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Leachate Geochemical Results for Ash and Burned Soil Samples from the October 2007 Southern California Wildfires

By Philip L. Hageman, Geoffrey S. Plumlee, Deborah A. Martin, Todd M. Hoefen, Gregory P. Meeker, Monique Adams, Paul J. Lamothe, and Michael W. Anthony

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Contents

Table

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Overview

This report is the second release of leachate geochemical data included as part of a multidisciplinary study of ash and burned soil samples from the October 2007 wildfires in southern California. Geochemical data for the first set of samples were released in an Open-File Report (Plumlee and others, 2007). This study is a continuation of that work.

The objectives of this leaching study are to aid in understanding the interactions of ash and burned soil with rainfall. For this study, 12 samples collected in early November 2007 were leached using the U.S. Geological Survey (USGS) Field Leach Test (FLT). Following leaching, sub-samples of the leachate were analyzed for pH and specific conductance. The leachate was then filtered, and aliquots were preserved for geochemical analysis. This report presents leachate geochemical data for pH, specific conductance, alkalinity, anions using ion chromatography (I.C.), cations using inductively coupled plasma—atomic mass spectrometry (ICP-MS), and mercury by continuous flow injection—cold vapor—atomic fluorescence (CVAFS).

Introduction

From November 2 – 9, 2007, USGS personnel collected both ash and burned soils from wildland and suburban areas burned by the southern California wildfires. This work was done as part of the Southern California Multi-Hazards Demonstration project (U.S. Geological Survey, 2007).

USGS researchers are applying a wide variety of analytical tools and methods to help identify key geochemical characteristics and properties of burned soil and ash samples. Understanding these characteristics are important due to the potential for adverse impacts on human health, water quality, air quality (airborne dust), endangered species, wildlife habitat, and for the potential for debris flows and flood runoff. These effects can occur in-situ or as the materials are mobilized by contact with wind or water.

Samples summarized in this report were collected from the Harris, Santiago, Canyon, and Grass Valley burn areas. Sampling procedures at each site typically included collection of both a surficial ash sample and a sample of the underlying soil from each sampling site. After collection, the samples were sent to Denver and processed for analysis.

Sample Collection and Preparation

Altogether, 28 samples were collected from the burn areas. Complete details of the sampling protocols used, as well as the mapped locations will be released in another report (T. Hoefen, written comm.). Because the main goal of the wildland sampling methodology was to understand and characterize the fire's effect on the overlying vegetation and the underlying soil, samples of both residual ash and the underlying burned soil were collected from each site. The materials were collected either as grab (single increment) or as composite (multi-increment) samples. The composite samples were collected either through compositing multiple increment samples from intervals along a transect (Transect composite), compositing multi-increment samples from intervals on spokes radiating from a centroid (Spoke composite), or compositing multiple increment samples from an area in a random manner (Random composite). In addition to sampling wildland burn areas, two composite samples were also collected from the ash/debris and underlying soils from burned residential sites (Residential random composite), one in Grass Valley and the other in the Harris burn areas. GPS coordinates were collected and recorded for each sampling site. Sample details are in table 1.

Table 1. Sample names, locations, and method of collection for samples included in this study.

Sample	Latitude	Longitude	Sampling Method
Harris02 - White Ash	32º 35' 46.3"	116º 46' 05.7"	Random composite
Harris02 - Ash	32º 35' 46.3"	116º 46' 05.7"	Random composite
Harris02 - Soil	32º 35' 46.3"	116º 46' 05.7"	Random composite
Harris05 - White Ash	32º 42' 11.0"	116º 57' 39.8"	Grab
Harris05 - Arundo Reed	32º 42' 11.0"	116º 57' 39.8"	Grab
Harris05 - Ash	32º 42' 11.0"	116º 57' 39.8"	Spoke composite
Harris05 - Soil	32º 42' 11.0"	116º 57' 39.8"	Spoke composite
Harris06 - Soil	32º 39' 47.3"	116º 40' 51.2"	Transect composite
Harris07 - Ash	32º 37' 22.2"	116º 41' 26.6"	Residential random composite
Santiago04 - Ash	33º 43' 11.4"	117º 35' 59.6"	Spoke composite
Santiago04 - Soil	33º 43' 11.4"	117º 35' 59.6"	Spoke composite
Canyon01 - Ash	34º 02' 44.0"	118º 42' 16.8"	Transect composite
Canyon01 - Soil	34º 02' 44.0"	118º 42' 16.8"	Transect composite
GrassValley01 - Ash	34º 16' 02.6"	117º 13' 06.0"	Residential random composite

