PORPHYRY INDICATOR MINERALS (PIMs): TARGETING MINERALIZED CENTRES USING APATITE TEXTURE AND CHEMISTRY

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**METHODS**

Samples were selected from different alteration assemblages at different vertical levels to determine and characterize the occurrence of apatite at various depths in a porphyry system. Samples were also collected from unmineralized host-rocks for direct comparison.

Analytical techniques included petrographic study employing optical and cathodoluminescence (CL) microscopy, scanning electron microscopy (SEM), electron microprobe analysis and MLA (Mineral Liberation Analysis) which is an automated scanning electron microscope.

**TEXTURAL CHARACTERISTICS**

- CL Image showing two primaryapatite grains in least altered rock with yellow to yellow-green luminescence and no obvious internal texture;
- CL Image ofapatite in altered-mineralized host rock showing replacement of the green-luminescent apatite by a dark green-to-grey-luminescent phase generating a ‘messy’ texture;
- SEM Image of apatite in figure 6 showing chlorite, as a very bright phase at all the rim and inside the apatite formed within a micro-fracture, which in figure 7 shows an envelope of green to grey-luminescent apatite.

Apatite in fresh host-rock:
- Displays strong luminescence of yellow to yellow-green and sometimes yellow-brown.
- No major internal structures were observed using either CL, SEM or MLA.

Apatite in altered host-rock:
- Looks very similar to that associated with unaltered host-rock when examined using a polarizing microscope and SEM.
- However, CL microscopy reveals thatapatite associated with altered host-rocks displays a unique green luminescence.
- Strongly altered apatite is overprinted by a complex network and bodies of dark-green to grey-luminescent domains, producing a characteristic ‘messy’ texture contemporaneous with muscovite alteration and associated copper mineralization.

**CONCLUSIONS**

- Apatite from unmineralized host rock displays yellow luminescence and is enriched in Mn, Cl and S.
- Altered apatite displays yellow-green luminescence due to excitation by Fe\(^{2+}\). Strongly-altered apatite shows dark-green to grey luminescence, producing a complex texture with remnants of green-luminescent apatite, and is depleted in Mn\(^{2+}\), Na, Cl and S.
- These results provide the first step towards application of resistate minerals as indicator for porphyry copper exploration.

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**REFERENCES**

- [1] Apatite as an Indicator of Porphyry Copper Deposits
- [2] Petrographic and Textural Characteristics
- [3] Chemical and Mineralogical Studies

**CHEMICAL CHARACTERISTICS**

Microprobe analysis on apatite from fresh and altered host rocks indicate that:
- There is no major change in Ca and P content of the apatite in fresh and altered host rock.
- Mn is significantly depleted in the altered rock. Loss of Mn explains observed loss of luminescence in apatite during the hydrothermal alteration event.
- Chlorine was also lost during alteration. Similarly, depletion in F is also expected.
- Na has also been lost during apatite alteration.
- Most of the reliably measured sulphur values were from fresh apatite. Therefore, sulphur may have also been lost from apatite during alteration event.

**APATITE IN PORPHYRY COPPER DEPOSITS**

Apatite is a common accessory mineral in igneous rocks related to porphyry copper deposits and may also form during K-silicate alteration. Trace element composition ofapatite has been used to recognize the host rock and degree of fractionation and oxidation state of the host magma. Apatite from porphyry deposits is Cl-rich, displays yellow luminescence under CL (cathodoluminescence) and shows complicated history of corrosion and redeposition with a characteristic zoning (liesegang rings).