Aspects of implementation and long-term performance of biologically induced mineralisation of carbonates in porous media

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We present the outcomes of studies into the behaviour of biologically induced mineralisation (BIM) of calcium carbonate for the purposes of contaminant sequestration and soil stabilisation. The implementation of BIM requires treatment of soil/aquifer material *in situ* through introduction of chemical precursors and potentially bacteria. However, natural subsurface heterogeneity causes preferential flow which may limit uniform delivery of such materials [1]. Incomplete contaminant biomineralisation or particle biocementation may therefore occur, with consequent implications for both achievement of the original engineering aim and long-term durability of the cemented / sequestered monolith due to excessive hydraulic conductivity.

Experiments on homogenous model aquifer material demonstrate that rapid carbonate formation occurs, allowing rapid sequestration of cadmium as a model contaminant. However, in heterogeneous systems preferential flow leads to immediate treatment of only highly permeable media. Over time, we demonstrate that mineralisation sufficiently alters hydraulic conductivity to cause diversion of flow to less permeable regions, leading to more uniform treatment.

In the long term, a carbonate monolith may deteriorate, particularly if significant porosity remains [2]. Spores of the mineralising organism (*Sporosarcina ureae*) are shown to survive calcification, sterilisation and carbonate dissolution, with further mineralisation upon germination. This imparts a mechanism of self-healing to the monolith, similar to that employed in construction materials [3], with deterioration potentially leading to further BIM and healing of the damage.

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