

Methods

Whole-rock geochemistry

Whole-rock analysis of twenty-seven samples from the Sixtymile district were analyzed by Analytical Laboratory Services (ALS) Geochemistry at their North Vancouver, British Columbia, Canada facility. Samples were crushed to <2 mm in a steel-jaw crusher and subsequently pulverized with a low-Cr-Mo mild steel ring mill so that > 85 % of the power passed 75 μm . For whole-rock geochemistry, major and minor oxides (SiO_2 , Al_2O_3 , Fe_2O_3 , CaO , MgO , Na_2O , K_2O , Cr_2O_3 , TiO_2 , MnO , P_2O_5 , SrO , and BaO) were analysed by X-ray fluorescence spectroscopy following lithium metaborate fusion (ALS Method ME-XRF26). Trace elements (Ba, Ce, Cr, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Nb, Nd, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, V, W, Y, Yb, and Zr) were determined by lithium metaborate fusion with digestion in nitric acid followed by analysis with inductively-coupled plasma-mass spectrometry (ICP-MS) (ALS Method ME-MS81). Total carbon and sulfur were analyzed by Leco induction furnace (ALS Methods C-IR07 and C-IR08, respectively).

Four acid digestion (ALS Method ME-4ACD81; HF, HCl, HClO_4 , and HNO_3) was used to digest samples for analysis of a variety of major-, minor-, and trace-elements (Ag, Cd, Co, Cu, Li, Mo, Ni, Pb, Sc, Se, and Zn), which was followed by analysis by ICP-MS. Fusion analysis is used for the geochemical plots and interpretation, however elements by four acid digestion are used when the element is known to not be found in resistant phase like zircon. Arsenic, Bi, Hg, In, Re, Sb, Sc, Se, Te, and Tl were analyzed by ICP-MS following an aqua regia digestion (ALS Method ME-MS42; 3:1 HCl: HNO_3).

Radiogenic isotopes

Six samples were sent to the University of Melbourne to obtain radiogenic (Sr-Nd-Pb) isotope data acquired by Nu Instruments Sapphire MC-ICPMS (e.g., Shane et al., 2017; Woodhead et al., 2019; Maas et al., 2022). The samples were weighed out (50-60 mg), basaltic samples were acid-leached with 6M HCl (100°C, 30 mins), rinsed, and dissolved with HF, HNO_3 , and HCl at low pressure. The felsic samples were digested using High Pressure Dissolution vessels with HF- HNO_3 and HCl. Lead was extracted using 1 pass over small (0.1 ml) beds of anion exchange (AG1-X8, 100-200 mesh, HBr-HCl; Kamber and Gladu, 2009). The eluant was retained and subsequently the REE were extracted using a combination of Eichrom TRU-resin chromatography with the Nd further cleaned up using Eichrom LN-resin (Pin et al., 2014). The eluant from the TRU-resin was retained and strontium was extracted using Eichrom Sr-resin (Pin et al., 2014). Total analytical blanks (≤ 50 pg for Sr, Nd, Hf and Pb) were negligible in all cases.

Isotopic analyses were done on Nu Instruments Sapphire multi-collector ICP-MS with sample uptake via a Glass Expansion PFA nebuliser and CETAC Aridus-3 desolvator. Instrumental mass bias in Sr and Nd isotope analyses was corrected by internal normalization to $^{88}\text{Sr}/^{86}\text{Sr} = 8.37521$ and $^{146}\text{Nd}/^{144}\text{Nd} = 0.7219$, respectively, using the exponential law. Typical internal precisions (2se) were ± 0.000016 (Sr) and ± 0.000010 (Nd) whereas external precision, based on the results for rock and synthetic standards are ± 0.000040 (Sr) and ± 0.000020 (Nd, all 2sd). The $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ results are reported relative to SRM987 = 0.710230 and JNdi Nd = 0.512115. Lead isotope results were corrected for mass bias using Tl-doping (Woodhead, 2002). This produces data with external precisions of ± 0.03 -0.05% (2sd, ± 0.006 -0.010 abs.) for $^{206}\text{Pb}/^{204}\text{Pb}$, and <0.1% (± 0.039 abs.) for $^{208}\text{Pb}/^{204}\text{Pb}$. Age corrections are based on parent/daughter ratios calculated from trace element data. Decay constants are: ^{87}Rb 1.397×10^{-11} /yr; ^{147}Sm 6.54×10^{-12} /yr, ^{238}U 0.155125×10^{-9} /yr, ^{235}U 0.98484×10^{-9} /yr, ^{232}Th 0.049485×10^{-9} /yr. The ϵ_{Nd}

values were calculated relative to modern CHUR composition with $^{147}\text{Sm}/^{144}\text{Nd} = 0.1960$, $^{143}\text{Nd}/^{144}\text{Nd} = 0.512630$ (Bouvier et al., 2008).