High-sulphidation epithermal Au-Ag-Cu mineralization at the McKay Hill property — a revised deposit model

***Lauren R. Blackburn*[1]**
Monster Mining Corporation[2]

Blackburn, L.R., 2010. High-sulphidation epithermal Au-Ag-Cu mineralization at the McKay Hill property — a revised deposit model. *In*: Yukon Exploration and Geology 2009, K.E. MacFarlane, L.H. Weston and L.R. Blackburn (eds.), Yukon Geological Survey, p. 85-101.

ABSTRACT

The past-producing McKay Hill property on NTS map sheet 106D/6 (Nash Creek) has previously been described as polymetallic Ag-Pb-Zn ± Au-style mineralization. During the 2009 YMIP-funded exploration program the central claims on the property were mapped and numerous distinct differences from the proposed polymetallic model became apparent. Unlike Keno Hill, veins on the McKay Hill property lack siderite gangue and are not present as vein-faults. Propylitic alteration halos surrounding vertically zoned ore shoots (high-level Au-Cu and deeper level Ag-Cu-Pb) were observed within consistently north-northwest-striking, near vertical, siliciclastic and hypabyssal-volcanic rocks. The Ag-Pb-Zn veins in the Keno Hill Camp were emplaced in discrete dilational fault structures within polydeformed clastic metasediments and are not associated with extensive alteration. Host rock competency in both areas is vital in controlling mineralization. Re-evaluating the regional framework could potentially illustrate the area's metallogenic potential for different types of mineral occurrences.

[1]*lauren.monstermining@gmail.com*

[2]*Suite 916-925 W Georgia Street, Vancouver, British Columbia, Canada, V6C 3L2*

INTRODUCTION

Bedrock mapping was completed during Monster Mining Corporation's 2009, YMIP-funded target evaluation exploration program over a 700 m^2 area on the southern flank of Horseshoe Hill in central Yukon. This area is 2 km north of the Beaver River on the Nash Creek 1:50 000-scale map sheet (NTS 106D/6; Fig. 1). The area is located approximately 50 km north-northwest of Keno City and is centered at 64° 20′ North Latitude, 135° 22′ West Longitude.

The Keno Hill camp is a historic mining camp that has been producing silver, lead and zinc ore for 95 years. The mineralogy of Keno Hill veins is a highly varied mix of sulphides (argentiferous galena and tetrahedrite) and sulphosalts (pyragerite and stephanite). An earlier stage of Au-As-Sn vein mineralization is found within the district; this stage is associated with significantly less silver, lead and zinc. From 1914 to 1989, total silver production exceeded 200 million ounces (J. McFaull, pers. comm., 2009).

The ATAC Resources Ltd. 540 km^2 Rau gold property (Yukon MINFILE 106D 098), located 2.6 km to the northeast of the McKay Hill property, is hosted in dolomitized or decalcified limestone and is proposed as the northern part of the *Carlin Trend* (ATAC Resources Ltd., web page accessed November 3, 2009). Potential for deeper level Carlin-style mineralization at the McKay Hill property has not been tested to date.

Monster Mining Corporation's 2009 exploration program included detailed mapping of a 450 m X 600 m area; collection and petrographic analysis of 10 thin sections and 7 polished sections; collection of 140 soil samples; and geochemical characterization and analysis of 8 rocks obtained from various veins at different levels. The recently staked White Hill occurrence (Yukon MINFILE 106D 038) situated on the western side of the claim block was located and prospected by M. Bindig.

Previous knowledge of bedrock geology of the 'Nash Creek' area was based on J.A. Roddick's 1972 Geological Survey of Canada (GSC) 1:250 000-scale map 1282A. It is this author's hope that findings at the Rau and McKay Hill properties will prompt the government to complete 1:50 000-scale mapping of the 106D/6 and 106D/7 map sheets.

PROPERTY HISTORY

The McKay Hill property (Yukon MINFILE 106D 037 and 038) history extends back to 1922 during the early days of the Keno Hill district staking rush. Extensive trenching and underground development work was completed on the property in these early years, and in the late 1940s, 143 tonnes of silver-ore grading 390 g/t Ag were produced by East Bay Gold Ltd. from Vein No. 6. In 1929, 832 m of diamond drilling was completed by Cominco Resources International Ltd. on the Carrie claim (quartz claim Snoose 7), the drilling was intended to intersect mineralization of Vein No. 6. Unfortunately, geological mapping of the property was limited, and talus slides were mapped as southwest trending which is roughly perpendicular to the actual bedrock orientation, therefore, attempts at drilling short horizontal holes did not intersect any appreciable mineralization. Falconbridge Limited held the property from 1972 to 1998 but no work was recorded in this period. In 2007, Monster Mining optioned the recently staked McKay Hill property from M. Bindig.

In contrast to the mineralization found in the Keno Hill camp, veins on the property contain relatively low-grade silver and high-grade lead; additionally the property is relatively distal from Keno City and was therefore deemed non-economic in the early years. For the last eighty years the mineralization found in the McKay Hill area was considered to be the northern extension of Keno Hill-style mineralization, and therefore prior to Monster Mining Corporation's (previously Northex Minerals Corp.) 2007 exploration program, no known geochemical analysis for gold or copper had been completed.

GEOLOGY OF THE NASH CREEK AREA

REGIONAL FRAMEWORK

The most recent mapping of the area was completed by the GSC in 1961 by L.J. Green and J.A. Roddick (Roddick, 1972). The south-central portion of NTS 106D (1:50 000 map sheets 6 and 7) has never been mapped at a scale of 1:50 000 and, to date, is relatively poorly understood.

The property is within the northwestern Omineca Belt in a band of regional-scale thrust faults — the Robert Service, Dawson and Tombstone thrusts imbricate rocks of the Selwyn Basin and MacKenzie Platform. McKay Hill is at the centre of the Dawson Thrust sheet, which is bound by

the Dawson thrust to the northeast and the Tombstone thrust to the southwest. The Robert Service thrust occurs between grey quartzite and carbonaceous phyllite of the Keno Hill Quartzite and the muscovite-chlorite phyllite and gritty psammite of the Hyland Group (Roots, 1997).

In the McKay Hill area, the Dawson thrust sheet is currently mapped as underlain by the Yusezyu Formation of the Upper Proterozoic to Lower Cambrian Hyland Group (PCH; Table 1). Approximately 7 km to the southwest, the Hyland Group rocks are overlain by the Earn Group (DME) metasediments, which host the Keno Hill mineral occurrences (Table 1; Fig. 2). The Hyland Group consists of, from oldest to youngest, coarse turbiditic clastics, limestone and fine clastic rocks typified by maroon and green shale and may include younger scattered mafic volcanic rocks (Gordey and Makepeace, 2003). The Hyland Group is divided into two formations – the Late Proterozoic to Cambrian Narchilla Formation (PCn) and the Late Proterozoic Yusezyu Formation (PY). The McKay Hill area is represented by the more widespread, older Yusezyu Formation which is described by Roots (1997) as consisting of metamorphosed sandstone, grit, black slate, minor limestone, chlorite schist and conglomerate.

