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Zircon and titanite petrochronology link plutonism, volcanism and porphyry copper deposit formation in the Yerington batholith, Nevada, USA

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Jurassic arc magmatism in the Yerington district, Nevada, USA, resulted in the emplacement of a composite batholith from which porphyry dikes were extracted and culminated in copper mineralization. Due to its unique exposure, the Yerington district provides access to an upper-crustal section from the plutonic roots of porphyry copper deposits to cogenetic volcanic rocks. High-precision zircon petrochronology, i.e. ID-TIMS U-Pb geochronology and LA-ICPMS trace element analysis, from all plutonic and hypabyssal bodies in the district (McLeod Hill quartz-monzodiorite, Bear quartz-monzonite, Luhr Hill granite and porphyritic dikes) reveals a geochemically and geochronologically continuous evolution extending over 2 Ma, significantly expanding the previously defined ~1 Ma lifetime of the magmatic system[1]. Overlapping zircon dates from the youngest crystals in the McLeod Hill and the oldest crystals in the Bear intrusion could indicate that the former was not entirely crystallized when the next magma body intruded. Zircons from the Bear and Luhr Hill intrusions record dates that overlap over almost their entire range, opening the possibility of coeval crystallization. Age spectra and geochemistry of zircons from porphyritic dikes resembles those from the Luhr Hill granite zircons, showing that they were extracted from the last and most evolved intrusion in agreement with field observations. Although the three intrusions could have grown incrementally from different magma pulses allowing them to remain locally partially molten for long periods of time, these findings could significantly change current thermal models for this magmatic-hydrothermal system in which the three plutons are separated by significant hiatuses[2]. Zircons from the Artesia Lake volcanic sequence also support the presence of an early cogenetic plutonic-volcanic activity. High-precision titanite U-Pb dates confirm the continuity between all magmatic bodies and extends the time that the McLeod Hill quartz-monzodiorite remained above titanite U-Pb closure temperatures, overlapping with zircon crystallization ages from all other plutonic and hypabyssal units. Combining high-precision zircon and titanite petrochronology provides insights into the thermal evolution of a composite pluton and sheds light on the link between plutonism, volcanism and porphyry copper deposit formation.

[1] Dilles & Wright (1988) GSA Bull. 100, 644–652.
[2] Schöpa et al. (2017) Econ. Geol. 112, 1653–1672.