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Magmatic-hydrothermal Orogenic Gold: Fact or Fiction?

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The dominant characteristics of gold deposits in metamorphic rocks, or the so-called orogenic gold deposits, have been well described for more than 30 years. Many studies accept the fact that deposits classified as orogenic gold are the consequences of crustal metamorphic processes. In more recent years, however, there has been a notable swing back to magmatic-hydrothermal processes being implicated for gold genesis in both Phanerozoic accretionary belts and Precambrian greenstone belts. Temporal or spatial associations with granitoids are taken as supporting evidence of genetic association, particularly where gold ores contain anomalous amounts of Bi, Mo, Te, and/or W or potassic alteration surrounds gold-bearing veins. Yet little in the petrological literature supports such a magmatic-hydrothermal genetic association for orogenic gold deposits that most consistently form at crustal depths of 6-12 km. Fluids exsolved from typically oxidized melts may form porphyry, skarn, replacement, and epithermal gold deposits in the upper 5 km of the crust. Magmas generally must rise to such shallow depths before they reach volatile saturation and undergo significant degassing capable of forming these types of oxidized intrusion-related gold deposits (IRGD). Fluid exsolution will in some slightly more deeply emplaced intrusions (i.e., 5-7 km) where significant amounts of CO_2 are present in the fluid phase, but such aqueous-carbonic fluids characterize more reduced intrusions that are associated with low gold grade and generally unproductive reduced IRGD. Furthermore, any fluid unmixed at great depth from an exceptionally hydrous melt is likely to remain within liquid-rich layers within a crystallizing mush before rising to the roof zone, where the focused fluid is then forcefully released due to high pressure gradients. It is unlikely that plutons emplaced below mesozonal orogenic gold deposits formed at 6-12 km, and hypozonal deposits formed even deeper, would consistently release large fluid volumes capable of forming the globally widespread orogenic gold deposits in metamorphic belts. The medium metamorphic grade breakdown of pyrite, chlorite and organic matter is a well-recognized process inherent to orogenic gold formation. Even where the metamorphic history of a terrane is poorly understood, implicated magmatic-hydrothermal genesis of orogenic gold seems theoretically unlikely and remains largely unproven.