After collection, samples were immediately packaged and shipped to the USGS Mineral Resources Program laboratories in Denver, Colorado, for sample preparation and analysis. To prepare the samples, the bulk composite samples were homogenized and then split using cone-and-quartering. One fourth of the sample was archived and the remainder dry sieved to pass a 2-mm (10-mesh) screen. The <2 mm samples were then distributed for further preparation or sent to the laboratories for analysis.

USGS Field Leach Test (FLT)

The FLT leaching procedure (Hageman, 2007) is used to identify and characterize the water leachable, water reactive phase of samples. The procedure uses deionized water (DI) to leach unground,

<2 mm splits of geologic or environmental samples. For this study, 6.25 grams of sample (ash or burned soil) was weighed into 125 mL wide-mouth plastic bottles. Then, 125 mL (DI) water was added slowly to each bottle so that no sample dust was lost. The bottles were tightly capped and vigorously shaken for 5 minutes using a mechanical shaker. After shaking, the contents were allowed to settle for 10 minutes. After settling, unfiltered sub-samples of the leachate were dispensed into disposable plastic beakers and measured for pH and specific conductance. Another portion of leachate was filtered using a 60-cc (cubic centimeter) syringe and a 0.45-micrometer (μm) pore-size nitrocellulose capsule filter. If filtration was difficult, a 0.70-μm glass fiber pre-filter was used in conjunction with the 0.45-μm filter in a serial manner. Sub-samples of filtrate (15 mL) for ICP-MS analysis were filtered into acid-washed bottles and preserved to pH <1.5 by acidification with ultra-pure nitric acid (HNO_3). Another split (40 ml) of filtrate was collected in plastic bottles and refrigerated for alkalinity and ion chromatography analysis. A third sub-sample of filtrate (30 ml) was collected and preserved for mercury analysis. This split was filtered into acid-washed borosilicate glass bottles with Teflon lined caps and preserved with 1.0 mL mercury-free concentrated hydrochloric acid per 30 mL of sample.

In addition to the leaching method described above, two samples were leached using the same equipment and protocols but different leaching ratios. This was performed in order to look at the possibility of identifying different or varying element solubility rates by use of various sample/leachate ratios. Samples Harris07- ash, and Grass Valley01-ash were each leached using 1:250 and 1:500 sample/leachate ratios. Leachate geochemical data for these samples are in table 2. These samples were also leached using the FLT procedure (Plumlee and others, 2007).

Analytical Methods

Brief descriptions of the analytical methods used in this study are listed below. Complete details for all of these methods can be found online (Taggart, 2002). Leachate geochemical data for all the methods are in table 2.

1. pH and specific conductance were determined using hand-held meters. Analysis was conducted on unfiltered leachate.

2. Cations, metals, and sulfate (SO_4) were determined using inductively coupled plasma—mass spectrometry (ICP-MS) for a 44-element suite. Analysis was conducted on filtered leachate preserved with Ultrex HNO_3 to a pH <1.5.

3. Fluoride, chloride, and nitrate (NO_3) were determined using ion chromatography (I.C.). Analysis was conducted on filtered leachate preserved by refrigeration.

4. Alkalinity was determined using automated titration. Analysis was conducted on filtered leachate preserved by refrigeration.

