2O_3	4.25	3.35	Ni	<0.001	na
MgO	44.4	32.7	K	0.0005	0.0017
NiO	0.229	0.159	Si	0.0012	0.0209
K_2O	0.004	0.005	Na	36.6	35.2
SiO_2	41.7	31.4	CO_2	26.8	23.7
Na_2O	0.010	1.50	HCO_3	35.4	30.8
CO_2	0.230	18.5			
C, noncarbonate	0.018	0.000	pH	7.87	0.00
H_2O, dehyd.[1]	0.820	3.30			
H_2O, chem.[2]	3.9	5.40			
Total	96.725	97.155			
LOI, total[3]	5.0	27.2			
Extent of carbonation, %[4]		45.7			

Carbonation test #SC-124 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.212	0.157	Cl	35.2	35.8
CaO	0.208	0.083	Cr	na	na
Cr_2O_3	0.029	0.018	Fe	0.0010	0.0015
FeO	0.72	0.55	Mg	0.0064	0.095
Fe_2O_3	4.26	3.13	Ni	na	na
MgO	49.4	31.5	K	0.0011	0.0020
NiO	0.204	0.153	Si	0.0025	0.0205
K_2O	<0.002	<0.002	Na	36.3	35.6
SiO_2	41.3	31.9	CO_2	25.3	24.2
Na_2O	0.007	0.945	HCO_3	32.0	32.7
CO_2	0.290	21.1			
C, noncarbonate	0.031	0.000	pH	7.83	7.88
H_2O, dehyd.[1]	0.83	1.58			
H_2O, chem.[2]	3.8	3.9			
Total	101.321	95.019			
LOI, total[3]	5.0	26.6			
Extent of carbonation, %[4]		48.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-125 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.212	0.149	Cl	35.2	35.4
CaO	0.208	0.046	Cr	na	na
Cr_2O_3	0.029	0.031	Fe	0.0010	0.0021
FeO	0.72	0.630	Mg	0.0064	0.1220
Fe_2O_3	4.26	3.15	Ni	na	na
MgO	49.4	29.2	K	0.0011	0.0020
NiO	0.204	0.153	Si	0.0025	0.0217
K_2O	<0.002	0.003	Na	36.3	35.0
SiO_2	41.3	31.7	CO_2	25.3	23.8
Na_2O	0.007	0.894	HCO_3	32.0	31.9
CO_2	0.290	21.2			
C, noncarbonate	0.031	0.000	pH	7.83	7.80
H_2O, dehyd.[1]	0.830	1.56			
H_2O, chem.[2]	3.8	4.04			
Total	101.321	92.696			
LOI, total[3]	5.0	26.8			
Extent of carbonation, %[4]		48.7			

Carbonation test #SC-126 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.215	0.138	Cl	36.1	35.2
CaO	0.085	0.023	Cr	na	na
Cr_2O_3	0.031	0.018	Fe	0.0016	0.0018
FeO	0.87	0.57	Mg	0.0056	0.064
Fe_2O_3	3.97	3.20	Ni	na	na
MgO	49.6	24.7	K	0.0006	0.0021
NiO	0.204	0.165	Si	0.0016	0.0192
K_2O	<0.002	0.003	Na	37.0	35.4
SiO_2	41.3	32.5	CO_2	26.5	22.5
Na_2O	0.009	1.00	HCO_3	35.0	28.7
CO_2	0.290	19.1			
C, noncarbonate	0.016	0.000	pH	8.33	7.85
H_2O, dehyd.[1]	0.820	1.660			
H_2O, chem.[2]	3.9	4.4			
Total	101.288	87.540			
LOI, total[3]	5.0	25.2			
Extent of carbonation, %[4]		42.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-127 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.215	0.139	Cl	36.1	36.3
CaO	0.085	0.038	Cr	na	na
Cr_2O_3	0.031	0.026	Fe	0.0019	0.0021
FeO	0.87	0.708	Mg	0.0042	0.0498
Fe_2O_3	3.97	3.09	Ni	na	na
MgO	49.6	31.0	K	0.0006	0.0019
NiO	0.204	0.165	Si	0.0016	0.0231
K_2O	<0.002	<0.002	Na	36.1	36.6
SiO_2	41.3	32.1	CO_2	25.9	23.9
Na_2O	0.009	1.30	HCO_3	33.6	32.0
CO_2	0.290	19.5			
C, noncarbonate	0.016	0.058	pH	7.82	8.01
H_2O, dehyd.[1]	0.820	1.52			
H_2O, chem.[2]	3.9	4.62			
Total	101.288	94.264			
LOI, total[3]	5.0	25.7			
Extent of carbonation, %[4]		43.7			

Carbonation test #SC-128 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.145	Cl	36.1	35.6
CaO	0.051	0.114	Cr	na	na
Cr_2O_3	0.030	0.025	Fe	0.0019	0.0020
FeO	0.72	0.71	Mg	0.0042	0.151
Fe_2O_3	4.132	3.12	Ni	na	na
MgO	42.3	37.0	K	0.0006	0.0022
NiO	0.210	0.165	Si	0.0016	0.0262
K_2O	0.004	<0.002	Na	36.1	33.6
SiO_2	41.5	32.3	CO_2	25.9	20.7
Na_2O	0.012	0.869	HCO_3	33.6	26.4
CO_2	0.330	19.5			
C, noncarbonate	0.004	0.000	pH	7.82	8.09
H_2O, dehyd.[1]	0.740	1.72			
H_2O, chem.[2]	4.1	4.5			
Total	94.368	100.122			
LOI, total[3]	5.2	25.7			
Extent of carbonation, %[4]		51.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-129 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.200	Cl	35.8	35.7
CaO	0.182	0.182	Cr	na	na
Cr_2O_3	0.247	0.146	Fe	0.0021	0.0024
FeO	8.58	7.976	Mg	0.0036	0.0674
Fe_2O_3	<0.010	<0.010	Ni	na	na
MgO	48.4	48.4	K	0.0006	0.0024
NiO	0.331	0.267	Si	0.0060	0.0182
K_2O	0.011	<0.002	Na	36.4	36.8
SiO_2	40.4	39.8	CO_2	26.1	25.0
Na_2O	0.030	0.126	HCO_3	34.1	32.6
CO_2	<0.01	1.0			
C, noncarbonate	0.039	0.032	pH	8.08	8.03
H_2O, dehyd.[1]	0.060	0.210			
H_2O, chem.[2]	0.3	0.65			
Total	98.800	99.025			
LOI, total[3]	0.39	1.92			
Extent of carbonation, %[4]		1.8			

Carbonation test #SC-130 **Cedar Hill serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.124	Cl	35.7	34.6
CaO	0.116	0.127	Cr	<0.0005	0.0900
Cr_2O_3	0.036	0.025	Fe	0.0021	0.0010
FeO	0.73	0.60	Mg	0.0036	0.067
Fe_2O_3	4.26	3.32	Ni	<0.0005	<0.0005
MgO	48.4	37.5	K	0.0006	0.0038
NiO	0.204	0.159	Si	0.0060	0.0281
K_2O	0.006	0.005	Na	36.4	31.8
SiO_2	40.9	31.2	CO_2	26.1	20.5
Na_2O	0.010	1.22	HCO_3	34.1	27.3
CO_2	0.330	20.5			
C, noncarbonate	0.024	0.075	pH	8.08	7.71
H_2O, dehyd.[1]	1.05	1.88			
H_2O, chem.[2]	3.6	4.1			
Total	99.813	100.886			
LOI, total[3]	4.99	26.6			
Extent of carbonation, %[4]		47.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-131 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.152	Cl	34.9	35.0
CaO	0.116	0.186	Cr	<0.0005	0.0070
Cr_2O_3	0.036	0.031	Fe	0.0015	0.0013
FeO	0.733	0.810	Mg	0.0011	0.0134
Fe_2O_3	4.261	3.446	Ni	<0.0005	<0.0005
MgO	48.4	41.6	K	0.0006	0.0060
NiO	0.204	0.178	Si	0.0015	0.0286
K_2O	0.006	0.007	Na	33.50	32.30
SiO_2	40.9	35.1	CO_2	26.00	20.90
Na_2O	0.010	0.758	HCO_3	33.70	27.10
CO_2	0.33	7.41			
C, noncarbonate	0.024	0.068	pH	7.75	8.18
H_2O, dehyd.[1]	1.050	3.950			
H_2O, chem.[2]	3.586	7.172			
Total	99.813	100.871			
LOI, total[3]	4.99	18.6			
Extent of carbonation, %[4]		14.4			

Carbonation test #SC-132 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.139	Cl	34.9	34.9
CaO	0.116	0.109	Cr	<0.0005	0.0110
Cr_2O_3	0.036	0.016	Fe	0.0015	0.0007
FeO	0.733	0.592	Mg	0.0011	0.1360
Fe_2O_3	4.26	3.50	Ni	<0.0005	<0.0005
MgO	48.4	38.1	K	0.0006	0.0038
NiO	0.204	0.173	Si	0.0015	0.0217
K_2O	0.006	0.010	Na	33.50	33.40
SiO_2	40.9	31.7	CO_2	26.00	21.10
Na_2O	0.010	0.826	HCO_3	33.70	28.20
CO_2	0.33	20.4			
C, noncarbonate	0.024	0.000	pH	7.75	7.84
H_2O, dehyd.[1]	1.050	1.910			
H_2O, chem.[2]	3.586	4.190			
Total	99.813	101.666			
LOI, total[3]	4.99	26.5			
Extent of carbonation, %[4]		47.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-133 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.125	Cl	35.6	37.0
CaO	0.116	0.102	Cr	<0.0005	0.0070
Cr_2O_3	0.036	0.013	Fe	0.0006	0.0007
FeO	0.733	0.540	Mg	0.0013	0.0228
Fe_2O_3	4.26	3.55	Ni	<0.0005	<0.0005
MgO	48.4	40.5	K	0.0007	0.0032
NiO	0.204	0.191	Si	0.0015	0.0223
K_2O	0.006	0.007	Na	36.20	34.50
SiO_2	40.9	33.6	CO_2	26.70	22.10
Na_2O	0.010	0.714	HCO_3	34.00	28.90
CO_2	0.33	11.1			
C, noncarbonate	0.024	0.241	pH	7.85	7.99
H_2O, dehyd.[1]	1.05	4.38			
H_2O, chem.[2]	3.586	6.479			
Total	99.813	101.483			
LOI, total[3]	4.99	22.2			
Extent of carbonation, %[4]		22.7			

Carbonation test #SC-134 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.128	Cl	35.6	37.4
CaO	0.157	0.242	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.044	Fe	0.0006	0.0018
FeO	7.72	7.86	Mg	0.0013	0.0136
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	52.1	K	0.0007	0.0024
NiO	0.300	0.289	Si	0.0015	0.0275
K_2O	0.007	0.011	Na	36.20	34.80
SiO_2	40.4	40.4	CO_2	26.70	26.00
Na_2O	0.010	0.054	HCO_3	34.00	35.70
CO_2	<0.01	0.2			
C, noncarbonate	0.026	0.024	pH	7.85	7.99
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.294	0.346			
Total	100.798	101.805			
LOI, total[3]	0.39	0.7			
Extent of carbonation, %[4]		0.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-135 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.161	Cl	37.8	36.7
CaO	0.157	0.171	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.067	Fe	0.0014	0.0017
FeO	7.72	7.63	Mg	0.0010	0.0220
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	51.6	K	0.0007	0.0019
NiO	0.300	0.321	Si	0.0013	0.0247
K_2O	0.007	0.005	Na	36.40	34.50
SiO_2	40.4	40.6	CO_2	27.20	27.50
Na_2O	0.010	0.062	HCO_3	36.70	36.90
CO_2	<0.01	0.4			
C, noncarbonate	0.026	0.027	pH	7.95	7.90
H_2O, dehyd.[1]	0.070	0.070			
H_2O, chem.[2]	0.294	0.333			
Total	100.798	101.438			
LOI, total[3]	0.39	0.8			
Extent of carbonation, %[4]		0.6			

Carbonation test #SC-136 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.107	Cl	37.8	37.8
CaO	0.157	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.080	Fe	0.0014	0.0026
FeO	7.72	6.43	Mg	0.0010	0.0328
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	44.4	K	0.0007	0.0019
NiO	0.300	0.285	Si	0.0013	0.0249
K_2O	0.007	0.015	Na	36.40	35.30
SiO_2	40.4	34.2	CO_2	27.20	27.10
Na_2O	0.010	0.151	HCO_3	36.70	36.30
CO_2	<0.01	13.0			
C, noncarbonate	0.026	0.512	pH	7.95	7.99
H_2O, dehyd.[1]	0.070	0.110			
H_2O, chem.[2]	0.29	2.0			
Total	100.798	101.486			
LOI, total[3]	0.39	15.6			
Extent of carbonation, %[4]		24.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-137 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.140	Cl	36.7	36.0
CaO	0.157	0.194	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.067	Fe	0.0036	0.0034
FeO	7.72	7.95	Mg	0.0011	0.0330
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	52.2	K	0.0009	0.0017
NiO	0.300	0.321	Si	0.0014	0.0321
K_2O	0.007	0.011	Na	35.80	34.70
SiO_2	40.4	40.4	CO_2	26.90	26.60
Na_2O	0.010	0.045	HCO_3	36.70	38.10
CO_2	<0.01	0.39			
C, noncarbonate	0.026	0.019	pH	7.68	7.60
H_2O, dehyd.[1]	0.070	0.060			
H_2O, chem.[2]	0.294	0.241			
Total	100.798	102.100			
LOI, total[3]	0.39	0.7			
Extent of carbonation, %[4]		0.6			

Carbonation test #SC-138 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.106	Cl	36.7	37.5
CaO	0.157	0.131	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.086	Fe	0.0036	0.0010
FeO	7.72	6.25	Mg	0.0011	0.0368
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	45.8	K	0.0009	0.0018
NiO	0.300	0.262	Si	0.0014	0.0222
K_2O	0.007	0.010	Na	35.80	35.80
SiO_2	40.4	31.9	CO_2	26.90	26.90
Na_2O	0.010	0.183	HCO_3	36.70	35.60
CO_2	<0.01	19.0			
C, noncarbonate	0.026	0.505	pH	7.68	7.88
H_2O, dehyd.[1]	0.070	0.100			
H_2O, chem.[2]	0.294	2.095			
Total	100.798	106.369			
LOI, total[3]	0.39	21.7			
Extent of carbonation, %[4]		38.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-139 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.162	Cl	37.5	37.4
CaO	0.157	0.157	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.088	Fe	0.0017	0.0018
FeO	7.72	7.42	Mg	0.0014	0.0518
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	48.2	K	0.0012	0.0015
NiO	0.300	0.331	Si	0.0020	0.0234
K_2O	0.007	0.004	Na	34.40	34.70
SiO_2	40.4	38.7	CO_2	27.60	27.40
Na_2O	0.010	0.106	HCO_3	36.30	37.00
CO_2	<0.01	5.0			
C, noncarbonate	0.026	0.005	pH	7.75	7.91
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.294	0.365			
Total	100.798	100.702			
LOI, total[3]	0.39	5.5			
Extent of carbonation, %[4]		8.6			

Carbonation test #SC-140 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.144	Cl	37.5	37.4
CaO	0.157	0.109	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.103	Fe	0.0017	0.0018
FeO	7.72	5.65	Mg	0.0014	0.0208
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	34.8	K	0.0012	0.0017
NiO	0.300	0.244	Si	0.0020	0.0253
K_2O	0.007	0.004	Na	34.40	33.00
SiO_2	40.4	27.6	CO_2	27.60	26.80
Na_2O	0.010	0.162	HCO_3	36.30	34.60
CO_2	<0.01	30.5			
C, noncarbonate	0.026	0.000	pH	7.75	7.98
H_2O, dehyd.[1]	0.070	0.050			
H_2O, chem.[2]	0.294	0.750			
Total	100.798	100.131			
LOI, total[3]	0.39	31.3			
Extent of carbonation, %[4]		71.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-141 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.154	Cl	37.5	37.4
CaO	0.172	0.111	Cr	<0.0005	0.0200
Cr_2O_3	0.013	0.021	Fe	0.0020	0.0017
FeO	0.75	1.21	Mg	0.0012	0.1260
Fe_2O_3	4.404	2.945	Ni	<0.0005	<0.0005
MgO	48.9	37.6	K	0.0006	0.0030
NiO	0.261	0.221	Si	0.0025	0.0338
K_2O	0.012	0.006	Na	33.60	30.00
SiO_2	41.7	32.7	CO_2	27.90	21.50
Na_2O	0.005	1.050	HCO_3	36.30	28.00
CO_2	0.27	19.2			
C, noncarbonate	0.004	0.000	pH	7.86	7.81
H_2O, dehyd.[1]	0.710	1.410			
H_2O, chem.[2]	3.836	4.290			
Total	101.230	100.988			
LOI, total[3]	4.82	24.9			
Extent of carbonation, %[4]		43.5			

Carbonation test #SC-142 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.180	Cl	37.5	37.5
CaO	0.172	0.187	Cr	<0.0005	0.0050
Cr_2O_3	0.013	0.026	Fe	0.0020	0.0012
FeO	0.75	0.53	Mg	0.0012	0.0198
Fe_2O_3	4.404	3.932	Ni	<0.0005	<0.0005
MgO	48.9	42.6	K	0.0006	0.0022
NiO	0.261	0.239	Si	0.0025	0.0230
K_2O	0.012	0.011	Na	33.60	34.00
SiO_2	41.7	36.8	CO_2	27.90	25.10
Na_2O	0.005	0.956	HCO_3	36.30	33.10
CO_2	0.27	9.2			
C, noncarbonate	0.004	0.000	pH	7.86	8.08
H_2O, dehyd.[1]	0.710	1.910			
H_2O, chem.[2]	3.836	4.910			
Total	101.230	101.469			
LOI, total[3]	4.82	16.0			
Extent of carbonation, %[4]		18.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-143 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.128	Cl	37.8	36.7
CaO	0.172	0.154	Cr	<0.0005	0.0077
Cr_2O_3	0.013	0.024	Fe	0.0021	0.0016
FeO	0.75	0.51	Mg	0.0011	0.1090
Fe_2O_3	4.404	3.546	Ni	<0.0005	<0.0005
MgO	48.9	38.0	K	0.0006	0.0019
NiO	0.261	0.219	Si	0.0025	0.0320
K_2O	0.012	0.005	Na	34.80	32.90
SiO_2	41.7	32.5	CO_2	27.80	25.20
Na_2O	0.005	1.117	HCO_3	36.00	33.30
CO_2	0.27	18.9			
C, noncarbonate	0.004	0.062	pH	7.87	7.93
H_2O, dehyd.[1]	0.710	1.370			
H_2O, chem.[2]	3.836	4.268			
Total	101.230	100.796			
LOI, total[3]	4.82	24.6			
Extent of carbonation, %[4]		42.6			

Carbonation test #SC-144 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.148	Cl	37.8	37.8
CaO	0.172	0.126	Cr	<0.0005	0.0010
Cr_2O_3	0.013	0.027	Fe	0.0021	0.0007
FeO	0.75	0.51	Mg	0.0011	0.0476
Fe_2O_3	4.404	3.460	Ni	<0.0005	<0.0005
MgO	48.9	35.2	K	0.0006	0.0025
NiO	0.261	0.209	Si	0.0025	0.0349
K_2O	0.012	0.011	Na	34.80	33.50
SiO_2	41.7	30.6	CO_2	27.80	24.50
Na_2O	0.005	0.857	HCO_3	36.00	32.80
CO_2	0.27	24.3			
C, noncarbonate	0.004	0.000	pH	7.87	8.05
H_2O, dehyd.[1]	0.710	1.010			
H_2O, chem.[2]	3.836	4.190			
Total	101.230	100.595			
LOI, total[3]	4.82	29.5			
Extent of carbonation, %[4]		58.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-145 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.138	Cl	37.5	36.1
CaO	0.172	0.147	Cr	<0.0005	0.0065
Cr_2O_3	0.013	0.020	Fe	0.0008	0.0010
FeO	0.75	0.46	Mg	0.0014	0.0710
Fe_2O_3	4.404	3.560	Ni	<0.0005	<0.0005
MgO	48.9	35.8	K	0.0007	0.0019
NiO	0.261	0.209	Si	0.0033	0.0352
K_2O	0.012	0.006	Na	34.30	31.70
SiO_2	41.7	31.9	CO_2	28.10	24.70
Na_2O	0.005	0.755	HCO_3	36.50	32.00
CO_2	0.27	21.3			
C, noncarbonate	0.004	0.027	pH	7.88	7.95
H_2O, dehyd.[1]	0.710	1.050			
H_2O, chem.[2]	3.836	4.423			
Total	101.230	99.789			
LOI, total[3]	4.82	26.8			
Extent of carbonation, %[4]		49.6			

Carbonation test #SC-146 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.113	Cl	37.5	38.7
CaO	0.172	0.171	Cr	<0.0005	<0.0005
Cr_2O_3	0.013	0.019	Fe	0.0008	0.0014
FeO	0.75	0.51	Mg	0.0014	0.0924
Fe_2O_3	4.404	3.288	Ni	<0.0005	<0.0005
MgO	48.9	33.0	K	0.0007	0.0019
NiO	0.261	0.201	Si	0.0033	0.0402
K_2O	0.012	0.005	Na	34.30	33.40
SiO_2	41.7	30.2	CO_2	28.10	25.80
Na_2O	0.005	0.883	HCO_3	36.50	34.90
CO_2	0.27	25.3			
C, noncarbonate	0.004	0.000	pH	7.88	7.79
H_2O, dehyd.[1]	0.710	1.260			
H_2O, chem.[2]	3.836	3.940			
Total	101.230	98.855			
LOI, total[3]	4.82	30.5			
Extent of carbonation, %[4]		62.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-147 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.195	Cl	35.9	33.1
CaO	0.172	0.185	Cr	<0.0005	0.0067
Cr_2O_3	0.013	0.016	Fe	0.0013	0.0022
FeO	0.75	0.72	Mg	0.0011	0.0688
Fe_2O_3	4.404	3.174	Ni	<0.0005	<0.0005
MgO	48.9	37.3	K	0.0007	0.0027
NiO	0.261	0.205	Si	0.0037	0.0284
K_2O	0.012	0.002	Na	33.20	28.70
SiO_2	41.7	31.2	CO_2	27.70	22.10
Na_2O	0.005	0.074	HCO_3	37.10	31.20
CO_2	0.27	21.0			
C, noncarbonate	0.004	0.000	pH	7.88	7.88
H_2O, dehyd.[1]	0.710	1.420			
H_2O, chem.[2]	3.836	4.080			
Total	101.230	99.612			
LOI, total[3]	4.82	26.5			
Extent of carbonation, %[4]		48.7			

Carbonation test #SC-148 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.148	Cl	35.9	34.1
CaO	0.172	0.206	Cr	<0.0005	<0.0005
Cr_2O_3	0.013	0.022	Fe	0.0013	0.0006
FeO	0.75	0.67	Mg	0.0011	0.0216
Fe_2O_3	4.404	2.931	Ni	<0.0005	<0.0005
MgO	48.9	36.0	K	0.0007	0.0024
NiO	0.261	0.191	Si	0.0037	0.0282
K_2O	0.012	0.006	Na	33.20	33.60
SiO_2	41.7	29.5	CO_2	27.70	23.80
Na_2O	0.005	0.869	HCO_3	37.10	32.10
CO_2	0.27	26.0			
C, noncarbonate	0.004	0.000	pH	7.88	7.93
H_2O, dehyd.[1]	0.710	1.300			
H_2O, chem.[2]	3.836	3.700			
Total	101.230	101.544			
LOI, total[3]	4.82	31.0			
Extent of carbonation, %[4]		64.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-149 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.137	Cl	35.0	34.8
CaO	0.172	0.207	Cr	<0.0005	0.0081
Cr_2O_3	0.013	0.018	Fe	0.0001	0.0001
FeO	0.75	0.66	Mg	0.0001	0.2280
Fe_2O_3	4.404	3.574	Ni	<0.0005	0.0032
MgO	48.9	40.0	K	0.0002	0.0012
NiO	0.261	0.209	Si	0.0008	0.0303
K_2O	0.012	0.005	Na	0.01	0.11
SiO_2	41.7	33.4	CO_2	37.80	30.30
Na_2O	0.005	0.034	HCO_3	40.80	34.90
CO_2	0.27	16.8			
C, noncarbonate	0.004	0.195	pH	7.74	8.17
H_2O, dehyd.[1]	0.710	1.580			
H_2O, chem.[2]	3.836	5.125			
Total	101.230	101.873			
LOI, total[3]	4.82	23.7			
Extent of carbonation, %[4]		36.9			

Carbonation test #SC-150 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.212	0.152	Cl	36.0	35.0
CaO	0.158	0.125	Cr	<0.0005	<0.0005
Cr_2O_3	0.020	0.024	Fe	0.0012	0.0018
FeO	1.90	1.22	Mg	0.0013	0.0474
Fe_2O_3	3.231	2.788	Ni	<0.0005	<0.0005
MgO	49.6	36.8	K	0.0008	0.0027
NiO	0.243	0.201	Si	0.0010	0.0388
K_2O	0.009	0.004	Na	34.30	29.90
SiO_2	42.1	32.5	CO_2	27.60	25.10
Na_2O	0.008	0.615	HCO_3	35.50	34.00
CO_2	0.49	21.9			
C, noncarbonate	0.000	0.063	pH	7.90	7.82
H_2O, dehyd.[1]	0.750	1.400			
H_2O, chem.[2]	3.420	3.837			
Total	102.166	101.658			
LOI, total[3]	4.66	27.2			
Extent of carbonation, %[4]		49.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-151 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.164	0.175	Cl	36.0	37.8
CaO	0.044	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.013	0.017	Fe	0.0012	0.0008
FeO	1.878	1.505	Mg	0.0013	0.0260
Fe_2O_3	2.56	3.00	Ni	<0.0005	<0.0005
MgO	44.9	41.9	K	0.0008	0.0023
NiO	0.197	0.221	Si	0.0010	0.0224
K_2O	0.002	0.005	Na	34.3	34.2
SiO_2	37.7	36.4	CO_2	27.6	27.0
Na_2O	0.007	0.297	HCO_3	35.5	35.3
CO_2	0.81	5.5			
C, noncarbonate	0.039	0.052	pH	7.90	7.91
H_2O, dehyd.[1]	0.360	0.450			
H_2O, chem.[2]	13.391	11.008			
Total	102.052	100.682			
LOI, total[3]	14.60	17.0			
Extent of carbonation, %[4]		9.9			

Carbonation test #SC-152 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.177	Cl	35.0	34.8
CaO	0.171	0.200	Cr	<0.0005	0.0010
Cr_2O_3	0.128	0.159	Fe	0.0011	0.0010
FeO	8.362	8.645	Mg	0.0010	0.0260
Fe_2O_3	0.300	<0.01	Ni	<0.0005	<0.0005
MgO	49.9	48.4	K	0.0007	0.0019
NiO	0.364	0.369	Si	0.0012	0.0228
K_2O	0.004	0.002	Na	33.8	33.0
SiO_2	40.6	39.6	CO_2	27.3	27.2
Na_2O	0.008	0.055	HCO_3	34.5	36.5
CO_2	0.00	0.70			
C, noncarbonate	0.072	0.029	pH	7.87	8.03
H_2O, dehyd.[1]	0.060	0.000			
H_2O, chem.[2]	0.388	0.311			
Total	100.608	98.641			
LOI, total[3]	0.52	1.0			
Extent of carbonation, %[4]		1.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-153 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.188	0.165	Cl	35.0	34.9
CaO	0.026	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.112	0.107	Fe	0.0011	0.0009
FeO	3.358	2.882	Mg	0.0010	0.0260
Fe_2O_3	1.84	2.06	Ni	<0.0005	<0.0005
MgO	43.3	40.6	K	0.0007	0.0016
NiO	0.290	0.267	Si	0.0012	0.0242
K_2O	0.003	0.004	Na	33.8	32.6
SiO_2	37.0	34.9	CO_2	27.3	25.4
Na_2O	0.003	0.737	HCO_3	34.5	34.1
CO_2	0.98	7.0			
C, noncarbonate	0.058	0.200	pH	7.87	8.03
H_2O, dehyd.[1]	0.440	0.420			
H_2O, chem.[2]	13.622	11.080			
Total	101.210	100.555			
LOI, total[3]	15.10	18.7			
Extent of carbonation, %[4]		13.2			

Carbonation test #SC-154 **SW OR Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.502	1.549	Cl	37.8	37.4
CaO	0.439	0.435	Cr	<0.0005	<0.0005
Cr_2O_3	0.158	0.181	Fe	0.0009	0.0011
FeO	3.088	2.753	Mg	0.0011	0.0224
Fe_2O_3	2.888	3.474	Ni	<0.0005	<0.0005
MgO	39.6	38.5	K	0.0005	0.0030
NiO	0.181	0.192	Si	0.0016	0.0300
K_2O	0.017	0.013	Na	34.6	33.4
SiO_2	38.5	38.1	CO_2	27.2	25.8
Na_2O	0.013	0.395	HCO_3	35.5	33.9
CO_2	0.26	1.72			
C, noncarbonate	0.087	0.138	pH	7.98	7.93
H_2O, dehyd.[1]	1.590	1.520			
H_2O, chem.[2]	12.863	12.422			
Total	101.222	101.341			
LOI, total[3]	14.80	15.8			
Extent of carbonation, %[4]		3.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-155 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.160	Cl	37.8	37.4
CaO	0.157	0.143	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.065	Fe	0.0009	0.0011
FeO	7.719	7.063	Mg	0.0011	0.0464
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	46.9	K	0.0005	0.0017
NiO	0.300	0.225	Si	0.0016	0.0272
K_2O	0.007	<0.01	Na	34.6	33.5
SiO_2	40.4	37.0	CO_2	27.2	27.4
Na_2O	0.010	0.118	HCO_3	35.5	35.2
CO_2	0.00	8.6			
C, noncarbonate	0.026	0.194	pH	7.98	7.90
H_2O, dehyd.[1]	0.070	0.110			
H_2O, chem.[2]	0.294	0.236			
Total	100.798	100.808			
LOI, total[3]	0.39	9.1			
Extent of carbonation, %[4]		15.3			

Carbonation test #SC-156 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.179	Cl	37.8	37.8
CaO	0.157	0.162	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.080	Fe	0.0011	0.0012
FeO	7.719	6.046	Mg	0.0010	0.0220
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	40.5	K	0.0008	0.0025
NiO	0.300	0.193	Si	0.0011	0.0214
K_2O	0.007	0.005	Na	33.2	32.3
SiO_2	40.4	30.8	CO_2	27.5	26.4
Na_2O	0.010	0.150	HCO_3	36.3	35.8
CO_2	0.00	22.20			
C, noncarbonate	0.026	0.000	pH	7.94	7.87
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.294	0.900			
Total	100.798	101.180			
LOI, total[3]	0.39	23.1			
Extent of carbonation, %[4]		46.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-157 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.138	Cl	37.8	37.8
CaO	0.157	0.135	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.077	Fe	0.0011	0.0009
FeO	7.719	5.751	Mg	0.0010	0.0096
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	38.0	K	0.0008	0.0030
NiO	0.300	0.209	Si	0.0011	0.0225
K_2O	0.007	0.008	Na	33.2	33.4
SiO_2	40.4	22.5	CO_2	27.5	27.3
Na_2O	0.010	0.433	HCO_3	36.3	35.2
CO_2	0.00	33.4			
C, noncarbonate	0.026	0.205	pH	7.94	7.90
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.294	0.805			
Total	100.798	101.683			
LOI, total[3]	0.39	34.5			
Extent of carbonation, %[4]		82.0			

Carbonation test #SC-158 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.149	Cl	37.4	37.4
CaO	0.204	0.180	Cr	<0.0005	0.0020
Cr_2O_3	0.019	0.028	Fe	0.0007	0.0005
FeO	0.913	0.913	Mg	0.0012	0.0724
Fe_2O_3	3.646	2.845	Ni	<0.0005	<0.0005
MgO	46.4	36.0	K	0.0011	0.0032
NiO	0.263	0.216	Si	0.0013	0.0235
K_2O	0.005	0.005	Na	32.9	31.3
SiO_2	41.1	34.4	CO_2	27.6	25.2
Na_2O	0.002	0.723	HCO_3	35.4	33.7
CO_2	0.33	16.70			
C, noncarbonate	0.044	0.000	pH	7.93	7.87
H_2O, dehyd.[1]	0.820	1.410			
H_2O, chem.[2]	6.376	5.490			
Total	100.322	99.083			
LOI, total[3]	7.57	23.6			
Extent of carbonation, %[4]		38.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-159 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.166	Cl	37.4	35.4
CaO	0.200	0.143	Cr	<0.0005	0.0090
Cr_2O_3	0.250	0.396	Fe	0.0007	0.0007
FeO	1.003	0.746	Mg	0.0012	0.0544
Fe_2O_3	4.00	2.72	Ni	<0.0005	<0.0005
MgO	49.6	35.0	K	0.0011	0.0023
NiO	3.920	3.410	Si	0.0013	0.0262
K_2O	0.006	0.002	Na	32.9	31.4
SiO_2	41.7	32.3	CO_2	27.6	24.5
Na_2O	0.023	0.570	HCO_3	35.4	34.7
CO_2	0.23	20.8			
C, noncarbonate	0.009	0.043	pH	7.93	7.57
H_2O, dehyd.[1]	0.820	1.850			
H_2O, chem.[2]	2.691	3.707			
Total	104.645	101.840			
LOI, total[3]	3.75	26.4			
Extent of carbonation, %[4]		47.4			

Carbonation test #SC-160 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.238	Cl	34.7	34.3
CaO	0.206	0.138	Cr	<0.0005	<0.0005
Cr_2O_3	2.572	2.587	Fe	0.0011	0.0013
FeO	7.963	6.394	Mg	0.0014	0.0736
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.2	48.7	K	0.0008	0.0020
NiO	6.108	5.981	Si	0.0015	0.0251
K_2O	0.003	0.002	Na	30.3	31.0
SiO_2	40.6	40.0	CO_2	26.7	27.4
Na_2O	0.009	0.057	HCO_3	32.7	37.1
CO_2	0.00	2.00			
C, noncarbonate	0.037	0.042	pH	7.98	7.65
H_2O, dehyd.[1]	0.070	0.060			
H_2O, chem.[2]	0.093	0.248			
Total	108.186	106.499			
LOI, total[3]	0.20	2.4			
Extent of carbonation, %[4]		3.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-161 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.236	0.221	Cl	34.7	35.2
CaO	0.192	0.315	Cr	<0.0005	<0.0005
Cr_2O_3	0.094	0.137	Fe	0.0011	0.0008
FeO	9.983	8.053	Mg	0.0014	0.0760
Fe_2O_3	0.56	<0.01	Ni	<0.0005	<0.0005
MgO	49.9	46.6	K	0.0008	0.0019
NiO	0.280	0.293	Si	0.0015	0.0224
K_2O	0.005	0.004	Na	30.3	32.0
SiO_2	44.7	37.0	CO_2	26.7	27.3
Na_2O	0.019	0.115	HCO_3	32.7	37.0
CO_2	0.06	7.7			
C, noncarbonate	0.015	0.000	pH	7.98	7.82
H_2O, dehyd.[1]	0.070	0.110			
H_2O, chem.[2]	0.355	0.460			
Total	106.486	100.970			
LOI, total[3]	0.50	8.2			
Extent of carbonation, %[4]		13.5			

Carbonation test #SC-162 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.236	0.191	Cl	33.3	32.8
CaO	0.192	0.206	Cr	<0.0005	<0.0005
Cr_2O_3	0.094	0.126	Fe	0.0008	0.0010
FeO	9.983	6.394	Mg	0.0001	0.0770
Fe_2O_3	0.558	<0.01	Ni	<0.0005	<0.0005
MgO	49.9	48.7	K	0.0010	0.0027
NiO	0.280	0.293	Si	0.0009	0.0243
K_2O	0.005	0.004	Na	34.0	34.0
SiO_2	44.7	38.7	CO_2	0.4	35.0
Na_2O	0.019	0.107	HCO_3	<0.0001	46.0
CO_2	0.06	3.93			
C, noncarbonate	0.015	0.000	pH	12.00	7.71
H_2O, dehyd.[1]	0.070	0.080			
H_2O, chem.[2]	0.355	0.340			
Total	106.486	99.139			
LOI, total[3]	0.50	4.4			
Extent of carbonation, %[4]		6.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-163 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.238	Cl	35.1	34.8
CaO	0.486	0.431	Cr	<0.0005	0.0500
Cr_2O_3	0.162	0.156	Fe	0.0008	0.0009
FeO	<0.01	0.129	Mg	0.0011	0.0402
Fe_2O_3	9.18	5.63	Ni	<0.0005	<0.0005
MgO	42.8	33.2	K	0.0008	0.0029
NiO	0.249	0.200	Si	0.0011	0.0267
K_2O	0.027	0.019	Na	31.7	29.2
SiO_2	43.4	33.8	CO_2	27.1	23.1
Na_2O	0.019	1.193	HCO_3	34.0	31.7
CO_2	0.12	15.2			
C, noncarbonate	0.033	0.000	pH	7.90	7.64
H_2O, dehyd.[1]	0.580	2.480			
H_2O, chem.[2]	3.447	6.020			
Total	102.237	99.661			
LOI, total[3]	4.18	23.7			
Extent of carbonation, %[4]		37.8			

Carbonation test #SC-164 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.142	Cl	37.0	36.1
CaO	0.125	0.157	Cr	<0.0005	0.0026
Cr_2O_3	0.016	0.021	Fe	0.0007	0.0007
FeO	0.849	0.540	Mg	0.0014	0.1010
Fe_2O_3	4.018	3.517	Ni	<0.0005	<0.0005
MgO	49.4	38.0	K	0.0017	0.0031
NiO	0.219	0.193	Si	0.0012	0.0258
K_2O	0.005	0.005	Na	52.3	49.5
SiO_2	41.5	32.1	CO_2	25.8	24.0
Na_2O	0.009	0.721	HCO_3	32.4	32.4
CO_2	0.26	19.90			
C, noncarbonate	0.021	0.000	pH	8.04	7.59
H_2O, dehyd.[1]	0.560	1.090			
H_2O, chem.[2]	4.449	4.510			
Total	101.709	100.857			
LOI, total[3]	5.29	25.5			
Extent of carbonation, %[4]		45.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-165 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.206	Cl	<0.0001	<0.0001
CaO	0.125	0.110	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.025	Fe	<0.0001	<0.0001
FeO	0.849	0.669	Mg	<0.0001	<0.0001
Fe_2O_3	4.02	3.29	Ni	<0.0005	<0.0005
MgO	49.4	36.0	K	<0.0001	<0.0001
NiO	0.219	0.181	Si	<0.0001	<0.0001
K_2O	0.005	0.005	Na	<0.0001	<0.0001
SiO_2	41.5	31.2	CO_2	<0.0001	<0.0001
Na_2O	0.009	1.297	HCO_3	<0.0001	<0.0001
CO_2	0.26	20.8			
C, noncarbonate	0.021	0.000	pH	8.23	7.63
H_2O, dehyd.[1]	0.560	1.380			
H_2O, chem.[2]	4.449	5.120			
Total	101.709	100.295			
LOI, total[3]	5.29	27.3			
Extent of carbonation, %[4]		47.6			

Carbonation test #SC-166 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.183	Cl	<0.0001	37.3
CaO	0.125	0.093	Cr	<0.0005	0.0030
Cr_2O_3	0.016	0.022	Fe	<0.0001	0.0007
FeO	0.849	0.540	Mg	<0.0001	0.1300
Fe_2O_3	4.018	3.446	Ni	<0.0005	<0.0005
MgO	49.4	37.1	K	<0.0001	0.0023
NiO	0.219	0.193	Si	<0.0001	0.0283
K_2O	0.005	0.004	Na	<0.0001	31.3
SiO_2	41.5	32.3	CO_2	<0.0001	25.4
Na_2O	0.009	0.764	HCO_3	<0.0001	34.4
CO_2	0.26	20.10			
C, noncarbonate	0.021	0.000	pH	7.90	7.55
H_2O, dehyd.[1]	0.560	1.250			
H_2O, chem.[2]	4.449	4.550			
Total	101.709	100.590			
LOI, total[3]	5.29	25.9			
Extent of carbonation, %[4]		45.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-167 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.362	Cl	35.5	35.1
CaO	0.486	0.383	Cr	<0.0005	0.0620
Cr_2O_3	0.162	0.152	Fe	0.0008	0.0010
FeO	<0.01	0.129	Mg	0.0010	0.0640
Fe_2O_3	9.18	5.32	Ni	<0.0005	<0.0005
MgO	42.8	33.0	K	0.0008	0.0022
NiO	0.249	0.195	Si	0.0012	0.0239
K_2O	0.027	0.021	Na	32.8	30.3
SiO_2	43.4	33.2	CO_2	27.7	23.4
Na_2O	0.019	1.194	HCO_3	35.4	32.4
CO_2	0.12	17.0			
C, noncarbonate	0.033	0.000	pH	7.66	7.64
H_2O, dehyd.[1]	0.580	2.860			
H_2O, chem.[2]	3.447	5.840			
Total	102.237	100.610			
LOI, total[3]	4.18	25.7			
Extent of carbonation, %[4]		43.2			

Carbonation test #SC-168 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.615	Cl	35.5	35.9
CaO	0.486	0.382	Cr	<0.0005	0.0570
Cr_2O_3	0.162	0.161	Fe	0.0008	0.0007
FeO	<0.01	0.142	Mg	0.0010	0.0810
Fe_2O_3	9.179	5.805	Ni	<0.0005	<0.0005
MgO	42.8	34.2	K	0.0008	0.0025
NiO	0.249	0.205	Si	0.0012	0.0286
K_2O	0.027	0.020	Na	32.8	30.0
SiO_2	43.4	34.4	CO_2	27.7	25.3
Na_2O	0.019	1.136	HCO_3	35.4	32.1
CO_2	0.12	13.60			
C, noncarbonate	0.033	0.000	pH	7.66	7.79
H_2O, dehyd.[1]	0.580	2.940			
H_2O, chem.[2]	3.447	5.460			
Total	102.237	100.065			
LOI, total[3]	4.18	22.0			
Extent of carbonation, %[4]		33.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-169 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.553	Cl	35.4	35.6
CaO	0.486	0.381	Cr	<0.0005	0.0520
Cr_2O_3	0.162	0.161	Fe	0.0011	0.0011
FeO	<0.01	0.206	Mg	0.0011	0.0692
Fe_2O_3	9.18	5.56	Ni	<0.0005	<0.0005
MgO	42.8	33.5	K	0.0006	0.0018
NiO	0.249	0.202	Si	0.0008	0.0210
K_2O	0.027	0.018	Na	28.2	30.0
SiO_2	43.4	33.4	CO_2	27.7	23.0
Na_2O	0.019	1.134	HCO_3	36.4	31.1
CO_2	0.12	15.5			
C, noncarbonate	0.033	0.000	pH	7.68	7.76
H_2O, dehyd.[1]	0.580	2.930			
H_2O, chem.[2]	3.447	5.270			
Total	102.237	99.783			
LOI, total[3]	4.18	23.7			
Extent of carbonation, %[4]		38.7			

Carbonation test #SC-170 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.285	Cl	35.4	35.4
CaO	0.486	0.439	Cr	<0.0005	0.0610
Cr_2O_3	0.162	0.143	Fe	0.0011	0.0012
FeO	<0.01	0.129	Mg	0.0011	0.0282
Fe_2O_3	9.179	5.247	Ni	<0.0005	<0.0005
MgO	42.8	32.8	K	0.0006	0.0020
NiO	0.249	0.191	Si	0.0008	0.0336
K_2O	0.027	0.017	Na	28.2	29.8
SiO_2	43.4	32.7	CO_2	27.7	23.1
Na_2O	0.019	1.263	HCO_3	36.4	31.8
CO_2	0.12	18.20			
C, noncarbonate	0.033	0.000	pH	7.68	7.66
H_2O, dehyd.[1]	0.580	2.010			
H_2O, chem.[2]	3.447	6.290			
Total	102.237	100.775			
LOI, total[3]	4.18	26.5			
Extent of carbonation, %[4]		47.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-171 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.268	Cl	35.1	35.4
CaO	0.486	0.242	Cr	<0.0005	0.0690
Cr_2O_3	0.162	0.152	Fe	0.0005	0.0006
FeO	<0.01	0.193	Mg	0.0009	0.0304
Fe_2O_3	9.18	5.28	Ni	<0.0005	<0.0005
MgO	42.8	26.5	K	0.0008	0.0021
NiO	0.249	0.191	Si	0.0017	0.0212
K_2O	0.027	0.017	Na	31.0	28.8
SiO_2	43.4	32.1	CO_2	27.6	22.6
Na_2O	0.019	1.225	HCO_3	37.2	31.0
CO_2	0.12	19.0			
C, noncarbonate	0.033	0.000	pH	7.66	7.73
H_2O, dehyd.[1]	0.580	3.140			
H_2O, chem.[2]	3.447	4.860			
Total	102.237	94.182			
LOI, total[3]	4.18	27.0			
Extent of carbonation, %[4]		49.5			

Carbonation test #SC-172 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.166	0.153	Cl	35.1	35.3
CaO	0.201	0.169	Cr	<0.0005	<0.0005
Cr_2O_3	0.018	0.020	Fe	0.0005	0.0006
FeO	7.757	7.770	Mg	0.0009	0.0244
Fe_2O_3	0.615	0.829	Ni	<0.0005	<0.0005
MgO	49.6	46.1	K	0.0008	0.0021
NiO	0.243	0.246	Si	0.0017	0.0240
K_2O	0.004	0.004	Na	31.0	30.0
SiO_2	40.2	40.2	CO_2	27.6	27.3
Na_2O	0.009	0.052	HCO_3	37.2	36.4
CO_2	0.00	0.67			
C, noncarbonate	0.082	0.093	pH	7.66	7.72
H_2O, dehyd.[1]	0.100	0.110			
H_2O, chem.[2]	0.909	0.837			
Total	99.900	97.266			
LOI, total[3]	1.09	1.7			
Extent of carbonation, %[4]		1.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-173 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.166	0.134	Cl	35.0	34.5
CaO	0.201	0.137	Cr	<0.0005	<0.0005
Cr_2O_3	0.018	0.019	Fe	0.0006	0.0006
FeO	7.757	7.603	Mg	0.0009	0.0262
Fe_2O_3	0.61	0.69	Ni	<0.0005	<0.0005
MgO	49.6	37.8	K	0.0006	0.0021
NiO	0.243	0.239	Si	0.0023	0.0234
K_2O	0.004	0.004	Na	30.1	297.0
SiO_2	40.2	37.7	CO_2	27.8	27.4
Na_2O	0.009	0.093	HCO_3	36.2	36.2
CO_2	0.00	4.9			
C, noncarbonate	0.082	0.028	pH	7.68	7.62
H_2O, dehyd.[1]	0.100	0.120			
H_2O, chem.[2]	0.909	0.812			
Total	99.900	90.211			
LOI, total[3]	1.09	5.8			
Extent of carbonation, %[4]		8.7			

Carbonation test #SC-174 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.221	0.167	Cl	35.0	35.0
CaO	0.124	0.139	Cr	<0.0005	<0.0005
Cr_2O_3	0.056	0.069	Fe	0.0006	0.0006
FeO	3.293	2.341	Mg	0.0009	0.0362
Fe_2O_3	4.475	3.617	Ni	<0.0005	<0.0005
MgO	47.1	34.8	K	0.0006	0.0041
NiO	0.267	0.209	Si	0.0023	0.0233
K_2O	0.008	0.004	Na	30.1	29.9
SiO_2	40.6	29.7	CO_2	27.8	25.5
Na_2O	0.014	0.518	HCO_3	36.2	33.4
CO_2	0.33	23.80			
C, noncarbonate	0.006	0.000	pH	7.68	7.69
H_2O, dehyd.[1]	0.700	2.010			
H_2O, chem.[2]	2.514	1.990			
Total	99.745	99.420			
LOI, total[3]	3.55	27.8			
Extent of carbonation, %[4]		57.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-175 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.221	0.168	Cl	35.1	34.3
CaO	0.124	0.096	Cr	<0.0005	<0.0005
Cr_2O_3	0.056	0.069	Fe	0.0007	0.0006
FeO	3.293	2.329	Mg	0.0011	0.0358
Fe_2O_3	4.48	3.23	Ni	<0.0005	<0.0005
MgO	47.1	31.5	K	0.0008	0.0039
NiO	0.267	0.192	Si	0.0020	0.0278
K_2O	0.008	0.004	Na	30.8	29.3
SiO_2	40.6	28.5	CO_2	27.8	26.0
Na_2O	0.014	0.558	HCO_3	36.1	34.2
CO_2	0.33	27.4			
C, noncarbonate	0.006	0.000	pH	7.69	7.55
H_2O, dehyd.[1]	0.700	1.230			
H_2O, chem.[2]	2.514	2.270			
Total	99.745	97.503			
LOI, total[3]	3.55	30.9			
Extent of carbonation, %[4]		69.8			

Carbonation test #SC-176 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.265	0.221	Cl	35.1	34.8
CaO	0.125	0.070	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.017	Fe	0.0007	0.0006
FeO	0.849	0.849	Mg	0.0011	0.0540
Fe_2O_3	4.018	2.716	Ni	<0.0005	<0.0005
MgO	49.4	35.3	K	0.0008	0.0017
NiO	0.219	0.167	Si	0.0020	0.0272
K_2O	0.005	0.004	Na	30.8	29.0
SiO_2	41.5	30.8	CO_2	27.8	24.8
Na_2O	0.009	0.656	HCO_3	36.1	34.0
CO_2	0.26	23.00			
C, noncarbonate	0.021	0.000	pH	7.69	7.21
H_2O, dehyd.[1]	0.560	1.380			
H_2O, chem.[2]	4.449	3.820			
Total	101.709	99.024			
LOI, total[3]	5.29	28.2			
Extent of carbonation, %[4]		54.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-177 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.177	Cl	34.6	34.0
CaO	0.157	0.316	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.017	Fe	0.0006	0.0007
FeO	7.719	7.153	Mg	0.0011	0.0092
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	44.3	K	0.0006	0.0082
NiO	0.300	0.210	Si	0.0022	0.0280
K_2O	0.007	0.003	Na	30.3	29.4
SiO_2	40.4	37.7	CO_2	26.9	23.6
Na_2O	0.010	0.198	HCO_3	37.0	26.7
CO_2	0.00	6.4			
C, noncarbonate	0.026	0.063	pH	7.69	8.32
H_2O, dehyd.[1]	0.070	0.380			
H_2O, chem.[2]	0.294	2.877			
Total	100.798	99.717			
LOI, total[3]	0.39	9.7			
Extent of carbonation, %[4]		11.2			

Carbonation test #SC-178 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.795	1.258	Cl	34.6	35.3
CaO	0.424	0.460	Cr	<0.0005	0.0550
Cr_2O_3	0.155	0.151	Fe	0.0006	0.0009
FeO	0.064	0.257	Mg	0.0011	0.0768
Fe_2O_3	6.634	5.061	Ni	<0.0005	<0.0005
MgO	43.4	34.5	K	0.0006	0.0044
NiO	0.242	0.191	Si	0.0022	0.0245
K_2O	0.025	0.020	Na	30.3	29.3
SiO_2	43.2	34.7	CO_2	26.9	23.3
Na_2O	0.013	1.163	HCO_3	37.0	31.8
CO_2	0.14	13.70			
C, noncarbonate	0.022	0.041	pH	7.69	7.75
H_2O, dehyd.[1]	0.650	3.220			
H_2O, chem.[2]	3.038	5.339			
Total	99.857	100.007			
LOI, total[3]	3.85	22.3			
Extent of carbonation, %[4]		32.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-179 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.795	1.255	Cl	35.1	34.9
CaO	0.424	0.449	Cr	<0.0005	0.0560
Cr_2O_3	0.155	0.156	Fe	0.0011	0.0012
FeO	0.064	0.206	Mg	0.0017	0.0284
Fe_2O_3	6.63	5.23	Ni	<0.0005	<0.0005
MgO	43.4	34.7	K	0.0008	0.0038
NiO	0.242	0.200	Si	0.0011	0.0234
K_2O	0.025	0.018	Na	31.0	28.3
SiO_2	43.2	34.4	CO_2	27.1	22.8
Na_2O	0.013	1.252	HCO_3	36.6	31.4
CO_2	0.14	13.4			
C, noncarbonate	0.022	0.023	pH	7.61	7.70
H_2O, dehyd.[1]	0.650	3.360			
H_2O, chem.[2]	3.038	5.617			
Total	99.857	100.265			
LOI, total[3]	3.85	22.4			
Extent of carbonation, %[4]		32.1			

Carbonation test #SC-180 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.165	Cl	35.1	35.0
CaO	0.157	0.250	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.024	Fe	0.0011	0.0012
FeO	7.719	7.449	Mg	0.0017	0.0858
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	51.6	46.4	K	0.0008	0.0080
NiO	0.300	0.242	Si	0.0011	0.0228
K_2O	0.007	0.003	Na	31.0	31.6
SiO_2	40.4	37.2	CO_2	27.1	26.8
Na_2O	0.010	0.293	HCO_3	36.6	36.3
CO_2	0.00	6.69			
C, noncarbonate	0.026	0.074	pH	7.61	7.74
H_2O, dehyd.[1]	0.070	0.430			
H_2O, chem.[2]	0.294	1.186			
Total	100.798	100.498			
LOI, total[3]	0.39	8.4			
Extent of carbonation, %[4]		11.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-181 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.166	0.159	Cl	37.3	35.7
CaO	0.201	0.176	Cr	0.0002	0.0001
Cr_2O_3	0.018	0.045	Fe	0.0011	0.0018
FeO	7.757	7.552	Mg	0.0010	0.0666
Fe_2O_3	0.61	<0.01	Ni	0.0001	0.0001
MgO	49.6	46.8	K	0.0008	0.0060
NiO	0.243	0.255	Si	0.0015	0.0274
K_2O	0.004	0.003	Na	30.9	30.6
SiO_2	40.2	37.2	CO_2	27.4	27.9
Na_2O	0.009	0.168	HCO_3	33.5	36.9
CO_2	0.00	6.2			
C, noncarbonate	0.082	0.000	pH	7.72	7.35
H_2O, dehyd.[1]	0.100	0.290			
H_2O, chem.[2]	0.909	1.240			
Total	99.900	100.080			
LOI, total[3]	1.09	7.7			
Extent of carbonation, %[4]		11.2			

Carbonation test #SC-182 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.180	Cl	37.3	36.4
CaO	0.157	0.172	Cr	0.0002	0.0002
Cr_2O_3	0.048	0.057	Fe	0.0011	0.0007
FeO	7.719	7.037	Mg	0.0010	0.0938
Fe_2O_3	<0.01	<0.01	Ni	0.0001	0.0005
MgO	51.6	43.6	K	0.0008	0.0092
NiO	0.300	0.265	Si	0.0015	0.0302
K_2O	0.007	0.006	Na	30.9	28.0
SiO_2	40.4	35.7	CO_2	27.4	24.4
Na_2O	0.010	0.461	HCO_3	33.5	30.0
CO_2	0.00	9.11			
C, noncarbonate	0.026	0.134	pH	7.72	7.75
H_2O, dehyd.[1]	0.070	0.540			
H_2O, chem.[2]	0.294	2.116			
Total	100.798	99.411			
LOI, total[3]	0.39	11.9			
Extent of carbonation, %[4]		16.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-187 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.183	Cl	34.4	35.7
CaO	0.157	0.070	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.076	Fe	0.0011	0.0016
FeO	7.719	7.101	Mg	0.0014	0.0246
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	46.9	K	0.0007	0.0021
NiO	0.300	0.267	Si	0.0002	0.0105
K_2O	0.007	0.009	Na	31.0	31.2
SiO_2	40.4	37.0	CO_2	27.0	28.4
Na_2O	0.010	0.148	HCO_3	33.4	35.1
CO_2	0.00	8.2			
C, noncarbonate	0.026	0.099	pH	7.74	7.83
H_2O, dehyd.[1]	0.070	0.070			
H_2O, chem.[2]	0.294	0.531			
Total	100.798	100.698			
LOI, total[3]	0.39	8.9			
Extent of carbonation, %[4]		14.6			

Carbonation test #SC-188 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.154	Cl	34.4	36.5
CaO	0.157	0.078	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.078	Fe	0.0011	0.0020
FeO	7.719	7.230	Mg	0.0014	0.0360
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	46.8	K	0.0007	0.0020
NiO	0.300	0.293	Si	0.0002	0.0109
K_2O	0.007	0.005	Na	31.0	32.1
SiO_2	40.4	38.7	CO_2	27.0	28.8
Na_2O	0.010	0.136	HCO_3	33.4	36.3
CO_2	0.00	5.39			
C, noncarbonate	0.026	0.049	pH	7.74	7.85
H_2O, dehyd.[1]	0.070	0.290			
H_2O, chem.[2]	0.294	0.691			
Total	100.798	99.873			
LOI, total[3]	0.39	6.4			
Extent of carbonation, %[4]		9.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-189 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.184	Cl	35.0	41.3
CaO	0.157	0.169	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.081	Fe	0.0016	0.0018
FeO	7.72	7.01	Mg	0.0011	0.0704
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	47.6	K	0.0006	0.0019
NiO	0.300	0.280	Si	0.0002	0.0120
K_2O	0.007	0.005	Na	30.50	35.40
SiO_2	40.4	40.9	CO_2	27.30	31.00
Na_2O	0.010	0.791	HCO_3	33.40	35.70
CO_2	0.00	0.9			
C, noncarbonate	0.026	0.021	pH	7.74	7.83
H_2O, dehyd.[1]	0.070	0.760			
H_2O, chem.[2]	0.294	1.419			
Total	100.798	100.019			
LOI, total[3]	0.39	3.1			
Extent of carbonation, %[4]		1.4			

Carbonation test #SC-190 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.191	Cl	35.0	35.5
CaO	0.157	0.161	Cr	<0.0005	0.0005
Cr_2O_3	0.048	0.061	Fe	0.0016	0.0017
FeO	7.72	7.74	Mg	0.0011	0.0164
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	48.9	K	0.0006	0.0015
NiO	0.300	0.293	Si	0.0002	0.0128
K_2O	0.007	0.005	Na	30.50	31.10
SiO_2	40.4	40.6	CO_2	27.30	28.00
Na_2O	0.010	0.096	HCO_3	33.40	34.60
CO_2	0.00	0.4			
C, noncarbonate	0.026	0.008	pH	7.74	7.85
H_2O, dehyd.[1]	0.070	0.110			
H_2O, chem.[2]	0.294	0.182			
Total	100.798	98.801			
LOI, total[3]	0.39	0.7			
Extent of carbonation, %[4]		0.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-191 **CH Serp B2 NM HT79A-C**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.299	0.202	Cl	34.5	34.5
CaO	0.141	0.131	Cr	<0.0005	<0.0005
Cr_2O_3	0.025	0.035	Fe	0.0010	0.0010
FeO	0.55	0.95	Mg	0.0014	0.0014
Fe_2O_3	4.346	2.874	Ni	<0.0005	<0.0005
MgO	47.8	36.3	K	0.0007	0.0007
NiO	0.256	0.213	Si	0.0011	0.0011
K_2O	0.006	0.005	Na	30.70	30.70
SiO_2	41.5	31.9	CO_2	27.40	27.40
Na_2O	0.008	0.659	HCO_3	34.40	34.40
CO_2	0.31	20.9			
C, noncarbonate	0.000	0.166	pH	7.80	7.50
H_2O, dehyd.[1]	0.900	1.620			
H_2O, chem.[2]	4.270	4.314			
Total	100.370	100.258			
LOI, total[3]	5.48	27.0			
Extent of carbonation, %[4]		49.6			

