

Dating of gypsum from different depositional environments using U-Pb and U-series geochronology

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Gypsum is an important mineral for reconstructing depositional environments in hyperarid and marine settings. Its application in geology was long hampered by the availability of suitable dating methods. We developed combined analytical protocols for ²³⁰Th-²³⁸U dating and ²³⁸U-²⁰⁶Pb dating of gypsum employing MC-ICPMS, thus covering the full age range from the Holocene to the Tertiary or even older [1]. For ²³⁰Th-²³⁸U dating, we developed a set of criteria that aid in assessing open system behaviour and detrital contamination. As example, measurements of young brine pool gypsum from the Soledad Formation in the Atacama Desert of Chile yielded an age cluster of slightly older than 200 kyrs, defining a possibly more humid period during marine isotope stage 7C interglacial. Our U-Pb dating attempts focused on marine gypsum from Mejillones peninsula and lacustrine gypsum from the Tiliviche paleo-lake in the Atacama Desert of Chile. Both types of gypsum display low Pb contents (lower ppb range) and unradiogenic Pb isotope compositions, thus requiring measurements of ²⁰⁴Pb for accurate common Pb corrections which is difficult to achieve using in situ techniques and is therefore done in solution mode after ion exchange separation of U and Pb from the sample matrix. Uranium, Th and Pb concentrations are obtained by isotope dilution on spiked aliquots (U-Pb) or via total spiking (U-Th). Whereas marine gypsum exhibits extremely low Pb contents at high ²³⁸U/²⁰⁴Pb (up to 1500), lacustrine gypsum exhibits somewhat higher Pb contents but lower ²³⁸U/²⁰⁴Pb (up to 20). Hence, lacustrine samples require Pb isotope measurements at highest precision in order to resolve the small differences caused by radiogenic ingrowth of ²⁰⁶Pb. For gypsum from Mejillones peninsula, we obtain an age of ca. 2 Ma and for evaporites from Tiliviche paleo-lake an age of ca. 9 Ma, both consistent with independent age constraints from cosmogenic nuclides and tephra layers. Collectively, these data indicate that combined ²³⁰Th-²³⁸U and ²³⁸U-²⁰⁶Pb dating are powerful tools to retrieve paleoenvironmental information for gypsum and related minerals through geologic time.

Reference

[1] Obert, J.C. et al. (2022) ²³⁰Th dating of gypsum from lacustrine, brackish-marine and terrestrial environments. *Chemical Geology* 607: 121019.