Leachate Geochemical Results for Ash Samples from the June 2007 Angora Wildfire Near Lake Tahoe in Northern California

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Overview

This report releases leachate geochemical data for ash samples produced by the Angora wildfire that burned from June 24 to July 2, 2007, near Lake Tahoe in northern California. The leaching studies are part of a larger interdisciplinary study whose goal is to identify geochemical characteristics and properties of the ash that may adversely affect human health, water quality, air quality, animal habitat, endangered species, debris flows, and flooding hazards.

The leaching study helps characterize and understand the interactions that occur when the ash comes in contact with rain or snowmelt, and helps identify the constituents that may be mobilized as run-off from these materials. Similar leaching studies were conducted on ash and burned soils from the October 2007 southern California wildfires (Hageman and others, 2008; Plumlee and others, 2007).

Introduction

On July 30, 2007, personnel from the U.S. Geological Survey (USGS) collected ash samples from forest and suburban residential areas in El Dorado County, California, that were burned by the Angora wildfire. All nineteen samples were leached using the USGS Field Leach Test (FLT) (Hageman, 2007). After leaching, aliquots of the leachate were analyzed for pH and specific conductance. Another portion of the leachate was filtered, and aliquots were preserved for geochemical analysis. This report presents leachate geochemical data for pH, specific conductance, anions by ion chromatography (I.C.), major elements by inductively coupled plasma—emission spectrometry (ICP-AES), cations by inductively coupled plasma—atomic mass spectrometry (ICP-MS), and mercury by continuous flow injection—cold vapor—atomic fluorescence (CVAFS).

Sample Collection and Preparation

Altogether, 19 ash samples were collected for this study (table 1). Surficial ash was collected from each sampling site from plots approximately 12 by 12 inches square using a clean plastic spoon or trowel and placed in clean plastic bags. A layer of soil up to two inches deep underlying the plots was collected separately and saved for future analysis. In addition to wildland burn areas, samples were also collected from burned residential areas. GPS coordinates and other information was collected and recorded for each sampling site.

Table 1. Sample names, locations, elevations, and site descriptions for 19 ash samples collected for this study.

[Angora10 was collected as two grab samples and combined into a single sample]

Sample	Latitude	Longitude	Elevation (ft.)	Site Description
Angora01	38º 51.832	120º 03.121	6,660	Forest
Angora02	38º 52.172	120º 03.043	6,546	Forest
Angora03	38º 52.399	120º 02.907	6,537	Forest
Angora04	38º 52.411	120º 03.326	6,793	Forest
Angora05	38º 52.448	120º 03.115	6,599	Forest
Angora06	38º 52.514	120º 02.817	6,483	Forest
Angora07	38º 52.669	120º 02.654	6,406	Forest
Angora08	38º 52.910	120º 02.917	6,512	Forest
Angora09	38º 52.905	120º 02.422	6,373	Residential
Angora10	38º 53.10	120º 02.4	6,420	Residential
	38º 53.19	120º 02.39	6,486	
Angora11	38º 53.3	120º 02.15	6,450	Residential
Angora12	38º 53.3	120º 02.1	6,350	Residential
Angora13	38º 53.7	120º 02.0	6,540	Forest
Angora14	38º 53.85	120º 01.9	6,630	Residential
Angora15	38º 53.9	120º 01.8	6,580	Residential
Angora16	38º 54.1	120º 01.7	6,790	Forest
Angora17	38º 54.2	120º 01.7	6,970	Forest
Angora18	38º 54.25	120º 01.7	7,010	Forest
Angora19	38º 54.4	120º 01.9	7,040	Forest

After collection, splits of the original samples were sent to the USGS Mineral Resources Program laboratories in Denver, Colorado, for processing and analysis. To prepare the samples, the bulk composite samples were split. One fourth of each sample was archived, and the remainder was distributed for further preparation or sent to the laboratories for analysis.

