Structural Controls and Tectonic Setting of Gold Mineralisation in the Broken River Orocline, Northeastern Australia

Raiza Rodrigues[1], Gideon Rosenbaum[1], Rob Heaslop[2]
[1]The University of Queensland, Brisbane, Australia, [2]Liberation Resources Pty Ltd, Brisbane, Australia

The Broken River Orocline, an orogenic curvature in northeastern Australia, hosts significant gold deposits, with mineralisation episodes linked to the complex structural and tectonic evolution of the orocline during the Paleozoic. Despite the region's recognised mineral potential, the structural controls and timing of mineralisation remain poorly understood. To address this, we conducted an integrated investigation using structural field data, aeromagnetic interpretation, paleostress reconstruction, and geochemical analyses of soil and rock chips. Our results reveal two distinct episodes of gold mineralisation, each associated with different quartz vein systems and tectonic regimes. The first episode, characterised by Au-As ± Sb ± Ag enrichment, occurs in the orocline's northern limb. These veins are controlled by pre-oroclinal structures, including isoclinal folds, axial plane foliations, and reverse faults. Their structural and geochemical signatures resemble those of epizonal orogenic gold systems, possibly formed during contractional deformation within a Middle–Late Devonian accretionary prism and later deformed by oroclinal bending. The second episode is confined to the orocline's hinge zone and features a >148 km² network of Au-Ag-Sb-As-Hg-bearing veins with chalcedony-rich textures, interpreted as a low-sulphidation epithermal system formed at shallow crustal levels. These veins were controlled by NW–SE-trending normal faults developed under NE–SW extensional, and are likely associated with Late Carboniferous–Early Permian felsic magmatism of the Kennedy Igneous Association (KIA). Hydrothermal fluids derived from this magmatism concentrated within the orocline's hinge zone, where pre-existing fabrics were optimally oriented for reactivation during NE–SW extension. An intrusion-related system associated with KIA may have also overprinted older orogenic gold deposits within the northern limb, as indicated by quartz vein exposures associated with magnetic and geochemical anomalies. These findings demonstrate the critical role of structural analysis in understanding the spatial–temporal distribution of gold deposits in orogenic curvatures, with implications for exploration in northeastern Australia and other comparable structurally complex settings.