



**GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6345**

**Characterization of the Flow and Chemistry of Adit
Drainage, Bralorne Mine, Bralorne, B.C.**



**A.J. Desbarats, M. B. Parsons, J. B. Percival, Y.T.J. Kwong and
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2010

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Desbarats, A.J., Parsons, M.B., Percival, J.B., Kwong, Y.T.J., Beauchemin, S., 2010: Characterization of the Flow and Chemistry of Adit Drainage, Bralorne Mine, Bralorne, B.C., Geological Survey of Canada, Open File 6345, 1 CD-ROM

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Chapter I Introduction

Background

During the 2006-2009 planning cycle, a project on “Assessing and Reducing Risk from Metals in the Environment” was carried out under the Environment and Health Program of the Earth Sciences Sector. The “Abandoned Mines” component of the project called for multidisciplinary studies of historical mines across Canada. The purpose of this research was to define district-scale natural background metal levels, to characterize processes controlling metal(loid) release, transport, and bio-accessibility from mine wastes, soils, and waters, and to synthesize this information in a geoenvironmental model. A geoenvironmental model is an integrated compilation of geological, geochemical and hydrological knowledge pertaining to the environmental behaviour of a class of ore deposits through the exploration, mining and post-closure phases of their development (Plumlee and Nash, 1995). In particular, the model aims to characterize the geochemical signature of the ore deposit class in the various waste streams associated with mining activities. The model may then be used to predict, qualitatively or semi-quantitatively, the environmental effects associated with the development of new ore deposits of the same class elsewhere. Geoenvironmental models could be of significant benefit to the review of environmental impact assessments for mining projects which is the mandate of the Legislated Environmental and Resources Assessment (LERA) service of Natural Resources Canada.

Mesothermal or “Orogenic” (Groves et al., 1998) gold deposits were selected for investigation because of their widespread occurrence, because they represent attractive exploration targets and because of environmental concerns related to arsenic typically associated with these deposits (Goldfarb et al., 1995; Ashley, 2002). The specific objectives of the study were to characterize the baseline geochemistry of the natural environment, and that of tailings, waste rock dumps and mine drainage. Given these requirements, a suitable site for investigations was found in the historic Bralorne-Pioneer mining camp of British Columbia (Church, 1996). For many years, this was the largest Canadian gold mining complex west of Ontario before closing in 1971 (Church, 1996). However, operations left a legacy of mill tailings and mine drainage containing very high concentrations of arsenic derived from arsenopyrite associated with the gold mineralization. Currently, there are plans to re-develop the Bralorne Mine and exploration activities at the site are on-going. In order to access the property, NRCan entered into a research agreement with the operator, Bralorne Gold Mines Ltd. A copy of this agreement is provided in Appendix 1.

Scope of the Report

This report was prepared in partial fulfillment of the terms of the agreement between NRCan and Bralorne Gold Mines Ltd. It also serves to document and archive data acquired over the course of the project. The scope of this report is limited to hydrological and hydrogeochemical investigations of drainage from adits of the Bralorne Mine. These investigations contribute to the hydrogeological component of the geoenvironmental model for mesothermal lode gold deposits. Results and data contributing to other components of the model are presented in a companion report (Parsons et al., 2010).

Accompanying CD

A Compact Disk (CD) accompanying this report contains four data files in Microsoft Excel[®] format. These files are described as follows:

- of_6345_MD800-Flow.xls: file containing results of continuous flow monitoring of drainage from the 800-Level adit.
- of_6345_MD800-Chem.xls: file containing results of weekly water chemistry sampling of drainage from the 800-Level adit.
- of_6345_UPeter-Flow.xls: file containing results of continuous flow monitoring of drainage from the Upper Peter adit.
- of_6345_UPeter-Chem.xls: file containing results of weekly water chemistry sampling of drainage from the Upper Peter adit.

Acknowledgements

The authors would like to thank William G. (Bill) Kocken, president of Bralorne Gold Mines Ltd., and Jasman Yee, metallurgical consultant, for their interest and support in the undertaking of this project. Friendly assistance in the field was provided by Robert (Ned) Reid, mine manager, and other mine personnel. Robert McCandless of Environment Canada suggested the study site and first approached Bralorne Gold Mines on behalf of the authors. Cris Martin, of Bralorne, ably performed the weekly sampling of drainage chemistry. Judy Vaive and Pierre Pelchat of the GSC Inorganic Geochemical Research Laboratory performed the water chemistry analyses. Alan Martin of Lorax Environmental Services Ltd., and Sam Alpay of the GSC provided helpful comments on draft versions of this report.

Site Description

The Bralorne Mine is located approximately 175 km north-east of Vancouver. The site is readily accessed from Vancouver by all-weather roads via Highway 99 to Lillooet and then Highway 40 onwards to Gold Bridge. A well-maintained gravel road continues south a further 12 km to the mine and the hamlet of Bralorne. During the snow-free months, the site can be accessed using an alternate, shorter route via Highway 99 to Pemberton, north on the Pemberton Meadows highway and then east directly to Bralorne on the unpaved Hurley River Forest Service road.

Bralorne lies within the “Interior Transition Ranges” ecoregion of the Montane Cordillera Ecozone (Environment Canada, 2009a). The ecoregion forms a mountainous upland within the eastern portion of the southern Pacific Ranges with elevations ranging between 300 and 3000 m. The 800-Level portal of the Bralorne Mine lies in the deeply incised valley of Cadwallader Creek, at an elevation of approximately 975m whereas the summit of nearby Mount Truax is at an elevation of 2880 m. The ecoregion exhibits a strong climatic gradient from west to east. According to Environment Canada Climate Normals (Environment Canada, 2009b), average annual precipitation at Whistler (Elev. 657.8 m), in the moist marine West Coast climatic zone, is 1229 mm. At Lillooet (Elev. 554.7 m), in the semi-arid Interior climatic zone, it is only 381

mm. Based on available meteorological data for Bralorne (Elev. 1015 m) between 1934 and 1963 (Environment Canada, 2009b), mean annual precipitation is 650 mm, mean July temperature is 15°C and mean January temperature is -7.3°C.

The locations of the 800-Level portal (lat: 50.778476 N; long: 122.820626 W; elev. 975m) and the portal of the Upper Peter adit (lat: 50.78892 N; long: 122.815487 W; elev. 1280m) are shown in Figure 1. The Bralorne mine is located on NTS map sheet 92J15.

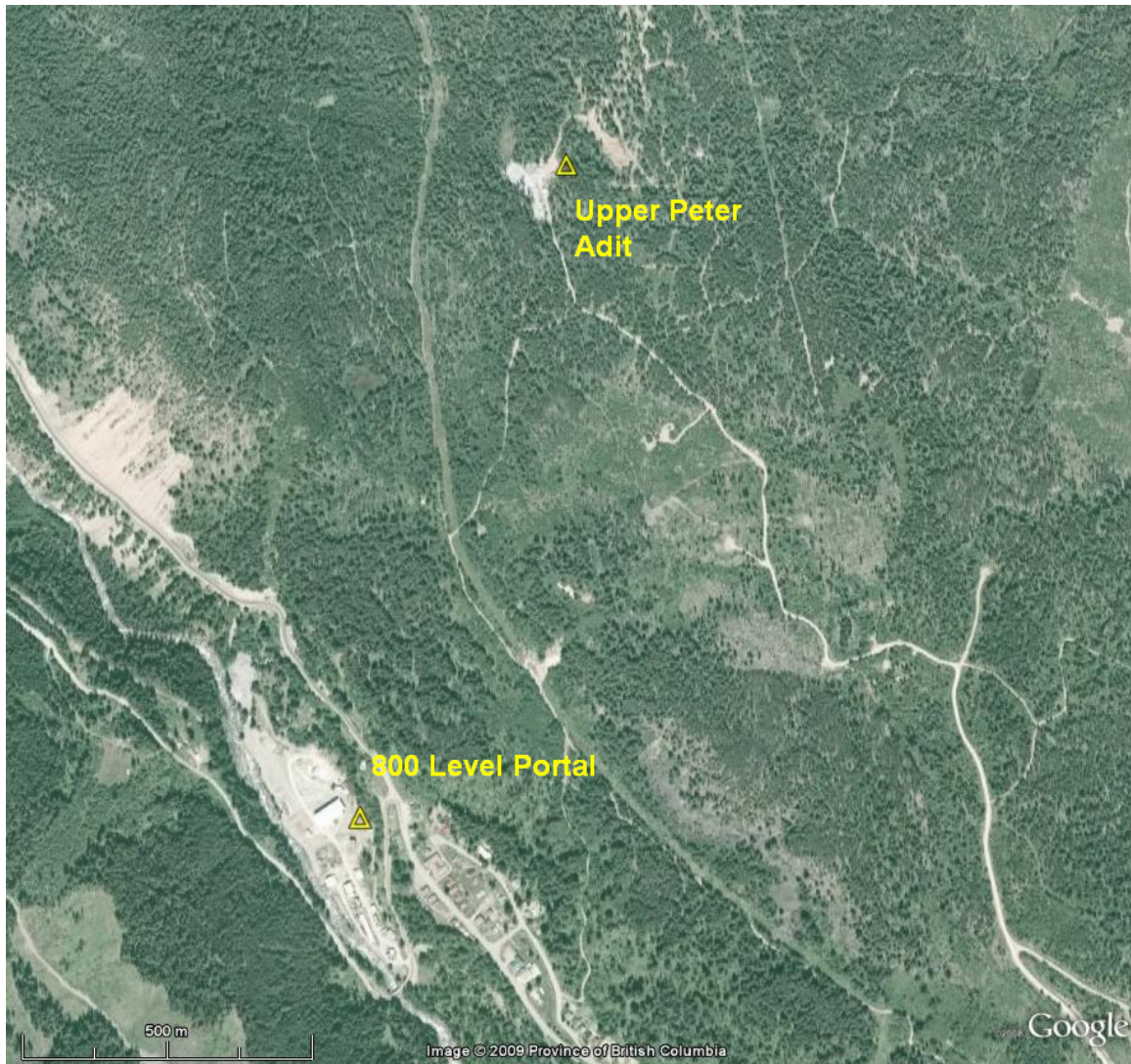


Figure 1: Locations of the 800-Level portal and the Upper Peter adit. The hamlet of Bralorne appears at the lower centre of the image.

Chapter II Methods

Flow Measurements

Flow measurements were performed on mine drainage from the 800-Level and Upper Peter adits. Methods for measuring flow in mining environments are reviewed in various guides including BC Field Sampling Manual – Part E (2003), Environment Canada (2001), and US EPA (2001). Two broad classes are commonly used: weirs and flumes. The choice of method depends on site conditions (such as available freeboard for mine water ponding), expected flow rates and water quality factors (e.g. suspended load). For conditions at the two Bralorne monitoring sites, “H-Type” flumes (Gwinn and Parsons, 1976; Grant and Dawson, 1997; Environment Canada, 2001; US EPA, 2001) were selected as the most appropriate primary flow measurement devices. They do not require freeboard for impounded water; they are accurate over a wide range of flow rates; and they are self-cleaning of sediment accumulation to some extent.

For “H-type” flumes, discharge (Q) is related to water level or stage (H) in the flume according to a general equation of the form (Gwinn and Parsons, 1976):

$$Q = A H^{1.5} + B H^{2.5}$$

The coefficients A and B depend on flume geometry and on measurement units. They can be calculated from formulae in Gwinn and Parsons (1976) or they can be estimated by least-squares regression using tabulated stage-discharge relationships as found in handbooks (Grant and Dawson, 1997). The latter approach was adopted here.

For the 800-Level adit, the primary flow monitoring device is an “H” flume with height D=1ft (0.305m). For this type and size of flume, discharge (Q) and stage (H) are related by:

$$Q = 48.12 H^{1.5} + 923.775 H^{2.5}$$

Where Q is in L/s and H is in m. The flume was fabricated locally using thin gauge steel plate. It is sited approximately 10 m outside the portal, on the edge of an embankment which provides free-flow conditions for the discharge. This discharge reports to a sump from where it is pumped to the tailings impoundment. Freeze-up of the flume was not a concern because of the warm (10°C) temperature and heavy flow of the effluent. The monitoring installation at the 800-Level portal is shown in Figure 2.

