Production of mycogenic phosphate biominerals for the remediation of radioactive contamination

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Microorganisms are able to induce the precipitation of phosphate biominerals *via* the action of phosphatase enzymes. These enzymes catalyse the hydrolysis of organic phosphate compounds, which releases inorganic phosphate to solution and may form precipitates with other ions present, e.g. Ca^{2+} [1, 2].

This process is a topic of interest due to its potential applications in the remediation of soil and groundwater contaminated by radioactive elements associated with nuclear power and mining industries, as phosphate minerals (e.g. hydroxyapatite; $Ca_{10}(PO_4)_6(OH)_2$) are able to immobilise many relevant elements [1–3].

Research into phosphate biominerals, as opposed to their abiotic counterparts, is driven by two main factors: (a) their superior ability to immobilise contaminants such as U, Sr, Co, and trivalent actinides [2]; and (b) the potentially novel methods of engineering a remediation solution.

In particular, microorganisms offer the potential for *in situ* remediation technologies (such as permeable reactive barriers) to be developed in a semi-passive way without such a reliance on invasive excavation procedures.

This project focuses on fungi, which have been relatively underresearched in biomineralisation processes when compared to bacteria. The vastly different growth patterns of filamentous fungi offer further possibilities for the engineering of a bioremediation strategy. For example, it may be possible to utilise chemical and topographical growth sensing mechanisms to “train” fungi to grow into a contaminated substrate and induce immobilisation through a biomineralisation mechanism.

In addition, this research investigates the optimisation of conditions for growth and enzyme productions, the influence of secreted metabolites (e.g. citric and oxalic acid) on biomineral formation, and the use of phytic acid ($C_6H_{18}O_{24}P_6$) as P source.

[1] Macaskie et al. (2004) in *Phosphorus in Environmental Technologies: Principles and Applications*, 549–581. [2] Handley-Sidhu et al. (2014) *Environ. Sci. Technol.* **48**, 6891–6898. [3] Rakovan & Pasteris (2015) *Elements*, **11**, 195–200.