New Models for Mineral Exploration in British Columbia: Is There a Continuum Between Porphyry Molybdenum Deposits and Intrusion-Hosted Gold Deposits?

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Abstract

One goal of this project is to develop new exploration models for porphyry molybdenum systems in western North America at both the deposit level and a regional scale. The first aspect of this research is comparison of the Adanac molybdenum deposit to other porphyry molybdenum deposits in North America based on mineralogical, trace element, and alteration zoning patterns. The second aspect is to analyze the geochemistry of the plutonic suite responsible for mineralization (Surprise Lake Batholith) and compare that to other plutonic suites hosting molybdenum deposits. In addition to standard geochemical measurements, we plan to determine oxidation state of the pluton using reflected light microscopy (magnetite/ilmenite) and to analyze for stable isotope geochemistry (oxygen and sulfur).

A second goal is assessing the possible connection between porphyry Mo and intrusion-hosted Au deposits. Intrusion-hosted Au deposits, such as those in the Tombstone Belt of Yukon, are known to occur in deep, reduced intrusions that may contain molybdenum as an important byproduct. Geochemical comparison of these suites may provide evidence of a possible genetic similarity. In addition, we plan to use Re-Os isotope signatures to test the possible links between Mo mineralization at Adanac and nearby (downstream) placer gold deposits to see if they have a common origin.

Adanac appears to be a Climax-type deposit. Trace element maps show that Mo has high values at depth on the NE and SW ends of the deposit and forms a blanket over the porphyry intrusions. F and W both are present and are coincident with Mo. Pb and Sn are present in trace amounts and are controlled by faults.

Methodology

A series of 4 cross sections were chosen in the deposit, one traversing roughly east-west and 3 traversing in north-south directions. Colored cross sections below show geology with descriptions and photographs of each lithology occuring in the sections. At selected drillholes on the cross sections, core was composited based on similar lithology and analyzed for 41 trace elements and fluorine on intervals of 30 to 50 ft. Samples were analyzed by Acme Labs in Vancouver using Inductively Coupled Plasma Emission Mass Spectrometry (ICP-MS). Thus far, the deposit has been analyzed for Mo, Pb, Zn, W, Cu, Sn, Au, and F. Values (ppm) of selected elements are shown below contoured against the backdrop of deposit geology to determine possible lithological or structural controls on elements that may be present (black and white pattern: see key).

Geologic Setting

The Adanac Molybdenum deposit is in northwest British Columbia near the nown of Atlin (Figure 1). The geology of the Atlin area was mapped by Aitken (1959) and the regional setting of the deposit is discussed by Christopher and Pinsent (1982). The area is underlain by serpentinites, limestones, basalts, and shales of the accreted Cache Creek terrane. It is Pennsylvanian and Permian in age and weakly metamorphosed. These rocks are intruded by two younger batholiths, the Fourth of July and the Suprise Lake.

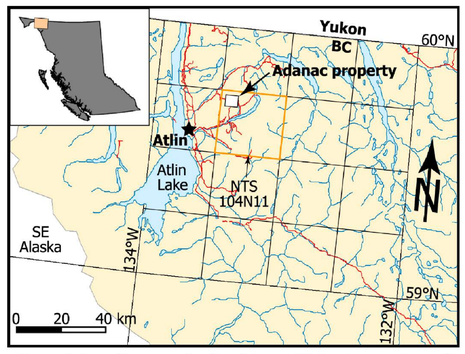


Figure 1. Location map for the Adanac Molybdenum deposit.

The Adanac deposit occurs on the western margin of the Surprise Lake Batholith (Figure 2). It occurs at the head of Ruby Creek, under the floor of an alpine cirque. Here, porphyry domes intrude the batholith, and mineralization occurs as a sub-horizontal stockwork of veins above these porphyries. These veins become vertical near the NE and SW ends of the deposit, at drillholes 301(A') and 314(B) (Figure 3). The mineralization and intrusions are cut off to the north by the Adera Fault, which also defines the southern boundary of the Fourth of July Batholith.

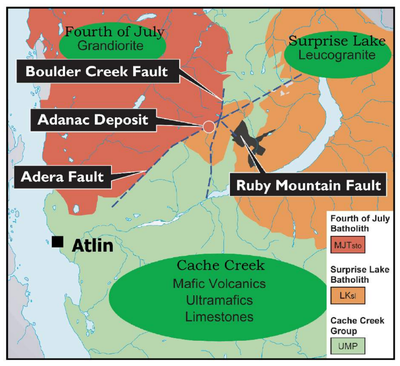


Figure 2. Generalized regional geology of the Adanac deposit.Modified from Aitken, 1959.

