RECLAMATION

Managing Water in the West

Technical Memorandum 86-6829009

Seepage Chemistry at Yellowtail Dam - A Geochemical Evaluation of Reservoir and Seepage Water and a Bacterial Residue Collected at Yellowtail Dam, Pick-Sloan Missouri Basin Project, Montana

U.S. Department of the Interior
Bureau of Reclamation
Dam Safety Office and Technical Service Center, Denver, Colorado

July 2006

MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Technical Memorandum 86-6829009

Seepage Chemistry at Yellowtail Dam - A Geochemical Evaluation of Reservoir and Seepage Water and a Bacterial Residue Collected at Yellowtail Dam, Pick-Sloan Missouri Basin Project, Montana

Dam Safety Office and Technical Service Center

Doug Craft

U.S. Department of the Interior
Bureau of Reclamation
Dam Safety Office and Technical Service Center
Denver, Colorado

July 2006

Introduction

During 2005, a brown slimey deposit was observed collecting at some of the drain outfalls in the Foundation Gallery at Yellowtail Dam, Montana. These drains intercept foundation seepage moving through collapsed breccia layers in the Madison formation limestone (Jepsen and Witherspoon, 1948), so there is an interest in establishing whether mineral dissolution or erosion is occurring along these seepage flow paths.

Samples of the slimey deposit were collected in November 2005, and the material was tested and evaluated by Doug Hurcomb, geologist, 86-68340, (Hurcomb, 2006). Hurcomb concluded that the material was bacterial, likely composed of several species of iron bacteria with minor amounts of sediment particles entrained in the biological matrix. Water samples were also collected by Jeff Lucero, GP-4500, Great Plains Regional Office, Billings Montana, in November 2005, and were analyzed by Basic Laboratory, Redding, California. A full laboratory quality control (QC) report was provided with each set of chemical analysis results, and Lucero provided an assessment of the data by email on February 10, 2006. In this email, he suggested that the residue was dominantly composed of iron bacteria.

Jay Stateler, Structural Behavior and Instrumentation Group, 86-68460, summarized the drainage flows, piezometric pressure and uplift pressure measurements following the relatively rapid rise in reservoir surface elevation during the summer of 2005 (Stateler, 2006). Some unexpectedly high flows in drains on the right abutment near Block 20, and on the left abutment near Block 7 were noted in his quarterly instrumentation data feedback email of April 27, 2006. Piezometer well level increases were noted in wells R-7, R-8, and R-28, along with elevated foundation pressure gage readings in Blocks 12, 15, and 18. These well levels, flows, and pressures were associated with rapid filling of the Bighorn Lake during the 2005 spring runoff after a period of low reservoir surface elevations.

In June 2006, I was asked by Dan Mares, 86-68130, to evaluate and summarize the available seepage chemistry and petrographic data with respect to geochemical processes that may be occurring along the seepage flow path at Yellowtail Dam. I was also asked to compare the November 2005 samples with chemistry data from seepage and reservoir water collected in May 1989 from Bighorn Lake and downstream seeps at Yellowtail Dam.

Chemistry Data Quality Evaluation

Evaluation of the QC reports from Basic Laboratory for the November 2005 Reservoir and Foundation Gallery samples revealed fully acceptable precision and accuracy check results for the chemical tests. No blind duplicate or check samples were submitted with the samples; however, Basic Laboratory is part of the Mid-Pacific Region Water Quality Branch's lab contracting and auditing program. Table 1 summarizes some independent checks of the November water quality results. Ion balance percentages suggest that the overall analysis results are acceptable; however, a comparison of calculated and measured TDS (total dissolved solids) suggests that the reported TDS for the Foundation Gallery sample is significantly biased low.

The reservoir sample was analyzed within recommended holding times. However, holding times were exceeded by 30 days for alkalinity and pH, and 16 days for other tests for the Foundation Gallery sample. Given that the formation of bacterial residues strongly implies that microbes have altered the chemistry of the seepage, the absence of field pH values and exceeded holding times are a data quality issue with respect to geochemical interpretation.

Bacterial metabolism and respiration processes that occur during subsurface seepage transit below the dam cause the stepwise lowering of oxidation-reduction potential. These changes will cause changes in chemical concentrations: depletion of dissolved oxygen, a decrease in pH, an increase in bicarbonate, and the chemical reduction of nitrate, iron and manganese oxyhydrates, and sulfate. The chemical reducing conditions developed during seepage transit are changed rapidly to oxidizing conditions once the seepage emerges in the drain and contacts atmospheric oxygen. The exposure to oxygen causes rapid changes in redox potential, pH, and may lead to precipitation of iron, manganese, calcite, and a decrease in calcium and bicarbonate concentrations in the seepage water.

Table 1 - Results of some basic checks on the overall quality of the major ions data analyzed by Basic Laboratory, Redding, California.

Sum of Cations meq/L	**Sum of Anions** meq/L	**Ion Balance** Percentage	**Calculated** TDS, mg/L	**TDS:SUM** ratio	**Sample**
10.5	11.4	- 3.93	802	0.60	Foundation Gallery
11.0	10.6	+1.52	761	0.94	Reservoir

Assessment of the November 2005 Sample Water Chemistry

The samples collected during November 2005 are representative of a low reservoir elevation hydraulic head. Under a lower head, seepage will flow more slowly along available flow paths, and bacterial processes will have more time to develop and change the seepage chemistry. The slower flows also imply that the emerging seepage may have initially entered the flow path some time well before the November reservoir samples were collected. Time-lagged flow of seepage means that the November reservoir water may not be representative of a different (likely, a lower concentration) chemistry from earlier in the season. This possible influence along with the observed similarity in concentrations between reservoir and seepage complicates the geochemical comparison of chemistry data.

Table 2 summarizes the measured concentrations for the November 2005 reservoir and Drainage Gallery (seepage) water samples. Figure 1 shows Stiff diagrams that plot these data, providing a visual image of the major ions water chemistry for both the November 2005 and the May 1989 seepage samples. Dissolved organic carbon, a bacterial food source, was also found in both reservoir (3.7 mg/L) and seepage water (3.4 mg/L). Silica, as SiO_2 was also observed in reservoir (10.7 mg/L) and Foundation Gallery seepage (10.7 mg/L).

Figure 1 - Stiff diagrams showing the major ions chemistry for samples collected from Yellowtail Dam seeps and the reservoir, Bighorn Lake. Plotted concentrations are in milliequivalents per liter (meq/L). The top blue polygons are from high reservoir elevation samples collected in May of 1989. The bottom 2 yellow polygons are from the November 2005 sampling event.

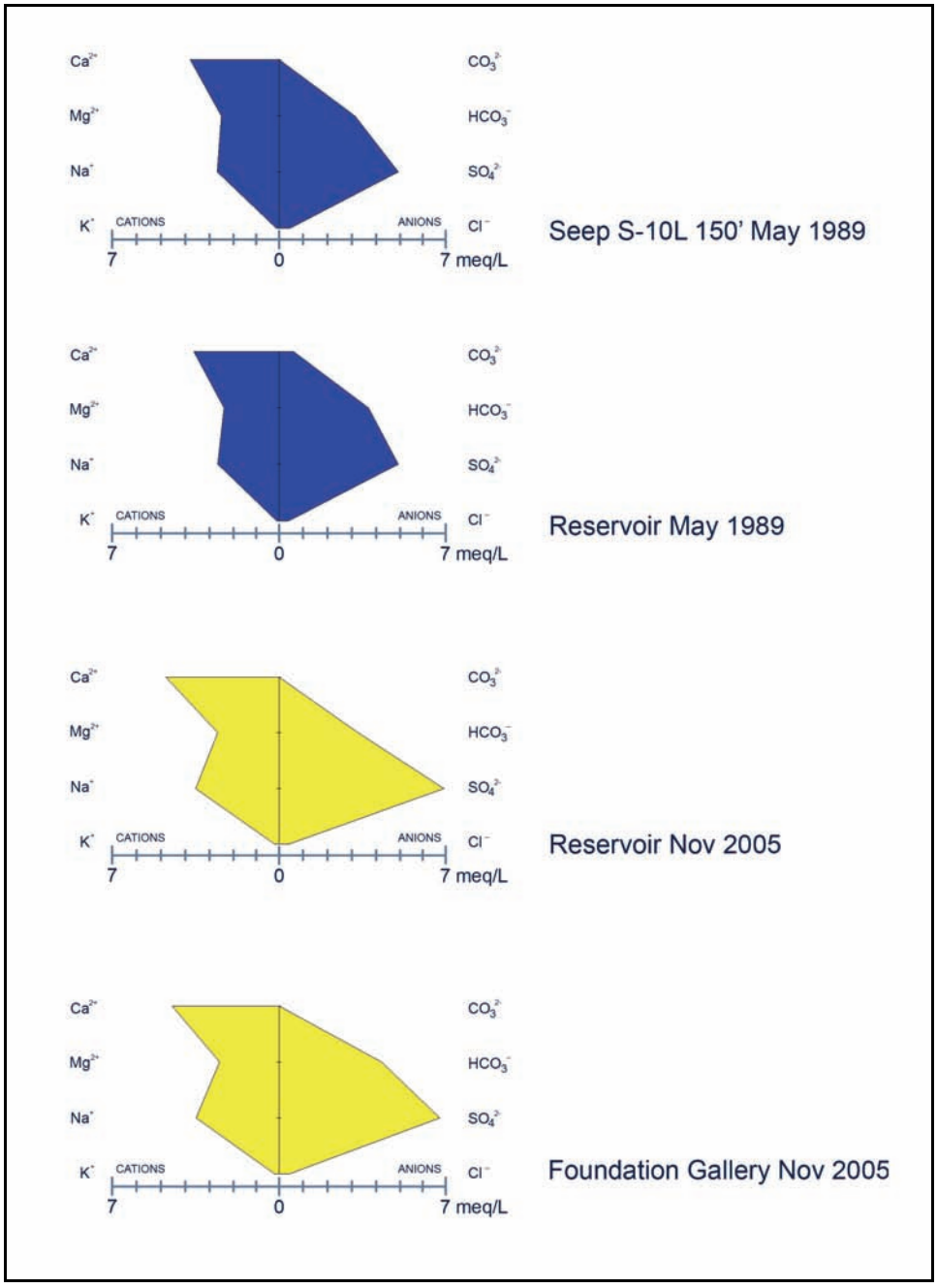

Table 2 - Major ions data for Reservoir and Foundation Gallery seepage water samples collected from Yellowtail Dam on November 23, 2005.

