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Drainage from adits and tailings piles in the Coeur d'Alene Mining District, Idaho: Sampling, Analytical Methods, and Results

by

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ABSTRACT

This report contains information about collecting, handling, and analyzing waters draining from adits and seeping from beneath tailings piles in the Coeur d'Alene mining district during August 1996, November 1996, and June 1997. Data include temperature, pH, conductivity, dissolved oxygen, alkalinity, flow, and total acid soluble and dissolved (<0.45 μm) major and trace ion concentrations for 11 adits and 5 tailings deposits. Interpretations of these data will be discussed in other publications.

INTRODUCTION

Previous studies examining waters draining diverse types of ore deposits indicate a wide range in values of pH and concentrations and suites of elements (Ficklin and others, 1992; Plumlee and others, 1993, 1995; Kelley and Taylor, 1997). Understanding the key factors that influence the geochemistry of waters draining mineralized areas is critical for minimizing impacts on water quality during the development of new mines and in the remediation of past mining activities. Research in the Colorado Mineral Belt suggests that the primary factors influencing pH and compositions of such drainage are the geology and geochemistry of the ore deposits and their host rocks, the physical exposure of the deposits to weathering processes, and geochemical processes such as oxidation, dissolution, precipitation, and sorption (Plumlee and others, 1993).

Researchers from the U.S. Geological Survey are in the process of developing a comprehensive geochemical database for waters draining different types of ore deposits. The intent is to use this database to predict the effects of mineralized deposits on water quality (Plumlee and others, 1993). Our work to characterize the geochemistry of waters draining from adits and beneath tailings piles in the Coeur d'Alene mining district is part of that effort. Our other motivation is to provide unbiased information about point sources of metals to surface and groundwater in the district and to understand the fundamental processes controlling the composition of such drainage. This information is necessary for directing on-going and prioritizing future remediation activities in the basin.

STUDY AREA

The Coeur d'Alene mining district is located in the north central Bitterroot Range in northern Idaho and western Montana (fig. 1). Total production from this area indicates that this district ranks as one of the world's largest producers of silver (Ag) and one of the United States' major producers of lead (Pb) and zinc (Zn). Information about the geology and genesis of ore deposits in the Coeur d'Alene district is found in Fryklund (1964), Hobbs and others (1965), Bennett and Venkatakrishnan (1982), Reid (1984), Criss and Fleck (1987, 1990), Leach and others (1988), Bennett and others (1989), and Constantopoulos and Larson (1991). Ore deposits in this area are steeply dipping Pb-Zn-Ag veins in Precambrian rocks of the Belt Supergroup. These host rocks are primarily quartzite and argillite with lesser amounts of interbedded carbonate and carbonate bearing rocks. Most mineralization is localized in quartzite to argillite transition zones in the middle Pritchard, Pritchard-Burke, and Revett-St. Regis formations.

The principal economic minerals are galena (PbS), sphalerite (ZnS), and silver bearing tetrahedrite [$(Cu,Fe)_{12}Sb_4S_{13}$] (Fryklund, 1964). Most veins contain small amounts of chalcopyrite ($CuFeS_2$) and some veins contain low concentrations of pyrrhotite ($Fe_{(1-x)}S$), magnetite (Fe_3O_4), and arsenopyrite (FeAsS). Pyrite (FeS_2) is ubiquitous, but variable in abundance, in the veins. The most important gangue minerals are quartz (SiO_2) and siderite ($FeCO_3$).

Mining began in the Coeur d'Alene River basin in the late 1800's. Over ninety mines now exist in the district and most are located along the South Fork of the Coeur d'Alene River and its major tributaries including Canyon Creek, Ninemile Creek, and Pine Creek (Bennett and others, 1989) (fig. 1). The Sunshine, Lucky Friday, Coeur, and Galena mines are the only mines currently operating in the district.

Production records indicate that the relative amounts of Pb, Zn, Ag, and Cu vary among the deposits in the Coeur d'Alene mining district (Bookstrom and others, 1996). The maps of Fryklund (1964) show subtype deposits where veins are either Zn rich, Pb rich, contain about equal portions of Zn and Pb, or Cu rich. Although we designed our sampling program to collect drainage from different subtype deposits, we realize that categorizing deposits based on production records is not completely valid because distinctly different veins were mined at some deposits. For example, Bunker Hill mine has Bluebird veins that are predominately an assemblage of sphalerite-pyrite-siderite (Zn rich) and Link veins that mainly contain galena, argentiferous tetrahedrite, and quartz (Pb-Ag rich), while the Star-Morning mine has veins that are Zn rich (Star) and Pb rich (Morning). In addition, the labyrinth of tunnels in the mining district makes it difficult to clearly distinguish which mines are draining through a given adit. For example, Tamarack #7 adit may drain both the Tamarack-Custer and Standard Mammoth mines. These mines fall into different subtype deposits according to the Fryklund (1964) classification scheme.

Despite the above drawbacks, we use production records to categorize ore deposits in the Coeur d'Alene mining district into Zn rich, Pb-Zn rich, Pb rich, and Cu rich deposits. The locations of our adit sample sites and the production records and assigned subtype of the associated ore deposits are summarized in table 1. Two of the three Cu rich deposits (Crescent and Silver Summit) had significant production (~12%) of Ag and occur in an area designated as the Silver Belt. The locations of adit sample sites are shown in figure 1.

Early ore separation methods were not very efficient, especially for Zn. Thus, early jig tailings were highly enriched in Zn. Later development of more efficient flotation methods resulted in tailings with lower metal concentrations. Of the tailings piles whose drainage we sampled, one consists of jig tailings only (Success), two have jig tailings covered by flotation tailings (Bunker Hill and Interstate-Callahan), and one consists solely of flotation tailings (Rex). Most tailings were deposited directly into the Coeur d'Alene River and its tributaries prior to installation of settling ponds in the 1960's. Flood events subsequently have re-distributed metal enriched tailings throughout the channel of the South Fork and main stem of the Coeur d'Alene River and its floodplain. Our sample from the Osburn tailings emanates from a floodplain area covered by fluvially deposited jig tailings. The locations of sample sites for drainage from beneath tailings piles are indicated in table 1 and figure 1.

METHODS

Field methods: Water draining from adits and beneath tailings piles in the Coeur d'Alene mining district was collected during August and November 1996 and June 1997. The August and November samples were collected when regional stream flow and flow from adits and tailings piles were low. The June samples were obtained after peak runoff when regional stream flow and flow from adits and tailings piles were high. Drainage from adits generally was sampled within 30 feet of the mine portal. Drainage from tailings piles was sampled within a few feet of the seep source and either at the base or just down gradient of the base of the pile.

