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Geochemical Data for Selected Rivers, Lake Waters, Hydrothermal Vents, and Subaerial Geysers in Yellowstone National Park, Wyoming and Vicinity, 1996–2004

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Chapter L *of*

Integrated Geoscience Studies in the Greater Yellowstone Area—Volcanic, Tectonic, and Hydrothermal Processes in the Yellowstone Geoecosystem

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Geochemical Data for Selected Rivers, Lake Waters, Hydrothermal Vents, and Subaerial Geysers in Yellowstone National Park, Wyoming and Vicinity, 1996–2004

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Abstract

Analyses of more than 400 water samples collected from creeks and rivers draining into Yellowstone Lake, hydrothermal vents and water-column profiles within Yellowstone Lake, and subaerial hot springs and geysers throughout Yellowstone National Park (the Park) are reported. The samples were collected from 1996 to 2004. All of the water samples were collected and analyzed as part of the USGS Mineral Resources Program Project, Integrated Geoscience Studies of the Greater Yellowstone Area. Goals of this study are to provide state-of-the-art chemical determinations of more than 45 elements and species to help understand the influences of hydrothermal processes within Yellowstone National Park.

Hydrothermal vents within Yellowstone Lake were sampled during 1996–2004. Sampling of creeks contributing to Yellowstone Lake began in 1997 and continued through 1999. Four water-column profiles were collected within Yellowstone Lake in both 1997 and 1998. Water samples were collected from subaerial geysers and hot springs throughout Yellowstone National Park during 1998–2002.

In 1999, mixing experiments were conducted using water samples collected from four subaerial hot springs: three in Norris Geyser Basin and one at West Thumb Geyser Basin. These thermal-water samples were mixed with Yellowstone Lake water to simulate processes at sublacustrine vents and to evaluate conservative–nonconservative behavior of elements during mixing. The results of these experiments are discussed in Balistrieri and others (this volume), and the full data sets are presented here.

The data reported in this paper clearly show the influence of hydrothermal processes on waters within Yellowstone National Park. Yellowstone Lake hydrothermal-indicator elements (As, B, Cl, Cs, Cu, Ge, Hg, Li, Mo, Sb, and W) as defined by Balistrieri and others (this volume) delineate areas of hydrothermal influx. The differences in the levels of these elements between the creek data and water-column profiles indicate an influx of hydrothermal water within Yellowstone Lake. The water-column samples have higher values of the hydrothermal-indicator elements than the creeks flowing into the lake; therefore significant input of hydrothermal-indicator elements from the hydrothermal vents within the lake is indicated.

There are large variations in the values of the indicator elements among vents in Yellowstone Lake. The values of the hydrothermal-indicator elements are elevated for all of the vent samples, but a group of the West Thumb vents contain the highest values. This could indicate more active vents and (or) less mixing with lake water during sampling or during ascent to the lake floor. The subaerial features in the Park also show considerable variations in the values of the indicator elements. Some thermal features in the Park, such as Porkchop and Green Dragon Geysers in Norris Geyser Basin, have highly elevated hydrothermal-indicator-element values, while other features have values similar to Yellowstone Lake water, which is 99 percent meteoric water. These differences must reflect varying amounts of hydrothermal activity and input in these areas.

Introduction

Yellowstone National Park (the Park) was first designated as a National Park in 1872 for its scenic beauty and spectacular hydrothermal activity. Ten thousand thermal features and 300 geysers in the more than 2-million-acre park represent over half of the Earth's known hydrothermal

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features and provide unique opportunities for research. Gooch and Whitfield (1888) were the first to carry out chemical analyses of thermal and surficial waters, and Allen and Day (1935) did the first extensive work. Beginning in the 1960s, the intensity of aqueous geochemical studies in Yellowstone has steadily increased (Ball, Nordstrom, Cunningham, and others, 1998; Ball, Nordstrom, Jenne, and Vivit, 1998; Ball and others, 2001, 2002; Balistrieri and others, this volume; Fournier, 1989; Kharaka and others, 1991, 2000; Thompson and others, 1975; Thompson and Yadav, 1979; Thompson and DeMonge, 1996; White and others, 1970, 1971, 1988). However, the development and widespread use of inductively coupled plasma (ICP) spectrographic methods in the late 1980s and early 1990s has led to a renaissance in trace-element geochemistry, with many more elements determined than by previous methods. For example, Balistrieri and others (this volume) have clearly shown that Mo and W are important geothermal elements, whereas most previous studies did not analyze for these elements. Balistrieri and others (this volume) conclude that As, B, Cl, Cs, Cu, Ge, Hg, Li, Mo, Sb, and W are important geothermal elements based on enrichments in Yellowstone Lake waters and in sublacustrine vent fluids. Shanks and others (this volume) would also include Tl, which is enriched in siliceous sinter deposits related to sublacustrine vents.

In the present study, water samples were collected from various sources throughout Yellowstone National Park and were analyzed for a suite of chemical components and stable-isotopic compositions to provide a basic understanding of the influences of hydrothermal processes on the water, sediments, and biota of Yellowstone Lake and surrounding areas. This report summarizes data on the geochemistry of water samples collected from creeks and rivers draining into and out of Yellowstone Lake, hydrothermal vents and water-column profiles within Yellowstone Lake, and subaerial geysers and hot springs throughout the Park. These different sources of water all contribute valuable information to the water chemistry in Yellowstone Lake and the Park as a whole. Sample locations, methods for collecting and analyzing the water samples, and analytical results are reported.

Study Area

All of the samples reported here were collected in Yellowstone National Park, which is situated in the northwest corner of Wyoming. The samples were collected throughout the Park concentrating around Yellowstone Lake and major hydrothermal areas, but with some lesser known hydrothermal areas also included (fig. 1).

Methods

Field Methods

Because very few water-quality data or discharge measurements were available for surface water flow into Yellowstone Lake, samples were collected during July 1997, August–September 1998, and July 1999 from the major streams that enter the lake (fig. 2). Locations were obtained by global positioning satellite (GPS), and the temperature and pH of the water were determined at each site. Point-source or integrated water samples were collected in 500-mL polyethylene bottles and brought to a field-based laboratory for processing. The bottles had been acid-washed and well rinsed with distilled, deionized water before use.

Estimates of stream discharge were made by timing floats and determining the cross-sectional area of the stream (in 1998) or by measuring the flow rate at 1 to 20 locations in a cross section of the stream using a velocity meter (in 1999). The accuracy of the flow estimates varied between years and sampling sites because different individuals used different methods at different times and because some streams could not be waded. Balistrieri and others (this volume) utilized these flow measurements to calculate a chemical mass balance for Yellowstone Lake and assess chemical fluxes. Because the U.S. Geological Survey (USGS) gages the Yellowstone River at its outlet from the lake (station 06186500), continuous discharge measurements from this site are available (http://waterdata.usgs.gov, accessed 5/18/04). Outflows from the lake during our sampling periods were 52±3 and 156±9 m^3/s in 1998 and 1999, respectively. Balistrieri and others (this volume), by comparing total fluxes into the lake from as many as 44 streams, changes in lake level, and flux out of the lake at Fishing Bridge, were able to calculate a total error for all the stream-flow measurements of ±22 percent relative to the measured flow at the gaging station.

Hydrothermal vent samples for this study were collected in the West Thumb, Mary Bay, and Stevenson Island areas (fig. 2). The West Thumb vent samples were from two shallow (≤5 m deep) vents and several vent fields at depths of 29–53 m. Shallow vent fluids from Mary Bay were collected near the shore off Steamboat Point and near Pelican Creek at depths of 7–10 m. Hydrothermal fluids were also collected from a deep hole in Mary Bay at depths of 48–54 m. Samples collected near Stevenson Island were from the deepest vents (95–110 m) in Yellowstone Lake.

All vent samples were collected with a submersible remotely operated vehicle (ROV) designed and piloted by Dave Lovalvo of Eastern Oceanics, Inc. Klump and others (1992) described an early version of that vehicle. Although the exact configuration of the vehicle varied from year to year, it always collected vent-fluid samples using piston-operated plastic syringes that were connected by

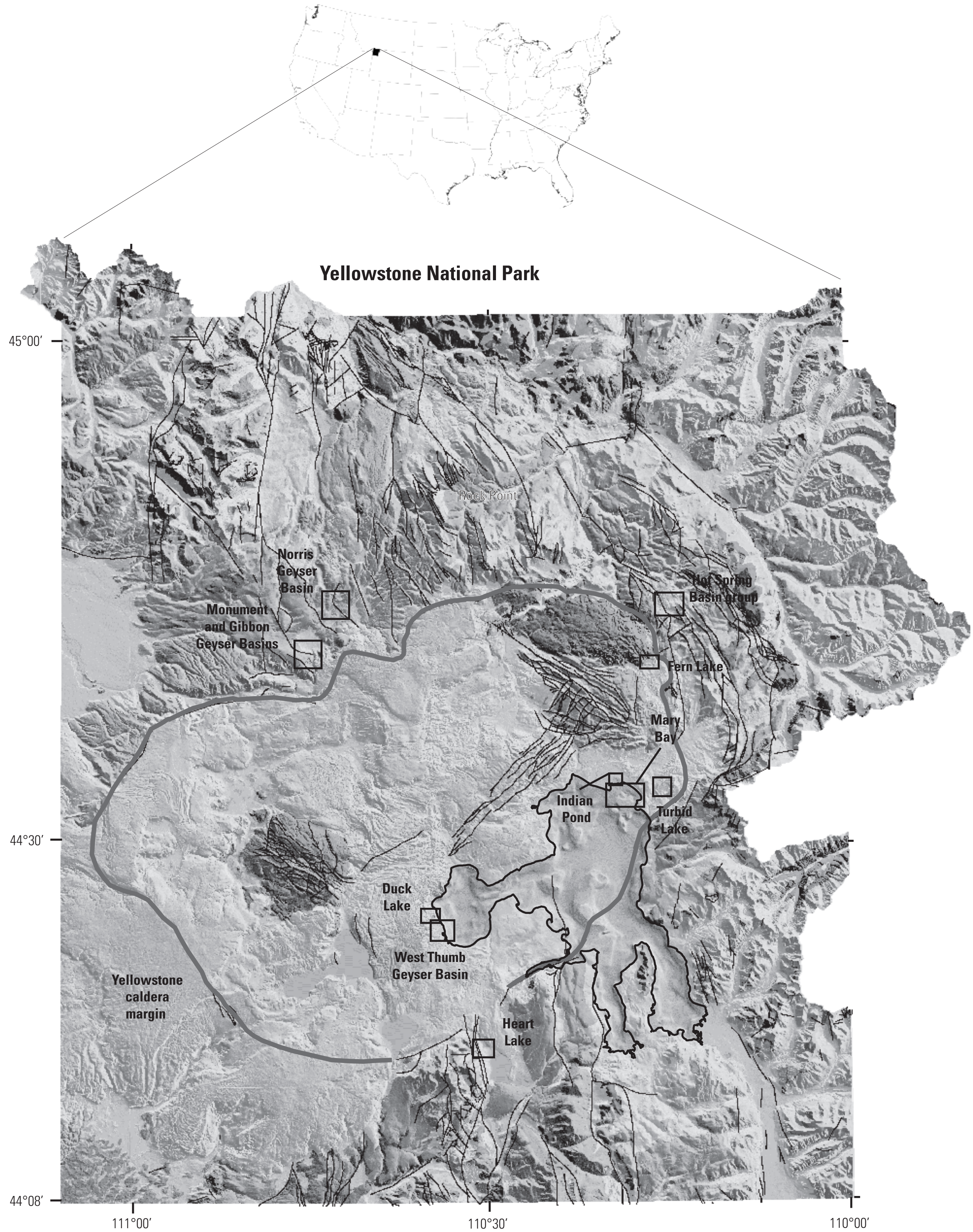

Figure 1. Map of Yellowstone National Park showing topography, faults (narrow black lines), and the caldera margin. Areas where multiple samples were collected are outlined with black rectangles and labeled accordingly.

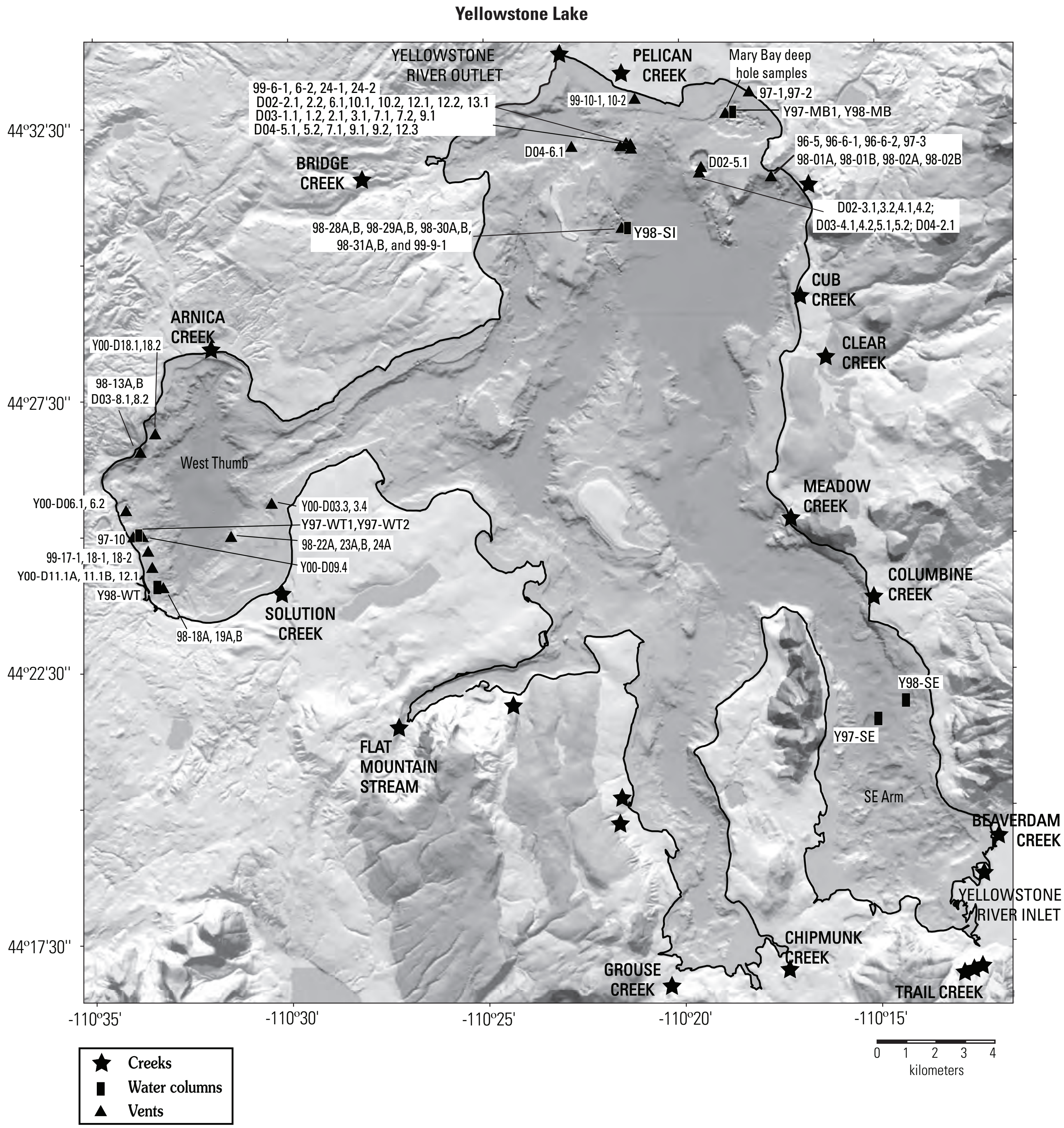

Figure 2. Detailed map of Yellowstone Lake with new bathymetry (see Morgan and others, this volume) showing locations of creeks and samples of water-column profiles and vents. Sampled from 1996–2004.

polypropylene tubing to an articulated and extendible probe. The temperature of each vent was continuously monitored during sample collection, and the probe was maintained in position by remotely maneuvering the submersible while making video observations in the control room of the support boat. After retrieval of the ROV, samples were transferred through 3-way valves from the syringes on the vehicle into other syringes for biological and chemical measurements. The vent samples were returned to the field-based laboratory for processing.

Samples from different depths in the water column of Yellowstone Lake were collected in Southeast Arm, West Thumb, and Mary Bay in July 1997 and 1998 and near Stevenson Island in July 1998 (fig. 2) using a trace-metal-clean hydrobottle (no internal cords) attached either to a Kevlar line, a Hydrolab cable, or the hydrowire on the research boat. All wire types produced consistent results with no evidence of contamination for the elements of interest. The water-column samples in Mary Bay were collected directly above the vents in the deep hole in Mary Bay. The water-column samples near Stevenson Island and from West Thumb were collected close to, but not directly above, known hydrothermal vents. Water-column samples from Southeast Arm were collected at least 10 km from any known hydrothermal vents. Water-column samples were placed in 500-mL acid-cleaned and well-rinsed polyethylene bottles on board the boat and returned to the field-based laboratory. In-place measurements of temperature, pH, conductivity, redox potential, and dissolved oxygen concentrations in the water column were made as a function of depth, using a Hydrolab, prior to collection of water samples. Those profiles were used to determine the depths for collection of water samples and to confirm that the entire water column was oxygenated at every site.

A large-volume (20 L) sample from the Yellowstone River at its outlet from Yellowstone Lake (near Fishing Bridge) (fig. 2) was collected in a low-density polyethylene container in July 1999. The sample was collected using Teflon tubing, an in-line 0.45-µm nylon-filter capsule, and a peristaltic pump. The sample was returned to the field-based laboratory for processing and for use in the mixing experiments described below.

Water samples from two subaerial geysers were collected from West Thumb Geyser Basin (Black Pool and Vandalized Pool) in September 1998. They were immediately filtered on-site using a 0.45-µm nylon filter. During July 1999, water samples were collected from three subaerial geysers in Norris Geyser Basin (Green Dragon, Echinus, and Porkchop Geysers) and from Black Pool at West Thumb Geyser Basin using a peristaltic pump with Teflon tubing and an in-line 0.45-µm nylon-filter capsule. These particular geysers were chosen because they are indicative of the spectrum of hydrothermal fluids observed in the Park. Water samples from Porkchop, Black Pool, and Vandalized Pool are neutral to alkaline and Cl-rich. The hydrothermal fluids from Green Dragon and Echinus are acidic and enriched in SO_4 and Cl. Geyser waters collected in 1999 were immediately mixed with filtered water collected from the Yellowstone Lake outlet at Fishing Bridge in 500-mL polyethylene bottles in proportions ranging from 10- (samples G1–W1) to 100-percent (samples G10–W10) geyser water. The temperatures of the mixtures were maintained by insulating the bottles. The samples were processed at the field-based laboratory less than 2 hours after mixing.

Water samples from many subaerial geysers throughout Yellowstone National Park were collected from 1998 through 2002. The samples generally were collected from the center or most active upwelling area of the geyser pools using an extendable, rigid sampling device. Temperature and pH were measured on site. Samples YNP-00-528.1 and 528.5 are duplicate water samples from an acidic Monument Geyser Basin hot spring. These duplicate samples were used to test for contamination related to an extendible aluminum sampling tool, which we use to place our polyethylene sampling bottles in the hottest portion of the spring. Sample 528.1 was collected using the sampling tool, whereas sample 528.5 was collected from the same spot using a polyethylene bottle on nylon line. Comparison of the data from these 2 samples (see appendix 4) indicates that the sampler is noncontaminating.

Laboratory Methods

Values of pH of vent fluids, water-column samples, and mixed solutions were determined at the field-based laboratory after standardizing a pH meter and electrode using six buffer solutions ranging from pH 1.68 to 10. Subsamples of all water samples were taken for analysis of dissolved elements, Hg, anions, oxygen-isotope values ($\delta^{18}O$), hydrogen isotope values (δD), and either alkalinity or dissolved inorganic carbon. Subsamples of water for sulfur isotopes of sulfide and sulfate ($\delta^{34}S_{H_2S}$, $\delta^{34}S_{SO_4}$) were collected where sufficient water was available. Samples for anion and dissolved-element determinations were obtained by filtering the water through 0.45-µm disposable nylon filters into new polyethylene bottles for anions; into acid-washed, well-rinsed polyethylene bottles for dissolved elements; and into acid-washed glass bottles with Teflon caps for Hg. Samples for dissolved Hg analyses were preserved with Ultrex concentrated HNO_3, saturated with sodium dichromate, to prevent volatilization of Hg. Anion samples were kept cool prior to analysis, whereas samples to be analyzed for dissolved elements were preserved by adding one drop of redistilled concentrated nitric acid per 10 mL of sample solution. Anion analyses of vent and water-column samples from 1996–1999 were by ion chromatography at the field-based laboratory. Anion analyses of all other water samples were by ion chromatography in the USGS laboratories in Denver, Colo. (Theodorakos, 2002). Dissolved elements were determined at the USGS laboratories in Denver, using inductively coupled plasma–atomic

Table 1. Analytical methods.

Descriptor	Method	Species determined (reported)	Equipment used	References or comments
ICP-MS	Inductively coupled plasma–mass spectrometry	Ag, Al, As, Au, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Ho, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pr, Rb, Re, Sb, Sc, Se, SiO_2, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr	Perkin Elmer Elan 6000 inductively coupled plasma–mass spectrometer	Lamothe and others (2002)
ICP-AES	Inductively coupled plasma–atomic emission spectrometry	B, Ca, K, Mg, Na	Perkin Elmer Optima 3000 simultaneous inductively coupled plasma–atomic emission spectrometer	Briggs (2002)
IC-Aq	Ion chromatography	F^-, Cl^-, NO_3^-, SO_4^{2-}	Dionex Model 2021 or equivalent, guard column AG4A or equivalent, separator column AS4A or equivalent, Dionex anion fiber suppressor (AFS-1) or Dionex micromembrane suppressor (AMMS-1)	Theodorakos (2002)
Hg-CVAFS	Mercury by cold vapor atomic fluorescence spectroscopy	Hg	Lachat QuikChem mercury analyzer with fluorescence detector	Hageman (2002)
ISO1	Oxygen isotopes	$\delta^{18}O$	MultiPrep coupled to a Micromass Optima isotope ratio mass spectrometer	Online method adapted from offline method in Epstein and Mayeda (1953)
ISO2	Hydrogen isotopes	δD	Finnigan MAT 252 isotope ratio mass spectrometer	Kendall and Coplen (1985)
ISO3	Sulfur isotopes on sulfide materials	$\delta^{34}S_{H_2S}$	Carlo Erba NC2500 elemental analyzer coupled to a Micromass Optima isotope ratio mass spectrometer	Giesemann and others (1994)
ISO4	Sulfur isotopes on sulfate materials	$\delta^{34}S_{SO_4}$	Carlo Erba NC2500 elemental analyzer coupled to a Micromass Optima isotope ratio mass spectrometer	Giesemann and others (1994)
ISO5	Carbon isotopes of dissolved total carbonate	$\delta^{13}C_{CO_3}$	A Matt Emmons acid injection multiprep device coupled to a Micromass Optima isotope ratio mass spectrometer	McCrea (1950). There is no reference for the Matt Emmons acid injection device. It consists of a heating block held at 90°C and an autosampler with a double needle that evacuates, injects acid, and then samples the evolved gas.

emission spectrometry (ICP–AES) for major ions and B (Briggs, 2002), inductively coupled plasma–mass spectrometry (ICP–MS) for minor elements (Lamothe and others, 2002), and cold vapor-atomic fluorescence spectroscopy (CVAFS) for Hg (Hageman, 2002).

Water samples for oxygen and hydrogen isotope analyses were placed in 20-mL glass scintillation vials, tightly capped, and analyzed at the USGS laboratories in Denver by isotope ratio mass spectrometry. Water samples were prepared for hydrogen-isotopic analyses using the Zn-reduction technique (Kendall and Coplen, 1985) and for oxygen-isotope analyses using an automated CO_2 equilibration technique (adapted from Epstein and Mayeda, 1953). Values of $\delta^{18}O$ and δD are relative to Vienna Standard Mean Ocean Water (VSMOW); they have reproducibility of approximately 0.2 and 1.0 per mil, respectively. Water samples for sulfur isotope analyses were initially collected in 40-mL glass vials with septa caps, but the 40-mL vials were replaced by 250-mL bottles with septa caps in 2003. The 250-mL bottles also allowed the determination of carbon isotope values of dissolved total carbonate ($\delta^{13}C_{CO_3}$). All water samples for sulfur and carbon isotopes were analyzed at the USGS laboratories in Denver by isotope ratio mass spectrometry following precipitation of Ag_2S from H_2S, $BaSO_4$ from dissolved total SO_4, and $BaCO_3$ from dissolved total CO_3. Sulfur-isotope analyses were performed by combustion using continuous flow techniques described by Giesemann and others (1994). Carbon-isotope analyses were performed by using an on-line acid-digestion method similar to the off-line method described by McCrea (1950). Values of $\delta^{34}S_{H_2S}$ and $\delta^{34}S_{SO_4}$ are relative to the standard Canyon Diablo troilite (CDT) with reproducibility of 0.2 per mil. Values of $\delta^{13}C_{CO_3}$ are relative to Vienna Peedee belemnite (VPDB); they have reproducibility of 0.1 per mil or better.

Alkalinity was determined using either a Chemetrics test kit (hot spring and stream samples) or by Gran titration (Stumm and Morgan, 1996) at the field-based laboratory (water-column and mixing-experiment samples). Dissolved total inorganic carbon content of vent fluids and water-column samples was determined by flow-injection analyses at the field-based laboratory. Table 1 provides a summary of the analytical methods.

Blank samples using distilled, deionized water were included with each batch of 20 samples. The blank samples had element concentrations below detection limits. Standard reference solutions, either from the USGS or from the National Institute of Standards and Technology, were included in each batch of samples. The standards, as well as duplicates of samples, were used to determine accuracy and precision of the analyses.

Results

Appendixes 1–4 tabulate the geochemical data discussed here and in Balistrieri and others (this volume). Each table contains detailed site data and water analyses. The data in this chapter are reported in mass/volume units, which provide a convenient conversion for the data in Balistrieri and others (this volume) that are reported in mol/volume units. Abbreviations for the methods (column 3) correspond to those listed in table 1. Blanks in the data fields exist because not all samples were analyzed by each method, and there were variations in the elements detected by ICP-MS. Samples within each table are sorted by location and then by sample collection date. Longitude and latitude in these tables and in figures 1–6 are referenced to the Clarke 1866 spheroid and North American 1927 datum.

Appendix 1 contains data for the water-column profiles and the creeks flowing into Yellowstone Lake. The pH values range from 2.5 to 8.5, with the majority of samples being in the neutral range (6.5 –7.5). Approximately neutral pH values are expected for samples of fresh water, whereas low values generally reflect hydrothermal influences related to oxidation of H_2S to produce H_2SO_4.

The values for boron and the major cations (Ca, K, Mg, Na) are highly variable. Boron values in the creeks range from <10 to 960 µg/L, with the majority of the values being <10 µg/L. Pelican Creek and Sedge Creek are the sources of the highest values for B (960 µg/L and 650 µg/L, respectively). The range in B values for the water-column data is <10 to 130 µg/L, with the bulk of the values between 50 and 100 µg/L. Boron is a hydrothermal-indicator element (Balistrieri and others, this volume). Therefore, B concentrations in Pelican Creek, Sedge Creek, and the water-column profiles indicate hydrothermal input.

Calcium values in both the creek data and water-column profiles are generally less than 10 mg/L. Potassium is low in both the creek and water-column samples. The highest K value for the creek data is 11 mg/L; in the water-column data, the highest value is 4.3 mg/L (MB-1). Magnesium values range from 1 to 50 mg/L in the creeks; most of the samples have values under 10 mg/L. The majority of the water-column data show a Mg range of 1.9 to 2.5 mg/L. Sodium values in the creek data are generally less than 10 mg/L, and the highest value is 41 mg/L (Pelican Creek). The majority of the water-column data have Na values between 6 and 10 mg/L.

In general, the values of the hydrothermal-indicator elements B, As, Cl, Cs, Cu, Ge, Li, Mo, Sb, and W show an increase from the creek data to the water-column-profile data, indicating that these elements are added within the lake from hydrothermal vents on the lake bottom (Balistrieri and others, this volume). This pattern is evident in appendix1 when comparing these elements between the creek and water-column data. For As, Cl, Cs, Mo, Sb, and W, the majority of the creek data have values very close to the lower limit of determination, whereas the water-column data have higher values. The values of these hydrothermal-indicator elements in the water-column data are not excessive, only generally higher than the creek data, indicating an addition of these elements from within the lake. A few of the creek samples, such as Pelican Creek and Sedge Creek, have values more consistent with or higher than the water-column data. There are higher values of Li in both the creek and water-column data than the other indicator elements. In the creek data, the Li values range from <0.1 to 190 µg/L, but the majority of the values are less than 20 µg/L. Some of the creek data have values in the 30–60 µg/L range, which is the same range as the water-column data.

The data from hydrothermal vents within Yellowstone Lake are presented in appendix 2. The range in pH values is 4.9 to 8.6. Boron is elevated in some of the vent samples, ranging from 35 to 730 µg/L. The highest value is from a West Thumb vent (sample 98-19a). Values for Ca range from 3.2 to 23 mg/L. The range in values of K and Mg is fairly narrow, <1 to 3.9 mg/L. Sodium values range from 6.0 to 160 mg/L, but the highest value is an anomaly. The majority of Na values are 7–10 mg/L.

West Thumb samples have higher values of most or all of the hydrothermal-indicator elements than other sublacustrine vent areas. Samples 96-2-6a, 97-10, 98-19a, YNP-99-17-1, Y00-D06.1, Y00-D06.2, and Y00-D09.4 have the highest hydrothermal-indicator-element values. Most vent samples have As values between 3.7 and 54 µg/L, but the West Thumb group listed above has values from 72 to 210 µg/L. Chlorine values in the majority of the vent samples range from 3 to 8 mg/L. Chlorine values greater than 23 mg/L are found only in West Thumb samples. The values of Cs for the bulk of the vent samples are less than 10 µg/L. All Cs values above 16 µg/L are West Thumb samples. Li values are quite high in some of the West Thumb samples, ranging from 110 to 1,200 µg/L. The majority of the rest of the vent samples have Li values between 34 and 77 µg/L. Two samples from Elliot's Crater rim (D02-3.2, D02-4.2) have Li values greater than 100 µg/L. Values for Mo are low in most vent samples, with a range of 0.04 to 7.5 µg/L. The highest Mo values (12–36 µg/L) are seen in a few of the West Thumb samples. The range in Sb values for the majority of the vent samples is <0.02–2.6 µg/L. The West Thumb samples listed above have Sb values from 4.2 to 400 µg/L. The values of W in the bulk of the vent samples are low, ranging from 1.0 to 6.4 µg/L. Any values of W greater than 6.4 µg/L correspond to West Thumb samples.

Appendix 3 presents data from the 1999 mixing experiments. The locations of the three geysers sampled from Norris Geyser Basin (Echinus, Green Dragon, and Porkchop) are shown in figure 3. The four geysers used in the mixing experiments were chosen because they represent the spectrum of hydrothermal fluids found in Yellowstone Park. Green Dragon and Echinus Geysers were chosen as the acidic, SO_4- and Cl-rich end member and have pH values of 2.6 and 3.2, respectively. Porkchop Geyser and Black Pool (West Thumb Geyser Basin) represent the neutral to alkaline, Cl-rich end member. Porkchop and Black Pool have pH values of 6.6 and 7.9, respectively.

The geyser waters were mixed with Yellowstone Lake water in varying amounts, so in appendix 3, samples G1, E1, P1, and W1 represent 10-percent geyser water and 90-percent lake water, and G10, E10, P10, and W10 are pure geyser water. Therefore the data in each of the series, progressing from 1 to 10, reflects the increase in geyser water, in 10-percent increments.

Boron is highly enriched in all four of the geyser waters (78–9,360 µg/L); therefore an increase in the value of B is seen in the progression from sample 1 through 10 for each mixing experiment. Calcium, with values from 0 to 5 mg/L, either decreases as geyser water increases or just fluctuates (Porkchop). Magnesium values also decrease through the mixing experiments. The values of K and Na increase with increasing amounts of geyser water. Sodium is quite enriched in the geyser waters, ranging from 159 to 406 mg/L.

Most of the hydrothermal-indicator elements are elevated in the geyser waters as is expected for hydrothermal features. Therefore enrichment in the values of the indicator elements increases as the amount of geyser water increases. The Echinus mixing experiment is the exception for the elements Mo, Sb, and W. The values of these three elements either fluctuate or decrease slightly through the Echinus mixing experiment, indicating similarities in the values of these elements between the lake outflow water and Echinus Geyser.

The As values range from 300 to 2,900 µg/L, Cl from 150 to 660 mg/L, and Cs from 81 to 500 µg/L. Values of Li are the highest of the hydrothermal-indicator-element values, varying from 1,000 to 7,000 µg/L. Molybdenum, Sb, and W are less elevated with ranges of 6.1–240 µg/L, 0.64–130 µg/L, and 5.8–350 µg/L, respectively. Of the four geysers sampled, Echinus Geyser has the lowest values for all hydrothermal-indicator elements. Porkchop Geyser has the highest values for As, Cl, Cs, Li, Mo, and Sb. The highest values for W are from Black Pool.

Data from subaerial features in Yellowstone National Park are summarized in appendix 4. The pH values range from 1.1 to 9.9. Boron values are high for many of the subaerial samples, which is consistent with B being a hydrothermal-indicator element. The range in B values is <10 to 9,360 µg/L. Values for Ca and K range from 1 to 60 mg/L. Magnesium values show the narrowest range, varying from <0.1 to 18 mg/L. Sodium values range from <0.1 to 430 mg/L.

The ranges in the values of the hydrothermal-indicator elements for the subaerial samples are fairly wide and highly variable between samples, even within the same area. The values of As range from 0.4 to 3,100 µg/L. The values of Cl and Cs vary from <0.08 to 660 mg/L and from 0.01 to 580 µg/L, respectively. Lithium values show the larg-

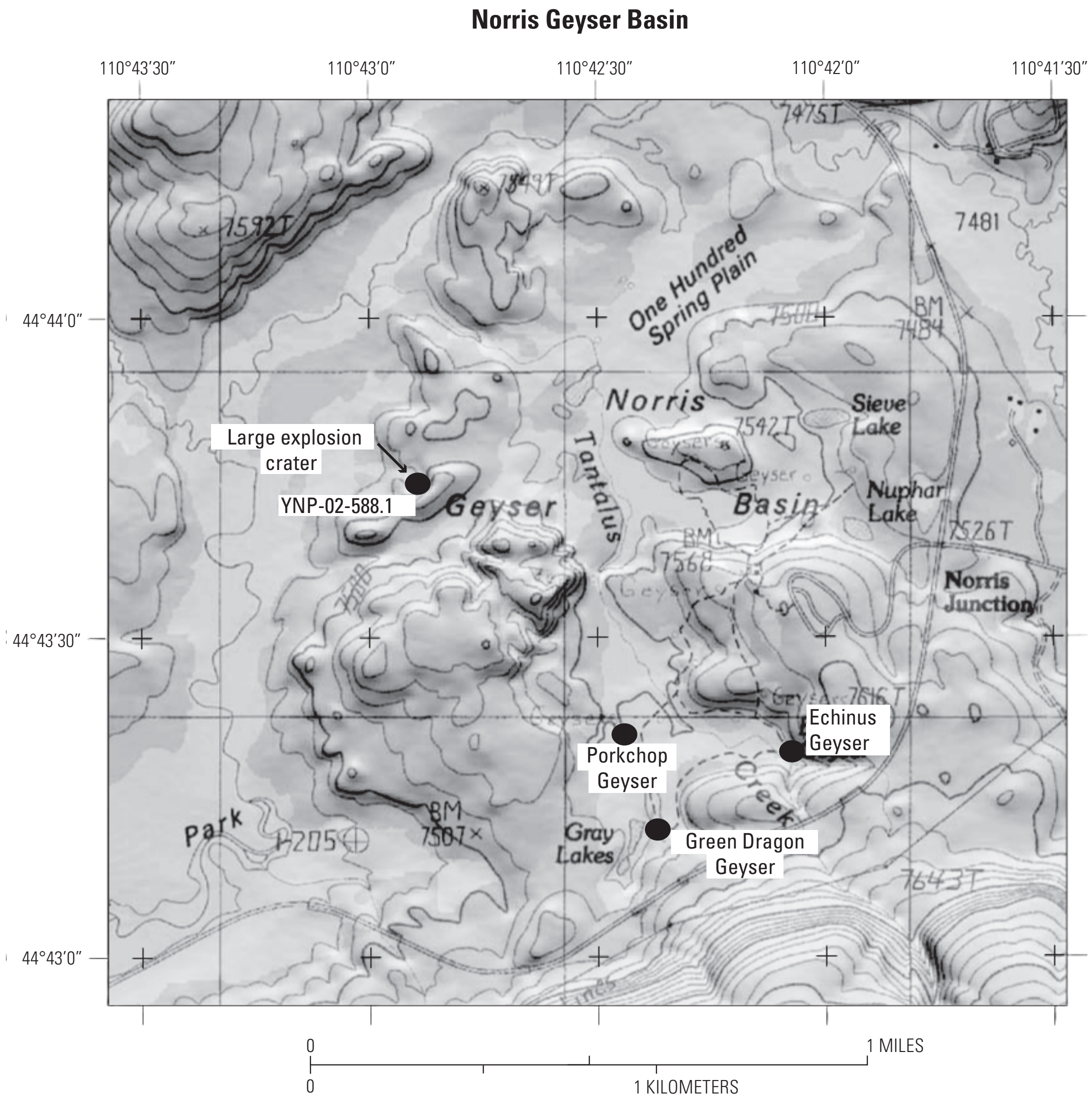

Figure 3. Map of the Norris Geyser Basin area showing sample locations of geysers and explosion crater. Echinus, Green Dragon, and Porkchop Geysers were sampled multiple years including 1999 for the mixing experiments.

est range, with a variation from 0.9 to 10,000 µg/L. The ranges in values for Mo, Sb, and W are smaller than the other indicator elements. Molybdenum values vary from <0.02 to 290 µg/L, whereas the range in Sb values is from <0.02 to 160 µg/L. Values of W vary from 0.2 to 390 µg/L. The variability in the data from the subaerial samples is related to the amount of hydrothermal influence in the samples. The four geysers used in the mixing experiments are also included in appendix 4 because they were sampled at other times unrelated to the mixing experiments. Porkchop Geyser has the highest values for As, B, Cl, Cs, Cu, Ge, Hg, Li, Mo, and Sb, and values of W are highest in Black Pool. The Heart Lake area has some samples with high levels of hydrothermal-indicator elements. Other areas sampled have lower levels of the indicator elements suggesting weaker hydrothermal activity. The differences in the hydrothermal-indicator elements could also be related to water sources and perhaps can help in source-water studies.

The geysers of Norris Geyser Basin reflect the spectrum of hydrothermal fluids found in Yellowstone National Park. Four geysers were sampled in Norris Geyser Basin (fig. 3)—three along the southern boardwalk of Back Basin and one in a large explosion crater to the west of Porcelain Basin. Both acidic and neutral to alkaline fluids are found in the geysers in Norris Geyser Basin. Porkchop Geyser has a neutral pH and very high values of the hydrothermal-indicator elements. Echinus Geyser is acidic and has much lower hydrothermal-indicator-element values than Porkchop.

Heart Lake Geyser Basin is shown in figure 4. Two geysers were sampled in both the Rustic Geyser area and a central geyser area. One geyser from the upper basin was

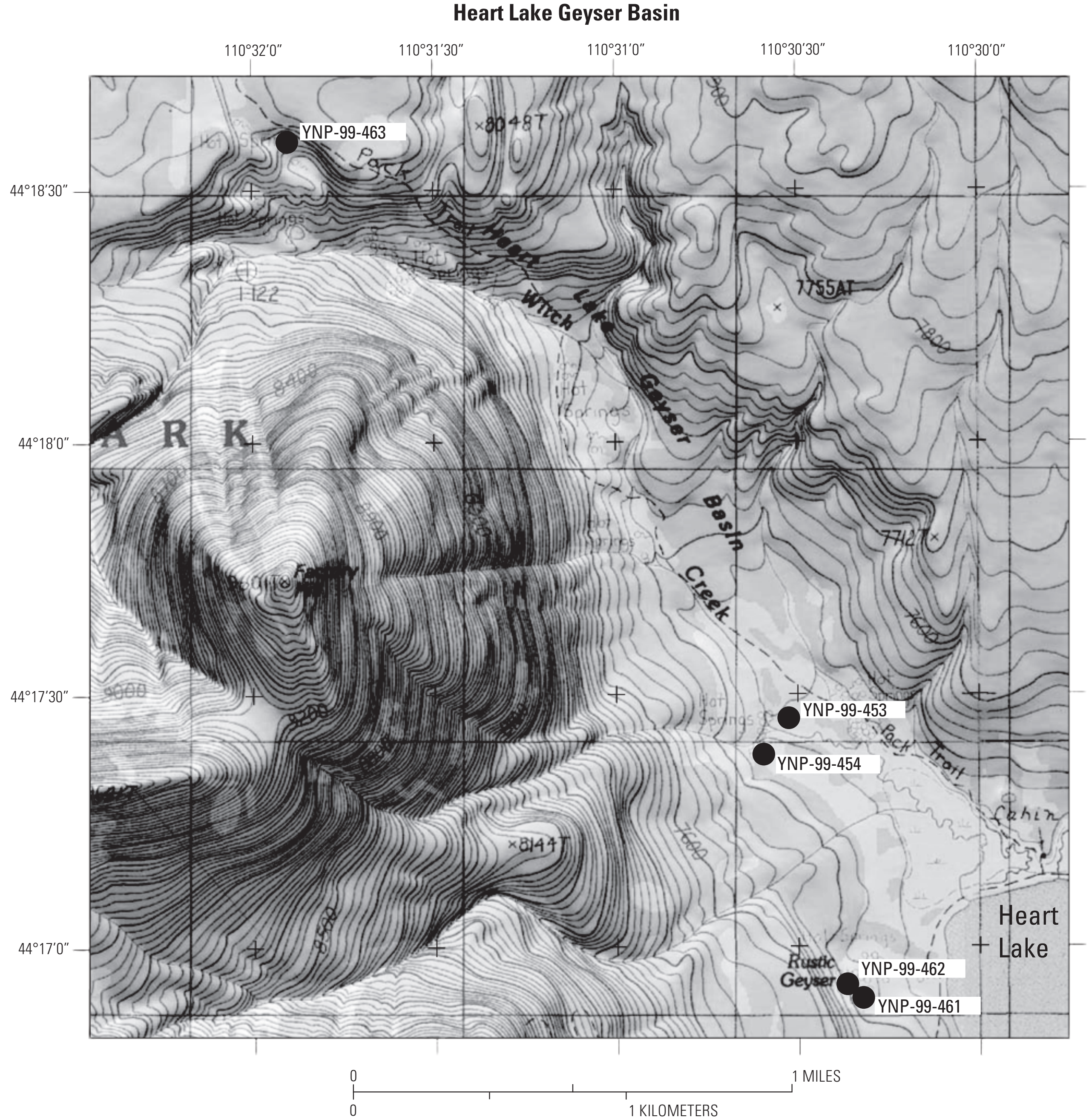

Figure 4. Map of Heart Lake Geyser Basin in northwest corner of Heart Lake. Locations of the five geysers sampled in 1999 are shown.

sampled. Representing the range of hydrothermal fluids found in the Park, two of the geysers are acidic and three are neutral to alkaline. The geyser from the upper basin is the most acidic, with a pH of 2.1, and has the lowest hydrothermal-indicator-element values. Three geysers have very similar high hydrothermal-indicator-element values: the alkaline geyser from the central geyser area (YNP-99-454) and the alkaline and acidic geysers from the Rustic Geyser area (YNP-99-461 and YNP-99-462).

Figure 5 shows both Gibbon and Monument Geyser Basins. Of the geysers sampled, thirteen were in Monument Geyser Basin, six were near the Gibbon River, one was at Artists Paintpots, and two samples were from Gibbon Geyser Basin. The geysers sampled in Monument Geyser Basin are all acidic (pH=1.1 to 2.5). The majority of the geysers near the Gibbon River are neutral to alkaline (pH=6.1 to 7.2), as is the geyser at Artists Paintpots (pH=7.3). In Gibbon Geyser Basin, one sample is near neutral (pH=6.1) and the other is acidic (pH=3.7).

