Economic Geology, v. 100, pp. 819–833

The Role of Preexisting Geologic Architecture in the Formation of Giant Porphyry-Related Cu ± Au Deposits: Examples from New Guinea and Chile

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Abstract

Development of giant porphyry-related copper and/or gold deposits in New Guinea and northern and central Chile occurred during Tertiary magmatic events that overprinted earlier extensional tectonic settings. The earlier tectonic settings consisted of a Mesozoic passive margin in New Guinea, a Jurassic-Cretaceous back-arc basin in northern Chile, and an Oligocene intra-arc basin in central Chile. The preexisting architecture of the basement rocks, the fault systems, and the stratigraphic packages associated with these settings played a strong role in controlling development of the giant deposits.

Although the extensional tectonic settings in these terranes were different, they share a number of elements that were used during formation of the Tertiary ore deposits. These were the presence of coupled systems of deeply detached, listric synsedimentary faults and steep transverse faults, and the presence of a relatively flat-lying heterogeneous volcano-sedimentary rock package. During Tertiary collision the deeply detached listric faults were inverted and strongly focused uplift, exhumation, and associated overpressuring-induced failure and fluid flow. In addition, steep transverse faults were activated to form wrench systems, with attendant steep, deeply tapping pathways for magma and/or fluid associated with dilatant jogs, flexures, or fault intersections. Ore deposits are commonly located in the hanging wall of the thrust faults.

Under compression associated with collision, the competent units of flat-lying stratigraphic packages formed plates overlying the folded, weaker units underneath and separated by a detachment or otherwise faulted contact. Examples of the competent upper units include the Darai/Mendi Limestone or equivalents in New Guinea and the lavas of the Farellones Formation in central Chile. These plates appear to have impeded magma ascent and formed a cap on a magma and/or fluid system pressurized by collision and orogenesis. This geometry provided an ideal location for focusing of magmas and magmatic hydrothermal fluids.

From these three example terranes a set of exploration indicators have been constructed to highlight belts that are prospective for giant porphyry Cu systems. These indicators include (1) the presence of magmatic arcs that migrated into preexisting extensional architectures; (2) coupled systems of deeply detached, listric synsedimentary faults and steep transverse faults; (3) rigid basement blocks that could form regional stress field perturbations; and (4) fold belts with a major plate (to 50 km wide) of competent, relatively undeformed or gently folded stratigraphy overlying more complexly folded and faulted parts of the sequence.

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0361-0128/05/3524/819-15 $6.00