Strict protocols were followed during sampling and handling of waters to ensure quality and comparison of data collected for widely spaced time intervals. Measurements of temperature, pH, conductivity, dissolved oxygen, and estimates of flow were made upon arrival at each site. Temperature was measured either with a mercury thermometer or a conductivity-temperature probe. Values of pH were determined with an Orion field meter and electrode calibrated with standard pH 1.68, 3, 4, 6, 7, and 10 buffers. Conductivity was determined with an Orion field conductivity meter and electrode after calibrating with a conductivity standard (0.01 M KCl) at the in-situ temperature of the sample. Oxygen was determined qualitatively with a Chemetrics dissolved oxygen kit. Flow was estimated semi-quantitatively using a bucket and stopwatch, timing a float for a given distance and measuring the cross section of the stream, or inserting a calibrated flume. A 1 L water sample was then collected after rinsing the bottle three times with sample. This sample was stored in the dark except during sub-sampling. The bottle was shaken to ensure mixing of the water before taking any aliquots. Aliquots for total acid soluble metals were poured from the 1 L bottle into acid cleaned high density polyethylene (HDPE) bottles. Aliquots for total acid soluble Hg were poured from the 1 L bottle into 60 mL glass bottles. Before dissolved sub-samples were taken, 0.45 μm nylon disposable filters were rinsed using 20 mL of sample. Aliquots for dissolved Fe(II), metals including Hg, anions (F^-, Cl^- and SO_4^{2-}), and alkalinity then were taken from the 1 L bottle using 60 mL syringes and filtered through rinsed filters into unwashed amber high density polyethylene (HDPE) bottles for Fe(II), acid cleaned HDPE bottles for metals, 60 mL glass bottles for Hg, or unwashed HDPE bottles for anions and alkalinity. Samples for Fe(II) immediately were preserved with 5 drops of redistilled concentrated hydrochloric acid (HCl) per 30 mL of sample. Samples for Hg were preserved by adding 6 drops of redistilled concentrated HCl per 60 mL of sample. Samples for metals were preserved by adding 6 drops of redistilled concentrated nitric acid (HNO_3) per 60 mL of sample. Anion samples were kept cold in an ice chest during transport to the laboratory. Alkalinity was determined in the field by Gran titration (Stumm and Morgan, 1996) using 1 mM HCl standardized with known concentrations of carbonate solutions. Protocols for sampling metals, Hg, anions, and alkalinity are summarized in table 2.

Laboratory methods: Ferrous Fe [Fe(II)] and major and trace ions were determined after returning to the laboratory. Ferrous Fe was determined within one week of sampling by colorimetry using the Ferrozine method (Stookey, 1976). The limit of detection for Fe(II) by this method was 60 μg/L. Potassium and Na concentrations were determined by flame atomic absorption spectrometry (FAAS). Calcium and Mg concentrations were determined by inductively coupled plasma - atomic emission spectrometry (ICP-AES). The remaining metal and metalloid (Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Fe, Hg, K, La, Mn, Mo, Ni, Pb, Rb, Sb, Sr, Tl, U, and Zn) concentrations were determined by inductively coupled plasma - mass spectrometry (ICP-MS). Protocols for laboratory methods are summarized in table 3. Limits of detection for the elements done by FAAS, ICP-AES, and ICP-MS are summarized in table 4. Ion chromatography was used to determine concentrations of anions. Reference standards from USGS (M100, M130, T-135, T-137, and AMW-2) and acid and filtering blanks were analyzed with each batch of samples.

RESULTS

The analytical results for waters from adits and tailings piles are summarized in tables 5-7. The data for adits are organized by deposit subtype and date of collection. The data from tailings seeps follows the adit data. Discussions about the geochemical processes that determine the composition of these waters will be presented in other publications.

QUALITY CONTROL

The analytical results for the USGS reference standards (M100, M130, T-135, T-137, and AMW-2) are summarized in tables 8 and 9. Agreement between concentrations in reference standards and accepted values generally was excellent, except for Fe in T-137 and AMW-2. The measured values were lower than the accepted values. The observation for AMW-2 is consistent with the reddish brown coating, probably precipitated Fe oxide, on the inside of the AMW-2 bottle. There is no obvious explanation for the measured low Fe values in T-137.

The analytical results for acid and filtering blanks indicated that all elements were below the limits of detection.

Duplicate samples from Interstate-Callahan #4 adit in August 1996 (samples A and B) and triplicate samples from Success #3 adit in June 1997 (samples A-C) indicated that variations in concentrations are less than 5% for almost all metals (tables 6 and 7). The notable exceptions are variations in low concentrations of Cd and Cu in waters from the Interstate-Callahan adit.

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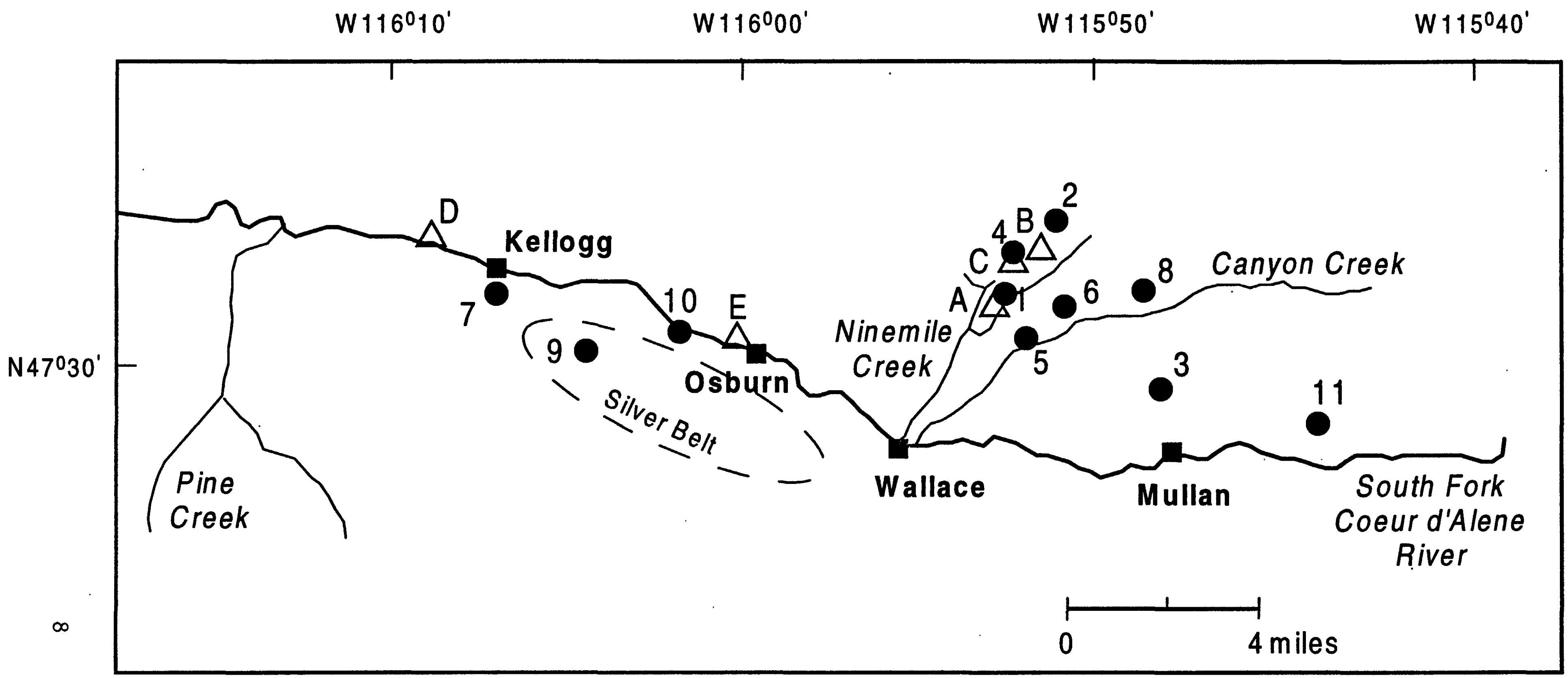

