

Use of a Field Portable Photometer for Rapid Geochemical Analysis of Streamwater and Springwater: a Case History from Poison Mountain, Southwestern British Columbia (NTS 0920/02)

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Introduction

Mineral exploration traditionally focuses on the analysis of rock, soil and stream sediment sampling for the detection of primary and secondary dispersion anomalies derived from outcropping mineralization. In the past, the analysis of surficial water samples for this purpose has been underutilized by the mineral exploration community because of the perceived difficulty of sampling and the relatively high cost of analysis at commercial laboratories. Now, alternative techniques are available that can provide rapid field analysis of waters at a relatively low cost and, hence, can significantly improve the ability to make exploration decisions by providing near real-time analyses.

Hydrogeochemistry, or aqueous geochemistry, is used extensively for exploration of geothermal resources (Zehner et al., 2006), but has not seen widespread use in mineral exploration. The application of hydrogeochemistry to mineral exploration is well documented by Taufen (1997). Lett, Sibbick and Runnells (1998) and Leybourne and Cameron (2007). It has been shown to be an excellent technique for identifying commodity and pathfinder element dispersion patterns from both outcropping and concealed mineralization. In addition, it is a good technique for exploring areas with difficult access, such as the coastal mountain ranges of British Columbia. Large areas can be sampled at a low sample density to identify hydrological basins containing anomalous metal sources. When water sampling is used in conjunction with stream sediment geochemistry and water pH, it can be an effective tool for both regional- and property-scale exploration.

A range of analytical instruments called portable spectrophotometers, or photometers, is available for field-based water testing. They can determine ion concentration by

measuring the colour and light transmittance of a solution after the addition of metal-sensitive colour dyes; a technique called visible light reflectance photometry. These devices can measure concentrations of a diverse suite of dissolved anions and cations to relatively low detection limits. The tests can be completed on location; providing almost real-time (i.e., within 48 hours) results. Cost of analysis, including photometer reagents, is a fraction of the cost of analysis at a commercial laboratory. For example, photometer analysis is \$5 to 12 per sample suite (depending on reagent selection) compared to up to \$200 for commercial water analysis. Operating costs for photometer analysis in this study was \$31.25/sample with two operators. Additional savings are realized by other aspects of real-time exploration, such as faster target identification, reduced field and overall exploration time, and a smaller environmental impact footprint than other sampling methods. This innovative technique could have far reaching consequences for exploration and large-scale environmental background testing and monitoring.

This proof of concept study was carried out at the previously drilled porphyry copper-gold-molybdenum deposit at Poison Mountain, southwestern BC (Seraphim and Rainboth, 1976; Raven, 1994; Brown, 1995). The study aims to test the reliability of the Palintest[®] Photometer 8000 by comparing the results from water samples analyzed using this instrument with the results of identical samples analyzed at ALS Environmental laboratory (Burnaby, BC). The study also partially tests for repeatability over time by comparing analyses of the water samples collected in late summer and fall. It also includes a comparison of the results of water sample analysis with stream sediment sample analysis, where applicable.

Interpretation of the results includes an examination of the accuracy and precision of the photometer readings based on replicate readings, the analysis of the manufactures' standard colour solutions and the results of field duplicate samples. The interpretation also addresses the dispersion distances of key anions and cations from the exposed porphyry mineralization and discusses the advantages of using

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this technique for mineral exploration throughout BC and elsewhere.

Background

The photometer field survey technique was conceived by the lead author and field tested on a geothermal exploration program carried out in 2012 by Alterra Power Corp. (Yehia et al., 2013). The geothermal industry relies heavily on water analysis in early stage exploration. To accelerate exploration at reduced cost, new types of devices designed for rapid water testing were investigated. After comparing the devices available at the time, it was decided that the Palintest Photometer 8000 was the most suitable and cost-effective instrument for use in the field. It was chosen mainly for its portability, ease of use, reagent selection (Table 1) and overall cost. Early results from the geothermal project at three main locations around the Coast Mountains of southwestern BC demonstrated the photometer's reliability and showed that meaningful results could be achieved rapidly in the field (Yehia et al., 2013). MYAR Consulting subsequently received cost-sharing funding from Canada's National Research Council (NRC), under the Industrial Research Assistance Program (IRAP), to test the technique's potential for mineral exploration. Results of that study demonstrated that the photometer can produce rapid meaningful field data at relatively low cost (Yehia, 2013).