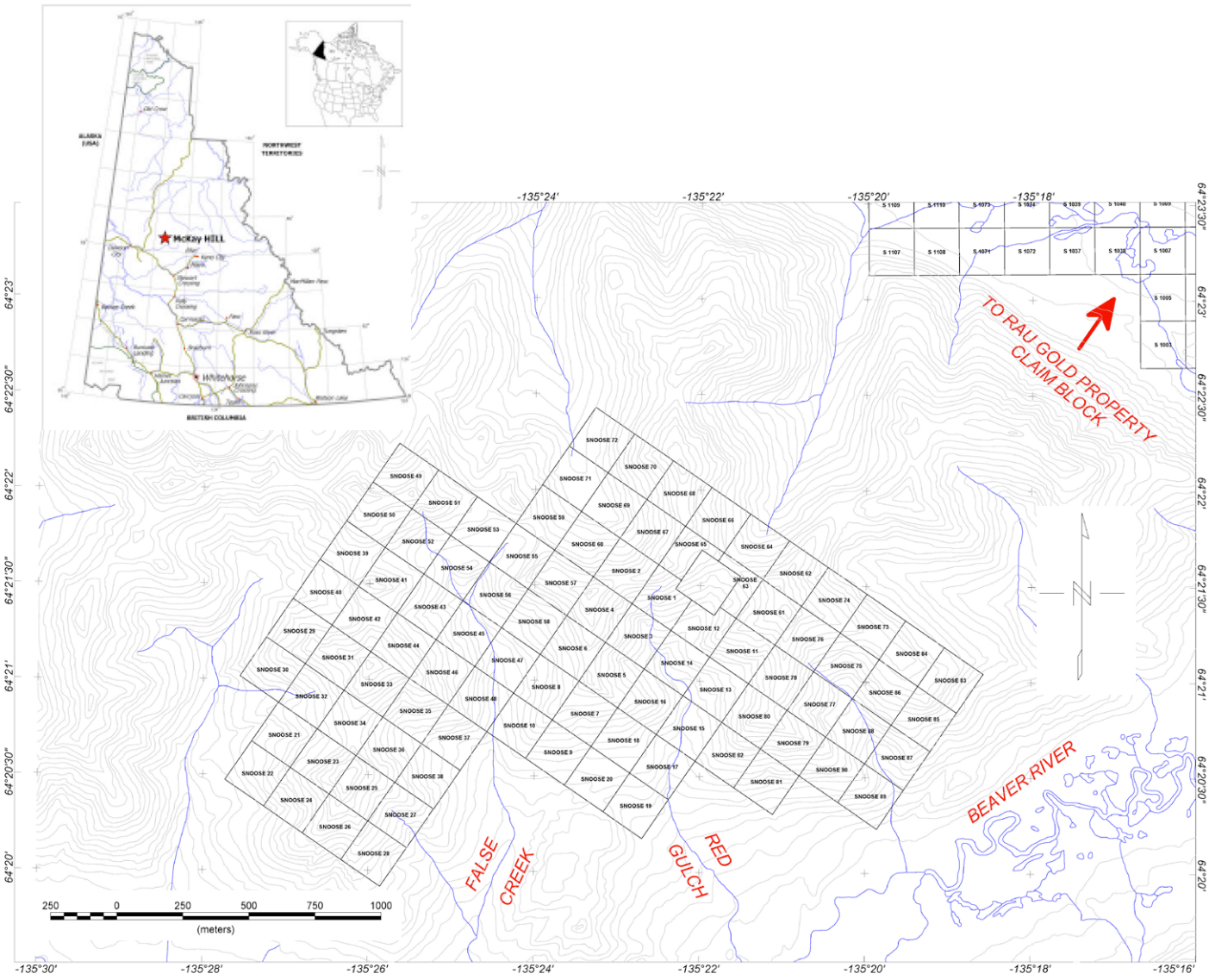


Figure 1. *McKay Hill property location map. Note ATAC Resources Ltd. Rau gold property to the northeast and the Beaver River to the south.*

Yusezyu Formation stratigraphy comprises shale-siltstone, sandstone-quartzite with younger lesser grits (Fig. 3). The extensive hypabyssal volcanic rocks found at McKay Hill are not incorporated into the geological models proposed for the formation. Conglomerate within the Yusezyu Formation are described as containing strained quartz and feldspar sedimentary clasts surrounded by little matrix material. However, on the McKay Hill property, the majority of clasts found within the conglomerate are undeformed and volcanic in origin. These findings suggest that the McKay Hill area is, in fact, not underlain by the Hyland Group Yusezyu Formation as currently interpreted.

Mapping completed by Abbott (1997) targeted the eastern Ogilvie Mountains on NTS map sheets 116A/10

Table 1. *Regional geological units (Gordey and Makepeace, 2003).*

Unit	Age	Rock Type
Hyland Group (PCH)	Upper Proterozoic to Lower Cambrian	greenschist facies metamorphosed coarse turbiditic clastics, limestone and fine clastic rocks typified by maroon and green shale and may include younger scattered mafic volcanic rocks
Earn Group (DME)	Devonian to Mississippian	graphitic shale, chert, siltstone, sandstone, greywacke and conglomerate; minor felsic to intermediate volcanic rocks

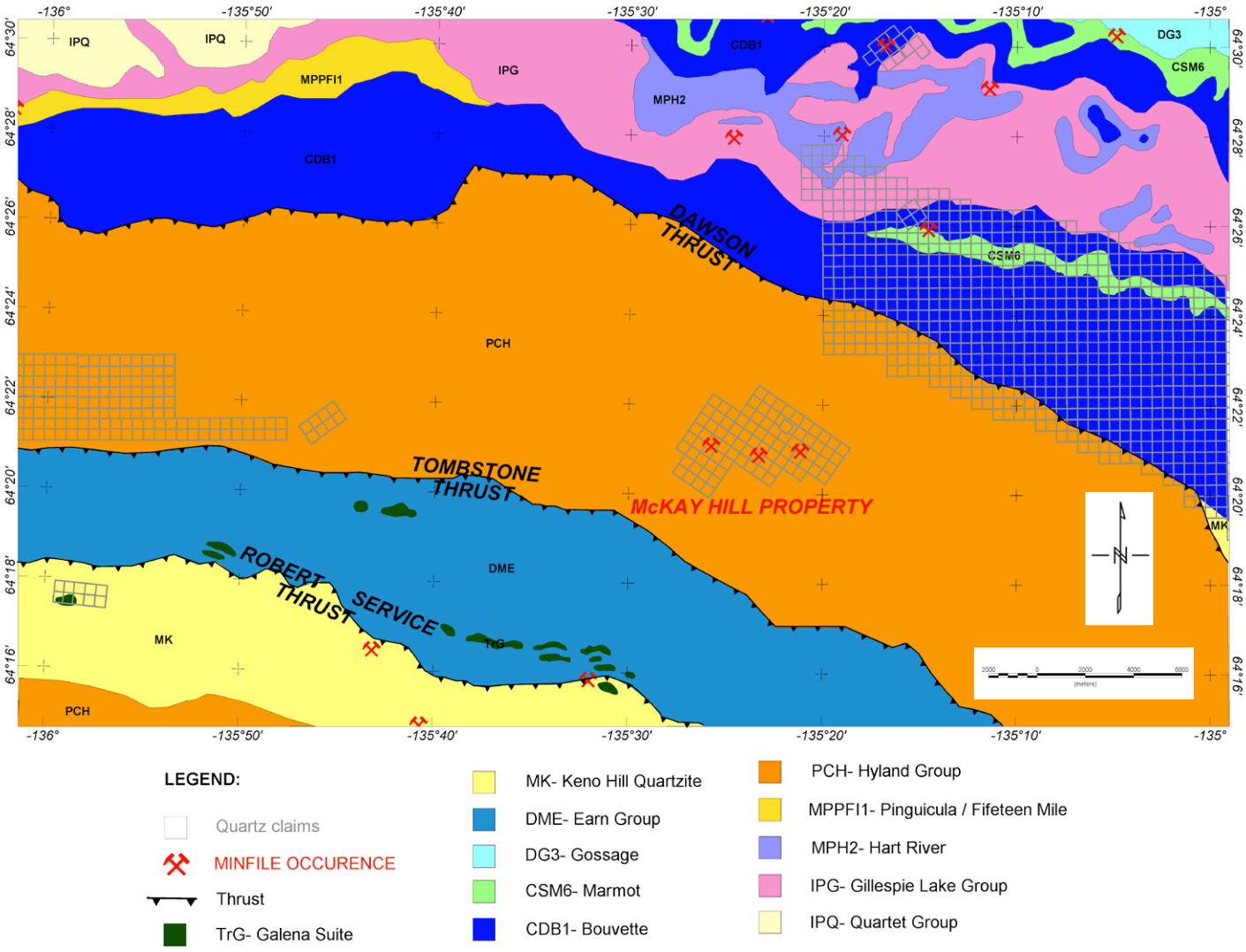


Figure 2. *Regional geological framework (Gordey and Makepeace 2003).*

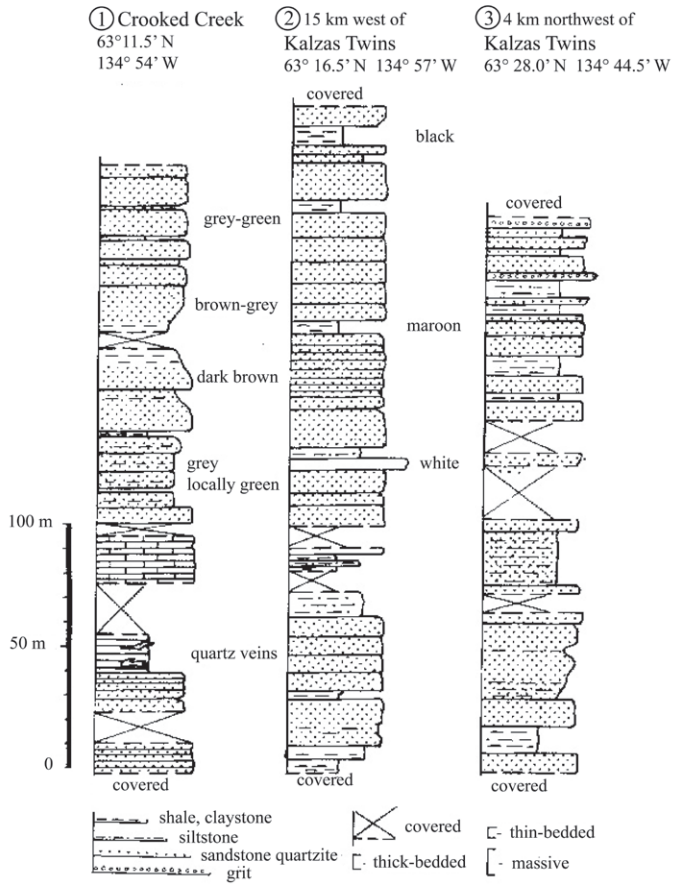


Figure 3. *Stratigraphic sections from parts of the Yusezyu Formation from three locations south-southwest of Mayo (Roots, 1997).*

and 116A/11, which straddle the boundary between the Foreland and the Omineca belts of the Cordilleran Orogen. In the region immediately south of the Dawson thrust on NTS 116A/11, Abbott (1997) mapped slivers of Middle (?) Cambrian to Early (?) Ordovician volcanic rocks. Goodfellow *et al.* (1995) introduced the name *"Dempster volcanics"* (COv) for this assemblage but it has never been formally defined. The volcanic rocks form weathering-resistant sequences 10 to 100 m thick, consisting mainly of flow breccias, hyaloclastic breccias, agglomerates and massive or pillowed flows (Abbott, 1997). Mafic volcanic rocks continue west into the Dawson map area where they form thick, extensive accumulations above the Hyland Group south of the Dawson Fault (Roots, 1988). Stratigraphic relationships between the volcanic rocks and the underlying strata are not well understood, but most of the rocks sharply overlie the Narchilla Formation of the Hyland Group (Abbott, 1997). These volcanic rocks are present south of the Dawson thrust and may be correlative to the hypabyssal volcanic rocks mapped on the McKay Hill property during the 2009 program.