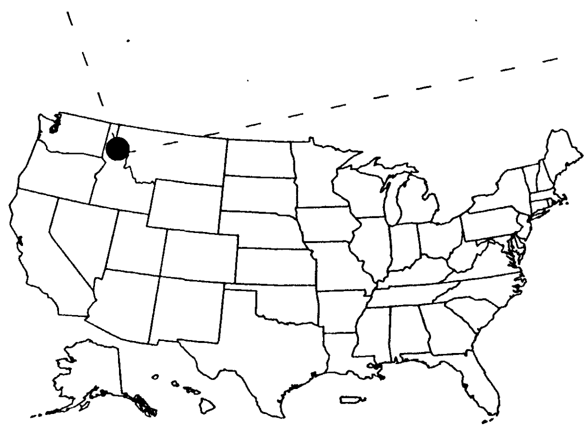

ADITS (●)

1. Success #3
2. Interstate-Callahan #4
3. Morning #5
4. Rex #2
5. Gem #3
6. Tamarack #7
7. Kellogg Tunnel
8. Hercules #5
9. Hooper Tunnel
10. Silver Dollar
11. Snowstorm #3

TAILINGS PILES (△)

A. Success
B. Interstate-Callahan
C. Rex
D. Bunker Hill
E. Osburn Flats

Figure 1. Maps indicating the location of the Coeur d'Alene mining district and locations of our sample sites.

Table 1. Categorization of ore deposits and locations of sample sites in the Coeur d'Alene mining district. n.m. = not measured

Ore Deposit	production % Zn	production % Pb	production % Ag	production % Cu	deposit subtype from production	stratigraphy	Adits	Latitude North	Longitude West	Elevation (m)
Success	77	23	0	0	Zn rich	Pritchard-Burke	Success #3	47^{0} 31' 37.51"	115^{0} 52' 35.40"	1132
Interstate-Callahan	76	24	0	0	Zn rich	middle Pritchard	Interstate-Callahan #4	47^{0} 32' 46.97"	115^{0} 51' 05.72"	1362
Star-Morning	49	51	0.1	0.1	Pb-Zn rich	Revett-St. Regis	Morning #5	47^{0} 29' 35.20"	115^{0} 48' 10.62"	1260
Rex	47	53	0.1	0.2	Pb-Zn rich	middle Pritchard	Rex #2	47^{0} 32' 10.02"	115^{0} 52' 18.88"	1255
Helena-Frisco	45	55	0.1	0.2	Pb-Zn rich	Pritchard-Burke	Gem #3	47^{0} 30' 31.46"	115^{0} 51' 56.77"	983
Tamarack-Custer	31	68	0.1	0.4	Pb rich	Pritchard-Burke	Tamarack #7	47^{0} 31' 07.93"	115^{0} 50' 51.88"	1044
Bunker Hill	31	69	0.1	0.3	Pb rich	Revett-St. Regis	Kellogg Tunnel	n.m.	n.m.	n.m.
Hercules	1	98	0.3	0.5	Pb rich	Pritchard-Burke	Hercules #5	47^{0} 31' 25.30"	115^{0} 48' 39.30"	1164
Crescent	5	25	13	57	Cu rich	Revett-St. Regis	Hooper Tunnel	47^{0} 30' 18.26"	116^{0} 04' 23.28"	806
Silver Summit	1	1	12	86	Cu rich	Revett-St. Regis	Silver Dollar	47^{0} 30' 41.22"	116^{0} 01' 45.93"	752
Snowstorm	0	0	0.5	99	Cu rich	Revett-St. Regis	Snowstorm #3	47^{0} 28' 53.47"	115^{0} 43' 43.13"	1375
							Tailings piles	**Latitude** North	**Longitude** West	**Elevation (m)**
							Success - upper seep	47^{0} 31' 29.05"	115^{0} 52' 49.20"	1311
							Success - lower seep	47^{0} 31' 28.09"	115^{0} 52' 50.91"	1311
							Interstate-Callahan seep	47^{0} 32' 16.49"	115^{0} 51' 30.96"	1270
							Rex seep	47^{0} 32' 01.33"	115^{0} 52' 20.40"	1273
							Bunker Hill - upper seep	47^{0} 32' 55.55"	116^{0} 08' 40.32"	692
							Bunker Hill - lower seep	47^{0} 32' 55.74"	116^{0} 08' 47.32"	685
							Osburn Flats seep	47^{0} 30' 36.72"	116^{0} 00' 06.35"	761

Production records from Bookstrom and others (1996)
Adit names from Hobbs and others (1965)

Table 2. Protocols for sampling metals, Hg, anions, and alkalinity.

Constituent	Container	Filter	Preservation
Total[1] metals	60 mL HDPE[2] bottle	none	6 drops concentrated HNO_3/60 mL of sample
Total Hg	60 mL glass bottle	none	6 drops concentrated HCl/60 mL of sample
Dissolved Fe(II)	30 mL amber HDPE bottle	0.45 μm Nylon	5 drops concentrated HCl/30 mL of sample
Dissolved metals	60 mL HDPE bottle	0.45 μm Nylon	6 drops concentrated HNO_3/60 mL of sample
Dissolved Hg	60 mL glass bottle	0.45 μm Nylon	6 drops concentrated HCl/60 mL of sample
Dissolved anions	30 mL HDPE bottle	0.45 μm Nylon	refrigerate
Alkalinity	30 mL HDPE bottle	0.45 μm Nylon	refrigerate

[1] Total acid soluble; pH < 2
[2] High Density Polyethylene

Table 3. Protocols for laboratory methods..

Constituent	Method
Fe(II)	Colorimetry – Ferrozine method (Stookey, 1976)
Na, K	Flame Atomic Absorption Spectrometry (FAAS)
Ca, Mg	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)
Metals[1]	Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)
Alkalinity	Titration with 1 mM HCl and Gran Plot (Stumm and Morgan, 1996)
Anions[2]	Ion Chromatography

[1] Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Fe, Hg, K, La, Mn, Mo, Ni, Pb, Rb, Sb, Sr, Tl, U, and Zn
[2] Cl, F, SO_4

Table 4. Limits of Detection (LOD) for elements analyzed by flame atomic absorption (K, Na), inductively coupled plasma-atomic emission spectrometry (Ca, Mg) and inductively coupled plasma-mass spectrometry (remaining elements). LOD = 3 times the standard deviation of 10 blank readings.

Symbol	Element	LOD	Units
Ag	Silver	0.01	$\mu g\ L^{-1}$
Al	Aluminum	0.03	$\mu g\ L^{-1}$
As	Arsenic	0.1	$\mu g\ L^{-1}$
Ba	Barium	0.01	$\mu g\ L^{-1}$
Be	Beryllium	0.1	$\mu g\ L^{-1}$
Bi	Bismuth	0.005	$\mu g\ L^{-1}$
Ca	Calcium	0.01	$mg\ L^{-1}$
Cd	Cadmium	0.01	$\mu g\ L^{-1}$
Ce	Cerium	0.005	$\mu g\ L^{-1}$
Co	Cobalt	0.01	$\mu g\ L^{-1}$
Cr	Chromium	0.05	$\mu g\ L^{-1}$
Cs	Cesium	0.005	$\mu g\ L^{-1}$
Cu	Copper	0.02	$\mu g\ L^{-1}$
Fe	Iron	10	$\mu g\ L^{-1}$
Hg	Mercury	0.05	$\mu g\ L^{-1}$
K	Potassium	0.005	$mg\ L^{-1}$
La	Lanthanum	0.005	$\mu g\ L^{-1}$
Mg	Magnesium	0.01	$mg\ L^{-1}$
Mn	Manganese	0.01	$\mu g\ L^{-1}$
Mo	Molybdenum	0.02	$\mu g\ L^{-1}$
Na	Sodium	0.001	$mg\ L^{-1}$
Ni	Nickel	0.05	$\mu g\ L^{-1}$
Pb	Lead	0.01	$\mu g\ L^{-1}$
Rb	Rubidium	0.01	$\mu g\ L^{-1}$
Sb	Antimony	0.01	$\mu g\ L^{-1}$
Sr	Strontium	0.005	$\mu g\ L^{-1}$
Tl	Thallium	0.002	$\mu g\ L^{-1}$
U	Uranium	0.001	$\mu g\ L^{-1}$
Zn	Zinc	0.05	$\mu g\ L^{-1}$

Table 5. Temperature (Temp.), pH, conductivity (Cond.), dissolved oxygen (O_2), alkalinity (Alk.), flow, and dissolved (<0.45 µm) concentrations of anions (Cl, F, SO_4) in waters draining adits and tailings piles in the Coeur d'Alene mining district. Flow measurements are very qualitative. n.m. = not measured.

