White mica mineral vectors to ore obtained by SWIR spectroscopy mapping in the Altar Porphyry Cu-(Au) deposit, San Juan, Argentina.

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Altar (31º 29' S, 70º 28' W) is a porphyry Cu-(Au-Mo) deposit with associated epithermal Au-(Ag-Cu) veins located in the Cordillera Principal of San Juan province (Argentina). Mineralization in Altar (995 Mt, 0.35% Cu, 0.083 g/t Au; Marek, 2014) is mainly hosted in a complex stockwork of quartz veinlets and disseminations.

Geochemistry of Cu, Au, and Mo delineates two mineralized centers located in the central ridge (Altar Central) and the east valley (Altar East). Copper-(Au) grades are spatially related with the areas of emplacement of the mineralized subvolcanic stocks and two zones of potassic alteration at depth with chalcopyrite ± pyrite ± bornite, as A veins and disseminations. A subsequent pulse, precipitated the quartz ± molybdenite veinlets (B veins). With progressive cooling of the fluids, the rocks were affected by chloritic alteration (chlorite + hematite ± rutile) as patches at deep, intermediate, and shallow levels. The phyllic alteration at depth is controlled by fractures associated with straight-walled type D veins and at shallow levels forms a continuous halo surrounding the potassic and chloritic alteration types. Kaolinite ± quartz ± rutile occurs at depth in the porphyries and the wall-rocks and forms the halos of type E veins. These late veins are rich in enargite, tennantite, pyrite, relict bornite, and traces of gold. Supergene alteration caused the enrichment of hypogene sulfides and their replacement by covellite ± digenite (Maydagán et al., 2015).

Previous studies (e.g., Cohen, 2011) demonstrated that the wavelength of the 2,200-nm absorption feature corresponding to the Al-OH bond energy of white mica-bearing samples is critical to determinate the pH of hydrothermal fluids in porphyry systems. The wavelength of the 2,200-nm feature of white mica (including both muscovite and illite), shifts from 2,195 nm in muscovite toward 2,220 nm in phengite, as Al is replaced by (Fe, Mg) +Si. Muscovitic white mica (including illite) composition reflects an acidic environment whereas a phengitic composition indicates a more neutral environment (e.g., Cohen, 2011).

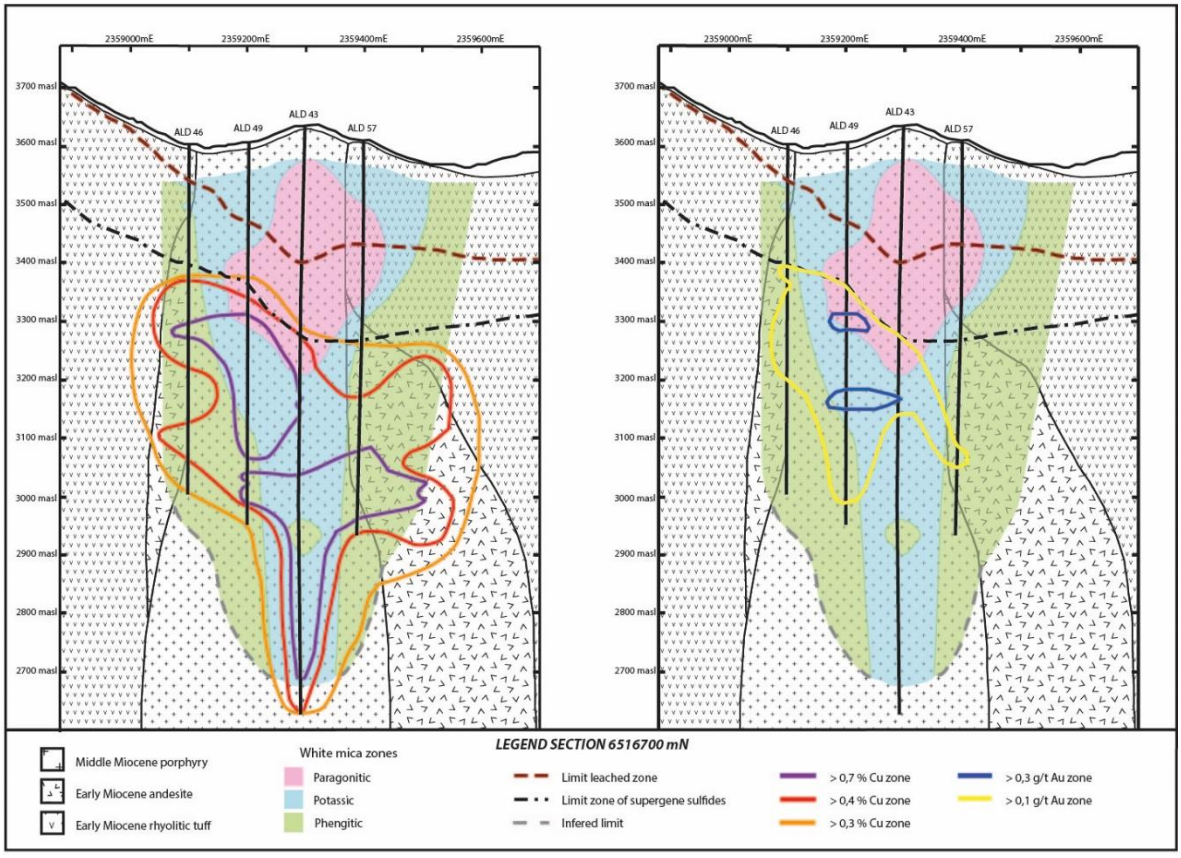
We performed Short Wave Infrared (SWIR) spectroscopy analyzes on 85 samples from three W-E sections that cut the Altar Central deposit. The objective of this contribution is to identify new mineral vectors towards Cu-rich cores in the deposit and compare the new data with previous microprobe and XRD analyses.

