Geology and Lithogeochemistry of the Hall Creek–Moose Creek Area

Dawson Mining Division, Yukon

NTS 116C/02

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January 19, 2017

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Summary

Rock samples collected by previous workers from the Baldy Showing in the Hall Creek area have returned values of Zn, Pb, Cu and Ag that approach ore grades. Mineralization occurs within siliceous schists that have been interpreted to represent distal volcanogenic massive sulphide (VMS) mineralization within the Permian Klondike Schist of the Yukon-Tanana terrane. The Baldy Showing is believed to occur along a belt of VMS mineralization belt that extends over a distance of 10 km from the Border occurrence to the west-southwest (in Alaska) to the Pub occurrence to the east-northeast.

The 2016 exploration program, undertaken with the assistance of the Yukon Mineral Exploration Program, focused on (i) obtaining a better understanding of the geological and geochemical characteristics of the Baldy Showing and (ii) using lithogeochemistry to identify favourable stratigraphy within the Klondike Schist in the Hall Creek–Moose Creek area to the east and northeast of the Baldy Showing. Sixty-three rock samples, collected within an area of approximately 6½ by 3 km, were submitted for whole rock geochemical analyses.

Results of the 2016 exploration program include:

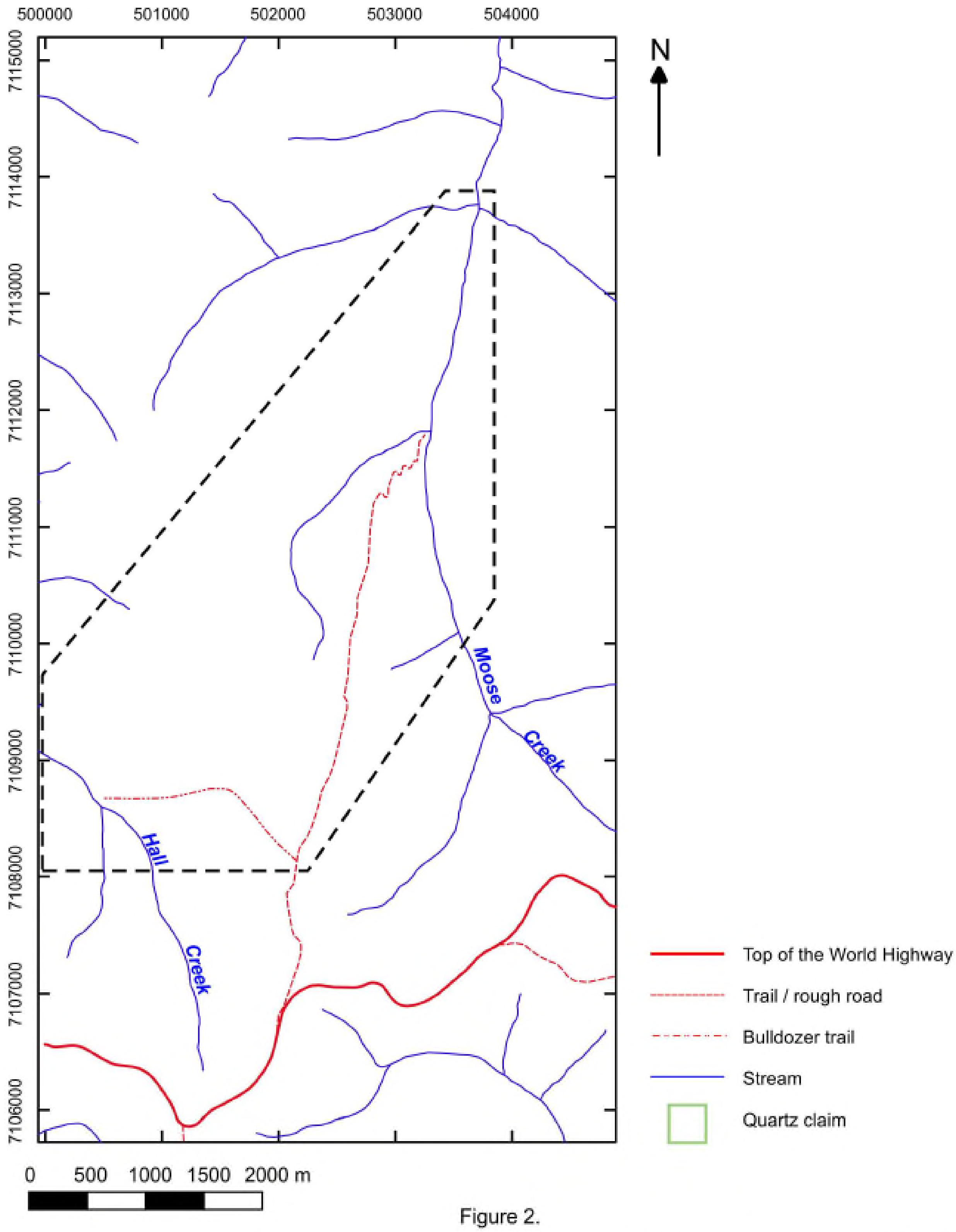
- A review of previous work coupled with field mapping leads the author to believe there are two mineralized zones along Hall Creek. The most significant occurrence, the Baldy Showing, was observed in 1989 by J. Mortensen of the GSC in a placer miner's test pit. By the 1990 field season the mineralization had been covered by alluvium. Samples collected by Mortensen returned up to 8.09% Zn and 3.43% Pb. A second, weaker zone of pyrite and sphalerite mineralization was observed in 2016 where erosion my Hall Creek exposes an outcropping of rock beneath slumped colluvium. This outcrop/subcrop showing, on the west bank of Hall Creek, is herein referred to as the North Baldy Showing and lies about 300 m downstream from the Baldy Showing.
- The North Baldy showing is located at the base of a hillside on the west side of Hall Creek and is prone to being covered by the downslope movement of colluvium. The lower part of the colluvium is frozen while the upper part is water saturated. As the author discovered, this material is extremely mobile when disturbed, especially if thawing occurs. Prior to hand stripping the North Baldy Showing sphalerite mineralization was not exposed in July of 2016 when the area was initially examined. The North Baldy showing was exposed by hand stripping of colluvium at the margin of an existing outcrop. This (expanded) outcrop was mapped in detail and sampled. Pyritic, muscovite/sericite-rich, highly siliceous rock (up to 84.37% SiO_2) containing minor amounts of disseminated and banded, dark brown to black sphalerite returned a maximum value of 0.71% Zn.
- Geological mapping of the Klondike Schist in the Hall Creek – Moose Creek area shows the area to be underlain mainly of felsic, quartz-muscovite schist with accessory biotite and/or chlorite in some outcrops. Outcrops of schist with intermediate chemical compositions were identified on Moose Creek. Most outcrops exhibit a strong foliation that generally strikes in an east or northeast direction with shallow dips to the north or northwest, roughly parallel to the bounding thrust faults. However, steep dips to the south or southeast were noted locally indicating structural complexity in the area.
- There is considerable controversy in the literature as to whether the protoliths of the rocks now forming the Klondike Schist were primarily volcanic or sedimentary. Interpretation of the 2016 lithogeochemical data indicates that the rocks have compositions that are consistent with metasomatically altered igneous sources (i.e. they are probably volcanic or volcaniclastic in origin).

- Lithogeochemical interpretation indicates widespread feldspar destructive alteration has occurred throughout much of the area. Given the broad extent of this alteration, it may reflect geochemical processes related to surface processes (e.g. weathering or marine hydration of volcanic glass) and/or alteration related to regional tectonism.
- Rocks near the North Baldy Showing have undergone intense feldspar destructive alteration (near total loss of Na) accompanied by Mg addition. This is interpreted as hydrothermal alteration in a marine setting consistent with a volcanogenic massive sulphide mineralization model. Rocks hosting the mineralization have atypical rare earth element patterns characterized by heavy rare earth element depletion.
- Based on widely spaced lithogeochemical data (due to a sparsity of outcrop in the Hall Creek area) strong hydrothermal alteration is recognized over a length of 700 m extending east-northeast from the North Baldy Showing.
- A second area considered to have high potential for VMS mineralization, based on geochemical alteration, has been identified along Moose Creek, about 3.5 km east-northeast of the North Baldy and Baldy showings. This area is underlain by geochemically distinctive, high-Zr felsic schist with strong negative Eu anomalies.

Location and Access

The Hall Creek–Moose Creek area is located in west-central Yukon, adjacent to the Alaska border, approximately 75 km west of Dawson City within the Dawson Mining Division (Figure 1). The Baldy and North Baldy showings lie near Hall Creek, which flows to the NNW into Alaska, about 2.5 km north of the Top of the World Highway (Figure 2). Access to the area may be gained by traveling north on a dirt road that leaves the Top of the World Highway 2 km east of the Alaska border. An old bulldozer trail extends westward from this road to Hall Creek, a distance of about 2 km. Access to the area may be gained by truck followed by ATV travel and walking. The Moose Creek area, to the northeast of the Hall Creek, is accessible by following the dirt road north from the highway by truck or ATV.

Figure 1. Map of southern and central Yukon showing the location of the Hall Creek–Moose Creek area (red circle). Map from Yukon Geological Survey MapMaker Online.



Part of NTS Map Area 116C/02
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Figure 2.

Map of the Hall Creek - Moose Creek area showing boundary of 2016 exploration

(area bounded by black dashed line)

Physiography

The Hall Creek–Moose Creek area (Figures 3 and 4) lies within the Klondike Plateau, an unglaciated subdivision of the Yukon Plateau. "Ridge crests in the area generally lie at elevations ranging from 1000 to 1400 metres and probably represent an old uplifted erosion surface…. Major streams and rivers have gentle gradients but tributary streams occupy narrow, V-shaped valleys with steep gradients and well developed dendritic patterns" (Schmidt, 1996a, p.2).

Topography in the Hall Creek–Moose Creek area is subdued with elevations ranging from 700 m to 1200 m. The area under consideration occurs near tree line, which occurs at about 925 m elevation. Above the tree line the ground is covered by typical alpine vegetation including mosses, grasses, sedges and low growing deciduous shrubs. At lower elevations, including the Hall Creek and Moose Creek valleys, the claims are covered by black spruce and alpine fir (Carne, 1991a, Schmidt, 1996a).

Estimates of overburden cover in the area are generally reported as being relatively thin (Carne, 1991a, 1993, Schmidt, 1996a). "Overburden thickness varies over the property but thicknesses encountered during sampling are estimated to be less than 1 metre" (Schmidt, 1996a, p.2). However, Haverslew (1978) reported thick overburden with abundant colluvial material in the Moose Creek area. "Bedrock exposure in the area is limited to road cuts, creek valleys and sporadic outcrops along the ridge tops" (Schmidt, 1996a, p.2). "Because the area is unglaciated, most of the property is mantled by soliflucted colluvium mixed with residual mineral soil that is capped by a thin layer of organic-rich soil and recent volcanic ash. Permafrost is probably relatively continuous" (Carne, 1991a).

Figure 3. Photo of Hall Creek valley. The HALL claims lie near the centre of the photo. View to 305° from near the Moose Creek Road at 502137E, 7107287N (UTM, NAD83, Zone 7W).

Figure 4. Photo of Moose Creek. View looking downstream (north) from 503277E, 711838N (UTM, NAD83, Zone 7W) near collection site of boulder sample 16HL155.

Regional Geology

The Hall Creek–Moose Creek area occurs within a fault bounded wedge of Klondike Schist within the Yukon-Tanana terrane, which consists of complexly deformed and metamorphosed mid- to late Paleozoic continental margin, arc and marginal basin assemblages (Figures 5 and 6). This terrane hosts a number of VMS and SEDEX deposits and occurrences including the VMS deposits of the Finlayson Lake district. “The Yukon-Tanana terrane consists of four tectonic assemblages of regional extent. They comprise a basal siliciclastic assemblage of continental margin affinity (Snowcap assemblage) overlain by three unconformity-bounded, mid- to late Paleozoic volcano-sedimentary successions of continental arc and back-arc affinities (Finlayson, Klinkit and Klondike assemblages)” (Colpron et al., 2006, p.1).

“The Klondike assemblage, which underlies much of the Stewart River and Dawson areas in the Klondike region …, consists of Middle to Late Permian calc-alkaline felsic and minor mafic metavolcanic rocks. Rocks of the Klondike assemblage have the geochemical character of continental arc magmatism…. They are interpreted to be the product of subduction of the Slide Mountain oceanic lithosphere beneath Yukon-Tanana terrane” (Colpron et al., 2006, p. 12).

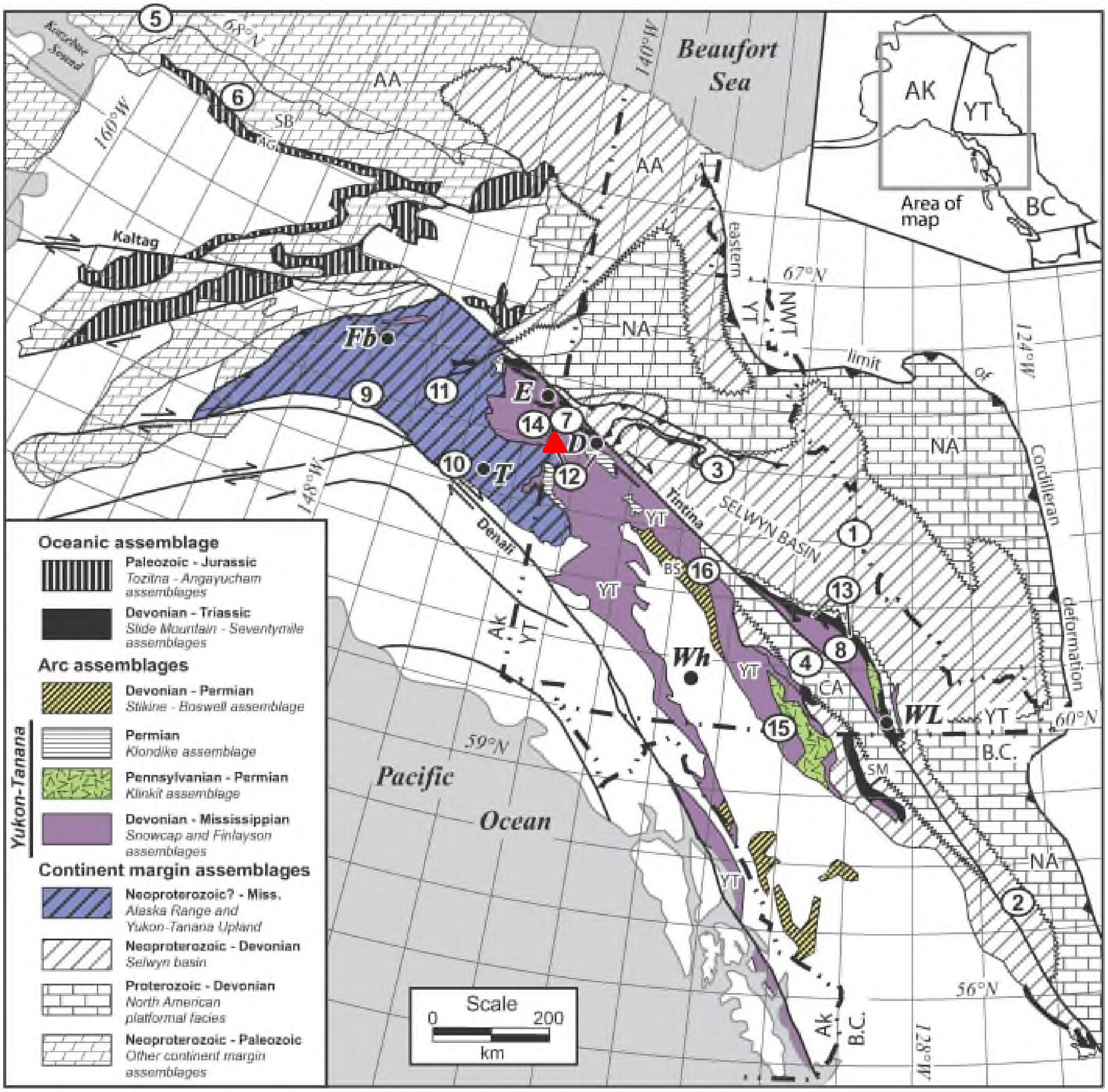


Figure 5. Regional geological setting and location of middle and late Paleozoic syngenetic base-metal districts and groups of deposits and occurrences in the northern Cordillera. Cities/towns are: Fb = Fairbanks; T = Tok; E = Eagle; D = Dawson; Wh = Whitehorse; WL = Watson Lake. Terrane designations are: AA = Arctic Alaska; AG = Angayucham; CA = Cassiar; SB = 'Schist Belt'; SM = Slide Mountain; YT = Yukon-Tanana. District and deposit/occurrence names as follows: 1 = Macmillan Pass; 2 = Gataga (Kechika trough); 3 = Marg; 4 = VMS deposits hosted by the Pelly Mountains volcanic belt; 5 = Red Dog; 6 = VMS deposits in the Schist Belt; 7 = SEDEX occurrences in Nasina assemblage in western Yukon and eastern Alaska; 8 = Finlayson Lake district; 9 = Bonnifield district; 10 = Delta district; 11 = SEDEX occurrences in Chena slate belt; 12 = VMS occurrences in Klondike Schist; 13 = Ice and Strike VMS deposits in SM; 14 = stratabound VMS(?) occurrences on Fortymile River; 15 = VMS(?) occurrences in southern YT; 16 = "Government showing" (YT). From Mortensen et al. (2006). The red triangle represents an area of Klondike Schist along the Alaska-Yukon border that hosts the Baldy VMS occurrence.

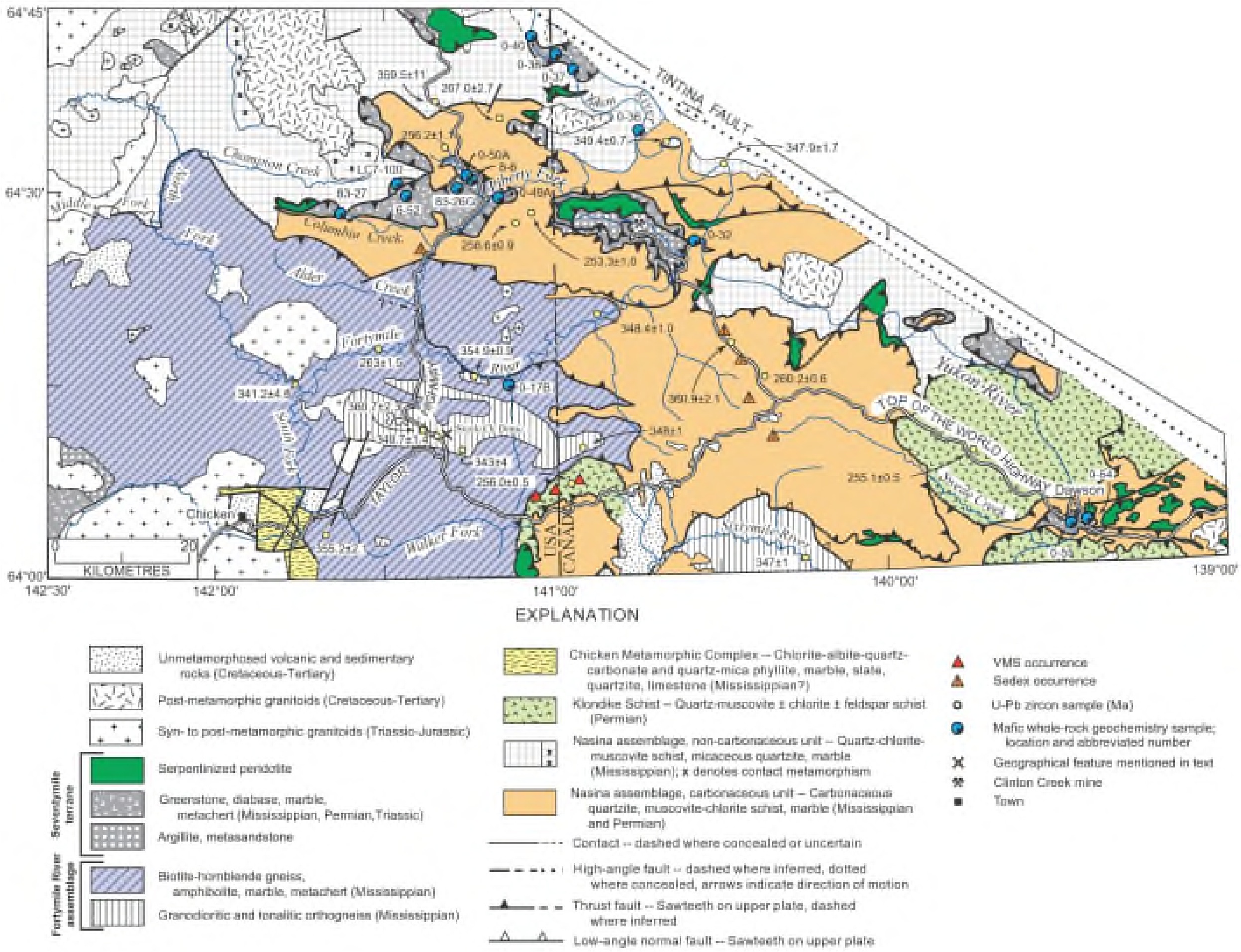


Figure 6. Generalized geologic map of easternmost Alaska and adjacent parts of Yukon (from Dusel-Bacon et al., 2006). The three red triangles just north of the Top of the World Highway near the USA – Canada border are, from west to east, the Border, Baldy and Pub VMS occurrences.

The metamorphic grade of the Klondike Schist is middle greenschist facies (Metcalfe, 1981; Metcalfe and Clark, 1983; Ryan et al., 2014). "The Klondike Schist … comprises three main lithologies: (1) fine-grained quartz-muscovite schist and quartz (± feldspar) augen schist that are interpreted to be derived from felsic volcanic and subvolcanic rocks, respectively; (2) mafic schist and metagabbro derived from mafic to intermediate volcanic rocks and mafic intrusions, respectively; and (3) tan to buff, fine-grained quartz-mica schist and quartzite that represent fine-grained metaclastic rocks. Most of the Klondike Schist appears to have experienced metamorphism at middle to upper greenschist facies. Small syngenetic base-metal occurrences have been identified in many localities within the Klondike Schist near the Alaska/Yukon border … indicating that much of the volcanism occurred in a submarine setting. Weakly to strongly foliated bodies of quartz monzonitic to granitic composition are also associated with the assemblage. Middle to Late Permian U-Pb zircon ages have been determined for layers of muscovite-quartz schist, interpreted to be felsic tuff, and for several of the quartz monzonitic to granitic metaplutonic bodies" (Dusel-Bacon et al., 2006, p. 46). Zircon collected from Klondike Schist near the head of Moose Creek returned a mid-Permian age (Mortensen, 1988a).

The average modal mineralogy for 22 samples of Klondike Schist, presented by Green (1972), is listed in Table 1. In identifying the Klondike Schist as a quartz-feldspar-muscovite schist, Green (1972, p. 109) is listing the minerals in order of decreasing abundance in the rock name. In the legend for Map 1284A (Dawson) Green describes the Klondike Schist as “mainly buff weathering, light pale green quartz-muscovite-chlorite schist, and schistose, chloritic quartzite, with all intermediate rock types also present; minor silvery muscovite schist, fine-grained quartz-biotite gneiss, thinly laminated quartz-graphite-sericite schist and quartzite”. It is interesting to note that feldspar is not mentioned – this may indicate a difficulty in recognizing feldspar during field mapping. “As no marker beds occur within the Klondike Schist and the original bedding cannot be determined, the structural pattern and probable thickness of the unit are unknown” (Green, 1972, p. 114).

Mineral	Percentage
quartz	44
K-feldspar	13
plagioclase	18
white mica	18
chlorite	1
biotite	1
epidote group	3
other	2

Table 1. Mean modal composition of 22 samples of the Klondike Schist (Green, 1972, p. 113).

Klondike schist in the Sixtymile District consists … “almost entirely of pale to medium green, well foliated, quartz-muscovite-chlorite schist with nearly ubiquitous quartz and rare feldspar augen to 4 mm in diameter. In some localities, the augen are subhedral to euhedral, suggesting that the rocks were derived from quartz and feldspar porphyries” (Mortensen, 1988a, p. 75). Note the lack of feldspar in the description except as augen.

Within the Hall Creek–Moose Creek area the Mississippian and Permian Nasina assemblage of greenschist facies carbonaceous quartzite, muscovite-chlorite schist and marble lies in thrust contact with the Klondike Schist to both the south and the immediate north. Further north amphibolite-facies rocks of the Mississippian Fortymile River assemblage occur, including orthogneiss, schist, gneiss and amphibolite (Dusel-Bacon et al., 2006). Erosional remnants of Late Cretaceous Carmacks Volcanics, including andesite flows and minor clastic sedimentary rocks, unconformably overlie the metamorphic rocks at higher elevations to the east (Carne, 1991a).

The Baldy VMS occurrence, along with the Border VMS occurrence to the southwest in Alaska and the Pub VMS occurrence to the northeast, are located within a northerly-dipping, thrust fault bounded slice of the Klondike Schist. “Two small, stratabound Pb-Zn(-Ba) occurrences lie within an east west-trending band of felsic metavolcanic rocks of the Klondike Schist that straddles the Alaska-Yukon border.… The Boundary and Baldy occurrences consist of narrow (<1 m thick) bands of disseminated to locally semi-massive galena, sphalerite, rare chalcopyrite and minor barite hosted within weakly pyritic quartz-muscovite schist. Lead isotopic analyses of galena from these and other similar base-metal occurrences within Klondike Schist yield a tight cluster of isotopic compositions that are consistent with a syngenetic origin…. Limonitic quartz-mica schist from the Boundary occurrence assayed 0.53% Cu, 2.6% Pb, 0.43% Zn and 154 g/tonne Ag … and a specimen from the Baldy occurrence (sample 96ADb62A; Table DR3) contained 0.99% Zn, 0.18% Pb and 0.16% Ba" (Dusel-Bacon et al., 2006, p. 62).

Exploration History

1976, Moose Creek Area: "The Moose Creek area, from limited reconnaissance in the area during 1976, was recognized as having potential for volcanogenic massive sulphides. The same felsic schists that are host to mineralization at the Boundary prospect, Alaska were followed and mapped eastward into the Moose Creek area of the Yukon for about 6 to 7 miles. The quartz sericite schist unit is exposed in the Moose Creek area through a strike length of about 3 miles and a width of about 1/2 mile" (Haverslew, 1978, p. 1).

1977, Moose Creek Area: In 1977 Ocean Home Exploration Co, Ltd. staked 40 claims to cover the Moose Creek (Pub) prospect about 3 km northeast Hall Creek. During the same year they collected 549 grid soil samples and completed a Turam survey over 7.5 line miles. "Anomalous lead-zinc geochemistry was found in pyrite-rich quartz sericite schist, with rocks and streams containing values in the order of 100 - 140 ppm lead and 250 - 450 ppm zinc. One rock sample from a zone 1 foot wide contained values of 740 ppm copper, 160 ppm lead, 6000 ppm zinc, and 7.6 ppm silver." (Haverslew, 1978, p. 1).

1980, Hall Creek Area: "The Baldy Claims were staked in May 1980 by Cominco Ltd. to cover an area along the Yukon/Alaska border containing anomalous soil/silt geochemistry and Cu, Pb, Zn sulphide float…. "Assessment work conducted on the claim group includes grid-soil-sampling and prospecting. The grid area has been sampled at 25 m intervals along lines spaced approximately 150 m apart. The most significant result is a coincident Cu, Pb, Zn soil geochemical anomaly adjacent to the international border. This anomaly is approx. 500-600 m long and 100-400 m wide" (Olfert, 1981, p.2).

1989, Hall Creek Area: In 1989, base metal mineralization at the Baldy Showing was identified by J.K. Mortensen of the GSC in a placer miner's test pit in the bed of Hall Creek (Carne, 1991a).

1990, Hall Creek Area: The area of the Baldy Showing was restaked by YGC in June, 1990 (Carne, 1991a). In 1990, two prospecting trips were undertaken on the Bal property (Baldy Showing area) by Archer, Cathro and Associates (1981) Limited on behalf of YGC Resources Ltd. The mineralization along Hall Creek is reported to have been covered by alluvium in 1990. "Samples of the mineralized zone collected by Mortensen were submitted for analysis by YGC along with rock samples collected from the property in 1990" (Carne, 1991a). The two best results, from the Mortensen samples, returned 3.43% Pb, 8.09% Zn, 0.20% Cu, 41 g/t Ag and 195 ppb Au from sample E42722 (heavy disseminated galena/sphalerite) and 1.00% Pb, 3.43% Zn, 0.12% Cu, 11.2 g/t Ag and 70 ppb Au from sample E42123 (moderate disseminated galena/sphalerite; Carne, 1991a and b). Three out of five samples described as pyritic schist returned elevated Pb values (270, 420, and 680 ppm Pb).

1990, Moose Creek Area: In 1990, 15 soil samples were collected in the Moose Creek by Archer, Cathro and Associates (1981) Limited on behalf of YGC Resources Ltd. (Carne, 1991c).

1991, Hall Creek Area: In 1991, one additional day of prospecting was undertaken in the Baldy Showing area by Archer, Cathro and Associates (1981) Limited on behalf of YGC Resources Ltd. "The old Cominco grid was relocated in 1991 and the best part of the geochemical anomaly was carefully prospected but due to deep weathering and overburden cover no mineralization was discovered to explain the geochemical response. Poorly exposed stratiform mineralization was located in slumped creek bank exposures downstream of the main geochemical anomaly" (Carne, 1991b). Of the four additional samples reported by Carne (1991b) the best sample consisted of banded disseminated galena-sphalerite-pyrite in quartz-sericite schist (sample T29893): 2.44% Pb, 5.64% Zn, 0.44% Cu, 33.8 g/t Ag (Au content was not determined).

1992, Hall Creek and Moose Creek Area: In 1992, Archer, Cathro and Associates (1981) Limited (acting for YGC Resources Ltd.) collected an additional 319 grid soil samples on grid lines between the original Bal and Pub grids (Carne 1993). A MaxMin (HLEM) survey was conducted over 2.1 line km's of cut grid in the Baldy Showing area. One weak conductor was detected but this did not correspond to the soil geochemical anomalies (Power, 1993, Appendix p. 2, in Carne 1993).

1995, Hall Creek Area: In 1995, 36 B horizon soil samples were collected from the Bal claims (Baldy Showing area) along 1.75 km of line (5 grid lines) by Northwest Geological Consulting Ltd. on behalf of Atna Resources Ltd. (Schmidt, 1996a).

1995, Moose Creek Area: In 1995, 58 soil samples were collected along 2.75 km of line (3 grid lines) on the Pub claims (Moose Creek area) by Northwest Geological Consulting Ltd. on behalf of Atna Resources Ltd. (Schmidt, 1996b).

2008, Hall Creek Area: In 2008, Shawn Ryan completed a small soil survey (81 samples) in the Hall Creek area (Ryan, 2009).

2011, Moose Creek Area: As part of the Fortymile Project, prospecting was conducted along Moose Creek that included silt, soil and rock sampling (Kreft, 2011).

Results of Previous Work in the Hall Creek–Moose Creek Area

Soil Geochemistry (Previous Work)

Cominco Ltd. collected approximately 350 soil samples in the Hall Creek area in 1980 with a 25 m sample interval on lines spaced approximately 150 m apart. "One significant anomalous area was detected and is located adjacent to the Alaska/Yukon border. This area is approximately 500-600 m long, 100-500 m wide and is anomalous in Cu, Pb and Zn" (Olfert, 1981, p. 3). This anomalous area mainly occurs adjacent to and west of Hall Creek (Figures 7 and 8). "Pb is the most anomalous element with values commonly in the 100-200 ppm range; background values are approx. 10-25 ppm. Two samples contained over 700 ppm Pb. Anomalous Zn values are in the range of 100-200 ppm with background values of 50-75 ppm. Anomalous Cu values are in the range of 25-100 ppm with background values of 10-15 ppm." (Olfert, 1981, p.3).

Soil sampling by Ocean Home Exploration and by Archer Cathro on behalf of YGC Resources Ltd. and Kennecott Canada between 1977 and 1992, in addition to the Cominco sampling described above, has resulted in grid soil coverage from the Alaska border near Hall Creek to the Moose Creek area, a distance of approximately 7 km (Haverslew, 1978; Olfert, 1981; Carne, 1991a; Carne, 1991c; Carne, 1993). The total number of soil samples collected during these surveys is approximately 1000 (Carne, 1993). In addition to the Hall Creek area, anomalous Pb, Zn and Cu soil values were detected over large areas in the Moose Creek area (Figure 7). "Soil samples were optimally collected from the B Horizon although soil profiles in the area are not sufficiently developed to be relatively differentiated. Most samples were probably taken from soliflucted mineral soils which include both B and C Horizons" (Carne, 1993). This lack of soil profile development was also noted by Haverslew (1978). "Although overburden cover is relatively light, deep weathering has resulted in leaching of mobile metals, such as copper and zinc, from near surface bedrock and soils. Relatively immobile elements, such as lead, generally reflect geochemical dispersion … regardless of the degree of weathering and oxidation" (Carne, 1993).

In 1995, small soil sampling programs were undertaken by Northwest Geological Consulting Ltd. on behalf of Atna Resources Ltd. in the Hall Creek and Moose Creek areas (Schmidt, 1996a and b). This sampling detected the Hall Creek soil anomaly but did not expand the boundaries of soil survey coverage.

In 2008, Shawn Ryan completed a small soil survey (81 samples) in the Hall Creek area (Ryan, 2009). This survey reconfirmed the presence of a Zn-Pb (+/- Cu) anomaly on the hillside west of Hall Creek.

In 2011, as part of the Fortymile Project, prospecting was conducted along Moose Creek that included silt, soil and rock sampling (Kreft, 2011).

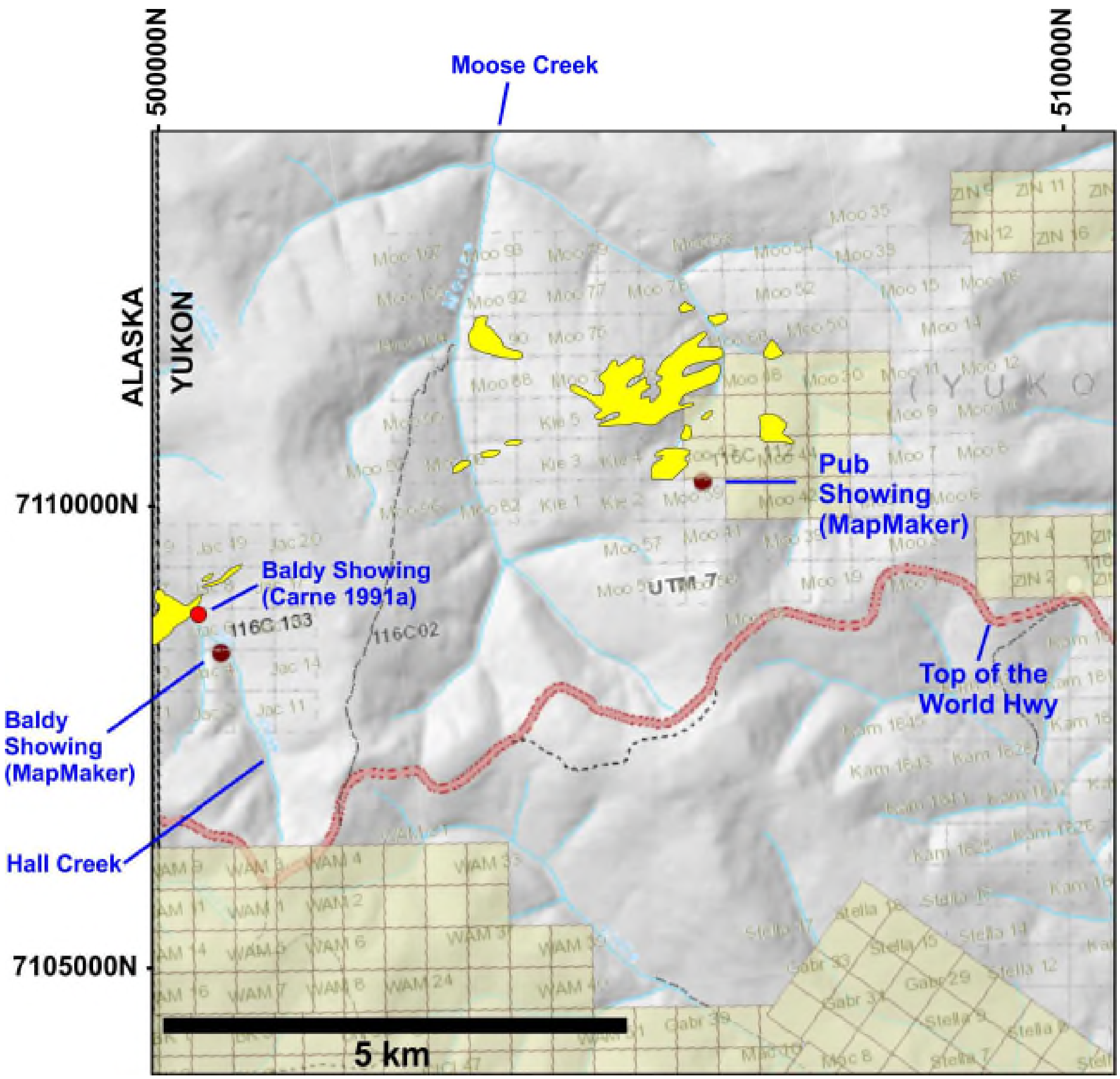
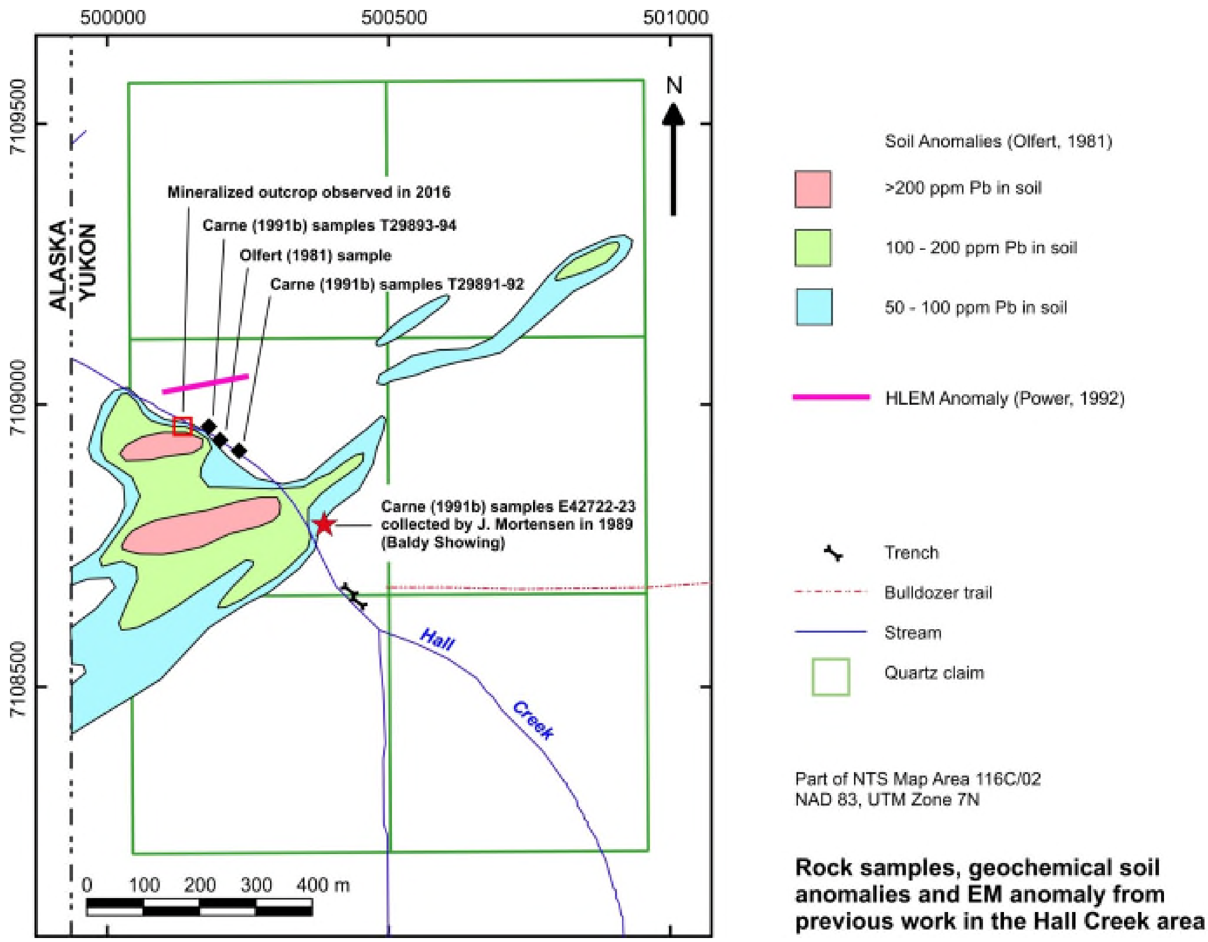


Figure 7. Map showing soil anomalies in the Hall Creek – Moose Creek area. Soil (B horizon) anomalies containing >50 ppm Pb are shown in yellow (after soil geochemical compilation by Carne, 1993). Light green rectangles represent quartz claims (as shown on 2016-Mar-30). Placer claims not shown. Base map from Yukon Geological Survey MapMaker Online.

Maximum values in western soil anomaly (Hall Creek area): 293 ppm Pb, 780 ppm Zn, 155 ppm Cu.

Maximum values in eastern soil anomaly (Moose Creek area): 350 ppm Pb, 620 ppm Zn, 190 ppm Cu.



Rock samples, geochemical soil anomalies and EM anomaly from previous work in the Hall Creek area

Figure 8.

Mineralization (Previous Work)

The Yukon Geological Survey Minfile description for the Baldy Showing (data.geology.gov.yk.ca/Occurrence/14855) includes the following information: "Extensive soil sampling by Cominco in 1980 outlined a 1300 by 100-500 m area of anomalous Pb, Zn and Cu around the showing, and subsequent prospecting uncovered disseminated sphalerite, chalcopyrite, galena and minor pyrite in the slumped bank of Hall Creek. The sulphides occur along the foliation in the host schist. A specimen collected by YGC in 1991 contained 3.43% Pb, 8.09% Zn, 0.20% Cu, 41.0 g/t Ag and 195 ppb Au." It is the author's opinion that (i) the sample containing 3.43% Pb and 8.09% Zn, collected in 1989 by J. Mortensen of the GSC from a placer miner's test pit, represents the Baldy Showing, (ii) the "slumped bank of Hall Creek" refers to a location a few hundred meters downstream from the Baldy Showing, and (iii) any significant sphalerite, chalcopyrite and galena mineralization discovered by prospecting outside of the Baldy Showing pit was located in float (see discussion below). Geochemical data for rock samples collected from the Baldy Showing and from along Hall Creek between the Baldy Showing and the Alaska border are presented in Table 2 (see Figure 8 for sample locations).

The earliest record of base metal mineralization along Hall Creek is from a 1980 exploration program by Cominco that discovered mineralized float in the creek bed. “The mineralization occurs as stratiform disseminations of sphalerite, chalcopyrite, galena and pyrite in quartz, muscovite, chlorite host rocks. One sample submitted for assay contained 1.44% Zn, 0.3% Pb, 0.1% Cu, 0.2 oz/t. Ag and 0.002 oz/t. Au…. All the mineralized float occurrences are located in the area containing the coincident Cu, Pb, Zn soil-geochemical anomaly” (Olfert, 1980, p 3). The mineralized float was located along Hall Creek about 300 m upstream along Hall Creek from the Alaska border (Figure 8, Table 2).

In 1989, J. Mortensen of the GSC observed base metal mineralization in a placer miner's test pit in the bed of Hall Creek. Samples of the mineralized zone collected by Mortensen were submitted for analyses by YGC Resources Ltd. as samples E42722 and E42723 (which returned up to 8.09% Zn and 3.43% Pb) with the results reported in Carne (1991a and 1991b). The sample location for samples E42722 and E42723 is shown on a map accompanying Carne (1991b) as being about 540 m upstream along Hall Creek from where the creek crosses the Alaska border. In the map accompanying Carne (1991a) this location is marked “Zn-Pb-Cu Showing”. This site is considered by the author to represent the Baldy Showing. The placer miner’s pit from which Mortensen collected the base metal mineralization was covered by alluvium at the time of the 1990 and 1991 exploration by YGC Resources Ltd. (Carne, 1991b).

Exploration in the Hall Creek area from 1990 to 1992 by YGC Resources Ltd. produced only two more significant base metal samples. Samples T29893 and T29894 are shown as having been collected approximately 270 m NW of the Mortensen’s Baldy Showing samples (E42722 and E42723) and near the downstream edge of the Cominco soil anomaly on the compilation map of Carne (1991b). These samples (T29893 and T29894) returned up to 5.64% Zn and 2.44% Pb from banded galena-sphalerite-pyrite mineralization in quartz-sericite schist (Carne 1991b). It is not possible to determine from Carne (1991b) if these samples were collected from outcrop of float (although, had they been from outcrop it would have represented a new showing and one would have expected more discussion). A subsequent report for YGC Resources Ltd. states that “Float mineralization consisting of disseminated sphalerite, galena and chalcopyrite in a siliceous matrix has been discovered in one area of the property” (Carne, 1993, p. 1). Thus, samples T29893 and T29894 are thought to have been collected from float.

The mineralization discovered along Hall Creek occurs as stratiform disseminations of sphalerite and galena accompanied by minor chalcopyrite and pyrite in quartz, muscovite, chlorite schist (Olfert, 1981; Carne, 1991). The mineralized, siliceous intervals are thought to represent a metamorphosed, Permian-aged, stratiform volcanogenic exhalite horizon (Carne, 1991b, 1993). The mineralization displays distal characteristics despite the relatively high grades of base metals and silver (Carne, 1993). “This zone is unusual in the very low pyrite content of the mineralization” (Carne, 1991, p. 6). “Lead isotope analysis of galena from the mineralized interval carried out by J.K. Mortensen yields a Middle to Upper Permian model age, concordant with age of the host rocks” (Carne, 1991b). This result supports the interpretation that the mineralization is syngenetic.

The known mineralization at the Baldy Showing coincides with a moderate strength part of a large Pb-Zn-Cu soil anomaly. “No mineralization has yet been discovered to explain the best part of the zone” (Carne, 1991).

Approximately 5.5 km to the east-northeast of the Baldy Showing disseminated sphalerite, galena and chalcopyrite with minor pyrite are reported to occur in siliceous Klondike Schist at the Pub Showing near the contact between chloritic and sericitic rocks (Carne, 1993). This showing lies east of the 2016 exploration area.

Mineralization at the Baldy Showing is thought to be hosted within the same stratigraphic sequence as the Boundary prospect located about 1.5 km to the west-southwest across the Alaska border (Olfert, 1981; Carne, 1991b). “Little information is publicly available on this deposit although it is known that the volcanogenic massive sulphide mineralization received extensive diamond drilling in the late 1970's” (Carne, 1991b). A sample of limonitic quartz-mica schist from the Boundary occurrence returned 0.53% Cu, 2.6% Pb, 0.43% Zn and 154 g/tonne Ag” (Dusel-Bacon et al., 2006).

In 2011, as part of the Fortymile Project, prospecting was conducted along Moose Creek that included silt, soil and rock sampling. One rock sample (MBR11-05), collected from the upper part of Moose Creek, returned >10% S, 858 ppm Cu, 61 ppm Pb and 5980 ppm Zn. This sample is described as “friable limonitic chlor-qtz schist with massive band py” (Kreft, 2011, sample description table). The sample descriptions do not differentiate between outcrop and float.

Whole Rock Geochemistry (Previous Work)

Whole rock geochemical data is available for a single specimen of Klondike Schist from the Baldy Occurrence (sample 96ADb62A; Dusel-Bacon et al., 2006, p. 62 and Table DR3). This sample of a quartz schist containing sphalerite, pyrite and minor chalcopyrite returned 82.08% SiO_2, 8.44% Al_2O_3, 2.35% Fe_2O_3 (total Fe), 0.70% MgO, 2.14% K_2O, 0.57% Na_2O, 2.14% S, 0.99% Zn, 0.18% Pb, 0.01% Cu, 2.2 ppm Ag and 0.16% Ba.

Summary of Previous Work

- Rock samples from the Baldy Showing in the Hall Creek area have returned metal values that could potentially support a mining operation (e.g. 8.09% Zn, 3.43% Pb, 0.20% Cu, 41 g/t Ag and 0.195 g/t Au).
- The multi-element (Pb-Zn-Cu) soil anomaly in the Hall Creek area is approximately 500-600 m long and 100-500 m wide (Figure 2).
- Work by both industry and government indicates that the Baldy Showing, and the nearby Border (in Alaska) and the Pub (Moose Creek) occurrences represent volcanogenic massive sulphide (VMS) deposits that may lie within the same stratigraphic package.
- The Baldy Showing lies within the Permian Klondike Schist (as do the Border and Pub showings). The Klondike Schist is part of the Yukon-Tanana terrane, which is composed primarily of arc assemblages known to host VMS deposits including those in the Devonian to Mississippian Finlayson assemblage in the Finlayson Lake district.