Station	Lab pH, standard units	Dissolved Solids, mg/L	Ca^{2+} Calcium, mg/L	Mg^{2+} Magnesium, mg/L	Na^{+} Sodium, mg/L	K^{+} Potassium, mg/L	HCO_3^{-} Bicarbonate, mg/L	SO_4^{2-} Sulfate, mg/L	Cl^{-} Chloride, mg/L
Reservoir	7.90	718	95.0	31.0	80.0	7.00	202	331	14.9
Foundation Gallery	8.13	478	89.0	30.0	79.0	7.00	260	321	15.7

Table 3 shows the difference data calculated for the November 2005 samples. Here, reservoir concentrations were subtracted from seepage concentrations.

Table 3 - Changes in major ions concentrations observed between the reservoir sample and the Foundation Drain seepage water. Negative values represent a decrease from reservoir to drain. Positive values represent an increase in concentration from reservoir to drain.

Ca^{2+} Calcium mg/L	Mg^{2+} Magnesium mg/L	Na^{+} Sodium mg/L	K^{+} Potassium mg/L	HCO_3^{-} Bicarbonate mg/L	SO_4^{2-} Sulfate mg/L	Cl^{-} Chloride mg/L
-6.00	-1.00	-1.00	0.00	58.0	-10.0	0.800

Tables 2 and 3 show that the Reservoir and Foundation Gallery waters both have similar concentrations. However, several constituent concentrations are greater than statistical measurement or sampling error. Notably, we see statistically significant *decreases* of 6 mg/L for calcium, and 10 mg/L for sulfate. We also see an significant *increase* for bicarbonate of 58.0 mg/L. The increased bicarbonate may be caused by bacterial processes during seepage transit, but exceeded sample holding times and the difference in elevation between the sampling location and the lab in Redding, California, may have also contributed to this increase.

There are two possible causes for the observed decreases in calcium and sulfate concentrations: anaerobic bacterial processes, and/or delayed seepage of lower concentration water from earlier in the season. The loss of sulfate (and the presence of dissolved organic carbon) suggest that bacterial activity in seepage had proceeded sufficiently to cause chemical reduction of sulfate to sulfide. The loss of sulfate concentration may be caused by out gassing of hydrogen sulfide gas (H_2S) on emergence from underground flow and before oxidation from exposure to the atmosphere. The loss of calcium may be caused by precipitation of calcite when the water chemistry changes on emergence and oxidation, or by delayed flow of lower concentration water.

MINTEQA2 Mineral Saturation Indices for the 2005 Samples

The MINTEQA2 model calculates the equilibrium distribution of the different chemical species that will form in a given water, and the saturation indices for minerals that may account for the observed concentrations. The saturation index is a measure of whether a

given mineral is undersaturated (negative saturation indices), near equilibrium with the mineral (saturation indices near zero), or oversaturated (positive saturation indices). Negative saturation indices suggest that the water will dissolve the mineral, while positive indices suggest that the mineral will not dissolve in the water and will eventually precipitate out of solution. Table 4 summarizes saturation indices calculated for the November 2005 samples, and the attached appendix provides the output from the MINTEQA2 model runs for reservoir and seepage water.

Table 4 - Mineral saturation indices for soluble minerals present in the foundation geology at Yellowtail Dam.

Mineral	***Reservoir***	***Foundation Gallery***
Calcite	-1.44	-1.01
Dolomite	-3.28	-2.40
Magnesite	-2.32	-1.87
Anhydrite	-1.17	-1.20
Gypsum	-0.800	-0.832

The saturation indices suggest that the Reservoir water will dissolve carbonate-containing minerals calcite, dolomite, and magnesite. Also, despite the decrease in calcium in the Foundation Gallery seepage, the less negative saturation indices suggest some dissolution of these minerals during transit. The reservoir water is also capable of dissolving sulfate-containing minerals like anhydrite and gypsum. Because the field pH was not measured and recommended holding times for the Foundation Gallery sample were exceeded, these conclusions must remain tentative. Future seepage samples should be collected as close to the emergence point as possible and field pH and temperature should be measured *in situ*.

Comparing the November 2005 and May 1989 Seepage Chemistry

The figure 1 Stiff diagrams for the May 1989 (Craft, 1989) samples allow a general comparison to the more recent samples. The more recent samples (lower yellow diagrams) are generally larger and higher in concentration compared to the May 1989 samples (upper blue diagrams) - most likely caused by the time of sampling during the annual hydrologic cycle. Samples in the fall would be expected to be higher in concentration compared to spring samples when snowmelt volume dilutes runoff.

The other significant observation is that the reservoir and seepage chemistry are very similar (note the similarity in shape and size of diagrams) for both 1989 and 2005 sets of data. These results suggest that fairly direct flowpaths exist between reservoir and seeps near the dam, and that seepage residence time is not long (on the order of many months or years).

Note that the Stiff diagrams and observed chemistry changes cannot be used to suggest a increasing or progressive seepage problem. The primary reason is that chemistry can

indicate if a water will dissolve calcite, or that some changes are *not* caused by mineral dissolution, but it cannot directly quantify a worsening seepage condition. This is especially true when we are not comparing data from the same seepage path over time so that gradual changes in chemistry can be quantified, and when flow-weighted masses cannot be evaluated. Seepage chemistry, however, can corroborate the direct physical assessment of a worsening seepage condition based on measurement of foundation pressures, seepage flows, and piezometer levels. Comments on the Petrographic Examination of the Foundation Gallery Deposits

The technical memorandum by Hurcomb (2006), concluded that the Foundation Gallery deposit material was bacterial in origin. The overall analysis of the material revealed the following data:

Wet Weight:	90.13 percent H_2O 0.58 percent organic materials (loss on ignition) 9.29 percent inorganic ash
Dry Weight:	94.6 percent inorganic ash 5.45 percent organic material

While I agree with the conclusion that iron bacteria are the cause of the Foundation Gallery deposits, I am concerned about the quantity of ash or insoluble materials in the deposits. Table 5 provides a summary of these results per unit volumes that assumes a bacterial deposit density of around 1 g/mL.

Table 5 - Quantities for estimating possible sediment transport in the observed bacterial deposits at Yellowtail Dam foundation gallery.

Substance	Quantity Per Liter	Quantity per Cubic Foot
Water	901.3 g/L	25.52 kg/ft^3
Organic Material	5.80 g/L	0.164 kg/ft^3
Dissolved Solids	0.80 g/L	0.023 kg/ft^3
Suspended Sediments	92.1 g/L	2.608 kg/ft^3

Table 5 corrects the reported inorganic ash content to account for evaporated solids from the seepage water chemical constituents (around 800 mg/L). These results still show that each liter of bacterial deposit will contain around 90 g of insoluble inorganic materials per liter, and 2.6 kg per cubic foot of material. If an estimate of the deposit volume can be made, these numbers can be used to estimate the quantity of insoluble materials deposited in the gallery.

The available data do not definitively identify the insoluble inorganic materials (most of the material from the deposit was amorphous to X-Ray diffraction), however, it appears that iron is a prominent crystalline component. It may be advisable to collect additional

bacterial deposits if deposition rates increase in the Foundation Galleries. An experienced microbiologist should also be consulted regarding whether iron bacteria can assimilate the apparently large amount (9.3 percent, wet-weight basis) of inorganic ash material into cell bodies and polysaccharide coatings.

The purpose of this future sampling would be to separate a large enough solid sample to determine whether materials from the breccia layers near the foundation are being removed along flow paths and "filtered" in the bacterial deposits at the seepage outfall. Rather than burning the material (as was performed to estimate organic matter), I suggest that a more gentle breakdown and removal of biological matrix using a sodium hypochlorite (clorox) solution, followed by wet sieving to remove and characterize particulates embedded in the bacterial deposits.

Conclusions and Recommendations

1. The most recent chemistry data are of limited geochemical interpretative value because of the lack of field pH measurements and exceeded sample holding times coupled with similarity in reservoir and seepage concentrations. However, the observed minor differences in concentrations appear to be consistent with bacterial processes known to be active along the foundation seepage flow paths.

2. The existing reservoir and seepage chemistry data from both spring 1989 and fall 2005 samples suggest that the reservoir and local seepage water will dissolve calcite, dolomite, gypsum, anhydrite, and other carbonate- and sulfate-containing minerals along seepage flow paths. However, the similarity between reservoir and seepage concentrations suggests that existing seepage flow paths are mature, and that most of the readily available soluble minerals have already been removed.

