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Why are hypozonal orogenic gold deposits restricted to Precambrian orogens?

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High-temperature (hypozonal) orogenic gold deposits formed at conditions of 500-700°C and 2-7 kbar in syn- to post-peak metamorphic shear zones, at an apparent geothermal gradient of 40-80°C/km, which is similar to mesozonal orogenic gold deposits [1]. Hypozonal orogenic gold deposits appear to be restricted to the Precambrian and they formed between ca. 3030 Ma (New Consort, Barberton Greenstone Belt, South Africa) and ca. 550 Ma (Navachab, Damara Orogen, Namibia). The PT conditions of orogenic gold formation define a linear trend in PT space, resembling terrane exhumation. The PT conditions of hypozonal orogenic gold deposits lie largely below the wet granite solidus, but always below the wet solidus of their host rock, and in the 1-phase stability field for aqueous-carbonic ore fluid compositions, as opposed to metamorphosed gold deposits [1].

Phanerozoic mesozonal orogenic gold deposits formed predominantly in external accretionary orogens with only a few and smaller examples in collisional orogens [2]. The orogenic gold deposits in external orogens are hosted by shear zone-controlled veins in accreted oceanic and island arc terranes, where gold mineralization is < 10 million years younger than the host rocks [2]. Hypozonal orogenic gold deposits are hosted by strike-slip shear zones separating greenstone belts from granite-gneiss terranes or in normal shear zones around metamorphic core complexes. Others are hosted by reverse shear zones close to major terrane boundaries, locally associated with a jump in metamorphic grade. The formation of hypozonal orogenic gold mineralization postdates the age of the host rocks by 40-100 million years, indicating a different tectonic setting compared to many mesozonal orogenic gold deposits. The regional geological evolution shows that the hypozonal gold mineralization formed in the centre or hinterland of Precambrian orogens during the collision stage in either an accretionary or a collisional orogen, when the terranes are uplifted. The important factors are the regional PTD evolution forming inverted or condensed metamorphic gradients in a dynamic orogeny after collision or accretion, where hydrothermal fluids can be generated by metamorphic processes and channelled into shear zones.

Although non-uniformitarian models for Precambrian orogens exist, the regional geological evolution and processes of orogenic gold mineralization are similar to processes that form metamorphic mountain belts in Phanerozoic orogenic settings. A possible explanation for the lack of Phanerozoic hypozonal orogenic gold deposits is a different thermal regime of the Precambrian crust, where higher metamorphic grades are reached at higher crustal levels, which however did not result in fundamentally different orogenic processes. This may be supported by increasingly faster exhumation rates of high-grade metamorphic rocks in Neoarchean orogens that are explained by increasingly stiffer and colder

crust, which can support a significant amount of crustal thickening similar to that observed in modern orogens.

References:

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