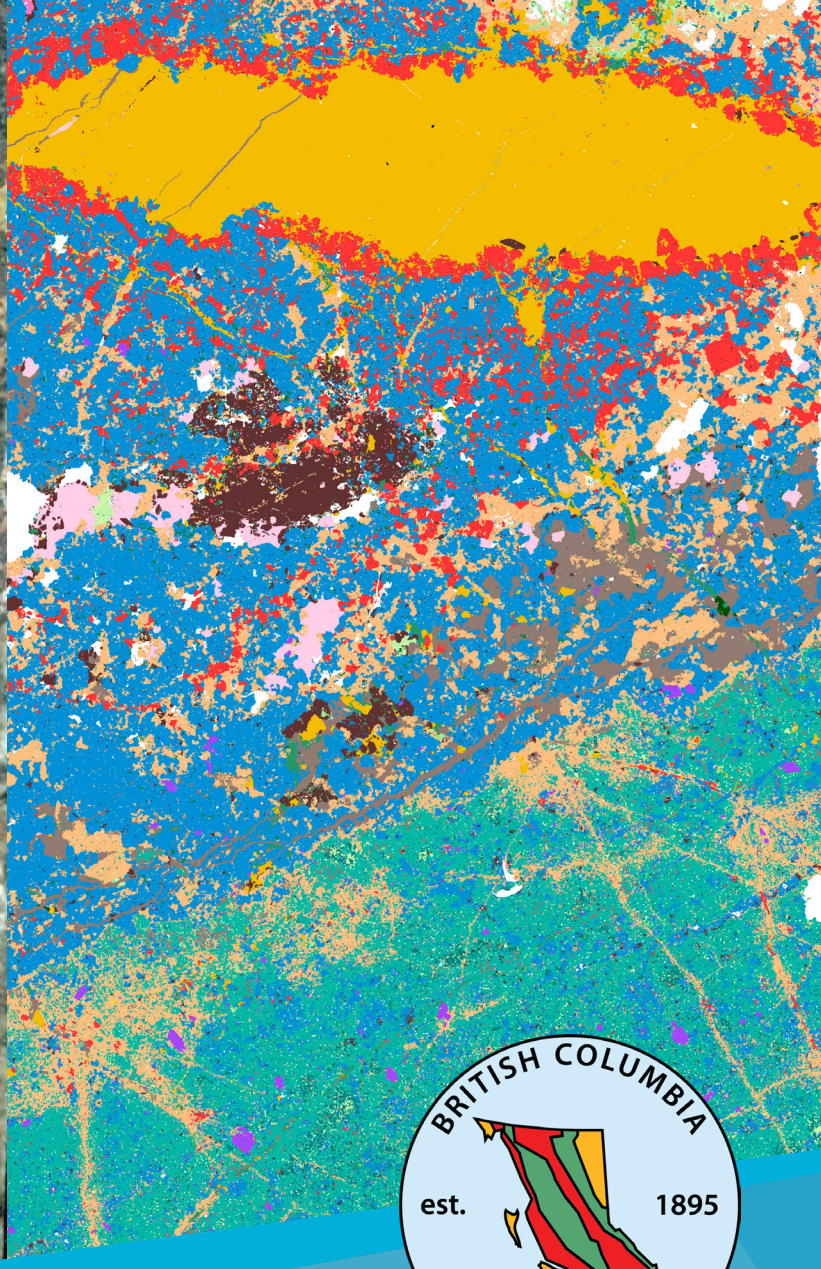

Data release from critical mineral studies of the Mount Polley, Schaft Creek, and New Afton porphyry deposits, British Columbia

Keanna Vaughan Forrester, Keani Whitmore, Audrey C. Graham, Dylan Goudie, Shaun Barker, Wyatt Bain, Evan Orovan, Roddy W. Campbell, Robert Creaser, Daniel Layton-Matthews

BRITISH COLUMBIA
Ministry of Mining and Critical Minerals

GeoFile 2026-09

Ministry of Mining and Critical Minerals
Mines Competitiveness and Authorizations Division
British Columbia Geological Survey

Recommended citation: Vaughan Forrester, K., Whitmore, K., Graham, A.C., Goudie, D., Barker, S., Bain, W., Orovan E., Campbell, R.W., Creaser, R., and Layton-Matthews, D., 2026. Data release from critical mineral studies of the Mount Polley, Schaft Creek, and New Afton porphyry deposits, British Columbia. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey GeoFile 2026-09, 6p.

