Mechanism of microbial amorphous calcium phosphate manufacture and its application to radionuclide remediation

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Serratia sp. bacterium produces amorphous calcium phosphate (BHAP), with a larger specific surface area and a more reactive surface compared to synthetically produced hydroxyapatite [1]. Previous research has shown that BHAP can remediate up to 10 times more Sr^{2+} and Co^{2+} from waters than commercially available hydroxyapatite [2].

Serratia sp. is unusual in that it contains high levels of an atypical phosphatase enzyme located in the bacterial periplasmic space, attached to organic extracellular polymeric substance (EPS) and free in solution; this enzyme cleaves glycerol-2-phosphate (G2P), liberating inorganic phosphate for BHAP formation [2-4]. Evidence suggests that the growth of BHAP is controlled within spatial localisation of the biological space and in close proximity to cells [2-4]. Images from transmission electron microscopy and atomic force microscopy show a network around the bacteria, consisting of EPS template and BHAP. Once fully loaded with BHAP, long needle shaped crystals appear to be broken away from the microbial surface.

Small angle neutron scattering (SANS) was carried out to examine size, shape, internal structure and spatial arrangement of bio-nanomaterial growth over time. Preliminary data of BHAP saturated bacteria showed fractal cluster models (eg, primary radii <10 Å, fractal dimensions around 2.7-2.8 and final cluster sizes between 150-350 Å).

[1] Oelkers and Montel. *Elements* 2008, **4**, 113-116. [2] Handley-Sidhu *et al* (2011) Environ. *Sci. Technol.* **45**, 6985-6990. [3] Askarieh *et al* (2000) *Waste Management* **20**, 93-106. [4] Handley-Sidhu *et al* (2011) *Biotechnol. Lett.* 2011, **33**, 79-87.