Using stable isotopes to constrain carbon and sulphur sequestration at the Carbfix site in Iceland

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Mitigating climate change is one of the greatest challenges of this century and one approach is to develop carbon-neutral energies. Carbon and sulphur are being mineralised at the CarbFix storage site at the Hellisheidi geothermal power plant in Iceland. Natural geothermal gases exsolve during electricity production and CO_2 and H_2S are re-dissolved in water and injected deep into the basaltic rocks. Several studies have already shown that carbon and sulphur are securely captured, as minerals within several months after injection into the reactive basaltic rocks. However, these studies also suggest co-precipitation of other phases including clays, zeolites and even epidote and actinolite at the highest temperature. These phases compete with carbonates and sulfides for available cations and pore space.

Quantifying the extent of crystallisation of these different phases with major and trace elements alone is challenging. An alternative approach is to trace secondary mineral formation using the stable isotopes of Fe, Cu, Zn and Sr. The precipitation of different secondary phases affects each isotope system to a different extent. Therefore, a multi-isotope approach can be used not only to monitor the extent of secondary mineral formation, but also to distinguish the precipitation of carbonates from mixed clays, oxides and Si-Al phases. This approach is unique in that in can be used to place direct quantitative constraints on the rates of mineral precipitation, masses of secondary minerals formed over a given time period, and, in the case of carbonates, moles of CO_2 fixed.