Sample #	Pb (%)	Zn (%)	Cu (%)	Ag (g/t)	Au (ppb)	Description	Source	Comment
na	0.3	1.44	0.1	6.9	70	strat. diss. of Sph, Cp, Gal and Py	Olfert (1981)	Float, Hall Creek, about 300 m upstream from Alaska border.
E42722	3.43	8.09	0.20	41.0	195	heavy dissem gal/sph	Carne (1991a, b)	Baldy Showing. Collected by Mortensen (GSC) in 1989 from placer miner's test pit. Analyzed by YGC Resources Ltd.
E42723	1.00	3.43	0.12	11.2	70	mod dissem gal/sph	Carne (1991a, b)	
T12001	0.0002	0.0108	0.0075	<0.2	<5	pyritic schist	Carne (1991a)	No details provided. Location unknown.
T12002	<0.002	0.0062	<0.0001	<0.2	<5	pyritic schist	Carne (1991a)	
KS-1	0.042	0.0012	0.0003	<0.2	<5	pyritic schist	Carne (1991a)	No details provided. Location unknown.
KS-2	0.027	0.0084	0.0010	<0.2	<5	pyritic schist	Carne (1991a)	
KS-3	0.068	0.0072	0.0140	<0.2	<5	pyritic schist	Carne (1991a)	
T29891	0.72	0.08	0.04	16.4	na	minor diss gl in SE-CL SHST	Carne (1991b)	Probably float. Location shown on compilation map in Carne (1991b). Near location of Olfert (1981) float sample.
T29892	0.20	0.03	0.04	3.4	na	minor diss gl-py in CL SHST	Carne (1991b)	
T29893	2.44	5.64	0.44	33.8	na	banded diss gl-sl-py in QZ-SE SHST	Carne (1991b)	Probably float. Location shown on compilation map in Carne (1991b). Near location of Olfert (1981) float sample.
T29894	1.41	2.65	0.29	23.2	na	diss gl-sl-py in QZ-SE SHST	Carne (1991b)	
96ADb 62A	0.18	0.99	0.01	2.2	4	Qz-Wm schist; Sp=Py>>Cpy	Dusel-Bacon et al. (2006)	No details provided.

Table 2. Rock geochemical results for sample from the Hall Creek area collected before 2016

Claim Staking

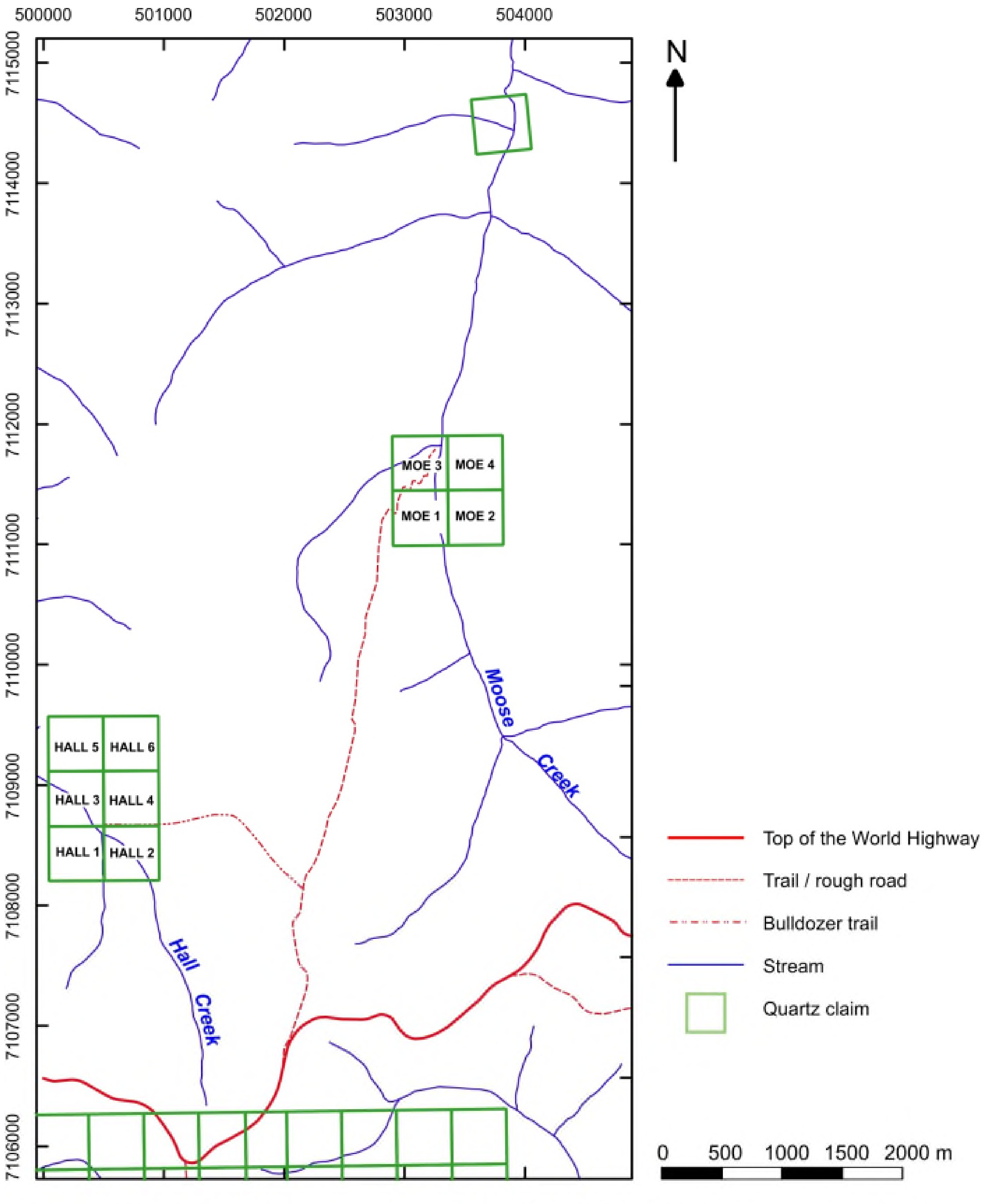
Two blocks of quartz claims were staked during the 2016 field program (Table 3 and Figure 9). All of the claims are registered in the Dawson Mining District to Glen Prior.

Hall Claim Block: This is a block of 6 claims (HALL 1 to HALL 6) that straddles Hall Creek within NTS map area 116C/02).

Moe Claim Block: This is a block of 4 claims (MOE 1 to MOE 4) that straddles Moose Creek within NTS map area 116C/02).

Claim Name	Tag Number	Recording Date
HALL 1	YF52001	2016-July-25
HALL 2	YF52002	2016-July-25
HALL 3	YF52003	2016-July-25
HALL 4	YF52004	2016-July-25
HALL 5	YF52005	2016-July-25
HALL 6	YF52006	2016-July-25
MOE 1	YF52007	2016-August-04
MOE 2	YF52008	2016-August-04
MOE 3	YF52009	2016-August-04
MOE 4	YF52010	2016-August-04

Table 3. Quartz claims staked during the 2016 field program in the Hall Creek–Moose Creek area.



Part of NTS Map Area 116C/02
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site
of Geomatics Yukon (Yukon Government)

Map of the Hall Creek - Moose Creek area showing quartz claims

(claims staked during 2016 exploration program labelled)

Figure 9.

Field Geology of the Hall Creek–Moose Creek Area

The area under investigation is underlain almost entirely by the Klondike Schist (Figure 10, Table 4). The Klondike Schist is in thrust fault contact with rocks of the Nasina Series to both the north and south (Mortensen, 1988b). Lithogeochemistry (discussed in detail in subsequent sections) permitted the identification of three units within the Klondike Schist: (i) mid-Zr felsic schist, which underlies most of the area, (ii) high-Zr felsic schist, and (iii) intermediate schist.

Age	Lithology
Tertiary or Quaternary	Olivine basalt
Late Cretaceous	Carmacks Group: basalt and andesite flows breccias and plugs
Early Cretaceous	Indian River Formation: quartz pebble conglomerate, sandstone, shale
Permian	Klondike Schist: quartz-muscovite schist, quartz and/or feldspar augen-bearing quartz-muscovite (chlorite) schist
Mississippian to Permian	Nasina Series: graphitic quartzite and quartz-muscovite schist
Mississippian	Fortymile River assemblage: o granodioritic, dioritic and tonalitic gneiss o chlorite (± biotite) schist, biotite-hornblende gneiss, amphibolite

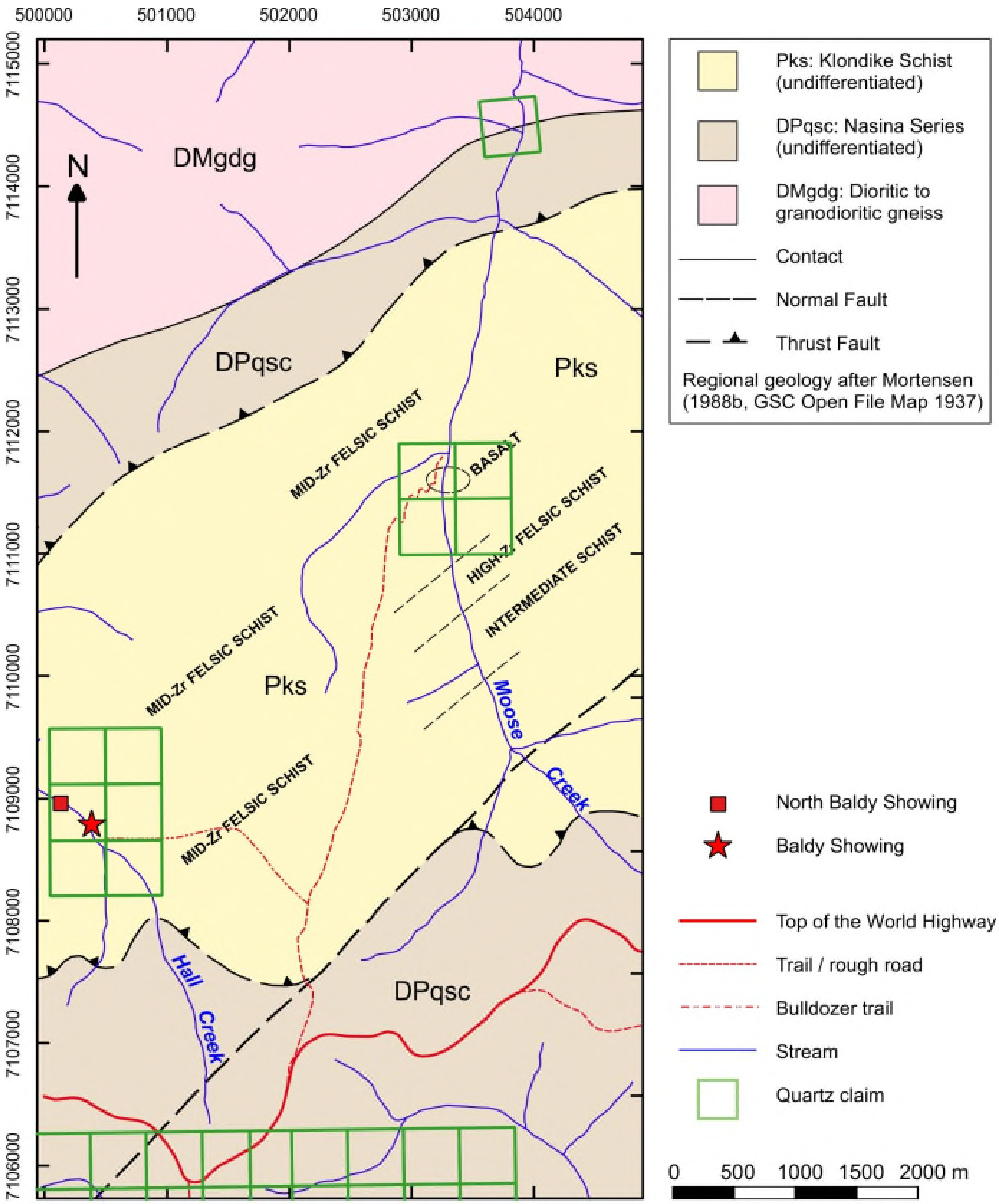
Table 4. Table of formations for western Yukon in the general Hall Creek – Moose Creek area (Mortensen, 1988b; Mortensen, 1988b; Carne, 1993; Dusel-Bacon et. al., 2006; Geomatics Yukon).

Outcrops of Klondike Schist within the Hall Creek–Moose Creek area have been identified mainly as quartz-muscovite schist and quartz-feldspar-muscovite schist (this report follows the naming convention used in previous reports on the Klondike Schist (e.g. Green, 1972; Metcalfe, 1981) by placing the most abundant mineral first in the rock name). The quartz is typically anhedral, light grey and somewhat glassy while the feldspar is mainly anhedral and white. Feldspar is commonly difficult to distinguish and many outcrops mapped as quartz-muscovite schist may in fact be quartz-feldspar-muscovite schist (as suggested by the significant Na_2O values in some of these rocks). A minority of outcrops contain fine grained, distinct, anhedral quartz grains (eyes) commonly 1 to 3 mm across. Muscovite is commonly silver to light silvery green, aphanitic to fine-grained and is transitional into sericite in many outcrops. Metamorphic mineral segregation within the rock into quartz-rich (± feldspar) and phyllosilicate-rich layers imparts a strong, pervasive foliation. The quartzose layers are thicker (commonly 1 to 5 mm) than the phyllosilicate layers (commonly < 1 mm). Muscovite is aligned parallel to the foliation. Outcrops are generally light grey on fresh (broken) surfaces and light to medium grey on weathered surfaces.

Accessory minerals in some outcrops include biotite and chlorite. Chlorite is typically bright, medium green in colour, fine to medium-grained and aligned parallel to foliation. Biotite is black, commonly fine grained and may be aligned parallel to foliation or randomly oriented. In a very small minority of outcrops, fine-grained biotite appears to be pseudomorphic after an elongate, prismatic mineral (possibly amphibole).

Metamorphic foliation intensity in outcrops of the Klondike Schist in the Hall Creek–Moose Creek area varies from moderate to very strong. Foliation generally trends in an east-northeast direction roughly parallel to the long axis of the area underlain by Klondike Schist and the bounding thrust faults (Figures 11 and 12). The foliation tends to dip at shallow to moderate angles to the north. Exceptions occur (i) on Hall Creek near the North Baldy Showing where moderate to steep south dips occur (ii) on Moose Creek near 7110290N where steep northerly dips occur and (iii) on Moose Creek between 7112000N and 7114000N where dips are steep and some southern dips are observed. Small scale folds, including crenulation folds, were noted in a few outcrops (Figure 13). The two fold hinges measured in the field plunge at shallow angles toward the southeast and west-southwest. The southern dips on Hall Creek and Moose Creek may be attributed to antiform – synform pairs and this interpretation is shown in Figures 11 and 12. However, faults may play a role as well. Olfert (1981) suggested the presence of an overturned syncline in the Hall Creek area.

In one large outcrop on Moose Creek near 7110290N, two distinctive layers up to 18 cm thick occur that are strongly suggestive of compositional contrast with the enclosing rocks (possibly indicative of bedding). These are parallel to one another and parallel to metamorphic foliation. There is also a weak indication of parallelism between compositional contrast (bedding?) and foliation at the North Baldy Showing.



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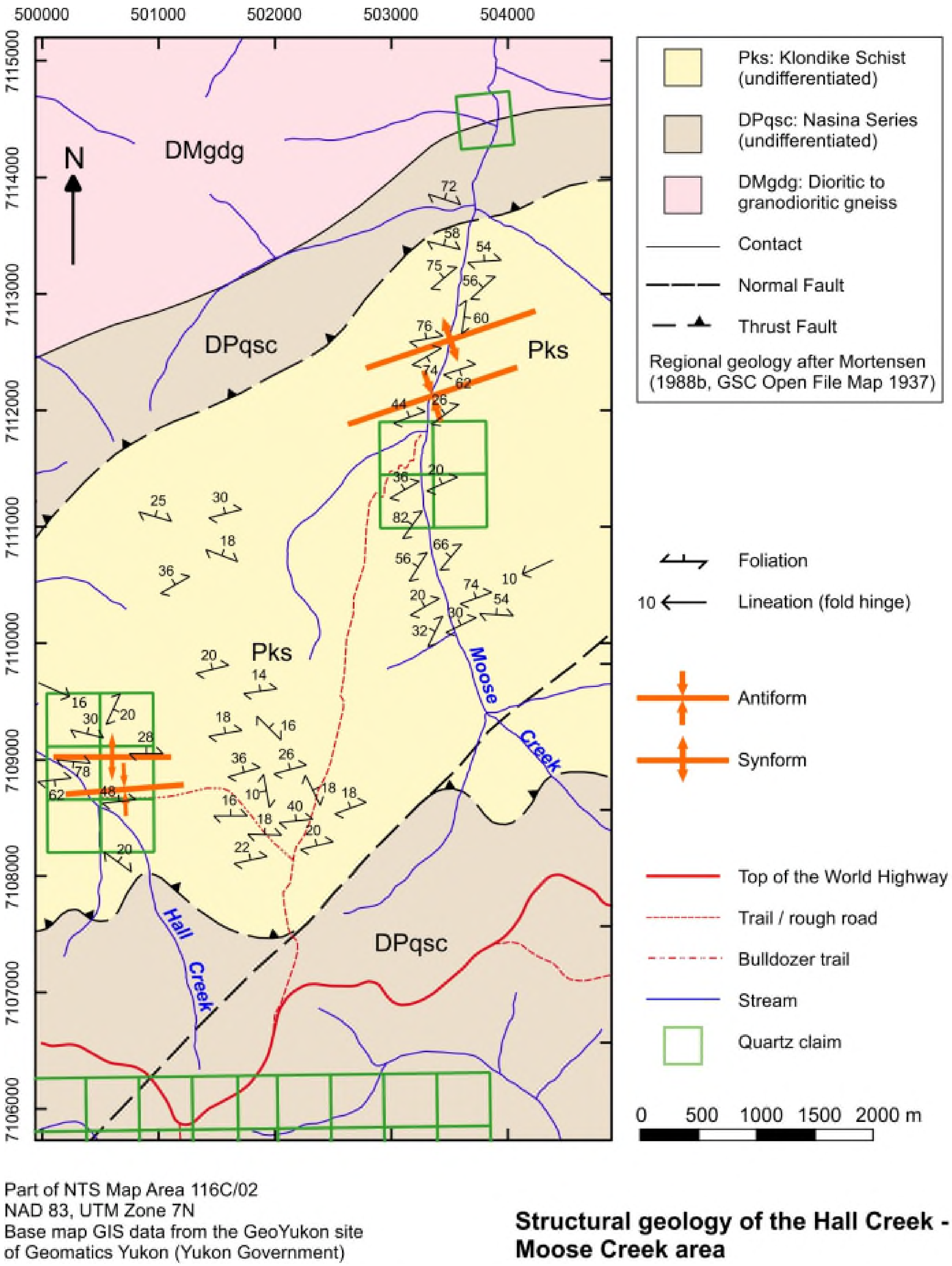
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site
of Geomatics Yukon (Yukon Government)

Geology of the Hall Creek - Moose Creek area

Figure 10.



Structural geology of the Hall Creek - Moose Creek area

Figure 11.

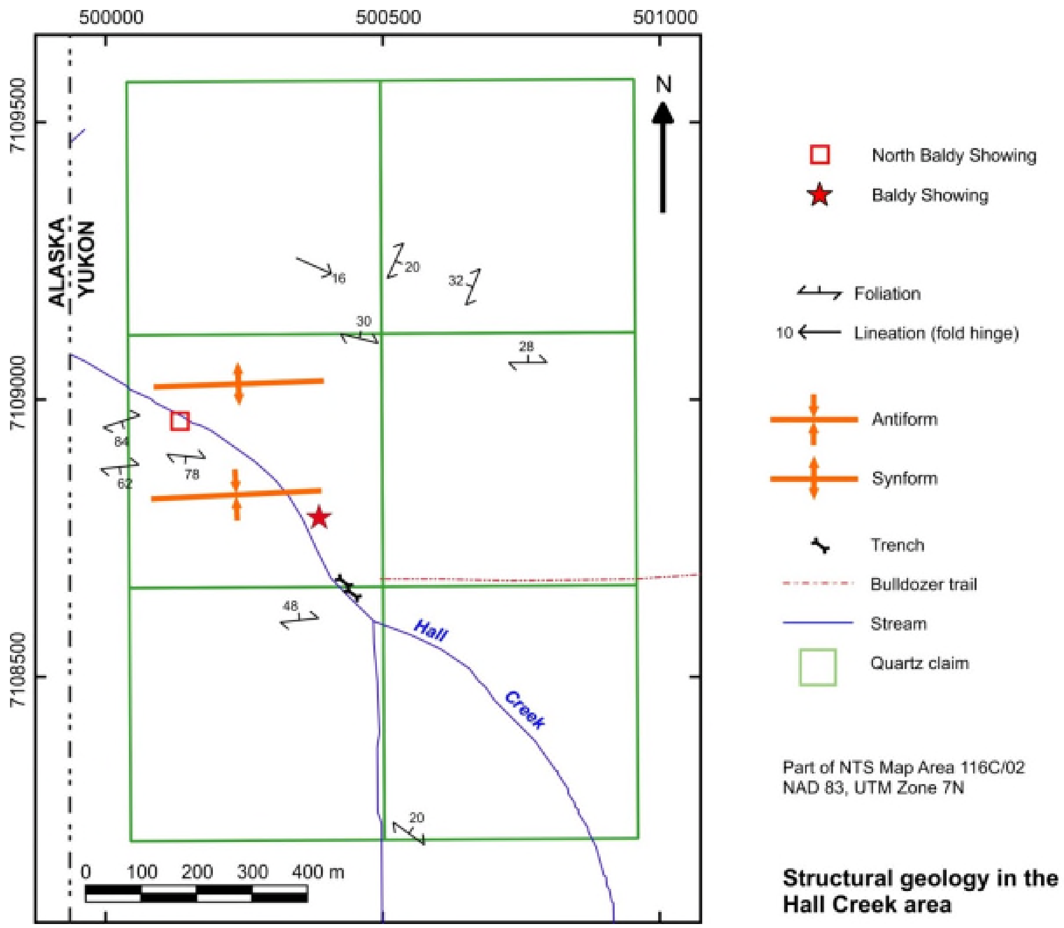


Figure 12.

Figure 13. Folded quartz-biotite-(muscovite-chlorite) schist on east side of Moose Creek (view towards 080° near coordinates 503470N, 7110290N and sample site 16HL141). Note lighter coloured, more competent unit in lower right part of photo. Black lines on hammer handle are spaced 10 cm apart.

A prominent outcrop of aphanitic to fine-grained, non-foliated, moderately magnetic, mafic (basaltic) rock was noted on the east side of Moose Creek at 7111650N. Fresh (broken) surfaces are black while the weathered surface is medium to dark (weakly greenish) grey to locally rusty brown (limonitic Fe-oxide stain). The rock contains rare (trace to 0.25%), anhedral to subhedral, medium green olivine crystals up to 2 mm across that appear relatively fresh. Rounded, spherical to oval (elongate about 2:1) amygdules of white, fine-grained calcite up to 10 x 5 mm are common along with moderate amounts of fine-grained, disseminated, spotty calcite. Weathered surface displays vesicular appearance where amygdules have weathered out. The outcrop displays numerous, multidirectional joint surfaces (possibly cooling joints). Just north (downstream) of this outcrop, and seeming to emanate from the same hillside (under overburden cover), are numerous boulders of similar material except that some of these contain abundant schistose country rock xenoliths.

Boulders of similar basaltic rock, with and without schistose xenoliths, are common along Moose Creek over a distance of about 400 m both upstream (south) and downstream (north) of the known basaltic outcrop. A small minority of these boulders contain olivine-rich nodules interpreted to be mantle xenoliths.

The mafic outcrop and associated boulders corresponds to the olivine basalt that Mortensen (1988a, p. 76-77) described in the Dawson map area: “Unaltered olivine basalt of Tertiary or Quaternary age occurs in several localities in the study area. These rocks contain olivine phenocrysts, olivine and pyroxene xenocrysts, and rounded peridotite nodules to 5 cm in diameter. A small body of basalt on the Sixtymile road … includes both massive and highly scoriaceous varieties, both of which contain abundant xenoliths of the underlying schists and Cretaceous-Tertiary sediments. Olivine basalt also occurs as locally derived boulders to 1 m diameter in the headwaters of Moose Creek about 15 km northwest of the Sixtymile occurrence, and as a small body capping massive greenstone 2.5 km west of the mouth of Clinton Creek …. The final locality where the basalts have been observed is on the west side of the Yukon River, 5.5 km upstream from Fortymile River. Here an apparently valley-filling accumulation about 100 m thick of massive to horizontally bedded debris flow material consisting mainly of olivine basalt is capped by 25 m of spectacularly columnar-jointed basalt.”

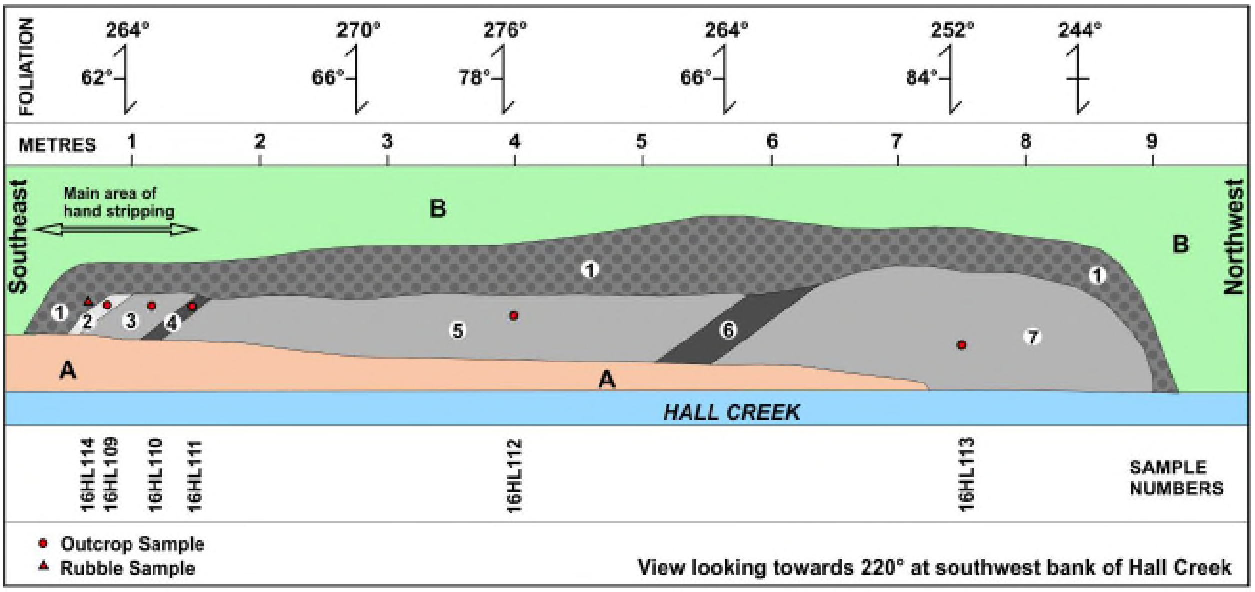
Field Description of North Baldy Showing

During the 2016 exploration program, sphalerite and pyrite mineralized outcrop/subcrop was located on the west bank of Hall Creek about 230 m upstream (southeast) of where the creek crosses the Alaska border and about 300 m downstream (northwest) of the Baldy Showing. The mineralization observed in 2016 is herein referred to as the North Baldy Showing. The report on 1991 exploration in the Hall Creek area for YGC Resources Ltd. states that "Poorly exposed stratiform mineralization was located in slumped creek bank exposures downstream of the main geochemical anomaly" (Carne, 1991b, p. 5). Given the sparsity of outcrop along this section of Hall Creek it is likely that the mineralized outcrop/subcrop observed in 2016 and the "slumped creek bank exposures" of Carne (1991b) represent the same location.

The North Baldy Showing was located at 500134E and 7108961N (UTM, NAD83, Zone 7N) by hand stripping at the southeast end of a low outcrop exposed by stream erosion along the west side of Hall Creek (Figures 14 to 16). Bedrock is overlain by water-saturated, mainly frozen sediment at the base of a moderately steep slope making it difficult to expand the exposure greatly by hand stripping (partly because stripping promotes thawing). The showing consists of very siliceous and very competent (hard) quartz-muscovite schist. Silicate mineralogy is estimated to consist of 90-95% aphanitic, light grey to white quartz and 5-10% pale, silvery-green, aphanitic to fine-grained muscovite (gradational to sericite). Sulphides consists of trace to 2% disseminated pyrite, some in cubes up to 1 mm across, and trace to 0.25% dark brown to black, disseminated, fine-grained sphalerite, some of which is aligned parallel to metamorphic foliation. Foliation at the mineralized interval is at 264°/62°S, which is at odds to the regional foliation which generally dips at shallow to moderate angles towards the north. Only the edge of the mineralized zone could be uncovered by hand stripping (due to the almost immediate slumping of overburden when disturbed) so the width of the mineralized interval is unknown (the maximum exposed true thickness exposed was 15 cm). The exposed, northern contact of the very siliceous mineralized interval with host felsic schist appears to be parallel to foliation. A sample of the mineralized outcrop (16HL109) returned 2041 ppm Zn, 57 ppm Pb, 83 ppm Cu, 0.24 ppm Ag, 14 ppb Au and 0.94% S.

Several pieces of siliceous, mineralized (pyrite ± sphalerite) material were uncovered lying on or near bedrock by hand stripping. A sample of one of the more mineralized pieces (16HL114) returned 7078 ppm Zn, 710 ppm Pb, 86 ppm Cu, 1.56 ppm Ag, 9 ppb Au and 4.52% S. This sample is described as an angular block of rubble (basal colluvium) 25 x 20 x 3.5 cm in size. It is a white to light grey rock composed mainly of aphanitic to fine-grained quartz with about 5% pale silvery green, aphanitic to fine-grained muscovite/sericite. The rock is moderately foliated (not strikingly schistose). It contains 5 to 10% pyrite, commonly in cubes up to 1 mm across, that occurs disseminated and in discontinuous bands up to 1 mm wide parallel to foliation. It also contains 0.5 to 1% fine-grained, black sphalerite that occurs disseminated and within discontinuous bands.

The outcrop immediately north of the mineralized interval, in the structural footwall, consists mainly of quartz-muscovite/sericite schist containing minor amounts (locally up to 5%) of disseminated pyrite. One narrow (15 cm), strongly manganese stained, possibly fragmental unit occurs about 0.7 m north of the mineralized zone. A sample of this material (16HL111) returned 1.25% MnO and 9.14% Fe_2O_3.



Unit Descriptions

A. Alluvium. Mainly gravel, pebbles and cobbles.

B. Moss, grass, shrubs and small spruce trees (covering colluvium).

1. Colluvium. Clast-rich in silty clay matrix. Clasts commonly gravel size but cobbles and boulders occur locally. Clasts tend to be angular. Upper 10 to 20 cm is water saturated. Lower part is frozen.

2. Quartz-muscovite schist (stripped exposure of North Baldy showing). Structural top not exposed (buried beneath colluvium). Very siliceous. 90-95% aphanitic, light grey to white quartz. 5-10% pale, silvery green, aphanitic to fine-grained muscovite. Trace - 2% disseminated, fine-grained pyrite (some in cubes up to 1 mm across). Trace to 0.25% disseminated dark brown to black, fine-grained sphalerite (some aligned parallel to foliation). Weakly foliated, very competent. Exposed true width is 0.15 m. Sharp contact with unit 3.

3. Quartz-muscovite schist. Somewhat similar to unit 2 but is much more strongly foliated (very schistose) and less siliceous. 70-75% aphanitic, light grey quartz and 20-25% pale, silvery green, aphanitic to fine-grained muscovite. 1-5% disseminated, fine-grained pyrite (some in cubes up to 1 mm across). Foliation surfaces display distinctive rusty (limonitic) blebs up to 1 mm across that are probably oxidized pyrite. True width is 0.35 m. Gradational contact with unit 4.

4. Black, Mn-stained zone composed, in part, of crumbly/blocky, possibly fragmental material. Locally stained rusty brown (limonitic). Locally contains medium-grained yellow to brown mica. True width is 0.15 m. Sharp contact with unit 5.

5. Quartz-muscovite schist. About 70% light grey, aphanitic quartz and 30% light silvery green, aphanitic to fine-grained muscovite. Nil to 2% fine-grained, disseminated pyrite (pyrite content decreases to northwest). Silvery sheen on foliation surfaces. Strong foliation. Pronounced crenulation/kink folding. Local Mn stain on foliation surfaces. True width is 2.0 m. Contact with unit 6 is relatively sharp.

6. Mn-oxide stained interval of quartz-muscovite schist (similar to unit 5 except for Mn stain). Strongly foliated. Foliation surfaces covered by black Mn stain such that overall colour of material is black (but actual percentage of Mn oxide is probably less than 2%). Interval contains about 5% white quartz veins and lenses up to 5 cm wide. True width is 0.32 m. Contact with unit 7 is relatively sharp.

7. Quartz-muscovite schist (similar to unit 5). About 70% aphanitic, light grey quartz and 30% pale, silvery green, aphanitic to fine-grained muscovite. Trace to 1%, disseminated, fine-grained pyrite with some cubes up to 1 mm across). Strong foliation. Exposed true width is 1.8 m. 1 to 2% white quartz veins and lenses up to 4 cm wide.

Figure 14. Geological sketch of the North Baldy Showing (unit 2) and adjacent outcrop.

Figure 15. North Baldy Showing and adjacent outcrop. Mineralization, largely covered by colluvium, occurs in stripped area near left (southeast) side of photo. Orange flags are spaced 0.5 m apart. View towards 220°.

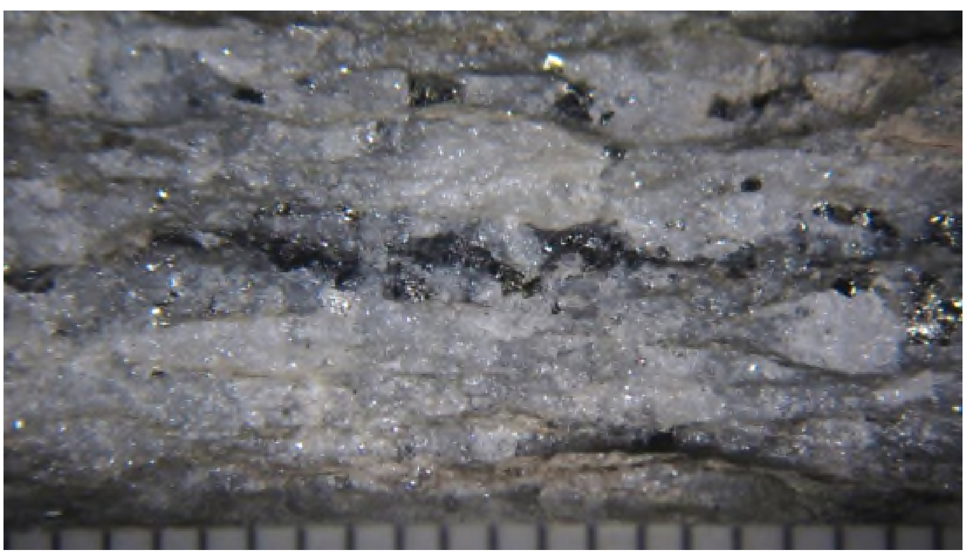


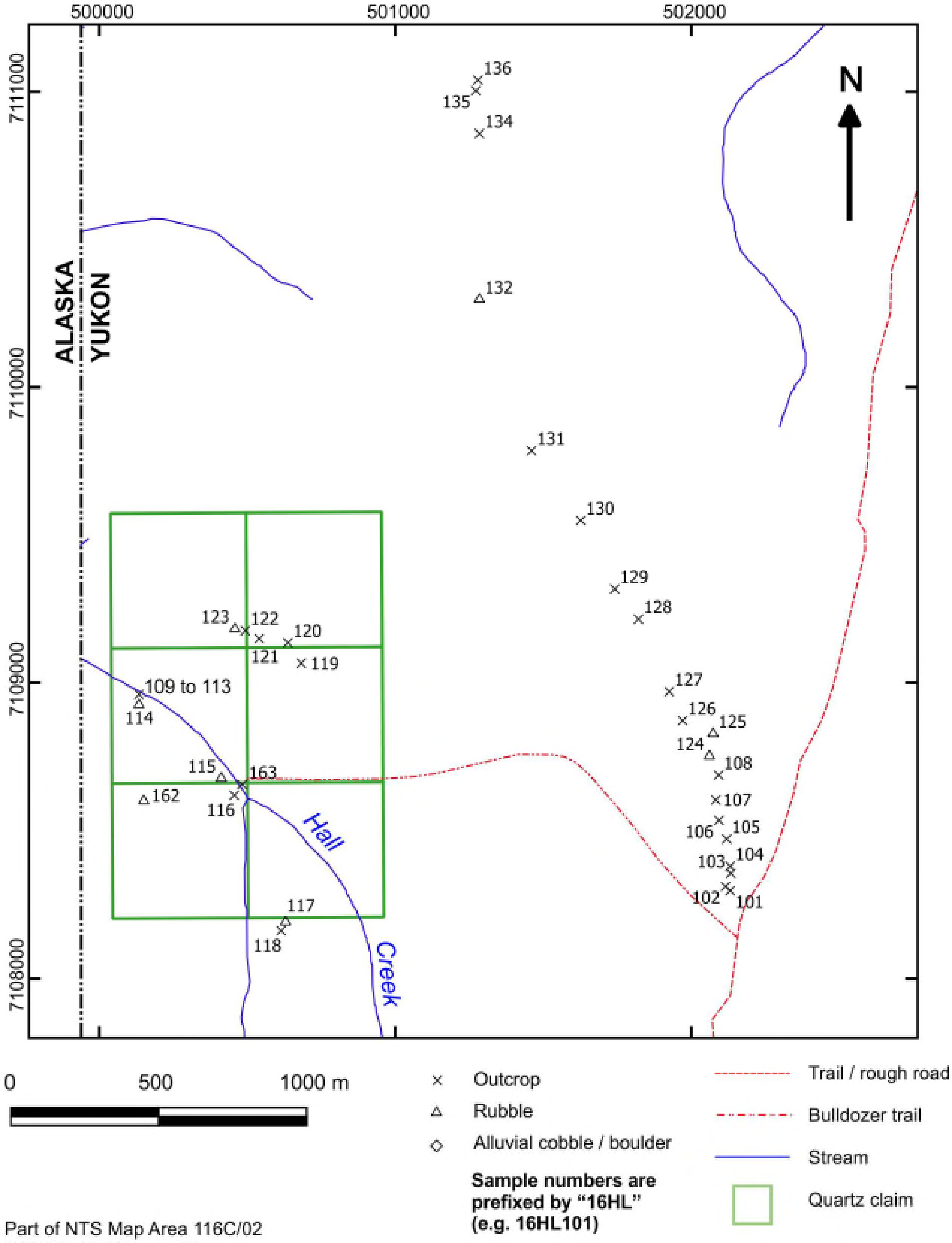
Figure 16. Binocular microscope view of sample 16HL114. Sphalerite (dark mineral) and pyrite occur in foliated, quartz-rich host. Scale bar is divided into 1 mm increments.

Lithogeochemistry: Whole Rock Analyses

Data Set

This set of data consists of 63 samples collected from outcrop and from rubble thought to be proximal to source. Sample locations are shown in Figures 17 and 18. The samples were collected over an area of about 6 x 4 km in the Hall Creek–Moose Creek area north of the Top of the World Highway and within 4 km of the Alaska–Yukon border within NTS map area 116C/02. The samples were collected in the Hall Creek valley, the north trending ridge between Hall Creek and Moose Creek, and along Moose Creek. The samples were collected for whole rock geochemical analyses (fusion digestion followed by ICP-OES and ICP-MS determinations including major oxides, high field strength elements and rare earth elements). These chemical data were obtained to help determine the regional and local stratigraphic setting of the Baldy and North Baldy base metal occurrences and to search for hydrothermal alteration patterns related to this mineralization and mineralization elsewhere in the project area. In addition to whole rock analytical analyses, these samples were also submitted for determination of a suite of elements, including base metals, silver and gold, by ICP-AES/MS after an aqua regia (partial) digestion.

Rock sample descriptions are provided in Appendix 1, analytical methods are described in Appendix 2 and the analytical results are presented in Appendix 3. The data for certified reference materials (standards) and duplicates introduced by the lab were reviewed and no issues were detected.



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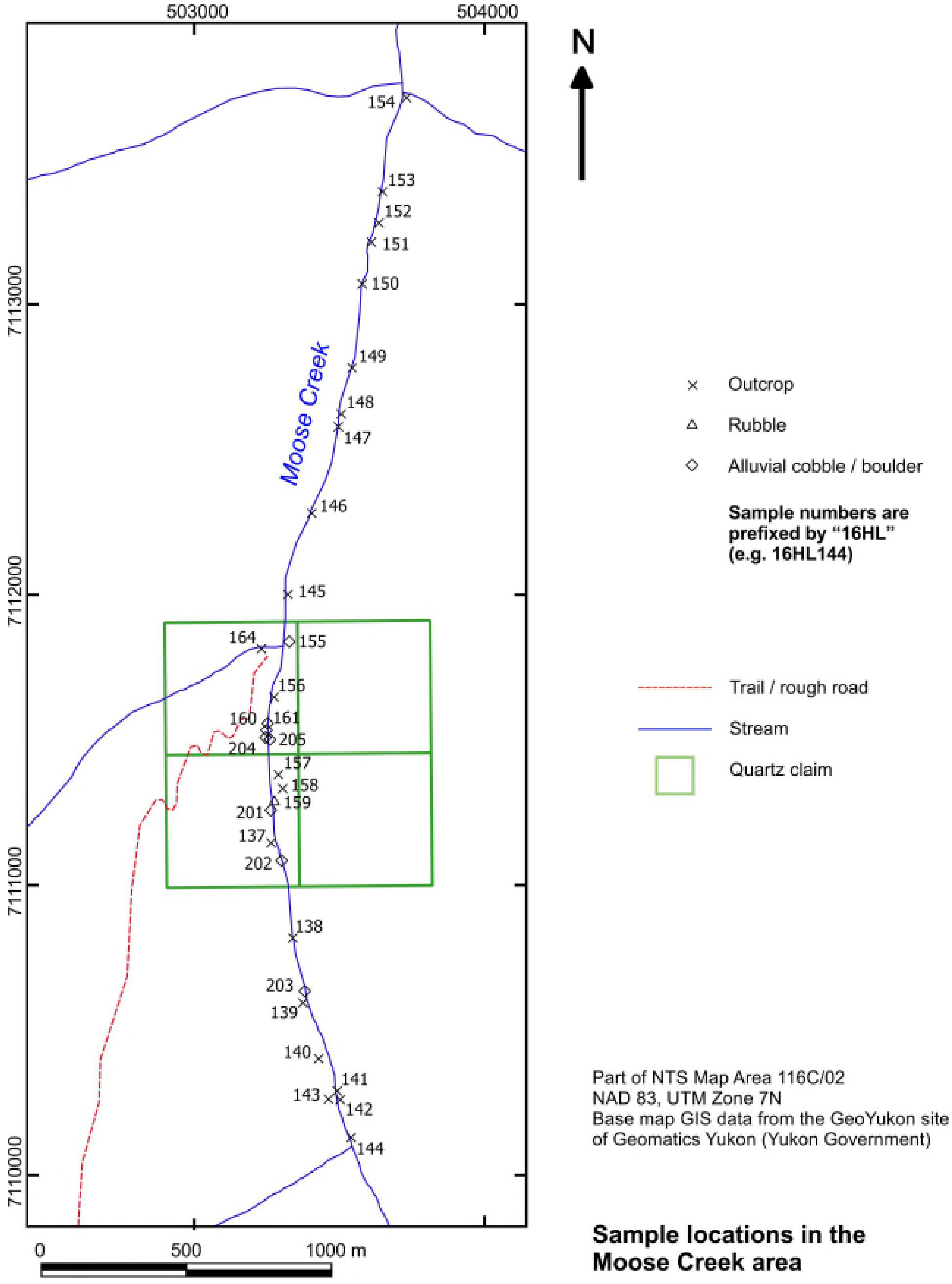
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Sample locations in the Hall Creek area

Figure 17.



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Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Sample locations in the Moose Creek area

Figure 18.

The Klondike Schist: Igneous or Sedimentary

Before attempting to interpret lithogeochemical data it is desirable to know as much as possible about the origin and field relationships of the rocks being considered. A fundamental piece of knowledge is whether the rocks are igneous or sedimentary. However, no compelling evidence to support either a volcanic or sedimentary origin for the Klondike Schist was observed during the 2016 field work although the very quartz-rich nature of some quartz-muscovite schist outcrops suggests silica enrichment by either sedimentary processes or hydrothermal alteration. Published opinions regarding the pre-metamorphic composition of the Klondike Schist have varied considerably indicating the equivocal nature of the field evidence. Examples from previous work are presented below.

"McConnell (1905b, p. 16B) and Cockfield (1921, p. 19) both concluded that the Klondike Schist was produced through regional metamorphism of igneous rocks" (Green, 1972, p. 115). However, Green was of the opinion that "…the Klondike Schist may have formed through the metamorphism of gritty arkosic rocks somewhat similar to those known on the northeast side of Tintina Trench" (Green, 1972, p. 115). In the legend of Map 1284, Green (1972) describes the Klondike Schist as being composed of various types of schist and quartzite along with minor gneiss.

Klondike Schist mylonite exposed in an outcrop section along the Yukon River near Dawson were interpreted to have formed from a predominantly arkosic succession (blastomylonite) containing minor thicknesses of rhyolitic volcanic rocks (protomylonite) near the base (Metcalfe, 1981; Metcalfe and Clark, 1983).

Within the Klondike schist Mortensen (1988a) identified chlorite-rich and muscovite-rich members thought to have been derived from mafic and felsic volcanic or volcaniclastic rocks, respectively, as well as strongly foliated quartz and feldspar augen schist (metaporphyry) and fine-grained quartzose metasediments. Mortensen concluded that "Although textural and bulk compositional evidence supports an igneous protolith for much of the unit, a substantial metasedimentary component cannot be ruled out."

"The Klondike assemblage, which underlies much of the Stewart River and Dawson areas in the Klondike region …, consists of Middle to Late Permian calc-alkaline felsic and minor mafic metavolcanic rocks. Rocks of the Klondike assemblage have the geochemical character of continental arc magmatism…." (Colpron et al., 2006, p. 12).

"The Klondike Schist … comprises three main lithologies: (1) fine-grained quartz-muscovite schist and quartz (± feldspar) augen schist that are interpreted to be derived from felsic volcanic and subvolcanic rocks, respectively; (2) mafic schist and metagabbro derived from mafic to intermediate volcanic rocks and mafic intrusions, respectively; and (3) tan to buff, fine-grained quartz-mica schist and quartzite that represent fine-grained metaclastic rocks" (Dusel-Bacon et al., 2006, p. 46).

Ryan et al. (2014, p. 6), based on mapping in the Stevenson Ridge area to the south of the Klondike District, determined that the "Klondike schist comprises variably deformed greenschist-facies volcanic, hypabyssal, and sedimentary rocks. Locally well preserved quartz and feldspar porphyritic felsic volcanic and volcaniclastic rocks … demonstrate a volcanic protolith; however, strongly deformed sericite, chlorite, and quartz-feldspar augen schists and phyllonite predominate.”

Reviewing the evidence and opinions of previous workers the author is left with the opinion that the Klondike Schist is likely composed largely of igneous (mainly volcanic) rocks and/or volcaniclastic rocks. However, common references to a sedimentary component (including quartzose metasediments or quartzite) suggest that some rocks may have undergone significant reworking in the sedimentary environment.

Tarney (1977) suggested that a simple SiO_2 versus TiO_2 diagram could be used to differentiate between sedimentary and igneous rocks. Such a diagram showing the Hall Creek–Moose Creek Klondike Schist samples is presented in Figure 19. Most of the Klondike Schist samples plot close to the dividing line in the igneous field but there is considerable scatter across the dividing line. This diagram does not appear to be widely used in the recent literature and its usefulness may be limited.

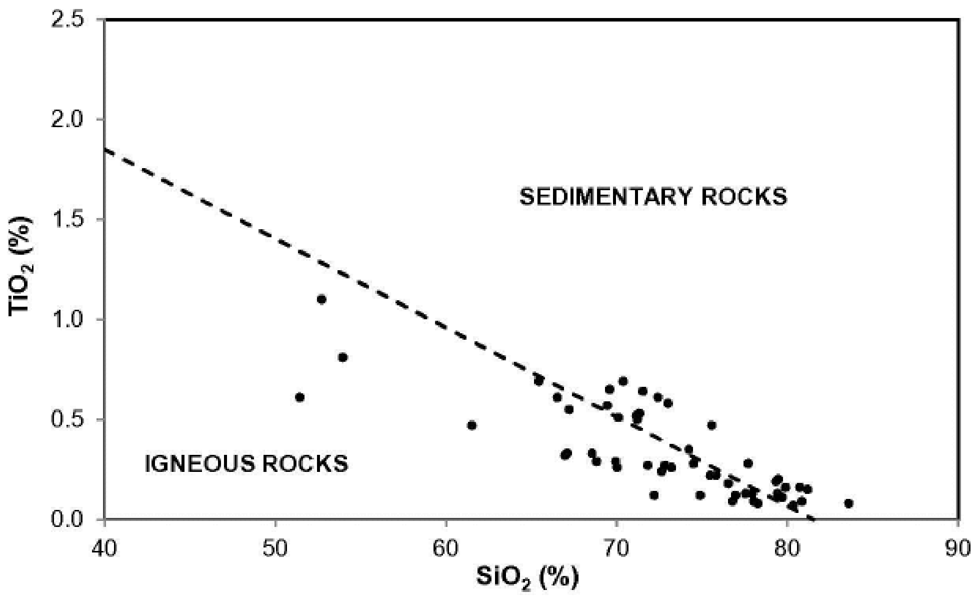


Figure 19. SiO_2 versus TiO_2 diagram of Tarney (1977) for differentiating between igneous and sedimentary rocks showing samples of Klondike Schist from the Hall Creek–Moose Creek area. Oxide values in weight percent.