4. Mercury was determined using continuous flow injection—cold vapor—atomic fluorescence spectrometry (CVAFS). Analysis was conducted on filtered leachate preserved with HCl.

In addition to this leaching study, splits of these samples are currently being analyzed using an assortment of other techniques including: bulk chemistry on solids; X-ray diffraction for mineralogy;

bioaccessibility of metals and metalloids in simulated biofluids; and particle size distribution. Results of these analyses will be published when completed.

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Table 2. FLT leachate geochemical data for ash and burned soil samples

[Fluoride, chloride, and nitrate by ion chromotography; cations, metals, and sulfate by ICP-MS; mercury by CVAFS. nm= not measured]

Sample	Alkalinity	pH	Specific Conductance (µS/cm)	F (mg/L)	Cl (mg/L)	NO_3 (mg/L)	Ag (µg/L)	Al (µg/L)	As (µg/L)
Harris02 White Ash	1826	11.9	1,470	2.6	13.5	266	< 1	33.5	13.5
Harris02 - Ash	94	9.9	250	2.6	5.4	1.8	< 1	477	12.5
Harris02 - Soil	49	8.1	160	3.3	3.2	9.1	< 1	260	10.6
Harris05 - White Ash	2185	13.0	1,540	0.5	46.5	3.2	< 1	5.1	5.1
Harris05 - Arundo Reed	535	11.4	6,600	1.1	687	8.7	< 1	2	2
Harris05 - Ash	266	11.6	3,200	1.8	139	2.7	< 1	2	1
Harris05 - Soil	71	9.3	250	2.3	9.2	6.2	< 1	115	1
Harris06 - Soil	47	8.3	130	1.5	3	1.9	< 1	270	< 1
Santiago04 - Ash	501	11.3	2,000	4.8	34	4.5	< 1	24.5	2
Santiago04 - Soil	71	9.3	190	1.4	3.8	6.5	< 1	249	1
Canyon01 - Ash	63	8.7	140	2.5	4	1.9	< 1	458	1
Canyon01 - Soil	19	6.8	40	0.6	3.2	1.8	< 1	53.5	< 1
Harris07 - Ash *250:1*	341	11.8	610	<.08	34.6	<.08	< 1	3040	130
Harris07 - Ash *500:1*	179	11.6	380	<.08	15.2	1.5	< 1	1870	21.5
Grass Valley01 - Ash *250:1*	429	11.7	700	<.08	11.9	<.08	< 1	1120	< 1
Grass Valley01 - Ash *500:1*	210	11.6	420	<.08	11.3	<.08	< 1	781	< 1
FLT Blank	11	6.2	0.67	<.08	<.08	<.08	< 1	< 2	< 1

Table 2—Continued.

Sample	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	Ca (mg/L)	Cd (µg/L)	Ce (µg/L)
Harris02 White Ash	39.6	< 0.05	< 0.2	16.5	0.04	< 0.01
Harris02 - Ash	31.3	< 0.05	< 0.2	31.6	< 0.02	0.13
Harris02 - Soil	11.8	< 0.05	< 0.2	11.1	0.03	0.96
Harris05 - White Ash	695	< 0.05	< 0.2	679	0.12	< 0.01
Harris05 - Arundo Reed	101	< 0.05	< 0.2	57.8	0.03	< 0.01
Harris05 - Ash	72.5	< 0.05	< 0.2	31.2	0.03	< 0.01
Harris05 - Soil	31	< 0.05	< 0.2	17.3	< 0.02	0.68
Harris06 - Soil	35.7	< 0.05	< 0.2	14.1	< 0.02	0.44
Santiago04 - Ash	26.4	< 0.05	< 0.2	23.2	0.07	< 0.01
Santiago04 - Soil	27.6	< 0.05	< 0.2	16.9	0.04	0.1
Canyon01 - Ash	16.6	< 0.05	< 0.2	12.6	< 0.02	0.2
Canyon01 - Soil	4.2	< 0.05	< 0.2	2.41	< 0.02	0.41
Harris07 - Ash *250:1*	169	< 0.05	< 0.2	55.5	< 0.02	< 0.01
Harris07 - Ash *500:1*	98.5	< 0.05	< 0.2	36.2	< 0.02	< 0.01
Grass Valley01 - Ash *250:1*	36.9	< 0.05	< 0.2	76.5	< 0.02	< 0.01
Grass Valley01 - Ash *500:1*	23.1	< 0.05	< 0.2	43.6	< 0.02	< 0.01
FLT Blank	< 0.2	< 0.05	< 0.2	< 0.2	< 0.02	< 0.01

