

La Colosa Au-Porphyry Deposit, Colombia: New Insights on the Structural Control and Ore-Forming Processes in the Northern Andes

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La Colosa mining project is located 30 km west of the City of Ibagué, Tolima Department, Colombia, at the eastern flank of the Central Cordillera. It has an inferred resource of 28.05 Moz, 1,039 Mt of ore with a grade of 0.84 g/t Au. The deposit is associated with an intrusive complex of Miocene age, which consists of three major magmatic pulses (early, intermineral, and late) emplaced into Triassic-Mesozoic basement rocks of the metamorphic Cajamarca Complex.

Based on a detailed structural study of the area, two ductile deformation events have been distinguished in the metamorphic rocks. Deformation event D₁ is characterized by a closed, subvertical to west-vergent folding with a penetrative NNE- to NNW-trending schistosity S₁. Deformation event D₂ overprints D₁ by formation of open folds with E- to SE-plunging fold axes and sub-horizontal schistosity S₂. Ductile deformation events can be correlated with compressional tectonics of the Andean orogeny, when various terranes of the Pacific realm accreted to the northwestern margin of South America along regional N- to NE-trending, right-lateral fault zones. Subsequent uplift of the Central Cordillera marked the transition from ductile to brittle deformation. Regional fault zones, including the NNE-trending Palestina fault system, were reactivated as left-lateral faults, triggered by the eastward migration of the Caribbean plate in the Miocene. The new stress field (deformation event D₃) caused the development of new secondary structures, including W- to WNW-striking faults, and the reactivation of previously formed N-trending structures within the broad Palestina fault system, which controlled the emplacement of the magmatic complex at La Colosa.

Three types of porphyry-style hydrothermal alteration are associated with the magmatic activity: (1) potassic alteration (mainly secondary biotite), which occurs as a pervasive replacement of ferromagnesian minerals and matrix in the early and intermineral porphyry stage rocks, (2) sodic-calcic alteration (albite ± actinolite ± epidote), which is confined to cm-scale patches in the early and intermineral stage rocks, and (3) propylitic alteration (chlorite ± epidote ± albite ± carbonates) within the late magmatic stage. Multiphase silicification occurs within the schistose metamorphic rocks.

Six major types of veinlets have been identified at the La Colosa project area. The veinlets occur in the magmatic rocks as well as in the metamorphic rocks. The veinlet sequence is (from oldest to youngest): EB-type, A-type, B-type, M-type, S-type, D-type, and CC-type and are associated with gold grade between 0.5 to 1.0 g/t. Porphyry-style veinlets are crosscut by quartz (colloform-crustiform texture) ± adularia ± gold with narrow halos of illite ± sericite ± carbonates. This younger, high grade zone (> 2 g/t Au average) is spatially and genetically controlled by a N-trending corridor of tension gashes, crossing the magmatic complex and extending towards the metamorphic rocks.

Geometallurgical work has been developed based on comminution tests. Results showed that values vary according to lithology envelopes. Intramineral diorites showed hardest characteristics even close to the surface, early diorites intermediated to softer hardness even at deepest areas into the deposit, and metamorphic rocks range from hard to soft rocks.