Crust-seawater exchange in the flanks of mid-ocean ridges

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The chemical and isotopic composition of seawater is strongly affected by exchange processes in ridge-flank hydrothermal systems (RFHS), which are responsible for >80% of the advective marine heat flux. RFHS related geochemical fluxes across the seabed are poorly constrained. Recent sampling of fluids from off-axis springs and from aquifer waters within the ridge flank crust has provided new constraints that we will present at the workshop. We focus on Li, because the data provide a clear picture. The δ^7Li of the open oceans (~ 31 ‰) differs markedly from the δ^7Li of the continental runoff (~ 16.5 ‰), requiring the uptake of ^{6}Li by low-temperature interaction between seafloor and seawater. Dorado Outcrop, a basaltic edifice on 18 to 23 Ma old crust of the Cocos Plate, issues 12.5°C warm fluids and represents the first sampled RFHS that is typical of much of the global flux. The end-member fluid of Dorado Outcrop is depleted in Li (25.0 ± 0.3 µmol Li kg^{-1} (1sd)) and enriched in δ^7Li (31.9 ± 0.2 ‰ (2sd)) relative to bottom seawater (26.2 ± 0.3 µmol Li kg^{-1} (1sd), 31.2 ± 0.2 ‰ (2sd)). If these changes in Li concentration and isotopic composition are combined with a temperature increase in the Dorado aquifer of 13°C and a global ridge flank heat flow of 8TW, we find that RFHS can explain 7 to 27 % of the observed shift in seawater composition (i.e., 31 ‰ vs. 16.5 ‰). We estimate a Li flux of 5.8×10^9 mol Li yr^{-1} which corresponds to 58 to 73 % of the continental runoff. The potential role of RFHS in the oceanic budgets of other elements, namely Mg, Sr and U, are also discussed in the presentation. The uncertainties here are still very large; more sampling of crustal fluids from drill holes in the ocean crust is dearly needed.