

The Cerro Quema High-Sulfidation Au-Cu Deposit (Azuerro Peninsula, Panama): Geologic Model and Implications for Exploration

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Cerro Quema is a high sulfidation epithermal Au-Cu deposit located in the Azuerro Peninsula (SW Panama). It is hosted by the dacite dome complex of the Río Quema Formation, a fore-arc basin sequence of Late Campanian to Maastrichtian age. Mineral resource estimates (Indicated + Inferred) are 30.86 Mt @ 0.73 g/t Au, containing 728,000 oz Au. Hydrothermal alteration and mineralization are controlled by E-trending regional faults.

Hydrothermal alteration at Cerro Quema consists of an inner zone of vuggy quartz (microcrystalline quartz, pyrite, and barite) that grades to advanced argillic alteration (quartz, alunite-natroalunite, APS minerals, kaolinite/dickite, pyrophyllite, barite, illite, and diaspore). The argillic alteration (quartz, kaolinite, illite, and illite-smectite) encloses the advanced argillic and vuggy quartz alteration halos, and grades out to a propylitic alteration zone (chlorite, epidote, carbonate, rutile, and pyrite). Mineralization is mainly restricted to the vuggy quartz and advanced argillic alteration zones consisting of dissemination and microveinlets of pyrite and minor chalcopyrite, enargite and tennantite, with traces of sphalerite. Late-stage base metal veins, composed of pyrite, chalcopyrite, sphalerite and galena, quartz and barite, crosscut older mineralization events.

The $\delta^{34}\text{S}$ values of sulfides (pyrite, enargite, and chalcopyrite) range from -4.8 to -12.7‰, whereas $\delta^{34}\text{S}$ of sulfates (barite and alunite) range from +14.1 to +17.4‰. Calculated $\delta^{34}\text{S}_{\text{SS}}$ results in -0.5‰ with $\text{XSO}_4^{2-} = 0.31$ and $\text{XH}_2\text{S} = 0.69$; this value indicates that the mineralizing fluid is a sulfide-dominant hydrothermal fluid of magmatic origin. The $\delta^{18}\text{O}$ values of vuggy quartz range from +9.0 to +17.5‰, and show an important variability throughout the deposit. This variability vectorizes the fluid source of Cerro Quema at depth and to the east.

Secondary fluid inclusions were measured in quartz phenocrysts of the host rock, affected by vuggy quartz alteration. These inclusions show a wide range on T_h and T_{mi} , from 140° to 212°C, and from -0.3° to -2.6°C, respectively. These data points to a fluid source to the east at certain depth in agreement with $\delta^{18}\text{O}$ values of vuggy quartz.

New $^{40}\text{Ar}/^{39}\text{Ar}$ data of country rocks combined with biostratigraphic ages of the volcanic sequence and crosscutting relationships suggest a maximum age of Lower Eocene (~55-49 Ma) for the Cerro Quema deposit. Its genesis was probably triggered by the emplacement of an underlying porphyry-like intrusion associated with the Valle Rico batholith. The Cerro Quema deposit formed when magmatic hydrothermal fluids upflowed in the eastern zone of the deposit. Exploration for porphyry copper mineralization should therefore be focused on that area. Additionally, high sulfidation epithermal deposits in the Azuerro Peninsula occur in the Cretaceous-Paleogene fore-arc, probably triggered by Lower Eocene fore-arc intrusions, and such consideration should be taken into account when exploring for high sulfidation epithermal and porphyry copper deposits in similar geologic terranes.