Age of Cu - Au - Ag mineralization at Copper Mountain:

Part of a ~200 Ma copper epoch in BC

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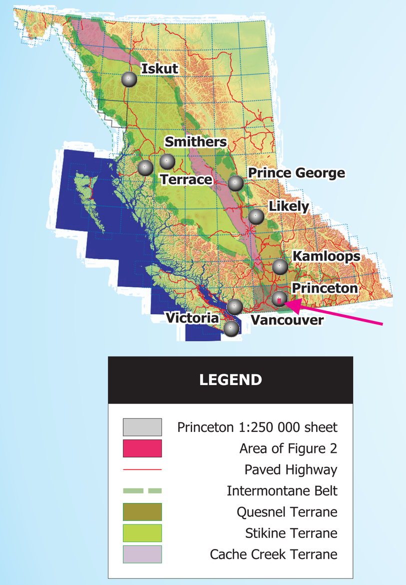
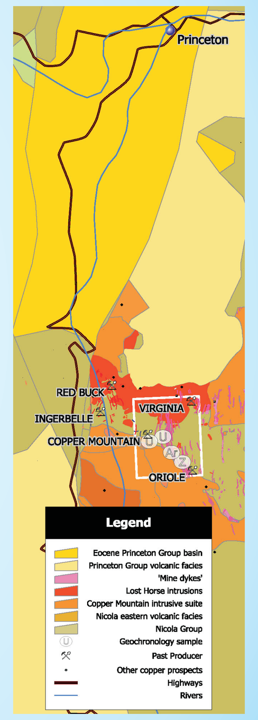
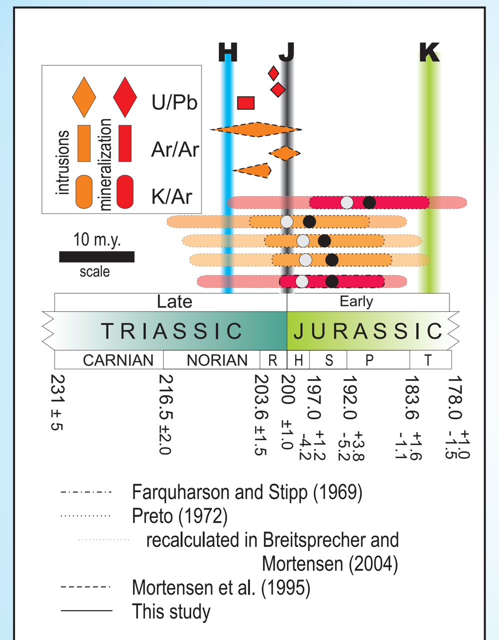
Introduction



A chain of alkalic Cu–Au±Ag–Mo porphyry deposits and coeval intrusive and volcanic rocks extend the length of the Canadian Cordillera. They are the product of a prolific metallogenic event. Mineralization at Copper Mountain is part of this event; recognized by workers in the 1970's as coeval with intrusions that host the mineralization along with nearly coeval volcanic rocks. However, by the mid 2000's this nearly coeval relationship was challenged by time scale revisions, changes to isotopic decay constants, improvements in dating techniques and over-interpretation of earlier cooling ages. If the isotopic age data were taken at face value, the mineralization at Copper Mountain appeared to be nearly10 million years younger than the host rocks. With a new era of deep porphyry exploration about to begin, it was imperative to know whether mineralization was related to a younger, perhaps hidden intrusion or if existing age data were misleading.

