

Integrated Structural and Geochronological Framework of the Giant Pueblo Viejo High-Sulfidation Epithermal Gold Deposit, Dominican Republic

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The Pueblo Viejo district, Dominican Republic, hosts one of the largest high-sulfidation epithermal gold deposits worldwide, with past production and resources exceeding ~37 Moz Au (December 31, 2025). Despite decades of exploration and mining, the structural controls and temporal evolution of the hydrothermal system remain incompletely constrained.

This study integrates structural mapping, drill-core observations, 3D geological modelling, and geochronological data to define the structural architecture and timing of mineralization in the Pueblo Viejo deposit and district. Structural analysis reveals that gold mineralization is primarily controlled by steep NE- and NW-trending fault systems and their intersections, which formed permeable pathways for hydrothermal fluids within a volcano-sedimentary basin developed in the Early Cretaceous Los Ranchos Formation.

Mineralization is spatially associated with intense silicification hosting Au-bearing pyrite, overprinting early advanced argillic alteration. Structural damage zones several meters wide localize brecciation, fluid flow, and high-grade mineralization. The volcanic architecture of the district suggests that the deposit formed within a paleovolcanic center characterized by felsic explosive volcanism and the emplacement of volcanic domes and associated phreatomagmatic breccias, which likely played an important role in controlling basin development and hydrothermal fluid circulation.

Alteration and mineralization crosscutting relationships and geochronological data indicate a complex, multi-stage hydrothermal history. Re–Os ages of pyrite suggest a main mineralization event around 113–110 Ma, whereas isotopic studies of hydrothermal minerals indicate subsequent hydrothermal activity and overprinting events. These observations suggest that the Pueblo Viejo system experienced multiple pulses of magmatic–hydrothermal activity during its evolution.

These results indicate that Pueblo Viejo represents a long-lived magmatic-hydrothermal system developed within an evolving volcanic basin and dome field, where structural intersections, reactive host rocks, and repeated hydrothermal pulses-controlled gold deposition. The integrated framework provides new insights into ore controls and exploration targeting across the Pueblo Viejo district and similar volcanic arc environments.