

Gold: Regional-scale Shear Zones, Faults, Fractures, Rheology and Exhumation

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This paper presents a multi-scale overview of orogenic gold, focusing on the source-to-sink processes of this structurally controlled ore type.

There is little direct evidence that gold-bearing fluids migrated along the regional-scale shear zones, yet orogenic gold deposits are widely assumed to be associated with these shear zones. A prevailing exploration model targets smaller-scale faults in their vicinity. We examine the relationships of gold, host rock rheology, and the structural and stratigraphic setting with the regional-scale shear zones.

A second, association is that many orogenic gold deposits occur adjacent to, or within, molasse-type sediments in late-stage basins. This spatial relationship implies substantial exhumation of the orogenic system. At depth, uplift drives prograde metamorphic reactions—particularly the chlorite-out reaction—that releases both aqueous fluid and gold. The liberated gold is transported by the migrating but broadly dispersed metamorphic fluid phase, typically moving along grain boundaries during active deformation. These fluids ascend from the lower mid-crustal creeping zone and may transiently accumulate above the so-called brittle–ductile transition, within the (higher) seismogenic crust. Under this mid-crustal régime, fluid flux is likely governed by advection in transient porosity waves and hydraulic fracturing. Migration is primarily upward but also lateral, through microfracture networks within rock units that are rheologically strong in compression but weak in extension, and without focusing into the impermeable regional-scale shear zones.

Under greenschist-facies conditions, rock rheology exerts a dominant influence on fluid flow paths. Rheological units of low tensile strength determine the geometry and position of ore bodies, the shape of which may mimic earlier deformation structures. In exploration, the geometry of the low-tensile host unit—often marking the outer envelope—can be just as important as the orientation and nature of veins, fabrics, and fractures within it. Faults may be regional or local barriers to fluid flow.