Project Area

Location and Access

The project area is located approximately 95 km northwest of Lillooet and is accessible via the Yalakom River Forest Service road (FSR). It is bounded by the headwaters of the Yalakom River to the east, and Churn Creek and Buck Mountain to the west (Figure 1). Elevations in the area range from 1600 m in the Yalakom River to 2250 m at the Poison Mountain peak. Above the treeline are bare alpine slopes at approximately at 2075 m and below this level the vegetation is mostly naturally occurring and replanted stands of lodgepole pine. The latter vegetation is located on the eastern slopes of Poison Mountain. The drainage divide south of the mountain between the Yalakom River and Churn Creek is occupied by a large swamp with beaver dams.

Geology

The Poison Mountain porphyry copper-gold-molybdenum deposit consists of disseminated and stockwork mineralization associated with small stocks that intrude sandstone, shale and conglomerate of the Lower Cretaceous Jackass Mountain Group (Seraphim and Rainboth, 1976; Raven, 1994; Brown, 1995). The three main porphyry intrusions are biotite diorite, hornblende diorite and granodiorite. Pri-

mary sulphide mineralization consists of pyrite, chalcopyrite, molybdenite and bornite. Weathering of bedrock extends to about 5 m in the sedimentary units, and is undeveloped in the quartz diorite porphyry. Supergene enrichment is intense along fractures and joints to a depth of about 80 m. Oxidation of copper sulphide minerals occurs to depths of about 10 m from the surface (Brown, 1995).

Sample Collection and Analysis

A first round of field sample collection was performed in late August 2014 (Figure 1). Water samples were collected directly from midstream sites, and from springs as close as possible to source. Samples were stored in #2 high density polyethylene (HDPE) bottles. Photometer sample bottles were reused and rinsed thoroughly at least twice with the sample waters with the cap on before sample collection. If a sample bottle displayed any type of discolouration, it was not used for sample collection and was recycled appropriately. Filtration and acid preservation were not carried out because the majority of samples were clear with very little fines, and analysis was carried out within 48 hours of collection. As well, filtration was not carried out to simulate expedited sampling and processing, as filtration adds a significant amount of time to overall procedures. Sample location sites were tested for temperature, pH, conductivity, total dissolved solids (TDS) and salinity, using an OAKTON Instruments PCS Testr 35 meter.

Table 1. Listing of photometer available reagents selected for this project and their published detection limits.

Type	Palintest published detection range (mg/l)
Aluminum	0–0.5
Boron	0–2.5
Bromine	0–10.0
Calcium hardness (calciol)	0–500
Chloride (chloridol, NaCl)	0–50 000
Copper (coppercol, free and total)	0–5.0
Fluoride	0–1.5
Hardness (hardicol, total)	0–500
Iron	0–10
Magnesium	0–100
Manganese	0–5.0
Molybdate (MoO ₄)	0–100
Nickel	0–10
Potassium	0–12
Silica (SiO ₂)	0–150
Sulphate (SO ₄)	0–200
Zinc	0–4.0