Eight samples were collected around Turbid Lake, and their locations are shown in figure 6. Two samples each were collected at Sedge Creek inlet, Bear Creek inlet, and

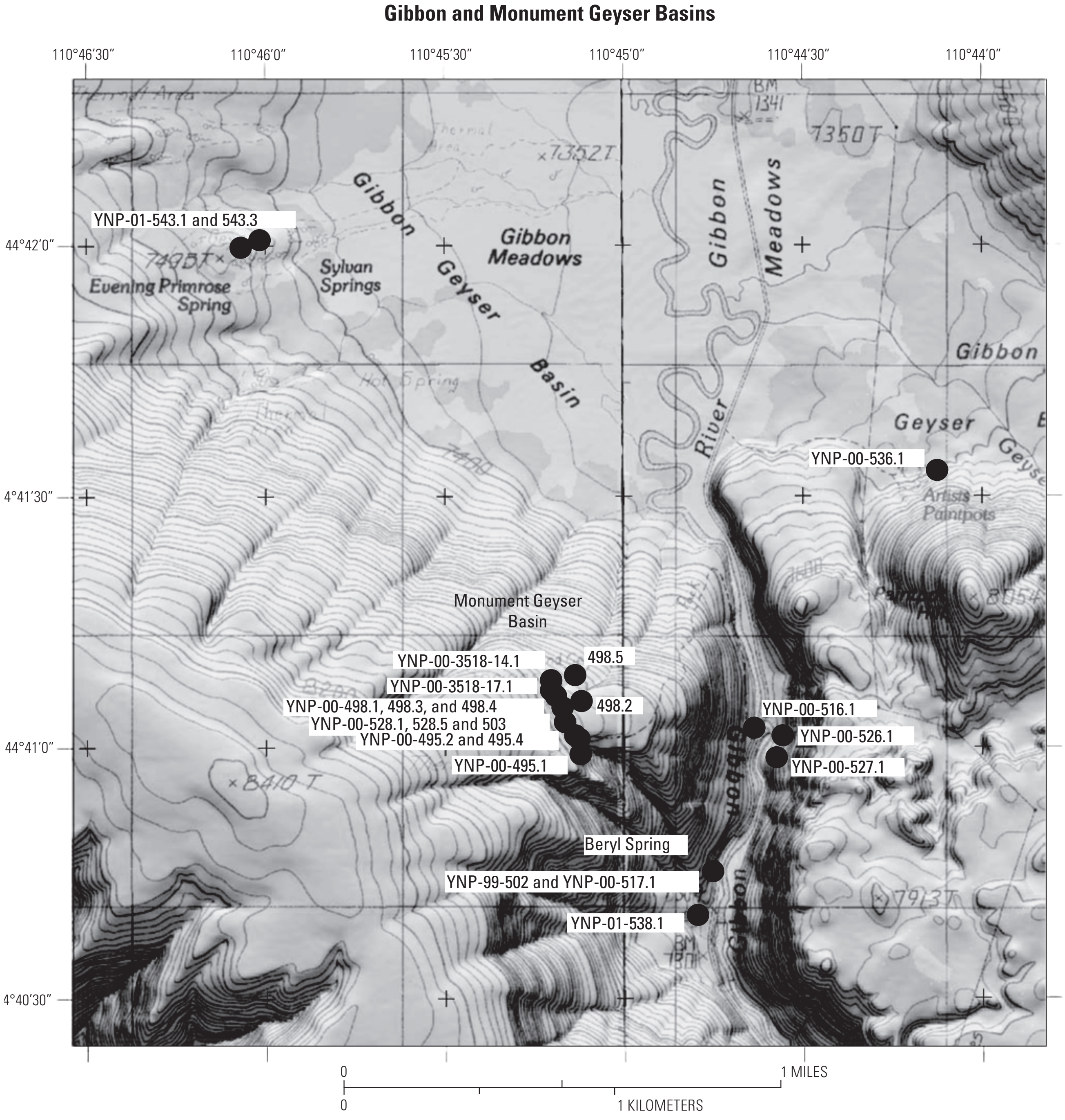

Figure 5. Map of Gibbon and Monument Geyser Basins area. Sample locations are shown in both geyser basins, along the Gibbon River at Beryl Spring, and at Artists Paintpots. Monument Geyser Basin was sampled in multiple years, most extensively in 2000.

the mudpots on the southeast shore. Two samples of lake water were also collected. The samples collected at the inlets to Turbid Lake have the lowest values for the hydrothermal-indicator elements. The mudpots have the highest hydrothermal-indicator-element values, and the lake has intermediate values. Therefore, there must be some input of hydrothermal water within the lake.

Summary

This chapter summarizes data on the geochemistry of more than 400 water samples collected from 1996 to 2004 from creeks and rivers draining into and out of Yellowstone Lake, hydrothermal vents and water-column profiles within Yellowstone Lake, and from subaerial geysers and hot springs

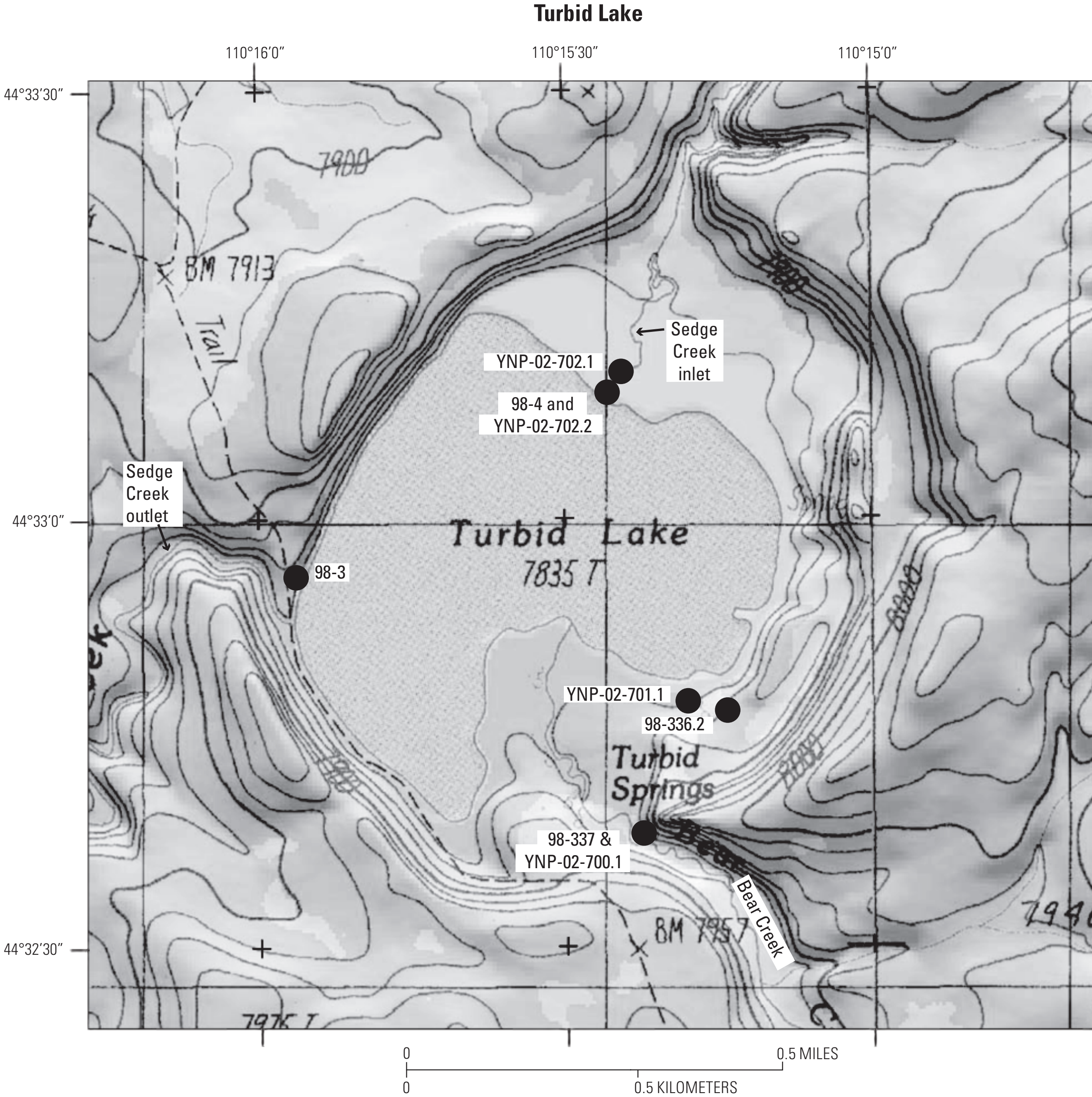

Figure 6. Detailed map of Turbid Lake showing inlets from Sedge and Bear Creeks at the north and south, respectively. The outlet to Sedge Creek is on the west side of the lake. Samples were collected in 1998 and 2002 at approximately the same locations.

throughout the Park. These different sources of water all contribute valuable information to the water chemistry in Yellowstone Lake and the Park as a whole. Goals of the geochemical fluid studies were to provide state-of-the-art chemical determinations of over 45 elements and species to help understand the influences of hydrothermal processes within Yellowstone National Park.

The values of the hydrothermal-indicator elements As, B, Cl, Cs, Cu, Ge, Li, Mo, Sb, and W can highlight hydrothermal activity in the Park (Balistrieri and others, this volume). An increase in the values of these indicator elements from the creek data to the water-column-profile data of Yellowstone Lake indicate that these elements are likely added within the lake from hydrothermal vents on the lake bottom. The increase in concentration of the geothermal-indicator elements in certain areas of the lake (West Thumb) and Park (Heart Lake and Norris Geyser Basins) suggest highly active hydrothermal features.

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Appendixes

Appendix 1. Site and analytical data from creeks and water column profiles.

Field no.			RS-16-97	RS-32-97	RS-35-97	RS-39-97	RS-40-97	30	37	39	41	40	38	RS-1-98
Drainage/ description			Yellowstone River inlet	Columbine Creek	Clear Creek	Sedge Creek	Pelican Creek	Yellowstone River outlet	Columbine Creek	Clear Creek	Sedge Creek	Pelican Creek	Yellowstone River outlet	Solution Cr
Latitude			44°18'28"N	44°24'3"N	44°28'35"N	44°31'26"N	44°33'38"N	44°34'3"N	44°24'3"N	44°28'35"N	44°31'26"N	44°33'38"N	44°34'3"N	44°24'22"N
Longitude			110°10'49"W	110°15'7"W	110°16'8"W	110°16'43"W	110°21'9"W	110°22'48"W	110°15'7"W	110°16'8"W	110°16'43"W	110°21'9"W	110°22'48"W	110°30'1"W
NPS no.			40	1099	1095	1089	1085		1099	1095	1089	1085		1163
Date			07/15/97	07/15/97	07/16/97	07/19/97	07/19/97	07/19/97	07/15/97	07/16/97	07/19/97	07/19/97	07/19/97	08/25/98
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			-	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	integrated
Collector			Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzalone	Sanzolone
pH			7.05	7.07	7.01	3.70	7.03	7.29	-	-	-	-	-	6.25
Conductivity	uS/cm		-	-	-	134	213	89	-	-	-	-	-	-
Temperature	°C		-	-	-	15.5	16.5	14.2	-	-	-	-	-	12.3
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-	6.7
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-	35
Sum CO_2	mM		-	0.34	0.58	0.12	1.53	1.04	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-
Comments			-	-	-	-	-	-	-	-	-	-	-	difficult flow measure-ment
Cl	mg/L	IC-Aq	-	-	-	3.4	11.4	4.4	-	-	-	-	-	0.6
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-	0.3
NO_3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-	< 0.1
SO_4	mg/L	IC-Aq	1.2	17.4	1.8	37.2	46.8	6.7	-	-	-	-	-	1.6
Ag	ug/L	ICPMS	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	16	1200	18	320	320	19	1800	160	470	2500	84	16
As	ug/L	ICPMS	0.3	< 0.2	0.3	9.2	14	12	0.3	0.2	12	29	13	2
Au	ug/L	ICPMS	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02
B	ug/L	ICPAES	0	< 10	< 10	280	480	83	< 10	< 10	270	480	82	20
Ba	ug/L	ICPMS	6.8	12	8.4	18	34	8.9	13	10	19	40	9.1	10
Be	ug/L	ICPMS	0.00	< 0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.05	0.05	< 0.05	0.07	0.05	< 0.05
Bi	ug/L	ICPMS	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	3.9	5.4	6.7	4.9	12	5.6	5.8	6.9	4.7	13	5.6	8.2
Cd	ug/L	ICPMS	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.1	2.9	0.2	1.0	0.2	0.05	4.6	0.60	1.4	1.6	0.2	0.3
Co	ug/L	ICPMS	0.0	0.2	0.02	0.4	0.2	< 0.02	0.3	0.08	0.4	0.3	0.06	0.1
Cr	ug/L	ICPMS	0.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1
Cs	ug/L	ICPMS	0.00	0.01	< 0.01	1.9	3.7	2.6	0.02	0.01	2.0	3.8	2.6	0.2
Cu	ug/L	ICPMS	0.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5	0.6
Dy	ug/L	ICPMS	0.01	0.18	0.073	0.12	0.03	< 0.005	0.29	0.12	0.15	0.17	0.008	0.02
Er	ug/L	ICPMS	0.01	0.12	0.058	0.081	0.01	0.005	0.17	0.075	0.073	0.10	0.007	0.02
Eu	ug/L	ICPMS	0.00	0.02	< 0.005	0.01	< 0.005	< 0.005	0.03	0.01	0.02	0.02	0.005	< 0.005
Fe	ug/L	ICPMS	28	170	27	360	110	11	400	110	640	1000	40	130
Ga	ug/L	ICPMS	0.00	0.04	< 0.02	< 0.02	< 0.02	< 0.02	0.08	< 0.02	0.03	0.04	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.02	0.22	0.094	0.13	0.02	< 0.005	0.35	0.14	0.17	0.19	0.02	0.02
Ge	ug/L	ICPMS	0.00	< 0.02	< 0.02	0.2	0.4	0.2	< 0.02	< 0.02	0.2	0.4	0.2	< 0.02
Hf	ug/L	ICPMS	0.00	< 0.05	14	2.1	10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5.7	< 0.05
Ho	ug/L	ICPMS	0.00	0.04	0.02	0.03	0.005	< 0.005	0.055	0.02	0.03	0.03	< 0.005	0.006
In	ug/L	ICPMS	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.1	1.1	0.56	1.3	6.6	1.7	1.2	0.61	1.4	6.4	1.6	1.8
La	ug/L	ICPMS	0.09	1.6	0.2	0.50	0.1	0.04	2.3	0.50	0.66	0.72	0.09	0.1
Li	ug/L	ICPMS	0.2	0.9	1.3	25	68	35	0.8	1.1	25	68	35	2.5
Mg	mg/L	ICPAES	1.6	2.7	1.5	2.1	7.2	2.4	2.8	1.5	2.1	7.0	2.3	2.8
Mn	ug/L	ICPMS	2.5	34	4.3	42	46	0.75	36	9.1	43	52	2.3	9.9
Mo	ug/L	ICPMS	0.2	0.2	0.4	0.4	0.50	1.1	0.2	0.5	0.4	0.5	1.1	0.59
Na	mg/L	ICPAES	2.4	3.4	2.6	6.2	22	9.0	3.5	2.6	5.8	21	8.6	2.9
Nb	ug/L	ICPMS	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.06	1.4	0.26	0.63	0.08	< 0.01	2.0	0.55	0.78	0.82	0.04	0.1
Ni	ug/L	ICPMS	0.6	0.9	0.2	1.1	1.3	0.5	1.0	0.3	1.2	1.6	0.5	1
P	ug/L	ICPMS	180	100	47	110	58	84	170	66	250	220	90	-
Pb	ug/L	ICPMS	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	0.02	0.34	0.05	0.1	0.02	< 0.01	0.52	0.1	0.2	0.20	0.02	0.03
Rb	ug/L	ICPMS	1.5	2.5	1.0	3.2	24	5.2	2.5	1.1	3.2	24	5.2	2.6
Re	ug/L	ICPMS	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.00	< 0.02	0.03	0.2	0.3	0.53	< 0.02	< 0.02	0.2	0.3	0.52	0.1
Sc	ug/L	ICPMS	0.6	0.7	0.6	0.6	2	0.3	0.7	0.4	0.6	2	0.3	1
Se	ug/L	ICPMS	0.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	< 0.2
SiO_2	mg/L	ICPMS	18	20	12	20	52	11	20	12	20	53	11	18
Sm	ug/L	ICPMS	0.02	0.22	0.05	0.1	0.03	< 0.01	0.34	0.08	0.2	0.1	0.01	0.02
Sn	ug/L	ICPMS	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	27	43	71	40	110	38	44	71	39	110	39	42
Ta	ug/L	ICPMS	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.00	0.03	0.01	0.02	< 0.005	< 0.005	0.053	0.02	0.02	0.03	< 0.005	0.005
Te	ug/L	ICPMS	0.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.00	< 0.005	0.02	0.03	0.04	< 0.005	0.02	< 0.005	0.02	0.06	0.007	< 0.005
Ti	ug/L	ICPMS	0.0	1.4	< 0.1	0.2	< 0.1	< 0.1	5.3	1.4	3.4	1.7	0.5	0.2
Tl	ug/L	ICPMS	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	0.00	0.02	0.008	0.01	< 0.005	< 0.005	0.02	0.01	0.01	0.02	< 0.005	< 0.005
U	ug/L	ICPMS	0.02	0.02	0.07	0.03	0.05	0.02	0.04	0.09	0.05	0.08	0.02	0.05
V	ug/L	ICPMS	3	1	1	1	2	1	2	1	2	3	1	1
W	ug/L	ICPMS	0.08	0.06	0.03	0.58	0.2	1.8	< 0.02	0.1	1.1	0.2	1.7	0.1
Y	ug/L	ICPMS	0.06	1.1	0.50	0.69	0.1	0.04	1.6	0.78	0.82	0.96	0.07	0.1
Yb	ug/L	ICPMS	0.0	0.1	0.05	0.06	0.02	< 0.01	0.1	0.08	0.08	0.08	< 0.01	0.01
Zn	ug/L	ICPMS	0.0	0.8	< 0.5	1	1	< 0.5	2	< 0.5	0.9	3	1	0.9
Zr	ug/L	ICPMS	0.00	< 0.05	0.2	0.08	0.2	< 0.05	0.08	< 0.05	0.05	< 0.05	0.1	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-	-	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-19.6	-18.89	-18.77	-18.55	-18.06	-16.38	-	-	-	-	-	-15.3
δD vs VSMOW	permil	ISO2	-143	-131.4		-140.4	-135.3	-128.8	-	-	-	-	-	-124.0
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-3.4	4.3	3.3	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-3.6	5.6	3.3	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			RS-2-98	RS-3-98	RS-4-98	RS-5-98	RS-6-98	RS-7-98	RS-8-98	RS-9-98	RS-10-98	RS-11-98	RS-12-98	RS-13-98	RS-14-98
Drainage/ description						Flat Mt. Stream			West side S. arm				Alder Lake Outlet		
Latitude			44°25'35"N	44°24'33"N	44°24'13"N	44°21'36"N	44°22'6"N	44°22'23"N	44°20'34"N	44°19'57"N	44°18'32"N	44°18'7"N	44°20'17"N	44°22'29"N	44°20'1"N
Longitude			110°27'40"W	110°25'5"W	110°24'27"W	110°27'4"W	110°24'16"W	110°23'11"W	110°21'25"W	110°21'23"W	110°20'59"W	110°20'23"W	110°19'2"W	110°17'48"W	110°16'33"W
NPS no.			1161	1158	1157	1155	1147	1143	1138	1137	no #	1131	1119	1118	1115
Date			08/25/98	08/25/98	08/25/98	08/25/98	08/25/98	08/25/98	08/26/98	08/26/98	08/26/98	08/26/98	08/26/98	08/26/98	08/27/98
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			point	point	point	integrated	point	point	point	point	point	point	point	point	point
Collector			Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone
pH			5.75	5.71	6.15	6.45	6.83	6.49	6.92	6.90	4.80	7.74	7.41	7.40	7.74
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	˚C		8.4	15.6	14.5	14.3	11.4	10.2	5.5	5.4	7.5	12.5	14.7	11.6	10.9
Flow	CFS		0.001	0.004	0.009	8.3	3.3	1.3	1.5	5.3	0.3	0.1	0.001	1.3	0.04
Alkalinity	Mg/L as $CaCO_3$		20	20	50	40	25	22	30	32	45	45	100	70	150
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-	-
Comments			no surface flow to lake	Headwater at Delusion Lake	no surface flow to lake	inlet to Flat Mt. Arm	-	-	-	-	-	-	no surface flow to lake	no surface flow to lake	abundant suspended sed
Cl	mg/L	IC-Aq	0.2	1.0	0.5	0.5	0.4	0.4	0.4	0.4	0.2	0.2	1.2	0.6	1.4
F	mg/L	IC-Aq	0.2	0.2	0.7	0.6	0.4	0.4	0.8	1.4	0.3	0.2	0.2	0.2	0.3
NO_3	mg/L	IC-Aq	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.4	< 0.1	0.2
SO_4	mg/L	IC-Aq	1.4	< 0.5	1.4	2.5	0.9	0.9	1.2	1.6	1.7	1.2	0.9	1.8	< 0.5
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	37	35	31	21	28	18	11	4.6	31	15	5.2	13	84
As	ug/L	ICPMS	0.5	0.6	2	4.9	0.2	< 0.2	0.2	0.3	0.9	0.8	2	0.6	9.2
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	12	12	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	10	< 10	11
Ba	ug/L	ICPMS	17	11	16	14	9.7	6.8	5.9	2	14	9.5	32	9.4	28
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.3	4.2	9.0	9.6	4.8	4.8	6.2	7.5	8.4	8.6	18	21	25
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.76	0.4	0.99	0.2	0.2	0.2	0.1	0.02	0.2	0.1	0.06	0.2	0.83
Co	ug/L	ICPMS	0.1	0.1	1.1	0.03	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.04	0.1	0.2	1.4
Cr	ug/L	ICPMS	1	< 1	< 1	< 1	14	< 1	< 1	< 1	< 1	< 1	< 1	1	1
Cs	ug/L	ICPMS	0.09	0.06	0.32	0.1	0.01	< 0.01	0.04	0.2	< 0.01	< 0.01	0.02	0.02	0.03
Cu	ug/L	ICPMS	0.6	< 0.5	< 0.5	< 0.5	2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	1
Dy	ug/L	ICPMS	0.089	0.04	0.066	0.02	0.062	0.04	0.02	< 0.005	0.02	0.057	< 0.005	0.01	0.04
Er	ug/L	ICPMS	0.059	0.03	0.058	0.02	0.051	0.04	0.01	< 0.005	0.02	0.05	0.005	0.01	0.02
Eu	ug/L	ICPMS	0.01	< 0.005	0.007	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.01
Fe	ug/L	ICPMS	59	140	370	52	29	20	30	17	36	38	170	110	300
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03
Gd	ug/L	ICPMS	0.090	0.05	0.067	0.01	0.057	0.057	0.02	< 0.005	0.02	0.056	0.006	0.01	0.04
Ge	ug/L	ICPMS	< 0.02	< 0.02	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.02	0.009	0.02	0.005	0.01	0.01	< 0.005	< 0.005	< 0.005	0.02	< 0.005	< 0.005	0.007
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	2.3	1.4	2.2	2.1	< 1	< 1	< 1	1.1	1.8	2.1	5.0	1.6	3.4
La	ug/L	ICPMS	0.4	0.2	0.3	0.07	0.2	0.2	0.05	0.01	0.09	0.1	0.02	0.1	0.3
Li	ug/L	ICPMS	0.1	1.0	5.9	3.9	1.3	0.6	3.2	3.1	0.3	< 0.1	0.3	0.4	0.6
Mg	mg/L	ICPAES	1.7	1.4	3.4	1.3	1.1	1.1	1.5	1.7	2.8	2.8	6.9	5.1	15
Mn	ug/L	ICPMS	10	30	230	7.3	2.3	0.24	6.4	0.23	2.9	8.4	150	13	500
Mo	ug/L	ICPMS	0.3	0.3	0.5	0.3	0.3	0.2	0.53	0.75	0.2	0.1	0.5	0.09	0.4
Na	mg/L	ICPAES	2.5	2.0	3.2	3.2	2.6	2.6	2.9	3.1	2.5	2.7	7.1	3.9	12
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.43	0.2	0.36	0.06	0.2	0.2	0.06	< 0.01	0.08	0.1	0.03	0.1	0.30
Ni	ug/L	ICPMS	1.0	1.0	3.0	0.6	1.7	1.0	0.3	0.3	0.6	0.7	1.0	1.7	4.6
P	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	ug/L	ICPMS	< 0.05	< 0.05	0.2	< 0.05	0.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1	< 0.05	0.06
Pr	ug/L	ICPMS	0.1	0.05	0.1	0.02	0.04	0.05	0.02	< 0.01	0.03	0.03	< 0.01	0.03	0.09
Rb	ug/L	ICPMS	4.4	2.6	6.0	6.1	1.4	1.3	1.9	1.8	1.4	2.2	3.0	1.8	3.2
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.05	0.03	0.04	0.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.05
Sc	ug/L	ICPMS	2	0.5	2	2	1	1	1	1	2	2	2	1	1
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
SiO_2	mg/L	ICPMS	34	7.7	34	40	18	19	26	26	30	38	42	29	28
Sm	ug/L	ICPMS	0.06	0.04	0.06	0.02	0.02	0.03	0.01	< 0.01	0.02	0.04	< 0.01	0.01	0.04
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	48	35	55	27	32	31	32	28	48	48	89	54	180
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.01	< 0.005	0.01	< 0.005	0.005	0.009	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	0.006
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.02	0.02	0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01
Ti	ug/L	ICPMS	0.4	0.2	0.4	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.2	0.1	< 0.1	0.2	0.8
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	0.01	< 0.005	0.007	< 0.005	0.007	0.006	< 0.005	< 0.005	< 0.005	0.007	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.02	0.01	0.02	0.06	0.01	0.01	0.03	0.16	0.02	0.04	0.009	0.50	0.66
V	ug/L	ICPMS	2	0.2	0.9	0.5	0.1	< 0.1	0.2	0.2	1	2	0.8	3	4
W	ug/L	ICPMS	0.03	0.04	0.1	0.05	0.02	< 0.02	< 0.02	0.04	0.03	0.05	0.2	< 0.02	0.3
Y	ug/L	ICPMS	0.5	0.2	0.5	0.1	0.3	0.3	0.1	0.03	0.1	0.4	0.02	0.1	0.2
Yb	ug/L	ICPMS	0.07	0.03	0.06	0.02	0.04	0.06	0.02	< 0.01	0.01	0.06	< 0.01	0.02	0.03
Zn	ug/L	ICPMS	2	1	1	0.9	22	1	0.5	0.6	0.5	1	1	0.8	2
Zr	ug/L	ICPMS	0.4	0.3	0.4	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1	0.5
Hg	ng/L	Hg CVAF	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-19.2	-9.7	-17.3	-18.7	-18.0	-17.9	-18.9	-19.1	-18.8	-18.9	-18.8	-18.4	-17.2
δD vs VSMOW	permil	ISO2	-146.8	-92.2	-136.3	-142.8	-134.9	-135.5	-140.7	-143.3	-141.3	-142.2	-144.8	-141.7	-132.0
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	6.89	2.94	2.89	-	-	8.63	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			RS-15-98	RS-16-98 Yellowstone River inlet	RS-17-98 Beaver Dam Cr	RS-17R-98 Beaver Dam Cr	RS-18-98 Trail Cr	RS-19-98	RS-20-98	RS-21-98	RS-22-98	RS-23-98 Grouse Cr	RS-24-98	RS-25-98	RS-26-98 Chipmunk Cr
Latitude			44°20'46"N	44°18'28"N	44°19'23"N	44°19'23"N	44°17'27"N	44°17'22"N	44°17'21"N	44°17'36"N	44°17'17"N	44°16'53"N	44°16'38"N	44°16'38"N	44°17'18"N
Longitude			110°13'22"W	110°10'49"W	110°11'6"W	110°11'6"W	110°12'9"W	W	W	W	W	W	W	W	110°17'7"W
NPS no.			1106	40	1107	1107	1108	1109	1110	1111	1126	1125	1123	1122	1121
Date			08/27/98	08/28/98	08/28/98	08/28/98	08/29/98	08/30/98	08/30/98	08/30/98	08/30/98	08/30/98	08/30/98	08/30/98	08/30/98
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			point	integrated	integrated	integrated	point	point	point	point	point	point	point	point	point
Collector			Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone
pH			7.90	7.12	7.55		8.50	7.63	7.64	7.95	8.16	7.93	8.04	7.00	8.49
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		9.1	15.1	17.1		13.9	7.9	7.9	17.7	8.8	10.4	11.6	16.0	16.9
Flow	CFS		0.002	500	56		9.0	3.2	7.9	1.0	1.0	10.7	0.5	0.001	21
Alkalinity	Mg/L as $CaCO_3$		70	35	35	35	60	50	55	70	150	110	100	75	50
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-	-
Comments			-	-	-	duplicate	abundant suspended sed	-	drainage not on 7.5 map	-	-	-	-	-	-
Cl	mg/L	IC-Aq	0.6	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.4	0.4	0.3	0.2
F	mg/L	IC-Aq	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.1	0.2	0.2	0.2
NO_3	mg/L	IC-Aq	< 0.1	< 0.1	< 0.1	< 0.1	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
SO_4	mg/L	IC-Aq	30	2.3	4.4	4.4	0.8	1.2	1.2	1.2	3.3	4.9	2.5	< 0.5	0.8
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	27	15	14	12	15	16	4.5	24	5.2	3.4	29	40	11
As	ug/L	ICPMS	0.3	0.4	0.5	0.5	0.7	0.3	0.2	0.6	0.3	< 0.2	< 0.2	2	0.4
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Ba	ug/L	ICPMS	23	8.7	13	13	16	33	29	32	280	66	7.9	23	22
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	14	5.8	3.9	3.9	11	10	11	11	40	31	12	14	9.5
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.09	0.07	0.06	0.05	0.2	0.09	0.02	0.1	0.03	0.02	0.4	0.4	0.09
Co	ug/L	ICPMS	0.04	0.04	< 0.02	< 0.02	0.1	< 0.02	< 0.02	0.05	0.07	0.09	< 0.02	0.4	0.04
Cr	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cs	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.01	0.02	< 0.01	< 0.01	0.01	0.02	< 0.01
Cu	ug/L	ICPMS	0.8	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	2	< 0.5
Dy	ug/L	ICPMS	0.04	0.005	0.008	0.01	0.01	0.006	< 0.005	0.01	0.01	< 0.005	0.14	0.03	0.006
Er	ug/L	ICPMS	0.02	< 0.005	< 0.005	0.007	0.008	< 0.005	< 0.005	0.01	< 0.005	< 0.005	0.11	0.02	< 0.005
Eu	ug/L	ICPMS	0.006	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	0.02	0.01	0.007	0.01	< 0.005
Fe	ug/L	ICPMS	38	27	14	10	190	32	23	59	96	80	33	140	41
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.052	0.006	0.008	< 0.005	0.02	0.009	< 0.005	0.03	< 0.005	< 0.005	0.18	0.050	< 0.005
Ge	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	0.05	0.008	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	2.2	1.4	1.4	1.4	2.7	2.2	2.3	2.4	1.5	1.1	1.7	1.7	1.8
La	ug/L	ICPMS	0.3	0.05	0.05	0.04	0.1	0.04	< 0.01	0.08	0.02	0.01	0.4	0.2	0.04
Li	ug/L	ICPMS	1.8	< 0.1	< 0.1	< 0.1	< 0.1	0.4	0.6	0.5	1.0	0.6	1.7	0.1	< 0.1
Mg	mg/L	ICPAES	12	2.5	1.5	1.5	4.0	1.7	1.5	3.5	15	10	3.2	5.3	2.1
Mn	ug/L	ICPMS	0.19	5.9	1.1	0.91	43	1.1	0.08	8.8	9.9	12	5.0	67	4.5
Mo	ug/L	ICPMS	0.1	0.2	0.3	0.3	0.2	0.07	0.06	0.09	0.5	0.54	0.52	0.3	0.08
Na	mg/L	ICPAES	4.9	3.7	7.7	7.7	4.3	2.8	2.6	3.1	10	5.1	3.0	4.3	2.5
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.30	0.05	0.04	0.04	0.07	0.04	0.01	0.08	0.02	0.01	0.53	0.26	0.03
Ni	ug/L	ICPMS	1.4	0.7	0.3	0.3	0.8	0.5	0.4	0.9	1.6	1.6	0.5	3.1	0.7
P	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	ug/L	ICPMS	< 0.05	< 0.05	1.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	0.07	0.01	0.01	0.01	0.03	0.01	< 0.01	0.02	< 0.01	< 0.01	0.1	0.06	0.01
Rb	ug/L	ICPMS	2.6	1.6	1.9	1.8	2.8	2.5	2.5	2.2	0.86	0.88	1.7	1.9	2.0
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	0.03	< 0.02	< 0.02	< 0.02
Sc	ug/L	ICPMS	2	0.9	1	1	1	2	1	1	0.3	0.4	0.6	0.9	1
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2
SiO_2	mg/L	ICPMS	41	23	26	25	27	37	33	29	10	9.2	30	21	24
Sm	ug/L	ICPMS	0.06	0.02	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	0.1	0.06	< 0.01
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	110	35	27	25	57	46	42	61	350	230	44	100	53
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02	0.006	< 0.005
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.008	0.005	< 0.005
Ti	ug/L	ICPMS	0.2	0.1	< 0.1	< 0.1	0.2	0.1	< 0.1	0.2	< 0.1	< 0.1	0.1	0.3	< 0.1
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02	< 0.005	< 0.005
U	ug/L	ICPMS	0.02	0.02	0.02	0.01	0.10	0.06	0.08	0.10	0.48	0.32	0.05	0.03	0.07
V	ug/L	ICPMS	3	3	3	3	3	2	2	3	0.2	0.2	0.6	2	2
W	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02
Y	ug/L	ICPMS	0.2	0.03	0.04	0.04	0.06	0.04	0.01	0.1	0.06	0.04	0.95	0.2	0.04
Yb	ug/L	ICPMS	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	0.1	0.03	< 0.01
Zn	ug/L	ICPMS	3	0.9	0.7	< 0.5	1	0.5	0.5	0.7	1	0.5	1	1	0.6
Zr	ug/L	ICPMS	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1	< 0.05	< 0.05	0.2	0.3	< 0.05
Hg	ng/L	Hg CVAF	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-18.5	-18.1	-18.5	-18.5	-16.8	-19.4	-19.6	-18.7	-18.6	-18.3	-18.4	-16.0	-18.6
δD vs VSMOW	permil	ISO2	-139.5	-136.4	-137.6	-138.5	-131.3	-144.9	-148.6	-142.9	-141.0	-139.5	-139.2	-127.3	-143.5
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	1.205	-	-4.99	-5.01	-	-	-	-	9.28	-	8.14	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			RS-27-98	RS-28-98	RS-29-98	RS-30-98	RS-31-98	RS-32-98	RS-33-98	RS-34-98	RS-35-98	RS-36-98	RS-37-98	RS-38-98	RS-39-98
Drainage/ description					Alluvium Cr			Columbine Cr	Meadow Cr		Clear Cr		Cub Cr	Little Cr	Sedge Cr
Latitude			44°21'47"N	44°22'37"N	44°23'9"N	44°23'41"N	44°23'48"N	44°24'3"N	44°25'37"N	44°27'7"N	44°28'35"N	44°28'47"N	44°29'23"N	44°30'2"N	44°31'26"N
Longitude			W	W	W	W	W	110°15'7"W	110°17'8"W	W	110°16'8"W	W	W	W	110°16'43"W
NPS no.			1103	1101	1100	None	None	1099	1097	1096	1095	1094	1093	1091	1089
Date			08/31/98	08/31/98	08/31/98	08/31/98	08/31/98	09/01/98	09/01/98	09/01/98	09/01/98	09/01/98	09/01/98	09/01/98	09/02/98
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			point	point	point	point	point	point	point	point	integrated	point	point	point	point
Collector			Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone
pH			7.77	2.95	2.52	2.74	6.61	6.94	7.31	7.09	7.98	7.31	8.07	7.93	3.43
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		6.8	10.3	12.0	19.5	13.6	9.6	9.6	8.1	14.2	9.5	14	12	13.3
Flow	CFS		1.3	0.2	0.3	-		14	3	0.004	21.4	0.6	7.5	0.8	7.2
Alkalinity	Mg/L as $CaCO_3$		125	-	-	-	75	55	30	25	45	45	90	50	
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-	-
Comments			-	no surface flow to lake	-	tributary to Columine Cr--2.2 CFS	Columbine Cr above 30, Fe stain, vents, 5 CFS	murky water	no surface flow to lake	no surface flow to lake	-	no surface flow to lake	-	-	-
Cl	mg/L	IC-Aq	0.5	1.1	2.0	1.1	0.4	0.4	0.3	0.5	0.3	0.4	0.5	0.4	5.1
F	mg/L	IC-Aq	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.3
NO_3	mg/L	IC-Aq	< 0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
SO_4	mg/L	IC-Aq	83	560	820	360	21	87	1.8	2.7	3.1	1.8	17	15	84
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	73	30000	73000	19000	80	49	29	190	9.7	120	26	94	480
As	ug/L	ICPMS	< 0.2	< 0.2	0.2	0.4	< 0.2	< 0.2	< 0.2	0.2	< 0.2	0.2	0.3	0.6	5.3
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	< 10	< 10	< 10	< 10	30	25	< 10	< 10	< 10	< 10	24	< 10	650
Ba	ug/L	ICPMS	21	16	12	22	28	30	7.9	9.8	11	11	24	17	37
Be	ug/L	ICPMS	< 0.05	1.1	2.3	1.1	< 0.05	< 0.05	< 0.05	0.1	< 0.05	0.08	< 0.05	< 0.05	0.07
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	34	53	49	22	15	20	5.6	5.8	9.2	5.5	16	11	8.2
Cd	ug/L	ICPMS	< 0.02	0.03	0.07	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.06	25	63	88	1.8	0.85	0.4	2.3	0.09	1.3	0.08	0.50	2.2
Co	ug/L	ICPMS	0.2	4.5	7.6	0.85	0.4	0.76	< 0.02	< 0.02	< 0.02	0.03	0.03	< 0.02	0.59
Cr	ug/L	ICPMS	< 1	30	74	14	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cs	ug/L	ICPMS	0.02	0.33	0.91	0.42	0.03	0.07	0.01	0.01	< 0.01	0.01	0.06	< 0.01	4.3
Cu	ug/L	ICPMS	0.8	6	10	1	< 0.5	< 0.5	< 0.5	0.7	0.9	0.6	< 0.5	0.6	0.5
Dy	ug/L	ICPMS	< 0.005	0.99	2.6	4.3	0.096	0.02	0.14	0.52	0.03	0.39	0.02	0.098	0.16
Er	ug/L	ICPMS	0.01	0.56	1.4	2.6	0.058	0.02	0.11	0.35	0.02	0.28	0.02	0.068	0.11
Eu	ug/L	ICPMS	< 0.005	0.37	0.93	0.40	< 0.005	0.006	0.007	0.02	< 0.005	0.02	< 0.005	0.008	0.02
Fe	ug/L	ICPMS	73	1700	1800	1800	71	40	33	48	37	100	40	32	870
Ga	ug/L	ICPMS	< 0.02	0.56	1.6	1.2	< 0.02	< 0.02	< 0.02	0.04	< 0.02	0.03	< 0.02	< 0.02	0.02
Gd	ug/L	ICPMS	0.01	1.4	3.7	5.2	0.099	0.04	0.18	0.57	0.03	0.44	0.02	0.088	0.18
Ge	ug/L	ICPMS	< 0.02	0.08	0.1	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.2
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.006	0.18	0.56	0.95	0.02	0.008	0.05	0.11	0.005	0.099	< 0.005	0.02	0.04
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	2.6	5.9	11	6.7	2.5	3.2	1.1	1.1	< 1	1.1	1.8	1.4	2.1
La	ug/L	ICPMS	0.05	11	23	35	0.80	0.50	0.4	2.0	0.07	1.3	0.07	0.4	0.98
Li	ug/L	ICPMS	9.5	15	19	15	6.0	7.8	1.7	1.1	4.2	0.8	14	2.5	60
Mg	mg/L	ICPAES	35	50	37	15	9.8	14	2.0	1.8	2.3	1.6	10	6.8	4.4
Mn	ug/L	ICPMS	49	510	670	370	79	210	5.0	0.69	3.9	3.6	8.3	0.55	50
Mo	ug/L	ICPMS	0.06	< 0.02	< 0.02	0.04	0.2	0.1	0.52	0.2	0.81	0.2	0.92	0.3	0.3
Na	mg/L	ICPAES	9.3	15	23	10	15	15	2.9	2.8	4.7	2.8	18	6.5	11
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.05	8.7	23	28	0.54	0.27	0.53	2.2	0.1	1.5	0.06	0.38	0.99
Ni	ug/L	ICPMS	3.0	24	22	4.0	2.0	3.2	0.5	0.7	0.6	0.9	0.7	0.8	2.1
P	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	ug/L	ICPMS	< 0.05	0.06	< 0.05	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05	0.08
Pr	ug/L	ICPMS	0.01	2.7	7.2	8.7	0.2	0.06	0.1	0.59	0.02	0.41	0.02	0.1	0.29
Rb	ug/L	ICPMS	3.7	13	34	18	5.3	7.5	1.7	1.5	1.3	1.3	4.4	2.5	5.1
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.3
Sc	ug/L	ICPMS	2	4	5.4	2	1	1	0.6	0.7	0.5	0.7	0.7	0.4	0.4
Se	ug/L	ICPMS	< 0.2	< 0.2	0.2	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
SiO_2	mg/L	ICPMS	43	88	95	63	31	37	22	24	17	21	27	28	31
Sm	ug/L	ICPMS	< 0.01	1.3	3.6	4.6	0.08	0.03	0.1	0.42	0.02	0.32	0.02	0.08	0.2
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	240	570	650	240	96	130	44	50	88	50	180	120	73
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	0.19	0.54	0.79	0.01	0.005	0.02	0.085	< 0.005	0.069	< 0.005	0.02	0.03
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	0.14	0.45	0.34	< 0.005	< 0.005	0.008	0.02	< 0.005	0.04	< 0.005	0.009	0.009
Ti	ug/L	ICPMS	0.4	17	20	14	< 0.1	0.3	0.1	0.5	< 0.1	0.4	< 0.1	0.4	0.4
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	0.063	0.18	0.34	0.006	< 0.005	0.02	0.04	< 0.005	0.04	< 0.005	0.01	0.01
U	ug/L	ICPMS	0.08	0.12	0.36	0.08	0.01	0.009	0.05	0.06	0.12	0.07	0.32	0.10	0.04
V	ug/L	ICPMS	1	4	8.2	10	< 0.1	< 0.1	0.6	0.4	0.6	0.2	0.5	1	1
W	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	< 0.02	< 0.02	< 0.02	0.4
Y	ug/L	ICPMS	0.07	4.6	12	22	0.53	0.2	0.95	2.8	0.2	2.1	0.1	0.57	0.92
Yb	ug/L	ICPMS	< 0.01	0.48	1.2	2.2	0.04	0.02	0.1	0.31	0.02	0.25	0.02	0.08	0.07
Zn	ug/L	ICPMS	2	20	37	10	6	7	1	2	1	2	1	1	4
Zr	ug/L	ICPMS	< 0.05	0.08	< 0.05	0.2	< 0.05	< 0.05	0.2	0.66	< 0.05	0.50	< 0.05	0.3	< 0.05
Hg	ng/L	Hg CVAF	<5	<5	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-18.8	-18.2	-19.7	-18.7	-18.0	-18.2	-18.0	-17.8	-18.0	-18.1	-18.3	-17.5	-16.7
δD vs VSMOW	permil	ISO2	-139.8	-132.8	-144.4	-140.6	-138.8	-140.0	-138.9	-136.6	-136.4	-139.1	-140.8	-137.9	-133.3
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	1.15	0.225	-0.14	0.35	2.53	0.92	-	-	-	-	3.74	6.05	-3.28