Carbonation test #SC-192 **FG olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.145	Cl	35.0	35.5
CaO	0.157	0.146	Cr	<0.0005	0.0005
Cr_2O_3	0.048	0.084	Fe	0.0013	0.0017
FeO	7.72	7.02	Mg	0.0011	0.0164
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	48.2	K	0.0006	0.0015
NiO	0.300	0.327	Si	0.0020	0.0128
K_2O	0.007	0.005	Na	30.80	31.10
SiO_2	40.4	38.7	CO_2	26.70	28.00
Na_2O	0.010	0.063	HCO_3	32.00	34.60
CO_2	0.00	4.3			
C, noncarbonate	0.026	0.047	pH	8.10	7.59
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.294	0.513			
Total	100.798	99.585			
LOI, total[3]	0.39	4.8			
Extent of carbonation, %[4]		7.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-193 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.145	Cl	35.0	35.4
CaO	0.157	0.058	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.059	Fe	0.0013	0.0130
FeO	7.72	6.63	Mg	0.0011	0.2950
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0014
MgO	51.6	39.5	K	0.0006	0.0019
NiO	0.300	0.191	Si	0.0020	0.0460
K_2O	0.007	0.002	Na	30.8	30.7
SiO_2	40.4	34.7	CO_2	26.7	NA
Na_2O	0.010	0.151	HCO_3	32.0	NA
CO_2	0.00	NA			
C, noncarbonate	0.026	NA	pH	8.10	5.95
H_2O, dehyd.[1]	0.070	0.060			
H_2O, chem.[2]	0.294	14.700			
Total	100.798	96.110			
LOI, total[3]	0.39	14.7			
Extent of carbonation, %		38.8	by weight gain		

Carbonation test #SC-194 **LANL CA Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.529	1.251	Cl	34.8	34.9
CaO	0.946	0.817	Cr	<0.0005	<0.0005
Cr_2O_3	0.196	0.199	Fe	0.0004	0.0003
FeO	2.82	1.87	Mg	0.0011	0.0476
Fe_2O_3	5.676	5.247	Ni	<0.0005	<0.0005
MgO	34.8	27.4	K	0.0008	0.0036
NiO	0.285	0.239	Si	0.0013	0.0223
K_2O	0.004	0.003	Na	29.60	27.70
SiO_2	46.4	38.5	CO_2	27.80	24.70
Na_2O	0.008	0.983	HCO_3	33.60	31.30
CO_2	1.78	12.1			
C, noncarbonate	0.000	0.000	pH	7.77	7.70
H_2O, dehyd.[1]	0.750	3.350			
H_2O, chem.[2]	2.710	4.450			
Total	97.944	96.371			
LOI, total[3]	5.24	19.9			
Extent of carbonation, %[4]		29.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-195 **TS olivine + MgO**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.114	Cl	34.8	34.5
CaO	0.157	0.208	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.068	Fe	0.0004	0.0002
FeO	7.72	6.46	Mg	0.0011	0.0562
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	44.8	K	0.0008	0.0017
NiO	0.300	0.229	Si	0.0013	0.0215
K_2O	0.007	0.002	Na	29.60	29.00
SiO_2	40.4	34.4	CO_2	27.80	26.80
Na_2O	0.010	0.179	HCO_3	33.60	33.20
CO_2	0.01	11.3			
C, noncarbonate	0.026	0.006	pH	7.77	7.81
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.287	0.304			
Total	100.798	98.170			
LOI, total[3]	0.39	11.7			
Extent of carbonation, %[4]		20.8			

Carbonation test #SC-196 **TS olivine + Magnetite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.134	Cl	37.1	37.0
CaO	0.157	0.160	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.073	Fe	0.0003	0.0004
FeO	7.72	9.08	Mg	0.0011	0.0966
Fe_2O_3	<0.01	2.788	Ni	<0.0005	<0.0005
MgO	51.6	46.1	K	0.0008	0.0029
NiO	0.300	0.253	Si	0.0014	0.0202
K_2O	0.007	0.005	Na	30.80	30.70
SiO_2	40.4	38.3	CO_2	26.90	27.40
Na_2O	0.010	0.055	HCO_3	34.60	35.90
CO_2	0.00	1.9			
C, noncarbonate	0.026	0.040	pH	7.84	7.75
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.294	0.530			
Total	100.798	99.399			
LOI, total[3]	0.39	2.5			
Extent of carbonation, %[4]		3.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-197 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.299	0.227	Cl	37.1	37.1
CaO	0.141	0.130	Cr	<0.0005	0.0063
Cr_2O_3	0.025	0.025	Fe	0.0003	0.0004
FeO	0.55	0.63	Mg	0.0011	0.0312
Fe_2O_3	4.346	3.546	Ni	<0.0005	<0.0005
MgO	47.8	39.8	K	0.0008	0.0021
NiO	0.256	0.187	Si	0.0014	0.0229
K_2O	0.006	0.004	Na	30.80	29.10
SiO_2	41.5	35.3	CO_2	26.90	24.90
Na_2O	0.008	0.729	HCO_3	34.60	32.90
CO_2	0.01	12.4			
C, noncarbonate	0.000	0.000	pH	7.84	7.77
H_2O, dehyd.[1]	0.900	1.550			
H_2O, chem.[2]	4.574	4.850			
Total	100.370	99.371			
LOI, total[3]	5.48	18.8			
Extent of carbonation, %[4]		26.3			

Carbonation test #SC-198 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.299	0.227	Cl	37.7	36.8
CaO	0.141	0.095	Cr	<0.0005	0.0065
Cr_2O_3	0.025	0.021	Fe	0.0003	0.0029
FeO	0.55	0.64	Mg	0.0010	1.8300
Fe_2O_3	4.346	4.661	Ni	<0.0005	<0.0005
MgO	47.8	39.1	K	0.0007	0.0019
NiO	0.256	0.202	Si	0.0022	0.0320
K_2O	0.006	0.004	Na	30.20	29.50
SiO_2	41.5	37.7	CO_2	27.00	29.70
Na_2O	0.008	0.217	HCO_3	34.20	41.80
CO_2	0.31	7.1			
C, noncarbonate	0.000	0.000	pH	7.97	7.38
H_2O, dehyd.[1]	0.900	2.290			
H_2O, chem.[2]	4.270	8.470			
Total	100.370	100.754			
LOI, total[3]	5.48	17.9			
Extent of carbonation, %[4]		14.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-199 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.299	0.319	Cl	37.7	36.2
CaO	0.141	0.063	Cr	<0.0005	0.0060
Cr_2O_3	0.025	0.026	Fe	0.0003	0.0038
FeO	0.55	0.66	Mg	0.0010	2.9100
Fe_2O_3	4.346	3.446	Ni	<0.0005	<0.0005
MgO	47.8	41.6	K	0.0007	0.0017
NiO	0.256	0.204	Si	0.0022	0.0330
K_2O	0.006	0.010	Na	30.20	28.60
SiO_2	41.5	44.5	CO_2	27.00	34.40
Na_2O	0.008	0.140	HCO_3	34.20	50.10
CO_2	0.01	0.2			
C, noncarbonate	0.000	0.031	pH	7.97	7.18
H_2O, dehyd.[1]	0.900	2.510			
H_2O, chem.[2]	4.574	5.739			
Total	100.370	99.479			
LOI, total[3]	5.48	8.5			
Extent of carbonation, %[4]		-0.2			

Carbonation test #SC-200 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.447	Cl	36.8	38.0
CaO	0.452	0.353	Cr	<0.0005	0.0490
Cr_2O_3	0.183	0.151	Fe	0.0004	0.0025
FeO	<0.01	<0.01	Mg	0.0014	2.1300
Fe_2O_3	6.048	5.676	Ni	<0.0005	<0.0005
MgO	43.3	33.8	K	0.0008	0.0025
NiO	0.229	0.192	Si	0.0014	0.0306
K_2O	0.019	0.018	Na	30.00	29.20
SiO_2	43.0	36.4	CO_2	27.10	30.60
Na_2O	0.004	0.392	HCO_3	34.10	43.00
CO_2	0.15	8.3			
C, noncarbonate	0.038	0.046	pH	7.75	7.39
H_2O, dehyd.[1]	0.960	3.740			
H_2O, chem.[2]	4.022	10.054			
Total	100.115	100.522			
LOI, total[3]	5.17	22.1			
Extent of carbonation, %[4]		18.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-201 **LANL CA Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.529	1.642	Cl	36.8	37.1
CaO	0.946	0.957	Cr	<0.0005	<0.0005
Cr_2O_3	0.196	0.237	Fe	0.0004	0.0106
FeO	2.82	2.34	Mg	0.0014	2.5200
Fe_2O_3	5.676	6.205	Ni	<0.0005	<0.0005
MgO	34.8	29.5	K	0.0008	0.0031
NiO	0.285	0.283	Si	0.0014	0.0377
K_2O	0.004	0.009	Na	30.00	30.10
SiO_2	46.4	47.1	CO_2	27.10	33.80
Na_2O	0.008	0.355	HCO_3	34.10	49.50
CO_2	0.01	0.8			
C, noncarbonate	0.000	0.036	pH	7.75	7.33
H_2O, dehyd.[1]	0.750	2.880			
H_2O, chem.[2]	4.484	6.354			
Total	97.944	98.707			
LOI, total[3]	5.24	10.1			
Extent of carbonation, %[4]		-2.4			

Carbonation test #SC-202 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.232	Cl	37.1	37.7
CaO	0.126	0.114	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.019	Fe	0.0004	0.0004
FeO	1.96	1.75	Mg	0.0015	0.0354
Fe_2O_3	2.288	2.345	Ni	<0.0005	<0.0005
MgO	45.1	42.8	K	0.0009	0.0031
NiO	0.191	0.191	Si	0.0024	0.0243
K_2O	0.004	0.006	Na	30.50	30.40
SiO_2	37.4	35.7	CO_2	27.20	27.30
Na_2O	0.007	0.876	HCO_3	34.70	35.10
CO_2	0.87	6.1			
C, noncarbonate	0.030	0.094	pH	7.76	7.81
H_2O, dehyd.[1]	0.530	0.560			
H_2O, chem.[2]	12.770	11.406			
Total	101.524	102.238			
LOI, total[3]	14.20	18.2			
Extent of carbonation, %[4]		11.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-203 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.206	Cl	37.1	37.3
CaO	0.126	0.144	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.019	Fe	0.0004	0.0003
FeO	1.96	1.52	Mg	0.0015	0.0246
Fe_2O_3	2.288	2.316	Ni	<0.0005	<0.0005
MgO	45.1	42.4	K	0.0009	0.0029
NiO	0.191	0.185	Si	0.0024	0.0246
K_2O	0.004	0.004	Na	30.50	30.00
SiO_2	37.4	35.7	CO_2	27.20	27.20
Na_2O	0.007	1.049	HCO_3	34.70	34.30
CO_2	0.00	6.7			
C, noncarbonate	0.030	0.061	pH	7.76	7.67
H_2O, dehyd.[1]	0.530	0.530			
H_2O, chem.[2]	13.636	11.069			
Total	101.524	102.013			
LOI, total[3]	14.20	18.4			
Extent of carbonation, %[4]		12.6			

Carbonation test #SC-204 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.180	Cl	36.9	36.3
CaO	0.126	0.298	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.023	Fe	0.0004	0.0004
FeO	1.96	1.53	Mg	0.0013	0.0286
Fe_2O_3	2.288	2.302	Ni	<0.0005	<0.0005
MgO	45.1	43.6	K	0.0008	0.0021
NiO	0.191	0.163	Si	0.0018	0.0230
K_2O	0.004	0.019	Na	30.10	29.20
SiO_2	37.4	36.6	CO_2	27.20	26.60
Na_2O	0.007	0.291	HCO_3	35.50	33.00
CO_2	0.87	5.7			
C, noncarbonate	0.030	0.013	pH	7.72	7.75
H_2O, dehyd.[1]	0.530	0.370			
H_2O, chem.[2]	12.770	10.647			
Total	101.524	101.696			
LOI, total[3]	14.20	16.7			
Extent of carbonation, %[4]		10.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-205 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.128	Cl	36.9	37.3
CaO	0.126	0.208	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.025	Fe	0.0004	0.0005
FeO	1.96	1.33	Mg	0.0013	0.0150
Fe_2O_3	2.288	2.659	Ni	<0.0005	<0.0005
MgO	45.1	39.1	K	0.0008	0.0022
NiO	0.191	0.165	Si	0.0018	0.0293
K_2O	0.004	0.010	Na	30.10	30.60
SiO_2	37.4	35.1	CO_2	27.20	27.00
Na_2O	0.007	0.949	HCO_3	35.50	34.90
CO_2	0.00	8.4			
C, noncarbonate	0.030	0.097	pH	7.72	7.74
H_2O, dehyd.[1]	0.530	0.450			
H_2O, chem.[2]	13.636	10.913			
Total	101.524	99.586			
LOI, total[3]	14.20	19.9			
Extent of carbonation, %[4]		16.5			

Carbonation test #SC-206 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.585	1.343	Cl	36.7	36.9
CaO	0.407	0.392	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.193	Fe	0.0006	0.0005
FeO	2.53	1.12	Mg	0.0016	0.0196
Fe_2O_3	3.174	4.990	Ni	<0.0005	<0.0005
MgO	39.3	38.1	K	0.0010	0.0047
NiO	0.233	0.257	Si	0.0012	0.0223
K_2O	0.013	0.011	Na	31.60	31.10
SiO_2	39.1	37.9	CO_2	27.20	26.70
Na_2O	0.006	0.437	HCO_3	33.30	34.20
CO_2	0.15	2.3			
C, noncarbonate	0.075	0.095	pH	7.78	7.80
H_2O, dehyd.[1]	0.760	0.820			
H_2O, chem.[2]	13.115	12.415			
Total	100.678	100.344			
LOI, total[3]	14.10	15.6			
Extent of carbonation, %[4]		4.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-207 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.208	Cl	<0.0001	0.1
CaO	0.126	0.099	Cr	<0.0005	<0.0005
Cr_2O_3	0.016	0.023	Fe	<0.0001	0.0001
FeO	1.96	1.26	Mg	<0.0001	0.0850
Fe_2O_3	2.288	2.688	Ni	<0.0005	<0.0005
MgO	45.1	41.8	K	<0.0001	0.0014
NiO	0.191	0.187	Si	<0.0001	0.1030
K_2O	0.004	0.004	Na	<0.0001	0.20
SiO_2	37.4	36.8	CO_2	<0.0001	1.08
Na_2O	0.007	0.039	HCO_3	<0.0001	1.39
CO_2	0.00	7.9			
C, noncarbonate	0.030	0.088	pH	6.03	7.08
H_2O, dehyd.[1]	0.530	0.420			
H_2O, chem.[2]	13.636	9.772			
Total	101.524	101.289			
LOI, total[3]	14.20	18.2			
Extent of carbonation, %[4]		15.3			

Carbonation test #SC-208 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.585	0.159	Cl	<0.0001	0.0
CaO	0.407	0.277	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.184	Fe	<0.0001	0.0001
FeO	2.53	2.41	Mg	<0.0001	0.0246
Fe_2O_3	3.174	3.503	Ni	<0.0005	<0.0005
MgO	39.3	35.0	K	<0.0001	0.0014
NiO	0.233	0.221	Si	<0.0001	0.0718
K_2O	0.013	0.016	Na	<0.0001	0.22
SiO_2	39.1	39.4	CO_2	<0.0001	0.89
Na_2O	0.006	0.044	HCO_3	<0.0001	1.17
CO_2	0.15	1.6			
C, noncarbonate	0.075	0.165	pH	6.33	6.94
H_2O, dehyd.[1]	0.760	1.330			
H_2O, chem.[2]	13.115	12.275			
Total	100.678	96.558			
LOI, total[3]	14.10	15.4			
Extent of carbonation, %[4]		3.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-209 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.195	Cl	36.9	36.3
CaO	0.157	0.096	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.075	Fe	0.0005	0.0006
FeO	7.72	7.87	Mg	0.0014	0.5720
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0010
MgO	51.6	49.4	K	0.0011	0.0022
NiO	0.300	0.255	Si	0.0015	0.0215
K_2O	0.007	0.008	Na	30.10	29.80
SiO_2	40.4	41.5	CO_2	0.72	2.43
Na_2O	0.010	0.064	HCO_3	0.74	3.46
CO_2	0.01	0.0			
C, noncarbonate	0.026	0.050	pH	5.36	7.07
H_2O, dehyd.[1]	0.070	0.060			
H_2O, chem.[2]	0.287	0.370			
Total	100.798	99.959			
LOI, total[3]	0.39	0.5			
Extent of carbonation, %[4]		0.0			

Carbonation test #SC-210 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.265	Cl	37.2	37.0
CaO	0.108	0.215	Cr	<0.0005	<0.0005
Cr_2O_3	0.020	0.021	Fe	0.0004	0.0002
FeO	6.54	6.83	Mg	0.0014	0.0224
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	45.6	K	0.0008	0.0018
NiO	0.216	0.221	Si	0.0021	0.0236
K_2O	0.008	0.003	Na	31.00	30.50
SiO_2	44.9	44.7	CO_2	27.50	27.70
Na_2O	0.037	0.049	HCO_3	34.70	36.50
CO_2	1.58	2.1			
C, noncarbonate	0.050	0.049	pH	7.73	7.74
H_2O, dehyd.[1]	0.060	0.070			
H_2O, chem.[2]	0.530	0.591			
Total	101.232	100.744			
LOI, total[3]	2.22	2.8			
Extent of carbonation, %[4]		1.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-211 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.191	0.206	Cl	37.2	36.8
CaO	0.239	0.206	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.044	Fe	0.0004	0.0002
FeO	6.28	7.09	Mg	0.0014	0.0180
Fe_2O_3	<0.01	0.029	Ni	<0.0005	<0.0005
MgO	46.8	45.4	K	0.0008	0.0015
NiO	0.227	0.238	Si	0.0021	0.0268
K_2O	0.003	0.002	Na	31.00	28.60
SiO_2	44.3	44.3	CO_2	27.50	27.80
Na_2O	0.021	0.041	HCO_3	34.70	34.70
CO_2	0.02	1.7			
C, noncarbonate	0.045	0.077	pH	7.73	7.74
H_2O, dehyd.[1]	0.060	0.050			
H_2O, chem.[2]	2.130	0.513			
Total	100.281	99.879			
LOI, total[3]	2.25	2.3			
Extent of carbonation, %[4]		0.1			

Carbonation test #SC-212 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.057	0.129	Cl	37.1	36.0
CaO	0.029	0.253	Cr	<0.0005	<0.0005
Cr_2O_3	0.124	0.126	Fe	0.0006	0.0005
FeO	5.65	5.79	Mg	0.0014	0.0118
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	36.1	34.7	K	0.0008	0.0014
NiO	0.215	0.223	Si	0.0047	0.0229
K_2O	0.003	0.003	Na	31.40	32.10
SiO_2	23.3	22.7	CO_2	27.40	27.10
Na_2O	0.132	0.171	HCO_3	34.40	34.70
CO_2	35.20	35.3			
C, noncarbonate	0.000	0.000	pH	7.82	7.95
H_2O, dehyd.[1]	0.080	0.000			
H_2O, chem.[2]	0.520	0.800			
Total	101.473	100.125			
LOI, total[3]	35.80	36.1			
Extent of carbonation, %[4]		1.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-213 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.210	Cl	36.6	31.9
CaO	0.157	0.294	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.114	Fe	0.0004	0.0004
FeO	7.72	7.95	Mg	0.0326	0.0196
Fe_2O_3	<0.01	0.057	Ni	<0.0005	<0.0005
MgO	51.6	50.1	K	0.0022	0.0029
NiO	0.300	0.280	Si	0.0147	0.0236
K_2O	0.007	0.002	Na	37.70	27.50
SiO_2	40.4	25.9	CO_2	25.90	23.90
Na_2O	0.010	0.068	HCO_3	28.60	29.30
CO_2	0.01	0.7			
C, noncarbonate	0.026	0.045	pH	8.40	7.93
H_2O, dehyd.[1]	0.070	0.050			
H_2O, chem.[2]	0.287	0.265			
Total	100.798	86.015			
LOI, total[3]	0.39	1.1			
Extent of carbonation, %[4]		1.2			

Carbonation test #SC-214 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.119	Cl	36.6	35.2
CaO	0.157	0.144	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.090	Fe	0.0004	0.0005
FeO	7.72	5.51	Mg	0.0326	0.0104
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	33.0	K	0.0022	0.0034
NiO	0.300	0.210	Si	0.0147	0.0232
K_2O	0.007	0.003	Na	37.70	30.90
SiO_2	40.4	40.4	CO_2	25.90	27.00
Na_2O	0.010	0.189	HCO_3	28.60	33.50
CO_2	0.00	33.4			
C, noncarbonate	0.026	0.000	pH	8.40	7.93
H_2O, dehyd.[1]	0.070	2.890			
H_2O, chem.[2]	0.294	0.000			
Total	100.798	115.979			
LOI, total[3]	0.39	33.9			
Extent of carbonation, %[4]		82.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-215 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.428	Cl	37.2	37.3
CaO	0.452	0.362	Cr	0.0330	0.0690
Cr_2O_3	0.183	0.172	Fe	0.0005	0.0007
FeO	<0.01	<0.01	Mg	0.0472	0.0506
Fe_2O_3	6.048	5.562	Ni	<0.0005	<0.0005
MgO	43.3	31.8	K	0.0023	0.0035
NiO	0.229	0.162	Si	0.0155	0.0242
K_2O	0.019	0.016	Na	28.60	26.00
SiO_2	43.0	33.6	CO_2	21.70	18.80
Na_2O	0.004	1.213	HCO_3	26.20	24.90
CO_2	0.00	16.0			
C, noncarbonate	0.038	0.000	pH	8.44	7.89
H_2O, dehyd.[1]	0.960	0.000			
H_2O, chem.[2]	4.168	9.100			
Total	100.115	99.438			
LOI, total[3]	5.17	25.1			
Extent of carbonation, %[4]		39.7			

Carbonation test #SC-216 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.160	Cl	37.2	35.2
CaO	0.157	0.151	Cr	0.0330	<0.0005
Cr_2O_3	0.048	0.149	Fe	0.0005	0.0005
FeO	7.72	7.74	Mg	0.0472	0.0310
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	48.9	K	0.0023	0.0036
NiO	0.300	0.293	Si	0.0155	0.0228
K_2O	0.007	0.003	Na	28.60	28.10
SiO_2	40.4	40.9	CO_2	21.70	22.90
Na_2O	0.010	0.041	HCO_3	26.20	29.80
CO_2	0.00	0.3			
C, noncarbonate	0.026	0.024	pH	8.44	7.81
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.294	0.326			
Total	100.798	98.915			
LOI, total[3]	0.39	0.6			
Extent of carbonation, %[4]		0.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-217 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.366	Cl	37.1	36.2
CaO	0.452	0.395	Cr	<0.0005	0.0580
Cr_2O_3	0.183	0.153	Fe	0.0006	0.0004
FeO	<0.01	<0.01	Mg	0.0014	0.0210
Fe_2O_3	6.048	5.333	Ni	<0.0005	<0.0005
MgO	43.3	32.5	K	0.0008	0.0026
NiO	0.229	0.146	Si	0.0047	0.0254
K_2O	0.019	0.014	Na	31.40	27.20
SiO_2	43.0	32.1	CO_2	27.40	21.80
Na_2O	0.004	1.336	HCO_3	34.40	30.30
CO_2	0.00	19.6			
C, noncarbonate	0.038	0.000	pH	7.82	7.91
H_2O, dehyd.[1]	0.960	3.360			
H_2O, chem.[2]	4.168	5.340			
Total	100.115	101.631			
LOI, total[3]	5.17	28.3			
Extent of carbonation, %[4]		50.9			

Carbonation test #SC-218 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.182	Cl	35.0	36.0
CaO	0.157	0.164	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.122	Fe	0.0004	0.0004
FeO	7.72	7.14	Mg	0.0009	0.0658
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	47.9	K	0.0013	0.0024
NiO	0.300	0.266	Si	0.0026	0.0201
K_2O	0.007	0.002	Na	29.40	28.10
SiO_2	40.4	37.7	CO_2	26.90	26.80
Na_2O	0.010	0.126	HCO_3	34.00	35.30
CO_2	0.00	6.5			
C, noncarbonate	0.026	0.011	pH	7.75	7.90
H_2O, dehyd.[1]	0.070	0.060			
H_2O, chem.[2]	0.294	0.459			
Total	100.798	100.622			
LOI, total[3]	0.39	7.1			
Extent of carbonation, %[4]		11.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-219 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.225	Cl	17.5	32.7
CaO	0.157	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.108	Fe	0.0002	0.0005
FeO	7.72	8.10	Mg	0.0248	0.0216
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	50.6	K	0.0013	0.0033
NiO	0.300	0.255	Si	0.0242	0.0201
K_2O	0.007	0.005	Na	13.60	28.00
SiO_2	40.4	40.0	CO_2	12.90	26.10
Na_2O	0.010	0.062	HCO_3	17.10	35.30
CO_2	0.01	0.4			
C, noncarbonate	0.026	0.083	pH	8.07	8.08
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.287	0.367			
Total	100.798	100.357			
LOI, total[3]	0.39	0.9			
Extent of carbonation, %[4]		0.7			

Carbonation test #SC-220 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.198	Cl	36.4	37.1
CaO	0.157	0.175	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.050	Fe	0.0005	0.0004
FeO	7.72	7.95	Mg	0.0005	0.0318
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	50.9	K	0.0015	0.0023
NiO	0.300	0.274	Si	0.0042	0.0202
K_2O	0.007	0.002	Na	27.00	25.80
SiO_2	40.4	40.4	CO_2	21.40	21.60
Na_2O	0.010	0.051	HCO_3	27.60	28.40
CO_2	0.00	1.1			
C, noncarbonate	0.026	0.064	pH	7.82	7.99
H_2O, dehyd.[1]	0.070	0.100			
H_2O, chem.[2]	0.294	0.366			
Total	100.798	101.616			
LOI, total[3]	0.39	1.6			
Extent of carbonation, %[4]		1.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-221 **TS FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.299	0.197	Cl	36.6	36.3
CaO	0.141	0.066	Cr	<0.0005	0.0100
Cr_2O_3	0.025	0.036	Fe	0.0006	0.0005
FeO	0.55	0.51	Mg	0.0007	0.0582
Fe_2O_3	4.346	3.574	Ni	<0.0005	<0.0005
MgO	47.8	25.4	K	0.0018	0.0029
NiO	0.256	0.188	Si	0.0016	0.0278
K_2O	0.006	0.007	Na	29.60	27.90
SiO_2	41.5	40.6	CO_2	26.40	25.00
Na_2O	0.008	0.774	HCO_3	34.80	33.40
CO_2	0.01	20.6			
C, noncarbonate	0.000	0.008	pH	7.87	8.02
H_2O, dehyd.[1]	0.900	1.530			
H_2O, chem.[2]	4.574	4.562			
Total	100.370	98.072			
LOI, total[3]	5.48	26.7			
Extent of carbonation, %[4]		48.7			

Carbonation test #SC-222 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.071	Cl	36.6	35.1
CaO	0.187	0.080	Cr	<0.0005	0.0046
Cr_2O_3	0.045	0.027	Fe	0.0006	<0.0001
FeO	0.86	0.57	Mg	0.0007	0.0736
Fe_2O_3	3.260	3.174	Ni	<0.0005	<0.0005
MgO	48.2	5.3	K	0.0018	<0.0001
NiO	0.216	0.176	Si	0.0016	<0.0001
K_2O	0.005	0.005	Na	29.60	28.00
SiO_2	42.4	31.7	CO_2	26.40	24.60
Na_2O	0.010	0.731	HCO_3	34.80	33.50
CO_2	0.32	21.0			
C, noncarbonate	0.010	0.129	pH	7.87	7.72
H_2O, dehyd.[1]	0.680	1.590			
H_2O, chem.[2]	3.900	4.581			
Total	100.245	69.114			
LOI, total[3]	4.91	27.3			
Extent of carbonation, %[4]		49.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-223 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.109	Cl	35.2	37.5
CaO	0.187	0.167	Cr	<0.0005	0.0063
Cr_2O_3	0.045	0.029	Fe	0.0005	<0.0001
FeO	0.86	0.66	Mg	2.5000	0.1060
Fe_2O_3	3.260	3.002	Ni	<0.0005	<0.0005
MgO	42.1	37.8	K	0.0013	<0.0001
NiO	0.216	0.173	Si	0.0026	<0.0001
K_2O	0.005	0.005	Na	25.20	24.20
SiO_2	42.4	31.0	CO_2	26.20	14.50
Na_2O	0.010	0.663	HCO_3	35.20	19.30
CO_2	0.01	22.1			
C, noncarbonate	0.010	0.000	pH	7.38	7.68
H_2O, dehyd.[1]	0.680	1.390			
H_2O, chem.[2]	4.213	4.010			
Total	94.111	101.129			
LOI, total[3]	4.91	27.5			
Extent of carbonation, %[4]		60.1			

Carbonation test #SC-224 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.072	Cl	35.2	37.6
CaO	0.157	0.043	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.132	Fe	0.0005	0.0005
FeO	7.72	6.54	Mg	2.5000	0.0450
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	8.0	K	0.0013	0.0019
NiO	0.300	0.298	Si	0.0026	0.0189
K_2O	0.007	0.004	Na	25.20	24.20
SiO_2	40.4	37.7	CO_2	26.20	16.30
Na_2O	0.010	0.133	HCO_3	35.20	21.60
CO_2	0.00	4.1			
C, noncarbonate	0.026	0.051	pH	7.38	7.58
H_2O, dehyd.[1]	0.070	0.070			
H_2O, chem.[2]	0.294	0.439			
Total	100.798	57.571			
LOI, total[3]	0.39	4.7			
Extent of carbonation, %[4]		7.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-225 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.123	Cl	36.4	37.0
CaO	0.157	0.035	Cr	<0.0005	<0.0005
Cr_2O_3	0.048	0.126	Fe	0.0005	0.0006
FeO	7.72	6.32	Mg	0.0005	0.0306
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.6	18.1	K	0.0015	0.0029
NiO	0.300	0.309	Si	0.0042	0.0207
K_2O	0.007	0.007	Na	27.00	27.40
SiO_2	40.4	39.4	CO_2	21.40	21.40
Na_2O	0.010	0.058	HCO_3	27.60	28.70
CO_2	0.01	1.1			
C, noncarbonate	0.026	0.026	pH	7.82	7.75
H_2O, dehyd.[1]	0.070	0.120			
H_2O, chem.[2]	0.287	0.294			
Total	100.798	65.930			
LOI, total[3]	0.39	1.5			
Extent of carbonation, %[4]		1.8			

Carbonation test #SC-226 **TS Olivine + MgO**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.142	Cl	36.7	37.0
CaO	0.204	0.228	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.027	Fe	0.0007	0.0009
FeO	7.64	7.18	Mg	0.0005	0.0320
Fe_2O_3	0.486	1.401	Ni	<0.0005	<0.0005
MgO	49.4	48.9	K	0.0016	0.0032
NiO	0.229	0.216	Si	0.0032	0.0204
K_2O	0.006	0.011	Na	29.30	29.00
SiO_2	40.4	35.7	CO_2	26.60	26.90
Na_2O	0.015	0.236	HCO_3	34.40	33.70
CO_2	0.00	6.1			
C, noncarbonate	0.098	0.158	pH	7.64	7.69
H_2O, dehyd.[1]	0.100	0.060			
H_2O, chem.[2]	1.052	1.102			
Total	99.867	101.490			
LOI, total[3]	1.25	7.4			
Extent of carbonation, %[4]		11.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-227 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.173	Cl	36.3	36.1
CaO	0.204	0.180	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.024	Fe	0.0005	0.0005
FeO	7.64	7.35	Mg	1.1900	0.0316
Fe_2O_3	0.486	1.430	Ni	<0.0005	<0.0005
MgO	49.4	46.6	K	0.0014	0.0027
NiO	0.229	0.216	Si	0.0018	0.0208
K_2O	0.006	0.004	Na	24.60	25.20
SiO_2	40.4	37.9	CO_2	20.60	16.00
Na_2O	0.015	0.121	HCO_3	30.00	21.70
CO_2	0.01	3.4			
C, noncarbonate	0.098	0.126	pH	7.38	7.62
H_2O, dehyd.[1]	0.100	0.120			
H_2O, chem.[2]	1.041	0.904			
Total	99.867	98.453			
LOI, total[3]	1.25	4.5			
Extent of carbonation, %[4]		5.9			

Carbonation test #SC-228 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.185	Cl	36.8	37.1
CaO	0.204	0.140	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.030	Fe	0.0006	0.0004
FeO	7.64	6.86	Mg	0.0004	0.0258
Fe_2O_3	0.486	1.730	Ni	<0.0005	<0.0005
MgO	49.4	39.0	K	0.0015	0.0042
NiO	0.229	0.204	Si	0.0039	0.0220
K_2O	0.006	0.005	Na	28.60	28.20
SiO_2	40.4	37.9	CO_2	26.70	26.30
Na_2O	0.015	0.272	HCO_3	34.10	34.50
CO_2	0.00	6.7			
C, noncarbonate	0.098	0.115	pH	7.61	7.76
H_2O, dehyd.[1]	0.100	0.140			
H_2O, chem.[2]	1.052	1.045			
Total	99.867	94.203			
LOI, total[3]	1.25	8.0			
Extent of carbonation, %[4]		12.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-229 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.112	Cl	36.8	36.2
CaO	0.187	0.102	Cr	<0.0005	0.0026
Cr_2O_3	0.045	0.026	Fe	0.0006	0.0005
FeO	0.86	0.48	Mg	0.0004	0.0852
Fe_2O_3	3.260	3.217	Ni	<0.0005	<0.0005
MgO	42.1	29.2	K	0.0015	0.0039
NiO	0.216	0.153	Si	0.0039	0.0240
K_2O	0.005	0.003	Na	28.60	28.40
SiO_2	42.4	31.2	CO_2	26.70	23.50
Na_2O	0.010	0.749	HCO_3	34.10	32.00
CO_2	0.01	21.1			
C, noncarbonate	0.010	0.131	pH	7.61	7.67
H_2O, dehyd.[1]	0.680	1.700			
H_2O, chem.[2]	4.213	4.769			
Total	94.111	92.955			
LOI, total[3]	4.91	27.7			
Extent of carbonation, %[4]		56.6			

Carbonation test #SC-230 **DB Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.112	Cl	36.7	41.1
CaO	0.215	0.320	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.269	Fe	0.0007	0.0005
FeO	9.52	7.13	Mg	0.0005	0.0260
Fe_2O_3	2.716	<0.01	Ni	<0.0005	<0.0005
MgO	51.2	48.2	K	0.0016	0.0041
NiO	<0.01	0.363	Si	0.0032	0.0207
K_2O	0.009	0.006	Na	29.30	32.40
SiO_2	40.4	40.0	CO_2	26.60	29.80
Na_2O	0.014	0.127	HCO_3	34.40	40.10
CO_2	0.31	2.1			
C, noncarbonate	0.047	0.061	pH	7.64	7.72
H_2O, dehyd.[1]	0.140	0.230			
H_2O, chem.[2]	2.763	2.269			
Total	107.640	101.239			
LOI, total[3]	3.26	4.7			
Extent of carbonation, %[4]		3.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-231 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.086	Cl	173.0	167.0
CaO	0.204	0.229	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.026	Fe	0.0096	0.0030
FeO	7.64	6.77	Mg	7.8000	7.8400
Fe_2O_3	0.486	2.187	Ni	<0.0005	0.0034
MgO	49.4	49.1	K	5.0600	4.9800
NiO	0.229	0.215	Si	0.0091	0.0104
K_2O	0.006	0.010	Na	75.80	75.90
SiO_2	40.4	40.0	CO_2	<0.0001	0.53
Na_2O	0.015	0.045	HCO_3	<0.0001	1.06
CO_2	0.01	0.6			
C, noncarbonate	0.098	0.076	pH	8.48	6.28
H_2O, dehyd.[1]	0.100	0.120			
H_2O, chem.[2]	1.041	1.054			
Total	99.867	100.460			
LOI, total[3]	1.25	1.8			
Extent of carbonation, %[4]		1.0			

Carbonation test #SC-232 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.074	Cl	37.4	38.9
CaO	0.222	0.263	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.099	Fe	0.0007	0.0011
FeO	7.58	7.32	Mg	0.0014	0.0316
Fe_2O_3	0.315	0.515	Ni	<0.0005	<0.0005
MgO	46.9	49.4	K	0.0020	0.0220
NiO	0.293	0.305	Si	0.0048	0.0220
K_2O	0.004	0.003	Na	29.40	32.20
SiO_2	40.9	40.2	CO_2	27.30	27.60
Na_2O	0.015	0.083	HCO_3	35.40	36.10
CO_2	0.13	1.4			
C, noncarbonate	0.000	0.042	pH	7.65	7.80
H_2O, dehyd.[1]	0.080	0.080			
H_2O, chem.[2]	0.540	0.608			
Total	97.134	100.442			
LOI, total[3]	0.75	2.2			
Extent of carbonation, %[4]		2.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-233 **DB Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.090	Cl	37.4	42.5
CaO	0.215	0.185	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.231	Fe	0.0007	0.0009
FeO	9.52	6.56	Mg	0.0014	0.0286
Fe_2O_3	2.716	<0.01	Ni	<0.0005	<0.0005
MgO	51.2	33.3	K	0.0020	0.0036
NiO	<0.01	0.305	Si	0.0048	0.0245
K_2O	0.009	0.004	Na	29.40	33.50
SiO_2	40.4	33.4	CO_2	27.30	30.80
Na_2O	0.014	0.173	HCO_3	35.40	40.50
CO_2	0.01	17.4			
C, noncarbonate	0.047	0.161	pH	7.38	7.68
H_2O, dehyd.[1]	0.140	0.170			
H_2O, chem.[2]	3.062	1.969			
Total	107.640	93.949			
LOI, total[3]	3.26	19.7			
Extent of carbonation, %[4]		33.4			

Carbonation test #SC-234 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.182	Cl	36.6	38.4
CaO	0.204	0.196	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.029	Fe	0.0005	0.0006
FeO	7.64	6.60	Mg	0.0005	0.0270
Fe_2O_3	0.486	0.500	Ni	<0.0005	<0.0005
MgO	50.4	39.3	K	0.0018	0.0037
NiO	0.229	0.216	Si	0.0038	0.0210
K_2O	0.006	0.005	Na	29.20	30.80
SiO_2	40.4	32.9	CO_2	27.40	27.90
Na_2O	0.015	0.151	HCO_3	34.20	37.00
CO_2	0.00	16.3			
C, noncarbonate	0.098	0.211	pH	7.66	7.87
H_2O, dehyd.[1]	0.100	0.090			
H_2O, chem.[2]	1.052	0.999			
Total	100.861	97.721			
LOI, total[3]	1.25	17.6			
Extent of carbonation, %[4]		32.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-235 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.125	Cl	36.6	36.8
CaO	0.222	0.192	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.088	Fe	0.0005	0.0005
FeO	7.58	6.28	Mg	0.0005	0.0354
Fe_2O_3	0.315	0.043	Ni	<0.0005	<0.0005
MgO	46.9	37.5	K	0.0018	0.0026
NiO	0.293	0.242	Si	0.0038	0.0211
K_2O	0.004	0.003	Na	29.20	29.70
SiO_2	40.9	31.4	CO_2	27.40	26.70
Na_2O	0.015	0.097	HCO_3	34.20	35.00
CO_2	0.01	22.1			
C, noncarbonate	0.000	0.168	pH	7.66	7.85
H_2O, dehyd.[1]	0.080	0.050			
H_2O, chem.[2]	0.659	0.682			
Total	97.134	98.987			
LOI, total[3]	0.75	23.0			
Extent of carbonation, %[4]		50.3			

Carbonation test #SC-236 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.106	Cl	36.6	36.9
CaO	0.222	0.201	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.088	Fe	0.0005	0.0005
FeO	7.58	6.30	Mg	0.0004	0.0256
Fe_2O_3	0.315	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	37.1	K	0.0021	0.0025
NiO	0.293	0.235	Si	0.0043	0.0226
K_2O	0.004	0.003	Na	29.50	29.00
SiO_2	40.9	31.9	CO_2	27.20	27.20
Na_2O	0.015	0.096	HCO_3	34.80	35.30
CO_2	0.13	21.2			
C, noncarbonate	0.000	0.094	pH	7.80	7.72
H_2O, dehyd.[1]	0.080	0.060			
H_2O, chem.[2]	0.540	0.646			
Total	97.134	98.051			
LOI, total[3]	0.75	22.0			
Extent of carbonation, %[4]		47.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-237 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.110	Cl	36.6	36.7
CaO	0.222	0.201	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.105	Fe	0.0005	0.0005
FeO	7.58	6.52	Mg	0.0004	0.0450
Fe_2O_3	0.315	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	39.3	K	0.0021	0.0026
NiO	0.293	0.235	Si	0.0043	0.0202
K_2O	0.004	0.003	Na	29.50	29.00
SiO_2	40.9	33.2	CO_2	27.20	27.20
Na_2O	0.015	0.098	HCO_3	34.80	36.20
CO_2	0.01	18.1			
C, noncarbonate	0.000	0.160	pH	7.80	7.80
H_2O, dehyd.[1]	0.080	0.180			
H_2O, chem.[2]	0.659	0.660			
Total	97.134	98.831			
LOI, total[3]	0.75	19.1			
Extent of carbonation, %[4]		39.2			

Carbonation test #SC-238 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.149	Cl	36.4	38.0
CaO	0.222	0.187	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.080	Fe	0.0006	0.0005
FeO	7.58	5.74	Mg	0.0005	0.0230
Fe_2O_3	0.315	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	37.8	K	0.0019	0.0022
NiO	0.293	0.223	Si	0.0055	0.0224
K_2O	0.004	0.002	Na	27.50	29.10
SiO_2	40.9	29.1	CO_2	27.60	27.20
Na_2O	0.015	0.154	HCO_3	35.40	35.10
CO_2	0.13	23.2			
C, noncarbonate	0.000	0.348	pH	7.62	7.83
H_2O, dehyd.[1]	0.080	0.110			
H_2O, chem.[2]	0.540	1.042			
Total	97.134	98.131			
LOI, total[3]	0.75	24.7			
Extent of carbonation, %[4]		53.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-239 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.126	Cl	36.4	37.2
CaO	0.238	0.203	Cr	<0.0005	<0.0005
Cr_2O_3	0.193	0.161	Fe	0.0006	0.0006
FeO	8.27	6.34	Mg	0.0005	0.0226
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.2	37.3	K	0.0019	0.0025
NiO	0.344	0.261	Si	0.0055	0.0206
K_2O	0.004	0.003	Na	27.50	29.10
SiO_2	40.4	30.4	CO_2	27.60	27.50
Na_2O	0.012	0.098	HCO_3	35.40	35.80
CO_2	0.01	23.8			
C, noncarbonate	0.010	0.155	pH	7.62	7.74
H_2O, dehyd.[1]	0.100	0.080			
H_2O, chem.[2]	0.371	0.665			
Total	99.428	99.578			
LOI, total[3]	0.49	24.7			
Extent of carbonation, %[4]		52.6			

Carbonation test #SC-240 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.166	Cl	37.2	36.7
CaO	0.238	0.214	Cr	<0.0005	<0.0005
Cr_2O_3	0.193	0.171	Fe	0.0005	0.0005
FeO	8.27	7.47	Mg	0.0005	0.0560
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.2	42.8	K	0.0017	0.0028
NiO	0.344	0.286	Si	0.0021	0.0200
K_2O	0.004	0.004	Na	29.10	28.90
SiO_2	40.4	35.5	CO_2	28.10	27.20
Na_2O	0.012	0.090	HCO_3	36.70	35.50
CO_2	0.13	11.8			
C, noncarbonate	0.010	0.120	pH	7.70	7.70
H_2O, dehyd.[1]	0.100	0.080			
H_2O, chem.[2]	0.250	0.600			
Total	99.428	99.297			
LOI, total[3]	0.49	12.6			
Extent of carbonation, %[4]		22.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-241 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.075	0.131	Cl	37.2	36.9
CaO	0.222	0.229	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.095	Fe	0.0005	0.0006
FeO	7.58	7.33	Mg	0.0005	0.0546
Fe_2O_3	0.315	0.043	Ni	<0.0005	<0.0005
MgO	46.9	47.8	K	0.0017	0.0024
NiO	0.293	0.274	Si	0.0021	0.0196
K_2O	0.004	0.004	Na	29.10	28.60
SiO_2	40.9	38.1	CO_2	28.10	27.90
Na_2O	0.015	0.071	HCO_3	36.70	37.10
CO_2	0.01	7.6			
C, noncarbonate	0.000	0.147	pH	7.62	7.83
H_2O, dehyd.[1]	0.080	0.080			
H_2O, chem.[2]	0.659	0.833			
Total	97.134	102.633			
LOI, total[3]	0.75	8.6			
Extent of carbonation, %[4]		14.4			

Carbonation test #SC-242 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.151	0.138	Cl	36.8	36.5
CaO	0.222	0.199	Cr	<0.0005	<0.0005
Cr_2O_3	0.086	0.088	Fe	0.0007	0.0004
FeO	7.38	7.35	Mg	0.0005	0.0570
Fe_2O_3	0.558	0.014	Ni	<0.0005	<0.0005
MgO	49.7	46.3	K	0.0017	0.0023
NiO	0.239	0.227	Si	0.0026	0.0192
K_2O	0.003	0.003	Na	29.80	28.10
SiO_2	40.9	38.3	CO_2	26.70	28.50
Na_2O	0.009	0.072	HCO_3	34.30	35.00
CO_2	0.00	6.3			
C, noncarbonate	0.027	0.042	pH	7.83	7.75
H_2O, dehyd.[1]	0.080	0.080			
H_2O, chem.[2]	0.653	0.578			
Total	100.016	99.670			
LOI, total[3]	0.76	7.0			
Extent of carbonation, %[4]		11.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-243 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.166	Cl	36.8	36.5
CaO	0.204	0.201	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.026	Fe	0.0007	0.0009
FeO	7.64	7.76	Mg	0.0005	0.0180
Fe_2O_3	0.486	0.758	Ni	<0.0005	<0.0005
MgO	49.4	42.4	K	0.0017	0.0064
NiO	0.229	0.219	Si	0.0026	0.0214
K_2O	0.006	0.005	Na	29.80	34.80
SiO_2	40.4	39.1	CO_2	26.70	26.40
Na_2O	0.015	0.083	HCO_3	34.30	33.70
CO_2	0.01	2.7			
C, noncarbonate	0.098	0.075	pH	7.83	7.76
H_2O, dehyd.[1]	0.100	0.140			
H_2O, chem.[2]	1.041	0.815			
Total	99.867	94.542			
LOI, total[3]	1.25	3.7			
Extent of carbonation, %[4]		4.7			

Carbonation test #SC-244 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.117	Cl	173.0	<0.0001
CaO	0.204	0.127	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.065	Fe	0.0096	<0.0001
FeO	7.64	6.81	Mg	7.8000	<0.0001
Fe_2O_3	0.486	1.816	Ni	<0.0005	<0.0005
MgO	49.4	38.8	K	5.0600	<0.0001
NiO	0.229	0.257	Si	0.0091	<0.0001
K_2O	0.006	0.009	Na	75.80	<0.0001
SiO_2	40.4	39.6	CO_2	<0.0001	<0.0001
Na_2O	0.015	0.063	HCO_3	<0.0001	<0.0001
CO_2	0.00	1.9			
C, noncarbonate	0.098	0.099	pH	8.48	6.02
H_2O, dehyd.[1]	0.100	0.060			
H_2O, chem.[2]	1.052	1.141			
Total	99.867	90.846			
LOI, total[3]	1.25	3.2			
Extent of carbonation, %[4]		3.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-245 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.109	Cl	36.8	37.5
CaO	0.183	0.105	Cr	<0.0005	<0.0005
Cr_2O_3	0.054	0.100	Fe	0.0010	0.0007
FeO	1.72	1.87	Mg	0.0004	0.0208
Fe_2O_3	3.431	1.415	Ni	<0.0005	<0.0005
MgO	34.5	22.5	K	0.0011	0.0341
NiO	0.181	0.144	Si	0.0044	0.0270
K_2O	0.005	0.008	Na	29.80	26.70
SiO_2	49.2	38.7	CO_2	26.30	23.40
Na_2O	0.015	2.575	HCO_3	35.00	30.10
CO_2	0.01	21.1			
C, noncarbonate	0.036	0.151	pH	7.53	7.63
H_2O, dehyd.[1]	0.570	1.470			
H_2O, chem.[2]	11.283	6.579			
Total	101.311	96.892			
LOI, total[3]	11.90	29.3			
Extent of carbonation, %[4]		66.8			

Carbonation test #SC-246 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.141	Cl	36.8	36.8
CaO	0.183	0.128	Cr	<0.0005	<0.0005
Cr_2O_3	0.054	0.051	Fe	0.0010	0.0007
FeO	1.72	1.00	Mg	0.0004	0.0154
Fe_2O_3	3.431	2.016	Ni	<0.0005	<0.0005
MgO	34.5	25.4	K	0.0011	0.0067
NiO	0.181	0.095	Si	0.0044	0.0246
K_2O	0.005	0.005	Na	29.80	27.60
SiO_2	49.2	38.9	CO_2	26.30	23.20
Na_2O	0.015	2.251	HCO_3	35.00	30.60
CO_2	0.84	20.6			
C, noncarbonate	0.036	0.268	pH	7.53	7.69
H_2O, dehyd.[1]	0.570	2.040			
H_2O, chem.[2]	10.454	6.092			
Total	101.311	98.995			
LOI, total[3]	11.90	29.0			
Extent of carbonation, %[4]		64.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-247 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.147	Cl	36.6	37.8
CaO	0.180	0.102	Cr	<0.0005	<0.0005
Cr_2O_3	0.365	0.191	Fe	0.0006	0.0005
FeO	8.76	5.52	Mg	0.0005	0.0164
Fe_2O_3	<0.01	0.458	Ni	<0.0005	<0.0005
MgO	42.1	30.5	K	0.0016	0.0090
NiO	0.280	0.160	Si	0.0018	0.0245
K_2O	0.004	0.004	Na	29.90	29.00
SiO_2	40.4	26.3	CO_2	26.50	23.80
Na_2O	0.019	7.778	HCO_3	33.90	31.10
CO_2	0.01	29.0			
C, noncarbonate	0.016	0.015	pH	7.85	8.02
H_2O, dehyd.[1]	0.000	1.440			
H_2O, chem.[2]	1.470	3.645			
Total	93.804	105.281			
LOI, total[3]	1.50	34.1			
Extent of carbonation, %[4]		79.3			

Carbonation test #SC-248 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.156	Cl	36.6	37.8
CaO	0.180	0.134	Cr	<0.0005	0.0015
Cr_2O_3	0.365	0.254	Fe	0.0006	0.0042
FeO	8.76	4.94	Mg	0.0005	1.8600
Fe_2O_3	<0.01	1.844	Ni	<0.0005	<0.0005
MgO	42.1	33.2	K	0.0016	0.0016
NiO	0.280	0.200	Si	0.0018	0.0279
K_2O	0.004	0.003	Na	29.90	28.10
SiO_2	40.4	30.2	CO_2	26.50	33.60
Na_2O	0.019	0.573	HCO_3	33.90	45.70
CO_2	0.00	12.3			
C, noncarbonate	0.016	0.273	pH	7.85	7.34
H_2O, dehyd.[1]	0.000	4.430			
H_2O, chem.[2]	1.484	10.597			
Total	93.804	99.031			
LOI, total[3]	1.50	27.6			
Extent of carbonation, %[4]		27.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-249 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.140	Cl	36.0	37.1
CaO	0.204	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.031	Fe	0.0005	0.0004
FeO	7.64	7.51	Mg	0.0004	0.0336
Fe_2O_3	0.486	0.829	Ni	<0.0005	<0.0005
MgO	49.4	40.3	K	0.0019	0.0068
NiO	0.229	0.229	Si	0.0027	0.0224
K_2O	0.006	0.006	Na	30.00	30.50
SiO_2	40.4	37.4	CO_2	27.30	28.10
Na_2O	0.015	0.098	HCO_3	34.80	35.00
CO_2	0.01	4.5			
C, noncarbonate	0.098	0.554	pH	7.80	7.81
H_2O, dehyd.[1]	0.100	0.200			
H_2O, chem.[2]	1.041	1.836			
Total	99.867	93.845			
LOI, total[3]	1.25	7.1			
Extent of carbonation, %[4]		8.1			

Carbonation test #SC-250 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.147	0.147	Cl	36.0	39.0
CaO	0.075	0.118	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.120	Fe	0.0005	0.0013
FeO	1.99	1.18	Mg	0.0004	1.8300
Fe_2O_3	3.088	2.130	Ni	<0.0005	<0.0005
MgO	38.5	23.9	K	0.0019	0.0009
NiO	0.204	0.148	Si	0.0027	0.0210
K_2O	0.004	0.003	Na	30.00	28.40
SiO_2	36.8	25.9	CO_2	27.30	32.80
Na_2O	0.008	0.485	HCO_3	34.80	45.00
CO_2	1.29	19.7			
C, noncarbonate	0.054	0.243	pH	7.80	7.21
H_2O, dehyd.[1]	1.050	6.300			
H_2O, chem.[2]	12.906	16.557			
Total	96.246	96.896			
LOI, total[3]	15.30	42.8			
Extent of carbonation, %[4]		53.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-251 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.147	0.176	Cl	37.0	38.5
CaO	0.075	0.101	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.110	Fe	0.0005	0.0009
FeO	1.99	1.11	Mg	0.0007	1.5400
Fe_2O_3	3.088	2.359	Ni	<0.0005	<0.0005
MgO	38.5	27.2	K	0.0019	0.0053
NiO	0.204	0.146	Si	0.0019	0.0244
K_2O	0.004	0.002	Na	29.40	27.30
SiO_2	36.8	25.9	CO_2	27.10	31.60
Na_2O	0.008	0.527	HCO_3	34.40	41.20
CO_2	0.01	19.4			
C, noncarbonate	0.054	0.255	pH	7.83	7.29
H_2O, dehyd.[1]	1.050	4.970			
H_2O, chem.[2]	14.190	17.475			
Total	96.246	99.706			
LOI, total[3]	15.30	42.1			
Extent of carbonation, %[4]		52.7			

Carbonation test #SC-252 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.147	0.143	Cl	37.0	36.8
CaO	0.075	0.084	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.115	Fe	0.0005	0.0007
FeO	1.99	1.13	Mg	0.0007	1.6400
Fe_2O_3	3.088	2.288	Ni	<0.0005	<0.0005
MgO	38.5	26.9	K	0.0019	0.0048
NiO	0.204	0.149	Si	0.0019	0.0232
K_2O	0.004	0.003	Na	29.40	26.50
SiO_2	36.8	25.9	CO_2	27.10	29.50
Na_2O	0.008	0.776	HCO_3	34.40	38.10
CO_2	1.29	19.2			
C, noncarbonate	0.054	0.250	pH	7.83	7.51
H_2O, dehyd.[1]	1.050	7.360			
H_2O, chem.[2]	12.906	15.990			
Total	96.246	100.236			
LOI, total[3]	15.30	42.8			
Extent of carbonation, %[4]		51.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-253 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.147	0.166	Cl	37.0	no sample
CaO	0.075	0.098	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.146	Fe	0.0004	<0.0001
FeO	1.99	1.36	Mg	0.0004	<0.0001
Fe_2O_3	3.088	2.316	Ni	<0.0005	<0.0005
MgO	38.5	26.0	K	0.0015	<0.0001
NiO	0.204	0.163	Si	0.0031	<0.0001
K_2O	0.004	0.004	Na	29.00	<0.0001
SiO_2	36.8	28.2	CO_2	26.50	<0.0001
Na_2O	0.008	0.186	HCO_3	33.00	<0.0001
CO_2	0.01	17.2			
C, noncarbonate	0.054	0.216	pH	8.06	0.00
H_2O, dehyd.[1]	1.050	8.110			
H_2O, chem.[2]	14.190	15.874			
Total	96.246	100.114			
LOI, total[3]	15.30	41.4			
Extent of carbonation, %[4]		45.1			

Carbonation test #SC-254 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.169	0.077	Cl	37.0	34.9
CaO	0.162	0.076	Cr	<0.0005	<0.0005
Cr_2O_3	0.088	0.075	Fe	0.0004	0.0003
FeO	8.28	5.24	Mg	0.0004	0.0402
Fe_2O_3	0.329	0.886	Ni	<0.0005	<0.0005
MgO	48.1	31.8	K	0.0015	0.0073
NiO	0.232	0.171	Si	0.0031	0.0250
K_2O	0.008	0.006	Na	29.00	26.60
SiO_2	40.0	28.2	CO_2	26.50	25.20
Na_2O	0.015	3.518	HCO_3	33.00	32.00
CO_2	0.25	27.3			
C, noncarbonate	0.058	0.379	pH	8.06	7.82
H_2O, dehyd.[1]	0.290	0.640			
H_2O, chem.[2]	1.282	1.981			
Total	99.257	100.419			
LOI, total[3]	1.88	30.3			
Extent of carbonation, %[4]		64.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-255 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.147	0.176	Cl	<0.0001	0.1
CaO	0.075	0.139	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.102	Fe	<0.0001	0.0005
FeO	1.99	1.07	Mg	<0.0001	2.6000
Fe_2O_3	3.088	1.859	Ni	<0.0005	<0.0005
MgO	38.5	26.5	K	<0.0001	0.0083
NiO	0.204	0.120	Si	<0.0001	0.0290
K_2O	0.004	0.003	Na	<0.0001	0.07
SiO_2	36.8	27.0	CO_2	<0.0001	15.60
Na_2O	0.008	0.011	HCO_3	<0.0001	21.50
CO_2	0.01	18.6			
C, noncarbonate	0.054	0.114	pH	8.41	7.20
H_2O, dehyd.[1]	1.050	7.150			
H_2O, chem.[2]	14.190	16.836			
Total	96.246	99.662			
LOI, total[3]	15.30	42.7			
Extent of carbonation, %[4]		49.8			

Carbonation test #SC-256 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.180	0.149	Cl	37.0	36.0
CaO	0.264	0.248	Cr	<0.0005	<0.0005
Cr_2O_3	0.042	0.038	Fe	0.0003	0.0004
FeO	7.24	7.46	Mg	0.0006	0.0484
Fe_2O_3	1.816	1.287	Ni	<0.0005	<0.0005
MgO	48.9	47.8	K	0.0017	0.0015
NiO	0.185	0.185	Si	0.0017	0.0352
K_2O	0.006	0.005	Na	28.90	28.00
SiO_2	41.3	39.4	CO_2	26.60	26.20
Na_2O	0.018	0.125	HCO_3	34.50	34.10
CO_2	0.00	2.1			
C, noncarbonate	0.102	0.094	pH	7.82	7.73
H_2O, dehyd.[1]	0.180	0.200			
H_2O, chem.[2]	1.098	1.106			
Total	101.336	100.114			
LOI, total[3]	1.38	3.5			
Extent of carbonation, %[4]		3.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-257 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.208	0.142	Cl	37.0	36.4
CaO	0.197	0.135	Cr	<0.0005	<0.0005
Cr_2O_3	0.025	0.191	Fe	0.0003	0.0005
FeO	7.40	4.79	Mg	0.0006	0.0438
Fe_2O_3	0.972	1.044	Ni	<0.0005	<0.0005
MgO	49.9	31.8	K	0.0017	0.0052
NiO	0.150	0.191	Si	0.0017	0.0199
K_2O	0.003	0.006	Na	28.90	27.20
SiO_2	39.8	27.8	CO_2	26.60	24.70
Na_2O	0.247	0.019	HCO_3	34.50	32.00
CO_2	0.18	27.8			
C, noncarbonate	0.085	0.273	pH	7.82	7.73
H_2O, dehyd.[1]	0.330	0.580			
H_2O, chem.[2]	1.802	1.847			
Total	101.299	96.660			
LOI, total[3]	2.40	30.5			
Extent of carbonation, %[4]		64.4			

