

Vein Texture and Fluid Inclusion Characterization of the Ag-Au Epithermal Events in the Guanajuato Mining District

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The Guanajuato district hosts world-class low- to intermediate-sulfidation epithermal Ag–Au vein deposits and has sustained continuous mining for over 450 years. Recent intensive exploration, at local and regional scales, integrating updated knowledge of the geological and hydrothermal evolution of the Sierra de Guanajuato, supports the onset of a new phase of resource development.

Mineralization is structurally controlled and localized along major subparallel NW-trending fault corridors that crosscut the entire stratigraphic sequence, from Late Jurassic sedimentary units to Oligocene rhyolitic flows. A late Oligocene ignimbritic event postdates and seals the mineralization. High-grade Ag–Au mineralization is preferentially developed within the La Esperanza Jurassic sedimentary formation and the overlying Paleocene conglomerate. At the southern end of the range, in the Codornices Sierra, silicified and argillized lithocaps sealing NW-trending structures are preserved. These features, together with the shared geodynamic evolution, highlight the regional exploration potential and emphasize the role of post-mineral tectonic processes in preserving hydrothermal systems.

Geochronological data indicate that mineralization occurred during two distinct pulses at ~31 and ~28 Ma. The second event is characterized by increased Au concentrations, lower Ag/Au ratios, and the development of NE- to NE–SW-trending structures. These differences are recorded in vein textures, petrography, geochemistry, geochronology, and fluid inclusion data. The first mineralizing event corresponds to Ag-rich quartz–adularia–carbonate veins formed in a NW-trending system, displaying a multistage evolution (five to six stages), with homogenization temperatures of 173–375 °C and salinities of 0.7–5.3 wt.% NaCl. Textural and fluid inclusion evidence indicates boiling of low-salinity fluids. The second event comprises high-grade Au mineralization in NE-oriented veins, comparable to the final stages of the first event, and is characterized by microcrystalline colloform-banded quartz–calcite, with temperatures of 170–300 °C and salinities of 1.4–3.2 wt.% NaCl. These results constrain the temporal evolution of the hydrothermal system and its relationship with successive tectonic events.