The Magmatic Duration of Climax-type Porphyry Mo Systems

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The duration of magmatism related to porphyry mineral systems is receiving increasing interest with respect to evaluating metal endowments and formation mechanisms. Most studies are focused on economically important porphyry Cu-Mo-Au systems, but porphyry Mo deposits are another significant global resource for base and critical mineral commodities. Although attempts have been made to relate magmatic duration to Mo endowment, the input geochronological data are mostly imprecise and/or inaccurate. For example, mineralization at the giant Climax Mo deposit in Colorado is often cited as occurring between 33–25 Ma. However, the oldest age is an average of zircon fission track dates that range from 50–17 Ma, and thus has a large uncertainty (33 ± 4.2 Ma, 2σ) (White and others, 1981). The Chalk Mountain topaz rhyolite that erupted from the Climax magma system initially had a reported K-Ar age with large uncertainty (27.7 ± 3.8 Ma), but new high-precision U-Pb zircon geochronology demonstrate it erupted at 26.299 ± 0.028 Ma. Molybdenum mineralizing intrusions elsewhere in Colorado have also yielded new higher-precision U-Pb zircon mean ages that differ by 1–2 Myr from previous dates. These differences are on the order of the total duration of mineralization for the largest porphyry Cu deposits (2–3 Myr), and are problematic for any attempt to model mineralization longevity. Instead, multi-sample high-precision geochronology studies are required. For example, high-precision geochronology indicates that the Questa porphyry Mo deposit (northern New Mexico) formed by multiple short-lived pulses over <500 kyr. Unmineralized fluorite and topaz-bearing leucogranites related to Oligocene extension in the Southern Rocky Mountains are also known to have been assembled in <1 Myr. More data are required, but we suggest that the total duration of episodic porphyry Mo mineralization is unlikely to exceed that of well-characterized porphyry Cu systems.