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GEOLOGICAL FATE AND IMPACT OF ISOSACCHARINIC ACID

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During the disposal of low-heat generating wastes in a cementitious geological disposal facility (GDF), cellulose can degrade via alkaline hydrolysis to form isosaccharinic acid (ISA). This is of interest due to the ability of ISA to complex key radionuclides, and potentially enhance their mobility. This project investigates ISA biodegradation and associated microbial processes GDF-relevant conditions using flow-through column systems. Batch experiments have shown that microbial communities in high-pH anaerobic sediments are able to degrade ISA, particularly using suitable electron acceptors such as nitrate ([1]); however, there is limited research on these interactions under dynamic conditions. Here we develop and apply methods to quantify ISA degradation and evaluate biogeochemical processes in column systems.

Column experiments were carried out using Pearson synthetic groundwater ([3]) as the influent solution. Columns were packed with sediment from Harpur Hill, a legacy lime-working site in Buxton, U.K ([2]), characterised by calcite- and silicate-rich material and average pH of 11–12. A range of ISA treatments were introduced to the influent and monitored over ~200 days to assess ISA removal and changes in redox conditions. Significant ISA removal was observed when nitrate was present as an electron acceptor, indicating active microbial degradation under alkaline, nitrate-reducing conditions.

Follow-on experiments have focused on the impact of ISA-degrading bacteria on the mobility of priority radionuclides. Se^{79} is a long-lived radioactive isotope that is of interest due to its mobility in groundwaters as Se(VI), and column experiments have confirmed Se(VI) reduction and continued ISA removal over ~100 days, accompanied by formation of a red precipitate and Se^{0} nanoparticles (confirmed by SEM-EDS). Further work will assess the bioreduction of U(VI) as an electron acceptor, coupled to ISA oxidation and extend to include genetic, geochemical and mineralogical analyses.

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