LOCAL GEOLOGY

Previous mapping completed in the area by Cockfield (1924; 1925a,b) recognized two units within the siliciclastic sequence: sedimentary and breccia/volcanic rocks. In 2009, these units were broken up and described more specifically as: sedimentary rocks comprising slate, conglomerate and sandstone grit, and hypabyssal volcanic rocks comprising basalt (amygdaloidal, vesicular and pillowed), andesite, volcanic tuff and their brecciated equivalents (Figs. 4, 5, 6).

Extensive fine-grained grey-blue slate and matrix-supported, polymictic, cobble-conglomerate (diamictite) are present as a steeply dipping, near-vertical succession striking roughly northwest. Slate bedding appears to be consistently parallel to foliation in the mapped area, less a few localized pockets where it was observed as an argillic-altered slate breccia related to brittle deformation along discrete topographic depressions presumed to be faults. Layers of fining-upwards, poorly bedded conglomerate are characterized by very fine to fine-grained, immature matrix material, enveloping poorly sorted subangular to subrounded clasts (Fig. 5a). The diamictite unit is one of the more favourable hosts for deep-level Ag-Cu-Pb mineralization. Clasts (≤15 cm) of primarily volcanic (and lesser sedimentary) origin appear to float in the finer grained detrital clay-rich matrix. A thin bed of poorly sorted sandstone grit overlies the conglomerate and is penetratively weathered a distinct rusty-orange colour.

The interior of the succession comprises thickening upward intercalations of volcanic rocks, most notably andesite and basaltic units with extensive local variation. Amygdaloidal, vesicular and pillowed basalts were observed on the property, illustrating the local variation along strike. Calcite (± quartz) circular to oblong amygdules (≤3 mm) comprise ≤35% of the amygdaloidal basalt. This unit was noted to almost always exhibit a weak to well-developed penetrative planar fabric and hosts numerous high-level siliceous veins. Two small, hillside outcrops of pillowed basalt were mapped on the southwest end of the map area on the west margin of the thick conglomerate layer. These pillows were distinctly concentric with a northeasterly younging direction and

locally were brecciated and generally vesicular (Fig. 5b). Highly porous basalts with abundant vesicles were noted on the property as small, but prolific, localized lenses on the west end of the map area. This unit appears to be a particularly favourable host for mineralization at depth. Volcanic tuff is a favourable host for deep-level base-metal mineralization at the Snowdrift Vein, where its groundmass is replaced with galena ± copper carbonate minerals (namely azurite, malachite ± chrysocolla). Outcrops of volcanic tuff, surrounded by resistant andesite, were noted to exhibit extensive iron-carbonate and propylitic alteration (Fig. 5c). At the centre of the map area, a resistant knob of massive (locally foliated), dark green hornblende-porphyritic to nearly aphanitic, locally propylitic-altered (clay ± pyrite) andesite forms the top of McKay Hill (Fig. 5d).

MINERALIZATION

High-sulphidation epithermal Au-Ag deposits are commonly irregularly shaped, a result of host rock permeability and geometry of ore-controlling structures (Fonseca and Bradshaw, 2005). Primary commodities include Au, Ag and Cu, subordinate As and Sb and highly variable mineralogy. Similar to Keno Hill mineralization, high-sulphidation epithermal veins typically contain galena, tetrahedrite/tennanite, sphalerite and silver sulphosalts.

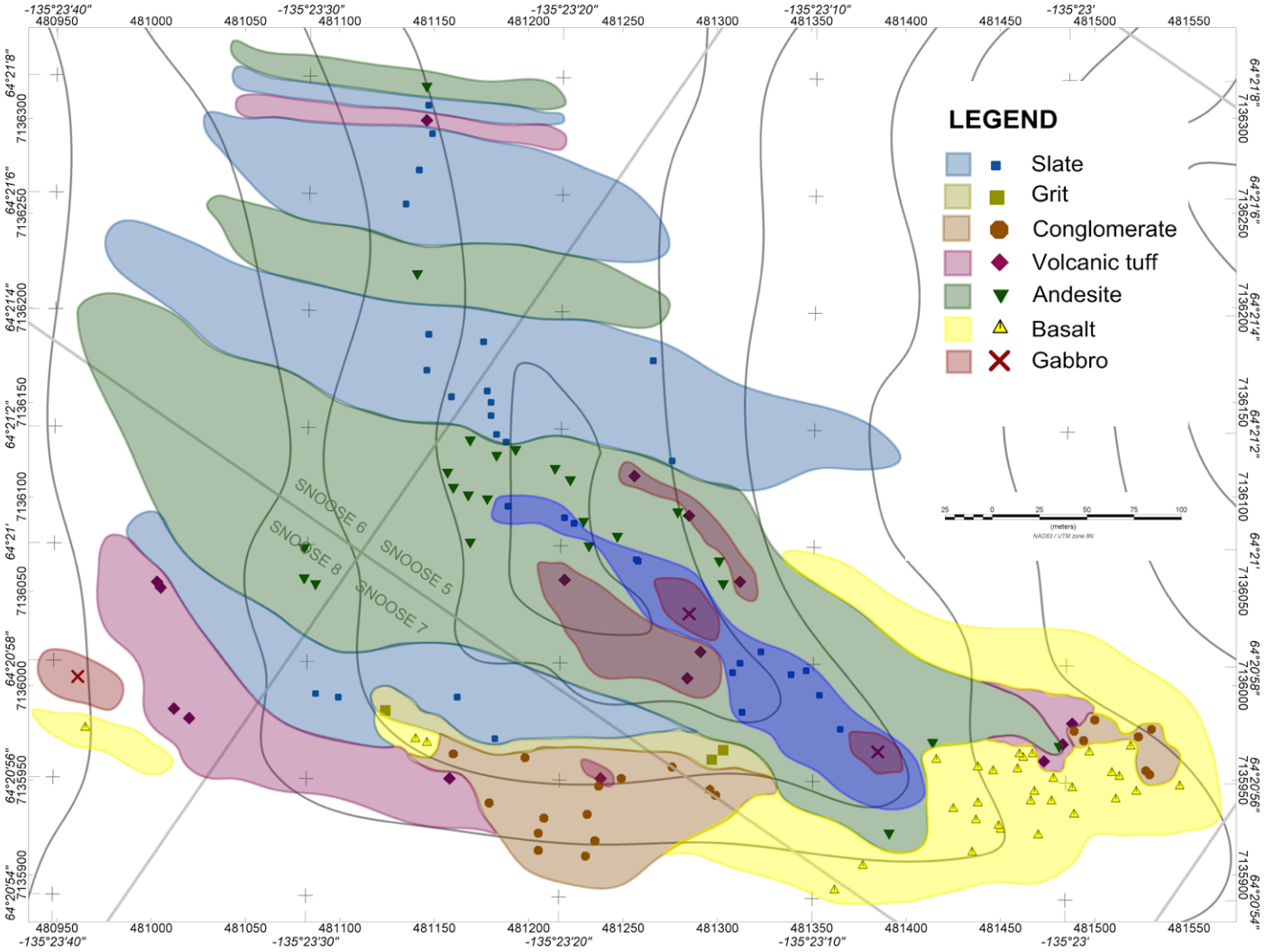


Figure 4. *Property geology on Snoose quartz claims numbers 5 to 8; symbols represent outcrop; shaded areas denote interpreted geology.*

Figure 5. *McKay Hill country rocks:* ***(a)*** *conglomerate,* ***(b)*** *pillow basalt,* ***(c)*** *volcanic tuff, and* ***(d)*** *andesite (locally hornblende-phyric).*

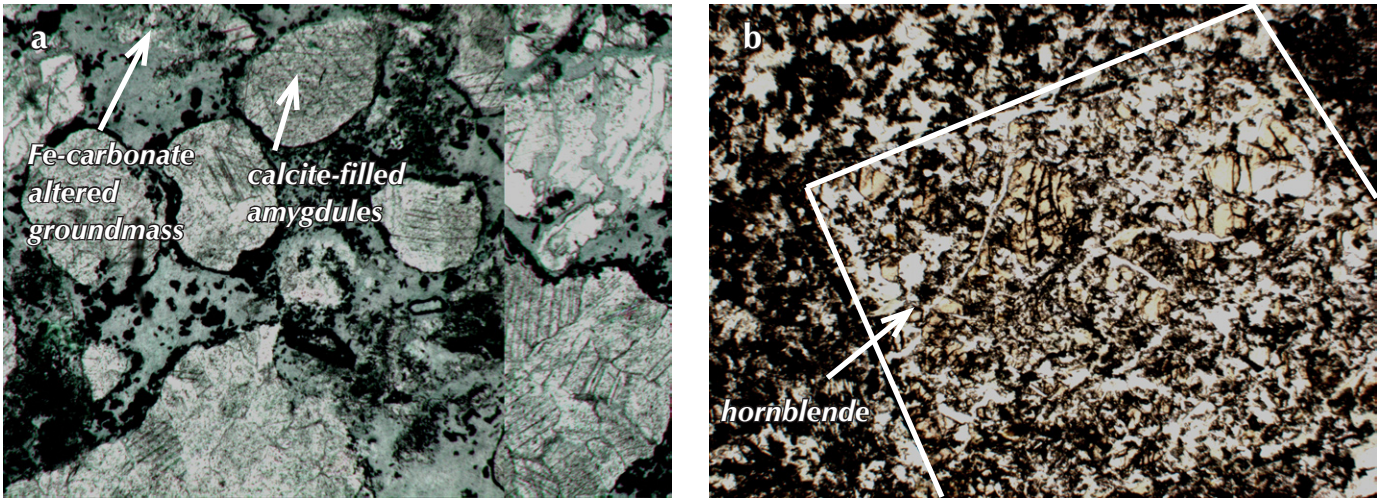


Figure 6. *McKay Hill country rocks in thin and polarized sections (field of view (FOV) = 7.2 mm):* ***(a)*** *amygdaloidal basalt, and* ***(b)*** *andesite (locally hornblende-phyric).*

The Keno Hill district mineralization is in the form of relatively large but isolated polymetallic Ag-Pb-Zn veins. The Ag-Pb-Zn veins in the Keno Hill camp were emplaced in discrete dilational (tensional stress) fault structures within polydeformed clastic metasediments and are not associated with extensive alteration. Conversely, the McKay Hill property has prolific veination in a localized area. Fifteen high-level Au-Cu and deeper level Ag-Cu-Pb veins are surficially exposed within a 450 x 600 m area (Figs. 4, 7).