Site Name	Temp. ^0C	pH	Cond. µS cm^{-1}	O_2 mg L^{-1}	Alk. meq L^{-1}	Flow L min^{-1}	Cl mg L^{-1}	F mg L^{-1}	SO_4 mg L^{-1}
Adits									
Zn rich deposits									
Success #3 (8/96)	6	6.89	578	7	1.86	15 to 20	0.9	n.m.	240
Success #3 (A) (6/97)	4.6	7.31	542	7	1.55	60	0.5	0.6	230
Success #3 (B) (6/97)	4.6	7.33	538	4.5	1.4	60	0.5	0.7	230
Success #3 (C) (6/97)	4.7	7.39	535	6.5	1.5	60	0.5	0.6	240
Interstate-Callahan #4 (A) (8/96)	8	7.38	204	7	1.63	80 to 120	0.4	n.m.	27
Interstate-Callahan #4 (B) (8/96)	8	7.28	204	5.5	1.74	120	0.4	n.m.	27
Interstate-Callahan #4 (6/97)	5.8	7.5	158	2	1.3	230	0.3	0.1	20
Pb-Zn rich deposits									
Morning #5 (8/96)	11	7.03	381	7	1.67	110	0.7	n.m.	130
Morning #5 (6/97)	9.5	7.57	363	6.5	1.18	150	0.3	0.2	140
Rex #2 (8/96)	7	7.1	150	6	0.69	12 to 20	0.4	n.m.	42
Rex #2 (6/97)	5.3	7.29	119	6	0.5	30	0.3	0.5	32
Gem #3 (8/96)	17	6.98	376	8	2.32	n.m.	1	n.m.	92
Gem #3 (6/97)	10.6	7.1	375	7	2.1	1700	0.7	0.2	99
Pb rich deposits									
Tamarack #7 (8/96)	13	7.51	205	8	1.81	n.m.	0.4	n.m.	22
Tamarack #7 (6/97)	10.6	7.5	216	5.5	1.59	3400	0.3	0.1	39
Kellogg Tunnel (6/97)	14.9	2.72	4140	>2.5	0	1700 to 3400*	4.8	1.7	4200
Hercules #5 (8/96)	13	7.75	221	6	2.45	4400	0.4	n.m.	25
Hercules #5 (6/97)	10.4	7.58	220	5.5	1.58	5100	0.3	0.1	39
Cu rich deposits									
Hooper Tunnel (8/96)	13	6.64	501	6	1.32	60	0.5	n.m.	210
Hooper Tunnel (6/97)	10.5	7.15	377	6	0.89	140	0.4	0.2	170
Silver Dollar (8/96)	18	7.63	370	7	3.62	15 to 25	0.9	n.m.	39
Silver Dollar (6/97)	14.3	7.72	374	5.5	3.68	40	0.6	0.2	35
Snowstorm #3 (6/97)	5.5	6.97	26	4	0.3	20400	0.1	<0.08	4.3
Tailings piles									
Success - upper seep (11/96)	3	4.85	157	6	0.1	17	1	0.2	68
Success - upper seep (6/97)	5.8	7.13	56	6	0.33	5	0.3	0.6	15
Success - lower seep (11/96)	5	6.11	184	4	0.24	3	0.4	0.2	85
Success - lower seep (6/97)	6.1	6.29	120	7	0.23	75	0.3	0.5	49
Interstate-Callahan seep (11/96)	5	4.8	679	>2.5	0.1	2 to 5	0.5	0.4	490
Interstate-Callahan seep (6/97)	6.5	4.6	674	7	0.09	12	0.7	0.2	410
Rex seep (11/96)	7	6.17	368	7	0.65	38	0.5	0.2	170
Rex seep (6/97)	5.5	6.66	450	9	0.84	95	0.4	0.2	190
Bunker Hill - upper seep (11/96)	5	5.69	783	3.5	0.53	110 to 190	2	1	440
Bunker Hill - lower seep (11/96)	8	6.05	639	5	0.73	2900	2	1	330
Osburn Flats seep (6/97)	7.7	6.62	201	1.5	1.04	100	1.8	0.1	56

*measured during sample collection. Average flow during 6/97 was 5300 L min^{-1} based on continuous monitoring by other workers (Earl Liverman, EPA, oral communication).

Table 6. Total acid soluble concentrations of elements in waters draining adits and tailings piles in the Coeur d'Alene mining district. n.m. = not measured.
* indicates data not reproducible.

