Controlling Strontium Partitioning during MICP under continuous flow

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Using subsurface microorganisms to induce calcium carbonate ($CaCO_3$) precipitation is an emerging groundwater remediation biotechnology. Bacterially driven reactions such as ureolysis can induce $CaCO_3$ precipitation, a process known as Microbially Induced Calcium carbonate Precipitation (MICP). MICP can facilitate the partitioning of metal contaminants, such as strontium (Sr), into $CaCO_3$ precipitates for long-term sequestration. For potential groundwater treatment applications, an important requirement is controlling the amount and distribution of $CaCO_3$, and the degree of metal partitioning into the precipitates.

Precipitate mass and distribution can be controlled by manipulating fluid flow and saturation states. This was demonstrated by performing MICP and Sr co-precipitation experiments in flat plate porous media reactors. These reactors were made of rectangular polycarbonate plates, etched to leave behind 1 mm^3 square pegs that served as porous media by clamping a glass cover plate on top of them. After allowing *Sporocarcina pasteurii* cells to attach and grow in the flow cells, precipitation was promoted via continuous flow of media containing dissolved Ca and Sr. Combinations of flow rates and Ca concentrations were studied. Additionally, a modified flow cell was used to assess spatio-temporal characteristics of Sr co-precipitation.

Ca removal rates correlated linearly with the Ca mass flow rates into the flow cell, suggesting that under the conditions tested, MICP was limited by Ca transport. Highest Ca and Sr removal was achieved at the lowest volumetric flow rate and Ca concentration tested. Lower Ca concentrations resulted in higher Sr partitioning. With distance into the flow cells, precipitate size increased accompanied by a decrease in Sr incorporation into $CaCO_3$. Distance from the inlet and time proved to be significant factors influencing urea utilization and Sr co-precipitation.