In the Upper Peter adit, the primary flow monitoring device is an “HS” flume with D=0.6 ft (0.183m). An “HS” flume is similar to an “H” flume but with dimensions and proportions optimized for measuring a lower range of flows. For this type and size of flume, discharge (Q) and stage (H) are related by:

$$Q = 18.809 H^{1.5} + 338.068 H^{2.5}$$

Where Q is in L/s and H is in m. This flume was made on site using 3/4" plywood. It was situated inside the adit, approximately 80 m from the portal and about 20 m downstream from a

pool formed by the flooded decline. This location was chosen deep within the adit in order to avoid freeze-up during the winter. Nonetheless, despite these precautions, drainage water did freeze during the winter of 2008-2009. Figure 3 shows the monitoring installation in the Upper Peter adit. Although some additional groundwater inflow occurs downstream of the flume and before the portal, this flow is negligible. However, the flow monitored at the flume may be somewhat less than the flow entering the settling pond downstream of the portal because of the additional capture of surface drainage.

A secondary flow monitoring device is required in order to measure the stage from which discharge is calculated using one of the equations above. Here, ultrasonic proximity sensors were mounted in stilling wells connected to head observation ports in each of the flumes. These sensors measure the distance from a fixed reference level to the water surface in the stilling well. Subtracting this distance from the reference elevation yields the water stage in the flume from which flow can be calculated using the appropriate discharge equation.

In addition to the ultrasonic proximity sensors, water temperature and electrical conductivity sensors were also deployed at each monitoring site. These probes were wired to data loggers for continuous recording at a six-hour frequency. Twice annually, the data loggers were downloaded and their batteries were replaced.

Because the speed of sound depends on air temperature, distance measurements from the ultrasonic proximity sensors had to be corrected for air temperature variations. At the 800-Level portal, measurements were corrected using air temperature data recorded at Water Survey of Canada station 08ME027 (Hurley River below Lone Goat Creek) located some 15 km away. In the Upper Peter adit, where temperatures do not vary much, air temperatures were estimated from water temperatures recorded simultaneously. Similarly, electrical conductivity (EC) measurements were corrected for water temperature variations and adjusted to standard conditions (25°C). EC measurements obtained in the Upper Peter adit were of acceptable quality. Unfortunately, EC measurements from 800-Level proved to be unusable because of the rapid build-up of carbonate scale on the sensors during long-term, unattended deployment. Finally, stage measurements at the 800-Level portal were corrected for gradual bio-fouling in the flume which restricts flow and therefore increases water levels slightly. Calculated flows were checked against flows measured by the “bucket and stop-watch” approach. Flow monitoring results are provided in digital format on the accompanying CD.



Figure 2: Effluent monitoring installation at the 800-Level portal.

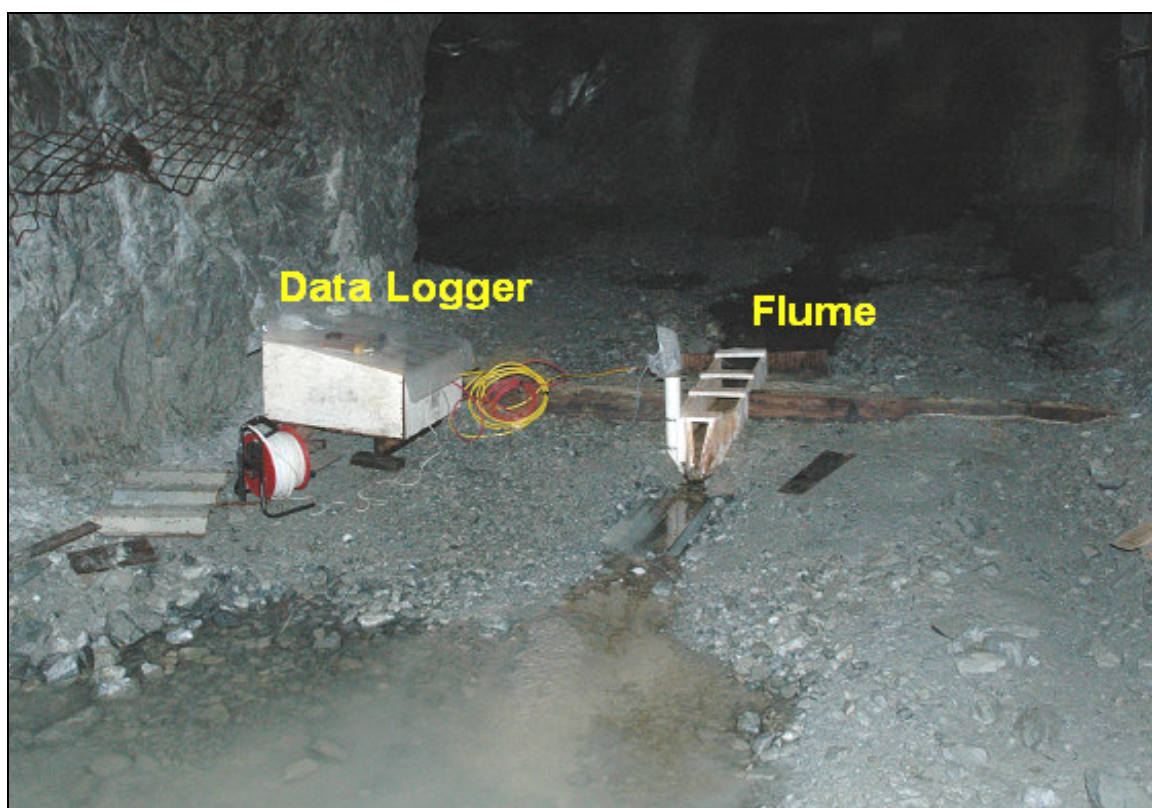


Figure 3: Effluent monitoring installation within the Upper Peter adit.

Water Chemistry

Drainage from the 800-Level and Upper Peter adits was sampled weekly between October 15th 2007 and December 7th 2008. Samples from the 800-Level adit were obtained at the flume discharge whereas samples from the Upper Peter adit were obtained from the drainage ditch immediately outside the portal. No water samples are available from the Upper Peter adit between November 19th 2007 and May 18th 2008 when drainage water at the portal was frozen completely. The total number of samples obtained from the 800-Level and Upper Peter adits were 60 and 36, respectively. Water chemistry results are provided on the accompanying CD.

For each sampling event and at each site, effluent temperature, pH and electrical conductivity were measured in the field, using instruments calibrated daily. A triple-rinsed 1L HDPE bottle was filled with effluent and transported to a clean indoor location for the preparation of a set of water samples. Each set consisted of three 60 mL HDPE bottles containing unfiltered (total) cations, filtered (dissolved) cations and anions, respectively. Samples for cations were acidified to $\text{pH} < 2$ using ultrapure nitric acid. Samples for dissolved cations and anions were filtered using 0.45 μm capsules. Samples were then refrigerated and stored in a dark location pending shipment in batches every four weeks to the Inorganic Geochemical Research Laboratory of the Geological Survey of Canada. Each batch shipment (8 sets of three samples) was supplemented by at least one sample blank, one acid blank, one travel blank and a field duplicate sample. Complete details of the water sampling protocol are provided in Appendix 2.

Analyses of trace elements were performed by Inductively-Coupled Plasma Mass Spectroscopy (ICP-MS) using a Thermo Corporation X-Series Quadrupole. Analyses of major elements were performed by Inductively-Coupled Atomic Emission Spectroscopy (ICP-AES) using a Perkin-Elmer 3000 DV. Anions were analyzed by Ion Chromatography (IC) using a DIONEX EG-40. Alkalinities were determined by titration. For each sample batch, analyses were performed on one or more certified standards of known concentrations. Element suites analyzed by each method and their corresponding detection limits are listed in Tables 1, 2 and 3.

Finally, charge balances were calculated for all (filtered) water samples. Charge balance errors were less than $\pm 5\%$ for 93% of the samples and less than the usual $\pm 10\%$ acceptance criterion for all samples.

Table 1: ICP-MS Element Suite			
Li (0.02)*	Be (0.005)	Al (2)	Ti (0.5)
V (0.1)	Mn (0.1)	Co (0.05)	Ni (0.2)
Cu (0.1)	Zn (0.5)	Ga (0.01)	Ge (0.02)
As (0.1)	Se (1)	Rb (0.05)	Sr (0.5)
Y (0.01)	Zr (0.05)	Nb (0.01)	Mo (.05)
Ag (0.005)	Cd (0.02)	In (0.01)	Sn (0.01)
Sb (0.01)	Te (0.02)	Cs (0.01)	Ba (0.2)
La (0.01)	Ce (0.01)	Pr (0.005)	Nd (0.005)
Sm (0.005)	Eu (0.005)	Tb (0.005)	Gd (0.005)
Dy (0.005)	Ho (0.005)	Er (0.005)	Tm (0.005)
Yb (0.005)	Lu (0.005)	Hf (0.01)	Ta (0.01)
W (0.02)	Re (0.005)	Pb (0.01)	U (0.005)
* lower detection limit in µg/L shown in brackets			

Table 2: ICP-AES Element Suite			
B (0.005)*	Ca (0.02)	Cr (0.001)	Fe (0.005)
K (0.05)	Mg (0.005)	Na (0.05)	P (0.05)
S (0.05)	Sc (0.001)	Si (0.02)	
* lower detection limit in mg/L shown in brackets			

Table 3: IC Element Suite			
F (0.01)*	Cl (0.01)	SO ₄ (0.02)	Br (0.02)
NO ₃ (0.02)	PO ₄ (0.02)		
* lower detection limit in mg/L shown in brackets			

Chapter III 800-Level Adit

Mine-water Flow

Drainage flowing from the 800-Level adit has three distinct sources: groundwater inflow to the workings of the King Mine; upwelling from the flooded workings of the Bralorne Mine (at the 55 Vein stope along the Empire Cross-Cut); and groundwater inflow in the vicinity of the Crown shaft. Synoptic sampling of drainage on 800-Level (described in Parsons et al. 2010) has revealed that each of these sources exhibits distinctive mine-water chemistry. This allows the flow contribution from each source to be determined using a mass balance approach with a conservative tracer such as chloride. Accordingly, for fall conditions observed on October 8-9 of 2007, infiltration to the King Mine, upwelling at the 55 Vein stope and infiltration around the Crown shaft account for 30%, 62% and 8% of portal discharge ($420 \text{ m}^3/\text{d}$) respectively. For early summer conditions observed on June 19th 2008, the corresponding contributions to portal discharge ($546 \text{ m}^3/\text{d}$) are 43%, 52%, 5%, respectively. However, the actual flux from the upwelling point changes little, being $260 \text{ m}^3/\text{d}$ in October of 2007 and $284 \text{ m}^3/\text{d}$ in June of 2008. Thus, while the shallow infiltration component of 800-Level discharge may fluctuate seasonally, the upwelling component, which makes up most of the flow, appears fairly steady.

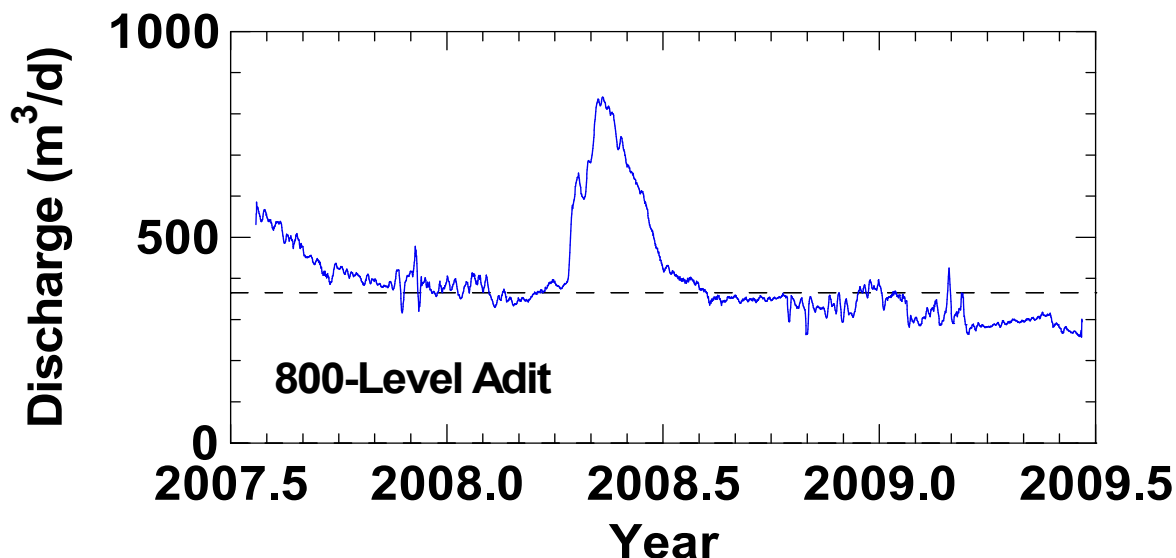


Figure 4: Hydrograph of discharge from the 800-Level adit for the period between July 1 2007 and July 1 2009. Dashed line indicates median flow rate.

