Gold and Plutonism

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In recent decades, there has been an increasing realization that some mesothermal gold deposits are intrusion related, which are nonetheless regarded by Groves et al. and Goldfarb et al. as a minor subset of orogenic gold systems and largely intrusion hosted. Wall and Taylor and Wall recognized the thermal aureole (pluton-related) gold (TAG) association of gold deposits as localized in the roof zone thermal aureoles and tops of felsic plutons, temporally related to the emplacement and cooling of such plutons. Here we demonstrate that the TAG association is widespread in space and time and provide a rationale and exploration model for TAG systems, illustrated by examples of major gold deposits and their geological environments. These environments are distinct from but may be transitional to those characteristic of epithermal, porphyry, orogenic, and Carlin-style gold and may overlap with iron oxide copper-gold associations.

Significant TAG deposits (and minor intrusions) are mainly localized above the margins of underlying (sill-like) plutons in areas where deformation was associated with pluton emplacement and/or with postemplacement reactivation of structures in response to regional stress fields. Other deposits occur within or spatially associated with cupolas more or less above the centers of the main plutons. Lithological contrasts within country-rock packages and their structures prior to pluton emplacement play major roles in the localization and morphologies of the TAG deposits.

Relatively high temperature mineralization (with distinctive vein and alteration parageneses and geochemical signatures) is pluton proximal, with more distal mineralization exhibiting classical mineralogical and geochemical zoning (As, Sb, Pb-Zn, and Ag) away from the pluton. In both pluton margin- and cupola-related environments, precious metal mineralization may form in retrograde conditions attending pluton cooling.

Plutons with associated TAG mineralization exhibit a relatively broad range of magmatic affiliations (most commonly ilmenite series “I type,” but also “S type” and magnetite series). The plutonic suites exhibit evidence of fractionation (and hybridization) in keeping with their relatively high temperature character. Commonly emplaced near the end of or postdating regional deformation and metamorphism, such plutons may form part of large igneous provinces that are not obviously related to subduction or collisional processes.

Top-of-pluton emplacement depths range from 5 to +10 km, resulting in broad thermal aureoles. At such depths magmatic-hydrothermal fluids will commonly be single phase, with low to moderate salinities. Such fluids may contain an excess of aqueous sulfur over aqueous iron and transport Au (plus other characteristic trace elements) through a broad down-temperature range. High-grade gold deposits nonetheless require efficient depositional mechanisms and these relate not only to temperature and pressure variations but also to fluid-rock interaction and fluid mixing.