Site Name	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	mg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}	μg L^{-1}
Adits														
Zn rich deposits														
Success #3 (8/96)	0.05	13	0.4	20	<0.1	0.01	93	285	0.21	8.4	<0.05	0.75	4.5	37
Success #3 (A) (6/97)	0.01	25	1.1	17	0.1	0.01	85	358	0.58	12	1.4	0.48	18	35
Success #3 (B) (6/97)	0.01	25	1	17	0.1	0.01	85	360	0.57	12	1.4	0.49	19	35
Success #3 (C) (6/97)	0.01	25	1.1	17	0.1	0.01	86	360	0.58	12	1.4	0.48	18	35
Interstate-Callahan #4 (A) (8/96)	0.12	5.4	<0.1	49	<0.1	0.01	35	0.16	0.03	0.04	<0.05	0.32	0.18	68
Interstate-Callahan #4 (B) (8/96)	0.11	3.8*	<0.1	49	<0.1	0.01	34	0.14	0.03	0.02	<0.05	0.28	0.09	63
Interstate-Callahan #4 (6/97)	<0.01	21	0.47	58	<0.1	<0.01	27	0.17	0.04	0.05	1.2	0.25	0.35	65
Pb-Zn rich deposits														
Morning #5 (8/96)	0.06	0.25	<0.1	1.1	<0.1	0.01	51	0.59	<0.01	0.03	<0.05	2	0.11	55
Morning #5 (6/97)	<0.01	0.4	0.43	8.9	<0.1	<0.01	38	45	<0.1	7.3	1.1	1.9	0.34	185
Rex #2 (8/96)	0.11	27	0.9	14	<0.1	0.01	21	5.8	0.2	0.21	0.19	0.36	1	18
Rex #2 (6/97)	<0.01	26	2.7	17	<0.1	<0.01	15	11	0.32	0.53	1.1	0.26	2.1	30
Gem #3 (8/96)	0.19	9.8	3.2	31	<0.1	0.01	55	11	0.31	11	<0.05	0.66	0.1	6800
Gem #3 (6/97)	0.01	19	4.1	29	<0.1	0.01	58	17	0.03	12	1.4	0.39	0.29	4500
Pb rich deposits														
Tamarack #7 (8/96)	1.4	450*	0.8	42	<0.1	0.01	34	4.2	0.54	0.34	0.07	0.32	0.82	760
Tamarack #7 (6/97)	<0.01	1.1	1.5	28	<0.1	<0.01	37	16	0.02	0.64	1.3	0.34	1	680
Kellogg Tunnel (6/97)	0.21	19500	1140	13	2.3	0.02	190	1585	18	612	7.6	0.87	2045	595000
Hercules #5 (8/96)	0.07	6.1	0.5	23	<0.1	0.01	38	0.99	0.04	0.11	<0.05	0.19	0.25	250
Hercules #5 (6/97)	0.04	435	1.5	21	<0.1	<0.01	35	32	0.7	5.8	0.86	0.32	13	460
Cu rich deposits														
Hooper Tunnel (8/96)	0.16	23	0.5	16	<0.1	<0.01	57	0.93	0.92	43	<0.05	0.88	535	35
Hooper Tunnel (6/97)	0.38	375	2.1	14	0.7	0.01	40	1.4	2.5	62	1.3	0.64	2035	265
Silver Dollar (8/96)	0.07	3.9*	12	122	0.4	0.01	36	0.03	0.02	0.13	2.3	1.8	1.5	72
Silver Dollar (6/97)	0.01	14	6.8	123	<0.1	<0.01	40	0.02	0.02	0.27	4.4	1.6	3	90
Snowstorm #3 (6/97)	0.02	1.5	1.1	19	<0.1	<0.01	3.7	0.05	0.02	0.2	0.3	0.05	528	10
Tailings piles														
Success - upper seep (11/96)	0.07	1280	0.31	24	0.2	n.m.	14	120	3.1	2.9	0.12	0.1	50	<10
Success - upper seep (6/97)	0.01	21	0.28	17	<0.1	<0.01	5	26	0.15	0.29	0.23	0.04	7.7	10
Success - lower seep (11/96)	0.06	64	0.49	62	0.1	n.m.	18	143	0.79	2.7	<0.05	0.07	23	<10
Success - lower seep (6/97)	0.01	118	0.44	42	<0.1	<0.01	11	81	0.72	1.7	0.17	0.03	26	<10
Interstate-Callahan seep (11/96)	0.13	670	2.1	12	<0.1	n.m.	46	670	13	45	0.22	0.13	43	730
Interstate-Callahan seep (6/97)	0.03	960	2.1	18	0.7	0.01	39	682	9.5	25	0.24	0.09	86	310
Rex seep (11/96)	0.07	23	0.87	50	<0.1	n.m.	54	36	0.39	1.7	0.41	0.19	2.1	2410
Rex seep (6/97)	0.01	1.8	3.6	33	<0.1	<0.01	60	9.2	1.4	13	1.1	0.3	0.51	12500
Bunker Hill - upper seep (11/96)	0.05	190	1.5	23	<0.1	n.m.	101	33	1.2	18	0.61	0.11	1.1	21400
Bunker Hill - lower seep (11/96)	0.02	203	0.61	27	<0.1	n.m.	90	33	0.58	5.1	0.28	0.17	1.9	3450
Osburn Flats seep (6/97)	<0.01	0.6	0.45	32	<0.1	<0.01	27	39	0.02	0.03	1.3	0.01	1.3	15

Table 6. (Continued) Total acid soluble concentrations of elements in waters draining adits and tailings piles in the Coeur d'Alene mining district.

Site Name	Hg µg L-1	K mg L-1	La µg L-1	Mg mg L-1	Mn µg L-1	Mo µg L-1	Na mg L-1	Ni µg L-1	Pb µg L-1	Rb µg L-1	Sb µg L-1	Sr µg L-1	Tl µg L-1	U µg L-1	Zn µg L-1
Adits															
Zn rich deposits															
Success #3 (8/96)	<0.05	1.2	0.11	5.8	2310	1.1	6.3	18	5.8	4.4	0.26	810	0.01	14	51100
Success #3 (A) (6/97)	<0.05	1.3	0.36	5	2325	0.86	4.9	20	58	3.9	0.21	567	0.01	9.1	57500
Success #3 (B) (6/97)	<0.05	1.3	0.36	5	2340	0.88	4.9	20	57	3.9	0.21	565	0.01	9.1	57800
Success #3 (C) (6/97)	<0.05	1.2	0.36	4.9	2330	0.86	4.9	20	59	3.9	0.21	572	0.01	9	57700
Interstate-Callahan #4 (A) (8/96)	<0.05	0.71	0.01	6.1	11	1.2	2.9	0.22	0.18	1.4	0.27	1850	<0.01	1.9	40
Interstate-Callahan #4 (B) (8/96)	<0.05	0.71	0.01	6.2	10	1.2	3	0.23	0.17	1.4	0.27	1930	<0.01	1.9	38
Interstate-Callahan #4 (6/97)	<0.05	0.65	0.02	5.1	20	0.79	2.4	0.48	0.61	1.2	0.57	1475	0.01	1.7	56
Pb-Zn rich deposits															
Morning #5 (8/96)	<0.05	0.72	<0.01	24	74	0.29	0.59	2.9	0.67	2.1	0.09	161	<0.01	0.11	398
Morning #5 (6/97)	<0.05	0.81	<0.01	26	8010	0.45	0.53	20	4.1	2.4	0.17	106	<0.01	0.05	4325
Rex #2 (8/96)	<0.05	0.91	0.12	4.2	16	1.5	4.7	1.1	54	1.7	0.17	170	<0.01	5.7	1250
Rex #2 (6/97)	<0.05	0.91	0.21	3.2	31	0.79	3.5	1.8	231	1.3	0.17	114	<0.01	2.7	2380
Gem #3 (8/96)	<0.05	2	0.15	9.9	6500	0.59	3.2	13	23	4.5	0.71	272	0.01	0.21	16200
Gem #3 (6/97)	<0.05	1.9	0.02	9.7	5950	0.56	2.7	15	21	3.8	0.28	240	0.01	0.18	18500
Pb rich deposits															
Tamarack #7 (8/96)	<0.05	0.83	0.19	7.7	266	3.3	1.9	0.97	15	1.9	1.1	238	0.01	0.88	650
Tamarack #7 (6/97)	<0.05	1.1	0.02	7.3	370	0.92	1.3	3.9	10	2.2	1	188	<0.01	0.54	2910
Kellogg Tunnel (6/97)	<0.05	4.5	4.9	235	211000	0.21	1.8	492	950	8.6	2.8	96	0.62	17	626000
Hercules #5 (8/96)	<0.05	0.99	0.02	8.5	80	1.5	2.6	0.65	8.7	1.9	1.5	266	<0.01	1.2	115
Hercules #5 (6/97)	<0.05	1	0.31	7.5	2570	0.85	1.8	9	527	2.3	1.3	200	0.01	0.85	2650
Cu rich deposits															
Hooper Tunnel (8/96)	<0.05	0.78	0.51	34	14200	1	1	69	5.3	2.4	5.3	47	0.05	0.48	138
Hooper Tunnel (6/97)	<0.05	0.74	1.2	24	13600	0.45	0.84	74	39	1.7	3.1	30	0.04	1.4	241
Silver Dollar (8/96)	<0.05	0.95	0.01	36	4.7	13	1.1	1.8	0.42	4	11	99	0.01	4.2	12
Silver Dollar (6/97)	<0.05	0.88	0.01	35	28	8.9	0.92	2	0.28	3.4	10	87	0.01	4.9	20
Snowstorm #3 (6/97)	<0.05	0.52	0.01	0.55	22	0.1	0.66	0.17	0.4	1.3	4	12	<0.01	0.04	14
Tailings piles															
Success - upper seep (11/96)	<0.05	0.78	2.1	1.9	257	0.12	2.5	6.3	220	1.1	0.28	322	0.01	1.1	20100
Success - upper seep (6/97)	<0.05	0.71	0.1	0.69	14	0.11	2.6	1.2	117	0.42	0.17	55	<0.01	0.14	3750
Success - lower seep (11/96)	<0.05	1	1.3	2.5	129	0.08	3.5	6.8	932	0.51	0.1	255	<0.01	0.28	24300
Success - lower seep (6/97)	<0.05	0.92	0.7	1.5	132	0.06	2.8	4.2	525	0.47	0.15	116	<0.01	0.22	14100
Interstate-Callahan seep (11/96)	<0.05	2.6	14	7	9500	0.26	2.7	116	235	3.3	0.03	685	0.02	1.1	171000
Interstate-Callahan seep (6/97)	<0.05	2.7	12	5.7	9520	0.03	2.2	112	405	3.7	0.11	405	0.02	0.92	181500
Rex seep (11/96)	<0.05	5.7	0.95	7.3	720	0.27	3.5	20	49	6.4	0.23	2710	0.01	0.21	13200
Rex seep (6/97)	<0.05	12	0.85	8.6	5100	0.37	2.9	34	98	12	0.98	2530	0.01	0.03	20850
Bunker Hill - upper seep (11/96)	<0.05	4.3	0.88	38	14800	0.38	6.9	24	135	4.6	0.05	420	0.05	0.02	20060
Bunker Hill - lower seep (11/96)	<0.05	4.3	0.39	38	5730	0.36	6.9	16	112	4.9	1.1	330	0.05	0.04	10110
Osburn Flats seep (6/97)	<0.05	1.5	0.01	7.8	6	0.04	2.9	2.2	2.3	0.83	0.32	76	<0.01	0.03	4960