The discharge hydrograph for 800-Level (Figure 4) covers a period of almost two years between late July of 2007 and late June of 2009. It shows the shoulder of the 2007 spring freshet and the entire 2008 freshet. Surprisingly, the hydrograph does not show any spring freshet in 2009. This is consistent with reports by local inhabitants that there was very little snow over the previous winter. During the monitoring period, the peak observed flow was $841 \text{ m}^3/\text{d}$ (9.73 L/s) on May 11th 2008. The minimum and median observed flows were $257 \text{ m}^3/\text{d}$ (2.97 L/s) and $366 \text{ m}^3/\text{d}$ (4.23 L/s), respectively.

Mine-water Chemistry

Major Species and pH

Box plots (Figure 5) summarize observed concentrations of major dissolved species in drainage from the 800-Level adit. Allowing for the logarithmic scale of these plots, the variability of concentrations for most species is small. This often reflects solubility control on their concentrations through equilibrium with mineral phases.

The relative proportions of major cations and anions in solution can be illustrated using ternary diagrams (Figure 6). By classifying samples in this manner, waters with chemically similar compositions can be delineated, and the evolution in water chemistry along flow paths can be defined. For cations, ternary diagrams are usually plotted using sodium (Na), magnesium (Mg) and calcium (Ca), while anions selected usually include bicarbonate (HCO_3^-), sulfate (SO_4^{2-}), and chloride (Cl^-). Figure 6 shows that the relative composition of the discharge (in terms of major cations and anions) is remarkably constant. Mine effluent can be characterized as mixed cation-bicarbonate-sulfate groundwater. Although minor, the chloride content of the effluent is notable in that it reflects deep groundwater inflow to the flooded Bralorne Mine. In the continent interior, shallow infiltration usually contains very little chloride.

Chemographs of pH and alkalinity (Figure 7) do not show any clear temporal pattern. Effluent pH is moderately alkaline throughout the year, and only on one occasion did pH approach the Metal Mine Effluent Regulations (Environment Canada, 2006) upper regulatory limit of 9.5.

The hardness of mine effluent appears fairly constant throughout most of the year (Figure 8). However, the chemograph shows a small spike and subsequent sharp drop associated with the spring freshet: the first flush of the workings contains a somewhat higher solute load compared to later flows which contain a greater component of snowmelt infiltration. The chemograph for sulfate (Figure 8) exhibits a similar behaviour which suggests that acidity generated by the oxidation of sulfides is being neutralized by calcium and magnesium carbonates. Sulfate concentrations exceed British Columbia Water Quality Guidelines (BCWQG, 2006).

Metals

Box plots of (total) metal concentrations in mine effluent are shown in Figure 9. Most metals exhibit fairly low concentrations although As, Fe and Mn are notable exceptions.

Chemographs for dissolved Fe, Mn, Al and Zn are fairly constant throughout the year (Figure 10), with concentrations close to detection limits in the cases of Al and Zn. Total metals, on the other hand, show considerable variations as a result of spring flushing of the workings and, possibly, due to mining activity during the winter of 2008. Total metal concentrations are much higher than dissolved values. Spikes in total Mn, Al and Zn concentrations coincide with spikes in total Fe and likely reflect sorption of these metals on particulate iron oxyhydroxides in the mine drainage. Concentrations of Mn slightly exceed the limits established by the Canadian Council of Ministers of the Environment (CCME, 2009).

For the main contaminants of concern at Bralorne, As and Sb, the chemographs of dissolved and total concentrations are different (Figure 11). Dissolved As is fairly constant throughout the year, reflecting its primary source in steady decant drainage from the flooded Bralorne workings. Total As concentrations are somewhat higher as a result of As sorption on iron oxyhydroxides. Through dilution with drainage from the King Mine and adsorption and co-precipitation with iron oxyhydroxides, filtered As levels decline from 5600 µg/L at the 55 Vein upwelling to 2360 µg/L at the portal, in October of 2007 (Parsons et al., 2010). Such non-conservative behavior of dissolved As is consistent with the observations of Strand (2007). In the latter study, the precipitation of iron between the upwelling and portal corresponded with a 30% decrease in filterable arsenic concentrations. The commensurate drop in both dissolved Fe and As strongly suggests that As is removed via sorption to Fe oxyhydroxides. Sorption of As on Fe particulates is explored in Figure 12 which shows particulate phase (total-dissolved) concentrations of As versus those of Fe. The plot shows a well-defined log-linear relationship between the two quantities providing clear evidence of As sorption on Fe oxyhydroxide particles. Nonetheless, total As concentrations at the portal are about five times the MMER monthly average regulatory limit of 500 µg/L. Furthermore, sorbed As is steadily accumulating in the 800-Level workings and these particulates can be flushed mechanically during periods of heavy flow. The spike of approximately 12 mg/L observed during the spring freshet is clearly a result of this process.

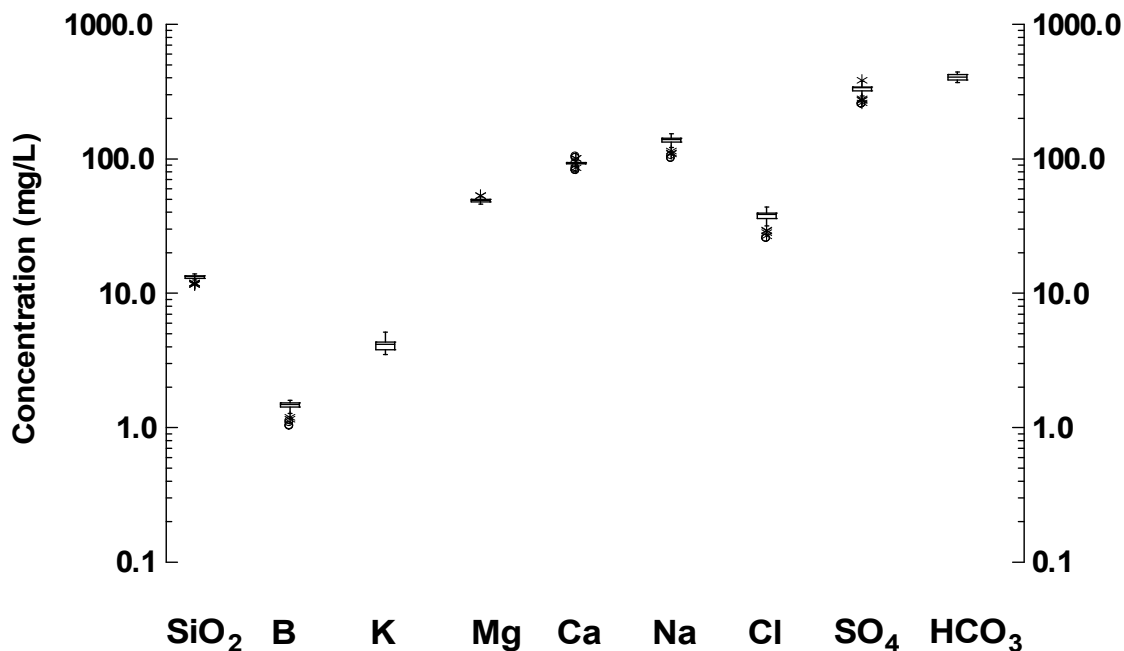


Figure 5: Box plots (n=60) of concentrations of major dissolved species in drainage from the 800-Level adit.

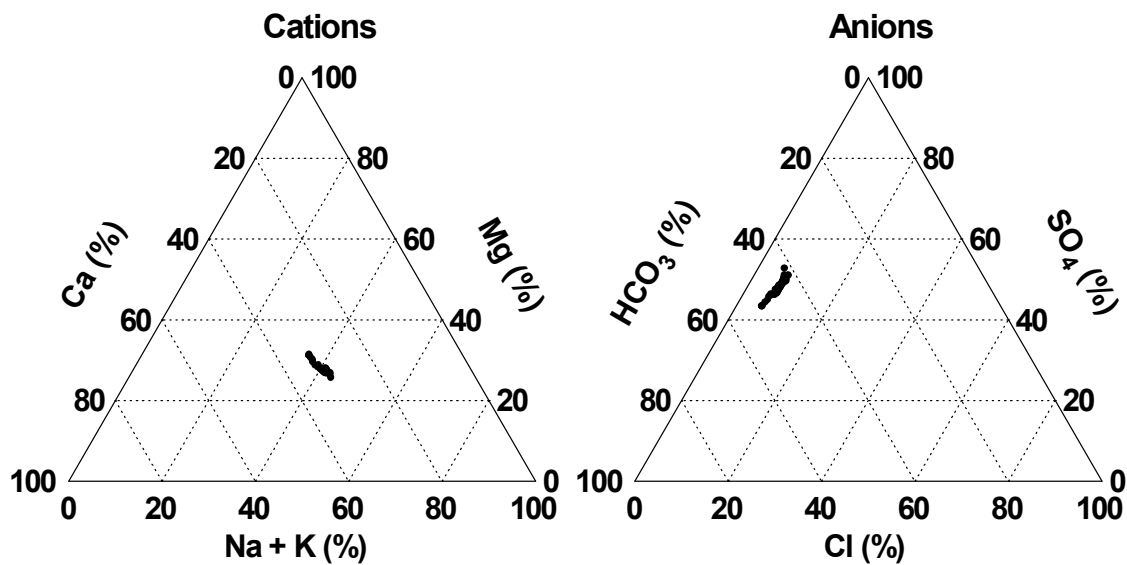


Figure 6: Ternary (Piper) plots showing the relative composition of major cations and anions (in % equivalents) of discharge from 800-Level.

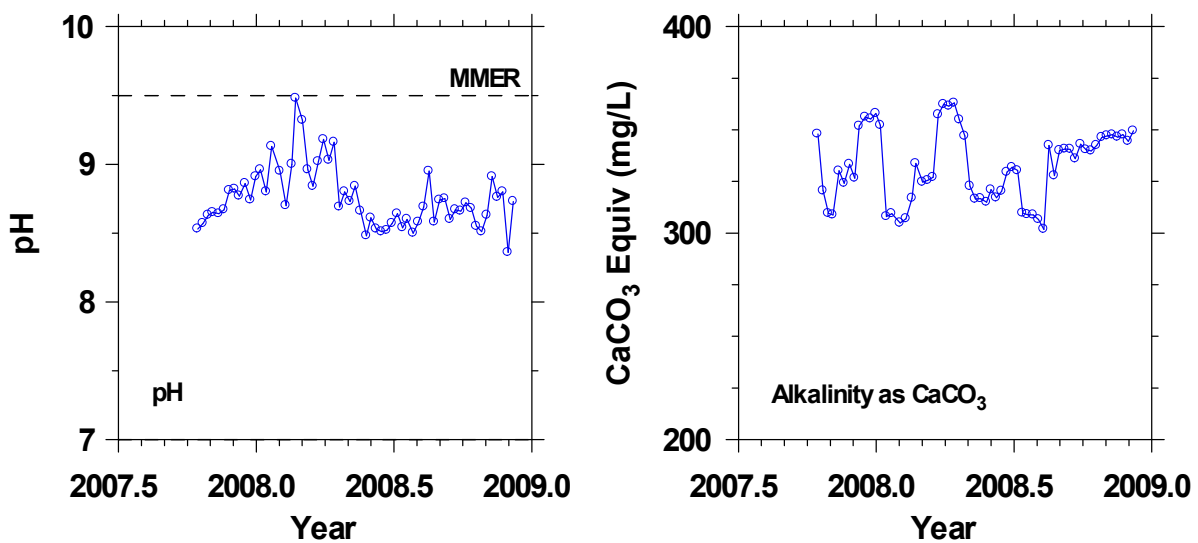


Figure 7: Chemographs of pH (left) and alkalinity for drainage from 800-Level.

