Isotopic signatures of crystal water of sulfate hydrate minerals

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Degradation of concrete caused by the formation of secondary hydrous sulfate minerals (e.g. thaumasite, ettringite and gypsum) can cause major problems concerning the durability of concrete structures. To provide a better understanding of the formation conditions we have investigated thaumasite ($Ca_3Si(OH)_6(CO_3)(SO_4)\bullet12H_2O$) and gypsum ($CaSO_4\bullet2H_2O$) in terms of extracting the crystal water and analysing its isotopic signature.

The crystal water was extracted via a cold trap attached to a Schlenk line setup. δ^2H and $\delta^{18}O$ of the extracted water were measured by wavelength scanned cavity ring-down spectroscopy (WS-CRDS). As internal standards gypsum and ettringite ($Ca_6Al_2(SO_4)_3(OH)_{12}\bullet26H_2O$) were synthesized in the lab and measured as described above. Preliminary results indicated that this novel approach is highly promising to trace the isotopic composition of the water during the precipitation of the respective hydrous sulfate mineral. The crystal water from several damaged concrete samples was successfully recovered and the isotopic values for δ^2H and $\delta^{18}O$ yielded values of -57.1 ±4.0 and -3.4 ±1.0‰, respectively. Compared to the average value of the local ground water (δ^2H= -83.0‰; $\delta^{18}O$= -12.0‰) heavier isotopes are preferentially bonded in the crystal water. This result backs up previous finding that highly concentrated interstitial solutions of the concrete (5000 up to 50000 mg L^{-1} of SO_4) are caused by evaporation and had invoked concrete damage.