Table 7. Dissolved (<0.45 µm) concentrations of elements in waters draining adits and tailings piles in the Coeur d'Alene mining district. n.m. = not measured.

Site Name	Ag µg L^{-1}	Al µg L^{-1}	As µg L^{-1}	Ba µg L^{-1}	Be µg L^{-1}	Bi µg L^{-1}	Ca mg L^{-1}	Cd µg L^{-1}	Ce µg L^{-1}	Co µg L^{-1}	Cr µg L^{-1}	Cs µg L^{-1}	Cu µg L^{-1}	Fe(II & III) µg L^{-1}	Fe(II) µg L^{-1}
Adits															
Zn rich deposits															
Success #3 (8/96)	0.07	4.2	<0.1	20	<0.1	<0.01	93	280	0.16	8.5	<0.05	0.72	4.2	<10	<60
Success #3 (A) (6/97)	0.01	5.2	1.1	17	0.1	n.m.	85	355	0.45	12	1.3	0.48	17	10	<60
Success #3 (B) (6/97)	0.01	5.2	1.1	17	0.1	n.m.	84	356	0.45	12	1.3	0.48	17	10	187
Success #3 (C) (6/97)	0.01	5.3	1.1	17	0.1	n.m.	85	360	0.44	12	1.3	0.48	17	10	<60
Interstate-Callahan #4 (A) (8/96)	0.07	0.16	<0.1	47	<0.1	<0.01	34	0.21	<0.01	0.03	<0.05	0.33	0.21	35	<60
Interstate-Callahan #4 (B) (8/96)	0.08	0.15	<0.1	48	<0.1	0.01	34	0.06	<0.01	0.02	<0.05	0.27	<0.01	33	<60
Interstate-Callahan #4 (6/97)	<0.01	0.4	0.46	56	<0.1	n.m.	27	0.04	0.02	0.03	1.1	0.18	0.12	15	<60
Pb-Zn rich deposits															
Morning #5 (8/96)	0.08	<0.1	<0.1	1.1	<0.1	0.01	50	0.58	<0.01	0.06	<0.05	1.9	0.12	10	<60
Morning #5 (6/97)	<0.01	0.1	0.36	8.8	<0.1	n.m.	37	45	<0.01	7.2	0.98	1.9	0.32	10	<60
Rex #2 (8/96)	0.06	6.5	0.7	13	<0.1	0.01	21	5.5	0.08	0.19	0.13	0.36	0.68	<10	<60
Rex #2 (6/97)	<0.01	3.9	2.6	17	<0.1	n.m.	15	11	0.09	0.49	1	0.25	1.2	10	<60
Gem #3 (8/96)	0.12	<0.1	1.7	31	<0.1	0.01	55	9.6	<0.01	11	<0.05	0.71	<0.01	4120	4300
Gem #3 (6/97)	0.01	0.3	2.3	28	<0.1	n.m.	58	17	<0.01	11	1.3	0.39	0.29	1520	1649
Pb rich deposits															
Tamarack #7 (8/96)	0.07	5.1	0.5	38	<0.1	0.01	33	2	<0.01	0.22	<0.05	0.28	<0.01	62	67
Tamarack #7 (6/97)	<0.01	0.3	0.79	28	<0.1	n.m.	37	9.2	0.01	0.58	1.3	0.34	0.52	10	<60
Kellogg Tunnel (6/97)	0.21	19400	715	12	2.4	n.m.	184	1570	17	610	6.7	0.85	2050	528000	38847
Hercules #5 (8/96)	0.08	2.8	<0.1	22	<0.1	0.01	38	0.65	<0.01	0.07	<0.05	0.19	<0.01	<10	<60
Hercules #5 (6/97)	0.04	29	0.56	21	<0.1	n.m.	35	32	0.08	5.6	0.84	0.32	0.93	<10	<60
Cu rich deposits															
Hooper Tunnel (8/96)	0.42	7.8	0.1	16	<0.1	<0.01	57	0.91	0.88	43	<0.05	0.07	525	<10	<60
Hooper Tunnel (6/97)	0.38	44	1.1	14	0.6	n.m.	39	1.3	2.41	62	1	0.64	2030	50	<60
Silver Dollar (8/96)	0.04	1.3	10	121	0.4	0.01	36	0.02	<0.01	0.11	1.9	1.7	1.2	15	<60
Silver Dollar (6/97)	0.01	0.6	5.8	122	<0.1	n.m.	40	0.02	0.02	0.22	3.8	1.5	2.2	10	<60
Snowstorm #3 (6/97)	0.02	0.2	1	20	<0.1	n.m.	3.6	0.04	0.02	0.19	0.31	0.05	520	<10	<60
Tailings piles															
Success - upper seep (11/96)	0.04	160	0.37	23	0.2	0.01	14	117	2.8	2.8	0.09	0.11	44	<10	<60
Success - upper seep (6/97)	0.01	6.4	0.27	17	<0.1	n.m.	5	26	0.05	0.27	0.21	0.04	7.3	<10	<60
Success - lower seep (11/96)	0.05	38	0.38	60	0.1	0.01	18	140	0.78	2.6	<0.05	0.07	22	<10	<60
Success - lower seep (6/97)	0.01	24	0.44	43	<0.1	n.m.	11	82	0.71	1.7	0.16	0.03	25	<10	<60
Interstate-Callahan seep (11/96)	0.05	665	2.1	12	<0.1	0.01	46	650	13	44	0.13	0.07	42	680	630
Interstate-Callahan seep (6/97)	0.03	910	2.1	18	0.7	n.m.	39	680	9.2	24	0.23	0.08	85	135	146
Rex seep (11/96)	0.04	2.5	0.62	49	<0.1	0.01	53	36	0.14	1.6	0.32	0.18	1.5	1260	1200
Rex seep (6/97)	0.01	0.2	2.1	33	<0.1	n.m.	60	8.8	0.32	13	0.96	0.3	0.18	6350	8165
Bunker Hill - upper seep (11/96)	0.05	183	1.5	23	<0.1	0.02	99	33	1.1	1.8	0.49	0.1	1	21200	20000
Bunker Hill - lower seep (11/96)	0.02	188	0.55	27	<0.1	0.01	89	32	0.53	5	0.29	0.15	1.7	2120	2000
Osburn Flats seep (6/97)	<0.01	0.1	0.43	31	<0.1	n.m.	27	38	0.01	0.03	1.1	0.01	1.1	<10	114