USGS Field Leach Test (FLT)

The FLT leaching procedure is used to rapidly 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 each sample were weighed into 125 mL wide-mouth plastic bottles. Then, 125 mL (DI) water was added slowly to each bottle so that no sample was lost. The bottles were tightly capped and vigorously shaken for 5 minutes on a horizontal shaking table. 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 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-AES and 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 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.

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 methods are in table 2.

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

2. Major elements (calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), and silica (SiO_2))were determined using ICP-AES. Analysis was conducted on filtered leachate preserved with Ultrex HNO_3 to a pH <1.5.

3. Cations, metals, and sulfate (SO_4) were determined using ICP-MS for a 44-element suite. Analysis was conducted on filtered leachate preserved with Ultrex HNO3 to a pH <1.5.

4. Fluoride (F), chloride (Cl), and nitrate (NO_3) were determined using I.C. Analysis was conducted on filtered leachate preserved by refrigeration.

5. Mercury (Hg) was determined using CVAFS. Analysis was conducted on filtered leachate preserved with HCl.

In addition to this leaching study, splits of these samples are currently being analyzed by an assortment of other techniques including total 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 samples.

[F, Cl, and NO_3 by ion chromatogrpahy; elements: B, Ca, K, Mg, Na, and SiO_2 by ICP-AES (itallics in table), cations, metals and SO_4 by ICP-MS; Hg by CVAFS]

Sample ID	pH	Specific Conductance	Cl	F	(NO_3)	Ag	Al	As	*B*
	(Standard Units)	(µS/cm)	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	*ug/L*
Angora01	10.0	81	2.2	0.5	0.6	<1	1760	3.6	*11*
Angora02	9.7	66	1.4	0.5	<.08	<1	1970	<1	*5.2*
Angora03	9.8	38	<.08	0.2	0.5	<1	1470	<1	*<5*
Angora04	10.2	75	1.3	0.3	0.5	<1	2550	<1	*13*
Angora05	10.3	120	1.7	0.5	<.08	<1	2920	<1	*22*
Angora06	9.7	51	1.2	0.5	<.08	<1	1890	<1	*7.5*
Angora07	9.7	23	<.08	0.2	0.5	<1	440	<1	*<5*
Angora08	10.3	82	1.4	0.12	1.3	<1	3440	<1	*13*
Angora09	9.6	23	1.2	0.2	0.5	<1	230	<1	*<5*
Angora10	11.5	360	5.0	0.2	0.5	<1	830	<1	*400*
Angora11	10.3	64	1.3	0.2	0.5	<1	1650	<1	*9.3*
Angora12	10.7	200	1.9	0.2	<.08	<1	470	58	*62*
Angora13	10.7	350	1.7	0.8	0.9	<1	200	<1	*37*
Angora14	10.1	140	8.2	0.4	0.6	<1	4900	<1	*44*
Angora15	10.0	52	0.4	0.2	0.5	<1	1170	<1	*7*
Angora16	10.1	45	1.2	0.1	0.5	<1	970	<1	*5.2*
Angora17	10.4	135	1.5	1.0	0.6	<1	4030	<1	*43*
Angora18	10.1	154	2.1	0.6	0.6	<1	2140	<1	*56*
Angora19	10.6	140	1.4	0.3	0.6	<1	4780	<1	*27*

Table 2—Continued.