Front cover:
Monzonite at the Mount Polley mine (sample 24EOR-180-4c). On left, thin section billet; on right, corresponding SEM-MLA image. At the top of the SEM-MLA image is a lozenge of chalcopyrite (yellow) surrounded by magnetite (red). Chalcopyrite also occurs as fine clots and fracture fills; magnetite also occurs as fine aggregates spatially associated with potassium feldspar (peach). The blue upper half of the image is predominantly clinopyroxene; the green lower half is predominantly albite. Titanite (dark brown) forms mm-scale clusters with minor calcite (pale pink) and zeolite (light brown).

Back cover:
In background, granodiorite to quartz monzonite unit (ca. 221-219 Ma) of the Hickman pluton (Stikine plutonic suite), which hosts the Schaft Creek deposit. In foreground, mafic intrusive unit (ca. 225 Ma) of the Hickman pluton, nine km southwest of Schaft Creek deposit. View to the west.

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Recommended citation: Vaughan Forrester, K., Whitmore, K., Graham, A.C., Goudie, D., Barker, S., Bain, W., Orovan E., Campbell, R.W., Creaser, R., and Layton-Matthews, D., 2026. Data release from critical mineral studies of the Mount Polley, Schaft Creek, and New Afton porphyry deposits, British Columbia. British Columbia Ministry of Mining and Critical Minerals, British Columbia Geological Survey GeoFile 2026-09, 6p.

Abstract

Porphyry Cu ± Mo ± Ag ± Au deposits commonly contain concentrations of companion metals (e.g., Te, Bi, Co, Sb, Sn, W) in addition to primary base and precious metal commodities. These companion metals, which could be recovered as byproducts, are on the critical mineral lists of many political jurisdictions. Although porphyry deposits in British Columbia have been extensively studied and developed, the amounts and distributions of companion metals across deposits of different ages and subclasses remain unclear. This contribution provides geochemical, geochronological, and microanalytical data for samples from three Late Triassic Au-rich porphyry deposits to support ongoing critical companion metal studies in British Columbia. The data include: 1) Bulk-rock geochemical data for mineralized drill core and rock samples from Schaft Creek (n=24), Mount Polley (n=36), and New Afton (n=102); 2) Re-Os geochronology data from molybdenite at Mount Polley (n=1); 3) sulphur isotope analysis of chalcopyrite, pyrite, and molybdenite from Mount Polley (n=18); 4) micro-X-ray fluorescence (μXRF) elemental concentration maps of samples from Schaft Creek (n=4); and Mount Polley (n=12); and 5) scanning electron microscopy-mineral liberation analysis (SEM-MLA) images of thin sections from New Afton (n=17), Mount Polley (n=12), and Schaft Creek (n=17).

Keywords:Au-rich porphyry, New Afton, Schaft Creek, Mount Polley, critical minerals, companion metals

1. Introduction

Primary commodities Cu, Au, Ag, and Mo have long-been produced from porphyry deposits in the Stikine, Quesnel, and Wrangell terranes of the British Columbian Cordillera (Fig. 1). Porphyry deposits are commonly classified as alkalic (Cu-Au) or calc-alkalic and formed predominantly: 1) in the late Triassic to early Jurassic before terrane accretion to North America; and 2) in the Cretaceous to Eocene in continental settings following accretion of the allochthonous terranes to North America. All varieties of porphyry deposits may also contain 'companion metals' (John and Taylor, 2016; Mudd et al., 2014, 2017; Nassar et al., 2015) that are on the critical minerals lists of different political jurisdictions (e.g., Hickin et al., 2024), including the 2024 iteration of the Canadian list (NRCan, 2024). These critical companion metals (e.g., Te, Bi, Co) could conceivably be recovered as byproducts of primary commodity mining (e.g., IGF, 2023).