Table 7. (Continued) Dissolved (<0.45 μm) concentrations of elements in waters draining adits and tailings piles in the Coeur d'Alene mining district.

Site Name	Hg μg L^{-1}	K mg L^{-1}	La μg L^{-1}	Mg mg L^{-1}	Mn μg L^{-1}	Mo μg L^{-1}	Na mg L^{-1}	Ni μg L^{-1}	Pb μg L^{-1}	Rb μg L^{-1}	Sb μg L^{-1}	Sr μg L^{-1}	Tl μg L^{-1}	U μg L^{-1}	Zn μg L^{-1}
Adits															
Zn rich deposits															
Success #3 (8/96)	<0.05	1.2	0.09	5.8	2260	1.1	6.2	18	2.8	4.3	0.28	802	0.01	14	50700
Success #3 (A) (6/97)	<0.05	1.3	0.31	4.9	2325	0.88	4.9	20	44	3.9	0.22	570	0.01	8.8	57300
Success #3 (B) (6/97)	<0.05	1.3	0.31	5	2330	0.88	4.9	20	45	3.9	0.22	563	0.01	8.6	57100
Success #3 (C) (6/97)	<0.05	1.2	0.31	4.9	2330	0.87	4.8	20	44	3.9	0.21	565	0.01	8.7	57800
Interstate-Callahan #4 (A) (8/96)	<0.05	0.71	<0.01	6.1	8.2	1.2	2.9	0.22	0.02	1.3	0.26	1780	<0.01	1.9	41
Interstate-Callahan #4 (B) (8/96)	<0.05	0.7	<0.01	6.1	7.2	1.2	3	0.23	0.03	1.4	0.27	1950	<0.01	1.9	36
Interstate-Callahan #4 (6/97)	<0.05	0.63	0.01	5	18	0.77	2.4	0.46	0.05	1.1	0.54	1475	<0.01	1.7	26
Pb-Zn rich deposits															
Morning #5 (8/96)	<0.05	0.73	<0.01	23	65	0.27	0.58	2.9	0.41	2.1	0.09	164	<0.01	0.11	401
Morning #5 (6/97)	<0.05	0.78	<0.01	25	7930	0.46	0.54	20	0.06	2.4	0.18	106	<0.01	0.05	4270
Rex #2 (8/96)	<0.05	0.91	0.06	4.2	15	1.5	4.7	1.1	42	1.7	0.18	167	<0.01	5.3	1210
Rex #2 (6/97)	<0.05	0.87	0.07	3.1	28	0.8	3.5	1.7	197	1.2	0.15	113	<0.01	2.5	2350
Gem #3 (8/96)	<0.05	2	<0.01	9.9	6360	0.58	3.1	12	0.12	4.4	0.18	275	<0.01	0.2	16300
Gem #3 (6/97)	<0.05	1.9	<0.01	9.7	5950	0.58	2.7	13	0.07	3.9	0.22	233	0.01	0.17	18030
Pb rich deposits															
Tamarack #7 (8/96)	<0.05	0.82	<0.01	7.8	245	3.4	1.9	0.94	0.06	1.6	1.1	234	<0.01	0.85	632
Tamarack #7 (6/97)	<0.05	1.1	0.01	7.2	362	0.96	1.3	3.6	0.21	2.3	1	186	<0.01	0.54	2800
Kellogg Tunnel (6/97)	<0.05	4.5	4.8	236	206300	0.19	1.8	470	825	8.5	1.2	97	0.63	17	615000
Hercules #5 (8/96)	<0.05	0.98	<0.01	8.6	49	1.4	2.6	0.57	0.54	1.8	1.4	252	<0.01	1.1	103
Hercules #5 (6/97)	<0.05	1	0.06	7.3	2480	0.87	1.8	8.7	223	2.3	1.2	203	0.01	0.36	2510
Cu rich deposits															
Hooper Tunnel (8/96)	<0.05	0.78	0.49	33	13900	1	1	70	3.8	2.3	5.3	45	0.05	0.46	142
Hooper Tunnel (6/97)	<0.05	0.75	1.2	23	13500	0.45	0.84	72	27	1.7	2.9	31	0.04	0.45	238
Silver Dollar (8/96)	<0.05	0.93	<0.01	35	4.5	13	1.1	1.1	0.45	3.9	10	96	0.01	4.1	11
Silver Dollar (6/97)	<0.05	0.87	0.01	34	27	9	0.91	1.8	0.05	3.4	10	88	0.01	4.9	19
Snowstorm #3 (6/97)	<0.05	0.53	0.01	0.55	22	0.08	0.65	0.12	0.2	1.3	3.9	12	<0.01	0.03	13
Tailings piles															
Success - upper seep (11/96)	<0.05	0.79	1.9	1.9	241	0.12	2.5	6.1	215	1.1	0.28	325	0.01	0.37	20200
Success - upper seep (6/97)	<0.05	0.69	0.04	0.69	14	0.11	2.6	1.1	112	0.41	0.16	55	<0.01	0.12	3760
Success - lower seep (11/96)	<0.05	1	1.3	2.5	123	0.08	3.5	6.6	930	0.51	0.09	258	<0.01	0.25	24200
Success - lower seep (6/97)	<0.05	0.92	0.68	1.5	133	0.07	2.8	4.2	515	0.47	0.16	118	<0.01	0.17	13600
Interstate-Callahan seep (11/96)	<0.05	2.6	14	7	9350	0.27	2.7	115	225	3.3	0.03	675	0.02	1.1	172000
Interstate-Callahan seep (6/97)	<0.05	2.7	11	5.6	9425	0.03	2.2	112	386	3.6	0.06	402	0.02	0.9	179500
Rex seep (11/96)	<0.05	5.8	0.58	7.4	708	0.23	3.6	20	5.3	6.5	0.15	2750	0.01	0.15	13100
Rex seep (6/97)	<0.05	12	0.27	8.6	5060	0.29	2.9	34	0.72	12	0.13	2510	0.01	0.02	20750
Bunker Hill - upper seep (11/96)	<0.05	4.4	0.85	37	14700	0.38	6.9	24	123	4.6	0.05	425	0.05	0.02	20150
Bunker Hill - lower seep (11/96)	<0.05	4.3	0.37	28	5710	0.37	6.8	15	35	4.8	1.2	332	0.05	0.03	10080
Osburn Flats seep (6/97)	<0.05	1.5	0.01	7.7	5.8	0.04	2.9	2.2	1.8	0.84	0.33	77	<0.01	0.03	4720

Table 8. Comparison of observed concentrations for trace ions in USGS reference standards during Coeur d'Alene sample analyses with published most probable values (MPV), standard deviations (STD), and numbers of measurements (N). Dotted line indicates no reported values for observed or published analysis. There were no reported N values for AMW-2.

