An Exploration Framework for Porphyry to Epithermal Transitions in the Toodoggone Mineral District (94E)

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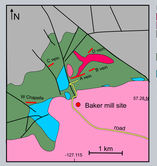
Abstract

The Toodoggone area in northeastern BC hosts numerous precious metal-rich mineral deposits and occurrences classified as low or high-sulfidation epithermal and to a lesser degree, porphyry type (Duuring et al. 2009). Exploration activities thus far were mostly focused on specific styles of mineralization and on high-grade ore-zones. Past production at Baker, Shasta and Lawyers is exclusively from veins previously classified as quartz-adularia or low-sulfidation type. However, field observations together with short wave Infrared Spectroscopy (SWIR) and thin section petrography strongly suggest that these mineralized zones are associated with andesitic to dacitic igneous rocks and correspond to intermediate-sulfidation veins which either overprint porphyry-style K-feldspar or intense quartz-sericite-pyrite alteration (Shasta and Baker, respectively) or occur distal to intense argillic alteration (Lawyers). At Baker intense quartz-sericite-pyrite alteration is affecting quartz-feldspar porphyry intrusions whereas Stuhini group basaltic rocks are widely altered to chlorite-sericite-pyrite. Quartz-magnetite-chalcopyrite veins within K-feldspar altered rocks were observed in drill-core drilled less than 200 m below the main veins at Baker. Quartz-alunite alteration, typical for high-sulfidation epithermal deposits has been confirmed at Alunite Ridge but also identified in the Creek-zone at the Brenda prospect. However, intense residual quartz alteration seems to be absent. Taking all observations together, the Toodoggone epithermal mineral occurrences are considered part of porphyry mineral systems (sensu Sillitoe, 2010) and past-producing veins are only a small part of the overall mineral system. Consequently, significant exploration potential particularly for porphyry-style Cu-Au mineralization remains in the district.

Baker

Small open pit from where "A" and "B" veins were exploited. Dark rocks correspond to Stuhini group basalts (sericite-chlorite-pyrite altered), light grey rocks are quartz-feldspar porphyry (sericite altered)

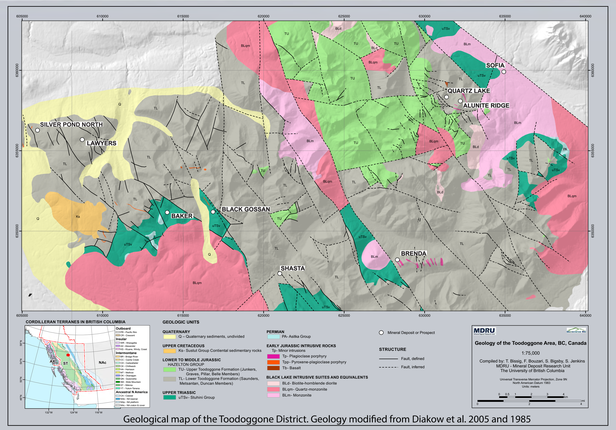


Simplified geological map of the Baker camp. Modified from Diakow et al. (1991)

Quartz-sericite altered quartz-feldspar porphyry cut by dark quartz-molybdenite vein. Rock has 220 ppm Mo.

- Intense quartz-sericite-pyrite alteration in felsic rocks
- sericite-chlorite-pyrite alteration in basaltic Takla group host-rocks
- Vein and alteration styles corresponds to shallow portions of porphyry systems
- Previous classification of Baker deposit as low-sulfidation epithermal not confirmed

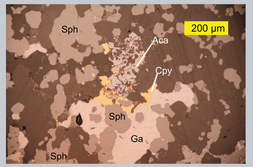
Banded quartz-magnetite vein stockwork cutting finegrained granodiorite porphyry. From drillhole drilled in 1987, hole ID unclear (likely #24 or 25). This rock corresponds to ca. 200 m below surface exposure of A vein.



Geological map of the Toodoggone District. Geology modified from Diakow et al. 2005 and 1985

Shasta

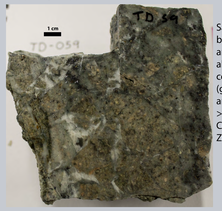
Sample TD-062: banded vein sample containing calcite (white) and sulfides



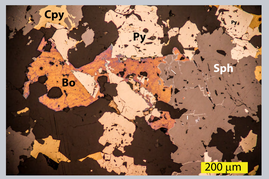
Reflected light photomicrograph of sample TD-062. Sulfides include sphalerite, galena, chalcopyrite and acanthite. > 1000 ppm Ag, 0.09% Cu, 4.3% Pb, 9.89% Zn.

Sample TD-054: banded quartz-calcite +/- chlorite, +/- pyrite vein cutting K-feldspar altered wallrock. 92 ppm Ag, 34 ppm Pb, 47 ppm Zn.

