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Bacteria mediated dissolution of pyromorphite Pb5(PO4)3Cl in presence of Pseudomonas putida bacteria - an effect on Pb remobilization in the environment

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The objective of the study was to determine the mechanisms of microbially enhanced dissolution of lead phosphate-pyromorphite Pb5(PO4)3Cl). Contrary to the current literature, the results of our experiments indicate a great potential for Pb remobilization in the environment by an aerobic microorganism acquiring phosphates. Broad knowledge exists about the role of Pb-apatites in regulating the behavior and the bioavailability of Pb in soils and wastewater. In situ Pb immobilization is one of the methods now routinely applied for the reclamation of Pb-contaminated soils, including shallow unconfined aquifers (Magalhaes & Silva, 2003; Magalhaes, 2002; Ma et al. 1993). This method is based on the principle that aqueous phosphates added to soil pore solutions form a very stable (insoluble) mineral pyromorphite (Pb-apatite) Pb5(PO4)3Cl. Bioavailability of aqueous Pb is thus minimized due to the very low solubility and the high thermodynamic stability of pyromorphite (Flis, 2007; Nriagu, 1974). Several reports have examined the ability of different bacterial species including Pseudomonas to solubilise insoluble inorganic phosphate compounds for example apatites (Welch et al., 2002; Maurice et al., 1999; Rodriguez and Fraga, 1999). Various species of Pseudomonas genera are encountered as common inhabitants of soils and wastes in the industrial areas under strong pollution influence. To date, there has not been any published evidence of microbial dissolution of pyromorphite.
The major objective of the project was to study Pseudomonas putida growth in the presence of Pb-apatite (Pb5(PO4)3Cl) as the sole source of phosphate. It was to test the hypothesis that in the phosphate deficient environment bacteria are able to actively scavenge for P from the Pb-apatite which results in remobilization of Pb in the environment. The bacteria growth was investigated at 22oC. Commercially available Pseudomonas putida strain was used throughout. The experiment and its controls were run in standard growth medium for the period of 10 days, at starting pH=6.5. Samples were periodically analysed for pH, bacterial density, Pb and P (UV-vis, ICP). Our results indicate that Pb may be mobilized from pyromorphite by microbial activity, both in phosphorous-rich and phosphorous-deficient environment. At the experimental conditions the presence of bacteria enhances the dissolution of pyromorphite, resulting in up to 20 times increase of Pbaq. The observed effects of microorganisms on Pb remobilization need to be considered in Pb remediation strategies that rely on pyromorphite formation.

References:
FLIS J.M., (2007). “Thermodynamic properties of minerals from pyromorphite-mimetite series”- Master Thesis, AGH-University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Mineralogy, Petrography and Geochemistry, Cracow, Poland.
MA Q.Y., TRAINA S.J., LOGAN T.J., RYAN J.A. (1993). “In-situ lead immobilization by apatite”. Environ. Sci. Technol., 27: 1803-1810.
MAURICE P.A, LEE Y.J., HERSMAN L.E. (1999). “Dissolution of Al-substituted goethites by an aerobic Pseudomonas mendocina var. Bacteria.” Gechim. Cosmochim. Acta. 64: 1363-1374.
MAGALHÃES M.C.F. (2002). “Arsenic. An environmental problem limited by solubility”. Pure Appl. Chem., 74(10): 1843-1850.
MAGALHÃES M.C.F., SLIVA, M.C.M.(2003). “Stability of lead(II) arsenates”. Monat. fur Chem. 134: 735-743
NRIAGU J.O., (1974). “Lead orthophosphates IV. Formation and stability in the environment.” Geochim.

Cosmochim. Acta, 37: 367-377.
RODRIGUEZ H. & FRAGA R. (1999). “Phosphate solubilizing bacteria and their role in plant growth promotion”. Biotechn. Advan. 17: 319-339.
WELCH S.A., TAUNTON A.E., BANFIELD J.F. (2002). “Effect of Microorganisms and Microbial Metabolites on Apatite Dissolution”. Geomicrobil. J. 19: 343-367.