Historically, workers in the Keno Hill camp recognized that some mineral associations were characteristic of certain veins and the following paragenic sequence is generally accepted: quartz, pyrite, arsenopyrite and sulphosalts; siderite, galena, sphalerite, pyrite and freiburgite (with additional fracturing); and cerrusite, anglesite, native silver and argentiferous jarosite (by supergene oxidation of sulphides and sulphosalts), and pyrargerite (Fig. 8; Roots, 1997). Similarly, vein ore mineralogy appears to be both spatially and temporally zoned at the McKay Hill property. The mineralization at McKay Hill appears to evolve from a high-level silica-rich system (SiO_2 + Cu + As ± Au) to a Pb + Ag ± Cu system (massive galena) at the lowermost exposed levels of the veins. This vertical zonation is evident as high-level quartz-rich Au-Cu mineralization in competent hypabyssal volcanic rocks to deeper level massive galena (Ag-Cu-Pb) mineralization in less competent sedimentary (± highly vesicular volcanic) rocks (Fig. 9). Although both properties exhibit spatial zonation, the zonation in the Keno Hill district is present laterally and on a much larger scale.

HIGH-LEVEL QUARTZ-CARBONATE — AU MINERALIZATION

High-level mineralization exposed on the ridgeline is present as distinct, milky-white quartz veins with azurite and malachite-lined fractures (Fig. 10). These veins precipitate along early structures or at lithologic boundaries. Locally, the veins are surrounded by an extensive propylitic alteration zone characterized by intense alteration forming a distinct bright orange-brown, iron-carbonate (Fe-chlorite and calcite) halo. Anhedral, coarse-grained milky-white quartz crystals lined by anhedral coatings and euhedral vug-filling crystals of copper carbonate minerals, namely azurite and malachite, were noted at this level. These siliceous veins are exposed on the ridge as distinct resistant tabular bodies and as

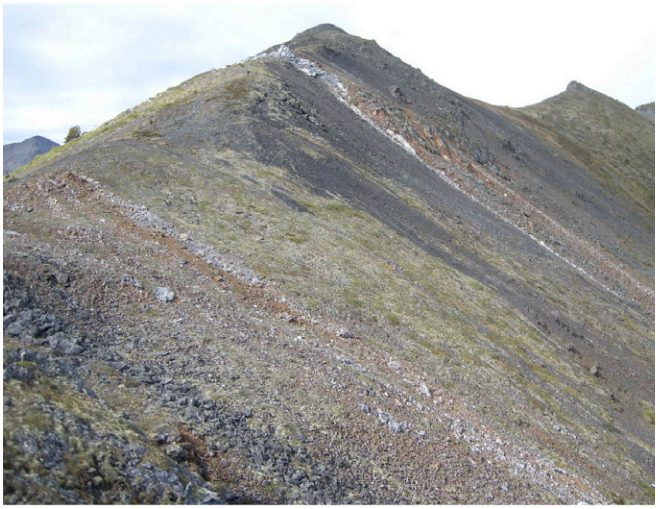
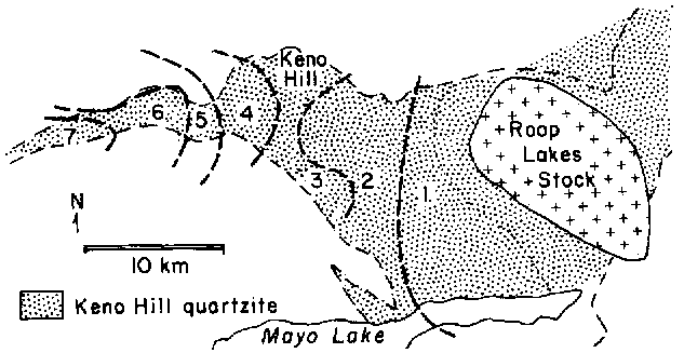


Figure 7. *View looking northwest illustrating 3 of 20 known mineralized sites on the central Snoose claims (distance viewed is approximately 200 m in length). Note Fe-carbonate (orange) alteration surrounding mineralized sites (photo courtesy of M. Bindig).*



1. FELDSPAR ZONE: K-feldspar, plagioclase, quartz, epidote, ± tourmaline, apatite, pyrite, arsenopyrite, ilmenite, cassiterite, muscovite

2. CALCITE ZONE: calcite, quartz, epidote ± pyrite, chalcopyrite, arsenopyrite, galena

3. JAMESONITE ZONE: jamesonite, boulangerite, arsenopyrite, sphalerite, chalcopyrite, tetrahedrite, quartz, calcite, native Au (overlaps with zone 4)

4. SIDERITE-CALCITE ZONE: siderite, quartz, calcite, galena, sphalerite, tetrahedrite, arsenopyrite, pyrite

5. PYRRHOTITE ZONE: siderite, quartz, calcite, galena, sphalerite, tetrahedrite, pyrrhotite, arsenopyrite, pyrite (same as zone 4 with pyrrhotite)

6. SIDERITE ZONE: siderite, quartz, galena, sphalerite, tetrahedrite, pyrite (similar to zones 4 and 5, but without calcite, arsenopyrite, pyrrhotite)

7. EPITHERMAL ZONE: quartz, pyrargyrite, acanthite, polybasite, stephanite, native Ag, pyrite, kaolinite ± marcasite, chalcopyrite, stibnite, barite (overlaps with zone 6)

Figure 8. *Schematic map of lateral mineral zonation in the Keno Hill camp. Contours are drawn according to the appearance or disappearance of specific vein minerals away from the Roop lakes pluton (Roots, 1997).*

linear float trains on sides slopes. Replacement and incorporation of country rocks in these high-level siliceous systems was not noted. The high-level veins have reported values up to 16.8 g/t Au, 668 g/t Ag and 3.9% Cu from grab and chip samples collected by Monster Mining Corp. (Table 2).

QUARTZ-CARBONATE-AU-GALENA-PB MINERALIZATION TRANSITION ZONE

A quartz-carbonate-gold to galena-lead transition zone is exposed at mid-level at the Snowdrift and Vein No. 6 sites. The Snowdrift Vein exposes the high-level quartz-carbonate-Au mineralization as a massive, white, siliceous vein evolving towards galena-lead-rich mineralization at