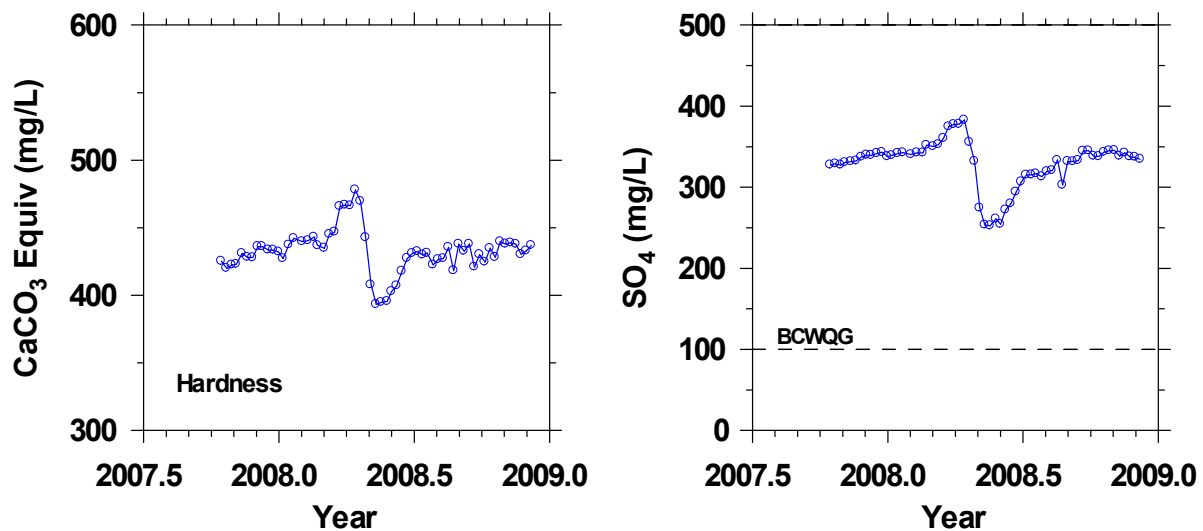


Figure 8: Chemographs of hardness (left) and sulfate (right) in discharge from 800-Level.

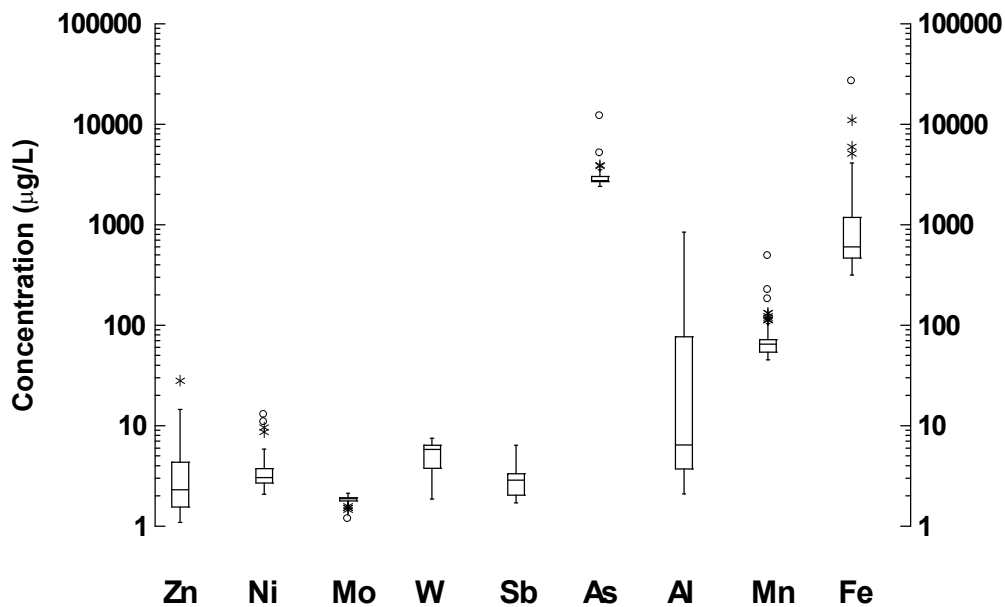


Figure 9: Box plots (n=60) of selected metal (total) concentrations in drainage from 800-Level.

Antimony (Sb) concentrations are generally very low and well within regulatory limits. Higher values are observed during the spring freshet because drainage from the King Mine (where Sb levels are somewhat higher) makes up a greater fraction of portal discharge. Figure 11 also shows that Sb occurs entirely in the dissolved ($< 0.45 \mu\text{m}$) phase.

Arsenic and Antimony Loadings

Loadings represent the mass of a given species discharged from the adit per unit of time. They are calculated by multiplying discharge flow rate by species concentration. Here, observed mine-water concentrations of As and Sb are multiplied by the average flow rate during the quasi-weekly period straddling the corresponding sampling event.

Figure 13 shows chemographs of loadings for As and Sb in effluent from the 800-Level adit. Loadings of total As spiked at close to 10 kg/d during the 2008 spring freshet although they remained close to 1 kg/d for most of the study period. Loadings of Sb also increased during the spring freshet as a combined result of greater flow and a greater relative contribution to flow from the workings of the King Mine.

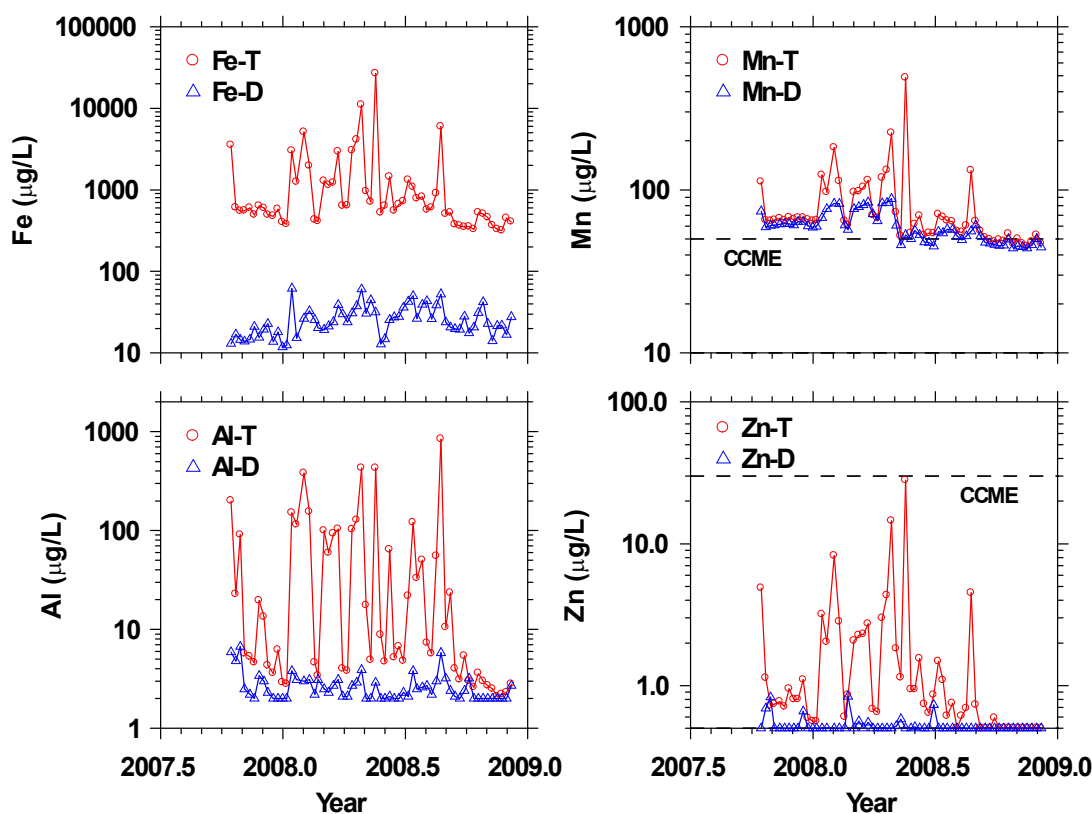


Figure 10: Chemographs of total (T) and dissolved (D) concentrations for selected metals in discharge from 800-Level.

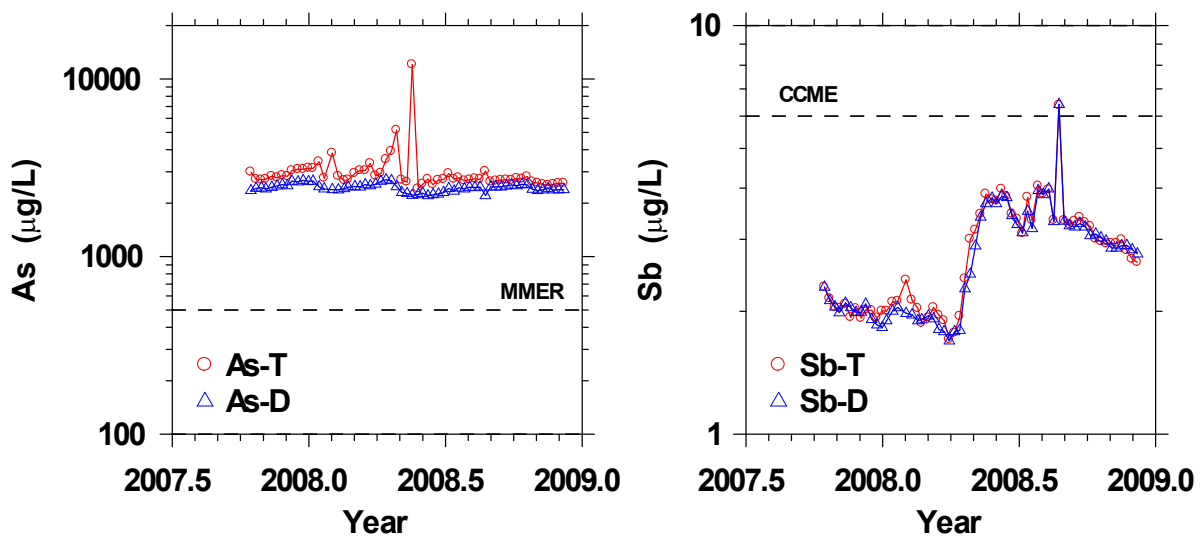


Figure 11: Chemographs of total (T) and dissolved (D) concentrations of As and Sb in discharge from 800-Level.

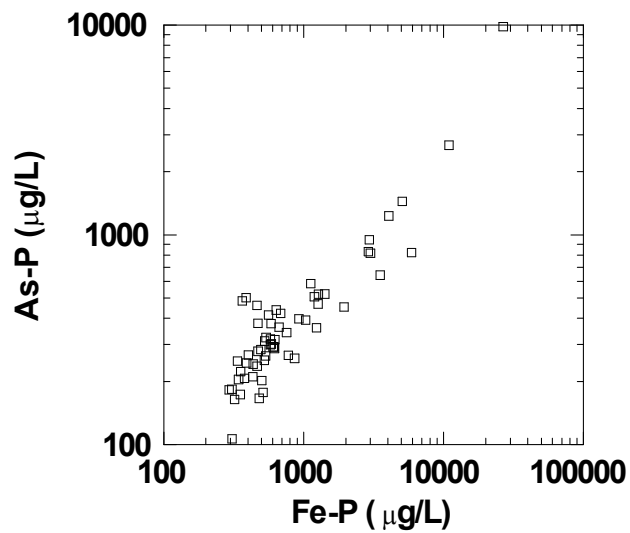


Figure 12: Plot of suspended particulate (P) As versus particulate (P) Fe in discharge from 800-Level.