   While the available chemistry data are insufficient to definitively indicate that seepage flows are increasing, seepage flow paths containing calcite, such as the Madison limestone near the foundation, may slowly enlarge and seepage flows can be expected to increase with the same reservoir elevation over periods of time on the order of decades.

3. Additional samples for chemistry tests are not recommended unless seepage flows change abruptly, or flows at similar reservoir elevations increase significantly over time. All seepage flows, however, should be monitored regularly, and increases in flow with the same reservoir surface elevation should be investigated. Any future seepage samples should follow procedures outlined in the Dam Safety Office's *Seepage Chemistry Manual* (Craft, 2006) and include *in situ* measurement of pH and temperature by field crews.

4. The formation of the bacterial deposits can be taken as a positive sign that seepage along these paths is flowing slowly enough for anaerobic bacterial processes to occur before seepage emergence - at least under lower reservoir elevations common during autumn. It is also reassuring that nuisance deposits requiring removal operations take several years to accumulate.

   I am cautiously concerned; however, that the high insoluble residue content of the bacterial deposits suggests that solid materials may be getting transported

from flow paths through collapsed breccia in the Madison formation containing adjacent Amsden Formation mudstones (Bureau of Reclamation, 2006; Jepsen and Witherspoon, 1948).

5. If bacterial deposition in the Foundation Galleries increases, additional bacterial samples should be collected for petrographic and chemical analysis. The alternative separation methods and wet sieving should be employed, and any insoluble residue should be digested and analyzed for an elemental scan by Inductively Coupled Plasma Emission Spectroscopy (ICP-ES). If bacterial samples are collected, an experienced microbiologist should be consulted to provide a detailed assessment of the bacterial species present and whether high ash contents are characteristic of these species. The following questions should guide any future investigation of the bacterial deposits:

   Given the rate of bacterial deposition, how much insoluble inorganic material has been removed from flow paths?

   Is this material originating from the breccia layers near the foundation? Do we have or can we get samples of this breccia (perhaps away from the dam) to compare with insoluble materials found in the bacterial deposits?

   Can an alternate separation method, such as oxidation of the bacteria with clorox and then wet sieving separate materials allow a more definitive petrographic identification?

6. The Dam Safety Office should consider installing sediment traps to collect any materials transported by seepage from the Foundation Gallery drains.

References

Bureau of Reclamation, 2006 (in review). *Yellowtail Dam Issue Evaluation - Geology for Foundation Stability Analysis and Block Evaluation - Phase 1*, Technical Memorandum Number YT-8320-01, U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado, and Pick-Sloan Missouri Basin Project, Great Plains Region, Billings, Montana.

Craft, D., 1989. *Chemical Analyses on Bighorn Lake and Downstream Seepage Samples to Evaluate Potential Mineral Dissolution in Abutments at Yellowtail Dam, Pick-Sloan Missouri Basin Project, Yellowtail Unit, Montana,* Applied Sciences Technical Memorandum 89-3-6, U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Applied Sciences Branch, Denver, Colorado.

Craft, D., 2006. *Seepage Chemistry Manual*, Report DSO-05-03, U.S. Department of the Interior, Bureau of Reclamation, Dam Safety Office, Denver, Colorado.

Hurcomb, D., 2006. *Petrographic Examination of Foundation Drain Sample - Yellowtail Dam Yellowtail Unit, Lower Bighorn Division, Pick-Sloan Missouri Basin*

Project, Montana, Technical Memorandum 8340-06-02, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Earth Sciences and Research Laboratory Group, Denver, Colorado.

Jepsen, D.H. and W.E. Witherspoon, 1948. *Memorandum Report, Explorations - Yellowtail Damsite - Hardin Unit, Montana Missouri Basin Project*, U.S. Department of the Interior, Bureau of Reclamation, July 14, 1948.

Stateler, J., 2006. *Yellowtail Dam - Feedback Concerning Dam Safety Monitoring Efforts*, email dated April 27, 2006, U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Structural Behavior and Instrumentation Group, 86-68460, Denver, Colorado.

APPENDIX

MINTEQA2 Output

```
_____________________________ PART 1 of OUTPUT FILE _____________________________
  PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 16-JUN-**  TIME:  9:39: 2

1.  Reservoir Hypolimnion 11-23-05
-------------------------------------------------------------------------------
 Temperature (Celsius):  10.00
 Units of concentration: MG/L
 Ionic strength to be computed.
 If specified, carbonate concentration represents total inorganic carbon.
 Do not automatically terminate if charge imbalance exceeds 30%
 Precipitation is allowed only for those solids specified as ALLOWED
   in the input file (if any).
 The maximum number of iterations is: 100
 The method used to compute activity coefficients is: Davies equation
 Intermediate output file
-------------------------------------------------------------------------------
    330  0.000E-01   -7.90 y
    140  9.934E+01   -2.76 y
      1  0.000E-01  -16.00 y
    150  9.500E+01   -3.58 y
    460  3.100E+01   -3.88 y
    500  8.000E+01   -2.84 y
    410  7.000E+00   -3.04 y
    732  3.310E+02   -3.55 y
    180  1.490E+01   -3.17 y
    281  1.500E-03   -5.63 y
    470  2.320E-02   -6.96 y
     30  5.000E-02   -5.35 y
    770  1.615E+01   -4.03 y

 H2O has been inserted as a COMPONENT
  3   3
3300021   -81.3605   133.8300
3301403    22.7222    -0.5300
    330     7.9000     0.0000
  6   1
      1     0.0000     0.0000

INPUT DATA BEFORE TYPE MODIFICATIONS

   ID        NAME       ACTIVITY GUESS    LOG GUESS   ANAL TOTAL
    330  H+1                 1.259E-08        -7.900   0.000E-01
    140  CO3-2               1.738E-03        -2.760   9.934E+01
      1  E-1                 1.000E-16       -16.000   0.000E-01
    150  Ca+2                2.630E-04        -3.580   9.500E+01
    460  Mg+2                1.318E-04        -3.880   3.100E+01
    500  Na+1                1.445E-03        -2.840   8.000E+01
    410  K+1                 9.120E-04        -3.040   7.000E+00
    732  SO4-2               2.818E-04        -3.550   3.310E+02
    180  Cl-1                6.761E-04        -3.170   1.490E+01
    281  Fe+3                2.344E-06        -5.630   1.500E-03
    470  Mn+2                1.096E-07        -6.960   2.320E-02
     30  Al+3                4.467E-06        -5.350   5.000E-02
    770  H4SiO4              9.333E-05        -4.030   1.615E+01
      2  H2O                 1.000E+00         0.000   0.000E-01

    Charge Balance: UNSPECIATED

       Sum of CATIONS=  1.096E-02 Sum of ANIONS =  1.063E-02

       PERCENT DIFFERENCE =  1.546E+00  (ANIONS - CATIONS)/(ANIONS + CATIONS)
            ------------------------------------------------------
           |  IMPROVED ACTIVITY GUESSES PRIOR TO FIRST ITERATION: |
           |       CO3-2       Log activity guess:    -6.94       |
           |       SO4-2       Log activity guess:    -2.46       |
           |       Fe+3        Log activity guess:   -18.13       |
           |       Mn+2        Log activity guess:    -6.37       |
           |       Al+3        Log activity guess:   -13.50       |
           |       H4SiO4      Log activity guess:    -3.78       |
           |                                                      |
            ------------------------------------------------------
```

PARAMETERS OF THE COMPONENT MOST OUT OF BALANCE:

ITER	NAME	TOTAL MOL	DIFF FXN	LOG ACTVTY	RESIDUAL
0	Fe+3	2.688E-08	-1.725E-11	-18.12787	1.456E-11
1	SO4-2	3.448E-03	-4.534E-04	-2.67544	4.531E-04
2	Fe+3	2.688E-08	2.011E-09	-18.12759	2.009E-09
3	Fe+3	2.688E-08	1.297E-10	-18.15893	1.270E-10
4	Fe+3	2.688E-08	-3.626E-12	-18.16102	9.381E-13

ID	NAME	ANAL MOL	CALC MOL	LOG ACTVTY	GAMMA	DIFF FXN
770	H4SiO4	1.681E-04	1.674E-04	-3.77494	1.003200	1.711E-10
470	Mn+2	4.226E-07	3.615E-07	-6.64556	0.625711	-2.503E-11
30	Al+3	1.854E-06	8.997E-14	-13.50408	0.348210	-3.316E-12
150	Ca+2	2.372E-03	1.980E-03	-2.90706	0.625711	-1.369E-07
460	Mg+2	1.276E-03	1.087E-03	-3.16756	0.625711	-7.520E-08
500	Na+1	3.482E-03	3.454E-03	-2.51256	0.889392	-6.043E-08
410	K+1	1.791E-04	1.775E-04	-3.80182	0.889392	-3.109E-09
732	SO4-2	3.448E-03	2.838E-03	-2.75064	0.625711	-1.968E-07
180	Cl-1	4.206E-04	4.206E-04	-3.42709	0.889392	-7.299E-09
281	Fe+3	2.688E-08	1.982E-18	-18.16096	0.348210	-3.067E-13
140	CO3-2	1.657E-03	1.823E-07	-6.94288	0.625711	0.000E-01
1	E-1	0.000E-01	1.823E-14	-13.73929	0.889392	0.000E-01
330	H+1	0.000E-01	1.415E-08	-7.90000	0.889392	0.000E-01
2	H2O	0.000E-01	1.598E-03	-0.00010	1.000000	0.000E-01