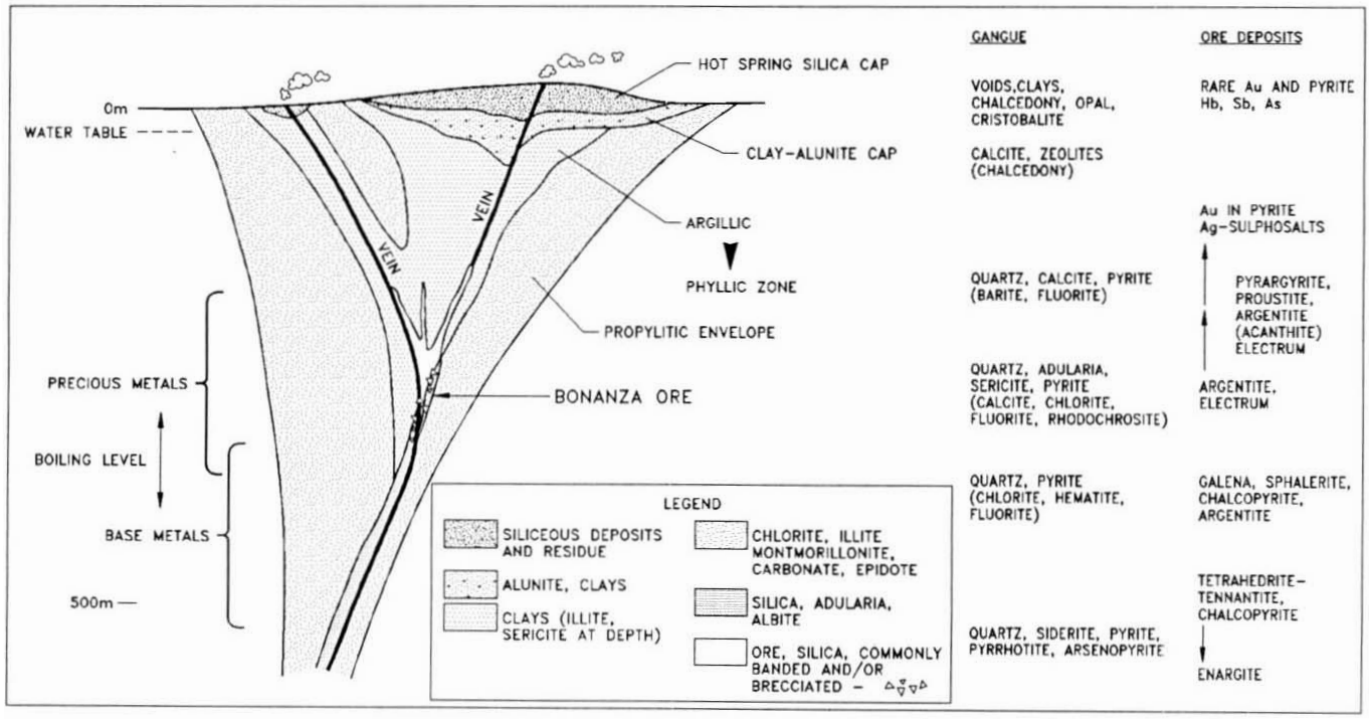


Figure 9. *Vertical mineral zonation of high-sulphidation epithermal veins (Panteleyev, 1991). Note high-level precious metal mineralization is associated with siliceous gangue and low-level mineralization is base metal in origin. Also note the propylitic envelope surrounding the ore shoot.*

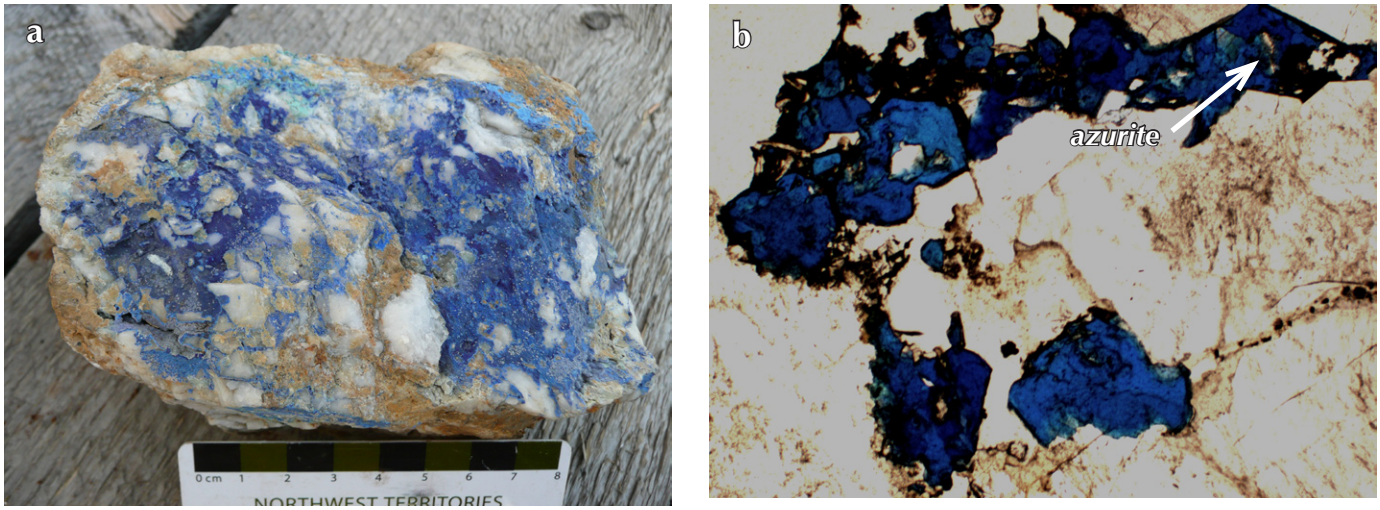


Figure 10. *Examples of high-level, siliceous Au-Cu mineralization at the McKay Hill property:* ***(a)*** *hand sample, and* ***(b)*** *thin section (FOV= 7.2 mm).*

lower levels within partially to wholly replaced diamictite and vesicular basaltic country rock material. In the transition zone, the copper-carbonate minerals (azurite, malachite ± scorodite) appeared to be associated with minor epidotization (Fig. 11). Late, translucent 6-sided, pyramidal quartz crystals are noted at this level and appear to be associated with brecciation and healing.

Presence of this 'clean quartz' continues down to lower levels and appears to represent relatively mid to late fluidization. Grab and chip samples collected from this transition zone by Monster Mining Corp. have reported values up to 0.9 g/t Au, 550 g/t Ag, 2.2% Cu and 8.8% Zn (Table 2). Au-Ag-Cu values within this zone tend to be relatively lower and there appears to be an

Table 2. *McKay Hill selected 2007 and 2008 geochemical results (Pautler, 2009).*

Zone	Vein	Sample	Width (m)	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)
High-level	Snowdrift	MK-06	Grab	15.6	668	3.9	0.94	2.4
	Snowdrift	526150	Grab	2.61	174	0.69	0.13	0.42
	Snowdrift	526196	1.5	1.37	57.2	0.63	4.7	1.51
	Blackhawk W	526244	Grab	1.14	100	1.46	0.17	0.27
	No. 8	MK-02	Grab	16.8	646	0.64	0.14	33
	No. 1 W	29887	Grab	0.765	502	2.4	0.47	46.4
Transition	Snowdrift	29885	Grab	0.085	470	0.595	0.29	46.5
	Blackhawk	29890	Grab	0.51	551	0.51	1.16	47.3
	Blackhawk	29889	Grab	0.9	484	0.53	8.33	54.6
	No. 9	29896	Grab	0.59	132	2.24	2.31	5.14
Low-level	North?	526241	Grab	1.84	372	1.96	7.01	22.74
	No. 6	526239	Grab	0.565	528	1.52	8.66	50.55
	No. 6	526238	1.1	0.83	683	0.78	0.4	40.5
	Snowdrift	29886	Grab	2.49	534	2.16	0.46	47

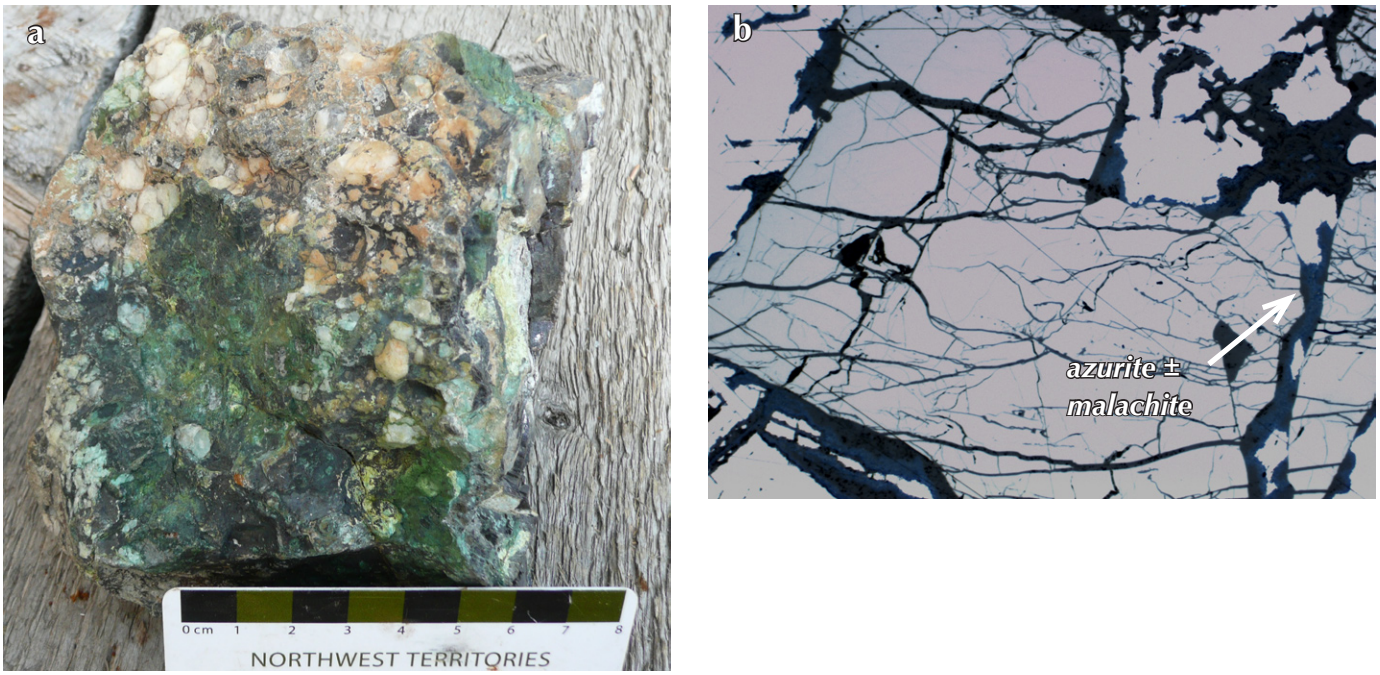


Figure 11. *Examples of mineralization within the transition zone at the McKay Hill Property:* ***(a)*** *hand sample, and* ***(b)*** *thin section (note brecciated texture; FOV= 3.6 mm).*

enrichment of zinc; rocks within this 'transition zone' typically contained up to 8% zinc.