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			RS-40-98	RS-41-98	RS-42-98	RS-43-98	RS-44-98	RS-45-98	RS-47-98	RS-1-99	RS-5-99	RS-7-99	RS-8-99	RS-9-99	RS-16-99
Drainage/ description			Pelican Cr	Bridge Cr	Big Thumb Cr	Little Thumb Cr	Arnica Cr	Weasel Cr		Solution Cr	Flat Mt. Stream		West side S arm		Yellowstone River Inlet
Latitude			44°33'38"N	44°31'45"N	44°24'18"N	44°26'9"N	44°28'46"N	44°31'17"N	44°32'16"N	44°24'22"N	44°21'36"N	44°22'23"N	44°20'34"N	44°19'57"N	44°18'28.2"N
Longitude			110°21'9"W	W	W	W	W	110°27'4"W	110°27'7"W	110°30'1"W	110°27'4"W	W	W	W	110°10'46.3"W
NPS no.			1085	1196	1168	1176	1182	1192	1199	-	-	-	-	-	-
Date			09/02/98	09/02/98	09/02/98	09/02/98	09/02/98	09/02/98	09/02/98	07/16/99	07/15/99	07/15/99	07/15/99	07/15/99	07/21/99
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			integrated	point	point	point	point	point	point	point	point	point	point	point	point
Collector			Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone	WRD
pH			7.43	8.09	6.99	6.87	8.39	6.97	6.93	7.17	7.55	7.35	7.55	7.73	?
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	˚C		14.9	16.5	19.4	16.6	18	11.8	12.5	13.2	12.2	9.2	6.9	5.7	?
Flow	CFS		35	2.1	0.5	0.3	11.7	0.005	0.01	?	4.6	2.2	2.9	3.4	3500
Alkalinity	Mg/L as $CaCO_3$		57	45	75	30	40	45	45	33	35	22	27	28	?
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-	-
Comments			abundant suspended sed	-	abundant algae	-	-	poor flow, braided channnel	poor flow, braided channnel	600 sq ft x sec-- velocity too low to measure	-	-	-	-	CFS estimate-could not wade
Cl	mg/L	IC-Aq	18	1.1	1.0	0.8	1.3	0.6	1.7	3.9	0.5	0.3	0.5	0.5	0.2
F	mg/L	IC-Aq	0.4	4.3	0.9	0.6	5.0	0.4	3.5	0.5	0.6	0.5	0.5	1.3	0.1
NO_3	mg/L	IC-Aq	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	<.1	0.1	<.1	0.1	0.6	<.1
SO_4	mg/L	IC-Aq	82	2.0	4.5	1.7	1.7	1.7	1.5	5.3	2.3	0.9	1.3	1.6	1.4
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	450	49	14	67	36	31	60	7.8	12	13	5.5	2	5.7
As	ug/L	ICPMS	18	3.7	8.5	2	2.7	0.3	1	11	5.4	0.6	0.5	0.6	<0.4
Au	ug/L	ICPMS	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	960	19	10	11	16	< 10	< 10	88.4	19.2	14.1	11.9	11.1	5.73
Ba	ug/L	ICPMS	44	16	28	26	6.1	21	14	11	16	7	7.3	3.1	6.6
Be	ug/L	ICPMS	< 0.05	0.07	0.1	< 0.05	0.3	< 0.05	0.5	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	18	8.4	12	5.1	6.9	4.6	7.0	5.21	8.36	4.06	5.08	6.63	3.24
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.50	0.3	0.1	0.71	0.3	0.78	0.4	0.2	0.2	0.2	0.1	0.04	0.08
Co	ug/L	ICPMS	0.08	< 0.02	< 0.02	0.09	< 0.02	0.07	0.05	0.06	<0.02	<0.02	<0.02	<0.02	0.02
Cr	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 1	< 1	< 1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	7.4	3.8	2.2	0.49	2.6	0.02	1.4	1.8	0.1	< 0.01	0.04	0.2	< 0.01
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	0.054	0.02	0.02	0.069	0.02	0.075	0.059	0.02	0.03	0.097	0.03	0.009	0.007
Er	ug/L	ICPMS	0.02	0.03	0.02	0.055	0.02	0.057	0.03	0.01	0.02	0.057	0.02	0.007	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.007	< 0.005	0.01	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	66	35	64	67	52	17	63	<30	<30	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.063	0.03	0.02	0.089	0.03	0.076	0.05	0.02	0.03	0.072	0.03	< 0.005	0.01
Ge	ug/L	ICPMS	0.4	0.2	0.2	0.02	0.2	< 0.02	0.04	0.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-	-	-	-	-	-
Ho	ug/L	ICPMS	0.01	0.008	0.006	0.02	0.005	0.02	0.01	0.006	0.009	0.02	0.009	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-
K	mg/L	ICPAES	11	4.3	7.8	2.3	2.6	2.5	2.2	1.67	1.79	0.606	0.865	1.02	0.888
La	ug/L	ICPMS	0.2	0.1	0.08	0.3	0.08	0.4	0.2	0.1	0.1	0.3	0.1	0.1	0.07
Li	ug/L	ICPMS	190	43	29	11	55	2.5	18	46	10	6.8	8.9	9.3	5.7
Mg	mg/L	ICPAES	11	1.8	4.5	1.7	1.5	1.6	2.0	2.14	1.15	1.03	1.27	1.56	1.38
Mn	ug/L	ICPMS	26	3.2	11	22	3.3	12	19	11	6.2	0.41	4.8	0.1	2.3
Mo	ug/L	ICPMS	0.5	4.9	16	0.79	5.7	0.4	2.2	1.2	0.4	0.2	0.5	0.78	< 0.2
Na	mg/L	ICPAES	41	11	17	3.5	13	2.6	4.1	7.86	2.72	2.2	2.53	2.85	2.09
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	0.04	0.02	0.03	0.04	< 0.02
Nd	ug/L	ICPMS	0.2	0.2	0.1	0.37	0.08	0.36	0.25	0.1	0.1	0.29	0.1	0.02	0.07
Ni	ug/L	ICPMS	1.2	0.4	0.6	0.4	0.2	0.5	1.0	0.4	<0.1	0.4	<0.1	<0.1	0.3
P	ug/L	ICPMS	-	-	-	-	-	-	-	2	4	< 1	< 1	1	17
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	0.06	0.04	0.02	0.1	0.02	0.1	0.07	0.03	0.03	0.07	0.02	< 0.01	0.01
Rb	ug/L	ICPMS	35	20	20	6.3	10	5.0	8.6	4.2	5.9	1	1.8	2	1.2
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	-	-	-	-	-	-
Sb	ug/L	ICPMS	0.4	0.09	0.4	< 0.02	0.04	< 0.02	0.03	0.63	0.41	0.05	<0.05	<0.05	<0.05
Sc	ug/L	ICPMS	0.4	0.5	0.5	0.2	0.3	0.2	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
SiO_2	mg/L	ICPMS	70	88	100	27	56	35	37	9.1	27	14	20	21	14
Sm	ug/L	ICPMS	0.05	0.02	0.01	0.08	0.02	0.08	0.04	0.02	0.03	0.06	0.02	< 0.01	< 0.01
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-	-	-	-	-	-
Sr	ug/L	ICPMS	160	33	70	38	19	42	35	38	29	29	32	29	24
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.05	< 0.02	< 0.02	< 0.02	0.03	0.05	< 0.03	< 0.03	0.06	< 0.03
Tb	ug/L	ICPMS	0.006	0.006	< 0.005	0.01	< 0.005	0.009	0.007	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.005	0.02	< 0.005	0.01	0.01	0.01	0.01	0.07	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	0.2	0.2	< 0.1	0.2	0.1	0.1	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.01	< 0.005	0.008	0.006	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.10	0.10	0.04	0.02	0.11	0.02	0.06	0.02	0.05	0.02	0.03	0.15	0.009
V	ug/L	ICPMS	1	1	0.3	0.2	0.5	1	0.4	0.56	<0.2	<0.2	<0.2	<0.2	2
W	ug/L	ICPMS	0.2	0.82	0.1	0.08	1.3	0.04	0.05	2.8	1.4	0.98	0.79	0.82	0.18
Y	ug/L	ICPMS	0.2	0.1	0.1	0.5	0.1	0.4	0.3	0.1	0.2	0.5	0.2	0.05	0.04
Yb	ug/L	ICPMS	0.02	0.02	0.02	0.06	0.02	0.06	0.04	0.01	0.02	0.05	0.03	< 0.01	< 0.01
Zn	ug/L	ICPMS	2	2	2	2	0.8	4	82	0.6	0.6	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	< 0.05	0.3	< 0.05	0.1	0.2	0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<5	<5	<5	<5	<5	<5	<5	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.8	-18.7	-17.4	-18.0	-19.1	-18.3	-19.0	-15.6	-18.3	-18.1	-18.5	-18.9	-18.5
δD vs VSMOW	permil	ISO2	-136.7	-146.7	-136.8	-132.0	-141.6	-142.7	-144.2	-124.3	-139.4	-139.3	-141.7	-142.3	-141.7
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	5.21	-	10.68	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			RS-17-99 Beaver Dam Creek	RS-18-99 Trail Creek	RS-19A-99 no name	RS-19B-99 no name	RS-20-99 no name	RS-23-99 Grouse Creek	RS-26-99 Chipmunk Creek	RS-32-99 Columbine Cr	RS-33-99 Meadow Cr	RS-35-99 Clear Cr	RS-37-99 Cub Cr	RS-39-99 Sedge Cr
Latitude			44°19'24"N	44°17'29.9"N	44°17'21.9"N	44°17'21.3"N	44°17'22.2"N	44°16'54.3"N	44°17'16.6"N	44°24'3"N	44°25'37"N	44°28'35"N	44°29'23"N	44°31'26"N
Longitude			110°11'4.8"W	110°12'4"W	110°12'24.8"W	110°12'20.4"W	110°12'31.4"W	110°20'13.6"W	110°17'0.8"W	110°15'7"W	110°17'8"W	110°16'8"W	W	110°16'43"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-	-
Date			07/20/99	07/20/99	07/20/99	07/20/99	07/20/99	07/21/99	07/21/99	07/16/99	07/16/99	07/13/99	07/13/99	07/12/99
Depth	m		-	-	-	-	-	-	-	-	-	-	-	-
Treatment/ Sample type			integrated	integrated	point	point	point	point	point	integrated	integrated	integrated	integrated	integrated
Collector			Gemery/WRD	Gemery/WRD	Gemery/WRD	Gemery/WRD	Gemery/WRD	Gemery/WRD	Gemery/WRD	Sanzolone	Sanzolone	Sanzolone	Sanzolone	Sanzolone
pH			7.38	7.86	8.03	7.83	8.09	8.24	8.04	6.58	6.75	7.25	7.60	3.66
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		7.5	21	9	9	7	11	15.5	4.3	5.7	8.4	8.8	16.0
Flow	CFS		85.1	4.67	0.92	0.66	3.52	10.5	34.7	63	6.4	132	57	48
Alkalinity	Mg/L as $CaCO_3$									20	20	22	30	
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	-
Comments			-	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	0.2	0.4	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	1.7
F	mg/L	IC-Aq	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2
NO_3	mg/L	IC-Aq	<.1	<.1	<.1	<.1	0.2	0.1	<.1	<.1	<.1	<.1	<.1	<.1
SO_4	mg/L	IC-Aq	1.9	1.1	1.2	1.2	1.2	4.2	0.7	14	1.4	1.9	3.6	31
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	4.6	12	5.2	20	<0.5	<0.5	5.5	170	38	14	40	140
As	ug/L	ICPMS	<0.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	5
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	5.65	9.57	6.08	6.31	5	6.74	<5	12.1	9.8	8.19	10.1	234
Ba	ug/L	ICPMS	11	21	34	25	32	58	24	11	9.2	8.2	9.4	18
Be	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.08
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	2.6	7.38	9.15	5.97	9.5	25.4	7.31	4.83	4.31	5.74	4.7	3.95
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.04	0.2	0.06	0.1	< 0.01	< 0.01	0.07	1.8	0.56	0.2	0.4	0.93
Co	ug/L	ICPMS	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	0.1	0.04	<0.02	<0.02	0.2
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	< 0.01	0.02	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.01	0.03	1.4
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	5	<0.5	<0.5
Dy	ug/L	ICPMS	0.01	0.02	0.008	0.02	< 0.005	0.01	0.01	0.11	0.26	0.073	0.14	0.13
Er	ug/L	ICPMS	0.006	0.006	< 0.005	0.02	< 0.005	< 0.005	0.005	0.069	0.17	0.05	0.084	0.078
Eu	ug/L	ICPMS	< 0.005	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.02	0.006	0.007	0.02
Fe	ug/L	ICPMS	<30	100	<30	<30	<30	<30	<30	30	<30	<30	<30	290
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	0.03	< 0.005	0.007	< 0.005	< 0.005	0.01	0.13	0.22	0.065	0.13	0.12
Ge	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.1
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02	0.056	0.02	0.03	0.03
In	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-
K	mg/L	ICPAES	1.03	1.85	2.01	2	2.06	0.96	1.6	1	0.898	0.46	0.628	1.12
La	ug/L	ICPMS	0.07	0.2	0.04	0.1	0.02	0.01	0.06	0.94	0.75	0.2	0.57	0.54
Li	ug/L	ICPMS	5.9	6.3	6.9	5.8	6.6	6.2	6.6	6.8	7	7.1	9.9	24
Mg	mg/L	ICPAES	1.02	2.51	1.54	1.61	1.46	8.38	1.6	2.63	1.65	1.26	2.17	1.91
Mn	ug/L	ICPMS	0.42	18	0.33	0.22	0.056	5.9	3	27	9.3	2.9	7.8	27
Mo	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.4	< 0.2	0.3	0.3	0.3	0.3	0.2
Na	mg/L	ICPAES	3.1	2.76	2.48	2.29	2.35	3.54	1.75	3.19	2.28	2.12	3.86	4.23
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.08	0.2	0.05	0.1	0.02	0.01	0.09	0.82	0.92	0.29	0.57	0.68
Ni	ug/L	ICPMS	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.2	0.5	0.4	2.5	0.4	1
P	ug/L	ICPMS	20	74	62	43	69	< 1	24	< 1	3	< 1	< 1	4
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.4	<0.05	0.07
Pr	ug/L	ICPMS	0.02	0.04	0.01	0.03	< 0.01	< 0.01	0.02	0.25	0.23	0.06	0.1	0.2
Rb	ug/L	ICPMS	1.5	2.6	2.8	3	2.7	0.84	2.3	2	1.7	0.82	1.6	2.3
Re	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-
Sb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.4	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
SiO_2	mg/L	ICPMS	19	15	29	26	29	6.6	20	18	19	10	14	17
Sm	ug/L	ICPMS	< 0.01	0.03	< 0.01	0.01	< 0.01	< 0.01	0.02	0.2	0.21	0.06	0.1	0.2
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	21	46	48	39	45	160	47	41	39	67	53	38
Ta	ug/L	ICPMS	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02	0.04	0.01	0.02	0.02
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	0.5
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.008	0.02	0.007	0.01	0.01
U	ug/L	ICPMS	0.007	0.04	0.06	0.03	0.08	0.27	0.03	0.008	0.06	0.05	0.06	0.04
V	ug/L	ICPMS	1.6	2.6	2.3	2.2	1.9	<0.2	1.8	0.4	0.61	0.52	0.3	0.96
W	ug/L	ICPMS	0.15	0.21	0.14	0.13	0.1	0.08	0.06	0.64	0.52	0.4	0.39	0.71
Y	ug/L	ICPMS	0.06	0.09	0.03	0.1	0.02	0.04	0.06	0.57	1.3	0.4	0.7	0.62
Yb	ug/L	ICPMS	< 0.01	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.06	0.2	0.04	0.09	0.1
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	<0.5	2	0.7	1
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	14	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-18.5	-17.6	-19.3	-18.7	-19.1	-18.0	-18.7	-18.6	-17.4	-18.0	-18.4	-18.1
δD vs VSMOW	permil	ISO2	-138.1	-135.9	-145.8	-141.6	-146.8	-144.0	-141.3	-136.9	-134.5	-131.7	-136.6	-134.4
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			RS-39R-99 Sedge Cr	RS-40-99 Pelican Cr	RS-41-99 Bridge Cr	RS-44-99 Arnica Cr	28 Inlet SE Arm	34 Mid SE Arm surface	35 SE Arm further from inlet	36 Inlet SE Arm	42 Mid SE Arm surface	43 SE Arm further from inlet	SE Arm further from inlet	7 SE Arm water column	8 SE Arm water column
Latitude			44°31'26"N	44°33'38"N	44°31'45"N	44°28'46"N	-	-	-	-	-	-	-	44°21'30.5"N	44°21'30.5"N
Longitude			110°16'43"W	110°21'9"W	110°27'48"W	W	-	-	-	-	-	-	-	110°15'0.5"W	W
NPS no.			-	-	-	-	-	-	-	-	-	-	-	-	-
Date			07/12/99	07/12/99	07/12/99	07/12/99	07/15/97	07/15/97	07/15/97	07/15/97	07/15/97	07/15/97	07/15/97	07/24/97	07/24/97
Depth	m		-	-	-	-	-	-	-	-	-	-	surface	2	5
Treatment/ Sample type			integrated	point	point	integrated	Filtered and acidified	Filtered and acidified	Filtered and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified
Collector			Sanzolone	Sanzolone	Sanzolone	Sanzolone	-	-	-	-	-	-	-	-	-
pH			3.66	7.61	7.93	8.03	7.05	7.05	7.10	-	-	-	7.10	7.41	7.50
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		16.0	17.7	22.1	19.3	-	-	-	-	-	-	-	-	-
Flow	CFS		-	85	1.7	11.5	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	30	40	38	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	0.47	0.48	0.55	-	-	-	0.55	0.55	0.54
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-	-	499	481
Comments			-	estimate-could not wade	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	1.7	9.9	0.9	1	0.2	0.2	3.4				3.4	3.3	3.2
F	mg/L	IC-Aq	0.2	0.3	4.2	5.2	-	-	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	<.1	0.4	<.1	<.1	-	-	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	31	38	1.6	1.6	1.1	1.4	5.1				5.1	4.5	5.0
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	140	150	70	21	16	13	28	530	660	200	28	27	17
As	ug/L	ICPMS	5	11	3.5	2.7	0.3	0.6	9.0	0.4	0.6	9.3	9.0	9.0	9.3
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
B	ug/L	ICPAES	234	347	15.3	17.9	< 10	< 10	62	< 10	< 10	60	62	60	58
Ba	ug/L	ICPMS	18	30	15	7.7	6.8	6.7	7.9	11	11	8.8	7.9	8.0	8.0
Be	ug/L	ICPMS	0.06	<0.05	0.05	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	3.97	9.47	6.68	6.16	3.9	4.1	5.2	4.4	4.7	5.2	5.2	4.9	4.8
Cd	ug/L	ICPMS	<0.02	0.03	<0.02	<0.02	< 0.02	< 0.02	0.04	< 0.02	0.03	0.06	0.04	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.96	0.2	0.4	0.2	0.1	0.1	0.07	1.2	1.3	0.3	0.07	0.06	0.06
Co	ug/L	ICPMS	0.2	0.08	0.03	0.02	0.04	0.03	< 0.02	0.3	0.4	0.06	< 0.02	< 0.02	< 0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	ug/L	ICPMS	1.4	2.7	2.6	2.1	< 0.01	0.03	1.8	0.01	0.07	1.9	1.8	1.8	1.8
Cu	ug/L	ICPMS	<0.5	0.6	<0.5	<0.5	< 0.5	< 0.5	0.5	0.7	0.9	0.8	0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.13	0.02	0.072	0.02	0.01	0.006	0.009	0.05	0.04	0.02	0.009	0.005	< 0.005
Er	ug/L	ICPMS	0.071	0.02	0.04	0.02	0.007	0.005	< 0.005	0.02	0.02	0.01	< 0.005	0.006	< 0.005
Eu	ug/L	ICPMS	0.02	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.01	0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	280	33	49	37	28	30	13	300	350	69	13	19	12
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	0.05	0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.15	0.02	0.04	0.03	0.02	0.01	0.01	0.04	0.058	0.02	0.01	0.005	0.009
Ge	ug/L	ICPMS	0.1	0.4	0.3	0.2	< 0.02	< 0.02	0.2	< 0.02	< 0.02	0.2	0.2	0.2	0.2
Hf	ug/L	ICPMS	-	-	-	-	< 0.05	< 0.05	8.9	< 0.05	< 0.05	0.53	8.9	0.52	< 0.05
Ho	ug/L	ICPMS	0.03	0.005	0.01	0.005	< 0.005	< 0.005	< 0.005	0.006	0.008	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	-	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.08	5.09	3.19	2.28	1.1	1.0	1.6	1.2	1.3	1.6	1.6	1.5	1.5
La	ug/L	ICPMS	0.55	0.2	0.2	0.1	0.09	0.1	0.06	0.60	0.70	0.2	0.06	0.05	0.05
Li	ug/L	ICPMS	23	75	32	44	0.2	0.5	26	0.1	0.6	26	26	25	26
Mg	mg/L	ICPAES	1.88	5.72	1.74	1.46	1.6	1.6	2.2	1.8	2.0	2.2	2.2	2.2	2.1
Mn	ug/L	ICPMS	27	22	4.2	6.7	2.5	2.8	0.81	9.6	13	2.8	0.81	0.71	0.51
Mo	ug/L	ICPMS	0.2	0.4	3.4	4.4	0.2	0.2	0.86	0.2	0.2	0.87	0.86	0.80	0.85
Na	mg/L	ICPAES	4.3	16.5	7.6	9.9	2.4	2.5	7.1	2.6	2.9	7.0	7.1	6.8	6.9
Nb	ug/L	ICPMS	< 0.02	< 0.02	0.08	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.67	0.1	0.26	0.09	0.06	0.06	0.02	0.47	0.56	0.1	0.02	< 0.01	0.02
Ni	ug/L	ICPMS	1	1.7	0.6	0.8	0.6	0.5	0.7	1.6	1.9	0.8	0.7	0.5	0.5
P	ug/L	ICPMS	4	< 1	6.5	5.4	180	170	110	260	270	130	110	110	110
Pb	ug/L	ICPMS	0.08	<0.05	<0.05	<0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2	< 0.05	< 0.05	1.5	< 0.05
Pr	ug/L	ICPMS	0.2	0.03	0.07	0.02	0.02	0.02	< 0.01	0.1	0.2	0.03	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	2.2	16	16	9.8	1.5	1.6	4.1	1.7	1.8	4.2	4.1	4.2	4.2
Re	ug/L	ICPMS	-	-	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.61	0.35	0.1	0.08	< 0.02	< 0.02	0.4	< 0.02	< 0.02	0.4	0.4	0.4	0.4
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	0.6	0.5	0.3	0.6	0.6	0.3	0.3	0.5	0.5
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	16	39	56	41	18	17	12	18	17	12	12	13	13
Sm	ug/L	ICPMS	0.1	0.02	0.07	0.02	0.02	0.02	< 0.01	0.07	0.08	0.03	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	38	88	37	23	27	28	35	29	30	36	35	35	35
Ta	ug/L	ICPMS	< 0.03	< 0.03	0.12	0.18	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.02	0.005	0.007	< 0.005	< 0.005	< 0.005	< 0.005	0.007	0.008	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005	0.01	< 0.005	< 0.005
Ti	ug/L	ICPMS	0.72	< 0.2	1.1	< 0.2	< 0.1	< 0.1	< 0.1	8.9	9.3	1.7	< 0.1	0.1	< 0.1
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	0.01	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.04	0.05	0.08	0.07	0.02	0.02	0.02	0.04	0.04	0.03	0.02	0.01	0.02
V	ug/L	ICPMS	0.93	1.5	1.3	0.4	3	3	1	3	3	1	1	1	1
W	ug/L	ICPMS	0.62	0.5	1.2	1.5	0.08	0.07	1.3	0.08	0.09	1.3	1.3	1.2	1.2
Y	ug/L	ICPMS	0.64	0.1	0.3	0.2	0.06	0.06	0.04	0.2	0.2	0.1	0.04	0.04	0.03
Yb	ug/L	ICPMS	0.07	0.01	0.05	0.02	< 0.01	< 0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	1	2	<0.5	<0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	0.9	< 0.5	< 0.5	< 0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.05	< 0.05	0.2	< 0.05	< 0.05	0.05	0.2	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-18.0	-17.9	-18.9	-19.0	-19.61	-19.12	-19.81	-	-	-	-19.81	-17.4	-17.6
δD vs VSMOW	permil	ISO2	-138.6	-138.3	-138.7	-145.9	-142.7	-144.3	-143.0	-	-	-	-143.0	-135.2	-132.6
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	3.1	3.4
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			9	10	11	12	13	14	15	16	17	18	19	20	21
Drainage/ description			SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column
Latitude			44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N
Longitude			W	W	W	W	W	W	W	W	W	W	W	W	W
NPS no.			-	-	-	-	-	-	-	-	-	-	-	-	-
Date			07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97
Depth	m		9 pump	9 bottle	13	20	30	50	70	90	2	5	9 pump	9 bottle	13
Treatment/ Sample type			Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-	-	-
pH			7.51	7.51	7.40	7.38	7.27	7.23	7.20	7.19	-	-	-	-	-
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	˚C		-	-	-	-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		0.54	0.56	0.57	0.59	0.62	0.62	0.62	0.63	-	-	-	-	-
HCO_3	mM	measured	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	-	-	-	-	-
HCO_3	uM	calculated	507	483	501	539	516	517	519	502	-	-	-	-	-
Comments			-	-	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	3.4	3.8	3.7	4.2	4.1	4.3	4.4	4.6	-	-	-	-	-
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	4.9	6.0	5.9	5.4	6.2	6.5	6.8	8.2	-	-	-	-	-
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	21	17	15	18	28	26	33	18	79	83	69	78	62
As	ug/L	ICPMS	10	10	11	12	11	12	12	13	9.1	9.0	10	10	11
Au	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
B	ug/L	ICPAES	66	67	69	77	75	77	81	85	58	58	64	65	67
Ba	ug/L	ICPMS	8.2	8.2	8.4	8.5	8.4	8.5	8.6	8.8	8.2	8.2	8.4	8.4	8.5
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.9	5.1	5.1	5.3	5.5	5.5	5.8	5.8	4.9	4.9	5.0	5.1	5.0
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.04	0.1	0.1	0.1	0.1	0.1
Co	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	0.02	0.02	0.03	0.02
Cr	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	ug/L	ICPMS	2.1	2.2	2.3	2.5	2.3	2.4	2.6	2.8	1.9	1.9	2.1	2.1	2.2
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5
Dy	ug/L	ICPMS	< 0.005	0.006	0.008	0.008	0.006	< 0.005	0.007	0.005	0.007	0.007	0.01	0.008	0.009
Er	ug/L	ICPMS	< 0.005	0.006	< 0.005	< 0.005	0.006	0.006	0.008	< 0.005	0.007	< 0.005	0.007	0.005	0.006
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	13	12	12	11	14	14	14	10	37	37	29	32	26
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	0.006	0.01	0.007	0.01	0.01	0.009	0.007	0.01	0.01	0.007	0.01	0.02
Ge	ug/L	ICPMS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.6	1.6	1.6	1.7	1.6	1.7	1.7	1.7	1.5	1.4	1.5	1.6	1.5
La	ug/L	ICPMS	0.04	0.04	0.05	0.05	0.07	0.07	0.06	0.05	0.09	0.1	0.07	0.08	0.08
Li	ug/L	ICPMS	29	30	30	34	33	34	35	38	26	26	29	30	30
Mg	mg/L	ICPAES	2.2	2.2	2.2	2.3	2.4	2.4	2.5	2.4	2.1	2.1	2.2	2.2	2.2
Mn	ug/L	ICPMS	0.36	0.31	0.33	0.26	0.43	0.34	0.40	0.28	1.9	1.9	1.3	1.6	1.2
Mo	ug/L	ICPMS	0.94	0.96	0.97	1.0	0.97	1.0	1.1	1.1	0.88	0.86	0.93	0.97	0.96
Na	mg/L	ICPAES	7.4	7.6	7.7	8.3	8.4	8.6	9.1	9.4	6.9	7.0	7.4	7.6	7.6
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.05	0.04	0.04	0.02	0.06	0.04	0.04	0.04	0.04
Ni	ug/L	ICPMS	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5
P	ug/L	ICPMS	110	98	100	110	120	100	110	110	140	120	110	110	110
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.02	0.02	0.01	0.01	0.01
Rb	ug/L	ICPMS	4.5	4.6	4.6	4.9	4.8	5.0	5.0	5.4	4.1	4.2	4.4	4.5	4.6
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.4	0.4	0.5	0.52	0.5	0.50	0.50	0.55	0.4	0.4	0.4	0.4	0.4
Sc	ug/L	ICPMS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Se	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	13	12	12	12	13	12	12	12	12	12	12	12	12
Sm	ug/L	ICPMS	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.02	0.01	0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	36	37	37	38	38	39	39	40	35	35	36	36	36
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	0.1	< 0.1	0.1	< 0.1	0.2	0.1	0.1	< 0.1	0.8	0.8	0.7	0.7	0.4
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02
V	ug/L	ICPMS	1	1	1	1	1	1	1	0.9	1	1	1	1	1
W	ug/L	ICPMS	1.4	1.4	1.6	1.7	1.5	1.7	1.6	1.8	1.3	1.3	1.4	1.4	1.6
Y	ug/L	ICPMS	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.06	0.05	0.05	0.05	0.06
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zr	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-17.0	-17.2	-17.3	-16.9	-16.7	-16.9	-16.9	-16.6	-	-	-	-	-
δD vs VSMOW	permil	ISO2	-132.3	-132.9	-125.1	-131.2	-128.8	-130.9	-130.6	-127.6	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	2.1	1.9	4.6	-	1.7	2.4	2.2	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	2.0	-	-	-	-	1.8	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			22	23	24	25	26							
Drainage/ description			SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	SE Arm water column	South East Arm water column	South East Arm water column	South East Arm water column	South East Arm water column	South East Arm water column	South East Arm water column	South East Arm water column
Latitude			44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'30.5"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N
Longitude			W	W	W	W	W	W	W	W	W	W	W	W
NPS no.			-	-	-	-	-	-	-	-	-	-	-	-
Date			07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/28/98	07/28/98	07/28/98	07/28/98	07/28/98	07/28/98	07/28/98
Depth	m		20	30	50	70	90	0	7.6	15.2	22.9	30.5	38.1	45.7
Treatment/ Sample type			Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-	-
pH			-	-	-	-	-	7.53	7.71	7.56	7.51	7.51	7.46	7.48
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	0.5	0.5	0.5	0.6	0.6	0.6	0.6
HCO_3	uM	calculated	-	-	-	-	-	504	552	528	548	546	561	562
Comments			-	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	-	-	-	-	-	3.3	4.3	3.8	4.3	4.5	4.7	4.7
F	mg/L	IC-Aq	-	-	-	-	-	0.5	0.5	0.8	0.5	0.5	0.5	0.5
NO_3	mg/L	IC-Aq	-	-	-	-	-	<.1	<.1	<.1	<.1	<.1	<.1	<.1
SO_4	mg/L	IC-Aq	-	-	-	-	-	4.8	5.9	5.4	5.9	6.2	6.4	6.2
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	ug/L	ICPMS	64	100	95	92	72	12.00	7.40	9.60	6.00	5.70	5.60	5.40
As	ug/L	ICPMS	12	11	12	12	13	9.60	12.00	10.00	11.00	12.00	12.00	13.00
Au	ug/L	ICPMS	0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	ug/L	ICPAES	74	73	76	77	84	54.00	76.99	61.99	73.99	81.99	76.99	78.99
Ba	ug/L	ICPMS	8.6	8.7	8.8	8.8	9.1	7.60	8.20	8.20	8.20	8.30	8.60	8.20
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	mg/L	ICPAES	5.4	5.4	5.5	5.5	5.6	4.30	5.20	4.60	5.20	5.50	5.10	5.30
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ce	ug/L	ICPMS	0.1	0.2	0.2	0.2	0.1	0.04	0.03	0.04	0.02	0.02	0.02	0.03
Co	ug/L	ICPMS	0.02	0.03	0.02	0.03	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cr	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Cs	ug/L	ICPMS	2.5	2.3	2.5	2.5	2.7	2.40	3.20	2.70	3.00	3.20	3.40	3.20
Cu	ug/L	ICPMS	< 0.5	< 0.5	0.5	< 0.5	< 0.5	0.00	0.00	0.00	0.00	0.50	0.00	0.00
Dy	ug/L	ICPMS	0.007	0.02	0.008	0.01	0.005	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Er	ug/L	ICPMS	0.01	0.006	0.005	< 0.005	0.007	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	ug/L	ICPMS	26	39	38	37	29	11.00	9.60	13.00	9.60	0.00	0.00	0.00
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gd	ug/L	ICPMS	0.009	0.01	0.008	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00
Ge	ug/L	ICPMS	0.2	0.2	0.2	0.2	0.2	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	mg/L	ICPAES	1.6	1.6	1.6	1.6	1.7	1.30	1.60	1.40	1.60	1.70	1.60	1.60
La	ug/L	ICPMS	0.08	0.1	0.09	0.09	0.08	0.03	0.02	0.03	0.03	0.03	0.02	0.02
Li	ug/L	ICPMS	34	32	34	35	38	29.01	38.01	34.01	38.01	40.01	40.01	41.01
Mg	mg/L	ICPAES	2.3	2.4	2.4	2.4	2.5	1.90	2.20	2.00	2.20	2.40	2.20	2.20
Mn	ug/L	ICPMS	0.91	1.4	1.3	1.5	1.6	0.42	0.08	0.10	0.35	0.20	0.23	0.17
Mo	ug/L	ICPMS	1.1	1.0	1.1	1.1	1.1	0.74	1.00	0.87	0.96	0.97	1.20	1.00
Na	mg/L	ICPAES	8.4	8.3	8.5	8.7	9.0	6.20	8.40	7.00	8.20	8.80	8.40	8.50
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nd	ug/L	ICPMS	0.05	0.06	0.07	0.07	0.04	0.02	0.03	0.04	0.04	0.03	0.02	0.03
Ni	ug/L	ICPMS	0.6	0.6	0.6	0.6	0.5	0.40	0.40	0.40	0.40	0.30	0.40	0.40
P	ug/L	ICPMS	110	110	120	120	120	15.00	15.00	16.00	14.00	16.00	15.00	16.00
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.00	0.00	0.08	0.00	0.00	0.00	0.00
Pr	ug/L	ICPMS	0.01	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Rb	ug/L	ICPMS	4.9	4.8	5.1	5.1	5.4	4.00	4.70	4.20	4.50	4.80	4.80	4.80
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb	ug/L	ICPMS	0.50	0.5	0.51	0.52	0.54	0.40	0.57	0.40	0.50	0.40	0.55	0.50
Sc	ug/L	ICPMS	0.4	0.4	0.4	0.3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Se	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO_2	mg/L	ICPMS	12	12	12	12	12	10.98	9.99	10.98	9.99	9.99	9.99	9.99
Sm	ug/L	ICPMS	0.01	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.00	0.08	0.10	0.08	0.09	0.10	0.06
Sr	ug/L	ICPMS	38	38	39	40	40	39.00	41.00	41.00	42.00	42.00	44.00	44.00
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	ug/L	ICPMS	0.7	1.0	0.8	0.8	0.5	0.20	0.20	0.10	0.00	0.00	0.00	0.00
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01
V	ug/L	ICPMS	1	1	1	1	1	2.00	1.00	2.00	1.00	1.00	1.00	1.00
W	ug/L	ICPMS	1.7	1.7	1.7	1.7	1.8	1.10	1.40	1.20	1.20	1.20	1.50	1.40
Y	ug/L	ICPMS	0.06	0.06	0.06	0.06	0.06	0.03	0.02	0.03	0.02	0.03	0.02	0.03
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zr	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.06	0.08	0.08	0.07	0.08	0.07	0.08
Hg	ng/L	Hg CVAF	-	-	-	-	-	<10	<10	<10	<10	<10	<10	<10
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-	-	-	-	-17.1	-16.7	-17.0	-16.8	-16.3	-16.2	-16.2
δD vs VSMOW	permil	ISO2	-	-	-	-	-	-131	-132	-130	-131	-129	-132	-130
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.							44	45	46	47	48	49	50
Drainage/ description			South East Arm water column	South East Arm water column	South East Arm water column	South East Arm water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column
Latitude			44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°21'53.8"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N
Longitude			W	W	W	W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-
Date			07/28/98	07/28/98	07/28/98	07/28/98	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97	07/24/97
Depth	m		53.3	61.0	68.6	73.2	0	2	4	5	5.9	0	2
Treatment/ Sample type			Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Raw and acidified	Raw and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-
pH			7.45	7.43	7.46	7.41	7.19	7.18	7.30	7.33	7.35	-	-
Conductivity	uS/cm		-	-	-	-	129	115	124	121	120	-	-
Temperature	˚C		-	-	-	-	13.5	11.7	11.4	11.2	10.0	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	0.77	0.70	0.67	-	0.68	-	-
HCO_3	mM	measured	0.6	0.6	0.6	0.6	0.7	0.6	0.6	-	0.6	-	-
HCO_3	uM	calculated	559	552	563	557	570	515	490	-	503	-	-
Comments			-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	4.6	4.6	4.6	4.4	8.0	5.5	5.6	-	5.6	-	-
F	mg/L	IC-Aq	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	<.1	<.1	<.1	<.1	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	6.2	6.2	6.3	6.6	7.6	7.2	7.4	0.0	7.3	-	-
Ag	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	5.20	5.40	6.50	7.30	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	14	44
As	ug/L	ICPMS	13.00	12.00	12.00	12.00	37	18	18	18	18	37	18
Au	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.006	< 0.005	0.006	< 0.005	< 0.005	0.005	0.006
B	ug/L	ICPAES	79.99	76.99	82.99	78.99	130	99	96	96	97	130	95
Ba	ug/L	ICPMS	8.70	8.60	8.40	8.30	8.7	9.0	8.8	8.7	9.0	8.7	8.9
Be	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.40	5.20	5.60	5.50	5.6	5.9	5.6	5.7	5.9	5.4	5.6
Cd	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.05	0.04
Co	ug/L	ICPMS	0.00	0.04	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Cr	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	ug/L	ICPMS	3.30	3.20	3.20	3.10	6.9	3.8	3.8	3.8	3.7	6.9	3.7
Cu	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005
Er	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	0.008	0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	0.00	0.00	11.00	11.00	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Ga	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.08	< 0.02	0.02	< 0.02	< 0.02	0.08	0.03
Gd	ug/L	ICPMS	0.00	0.01	0.00	0.01	< 0.005	0.006	0.01	< 0.005	< 0.005	0.01	0.008
Ge	ug/L	ICPMS	0.20	0.20	0.20	0.20	0.8	0.3	0.3	0.4	0.4	0.7	0.3
Hf	ug/L	ICPMS	0.00	0.00	0.00	0.00	5.8	1.2	0.1	< 0.05	< 0.05	0.71	5.6
Ho	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.60	1.60	1.70	1.70	2.0	1.8	1.8	1.8	1.8	1.9	1.7
La	ug/L	ICPMS	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Li	ug/L	ICPMS	40.01	39.01	39.01	39.01	69	46	45	44	45	69	45
Mg	mg/L	ICPAES	2.30	2.30	2.40	2.40	2.4	2.4	2.4	2.3	2.4	2.4	2.3
Mn	ug/L	ICPMS	0.10	0.13	0.13	0.16	0.37	0.31	0.26	0.29	0.25	0.87	0.87
Mo	ug/L	ICPMS	1.00	1.20	0.97	1.10	2.5	1.6	1.6	1.5	1.6	2.5	1.6
Na	mg/L	ICPAES	8.60	8.40	8.90	8.70	14	11	10	10	11	14	10
Nb	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.02	0.03	0.02	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ni	ug/L	ICPMS	0.50	0.40	0.40	0.40	0.4	0.4	0.4	0.4	0.4	0.4	0.4
P	ug/L	ICPMS	21.00	16.00	15.00	16.00	71	70	69	73	70	73	73
Pb	ug/L	ICPMS	0.10	0.00	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	4.80	4.90	4.90	4.80	7.9	6.2	6.1	6.1	6.2	7.8	6.2
Re	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.50	0.54	0.50	0.50	1.8	0.79	0.78	0.79	0.79	1.8	0.78
Sc	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Se	ug/L	ICPMS	0.00	0.00	0.00	0.00	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	9.99	9.99	9.99	9.99	12	10	10	10	10	12	9.8
Sm	ug/L	ICPMS	0.01	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	0.10	0.00	0.10	0.10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	44.00	44.00	44.00	44.00	40	40	39	39	40	38	40
Ta	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tl	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	1.00	1.00	1.00	1.00	0.8	0.9	0.8	0.9	0.9	0.9	0.9
W	ug/L	ICPMS	1.20	1.40	1.40	1.30	6.8	3.2	3.0	2.9	2.9	7.0	3.2
Y	ug/L	ICPMS	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.04
Yb	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	0.00	0.00	0.00	0.00	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zr	ug/L	ICPMS	0.06	0.06	0.07	0.30	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	2.4
Hg	ng/L	Hg CVAF	<10	<10	<10	<10	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.3	-16.2	-16.2	-16.7	-16.4	-16.2	-16.3	-16.4	-16.2	-	-
δD vs VSMOW	permil	ISO2	-131	-126	-131	-133	-128.2	-127.9	-	-126.6	-128.1	-	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	2.5	2.2	2.1	2.4	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	2.0	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no.			51	52	53	54	55	56	57	58	59	60	61
Drainage/ description			West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT1) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column	West Thumb (WT2) water column
Latitude			44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N	44°24'59.3"N
Longitude			110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W	110°34'0"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-
Date			07/24/97	07/24/97	07/24/97	07/25/97	07/25/97	07/25/97	07/25/97	07/25/97	07/25/97	07/25/97	07/25/97
Depth	m		4	5	5.9	0	2	4	5	8	0	2	4
Treatment/ Sample type			Raw and acidified	Raw and acidified	Raw and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Raw and acidified	Raw and acidified	Raw and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-
pH			-	-	-	7.96	7.74	7.71	7.64	7.44	-	-	-
Conductivity	uS/cm		-	-	-	117	115	116	118	118	-	-	-
Temperature	°C		-	-	-	12.3	11.8	11.7	11.5	10.3	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	0.72	0.68	0.65	0.68	0.70	-	-	-
HCO_3	mM	measured	-	-	-	0.7	0.6	0.6	0.6	0.6	-	-	-
HCO_3	uM	calculated	-	-	-	514	481	499	486	506	-	-	-
Comments			-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	-	-	-	5.8	5.5	5.5	5.7	5.9	-	-	-
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	-	-	-	6.9	7.3	7.2	7.2	7.1	-	-	-
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	10	8.8	10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	19	10	16
As	ug/L	ICPMS	18	18	18	22	18	19	18	20	22	18	19
Au	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005
B	ug/L	ICPAES	94	95	94	100	97	96	95	100	99	94	96
Ba	ug/L	ICPMS	8.8	8.9	8.9	8.6	8.8	8.9	8.9	8.9	8.9	8.9	9.1
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.6	5.6	5.6	5.6	5.9	5.6	5.8	5.7	5.7	5.7	5.6
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.04	0.04	0.04	0.02	0.01	0.01	0.02	0.01	0.07	0.05	0.06
Co	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Cr	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cs	ug/L	ICPMS	3.7	3.7	3.7	4.4	3.6	3.8	3.8	4.1	4.5	3.7	3.9
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.008	0.007	0.005	0.006	< 0.005	0.005	< 0.005	0.006	0.008	0.006	0.007
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	11	< 10	11
Ga	ug/L	ICPMS	0.02	0.02	0.02	0.03	0.02	0.02	< 0.02	0.03	0.04	< 0.02	0.02
Gd	ug/L	ICPMS	0.005	0.006	< 0.005	< 0.005	0.01	< 0.005	< 0.005	0.009	0.02	0.01	0.008
Ge	ug/L	ICPMS	0.4	0.3	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.8	1.8	1.7	1.8
La	ug/L	ICPMS	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04
Li	ug/L	ICPMS	44	44	43	51	43	45	45	48	50	43	44
Mg	mg/L	ICPAES	2.4	2.3	2.4	2.4	2.4	2.3	2.3	2.4	2.3	2.4	2.4
Mn	ug/L	ICPMS	0.82	0.85	0.87	0.48	0.25	0.38	0.24	0.41	1.5	1.0	1.4
Mo	ug/L	ICPMS	1.5	1.6	1.6	1.7	1.5	1.6	1.5	1.6	1.7	1.5	1.5
Na	mg/L	ICPAES	10	10	10	11	10	10	10	11	11	10	10
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ni	ug/L	ICPMS	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4
P	ug/L	ICPMS	74	77	68	71	63	62	66	61	66	76	80
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	6.3	6.2	6.0	6.5	6.0	6.1	6.2	6.6	6.6	6.2	6.1
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.78	0.77	0.78	0.89	0.74	0.80	0.77	0.83	0.91	0.78	0.80
Sc	ug/L	ICPMS	0.2	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.2	0.2
Se	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	9.9	9.7	9.7	10	9.5	10	9.6	9.8	10	9.5	9.7
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	40	40	40	40	40	40	40	40	40	40	40
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
W	ug/L	ICPMS	3.0	3.0	2.9	3.5	3.0	3.2	3.1	3.3	3.5	2.9	3.1
Y	ug/L	ICPMS	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zr	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-	-	-16.3	-16.3	-16.2	-16.4	-16.4	-	-	-
δD vs VSMOW	permil	ISO2	-	-	-	-127.6	-125.2	-124.9	-125.6	-126.4	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	2.6	1.8	2.0	2.2	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	2.1	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			62 West Thumb (WT2) water column	63 West Thumb (WT2) water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column	West Thumb water column
Latitude			44°24'59.3"N	44°24'59.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N	44°24'3.3"N
Longitude			110°34'0"W	110°34'0"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W	110°33'19"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-
Date			07/25/97	07/25/97	07/19/98	07/19/98	07/19/98	07/19/98	07/19/98	07/19/98	07/19/98	07/19/98	07/19/98
Depth	m		5	8	0	2	5	10	15	20	25	30	40
Treatment/ Sample type			Raw and acidified	Raw and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-
pH			-	-	7.49	7.56	7.43	7.57	7.54	7.45	7.44	7.45	7.33
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
HCO_3	uM	calculated	-	-	714	707	670	655	672	707	664	668	679
Comments			-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	-	-	5.3	5.2	5.4	5.6	5.5	5.7	5.6	5.6	5.9
F	mg/L	IC-Aq	-	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
NO_3	mg/L	IC-Aq	-	-	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
SO_4	mg/L	IC-Aq	-	-	7	7	7	7	7.1	7.1	7.1	7.1	7
Ag	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	ug/L	ICPMS	10	17	5.60	3.40	3.50	2.20	3.20	5.50	3.40	2.10	2.10
As	ug/L	ICPMS	18	20	17.00	17.00	18.00	18.00	18.00	19.00	19.00	18.00	20.00
Au	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	ug/L	ICPAES	94	99	85.99	81.99	84.99	84.99	83.99	84.99	82.99	85.99	86.99
Ba	ug/L	ICPMS	8.8	8.9	8.30	8.20	8.60	8.10	8.50	8.10	8.30	8.30	8.00
Be	ug/L	ICPMS	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Bi	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	mg/L	ICPAES	5.7	5.8	5.20	4.90	5.00	4.90	4.80	4.80	4.80	4.90	4.90
Cd	ug/L	ICPMS	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ce	ug/L	ICPMS	0.06	0.06	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02
Co	ug/L	ICPMS	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00
Cr	ug/L	ICPMS	< 0.5	< 0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cs	ug/L	ICPMS	3.7	4.1	3.50	3.50	3.70	3.70	3.70	3.80	3.80	3.90	3.90
Cu	ug/L	ICPMS	< 0.5	< 0.5	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dy	ug/L	ICPMS	0.008	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Er	ug/L	ICPMS	0.006	< 0.005	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Eu	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	ug/L	ICPMS	< 10	12	0.00	9.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ga	ug/L	ICPMS	0.02	0.03	0.02	0.03	0.04	0.10	0.00	0.06	0.04	0.00	0.07
Gd	ug/L	ICPMS	0.007	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Ge	ug/L	ICPMS	0.4	0.4	0.30	0.30	0.30	0.30	0.30	0.40	0.30	0.40	0.40
Hf	ug/L	ICPMS	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ho	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	mg/L	ICPAES	1.7	1.8	1.50	1.50	1.60	1.50	1.50	1.50	1.50	1.60	1.50
La	ug/L	ICPMS	0.03	0.04	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.01
Li	ug/L	ICPMS	43	47	50.01	48.01	52.01	54.02	52.01	54.02	54.02	52.01	55.02
Mg	mg/L	ICPAES	2.3	2.4	2.20	2.10	2.10	2.10	2.10	2.00	2.10	2.10	2.10
Mn	ug/L	ICPMS	1.0	1.6	0.19	0.10	0.06	0.02	0.00	0.03	0.06	0.02	0.09
Mo	ug/L	ICPMS	1.6	1.6	1.20	1.40	1.50	1.10	1.20	1.50	1.10	1.40	1.40
Na	mg/L	ICPAES	10	11	9.40	8.90	9.20	9.20	8.90	9.20	9.20	9.30	9.50
Nb	ug/L	ICPMS	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nd	ug/L	ICPMS	< 0.01	< 0.01	0.02	0.00	0.00	0.01	0.04	0.02	0.00	0.02	0.02
Ni	ug/L	ICPMS	0.4	0.4	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
P	ug/L	ICPMS	72	77	15.00	12.00	12.00	12.00	15.00	14.00	13.00	16.00	13.00
Pb	ug/L	ICPMS	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
Pr	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rb	ug/L	ICPMS	6.2	6.4	5.50	5.60	5.90	5.60	5.80	5.80	5.90	5.70	5.80
Re	ug/L	ICPMS	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb	ug/L	ICPMS	0.77	0.84	0.62	0.64	0.72	0.69	0.68	0.72	0.70	0.72	0.69
Sc	ug/L	ICPMS	0.2	0.3	0.10	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Se	ug/L	ICPMS	<0.5	<0.5	0.00	0.00	0.00	1100.00	0.00	0.00	0.00	220.00	0.00
SiO_2	mg/L	ICPMS	9.5	9.8	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	12.98
Sm	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sn	ug/L	ICPMS	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sr	ug/L	ICPMS	40	40	44.00	43.00	44.00	44.00	45.00	43.00	44.00	44.00	43.00
Ta	ug/L	ICPMS	< 0.02	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tb	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Te	ug/L	ICPMS	< 0.1	< 0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Th	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	ug/L	ICPMS	< 0.1	< 0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tl	ug/L	ICPMS	< 0.05	< 0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tm	ug/L	ICPMS	< 0.005	< 0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U	ug/L	ICPMS	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	0.9	0.9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
W	ug/L	ICPMS	3.0	3.4	1.70	1.70	1.90	1.50	1.70	1.90	1.60	1.90	2.00
Y	ug/L	ICPMS	0.03	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Yb	ug/L	ICPMS	< 0.01	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn	ug/L	ICPMS	< 0.5	< 0.5	0.00	0.70	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Zr	ug/L	ICPMS	< 0.05	< 0.05	0.98	0.10	0.07	0.10	0.05	0.07	0.06	0.06	0.08
Hg	ng/L	Hg CVAF	-	-	<10	-	16	<10	-	<10	-	13	10
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-	-16.1	-16.1	-16.1	-16.2	-16.1	-16.2	-16.1	-16.1	-16.1
δD vs VSMOW	permil	ISO2	-	-	-130	-130	-128	-130	-130	-130	-129	-127	-131
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			West Thumb water column	West Thumb water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column
Latitude			44°24'3.3"N	44°24'3.3"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N
Longitude			110°33'19"W	110°33'19"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W
NPS no.			-	-	-	-	-	-	-	-	-	-
Date			07/19/98	07/19/98	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97
Depth	m		60	80	0	5	10	12	17	20	30	40
Treatment/ Sample type			Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified
Collector			-	-	-	-	-	-	-	-	-	-
pH			7.19	7.26	7.55	7.56	7.61	7.34	6.74	6.73	6.74	6.76
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	0.64	0.65	0.65	0.67	0.79	0.77	0.77	0.76
HCO_3	mM	measured	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5
HCO_3	uM	calculated	677	691	462	473	483	467	465	441	443	454
Comments			-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	6	5.9	4.6	4.6	4.6	5.0	6.1	6.3	6.6	6.3
F	mg/L	IC-Aq	0.6	0.6	-	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	<.1	<.1	-	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	6.6	6.5	6.5	6.5	6.1	7.1	7.7	8.7	8.4	8.0
Ag	ug/L	ICPMS	0.00	0.00	0.03	0.02	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	2.10	1.90	15	13	12	8.3	9.3	10	10	10
As	ug/L	ICPMS	21.00	22.00	12	12	12	13	17	17	17	17
Au	ug/L	ICPMS	0.00	0.00	0.02	< 0.005	< 0.005	0.01	0.01	< 0.005	0.02	< 0.005
B	ug/L	ICPAES	89.99	88.99	440	430	< 10	< 10	< 10	< 10	11	13
Ba	ug/L	ICPMS	8.00	8.00	8.5	8.5	8.4	8.6	9.4	9.2	9.3	9.3
Be	ug/L	ICPMS	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.90	5.00	150	150	23	22	11	11	38	38
Cd	ug/L	ICPMS	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.01	0.00	0.03	0.04	0.04	0.04	0.06	0.05	0.05	0.05
Co	ug/L	ICPMS	0.03	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Cr	ug/L	ICPMS	0.00	0.00	1	1	2	2	2	2	2	2
Cs	ug/L	ICPMS	4.30	4.40	2.4	2.5	2.5	2.7	3.8	3.8	3.8	3.8
Cu	ug/L	ICPMS	0.00	1.00	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.00	0.01	< 0.005	< 0.005	0.006	0.006	0.006	0.006	0.009	0.006
Er	ug/L	ICPMS	0.00	0.01	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	10.00	0.00	29	23	16	12	16	14	16	15
Ga	ug/L	ICPMS	0.00	0.06	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.00	0.01	0.007	0.007	0.008	< 0.005	0.006	0.005	0.008	0.005
Ge	ug/L	ICPMS	0.40	0.40	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Hf	ug/L	ICPMS	0.00	0.00	0.2	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.60	1.60	4.3	4.3	3.0	3.1	0.93	1.0	1.2	1.2
La	ug/L	ICPMS	0.01	0.01	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
Li	ug/L	ICPMS	56.02	58.02	35	35	36	38	47	48	48	48
Mg	mg/L	ICPAES	2.10	2.10	90	91	6.02	6.07	2.01	2.02	10	10
Mn	ug/L	ICPMS	0.31	0.20	0.35	0.28	0.17	0.94	2.8	2.8	2.8	2.7
Mo	ug/L	ICPMS	1.60	1.70	1.1	1.0	1.0	1.1	1.1	1.1	1.1	1.1
Na	mg/L	ICPAES	9.90	10.00	273	284	36	37	31	32	21	22
Nb	ug/L	ICPMS	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.02	0.03	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.02	0.02
Ni	ug/L	ICPMS	0.30	0.30	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.5
P	ug/L	ICPMS	19.00	17.00	92	87	85	86	98	92	94	93
Pb	ug/L	ICPMS	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	6.00	6.10	4.9	5.0	5.0	5.3	6.0	6.0	6.0	5.9
Re	ug/L	ICPMS	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.84	0.80	0.57	0.54	0.54	0.60	0.75	0.75	0.74	0.77
Sc	ug/L	ICPMS	0.00	0.00	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Se	ug/L	ICPMS	0.00	0.00	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	12.98	12.98	10	11	11	11	11	12	12	12
Sm	ug/L	ICPMS	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Sn	ug/L	ICPMS	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	43.00	43.00	36	37	37	37	38	38	38	38
Ta	ug/L	ICPMS	0.00	0.00	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	0.00	0.00	0.4	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	0.00	0.00	0.8	0.3	0.4	0.3	0.2	0.2	0.2	0.1
Tl	ug/L	ICPMS	0.00	0.00	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	0.00	0.00	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	1.00	1.00	0.9	0.9	1	0.9	0.9	0.9	0.9	0.9
W	ug/L	ICPMS	2.20	2.20	1.5	1.6	1.6	1.8	2.2	2.2	2.2	2.3
Y	ug/L	ICPMS	0.02	0.02	0.04	0.03	0.04	0.04	0.05	0.04	0.04	0.05
Yb	ug/L	ICPMS	0.00	0.00	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	0.00	0.60	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zr	ug/L	ICPMS	0.05	0.07	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	<10	10	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.1	-16.1	-16.5	-16.4	-16.4	-16.3	-16.7	-16.4	-16.5	-16.4
δD vs VSMOW	permil	ISO2	-130	-131	-129.6	-129.1	-129.4	-129.5	-129.3	-129.6	-129.5	-129.5
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	2.4	2.4	1.7	2.1	2.2	3.4	4.2	2.6
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column	Mary Bay (MB-1) water column
Latitude			44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N
Longitude			110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W
NPS no.			-	-	-	-	-	-	-	-	-	-
Date			07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97	07/26/97
Depth	m		48	0	5	10	12	17	20	30	40	48
Treatment/ Sample type			Filtered and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified	Raw and acidified
Collector			-	-	-	-	-	-	-	-	-	-
pH			6.73	-	-	-	-	-	-	-	-	-
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		0.78	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	0.5	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	470	-	-	-	-	-	-	-	-	-
Comments			-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	6.1	-	-	-	-	-	-	-	-	-
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
NO_3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
SO_4	mg/L	IC-Aq	7.7	-	-	-	-	-	-	-	-	-
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	10	54	64	60	66	65	66	60	66	270
As	ug/L	ICPMS	16	12	13	12	14	18	18	18	18	19
Au	ug/L	ICPMS	0.02	0.007	< 0.005	0.006	< 0.005	0.006	< 0.005	0.02	0.02	< 0.005
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	9.4	8.7	8.8	8.6	9.0	9.7	9.7	9.5	9.6	11
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.06	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.55
Co	ug/L	ICPMS	0.02	0.02	0.02	< 0.02	0.02	0.03	0.03	0.03	0.03	0.08
Cr	ug/L	ICPMS	2	2	2	3	3	3	3	3	3	4
Cs	ug/L	ICPMS	3.8	2.5	2.5	2.4	2.8	3.8	3.9	3.8	3.8	4.0
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5
Dy	ug/L	ICPMS	0.006	0.009	0.008	0.008	0.006	0.01	0.009	0.01	0.01	0.03
Er	ug/L	ICPMS	< 0.005	0.007	0.005	< 0.005	0.005	< 0.005	0.006	0.006	< 0.005	0.01
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Fe	ug/L	ICPMS	25	27	29	30	32	41	42	38	40	150
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03
Gd	ug/L	ICPMS	0.005	0.01	0.01	0.01	0.008	0.009	0.01	0.01	0.01	0.04
Ge	ug/L	ICPMS	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
La	ug/L	ICPMS	0.04	0.06	0.07	0.07	0.07	0.08	0.08	0.07	0.09	0.3
Li	ug/L	ICPMS	48	35	35	35	38	48	48	48	48	48
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Mn	ug/L	ICPMS	3.4	1.3	1.4	1.4	1.9	3.4	3.3	3.3	3.4	4.9
Mo	ug/L	ICPMS	1.1	1.0	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.02	0.03	0.02	0.04	0.05	0.05	0.04	0.04	0.06	0.22
Ni	ug/L	ICPMS	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.8
P	ug/L	ICPMS	86	100	91	100	95	120	100	110	110	150
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	3.6
Pr	ug/L	ICPMS	< 0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.06
Rb	ug/L	ICPMS	5.9	5.0	5.0	5.0	5.2	6.0	5.9	5.9	5.9	6.0
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.78	0.54	0.53	0.53	0.60	0.75	0.77	0.76	0.75	0.77
Sc	ug/L	ICPMS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Se	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SiO_2	mg/L	ICPMS	12	11	11	11	11	12	12	12	12	12
Sm	ug/L	ICPMS	0.01	0.02	0.01	< 0.01	0.01	< 0.01	0.01	0.01	0.01	0.04
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	38	37	37	37	37	38	38	38	38	39
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	0.1	0.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	0.2	0.7	0.8	0.9	1.0	0.9	1.1	1.0	1.1	4.0
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02
V	ug/L	ICPMS	0.9	1	1	1	1	0.9	1	0.9	0.9	1
W	ug/L	ICPMS	2.2	1.7	1.8	1.6	1.8	2.2	2.2	2.2	2.3	1.9
Y	ug/L	ICPMS	0.05	0.06	0.05	0.05	0.06	0.07	0.06	0.06	0.06	0.2
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.02
Zn	ug/L	ICPMS	< 0.5	0.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1
Zr	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.5	-16.4	-16.5	-16.8	-16.4	-16.4	-16.4	-16.3	-
δD vs VSMOW	permil	ISO2	-	-130.2	-129.1	-129.7	-129.7	-129.7	-129.4	-129.2	-129.2	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	Mary Bay water column	off Stevenson Island water column	off Stevenson Island water column
Latitude			44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°30'38.7"N	44°30'38.7"N
Longitude			W	110°18'38.5"W	110°18'38.5"W	110°18'38.5"W	W	W	W	W	W	110°21'17.4"W	110°21'17.4"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-
Date			07/24/98	07/24/98	07/24/98	07/24/98	07/24/98	07/24/98	07/24/98	07/24/98	07/24/98	07/25/98	07/25/98
Depth	m		0	7.6	15.2	22.9	30.5	35.1	39.6	44.2	48.8	0	7.6
Treatment/ Sample type			Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified
Collector			-	-	-	-	-	-	-	-	-	-	-
pH			7.41	7.52	7.01	6.92	6.91	6.94	6.9	6.9	6.92	7.72	7.72
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-	-
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
HCO_3	uM	calculated	658	562	629	604	612	610	623	610	614	636	625
Comments			-	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	4.6	4.7	6.9	6.3	6.2	6.2	6.2	6.2	6.5	4.6	4.6
F	mg/L	IC-Aq	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.8	0.5
NO_3	mg/L	IC-Aq	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
SO_4	mg/L	IC-Aq	6.6	6.4	7.3	7.3	7.3	7.3	7.3	7.3	7.4	6.7	6.7
Ag	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Al	ug/L	ICPMS	10.00	6.10	5.10	5.40	9.40	5.70	6.10	5.60	5.80	7.70	7.60
As	ug/L	ICPMS	14.00	14.00	19.00	18.00	18.00	18.00	18.00	18.00	16.00	13.00	13.00
Au	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	ug/L	ICPAES	79.99	73.99	109.99	99.99	95.99	99.99	109.99	109.99	109.99	76.99	75.99
Ba	ug/L	ICPMS	8.40	7.70	8.80	9.00	8.90	8.80	9.00	9.00	9.00	8.20	13.00
Be	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Bi	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	mg/L	ICPAES	5.00	4.80	4.80	5.00	4.50	4.60	5.10	5.10	5.00	5.00	4.90
Cd	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
Ce	ug/L	ICPMS	0.03	0.02	0.03	0.03	0.05	0.02	0.03	0.03	0.05	0.02	0.02
Co	ug/L	ICPMS	0.02	0.00	0.02	0.00	0.00	0.09	0.02	0.02	0.05	0.07	0.00
Cr	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cs	ug/L	ICPMS	2.80	2.70	4.40	4.00	4.20	4.10	4.20	4.30	3.90	2.80	2.80
Cu	ug/L	ICPMS	0.60	0.00	0.50	0.50	0.00	0.00	0.00	0.50	0.50	0.50	0.00
Dy	ug/L	ICPMS	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.02	0.00	0.00
Er	ug/L	ICPMS	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00
Eu	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	ug/L	ICPMS	9.80	0.00	11.00	12.00	14.00	12.00	12.00	10.00	26.00	0.00	10.00
Ga	ug/L	ICPMS	0.00	0.00	0.07	0.03	0.02	0.00	0.06	0.03	0.05	0.02	0.04
Gd	ug/L	ICPMS	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00
Ge	ug/L	ICPMS	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.20	0.30	0.20	0.30
Hf	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.07
Ho	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
In	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	mg/L	ICPAES	1.50	1.40	1.50	1.60	1.40	1.50	1.60	1.60	1.60	1.50	1.40
La	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.10	0.02	0.02	0.02	0.04	0.02	0.02
Li	ug/L	ICPMS	45.01	44.01	62.02	56.02	54.02	56.02	58.02	57.02	57.02	41.01	41.01
Mg	mg/L	ICPAES	2.10	2.10	2.10	2.20	2.00	2.20	2.30	2.30	2.30	2.10	2.10
Mn	ug/L	ICPMS	0.40	0.08	3.80	3.30	5.80	3.00	3.40	3.20	6.40	0.32	0.15
Mo	ug/L	ICPMS	1.10	0.98	1.00	1.10	0.98	1.10	1.10	1.20	1.10	1.40	1.20
Na	mg/L	ICPAES	8.30	8.00	9.20	9.10	7.90	8.20	9.00	8.90	8.90	8.20	8.10
Nb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nd	ug/L	ICPMS	0.02	0.02	0.03	0.02	0.02	0.02	0.04	0.02	0.03	0.03	0.02
Ni	ug/L	ICPMS	0.30	0.40	0.40	0.40	0.40	0.40	0.40	0.30	0.50	0.40	0.30
P	ug/L	ICPMS	13.00	14.00	12.00	14.00	14.00	12.00	14.00	14.00	13.00	10.00	12.00
Pb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pr	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.01	0.00	0.00
Rb	ug/L	ICPMS	5.00	4.90	5.90	5.80	5.80	5.60	6.00	5.90	5.80	4.90	5.20
Re	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb	ug/L	ICPMS	0.55	0.56	0.82	0.79	0.74	0.76	0.77	0.83	0.87	0.69	0.59
Sc	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Se	ug/L	ICPMS	1600.00	0.00	0.00	620.00	830.00	1800.00	0.00	0.00	0.00	0.00	0.00
SiO_2	mg/L	ICPMS	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	10.98
Sm	ug/L	ICPMS	0.00	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.02
Sn	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sr	ug/L	ICPMS	45.00	44.00	44.00	45.00	46.00	44.00	45.00	46.00	45.00	42.00	43.00
Ta	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Te	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Th	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Ti	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tl	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tm	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U	ug/L	ICPMS	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01
V	ug/L	ICPMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
W	ug/L	ICPMS	1.50	1.30	1.80	1.60	1.60	1.80	1.90	1.80	1.60	1.00	1.20
Y	ug/L	ICPMS	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.02	0.04	0.02	0.01
Yb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn	ug/L	ICPMS	0.60	1.00	2.00	0.90	1.00	1.00	2.00	0.80	8.00	0.60	0.70
Zr	ug/L	ICPMS	0.06	0.06	0.07	0.07	0.07	0.07	0.05	0.00	0.00	0.20	0.20
Hg	ng/L	Hg CVAF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.2	-16.3	-16.2	-16.3	-16.3	-16.3	-16.3	-16.3	-16.3	-16.5	-16.5
δD vs VSMOW	permil	ISO2	-134	-135	-135	-126	-132	-132	-128	-132	-125	-128	-127
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Site and analytical data from creeks and water column profiles—*Continued*.

