Mineralogical and Geochemical Vectors within Advanced Argillic-Altered Rocks of British Columbia

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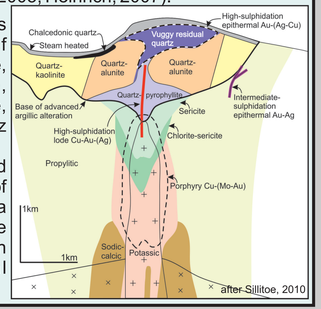
Introduction

Advanced argillic-alteration zones in the upper parts of porphyry copper systems, also known as 'lithocaps', have a blanket-like geometry with areal extents of >10 km^2, reach up to 1 km in thickness and form the largest near-surface footprints of porphyry copper systems. Zones of advanced argillic-alteration are formed by an early stage of intense acid leaching of the wallrocks and a subsequent stage of weakly acidic fluid flow, which deposits sulphides and quartz (Simmons et al. 2005; Heinrich, 2007).

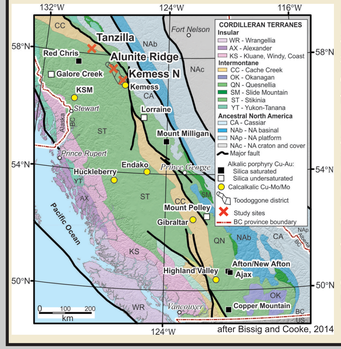
Advanced argillic-altered rocks contain various proportions of minerals such as sericite, andalusite, pyrophyllite, topaz, diaspore, corundum, zunyite, dickite, alunite, kaolinite, dumortierite and quartz (Meyer and Hemley, 1967).

The recognition of mineralogical and geochemical patterns within areas of advanced argillic-alteration provides a fundamental opportunity to identify the presence of high-sulphidation epithermal gold and potential underlying porphyry mineralization.



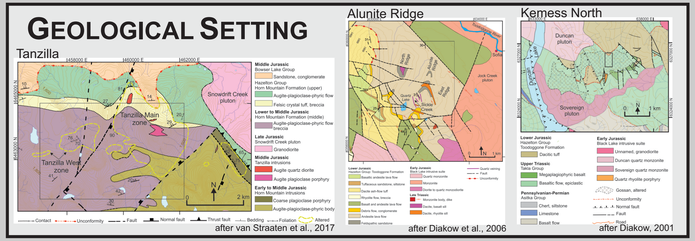
Advanced Argillic-Alteration in BC

Advanced argillic-alteration is not a common feature in many porphyry deposits in British Columbia; this is attributed to the erosion that has destroyed and removed the shallow parts of porphyry systems in many districts.

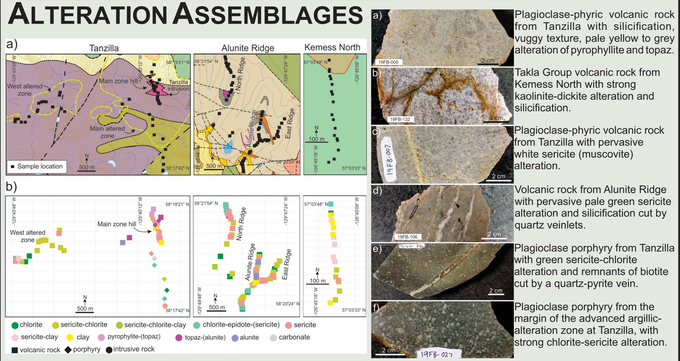


However, advanced argillic-alteration zones are preserved in some locations in BC, within districts that are highly prospective to host porphyry-type mineralization. Zones of advanced argillic-alteration cover large areas in northern BC and Vancouver Island. In this study, alteration-mineral assemblages and compositions across advanced argillic-alteration zones in three BC mineral properties are characterized: the Tanzilla, Alunite Ridge and Kemess North.

Geological Setting



Alteration Assemblages



a) Plagioclase-phyric volcanic rock from Tanzilla with silicification, vuggy texture, pale yellow to grey alteration of pyrophyllite and topaz.

b) Takla Group volcanic rock from Kemess North with strong kaolinite-dickite alteration and silicification.

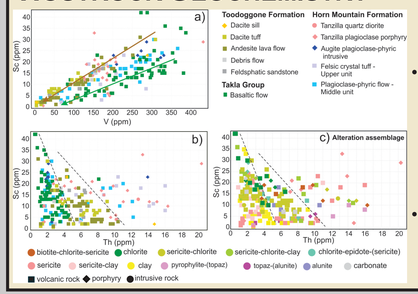
c) Plagioclase-phyric volcanic rock from Tanzilla with pervasive white sericite (muscovite) alteration.

d) Volcanic rock from Alunite Ridge with pervasive pale green sericite alteration and silicification cut by quartz veinlets.

e) Plagioclase porphyry from Tanzilla with green sericite-chlorite alteration and remnants of biotite cut by a quartz-pyrite vein.

