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New perspectives into the timing and nature of fluid exsolution and migration in Cu porphyry-forming magmatic systems – evidence from the Yerington District, Nevada

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Porphyry Cu deposits provide around 75% of the world's copper and are an important source of gold and other metals [1]. One aspect of porphyry deposit models that is poorly understood is whether the mineralising fluids from which they form derived from: (i) high-level Cu-rich porphyry magmatic stocks; (ii) feeder chambers at mid-upper crustal levels; (iii) a lower crustal reservoir; or (iv) a combination of these in a transcrustal mush zone (e.g. [2]). Magmatic-hydrothermal mineralisation is often spatially, temporally and texturally linked to high-level porphyry stocks. It is unlikely, however, that enough fluid could be derived from such a limited volume of magma [1]. From mass-balance calculations and high-precision CA-ID-TIMS U-Pb zircon studies [3,4], mineralising fluids are also derived from a longer-lived, deeper, yet rarely observed magmatic source, possibly at 5 to 15 km depth. How and when such fluids are transported from these depths is unclear.

Due to tectonic tilting, the classic Yerington District, Nevada, offers a well-exposed ca. 8 km deep section from volcanic to plutonic environments [5] and a rare opportunity to study the temporal relationships in the deeper magmatic environment that lead to porphyry Cu deposits. The general sequence of deeper pluton emplacement that culminated in porphyry Cu formation has long been established [6] but there is relatively little detail on the timing, nature and depth of volatile exsolution and migration. Based on macro- to micro-scale field-based and textural observations we revise the relative chronological framework. The upper part of the Luhr Hill granite pluton, previously suggested to have been the source of mineralising fluids, shows no evidence of volatile exsolution, indeed from the presence of graphic textures in quartz-feldspar orbicules the magmas are likely to have been fluid undersaturated. In contrast, aplite dykes, which are volumetrically minor yet occur pervasively from below to within the porphyry Cu deposits, show extensive evidence for volatile exsolution and mineralisation. The aplites are penecontemporaneous with, yet distinct from porphyritic dyke intrusions and cross-cut the upper portions of the Luhr Hill granite and its cupolas. New high-precision CA-ID-TIMS zircon U-Pb ages are reassessing the temporal relationships between plutonic, hypabyssal and volcanic components of the system and their correlations with hypogene mineralisation. Age determinations indicate that the plutonic phases, are at least 2 Myrs younger than previously reported ages [6,7] and that pluton construction was linked to a previously unrecorded episode of volcanism.

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