
R13
Evolution of a Laramide Porphyry Cu Cluster near Tucson, Arizona

Roy Greig, Mark Barton
University of Arizona, Tucson, AZ, USA

A new structural reconstruction of the Tucson, Arizona, area, combined with synthesis of new and available geochronological, petrological, and geologic data, demonstrates that at least seven porphyry centers in the area share many characteristics and represent a super cluster that formed as part of a longer-term igneous history. Exposures from 0- to ~15-km paleodepth, in four variably tilted mountain ranges, display late Cretaceous to Eocene-age (Laramide) igneous rocks with a >30 Ma history, which can be split into three distinct phases, which have comparable total volumes but different compositions, styles, and related hydrothermal features.

An early phase of magmatism (Group 1), between 76 and 69 Ma, consisted of compositionally diverse (basalt-rhyolite), widespread volcanism, including large felsic calderas and smaller volumes of lavas, and emplacement of compositionally zoned diorite-granite plutons. Related porphyry-type hydrothermal features (potassic and sericitic alteration, proximal Cu and distal Zn-Pb mineralization) are in general weakly developed and formed no major ore deposits.

Group 2 igneous centers (65-57 Ma) are compositionally homogeneous, felsic (granodiorite-granite; rhyodacite), and characterized by relatively voluminous plutonism and minor volcanism (lavas and small ash-flow tuffs). Porphyry-type hydrothermal features are well developed at shallow levels (potassic and sericitic alteration) and variably developed at deeper levels (coarse muscovite), in all of these centers, but only a few centers formed significant porphyry Cu deposits (e.g., Sierrita, Mission-Pima-Twin Buttes, Rosemont). Though the relative development of alteration types varies, the footprint of the porphyry systems is roughly proportional to contained metals.

Group 3 magmatism (57-42? Ma) is characterized by large sheets of peraluminous (biotite ± muscovite ± garnet) granite emplaced at depths of 4-15 km. These contain numerous simple pegmatites but lack significant hydrothermal systems or other mineralization.

The igneous history and geochemistry suggests that the variation in igneous compositions between age groups was the result of the proliferation of crustal melts, which increasingly filtered out mafic inputs to the upper crust. This may have prevented mafic recharge, which has been linked elsewhere to caldera-forming eruptions, thus controlling the contrasting fate of large magma chambers and their contained metals and volatiles: several of those in Group 1 erupted, forming calderas, while those in Group 2 formed large porphyry Cu deposits. The contrasting fates of these chambers may also relate to their apparently differing geometry, as can be inferred from tilted caldera and pluton exposures.

The similarities between the large and small Group 2 porphyry systems suggest that the volatile and metal contents of Group 2 magmas were roughly uniform and that accumulation of sufficient magma volumes was the key driver of productivity. This may have been facilitated by focusing of magma inputs in a manner analogous to that seen in other maturing arc volcanic centers.

This history of Tucson area parallels regional patterns and illustrates how productive porphyry Cu clusters emerge from a spectrum of tectonic and igneous processes operating on a range of temporal and spatial scales.