Carbonation test #SC-258 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.214	0.150	Cl	37.1	36.7
CaO	0.250	0.175	Cr	<0.0005	<0.0005
Cr_2O_3	0.357	0.251	Fe	0.0005	0.0004
FeO	7.37	4.50	Mg	0.0006	0.0200
Fe_2O_3	<0.01	0.886	Ni	<0.0005	<0.0005
MgO	49.9	33.0	K	0.0018	0.0091
NiO	0.255	0.168	Si	0.0017	0.0248
K_2O	0.010	0.006	Na	27.90	27.20
SiO_2	40.0	26.7	CO_2	26.80	24.40
Na_2O	0.028	1.671	HCO_3	34.20	31.50
CO_2	0.43	28.8			
C, noncarbonate	0.041	0.180	pH	7.86	7.86
H_2O, dehyd.[1]	0.240	0.940			
H_2O, chem.[2]	1.439	2.880			
Total	100.547	100.348			
LOI, total[3]	2.15	32.8			
Extent of carbonation, %[4]		67.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-259 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.138	Cl	37.1	36.7
CaO	0.119	0.088	Cr	<0.0005	<0.0005
Cr_2O_3	0.067	0.072	Fe	0.0005	0.0005
FeO	6.12	6.33	Mg	0.0006	0.0582
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	52.6	38.1	K	0.0018	0.0049
NiO	0.265	0.229	Si	0.0017	0.0231
K_2O	0.003	0.003	Na	27.90	29.40
SiO_2	41.3	36.2	CO_2	26.80	26.80
Na_2O	0.008	0.070	HCO_3	34.20	34.80
CO_2	0.01	10.8			
C, noncarbonate	0.026	0.292	pH	7.86	7.72
H_2O, dehyd.[1]	0.050	0.000			
H_2O, chem.[2]	0.238	0.708			
Total	100.898	93.018			
LOI, total[3]	0.32	11.8			
Extent of carbonation, %[4]		19.8			

Carbonation test #SC-260 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.127	Cl	36.9	36.4
CaO	0.119	0.110	Cr	<0.0005	<0.0005
Cr_2O_3	0.067	0.068	Fe	0.0006	0.0004
FeO	6.12	6.68	Mg	0.0005	0.0416
Fe_2O_3	<0.01	0.672	Ni	<0.0005	<0.0005
MgO	52.6	39.3	K	0.0022	0.0046
NiO	0.265	0.223	Si	0.0021	0.0226
K_2O	0.003	0.002	Na	28.80	29.20
SiO_2	41.3	35.1	CO_2	26.10	26.60
Na_2O	0.008	0.072	HCO_3	31.80	34.50
CO_2	0.00	13.9			
C, noncarbonate	0.026	0.196	pH	8.03	7.68
H_2O, dehyd.[1]	0.050	0.050			
H_2O, chem.[2]	0.244	0.054			
Total	100.898	96.531			
LOI, total[3]	0.32	14.2			
Extent of carbonation, %[4]		26.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-261 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.214	0.127	Cl	36.9	36.5
CaO	0.250	0.110	Cr	<0.0005	<0.0005
Cr_2O_3	0.357	0.068	Fe	0.0006	0.0096
FeO	7.37	6.68	Mg	0.0005	0.9880
Fe_2O_3	<0.01	0.672	Ni	<0.0005	<0.0005
MgO	49.9	39.3	K	0.0022	0.0064
NiO	0.255	0.223	Si	0.0021	0.0337
K_2O	0.010	0.002	Na	28.80	27.60
SiO_2	40.0	35.1	CO_2	26.10	28.10
Na_2O	0.028	0.072	HCO_3	31.80	36.80
CO_2	0.02	13.9			
C, noncarbonate	0.041	0.196	pH	8.03	7.62
H_2O, dehyd.[1]	0.240	0.050			
H_2O, chem.[2]	1.849	0.054			
Total	100.547	96.531			
LOI, total[3]	2.15	14.2			
Extent of carbonation, %[4]		26.5			

Carbonation test #SC-262 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.183	0.183	Cl	37.1	36.6
CaO	0.083	0.241	Cr	<0.0005	0.0005
Cr_2O_3	0.291	0.326	Fe	0.0004	0.0152
FeO	6.92	7.92	Mg	0.0004	1.6800
Fe_2O_3	<0.01	1.101	Ni	<0.0005	0.0005
MgO	47.4	44.8	K	0.0022	0.0071
NiO	0.272	0.242	Si	0.0023	0.0354
K_2O	0.008	0.004	Na	28.10	29.00
SiO_2	41.9	38.7	CO_2	26.70	31.10
Na_2O	0.019	0.112	HCO_3	33.60	40.90
CO_2	0.45	2.0			
C, noncarbonate	0.110	0.155	pH	7.82	7.40
H_2O, dehyd.[1]	1.240	1.640			
H_2O, chem.[2]	3.100	2.965			
Total	102.028	100.353			
LOI, total[3]	4.90	6.7			
Extent of carbonation, %[4]		2.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-263 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.156	0.127	Cl	37.1	35.6
CaO	0.086	0.067	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.158	Fe	0.0004	0.0005
FeO	6.66	6.52	Mg	0.0004	0.0308
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	52.2	40.6	K	0.0022	0.0050
NiO	0.344	0.255	Si	0.0023	0.0256
K_2O	0.004	0.004	Na	28.10	27.60
SiO_2	40.6	31.9	CO_2	26.70	25.80
Na_2O	0.010	0.092	HCO_3	33.60	32.50
CO_2	0.01	19.6			
C, noncarbonate	0.019	0.291	pH	7.82	7.81
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.000	0.219			
Total	100.431	99.923			
LOI, total[3]	0.00	20.2			
Extent of carbonation, %[4]		39.8			

Carbonation test #SC-264 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.156	0.110	Cl	37.2	35.2
CaO	0.086	0.096	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.155	Fe	0.0008	0.0006
FeO	6.66	6.09	Mg	0.0006	0.0474
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	52.2	40.3	K	0.0020	0.0039
NiO	0.344	0.257	Si	0.0020	0.0267
K_2O	0.004	0.006	Na	28.40	26.70
SiO_2	40.6	31.2	CO_2	26.70	25.80
Na_2O	0.010	0.103	HCO_3	33.10	33.60
CO_2	0.00	22.3			
C, noncarbonate	0.019	0.264	pH	7.97	7.77
H_2O, dehyd.[1]	0.070	0.000			
H_2O, chem.[2]	0.000	0.000			
Total	100.424	100.901			
LOI, total[3]	0.00	22.5			
Extent of carbonation, %[4]		46.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-265 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.236	0.155	Cl	37.2	35.6
CaO	0.215	0.147	Cr	<0.0005	<0.0005
Cr_2O_3	0.468	0.298	Fe	0.0008	0.0007
FeO	9.55	5.15	Mg	0.0006	0.0296
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.1	28.9	K	0.0020	0.0059
NiO	0.272	0.186	Si	0.0020	0.0366
K_2O	0.008	0.005	Na	28.40	26.50
SiO_2	37.9	24.8	CO_2	26.70	24.80
Na_2O	0.017	0.698	HCO_3	33.10	32.50
CO_2	0.01	31.6			
C, noncarbonate	0.109	0.426	pH	7.97	7.76
H_2O, dehyd.[1]	1.720	0.600			
H_2O, chem.[2]	3.078	1.774			
Total	100.637	94.701			
LOI, total[3]	4.92	34.4			
Extent of carbonation, %[4]		79.5			

Carbonation test #SC-266 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.182	0.146	Cl	37.0	35.7
CaO	0.140	0.130	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.177	Fe	0.0006	0.0006
FeO	7.63	5.66	Mg	0.0005	0.0536
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.7	36.6	K	0.0022	0.0045
NiO	0.342	0.272	Si	0.0020	0.0202
K_2O	0.004	0.004	Na	28.60	27.00
SiO_2	40.4	31.0	CO_2	27.40	26.50
Na_2O	0.010	0.101	HCO_3	34.80	35.40
CO_2	0.00	22.3			
C, noncarbonate	0.019	0.314	pH	7.86	7.73
H_2O, dehyd.[1]	0.000	0.000			
H_2O, chem.[2]	0.141	0.386			
Total	100.812	97.155			
LOI, total[3]	0.16	23.0			
Extent of carbonation, %[4]		46.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-267 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.182	0.121	Cl	37.0	36.0
CaO	0.140	0.151	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.143	Fe	0.0006	0.0006
FeO	7.63	5.39	Mg	0.0005	0.0362
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.7	37.6	K	0.0022	0.0042
NiO	0.342	0.265	Si	0.0020	0.0211
K_2O	0.004	0.004	Na	28.60	26.80
SiO_2	40.4	30.8	CO_2	27.40	26.10
Na_2O	0.010	0.094	HCO_3	34.80	32.50
CO_2	0.01	22.4			
C, noncarbonate	0.019	0.187	pH	7.86	7.77
H_2O, dehyd.[1]	0.000	0.070			
H_2O, chem.[2]	0.133	0.143			
Total	100.812	97.412			
LOI, total[3]	0.16	22.8			
Extent of carbonation, %[4]		47.1			

Carbonation test #SC-268 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.182	0.136	Cl	36.5	35.6
CaO	0.140	0.119	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.180	Fe	0.0005	0.0006
FeO	7.63	6.73	Mg	0.0004	0.0234
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.7	36.1	K	0.0024	0.0046
NiO	0.342	0.272	Si	0.0023	0.0237
K_2O	0.004	0.012	Na	28.00	26.80
SiO_2	40.4	32.3	CO_2	27.00	25.80
Na_2O	0.010	0.090	HCO_3	33.00	33.50
CO_2	0.00	19.2			
C, noncarbonate	0.019	0.240	pH	7.96	7.85
H_2O, dehyd.[1]	0.000	0.100			
H_2O, chem.[2]	0.141	0.160			
Total	100.812	95.688			
LOI, total[3]	0.16	19.7			
Extent of carbonation, %[4]		38.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-269 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.236	0.306	Cl	36.5	35.9
CaO	0.215	0.224	Cr	<0.0005	<0.0005
Cr_2O_3	0.468	0.649	Fe	0.0005	0.0033
FeO	9.55	10.06	Mg	0.0004	2.1200
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.1	44.6	K	0.0024	0.0051
NiO	0.272	0.271	Si	0.0023	0.0351
K_2O	0.008	0.011	Na	28.00	35.60
SiO_2	37.9	37.4	CO_2	27.00	33.30
Na_2O	0.017	1.564	HCO_3	33.00	44.60
CO_2	0.01	0.8			
C, noncarbonate	0.109	0.101	pH	7.96	7.24
H_2O, dehyd.[1]	1.720	2.100			
H_2O, chem.[2]	3.078	2.979			
Total	100.637	101.095			
LOI, total[3]	4.92	6.0			
Extent of carbonation, %[4]		0.7			

Carbonation test #SC-270 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.249	0.276	Cl	35.9	37.1
CaO	0.162	0.087	Cr	<0.0005	<0.0005
Cr_2O_3	0.047	0.047	Fe	0.0007	0.0006
FeO	7.18	6.73	Mg	0.0005	0.0484
Fe_2O_3	<0.01	0.129	Ni	<0.0005	<0.0005
MgO	48.4	44.3	K	0.0024	0.0042
NiO	0.242	0.214	Si	0.0023	0.0312
K_2O	0.002	0.003	Na	35.60	35.20
SiO_2	40.0	36.8	CO_2	27.10	26.70
Na_2O	0.039	0.102	HCO_3	33.90	33.80
CO_2	5.22	11.8			
C, noncarbonate	0.085	0.170	pH	7.84	7.85
H_2O, dehyd.[1]	0.000	0.050			
H_2O, chem.[2]	0.125	0.280			
Total	101.771	100.952			
LOI, total[3]	5.43	12.3			
Extent of carbonation, %[4]		13.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-271 FG Olivine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.144	Cl	35.9	36.0
CaO	0.190	0.220	Cr	<0.0005	<0.0005
Cr_2O_3	0.085	0.076	Fe	0.0007	0.0004
FeO	7.08	5.87	Mg	0.0005	0.0260
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.6	36.0	K	0.0024	0.0053
NiO	0.235	0.177	Si	0.0023	0.0315
K_2O	0.009	0.004	Na	35.60	35.20
SiO_2	39.6	29.5	CO_2	27.10	26.20
Na_2O	0.044	0.154	HCO_3	33.90	33.50
CO_2	0.03	27.6			
C, noncarbonate	0.086	0.247	pH	7.84	7.82
H_2O, dehyd.[1]	0.090	0.050			
H_2O, chem.[2]	5.381	0.403			
Total	100.553	100.443			
LOI, total[3]	5.59	28.3			
Extent of carbonation, %[4]		56.1			

Carbonation test #SC-272 TS Olivine

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.236	0.266	Cl	<0.0001	36.0
CaO	0.215	0.302	Cr	<0.0005	<0.0005
Cr_2O_3	0.468	0.307	Fe	<0.0001	0.0004
FeO	9.55	9.56	Mg	<0.0001	0.0260
Fe_2O_3	<0.01	0.429	Ni	<0.0005	<0.0005
MgO	42.4	44.1	K	<0.0001	0.0053
NiO	0.272	0.238	Si	<0.0001	0.0315
K_2O	0.008	0.004	Na	<0.0001	35.20
SiO_2	37.9	37.2	CO_2	<0.0001	26.20
Na_2O	0.017	0.045	HCO_3	<0.0001	33.50
CO_2	0.01	3.1			
C, noncarbonate	0.109	0.188	pH	6.01	6.62
H_2O, dehyd.[1]	1.720	1.910			
H_2O, chem.[2]	3.078	3.022			
Total	95.995	100.719			
LOI, total[3]	4.92	8.2			
Extent of carbonation, %[4]		5.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-273 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.210	0.181	Cl	<0.0001	0.0
CaO	0.311	0.270	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.146	Fe	<0.0001	0.0086
FeO	8.39	6.73	Mg	<0.0001	1.9600
Fe_2O_3	0.686	0.758	Ni	<0.0005	<0.0005
MgO	48.1	36.0	K	<0.0001	0.0033
NiO	0.228	0.191	Si	<0.0001	0.1090
K_2O	0.005	0.004	Na	<0.0001	0.03
SiO_2	38.9	32.1	CO_2	<0.0001	<0.0001
Na_2O	0.022	0.020	HCO_3	<0.0001	<0.0001
CO_2	0.02	14.8			
C, noncarbonate	0.045	0.131	pH	6.01	6.46
H_2O, dehyd.[1]	0.290	2.880			
H_2O, chem.[2]	2.278	4.189			
Total	99.663	98.369			
LOI, total[3]	2.63	22.0			
Extent of carbonation, %[4]		29.1			

Carbonation test #SC-274 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.212	Cl	<0.0001	0.0
CaO	0.207	0.227	Cr	<0.0005	<0.0005
Cr_2O_3	0.645	0.554	Fe	<0.0001	0.0087
FeO	11.39	8.93	Mg	<0.0001	2.3700
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	42.8	33.5	K	<0.0001	0.0018
NiO	0.285	0.246	Si	<0.0001	0.1120
K_2O	0.005	0.003	Na	<0.0001	0.02
SiO_2	37.0	31.4	CO_2	<0.0001	<0.0001
Na_2O	0.018	0.017	HCO_3	<0.0001	<0.0001
CO_2	0.01	15.1			
C, noncarbonate	0.083	0.319	pH	6.01	6.87
H_2O, dehyd.[1]	1.910	2.140			
H_2O, chem.[2]	2.823	3.641			
Total	97.411	96.327			
LOI, total[3]	4.83	21.2			
Extent of carbonation, %[4]		31.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-275 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.248	0.206	Cl	<0.0001	0.1
CaO	0.207	0.229	Cr	<0.0005	<0.0005
Cr_2O_3	0.645	0.513	Fe	<0.0001	0.0003
FeO	11.39	9.22	Mg	<0.0001	0.6700
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	42.8	34.8	K	<0.0001	0.0016
NiO	0.285	0.239	Si	<0.0001	0.0946
K_2O	0.005	0.004	Na	<0.0001	0.01
SiO_2	37.0	31.4	CO_2	<0.0001	2.18
Na_2O	0.018	0.016	HCO_3	<0.0001	2.31
CO_2	0.01	17.4			
C, noncarbonate	0.083	0.151	pH	6.01	7.31
H_2O, dehyd.[1]	1.910	1.240			
H_2O, chem.[2]	2.823	1.409			
Total	97.411	96.899			
LOI, total[3]	4.83	20.2			
Extent of carbonation, %[4]		37.9			

Carbonation test #SC-276 **DB Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.189	0.108	Cl	36.1	37.1
CaO	0.075	0.121	Cr	<0.0005	<0.0005
Cr_2O_3	0.520	0.395	Fe	0.0004	0.0003
FeO	8.27	5.52	Mg	0.0005	0.0620
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	40.1	31.5	K	0.0022	0.0046
NiO	0.545	0.375	Si	0.0028	0.0358
K_2O	0.006	0.005	Na	35.60	34.20
SiO_2	39.8	26.7	CO_2	26.50	24.40
Na_2O	0.016	1.345	HCO_3	33.50	30.50
CO_2	0.01	29.4			
C, noncarbonate	0.006	0.376	pH	7.92	7.84
H_2O, dehyd.[1]	0.280	0.730			
H_2O, chem.[2]	1.183	1.994			
Total	91.019	98.613			
LOI, total[3]	1.48	32.5			
Extent of carbonation, %[4]		84.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-277 **DB Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.189	0.182	Cl	36.1	36.7
CaO	0.075	0.045	Cr	<0.0005	0.0011
Cr_2O_3	0.520	0.577	Fe	0.0004	0.0193
FeO	8.27	8.59	Mg	0.0005	3.3500
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	40.1	33.7	K	0.0022	0.0036
NiO	0.545	0.518	Si	0.0028	0.0394
K_2O	0.006	0.006	Na	35.60	33.40
SiO_2	39.8	40.9	CO_2	26.50	35.40
Na_2O	0.016	1.402	HCO_3	33.50	53.70
CO_2	0.01	0.7			
C, noncarbonate	0.006	0.028	pH	7.92	7.29
H_2O, dehyd.[1]	0.280	2.850			
H_2O, chem.[2]	1.183	1.962			
Total	91.019	91.344			
LOI, total[3]	1.48	5.5			
Extent of carbonation, %[4]		0.6			

Carbonation test #SC-278 **SW OR Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.534	1.345	Cl	36.8	35.9
CaO	0.395	0.192	Cr	<0.0005	<0.0005
Cr_2O_3	0.231	0.208	Fe	0.0005	0.0004
FeO	1.88	1.52	Mg	0.0005	0.0374
Fe_2O_3	4.189	3.717	Ni	<0.0005	<0.0005
MgO	37.3	23.2	K	0.0023	0.0052
NiO	0.216	0.183	Si	0.0042	0.0397
K_2O	0.016	0.022	Na	35.60	33.20
SiO_2	37.2	31.4	CO_2	27.00	23.10
Na_2O	0.027	2.211	HCO_3	33.80	29.40
CO_2	0.02	14.0			
C, noncarbonate	0.033	0.209	pH	7.98	7.67
H_2O, dehyd.[1]	2.830	3.390			
H_2O, chem.[2]	15.518	11.401			
Total	101.417	93.056			
LOI, total[3]	18.40	29.0			
Extent of carbonation, %[4]		36.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-279 **CH Serp B2NM**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.171	0.124	Cl	36.8	36.1
CaO	0.157	0.189	Cr	<0.0005	<0.0005
Cr_2O_3	0.061	0.045	Fe	0.0005	0.0004
FeO	1.83	1.67	Mg	0.0005	0.0164
Fe_2O_3	2.588	2.145	Ni	<0.0005	<0.0005
MgO	42.9	35.8	K	0.0023	0.0041
NiO	0.214	0.187	Si	0.0042	0.0300
K_2O	0.009	0.004	Na	35.60	37.70
SiO_2	35.9	30.8	CO_2	27.00	23.90
Na_2O	0.021	1.150	HCO_3	33.80	31.00
CO_2	0.02	16.9			
C, noncarbonate	0.029	0.218	pH	7.98	7.77
H_2O, dehyd.[1]	2.410	2.610			
H_2O, chem.[2]	15.046	8.172			
Total	101.433	100.036			
LOI, total[3]	17.50	27.9			
Extent of carbonation, %[4]		38.5			

Carbonation test #SC-280 **CH Serp B2NM**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.171	0.146	Cl	36.8	36.0
CaO	0.157	0.172	Cr	<0.0005	<0.0005
Cr_2O_3	0.061	0.091	Fe	0.0005	0.0005
FeO	1.83	1.30	Mg	0.0006	0.0150
Fe_2O_3	2.588	2.087	Ni	<0.0005	<0.0005
MgO	42.9	34.3	K	0.0021	0.0044
NiO	0.214	0.210	Si	0.0023	0.0299
K_2O	0.009	0.005	Na	38.80	33.80
SiO_2	35.9	30.0	CO_2	27.10	23.90
Na_2O	0.021	2.939	HCO_3	35.80	30.20
CO_2	0.02	18.1			
C, noncarbonate	0.029	0.310	pH	7.90	7.77
H_2O, dehyd.[1]	2.410	3.310			
H_2O, chem.[2]	15.046	8.880			
Total	101.433	101.821			
LOI, total[3]	17.50	30.6			
Extent of carbonation, %[4]		42.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-281 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.215	0.127	Cl	37.2	36.5
CaO	0.224	0.207	Cr	<0.0005	<0.0005
Cr_2O_3	0.782	0.541	Fe	0.0005	0.0006
FeO	11.31	7.53	Mg	0.0006	0.0318
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	30.0	K	0.0021	0.0052
NiO	0.323	0.211	Si	0.0025	0.0418
K_2O	0.010	0.005	Na	36.70	35.60
SiO_2	39.4	23.3	CO_2	26.90	25.80
Na_2O	0.218	2.332	HCO_3	34.10	34.40
CO_2	0.16	31.4			
C, noncarbonate	0.120	0.110	pH	7.82	7.74
H_2O, dehyd.[1]	0.810	0.770			
H_2O, chem.[2]	1.478	3.420			
Total	100.777	99.979			
LOI, total[3]	2.57	35.7			
Extent of carbonation, %[4]		79.5			

Carbonation test #SC-282 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.215	0.210	Cl	37.2	36.2
CaO	0.224	0.211	Cr	<0.0005	0.0040
Cr_2O_3	0.782	0.764	Fe	0.0005	0.0110
FeO	11.31	11.19	Mg	0.0006	0.1940
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	44.4	K	0.0021	0.0036
NiO	0.323	0.316	Si	0.0025	0.0290
K_2O	0.010	0.006	Na	36.70	35.60
SiO_2	39.4	38.5	CO_2	26.90	27.00
Na_2O	0.218	0.979	HCO_3	34.10	36.00
CO_2	0.16	0.6			
C, noncarbonate	0.120	0.099	pH	7.82	7.45
H_2O, dehyd.[1]	0.810	0.960			
H_2O, chem.[2]	1.478	0.000			
Total	100.777	98.241			
LOI, total[3]	2.57	0.8			
Extent of carbonation, %[4]		0.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-283 **SW OR Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.534	1.292	Cl	36.0	34.9
CaO	0.395	0.534	Cr	<0.0005	<0.0005
Cr_2O_3	0.231	0.210	Fe	0.0005	0.0006
FeO	1.88	1.38	Mg	0.0005	0.0252
Fe_2O_3	4.189	3.489	Ni	<0.0005	<0.0005
MgO	34.3	30.7	K	0.0022	0.0053
NiO	0.216	0.174	Si	0.0022	0.0482
K_2O	0.016	0.026	Na	36.40	34.00
SiO_2	37.2	30.4	CO_2	27.10	23.20
Na_2O	0.027	2.992	HCO_3	34.90	30.00
CO_2	0.02	14.4			
C, noncarbonate	0.033	0.010	pH	7.91	7.71
H_2O, dehyd.[1]	2.830	4.860			
H_2O, chem.[2]	15.518	10.430			
Total	98.432	100.848			
LOI, total[3]	18.40	29.7			
Extent of carbonation, %[4]		40.5			

Carbonation test #SC-284 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.229	0.171	Cl	36.0	34.7
CaO	0.266	0.274	Cr	<0.0005	<0.0005
Cr_2O_3	0.858	0.573	Fe	0.0005	0.0008
FeO	11.32	7.51	Mg	0.0005	0.0338
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	29.7	K	0.0022	0.0050
NiO	0.316	0.211	Si	0.0022	0.0405
K_2O	0.006	0.004	Na	36.40	34.70
SiO_2	38.1	50.1	CO_2	27.10	25.00
Na_2O	0.503	0.884	HCO_3	34.90	31.90
CO_2	0.37	32.4			
C, noncarbonate	0.120	0.467	pH	7.91	7.86
H_2O, dehyd.[1]	1.060	0.600			
H_2O, chem.[2]	1.457	1.533			
Total	100.350	124.370			
LOI, total[3]	3.01	35.0			
Extent of carbonation, %[4]		83.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-285 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.510	0.516	Cl	36.0	35.6
CaO	0.192	0.211	Cr	<0.0005	<0.0005
Cr_2O_3	0.087	0.068	Fe	0.0005	0.0006
FeO	7.68	7.35	Mg	0.0006	0.0254
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.3	43.1	K	0.0024	0.0144
NiO	0.261	0.223	Si	0.0021	0.0317
K_2O	0.068	0.073	Na	37.30	36.30
SiO_2	22.7	43.2	CO_2	27.40	26.40
Na_2O	0.026	0.433	HCO_3	34.80	33.90
CO_2	0.02	4.0			
C, noncarbonate	0.112	0.164	pH	7.83	7.83
H_2O, dehyd.[1]	0.150	0.190			
H_2O, chem.[2]	0.709	0.736			
Total	77.756	100.263			
LOI, total[3]	0.99	5.1			
Extent of carbonation, %[4]		7.4			

Carbonation test #SC-286 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.229	0.143	Cl	35.7	35.6
CaO	0.266	0.134	Cr	<0.0005	<0.0005
Cr_2O_3	0.858	0.617	Fe	0.0007	0.0008
FeO	11.32	8.21	Mg	0.0005	0.0224
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	31.5	K	0.0025	0.0058
NiO	0.316	0.237	Si	0.0045	0.0430
K_2O	0.006	0.007	Na	36.00	36.10
SiO_2	38.1	28.5	CO_2	26.90	26.00
Na_2O	0.503	3.774	HCO_3	34.60	33.30
CO_2	0.37	19.6			
C, noncarbonate	0.120	0.061	pH	7.80	7.85
H_2O, dehyd.[1]	1.060	1.540			
H_2O, chem.[2]	1.457	4.299			
Total	100.350	98.576			
LOI, total[3]	3.01	25.5			
Extent of carbonation, %[4]		42.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-287 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.297	0.197	Cl	35.7	35.0
CaO	0.158	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.240	0.184	Fe	0.0007	0.0006
FeO	7.73	6.57	Mg	0.0005	0.0648
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.6	41.3	K	0.0025	0.0055
NiO	0.367	0.286	Si	0.0045	0.0365
K_2O	0.019	0.015	Na	36.00	37.10
SiO_2	43.4	35.9	CO_2	26.90	26.40
Na_2O	0.075	0.226	HCO_3	34.60	34.50
CO_2	0.06	16.3			
C, noncarbonate	0.069	0.221	pH	7.80	7.76
H_2O, dehyd.[1]	0.160	0.180			
H_2O, chem.[2]	0.185	0.399			
Total	101.366	101.959			
LOI, total[3]	0.47	17.1			
Extent of carbonation, %[4]		33.6			

Carbonation test #SC-288 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.161	0.153	Cl	37.0	36.3
CaO	0.262	0.203	Cr	<0.0005	<0.0005
Cr_2O_3	0.305	0.229	Fe	0.0006	0.0005
FeO	8.48	6.78	Mg	0.0005	0.0638
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	39.5	K	0.0022	0.0043
NiO	0.421	0.322	Si	0.0026	0.0430
K_2O	0.005	0.004	Na	40.60	35.60
SiO_2	40.4	31.0	CO_2	26.80	27.00
Na_2O	0.136	0.268	HCO_3	35.90	34.90
CO_2	0.10	21.2			
C, noncarbonate	0.038	0.214	pH	7.72	7.80
H_2O, dehyd.[1]	0.210	0.200			
H_2O, chem.[2]	0.371	0.486			
Total	102.321	100.542			
LOI, total[3]	0.72	22.1			
Extent of carbonation, %[4]		43.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-289 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.229	0.176	Cl	36.8	36.5
CaO	0.266	0.136	Cr	<0.0005	<0.0005
Cr_2O_3	0.858	0.653	Fe	0.0006	0.0004
FeO	11.32	7.46	Mg	0.0005	0.0480
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	32.0	K	0.0021	0.0050
NiO	0.316	0.230	Si	0.0021	0.0325
K_2O	0.006	0.007	Na	37.50	35.40
SiO_2	38.1	26.3	CO_2	27.20	26.00
Na_2O	0.503	3.707	HCO_3	36.20	33.40
CO_2	0.37	27.7			
C, noncarbonate	0.120	0.060	pH	7.61	7.75
H_2O, dehyd.[1]	1.060	0.760			
H_2O, chem.[2]	1.457	4.380			
Total	100.350	103.586			
LOI, total[3]	3.01	32.9			
Extent of carbonation, %[4]		66.3			

Carbonation test #SC-290 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.229	0.198	Cl	36.8	36.6
CaO	0.266	0.144	Cr	<0.0005	<0.0005
Cr_2O_3	0.858	0.731	Fe	0.0006	0.0006
FeO	11.32	9.53	Mg	0.0005	0.3110
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.8	39.1	K	0.0021	0.0046
NiO	0.316	0.266	Si	0.0021	0.0436
K_2O	0.006	0.005	Na	37.50	35.60
SiO_2	38.1	32.5	CO_2	27.20	27.20
Na_2O	0.503	2.413	HCO_3	36.20	33.80
CO_2	0.37	13.5			
C, noncarbonate	0.120	0.176	pH	7.61	7.62
H_2O, dehyd.[1]	1.060	0.750			
H_2O, chem.[2]	1.457	3.374			
Total	100.350	102.738			
LOI, total[3]	3.01	17.8			
Extent of carbonation, %[4]		26.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-291 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.173	0.145	Cl	37.0	35.6
CaO	0.151	0.168	Cr	<0.0005	<0.0005
Cr_2O_3	0.246	0.206	Fe	0.0008	0.0007
FeO	7.32	7.50	Mg	0.0007	0.0838
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	40.5	K	0.0024	0.0047
NiO	0.368	0.337	Si	0.0019	0.0383
K_2O	0.004	0.004	Na	36.40	34.70
SiO_2	40.6	36.8	CO_2	27.00	26.00
Na_2O	0.090	0.189	HCO_3	34.70	34.10
CO_2	0.07	8.9			
C, noncarbonate	0.031	0.129	pH	7.74	7.77
H_2O, dehyd.[1]	0.130	0.110			
H_2O, chem.[2]	0.492	0.481			
Total	96.642	95.393			
LOI, total[3]	0.72	9.6			
Extent of carbonation, %[4]		17.4			

Carbonation test #SC-292 **Ivtek magnetite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.045	0.032	Cl	37.0	36.4
CaO	0.806	0.737	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.009	Fe	0.0008	0.0007
FeO	28.17	27.92	Mg	0.0007	0.0136
Fe_2O_3	57.761	60.192	Ni	<0.0005	<0.0005
MgO	0.4	0.5	K	0.0024	0.0232
NiO	<0.01	<0.01	Si	0.0019	0.0366
K_2O	0.013	0.007	Na	36.40	35.10
SiO_2	5.5	5.5	CO_2	27.00	26.80
Na_2O	0.036	0.065	HCO_3	34.70	35.90
CO_2	0.03	1.5			
C, noncarbonate	0.047	0.044	pH	7.74	7.62
H_2O, dehyd.[1]	0.000	0.000			
H_2O, chem.[2]	1.717	0.306			
Total	94.523	96.775			
LOI, total[3]	1.79	1.8			
Extent of carbonation, %[4]		0.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-293 **SW OR Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.547	1.481	Cl	36.9	37.1
CaO	0.388	0.379	Cr	<0.0005	<0.0005
Cr_2O_3	0.361	0.336	Fe	0.0005	0.0017
FeO	2.79	2.57	Mg	0.0005	0.0466
Fe_2O_3	4.804	3.460	Ni	<0.0005	<0.0005
MgO	35.8	34.5	K	0.0022	0.0069
NiO	0.258	0.241	Si	0.0027	0.0300
K_2O	0.025	0.016	Na	38.00	38.00
SiO_2	38.5	37.7	CO_2	26.80	25.80
Na_2O	1.100	2.750	HCO_3	34.60	32.60
CO_2	0.82	1.5			
C, noncarbonate	0.060	0.091	pH	7.89	7.97
H_2O, dehyd.[1]	2.920	2.050			
H_2O, chem.[2]	12.104	14.489			
Total	101.497	101.476			
LOI, total[3]	15.90	18.1			
Extent of carbonation, %[4]		3.0			

Carbonation test #SC-294 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.206	Cl	36.9	36.5
CaO	0.200	0.194	Cr	<0.0005	<0.0005
Cr_2O_3	0.183	0.155	Fe	0.0005	0.0007
FeO	8.17	8.71	Mg	0.0005	0.0234
Fe_2O_3	<0.01	0.257	Ni	<0.0005	<0.0005
MgO	49.9	48.6	K	0.0022	0.0043
NiO	0.336	0.340	Si	0.0027	0.0408
K_2O	0.007	0.007	Na	38.00	35.00
SiO_2	40.2	38.9	CO_2	26.80	26.70
Na_2O	0.090	0.199	HCO_3	34.60	35.20
CO_2	0.07	2.6			
C, noncarbonate	0.069	0.102	pH	7.89	7.75
H_2O, dehyd.[1]	0.210	0.170			
H_2O, chem.[2]	0.934	0.878			
Total	100.577	101.306			
LOI, total[3]	1.28	3.7			
Extent of carbonation, %[4]		4.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-295 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.167	Cl	37.0	35.9
CaO	0.255	0.221	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.165	Fe	0.0006	0.0004
FeO	8.16	6.45	Mg	0.0005	0.0566
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	39.1	K	0.0023	0.0037
NiO	0.298	0.233	Si	0.0021	0.0456
K_2O	0.005	0.006	Na	36.20	35.20
SiO_2	40.2	31.2	CO_2	26.60	26.40
Na_2O	0.047	0.244	HCO_3	33.50	35.60
CO_2	0.03	21.8			
C, noncarbonate	0.028	0.140	pH	7.96	7.72
H_2O, dehyd.[1]	0.180	0.160			
H_2O, chem.[2]	0.637	2.400			
Total	100.721	102.346			
LOI, total[3]	0.88	24.5			
Extent of carbonation, %[4]		46.1			

Carbonation test #SC-296 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.191	Cl	37.1	36.3
CaO	0.255	0.339	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.158	Fe	0.0007	0.0005
FeO	8.16	7.91	Mg	0.0006	0.0234
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	38.6	K	0.0022	0.0034
NiO	0.298	0.267	Si	0.0024	0.0328
K_2O	0.005	0.005	Na	36.20	35.00
SiO_2	40.2	37.0	CO_2	27.30	26.40
Na_2O	0.047	0.216	HCO_3	36.00	34.70
CO_2	0.03	6.9			
C, noncarbonate	0.028	0.151	pH	7.83	7.85
H_2O, dehyd.[1]	0.180	0.190			
H_2O, chem.[2]	0.637	0.529			
Total	100.721	92.521			
LOI, total[3]	0.88	7.8			
Extent of carbonation, %[4]		12.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-297 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.149	Cl	37.1	36.8
CaO	0.255	0.154	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.145	Fe	0.0007	0.0007
FeO	8.16	6.93	Mg	0.0006	0.0418
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	41.5	K	0.0022	0.0039
NiO	0.298	0.234	Si	0.0024	0.0242
K_2O	0.005	0.003	Na	36.20	35.00
SiO_2	40.2	32.7	CO_2	27.30	26.80
Na_2O	0.047	0.255	HCO_3	36.00	34.70
CO_2	0.03	17.8			
C, noncarbonate	0.028	0.292	pH	7.83	7.81
H_2O, dehyd.[1]	0.180	0.080			
H_2O, chem.[2]	0.637	0.328			
Total	100.721	100.557			
LOI, total[3]	0.88	18.5			
Extent of carbonation, %[4]		35.7			

Carbonation test #SC-298 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.142	Cl	37.1	36.8
CaO	0.255	0.160	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.113	Fe	0.0007	0.0008
FeO	8.16	6.01	Mg	0.0006	0.0540
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	36.8	K	0.0022	0.0038
NiO	0.298	0.210	Si	0.0029	0.0277
K_2O	0.005	0.003	Na	35.80	35.10
SiO_2	40.2	29.7	CO_2	27.20	27.10
Na_2O	0.047	0.332	HCO_3	35.80	35.30
CO_2	0.03	25.4			
C, noncarbonate	0.028	0.408	pH	7.72	7.71
H_2O, dehyd.[1]	0.180	0.140			
H_2O, chem.[2]	0.637	0.452			
Total	100.721	99.912			
LOI, total[3]	0.88	26.4			
Extent of carbonation, %[4]		56.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-299 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.178	Cl	37.1	36.5
CaO	0.255	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.129	Fe	0.0007	0.0005
FeO	8.16	6.23	Mg	0.0006	0.0300
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	41.8	K	0.0022	0.0037
NiO	0.298	0.216	Si	0.0029	0.0298
K_2O	0.005	0.007	Na	35.80	33.80
SiO_2	40.2	33.2	CO_2	27.20	26.40
Na_2O	0.047	0.270	HCO_3	35.80	35.20
CO_2	0.03	16.5			
C, noncarbonate	0.028	0.297	pH	7.72	7.81
H_2O, dehyd.[1]	0.180	0.200			
H_2O, chem.[2]	0.637	0.403			
Total	100.721	99.510			
LOI, total[3]	0.88	17.4			
Extent of carbonation, %[4]		32.6			

Carbonation test #SC-300 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.179	Cl	36.9	36.4
CaO	0.255	0.124	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.142	Fe	0.0005	0.0005
FeO	8.16	7.22	Mg	0.0005	0.0366
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	43.1	K	0.0022	0.0040
NiO	0.298	0.225	Si	0.0029	0.0309
K_2O	0.005	0.005	Na	36.10	34.00
SiO_2	40.2	34.0	CO_2	27.40	26.20
Na_2O	0.047	0.255	HCO_3	35.30	33.60
CO_2	0.03	14.3			
C, noncarbonate	0.028	0.247	pH	7.71	7.78
H_2O, dehyd.[1]	0.180	0.190			
H_2O, chem.[2]	0.637	0.463			
Total	100.721	100.472			
LOI, total[3]	0.88	15.2			
Extent of carbonation, %[4]		27.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-301 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.151	Cl	36.9	36.7
CaO	0.255	0.144	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.113	Fe	0.0005	0.0005
FeO	8.16	6.61	Mg	0.0005	0.0420
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	38.6	K	0.0022	0.0038
NiO	0.298	0.201	Si	0.0029	0.0294
K_2O	0.005	0.006	Na	36.10	34.60
SiO_2	40.2	30.6	CO_2	27.40	26.70
Na_2O	0.047	0.318	HCO_3	35.30	35.00
CO_2	0.03	22.8			
C, noncarbonate	0.028	0.327	pH	7.71	7.73
H_2O, dehyd.[1]	0.180	0.140			
H_2O, chem.[2]	0.637	0.533			
Total	100.721	100.571			
LOI, total[3]	0.88	23.8			
Extent of carbonation, %[4]		48.8			

Carbonation test #SC-302 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.149	Cl	36.9	36.4
CaO	0.255	0.143	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.136	Fe	0.0005	0.0004
FeO	8.16	6.59	Mg	0.0005	0.0444
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	37.5	K	0.0024	0.0040
NiO	0.298	0.206	Si	0.0037	0.0326
K_2O	0.005	0.006	Na	35.40	34.20
SiO_2	40.2	29.7	CO_2	27.10	26.30
Na_2O	0.047	0.295	HCO_3	35.90	34.70
CO_2	0.03	23.8			
C, noncarbonate	0.028	0.335	pH	7.74	7.72
H_2O, dehyd.[1]	0.180	0.110			
H_2O, chem.[2]	0.637	0.555			
Total	100.721	99.531			
LOI, total[3]	0.88	24.8			
Extent of carbonation, %[4]		51.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-303 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.197	0.149	Cl	36.9	36.1
CaO	0.255	0.127	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.139	Fe	0.0005	0.0007
FeO	8.16	6.72	Mg	0.0005	0.0398
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	40.1	K	0.0024	0.0043
NiO	0.298	0.229	Si	0.0037	0.0348
K_2O	0.005	0.009	Na	35.40	35.20
SiO_2	40.2	31.0	CO_2	27.10	26.30
Na_2O	0.047	0.427	HCO_3	35.90	33.50
CO_2	0.03	21.2			
C, noncarbonate	0.028	0.314	pH	7.74	7.80
H_2O, dehyd.[1]	0.180	0.160			
H_2O, chem.[2]	0.637	0.426			
Total	100.721	101.041			
LOI, total[3]	0.88	22.1			
Extent of carbonation, %[4]		44.4			

Carbonation test #SC-304 **Siletz basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	15.456	11.375	Cl	37.0	36.8
CaO	10.158	12.397	Cr	<0.0005	<0.0005
Cr_2O_3	0.038	0.083	Fe	0.0008	0.0011
FeO	6.79	7.27	Mg	0.0005	0.0140
Fe_2O_3	3.103	2.531	Ni	<0.0005	<0.0005
MgO	8.0	8.2	K	0.0022	0.0502
NiO	0.008	0.037	Si	0.0023	0.0237
K_2O	0.154	0.149	Na	39.50	37.00
SiO_2	45.1	43.6	CO_2	26.90	24.20
Na_2O	2.561	3.923	HCO_3	34.90	31.50
CO_2	1.90	1.4			
C, noncarbonate	0.002	0.069	pH	7.96	7.67
H_2O, dehyd.[1]	3.090	2.670			
H_2O, chem.[2]	2.338	25.631			
Total	98.698	119.445			
LOI, total[3]	7.33	29.8			
Extent of carbonation, %[4]		5.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-305 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.170	Cl	37.2	36.2
CaO	0.193	0.111	Cr	<0.0005	<0.0005
Cr_2O_3	0.867	0.643	Fe	0.0006	0.0006
FeO	11.63	7.85	Mg	0.0006	0.1030
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	34.8	K	0.0026	0.0060
NiO	0.339	0.253	Si	0.0022	0.0358
K_2O	0.011	0.008	Na	35.50	34.20
SiO_2	38.7	27.8	CO_2	27.20	25.60
Na_2O	0.325	2.399	HCO_3	34.70	33.10
CO_2	0.24	23.2			
C, noncarbonate	0.115	0.328	pH	7.89	7.68
H_2O, dehyd.[1]	0.860	0.810			
H_2O, chem.[2]	1.464	3.762			
Total	103.076	102.162			
LOI, total[3]	2.68	28.1			
Extent of carbonation, %[4]		50.0			

Carbonation test #SC-306 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.152	Cl	37.2	36.4
CaO	0.193	0.130	Cr	<0.0005	<0.0005
Cr_2O_3	0.867	0.580	Fe	0.0006	0.0004
FeO	11.63	8.12	Mg	0.0006	0.1040
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	33.2	K	0.0026	0.0052
NiO	0.339	0.220	Si	0.0022	0.0308
K_2O	0.011	0.006	Na	35.50	34.00
SiO_2	38.7	27.2	CO_2	27.20	25.50
Na_2O	0.325	2.157	HCO_3	34.70	34.50
CO_2	0.24	26.3			
C, noncarbonate	0.115	0.342	pH	7.89	7.63
H_2O, dehyd.[1]	0.860	0.660			
H_2O, chem.[2]	1.464	2.498			
Total	103.076	101.493			
LOI, total[3]	2.68	29.8			
Extent of carbonation, %[4]		59.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-307 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.212	Cl	37.0	36.8
CaO	0.193	0.172	Cr	<0.0005	<0.0005
Cr_2O_3	0.867	0.744	Fe	0.0008	0.0005
FeO	11.63	10.52	Mg	0.0005	0.1230
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	42.8	K	0.0022	0.0051
NiO	0.339	0.272	Si	0.0023	0.0306
K_2O	0.011	0.005	Na	39.50	34.00
SiO_2	38.7	35.1	CO_2	26.90	26.80
Na_2O	0.325	2.413	HCO_3	34.90	35.30
CO_2	0.24	6.9			
C, noncarbonate	0.115	0.192	pH	7.96	7.68
H_2O, dehyd.[1]	0.860	0.880			
H_2O, chem.[2]	1.464	3.148			
Total	103.076	103.304			
LOI, total[3]	2.68	11.1			
Extent of carbonation, %[4]		11.9			

Carbonation test #SC-308 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.179	Cl	37.2	36.5
CaO	0.193	0.250	Cr	<0.0005	<0.0005
Cr_2O_3	0.867	0.697	Fe	0.0005	0.0005
FeO	11.63	8.95	Mg	0.0005	0.1280
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	37.3	K	0.0021	0.0050
NiO	0.339	0.246	Si	0.0028	0.0530
K_2O	0.011	0.005	Na	33.80	33.70
SiO_2	38.7	31.2	CO_2	27.20	26.60
Na_2O	0.325	2.305	HCO_3	34.50	34.90
CO_2	0.24	16.1			
C, noncarbonate	0.115	0.276	pH	7.89	7.71
H_2O, dehyd.[1]	0.860	0.750			
H_2O, chem.[2]	1.464	3.574			
Total	103.076	101.877			
LOI, total[3]	2.68	20.7			
Extent of carbonation, %[4]		31.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-309 **Penn MD Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.251	0.231	Cl	37.2	36.4
CaO	0.239	0.292	Cr	<0.0005	<0.0005
Cr_2O_3	0.070	0.061	Fe	0.0005	0.0005
FeO	3.13	2.97	Mg	0.0005	0.0256
Fe_2O_3	4.089	3.875	Ni	<0.0005	<0.0005
MgO	41.8	40.6	K	0.0021	0.0048
NiO	0.153	0.149	Si	0.0028	0.0298
K_2O	0.290	0.369	Na	33.80	36.40
SiO_2	36.8	36.2	CO_2	27.20	26.80
Na_2O	2.453	2.292	HCO_3	34.50	35.00
CO_2	1.82	4.7			
C, noncarbonate	0.039	0.098	pH	7.89	7.62
H_2O, dehyd.[1]	0.420	0.260			
H_2O, chem.[2]	11.421	10.382			
Total	102.952	102.417			
LOI, total[3]	13.70	15.4			
Extent of carbonation, %[4]		7.6			

Carbonation test #SC-310 **Penn MD Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.251	0.188	Cl	36.8	36.4
CaO	0.239	0.316	Cr	<0.0005	<0.0005
Cr_2O_3	0.070	0.064	Fe	0.0006	0.0006
FeO	3.13	2.92	Mg	0.0005	0.0248
Fe_2O_3	4.089	3.889	Ni	<0.0005	<0.0005
MgO	41.8	41.0	K	0.0024	0.0052
NiO	0.153	0.153	Si	0.0021	0.0338
K_2O	0.290	0.317	Na	36.10	34.80
SiO_2	36.8	36.2	CO_2	27.20	26.70
Na_2O	2.453	2.062	HCO_3	34.40	36.40
CO_2	1.82	4.7			
C, noncarbonate	0.039	0.119	pH	7.86	7.60
H_2O, dehyd.[1]	0.420	0.190			
H_2O, chem.[2]	11.421	10.661			
Total	102.952	102.719			
LOI, total[3]	13.70	15.7			
Extent of carbonation, %[4]		7.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-311 **FG Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.123	0.082	Cl	36.8	36.3
CaO	0.210	0.139	Cr	<0.0005	<0.0005
Cr_2O_3	0.278	0.229	Fe	0.0006	0.0004
FeO	7.14	6.36	Mg	0.0005	0.0532
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.7	39.5	K	0.0024	0.0041
NiO	0.407	0.294	Si	0.0021	0.0312
K_2O	0.004	0.003	Na	36.10	34.20
SiO_2	40.4	31.4	CO_2	27.20	26.40
Na_2O	0.063	0.243	HCO_3	34.40	32.80
CO_2	0.05	21.8			
C, noncarbonate	0.067	0.260	pH	7.86	7.72
H_2O, dehyd.[1]	0.100	0.110			
H_2O, chem.[2]	0.356	0.330			
Total	99.965	100.755			
LOI, total[3]	0.57	22.5			
Extent of carbonation, %[4]		46.5			

Carbonation test #SC-312 **SW OR Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.453	1.553	Cl	37.0	36.2
CaO	0.449	0.547	Cr	<0.0005	<0.0005
Cr_2O_3	0.284	0.289	Fe	0.0004	0.0006
FeO	2.82	2.50	Mg	0.0007	0.0380
Fe_2O_3	3.617	3.517	Ni	<0.0005	<0.0005
MgO	38.8	38.0	K	0.0025	0.0050
NiO	0.242	0.255	Si	0.0024	0.0416
K_2O	0.016	0.018	Na	34.10	33.40
SiO_2	38.7	38.5	CO_2	27.20	26.10
Na_2O	0.067	0.252	HCO_3	34.80	35.00
CO_2	0.05	1.6			
C, noncarbonate	0.094	0.106	pH	7.80	7.66
H_2O, dehyd.[1]	1.510	1.370			
H_2O, chem.[2]	13.347	12.564			
Total	101.465	101.004			
LOI, total[3]	15.00	15.6			
Extent of carbonation, %[4]		3.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-313 **CH Serp**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.202	0.165	Cl	37.0	36.0
CaO	0.133	0.139	Cr	<0.0005	<0.0005
Cr_2O_3	0.260	0.265	Fe	0.0004	0.0005
FeO	3.33	3.05	Mg	0.0007	0.0262
Fe_2O_3	1.630	1.587	Ni	<0.0005	<0.0005
MgO	44.3	40.8	K	0.0025	0.0038
NiO	0.290	0.276	Si	0.0024	0.0362
K_2O	0.005	0.013	Na	34.10	34.90
SiO_2	37.4	34.4	CO_2	27.20	24.40
Na_2O	0.081	2.251	HCO_3	34.80	31.90
CO_2	0.06	6.8			
C, noncarbonate	0.065	0.165	pH	7.80	7.73
H_2O, dehyd.[1]	1.070	0.920			
H_2O, chem.[2]	14.005	11.955			
Total	102.842	102.776			
LOI, total[3]	15.20	19.8			
Extent of carbonation, %[4]		12.3			

Carbonation test #SC-314 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.195	0.215	Cl	36.8	35.9
CaO	0.168	0.196	Cr	<0.0005	<0.0005
Cr_2O_3	0.134	0.063	Fe	0.0005	0.0159
FeO	8.12	7.89	Mg	0.0005	0.4890
Fe_2O_3	0.500	0.929	Ni	<0.0005	<0.0005
MgO	50.2	49.6	K	0.0025	0.0069
NiO	0.290	0.274	Si	0.0025	0.0368
K_2O	0.009	0.006	Na	34.20	31.70
SiO_2	40.2	40.4	CO_2	26.60	28.10
Na_2O	0.167	0.126	HCO_3	33.90	38.80
CO_2	0.12	0.3			
C, noncarbonate	0.084	0.108	pH	7.94	7.39
H_2O, dehyd.[1]	0.240	0.210			
H_2O, chem.[2]	1.152	1.132			
Total	101.640	101.414			
LOI, total[3]	1.60	1.7			
Extent of carbonation, %[4]		0.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-315 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.195	0.212	Cl	36.8	33.8
CaO	0.168	0.160	Cr	<0.0005	0.0029
Cr_2O_3	0.134	0.069	Fe	0.0005	0.0185
FeO	8.12	8.07	Mg	0.0005	0.4470
Fe_2O_3	0.500	1.187	Ni	<0.0005	<0.0005
MgO	50.2	49.9	K	0.0025	0.0053
NiO	0.290	0.266	Si	0.0025	0.0358
K_2O	0.009	0.006	Na	34.20	32.90
SiO_2	40.2	40.4	CO_2	26.60	27.70
Na_2O	0.167	0.163	HCO_3	33.90	<0.0001
CO_2	0.12	0.0			
C, noncarbonate	0.084	0.144	pH	7.94	7.91
H_2O, dehyd.[1]	0.240	0.190			
H_2O, chem.[2]	1.152	1.156			
Total	101.640	101.959			
LOI, total[3]	1.60	1.5			
Extent of carbonation, %[4]		-0.3			

Carbonation test #SC-316 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.162	Cl	36.8	36.6
CaO	0.204	0.157	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.043	Fe	0.0005	0.0004
FeO	7.64	6.88	Mg	0.0005	0.0350
Fe_2O_3	0.486	1.558	Ni	<0.0005	<0.0005
MgO	49.4	41.6	K	0.0025	0.0084
NiO	0.229	0.195	Si	0.0025	0.0292
K_2O	0.006	0.014	Na	34.20	33.10
SiO_2	40.4	33.2	CO_2	26.60	25.90
Na_2O	0.015	0.350	HCO_3	33.90	35.50
CO_2	0.01	16.7			
C, noncarbonate	0.098	0.322	pH	7.94	7.73
H_2O, dehyd.[1]	0.100	0.070			
H_2O, chem.[2]	1.041	0.708			
Total	99.867	101.939			
LOI, total[3]	1.25	17.8			
Extent of carbonation, %[4]		34.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-317 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.145	Cl	36.8	36.3
CaO	0.204	0.094	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.039	Fe	0.0005	0.0004
FeO	7.64	6.69	Mg	0.0005	0.0314
Fe_2O_3	0.486	0.500	Ni	<0.0005	<0.0005
MgO	49.4	37.3	K	0.0023	0.0107
NiO	0.229	0.191	Si	0.0018	0.0302
K_2O	0.006	0.006	Na	33.40	32.90
SiO_2	40.4	33.2	CO_2	25.70	24.90
Na_2O	0.015	0.336	HCO_3	32.30	32.40
CO_2	0.01	17.0			
C, noncarbonate	0.098	0.300	pH	7.88	7.89
H_2O, dehyd.[1]	0.100	0.070			
H_2O, chem.[2]	1.041	0.730			
Total	99.867	96.567			
LOI, total[3]	1.25	18.1			
Extent of carbonation, %[4]		34.8			

Carbonation test #SC-318 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.160	0.140	Cl	36.8	35.1
CaO	0.204	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.031	0.042	Fe	0.0005	0.0004
FeO	7.64	6.82	Mg	0.0005	0.0412
Fe_2O_3	0.486	0.458	Ni	<0.0005	<0.0005
MgO	49.4	41.1	K	0.0023	0.0149
NiO	0.229	0.191	Si	0.0018	0.0318
K_2O	0.006	0.007	Na	33.40	31.20
SiO_2	40.4	33.2	CO_2	25.70	23.50
Na_2O	0.015	0.317	HCO_3	32.30	32.30
CO_2	0.01	17.1			
C, noncarbonate	0.098	0.273	pH	7.88	7.71
H_2O, dehyd.[1]	0.100	0.000			
H_2O, chem.[2]	1.041	0.927			
Total	99.867	100.719			
LOI, total[3]	1.25	18.3			
Extent of carbonation, %[4]		35.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-319 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.195	0.154	Cl	37.4	36.2
CaO	0.168	0.227	Cr	<0.0005	<0.0005
Cr_2O_3	0.134	0.077	Fe	0.0004	0.0005
FeO	8.12	7.24	Mg	0.0005	0.0520
Fe_2O_3	0.500	0.343	Ni	<0.0005	<0.0005
MgO	50.2	43.8	K	0.0026	0.0059
NiO	0.290	0.210	Si	0.0027	0.0448
K_2O	0.009	0.007	Na	33.60	32.60
SiO_2	40.2	35.9	CO_2	26.80	26.80
Na_2O	0.167	0.518	HCO_3	35.50	35.00
CO_2	0.12	10.5			
C, noncarbonate	0.084	0.204	pH	7.93	7.75
H_2O, dehyd.[1]	0.240	0.270			
H_2O, chem.[2]	1.152	1.126			
Total	101.640	100.593			
LOI, total[3]	1.60	12.1			
Extent of carbonation, %[4]		19.3			

Carbonation test #SC-320 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.510	0.472	Cl	37.4	35.5
CaO	0.157	0.172	Cr	<0.0005	0.0005
Cr_2O_3	2.295	2.017	Fe	0.0004	0.0005
FeO	14.67	11.14	Mg	0.0005	0.0346
Fe_2O_3	2.059	1.816	Ni	<0.0005	<0.0005
MgO	37.5	33.3	K	0.0026	0.0045
NiO	0.382	0.344	Si	0.0027	0.0395
K_2O	0.004	0.004	Na	33.60	30.60
SiO_2	30.8	28.2	CO_2	26.80	23.10
Na_2O	0.028	3.181	HCO_3	35.50	30.60
CO_2	0.02	10.9			
C, noncarbonate	0.424	0.255	pH	7.93	7.74
H_2O, dehyd.[1]	5.090	3.420			
H_2O, chem.[2]	7.465	6.225			
Total	101.379	101.513			
LOI, total[3]	13.00	20.8			
Extent of carbonation, %[4]		23.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-321 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.191	0.111	Cl	37.1	35.4
CaO	0.189	0.134	Cr	<0.0005	<0.0005
Cr_2O_3	0.406	0.265	Fe	0.0006	0.0006
FeO	8.18	4.64	Mg	0.0005	0.0104
Fe_2O_3	0.729	1.330	Ni	<0.0005	<0.0005
MgO	46.9	30.8	K	0.0024	0.0092
NiO	0.295	0.186	Si	0.0030	0.0356
K_2O	0.010	0.005	Na	34.10	30.10
SiO_2	42.4	25.5	CO_2	27.00	23.00
Na_2O	0.051	3.235	HCO_3	34.90	29.90
CO_2	0.04	30.3			
C, noncarbonate	0.095	0.571	pH	7.87	7.84
H_2O, dehyd.[1]	0.270	1.020			
H_2O, chem.[2]	2.037	5.209			
Total	101.775	103.308			
LOI, total[3]	2.44	37.1			
Extent of carbonation, %[4]		76.4			

Carbonation test #SC-322 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	4.025	3.609	Cl	37.1	36.0
CaO	0.554	0.476	Cr	<0.0005	<0.0005
Cr_2O_3	0.206	0.272	Fe	0.0006	0.0005
FeO	<0.01	0.94	Mg	0.0005	0.0836
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	52.9	47.6	K	0.0024	0.0040
NiO	0.013	0.006	Si	0.0030	0.0312
K_2O	0.006	0.007	Na	34.10	32.10
SiO_2	42.6	38.7	CO_2	27.00	26.70
Na_2O	0.039	0.225	HCO_3	34.90	34.60
CO_2	0.03	7.6			
C, noncarbonate	0.018	0.160	pH	7.87	7.73
H_2O, dehyd.[1]	0.000	0.080			
H_2O, chem.[2]	0.004	0.000			
Total	100.357	99.702			
LOI, total[3]	0.05	7.6			
Extent of carbonation, %[4]		14.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-323 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.161	0.128	Cl	36.9	35.7
CaO	0.210	0.148	Cr	<0.0005	<0.0005
Cr_2O_3	0.237	0.168	Fe	0.0004	0.0004
FeO	8.25	5.60	Mg	0.0006	0.0530
Fe_2O_3	<0.01	0.858	Ni	<0.0005	<0.0005
MgO	48.9	35.0	K	0.0024	0.0072
NiO	0.290	0.216	Si	0.0018	0.0376
K_2O	0.017	0.008	Na	34.50	30.90
SiO_2	40.0	28.5	CO_2	27.00	25.40
Na_2O	0.152	0.816	HCO_3	33.90	33.00
CO_2	0.11	27.7			
C, noncarbonate	0.090	0.440	pH	7.90	7.76
H_2O, dehyd.[1]	0.360	0.330			
H_2O, chem.[2]	1.507	0.930			
Total	100.302	100.777			
LOI, total[3]	2.07	29.4			
Extent of carbonation, %[4]		64.8			

