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Optimized method for U-series dating of sedimentary gypsum crystals

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Gypsum is a crucial environmental archive in hyperarid environments; however, its utility in earth and environmental sciences has encountered challenges due to the limited availability of suitable dating methods. In this study, we reevaluate the feasibility of ^{230}Th/U dating for sedimentary gypsum collected from a sediment core drilled in the Salar de Llamara, Atacama Desert, Northern Chile. Sediments in this core are comprised predominantly of gypsum occurring in a range of crystal sizes from fine sand to cm-scale selenite crystals. Sample selection for this study was focused on large single crystals extracted from the sediment core. Common issues identified in gypsum analyses, such as low U content, challenges in sample dissolution, and the contribution of detrital Th, prompted the current study's aim to enhance measurable uranium and thorium in samples. This is achieved by increasing the initial sample size digested while maintaining an optimum solution volume for efficient column chemistry using Eichrom UTEVA columns, thereby minimizing the Th-related issues arising from detrital contributions as well as absorption by particles or beaker walls. We investigated dissolution in various concentrations of HNO_3 and assessed the impact of filtration prior to column chemistry. High-precision uranium and thorium isotope analysis conducted using Thermo Fisher Neptune Plus^{TM} MC-ICP-MS. Age calculation and uncertainty propagation were conducted through Monte Carlo simulation. The results reveal that the sample initially dissolved in low molarity HNO_3 exhibits the youngest age with minimal age correction and a smaller uncertainty. Ages resulting from our new sample preparation workflow are consistent with radiocarbon stratigraphy constructed from measurements of co-occurring sedimentary organic matter, demonstrating the utility of this method. Improved age constraints in gypsum-dominated sedimentary environments will provide enhanced understanding of the rate of past changes in environmental conditions and ecosystems services.