Geochronologic data from the Kitsault River area, northwest British Columbia

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Front cover: Well-exposed massive flows of andesitic tuff breccia from the lower Hazelton Group, northwest of Kinskuch Lake. **Photo by Rebecca Hunter.**

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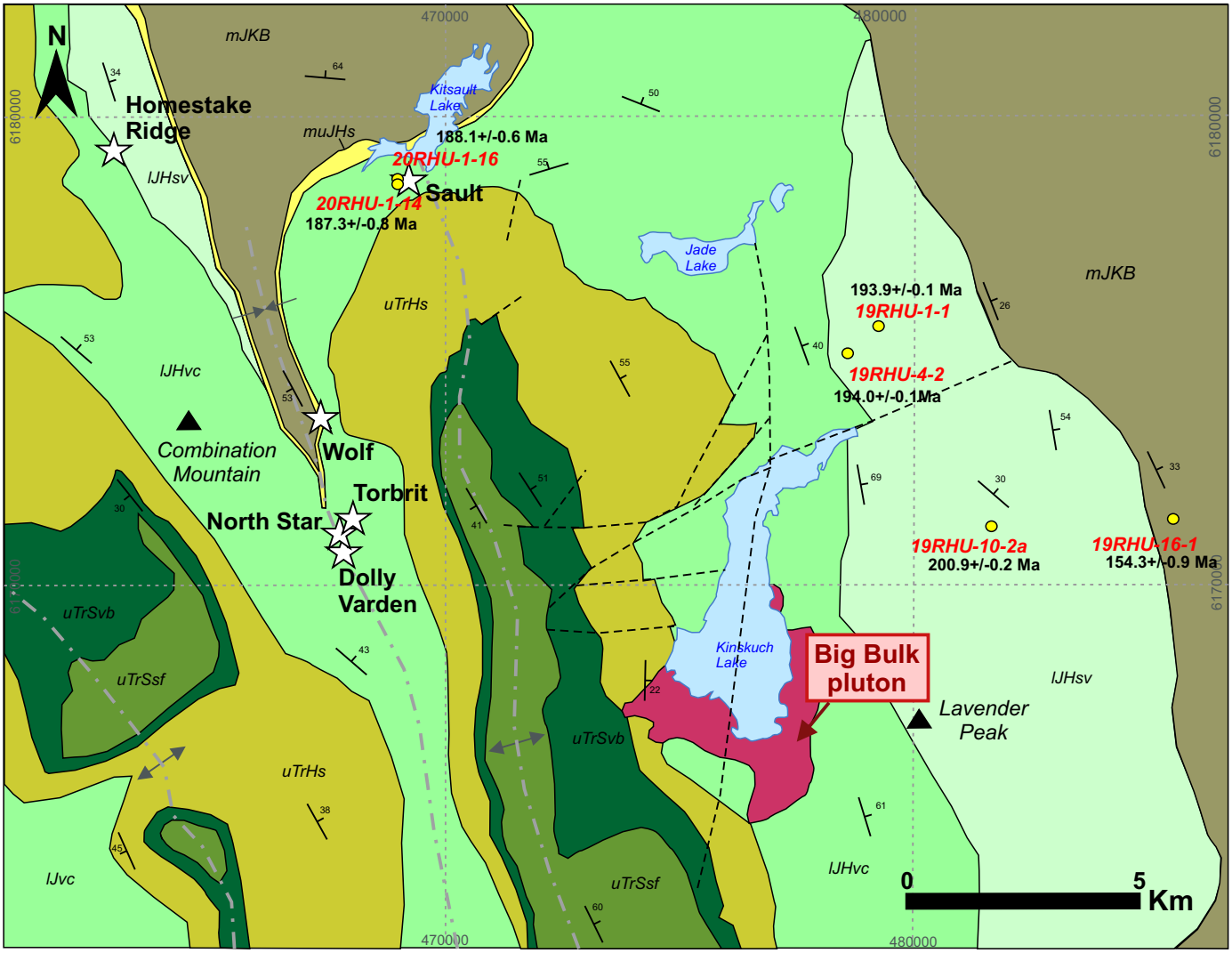
Summary

The Hazelton Group is an extensive package of volcanic and sedimentary rocks that span the entire width of the Stikine terrane (Marsden and Thorkelson, 1992; Gagnon et al., 2012; Nelson et al., 2018). The geochronological data presented herein are part of a larger study to better resolve the ages of the Hazelton and Bowser Lake groups in the Kitsault River area. The results are from samples collected during 2019 and 2020 (Fig. 1) and serve as a data repository for summaries and interpretations presented in Hunter et al. (2022). Appendix 1 includes geochronologic results and sample information and Appendix 2 includes images of the zircons analysed (BCGS_GF2022-13.zip). Samples were collected by R. Hunter in 2019 and C. Sebert in 2020.

