Mg-isotope fractionation during the 25°C dissolution of hydromagnesite and at equilibrium

U.-N. Berninger[12]*, G. Jordan[2], V. Mavromatis[3],
A. Pérez-Fernàndez[1] and E. H. Oelkers[14]

[1]Géoscience Environnement Toulouse, CNRS-UPS, 31400 Toulouse, France
(*corresponding author: berninger@get.obs-mip.fr)
[2]Department für Geo- und Umweltwissenschaften, LMU, 80333 München, Germany
[3]Institut für Angewandte Geowissenschaften, TUG, 8010 Graz, Austria
[4]Earth Sciences, UCL, WC1E 6BT London, United Kingdom

Natural fluid compositons are commonly interpreted assuming that minerals release their isotopes to the fluid phase conservatively while dissolving and do not effect fluid isotopic compositons when they are at bulk equilibrium. This study was aimed to test the valdity of these assumptions using some simple closed-system experiments.

Natural hydromagnesite ($Mg_5(CO_3)_4(OH)_2*4H_2O$) from stromatolite precipitates from Lake Salda, Turkey, was dissolved in aqueous pH 9 $NaHCO_3/Na_2CO_3$ buffer solutions and at 0.1M ionic strength. Prior to the experiments the hydromagnesite was hand milled, cleaned with H_2O_2 to remove organics and oven dried at 50°C for 24 hours. Mg isotope compositions of both filtered solutions and solids were measured by MC-ICP-MS.

Bluk fluid-mineral chemical equilibrium was attained after two days but sampling continued for 1.5 years. During this time the aqueous solution became isotopically heavier – isotopic steady state was not attained even after 1.5 years of fluid-mineral interactions at bulk chemical equilibrium conditions. This isotope fractionation during dissolution and equilibrium is interpreted to stem from the two way transfer of material to and from the mineral, consistent with the concept of dynamic equilibrium. These observations clearly question the use of the conservative transfer assumption to interpret the isotopic signatures of natural fluids.