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Trace element patterns of evaporite minerals in the Atacama Desert and their potential for Lu-Hf dating

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Comprehending the chronology of (hyper-)arid environments is of essential importance in order to constrain the related evolution of biota and Earth surface processes through time. The Atacama Desert, as one of the oldest and driest deserts on the Earth, is an outstanding archive of arid and humid periods. Sediments and soils in the Atacama are mainly composed of gypsum, halite and nitrates. Dating the chronology of these mineralisations has so far been entirely based on indirect methods.

Here, we present trace element data for gypsum, halites, nitrates, carbonates, and diatomites to evaluate their potential for direct dating by Lu-Hf. Typical Lu-Hf concentrations in evaporites from the Atacama Desert are in the lower ppb and ppt range. Trace element contents for samples from Pisagua, Salar Grande, Rio Loa, Mejillones, and Salar de Imilac range from 1.30 ppt to 162 ppb for Lu, and from 15.9 ppt to 1123 ppb for Hf. Respective $^{176}Lu/^{177}Hf$ ratios range between 0.00651-0.148. The highest $^{176}Lu/^{177}Hf$ ratios were measured in carbonates, the lowest in nitrates. Digestion of detrital impurities in halites confirm an expected increase of the Hf concentrations with an increasing detrital component. This detrital effect lowers the Lu/Hf ratios and it would obscure the original isotopic composition of the mineralisations.

We present new developments and optimization of analytical protocols that permit (1) an improved separation of detrital components from evaporate minerals to minimize the impurity effects, and (2) Lu-Hf measurements on several hundred pg to a few ng of Hf. Our first data show that Lu-Hf dating of gypsum, nitrates, halites and diatomites is very challenging, whereas carbonates represent the most feasible target materials.