For LA-ICP-MS analysis, rock samples underwent standard mineral separation procedures and zircons were handpicked in alcohol and mounted in epoxy along with reference materials. Grain mounts were wet ground with carbide abrasive paper and polished with diamond paste. Cathodoluminescence (CL) imaging was carried out on a Philips XL-30 scanning electron microscope (SEM) equipped with a Bruker Quanta 200 energy-dispersion X-ray microanalysis system at the Electron Microbeam/X-Ray Diffraction Facility (EMXDF) at the University of British Columbia. An operating voltage of 15 kV was used, with a spot diameter of 6 µm and peak count time of 17-27 seconds. After removal of the carbon coat, the grain mount surface was washed with mild soap and rinsed with high-purity water. Before analysis, the grain mount surface was cleaned with 3 N HNO_3 acid and again rinsed with high-purity water to remove any surficial Pb contamination that could interfere with the early portions of the spot analyses. Analyses were conducted using a Resonetics RESOlution M-50-LR, which contains a Class I laser device equipped with a UV excimer laser source (Coherent COMPex Pro 110, 193 nm, pulse width of 4 ns), and a two-volume cell designed and developed by Laurin Technic Pty. Ltd. (Australia). This sample chamber allowed for the investigation of several grain mounts in one analytical session. The laser path was fluxed by N_2 to ensure better stability. Ablation was carried out in a cell with a volume of approximately 20 cm^3 and a He gas stream that ensured better signal stability and lower U-Pb fractionation (Eggins et al., 1998). The laser cell was connected via a Teflon squid to an Agilent 7700x quadrupole ICP-MS housed at PCIGR. A pre-ablation shot was used to ensure that the spot area on grain surface was free of contamination. Samples and reference materials were analyzed for 36 isotopes: ^{7}Li, ^{29}Si, ^{31}P, ^{43}Ca,^{45}Sc, ^{49}Ti, Fe (^{56}Fe, ^{57}Fe), ^{89}Y, ^{91}Zr, ^{93}Nb, ^{95}Mo, ^{98}Mo, ^{139}La, ^{140}Ce, 141Pr, ^{146}Nd, 147Sm, ^{153}Eu, ^{157}Gd, ^{159}Tb, ^{163}Dy, ^{165}Ho, ^{166}Er, ^{169}Tm, ^{172}Lu, ^{177}Hf, ^{181}Ta, ^{202}Hg, Pb (^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb), ^{232}Th, and U (^{235}U, ^{238}U) with a dwell time of 0.02 seconds for each isotope. Pb/U and Pb/Pb ratios and trace element concentrations were determined on the same spots. These isotopes were selected based on their relatively high natural abundances and absence of interferences. The settings for the laser were: spot size of 34 µm with a total ablation time of 30 seconds, frequency of 5 Hz, fluence of 5 J/cm^2, power of 7.8 mJ after attenuation, pit depths of approximately 15 µm, He flow rate of 800 mL/min, N_2 flow rate of 2 mL/min, and a carrier gas (Ar) flow rate of 0.57 L/min. Reference materials were analyzed throughout the sequence to allow for drift correction and to characterize downhole fractionation for Pb/U and Pb/Pb isotopic ratios. For trace elements, NIST



Legend

Bowser Lake Group (Middle Jurassic)

- mJKB — mudstone, sandstone, chert pebble conglomerate

Hazelton Group (Lower-Middle Jurassic)

- muJHs — felsic to intermediate volcanic, sedimentary rocks
- lJHsv — marine sedimentary and volcanic rocks
- lJHvc — intermediate volcanic rocks
- uTrHs — sedimentary rocks (transitional unit)

Stuhini Group (Upper Triassic)

- uTrSvb — basaltic volcanic rocks
- uTrSsf — mudstone and siltstone

- Sample Location
- Deposits
- Faults
- Axial Trace
- Bedding

Fig. 1. Simplified geological map of the Kitsault River area with geochronology sample locations (after Alldrick et al., 1986; MacIntyre et al., 1994).