Field no. Drainage/ description			off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	off Stevenson Island water column	G1 diss Yellowstone River @ outlet	G1 tot Yellowstone River @ outlet	E1 diss Yellowstone River @ outlet
Latitude			44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°34'3.2"N	44°34'3.2"N	44°34'3.2"N
Longitude			W	W	W	W	W	W	W	W	110°22'45.3"W	110°22'45.3"W	110°22'45.3"W
NPS no.			-	-	-	-	-	-	-	-	-	-	-
Date			07/25/98	07/25/98	07/25/98	07/25/98	07/25/98	07/25/98	07/25/98	07/25/98	07/22/99	07/22/99	07/22/99
Depth	m		15.2	30.5	45.7	61.0	76.2	91.4	98.1	104.2	-	-	-
Treatment/ Sample type			Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	Filtered and acidified	dissolved	total	dissolved
Collector			-	-	-	-	-	-	-	-	Balistrieri	Balistrieri	Balistrieri
pH			7.53	7.44	7.38	7.37	7.39	7.37	7.39	7.39	7.2	7.2	7.3
Conductivity	uS/cm		-	-	-	-	-	-	-	-	87	87	87
Temperature	°C		-	-	-	-	-	-	-	-	16.1	16.1	19.9
Flow	CFS		-	-	-	-	-	-	-	-	-	-	-
Alkalinity	Mg/L as $CaCO_3$		-	-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	-	-	-
HCO_3	uM	calculated	640	632	610	621	630	631	616	628	-	-	-
Comments			-	-	-	-	-	-	-	-	temperature @ filter	temperature @ filter	temperature @ filter
Cl	mg/L	IC-Aq	4.8	4.9	5	5.3	5	5	4.9	4.9	4.7	4.7	4.5
F	mg/L	IC-Aq	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
NO_3	mg/L	IC-Aq	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.35	<.35	<.35
SO_4	mg/L	IC-Aq	7	7.1	7.1	7.1	7.2	7.1	7.1	7.2	7.2	7.2	7.2
Ag	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	4.00	3.60	4.40	10.00	3.70	3.60	4.70	4.60	2.4	2	1
As	ug/L	ICPMS	13.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	11	11	24
Au	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	77.99	80.99	80.99	80.99	81.99	79.99	75.99	82.99	89.4	82.4	124
Ba	ug/L	ICPMS	8.10	8.10	8.40	8.40	8.10	8.40	8.00	8.20	8.5	8.4	8.9
Be	ug/L	ICPMS	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	<0.05	<0.05	<0.05
Bi	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.90	5.00	4.90	5.00	5.00	4.90	4.70	5.20	5.1	5.1	5
Cd	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.02	0.03	0.03	0.02
Co	ug/L	ICPMS	0.00	0.00	0.00	0.03	0.05	0.02	0.03	0.00	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<1	<1	<1
Cs	ug/L	ICPMS	2.80	3.00	3.00	3.00	2.90	3.00	2.80	3.00	2.2	2.2	2.3
Cu	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	< 0.005	0.005	0.005
Er	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	0.00	9.70	0.00	9.90	0.00	10.00	0.00	0.00	<30	<30	<30
Ga	ug/L	ICPMS	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.03	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	< 0.005	< 0.005	0.008
Ge	ug/L	ICPMS	0.30	0.30	0.30	0.20	0.20	0.20	0.20	0.30	0.2	0.2	0.2
Hf	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
Ho	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
K	mg/L	ICPAES	1.50	1.50	1.50	1.50	1.60	1.50	1.40	1.60	1.7	1.6	1.68
La	ug/L	ICPMS	0.03	0.02	0.01	0.03	0.01	0.02	0.02	0.02	0.03	0.02	0.03
Li	ug/L	ICPMS	44.01	45.01	44.01	46.01	45.01	45.01	44.01	45.01	42	42	44
Mg	mg/L	ICPAES	2.10	2.20	2.10	2.20	2.20	2.10	2.10	2.20	2.23	2.18	2.19
Mn	ug/L	ICPMS	0.06	0.10	0.14	0.39	0.07	0.26	0.55	1.20	0.45	0.48	0.38
Mo	ug/L	ICPMS	1.20	1.20	1.00	1.00	1.00	0.97	1.00	1.20	0.95	0.92	5.9
Na	mg/L	ICPAES	8.20	8.60	8.40	8.60	8.60	8.30	8.00	8.90	8.75	8.48	9.19
Nb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06	< 0.02
Nd	ug/L	ICPMS	0.02	0.02	0.02	0.04	0.01	0.01	0.01	0.02	0.04	0.03	0.03
Ni	ug/L	ICPMS	0.40	0.30	0.40	0.50	0.40	0.40	0.40	0.40	0.4	0.4	0.3
P	ug/L	ICPMS	10.00	12.00	16.00	14.00	16.00	14.00	15.00	14.00	1	4	< 1
Pb	ug/L	ICPMS	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	4.90	5.10	5.20	5.10	5.10	5.10	4.90	5.20	4.1	4.1	4.2
Re	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
Sb	ug/L	ICPMS	0.62	0.59	0.63	0.66	0.62	0.56	0.51	0.59	0.47	0.45	1.7
Sc	ug/L	ICPMS	0.20	0.10	0.00	0.00	0.00	0.10	0.30	0.00	0.2	0.2	< 0.1
Se	ug/L	ICPMS	0.00	0.00	0.00	1100.00	15.00	0.00	0.00	0.00	< 0.3	< 0.3	< 0.3
SiO_2	mg/L	ICPMS	10.98	10.98	10.98	10.98	10.98	11.98	10.98	10.98	9.7	9.8	8.9
Sm	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
Sr	ug/L	ICPMS	43.00	43.00	42.00	44.00	44.00	44.00	42.00	44.00	36	36	36
Ta	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	< 0.03
Tb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
Th	ug/L	ICPMS	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.2	< 0.2	< 0.2
Tl	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01
V	ug/L	ICPMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.76	0.92
W	ug/L	ICPMS	1.30	1.30	1.20	1.20	1.30	1.20	1.40	1.30	0.89	0.97	11
Y	ug/L	ICPMS	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02
Yb	ug/L	ICPMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	1.00	0.00	0.00	37.01	0.00	0.60	1.00	1.00	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	0.10	0.08	0.09	0.08	0.10	0.09	0.08	0.07	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<10	<10	<10	<10	<10	<10	<10	<10	<5	<5	330
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.5	-16.5	-16.6	-16.1	-16.5	-16.5	-16.5	-16.5	-16.72	-	-16.65
δD vs VSMOW	permil	ISO2	-128	-125	-131	-129	-129	-128	-128	-129	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S$ vs CDT	permil	ISO4	-	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake.

