

Stable isotope fractionation of Ba and Sr in witherite and strontianite at near chemical equilibrium conditions

MAVROMATIS. V.¹, VAN ZUILEN, K.², NAEGLER T.³,
EISENHAEUER A.⁴, DIETZEL. M.⁵

¹ Geosciences Environnement Toulouse (GET) CNRS, Toulouse, France, ² Institut de Physique du Globe de Paris, Paris, France, ³ Institute of Geological Sciences, University of Bern, Switzerland, ⁴ Helmholtz Centre for Ocean Research GEOMAR, Germany, ⁵ Institute of Applied Geosciences, TU Graz, Graz, Austria (vasileios.mavromatis@get.omp.eu),

The isotopic composition of the so called “non-traditional” stable isotopes in carbonates has been seen as an important tool by the geochemical community in order to unravel the environmental conditions occurred at the time of mineral deposition. The distribution of stable isotopes between fluid and solid however is well known to be affected by a number of processes including growth kinetics. Thus knowledge of the fractionation factor between solid and fluid at near equilibrium conditions is a prerequisite in order to mechanistically describe isotopic offsets due to far from equilibrium mineral growth. In this study we examine the extent of stable Ba and Sr isotope fractionation in their respected alkaline earth carbonates witherite (BaCO_3) and strontianite (SrCO_3) at near equilibrium conditions. The overall aim of this study is to describe isotopic fractionation at equilibrium but also to provide insights on mineral reactivity under chemical equilibrium conditions.

The conducted experimental work examines the stable isotope distribution between carbonate minerals and reactive fluids as the fluid-rock system progressively moves towards equilibrium conditions starting from both fluid undersaturation and oversaturation conditions with respect to the precipitating carbonate phase. The obtained results suggest that the exchange of elements between solid and fluid continues after achievement of chemical equilibrium for both fluid-rock pairs suggesting that achievement of isotopic equilibrium occurs later than chemical equilibrium. Moreover it is suggested that isotopic exchange between solid and fluid is not limited only to the outer surface layer of witherite and strontianite, but it affects up to 8 unit cells below the mineral surface. This observation has strong implications for the use of the elemental and isotopic composition of sedimentary carbonates as environmental archives, e.g., as isotopic and likely trace elemental exchange between solid and fluid occurs at a significant level after the achievement of chemical equilibrium in the fluid-solid system.