Studies of critical companion metals in porphyry and related skarn and epithermal deposits in the province have been limited (e.g., Lawley et al., 2025), and thus their distributions remain largely unknown. Supporting summaries presented in Bain et al. (2026) and Graham et al. (2026), herein we present geochemical, geochronologic, sulphur isotope, micro-X-Ray fluorescence (μXRF), and scanning electron microscopy-

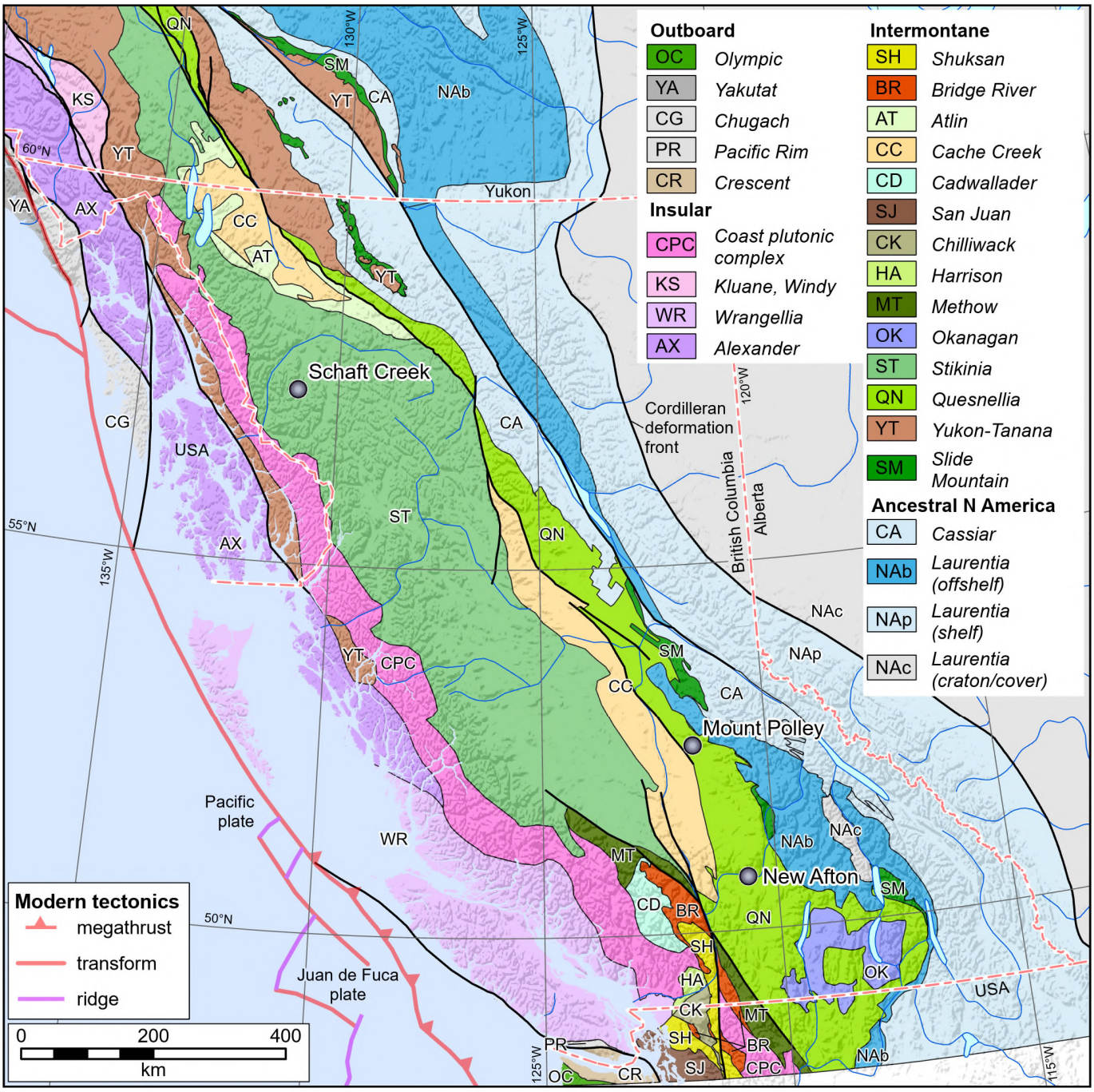

Fig. 1. Locations of Mount Polley, New Afton, and Schaft Creek deposits. Terranes after Colpron (2020).