Field No. Description			96-2-6A West Thumb Trout Jacuzzi	97-10f West Thumb Trout Jacuzzi	97-10r West Thumb Trout Jacuzzi	98-18A West Thumb off Grant	98-19A West Thumb off Grant	98-19B West Thumb off Grant (0.5-1m above 98-19A)	98-22A West Thumb SE central basin vent field	98-23A West Thumb SE central basin vent field	98-23B West Thumb SE central basin vent field (0.5-1m above 98-23A)	98-24A West Thumb SE central basin vent field
Latitude			44°24'59.1"N	44°24'59.1"N	44°24'59.1"N	44°24'3.9"N	44°24'3.9"N	44°24'3.9"N	44°25'0.3"N	44°25'0.3"N	44°25'0.3"N	44°25'0.3"N
Longitude			110°34'10"W	110°34'10"W	110°34'10"W	110°33'14.8"W	110°33'14.8"W	110°33'14.8"W	110°31'28.4"W	110°31'28.4"W	110°31'28.4"W	110°31'28.4"W
Date			-	7/24/97	7/24/97	7/19/98	-	-	-	-	-	-
Temp	°C		-	31.7	-	30	58-62	-	8.7-10.2	13.6-14.1	-	7.3
pH			-	7.2	-	5.5	8.3	7.6	5.8	6.1	6.6	7.1
Depth	m		5	5	5	37	47	46	52	50	49	63
Treatment			Raw	Filtered	Raw	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		-	1.49	-	5.46	1.71	0.80	2.43	2.20	1.21	0.76
HCO3	mM	measured	-	1.286	-	0.691	1.675	0.752	0.563	0.822	0.756	0.641
HCO3	uM	calc	-	2056	-	679	3036	665	683	966	792	720
Cl	mg/L	IC-Aq	-	4.1	-	5.8	40.7	6.3	5.8	13.1	7.8	5.6
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
NO3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
SO4	mg/L	IC-Aq	-	11.7	-	-	-	-	-	-	-	-
Ag	ug/L	ICPMS	< 0.05	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	36	59	160	38	160	3.9	4.9	11	4.0	3.9
As	ug/L	ICPMS	210	180	190	22	190	25	24	45	28	24
Au	ug/L	ICPMS	< 0.01	< 0.005	< 0.005	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	-	-	-	88	730	100	81	160	100	74
Ba	ug/L	ICPMS	10	8.7	9.2	17	9.2	10	11	11	9.6	10
Be	ug/L	ICPMS	0.2	0.2	0.2	< 0.05	0.2	< 0.05	< 0.05	0.07	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	-	-	4.4	3.6	4.9	4.2	4.2	4.4	4.0
Ca	mg/L	ICPMS	4	3.5	3.6	5.6	4.4	5.2	5.4	5.6	5.2	5.7
Cd	ug/L	ICPMS	< 0.1	< 0.02	0.08	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.05	0.02	0.2	0.2	0.2	0.02	0.03	0.02	0.02	0.02
Co	ug/L	ICPMS	< 0.1	0.02	0.08	0.1	0.08	0.06	0.04	0.05	0.06	0.03
Cr	ug/L	ICPMS	< 5	2	2	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cs	ug/L	ICPMS	13	37	37	5.4	84	4.6	4.7	15	6.8	4.6
Cu	ug/L	ICPMS	0.8	< 0.5	< 0.5	< 0.5	< 0.5	0.7	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	< 0.05	0.006	0.01	0.01	0.01	0.005	0.006	0.005	< 0.005	< 0.005
Er	ug/L	ICPMS	< 0.05	< 0.005	0.006	< 0.005	0.006	< 0.005	< 0.005	0.008	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	< 500	< 10	24	30	19	11	< 10	< 10	< 10	10
Ga	ug/L	ICPMS	1.2	0.81	0.88	0.1	9.8	0.1	0.05	0.94	0.4	0.05
Gd	ug/L	ICPMS	< 0.05	< 0.005	0.01	0.02	0.02	< 0.005	0.006	0.008	< 0.005	< 0.005
Ge	ug/L	ICPMS	5.2	4.6	4.8	0.5	9.8	0.5	0.4	1.6	0.8	0.4
Hf	ug/L	ICPMS	0.2	0.50	0.3	< 0.05	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	-	-	-	1.5	3.9	1.6	1.5	2.0	1.7	1.4
K	ug/L	ICPMS	2700	2600	2700	1700	7900	1500	1500	3600	1600	1600
La	ug/L	ICPMS	< 0.05	0.02	0.08	0.1	0.1	0.02	0.02	0.02	0.02	0.02
Li	ug/L	ICPMS	240	310	310	63	610	61	61	110	72	61
Lu	ug/L	ICPMS	< 0.05	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPAES	-	-	-	2.1	1.6	2.3	1.8	1.8	1.9	1.8
Mg	mg/L	ICPMS	1.6	1.6	1.7	2.7	1.9	2.7	2.7	2.7	2.6	2.8
Mn	ug/L	ICPMS	7.8	0.75	1.4	6.7	4.0	0.48	2.4	4.4	2.9	1.1
Mo	ug/L	ICPMS	12	13	13	2.1	36	2.8	2.1	6.6	2.7	1.7
Na	mg/L	ICPAES	-	-	-	8.9	64	9.6	9.3	17	12	8.6
Na	mg/L	ICPMS	39	47	48	11	89	11	11	21	13	11
Nb	ug/L	ICPMS	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	< 0.05	< 0.01	0.04	0.08	0.06	0.03	0.04	0.01	0.01	0.02
Ni	ug/L	ICPMS	0.4	0.4	3.2	0.4	0.3	0.3	0.3	0.3	0.4	0.3
P	ug/L	ICPMS	-	62	76	150	110	140	150	140	140	150
Pb	ug/L	ICPMS	0.1	< 0.05	0.5	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	< 0.05	< 0.01	0.01	0.03	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	21	28	28	7.2	47	6.5	6.6	13	7.6	6.3
Re	ug/L	ICPMS	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	10	11	11	1.1	17	1.8	1.2	2.5	1.4	0.94
Sc	ug/L	ICPMS	0.8	1	1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 5	0.5	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
SiO2	mg/L	ICPMS	34	35	37	18	77	13	13	27	16	13
Sm	ug/L	ICPMS	< 0.05	< 0.01	0.01	0.01	0.02	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	< 1	< 0.05	< 0.05	< 0.05	0.2	0.09	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	33	33	33	48	35	46	46	47	44	46
Ta	ug/L	ICPMS	< 0.05	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.5	0.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	0.02	< 0.005	< 0.005	< 0.005	0.005	< 0.005
Ti	ug/L	ICPMS	< 0.5	0.8	1.4	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tl	ug/L	ICPMS	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.02	0.02	0.02	0.02	0.03	0.01	0.009	0.008	0.01	0.01
V	ug/L	ICPMS	0.9	0.7	0.8	1	1	1	1	1	1	1
W	ug/L	ICPMS	48	48	48	2.5	81	5.7	3.2	10	4.3	2.6
Y	ug/L	ICPMS	< 0.1	0.03	0.06	0.06	0.05	0.02	0.02	0.02	0.02	0.03
Yb	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	70	10	10	32	76	10	20	52	20	7
Zr	ug/L	ICPMS	< 0.1	0.1	0.1	0.05	0.4	< 0.05	< 0.05	0.05	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	19	28	15	35	160	50	<10
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-	-15.9	-15.9	-16.21	-16.13	-16.15	-15.97	-16.09	-16.08	-15.83
δD vs VSMOW	per mil	ISO2	-	-126.3	-	-129.9	-132.5	-132	-132.3	-131.7	-131.2	-129.4
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	8.0	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			YNP-99-17-1 West Thumb, SE of Geyser Basin	YNP-99-18-1 West Thumb, SE of Geyser Basin	YNP-99-18-2 West Thumb, SE of Geyser Basin	Y00-D03.3 West Thumb, E basin bottom water	Y00-D03.4 West Thumb, E basin bottom water	Y00-D06.1 West Thumb, Evil Twin crater	Y00-D06.2 West Thumb, Evil Twin crater	Y00-D09.4 West Thumb, off Geyser Basin	Y00-D11.1A West Thumb, NE of Grant	Y00-D11.1B West Thumb, NE of Grant
Latitude			44°24'43.4"N	44°24'43.4"N	44°24'43.4"N	44°25'37"N	44°25'37"N	44°25'29.1"N	44°25'29.1"N	44°24'59.1"N	44°24'26.9"N	44°24'26.7"N
Longitude			110°33'34.2"W	110°33'34.2"W	110°33'34.2"W	110°30'28"W	110°30'28"W	110°34'12"W	110°34'12"W	110°33'46.7"W	110°33'30.8"W	110°33'33.5"W
Date			7/24/99	7/24/99	7/24/99	7/27/00	7/27/00	7/28/00	7/28/00	7/29/00	7/30/00	7/30/00
Temp	°C		-	-	-	15.6	15.6	17.1	35.2	66.1	27.8	27.8
pH			5.4	6.0	6.2	7.6	7.5	7.0	6.6	6.4	5.9	5.9
Depth	m		21	21	21	10	10	42	31	30	23	23
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		-	-	-	-	-	-	-	-	-	-
HCO3	mM	measured	-	-	-	-	-	-	-	-	-	-
HCO3	uM	calc	632	530	514	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	11	7.3	6.8	4.9	1.2	7.1	24	72	5.1	5.2
F	mg/L	IC-Aq	1.4	0.8	0.7	0.7	0.3	0.8	1.7	2.6	0.7	0.7
NO3	mg/L	IC-Aq	<.35	<.35	<.35	<.08	<.08	0.3	<.08	0.2	0.2	<.08
SO4	mg/L	IC-Aq	9.3	8.4	8.0	6.9	1.8	7.5	8.9	10.0	8.0	8.0
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	0.03	0.02	0.01	0.01	0.01	<0.01	<0.01
Al	ug/L	ICPMS	22	6.2	2.3	3.4	9.5	4.4	4.9	15	10	8.2
As	ug/L	ICPMS	72	36	32	14	15	81	170	180	20	20
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	191	130	121	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	11	9.9	9.4	9.5	11	14	22	250	10	9.9
Be	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.5	0.64	<0.05	<0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.27	5.28	5.55	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.5	4.5	4.6	5.2	4.7	4	3.6	23	4.5	4.4
Cd	ug/L	ICPMS	0.02	0.03	0.05	0.04	0.07	<0.02	<0.02	<0.02	0.04	0.02
Ce	ug/L	ICPMS	0.06	0.04	0.01	< 0.01	< 0.01	0.2	0.4	0.1	0.04	0.04
Co	ug/L	ICPMS	0.3	0.04	<0.02	<0.02	0.05	0.04	0.05	0.07	<0.02	0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	15	6.8	6	2.9	2.8	23	40	110	3.6	3.6
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.01	0.04	0.01	< 0.005	< 0.005
Er	ug/L	ICPMS	0.006	0.008	< 0.005	< 0.005	< 0.005	0.01	0.02	0.02	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	<30	<30	<30	<1	2	19	5	500	9.6	9.2
Ga	ug/L	ICPMS	0.1	0.09	0.07	0.02	0.03	< 0.02	< 0.02	< 0.02	0.02	0.02
Gd	ug/L	ICPMS	0.01	0.005	0.007	< 0.005	< 0.005	0.01	0.02	0.01	< 0.005	0.008
Ge	ug/L	ICPMS	1.5	0.8	0.6	0.4	0.4	1	5.1	15	0.6	0.6
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	2.2	1.86	1.87	-	-	-	-	-	-	-
K	ug/L	ICPMS	2000	1700	1700	1600	1500	2100	3700	14000	1600	1600
La	ug/L	ICPMS	0.03	0.03	0.02	0.03	0.02	0.09	0.2	0.08	0.04	0.04
Li	ug/L	ICPMS	120	71	66	46	45	69	210	1200	50	49
Lu	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPAES	2.23	2.29	2.3	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	2	2	2	2.3	2.2	1.7	1.2	12	2.1	2.1
Mn	ug/L	ICPMS	2.3	1.2	0.76	0.31	0.57	14	24	140	2.3	2
Mo	ug/L	ICPMS	4.2	2.3	2.2	1.4	1.4	2	4.5	1	1.6	1.6
Na	mg/L	ICPAES	19	12.6	12.2	-	-	-	-	-	-	-
Na	mg/L	ICPMS	16	11	10	9	9	14	43	160	9.6	9.5
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	-	-	-	-	-	-	-
Nd	ug/L	ICPMS	0.05	0.04	0.03	0.01	< 0.01	0.09	0.21	0.07	0.02	0.03
Ni	ug/L	ICPMS	0.4	0.3	0.2	0.3	0.5	0.4	0.2	0.2	0.4	0.4
P	ug/L	ICPMS	< 2	< 2	< 2	5	6	7	7	50	6	8
Pb	ug/L	ICPMS	<0.05	0.09	0.07	<0.05	<0.05	0.08	0.2	0.1	0.1	0.2
Pr	ug/L	ICPMS	0.01	0.01	< 0.01	< 0.01	< 0.01	0.02	0.04	0.02	< 0.01	< 0.01
Rb	ug/L	ICPMS	10	7.2	6.8	5.8	6.1	13	24	83	6.2	6.1
Re	ug/L	ICPMS	-	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	4.2	1.6	1.3	0.78	0.82	5.5	400	4.9	1.3	2.4
Sc	ug/L	ICPMS	0.4	0.3	0.3	-	-	-	-	-	-	-
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
SiO2	mg/L	ICPMS	16	12	11	9.7	9.8	13	30	95	10	10
Sm	ug/L	ICPMS	0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	0.04	0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	41	42	42	45	44	40	40	510	43	43
Ta	ug/L	ICPMS	0.04	< 0.03	< 0.03	-	-	-	-	-	-	-
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	< 0.8	< 0.8	< 0.8	-	-	-	-	-	-	-
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.005	0.007	0.007	0.02	0.03	0.008	0.02	0.04	0.009	0.01
V	ug/L	ICPMS	0.9	0.8	0.9	0.83	0.98	1.2	1.5	1.6	0.83	0.82
W	ug/L	ICPMS	10	6.4	5.8	2	2.2	9.6	29	40	3.4	3.1
Y	ug/L	ICPMS	0.05	0.03	0.03	0.02	0.01	0.09	0.3	0.2	0.05	0.05
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	22	3	8	6	280	1	3	10	3	6
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	-	-	-	-	-	-	-
Hg	ng/L	Hg CVAF	6.0	5.0	6.0	0.008	<0.005	0.01	0.07	0.006	0.041	0.048
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.0	-16.1	-16.1	-16.1	-16.1	-16.3	-16.2	-16.5	-16.3	-16.3
δD vs VSMOW	per mil	ISO2	-127.8	-127.9	-126.6	-126.8	-126.4	-126.3	-129.8	-134.8	-128.0	-126.8
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			Y00-D12.1 West Thumb, NE of Grant	98-13A West Thumb off Bluff Point (Otter Vent)	98-13B West Thumb off Bluff Point (Otter Vent) (0.5m above 98-13A)	D03-8.1 WT, Otter vent	D03-8.2 WT, Otter vent	Y00-D18.1 West Thumb, N of Bluff Point	Y00-D18.2 West Thumb, N of Bluff Point (same vent as Y00-D18.1)	96-5 Steamboat Point vent	96-6-1 Steamboat Point vent
Latitude			44º24'26.7"N	44º26'36.0"N	44º26'36.0"N	44º26'35.998"N	44º26'35.998"N	44º26'56.8"N	44º26'56.8"N	44º31'35.7"N	44º31'35.7"N
Longitude			110º33'33.0"W	110º33'56.1"W	110º33'56.1"W	110º33'56.1"W	110º33'56.1"W	110º33'30.5"W	110º33'30.5"W	110º17'39.5"W	110º17'39.5"W
Date			7/30/00	7/18/98	7/18/98	8/16/03	8/16/03	8/2/00	8/2/00	-	-
Temp	˚C		31.7	68	-	66.9	66.9	42.0	49.3	89	93
pH			-	8.6	8.3	8.1	8	7.1	7.3	-	-
Depth	m		23	5	5	1.7	1.7	59	59	-	-
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Raw	Raw
sum CO2	mM		-	0.91	0.79	-	-	-	-	0.98	1.17
HCO3	mM	measured	-	0.884	0.774	-	-	-	-	-	-
HCO3	uM	calc	-	1384	948	-	-	-	-	-	-
Cl	mg/L	IC-Aq	5.3	1.8	3.3	5	4.7	4.6	4.6	-	-
F	mg/L	IC-Aq	0.7	-	-	0.5	1.6	2.7	3.1	-	-
NO3	mg/L	IC-Aq	<.08	-	-	<.08	<.08	<.08	0.2	-	-
SO4	mg/L	IC-Aq	8.4	-	-	6.9	6.6	6.3	6.1	-	-
Ag	ug/L	ICPMS	<0.01	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	< 0.05	< 0.05
Al	ug/L	ICPMS	30	21	11	4.4	3.3	3.7	4.5	58	40
As	ug/L	ICPMS	18	9.2	14	14	13	15	16	11	15
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	-	35	62	-	-	-	-	-	-
Ba	ug/L	ICPMS	9.5	5	7.7	7.8	7.9	9.7	9.9	25	11
Be	ug/L	ICPMS	<0.05	< 0.05	0.07	<0.05	<0.05	<0.05	<0.05	< 0.2	< 0.2
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.03	< 0.03	< 0.01	< 0.01	< 0.05	< 0.05
Ca	mg/L	ICPAES	-	3.2	3.8	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.3	3.6	4.5	4.2	4.2	3.8	3.7	5.5	4.9
Cd	ug/L	ICPMS	0.04	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	< 0.1	< 0.1
Ce	ug/L	ICPMS	0.04	0.5	0.04	< 0.01	< 0.01	0.04	0.07	0.2	0.1
Co	ug/L	ICPMS	0.02	0.2	0.1	<0.02	<0.02	<0.02	0.03	< 0.1	< 0.1
Cr	ug/L	ICPMS	<1	< 1	< 1	<1	<1	<1	<1	< 5	< 5
Cs	ug/L	ICPMS	3.5	9.3	5.2	3	2.8	3.6	4	1.3	1.2
Cu	ug/L	ICPMS	<0.5	< 0.5	< 0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.6
Dy	ug/L	ICPMS	0.005	0.01	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.05	< 0.05
Er	ug/L	ICPMS	< 0.005	0.006	< 0.005	< 0.005	< 0.005	0.007	0.005	< 0.05	< 0.05
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Fe	ug/L	ICPMS	13	< 10	< 10	<2	<2	8.2	10	< 500	< 500
Ga	ug/L	ICPMS	< 0.02	2.4	0.83	0.087	0.054	0.02	0.02	0.2	< 0.1
Gd	ug/L	ICPMS	0.008	< 0.005	0.006	< 0.005	< 0.005	0.006	0.008	< 0.05	< 0.05
Ge	ug/L	ICPMS	0.5	1.4	0.7	0.47	0.38	0.7	0.9	0.2	0.3
Hf	ug/L	ICPMS	-	0.3	< 0.05	<5	<5	-	-	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
K	mg/L	ICPAES	-	< 1	1.0	-	-	-	-	-	-
K	ug/L	ICPMS	1700	680	1400	1400	1400	2200	2400	2200	1600
La	ug/L	ICPMS	0.04	0.03	0.02	< 0.01	< 0.01	0.05	0.05	0.1	0.07
Li	ug/L	ICPMS	50	120	77	50	47	64	69	34	40
Lu	ug/L	ICPMS	-	-	-	-	-	-	-	< 0.05	< 0.05
Mg	mg/L	ICPAES	-	< 1	1.3	-	-	-	-	-	-
Mg	mg/L	ICPMS	2	0.20	1.7	1.9	1.9	1.7	1.6	1.8	1.9
Mn	ug/L	ICPMS	4	6.9	2.8	1.2	0.9	13	17	6.4	9.5
Mo	ug/L	ICPMS	1.6	16	7.5	2.4	1.9	4.2	5.1	1.4	1.2
Na	mg/L	ICPAES	-	25	14	-	-	-	-	-	-
Na	mg/L	ICPMS	10	29	17	9.4	8.5	13	14	7.2	7.2
Nb	ug/L	ICPMS	-	< 0.02	< 0.02	-	-	-	-	< 0.1	< 0.1
Nd	ug/L	ICPMS	0.03	0.05	0.03	< 0.01	< 0.01	0.03	0.06	0.1	0.07
Ni	ug/L	ICPMS	0.4	< 0.1	0.2	0.6	0.42	0.4	0.3	0.3	0.5
P	ug/L	ICPMS	8	43	110	< 1	< 1	9	9	-	-
Pb	ug/L	ICPMS	0.08	0.2	< 0.05	<0.05	<0.05	0.06	0.06	0.2	0.09
Pr	ug/L	ICPMS	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.05	< 0.05
Rb	ug/L	ICPMS	6.8	5.2	5.5	4.7	4.6	11	12	8.2	4.6
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.05	< 0.05
Sb	ug/L	ICPMS	1.1	0.54	0.82	0.81	0.8	0.89	1.6	0.4	0.6
Sc	ug/L	ICPMS	-	< 0.1	< 0.1	-	-	-	-	< 0.5	< 0.5
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 5	< 5
SiO2	mg/L	ICPMS	12	97	45	14	11	41	47	17	12
Sm	ug/L	ICPMS	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.05	< 0.05
Sn	ug/L	ICPMS	-	< 0.05	< 0.05	-	-	-	-	< 1	< 1
Sr	ug/L	ICPMS	40	6.6	30	36	37	35	35	50	38
Ta	ug/L	ICPMS	-	0.04	< 0.02	-	-	-	-	< 0.05	< 0.05
Tb	ug/L	ICPMS	< 0.005	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Te	ug/L	ICPMS	-	< 0.1	< 0.1	-	-	-	-	< 0.5	< 0.5
Th	ug/L	ICPMS	< 0.005	0.04	0.01	< 0.08	< 0.08	< 0.005	< 0.005	< 0.05	< 0.05
Ti	ug/L	ICPMS	-	0.1	< 0.1	-	-	-	-	1	0.8
Tl	ug/L	ICPMS	<0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	< 0.1	0.1
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
U	ug/L	ICPMS	0.009	0.03	0.008	0.012	0.013	0.02	0.02	< 0.02	< 0.02
V	ug/L	ICPMS	0.75	0.2	0.7	0.82	0.86	0.63	0.69	0.9	1.3
W	ug/L	ICPMS	2.8	9.1	4.7	3.1	2.7	3.9	4.2	2.2	2.5
Y	ug/L	ICPMS	0.05	0.03	0.01	< 0.01	0.01	0.04	0.06	< 0.1	< 0.1
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Zn	ug/L	ICPMS	2	41	10	0.59	<0.5	4	6	12	21
Zr	ug/L	ICPMS	-	6.9	0.4	-	-	-	-	< 0.1	< 0.1
Hg	ng/L	Hg CVAF	0.019	36	12	-	-	<0.005	0.007	-	-
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.3	-19.12	-17.39	-16.3	-16.0	-16.8	-17.0	-	-
δD vs VSMOW	per mil	ISO2	-129.1	-145.4	-137.8	-134.8	-131.9	-131.5	-132.2	-	-
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	2.4	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-5.8	-5.5	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			96-6-2 Steamboat Point vent	97-3 Steamboat Point vent	98-01A Steamboat Point vent	98-01B Steamboat Pt (1m above 98-01A)	98-02A Steamboat Point vent	98-02B Steamboat Pt (1m above 98-02A)	YNP-99-11-1 Steamboat Point vent	YNP-99-11-2 Steamboat Point vent	96-8(5) Mary Bay deep hole	96-8(6) Mary Bay deep hole	96-8(6) Mary Bay deep hole
Latitude			44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°31'35.7"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N
Longitude			110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°17'39.5"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W
Date			-	7/19/97	7/15/98	7/15/98	7/15/98	7/15/98	7/21/99	7/21/99	-	-	-
Temp	°C		-	28.3	33	20	55	25	32.0	32.0	-	-	-
pH			-	5.4	5.9	6.6	6.1	6.5	6.3	6.7	-	-	-
Depth	m		-	4	5	4	5	4	5	5	-	-	-
Treatment			Raw	Raw	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Raw	Raw	Raw
sum CO2	mM		-	2.08	2.37	0.92	1.74	1.07	-	-	-	-	-
HCO3	mM	measured	-	0.227	0.632	0.610	0.641	0.638	-	-	-	-	-
HCO3	uM	calc	-	397	551	625	545	607	434	476	-	-	-
Cl	mg/L	IC-Aq	-	4.4	4.5	4.5	4.4	4.5	4.1	4.1	-	-	-
F	mg/L	IC-Aq	-	-	-	-	-	-	0.5	0.5	-	-	-
NO3	mg/L	IC-Aq	-	-	-	-	-	-	<.1	<.1	-	-	-
SO4	mg/L	IC-Aq	-	8.2	9.9	7.6	10.9	7.6	8.8	7.6	-	-	-
Ag	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.4	0.2	< 0.05	< 0.05	< 0.05
Al	ug/L	ICPMS	100	67	15	9.8	16	10	0.7	2.9	230	780	760
As	ug/L	ICPMS	14	10	6.6	14	7.1	13	13	13	21	54	54
Au	ug/L	ICPMS	< 0.01	< 0.005	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	-	-	86	70	83	77	79.8	84.5	-	-	-
Ba	ug/L	ICPMS	14	13	10	9.6	16	9.6	11	15	14	25	26
Be	ug/L	ICPMS	< 0.2	< 0.05	< 0.05	< 0.05	0.07	< 0.05	<0.05	<0.05	< 0.2	< 0.2	< 0.2
Bi	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.052	< 0.01	< 0.05	< 0.05	< 0.05
Ca	mg/L	ICPAES	-	-	4.8	4.2	4.8	4.5	5.15	5.06	-	-	-
Ca	mg/L	ICPMS	4.7	4.0	5.3	5.3	5.6	5.3	4.4	4.4	4.9	4.7	4.9
Cd	ug/L	ICPMS	< 0.1	0.04	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	<0.02	< 0.1	< 0.1	< 0.1
Ce	ug/L	ICPMS	0.2	0.1	0.06	0.04	0.06	0.04	0.2	0.04	0.7	2.1	2.1
Co	ug/L	ICPMS	< 0.1	0.04	0.1	0.08	0.03	0.04	0.2	0.07	0.2	0.5	0.5
Cr	ug/L	ICPMS	< 5	3	< 1	< 1	< 1	< 1	<1	<1	< 5	< 5	< 5
Cs	ug/L	ICPMS	1.1	2.5	2.8	2.9	3.0	2.7	2.2	2.3	1.6	1.9	2
Cu	ug/L	ICPMS	0.5	< 0.5	< 0.5	1	< 0.5	< 0.5	<0.5	<0.5	1.2	2.1	2.1
Dy	ug/L	ICPMS	< 0.05	0.009	< 0.005	< 0.005	0.01	< 0.005	0.01	< 0.005	< 0.05	0.1	0.1
Er	ug/L	ICPMS	< 0.05	0.008	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.007	< 0.05	0.06	0.06
Eu	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.05
Fe	ug/L	ICPMS	< 500	26	14	13	11	12	<30	<30	< 500	2100	2100
Ga	ug/L	ICPMS	< 0.1	0.02	0.04	< 0.02	0.2	< 0.02	< 0.02	< 0.02	< 0.1	0.2	0.2
Gd	ug/L	ICPMS	< 0.05	0.008	0.01	< 0.005	< 0.005	0.006	0.02	0.01	0.05	0.1	0.1
Ge	ug/L	ICPMS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.4
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-	-	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.05
In	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	< 0.05	< 0.05	< 0.05
K	mg/L	ICPAES	-	-	1.4	1.2	1.7	1.4	1.52	1.56	-	-	-
K	ug/L	ICPMS	1500	1300	1400	1400	1600	1400	1400	1400	1600	1600	1600
La	ug/L	ICPMS	0.1	0.08	0.04	0.04	0.04	0.03	0.1	0.04	0.4	1	1
Li	ug/L	ICPMS	43	34	42	42	41	43	41	43	51	52	53
Lu	ug/L	ICPMS	< 0.05	-	-	-	-	-	-	-	< 0.05	< 0.05	< 0.05
Mg	mg/L	ICPAES	-	-	2.2	2.0	2.0	2.2	2.2	2.18	-	-	-
Mg	mg/L	ICPMS	2.2	1.9	2.6	2.7	2.5	2.6	2	2.1	2.1	2.6	2.6
Mn	ug/L	ICPMS	4.4	2.3	2.3	1.4	3.8	1.3	1.8	1.2	14	35	34
Mo	ug/L	ICPMS	1.2	1.0	0.93	0.98	0.91	1.0	3.1	1.5	1.1	1.6	1.6
Na	mg/L	ICPAES	-	-	7.4	6.5	7.1	7.2	8.63	8.54	-	-	-
Na	mg/L	ICPMS	8.2	7.0	8.5	8.9	8.5	8.7	7.2	7.4	8.1	9.5	9.7
Nb	ug/L	ICPMS	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.3	0.2	< 0.1	< 0.1	< 0.1
Nd	ug/L	ICPMS	0.1	0.05	0.04	0.04	0.05	0.04	0.09	0.04	0.4	0.9	0.9
Ni	ug/L	ICPMS	0.7	0.5	0.4	0.4	0.2	0.4	0.4	0.4	1.1	2.6	2.6
P	ug/L	ICPMS	-	76	150	150	110	110	2	2	-	-	-
Pb	ug/L	ICPMS	0.2	< 0.05	0.3	< 0.05	< 0.05	< 0.05	<0.05	<0.05	0.3	0.7	0.7
Pr	ug/L	ICPMS	< 0.05	0.01	0.01	0.01	0.01	< 0.01	0.02	< 0.01	0.09	0.2	0.2
Rb	ug/L	ICPMS	4.6	5.7	5.2	5.4	6.9	5.0	4	4.1	5.1	5.6	5.6
Re	ug/L	ICPMS	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	-	-	< 0.05	< 0.05	< 0.05
Sb	ug/L	ICPMS	0.6	0.1	< 0.02	0.54	< 0.02	0.4	1	0.63	0.7	1.3	1.4
Sc	ug/L	ICPMS	< 0.5	0.4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.5	< 0.5	< 0.5
Se	ug/L	ICPMS	< 5	0.5	< 0.2	< 0.2	< 0.2	< 0.2	0.6	< 0.3	< 5	< 5	< 5
SiO2	mg/L	ICPMS	12	11	12	12	15	12	9.2	9.4	13	18	18
Sm	ug/L	ICPMS	< 0.05	0.02	0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.06	0.2	0.2
Sn	ug/L	ICPMS	< 1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-	-	< 1	< 1	< 1
Sr	ug/L	ICPMS	38	39	45	46	50	46	36	36	40	42	42
Ta	ug/L	ICPMS	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.28	0.21	< 0.05	< 0.05	< 0.05
Tb	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.05
Te	ug/L	ICPMS	< 0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1			< 0.5	< 0.5	< 0.5
Th	ug/L	ICPMS	< 0.05	< 0.005	0.005	< 0.005	0.005	< 0.005	< 0.02	< 0.02	< 0.05	< 0.05	0.05
Ti	ug/L	ICPMS	2.3	1.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	6.2	20	20
Tl	ug/L	ICPMS	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2	0.05	0.1	0.1	0.1
Tm	ug/L	ICPMS	< 0.05	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.05
U	ug/L	ICPMS	< 0.02	0.01	0.01	0.02	0.009	0.007	0.01	0.009	< 0.02	0.04	0.04
V	ug/L	ICPMS	1.4	0.8	1	1	0.9	1	1.4	1	1.7	7	7.1
W	ug/L	ICPMS	2.4	1.9	1.3	1.2	1.2	1.3	1.5	1.4	2.6	3.5	3.5
Y	ug/L	ICPMS	< 0.1	0.06	0.03	0.03	0.04	0.02	0.07	0.02	0.2	0.6	0.6
Yb	ug/L	ICPMS	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.05	0.06	< 0.05
Zn	ug/L	ICPMS	14	20	31	10	3	4	20	4	9.3	< 5	< 5
Zr	ug/L	ICPMS	< 0.1	< 0.05	< 0.05	< 0.05	< 0.05	0.05	< 0.2	< 0.2	0.2	0.3	0.3
Hg	ng/L	Hg CVAF	-	-	31	26	31	18	0.0	10.0	-	-	-
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-	-16.7	-16.33	-16.36	-16.49	-16.35	-16.5	-16.6	-	-	-
δD vs VSMOW	per mil	ISO2	-	-131.8	-130.3	-129.6	-125.6	-130.2	-130.7	-130.0	-	-	-
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	3.0	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	2.5	-	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			96-12-1 Mary Bay deep hole	96-12-2 Mary Bay deep hole	97-4a Mary Bay deep hole	97-4b Mary Bay deep hole	97-7a Mary Bay deep hole	97-8a Mary Bay deep hole	97-8b Mary Bay deep hole	97-12f Mary Bay deep hole	97-7a Mary Bay deep hole	97-8a Mary Bay deep hole
Latitude			44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'43.5"N	44°32'43.5"N	44°32'42.8"N	44°32'42.8"N	44°32'43.5"N
Longitude			110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'41.4"W	110°18'41.4"W	110°18'39.1"W	110°18'39.1"W	110°18'41.4"W
Date			-	-	7/20/97	7/20/97	7/22/97	7/23/97	7/23/97	7/26/97	7/22/97	7/23/97
Temp	°C		30	80	65.6	82.2	85.0	79.4	66.1	35.0	85.0	79.4
pH			-	-	5.0	5.2	4.9	6.6	5.7	5.1	4.9	6.6
Depth	m		-	-	-	-	-	53	53	-	-	53
Treatment			Raw	Raw	Raw	Raw	Filtered	Filtered	Filtered	Filtered	Raw	Raw
sum CO2	mM		1.00	1.03	20.79	13.57	26.91	0.84	20.55	22.42	-	-
HCO3	mM	measured	-	-	0.929	0.823	0.964	0.532	3.484	1.168	-	-
HCO3	uM	calc	-	-	233	369	271	364	440	293	-	-
Cl	mg/L	IC-Aq	-	-	6.1	5.2	4.9	5.9	5.1	5.5	3.3	-
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
NO3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-	-
SO4	mg/L	IC-Aq	-	-	11.8	11.0	10.5	8.2	7.5	11.0	5.2	-
Ag	ug/L	ICPMS	< 0.05	< 0.05	< 0.01	< 0.01	0.2	< 0.01	< 0.01	< 0.01	0.09	< 0.01
Al	ug/L	ICPMS	290	1900	600	4000	92	12	530	96	280	60
As	ug/L	ICPMS	23	52	7.4	12	3.7	14	8.3	12	5.2	15
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.005	0.01	0.2	< 0.005	0.08	0.01	0.02	0.02
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	14	33	23	70	18	12	58	12	17	11
Be	ug/L	ICPMS	< 0.2	< 0.2	< 0.05	0.2	0.09	< 0.05	0.2	< 0.05	0.08	< 0.05
Bi	ug/L	ICPMS	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.7	5.2	3.6	4.5	3.7	4.0	4.8	3.7	3.5	4.0
Cd	ug/L	ICPMS	< 0.1	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.7	7.6	1.1	9.3	0.2	0.06	0.2	0.2	0.96	0.1
Co	ug/L	ICPMS	0.2	1.7	0.07	0.66	0.05	0.05	0.04	0.04	0.05	0.04
Cr	ug/L	ICPMS	< 5	8.4	4	6	3	2	3	3	3	2
Cs	ug/L	ICPMS	1.6	2	3.8	6.0	3.5	3.4	2.3	4.0	3.5	3.4
Cu	ug/L	ICPMS	0.7	6	< 0.5	< 0.5	< 0.5	6	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	< 0.05	0.4	0.069	0.39	0.01	0.009	0.03	0.01	0.04	0.01
Er	ug/L	ICPMS	< 0.05	0.2	0.04	0.18	0.009	0.005	0.03	0.01	0.03	0.007
Eu	ug/L	ICPMS	< 0.05	0.1	0.01	0.095	< 0.005	< 0.005	< 0.005	< 0.005	0.01	< 0.005
Fe	ug/L	ICPMS	740	2700	280	1300	39	13	340	100	83	34
Ga	ug/L	ICPMS	< 0.1	0.8	0.03	0.4	< 0.02	< 0.02	< 0.02	< 0.02	0.04	< 0.02
Gd	ug/L	ICPMS	0.05	0.5	0.084	0.48	0.02	0.009	0.04	0.02	0.072	0.01
Ge	ug/L	ICPMS	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.05	0.07	0.01	0.072	< 0.005	< 0.005	0.007	< 0.005	0.008	< 0.005
In	ug/L	ICPMS	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	1600	1800	1200	1300	1300	1300	1300	1200	1200	1200
La	ug/L	ICPMS	0.4	3.8	0.51	4.6	0.08	0.05	0.07	0.08	0.50	0.08
Li	ug/L	ICPMS	56	55	41	40	38	42	34	44	37	42
Lu	ug/L	ICPMS	< 0.05	< 0.05	-	-	-	-	-	-	-	-
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	2.4	2.8	1.8	2.4	1.6	1.8	2.4	1.8	1.5	1.8
Mn	ug/L	ICPMS	28	22	9.8	20	5.5	2.8	31	5.8	4.4	2.3
Mo	ug/L	ICPMS	1.3	2.7	0.2	0.2	0.1	1.2	0.2	0.4	0.2	1.2
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	9.9	9.6	6.8	6.7	6.5	7.4	6.2	7.3	6.0	7.2
Nb	ug/L	ICPMS	< 0.1	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.4	3.5	0.54	4.2	0.06	0.03	0.1	0.09	0.38	0.06
Ni	ug/L	ICPMS	1.3	7.6	0.4	3.0	0.2	0.5	0.5	0.4	0.2	0.5
P	ug/L	ICPMS	-	-	200	740	140	140	220	100	140	88
Pb	ug/L	ICPMS	0.2	2.8	< 0.05	0.76	< 0.05	0.3	< 0.05	< 0.05	0.1	< 0.05
Pr	ug/L	ICPMS	0.09	0.9	0.1	1.0	0.02	< 0.01	0.02	0.02	0.1	0.01
Rb	ug/L	ICPMS	5.3	6.2	5.8	7.3	6.4	5.9	5.6	5.9	6.3	5.9
Re	ug/L	ICPMS	< 0.05	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.9	2	0.05	0.02	< 0.02	0.72	0.03	0.2	< 0.02	0.71
Sc	ug/L	ICPMS	< 0.5	0.5	0.5	0.6	0.5	0.4	0.7	0.4	0.5	0.4
Se	ug/L	ICPMS	< 5	< 5	5.0	2	4	0.5	3	3	4	0.6
SiO2	mg/L	ICPMS	14	22	13	17	15	11	20	9.5	14	11
Sm	ug/L	ICPMS	0.06	0.6	0.09	0.65	0.01	< 0.01	0.03	0.01	0.08	0.01
Sn	ug/L	ICPMS	< 1	< 1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	40	48	40	54	33	36	58	36	34	37
Ta	ug/L	ICPMS	< 0.05	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.05	0.08	0.01	0.070	< 0.005	< 0.005	0.005	< 0.005	0.008	< 0.005
Te	ug/L	ICPMS	< 0.5	< 0.5	< 0.1	< 0.1	0.8	< 0.1	0.2	0.3	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.05	0.1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	7.2	56	12	45	4.5	0.6	3.5	2.8	8.5	1.3
Tl	ug/L	ICPMS	0.1	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.05	< 0.05	0.006	0.03	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.02	0.1	0.02	0.16	0.02	0.02	< 0.005	0.009	0.04	0.02
V	ug/L	ICPMS	2.1	8.4	1	4	0.5	0.8	1	0.8	0.7	0.8
W	ug/L	ICPMS	2.8	1.8	1.8	1.1	1.8	2.2	1.1	3.6	1.8	2.2
Y	ug/L	ICPMS	0.2	2	0.4	1.8	0.09	0.05	0.2	0.1	0.2	0.07
Yb	ug/L	ICPMS	< 0.05	0.2	0.03	0.2	< 0.01	< 0.01	0.03	0.01	0.02	< 0.01
Zn	ug/L	ICPMS	10	12	3	44	0.5	34	< 0.5	1	34	31
Zr	ug/L	ICPMS	0.2	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.08	0.06	< 0.05
Hg	ng/L	Hg CVAF	-	-	-	-	-	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-	-	-16.6	-16.6	-16.9	-16.6	-17.1	-17.0	-16.9	-16.8
δD vs VSMOW	per mil	ISO2	-	-	-	-129.9	-130.3	-128.9	-	-128.9	-130.3	-
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-0.5	-	3.6	-	3.5	1.5	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	3.8	-	4.3	3.6	-	4.2	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			97-12r Mary Bay deep hole	98-26A Mary Bay deep hole	98-27A Mary Bay deep hole	98-27B Mary Bay deep hole (0.5m above 98-27A)	YNP-99-12-1 Mary Bay deep hole	YNP-99-12-2 Mary Bay deep hole	YNP-99-13-1 Mary Bay deep hole	YNP-99-13-2 Mary Bay deep hole	97-1 Mary Bay nearshore	97-2 Mary Bay nearshore
Latitude			44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'42.8"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°32'43.5"N	44°33'6"N	44°33'6"N
Longitude			110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'39.1"W	110°18'38.5"W	110°18'38.5"W	110°18'38.5"W	110°18'38.5"W	110°18'9"W	110°18'9"W
Date			7/26/97	7/24/98	7/24/98	7/24/98	7/22/99	7/22/99	7/22/99	7/22/99	7/26/97	7/26/97
Temp	˚C		35.0	50	66; max 103	95	30.1	30.1	7.3	7.3	-	-
pH			5.1	5.2	5.9	6.6	5.4	6.7	4.8	6.6	6.3	-
Depth	m		-	50	48	47	41	41	46	46	-	-
Treatment			Raw	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Raw
sum CO2	mM		-	8.35	2.28	0.90	-	-	-	-	-	-
HCO3	mM	measured	-	0.551	0.588	0.578	-	-	-	-	-	-
HCO3	uM	calc	-	468	582	624	514	447	320	447	-	-
Cl	mg/L	IC-Aq	-	6.0	5.7	5.8	5.4	5.2	5.1	5.3	4.7	-
F	mg/L	IC-Aq	-	-	-	-	0.5	0.5	0.5	0.5	-	-
NO3	mg/L	IC-Aq	-	-	-	-	<.1	<.1	<.35	<.35	-	-
SO4	mg/L	IC-Aq	-	-	-	-	11.0	7.7	14.0	8.1	8.3	-
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.61	0.01	0.09	<0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	230	110	23	4.2	14	<0.5	110	2	9.3	210
As	ug/L	ICPMS	13	17	32	19	14	13	8.1	14	12	13
Au	ug/L	ICPMS	0.005	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.007	< 0.005
B	ug/L	ICPAES	-	80	88	85	143	95.9	88.8	97.2	-	-
Ba	ug/L	ICPMS	13	14	15	10	67	9.6	33	9.7	9.9	11
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	0.1	<0.05	0.09	<0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	3.7	4.0	4.3	6.32	5.31	5.33	5.42	-	-
Ca	mg/L	ICPMS	3.6	5.0	5.2	5.7	5.4	4.3	4.4	4.3	4.1	4.1
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	<0.02	<0.02	0.04	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.5	0.3	0.2	0.04	0.1	0.03	0.3	0.04	0.1	0.4
Co	ug/L	ICPMS	0.06	0.05	0.2	0.05	0.07	0.06	0.04	0.04	0.06	0.1
Cr	ug/L	ICPMS	3	< 1	< 1	< 1	<1	<1	<1	<1	3	3
Cs	ug/L	ICPMS	4.0	4.1	4.3	4.1	3.4	3	3.8	3	2.5	2.5
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	<0.5	<0.5	<0.5	<0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.03	0.03	0.01	0.007	0.01	< 0.005	0.05	< 0.005	0.009	0.02
Er	ug/L	ICPMS	0.02	0.03	0.01	0.007	0.007	< 0.005	0.03	< 0.005	< 0.005	0.009
Eu	ug/L	ICPMS	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007	< 0.005	< 0.005	0.006
Fe	ug/L	ICPMS	150	360	520	13	<30	<30	87	<30	32	150
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02
Gd	ug/L	ICPMS	0.02	0.03	0.03	0.008	0.01	< 0.005	0.056	0.006	0.02	0.03
Ge	ug/L	ICPMS	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	-	-	-	-	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.006	< 0.005	0.008	< 0.005	< 0.005	< 0.005	0.01	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	< 0.01	< 0.01
K	mg/L	ICPAES	-	1.3	1.5	1.4	2.22	1.62	1.74	1.64	-	-
K	ug/L	ICPMS	1200	1400	1500	1500	2000	1400	1600	1500	1300	1300
La	ug/L	ICPMS	0.2	0.1	0.1	0.02	0.05	0.03	0.1	0.03	0.06	0.2
Li	ug/L	ICPMS	45	54	55	59	51	50	46	51	36	36
Lu	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPAES	-	1.7	1.7	1.8	2.9	2.25	2.39	2.28	-	-
Mg	mg/L	ICPMS	1.8	2.5	2.6	2.7	2.6	2	2.1	2.1	2.0	2.0
Mn	ug/L	ICPMS	6.2	23	28	3.6	26	1.4	12	1.4	14	16
Mo	ug/L	ICPMS	0.53	0.2	0.81	1.0	0.6	1.1	0.2	1	1.1	1.1
Na	mg/L	ICPAES	-	7.4	8.2	8.4	9.9	9.44	9.1	9.7	-	-
Na	mg/L	ICPMS	7.3	9.1	9.7	9.7	8.3	7.8	7.4	7.8	7.2	7.2
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.2	0.2	0.1	0.1	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.20	0.20	0.09	0.03	0.06	0.05	0.21	0.04	0.03	0.2
Ni	ug/L	ICPMS	0.5	0.4	0.5	0.4	0.3	0.4	0.2	0.5	0.4	0.7
P	ug/L	ICPMS	120	300	360	110	25	1	28	3	54	86
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	0.1	< 0.05	0.09
Pr	ug/L	ICPMS	0.05	0.04	0.02	< 0.01	0.02	< 0.01	0.05	< 0.01	< 0.01	0.05
Rb	ug/L	ICPMS	5.7	5.5	6.3	6.0	6.6	4.7	5.2	4.7	5.5	5.5
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	-	-	-	-	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.2	< 0.02	< 0.02	0.67	0.09	0.63	<0.05	0.63	0.60	0.60
Sc	ug/L	ICPMS	0.3	< 0.1	< 0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1	0.4	0.4
Se	ug/L	ICPMS	2	< 0.2	< 0.2	< 0.2	0.5	< 0.3	0.5	< 0.3	<0.5	0.5
SiO2	mg/L	ICPMS	9.8	11	16	12	24	9.1	14	9.2	9.9	10
Sm	ug/L	ICPMS	0.03	0.05	0.02	0.01	0.01	< 0.01	0.06	0.02	0.02	0.03
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	-	-	-	-	< 0.05	< 0.05
Sr	ug/L	ICPMS	36	43	48	48	64	36	46	38	39	38
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.19	0.18	0.14	0.12	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	0.1	< 0.1	< 0.1	< 0.1	-	-	-		< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.006	< 0.02	< 0.02	< 0.02	< 0.02	< 0.005	< 0.005
Ti	ug/L	ICPMS	5.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	1.1	< 0.2	0.4	2.5
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.02	0.007	0.01	0.01	< 0.005	0.009	< 0.005	0.009	0.01	0.02
V	ug/L	ICPMS	1	2	1	1	0.73	0.8	0.53	0.82	0.9	1
W	ug/L	ICPMS	3.6	1.7	1.7	1.6	1.6	1.5	1.3	1.7	2.2	2.1
Y	ug/L	ICPMS	0.2	0.2	0.1	0.03	0.05	0.03	0.3	0.03	0.05	0.1
Yb	ug/L	ICPMS	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	0.01
Zn	ug/L	ICPMS	10	5	2	5	<0.5	6	<0.5	6	< 0.5	< 0.5
Zr	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.2	< 0.2	< 0.2	< 0.2	< 0.05	< 0.05
Hg	ng/L	Hg CVAF	-	28	12	<10	5.0	6.0	0.0	8.0	-	-
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.7	-16.33	-16.43	-16.19	-16.8	-16.3	-16.6	-16.5	-16.35	-
δD vs VSMOW	per mil	ISO2	-	-129.4	-132.1	-132	-130.4	-130.5	-130.1	-128.2	-129	-
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			98-11A Mary Bay Deep Hole	98-11B 0.5m above 98-11A	98-28A Deep Vent E of Stevenson Island	98-28B Deep Vent E of Stevenson Island	98-29A Deep Vent E of Stevenson Island	98-29B Deep Vent E of Stevenson Island	98-30A Deep Vent E of Stevenson Island	98-30B Deep Vent E of Stevenson Island (0.5m above 98-30A)	98-31A Deep Vent E of Stevenson Island
Latitude			44°32'42.8"N	44°32'42.8"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N	44°30'38.7"N
Longitude			110°18'42.5"W	110°18'42.5"W	110°21'17.4"W	110°21'17.4"W	110°21'17.4"W	110°21'17.4"W	110°21'17.4"W	110°21'17.4"W	110°21'17.4"W
Date			7/17/98	7/17/98	7/25/98	7/25/98	7/25/98	7/25/98	7/26/98	7/26/98	7/26/98
Temp	°C		12	-	95; max 106	55-85	15-25 above vent	8.7-9.7	102	10	39.5
pH			6.9	6.9	5.4	5.3	5.6	6.2	5.1	6.7	6.1
Depth	m		41	41	106	106	107	102	105	105	93
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		0.84	0.83	9.81	9.37	4.16	1.40	4.39	0.65	0.98
HCO3	mM	measured	0.645	0.639	1.055	0.692	0.596	0.595	0.214	0.442	0.340
HCO3	uM	calc	588	581	670	650	599	703	509	647	551
Cl	mg/L	IC-Aq	5.6	5.7	5.2	5.2	4.8	4.8	5.0	4.8	4.8
F	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-
NO3	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-
SO4	mg/L	IC-Aq	-	-	-	-	-	-	-	-	-
Ag	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Al	ug/L	ICPMS	6.1	6.8	16	20	36	5.2	100	4.4	15
As	ug/L	ICPMS	18	17	10	15	22	15	21	15	14
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	94	98	68	70	70	69	62	67	68
Ba	ug/L	ICPMS	11	12	81	39	12	11	17	9.8	27
Be	ug/L	ICPMS	< 0.05	< 0.05	0.07	< 0.05	0.07	0.06	< 0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.6	4.6	4.5	4.5	3.7	4.2	3.7	4.1	3.8
Ca	mg/L	ICPMS	5.3	5.2	6.2	6.0	5.2	5.9	5.4	5.7	5.3
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.03	0.03	0.1	0.1	0.4	0.04	0.4	0.04	0.50
Co	ug/L	ICPMS	0.2	0.1	0.07	0.08	0.04	0.1	0.1	0.05	0.5
Cr	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cs	ug/L	ICPMS	3.7	3.8	3.1	3.0	2.8	3.2	3.1	3.0	2.2
Cu	ug/L	ICPMS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dy	ug/L	ICPMS	0.01	< 0.005	0.01	0.01	0.02	0.01	0.03	0.005	0.04
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.006	0.02	0.008	0.02	< 0.005	0.02
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.008
Fe	ug/L	ICPMS	13	14	100	130	230	12	130	11	450
Ga	ug/L	ICPMS	0.03	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	0.008	0.01	0.02	0.01	0.04	0.008	0.03	< 0.005	0.050
Ge	ug/L	ICPMS	0.3	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.3
Hf	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	0.007	< 0.005	0.008
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.4	1.4	1.6	1.6	1.4	1.4	1.3	1.4	1.4
K	ug/L	ICPMS	1400	1400	1600	1600	1400	1600	1400	1500	1500
La	ug/L	ICPMS	0.03	0.03	0.07	0.08	0.2	0.04	0.2	0.02	0.2
Li	ug/L	ICPMS	54	53	46	46	48	51	43	48	48
Lu	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPAES	2.1	2.2	2.0	2.1	1.7	1.8	1.5	1.8	1.7
Mg	mg/L	ICPMS	2.6	2.6	3.0	3.1	2.7	2.9	2.4	2.7	2.5
Mn	ug/L	ICPMS	2.7	2.7	23	23	9.4	7.7	30	5.0	76
Mo	ug/L	ICPMS	1.1	1.2	0.3	0.3	0.86	1.3	0.04	1.1	2.0
Na	mg/L	ICPAES	7.8	7.9	7.6	7.7	7.0	7.6	6.5	7.5	7.4
Na	mg/L	ICPMS	9.3	9.1	9.4	9.1	9.1	9.7	8.3	9.4	9.0
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.04	0.05	0.07	0.07	0.21	0.05	0.20	0.01	0.25
Ni	ug/L	ICPMS	0.5	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.7
P	ug/L	ICPMS	87	140	340	370	190	180	410	130	120
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	< 0.01	0.01	0.02	0.02	0.05	< 0.01	0.05	< 0.01	0.06
Rb	ug/L	ICPMS	5.8	5.6	5.8	5.9	5.2	5.8	5.4	5.7	5.0
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.83	0.74	< 0.02	< 0.02	< 0.02	0.71	< 0.02	0.58	0.96
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
SiO2	mg/L	ICPMS	12	11	17	17	13	12	20	12	15
Sm	ug/L	ICPMS	0.01	0.02	0.02	0.01	0.03	0.01	0.06	0.01	0.05
Sn	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	46	47	64	60	45	48	48	49	50
Ta	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ti	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tl	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.02	< 0.005	0.007	< 0.005	0.007	0.007	0.01	0.008
V	ug/L	ICPMS	1	1	1	1	2	1	2	1	4
W	ug/L	ICPMS	1.7	1.7	1.6	1.6	1.6	1.6	1.0	1.5	1.9
Y	ug/L	ICPMS	0.03	0.02	0.05	0.05	0.1	0.04	0.1	0.03	0.2
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	0.01	0.02
Zn	ug/L	ICPMS	82	32	2	5	2	3	2	5	1
Zr	ug/L	ICPMS	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1
Hg	ng/L	Hg CVAF	10	14	16	17	<10	<10	170	<10	<10
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.27	-16.43	-16.23	-16.22	-16.14	-16.03	-16.55	-16.11	-16.18
δD vs VSMOW	per mil	ISO2	-129	-128.8	-126.3	-130.9	-131.7	-130.8	-125.3	-128.3	-129.1
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			98-31B Deep Vent E of Stevenson Island (0.5m above 98-31A)	YNP-99-9-1 Deep Vent E of Stevenson Island	YNP-99-10-1 nearshore vent between Pelican & Storm	YNP-99-10-2 nearshore vent between Pelican & Storm	YNP-99-6-1 Inflated Plain-hydrothermal vent	YNP-99-6-2 Inflated Plain-hydrothermal vent	YNP-99-24-1 Inflated Plain-hydrothermal vent	YNP-99-24-2 Inflated Plain-hydrothermal vent	D02-2.1 Inflated Plain-hydrothermal vent	D02-2.2 Inflated Plain-hydrothermal vent
Latitude			44°30'38.7"N	44°30'39.9"N	44°33'5.1"N	44°33'5.1"N	44°32'9.9"N	44°32'9.9"N	44°32'9.9"N	44°32'9.9"N	44°32'10.0"N	44°32'10.0"N
Longitude			110°21'17.4"W	110°21'19.4"W	110°21'3.1"W	110°21'3.1"W	110°21'24.5"W	110°21'24.5"W	110°21'24.5"W	110°21'24.5"W	110°21'18.2"W	110°21'18.2"W
Date			7/26/98	7/20/99	7/21/99	7/21/99	7/18/99	7/18/99	7/27/99	7/27/99	8/18/02	8/18/02
Temp	°C		-	39.6	18.1	18.1	47.2	47.2	8.3	8.3	-	-
pH			7.1	5.3	7.3	7.2	6.0	6.8	5.7	6.9	6.8	5.2
Depth	m		93	105	shallow	shallow	8	8	18	18	-	-
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		0.64	-	-	-	-	-	-	-	-	-
HCO3	mM	measured	0.542	-	-	-	-	-	-	-	-	-
HCO3	uM	calc	675	458	504	538	448	469	717	437	-	-
Cl	mg/L	IC-Aq	4.9	4.7	4.3	4.2	4.2	4.2	4.9	4.9	4.7	4.7
F	mg/L	IC-Aq	-	0.5	0.4	0.5	0.5	0.5	0.6	0.5	0.4	0.4
NO3	mg/L	IC-Aq	-	<.1	<.1	<.1	<.1	<.1	<.35	<.35	0.8	0.5
SO4	mg/L	IC-Aq	-	11.0	6.8	6.8	8.4	7.0	14.0	7.6	7.7	14
Ag	ug/L	ICPMS	< 0.01	<0.01	<0.01	<0.01	0.62	0.1	0.02	<0.01	< 3	< 3
Al	ug/L	ICPMS	4.5	51	8.1	7.2	2.4	2	7.4	1.1	10.5	16
As	ug/L	ICPMS	16	16	13	13	14	12	17	13	10.4	10.9
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-
B	ug/L	ICPAES	67	89.9	76	81.8	76.1	76.4	99.8	89.2	-	-
Ba	ug/L	ICPMS	10	12	12	12	10	9.3	170	9.1	8.6	10.2
Be	ug/L	ICPMS	< 0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	0.055	< 0.01	< 0.01	< 0.01	< 0.2	< 0.2
Ca	mg/L	ICPAES	4.1	4.97	4.9	4.92	5.05	5.04	9.91	5.15	-	-
Ca	mg/L	ICPMS	5.9	4.7	4.6	4.8	4.4	4.4	8.3	4.4	3.9	3.9
Cd	ug/L	ICPMS	< 0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	< 0.02	< 0.02
Ce	ug/L	ICPMS	0.02	0.4	0.04	0.04	0.04	0.03	0.04	0.02	0.03	0.06
Co	ug/L	ICPMS	0.04	0.4	0.06	0.05	0.04	<0.02	0.07	<0.02	0.03	0.04
Cr	ug/L	ICPMS	< 1	<1	<1	<1	<1	<1	<1	<1	5.2	< 1
Cs	ug/L	ICPMS	3.2	2.6	2.4	2.4	2.4	2.3	2.8	2.5	2.36	2.35
Cu	ug/L	ICPMS	< 0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	< 0.5
Dy	ug/L	ICPMS	0.005	0.04	0.01	< 0.005	0.006	< 0.005	0.01	< 0.005	0.005	0.005
Er	ug/L	ICPMS	< 0.005	0.02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	10	230	<30	<30	<30	<30	33	<30	< 50	< 50
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.06	0.03	< 0.05	< 0.05
Gd	ug/L	ICPMS	0.006	0.02	< 0.005	0.01	0.007	0.006	< 0.005	0.006	0.005	0.007
Ge	ug/L	ICPMS	0.4	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.27	0.25
Hf	ug/L	ICPMS	< 0.05	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	-	-	-	-	-	-	-	-	-
K	mg/L	ICPAES	1.4	1.58	1.54	1.54	1.55	1.53	2.78	1.63	-	-
K	ug/L	ICPMS	1600	1500	1500	1500	1400	1400	2400	1400	1340	1300
La	ug/L	ICPMS	0.01	0.2	0.04	0.04	0.03	0.03	0.04	0.02	0.03	0.04
Li	ug/L	ICPMS	49	54	48	50	45	45	43	45	40.4	38.8
Lu	ug/L	ICPMS	-	-	-	-	-	-	-	-	< 0.1	< 0.1
Mg	mg/L	ICPAES	1.8	2.25	2.15	2.17	2.2	2.18	3.89	2.28	-	-
Mg	mg/L	ICPMS	2.8	2.2	2.1	2.2	2	2	3.4	2	2.05	1.98
Mn	ug/L	ICPMS	0.80	9	1.5	0.77	3.2	1.5	34	0.65	1.4	2.3
Mo	ug/L	ICPMS	1.4	0.4	1	0.96	3.2	1.7	1.2	1.2	< 2	< 2
Na	mg/L	ICPAES	7.5	8.5	7.77	7.76	7.98	7.98	10.7	8.42	-	-
Na	mg/L	ICPMS	9.4	8.4	7.5	7.8	7.4	7.2	9	7.2	8.09	7.76
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.4	0.3	< 0.02	< 0.02	< 0.2	< 0.2
Nd	ug/L	ICPMS	0.03	0.21	0.04	0.04	0.04	0.04	0.04	0.02	0.02	0.04
Ni	ug/L	ICPMS	0.4	0.5	0.4	0.4	0.5	0.4	0.1	0.2	0.6	0.7
P	ug/L	ICPMS	140	19	2	3	5.9	5.3	< 2	< 2	< 0.01	< 0.01
Pb	ug/L	ICPMS	< 0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05
Pr	ug/L	ICPMS	< 0.01	0.06	< 0.01	0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	5.8	4.8	4.6	4.7	4.3	4.2	8	4.9	4.36	4.37
Re	ug/L	ICPMS	< 0.02	-	-	-	-	-	-	-	-	-
Sb	ug/L	ICPMS	0.59	<0.05	0.5	0.54	0.86	0.73	<0.2	0.4	0.53	0.54
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	0.2	0.1	0.2	0.3	1.2	1.1
Se	ug/L	ICPMS	< 0.2	< 0.3	< 0.3	< 0.3	0.5	< 0.3	< 0.3	< 0.3	< 1	< 1
SiO2	mg/L	ICPMS	12	9.7	11	10	9.7	9.4	21	9.2	3.8	3.8
Sm	ug/L	ICPMS	< 0.01	0.03	0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	< 0.05	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	51	41	40	42	38	37	100	43	35.1	35.3
Ta	ug/L	ICPMS	< 0.02	< 0.03	< 0.03	< 0.03	0.24	0.2	< 0.03	< 0.03	0.06	0.04
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	< 0.1	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	0.006	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.59	< 0.2
Ti	ug/L	ICPMS	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.8	< 0.8	< 0.5	< 0.5
Tl	ug/L	ICPMS	< 0.05	<0.05	<0.05	<0.05	0.2	<0.05	<0.05	<0.05	< 0.1	< 0.1
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	< 0.005	0.01	0.01	0.008	0.01	0.005	0.01	< 0.1	< 0.1
V	ug/L	ICPMS	1	1.9	0.9	0.87	1.1	1.1	0.8	1	0.8	0.9
W	ug/L	ICPMS	1.7	1.4	1.4	1.5	1.6	1.6	5.5	4	1.03	1.18
Y	ug/L	ICPMS	0.02	0.1	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.04
Yb	ug/L	ICPMS	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.005	< 0.005
Zn	ug/L	ICPMS	8	<0.5	10	20	2	4	<0.5	6	13.7	3
Zr	ug/L	ICPMS	0.07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<10	5.0	0.0	5.0	26.0	21.0	0.0	0.0	< 5	50
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.19	-16.4	-16.6	-16.6	-16.8	-16.7	-16.4	-16.5	-	-16.1
δD vs VSMOW	per mil	ISO2	-126.7	-132.0	-134.3	-131.2	-130.0	-130.3	-131.3	-128.6	-	-127.5
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-	-	-	-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			D02-10.1 Inflated Plain-hydrothermal vent	D02-10.2 Inflated Plain-hydrothermal vent	D02-12.1 Inflated Plain-hydrothermal vent	D02-12.2 Inflated Plain-hydrothermal vent	D02-13.1 Inflated Plain-hydrothermal vent	D02-6.1 Inflated Plain-hydrothermal vent	D03-1.1 Inflated Plain-hydrothermal vent	D03-1.2 Inflated Plain-hydrothermal vent	D03-2.1 Inflated Plain-hydrothermal vent	D03-3.1 Inflated Plain-hydrothermal vent
Latitude			44º32'10.4"N	44º32'10.4"N	44º32'10.2"N	44º32'10.2"N	44º32'10.2"N	44º32'8.6"N	44º32'5.161"N	44º32'5.161"N	44º32'5.323"N	44º32'8.206"N
Longitude			110º21'15.8"W	110º21'15.8"W	110º21'18.5"W	110º21'18.5"W	110º21'18.5"W	110º21'15.3"W	110º21'15.624"W	110º21'15.624"W	110º21'15.432"W	110º21'15.75"W
Date			9/26/02	9/26/02	9/27/02	9/27/02	9/27/02	8/20/02	8/7/03	8/7/03	8/9/03	8/9/03
Temp	˚C		35	63	85	22	-	77.8	45	61	69	39
pH			5.2	5.8	5.9	6.7	-	-	5.47	6.69	6.7	6.8
Depth	m		29	29	15	16	13	10	23.9	28.4	29.7	7.9
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		-	-	-	-	-	-	-	-	-	-
HCO3	mM	measured	-	-	-	-	-	-	-	-	-	-
HCO3	uM	calc	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	5.2	5.1	5.1	5.2	5.2	-	4.7	4.8	4.9	4.9
F	mg/L	IC-Aq	0.6	0.6	0.7	0.6	0.6	-	0.6	0.5	0.5	0.5
NO3	mg/L	IC-Aq	<.18	<.18	<.18	2	0.3	-	<.08	<.08	<.08	<.08
SO4	mg/L	IC-Aq	12	11	10	8.9	12	-	15	8.6	8.8	7.8
Ag	ug/L	ICPMS	<0.01	<0.01	0.2	<0.01	<0.01	< 3	0.062	0.013	<0.01	<0.01
Al	ug/L	ICPMS	3	3.5	3.2	2.1	2.3	218	28	5.3	4.7	3.7
As	ug/L	ICPMS	15	14	13	13	13	21.8	19	14	13	13
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	0.052	0.013	< 0.01	< 0.01
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	2	2	3	3	3	23.2	13	9.1	8.8	9
Be	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	<0.05	<0.05	<0.05	<0.05
Bi	ug/L	ICPMS	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.2	< 0.03	< 0.03	< 0.03	< 0.03
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.8	4.7	4.7	4.7	4.6	4.0	4.3	4.3	4.3	4.2
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.02	0.01	0.01	0.01	0.01	0.11	0.16	0.052	0.032	0.034
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	0.12	0.03	0.068	<0.02	<0.02
Cr	ug/L	ICPMS	2	2	1	2	1	< 1	5.4	3.2	<1	<1
Cs	ug/L	ICPMS	2.4	2.4	2.4	2.4	2.3	2.83	2.5	2.4	2.4	2.5
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	10.8	<0.5	0.6	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.008	0.015	0.0054	0.005	< 0.005
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	0.0074	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	9	8.3	7	6.2	6.5	87	22	5.7	<2	<2
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.013	< 0.005	0.005	0.0079
Ge	ug/L	ICPMS	0.3	0.3	0.3	0.3	0.3	0.33	0.31	0.32	0.31	0.33
Hf	ug/L	ICPMS	-	-	-	-	-	-	<5	<5	20	<5
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	1700	1700	1600	1600	1600	2000	1600	1500	1500	1500
La	ug/L	ICPMS	0.01	0.02	< 0.01	0.01	< 0.01	0.04	0.079	0.034	0.029	0.024
Li	ug/L	ICPMS	43	43	42	42	42	37.2	43	47	44	44
Lu	ug/L	ICPMS	-	-	-	-	-	< 0.1	-	-	-	-
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	2.4	2.4	2.3	2.3	2.3	1.76	2.1	2.1	2.1	2
Mn	ug/L	ICPMS	0.81	0.076	0.7	0.53	3.8	12.5	2.5	1.6	1.1	1.3
Mo	ug/L	ICPMS	3	2	1.7	1.8	1.6	< 2	4.7	2.8	2	1.8
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	9.1	9.2	9	9	8.9	10.1	7.9	8	8	7.8
Nb	ug/L	ICPMS	-	-	-	-	-	< 0.2	-	-	-	-
Nd	ug/L	ICPMS	0.01	0.02	0.01	< 0.01	0.01	0.08	0.091	0.032	0.027	0.022
Ni	ug/L	ICPMS	0.4	0.5	0.3	0.4	0.4	1.3	1.4	3	1.1	0.53
P	ug/L	ICPMS	9	6	5	3	< 3	0.02	7.6	5.3	5	1
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	1	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.023	0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	4.8	4.9	4.8	4.8	4.7	7.16	4.7	4.6	4.5	4.6
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	-	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.95	0.85	0.72	0.77	0.89	0.75	0.55	0.92	0.82	0.9
Sc	ug/L	ICPMS	-	-	-	-	-	2.5	-	-	-	-
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 1	< 0.2	< 0.2	< 0.2	< 0.2
SiO2	mg/L	ICPMS	10	10	9.9	9.1	9.4	10	9.2	8.5	8.3	8.4
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.017	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	37	38	37	37	37	45.8	39	39	39	39
Ta	ug/L	ICPMS	-	-	-	-	-	< 0.02	-	-	-	-
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.2	< 0.08	< 0.08	< 0.08	< 0.08
Ti	ug/L	ICPMS	-	-	-	-	-	< 0.5	-	-	-	-
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.1	<0.05	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.1	0.055	0.023	0.015	0.012
V	ug/L	ICPMS	0.9	1	0.9	0.9	0.9	2.5	1.1	0.81	0.84	1.1
W	ug/L	ICPMS	4.2	3.1	3	2.7	2.5	0.82	2.2	2.3	2.2	2.2
Y	ug/L	ICPMS	0.01	0.02	< 0.01	< 0.01	0.01	0.04	0.082	0.032	0.027	0.024
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.007	0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	0.5	<0.5	<0.5	<0.5	<0.5	31.4	5.1	5.9	5.8	5.4
Zr	ug/L	ICPMS	-	-	-	-	-	< 0.2	-	-	-	-
Hg	ng/L	Hg CVAF	20	10	22	20	16	-	-	-	-	-
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.2	-16.3	-16.2	-15.9	-16.0	-	-16.2	-16.3	-16.1	-16.1
δD vs VSMOW	per mil	ISO2	-127.2	-127.4	-127	-125	-126.8	-	-130.3	-129.7	-128.5	-129.7
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	-	-	2.4	2.6	2.1	2.7
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-	-	-1.5	-6.9	-5.7	-3.4