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.415E-08	1.259E-08	-7.90000	0.88939	0.051
140	CO3-2	1.823E-07	1.141E-07	-6.94288	0.62571	0.204
770	H4SiO4	1.674E-04	1.679E-04	-3.77494	1.00320	-0.001
150	Ca+2	1.980E-03	1.239E-03	-2.90706	0.62571	0.204
460	Mg+2	1.087E-03	6.799E-04	-3.16756	0.62571	0.204
500	Na+1	3.454E-03	3.072E-03	-2.51256	0.88939	0.051
410	K+1	1.775E-04	1.578E-04	-3.80182	0.88939	0.051
732	SO4-2	2.838E-03	1.776E-03	-2.75064	0.62571	0.204
180	Cl-1	4.206E-04	3.740E-04	-3.42709	0.88939	0.051
281	Fe+3	1.982E-18	6.903E-19	-18.16096	0.34821	0.458
470	Mn+2	3.615E-07	2.262E-07	-6.64556	0.62571	0.204
30	Al+3	8.997E-14	3.133E-14	-13.50408	0.34821	0.458

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301400	HCO3 -	4.971E-05	4.421E-05	-4.35450	0.88939	10.539
3301401	H2CO3 AQ	1.057E-06	1.060E-06	-5.97463	1.00320	16.767
3307320	HSO4 -	1.626E-09	1.446E-09	-8.83969	0.88939	1.862
3300020	OH-	2.720E-07	2.420E-07	-6.61627	0.88939	-14.465
3307700	H3SiO4 -	7.714E-07	6.860E-07	-6.16365	0.88939	-10.238
3307701	H2SiO4 -2	2.546E-11	1.593E-11	-10.79775	0.62571	-22.619
4603300	MgOH +	2.535E-08	2.254E-08	-7.64700	0.88939	-12.328
4601400	MgCO3 AQ	5.859E-08	5.878E-08	-7.23076	1.00320	2.878
4601401	MgHCO3 +	3.630E-07	3.228E-07	-6.49105	0.88939	11.570
4607320	MgSO4 AQ	1.888E-04	1.894E-04	-3.72252	1.00320	2.194
1503300	CaOH +	7.610E-09	6.768E-09	-8.16953	0.88939	-13.111
1501400	CaHCO3 +	4.031E-07	3.585E-07	-6.44553	0.88939	11.355
1501401	CaCO3 AQ	1.548E-07	1.553E-07	-6.80895	1.00320	3.040
1507320	CaSO4 AQ	3.916E-04	3.928E-04	-3.40577	1.00320	2.251
5001400	NaCO3 -	3.292E-09	2.928E-09	-8.53344	0.88939	0.973
5001401	NaHCO3 AQ	5.287E-08	5.304E-08	-7.27543	1.00320	10.079
5007320	NaSO4 -	2.781E-05	2.474E-05	-4.60668	0.88939	0.707
4107320	KSO4 -	1.681E-06	1.495E-06	-5.82532	0.88939	0.778
303300	AlOH +2	1.404E-11	8.786E-12	-11.05620	0.62571	-5.248
303301	Al(OH)2 +	1.765E-08	1.569E-08	-7.80427	0.88939	-10.049
303302	Al(OH)4 -	2.727E-07	2.425E-07	-6.61526	0.88939	-24.660
307320	AlSO4 +	5.404E-14	4.806E-14	-13.31820	0.88939	2.987

307321	Al(SO4)2 -	7.166E-15	6.373E-15	-14.19563	0.88939	4.861
303303	Al(OH)3 AQ	1.564E-06	1.569E-06	-5.80437	1.00320	-16.001
2813300	FeOH +2	2.232E-13	1.397E-13	-12.85484	0.62571	-2.390
2817320	FeSO4 +	8.081E-18	7.187E-18	-17.14342	0.88939	3.819
2811800	FeCl +2	7.553E-21	4.726E-21	-20.32549	0.62571	1.466
2811801	FeCl2 +	1.465E-23	1.303E-23	-22.88514	0.88939	2.181
2811802	FeCl3 AQ	4.857E-28	4.873E-28	-27.31223	1.00320	1.129
2813301	FeOH2 +	1.047E-08	9.308E-09	-8.03116	0.88939	-5.619
2813302	FeOH3 AQ	8.657E-09	8.685E-09	-8.06125	1.00320	-13.601
2813303	FeOH4 -	7.755E-09	6.897E-09	-8.16135	0.88939	-21.549
2817321	Fe(SO4)2 -	4.266E-19	3.794E-19	-18.42085	0.88939	5.292
2813304	Fe2(OH)2+4	6.580E-24	1.009E-24	-23.99631	0.15328	-2.660
2813305	Fe3(OH)4+5	3.421E-29	1.826E-30	-29.73853	0.05337	-5.583
4701800	MnCl +	3.848E-10	3.423E-10	-9.46565	0.88939	0.658
4701801	MnCl2 AQ	3.466E-14	3.477E-14	-13.45874	1.00320	0.040
4701802	MnCl3 -	6.593E-18	5.864E-18	-17.23183	0.88939	-0.254
4703300	MnOH +	1.433E-10	1.274E-10	-9.89475	0.88939	-11.098
4703301	Mn(OH)3 -1	2.019E-18	1.795E-18	-17.74585	0.88939	-34.749
4700020	MnO4 -	4.163E-10	3.703E-10	-9.43145	0.88939	-134.631
4700021	MnO4 -2	2.817E-13	1.762E-13	-12.75389	0.62571	-124.061
4707320	MnSO4 AQ	6.000E-08	6.019E-08	-7.22046	1.00320	2.174
4701400	MnHCO3 +	1.454E-10	1.293E-10	-9.88844	0.88939	11.651

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	1.598E-03	-2.796	0.000	0.000
3301403	CO2 (g)	1.605E-03	-2.795	22.743	-0.530
330	H+1	-3.255E-03	-2.487	7.900	0.000
3300021	O2 (g)	-5.207E-10	-9.283	-86.557	133.830

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
1	E-1	1.823E-14	-13.739	0.000	0.000
3301404	CH4 (g)	0.000E-01	-153.388	42.469	-61.000

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H4SiO4

99.5 PERCENT BOUND IN SPECIES # 770 H4SiO4

Mn+2

85.5 PERCENT BOUND IN SPECIES # 470 Mn+2

14.2 PERCENT BOUND IN SPECIES #4707320 MnSO4 AQ

Al+3

14.7 PERCENT BOUND IN SPECIES # 303302 Al(OH)4 -

84.3 PERCENT BOUND IN SPECIES # 303303 Al(OH)3 AQ

Ca+2

83.5 PERCENT BOUND IN SPECIES # 150 Ca+2

16.5 PERCENT BOUND IN SPECIES #1507320 CaSO4 AQ

Mg+2

85.2 PERCENT BOUND IN SPECIES # 460 Mg+2

	14.8	PERCENT BOUND IN SPECIES	#4607320	MgSO4 AQ
Na+1				
	99.2	PERCENT BOUND IN SPECIES	# 500	Na+1
K+1				
	99.1	PERCENT BOUND IN SPECIES	# 410	K+1
SO4-2				
	82.3	PERCENT BOUND IN SPECIES	# 732	SO4-2
	5.5	PERCENT BOUND IN SPECIES	#4607320	MgSO4 AQ
	11.4	PERCENT BOUND IN SPECIES	#1507320	CaSO4 AQ
Cl-1				
	100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1
Fe+3				
	38.9	PERCENT BOUND IN SPECIES	#2813301	FeOH2 +
	32.2	PERCENT BOUND IN SPECIES	#2813302	FeOH3 AQ
	28.9	PERCENT BOUND IN SPECIES	#2813303	FeOH4 -
CO3-2				
	95.6	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
	2.0	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
E-1				
	99.9	PERCENT BOUND IN SPECIES	#4700020	MnO4 -
H+1				
	108.8	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
	4.6	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
H2O				
	4.4	PERCENT BOUND IN SPECIES	#3300020	OH-
	17.6	PERCENT BOUND IN SPECIES	# 303302	Al(OH)4 -
	75.6	PERCENT BOUND IN SPECIES	# 303303	Al(OH)3 AQ

---------- EQUILIBRATED MASS DISTRIBUTION ----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
770	H4SiO4	1.681E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
470	Mn+2	4.226E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
30	Al+3	1.854E-06	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.372E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	1.276E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	3.482E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
410	K+1	1.791E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
732	SO4-2	3.448E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	4.206E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
281	Fe+3	2.688E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	5.198E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
1	E-1	-2.083E-09	100.0	0.000E-01	0.0	0.000E-01	0.0
330	H+1	4.568E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	6.203E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 9.766E-03 Sum of ANIONS 6.177E-03

PERCENT DIFFERENCE = 2.251E+01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 1.388E-02