mineral liberation analysis (SEM-MLA) data from three Late Triassic Au-rich porphyry deposits: the currently producing Mount Polley and New Afton mines, and the Schaft Creek deposit (Fig. 1). In BCGS_GF2026-09.zip are: Appendix 1 with metadata and geochemical results for 162 samples with 13 additional quality control analyses; Appendix 2 with geochronology and associated metadata from one Re-Os molybdenite analysis; Appendix 3 with S-isotope measurements from 18 samples and associated quality control data; Appendix 4 with elemental concentration maps for four thin sections from micro-X-ray fluorescence (μXRF) in layered .pdf files that the user can toggle layers to view available elements; Appendix 5 with modal mineralogy data (area %) derived from SEM-MLA analysis for 46 thin sections; Appendix 6 includes false-colour mineral maps and backscattered electron (BSE) images from SEM-MLA analysis, along with geochemical spider diagrams showing metal enrichment relative to the average composition of continental crust (Rudnick and Gao, 2014); and Appendix 7 provides Axioscan images of selected thin sections (complete data are available upon request).

2. Methods

2.1. Whole-rock geochemistry methods

2.1.1. Sample preparation

A total of 162 samples for geochemistry were collected from drill core (n=151) and outcrop (n=11) in 2024. Hand specimens and drill core samples were prepared at the BCGS. Samples were cut, crushed using a steel jaw crusher, and sieved to isolate the 0.5 to 2 mm fraction. Coarse crush that did not pass through a 10 mesh (2 mm) was retained; the fine fraction that passed through 35 mesh (<500 µm) was discarded. A chromium-steel ring and puck mill dedicated to mineralized samples was used to pulverize each sample for 20 seconds; pulps were then screened to 100% through 200 mesh (<74 µm) using a stainless-steel sieve. The mill was cleaned between each sample by pulverizing ~40 g of silica sand twice and wiping all parts with ethanol. Coarse silica blanks were pulverized sequentially in the sample stream. Approximately 20 -100 g of <74 µm pulp was sent to ALS Canada Ltd., North Vancouver, for geochemical analysis. Remaining sample material, crush, and pulp were archived.

2.1.2. Analytical methods

At ALS Canada Ltd., subsamples of the pulps were analyzed by a package that varies digestion and analysis methods between analytes (method CCP-PKG01; ALS, 2024). Samples that returned greater than the detection range for specific analytes were re-analyzed with ore-grade methods while maintaining consistency in the digestion method (Appendix 1, Attributes). For analytes that yielded greater than detection ranges, results from the ore-grade methods supersede previous results.

Major-element oxides were measured by method ME-ICP06 (ALS, 2024). A 0.1 g subsample was mixed with a Li borate flux and fused in a furnace at 1025°C. The melt was cooled and dissolved in nitric, hydrochloric, and hydrofluoric acid, and the resultant solution was analyzed by inductively coupled plasma (ICP) atomic emission spectroscopy (AES). Results were corrected for inter-element spectral interference before being reported; total (%) and loss on ignition (LOI%) values were included.

Carbon and S were analyzed by LECO Infrared Spectroscopy (ME-IR08) in which a sample is combusted in a high-frequency LECO induction furnace in a stream of oxygen that converts S into SO_2 and C into CO_2. The resultant gas was passed directly into a cell with infrared (IR) energy, which absorbed the SO_2 and CO_2 at different wavelengths. Absorption was quantitatively detected and used to calculate total S and total C. Samples from Mount Polley and New Afton were analyzed for Cl and F by ion chromatography following KOH fusion (0.2 g subsample, method IC881).