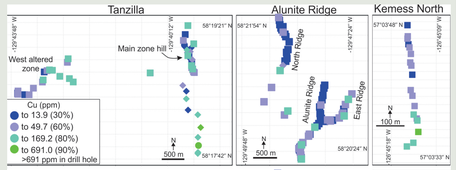
f) Plagioclase porphyry from the margin of the advanced argillic-alteration zone at Tanzilla, with strong chlorite-sericite alteration.

Hostrock Geochemistry

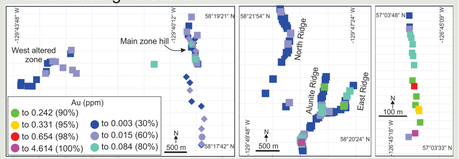


- All hostrocks show a positive trend of Sc against V however, the slope of the trend is slightly different.
- The trend from high Sc to high Th reflects a change in composition from more mafic Takla volcanic rocks to mafic-intermediate felsic rocks of the Toodoggone and Horn Mountain formations.
- Th-Sc diagram colour-coded by alteration assemblage shows that there is no distinct hostrock influence on alteration.

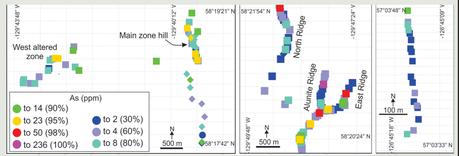
Geochemical Vectors



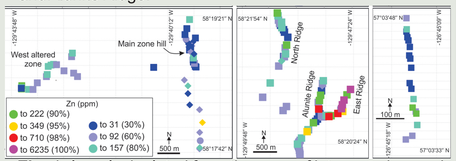
- **Copper** is not present in notable concentrations in advanced argillic-altered rocks of the study areas. In fact, Cu seems to have been depleted within the zones of strong advanced argillic alteration.



- **Gold** locally shows weak anomalies in advanced argillic-altered rocks but the data do not reveal a clear trend.

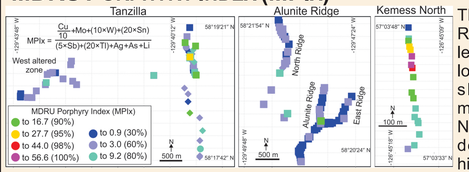


- **Arsenic** concentrations occur with the advanced argillic-alteration at Alunite Ridge and Tanzilla whereas the As concentration at Kemess North is low suggesting a deeper setting for the alteration at Kemess North relative to Tanzilla and Alunite Ridge.



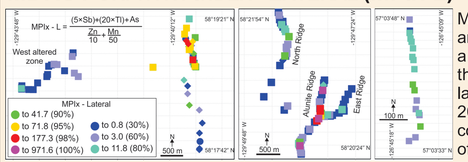
- **Zinc** is largely depleted from the zone of intense advanced argillic-alteration at Tanzilla and Kemess North. At Alunite Ridge, the highest zinc concentration occur within the East Ridge, distal to the main area of Alunite Ridge.

MDRU Porphyry Index (MPIx)



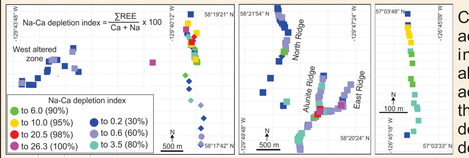
The MPIx indicates that Alunite Ridge represents the shallowest levels among the study sites, with low MPIx ratios. Tanzilla represents slightly deeper levels, with moderate MPIx ratios. Kemess North represents a relatively deeper environment, with the highest MPIx ratios

MDRU Porphyry Index - Lateral (MPIx-L)



MPIx-Lateral compares metals that are enriched in the shallow parts of a porphyry system (Sb, As, Tl) to those that those that are more laterally dispersed (Halley et al., 2015) and typically have higher concentrations in more distal parts of the porphyry system (Zn, Mn).

Na-Ca Depletion Index



Ca and Na depletion casued by acid leaching correlates with the intensity of advanced argillic alteration. Zones of most intense advanced argillic alteration have the highest level of Na and Ca depletion, with the index gradually decreasing distally.

Exploration Implications

- **Alteration zoning** consists of (central to outward): strong silicification locally with topaz, andalusite, alunite and pyrophyllite, white sericite and clay (kaolinite-dickite), pale green sericite, green sericite-chlorite alteration, and chlorite-epidote-(sericite).
- **The MDRU Porphyry Index (MPIx)** shows the vertical zoning and indicates that Kemess North represents deeper setting whereas Alunite Ridge, relatively, shallower environment.
- **The MDRU Porphyry Index-Lateral (MPIx-Lateral)** maps the geochemical vectors on a horizontal profile and provides lateral vector at shallow-level porphyry environment.
- **The Na-Ca depletion index** maps Ca and alkali depletion within and around zones of advanced argillic alteration and provides a vector toward zones of high fluid flow and potentially to the more central parts of alteration above a porphyry centre.

Acknowledgements

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