SEG-MJD 2016 Conference

# Assessing Geological Controls for Iron Oxide Copper-Gold Mineralization in the Punta del Cobre District, Chile

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The Coastal Cordillera in northern Chile hosts one of the youngest iron oxide copper-gold (IOCG) belts in the world. The Candelaria-Punta del Cobre district is the largest IOCG camp in the belt, hosting the major Candelaria mine, five more operating mines (Santos, Alcaparrosa, Atacama Kozan, Carola, and Punta del Cobre), and numerous smaller operations, past producers, and prospects. The stratigraphic, lithological, and structural setting for Candelaria, Alcaparrosa, and Santos are being evaluated to establish the controls on magmatism, structure, hydrothermal alteration, and mineralization.

Deposits in the area are hosted in the volcanic Punta del Cobre Formation, divided into Lower and Upper Andesite members. Candelaria hosts breccia, replacement, and manto styles of mineralization located at and below the Lower Andesite-Upper Andesite contact in a faulted anticlinal structure 1 km east of the Copiapó batholith. Alcaparrosa, located north of Candelaria, has a similar setting, but is located close to the contact of the Copiapó batholith. Santos is located ~3 km farther to the east and consists dominantly of breccia mineralization in an irregular pipe-like feature that cuts the "Albitófiro" unit at the top of the Lower Andesite.

The Lower Andesite consists of massive and fragmental andesitic volcanic units. The Albitófiro, occurring at the top of the Lower Andesite, is locally quartz-phyric and is interpreted to be dacitic. It varies considerably in thickness (50–>300 m). The lower and upper parts of the Albitófiro consist of monomictic breccias, which may dominate when the unit is thin. The irregular thickness and the distribution of autoclastic breccias around more massive domains suggest that the Albitófiro formed as one or more coalescing domes. A fine-grain black rock interpreted as a volcanic sediment or tuffaceous unit occurs locally overlying the Lower Andesite in the Candelaria and Alcaparrosa deposits. The Upper Andesite varies from andesitic units and sediments in the west (Candelaria and Alcaparrosa) to massive basaltic units in the east (Santos).

Geochemical characterization indicates that the Lower and Upper Andesite have similar major and immobile element ratios, but the Lower Andesite is enriched in LREE and depleted in MREE compared to the Upper Andesite. The dacitic Albitófiro and basaltic units in the Upper Andesite each have distinctive geochemistry consistent with their interpreted compositions.

Alteration is pervasive in the Lower Andesite at the three deposits and is characterized by early magnetite-biotite-chlorite, overprinted by actinolite and K-feldspar alteration. Alteration in the Upper Andesite consists of diopside, brown garnet, scapolite, and K-feldspar alteration close to the lower contact with the Lower Andesite and generally decreases in intensity upward.

Lithological and geochemical differences among the Candelaria, Alcaparrosa, and Santos deposits indicate that volcanic lithologies in the area are more complex than previously defined. East-west variation in the Upper Andesite suggests units were sourced from different volcanic centers, possibly separated by a fundamental north-south break coincident with

major structures. Understanding the magmatic evolution in the district provides constraints on magmatic evolution and has implications for controls for and sources of IOCG mineralization.