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EMPLACEMENT DEPTH AND CARBON DIOXIDE-RICH FLUID INCLUSIONS IN INTRUSION-RELATED GOLD DEPOSITS

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Abstract

Phanerozoic intrusion-related gold deposits have many consistent characteristics such as a spatial, temporal, and geochemical association with moderately reduced (predominantly ilmenite-series) I-type intrusions. The deposits exhibit a range of characteristics that vary over a wide range of emplacement depths (<1–>7 km). Deposits in shallow crustal settings (~<5 km) are associated with stocks, sills, dikes, and volcanic domes and include systems with epithermal-style veins to breccia and stockwork similar to porphyry-type settings. Deeper systems (~>5 km) have characteristics of mesothermal environments, and are hosted by plutons containing sheeted veins, greissen, and disseminated gold. Fluid characteristics also vary with depth. Deposits in shallow environments contain high-temperature (>350°C), immiscible brine (>30 wt % NaCl equiv) and low-salinity (<5 wt % NaCl equiv) vapor that commonly contains carbon dioxide. Deposits in deeper environments contain abundant low-salinity, carbon dioxide-rich aqueous fluids (<10 wt % NaCl equiv) that, in some deposits, are postdated by moderate- to high-salinity brines (10–40 wt % NaCl equiv). These contrasting fluid types are interpreted to be magmatic in origin and are the result of the complex interplay between exsolution of different volatiles (carbon dioxide, water, and chlorine) from felsic magmas emplaced at different crustal levels. Experimental studies have shown that carbon dioxide will exsolve from felsic magmas at much higher pressures than water and chlorine, due to its lower solubility in the melt. Thus, deposits formed from felsic magmas in deeper environments will contain abundant, carbon dioxide-rich fluids. Subsequent fluids released from the magma are likely to be water rich and more saline. Felsic magmas in shallow environments will contain lower concentrations of carbon dioxide that will partition into the vapor phase during phase separation between brine and vapor.