LOW-LEVEL GALENA-PB MINERALIZATION

Fluids continue to evolve and are found at depth as prolific base-metal mineralization. Low-level mineralization exposed on the hillsides of the property is found as extensive galena ± malachite, azurite, scorodite mineralization (Fig. 12). These veins have reported values up to 2.5 g/t Au, 700 g/t Ag and 2.2% Cu from grab and chip samples collected by Monster Mining Corp. (Table 2). Mineralization at this level depends extensively on the lithologic permeability and competency of the country rocks and shows variation property-wide in its mineralization style. Mineralization may be present as vein breccias (North vein?), matrix-replacing flow-banded/layered galena within diamictite (Vein No. 6), to nearly whole-rock replacement in the vesicular basalts found at lower levels in the Snowdrift Vein system. Ore was mined from the property at Vein No. 6 within partially to wholly matrix-replaced diamictite; flow-banded galena characterizes the current matrix-material which envelops rotten, soft clasts that exhibit extensive iron-carbonate alteration (Fig. 13). Locally, brecciated parts of vein material contain clean prismoidal quartz gangue; these crystals were observed to contain inclusions of euhedral cubic galena which may be suitable for fluid inclusion geochemical analysis (Fig. 14).

ALTERATION

Propylitic alteration (chlorite, calcite, pyrite, epidote, zeolite) is an early-developed, widespread and district-wide alteration in many epithermal districts (Panteleyev, 1994). Commonly, zoning of hydrothermal alteration in epithermal systems is one of the key exploration guides. Within the broad areas of propylitic alteration are more restricted zones of sericitic alteration or recessive-weathering clay alteration, surrounding central zones of silicification or quartz veining (some parts which may be mineralized; Panteleyev, 1994).

Alteration is minimal within the Keno Hill area. Weak alteration is present within the prolific Triassic 'greenstone' (meta-gabbro/diorite) found striping through the district. Locally, alteration of arsenopyrite to scorodite occurs in the early quartz-gold veins that are thought to be associated with Tombstone magmatism (*e.g.*, Homestake Vein No. 1, Yukon MINFILE 105M 011).

The most striking aerial feature of the McKay Hill property is the distinct, bright orange alteration vein halos, which consistently occur at mineralized sites (Fig. 7). The iron-carbonate alteration is evident in thin section as Fe-chlorite and calcite which overprint essentially all primary minerals. These alteration halos surround all mineralized sites with minor variations in intensity but are indiscriminate to the various lithologies. Propylitic alteration appears to be coeval with vein emplacement and is present as clay (illite?), calcite and chlorite close to vein emplacement, and pyrite and epidote distal from vein emplacement.

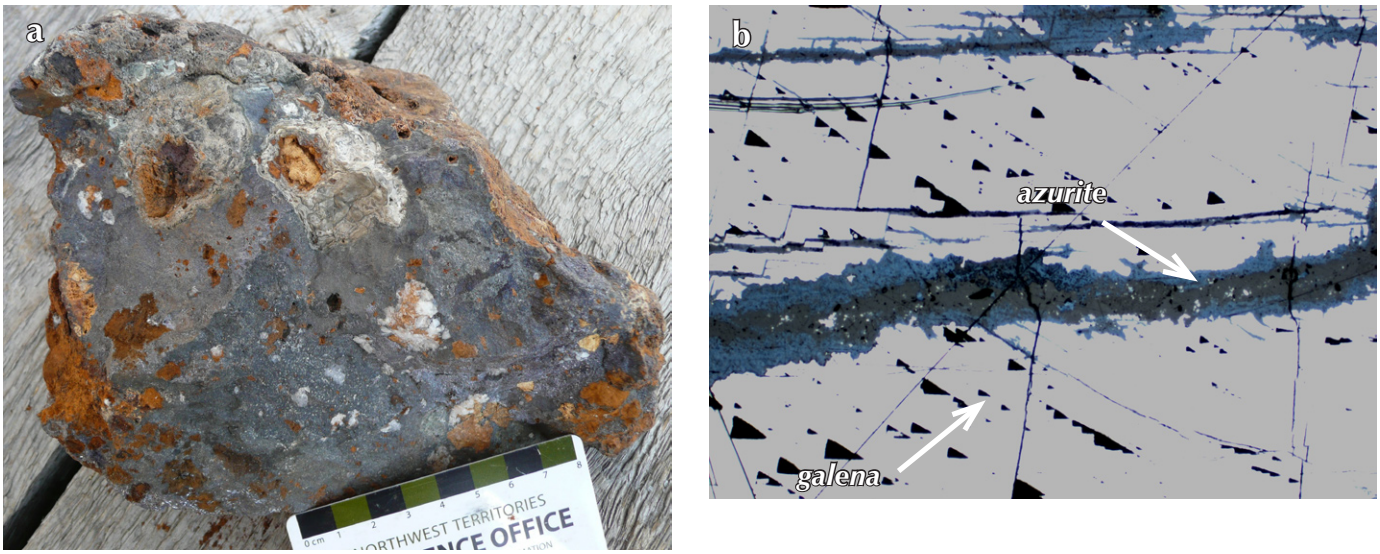


Figure 12. *Examples of deep-level, siliceous Au-Cu mineralization at the McKay Hill property:* ***(a)*** *hand sample, and* ***(b)*** *thin section (FOV= 3.6 mm).*

Figure 13. *Progressive Fe-carbonate alteration and destruction of the conglomerate framework clasts with late-stage matrix replacement of galena.*

Figure 14. *Euhedral quartz prisms with cubic galena inclusions surrounded in banded base-metal mineralization (galena + malachite ± scorodite, chrysocolla).*
mal = malachite, sco = scorodite, chrys = chryscolla.

STRUCTURAL CONTROLS

Previously, epithermal deposits were closely associated with felsic volcanic rocks related to caldera resurgence; this model has largely been refuted by studies performed in the 1970s and 1980s by the United States Geological Survey (USGS; *i.e.*, Lipan and Steven, 1976; Stack, 1980). Siberman and McKee (1974) completed a radiometric data survey on epithermal deposits in Tertiary volcanic areas of the southwestern United States and found that mineralization was 2 to 17 million years younger than the caldera volcanism, thereby refuting the theory that hydrothermal activity is exclusively related to caldera volcanism. Today, epithermal hydrothermal solutions are largely considered to be meteoric in origin. In addition to meteoric waters, epithermal solutions can contain magmatic fluids, seawater, evaporate and connate waters, deep brines, metamorphic fluids and even far-travelled mesothermal-source fluids (Panteleyev, 1991).

Host rock competency in both Keno Hill and McKay Hill areas has consistently proven vital in controlling mineralization. In the Keno Hill district, almost all veins are hosted in the Keno Hill Quartzite, a very hard, well-indurated rock which exhibits brittle failure when faulted, leaving open space fillings making it an ideal host for the silver ore bodies in the camp. Typically, the veins pinch out or cap when they run into the softer, finer grained

metasedimentary rocks. These veins were emplaced in discrete dilational fault structures associated with late transpressional and transtensional brittle deformation.

At McKay Hill, vein propagation appears to be primarily controlled by competency and lithologic permeability contrasts between units (with localized brecciation of massive volcanic wall rocks; V. Bennett, pers. comm., 2009). Additionally, mineralization present as matrix replacement was found as an irregular body within the thick package of fining-upward conglomerate where the veins propagate as northeast-trending, steeply south-dipping structures within the southeast-trending low-angle slickensides preserved on local, discrete, fault surfaces. Vesicular basalts and volcanic tuffs in the southwest part of the map area are also favourable hosts at depth. Locally, vesicular basalts were wholly replaced and the volcanic tuff unit displayed similar replacement textures to the diamictite unit within its groundmass (e.g., the Snowdrift vein system).

SOURCE OF FLUIDS

The source of fluids for the McKay Hill property is currently unknown. Historically, the Keno Hill district veins have been considered to result from differentiation of magma with the development of a volatile fluid phase that escaped along faults to form the veins (Fonseca and Bradshaw, 2005). Roots (1997) suggests the most likely age of the hydrothermal cell and alteration is during, and immediately following, intrusion of the Roop Lakes pluton. However, recent geochronological work by Bennett (pers. comm., 2009) suggests that Keno Hill mineralization may not be associated with the emplacement of these intrusions but rather may be related to a non-magmatic source.

Epithermal deposits are now considered to form from relatively dilute, near-neutral to weakly-alkaline chloride water (<5 wt% NaCl equivalent) that undergoes boiling or effervescent degassing, fluid mixing and oxidation at temperatures generally between 200 to 230°C and most commonly between 230 and 260°C (Fig. 14; Panteleyev, 1994). Buchanan's (1981) "boiling model" suggests that alteration and coeval mineralization results from boiling and oxidation of the ascending hydrothermal fluids that repeatedly heal ore structures. Episodic refracturing/brecciation along these conduits decreases fluid pressure, thereby cooling the fluids and resulting in precipitation of ore that is commonly banded/layered. At McKay Hill, distinctly layered galena, present as replaced matrix material within the diamictite and clean quartz that is surrounded by layered base metals within brecciated zones, supports the repetitive temporal refracturing-healing events associated with these deposits.