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			D03-7.1 Inflated Plain-hydrothermal vent	D03-7.2 Inflated Plain-hydrothermal vent	D03-9.1 Inflated Plain-hydrothermal vent	D04-5.1 Inflated Plain: water sample in sediment plume just above vent	D04-5.2 Inflated Plain: water sample- bubbler from edge of plume hole	D04-7.1 Inflated Plain: water sample from bubbler	D04-9.1 Inflated Plain: same site as D02-12 and D03-7	D04-9.2 Inflated Plain: same site as D02-12 and D03-7	D04-12.3 Inflated Plain: same as D04-5	D02-5.1 Vent in Elliott's Crater
Latitude			44°32'9.281"N	44°32'9.281"N	44°32'5.489"N	44°32'4.98"N	44°32'4.98"N	44°32'10.163"N	44°32'15.521"N	44°32'15.521"N	44°32'8.135"N	44°31'46.4"N
Longitude			110°21'17.964"W	110°21'17.964"V	110°21'16.23"W	110°21'14.7"W	110°21'14.7"W	110°21'30.305"W	110°21'29.921"W	110°21'29.921"W	110°21'15.455"W	110°19'25.6"W
Date			8/14/03	8/14/03	8/17/03	8/10/04	8/10/04	8/11/04	8/13/04	8/13/04	8/13/04	8/20/02
Temp	°C		70	99.3	87.4				12.1	15.2		57.2
pH			6.5	7.3	6.6	6.5	6.7	6.9	7.0	6.4	4.9	-
Depth	m		13.7	13.7	28.4	15.4	11.2	11.4	12.3	11.9	11.1	61
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		-	-	-	-	-	-	-	-	-	-
HCO3	mM	measured	-	-	-	0.50	0.52	0.42	0.52	0.52	-	-
HCO3	uM	calc	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	5	7.3	4.8	4.8	4.8	4.9	4.9	4.9	5.1	5
F	mg/L	IC-Aq	0.5	0.5	0.9	0.54	0.54	0.57	0.57	0.66	0.62	0.5
NO3	mg/L	IC-Aq	<.08	<.08	<.08	<.08	<.08	<.08	<.08	<.08	0.14	<.08
SO4	mg/L	IC-Aq	7.1	7.4	6.5	8.4	7.9	8.3	7.8	9.8	9.3	8.2
Ag	ug/L	ICPMS	<0.01	<0.01	0.012	<3	<3	<3	<3	<3	<3	< 3
Al	ug/L	ICPMS	7.1	3.6	4.2	4	2.7	2.5	4.3	9	432	3.4
As	ug/L	ICPMS	12	12	12	16.1	15.5	12.8	15.2	14.8	2	13.8
Au	ug/L	ICPMS	0.011	< 0.01	0.018	-	-	-	-	-	-	-
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	9.2	8.5	9.2	9.47	9.11	8.83	10.1	9.57	16.8	8.44
Be	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	< 0.05
Bi	ug/L	ICPMS	< 0.03	< 0.03	< 0.03	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.2	4.3	4.4	5.43	5.45	4.86	5.23	5.18	5.13	5.1
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	< 0.02
Ce	ug/L	ICPMS	0.03	0.015	0.04	0.02	0.03	0.14	0.04	0.04	0.42	0.03
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	0.03	0.06	0.31	0.03	0.04	0.02	0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	7.6	< 1
Cs	ug/L	ICPMS	2.4	2.4	2.5	2.73	2.78	2.65	2.79	2.76	3.61	2.24
Cu	ug/L	ICPMS	1.8	<0.5	<0.5	0.52	0.87	<0.5	<0.5	<0.5	<0.5	0.87
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.008	< 0.005	0.005	0.02	< 0.005
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	0.02	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007	< 0.005
Fe	ug/L	ICPMS	<2	<2	<2	<50	<50	<50	<50	<50	78	< 50
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Gd	ug/L	ICPMS	< 0.005	< 0.005	0.007	< 0.005	< 0.005	0.01	0.005	< 0.005	0.03	0.006
Ge	ug/L	ICPMS	0.33	0.33	0.32	0.38	0.36	0.38	0.38	0.36	< 0.05	0.32
Hf	ug/L	ICPMS	7	<5	10							-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	1500	1500	1500	1.79	1.81	1.71	1.72	1.7	2.4	1720
La	ug/L	ICPMS	0.023	0.011	0.031	0.02	0.02	0.07	0.03	0.02	0.16	0.04
Li	ug/L	ICPMS	42	42	43	46	46.4	45.9	45.6	45.5	47.2	41.2
Lu	ug/L	ICPMS	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	2	2	2	2.4	2.34	2.16	2.29	2.28	2.11	2.31
Mn	ug/L	ICPMS	1.2	1.1	1.2	1.3	1.4	48.9	2.4	2	19.2	1.6
Mo	ug/L	ICPMS	1.2	1.3	1.3	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	7.5	7.6	7.8	9.73	9.62	9.38	9.4	9.2	10.4	9.13
Nb	ug/L	ICPMS	-	-	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Nd	ug/L	ICPMS	0.026	0.012	0.032	0.01	0.02	0.06	0.02	0.02	0.23	0.02
Ni	ug/L	ICPMS	0.61	0.72	0.52	1	1.1	0.8	0.6	0.7	1.1	0.6
P	ug/L	ICPMS	< 1	< 1	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.2	< 0.01
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	0.06	< 0.01
Rb	ug/L	ICPMS	4.5	4.4	4.6	5.45	5.41	5.13	5.34	5.3	8.42	4.44
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	-	-	-	-	-	-	-
Sb	ug/L	ICPMS	0.71	1	0.69	0.87	0.84	1.18	0.85	0.76	<0.3	0.66
Sc	ug/L	ICPMS	-	-	-	0.8	0.7	0.7	0.7	0.7	2	1
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 1	< 1	< 1	< 1	< 1	< 1	< 1
SiO2	mg/L	ICPMS	8.4	8.4	8.1	10.4	9.8	9.6	9.9	9.8	27.1	3.8
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.04	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	39	39	40	44.8	44	40.4	44.3	43.2	47.3	35.4
Ta	ug/L	ICPMS	-	-	-	0.08	0.07	0.06	0.04	0.03	0.02	0.04
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.08	< 0.08	< 0.08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Ti	ug/L	ICPMS	-	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.0095	0.01	0.0077	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
V	ug/L	ICPMS	0.98	0.87	0.94	1.1	1	1.9	1	1.1	2.8	0.9
W	ug/L	ICPMS	2.1	2.1	2.2	1.81	1.6	2.11	1.6	1.55	1.08	1.81
Y	ug/L	ICPMS	0.021	0.014	0.028	0.02	0.02	0.06	0.03	0.02	0.15	0.04
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.02	0.005
Zn	ug/L	ICPMS	0.85	2.7	1.4	3.9	5.5	1.7	1.4	1.9	1.6	3
Zr	ug/L	ICPMS	-	-	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	-	-	-	<5	<5	<5	<5	<5		17
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.0	-15.7	-16.1	-15.8	-15.8	-15.8	-15.8	-15.7	-16.0	-16.2
δD vs VSMOW	per mil	ISO2	-128.7	-123.5	-129.8	-128.8	-129.8	-128.2	-127.7	-127.0	-127.3	-126.9
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	2.7	2.4	-	-	-	-	-	-	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-2.5	-4.0	-4.8							-

Appendix 2. Site and analytical data from hydrothermal vents in Yellowstone Lake—*Continued*.

Field No. Description			D02-3.1 Elliott's Crater rim- Sucker Vent	D02-3.2 Elliott's Crater rim- Sucker Vent	D02-4.1 Elliott's Crater rim- Sucker Vent	D02-4.2 Elliott's Crater rim- Sucker Vent	D03-4.1 Elliott's Crater rim- Sucker Vent	D03-4.2 Elliott's Crater rim- Sucker Vent	D03-5.1 Elliott's Crater rim- Sucker Vent	D03-5.2 Elliott's Crater rim- Sucker Vent	D04-2.1 Chico/Sucker: water sample- vent	D04-6.1 Bubbler N of Stevenson: water sample- new bubbler near edge of lava flow
Latitude			44°31'39.6"N	44°31'39.6"N	44°31'39.6"N	44°31'39.6"N	44°31'39.694"N	44°31'39.695"N	44°31'39.695"N	44°31'39.695"N	44°31'39.179"N	44°32'5.927"N
Longitude			110°19'29.6"W	110°19'29.6"W	110°19'29.6"W	110°19'29.6"W	110°19'30.138"W	110°19'30.138"W	110°19'30.138"W	10°19'30.138"V	110°19'30.24"W	110°22'45.299"W
Date			8/19/02	8/19/02	8/19/02	8/19/02	8/12/03	8/12/03	8/12/03	8/12/03	8/9/04	8/11/04
Temp	°C		91.1	29.1	59.1	82.2	61	61	96	30		
pH			-	-	-	-	7	7.5	7.1	7.5	6.9	7.2
Depth	m		12	12	14	13	10.2	-	11.1	-	11.9	36.3
Treatment			Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered	Filtered
sum CO2	mM		-	-	-	-	-	-	-	-	-	-
HCO3	mM	measured	-	-	-	-	-	-	-	-	0.50	0.48
HCO3	uM	calc	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	5.7	23	7.3	15	4.7	4.7	4.9	6.9	6.7	4.9
F	mg/L	IC-Aq	0.5	0.8	0.5	0.6	0.5	0.5	0.5	0.5	0.54	0.55
NO3	mg/L	IC-Aq	<.08	<.08	0.4	<.08	<.08	<.08	<.08	<.08	<.08	<.08
SO4	mg/L	IC-Aq	7.6	12	8	9.8	9.4	7.4	9.3	7.4	7.8	7.5
Ag	ug/L	ICPMS	< 3	< 3	< 3	< 3	<0.01	<0.01	<0.01	<0.01	<3	<3
Al	ug/L	ICPMS	6.2	8	60.3	5.6	3.6	2.9	3.2	3.4	4.8	2.1
As	ug/L	ICPMS	13.7	41.5	17.2	33.9	16	13	18	13	17.9	16.5
Au	ug/L	ICPMS	-	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-	-
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	10.2	44.7	14.3	32.2	13	8.9	14	8.9	13	10.5
Be	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bi	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.03	< 0.03	< 0.03	< 0.03	< 0.2	< 0.2
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	4.1	6.2	4.3	5.3	4.5	4.2	4.5	4.2	5.6	5.45
Cd	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.02	0.03	0.04	0.03	0.021	0.013	0.028	0.022	0.01	0.04
Co	ug/L	ICPMS	< 0.02	0.02	0.23	0.02	<0.02	<0.02	<0.02	<0.02	0.05	0.03
Cr	ug/L	ICPMS	< 1	< 1	< 1	< 1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	3.18	15.6	4.49	9.94	4.2	2.6	4.9	2.6	4.28	2.73
Cu	ug/L	ICPMS	< 0.5	0.5	0.53	< 0.5	<0.5	0.51	0.5	<0.5	<0.5	0.54
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	0.005
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	< 50	< 50	56	< 50	<2	<2	<2	<2	<50	<50
Ga	ug/L	ICPMS	< 0.05	0.07	0.05	< 0.05	0.027	< 0.02	0.026	< 0.02	< 0.05	< 0.05
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007
Ge	ug/L	ICPMS	0.33	1.5	0.46	0.98	0.53	0.34	0.56	0.33	0.54	0.4
Hf	ug/L	ICPMS	-	-	-	-	<5	<5	<5	<5		
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	-	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-	-
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	1430	3160	1610	2470	1700	1500	1800	1500	2	1.8
La	ug/L	ICPMS	0.02	0.02	0.03	0.02	0.019	0.016	0.022	0.015	0.01	0.04
Li	ug/L	ICPMS	47	158	58.5	108	59	46	62	44	60.3	47.2
Lu	ug/L	ICPMS	< 0.1	< 0.1	0.5	< 0.1	-	-	-	-	< 0.1	< 0.1
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	2.04	2.84	2.12	2.55	2.1	2	2.2	2	2.46	2.39
Mn	ug/L	ICPMS	1.6	16.2	4.1	12.9	3	1	4	0.96	3	4
Mo	ug/L	ICPMS	< 2	< 2	< 2	< 2	1.6	1.6	1.4	1.4	< 2	< 2
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	8.99	26.8	16.9	18.9	10	8	11	7.9	12	9.7
Nb	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	-	-	-	-	< 0.2	< 0.2
Nd	ug/L	ICPMS	0.01	0.01	0.02	0.02	0.018	0.012	0.02	0.02	< 0.01	0.03
Ni	ug/L	ICPMS	0.6	0.6	190	0.5	0.78	0.79	0.4	0.51	1	0.9
P	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 1	< 1	4	< 1	< 0.01	< 0.01
Pb	ug/L	ICPMS	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	5.02	15	6.2	11	6	4.6	6.3	4.7	6.49	5.54
Re	ug/L	ICPMS	-	-	-	-	< 0.02	< 0.02	< 0.02	< 0.02	-	-
Sb	ug/L	ICPMS	1.56	2.64	1.3	2.15	0.92	1.2	1.3	1.1	1.04	0.84
Sc	ug/L	ICPMS	1.3	4.2	1.6	2.9	-	-	-	-	1.1	0.8
Se	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 0.2	< 0.2	< 0.2	< 0.2	< 1	< 1
SiO2	mg/L	ICPMS	4.6	16.6	5.7	11.2	12	8.6	12	8.4	14	10
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	38.6	89.4	45.2	69.2	46	40	47	40	49.9	44.9
Ta	ug/L	ICPMS	0.04	0.04	0.04	0.04	-	-	-	-	0.08	0.07
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.08	< 0.08	< 0.08	< 0.08	< 0.2	< 0.2
Ti	ug/L	ICPMS	< 0.5	< 0.5	2.2	< 0.5	-	-	-	-	< 0.5	< 0.5
Tl	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	<0.05	<0.05	<0.05	<0.05	<0.1	<0.1
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	0.013	0.012	0.012	0.013	< 0.1	< 0.1
V	ug/L	ICPMS	0.9	0.8	1	1	0.88	0.89	0.9	0.89	1	1
W	ug/L	ICPMS	1.41	3.94	2.14	3.24	2.7	2.3	2.9	2.3	1.59	1.52
Y	ug/L	ICPMS	0.01	0.02	0.02	0.02	0.018	0.015	0.021	0.017	0.01	0.05
Yb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	< 0.01	< 0.01	< 0.005	< 0.005
Zn	ug/L	ICPMS	< 0.5	0.8	3.3	< 0.5	4.8	5.1	3.1	2.9	0.8	1.8
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	-	-	-	-	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	< 5	18	10	15	-	-	-	-	<5	<5
$\delta^{18}O$ vs VSMOW	per mil	ISO1	-16.1	-16.3	-16.1	-16.2	-16.2	-16.2	-16.2	-16.1	-15.8	-15.9
δD vs VSMOW	per mil	ISO2	-127	-130.6	-126.8	-131.1	-131.7	-128.5	-130.7	-130	-129.5	-125.4
$\delta^{34}S_{H2S}$ vs CDT	per mil	ISO3	-	-	-	-	-	-	-	-	-	-
$\delta^{34}S_{SO4}$ vs CDT	per mil	ISO4	-	-	-	-	2.4	2.4	2.4	2.2	-	-
$\delta^{13}C_{CO3}$ vs VPDB	per mil	ISO5	-	-	-	-	-4.6	-	-4.7	-7.0		

Appendix 3. Site and analytical data from the 1999 mixing experiments.

Field no. Sample name/ description			G1 diss Norris/Green Dragon	G1 tot Norris/Green Dragon	G2 diss Norris/Green Dragon	G2 tot Norris/Green Dragon	G3 diss Norris/Green Dragon	G3 tot Norris/Green Dragon	G4 diss Norris/Green Dragon
Latitude			44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N
Longitude			110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W
Collection date			07/22/99	07/22/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		16.1	16.1	19.1	19.1	17.5	17.5	20.4
pH			7.2	7.2	6.6	6.6	6.2	6.2	5.3
Conductivity	uS/cm		87	87	162	162	223	223	395
Cl	mg/L	IC-Aq	4.7	-	21	-	37	-	80
F	mg/L	IC-Aq	0.5	-	0.8	-	1	-	1.6
NO_3	mg/L	IC-Aq	<.35	-	<.35	-	<.35	-	<.35
SO_4	mg/L	IC-Aq	7.2	-	14	-	20	-	37
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	2.4	2	120	140	190	240	570
As	ug/L	ICPMS	11	11	81	82	140	140	310
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	89.4	82.4	355	354	603	602	1260
Ba	ug/L	ICPMS	8.5	8.4	10	10	11	11	14
Be	ug/L	ICPMS	<0.05	<0.05	0.1	0.09	0.2	0.1	0.5
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.1	5.1	5.04	4.91	5.02	5.06	4.82
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.03	0.03	0.4	0.5	0.79	0.86	1.9
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	2.2	2.2	17	17	29	29	62
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	0.005	0.052	0.054	0.088	0.11	0.21
Er	ug/L	ICPMS	0.005	< 0.005	0.03	0.04	0.054	0.053	0.12
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01
Fe	ug/L	ICPMS	<30	<30	<30	<30	<30	<30	100
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.02	0.03	0.04	0.04
Gd	ug/L	ICPMS	< 0.005	< 0.005	0.066	0.054	0.093	0.091	0.21
Ge	ug/L	ICPMS	0.2	0.2	1.3	1.3	2.1	2.1	4.6
Ho	ug/L	ICPMS	< 0.005	< 0.005	0.01	0.02	0.02	0.02	0.04
K	mg/L	ICPAES	1.7	1.6	3.72	3.84	5.8	5.62	10.8
La	ug/L	ICPMS	0.03	0.02	0.2	0.3	0.4	0.4	0.9
Li	ug/L	ICPMS	42	42	210	210	350	340	740
Mg	mg/L	ICPAES	2.23	2.18	2.06	2.09	2.04	2	1.78
Mn	ug/L	ICPMS	0.45	0.48	7.2	7.4	13	13	29
Mo	ug/L	ICPMS	0.95	0.92	1.9	2	2.9	3	5.8
Na	mg/L	ICPAES	8.75	8.48	20.3	19.7	29.8	30	55.2
Nb	ug/L	ICPMS	0.07	0.06	0.07	0.05	0.06	0.05	0.06
Nd	ug/L	ICPMS	0.04	0.03	0.22	0.25	0.36	0.42	0.86
Ni	ug/L	ICPMS	0.4	0.4	0.4	0.4	0.3	0.4	0.3
P	ug/L	ICPMS	1	4	4.2	4	< 1	3	4
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	0.05	0.06	0.1	0.1	0.21
Rb	ug/L	ICPMS	4.1	4.1	21	22	35	36	76
Sb	ug/L	ICPMS	0.47	0.45	2.1	2.1	3.4	3.4	5.8
Sc	ug/L	ICPMS	0.2	0.2	0.2	0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.3	0.3	0.4	0.9
SiO_2	mg/L	ICPMS	9.7	9.8	25	25	38	37	74
Sm	ug/L	ICPMS	< 0.01	< 0.01	0.06	0.05	0.08	0.09	0.2
Sr	ug/L	ICPMS	36	36	34	35	33	34	31
Ta	ug/L	ICPMS	0.04	0.05	0.06	0.08	0.08	0.04	0.06
Tb	ug/L	ICPMS	< 0.005	< 0.005	0.009	0.009	0.02	0.01	0.04
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.008	0.007	0.02
U	ug/L	ICPMS	0.01	0.02	0.02	0.02	0.02	0.03	0.03
V	ug/L	ICPMS	0.77	0.76	0.85	0.74	0.76	0.7	0.8
W	ug/L	ICPMS	0.89	0.97	2.6	2.8	4.5	4.6	9.4
Y	ug/L	ICPMS	0.03	0.03	0.3	0.3	0.4	0.53	1.2
Yb	ug/L	ICPMS	< 0.01	< 0.01	0.02	0.03	0.05	0.06	0.1
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<5	<5	9	<5	6	6	26
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.72	-	-16.28	-	-16.08	-	-15.41

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			G4 tot Norris/Green Dragon	G5 diss Norris/Green Dragon	G5 tot Norris/Green Dragon	G6 diss Norris/Green Dragon	G6 tot Norris/Green Dragon	G7 diss Norris/Green Dragon	G7 tot Norris/Green Dragon
Latitude			44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N
Longitude			110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		20.4	25.6	25.6	24.9	24.9	26.5	26.5
pH			5.3	3.6	3.6	3.1	3.1	2.9	2.9
Conductivity	uS/cm		395	665	665	965	965	1285	1285
Cl	mg/L	IC-Aq	-	130	-	190	-	240	-
F	mg/L	IC-Aq	-	1.6	-	2.1	-	2.7	-
NO_3	mg/L	IC-Aq	-	<.35	-	0.7	-	<.35	-
SO_4	mg/L	IC-Aq	-	57	-	78	-	100	-
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	560	980	980	1900	1900	2500	2500
As	ug/L	ICPMS	320	520	520	860	870	1100	1100
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	1260	2080	2090	2860	2900	3670	3680
Ba	ug/L	ICPMS	14	18	18	23	23	26	26
Be	ug/L	ICPMS	0.4	0.7	0.9	1.7	1.7	1.9	2
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.82	4.72	4.63	4.54	4.5	4.4	4.32
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	1.9	3.2	3.2	4.6	4.9	6.1	6.1
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	63	100	100	150	150	200	200
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	0.23	0.36	0.4	0.53	0.57	0.71	0.74
Er	ug/L	ICPMS	0.13	0.23	0.21	0.28	0.31	0.39	0.41
Eu	ug/L	ICPMS	0.01	0.02	0.006	0.02	0.02	0.02	0.03
Fe	ug/L	ICPMS	100	190	190	360	370	480	480
Ga	ug/L	ICPMS	0.05	0.07	0.08	0.1	0.1	0.2	0.2
Gd	ug/L	ICPMS	0.18	0.33	0.32	0.47	0.47	0.62	0.55
Ge	ug/L	ICPMS	4.6	7.4	7.5	12	13	16	16
Ho	ug/L	ICPMS	0.04	0.072	0.068	0.1	0.11	0.15	0.14
K	mg/L	ICPAES	10.9	17.2	17.2	24.2	24	31.2	30.6
La	ug/L	ICPMS	0.95	1.6	1.6	2.3	2.3	3	3
Li	ug/L	ICPMS	750	1200	1200	2500	2600	3400	3500
Mg	mg/L	ICPAES	1.78	1.51	1.51	1.24	1.25	0.953	0.949
Mn	ug/L	ICPMS	28	48	48	83	82	110	100
Mo	ug/L	ICPMS	6	9.5	11	15	16	20	21
Na	mg/L	ICPAES	55.6	88.2	86.8	120	122	154	151
Nb	ug/L	ICPMS	0.05	0.06	0.06	0.08	0.08	0.09	0.08
Nd	ug/L	ICPMS	0.87	1.4	1.6	2	2	2.5	2.7
Ni	ug/L	ICPMS	0.3	0.2	0.2	0.2	0.2	0.2	0.2
P	ug/L	ICPMS	4.3	8.1	7.6	21	21	20	20
Pb	ug/L	ICPMS	0.08	0.2	0.2	0.2	0.2	0.3	0.3
Pr	ug/L	ICPMS	0.22	0.37	0.4	0.55	0.55	0.72	0.72
Rb	ug/L	ICPMS	76	120	120	200	200	250	250
Sb	ug/L	ICPMS	5.6	4.8	5.9	7.2	7	7.9	7.2
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	1.2	1.8	1.9	2.9	2.7	3.8	3.8
SiO_2	mg/L	ICPMS	74	120	120	230	230	300	300
Sm	ug/L	ICPMS	0.23	0.33	0.32	0.43	0.52	0.55	0.57
Sr	ug/L	ICPMS	31	27	27	27	27	22	23
Ta	ug/L	ICPMS	0.05	0.06	0.05	0.04	0.04	0.04	0.04
Tb	ug/L	ICPMS	0.03	0.054	0.063	0.084	0.088	0.11	0.11
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	0.3	0.5	0.6	1.2	1.3	1.6	1.6
Tl	ug/L	ICPMS	0.1	0.2	0.2	0.3	0.3	0.4	0.4
Tm	ug/L	ICPMS	0.02	0.03	0.03	0.04	0.05	0.058	0.058
U	ug/L	ICPMS	0.04	0.05	0.07	0.06	0.08	0.08	0.09
V	ug/L	ICPMS	0.82	0.78	0.84	1.3	1.3	1.3	1.3
W	ug/L	ICPMS	9.7	15	18	21	24	30	32
Y	ug/L	ICPMS	1.2	1.9	2	3.2	3.3	4.2	4.3
Yb	ug/L	ICPMS	0.1	0.2	0.2	0.24	0.26	0.3	0.31
Zn	ug/L	ICPMS	2	3	3	5	5	7	6
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	21	51	35	25	55	7	62
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-14.62	-	-14.05	-	-13.70	-

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			**G8 diss Norris/Green Dragon**	**G8 tot Norris/Green Dragon**	**G9 diss Norris/Green Dragon**	**G9 tot Norris/Green Dragon**	**G10 diss Norris/Green Dragon**	**G10 tot Norris/Green Dragon**	**E1 diss Norris/Echinus**
Latitude			44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'19.5"N
Longitude			110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'4.9"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/22/99
Temp at filter	°C		30.6	30.6	32.1	32.1	30.1	30.1	19.9
pH			2.7	2.7	2.6	2.6	2.6	2.6	7.3
Conductivity	uS/cm		1603	1603	1785	1785	1984	1984	87
Cl	mg/L	IC-Aq	300	-	330	-	330	-	4.5
F	mg/L	IC-Aq	3.1	-	5.6	-	5.6	-	0.4
NO_3	mg/L	IC-Aq	<.35	-	<.35	-	<.35	-	<.35
SO_4	mg/L	IC-Aq	120	-	130	-	150	-	7.2
Ag	ug/L	ICPMS	0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01
Al	ug/L	ICPMS	3100	3200	3600	3500	4000	4000	1
As	ug/L	ICPMS	1400	1400	1500	1500	1700	1700	24
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	4370	4440	4920	4930	5430	5460	124
Ba	ug/L	ICPMS	31	30	32	32	35	35	8.9
Be	ug/L	ICPMS	2.8	2.8	2.6	3.4	3.5	3.6	<0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.23	4.21	4.18	4.07	4.02	4.02	5
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	7.5	7.4	8.3	8.3	9.1	9	0.02
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	240	240	260	270	300	300	2.3
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	0.87	0.85	0.94	0.95	1	1	0.005
Er	ug/L	ICPMS	0.49	0.45	0.5	0.53	0.55	0.57	< 0.005
Eu	ug/L	ICPMS	0.03	0.03	0.03	0.03	0.04	0.03	< 0.005
Fe	ug/L	ICPMS	600	600	660	660	750	750	<30
Ga	ug/L	ICPMS	0.2	0.2	0.2	0.2	0.3	0.2	< 0.02
Gd	ug/L	ICPMS	0.75	0.75	0.79	0.84	0.84	0.94	0.008
Ge	ug/L	ICPMS	20	20	22	23	25	25	0.2
Ho	ug/L	ICPMS	0.19	0.18	0.19	0.19	0.2	0.21	< 0.005
K	mg/L	ICPAES	37.6	37.4	42	41	45.8	45.7	1.68
La	ug/L	ICPMS	3.7	3.7	4	4	4.4	4.5	0.03
Li	ug/L	ICPMS	4300	4700	5400	5500	6200	6400	44
Mg	mg/L	ICPAES	0.659	0.671	0.502	0.505	0.316	0.316	2.19
Mn	ug/L	ICPMS	130	130	140	140	160	160	0.38
Mo	ug/L	ICPMS	26	26	28	29	32	33	5.9
Na	mg/L	ICPAES	186	188	206	203	224	227	9.19
Nb	ug/L	ICPMS	0.1	0.08	0.09	0.08	0.08	0.08	< 0.02
Nd	ug/L	ICPMS	3.3	3.2	3.6	3.6	3.9	4	0.03
Ni	ug/L	ICPMS	0.1	0.1	<0.1	0.1	<0.1	<0.1	0.3
P	ug/L	ICPMS	21	20	19	17	17	15	< 1
Pb	ug/L	ICPMS	0.4	0.4	0.6	0.5	0.52	0.5	<0.05
Pr	ug/L	ICPMS	0.86	0.87	0.97	0.95	1	1.1	< 0.01
Rb	ug/L	ICPMS	310	310	350	350	390	390	4.2
Sb	ug/L	ICPMS	8	5.6	6.4	4.2	5.6	6	1.7
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	4.4	4.5	4.7	4.4	4.7	4.5	< 0.3
SiO_2	mg/L	ICPMS	370	380	420	420	470	480	8.9
Sm	ug/L	ICPMS	0.75	0.73	0.8	0.82	0.84	0.88	< 0.01
Sr	ug/L	ICPMS	18	18	16	16	13	13	36
Ta	ug/L	ICPMS	0.06	0.04	0.05	0.05	0.05	0.05	< 0.03
Tb	ug/L	ICPMS	0.13	0.13	0.15	0.15	0.16	0.16	< 0.005
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	2.1	1.7	2.1	2	2.1	2.3	< 0.2
Tl	ug/L	ICPMS	0.5	0.5	0.52	0.52	0.58	0.58	<0.05
Tm	ug/L	ICPMS	0.065	0.07	0.078	0.074	0.087	0.083	< 0.005
U	ug/L	ICPMS	0.11	0.12	0.12	0.12	0.13	0.14	0.01
V	ug/L	ICPMS	1.4	1.4	1.4	1.3	1.4	1.4	0.92
W	ug/L	ICPMS	40	40	43	45	50	50	11
Y	ug/L	ICPMS	5.2	5.2	5.8	5.9	6.6	6.6	0.02
Yb	ug/L	ICPMS	0.4	0.37	0.44	0.45	0.51	0.5	< 0.01
Zn	ug/L	ICPMS	8	8	9	9	10	10	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	0.86	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	8	71	10	67	7	80	330
$\delta^{18}O$ vs VSMOW	permil	ISO1	-12.56	-	-12.09	-	-11.59	-	-16.65

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			**E1 tot Norris/Echinus**	**E2 diss Norris/Echinus**	**E2 tot Norris/Echinus**	**E3 diss Norris/Echinus**	**E3 tot Norris/Echinus**	**E4 diss Norris/Echinus**
Latitude			44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N
Longitude			110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W
Collection date			07/22/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		19.9	20.2	20.2	21.7	21.7	20.2
pH			7.3	6.8	6.8	6.7	6.7	6.2
Conductivity	uS/cm		87	158	158	196	196	313
Cl	mg/L	IC-Aq	-	13	-	17	-	34
F	mg/L	IC-Aq	-	1	-	1.1	-	1.5
NO_3	mg/L	IC-Aq	-	<.35	-	<.35	-	0.4
SO_4	mg/L	IC-Aq	-	22	-	31	-	61
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	2	120	120	170	180	330
As	ug/L	ICPMS	16	31	30	38	39	66
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	102	246	242	321	328	603
Ba	ug/L	ICPMS	9	12	12	14	15	20
Be	ug/L	ICPMS	<0.05	0.5	0.4	0.6	0.6	1.6
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.09	4.98	5	5.08	5.06	5.04
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.03	2.3	2.4	3.5	3.7	7.1
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	2.3	7.7	7.9	11	11	20
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	0.41	0.44	0.6	0.66	1.3
Er	ug/L	ICPMS	< 0.005	0.23	0.23	0.35	0.36	0.72
Eu	ug/L	ICPMS	< 0.005	0.01	0.009	0.02	0.02	0.04
Fe	ug/L	ICPMS	<30	63	66	120	130	300
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	0.32	0.38	0.47	0.55	1
Ge	ug/L	ICPMS	0.2	0.8	0.8	1.1	1.1	2.2
Ho	ug/L	ICPMS	< 0.005	0.088	0.092	0.12	0.14	0.25
K	mg/L	ICPAES	1.64	4.75	4.71	6.44	6.41	11.7
La	ug/L	ICPMS	0.03	0.63	0.73	1.1	1.1	2.1
Li	ug/L	ICPMS	46	110	110	150	150	260
Mg	mg/L	ICPAES	2.2	2.05	2.04	2	1.99	1.8
Mn	ug/L	ICPMS	0.42	14	14	21	22	44
Mo	ug/L	ICPMS	2.8	2.5	2.1	2.1	1.9	2.5
Na	mg/L	ICPAES	8.66	19.1	19.1	24.9	24.9	42.5
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.04	1.2	1.3	1.8	1.9	3.8
Ni	ug/L	ICPMS	0.4	0.3	0.3	0.3	0.3	0.2
P	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 1	< 1
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	0.29	0.28	0.42	0.46	0.9
Rb	ug/L	ICPMS	4.2	27	28	39	40	77
Sb	ug/L	ICPMS	1	0.86	0.79	0.73	0.68	0.7
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
SiO_2	mg/L	ICPMS	9.2	23	23	30	31	54
Sm	ug/L	ICPMS	< 0.01	0.33	0.35	0.46	0.56	1
Sr	ug/L	ICPMS	37	34	35	34	34	30
Ta	ug/L	ICPMS	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Tb	ug/L	ICPMS	< 0.005	0.065	0.069	0.1	0.1	0.21
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.05
Ti	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	0.08
Tm	ug/L	ICPMS	< 0.005	0.03	0.03	0.04	0.04	0.098
U	ug/L	ICPMS	0.01	0.14	0.14	0.21	0.23	0.4
V	ug/L	ICPMS	0.9	0.79	0.72	0.62	0.62	0.53
W	ug/L	ICPMS	6.3	5.2	4	3.8	3.4	3.5
Y	ug/L	ICPMS	0.03	2	2.2	3.1	3.4	6.6
Yb	ug/L	ICPMS	< 0.01	0.2	0.2	0.29	0.31	0.58
Zn	ug/L	ICPMS	<0.5	<0.5	0.5	1	1	3
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<5	13	<5	5	<5	5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.65	-	-16.63	-	-16.55

