A 3.3 Ga Mo-Cu porphyry-style deposit at Spinifex Ridge, East Pilbara, Western Australia: Re-Os dating of Paleoarchean molybdenite

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Here we show that the Re-Os chronometer is robust for Paleoarchean molybdenites. Prior to this study, AIRIE's oldest dated molybdenite was from the 3128 ± 13 Ma Sergeevske porphyry Au-Cu-Mo deposit, Ukraine. The youngest is from the 2.120 ± 0.007 Ma Boyongan porphyry Cu-Au deposit, Philippines. Thus, molybdenite chronology can be readily used across the full span of geologic time [1].

The Spinifex Ridge (Coppins Gap) Mo-Cu deposit is located immediately north of the variably deformed Mount Edgar batholith in the 3.52-2.85 Ga East Pilbara granite-greenstone terrane. Mo-Cu mineralization, estimated at 481 million tons carrying 0.06% Mo and 0.08% Cu, is associated with high-level quartz-plagioclase porphyry intruded into Warrawoona Group basalts and rhyolites, and porphyritic granodiorite bodies [2]. Quartz veins with molybdenite and chalcopyrite are most abundant where both granodiorite and quartz-plagioclase porphyry are present.

Two molybdenite samples ascertain the timing of porphyry-style Mo-Cu mineralization at Spinifex Ridge. The drill core samples (SRD053, 227.2 and 227.6 m) represent main-stage stockwork ore hosted in potassically altered porphyry. Molybdenite was analyzed by NTIMS using a Carius tube digestion and double Os spike. Re-Os ages are 3298 ± 11 for a 1.5 cm quartz vein with irregular molybdenite selvages and 3284 ± 11 Ma for a 0.2 cm molybdenite clot adjacent to a similar vein. Ages are indistinguishable within their 2-sigma uncertainties, and agree with SHRIMP U-Pb zircon ages [3] for the Mount Edgar batholith (3314 ± 13 Ma, Coppin Gap suite; 3304 ± 10 Ma, Boodallana suite).

Ore zone geometry inclusive of silicified, brecciated borders to the quartz-plagioclase porphyry suggest that the entire intrusive-mineralization system was strongly tilted by regional listric faulting that accompanied uplift of the batholith. The Re-Os dates present a maximum age for that faulting and a minimum age for the hosting quartz-plagioclase porphyry. The geology supports formation of the Spinifex Ridge Mo-Cu deposit in a weakly extending brittle regime at ~3.3 Ga, similar to magmatic-tectonic conditions that produce Mo-Cu porphyry-style deposits today.

References

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Atlantic cold-water spells into the Mediterranean caused the abrupt changes in the Levant's post-Glacial hydrology and human-culture development

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Intrusion of cold Atlantic-water to the east Mediterranean at the 14th millennium BP (e.g "melt water pulse MWP1-A") caused the abrupt drop of Lake Lisan (the last glacial precursor of the Dead Sea) from its maximum MIS2 stand of ~160 m (below mean sea level) to its lowest level (< 500 m bmsl), marking the severest catastrophic aridity that prevailed in the late Quaternary Levant. Regional rains resumed and lake level rose during the Younger Dryas (13 millennium BP) but dropped sharply again during the 11th millennium BP (reflecting "melt water pulse MWP1-B").

While the "melt-water pulses" amplified the post-glacial warming trend in the Levant, causing extreme aridities, the NA-cooling of the YD imposed a strong deviation from this trend. It seems that the YD cooling lags after the melt water pulses by causing shifts in the Polar fronts and Westerlies that brought more rain to the Levant.

The abrupt changes in the Levant climate led the major developments in the regional cultural evolution - the collapse of the Natufian culture and the rise of the Pre-Pottery Neolithic (PPN) culture and agriculture society upon the transition to the milder Holocene.

The rapidity of the response of the regional hydrological systems to the global climate changes and the sensitivity of past human cultures to these changes are certainly important lessons and alarming signals for our human society.