Orogenic gold systems in 3-D space and time

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Lode gold deposits (structurally hosted gold-bearing quartz vein systems) occur in deformed, low- to medium-grade metamorphosed rocks of ages ranging from Archean to Cenozoic. They commonly form clusters along regional-scale faults or fault systems, deposited by low salinity, mixed H_2O-CO_2 fluids, representing a distinct mineral system[1]. Hronsky et al.[2] proposed a unifying model for orogenic systems in which three key variables must coincide in order to concentrate significant gold resources to economic grades: 1) long-term fertilization of the upper mantle through subduction-related fluids and magmas; 2) lithosphere-scale structures providing mantle-to-crust pathways; and 3) a transient remobilization event in which gold is transported upward by fluids or magmas. Additionally, changes in ambient stress such as extensional collapse may be necessary to both trigger variables 2 and 3, and to prevent erosion of the high structural levels at which gold is trapped[3].

Decades of research on Canadian gold deposits have resulted in characterization and understanding at the deposit, camp and district scales[4,5,6]. The complex structural, lithological and geochemical nature of lode gold deposits is reflected in the variety of models proposed for the source of gold, the transport media and structural controls. A recent model, developed for greenstone-hosted deposits of the Timmins and Kirkland Lake camps (~100 million ounces Au) in the southern Abitibi greenstone belt, recognizes a complex series of steps necessary to form and preserve significant gold deposits[3]. Key among these is transient synorogenic extension, which created deep-penetrating faults, triggered alkaline magmatism, opened synorogenic basins that accumulated conglomerates, and, through crustal thinning, limited post-orogenic erosion of the gold-bearing structural levels. In the Abitibi, the extensional phase (2686-2672 Ma) followed ca. 2687 Ma early thrust imbrication by a few million years and was succeeded by renewed thrusting and compression (2670-2660 Ma) and younger strike-slip faulting along structural 'breaks'[3]. The main features observed on detailed seismic reflection profiles across Abitibi gold camps are antiformal culminations of thrust stacks, truncated by steeply-dipping fault zones[7]. These sub-vertical truncation zones extend to depths of a few kilometres, where they are underlain by sub-horizontal reflectors, inferred to represent ductile extensional fabrics in gneisses, developed after 2660 Ma[8]. A significant gold deposit is present at these deep structural levels: the Borden Lake deposit occurs in stretched-pebble conglomerate equivalent in age to the upper crustal extensional basins.

Can such a region-specific model be applied elsewhere? Bleeker[3] drew comparisons to the Archean Slave and Yilgarn cratons and their gold-producing regions. In west Africa, the Birimian (2.2-2.06 Ga) craton exhibits many similar features in its gold-bearing greenstone belts[9]. Recently, Honsberger and Bleeker[10] documented a striking resemblance between Paleozoic gold systems of the Newfoundland Appalachians (ca. 0.45 Ga) and those of the Abitibi belt, suggesting that a recurring sequence of tectonic processes may be responsible for localizing *and* preserving structurally-hosted gold deposits within accretionary terranes.

References

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