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Giant Porphyry Deposits: Characteristics, Distribution, and Tectonic Controls

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Abstract

More than half of the 25 largest known porphyry copper deposits, defined in terms of contained copper metal, formed during three time periods: the Paleocene to Eocene, Eocene to Oligocene, and middle Miocene to Pliocene. These giant deposits are clustered within three provinces, central Chile, northern Chile, and southwest Arizona-northern Mexico. Other giant deposits occur in Montana, Utah, Panama, Peru, Argentina, Irian Jaya, Mongolia, and Iran. Compressive tectonic environments, thickened continental crust, and active uplift and erosion were associated with the formation of many of these deposits. Calc-alkalic magmas are most favorable for the formation of giant porphyry copper deposits, although several of the largest systems are associated with high K calc-alkalic intrusions.

The 25 largest gold-rich porphyry deposits are concentrated in the southwest Pacific and South America, with other occurrences in Eurasia, British Columbia, Alaska, and New South Wales. Many of the deposits formed in the last 13 m.y. The largest of the deposits are associated with high K calc-alkalic intrusions. Many calc-alkalic porphyritic intrusions have also produced giant gold-rich porphyries.

In the last 20 m.y., the formation of giant porphyry copper-molybdenum and copper-gold deposits in the circum-Pacific region has been closely associated with subduction of aseismic ridges, seamount chains, and oceanic plateaus beneath oceanic island and continental arcs. In several examples, these tectonic perturbations have promoted flat-slab subduction, crustal thickening, uplift and erosion, and adakitic magmatism coeval with the formation of well-endowed porphyry and/or epithermal mineral provinces. Similar tectonic features are inferred to be associated with the giant porphyry copper-molybdenum provinces of northern Chile (Eocene-Oligocene) and southwest United States (Cretaceous-Paleocene).

Topographic and thermal anomalies on the downgoing slab appear to act as tectonic triggers for porphyry ore formation. Other factors, such as sutures in the overriding plate, permeability architecture of the upper crust, efficient processes of ore transport and deposition, and, in some cases, formation and preservation of supergene enrichment blankets are also vital for the development of high-grade giant ore deposits. A low-grade geochemical anomaly may be the final product of mineralization, if ore-forming processes do not operate efficiently, even in the most favorable geodynamic settings.

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