# Seafloor alteration traced by stable isotope ($\delta^{44}Ca$, $\delta^{34}S$, $\delta^{18}O$) fractionation of sulfates

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At mid-ocean ridges, seawater carrying $SO_4$ infiltrates the oceanic crust whereas $H_2S$ predominates in fluid emissions from hydrothermal vents with $\delta^{34}S$ lower than that of seawater. The absence of $SO_4$ in hydrothermal fluids is in part due to anhydrite formation, but $\delta^{34}S$ values of hydrothermal sulfides indicate a contribution from reduction of seawater $SO_4$. These contrasting pathways of seawater $SO_4$ highlight the need to explore sulfur cycling and quantify the impact of seafloor alteration on isotope systematics in the oceanic crust.

The sample set comprised anhydrite from seawater hydrothermal systems at Surtsey and Reykjanes in Iceland. The chemical and isotopic composition ($\delta^{34}S$, $\delta^{18}O$) of anhydrite was measured *in-situ* using EMPA and SIMS, respectively. The natural dataset coupled with geochemical modelling was used to assess the major sources (seawater, basalt) of anhydrite-forming elements (Ca, S, O) to the system. In addition, the same modelling approach was utilized to investigate the processes affecting isotope systematics ($\delta^{44}Ca$, $\delta^{34}S$, $\delta^{18}O$) of anhydrite upon low temperature (50-150°C) seafloor alteration.

Geochemical modelling revealed that deviations in $\delta^{44}Ca$, $\delta^{34}S$ and $\delta^{18}O$ of anhydrite from the isotope values of seawater and host rock are caused by equilibrium isotope fractionation upon progressive seafloor alteration. Thereby, most sulfur derives from seawater whereas the origin of calcium and oxygen changes from seawater- to a basalt-dominated source with progressive alteration. Reduction of $SO_4$ to sulfide is limited at low temperature, whereas it is a major source of sulfur at high temperature contributing to $H_2S$ emissions in vent fluids. Seawater-rock interaction and redox processes may be main sources of Ca, S and O and greatly contribute to the modification of the isotopic composition of the altered oceanic crust.