- Multiple mineralization stages
- Early potassic alteration
- Early Cu-rich mineralization followed by carbonate, silver-base metal stage
- Mineralization classified as intermediate-sulfidation

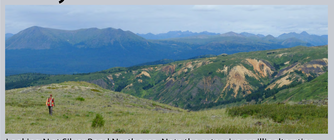


Sample TD-059: breccia containing angular K-feldspar altered wallrock cemented by quartz (grey)-dark sulfides and late calcite (white). >1000 ppm Ag, 0.71% Cu, 0.84 % Pb, 1.26 % Zn.

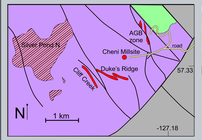


Reflected light photomicrograph of sample TD-059 showing abundance of Cu bearing minerals, including bornite (previously undocumented)

Lawyers and Silver Pond N

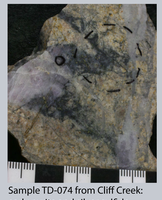


Looking N at Silver Pond North area. Note the extensive argillic alteration



Simplified geological map of the Lawyers camp. Modified from Diakow et al. (1991)

Lower Jurassic
Lower Toodoggone Formation
dacitic volcaniclastic rocks
Pyroxene phyric basalt
Trachyandesite lava and volcaniclastic rocks
Intense argillic alteration
Mineralized zones
Faults



Sample TD-074 from Cliff Creek: early pyrite and silver sulfide bearing quartz cut by white quartz and amethyst. 389 ppm Ag

Banded quartz-amethyst vein from the Amethyst Gold Breccia (AGB) zone

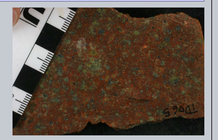
- Quartz-sericite-pyrite alteration overprinted by intense kaolinite alteration at Silver Pond N
- Cliff Creek, Duke's ridge and Amethyst Quartz breccia are distal intermediate to low-sulfidation epithermal veins (cf. Shasta)
- Porphyry potential at depth in the Silver Pond N area.

Brenda

Main alteration zone at Brenda showing rusty outcrops of Lower Toodoggone Formation volcanic rocks altered to quartz, sericite (illite)-pyrite +/- chlorite and locally to alunite and

- Alteration dominantly quartz-sericite-chlorite-pyrite. Locally presence of alunite and pyrophyllite, including at the creek zone in the lower parts of the property
- Exposed alteration corresponds to shallow portions of a porphyry system

Example of the altered volcanic host rock with abundant alunite and pyrophyllite and remnants of sulfides oxidized to hematite and jarosite.



Monzonitic porphyry dike affected by chlorite and epidote alteration. Probably post-mineral as no veins and only negligible sulfide observed.

Sofia

- Represents deeper parts of the a porphyry system with abundant quartz-magnetite veins and local sericite-chlorite-sulfide overprint.

The Sofia prospect is located at the bottom of the Toodoggone river valley ca. 3 km E of Alunite Ridge. It is characterized by a small rusty outcrop of granodiorite in contact with Stuhini group volcanic rocks cut by several veins and late aplite dikes.

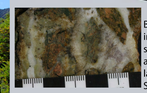
The granodiorite is cut by quartz-magnetite veins with well-developed K-feldspar alteration halo (pink). These veins are largely barren of sulfides but locally trace copper oxides occurs.

Barren K-silicate alteration cut by quartz veins and late aplite dikes (pink). Rock is overprinted by chlorite-sericite-pyrite-chalcopyrite alteration (patchy green) especially in mafic volcanic rocks.

Example of pervasive chlorite-sericite-sulfide alteration largely after earlier stage biotite alteration in mafic hostrock. Mineralization occurs in veinlets and disseminated and is dominated by pyrite with lesser chalcopyrite.

Alunite Ridge, Qtz Lake

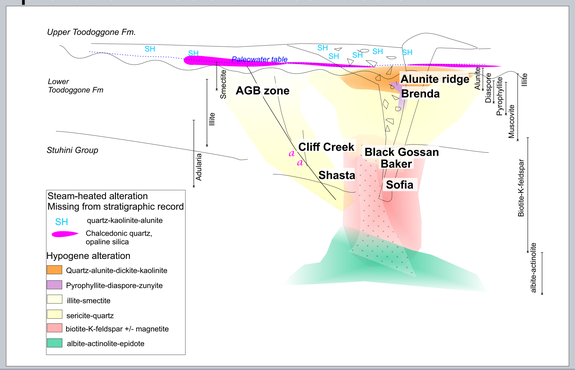
Quartz-alunite altered sample from Alunite Ridge (see X for location)



Brecciated low to intermediate-sulfidation vein with amethyst. Quartz lake, drill core DDH SG-04-18, ~ 13 m

- Exposed alteration corresponds to shallow parts of porphyry system
- no residual quartz zone with mineralization observed.
- Porphyry potential at depth.

Exploration model and conclusions



- Epithermal and porphyry ocurrences in the Toodoggone district are all part of porphyry systems (cf. Sillitoe, 2010)
- Epithermal ocurrences are not of low-sulfidation type related to rift settings and bimodal magmatism (cf. Sillitoe and Hedenquist, 2003)
- Significant potential for porphyry Cu (-Au, Mo) exists where previously epithermal Au-Ag was the main focus of exploration

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