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Emplacement of the Yerington batholith and associated porphyry dikes, Nevada, USA: a conciliation challenge between field observations and high precision zircon petrochronology

Maria Paula Castellanos Melendez and Cyril Chelle-Michou
Institute of Geochemistry and Petrology, Department of Earth Sciences, ETH Zurich, Switzerland

In porphyry copper deposits, where ore grades are low, the volume of the ore body determines its economic potential. However, the factors that control their size are still an open question and understanding them is crucial for finding new and large porphyry copper deposits (PCDs); especially in a society with an ever-increasing Cu demand. One of the most important, but highly debated size-modulating factors, time, could make the difference for a magmatic system to form small or large PCDs. The limited access to the plutonic roots of PCDs hinders our ability to study the plutonic and the porphyritic systems as a whole. However, Cenozoic tilting of the Yerington district (Nevada, USA) make it the perfect place for a key study as the Yerington batholith and associated volcanic sequences, porphyritic dikes and Cu mineralized centers are exposed. The complex upper-crustal batholith is comprised of three consecutive plutons that with time increase in silica content, granulometry and depth of emplacement while decreasing in volume: the McLeod quartz monzodiorite, the Bear quartz monzonite and the Luhr Hill granite with associated porphyritic dikes that formed Cu mineralization. Field observations show sharp intrusive contacts between the three plutons, until now have been interpreted as periods of magmatic quiescence that separate the emplacement of the three intrusions, overall accounting for 1 Ma of magmatic activity (Dilles & Wright, 1988; Schöpa et al., 2017). However, our new high-precision zircon U-Pb ID-TIMS dates spread over 2 Ma and show a continuum in zircon crystallization from the McLeod quartz monzodiorite and coeval volcanics to the Luhr Hill granite and porphyritic dikes with no hiatuses. In-situ trace element LA-ICPMS analyses on zircon further indicate a continuous geochemical evolution from intermediate compositions and higher Ti-in-zircon temperatures in the oldest zircons towards colder and evolved ones in the youngest ones, following normal fractional crystallization trends with the onset of titanite crystallization during evolution. These data argue for a sustained crystallization of the three main plutonic bodies. Our new lifetime of the magmatic system in view of zircon crystallization ages changes the previously defined thermal models for the Yerington district and affects how we assess its mineralizing potential. This questions the thermal budget of these upper crustal magma chambers, which should remain partially molten for about a million years to produce the observed zircon age spectra in each pluton. Such considerations open the discussion of zircon crystallization in the deep crust, reconciling these new high-precision data and the well-stablished field crosscutting relationships, and impacting the current understanding and application of zircon petrochronology in porphyry

copper systems.

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