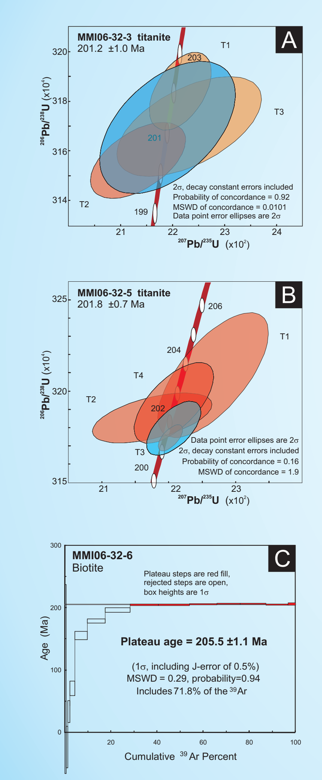


Time scale evolution

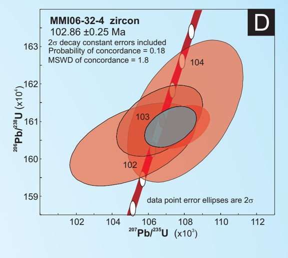


Early studies at Copper Mountain argued for nearly synchronous deposition of sparsely fossiliferous country rocks, and isotopically dated intrusion and mineralization (Preto, 1972). However, a time scale revision in 1982 (Harland et al., 1982; H) pushed the Triassic-Jurassic boundary back to 208 Ma; creating a ~15 m.y. lag between deposition of arc strata and intrusion. A subsequent revision of the Jurassic time scale (Pálfy et al., 2000; J), moderated the 1982 Triassic-Jurassic boundary revision, placing it at 200 ±1.0 Ma. The Copper Mountain story then was: intrusion ~202 Ma, in the Late Triassic, followed by mineralization ~193 Ma, in the Early Jurassic. In light of typical durations for hypogene ore formation, which range from 0.01 to 0.1 m.y. for Cu±Mo±Au porphyry deposits worldwide (McInnis, et al., 2005), the lag time of nearly 10 m.y. seemed unreasonable, and most likely attributable to the large errors of the age determinations from mineralization.

Geochronologic results



Our sampling of mineralization includes titanite-biotite–bearing veins in the margin of the Copper Mountain stock and those equidistant between the Copper Mountain stock and the body of Lost Horse intrusions. In addition to this spatial variability, we have used two different techniques: U-Pb titanite (A, B) and $^{40}Ar/^{39}Ar$ biotite (C) dating with closure temperatures of 660–700°C (Scott and St-Onge, 1995), and 300–450°C (McDougall and Harrison, 1999), respectively. These techniques are more robust than the K-Ar biotite technique used in the past. Our results for the titanite-bearing veins, 201.2 ±1.0 Ma and 201.8 ±0.7 Ma, are identical, within error, to the crystallization ages reported by Mortensen et al. (1995). If there is any systematic difference in the ages of intrusion and mineralization, its measurement is beyond the resolution of the geochronometers available to us.



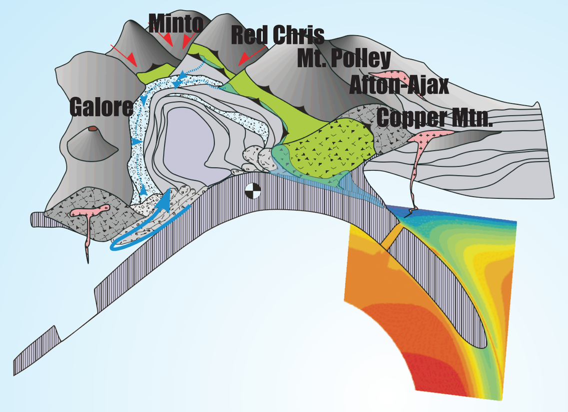
New geochronologic results from this study: (A, B) U-Pb TIMS dating of titanite from mineralized veins, (C) $^{40}Ar/^{39}Ar$ age determination on euhedral biotite from massive bornite ore, and (D) U-Pb zircon result from the "Mine dykes".

What's in it for you?

~200-205Ma alkalic Cu-Au-Ag±Mo deposits are known from throughout the Quesnel and from northern Stikine terranes. They have yet to be discovered in the poorly explored southern Stikine Terrane. This represents a significant exploration opportunity.


Outcrop hunting, Tatla Lake, Interior Plateau.

Mineralized arcs



Quesnel Arc accreted to ancestral North America (ANA, or a crustal ribbon that lay adjacent to ANA) in Early Jurassic time (~186 Ma; Nixon et al., 1993). Subduction of ancient Pacific Ocean crust to form the proto-Quesnel and conjoined Stikine arcs is believed to have begun in the Devonian (e.g., Brown et al., 1996; Mihalynuk, 1999; Logan and Koyanagi, 2000). Arc growth continued sporadically with a significant pulse in the Late Triassic. Near the end of this magmatic pulse, ~204Ma, a chain of Cu-Au±Ag-laden porphyry intrusions were emplaced along the arc axes. Copper Mountain is one of the southernmost deposits within this important metallogenic belt.

