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White Mica Alteration in Porphyry Systems: Insights from the Gaby Porphyry Cu Deposit, Northern Chile

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In porphyry systems, spatial distribution of white mica alteration frequently correlates with economic Cu-Mo(-Au) mineralization. White mica occurs either i) as coarse-grained infill of open-space veins with quartz, found in apical to root zones of the system; ii) as pervasive alteration or alteration halos commonly in association with chlorite and chalcopyrite, or iii) as a sericitic alteration halo together with quartz and pyrite along porphyry D-veins.

In the Gaby porphyry copper deposit (northern Chile), white mica alteration is well developed in Eocene porphyries, intruding a Carboniferous-Permian volcano-sedimentary sequence and a Permo-Triassic plutonic complex, correlating generally with relatively high Cu grades. Using a combination of chemical in-situ and mapping techniques and integrating both textural and chemical characteristics, we evidence two stages of white mica alteration. Early stage is associated with high Cu grades, shows low Mg/Fe ratios, and is divided in four substages: E1 and E2 developed as coarse-grained white mica in the apical zone of the porphyry near USTs, as pervasive alteration, with high Fe content, and infill of mica-quartz veins with high W and Sn, respectively; E3 is intergrown with chlorite and chalcopyrite as disseminations or early halo veins, with high Li, or enriched in Ti, Sc, V, and Cr when developed on volcanic rocks. Late white mica alteration has lower Cu grades, high Mg/Fe ratios, and is divided into two substages: L1 forming thin veinlets with chlorite is rich in Li, Fe, Mg; L2 is related to D-veins with pyrite and has low Mg and Fe content. Chlorite is present in both early, Cu-rich and late, Cu-poor white mica alterations, but in different proportions. Within the alteration halo, the chemical composition of white mica combined with quantitative mineralogy provides evidence of extensive vein reopening, highlighting the significance of telescoping in hydrothermal alteration styles in porphyry systems.