Gypsum precipitation under hyper-saline conditions: size, morphology and brine turbidity

A.G. REISS[*1,2], I. GAVRIELI[2] AND J. GANOR[1]

[1]Department of Geological & Environmental Sciences, Ben-Gurion university of the Negev, Beer-Sheva 84105, Israel (*correspondence: reissam@post.bgu.ac.il)

[2]Geological Survey of Israel, Jerusalem 95501, Israel

The Dead Sea (DS) is a hyper-saline lake oversaturated with respect to gypsum ($\Omega_{gypsum} \sim 1.5$). The extremely high Ca^{2+}/SO_4^{2-} ratio in the brine dictates very low precipitation potential while the little gypsum that does precipitate is masked by massive halite precipitation. However, mixing of seawater and/or reject brine from desalinization, as proposed in the Red Sea-Dead Sea project, is expected to result in massive gypsum precipitation in the DS. This may lead to whitening (turbidity) of the surface water due to minute gypsum crystals that will remain afloat. The factors determining if such whitening will occur are the size and morphology of the precipitating crystals, Hence the importance of understanding the controls governing these parameters under hyper-saline conditions.

A set of batch experiments was conducted. Varying amounts of DS brine and Red Sea (RS) brine enriched with Ca^{2+} and SO_4^{2-} were mixed. At designated times turbidity was measured, a sample was taken for chemical analysis and the crystals were seperated from solution. The crystals were then imaged and their size and shape were analyzed by utilizing image processing techniques.

A linear relationship was found between turbidity and the amount of gypsum precipitate, which is oversaturation dependent. Higher initial oversatureaion leads to higher turbidity per mole of mineral precipitated. If no mechanism keeps the formed crystals in suspension, turbidity first increases as crystals precipitate and grow and then decreases as the crystals settle to the bottom. Within a few hours the brine clears out, regardless of maximum turbidity achived.

Crystal population analysis shows that crystal size is log-normally distributed and that the average crystal size increases linearly with time. The morphology was found to be chemistry dependent. The main morphology determining parameters were found to be the initial distance from equilibrium and the ratio of DS to RS in the mixture. Increasing oversaturation while $\Omega_{gypsum} \leq 2.7$ results in crystal elongation. At Ω_{gypsum}~2.7 the morphology changes to needles that grow radially from a center. Decreasing DS/RS ratio results in crystal elongation. It is yet to be determined how these findings interplay in a natural environment.