Sample ID	Ba	Be	Bi	*Ca*	Cd	Ce	Co	Cr	Cs	Cu
	ug/L	ug/L	ug/L	*mg/L*	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Angora01	39	0.05	< 0.2	*13*	<0.02	< 0.01	0.04	<1	< 0.02	0.5
Angora02	61	0.06	< 0.2	*11*	<0.02	< 0.01	0.02	<1	< 0.02	<0.5
Angora03	39	<0.05	< 0.2	*6.5*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora04	100	0.08	< 0.2	*13*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora05	210	<0.05	< 0.2	*16*	<0.02	< 0.01	<0.02	<1	0.06	0.9
Angora06	36	<0.05	< 0.2	*9.1*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora07	7	<0.05	< 0.2	*3.7*	0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora08	87	<0.05	< 0.2	*9.9*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora09	8	0.07	< 0.2	*3.5*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora10	27	<0.05	< 0.2	*33*	0.24	< 0.01	<0.02	12.5	0.05	7.9
Angora11	17	<0.05	< 0.2	*10*	<0.02	< 0.01	<0.02	<1	< 0.02	<0.5
Angora12	15	<0.05	< 0.2	*7.8*	<0.02	< 0.01	0.02	43.7	< 0.02	3
Angora13	78	<0.05	< 0.2	*22*	<0.02	< 0.01	0.40	<1	0.08	3.3
Angora14	224	<0.05	< 0.2	*21*	<0.02	< 0.01	0.02	<1	< 0.02	0.7
Angora15	39	<0.05	< 0.2	*7.5*	<0.02	< 0.01	0.06	<1	< 0.02	<0.5
Angora16	57	<0.05	< 0.2	*7.0*	<0.02	< 0.01	0.02	<1	< 0.02	<0.5
Angora17	59	<0.05	< 0.2	*21*	<0.02	< 0.01	0.05	<1	0.04	1.9
Angora18	17	<0.05	< 0.2	*23*	0.03	< 0.01	0.16	<1	0.03	13.3
Angora19	44	<0.05	< 0.2	*21*	<0.02	< 0.01	0.11	<1	< 0.02	1.8

Table 2—Continued.

Sample ID	Dy	Er	Eu	Fe	Ga	Gd	Ge	Hg	Ho	*K*
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ng/L	ug/L	*mg/L*
Angora01	< 0.005	< 0.005	0.01	<50	0.4	0.007	0.06	<5	< 0.005	*3.0*
Angora02	< 0.005	< 0.005	0.01	<50	0.2	0.01	0.06	<5	< 0.005	*1.1*
Angora03	< 0.005	< 0.005	0.008	<50	0.1	< 0.005	< 0.05	<5	< 0.005	*0.79*
Angora04	< 0.005	< 0.005	0.02	<50	0.4	< 0.005	< 0.05	<5	< 0.005	*1.4*
Angora05	< 0.005	< 0.005	0.03	<50	0.4	< 0.005	0.05	<5	< 0.005	*8.2*
Angora06	< 0.005	< 0.005	0.007	<50	0.2	0.007	0.05	<5	< 0.005	*0.89*
Angora07	< 0.005	< 0.005	< 0.005	<50	0.1	< 0.005	< 0.05	<5	< 0.005	*0.23*
Angora08	< 0.005	< 0.005	0.01	<50	0.3	0.006	< 0.05	<5	< 0.005	*7.0*
Angora09	< 0.005	< 0.005	< 0.005	<50	< 0.05	< 0.005	< 0.05	<5	< 0.005	*0.27*
Angora10	< 0.005	< 0.005	0.009	<50	0.3	0.006	0.1	<5	< 0.005	*4.8*
Angora11	< 0.005	< 0.005	0.007	<50	0.4	< 0.005	< 0.05	<5	< 0.005	*0.62*
Angora12	< 0.005	< 0.005	0.008	<50	0.2	0.01	0.06	<5	< 0.005	*17*
Angora13	< 0.005	< 0.005	0.01	<50	0.1	< 0.005	< 0.05	<5	< 0.005	*64*
Angora14	< 0.005	< 0.005	0.04	<50	0.4	< 0.005	< 0.05	<5	< 0.005	*5.3*
Angora15	< 0.005	< 0.005	0.005	<50	0.1	0.009	< 0.05	<5	< 0.005	*2.2*
Angora16	< 0.005	< 0.005	0.007	<50	0.2	0.006	< 0.05	<5	< 0.005	*0.43*
Angora17	< 0.005	< 0.005	0.006	<50	0.6	0.005	0.06	<5	< 0.005	*5.7*
Angora18	< 0.005	< 0.005	0.007	<50	0.4	< 0.005	< 0.05	<5	< 0.005	*8.0*
Angora19	< 0.005	< 0.005	0.01	<50	0.4	< 0.005	< 0.05	<5	< 0.005	*5.5*

Table 2—Continued.