Possible fluid sources include the high-level Cretaceous granitic stock present at McQuesten Lake (unit mKqS) located ~36 km away on a bearing of 185° (roughly south) to the McKay Hill property. Also, streams in the area surrounding Steamboat Mountain are highly anomalous in thorium, possibly indicating the presence of an unmapped or buried intrusion just to the south of the property, based on a spatial association established in a study by Gleeson and Boyle (1980) between thorium and Tombstone Suite plutons. Plotting the first vertical derivative of the magnetic field using YGS' MapMaker program (*http://maps.gov.yk.ca/imf.jsp?site=YGS*), a small magnetic high appears to be present adjacent to the property, which may represent a small (Tombstone age?) stock.

Alternatively, stratovolcanoes around the Pacific Rim or volcanic dome and dome-flow complexes in continental volcanic settings display volcano-related hydrothermal systems with possible magmatic-hydrothermal, magmatic steam and steam-heated acid sulphate environments (Panteleyev, 1991). Some sites of high-level hydrothermal activity and hot spring deposits have survived over great lengths of time and could provide the steam-heated acid sulphate environments required. Panteleyev (1991) suggests that manifestations of active or extinct geothermal activity at surface are the zones of distinctive hydrothermal alteration that overlie the deeper geothermal systems. Sites of hot spring discharge at the highest structural level are represented at present by the Nash Creek hot springs, located 39.5 km away on a bearing of 055°.

DISCUSSION

To date, mineralization at McKay Hill has been interpreted to be typical of the Keno Hill camp, namely polymetallic Ag-Pb-Zn ± Au shear-hosted vein-style mineralization. During Monster Mining Corporation's 2009 YMIP-funded exploration program, numerous distinct differences became apparent. These findings lead to significant implications in interpreting the geology of the area, potential of the McKay Hill prospect, and potentially, the regional geology.

The McKay Hill area is currently mapped as being underlain by the Yusezyu Formation of the Upper

Proterozoic to Lower Cambrian Hyland Group which comprises metamorphosed sandstone, grit, black slate, minor limestone, chlorite schist and conglomerate. Stratigraphic work completed by Roots (1997) describes the metaconglomerate unit as containing deformed quartz and feldspar clasts that are sedimentary in origin; the clasts within the undeformed conglomerate at McKay Hill are primarily volcanic in origin suggesting that the rocks on the McKay Hill property are not part of the Yusezyu Formation. A thin layer of sandstone grit mapped on McKay Hill may represent the uppermost Yusezyu Formation. However, the predominant hypabyssal volcanic rocks mapped on the property are not present in the stratigraphic sections of Yusezyu Formation mapped by Roots (1997).

Geological mapping completed by Abbott (1997) targeted the Hart River area in the eastern Ogilvie Mountains, the region immediately south of the Dawson thrust on NTS 116A/11. Here, Abbott mapped slivers of Cambrian to Ordovician volcanic rocks (Dempster volcanics (COv)). Roots (1988) found that these mafic volcanic rocks continue west into the Dawson map area, where they form thick, extensive accumulations above the Hyland Group south of the Dawson thrust. Stratigraphic relationships between the volcanic rocks and the underlying strata are not well understood, but most of the rocks sharply overlie the Narchilla Formation of the Hyland Group (Abbott, 1997). These volcanic rocks are present south of the Dawson thrust (*i.e.*, are part of the Dawson Thrust sheet) and may be correlative to the hypabyssal volcanic rocks mapped on the McKay Hill property during the 2009 program.

Observations made during the 2009 program suggest that the McKay Hill area is not underlain by the Yusezyu Formation of the Upper Proterozoic to Lower Cambrian Hyland Group as currently interpreted, but rather may be correlative to the Cambrian to Ordovician Dempster volcanics (COv) mapped to the northwest on NTS 116A/11. It is crucial to re-evaluate our current interpretations of the regional geology as it could potentially illustrate the area's metallogenic potential for many different types of mineral occurrences.

The siliciclastic-volcanic package present at McKay Hill would have been developed by frontal accretion whereby younger sediments were scraped off near the trench or by underplating of subducted sediments along the shallow parts of the subduction decollement (Fig. 15). If this were the case, the east-facing pillow structures measured indicate an easterly younging direction allowing for creation of a simplified stratigraphic column, whereby frontal accretion over the life of the convergent margin

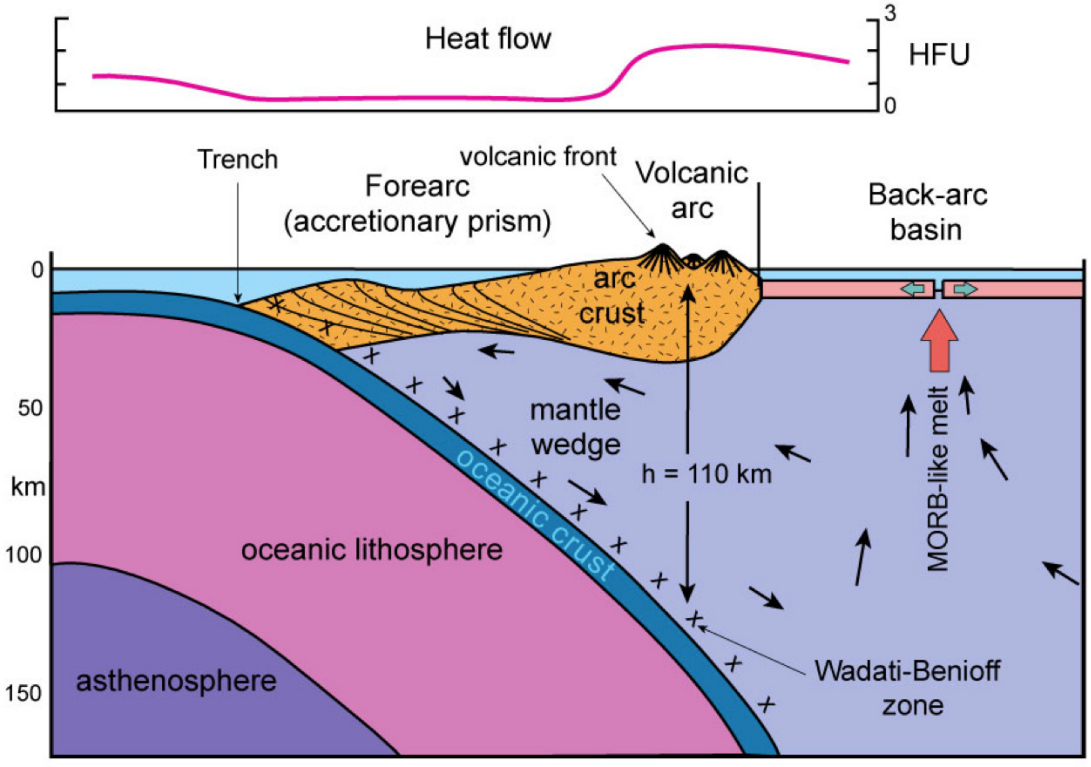


Figure 15. *Schematic cross section through a typical island arc (Gill, 1981).*

will result in younger sediments defining the outermost margins, leaving an inlier of older volcanic rocks (Winter, 2001). The rocks may represent an arc assemblage, possibly preserved as an accretionary prism. Furthermore, the diamictite-sandstone grit sedimentary interior appears to represent a partially preserved debris-flow sequence syndepositional with convergence. These expansive sedimentary rocks contain intercalations of hypabyssal volcanic rocks that show variation in thickness along strike, from tens to hundreds of feet thick.

In contrasting the polymetallic Ag-Pb-Zn ± Au-style mineralization found in the Keno Hill district, to the high-level Au-Cu and deeper level Ag-Cu-Pb mineralization at the McKay Hill property, numerous differences become evident (Table 3). Namely, (1) mineralization at McKay Hill exhibits distinct local vertical zonation with low-level base-metal mineralization and high-level siliceous precious metal mineralization; (2) ore shoot textures illustrate repetitive brecciation and healing; (3) mineralization is not present as vein faults; (4) gangue mineralogy is exclusively quartz; (5) country rocks are not polydeformed; (6) prolific iron-carbonate alteration associated with mineralization moves outwards into a more extensive propylitic envelope; and, (7) McKay Hill is present at the centre of the Dawson thrust sheet which is separated from the Keno Hill deposits by the Tombstone thrust.

Gold mineralization found as an "acid cap" in high-level siliceous veins is one of the hallmarks of epithermal deposits. This type of mineralization is found within numerous high-level veins on the property. At deeper levels, the neutral to slightly alkaline conditions are favourable sites for silver mineralization and are commonly banded or layered, resulting from the episodic precipitation of cooler fluids, a feature observed in the matrix-replaced diamictite and the groundmass-replaced volcanic tuff.

At present, there are 24 known high-sulphidation epithermal Yukon MINFILE occurrences in Yukon; three of these are the well-known past producers, the Tally-Ho, the Brown-McDade and the Moosehorn. An epithermal high-sulphidation model appears to most accurately fit the observations made at the McKay Hill property. More specifically, Panteleyev's (1994) Canadian Cordilleran epithermal model appears to most closely fit the relationships observed (Fig. 16). However, the oldest known favourable host-rocks in the Canadian Cordillera are subaerial andesitic rocks deposited near the end of Early Jurassic island arc volcanism, a significantly later date than the current age for the interpreted geology present at McKay Hill.

Possible fluid sources include: (1) the high-level Cretaceous granitic stock present at McQuesten Lake; (2) potential presence of an un-mapped or buried Tombstone-age (?) intrusion at Steamboat Mountain; (3) small magnetic high adjacent to the property may represent a small (Tombstone-age?) stock; and (4) the Nash Creek hot springs may overlie a deeper geothermal system which could provide the steam-heated acid sulphate environments required.