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued.*

Field no. Sample name/ description			**E4 tot Norris/Echinus**	**E5 diss Norris/Echinus**	**E5 tot Norris/Echinus**	**E6 diss Norris/Echinus**	**E6 tot Norris/Echinus**	**E7 diss Norris/Echinus**
Latitude			44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N
Longitude			110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		20.2	24.1	24.1	25.9	25.9	28.3
pH			6.2	5.8	5.8	5.1	5.1	3.7
Conductivity	uS/cm		313	463	463	627	627	814
Cl	mg/L	IC-Aq	-	53	-	78	-	98
F	mg/L	IC-Aq	-	2.3	-	4.3	-	2.8
NO_3	mg/L	IC-Aq	-	<.35	-	0.5	-	0.7
SO_4	mg/L	IC-Aq	-	95	-	140	-	180
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	<0.01	0.56
Al	ug/L	ICPMS	370	610	620	910	880	1300
As	ug/L	ICPMS	66	100	100	150	150	200
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	604	927	945	1320	1330	1690
Ba	ug/L	ICPMS	20	28	28	36	36	42
Be	ug/L	ICPMS	1.3	2.4	2.5	3.5	3.5	4.9
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.048
Ca	mg/L	ICPAES	4.93	5	5.03	4.97	4.98	4.93
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	7.7	12	13	18	18	23
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	20	32	31	45	44	54
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	1.4	2.3	2.4	3.3	3.3	4.3
Er	ug/L	ICPMS	0.76	1.2	1.3	1.7	1.9	2.3
Eu	ug/L	ICPMS	0.03	0.061	0.056	0.083	0.088	0.11
Fe	ug/L	ICPMS	310	550	560	810	820	1300
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	1.1	1.9	2	2.6	2.8	3.7
Ge	ug/L	ICPMS	2.1	3.5	3.5	4.9	4.9	6.8
Ho	ug/L	ICPMS	0.28	0.45	0.46	0.65	0.68	0.84
K	mg/L	ICPAES	11.8	18.1	18.5	25.8	26	34.5
La	ug/L	ICPMS	2.2	3.7	3.7	5.2	5.3	6.6
Li	ug/L	ICPMS	260	410	410	570	570	690
Mg	mg/L	ICPAES	1.81	1.55	1.57	1.31	1.32	1.11
Mn	ug/L	ICPMS	43	74	72	100	110	170
Mo	ug/L	ICPMS	2.3	3.1	3	3.6	3.6	7.6
Na	mg/L	ICPAES	41.6	65.3	65.6	90.1	90.3	117
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.03	< 0.02	0.64
Nd	ug/L	ICPMS	4.1	6.4	6.6	9.1	9.7	12
Ni	ug/L	ICPMS	0.3	0.2	0.2	0.2	0.2	0.2
P	ug/L	ICPMS	< 1	< 1	< 1	1	< 1	6.5
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	0.09
Pr	ug/L	ICPMS	0.9	1.5	1.6	2.2	2.2	2.8
Rb	ug/L	ICPMS	77	130	130	180	180	250
Sb	ug/L	ICPMS	0.69	0.75	0.73	0.79	0.74	1.4
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	3
Se	ug/L	ICPMS	0.3	0.8	0.5	0.9	0.9	2.1
SiO_2	mg/L	ICPMS	54	88	88	120	120	180
Sm	ug/L	ICPMS	1.1	1.7	1.7	2.5	2.6	3.3
Sr	ug/L	ICPMS	30	28	28	22	22	19
Ta	ug/L	ICPMS	< 0.03	0.04	< 0.03	< 0.03	0.03	0.53
Tb	ug/L	ICPMS	0.22	0.35	0.38	0.53	0.52	0.66
Th	ug/L	ICPMS	0.05	0.12	0.16	0.22	0.2	0.35
Ti	ug/L	ICPMS	< 0.2	0.5	0.5	1	1	2.5
Tl	ug/L	ICPMS	0.08	0.1	0.2	0.2	0.2	0.58
Tm	ug/L	ICPMS	0.11	0.17	0.18	0.23	0.25	0.31
U	ug/L	ICPMS	0.47	0.65	0.75	0.94	1.1	1.4
V	ug/L	ICPMS	0.55	0.4	0.5	0.4	0.3	1
W	ug/L	ICPMS	3.3	3.3	3.3	3.2	3	2.1
Y	ug/L	ICPMS	7	12	12	17	18	24
Yb	ug/L	ICPMS	0.63	0.95	1.1	1.5	1.5	1.8
Zn	ug/L	ICPMS	3	5	5	7	8	10
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
Hg	ng/L	Hg CVAF	<5	10	<5	7	<5	9
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.77	-	-16.65	-	-16.60

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			**E7 tot Norris/Echinus**	**E8 diss Norris/Echinus**	**E8 tot Norris/Echinus**	**E9 diss Norris/Echinus**	**E9 tot Norris/Echinus**	**E10 diss Norris/Echinus**
Latitude			44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N
Longitude			110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		28.3	31.8	31.8	34.5	34.5	35.4
pH			3.7	3.4	3.4	3.2	3.2	3.2
Conductivity	uS/cm		814	1008	1008	1144	1144	1272
Cl	mg/L	IC-Aq	-	120	-	130	-	150
F	mg/L	IC-Aq	-	3.9	-	4.3	-	4.8
NO_3	mg/L	IC-Aq	-	<.35	-	<.35	-	<.35
SO_4	mg/L	IC-Aq	-	210	-	240	-	260
Ag	ug/L	ICPMS	0.2	0.1	0.09	0.07	0.05	0.04
Al	ug/L	ICPMS	1300	1600	1600	1800	1800	2000
As	ug/L	ICPMS	200	240	240	270	260	290
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	1700	2060	2060	2310	2300	2540
Ba	ug/L	ICPMS	42	48	49	55	55	60
Be	ug/L	ICPMS	4.8	5.8	5.9	6.4	6.5	7
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.95	4.88	4.83	4.81	4.82	4.74
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	23	28	28	32	31	36
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	54	66	65	74	73	81
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	4.2	5.4	5.4	6.2	5.9	6.7
Er	ug/L	ICPMS	2.4	2.9	2.9	3.4	3.3	3.5
Eu	ug/L	ICPMS	0.12	0.14	0.14	0.15	0.16	0.17
Fe	ug/L	ICPMS	1300	1600	1500	1700	1700	1900
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	3.6	4.4	4.4	5	5	5.6
Ge	ug/L	ICPMS	6.6	8.1	8.1	8.8	8.9	9.9
Ho	ug/L	ICPMS	0.88	1.1	1.1	1.2	1.2	1.3
K	mg/L	ICPAES	35.1	42.4	42.1	47.3	47.2	51.9
La	ug/L	ICPMS	6.5	8.1	8.2	9.4	8.9	10
Li	ug/L	ICPMS	720	900	890	1000	1000	1100
Mg	mg/L	ICPAES	1.09	0.848	0.842	0.666	0.664	0.499
Mn	ug/L	ICPMS	160	200	190	210	210	230
Mo	ug/L	ICPMS	4.8	5.4	5.1	5.8	5.5	6
Na	mg/L	ICPAES	117	143	140	158	156	172
Nb	ug/L	ICPMS	0.5	0.4	0.3	0.3	0.2	0.2
Nd	ug/L	ICPMS	12	15	14	16	16	18
Ni	ug/L	ICPMS	0.3	0.2	0.1	0.1	<0.1	<0.1
P	ug/L	ICPMS	7.6	7.5	6.4	6.6	4.9	3
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	0.07	0.05	<0.05
Pr	ug/L	ICPMS	2.8	3.5	3.4	3.9	3.9	4.2
Rb	ug/L	ICPMS	240	290	280	310	310	350
Sb	ug/L	ICPMS	0.85	0.87	0.8	0.82	0.8	0.82
Sc	ug/L	ICPMS	2	1	0.5	0.4	< 0.1	< 0.1
Se	ug/L	ICPMS	1.6	1.6	1.6	1.8	1.8	1.7
SiO_2	mg/L	ICPMS	180	220	220	250	240	270
Sm	ug/L	ICPMS	3.3	4	3.9	4.7	4.5	4.9
Sr	ug/L	ICPMS	19	14	13	10	10	7
Ta	ug/L	ICPMS	0.43	0.36	0.31	0.31	0.26	0.23
Tb	ug/L	ICPMS	0.66	0.86	0.84	0.96	0.99	1
Th	ug/L	ICPMS	0.34	0.45	0.56	0.57	0.6	0.66
Ti	ug/L	ICPMS	2.4	3	2.6	3	3	3.2
Tl	ug/L	ICPMS	0.4	0.5	0.4	0.5	0.5	0.53
Tm	ug/L	ICPMS	0.32	0.41	0.41	0.42	0.45	0.48
U	ug/L	ICPMS	1.4	1.8	1.8	2	2	2.3
V	ug/L	ICPMS	0.67	0.5	0.4	0.3	<0.2	<0.2
W	ug/L	ICPMS	2	2.1	2.2	2.3	2.2	2.1
Y	ug/L	ICPMS	23	29	28	32	31	34
Yb	ug/L	ICPMS	1.8	2.2	2.3	2.6	2.6	2.9
Zn	ug/L	ICPMS	10	10	10	20	10	20
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	7	10	8	12	10	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.62	-	-16.59	-	-16.53

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			E10 tot Norris/Echinus	P1 diss Norris/Pork chop	P1 tot Norris/ Pork chop	P2 diss Norris/ Pork chop	P2 tot Norris/ Pork chop	P3 diss Norris/ Pork chop	P3 tot Norris/ Pork chop
Latitude			44°43'19.5"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N
Longitude			110°42'4.9"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W
Collection date			07/23/99	07/22/99	07/22/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		35.4	14.6	14.6	15.8	15.8	14.6	14.6
pH			3.2	7.5	7.5	7.4	7.4	7.3	7.3
Conductivity	uS/cm		1272	87	87	223	223	287	287
Cl	mg/L	IC-Aq	-	4.7	-	41	-	60	-
F	mg/L	IC-Aq	-	0.5	-	0.7	-	0.9	-
NO_3	mg/L	IC-Aq	-	<.35	-	0.4	-	<.35	-
SO_4	mg/L	IC-Aq	-	7.2	-	8.6	-	9	-
Ag	ug/L	ICPMS	0.03	<0.01	<0.01	0.01	<0.01	<0.01	0.01
Al	ug/L	ICPMS	1900	2	2	1	1	0.9	1
As	ug/L	ICPMS	280	11	11	170	170	260	260
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	2590	78	77.2	659	669	940	933
Ba	ug/L	ICPMS	59	8.6	8.7	8.8	8.9	8.8	9
Be	ug/L	ICPMS	7.6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.74	5.27	5.19	5.3	5.31	5.28	5.17
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	36	0.02	0.03	0.02	0.02	0.02	0.03
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	81	2.2	2.2	37	38	54	55
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	6.8	0.006	< 0.005	< 0.005	< 0.005	0.005	0.008
Er	ug/L	ICPMS	3.5	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	0.17	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	1800	<30	<30	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	5.4	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ge	ug/L	ICPMS	9.6	0.2	0.2	2.3	2.2	3.2	3.2
Ho	ug/L	ICPMS	1.4	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L	ICPAES	52	1.51	1.56	4.87	4.95	6.49	6.39
La	ug/L	ICPMS	10	0.03	0.03	0.03	0.03	0.03	0.03
Li	ug/L	ICPMS	1100	42	42	400	400	570	580
Mg	mg/L	ICPAES	0.504	2.22	2.23	2.09	2.11	2.03	2
Mn	ug/L	ICPMS	220	0.42	0.42	2.3	2.1	2.9	2.9
Mo	ug/L	ICPMS	5.9	0.87	0.86	12	13	20	20
Na	mg/L	ICPAES	172	8.58	8.62	32.1	32.2	42.9	41.9
Nb	ug/L	ICPMS	0.2	0.1	0.09	0.1	0.1	0.09	0.09
Nd	ug/L	ICPMS	18	0.03	0.03	0.03	0.03	0.03	0.03
Ni	ug/L	ICPMS	<0.1	0.4	0.4	0.3	0.3	0.3	0.3
P	ug/L	ICPMS	2	1	2	2	2	1	2
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	4.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	340	4	4	31	31	44	45
Sb	ug/L	ICPMS	0.79	0.47	0.47	8.8	9.1	14	13
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	0.3	0.2	0.4	0.3
Se	ug/L	ICPMS	1.6	< 0.3	< 0.3	0.5	0.6	0.8	0.9
SiO_2	mg/L	ICPMS	260	9	9.1	26	26	35	35
Sm	ug/L	ICPMS	5.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	ug/L	ICPMS	6.8	35	36	35	34	34	35
Ta	ug/L	ICPMS	0.21	0.11	0.09	0.12	0.1	0.11	0.08
Tb	ug/L	ICPMS	1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Th	ug/L	ICPMS	0.6	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	2.6	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Tl	ug/L	ICPMS	0.51	<0.05	<0.05	<0.05	0.05	0.08	0.08
Tm	ug/L	ICPMS	0.51	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	2.2	0.01	0.01	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	<0.2	0.82	0.85	1.3	1.2	1.3	1.4
W	ug/L	ICPMS	2.2	1.4	1.3	6.8	7.9	11	11
Y	ug/L	ICPMS	34	0.03	0.02	0.02	0.03	0.02	0.02
Yb	ug/L	ICPMS	2.9	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	20	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	8	<5	<5	<5	<5	<5	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.60	-	-16.85	-	-16.62	-

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			**P4 diss Norris/ Pork chop**	**P4 tot Norris/ Pork chop**	**P5 diss Norris/ Pork chop**	**P5 tot Norris/ Pork chop**	**P6 diss Norris/ Pork chop**	**P6 tot Norris/ Pork chop**	**P7 diss Norris/ Pork chop**
Latitude			44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N
Longitude			110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		17.1	17.1	19.6	19.6	22.4	22.4	25.6
pH			7.2	7.2	7.1	7.1	7.0	7.0	6.8
Conductivity	uS/cm		591	591	905	905	1220	1220	1565
Cl	mg/L	IC-Aq	150	-	230	-	330	-	430
F	mg/L	IC-Aq	1.4	-	2.4	-	2.8	-	4.4
NO_3	mg/L	IC-Aq	0.5	-	1.3	-	<.35	-	<.35
SO_4	mg/L	IC-Aq	14	-	22	-	25	-	22
Ag	ug/L	ICPMS	0.03	0.03	0.04	0.03	0.04	0.03	0.04
Al	ug/L	ICPMS	4.9	3.8	2.8	3	9.7	1	<0.5
As	ug/L	ICPMS	820	830	1300	1300	1800	1800	2200
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	2250	2300	3620	3560	4970	4880	6340
Ba	ug/L	ICPMS	11	10	10	10	11	11	11
Be	ug/L	ICPMS	<0.05	<0.05	0.1	<0.05	0.1	<0.05	0.1
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.2	5.38	5.32	5.12	5.22	5.14	5.19
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.02	0.01	< 0.01
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	150	150	230	240	320	320	410
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005
Er	ug/L	ICPMS	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	<30	<30	<30	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	0.02
Gd	ug/L	ICPMS	< 0.005	< 0.005	0.01	0.008	< 0.005	< 0.005	< 0.005
Ge	ug/L	ICPMS	10	10	16	16	22	22	27
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L	ICPAES	13.9	14.3	21.8	22.2	30.5	30	39.1
La	ug/L	ICPMS	0.02	0.03	0.02	0.03	0.02	0.02	< 0.01
Li	ug/L	ICPMS	2200	2200	3500	3400	5000	5000	6500
Mg	mg/L	ICPAES	1.72	1.76	1.43	1.4	1.1	1.08	0.747
Mn	ug/L	ICPMS	9.3	9.3	14	14	19	19	23
Mo	ug/L	ICPMS	64	65	100	110	150	150	190
Na	mg/L	ICPAES	93.1	96.7	151	150	202	200	262
Nb	ug/L	ICPMS	0.2	0.2	0.2	0.1	0.2	0.2	0.2
Nd	ug/L	ICPMS	0.03	0.03	0.02	0.02	0.02	0.01	0.02
Ni	ug/L	ICPMS	0.4	0.4	0.3	0.3	0.2	0.2	0.1
P	ug/L	ICPMS	16	14	16	17	16	14	13
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	130	130	200	200	280	280	350
Sb	ug/L	ICPMS	39	40	62	62	86	84	110
Sc	ug/L	ICPMS	0.5	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	2.8	2.9	4.5	4.7	6.3	6.5	8.3
SiO_2	mg/L	ICPMS	110	110	170	170	230	230	290
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	ug/L	ICPMS	40	39	33	33	30	30	24
Ta	ug/L	ICPMS	0.15	0.16	0.16	0.12	0.16	0.14	0.17
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	0.4	0.2	0.4
Tl	ug/L	ICPMS	0.2	0.3	0.4	0.4	0.6	0.59	0.77
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.009	0.008	< 0.005	< 0.005	< 0.005
V	ug/L	ICPMS	2.8	2.6	2.7	2.4	2.5	2.4	2.5
W	ug/L	ICPMS	32	34	55	57	79	79	100
Y	ug/L	ICPMS	0.02	0.02	0.02	0.02	0.01	0.02	0.01
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<5	15	<5	<5	10	7	7
$\delta^{18}O$ vs VSMOW	permil	ISO1	-15.98	-	-15.47	-	-15.00	-	-14.34

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*.

Field no. Sample name/ description			**P7 tot** **Norris/ Pork chop**	**P8 diss** **Norris/ Pork chop**	**P8 tot** **Norris/ Pork chop**	**P9 diss** **Norris/ Pork chop**	**P9 tot** **Norris/ Pork chop**	**P10 diss** **Norris/ Pork chop**	**P10 tot** **Norris/ Pork chop**
Latitude			44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N
Longitude			110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W
Collection date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99
Temp at filter	°C		25.6	25.3	25.3	28.9	28.9	31.5	31.5
pH			6.8	6.9	6.9	6.7	6.7	6.6	6.6
Conductivity	uS/cm		1565	1865	1865	2080	2080	2300	2300
Cl	mg/L	IC-Aq	-	530	-	600	-	620	-
F	mg/L	IC-Aq	-	5.1	-	5.7	-	6.5	-
NO_3	mg/L	IC-Aq	-	0.5	-	0.5	-	0.5	-
SO_4	mg/L	IC-Aq	-	28	-	30	-	32	-
Ag	ug/L	ICPMS	0.03	0.04	0.04	0.03	0.03	0.03	0.02
Al	ug/L	ICPMS	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
As	ug/L	ICPMS	2200	2700	2600	2800	2800	3100	3100
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	6200	7390	7470	8400	8330	9250	9360
Ba	ug/L	ICPMS	11	11	11	11	11	11	11
Be	ug/L	ICPMS	0.1	3.6	3	5.5	5.8	5.2	5.2
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.93	5	4.99	5.16	4.93	5.01	5.16
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	410	490	480	530	530	580	580
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	<30	<30	<30	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.02	0.02	0.03	< 0.02
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ge	ug/L	ICPMS	27	33	32	35	36	40	40
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L	ICPAES	37.9	46	45.8	52.1	50.8	57.1	57.9
La	ug/L	ICPMS	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Li	ug/L	ICPMS	6600	7900	7900	8900	8900	9800	10000
Mg	mg/L	ICPAES	0.73	0.443	0.448	0.232	0.23	<0.1	<0.1
Mn	ug/L	ICPMS	24	28	28	30	30	33	33
Mo	ug/L	ICPMS	190	230	230	250	250	280	280
Na	mg/L	ICPAES	257	306	309	347	342	383	386
Nb	ug/L	ICPMS	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Nd	ug/L	ICPMS	0.02	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ni	ug/L	ICPMS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
P	ug/L	ICPMS	12	9.7	9.4	6.8	6.4	5.6	6
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	350	420	410	460	460	490	510
Sb	ug/L	ICPMS	110	130	130	140	140	150	150
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	7.7	9.6	9.2	10	10	9.8	11
SiO_2	mg/L	ICPMS	300	350	350	380	380	410	420
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	ug/L	ICPMS	24	20	20	17	17	14	14
Ta	ug/L	ICPMS	0.15	0.14	0.15	0.12	0.12	0.16	0.15
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	< 0.2	0.3	< 0.2	0.3	0.3	0.2	0.5
Tl	ug/L	ICPMS	0.76	0.94	0.92	1	1	1.2	1.2
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
V	ug/L	ICPMS	2.4	2.7	2.6	2.7	2.7	2.8	2.8
W	ug/L	ICPMS	110	130	130	140	140	160	160
Y	ug/L	ICPMS	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	<5	14	5	10	<5	7	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-13.93	-	-13.50	-	-13.03	-

Appendix 3. Site and analytical data from the 1999 mixing experiments—*Continued*

Field no. Sample name/ description			W1 diss West Thumb/ Black pool	W1 tot West Thumb/ Black pool	W2 diss West Thumb/ Black pool	W2 tot West Thumb/ Black pool	W3 diss West Thumb/ Black pool	W3 tot West Thumb/ Black pool	W4 diss West Thumb/ Black pool	W4 tot West Thumb/ Black pool
Latitude			44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N
Longitude			110°34'17"W	110°34'17"W	110°34'17"W	110°34'17"W	110°34'17"W	110°34'17"W	110°34'17"W	110°34'17"W
Collection date			07/22/99	07/22/99	07/24/99	07/24/99	07/24/99	07/24/99	07/24/99	07/24/99
Temp at filter	°C		16.5	16.5	16.6	16.6	19.8	19.8	21.3	21.3
pH			7.5	7.5	7.6	7.6	7.6	7.6	7.7	7.7
Conductivity	uS/cm		87	87	172	172	303	303	490	490
Cl	mg/L	IC-Aq	4.7	-	15	-	35	-	62	-
F	mg/L	IC-Aq	0.5	-	1.7	-	3.8	-	7	-
NO_3	mg/L	IC-Aq	0.5	-	0.4	-	<.35	-	0.5	-
SO_4	mg/L	IC-Aq	7.2	-	8.7	-	11	-	14	-
Ag	ug/L	ICPMS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	ug/L	ICPMS	1	2	14	14	34	33	62	63
As	ug/L	ICPMS	12	12	94	98	240	240	440	460
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	105	90.4	221	220	432	432	770	782
Ba	ug/L	ICPMS	8.5	8.6	8.3	8.2	7.6	7.8	7	7.3
Be	ug/L	ICPMS	<0.05	<0.05	0.2	0.2	0.7	0.6	1.3	1.3
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	4.87	4.93	4.84	4.85	4.59	4.52	4.19	4.17
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.03
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	2.3	2.2	16	16	38	37	66	67
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	< 0.005	0.007	0.009	< 0.005	0.007	< 0.005	< 0.005
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	<30	<30	<30	<30	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	0.4	0.4	1.1	1.2	2.2	2.2
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.008	< 0.005	0.005	< 0.005
Ge	ug/L	ICPMS	0.2	0.2	2.1	2.1	5.1	5.1	9.5	9.7
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
K	mg/L	ICPAES	1.65	1.56	2.25	2.24	3.32	3.42	4.92	4.98
La	ug/L	ICPMS	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
Li	ug/L	ICPMS	40	41	200	200	440	450	810	820
Mg	mg/L	ICPAES	2.16	2.16	2.1	2.08	1.94	1.97	1.74	1.74
Mn	ug/L	ICPMS	0.4	0.44	0.47	0.51	0.62	0.62	0.78	0.78
Mo	ug/L	ICPMS	1.6	1.2	4.6	4.8	11	11	21	22
Na	mg/L	ICPAES	8.76	8.44	26.3	26.3	53.9	53.1	93.5	93.5
Nb	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.06	0.04	0.1	0.1
Nd	ug/L	ICPMS	0.03	0.03	0.02	0.03	0.03	0.04	0.02	0.03
Ni	ug/L	ICPMS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2
P	ug/L	ICPMS	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	3.9	4	11	11	23	23	39	40
Sb	ug/L	ICPMS	1.6	0.94	5.2	5.2	12	12	23	23
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.6	0.7
SiO_2	mg/L	ICPMS	8.4	8.7	19	19	36	36	62	63
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01
Sr	ug/L	ICPMS	35	34	33	35	33	32	28	29
Ta	ug/L	ICPMS	< 0.03	< 0.03	0.04	< 0.03	0.14	0.11	0.25	0.2
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
Tl	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
V	ug/L	ICPMS	0.64	0.7	0.69	0.68	0.62	0.63	0.6	0.6
W	ug/L	ICPMS	5.1	3.3	14	15	38	40	77	81
Y	ug/L	ICPMS	0.03	0.02	0.02	0.03	0.03	0.03	0.02	0.02
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	5	<5	8	<5	5	<5	9	<5
$\delta^{18}O$ vs VSMOW	permil	ISO1	-16.17	-	-16.57	-	-16.56	-	-15.98	-

Appendix 4. Site and analytical data from subaerial hydrothermal features.

