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Molecular characterization of the speciation of uranium associated with the marine bacterium Idiomarina loihiensis MAH

The present study describes the speciation of uranium associated with Idiomarina loihiensis MAH1, a bacterial strain with biomineralization potential abilities isolated from the Alboran Sea in the west side of the Mediterranean Sea. The interactions of uranium with this marine bacterium was studied both in NaClO4 solution as well as in Sea water using a multidisciplinary approach combining X-ray Absorption Spectroscopy (XAS), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray (EDX) analysis and Time-Resolve Laser-Induced Fluorescence Spectroscopy (TRLFS).

The results indicated that the speciation of uranium associated with the cells of the strain studied is highly dependent on the speciation of the background electrolyte used (NaClO4 solution and Sea water). In NaClO4 solution (at U concentration of 0.5 mM, pH 4.3), EXAFS spectroscopy analysis indicated that the bacterial cells coordinated U through phosphate groups in a monodentate fashion mode and carboxyl groups in a bidentate binding mode. TRLFS results corroborate the EXAFS analysis showing the main implication of phosphate groups in the coordination of U. The uranium bacterial complexes were located within the extracellular polysaccharides (EPS), at the cell wall and some accumulates were observed intracellularly as was demonstrated by TEM analysis. However, in Sea water and at U concentration of 5x10-4 M (environmentally relevant concentration), TRLFS analysis indicated that the marine bacterium precipitate this radionuclide as U carbonate mineral phases. In addition, a part of the metal was coordinated to phosphate groups. TEM analysis showed that the accumulated U was located only at the cell surface as electro dense precipitates.

The results of this study will help on understanding the role of microbial process on the transport and mobility of radionuclides in the Alboran Sea as it is the only connection between the Mediterranean Sea and the Atlantic Ocean, and where the transportation of radioactive waste and the traffic of nuclear submarines are very intense.

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