Table 2—Continued.

Sample	Co (µg/L)	Cr (µg/L)	Cs (µg/L)	Cu (µg/L)	Dy (µg/L)	Er (µg/L)
Harris02 White Ash	0.37	4.3	46.5	8.5	< 0.005	< 0.005
Harris02 - Ash	1.56	< 1	0.03	6.5	0.01	0.01
Harris02 - Soil	6.33	< 1	0.05	3.4	0.44	0.27
Harris05 - White Ash	0.73	2.4	4.09	21.2	< 0.005	< 0.005
Harris05 - Arundo Reed	2.38	< 1	0.99	11.8	< 0.005	< 0.005
Harris05 - Ash	1.39	< 1	0.52	19.2	< 0.005	< 0.005
Harris05 - Soil	1.6	< 1	< 0.02	7.4	0.096	0.051
Harris06 - Soil	0.44	< 1	< 0.02	2.7	0.05	0.03
Santiago04 - Ash	1.72	1.9	0.82	80	< 0.005	< 0.005
Santiago04 - Soil	1.52	< 1	< 0.02	10.1	0.03	0.02
Canyon01 - Ash	0.84	1	< 0.02	3.2	0.056	0.03
Canyon01 - Soil	0.53	< 1	< 0.02	1.4	0.064	0.05
Harris07 - Ash *250:1*	< 0.02	4.1	0.09	1.1	< 0.005	< 0.005
Harris07 - Ash *500:1*	< 0.02	2	0.05	0.63	< 0.005	< 0.005
Grass Valley01 - Ash *250:1*	< 0.02	3	0.04	340	< 0.005	< 0.005
Grass Valley01 - Ash *500:1*	< 0.02	1.4	0.02	0.67	< 0.005	< 0.005
FLT Blank	< 0.02	< 1	< 0.02	< 0.5	< 0.005	< 0.005

Table 2—Continued.

Sample	Eu (µg/L)	Fe (µg/L)	Ga (µg/L)	Gd (µg/L)	Ge (µg/L)	Hg ng/L
Harris02 White Ash	0.008	< 50	0.2	< 0.005	0.05	7
Harris02 - Ash	0.007	< 50	0.47	0.02	< 0.05	10
Harris02 - Soil	0.082	212	0.1	0.48	< 0.05	16
Harris05 - White Ash	0.062	< 50	0.27	0.005	0.08	<5
Harris05 - Arundo Reed	0.01	< 50	0.05	0.005	0.1	15
Harris05 - Ash	0.005	< 50	< 0.05	< 0.005	< 0.05	5
Harris05 - Soil	0.03	63	0.1	0.11	< 0.05	8
Harris06 - Soil	0.008	< 50	0.2	0.04	< 0.05	6
Santiago04 - Ash	< 0.005	< 50	0.1	< 0.005	< 0.05	<5
Santiago04 - Soil	0.01	< 50	0.08	0.04	< 0.05	14
Canyon01 - Ash	0.009	< 50	0.1	0.052	< 0.05	<5
Canyon01 - Soil	0.01	< 50	< 0.05	0.067	< 0.05	<5
Harris07 - Ash *250:1*	0.02	< 50	1.2	< 0.005	< 0.05	nm
Harris07 - Ash *500:1*	0.005	< 50	0.79	< 0.005	< 0.05	nm
Grass Valley01 - Ash *250:1*	< 0.005	< 50	0.47	< 0.005	< 0.05	nm
Grass Valley01 - Ash *500:1*	< 0.005	< 50	0.37	< 0.005	< 0.05	nm
FLT Blank	< 0.005	< 50	< 0.05	< 0.005	< 0.05	<5

Table 2—Continued.

