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Exploration for orogenic gold deposits: Structural sequence vs structural geometry

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For most structural studies of ore deposits, the classical approach of determination of structural sequence is applied to place the depositwithin a temporal framework. This approach may or may not have exploration implications beyond the mine scale dependant on whether the oretype is syngenetic to diagenetic or formed early to late in the sequence of structural events.

For orogenic gold deposits, integrated terrane to district scale tectonic, structural and geochronological studies worldwide have demonstrated a late-kinematic timing of gold mineralization related to a change from compression (normally annotated D1-D2) to transpression or transtension (D3-D4) during a change in far-field stress, at least in some cases caused by a change in plate motion. This implies that any pre-existing structures can host subsequent gold mineralization, leading to previous mine-based structural studies that relate gold deposition to one or more of D1 to D4, commonly with the implication that gold mineralization extended over a period of tens of millions of years. This is despite the fact that deposits supposed to have formed at different times have similar ore and alteration assemblages, combined with largely undeformed to weakly deformed gold -related minerals and gold itself, that are incompatible with such a model.

Based on their late structural timing, it is the final structural geometry of the district, encompassing the interaction of all previous structures and any syn-deformational igneous intrusions, that controls the location of the orogenic gold deposits. In particular, structural inhomogeneities and complexities promote the development of self-organised critical systems that control ore-fluid flux and dictate the site of gold deposition.

The influence of structural complexity on location of orogenic gold deposits is evident at the orogeny to terrane to district scale, and can be quantified using the concept of fractal dimension. The late timing of orogenic gold at the district scale leads to repetitive geometries in terms of 'locked-up' anticlinal fold profiles, the trend and spacing of pairs of late high-angle accommodation faults that rotate and dilate earlier-formed structures between them, and changes in the trend and dip of rigid granite pluton contacts with supracrustal rocks.

These repetitive structural geometries facilitate the use of GIS-based prospectivity mapping based on high-quality geological/geophysical maps and various forms of 'stress mapping and numerical modelling methodologies that assume specific far-field stresses at the time of gold mineralization.