Microbially Induced Calcite Precipitation by Bacillus subtilis 168 for Underground Gas Stagnation, Soil Compaction, and Ion Sequestration

Mathai, Noah (School: Plano West Senior High School)

Microbially Induced Calcite Precipitation (MICP) is a biochemical reaction that certain urease positive bacteria can perform. Through MICP, said bacteria can precipitate microscopic limestone crystals that act as particle adhesives in sand, soil, and concrete. This study was conducted to examine if MICP crystallization by Bacillus subtilis 168 could be used to compact soil and impede the proliferation of underground CO2 into the atmosphere. Bacillus subtilis 168 was grown with Media 415, transferred into urea-CaCl 2-dextrose liquid media, and administered into soil plots. Through MICP, the Bacillus excreted carbonate ions that reacted with calcium in the media to generate limestone crystals that solidified the soil. The soil was modulated by introducing P 2O5 and Lime (MgCO3, CaO, MgO) fertilizers, which decreased and increased pH respectively. Following treatment with bacteria and fertilizers, the soil was inserted into a chamber with NaHCO3 deposited beneath it. When HC 2H3O2 was administered, NaHCO3 released CO2 that rose through the soil and was detected by a UV gas-probe. After collecting CO2 effluxes in ppm from the soil plots, it was determined that soil treated with only MICP stagnated CO2 efflux to the highest extent. Soils treated with MICP and lime produced similar results, suggesting that lime played a minimal role in particle consolidation, likely because lime fertilizer was too large to be used by the bacteria. P2O5-treated soils had the highest effluxes, possibly because protons emitted by P2O5 reacted with limestone to produce additional CO 2. Statistical analysis suggested data significance. MICP used for grouting and ion detoxification is discussed.