What to sample

Four samples were selected for isotopic age determination. Two samples were collected from mineralized veins that contain medium-grained crystals of titanite for U-Pb determination (left). Because of the relatively high closure temperature for lead diffusion in titanite at 660–700°C (Scott and St-Onge, 1995), straightforward isotopic age determinations were anticipated from the two vein samples. In addition, coarse-grained euhedral biotite was extracted from an archival specimen of museum-quality massive bornite-chalcopyrite-biotite from the 'Big Lead' to provide a 40Ar/39Ar cooling age on mineralization from a spectacular 'glory hole' (now mined out).

The fourth sample, a relatively unaltered representative sample of the 'mine dyke' swarm (Photo in panel to right), was collected to date the late, crosscutting intrusions.

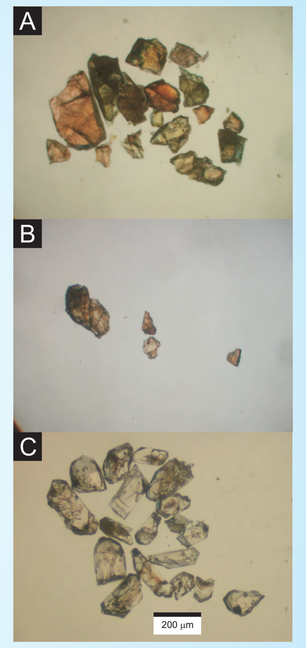
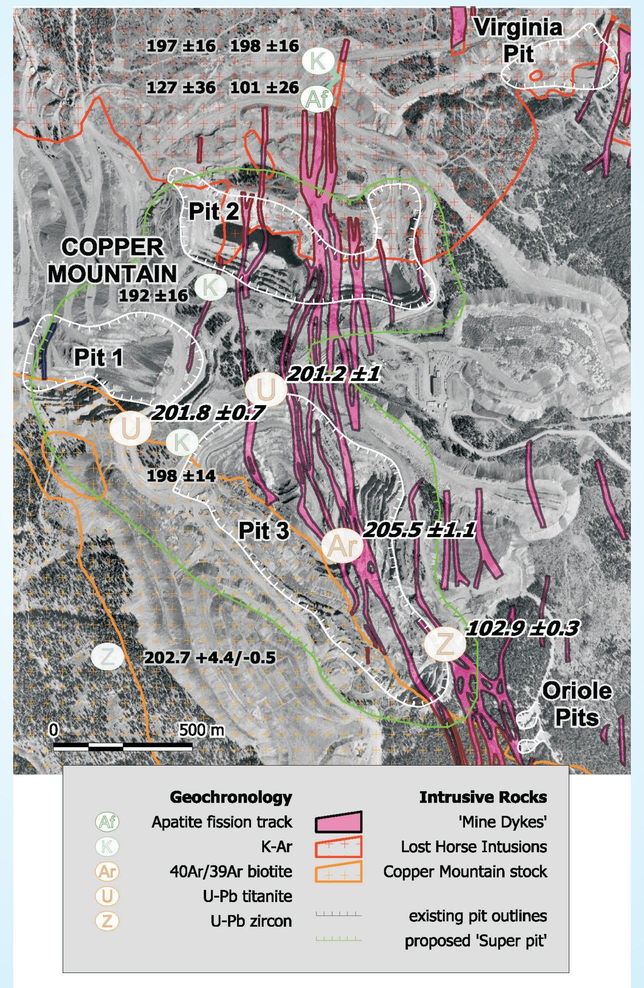


Photo above left is one of the titanite-bearing veins sampled for age determination. The photomicrographs above show the high quality of the picked titatnite grains (A, B) from the mineralized veins, and zircons (C) from the "Mine dykes".