Carbonation test #SC-324 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.101	Cl	36.9	36.0
CaO	0.245	0.193	Cr	<0.0005	<0.0005
Cr_2O_3	0.200	0.141	Fe	0.0004	0.0005
FeO	8.40	5.96	Mg	0.0006	0.0290
Fe_2O_3	<0.01	0.786	Ni	<0.0005	<0.0005
MgO	50.6	36.6	K	0.0024	0.0059
NiO	0.293	0.191	Si	0.0018	0.0380
K_2O	0.005	0.005	Na	34.50	32.10
SiO_2	39.8	28.2	CO_2	27.00	25.80
Na_2O	0.045	0.554	HCO_3	33.90	33.70
CO_2	0.03	26.1			
C, noncarbonate	0.085	0.447	pH	7.90	7.81
H_2O, dehyd.[1]	0.280	0.250			
H_2O, chem.[2]	1.401	0.903			
Total	101.550	100.510			
LOI, total[3]	1.80	27.7			
Extent of carbonation, %[4]		58.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-325 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.165	0.094	Cl	36.8	36.0
CaO	0.215	0.234	Cr	<0.0005	<0.0005
Cr_2O_3	0.187	0.146	Fe	0.0007	0.0005
FeO	8.36	5.21	Mg	0.0005	0.0356
Fe_2O_3	0.315	1.244	Ni	<0.0005	<0.0005
MgO	49.9	35.0	K	0.0023	0.0076
NiO	0.271	0.200	Si	0.0020	0.0404
K_2O	0.006	0.008	Na	33.50	30.80
SiO_2	40.0	27.8	CO_2	27.40	25.30
Na_2O	0.047	0.716	HCO_3	35.20	33.90
CO_2	0.03	28.8			
C, noncarbonate	0.092	0.430	pH	7.85	7.68
H_2O, dehyd.[1]	0.300	0.360			
H_2O, chem.[2]	1.603	0.810			
Total	101.512	101.048			
LOI, total[3]	2.03	30.4			
Extent of carbonation, %[4]		67.2			

Carbonation test #SC-326 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.368	Cl	36.8	36.0
CaO	0.488	0.402	Cr	<0.0005	<0.0005
Cr_2O_3	0.874	0.653	Fe	0.0007	0.0004
FeO	1.72	1.36	Mg	0.0005	0.0422
Fe_2O_3	4.732	3.531	Ni	<0.0005	<0.0005
MgO	40.1	27.4	K	0.0023	0.0060
NiO	0.674	0.500	Si	0.0020	0.0182
K_2O	0.023	0.016	Na	33.50	28.00
SiO_2	37.9	27.4	CO_2	27.40	18.20
Na_2O	0.136	3.087	HCO_3	35.20	24.50
CO_2	0.10	27.9			
C, noncarbonate	0.099	0.266	pH	7.85	7.60
H_2O, dehyd.[1]	0.940	1.830			
H_2O, chem.[2]	14.160	5.404			
Total	103.678	101.062			
LOI, total[3]	15.30	35.4			
Extent of carbonation, %[4]		84.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-327 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.553	Cl	37.1	34.7
CaO	0.488	0.418	Cr	<0.0005	0.0007
Cr_2O_3	0.874	0.775	Fe	0.0004	0.0010
FeO	1.72	0.98	Mg	0.0005	3.4000
Fe_2O_3	4.732	4.289	Ni	<0.0005	<0.0005
MgO	40.1	25.9	K	0.0023	0.0166
NiO	0.674	0.566	Si	0.0018	0.0374
K_2O	0.023	0.021	Na	35.60	29.80
SiO_2	37.9	31.7	CO_2	26.90	32.40
Na_2O	0.136	0.681	HCO_3	35.20	44.70
CO_2	0.10	15.1			
C, noncarbonate	0.099	0.269	pH	7.79	7.14
H_2O, dehyd.[1]	0.940	4.620			
H_2O, chem.[2]	14.160	14.811			
Total	103.678	101.609			
LOI, total[3]	15.30	34.8			
Extent of carbonation, %[4]		38.2			

Carbonation test #SC-328 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.638	1.256	Cl	37.1	36.0
CaO	0.431	0.287	Cr	<0.0005	<0.0005
Cr_2O_3	0.278	0.212	Fe	0.0004	0.0004
FeO	1.63	0.94	Mg	0.0005	0.0560
Fe_2O_3	4.604	3.860	Ni	<0.0005	<0.0005
MgO	37.6	27.5	K	0.0023	0.0066
NiO	0.227	0.185	Si	0.0018	0.0355
K_2O	0.041	0.017	Na	35.60	30.50
SiO_2	37.9	27.6	CO_2	26.90	20.20
Na_2O	0.057	3.100	HCO_3	35.20	25.70
CO_2	0.04	25.3			
C, noncarbonate	0.094	0.525	pH	7.79	7.71
H_2O, dehyd.[1]	1.420	4.540			
H_2O, chem.[2]	14.444	5.835			
Total	100.413	101.178			
LOI, total[3]	16.00	36.2			
Extent of carbonation, %[4]		78.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-329 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.111	Cl	36.7	37.2
CaO	0.179	0.125	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.080	Fe	0.0005	0.0004
FeO	8.26	6.43	Mg	0.0005	0.0630
Fe_2O_3	<0.01	0.615	Ni	<0.0005	<0.0005
MgO	51.4	37.6	K	0.0024	0.0043
NiO	0.297	0.227	Si	0.0019	0.0304
K_2O	0.004	0.004	Na	33.10	33.20
SiO_2	40.2	31.0	CO_2	27.10	27.60
Na_2O	0.046	0.272	HCO_3	33.20	34.20
CO_2	0.03	21.8			
C, noncarbonate	0.006	0.460	pH	7.89	7.79
H_2O, dehyd.[1]	0.150	0.170			
H_2O, chem.[2]	0.650	0.670			
Total	101.466	99.625			
LOI, total[3]	0.84	23.1			
Extent of carbonation, %[4]		45.2			

Carbonation test #SC-330 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.135	Cl	36.7	35.6
CaO	0.179	0.140	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.137	Fe	0.0005	0.0323
FeO	8.26	7.68	Mg	0.0005	0.5110
Fe_2O_3	<0.01	0.529	Ni	<0.0005	0.0015
MgO	51.4	50.9	K	0.0024	0.0028
NiO	0.297	0.305	Si	0.0019	0.0304
K_2O	0.004	0.007	Na	33.10	33.10
SiO_2	40.2	40.9	CO_2	27.10	28.30
Na_2O	0.046	0.085	HCO_3	33.20	38.50
CO_2	0.03	0.0			
C, noncarbonate	0.006	0.042	pH	7.89	7.17
H_2O, dehyd.[1]	0.150	0.120			
H_2O, chem.[2]	0.650	0.608			
Total	101.466	101.552			
LOI, total[3]	0.84	0.8			
Extent of carbonation, %[4]		-0.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-331 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.114	Cl	36.9	35.0
CaO	0.179	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.132	Fe	0.0005	0.0263
FeO	8.26	7.49	Mg	0.0005	0.4890
Fe_2O_3	<0.01	0.701	Ni	<0.0005	0.0018
MgO	51.4	51.1	K	0.0023	0.0033
NiO	0.297	0.314	Si	0.0028	0.0320
K_2O	0.004	0.003	Na	33.00	30.70
SiO_2	40.2	40.2	CO_2	26.10	27.80
Na_2O	0.046	0.082	HCO_3	33.10	34.70
CO_2	0.03	0.0			
C, noncarbonate	0.006	0.030	pH	7.89	7.18
H_2O, dehyd.[1]	0.150	0.130			
H_2O, chem.[2]	0.650	0.730			
Total	101.466	101.161			
LOI, total[3]	0.84	0.9			
Extent of carbonation, %[4]		-0.2			

Carbonation test #SC-332 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.124	Cl	36.9	36.4
CaO	0.179	0.176	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.111	Fe	0.0005	0.0004
FeO	8.26	7.56	Mg	0.0005	0.7520
Fe_2O_3	<0.01	0.772	Ni	<0.0005	<0.0005
MgO	51.4	50.4	K	0.0023	0.0038
NiO	0.297	0.321	Si	0.0028	0.3310
K_2O	0.004	0.003	Na	33.00	32.50
SiO_2	40.2	40.6	CO_2	26.10	29.10
Na_2O	0.046	0.088	HCO_3	33.10	33.90
CO_2	0.03	0.5			
C, noncarbonate	0.006	0.040	pH	7.89	7.88
H_2O, dehyd.[1]	0.150	0.120			
H_2O, chem.[2]	0.650	0.710			
Total	101.466	101.602			
LOI, total[3]	0.84	1.4			
Extent of carbonation, %[4]		0.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-333 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.117	Cl	36.9	36.4
CaO	0.179	0.162	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.130	Fe	0.0006	0.0006
FeO	8.26	8.22	Mg	0.0005	0.6510
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	48.7	K	0.0022	0.0036
NiO	0.297	0.280	Si	0.0045	0.0272
K_2O	0.004	0.004	Na	34.50	32.50
SiO_2	40.2	40.0	CO_2	25.70	28.30
Na_2O	0.046	0.249	HCO_3	33.00	35.00
CO_2	0.03	1.5			
C, noncarbonate	0.006	0.084	pH	7.84	7.81
H_2O, dehyd.[1]	0.150	0.150			
H_2O, chem.[2]	0.650	0.766			
Total	101.466	100.396			
LOI, total[3]	0.84	2.5			
Extent of carbonation, %[4]		2.3			

Carbonation test #SC-334 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.128	Cl	36.9	36.6
CaO	0.179	0.133	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.135	Fe	0.0006	0.0005
FeO	8.26	7.50	Mg	0.0005	0.1380
Fe_2O_3	<0.01	0.472	Ni	<0.0005	<0.0005
MgO	51.4	47.4	K	0.0022	0.0038
NiO	0.297	0.274	Si	0.0045	0.0284
K_2O	0.004	0.004	Na	34.50	32.50
SiO_2	40.2	38.3	CO_2	25.70	26.90
Na_2O	0.046	0.233	HCO_3	33.00	33.80
CO_2	0.03	5.6			
C, noncarbonate	0.006	0.136	pH	7.84	7.87
H_2O, dehyd.[1]	0.150	0.160			
H_2O, chem.[2]	0.650	0.724			
Total	101.466	101.233			
LOI, total[3]	0.84	6.6			
Extent of carbonation, %[4]		9.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-335 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.150	Cl	36.8	36.3
CaO	0.179	0.102	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.114	Fe	0.0005	0.0004
FeO	8.26	6.33	Mg	0.0005	0.0750
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	41.6	K	0.0024	0.0038
NiO	0.297	0.239	Si	0.0023	0.0302
K_2O	0.004	0.007	Na	33.20	31.50
SiO_2	40.2	33.2	CO_2	27.00	26.40
Na_2O	0.046	0.195	HCO_3	32.90	32.70
CO_2	0.03	16.8			
C, noncarbonate	0.006	0.045	pH	7.96	7.90
H_2O, dehyd.[1]	0.150	0.260			
H_2O, chem.[2]	0.650	0.395			
Total	101.466	99.414			
LOI, total[3]	0.84	17.5			
Extent of carbonation, %[4]		32.7			

Carbonation test #SC-336 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.131	Cl	36.8	36.6
CaO	0.179	0.121	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.107	Fe	0.0005	0.0004
FeO	8.26	6.70	Mg	0.0005	0.0356
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	41.8	K	0.0024	0.0038
NiO	0.297	0.241	Si	0.0023	0.0332
K_2O	0.004	0.005	Na	33.20	32.90
SiO_2	40.2	33.2	CO_2	27.00	26.60
Na_2O	0.046	0.210	HCO_3	32.90	32.80
CO_2	0.03	17.7			
C, noncarbonate	0.006	0.099	pH	7.96	7.99
H_2O, dehyd.[1]	0.150	0.260			
H_2O, chem.[2]	0.650	0.341			
Total	101.466	100.859			
LOI, total[3]	0.84	18.4			
Extent of carbonation, %[4]		34.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-337 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.138	Cl	36.8	36.9
CaO	0.179	0.125	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.081	Fe	0.0007	0.0004
FeO	8.26	6.90	Mg	0.0005	0.0410
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	47.1	K	0.0004	0.0049
NiO	0.297	0.232	Si	0.0031	0.0311
K_2O	0.004	0.005	Na	33.30	32.30
SiO_2	40.2	33.8	CO_2	26.60	26.10
Na_2O	0.046	1.725	HCO_3	33.80	33.10
CO_2	0.03	13.0			
C, noncarbonate	0.006	0.002	pH	7.89	8.06
H_2O, dehyd.[1]	0.150	0.770			
H_2O, chem.[2]	0.650	2.428			
Total	101.466	106.292			
LOI, total[3]	0.84	16.2			
Extent of carbonation, %[4]		24.2			

Carbonation test #SC-338 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.212	0.124	Cl	36.8	36.5
CaO	0.162	0.136	Cr	<0.0005	<0.0005
Cr_2O_3	0.921	0.665	Fe	0.0007	0.0006
FeO	10.87	8.19	Mg	0.0005	0.0470
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	53.2	34.7	K	0.0004	0.0086
NiO	0.611	0.453	Si	0.0031	0.0320
K_2O	0.007	0.005	Na	33.30	31.50
SiO_2	38.5	27.4	CO_2	26.60	25.20
Na_2O	0.053	0.693	HCO_3	33.80	30.90
CO_2	0.04	26.8			
C, noncarbonate	0.094	0.256	pH	7.89	7.77
H_2O, dehyd.[1]	0.320	0.430			
H_2O, chem.[2]	1.266	0.814			
Total	106.288	100.607			
LOI, total[3]	1.72	28.3			
Extent of carbonation, %[4]		55.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-339 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.188	0.119	Cl	36.9	35.7
CaO	0.312	0.165	Cr	<0.0005	<0.0005
Cr_2O_3	1.254	0.890	Fe	0.0004	0.0004
FeO	12.99	9.29	Mg	0.0004	0.0390
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	29.2	K	0.0026	0.0064
NiO	0.471	0.344	Si	0.0030	0.0338
K_2O	0.006	0.009	Na	31.90	30.10
SiO_2	35.5	24.4	CO_2	27.10	23.60
Na_2O	0.046	1.248	HCO_3	34.40	30.20
CO_2	0.03	29.3			
C, noncarbonate	0.136	0.443	pH	7.88	7.80
H_2O, dehyd.[1]	2.400	1.070			
H_2O, chem.[2]	3.690	2.287			
Total	103.965	98.734			
LOI, total[3]	6.26	33.1			
Extent of carbonation, %[4]		68.1			

Carbonation test #SC-340 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.124	0.116	Cl	36.9	36.6
CaO	0.179	0.133	Cr	<0.0005	<0.0005
Cr_2O_3	0.097	0.124	Fe	0.0004	0.0005
FeO	8.26	7.59	Mg	0.0004	0.1360
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	51.4	45.8	K	0.0026	0.0033
NiO	0.297	0.271	Si	0.0030	0.0296
K_2O	0.004	0.006	Na	31.90	34.80
SiO_2	40.2	37.4	CO_2	27.10	27.00
Na_2O	0.046	0.210	HCO_3	34.40	33.20
CO_2	0.03	7.1			
C, noncarbonate	0.006	0.080	pH	7.88	7.76
H_2O, dehyd.[1]	0.150	0.200			
H_2O, chem.[2]	0.650	0.660			
Total	101.466	99.701			
LOI, total[3]	0.84	8.1			
Extent of carbonation, %[4]		12.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-341 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.111	0.108	Cl	36.9	36.0
CaO	0.148	0.153	Cr	<0.0005	<0.0005
Cr_2O_3	0.052	0.039	Fe	0.0003	0.0004
FeO	6.87	6.05	Mg	0.0005	0.0502
Fe_2O_3	1.058	0.515	Ni	<0.0005	<0.0005
MgO	51.9	42.4	K	0.0022	0.0053
NiO	0.267	0.223	Si	0.0007	0.0274
K_2O	0.006	0.003	Na	37.40	32.00
SiO_2	40.6	34.4	CO_2	26.90	26.40
Na_2O	0.047	0.160	HCO_3	33.20	33.70
CO_2	0.03	14.5			
C, noncarbonate	0.016	0.153	pH	7.91	7.84
H_2O, dehyd.[1]	0.070	0.090			
H_2O, chem.[2]	0.609	0.757			
Total	101.834	99.636			
LOI, total[3]	0.73	15.5			
Extent of carbonation, %[4]		27.8			

Carbonation test #SC-342 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.092	0.088	Cl	36.9	35.8
CaO	0.182	0.128	Cr	<0.0005	<0.0005
Cr_2O_3	0.127	0.113	Fe	0.0003	0.0006
FeO	7.44	6.61	Mg	0.0005	0.0710
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.9	37.6	K	0.0022	0.0048
NiO	0.267	0.193	Si	0.0007	0.0342
K_2O	0.004	0.004	Na	37.40	32.80
SiO_2	43.4	30.8	CO_2	26.90	27.00
Na_2O	0.048	0.231	HCO_3	33.20	34.20
CO_2	0.04	23.5			
C, noncarbonate	0.000	0.276	pH	7.91	7.67
H_2O, dehyd.[1]	0.130	0.100			
H_2O, chem.[2]	0.604	0.624			
Total	102.263	100.313			
LOI, total[3]	0.77	24.5			
Extent of carbonation, %[4]		51.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-343 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.120	0.090	Cl	36.5	36.2
CaO	0.131	0.125	Cr	<0.0005	<0.0005
Cr_2O_3	0.067	0.068	Fe	0.0010	0.0007
FeO	8.90	7.41	Mg	0.0004	0.0440
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.6	38.6	K	0.0024	0.0043
NiO	0.267	0.216	Si	0.0025	0.0351
K_2O	0.004	0.005	Na	33.70	32.60
SiO_2	40.4	33.6	CO_2	27.40	26.40
Na_2O	0.046	0.186	HCO_3	32.50	34.30
CO_2	0.03	16.3			
C, noncarbonate	0.014	0.311	pH	7.94	7.85
H_2O, dehyd.[1]	0.110	0.120			
H_2O, chem.[2]	0.702	0.569			
Total	100.407	97.620			
LOI, total[3]	0.86	17.3			
Extent of carbonation, %[4]		32.4			

Carbonation test #SC-344 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.117	0.108	Cl	36.5	36.2
CaO	0.126	0.133	Cr	<0.0005	<0.0005
Cr_2O_3	0.059	0.072	Fe	0.0010	0.0006
FeO	8.21	6.78	Mg	0.0004	0.0466
Fe_2O_3	0.257	0.229	Ni	<0.0005	<0.0005
MgO	48.9	40.5	K	0.0024	0.0041
NiO	0.267	0.234	Si	0.0025	0.0286
K_2O	0.008	0.009	Na	33.70	33.10
SiO_2	40.4	33.8	CO_2	27.40	27.10
Na_2O	0.048	0.197	HCO_3	32.50	32.30
CO_2	0.04	15.2			
C, noncarbonate	0.000	0.432	pH	7.94	7.66
H_2O, dehyd.[1]	0.110	0.100			
H_2O, chem.[2]	0.694	0.968			
Total	99.276	98.719			
LOI, total[3]	0.84	16.7			
Extent of carbonation, %[4]		30.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-345 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.157	0.079	Cl	36.7	36.3
CaO	0.151	0.153	Cr	<0.0005	<0.0005
Cr_2O_3	0.221	0.193	Fe	0.0004	0.0006
FeO	8.99	6.65	Mg	0.0004	0.0470
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.6	37.3	K	0.0023	0.0041
NiO	0.293	0.227	Si	0.0027	0.0365
K_2O	0.006	0.003	Na	33.70	32.70
SiO_2	40.4	30.0	CO_2	26.30	26.80
Na_2O	0.047	0.306	HCO_3	31.00	33.80
CO_2	0.03	25.3			
C, noncarbonate	0.000	0.225	pH	0.00	0.00
H_2O, dehyd.[1]	0.170	0.280			
H_2O, chem.[2]	0.465	0.395			
Total	101.542	101.068			
LOI, total[3]	0.67	26.2			
Extent of carbonation, %[4]		55.3			

Carbonation test #SC-346 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.108	0.080	Cl	36.7	36.2
CaO	0.157	0.094	Cr	<0.0005	<0.0005
Cr_2O_3	0.117	0.112	Fe	0.0004	0.0005
FeO	8.43	7.00	Mg	0.0004	0.0382
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.7	41.3	K	0.0023	0.0030
NiO	0.286	0.248	Si	0.0027	0.0314
K_2O	0.004	0.003	Na	33.70	32.60
SiO_2	40.6	32.5	CO_2	26.30	26.70
Na_2O	0.043	0.208	HCO_3	31.00	33.40
CO_2	0.03	18.2			
C, noncarbonate	0.037	0.143	pH	8.00	7.83
H_2O, dehyd.[1]	0.110	0.170			
H_2O, chem.[2]	0.371	0.487			
Total	101.075	100.547			
LOI, total[3]	0.55	19.0			
Extent of carbonation, %[4]		36.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-347 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.149	0.115	Cl	36.8	36.5
CaO	0.199	0.224	Cr	<0.0005	<0.0005
Cr_2O_3	0.034	0.034	Fe	0.0004	0.0004
FeO	6.34	6.39	Mg	0.0005	0.0408
Fe_2O_3	1.001	0.772	Ni	<0.0005	<0.0005
MgO	50.7	47.1	K	0.0024	0.0047
NiO	0.276	0.258	Si	0.0028	0.0316
K_2O	0.003	0.004	Na	32.00	31.30
SiO_2	41.1	37.4	CO_2	27.10	26.60
Na_2O	0.043	0.154	HCO_3	33.90	32.20
CO_2	0.03	7.2			
C, noncarbonate	0.018	0.106	pH	7.86	7.94
H_2O, dehyd.[1]	0.070	0.080			
H_2O, chem.[2]	0.561	0.504			
Total	100.539	100.331			
LOI, total[3]	0.68	7.9			
Extent of carbonation, %[4]		13.0			

Carbonation test #SC-348 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.163	0.151	Cl	36.8	36.0
CaO	0.148	0.165	Cr	<0.0005	<0.0005
Cr_2O_3	0.052	0.046	Fe	0.0004	0.0007
FeO	8.39	7.42	Mg	0.0005	0.0416
Fe_2O_3	<0.01	0.114	Ni	<0.0005	<0.0005
MgO	50.4	44.8	K	0.0024	0.0058
NiO	0.257	0.242	Si	0.0028	0.0682
K_2O	0.008	0.006	Na	32.00	32.30
SiO_2	40.4	36.2	CO_2	27.10	27.00
Na_2O	0.048	0.144	HCO_3	33.90	34.20
CO_2	0.04	10.5			
C, noncarbonate	0.000	0.114	pH	7.86	7.71
H_2O, dehyd.[1]	0.110	0.080			
H_2O, chem.[2]	0.664	0.506			
Total	100.713	100.414			
LOI, total[3]	0.81	11.2			
Extent of carbonation, %[4]		19.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-349 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.137	0.135	Cl	36.7	36.0
CaO	0.168	0.144	Cr	<0.0005	<0.0005
Cr_2O_3	0.113	0.099	Fe	0.0005	0.0004
FeO	7.45	6.81	Mg	0.0005	0.0222
Fe_2O_3	0.686	<0.01	Ni	<0.0005	<0.0005
MgO	50.4	44.4	K	0.0025	0.0040
NiO	0.283	0.255	Si	0.0036	0.0324
K_2O	0.006	0.004	Na	33.80	32.50
SiO_2	40.9	35.5	CO_2	27.00	25.40
Na_2O	0.055	0.190	HCO_3	33.80	31.90
CO_2	0.04	13.0			
C, noncarbonate	0.022	0.152	pH	7.86	7.94
H_2O, dehyd.[1]	0.100	0.130			
H_2O, chem.[2]	0.617	0.418			
Total	100.942	101.281			
LOI, total[3]	0.78	13.7			
Extent of carbonation, %[4]		25.0			

Carbonation test #SC-350 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.152	0.125	Cl	36.7	35.2
CaO	0.100	0.030	Cr	<0.0005	<0.0005
Cr_2O_3	0.126	0.105	Fe	0.0005	0.0004
FeO	7.31	6.70	Mg	0.0005	0.0566
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.6	41.8	K	0.0025	0.0049
NiO	0.305	0.267	Si	0.0036	0.0308
K_2O	0.005	0.003	Na	33.80	31.30
SiO_2	41.1	34.7	CO_2	27.00	26.30
Na_2O	0.045	0.224	HCO_3	33.80	32.50
CO_2	0.03	13.9			
C, noncarbonate	0.001	0.296	pH	7.86	7.66
H_2O, dehyd.[1]	0.120	0.160			
H_2O, chem.[2]	0.666	0.644			
Total	100.506	98.897			
LOI, total[3]	0.82	15.0			
Extent of carbonation, %[4]		26.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-351 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.174	0.095	Cl	36.6	36.1
CaO	0.146	0.141	Cr	<0.0005	2.4300
Cr_2O_3	0.152	0.132	Fe	0.0005	0.0005
FeO	8.32	6.63	Mg	0.0006	0.0488
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	2.5400
MgO	49.9	40.6	K	0.0021	0.0041
NiO	0.312	0.252	Si	0.0023	0.0306
K_2O	0.005	0.002	Na	32.10	32.10
SiO_2	40.9	32.1	CO_2	25.90	25.90
Na_2O	0.044	0.202	HCO_3	31.00	31.30
CO_2	0.03	19.0			
C, noncarbonate	0.027	0.335	pH	7.79	0.00
H_2O, dehyd.[1]	0.090	0.150			
H_2O, chem.[2]	0.611	0.715			
Total	100.684	100.362			
LOI, total[3]	0.76	20.2			
Extent of carbonation, %[4]		39.3			

Carbonation test #SC-352 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.172	0.128	Cl	36.6	36.2
CaO	0.064	0.035	Cr	<0.0005	<0.0005
Cr_2O_3	0.227	<0.01	Fe	0.0005	0.0006
FeO	7.89	5.34	Mg	0.0006	0.0596
Fe_2O_3	<0.01	0.372	Ni	<0.0005	<0.0005
MgO	49.1	34.5	K	0.0021	0.0065
NiO	0.227	<0.01	Si	0.0023	0.0350
K_2O	0.004	0.004	Na	32.10	31.00
SiO_2	40.0	27.2	CO_2	25.90	25.40
Na_2O	0.044	0.596	HCO_3	31.00	30.30
CO_2	0.03	30.1			
C, noncarbonate	0.028	0.285	pH	7.79	7.69
H_2O, dehyd.[1]	0.210	0.230			
H_2O, chem.[2]	1.300	1.185			
Total	99.276	99.931			
LOI, total[3]	1.57	31.8			
Extent of carbonation, %[4]		73.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-353 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.132	0.168	Cl	36.8	35.9
CaO	0.167	0.059	Cr	<0.0005	<0.0005
Cr_2O_3	0.631	0.390	Fe	0.0006	0.0014
FeO	8.90	6.10	Mg	0.0006	0.0254
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.1	31.5	K	0.0022	0.0041
NiO	0.349	0.230	Si	0.0034	0.0355
K_2O	0.005	0.003	Na	33.60	31.00
SiO_2	38.7	25.9	CO_2	27.00	25.30
Na_2O	0.061	2.844	HCO_3	32.00	31.90
CO_2	0.04	32.6			
C, noncarbonate	0.033	0.393	pH	7.80	7.69
H_2O, dehyd.[1]	1.900	0.690			
H_2O, chem.[2]	2.462	1.417			
Total	100.497	102.282			
LOI, total[3]	4.44	35.1			
Extent of carbonation, %[4]		83.7			

Carbonation test #SC-354 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.132	0.155	Cl	36.5	36.0
CaO	0.167	0.075	Cr	<0.0005	<0.0005
Cr_2O_3	0.631	0.389	Fe	0.0014	0.0010
FeO	8.90	5.98	Mg	0.0486	0.0290
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.1	31.0	K	0.0050	0.0061
NiO	0.349	0.239	Si	0.0331	0.0364
K_2O	0.005	0.004	Na	32.10	31.00
SiO_2	38.7	25.9	CO_2	24.40	24.00
Na_2O	0.061	0.793	HCO_3	27.70	30.10
CO_2	0.04	32.6			
C, noncarbonate	0.033	0.373	pH	8.32	7.85
H_2O, dehyd.[1]	1.900	0.520			
H_2O, chem.[2]	2.462	0.807			
Total	100.497	98.828			
LOI, total[3]	4.44	34.3			
Extent of carbonation, %[4]		83.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test #SC-355 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.152	0.104	Cl	36.5	36.2
CaO	0.100	0.107	Cr	<0.0005	<0.0005
Cr_2O_3	0.126	0.118	Fe	0.0014	0.0006
FeO	7.31	6.54	Mg	0.0486	0.0556
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.6	41.3	K	0.0050	0.0071
NiO	0.305	0.261	Si	0.0331	0.0343
K_2O	0.005	0.005	Na	32.10	33.50
SiO_2	41.1	34.0	CO_2	24.40	25.90
Na_2O	0.045	0.191	HCO_3	27.70	31.70
CO_2	0.03	15.8			
C, noncarbonate	0.001	0.158	pH	8.32	7.86
H_2O, dehyd.[1]	0.120	0.110			
H_2O, chem.[2]	0.666	0.532			
Total	100.506	99.222			
LOI, total[3]	0.82	16.6			
Extent of carbonation, %[4]		31.2			

Carbonation test #SC-356 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.152	0.150	Cl	0.0	0.0
CaO	0.100	0.101	Cr	<0.0005	0.0021
Cr_2O_3	0.126	0.129	Fe	0.0006	0.2000
FeO	7.31	7.49	Mg	<0.0001	<0.0001
Fe_2O_3	<0.01	0.243	Ni	<0.0005	0.0007
MgO	50.6	48.1	K	<0.0001	0.2760
NiO	0.305	0.305	Si	0.0003	0.1470
K_2O	0.005	0.004	Na	<0.0001	1.02
SiO_2	41.1	40.0	CO_2	<0.0001	1.41
Na_2O	0.045	0.040	HCO_3	<0.0001	31.70
CO_2	0.03	1.9			
C, noncarbonate	0.001	0.076	pH	7.00	7.14
H_2O, dehyd.[1]	0.120	0.100			
H_2O, chem.[2]	0.666	0.514			
Total	100.506	99.120			
LOI, total[3]	0.82	2.6			
Extent of carbonation, %[4]		3.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-357 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.103	Cl	0.004	0.011
CaO	0.185	0.132	Cr	<0.0005	<0.0005
Cr_2O_3	0.327	0.289	Fe	<0.0001	0.0001
FeO	7.83	6.83	Mg	0.0006	0.3280
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	50.1	41.0	K	<0.0001	0.0014
NiO	0.326	0.277	Si	<0.0001	0.1570
K_2O	0.003	0.002	Na	0.000	0.017
SiO_2	40.6	35.1	CO_2	<0.0001	1.48
Na_2O	0.052	0.048	HCO_3	<0.0001	1.88
CO_2	0.04	10.3			
C, noncarbonate	0.027	0.739	pH		7.09
H_2O, dehyd.[1]	0.250	0.760			
H_2O, chem.[2]	1.214	2.801			
Total	101.105	98.365			
LOI, total[3]	1.53	14.6			
Extent of carbonation, %[4]		18.9			

Carbonation test SC-358 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.118	Cl	0.0038	0.0071
CaO	0.185	0.138	Cr	<0.0005	<0.0005
Cr_2O_3	0.327	0.345	Fe	<0.0001	0.0224
FeO	7.83	7.18	Mg	0.0006	2.3600
Fe_2O_3	<0.01	0.071	Ni	<0.0005	0.0036
MgO	50.1	42.4	K	<0.0001	0.0014
NiO	0.326	0.299	Si	<0.0001	0.1660
K_2O	0.003	0.004	Na	0.000	0.012
SiO_2	40.6	36.6	CO_2	<0.0001	3.71
Na_2O	0.052	0.047	HCO_3	<0.0001	4.53
CO_2	0.04	7.6			
C, noncarbonate	0.027	0.067	pH		6.54
H_2O, dehyd.[1]	0.250	1.910			
H_2O, chem.[2]	1.214	2.463			
Total	101.105	99.229			
LOI, total[3]	1.53	12.0			
Extent of carbonation, %[4]		13.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-359 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.078	Cl	0.0368	0.0357
CaO	0.185	0.101	Cr	<0.0005	<0.0005
Cr_2O_3	0.327	0.237	Fe	0.0006	0.0006
FeO	7.83	5.22	Mg	0.0006	0.0970
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	50.1	32.3	K	0.0022	0.0060
NiO	0.326	0.216	Si	0.0034	0.0675
K_2O	0.003	0.005	Na	33.6	31.6
SiO_2	40.6	27.0	CO_2	27.0	16.7
Na_2O	0.052	0.539	HCO_3	32.0	22.3
CO_2	0.04	32.1			
C, noncarbonate	0.027	0.319	pH	7.80	7.53
H_2O, dehyd.[1]	0.250	0.330			
H_2O, chem.[2]	1.214	0.851			
Total	101.105	99.330			
LOI, total[3]	1.53	33.6			
Extent of carbonation, %[4]		78.8			

Carbonation test SC-360 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.155	Cl	0.0367	0.0365
CaO	0.185	0.059	Cr	<0.0005	0.0007
Cr_2O_3	0.327	0.266	Fe	0.0006	0.0846
FeO	7.835	7.526	Mg	0.0004	4.0000
Fe_2O_3	<0.01	0.272	Ni	<0.0005	0.0180
MgO	50.1	40.0	K	0.0023	0.0072
NiO	0.326	0.289	Si	0.0020	0.0287
K_2O	0.003	0.007	Na	32.4	31.1
SiO_2	40.6	41.1	CO_2	27.8	34.6
Na_2O	0.052	0.175	HCO_3	30.5	51.9
CO_2	0.04	0.6			
C, noncarbonate	0.027	0.000	pH	7.93	7.23
H_2O, dehyd.[1]	0.250	1.450			
H_2O, chem.[2]	1.214	3.080			
Total	101.105	94.893			
LOI, total[3]	1.53	5.1			
Extent of carbonation, %[4]		0.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-361 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.140	0.097	Cl	36.7	36.4
CaO	0.1	0.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.248	0.162	Fe	0.0006	0.0007
FeO	7.938	5.275	Mg	0.0004	0.0892
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.240	32.332	K	0.0023	0.0054
NiO	0.294	0.196	Si	0.0020	0.0458
K_2O	0.006	0.006	Na	32.4	30.8
SiO_2	40.2	27.0	CO_2	27.8	1.0
Na_2O	0.047	0.511	HCO_3	30.5	1.0
CO_2	0.04	31.6			
C, noncarbonate	0.053	0.226	pH	7.93	7.41
H_2O, dehyd.[1]	0.270	0.320			
H_2O, chem.[2]	1.192	1.454			
Total	100.776	99.247			
LOI, total[3]	1.55	33.6			
Extent of carbonation, %[4]		76.6			

Carbonation test SC-362 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.140	0.164	Cl	0.0	<0.0001
CaO	0.1	0.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.248	0.246	Fe	<0.0001	0.0230
FeO	7.938	7.011	Mg	0.0006	2.0500
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0022
MgO	50.240	42.115	K	<0.0001	0.0012
NiO	0.294	0.285	Si	<0.0001	0.1570
K_2O	0.006	0.007	Na	0.0	0.1
SiO_2	40.2	36.8	CO_2	<0.0001	1.7
Na_2O	0.047	0.051	HCO_3	<0.0001	1.9
CO_2	0.04	7.9			
C, noncarbonate	0.014	0.118	pH		7.89
H_2O, dehyd.[1]	0.270	1.060			
H_2O, chem.[2]	1.231	3.102			
Total	100.776	99.010			
LOI, total[3]	1.55	12.2			
Extent of carbonation, %[4]		13.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-363 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.637	0.452	Cl	36.2	35.7
CaO	0.2	0.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.132	0.108	Fe	0.0004	0.0004
FeO	7.783	5.776	Mg	0.0005	0.0666
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.576	35.151	K	0.0024	0.0283
NiO	0.303	0.215	Si	0.0021	0.0355
K_2O	0.017	0.008	Na	32.3	31.3
SiO_2	40.9	30.8	CO_2	27.2	27.5
Na_2O	0.042	0.383	HCO_3	32.3	31.1
CO_2	0.03	28.1			
C, noncarbonate	0.000	0.000	pH	7.86	7.79
H_2O, dehyd.[1]	0.450	0.440			
H_2O, chem.[2]	0.999	-2.840			
Total	100.982	98.773			
LOI, total[3]	1.48	25.7			
Extent of carbonation, %[4]		65.5			

Carbonation test SC-364 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.416	0.300	Cl	36.2	37.0
CaO	0.1	0.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.105	0.090	Fe	0.0004	0.0004
FeO	7.680	6.278	Mg	0.0005	0.0564
Fe_2O_3	0.100	<0.01	Ni	<0.0005	<0.0005
MgO	50.405	37.804	K	0.0024	0.0140
NiO	0.311	0.242	Si	0.0021	0.0400
K_2O	0.010	0.006	Na	32.3	32.2
SiO_2	41.1	32.9	CO_2	27.2	27.2
Na_2O	0.040	0.048	HCO_3	32.3	32.4
CO_2	0.03	19.4			
C, noncarbonate	0.000	0.155	pH	7.86	7.87
H_2O, dehyd.[1]	0.240	0.270			
H_2O, chem.[2]	0.830	0.375			
Total	101.382	98.117			
LOI, total[3]	1.10	20.2			
Extent of carbonation, %[4]		39.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-365 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	<0.01	<0.01	Cl	37.0	37.5
CaO	46.0	42.1	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0005
FeO	0.682	0.656	Mg	0.0005	0.0093
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.454	0.489	K	0.0023	0.0083
NiO	<0.01	<0.01	Si	0.0025	0.0290
K_2O	0.036	0.030	Na	34.0	33.0
SiO_2	48.6	44.9	CO_2	26.3	27.1
Na_2O	0.039	0.147	HCO_3	30.8	33.4
CO_2	0.03	10.5			
C, noncarbonate	0.036	0.084	pH	7.94	7.83
H_2O, dehyd.[1]	0.050	0.070			
H_2O, chem.[2]	3.116	0.346			
Total	99.037	99.364			
LOI, total[3]	3.23	11.0			
Extent of carbonation, %[4]		23.7			

Carbonation test SC-366 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	<0.01	<0.01	Cl	37.0	37.1
CaO	46.0	41.6	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0004
FeO	0.682	0.682	Mg	0.0005	0.0052
Fe_2O_3	<0.01	0.014	Ni	<0.0005	<0.0005
MgO	0.454	0.492	K	0.0023	0.0132
NiO	<0.01	<0.01	Si	0.0025	0.0308
K_2O	0.036	0.031	Na	34.0	32.1
SiO_2	48.6	44.5	CO_2	26.3	27.0
Na_2O	0.039	0.174	HCO_3	30.8	32.5
CO_2	0.03	10.8			
C, noncarbonate	0.036	0.242	pH	7.94	7.89
H_2O, dehyd.[1]	0.050	0.070			
H_2O, chem.[2]	3.116	0.488			
Total	99.037	99.048			
LOI, total[3]	3.23	11.6			
Extent of carbonation, %[4]		24.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-367 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	<0.01	<0.01	Cl	36.8	36.6
CaO	46.0	43.0	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0004
FeO	0.682	0.592	Mg	0.0004	0.0025
Fe_2O_3	<0.01	0.129	Ni	<0.0005	<0.0005
MgO	0.454	0.429	K	0.0023	0.0089
NiO	<0.01	<0.01	Si	0.0043	0.0306
K_2O	0.036	0.028	Na	31.7	31.6
SiO_2	48.6	44.5	CO_2	27.0	26.6
Na_2O	0.039	0.182	HCO_3	31.4	33.0
CO_2	0.03	12.1			
C, noncarbonate	0.036	0.118	pH	7.86	7.85
H_2O, dehyd.[1]	0.050	0.050			
H_2O, chem.[2]	3.116	0.432			
Total	99.037	101.513			
LOI, total[3]	3.23	12.7			
Extent of carbonation, %[4]		29.3			

Carbonation test SC-368 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.038	0.052	Cl	36.8	36.7
CaO	44.2	36.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.008	<0.01	Fe	0.0005	0.0004
FeO	0.862	0.643	Mg	0.0004	0.0019
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.496	0.469	K	0.0023	0.0417
NiO	<0.01	<0.01	Si	0.0043	0.0201
K_2O	0.038	0.017	Na	31.7	33.1
SiO_2	48.6	40.0	CO_2	27.0	26.3
Na_2O	0.028	0.329	HCO_3	31.4	32.1
CO_2	0.02	18.9			
C, noncarbonate	0.167	0.242	pH	7.86	7.90
H_2O, dehyd.[1]	0.080	0.080			
H_2O, chem.[2]	3.252	0.478			
Total	97.766	97.315			
LOI, total[3]	3.52	19.7			
Extent of carbonation, %[4]		58.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-369 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.038	0.053	Cl	35.9	36.0
CaO	44.2	42.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.008	<0.01	Fe	0.0005	0.0005
FeO	0.862	0.746	Mg	0.0003	0.0045
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.496	0.496	K	0.0024	0.0099
NiO	<0.01	<0.01	Si	0.0017	0.0414
K_2O	0.038	0.033	Na	35.3	31.2
SiO_2	48.6	47.7	CO_2	26.7	27.3
Na_2O	0.028	0.053	HCO_3	32.0	34.4
CO_2	0.02	4.0			
C, noncarbonate	0.167	0.047	pH	8.03	7.21
H_2O, dehyd.[1]	0.080	0.170			
H_2O, chem.[2]	3.252	0.323			
Total	97.766	96.204			
LOI, total[3]	3.52	4.6			
Extent of carbonation, %[4]		4.0			

Carbonation test SC-370 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.060	Cl	0.0	0.1
CaO	46.2	53.0	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	<0.0001	<0.0001
FeO	0.772	0.515	Mg	0.0006	0.0093
Fe_2O_3	<0.01	0.157	Ni	<0.0005	<0.0005
MgO	0.471	0.487	K	<0.0001	0.0254
NiO	<0.01	<0.01	Si	<0.0001	0.1700
K_2O	0.033	0.013	Na	0.000	0.118
SiO_2	48.6	37.7	CO_2	<0.0001	0.550
Na_2O	0.013	0.010	HCO_3	<0.0001	0.720
CO_2	0.01	21.1			
C, noncarbonate	0.043	0.221	pH	NA	6.65
H_2O, dehyd.[1]	0.070	1.550			
H_2O, chem.[2]	3.398	0.629			
Total	99.594	115.425			
LOI, total[3]	3.52	23.5			
Extent of carbonation, %[4]		64.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-371 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.055	Cl	35.9	35.5
CaO	44.2	37.5	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0004
FeO	0.669	0.437	Mg	0.0003	0.0018
Fe_2O_3	<0.01	0.114	Ni	<0.0005	<0.0005
MgO	0.424	0.486	K	0.0024	0.0595
NiO	<0.01	<0.01	Si	0.0017	0.0359
K_2O	0.033	0.007	Na	35.3	31.5
SiO_2	47.9	36.2	CO_2	26.7	24.7
Na_2O	0.010	0.977	HCO_3	32.0	30.1
CO_2	0.01	23.8			
C, noncarbonate	0.000	0.315	pH	8.03	7.81
H_2O, dehyd.[1]	0.230	1.120			
H_2O, chem.[2]	4.003	1.365			
Total	97.561	102.330			
LOI, total[3]	4.24	26.6			
Extent of carbonation, %[4]		78.9			

Carbonation test SC-372 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.032	Cl	0.0	0.1
CaO	40.3	33.2	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	<0.0001	<0.0001
FeO	0.669	0.553	Mg	0.0006	0.0176
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	0.424	0.539	K	<0.0001	0.0370
NiO	<0.01	<0.01	Si	<0.0001	0.1510
K_2O	0.033	0.008	Na	0.0003	0.124
SiO_2	47.9	35.5	CO_2	<0.0001	0.600
Na_2O	0.010	0.016	HCO_3	<0.0001	0.760
CO_2	0.01	24.8			
C, noncarbonate	0.000	0.282	pH	NA	6.64
H_2O, dehyd.[1]	0.230	1.960			
H_2O, chem.[2]	4.003	1.258			
Total	93.643	98.165			
LOI, total[3]	4.24	28.3			
Extent of carbonation, %[4]		92.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-373 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.041	Cl	0.0038	0.0300
CaO	40.3	36.4	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	<0.0001	0.0002
FeO	0.669	0.579	Mg	0.0006	0.0696
Fe_2O_3	<0.01	0.014	Ni	<0.0005	<0.0005
MgO	0.424	0.380	K	<0.0001	0.0178
NiO	<0.01	<0.01	Si	<0.0001	0.1140
K_2O	0.033	0.017	Na	0.0003	0.022
SiO_2	47.9	38.3	CO_2	<0.0001	1.100
Na_2O	0.010	0.011	HCO_3	<0.0001	1.430
CO_2	0.01	16.9			
C, noncarbonate	0.000	0.098	pH	NA	6.34
H_2O, dehyd.[1]	0.230	2.220			
H_2O, chem.[2]	4.003	2.082			
Total	93.643	97.016			
LOI, total[3]	4.24	21.3			
Extent of carbonation, %[4]		52.8			

Carbonation test SC-374 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.021	Cl	0.0038	0.0300
CaO	40.3	33.7	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	<0.0001	<0.0001
FeO	0.669	0.515	Mg	0.0006	0.0100
Fe_2O_3	<0.01	0.114	Ni	<0.0005	<0.0005
MgO	0.424	0.482	K	<0.0001	0.0349
NiO	<0.01	<0.01	Si	<0.0001	0.1700
K_2O	0.033	0.009	Na	0.0003	0.018
SiO_2	47.9	36.4	CO_2	<0.0001	0.420
Na_2O	0.010	0.014	HCO_3	<0.0001	0.560
CO_2	0.01	25.5			
C, noncarbonate	0.000	0.131	pH	NA	6.76
H_2O, dehyd.[1]	0.230	1.420			
H_2O, chem.[2]	4.003	0.749			
Total	93.643	99.045			
LOI, total[3]	4.24	27.8			
Extent of carbonation, %[4]		96.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-375 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.050	0.037	Cl	0.0038	0.0200
CaO	51.1	36.7	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	<0.0001	<0.0001
FeO	0.772	0.656	Mg	0.0006	0.0089
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	0.471	0.482	K	<0.0001	0.0210
NiO	<0.01	<0.01	Si	<0.0001	0.1960
K_2O	0.033	0.016	Na	0.0003	0.015
SiO_2	48.6	38.9	CO_2	<0.0001	0.480
Na_2O	0.013	0.010	HCO_3	<0.0001	0.540
CO_2	0.01	20.0			
C, noncarbonate	0.043	0.232	pH	NA	6.72
H_2O, dehyd.[1]	0.070	0.580			
H_2O, chem.[2]	3.398	0.988			
Total	104.491	98.639			
LOI, total[3]	3.52	21.8			
Extent of carbonation, %[4]		53.4			

Carbonation test SC-376 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.701	1.668	Cl	38.4	38.0
CaO	<0.01	0.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.256	0.295	Fe	0.0007	0.0007
FeO	3.139	2.753	Mg	0.0004	0.0270
Fe_2O_3	4.289	4.203	Ni	<0.0005	<0.0005
MgO	38.301	37.307	K	0.0023	0.0074
NiO	0.201	0.205	Si	0.0032	0.0452
K_2O	<0.01	0.005	Na	32.4	31.7
SiO_2	38.3	37.4	CO_2	26.5	27.4
Na_2O	<0.01	0.611	HCO_3	32.7	33.8
CO_2	0.00	1.1			
C, noncarbonate	0.019	0.034	pH	7.98	7.79
H_2O, dehyd.[1]	1.290	1.400			
H_2O, chem.[2]	13.091	12.316			
Total	100.581	99.769			
LOI, total[3]	14.40	14.8			
Extent of carbonation, %[4]		2.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-377 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.615	1.557	Cl	38.4	38.1
CaO	0.397	0.395	Cr	<0.0005	0.6000
Cr_2O_3	0.327	0.282	Fe	0.0007	0.0005
FeO	1.878	1.968	Mg	0.0004	0.0300
Fe_2O_3	5.233	4.875	Ni	<0.0005	<0.0005
MgO	39.130	33.990	K	0.0023	0.0044
NiO	0.000	0.192	Si	0.0032	0.0604
K_2O	0.003	0.005	Na	32.4	31.3
SiO_2	38.5	35.7	CO_2	26.5	26.6
Na_2O	0.014	0.873	HCO_3	32.7	33.9
CO_2	0.01	2.4			
C, noncarbonate	0.024	0.083	pH	7.98	7.82
H_2O, dehyd.[1]	1.080	1.700			
H_2O, chem.[2]	12.485	12.057			
Total	100.707	96.065			
LOI, total[3]	13.60	16.2			
Extent of carbonation, %[4]		5.0			

Carbonation test SC-378 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.077	0.054	Cl	38.5	38.4
CaO	45.1	36.9	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0005
FeO	0.862	0.527	Mg	0.0005	0.0027
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.451	0.454	K	0.0005	0.0190
NiO	<0.01	<0.01	Si	0.0032	0.0398
K_2O	0.037	0.026	Na	32.6	35.0
SiO_2	48.6	40.4	CO_2	26.1	26.6
Na_2O	0.024	0.333	HCO_3	32.7	32.0
CO_2	0.02	17.5			
C, noncarbonate	0.040	0.344	pH	7.88	7.71
H_2O, dehyd.[1]	0.060	0.120			
H_2O, chem.[2]	3.442	1.036			
Total	98.628	97.767			
LOI, total[3]	3.56	19.0			
Extent of carbonation, %[4]		50.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-379 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.077	0.080	Cl	38.5	38.6
CaO	44.4	37.9	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0005	0.0004
FeO	0.862	0.605	Mg	0.0005	0.0012
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.451	0.443	K	0.0005	0.0251
NiO	<0.01	<0.01	Si	0.0032	0.0330
K_2O	0.037	0.023	Na	32.6	32.5
SiO_2	48.6	40.4	CO_2	26.1	26.2
Na_2O	0.024	0.336	HCO_3	32.7	31.6
CO_2	0.02	18.0			
C, noncarbonate	0.040	0.187	pH	7.88	7.89
H_2O, dehyd.[1]	0.060	0.170			
H_2O, chem.[2]	3.442	0.643			
Total	97.928	98.838			
LOI, total[3]	3.56	19.0			
Extent of carbonation, %[4]		53.3			

Carbonation test SC-380 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.077	0.091	Cl	37.9	37.4
CaO	44.4	37.9	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0004	0.0006
FeO	0.862	0.592	Mg	0.0004	0.0088
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.451	0.459	K	0.0024	0.0562
NiO	<0.01	<0.01	Si	0.0026	0.0300
K_2O	0.037	0.010	Na	31.5	31.1
SiO_2	48.6	40.4	CO_2	27.1	26.0
Na_2O	0.024	0.314	HCO_3	32.8	31.8
CO_2	0.02	18.8			
C, noncarbonate	0.040	0.219	pH	7.85	7.74
H_2O, dehyd.[1]	0.060	0.070			
H_2O, chem.[2]	3.442	0.711			
Total	97.928	99.618			
LOI, total[3]	3.56	19.8			
Extent of carbonation, %[4]		56.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-381 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.077	0.037	Cl	37.9	37.8
CaO	44.4	38.5	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	<0.01	Fe	0.0004	0.0004
FeO	0.862	0.515	Mg	0.0004	0.0012
Fe_2O_3	<0.01	0.029	Ni	<0.0005	<0.0005
MgO	0.451	0.396	K	0.0024	0.0182
NiO	<0.01	<0.01	Si	0.0026	0.0323
K_2O	0.037	0.030	Na	31.5	31.7
SiO_2	48.6	41.3	CO_2	27.1	26.1
Na_2O	0.024	0.274	HCO_3	32.8	33.6
CO_2	0.02	17.2			
C, noncarbonate	0.040	0.206	pH	7.85	7.86
H_2O, dehyd.[1]	0.060	0.460			
H_2O, chem.[2]	3.442	1.034			
Total	97.928	99.948			
LOI, total[3]	3.56	18.9			
Extent of carbonation, %[4]		50.0			

Carbonation test SC-382 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.026	1.498	Cl	38.2	37.8
CaO	0.371	0.479	Cr	<0.0005	2.2000
Cr_2O_3	0.222	0.235	Fe	0.0004	0.0005
FeO	1.505	1.660	Mg	0.0004	0.0224
Fe_2O_3	4.332	3.489	Ni	<0.0005	<0.0005
MgO	36.643	35.483	K	0.0024	0.0049
NiO	0.000	0.202	Si	0.0054	0.0366
K_2O	0.005	0.022	Na	31.8	31.6
SiO_2	37.9	37.2	CO_2	26.6	26.0
Na_2O	0.017	1.306	HCO_3	32.4	33.1
CO_2	0.01	2.7			
C, noncarbonate	0.010	0.061	pH	7.77	7.88
H_2O, dehyd.[1]	1.250	1.830			
H_2O, chem.[2]	13.327	12.359			
Total	96.588	98.497			
LOI, total[3]	14.60	16.9			
Extent of carbonation, %[4]		5.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-383 **Cedar Hill Antigorite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.139	Cl	38.2	38.0
CaO	<0.01	0.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.082	0.045	Fe	0.0004	0.0006
FeO	3.049	3.036	Mg	0.0004	0.0170
Fe_2O_3	6.019	3.317	Ni	<0.0005	<0.0005
MgO	42.447	38.467	K	0.0024	0.0050
NiO	0.214	0.227	Si	0.0054	0.0350
K_2O	<0.01	0.004	Na	31.8	31.1
SiO_2	36.4	34.4	CO_2	26.6	26.4
Na_2O	<0.01	1.277	HCO_3	32.4	32.3
CO_2	0.00	5.6			
C, noncarbonate	0.017	0.079	pH	7.77	7.78
H_2O, dehyd.[1]	0.620	1.080			
H_2O, chem.[2]	13.563	11.031			
Total	102.606	98.910			
LOI, total[3]	14.20	17.8			
Extent of carbonation, %[4]		10.6			

Carbonation test SC-384 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.173	0.127	Cl	38.0	38.2
CaO	0.106	0.136	Cr	<0.0005	<0.0005
Cr_2O_3	0.060	0.058	Fe	0.0005	0.0004
FeO	7.616	6.818	Mg	0.0004	0.0534
Fe_2O_3	0.057	0.172	Ni	<0.0005	<0.0005
MgO	50.903	44.436	K	0.0023	0.0039
NiO	0.305	0.257	Si	0.0035	0.0298
K_2O	0.006	0.004	Na	33.8	32.1
SiO_2	40.6	35.1	CO_2	26.7	26.7
Na_2O	0.018	0.134	HCO_3	31.4	32.0
CO_2	0.01	12.6			
C, noncarbonate	0.021	0.061	pH	7.96	7.87
H_2O, dehyd.[1]	0.120	0.170			
H_2O, chem.[2]	0.575	0.669			
Total	100.622	100.727			
LOI, total[3]	0.73	13.5			
Extent of carbonation, %[4]		23.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-385 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.111	Cl	38.0	38.0
CaO	0.064	0.088	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.055	Fe	0.0005	0.0004
FeO	7.860	6.600	Mg	0.0004	0.0668
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.416	41.286	K	0.0023	0.0044
NiO	0.308	0.227	Si	0.0035	0.0300
K_2O	0.004	0.004	Na	33.8	32.4
SiO_2	40.4	32.7	CO_2	26.7	26.9
Na_2O	0.018	0.160	HCO_3	31.4	33.1
CO_2	0.00	18.0			
C, noncarbonate	0.030	0.187	pH	7.96	7.88
H_2O, dehyd.[1]	0.130	0.210			
H_2O, chem.[2]	0.810	0.703			
Total	98.273	100.363			
LOI, total[3]	0.97	19.1			
Extent of carbonation, %[4]		38.0			

Carbonation test SC-386 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.606	1.455	Cl	36.5	37.2
CaO	0.385	0.425	Cr	<0.0005	<0.0005
Cr_2O_3	0.178	0.180	Fe	0.0004	0.0006
FeO	1.531	1.531	Mg	0.0006	0.0324
Fe_2O_3	4.189	3.860	Ni	<0.0005	<0.0005
MgO	39.296	37.804	K	0.0023	0.0043
NiO	0.221	0.214	Si	0.0057	0.0330
K_2O	0.005	0.005	Na	32.0	31.2
SiO_2	38.9	37.9	CO_2	26.5	26.0
Na_2O	0.016	0.683	HCO_3	31.9	31.1
CO_2	0.31	2.5			
C, noncarbonate	0.002	0.033	pH	7.87	7.82
H_2O, dehyd.[1]	1.330	2.130			
H_2O, chem.[2]	12.658	12.207			
Total	100.664	100.924			
LOI, total[3]	14.30	16.9			
Extent of carbonation, %[4]		5.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-387 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.126	Cl	36.5	37.3
CaO	0.1	0.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.048	Fe	0.0004	0.0006
FeO	7.860	5.480	Mg	0.0006	0.0222
Fe_2O_3	<0.01	0.014	Ni	<0.0005	<0.0005
MgO	48.416	35.649	K	0.0023	0.0048
NiO	0.308	0.216	Si	0.0057	0.0358
K_2O	0.004	0.006	Na	32.0	31.0
SiO_2	40.4	28.5	CO_2	26.5	26.3
Na_2O	0.018	0.182	HCO_3	31.9	32.3
CO_2	0.00	28.0			
C, noncarbonate	0.030	0.238	pH	7.87	7.97
H_2O, dehyd.[1]	0.130	0.190			
H_2O, chem.[2]	0.810	0.672			
Total	98.273	99.389			
LOI, total[3]	0.97	29.1			
Extent of carbonation, %[4]		67.4			

Carbonation test SC-388 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.557	1.574	Cl	37.4	37.9
CaO	0.4	0.4	Cr	<0.0005	<0.0005
Cr_2O_3	0.209	0.209	Fe	0.0005	0.0005
FeO	3.010	2.226	Mg	0.0004	0.0208
Fe_2O_3	2.659	3.117	Ni	<0.0005	<0.0005
MgO	38.633	37.307	K	0.0023	0.0047
NiO	0.223	0.207	Si	0.0024	0.0345
K_2O	0.006	0.007	Na	32.2	30.4
SiO_2	39.4	37.7	CO_2	27.1	26.1
Na_2O	0.018	0.857	HCO_3	34.3	32.0
CO_2	0.25	2.4			
C, noncarbonate	0.023	0.054	pH	7.76	7.85
H_2O, dehyd.[1]	1.330	2.250			
H_2O, chem.[2]	12.897	12.576			
Total	100.569	100.822			
LOI, total[3]	14.50	17.3			
Extent of carbonation, %[4]		5.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-389 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.160	Cl	37.4	38.1
CaO	0.064	0.213	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.086	Fe	0.0005	0.0005
FeO	7.860	6.921	Mg	0.0004	0.0698
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.416	43.773	K	0.0023	0.0048
NiO	0.308	0.267	Si	0.0024	0.0352
K_2O	0.004	0.005	Na	32.2	31.4
SiO_2	40.4	35.5	CO_2	27.1	26.9
Na_2O	0.018	0.174	HCO_3	34.3	33.3
CO_2	0.00	12.0			
C, noncarbonate	0.030	0.105	pH	7.76	7.90
H_2O, dehyd.[1]	0.130	0.280			
H_2O, chem.[2]	0.810	0.715			
Total	98.273	100.212			
LOI, total[3]	0.97	13.1			
Extent of carbonation, %[4]		23.6			