Sample	Ho (µg/L)	K (mg/L)	La (µg/L)	Li (µg/L)	Lu (µg/L)	Mg (mg/L)
Harris02 White Ash	< 0.005	-	< 0.01	44.4	< 0.1	15
Harris02 - Ash	< 0.005	24.4	0.08	8.9	< 0.1	4.12
Harris02 - Soil	0.098	24.8	0.65	5.3	< 0.1	3.4
Harris05 - White Ash	< 0.005	146	< 0.01	6.5	< 0.1	0.03
Harris05 - Arundo Reed	< 0.005	141	< 0.01	2	< 0.1	88.8
Harris05 - Ash	< 0.005	-	< 0.01	5.4	< 0.1	19.2
Harris05 - Soil	0.02	27.7	0.29	2.3	< 0.1	11.4
Harris06 - Soil	0.007	8.45	0.14	0.6	< 0.1	2.72
Santiago04 - Ash	< 0.005	-	< 0.01	9.4	< 0.1	18.8
Santiago04 - Soil	0.007	32.4	0.05	1.4	< 0.1	4.24
Canyon01 - Ash	0.01	6.16	0.12	3.3	< 0.1	6.68
Canyon01 - Soil	0.02	2.95	0.18	1.3	< 0.1	1.59
Harris07 - Ash *250:1*	< 0.005	3.86	< 0.01	3.4	< 0.1	0.15
Harris07 - Ash *500:1*	< 0.005	1.84	< 0.01	4	< 0.1	0.14
Grass Valley01 - Ash *250:1*	< 0.005	1.41	< 0.01	1.4	< 0.1	0.08
Grass Valley01 - Ash *500:1*	< 0.005	0.68	0.01	0.6	< 0.1	0.04
FLT Blank	< 0.005	< 0.03	< 0.01	< 0.1	< 0.1	< 0.01

Table 2—Continued.

Sample	Mn (µg/L)	Mo (µg/L)	Na (mg/L)	Nb (µg/L)	Nd (µg/L)	Ni (µg/L)
Harris02 White Ash	8	7.8	141	< 0.2	0.01	2.5
Harris02 - Ash	54.8	3.9	2.93	< 0.2	0.1	1.3
Harris02 - Soil	750	3	2.41	< 0.2	1.28	2.8
Harris05 - White Ash	14.8	47.9	245	< 0.2	0.02	< 0.4
Harris05 - Arundo Reed	8.2	14.4	23.8	< 0.2	< 0.01	< 0.4
Harris05 - Ash	3.9	14.4	62.6	< 0.2	< 0.01	0.5
Harris05 - Soil	42	2	5.97	< 0.2	0.46	1.4
Harris06 - Soil	56.7	< 2	1.24	< 0.2	0.16	0.4
Santiago04 - Ash	4.9	41.8	17.3	< 0.2	< 0.01	5
Santiago04 - Soil	34.3	2.8	1.37	< 0.2	0.07	2.4
Canyon01 - Ash	68.8	3.2	2.36	< 0.2	0.16	7.8
Canyon01 - Soil	59.2	< 2	1.82	< 0.2	0.24	2.4
Harris07 - Ash *250:1*	0.6	2.9	11.1	< 0.2	< 0.01	< 0.4
Harris07 - Ash *500:1*	0.5	< 2	4.22	< 0.2	< 0.01	< 0.4
Grass Valley01 - Ash *250:1*	0.6	< 2	2.67	< 0.2	< 0.01	< 0.4
Grass Valley01 - Ash *500:1*	0.6	< 2	1.39	< 0.2	< 0.01	< 0.4
FLT Blank	< 0.2	< 2	0.16	< 0.2	< 0.01	< 0.4

Table 2—Continued.

