Metal-microbe-mineral interactions in extreme environments: The acidic pit lake perspective

J. SÁNCHEZ-ESPAÑA[1], D. AYALA[2], W. D. BURGOS[2], L. VAN DER GRAAF[3], I. SÁNCHEZ-ANDREA[3], M. MAAR[4], J. MEIER[4], C. FALAGÁN[5], I. YUSTA[6]

[1]Spanish Geological Survey, Calera 1, 28760, Tres Cantos, Madrid, Spain (j.sanchez@igme.es)
[2]Pennsylvania State University, University Park, PA 16802, USA (dk9@psu.org) (wdb@engr.psu.edu)
[3] Wageningen University, Department Microbiology, The Netherlands (lot.vandergraaf@wur.nl) (irene.sanchezandrea@wur.nl)
[4] University Koblenz-Landau, 56070 Koblenz, Germany (monamaar@uni-koblenz.de) (jmeier@unikoblenz.de)
[5]University of Exeter, Penryn Campus, Exeter, Cornwall TR10 9FE, UK (C.Falagan@exeter.ac.uk)
[6]University of the Basque Country, Apdo. 644, Bilbao, Spain (i.yusta@ehu.es)

Acidic pit lakes formed in abandoned metal and coal mines are unique aqueous environments of great biogeochemical and geomicrobiological interest. Their extreme chemical conditions (low pH, extremely high metal concentrations, low carbon and nutrient availability) and their usually permanent (meromictic) stratification make them unrivaled model systems for the study of extremophiles, their role in sulfur, iron and nutrient cycling, and their interaction with many different toxic metals. The microbial ecology and major metabolic activity of the upper, oxidizing layers, strongly related with the iron cycle, are generally well established and do not differ significantly from other near-surface acid mine drainage systems. The transitional and bottom anoxic layers, however, exhibit a higher complexity and microbial diversity, with dominance of anaerobic metabolisms centered on the S cycle with a marked influence on metal dynamics (Al, Si, Cu, Zn, As, Pb, U, Th). This presentation will revise the most recent research conducted in different acidic pit lakes, from microbial community profiling at different depths via 16S rRNA gene amplicon analysis, metagenomics and trancriptomics, through laboratory experiments with bacterial cultures under controlled conditions to high-resolution electron microscopy of mineral markers of bacterial activity. We will discuss the most relevant findings related with metal-microbe interaction at high ionic strength and the possible implications in a wide range of disciplines, from geobiology and environmental geochemistry to biotechnology.