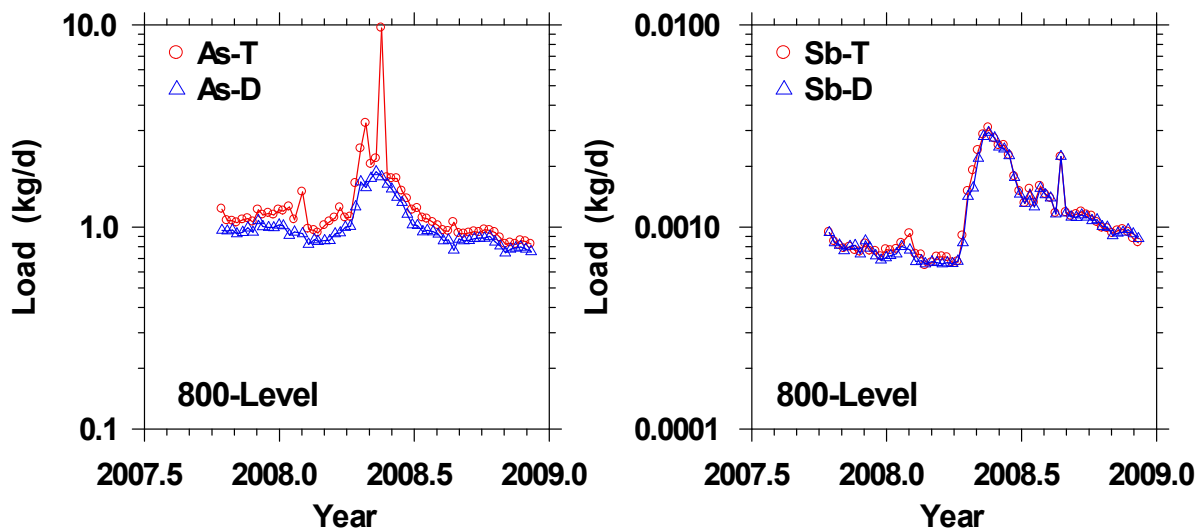


Figure 13: Loadings of total (T) and dissolved (D) As and Sb in discharge from the 800-Level adit.

Chapter IV Upper Peter Adit

Mine-water Flow

Groundwater has flooded the decline and lower mine workings accessed from the Upper Peter adit. The resulting pool of mine-water decants to the adit and drains through the portal to a small settling pond and a wetland beyond. The flume was sited 80 m inside the portal where ambient conditions were expected to be warm enough to prevent freezing during the winter. Unfortunately, freezing conditions did develop in the adit in mid-December of 2008 and no further flow measurements were obtained. At the portal, where drainage chemistry was sampled, flow ceased due to freezing conditions between early December 2007 and mid-May 2008. Thus, no drainage chemistry results are available for that period.

Generally, because the workings are at shallow depth, the hydrograph response to rainfall or snowmelt events is relatively rapid and sharp (Figure 14 –top). Nonetheless, during most of the monitoring period, the Upper Peter adit flowed at the very modest median rate of 7.2m³/d or about 5 L/min. Discharge peaked in early May of 2008 at more than 30m³/d (22 L/min). It should be noted that discharge from the adit is well below the 50m³/d threshold that triggers the application of MMER. The chemograph of electrical conductivity (Figure 14 – bottom) shows minor fluctuations over the year albeit with a clear freshening associated with the infiltration of snowmelt in the spring.

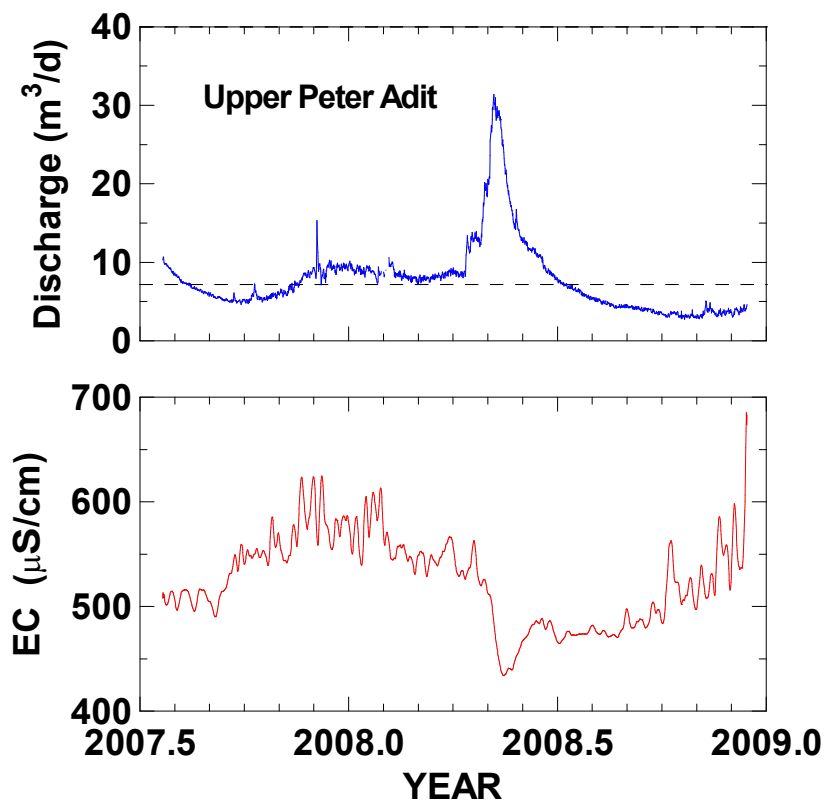


Figure 14: Hydrograph of discharge rate from the Upper Peter adit between July 1 2007 and December 31 2008 (top); Chemograph of effluent electrical conductivity (bottom).

Mine-water Chemistry

Major Species and pH

The box plots of Figure 15 characterize concentrations of the major dissolved species in drainage from the Upper Peter adit. Although concentrations are lower than those observed in effluent from the 800-Level adit, the chemical signature appears similar. However, in relative terms, the ternary plots of Figure 16 show that the composition of drainage from the Upper Peter adit is somewhat different: Sulfate proportions are lower relative to those of other anions whereas bicarbonate proportions are higher. Chloride fractions are much lower than those observed in the drainage from 800-Level. These observations reflect the very short groundwater infiltration path to the Upper Peter workings.

Chemographs of effluent pH and alkalinity show little variation over time (Figure 17) and pH stays well below the MMER limit for alkaline drainage. Hardness and sulfate concentrations are fairly constant throughout the year (Figure 18) although there is an indication that levels may be somewhat higher over the winter months when sampling was interrupted.

Metals

Although the composition of drainage from the Upper Peter adit is similar to that of the 800-Level adit in terms of major dissolved species, the box plots of concentrations in Figure 19 suggest significant differences in their trace metal signatures. Drainage from the Upper Peter adit contains much higher levels of Zn, Ni and Sb and lower levels of Fe and Mn. Although still very high, concentrations of As are lower than those in drainage from 800-Level also.

Chemographs of selected metals do not show any clear pattern of variation over the year (Figure 20). Manganese appears to occur mainly in dissolved form. Zinc concentrations approach their CCME limit likely due to Zn mobilization from minor sphalerite mineralization in the Upper Peter workings.

Concentrations of the contaminants of concern, As and Sb, show little variation throughout the year and these species are almost entirely in dissolved form (Figure 21). However, concentrations of As and Sb greatly exceed MMER and CCME regulatory limits, respectively. Concentrations of Sb are particularly high and would represent an environmental concern if the loadings from the adit were not so low due to the weak flows.

Arsenic and Antimony Loadings

Temporal variations in As and Sb loadings in drainage from the Upper Peter adit are shown in Figure 22. Given that concentrations of these species do not vary much (Figure 21), variations in loadings are mainly the result of flow variations. Loadings of As in drainage from the Upper Peter adit are approximately three orders of magnitude lower than in drainage from 800-Level. However, Sb loadings are of the same order magnitude as those observed on 800-Level.

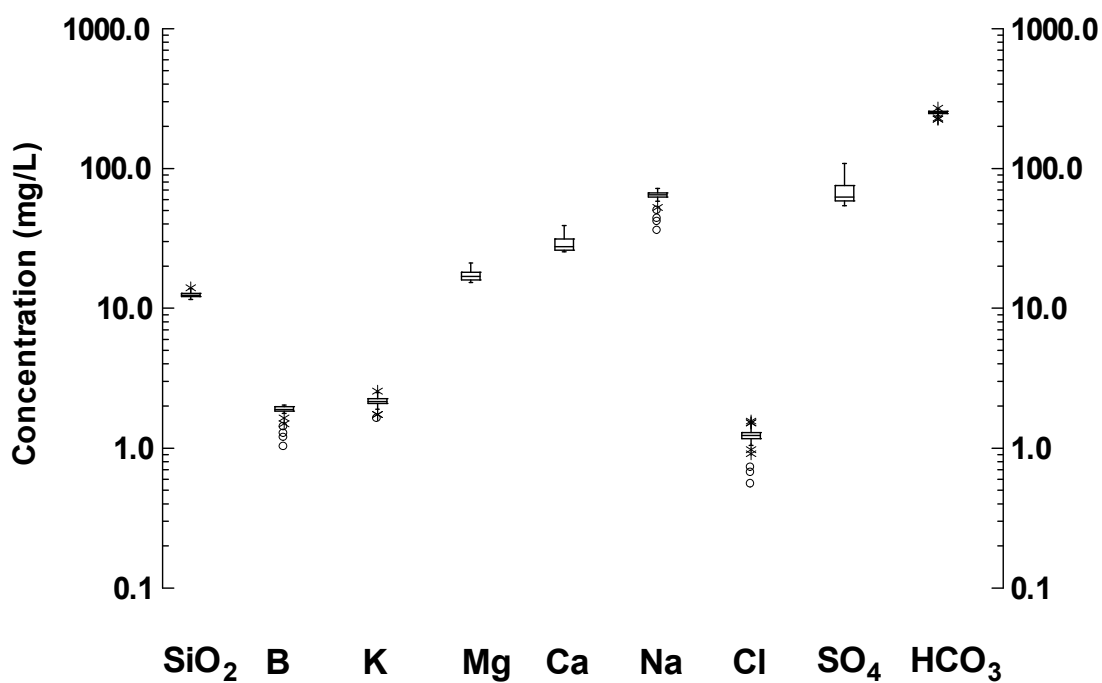


Figure 15: Box plots (n=36) of concentrations of major dissolved species in drainage from the Upper Peter adit.

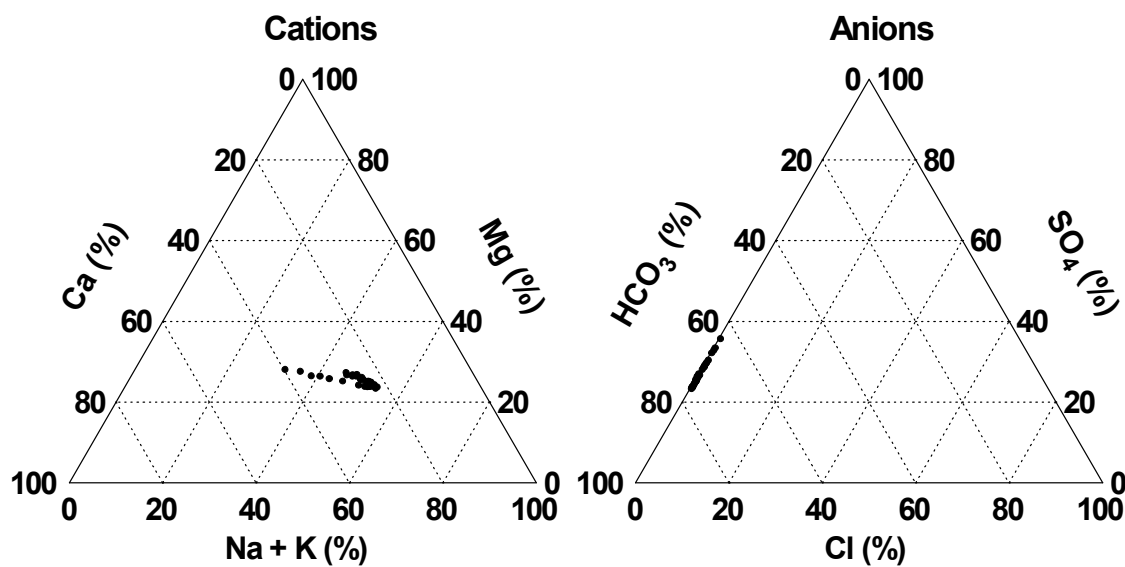


Figure 16: Ternary plots showing the relative composition of cations and anions (in % equivalents) of discharge from the Upper Peter adit.