An attempt is made herein to use the SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram of Heron (1988) for the classification of terrigenous sedimentary rocks to gauge the igneous versus sedimentary nature of the Klondike Schist in the Hall Creek–Moose Creek area. In Figure 20 chemical data for 216 nonhydrated, subalkaline rhyolitic obsidian analyses published by the USGS (MacDonald et al., 1992), representing unaltered magmatic compositions from a variety of tectonic settings, are plotted on the classification diagram of Heron (1988). Note that the vast majority fall in the arkose field with minor scatter into the wacke field. Immature sediments derived from felsic igneous rocks may reasonably be expected to have arkosic compositions. However, more mature sediments, having undergone chemical evolution and mechanical sorting in the surface environment, will tend to move towards the fields for shales and quartz arenites.

The SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram of Heron (1988) for the classification of terrigenous sedimentary rocks is shown Figure 21 with the felsic Klondike Schist samples of the Hall Creek–Moose Creek area plotted. The Hall Creek–Moose Creek samples mainly fall within the fields defined by arkoses and wackes. The scatter of data from the arkose field, where felsic igneous data would be expected to plot, into the wacke field may indicate a sedimentary component (compare to previous figure).

A third SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram (Heron, 1988), showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981), is presented in Figure 22. Samples determined by Metcalfe (1981) to be metarhyolite (protomylonite granofels) plot in or very near the arkose field in the same area as the greatest density of unaltered rhyolitic obsidian samples of MacDonald et al. (1992, see Figure 20). Most samples of arkosic metasedimentary rock (mylonitic schist) from the Dawson area plot in the arkose and wacke fields similar to the distribution of Hall Creek–Moose Creek Klondike Schist samples. Metcalfe (1981) speculated that the metasediments (mylonitic schists) were "… possibly derived from erosion of the rhyolites, or genetically equivalent rocks'" (Metcalfe, 1981, p. 53).

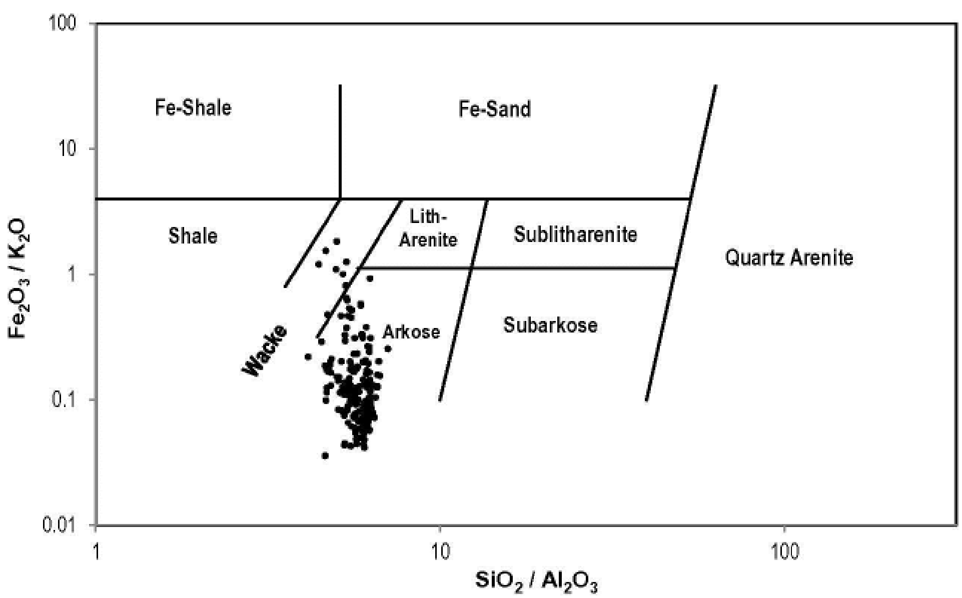


Figure 20. SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram of Heron (1988) for the classification of rocks derived from terrigenous sediments showing data for 216 nonhydrated, subalkaline rhyolitic obsidian analyses published by the USGS (MacDonald et al., 1992). Oxide values in weight percent.

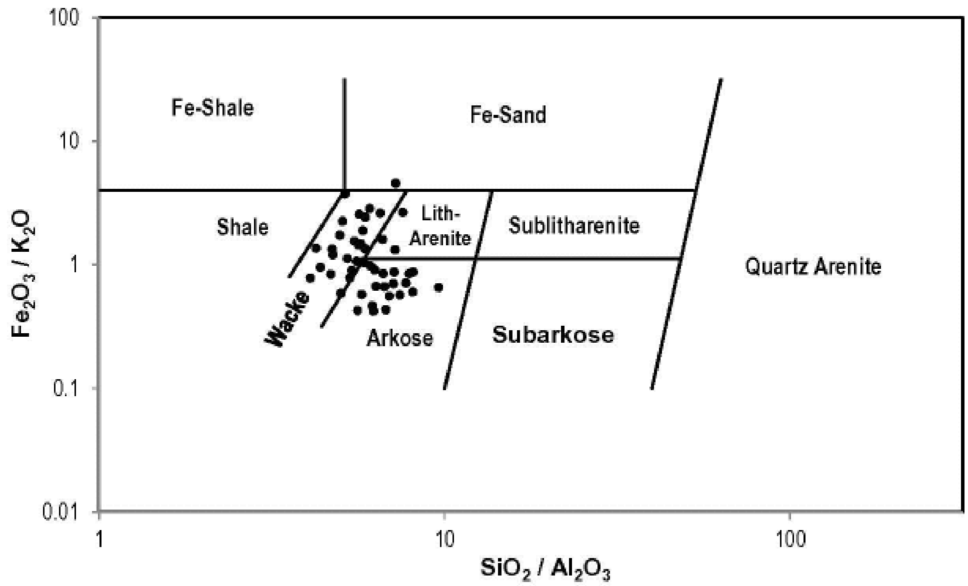


Figure 21. SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram of Heron (1988) for the classification of rocks derived from terrigenous sediments showing samples from the Hall Creek–Moose Creek area. Oxide values in weight percent.

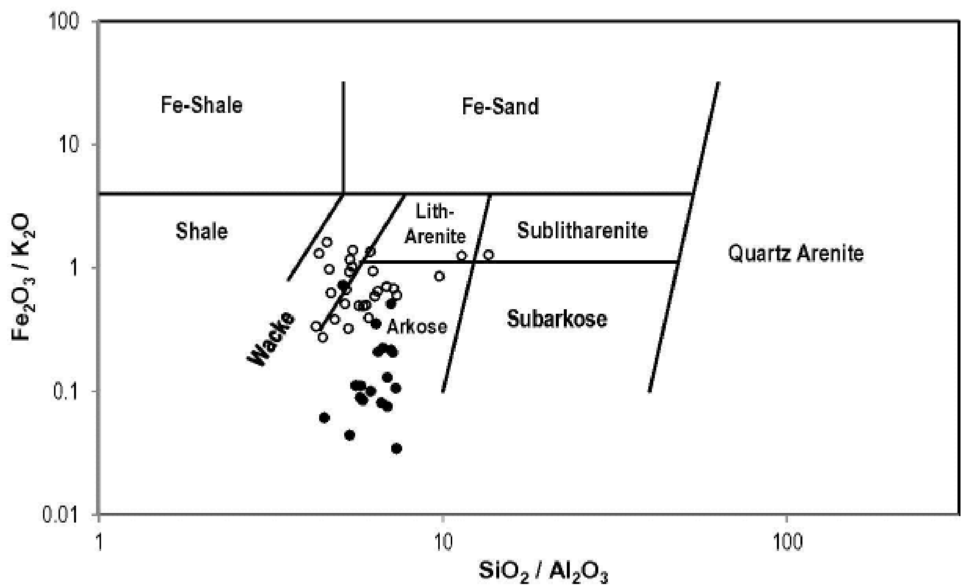


Figure 22. SiO_2/Al_2O_3 versus Fe_2O_3/K_2O diagram of Heron (1988) for the classification of rocks derived from terrigenous sediments showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). Filled circles represent protomylonite granofels (metarhyolite) and open circles represent mylonitic schist (arkosic metasedimentary rock). Oxide values in weight percent.

The preceding review of Klondike Schist literature, geochemistry and field observations regarding the nature of the Klondike Schist in the Hall Creek–Moose Creek area is inconclusive and a sedimentary protolith for some or all of these rocks cannot be ruled out. However, much of the data supports the contention that, if the protolith is sedimentary, it is likely to have formed from an immature sediment deposited on the flank of a volcanic arc. In proceeding with the discussion of lithogeochemistry an igneous-biased approach is taken based upon the belief that the chemical composition of most rocks of the Klondike Schist should reflect dominantly igneous processes (e.g. igneous rocks, volcaniclastic rocks and sedimentary rock of igneous derivation that have not undergone significant chemical modification in the surface environment). This approach will provide a framework upon which to characterize the geological/geochemical setting of the Hall Creek–Moose Creek area and to assess hydrothermal alteration effects

Selection of Lithogeochemical Groups

For the purpose of the geochemical discussion the 63 rock samples collected from the Hall Creek project area that were analysed for major oxides and trace elements have been divided as follows:

Group 1: All of the samples except one were collected from within the area underlain by Klondike Schist as mapped by Mortensen (1988b). The exception is sample 16HL154, which was collected adjacent to Moose Creek just north of the mapped distribution of the Klondike Schist within the mapped area of the Nasina Series (Mortensen, 1988b). This sample (19HL154), which is felsic in character, is assigned to Group 1.

Group 2: The remaining samples were all collected within the area mapped as Klondike Schist by Mortensen (1988b). Four of these samples were collected from non-foliated basaltic rocks – one from outcrop adjacent to Moose Creek (16HL156) and three from boulders in the Moose Creek channel near the mafic outcrop (16HL155, 160 and 161; each of the sampled boulders contains olivine-rich nodules). These 4 basaltic samples are assigned to Group 2.

The remaining samples are all of Klondike Schist.

Group 3: Five samples collected from the outcrop containing the North Baldy Showing and one sample of rubble/colluvium lying on the bedrock above the showing are assigned to Group 3 (16HL109 to 114). Sphalerite was identified in two of these samples during field work and these samples returned 2041 and 7078 ppm Zn (samples HL109 and 16HL114 respectively). The mineralization occurs in very siliceous rock containing 1% to 10% pyrite. This sample group may be further subdivided into:

- the two samples in which sphalerite was noted (16HL109 and 16HL114),
- a manganese rich sample (16HL111) and
- the remaining three outcrop samples (16HL110, 16HL112 and 16HL113).

The remaining Klondike Schist samples are divided primarily on geochemical characteristics.

Group 4: Five samples of rocks with intermediate geochemical characteristics were collected from outcrops along Hall Creek (16HL140 to 144). Four of these samples are relatively unaltered (16HL140, 142, 143 and 144). The site from which sample 16HL143 was collected was distinctive in the field due to strong carbonate alteration accompanied by fuchsite (or mariposite).

Group 5: Two samples of high-Zr felsic rocks (383 and 694 ppm Zr) were collected from outcrop adjacent to Moose Creek (16HL138 and 139). Both of these samples are strongly altered (Ishikawa Alteration Index values of >87 and Na_2O values of <0.15%).

Group 6: The remaining Klondike Schist samples, which form the bulk of the data set and represent the majority of outcrops in the Hall Creek – Moose Creek project area, are felsic in nature with moderate Zr values (98 to 246 ppm Zr). The Zr range of these rocks is not particularly low when compared to worldwide data for rhyolitic rocks (e.g. MacDonald et al., 1992). For the purposes of this discussion, these samples will be referred to as mid-Zr felsic rocks to distinguish them from the high-Zr felsic rocks in Group 5.

The Group 6 rocks are further subdivided on the basis of geochemical alteration as follows:

- Samples with Ishikawa Alteration Index values of >70 and < 0.25% Na_2O (herein referred to as strongly altered). Note that both samples in Group 5 meet the geochemical alteration criteria of this group.
- Samples with Ishikawa Alteration Index values of >70 but with Na_2O values of >0.25% Na_2O (herein referred to as moderately altered).
- Samples with Ishikawa Alteration Index values of <70 (herein referred to as least altered). Ishikawa Alteration Index values in this group range from 32 to 69 and Na_2O values range from 0.81% to 5.54%.

Least Altered Klondike Schist Subset: For the geochemical discussion that follows the least altered Klondike Schist samples include Group 4 intermediate rocks, excluding the sample with strong carbonate alteration, and the Group 6 mid-Zr felsic rocks with Ishikawa Alteration Index values of <70.

Magmatic Series Classification

On a SiO_2 versus Na_2O+K_2O diagram, after Irvine and Baragar (1971), the least altered Klondike Schists plot in the subalkaline field while the mafic rocks fall in the alkaline field (Figure 23). Altered samples of Klondike Schist scatter toward the X axis reflecting their lower $Na_2O + K_2O$ values. The basaltic samples from the Moose Creek valley plot in the alkaline field.

On a SiO_2 versus Na_2O+K_2O diagram the Dawson area Klondike Schist samples of Metcalfe (1981) plot mainly in the subalkaline field (Figure 24). The samples of metarhyolite tend to have higher $Na_2O + K_2O$ values that the metasediments and four of these samples plot in the alkaline field.

On the AFM diagram of Irvine and Baragar (1971) the least altered Klondike Schists samples plot along the dividing line between the calk-alkaline and tholeiitic series (Figure 25). The scatter into the tholeiitic field may be due to depletion of the alkali metals Na and K. A second AFM diagram showing geochemical data for the Klondike Schist from an exposure beside the Yukon River near Dawson is presented in Figure 26. Note that these samples fall well within the calc-alkaline field with the metarhyolite (protomylonite granofels) samples plotting near the $Na_2O + K_2O$ (“A”) apex.

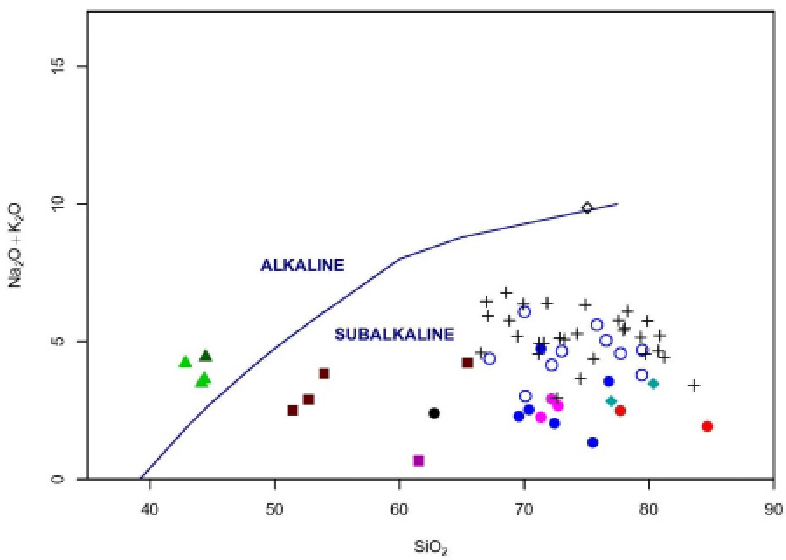


Figure 23, SiO_2 versus Na_2O+K_2O diagram after Irvine and Baragar (1971) showing samples from the Hall Creek–Moose Creek area. Oxide values in weight percent. Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

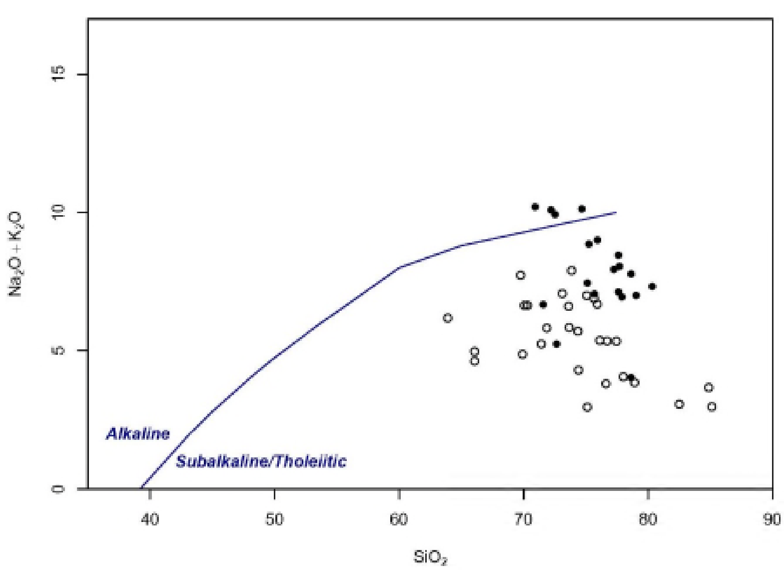


Figure 24. SiO_2 versus Na_2O+K_2O diagram of Irvine and Baragar (1971) showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). Filled circles represent protomylonite granofels (metarhyolite) and open circles represent mylonitic schist (arkosic metasedimentary rock).

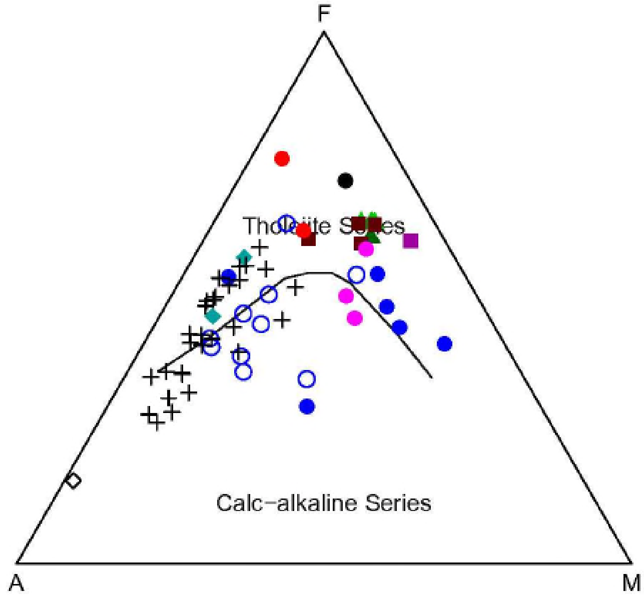


Figure 25. AFM diagram of Irvine and Baragar (1971) showing samples from the Hall Creek–Moose Creek area. A = Na_2O + K_2O, F = FeO + 0.8998 x Fe_2O_3, M = MgO (all in weight percent). Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

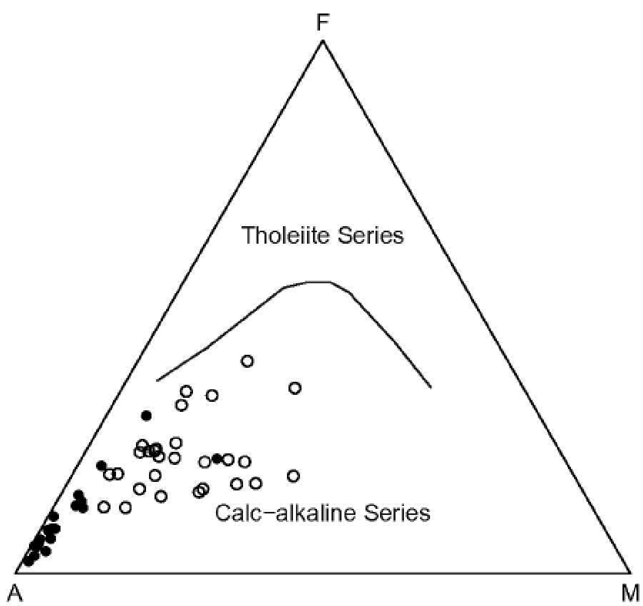


Figure 26. AFM diagram of Irvine and Baragar (1971) showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). A = Na_2O + K_2O, F = FeO + 0.8998 x Fe_2O_3, M = MgO (all in weight percent). Filled circles represent protomylonite granofels, interpreted to be metarhyolite, and open circles represent mylonitic schist, interpreted do be arkosic metasedimentary rock (lithologic interpretation of Metcalfe, 1981).

On the SiO_2 vs K_2O discrimination diagram of Peccerillo and Taylor (1976) most of the least altered Klondike Schist samples lie within the calc-alkaline field although there is a considerable range of K_2O values (Figure 27). Note that some of the samples have relatively high K contents and plot in the high-K calc-alkaline field with minor scatter into the shoshonite series field. The one sample of the Nasina Series plots within the field of the shoshonite series. A similar diagram showing data for the Yukon River Klondike Schist (Metcalfe, 1981) shows the metarhyolite to have relatively high K_2O values and plot mainly within the high-K calc-alkaline field and the shoshonite series field (Figure 28). The arkosic metasedimentary rocks mainly fall within the calc-alkaline field but there is a considerable range of K_2O values.

On the Zr/Y versus Th/Y diagram for differentiating between tholeiitic and calc-alkaline magma series (Ross and Bedard, 2009) the Klondike Schist samples of the Hall Creek–Moose Creek area fall almost entirely within the calc-alkaline field (Figure 29). This diagram is more applicable to altered rocks than more traditional discrimination diagrams, such as the AFM diagram of Irvine and Baragar (1971) and the SiO_2 versus K_2O plot of Peccerillo and Taylor (1976), as it utilized elements that may be relatively immobile during rock alteration processes. Note, however, that this diagram does not enable discrimination between calc-alkaline rocks and rocks of the shoshonite series.

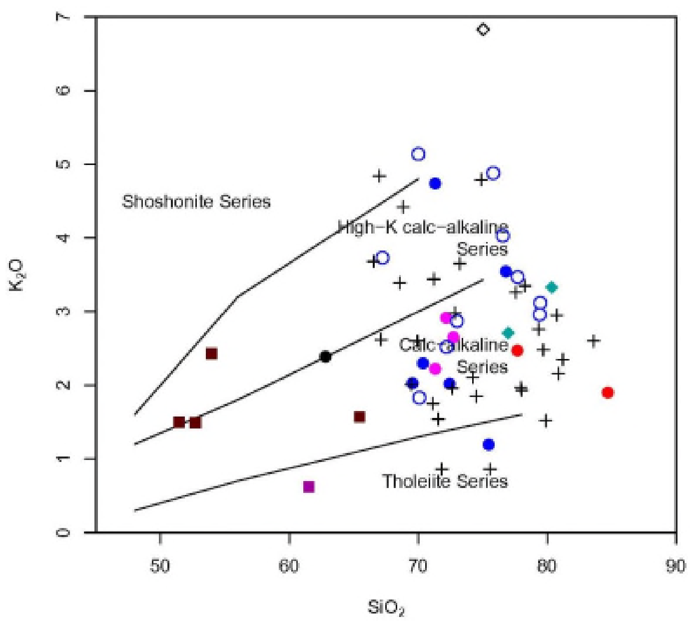


Figure 27. SiO_2 versus K_2O magma series classification diagram for samples of Klondike Schist and Nasina Series from the Hall Creek–Moose Creek area (Peccerillo and Taylor, 1976). Symbols represent Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

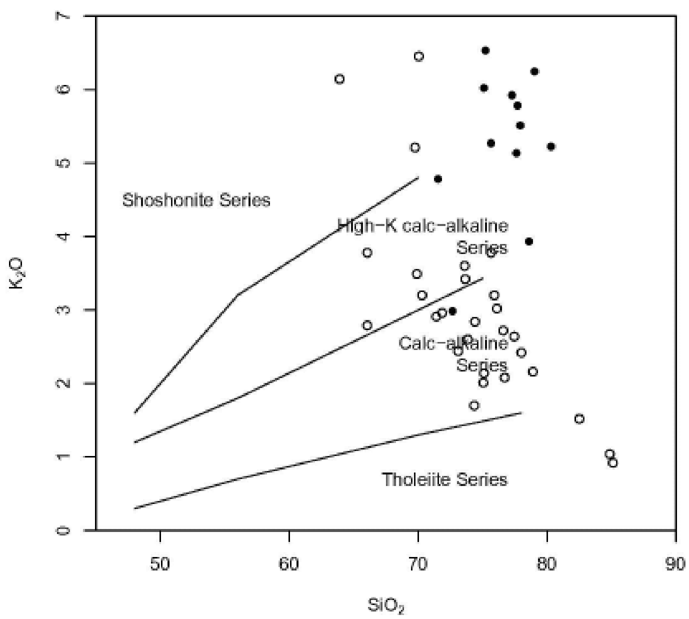


Figure 28. SiO_2 versus K_2O magma series classification diagram (Peccerillo and Taylor, 1976) showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). Filled circles represent protomylonite granofels (metarhyolite) and open circles represent mylonitic schist (arkosic metasedimentary rock).

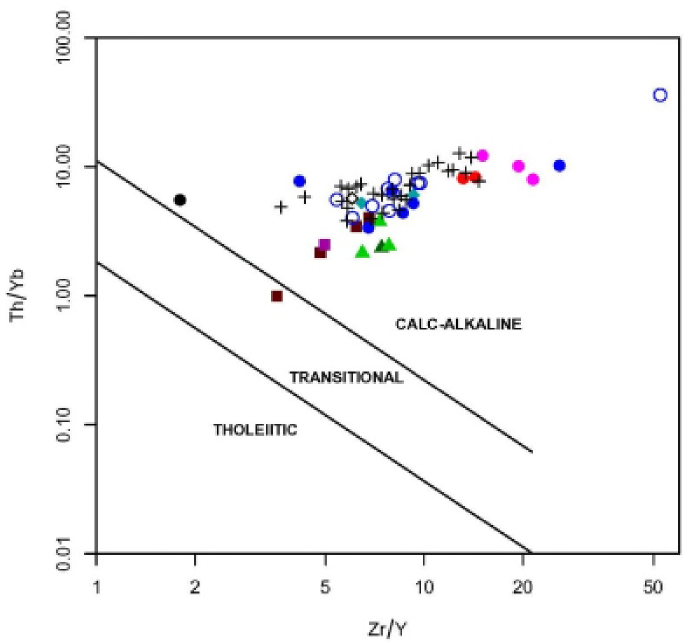


Figure 29. Zr/Y versus Th/Y magma series classification diagram of Ross and Bedard (2009) showing samples from the Hall Creek – Moose Creek area. See previous diagrams for symbol descriptions.

Rock Type Classification

The SiO_2 versus Na_2O+K_2O geochemical diagram of Le Bas et al. (1986) for naming volcanic rocks is presented in Figure 30 with geochemical data for mafic and intermediate Hall Creek–Moose Creek samples plotted. The samples from the basaltic outcrop and basaltic boulders plot in the field of basalt above the alkaline versus subalkaline dividing line and may be classified as alkaline basalts. On a volatile free basis their silica contents place them just above the field of ultramafic (ultrabasic) rocks. The samples of the intermediate group plot in the basaltic andesite field (1 samples), andesite field (2 sample) and the dacite field (2 samples). Note that one of the two samples in the dacite field is strongly carbonate altered.

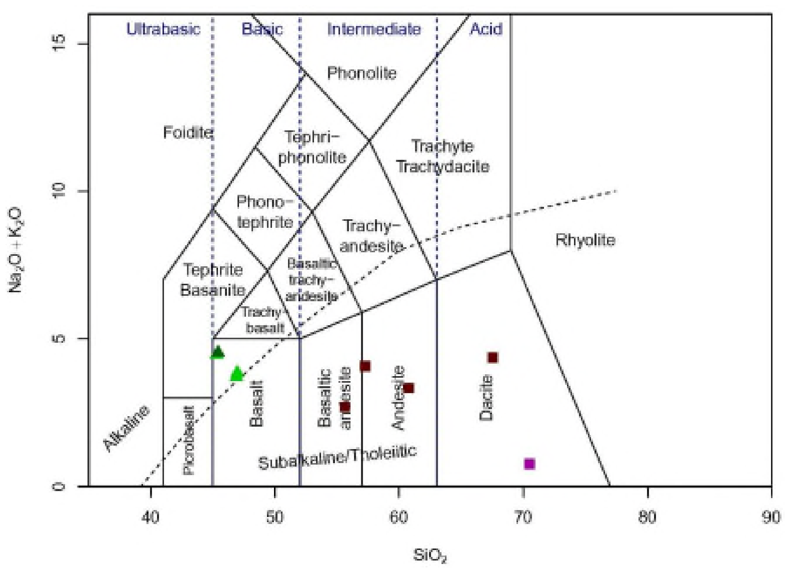


Figure 30. SiO_2 versus Na_2O+K_2O volcanic rock classification diagram of Le Bas et al. (1986) showing samples of basalt and intermediate Klondike Schist. Oxide values in weight percent after recalculation on a volatile free basis (Gillespie and Style, 1999). Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), least altered intermediate Klondike Schist (brown squares), and carbonate-altered intermediate Klondike Schist (purple square).

The SiO_2 versus Na_2O+K_2O geochemical diagram of Le Bas et al. (1986) for naming volcanic rocks presented in Figure 31 displays data for felsic Hall Creek –Moose Creek samples. Most plot in the subalkaline rhyolite field with a few falling into the dacite field. However, the very high SiO_2 values of many samples are unlikely to represent primary igneous values. In Figure 32 another Le Bas et al. (1986) diagram is presented with data for 216 essentially unaltered, nonhydrated, subalkaline rhyolitic obsidian samples from a USGS data set shown (MacDonald et al, 1992). This data set contains samples from primitive island arcs, mature island arcs, continental margins, continental interiors, and oceanic extensional zones. The highest silica value in this data set is 77.50% SiO_2. Although somewhat higher silica values are possible in volcanic rocks, primary igneous SiO_2 value of >78% are unusual.

The trend of least altered Hall Creek–Moose Creek felsic rocks is toward increasing SiO_2 values with decreasing value of Na_2O+K_2O and that, if the trend were extended, the X-axis intercept of trend would be near 100% SiO_2. This trend is consistent with silicification. In particular, the sphalerite-bearing samples from the North Baldy Showing and the two sample of high-Zr felsic rock plot near the lower right part of the trend suggestive of silicification in addition to Na depletion.

An additional Le Bas et al. (1986) diagram, this one showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981), is presented in Figure 33. Samples of metarhyolite (protomylonite granofels) plot in the rhyolite field with most lying near the subalkaline–alkaline dividing line. Most samples of arkosic metasedimentary rock (mylonitic schist) also plot in the rhyolite field but in an area of lower Na_2O+K_2O values similar to felsic schists of the Hall Creek–Moose Creek area.

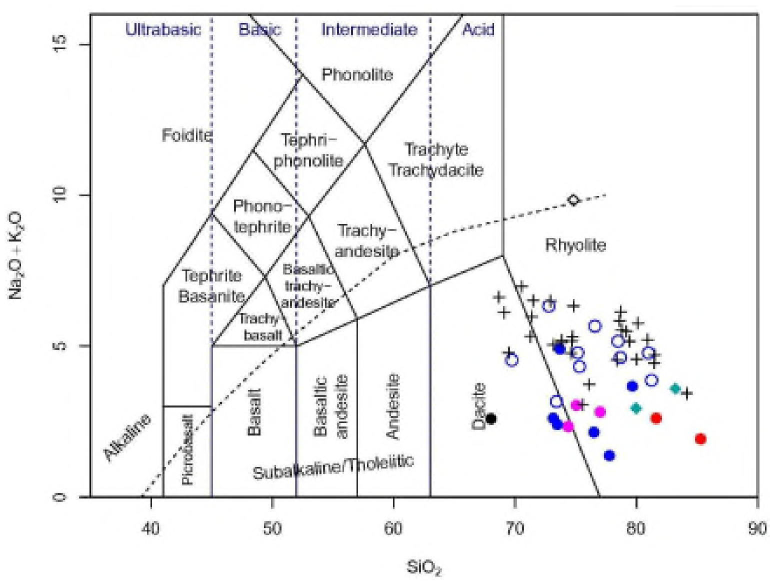


Figure 31. SiO_2 versus Na_2O+K_2O volcanic rock classification diagram of Le Bas et al. (1986) showing samples of felsic Klondike Schist from the Hall Creek–Moose Creek area (the one Nasina Series sample is also shown). Oxide values in weight percent after recalculation on a volatile free basis (Gillespie and Style, 1999). Symbols represent Nasina Series sample (open black diamond), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

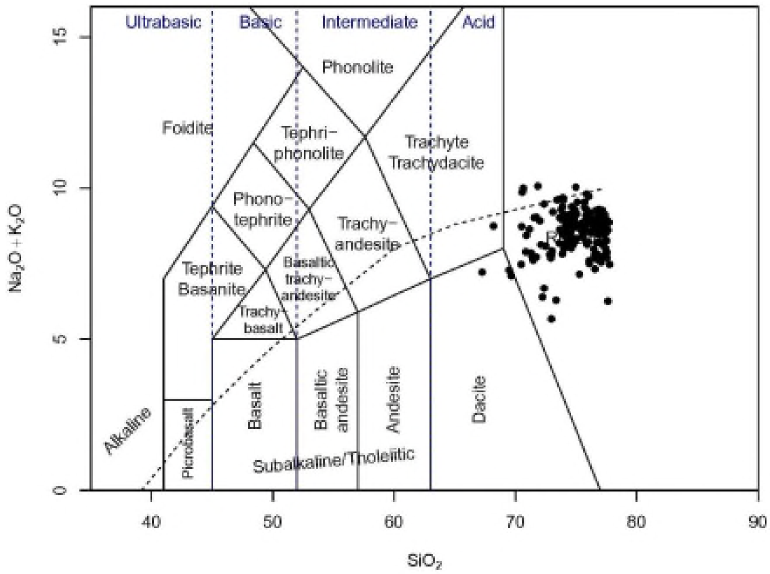


Figure 32. SiO_2 versus Na_2O+K_2O volcanic rock classification diagram of Le Bas et al. (1986) showing data for 216 nonhydrated, subalkaline rhyolitic obsidian analyses published by the USGS (MacDonald et al., 1992). Oxide values in weight percent after recalculation on a volatile free basis (Gillespie and Style, 1999).

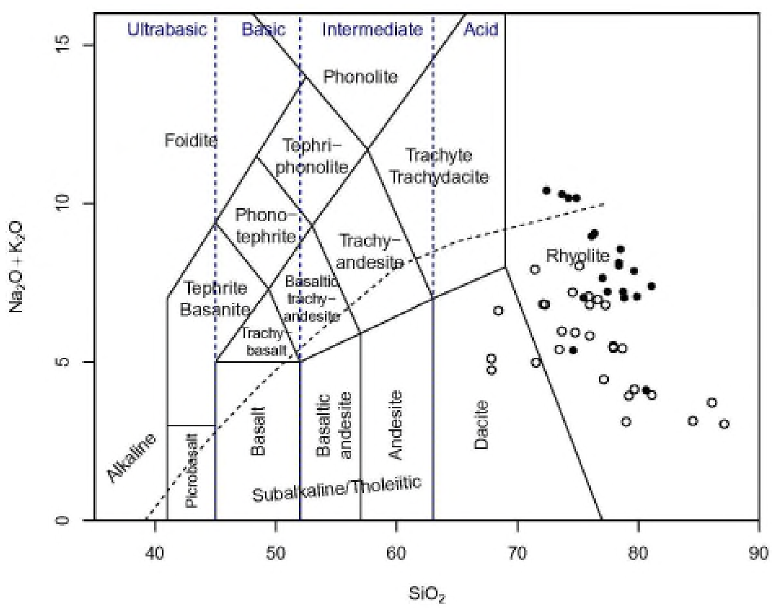


Figure 33. SiO_2 versus Na_2O+K_2O volcanic rock classification diagram of Le Bas et al. (1986) showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). Filled circles represent protomylonite granofels (metarhyolite) and open circles represent mylonitic schist (arkosic metasedimentary rock). Oxide values in weight percent after recalculation on a volatile free basis (Gillespie and Style, 1999).

On the Zr/TiO_2 versus SiO_2 volcanic rock classification diagram of Winchester and Floyd (1977), shown in Figure 34, the mafic rock samples from the Moose Creek valley are classified as alkaline basalts in agreement with their placement on the SiO_2 versus total alkalis diagram of Le Bas et al. (1986). The intermediate Klondike Schist samples plot as subalkaline basalt (2 samples), andesite (2 samples including the carbonate altered sample) and dacite (1 sample). The two samples of high-Zr felsic Klondike Schist plot near the line separating rhyolite from comendite/pantellerite. The samples of the mid-Zr felsic Klondike Schist plot in the subalkaline dacite, rhyodacite and rhyolite fields. The one sample from the Nasina Series plots as a subalkaline rhyolite.

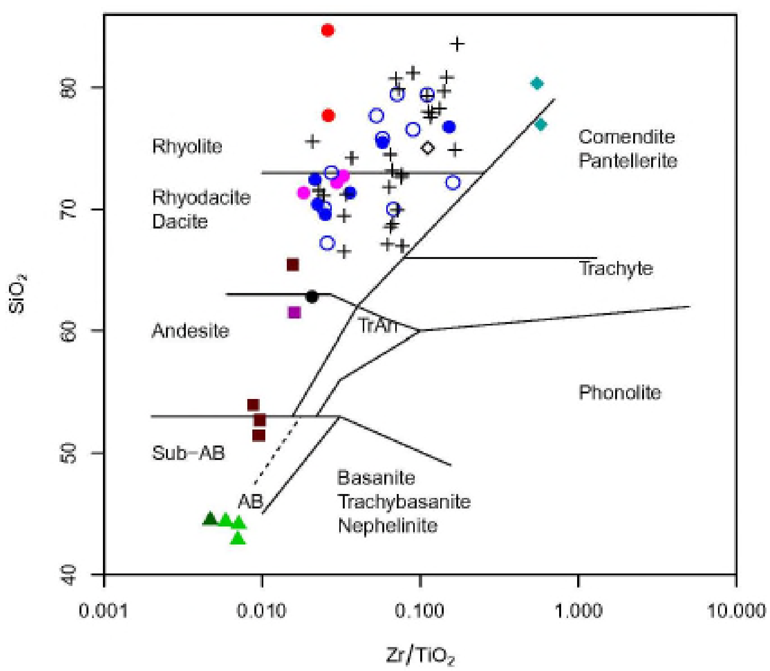


Figure 34. Zr/TiO_2 versus SiO_2 volcanic rock classification diagram of Winchester and Floyd (1977) showing data for rocks from the Hall Creek–Moose Creek area. AB = alkali basalt. Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

On the Nb/Y versus Zr/Ti volcanic rock classification diagram of Pearce (1996) the basaltic rock samples are classified as alkaline basalt as on previous diagrams. The intermediate Klondike Schist samples plot as andesite, basaltic andesite and basalt. The two samples of high-Zr felsic Klondike Schist plot in the alkaline rhyolite field (a function of their elevated Zr contents). The samples of mid-Zr felsic Klondike Schist plot mainly in the andesite, dacite, rhyolite and trachyte fields. The one sample from the Nasina Series plots in the dacite/rhyolite field.

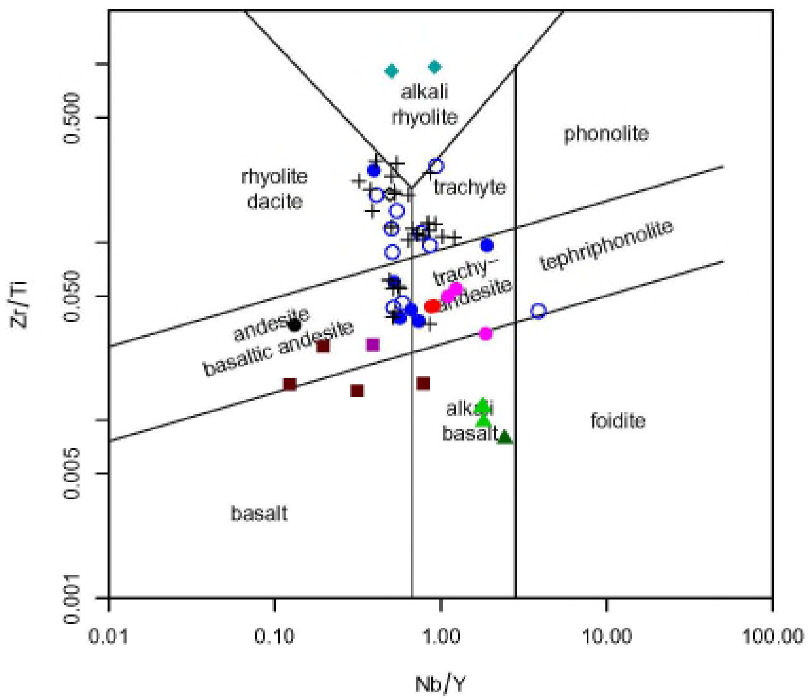


Figure 35. Nb/Y versus Zr/Ti volcanic rock classification diagram (Pearce, 1996, modified after Winchester and Floyd, 1977) showing data for rocks from the Hall Creek–Moose Creek area.

Tectonic Setting Discrimination

On the Yb versus Ta tectonic discrimination diagram of Pearce (1984) for granitic rocks the less altered, felsic Klondike Schist samples plot in the volcanic arc fields (Figure 36).

On the Yb versus Th/Ta tectonic discrimination diagram of Gorton and Schandl (2000) the less altered, felsic Klondike Schist samples lay mainly in the active continental margin field (Figure 37).

On the triangular tectonic diagram of Wood (1980) the Moose Creek basaltic samples fall in the alkaline within plate basalt field and the less altered intermediate Klondike Schist samples plot in the calc-alkaline destructive plate margin basalt field (Figure 38).

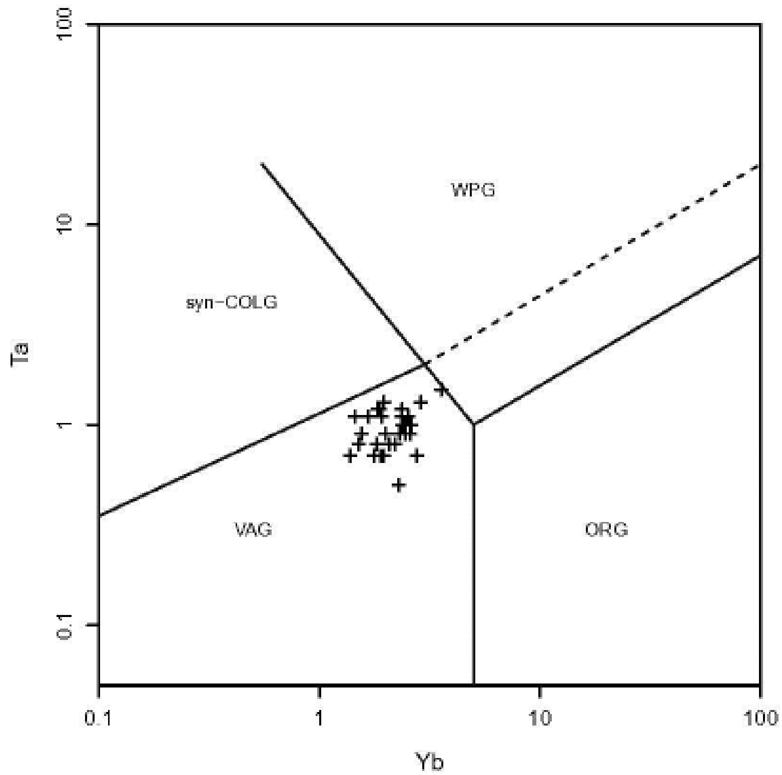


Figure 36. Yb versus Ta tectonic discrimination diagram of Pearce (1984) with less altered felsic Klondike Schist samples plotted. Fields shown are volcanic arc granite (VAG), syn-collision granite (syn-COLG), within plate granite (WAG) and ocean ridge granite (ORG).

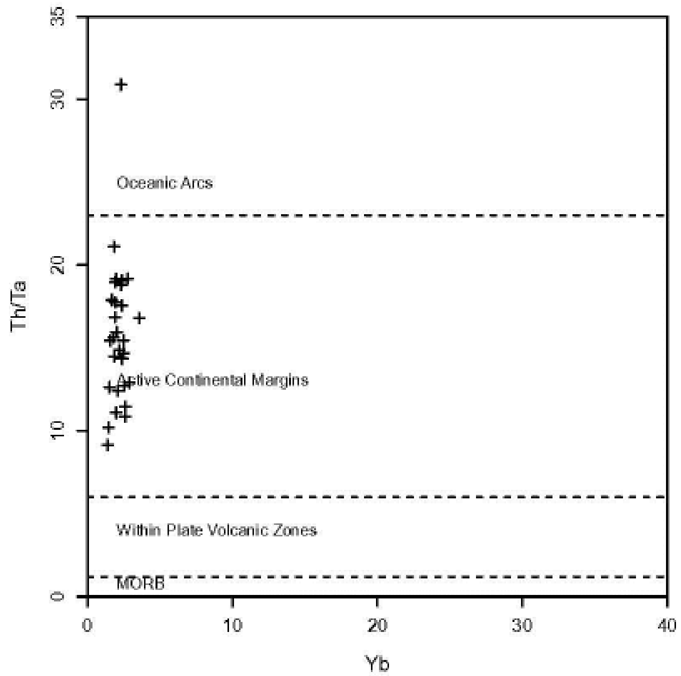


Figure 37. Tectonic discrimination diagrams of Gorton and Schandl (2000) with less altered felsic Klondike Schist samples plotted.

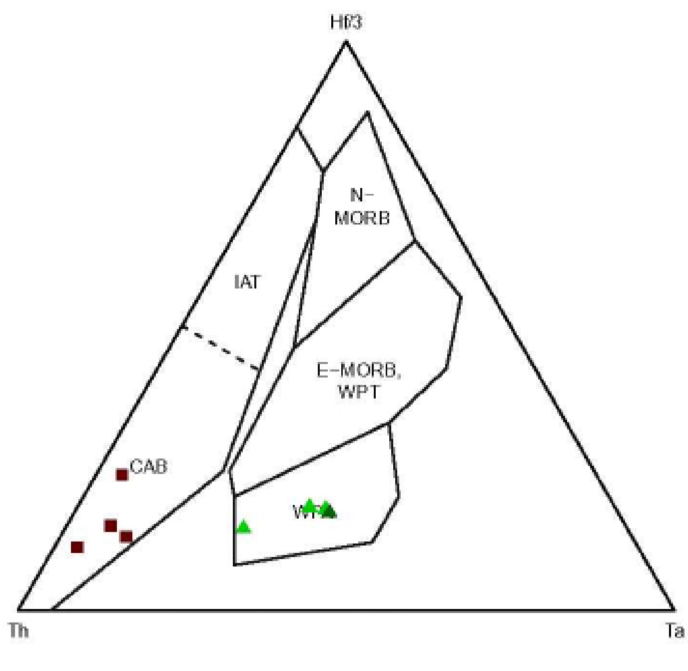


Figure 38. Tectonic discrimination diagrams of Wood (1980) for basaltic rocks showing samples from the Hall Creek–Moose Creek area. Fields are for N-MORB, E-MORB, alkaline within plate basalt (WPA), calc-alkaline destructive plate margin basalts (CAB) and primitive arc tholeiites (IAT). Sample set consist of basaltic outcrop (dark green triangle), basaltic boulders (light green triangles) and less altered intermediate Klondike Schist samples (brown squares).

Rare Earth Element Diagrams

Chondrite normalized rare earth element (REE) spider diagrams for the rocks collected from the Hall Creek–Moose Creek area are presented in Figures 39 to 46.

The chondrite normalized REE trends of the four basaltic samples collected along Moose Creek are remarkably straight with Lu values about 6 to 7 times chondrite and La values of 90 to 100 times chondrite (Figure 39).

The chondrite normalized REE patterns of the intermediate Klondike Schist from the Moose Creek valley are shown in Figure 40. The heavy rare earth elements (HREE) are fairly uniform at about 7 to 10 times chondrite. The light rare earth elements (LREE) are more enriched with values of between 20 and 80 time chondrite. These samples display little to no Eu anomaly.

The single sample from the Nasina Series, shown in Figure 41, has a REE pattern similar to least altered mid-Zr felsic rocks (see below).

The chondrite normalized trends of the least altered mid-Zr felsic Klondike Schist samples, shown in Figure 42, display relatively flat HREE slopes and moderate LREE slopes. HREE values vary from 60 to 20 while La values vary from about 60 to 200. Most samples display a modest negative Eu anomaly.

The chondrite normalized trends for most of the moderately altered mid-Zr felsic Klondike Schist, shown in Figure 43, mimic those of the least altered group with one striking exception. Sample 16HL121 is strongly depleted in HREE, is somewhat enriched in the lightest REE, and displays a very steep chondrite normalized slope through the light to the middle REE parts of the spider diagram.