612 glass was used for both drift correction and trace element calibration, with sample spacing between every five to eight unknowns, and ^{90}Zr was used as the internal standard assuming stoichiometric values for zircon. NIST 610 glass was analyzed after each NIST 612 analysis and used as a monitor reference material for trace elements. For U-Pb analyses, natural zircon reference materials were used, including Plešovice (Sláma et al., 2008; 337.13 ± 0.33 Ma) or 91500 (Wiedenbeck et al., 1995; 2004; 1062.4 ± 0.4 Ma, $^{206}Pb/^{238}U$ date) as the internal reference material and both Temora2 (Black et al. 2004; 416.78 ± 0.33 Ma) and Plešovice and/or 91500 as monitoring reference materials; the zircon reference materials were placed between the unknowns in a similar fashion as the NIST glasses. Raw data were reduced using the Iolite 3.4 extension (Paton et al., 2011) for Igor ProTM yielding concentration values, Pb/U and Pb/Pb dates, and their respective propagated uncertainties. Standard concordia and probability density diagrams were constructed, and weighted averages were calculated with Isoplot (Ludwig, 2012).

For the CA-TIMS analysis, the procedures described here are modified from Mundil et al. (2004), Mattinson (2005), and Scoates and Friedman (2008). After rock samples underwent standard mineral separation procedures zircons were handpicked in alcohol. The clearest, crack- and inclusion-free grains were selected, photographed, and then annealed in quartz glass crucibles at 900˚C for 60 hours. Selected individual annealed grains were transferred into clean 300 mL PFA microcapsules (crucibles) and ultrapure HF (up to 50% strength, 500 mL) and HNO_3 (up to 14 N, 50 mL) were added for chemical abrasion leaching. The grains were placed in 125 mL PTFE liners (up to 15 per liner), and about 2 mL HF and 0.2 mL HNO_3 of the same strength as acid within the beakers containing the samples was added to the liners. The liners were then slid into stainless steel Parr™ high pressure dissolution devices, which were sealed and brought up to a maximum of 190˚C for 8-16 hours (typically 175˚C for 12 hours). The beakers were removed from the liners and zircons were separated from leachate. The zircons were rinsed with >18 MΩ.cm water and sub-boiled acetone. Then 200 mL of sub-boiled 6N HCl was added and the beakers were set on a hotplate at 80˚-130˚C for 30 minutes and again rinsed with water and acetone. Masses were estimated from the dimensions (volumes) of grains. For full dissolution in same microcapsules (crucibles), about 50 mL 50% HF and 5 mL 14 N HNO_3 were added and each was spiked with a $^{233-235}U$-^{205}Pb tracer solution (EARTHTIME ET535), capped and again placed in a Parr liner (up to 15 microcapsules per liner). HF and nitric acids in a 10:1 ratio, respectively, were added to the liner, which was then placed in the Parr high-pressure device and dissolution was achieved at 220˚C for 40 hours. The resulting solutions were dried on a hotplate at 130˚C, 50 mL 6N HCl was added to microcapsules, and fluorides were dissolved in the high-pressure Parr devices for 12 hours at 180˚C. HCl solutions were transferred into clean 7 mL PFA beakers and dried with 2 mL of 0.5 N H_3PO_4. Samples were loaded onto degassed, zone-refined Re filaments in 2 mL of silicic acid emitter (Gerstenberger and Haase, 1997). Isotopic ratios were measured with single collector VG 54R thermal ionization mass spectrometers equipped with analogue Daly photomultipliers. Analytical blanks are 0.1 pg for U and up to 1 pg for Pb. U fractionation was determined directly on individual runs using the EARTHTIME ET535 mixed $^{233-235}U$-^{205}Pb isotopic tracer, and Pb isotopic ratios were corrected for fractionation of 0.40 ± 0.04%/amu, based on replicate analyses of the NBS-982 reference material and the values recommended by Thirlwall (2000). Data reduction employed the Excel-based program of Schmitz and Schoene (2007). Unless otherwise noted, all errors are quoted at the 2 sigma or 95% level of confidence. Isotopic dates were calculated with the decay constants l_{238}=1.55125E-10 and l_{235}=9.8485E-10 (Jaffe et al, 1971) and a $^{238}U/^{235}U$ ratio of 137.88. EARTHTIME U-Pb synthetic solutions were analyzed on an on-going basis to monitor the accuracy of results. Standard concordia diagrams were constructed and regression intercepts, and weighted averages were calculated with Isoplot (Ludwig, 2012).

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