EQUILIBRIUM pH = 7.900

EQUILIBRIUM pe = 13.739 or Eh = 771.87 mv

DATE ID NUMBER: ******
TIME ID NUMBER: 9390306

1. Reservoir Hypolimnion 11-23-05
Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]
2003000	ALOH3(A)	-1.234	[1.000] 30 [3.000] 2 [-3.000] 330
6003000	ALOHSO4	-5.125	[-1.000] 330 [1.000] 30 [1.000] 732 [1.000] 2
6003001	AL4(OH)10SO4	-0.468	[-10.000] 330 [4.000] 30 [1.000] 732 [10.000] 2
6041000	ALUM K	-17.358	[1.000] 410 [1.000] 30 [2.000] 732 [12.000] 2
6041001	ALUNITE	-0.918	[1.000] 410 [3.000] 30 [2.000] 732 [6.000] 2 [-6.000] 330
6015000	ANHYDRITE	-1.167	[1.000] 150 [1.000] 732
5015000	ARAGONITE	-1.639	[1.000] 150 [1.000] 140
5046000	ARTINITE	-8.194	[-2.000] 330 [2.000] 460 [1.000] 140 [5.000] 2
2003001	BOEHMITE	0.525	[-3.000] 330 [1.000] 30 [2.000] 2
2046000	BRUCITE	-5.163	[1.000] 460 [2.000] 2 [-2.000] 330
5015001	CALCITE	-1.444	[1.000] 150 [1.000] 140
2077000	CHALCEDONY	-0.073	[-2.000] 2 [1.000] 770
8646000	CHRYSOTILE	-3.879	[-6.000] 330 [3.000] 460 [2.000] 770 [1.000] 2
8246000	CLINOENSTITE	-3.258	[-1.000] 2 [1.000] 460 [1.000] 770 [-2.000] 330
2077001	CRISTOBALITE	0.026	[-2.000] 2 [1.000] 770
2003002	DIASPORE	2.366	[-3.000] 330 [1.000] 30 [2.000] 2
8215000	DIOPSIDE	-3.164	[-2.000] 2 [1.000] 150 [1.000] 460 [2.000] 770 [-4.000] 330
5015002	DOLOMITE	-3.282	[1.000] 150 [1.000] 460 [2.000] 140
6046000	EPSOMITE	-3.669	[1.000] 460 [1.000] 732 [7.000] 2
8646003	SEPIOLITE(C)	-3.032	[-0.500] 2 [2.000] 460 [3.000] 770 [-4.000] 330
2028100	FERRIHYDRITE	0.648	[-3.000] 330 [1.000] 281 [3.000] 2
4128100	FEOH)2.7CL.3	5.181	[-2.700] 330 [1.000] 281 [2.700] 2 [0.300] 180
6028100	FE2(SO4)3	-50.449	[2.000] 281 [3.000] 732
8046000	FORSTERITE	-8.692	[-4.000] 330 [2.000] 460 [1.000] 770
2003003	GIBBSITE (C)	0.540	[-3.000] 330 [1.000] 30 [3.000] 2
3003000	Al2O3	-2.588	[2.000] 30 [3.000] 2 [-6.000] 330
2028102	GOETHITE	4.477	[-3.000] 330 [1.000] 281 [2.000] 2
6015001	GYPSUM	-0.800	[1.000] 150 [1.000] 732 [2.000] 2
4150000	HALITE	-7.486	[1.000] 500 [1.000] 180
3028100	HEMATITE	13.888	[-6.000] 330 [2.000] 281 [3.000] 2
5015003	HUNTITE	-11.213	[3.000] 460 [1.000] 150 [4.000] 140
5046001	HYDRMAGNESIT	-21.071	[5.000] 460 [4.000] 140 [-2.000] 330 [6.000] 2
6050000	JAROSITE NA	-5.302	[-6.000] 330 [1.000] 500 [3.000] 281 [2.000] 732 [6.000] 2
6041002	JAROSITE K	-2.801	[-6.000] 330 [1.000] 410 [3.000] 281 [2.000] 732 [6.000] 2
6028101	JAROSITE H	-10.526	[-5.000] 330 [3.000] 281 [2.000] 732 [7.000] 2
8450000	MAGADIITE	-6.736	[-1.000] 330 [-9.000] 2 [1.000] 500 [7.000] 770
3028101	MAGHEMITE	4.692	[-6.000] 330 [2.000] 281 [3.000] 2
5046002	MAGNESITE	-2.321	[1.000] 460 [1.000] 140
6050001	MIRABILITE	-5.925	[2.000] 500 [1.000] 732 [10.000] 2
3050000	NATRON	-10.047	[2.000] 500 [1.000] 140 [10.000] 2
5046003	NESQUEHONITE	-4.715	[1.000] 460 [1.000] 140 [3.000] 2
8646001	PHLOGOPITE	-28.787	[-10.000] 330 [1.000] 410 [3.000] 460 [1.000] 30 [3.000] 770
2077002	QUARTZ	0.473	[-2.000] 2 [1.000] 770
8646004	SEPIOLITE(A)	-4.840	[-0.500] 2 [2.000] 460 [3.000] 770 [-4.000] 330
2077003	SIO2(A,GL)	-0.584	[-2.000] 2 [1.000] 770
2077004	SIO2(A,PT)	-0.913	[-2.000] 2 [1.000] 770
8646002	TALC	-1.616	[-4.000] 2 [3.000] 460 [4.000] 770 [-6.000] 330