Ag, Cd, Co, Cu, Li, Mo, Ni, Pb, and Zn were analyzed with method ME-4ACD81, which uses ICP-AES following Li borate fusion and digestion of a 0.25 g subsample in a 4-acid (perchloric, nitric, hydrofluoric, hydrochloric) solution. Samples that yielded greater than the detection ranges (100 ppm Ag, 1% Cu or Mo) were re-analyzed for single analytes with method ME-OG62, a 4-acid digestion on 0.4 g subsample followed by ICP-AES analysis.

Volatile trace elements (e.g., As, Bi, Hg, In, Sb, Te) were analyzed (0.5 g subsample) by ICP-MS using collision cell technology for lowest detection limits following 45-minute digestion by aqua regia. The resulting solution was cooled, diluted to 12.5 mL with de-ionised water and mixed (ALS method ME-MS42). These elements were analyzed using relatively low-temperature aqua regia digestion to avoid volatilization as is common with higher temperature four-acid digestion or fusion methods. Samples that yielded As greater than the detection range (250 ppm) were further analyzed with ME-ICP41a, an intermediate level aqua regia (ICP-AES) method with higher upper and lower detection limits.

Trace (lithophile) elements (e.g., Ba, Ga, Ge, Sn, U, V, W) were measured by method ME-MS81 (ALS, 2024), which uses the same Li borate fusion and acid digestion as ME-ICP06 followed by ICP-mass spectrometry (MS) analysis. This fusion is considered the best method for complete dissolution of trace elements from silicates, although some zircon, metal oxides, rare-earth phosphates, and sulphides may not be fully recovered (ALS, 2024).

Samples from Mount Polley were analyzed for platinum group elements (Pt, Pd, Rh, Ir, Os, and Ru) using ICM-MS following nickel sulphide collection fire assay (30 g sample, PGM-MS25NS). Samples from New Afton and Schaft Creek were initially analyzed for Au, Pt, and Pd by super trace fire assay and ICP-MS finish (30 g sample, PGM-MS23L); New Afton samples that yielded greater than the detection range for Pd were analyzed by PGM-MS25NS. For samples with insufficient sample remaining (NSS), the retained coarse rejects were submitted. Samples that yielded >1000 ppb Au were analyzed by fire assay and atomic absorption spectrometry (AAS; 30 g sample, method Au-AA25).

2.1.3. Quality assurance

A total of 13 quality control samples (silica blanks, pulp duplicates, and standards) were inserted into the sample stream at the BCGS laboratory (Appendix 1).

2.1.3.1. Preparation blanks

To monitor sample preparation contamination, three coarse silica sand blanks (Sigma-Aldrich-certified as ≥99.995 weight% SiO_2) were pulverized in the same manner as routine samples (Appendix 1, Blanks-contamination). Analytical results from silica blanks are acceptable, with Cu concentrations ≤ 24 ppm, and Mo ≤ 9 ppm. Values of hundreds of ppm Cr (≤ 303 ppm) and ≤ 0.3% Fe_2O_3 likely represent contamination from the chromium steel mill.

2.1.3.2. Pulp duplicates

To assess precision of the results, six pulp duplicates were split from their parent sample after pulverization (Appendix 1, Duplicates-precision). The pulp duplicates represent the homogeneity of the pulp after pulverization and analytical

reproducibility (precision), which is assessed by performance of the pulp duplicates relative to their parent samples. Relative analytical precision is estimated by the average coefficient of variation, CV_{AVR} (%) for six data pairs (parent-duplicate) (e.g., Van der Vlugt et al., 2022).

$$CV_{AVR}\ (\%) = 100\sqrt{\frac{2}{N}\sum_{i=1}^{N}\left(\frac{(a_i-b_i)^2}{(a_i+b_i)^2}\right)} \quad \text{Eqn. 1}$$

where a_i and b_i are the analytical results for the i^{th} pair of duplicate samples, and N is the number of the data pairs (Abzalov, 2008). In cases where analytes were below the detection range for the given method, the values were replaced with ½ LoD (e.g., <5 ppm was replaced with 2.5 ppm) for the calculation of CV_{AVR}.

