Bacterial mutualism as new strategy of survive extreme acidic and microaerophilic conditions

J. CASTILLO[1]*, B. LINAGE[1], C. FOURIE[1], M. VERMEULEN[1], E. CASON[1], E. COETSEE-HUGO[1], H.SWART[1], J.M. NIETO[2], F. MACIAS[2], M. CARABALLO[3], M. BECERRA-HERRERA[4], A. GOMEZ-ARIAS[1], A. CORZO[5], S. PAPASPYROU[6], J.L. JIMENEZ-ARIAS[5], J.A. GONZALEZ-PEREZ[7] AND E. VAN HEERDEN[1].

[1]Departments of Microbial, Biochemical and Food and of Physics, University of the Free State, South Africa, castillohernandezj@ufs.ac.za
[2]Department of Geology, University of Huelva, Spain
[3, 4]Depts. of Mn. E. and Inorg-Anal. Ch., University of Chile
[5, 6]Depts. of Biol. And Biomed., University of Cadiz, Spain
[7] Department of Geoecolgy-Biogeochemistry, IRNAS, Spain

The Iberian Pyrite belt contains some of the most diverse and extreme acidic ecosystems. In order to study the biogeochemical processes supporting the biome under acidic and oxygen limiting conditions, a biofilm was sampled from an abandoned mine pithead. Physico-chemical conditions of the microenviroments ranged from microaerophilic (pH, Eh, and DO of 2.76, 508 mV and 16.9 μM, respectively) to anaerobic (pH, Eh, and DO of 2.35, 555 mV and 3.8 μM respectively). Fe and Al showed the highest concentrations (600 and 108 mg/L, respectively) followed by other trace metals, mainly Cu and Zn (14 and 15 mg/L). Analysis by SEM-EDS, XRD, XPS and Py-GC/MS-CSIA revealed that the SOx species present in the biofilm were originated from oxidative processes ($\delta^{18}O$ and $\delta^{34}S$) and it was associated with Cu^0. The copper interaction is interesting as it acts as cofactor for enzymes such as cytochrome oxidases or superoxide dismutases because of its ability to cycle between Cu^{2+} and Cu^{+}. One consideration is the accumulation of $Cu^{+/2+}$ ions as it contributes to oxidative stress due its participation in Fenton-type reactions. Next generation microbial diversity analysis showed the coexistence of oxido-reductive microorganisms such as *Alicyclobacillus sp*. and *Desulfosporosinus sp*.. This special coexistence and data suggested novel strategies for ROSs (Radical Oxygen Species) and copper homeostasis. Thus, the oxidation processes by *Alicyclobacillus sp*. generates ROSs that oxidize CuS precipitated by *Desulfosporosinus sp*. metabolism. This oxidation releases SOx and Cu^0, which accumulate in the biofilm. This process could regulate the ROSs in the system and could allow the accumulation of Cu^0 as a neoformed mineral phase now possibly not toxic for the biofilm.