The chondrite normalized trends of the most of the strongly altered mid-Zr felsic Klondike Schist samples, shown in Figure 44, display considerable variation. Sample 16HL162 is depleted in heavy rare earth elements, middle rare earth elements (MREE) and all light rare earth elements except La. Sample 16HL119 is depleted in MREE and LREE (including La). Sample 16HL122 is somewhat enriched in the LREE except for Ce and displays negative Ce anomaly.

Figure 45 shows the chondrite normalized REE values of the two high-Zr felsic Klondike Schist samples. These samples have flat HREE patterns of about 30 to 40 times chondrite, enriched relative to most of the mid-Zr felsic schists, and sloping LREE patterns with La values averaging about 200 times chondrite (near the upper limit of mid-Zr felsic rocks). They therefore have a flatter overall REE pattern than the mid-Zr felsic rocks. The most striking characteristic of these REE patterns is the very pronounced negative Eu anomalies.

Chondrite normalized REE spider diagrams depicting the REE chemistry of the samples from the North Baldy Showing and adjacent outcrop are presented in Figure 46. All of the patterns are anomalous compared to the least altered felsic schists. The samples, with the exception of the Fe and Mn enriched sample, display remarkably consistent, HREE depleted values of about 4 to 5 times chondrite. These five sample are variably depleted in MREE and LREE with the sphalerite-bearing samples displaying values near the middle of the range. The one sample enriched in Fe and Mn is also enriched in HREE and MREE compared to least altered mid-Zr felsic schists. All of the samples from the North Baldy Showing and adjacent outcrop display a weak to moderate, negative Eu anomaly.

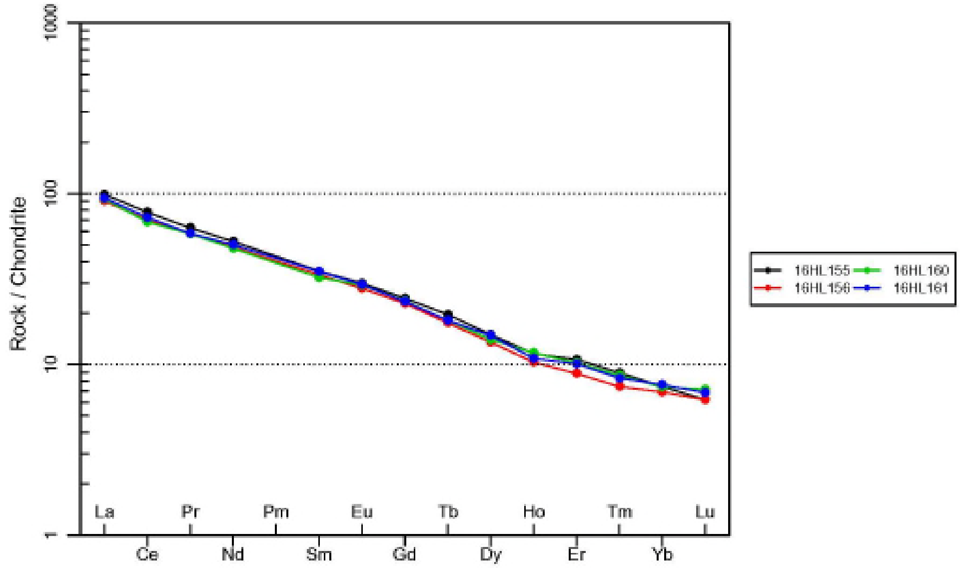


Figure 39. Chondrite normalized spider diagram showing rare earth element chemistry of Moose Creek basaltic rocks. Chondrite values used for normalization are those of Boynton (1984).

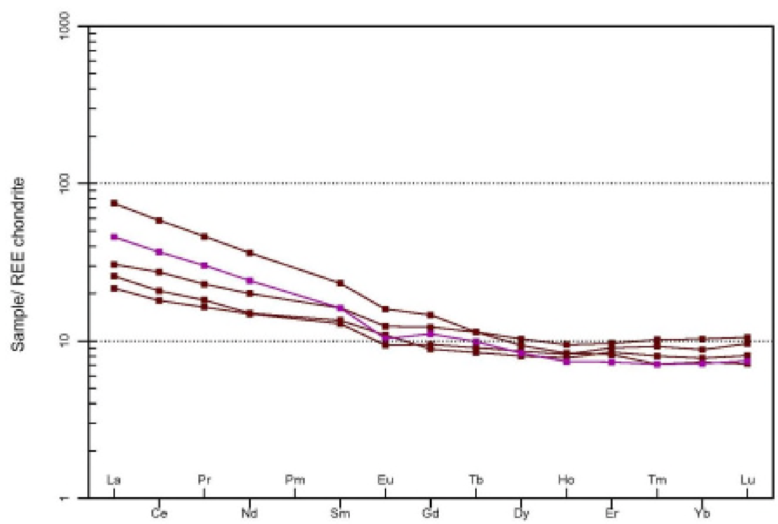


Figure 40. Chondrite normalized spider diagram showing rare earth element chemistry of Moose Creek intermediate Klondike Schist. Chondrite values used for normalization are those of Boynton (1984). Sample shown in magenta is strongly carbonate altered (16HL143).

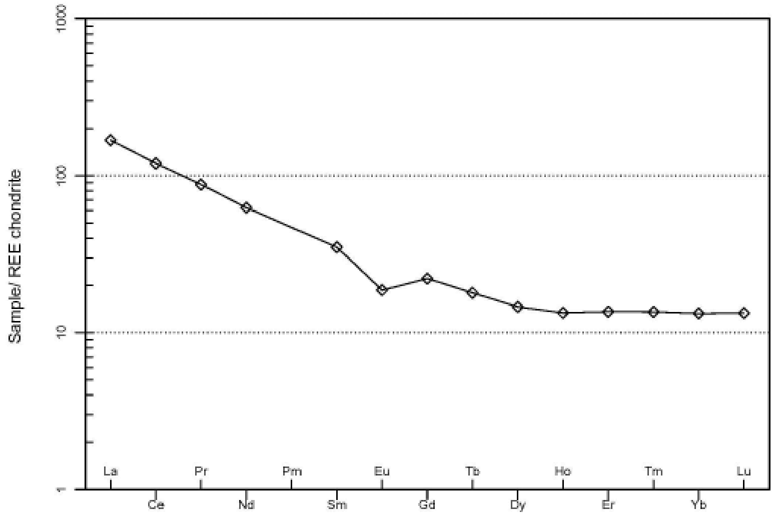


Figure 41. Chondrite normalized spider diagram showing rare earth element chemistry of the Nasina Series sample (16HL154) from the Moose Creek area. Chondrite values used for normalization are those of Boynton (1984).

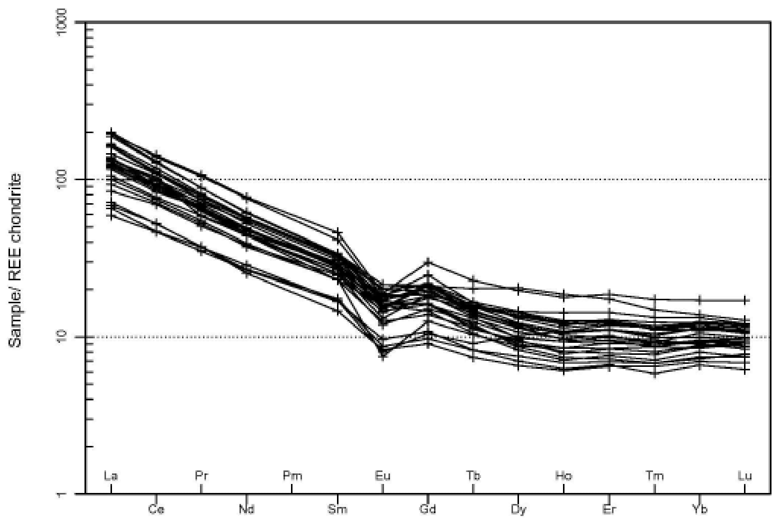


Figure 42. Chondrite normalized spider diagram showing rare earth element chemistry of least altered, mid-Zr Klondike Schist samples from the Hall Creek–Moose Creek area. Chondrite values used for normalization are those of Boynton (1984).

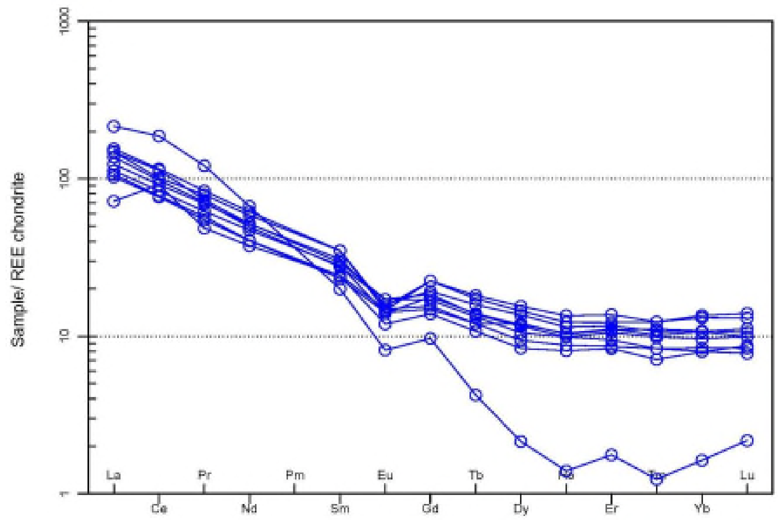


Figure 43. Chondrite normalized spider diagram showing rare earth element chemistry of moderately altered, mid-Zr felsic Klondike Schist samples from the Hall Creek–Moose Creek area. Chondrite values used for normalization are those of Boynton (1984). The sample with the anomalous rare earth element pattern, including pronounced HREE depletion, is 16HL121.

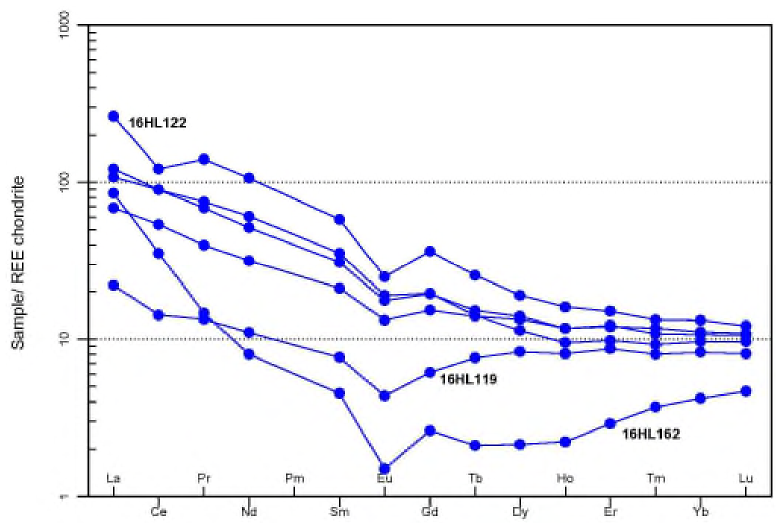


Figure 44. Chondrite normalized spider diagram showing rare earth element chemistry of strongly altered, mid-Zr felsic Klondike Schist samples from the Hall Creek–Moose Creek area. Chondrite values used for normalization are those of Boynton (1984).

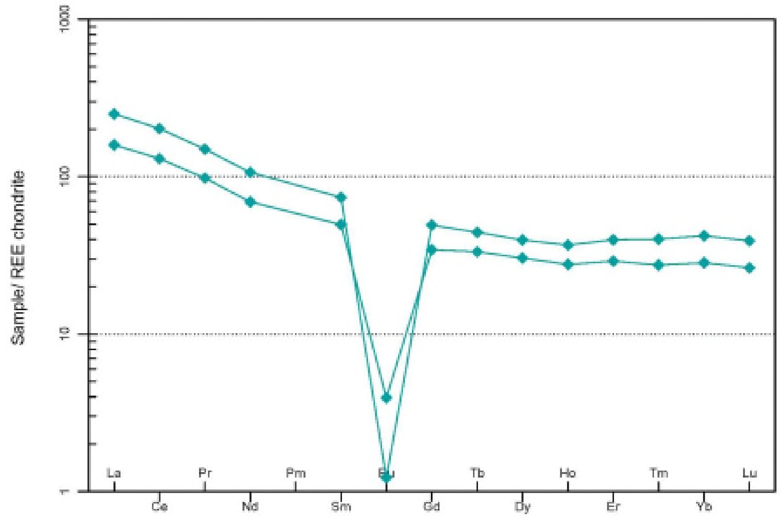


Figure 45. Chondrite normalized spider diagram showing rare earth element chemistry of high-Zr felsic Klondike Schist samples from the Moose Creek valley. Both samples are strongly altered. Chondrite values used for normalization are those of Boynton (1984). The upper sample with the strongest Eu anomaly is 16HL139 and the lower sample is 16HL138.

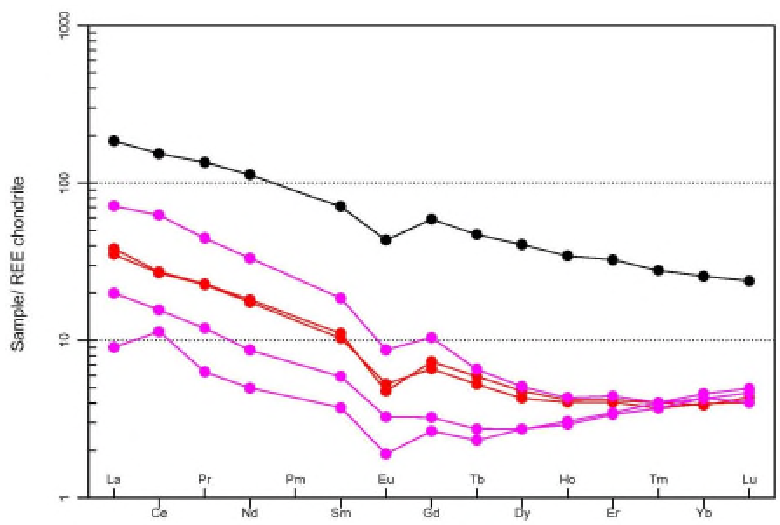


Figure 46. Chondrite normalized spider diagram showing rare earth element chemistry of samples from the North Baldy Showing and adjacent outcrop. Chondrite values used for normalization are those of Boynton (1984). Samples with sphalerite are shown in red (16HL109 and 114). Sample enriched in Mn and Fe is shown in black (16HL111). Samples from outcrop to the north of the mineralization are shown in magenta (16HL110, 112 and 113).

Alteration Diagrams

A ternary $CaO+Na_2O–Al_2O_3–K_2O$ diagram, with oxides expressed as molecular weights, is shown in Figure 47 displaying data for 216 nonhydrated, subalkaline rhyolitic obsidian analyses published by the USGS (MacDonald et al., 1992). Note that almost all of the USGS samples plot very near the tie-line between plagioclase and K-feldspar.

A second ternary $CaO+Na_2O–Al_2O_3–K_2O$ diagram is presented in Figure 48 showing the Hall Creek–Moose Creek data. In contrast to the rhyolitic obsidian data, nearly all of the Hall Creek–Moose Creek Klondike Schist samples fall well above the feldspar tie-line. The trend away from the $CaO+Na_2O$ apex may be interpreted as (i) a feldspar destructive weathering trend (e.g. Liu et al., 2009; Mishra and Sen, 2012) with the whole rock compositional trend moving toward the composition of illite with increasing alteration (which would undergo metamorphic transition to muscovite/sericite/phengite ± chlorite at greenschist facies metamorphism) or (ii) as a feldspar destructive hydrothermal alteration trend with the whole rock compositional trend moving toward muscovite/sericite/phengite ± and chlorite with increasing alteration.

A third ternary $CaO+Na_2O–Al_2O_3–K_2O$ diagram, showing data for the Dawson area Klondike Schist samples of Metcalfe (1981), is presented in Figure 49. Note that the metarhyolite samples tend to plot near the feldspar tie-line but with K-rich compositions. The metasedimentary mylonitic schist samples have lower relative K contents and plot in an area of the diagram similar to the least altered Hall Creek–Moose Creek felsic Klondike Schist samples.

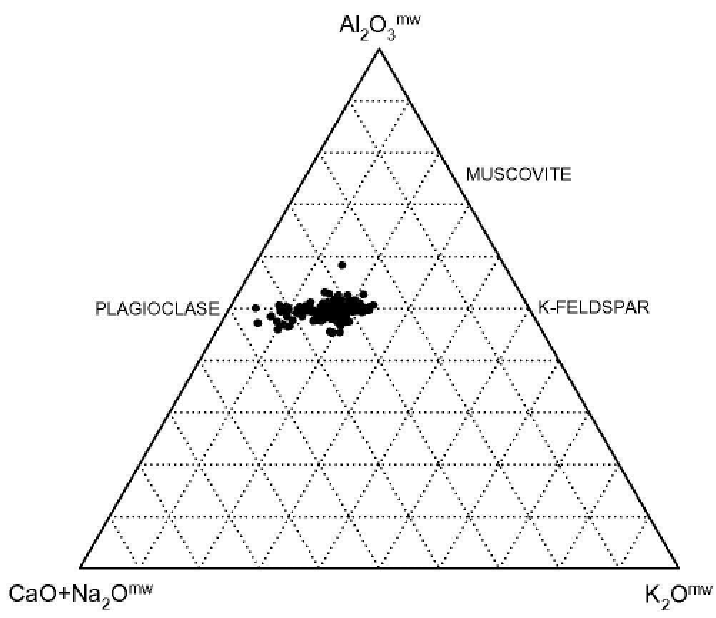


Figure 47. Ternary $CaO+Na_2O–Al_2O_3–K_2O$ diagram showing data for 216 nonhydrated, subalkaline rhyolitic obsidian analyses published by the USGS (MacDonald et al., 1992).

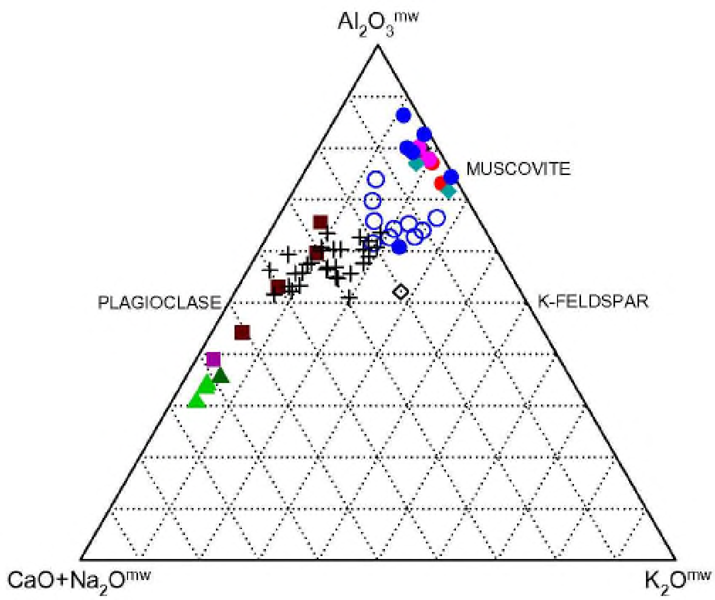


Figure 48. Ternary CaO+Na₂O–Al₂O₃–K₂O diagram showing samples from the Hall Creek–Moose Creek area. Oxides expressed in molecular weights. Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

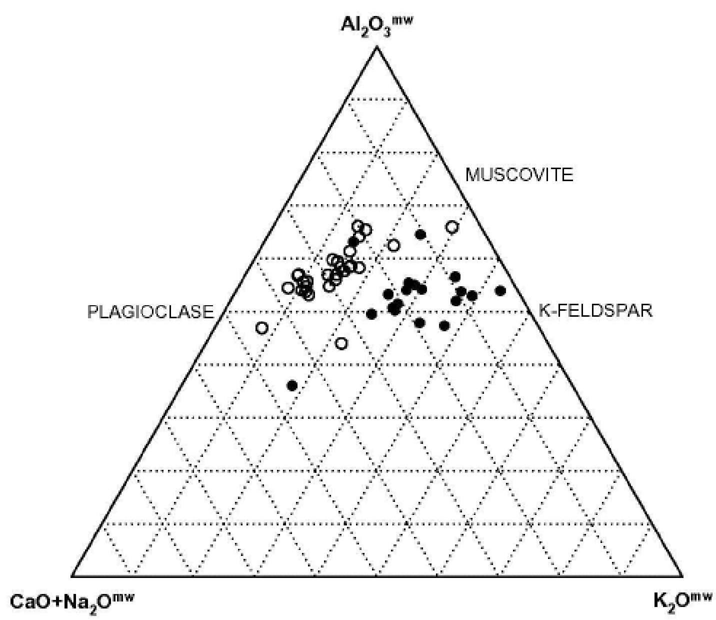


Figure 49. Ternary CaO+Na₂O–Al₂O₃–K₂O diagram) showing data for Klondike Schist samples collected near Dawson (Metcalfe, 1981). Filled circles represent protomylonite granofels (metarhyolite) and open circles represent mylonitic schist (arkosic metasedimentary rock).

Large et al. (2001) discuss hydrothermal alteration in terms of a binary plot of the Ishikawa alteration index versus chlorite-carbonate-pyrite (CCP) alteration index (Figure 50). The Ishikawa alteration index of Ishikawa et al. (1976) is defined as 100 x (K_2O+MgO)/(K_2O+MgO+Na_2O+CaO). The CCP index (Large et al. 2001) is defined as 100 x (MgO+FeO)/(MgO+FeO+Na_2O+K_2O). Several Hall Creek–Moose Creek samples, including all of the samples from the North Baldy Showing and adjacent outcrop, are characterized by very high Ishikawa index values and moderate to high CCP index values (similar to samples from the footwall alteration zone at the Rosebery VMS deposit) . The one sample of strongly carbonate altered basaltic andesite has a high CCP index value and a low Ishikawa index value. The basalt samples plot near the upper boundary for least altered andesites and basalts. This may reflect, at least in part, a dolomitic (Mg) component within the calcite-rich amygdules they contain.

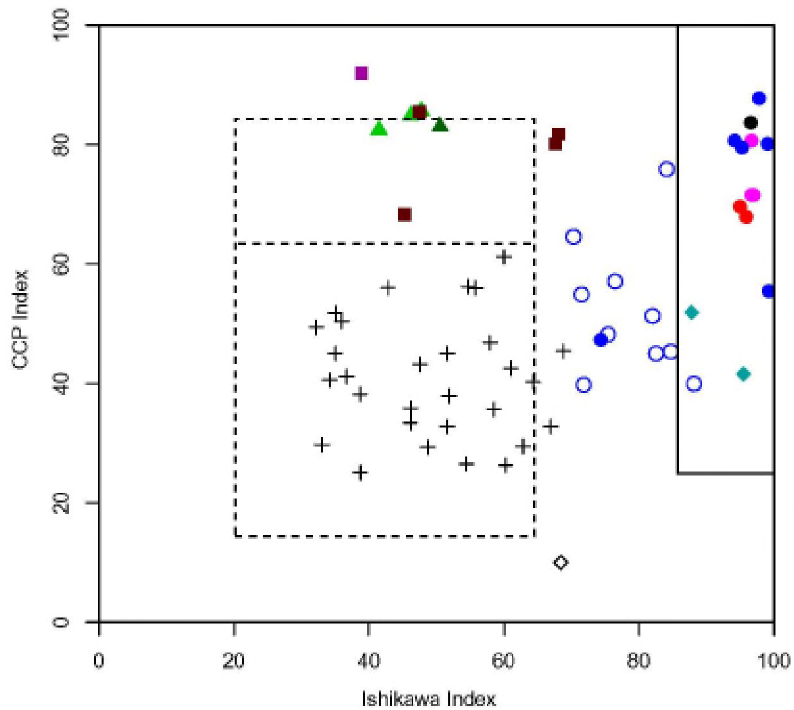


Figure 50. Binary diagram of Ishikawa alteration index versus chlorite-carbonate-pyrite (CCP) alteration index after Large et al. (2001) showing Hall Creek–Moose creek sample data. Lower dashed rectangle represents the field of least altered rhyolite and dacite, upper dashed box represents the field of least altered andesite and basalt, solid rectangle in upper right corner represents the field of strongly altered footwall chlorite-sericite-pyrite zone at the Rosebery VMS deposit (boundaries of Large et al., 2001). Symbols represent basalt outcrop (dark green triangle), basalt boulders (light green triangles), Nasina Series sample (open black diamond), least altered intermediate Klondike Schist (brown squares), carbonate-altered intermediate schist (purple square), least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

A diagram showing the Na_2O and MgO values for felsic Klondike Schist samples from the Hall Creek–Moose Creek area is presented in Figure 51. The severely Na depleted samples (<0.25% Na_2O) can be divided into two groups: (i) those with MgO values similar to the less altered felsic schists (0.5 to 1.5% MgO) and (ii) those with markedly elevated MgO contents (3 to 7% MgO). Within a VMS alteration system Mg enrichment is characteristic of the footwall. It is interesting to note that the two samples of sphalerite-bearing material from the North Baldy Showing have background Mg values whereas the four samples collected just north of the mineralized zone, in the structural footwall, display strong Mg enrichments.

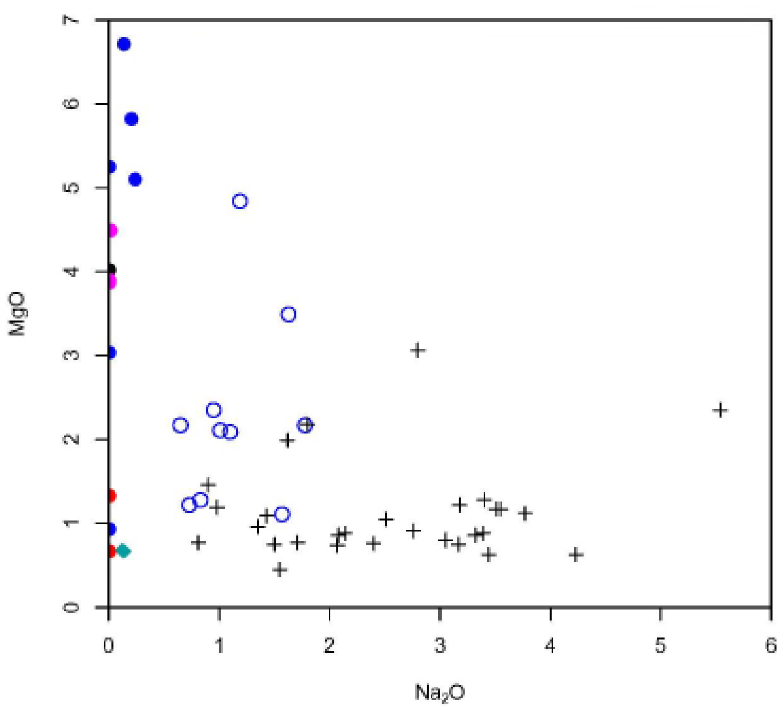


Figure 51. Na_2O versus MgO diagram showing data for felsic Klondike Schist samples from the Hall Creek–Moose Creek area. Symbols represent least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

The relationships between Na, K, Mg and Al geochemistry and alteration mineralogy is displayed in Figures52 and 53 using molar ratio diagrams. Davies Whitehead (2006) showed that the vast majority of felsic volcanic rocks collected at sites remote from mineral deposits plot in the area bounded by K-feldspar, albite and plagioclase (with a 40% anorthite component) on a K_2O/Al_2O_3 versus Na_2O/Al_2O_3 molar ratio diagram (Figure 52). Nearly all of the Hall Creek–Moose Creek Klondike Schist samples plot below the K-feldspar–plagioclase (An_{40}) tie-line indicative of feldspar destructive alteration accompanied by the formation of phyllosilicates. Strongly altered samples (those with less than <0.25% Na_2O) plot along the X axis near the position of muscovite or midway between muscovite and chlorite.

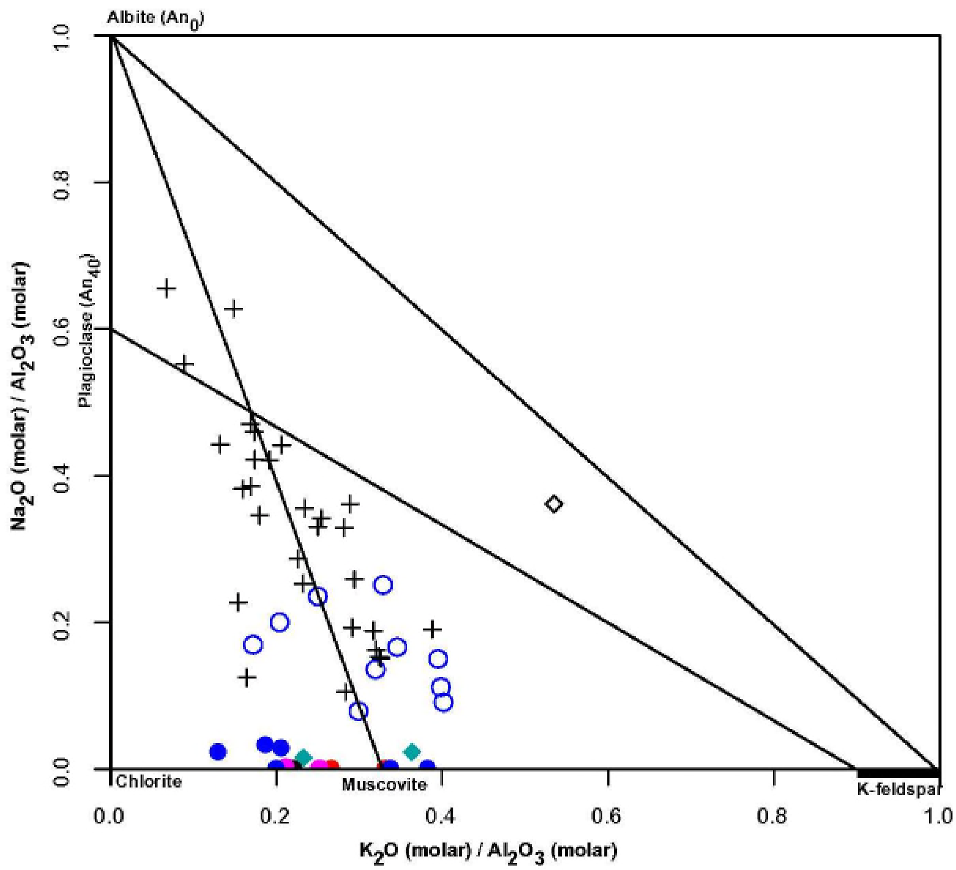


Figure 52. Molar ratio diagram after Davies and Whitehead (2006) showing relationship between K, Na, Al and mineralogy. Data for felsic Klondike Schist samples and Nasina Series sample from the Hall Creek–Moose Creek area plotted. Symbols represent least altered mid-Zr felsic Klondike Schist (black crosses), moderately altered mid-Zr felsic Klondike Schist (open, dark blue circles), strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

The most strongly altered samples are plotted on the K_2O/Al_2O_3 versus MgO/Al_2O_3 molar ratio diagram of Davies and Whitehead (2006) in Figure 53. The samples with higher MgO/Al_2O_3 ratios plot near the muscovite–high-Mg chlorite tie-line strongly suggesting the presence of high-Mg chlorite in these samples.

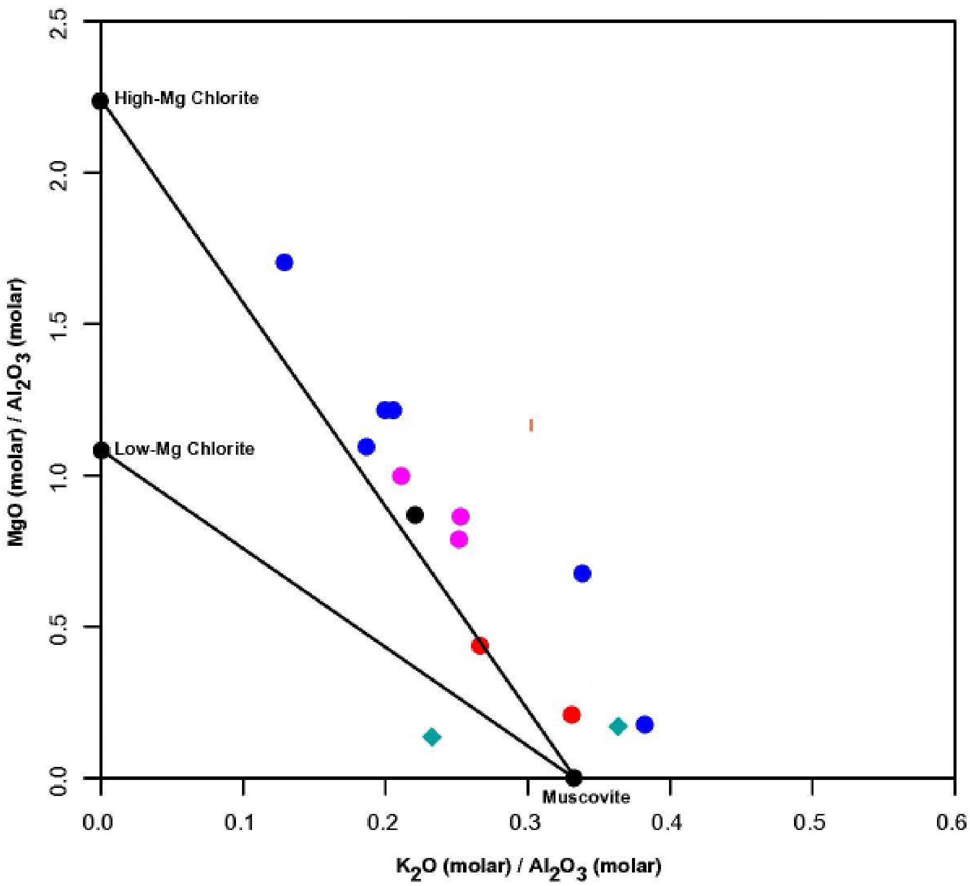


Figure 53. Molar ratio diagram after Davies and Whitehead (2006) showing relationship between K, Mg, Al and mineralogy. Data for the most strongly altered felsic Klondike Schist samples from the Hall Creek–Moose Creek area plotted. Symbols represent strongly altered mid-Zr felsic Klondike Schist (filled, dark blue circles), high-Zr felsic Klondike Schist (filled, light blue diamonds), North Baldy Showing samples (red circles), Mn-rich sample from near North Baldy Showing (black circle), and samples of mid-Zr felsic Klondike Schist from outcrop near the North Baldy Showing (magenta circles).

Discussion: Protoliths

As discussed above, previous workers have had considerable difficulty determining if the Klondike Schist is mainly volcanic or mainly sedimentary both at the regional scale and at the outcrop scale. The detailed work of Metcalfe (1981) on a exposure of Klondike Schist along the Yukon River near Dawson, which included field mapping, geochemistry and thin section study, was able to convincingly differentiate between "blastomylonitic schist" of sedimentary (possibly volcaniclastic) origin and volumetrically less significant "protomylonitic granofels" derived from rhyolite. The protomylonite granofels have a low mica content and retain primary textures indicative of volcanic origin, including euhedral to subhedral crystals of K-feldspar, due to concentration of deformational strain in the enclosing micaceous mylonitic schists (Metcalfe, 1981).

Outcrops of Klondike Schist observed while working in the Hall Creek–Moose Creek area micaceous and moderately to intensely foliated. Anhedral to (rarely) weakly subhedral, altered feldspars were observed in a minority of outcrops. No domains of low strain were observed as might be expected in the centres of thick flows or high level stocks in a volcanic terrane. In other words, no igneous appearing outcrops, akin to the protomylonitic granofels of Metcalfe (1981), were observed. Based on field observation and geochemical comparisons, the Klondike Schists of the Hall Creek–Moose Creek area are similar the metasedimentary mylonitic schists of Metcalfe (1981).

Klondike Schist samples from the Hall Creek–Moose Creek area display geochemical (and field) evidence of having undergone weak to moderate feldspar-destructive alteration over a wide area. Similar geochemical characteristics are evident in the data of Metcalfe (1981) for mylonites (metasedimentary rocks) of the Klondike Schist in the Dawson area. Possible causes of the "background" alterations include:

(i) weathering and transport in the surface environment.
(ii) interaction of glassy volcanic/pyroclastic material with sea water, and
(iii) hydrothermal metasomatism related to tectonism (most likely during the development of mylonitic fabric).

If the Hall Creek project area samples are metasedimentary the geochemical data suggest that they are relatively immature. On sedimentary rock classification diagrams they plot in the fields of arkose and wacke and do not show the variation in Si/Al ratios characteristic of mature sediments such as sandstones and shales. The retention of distinctive geochemical characteristics in two units along Moose Creek, the high-Zr felsic Klondike Schist and the intermediate Klondike Schist, argue against extensive mixing in the surface environment. The geochemical nature of the high-Zr felsic Klondike Schist with their very distinctive trace element characteristics, including HREE enriched REE patterns, provides a compelling argument for classifying these rocks as volcanic. However, both samples of this rock type are extensively altered precluding a definitive assignment.

In summary, the author favours an interpretation in which the Klondike Schist in the Hall Creek–Moose Creek area represents a sequence of mainly volcaniclastic rocks that display the effects of modest feldspar-destructive alteration over a broad (regional) area possibly due to chemical changes in the surface environment or tectonically induced metasomatism.

Rocks of the Klondike Schist in the Hall Creek – Moose Creek area are calc-alkaline. Protoliths of the mid-Zr felsic schists appear to have been rhyolitic and dacitic in composition (possibly volcaniclastic rhyolite and volcaniclastic dacite). The high-Zr felsic schists with their distinctive chemical composition, were most likely rhyolitic. The intermediate schists appear to have been andesitic. The non-foliated mafic rocks (outcrop and boulders) are alkali basalts.

Discussion: Tectonic Setting

The Klondike Cycle (Cycle VI) represents the last magmatic cycle of the Devonian to Permian Yukon-Tanana terrane and it includes the magmatism represented by the mid- to Late Permian Klondike Schist (~263-253 Ma), "…a sequence of felsic volcanic and volcaniclastic rocks with lesser interlayered mafic rocks, and coeval and probably cogenetic monzonitic to quartz-monzonitic granitoids …. Although limited, geochemical data for felsic rocks of the Klondike Schist consistently exhibit flat calc-alkalic signatures, with low Nb, Eu, Ti, Sc and V relative to UCC … indicative of an arc setting …." (Piercy et al., 2006, p. 307). Dusel-Bacon et al. (2006, p. 59) noted that their single sample of Klondike Schist had a calc-alkalic arc signature with a chemical pattern similar to that of "… a Crater Lake-type continental-margin arc".

The analyses of Klondike Schist samples from the Hall Creek–Moose Creek area adds to the volume of data that may be applied to the question of tectonic setting. These data indicate an origin in a calc-alkaline, possibly continental, arc environment in agreement with the conclusion of Piercy et al. (2006) and Dusel-Bacon et al. (2006).

The samples of non-foliated basalt collected along Moose Creek have alkaline characteristics and appear to have been generated in a non-arc (within plate) tectonic setting.

Discussion: Hydrothermal Alteration

The upper range of silica values for samples of Klondike Schist (up to 83.59 % SiO_2) is too high for unaltered igneous rocks (although silica enrichment in surface weathering/sedimentation processes cannot be ruled out). The distribution of silica values in samples from the Hall Creek–Moose area is shown in Figure 54. There does not appear to be a mappable silica distribution pattern except for an area of lower values representing samples from the intermediate schist along Moose Creek.

All six samples from the North Baldy Showing outcrop beside Hall Creek have undergone intense geochemical alteration. These rocks are characterized by Ishikawa Alteration Index values of >90 and Na_2O values of <0.025% (Figure 55 and 56). These values demonstrate that the base metal mineralization at the North Baldy Showing is accompanied by intense hydrothermal alteration and supports the interpretation of the showing as a VMS occurrence (perhaps hosted in volcaniclastic rocks). Other samples of Klondike Schist with very high Ishikawa alteration index values and very low Na contents include (i) one sample of rubble collected on the hillside southwest of Hall Creek and south of the North

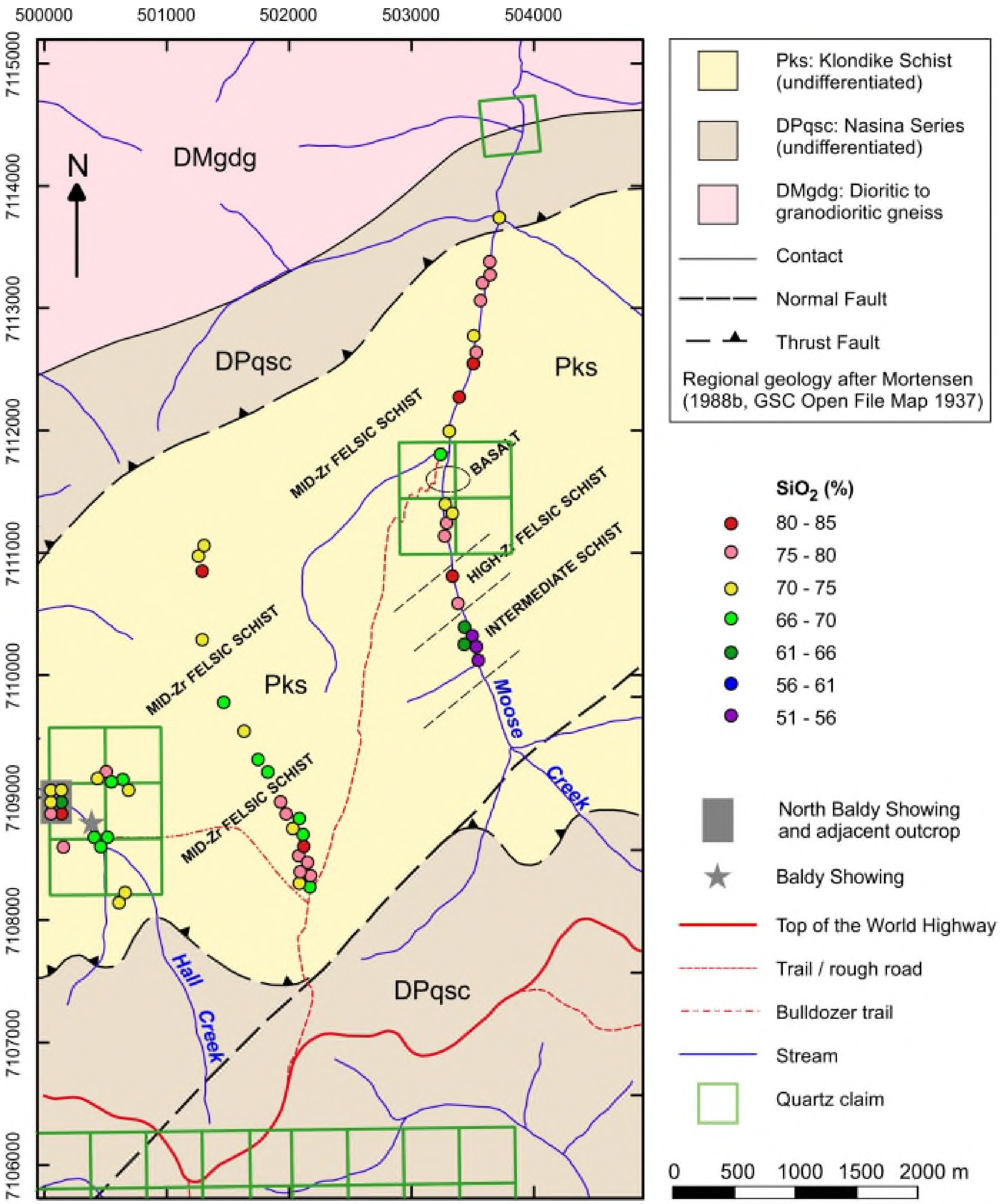
Baldy Showing, (ii) three outcrop samples from the hillside northeast of Hall Creek and east-northeast of the North Baldy Showing, (iii) a single outcrop sample from the ridge between Hall and Moose creeks near the rough road and (iv) the two samples of high-Zr felsic schist collected near Moose Creek. One sample of intermediate schist from near Moose Creek also has a very low Na_2O value (0.05%) but a low Ishikawa alteration index value (39) due largely to a high CaO content (7.31%). This sample is of strongly carbonate altered material.

The most strongly altered samples have chemical characteristics consistent with formation in the footwall of a VMS deposit .

Several rock samples display evidence of having undergone significant REE mobility (see Figure 43 to 46) and these samples are highlighted in Figure 57. Samples at and near the North Baldy Showing display strong HREE depletion (7 samples), enrichment in MREE and HREE (1 sample), LREE and MREE depletion (1 sample) and LREE enrichment (1 sample). The two samples of high-Zr felsic schist collected along Moose Creek both display HREE enrichment and very pronounced negative Eu anomalies (strong negative Eu anomalies may be associated with VMS footwall alteration).

As aqua regia will totally digest carbonate but only partly digest silicates, Ca values obtained after aqua regia digestions are useful for detecting calcium carbonate alteration (calcite and other Ca-bearing carbonates). A map showing aqua regia calcium values in samples of Klondike Schist is showing Figure 58. All of the intermediate schist samples show evidence of weak to strong carbonate alteration (the sample with highest aqua regia Ca value of 4.7% (16HL143) is from a strongly carbonate altered outcrop). Carbonate alteration is also evident southwest of Hall Creek. Note that all of the samples containing >0.5% aqua regia Ca also contain >0.2% total C (to a maximum of 3.29% C in sample 16HL143). The distribution of carbonate alteration is of interest in gold exploration so the carbonate alteration detected along Moose Creek, a known gold placer stream, is intriguing.

Zn values in rock samples from the Klondike Schist and Nasina Series are shown in Figure 59. Values of over 1000 ppm Zn were only detected in samples of the North Baldy Showing and adjacent outcrop: 2041 ppm Zn in sample 16HL109 from the showing and 7078 ppm Zn in sample 16HL114 of rubble found lying on bedrock while striping the showing and 1215 ppm Zn from a sample (16HL111) of heavily Mn stained bedrock collected less than a metre away from the showing. Three samples in the general vicinity of the North Baldy Showing returned from 174 to 272 ppm Zn and a sample of intermediate schist from near Moose Creek returned 291 ppm Zn.



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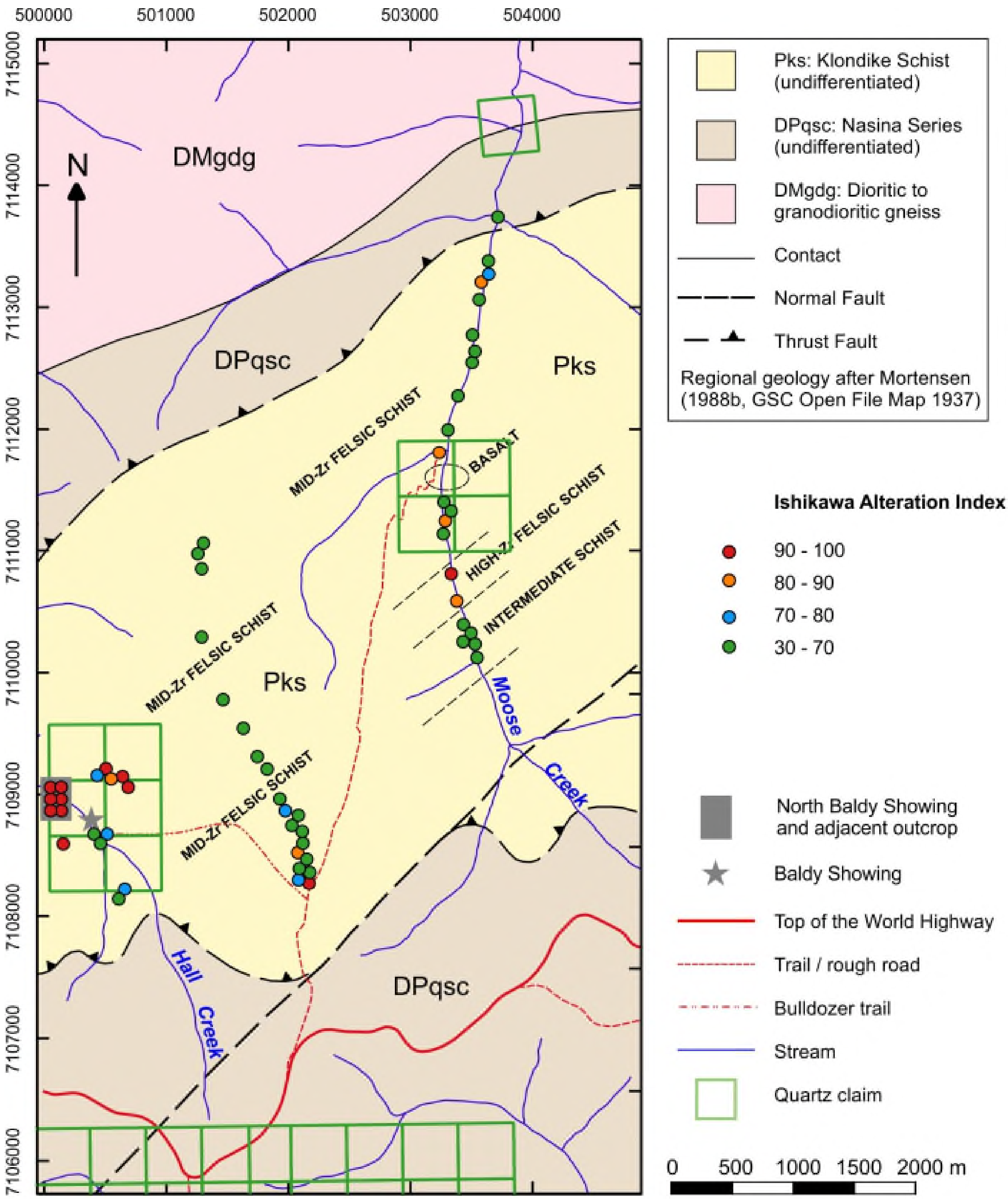
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

SiO_2 values in rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

Figure 54.



