Defining the Lifespan of a Giant Porphyry Cu Deposit: Re-Os Dating at Los Pelambres, Chile

H. STEIN[1], R. MARKEY[1], R. SILLITOE[2] AND J. PERELLÓ[2]

[1] AIRIE Program, Colorado State University, Fort Collins, CO 80523-1482 USA (hstein@cnr.colostate.edu)
[2] 27 West Hill Park, Highgate Village, London N6 6ND, UK
[3] Antofagasta Minerals, Ahumada 11, Piso 12, Santiago, Chile (jperello@aminerals.cl)

Dating magmatic-hydrothermal mineralization, such as porphyry-type deposits, has relied heavily on Ar-based chronometers applied to silicate minerals believed to be associated with ore-forming events. While this may provide an approximate timing of mineralization, the potential for loss of accuracy is high in systems that have been exposed to repeated intrusive and associated thermal events, as substantially submagmatic locking temperatures compromise the ability of Ar-based chronometers to retain primary ages. In such circumstances, $^{40}Ar/^{39}Ar$ and K-Ar ages can be expected to underestimate the true ages of mineralization, potentially leading to erroneous interpretations for the time of ore formation. In contrast, the robust Re-Os chronometer in molybdenite offers excellent geologic and analytical reproducibility (<0.4%) for replicate analyses of multiple mineral separates from single samples (Stein et al. 2001). We use this chronometer to examine the lifespan of the giant Los Pelambres porphyry Cu deposit in the Chilean Andes.

Cu mineralization at Los Pelambres is largely confined to a composite tonalite stock cut by several porphyry phases, and contains numerous hydrothermal veinlet generations related to Cu-Mo introduction; biotite K-Ar ages range from 8.9 to 10.7 Ma (Atkinson et al. 1996). A sample of an intermediate B-type veinlet was dated by both conventional single ^{190}Os and ^{185}Re spikes, and a mixed ^{185}Re-$^{190,188}Os$ double spike. The results are 11.33 ± 0.09 and 11.45 ± 0.01 Ma, respectively. The double Os component permits assessment of common Os and a fractionation correction for the Os measurement, and the mixed Re-Os feature eliminates error introduced during spike weighing. Our preliminary data suggest a lifespan on the order of 1 m.y., significantly more extended than recently proposed Ar-based durations of 0.2-0.5 m.y. for several smaller porphyry Cu deposits. This may reflect a compromised Ar geochronology and/or the additional time required to generate a giant porphyry Cu deposit. As predicted, our Re-Os ages are older than published K-Ar ages. We believe that high Re concentrations, as seen at Los Pelambres (hundreds of ppm), require a subduction-related model in which mantle involvement is essential to porphyry ore-forming processes.

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The fall and rise of the Dead Sea during the post – Glacial and the Younger Dryas event

MORDECHAI STEIN

Institute of Earth Sciences, The Hebrew University, Givat Ram, Jerusalem, 91904. motis@vms.huji.ac.il

The Pleistocene–Holocene climatic history of the East Mediterranean region is recorded in the evaporitic and clastic sediments, which were deposited in water bodies that filled the tectonic depressions along the Dead Sea Transform. The regional climatic regime and the limnological evolution of the lakes appear to be modulated by fluctuations in the North Atlantic (NA) climate, where cold episodes in the NA are correlated with fluvial conditions and warm episodes in the NA are correlated with arid conditions in the lakes. U-series and radiocarbon chronologies of authigenic aragonite and organic remains combined with lake level reconstruction and geochemical studies provided a high-resolution (centennial to annual scale) paleoclimatic history of the region. Here, I focus on the transition from the last Glacial Lake Lisan (70 to 15 kyr BP) to the Holocene Dead Sea. At 26-23 kyr BP Lake Lisan rose to its maximum stand of ~ 170 m below mean sea level (m bsl), which is about 100 m above its “mean” level of ~ 280 m bsl. Then, the lake begun to recede and arrived at 14-13 kyr BP to its minimum stand of ~ 450 m bsl (35 m below the present day level, which has been dictated by anthropogenic activity). This low stand is reflected by a depositional hiatus in sedimentary cores, which were drilled along the retreating shores of the modern Dead Sea. The hiatus is overlain by detrital matter, dated to 12.8 kyr BP, and a thick massive salt layer, which marks the transition to the Holocene at 10 kyr BP. Before deposition of the salt above the hiatus, lake-level rose above the surface of salt (> 435 m bsl). This lake rise can be correlated with the onset of the YD cold event in the northern- hemisphere. It was followed by a short arid episode causing the deposition of the salt. The high-resolution chronological record of the lakes and its sensitivity to the NA climate provide constraints on the rates of NA-induced climatic changes in the studied region. For example, while the episodes of maximum and minimum lake stands lasted for 2-3 kyr, the rise of the lake to the maximum stand and its fall to the minimum stand occurred over less than several hundred of years.