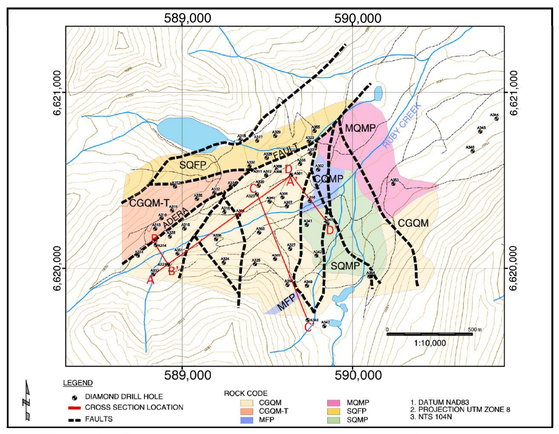
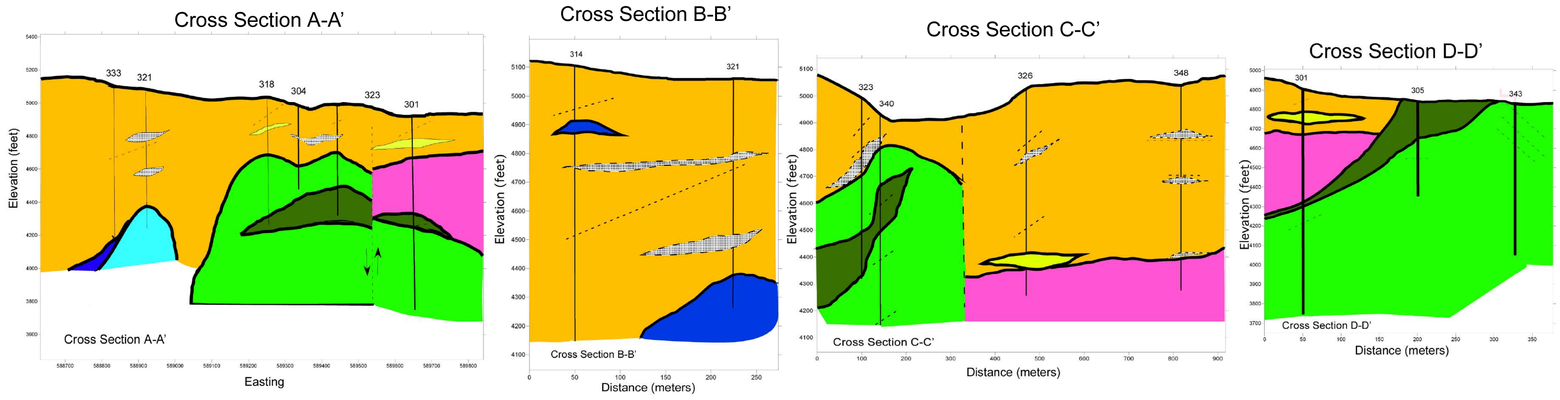
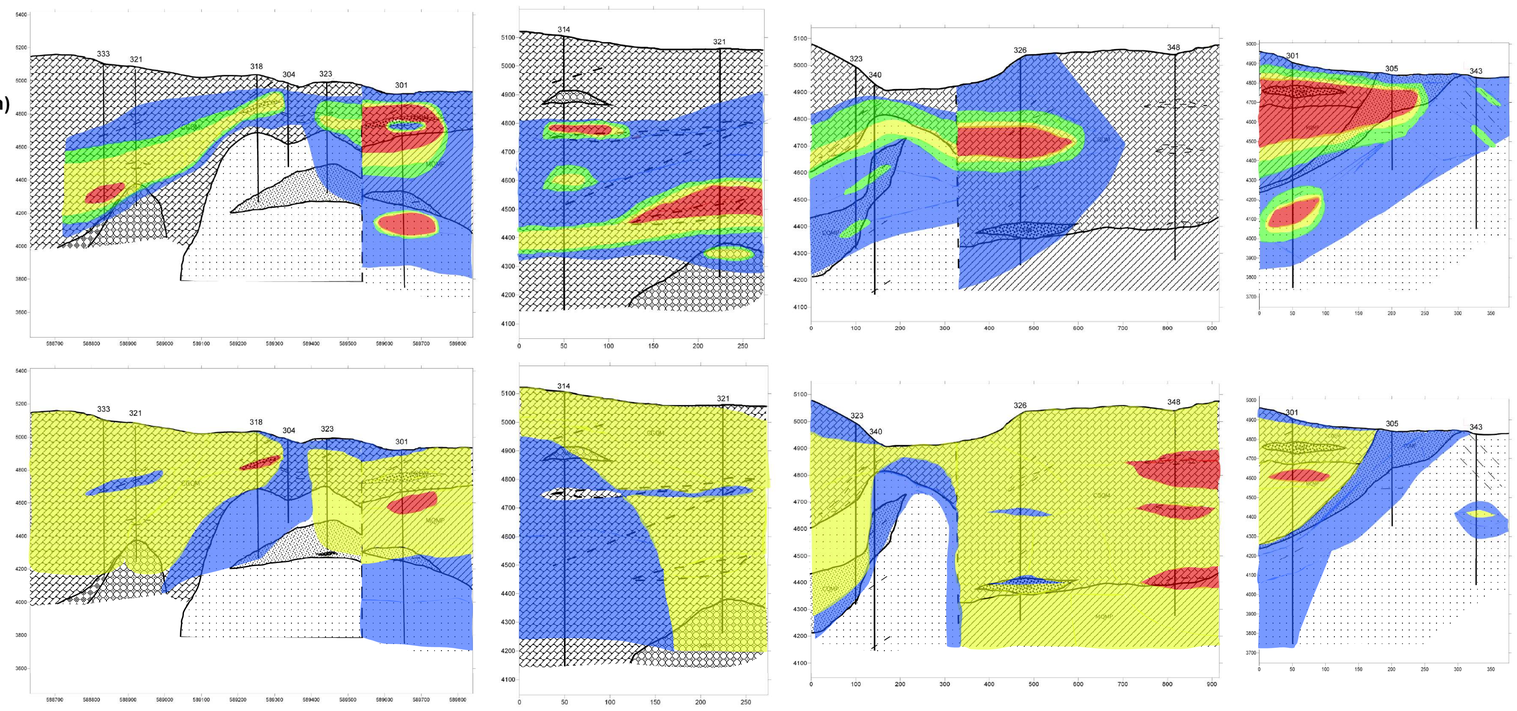