Element	Units	8/96 T-135 observed	11/96 T-135 observed	6/97 T-135 observed	T-135 MPV	T-135 STD	T-135 N	8/96 T-137 observed	11/96 T-137 observed	6/97 T-137 observed	T-137 MPV	T-137 STD	T-137 N	8/96 AMW-2 observed	11/96 AMW-2 observed	6/97 AMW-2 observed	AMW-2 MPV	AMW-2 STD
Ag	$\mu g\ L^{-1}$	---------	---------	9.33	9.81	1.05	71	---------	---------	0.34	0.3	1.5	17	---------	---------	---------	---------	---------
Al	$\mu g\ L^{-1}$	8.65	9.25	9.62	10.5	6.8	51	30.2	30.1	30.9	30.5	6.9	55	20500	20700	20400	20600	1800
As	$\mu g\ L^{-1}$	10.4	10.2	9.8	10	1.1	75	---------	---------	0.56	0.8	1	21	---------	---------	---------	56	14.1
Ba	$\mu g\ L^{-1}$	66.3	66.8	65.7	67.8	4.3	71	62.7	63.5	64.1	65	4.8	74	5.46	5.61	5.75	6	20.7
Be	$\mu g\ L^{-1}$	56.7	57.3	56.3	59	2.6	28	4.83	4.96	4.92	5.2	0.5	64	12.6	13.2	12.7	14	2.7
Bi	$\mu g\ L^{-1}$	0.03	0.03	0.04	---------	---------	---------	0.04	0.04	0.04	---------	---------	---------	0.02	0.03	0.02	---------	---------
Ca	$mg\ L^{-1}$	10.2	10.3	10.4	10.4	0.6	93	38.9	38.7	39.3	38.1	1.5	88	330	320	326	---------	---------
Cd	$\mu g\ L^{-1}$	50.4	50.3	51.1	50.5	3.2	87	6.51	6.83	6.72	6.8	0.52	80	125	128	126	130	14
Ce	$\mu g\ L^{-1}$	0.03	0.03	0.02	---------	---------	---------	0.05	0.05	0.05	---------	---------	---------	380	375	370	---------	---------
Cl	$mg\ L^{-1}$	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	12.1	---------	12	7.9	3
Co	$\mu g\ L^{-1}$	38.5	39.1	38.8	40	2.6	62	0.19	0.2	0.21	0.4	0.5	11	133	140	141	138	14.8
Cr	$\mu g\ L^{-1}$	77.5	77.8	76.3	79	5.5	85	17.6	16.1	17.8	19.4	2	81	9.81	9.56	9.75	20	18.5
Cs	$\mu g\ L^{-1}$	0.01	0.01	0.01	---------	---------	---------	0.02	0.02	0.02	---------	---------	---------	7.65	7.48	7.45	---------	---------
Cu	$\mu g\ L^{-1}$	59.3	60.5	60.6	62	4.2	93	1.55	1.73	1.71	1.9	1.2	47	4750	4920	4880	5100	204
F	$mg\ L^{-1}$	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	5.4	2.5	1.9
Fe	$\mu g\ L^{-1}$	218	225	223	228	11	95	35	40	50	71	9	90	98700	99100	99200	145000	15000
K	$mg\ L^{-1}$	0.95	0.97	0.98	0.96	0.09	82	1.14	1.17	1.16	1.19	0.13	76	3.82	3.85	3.91	---------	---------
La	$\mu g\ L^{-1}$	0.02	0.02	0.02	---------	---------	---------	0.03	0.03	0.03	---------	---------	---------	147	142	142	---------	---------
Mg	$mg\ L^{-1}$	1.73	1.87	1.93	2	0.09	92	9.65	9.85	9.96	10.1	0.5	89	116	113	115	---------	---------
Mn	$\mu g\ L^{-1}$	403	410	415	423	20	93	92.1	68.8	91.6	98	5	91	83500	84200	85100	87300	6400
Mo	$\mu g\ L^{-1}$	66.3	65.1	64.3	63	5.1	58	9.75	9.62	9.25	8.9	1.8	41	0.98	1	1.05	---------	---------
Na	$mg\ L^{-1}$	31.2	30.9	30.4	30.8	1.2	90	21.3	21.7	21.7	22	1.1	87	27.4	27.1	27.8	---------	---------
Ni	$\mu g\ L^{-1}$	62.3	63.4	61.8	65.6	5	80	14.2	14.6	14.5	15	2.5	73	215	220	213	260	52
Pb	$\mu g\ L^{-1}$	115	110	107	103	7	87	6.32	6.28	6.25	6.3	1	80	32.1	33.2	34.1	43	53
Rb	$\mu g\ L^{-1}$	0.65	0.65	0.64	---------	---------	---------	0.86	0.84	0.83	---------	---------	---------	22.4	22.5	21.6	---------	---------
Sb	$\mu g\ L^{-1}$	85.3	85.4	81.2	76.3	8.7	52	17.6	17.1	16.7	15.5	2.7	53	7.12	6.95	6.85	---------	---------
SO_4	$mg\ L^{-1}$	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	1900	---------	2200	1980	245
Sr	$\mu g\ L^{-1}$	50.1	50.2	49.8	46	2.3	47	235	235	240	230	14	45	1500	1520	1530	1570	78
Tl	$\mu g\ L^{-1}$	0.25	0.25	0.24	---------	---------	---------	165	166	163	---------	---------	---------	0.44	0.45	0.43	---------	---------
U	$\mu g\ L^{-1}$	0.26	0.26	0.26	---------	---------	---------	10.7	10.5	10.5	10	0.5	6	70.6	72.1	69.8	---------	---------
Zn	$\mu g\ L^{-1}$	47.8	47.7	47.5	48.2	4.7	88	45.6	46.3	46.4	49.5	4.2	85	41500	42200	42700	44000	3700

Table 9. Comparison of observed concentrations for major ions in USGS reference standards during Coeur d'Alene sample analyses with published most probable values (MPV), standard deviations (STD), and numbers of measurements (N). Dotted line indicates no reported values for observed analysis.

Element	Units	8/96 M-100 observed	11/96 M-100 observed	6/97 M-100 observed	M-100 MPV	M-100 STD	M-100 N	8/96 M-130 observed	11/96 M-130 observed	6/97 M-130 observed	M-130 MPV	M-130 STD	M-130 N
Ca	mg L^{-1}	186	185	187	180	8	53	21.3	21.4	21.5	21.2	1	95
Cl	mg L^{-1}	69.5	81	82	79	2	52	19.2	22	21	21.4	1.9	99
F	mg L^{-1}	---------	1.8	1.9	0.89	0.07	42	---------	1.9	1.1	1.23	0.09	65
K	mg L^{-1}	4.62	4.63	4.57	4.5	0.7	55	3.08	3.03	3.05	3	0.23	88
Mg	mg L^{-1}	100	100	99	98	5	54	5.89	5.93	5.89	5.9	0.27	91
Na	mg L^{-1}	285	283	278	281	12	55	35.7	35.9	35.3	35.8	1.6	93
SO_4	mg L^{-1}	1200	1150	1150	1180	55	53	57	63	56	58	2.6	90