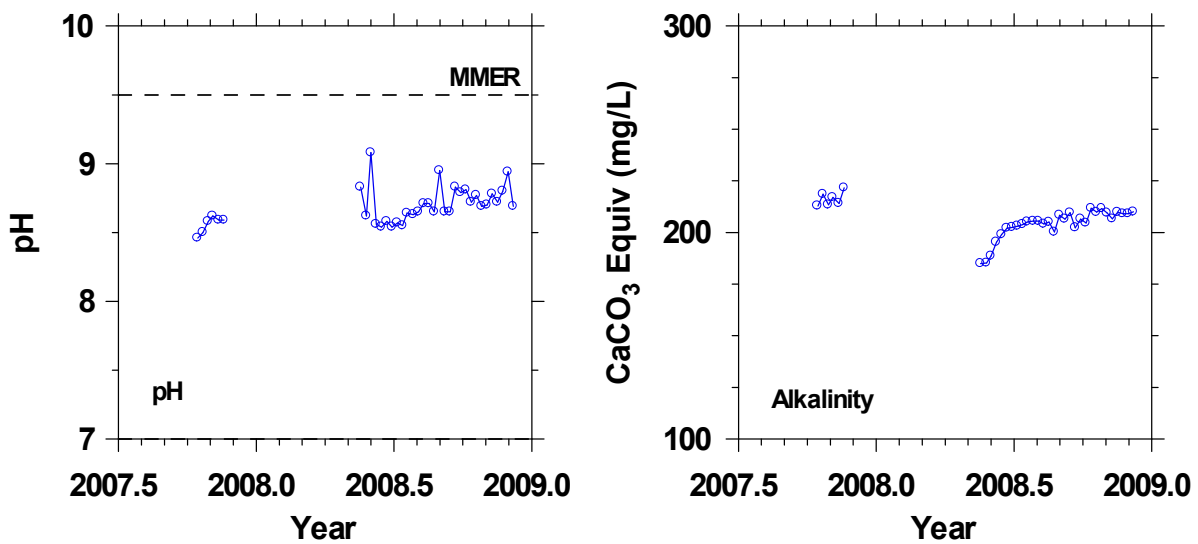


Figure 17: Chemographs of pH (left) and alkalinity (right) for discharge from the Upper Peter adit.

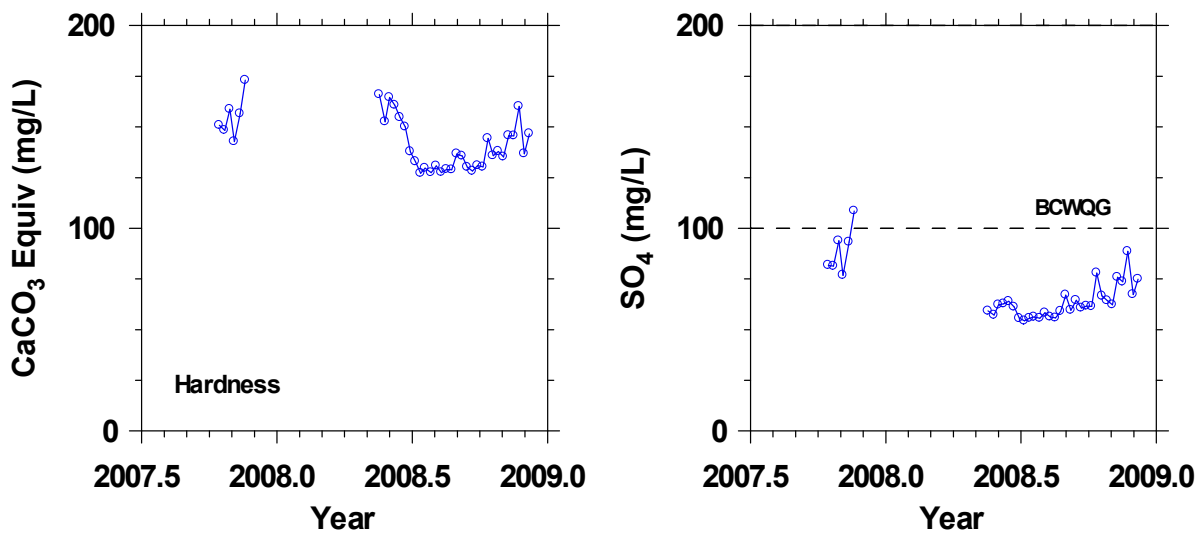


Figure 18: Chemographs of hardness (left) and sulfate (right) in discharge from the Upper Peter adit.

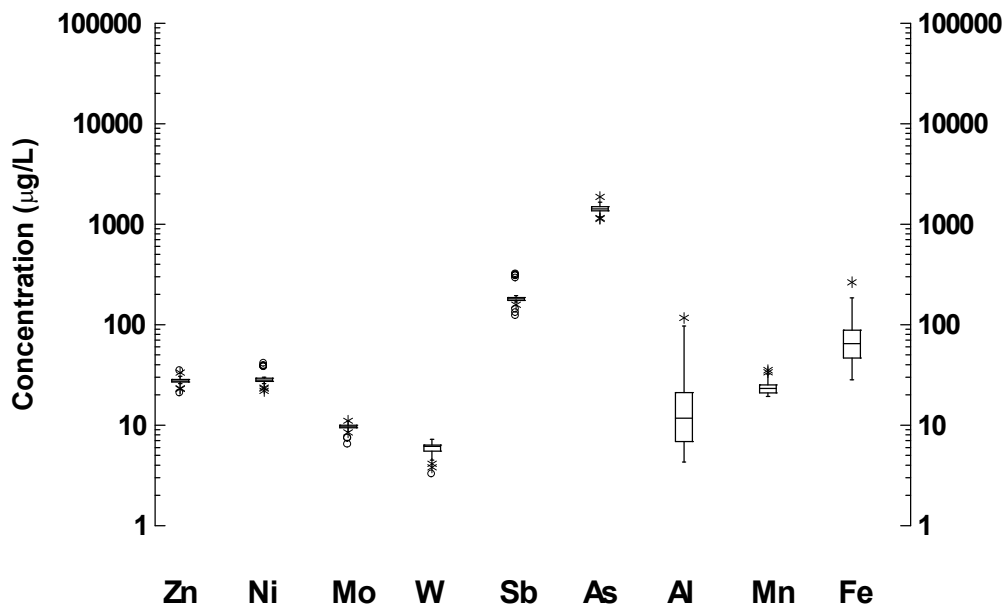


Figure 19: Box plots (n=36) of (total) concentrations for selected metals in drainage from the Upper Peter adit.

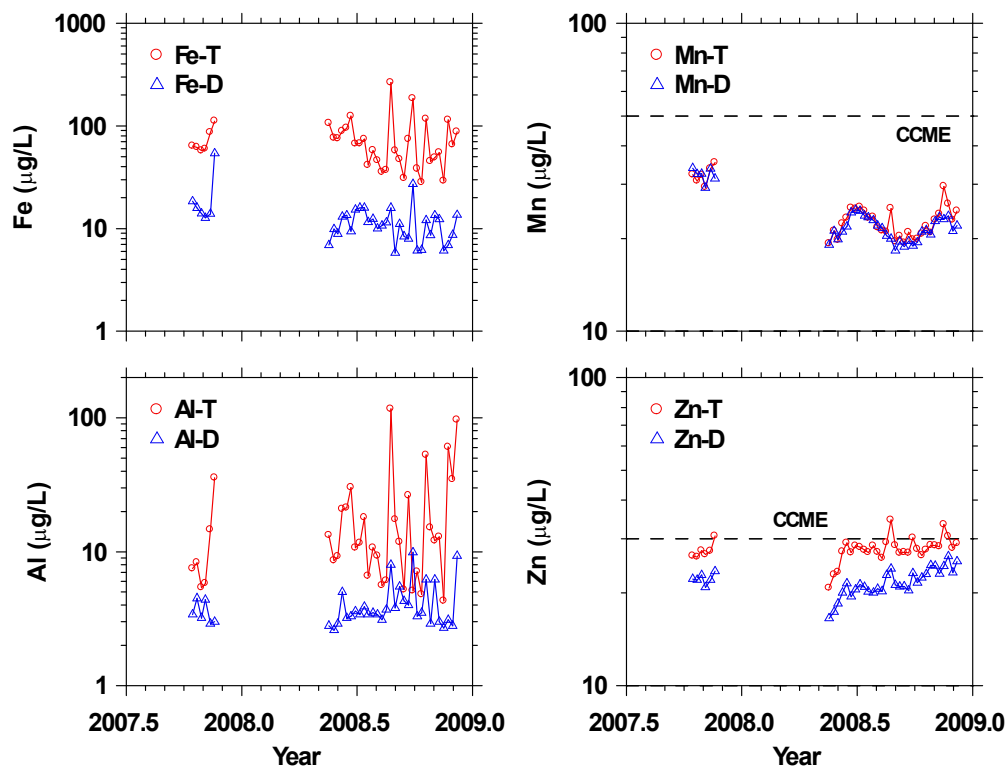


Figure 20: Chemographs of total (T) and dissolved (D) concentrations for selected metals in discharge from the Upper Peter adit.

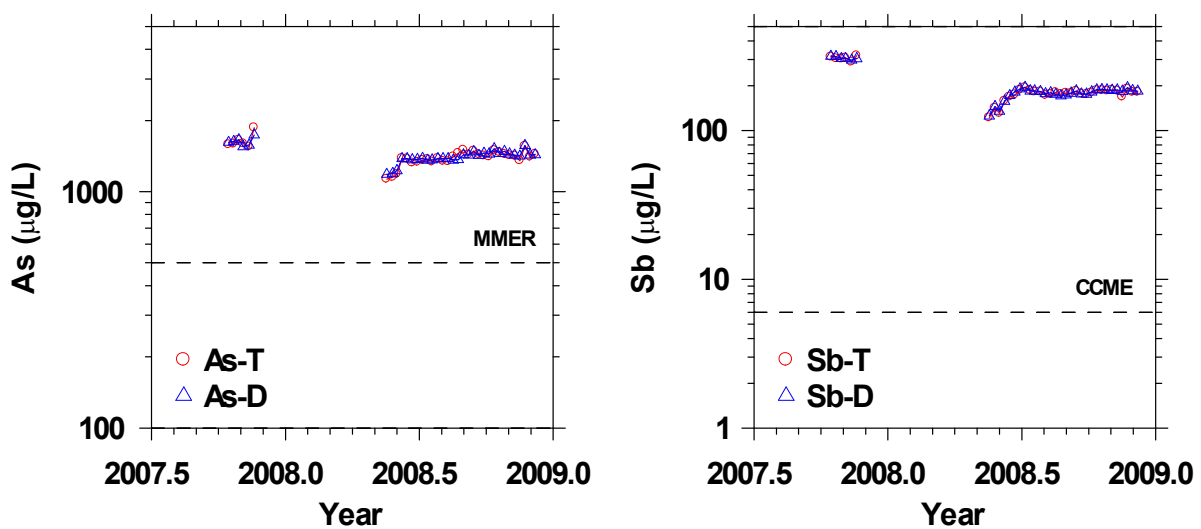


Figure 21: Chemographs of total (T) and dissolved (D) concentrations of As and Sb in drainage from the Upper Peter adit.

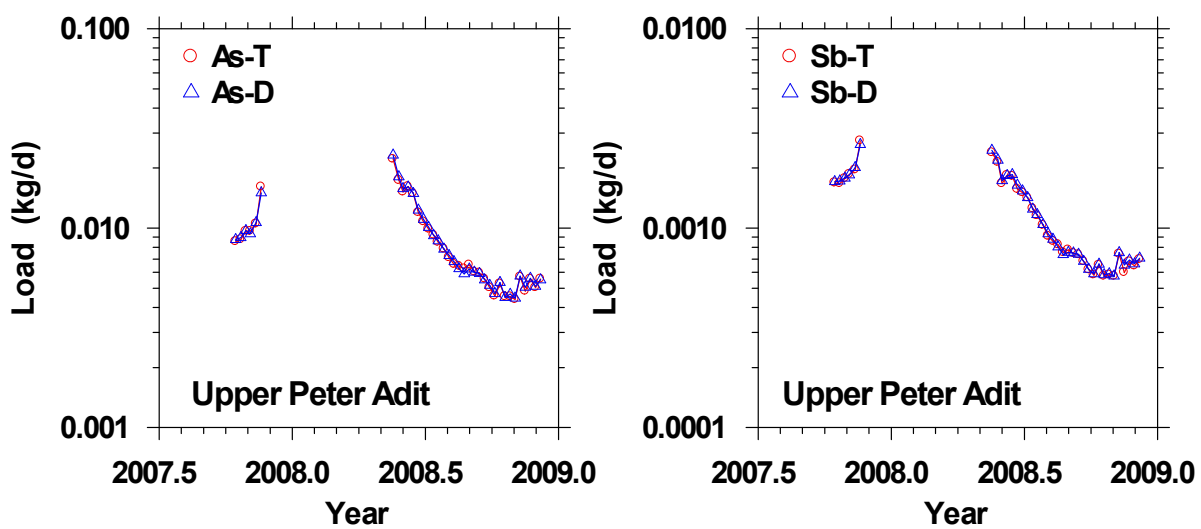


Figure 22: Loadings of total (T) and dissolved (D) As and Sb in drainage from the Upper Peter adit.