Carbonation test SC-390 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.244	Cl	38.2	37.4
CaO	0.064	0.322	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.112	Fe	0.0008	0.0008
FeO	7.860	7.603	Mg	0.0005	0.0320
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.416	48.747	K	0.0027	0.0044
NiO	0.308	0.308	Si	0.0056	0.0346
K_2O	0.004	0.005	Na	31.4	30.3
SiO_2	40.4	39.8	CO_2	27.0	26.6
Na_2O	0.018	0.338	HCO_3	32.2	32.7
CO_2	0.00	1.6			
C, noncarbonate	0.030	0.040	pH	7.76	7.89
H_2O, dehyd.[1]	0.130	0.270			
H_2O, chem.[2]	0.810	0.860			
Total	98.273	100.271			
LOI, total[3]	0.97	2.8			
Extent of carbonation, %[4]		2.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-391 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.108	0.106	Cl	38.2	38.5
CaO	0.4	0.3	Cr	<0.0005	<0.0005
Cr_2O_3	0.208	0.229	Fe	0.0008	0.0005
FeO	2.316	2.187	Mg	0.0005	0.0212
Fe_2O_3	3.045	3.188	Ni	<0.0005	<0.0005
MgO	37.472	37.141	K	0.0027	0.0041
NiO	0.216	0.234	Si	0.0056	0.0426
K_2O	0.004	0.005	Na	31.4	33.2
SiO_2	39.4	38.7	CO_2	27	26.7
Na_2O	0.018	0.264	HCO_3	32.2	33.7
CO_2	0.17	1.6			
C, noncarbonate	0.040	0.060	pH	7.90	7.82
H_2O, dehyd.[1]	1.380	1.320			
H_2O, chem.[2]	13.310	12.570			
Total	98.029	97.915			
LOI, total[3]	14.90	15.5			
Extent of carbonation, %[4]		3.3			

Carbonation test SC-392 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.098	0.086	Cl	38.0	38.2
CaO	0.344	0.355	Cr	<0.0005	<0.0005
Cr_2O_3	0.227	0.197	Fe	0.0005	0.0004
FeO	1.402	1.171	Mg	0.0004	0.0214
Fe_2O_3	3.732	3.689	Ni	<0.0005	<0.0005
MgO	36.975	33.825	K	0.0024	0.0044
NiO	0.216	0.193	Si	0.0022	0.0463
K_2O	0.004	0.004	Na	34.6	29.0
SiO_2	37.2	33.4	CO_2	26.6	22.9
Na_2O	0.018	1.082	HCO_3	33.3	27.3
CO_2	1.13	10.6			
C, noncarbonate	0.019	0.107	pH	7.71	7.76
H_2O, dehyd.[1]	2.730	4.000			
H_2O, chem.[2]	13.921	9.893			
Total	98.040	98.576			
LOI, total[3]	17.80	24.6			
Extent of carbonation, %[4]		25.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-393 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.563	1.130	Cl	38.0	37.7
CaO	0.316	0.227	Cr	<0.0005	<0.0005
Cr_2O_3	0.231	0.189	Fe	0.0005	0.0004
FeO	1.917	0.823	Mg	0.0004	0.0324
Fe_2O_3	3.460	3.574	Ni	<0.0005	<0.0005
MgO	34.985	29.016	K	0.0024	0.0034
NiO	0.206	0.167	Si	0.0022	0.0385
K_2O	0.004	0.004	Na	34.6	29.1
SiO_2	38.3	29.5	CO_2	26.6	21.3
Na_2O	0.017	1.820	HCO_3	33.3	25.7
CO_2	0.67	22.1			
C, noncarbonate	0.040	0.198	pH	7.71	7.77
H_2O, dehyd.[1]	1.900	4.820			
H_2O, chem.[2]	13.990	5.982			
Total	97.593	99.572			
LOI, total[3]	16.60	33.1			
Extent of carbonation, %[4]		70.0			

Carbonation test SC-394 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.158	Cl	38.6	39.1
CaO	0.064	0.055	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.073	Fe	0.0004	0.0005
FeO	7.860	5.352	Mg	0.0005	0.0170
Fe_2O_3	<0.01	0.214	Ni	<0.0005	<0.0005
MgO	48.416	29.182	K	0.0023	0.0045
NiO	0.308	0.200	Si	0.0022	0.0396
K_2O	0.004	0.002	Na	31.8	31.0
SiO_2	40.4	26.7	CO_2	26.5	27.0
Na_2O	0.018	0.216	HCO_3	32.1	33.3
CO_2	0.00	32.9			
C, noncarbonate	0.030	0.281	pH	7.87	7.92
H_2O, dehyd.[1]	0.130	0.090			
H_2O, chem.[2]	0.810	0.229			
Total	98.273	95.693			
LOI, total[3]	0.97	33.5			
Extent of carbonation, %[4]		84.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-395 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.148	Cl	38.6	37.3
CaO	0.064	0.119	Cr	<0.0005	<0.0005
Cr_2O_3	0.055	0.130	Fe	0.0004	0.0005
FeO	7.860	6.458	Mg	0.0005	0.0508
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.7700
MgO	48.416	41.286	K	0.0023	0.0054
NiO	0.308	0.267	Si	0.0022	0.0424
K_2O	0.004	0.005	Na	31.8	32.8
SiO_2	40.4	33.2	CO_2	26.5	26.3
Na_2O	0.018	0.214	HCO_3	32.1	32.2
CO_2	0.00	17.9			
C, noncarbonate	0.030	0.135	pH	7.87	7.93
H_2O, dehyd.[1]	0.130	0.190			
H_2O, chem.[2]	0.810	0.475			
Total	98.273	100.488			
LOI, total[3]	0.97	18.7			
Extent of carbonation, %[4]		37.8			

Carbonation test SC-396 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.540	1.272	Cl	38.1	37.6
CaO	0.399	0.271	Cr	<0.0005	<0.0005
Cr_2O_3	0.218	0.190	Fe	0.0005	0.0004
FeO	1.479	1.158	Mg	0.0005	0.0160
Fe_2O_3	4.075	3.546	Ni	<0.0005	<0.0005
MgO	36.643	30.508	K	0.0024	0.0064
NiO	0.193	0.167	Si	0.0028	0.0525
K_2O	0.019	0.013	Na	31.5	28.9
SiO_2	37.2	31.7	CO_2	26.7	23.2
Na_2O	0.032	2.278	HCO_3	31.8	28.5
CO_2	1.09	12.6			
C, noncarbonate	0.019	0.061	pH	7.86	7.89
H_2O, dehyd.[1]	2.900	5.600			
H_2O, chem.[2]	13.991	9.639			
Total	99.823	98.965			
LOI, total[3]	18.00	27.9			
Extent of carbonation, %[4]		32.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-397 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.130	0.926	Cl	38.1	37.6
CaO	0.495	0.557	Cr	<0.0005	<0.0005
Cr_2O_3	0.202	0.170	Fe	0.0005	0.0003
FeO	1.878	0.888	Mg	0.0005	0.0394
Fe_2O_3	3.917	3.374	Ni	<0.0005	<0.0005
MgO	36.643	26.529	K	0.0024	0.0052
NiO	0.202	0.153	Si	0.0028	0.0563
K_2O	0.004	0.004	Na	31.5	28.3
SiO_2	39.4	30.0	CO_2	26.7	21.2
Na_2O	0.017	2.372	HCO_3	31.8	26.8
CO_2	0.54	22.8			
C, noncarbonate	0.021	0.197	pH	7.86	7.83
H_2O, dehyd.[1]	1.140	4.480			
H_2O, chem.[2]	13.899	6.723			
Total	99.454	99.123			
LOI, total[3]	15.60	34.2			
Extent of carbonation, %[4]		69.8			

Carbonation test SC-398 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.315	1.179	Cl	38.0	37.4
CaO	0.677	0.660	Cr	<0.0005	<0.0005
Cr_2O_3	0.210	0.197	Fe	0.0003	0.0002
FeO	2.419	1.994	Mg	0.0004	0.0202
Fe_2O_3	3.017	3.403	Ni	<0.0005	<0.0005
MgO	36.975	33.493	K	0.0031	0.0046
NiO	0.210	0.193	Si	0.0024	0.0526
K_2O	0.004	0.006	Na	31.2	30.2
SiO_2	40.0	37.4	CO_2	26.9	25.6
Na_2O	0.018	0.806	HCO_3	32.3	31.7
CO_2	0.36	4.0			
C, noncarbonate	0.009	0.073	pH	7.88	7.83
H_2O, dehyd.[1]	1.170	2.480			
H_2O, chem.[2]	12.661	11.427			
Total	99.050	97.370			
LOI, total[3]	14.20	18.0			
Extent of carbonation, %[4]		9.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-399 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.525	1.434	Cl	38.0	37.6
CaO	0.299	0.301	Cr	<0.0005	<0.0005
Cr_2O_3	0.200	0.186	Fe	0.0003	0.0003
FeO	2.329	1.891	Mg	0.0004	0.0192
Fe_2O_3	3.803	3.317	Ni	<0.0005	<0.0005
MgO	34.819	34.322	K	0.0031	0.0042
NiO	0.201	0.191	Si	0.0024	0.0345
K_2O	0.008	0.006	Na	31.2	29.8
SiO_2	39.8	36.8	CO_2	26.9	25.2
Na_2O	0.019	0.891	HCO_3	32.3	32.6
CO_2	0.50	6.3			
C, noncarbonate	0.016	0.108	pH	7.88	7.83
H_2O, dehyd.[1]	1.630	2.810			
H_2O, chem.[2]	12.254	11.172			
Total	97.395	99.735			
LOI, total[3]	14.40	20.4			
Extent of carbonation, %[4]		15.7			

Carbonation test SC-400 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.540	1.111	Cl	38.2	37.6
CaO	0.3	0.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.213	0.162	Fe	0.0004	0.0004
FeO	0.965	0.463	Mg	0.0005	0.0382
Fe_2O_3	4.575	3.817	Ni	<0.0005	<0.0005
MgO	34.322	27.192	K	0.0023	0.0036
NiO	0.202	0.148	Si	0.0028	0.0534
K_2O	0.004	0.004	Na	30.6	27.2
SiO_2	39.6	29.7	CO_2	26.1	20.5
Na_2O	0.016	2.022	HCO_3	33.3	25.6
CO_2	0.53	22.0			
C, noncarbonate	0.007	0.196	pH	7.89	7.78
H_2O, dehyd.[1]	1.260	5.030			
H_2O, chem.[2]	14.203	6.974			
Total	97.727	99.098			
LOI, total[3]	16.00	34.2			
Extent of carbonation, %[4]		72.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-401 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.529	1.466	Cl	38.2	38.0
CaO	0.288	0.252	Cr	<0.0005	<0.0005
Cr_2O_3	0.203	0.200	Fe	0.0004	0.0003
FeO	2.547	2.097	Mg	0.0005	0.0212
Fe_2O_3	2.988	3.117	Ni	<0.0005	<0.0005
MgO	34.156	32.996	K	0.0023	0.0047
NiO	0.206	0.200	Si	0.0028	0.0439
K_2O	0.004	0.004	Na	30.6	29.4
SiO_2	38.9	37.4	CO_2	26.1	26.2
Na_2O	0.016	1.045	HCO_3	33.3	33.5
CO_2	0.42	3.9			
C, noncarbonate	0.000	0.057	pH	7.89	7.77
H_2O, dehyd.[1]	1.160	2.510			
H_2O, chem.[2]	12.620	12.073			
Total	95.074	97.314			
LOI, total[3]	14.20	18.5			
Extent of carbonation, %[4]		9.2			

Carbonation test SC-402 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.474	1.188	Cl	38.2	38.6
CaO	0.228	0.228	Cr	<0.0005	<0.0005
Cr_2O_3	0.216	0.151	Fe	0.0005	0.0003
FeO	1.544	0.901	Mg	0.0003	0.0288
Fe_2O_3	3.660	3.474	Ni	<0.0005	<0.0005
MgO	33.161	27.524	K	0.0028	0.0037
NiO	0.201	0.154	Si	0.0085	0.0462
K_2O	0.007	0.010	Na	30.4	27.8
SiO_2	38.3	30.0	CO_2	26.6	21.5
Na_2O	0.027	2.049	HCO_3	30.8	25.1
CO_2	0.68	21.1			
C, noncarbonate	0.013	0.051	pH	7.96	7.80
H_2O, dehyd.[1]	1.500	5.060			
H_2O, chem.[2]	13.907	6.989			
Total	94.912	98.829			
LOI, total[3]	16.10	33.2			
Extent of carbonation, %[4]		70.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-403 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.563	1.376	Cl	38.2	37.6
CaO	0.246	0.224	Cr	<0.0005	<0.0005
Cr_2O_3	0.184	0.164	Fe	0.0005	0.0003
FeO	2.290	1.865	Mg	0.0003	0.0234
Fe_2O_3	2.859	3.002	Ni	<0.0005	<0.0005
MgO	35.317	31.172	K	0.0028	0.0044
NiO	0.211	0.182	Si	0.0085	0.0412
K_2O	0.005	0.006	Na	30.4	29.2
SiO_2	38.3	34.7	CO_2	26.6	25.0
Na_2O	0.016	1.631	HCO_3	30.8	31.6
CO_2	0.89	6.7			
C, noncarbonate	0.000	0.071	pH	7.96	7.82
H_2O, dehyd.[1]	2.330	3.930			
H_2O, chem.[2]	13.480	11.999			
Total	97.685	96.978			
LOI, total[3]	16.70	22.7			
Extent of carbonation, %[4]		15.7			

Carbonation test SC-404 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.462	1.449	Cl	38.3	37.8
CaO	0.400	0.453	Cr	<0.0005	<0.0005
Cr_2O_3	0.184	0.162	Fe	0.0004	0.0004
FeO	2.187	1.827	Mg	0.0003	0.0198
Fe_2O_3	3.203	3.117	Ni	<0.0005	<0.0005
MgO	35.151	33.493	K	0.0028	0.0051
NiO	0.199	0.192	Si	0.0090	0.0446
K_2O	0.005	0.005	Na	30.2	29.3
SiO_2	38.7	35.9	CO_2	27	25.0
Na_2O	0.013	1.523	HCO_3	32.7	30.2
CO_2	0.84	6.3			
C, noncarbonate	0.019	0.088	pH	7.82	7.79
H_2O, dehyd.[1]	2.250	3.720			
H_2O, chem.[2]	13.391	11.582			
Total	98.025	99.862			
LOI, total[3]	16.50	21.7			
Extent of carbonation, %[4]		14.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-405 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.306	1.529	Cl	38.3	37.5
CaO	0.306	0.256	Cr	<0.0005	<0.0005
Cr_2O_3	0.156	0.175	Fe	0.0004	0.0004
FeO	2.573	2.046	Mg	0.0003	0.0214
Fe_2O_3	2.716	2.988	Ni	<0.0005	<0.0005
MgO	38.136	31.338	K	0.0028	0.0046
NiO	0.214	0.195	Si	0.0090	0.0418
K_2O	0.005	0.006	Na	30.2	32.1
SiO_2	38.9	35.9	CO_2	27.0	25.1
Na_2O	0.013	1.146	HCO_3	32.7	32.3
CO_2	0.49	5.2			
C, noncarbonate	0.006	0.041	pH	7.82	7.83
H_2O, dehyd.[1]	1.370	2.670			
H_2O, chem.[2]	12.834	11.789			
Total	99.061	95.318			
LOI, total[3]	14.70	19.7			
Extent of carbonation, %[4]		11.5			

Carbonation test SC-406 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.187	1.222	Cl	38.2	37.7
CaO	0.292	0.194	Cr	<0.0005	<0.0005
Cr_2O_3	0.200	0.162	Fe	0.0005	0.0004
FeO	2.599	2.007	Mg	0.0003	0.0194
Fe_2O_3	2.745	2.988	Ni	<0.0005	<0.0005
MgO	34.985	28.021	K	0.0028	0.0045
NiO	0.201	0.188	Si	0.0031	0.0452
K_2O	0.006	0.006	Na	35.2	30.0
SiO_2	38.1	34.9	CO_2	26.7	25.0
Na_2O	0.016	1.343	HCO_3	32	28.7
CO_2	0.56	6.2			
C, noncarbonate	0.000	0.062	pH	7.81	7.89
H_2O, dehyd.[1]	1.370	2.940			
H_2O, chem.[2]	12.670	11.648			
Total	94.912	91.804			
LOI, total[3]	14.60	20.8			
Extent of carbonation, %[4]		15.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-407 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.466	1.166	Cl	38.2	37.5
CaO	0.306	0.206	Cr	<0.0005	<0.0005
Cr_2O_3	0.186	0.156	Fe	0.0005	0.0004
FeO	1.930	2.007	Mg	0.0003	0.0270
Fe_2O_3	3.317	2.273	Ni	<0.0005	<0.0005
MgO	35.483	27.358	K	0.0028	0.0041
NiO	0.197	0.162	Si	0.0031	0.0482
K_2O	0.008	0.004	Na	35.2	28.8
SiO_2	37.9	31.0	CO_2	26.7	22.4
Na_2O	0.021	2.494	HCO_3	32.0	28.5
CO_2	1.21	15.8			
C, noncarbonate	0.001	0.128	pH	7.81	7.72
H_2O, dehyd.[1]	2.780	5.830			
H_2O, chem.[2]	14.509	9.442			
Total	99.280	98.046			
LOI, total[3]	18.50	31.2			
Extent of carbonation, %[4]		43.8			

Carbonation test SC-408 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.336	Cl	37.9	37.8
CaO	0.389	0.218	Cr	<0.0005	<0.0005
Cr_2O_3	0.241	0.162	Fe	0.0005	0.0004
FeO	2.727	0.695	Mg	0.0004	0.0470
Fe_2O_3	2.817	3.903	Ni	<0.0005	<0.0005
MgO	40.623	26.363	K	0.0029	0.0056
NiO	0.220	0.157	Si	0.0028	0.0510
K_2O	0.006	0.004	Na	30.3	26.8
SiO_2	39.1	29.5	CO_2	26.6	20.9
Na_2O	0.017	2.319	HCO_3	33.4	26.3
CO_2	0.20	21.1			
C, noncarbonate	0.008	0.171	pH	7.75	7.74
H_2O, dehyd.[1]	0.980	5.250			
H_2O, chem.[2]	13.212	7.679			
Total	102.318	98.879			
LOI, total[3]	14.40	34.2			
Extent of carbonation, %[4]		57.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-409 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.140	0.138	Cl	0.004	0.790
CaO	0.094	2.379	Cr	<0.0005	<0.0005
Cr_2O_3	0.248	0.139	Fe	<0.0001	0.0052
FeO	7.938	6.896	Mg	0.0006	1.2100
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.240	33.825	K	<0.0001	0.0014
NiO	0.294	0.233	Si	<0.0001	0.1440
K_2O	0.006	0.002	Na	0.000	0.232
SiO_2	40.2	34.4	CO_2	<0.0001	2.400
Na_2O	0.047	0.033	HCO_3	<0.0001	3.050
CO_2	0.39	9.4			
C, noncarbonate	0.023	0.153	pH		7.07
H_2O, dehyd.[1]	0.270	1.270			
H_2O, chem.[2]	0.867	4.007			
Total	100.776	92.887			
LOI, total[3]	1.55	14.8			
Extent of carbonation, %[4]		16.6			

Carbonation test SC-410 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.140	0.123	Cl	37.9	37.6
CaO	0.094	1.931	Cr	<0.0005	<0.0005
Cr_2O_3	0.248	0.187	Fe	0.0005	0.0004
FeO	7.938	5.313	Mg	0.0004	0.0976
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	50.240	32.167	K	0.0029	0.0211
NiO	0.294	0.197	Si	0.0028	0.0663
K_2O	0.006	0.005	Na	30.3	29.6
SiO_2	40.2	24.2	CO_2	26.6	
Na_2O	0.047	0.488	HCO_3	33.4	
CO_2	0.39	31.1			
C, noncarbonate	0.023	0.482	pH	7.75	7.58
H_2O, dehyd.[1]	0.270	0.270			
H_2O, chem.[2]	0.867	1.348			
Total	100.776	97.785			
LOI, total[3]	1.55	33.2			
Extent of carbonation, %[4]		74.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-411 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.137	0.179	Cl	38.0	38.1
CaO	0.168	0.096	Cr	<0.0005	<0.0005
Cr_2O_3	0.113	0.057	Fe	0.0005	0.0004
FeO	7.449	7.101	Mg	0.0003	0.0530
Fe_2O_3	0.686	<0.01	Ni	<0.0005	<0.0005
MgO	50.405	43.939	K	0.0027	0.0046
NiO	0.283	0.280	Si	0.0058	0.0477
K_2O	0.006	0.005	Na	35.5	34.9
SiO_2	40.9	34.9	CO_2	26.6	26.9
Na_2O	0.055	0.135	HCO_3	33.1	34.4
CO_2	0.00	8.4			
C, noncarbonate	0.022	0.120	pH	7.96	7.94
H_2O, dehyd.[1]	0.100	0.080			
H_2O, chem.[2]	0.658	0.600			
Total	100.942	95.853			
LOI, total[3]	0.78	9.2			
Extent of carbonation, %[4]		15.3			

Carbonation test SC-412 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	15.7	15.8	Cl	38.0	37.9
CaO	9.40	9.39	Cr	<0.0005	<0.0005
Cr_2O_3	0.017	0.070	Fe	0.0005	0.0015
FeO	8.58	8.84	Mg	0.0003	0.0120
Fe_2O_3	2.43	2.47	Ni	<0.0005	<0.0005
MgO	7.13	7.18	K	0.0027	0.0421
NiO	0.007	0.018	Si	0.0058	0.0506
K_2O	0.548	0.423	Na	35.5	34.9
SiO_2	47.1	47.7	CO_2	26.6	26.1
Na_2O	2.40	2.80	HCO_3	33.1	33.5
CO_2	0.00	0.580			
C, noncarbonate	0.022	0.023	pH	7.96	7.77
H_2O, dehyd.[1]	0.790	0.620			
H_2O, chem.[2]	1.108	1.167			
Total	95.182	97.049			
LOI, total[3]	1.92	2.4			
Extent of carbonation, %[4]		2.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-413 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	15.531	15.135	Cl	37.9	37.8
CaO	9.515	9.151	Cr	<0.0005	<0.0005
Cr_2O_3	0.108	0.070	Fe	0.0005	0.0019
FeO	9.597	8.800	Mg	0.0003	0.0090
Fe_2O_3	1.673	2.659	Ni	<0.0005	<0.0005
MgO	7.130	7.097	K	0.0030	0.0498
NiO	0.018	0.018	Si	0.0083	0.0360
K_2O	0.434	0.410	Na	34.8	33.8
SiO_2	48.1	47.1	CO_2	26.3	25.7
Na_2O	1.995	3.990	HCO_3	33.2	33.0
CO_2	0.00	1.1			
C, noncarbonate	0.049	0.040	pH	7.98	7.79
H_2O, dehyd.[1]	0.460	0.690			
H_2O, chem.[2]	1.481	1.980			
Total	96.125	98.223			
LOI, total[3]	1.99	3.8			
Extent of carbonation, %[4]		5.4			

Carbonation test SC-414 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	14.965	13.793	Cl	37.9	38.0
CaO	10.1	10.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.100	0.099	Fe	0.0005	0.0020
FeO	9.726	8.684	Mg	0.0003	0.0082
Fe_2O_3	1.301	2.145	Ni	<0.0005	<0.0005
MgO	7.461	6.964	K	0.0030	0.1020
NiO	0.033	0.033	Si	0.0083	0.0443
K_2O	0.452	0.367	Na	34.8	35.6
SiO_2	47.7	45.1	CO_2	26.3	24.8
Na_2O	2.925	4.367	HCO_3	33.2	32.5
CO_2	0.14	2.9			
C, noncarbonate	0.041	0.102	pH	7.98	7.71
H_2O, dehyd.[1]	0.220	0.350			
H_2O, chem.[2]	1.789	3.098			
Total	96.948	98.230			
LOI, total[3]	2.19	6.5			
Extent of carbonation, %[4]		13.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-415 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	15.683	14.190	Cl	38.2	42.8
CaO	9.40	9.82	Cr	<0.0005	<0.0005
Cr_2O_3	0.017	0.062	Fe	0.0005	0.0004
FeO	8.581	8.619	Mg	0.0003	0.0067
Fe_2O_3	2.431	2.473	Ni	<0.0005	<0.0005
MgO	7.130	6.765	K	0.0029	0.0462
NiO	0.007	0.011	Si	0.0036	0.0398
K_2O	0.548	0.358	Na	38.4	38.8
SiO_2	47.1	46.0	CO_2	26.6	29.7
Na_2O	2.399	2.898	HCO_3	32.4	36.4
CO_2	0.00	3.89			
C, noncarbonate	0.022	0.058	pH	7.82	7.78
H_2O, dehyd.[1]	0.790	0.630			
H_2O, chem.[2]	1.108	1.112			
Total	95.182	96.885			
LOI, total[3]	1.92	5.7			
Extent of carbonation, %[4]		19.8			

Carbonation test SC-416 **Sumpter Talc**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.400	1.236	Cl	38.2	38.9
CaO	3.1	3.4	Cr	<0.0005	<0.0005
Cr_2O_3	8.769	0.174	Fe	0.0005	0.0004
FeO	11.874	6.883	Mg	0.0003	0.0135
Fe_2O_3	<0.01	0.929	Ni	<0.0005	<0.0005
MgO	26.032	29.348	K	0.0029	0.0163
NiO	0.342	0.160	Si	0.0036	0.0375
K_2O	0.021	0.021	Na	38.4	36.7
SiO_2	47.3	52.4	CO_2	26.6	27.0
Na_2O	0.104	0.283	HCO_3	32.4	33.6
CO_2	0.00	1.9			
C, noncarbonate	1.020	0.114	pH	7.82	7.86
H_2O, dehyd.[1]	0.000	0.220			
H_2O, chem.[2]	3.430	2.256			
Total	103.336	99.298			
LOI, total[3]	4.45	4.5			
Extent of carbonation, %[4]		5.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-417 **Sumpter Talc**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.400	1.289	Cl	38.2	44.0
CaO	3.06	2.77	Cr	<0.0005	<0.0005
Cr_2O_3	8.769	7.381	Fe	0.0002	0.0004
FeO	11.874	10.253	Mg	0.0003	0.0025
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	26.032	22.550	K	0.0028	0.0322
NiO	0.342	0.312	Si	0.0033	0.0406
K_2O	0.021	0.010	Na	36.1	37.5
SiO_2	47.3	41.7	CO_2	27.0	25.4
Na_2O	0.104	1.982	HCO_3	32.6	30.4
CO_2	0.00	5.2			
C, noncarbonate	1.020	0.810	pH	7.87	8.21
H_2O, dehyd.[1]	0.000	3.750			
H_2O, chem.[2]	3.430	2.500			
Total	103.336	100.563			
LOI, total[3]	4.45	12.3			
Extent of carbonation, %[4]		14.5			

Carbonation test SC-418 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.787	1.321	Cl	38.2	38.7
CaO	0.383	0.294	Cr	<0.0005	<0.0005
Cr_2O_3	0.186	0.183	Fe	0.0002	0.0003
FeO	1.968	1.814	Mg	0.0003	0.0198
Fe_2O_3	4.647	2.273	Ni	<0.0005	<0.0005
MgO	38.467	27.192	K	0.0028	0.0048
NiO	0.229	0.178	Si	0.0033	0.0526
K_2O	0.008	0.008	Na	36.1	32.0
SiO_2	40.6	30.4	CO_2	27.0	20.9
Na_2O	0.027	3.195	HCO_3	32.6	25.9
CO_2	0.44	19.7			
C, noncarbonate	0.028	0.023	pH	7.87	7.71
H_2O, dehyd.[1]	0.350	5.130			
H_2O, chem.[2]	10.682	8.847			
Total	99.850	100.536			
LOI, total[3]	11.50	33.7			
Extent of carbonation, %[4]		55.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-419 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.583	1.614	Cl	38.0	37.4
CaO	0.354	0.341	Cr	<0.0005	<0.0005
Cr_2O_3	0.251	0.243	Fe	0.0004	0.0003
FeO	2.612	2.380	Mg	0.0002	0.0206
Fe_2O_3	2.702	2.945	Ni	<0.0005	<0.0005
MgO	37.141	35.151	K	0.0027	0.0047
NiO	0.225	0.216	Si	0.0043	0.0522
K_2O	0.005	0.005	Na	35.4	33.3
SiO_2	38.9	37.7	CO_2	26.9	25.6
Na_2O	0.019	0.962	HCO_3	33.3	32.2
CO_2	0.43	2.99			
C, noncarbonate	0.027	0.085	pH	7.70	7.78
H_2O, dehyd.[1]	1.310	1.510			
H_2O, chem.[2]	14.033	13.315			
Total	99.628	99.410			
LOI, total[3]	15.80	17.9			
Extent of carbonation, %[4]		6.3			

Carbonation test SC-420 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.504	1.187	Cl	38.0	37.1
CaO	0.400	0.312	Cr	<0.0005	<0.0005
Cr_2O_3	0.213	0.189	Fe	0.0004	0.0006
FeO	2.200	1.029	Mg	0.0002	0.0250
Fe_2O_3	3.689	3.474	Ni	<0.0005	<0.0005
MgO	34.654	27.192	K	0.0027	0.0046
NiO	0.238	0.172	Si	0.0043	0.0466
K_2O	0.009	0.007	Na	35.4	32.4
SiO_2	41.1	29.7	CO_2	26.9	22.4
Na_2O	0.020	3.249	HCO_3	33.3	28.2
CO_2	0.53	16.7			
C, noncarbonate	0.010	0.212	pH	7.70	7.78
H_2O, dehyd.[1]	0.380	3.160			
H_2O, chem.[2]	9.380	11.928			
Total	94.301	98.547			
LOI, total[3]	10.30	32.0			
Extent of carbonation, %[4]		49.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-421 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.387	1.256	Cl	36.9	35.9
CaO	0.326	0.365	Cr	<0.0005	<0.0005
Cr_2O_3	0.225	0.232	Fe	0.0006	0.0005
FeO	2.277	2.058	Mg	0.0003	0.0172
Fe_2O_3	3.145	3.732	Ni	<0.0005	<0.0005
MgO	38.799	38.799	K	0.0026	0.0051
NiO	0.206	0.213	Si	0.0044	0.0552
K_2O	0.014	0.007	Na	35.2	33.3
SiO_2	38.9	37.7	CO_2	27.0	25.5
Na_2O	0.027	0.298	HCO_3	33.4	31.3
CO_2	0.36	2.94			
C, noncarbonate	0.036	0.078	pH	7.79	7.79
H_2O, dehyd.[1]	1.350	1.450			
H_2O, chem.[2]	14.054	12.832			
Total	101.142	101.912			
LOI, total[3]	15.80	17.3			
Extent of carbonation, %[4]		6.1			

Carbonation test SC-422 **Synthetic Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.268	0.200	Cl	36.9	36.4
CaO	0.838	0.691	Cr	<0.0005	<0.0005
Cr_2O_3	0.036	0.034	Fe	0.0006	0.0004
FeO	56.991	54.547	Mg	0.0003	0.0017
Fe_2O_3	7.821	2.216	Ni	<0.0005	<0.0005
MgO	0.436	0.426	K	0.0026	0.0216
NiO	<0.01	<0.01	Si	0.0044	0.0438
K_2O	0.022	0.013	Na	35.2	33.6
SiO_2	30.4	26.5	CO_2	27.0	26.6
Na_2O	0.036	0.418	HCO_3	33.4	33.0
CO_2	0.00	11.1			
C, noncarbonate	0.078	0.261	pH	7.77	7.77
H_2O, dehyd.[1]	0.000	0.140			
H_2O, chem.[2]	0.712	0.199			
Total	97.617	96.772			
LOI, total[3]	0.79	11.7			
Extent of carbonation, %[4]		34.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-423 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.181	0.130	Cl	36.9	36.1
CaO	0.259	0.222	Cr	<0.0005	<0.0005
Cr_2O_3	0.127	0.134	Fe	0.0004	0.0004
FeO	8.015	6.317	Mg	0.0002	0.0214
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.587	35.151	K	0.0029	0.0057
NiO	0.235	0.309	Si	0.0024	0.0662
K_2O	0.003	0.003	Na	33.9	33.4
SiO_2	40.4	31.4	CO_2	27.1	26.6
Na_2O	0.018	0.257	HCO_3	33.5	32.4
CO_2	0.21	22.2			
C, noncarbonate	0.007	0.241	pH	7.79	7.85
H_2O, dehyd.[1]	0.160	0.170			
H_2O, chem.[2]	0.743	0.589			
Total	97.978	97.172			
LOI, total[3]	1.12	23.2			
Extent of carbonation, %[4]		49.6			

Carbonation test SC-424 **Synthetic Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.268	0.132	Cl	36.9	39.7
CaO	0.838	0.690	Cr	<0.0005	<0.0005
Cr_2O_3	0.036	0.029	Fe	0.0004	0.0005
FeO	56.991	52.617	Mg	0.0002	0.0014
Fe_2O_3	7.821	<0.01	Ni	<0.0005	<0.0005
MgO	0.436	0.415	K	0.0029	0.0233
NiO	<0.01	0.017	Si	0.0024	0.0380
K_2O	0.022	0.013	Na	33.9	37.3
SiO_2	30.4	24.2	CO_2	27.1	28.3
Na_2O	0.036	0.448	HCO_3	33.5	35.3
CO_2	0.00	19.2			
C, noncarbonate	0.078	0.180	pH	7.79	7.87
H_2O, dehyd.[1]	0.000	0.130			
H_2O, chem.[2]	0.712	-0.910			
Total	97.617	97.134			
LOI, total[3]	0.79	18.6			
Extent of carbonation, %[4]		65.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-425 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.173	0.075	Cl	36.7	36.6
CaO	0.106	0.172	Cr	<0.0005	<0.0005
Cr_2O_3	0.060	0.165	Fe	0.0005	0.0004
FeO	7.616	6.561	Mg	0.0003	0.0362
Fe_2O_3	0.057	0.186	Ni	<0.0005	<0.0005
MgO	50.903	32.001	K	0.0028	0.0054
NiO	0.305	0.234	Si	0.0045	0.0460
K_2O	0.006	0.005	Na	35.0	33.9
SiO_2	40.6	28.0	CO_2	27.0	26.8
Na_2O	0.018	0.328	HCO_3	33.1	33.1
CO_2	0.00	27.9			
C, noncarbonate	0.021	0.226	pH	7.68	7.78
H_2O, dehyd.[1]	0.120	0.190			
H_2O, chem.[2]	0.589	0.684			
Total	100.622	96.752			
LOI, total[3]	0.73	29.0			
Extent of carbonation, %[4]		64.1			

Carbonation test SC-426 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.729	1.132	Cl	36.7	36.7
CaO	0.389	0.439	Cr	<0.0005	<0.0005
Cr_2O_3	0.241	0.184	Fe	0.0005	0.0005
FeO	2.727	1.235	Mg	0.0003	0.0242
Fe_2O_3	2.817	3.346	Ni	<0.0005	<0.0005
MgO	40.623	29.182	K	0.0028	0.0044
NiO	0.220	0.169	Si	0.0045	0.0570
K_2O	0.006	0.005	Na	35.0	32.6
SiO_2	39.1	31.0	CO_2	27.0	23.0
Na_2O	0.017	3.828	HCO_3	33.1	31.0
CO_2	0.20	14.3			
C, noncarbonate	0.008	0.117	pH	7.68	7.63
H_2O, dehyd.[1]	0.980	5.030			
H_2O, chem.[2]	13.212	9.653			
Total	102.318	99.640			
LOI, total[3]	14.40	29.1			
Extent of carbonation, %[4]		35.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-427 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	13.018	11.885	Cl	37.2	37.3
CaO	7.458	8.227	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.020	Fe	0.0006	0.0007
FeO	10.472	10.086	Mg	0.0003	0.0045
Fe_2O_3	3.603	3.774	Ni	<0.0005	<0.0005
MgO	4.361	3.979	K	0.0029	0.1180
NiO	<0.01	0.011	Si	0.0073	0.0530
K_2O	0.970	0.861	Na	34.4	34.4
SiO_2	47.5	49.2	CO_2	27.00	26.3
Na_2O	2.817	4.610	HCO_3	33.5	32.6
CO_2	0.11	0.930			
C, noncarbonate	0.017	0.026	pH	7.69	7.85
H_2O, dehyd.[1]	1.410	0.960			
H_2O, chem.[2]	1.353	1.794			
Total	93.088	96.369			
LOI, total[3]	2.89	3.7			
Extent of carbonation, %[4]		4.9			

Carbonation test SC-428 **Labradorite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	24.563	23.429	Cl	37.2	37.9
CaO	11.2	11.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.033	0.032	Fe	0.0006	0.0030
FeO	1.672	1.814	Mg	0.0003	0.0025
Fe_2O_3	<0.01	0.172	Ni	<0.0005	<0.0005
MgO	0.335	0.366	K	0.0029	0.0493
NiO	<0.01	0.006	Si	0.0073	0.0487
K_2O	0.376	0.349	Na	34.4	36.8
SiO_2	54.3	52.8	CO_2	27.0	27.4
Na_2O	5.756	5.769	HCO_3	33.5	36.0
CO_2	0.000	0.700			
C, noncarbonate	0.024	0.012	pH	7.69	7.68
H_2O, dehyd.[1]	0.050	0.090			
H_2O, chem.[2]	0.326	0.968			
Total	98.709	97.575			
LOI, total[3]	0.40	1.8			
Extent of carbonation, %[4]		6.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-429 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.128	Cl	36.7	36.4
CaO	0.204	0.221	Cr	<0.0005	<0.0005
Cr_2O_3	0.101	0.088	Fe	0.0004	0.0003
FeO	8.118	6.046	Mg	0.0003	0.0412
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.410	36.478	K	0.0025	0.0056
NiO	0.322	0.215	Si	0.0025	0.0480
K_2O	0.004	0.004	Na	34.6	33.9
SiO_2	40.6	30.0	CO_2	27.8	26.5
Na_2O	0.052	0.326	HCO_3	34.8	33.4
CO_2	0.25	25.1			
C, noncarbonate	0.045	0.240	pH	7.70	7.72
H_2O, dehyd.[1]	0.170	0.120			
H_2O, chem.[2]	0.985	1.140			
Total	100.509	100.057			
LOI, total[3]	1.45	26.6			
Extent of carbonation, %[4]		56.2			

Carbonation test SC-430 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.127	0.106	Cl	36.7	35.4
CaO	0.311	0.196	Cr	<0.0005	<0.0005
Cr_2O_3	0.072	0.067	Fe	0.0004	0.0003
FeO	7.809	6.471	Mg	0.0003	0.0346
Fe_2O_3	0.372	<0.01	Ni	<0.0005	<0.0005
MgO	50.240	39.462	K	0.0025	0.0043
NiO	0.309	0.207	Si	0.0025	0.0414
K_2O	0.005	0.006	Na	34.6	32.4
SiO_2	40.9	32.5	CO_2	27.8	26.1
Na_2O	0.016	0.231	HCO_3	34.8	33.1
CO_2	0.12	19.7			
C, noncarbonate	0.013	0.313	pH	7.70	7.86
H_2O, dehyd.[1]	0.060	0.050			
H_2O, chem.[2]	0.757	0.637			
Total	101.072	99.964			
LOI, total[3]	0.95	20.7			
Extent of carbonation, %[4]		40.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-431 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.134	0.097	Cl	36.8	36.8
CaO	0.505	0.135	Cr	<0.0005	<0.0005
Cr_2O_3	0.098	0.082	Fe	0.0004	0.0003
FeO	7.938	7.050	Mg	0.0003	0.0412
Fe_2O_3	2.602	3.374	Ni	<0.0005	<0.0005
MgO	49.410	37.970	K	0.0029	0.0041
NiO	0.288	0.229	Si	0.0028	0.0370
K_2O	0.003	0.003	Na	34.6	34.2
SiO_2	41.1	34.7	CO_2	27.4	27.1
Na_2O	0.019	0.156	HCO_3	33.4	34.1
CO_2	0.00	15.2			
C, noncarbonate	0.000	0.162	pH	7.87	7.84
H_2O, dehyd.[1]	0.050	0.070			
H_2O, chem.[2]	0.710	0.768			
Total	102.831	99.952			
LOI, total[3]	0.76	16.2			
Extent of carbonation, %[4]		30.3			

Carbonation test SC-432 **Ward's Augite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.111	0.956	Cl	36.8	37.6
CaO	22.5	22.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.034	0.036	Fe	0.0004	0.0002
FeO	5.429	8.131	Mg	0.0003	0.0038
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	11.756	11.756	K	0.0029	0.0326
NiO	0.010	0.014	Si	0.0028	0.0376
K_2O	0.038	0.028	Na	34.6	35.1
SiO_2	52.2	51.3	CO_2	27.4	25.6
Na_2O	0.488	0.581	HCO_3	33.4	33.9
CO_2	0.380	0.820			
C, noncarbonate	0.006	0.019	pH	7.87	7.87
H_2O, dehyd.[1]	0.070	0.050			
H_2O, chem.[2]	0.324	0.231			
Total	94.372	96.632			
LOI, total[3]	0.78	1.1			
Extent of carbonation, %[4]		1.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-433 **Ward's Augite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.929	2.437	Cl	0.004	0.140
CaO	21.8	18.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.398	0.333	Fe	<0.0001	0.0001
FeO	12.376	8.131	Mg	0.0006	0.0846
Fe_2O_3	<0.01	2.960	Ni	<0.0005	0.0002
MgO	11.474	9.550	K	<0.0001	0.006
NiO	0.891	0.738	Si	<0.0001	0.161
K_2O	0.042	0.031	Na	0.0003	0.346
SiO_2	47.9	40.2	CO_2	<0.0001	1.10
Na_2O	0.576	0.325	HCO_3	<0.0001	1.72
CO_2	0.41	11.1			
C, noncarbonate	0.078	0.171	pH		7.83
H_2O, dehyd.[1]	0.000	0.770			
H_2O, chem.[2]	0.832	4.759			
Total	99.752	99.714			
LOI, total[3]	1.32	16.8			
Extent of carbonation, %[4]		32.5			

Carbonation test SC-434 **Ward's Anorthite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	23.1	22.1	Cl	0.0038	0.0200
CaO	14.4	14.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.073	0.068	Fe	<0.0001	<0.0001
FeO	3.924	2.714	Mg	0.0006	0.0602
Fe_2O_3	2.116	2.702	Ni	<0.0005	0.0001
MgO	7.942	7.345	K	<0.0001	0.0028
NiO	0.242	0.232	Si	<0.0001	0.0729
K_2O	0.045	0.041	Na	0.0003	0.122
SiO_2	42.8	40.9	CO_2	<0.0001	0.780
Na_2O	0.554	0.410	HCO_3	<0.0001	1.060
CO_2	0.16	1.9			
C, noncarbonate	0.047	0.071	pH		7.6.908
H_2O, dehyd.[1]	0.070	0.650			
H_2O, chem.[2]	2.433	4.889			
Total	97.856	97.995			
LOI, total[3]	2.71	7.6			
Extent of carbonation, %[4]		8.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-435 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	11.734	13.434	Cl	0.004	0.020
CaO	6.79	7.58	Cr	<0.0005	<0.0005
Cr_2O_3	0.156	0.145	Fe	<0.0001	0.0002
FeO	10.253	7.976	Mg	0.0006	0.0283
Fe_2O_3	3.374	5.047	Ni	<0.0005	<0.0005
MgO	3.780	4.112	K	<0.0001	0.0516
NiO	0.328	0.303	Si	<0.0001	0.1160
K_2O	0.997	0.915	Na	0.0003	0.877
SiO_2	50.7	48.1	CO_2	<0.0001	2.120
Na_2O	2.804	2.238	HCO_3	<0.0001	2.670
CO_2	0.000	1.76			
C, noncarbonate	0.060	0.095	pH		7.39
H_2O, dehyd.[1]	0.000	0.260			
H_2O, chem.[2]	2.260	5.035			
Total	93.235	97.038			
LOI, total[3]	2.32	7.2			
Extent of carbonation, %[4]		11.4			

Carbonation test SC-436 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.140	Cl	36.8	36.8
CaO	0.228	0.248	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.107	Fe	0.0004	0.0003
FeO	8.015	5.789	Mg	0.0003	0.0454
Fe_2O_3	<0.01	0.372	Ni	<0.0005	<0.0005
MgO	48.4	35.5	K	0.0028	0.0164
NiO	0.290	0.204	Si	0.0033	0.0375
K_2O	0.004	0.004	Na	34.3	33.0
SiO_2	40.6	31.0	CO_2	28.1	26.5
Na_2O	0.014	0.448	HCO_3	35.0	33.4
CO_2	0.14	22.8			
C, noncarbonate	0.018	0.307	pH	7.68	7.76
H_2O, dehyd.[1]	0.090	0.080			
H_2O, chem.[2]	0.902	0.913			
Total	99.094	97.914			
LOI, total[3]	1.15	24.1			
Extent of carbonation, %[4]		50.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-437 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	14.039	12.168	Cl	0.004	0.120
CaO	7.71	8.05	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.023	Fe	<0.0001	0.0002
FeO	9.443	9.649	Mg	0.0006	0.0312
Fe_2O_3	3.045	3.060	Ni	<0.0005	<0.0005
MgO	4.875	4.410	K	<0.0001	0.0492
NiO	<0.01	0.014	Si	<0.0001	0.1520
K_2O	1.073	0.990	Na	0.0003	0.263
SiO_2	50.7	51.3	CO_2	<0.0001	0.710
Na_2O	2.790	3.222	HCO_3	<0.0001	0.950
CO_2	0.00	0.00			
C, noncarbonate	0.043	0.034	pH		6.86
H_2O, dehyd.[1]	0.780	0.800			
H_2O, chem.[2]	1.147	0.906			
Total	95.652	94.665			
LOI, total[3]	1.97	1.7			
Extent of carbonation, %[4]		0.0			

Carbonation test SC-438 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.182	0.193	Cl	36.8	40.8
CaO	0.260	0.334	Cr	<0.0005	<0.0005
Cr_2O_3	0.127	0.093	Fe	0.0004	0.0006
FeO	8.079	6.998	Mg	0.0003	0.0356
Fe_2O_3	<0.01	0.129	Ni	<0.0005	<0.0005
MgO	47.3	40.1	K	0.0028	0.0178
NiO	0.305	0.274	Si	0.0033	0.0388
K_2O	0.005	0.005	Na	34.3	33.7
SiO_2	40.6	35.5	CO_2	28.1	27.3
Na_2O	0.017	0.988	HCO_3	35.0	34.4
CO_2	0.12	10.5			
C, noncarbonate	0.055	0.094	pH	7.68	7.84
H_2O, dehyd.[1]	0.180	0.490			
H_2O, chem.[2]	0.675	1.716			
Total	97.908	97.452			
LOI, total[3]	1.03	12.8			
Extent of carbonation, %[4]		20.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-439 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.133	Cl	37.0	36.5
CaO	0.214	0.197	Cr	<0.0005	<0.0005
Cr_2O_3	0.096	0.111	Fe	0.0004	0.0003
FeO	8.066	6.420	Mg	0.0002	0.0486
Fe_2O_3	<0.01	0.357	Ni	<0.0005	<0.0005
MgO	50.2	42.3	K	0.0027	0.0058
NiO	0.305	0.255	Si	0.0033	0.0336
K_2O	0.004	0.003	Na	34.6	33.6
SiO_2	41.1	34.9	CO_2	27.2	26.4
Na_2O	0.017	0.454	HCO_3	34.8	33.8
CO_2	0.16	14.4			
C, noncarbonate	0.060	0.310	pH	7.85	7.79
H_2O, dehyd.[1]	0.180	0.230			
H_2O, chem.[2]	0.810	0.960			
Total	101.426	100.982			
LOI, total[3]	1.21	15.9			
Extent of carbonation, %[4]		27.8			

Carbonation test SC-440 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.430	1.292	Cl	37.0	36.3
CaO	0.428	0.364	Cr	<0.0005	<0.0005
Cr_2O_3	0.237	0.186	Fe	0.0004	0.0003
FeO	1.647	1.171	Mg	0.0002	0.0290
Fe_2O_3	3.960	3.603	Ni	<0.0005	<0.0005
MgO	38.0	31.8	K	0.0027	0.0057
NiO	0.209	0.165	Si	0.0033	0.0411
K_2O	0.005	0.005	Na	34.6	31.4
SiO_2	39.1	32.7	CO_2	27.2	23.5
Na_2O	0.015	2.372	HCO_3	34.8	30.3
CO_2	0.90	12.9			
C, noncarbonate	0.056	0.000	pH	7.85	7.89
H_2O, dehyd.[1]	1.590	4.030			
H_2O, chem.[2]	13.654	10.770			
Total	101.251	101.425			
LOI, total[3]	16.20	27.7			
Extent of carbonation, %[4]		32.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-441 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.493	1.209	Cl	36.8	34.6
CaO	0.514	0.413	Cr	<0.0005	<0.0005
Cr_2O_3	0.234	0.187	Fe	0.0004	0.0004
FeO	1.827	1.081	Mg	0.0002	0.0304
Fe_2O_3	3.889	3.460	Ni	<0.0005	<0.0005
MgO	39.3	31.5	K	0.0028	0.0045
NiO	0.213	0.173	Si	0.0058	0.0410
K_2O	0.007	0.006	Na	33.1	29.5
SiO_2	40.0	31.9	CO_2	27.2	21.7
Na_2O	0.019	2.534	HCO_3	33.4	28.4
CO_2	0.66	15.1			
C, noncarbonate	0.061	0.109	pH	7.71	7.65
H_2O, dehyd.[1]	1.100	4.140			
H_2O, chem.[2]	11.579	9.651			
Total	100.895	101.442			
LOI, total[3]	13.40	29.0			
Extent of carbonation, %[4]		38.6			

Carbonation test SC-442 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.653	1.525	Cl	36.8	36.6
CaO	0.382	0.383	Cr	<0.0005	<0.0005
Cr_2O_3	0.229	0.200	Fe	0.0004	0.0003
FeO	1.814	1.145	Mg	0.0002	0.0228
Fe_2O_3	3.603	3.717	Ni	<0.0005	<0.0005
MgO	38.5	34.7	K	0.0028	0.0047
NiO	0.182	0.167	Si	0.0058	0.0445
K_2O	0.005	0.005	Na	33.1	35.4
SiO_2	38.5	34.7	CO_2	27.2	24.0
Na_2O	0.015	1.055	HCO_3	33.4	30.5
CO_2	0.89	11.7			
C, noncarbonate	0.064	0.067	pH	7.71	7.66
H_2O, dehyd.[1]	1.990	5.070			
H_2O, chem.[2]	13.456	9.663			
Total	101.259	104.009			
LOI, total[3]	16.40	26.5			
Extent of carbonation, %[4]		28.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-443 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.212	0.137	Cl	35.7	36.3
CaO	0.257	0.309	Cr	<0.0005	<0.0005
Cr_2O_3	0.295	0.273	Fe	0.0004	0.0004
FeO	7.732	6.510	Mg	0.0003	0.0594
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.1	40.6	K	0.0027	0.0051
NiO	0.302	0.233	Si	0.0029	0.0415
K_2O	0.005	0.007	Na	34.0	33.0
SiO_2	40.9	33.8	CO_2	27.2	26.7
Na_2O	0.014	0.717	HCO_3	33.5	33.2
CO_2	0.14	15.1			
C, noncarbonate	0.041	0.269	pH	7.67	7.76
H_2O, dehyd.[1]	0.190	0.490			
H_2O, chem.[2]	0.579	1.141			
Total	99.707	99.609			
LOI, total[3]	0.95	17.0			
Extent of carbonation, %[4]		30.1			

Carbonation test SC-444 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.515	1.085	Cl	35.7	36.4
CaO	0.533	0.470	Cr	<0.0005	<0.0005
Cr_2O_3	0.222	0.189	Fe	0.0004	0.0003
FeO	1.853	1.209	Mg	0.0003	0.0234
Fe_2O_3	3.374	2.859	Ni	<0.0005	<0.0005
MgO	37.3	27.9	K	0.0027	0.0044
NiO	0.190	0.148	Si	0.0029	0.0501
K_2O	0.006	0.005	Na	34.0	30.3
SiO_2	38.5	28.9	CO_2	27.2	21.8
Na_2O	0.018	2.372	HCO_3	33.5	27.9
CO_2	0.62	21.1			
C, noncarbonate	0.029	0.231	pH	7.67	7.72
H_2O, dehyd.[1]	1.530	5.370			
H_2O, chem.[2]	13.721	7.199			
Total	99.425	98.973			
LOI, total[3]	15.90	33.9			
Extent of carbonation, %[4]		61.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-445 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.549	1.243	Cl	36.8	36.3
CaO	0.533	0.476	Cr	<0.0005	<0.0005
Cr_2O_3	0.241	0.208	Fe	0.0003	0.0003
FeO	2.161	1.248	Mg	0.0003	0.0262
Fe_2O_3	3.017	2.931	Ni	<0.0005	<0.0005
MgO	38.0	30.8	K	0.0026	0.0042
NiO	0.206	0.182	Si	0.0027	0.0498
K_2O	0.008	0.005	Na	36.2	33.2
SiO_2	38.3	30.6	CO_2	27.8	23.0
Na_2O	0.022	2.143	HCO_3	34.6	28.0
CO_2	0.71	16.6			
C, noncarbonate	0.032	0.250	pH	7.75	7.72
H_2O, dehyd.[1]	1.800	4.740			
H_2O, chem.[2]	13.958	8.310			
Total	100.501	99.768			
LOI, total[3]	16.50	29.9			
Extent of carbonation, %[4]		44.5			

Carbonation test SC-446 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.472	1.340	Cl	36.8	36.4
CaO	0.529	0.512	Cr	<0.0005	<0.0005
Cr_2O_3	0.234	0.209	Fe	0.0003	0.0003
FeO	1.968	1.312	Mg	0.0003	0.0292
Fe_2O_3	3.103	3.174	Ni	<0.0005	<0.0005
MgO	37.5	33.3	K	0.0026	0.0047
NiO	0.215	0.190	Si	0.0027	0.0554
K_2O	0.004	0.004	Na	36.2	31.2
SiO_2	37.9	32.1	CO_2	27.8	23.3
Na_2O	0.016	2.116	HCO_3	34.6	29.8
CO_2	0.83	11.4			
C, noncarbonate	0.029	0.179	pH	7.75	7.78
H_2O, dehyd.[1]	2.000	2.660			
H_2O, chem.[2]	13.941	10.661			
Total	99.679	99.174			
LOI, total[3]	16.80	24.9			
Extent of carbonation, %[4]		28.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-447 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.604	1.479	Cl	37.0	36.3
CaO	0.546	0.514	Cr	<0.0005	<0.0005
Cr_2O_3	0.232	0.208	Fe	0.0003	0.0003
FeO	2.046	1.634	Mg	0.0003	0.0218
Fe_2O_3	2.945	3.117	Ni	<0.0005	<0.0005
MgO	36.0	32.3	K	0.0027	0.0048
NiO	0.220	0.196	Si	0.0033	0.0500
K_2O	0.007	0.006	Na	34.6	32.8
SiO_2	37.9	34.4	CO_2	27.7	25.2
Na_2O	0.027	1.577	HCO_3	34.7	32.5
CO_2	0.86	7.1			
C, noncarbonate	0.006	0.115	pH	7.64	7.69
H_2O, dehyd.[1]	2.790	5.200			
H_2O, chem.[2]	13.244	8.695			
Total	98.373	96.606			
LOI, total[3]	16.90	21.1			
Extent of carbonation, %[4]		16.6			

Carbonation test SC-448 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.580	1.164	Cl	37.0	36.0
CaO	0.487	0.527	Cr	<0.0005	<0.0005
Cr_2O_3	0.229	0.187	Fe	0.0003	0.0004
FeO	1.595	0.669	Mg	0.0003	0.0182
Fe_2O_3	3.689	3.431	Ni	<0.0005	<0.0005
MgO	34.2	26.4	K	0.0027	0.0038
NiO	0.220	0.171	Si	0.0033	0.0443
K_2O	0.005	0.006	Na	34.6	32.2
SiO_2	38.3	28.9	CO_2	27.7	24.5
Na_2O	0.021	2.238	HCO_3	34.7	31.1
CO_2	0.60	20.3			
C, noncarbonate	0.074	0.000	pH	7.64	7.62
H_2O, dehyd.[1]	1.210	2.980			
H_2O, chem.[2]	14.316	7.920			
Total	96.476	94.837			
LOI, total[3]	16.20	31.2			
Extent of carbonation, %[4]		64.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-449 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.506	1.168	Cl	37.2	36.0
CaO	0	0	Cr	<0.0005	<0.0005
Cr_2O_3	0.227	0.189	Fe	0.0004	0.0003
FeO	2.007	0.836	Mg	0.0003	0.0296
Fe_2O_3	3.403	3.646	Ni	<0.0005	<0.0005
MgO	37.6	29.8	K	0.0028	0.0039
NiO	0.206	0.171	Si	0.0034	0.0444
K_2O	0.007	0.006	Na	34.6	32.7
SiO_2	38.1	31.4	CO_2	26.7	24.6
Na_2O	0.014	1.860	HCO_3	33.5	32.3
CO_2	0.63	16.5			
C, noncarbonate	0.046	0.287	pH	7.99	7.66
H_2O, dehyd.[1]	2.310	7.200			
H_2O, chem.[2]	13.714	5.513			
Total	100.270	99.070			
LOI, total[3]	16.70	29.5			
Extent of carbonation, %[4]		44.8			

Carbonation test SC-450 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.580	1.185	Cl	37.2	36.8
CaO	0.487	0.346	Cr	<0.0005	<0.0005
Cr_2O_3	0.229	0.184	Fe	0.0004	0.0004
FeO	1.595	0.656	Mg	0.0003	0.0234
Fe_2O_3	3.689	3.589	Ni	<0.0005	<0.0005
MgO	34.2	27.4	K	0.0028	0.0036
NiO	0.220	0.167	Si	0.0034	0.0590
K_2O	0.005	0.009	Na	34.6	32.6
SiO_2	38.3	28.0	CO_2	26.7	24.8
Na_2O	0.021	2.507	HCO_3	33.5	32.3
CO_2	0.60	20.4			
C, noncarbonate	0.074	0.272	pH	7.99	7.67
H_2O, dehyd.[1]	1.210	6.290			
H_2O, chem.[2]	14.316	4.238			
Total	96.476	95.225			
LOI, total[3]	16.20	31.2			
Extent of carbonation, %[4]		64.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-451 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.570	1.319	Cl	37.3	36.3
CaO	0.515	0.472	Cr	<0.0005	<0.0005
Cr_2O_3	0.193	0.164	Fe	0.0003	0.0003
FeO	2.046	1.261	Mg	0.0003	0.0200
Fe_2O_3	3.160	3.303	Ni	<0.0005	<0.0005
MgO	36.5	30.8	K	0.0026	0.0039
NiO	0.178	0.146	Si	0.0028	0.0404
K_2O	0.009	0.007	Na	34.8	34.4
SiO_2	35.1	30.6	CO_2	26.6	25.6
Na_2O	0.040	2.103	HCO_3	32.2	32.7
CO_2	0.71	13.6			
C, noncarbonate	0.057	0.208	pH	7.99	7.76
H_2O, dehyd.[1]	2.490	3.790			
H_2O, chem.[2]	13.843	9.102			
Total	96.373	96.906			
LOI, total[3]	17.10	26.7			
Extent of carbonation, %[4]		36.3			

Carbonation test SC-452 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.583	1.336	Cl	37.3	35.5
CaO	0.500	0.507	Cr	<0.0005	<0.0005
Cr_2O_3	0.184	0.167	Fe	0.0003	0.0002
FeO	2.046	1.106	Mg	0.0003	0.0222
Fe_2O_3	3.303	3.660	Ni	<0.0005	<0.0005
MgO	36.8	31.0	K	0.0026	0.0038
NiO	0.171	0.148	Si	0.0028	0.0481
K_2O	0.005	0.006	Na	34.8	33.6
SiO_2	37.7	31.9	CO_2	26.6	25.7
Na_2O	0.031	1.429	HCO_3	32.2	33.9
CO_2	0.57	13.3			
C, noncarbonate	0.042	0.230	pH	7.99	7.72
H_2O, dehyd.[1]	1.580	3.610			
H_2O, chem.[2]	13.208	9.060			
Total	97.683	97.440			
LOI, total[3]	15.40	26.2			
Extent of carbonation, %[4]		35.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-453 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.627	1.394	Cl	36.8	36.8
CaO	0.518	0.467	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.178	Fe	0.0003	0.0003
FeO	1.994	1.068	Mg	0.0003	0.0214
Fe_2O_3	3.474	3.774	Ni	<0.0005	<0.0005
MgO	37.3	31.8	K	0.0027	0.0041
NiO	0.165	0.145	Si	0.0046	0.0337
K_2O	0.010	0.007	Na	34.1	33.3
SiO_2	37.4	31.9	CO_2	27.1	25.5
Na_2O	0.021	1.510	HCO_3	34.5	32.7
CO_2	0.69	12.1			
C, noncarbonate	0.046	0.208	pH	7.75	7.76
H_2O, dehyd.[1]	2.030	4.230			
H_2O, chem.[2]	13.634	9.562			
Total	99.149	98.355			
LOI, total[3]	16.40	26.1			
Extent of carbonation, %[4]		30.9			