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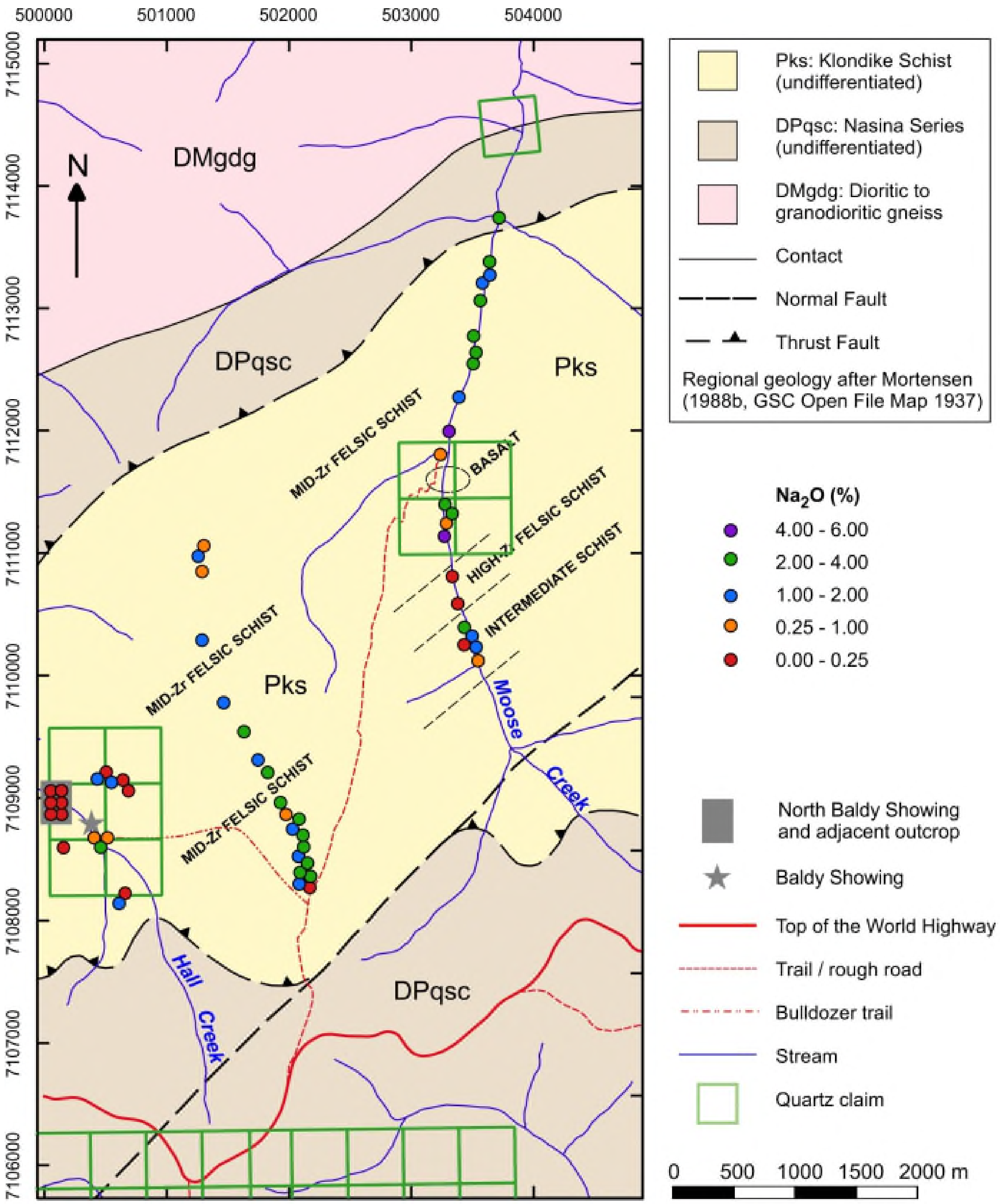
Ishikawa Alteration Index values in rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

Figure 55.



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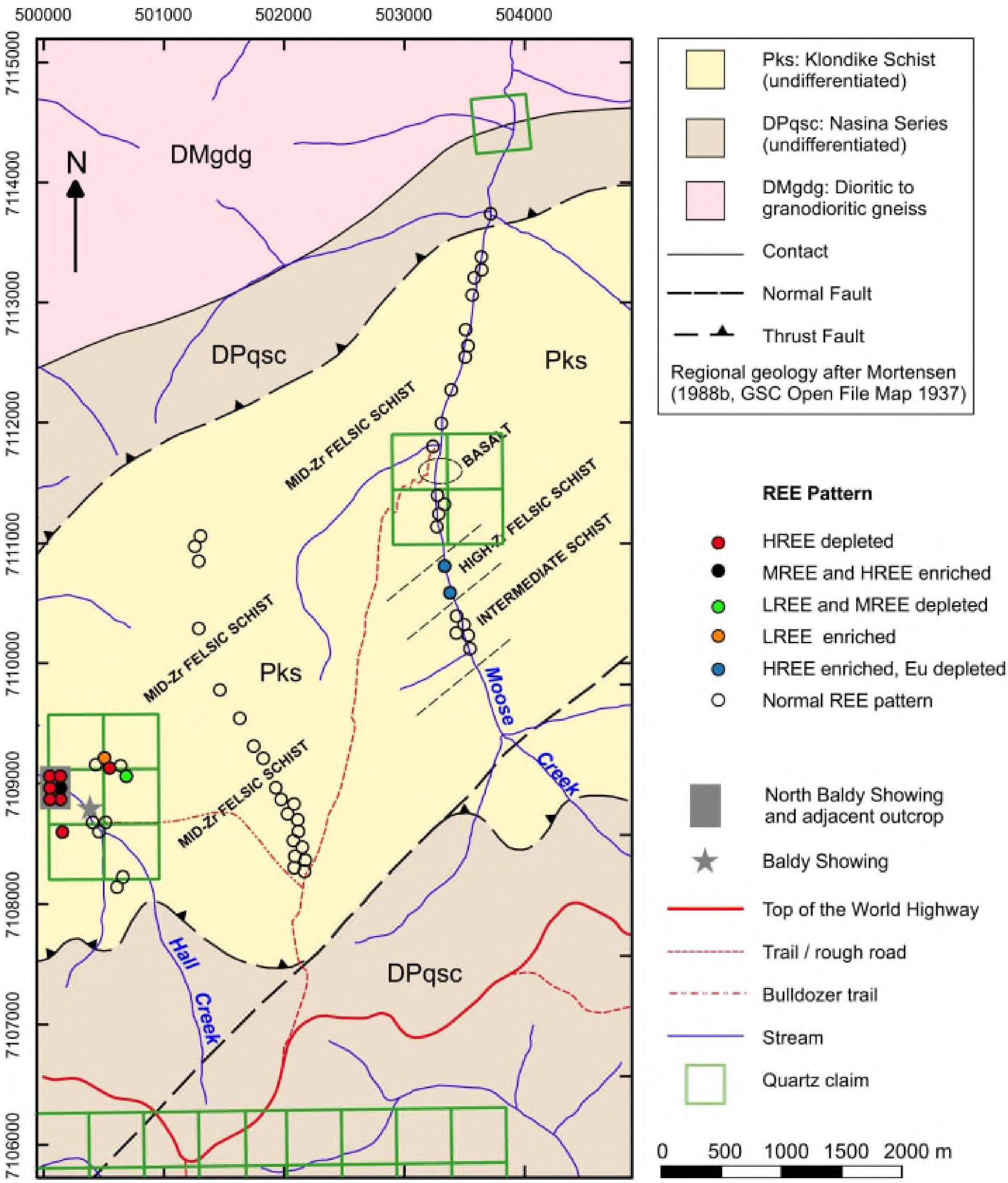
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Na_2O values in Rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

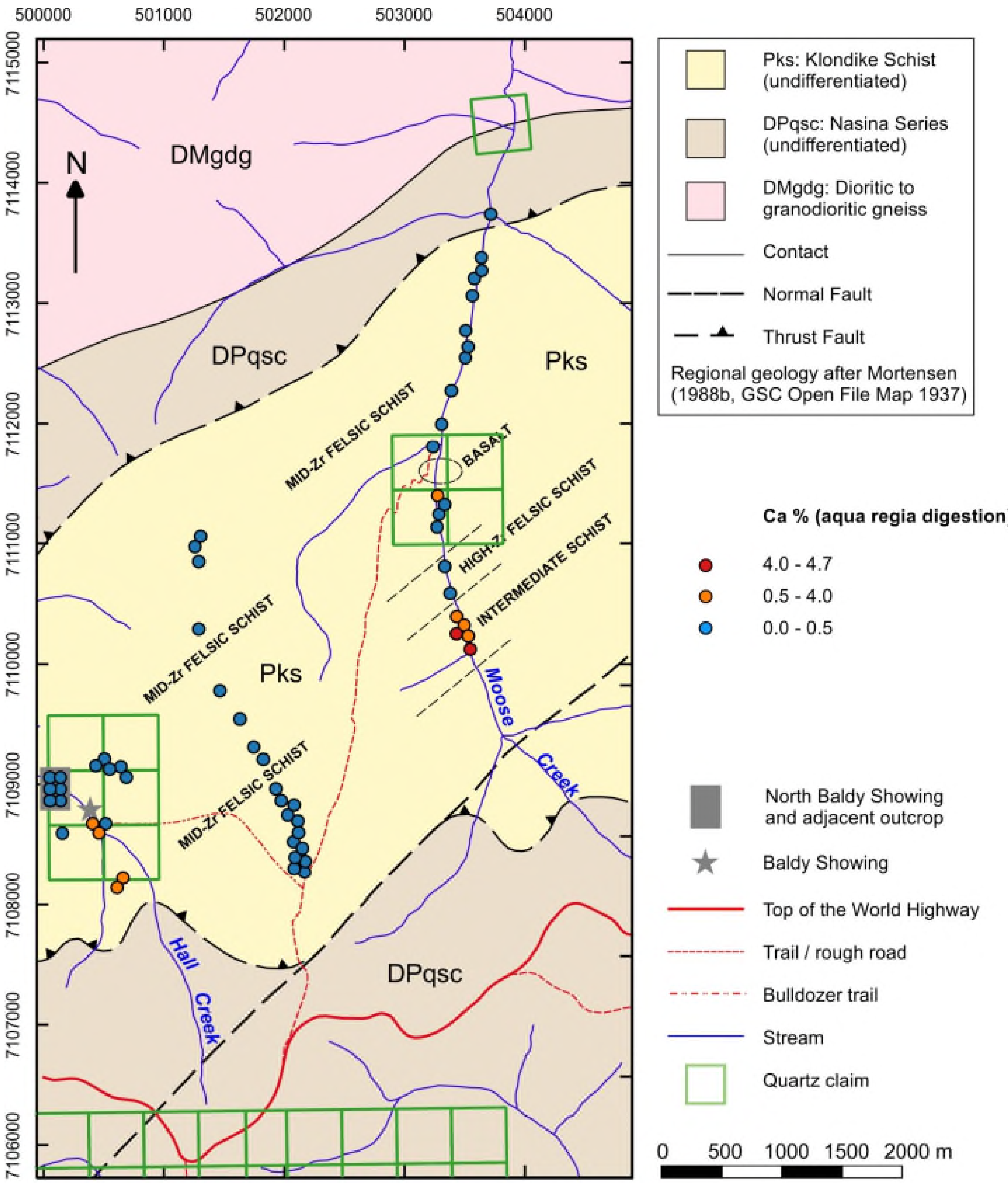
Figure 56.



Part of NTS Map Area 116C/02
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Rare earth element patterns in rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

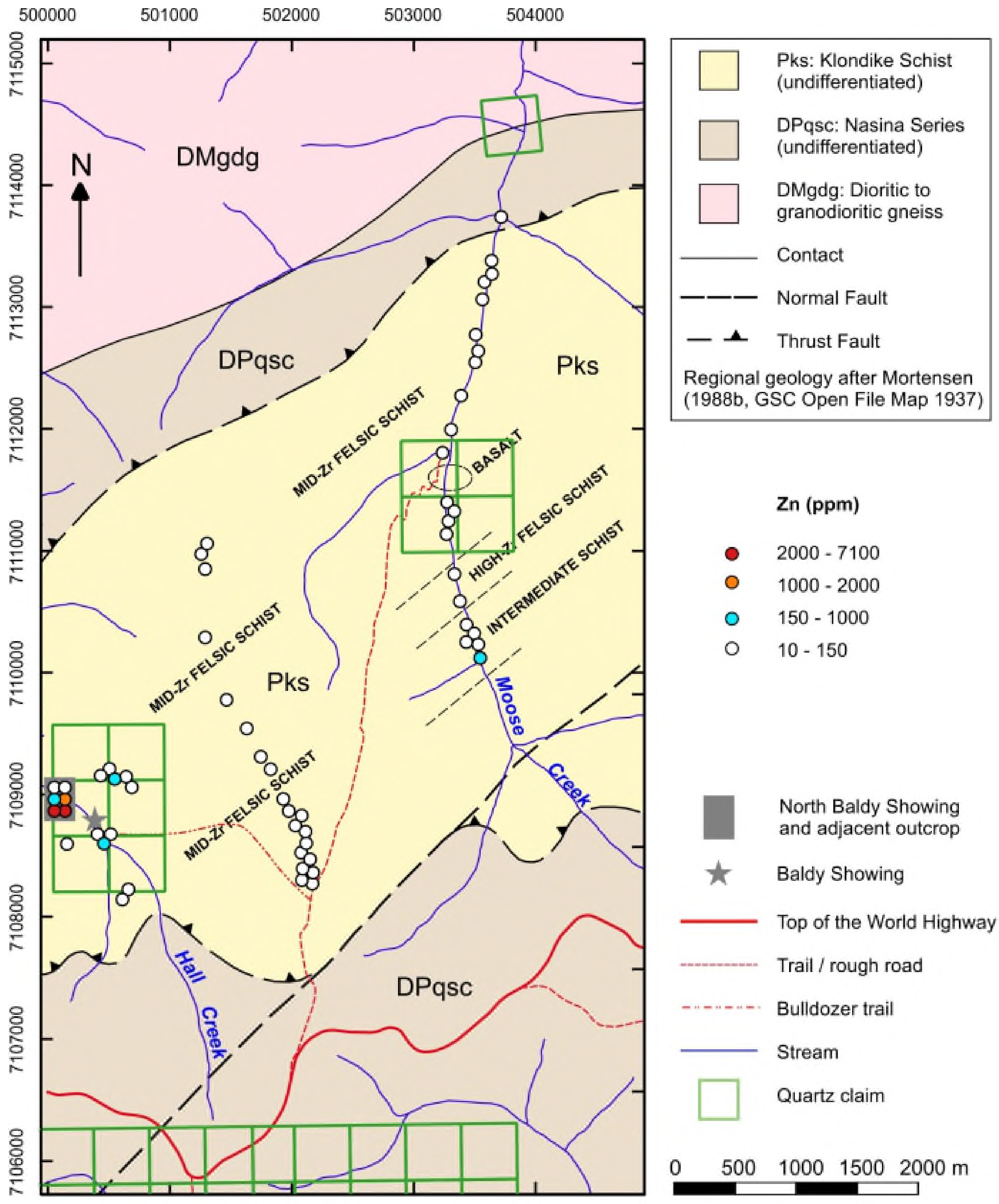
Figure 57.



Part of NTS Map Area 116C/02
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Ca (aqua regia digestion) values in rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

Figure 58.



Part of NTS Map Area 116C/02
NAD 83, UTM Zone 7N
Base map GIS data from the GeoYukon site of Geomatics Yukon (Yukon Government)

Zn values in rocks of the Klondike Schist and Nasina Series in the Hall Creek - Moose Creek area

Figure 59.

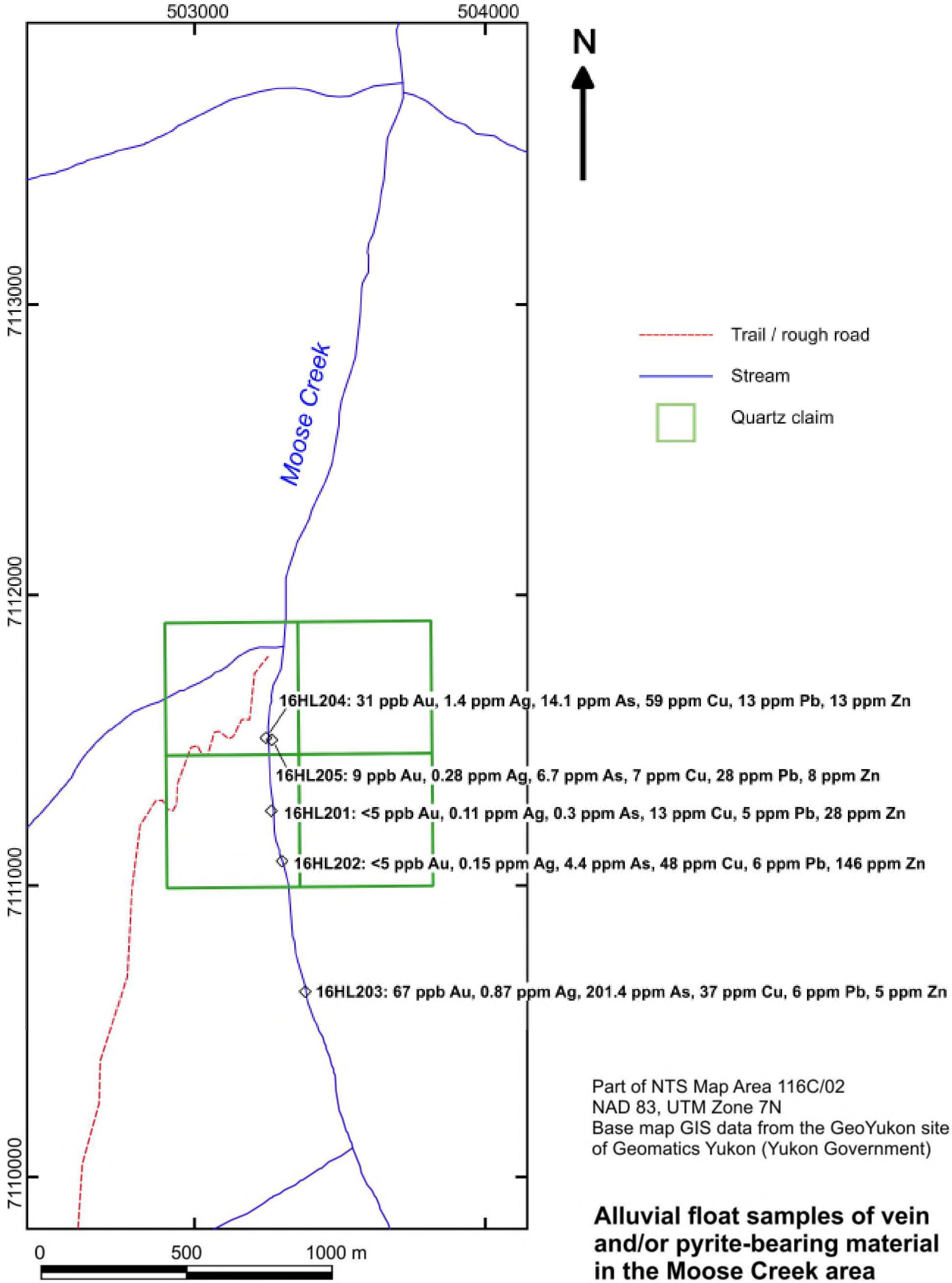
Lithogeochemistry: Partial Rock Analyses

Data Set

Five samples, containing quartz (± Fe-carbonate) vein material and/or pyrite, were collected from alluvial float along Moose Creek. Extensive placer gold workings occur downstream of the sample sites. These samples were submitted for determination of a suite of elements, including base metals, silver and gold, by ICP-AES/MS after aqua regia digestion (which does not completely dissolve some minerals including silicates and oxides but is generally effective in completely digesting sulphides and gold). Sample locations are shown in Figure 60 and analytical results are presented in Appendix 2.

Results

The maximum values returned from these five samples of alluvial float are 67 ppb Au, 1.4 ppm Ag, 201 ppm As, 59 ppm Cu, 28 ppm Pb and 146 ppm Zn. No follow-up work is recommended based upon the results obtained from these five samples.



Alluvial float samples of vein and/or pyrite-bearing material in the Moose Creek area

Figure 60.

Mineralogy of Mantle Xenoliths

Several boulders containing olivine-rich nodules (interpreted to be mantle xenoliths) were observed along a few hundred metre section of Moose Creek. Although considered a “long shot” given the tectonic setting it was decided to investigate the mineralogy of these xenoliths for indications of possible diamond potential. Photographs of one of these boulders are presented in Figures 61 and 62.

Figure 61. Boulder beside Hall Creek from which rock sample 16HL161 and xenolith mineral sample 16HL303 were collected. Hammer handle is marked in 10 cm increments.

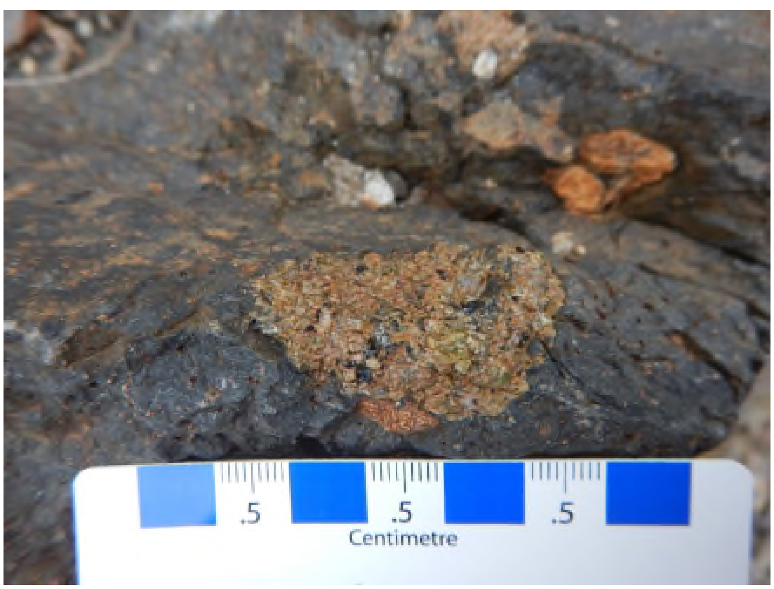


Figure 62. Boulder beside Hall Creek with view centred on xenolith from which xenolith mineral sample 16HL303 was collected.

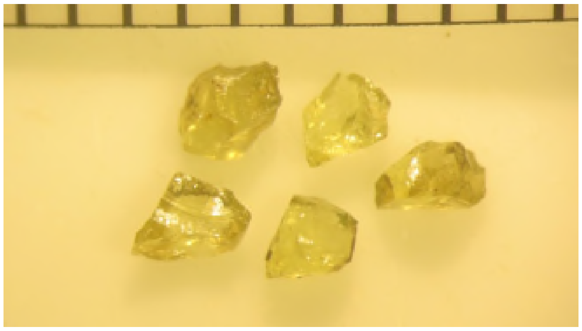
The boulders in question are massive (non-foliated), aphanitic to fine-grained, mafic (basaltic) in character and contain numerous calcite amygdules as well as rare olivine crystals. Within this same area, on the east side of Moose Creek, is a prominent outcrop of massive (non-foliated) basaltic rock similar the boulders except for the absence mantle xenoliths. Although the exposed outcrop of basaltic rock is barren of xenoliths, nearby blocks of scree/rubble contain numerous xenoliths of schistose rock similar in appearance to the Klondike Schist.

Three samples of the boulders hosting the mantle xenoliths, but excluding xenolith material, and one sample of the mafic outcrop were submitted for whole rock analyses. As demonstrated in Figures 30, 34 and 35 they share very similar chemical characteristics. Their volatile-free silica values places these rocks just on the mafic side of the ultramafic-mafic dividing line. They are alkaline in nature and may be reasonably classified as alkali olivine basalt.

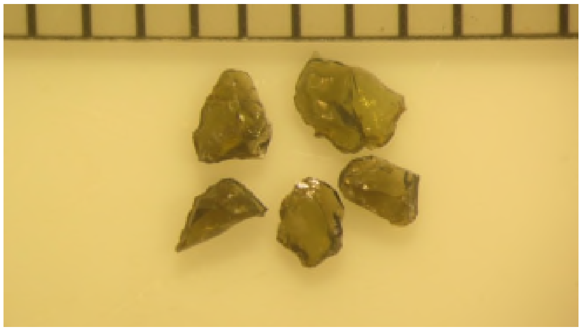
Xenolith samples were crushed by hand methods to sand sized particles. The crushed samples were then examined with a binocular microscope for mineral identification and selection of grains for microprobe analyses. The xenoliths are dominated by pale green olivine with subordinate amount of pale greyish-green orthopyroxene, bright green clinopyroxene and black spinel. Thus, the nodules may be classified as lherzolite based upon their mineralogy.

Due to the bright green colour of the clinopyroxene (noted in the field) it was hoped that if might be rich enough in chrome to place it (and the nodules) in the diamond stability field.

Microprobe methodology is described in Appendix 4 and mineral grain microprobe results are presented in Appendix 5. The olivine-orthopyroxene-diopside-spinel compositions of the xenloliths, tentatively identified by observation with a binocular microscope, were confirmed by the microprobe analyses. Photographs of some of the grains selected for analytical analyses, taken while viewed with a binocular microscope, are shown in Figure 63.

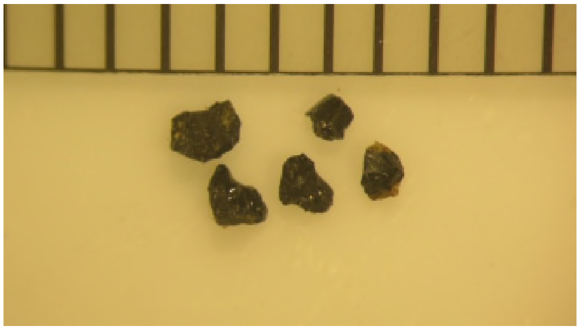


A: Olivine.



B: Orthopyroxene.

C: Diopside.



D: Spinel.

Figure 63. Binocular microscope view of grains selected mantle xenolith sample 16HL302 (after hand crushing). Scale bar divided into 1 mm increments.

Microprobe data for the pyroxenes Moose Creek pyroxenes are shown in a mole percent Mg_2Si_2O6 – $Ca_2Si_2O_6$– $Fe_2Si_2O_6$ diagram for the classification of Na-poor pyroxenes (Morimoto, 1988) in Figure 64. The clinopyroxenes plot in the diopside and augite fields and the orthopyroxenes plot in the enstatite field.

Based on the pyroxene nomenclature recommendations of Morimoto (1989), the modifier chromian may be added to pyroxenes containing greater than 0.01 cations of Cr per formula unit (approximately 0.4 wt. % Cr_2O_3). On this basis, all of the probed pyroxene grains from Moose Creek are chromian pyroxenes (Appendix 5).

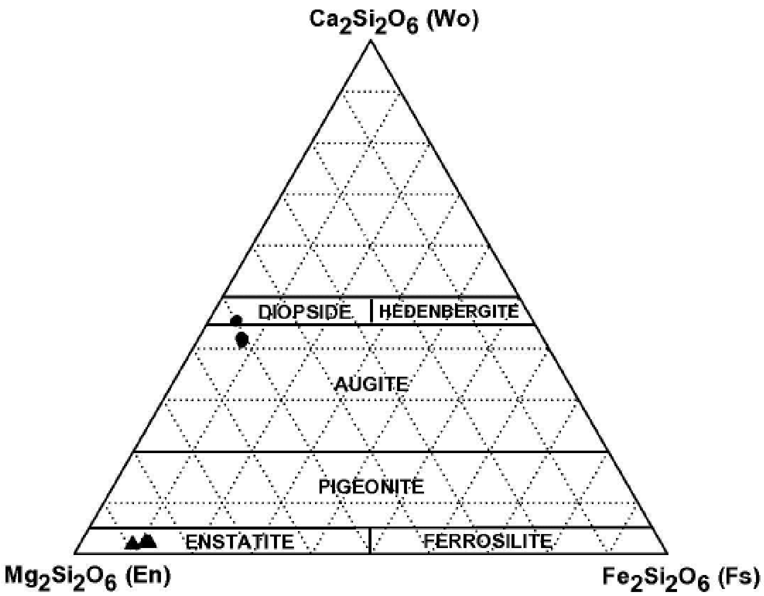


Figure 64. Mole percent $Mg_2Si_2O_6$ – $Ca_2Si_2O_6$– $Fe_2Si_2O_6$ diagram for the classification of Na-poor pyroxenes (Morimoto (1988). Clinopyroxenes represented by filled circles and orthopyroxenes represented by filled tringles.

On the Al_2O_3 versus Cr_2O_3 discrimination plot of Ramsay and Tompkins (1994), most of the clinopyroxene from the Moose Creek nodules lie within the field of clinopyroxene from spinel lherzolite and 'off-craton' garnet peridotite (Figure 65).

Morris et al. (2002) defined a field on a molar Al–Cr–Na diagram that , based on their study, encloses 85% of diopsides from kimberlite (Figure 66). This field outlines lherzolitic clinopyroxenes that have equilibrated at pressures greater than 30 kbar (Morris et al., 2002). The compositions of the Moose Creek xenolith clinopyroxenes fall outside of this field.

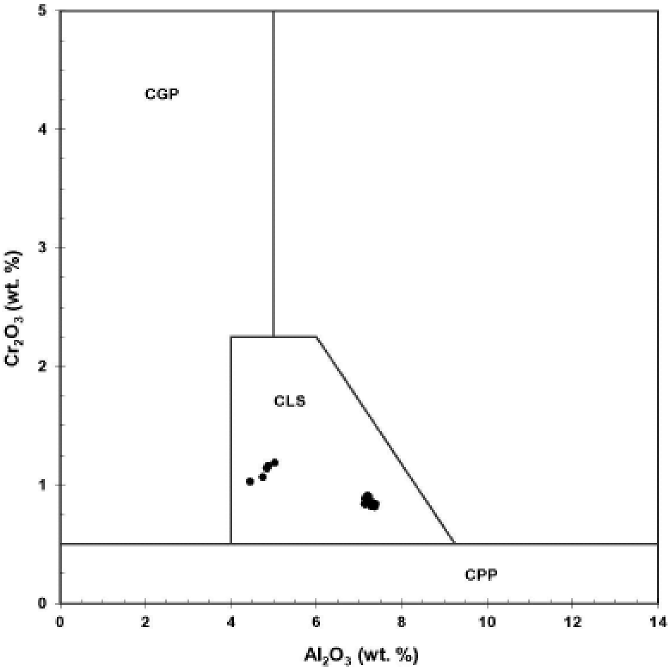


Figure 65. Al_2O_3 versus Cr_2O_3 diagram, after Ramsay and Tompkins (1994), showing compositions of clinopyroxenes from Moose Creek mantle nodules (filled circles). CGP - clinopyroxene from garnet peridotite; CLS – clinopyroxene from spinel lherzolite and 'off-craton' garnet peridotite; CPP – eclogitic, megacrystic and cognate clinopyroxene.

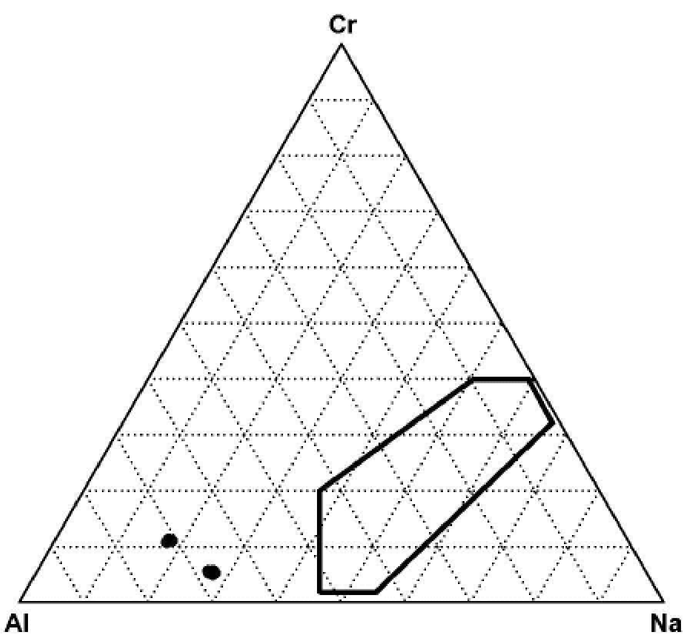


Figure 66. Al-Cr-Na (molar) diagram, after Morris et al. (2002), showing compositions of clinopyroxenes from Moose Creek mantle nodules (filled circles). The polygon outlined by the heavy border contains 85% of the diopside from kimberlite based on the Morris et al. (2002) study.

“Olivine is well represented as an inclusion in diamond from both kimberlites and lamproites; characteristically highly magnesian-rich forsterite ($Fo_{90.2-96.6}$), with significant amounts of nickel (0.2-0.49 wt. % NiO)” (Fipke et al., 1995, p. 65). Figure 67 demonstrates that the NiO range of the olivine samples from the Moose Creek mantle nodules fall within that range but that only a few of the Mg# values meet the criteria.

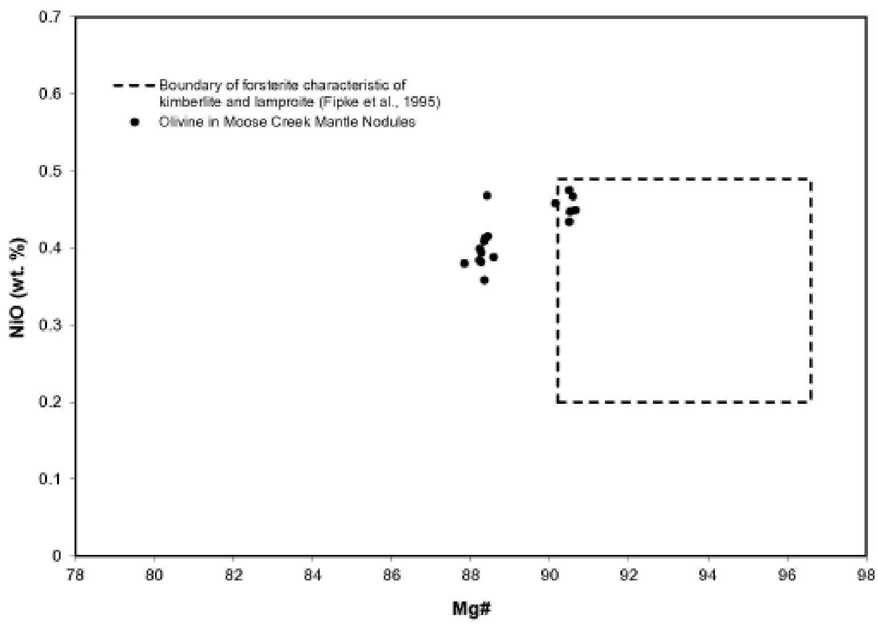


Figure 67. Mg# versus NiO diagram, after Fipke et al. (1995) showing composition of olivines from Moose Creek mantle nodules (filled circles).The polygon outlined by the dashed boundary represents the field of foresterite (Mg-rich olivine) characteristic of kimberlite and lamproite. Mg# = 100 x molar Mg / (molar Mg + molar Fe).

The Mg and Cr_2O_3 range of olivine from inclusions in diamonds (Fipke et al., 1995) is shown in Figure 68. The compositional data for olivine samples from the Moose Creek mantle nodules fall outside of the diamond inclusion field.

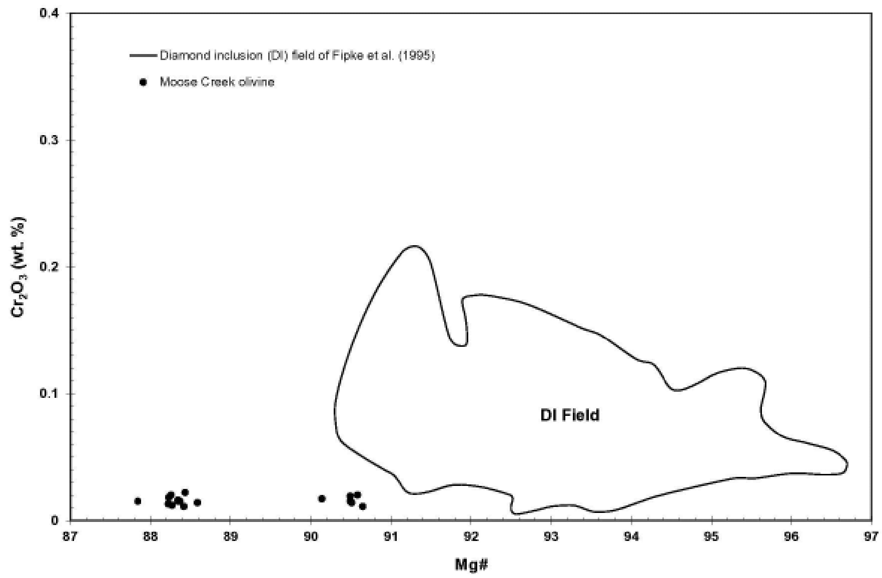


Figure 68. Mg# versus Cr_2O_3 diagram, after Fipke et al. (1995) showing compositions of olivines from Moose Creek mantle nodules (filled circles). The polygon outlined by the dashed boundary represents the field of olivines found in diamond inclusions. Mg# = 100 x molar Mg / (molar Mg + molar Fe).

The spinel group mineral in the Moose Creek mantle nodules is spinel (not chromite). Their MgO and Cr_2O_3 compositions are shown in Figure 69 relative to the field of chromite from diamond inclusions (Gurney and Zweistra, 1995).

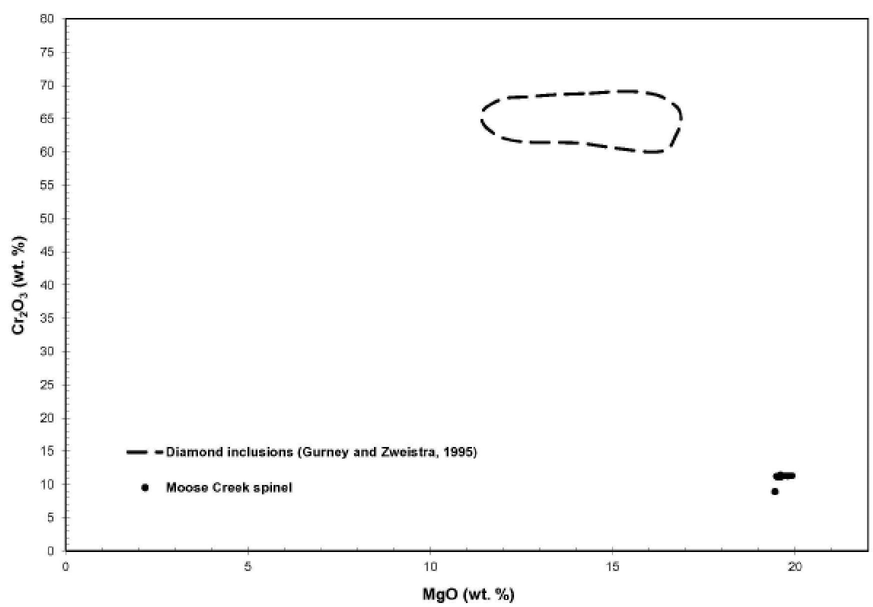


Figure 69. MgO versus Cr_2O_3 diagram, after Gurney and Zweistra (1995) showing compositions of spinel from Moose Creek mantle nodules (filled circles). The polygon outlined by the dashed boundary represents the field of spinel (chromite) found in diamond inclusions.

Conclusions

The Hall Creek–Moose Creek area, explored during 2016, is underlain primarily by the Permian Klondike Schist (part of the Yukon-Tanana Terrane). Lithogeochemical data from these rocks indicates deposition in a calc-alkaline arc environment, which is a setting permissive for the formation of VMS deposits.

Rocks of the Klondike Schist in the Hall Creek–Moose Creek area are mainly felsic with many having rhyolitic chemical compositions. Interpretation of geological mapping and lithogeochemical data suggests these rocks may be volcaniclastic in origin.

Strongly Na depleted rocks in which the aluminous component occurs almost entirely in K-mica and/or chlorite are the hallmark of VMS hydrothermal alteration zones, especially when accompanied by evidence of REE mobility. The lithogeochemical survey completed in 2016 has identified this style of alteration over an area of at least 700 m by 300 m in the Hall Creek area.

The area of strong hydrothermal alteration in the Hall Creek area corresponds with a pronounced base metal soil anomaly up to 1200 m long by 450 m wide detected during previous exploration programs.

The Baldy Showing, from which samples containing up to 8.09% Zn, 3.43% Pb, and 41.0 g/t Ag were collected, lies near the southern boundary of the hydrothermal alteration zone (and soil anomaly). The Baldy Showing was exposed in a placer miner’s test pit (probably excavated by a bulldozer) in 1989 but has been covered by alluvium since 1990. The width of the Baldy mineralized zone in unknown.

The North Baldy showing, from which samples containing up to 0.71% Zn, 0.07% Pb and 1.6 g/t Ag were obtained during the 2016 program, lies near the northern boundary of the hydrothermal alteration zone (and base metal soil anomaly). The width and grade potential of the North Baldy showing, which subcrops beneath colluvium, could not be assessed due to nearly continuous slumping of overburden during hand stripping.

A synform has been mapped between the Baldy and North Baldy showings making it possible that the two showings are on the same stratigraphic horizon.

Two samples of rhyolitic Klondike Schist with distinctive high-Zr and high-HREE chemistry collected near Moose Creek are characterized by strong feldspar-destructive alteration that may indicate a second VMS hydrothermal alteration zone. A rock sample (probably float) collected in 2011 downstream from these outcrops returned 0.60% Zn from a chloritic quartz schist with massive banded pyrite.

Recommendations

- The geological mapping and lithogeochemical surveying initiated in 2016 should be extended eastward into the Pub VMS Showing area and to the west, into Alaska, into the Boundary VMS Showing area.
- Width and grade data for the Baldy and North Baldy showings needs to be obtained either by mechanical trenching or shallow drilling. It should be possible to reopen the Baldy test pit by trenching. Mechanical trenching of the North Baldy Showing may be problematic due to the likelihood of slumping colluvium.
- An investigation of geophysical methods to aid exploration should be undertaken. Electromagnetic methods may encounter difficulties because (i) the mineralization, even if consisting of massive sulphide, may be sphalerite and galena-rich with isolated pyrite (thus being a poor conductor), and (ii) mineralized horizons are likely to dip (and plunge) at shallow angles making them difficult EM targets. This style of mineralization may respond to I.P surveying.

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Statement of Qualifications

I, Glen Prior, of 793 Birch Avenue, Sherwood Park, Alberta do hereby declare:

- That I am a self-employed geologist.
- That I am a Professional Geologist registered with the Association of Professional Engineers and Geoscientists of Alberta (Member Number M73587).
- That I graduated from Laurentian University in Sudbury, Ontario, with a B.Sc. (Honours) degree in geology in 1982, from Laurentian University in Sudbury, Ontario, with a M.Sc. degree in geology in 1987 and from Carleton University in Ottawa, Ontario, with a Ph.D. degree in geology in 1996.
- That I practiced my profession full-time from 1986 to 1991 and continuously since 1996 including 5 years with Norwin Geological Ltd. (Vice President), 5 years with Aur Resources Inc. (holding the positions of Senior Project Geologist and Senior Geologist) and 12 years with the Alberta Geological Survey (holding the positions of Geologist, Senior Geologist and Section Leader).
- That I wrote this report and executed the exploration program described in this report.

January 19, 2017

Sherwood Park, Alberta

Glen Prior

Appendix 1

Rock Sample Descriptions

Location Coordinates: UTM, NAD83, Zone 7W

(also Zone 7N where N indicates north)

Sample	East	North	Elev (m)	Site Type	Description
16HL101	502131	7108298	1215	outcrop	Quartz-muscovite schist. Light grey, light grey weathering. Quartz is mainly fine grained (aphanitic to medium grained) and white to light grey. Quartz-rich lenses are commonly 1 to 2 mm thick and essentially pure quartz. Muscovite is mainly silver-coloured with some being medium greenish-grey. The muscovite is medium grained to aphanitic (grading to sericite) and occurs in layers of essentially pure muscovite commonly ≤ 1 mm thick. Overall about 90% quartz and 10% muscovite. Muscovite layers commonly display very weak, light brown, Fe-oxide stain. Local, minor, fine-grained limonitic cavities that may have been occupied by pyrite occur in quartz-rich layers. Not magnetic. No reaction to dilute HCl. Strongly foliated (schistose) at 076°/20°N. Small outcrop at south end of large outcrop area. Boudinaged, white, barren-appearing quartz veins up to 5 cm wide occur in nearby outcrop - these are weakly Fe stained.
16HL102	502115	7108312	1227	outcrop	Quartz-muscovite schist. Similar to 16HL101 but contains 1 to 5% elongate (oval; approximately 2:1 ratio of length to thickness) light grey quartz augen commonly up to 2 x 1 mm. Foliation (schistosity) at 078°/22°N. Central part of large outcrop area trending 250°.
16HL103	502133	7108356	1223	outcrop	Quartz-feldspar-muscovite schist. About 20% foliation parallel, silver, aphanitic to fine-grained muscovite. 1 to 2% disseminated biotite (fine grained). Rare (<1%) light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained mixture of light grey quartz and white feldspar. Separation into quartz-rich and mica-rich layers less well developed than in 16HL101 and 102. Foliation at 092°/18°N. Not magnetic. No response to dilute HCl. Small outcrop.
16HL104	502131	7108380	1222	outcrop	Quartz-muscovite-(biotite) schist. Light grey, light grey weathering. Mineral segregation into layers is moderately developed. About 20% foliation parallel, aphanitic to fine-grained, silver muscovite. 0.5 to 1% light grey quartz "eyes" up to 1 mm across. Remainder is mixture of light grey to white, aphanitic to fine-grained quartz and feldspar. Not magnetic. No reaction to dilute HCl. Very small scale folding (kink bands/chevron folding) is quite pronounced. Foliation at 070°/18°N. Large outcrop.
16HL105	502119	7108472	1225	outcrop	Quartz-feldspar-muscovite schist. Light grey to greyish white, weathers light grey. Mineral layering at 1 mm scale. About 10% muscovite that is aphanitic to fine-grained and silver to waxy light grey (gradational to sericite). Remainder is aphanitic to fine grained mixture of light grey quartz and white feldspar. Moderate to strong foliation at 084°/40°N. Large outcrop.
16HL106	502093	7108535	1226	outcrop	Quartz-muscovite-(biotite) schist. Light grey, weathers light grey. Millimetre scale layering is somewhat poorly defined. Quartz is white to light grey, aphanitic to fine-grained. Muscovite is fine to medium-grained and silver. Approximately 5% fine-grained disseminated biotite. No chlorite. Foliation at 090°/16°N. Small to moderate sized outcrop.

16HL107	502082	7108604	1238	outcrop	Quartz-feldspar-muscovite schist. Light grey, light grey weathering. About 10% aphanitic to fine-grained, silver muscovite and 1% fine-grained, disseminated biotite. Quartzofeldspathic component consists mainly of approximately equal amounts of aphanitic to fine-grained, light grey quartz and white, aphanitic to medium-grained, anhedral feldspar. A small percentage of quartz is composed of what appear to be single light grey crystals ("eyes") up to 3 mm across. Some feldspar occurs as "clots" up to 4 mm across and very rarely crystal faces (or cleavage planes) are noted. Rock contains a trace amount of pyrite cubes up to 1 mm across. Has granular appearance with only minor mineral segregation. Weak foliation at 334°/18°NE. Small outcrop.
16HL108	502092	7108688	1246	outcrop	Quartz-feldspar-muscovite-biotite schist. Contains about 15% aphanitic to fine-grained, silver muscovite and 5% fine-grained, disseminated biotite. Quartzofeldspathic component consists of about equal amounts of light grey, aphanitic to fine-grained quartz and white, fine to medium-grained, anhedral to rarely subhedral feldspar up to 4 x 2 mm (a few crystal faces or cleavage plains noted). Somewhat granular appearance similar to 16HL107. Weak foliation at 350°/10°W. Large outcrop near peak of ridge.
16HL109	500134	7108961	825	outcrop section (0.9 m)	Quartz-muscovite schist. Very siliceous and very competent (hard). Very light grey (broken surface). 90-95% aphanitic, very light grey quartz. 5-10% pale, silver to silvery-green, aphanitic to fine-grained muscovite/sericite. Trace to 2% disseminated pyrite, some in cubes up to 1 mm across. Trace to 0.25%, disseminated, dark brown to black, fine-grained sphalerite, some aligned parallel to foliation. Not magnetic. Structural top of lithologic unit is covered by overburden so cannot determine thickness of unit. Exposed true thickness is 0.15 m. Weakly foliated parallel to unit contact at 264°/62°S.
16HL110	500134	7108961	825	outcrop section (1.5 m)	Quartz-muscovite schist. Light grey. Somewhat similar to 16HL109 but much more foliated (truly schistose) and less siliceous. Approximately 75% aphanitic to fine-grained, light grey quartz. Approximately 25% silver to light silvery-green, aphanitic to fine-grained muscovite/sericite. 1-5% disseminated pyrite, some in cubes up to 1 mm across. Foliation surfaces display distinctive rusty blebs up to 1 mm across that are probably oxidized pyrite grains.
16HL111	500134	7108961	825	outcrop section (1.6 m)	Black, Mn-stained interval composed, in part, of crumbly/blocky, possibly fragmental material. Locally stained rusty brown (limonitic). Locally contains medium-grained yellow to brown mica.
16HL112	500134	7108961	825	outcrop section (4.0 m)	Quartz-muscovite schist. Light grey to light greenish-grey. Approximately 70% light grey, aphanitic to fine-grained quartz. Approximately 30% silver to light silvery green, aphanitic to fine-grained muscovite/sericite. Pronounced small scale kink bands (chevron folds). Foliation surfaces have a silvery sheen along with minor Mn stain. Trace to 1% fine-grained disseminated pyrite. Strong foliation at 276°/78°S.