Chapter V Summary

- Median discharge rate from the 800-Level adit during the study period was 366m³/d while the peak observed flow was 841m³/d during the spring freshet of 2008.
- Approximately 62% of discharge from 800-Level originates at the 55 Vein stope where there is upwelling of warm (22°C), high-arsenic (5600 ug/L) mine-water from the flooded workings of the Bralorne Mine. (Observations of October 2007)
- Drainage from 800-Level is moderately alkaline, with pH ranging between 8.3 and 9.5.
- Median total arsenic (As) and antimony (Sb) concentrations in drainage from 800-Level were 2741 µg/L and 2.8 µg/L, respectively. Corresponding median dissolved (< 0.45 µm) concentrations were 2451 µg/L and 2.8 µg/L , respectively.
- Average total loadings of arsenic and antimony from 800-Level were 1.34 kg/d and 0.001 kg/d, respectively.
- Approximately 24% of the arsenic mass flux from 800-Level is sorbed on iron oxyhydroxide particulates. Sorbed arsenic is also accumulating in the workings and large quantities may be flushed during spring freshet.
- Median discharge rate from the Upper Peter adit during the study period was 7m³/d while the peak observed flow was 30m³/d during the spring freshet of 2008. These flows are below the 50 m³/d threshold that triggers the Metal Mine Effluent Regulations (MMER).
- The drainage from the Upper Peter adit is moderately alkaline, with pH ranging between 8.4 and 9.1.
- Median total arsenic (As) and antimony (Sb) concentrations in drainage from the Upper Peter adit were 1427 µg/L and 198µg/L, respectively. All As and Sb occurred in the dissolved (< 0.45 µm) phase.
- Average total loadings of arsenic and antimony from Upper Peter adit were 0.009 kg/d and 0.001 kg/d, respectively.

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Appendix 1: Agreement between NRCan and Bralorne Gold Mines Ltd.

Geoenvironmental Model for Mesothermal Lode Gold Deposits

LETTER OF AGREEMENT

BETWEEN

BRALORNE GOLD MINES LIMITED, A COMPANY INCORPORATED UNDER THE LAWS OF CANADA, HAVING A BUSINESS ADDRESS AT SUITE 400, 455 GRANVILLE ST., VANCOUVER, BRITISH COLUMBIA, CANADA, V6C 1T1

AND

**HER MAJESTY THE QUEEN IN RIGHT OF CANADA,
AS REPRESENTED BY THE MINISTER OF NATURAL RESOURCES CANADA
AND ACTING THROUGH THE EARTH SCIENCES SECTOR**

This Agreement is made in duplicate.

Bralorne Gold Mines Limited (hereinafter "the Company"), and Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada, and acting through the Earth Sciences Sector (hereinafter the "ESS"), have agreed to undertake the collaborative project described below. Work carried out under this Agreement supports the ESS Program on Environment and Health through the project on "Assessing and Reducing Risk from Metals in the Environment".

DEFINITIONS

In this Agreement:

"Agreement" means this Agreement and any attached Schedule(s).

"Background Intellectual Property" (hereinafter "Background IP") means the rights to all inventions, patents, know-how, data and information and other rights owned by a party prior to the commencement of this Agreement and essential for the performance of any work under this Agreement.

"Intellectual Property" (hereinafter "IP") means any information developed in the performance of the Project including, without limitation, data, techniques, methods, processes, know-how, inventions, designs, formulae, photographs, drawings, plans, specifications, reports, studies, technical and procedural manuals, programs including computer hardware and software and source code, whether susceptible to copyright or not, and all patents, copyrights, trademarks and industrial designs arising therefrom.

"Project" means the Project described below.

OBJECTIVES / PURPOSE AND SCOPE

The overall objective of this project is to develop a geoenvironmental model for mesothermal lode gold deposits by studying the archetypal historic Bralorne and Pioneer mine sites in British Columbia, and other mineralized areas in the Cadwallader Creek catchment in British Columbia (hereinafter the "Project"). Such a model will be used to predict, qualitatively or semi-quantitatively, the environmental effects associated with the development of similar gold deposits throughout Canada.

Geoenvironmental models of ore deposit types are integrated compilations of geological, geochemical and hydrological knowledge pertaining to the environmental behaviour of different classes of ore deposit through the exploration, mining and post-closure phases of their development. They characterize the environmental signatures of these ore deposit types in the waters, soils, and wastes associated with natural background conditions and subsequent mining activities. A geoenvironmental model for mesothermal lode gold deposits will be developed through research in the Bralorne camp aimed at defining catchment-scale natural background levels for metal(loids) of concern, and at characterizing the processes controlling the release, transport and bio-accessibility of metal(loids) from mine wastes and drainage waters. These research objectives will be addressed through the following activities:

- 1) Monitor the flow rate and chemistry of drainage from mine portals.
- 2) Collect and analyze soils, mine wastes, sediments, and surface water samples.
- 3) Analyze metal(loid) concentrations and speciation in mine wastes and waters.
- 4) Sample host rocks and secondary minerals, and perform analyses of mineralogy.
- 5) Characterize metal release from submerged mine wastes.

Upon conclusion of the fieldwork, lab analyses and interpretation, project members will prepare reports, maps, and databases summarizing the key results of this geoenvironmental models investigation. These reports will consist of traditional scientific outputs and conference presentations, online databases, and website descriptions of activities.

PROJECT SCHEDULE

Field investigations will be carried out in the Bralorne camp between April 1st and October 31st in each of the years 2007 and 2008. Proposed dates for site visits by the ESS staff will be discussed with the Company, and as planning for the field season proceeds to accommodate the schedules of both parties. In 2007, the ESS anticipates two two-week site visits, likely in June, and again in late August or September. In 2008, similar site visits are anticipated. The final project report shall be completed by fiscal year-end March 31st 2009.

DURATION

The Agreement between the Company and the ESS shall come into force upon execution by the parties and shall expire on March 31st, 2009, unless terminated earlier in accordance with the provisions of this Agreement. The Agreement may be extended upon mutual written consent of the parties.

ESS RESPONSIBILITIES

The ESS shall keep the Company informed of ongoing developments in Project plans, scheduling of field activities, and progress of laboratory analyses as the Project proceeds. Copies of interim Project reports (e.g. conference abstracts, posters) will be provided to the Company as they become available. Upon the conclusion of the Project in March 2009, the ESS staff will complete a final report for release to the Company containing the results of all monitoring and sample analyses conducted on the properties of the Company. The report will contain interpretations of results as they relate to the exploration and environmental objectives of the Company. In addition, the ESS shall complete peer-reviewed publications for release to the scientific community and make these publications available to the Company.

While working on the Company property, the ESS staff (including contracted assistants or project partners) agree to follow Company policies regarding personal conduct and health and safety requirements. The ESS will conduct its share of the Project in a diligent and professional manner, and in accordance with the applicable laws of the Province of British Columbia.

THE COMPANY'S RESPONSIBILITIES

The Company shall provide the ESS scientists with an indoor working area and access to the mine site for the duration of this Agreement, as safety and any other over-riding considerations permit. The Company shall also provide the ESS scientists (and contracted assistants or project partners) with meals and accommodation in camp. The ESS will cover the costs of accommodating female members of the Project team in nearby motels, unless suitable accommodations exist on the Company's property. The Company shall provide copies of ongoing environmental monitoring data to the ESS to assist in the Project planning. The Company will communicate any changes, in writing, regarding site access or the environmental conditions surrounding pre-determined ESS sampling or monitoring points to the ESS staff as soon as possible so that these changes may be incorporated into the Project plan and/or interpretation of results.

RESOURCE CONTRIBUTION AND FUNDING ARRANGEMENTS

There will be no exchange of funds between the parties under this Agreement. No cost incurred by one party will be assumed by the other party unless agreed to in writing prior to incurring such cost.

The ESS shall contribute in-kind support valued at approximately \$200,000 in each of fiscal years 2007-2008 and 2008-2009 toward this Project. This amount shall consist primarily of return travel costs to Bralorne, British Columbia, materials and supplies, data logging, sampling equipment, contract analyses, in-house ESS laboratory services, publication charges, ESS staff salaries and possible accommodation expenses for female members of the Project team.

The Company shall contribute in-kind support valued at \$25,000 toward this Project. This amount shall consist primarily of meals and accommodation for the ESS scientists, and occasional time of the Company's personnel.

DISPOSITION OF ASSETS

Any assets purchased or acquired in support of the Project will be the property of the purchasing party at the completion or termination of the Project.

INTELLECTUAL PROPERTY

The Company and the ESS shall retain all rights and title to their existing proprietary knowledge and Background Intellectual Property that they bring to the Project. Intellectual Property arising out of, or resulting from this Project, shall be owned by the ESS.

As part of this Agreement, the ESS hereby grants to the Company a non-exclusive, royalty-free, irrevocable, worldwide, and perpetual right to publish and redistribute the Intellectual Property arising out of or resulting from this Project. Notwithstanding these rights granted to the Company, the ESS retains the sole right to present Project results at scientific conferences and to publish data and interpretations in the ESS products and peer-reviewed scientific journals.

The ESS shall provide copies of all data and related publications, in digital and/or hard copy format, to the Company upon the completion of the Project.

PUBLICATIONS

The ESS and the Company may release into the public domain general information regarding the Project such as its title, the name of the Company and the level of the ESS and the Company support.

AMENDMENT

No amendments of this Agreement or any waiver of any of the terms and provisions shall be valid unless effected by a written amendment signed by the authorized representative of the parties.

TERMINATION

Either party may, by giving the other party thirty (30) days written notice, terminate this Agreement. Each party shall immediately upon termination, return the other party's papers, materials or other property held for the purpose of carrying out the Project. Notwithstanding any other provisions set out in this Agreement, upon termination all expenses and costs incurred by a party shall be paid for by the party who incurred such expenses and costs.

INDEMNIFICATION

The ESS shall indemnify and save harmless the Company, its officers, employees and agents from and against any and all claims, losses, damages, costs, expenses, actions and other proceedings brought, made, sustained, prosecuted or threatened to be brought or prosecuted, in any manner based upon, occasioned by or attributable to any injury to or death of a person or damage to or loss of property arising from any willful or negligent act or omission on the part of the ESS or its officers, employees or agents in the performance of this Agreement. The Company shall have the right to defend any such action or proceeding with counsel of its own choosing.

The Company shall indemnify and save harmless the ESS, its officers, employees and agents from and against any and all claims, losses, damages, costs, expenses, actions and other proceedings brought, made, sustained, prosecuted or threatened to be brought or prosecuted, in any manner based upon, occasioned by or attributable to any injury to or death of a person or damage to or loss of property arising from any willful or negligent act or omission on the part of the Company or its officers, employees or agents in the performance of this Agreement. The ESS shall have the right to defend any such action or proceeding with counsel of its own choosing.

INSURANCE

The ESS is its own insurer and as such will assume all the risks and financial responsibility for any loss or damage to its own property and premises caused by its servants and agents.

LIMITATION OF LIABILITY

Neither party shall be liable to the other party for loss of revenue or contracts, or any consequential loss of any kind relating to the Project or this Agreement.

WARRANTY

The ESS makes no representation or warranty respecting the results arising from the Project, either expressly or implied by law or otherwise, including but not limited to, implied warranties or conditions of merchantability or fitness for a particular purpose.

CONFIDENTIALITY

All information and data concerning or derived from scientific work performed by the ESS shall be available to the public. The ESS shall not disclose any proprietary information belonging to the Company to any person other than its staff, and its own professional advisors or consultants, without the prior written consent of the Company. Such proprietary information belonging to the Company shall be marked by the Company as "Confidential". Except to the extent required by law or by regulation of any securities commission, stock exchange or other regulatory body having jurisdiction over the Company, such information will be maintained confidential by the Company. The text of any news releases or other public statements which the Company is required to make with respect to the Project pursuant to the foregoing shall be made available to the ESS prior to publication, and the ESS shall have the right to review and make suggestions for changes therein within forty eight (48) hours of delivery, except on Saturday, Sunday or statutory holiday in Ontario, when said review will be conducted on the two next business days.