Carbonation test SC-454 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.820	1.559	Cl	36.8	36.6
CaO	0.500	0.498	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.164	Fe	0.0003	0.0004
FeO	2.174	1.158	Mg	0.0003	0.0314
Fe_2O_3	3.431	3.789	Ni	<0.0005	<0.0005
MgO	39.3	32.5	K	0.0027	0.0040
NiO	0.174	0.141	Si	0.0046	0.0424
K_2O	0.005	0.006	Na	34.1	33.0
SiO_2	38.1	31.4	CO_2	27.1	25.2
Na_2O	0.015	1.213	HCO_3	34.5	32.7
CO_2	0.39	12.8			
C, noncarbonate	0.030	0.197	pH	7.75	7.68
H_2O, dehyd.[1]	0.600	2.800			
H_2O, chem.[2]	11.480	10.403			
Total	98.189	98.674			
LOI, total[3]	12.50	26.2			
Extent of carbonation, %[4]		32.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-455 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.580	1.326	Cl	36.8	36.2
CaO	0.521	0.474	Cr	<0.0005	<0.0005
Cr_2O_3	0.197	0.164	Fe	0.0004	0.0003
FeO	2.046	0.978	Mg	0.0003	0.0190
Fe_2O_3	3.574	3.860	Ni	<0.0005	<0.0005
MgO	36.0	31.5	K	0.0027	0.0042
NiO	0.169	0.140	Si	0.0026	0.0298
K_2O	0.015	0.009	Na	33.2	31.9
SiO_2	38.7	30.8	CO_2	27.8	25.2
Na_2O	0.022	1.167	HCO_3	35.5	31.5
CO_2	0.50	13.0			
C, noncarbonate	0.029	0.062	pH	7.65	7.70
H_2O, dehyd.[1]	1.110	5.960			
H_2O, chem.[2]	12.661	8.878			
Total	97.126	98.328			
LOI, total[3]	14.30	27.9			
Extent of carbonation, %[4]		35.3			

Carbonation test SC-456 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.517	1.064	Cl	36.8	36.5
CaO	0.505	0.423	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.153	Fe	0.0004	0.0003
FeO	2.303	0.862	Mg	0.0003	0.0150
Fe_2O_3	3.417	3.274	Ni	<0.0005	<0.0005
MgO	37.6	26.9	K	0.0027	0.0037
NiO	0.172	0.125	Si	0.0026	0.0340
K_2O	0.007	0.007	Na	33.2	30.4
SiO_2	38.1	27.8	CO_2	27.8	24.1
Na_2O	0.018	2.238	HCO_3	35.5	31.1
CO_2	0.56	25.8			
C, noncarbonate	0.032	0.000	pH	7.65	7.7.751
H_2O, dehyd.[1]	1.340	4.860			
H_2O, chem.[2]	13.468	4.840			
Total	99.251	98.317			
LOI, total[3]	15.40	35.5			
Extent of carbonation, %[4]		79.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-457 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.657	1.228	Cl	36.9	36.0
CaO	0.595	0.514	Cr	<0.0005	<0.0005
Cr_2O_3	0.199	0.148	Fe	0.0005	0.0005
FeO	2.110	0.836	Mg	0.0002	0.0212
Fe_2O_3	3.346	3.531	Ni	<0.0005	<0.0005
MgO	37.3	27.9	K	0.0027	0.0036
NiO	0.171	0.125	Si	0.0024	0.0384
K_2O	0.010	0.009	Na	35.8	32.2
SiO_2	37.7	29.5	CO_2	26.0	24.5
Na_2O	0.021	1.928	HCO_3	31.0	30.8
CO_2	0.53	22.9			
C, noncarbonate	0.045	0.330	pH	8.14	7.66
H_2O, dehyd.[1]	1.470	2.900			
H_2O, chem.[2]	13.755	7.870			
Total	98.866	99.696			
LOI, total[3]	15.80	34.0			
Extent of carbonation, %[4]		68.7			

Carbonation test SC-458 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.483	1.268	Cl	36.9	36.4
CaO	0.487	0.285	Cr	<0.0005	<0.0005
Cr_2O_3	0.175	0.152	Fe	0.0005	0.0003
FeO	1.570	0.334	Mg	0.0002	0.0222
Fe_2O_3	3.832	4.575	Ni	<0.0005	<0.0005
MgO	34.8	25.9	K	0.0027	0.0046
NiO	0.155	0.140	Si	0.0024	0.0490
K_2O	0.004	0.004	Na	35.8	30.9
SiO_2	36.8	33.2	CO_2	26.0	24.1
Na_2O	0.015	2.319	HCO_3	31.0	31.6
CO_2	1.26	9.1			
C, noncarbonate	0.063	0.194	pH	8.14	7.67
H_2O, dehyd.[1]	3.680	5.230			
H_2O, chem.[2]	13.597	10.666			
Total	97.936	93.303			
LOI, total[3]	18.60	25.2			
Extent of carbonation, %[4]		22.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-459 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.353	1.205	Cl	37.3	36.0
CaO	0.420	0.400	Cr	<0.0005	<0.0005
Cr_2O_3	0.175	0.162	Fe	0.0005	0.0004
FeO	2.033	1.775	Mg	0.0003	0.0216
Fe_2O_3	3.031	3.317	Ni	<0.0005	<0.0005
MgO	30.0	36.1	K	0.0028	0.0049
NiO	0.159	0.150	Si	0.0023	0.0486
K_2O	0.004	0.004	Na	33.0	31.7
SiO_2	37.4	35.7	CO_2	27.3	24.9
Na_2O	0.015	0.721	HCO_3	34.8	32.2
CO_2	1.09	6.9			
C, noncarbonate	0.029	0.102	pH	7.75	7.72
H_2O, dehyd.[1]	3.240	2.560			
H_2O, chem.[2]	13.341	11.258			
Total	92.339	100.408			
LOI, total[3]	17.70	20.8			
Extent of carbonation, %[4]		18.5			

Carbonation test SC-460 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.296	1.177	Cl	37.3	36.3
CaO	0.491	0.430	Cr	<0.0005	<0.0005
Cr_2O_3	0.183	0.171	Fe	0.0005	0.0004
FeO	2.238	1.891	Mg	0.0003	0.0140
Fe_2O_3	3.245	3.188	Ni	<0.0005	<0.0005
MgO	30.7	35.0	K	0.0028	0.0039
NiO	0.163	0.153	Si	0.0023	0.0392
K_2O	0.005	0.004	Na	33.0	31.7
SiO_2	38.9	35.7	CO_2	27.3	26.0
Na_2O	0.015	1.725	HCO_3	34.8	33.8
CO_2	0.68	7.2			
C, noncarbonate	0.042	0.125	pH	7.75	7.75
H_2O, dehyd.[1]	2.540	4.280			
H_2O, chem.[2]	12.538	10.195			
Total	93.047	101.251			
LOI, total[3]	15.80	21.8			
Extent of carbonation, %[4]		20.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-461 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.716	1.483	Cl	36.9	36.7
CaO	0.536	0.515	Cr	<0.0005	<0.0005
Cr_2O_3	0.203	0.177	Fe	0.0003	0.0004
FeO	1.955	1.711	Mg	0.0003	0.0204
Fe_2O_3	3.617	3.474	Ni	<0.0005	<0.0005
MgO	37.5	33.7	K	0.0028	0.0041
NiO	0.174	0.153	Si	0.0024	0.0307
K_2O	0.010	0.008	Na	34.2	32.9
SiO_2	39.8	35.7	CO_2	26.8	26.3
Na_2O	0.018	1.283	HCO_3	34.5	34.5
CO_2	0.59	8.0			
C, noncarbonate	0.045	0.134	pH	7.84	7.72
H_2O, dehyd.[1]	1.530	2.450			
H_2O, chem.[2]	12.535	11.106			
Total	100.194	99.889			
LOI, total[3]	14.70	21.7			
Extent of carbonation, %[4]		19.1			

Carbonation test SC-462 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.266	0.184	Cl	36.9	36.5
CaO	0.211	0.213	Cr	<0.0005	<0.0005
Cr_2O_3	0.310	0.221	Fe	0.0003	0.0002
FeO	7.500	6.304	Mg	0.0003	0.0302
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.3	32.5	K	0.0028	0.0058
NiO	0.270	0.186	Si	0.0024	0.0352
K_2O	0.005	0.004	Na	34.2	32.0
SiO_2	40.6	27.8	CO_2	26.8	24.8
Na_2O	0.020	0.934	HCO_3	34.5	31.4
CO_2	0.33	29.7			
C, noncarbonate	0.024	0.034	pH	7.84	7.71
H_2O, dehyd.[1]	0.320	0.550			
H_2O, chem.[2]	1.046	1.616			
Total	97.210	100.254			
LOI, total[3]	1.72	31.9			
Extent of carbonation, %[4]		75.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-463 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.137	0.060	Cl	36.4	36.5
CaO	0.203	0.242	Cr	<0.0005	<0.0005
Cr_2O_3	0.284	0.186	Fe	0.0004	0.0004
FeO	7.719	4.992	Mg	0.0003	0.0280
Fe_2O_3	<0.01	0.815	Ni	<0.0005	<0.0005
MgO	48.6	32.3	K	0.0028	0.0075
NiO	0.255	0.176	Si	0.0022	0.0380
K_2O	0.011	0.008	Na	33.8	31.9
SiO_2	39.8	27.8	CO_2	27.3	25.4
Na_2O	0.020	0.593	HCO_3	33.4	31.2
CO_2	0.34	30.2			
C, noncarbonate	0.000	0.628	pH	7.63	7.74
H_2O, dehyd.[1]	0.230	0.330			
H_2O, chem.[2]	1.100	-0.158			
Total	98.671	98.214			
LOI, total[3]	1.67	31.0			
Extent of carbonation, %[4]		73.9			

Carbonation test SC-464 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.131	0.054	Cl	36.4	35.9
CaO	0.3	0.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.109	Fe	0.0004	0.0004
FeO	7.783	5.377	Mg	0.0003	0.0382
Fe_2O_3	0.172	0.272	Ni	<0.0005	<0.0005
MgO	47.918	32.830	K	0.0028	0.0054
NiO	0.246	0.167	Si	0.0022	0.0317
K_2O	0.006	0.003	Na	33.8	31.4
SiO_2	40.2	28.5	CO_2	27.3	25.8
Na_2O	0.017	0.460	HCO_3	33.4	32.6
CO_2	0.30	28.7			
C, noncarbonate	0.000	0.457	pH	7.63	7.76
H_2O, dehyd.[1]	0.150	0.210			
H_2O, chem.[2]	1.000	0.933			
Total	98.364	98.252			
LOI, total[3]	1.45	30.3			
Extent of carbonation, %[4]		69.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-465 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.127	Cl	36.7	35.9
CaO	0.174	0.203	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.120	Fe	0.0003	0.0003
FeO	8.015	5.686	Mg	0.0003	0.0726
Fe_2O_3	0.057	0.372	Ni	<0.0005	<0.0005
MgO	43.6	35.3	K	0.0028	0.0049
NiO	0.242	0.178	Si	0.0023	0.0356
K_2O	0.010	0.005	Na	33.4	31.9
SiO_2	40.6	30.0	CO_2	27.3	26.1
Na_2O	0.021	0.278	HCO_3	34.6	33.8
CO_2	0.17	24.7			
C, noncarbonate	0.004	0.429	pH	7.59	7.59
H_2O, dehyd.[1]	0.160	0.130			
H_2O, chem.[2]	0.806	0.941			
Total	94.249	98.436			
LOI, total[3]	1.14	26.2			
Extent of carbonation, %[4]		61.9			

Carbonation test SC-466 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.227	0.141	Cl	36.7	36.5
CaO	0.168	0.131	Cr	<0.0005	<0.0005
Cr_2O_3	0.292	0.254	Fe	0.0003	0.0003
FeO	7.757	6.265	Mg	0.0003	0.0276
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	42.9	30.8	K	0.0028	0.0068
NiO	0.255	0.185	Si	0.0023	0.0433
K_2O	0.005	0.004	Na	33.4	31.0
SiO_2	40.2	28.7	CO_2	27.3	25.4
Na_2O	0.017	1.469	HCO_3	34.6	32.6
CO_2	0.29	24.7			
C, noncarbonate	0.014	0.539	pH	7.59	7.75
H_2O, dehyd.[1]	0.270	0.570			
H_2O, chem.[2]	0.776	3.091			
Total	93.234	96.856			
LOI, total[3]	1.35	28.9			
Extent of carbonation, %[4]		62.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-467 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.123	Cl	36.6	35.5
CaO	0.228	0.234	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.118	Fe	0.0004	0.0005
FeO	8.015	5.815	Mg	0.0003	0.0272
Fe_2O_3	<0.01	0.172	Ni	<0.0005	<0.0005
MgO	48.4	34.3	K	0.0028	0.0052
NiO	0.290	0.178	Si	0.0022	0.0454
K_2O	0.004	0.005	Na	33.9	32.4
SiO_2	40.6	29.5	CO_2	26.7	25.7
Na_2O	0.014	0.632	HCO_3	34.0	32.9
CO_2	0.14	24.9			
C, noncarbonate	0.018	0.394	pH	7.79	7.66
H_2O, dehyd.[1]	0.090	0.720			
H_2O, chem.[2]	0.902	1.186			
Total	99.094	98.321			
LOI, total[3]	1.15	27.2			
Extent of carbonation, %[4]		56.9			

Carbonation test SC-468 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.109	Cl	36.6	36.3
CaO	0.332	0.278	Cr	<0.0005	<0.0005
Cr_2O_3	0.181	0.114	Fe	0.0004	0.0004
FeO	7.732	5.558	Mg	0.0003	0.0254
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.3	30.5	K	0.0028	0.0061
NiO	0.267	0.178	Si	0.0022	0.0400
K_2O	0.003	0.002	Na	33.9	32.4
SiO_2	39.8	27.8	CO_2	26.7	25.3
Na_2O	0.018	1.173	HCO_3	34.0	32.9
CO_2	0.36	26.5			
C, noncarbonate	0.008	0.258	pH	7.79	7.75
H_2O, dehyd.[1]	0.280	0.990			
H_2O, chem.[2]	1.112	2.652			
Total	97.545	96.132			
LOI, total[3]	1.76	30.4			
Extent of carbonation, %[4]		62.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-469 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.219	0.126	Cl	36.5	36.5
CaO	0.278	0.228	Cr	<0.0005	<0.0005
Cr_2O_3	0.276	0.197	Fe	0.0003	0.0004
FeO	8.915	6.162	Mg	0.0003	0.0254
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.4	32.3	K	0.0027	0.0051
NiO	0.284	0.191	Si	0.0021	0.0365
K_2O	0.005	0.003	Na	34.0	32.0
SiO_2	39.4	27.0	CO_2	27.0	26.4
Na_2O	0.020	0.392	HCO_3	34.6	33.6
CO_2	0.26	31.0			
C, noncarbonate	0.081	0.760	pH	7.60	7.75
H_2O, dehyd.[1]	0.510	0.500			
H_2O, chem.[2]	0.919	1.340			
Total	100.542	100.187			
LOI, total[3]	1.77	33.6			
Extent of carbonation, %[4]		74.7			

Carbonation test SC-470 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.118	Cl	36.5	36.4
CaO	0.228	0.193	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.078	Fe	0.0003	0.0003
FeO	8.015	6.085	Mg	0.0003	0.0352
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	37.5	K	0.0027	0.0052
NiO	0.290	0.168	Si	0.0021	0.0306
K_2O	0.004	0.004	Na	34.0	31.4
SiO_2	40.6	32.9	CO_2	27.0	23.5
Na_2O	0.014	0.336	HCO_3	34.6	26.0
CO_2	0.14	23.0			
C, noncarbonate	0.018	0.393	pH	7.60	7.72
H_2O, dehyd.[1]	0.090	0.400			
H_2O, chem.[2]	0.902	0.207			
Total	99.094	101.400			
LOI, total[3]	1.15	24.0			
Extent of carbonation, %[4]		51.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-471 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.133	Cl	36.6	36.4
CaO	0.228	0.239	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.077	Fe	0.0003	0.0007
FeO	8.015	6.149	Mg	0.0003	0.0272
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	38.3	K	0.0029	0.0057
NiO	0.290	0.181	Si	0.0035	0.0330
K_2O	0.004	0.003	Na	32.3	31.6
SiO_2	40.6	31.7	CO_2	26.7	26.9
Na_2O	0.014	0.880	HCO_3	33.8	33.1
CO_2	0.14	19.7			
C, noncarbonate	0.018	0.473	pH	7.86	7.81
H_2O, dehyd.[1]	0.090	0.860			
H_2O, chem.[2]	0.902	1.467			
Total	99.094	100.127			
LOI, total[3]	1.15	22.5			
Extent of carbonation, %[4]		42.1			

Carbonation test SC-472 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.130	Cl	36.6	36.5
CaO	0.228	0.546	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.112	Fe	0.0003	0.0004
FeO	8.015	6.381	Mg	0.0003	0.0276
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	37.6	K	0.0029	0.0049
NiO	0.290	0.193	Si	0.0035	0.0330
K_2O	0.004	0.006	Na	32.3	36.7
SiO_2	40.6	31.9	CO_2	26.7	25.7
Na_2O	0.014	1.388	HCO_3	33.8	32.9
CO_2	0.14	18.1			
C, noncarbonate	0.018	0.270	pH	7.86	7.85
H_2O, dehyd.[1]	0.090	0.760			
H_2O, chem.[2]	0.902	1.870			
Total	99.094	99.271			
LOI, total[3]	1.15	21.0			
Extent of carbonation, %[4]		37.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-473 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.547	1.332	Cl	36.6	36.0
CaO	0.557	0.546	Cr	<0.0005	<0.0005
Cr_2O_3	0.202	0.189	Fe	0.0003	0.0004
FeO	2.689	2.560	Mg	0.0003	0.0384
Fe_2O_3	2.945	2.888	Ni	<0.0005	<0.0005
MgO	38.0	36.3	K	0.0029	0.0066
NiO	0.178	0.173	Si	0.0027	0.0416
K_2O	0.006	0.004	Na	33.2	31.8
SiO_2	39.6	38.5	CO_2	26.4	26.4
Na_2O	0.024	0.938	HCO_3	33.4	33.8
CO_2	0.17	1.6			
C, noncarbonate	0.043	0.078	pH	7.70	7.67
H_2O, dehyd.[1]	1.470	2.110			
H_2O, chem.[2]	12.917	12.352			
Total	100.296	99.549			
LOI, total[3]	14.60	16.1			
Extent of carbonation, %[4]		3.2			

Carbonation test SC-474 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.110	Cl	36.6	36.2
CaO	0.174	0.243	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.082	Fe	0.0003	0.0006
FeO	8.015	5.853	Mg	0.0003	0.0338
Fe_2O_3	0.057	<0.01	Ni	<0.0005	<0.0005
MgO	43.6	35.2	K	0.0029	0.0056
NiO	0.242	0.172	Si	0.0027	0.0364
K_2O	0.010	0.002	Na	33.2	32.0
SiO_2	40.6	30.0	CO_2	26.4	26.0
Na_2O	0.021	0.328	HCO_3	33.4	32.8
CO_2	0.17	25.2			
C, noncarbonate	0.004	0.432	pH	7.70	7.74
H_2O, dehyd.[1]	0.160	0.260			
H_2O, chem.[2]	0.806	0.608			
Total	94.249	98.392			
LOI, total[3]	1.14	26.5			
Extent of carbonation, %[4]		63.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-475 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.251	0.159	Cl	37.0	35.0
CaO	0.217	0.225	Cr	<0.0005	<0.0005
Cr_2O_3	0.585	0.422	Fe	0.0004	0.0003
FeO	10.562	7.063	Mg	0.0003	0.0334
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.4	30.2	K	0.0028	0.0066
NiO	0.355	0.242	Si	0.0036	0.0420
K_2O	0.006	0.003	Na	33.2	31.6
SiO_2	38.3	25.7	CO_2	26.7	24.5
Na_2O	0.025	0.865	HCO_3	32.9	31.7
CO_2	0.33	31.9			
C, noncarbonate	0.044	0.784	pH	7.83	7.71
H_2O, dehyd.[1]	1.340	0.990			
H_2O, chem.[2]	1.296	0.926			
Total	98.736	99.429			
LOI, total[3]	3.01	34.6			
Extent of carbonation, %[4]		82.5			

Carbonation test SC-476 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.087	Cl	37.0	35.4
CaO	0.228	0.174	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.148	Fe	0.0004	0.0002
FeO	8.015	6.265	Mg	0.0003	0.0348
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	34.3	K	0.0028	0.0054
NiO	0.290	0.214	Si	0.0036	0.0370
K_2O	0.004	0.002	Na	33.2	30.2
SiO_2	40.6	31.0	CO_2	26.7	25.3
Na_2O	0.014	0.352	HCO_3	32.9	31.9
CO_2	0.14	25.4			
C, noncarbonate	0.018	0.478	pH	7.83	7.77
H_2O, dehyd.[1]	0.090	0.430			
H_2O, chem.[2]	0.902	0.492			
Total	99.094	99.383			
LOI, total[3]	1.15	26.8			
Extent of carbonation, %[4]		58.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-477 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.120	0.085	Cl	36.4	36.4
CaO	0.157	0.207	Cr	<0.0005	<0.0005
Cr_2O_3	0.132	0.105	Fe	0.0001	0.0002
FeO	8.066	6.008	Mg	0.0003	0.0332
Fe_2O_3	0.286	<0.01	Ni	<0.0005	<0.0005
MgO	45.9	34.3	K	0.0029	0.0065
NiO	0.303	0.210	Si	0.0068	0.0352
K_2O	0.003	0.001	Na	33.7	32.5
SiO_2	41.3	31.2	CO_2	27.0	25.9
Na_2O	0.021	0.311	HCO_3	34.0	32.6
CO_2	0.22	26.2			
C, noncarbonate	0.000	0.350	pH	7.64	7.79
H_2O, dehyd.[1]	0.220	0.250			
H_2O, chem.[2]	0.600	0.400			
Total	97.345	99.683			
LOI, total[3]	1.04	27.2			
Extent of carbonation, %[4]		63.8			

Carbonation test SC-478 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.119	Cl	36.4	36.8
CaO	0.194	0.172	Cr	<0.0005	<0.0005
Cr_2O_3	0.194	0.162	Fe	0.0001	0.0004
FeO	7.809	5.776	Mg	0.0003	0.0266
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.4	34.0	K	0.0029	0.0052
NiO	0.286	0.216	Si	0.0068	0.0388
K_2O	0.010	0.004	Na	33.7	33.5
SiO_2	40.9	31.0	CO_2	27.0	25.4
Na_2O	0.023	0.398	HCO_3	34.0	33.1
CO_2	0.35	27.0			
C, noncarbonate	0.014	0.371	pH	7.64	7.80
H_2O, dehyd.[1]	1.430	0.490			
H_2O, chem.[2]	1.486	0.639			
Total	99.269	100.359			
LOI, total[3]	3.28	28.5			
Extent of carbonation, %[4]		65.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-479 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.191	0.136	Cl	36.6	35.9
CaO	0.224	0.194	Cr	<0.0005	<0.0005
Cr_2O_3	0.101	0.094	Fe	0.0005	0.0005
FeO	7.796	6.445	Mg	0.0003	0.0420
Fe_2O_3	0.629	<0.01	Ni	<0.0005	<0.0005
MgO	47.9	37.5	K	0.0028	0.0048
NiO	0.293	0.235	Si	0.0020	0.0302
K_2O	0.003	0.003	Na	37.1	31.3
SiO_2	42.8	49.0	CO_2	27.3	26.4
Na_2O	0.018	0.174	HCO_3	34.2	33.1
CO_2	0.10	19.3			
C, noncarbonate	0.005	0.413	pH	7.57	7.82
H_2O, dehyd.[1]	0.100	0.260			
H_2O, chem.[2]	0.625	0.627			
Total	100.789	114.344			
LOI, total[3]	0.83	20.6			
Extent of carbonation, %[4]		41.6			

Carbonation test SC-480 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.143	0.071	Cl	36.6	36.0
CaO	0.235	0.190	Cr	<0.0005	<0.0005
Cr_2O_3	0.234	0.181	Fe	0.0005	0.0004
FeO	8.594	6.111	Mg	0.0003	0.0312
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.1	34.2	K	0.0028	0.0044
NiO	0.218	0.242	Si	0.0020	0.0357
K_2O	0.003	0.002	Na	37.1	33.1
SiO_2	41.1	29.3	CO_2	27.3	26.0
Na_2O	0.018	0.307	HCO_3	34.2	33.8
CO_2	0.13	27.9			
C, noncarbonate	0.009	0.626	pH	7.57	7.79
H_2O, dehyd.[1]	0.270	0.330			
H_2O, chem.[2]	0.551	0.544			
Total	100.559	99.970			
LOI, total[3]	0.96	29.4			
Extent of carbonation, %[4]		65.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-481 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.106	0.080	Cl	36.5	36.8
CaO	0.241	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.136	0.121	Fe	0.0003	0.0002
FeO	8.182	6.124	Mg	0.0003	0.0796
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.4	36.6	K	0.0028	0.0043
NiO	0.344	0.241	Si	0.0025	0.0333
K_2O	0.003	0.002	Na	33.2	34.2
SiO_2	41.1	31.7	CO_2	26.1	26.9
Na_2O	0.023	0.231	HCO_3	32.3	35.3
CO_2	0.11	23.8			
C, noncarbonate	0.010	0.525	pH	7.96	7.70
H_2O, dehyd.[1]	0.170	0.220			
H_2O, chem.[2]	0.580	0.955			
Total	100.389	100.770			
LOI, total[3]	0.87	25.5			
Extent of carbonation, %[4]		52.6			

Carbonation test SC-482 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.156	0.092	Cl	36.5	35.5
CaO	0.199	0.164	Cr	<0.0005	<0.0005
Cr_2O_3	0.088	0.068	Fe	0.0003	0.0003
FeO	7.938	5.480	Mg	0.0003	0.0408
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.2	37.0	K	0.0028	0.0044
NiO	0.319	0.216	Si	0.0025	0.0325
K_2O	0.002	0.002	Na	33.2	33.0
SiO_2	41.1	31.2	CO_2	26.1	25.8
Na_2O	0.013	0.243	HCO_3	32.3	32.7
CO_2	0.20	23.1			
C, noncarbonate	0.000	0.386	pH	7.96	7.82
H_2O, dehyd.[1]	0.270	0.310			
H_2O, chem.[2]	0.600	0.604			
Total	100.104	98.874			
LOI, total[3]	1.07	24.4			
Extent of carbonation, %[4]		50.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-483 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.126	0.114	Cl	36.8	36.3
CaO	0.220	0.158	Cr	<0.0005	<0.0005
Cr_2O_3	0.127	0.085	Fe	0.0004	0.0006
FeO	8.182	6.265	Mg	0.0003	0.0530
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.7	37.0	K	0.0028	0.0050
NiO	0.328	0.214	Si	0.0022	0.0515
K_2O	0.003	0.003	Na	34.2	33.3
SiO_2	40.0	31.2	CO_2	26.3	26.1
Na_2O	0.014	0.270	HCO_3	33.0	34.1
CO_2	0.22	22.5			
C, noncarbonate	0.003	0.529	pH	8.00	7.88
H_2O, dehyd.[1]	0.480	0.260			
H_2O, chem.[2]	0.887	0.811			
Total	99.342	99.417			
LOI, total[3]	1.59	24.1			
Extent of carbonation, %[4]		49.3			

Carbonation test SC-484 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.168	0.135	Cl	36.8	35.7
CaO	0.211	0.160	Cr	<0.0005	<0.0005
Cr_2O_3	0.126	0.115	Fe	0.0004	0.0004
FeO	8.375	5.583	Mg	0.0003	0.0394
Fe_2O_3	<0.01	0.944	Ni	<0.0005	<0.0005
MgO	49.7	36.8	K	0.0028	0.0046
NiO	0.325	0.221	Si	0.0022	0.0424
K_2O	0.003	0.002	Na	34.2	32.0
SiO_2	40.4	31.0	CO_2	26.3	25.5
Na_2O	0.012	0.305	HCO_3	33.0	31.6
CO_2	0.22	23.7			
C, noncarbonate	0.003	0.512	pH	8.00	8.00
H_2O, dehyd.[1]	0.500	0.240			
H_2O, chem.[2]	0.887	0.948			
Total	101.005	100.695			
LOI, total[3]	1.61	25.4			
Extent of carbonation, %[4]		51.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-485 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.172	0.132	Cl	36.6	35.2
CaO	0.196	0.228	Cr	<0.0005	<0.0005
Cr_2O_3	0.262	0.208	Fe	0.0003	0.0003
FeO	8.658	6.793	Mg	0.0003	0.0518
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.7	36.0	K	0.0028	0.0059
NiO	0.255	0.201	Si	0.0024	0.0483
K_2O	0.003	0.002	Na	32.7	33.7
SiO_2	40.9	31.9	CO_2	26.7	26.3
Na_2O	0.015	0.313	HCO_3	33.9	32.4
CO_2	0.25	21.0			
C, noncarbonate	0.000	0.009	pH	7.84	8.07
H_2O, dehyd.[1]	0.570	0.600			
H_2O, chem.[2]	0.760	-0.109			
Total	100.748	97.232			
LOI, total[3]	1.58	21.5			
Extent of carbonation, %[4]		44.8			

Carbonation test SC-486 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.145	0.099	Cl	36.6	34.4
CaO	0.235	0.174	Cr	<0.0005	<0.0005
Cr_2O_3	0.200	0.168	Fe	0.0003	0.0003
FeO	8.375	6.510	Mg	0.0003	0.0268
Fe_2O_3	<0.01	0.114	Ni	<0.0005	<0.0005
MgO	48.4	34.3	K	0.0028	0.0050
NiO	0.299	0.207	Si	0.0024	0.0342
K_2O	0.009	0.013	Na	32.7	33.6
SiO_2	40.6	28.7	CO_2	26.7	25.5
Na_2O	0.027	0.381	HCO_3	33.9	32.3
CO_2	0.22	27.0			
C, noncarbonate	0.010	0.551	pH	7.84	7.98
H_2O, dehyd.[1]	0.490	0.340			
H_2O, chem.[2]	0.850	1.009			
Total	99.924	99.556			
LOI, total[3]	1.57	28.9			
Extent of carbonation, %[4]		63.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-487 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.143	0.080	Cl	34.8	33.6
CaO	0.217	0.180	Cr	<0.0005	<0.0005
Cr_2O_3	0.221	0.165	Fe	0.0004	0.0006
FeO	8.619	6.394	Mg	0.0003	0.0206
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	33.3	K	0.0027	0.0041
NiO	0.314	0.223	Si	0.0043	0.0396
K_2O	0.007	0.007	Na	34.3	32.7
SiO_2	40.6	28.7	CO_2	26.3	25.8
Na_2O	0.017	0.282	HCO_3	34.6	32.4
CO_2	0.13	28.2			
C, noncarbonate	0.011	0.554	pH	7.78	7.95
H_2O, dehyd.[1]	0.150	0.140			
H_2O, chem.[2]	0.629	1.106			
Total	99.521	99.326			
LOI, total[3]	0.92	30.0			
Extent of carbonation, %[4]		67.1			

Carbonation test SC-488 **50% TS Olivine + 50% Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.207	0.150	Cl	34.8	34.4
CaO	0.451	0.430	Cr	<0.0005	<0.0005
Cr_2O_3	0.046	0.066	Fe	0.0004	0.0002
FeO	32.4	24.2	Mg	0.0003	0.0130
Fe_2O_3	3.910	3.589	Ni	<0.0005	<0.0005
MgO	24.4	18.9	K	0.0027	0.0083
NiO	0.154	0.115	Si	0.0043	0.0374
K_2O	0.013	0.014	Na	34.3	33.9
SiO_2	35.4	26.5	CO_2	26.3	25.7
Na_2O	0.027	0.284	HCO_3	34.6	34.5
CO_2	0.00	24.4			
C, noncarbonate	0.054	0.391	pH	7.78	8.01
H_2O, dehyd.[1]	0.065	0.110			
H_2O, chem.[2]	0.761	-0.401			
Total	97.945	98.762			
LOI, total[3]	0.88	24.5			
Extent of carbonation, %[4]		68.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-489 **75% TS Olivine + 25% Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.136	Cl	34.4	36.8
CaO	0.258	0.248	Cr	<0.0005	<0.0005
Cr_2O_3	0.050	0.091	Fe	0.0004	0.0005
FeO	20.1	14.5	Mg	0.0003	0.0154
Fe_2O_3	1.955	1.916	Ni	<0.0005	0.0250
MgO	36.4	25.5	K	0.0026	0.0121
NiO	0.231	0.159	Si	0.0031	0.0399
K_2O	0.009	0.006	Na	33.6	35.5
SiO_2	37.9	27.4	CO_2	26.1	27.9
Na_2O	0.022	0.233	HCO_3	34.5	36.1
CO_2	0.00	27.1			
C, noncarbonate	0.042	0.574	pH	7.99	7.95
H_2O, dehyd.[1]	0.098	0.100			
H_2O, chem.[2]	0.786	0.726			
Total	98.109	98.743			
LOI, total[3]	0.93	28.5			
Extent of carbonation, %[4]		71.1			

Carbonation test SC-490 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.237	0.231	Cl	34.4	34.1
CaO	0.645	0.681	Cr	<0.0005	<0.0005
Cr_2O_3	0.041	0.066	Fe	0.0004	0.0004
FeO	44.7	40.7	Mg	0.0003	0.0024
Fe_2O_3	5.865	9.894	Ni	<0.0005	<0.0005
MgO	12.4	12.2	K	0.0026	0.0104
NiO	0.077	0.076	Si	0.0031	0.0306
K_2O	0.018	0.019	Na	33.6	34.6
SiO_2	32.9	31.7	CO_2	26.1	25.5
Na_2O	0.031	0.326	HCO_3	34.5	33.7
CO_2	0.00	3.3			
C, noncarbonate	0.066	0.129	pH	7.99	7.95
H_2O, dehyd.[1]	0.033	0.310			
H_2O, chem.[2]	0.737	0.521			
Total	97.781	100.038			
LOI, total[3]	0.84	4.3			
Extent of carbonation, %[4]		8.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-491 **25% TS Olivine + 75% Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.237	0.163	Cl	34.8	34.2
CaO	0.645	0.585	Cr	<0.0005	<0.0005
Cr_2O_3	0.041	0.065	Fe	0.0004	0.0005
FeO	44.7	32.4	Mg	0.0003	0.0037
Fe_2O_3	5.865	11.981	Ni	<0.0005	<0.0005
MgO	12.4	10.4	K	0.0026	0.0104
NiO	0.077	0.032	Si	0.0039	0.0402
K_2O	0.018	0.016	Na	31.5	30.4
SiO_2	32.9	27.8	CO_2	26.5	25.2
Na_2O	0.031	0.810	HCO_3	34.7	32.1
CO_2	0.00	13.7			
C, noncarbonate	0.066	0.231	pH	7.90	7.94
H_2O, dehyd.[1]	0.033	0.260			
H_2O, chem.[2]	0.737	0.209			
Total	97.781	98.678			
LOI, total[3]	0.84	14.4			
Extent of carbonation, %[4]		38.3			

Carbonation test SC-492 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.173	0.125	Cl	34.8	33.7
CaO	0.106	0.133	Cr	<0.0005	<0.0005
Cr_2O_3	0.060	0.238	Fe	0.0004	0.0006
FeO	7.616	8.105	Mg	0.0003	0.0352
Fe_2O_3	0.057	<0.01	Ni	<0.0005	<0.0005
MgO	50.9	44.6	K	0.0026	0.0047
NiO	0.305	0.225	Si	0.0039	0.0425
K_2O	0.006	0.005	Na	31.5	29.3
SiO_2	40.6	37.4	CO_2	26.5	25.9
Na_2O	0.018	0.448	HCO_3	34.7	32.9
CO_2	0.00	7.0			
C, noncarbonate	0.021	0.149	pH	7.90	7.91
H_2O, dehyd.[1]	0.120	0.400			
H_2O, chem.[2]	0.589	0.741			
Total	100.622	99.649			
LOI, total[3]	0.73	8.3			
Extent of carbonation, %[4]		12.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-493 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.158	Cl	37.5	36.1
CaO	0.174	0.169	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.212	Fe	0.0003	0.0002
FeO	8.015	6.741	Mg	0.0003	0.0474
Fe_2O_3	0.057	<0.01	Ni	<0.0005	<0.0005
MgO	43.6	42.9	K	0.0026	0.0046
NiO	0.242	0.293	Si	0.0031	0.0337
K_2O	0.010	0.004	Na	33.9	31.9
SiO_2	40.6	37.7	CO_2	26.9	25.8
Na_2O	0.021	0.984	HCO_3	33.7	33.0
CO_2	0.17	6.7			
C, noncarbonate	0.004	0.164	pH	8.02	7.95
H_2O, dehyd.[1]	0.160	0.320			
H_2O, chem.[2]	0.806	1.546			
Total	94.249	97.877			
LOI, total[3]	1.14	8.7			
Extent of carbonation, %[4]		13.3			

Carbonation test SC-494 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.117	Cl	37.5	35.8
CaO	0.174	0.273	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.155	Fe	0.0003	0.0003
FeO	8.015	7.114	Mg	0.0003	0.0360
Fe_2O_3	0.057	0.172	Ni	<0.0005	0.0055
MgO	43.6	45.1	K	0.0026	0.0045
NiO	0.242	0.280	Si	0.0031	0.0297
K_2O	0.010	0.003	Na	33.9	30.7
SiO_2	40.6	36.8	CO_2	26.9	25.3
Na_2O	0.021	0.531	HCO_3	33.7	33.4
CO_2	0.17	7.6			
C, noncarbonate	0.004	0.169	pH	8.02	7.93
H_2O, dehyd.[1]	0.160	0.240			
H_2O, chem.[2]	0.806	0.971			
Total	94.249	99.511			
LOI, total[3]	1.14	9.0			
Extent of carbonation, %[4]		15.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-495 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.251	0.151	Cl	36.9	35.0
CaO	0.217	0.239	Cr	<0.0005	<0.0005
Cr_2O_3	0.585	0.370	Fe	0.0003	0.0002
FeO	10.56	7.35	Mg	0.0004	0.0362
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.4	31.0	K	0.0027	0.0043
NiO	0.355	0.243	Si	0.0022	0.0326
K_2O	0.006	0.003	Na	32.1	29.6
SiO_2	38.3	26.1	CO_2	26.6	24.3
Na_2O	0.025	0.617	HCO_3	34.5	31.2
CO_2	0.33	31.0			
C, noncarbonate	0.044	0.590	pH	7.95	7.89
H_2O, dehyd.[1]	1.340	0.650			
H_2O, chem.[2]	1.296	1.160			
Total	98.736	99.475			
LOI, total[3]	3.01	33.4			
Extent of carbonation, %[4]		79.1			

Carbonation test SC-496 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.144	Cl	36.9	36.9
CaO	0.174	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.142	Fe	0.0003	0.0003
FeO	8.015	7.089	Mg	0.0004	0.0440
Fe_2O_3	0.057	0.043	Ni	<0.0005	0.0160
MgO	43.6	44.6	K	0.0027	0.0046
NiO	0.242	0.280	Si	0.0022	0.0294
K_2O	0.010	0.004	Na	32.1	32.5
SiO_2	40.6	40.0	CO_2	26.6	24.7
Na_2O	0.021	0.879	HCO_3	34.5	30.5
CO_2	0.17	8.2			
C, noncarbonate	0.004	0.185	pH	7.95	8.03
H_2O, dehyd.[1]	0.160	0.330			
H_2O, chem.[2]	0.806	1.125			
Total	94.249	103.183			
LOI, total[3]	1.14	9.8			
Extent of carbonation, %[4]		16.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-497 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.185	0.123	Cl	36.7	36.0
CaO	0.174	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.146	Fe	0.0003	0.0004
FeO	8.015	7.024	Mg	0.0003	0.0468
Fe_2O_3	0.057	0.014	Ni	0.0220	0.0005
MgO	43.6	45.1	K	0.0031	0.0051
NiO	0.242	0.284	Si	0.0035	0.0294
K_2O	0.010	0.006	Na	32.9	31.2
SiO_2	40.6	37.0	CO_2	26.7	26.0
Na_2O	0.021	0.847	HCO_3	33.6	33.3
CO_2	0.17	7.7			
C, noncarbonate	0.004	0.130	pH	7.82	7.76
H_2O, dehyd.[1]	0.160	0.260			
H_2O, chem.[2]	0.806	1.190			
Total	94.249	100.031			
LOI, total[3]	1.14	9.3			
Extent of carbonation, %[4]		15.6			

Carbonation test SC-498 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.131	0.104	Cl	36.7	35.3
CaO	0.273	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.151	0.183	Fe	0.0003	0.0004
FeO	7.78	5.27	Mg	0.0003	0.0418
Fe_2O_3	0.172	0.629	Ni	0.0220	0.0005
MgO	47.9	34.3	K	0.0031	0.0059
NiO	0.246	0.229	Si	0.0035	0.0314
K_2O	0.006	0.013	Na	32.9	30.4
SiO_2	40.2	29.1	CO_2	26.7	24.2
Na_2O	0.017	0.566	HCO_3	33.6	30.6
CO_2	0.30	26.7			
C, noncarbonate	0.000	0.513	pH	7.82	7.96
H_2O, dehyd.[1]	0.150	0.300			
H_2O, chem.[2]	1.000	0.687			
Total	98.364	98.782			
LOI, total[3]	1.45	28.2			
Extent of carbonation, %[4]		62.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-499 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.127	0.140	Cl	36.8	36.6
CaO	0.311	0.182	Cr	<0.0005	<0.0005
Cr_2O_3	0.072	0.132	Fe	0.0004	0.0004
FeO	7.809	7.333	Mg	0.0003	0.0382
Fe_2O_3	0.372	0.114	Ni	<0.0005	<0.0005
MgO	50.2	46.4	K	0.0028	0.0040
NiO	0.309	0.280	Si	0.0059	0.0325
K_2O	0.005	0.007	Na	32.2	31.2
SiO_2	40.9	38.7	CO_2	27.3	26.4
Na_2O	0.016	0.396	HCO_3	35.6	34.4
CO_2	0.12	4.5			
C, noncarbonate	0.013	0.084	pH	7.08	8.00
H_2O, dehyd.[1]	0.060	0.240			
H_2O, chem.[2]	0.757	0.936			
Total	101.072	99.522			
LOI, total[3]	0.95	5.8			
Extent of carbonation, %[4]		7.7			

Carbonation test SC-500 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.161	0.168	Cl	36.8	36.4
CaO	0.167	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.099	0.104	Fe	0.0004	0.0004
FeO	7.783	7.037	Mg	0.0003	0.0474
Fe_2O_3	<0.01	0.558	Ni	<0.0005	<0.0005
MgO	49.2	44.9	K	0.0028	0.0045
NiO	0.272	0.256	Si	0.0059	0.0432
K_2O	0.004	0.005	Na	32.2	33.6
SiO_2	40.9	32.3	CO_2	27.3	26.9
Na_2O	0.021	0.349	HCO_3	35.6	32.6
CO_2	0.11	6.8			
C, noncarbonate	0.012	0.130	pH	7.71	8.00
H_2O, dehyd.[1]	0.170	0.270			
H_2O, chem.[2]	0.588	0.840			
Total	99.494	93.875			
LOI, total[3]	0.88	8.0			
Extent of carbonation, %[4]		12.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-501 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.234	0.156	Cl	36.0	36.0
CaO	0.208	0.092	Cr	<0.0005	<0.0005
Cr_2O_3	0.751	0.555	Fe	0.0003	0.0003
FeO	12.30	8.31	Mg	0.0003	0.0268
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	43.9	27.0	K	0.0028	0.0086
NiO	0.304	0.216	Si	0.0028	0.0425
K_2O	0.005	0.004	Na	32.6	30.6
SiO_2	37.0	25.0	CO_2	27.5	24.7
Na_2O	0.016	0.822	HCO_3	34.5	31.7
CO_2	0.48	32.5			
C, noncarbonate	0.068	0.420	pH	7.87	7.94
H_2O, dehyd.[1]	2.040	0.700			
H_2O, chem.[2]	1.882	0.880			
Total	99.237	96.714			
LOI, total[3]	4.47	34.5			
Extent of carbonation, %[4]		85.3			

Carbonation test SC-502 **25% TS Olivine 75% Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.237	0.191	Cl	36.0	35.8
CaO	0.645	0.551	Cr	<0.0005	<0.0005
Cr_2O_3	0.041	0.044	Fe	0.0003	0.0004
FeO	44.7	36.8	Mg	0.0003	0.0109
Fe_2O_3	5.865	2.259	Ni	<0.0005	<0.0005
MgO	12.4	9.1	K	0.0028	0.0090
NiO	0.077	0.025	Si	0.0028	0.0309
K_2O	0.018	0.013	Na	32.6	32.9
SiO_2	32.9	25.7	CO_2	27.5	26.8
Na_2O	0.031	0.368	HCO_3	34.5	34.4
CO_2	0.00	20.6			
C, noncarbonate	0.066	0.488	pH	7.87	7.86
H_2O, dehyd.[1]	0.033	0.060			
H_2O, chem.[2]	0.737	-1.348			
Total	97.781	94.803			
LOI, total[3]	0.84	19.8			
Extent of carbonation, %[4]		62.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-503 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.234	0.115	Cl	36.1	35.4
CaO	0.208	0.095	Cr	<0.0005	<0.0005
Cr_2O_3	0.751	0.545	Fe	0.0004	0.0004
FeO	12.30	7.74	Mg	0.0004	0.0344
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	43.9	28.2	K	0.0026	0.0046
NiO	0.304	0.211	Si	0.0035	0.0562
K_2O	0.005	0.006	Na	32.8	30.8
SiO_2	37.0	24.2	CO_2	27.7	25.0
Na_2O	0.016	2.642	HCO_3	34.5	30.3
CO_2	0.48	30.8			
C, noncarbonate	0.068	0.544	pH	7.68	7.87
H_2O, dehyd.[1]	2.040	1.040			
H_2O, chem.[2]	1.882	4.016			
Total	99.237	100.120			
LOI, total[3]	4.47	36.4			
Extent of carbonation, %[4]		78.8			

Carbonation test SC-504 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.234	0.137	Cl	36.1	35.5
CaO	0.208	0.183	Cr	<0.0005	<0.0005
Cr_2O_3	0.751	0.627	Fe	0.0004	0.0003
FeO	12.30	9.34	Mg	0.0004	0.0844
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	43.9	32.3	K	0.0026	0.0062
NiO	0.304	0.227	Si	0.0035	0.0572
K_2O	0.005	0.003	Na	32.8	33.8
SiO_2	37.0	26.3	CO_2	27.7	25.5
Na_2O	0.016	3.019	HCO_3	34.5	32.1
CO_2	0.48	24.6			
C, noncarbonate	0.068	0.326	pH	7.70	7.85
H_2O, dehyd.[1]	2.040	1.150			
H_2O, chem.[2]	1.882	4.524			
Total	99.237	102.782			
LOI, total[3]	4.47	30.6			
Extent of carbonation, %[4]		57.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-505 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.090	Cl	36.2	35.9
CaO	0.192	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.418	0.314	Fe	0.0002	0.0002
FeO	8.93	6.45	Mg	0.0003	0.0462
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	33.0	K	0.0026	0.0039
NiO	0.302	0.207	Si	0.0030	0.0387
K_2O	0.003	0.012	Na	33.1	30.6
SiO_2	40.0	27.6	CO_2	27.3	26.5
Na_2O	0.022	0.337	HCO_3	32.4	33.6
CO_2	0.18	29.7			
C, noncarbonate	0.013	0.044	pH	7.81	7.88
H_2O, dehyd.[1]	0.460	0.260			
H_2O, chem.[2]	0.857	1.096			
Total	99.805	99.248			
LOI, total[3]	1.51	31.1			
Extent of carbonation, %[4]		72.1			

Carbonation test SC-506 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.129	Cl	36.2	35.7
CaO	0.192	0.238	Cr	<0.0005	<0.0005
Cr_2O_3	0.418	0.402	Fe	0.0002	0.0003
FeO	8.93	8.41	Mg	0.0003	0.0148
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0023
MgO	48.2	42.9	K	0.0026	0.0043
NiO	0.302	0.309	Si	0.0030	0.0334
K_2O	0.003	0.008	Na	33.1	33.7
SiO_2	40.0	36.4	CO_2	27.3	27.1
Na_2O	0.022	1.031	HCO_3	32.4	34.4
CO_2	0.18	6.9			
C, noncarbonate	0.013	0.110	pH	7.81	8.03
H_2O, dehyd.[1]	0.460	0.720			
H_2O, chem.[2]	0.857	1.260			
Total	99.805	98.824			
LOI, total[3]	1.51	9.0			
Extent of carbonation, %[4]		12.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-507 **Texas Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.465	0.450	Cl	35.7	35.2
CaO	0.100	0.116	Cr	<0.0005	<0.0005
Cr_2O_3	0.341	0.300	Fe	0.0004	0.0003
FeO	1.34	1.35	Mg	0.0003	0.0274
Fe_2O_3	4.60	4.69	Ni	0.0014	0.0008
MgO	38.8	37.1	K	0.0030	0.0038
NiO	0.251	0.232	Si	0.0036	0.0464
K_2O	0.004	0.003	Na	32.9	29.8
SiO_2	37.9	35.5	CO_2	27.1	26.6
Na_2O	0.012	1.496	HCO_3	33.9	33.4
CO_2	0.21	2.7			
C, noncarbonate	0.013	0.054	pH	7.96	7.85
H_2O, dehyd.[1]	2.090	2.380			
H_2O, chem.[2]	13.287	12.706			
Total	99.379	99.089			
LOI, total[3]	15.60	17.8			
Extent of carbonation, %[4]		5.8			

Carbonation test SC-508 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.089	Cl	35.7	34.9
CaO	0.192	0.187	Cr	<0.0005	<0.0005
Cr_2O_3	0.418	0.304	Fe	0.0004	0.0004
FeO	8.93	6.93	Mg	0.0003	0.0786
Fe_2O_3	<0.01	<0.01	Ni	0.0014	<0.0005
MgO	48.2	36.1	K	0.0030	0.0045
NiO	0.302	0.228	Si	0.0036	0.0386
K_2O	0.003	0.006	Na	32.9	31.2
SiO_2	40.0	29.1	CO_2	27.1	26.2
Na_2O	0.022	0.398	HCO_3	33.9	32.4
CO_2	0.18	22.9			
C, noncarbonate	0.013	0.270	pH	7.96	7.93
H_2O, dehyd.[1]	0.460	0.480			
H_2O, chem.[2]	0.857	0.850			
Total	99.805	97.886			
LOI, total[3]	1.51	24.5			
Extent of carbonation, %[4]		50.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-509 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.735	1.151	Cl	35.1	34.6
CaO	0.488	0.395	Cr	<0.0005	<0.0005
Cr_2O_3	0.874	0.212	Fe	0.0002	0.0002
FeO	1.72	1.40	Mg	0.0003	0.0430
Fe_2O_3	4.73	3.19	Ni	0.0013	<0.0005
MgO	40.1	25.7	K	0.0030	0.0145
NiO	0.674	0.165	Si	0.0032	0.0552
K_2O	0.023	0.014	Na	32.0	27.1
SiO_2	37.9	24.8	CO_2	27.1	18.3
Na_2O	0.136	5.35	HCO_3	32.5	22.7
CO_2	0.49	23.3			
C, noncarbonate	0.099	0.241	pH	7.71	7.80
H_2O, dehyd.[1]	0.94	3.70			
H_2O, chem.[2]	13.77	8.76			
Total	103.678	98.395			
LOI, total[3]	15.30	36.0			
Extent of carbonation, %[4]		66.0			

Carbonation test SC-510 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.852	0.693	Cl	35.1	34.7
CaO	0.309	0.283	Cr	<0.0005	<0.0005
Cr_2O_3	0.107	0.105	Fe	0.0002	0.0004
FeO	7.629	6.407	Mg	0.0003	0.0820
Fe_2O_3	0.100	0.114	Ni	0.0013	<0.0005
MgO	50.1	39.8	K	0.0030	0.0464
NiO	0.280	0.216	Si	0.0032	0.0332
K_2O	0.036	0.015	Na	32.0	33.2
SiO_2	41.7	33.8	CO_2	27.1	1.0
Na_2O	0.028	0.284	HCO_3	32.5	1.0
CO_2	0.00	18.0			
C, noncarbonate	0.045	0.197	pH	7.71	7.94
H_2O, dehyd.[1]	0.200	0.250			
H_2O, chem.[2]	0.905	1.053			
Total	102.282	101.213			
LOI, total[3]	1.15	19.5			
Extent of carbonation, %[4]		36.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-511 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.039	0.828	Cl	35.4	34.7
CaO	0.215	0.172	Cr	<0.0005	<0.0005
Cr_2O_3	0.247	0.170	Fe	0.0003	0.0004
FeO	7.65	5.90	Mg	0.0003	0.1220
Fe_2O_3	0.315	0.200	Ni	<0.0005	<0.0005
MgO	48.4	36.1	K	0.0026	0.0648
NiO	0.261	0.195	Si	0.0024	0.0520
K_2O	0.060	0.025	Na	33.0	30.8
SiO_2	41.3	31.4	CO_2	27.4	25.8
Na_2O	0.053	0.442	HCO_3	34.4	31.9
CO_2	0.14	24.2			
C, noncarbonate	0.017	0.135	pH	7.76	7.83
H_2O, dehyd.[1]	0.330	0.360			
H_2O, chem.[2]	0.943	0.605			
Total	100.979	100.830			
LOI, total[3]	1.43	25.3			
Extent of carbonation, %[4]		55.0			

Carbonation test SC-512 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.039	0.952	Cl	35.4	34.9
CaO	0.215	0.193	Cr	<0.0005	<0.0005
Cr_2O_3	0.247	0.140	Fe	0.0003	0.0004
FeO	7.65	7.33	Mg	0.0003	0.1020
Fe_2O_3	0.315	2.473	Ni	<0.0005	0.0008
MgO	48.4	44.4	K	0.0026	0.0520
NiO	0.261	0.267	Si	0.0024	0.0529
K_2O	0.060	0.033	Na	33.0	31.3
SiO_2	41.3	38.1	CO_2	27.4	26.3
Na_2O	0.053	1.442	HCO_3	34.4	33.2
CO_2	0.14	5.5			
C, noncarbonate	0.017	0.078	pH	7.76	7.87
H_2O, dehyd.[1]	0.330	0.540			
H_2O, chem.[2]	0.943	2.372			
Total	100.979	103.880			
LOI, total[3]	1.43	8.5			
Extent of carbonation, %[4]		9.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-513 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.280	0.246	Cl	35.7	34.9
CaO	0.199	0.193	Cr	<0.0005	<0.0005
Cr_2O_3	0.133	0.132	Fe	0.0003	0.0003
FeO	7.51	7.31	Mg	0.0003	0.0576
Fe_2O_3	0.543	<0.01	Ni	<0.0005	<0.0005
MgO	47.9	43.3	K	0.0026	0.0154
NiO	0.318	0.293	Si	0.0022	0.0320
K_2O	0.014	0.011	Na	32.4	30.8
SiO_2	41.3	37.7	CO_2	26.4	26.1
Na_2O	0.050	0.224	HCO_3	32.3	32.7
CO_2	0.00	8.7			
C, noncarbonate	0.025	0.114	pH	7.97	7.87
H_2O, dehyd.[1]	0.100	0.130			
H_2O, chem.[2]	0.665	0.626			
Total	99.047	98.873			
LOI, total[3]	0.79	9.5			
Extent of carbonation, %[4]		16.6			

Carbonation test SC-514 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.304	0.293	Cl	35.7	34.4
CaO	0.218	0.350	Cr	<0.0005	<0.0005
Cr_2O_3	0.100	0.096	Fe	0.0003	0.0004
FeO	7.745	7.539	Mg	0.0003	0.0378
Fe_2O_3	0.186	0.600	Ni	<0.0005	<0.0005
MgO	48.2	47.3	K	0.0026	0.0171
NiO	0.321	0.304	Si	0.0022	0.0322
K_2O	0.016	0.011	Na	32.4	31.0
SiO_2	41.7	40.4	CO_2	26.4	26.4
Na_2O	0.048	0.182	HCO_3	32.3	33.9
CO_2	0.00	3.0			
C, noncarbonate	0.024	0.055	pH	7.97	7.93
H_2O, dehyd.[1]	0.100	0.110			
H_2O, chem.[2]	0.656	0.565			
Total	99.685	100.833			
LOI, total[3]	0.78	3.8			
Extent of carbonation, %[4]		5.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-515 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.300	0.265	Cl	35.1	34.0
CaO	0.232	0.238	Cr	0.0006	<0.0005
Cr_2O_3	0.136	0.136	Fe	0.0002	0.0004
FeO	7.86	7.60	Mg	0.0003	0.0640
Fe_2O_3	0.343	0.315	Ni	<0.0005	<0.0005
MgO	49.2	44.6	K	0.0026	0.0151
NiO	0.318	0.295	Si	0.0029	0.0357
K_2O	0.020	0.013	Na	32.6	32.0
SiO_2	41.1	38.3	CO_2	27.0	26.3
Na_2O	0.050	0.206	HCO_3	33.1	33.1
CO_2	0.00	5.6			
C, noncarbonate	0.028	0.087	pH	7.93	7.93
H_2O, dehyd.[1]	0.120	0.130			
H_2O, chem.[2]	0.632	0.563			
Total	100.360	98.326			
LOI, total[3]	0.78	6.4			
Extent of carbonation, %[4]		10.1			

Carbonation test SC-516 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	13.3	11.6	Cl	35.1	36.2
CaO	8.17	8.03	Cr	0.0006	<0.0005
Cr_2O_3	0.077	0.074	Fe	0.0002	0.0004
FeO	10.37	9.74	Mg	0.0003	0.0060
Fe_2O_3	1.69	2.80	Ni	<0.0005	<0.0005
MgO	4.9	4.9	K	0.0026	0.3800
NiO	0.013	0.013	Si	0.0029	0.0438
K_2O	0.895	0.825	Na	32.6	32.4
SiO_2	51.6	50.3	CO_2	27	26.4
Na_2O	2.36	3.41	HCO_3	33.1	33.5
CO_2	0.00	1.8			
C, noncarbonate	0.039	0.035	pH	7.93	7.85
H_2O, dehyd.[1]	0.650	0.760			
H_2O, chem.[2]	1.052	1.375			
Total	95.092	95.609			
LOI, total[3]	1.74	4.0			
Extent of carbonation, %[4]		10.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-517 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	13.283	12.603	Cl	36.2	35.5
CaO	8.171	8.563	Cr	<0.0005	<0.0005
Cr_2O_3	0.077	0.075	Fe	0.0002	0.0004
FeO	10.369	9.919	Mg	0.0003	0.0035
Fe_2O_3	1.687	2.473	Ni	<0.0005	<0.0005
MgO	4.9	4.7	K	0.0027	0.3860
NiO	0.013	0.013	Si	0.0017	0.0378
K_2O	0.895	0.843	Na	32.8	30.8
SiO_2	51.6	49.0	CO_2	27.1	<0.0001
Na_2O	2.359	4.098	HCO_3	32.1	<0.0001
CO_2	0.00	2.4			
C, noncarbonate	0.039	0.048	pH	7.68	7.63
H_2O, dehyd.[1]	0.650	0.490			
H_2O, chem.[2]	1.052	2.072			
Total	95.092	97.286			
LOI, total[3]	1.74	5.0			
Extent of carbonation, %[4]		13.5			

