

Quantitative Structural Controls on Gold Mineralization at the Porgera Tier-1 Epithermal Gold Deposit, Papua New Guinea

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The Porgera gold deposit in Papua New Guinea is a Tier-1 alkalic low-sulfidation epithermal system hosting approximately 31.3 Moz Au at an average grade of ~4.5 g/t. Despite decades of mining and extensive geological datasets, mineralization controls across the deposit have remained incompletely constrained due to the lack of a unified deposit-scale structural framework integrating underground observations, surface mapping, and drilling information.

Underground structural mapping provided the key dataset to define the geometry and kinematics of the main mineralized structures. Structural analysis and paleostress inversion of Stage 2 fault-slip data define a syn-mineral extensional regime characterized by a subvertical maximum principal stress axis ($\sigma_1 = 214^\circ/71^\circ$) and a subhorizontal intermediate principal stress axis ($\sigma_2 = 073^\circ/15^\circ$). This stress configuration controlled the development of ENE-striking normal vein systems hosting the principal gold mineralization. These structures interact with earlier NNE-striking polymetallic veins formed during a compressive–transpressive stage, generating zones of enhanced permeability that focus hydrothermal fluid flow and control high-grade ore shoot development.

Cross sections, long sections, and level maps constrain the continuity and geometry of the principal mineralized corridors, forming the basis for three-dimensional structural modelling. The resulting framework defines the architecture and connectivity of the main structures and their relationship with gold distribution.

To quantitatively evaluate structural controls on mineralization, gram-meter analysis was integrated with the 3D framework. Peak gram-meter values coincide with structural intersections, dip inflections, σ_2 orientation, local strike-azimuth changes, and competence contrasts between intrusive and sedimentary rocks. These relationships indicate that structural complexity enhances permeability and fluid focusing, directly controlling vein thickness and high-grade ore shoot development.

This integrated model establishes a quantitative link between structural architecture and gold distribution, providing a predictive framework for near-mine targeting within the Tier-1 Porgera system.