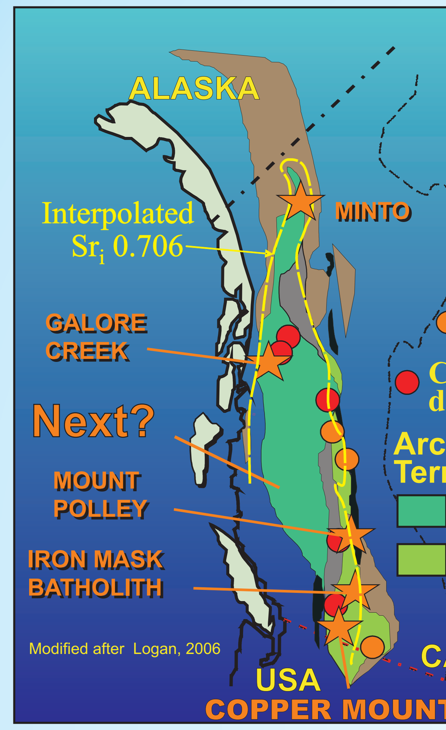
Copper Mountain deposit

Underground mass mining techniques have enabled profitable extraction of the deep portions of porphyry deposits at minesites worldwide. Often considered a relatively new innovation, 'block caving' was originally developed for copper mining in Utah in 1906 (Barger and Schurr, 1944). Profitable underground mining of large tonnage, low-grade deposits combined with the recent strength in metal commodity prices has prompted deep exploration of porphyry deposits in British Columbia, especially within the prolific Quesnel terrane (Figure 1). Copper Mountain Mining Corp. has demonstrated the potential for subsurface extensions to mineralization that was extracted from open pits at Copper Mountain.



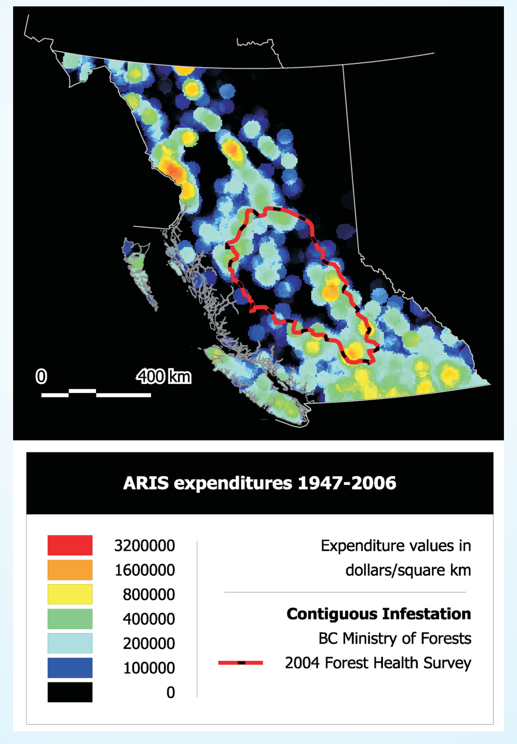
In 2009, the company reported a resource of 470.8 million tonnes grading 0.311% Cu (0.15% Cu cut-off; O'Rourke, 2008) adjacent to, and beneath, the proposed 'Super pit' (see Figure at left; Holbek, 2009). Current plans are to extract 211.2 million tonnes at 0.361% Cu from the Super pit (Chance et al., 2009). This resource of more than 1 billion kg Cu adds significantly to historical production between 1908 and 1996 of ~650 million kilograms of Cu, nearly 16 million grams Au, and over 648 million grams Ag (BC Geological Survey, 2009; MINFILE 092HSE001). In addition, largely untested magnetotelluric targets extend 1000 m below the lowest planned Super pit levels (Holbek, 2007, 2009).

Province-wide Potential



Contemporaneity of intrusion and hypogene mineralization at Copper Mountain is consistent with the results of similarly robust datasets elsewhere within the Cordilleran belt of alkalic porphyry deposits (e.g. Iron Mask and Mt. Polley; Logan et al., 2007). Our new data provide a tight integration with the ~ 205–200 Ma alkalic Cu-Au-Ag±Mo porphyry event that stretches the length of the Canadian Cordillera. In detail, it is a belt duplicated within the coeval Quesnel and Stikine arcs. So far, however, no sizable alkalic porphyry deposit of this vintage is known from southern Stikinia.

Yet, there is no compelling geological reason as to why such deposits should not exist in the expansive southern Stikine terrane. Most likely, they are yet to be discovered as much of southern Stikinia is underlain by the Interior Plateau, a region historically avoided by mineral explorationists because of the challenges of working in the relatively poorly exposed region. In some parts of the plateau, these challenges are more perceived than real as outcropings of old arc rocks can be found (e.g. Mihalynuk et al., 2007, 2008). The center figure shows the deficit of recorded mineral exploration expenditures in this region. The other mineral exploration "black hole" within the Stikine terrane (to the northwest) corresponds with the Late Jurassic Bowser Basin.



Within the last decade, access to much of southern Stikinia has increased dramatically as logging operations harvest the pine forests, most of which have been killed by the Mountain Pine Beetle (red area in figure at right). Southern Stikine terrane represents a largely untapped exploration opportunity. It may be home to the next member of the Cordilleran-wide chain of 200-205 Ma alkalic Cu-Au-Ag±Mo poprphyry deposits.