Carbonation test SC-518 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	13.283	12.981	Cl	0.2	0.4
CaO	8.171	8.269	Cr	<0.0005	<0.0005
Cr_2O_3	0.077	0.078	Fe	<0.0001	10.7000
FeO	10.369	11.797	Mg	<0.0001	0.5820
Fe_2O_3	1.687	<0.01	Ni	<0.0005	0.0130
MgO	4.9	4.5	K	0.0053	0.1680
NiO	0.013	0.029	Si	<0.0001	0.2850
K_2O	0.895	0.975	Na	0.3	0.6
SiO_2	51.6	51.6	CO_2	0.072	<0.0001
Na_2O	2.359	2.629	HCO_3	0.061	<0.0001
CO_2	0.00	0.0			
C, noncarbonate	0.039	0.022	pH	9.30	4.60
H_2O, dehyd.[1]	0.650	0.920			
H_2O, chem.[2]	1.052	1.898			
Total	95.092	95.697			
LOI, total[3]	1.74	2.8			
Extent of carbonation, %[4]		0.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-519 **Anorthite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	21.9	19.3	Cl	36.2	34.7
CaO	14.0	12.0	Cr	<0.0005	<0.0005
Cr_2O_3	1.75	1.62	Fe	0.0002	0.0020
FeO	7.53	6.43	Mg	0.0003	0.0117
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0056
MgO	7.3	6.8	K	0.0027	0.0346
NiO	0.188	0.165	Si	0.0017	0.0202
K_2O	0.049	0.042	Na	32.8	29.6
SiO_2	40.2	36.8	CO_2	27.1	20.0
Na_2O	0.495	3.060	HCO_3	32.1	26.8
CO_2	0.22	4.9			
C, noncarbonate	0.240	0.293	pH	7.68	7.79
H_2O, dehyd.[1]	0.260	0.470			
H_2O, chem.[2]	2.310	3.107			
Total	96.499	94.903			
LOI, total[3]	3.03	8.8			
Extent of carbonation, %[4]		21.0			

Carbonation test SC-520 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.12	0.96	Cl	34.9	33.5
CaO	22.2	20.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.199	0.193	Fe	0.0001	0.0002
FeO	7.64	6.77	Mg	0.0003	0.0037
Fe_2O_3	2.77	3.32	Ni	0.0034	<0.0005
MgO	11.6	10.3	K	0.0025	0.0232
NiO	0.048	0.047	Si	0.0028	0.0390
K_2O	0.056	0.040	Na	31.8	29.2
SiO_2	50.3	46.9	CO_2	26.6	24.5
Na_2O	0.547	1.348	HCO_3	34.3	31.2
CO_2	0.58	4.7			
C, noncarbonate	0.021	0.140	pH	7.56	7.89
H_2O, dehyd.[1]	0.260	0.500			
H_2O, chem.[2]	0.949	2.090			
Total	98.320	97.296			
LOI, total[3]	1.81	7.4			
Extent of carbonation, %[4]		12.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-521 **Synthetic Fayalite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.214	0.186	Cl	34.9	34.2
CaO	1.059	0.949	Cr	<0.0005	<0.0005
Cr_2O_3	0.071	0.059	Fe	0.0001	0.0003
FeO	36.5	24.4	Mg	0.0003	0.0019
Fe_2O_3	29.3	32.2	Ni	0.0034	<0.0005
MgO	0.4	0.4	K	0.0025	0.0155
NiO	0.023	0.019	Si	0.0028	0.0495
K_2O	0.025	0.022	Na	31.8	28.8
SiO_2	29.1	24.4	CO_2	26.6	22.2
Na_2O	0.071	3.195	HCO_3	34.3	28.5
CO_2	0.00	6.6			
C, noncarbonate	0.145	0.210	pH	7.56	7.85
H_2O, dehyd.[1]	0.070	2.550			
H_2O, chem.[2]	1.355	4.080			
Total	98.413	99.229			
LOI, total[3]	1.57	13.4			
Extent of carbonation, %[4]		29.6			

Carbonation test SC-522 **YM Talc**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.276	0.221	Cl	35.3	34.7
CaO	0.137	0.171	Cr	<0.0005	<0.0005
Cr_2O_3	0.032	0.029	Fe	0.0004	0.0003
FeO	2.058	1.377	Mg	0.0003	0.0188
Fe_2O_3	0.243	0.672	Ni	<0.0005	<0.0005
MgO	28.4	23.2	K	0.0026	0.0083
NiO	0.077	0.065	Si	0.0030	0.0381
K_2O	0.009	0.008	Na	35.2	30.3
SiO_2	58.0	49.0	CO_2	26.8	23.6
Na_2O	0.060	1.361	HCO_3	33.7	28.8
CO_2	0.28	14.9			
C, noncarbonate	0.025	0.124	pH	7.93	7.88
H_2O, dehyd.[1]	2.040	3.460			
H_2O, chem.[2]	7.125	4.816			
Total	98.691	99.407			
LOI, total[3]	9.47	23.3			
Extent of carbonation, %[4]		53.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-523 **Ivtek Magnetite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.041	0.070	Cl	35.3	35.0
CaO	0.949	0.893	Cr	<0.0005	<0.0005
Cr_2O_3	0.019	0.019	Fe	0.0004	0.0006
FeO	14.7	10.9	Mg	0.0003	0.0094
Fe_2O_3	73.6	76.1	Ni	<0.0005	<0.0005
MgO	0.6	0.6	K	0.0026	0.0232
NiO	0.008	0.005	Si	0.0030	0.0266
K_2O	0.021	0.010	Na	35.2	32.0
SiO_2	5.99	5.78	CO_2	26.8	25.2
Na_2O	0.046	0.487	HCO_3	33.7	31.0
CO_2	1.00	1.2			
C, noncarbonate	0.071	0.104	pH	7.93	7.94
H_2O, dehyd.[1]	0.160	0.780			
H_2O, chem.[2]	0.849	1.806			
Total	98.050	98.730			
LOI, total[3]	2.08	3.9			
Extent of carbonation, %[4]		2.2			

Carbonation test SC-524 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.155	0.111	Cl	35.3	34.5
CaO	0.183	0.158	Cr	<0.0005	<0.0005
Cr_2O_3	0.161	0.126	Fe	0.0002	0.0003
FeO	8.221	6.278	Mg	0.0003	0.0400
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.9	37.6	K	0.0027	0.0048
NiO	0.305	0.219	Si	0.0014	0.0338
K_2O	0.008	0.007	Na	31.4	30.2
SiO_2	40.9	31.4	CO_2	26.2	25.4
Na_2O	0.045	0.221	HCO_3	31.1	32.2
CO_2	0.00	21.6			
C, noncarbonate	0.049	0.315	pH	7.95	7.99
H_2O, dehyd.[1]	0.110	0.160			
H_2O, chem.[2]	0.661	0.925			
Total	99.672	99.206			
LOI, total[3]	0.82	23.0			
Extent of carbonation, %[4]		47.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-525 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.382	0.283	Cl	35.3	35.1
CaO	0.138	0.157	Cr	<0.0005	<0.0005
Cr_2O_3	0.134	0.108	Fe	0.0002	0.0003
FeO	7.68	6.37	Mg	0.0003	0.0580
Fe_2O_3	<0.01	0.014	Ni	<0.0005	<0.0005
MgO	47.8	30.7	K	0.0027	0.0247
NiO	0.361	0.270	Si	0.0014	0.0442
K_2O	0.024	0.013	Na	31.4	30.0
SiO_2	40.9	31.9	CO_2	26.2	25.8
Na_2O	0.052	0.268	HCO_3	31.1	34.1
CO_2	0.00	20.5			
C, noncarbonate	0.031	0.205	pH	7.95	7.91
H_2O, dehyd.[1]	0.150	0.170			
H_2O, chem.[2]	0.769	1.025			
Total	98.334	91.931			
LOI, total[3]	0.95	21.9			
Extent of carbonation, %[4]		45.3			

Carbonation test SC-526 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.152	0.121	Cl	35.9	35.1
CaO	0.186	0.150	Cr	<0.0005	<0.0005
Cr_2O_3	0.175	0.153	Fe	0.0009	0.0003
FeO	8.07	6.68	Mg	0.0003	0.0392
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.4	38.8	K	0.0029	0.0048
NiO	0.360	0.286	Si	0.0024	0.0379
K_2O	0.013	0.007	Na	31.3	31.0
SiO_2	40.9	32.9	CO_2	26.4	25.7
Na_2O	0.103	0.197	HCO_3	33.1	33.1
CO_2	0.00	18.9			
C, noncarbonate	0.031	0.232	pH	7.94	7.95
H_2O, dehyd.[1]	0.120	0.210			
H_2O, chem.[2]	0.660	1.158			
Total	100.137	99.835			
LOI, total[3]	0.81	20.5			
Extent of carbonation, %[4]		39.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-527 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.138	0.079	Cl	35.9	35.2
CaO	0.218	0.174	Cr	<0.0005	<0.0005
Cr_2O_3	0.322	0.265	Fe	0.9000	0.0003
FeO	8.41	5.96	Mg	0.3000	0.0458
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	32.5	K	2.9000	0.0045
NiO	0.380	0.267	Si	2.4000	0.0533
K_2O	0.008	0.007	Na	31.3	31.1
SiO_2	40.2	28.2	CO_2	26.4	25.2
Na_2O	0.024	0.256	HCO_3	33.1	32.9
CO_2	0.13	27.9			
C, noncarbonate	0.023	0.416	pH	7.94	7.90
H_2O, dehyd.[1]	0.350	0.400			
H_2O, chem.[2]	0.737	1.584			
Total	99.213	98.041			
LOI, total[3]	1.24	30.3			
Extent of carbonation, %[4]		66.4			

Carbonation test SC-528 **Texas Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.521	0.378	Cl	35.8	35.8
CaO	0.098	0.087	Cr	<0.0005	<0.0005
Cr_2O_3	0.057	0.065	Fe	0.0004	0.0004
FeO	0.386	0.785	Mg	0.0003	0.0154
Fe_2O_3	3.36	2.24	Ni	<0.0005	<0.0005
MgO	41.8	38.8	K	0.0028	0.0040
NiO	0.178	0.233	Si	0.0024	0.0310
K_2O	0.005	0.007	Na	30.8	31.3
SiO_2	41.1	39.8	CO_2	26.0	26.2
Na_2O	0.019	0.983	HCO_3	32.3	33.6
CO_2	0.12	1.7			
C, noncarbonate	0.016	0.057	pH	8.10	7.92
H_2O, dehyd.[1]	1.29	1.56			
H_2O, chem.[2]	13.57	13.07			
Total	102.483	99.773			
LOI, total[3]	15.0	16.4			
Extent of carbonation, %[4]		3.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-529 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.215	Cl	35.8	36.1
CaO	0.192	0.235	Cr	<0.0005	<0.0005
Cr_2O_3	0.418	0.460	Fe	0.0004	0.0003
FeO	8.877	8.761	Mg	0.0003	0.0314
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.7	46.8	K	0.0028	0.0041
NiO	0.302	0.369	Si	0.0024	0.0275
K_2O	0.003	0.007	Na	30.8	31.0
SiO_2	40.0	38.1	CO_2	26	26.1
Na_2O	0.022	1.092	HCO_3	32.3	32.6
CO_2	0.19	3.4			
C, noncarbonate	0.021	0.078	pH	8.10	7.86
H_2O, dehyd.[1]	0.600	0.390			
H_2O, chem.[2]	0.849	1.652			
Total	100.401	101.477			
LOI, total[3]	1.66	5.5			
Extent of carbonation, %[4]		5.6			

Carbonation test SC-530 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.176	0.185	Cl	35.2	34.6
CaO	0.192	0.236	Cr	<0.0005	<0.0005
Cr_2O_3	0.418	0.400	Fe	0.0003	0.0003
FeO	8.93	8.63	Mg	0.0003	0.0316
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.4	46.1	K	0.0027	0.0040
NiO	0.302	0.360	Si	0.0020	0.0302
K_2O	0.003	0.007	Na	31.9	30.6
SiO_2	40.0	38.3	CO_2	26.8	26.1
Na_2O	0.022	0.927	HCO_3	32.7	34.1
CO_2	0.18	3.0			
C, noncarbonate	0.018	0.093	pH	7.84	7.89
H_2O, dehyd.[1]	0.480	0.290			
H_2O, chem.[2]	0.892	1.557			
Total	100.031	100.097			
LOI, total[3]	1.57	5.0			
Extent of carbonation, %[4]		5.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-531 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.144	Cl	35.2	34.3
CaO	0.139	0.182	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.165	Fe	0.0003	0.0003
FeO	7.74	7.76	Mg	0.0003	0.0418
Fe_2O_3	<0.01	0.429	Ni	<0.0005	<0.0005
MgO	48.1	43.3	K	0.0027	0.0252
NiO	0.303	0.299	Si	0.0020	0.0318
K_2O	0.027	0.015	Na	31.9	31.6
SiO_2	40.9	39.6	CO_2	26.8	26.0
Na_2O	0.048	0.301	HCO_3	32.7	33.5
CO_2	0.00	3.02			
C, noncarbonate	0.034	0.069	pH	7.84	7.96
H_2O, dehyd.[1]	0.200	0.170			
H_2O, chem.[2]	0.726	0.721			
Total	98.531	96.126			
LOI, total[3]	0.96	4.0			
Extent of carbonation, %[4]		5.4			

Carbonation test SC-532 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.120	Cl	35.0	35.0
CaO	0.139	0.110	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.127	Fe	0.0003	0.0003
FeO	7.745	6.188	Mg	0.0003	0.0652
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	30.5	K	0.0025	0.0220
NiO	0.303	0.248	Si	0.0029	0.0326
K_2O	0.027	0.012	Na	31.0	30.7
SiO_2	40.9	31.9	CO_2	26.2	26.3
Na_2O	0.048	0.272	HCO_3	32	33.4
CO_2	0.00	20.9			
C, noncarbonate	0.034	0.146	pH	7.99	7.92
H_2O, dehyd.[1]	0.200	0.130			
H_2O, chem.[2]	0.726	0.724			
Total	98.531	91.361			
LOI, total[3]	0.96	21.9			
Extent of carbonation, %[4]		46.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-533 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.200	0.452	Cl	35.1	34.6
CaO	0.139	0.185	Cr	<0.0005	<0.0005
Cr_2O_3	0.164	0.174	Fe	0.0004	0.0003
FeO	7.745	7.500	Mg	0.0003	0.0348
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.1	46.9	K	0.0028	0.0234
NiO	0.303	0.299	Si	0.0023	0.0312
K_2O	0.027	0.019	Na	33.2	31.8
SiO_2	40.9	39.6	CO_2	26.9	26.3
Na_2O	0.048	0.286	HCO_3	32.7	33.0
CO_2	0.00	2.9			
C, noncarbonate	0.034	0.064	pH	7.85	7.88
H_2O, dehyd.[1]	0.200	0.190			
H_2O, chem.[2]	0.726	0.686			
Total	98.531	99.245			
LOI, total[3]	0.96	3.8			
Extent of carbonation, %[4]		5.2			

Carbonation test SC-534 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.754	0.467	Cl	35.0	36.6
CaO	0.197	0.146	Cr	<0.0005	<0.0005
Cr_2O_3	0.247	0.134	Fe	0.0003	0.0005
FeO	7.67	5.53	Mg	0.0003	0.0568
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	32.5	K	0.0025	0.0374
NiO	0.316	0.207	Si	0.0029	0.0377
K_2O	0.036	0.018	Na	31.0	30.9
SiO_2	40.6	28.7	CO_2	26.2	25.8
Na_2O	0.048	0.357	HCO_3	32.0	32.0
CO_2	0.15	28.3			
C, noncarbonate	0.005	0.386	pH	7.99	7.94
H_2O, dehyd.[1]	0.290	0.230			
H_2O, chem.[2]	0.755	0.884			
Total	99.363	97.826			
LOI, total[3]	1.20	29.8			
Extent of carbonation, %[4]		68.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-535 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.240	0.182	Cl	35.1	34.8
CaO	0.273	0.316	Cr	<0.0005	<0.0005
Cr_2O_3	0.109	0.082	Fe	0.0004	0.0003
FeO	8.324	6.304	Mg	0.0003	0.0506
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0042
MgO	46.8	31.7	K	0.0028	0.0143
NiO	0.328	0.229	Si	0.0023	0.0299
K_2O	0.010	0.007	Na	33.2	33.4
SiO_2	39.6	31.9	CO_2	26.9	26.1
Na_2O	0.056	0.271	HCO_3	32.7	33.2
CO_2	0.10	24.4			
C, noncarbonate	0.043	0.071	pH	7.85	7.93
H_2O, dehyd.[1]	0.070	0.140			
H_2O, chem.[2]	1.257	-0.511			
Total	97.145	95.036			
LOI, total[3]	1.47	24.1			
Extent of carbonation, %[4]		57.0			

Carbonation test SC-536 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.763	0.510	Cl	35.8	35.0
CaO	0.214	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.202	0.105	Fe	0.0003	0.0003
FeO	7.72	5.47	Mg	0.0003	0.0432
Fe_2O_3	<0.01	<0.01	Ni	0.0045	0.0047
MgO	48.1	32.2	K	0.0025	0.0374
NiO	0.280	0.204	Si	0.0014	0.0396
K_2O	0.044	0.020	Na	31.9	28.9
SiO_2	40.9	28.7	CO_2	26.5	25.4
Na_2O	0.064	0.355	HCO_3	33.3	33.4
CO_2	0.12	29.4			
C, noncarbonate	0.014	0.176	pH	8.03	7.91
H_2O, dehyd.[1]	0.310	0.270			
H_2O, chem.[2]	0.796	0.654			
Total	99.471	98.135			
LOI, total[3]	1.24	30.5			
Extent of carbonation, %[4]		72.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-537 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.325	0.219	Cl	35.8	35.6
CaO	0.185	0.167	Cr	<0.0005	<0.0005
Cr_2O_3	0.129	0.114	Fe	0.0003	0.0003
FeO	7.745	6.188	Mg	0.0003	0.0520
Fe_2O_3	<0.01	<0.01	Ni	0.0045	<0.0005
MgO	47.6	37.3	K	0.0025	0.0129
NiO	0.286	0.227	Si	0.0014	0.0458
K_2O	0.019	0.011	Na	31.9	30.1
SiO_2	41.5	33.4	CO_2	26.5	25.8
Na_2O	0.054	0.214	HCO_3	33.3	33.8
CO_2	0.00	20.4			
C, noncarbonate	0.029	0.282	pH	8.03	7.89
H_2O, dehyd.[1]	0.060	0.060			
H_2O, chem.[2]	0.681	0.758			
Total	98.602	99.320			
LOI, total[3]	0.77	21.5			
Extent of carbonation, %[4]		45.1			

Carbonation test SC-538 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.238	0.160	Cl	36.2	35.4
CaO	0.203	0.154	Cr	<0.0005	<0.0005
Cr_2O_3	0.364	0.235	Fe	0.0003	0.0003
FeO	8.76	6.05	Mg	0.0003	0.0500
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.4	32.7	K	0.0027	0.0044
NiO	0.342	0.239	Si	0.0019	0.0378
K_2O	0.024	0.013	Na	32.5	30.0
SiO_2	40.2	27.4	CO_2	26.2	25.3
Na_2O	0.062	0.379	HCO_3	33.8	33.4
CO_2	0.18	30.4			
C, noncarbonate	0.011	0.553	pH	7.78	7.89
H_2O, dehyd.[1]	0.560	0.320			
H_2O, chem.[2]	0.809	1.127			
Total	99.195	99.674			
LOI, total[3]	1.56	32.4			
Extent of carbonation, %[4]		75.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-539 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.463	0.333	Cl	36.2	35.1
CaO	0.168	0.162	Cr	<0.0005	<0.0005
Cr_2O_3	0.177	0.131	Fe	0.0003	0.0002
FeO	7.83	5.85	Mg	0.0003	0.0806
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.1	35.5	K	0.0027	0.0283
NiO	0.286	0.218	Si	0.0019	0.0468
K_2O	0.027	0.015	Na	32.5	31.8
SiO_2	41.7	31.4	CO_2	26.2	25.6
Na_2O	0.059	0.337	HCO_3	33.8	34.0
CO_2	0.00	23.4			
C, noncarbonate	0.036	0.404	pH	7.78	7.81
H_2O, dehyd.[1]	0.250	0.220			
H_2O, chem.[2]	0.714	1.176			
Total	96.830	99.179			
LOI, total[3]	1.00	25.2			
Extent of carbonation, %[4]		56.4			

Carbonation test SC-540 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.463	0.314	Cl	35.8	35.2
CaO	0.168	0.154	Cr	<0.0005	<0.0005
Cr_2O_3	0.177	0.107	Fe	0.0003	0.0003
FeO	7.83	5.81	Mg	0.0004	0.0566
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	45.1	34.8	K	0.0025	0.0256
NiO	0.286	0.206	Si	0.0024	0.0382
K_2O	0.027	0.015	Na	31.8	30.2
SiO_2	41.7	30.0	CO_2	26.9	26.3
Na_2O	0.059	0.317	HCO_3	32.8	32.4
CO_2	0.00	25.6			
C, noncarbonate	0.036	0.183	pH	7.96	7.92
H_2O, dehyd.[1]	0.250	0.220			
H_2O, chem.[2]	0.714	0.797			
Total	96.830	98.498			
LOI, total[3]	1.00	26.8			
Extent of carbonation, %[4]		63.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-541 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.805	0.497	Cl	35.8	34.9
CaO	0.214	0.154	Cr	<0.0005	<0.0005
Cr_2O_3	0.199	0.133	Fe	0.0003	0.0003
FeO	7.62	5.29	Mg	0.0004	0.0524
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.1	31.5	K	0.0025	0.0455
NiO	0.280	0.191	Si	0.0024	0.0509
K_2O	0.040	0.018	Na	31.8	31.4
SiO_2	40.6	27.8	CO_2	26.9	24.6
Na_2O	0.067	0.399	HCO_3	32.8	32.4
CO_2	0.14	31.3			
C, noncarbonate	0.009	0.238	pH	7.96	7.94
H_2O, dehyd.[1]	0.380	0.300			
H_2O, chem.[2]	0.951	0.562			
Total	97.442	98.393			
LOI, total[3]	1.48	32.4			
Extent of carbonation, %[4]		82.3			

Carbonation test SC-542 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.391	0.289	Cl	36.2	35.0
CaO	0.043	0.100	Cr	<0.0005	<0.0005
Cr_2O_3	0.146	0.117	Fe	0.0003	0.0004
FeO	7.58	5.63	Mg	0.0006	0.0520
Fe_2O_3	<0.01	<0.01	Ni	0.0060	<0.0005
MgO	40.8	34.2	K	0.0023	0.0183
NiO	0.293	0.216	Si	0.0047	0.0323
K_2O	0.023	0.014	Na	33.2	30.7
SiO_2	40.9	31.0	CO_2	26.9	26.0
Na_2O	0.056	0.287	HCO_3	34.9	31.2
CO_2	0.12	22.8			
C, noncarbonate	0.000	0.227	pH	7.88	7.93
H_2O, dehyd.[1]	0.180	0.170			
H_2O, chem.[2]	0.550	0.703			
Total	91.029	95.734			
LOI, total[3]	0.85	23.9			
Extent of carbonation, %[4]		59.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-543 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.219	0.178	Cl	36.2	33.3
CaO	0.221	0.072	Cr	<0.0005	<0.0005
Cr_2O_3	0.083	0.097	Fe	0.0003	0.0002
FeO	7.552	6.780	Mg	0.0006	0.0458
Fe_2O_3	0.343	0.100	Ni	0.0060	0.0077
MgO	50.6	38.6	K	0.0023	0.0055
NiO	0.293	0.248	Si	0.0047	0.0328
K_2O	0.004	0.009	Na	33.2	30.0
SiO_2	41.5	34.9	CO_2	26.9	25.0
Na_2O	0.019	0.187	HCO_3	34.9	31.4
CO_2	0.00	13.6			
C, noncarbonate	0.019	0.028	pH	7.88	7.93
H_2O, dehyd.[1]	0.090	0.160			
H_2O, chem.[2]	0.651	0.512			
Total	101.568	95.476			
LOI, total[3]	0.76	14.3			
Extent of carbonation, %[4]		26.2			

Carbonation test SC-544 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.469	0.333	Cl	35.7	33.3
CaO	0.238	0.285	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.134	Fe	0.0003	0.0004
FeO	7.74	5.74	Mg	0.0006	0.0540
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.4	35.2	K	0.0022	0.0202
NiO	0.286	0.227	Si	0.0015	0.0664
K_2O	0.025	0.014	Na	34.2	29.8
SiO_2	40.6	29.1	CO_2	26.8	25.0
Na_2O	0.051	0.367	HCO_3	33.8	30.6
CO_2	0.12	27.9			
C, noncarbonate	0.010	0.136	pH	7.99	7.90
H_2O, dehyd.[1]	0.230	0.210			
H_2O, chem.[2]	0.690	0.754			
Total	100.101	100.342			
LOI, total[3]	1.05	29.0			
Extent of carbonation, %[4]		65.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-545 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.514	0.350	Cl	35.7	33.6
CaO	0.171	0.134	Cr	<0.0005	<0.0005
Cr_2O_3	0.175	0.126	Fe	0.0003	0.0005
FeO	7.68	5.53	Mg	0.0006	0.0320
Fe_2O_3	0.200	0.029	Ni	<0.0005	<0.0005
MgO	47.8	32.5	K	0.0022	0.0208
NiO	0.299	0.215	Si	0.0015	0.0351
K_2O	0.024	0.013	Na	34.2	30.5
SiO_2	40.9	28.2	CO_2	26.8	24.6
Na_2O	0.058	0.426	HCO_3	33.8	31.5
CO_2	0.11	29.7			
C, noncarbonate	0.017	0.364	pH	7.99	7.92
H_2O, dehyd.[1]	0.260	0.220			
H_2O, chem.[2]	0.823	0.716			
Total	98.944	98.562			
LOI, total[3]	1.21	31.0			
Extent of carbonation, %[4]		73.9			

Carbonation test SC-546 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.219	0.276	Cl	35.3	35.3
CaO	0.221	0.175	Cr	<0.0005	<0.0005
Cr_2O_3	0.083	0.126	Fe	0.0002	0.0003
FeO	7.55	6.01	Mg	0.0005	0.0488
Fe_2O_3	0.343	0.129	Ni	<0.0005	<0.0005
MgO	50.6	36.1	K	0.0021	0.0190
NiO	0.293	0.241	Si	0.0018	0.0249
K_2O	0.004	0.012	Na	30.4	30.0
SiO_2	41.5	31.0	CO_2	26.7	26.1
Na_2O	0.019	0.324	HCO_3	33.7	32.0
CO_2	0.00	23.0			
C, noncarbonate	0.019	0.083	pH	7.93	7.92
H_2O, dehyd.[1]	0.090	0.160			
H_2O, chem.[2]	0.651	0.757			
Total	101.568	98.455			
LOI, total[3]	0.76	24.0			
Extent of carbonation, %[4]		49.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-547 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.469	0.399	Cl	35.3	33.5
CaO	0.238	0.133	Cr	<0.0005	<0.0005
Cr_2O_3	0.180	0.175	Fe	0.0002	0.0004
FeO	7.74	6.91	Mg	0.0005	0.1090
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0018
MgO	49.4	41.0	K	0.0021	0.0185
NiO	0.286	0.275	Si	0.0018	0.0385
K_2O	0.025	0.019	Na	30.4	31.1
SiO_2	40.6	35.3	CO_2	26.7	25.3
Na_2O	0.051	0.364	HCO_3	33.7	31.8
CO_2	0.12	12.6			
C, noncarbonate	0.010	0.091	pH	7.93	7.92
H_2O, dehyd.[1]	0.230	0.250			
H_2O, chem.[2]	0.690	0.759			
Total	100.101	98.226			
LOI, total[3]	1.05	13.7			
Extent of carbonation, %[4]		24.3			

Carbonation test SC-548 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.514	0.399	Cl	36.3	35.2
CaO	0.171	0.126	Cr	<0.0005	<0.0005
Cr_2O_3	0.175	0.190	Fe	0.0002	0.0004
FeO	7.68	6.75	Mg	0.0006	0.1600
Fe_2O_3	0.200	<0.01	Ni	<0.0005	<0.0005
MgO	47.8	42.1	K	0.0020	0.0206
NiO	0.299	0.277	Si	0.0021	0.0432
K_2O	0.024	0.017	Na	31.3	31.1
SiO_2	40.9	35.1	CO_2	25.8	26.4
Na_2O	0.058	1.219	HCO_3	33.2	32.2
CO_2	0.11	12.9			
C, noncarbonate	0.017	0.079	pH	7.89	7.89
H_2O, dehyd.[1]	0.260	0.290			
H_2O, chem.[2]	0.823	1.531			
Total	98.944	100.982			
LOI, total[3]	1.21	14.8			
Extent of carbonation, %[4]		25.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-549 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.469	0.283	Cl	36.3	33.6
CaO	0.197	0.182	Cr	<0.0005	<0.0005
Cr_2O_3	0.187	0.132	Fe	0.0002	0.0003
FeO	7.85	5.85	Mg	0.0006	0.0654
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.6	34.3	K	0.0020	0.0200
NiO	0.318	0.233	Si	0.0021	0.0352
K_2O	0.032	0.017	Na	31.3	30.1
SiO_2	40.4	29.3	CO_2	25.8	24.5
Na_2O	0.159	0.334	HCO_3	33.2	31.6
CO_2	0.00	26.4			
C, noncarbonate	0.042	0.235	pH	7.89	7.90
H_2O, dehyd.[1]	0.210	0.240			
H_2O, chem.[2]	0.809	0.925			
Total	98.289	98.465			
LOI, total[3]	1.06	27.8			
Extent of carbonation, %[4]		63.0			

Carbonation test SC-550 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.469	0.283	Cl	35.6	35.2
CaO	0.197	0.147	Cr	<0.0005	<0.0005
Cr_2O_3	0.187	0.135	Fe	0.0002	0.0003
FeO	7.85	5.72	Mg	0.0005	0.0874
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.6	35.0	K	0.0020	0.0193
NiO	0.318	0.237	Si	0.0019	0.0418
K_2O	0.032	0.014	Na	31.1	30.4
SiO_2	40.4	30.6	CO_2	26.3	26.2
Na_2O	0.159	0.319	HCO_3	32.6	33.9
CO_2	0.00	24.7			
C, noncarbonate	0.042	0.119	pH	7.78	7.84
H_2O, dehyd.[1]	0.210	0.270			
H_2O, chem.[2]	0.809	0.811			
Total	98.289	98.338			
LOI, total[3]	1.06	25.9			
Extent of carbonation, %[4]		57.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-551 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.182	0.144	Cl	35.6	35.3
CaO	0.174	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.148	0.140	Fe	0.0003	0.0006
FeO	8.14	6.75	Mg	0.0007	0.0566
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.4	40.3	K	0.0019	0.0047
NiO	0.291	0.242	Si	0.0024	0.0304
K_2O	0.008	0.011	Na	32.0	30.8
SiO_2	40.6	34.0	CO_2	26.8	26.2
Na_2O	0.047	0.237	HCO_3	33.9	34.2
CO_2	0.11	16.7			
C, noncarbonate	0.003	0.222	pH	7.72	7.96
H_2O, dehyd.[1]	0.120	0.180			
H_2O, chem.[2]	0.447	0.498			
Total	99.731	99.575			
LOI, total[3]	0.68	17.6			
Extent of carbonation, %[4]		33.7			

Carbonation test SC-552 **Shell Wollastonite as received**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	<0.01	0.086	Cl	0.004	0.488
CaO	46.0	40.2	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.002	Fe	<0.0001	<0.0001
FeO	0.682	0.566	Mg	0.0006	0.0111
Fe_2O_3	<0.01	0.086	Ni	<0.0005	<0.0005
MgO	0.5	0.6	K	<0.0001	0.0160
NiO	<0.01	0.002	Si	<0.0001	0.2140
K_2O	0.036	0.027	Na	0.000	0.412
SiO_2	48.6	42.1	CO_2	<0.0001	0.790
Na_2O	0.039	0.053	HCO_3	<0.0001	0.970
CO_2	3.05	13.5			
C, noncarbonate	0.036	0.156	pH		6.87
H_2O, dehyd.[1]	0.050	0.820			
H_2O, chem.[2]	0.094	0.724			
Total	99.037	98.880			
LOI, total[3]	3.23	15.2			
Extent of carbonation, %[4]		34.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-553 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.139	Cl	35.6	34.7
CaO	0.221	0.225	Cr	<0.0005	<0.0005
Cr_2O_3	0.364	0.285	Fe	0.0003	0.0004
FeO	8.75	7.18	Mg	0.0007	0.0546
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	38.3	K	0.0019	0.0061
NiO	0.410	0.323	Si	0.0024	0.0378
K_2O	0.009	0.008	Na	32.0	32.4
SiO_2	40.0	32.1	CO_2	26.8	25.8
Na_2O	0.048	0.224	HCO_3	33.9	33.0
CO_2	0.00	19.2			
C, noncarbonate	0.025	0.200	pH	7.72	7.96
H_2O, dehyd.[1]	0.140	0.200			
H_2O, chem.[2]	0.385	0.600			
Total	98.803	98.974			
LOI, total[3]	0.55	20.2			
Extent of carbonation, %[4]		40.8			

Carbonation test SC-554 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.146	Cl	36.0	36.0
CaO	0.221	0.213	Cr	<0.0005	<0.0005
Cr_2O_3	0.364	0.329	Fe	0.0005	0.0006
FeO	8.75	6.69	Mg	0.0006	0.0694
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	36.6	K	0.0021	0.0048
NiO	0.410	0.321	Si	0.0023	0.0386
K_2O	0.009	0.008	Na	32.3	31.8
SiO_2	40.0	30.4	CO_2	26.2	26.5
Na_2O	0.048	0.052	HCO_3	32.8	32.6
CO_2	0.00	23.3			
C, noncarbonate	0.025	0.171	pH	8.00	7.79
H_2O, dehyd.[1]	0.140	0.120			
H_2O, chem.[2]	0.385	0.209			
Total	98.803	98.579			
LOI, total[3]	0.55	23.8			
Extent of carbonation, %[4]		52.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-555 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.198	0.229	Cl	36.0	34.9
CaO	0.221	0.171	Cr	<0.0005	<0.0005
Cr_2O_3	0.364	0.348	Fe	0.0005	0.0004
FeO	8.75	8.13	Mg	0.0006	0.0464
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	45.9	K	0.0021	0.0032
NiO	0.410	0.394	Si	0.0023	0.0338
K_2O	0.009	0.013	Na	32.3	31.8
SiO_2	40.0	37.4	CO_2	26.2	26.4
Na_2O	0.048	0.264	HCO_3	32.8	32.1
CO_2	0.00	6.3			
C, noncarbonate	0.025	0.068	pH	8.00	7.87
H_2O, dehyd.[1]	0.140	0.170			
H_2O, chem.[2]	0.385	0.332			
Total	98.803	99.796			
LOI, total[3]	0.55	6.9			
Extent of carbonation, %[4]		11.6			

Carbonation test SC-556 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.165	0.157	Cl	35.0	35.1
CaO	0.248	0.140	Cr	<0.0005	<0.0005
Cr_2O_3	0.248	0.253	Fe	0.0004	0.0003
FeO	8.97	6.19	Mg	0.0007	0.0244
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.4	34.7	K	0.0018	0.0034
NiO	0.303	0.219	Si	0.0020	0.0520
K_2O	0.008	0.011	Na	31.6	30.8
SiO_2	39.8	26.1	CO_2	26.8	25.5
Na_2O	0.255	0.391	HCO_3	33.6	30.1
CO_2	0.16	32.7			
C, noncarbonate	0.017	0.346	pH	7.82	7.90
H_2O, dehyd.[1]	0.520	0.280			
H_2O, chem.[2]	0.883	0.474			
Total	98.986	101.912			
LOI, total[3]	1.58	33.8			
Extent of carbonation, %[4]		84.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-557 **Nyco Woll Tails**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	4.61	4.29	Cl	0.004	0.558
CaO	34.1	31.3	Cr	<0.0005	<0.0005
Cr_2O_3	0.010	0.011	Fe	<0.0001	0.0001
FeO	4.04	3.73	Mg	0.0006	0.0172
Fe_2O_3	9.08	8.99	Ni	<0.0005	<0.0005
MgO	2.30	2.47	K	<0.0001	0.0039
NiO	0.006	0.008	Si	<0.0001	0.1970
K_2O	0.021	0.018	Na	0.000	0.481
SiO_2	43.2	40.6	CO_2	<0.0001	0.740
Na_2O	0.132	0.115	HCO_3	<0.0001	1.04
CO_2	0.54	6.3			
C, noncarbonate	0.016	0.055	pH		6.98
H_2O, dehyd.[1]	0.000	0.280			
H_2O, chem.[2]	0.074	0.465			
Total	98.186	98.744			
LOI, total[3]	0.63	7.1			
Extent of carbonation, %[4]		19.6			

Carbonation test SC-558 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.178	0.127	Cl	35.0	33.5
CaO	0.182	0.165	Cr	<0.0005	<0.0005
Cr_2O_3	0.555	0.417	Fe	0.0004	0.0003
FeO	9.456	6.908	Mg	0.0007	0.0606
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	48.2	34.2	K	0.0018	0.0042
NiO	0.487	0.359	Si	0.0020	0.0386
K_2O	0.010	0.008	Na	31.6	31.1
SiO_2	39.8	29.1	CO_2	26.8	25.7
Na_2O	0.048	0.274	HCO_3	33.6	32.7
CO_2	0.00	26.0			
C, noncarbonate	0.051	0.264	pH	7.82	7.89
H_2O, dehyd.[1]	0.150	0.170			
H_2O, chem.[2]	0.269	0.466			
Total	99.427	98.408			
LOI, total[3]	0.47	26.9			
Extent of carbonation, %[4]		59.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-559 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.184	0.148	Cl	35.0	34.9
CaO	0.189	0.151	Cr	<0.0005	<0.0005
Cr_2O_3	0.564	0.424	Fe	0.0004	0.0005
FeO	9.76	6.47	Mg	0.0005	0.0432
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	47.9	34.3	K	0.0021	0.0033
NiO	0.475	0.356	Si	0.0021	0.0326
K_2O	0.013	0.009	Na	31.8	30.4
SiO_2	40.0	28.5	CO_2	26.9	25.9
Na_2O	0.136	0.340	HCO_3	34.0	32.6
CO_2	0.00	27.2			
C, noncarbonate	0.053	0.397	pH	7.72	7.98
H_2O, dehyd.[1]	0.160	0.160			
H_2O, chem.[2]	0.187	0.543			
Total	99.648	98.975			
LOI, total[3]	0.40	28.3			
Extent of carbonation, %[4]		63.9			

Carbonation test SC-560 **Nyco Wollastonite Dust Head**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.74	2.27	Cl	0.0	0.8
CaO	39.3	33.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.009	Fe	<0.0001	<0.0001
FeO	1.66	1.48	Mg	0.0006	0.0115
Fe_2O_3	3.70	3.33	Ni	<0.0005	<0.0005
MgO	1.2	1.2	K	<0.0001	0.0077
NiO	<0.01	0.004	Si	<0.0001	0.1860
K_2O	0.055	0.047	Na	0.000	0.544
SiO_2	46.0	38.5	CO_2	<0.0001	0.680
Na_2O	0.167	0.183	HCO_3	<0.0001	1.000
CO_2	2.36	14.6			
C, noncarbonate	0.040	0.215	pH		6.93
H_2O, dehyd.[1]	0.080	0.630			
H_2O, chem.[2]	0.240	1.255			
Total	97.566	97.465			
LOI, total[3]	2.72	16.7			
Extent of carbonation, %[4]		45.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-561 **Nyco Wollastonite Dust Head**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.740	2.267	Cl	0.0038	0.0563
CaO	39.3	35.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.007	Fe	<0.0001	0.0001
FeO	1.66	1.45	Mg	0.0006	0.0104
Fe_2O_3	3.70	2.99	Ni	<0.0005	<0.0005
MgO	1.2	1.1	K	<0.0001	0.0064
NiO	<0.01	0.003	Si	<0.0001	0.2360
K_2O	0.055	0.049	Na	0.0003	0.067
SiO_2	46.0	40.4	CO_2	<0.0001	0.429
Na_2O	0.167	0.171	HCO_3	<0.0001	0.630
CO_2	2.36	12.8			
C, noncarbonate	0.040	0.247	pH		6.75
H_2O, dehyd.[1]	0.080	0.650			
H_2O, chem.[2]	0.240	0.903			
Total	97.566	98.205			
LOI, total[3]	2.72	14.6			
Extent of carbonation, %[4]		37.8			

Carbonation test SC-562 **Nyco Wollastonite Dust Head**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.740	2.248	Cl	35.0	32.5
CaO	39.318	35.820	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.006	Fe	0.0004	0.0003
FeO	1.660	1.595	Mg	0.0005	0.0024
Fe_2O_3	3.703	2.888	Ni	<0.0005	<0.0005
MgO	1.2	1.1	K	0.0021	0.0105
NiO	<0.01	0.002	Si	0.0021	0.0414
K_2O	0.055	0.052	Na	31.8	29.6
SiO_2	46.0	41.3	CO_2	26.9	24.6
Na_2O	0.167	0.305	HCO_3	34	31.7
CO_2	2.36	11.6			
C, noncarbonate	0.040	0.234	pH	7.72	7.81
H_2O, dehyd.[1]	0.080	0.090			
H_2O, chem.[2]	0.240	0.676			
Total	97.566	97.876			
LOI, total[3]	2.72	12.6			
Extent of carbonation, %[4]		33.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-563 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.195	Cl	35.2	34.7
CaO	0.194	0.263	Cr	<0.0005	<0.0005
Cr_2O_3	0.054	0.039	Fe	0.0004	0.0002
FeO	7.99	8.14	Mg	0.0004	0.0174
Fe_2O_3	1.015	0.801	Ni	<0.0005	<0.0005
MgO	47.8	46.8	K	0.0019	0.0040
NiO	0.242	0.242	Si	0.0030	0.0304
K_2O	0.013	0.012	Na	32.3	30.9
SiO_2	39.1	40.2	CO_2	26.4	26.3
Na_2O	0.089	0.148	HCO_3	32.2	32.9
CO_2	0.00	1.4			
C, noncarbonate	0.085	0.081	pH	7.90	7.88
H_2O, dehyd.[1]	0.140	0.120			
H_2O, chem.[2]	0.905	0.779			
Total	97.835	99.160			
LOI, total[3]	1.13	2.3			
Extent of carbonation, %[4]		2.4			

Carbonation test SC-564 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.487	0.440	Cl	0.0038	0.7950
CaO	44.6	40.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.009	0.010	Fe	<0.0001	<0.0001
FeO	0.810	0.823	Mg	0.0006	0.0045
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.194	0.295	K	<0.0001	0.0023
NiO	<0.01	0.003	Si	<0.0001	0.2260
K_2O	0.026	0.022	Na	0.000	0.508
SiO_2	50.1	44.5	CO_2	<0.0001	0.600
Na_2O	0.126	0.123	HCO_3	<0.0001	0.941
CO_2	0.41	10.9			
C, noncarbonate	0.003	0.045	pH		6.93
H_2O, dehyd.[1]	0.000	0.640			
H_2O, chem.[2]	-0.103	0.815			
Total	96.658	98.631			
LOI, total[3]	0.31	12.4			
Extent of carbonation, %[4]		33.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-565 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.206	0.197	Cl	35.2	34.6
CaO	0.194	0.203	Cr	<0.0005	<0.0005
Cr_2O_3	0.054	0.050	Fe	0.0004	0.0002
FeO	7.99	0.913	Mg	0.0004	0.0184
Fe_2O_3	1.02	<0.01	Ni	<0.0005	<0.0005
MgO	47.8	42.6	K	0.0019	0.0043
NiO	0.242	0.223	Si	0.0030	0.0344
K_2O	0.013	0.010	Na	32.3	32.0
SiO_2	39.1	39.4	CO_2	26.4	26.2
Na_2O	0.089	0.150	HCO_3	32.2	33.7
CO_2	0.00	2.3			
C, noncarbonate	0.085	0.087	pH	7.90	7.91
H_2O, dehyd.[1]	0.140	0.100			
H_2O, chem.[2]	0.905	0.863			
Total	97.835	87.111			
LOI, total[3]	1.13	3.4			
Extent of carbonation, %[4]		4.2			

Carbonation test SC-566 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.487	0.478	Cl	0.0038	0.8350
CaO	44.6	39.3	Cr	<0.0005	<0.0005
Cr_2O_3	0.009	0.009	Fe	<0.0001	0.0001
FeO	0.810	7.269	Mg	0.0006	0.0027
Fe_2O_3	<0.01	1.087	Ni	<0.0005	<0.0005
MgO	0.194	0.371	K	<0.0001	0.0015
NiO	<0.01	0.019	Si	<0.0001	0.3200
K_2O	0.026	0.029	Na	0.0003	0.390
SiO_2	50.1	44.3	CO_2	<0.0001	0.586
Na_2O	0.126	0.150	HCO_3	<0.0001	0.800
CO_2	0.41	10.5			
C, noncarbonate	0.003	0.604	pH		7.01
H_2O, dehyd.[1]	0.000	0.400			
H_2O, chem.[2]	-0.103	0.196			
Total	96.658	104.712			
LOI, total[3]	0.31	11.7			
Extent of carbonation, %[4]		31.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-567 **Columbia River Basalt**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.173	0.124	Cl	35.1	35.0
CaO	0.171	0.141	Cr	<0.0005	<0.0005
Cr_2O_3	0.482	0.300	Fe	0.0004	0.0003
FeO	9.13	6.28	Mg	0.0004	0.0458
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	46.6	29.3	K	0.0018	0.0041
NiO	0.369	0.255	Si	0.0020	0.0574
K_2O	0.011	0.009	Na	31.6	29.9
SiO_2	39.1	27.6	CO_2	26.6	25.3
Na_2O	0.053	0.365	HCO_3	33.8	32.2
CO_2	0.13	29.8			
C, noncarbonate	0.035	0.267	pH	7.79	7.89
H_2O, dehyd.[1]	0.390	0.300			
H_2O, chem.[2]	0.955	1.033			
Total	97.645	95.816			
LOI, total[3]	1.51	31.4			
Extent of carbonation, %[4]		74.7			

Carbonation test SC-568 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.425	0.329	Cl	0.0038	0.4840
CaO	46.2	37.4	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.006	Fe	<0.0001	<0.0001
FeO	0.926	1.029	Mg	0.0006	0.0080
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.237	0.660	K	<0.0001	0.0027
NiO	0.005	0.005	Si	<0.0001	0.2110
K_2O	0.026	0.021	Na	0.0003	0.384
SiO_2	50.1	41.1	CO_2	<0.0001	0.603
Na_2O	0.118	0.126	HCO_3	<0.0001	0.854
CO_2	0.42	16.8			
C, noncarbonate	0.021	0.185	pH		6.77
H_2O, dehyd.[1]	0.000	0.640			
H_2O, chem.[2]	0.109	1.075			
Total	98.528	99.309			
LOI, total[3]	0.55	18.7			
Extent of carbonation, %[4]		53.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-569 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.531	0.399	Cl	0.0038	0.0875
CaO	46.2	34.6	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.005	Fe	<0.0001	<0.0001
FeO	1.402	0.798	Mg	0.0006	0.0080
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.212	0.279	K	<0.0001	0.0029
NiO	0.004	0.003	Si	<0.0001	0.1700
K_2O	0.034	0.025	Na	0.000	0.069
SiO_2	50.3	37.7	CO_2	<0.0001	0.463
Na_2O	0.116	0.095	HCO_3	<0.0001	0.574
CO_2	0.54	23.2			
C, noncarbonate	0.025	0.278	pH		6.18
H_2O, dehyd.[1]	0.060	1.400			
H_2O, chem.[2]	0.075	1.122			
Total	99.453	99.815			
LOI, total[3]	0.70	26.0			
Extent of carbonation, %[4]		79.7			

Carbonation test SC-570 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.557	0.431	Cl	0.0038	0.0325
CaO	46.7	35.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.004	Fe	<0.0001	<0.0001
FeO	0.810	0.643	Mg	0.0006	0.0074
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.196	0.260	K	<0.0001	0.0030
NiO	0.008	0.003	Si	<0.0001	0.1740
K_2O	0.029	0.021	Na	0.000	0.029
SiO_2	50.3	37.4	CO_2	<0.0001	0.417
Na_2O	0.109	0.089	HCO_3	<0.0001	0.434
CO_2	0.50	23.3			
C, noncarbonate	0.036	0.111	pH		6.78
H_2O, dehyd.[1]	0.000	1.260			
H_2O, chem.[2]	0.204	0.729			
Total	99.463	99.411			
LOI, total[3]	0.74	25.4			
Extent of carbonation, %[4]		80.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-571 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.557	0.442	Cl	0.0038	0.0269
CaO	46.7	35.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.004	Fe	<0.0001	<0.0001
FeO	0.810	0.746	Mg	0.0006	0.0026
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.196	0.219	K	<0.0001	0.0020
NiO	0.008	0.004	Si	<0.0001	0.1520
K_2O	0.029	0.022	Na	0.000	0.017
SiO_2	50.3	37.7	CO_2	<0.0001	0.380
Na_2O	0.109	0.092	HCO_3	<0.0001	0.546
CO_2	0.50	23.3			
C, noncarbonate	0.036	0.151	pH		6.49
H_2O, dehyd.[1]	0.000	1.230			
H_2O, chem.[2]	0.204	1.019			
Total	99.463	100.421			
LOI, total[3]	0.74	25.7			
Extent of carbonation, %[4]		80.1			

Carbonation test SC-572 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.531	0.391	Cl	0.0038	0.0188
CaO	46.2	35.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.007	Fe	<0.0001	<0.0001
FeO	1.402	0.759	Mg	0.0006	0.0084
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.212	0.249	K	<0.0001	0.0032
NiO	0.004	0.003	Si	<0.0001	0.1650
K_2O	0.034	0.021	Na	0.000	0.020
SiO_2	50.3	38.1	CO_2	<0.0001	0.400
Na_2O	0.116	0.095	HCO_3	<0.0001	0.549
CO_2	0.54	22.0			
C, noncarbonate	0.025	0.306	pH		6.53
H_2O, dehyd.[1]	0.060	1.270			
H_2O, chem.[2]	0.075	1.224			
Total	99.453	99.385			
LOI, total[3]	0.70	24.8			
Extent of carbonation, %[4]		74.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-573 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.591	0.429	Cl	0.0038	0.0094
CaO	45.6	30.9	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.005	Fe	<0.0001	<0.0001
FeO	0.823	0.669	Mg	0.0006	0.0125
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.204	0.202	K	<0.0001	0.0046
NiO	0.003	0.003	Si	<0.0001	0.1940
K_2O	0.027	0.020	Na	0.000	0.019
SiO_2	50.7	37.9	CO_2	<0.0001	0.434
Na_2O	0.136	0.095	HCO_3	<0.0001	0.556
CO_2	0.64	22.1			
C, noncarbonate	0.017	0.268	pH		6.64
H_2O, dehyd.[1]	0.100	1.630			
H_2O, chem.[2]	0.153	1.702			
Total	99.018	95.910			
LOI, total[3]	0.91	25.7			
Extent of carbonation, %[4]		76.2			

Carbonation test SC-574 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.425	0.327	Cl	0.0038	0.0062
CaO	46.2	35.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.009	Fe	<0.0001	<0.0001
FeO	0.926	0.759	Mg	0.0006	0.0089
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.237	0.169	K	<0.0001	0.0024
NiO	0.005	0.004	Si	<0.0001	0.1940
K_2O	0.026	0.020	Na	0.000	0.013
SiO_2	40.9	40.9	CO_2	<0.0001	0.391
Na_2O	0.118	0.089	HCO_3	<0.0001	0.556
CO_2	0.42	16.5			
C, noncarbonate	0.021	0.247	pH		6.55
H_2O, dehyd.[1]	0.000	1.080			
H_2O, chem.[2]	0.109	1.073			
Total	89.329	96.818			
LOI, total[3]	0.55	18.9			
Extent of carbonation, %[4]		52.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-575 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.531	0.418	Cl	0.0038	0.0031
CaO	46.2	27.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.011	Fe	<0.0001	<0.0001
FeO	1.402	0.849	Mg	0.0006	0.0032
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.212	0.177	K	<0.0001	0.0028
NiO	0.004	0.003	Si	<0.0001	0.1080
K_2O	0.034	0.021	Na	0.000	0.010
SiO_2	38.1	38.1	CO_2	<0.0001	0.411
Na_2O	0.116	0.097	HCO_3	<0.0001	0.538
CO_2	0.54	22.1			
C, noncarbonate	0.025	0.168	pH		6.60
H_2O, dehyd.[1]	0.060	1.260			
H_2O, chem.[2]	0.075	1.172			
Total	87.259	92.200			
LOI, total[3]	0.70	24.7			
Extent of carbonation, %[4]		74.7			

Carbonation test SC-576 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.557	0.419	Cl	0.0038	0.0031
CaO	46.7	35.4	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.005	Fe	<0.0001	<0.0001
FeO	0.810	0.373	Mg	0.0006	0.0035
Fe_2O_3	<0.01	0.586	Ni	<0.0005	<0.0005
MgO	0.196	0.187	K	<0.0001	0.0033
NiO	0.008	0.002	Si	<0.0001	0.1660
K_2O	0.029	0.025	Na	0.000	0.011
SiO_2	50.3	39.8	CO_2	<0.0001	0.366
Na_2O	0.109	0.097	HCO_3	<0.0001	0.535
CO_2	0.50	20.1			
C, noncarbonate	0.036	0.144	pH		6.74
H_2O, dehyd.[1]	0.000	1.650			
H_2O, chem.[2]	0.204	1.106			
Total	99.463	99.886			
LOI, total[3]	0.74	23.0			
Extent of carbonation, %[4]		66.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-577 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.169	0.151	Cl	0.0038	0.0062
CaO	44.9	44.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.001	Fe	<0.0001	<0.0001
FeO	0.708	0.656	Mg	0.0006	0.0100
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.428	0.410	K	<0.0001	0.0037
NiO	0.003	<0.01	Si	<0.0001	0.1220
K_2O	0.042	0.040	Na	0.000	0.007
SiO_2	46.6	48.1	CO_2	<0.0001	0.823
Na_2O	0.044	0.047	HCO_3	<0.0001	1.620
CO_2	3.16	4.4			
C, noncarbonate	0.039	0.076	pH		6.11
H_2O, dehyd.[1]	0.080	0.150			
H_2O, chem.[2]	-2.209	0.464			
Total	94.022	98.754			
LOI, total[3]	1.07	5.1			
Extent of carbonation, %[4]		3.8			

Carbonation test SC-578 **Cedar Hill Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.399	0.348	Cl	35.1	33.9
CaO	0.169	0.215	Cr	<0.0005	<0.0005
Cr_2O_3	0.070	0.069	Fe	0.0004	0.0003
FeO	2.38	2.41	Mg	0.0004	0.0278
Fe_2O_3	3.97	3.69	Ni	<0.0005	<0.0005
MgO	41.8	39.5	K	0.0018	0.0202
NiO	0.153	0.143	Si	0.0020	0.0331
K_2O	0.021	0.015	Na	31.6	30.0
SiO_2	36.6	35.1	CO_2	26.6	24.9
Na_2O	0.046	0.620	HCO_3	33.8	31.1
CO_2	0.80	5.4			
C, noncarbonate	0.048	0.110	pH	7.79	7.76
H_2O, dehyd.[1]	0.760	0.850			
H_2O, chem.[2]	12.292	10.290			
Total	99.478	98.651			
LOI, total[3]	13.90	16.6			
Extent of carbonation, %[4]		10.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-579 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.185	Cl	0.0038	0.1110
CaO	45.8	38.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.002	Fe	<0.0001	0.0001
FeO	0.720	0.630	Mg	0.0006	0.0051
Fe_2O_3	<0.01	0.043	Ni	<0.0005	<0.0005
MgO	0.419	0.439	K	<0.0001	0.0054
NiO	0.001	0.002	Si	<0.0001	0.1100
K_2O	0.041	0.081	Na	0.000	0.141
SiO_2	48.6	40.6	CO_2	<0.0001	0.340
Na_2O	0.045	0.087	HCO_3	<0.0001	0.520
CO_2	3.09	15.5			
C, noncarbonate	0.092	0.150	pH		6.83
H_2O, dehyd.[1]	0.060	1.810			
H_2O, chem.[2]	0.218	1.340			
Total	99.148	99.394			
LOI, total[3]	3.46	18.8			
Extent of carbonation, %[4]		42.0			

Carbonation test SC-580 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.121	Cl	0.0038	0.0073
CaO	45.8	36.9	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.002	Fe	<0.0001	<0.0001
FeO	0.720	0.592	Mg	0.0006	0.0030
Fe_2O_3	<0.01	0.086	Ni	<0.0005	<0.0005
MgO	0.419	0.385	K	<0.0001	0.0135
NiO	0.001	0.003	Si	<0.0001	0.1620
K_2O	0.041	0.031	Na	0.000	0.023
SiO_2	48.6	37.7	CO_2	<0.0001	0.431
Na_2O	0.045	0.046	HCO_3	<0.0001	0.531
CO_2	3.09	20.5			
C, noncarbonate	0.092	0.135	pH		6.50
H_2O, dehyd.[1]	0.060	1.830			
H_2O, chem.[2]	0.218	1.335			
Total	99.148	99.657			
LOI, total[3]	3.46	23.8			
Extent of carbonation, %[4]		62.5			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-581 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.121	0.101	Cl	0.0038	0.0152
CaO	46.6	39.9	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.002	Fe	<0.0001	<0.0001
FeO	0.759	0.669	Mg	0.0006	0.0038
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.479	0.305	K	<0.0001	0.0137
NiO	0.001	0.003	Si	<0.0001	0.2000
K_2O	0.041	0.029	Na	0.000	0.036
SiO_2	48.1	40.6	CO_2	<0.0001	0.391
Na_2O	0.045	0.047	HCO_3	<0.0001	0.485
CO_2	3.05	15.8			
C, noncarbonate	0.082	0.108	pH		6.81
H_2O, dehyd.[1]	0.000	1.060			
H_2O, chem.[2]	0.228	0.632			
Total	99.535	99.280			
LOI, total[3]	3.36	17.6			
Extent of carbonation, %[4]		42.4			

Carbonation test SC-582 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.121	0.098	Cl	0.0038	0.0152
CaO	46.6	38.5	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.002	Fe	<0.0001	<0.0001
FeO	0.759	0.515	Mg	0.0006	0.0037
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.479	0.396	K	<0.0001	0.0144
NiO	0.001	0.002	Si	<0.0001	0.1720
K_2O	0.041	0.029	Na	0.000	0.016
SiO_2	48.1	39.6	CO_2	<0.0001	0.430
Na_2O	0.045	0.047	HCO_3	<0.0001	0.564
CO_2	3.05	16.7			
C, noncarbonate	0.082	0.292	pH		6.63
H_2O, dehyd.[1]	0.000	1.640			
H_2O, chem.[2]	0.228	1.268			
Total	99.535	99.044			
LOI, total[3]	3.36	19.9			
Extent of carbonation, %[4]		45.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-583 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.121	0.081	Cl	0.0038	0.0121
CaO	46.6	39.0	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.002	Fe	<0.0001	<0.0001
FeO	0.759	0.592	Mg	0.0006	0.0031
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.479	0.403	K	<0.0001	0.0109
NiO	0.001	0.001	Si	<0.0001	0.1400
K_2O	0.041	0.027	Na	0.000	0.016
SiO_2	48.1	40.4	CO_2	<0.0001	0.378
Na_2O	0.045	0.043	HCO_3	<0.0001	0.543
CO_2	3.05	15.8			
C, noncarbonate	0.082	0.198	pH		6.67
H_2O, dehyd.[1]	0.000	1.830			
H_2O, chem.[2]	0.228	1.372			
Total	99.535	99.820			
LOI, total[3]	3.36	19.2			
Extent of carbonation, %[4]		42.4			

