Distinctive Chemical Composition of Gold-Ore-Forming Magmas

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Magmatic-hydrothermal gold deposits generally form in convergent margins or post-subduction settings and tend to cluster in restricted regions of the crust (as a metallogenic province). Magmatic fertility is affected by geochemical inheritance and metal budget derived from the melt source as well as by a chain of processes that occur during magma emplacement. The contribution of a metasomatized subcontinental lithospheric mantle (SCLM) source has been regarded as the most preeminent parameter for gold fertility. Geodynamic settings that favor the participation of these pre-enriched portions of the SCLM in the melting column and magma chemistry also have petrogenetic control on the gold endowment of magmatic-hydrothermal systems.

The contrast in the melt source region of gold-fertile and gold-infertile magmas is emphasized by the differences in chemical composition between primitive melts spatially and temporally associated with ore-forming magmas in major gold districts and primitive magmas from magmatic belts unrelated to gold mineralization. The fertile ones are enriched in highly incompatible elements compared to infertile ones, whereas they have a comparable concentration of mildly incompatible elements. In order to investigate the participation of an enriched source in the melting column of ore-forming magmas, the chemical composition of a large dataset of ore-related magmas from gold-rich deposits is compared with the chemical composition of intrusive rocks from magmatic belts that lack gold mineralization.

Low- to high-K_2O calc-alkalic magmas that exsolve a gold-ore-forming magmatic-hydrothermal fluid can be distinguished from infertile magmas by a series of trace element ratios having a highly incompatible element in the numerator and a mildly incompatible element in the denominator. Although this trend is evident for calc-alkalic magmas, potassic alkalic magmas are often enriched in those highly incompatible elements regardless of their metallogenic signature and the enigma connecting alkaline magmatism and gold enrichment still needs investigation.