Figure 3. Surface geology of the Adanac deposit showing drill hole and cross section locations. Modified from Christopher and Pinsent, 1982.

Geology





Lithologic Key

(Lithologies are listed in order of oldest to youngest)

CGQM (coarse grained quartz monzonite)
The most common lithology in the deposit. Historically called "quartz monzonite", the rock is actually a granite. The main constituents are grains of perthitic potassium feldspar, plagioclase and quartz ranging in size from 0.5 to 3.5cm. Potassium feldspar is the more common mineral at 50-60% in hand specimen. Plagioclase is 20-50% and quartz is 20-35%. There are trace amounts of biotite as well. The texture is variable and commonly contains groundmass which increases to about 25% in a transitional variety of CGQM (not shown).

MQMP (mafic quartz monzonite porphyry)
This rock is characterized by an abundance of biotite which occurs as smaller phenocrysts amid larger plagioclase crystals (1mm- 1cm). Quartz is also present in this finer phase of phenocrysts (1-4mm). Plagioclase and quartz are subhedral to euhedral. Groundmass is compositionally similar to CGQM.

SQMP (sparse quartz monzonite porphyry)
This lithology is compositionally similar to CGQM. Phenocrysts are 10-30% of hand specimen and consist of 2mm to 1cm size grains of plagioclase, potassium feldspar, and quartz. Groundmass (aphanitic to fine-grainecompositiond) is of a similar with the addition of biotite.

CQMP (crowded quartz monzonite porphyry)
This rock is a version of the porphyry that has an increased phenocryst count that reaches 75%. Groundmass may also increase in grain size to 1mm.

MFP (megacrystic feldspar porphyry)
A distinctly different lithology from others in the deposit. Contains a greenish-blue aphanitic groundmass. Phenocrysts consist of large euhedral plagioclase crystals (up to 4cm) and smaller 1-2mm biotite crystals. Total phenocryst amount is around 30%. Determination of groundmass composition is pending thin section analysis.

MEQM (medium-equigranular quartz monzonite)
Composition is the same as CGQM but noticeably equigranular and with smaller grains (1cm). Irregular and mosaic like textures indicate recrystallization.

FGQM (fine-grained quartz monzonite)
This rock is compositionally most similar to CGQM. The composition does vary to exclude biotite, however, and the texture is variable as well. It can be aplitic to porphyritic with phenocrysts (feldspars) up to 0.5cm in size and 10% of the rock.

Fault
Horizontal dashed lines indicate a fault of unknown orientation.

Silicified Zone

Preliminary Conclusions

Molybdenum values are high (670-1430 ppm) at drillhole 301 where quartz veins are vertical. Mineralization follows subhorizontal quartz veins to the southwestern end of the deposit. This forms a steeply dipping blanket of mineralization that lies above the sparse quartz monzonite porphyry intrusion. Fluorine is abundant in the deposit as well and high values (1000-3300 ppm) tend to mimic molybdenum mineralization, but extend further out in the deposit. W, Pb, and Zn all are present in trace amounts (up to 200 ppm). Tungsten appears to be coincident with molybdenum in the deposit. Lead and zinc contents are controlled by faults. The deposit contains only trace amounts (10 ppm) of Cu and Sn. There is less than 0.1 ppm of Au.

Future Research

In spring 2007, additional trace elements will be contoured on the same cross sections. Information about hydrothermal alteration in the deposit is being gathered from megascopic and petrographic observations and plotted on sections for comparison to the trace element patterns. Additional sampling of the deposit and the Surprise Lake Batholith is planned for summer of 2007. These samples will be used to refine deposit level maps of alteration and to collect regional geochemical data from the Surprise Lake pluton. During fall 2007 and spring 2008 the research will progress to a more regional focus. Re-Os isotope signatures of placer gold and molybdenum will be compared to test the possibility of a link between the two types of mineralization. Isotope ratios of sulfur and oxygen will be determined as well as the redox state of the pluton. These geochemical data will refine the connection between the Adanac Molybdenum deposit and associated host pluton chemistry, and allow for comparison to other Mo deposits in the North American Cordillera. The final goal is to determine geochemical similarities between plutons that produce metal deposits (Mo, W, Au), as compared to barren plutons, in order to create new parameters for exploration models at the regional scale.