We consider that CV_{AVR} values of <20% indicate generally acceptable precision. Several key analytes including Ag, Au, Cu, Mo, Pb, Pd, Pt, Sb, Se, Te yielded >20% CV_{AVR}. This poor replication of duplicates may be a result of heterogeneity of the pulp, poor analytical precision, or a combination of the two factors.

2.1.3.3. Standards

Four standards were included in the sample stream as pulps (Appendix 1, Standards-accuracy). The results from these reference materials can be used to assess analytical accuracy, which is the analytical result relative to their recommended or certified values and standard deviation (or 95% confidence interval). Standards included Canadian Certified Reference Materials Project CANMET TDB-1 (n=1), BCGS-Till-2013 homogenized bulk sample (n=2), and OREAS 503c.

For replicate analyses of standards, accurate or unbiased analytical results for each analyte satisfy the following condition:

$$\frac{|m-\mu|}{2\sqrt{{\sigma_L}^2+\frac{{S_w}^2}{n}}} \leq 1 \quad \text{Eqn. 2}$$

where m is the average of replicate analyses (or the result if n=1), μ is the recommended or certified reference mean (i.e., expected value/EV), σ_L is the interlaboratory certified standard deviation, n is the number of analyses (i.e., n=1 or 2), and $S_w = CV_{AVR} * m$ (representing analytical precision) (e.g., Van der Vlugt et al., 2022). The amount of TDB-1 submitted was insufficient for most analyses (NSS) but yielded accurate results for certified values of Pd and Pt. The sample of OREAS 503c yielded NSS for Au, marginally accurate results for Sb, La, Sr, and Y, and accurate results for all other analytes (including Ag, As, Bi, Cd, Cu, Mo, Ni, Pb, Se, Te, V, and Zn). The analytical results for BCGS-Till-2013 are marginally accurate for Cd, Sb, Ce, and Hf, inaccurate for Rb and Sr, and accurate for the remainder of analytes that can be assessed (including Ag, As, Au, Bi, Co, Cu, Mo, Ni, Pb, Se, Te, V, and Zn). The relatively poor precision (i.e., large CV_{AVR} values), represented by S_w in Equation 2, has the effect of increasing the tolerance for accuracy.

2.2. Re-Os molybdenite geochronology

Methods used for molybdenite Re-Os analysis are described in detail by Selby and Creaser (2004). Areas of the sample (n=1) with visible molybdenite were selected, and a molybdenite mineral separate was prepared by metal-free crushing and sieving followed by magnetic and gravity concentration methods. The ^{187}Re and ^{187}Os concentrations in molybdenite were determined by isotope dilution mass spectrometry using Carius-tube, solvent extraction, anion chromatography, and negative thermal ionization mass spectrometry techniques. For this work, a mixed, double-Os spike containing known amounts of isotopically enriched ^{185}Re, ^{190}Os, and ^{188}Os analysis was used (Markey et al., 2007). Isotopic analysis used a ThermoScientific Triton mass spectrometer by Faraday collector. Total procedural blanks for Re and Os are <3 picograms and <0.5 picograms, respectively, which are insignificant in comparison to the Re and Os concentrations in molybdenite. The Reference Material 8599 Henderson molybdenite (Markey et al., 2007) is routinely analyzed as a standard, and during the past 2 years returned an average Re-Os date of 27.83 ± 0.09 Ma (n=14), indistinguishable within uncertainty from the Reference Age Value of 27.66 ± 0.1 Ma (Wise and Watters, 2011). The ^{187}Re decay constant used is 1.666 x 10^{-11} a^{-1} (Smoliar et al, 1996).

2.3. S-isotope measurements

At the BCGS, a hand-held drill was used to extract 18 pulp samples into glass vials from coarse grains of chalcopyrite, pyrite, and molybdenite. These were sent to Queen's Facility for Isotope Research (QFIR) for analysis of sulfur (S) isotopes. At QFIR, samples were weighed into tin capsules and the sulfur isotopic compositions were measured using a MAT 253 Stable Isotope Ratio Mass Spectrometer coupled to a Costech ECS 4010 Elemental Analyzer.

