Bioremediation of radioactive strontium contaminated sea water by biogenic Ca-carbonate

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Radioactive strontium leaked into saline environments, including the ocean, by the Fukushima Daiichi Nuclear Power Plant accident. Since Sr is not effectively removed by general adsorbents at high salinity, a suitable alternative removal method is necessary. To devlop a ^{90}Sr removal method for a highly saline environment, we have studied the removal of Sr from sea water using Ca-carbonate producing microorganisms.

A diluted Marine broth 2216 (3.76 g/l) containing 20 g/l urea and 30 g/l NaCl was used for cultivation. The media were prepared with various final concentration of $SrCl_2$ (0.01–5.0 mM) and NaCl (0.3–10 wt%). The concentration of soluble Sr in the culture was measured using ICP-AES. The precipitates were analyzed using SEM, TEM, XAFS and XRD.

We isolated five strains of ureolytic microorganism that can remove Sr from marine sediments. Among them, the strain KW3b exhibited the highest Sr removal (98–100% removal) from various initial Sr concentration (0.01–5.0 mM) within 1–2 days culture. The strain also removed 92–100% of Sr even in 0.3–5.0 wt% of NaCl solutions, indicating the high halotorelance. The precipitate formed during the reaction exhibited a crown shape with 10–20 μm in size and uniform Ca and Sr distribution. Needle-like crystals formed with aragonite-structure. XAFS analysis revealed that Sr in the precipitate was incorporated as Sr^{2+} ion and $SrCO_3$, and the abundance ratio of $SrCO_3$ was increased over cultivation time. These results suggest that the strain KW3b removed soluble Sr and incorporated it into a biogenic carbonarte minerals. Consequently, the biomineralization utilizing the specially selected strein is the effective method to remove Sr even under highly saline environment.