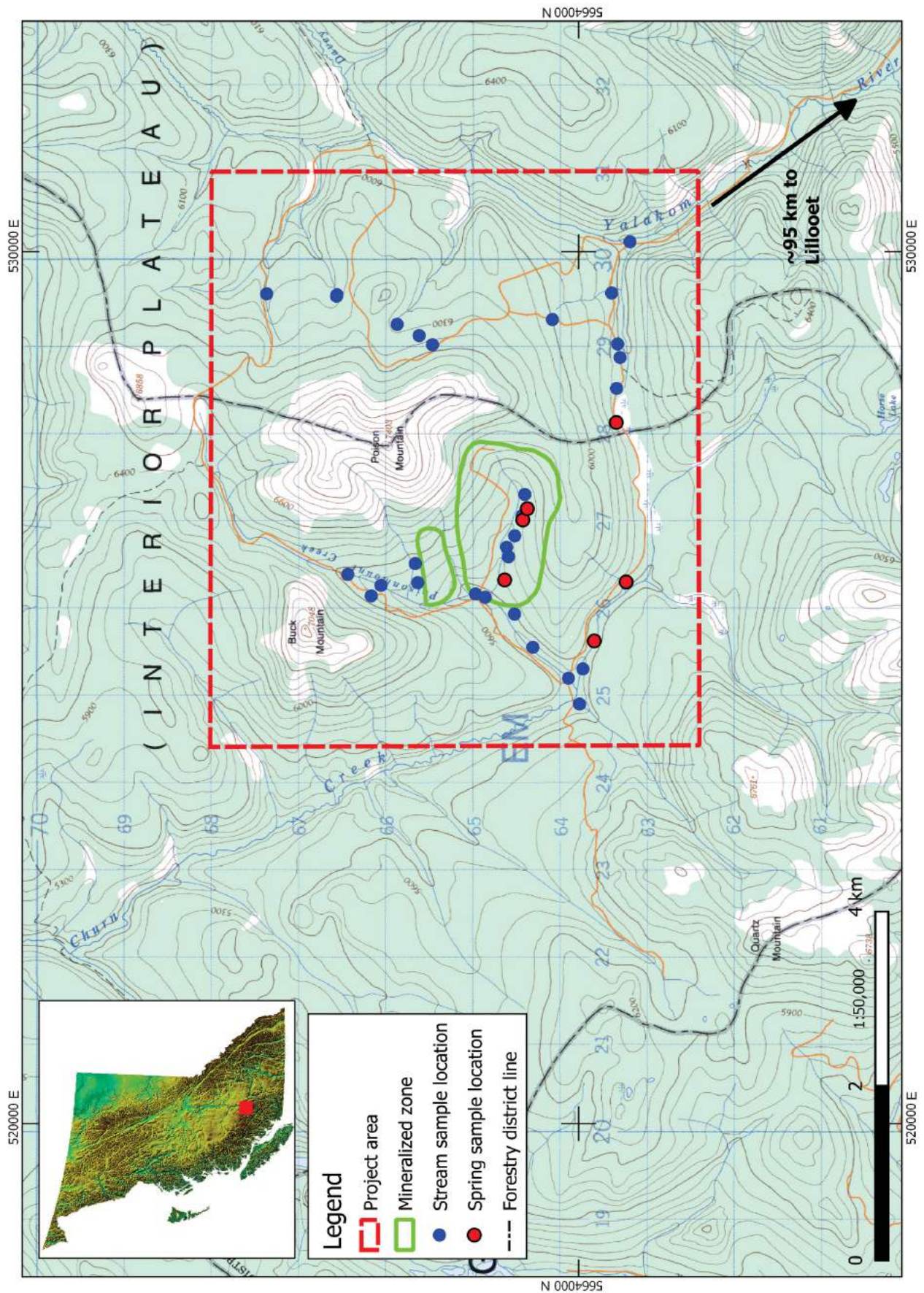


Figure 1. Poison Mountain project area and sample location map, southwestern British Columbia (background raster image from Natural Resources Canada, 1992). UTM Zone 10.

The same sample bottles as above were used for analysis at ALS Environmental laboratory. They were rinsed twice and the water was not filtered to match the photometer sample collection procedure and to prevent data disparity. The water samples were collected in 1 L and 250 mL bottles, and 3 mL of ultrapure nitric acid was added to the 250 mL bottle for sample preservation. Water in the 250 mL bottle is intended for cations analysis and the water in the 1 L bottle is required by the laboratory for TDS analysis, quality control–quality assurance (QA-QC) monitoring of results and possible repeatability tests for various reasons.

Stream sediment samples were wet sieved to –20 mesh and collected in Hubco Inc.’s New Sentry 5 by 8 in. (13 by 20 cm) sample bags. The bags were allowed to stand to drain excess water and then stored in Ziploc® sealed freezer bags to prevent cross-contamination between samples. All sampling equipment was rinsed thoroughly before and after each sample collection.

The following samples were analyzed in August:

- 1) forty water samples for photometer analysis, four of which were field duplicates, and one QC deionized water,
- 2) twenty water samples submitted to ALS Environmental laboratory, including four field duplicates and a fifth duplicate for the deionized water sample, and
- 3) thirty-three stream sediment samples, including four field duplicates.

During the survey, all of the samples above were stored inside coolers at room temperature. Water samples were transported in coolers to the ALS Environmental laboratory and sediments delivered to the ALS Mineral laboratory (North Vancouver, BC).

Samples collected for photometer analysis were tested within 48 hours. The reagents listed in Table 1 were used for each sample.

Quality control measures used for the project included

- 1) collection of field duplicates for each sample type,
- 2) photometer calibration tests every eight samples using manufacturer’s standard solutions,
- 3) triplicate photometer readings were taken for each reagent for each sample to measure instrument precision, and
- 4) deionized water blanks were used to monitor contamination and instrument drift.

MYAR returned to the project site in October to repeat the sampling as part of testing for differences in geochemical responses resulting from repeatability over time; in this case summer and fall. Details of this work will be presented in a future publication.

Future Work

Now that all of the data has been collected, the following analysis and reporting is planned:

- 1) estimation of photometer analytical precision by replicate readings,
- 2) estimation of photometer accuracy by comparing photometer and laboratory results,
- 3) comparison between the summer and fall results,
- 4) comparison of stream sediment laboratory results and photometer results,
- 5) evaluation of the relative costs of photometer and laboratory analysis, and
- 6) commentary on the validity of the photometer technique.

The project is expected to be completed in early 2015, and a final report will be released by Geoscience BC.

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