Sample	P (mg/L)	Pb (µg/L)	Pr (µg/L)	Rb (µg/L)	Sb (µg/L)	Sc (µg/L)
Harris02 White Ash	0.5	0.4	< 0.01	1150	4.42	2.2
Harris02 - Ash	0.3	0.2	0.02	4.4	2.94	< 0.6
Harris02 - Soil	1.5	0.3	0.25	2.06	2.18	< 0.6
Harris05 - White Ash	0.03	0.3	< 0.01	4420	1.55	< 0.6
Harris05 - Arundo Reed	0.03	0.2	< 0.01	1130	5.06	< 0.6
Harris05 - Ash	0.07	0.2	< 0.01	632	5.11	< 0.6
Harris05 - Soil	1.1	0.2	0.1	3.66	2.77	< 0.6
Harris06 - Soil	0.6	0.3	0.04	2.14	1.96	< 0.6
Santiago04 - Ash	0.4	0.4	< 0.01	133	17.3	0.8
Santiago04 - Soil	1.1	0.2	0.01	2.28	2.68	< 0.6
Canyon01 - Ash	0.5	0.2	0.03	3.25	2.17	< 0.6
Canyon01 - Soil	0.2	0.3	0.06	1.27	1.02	< 0.6
Harris07 - Ash *250:1*	< 0.01	1.5	< 0.01	5.98	6.28	< 0.6
Harris07 - Ash *500:1*	< 0.01	0.75	< 0.01	2.98	5.49	< 0.6
Grass Valley01 - Ash *250:1*	< 0.01	3.1	< 0.01	2	5.7	< 0.6
Grass Valley01 - Ash *500:1*	< 0.01	0.52	< 0.01	1.05	5.5	< 0.6
FLT Blank	< 0.01	0.1	< 0.01	0.01	1.38	< 0.6

Table 2—Continued.

Sample	Se (µg/L)	SiO2 (mg/L)	Sm (µg/L)	SO_4 (mg/L)	Sr (µg/L)	Ta (µg/L)
Harris02 White Ash	14.8	13.8	< 0.01	504	91.4	0.29
Harris02 - Ash	1	2.4	0.01	28	122	0.2
Harris02 - Soil	1.1	2.2	0.33	9	49.3	0.07
Harris05 - White Ash	115	0.5	< 0.01	6760	2780	< 0.02
Harris05 - Arundo Reed	13	4	< 0.01	2210	444	< 0.02
Harris05 - Ash	18.5	4.2	< 0.01	1170	271	0.1
Harris05 - Soil	1.7	2.3	0.12	40	83.1	< 0.02
Harris06 - Soil	< 1	0.4	0.03	7	66.7	0.27
Santiago04 - Ash	6.2	10	< 0.01	320	107	0.43
Santiago04 - Soil	< 1	1	0.02	18	55.9	< 0.02
Canyon01 - Ash	< 1	1.6	0.03	16	40.1	< 0.02
Canyon01 - Soil	< 1	0.9	0.05	2	7.6	< 0.02
Harris07 - Ash *250:1*	< 1	4.6	< 0.01	13	81.2	< 0.02
Harris07 - Ash *500:1*	< 1	3.8	< 0.01	9	55	< 0.02
Grass Valley01 - Ash *250:1*	< 1	2.2	< 0.01	91	175	< 0.02
Grass Valley01 - Ash *500:1*	< 1	1.5	< 0.01	51	101	< 0.02
FLT Blank	< 1	< 0.2	< 0.01	< 2	< 0.5	0.04

Table 2—Continued.