16HL113	500134	7108961	825	outcrop section (7.5 m)	Quartz-muscovite schist. Similar to 16HL112. Light grey. Approximately 70% aphanitic to fine-grained, light grey quartz. Approximately 30% silver to light silvery green, aphanitic to fine-grained muscovite/sericite. Trace to 1% disseminated pyrite, mainly fine-grained but with some cubes up to 1 mm across. Strong foliation at 252°/84°S. 1-2% white quartz veins and lenses up to 4 cm wide occur in nearby rock.
16HL114	500134	7108961	825	rubble	Quartz-muscovite schist. Angular block of rubble or basal colluvium dug out of bank while stripping outcrop between 0.0 and 1.0 m on Hall Creek section. 25 x 20 x 3.5 cm. Very light grey (broken surface). Mainly aphanitic to fine-grained, very light grey quartz. About 5% light (pale) silvery green (or pale greenish silver), aphanitic to fine-grained muscovite/sericite. Not well foliated (not very schistose). 5-10% pyrite, commonly cubic, up to 1 mm across, disseminated and in discontinuous bands up to 1 mm wide parallel to foliation. 0.5 to 1% fine-grained, black sphalerite in discontinuous pyrite-rich bands and disseminated.
16HL115	500412	7108677	844	rubble	Quartz-muscovite-biotite schist. 10-20% aphanitic to fine-grained, silver muscovite (bordering on sericite). 10-20% fine-grained biotite pseudomorphic after elongate mineral randomly oriented within the plane of foliation (possibly amphibole). Remained is aphanitic to fine-grained, light grey to white material consisting of quartz and, possibly, feldspar. The quartzofeldspathic material occurs in discontinuous, poorly developed layers up to 3 mm thick and, less commonly, in augen up to 8 x 4 mm. Rubble covering an area of approximately 5 x 4 m on east side of Hall Creek containing blocks up to 150 x 100 x 20 cm at various orientations.
16HL116	500456	7108620	849	outcrop	Quartz-feldspar-muscovite-biotite schist. Light to medium grey, weathers medium to dark grey with silvery sheen. 10-20% silvery, aphanitic to fine-grained muscovite/sericite. 5 to 15% fine grained, disseminated biotite (some in small clots). 1 to 3% light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained mixture of light grey quartz and white, anhedral feldspar. Moderate foliation at 084°/48°N. Small outcrop west of and adjacent to Hall Creek.
16HL117	500629	7108191	961	rubble	Quartz-muscovite-(biotite) schist. Rubble. Several large slabs (up to 100x70x5 cm) of same composition in 4 x 3 m area (with more downslope). Sample is from a 100x70x5 cm slab. Moderate to strong foliation. Trace disseminated, fine-grained pyrite. Approximately 2% very distinct light grey quartz eyes up to 2 mm across.
16HL118	500614	7108162	968	outcrop	Quartz-muscovite-(biotite) schist. Trace disseminated, fine-grained pyrite. Approximately 2% distinctive, light grey quartz eyes up to 2 mm across. Strong foliation at 306°/20°NE. Tends to weather (and break) into slabs 1 to 3 cm thick. Medium sized outcrop.

16HL119	500682	7109066	942	outcrop	Quartz-(muscovite) schist. Light grey to white, weathers light grey. Approximately 90-95% aphanitic to fine-grained quartz. Approximately 5 to 10% silvery to pale green. aphanitic to fine-grained muscovite (gradational to sericite). Muscovite is segregated into bands 0.1 to 1 mm thick. Quartz bands typically 1-5 mm thick. Very weak Fe-oxide stain. Foliation surfaces have light brownish (Fe-oxide) - silver sheen. Trace to 0.5% limonitic cavities up to 1 mm across that may represent weathered pyrite. Trace to 1% indistinct, soft, white to light brownish-white blebs up to 1 mm across that may represent altered feldspar. Strong foliation at 270°/28°N. Small outcrop.
16HL120	500637	7109135	931	outcrop	Quartz-(muscovite) schist. Light grey to white, weathers light grey. 90-95% aphanitic to fine-grained quartz in bands 2-5 mm thick. 5-10% light silver to pale green (silver to light brownish silver on foliation surfaces), aphanitic to fine-grained muscovite/sericite in bands <0.5 thick. Trace amount of fine-grained biotite. Very weak Fe-oxide stain on foliation surfaces. Trace to 1% indistinct blebs up to 1 mm across that may be altered feldspar. Strong foliation at 022°/32°NW. Small outcrop.
16HL121	500540	7109149	926	outcrop	Quartz-muscovite schist. Light greenish-grey, weathers light green to light brown (Fe-oxide stain). 85-90% aphanitic quartz. 10-15% waxy, silvery green, aphanitic to fine-grained muscovite/sericite. Muscovite/sericite is a little darker coloured than in previous outcrops and may be accompanied by very minor chlorite. Trace to 1% disseminated Fe-oxide blebs up to 1 mm across may represent oxidized pyrite. Moderate to strong foliation with very open, small scale folds. Representative foliation at 284°/30°N. Small scale open fold axes plunge 16° toward 114°. Small outcrop.
16HL122	500493	7109176	920	outcrop	Quartz-muscovite-((chlorite)) schist. Light grey, light grey weathering. Very small scale kink/chevron folds. 85-90% aphanitic, light grey to white quartz. 10-15% waxy, silvery, aphanitic to fine-grained muscovite (muscovite is gradational into sericite). Trace to 2% fine-grained, medium green, disseminated chlorite. Trace to 1% fine-grained, disseminated biotite. Quartz-rich bands are typically 2-10 cm thick (average is somewhat thicker than previous outcrops). Sericite-rich bands are ≤1 mm thick. Strong foliation. Foliation across most of outcrop at 025°/20°ESE. Foliation near top of outcrop at 280°/12°N. Small outcrop.
16HL123	500458	7109182	927	rubble	Quartz-muscovite-(chlorite) schist. Light grey, light grey weathering. 85-90% aphanitic, light grey quartz in 1-8 mm thick bands. 10-15% very pale, waxy, silvery green, aphanitic to fine-grained muscovite/sericite in bands ≤0.5 mm. 1-3% disseminated, bright, medium-green chlorite. Moderate to strong foliation with small scale open folds. Sample collected from one of several large rubble blocks (up to >2x2x1.5 m. Just east of claim line.

16HL124	502061	7108752	1249	outcrop / rubble	Quartz-feldspar-muscovite-biotite schist. Light grey, light grey weathering. Weak foliation with rock domains typically 3 to 15 cm thick between major foliation surfaces. Approximately 5% fine-grained, randomly oriented, disseminated biotite. 5-20% light pinkish-orange, soft, altered, disseminated, anhedral feldspar up to 2 mm across. 5-10% pale, aphanitic to fine-grained, silver muscovite/sericite, generally parallel to foliation but not segregated into bands. Remainder is aphanitic to fine-grained, somewhat sugary-appearing, light grey quartz. No mineral segregation into bands. Weak foliation at 280°/10°N (if outcrop). Sample from small outcrop or large rubble block approximately 5 m x 5 m by 2 m high.
16HL125	502073	7108828	1236	rubble	Quartz-feldspar-muscovite-biotite schist. Light grey, light grey weathering. Approximately 5% fine-grained, disseminated, randomly oriented biotite. Approximately 5% silver, aphanitic to fine-grained muscovite (/sericite) that tends to be foliation parallel. 5-20% anhedral, white to light pinkish orange, disseminated feldspar up to 1 mm across. Remainder is aphanitic to fine-grained, somewhat sugary-appearing, light grey quartz. No mineral segregation into layers. Rock tends to weather into layers 3 to 15 cm thick. Large block of rubble 10 m x 4 m x 2 m high on gentle north-facing slope.
16HL126	501970	7108872	1227	outcrop	Quartz-biotite-feldspar-muscovite schist. Light medium grey, light grey weathering. Approximately 10% fine-grained biotite of which about 1/2 occurs as disseminated, randomly oriented flakes and about 1/2 occurs as biotite on foliation planes. Approximately 5% foliation parallel, silver to pale, silvery, yellow-green muscovite/sericite. 5-10% indistinct, somewhat soft, anhedral mineral that is white to very pale brownish orange that is probably altered feldspar. Remainder is aphanitic to fine-grained, light grey quartz. Approximately 0.1 mm thick, mica-rich layers occur that are typically spaced 2 to 5 mm apart. Outcrop tends to weather into 2 to 15 cm thick slabs. Moderate foliation at 075°/26°N. Small outcrop.
16HL127	501925	7108970	1210	outcrop	Quartz-muscovite-biotite schist. Light grey, light grey weathering. No distinct mineral layering but micas form foliation surfaces. Approximately 2% fine-grained, foliation parallel biotite. 5-15% silver, foliation parallel, aphanitic to fine-grained muscovite (/sericite). Remainder appears to be aphanitic to fine-grained quartz. Nil to trace amount (4 grains noted) of fine-grained, tarnished pyrite. Minor kink/chevron folds. Strong foliation at 074°/36°N. Small outcrop.
16HL128	501821	7109215	1184	outcrop	Quartz-feldspar-muscovite-biotite schist. Light grey, light grey weathering. Approximately 5% fine-grained biotite, disseminated (randomly oriented) and foliation parallel. 5-15% foliation parallel, silver to silvery yellow, aphanitic to fine-grained muscovite (/sericite). 5-20% anhedral, white feldspar commonly up to 1 mm across and rarely up to 2 mm across. Feldspar is somewhat indistinct. Nil to trace disseminated, cubic pyrite. Remainder is aphanitic to fine-grained, light grey quartz. Foliation planes are rich in micas but no overall mineral layering. Foliation at 315°/16°NE. Small outcrop.

16HL129	501741	7109317	1178	outcrop	Quartz-muscovite-biotite schist. Light to medium grey, light grey weathering. Approximately 10% fine-grained biotite, randomly oriented (disseminated) and foliation parallel. Approximately 10% silvery-yellow, foliation parallel muscovite (/sericite). Nil to trace, disseminated, fine-grained pyrite. Remainder appears to be aphanitic to fine-grained quartz. Well foliated but not layered. Foliation at 080°/18°N. Small outcrop.
16HL130	501626	7109549	1172	outcrop	Quartz-feldspar-muscovite-biotite schist. 5-10% fine-grained biotite (mainly foliation parallel). 5-15% silvery yellow, foliation parallel, aphanitic to fine-grained muscovite (/sericite). 15-25% anhedral to very rarely subhedral, white to light pinkish orange feldspar, commonly up to 1 mm across but some up to 2 mm across (note: in nearby rock the feldspar becomes indistinct). Nil to trace amounts of fine-grained pyrite. Remainder is aphanitic to fine-grained, light grey quartz. Foliation at 082°/14°N. Small outcrop.
16HL131	501460	7109785	1151	outcrop	Quartz-muscovite-biotite schist. Light to medium grey, light grey weathering. 5-10% fine-grained biotite (most is foliation parallel but some is not). 5-15% silvery pale yellow-green, foliation parallel, aphanitic to fine-grained muscovite (/sericite). Cannot identify feldspar at sample site but feldspar present in nearby rock. Remainder appears to be aphanitic to fine-grained quartz. Moderate foliation at 076°/20°N.
16HL132	501284	7110297	1083	rubble	Quartz-muscovite schist. Light brownish grey, weathers white. Approximately 95% aphanitic to fine-grained, somewhat sugary appearing quartz. Approximately 5% light silvery green, non-segregated muscovite/sericite. Very weak foliation. Sample from one of four large blocks about 1 m x 1 m x 0.1 m thick lying close together with small pieces of similar material nearby.
16HL134	501284	7110858	1082	outcrop	Quartz-muscovite schist. Very light grey, light grey to white weathering. Approximately 1% fine-grained biotite. Approximately 5% (possibly up to 10%) pale silvery green, foliation parallel muscovite/sericite, Remainder is aphanitic to fine-grained, light grey to white quartz. Foliation at 292°/18°N. Small outcrop.
16HL135	501272	7111003	1091	outcrop	Quartz-muscovite-chlorite schist. Very light grey, weathers light grey. 5-10% fine-grained, bright medium-green chlorite, disseminated, mainly foliation parallel. 5-10% silvery yellow-brown, foliation-parallel muscovite (grading into sericite). Remainder is light grey to white, aphanitic to fine-grained quartz. Moderate foliation. Outcrop tends to weather into slabs 3 to 10 cm thick. Foliation at 286°/25°N. Moderate sized outcrop trending 300°.
16HL136	501279	7111039	1092	outcrop	Quartz-muscovite-chlorite schist. Very light grey, weathers light grey. 5-10% fine to medium-grained, bright green, disseminated chlorite (foliation parallel). 5-10% pale, silvery yellow-brown, aphanitic to fine-grained muscovite/sericite (foliation parallel). Remainder is aphanitic to fine-grained, light grey to white quartz. Moderate foliation at 076°/30°N. Small outcrop.

16HL137	503265	7111145	680	outcrop	Quartz-feldspar-biotite-muscovite schist. Light grey, light grey weathering. Very weak limonitic stain on surface and some foliation planes. Approximately 10% fine-grained, foliation parallel biotite. Approximately 5% silver, fine-grained muscovite sericite grading to sericite. 10-20% white, anhedral to rarely weakly subhedral feldspar - most is somewhat elongate and augen-like. Feldspar is difficult to distinguish from quartz on fresh surfaces (feldspar is most apparent on weathered surfaces that are not parallel to foliation). Very rare (2 noted) light grey quartz eyes up to 2 mm across. Nil to trace fine-grained disseminated pyrite. Remainder is aphanitic to fine-grained, light grey to white quartz. Segregated into mica-rich laminae ≤0.1 mm thick and quartz-feldspar layers 1 to 3 mm thick. Moderate to strong foliation at 036°/82°NW. Sample from 15 m long, low outcrop trending 348° (parallel to stream) on east side of creek.
16HL138	503330	7110817	687	outcrop	Quartz-muscovite schist. Approximately 5% silver, foliation parallel, fine-grained muscovite (grading to sericite). Trace - 2% fine-grained, disseminated pyrite and/or pyrrhotite. Remainder is light grey to white, aphanitic quartz. Moderate foliation at 032°/56°NW. Small, low outcrop on east bank.
16HL139	503375	7110594	704	outcrop ?	Quartz-feldspar-muscovite schist. Light green, black weathering. Approximately 5% silver, foliation parallel, fine-grained muscovite (grading to sericite). 10-20% white, anhedral to rarely subhedral feldspar up to 3 mm long. 0.5-1% light grey quartz eyes up to 2 mm across. Remainder is light grey, aphanitic to fine-grained quartz. Strong Mn coating on weathered surface and on foliation planes. Moderate to strong foliation at 040°/66°NW. Very small, low outcrop (?), approximately 2 m exposure, on west side of creek.
16HL140	503429	7110401	713	outcrop	Quartz-biotite-muscovite schist. Light to medium grey, weathers medium grey. 5 to 15% silvery, foliation parallel, muscovite/sericite. 10 to 20% fine-grained, foliation parallel biotite. Some biotite appears to be pseudomorphic after elongate mineral (possibly amphibole). Trace to 1% aphanitic to fine-grained chlorite. 1-3% fine-grained, disseminated pyrite. Remainder is light grey, aphanitic to fine-grained quartz. No significant mineral segregation (layering). Not magnetic. Weak to moderate foliation at 060°/20°NW. Small to medium sized outcrop about 20 m above stream on west bank. Nearby rock contains minor calcite veining.
16HL141	503473	7110290	699	outcrop	Quartz-biotite-(muscovite-chlorite) schist. Light to medium grey, medium grey weathering. Outcrop is strongly foliated to schistose. 10-30% fine-grained biotite (most is foliation parallel). About 5% silvery brown, fine-grained muscovite. 1 to 5% aphanitic to fine-grained chlorite. Remainder is aphanitic, light grey quartz (± feldspar). Foliation near sample site is 070°/74°N. Dip of foliation changes from shallow dips near the north end to very steep dips near the south end. Tight isoclinal folding (chevron folding) is evident at cm to 10's of cm scale and at metre scale. Plunge of fold axes is approximately 10° toward 245°. At south end of outcrop foliation dips steeply south on south side of isoclinal antiform. Two intervals of much more felsic, light grey, light grey weathering rock, thought to represent more siliceous beds, lie parallel to foliation - these are 10 cm thick (upper) and 18 cm thick (lower). Attitude of lower layer is 072°/76°N (about 1 m north of sample site). Very large outcrop on east bank of stream.

16HL142	503488	7110265	713	outcrop	Quartz-muscovite-biotite schist. Light greenish-grey, light rusty brown weathering (limonitic stain). 10-15% pale silvery green, aphanitic to fine-grained, foliation parallel muscovite/sericite. Approximately 5% fine-grained, disseminated, foliation parallel biotite (possibly after amphibole). Approximately 1% hairline to 1 mm Fe-carbonate veinlets. Remainder is aphanitic, light grey quartz (± feldspar). Moderate to strong foliation. Small scale folding evident. Average foliation at approximately 094°/54°N. Small outcrop on east bank about 10 m above stream.
16HL143	503453	7110267	714	outcrop	Quartz-Fe-carbonate-fuchsite alteration zone. Lower part of outcrop (sampled). Light greenish-grey, weathers rusty brown (Fe-carbonate weathering to Fe-oxide) to locally black (Mn-oxide). Approximately 5% bright, light to medium green fuchsite along somewhat irregular foliation surfaces. Remainder is a mixture of aphanitic, white to light grey quartz and aphanitic, white Fe-carbonate in irregular domains. No sulphides noted. Weak, irregular foliation. Upper part of outcrop (not sampled) is similar to 16HL142 with a moderate to strong foliation at 026°/32°NW. Contact between upper and lower lithologies appears gradational. Small to medium sized outcrop on west band extending upwards from stream for about 10 m.
16HL144	503541	7110129	717	outcrop	Quartz-biotite-muscovite schist. Medium grey, medium grey weathering. 15 to 25% fine-grained, foliation parallel biotite. 10 to 20% foliation parallel, aphanitic to fine-grained, silver muscovite (/sericite). Trace to 1% fine-grained, disseminated pyrite or pyrrhotite. Remainder is aphanitic, light grey quartz (± feldspar). Strong calcite alteration (veinlets and disseminated). Moderate to strong foliation at 064°/30°NW. Large outcrop on east bank about 50 m long x 20 m high - appears relatively homogeneous.
16HL145	503303	7112001	654	outcrop	Quartz-muscovite-biotite-(chlorite) schist. Light grey, weathers light grey to weakly rusty brown (limonitic stain). 5-10% fine-grained biotite. 5-10% silver, aphanitic to fine-grained muscovite (/sericite). 1-2% medium green, fine-grained chlorite. Trace to 1% light grey quartz eyes up to 2 mm across that are slightly elongate parallel to foliation. 2-4% fine to medium-grained pyrite, some cubic, commonly along very discontinuous bands parallel to foliation. Remainder is aphanitic to fine-grained, light grey to white quartz. Moderate to strong foliation at 070°/44°N. Sample site is near contact between more competent rock above (sampled) and zone of bleached, very incompetent (friable) rocks below with moderate limonitic stain. Small to medium sized outcrop on east side of Moose Creek.
16HL146	503385	7112280	639	outcrop	Quartz-muscovite-biotite schist. Light grey, light grey to light brown weathering (weak limonitic stain). 5-15% silver, aphanitic to fine-grained muscovite, foliation parallel, bordering on sericite. 2-5% fine-grained, foliation parallel biotite. Very weak, spotty limonite. Trace to 1% light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained, light grey to white quartz. Moderate to strong foliation at 072°/62°S. Small outcrop on east side of stream near water level.

16HL147	503497	7112578	640	outcrop	Quartz-muscovite-(biotite) schist. Very light grey, light brown (limonite stain) weathering. 10-15% silver, foliation parallel, aphanitic to fine-grained muscovite (/sericite). 1-3% fine-grained biotite (some randomly oriented, some foliation parallel). 2-4% fine to medium-grained, disseminated pyrite (some cubic). Remainder is aphanitic to fine-grained, light grey to white quartz. Strong foliation at 060°/74°S. Small outcrop on east side of creek just above water level.
16HL148	503507	7112622	640	outcrop	Quartz-feldspar-muscovite schist. Very light grey to white, light rusty brown weathering (Fe-oxide stain). Approximately 5% silver, aphanitic to fine-grained muscovite (/sericite); 1-2% disseminated, fine to medium-grained pyrite (some cubes). 1-3% light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained mixture of light grey quartz and white feldspar. Moderate foliation at 080°/76°N. Small outcrop on east side of creek just above water level.
16HL149	503504	7112781	637	outcrop	Quartz-feldspar-muscovite-biotite-(chlorite) schist. Medium grey, light to medium grey weathering. 10-15% fine-grained, foliation parallel biotite (some possibly after amphibole). 2-4% fine grained, medium green chlorite. 10-15% silver, aphanitic to fine-grained muscovite (bordering on sericite). Approximately 10% very distinct, light grey (to light bluish grey) quartz eyes up to 2 mm across. Trace disseminated, fine grained pyrite. Remainder is mixture of aphanitic to medium-grained, anhedral, light grey quartz and anhedral, white feldspar. No mineral segregation into layers. Weak to moderate foliation at 008°/60°E. Small outcrop on east bank near stream level.
16HL150	503559	7113070	637	outcrop	Quartz-muscovite schist. Approximately 10% bright silver, aphanitic to fine-grained muscovite (bordering on sericite). Trace disseminated, fine-grained pyrite. Remainder appears to be aphanitic to fine-grained, light grey to white quartz. "Hints" of possible feldspar on joint surfaces (anhedral, up to 2 mm across, soft). Moderate to strong foliation at 048°/56°NW. Small to moderate sized outcrop on east bank at water level.
16HL151	503576	7113214	624	outcrop	Quartz-feldspar-muscovite-biotite schist. Light grey, light grey weathering. Approximately 5% fine-grained biotite - most occurs in clusters up to 2 mm across (possibly replacing hornblende). Approximately 5% silver, foliation parallel, aphanitic to fine-grained muscovite (/ sericite). 10-20% white, hard, disseminated, anhedral to weakly subhedral feldspar up to 3 mm across. 5-10% light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained, light grey quartz. Weak to moderate foliation at 050°/75°NW. Outcrop locally contains rare pyrite cubes up to 8 mm across (not in sample). Small outcrop on east side of creek near water level.
16HL152	503637	7113280	622	outcrop	Quartz-feldspar-muscovite schist. Light grey, light grey weathering. 5-10% silver, foliation parallel, aphanitic to fine-grained muscovite (/sericite). 10-15% competent, white, euhedral feldspar up to 3 mm across. Approximately 5% light grey quartz eyes up to 3 mm across (but commonly up to 2 mm across). 1-2% fine-grained, disseminated pyrite. Strong foliation at 086°/54°N. Small outcrop on east bank that extends upwards for about 8 m from water level.

16HL153	503634	7113388	619	outcrop	Quartz-feldspar-biotite-muscovite-(chlorite) schist. Light grey, light grey weathering. 5-10% blebby (blebs up to 3 mm across) fine-grained biotite. 5-10% foliation parallel, silver, aphanitic-fine grained muscovite. 1-2% fine-grained, foliation parallel, bright, medium green chlorite. Trace disseminated, fine-grained pyrite (some cubes). Remainder is aphanitic material containing light grey quartz and probably feldspar (white). "Hints" of feldspar on weathered surface. Strong foliation at 104°/58°N. Small outcrop on east bank near water level.
16HL154	503712	7113748	611	outcrop	Quartz-feldspar-muscovite schist. Light grey, light grey to light rusty brown weathering (limonitic stain). Approximately 5% silver, foliation parallel, aphanitic to fine-grained muscovite. Trace to 1% fine-grained, disseminated pyrite. Remainder is aphanitic, light grey to white material probably composed of both quartz and feldspar. Weak to moderate foliation at 108°/72°N. Small outcrop (and abundant related rubble) at water level on east bank of creek just upstream (south) of tributary flowing in from east (note: map on GPS unit shows this spot as being below (north) of tributary).
16HL155	503277	7111838	666	alluvial boulder	Basalt (boulder). The rock (boulder) that hosts the olivine-rich nodules of sample 16HL301 (nodules excluded from rock geochemical sample). Black (fresh) and weathers medium to dark greyish-green. Aphanitic to fine-grained. Round to irregular amygdules of aphanitic, white calcite up to 14 x 8 mm but most are 1 to 4 mm across (some show evidence of filling inward from edges). Amygdules weather light brown (Fe-oxide stain) so probably contain some iron (but most react strongly to dilute HCL without scratching/powdering). Also, moderate to strong, hairline fracture-controlled and spotty calcite. Rock is uniformly moderately to strongly magnetic. Weathered surface of boulder is "pockmarked" with irregular to round cavities, some Fe-oxide bearing, where calcite amygdules have weathered out. Approximately 0.5% disseminated, anhedral to weakly subhedral, pale green olivine phenocrysts (or xenocrysts) up to 2 mm across. Boulder is massive (i.e. not foliated). Boulder on east bank of Moose Creek. Approximately 45 x 40 x >25 cm. Subround.
16HL156	503240	7111647	669	outcrop	Basalt. Black (fresh surface), medium to dark (weakly greenish) grey to locally medium rusty brown (limonitic Fe-oxide stain) weathering. Aphanitic to fine-grained. Trace disseminated pyrrhotite. Rounded, spherical to oval (elongate about 2:1) amygdules of white, fine-grained calcite up to 10 x 5 mm. Rock also contains a moderate amount of fine-grained, disseminated, spotty calcite. Trace to 0.5% lenses/blebs/domains of pale medium green soft material (possibly altered olivine) up to 5 mm across - these tend to have calcite rims. Rare (trace to 0.25%), anhedral to subhedral, hard, medium green olivine crystals up to 2 mm across. Weathered surface displays vesicular appearance where amygdules have weathered out. Outcrop is strongly jointed (multidirectional - possibly cooling joints) but is not foliated. Rock looks quite similar to 16HL155 except for lack of nodules. Rock is moderately magnetic. One example noted of anhedral, glassy, black mineral up to 3 mm across with hardness of about 4 to 5 containing white streaks. This mineral has a pale greenish-white rim (reaction rim?) that is not calcite. Prominent outcrop about 10 m across and 10 m high on east bank of stream. Just north (downstream) of this outcrop, and seeming to emanate from same hillside (under overburden cover) are numerous boulders of similar material except that some of these

					contain abundant country rock xenoliths (felsic schist).
16HL157	503290	7111380	681	outcrop	Quartz-feldspar-muscovite-biotite schist. Light to medium grey, light to medium grey to limonitic brown weathering (Fe-oxide stain). Approximately 10% fine-grained, foliation parallel biotite. Approximately 10% foliation parallel, aphanitic to fine-grained silver muscovite. Trace disseminated pyrite (or pyrrhotite). Remainder is aphanitic to fine-grained mixture of light grey quartz and white feldspar. Some quartzofeldspathic material occurs in augen commonly up to 5 mm across. Strong foliation at 060°/36°NW. Small to medium sized outcrop on east bank about 20 m above stream. Parts of outcrop (not sampled) are more strongly foliated (very strong), friable and stained by limonite.
16HL158	503271	7111286	677	outcrop?	Quartz-muscovite schist. Light grey, light grey weathering. Approximately 10% foliation parallel, silver muscovite. Approximately 5% disseminated, bright, orange-brown, poorly formed specks up to 1 mm across that may be an incipient metamorphic mineral (staurolite?). Remainder is light grey to white, aphanitic to fine-grained quartz. Strong foliation (at 028°/58°E but may be slumped block). Small outcrop or slumped block, 3 x 2 m exposure on east bank about 5 m above stream.
16HL159	503305	7111332	693	outcrop	Quartz-feldspar-muscovite-(biotite) schist. Light to medium grey, light to medium grey weathering. Approximately 10% foliation parallel, aphanitic to fine-grained muscovite. Approximately 2% foliation parallel, fine-grained biotite. Remainder is aphanitic to fine-grained mixture of light grey quartz and white, anhedral feldspar. Some quartzofeldspathic material occurs in boudins/lozenges up to 11 mm long x 4 mm thick. Strong foliation at 066°/20°NW. Small outcrop on east side of stream about 30 m above water level at the top of small slump/slide.
16HL160	503234	7111533	667	alluvial boulder	Basalt (boulder). Subangular to angular. About 42 x 27 x >20 cm. Xenolith-bearing (see 16HL302) - xenoliths excluded from rock geochemical sample. Black, dark grey weathering. Aphanitic to fine-grained. 0.5 - 1% pale yellow-green to pale green anhedral olivine (disseminated). 2 to 4%, white, calcite amygdules up to 40 x 15 mm. Weathered surface appears moderately vesicular (probably do to weathering of calcite amygdules). Olivine-bearing xenoliths (nodules) are rounded. No other xenolith types noted. Boulder on east bank just above stream level.
16HL161	503238	7111556	668	alluvial boulder	Basalt (boulder). Subangular to angular. About 40 x 40 x >25 cm. Dark grey, minor Fe-oxide on surface (Fe-carbonate weathering?). Weakly vesicular appearance - probably weathered calcite amygdules. Contains mantle nodules (see sample 16HL303) - nodules excluded from rock geochemical sample. On east bank about 1 m above stream level.

16HL162	500150	7108601	929	boulder	Quartz-muscovite-(biotite) schist. Light grey fresh surface (weathered surface is lichen covered). 10-20% foliation parallel, pale green, aphanitic to fine-grained muscovite/sericite. Approximately 2% fine-grained, foliation parallel biotite. Trace to 0.25% (rare), very distinct, round, light grey quartz eyes up to 2 mm across. Remainder is aphanitic to fine-grained, light grey quartz. Weak limonite alteration - spotty and foliation controlled. Weak foliation. Subround to subangular boulder (of which area 30 cm across is exposed).
16HL163	500482	7108656	856	outcrop	Quartz-muscovite-biotite schist. Medium grey, medium grey weathering. 10-20% silver, foliation parallel, aphanitic to fine-grained muscovite. 10-20% fine-grained biotite that occurs (a) disseminated (foliation parallel) and (b) as a replacement of a long, prismatic mineral up to 10 x 1 mm (possibly amphibole). Approximately 5% light grey quartz eyes up to 3 mm across (some with pressure shadows of aphanitic quartz) - most is somewhat elongate (oval) with length to thickness ratios of 1.5:1 to 2:1. Remainder is aphanitic to fine-grained, light grey quartz. Moderate foliation at 022°/26°W (but may be slumped). Small outcrop or slump block. This sample is very similar to 16HL115.
16HL164	503232	7111813	661	outcrop	Quartz-muscovite-biotite schist. Light to medium grey, light grey to light brown weathering (weak limonitic stain). Approximately 10% silver to pale green, foliation parallel, aphanitic to fine-grained muscovite/sericite (muscovite/sericite appears silver on foliation surfaces but pale green on freshly broken surfaces). Approximately 5% fine-grained biotite - both foliation parallel and random orientations. Weak spotty and foliation-controlled limonite. Remainder is aphanitic to fine-grained, light grey to white quartz. Strong foliation at 054°/26°NW. Small to medium sized outcrop above road on west side of Moose Creek.
16HL201	503259	7111257	680	alluvial clast	Quartz-Fe-carbonate vein material. Alluvial clast near east stream bank. Approximately 40 x 10 x 10 cm. Very angular. Light grey, weathers dark rusty brown. Approximately 90% aphanitic, light grey quartz. Approximately 10% white, aphanitic Fe-carbonate. Overall about 1 to 2% fine-grained disseminated pyrite - mainly within Fe-carbonate. Fe-carbonate occurs as veinlets up to 5 mm wide within quartz.
16HL202	503281	7111084	677	alluvial clast	Quartz-(Fe-carbonate) vein material. Angular alluvial clast, 25 x 20 x 10 cm. Light grey, weathers dark rusty brown. Mainly aphanitic, light grey quartz. Trace to 1% fine-grained pyrrhotite (weakly magnetic), disseminated and in small blebs, plus minor cubic pyrite.
16HL203	503361	7110614	696	alluvial clast	Quartz vein material. Subangular alluvial clast approximately 15 x 10 x 5 cm. Light grey, rusty brown (Fe-oxide stain) weathering. Nearly pure, light grey, aphanitic quartz. 3-5% disseminated (to very locally blebby), fine-grained pyrite up to 1 mm across (commonly cubic). Sample site is approximately opposite very old log cabin on east bank.
16HL204	503231	7111508	674	alluvial clast	Quartz vein material. Angular clast about 15 x 10 x 10 cm. White, aphanitic. Mainly barren appearing with weak limonitic stain. One area (sampled) contains two types of pyrite: aphanitic pyrite in pods/blebs and fine-grained pyrite in hairline veinlets that cut the aphanitic pods and blebs. Fracture-controlled, fine-grained, silver muscovite occurs near pyrite. Located on longitudinal bar near centre of stream channel.

16HL205	503246	7111501	668	alluvial clast	Quartz-muscovite schist clast. Subround clast about 12 x 10 x 3 cm. 5-15% blebby and disseminated, fine-grained pyrite. Light grey, rusty brown (limonitic) weathering. Located on east side of stream near bank.
16HL301	503277	7111838	666	xenolith in alluvial boulder	Mantle xenolith (nodule) in basalt boulder (boulder is sample 16HL155). Five olivine-bearing nodules visible on surface of boulder (30 x 15 mm; 25 x 15 mm; 40 x 25 mm; 80 x 70 mm; 50 x 30 mm). Sample is of 40 x 25 mm nodule composed mainly of fine to medium-grained (<1 to 2 mm) anhedral, pale yellow-green olivine. Approximately 5% anhedral, black, hard, somewhat glassy mineral up to 2 cm across that streaks white (spinel). Approximately 1% bright, medium green, anhdedral, fine-grained (<1 to 1 mm) diopside (possibly Cr-diopside). Nodule is not magnetic. Overall colour of freshly broken nodule is pale green. Weathered surface and weathering rind (up to 8 mm thick) of nodule are medium brown (Fe-oxide stain) suggesting presence of an Fe-bearing mineral. See 16HL155 for description of host rock (boulder).
16HL302	503234	7111533	667	xenolith in alluvial boulder	Mantle xenolith (nodule) in basalt boulder (boulder is sample 16HL160). Six olivine-diopside xenoliths noted on surface of boulder (35 x 15 mm; 40 x 30 mm; 20 x 10 mm; 60 x 35 mm; 15 x 12 mm; 50 x 30 mm). Sample is of 40 x 30 mm nodule (similar to 16HL301). See 16HL160 for description of host rock (boulder).
16HL303	503238	7111556	668	xenolith in alluvial boulder	Mantle xenolith (nodule) in basalt boulder (boulder is sample 16HL161). Twelve olivine-diopside xenoliths noted (25 x 18 mm; 15 x 8 mm; 12 x 6 mm; 17 x 12 mm; 40 x 25 mm; 25 x 8 mm; 18 x 12 mm; 20 x 11 mm; 17 x 8 mm; 75 x 40 mm (most eroded, only veneer remains); 17 x 10 mm; 60 x 27 mm). Sample is of 40 x 25 mm nodule. Similar to 16HL301. See 16HL161 for description of host rock (boulder).

Appendix 2

Analytical Methods

Rock Geochemistry

Laboratory

Rock sample geochemical analyses were performed at MS Analytical of Langley, British Columbia. This laboratory meets (or exceeds) the requirements outlined in the ISO 9001 and ISO/IEC 17025 standards. The method descriptions outlined below were provided by MS Analytical.

Method Code PRP-910
Sample Preparation

The sample is dried, crushed to 70% passing 2mm, and then passed through a riffle splitter to obtain a homogenized, representative split of 250 g. This sub-sample is then pulverized with a ring and puck (chrome steel) until 85% is less than 75 microns in size. The aliquot for analysis is taken from this material.

Method Code WRA-310 (*included in WRA-330*)
MULTI-ELEMENT DETERMINATION OF MINERALOGICAL SAMPLES USING A LITHIUM BORATE FUSION AND ICP-OES FINISH

A 0.15 g pulverised subsample is decomposed using lithium borate fusion. During fusion, material is heated in a muffle furnace at 1000° C with lithium borate flux. The fused sample is then cooled and dissolved in 4% nitric acid. The resulting solution is analyzed by Inductively Coupled Plasma-Optical Emission Spectroscopy and the quantified concentrations of the following elements, reported as oxides, is reported (each with an analytical range of 0.01% to 100%):

SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, Cr_2O_3, BaO, SrO

Loss on ignition (LOI) at 1000° C and the “Total” (sum of oxides and LOI) are also reported.

Method Codes LOI-1000 (*included in WRA-330*)
DETERMINATION OF LOSS ON IGNITION IN MINERALOGICAL SAMPLES

1 g of pulverised subsample is weighed into a crucible, placed in an oven or furnace at 1000° C for one hour, cooled and then weighed again. The loss on ignition is calculated from the difference in weight.

Method Code SPM-512 (*included in WRA-330*)
DETERMINATION OF TOTAL CARBON AND SULFUR IN MINERALOGICAL SAMPLES

0.3 g of pulverised subsample is weighed into a ceramic crucible and analyzed for total carbon and sulphur using a LECO analyzer. Iron and tungsten accelerators are added to the sample and a stream of oxygen is passed over the sample in the induction furnace. As the sample is heated, carbon dioxide and sulfur dioxide released from the sample are measured by an IR detection system and the total contents of carbon and sulphur are determined. The analytical range is 0.01 to 50% for carbon and 0.01 to 20% for sulphur.

Method Code IMS-300 (*included in WRA-330*)
MULTI-ELEMENT DETERMINATION OF MINERALOGICAL SAMPLES USING A LITHIUM BORATE FUSION AND ICP-MS FINISH

A 0.15 g pulverised subsample is decomposed using lithium borate fusion. During fusion, weighed samples are heated in a muffle furnace at 1000° C with lithium borate flux. The fused sample is then cooled and dissolved in 4% nitric acid. The resulting solution is analyzed by Inductively Coupled Plasma-Mass Spectroscopy and the quantified multi-element concentrations reported as noted in the table below.

Element	Range (ppm)	Element	Range (ppm)	Element	Range (ppm)
Ba	0.5 – 10000	Ho	0.01 – 1000	Ta	0.1 – 10000
Ce	0.5 – 10000	La	0.5 – 10000	Tb	0.01 – 1000
Cr	10 – 10000	Lu	0.01 – 1000	Th	0.05 – 1000
Cs	0.01 – 10000	Nb	0.2 – 10000	Tm	0.01 – 1000
Dy	0.05 – 1000	Nd	0.1 – 10000	U	0.05 – 2000
Er	0.03 – 1000	Pr	0.03 – 2000	V	5 – 5000
Eu	0.03 – 1000	Rb	0.2 – 10000	W	1 – 10000
Ga	0.1 – 1000	Sm	0.03 – 1000	Y	0.5 – 10000
Gd	0.05 – 1000	Sn	1 – 10000	Yb	0.03 – 1000
Hf	0.2 – 10000	Sr	0.1 – 10000	Zr	2 – 5000

Method Code IMS-130

MULTI-ELEMENT DETERMINATION OF MINERALOGICAL SAMPLES USING A TWO ACID (AQUA REGIA) DIGESTION AND ICP-AES/MS FINISH

The pulverised subsample is weighed (0.15 g) and digested under heat with a hydrochloric acid and nitric acid mixture in a 3:1 ration (aqua regia). Upon completion of the digestion step, the sample is made up to volume with deionized water. This sample solution is then analyzed by Inductively Coupled Plasma-Atomic Emission Spectroscopy and Inductively Coupled Plasma Mass Spectrometry. The quantified element concentrations are reported as noted in the following table. The values for Al, B, Ba, Ca, Cr, Fe, K, Mg, Mn, Na, P, S, Ti and Zn are always reported based on ICP-AES data. The remaining elements are typically reported based on ICP-MS data but this may vary depending upon concentration ranges. Note that aqua regia digestion may provide only partial recovery for some elements, including (but not limited to): Al, Ba, Ca, Cr, Hf, K, La, Mg, Na, Nb, P, Sc, Sr, Ta, Ti, Tl, W and Zr.

Element	Range	Element	Range	Element	Range
Ag	0.01-100 ppm	Ge	0.05-500 ppm	S	0.01-10%
Al	0.01-25%	Hf	0.02-500 ppm	Sb	0.05-10,000 ppm
As	0.1-10,000 ppm	Hg	0.01-10,000 ppm	Sc	0.1-10,000 ppm
Au	0.005-25 ppm	In	0.005-500 ppm	Se	0.2-1,000 ppm
B	10-10,000 ppm	K	0.01-10%	Sn	0.2-500 ppm
Ba	10-10,000 ppm	La	0.2-10,000 ppm	Sr	0.2-10,000 ppm
Be	0.05-1,000 ppm	Li	0.1-10,000 ppm	Ta	0.01-500 ppm
Bi	0.01-10,000 ppm	Mg	0.01-25%	Te	0.01-500 ppm
Ca	0.01-25%	Mn	5-50,000 ppm	Th	0.2-10,000 ppm
Cd	0.01-1,000 ppm	Mo	0.05-10,000 ppm	Ti	0.005-10%
Ce	0.02-500 ppm	Na	0.01-10%	Tl	0.02-10,000 ppm
Co	0.1-10,000 ppm	Nb	0.05-500 ppm	U	0.05-10,000 ppm
Cr	1-10,000 ppm	Ni	0.2-10,000 ppm	V	1-10,000 ppm
Cs	0.05-500 ppm	P	10-10,000 ppm	W	0.05-10,000 ppm
Cu	0.2-10,000 ppm	Pb	0.2-10,000 ppm	Y	0.05-500 ppm
Fe	0.01-50%	Rb	0.1-10,000 ppm	Zn	2-10,000 ppm
Ga	0.05-10,000	Re	0.001-50 ppm	Zr	0.5-500 ppm

Appendix 3

Analytical Results

Rock Geochemistry

MS Analytical
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To: **Glen Prior**
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CERTIFICATE OF ANALYSIS:	**MA0090-OCT16**

Project Name:	HL
Job Received Date:	27-Oct-2016
Job Report Date:	14-Nov-2016
Report Version:	Final

COMMENTS:

Test results reported relate only to the samples as received by the laboratory.Unless otherwise stated above, sufficient sample was received for the methods requested and all samples were received in acceptable condition. Analytical results in unsigned reports marked "preliminary" are subject to change, pending final QC review. Please refer to MS Analyticals' *Schedule of Services and Fees* for our complete Terms and Conditions

SAMPLE PREPARATION	
METHOD CODE	DESCRIPTION
PRP-910	Dry, Crush to 70% passing 2mm, Split 250g, Pulverize to 85% passing 75µm

ANALYTICAL METHODS	
METHOD CODE	DESCRIPTION
WRA-330	Whole Rock, C & S, Refractories and Rare Earth Elements
IMS-130	Multi-Element, 0.5g, 3:1 Aqua Regia, ICP-AES/MS, Ultra Trace Level

Signature:

Jimbo Zheng BSc., PChem, BC Certified Assayer
Senior Analytical Chemist
MS Analytical

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To: **Glen Prior**
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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	Sample Type	PWE-100 Rec. Wt. kg 0.01	Method Analyte Units LOR	SPM-512 TC % 0.01	SPM-512 TS % 0.01	WRA-310 Al2O3 % 0.01	WRA-310 BaO % 0.01	WRA-310 CaO % 0.01	WRA-310 Cr2O3 % 0.01	WRA-310 Fe2O3 % 0.01	WRA-310 K2O % 0.01	WRA-310 MgO % 0.01	WRA-310 MnO % 0.01
16HL101	Rock	0.28		0.10	0.04	12.12	0.28	0.19	0.02	4.32	2.30	5.82	0.06
16HL102	Rock	0.30		0.06	<0.01	12.43	0.21	0.23	0.02	3.88	2.87	2.17	0.04
16HL103	Rock	0.34		0.03	<0.01	12.55	0.27	0.04	0.01	1.51	3.26	1.05	0.02
16HL104	Rock	0.47		0.06	<0.01	11.95	0.22	0.10	0.02	2.33	2.76	0.76	0.02
16HL105	Rock	0.43		0.03	<0.01	12.31	0.24	0.68	0.01	1.31	1.97	0.63	0.01
16HL106	Rock	0.41		0.03	<0.01	11.05	0.27	0.29	0.02	2.24	4.03	2.11	0.04
16HL107	Rock	0.59		0.05	<0.01	10.02	0.21	0.90	0.02	2.05	2.35	0.86	0.04
16HL108	Rock	0.51		0.01	<0.01	14.71	0.30	2.13	0.01	3.13	2.60	1.12	0.06
16HL109	Rock	0.56		<0.01	0.94	7.72	0.05	0.13	0.03	3.01	1.90	1.33	0.06
16HL110	Rock	0.25		<0.01	0.84	11.38	0.06	0.21	0.03	5.41	2.22	4.49	0.10
16HL111	Rock	0.36		0.31	0.04	11.71	0.09	0.22	0.03	9.14	2.39	4.02	1.25
16HL112	Rock	0.43		0.03	0.28	12.52	0.14	0.23	0.02	3.82	2.91	3.90	0.07
16HL113	Rock	0.46		<0.01	0.22	11.34	0.10	0.20	0.02	3.10	2.65	3.87	0.07
16HL114	Rock	0.91		0.02	4.52	8.08	0.07	0.16	0.03	5.57	2.47	0.67	0.04
16HL115	Rock	0.54		0.50	<0.01	14.06	0.20	3.36	0.02	4.91	3.68	1.46	0.13
16HL116	Rock	0.64		0.29	0.01	13.69	0.13	2.57	0.02	4.50	2.01	1.22	0.13
16HL117	Rock	0.51		0.47	0.24	13.42	0.28	1.95	0.02	3.69	4.74	0.93	0.10
16HL118	Rock	0.47		0.55	0.04	12.79	0.21	2.43	0.02	3.66	3.44	0.75	0.08
16HL119	Rock	0.31		0.08	0.03	10.94	0.06	0.06	0.02	3.22	2.02	5.25	0.05
16HL120	Rock	0.32		0.05	<0.01	11.78	0.16	0.20	0.02	4.89	2.03	5.10	0.07
16HL121	Rock	0.34		0.02	0.45	11.53	0.20	0.07	0.07	5.19	1.83	4.84	0.06
16HL122	Rock	0.36		0.07	<0.01	11.33	0.27	0.04	0.02	1.53	3.54	3.03	0.02
16HL123	Rock	0.41		0.03	<0.01	13.39	0.31	0.22	0.01	2.26	2.52	3.49	0.03
16HL124	Rock	0.43		0.03	<0.01	12.47	0.46	2.01	0.02	3.76	3.65	1.09	0.07
16HL125	Rock	0.40		0.01	<0.01	15.79	0.28	3.38	0.01	3.55	2.62	0.86	0.06