1. Reservoir Hypolimnion 11-23-05

ID #	NAME	Sat. Index	Stoichiometry in [brackets]
6050002	THENARDITE	-7.619	[2.000] 500 [1.000] 732
5050001	THERMONATR	-12.202	[2.000] 500 [1.000] 140 [1.000] 2
8215001	TREMOLITE	-1.548	[-8.000] 2 [2.000] 150 [5.000] 460 [8.000] 770 [-14.000] 330
3047000	HAUSMANNITE	6.090	[-8.000] 330 [-2.000] 1 [3.000] 470 [4.000] 2
2047003	PYROCROITE	-6.811	[-2.000] 330 [1.000] 470 [2.000] 2
5047000	RHODOCHROSIT	-3.259	[1.000] 470 [1.000] 140
4147000	MNCL2, 4H2O	-15.535	[1.000] 470 [2.000] 180 [4.000] 2
6047000	MNSO4	-12.666	[1.000] 470 [1.000] 732
8450001	ANALCIME	0.428	[1.000] 500 [1.000] 30 [2.000] 770 [-1.000] 2 [-4.000] 330
8603000	HALLOYSITE	2.305	[2.000] 30 [2.000] 770 [1.000] 2 [-6.000] 330
8603001	KAOLINITE	5.746	[2.000] 30 [2.000] 770 [1.000] 2 [-6.000] 330
8415000	LEONHARDITE	16.566	[-1.000] 2 [-16.000] 330 [2.000] 150 [8.000] 770 [4.000] 30
8450002	LOW ALBITE	0.991	[1.000] 500 [1.000] 30 [3.000] 770 [-4.000] 330 [-4.000] 2
8450003	ANALBITE	-0.024	[1.000] 500 [1.000] 30 [3.000] 770 [-4.000] 330 [-4.000] 2
8641000	MUSCOVITE	8.067	[1.000] 410 [3.000] 30 [3.000] 770 [-10.000] 330
8415001	ANORTHITE	-2.439	[1.000] 150 [2.000] 30 [2.000] 770 [-8.000] 330
8603002	PYROPHYLLITE	6.890	[2.000] 30 [4.000] 770 [-4.000] 2 [-6.000] 330
8415002	LAUMONTITE	1.766	[1.000] 150 [2.000] 30 [4.000] 770 [-8.000] 330
8415003	WAIRAKITE	-3.137	[1.000] 150 [2.000] 30 [4.000] 770 [-8.000] 330 [-2.000] 2
2015000	LIME	-21.701	[-2.000] 330 [1.000] 150 [1.000] 2
2015001	PORTLANDITE	-10.974	[-2.000] 330 [1.000] 150 [2.000] 2
2046001	PERICLASE	-10.281	[-2.000] 330 [1.000] 460 [1.000] 2
3046000	SPINEL	-6.768	[-8.000] 330 [1.000] 460 [2.000] 30 [4.000] 2
3046001	MAG-FERRITE	4.358	[-8.000] 330 [1.000] 460 [2.000] 281 [4.000] 2
8215002	WOLLASTONITE	-4.635	[-1.000] 2 [-2.000] 330 [1.000] 770 [1.000] 150
8215003	P-WOLLSTANIT	-5.546	[-1.000] 2 [-2.000] 330 [1.000] 770 [1.000] 150
8015001	CA-OLIVINE	-17.762	[-4.000] 330 [1.000] 770 [2.000] 150
8015002	LARNITE	-19.353	[-4.000] 330 [1.000] 770 [2.000] 150
8015007	CA3SIO5	-43.092	[-6.000] 330 [1.000] 770 [3.000] 150 [1.000] 2
8015003	MONTICELLITE	-10.441	[-4.000] 330 [1.000] 770 [1.000] 150 [1.000] 460
8015005	AKERMINITE	-19.572	[-1.000] 2 [-6.000] 330 [2.000] 770 [2.000] 150 [1.000] 460
8015004	MERWINITE	-28.941	[-8.000] 330 [2.000] 770 [1.000] 460 [3.000] 150
8441000	KALSILITE	-3.442	[-4.000] 330 [1.000] 770 [1.000] 30 [1.000] 410
8441001	LEUCITE	-0.536	[-2.000] 2 [-4.000] 330 [2.000] 770 [1.000] 30 [1.000] 410
8441002	MICROCLINE	1.876	[-4.000] 2 [-4.000] 330 [3.000] 770 [1.000] 30 [1.000] 410
8441003	H SANIDINE	1.354	[-4.000] 2 [-4.000] 330 [3.000] 770 [1.000] 30 [1.000] 410
8450004	NEPHELINE	-3.699	[-4.000] 330 [1.000] 770 [1.000] 30 [1.000] 500
8015006	GEHLENITE	-18.928	[-10.000] 330 [2.000] 30 [1.000] 770 [2.000] 150 [3.000] 2
3028102	LEPIDOCROCIT	4.168	[-3.000] 330 [1.000] 281 [2.000] 2
ID #	NAME	Sat. Index	Stoichiometry in [brackets]
8650000	NA-NONTRONIT	16.871	[-7.320] 330 [-2.680] 2 [0.330] 30 [2.000] 281 [0.330] 500 [3.670] 770
8641002	K-NONTRONITE	17.490	[-7.320] 330 [-2.680] 2 [0.330] 30 [2.000] 281 [0.330] 410 [3.670] 770
8615000	CA-NONTRONIT	23.599	[-7.320] 330 [-2.680] 2 [0.330] 30 [2.000] 281 [0.167] 150 [3.670] 770

```
  8646005 MG-NONTRONIT   23.256    [ -7.320] 330  [ -2.680]   2  [  0.330]  30
                                   [  2.000] 281  [  0.167] 460  [  3.670] 770
  8646006 Montmorillon    7.712    [  3.810] 770  [  0.490] 460  [ -6.760] 330
                                   [ -3.240]   2  [  0.220] 281  [  1.710]  30

_____________________________________ PART 1 of OUTPUT FILE ____________________________________
  PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 16-JUN-**  TIME:  9:39: 3


2.  Foundation Gallery Seepage 11-23-05


-------------------------------------------------------------------------------
 Temperature (Celsius):  10.00
 Units of concentration: MG/L
 Ionic strength to be computed.
 If specified, carbonate concentration represents total inorganic carbon.
 Do not automatically terminate if charge imbalance exceeds 30%
 Precipitation is allowed only for those solids specified as ALLOWED
   in the input file (if any).
 The maximum number of iterations is: 100
 The method used to compute activity coefficients is: Davies equation
 Intermediate output file

-------------------------------------------------------------------------------
    330  0.000E-01   -8.13 y
    140  1.279E+02   -2.72 y
      1  0.000E-01  -16.00 y
    150  8.900E+01   -2.29 y
    460  3.000E+01   -5.09 y
    500  7.900E+01   -2.96 y
    410  7.000E+00   -3.43 y
    732  3.210E+02   -2.29 y
    180  1.570E+01   -3.63 y
    281  1.500E-03   -6.66 y
    470  2.000E-04   -6.96 y
     30  2.000E-03   -5.69 y
    770  1.664E+01   -4.25 y

 H2O has been inserted as a COMPONENT
  3   3
3300021   -81.3605   133.8300
3301403    22.7222    -0.5300
    330     8.1300     0.0000
  6   1
      1     0.0000     0.0000

INPUT DATA BEFORE TYPE MODIFICATIONS

   ID        NAME       ACTIVITY GUESS    LOG GUESS   ANAL TOTAL
    330  H+1                 7.413E-09        -8.130   0.000E-01
    140  CO3-2               1.905E-03        -2.720   1.279E+02
      1  E-1                 1.000E-16       -16.000   0.000E-01
    150  Ca+2                5.129E-03        -2.290   8.900E+01
    460  Mg+2                8.128E-06        -5.090   3.000E+01
    500  Na+1                1.096E-03        -2.960   7.900E+01
    410  K+1                 3.715E-04        -3.430   7.000E+00
    732  SO4-2               5.129E-03        -2.290   3.210E+02
    180  Cl-1                2.344E-04        -3.630   1.570E+01
    281  Fe+3                2.188E-07        -6.660   1.500E-03
    470  Mn+2                1.096E-07        -6.960   2.000E-04
     30  Al+3                2.042E-06        -5.690   2.000E-03
    770  H4SiO4              5.623E-05        -4.250   1.664E+01
      2  H2O                 1.000E+00         0.000   0.000E-01


     Charge Balance: UNSPECIATED

       Sum of CATIONS=  1.053E-02 Sum of ANIONS =  1.140E-02

       PERCENT DIFFERENCE =  3.943E+00  (ANIONS - CATIONS)/(ANIONS + CATIONS)
```

```
 ------------------------------------------------------
|  IMPROVED ACTIVITY GUESSES PRIOR TO FIRST ITERATION: |
|       CO3-2       Log activity guess:    -6.48       |
|       SO4-2       Log activity guess:    -2.48       |
|       Fe+3        Log activity guess:   -18.83       |
|       Mn+2        Log activity guess:    -8.44       |
|       Al+3        Log activity guess:   -15.62       |
|       H4SiO4      Log activity guess:    -3.76       |
|                                                      |
 ------------------------------------------------------
```


PC MINTEQA2 v3.10 DATE OF CALCULATIONS: 16-JUN-** TIME: 9:39: 3

PARAMETERS OF THE COMPONENT MOST OUT OF BALANCE:

ITER	NAME	TOTAL MOL	DIFF FXN	LOG ACTVTY	RESIDUAL
0	Fe+3	2.688E-08	-1.949E-11	-18.83482	1.681E-11
1	SO4-2	3.344E-03	3.708E-04	-2.59933	3.704E-04
2	Fe+3	2.688E-08	2.028E-09	-18.83450	2.026E-09
3	Fe+3	2.688E-08	1.271E-10	-18.86610	1.244E-10
4	Fe+3	2.688E-08	-3.768E-12	-18.86815	1.080E-12

ID	NAME	ANAL MOL	CALC MOL	LOG ACTVTY	GAMMA	DIFF FXN
770	H4SiO4	1.732E-04	1.719E-04	-3.76338	1.003099	1.546E-10
470	Mn+2	3.643E-09	3.107E-09	-8.70846	0.629747	-2.053E-13
30	Al+3	7.418E-08	6.593E-16	-15.63278	0.353283	-2.261E-13
150	Ca+2	2.222E-03	1.857E-03	-2.93191	0.629747	-1.224E-07
460	Mg+2	1.235E-03	1.053E-03	-3.17843	0.629747	-6.944E-08
500	Na+1	3.439E-03	3.412E-03	-2.51726	0.890823	-5.686E-08
410	K+1	1.791E-04	1.775E-04	-3.80104	0.890823	-2.962E-09
732	SO4-2	3.344E-03	2.771E-03	-2.75825	0.629747	-1.831E-07
180	Cl-1	4.431E-04	4.431E-04	-3.40367	0.890823	-7.328E-09
281	Fe+3	2.688E-08	3.835E-19	-18.86809	0.353283	-2.983E-13
140	CO3-2	2.133E-03	5.223E-07	-6.48288	0.629747	0.000E-01
1	E-1	0.000E-01	3.095E-14	-13.50929	0.890823	0.000E-01
330	H+1	0.000E-01	8.322E-09	-8.13000	0.890823	0.000E-01
2	H2O	0.000E-01	2.044E-03	-0.00010	1.000000	0.000E-01

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	8.322E-09	7.413E-09	-8.13000	0.89082	0.050
140	CO3-2	5.223E-07	3.289E-07	-6.48288	0.62975	0.201
770	H4SiO4	1.719E-04	1.724E-04	-3.76338	1.00310	-0.001
150	Ca+2	1.857E-03	1.170E-03	-2.93191	0.62975	0.201
460	Mg+2	1.053E-03	6.631E-04	-3.17843	0.62975	0.201
500	Na+1	3.412E-03	3.039E-03	-2.51726	0.89082	0.050
410	K+1	1.775E-04	1.581E-04	-3.80104	0.89082	0.050
732	SO4-2	2.771E-03	1.745E-03	-2.75825	0.62975	0.201
180	Cl-1	4.431E-04	3.948E-04	-3.40367	0.89082	0.050
281	Fe+3	3.835E-19	1.355E-19	-18.86809	0.35328	0.452
470	Mn+2	3.107E-09	1.957E-09	-8.70846	0.62975	0.201
30	Al+3	6.593E-16	2.329E-16	-15.63278	0.35328	0.452

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301400	HCO3 -	8.428E-05	7.508E-05	-4.12450	0.89082	10.539
3301401	H2CO3 AQ	1.057E-06	1.060E-06	-5.97463	1.00310	16.767
3307320	HSO4 -	9.395E-10	8.369E-10	-9.07730	0.89082	1.861
3300020	OH-	4.613E-07	4.109E-07	-6.38627	0.89082	-14.466
3307700	H3SiO4 -	1.343E-06	1.196E-06	-5.92209	0.89082	-10.239
3307701	H2SiO4 -2	7.493E-11	4.719E-11	-10.32620	0.62975	-22.622
4603300	MgOH +	4.191E-08	3.734E-08	-7.42787	0.89082	-12.329
4601400	MgCO3 AQ	1.648E-07	1.653E-07	-6.78163	1.00310	2.878
4601401	MgHCO3 +	6.002E-07	5.347E-07	-6.27192	0.89082	11.570
4607320	MgSO4 AQ	1.810E-04	1.816E-04	-3.74100	1.00310	2.194
1503300	CaOH +	1.218E-08	1.085E-08	-7.96439	0.89082	-13.112
1501400	CaHCO3 +	6.454E-07	5.749E-07	-6.24039	0.89082	11.355