Sample	Tb (µg/L)	Th (µg/L)	Ti (µg/L)	Tl (µg/L)	Tm (µg/L)	U (µg/L)
Harris02 White Ash	< 0.005	< 0.2	6.4	< 0.1	< 0.005	0.26
Harris02 - Ash	< 0.005	< 0.2	0.8	< 0.1	< 0.005	0.25
Harris02 - Soil	0.07	< 0.2	5.2	< 0.1	0.04	< 0.1
Harris05 - White Ash	< 0.005	< 0.2	72	< 0.1	< 0.005	< 0.1
Harris05 - Arundo Reed	< 0.005	< 0.2	25.8	< 0.1	< 0.005	0.15
Harris05 - Ash	< 0.005	< 0.2	14	< 0.1	< 0.005	0.13
Harris05 - Soil	0.02	< 0.2	11.2	< 0.1	0.007	0.37
Harris06 - Soil	0.007	< 0.2	1.4	< 0.1	0.005	0.11
Santiago04 - Ash	< 0.005	< 0.2	4.8	< 0.1	< 0.005	0.24
Santiago04 - Soil	0.005	< 0.2	0.8	< 0.1	< 0.005	0.1
Canyon01 - Ash	0.008	< 0.2	0.9	< 0.1	0.005	0.22
Canyon01 - Soil	0.02	< 0.2	< 0.5	< 0.1	0.007	< 0.1
Harris07 - Ash *250:1*	< 0.005	< 0.2	< 0.5	< 0.1	< 0.005	< 0.1
Harris07 - Ash *500:1*	< 0.005	< 0.2	< 0.5	< 0.1	< 0.005	< 0.1
Grass Valley01 - Ash *250:1*	< 0.005	< 0.2	1.1	< 0.1	< 0.005	< 0.1
Grass Valley01 - Ash *500:1*	< 0.005	< 0.2	0.8	< 0.1	< 0.005	< 0.1
FLT Blank	< 0.005	< 0.2	< 0.5	< 0.1	< 0.005	< 0.1

Table 2—Continued.

Sample	V (µg/L)	W (µg/L)	Y (µg/L)	Yb (µg/L)	Zn (µg/L)	Zr (µg/L)
Harris02 White Ash	37.9	< 0.5	0.03	< 0.005	14.8	0.3
Harris02 - Ash	7.9	< 0.5	0.1	< 0.005	2.2	< 0.2
Harris02 - Soil	1.8	< 0.5	2.41	0.18	5.1	0.58
Harris05 - White Ash	0.7	0.62	0.06	0.005	36.2	< 0.2
Harris05 - Arundo Reed	8.1	0.55	< 0.01	< 0.005	11.4	< 0.2
Harris05 - Ash	32	0.61	< 0.01	< 0.005	5.3	< 0.2
Harris05 - Soil	10.8	< 0.5	0.37	0.04	6.2	0.88
Harris06 - Soil	3.9	< 0.5	0.28	0.03	5.6	0.54
Santiago04 - Ash	17.6	1.96	< 0.01	< 0.005	6	< 0.2
Santiago04 - Soil	2.6	< 0.5	0.17	0.01	7.7	< 0.2
Canyon01 - Ash	8.8	< 0.5	0.36	0.03	6.3	< 0.2
Canyon01 - Soil	1.5	< 0.5	0.42	0.05	12.4	< 0.2
Harris07 - Ash *250:1*	7.2	< 0.5	< 0.01	< 0.005	12.5	< 0.2
Harris07 - Ash *500:1*	5.1	< 0.5	< 0.01	< 0.005	8.4	< 0.2
Grass Valley01 - Ash *250:1*	9.8	4.08	< 0.01	< 0.005	17.4	< 0.2
Grass Valley01 - Ash *500:1*	7.4	< 0.5	< 0.01	< 0.005	8.6	< 0.2
FLT Blank	< 0.5	< 0.5	< 0.01	< 0.005	14.6	< 0.2