Assessing the Timing of the Magmatic to Hydrothermal Transition and Onset of Porphyry Mineralization Across the Yerington Porphyry System, USA

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Porphyry Cu(-Au-Mo) deposits form in the upper ~2-8 km regions of large, long-lived magmatic-hydrothermal systems. The timescales over which sufficient volumes of mineralizing fluids are extracted and focused from magma source regions into the narrow, shallow zones of mineralization remains unclear. Here, we provide fundamental constraints on the relative timing and duration of porphyry-style mineralization from detailed field, mineralogical, geochemical and geochronological studies of the classic Yerington porphyry-district of Nevada, where Cenozoic extension and tilting has exposed an exceptional top to bottom ca. 8 km cross-section through the porphyry system. From high precision zircon U-Pb dating, the exposed Luhr Hill granite cupola of the Yerington batholith, and multiple generations of aplitic- and porphyry dikes, on which the porphyry-type deposits are centred, were emplaced within only a few 100 kyrs. Cu mineralization within miarolitic cavities and USTs in the dikes, and associated quartz veins, was paragenetically late in the magmatic to hydrothermal transition, not occurring until the fluids responsible had cooled below ~600 °C. From molybdenite Re-Os age determinations, hydrothermal mineralization in the Bear and Ann Mason deposits was coeval with and much longer lived (>1 Myrs) than magma emplacement. We suggest that the early, high temperature fluids travelled up into the epithermal environment and it was fluids from deeper, which had cooled over time, which moved up through permeable, partially crystallised ‘mush' dikes which produced hypogene mineralization. We suggest that this process is considered in all new genetic, exploration and numerical models for porphyry and similar types of magmatic-hydrothermal systems.