Values of $\delta^{34}S$ were calculated by calibrating results to certified reference materials and then normalizing the $^{34}S/^{32}S$ ratios in the sample to that in the Vienna Canyon Diablo Troilite (VCDT) international standard. Values are reported using the delta (δ) notation in units of permille (‰) and are reproducible to 0.2‰. Additional quality control analyses included three standards and one duplicate analyses, which were used to calculate precision of 0.2‰. Accuracy is based upon primary or secondary standard analyses as follows: isotope $\delta^{34}S$ standard deviation 0.3‰.

2.4. µXRF

A Bruker TornadoPlus µXRF instrument fitted with two 60 mm^2 detectors at the Mineral Deposit Research Unit, The University of British Columbia, was used for analysis. An

Rh X-ray tube, excited to 50kV and 600nA current generates X-rays, which are focussed through a polycapillary X-ray optic on the sample. The X-ray spot generated has a diameter of ~19µm. Data were collected with a spatial resolution of 50µm (generating images with a pixel resolution of 50 x 50µm), with a counting time of 10ms per pixel, typically generating several thousand X-ray counts per pixel. Sampling occurs as a sequential line scan, whereby the 19µm spot moves along the sample as the instrument stage travels from left to right, the stage then steps back to its starting point, travels 100µm down, and then travels left to right again. Data were processed in Bruker ESPRIT® software. In the software, a colour stretch was applied to count data so that higher counts appear as brighter colors producing intensity maps. Finally, a fundamental parameter (FP) method in Bruker ESPRIT® software was applied to each map to quantify results, which accounts for peak overlaps and background corrections. Because no standards were analyzed with unknown samples, the results should be treated as semi-quantitative, with significant uncertainties on any individual pixel. However, the fundamental parameter method has the advantage that it helps the viewer to determine likely 'true' variations in element intensities in a sample by removing variations in count rates caused by sample geometry and colour stretches, which are applied across very low count rate elements. Colours outside the edge of the sample represent artefacts introduced by the background substrate of the samples and are considered inaccurate. Elemental concentration maps are provided in Appendix 4.

2.5. Scanning electron microscopy-mineral liberation analysis (SEM-MLA)

Polished thin sections were examined using a scanning electron microscope (SEM) and derived backscatter electron (BSE) images, and quantitative mineral abundance maps and determinations by mineral liberation analysis (MLA). The SEM work was undertaken at the CREAIT Microanalysis Facility, Memorial University, using a FEI MLA 650 field emission gun SEM equipped with two Brucker silicon drift EDS detectors. Operating conditions included 25kV accelerating voltage for BSE images. Operating conditions for MLA included a 25kV accelerating voltage and a 10nA current. Thin sections were measured in GXMAP (grain-based X-ray mapping) mode where X-ray analyses were triggered for a BSE range of 40 to 255. Each X-ray measurement was acquired for 12ms on a 1.5 by 1.5mm frame with a resolution of 500 by 500 pixels per frame and an imaging scan speed of 16µsec. Data reduction was performed on MLA Data View (FEI) software version 3.1.4.683.

2.6. Petrography

Polished thin sections were prepared and automated petrographic images were created using Zeiss Axioscan Geo7 at The University of British Columbia, Mineral Deposits Research Unit. These images include plane, polarized, circular polarized, and reflected light photomicrographs. This imagery is viewed online and, with real-time pan and zoom functionality, allows the petrographer to conduct thin section-to micron-scale mineralogical and textural evaluation of samples and immediate comparison with other datasets.

Acknowledgements

We thank Teck Resources Limited, New Gold Inc., and Imperial Metals Corp. for facilitating this work. We also thank Sean Tombe and Devin Wade (New Gold Inc.), Mike Takaichi and Chris Herron (Teck Resources Limited), Freia de Waal, and Benjamin Johnstone for their help accessing drill core and arranging fieldwork at the New Afton and Schaft Creek deposits. Kaitlyn McLaren (BCGS) provided geographic information system support.

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