Sample ID	La	Li	Lu	*Mg*	Mn	Mo	*Na*	Nb	Nd	Ni
	ug/L	ug/L	ug/L	*mg/L*	ug/L	ug/L	*mg/L*	ug/L	ug/L	ug/L
Angora01	0.03	6.2	< 0.1	*0.92*	4.3	< 2	*0.19*	0.26	0.05	4.2
Angora02	< 0.01	< 0.1	< 0.1	*0.86*	20.4	< 2	*0.28*	< 0.2	< 0.01	<0.4
Angora03	< 0.01	< 0.1	< 0.1	*0.33*	27.5	< 2	*<0.1*	< 0.2	< 0.01	<0.4
Angora04	< 0.01	< 0.1	< 0.1	*0.78*	8.3	< 2	*0.12*	< 0.2	< 0.01	<0.4
Angora05	< 0.01	< 0.1	< 0.1	*1.9*	14.5	< 2	*0.27*	< 0.2	< 0.01	0.4
Angora06	< 0.01	< 0.1	< 0.1	*0.55*	27.9	< 2	*0.18*	< 0.2	< 0.01	<0.4
Angora07	< 0.01	< 0.1	< 0.1	*0.27*	18.8	< 2	*0.4*	< 0.2	< 0.01	<0.4
Angora08	< 0.01	0.2	< 0.1	*0.87*	4.6	2.7	*0.3*	< 0.2	< 0.01	<0.4
Angora09	< 0.01	< 0.1	< 0.1	*0.34*	12.4	< 2	*0.27*	< 0.2	< 0.01	<0.4
Angora10	< 0.01	< 0.1	< 0.1	*0.4*	1.1	19.9	*8.6*	< 0.2	< 0.01	0.4
Angora11	< 0.01	< 0.1	< 0.1	*0.55*	6.0	< 2	*0.14*	< 0.2	< 0.01	<0.4
Angora12	< 0.01	< 0.1	< 0.1	*1.0*	7.3	1.9	*21*	< 0.2	< 0.01	0.7
Angora13	< 0.01	0.3	< 0.1	*9.3*	1.4	2.3	*0.49*	< 0.2	< 0.01	0.6
Angora14	< 0.01	< 0.1	< 0.1	*2.0*	10.3	3.6	*0.21*	< 0.2	< 0.01	0.4
Angora15	< 0.01	< 0.1	< 0.1	*0.44*	6.5	< 2	*0.23*	< 0.2	< 0.01	<0.4
Angora16	< 0.01	< 0.1	< 0.1	*0.33*	8.5	< 2	*0.11*	< 0.2	< 0.01	<0.4
Angora17	< 0.01	< 0.1	< 0.1	*1.4*	5.8	16.9	*0.18*	< 0.2	< 0.01	0.5
Angora18	< 0.01	< 0.1	< 0.1	*2.7*	10	5.6	*0.41*	< 0.2	< 0.01	0.7
Angora19	< 0.01	< 0.1	< 0.1	*0.84*	6.0	2.3	*0.19*	< 0.2	< 0.01	0.4

Table 2—Continued.