NOTICE

Where in this Agreement any notice is required to be given or made by either party, it shall be in writing and is effective if it is sent by registered mail, by facsimile, by electronic mail or delivered in person, addressed as follows:

For: Bralorne Gold Mines Limited
Name: William G. Kocken, President and Director
Address: Suite 400, 455 Granville St. Vancouver, BC V6C 1T1
Phone: (604) 682-3701
Fax: (604) 682-3600
E-mail: mining@bralorne.com

For: The Earth Sciences Sector, Natural Resources Canada
Name: Andrew Rencz, Environment & Health Program Manager
Address: Room 208, 601 Booth Street, Ottawa ON K1A 0E8
Phone: (613) 995-4786
Fax: (613) 947-8768
E-mail: Andy.Rencz@nrcan-nrcan.gc.ca

Any notice shall be effective if sent by registered mail, when the postal receipt is acknowledged by the other party; by electronic communication or facsimile, when transmitted and receipt is confirmed; and by messenger or specialized courier agency, when delivered. A party may change its representative or address by giving written notice of change to the other parties in accordance with this clause.

ACKNOWLEDGEMENT

The parties agree to acknowledge the role and contribution of each other in any publications, other media and/or announcements relating to the Project or this Agreement.

ASSIGNMENT

This Agreement may not be assigned in whole or in part by a party without the prior written consent of the other party and any assignment made without that consent is void and of no effect.

Where an assignment of this Agreement is made pursuant to the above clause, such assignment shall not relieve the assignor of any obligation under this Agreement or impose any liability upon the remaining party.

APPLICABLE LAW

This Agreement shall be interpreted in accordance with the laws in force in the Province of British Columbia.

DISPUTE RESOLUTION

The parties agree to negotiate all disputes arising from this Agreement in good faith after receiving written notification of the existence of a dispute from any party.

FORCE MAJEURE

No party shall be liable to the other party for any failure or delay in the performance of the Project caused by a force majeure. Should a force majeure affect the operation or completion of the Project, the parties shall consult with each other and decide on the necessary action to take. For the purpose of this Agreement, the term "force majeure" means any circumstances beyond the control of a party including, but not limited to, acts of God, labour difficulties, transportation problems or governmental action.

LEGAL RELATIONSHIP

Nothing in this Agreement creates the relationship of principal and agent, employer and employee, partnership or joint venture between the parties.

SUCCESSORS

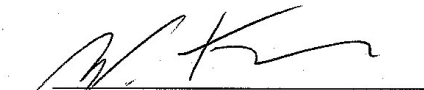
This Agreement shall enure to the benefit of and shall be binding upon the parties and their respective representatives, successors and assigns.

ENTIRE AGREEMENT

This Agreement constitutes the entire agreement between the parties with respect to the subject matter of this Agreement and supersedes all previous negotiations, communications and other agreements, whether written or oral, between the parties in respect of the same subject matter.

IN WITNESS WHEREOF each of the parties has caused this Agreement to be duly executed as of the last day and year written below.

BRALORNE GOLD MINES
LIMITED



William G. Kocken

President and Director

Title President

May 24-07

Date

HER MAJESTY THE QUEEN IN RIGHT OF
CANADA, AS REPRESENTED BY THE
MINISTER OF NATURAL RESOURCES
CANADA



Dr. Andrew Rencz

Program Manager

Title

May 08/07

Date

Appendix 2: Water Sampling Protocol

WATER SAMPLE COLLECTION

- 1) Before heading out to sample: calibrate Electrical Conductivity (EC) meter using 1413 uS/cm solution; calibrate pH meter using pH=7 buffer solution (first) and pH=10 buffer solution (second).
- 2) Before heading out to sample: pre-label 60 mL HDPE sample bottles as follows (one set of three for each the 800 Level portal and the Upper Peter portal): dissolved cations, filtered and acidified (marked C+ and FA); total cations, unfiltered and acidified (marked C+ and UA); anions, filtered and unacidified (marked A- and FU). Indicate the date and approximate time of sampling.
- 3) At each sample site (800 level and Upper Peter): Record EC, pH and temperature of water. Record temperature readings from both the EC and pH meters.
- 4) At each sample site (800 level and Upper Peter): Rinse the corresponding 1L HDPE sample collection bottle at least three (3) times with the water being collected in order to remove any possible contamination.
- 5) Collect water samples in rinsed 1L bottles. Fill bottles completely in order to minimize air space. At 800 Level, collect sample directly from flume discharge point. At the Upper Peter portal, take sample upstream of rinsing and try not to muddy bottom of channel. Use scoop (rinsed 3 or more times) to fill bottle if water is too shallow to dip bottle.
- 6) Return to base with filled 1L bottles from both sample locations.
- 7) Back at home:
 - a) **Unfiltered Cation Samples:** For each sample location, rinse the total cations (C+ UA) sample bottle at least twice (10-20 mL per rinse), pour directly from the 1L collection bottle, and leave just enough space for adding 0.5 mL acid later on.
 - b) **Filtered Cation Samples:** Select fresh syringe and filter(s) for each sample location and rinse syringe at least three times with sample water; Remove the plunger from the syringe and place a filter capsule on the end of the syringe (do not touch the tips of the syringe or filter with your hands, handle from the sides only). Carefully pour water from the 1L collection bottle into the syringe barrel (water may begin to drip through the capsule filter, so take care to avoid contaminating other samples). Gently reinsert the syringe plunger, discard about the first 40 mL of sample through the filter. Use the next 10 mL through the filter to rinse the dissolved cations (C+ FA) sample bottle. Discard the 10 mL of rinse sample, shaking to remove excess. Repeat the process (temporarily remove the filter before removing the syringe plunger) and fill the (C+ FA) bottle, leaving just enough space for adding 0.5 mL acid later on.
 - c) **Filtered Anion Samples:** Repeat the rinsing, filtering and filling for the anions (A- FU) sample bottle. If you need to replace the filter (it may get clogged), remember to rinse filter with the first 40 mL of sample. *Fill the anions (A- FU) bottle to the top, leaving no airspace*, and seal tightly. Discard any excess water once you have completed the bottle filling.
- 8) Store water sample bottles in a cooler or fridge (do not allow bottle to be immersed in ice water, store in plastic bags, by batch, and keep dry) and acidify as soon as possible (within 24 hours) as per the instructions that follow. The 1L sample collection bottles should be rinsed out with distilled water after all 60 mL bottles are filled.

WATER SAMPLE (CATIONS) ACIDIFICATION

General comments:

Please use caution when working with nitric acid. See attached MSDS sheets. Ensure that proper safety procedures are followed when handling nitric acid. It can cause severe burns. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. In case of contact with skin, rinse with plenty of water, if available neutralize acid with a mild basic neutralizing solution or make a paste of baking soda (off the shelf) and water. Wear suitable protective equipment (eye protection). Non-powered vinyl gloves have been provided (do not use powdered gloves: powder will contaminate the water samples).

- 1) Attach a 10 mL Repeater Plus “Combitip” syringe (*new syringe each sampling day*) to the Eppendorf Repeater Plus pipette. Set the dial on the Repeater to 2.5 (2.5 = 0.5 mL).
- 2) Loosen the lids (but do not remove) of all of the sample bottles to be acidified, ie those marked “C+” for cations.
- 3) Rinse the small 15 mL HDPE round bottle labelled “ACID” with a small amount of DDI (Deionized Distilled water). Transfer the approximate amount of acid required to acidify the samples collected by pouring from the Teflon 8M nitric acid “mother” bottle into the round 15 mL HDPE bottle (be careful not to contaminate the lid of the Teflon Nitric acid i.e. do not place face down on the work surface).
- 4) Follow the instructions provided with Repeater Plus Pipette (RPP) to fill the syringe with the 8M nitric acid provided. The lower lever is used for filling the syringe; the top, spring loaded lever, is used for dispensing. Using the lower lever, fill syringe to about 1/3 to 1/2, ie enough to acidify the four C+ bottles of the day (or about 5 mL to account for the acid loss during priming). Do not immerse the syringe any further than necessary into the acid bottle for filling (i.e. do not immerse any writing on the repeater syringe in the acid) or you will contaminate the acid.
- 5) Prime the Repeater Plus Pipette (RPP) into a spare bottle (label this bottle as “waste”) containing a small amount of DDI water by depressing the (top) dispensing lever once or more, until any air bubbles are gone from the syringe.
- 6) With one hand, lift the loosened lid off the sample bottle, with the RPP in your other hand, dispense one 0.5 mL dose (dial set at 2.5 on the RPP) of the nitric acid into the sample (making sure to hold the tip of dispenser at least 2-3 cm above the sample surface to avoid contaminating the tip), immediately replace cap (do not re-tighten until all samples have been acidified) and proceed to next sample bottle marked “C+”. Refill the syringe if required (each sample should receive the same amount of acid so you should refill and reprime the repeater **before** it is empty. If it is necessary to put the RPP down, it can be placed on its side but you must ensure that the “Combitip” syringe does not come in contact with anything (counter, clothing etc). If the tip becomes contaminated, replace with a fresh one.
- 7) Tighten caps on all four bottles marked “C+” and shake the samples to mix.
- 8) Do not return any unused acid to the Teflon 8M acid “mother” bottle. Transfer any acid remaining in the 15 mL HDPE round bottle into the bottle labelled “waste”. Rinse the HDPE bottle with DDI water and recap. This bottle can be used several times but if contamination is suspected use a new bottle. Several bags of 15 mL bottles are provided. Empty the RPP “Combitip” syringe into the “waste” bottle and rinse the syringe well with tap water prior to disposal.
- 9) Until shipment and analysis, the samples should be stored in a cool dark location. Refrigeration to 4°C is ideal.

CONTROLS - BLANKS AND DUPLICATES

Four different types of control are used to flag problems (contamination, analytical errors) in the sampling, preparation, shipment and analysis of water samples. They are designed to pin-point where in the process a problem may be occurring. Each type of control is described below:

Sample blanks

The idea of a sample blank is to prepare a 60 mL bottle of DDI water as you would a filtered and acidified water sample. This type of control will highlight any contamination problems associated with the sample preparation procedure. To prepare a sample blank: Transfer enough DDI water from “mother” container to a collection bottle after rinsing it. *Do not use a previously used collection bottle, except one that is reserved for DDI water only.* Using a fresh filter and syringe, rinsed as per instructions, fill a 60 mL sample bottle marked “SB – FA” (Sample Blank- filtered and acidified). Acidify the sample blank along with regular samples, as per instructions. Prepare one sample blank per batch of samples shipped to the GSC lab, ie every four weeks. This is equivalent to one sample blank per eight samples.

Acid blanks

The idea of an acid blank is similar to that of a sample blank. However, this type of control will highlight any problem with the acid used to prepare the samples. Prepare an acid blank as you would a sample blank but do not filter the sample. Simply pour water directly from the DDI collection bottle into a DDI-double-rinsed 60 mL sample bottle and acidify along with regular water samples, as per instructions. Mark the acid blank bottle as “AB – UA” (Acid Blank – unfiltered and acidified). Prepare one acid blank per batch of samples shipped to the GSC lab, ie every four weeks. This is equivalent to one acid blank per eight samples.

Travel blanks

A travel blank is similar to an acid blank except that the sample bottle of DDI water is sent to you from the GSC lab. This type of control is used to identify problems with the shipping and handling of water samples. Using a pre-filled DDI sample bottle from the GSC, acidify the travel blank along with regular samples and the other blanks. Mark the travel blank bottle “TB – UA” (Travel Blank – unfiltered and acidified). Prepare one travel blank per batch of samples shipped to the GSC lab, ie every four weeks. This is equivalent to one travel blank per eight samples.

Duplicate field samples

A duplicate field sample is just like a regular water sample. It is a type of control that flags accidental contamination during the sampling process. To prepare a duplicate sample, simply fill two additional 60 mL sample bottles marked “DUP C+ FA” (Duplicate, cations, filtered and acidified) and “DUP A- FU” (Duplicate, anions, filtered and unacidified) as per usual procedure. Do this once every four weeks, for a random sampling day, alternating between the Upper Peter portal and the 800 Level portal.