

$\delta^{26}\text{Mg}$ - $\delta^{30}\text{Si}$ of off-axis ridge fluids: Constraints on the ridge flank water flux and the oceanic Mg-Si budgets

L. ANDRÉ¹, F. PLANCHON^{1,2}, C. DELVIGNE¹
AND C. MONNIN³

¹Royal Museum for Central Africa,
Leuvensesteenweg 13, Tervuren, B 3080,
Belgium

²Laboratoire des Sciences de l'Environnement Marin,
IUEM, Brest, France

³Geosciences Environment Toulouse, Observatoire
Midi-Pyré
nées, 14 Avenue Edouard Belin, F-31400 Toulouse,
France

We measured the dissolved Mg and Si isotopic compositions of near-basement pore water samples collected at ten boreholes drilled along a E-W transect on the eastern flank of the Juan de Fuca ridge (JdFR) during ODP Leg 168. Starting from the proximity of the ridge axis, $\delta^{26}\text{Mg}$ and $\delta^{30}\text{Si}$ first change from -1.0‰ down to -2.6‰ and +1.7‰ up to +2.1‰, respectively, but becomes heavier (up to -1.5‰) and lighter (down to +1.4‰) eastwards. These trends result from seawater-basalt interactions occurring in two steps: (a) a low temperature (<40°C) steady-state uptake of Mg and Si by smectitic clays that partition heavy Mg and light Si; (b) a warmer (40-60°C) Rayleigh-controlled Mg loss with no major change in Si content but lighter $\delta^{30}\text{Si}$ due to silicate replacement by carbonates. Assuming: (a) an ocean at steady state for its Mg isotopic composition; (b) potential outflows of ridge flank hydrothermal fluids (RFHF) to the ocean with compositions close to the mean upwelled JdFR fluids ([Mg]:4.2 mmol kg⁻¹; $\delta^{26}\text{Mg}$:-2.3‰), the global RFHF discharge to the ocean is fixed at 12 10¹⁴ kg yr⁻¹, in line with water fluxes calculated from a recent model of hydrothermal heat transports⁽¹⁾: 4-26 10¹⁴ kg yr⁻¹. We finally estimate the Mg-Si RFHF discharges to the global ocean at 4.0±1 and 0.6±0.3 Tmol yr⁻¹, respectively.

(1) Grose and Afonso. Solid Earth 6, 1131-1155, 2015