The equipment used for the measurements was an Analytical Spectral Devices, Inc. TerraSpec™ short-wave infrared (SWIR) spectroscopic mineral analyzer. This equipment measures SWIR spectra from 350nm to 2500nm wavelength range, with spectral resolution of 3nm. Raw spectra were processed into The Spectral Geologist V.8.0.2.17 software™ for viewing and extraction of numeric parameters such as the wavelength, width and depth of specific absorption features. Then, spectra was interpreted by comparing the unknown

spectra to reference spectra from SPECMIN-PRO 3.1, and The Spectral Geologist™ software.

Alteration zones based on the position of the wavelength of Al-OH absorption (ca. 2200 nm) feature in white micas (WM) were mapped in a section of Altar Central. The results revealed a peripheral zone with phengitic WM (>2209nm) that encompasses an internal zone of normal potassic WM (2200 – 2209nm). At depths between 3550 and 3200 m.a.s.l within the normal potassic WM zone, a hanging level with absorption features <2200nm is interpreted as WM with paragonitic tendency.

The spatial distribution of Cu-Au grades in hypogene zone corresponds to the WM zonation described above, where copper higher grades (>0.7%) correlate to potassic WM even to the transition to phengitic type. In the case of gold, the medium-grade zone (0.1 - 0.2 g/t) correlates with potassic WM and part of the phengitic type to the west. Furthermore, higher gold grades (>0.3 g/t) observed at hole ALD-49, related to D type veins coincides with the transition zone from potassic to paragonitic WM located at shallower levels.



The normal potassic WM zone recognized herein reflects the main channel of acid fluids during the phyllic-stage. The external halo with phengitic WM (+chlorite) indicates peripheral fluids that are more neutral. At depth, phengitic WM + chlorite overprints early potassic (biotitic) alteration. The shallower zone characterized by WM paragonitic tendency (+kaolinite) represent more acidic conditions, suggesting a transition to the epithermal environment (base of lithocap).

Previous studies of the Altar deposit (Maydagán et al., 2016) analyzed the Cu and Au distribution, demonstrating the existence of remobilization and hypogene enrichment zones related to phyllic stage alteration. In this research, we found that the zonation of WM generated during phyllic-stage overprint, determined by drifting in 2200nm wavelength feature, is correlated with Cu and Au grades in the hypogene environment.

Finally, the results obtained support the use of white micas composition by reflectance spectroscopy as a vectoring tool to high-grade mineralization in porphyry systems like the Altar project.

References

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