***Please refer to the cover page for comments regarding this certificate. ***

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	Sample Type	PWE-100 Rec. Wt. kg 0.01	Method Analyte Units LOR	SPM-512 TC % 0.01	SPM-512 TS % 0.01	WRA-310 Al2O3 % 0.01	WRA-310 BaO % 0.01	WRA-310 CaO % 0.01	WRA-310 Cr2O3 % 0.01	WRA-310 Fe2O3 % 0.01	WRA-310 K2O % 0.01	WRA-310 MgO % 0.01	WRA-310 MnO % 0.01
16HL126	Rock	0.47		0.05	<0.01	10.03	0.24	0.55	0.02	2.50	2.96	1.28	0.04
16HL127	Rock	0.36		<0.01	<0.01	11.88	0.29	0.95	0.01	1.64	2.48	0.74	0.02
16HL128	Rock	0.42		<0.01	<0.01	15.68	0.29	1.59	0.02	3.23	3.39	0.88	0.04
16HL129	Rock	0.37		0.03	<0.01	16.36	0.51	1.48	0.02	3.76	4.84	1.99	0.07
16HL130	Rock	0.33		0.03	<0.01	13.92	0.21	2.12	0.01	3.35	2.98	0.88	0.05
16HL131	Rock	0.35		<0.01	<0.01	14.68	0.32	2.09	0.02	3.68	4.42	0.96	0.07
16HL132	Rock	0.30		<0.01	<0.01	13.37	0.32	2.84	0.02	2.04	4.79	0.45	0.03
16HL134	Rock	0.34		<0.01	<0.01	8.69	0.24	1.06	0.02	1.70	2.60	0.77	0.03
16HL135	Rock	0.36		<0.01	<0.01	13.03	0.20	1.40	0.01	2.74	1.85	2.18	0.04
16HL136	Rock	0.37		<0.01	<0.01	12.92	0.22	3.23	0.01	2.84	1.96	1.19	0.05
16HL137	Rock	0.44		<0.01	0.03	11.09	0.21	0.13	0.02	2.00	1.52	0.63	0.03
16HL138	Rock	0.39		0.01	1.33	9.92	0.24	0.05	0.01	2.00	3.33	0.67	0.01
16HL139	Rock	0.38		0.31	0.24	12.61	0.04	0.35	0.01	2.64	2.71	0.68	0.05
16HL140	Rock	0.45		0.22	0.69	13.39	0.07	3.18	0.01	6.51	1.57	3.26	0.09
16HL141	Rock	0.43		0.41	0.09	15.85	0.27	3.19	0.01	9.25	2.43	7.16	0.10
16HL142	Rock	0.36		2.22	<0.01	13.98	0.15	1.88	<0.01	8.28	1.49	5.51	0.12
16HL143	Rock	0.43		3.29	0.04	8.96	0.04	7.31	0.09	4.06	0.62	4.06	0.11
16HL144	Rock	0.40		1.28	0.40	14.09	0.05	8.01	0.03	8.91	1.50	6.64	0.18
16HL145	Rock	0.57		0.02	0.84	13.91	0.10	0.43	0.01	3.21	0.86	2.35	0.04
16HL146	Rock	0.47		0.07	<0.01	10.87	0.30	0.13	0.02	1.67	2.95	0.77	0.03
16HL147	Rock	0.50		<0.01	0.63	11.36	0.31	0.07	0.02	1.51	2.16	0.80	0.01
16HL148	Rock	0.47		0.80	0.44	10.46	0.06	0.26	0.02	3.92	0.86	1.17	0.07
16HL149	Rock	0.63		<0.01	<0.01	10.91	0.11	0.41	0.02	4.57	1.75	3.06	0.07
16HL150	Rock	0.48		<0.01	<0.01	12.56	0.28	0.05	0.01	1.41	3.35	0.91	0.02
16HL151	Rock	0.40		<0.01	0.20	10.87	0.28	0.12	0.03	3.03	3.47	2.09	0.04

***Please refer to the cover page for comments regarding this certificate. ***

MS Analytical
An A2 Global Company

MS Analytical
Unit 1, 20120 102nd Avenue
Langley, BC V1M 4B4
Phone: +1-604-888-0875

To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	Sample Type	PWE-100 Rec. Wt. kg 0.01	Method Analyte Units LOR	SPM-512 TC % 0.01	SPM-512 TS % 0.01	WRA-310 Al2O3 % 0.01	WRA-310 BaO % 0.01	WRA-310 CaO % 0.01	WRA-310 Cr2O3 % 0.01	WRA-310 Fe2O3 % 0.01	WRA-310 K2O % 0.01	WRA-310 MgO % 0.01	WRA-310 MnO % 0.01
16HL152	Rock	0.49		0.17	0.18	10.28	0.23	0.09	0.02	2.21	3.12	1.11	0.03
16HL153	Rock	0.41		<0.01	0.09	12.41	0.17	0.07	0.02	1.75	1.93	1.17	0.03
16HL154	Rock	0.56		0.09	0.11	13.83	0.23	0.19	0.01	1.03	6.83	0.17	0.03
16HL155	Rock	0.35		1.04	<0.01	11.86	0.07	11.41	0.07	12.61	1.51	8.49	0.19
16HL156	Rock	0.68		0.23	0.03	12.80	0.06	9.40	0.04	12.90	1.94	10.21	0.16
16HL157	Rock	0.47		0.27	0.21	12.64	0.12	2.54	0.02	3.94	1.54	1.28	0.12
16HL158	Rock	0.48		0.05	<0.01	13.16	0.27	0.09	0.02	2.79	4.88	1.22	0.04
16HL159	Rock	0.40		0.06	0.34	13.53	0.17	1.77	0.02	3.27	2.11	0.75	0.08
16HL160	Rock	0.27		0.53	<0.01	11.63	0.07	9.60	0.07	12.72	1.34	9.40	0.17
16HL161	Rock	0.48		0.71	<0.01	11.68	0.06	9.92	0.07	12.62	1.37	9.08	0.17
16HL162	Rock	0.40		0.06	<0.01	9.97	0.04	0.03	0.02	3.15	1.19	6.71	0.08
16HL163	Rock	0.40		0.03	0.03	13.51	0.26	1.84	0.03	6.46	3.73	2.17	0.13
16HL164	Rock	0.40		0.14	<0.01	13.97	0.29	0.40	0.02	3.00	5.14	2.35	0.05
16HL201	Rock	0.37											
16HL202	Rock	0.27											
16HL203	Rock	0.37											
16HL204	Rock	0.14											
16HL205	Rock	0.39											
DUP 16HL124													
DUP 16HL137													
DUP 16HL103				0.03	<0.01								
DUP 16HL160				0.53	<0.01								
DUP 16HL102						12.49	0.21	0.24	0.01	3.90	2.88	2.15	0.04

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To: **Glen Prior**
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Sherwood Park, Alberta
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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	Sample Type	PWE-100 Rec. Wt. kg 0.01	Method Analyte Units LOR	SPM-512 TC % 0.01	SPM-512 TS % 0.01	WRA-310 Al2O3 % 0.01	WRA-310 BaO % 0.01	WRA-310 CaO % 0.01	WRA-310 Cr2O3 % 0.01	WRA-310 Fe2O3 % 0.01	WRA-310 K2O % 0.01	WRA-310 MgO % 0.01	WRA-310 MnO % 0.01
DUP 16HL126						10.02	0.24	0.57	0.02	2.49	3.02	1.27	0.04
DUP 16HL102													
DUP 16HL126													
STD BLANK													
STD BLANK													
STD BLANK				<0.01	<0.01								
STD BLANK				<0.01	<0.01								
STD BLANK						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
STD BLANK						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
STD BLANK													
STD BLANK													
STD OREAS 24b													
SD OREAS 904													
STD OREAS 24b				0.19	0.19								
STD OREAS 504				0.49	1.33								
STD SY-4						20.55	0.04	7.82	<0.01	6.14	1.64	0.51	0.10
STD OREAS 120						8.91	0.11	0.10	<0.01	2.26	3.18	0.40	0.10
STD GMN-04													
STD OREAS 24b													
STD SY-4													

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T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	WRA-310 Na_2O % 0.01	WRA-310 P_2O_5 % 0.01	WRA-310 SiO_2 % 0.01	WRA-310 SrO % 0.01	WRA-310 TiO_2 % 0.01	WRA-310 LOI % 0.01	WRA-310 Total %	IMS-300 Ba ppm 0.5	IMS-300 Ce ppm 0.1	IMS-300 Cr ppm 10	IMS-300 Cs ppm 0.01	IMS-300 Dy ppm 0.05	IMS-300 Er ppm 0.03
16HL101	0.21	0.14	70.39	<0.01	0.69	4.09	100.63	2592.9	43.6	188	0.63	4.30	2.56
16HL102	1.78	0.13	73.00	<0.01	0.58	2.47	99.80	2091.8	73.8	127	1.14	3.89	2.30
16HL103	2.51	0.02	77.55	<0.01	0.13	1.73	100.68	2467.4	37.8	104	0.48	3.29	2.48
16HL104	2.40	0.03	79.33	<0.01	0.19	1.65	101.74	2058.9	80.4	124	0.42	4.58	2.64
16HL105	3.44	0.02	77.94	0.02	0.13	1.33	100.06	2255.7	67.4	88	2.36	6.59	3.66
16HL106	1.01	0.04	76.55	<0.01	0.18	1.75	99.58	2481.1	91.5	142	6.00	3.73	2.22
16HL107	2.08	0.03	81.19	0.01	0.15	1.33	101.25	1990.2	69.6	157	4.08	3.87	2.07
16HL108	3.77	0.08	69.94	0.04	0.29	1.54	99.71	2769.5	90.7	97	6.44	3.82	2.32
16HL109	<0.01	0.08	84.70	<0.01	0.38	2.35	101.73	524.4	21.6	209	1.16	1.38	0.85
16HL110	0.02	0.14	71.33	<0.01	0.62	3.75	99.76	574.2	9.2	273	1.53	0.88	0.73
16HL111	<0.01	0.17	62.80	<0.01	0.59	6.30	98.71	827.6	124.0	218	1.86	13.07	6.85
16HL112	<0.01	0.15	72.19	<0.01	0.38	3.33	99.64	1284.1	50.4	147	1.68	1.64	0.93
16HL113	<0.01	0.14	72.72	<0.01	0.32	3.06	97.58	1006.6	12.6	146	1.57	0.88	0.71
16HL114	<0.01	0.08	77.68	<0.01	0.38	3.85	99.09	680.6	22.0	221	1.61	1.54	0.88
16HL115	0.90	0.12	66.52	0.02	0.61	3.54	99.53	1959.8	74.9	164	1.50	4.36	2.58
16HL116	3.18	0.11	69.45	0.01	0.57	2.67	100.27	1258.5	80.6	184	1.14	4.66	2.67
16HL117	<0.01	0.11	71.33	<0.01	0.53	3.62	100.73	2594.7	72.5	169	1.45	4.49	2.52
16HL118	1.50	0.10	71.20	<0.01	0.50	3.72	100.41	2060.5	80.2	168	1.31	4.31	2.59
16HL119	<0.01	0.10	72.42	<0.01	0.61	3.83	98.57	548.9	11.5	156	0.88	2.67	1.82
16HL120	0.24	0.13	69.58	<0.01	0.65	3.72	98.57	1561.4	72.4	157	1.03	3.65	2.06
16HL121	1.19	0.16	70.09	<0.01	0.51	5.36	101.09	1943.9	151.1	500	1.41	0.69	0.37
16HL122	<0.01	0.02	76.78	<0.01	0.09	2.62	99.30	2726.7	98.4	153	3.12	6.12	3.15
16HL123	1.63	0.01	72.19	0.01	0.12	2.86	99.06	2891.3	93.5	105	1.63	4.66	2.57
16HL124	1.43	0.06	73.21	0.06	0.26	1.46	100.01	4315.7	83.5	132	7.14	2.90	1.65
16HL125	3.32	0.09	67.10	0.05	0.33	1.43	98.87	2653.3	103.4	87	5.38	3.94	2.34

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To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	WRA-310 Na_2O % 0.01	WRA-310 P_2O_5 % 0.01	WRA-310 SiO_2 % 0.01	WRA-310 SrO % 0.01	WRA-310 TiO_2 % 0.01	WRA-310 LOI % 0.01	WRA-310 Total %	IMS-300 Ba ppm 0.5	IMS-300 Ce ppm 0.1	IMS-300 Cr ppm 10	IMS-300 Cs ppm 0.01	IMS-300 Dy ppm 0.05	IMS-300 Er ppm 0.03
16HL126	0.83	0.02	79.42	<0.01	0.13	1.67	99.70	2312.8	81.5	155	7.78	4.99	2.88
16HL127	2.07	0.01	79.69	0.02	0.11	1.37	101.30	2757.3	87.7	85	3.86	4.58	2.62
16HL128	3.39	0.08	68.55	0.03	0.33	1.60	99.09	2775.5	95.5	123	4.51	3.73	1.99
16HL129	1.62	0.09	66.97	0.03	0.32	2.38	100.42	4792.2	105.4	114	6.10	3.66	1.99
16HL130	2.14	0.09	72.83	0.04	0.27	1.76	100.66	1997.4	73.8	115	8.75	2.65	1.59
16HL131	1.35	0.08	68.82	0.02	0.29	1.90	98.70	2942.4	88.3	150	7.13	3.16	1.91
16HL132	1.55	0.01	74.88	0.02	0.12	1.18	101.62	3110.9	115.2	122	6.63	6.34	3.92
16HL134	0.81	<0.01	83.59	0.03	0.08	1.31	100.93	2226.6	112.2	134	3.59	4.20	2.53
16HL135	1.80	0.06	74.50	0.04	0.28	2.38	100.51	1901.7	79.2	104	4.60	3.08	1.76
16HL136	0.98	0.06	72.62	0.05	0.24	2.07	98.46	2029.5	75.4	104	3.42	2.78	1.51
16HL137	4.23	0.03	79.88	<0.01	0.16	0.78	100.70	1886.7	60.5	128	0.68	3.00	1.77
16HL138	0.14	0.02	80.34	<0.01	0.07	2.45	99.25	2250.2	105.4	100	1.51	9.79	6.11
16HL139	0.12	<0.01	76.96	<0.01	0.12	4.45	100.74	399.8	163.0	115	2.25	12.73	8.33
16HL140	2.66	0.11	65.44	<0.01	0.69	2.87	99.84	625.6	22.1	90	1.24	3.32	2.03
16HL141	1.41	0.10	53.96	<0.01	0.81	5.26	99.80	2463.9	16.8	127	3.90	2.58	1.78
16HL142	1.40	0.28	52.71	<0.01	1.10	11.30	98.20	1334.8	47.2	39	6.30	3.02	1.72
16HL143	0.05	0.11	61.52	<0.01	0.47	13.91	101.31	335.1	29.7	670	1.73	2.69	1.54
16HL144	0.99	0.08	51.44	<0.01	0.61	7.13	99.67	462.4	14.6	257	1.09	2.77	1.90
16HL145	5.54	0.07	71.81	<0.01	0.27	1.98	100.58	920.9	42.2	86	0.20	2.11	1.36
16HL146	1.71	0.03	80.73	<0.01	0.16	1.63	100.99	2644.4	42.5	157	0.63	2.42	1.45
16HL147	3.05	0.01	80.85	<0.01	0.09	1.57	101.80	2903.6	57.7	152	0.48	2.81	1.92
16HL148	3.51	0.11	75.56	<0.01	0.47	4.15	100.63	573.5	37.5	167	0.34	2.25	1.39
16HL149	2.80	0.14	71.13	<0.01	0.52	1.70	97.19	1030.2	56.2	133	1.37	3.46	2.15
16HL150	2.76	0.03	78.27	<0.01	0.08	1.42	101.15	2560.5	79.6	109	0.69	4.63	2.99
16HL151	1.10	0.06	77.70	<0.01	0.28	1.65	100.70	2588.2	67.5	217	2.59	3.81	2.33

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Unit 1, 20120 102nd Avenue
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To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	WRA-310 Na_2O % 0.01	WRA-310 P_2O_5 % 0.01	WRA-310 SiO_2 % 0.01	WRA-310 SrO % 0.01	WRA-310 TiO_2 % 0.01	WRA-310 LOI % 0.01	WRA-310 Total %	IMS-300 Ba ppm 0.5	IMS-300 Ce ppm 0.1	IMS-300 Cr ppm 10	IMS-300 Cs ppm 0.01	IMS-300 Dy ppm 0.05	IMS-300 Er ppm 0.03
16HL152	1.57	0.05	79.46	<0.01	0.20	1.94	100.31	2160.4	61.8	147	1.24	3.03	1.81
16HL153	3.55	<0.01	78.02	<0.01	0.09	1.48	100.68	1535.2	74.3	117	0.89	3.20	2.10
16HL154	3.04	0.02	75.04	0.01	0.14	0.80	101.37	2010.9	96.7	104	1.54	4.70	2.86
16HL155	2.71	0.59	42.85	0.09	2.38	5.06	99.87	674.8	62.8	511	5.58	4.82	2.25
16HL156	2.50	0.49	44.47	0.08	3.04	2.94	101.03	579.8	56.6	269	0.35	4.35	1.86
16HL157	3.40	0.17	71.54	0.02	0.64	2.38	100.35	1099.8	62.2	166	1.22	4.42	2.69
16HL158	0.73	0.05	75.81	<0.01	0.22	2.31	101.57	2412.7	62.9	140	1.02	2.70	1.75
16HL159	3.17	0.07	74.22	0.02	0.35	1.85	101.38	1516.2	71.9	135	1.24	3.67	2.34
16HL160	2.15	0.62	44.13	0.08	2.35	4.65	98.98	619.9	55.2	449	1.11	4.52	2.15
16HL161	2.27	0.64	44.37	0.08	2.35	4.67	99.34	565.1	58.6	484	4.59	4.76	2.12
16HL162	0.14	0.04	75.47	<0.01	0.22	3.73	100.79	350.3	28.6	179	0.58	0.69	0.61
16HL163	0.65	0.12	67.22	0.03	0.55	2.32	99.02	2176.6	73.9	191	1.48	4.40	2.44
16HL164	0.95	0.07	70.01	<0.01	0.26	2.67	99.19	2619.5	78.8	166	2.99	3.39	1.99
16HL201													
16HL202													
16HL203													
16HL204													
16HL205													
DUP 16HL124													
DUP 16HL137													
DUP 16HL103													
DUP 16HL160													
DUP 16HL102	1.54	0.14	73.13	<0.01	0.58	2.48	99.78						

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
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Sample ID	WRA-310 Na_2O % 0.01	WRA-310 P_2O_5 % 0.01	WRA-310 SiO_2 % 0.01	WRA-310 SrO % 0.01	WRA-310 TiO_2 % 0.01	WRA-310 LOI % 0.01	WRA-310 Total %	IMS-300 Ba ppm 0.5	IMS-300 Ce ppm 0.1	IMS-300 Cr ppm 10	IMS-300 Cs ppm 0.01	IMS-300 Dy ppm 0.05	IMS-300 Er ppm 0.03
DUP 16HL126	0.82	0.02	79.22	<0.01	0.14	1.65	99.53						
DUP 16HL102								1847.0	65.5	110	1.01	3.40	2.09
DUP 16HL126								2326.5	82.7	150	7.91	4.81	2.76
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK	<0.01	<0.01	<0.01	<0.01	<0.01								
STD BLANK	<0.01	<0.01	<0.01	<0.01	<0.01								
STD BLANK								<0.5	<0.1	<10	<0.01	<0.05	<0.03
STD BLANK								<0.5	<0.1	<10	<0.01	<0.05	<0.03
STD OREAS 24b													
SD OREAS 904													
STD OREAS 24b													
STD OREAS 504													
STD SY-4	7.13	0.11	51.22	0.13	0.28								
STD OREAS 120	0.30	0.03	81.66	0.01	0.40								
STD GMN-04						31.72							
STD OREAS 24b								761.0	87.3	145	10.53	5.85	3.37
STD SY-4								335.5	125.2	12	1.50	18.06	14.54

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Unit 1, 20120 102nd Avenue
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Phone: +1-604-888-0875

To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-300 Eu ppm 0.03	IMS-300 Ga ppm 0.2	IMS-300 Gd ppm 0.05	IMS-300 Hf ppm 0.2	IMS-300 Ho ppm 0.01	IMS-300 La ppm 0.1	IMS-300 Lu ppm 0.01	IMS-300 Nb ppm 0.1	IMS-300 Nd ppm 0.1	IMS-300 Pr ppm 0.03	IMS-300 Rb ppm 0.2	IMS-300 Sm ppm 0.03	IMS-300 Sn ppm 5
16HL101	0.97	16.9	3.95	4.7	0.84	21.3	0.34	13.0	19.0	4.85	65.2	4.11	<5
16HL102	1.09	18.2	4.03	4.7	0.74	22.3	0.34	11.9	22.5	5.91	86.4	4.73	<5
16HL103	0.59	18.2	2.71	5.0	0.78	20.4	0.39	10.6	17.1	4.52	103.2	3.33	<5
16HL104	0.96	18.3	4.83	6.2	0.91	30.8	0.38	15.2	26.4	7.12	94.8	5.22	7
16HL105	1.10	14.9	5.46	4.6	1.34	36.1	0.41	13.4	29.0	8.09	69.1	5.79	6
16HL106	1.26	14.7	4.78	4.7	0.71	45.8	0.32	10.8	31.1	8.94	136.3	5.72	<5
16HL107	1.31	13.1	5.02	3.7	0.74	37.4	0.28	8.4	28.5	7.94	93.2	5.69	<5
16HL108	1.47	19.4	5.09	5.4	0.76	50.8	0.34	14.5	33.6	9.63	119.6	6.23	5
16HL109	0.39	10.4	1.71	2.5	0.29	10.9	0.13	6.0	10.5	2.76	76.3	2.01	<5
16HL110	0.14	16.2	0.69	3.3	0.22	2.8	0.15	9.9	3.0	0.77	95.9	0.73	6
16HL111	3.19	17.9	15.22	3.2	2.47	57.1	0.77	8.9	67.6	16.52	98.8	13.77	6
16HL112	0.64	16.3	2.70	2.9	0.31	22.1	0.16	8.3	20.0	5.44	113.6	3.62	<5
16HL113	0.24	15.9	0.84	2.7	0.21	6.2	0.13	6.7	5.2	1.46	108.3	1.15	6
16HL114	0.35	11.9	1.90	2.5	0.30	11.9	0.14	6.9	10.9	2.79	102.6	2.16	<5
16HL115	1.25	19.4	5.44	5.5	0.87	39.1	0.37	13.3	32.6	8.70	132.8	6.01	5
16HL116	1.35	17.4	5.69	4.9	0.85	42.1	0.35	12.0	34.0	9.07	74.0	6.31	<5
16HL117	1.29	18.5	5.02	5.1	0.84	37.8	0.35	12.5	30.8	8.38	192.3	6.04	<5
16HL118	1.24	17.5	5.52	4.9	0.86	41.8	0.36	12.7	33.7	9.12	137.9	6.47	<5
16HL119	0.32	15.0	1.59	3.3	0.58	6.8	0.26	11.3	6.6	1.63	70.4	1.49	5
16HL120	1.39	16.7	5.07	4.3	0.68	33.5	0.31	11.7	36.5	9.18	74.9	6.90	<5
16HL121	0.60	17.8	2.51	3.4	0.10	66.8	0.07	9.3	40.0	14.78	62.3	3.89	14
16HL122	1.83	17.0	9.43	4.1	1.15	81.7	0.39	13.0	63.8	17.12	127.6	11.33	6
16HL123	1.07	18.0	5.82	5.7	0.88	48.0	0.45	18.5	37.0	10.19	69.7	6.82	6
16HL124	1.24	17.3	4.15	4.7	0.58	41.3	0.29	10.6	26.4	7.72	180.3	5.20	6
16HL125	1.58	21.4	5.50	5.1	0.78	58.4	0.36	14.1	37.2	10.78	126.1	6.61	6

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MS Analytical

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name:	HL
Job Received Date:	27-Oct-2016
Job Report Date:	14-Nov-2016
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	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300
	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb	Sm	Sn
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.03	0.2	0.05	0.2	0.01	0.1	0.01	0.1	0.1	0.03	0.2	0.03	5
16HL126	1.13	14.8	5.82	4.0	0.97	46.0	0.42	10.9	35.1	9.64	137.9	6.80	6
16HL127	1.12	16.9	5.60	4.2	0.86	45.3	0.35	12.2	34.3	9.49	104.1	6.34	6
16HL128	1.49	20.5	5.44	5.6	0.69	52.0	0.27	15.3	34.4	9.89	112.6	6.47	6
16HL129	1.58	21.0	5.30	6.1	0.69	60.4	0.30	16.0	36.7	10.79	154.7	6.53	6
16HL130	1.16	18.7	3.77	4.9	0.51	43.0	0.24	12.3	26.5	7.92	121.7	4.49	6
16HL131	1.36	19.9	4.79	4.9	0.67	49.9	0.32	13.6	31.5	9.06	184.0	5.57	6
16HL132	1.39	23.3	7.71	6.0	1.28	60.4	0.55	19.5	46.3	13.03	168.8	8.99	8
16HL134	1.33	14.3	6.41	3.5	0.82	61.8	0.36	9.5	45.5	12.74	113.0	8.10	<5
16HL135	1.16	16.1	4.21	4.6	0.56	41.4	0.30	15.1	27.4	7.97	63.1	4.92	5
16HL136	1.20	18.7	4.23	5.0	0.53	40.3	0.24	12.6	28.5	8.22	60.0	5.42	6
16HL137	0.92	14.3	3.57	3.3	0.61	31.0	0.29	8.4	23.5	6.66	61.4	4.49	5
16HL138	0.29	23.0	8.88	12.7	1.99	49.3	0.85	30.0	41.5	11.94	178.1	9.69	13
16HL139	0.09	31.3	12.77	20.9	2.64	77.5	1.26	68.7	63.9	18.26	229.1	14.40	18
16HL140	0.91	14.4	3.17	2.9	0.68	9.5	0.34	3.4	12.0	2.80	48.8	3.16	<5
16HL141	0.80	16.5	2.30	2.0	0.56	8.0	0.26	4.6	9.0	2.22	62.4	2.63	<5
16HL142	1.17	17.1	3.78	3.1	0.60	23.2	0.23	12.2	21.8	5.63	54.3	4.53	<5
16HL143	0.76	11.6	2.87	2.2	0.53	14.2	0.24	5.9	14.5	3.68	22.6	3.16	<5
16HL144	0.69	15.1	2.46	1.8	0.59	6.7	0.31	2.0	8.9	2.00	47.8	2.51	<5
16HL145	0.61	14.3	2.34	5.0	0.44	22.3	0.22	14.1	15.2	4.56	19.1	2.85	<5
16HL146	0.64	17.7	2.52	3.2	0.49	21.2	0.25	11.9	16.1	4.52	100.0	3.41	8
16HL147	0.55	12.9	3.25	4.4	0.61	28.9	0.31	12.6	22.4	6.41	65.4	4.55	<5
16HL148	0.71	12.1	2.80	2.7	0.45	18.3	0.20	10.0	15.9	4.28	28.6	3.28	<5
16HL149	1.07	14.5	4.16	3.6	0.70	26.1	0.29	9.8	23.0	6.16	51.4	4.81	<5
16HL150	1.05	16.1	4.57	3.6	1.02	42.0	0.39	9.3	29.5	8.51	99.1	5.36	5
16HL151	1.03	15.2	4.59	4.2	0.75	34.8	0.32	10.9	28.2	7.58	106.6	5.49	<5

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Project Name: HL
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	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300
	Eu	Ga	Gd	Hf	Ho	La	Lu	Nb	Nd	Pr	Rb	Sm	Sn
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.03	0.2	0.05	0.2	0.01	0.1	0.01	0.1	0.1	0.03	0.2	0.03	5
16HL152	1.04	14.0	3.85	4.0	0.63	31.7	0.27	9.0	24.2	6.68	100.7	4.54	7
16HL153	0.88	16.4	3.89	3.5	0.67	37.1	0.32	9.5	26.5	7.69	66.2	4.90	<5
16HL154	1.37	14.5	5.73	5.0	0.96	52.1	0.43	12.7	37.5	10.72	142.8	6.83	<5
16HL155	2.20	21.1	6.32	4.3	0.83	30.7	0.20	40.0	31.5	7.68	25.0	6.86	<5
16HL156	2.05	22.0	5.90	4.0	0.74	28.1	0.20	46.8	29.1	7.06	34.0	6.54	<5
16HL157	1.27	17.0	5.03	4.3	0.89	32.7	0.39	12.9	27.3	7.19	68.3	5.60	10
16HL158	0.88	23.2	3.59	3.8	0.58	33.0	0.28	14.1	24.3	7.00	139.8	4.72	9
16HL159	1.16	16.7	4.72	3.8	0.77	38.1	0.31	10.8	29.4	8.02	87.3	5.39	11
16HL160	2.14	19.2	6.09	4.5	0.84	28.8	0.23	38.5	28.7	7.09	16.6	6.30	<5
16HL161	2.16	20.3	6.04	4.0	0.78	29.2	0.22	38.5	30.1	7.12	20.2	6.82	<5
16HL162	0.11	13.6	0.68	3.5	0.16	26.4	0.15	9.3	4.8	1.78	42.2	0.88	6
16HL163	1.17	18.5	4.99	4.2	0.82	38.4	0.36	12.2	30.9	8.46	133.0	6.02	11
16HL164	1.26	19.4	4.39	5.2	0.71	42.7	0.25	14.0	29.6	8.65	152.0	5.37	5
16HL201													
16HL202													
16HL203													
16HL204													
16HL205													
DUP 16HL124													
DUP 16HL137													
DUP 16HL103													
DUP 16HL160													
DUP 16HL102													

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Sample ID	IMS-300 Eu ppm 0.03	IMS-300 Ga ppm 0.2	IMS-300 Gd ppm 0.05	IMS-300 Hf ppm 0.2	IMS-300 Ho ppm 0.01	IMS-300 La ppm 0.1	IMS-300 Lu ppm 0.01	IMS-300 Nb ppm 0.1	IMS-300 Nd ppm 0.1	IMS-300 Pr ppm 0.03	IMS-300 Rb ppm 0.2	IMS-300 Sm ppm 0.03	IMS-300 Sn ppm 5
DUP 16HL126													
DUP 16HL102	0.98	16.3	3.81	3.9	0.69	20.3	0.28	9.7	19.6	5.24	76.3	4.15	<5
DUP 16HL126	1.15	15.2	5.82	3.7	0.97	46.2	0.41	11.0	35.0	9.65	138.8	6.73	6
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK	<0.03	<0.2	<0.05	<0.2	<0.01	<0.1	<0.01	<0.1	<0.1	<0.03	<0.2	<0.03	<5
STD BLANK	<0.03	<0.2	<0.05	<0.2	<0.01	<0.1	<0.01	<0.1	<0.1	<0.03	<0.2	<0.03	<5
STD OREAS 24b													
SD OREAS 904													
STD OREAS 24b													
STD OREAS 504													
STD SY-4													
STD OREAS 120													
STD GMN-04													
STD OREAS 24b	1.35	19.8	6.61	6.0	1.13	45.4	0.46	16.4	38.0	10.18	166.4	7.40	7
STD SY-4	1.93	35.2	13.90	10.8	4.30	58.8	2.14	13.7	56.9	14.88	56.1	12.75	12

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	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-300	IMS-130	IMS-130
	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr	Ag	Al
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample ID	0.1	0.1	0.01	0.05	0.01	0.05	10	1	0.5	0.03	2	0.01	0.01
16HL101	37.4	1.0	0.66	7.52	0.35	6.72	102	5	22.9	2.23	155	0.15	2.61
16HL102	60.4	0.9	0.57	10.32	0.36	2.75	80	3	20.3	2.26	159	0.20	1.49
16HL103	45.0	1.0	0.43	11.45	0.37	2.72	<10	4	20.2	2.61	151	0.02	0.64
16HL104	50.3	1.1	0.73	13.99	0.38	2.24	29	2	23.9	2.53	210	0.03	0.67
16HL105	155.8	1.3	0.96	16.77	0.48	7.20	24	3	35.6	2.88	154	0.57	0.62
16HL106	30.6	0.9	0.65	16.00	0.32	3.91	14	3	19.9	2.01	162	0.05	0.90
16HL107	118.5	0.7	0.69	13.27	0.31	4.31	11	4	21.7	1.89	135	0.09	0.71
16HL108	305.3	1.2	0.68	21.06	0.33	6.04	19	2	21.5	2.37	208	0.03	1.19
16HL109	17.2	0.5	0.25	6.84	0.12	2.34	60	7	6.9	0.83	99	0.24	1.12
16HL110	17.7	0.7	0.11	7.06	0.13	1.98	117	5	5.3	0.89	114	0.36	2.44
16HL111	22.0	0.7	2.23	29.40	0.90	13.05	112	8	67.8	5.34	122	0.65	2.32
16HL112	21.8	0.7	0.31	11.73	0.13	2.37	58	8	7.5	0.96	113	<0.01	1.82
16HL113	19.5	0.7	0.13	9.08	0.12	2.38	54	11	5.4	0.90	105	0.02	1.82
16HL114	17.8	0.5	0.28	6.54	0.13	2.28	61	7	7.6	0.81	100	1.56	0.57
16HL115	147.0	1.0	0.75	14.69	0.38	3.55	68	7	23.6	2.46	201	<0.01	1.60
16HL116	137.3	0.9	0.79	13.91	0.36	3.33	54	3	23.3	2.46	188	0.01	1.59
16HL117	55.1	1.0	0.72	15.13	0.38	2.13	40	7	23.8	2.32	190	0.13	0.68
16HL118	87.4	1.0	0.73	14.36	0.38	4.28	38	3	22.9	2.38	170	0.03	0.70
16HL119	31.1	0.9	0.36	7.54	0.26	1.85	66	9	15.3	1.72	132	0.02	2.32
16HL120	30.5	0.9	0.67	10.45	0.30	3.08	100	4	17.6	2.01	163	<0.01	2.71
16HL121	86.6	0.8	0.20	12.27	0.04	7.27	82	8	2.4	0.34	126	0.86	2.00
16HL122	33.0	1.1	1.21	21.15	0.43	4.81	<10	4	32.8	2.75	137	0.05	1.32
16HL123	118.9	1.9	0.82	21.20	0.40	2.02	<10	4	19.8	2.83	193	0.05	1.50
16HL124	497.0	0.8	0.55	16.89	0.25	4.90	21	2	14.6	1.82	173	0.04	1.22
16HL125	483.0	1.1	0.74	20.95	0.34	6.06	16	3	22.2	2.36	204	0.15	0.99

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Sample ID	IMS-300 Sr ppm 0.1	IMS-300 Ta ppm 0.1	IMS-300 Tb ppm 0.01	IMS-300 Th ppm 0.05	IMS-300 Tm ppm 0.01	IMS-300 U ppm 0.05	IMS-300 V ppm 10	IMS-300 W ppm 1	IMS-300 Y ppm 0.5	IMS-300 Yb ppm 0.03	IMS-300 Zr ppm 2	IMS-130 Ag ppm 0.01	IMS-130 Al % 0.01
16HL126	85.8	1.0	0.86	15.24	0.40	4.46	17	2	26.6	2.74	144	0.21	1.22
16HL127	218.5	0.9	0.75	16.92	0.36	5.37	<10	4	24.2	2.31	155	0.05	0.74
16HL128	276.9	1.2	0.70	20.23	0.30	8.17	19	4	19.4	1.88	214	0.08	0.88
16HL129	239.9	1.3	0.65	24.90	0.28	5.80	19	4	19.2	1.96	246	0.06	1.28
16HL130	366.0	1.1	0.50	19.67	0.23	2.70	16	5	14.8	1.67	206	0.05	0.99
16HL131	212.1	1.1	0.63	19.53	0.29	5.81	15	4	18.8	1.91	194	0.03	0.97
16HL132	180.6	1.5	1.08	25.20	0.56	8.59	<10	4	35.7	3.57	199	0.03	0.53
16HL134	224.4	0.5	0.78	15.44	0.37	5.41	<10	6	23.4	2.29	137	<0.01	0.48
16HL135	339.2	1.2	0.53	17.40	0.26	5.55	12	3	14.8	1.84	181	<0.01	1.42
16HL136	473.4	0.9	0.57	13.90	0.22	4.53	17	4	13.6	1.55	182	<0.01	1.21
16HL137	48.3	0.7	0.54	10.95	0.28	2.34	11	2	16.7	1.77	117	0.01	0.73
16HL138	25.7	3.0	1.58	31.12	0.89	7.94	<10	3	59.4	5.94	383	0.15	0.40
16HL139	8.4	4.7	2.10	53.13	1.30	14.61	<10	4	74.9	8.79	694	0.27	0.59
16HL140	100.0	0.3	0.54	7.43	0.33	2.07	131	3	17.4	2.15	108	0.17	2.39
16HL141	96.9	0.3	0.40	3.51	0.26	0.99	343	3	14.7	1.62	71	0.07	4.53
16HL142	38.6	0.8	0.54	6.14	0.23	1.82	188	<1	15.6	1.53	106	<0.01	1.76
16HL143	54.1	0.3	0.47	3.75	0.23	1.54	120	1	15.1	1.50	75	0.07	0.77
16HL144	68.0	0.1	0.43	1.82	0.30	0.73	225	2	16.3	1.84	58	0.60	4.75
16HL145	89.4	1.1	0.35	11.21	0.21	2.24	33	4	11.7	1.45	172	0.01	1.12
16HL146	47.3	0.8	0.39	10.11	0.22	2.66	22	3	14.0	1.51	112	0.66	0.52
16HL147	54.3	0.9	0.49	14.36	0.29	3.82	<10	3	14.6	1.99	132	0.04	0.59
16HL148	52.3	0.7	0.39	6.40	0.19	7.24	38	5	11.7	1.38	98	<0.01	0.45
16HL149	53.2	0.7	0.62	7.76	0.29	2.46	61	3	18.5	1.96	127	0.18	2.05
16HL150	54.9	0.7	0.72	13.43	0.43	3.26	<10	4	29.0	2.76	106	0.01	0.54
16HL151	44.3	0.8	0.66	11.08	0.33	2.69	29	4	21.3	2.23	148	0.14	1.24

***Please refer to the cover page for comments regarding this certificate. ***

MS Analytical
An A2 Global Company

MS Analytical
Unit 1, 20120 102nd Avenue
Langley, BC V1M 4B4
Phone: +1-604-888-0875

To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-300 Sr ppm 0.1	IMS-300 Ta ppm 0.1	IMS-300 Tb ppm 0.01	IMS-300 Th ppm 0.05	IMS-300 Tm ppm 0.01	IMS-300 U ppm 0.05	IMS-300 V ppm 10	IMS-300 W ppm 1	IMS-300 Y ppm 0.5	IMS-300 Yb ppm 0.03	IMS-300 Zr ppm 2	IMS-130 Ag ppm 0.01	IMS-130 Al % 0.01
16HL152	39.2	0.7	0.57	11.03	0.27	2.99	18	6	17.8	1.76	143	0.25	0.73
16HL153	81.9	0.8	0.59	11.91	0.30	3.57	<10	2	18.0	2.20	101	0.02	0.92
16HL154	105.5	1.0	0.85	15.74	0.44	4.94	<10	2	25.9	2.77	156	0.08	0.24
16HL155	761.5	2.7	0.93	5.81	0.29	1.22	214	1	22.8	1.55	167	0.05	1.32
16HL156	663.9	3.0	0.83	3.40	0.24	1.09	240	<1	19.3	1.44	143	0.09	3.15
16HL157	160.1	0.9	0.73	9.77	0.40	4.01	87	3	25.1	2.57	146	0.06	1.39
16HL158	32.7	0.6	0.51	11.21	0.23	2.75	25	5	16.4	1.66	127	<0.01	0.51
16HL159	148.8	0.8	0.66	9.93	0.32	3.79	41	3	22.1	2.08	129	<0.01	0.85
16HL160	690.3	3.3	0.86	3.76	0.28	1.17	192	2	21.4	1.54	167	0.05	1.60
16HL161	727.6	2.6	0.86	3.42	0.27	1.18	202	<1	21.3	1.59	138	0.05	1.47
16HL162	17.7	0.7	0.10	8.99	0.12	1.25	22	2	4.9	0.88	127	0.01	2.65
16HL163	203.3	0.8	0.75	9.03	0.35	3.18	57	1	23.5	2.24	142	0.02	1.95
16HL164	69.0	0.9	0.63	12.46	0.27	6.12	16	5	18.4	1.67	176	0.08	0.98
16HL201												0.11	0.09
16HL202												0.15	0.05
16HL203												0.87	0.09
16HL204												1.40	0.12
16HL205												0.28	0.77
DUP 16HL124												0.04	1.22
DUP 16HL137												0.02	0.75
DUP 16HL103													
DUP 16HL160													
DUP 16HL102													

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To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-300 Sr ppm 0.1	IMS-300 Ta ppm 0.1	IMS-300 Tb ppm 0.01	IMS-300 Th ppm 0.05	IMS-300 Tm ppm 0.01	IMS-300 U ppm 0.05	IMS-300 V ppm 10	IMS-300 W ppm 1	IMS-300 Y ppm 0.5	IMS-300 Yb ppm 0.03	IMS-300 Zr ppm 2	IMS-130 Ag ppm 0.01	IMS-130 Al % 0.01
DUP 16HL126													
DUP 16HL102	50.8	0.7	0.58	9.11	0.29	2.48	64	3	17.5	2.05	141		
DUP 16HL126	84.8	1.0	0.80	14.05	0.42	4.42	17	2	26.6	2.63	137		
STD BLANK												<0.01	<0.01
STD BLANK												<0.01	<0.01
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK	<0.1	<0.1	<0.01	<0.05	<0.01	<0.05	<10	<1	<0.5	<0.03	<2		
STD BLANK	<0.1	<0.1	<0.01	<0.05	<0.01	<0.05	<10	<1	<0.5	<0.03	<2		
STD OREAS 24b												0.07	3.20
SD OREAS 904												0.36	1.29
STD OREAS 24b													
STD OREAS 504													
STD SY-4													
STD OREAS 120													
STD GMN-04													
STD OREAS 24b	117.5	1.4	0.96	17.20	0.49	3.24	112	5	31.2	3.20	222		
STD SY-4	1163.1	0.9	2.60	1.48	2.24	0.83	<10	<1	117.2	14.77	491		

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.1	0.005	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
16HL101	1.8	<0.005	<10	194	0.22	0.39	0.13	0.04	36.95	3.0	98	0.17	3.5
16HL102	1.4	<0.005	<10	216	0.30	0.23	0.13	0.22	59.13	7.3	63	0.61	28.4
16HL103	0.5	<0.005	<10	275	0.29	0.02	0.01	0.09	33.02	0.8	63	0.17	1.5
16HL104	0.8	<0.005	<10	262	0.26	0.04	0.03	0.41	66.88	1.2	72	0.11	14.2
16HL105	1.2	<0.005	<10	295	0.33	0.27	0.11	0.09	33.08	1.4	52	0.95	15.5
16HL106	0.5	<0.005	<10	238	0.44	0.11	0.09	0.08	77.13	1.4	79	2.94	2.1
16HL107	0.5	<0.005	<10	237	0.32	0.37	0.15	0.05	31.17	1.6	86	1.52	1.8
16HL108	0.6	<0.005	<10	340	0.47	0.10	0.32	0.05	38.19	2.5	55	4.25	4.6
16HL109	25.5	0.014	<10	79	0.17	0.47	0.08	25.98	21.07	10.7	96	0.17	83.4
16HL110	16.7	0.007	<10	66	0.20	0.72	0.13	0.49	9.43	13.5	131	0.30	54.1
16HL111	25.0	0.012	<10	238	0.64	1.58	0.14	44.13	105.89	370.9	94	0.40	357.0
16HL112	3.8	<0.005	<10	96	0.21	0.11	0.15	0.28	48.10	9.5	71	0.14	13.7
16HL113	2.2	<0.005	<10	103	0.20	0.08	0.14	0.36	11.15	6.8	67	0.20	7.8
16HL114	19.3	0.009	<10	82	0.15	3.27	0.12	60.66	21.16	8.9	92	0.25	86.4
16HL115	0.9	<0.005	<10	254	0.45	0.03	1.67	0.15	20.56	7.9	65	0.81	2.5
16HL116	0.2	<0.005	<10	289	0.34	0.17	1.08	0.36	37.64	7.1	95	0.79	7.5
16HL117	0.5	<0.005	<10	267	0.25	0.20	1.33	0.06	64.81	5.2	78	0.33	4.7
16HL118	<0.1	<0.005	<10	242	0.23	0.05	1.69	0.09	53.89	4.7	85	0.39	7.4
16HL119	<0.1	<0.005	<10	72	0.24	0.29	0.04	0.02	9.31	0.9	88	0.09	3.5
16HL120	0.3	<0.005	<10	118	0.28	0.03	0.13	0.04	61.97	4.0	86	0.15	20.4
16HL121	1.1	<0.005	<10	217	0.20	1.29	0.02	0.14	120.43	0.9	220	0.42	30.0
16HL122	0.4	<0.005	<10	290	0.42	0.04	0.02	0.04	47.16	0.8	93	1.86	4.7
16HL123	<0.1	<0.005	<10	249	0.27	0.09	0.03	0.07	45.86	0.7	63	0.24	1.4
16HL124	0.2	<0.005	<10	468	0.56	0.06	0.28	0.03	36.68	2.3	81	4.49	3.2
16HL125	<0.1	<0.005	<10	353	0.43	0.10	0.40	0.06	24.70	2.0	52	2.76	2.9

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To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.1	0.005	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
16HL126	0.4	<0.005	<10	414	0.46	0.33	0.11	0.17	44.79	1.8	88	5.19	14.4
16HL127	<0.1	<0.005	<10	396	0.43	0.08	0.11	0.05	22.44	0.6	53	1.42	1.6
16HL128	0.4	<0.005	<10	355	0.54	0.08	0.26	0.04	33.58	2.6	67	1.68	21.3
16HL129	0.5	<0.005	<10	577	0.51	0.10	0.21	0.06	34.40	2.5	60	3.34	5.9
16HL130	0.3	<0.005	<10	294	0.51	0.05	0.25	0.02	14.56	3.0	66	4.93	6.2
16HL131	<0.1	<0.005	<10	347	0.57	0.10	0.31	0.02	30.94	1.8	93	2.09	2.3
16HL132	0.5	<0.005	<10	138	0.39	0.11	0.27	0.05	32.57	0.3	72	0.56	1.3
16HL134	0.5	<0.005	<10	238	0.25	0.13	0.12	0.04	18.23	0.7	84	0.34	2.8
16HL135	<0.1	<0.005	<10	210	0.31	0.11	0.21	0.05	39.86	2.0	63	0.68	3.4
16HL136	2.2	<0.005	<10	208	0.36	0.09	0.38	0.05	32.90	2.2	59	0.54	1.9
16HL137	0.8	<0.005	<10	492	0.45	0.12	0.04	<0.01	57.73	2.3	74	0.51	1.9
16HL138	29.3	0.012	<10	209	0.45	0.27	0.03	0.42	43.13	1.5	58	0.33	6.2
16HL139	2.6	<0.005	<10	75	0.49	0.41	0.24	0.43	141.36	2.6	60	0.69	12.6
16HL140	2.1	<0.005	<10	261	0.15	0.04	0.85	0.10	11.93	21.2	50	1.02	42.3
16HL141	2.4	<0.005	<10	577	0.21	0.02	1.36	0.13	9.36	28.1	77	2.39	17.3
16HL142	0.4	<0.005	<10	707	0.39	<0.01	0.97	0.04	41.66	15.0	19	4.00	1.1
16HL143	5.1	<0.005	<10	57	0.44	0.10	4.70	0.27	14.00	18.6	234	0.96	12.0
16HL144	1.6	<0.005	<10	264	0.25	0.05	4.24	1.76	3.19	32.1	175	0.83	65.2
16HL145	0.3	<0.005	<10	156	0.19	0.14	0.14	0.09	26.03	6.1	46	0.06	8.3
16HL146	0.3	<0.005	<10	357	0.45	1.11	0.08	0.75	31.75	1.4	84	0.17	1.7
16HL147	3.1	<0.005	<10	394	0.25	0.26	0.02	0.08	46.13	1.1	83	0.15	2.4
16HL148	<0.1	<0.005	<10	107	0.26	0.06	0.15	0.07	29.27	6.1	85	0.15	3.0
16HL149	0.3	<0.005	<10	315	0.43	0.04	0.20	0.16	38.87	7.4	74	1.04	18.0
16HL150	0.4	<0.005	<10	276	0.40	0.03	0.02	0.07	77.73	0.5	62	0.09	2.6
16HL151	0.3	<0.005	<10	432	0.42	0.08	0.07	0.14	61.25	5.5	117	1.70	12.6

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To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-130 As ppm 0.1	IMS-130 Au ppm 0.005	IMS-130 B ppm 10	IMS-130 Ba ppm 10	IMS-130 Be ppm 0.05	IMS-130 Bi ppm 0.01	IMS-130 Ca % 0.01	IMS-130 Cd ppm 0.01	IMS-130 Ce ppm 0.02	IMS-130 Co ppm 0.1	IMS-130 Cr ppm 1	IMS-130 Cs ppm 0.05	IMS-130 Cu ppm 0.2
16HL152	0.2	<0.005	<10	293	0.45	0.31	0.05	0.24	50.95	2.4	71	0.47	5.6
16HL153	0.7	<0.005	<10	294	0.37	0.07	0.02	0.06	68.93	1.7	71	0.36	1.7
16HL154	0.7	<0.005	<10	77	0.20	0.17	0.12	0.13	76.36	1.5	52	0.23	2.8
16HL155	<0.1	<0.005	<10	294	1.21	<0.01	2.86	0.22	42.39	44.2	266	4.86	48.0
16HL156	0.8	<0.005	<10	74	1.23	<0.01	1.67	0.09	39.93	47.1	101	0.28	71.1
16HL157	0.5	<0.005	<10	331	0.38	0.20	1.00	0.22	29.91	9.7	88	0.54	27.5
16HL158	<0.1	<0.005	<10	205	0.40	<0.01	0.04	<0.01	46.84	1.4	72	0.14	1.1
16HL159	0.1	<0.005	<10	248	0.29	0.11	0.37	0.04	26.34	9.4	67	0.22	1.5
16HL160	0.2	<0.005	<10	283	1.20	<0.01	1.97	0.15	45.72	49.9	277	1.12	53.7
16HL161	0.6	<0.005	<10	226	1.14	<0.01	2.07	0.10	43.17	45.3	271	4.25	48.5
16HL162	0.6	<0.005	<10	56	0.26	0.17	<0.01	0.06	28.26	2.0	104	0.10	6.1
16HL163	0.6	<0.005	<10	445	0.61	0.08	0.33	0.10	31.26	8.7	97	1.03	13.7
16HL164	0.2	<0.005	<10	229	0.46	0.16	0.26	0.51	61.34	2.9	90	1.13	3.2
16HL201	0.3	<0.005	<10	23	0.07	0.10	7.74	0.09	4.85	3.5	78	0.05	13.1
16HL202	4.4	<0.005	<10	36	0.10	0.04	8.10	1.81	3.27	9.3	59	<0.05	48.1
16HL203	201.4	0.067	<10	43	<0.05	0.16	0.03	0.02	1.43	3.1	165	0.09	36.6
16HL204	14.1	0.031	<10	31	0.09	0.10	0.17	0.05	5.05	4.4	296	0.07	59.3
16HL205	6.7	0.009	<10	13	0.64	0.24	0.01	0.02	14.85	1.0	83	0.81	6.8
DUP 16HL124	0.4	<0.005	<10	465	0.56	0.06	0.28	0.03	38.84	2.3	81	4.62	3.2
DUP 16HL137	0.6	<0.005	<10	501	0.43	0.12	0.04	0.02	56.59	2.2	75	0.50	2.2
DUP 16HL103													
DUP 16HL160													
DUP 16HL102													

