**S2**

## Creation and Destruction of Permeability in the Porphyry Cu Environment

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Porphyry Cu deposits are crustal-scale features requiring deep crustal formation of a hydrous and oxidized magma, magma ascent along extant permeability fabrics to create an upper crustal convecting magma chamber, volatile saturation of the magma chamber, and finally the episodic upward escape of an ore-forming hydrothermal fluid and a phenocryst-rich porphyry magma to produce ores. Three fluid regimes involved are the deep magma ± volatile zone at lithostatic pressure, an overlying zone of transiently ascending magmatic-hydrothermal fluids that breaches ductile rock at temperatures ca. 700° to 400°C, and an upper brittle zone at temperatures <400°C characterized by hydrostatically pressured nonmagmatic and magmatic fluids. Critical steps include the formation of the magma chamber, magmatic vapor exsolution and collection of a hydrothermal fluid in cupola(s), and episodic hydrofracturing of the chamber roof in order to create the permeability that allows hydrothermal fluid to rise along with a phenocryst-bearing magma. The interplay between stress produced by far-field tectonics and stress produced by buoyant magma and magmatic hydrothermal fluid creates the fracture permeability that extends from the cupola through an overlying ductile zone where temperatures exceed ~400°C into an shallower brittle zone where temperatures are less than ~400°C. As a consequence, during each fluid escape and magma intrusion event, the rising hydrothermal fluid ascends, depressurizes, cools, reacts with wall rocks, and precipitates quartz plus sulfide minerals, which progressively seal the permeability fabric. A consistent vein geometry in porphyry Cu deposits is formed by steeply dipping, mutually crosscutting veins. The principal orientation consists of closely spaced sheeted veins whose geometry reflects the far-field stress and likely formed in advance of a rising porphyry magma. Subsidiary veins may be orthogonal to the main vein orientation as radial or concentric veins that reflect magma expansion and extensional strain in the wall rocks as they are stretched by ascent of the buoyant magma. Episodic magmatic-hydrothermal fluid-driven hydrofracturing creates permeability that is destroyed as well as enhanced by vein and wall-rock mineral precipitation or dissolution, and by wall-rock hydrothermal alteration, depending upon fluid and host-rock compositions. The pulsing character of porphyry Cu systems, in part produced by permeability creation and destruction, creates polyphase overprinted intrusive complexes, vein networks, and alteration mineralogy that reflects temporal temperature fluctuations beginning at magma temperatures but continuing to low temperatures. Temperature oscillations locally allow external nonmagmatic fluids to access principally the marginal areas but also in some cases the center of the porphyry Cu ore zone at ca. <400°C between magmatic fluid and porphyry dike emplacement events. Over time, the upper part of the source magma chamber crystallizes downward, accompanied by diminishing magmatic fluid input upward, leading to cooling and isothermal collapse of the porphyry system. Cooling permits the access of external circulating groundwater into the waning magmatic-hydrothermal plume. Magmatic-hydrothermal fluids dominate at temperatures >400°C at pressures transient between lithostatic and superhydrostatic. The external, nonmagmatic saline formation waters or meteoric waters dominate the surrounding and overlying brittle crust at temperatures <400°C at hydrostatic pressures.