1501401	CaCO3 AQ	4.216E-07	4.229E-07	-6.37381	1.00310	3.040
1507320	CaSO4 AQ	3.634E-04	3.645E-04	-3.43824	1.00310	2.251
5001400	NaCO3 -	9.377E-09	8.353E-09	-8.07814	0.89082	0.972
5001401	NaHCO3 AQ	8.882E-08	8.910E-08	-7.05014	1.00310	10.079
5007320	NaSO4 -	2.699E-05	2.404E-05	-4.61900	0.89082	0.707
4107320	KSO4 -	1.652E-06	1.472E-06	-5.83216	0.89082	0.777
303300	AlOH +2	1.762E-13	1.109E-13	-12.95490	0.62975	-5.251
303301	Al(OH)2 +	3.778E-10	3.365E-10	-9.47298	0.89082	-10.050
303302	Al(OH)4 -	1.684E-08	1.500E-08	-7.82397	0.89082	-24.661
307320	AlSO4 +	3.942E-16	3.511E-16	-15.45451	0.89082	2.987
307321	Al(SO4)2 -	5.136E-17	4.576E-17	-16.33956	0.89082	4.860
303303	Al(OH)3 AQ	5.696E-08	5.714E-08	-7.24307	1.00310	-16.001
2813300	FeOH +2	7.394E-14	4.656E-14	-13.33197	0.62975	-2.393
2817320	FeSO4 +	1.556E-18	1.386E-18	-17.85816	0.89082	3.818
2811800	FeCl +2	1.555E-21	9.790E-22	-21.00920	0.62975	1.463
2811801	FeCl2 +	3.197E-24	2.848E-24	-23.54543	0.89082	2.180
2811802	FeCl3 AQ	1.121E-28	1.124E-28	-27.94910	1.00310	1.129
2813301	FeOH2 +	5.915E-09	5.269E-09	-8.27828	0.89082	-5.620
2813302	FeOH3 AQ	8.323E-09	8.349E-09	-8.07838	1.00310	-13.601
2813303	FeOH4 -	1.264E-08	1.126E-08	-7.94848	0.89082	-21.550
2817321	Fe(SO4)2 -	8.072E-20	7.191E-20	-19.14320	0.89082	5.292
2813304	Fe2(OH)2+4	7.125E-25	1.121E-25	-24.95056	0.15728	-2.671
2813305	Fe3(OH)4+5	2.067E-30	1.148E-31	-30.93990	0.05556	-5.600
4701800	MnCl +	3.508E-12	3.125E-12	-11.50513	0.89082	0.657
4701801	MnCl2 AQ	3.341E-16	3.351E-16	-15.47480	1.00310	0.040
4701802	MnCl3 -	6.695E-20	5.964E-20	-19.22447	0.89082	-0.255
4703300	MnOH +	2.102E-12	1.872E-12	-11.72765	0.89082	-11.099
4703301	Mn(OH)3 -1	8.540E-20	7.608E-20	-19.11875	0.89082	-34.750
4700020	MnO4 -	1.761E-11	1.569E-11	-10.80435	0.89082	-134.632
4700021	MnO4 -2	2.014E-14	1.268E-14	-13.89679	0.62975	-124.064
4707320	MnSO4 AQ	5.101E-10	5.117E-10	-9.29097	1.00310	2.174
4701400	MnHCO3 +	2.132E-12	1.900E-12	-11.72133	0.89082	11.650

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	2.044E-03	-2.689	0.000	0.000
3301403	CO2 (g)	2.045E-03	-2.689	22.743	-0.530
330	H+1	-4.176E-03	-2.379	8.130	0.000
3300021	O2 (g)	-2.204E-11	-10.657	-86.557	133.830

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
1	E-1	3.095E-14	-13.509	0.000	0.000
3301404	CH4 (g)	0.000E-01	-153.388	42.469	-61.000

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H4SiO4

99.2 PERCENT BOUND IN SPECIES # 770 H4SiO4

Mn+2

85.3 PERCENT BOUND IN SPECIES # 470 Mn+2

14.0 PERCENT BOUND IN SPECIES #4707320 MnSO4 AQ

Al+3

22.7 PERCENT BOUND IN SPECIES # 303302 Al(OH)4 -

76.8 PERCENT BOUND IN SPECIES # 303303 Al(OH)3 AQ

Ca+2

83.6	PERCENT BOUND IN SPECIES #	150	Ca+2
16.4	PERCENT BOUND IN SPECIES #	1507320	CaSO4 AQ

Mg+2

85.3	PERCENT BOUND IN SPECIES #	460	Mg+2
14.7	PERCENT BOUND IN SPECIES #	4607320	MgSO4 AQ

Na+1

99.2	PERCENT BOUND IN SPECIES #	500	Na+1

K+1

99.1	PERCENT BOUND IN SPECIES #	410	K+1

SO4-2

82.9	PERCENT BOUND IN SPECIES #	732	SO4-2
5.4	PERCENT BOUND IN SPECIES #	4607320	MgSO4 AQ
10.9	PERCENT BOUND IN SPECIES #	1507320	CaSO4 AQ

Cl-1

100.0	PERCENT BOUND IN SPECIES #	180	Cl-1

Fe+3

22.0	PERCENT BOUND IN SPECIES #	2813301	FeOH2 +
31.0	PERCENT BOUND IN SPECIES #	2813302	FeOH3 AQ
47.0	PERCENT BOUND IN SPECIES #	2813303	FeOH4 -

CO3-2

96.0	PERCENT BOUND IN SPECIES #	3301400	HCO3 -
1.2	PERCENT BOUND IN SPECIES #	3301401	H2CO3 AQ

E-1

99.9	PERCENT BOUND IN SPECIES #	4700020	MnO4 -

H+1

98.5	PERCENT BOUND IN SPECIES #	3301400	HCO3 -
2.5	PERCENT BOUND IN SPECIES #	3301401	H2CO3 AQ

H2O

54.8	PERCENT BOUND IN SPECIES #	3300020	OH-
5.0	PERCENT BOUND IN SPECIES #	4603300	MgOH +
1.4	PERCENT BOUND IN SPECIES #	1503300	CaOH +
8.0	PERCENT BOUND IN SPECIES #	303302	Al(OH)4 -
20.3	PERCENT BOUND IN SPECIES #	303303	Al(OH)3 AQ
1.4	PERCENT BOUND IN SPECIES #	2813301	FeOH2 +
3.0	PERCENT BOUND IN SPECIES #	2813302	FeOH3 AQ
6.0	PERCENT BOUND IN SPECIES #	2813303	FeOH4 -

PART 5 of OUTPUT FILE

PC MINTEQA2 v3.10 DATE OF CALCULATIONS: 16-JUN-** TIME: 9:39: 3

EQUILIBRATED MASS DISTRIBUTION

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
770	H4SiO4	1.732E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
470	Mn+2	3.643E-09	100.0	0.000E-01	0.0	0.000E-01	0.0
30	Al+3	7.418E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.222E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	1.235E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	3.439E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
410	K+1	1.791E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
732	SO4-2	3.344E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	4.431E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
281	Fe+3	2.688E-08	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	8.779E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
1	E-1	-8.815E-11	100.0	0.000E-01	0.0	0.000E-01	0.0
330	H+1	8.555E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	8.418E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 9.411E-03 Sum of ANIONS 6.100E-03

PERCENT DIFFERENCE = 2.134E+01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 1.344E-02

EQUILIBRIUM pH = 8.130

EQUILIBRIUM pe = 13.509 or Eh = 758.95 mv

DATE ID NUMBER: ******
TIME ID NUMBER: 9390317

PART 6 of OUTPUT FILE

PC MINTEQA2 v3.10 DATE OF CALCULATIONS: 16-JUN-** TIME: 9:39: 3

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]
2003000	ALOH3(A)	-2.673	[1.000] 30 [3.000] 2 [-3.000] 330
6003000	ALOHSO4	-7.031	[-1.000] 330 [1.000] 30 [1.000] 732 [1.000] 2
6003001	AL4(OH)10SO4	-6.690	[-10.000] 330 [4.000] 30 [1.000] 732 [10.000] 2
6041000	ALUM K	-19.501	[1.000] 410 [1.000] 30 [2.000] 732 [12.000] 2
6041001	ALUNITE	-5.938	[1.000] 410 [3.000] 30 [2.000] 732 [6.000] 2 [-6.000] 330
6015000	ANHYDRITE	-1.200	[1.000] 150 [1.000] 732
5015000	ARAGONITE	-1.204	[1.000] 150 [1.000] 140
5046000	ARTINITE	-7.296	[-2.000] 330 [2.000] 460 [1.000] 140 [5.000] 2
2003001	BOEHMITE	-0.913	[-3.000] 330 [1.000] 30 [2.000] 2
2046000	BRUCITE	-4.714	[1.000] 460 [2.000] 2 [-2.000] 330
5015001	CALCITE	-1.008	[1.000] 150 [1.000] 140
2077000	CHALCEDONY	-0.061	[-2.000] 2 [1.000] 770
8646000	CHRYSOTILE	-2.508	[-6.000] 330 [3.000] 460 [2.000] 770 [1.000] 2
8246000	CLINOENSTITE	-2.797	[-1.000] 2 [1.000] 460 [1.000] 770 [-2.000] 330
2077001	CRISTOBALITE	0.037	[-2.000] 2 [1.000] 770
2003002	DIASPORE	0.928	[-3.000] 330 [1.000] 30 [2.000] 2