Sample ID	P	Pb	Pr	Rb	Sb	Sc	Se	*SiO_2*	Sm	SO_4
	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	*mg/L*	ug/L	mg/L
Angora01	0.2	<0.05	0.02	1.5	2.0	< 0.6	< 1	*0.27*	0.01	8
Angora02	0.1	<0.05	< 0.01	1.2	2.4	< 0.6	< 1	*0.17*	< 0.01	13
Angora03	0.1	<0.05	< 0.01	0.70	1.5	< 0.6	< 1	*0.32*	< 0.01	6
Angora04	0.2	<0.05	< 0.01	1.9	1.3	< 0.6	< 1	*0.64*	< 0.01	9
Angora05	0.2	<0.05	< 0.01	13.6	1.5	< 0.6	< 1	*0.49*	< 0.01	16
Angora06	0.2	<0.05	< 0.01	1.2	2.0	< 0.6	< 1	*0.18*	< 0.01	7
Angora07	0.1	<0.05	< 0.01	0.32	3.0	< 0.6	< 1	*0.43*	< 0.01	4
Angora08	0.2	<0.05	< 0.01	4.9	1.7	< 0.6	< 1	*0.67*	< 0.01	6
Angora09	0.1	<0.05	< 0.01	0.25	1.2	< 0.6	< 1	*0.37*	0.02	3
Angora10	< 0.01	4.5	< 0.01	5.3	6.7	< 0.6	1.2	*2.4*	< 0.01	22
Angora11	0.2	<0.05	< 0.01	0.80	1.9	< 0.6	< 1	*0.44*	< 0.01	10
Angora12	0.3	<0.05	< 0.01	10.0	1.8	< 0.6	< 1	*0.99*	< 0.01	15
Angora13	0.1	<0.05	< 0.01	19.1	1.6	< 0.6	1.1	*1.3*	< 0.01	18
Angora14	0.07	<0.05	< 0.01	4.4	1.7	< 0.6	< 1	*0.58*	0.02	25
Angora15	0.2	<0.05	< 0.01	1.4	1.7	< 0.6	< 1	*0.17*	< 0.01	7
Angora16	0.2	<0.05	< 0.01	0.41	1.1	< 0.6	< 1	*0.14*	< 0.01	4
Angora17	0.09	<0.05	< 0.01	6.0	1.6	< 0.6	< 1	*1.3*	< 0.01	19
Angora18	0.4	<0.05	< 0.01	8.8	2.9	< 0.6	< 1	*0.35*	< 0.01	28
Angora19	0.07	<0.05	< 0.01	7.4	1.5	< 0.6	< 1	*0.90*	< 0.01	13

Table 2—Continued.

Sample ID	Sr	Ta	Tb	Th	Ti	Tl	Tm	U	V	W
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Angora01	92	0.2	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	49.6	4	0.7
Angora02	110	0.2	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	1.21	1.8	< 0.5
Angora03	56	0.2	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.21	0.8	< 0.5
Angora04	86	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.16	1.9	< 0.5
Angora05	166	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.13	1.8	< 0.5
Angora06	68	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.13	1.5	< 0.5
Angora07	25	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	1.1	< 0.5
Angora08	130	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.12	1.6	< 0.5
Angora09	21	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	1.3	< 0.5
Angora10	52	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	11.2	0.7
Angora11	59	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.17	3.4	< 0.5
Angora12	33	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	1.44	40.6	< 0.5
Angora13	165	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	6.8	< 0.5
Angora14	318	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	2	< 0.5
Angora15	78	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	0.14	1.6	< 0.5
Angora16	48	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	1	< 0.5
Angora17	230	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	3.7	< 0.5
Angora18	308	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	3.7	0.6
Angora19	225	0.1	< 0.005	< 0.2	< 0.5	<0.1	< 0.005	< 0.1	2.9	< 0.5

Table 2—Continued.

Sample ID	Yb	Zn	Zr
	ug/L	ug/L	ug/L
Angora01	0.006	3.1	< 0.2
Angora02	0.01	<0.5	< 0.2
Angora03	< 0.005	<0.5	< 0.2
Angora04	< 0.005	1.2	< 0.2
Angora05	0.007	<0.5	< 0.2
Angora06	< 0.005	<0.5	< 0.2
Angora07	0.01	<0.5	0.5
Angora08	< 0.005	<0.5	< 0.2
Angora09	< 0.005	<0.5	< 0.2
Angora10	0.01	2.0	< 0.2
Angora11	0.007	<0.5	< 0.2
Angora12	< 0.005	0.9	< 0.2
Angora13	< 0.005	<0.5	< 0.2
Angora14	< 0.005	<0.5	< 0.2
Angora15	0.008	<0.5	< 0.2
Angora16	< 0.005	<0.5	< 0.2
Angora17	< 0.005	<0.5	< 0.2
Angora18	0.006	<0.5	< 0.2
Angora19	< 0.005	<0.5	< 0.2