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-130 As ppm 0.1	IMS-130 Au ppm 0.005	IMS-130 B ppm 10	IMS-130 Ba ppm 10	IMS-130 Be ppm 0.05	IMS-130 Bi ppm 0.01	IMS-130 Ca % 0.01	IMS-130 Cd ppm 0.01	IMS-130 Ce ppm 0.02	IMS-130 Co ppm 0.1	IMS-130 Cr ppm 1	IMS-130 Cs ppm 0.05	IMS-130 Cu ppm 0.2
DUP 16HL126													
DUP 16HL102													
DUP 16HL126													
STD BLANK	<0.1	<0.005	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
STD BLANK	<0.1	<0.005	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD OREAS 24b	8.1	<0.005	<10	143	1.70	0.66	0.45	0.05	66.55	16.5	100	9.67	36.4
SD OREAS 904	94.4	0.021	11	66	6.68	3.70	0.04	0.06	71.40	82.9	18	0.71	6221.8
STD OREAS 24b													
STD OREAS 504													
STD SY-4													
STD OREAS 120													
STD GMN-04													
STD OREAS 24b													
STD SY-4													

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
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	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na
	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
Sample ID	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01
16HL101	2.52	6.31	0.12	0.41	0.01	0.010	0.23	16.9	10.0	3.01	408	3.08	0.02
16HL102	2.17	4.64	0.12	0.20	<0.01	0.018	0.44	16.6	4.9	1.02	269	1.57	0.03
16HL103	0.41	2.37	0.08	0.41	<0.01	0.010	0.43	16.6	2.4	0.27	99	0.83	0.04
16HL104	0.94	2.84	0.12	0.11	<0.01	0.021	0.36	23.5	1.7	0.23	90	0.20	0.03
16HL105	0.45	2.63	0.09	0.07	<0.01	0.019	0.30	17.4	3.9	0.20	44	0.59	0.05
16HL106	0.73	3.06	0.15	0.23	<0.01	0.009	0.70	35.2	12.8	0.63	207	0.14	0.02
16HL107	0.71	2.37	0.09	0.04	<0.01	0.009	0.45	16.5	7.6	0.36	174	0.93	0.04
16HL108	1.28	4.51	0.14	0.05	<0.01	0.008	0.64	20.9	11.0	0.55	292	<0.05	0.06
16HL109	1.78	2.91	0.09	0.05	0.47	0.274	0.21	9.0	4.1	0.85	442	2.16	0.02
16HL110	3.35	6.46	0.10	0.08	0.03	0.054	0.23	2.1	10.5	2.36	739	1.23	0.02
16HL111	5.85	5.82	0.22	0.15	0.13	0.116	0.17	45.7	9.0	2.04	9423	3.43	0.02
16HL112	2.05	4.43	0.11	0.09	0.01	0.016	0.18	19.3	8.4	1.84	498	1.01	0.02
16HL113	1.72	4.47	0.08	0.07	<0.01	0.017	0.22	4.7	8.8	1.91	468	1.97	0.02
16HL114	3.49	1.55	0.08	0.06	1.68	0.360	0.30	9.8	1.7	0.17	265	5.71	0.02
16HL115	2.25	4.42	0.12	0.08	<0.01	0.013	0.75	9.9	5.0	0.91	772	1.34	0.03
16HL116	2.39	5.32	0.15	0.09	0.02	0.018	0.66	19.4	4.8	0.93	904	0.86	0.04
16HL117	1.19	2.05	0.14	0.15	<0.01	0.008	0.52	31.5	1.9	0.18	758	0.92	0.02
16HL118	1.50	2.11	0.11	0.14	0.02	0.013	0.49	25.1	1.5	0.19	598	0.77	0.03
16HL119	1.89	5.37	0.07	0.05	<0.01	0.023	0.18	4.3	11.6	2.72	368	1.12	0.02
16HL120	2.97	6.87	0.15	0.08	<0.01	0.015	0.16	26.9	14.3	2.84	467	0.21	0.02
16HL121	3.13	7.55	0.17	0.19	0.04	0.026	0.24	49.5	11.4	2.31	393	3.78	0.10
16HL122	0.64	3.92	0.20	0.61	<0.01	0.011	0.61	49.7	11.8	1.29	156	0.31	0.02
16HL123	0.97	4.05	0.11	0.04	<0.01	0.021	0.21	21.7	10.1	1.54	156	0.77	0.04
16HL124	1.47	4.28	0.14	0.05	<0.01	0.006	0.84	14.6	11.3	0.60	338	0.06	0.04
16HL125	1.09	3.35	0.12	0.03	<0.01	0.005	0.57	12.6	7.4	0.34	216	0.75	0.06

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MS Analytical
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Phone: +1-604-888-0875

To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-130 Fe % 0.01	IMS-130 Ga ppm 0.05	IMS-130 Ge ppm 0.05	IMS-130 Hf ppm 0.02	IMS-130 Hg ppm 0.01	IMS-130 In ppm 0.005	IMS-130 K % 0.01	IMS-130 La ppm 0.2	IMS-130 Li ppm 0.1	IMS-130 Mg % 0.01	IMS-130 Mn ppm 5	IMS-130 Mo ppm 0.05	IMS-130 Na % 0.01
16HL126	1.22	4.15	0.14	0.04	<0.01	0.024	0.85	24.2	9.3	0.75	260	0.43	0.03
16HL127	0.40	2.61	0.07	<0.02	<0.01	0.011	0.42	9.0	5.0	0.22	79	0.52	0.05
16HL128	0.91	3.33	0.11	0.06	<0.01	0.007	0.58	16.1	9.9	0.27	151	0.82	0.05
16HL129	1.15	3.53	0.12	0.04	<0.01	0.006	0.90	18.5	17.6	0.80	286	0.59	0.03
16HL130	1.07	2.90	0.09	<0.02	<0.01	<0.005	0.61	8.4	7.1	0.36	154	0.86	0.04
16HL131	0.87	2.95	0.09	0.03	<0.01	<0.005	0.66	16.6	7.4	0.25	211	0.40	0.04
16HL132	0.28	2.70	0.08	0.02	<0.01	0.012	0.27	16.9	2.3	0.03	38	0.43	0.04
16HL134	0.33	1.71	<0.05	<0.02	<0.01	0.009	0.28	9.2	2.4	0.08	54	1.05	0.02
16HL135	1.19	3.89	0.09	<0.02	<0.01	0.011	0.21	19.5	8.4	0.96	177	0.34	0.04
16HL136	0.88	3.64	0.09	0.02	<0.01	0.008	0.20	18.8	6.1	0.63	161	0.96	0.03
16HL137	1.02	3.80	0.13	0.10	<0.01	0.018	0.51	28.8	3.0	0.34	220	0.49	0.08
16HL138	1.25	1.97	0.09	0.32	0.12	0.035	0.27	20.0	2.2	0.04	35	3.62	0.01
16HL139	1.02	2.87	0.21	0.34	0.03	0.021	0.32	64.3	5.3	0.21	378	8.33	<0.01
16HL140	4.22	8.89	0.20	0.03	<0.01	0.029	0.70	4.8	20.7	1.97	501	1.09	0.09
16HL141	6.23	12.42	0.25	0.03	<0.01	0.041	0.82	4.2	36.1	4.17	699	0.38	0.06
16HL142	5.64	6.90	0.18	0.05	<0.01	0.045	0.37	20.1	10.3	3.38	858	0.28	0.03
16HL143	2.83	2.43	0.07	0.05	0.01	0.035	0.11	5.6	5.9	2.39	849	2.16	0.01
16HL144	5.91	10.03	0.15	<0.02	0.02	0.011	0.90	1.4	16.2	3.85	1181	0.71	0.21
16HL145	1.84	4.49	0.08	0.08	<0.01	0.015	0.14	13.2	3.9	1.16	248	0.65	0.08
16HL146	0.50	2.13	0.09	0.09	0.02	0.007	0.38	14.6	1.8	0.16	158	8.19	0.03
16HL147	0.77	1.83	0.09	0.25	0.01	<0.005	0.37	22.5	2.5	0.27	47	4.87	0.05
16HL148	2.52	1.57	0.07	0.06	<0.01	0.014	0.14	13.6	2.2	0.91	557	1.35	0.05
16HL149	2.85	7.29	0.16	0.13	<0.01	0.016	0.84	17.5	10.4	1.77	507	0.57	0.05
16HL150	0.28	2.21	0.12	0.29	<0.01	0.005	0.42	40.1	4.4	0.16	64	0.92	0.03
16HL151	1.47	4.08	0.17	0.16	<0.01	0.012	0.95	30.8	7.2	0.89	258	0.82	0.03

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Phone: +1-604-888-0875

To: **Glen Prior**
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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na
	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
Sample ID	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01
16HL152	1.01	2.62	0.13	0.18	<0.01	0.021	0.57	25.8	6.0	0.52	205	1.31	0.03
16HL153	0.82	3.95	0.12	0.38	<0.01	0.007	0.38	32.8	4.1	0.65	196	0.55	0.06
16HL154	0.54	1.20	0.12	0.12	<0.01	0.020	0.21	38.6	0.7	0.05	172	0.72	0.05
16HL155	7.14	6.68	0.18	0.37	<0.01	0.019	0.13	21.1	4.9	3.14	1067	1.62	0.55
16HL156	7.46	10.91	0.21	0.69	<0.01	0.021	0.42	19.9	7.2	4.14	854	4.16	1.05
16HL157	2.11	6.26	0.12	0.06	<0.01	0.026	0.51	14.8	7.2	0.97	703	1.22	0.07
16HL158	0.60	1.92	0.10	0.16	0.01	0.005	0.43	24.0	1.2	0.17	174	1.24	0.02
16HL159	1.27	3.12	0.09	0.07	<0.01	0.025	0.31	13.4	4.1	0.37	439	1.35	0.05
16HL160	7.43	7.57	0.18	0.44	<0.01	0.022	0.09	22.6	9.8	3.91	956	1.60	0.18
16HL161	7.23	7.37	0.16	0.44	<0.01	0.021	0.10	21.2	7.3	3.66	970	1.63	0.26
16HL162	1.80	6.73	0.06	0.08	<0.01	0.026	0.13	25.1	9.2	3.32	506	0.63	0.03
16HL163	3.09	5.58	0.15	0.09	<0.01	0.023	1.02	15.9	6.4	1.04	629	0.28	0.03
16HL164	1.02	3.18	0.15	0.17	<0.01	0.006	0.76	31.2	7.7	0.64	275	3.39	0.02
16HL201	4.31	0.43	0.05	<0.02	0.08	0.007	0.04	2.0	0.4	3.73	3246	1.61	0.01
16HL202	3.40	0.23	<0.05	<0.02	0.02	0.072	0.03	1.5	0.3	4.27	2839	1.39	<0.01
16HL203	4.07	0.32	0.05	<0.02	<0.01	<0.005	0.04	0.5	0.3	0.02	31	2.19	<0.01
16HL204	2.18	0.51	<0.05	<0.02	0.56	<0.005	0.09	2.3	0.7	0.09	90	4.83	<0.01
16HL205	6.23	2.34	0.09	0.32	0.65	0.006	0.28	4.4	3.1	0.03	14	2.55	<0.01
DUP 16HL124	1.47	4.37	0.14	0.05	<0.01	0.006	0.84	15.4	11.4	0.60	339	<0.05	0.03
DUP 16HL137	1.03	3.72	0.14	0.10	<0.01	0.017	0.52	28.2	2.8	0.34	223	0.49	0.08
DUP 16HL103													
DUP 16HL160													
DUP 16HL102													

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To: **Glen Prior**
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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-130 Fe % 0.01	IMS-130 Ga ppm 0.05	IMS-130 Ge ppm 0.05	IMS-130 Hf ppm 0.02	IMS-130 Hg ppm 0.01	IMS-130 In ppm 0.005	IMS-130 K % 0.01	IMS-130 La ppm 0.2	IMS-130 Li ppm 0.1	IMS-130 Mg % 0.01	IMS-130 Mn ppm 5	IMS-130 Mo ppm 0.05	IMS-130 Na % 0.01
DUP 16HL126													
DUP 16HL102													
DUP 16HL126													
STD BLANK	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01
STD BLANK	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD OREAS 24b	3.94	11.35	0.31	0.56	<0.01	0.047	1.17	32.7	49.2	1.36	350	3.83	0.11
SD OREAS 904	6.10	3.44	0.17	0.57	0.05	0.178	0.65	34.4	3.8	0.14	401	2.06	0.01
STD OREAS 24b													
STD OREAS 504													
STD SY-4													
STD OREAS 120													
STD GMN-04													
STD OREAS 24b													
STD SY-4													

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To: **Glen Prior**
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T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

Sample ID	IMS-130 Nb ppm 0.05	IMS-130 Ni ppm 0.2	IMS-130 P ppm 10	IMS-130 Pb ppm 0.2	IMS-130 Rb ppm 0.1	IMS-130 Re ppm 0.001	IMS-130 S % 0.01	IMS-130 Sb ppm 0.05	IMS-130 Sc ppm 0.1	IMS-130 Se ppm 0.2	IMS-130 Sn ppm 0.2	IMS-130 Sr ppm 0.2	IMS-130 Ta ppm 0.01
16HL101	<0.05	11.8	689	16.2	9.1	0.001	0.09	<0.05	2.2	0.6	0.2	13.1	<0.01
16HL102	<0.05	11.8	680	8.0	22.4	<0.001	<0.01	<0.05	2.8	0.4	0.3	7.8	<0.01
16HL103	0.14	1.7	64	14.8	19.9	<0.001	<0.01	<0.05	0.8	0.2	0.4	4.4	<0.01
16HL104	0.21	2.2	153	10.9	17.5	<0.001	<0.01	<0.05	1.4	0.3	0.5	4.8	<0.01
16HL105	0.57	3.8	129	14.7	17.5	<0.001	<0.01	0.08	1.2	0.4	0.7	23.9	0.01
16HL106	0.25	2.4	209	8.4	43.4	<0.001	<0.01	<0.05	1.1	0.3	0.5	11.3	0.01
16HL107	0.45	2.3	175	21.6	27.7	<0.001	<0.01	<0.05	0.9	<0.2	0.5	24.2	<0.01
16HL108	0.44	2.2	383	7.6	52.3	<0.001	<0.01	<0.05	1.1	0.2	0.7	44.8	0.01
16HL109	0.07	20.2	364	57.4	10.6	0.001	0.88	0.10	1.6	0.3	0.3	3.2	<0.01
16HL110	<0.05	33.3	601	43.3	13.2	0.001	0.81	<0.05	3.5	<0.2	0.5	3.3	<0.01
16HL111	<0.05	64.9	797	596.2	9.5	0.003	0.07	0.12	6.1	1.2	0.3	8.8	0.01
16HL112	<0.05	21.2	697	19.2	9.0	<0.001	0.29	0.11	1.4	<0.2	0.2	4.1	<0.01
16HL113	<0.05	17.8	642	10.9	10.9	<0.001	0.23	<0.05	1.3	<0.2	0.3	3.4	<0.01
16HL114	0.07	21.2	401	709.8	14.9	0.001	4.20	0.37	1.3	0.8	0.4	4.0	<0.01
16HL115	0.17	8.0	607	3.7	44.5	<0.001	<0.01	<0.05	2.8	<0.2	0.5	35.3	<0.01
16HL116	0.13	7.5	558	4.0	36.8	<0.001	0.02	<0.05	5.0	<0.2	0.5	34.5	<0.01
16HL117	0.12	4.0	498	2.6	33.1	0.001	0.29	0.36	1.4	<0.2	0.3	33.7	<0.01
16HL118	0.07	3.9	482	1.8	27.9	<0.001	0.05	0.14	1.9	<0.2	0.3	45.4	<0.01
16HL119	<0.05	4.7	554	3.0	7.5	<0.001	0.05	<0.05	2.0	<0.2	0.2	8.6	<0.01
16HL120	<0.05	7.9	681	5.6	6.9	<0.001	<0.01	<0.05	2.6	<0.2	<0.2	10.4	<0.01
16HL121	0.45	49.5	756	262.2	13.0	<0.001	0.52	0.16	5.1	0.5	1.0	57.7	0.02
16HL122	0.28	2.4	98	18.8	39.1	0.001	<0.01	<0.05	0.8	0.3	0.4	6.5	0.01
16HL123	0.14	2.9	53	7.5	8.0	<0.001	<0.01	0.06	1.9	<0.2	0.4	10.4	<0.01
16HL124	0.45	3.3	317	5.2	78.6	<0.001	<0.01	<0.05	0.9	<0.2	0.6	71.1	<0.01
16HL125	0.60	2.1	433	9.0	46.5	<0.001	<0.01	<0.05	0.8	<0.2	0.6	56.3	0.01

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
Job Report Date: 14-Nov-2016
Report Version: Final

	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.05	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01
16HL126	0.37	7.4	110	22.9	63.5	<0.001	<0.01	<0.05	2.0	<0.2	0.7	24.5	0.01
16HL127	0.17	1.8	73	8.9	26.2	<0.001	<0.01	<0.05	1.0	<0.2	0.5	32.3	<0.01
16HL128	0.31	3.2	440	6.8	31.3	<0.001	<0.01	<0.05	0.9	<0.2	0.6	41.3	<0.01
16HL129	0.44	3.2	447	7.0	49.6	<0.001	<0.01	<0.05	0.8	<0.2	0.5	28.3	0.01
16HL130	0.48	2.5	445	4.2	40.4	<0.001	<0.01	<0.05	0.5	<0.2	0.4	43.2	<0.01
16HL131	0.31	3.0	394	7.4	41.0	<0.001	<0.01	<0.05	0.6	<0.2	0.5	31.8	0.01
16HL132	0.35	1.8	67	6.2	13.7	<0.001	<0.01	<0.05	1.1	<0.2	0.6	21.9	<0.01
16HL134	0.13	2.6	37	8.2	14.9	<0.001	<0.01	<0.05	1.0	<0.2	0.4	32.4	<0.01
16HL135	0.08	2.3	320	8.9	8.7	<0.001	<0.01	<0.05	1.2	<0.2	0.6	46.9	<0.01
16HL136	0.11	3.0	314	7.8	6.8	<0.001	<0.01	0.06	0.9	0.7	0.5	66.1	<0.01
16HL137	0.26	3.2	162	3.7	33.4	<0.001	0.05	<0.05	1.4	0.7	0.8	8.2	<0.01
16HL138	0.92	6.6	28	15.7	14.9	<0.001	1.25	0.84	0.1	1.1	0.7	5.7	0.02
16HL139	1.95	4.1	<10	56.0	28.0	0.002	0.26	0.23	0.2	1.0	1.2	6.9	0.02
16HL140	0.33	8.0	529	7.1	25.2	0.001	0.72	<0.05	13.0	0.9	0.6	10.8	<0.01
16HL141	0.14	18.7	391	5.4	23.9	<0.001	0.14	0.06	22.3	0.8	0.4	22.3	<0.01
16HL142	0.12	1.7	1270	1.0	19.4	<0.001	0.01	<0.05	18.9	0.8	0.4	18.4	<0.01
16HL143	0.07	41.5	483	9.8	4.6	0.002	0.08	0.08	14.1	1.0	0.3	28.1	<0.01
16HL144	0.06	52.4	334	127.7	30.2	<0.001	0.52	0.21	12.9	0.8	0.2	32.6	<0.01
16HL145	0.43	4.4	359	4.1	3.8	<0.001	0.87	<0.05	2.0	1.0	0.4	12.0	<0.01
16HL146	0.18	3.4	141	150.1	15.7	0.006	<0.01	0.13	0.7	0.7	0.4	12.2	<0.01
16HL147	0.29	2.4	53	3.9	14.1	<0.001	0.61	<0.05	0.5	0.8	0.3	7.0	<0.01
16HL148	0.08	5.6	538	2.7	5.6	<0.001	0.45	<0.05	2.6	0.5	<0.2	11.4	<0.01
16HL149	0.13	9.6	663	7.3	31.8	<0.001	<0.01	<0.05	4.5	0.9	0.4	16.5	<0.01
16HL150	0.14	1.9	61	4.7	15.2	<0.001	<0.01	<0.05	0.4	0.7	0.3	7.3	<0.01
16HL151	0.28	7.2	288	19.2	46.8	<0.001	0.24	<0.05	1.6	1.3	0.5	10.8	<0.01

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MS Analytical

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Phone: +1-604-888-0875

To: **Glen Prior**
793 Birch Avenue
Sherwood Park, Alberta
T8A 1X2

CERTIFICATE OF ANALYSIS: MA0090-OCT16

Project Name: HL
Job Received Date: 27-Oct-2016
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Sample ID	IMS-130 Nb ppm 0.05	IMS-130 Ni ppm 0.2	IMS-130 P ppm 10	IMS-130 Pb ppm 0.2	IMS-130 Rb ppm 0.1	IMS-130 Re ppm 0.001	IMS-130 S % 0.01	IMS-130 Sb ppm 0.05	IMS-130 Sc ppm 0.1	IMS-130 Se ppm 0.2	IMS-130 Sn ppm 0.2	IMS-130 Sr ppm 0.2	IMS-130 Ta ppm 0.01
16HL152	0.26	3.2	197	17.4	26.8	<0.001	0.20	<0.05	0.9	0.6	0.6	8.6	<0.01
16HL153	0.21	2.3	43	6.6	17.7	<0.001	0.11	0.12	0.6	1.0	0.4	10.0	<0.01
16HL154	0.11	2.2	66	15.0	8.5	0.002	0.13	<0.05	1.3	0.8	0.2	14.6	<0.01
16HL155	2.23	238.3	2420	0.8	8.1	<0.001	<0.01	<0.05	1.8	1.1	0.9	164.2	0.05
16HL156	3.54	190.8	2159	1.5	16.6	<0.001	0.06	<0.05	2.7	1.5	1.0	256.0	0.09
16HL157	0.37	18.5	745	1.8	26.7	<0.001	0.24	<0.05	4.1	0.8	1.6	31.8	<0.01
16HL158	0.16	3.2	173	3.4	13.7	<0.001	<0.01	<0.05	0.6	0.4	0.4	11.4	<0.01
16HL159	0.16	7.2	328	1.2	15.1	<0.001	0.35	<0.05	1.4	0.3	1.1	22.2	<0.01
16HL160	2.11	258.2	2651	0.7	4.9	<0.001	<0.01	<0.05	2.1	1.1	1.0	167.5	0.06
16HL161	1.81	258.3	2601	1.0	7.1	<0.001	<0.01	<0.05	1.9	0.9	1.0	166.5	0.04
16HL162	0.23	4.7	123	2.4	5.1	<0.001	0.02	<0.05	2.5	0.8	0.5	4.5	<0.01
16HL163	0.32	10.0	568	4.4	60.9	<0.001	0.05	<0.05	2.7	0.8	1.4	38.0	<0.01
16HL164	0.21	4.7	328	17.5	36.0	<0.001	<0.01	<0.05	0.8	0.7	0.4	16.9	<0.01
16HL201	0.15	13.5	79	4.8	1.8	<0.001	1.42	0.19	1.4	1.8	<0.2	76.8	<0.01
16HL202	0.11	13.0	569	6.3	1.2	<0.001	0.68	0.31	0.7	1.6	<0.2	243.3	<0.01
16HL203	0.08	37.2	<10	6.0	1.9	<0.001	4.58	1.27	<0.1	6.1	0.3	1.4	<0.01
16HL204	0.23	15.3	12	12.5	6.6	<0.001	2.16	3.35	<0.1	1.8	0.5	5.0	<0.01
16HL205	0.89	14.3	1446	27.7	19.6	<0.001	7.50	0.42	0.1	1.1	1.3	173.6	<0.01
DUP 16HL124	0.52	3.4	309	5.1	82.5	<0.001	<0.01	<0.05	0.9	<0.2	0.7	69.9	0.01
DUP 16HL137	0.36	3.2	164	3.8	33.2	<0.001	0.05	<0.05	1.5	0.8	0.7	8.5	<0.01
DUP 16HL103													
DUP 16HL160													
DUP 16HL102													

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DUP 16HL126													
DUP 16HL102													
DUP 16HL126													
STD BLANK	<0.05	<0.2	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01
STD BLANK	<0.05	<0.2	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	0.2	<0.2	<0.2	<0.01
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD BLANK													
STD OREAS 24b	0.39	58.2	612	8.4	119.3	<0.001	0.18	0.48	9.8	0.5	2.4	29.7	<0.01
SD OREAS 904	0.07	35.9	935	8.6	24.3	<0.001	0.03	0.89	3.7	2.6	0.6	16.2	<0.01
STD OREAS 24b													
STD OREAS 504													
STD SY-4													
STD OREAS 120													
STD GMN-04													
STD OREAS 24b													
STD SY-4													

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	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05	2	0.5
16HL101	0.08	7.2	0.007	0.14	3.27	22	0.08	5.85	71	22.4
16HL102	0.09	9.8	0.031	0.27	1.29	17	0.07	9.52	58	10.0
16HL103	0.06	12.0	0.013	0.14	1.22	1	1.32	5.21	37	15.6
16HL104	0.07	13.4	0.010	0.10	0.96	5	0.18	10.45	61	5.2
16HL105	0.08	11.1	0.016	0.13	2.51	4	0.93	13.56	17	2.7
16HL106	0.05	13.8	0.034	0.34	1.90	2	0.16	15.34	31	8.8
16HL107	0.04	6.9	0.039	0.20	1.05	2	1.67	6.49	29	1.8
16HL108	0.03	7.8	0.085	0.39	1.09	5	0.16	5.15	49	2.8
16HL109	0.07	5.7	0.005	0.13	1.59	11	1.67	5.31	2041	2.6
16HL110	0.07	6.8	0.009	0.14	0.70	29	0.24	2.93	272	2.9
16HL111	0.22	35.7	0.006	0.31	11.81	25	1.30	65.82	1215	9.2
16HL112	0.11	9.6	0.006	0.20	1.15	10	0.16	5.54	93	3.6
16HL113	0.04	7.6	0.007	0.09	1.52	9	1.26	3.81	109	2.9
16HL114	0.34	5.6	0.010	0.34	1.12	8	0.31	6.20	7078	2.4
16HL115	0.12	6.7	0.096	0.30	0.78	15	1.05	5.34	63	3.1
16HL116	0.06	9.0	0.074	0.25	0.93	21	0.12	10.62	174	3.4
16HL117	0.06	14.6	0.021	0.22	0.74	5	1.07	17.75	18	5.5
16HL118	<0.01	13.1	0.021	0.22	1.98	6	0.08	13.27	27	6.7
16HL119	<0.01	7.5	<0.005	0.05	1.08	15	1.64	8.54	80	2.6
16HL120	<0.01	12.1	0.008	0.06	2.30	26	0.12	12.85	97	4.3
16HL121	0.06	13.0	0.199	0.17	6.23	25	1.25	1.52	263	9.8
16HL122	0.01	22.1	0.012	0.35	3.12	<1	0.22	34.92	73	27.4
16HL123	<0.01	17.5	0.005	0.06	0.75	<1	1.23	11.49	79	1.8
16HL124	0.01	6.6	0.089	0.64	0.82	6	0.19	3.25	59	2.3
16HL125	<0.01	5.8	0.092	0.36	0.86	4	1.02	3.73	41	1.4

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CERTIFICATE OF ANALYSIS: MA0090-OCT16

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	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130	IMS-130
	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sample ID	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05	2	0.5
16HL126	<0.01	8.6	0.039	0.54	1.96	4	0.18	15.39	72	1.6
16HL127	<0.01	5.7	0.012	0.23	0.99	1	1.06	4.95	29	0.6
16HL128	0.03	7.5	0.051	0.25	1.45	4	1.20	4.64	30	3.5
16HL129	0.02	7.8	0.066	0.43	0.84	3	0.57	3.60	49	2.1
16HL130	0.02	5.0	0.057	0.32	0.42	3	1.41	2.36	40	0.6
16HL131	0.02	6.6	0.062	0.31	0.86	3	0.62	3.86	32	1.3
16HL132	0.02	5.8	0.010	0.07	1.01	<1	0.54	5.54	19	0.7
16HL134	<0.01	3.4	<0.005	0.10	0.79	<1	1.77	4.39	10	<0.5
16HL135	<0.01	9.0	0.007	0.05	1.02	3	0.45	4.78	45	0.6
16HL136	0.04	5.9	0.007	0.04	0.69	3	1.32	2.93	38	0.8
16HL137	0.05	11.8	0.050	0.24	1.33	4	0.55	10.94	34	2.6
16HL138	0.05	25.5	<0.005	0.08	3.18	<1	1.87	15.62	112	10.6
16HL139	0.03	42.8	<0.005	0.19	6.51	<1	0.77	30.28	136	12.7
16HL140	0.05	3.2	0.132	0.15	0.87	98	0.93	8.62	70	0.9
16HL141	0.03	2.3	0.078	0.15	0.41	265	0.32	6.22	83	0.9
16HL142	0.03	6.3	0.032	0.10	0.75	123	0.43	12.56	91	1.6
16HL143	0.06	3.1	<0.005	0.05	0.68	54	0.37	12.37	70	1.4
16HL144	0.02	0.6	0.128	0.18	0.14	161	0.59	3.08	291	<0.5
16HL145	0.04	10.8	0.048	<0.02	1.01	12	1.30	6.30	41	2.2
16HL146	0.03	10.4	0.008	0.12	1.77	3	0.67	6.65	19	2.3
16HL147	0.03	14.2	0.008	0.09	2.46	1	0.68	4.92	20	5.5
16HL148	0.03	6.4	<0.005	0.04	5.68	11	2.12	5.79	65	2.4
16HL149	0.05	7.0	0.123	0.24	0.84	31	0.56	9.33	85	3.3
16HL150	0.04	14.6	0.005	0.10	1.34	<1	1.91	4.47	11	7.5
16HL151	0.07	10.9	0.076	0.42	1.57	7	0.99	12.06	46	5.1

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16HL152	0.05	10.5	0.025	0.23	1.43	3	2.13	2.98	65	5.7
16HL153	0.05	14.4	0.012	0.13	1.79	<1	0.63	10.72	28	11.9
16HL154	0.02	14.9	<0.005	0.11	2.97	<1	1.01	16.28	26	3.5
16HL155	0.04	2.4	0.781	<0.02	0.47	116	0.39	12.13	111	20.6
16HL156	0.12	2.7	1.048	0.03	0.60	131	0.49	11.20	101	34.4
16HL157	0.08	7.3	0.105	0.17	1.34	36	0.69	11.05	101	2.2
16HL158	0.05	10.7	0.007	0.10	1.25	2	2.08	5.62	16	3.4
16HL159	0.03	6.8	0.033	0.10	0.83	8	0.48	7.73	20	1.9
16HL160	0.06	1.8	0.820	<0.02	0.43	129	0.47	12.46	112	23.0
16HL161	0.06	1.7	0.764	<0.02	0.42	123	0.45	12.02	107	22.1
16HL162	0.06	10.8	0.007	0.04	0.76	7	0.11	2.95	72	2.5
16HL163	0.06	6.9	0.123	0.46	0.80	19	0.32	5.66	105	3.0
16HL164	0.02	14.4	0.031	0.33	4.25	3	2.70	6.37	69	5.1
16HL201	0.07	0.9	<0.005	0.45	4.97	10	0.32	8.24	28	1.0
16HL202	0.07	0.3	<0.005	0.10	2.67	11	2.08	8.91	146	0.9
16HL203	0.15	0.2	<0.005	0.09	0.07	3	0.20	0.18	5	<0.5
16HL204	0.06	1.4	<0.005	1.63	0.21	2	10.53	0.59	13	0.7
16HL205	0.03	5.5	<0.005	2.30	2.21	4	0.83	8.63	8	9.3
DUP 16HL124	0.02	6.3	0.088	0.59	0.79	6	0.15	3.43	59	2.3
DUP 16HL137	0.02	12.3	0.051	0.24	1.39	4	0.60	10.88	35	2.5
DUP 16HL103										
DUP 16HL160										
DUP 16HL102										

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DUP 16HL126										
DUP 16HL102										
DUP 16HL126										
STD BLANK	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05	<2	<0.5
STD BLANK	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05	<2	<0.5
STD BLANK										
STD BLANK										
STD BLANK										
STD BLANK										
STD BLANK										
STD BLANK										
STD OREAS 24b	0.06	15.1	0.204	0.66	1.61	76	1.16	12.88	97	26.3
SD OREAS 904	0.04	7.8	0.007	0.17	4.99	23	0.57	16.82	25	18.2
STD OREAS 24b										
STD OREAS 504										
STD SY-4										
STD OREAS 120										
STD GMN-04										
STD OREAS 24b										
STD SY-4										

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Appendix 4

Analytical Methods

Mineral Grain Microprobe Analyses

Microprobe analysis was undertaken by the Saskatchewan Research Council (SRC) of Saskatoon, Saskatchewan. The following method description was provided by SRC.

Grains were analyzed using a Cameca Instruments SX-100 electron probe microanalyzer fitted with 5 tunable wavelength dispersive spectrometers. The analytical conditions are set to 20 nA beam current, measured in a faraday cup, with an accelerating potential of 20 kV. The incident beam is approximately 100 nm diameter (fully focused). Our typical analytical protocol includes Si, Ti, Al, V, Cr, Nb, Fe, Mn, Ni, Mg, Ca, Zn, Na and K reported as oxides with detection limits between 20 and 100 ppm (1 sigma). The raw X-ray intensity counts are converted to oxide concentrations using a phi-rho-Z correction. Accuracy and reproducibility are assessed by repeat (5 times) analysis of a secondary glass standard (GOR-128).

Appendix 5

Analytical Results

Mineral Grain Microprobe Analyses

Glen Prior

Samples: 56

SRC Advanced Microanalysis Centre
125 - 15 Innovation Blvd, Saskatoon, SK, S7N 2X8
Tel: 306.933.7893 Fax: 306.933.5656 Email: microlab@src.sk.ca

Group No.: AMC2016-176

Date of Report: Nov. 21, 2016

Electron Probe Microanalysis

Samples	Spot No.	Mineral	SiO_2 wt%	TiO_2 wt%	Al_2O_3 wt%	Cr_2O_3 wt%	V_2O_3 wt%	FeO wt%	MnO wt%	NiO wt%	ZnO wt%	MgO wt%	CaO wt%	Na_2O wt%	K_2O wt%	Nb_2O_5 wt%	Total
GOR128	1		45.935	0.294	9.975	0.314	0.029	9.784	0.172	0.135	<0.006	26.021	6.204	0.592	0.035	<0.008	99.489
GOR128	2		45.948	0.289	9.953	0.318	0.030	9.757	0.171	0.136	<0.006	26.024	6.207	0.586	0.034	<0.008	99.455
GOR128	3		45.962	0.284	9.919	0.321	0.034	9.811	0.176	0.137	<0.006	26.141	6.221	0.577	0.034	<0.008	99.616
GOR128	4		45.986	0.288	9.916	0.320	0.017	9.736	0.176	0.135	<0.006	26.141	6.207	0.584	0.035	<0.008	99.542
GOR128	5		45.927	0.295	9.961	0.317	0.021	9.754	0.176	0.136	<0.006	26.069	6.218	0.581	0.036	<0.008	99.491
16HL301A	1	olivine	40.551	<0.002	0.013	0.020	<0.004	9.181	0.119	0.467	<0.005	49.549	0.081	0.005	<0.001	<0.008	99.986
16HL301A	2	olivine	40.466	<0.002	0.005	0.014	<0.004	9.205	0.131	0.447	<0.006	49.261	0.082	0.005	<0.001	<0.008	99.617
16HL301A	3	olivine	40.509	<0.002	0.005	0.019	<0.004	9.180	0.140	0.475	<0.006	49.019	0.081	0.007	<0.001	<0.008	99.434
16HL301A	4	olivine	40.596	<0.002	0.015	0.015	<0.004	9.202	0.123	0.434	<0.006	49.140	0.081	0.004	<0.001	<0.008	99.611
16HL301A	5	olivine	40.260	<0.002	0.005	0.011	<0.004	9.168	0.125	0.449	0.011	49.856	0.080	<0.002	<0.001	<0.008	99.964
16HL301B	1	cpx	51.660	0.167	5.031	1.185	0.036	2.644	0.097	0.046	<0.006	16.691	21.052	0.750	0.004	<0.008	99.364
16HL301B	2	cpx	51.367	0.173	4.844	1.138	0.027	2.680	0.088	0.056	<0.006	16.628	21.104	0.724	<0.001	<0.008	98.830
16HL301B	3	cpx	51.135	0.165	4.454	1.025	0.038	2.621	0.087	0.054	<0.006	16.763	21.122	0.695	<0.001	<0.008	98.160
16HL301B	4	cpx	51.775	0.180	4.748	1.064	0.030	2.599	0.084	0.059	<0.006	16.914	21.196	0.702	0.002	<0.008	99.353
16HL301B	5	cpx	50.958	0.178	4.871	1.158	0.036	2.611	0.083	0.059	<0.006	16.785	21.209	0.733	0.003	<0.008	98.682
16HL301B	6	olivine	40.895	<0.002	0.011	0.017	<0.004	9.213	0.131	0.458	<0.006	47.250	0.082	0.004	<0.001	<0.008	98.061
16HL301D	1	opx	54.561	0.063	4.213	0.654	0.006	5.715	0.133	0.118	<0.005	33.267	0.977	0.052	<0.001	0.016	99.776
16HL301D	2	opx	55.126	0.064	4.055	0.647	0.006	5.736	0.136	0.102	<0.005	32.751	0.991	0.047	0.004	<0.008	99.665
16HL301D	3	opx	54.384	0.066	4.411	0.702	0.021	5.765	0.139	0.106	<0.005	32.844	0.974	0.050	0.002	<0.008	99.464
16HL301D	4	opx	54.562	0.061	4.127	0.632	0.020	5.766	0.123	0.130	<0.005	33.046	0.962	0.049	<0.001	<0.008	99.479
16HL301D	5	olivine	40.298	<0.002	0.008	0.011	<0.004	11.214	0.119	0.468	<0.005	48.011	0.082	0.003	<0.001	<0.008	100.215
16HL302A	1	olivine	39.757	<0.002	0.031	0.015	<0.004	11.331	0.137	0.413	<0.006	48.274	0.096	0.014	<0.001	<0.008	100.069
16HL302A	2	olivine	39.962	<0.002	0.060	0.015	<0.004	11.342	0.139	0.358	<0.006	48.238	0.102	0.014	0.004	<0.008	100.235
16HL302A	3	olivine	40.049	<0.002	0.021	0.014	<0.004	11.147	0.140	0.388	<0.006	48.520	0.100	0.009	0.003	<0.008	100.391
16HL302A	4	olivine	39.942	<0.002	0.019	0.015	0.005	11.805	0.147	0.380	<0.006	47.841	0.105	0.017	<0.001	0.017	100.293
16HL302A	5	olivine	39.798	<0.002	0.029	0.022	<0.004	11.223	0.137	0.415	<0.006	48.126	0.101	0.011	<0.001	<0.008	99.861
16HL302B	1	cpx	51.028	0.466	7.204	0.878	0.035	4.004	0.101	0.045	<0.006	15.765	18.164	1.780	0.002	<0.008	99.472
16HL302B	2	cpx	51.039	0.476	7.234	0.896	0.020	3.982	0.113	0.048	<0.006	15.693	18.134	1.782	0.005	<0.008	99.423
16HL302B	3	cpx	51.042	0.447	7.152	0.884	0.033	3.771	0.101	0.042	<0.006	15.927	18.192	1.695	0.005	<0.008	99.290
16HL302B	4	cpx	50.939	0.465	7.200	0.909	0.024	3.969	0.097	0.043	<0.006	15.658	18.112	1.778	0.005	<0.008	99.200
16HL302B	5	cpx	51.070	0.451	7.150	0.834	0.026	3.829	0.081	0.052	<0.006	15.835	18.372	1.719	0.007	<0.008	99.427
16HL302C	1	spinel	0.073	0.214	54.335	11.263	0.056	12.971	0.092	0.418	0.065	19.798	<0.001	<0.002	<0.001	0.019	99.305

Samples	Spot No.	Mineral	SiO_2 wt%	TiO_2 wt%	Al_2O_3 wt%	Cr_2O_3 wt%	V_2O_3 wt%	FeO wt%	MnO wt%	NiO wt%	ZnO wt%	MgO wt%	CaO wt%	Na_2O wt%	K_2O wt%	Nb_2O_5 wt%	Total
16HL302C	2	spinel	0.085	0.211	54.342	11.286	0.058	13.020	0.094	0.408	0.082	19.905	<0.001	<0.002	<0.001	0.013	99.504
16HL302C	3	spinel	0.073	0.220	54.230	11.401	0.070	13.096	0.088	0.399	0.059	19.595	<0.001	<0.002	<0.001	<0.008	99.229
16HL302C	4	spinel	0.088	0.222	54.838	11.306	0.064	13.352	0.078	0.397	0.063	19.709	<0.001	<0.002	<0.001	0.008	100.125
16HL302C	5	spinel	0.074	0.345	55.498	8.907	0.071	14.471	0.092	0.449	0.095	19.448	<0.001	<0.002	<0.001	<0.008	99.450
16HL302D	1	opx	53.366	0.142	5.632	0.477	0.020	7.143	0.135	0.115	<0.005	31.734	1.069	0.182	<0.001	<0.008	100.016
16HL302D	2	opx	53.336	0.140	5.605	0.488	0.022	7.192	0.137	0.111	<0.005	31.737	1.075	0.190	<0.001	<0.008	100.033
16HL302D	3	opx	53.195	0.138	5.636	0.490	0.007	7.011	0.128	0.123	<0.005	31.831	1.121	0.182	<0.001	<0.008	99.862
16HL302D	4	opx	53.394	0.145	5.685	0.492	0.006	6.961	0.128	0.125	<0.005	31.922	1.059	0.178	<0.001	<0.008	100.096
16HL302D	5	opx	53.273	0.137	5.575	0.485	0.023	7.097	0.121	0.097	<0.005	31.789	1.105	0.185	0.003	0.008	99.897
16HL303A	1	olivine	39.822	<0.002	0.055	0.020	<0.004	11.388	0.139	0.382	<0.006	48.018	0.097	0.019	<0.001	<0.008	99.941
16HL303A	2	olivine	39.840	<0.002	0.027	0.013	<0.004	11.473	0.145	0.384	<0.006	48.207	0.101	0.010	<0.001	<0.008	100.200
16HL303A	3	olivine	39.853	0.002	0.026	0.016	<0.004	11.319	0.146	0.409	<0.006	48.115	0.097	0.011	<0.001	<0.008	99.995
16HL303A	4	olivine	39.786	0.003	0.028	0.012	0.005	11.376	0.140	0.394	<0.006	48.019	0.103	0.008	<0.001	<0.008	99.874
16HL303A	5	olivine	39.982	0.002	0.021	0.018	<0.004	11.447	0.143	0.399	0.010	48.130	0.105	0.006	<0.001	<0.008	100.263
16HL303B	1	cpx	50.933	0.451	7.294	0.818	0.041	4.069	0.111	0.051	<0.006	15.867	17.796	1.798	0.007	0.015	99.250
16HL303B	2	cpx	50.955	0.500	7.392	0.837	0.039	4.110	0.099	0.061	<0.006	15.764	17.603	1.845	0.007	<0.008	99.211
16HL303B	3	cpx	51.005	0.468	7.370	0.813	0.037	4.132	0.093	0.039	<0.006	15.883	17.815	1.828	0.004	<0.008	99.488
16HL303B	4	cpx	51.109	0.455	7.316	0.846	0.051	3.931	0.094	0.050	<0.006	15.781	18.090	1.758	0.006	<0.008	99.486
16HL303B	5	cpx	51.105	0.477	7.140	0.836	0.042	4.109	0.113	0.035	<0.006	15.729	18.022	1.801	0.008	<0.008	99.418
16HL303C	1	spinel	0.072	0.252	54.153	11.076	0.071	13.378	0.076	0.387	0.075	19.594	<0.001	<0.002	<0.001	<0.008	99.133
16HL303C	2	spinel	0.090	0.248	54.161	11.233	0.068	13.495	0.100	0.388	0.054	19.499	<0.001	<0.002	<0.001	<0.008	99.336
16HL303C	3	spinel	0.077	0.247	54.354	11.116	0.075	13.592	0.103	0.376	0.067	19.512	<0.001	<0.002	<0.001	<0.008	99.520
16HL303C	4	spinel	0.066	0.267	54.284	11.281	0.072	13.670	0.092	0.359	0.078	19.578	<0.001	<0.002	<0.001	<0.008	99.747
16HL303C	5	spinel	0.080	0.238	54.237	11.238	0.058	13.489	0.088	0.382	0.070	19.651	<0.001	<0.002	<0.001	<0.008	99.529
16HL303D	1	opx	53.722	0.139	5.704	0.475	0.024	7.394	0.149	0.092	<0.005	31.495	1.064	0.190	0.002	<0.008	100.450
16HL303D	2	opx	53.771	0.131	5.717	0.481	0.010	7.241	0.128	0.098	<0.005	31.690	1.069	0.181	0.002	<0.008	100.518
16HL303D	3	opx	53.788	0.154	5.781	0.493	0.021	7.422	0.135	0.093	<0.005	31.444	1.136	0.192	<0.001	<0.008	100.658
16HL303D	4	opx	53.862	0.146	5.569	0.473	0.013	7.206	0.140	0.101	<0.005	31.531	1.080	0.184	<0.001	<0.008	100.303
16HL303D	5	opx	53.719	0.137	5.630	0.486	0.015	7.184	0.135	0.099	<0.005	31.591	1.084	0.194	<0.001	<0.008	100.274

YMEP FINAL SUBMISSION FORM

	Date submitted: 2017-January-19
submit by January 31st to: *(winter placer projects may submit at pre-approved date)*	YMIP- EMR/ YTG Street address: 102-300 Main Street — YMEP@gov.yk .ca Mailing address: Box 2703, K-102 — phone: 867-456-3828 Whitehorse, Yt, Y1A 2C6 — fax: 867-667-3198

CONTACT INFO		***PROJECT INFO***	
Name:	Glen Prior	YMEP no:	16-070
Address:	793 Birch Avenue, Sherwood Park, Alberta	Project name:	Hall Creek Project
	T8A 1X2	Project type:	Hard Rock
email	gprior001@gmail.com	Project module:	Focused Regional
Phone:	780-464-0057		

Is the final report enclosed? ☑ yes ☐ no — ☑ hard copy ☑ pdf copy ☑ digital spreadsheet of station location data

Comment:

PROJECT SUMMARY

Total project expenditures: $22,140.22

Number of new claims since March 31st: 10

Has an option resulted since March 31? ☐ yes ☑ no ☐ in negotiation

Number of calendar field days: 20 (+ 2 travel days)

Number of person-days of employment: 22 paid ____ days of unpaid work

Total no. of samples: 68 rocks ____ silts ____ soils 56 mineral grains other

Total length/volume of trenching/ shafting: ____

Total number of line-km of geophysics ____

Total meters drilled ____ diamond drill ____ RC drill ____ auger/percussion drill

Other products (provide details):

FINANCIAL SUMMARY

This is not an expense claim form.To request reimbursement of expenses, please submit a separate detailed expense claim form.

Total daily field allowance	$2,000.00	Total contractor costs	
Total field air transportation costs (helicopter/plane)		Total excavating/ heavy equipment costs	
Total truck/ mileage costs	$1,100.00	Total assay/analyses costs	$4,964.42
Total wages paid	$10,000.00	Total reclamation costs	
Total light equipment rental costs		Total report writing cost	$2,000.00
Other (please specify)		Total staking costs	$1,000.00
Other (please specify)	quad ($880.00), shipping ($195.80)		

Your feedback on any aspect of the program:

Note: Amount listed for total wages paid (above) does not include wages related to staking and report writing (listed separately).

This is an excellent program to encourage mineral exploration in the Yukon. I would not have been able to undertake the 2016 Hall Creek exploration project without YMEP assistance.

The Department of Energy, Mines and Resources may verify all statements related to and made on this form, in any previously submitted reports, interim claims and in the Summary or Technical Report which accompanies it.

I certify that;

1. I am the person, or the representative of the company or partnership, named in the Application for Funding and in the Contribution Agreement under the Yukon Mining Incentives Program.

2. I am a person who is nineteen years of age or older, and I have complied with all the requirements of the said program.

3. I hereby apply for the final payment of a contribution under the Yukon Mineral Exploration Program (YMEP) and declare the information contained within the Summary or Technical Report and this form to be true and accurate.

Date 2017-January-19

Signature of Applicant [signature]

Name (print) Glen Prior

(see reverse)