ID #	NAME	Sat. Index	Stoichiometry in [brackets]							
8215000	DIOPSIDE	-2.256	[-2.000]	2	[1.000]	150	[1.000]	460		
			[2.000]	770	[-4.000]	330				
5015002	DOLOMITE	-2.398	[1.000]	150	[1.000]	460	[2.000]	140		
6046000	EPSOMITE	-3.688	[1.000]	460	[1.000]	732	[7.000]	2		
8646003	SEPIOLITE(C)	-2.099	[-0.500]	2	[2.000]	460	[3.000]	770		
			[-4.000]	330						
2028100	FERRIHYDRITE	0.631	[-3.000]	330	[1.000]	281	[3.000]	2		
4128100	FEOH)2.7CL.3	5.102	[-2.700]	330	[1.000]	281	[2.700]	2		
			[0.300]	180						
6028100	FE2(SO4)3	-51.886	[2.000]	281	[3.000]	732				
8046000	FORSTERITE	-7.782	[-4.000]	330	[2.000]	460	[1.000]	770		
2003003	GIBBSITE (C)	-0.898	[-3.000]	330	[1.000]	30	[3.000]	2		
3003000	Al2O3	-5.466	[2.000]	30	[3.000]	2	[-6.000]	330		
2028102	GOETHITE	4.459	[-3.000]	330	[1.000]	281	[2.000]	2		
6015001	GYPSUM	-0.832	[1.000]	150	[1.000]	732	[2.000]	2		
4150000	HALITE	-7.467	[1.000]	500	[1.000]	180				
3028100	HEMATITE	13.854	[-6.000]	330	[2.000]	281	[3.000]	2		
5015003	HUNTITE	-9.431	[3.000]	460	[1.000]	150	[4.000]	140		
5046001	HYDRMAGNESIT	-18.825	[5.000]	460	[4.000]	140	[-2.000]	330		
			[6.000]	2						
6050000	JAROSITE NA	-6.063	[-6.000]	330	[1.000]	500	[3.000]	281		
			[2.000]	732	[6.000]	2				
6041002	JAROSITE K	-3.557	[-6.000]	330	[1.000]	410	[3.000]	281		
			[2.000]	732	[6.000]	2				
6028101	JAROSITE H	-11.513	[-5.000]	330	[3.000]	281	[2.000]	732		
			[7.000]	2						
8450000	MAGADIITE	-6.430	[-1.000]	330	[-9.000]	2	[1.000]	500		
			[7.000]	770						
3028101	MAGHEMITE	4.658	[-6.000]	330	[2.000]	281	[3.000]	2		
5046002	MAGNESITE	-1.872	[1.000]	460	[1.000]	140				
6050001	MIRABILITE	-5.943	[2.000]	500	[1.000]	732	[10.000]	2		
3050000	NATRON	-9.596	[2.000]	500	[1.000]	140	[10.000]	2		
5046003	NESQUEHONITE	-4.265	[1.000]	460	[1.000]	140	[3.000]	2		
8646001	PHLOGOPITE	-28.613	[-10.000]	330	[1.000]	410	[3.000]	460		
			[1.000]	30	[3.000]	770				
2077002	QUARTZ	0.484	[-2.000]	2	[1.000]	770				
8646004	SEPIOLITE(A)	-3.907	[-0.500]	2	[2.000]	460	[3.000]	770		
			[-4.000]	330						
2077003	SIO2(A,GL)	-0.573	[-2.000]	2	[1.000]	770				
2077004	SIO2(A,PT)	-0.901	[-2.000]	2	[1.000]	770				
8646002	TALC	-0.223	[-4.000]	2	[3.000]	460	[4.000]	770		
			[-6.000]	330						
6050002	THENARDITE	-7.636	[2.000]	500	[1.000]	732				
5050001	THERMONATR	-11.751	[2.000]	500	[1.000]	140	[1.000]	2		
8215001	TREMOLITE	1.660	[-8.000]	2	[2.000]	150	[5.000]	460		
			[8.000]	770	[-14.000]	330				
3047000	HAUSMANNITE	1.281	[-8.000]	330	[-2.000]	1	[3.000]	470		
			[4.000]	2						
2047003	PYROCROITE	-8.414	[-2.000]	330	[1.000]	470	[2.000]	2		
5047000	RHODOCHROSIT	-4.862	[1.000]	470	[1.000]	140				
4147000	MNCL2, 4H2O	-17.551	[1.000]	470	[2.000]	180	[4.000]	2		
6047000	MNSO4	-14.737	[1.000]	470	[1.000]	732				
8450001	ANALCIME	-0.763	[1.000]	500	[1.000]	30	[2.000]	770		
			[-1.000]	2	[-4.000]	330				
8603000	HALLOYSITE	-0.549	[2.000]	30	[2.000]	770	[1.000]	2		
			[-6.000]	330						
8603001	KAOLINITE	2.892	[2.000]	30	[2.000]	770	[1.000]	2		
			[-6.000]	330						
8415000	LEONHARDITE	11.774	[-1.000]	2	[-16.000]	330	[2.000]	150		
			[8.000]	770	[4.000]	30				
8450002	LOW ALBITE	-0.187	[1.000]	500	[1.000]	30	[3.000]	770		
			[-4.000]	330	[-4.000]	2				
8450003	ANALBITE	-1.202	[1.000]	500	[1.000]	30	[3.000]	770		
			[-4.000]	330	[-4.000]	2				
8641000	MUSCOVITE	4.016	[1.000]	410	[3.000]	30	[3.000]	770		
			[-10.000]	330						
8415001	ANORTHITE	-4.858	[1.000]	150	[2.000]	30	[2.000]	770		
			[-8.000]	330						
8603002	PYROPHYLLITE	4.059	[2.000]	30	[4.000]	770	[-4.000]	2		
			[-6.000]	330						
8415002	LAUMONTITE	-0.630	[1.000]	150	[2.000]	30	[4.000]	770		
			[-8.000]	330						
8415003	WAIRAKITE	-5.533	[1.000]	150	[2.000]	30	[4.000]	770		
			[-8.000]	330	[-2.000]	2				

ID #	NAME	Sat. Index	Stoichiometry in [brackets]									
2015000	LIME	-21.265	[-2.000]	330	[1.000]	150	[1.000]	2				
2015001	PORTLANDITE	-10.539	[-2.000]	330	[1.000]	150	[2.000]	2				
2046001	PERICLASE	-9.832	[-2.000]	330	[1.000]	460	[1.000]	2				
3046000	SPINEL	-9.197	[-8.000]	330	[1.000]	460	[2.000]	30				
			[4.000]	2								
3046001	MAG-FERRITE	4.772	[-8.000]	330	[1.000]	460	[2.000]	281				
			[4.000]	2								
8215002	WOLLASTONITE	-4.188	[-1.000]	2	[-2.000]	330	[1.000]	770				
			[1.000]	150								
8215003	P-WOLLSTANIT	-5.099	[-1.000]	2	[-2.000]	330	[1.000]	770				
			[1.000]	150								
8015001	CA-OLIVINE	-16.880	[-4.000]	330	[1.000]	770	[2.000]	150				
8015002	LARNITE	-18.471	[-4.000]	330	[1.000]	770	[2.000]	150				
8015007	CA3SIO5	-41.775	[-6.000]	330	[1.000]	770	[3.000]	150				
			[1.000]	2								
8015003	MONTICELLITE	-9.545	[-4.000]	330	[1.000]	770	[1.000]	150				
			[1.000]	460								
8015005	AKERMINITE	-18.229	[-1.000]	2	[-6.000]	330	[2.000]	770				
			[2.000]	150	[1.000]	460						
8015004	MERWINITE	-27.163	[-8.000]	330	[2.000]	770	[1.000]	460				
			[3.000]	150								
8441000	KALSILITE	-4.638	[-4.000]	330	[1.000]	770	[1.000]	30				
			[1.000]	410								
8441001	LEUCITE	-1.721	[-2.000]	2	[-4.000]	330	[2.000]	770				
			[1.000]	30	[1.000]	410						
8441002	MICROCLINE	0.702	[-4.000]	2	[-4.000]	330	[3.000]	770				
			[1.000]	30	[1.000]	410						
8441003	H SANIDINE	0.181	[-4.000]	2	[-4.000]	330	[3.000]	770				
			[1.000]	30	[1.000]	410						
8450004	NEPHELINE	-4.901	[-4.000]	330	[1.000]	770	[1.000]	30				
			[1.000]	500								
8015006	GEHLENITE	-20.924	[-10.000]	330	[2.000]	30	[1.000]	770				
			[2.000]	150	[3.000]	2						
3028102	LEPIDOCROCIT	4.151	[-3.000]	330	[1.000]	281	[2.000]	2				
8650000	NA-NONTRONIT	16.479	[-7.320]	330	[-2.680]	2	[0.330]	30				
			[2.000]	281	[0.330]	500	[3.670]	770				
8641002	K-NONTRONITE	17.100	[-7.320]	330	[-2.680]	2	[0.330]	30				
			[2.000]	281	[0.330]	410	[3.670]	770				
8615000	CA-NONTRONIT	23.205	[-7.320]	330	[-2.680]	2	[0.330]	30				
			[2.000]	281	[0.167]	150	[3.670]	770				
8646005	MG-NONTRONIT	22.863	[-7.320]	330	[-2.680]	2	[0.330]	30				
			[2.000]	281	[0.167]	460	[3.670]	770				
8646006	Montmorillon	5.510	[3.810]	770	[0.490]	460	[-6.760]	330				
			[-3.240]	2	[0.220]	281	[1.710]	30				