

Deep Characterization of the Santa Cecilia Porphyry Au-Cu System, Maricunga Belt, Northern Chile

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New observations from the Cerro del Medio porphyry Au–Cu system, together with recently acquired data from the adjacent Pircas and Gemelos targets, refine our understanding of magmatic–hydrothermal processes within the Santa Cecilia–Caspiche district of the Maricunga Belt, northern Chile. The system records late Oligocene to early Miocene activity (25.2–24.7 Ma) and lies adjacent to the Caspiche deposit (1,091 Mt @ 0.55 g/t Au), separated by a ~250 m–wide valley, within a regionally significant metallogenic belt along the Chile–Argentina border. Incorporation of new geological, mineralogical, and geochronological information from Pircas and Gemelos allows a more comprehensive evaluation of the nature, timing, and spatial distribution of Cu–Au mineralization across the Santa Cecilia property. Objectives include (1) characterization of alteration mineral assemblages and zoning, (2) temporal constraints on hydrothermal and mineralization events, (3) evaluation of Cu–Au grade distribution across alteration stages, and (4) assessment of genetic relationships between adjacent porphyry centers. Methods integrate petrography, X-ray diffraction, μ XRF mapping, whole-rock geochemistry, fluid inclusion microthermometry, stable isotope analyses ($\delta^{34}\text{S}$, δD – $\delta^{18}\text{O}$), and $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology of alunite, biotite, and muscovite, complemented by molybdenite Re–Os dating. Results define a well-developed porphyry-style vertical alteration sequence consisting of (1) biotite–magnetite (potassic) alteration hosting the highest Cu grades, (2) chlorite–white mica alteration, (3) white mica (sericitic) alteration, and (4) an advanced argillic aluminosilicate lithocap indicative of deeper porphyry potential. Three main mineralization stages are recognized: (1) magnetite–quartz, (2) quartz-rich, and (3) sulfide–sulfate, the latter locally remobilizing and diluting Cu mineralization. Comparable alteration and mineralization patterns at Caspiche suggest a shared magmatic–hydrothermal source, underscoring the exploration potential of the Santa Cecilia district.