Carbonation test SC-584 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.169	0.134	Cl	0.0038	0.0133
CaO	44.91	34.84	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.003	Fe	<0.0001	<0.0001
FeO	0.708	0.630	Mg	0.0006	0.0035
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.428	0.310	K	<0.0001	0.0222
NiO	0.003	<0.01	Si	<0.0001	0.1450
K_2O	0.042	0.020	Na	0.0003	0.017
SiO_2	46.6	35.9	CO_2	<0.0001	0.438
Na_2O	0.044	0.035	HCO_3	<0.0001	0.577
CO_2	3.16	22.6			
C, noncarbonate	0.039	0.402	pH		6.60
H_2O, dehyd.[1]	0.080	2.460			
H_2O, chem.[2]	-2.209	1.738			
Total	94.022	99.112			
LOI, total[3]	1.07	27.2			
Extent of carbonation, %[4]		73.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-585 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.169	0.118	Cl	0.0038	0.0121
CaO	44.9	30.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.025	Fe	<0.0001	<0.0001
FeO	0.708	0.527	Mg	0.0006	0.0017
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.428	0.277	K	<0.0001	0.0163
NiO	0.003	0.019	Si	<0.0001	0.1700
K_2O	0.042	0.253	Na	0.000	0.012
SiO_2	46.6	37.0	CO_2	<0.0001	0.322
Na_2O	0.044	0.160	HCO_3	<0.0001	0.427
CO_2	3.16	21.5			
C, noncarbonate	0.039	0.242	pH		6.67
H_2O, dehyd.[1]	0.080	1.500			
H_2O, chem.[2]	-2.209	1.258			
Total	94.022	93.393			
LOI, total[3]	1.07	24.5			
Extent of carbonation, %[4]		68.1			

Carbonation test SC-586 **Shell Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.142	0.124	Cl	0.0038	0.0091
CaO	45.8	33.0	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.005	Fe	<0.0001	<0.0001
FeO	0.720	0.643	Mg	0.0006	0.0016
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.419	0.323	K	<0.0001	0.0111
NiO	0.001	0.014	Si	<0.0001	0.1560
K_2O	0.041	0.031	Na	0.000	0.012
SiO_2	48.6	37.7	CO_2	<0.0001	0.264
Na_2O	0.045	0.046	HCO_3	<0.0001	0.372
CO_2	3.09	20.2			
C, noncarbonate	0.092	0.267	pH		6.82
H_2O, dehyd.[1]	0.060	1.630			
H_2O, chem.[2]	0.218	0.503			
Total	99.148	94.459			
LOI, total[3]	3.46	22.6			
Extent of carbonation, %[4]		61.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-587 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.425	0.418	Cl	0.0038	0.0018
CaO	46.2	38.3	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.010	Fe	<0.0001	<0.0001
FeO	0.926	0.875	Mg	0.0006	0.0014
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.237	0.259	K	<0.0001	0.0020
NiO	0.005	0.014	Si	<0.0001	0.2010
K_2O	0.026	0.021	Na	0.000	0.006
SiO_2	50.1	41.5	CO_2	<0.0001	0.316
Na_2O	0.118	0.096	HCO_3	<0.0001	0.394
CO_2	0.42	14.4			
C, noncarbonate	0.021	0.440	pH		6.76
H_2O, dehyd.[1]	0.000	1.230			
H_2O, chem.[2]	0.109	6.530			
Total	98.528	104.133			
LOI, total[3]	0.55	22.6			
Extent of carbonation, %[4]		44.4			

Carbonation test SC-588 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.40	1.38	Cl	36.3	35.2
CaO	0.613	0.589	Cr	<0.0005	<0.0005
Cr_2O_3	0.317	0.310	Fe	0.0003	0.0005
FeO	2.65	2.47	Mg	0.0005	0.0234
Fe_2O_3	0.643	4.661	Ni	<0.0005	<0.0005
MgO	37.1	35.5	K	0.0023	0.0054
NiO	0.210	0.215	Si	0.0023	0.0509
K_2O	0.011	0.011	Na	32.6	31.0
SiO_2	38.7	37.7	CO_2	26.0	25.5
Na_2O	0.046	1.263	HCO_3	32.7	31.9
CO_2	0.13	1.3			
C, noncarbonate	0.027	0.054	pH	7.75	7.89
H_2O, dehyd.[1]	1.110	1.520			
H_2O, chem.[2]	12.633	12.416			
Total	95.653	99.338			
LOI, total[3]	13.90	15.3			
Extent of carbonation, %[4]		2.8			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-589 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	1.701	1.825	Cl	36.3	35.4
CaO	0.472	0.515	Cr	<0.0005	<0.0005
Cr_2O_3	0.304	0.297	Fe	0.0003	0.0005
FeO	2.483	2.431	Mg	0.0005	0.0222
Fe_2O_3	4.86	4.23	Ni	<0.0005	<0.0005
MgO	36.6	37.0	K	0.0023	0.0077
NiO	0.218	0.225	Si	0.0023	0.0456
K_2O	0.015	0.012	Na	32.6	30.5
SiO_2	37.7	38.1	CO_2	26.0	25.5
Na_2O	0.058	0.332	HCO_3	32.7	33.1
CO_2	0.19	1.17			
C, noncarbonate	0.023	0.051	pH	7.75	7.78
H_2O, dehyd.[1]	1.170	1.260			
H_2O, chem.[2]	12.817	12.219			
Total	98.606	99.624			
LOI, total[3]	14.20	14.7			
Extent of carbonation, %[4]		2.4			

Carbonation test SC-590 **Cedar Hill Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.323	0.312	Cl	36.6	35.4
CaO	0.221	0.295	Cr	<0.0005	<0.0005
Cr_2O_3	0.078	0.088	Fe	0.0003	0.0003
FeO	2.06	1.81	Mg	0.0006	0.0244
Fe_2O_3	4.83	4.85	Ni	<0.0005	<0.0005
MgO	41.5	39.0	K	0.0020	0.0142
NiO	0.238	0.225	Si	0.0024	0.0332
K_2O	0.015	0.013	Na	30.6	29.2
SiO_2	36.8	34.9	CO_2	26.6	25.0
Na_2O	0.047	1.469	HCO_3	32.5	30.7
CO_2	0.81	5.71			
C, noncarbonate	0.014	0.082	pH	7.71	7.92
H_2O, dehyd.[1]	0.610	1.030			
H_2O, chem.[2]	12.366	10.878			
Total	99.862	100.599			
LOI, total[3]	13.80	17.7			
Extent of carbonation, %[4]		11.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-591 **Cedar Hill Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.231	0.221	Cl	36.6	35.0
CaO	0.071	0.092	Cr	<0.0005	<0.0005
Cr_2O_3	0.050	0.053	Fe	0.0003	0.0003
FeO	2.89	2.59	Mg	0.0006	0.0224
Fe_2O_3	3.47	4.35	Ni	<0.0005	<0.0005
MgO	41.8	33.3	K	0.0020	0.0068
NiO	0.248	0.244	Si	0.0024	0.0338
K_2O	0.012	0.013	Na	30.6	30.4
SiO_2	37.0	35.7	CO_2	26.6	25.4
Na_2O	0.039	0.536	HCO_3	32.5	32.8
CO_2	0.83	5.3			
C, noncarbonate	0.012	0.077	pH	7.71	7.85
H_2O, dehyd.[1]	0.460	0.550			
H_2O, chem.[2]	12.398	10.323			
Total	99.512	93.346			
LOI, total[3]	13.70	16.2			
Extent of carbonation, %[4]		9.9			

Carbonation test SC-592 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.591	0.425	Cl	0.0038	0.0970
CaO	45.6	34.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.006	0.005	Fe	<0.0001	<0.0001
FeO	0.823	0.708	Mg	0.0006	0.0037
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.204	0.196	K	<0.0001	0.0046
NiO	0.003	0.019	Si	<0.0001	0.0980
K_2O	0.027	0.029	Na	0.000	0.108
SiO_2	50.7	39.6	CO_2	<0.0001	0.344
Na_2O	0.136	0.102	HCO_3	<0.0001	0.461
CO_2	0.64	20.8			
C, noncarbonate	0.017	0.143	pH		7.05
H_2O, dehyd.[1]	0.100	0.720			
H_2O, chem.[2]	0.153	0.737			
Total	99.018	97.601			
LOI, total[3]	0.91	22.4			
Extent of carbonation, %[4]		70.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-593 **Southwest Oregon Lizardite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	2.06	1.74	Cl	36.2	35.8
CaO	0.518	0.725	Cr	<0.0005	<0.0005
Cr_2O_3	0.294	0.281	Fe	0.0002	0.0004
FeO	2.89	2.89	Mg	0.0007	0.0316
Fe_2O_3	4.12	3.63	Ni	<0.0005	<0.0005
MgO	36.3	33.2	K	0.0018	0.0329
NiO	0.206	0.197	Si	0.0039	0.0469
K_2O	0.042	0.022	Na	30.0	29.6
SiO_2	38.7	36.6	CO_2	26.3	25.7
Na_2O	0.066	2.143	HCO_3	32.1	31.9
CO_2	0.16	1.95			
C, noncarbonate	0.026	0.044	pH	7.87	7.79
H_2O, dehyd.[1]	1.360	2.130			
H_2O, chem.[2]	12.854	13.176			
Total	99.631	98.674			
LOI, total[3]	14.40	17.3			
Extent of carbonation, %[4]		4.4			

Carbonation test SC-594 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.487	Cl	36.2	35.2
CaO	45.8	35.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	0.0002	0.0004
FeO	0.862	0.682	Mg	0.0007	0.0023
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.257	K	0.0018	0.0124
NiO	<0.01	0.010	Si	0.0039	0.0384
K_2O	0.028	0.020	Na	30.0	33.6
SiO_2	50.9	39.6	CO_2	26.3	24.6
Na_2O	0.096	0.504	HCO_3	32.1	31.8
CO_2	0.56	20.3			
C, noncarbonate	0.000	0.170	pH	7.87	7.96
H_2O, dehyd.[1]	0.000	0.110			
H_2O, chem.[2]	0.120	1.120			
Total	99.141	99.062			
LOI, total[3]	0.68	21.7			
Extent of carbonation, %[4]		68.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-595 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.431	Cl	0.0038	0.1480
CaO	45.8	34.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.003	Fe	<0.0001	0.0002
FeO	0.862	0.772	Mg	0.0006	0.0052
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.206	K	<0.0001	0.0038
NiO	<0.01	<0.01	Si	<0.0001	0.1350
K_2O	0.028	0.042	Na	0.000	0.142
SiO_2	50.9	37.4	CO_2	<0.0001	0.496
Na_2O	0.096	0.127	HCO_3	<0.0001	0.644
CO_2	0.560	22.9			
C, noncarbonate	0.000	0.150	pH		6.63
H_2O, dehyd.[1]	0.000	1.830			
H_2O, chem.[2]	0.120	1.920			
Total	99.141	99.959			
LOI, total[3]	0.68	26.8			
Extent of carbonation, %[4]		79.7			

Carbonation test SC-596 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.459	Cl	0.0038	0.0121
CaO	45.8	36.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	<0.0001	0.0002
FeO	0.862	0.772	Mg	0.0006	0.0026
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.222	K	<0.0001	0.0030
NiO	<0.01	<0.01	Si	<0.0001	0.2120
K_2O	0.028	0.023	Na	0.000	0.013
SiO_2	50.9	20.3	CO_2	<0.0001	0.424
Na_2O	0.096	0.125	HCO_3	<0.0001	0.519
CO_2	0.56	20.2			
C, noncarbonate	0.000	0.157	pH		6.54
H_2O, dehyd.[1]	0.000	0.810			
H_2O, chem.[2]	0.120	0.933			
Total	99.141	80.085			
LOI, total[3]	0.68	22.1			
Extent of carbonation, %[4]		67.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-597 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.384	Cl	0.0038	0.0182
CaO	45.8	32.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.005	Fe	<0.0001	<0.0001
FeO	0.862	0.913	Mg	0.0006	0.0049
Fe_2O_3	<0.01	0.701	Ni	<0.0005	<0.0005
MgO	0.206	0.189	K	<0.0001	0.0022
NiO	<0.01	0.005	Si	<0.0001	0.0958
K_2O	0.028	0.079	Na	0.0003	0.024
SiO_2	50.9	35.9	CO_2	<0.0001	0.512
Na_2O	0.096	0.098	HCO_3	<0.0001	0.604
CO_2	0.56	22.9			
C, noncarbonate	0.000	0.180	pH		6.53
H_2O, dehyd.[1]	0.000	2.350			
H_2O, chem.[2]	0.120	2.570			
Total	99.141	99.055			
LOI, total[3]	0.68	28.0			
Extent of carbonation, %[4]		79.7			

Carbonation test SC-598 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.423	Cl	0.0038	0.0364
CaO	45.8	36.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	<0.0001	0.0005
FeO	0.862	0.798	Mg	0.0006	0.0029
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.206	K	<0.0001	0.0028
NiO	<0.01	0.004	Si	<0.0001	0.2190
K_2O	0.028	0.022	Na	0.0003	0.037
SiO_2	50.9	38.5	CO_2	<0.0001	0.360
Na_2O	0.096	0.092	HCO_3	<0.0001	0.455
CO_2	0.56	21.8			
C, noncarbonate	0.000	0.090	pH		6.76
H_2O, dehyd.[1]	0.000	0.600			
H_2O, chem.[2]	0.120	0.910			
Total	99.141	99.556			
LOI, total[3]	0.68	23.4			
Extent of carbonation, %[4]		74.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-599 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.395	Cl	0.0038	0.0273
CaO	45.8	37.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	<0.0001	<0.0001
FeO	0.862	0.708	Mg	0.0006	0.0058
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.211	K	<0.0001	0.0040
NiO	<0.01	0.089	Si	<0.0001	0.1950
K_2O	0.028	0.027	Na	0.000	0.014
SiO_2	50.9	38.5	CO_2	<0.0001	0.346
Na_2O	0.096	0.128	HCO_3	<0.0001	0.491
CO_2	0.56	19.1			
C, noncarbonate	0.000	0.207	pH		6.64
H_2O, dehyd.[1]	0.000	1.380			
H_2O, chem.[2]	0.120	1.413			
Total	99.141	99.388			
LOI, total[3]	0.68	22.1			
Extent of carbonation, %[4]		63.1			

Carbonation test SC-600 **Cedar Hill Serpentine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.778	0.650	Cl	36.2	35.5
CaO	0.304	0.362	Cr	<0.0005	<0.0005
Cr_2O_3	0.121	0.106	Fe	0.0004	0.0002
FeO	2.37	1.94	Mg	0.0006	0.0594
Fe_2O_3	4.32	4.46	Ni	<0.0005	<0.0005
MgO	41.3	37.8	K	0.0019	0.0374
NiO	0.239	0.223	Si	0.0017	0.0344
K_2O	0.031	0.019	Na	30.6	29.6
SiO_2	35.5	24.8	CO_2	26.3	25.0
Na_2O	0.061	1.820	HCO_3	35.1	31.1
CO_2	0.88	6.5			
C, noncarbonate	0.022	0.000	pH	7.81	7.74
H_2O, dehyd.[1]	0.730	1.200			
H_2O, chem.[2]	12.268	11.430			
Total	98.919	91.303			
LOI, total[3]	13.90	19.1			
Extent of carbonation, %[4]		12.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-601 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.359	Cl	0.0038	0.0879
CaO	45.8	33.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.003	Fe	<0.0001	<0.0001
FeO	0.862	0.515	Mg	0.0006	0.0024
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.217	K	<0.0001	0.0023
NiO	<0.01	0.008	Si	<0.0001	0.1020
K_2O	0.028	0.021	Na	0.0003	0.073
SiO_2	50.9	36.2	CO_2	<0.0001	0.418
Na_2O	0.096	0.108	HCO_3	<0.0001	0.506
CO_2	0.56	21.3			
C, noncarbonate	0.000	0.307	pH		6.66
H_2O, dehyd.[1]	0.000	2.720			
H_2O, chem.[2]	0.120	2.773			
Total	99.141	98.206			
LOI, total[3]	0.68	27.1			
Extent of carbonation, %[4]		72.5			

Carbonation test SC-602 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.408	Cl	0.0038	0.0273
CaO	45.8	35.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.003	Fe	<0.0001	<0.0001
FeO	0.862	0.630	Mg	0.0006	0.0026
Fe_2O_3	<0.01	2.016	Ni	<0.0005	<0.0005
MgO	0.206	0.199	K	<0.0001	0.0030
NiO	<0.01	0.011	Si	<0.0001	0.1630
K_2O	0.028	0.020	Na	0.0003	0.013
SiO_2	50.9	37.7	CO_2	<0.0001	0.366
Na_2O	0.096	0.127	HCO_3	<0.0001	0.470
CO_2	0.56	20.6			
C, noncarbonate	0.000	0.348	pH		6.66
H_2O, dehyd.[1]	0.000	1.980			
H_2O, chem.[2]	0.120	2.372			
Total	99.141	101.905			
LOI, total[3]	0.68	25.3			
Extent of carbonation, %[4]		69.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-603 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.455	Cl	0.0038	0.0424
CaO	46.2	38.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.004	Fe	<0.0001	<0.0001
FeO	1.261	0.733	Mg	0.0006	0.0046
Fe_2O_3	<0.01	0.214	Ni	<0.0005	<0.0005
MgO	0.212	0.232	K	<0.0001	0.0024
NiO	0.070	0.005	Si	<0.0001	0.3810
K_2O	0.028	0.024	Na	0.0003	0.024
SiO_2	50.5	42.8	CO_2	<0.0001	0.382
Na_2O	0.142	0.133	HCO_3	<0.0001	0.573
CO_2	0.47	13.1			
C, noncarbonate	0.007	0.245	pH		7.12
H_2O, dehyd.[1]	0.000	0.790			
H_2O, chem.[2]	0.113	0.965			
Total	99.529	98.445			
LOI, total[3]	0.59	15.1			
Extent of carbonation, %[4]		39.3			

Carbonation test SC-604 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.491	Cl	0.0038	0.0182
CaO	46.2	38.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.004	Fe	<0.0001	<0.0001
FeO	1.261	0.926	Mg	0.0006	0.0032
Fe_2O_3	<0.01	0.944	Ni	<0.0005	<0.0005
MgO	0.212	0.199	K	<0.0001	0.0025
NiO	0.070	0.004	Si	<0.0001	0.3010
K_2O	0.028	0.023	Na	0.0003	0.009
SiO_2	50.5	41.3	CO_2	<0.0001	0.348
Na_2O	0.142	0.135	HCO_3	<0.0001	0.488
CO_2	0.47	14.1			
C, noncarbonate	0.007	0.262	pH		6.58
H_2O, dehyd.[1]	0.000	1.110			
H_2O, chem.[2]	0.113	1.928			
Total	99.529	99.893			
LOI, total[3]	0.59	17.4			
Extent of carbonation, %[4]		42.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-605 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.474	Cl	0.0038	0.0152
CaO	46.2	38.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.005	Fe	<0.0001	0.0021
FeO	1.261	0.862	Mg	0.0006	0.0036
Fe_2O_3	<0.01	0.429	Ni	<0.0005	<0.0005
MgO	0.212	0.189	K	<0.0001	0.0018
NiO	0.070	0.034	Si	<0.0001	0.0569
K_2O	0.028	0.041	Na	0.0003	0.007
SiO_2	50.5	41.9	CO_2	<0.0001	0.858
Na_2O	0.142	0.144	HCO_3	<0.0001	1.140
CO_2	0.47	14.0			
C, noncarbonate	0.007	0.049	pH		6.14
H_2O, dehyd.[1]	0.000	1.440			
H_2O, chem.[2]	0.113	1.911			
Total	99.529	99.567			
LOI, total[3]	0.59	17.4			
Extent of carbonation, %[4]		42.6			

Carbonation test SC-606 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.514	Cl	0.0038	0.0053
CaO	46.2	37.9	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.006	Fe	<0.0001	0.0001
FeO	1.261	0.630	Mg	0.0006	0.0044
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.212	0.182	K	<0.0001	0.0022
NiO	0.070	0.004	Si	<0.0001	0.1080
K_2O	0.028	0.026	Na	0.0003	0.007
SiO_2	50.5	43.2	CO_2	<0.0001	0.372
Na_2O	0.142	0.132	HCO_3	<0.0001	0.500
CO_2	0.47	13.4			
C, noncarbonate	0.007	0.303	pH		6.79
H_2O, dehyd.[1]	0.000	0.770			
H_2O, chem.[2]	0.113	1.127			
Total	99.529	98.228			
LOI, total[3]	0.59	15.6			
Extent of carbonation, %[4]		40.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-607 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.486	Cl	0.0038	0.0047
CaO	46.2	39.7	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.005	Fe	<0.0001	<0.0001
FeO	1.261	0.785	Mg	0.0006	0.0020
Fe_2O_3	<0.01	0.029	Ni	<0.0005	<0.0005
MgO	0.212	0.182	K	<0.0001	0.0021
NiO	0.070	0.011	Si	<0.0001	0.1010
K_2O	0.028	0.024	Na	0.0003	0.005
SiO_2	50.5	42.8	CO_2	<0.0001	0.304
Na_2O	0.142	0.137	HCO_3	<0.0001	0.427
CO_2	0.47	12.1			
C, noncarbonate	0.007	0.198	pH		7.25
H_2O, dehyd.[1]	0.000	0.800			
H_2O, chem.[2]	0.113	1.602			
Total	99.529	98.883			
LOI, total[3]	0.59	14.7			
Extent of carbonation, %[4]		35.8			

Carbonation test SC-608 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.561	0.489	Cl	0.0038	0.0045
CaO	46.2	38.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.005	Fe	<0.0001	<0.0001
FeO	1.261	0.733	Mg	0.0006	0.0044
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.212	0.196	K	<0.0001	0.0026
NiO	0.070	0.005	Si	<0.0001	0.0982
K_2O	0.028	0.025	Na	0.0003	0.006
SiO_2	50.5	43.2	CO_2	<0.0001	0.342
Na_2O	0.142	0.133	HCO_3	<0.0001	0.482
CO_2	0.47	13.1			
C, noncarbonate	0.007	0.245	pH		6.69
H_2O, dehyd.[1]	0.000	0.710			
H_2O, chem.[2]	0.113	1.145			
Total	99.529	98.758			
LOI, total[3]	0.59	15.2			
Extent of carbonation, %[4]		39.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-609 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.465	Cl	0.0038	0.0016
CaO	45.8	37.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	<0.0001	<0.0001
FeO	0.862	0.849	Mg	0.0006	0.0039
Fe_2O_3	<0.01	0.329	Ni	<0.0005	<0.0005
MgO	0.206	0.172	K	<0.0001	0.0021
NiO	<0.01	0.010	Si	<0.0001	0.0452
K_2O	0.028	0.072	Na	0.0003	0.004
SiO_2	50.9	39.6	CO_2	<0.0001	0.328
Na_2O	0.096	0.140	HCO_3	<0.0001	0.458
CO_2	0.56	17.9			
C, noncarbonate	0.000	0.145	pH		6.92
H_2O, dehyd.[1]	0.000	1.660			
H_2O, chem.[2]	0.120	2.595			
Total	99.141	101.697			
LOI, total[3]	0.68	22.3			
Extent of carbonation, %[4]		58.1			

Carbonation test SC-610 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.569	Cl	0.0038	0.0018
CaO	45.8	45.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.004	Fe	<0.0001	0.0067
FeO	0.862	0.785	Mg	0.0006	0.0112
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.209	K	<0.0001	0.0013
NiO	<0.01	0.011	Si	<0.0001	0.0714
K_2O	0.028	0.025	Na	0.0003	0.005
SiO_2	50.9	48.1	CO_2	<0.0001	0.964
Na_2O	0.096	0.121	HCO_3	<0.0001	1.090
CO_2	0.56	4.84			
C, noncarbonate	0.000	0.039	pH		6.48
H_2O, dehyd.[1]	0.000	0.450			
H_2O, chem.[2]	0.120	1.001			
Total	99.141	101.383			
LOI, total[3]	0.68	6.3			
Extent of carbonation, %[4]		12.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-611 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.467	Cl	0.0038	0.0016
CaO	45.8	41.1	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.003	Fe	<0.0001	<0.0001
FeO	0.862	0.862	Mg	0.0006	0.0117
Fe_2O_3	<0.01	0.014	Ni	<0.0005	<0.0005
MgO	0.206	0.187	K	<0.0001	0.0013
NiO	<0.01	0.013	Si	<0.0001	0.0518
K_2O	0.028	0.041	Na	0.0003	0.004
SiO_2	50.9	44.5	CO_2	<0.0001	0.578
Na_2O	0.096	0.139	HCO_3	<0.0001	0.778
CO_2	0.56	11.1			
C, noncarbonate	0.000	0.101	pH		6.73
H_2O, dehyd.[1]	0.000	1.530			
H_2O, chem.[2]	0.120	1.369			
Total	99.141	101.461			
LOI, total[3]	0.68	14.1			
Extent of carbonation, %[4]		32.6			

Carbonation test SC-612 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.597	0.391	Cl	0.0029	0.0051
CaO	45.8	34.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.003	0.003	Fe	0.0004	0.0001
FeO	0.862	0.669	Mg	0.0008	0.0025
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.206	0.172	K	0.0002	0.0028
NiO	<0.01	0.004	Si	0.0012	0.0716
K_2O	0.028	0.043	Na	0.0082	0.013
SiO_2	50.9	37.9	CO_2	0.016	0.344
Na_2O	0.096	0.136	HCO_3	0.031	0.458
CO_2	0.56	22.8			
C, noncarbonate	0.000	0.027	pH	0.00	6.71
H_2O, dehyd.[1]	0.000	1.230			
H_2O, chem.[2]	0.120	1.343			
Total	99.141	99.524			
LOI, total[3]	0.68	25.4			
Extent of carbonation, %[4]		79.2			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-613 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.274	0.193	Cl	0.0038	0.0019
CaO	46.2	36.4	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.006	Fe	<0.0001	0.0001
FeO	0.849	0.720	Mg	0.0006	0.0024
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.177	0.137	K	<0.0001	0.0015
NiO	0.005	0.006	Si	<0.0001	0.0747
K_2O	0.027	0.018	Na	0.0003	0.006
SiO_2	50.7	39.8	CO_2	<0.0001	0.476
Na_2O	0.129	0.080	HCO_3	<0.0001	0.537
CO_2	0.74	19.0			
C, noncarbonate	0.016	0.125	pH		6.47
H_2O, dehyd.[1]	0.000	1.030			
H_2O, chem.[2]	0.114	1.645			
Total	99.213	99.131			
LOI, total[3]	0.87	21.8			
Extent of carbonation, %[4]		61.7			

Carbonation test SC-614 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.512	0.440	Cl	0.0038	0.0019
CaO	45.6	39.6	Cr	<0.0005	<0.0005
Cr_2O_3	0.005	0.005	Fe	<0.0001	0.0001
FeO	0.888	0.759	Mg	0.0006	0.0024
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0006
MgO	0.172	0.166	K	<0.0001	0.0012
NiO	0.003	0.005	Si	<0.0001	0.1170
K_2O	0.050	0.021	Na	0.0003	0.005
SiO_2	51.6	43.9	CO_2	<0.0001	0.452
Na_2O	0.151	0.137	HCO_3	<0.0001	0.610
CO_2	0.29	12.4			
C, noncarbonate	0.024	0.136	pH		6.88
H_2O, dehyd.[1]	0.000	0.280			
H_2O, chem.[2]	0.016	1.184			
Total	99.283	98.988			
LOI, total[3]	0.33	14.0			
Extent of carbonation, %[4]		38.0			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-615 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.274	0.217	Cl	0.0038	0.0014
CaO	46.2	37.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.005	Fe	<0.0001	<0.0001
FeO	0.849	0.785	Mg	0.0006	0.0025
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.177	0.160	K	<0.0001	0.0022
NiO	0.005	0.005	Si	<0.0001	0.1070
K_2O	0.027	0.016	Na	0.0003	0.005
SiO_2	50.7	41.3	CO_2	<0.0001	0.418
Na_2O	0.129	0.082	HCO_3	<0.0001	0.488
CO_2	0.74	16.0			
C, noncarbonate	0.016	0.233	pH		6.71
H_2O, dehyd.[1]	0.000	1.520			
H_2O, chem.[2]	0.114	1.447			
Total	99.213	98.977			
LOI, total[3]	0.87	19.2			
Extent of carbonation, %[4]		49.7			

Carbonation test SC-616 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.661	0.559	Cl	0.0038	0.0031
CaO	45.6	35.3	Cr	<0.0005	<0.0005
Cr_2O_3	0.004	0.005	Fe	<0.0001	0.0006
FeO	0.939	0.849	Mg	0.0006	0.0040
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	0.0007
MgO	0.209	0.184	K	<0.0001	0.0017
NiO	0.002	0.003	Si	<0.0001	0.1190
K_2O	0.084	0.026	Na	0.0003	0.006
SiO_2	51.1	46.4	CO_2	<0.0001	0.474
Na_2O	0.222	0.154	HCO_3	<0.0001	0.757
CO_2	0.34	8.76			
C, noncarbonate	0.000	0.089	pH		6.69
H_2O, dehyd.[1]	0.000	0.710			
H_2O, chem.[2]	-0.010	0.641			
Total	99.194	93.664			
LOI, total[3]	0.33	10.2			
Extent of carbonation, %[4]		25.4			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-617 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.274	0.184	Cl	0.0038	0.0017
CaO	46.2	32.6	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.005	Fe	<0.0001	0.0001
FeO	0.849	0.695	Mg	0.0006	0.0025
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.177	0.172	K	<0.0001	0.0020
NiO	0.005	0.003	Si	<0.0001	0.1110
K_2O	0.027	0.017	Na	0.0003	0.005
SiO_2	50.7	41.3	CO_2	<0.0001	0.430
Na_2O	0.129	0.091	HCO_3	<0.0001	0.516
CO_2	0.74	16.4			
C, noncarbonate	0.016	0.194	pH		6.62
H_2O, dehyd.[1]	0.000	1.500			
H_2O, chem.[2]	0.114	1.406			
Total	99.213	94.557			
LOI, total[3]	0.87	19.5			
Extent of carbonation, %[4]		51.3			

Carbonation test SC-618 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.274	0.195	Cl	0.0038	0.0084
CaO	46.2	36.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.007	0.005	Fe	<0.0001	0.0001
FeO	0.849	1.235	Mg	0.0006	0.0027
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.177	0.140	K	<0.0001	0.0024
NiO	0.005	0.015	Si	<0.0001	0.1040
K_2O	0.027	0.046	Na	0.0003	0.011
SiO_2	50.7	41.1	CO_2	<0.0001	0.418
Na_2O	0.129	0.085	HCO_3	<0.0001	0.488
CO_2	0.74	16.3			
C, noncarbonate	0.016	0.171	pH		6.56
H_2O, dehyd.[1]	0.000	1.280			
H_2O, chem.[2]	0.114	1.149			
Total	99.213	98.493			
LOI, total[3]	0.87	18.9			
Extent of carbonation, %[4]		50.9			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-619 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.557	0.616	Cl	0.0038	0.0032
CaO	46.6	37.5	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.003	Fe	<0.0001	0.0005
FeO	1.106	1.029	Mg	0.0006	0.0025
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.196	0.209	K	<0.0001	0.0018
NiO	0.020	0.011	Si	<0.0001	0.1170
K_2O	0.028	0.028	Na	0.0003	0.005
SiO_2	51.3	47.3	CO_2	<0.0001	0.516
Na_2O	0.094	0.146	HCO_3	<0.0001	0.747
CO_2	0.26	8.12			
C, noncarbonate	0.006	0.000	pH		6.72
H_2O, dehyd.[1]	0.000	0.550			
H_2O, chem.[2]	0.024	0.240			
Total	100.231	95.730			
LOI, total[3]	0.29	8.9			
Extent of carbonation, %[4]		22.9			

Carbonation test SC-620 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.812	0.727	Cl	0.0038	0.0022
CaO	46.7	42.4	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.004	Fe	<0.0001	0.0003
FeO	1.029	0.978	Mg	0.0006	0.0018
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.239	0.234	K	<0.0001	0.0017
NiO	0.002	0.006	Si	<0.0001	0.1190
K_2O	0.051	0.034	Na	0.0003	0.005
SiO_2	51.3	47.5	CO_2	<0.0001	0.438
Na_2O	0.213	0.201	HCO_3	<0.0001	0.577
CO_2	0.28	7.26			
C, noncarbonate	0.005	0.039	pH		6.72
H_2O, dehyd.[1]	0.000	0.340			
H_2O, chem.[2]	0.025	0.581			
Total	100.735	100.293			
LOI, total[3]	0.31	8.2			
Extent of carbonation, %[4]		20.1			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-621 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.826	0.777	Cl	0.0038	0.0031
CaO	46.7	43.8	Cr	<0.0005	<0.0005
Cr_2O_3	0.002	0.002	Fe	<0.0001	0.0003
FeO	0.965	0.926	Mg	0.0006	0.0014
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	0.250	0.217	K	<0.0001	0.0012
NiO	0.002	0.009	Si	<0.0001	0.1190
K_2O	0.040	0.032	Na	0.0003	0.003
SiO_2	51.8	47.9	CO_2	<0.0001	0.430
Na_2O	0.193	0.158	HCO_3	<0.0001	0.558
CO_2	0.24	6.16			
C, noncarbonate	0.006	0.149	pH		6.79
H_2O, dehyd.[1]	0.000	0.350			
H_2O, chem.[2]	0.064	0.491			
Total	101.093	100.987			
LOI, total[3]	0.31	7.2			
Extent of carbonation, %[4]		16.9			

Carbonation test SC-622 **Nyco 100 Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.726	0.552	Cl	0.004	0.002
CaO	45.2	41.7	Cr	<0.0005	<0.0005
Cr_2O_3	<0.01	0.005	Fe	<0.0001	0.0001
FeO	1.222	1.299	Mg	0.0006	0.0014
Fe_2O_3	0.443	0.315	Ni	<0.0005	<0.0005
MgO	0.274	0.270	K	<0.0001	0.0013
NiO	<0.01	0.016	Si	<0.0001	0.1020
K_2O	0.048	0.036	Na	0.0003	0.003
SiO_2	51.3	48.3	CO_2	<0.0001	0.316
Na_2O	0.168	0.166	HCO_3	<0.0001	0.482
CO_2	0.25	5.65			
C, noncarbonate	0.001	0.238	pH		6.81
H_2O, dehyd.[1]	0.000	0.220			
H_2O, chem.[2]	0.069	1.272			
Total	99.738	100.083			
LOI, total[3]	0.32	7.4			
Extent of carbonation, %[4]		15.7			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-623 **Nyco Tails**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	4.610	3.798	Cl	0.0038	0.0016
CaO	34.1	32.2	Cr	<0.0005	<0.0005
Cr_2O_3	0.010	0.014	Fe	<0.0001	0.0001
FeO	4.040	3.744	Mg	0.0006	0.0024
Fe_2O_3	9.079	4.475	Ni	<0.0005	<0.0005
MgO	2.30	2.02	K	<0.0001	0.0023
NiO	0.006	0.021	Si	<0.0001	0.0967
K_2O	0.021	0.017	Na	0.0003	0.004
SiO_2	43.2	38.9	CO_2	<0.0001	0.398
Na_2O	0.132	0.127	HCO_3	<0.0001	0.528
CO_2	0.54	6.65			
C, noncarbonate	0.016	0.085	pH		6.86
H_2O, dehyd.[1]	0.000	0.220			
H_2O, chem.[2]	0.074	0.475			
Total	98.186	92.766			
LOI, total[3]	0.63	7.4			
Extent of carbonation, %[4]		20.8			

Carbonation test SC-624 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.128	0.146	Cl	36.2	35.8
CaO	0.372	0.225	Cr	<0.0005	<0.0005
Cr_2O_3	0.161	0.159	Fe	0.0003	0.0004
FeO	8.59	7.50	Mg	0.0006	0.0528
Fe_2O_3	0.029	<0.01	Ni	<0.0005	<0.0005
MgO	46.9	37.3	K	0.0019	0.0050
NiO	0.344	0.312	Si	0.0012	0.0229
K_2O	0.009	0.009	Na	30.6	29.3
SiO_2	40.9	35.3	CO_2	25.2	26.3
Na_2O	0.063	0.235	HCO_3	29.9	32.2
CO_2	0.00	13.0			
C, noncarbonate	0.031	0.082	pH	7.80	7.86
H_2O, dehyd.[1]	0.180	0.270			
H_2O, chem.[2]	1.009	0.948			
Total	98.703	95.491			
LOI, total[3]	1.22	14.3			
Extent of carbonation, %[4]		26.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-625 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.144	0.134	Cl	36.2	36.2
CaO	0.075	0.308	Cr	<0.0005	<0.0005
Cr_2O_3	0.059	0.060	Fe	0.0003	0.0003
FeO	7.22	7.53	Mg	0.0006	0.0340
Fe_2O_3	1.887	0.572	Ni	<0.0005	<0.0005
MgO	50.6	48.2	K	0.0019	0.0031
NiO	0.457	0.318	Si	0.0012	0.0136
K_2O	0.013	0.007	Na	30.6	31.6
SiO_2	41.1	37.0	CO_2	25.2	26.6
Na_2O	0.066	0.126	HCO_3	29.9	34.7
CO_2	0.00	2.64			
C, noncarbonate	0.019	0.052	pH	7.80	7.88
H_2O, dehyd.[1]	0.000	0.000			
H_2O, chem.[2]	0.231	0.298			
Total	101.814	97.301			
LOI, total[3]	0.25	3.0			
Extent of carbonation, %[4]		4.5			

Carbonation test SC-626 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.141	0.126	Cl	37.5	37.2
CaO	0.182	0.155	Cr	<0.0005	<0.0005
Cr_2O_3	0.026	0.031	Fe	0.0002	0.0002
FeO	7.32	7.14	Mg	0.0006	0.0300
Fe_2O_3	0.172	0.100	Ni	<0.0005	<0.0005
MgO	49.7	46.6	K	0.0025	0.0026
NiO	0.312	0.317	Si	0.0022	0.0148
K_2O	0.042	0.007	Na	30.8	30.5
SiO_2	41.1	39.4	CO_2	27.1	26.9
Na_2O	0.077	0.125	HCO_3	33.8	34.2
CO_2	0.00	4.67			
C, noncarbonate	0.010	0.000	pH	7.88	7.90
H_2O, dehyd.[1]	0.000	0.000			
H_2O, chem.[2]	0.190	0.280			
Total	99.289	98.907			
LOI, total[3]	0.20	5.0			
Extent of carbonation, %[4]		8.3			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 °C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 °C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Appendix F: Feed and Product Chemistry

Carbonation test SC-627 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	0.162	0.120	Cl	37.5	36.3
CaO	0.161	0.180	Cr	<0.0005	<0.0005
Cr_2O_3	0.174	0.136	Fe	0.0002	0.0005
FeO	8.07	6.68	Mg	0.0006	0.0440
Fe_2O_3	<0.01	<0.01	Ni	<0.0005	<0.0005
MgO	49.7	39.0	K	0.0025	0.0032
NiO	0.325	0.247	Si	0.0022	0.0177
K_2O	0.011	0.009	Na	30.8	30.3
SiO_2	40.9	32.5	CO_2	27.1	25.9
Na_2O	0.078	0.274	HCO_3	33.8	32.6
CO_2	0.12	20.0			
C, noncarbonate	0.000	0.052	pH	7.88	7.97
H_2O, dehyd.[1]	0.200	0.270			
H_2O, chem.[2]	0.530	0.778			
Total	100.429	100.225			
LOI, total[3]	0.85	21.1			
Extent of carbonation, %[4]		41.9			

Carbonation test SC-628 **Gabro**

	Solids Analysis, wt%			Solution Analysis, g/L	
Species	Feed	Product	Species	Initial	Final
Al_2O_3	13.7	13.1	Cl	37.8	37.6
CaO	6.83	6.49	Cr	<0.0005	<0.0005
Cr_2O_3	0.040	0.038	Fe	0.0003	0.0003
FeO	15.18	13.64	Mg	0.0006	0.0069
Fe_2O_3	0.157	1.158	Ni	<0.0005	<0.0005
MgO	7.76	7.20	K	0.0025	0.1430
NiO	0.106	0.099	Si	0.0013	0.0146
K_2O	0.277	0.187	Na	32.4	30.8
SiO_2	43.2	40.0	CO_2	27.3	26.5
Na_2O	2.238	2.467	HCO_3	33.9	32.6
CO_2	0.23	6.97			
C, noncarbonate	0.036	0.058	pH	7.73	7.91
H_2O, dehyd.[1]	0.140	0.390			
H_2O, chem.[2]	1.524	1.492			
Total	91.467	93.264			
LOI, total[3]	1.93	8.9			
Extent of carbonation, %[4]		31.6			

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105 ^{o}C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000 ^{o}C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$,

$CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

Table G1. Solids and solution chemistry for test SC-80.

Carbonation test #SC80 **CH serp.**

	Solids Analysis, wt%			Solution Analysis, g/L	
	Feed	Product			
wt, g	167	231.1			
Species			Species	Initial	Final
Al_2O_3	0.188	0.221	Cl	37.1	36.4
CaO	0.095	0.235	Cr	na	na
Cl	<0.010	0.016	Fe	0.0010	0.0013
Cr_2O_3	na	na	Mg	0.0011	0.019
FeO	3.25	2.29	Ni	na	na
Fe_2O_3	4.60	3.26	K	0.0010	0.0018
MgO	47.6	33.0	Si	0.0015	0.0244
NiO	na	na	Na	34.2	32.2
K_2O	0.007	0.007	CO_2	22.7	23.7
SiO_2	40.9	29.5	HCO_3	23.5	32.6
Na_2O	0.009	0.535			
CO_2	0.270	27.3	pH	7.79	8.01
C, noncarbonate	0.019	0.049			
H_2O, dehyd.[1]	0.65	0.75			
H_2O, chem.[2]	3.5	1.6			
Total	101.035	98.782	Vol., liters	0.900	0.720
LOI, total[3]	4.4	29.7			
Extent of carbonation, %[4,5]		68.9		67.0	

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105° C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

[5] Extent of carbonation (yellow shade) corrected for CO_2 in product solids originating from solution.

Table G2. Mass and elemental balance for test SC-80.

	Feed solids		Feed solution		Feed slurry	Solids			Solution			Closure
wt, g		167		84.604			231.1			66.489		
wt, pct		100										
Element	wt, pct	wt, g			wt, g	wt, pct	wt, g	dist., pct	wt, pct	wt, g	dist., pct	
Al	0.099	0.166			0.166	0.117	0.270	162.9			0.0	162.9
Ca	0.068	0.113			0.113	0.168	0.388	342.9			0.0	342.9
Cl	<0.010	0.000	39.466	33.390	33.390	0.016	0.037	0.1	39.417	26.208	78.5	78.6
Cr	na				0.000							0.0
Fe_{Total}	5.750	9.603	0.001	0.001	9.603	4.060	9.383	97.7	0.001	0.001	0.0	97.7
Mg	28.700	47.929	0.001	0.001	47.930	19.900	45.989	96.0	0.021	0.014	0.0	96.0
Ni	na				0.000							0.0
Oxygen	46.574	77.779			77.779	41.991	97.041	124.8			0.0	124.8
K	0.006	0.010	0.001	0.001	0.011	0.006	0.014	129.0	0.002	0.001	12.1	141.0
Si	19.100	31.897	0.002	0.001	31.898	13.800	31.892	100.0	0.026	0.018	0.1	100.0
Na	0.007	0.011	36.381	30.780	30.791	0.397	0.917	3.0	34.869	23.184	75.3	78.3
CO_2	0.270	0.451	24.148	20.430	20.881	27.300	63.090	302.1	25.664	17.064	81.7	383.9
C					0.000							0.0
H_2O, dehyd.[1]	0.650	1.086			1.086	0.750	1.733	159.7			0.0	159.7
H_2O, chem.[2]	4.430	7.398			7.398	1.601	3.699	50.0			0.0	50.0
Total		176.442		84.604	261.046		254.454			66.489		

Element	wt gain, g	moles
Cl	0.037	0.001
Na	0.906	0.039
CO_2	62.639	1.424

Species	moles	wt, g	wt, pct
Na as: $NaCl_2$	0.001	0.024	0.010
Na as: Na_2CO_3	0.038	0.882	0.382
Total Na	0.039	0.906	0.392
CO_2 as: Ca, Fe, Mg carbonate	1.404	61.795	26.740

$Na + 2Cl = NaCl_2$

$2Na + 0.5O_2 + CO_2 = Na_2CO_3$

Table G3. Solids and solution chemistry for test SC-92.

Carbonation test #SC92 **CH serp.**

	Solids Analysis, wt%			Solution Analysis, g/L	
	Feed	Product			
wt, g	167	191.6			
Species			Species	Initial	Final
Al_2O_3	0.188	0.147	Cl	36.4	36.5
CaO	0.095	0.062	Cr	na	na
Cl	<0.010	0.270	Fe	0.0020	0.0020
Cr_2O_3	na	na	Mg	0.0011	0.025
FeO	3.25	2.740	Ni	na	na
Fe_2O_3	4.60	4.861	K	0.0010	0.0010
MgO	47.6	39.0	Si	0.0010	0.0190
NiO	na	na	Na	33.9	33.4
K_2O	0.007	0.004	CO_2	26.2	24.8
SiO_2	40.9	34.9	HCO_3	36.9	32.3
Na_2O	0.009	0.717			
CO_2	0.270	11.5	pH	7.76	8.00
C, noncarbonate	0.019	0.051			
H_2O, dehyd.[1]	0.65	1.41			
H_2O, chem.[2]	3.5	4.1			
Total	101.035	99.737	Vol., liters	0.900	0.740
LOI, total[3]	4.4	17.1			
Extent of carbonation, %[4,5]		23.5		22.2	

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105° C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

[5] Extent of carbonation (yellow shade) corrected for CO_2 in product solids originating from solution.

Table G4. Mass and elemental balance for test SC-92.

	Feed solids		Feed solution		Feed slurry	Solids			Solution			Closure
wt, g		167.0		86.9			191.6			71.1		
wt, pct		100										
Element	wt, pct	wt, g	wt, pct	wt, g	wt, g	wt, pct	wt, g	dist., pct	wt, pct	wt, g	dist., pct	
Al	0.099	0.166			0.166	0.078	0.149	90.0			0.0	90.0
Ca	0.068	0.113			0.113	0.044	0.084	74.5			0.0	74.5
Cl	<0.010	0.000	37.718	32.760	32.760	0.27	0.517	1.6	38.524	27.375	83.6	85.1
Cr	na				0.000							0.0
Fe_{Total}	5.750	9.603	0.002	0.002	9.604	5.530	10.595	110.3	0.002	0.002	0.0	110.3
Mg	28.700	47.929	0.001	0.001	47.930	23.500	45.026	93.9	0.026	0.019	0.0	94.0
Ni	na				0.000							0.0
Oxygen	46.574	77.779			77.779	45.097	86.406	111.1			0.0	111.1
K	0.006	0.010	0.001	0.001	0.011	0.003	0.006	53.5	0.001	0.001	7.0	60.4
Si	19.100	31.897	0.001	0.001	31.898	16.300	31.231	97.9	0.020	0.014	0.0	98.0
Na	0.007	0.011	35.128	30.510	30.521	0.532	1.019	3.3	35.252	25.050	82.1	85.4
CO_2	0.270	0.451	27.149	23.580	24.031	11.500	22.034	91.7	26.175	18.600	77.4	169.1
C					0.000							0.0
H_2O, dehyd.[1]	0.650	1.086			1.086	1.410	2.702	248.9			0.0	248.9
H_2O, chem.[2]	4.430	7.398			7.398	4.139	7.929	107.2			0.0	107.2
Total		176.442		86.855	263.297		207.699			71.060		

Element	wt gain, g	moles
Cl	0.517	0.015
Na	1.008	0.044
CO_2	21.583	0.491

Species	moles	wt, g	wt, pct
Na as: $NaCl_2$	0.015	0.335	0.175
Na as: Na_2CO_3	0.029	0.672	0.351
Total Na	0.044	1.008	0.526
CO_2 as: Ca, Fe, Mg carbonate	0.476	20.940	10.929

$Na + 2Cl = NaCl_2$

$2Na + 0.5O_2 + CO_2 = Na_2CO_3$

Table G5. Solids and solution chemistry for test SC-169.

Carbonation test #SC169 **SW OR Liz**

	Solids Analysis, wt%			Solution Analysis, g/L	
	Feed	Product			
wt, g	167	206.8			
Species			Species	Initial	Final
Al_2O_3	1.729	1.553	Cl	35.4	35.6
CaO	0.486	0.381	Cr	<0.0005	0.0520
Cl	<0.010	0.016	Fe	0.0011	0.0011
Cr_2O_3	0.162	0.161	Mg	0.0011	0.069
FeO	0.00	0.206	Ni	<0.0005	<0.0005
Fe_2O_3	9.18	5.562	K	0.0006	0.0018
MgO	42.8	33.5	Si	0.0008	0.0210
NiO	0.249	0.202	Na	28.2	30.0
K_2O	0.027	0.018	CO_2	27.7	23.0
SiO_2	43.4	33.4	HCO_3	36.4	31.1
Na_2O	0.019	1.134			
CO_2	0.120	15.5	pH	7.68	7.76
C, noncarbonate	0.033	0.000			
H_2O, dehyd.[1]	0.58	2.93			
H_2O, chem.[2]	3.4	5.3			
Total	102.237	99.799	Vol., liters	0.900	0.720
LOI, total[3]	4.2	23.7			
Extent of carbonation, %[4,5]		38.7	36.1		

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105° C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

[5] Extent of carbonation (yellow shade) corrected for CO_2 in product solids originating from solution.

Table G6. Mass and elemental balance for test SC-169.

	Feed solids		Feed solution		Feed slurry	Solids			Solution			Closure
wt, g		167		82.173			206.8			63.859		
wt, pct		100										
Element	wt, pct	wt, g	wt, pct	wt, g	wt, g	wt, pct	wt, g	dist., pct	wt, pct	wt, g	dist., pct	
Al	0.915	1.528			1.528	0.822	1.700	111.2				111.2
Ca	0.347	0.579			0.579	0.272	0.562	97.1				97.1
Cl	<0.010	0.000	38.772	31.860	31.860	0.016	0.033	0.1	40.138	25.632	80.5	80.6
Cr	0.111	0.185	0.000	0.000	0.185	0.11	0.227	122.7	0.059	0.037	20.2	142.9
Fe_{Total}	6.420	10.721	0.001	0.001	10.722	4.050	8.375	78.1	0.001	0.001	0.0	78.1
Mg	25.800	43.086	0.001	0.001	43.087	20.200	41.774	97.0	0.078	0.050	0.1	97.1
Ni	0.196		0.000		0.000				0.000			0.0
Oxygen	47.485	79.300			79.300	46.438	96.034	121.1				121.1
K	0.023	0.038	0.001	0.001	0.038	0.015	0.031	82.5	0.002	0.001	3.4	85.9
Si	20.300	33.901	0.001	0.001	33.902	15.600	32.261	95.2	0.024	0.015	0.0	95.2
Na	0.014	0.023	30.886	25.380	25.403	0.841	1.739	6.8	33.825	21.600	85.0	91.9
CO_2	0.120	0.200	30.338	24.930	25.130	15.500	32.054	127.6	25.932	16.560	65.9	193.4
C					0.000							0.0
H_2O, dehyd.[1]	0.580	0.969			0.969	2.930	6.059	625.6				625.6
H_2O, chem.[2]	4.180	6.981			6.981	5.270	10.898	156.1				156.1
Total		177.511		82.173	259.684		231.749			63.896		

Element	wt gain, g	moles
Cl	0.033	0.001
Na	1.716	0.075
CO_2	31.854	0.724

Species	moles	wt, g	wt, pct
Na as: $NaCl_2$	0.001	0.021	0.010
Na as: Na_2CO_3	0.074	1.695	0.819
Total Na	0.075	1.716	0.830
CO_2 as: Ca, Fe, Mg carbonate	0.687	30.232	14.619

$Na + 2Cl = NaCl_2$

$2Na + 0.5O_2 + CO_2 = Na_2CO_3$

Table G7. Solids and solution chemistry for test SC-387.

Carbonation test #SC387 **TS Olivine**

	Solids Analysis, wt%			Solution Analysis, g/L	
	Feed	Product			
wt, g	167	230.4			
Species			Species	Initial	Final
Al_2O_3	0.145	0.126	Cl	36.5	37.3
CaO	0.064	0.114	Cr	<0.0005	<0.0005
Cl	<0.010	0.015	Fe	0.0004	0.0006
Cr_2O_3	0.055	0.048	Mg	0.0006	0.022
FeO	7.86	5.480	Ni	<0.0005	<0.0005
Fe_2O_3	0.00	0.014	K	0.0023	0.0048
MgO	48.4	35.6	Si	0.0057	0.0358
NiO	0.308	0.216	Na	32.0	31.0
K_2O	0.004	0.006	CO_2	26.5	26.3
SiO_2	40.4	28.5	HCO_3	31.9	32.3
Na_2O	0.018	0.182			
CO_2	0.000	28.0	pH	7.87	7.97
C, noncarbonate	0.030	0.238			
H_2O, dehyd.[1]	0.13	0.19			
H_2O, chem.[2]	0.8	0.7			
Total	98.273	99.404	Vol., liters	0.900	0.710
LOI, total[3]	1.0	29.1			
Extent of carbonation, %[4,5]		67.4	67.0		

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105° C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

[5] Extent of carbonation (yellow shade) corrected for CO_2 in product solids originating from solution.

Table G8. Mass and elemental balance for test SC-387.

	Feed solids		Feed solution		Feed slurry	Solids			Solution			Closure
wt, g		167		85.508			230.4			67.211		
wt, pct		100										
Element	wt, pct	wt, g	wt, pct	wt, g	wt, g	wt, pct	wt, g	dist., pct	wt, pct	wt, g	dist., pct	
Al	0.077	0.128			0.128	0.067	0.154	120.2				120.2
Ca	0.046	0.077			0.077	0.082	0.188	245.0				245.0
Cl	<0.010	0.000	38.417	32.850	32.850	0.015	0.035	0.1	39.403	26.483	80.6	80.7
Cr	0.038	0.063	0.000	0.000	0.063	0.0329	0.076	120.7	0.000	0.000	0.0	120.7
Fe_{Total}	6.110	10.204	0.000	0.000	10.204	4.270	9.838	96.4	0.001	0.000	0.0	96.4
Mg	29.200	48.764	0.001	0.001	48.765	21.500	49.536	101.6	0.023	0.016	0.0	101.6
Ni	0.242		0.000		0.000				0.000			0.0
Oxygen	43.492	72.632			72.632	41.058	94.598	130.2				130.2
K	0.004	0.006	0.002	0.002	0.008	0.005	0.012	142.5	0.005	0.003	42.2	184.7
Si	18.900	31.563	0.006	0.005	31.568	13.300	30.643	97.1	0.038	0.025	0.1	97.2
Na	0.013	0.022	33.681	28.800	28.822	0.135	0.311	1.1	32.748	22.010	76.4	77.4
CO_2	0.000	0.000	27.892	23.850	23.850	28.000	64.512	270.5	27.783	18.673	78.3	348.8
C					0.000							0.0
H_2O, dehyd.[1]	0.130	0.217			0.217	0.190	0.438	201.6				201.6
H_2O, chem.[2]	0.970	1.620			1.620	0.672	1.548	95.5				95.5
Total		165.295		85.508	250.804		251.887			67.211		

Element	wt gain, g	moles
Cl	0.035	0.001
Na	0.289	0.013
CO_2	64.512	1.466

Species	moles	wt, g	wt, pct
Na as: $NaCl_2$	0.001	0.022	0.010
Na as: Na_2CO_3	0.012	0.267	0.116
Total Na	0.013	0.289	0.126
CO_2 as: Ca, Fe, Mg carbonate	1.460	64.257	27.889

$Na + 2Cl = NaCl_2$

$2Na + 0.5O_2 + CO_2 = Na_2CO_3$

Table G9. Solids and solution chemistry for test SC-564.

Carbonation test #SC564 **Wollastonite**

	Solids Analysis, wt%			Solution Analysis, g/L	
	Feed	Product			
wt, g	167	185.8			
Species			Species	Initial	Final
Al_2O_3	0.487	0.440	Cl	0.0	0.8
CaO	44.634	40.017	Cr	<0.0005	<0.0005
Cl	<0.010	<0.010	Fe	0.0004	<0.0001
Cr_2O_3	0.009	0.010	Mg	0.0006	0.005
FeO	0.81	0.823	Ni	<0.0005	<0.0005
Fe_2O_3	0.00	0.000	K	<0.0001	0.0023
MgO	0.2	0.3	Si	<0.0001	0.2260
NiO	0.000	0.003	Na	0.0	0.5
K_2O	0.026	0.022	CO_2	<0.0001	0.6
SiO_2	50.1	44.5	HCO_3	<0.0001	0.9
Na_2O	0.126	0.123			
CO_2	0.410	10.9	pH	5.80	6.93
C, noncarbonate	0.003	0.045			
H_2O, dehyd.[1]	0.00	0.64			
H_2O, chem.[2]	0.0	0.8			
Total	96.761	98.631	Vol., liters	0.900	0.840
LOI, total[3]	0.3	12.4			
Extent of carbonation, %[4,5]		33.2		31.9	

[1] Water of dehydration (free moisture), measured as weight loss after heating for 1 hour at 105° C in air.

[2] Chemically-bonded (interstitial) water, measured as the difference between the LOI and all other volatiles.

[3] Loss on Ignition, measured as weight loss after heating for 1 hour at 1,000° C in argon.

[4] Carbonation based on the stoichiometry of the following reactions: $MgO + CO_2 = MgCO_3$, $CaO + CO_2 = CaCO_3$, $FeO + CO_2 = FeCO_3$

[5] Extent of carbonation (yellow shade) corrected for CO_2 in product solids originating from solution.

Table G10. Mass and elemental balance for test SC-564.

	Feed solids		Feed solution		Feed slurry	Solids			Solution			Closure
wt, g		167		0.005			185.8			1.794		
wt, pct		100										
Element	wt, pct	wt, g	wt, pct	wt, g	wt, g	wt, pct	wt, g	dist., pct	wt, pct	wt, g	dist., pct	
Al	0.258	0.431			0.431	0.233	0.433	100.5				100.5
Ca	31.900	53.273			53.273	28.600	53.139	99.7				99.7
Cl	<0.010	0.000	74.510	0.003	0.003	<0.010	0.000	0.0	37.223	0.668	19526.3	19526.3
Cr	0.006	0.010	0.000	0.000	0.010	0.0068	0.013	122.0	0.000	0.000	0.0	122.0
Fe_{Total}	0.630	1.052	7.843	0.000	1.052	0.640	1.189	113.0	0.000	0.000	0.0	113.0
Mg	0.117	0.195	11.765	0.001	0.196	0.178	0.331	168.8	0.211	0.004	1.9	170.7
Ni	0.000		0.000		0.000				0.000			0.0
Oxygen	40.073	66.922			66.922	40.621	75.473	112.8				112.8
K	0.022	0.036	0.000	0.000	0.036	0.019	0.034	94.9	0.108	0.002	5.3	100.2
Si	23.400	39.078	0.000	0.000	39.078	20.800	38.646	98.9	10.582	0.190	0.5	99.4
Na	0.093	0.156	5.882	0.000	0.156	0.091	0.169	108.4	23.785	0.427	273.1	381.6
CO_2	0.410	0.685	0.000	0.000	0.685	10.900	20.252	2957.8	28.093	0.504	73.6	3031.4
C					0.000							0.0
H_2O, dehyd.[1]	0.000	0.000			0.000	0.640	1.189					0.0
H_2O, chem.[2]	0.310	0.518			0.518	0.815	1.514	292.4				292.4
Total		162.357		0.005	162.361		192.383			1.794		

Element	wt gain, g	moles
Cl	0.000	0.000
Na	0.013	0.001
CO_2	19.568	0.445

Species	moles	wt, g	wt, pct
Na as: $NaCl_2$	0.000	0.000	0.000
Na as: Na_2CO_3	0.001	0.013	0.007
Total Na	0.001	0.013	0.007
CO_2 as: Ca, Fe, Mg carbonate	0.444	19.555	10.525

$Na + 2Cl = NaCl_2$

$2Na + 0.5O_2 + CO_2 = Na_2CO_3$