The Canadian Cordilleran (British Columbia) epithermal model infers a continuum from porphyry copper and skarn deposits, to epithermal veins and hot spring discharge deposits (Panteleyev, 1994). In terms of a fluid source, this model may explain the presence of Mississippi Valley-type (MVT) mineral occurrences resulting from regional-scale fluid migration. MVT

Table 3. *Contrasting Keno Hill and McKay Hill host rocks and mineralization styles.*

Keno Hill camp	McKay Hill property
polymetallic Ag-Pb-An ± Au-style mineralization	high-level Au-Cu and deeper level Ag-Pb ± Cu mineralization
vein faults	veins episodically brecciate and heal
siderite ± quartz gangue	quartz gangue
mineralization present only as veins	mineralization: vein breccias, veins, partial to whole rock replacement
large-scale lateral mineral zonation	local vertical mineral zonation
little to no alteration	extensive propylitic alteration
Keno Hill Quartzite and Carbonaceous Phyllite country rock (Devonian Earn Group)	siliciclastic sediments and hypabyssal volcanic rocks (Upper Proterozoic to Lower Cambrian)
country rocks are intensely folded	country rocks consistently trend NNW, dip nearly vertical

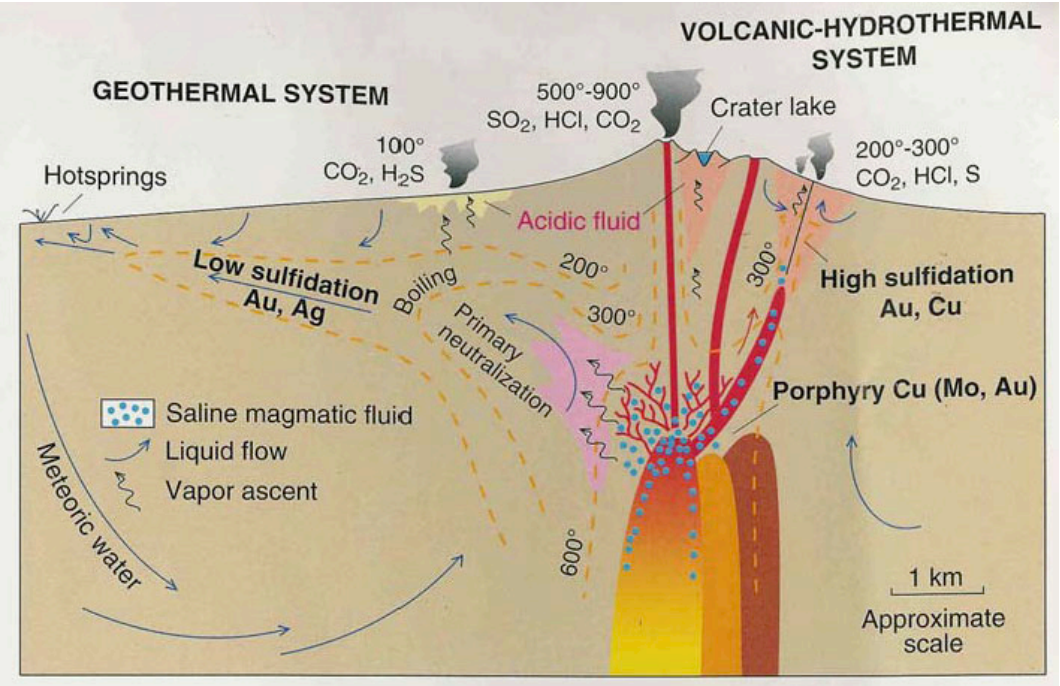


Figure 16. *Fluidization in high-sulphidation epithermal deposits (Panteleyev, 1991).*

occurrences are found proximal to the McKay Hill area on the opposite side of the Dawson thrust, near the margins of the middle Proterozoic Hart River (mPH2) rocks (Yukon MINFILE 106D 040, 042 and 043).

Accurately understanding the mineralization styles present at McKay Hill is crucial to assessing the full potential of the property.

ACKNOWLEDGEMENTS

The Yukon Geological Survey's Yukon Mining Incentives Program (YMIP) provided funding for this project; this funding is solely responsible for enabling us to perform our 2009 exploration program. Thank you to the YGS for use of their petrographic microscope and particularly to Venessa Bennett for her valuable insights and observations during a property tour she organized which greatly benefitted this project; to Grant Abbott and Charlie Roots for their helpful tips concerning the regional stratigraphy; to Dave Tupper for the countless hours of geological banter during the summer field season and for his valuable comments; to Robert Weicker for his edits and Dave White for his constructive comments and valuable input which greatly improved this paper; to Karen MacFarlane for editing this paper. Last but not least, a special thank you to Monster Mining Corporation for their open-mindedness towards the re-evaluation of the McKay Hill property and funding of this paper.

REFERENCES

Abbott, G., 1997. Geology of the Upper Hart River Area, Eastern Ogilvie Mountains, Yukon Territory (116A/10, 116A/11). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Bulletin 9, 92 p.

ATAC Resources Ltd., undated: Rau Property; ATAC Resources Ltd., <*http://www.atacresources.com/s/Rau.asp*> [accessed November 3, 2009].

Buchanan, L.J., 1981. Precious metal deposits associated with volcanic environments in the southwest. *In:* Relations of tectonics to ore deposits in the southern Cordillera, W.R. Dickinson and W.D. Payne (eds.), Arizona Geological Society, Digest, vol. XIV, p. 237-262.

Cockfield, W.E., 1924a. Upper Beaver River Area, Mayo District, Yukon. *In*: Geological Survey of Canada, Summary Report 1924 Part A, p. 1-18.

Cockfield, W.E., 1924b. Silver-Lead Deposits of the Beaver River Area, Yukon. *In*: Geological Survey of Canada, Summary Report 1923 Part A, p. 22-28.

Cockfield, W.E., 1925a. Upper Beaver River Area, Mayo District, Yukon. *In*: Geological Survey of Canada, Summary Report 1924 Part A, p. 1-18.

Cockfield, W.E., 1925b. Upper Beaver River Area, Mayo District, Yukon. Geological Survey of Canada, Multicoloured Geological Map 2064, 1925.

Fonseca, A. and Bradshaw, G., 2005. Yukon Mineral Deposit Profiles. Yukon Geological Survey, Open File 2005-5, 163 p.

Gill, J.B., 1981. Orogenic Andesites and Plate Tectonics. Springer-Verlag, Berlin, Germany, 390 p.

Gleeson, C.F. and Boyle, R.W., 1980. Minor and trace element distribution in the heavy minerals of the rivers and streams of the Keno Hill District, Yukon Territory. Geological Survey of Canada, Paper 76-31, 9 p.

Goodfellow, W.D., Cecile, M.P. and Leybourne, M.I., 1995. Geochemistry, petrogenesis and tectonic setting of Lower Paleozoic alkalic and potassic volcanic rocks, northern Canadian Cordilleran Miogeocline. Canadian Journal of Earth Sciences, vol. 32, p. 1236-1254.

Gordey, S.P. and Makepeace, A.J. (compilers), 2003. Yukon Digital Geology. Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada. Open File 1991-1 (D).

Lipan, P.W. and Steven, T.A., 1976. Calderas of the San Juan volcanic field, southwestern Colorado. United States Geological Survey, Professional Paper 958, 35 p.

Panteleyev, A., 1991. Gold in the Canadian Cordillera: A focus on epithermal and deeper environments. *In*: Ore deposits, tectonics and metallogeny in the Canadian Cordillera, Paper 1991-4, Province of British Columbia – Ministry of Energy, Mines and Petroleum Resources, p. 163-212.

Panteleyev, A., 1994. A Canadian Cordilleran Model for Epithermal Gold-Silver Deposits. *In*: Ore Deposit Models: Geoscience Canada, Reprint Series 3, R.G. Roberts and P.A. Sheahan (eds.), Geological Association of Canada, p. 31-43.

Pautler, J., 2009. Geological and Geochemical evaluation report on the McKay Hill Project, Assessment Report, 38 p.

Roddick, J.A., 1972. Geology of Nash Creek, Yukon Territory. Geological Survey of Canada Map 1282A, 1:250 000 scale.

Roots, C.F., 1988. Cambro-Ordivician volcanic rocks in eastern Dawson map area, Olgilvie Mountains, Yukon. *In*: Yukon Geology, v. 2, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 81-87.

Roots, C.F., 1997. Geology of the Mayo Map Area, Yukon Territory (105M). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Bulletin 7, 82 p.

Siberman, M.L. and McKee, E.H., 1974. Ages of Tertiary volcanic rocks and hydrothermal precious metal deposits in central and western Nevada: Nevada Bureau of Mines, Geology Report 19, p. 67-72.

Stack, J.F., 1980. Multi-stage vein ores of the Lake City district, western San Juan Mountains, Colorado: Economic Geology, vol. 75, p. 963-991.

Winter, J.D., 2001. An Introduction to Igneous and Metamorphic Petrology. Prentice-Hall, New Jersey, United States of America, 697 p.

YGS MapMaker Online, 2009. Yukon Geological Survey, <*http://maps.gov.yk.ca/imf.jsp?site=YGS*> [accessed November 15, 2009].

Yukon MINFILE, 2009. Yukon Minfile - A database of mineral occurrences. Yukon Geological Survey, <*http://www.geology.gov.yk.ca/databases_gis.html*> [accessed November 1, 2009].