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Geophysical Data Interpretation in a 3D Environment Provides Insights into Porphyry Copper Systems near Silverton, Colorado

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The Silverton caldera in the San Juan Mountains of southwest Colorado hosts mineralization and alteration associated with porphyry copper systems. Most production came from polymetallic veins worked over a 121-year period that yielded a total of 16.4 million metric tonnes of gold, silver, copper, lead, and zinc ore. However, extensive postmineralization erosion has exposed significant vertical extents of the porphyry copper systems from shallow lithocaps to moderately deep, quartz-molybdenite stockwork veins and sericitic alteration, thereby indicating the potential for additional porphyry-style mineralization. Airborne electromagnetic and magnetic surveys provide relatively continuous observations that can geophysically characterize outcropped and concealed components of the porphyry copper systems. We interpret Versatile Time Domain Electromagnetic (VTEM) and magnetic data along with three-dimensional geologic modeling to better understand the ore systems. We model the porphyry copper systems along 1-km-spaced east-west profiles across a 9- x 10-km area.

The Silverton caldera is composed of Oligocene to Miocene volcanic and intrusive rocks that exhibit extensive propylitic alteration and more localized sericitic and advanced argillic alteration. Intrusions along the caldera margin host quartz-sericite-pyrite veins with lesser molybdenite exposed on Mt Moly and in surrounding valleys. To the north, mountain peaks in the Red Mountain district exhibit a lithocap around 3 km in diameter that overlies sericitic-altered rocks exposed in the surrounding incised valleys. Similar alteration patterns are present to the south along a ridge of vuggy quartz at Ohio Peak, and the alteration patterns continue south an additional 2.5 km to Anvil Mountain where the lithocap broadens to around 4 km.

Maps of VTEM calculated time constant (tau) indicate that conductive features underlie the lithocaps and sericitic-altered rocks, whereas propylitic-altered rocks are commonly resistive. Aeromagnetic data show magnetic highs over the intrusion-hosted molybdenite stockwork veins and sericitic-altered rocks at Mt Moly; however, low magnetic susceptibility measurements indicate that such rocks are not the source. Magnetic depth estimates suggest sources around 300- to 500-m depth near the mountain peak that shallow to 200 m in the valleys where the sericitic alteration is less intense, which may reflect the presence of magnetite-rich potassic or propylitic-altered rocks. VTEM 1D inversion results show changes in conductivity down to 250-m depth at Mt Moly where a trend of decreasing conductivity with decreasing intensity of sericitic alteration is observed from the mountain peak toward the valleys. Low conductivity occurs over a mapped zone of quartz-alunite-pyrophyllite alteration. The Red Mountain district lithocap exhibits magnetic lows, suggesting magnetite destructive alteration that is corroborated with very low magnetic susceptibility measurements. The northernmost east-west section occurs at the southern extent of the district. In this section, the VTEM inversion results show conductive sericitic alteration in the valleys beneath the lithocap where magnetic depth estimates indicate sources <200-m depth. The Ohio Peak-Anvil Mountain area shows moderate magnetic highs centered near Anvil Mountain with depth estimates generally <200 m. VTEM inversion results indicate conductive rocks beneath the lithocap and sericitic-altered rocks with the exception being the silicified rocks that exhibit very low conductivities.