Field no. Sample name & description			RS-49-98 Vandalized Pool-West Thumb GB 1998	RS-48-98 Black Pool-West Thumb GB 1998	W10 diss West Thumb/ Black pool	W10 tot West Thumb/ Black pool	W10ADISS West Thumb/ Black pool	W10ATOT West Thumb/ Black pool	98-343 Duck Lake	YNP-99-408 On knob of tuff of Bluff Point,WTGB	YNP-02-705.1 Indian Pond- from shore	98-3 Turbid Lake-West shore	YNP-02-702.2 Turbid Lake water-from shore near Sedge Cr. Inlet
Latitude			44°25'0"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'6"N	44°25'10.7"N	44°26'45.2"N	44°33'22"N	44°32'54.2"N	44°33'8"N
Longitude			110°34'20"	110°34'17"W	110°34'17"	110°34'17"	110°34'17"	110°34'17"	110°34'49.3"	110°33'27.3"	110°19'30"W	110°15'55.3"	110°15'26"W
Collection Date			09/03/98	09/03/98	07/24/99	07/24/99	07/24/99	07/24/99	07/20/98	06/24/99	9/16/2002	07/15/98	9/11/2002
Temperature	˚C		-	-	40.2	40.2	1.6	1.6	-	94.0	17.0	24.3	21
pH			8.2	8.2	7.9	7.9	8.3	8.3	5.0	4.2	7.2	3.4	2.5
Conductivity	uS/cm		-	-	2020	2020	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	4.37	-
HCO_3	mM	measured	6.8	6.8	-	-	-	-	-	-	-	0.0	-
HCO_3	uM	calculated	6989	6991	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	310	300	300	-	290	-	ns	2	310	12	4.5
F	mg/L	IC-Aq	26	25	26	-	25	-	ns	0.1	5.9	0.3	0.2
NO_3	mg/L	IC-Aq	< 0.1	< 0.1	0.5	-	1.2	-	ns	<.35	0.6	1	0.5
SO_4	mg/L	IC-Aq	47	39	45	-	46	-	ns	30	31	40	86
Ag	ug/L	ICPMS	< 0.01	< 0.01	0.04	0.03	<0.01	<0.01	< 0.01	0.3	<0.1	< 0.01	<0.01
Al	ug/L	ICPMS	100	370	300	300	290	290	7.0	630	110	140	370
As	ug/L	ICPMS	1600	1600	2400	2400	2300	2300	0.4	2.1	1200	6.9	16
Au	ug/L	ICPMS	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	< 0.1	< 0.01	< 0.01
B	ug/L	ICPAES	3700	3600	3430	3470	3520	3470	< 10	-	-	290	-
Ba	ug/L	ICPMS	< 0.02	< 0.02	0.4	0.4	0.8	2	4	94	20	15	31
Be	ug/L	ICPMS	2.0	7.6	5.4	5.6	7.2	6.8	< 0.05	0.1	<0.5	< 0.05	0.09
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	< 0.3	< 0.01	< 0.03
Ca	mg/L	ICPAES	< 1	< 1	0.86	0.865	0.85	0.851	1.2	-	-	4.0	-
Ca	mg/L	ICPMS	-	-	-	-	-	-	-	-	12	-	6
Cd	ug/L	ICPMS	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	< 0.02	<0.02	<0.2	< 0.02	0.02
Ce	ug/L	ICPMS	0.04	0.06	0.02	0.02	0.02	0.02	0.05	0.41	0.1	0.79	2.2
Co	ug/L	ICPMS	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.06	<0.2	0.3	0.85
Cr	ug/L	ICPMS	< 1	< 1	1	1	<1	<1	< 1	<1	<10	< 1	<1
Cs	ug/L	ICPMS	80	240	300	300	270	270	0.01	-	110	2.0	3.3
Cu	ug/L	ICPMS	0.7	< 0.5	<0.5	<0.5	<0.5	<0.5	0.6	2	<5	0.7	1
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.052	< 0.05	0.10	0.18
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.03	< 0.05	0.061	0.097
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.05	0.008	0.02
Fe	ug/L	ICPMS	< 10	< 10	<30	<30	<30	<30	< 10	1800	140	390	1600
Ga	ug/L	ICPMS	6.8	6.5	12	12	12	12	< 0.02	-	0.3	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.06	< 0.05	0.11	0.2
Ge	ug/L	ICPMS	32	32	54	54	52	53	< 0.02	-	11	0.2	0.4
Hf	ug/L	ICPMS	0.60	0.70	-	-	-	-	< 0.05	-	-	< 0.05	-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.01	< 0.05	0.02	0.04
In	ug/L	ICPMS	< 0.01	< 0.01	-	-	-	-	< 0.01	< 0.01	< 0.1	< 0.01	< 0.01
K	mg/L	ICPAES	12	20	19.5	19.6	19.1	19.1	1.1	-	-	1.0	-
K	ug/L	ICPMS	-	-	-	-	-	-	-	-	10000	-	1800
La	ug/L	ICPMS	0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.04	0.2	< 0.1	0.4	1.2
Li	ug/L	ICPMS	3600	4300	3900	3900	4500	4500	0.9	3.2	840	19	38
Mg	mg/L	ICPAES	< 1	< 1	<0.1	<0.1	<0.1	<0.1	< 1	-	-	1.9	-
Mg	mg/L	ICPMS	-	-	-	-	-	-	-	-	3.5	-	3.2
Mn	ug/L	ICPMS	0.65	2.2	2.4	2.6	2.2	2.3	1.3	17	7.2	34	76
Mo	ug/L	ICPMS	100	89	110	110	110	110	0.04	0.9	5.1	0.08	0.4
Na	mg/L	ICPAES	110	430	406	415	404	408	< 1	-	-	4.3	-
Na	mg/L	ICPMS	-	-	-	-	-	-	-	-	230	-	9.1
Nb	ug/L	ICPMS	0.05	0.06	0.72	0.63	0.4	0.3	< 0.02		-	< 0.02	-
Nd	ug/L	ICPMS	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.06	0.21	< 0.1	0.57	1
Ni	ug/L	ICPMS	0.2	< 0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	0.3	1	0.8	2.4
P	ug/L	ICPMS	-	-	< 2	< 2	< 2	< 2	34	< 6	< 30	180	54
Pb	ug/L	ICPMS	< 0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	<0.05	<0.5	0.2	0.3
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.05	< 0.1	0.1	0.27
Rb	ug/L	ICPMS	100	150	200	200	200	200	2.7	38	94	2.7	4.6
Re	ug/L	ICPMS	< 0.02	< 0.02	-	-	-	-	< 0.02	-	< 0.2	< 0.02	< 0.02
Sb	ug/L	ICPMS	100	100	100	100	96	96	< 0.02	0.62	34	1.1	0.24
Sc	ug/L	ICPMS	< 0.1	0.3	3	3	< 0.1	< 0.1	< 0.1	-	-	< 0.1	-
Se	ug/L	ICPMS	2	2	4.8	4.7	3.3	3.6	< 0.2	< 0.2	2	< 0.2	< 0.2
SiO_2	mg/L	ICPMS	320	360	290	300	290	300	4	120	76	24	27
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.06	< 0.1	0.08	0.2
Sn	ug/L	ICPMS	< 0.05	< 0.05	-	-	-	-	< 0.05	-	-	< 0.05	-
Sr	ug/L	ICPMS	1.6	1.8	2	2	2.1	2.1	12	4.5	94	46	61
Ta	ug/L	ICPMS	0.09	0.1	1.1	0.96	0.51	0.52	< 0.02	-	-	< 0.02	-
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.05	0.02	0.03
Te	ug/L	ICPMS	< 0.1	< 0.1	-	-	-	-	< 0.1	-	-	< 0.1	-
Th	ug/L	ICPMS	< 0.005	0.008	< 0.02	< 0.02	< 0.02	< 0.02	< 0.005	-	2.6	0.005	0.11
Ti	ug/L	ICPMS	0.2	0.2	3.5	3.4	3	3	< 0.1	-	-	0.4	-
Tl	ug/L	ICPMS	0.07	0.1	0.2	0.2	0.2	0.2	< 0.05	0.2	<0.5	< 0.05	<0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.05	0.01	0.01
U	ug/L	ICPMS	0.02	< 0.005	0.005	0.006	0.007	< 0.005	0.009	0.09	< 0.05	0.02	0.04
V	ug/L	ICPMS	0.9	0.7	0.8	0.8	0.5	0.5	0.2	<0.2	2	2	4
W	ug/L	ICPMS	250	240	390	380	350	350	0.04	0.2	71	0.4	0.74
Y	ug/L	ICPMS	< 0.01	0.01	0.01	0.01	0.01	0.01	0.05	-	< 0.1	0.50	0.99
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.1	0.06	0.1
Zn	ug/L	ICPMS	2	1	<0.5	<0.5	0.6	0.6	2	2	6	2	5
Zr	ug/L	ICPMS	0.2	0.84	0.3	< 0.2	< 0.2	< 0.2	0.1	-	-	0.1	-
Hg	ng/L	Hg CVAF	240	80	28	26	-	-	-	18	10	-	10
$\delta^{18}O$ vs VSMOW	permil	ISO1	-12.06	-13.94	-14.41	-	-14.45	-	-11.2	-14.9	-10.9	-17.51	-17.0
δD vs VSMOW	permil	ISO2	-134.2	-140.1	-	-	-	-	-108.5	-144.8	-107.8	-136.7	-129.9
$\delta^{34}S$ vs CDT	permil	ISO3	14.26	15.18	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. Sample name & description			**98-4 Sedge Crk inlet to Turbid Lake-bubbler**	**YNP-02-702.1 Turbid Lake-Sedge Cr. Inlet**	**98-336.2 mudpot SE of Turbid Lake**	**YNP-02-701.1 Turbid Lake-mudpot**	**98-337 Bear Crk. inlet to Turbid Lake**	**YNP-02-700.1 Turbid Lake- Bear Creek inlet**	**98-329.2w Mushpots-U. Pelican Cr.-Black Pond**	**98-329.3 Mushpots-U. Pelican Cr.-S. end, Clear Pond**	**98-333.1 new thermal area-N. of mushpots-Frying Pan**	**98-333.2 new thermal area-N. of mushpots-pool near top**
Latitude			44°33'8.2"N	44°32'11.3"N	44°32'47"N	44°32'48"N	44°32'37.8"N	44°32'37.8"N	44°38'3.2"N	44°38'3.2"N	44°38'14.2"N	44°38'14.2"N
Longitude			110°15'26"W	110°15'24"W	110°15'14.5"	110°15'18.5"W	110°15'26.5"	110°15'26.5"W	110°13'35.3"	110°13'35.3"	110°13'33.3"	110°13'33.3"
Collection Date			07/15/98	9/11/2002	07/16/98	9/11/2002	07/16/98	9/11/2002	07/10/98	07/11/98	07/13/98	07/13/98
Temperature	˚C		14.3	14	56.6	49	20.2	13	62.5	76.2	86.0	66.1
pH			7.6	6.2	1.5	1.1	6.2	7.2	2.8	4.3	6.9	2.3
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		0.69	-	-	-	0.88	-	2.07	2	1.18	1.4
HCO_3	mM	measured	0.4	-	-	-	0.4	-	0.0	0.0	0.9	0.0
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	0.3	2.3	10	6.7	0.8	2.2	1.2	1.5	1	1.1
F	mg/L	IC-Aq	0.2	0.2	0.2	0.5	1.1	0.3	0.2	1.6	0.4	0.2
NO_3	mg/L	IC-Aq	<.1	0.4	<.1	0.9	<.1	<.18	<.1	<.1	<.1	<.1
SO_4	mg/L	IC-Aq	5	4.8	910	2400	10	5.3	460	460	410	540
Ag	ug/L	ICPMS	< 0.01	<0.01	< 0.01	<0.01	0.01	<0.01	< 0.01	0.1	< 0.01	< 0.01
Al	ug/L	ICPMS	14	9.5	7600	19000	29	22	840	25	7.4	7800
As	ug/L	ICPMS	3.1	2.9	12	37	2	5.6	2	3.1	0.4	1
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01
B	ug/L	ICPAES	26	-	1400	-	46	-	56	1100	520	100
Ba	ug/L	ICPMS	6.8	14	36	39	10	9.6	58	78	63	45
Be	ug/L	ICPMS	< 0.05	<0.05	0.05	0.2	< 0.05	<0.05	1.0	0.2	0.2	0.6
Bi	ug/L	ICPMS	< 0.01	< 0.03	< 0.01	< 0.03	< 0.01	< 0.03	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	3.7	-	2.6	-	4.1	-	51	39	57	38
Ca	mg/L	ICPMS	-	8.6	-	5.2	-	7.7	-	-	-	-
Cd	ug/L	ICPMS	< 0.02	<0.02	0.05	0.07	< 0.02	<0.02	< 0.02	< 0.02	< 0.02	0.08
Ce	ug/L	ICPMS	0.1	0.1	7.1	21	0.3	0.1	4.1	0.3	0.01	4.8
Co	ug/L	ICPMS	0.08	0.1	0.73	5.6	0.1	0.05	7.7	0.04	0.02	6.2
Cr	ug/L	ICPMS	< 1	<1	4	20	< 1	<1	< 1	< 1	< 1	8
Cs	ug/L	ICPMS	0.06	0.1	13	14	0.47	0.02	4.8	9.4	15	8.6
Cu	ug/L	ICPMS	< 0.5	0.8	3	2	< 0.5	0.6	0.9	1	< 0.5	1
Dy	ug/L	ICPMS	0.03	0.02	0.21	0.56	0.058	0.04	0.78	0.02	< 0.005	0.44
Er	ug/L	ICPMS	0.01	0.01	0.087	0.29	0.04	0.02	0.37	0.009	< 0.005	0.18
Eu	ug/L	ICPMS	0.007	< 0.005	0.055	0.2	< 0.005	< 0.005	0.17	< 0.005	< 0.005	0.12
Fe	ug/L	ICPMS	58	200	800	4300	68	100	1100	50	50	2600
Ga	ug/L	ICPMS	< 0.02	< 0.02	2.2	5.1	< 0.02	< 0.02	0.2	0.04	0.07	0.3
Gd	ug/L	ICPMS	0.02	0.02	0.29	0.78	0.061	0.03	0.87	0.02	< 0.005	0.48
Ge	ug/L	ICPMS	< 0.02	0.02	0.6	0.6	< 0.02	< 0.02	0.9	4.5	1.7	0.9
Hf	ug/L	ICPMS	< 0.05	-	< 0.05	-	< 0.05	-	< 0.05	< 0.05	< 0.05	< 0.05
Ho	ug/L	ICPMS	0.005	0.006	0.03	0.11	0.01	0.008	0.14	< 0.005	< 0.005	0.077
In	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
K	mg/L	ICPAES	1.1	-	3.8	-	1.1	-	17	19	24	24
K	ug/L	ICPMS	-	2100	-	8200	-	1700	-	-	-	-
La	ug/L	ICPMS	0.09	0.1	4.3	13	0.2	0.1	1.5	0.2	< 0.01	1.9
Li	ug/L	ICPMS	3.4	10	77	87	6.0	5.2	51	77	49	22
Mg	mg/L	ICPAES	2	-	< 1	-	2.1	-	18	15	9.3	9.3
Mg	mg/L	ICPMS	-	4.8	-	1.4	-	4.2	-	-	-	-
Mn	ug/L	ICPMS	8.1	21	85	120	18	11	740	240	700	540
Mo	ug/L	ICPMS	0.2	0.5	< 0.02	0.82	0.56	0.81	< 0.02	0.2	< 0.02	< 0.02
Na	mg/L	ICPAES	2.5	-	18	-	2.8	-	68	84	70	42
Na	mg/L	ICPMS	-	5.8	-	27	-	4.5	-	-	-	-
Nb	ug/L	ICPMS	< 0.02	-	< 0.02	-	< 0.02	-	< 0.02	< 0.02	< 0.02	< 0.02
Nd	ug/L	ICPMS	0.1	0.09	2.7	7.9	0.21	0.1	3.5	0.1	< 0.01	3.2
Ni	ug/L	ICPMS	0.2	0.8	2.0	14	0.4	0.6	9.8	0.1	0.2	22
P	ug/L	ICPMS	430	31	650	220	160	19	150	480	80	65
Pb	ug/L	ICPMS	0.1	<0.05	1.3	5.8	< 0.05	<0.05	0.1	< 0.05	< 0.05	0.4
Pr	ug/L	ICPMS	0.02	0.02	0.82	2.5	0.05	0.03	0.72	0.04	< 0.01	0.73
Rb	ug/L	ICPMS	2.6	3.3	9.3	12	2.6	2.4	54	71	150	130
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	0.2	0.2	0.2	0.2	0.2	0.2	< 0.02	< 0.02	< 0.02	0.09
Sc	ug/L	ICPMS	< 0.1	-	< 0.1	-	< 0.1	-	4	2	1	2
Se	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	220	< 0.2
SiO_2	mg/L	ICPMS	33	34	110	100	26	25	190	140	160	160
Sm	ug/L	ICPMS	0.02	0.02	0.37	1.3	0.08	0.03	0.89	0.04	< 0.01	0.66
Sn	ug/L	ICPMS	< 0.05	-	0.6	-	< 0.05	-	< 0.05	< 0.05	< 0.05	< 0.05
Sr	ug/L	ICPMS	36	62	100	190	50	63	460	660	650	580
Ta	ug/L	ICPMS	< 0.02	-	< 0.02	-	< 0.02	-	< 0.02	< 0.02	< 0.02	< 0.02
Tb	ug/L	ICPMS	< 0.005	< 0.005	0.04	0.1	0.008	< 0.005	0.13	0.007	< 0.005	0.093
Te	ug/L	ICPMS	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1
Th	ug/L	ICPMS	0.05	0.08	0.23	2.9	0.006	< 0.04	< 0.005	< 0.005	< 0.005	0.10
Ti	ug/L	ICPMS	0.1	-	4.3	-	0.2	-	1.8	1.7	1.4	3.2
Tl	ug/L	ICPMS	< 0.05	<0.05	< 0.05	<0.05	< 0.05	<0.05	< 0.05	< 0.05	< 0.05	< 0.05
Tm	ug/L	ICPMS	< 0.005	< 0.005	0.01	0.04	0.006	< 0.005	0.056	< 0.005	< 0.005	0.03
U	ug/L	ICPMS	0.03	0.03	0.14	0.37	0.03	0.03	0.32	0.007	< 0.005	0.49
V	ug/L	ICPMS	5	3	4	12	1	0.8	2	0.2	< 0.1	8.7
W	ug/L	ICPMS	0.06	0.3	0.2	1.2	0.05	0.68	0.2	1.2	0.67	0.2
Y	ug/L	ICPMS	0.1	0.1	0.77	2.4	0.3	0.2	3.5	0.2	< 0.01	1.6
Yb	ug/L	ICPMS	0.01	0.01	0.08	0.28	0.03	0.02	0.30	0.01	< 0.01	0.2
Zn	ug/L	ICPMS	0.9	0.9	9	10	0.8	0.8	34	2	0.8	20
Zr	ug/L	ICPMS	0.06	-	0.3	-	0.1	-	< 0.05	0.07	< 0.05	0.08
Hg	ng/L	Hg CVAF	-	11	-	700	-	10	-	-	-	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-18.66	-18.3	-1.22	-4.8	-18.02	-17.7	-8.89	-9.62	-13.39	-10.6
δD vs VSMOW	permil	ISO2	-140.2	-135.4	-102.5	-102	-137.3	-129.6	-118.7	-126.8	-135.4	-125.4
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. / Sample name & description			YNP-01-569.1 Fern Lake	YNP-99-436diss Ponuntpa Springs	YNP-99-438diss crater near Hot Springs Basin Group	98-348 Vermillion Spr.-Sour Crk. Dome	YNP-00-532.1 Black dog beach vent	YNP-99-429.1tot Porkchop Hot Spring, Norris	YNP-99-429.1diss Porkchop Hot Spring, Norris	YNP-99-429.2tot Porkchop Hot Spring, Norris	YNP-99-429.2diss Porkchop Hot Spring, Norris
Latitude			44°40'37.8"N	44°40'10.2"N	44°44'39.2"N	44°35'4.8"N	44°33'17.4"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N
Longitude			110°16'5.1"W	110°17'26.3"W	110°14'4.3"W	110°18'49.3"	110°19'19.8"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W
Collection Date			-	07/13/99	07/14/99	07/21/98	09/02/00	07/04/99	07/04/99	07/04/99	07/04/99
Temperature	°C		44	43.0	86.0	53.1	42.1	55.0	55.0	55.0	55.0
pH			5.5	6.2	1.5	2.3	6.4	7.0	7.0	7.0	7.0
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	210	280	4	14	320	-	650	-	660
F	mg/L	IC-Aq	0.7	5.4	0.3	0.8	1.8	-	6.1	-	6.2
NO_3	mg/L	IC-Aq	0.7	1.2	<.1	0.1	0.2	-	<.1	-	<.1
SO_4	mg/L	IC-Aq	290	2.3	1000	350	1.2	-	34	-	34
Ag	ug/L	ICPMS	5.2	0.02	<0.01	< 0.01	<0.01	0.68	0.3	0.2	0.1
Al	ug/L	ICPMS	40	<0.5	19000	36000	45	240	71	86	69
As	ug/L	ICPMS	49	5.5	13	140	240	3100	3000	3000	3100
Au	ug/L	ICPMS	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	-	8110	554	1600	-	9120	9140	9040	9070
Ba	ug/L	ICPMS	51	140	68	21	420	12	11	11	11
Be	ug/L	ICPMS	<0.5	5.5	1.3	0.8	<0.05	6.1	5.5	3.5	6.4
Bi	ug/L	ICPMS	< 0.3	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	19.4	10.8	2.5	-	5.15	5.15	5.19	5.04
Ca	mg/L	ICPMS	44	-	-	-	59	-	-	-	-
Cd	ug/L	ICPMS	<0.2	<0.02	0.03	0.03	0.04	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	< 0.1	0.01	24	21	0.03	0.1	0.02	0.02	< 0.01
Co	ug/L	ICPMS	<0.2	<0.02	0.1	0.56	0.77	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<10	<1	3	4	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	15	100	1.8	24	0.34	580	570	570	580
Cu	ug/L	ICPMS	<5	<0.5	0.5	0.6	0.6	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.05	0.006	1.5	1.6	< 0.005	0.009	< 0.005	< 0.005	< 0.005
Er	ug/L	ICPMS	< 0.05	0.008	0.93	0.78	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Eu	ug/L	ICPMS	< 0.05	< 0.005	0.24	0.098	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Fe	ug/L	ICPMS	75	330	4100	7500	1600	<30	<30	<30	<30
Ga	ug/L	ICPMS	< 0.2	< 0.02	5.8	3.2	< 0.02	3.4	3	3.3	3.3
Gd	ug/L	ICPMS	< 0.05	< 0.005	1.3	1.8	< 0.005	0.01	< 0.005	< 0.005	< 0.005
Ge	ug/L	ICPMS	9	31	0.7	1.4	7.9	39	38	39	39
Hf	ug/L	ICPMS	-	-	-	< 0.05	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.05	< 0.005	0.32	0.30	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
In	ug/L	ICPMS	< 0.1	-	-	0.02	< 0.01	-	-	-	-
K	mg/L	ICPAES	-	23.3	20.2	12	-	58	58.3	58.8	57.1
K	ug/L	ICPMS	80000	-	-	-	50000	-	-	-	-
La	ug/L	ICPMS	< 0.1	< 0.01	16	8.3	0.03	0.06	0.01	0.02	0.01
Li	ug/L	ICPMS	1600	440	25	250	750	8900	8900	9100	9200
Mg	mg/L	ICPAES	-	6.87	7.88	1	-	<0.1	<0.1	<0.1	<0.1
Mg	mg/L	ICPMS	13	-	-	-	63	-	-	-	-
Mn	ug/L	ICPMS	520	78	44	42	70	34	33	34	34
Mo	ug/L	ICPMS	11	1.2	1.1	0.2	0.5	280	280	290	290
Na	mg/L	ICPAES	-	<0.1	23.5	10	-	379	379	377	380
Na	mg/L	ICPMS	260	-	-	-	>300	-	-	-	-
Nb	ug/L	ICPMS	-	0.2	0.1	< 0.02	-	0.88	0.65	0.5	0.4
Nd	ug/L	ICPMS	< 0.1	< 0.01	8.4	9.8	0.01	0.07	< 0.01	< 0.01	< 0.01
Ni	ug/L	ICPMS	<1	<0.1	0.4	2.2	3.1	<0.1	<0.1	<0.1	<0.1
P	ug/L	ICPMS	740	7.3	62	110	21	16	12	16	10
Pb	ug/L	ICPMS	<0.5	<0.05	5.1	< 0.05	0.1	0.07	<0.05	<0.05	<0.05
Pr	ug/L	ICPMS	< 0.1	< 0.01	2.7	2.6	< 0.01	0.02	< 0.01	< 0.01	< 0.01
Rb	ug/L	ICPMS	240	150	66	65	63	500	480	490	500
Re	ug/L	ICPMS	< 0.2	-	-	< 0.02	< 0.02	-	-	-	-
Sb	ug/L	ICPMS	2.6	1.2	0.32	0.69	0.2	160	160	160	160
Sc	ug/L	ICPMS	-	< 0.1	< 0.1	0.4	-	4	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	< 2	4.6	< 0.3	1300	0.95	12	12	12	12
SiO_2	mg/L	ICPMS	140	130	170	170	170	460	440	460	450
Sm	ug/L	ICPMS	< 0.1	< 0.01	1.6	2.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sn	ug/L	ICPMS	-	-	-	0.2	-	-	-	-	-
Sr	ug/L	ICPMS	470	270	130	27	410	14	14	14	14
Ta	ug/L	ICPMS	-	0.31	0.13	< 0.02	-	0.86	0.64	0.56	0.48
Tb	ug/L	ICPMS	< 0.05	< 0.005	0.22	0.31	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Te	ug/L	ICPMS	-	-	-	< 0.1	-	-	-	-	-
Th	ug/L	ICPMS	< 0.4	0.04	3.9	2.3	0.38	< 0.02	< 0.02	< 0.02	< 0.02
Ti	ug/L	ICPMS	-	< 0.2	11	1.5	-	1.3	0.6	0.7	0.6
Tl	ug/L	ICPMS	<0.5	0.3	0.2	0.4	<0.05	1.2	1.2	1.2	1.1
Tm	ug/L	ICPMS	< 0.05	< 0.005	0.13	0.11	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
U	ug/L	ICPMS	< 0.05	< 0.005	0.72	0.60	0.04	< 0.005	< 0.005	< 0.005	< 0.005
V	ug/L	ICPMS	2	0.5	2.1	8.6	0.71	5.7	3.7	3.3	3
W	ug/L	ICPMS	20	36	7.5	0.3	0.2	140	150	150	160
Y	ug/L	ICPMS	< 0.1	0.1	7.7	7.2	0.08	0.04	0.01	< 0.01	< 0.01
Yb	ug/L	ICPMS	< 0.1	0.01	0.88	0.66	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	ug/L	ICPMS	<5	<0.5	10	32	4	<0.5	<0.5	<0.5	<0.5
Zr	ug/L	ICPMS	-	< 0.2	0.7	< 0.05	-	0.7	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	10	68	126	-	<0.005	36	-	16	-
$\delta^{18}O$ vs VSMOW	permil	ISO1	-17.6	-17.6	-15.7	-16.9	-17.7	-12.8	-	-12.8	-
δD vs VSMOW	permil	ISO2	-146.8	-149.3	-137.3	-137.4	-144.8	-138.1	-	-137.5	-
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. Sample name & description			P10 diss Norris/Pork chop	P10 tot Norris/Pork chop	P10Adiss Norris/Pork chop	P10Atot Norris/Pork chop	YNP-99-430.1tot Echinus Hot Spring, Norris	YNP-99-430.1diss Echinus Hot Spring, Norris	YNP-99-430.2tot Echinus Hot Spring, Norris	YNP-99-430.2diss Echinus Hot Spring, Norris	E10 diss Norris/Echinus
Latitude			44°43'21"N	44°43'21"N	44°43'21"N	44°43'21"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'19.5"N
Longitude			110°42'28"W	110°42'28"W	110°42'28"W	110°42'28"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'4.9"W
Collection Date			07/23/99	07/23/99	07/23/99	07/23/99	07/04/99	07/04/99	07/04/99	07/04/99	07/23/99
Temperature	°C		31.5	31.5	1.6	1.6	80.0	80.0	80.0	80.0	35.4
pH			6.6	6.6	7.0	7.0	3.3	3.3	3.3	3.3	3.2
Conductivity	uS/cm		2300	2300	-	-	-	-	-	-	1272
Sum CO_2	mM		-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	620	-	660	-	-	150	-	150	150
F	mg/L	IC-Aq	6.5	-	5.6	-	-	4.7	-	4.8	4.8
NO_3	mg/L	IC-Aq	0.5	-	<.35	-	-	0.7	-	<.1	<.35
SO_4	mg/L	IC-Aq	32	-	36	-	-	250	-	260	260
Ag	ug/L	ICPMS	0.03	0.02	0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.04
Al	ug/L	ICPMS	<0.5	<0.5	<0.3	<0.3	1900	1900	1900	1900	2000
As	ug/L	ICPMS	3100	3100	2800	2900	310	290	280	280	290
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	9250	9360	9330	9220	2500	2400	2450	2420	2540
Ba	ug/L	ICPMS	11	11	9.4	9.6	61	62	59	61	60
Be	ug/L	ICPMS	5.2	5.2	2.7	2.9	7.5	6.6	7.3	8.1	7
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ca	mg/L	ICPAES	5.01	5.16	5	5.01	4.73	4.66	4.6	4.6	4.74
Ca	mg/L	ICPMS	-	-	-	-	-	-	-	-	-
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ce	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	37	36	36	36	36
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cs	ug/L	ICPMS	580	580	500	500	84	86	82	84	81
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	6.8	6.6	6.6	6.8	6.7
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	3.9	3.7	3.7	3.7	3.5
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.19	0.16	0.18	0.19	0.17
Fe	ug/L	ICPMS	<30	<30	<30	<30	2000	1800	1900	1800	1900
Ga	ug/L	ICPMS	0.03	< 0.02	0.02	0.04	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	5.6	5.6	5.5	5.6	5.6
Ge	ug/L	ICPMS	40	40	38	37	9.8	10	9.7	9.8	9.9
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	1.4	1.3	1.4	1.4	1.3
In	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
K	mg/L	ICPAES	57.1	57.9	57.2	57.4	52.2	51.2	50.7	50.7	51.9
K	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
La	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	11	10	10	10	10
Li	ug/L	ICPMS	9800	10000	7000	7000	1100	1100	1100	1100	1100
Mg	mg/L	ICPAES	<0.1	<0.1	<0.1	<0.1	0.503	0.494	0.497	0.49	0.499
Mg	mg/L	ICPMS	-	-	-	-	-	-	-	-	-
Mn	ug/L	ICPMS	33	33	28	29	210	210	200	210	230
Mo	ug/L	ICPMS	280	280	230	240	14	8.5	8	7.1	6
Na	mg/L	ICPAES	383	386	360	359	167	170	168	168	172
Na	mg/L	ICPMS	-	-	-	-	-	-	-	-	-
Nb	ug/L	ICPMS	0.1	0.1	0.03	0.02	0.2	0.2	0.2	0.2	0.2
Nd	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	19	18	19	19	18
Ni	ug/L	ICPMS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
P	ug/L	ICPMS	5.6	6	< 2	< 2	2	< 1	1	< 1	3
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	<0.05	0.2	0.1	0.2	0.1	<0.05
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	4.5	4.5	4.4	4.4	4.2
Rb	ug/L	ICPMS	490	510	500	480	360	370	360	370	350
Re	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Sb	ug/L	ICPMS	150	150	130	130	1.5	1.2	1.1	0.98	0.82
Sc	ug/L	ICPMS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Se	ug/L	ICPMS	9.8	11	7.2	7.4	2.4	2.7	2	1.8	1.7
SiO_2	mg/L	ICPMS	410	420	310	320	250	250	240	250	270
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	5.3	5.1	5.2	5.4	4.9
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	14	14	13	14	7.2	7.2	7.1	7.3	7
Ta	ug/L	ICPMS	0.16	0.15	0.04	< 0.03	0.2	0.18	0.17	0.17	0.23
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	1.1	1.1	1	1.1	1
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	0.64	0.68	0.78	0.7	0.66
Ti	ug/L	ICPMS	0.2	0.5	< 0.8	< 0.8	2.6	2.2	2.5	2.5	3.2
Tl	ug/L	ICPMS	1.2	1.2	0.98	0.98	0.61	0.59	0.58	0.56	0.53
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	0.51	0.53	0.53	0.52	0.48
U	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	< 0.005	2.2	2.2	2.2	2.2	2.3
V	ug/L	ICPMS	2.8	2.8	2	2	0.4	0.3	<0.2	<0.2	<0.2
W	ug/L	ICPMS	160	160	110	120	18	8	8.9	4.8	2.1
Y	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	36	36	35	36	34
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	3	3	2.9	3	2.9
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	20	20	20	20	20
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hg	ng/L	Hg CVAF	7	<5	-	-	7	-	6	-	<5
$\delta^{18}O$ vs VSMOW	permil	IS01	-13.03	-	-13.09	-	-16.6	-	-16.5	-	-16.53
δD vs VSMOW	permil	IS02	-	-	-	-	-141.8	-	-142.9	-	-
$\delta^{34}S$ vs CDT	permil	IS03	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. Sample name & description			E10 tot Norris/Echinus	E10Adiss Norris/Echinus	E10Atot Norris/Echinus	G10 diss Norris/Green Dragon	G10 tot Norris/Green Dragon	G10Adiss Norris/Green Dragon	G10Atot Norris/Green Dragon	YNP-02-588.1 Large explosion crater N of gap, Norris	YNP-99-453 Heart Lake/fissure geyser area
Latitude			44°43'19.5"N	44°43'19.5"N	44°43'19.5"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'12.2"N	44°43'43.5"N	44°17'27.2"N
Longitude			110°42'4.9"W	110°42'4.9"W	110°42'4.9"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'23"W	110°42'53"W	110°30'31"W
Collection Date			07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	07/23/99	9/19/2002	07/22/99
Temperature	˚C		35.4	1.6	1.6	30.1	30.1	1.6	1.6	39	92.0
pH			3.2	3.3	3.3	2.6	2.6	2.8	2.8	1.6	7.0
Conductivity	uS/cm		1272	-	-	1984	1984	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	-	150	-	330	-	360	-	180	140
F	mg/L	IC-Aq	-	4.8	-	5.6	-	4.5	-	4.1	12
NO_3	mg/L	IC-Aq	-	<.35	-	<.35	-	0.5	-	<.18	<.35
SO_4	mg/L	IC-Aq	-	290	-	150	-	160	-	520	110
Ag	ug/L	ICPMS	0.03	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.1	0.3
Al	ug/L	ICPMS	1900	1800	1800	4000	4000	2600	2600	19000	46
As	ug/L	ICPMS	280	300	300	1700	1700	1400	1400	2100	690
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.01
B	ug/L	ICPAES	2590	2500	2540	5430	5460	5450	5420	-	1700
Ba	ug/L	ICPMS	59	57	59	35	35	28	29	68	5
Be	ug/L	ICPMS	7.6	6.3	6.9	3.5	3.6	2	2.4	3	1.3
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.3	< 0.01
Ca	mg/L	ICPAES	4.74	4.78	4.76	4.02	4.02	4.08	4.09	-	3.05
Ca	mg/L	ICPMS	-	-	-	-	-	-	-	6.9	-
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02
Ce	ug/L	ICPMS	36	35	35	9.1	9	7.4	7.3	22	0.01
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	<0.02
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	<1	<1	<10	<1
Cs	ug/L	ICPMS	81	82	81	300	300	240	230	160	170
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<0.5
Dy	ug/L	ICPMS	6.8	6.6	6.6	1	1	0.87	0.87	4.6	< 0.005
Er	ug/L	ICPMS	3.5	3.6	3.6	0.55	0.57	0.49	0.52	2.4	< 0.005
Eu	ug/L	ICPMS	0.17	0.18	0.17	0.04	0.03	0.03	0.03	0.4	< 0.005
Fe	ug/L	ICPMS	1800	1900	1900	750	750	590	590	7600	<30
Ga	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.3	0.2	0.2	0.2	5	11
Gd	ug/L	ICPMS	5.4	5.6	5.6	0.84	0.94	0.81	0.78	4.1	< 0.005
Ge	ug/L	ICPMS	9.6	11	11	25	25	22	22	18	17
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	1.4	1.3	1.3	0.2	0.21	0.18	0.18	0.87	< 0.005
In	ug/L	ICPMS	-	-	-	-	-	-	-	< 0.1	-
K	mg/L	ICPAES	52	51.7	51.6	45.8	45.7	45.5	45.8	-	34.8
K	ug/L	ICPMS	-	-	-	-	-	-	-	41000	-
La	ug/L	ICPMS	10	10	10	4.4	4.5	3.6	3.6	9	< 0.01
Li	ug/L	ICPMS	1100	1000	1100	6200	6400	3700	3800	1600	2800
Mg	mg/L	ICPAES	0.504	0.495	0.493	0.316	0.316	0.323	0.316	-	0.104
Mg	mg/L	ICPMS	-	-	-	-	-	-	-	0.9	-
Mn	ug/L	ICPMS	220	230	220	160	160	130	130	110	28
Mo	ug/L	ICPMS	5.9	6.1	6.4	32	33	25	26	18	54
Na	mg/L	ICPAES	172	159	159	224	227	217	212	-	198
Na	mg/L	ICPMS	-	-	-	-	-	-	-	150	-
Nb	ug/L	ICPMS	0.2	< 0.02	< 0.02	0.08	0.08	< 0.02	< 0.02	-	0.3
Nd	ug/L	ICPMS	18	18	18	3.9	4	3.3	3.3	17	< 0.01
Ni	ug/L	ICPMS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2	<0.1
P	ug/L	ICPMS	2	< 2	< 2	17	15	3	2	< 30	< 2
Pb	ug/L	ICPMS	<0.05	0.06	<0.05	0.52	0.5	0.4	0.5	3	<0.05
Pr	ug/L	ICPMS	4.2	4.2	4.3	1	1.1	0.88	0.87	3.8	< 0.01
Rb	ug/L	ICPMS	340	400	390	390	390	350	360	230	280
Re	ug/L	ICPMS	-	-	-	-	-	-	-	< 0.2	-
Sb	ug/L	ICPMS	0.79	0.74	0.64	5.6	6	3.1	12	25	23
Sc	ug/L	ICPMS	< 0.1	1	2	< 0.1	< 0.1	0.2	< 0.1	-	2
Se	ug/L	ICPMS	1.6	1.3	1.6	4.7	4.5	4.2	4.1	< 2	2.5
SiO_2	mg/L	ICPMS	260	260	250	470	480	330	330	290	230
Sm	ug/L	ICPMS	5.1	5	5.1	0.84	0.88	0.78	0.76	5	< 0.01
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	6.8	7.9	7.8	13	13	12	12	17	22
Ta	ug/L	ICPMS	0.21	< 0.03	< 0.03	0.05	0.05	< 0.03	< 0.03	-	0.52
Tb	ug/L	ICPMS	1	1	1	0.16	0.16	0.14	0.14	0.73	< 0.005
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	0.6	0.58	0.71	< 0.02	< 0.02	0.05	0.04	1.3	< 0.02
Ti	ug/L	ICPMS	2.6	3	2	2.1	2.3	2	2	-	3.5
Tl	ug/L	ICPMS	0.51	0.5	0.52	0.58	0.58	0.51	0.52	<0.5	0.4
Tm	ug/L	ICPMS	0.51	0.5	0.5	0.087	0.083	0.062	0.073	0.3	< 0.005
U	ug/L	ICPMS	2.2	2.2	2.3	0.13	0.14	0.13	0.12	0.8	0.008
V	ug/L	ICPMS	<0.2	0.2	0.2	1.4	1.4	1	1	4	3
W	ug/L	ICPMS	2.2	6.8	5.8	50	50	36	40	39	97
Y	ug/L	ICPMS	34	38	38	6.6	6.6	5.9	6	21	< 0.01
Yb	ug/L	ICPMS	2.9	2.8	2.8	0.51	0.5	0.4	0.39	2.1	< 0.01
Zn	ug/L	ICPMS	20	20	20	10	10	9	9	40	<0.5
Zr	ug/L	ICPMS	< 0.2	< 0.2	< 0.2	0.86	< 0.2	< 0.2	< 0.2	-	< 0.2
Hg	ng/L	Hg CVAF	8	-	-	7	80	-	-	160	62
$\delta^{18}O$ vs VSMOW	permil	ISO1	-	-16.87	-	-11.59	-	-11.93	-	-9.2	-16.1
δD vs VSMOW	permil	ISO2	-	-	-	-	-	-	-	-117.4	-138.7
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no.			YNP-99-454	YNP-99-461	YNP-99-462	YNP-99-463	YNP-99-478	YNP-99-501	YNP-99-502	YNP-99-502R	YNP-00-517.1	YNP-01-538.1
Sample name & description			Heart Lake/fissure geyser area	Heart Lake/Rustic geyser area	Heart Lake/Rustic geyser area	Heart Lake/upper geyser area	Imperial Geyser, at Twin Buttes	Boiling River	Beryl Springs	Beryl Springs	Beryl Springs	Lower acid sulfate area near Beryl Springs
Latitude			44°17'22.2"N	44°16'54"N	44°16'55.5"N	44°18'36.9"N	44°31'54.2"N	45°0'0.2"N	44°40'45"N	44°40'45"N	44°40'45"N	44°40'39.5"N
Longitude			110°30'35"W	110°30'20"W	110°30'22"W	110°31'52.1"	110°52'19.4"W	110°40'57.2"	110°44'46"W	110°44'46"W	110°44'46"W	110°44'48.1"W
Collection Date			07/22/99	07/25/99	07/25/99	07/25/99	08/13/99	-	-	-	08/12/00	7/5/2001
Temperature	°C		88.0	88.0	92.0	94.0	90.0	-	-	-	89.4	84
pH			9.9	4.6	9.2	2.1	8.8	-	-	-	6.8	1.6
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	360	310	310	4	180	150	540	-	530	400
F	mg/L	IC-Aq	35	23	31	0.2	24	3.4	19	-	17	12
NO_3	mg/L	IC-Aq	<.35	<.35	1.2	0.5	<.35	1.8	<.35	-	<.08	<.18
SO_4	mg/L	IC-Aq	170	140	140	150	16	520	65	-	65	130
Ag	ug/L	ICPMS	0.06	<0.01	<0.01	<0.01	0.58	<0.08	<0.08	<0.08	0.03	0.07
Al	ug/L	ICPMS	260	260	150	2900	160	3	210	200	220	34000
As	ug/L	ICPMS	1600	1400	1400	12	1000	630	2500	2400	2000	12
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	4170	3610	3490	48.3	-	-	-	-	-	-
Ba	ug/L	ICPMS	2	0.6	2	51	<0.06	50	2.6	2.5	2	39
Be	ug/L	ICPMS	4.2	5.1	3.8	0.6	2.3	0.8	3.9	4.6	9.7	3.7
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	-	< 600	< 600	< 600	< 0.01	< 0.03
Ca	mg/L	ICPAES	0.941	0.898	1.08	0.487	-	-	-	-	-	-
Ca	mg/L	ICPMS	-	-	-	-	-	260	4.1	3.8	3.7	5.2
Cd	ug/L	ICPMS	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	0.2
Ce	ug/L	ICPMS	0.02	0.01	0.02	8.9	< 0.02	0.02	0.06	0.06	0.02	140
Co	ug/L	ICPMS	<0.02	<0.02	<0.02	0.09	<0.02	<0.02	<0.02	<0.02	<0.02	0.4
Cr	ug/L	ICPMS	<1	<1	<1	<1	30	2	<1	<1	<1	2
Cs	ug/L	ICPMS	370	370	180	3.6		160	420	410	440	4.8
Cu	ug/L	ICPMS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	9
Dy	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.75	< 0.007	< 0.005	0.01	0.006	< 0.005	9.9
Er	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.43	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	5.2
Eu	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.079	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.77
Fe	ug/L	ICPMS	<30	<30	<30	420	<30	<9	<9	<9	8.5	3600
Ga	ug/L	ICPMS	23	18	15	0.3	-	< 0.02	14	13	17	1
Gd	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.76	< 0.006	< 0.005	0.008	0.008	0.006	10
Ge	ug/L	ICPMS	42	39	37	0.2	-	3.9	26	26	50	0.8
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.16	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	1.9
In	ug/L	ICPMS	-	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05
K	mg/L	ICPAES	27.7	16.2	9.11	3.15	-	-	-	-	-	-
K	ug/L	ICPMS	-	-	-	-	-	58000	21000	20000	19000	32000
La	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	3.7	< 0.01	0.01	0.03	0.03	0.03	55
Li	ug/L	ICPMS	6400	6400	6200	13	2600	1600	6700	6600	6700	31
Mg	mg/L	ICPAES	<0.1	<0.1	<0.1	0.116	-	-	-	-	-	-
Mg	mg/L	ICPMS	-	-	-	-	-	63	0.06	0.05	<0.01	0.57
Mn	ug/L	ICPMS	0.27	0.91	0.27	11	2.6	27	25	24	18	170
Mo	ug/L	ICPMS	100	96	94	2.1	23	< 0.4	120	110	120	1.4
Na	mg/L	ICPAES	400	372	368	2.13	-	-	-	-	-	-
Na	mg/L	ICPMS	-	-	-	-	-	120	>200	>200	>300	26
Nb	ug/L	ICPMS	0.7	0.5	0.4	< 0.02	-	-	-	-	-	-
Nd	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	4.7	< 0.02	< 0.01	0.02	0.03	0.01	57
Ni	ug/L	ICPMS	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	3.4
P	ug/L	ICPMS	< 2	< 2	< 2	< 2	24	< 10	< 10	< 10	< 5	66
Pb	ug/L	ICPMS	<0.05	<0.05	<0.05	0.4	<0.05	0.2	0.2	<0.1	<0.05	5.5
Pr	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	1.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	16
Rb	ug/L	ICPMS	340	200	110	13	100	300	300	280	310	160
Re	ug/L	ICPMS	-	-	-	-	-	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	48	59	48	0.73	24	<0.2	72	69	79	0.66
Sc	ug/L	ICPMS	2	0.8	0.8	0.3	-	-	-	-	-	-
Se	ug/L	ICPMS	5.5	4.4	4.1	< 0.3	3	2	6.3	5.7	1.8	< 0.2
SiO_2	mg/L	ICPMS	330	300	340	110	240	50	240	230	250	290
Sm	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	0.9	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	12
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	13	24	3	3.5	< 0.09	1800	6.8	6.2	6.6	14
Ta	ug/L	ICPMS	1.1	0.75	0.64	< 0.03	-	-	-	-	-	-
Tb	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.12	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	1.6
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	0.07	-	0.01	0.02	0.044	0.1	32
Ti	ug/L	ICPMS	5.9	4.5	4.3	1	-	-	-	-	-	-
Tl	ug/L	ICPMS	0.52	0.3	0.1	0.06	0.08	0.1	0.2	0.1	0.1	0.5
Tm	ug/L	ICPMS	< 0.005	< 0.005	< 0.005	0.056	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.68
U	ug/L	ICPMS	0.01	0.04	0.05	0.37	0.1	0.07	0.006	< 0.005	< 0.005	2.3
V	ug/L	ICPMS	2	2	2	<0.1	1.3	0.84	3.4	2.3	<0.2	0.2
W	ug/L	ICPMS	280	260	250	12	260	10	140	140	160	1.7
Y	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	3.7	-	0.07	0.05	0.04	0.04	48
Yb	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	0.38	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	4
Zn	ug/L	ICPMS	<0.5	<0.5	<0.5	8	<0.5	1	1	0.7	<0.5	120
Zr	ug/L	ICPMS	0.4	< 0.2	< 0.2	< 0.2	-	-	-	-	-	-
Hg	ng/L	Hg CVAF	49	51	45	16	27	<5	23	-	0.026	170
$\delta^{18}O$ vs VSMOW	permil	ISO1	-17.0	-16.4	-16.8	-14.0	-17.7	-18.9	-15.2	-	-14.7	-5.5
δD vs VSMOW	permil	ISO2	-141.5	-142.4	-140.9	-123	-143.8	-	-140.3	-	-140.2	-112.6
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. Sample name & description			YNP-99-503 Monument Geyser Basin	YNP-00-495.1 Monument hot pool	YNP-00-495.2 Monument hot pool	YNP-00-495.4 Monument Geyser Basin	YNP-00-498.1 Monument hot pool	YNP-00-498.2 Monument hot pool	YNP-00-498.3 Monument hot pool	YNP-00-498.4 Monument hot pool	YNP-00-498.5 Monument hot pool
Latitude			44°41'4"N	44°40'59.5"N	44°41'0.9"N	44°41'0.9"N	44°41'5"N	44°41'5.5"N	44°41'5"N	44°41'5"N	44°41'8.5"N
Longitude			110°45'10"W	110°45'8"W	110°45'8.5"W	110°45'8.5"W	110°45'10.5"W	110°45'7"W	110°45'10.5"W	110°45'10.5"W	110°45'8"W
Collection Date			-	07/01/00	07/01/00	10/08/00	07/10/00	07/10/00	07/10/00	07/10/00	07/10/00
Temperature	˚C		-	88.5	88.4	90.6	83.7	23.4	88.7	87.7	21.9
pH			-	1.1	1.3	-	1.1	1.2	1.8	2.5	2.3
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	360	1	0.5	-	<.08	2	2.9	310	110
F	mg/L	IC-Aq	13	0.7	0.2	-	0.4	0.3	0.2	6.1	2.1
NO_3	mg/L	IC-Aq	<.35	<.08	<.08	-	<.08	<.08	0.2	<.08	0.2
SO_4	mg/L	IC-Aq	280	750	300	-	2700	630	1000	310	610
Ag	ug/L	ICPMS	<0.08	<0.01	<0.01	0.2	<0.01	<0.01	<0.01	0.03	0.01
Al	ug/L	ICPMS	5500	19000	3900	39000	86000	20000	11000	5500	12000
As	ug/L	ICPMS	1700	10	5.4	31	18	130	140	1000	800
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	88	65	89	28	110	69	85	82	59
Be	ug/L	ICPMS	3.8	0.67	0.67	2.8	2.8	2.7	1.8	1.4	2.1
Bi	ug/L	ICPMS	< 600	< 0.01	< 0.01	0.06	0.04	0.1	0.087	< 0.01	< 0.01
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	1.7	1.1	0.77	3	2.3	1.7	0.61	1.4	1.2
Cd	ug/L	ICPMS	<0.02	0.08	<0.02	0.2	0.06	0.06	<0.02	<0.02	0.03
Ce	ug/L	ICPMS	4.7	24	9	28	67	53	19	7.2	15
Co	ug/L	ICPMS	0.05	0.1	0.1	0.4	0.4	0.3	0.4	0.06	0.08
Cr	ug/L	ICPMS	<1	<1	<1	10	5	<1	<1	<1	<1
Cs	ug/L	ICPMS	260	2.4	2.6	16	4.9	12	18	190	120
Cu	ug/L	ICPMS	<0.5	2	0.6	6	3	1	1	<0.5	1
Dy	ug/L	ICPMS	0.28	1.2	0.54	1.5	3.4	3.8	0.84	0.39	0.78
Er	ug/L	ICPMS	0.15	0.68	0.29	0.69	2	1.8	0.5	0.2	0.4
Eu	ug/L	ICPMS	0.081	0.29	0.094	0.59	1.1	0.56	0.28	0.1	0.27
Fe	ug/L	ICPMS	910	1300	720	1800	5600	4600	1100	1000	1400
Ga	ug/L	ICPMS	1.2	1.8	1.4	14	45	4	12	0.68	3.8
Gd	ug/L	ICPMS	0.23	1.1	0.54	1.6	3.2	3.6	0.72	0.37	0.7
Ge	ug/L	ICPMS	16	0.4	0.3	1.9	1.2	1	1.7	21	11
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	0.056	0.19	0.084	0.26	0.56	0.56	0.14	0.06	0.12
In	ug/L	ICPMS	< 0.01	0.26	0.01	0.22	0.24	0.07	0.04	< 0.01	0.01
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	43000	13000	6800	20000	36000	17000	7000	29000	19000
La	ug/L	ICPMS	2.7	15	5.8	17	45	31	15	3.8	9.9
Li	ug/L	ICPMS	4500	2.8	7.3	9.4	14	19	27	3500	1300
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	0.08	0.13	0.14	0.38	0.37	0.3	0.07	0.1	0.11
Mn	ug/L	ICPMS	19	18	15	48	42	39	9.5	14	19
Mo	ug/L	ICPMS	99	0.2	0.5	7.6	0.51	4.4	68	32	14
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	>200	6.4	3.8	12	19	12	3.6	190	77
Nb	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Nd	ug/L	ICPMS	1.8	9.3	3.9	12	25	25	5.7	3	5.5
Ni	ug/L	ICPMS	0.2	0.3	0.2	3.9	1.2	0.8	0.6	0.1	0.4
P	ug/L	ICPMS	< 10	2200	< 5	51	140	5	8	< 5	< 5
Pb	ug/L	ICPMS	1.6	8.5	2.9	26	31	6.4	32	1	4
Pr	ug/L	ICPMS	0.54	2.4	0.97	3.5	7.1	6.2	1.6	0.74	1.6
Rb	ug/L	ICPMS	380	45	36	69	140	100	30	300	180
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	ug/L	ICPMS	38	0.3	1.9	7.3	1.3	11	42	26	29
Sc	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Se	ug/L	ICPMS	4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
SiO_2	mg/L	ICPMS	210	200	150	290	220	220	190	240	260
Sm	ug/L	ICPMS	0.33	1.5	0.64	2.2	3.7	4.1	0.8	0.49	0.86
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	8.2	14	5.9	18	41	17	12	9.7	13
Ta	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Tb	ug/L	ICPMS	0.04	0.18	0.076	0.26	0.44	0.48	0.1	0.052	0.11
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	0.46	0.98	0.6	1.4	26	6	5.6	0.59	2.6
Ti	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Tl	ug/L	ICPMS	0.2	0.3	0.1	0.4	0.62	0.53	0.56	0.2	0.55
Tm	ug/L	ICPMS	0.02	0.099	0.04	0.093	0.27	0.22	0.067	0.03	0.04
U	ug/L	ICPMS	0.52	2	0.27	0.97	2.7	1.1	1.1	0.5	0.8
V	ug/L	ICPMS	1.8	1.9	<0.2	1	7.2	2.8	0.77	<0.2	0.4
W	ug/L	ICPMS	88	0.2	0.2	0.94	0.2	0.3	2.4	23	12
Y	ug/L	ICPMS	1.2	6	3.5	5.2	21	23	5.2	2.4	4.4
Yb	ug/L	ICPMS	0.1	0.75	0.26	0.59	1.7	1.5	0.41	0.2	0.3
Zn	ug/L	ICPMS	7	68	6	38	93	45	37	10	10
Zr	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Hg	ng/L	Hg CVAF	95	-	0.025	-	0.029	0.074	0.05	0.058	0.031
$\delta^{18}O$ vs VSMOW	permil	ISO1	-12.5	-11.1	-15.5	-9.6	-9.1	-13.1	-11.3	-12.1	-12.0
δD vs VSMOW	permil	ISO2	-56.3	-120.3	-134.4	-115	-114.8	-124.2	-119.8	-126.8	-118.8
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-

Appendix 4. Site and analytical data from subaerial hydrothermal features—*Continued*.

Field no. Sample name & description			YNP-00-516.1 spring, base of Monument trail	YNP-00-3518-14.1 vent, Monument	YNP-00-3518-17.1 vent, Monument	YNP-00-526.1 Monument, vent across river	YNP-00-527.1 Monument, vent across river	YNP-00-528.1 Monument, sulfur cauldron	YNP-00-528.5 Monument, sulfur cauldron	YNP-00-536.1 Artist's Paint Pots	YNP-01-543.1 Gibbon geyser basin
Latitude			44°41'2.5"N	44°41'8"N	44°41'7.5"N	44°41'1.2"N	44°40'58.2"N	44°41'3"N	44°41'3"N	44°41'33.9"N	44°42'0"N
Longitude			110°44'39"W	110°45'10.9"W	110°45'12.5"W	110°44'33.5"W	110°44'34.2"W	110°45'10.1"W	110°45'10.1"W	110°44'6.6"W	110°46'4.5"W
Collection Date			08/12/00	08/12/00	08/12/00	08/30/00	08/30/00	08/30/00	08/30/00	10/10/00	7/9/2001
Temperature	˚C		81.4	86.6	82.0	90.6	91.6	71.1	71.1	90.7	82.5
pH			7.2	-	1.6	6.1	6.7	1.1	1.1	7.3	6.1
Conductivity	uS/cm		-	-	-	-	-	-	-	-	-
Sum CO_2	mM		-	-	-	-	-	-	-	-	-
HCO_3	mM	measured	-	-	-	-	-	-	-	-	-
HCO_3	uM	calculated	-	-	-	-	-	-	-	-	-
Cl	mg/L	IC-Aq	550	26	2.4	2	2.2	<.08	-	6.2	530
F	mg/L	IC-Aq	18	1.5	0.2	1.2	4	0.7	-	0.3	18
NO_3	mg/L	IC-Aq	<.08	<.08	0.2	<.08	0.3	<.08	-	<.18	<.18
SO_4	mg/L	IC-Aq	53	2300	670	200	190	4000	-	870	170
Ag	ug/L	ICPMS	0.03	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	2	0.6
Al	ug/L	ICPMS	40	26000	10000	98	720	>200000	>200000	160	350
As	ug/L	ICPMS	2100	170	79	5.9	5.3	680	670	2100	3000
Au	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1
B	ug/L	ICPAES	-	-	-	-	-	-	-	-	-
Ba	ug/L	ICPMS	8	40	67	83	56	75	70	0.8	6
Be	ug/L	ICPMS	8	2.4	0.49	1.1	2.3	3.5	3.6	1	2
Bi	ug/L	ICPMS	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.1	0.097	< 0.3	< 0.3
Ca	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Ca	mg/L	ICPMS	3.2	0.69	0.66	18	9.9	5.9	6	6.6	6.6
Cd	ug/L	ICPMS	<0.02	0.07	0.03	<0.02	<0.02	0.3	0.3	<0.2	<0.2
Ce	ug/L	ICPMS	0.05	31	8.9	0.05	0.54	140	140	< 0.1	0.1
Co	ug/L	ICPMS	<0.02	0.08	0.1	<0.02	<0.02	1.6	1.6	<0.2	<0.2
Cr	ug/L	ICPMS	<1	<1	<1	<1	<1	11	12	<10	<10
Cs	ug/L	ICPMS	450	59	9.1	16	20	29	29	420	370
Cu	ug/L	ICPMS	<0.5	1	0.7	2	0.8	2	3	<5	<5
Dy	ug/L	ICPMS	0.03	1.2	0.35	0.02	0.056	5.7	5.6	< 0.05	< 0.05
Er	ug/L	ICPMS	0.01	0.59	0.22	0.01	0.02	3.3	3.2	< 0.05	< 0.05
Eu	ug/L	ICPMS	< 0.005	0.24	0.13	< 0.005	< 0.005	1.5	1.5	< 0.05	< 0.05
Fe	ug/L	ICPMS	71	730	740	26	110	30000	30000	61	90
Ga	ug/L	ICPMS	6.4	32	5.2	0.2	0.3	81	82	12	3
Gd	ug/L	ICPMS	0.02	1.1	0.37	0.006	0.04	5.3	5.2	< 0.05	< 0.05
Ge	ug/L	ICPMS	49	3.5	1.2	1.8	2	2.2	1.9	44	73
Hf	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Ho	ug/L	ICPMS	< 0.005	0.18	0.064	< 0.005	0.009	0.94	0.96	< 0.05	< 0.05
In	ug/L	ICPMS	< 0.01	0.04	0.01	< 0.01	< 0.01	0.99	1	< 0.1	< 0.1
K	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
K	ug/L	ICPMS	17000	11000	8300	49000	37000	80000	80000	16000	47000
La	ug/L	ICPMS	0.04	27	6.6	0.04	0.3	89	91	< 0.1	0.1
Li	ug/L	ICPMS	5800	270	18	120	130	34	34	4800	5800
Mg	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Mg	mg/L	ICPMS	0.1	0.06	0.11	0.77	0.24	1.3	1.3	0.2	0.2
Mn	ug/L	ICPMS	25	12	12	710	240	140	150	3.8	23
Mo	ug/L	ICPMS	100	4.7	2.1	0.3	0.87	4.5	4.3	86	170
Na	mg/L	ICPAES	-	-	-	-	-	-	-	-	-
Na	mg/L	ICPMS	>300	19	2.9	64	56	24	24	370	440
Nb	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Nd	ug/L	ICPMS	0.05	10	2.9	0.03	0.21	43	43	< 0.1	< 0.1
Ni	ug/L	ICPMS	<0.1	0.6	0.7	<0.1	<0.1	3.5	4.2	<1	<1
P	ug/L	ICPMS	< 5	44	< 5	7	< 5	460	470	< 30	< 30
Pb	ug/L	ICPMS	0.05	10	4.8	0.06	0.2	56	54	2	<0.5
Pr	ug/L	ICPMS	0.01	3	0.84	< 0.01	0.06	13	13	< 0.1	< 0.1
Rb	ug/L	ICPMS	270	59	24	350	260	270	270	230	460
Re	ug/L	ICPMS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.2	< 0.2
Sb	ug/L	ICPMS	130	48	7.7	0.4	0.4	1.3	1	120	42
Sc	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Se	ug/L	ICPMS	1.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	4	5
SiO_2	mg/L	ICPMS	200	260	140	150	190	160	160	180	480
Sm	ug/L	ICPMS	0.01	1.4	0.41	< 0.01	0.03	6.3	6.4	< 0.1	< 0.1
Sn	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Sr	ug/L	ICPMS	12	13	13	98	40	73	75	4	14
Ta	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Tb	ug/L	ICPMS	< 0.005	0.15	0.04	< 0.005	0.006	0.75	0.76	< 0.05	< 0.05
Te	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Th	ug/L	ICPMS	0.17	14	1	0.09	0.1	56	55	5.6	12
Ti	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Tl	ug/L	ICPMS	<0.05	0.4	0.2	<0.05	0.2	2.4	2.5	0.6	<0.5
Tm	ug/L	ICPMS	< 0.005	0.076	0.03	< 0.005	< 0.005	0.41	0.4	< 0.05	< 0.05
U	ug/L	ICPMS	0.02	1.5	0.28	0.007	0.005	4.1	4.1	0.06	< 0.05
V	ug/L	ICPMS	<0.2	0.98	0.84	<0.2	<0.2	20	20	1	<1
W	ug/L	ICPMS	190	2.8	0.78	0.81	0.69	0.4	0.3	110	160
Y	ug/L	ICPMS	0.2	6.4	2.4	0.2	0.3	36	37	< 0.1	< 0.1
Yb	ug/L	ICPMS	0.01	0.53	0.2	< 0.01	0.02	2.8	2.8	< 0.1	< 0.1
Zn	ug/L	ICPMS	<0.5	24	8	0.8	1	62	67	7	6
Zr	ug/L	ICPMS	-	-	-	-	-	-	-	-	-
Hg	ng/L	Hg CVAF	0.005	0.015	0.01	0.005	0.01	0.014	-	40	150
$\delta^{18}O$ vs VSMOW	permil	ISO1	-15.9	-11.7	-5.9	-16.1	-14.8	-5.0	-	-15.7	-10.2
δD vs VSMOW	permil	ISO2	-144.9	-119.0	-108.1	-138.8	-132.3	-105.9	-	-143.2	-123.7
$\delta^{34}S$ vs CDT	permil	ISO3	-	-	-	-	-	-	-	-	-