

Geology and Characteristics of the Oracle Ridge Copper Skarn, Arizona (USA)

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The Oracle Ridge Cu-skarn, located in the Santa Catalina Mountains of southeastern Arizona, is hosted by Paleozoic sedimentary rocks underlain by the Laramide-age Leatherwood granodiorite. U-Pb LA-ICP-MS dating of skarn-related garnet yielded ages in the range between 67-69 Ma, overlapping with the Leatherwood granodiorite and providing direct evidence for a genetic link between the intrusion, skarn alteration, and copper mineralization. Importantly, the Oracle Ridge Cu-skarn deposit provides a unique opportunity to study metasomatic processes as a function of protolith composition and distance to the causative intrusion, as both limestone and dolostone wallrocks were overprinted by skarn alteration which resulted in skarn composition ranging from magnesian to calcic. Garnet color changes systematically from dark red to brown to tan to green with increasing distance to the intrusion, at the same time the garnet/pyroxene ratio decreases. Conversely, magnesian skarns change from olivine+pyroxene to pyroxene+phlogopite to tremolite+pyroxene to talc+serpentine+pyroxene along the fluid flow path. This study presents the first detailed documentation of such spatial zoning in magnesian skarns lacking garnet occurring parallel to calcic skarn zonation, and thus provide an important framework for the recognition of these zoning patterns. Additionally, magnesian skarns are characterized by higher abundances of magnetite, bornite and chalcocite as well as higher copper grades relative to calcic skarns. Moreover, higher abundances of Bi, Te, and Co sulfide and telluride minerals are recognized in magnesian skarns. We propose that the enrichment in Cu and other critical elements in magnesian skarns is a result of early magnetite precipitation and related Fe depletion in the subsequent retrograde stage that promotes the precipitation of Cu (and Bi, Te, Co) sulfides with high Cu/Fe ratios. Both the higher abundance of magnetite and the distinct zoning in magnesian skarns may be useful for the exploration of concealed skarn-porphyry systems.