Microbial sulphur isotope fractionation in a Mars analogue environment at Rio Tinto, SW Spain

Esther Velasco (1,2,3), Paul Mason (3), Elena Gonzalez-Toril (4), Tanja Zegers (3,5), Gareth Davies (2), Ricardo Amils (1,4)

(1) CBM-SO, Autonoma University of Madrid, Spain (evelasco@cbm.uam.es), (2) Faculty of Life and Earth Sciences, Vrije University of Amsterdam, The Netherlands, (3) Department of Earth Sciences, University of Utrecht, The Netherlands, (4) Centro de Astrobiología, Madrid, Spain, (5) ESTEC, European Space Agency, Noordwijk, The Netherlands

The development of geochemical proxies for possible early life on Mars is important in preparation for future space missions, especially those that will return samples to Earth. Sulfur isotopes are likely to be a key future tool for this purpose since abundant sulphate minerals on the surface of Mars [1], such as jarosite (KFe3+3(SO4)2(OH)6), may record the activity of sulphur metabolizing microorganisms. Little is currently known about the sulphur isotope effects associated with sulphate reduction in the acidic environments where jarosite and other minerals are likely to have precipitated. Here we investigate the relationship between sulphate reducing activity and sulphur isotope fractionation in a modern hyper-acidic subareal environment at Rio Tinto, SW Spain [2,3,4]. The geochemical characteristics of Rio Tinto are the consequence of modern weathering of pyrite-rich ores in the Iberian Pyritic Belt, and the metabolism of iron and sulphur compounds by chemolithotrophic microorganisms. This results in a high concentration of ferric iron that is soluble under the acidic conditions generated by the biological activity. These conditions cause the precipitation of ferric-bearing minerals, including amorphous phases and hydronium jarosite. Sulphate reducing bacteria have recently been isolated from Rio Tinto sediments despite the fact that high concentrations of ferrous iron can inhibit microbial sulphate reduction.

Flow-through reactor experiments were performed using sediment samples from Río Tinto, in localities where the potential for sulphate-reducing activity was previously identified. Sediments were taken both in the upper part of the river and in the estuary where tidal effects have created a dynamic environment, with mixing between hyperacidic and marine conditions. Sediments were incubated in the laboratory at 30°C, using an artificial input solution with sulphate in excess using techniques developed by Stam et al. [5]. Two sets of experiments were done at pH 7 and pH 3 with electron donors provided by the natural substrate. Duplicate reactors were incubated for a total of 10 weeks. Initial data indicate moderate potential sulfate reduction rates of between 5 and 45 nM cm-3 h-1 at both pH 7 and pH 3. Isotope effects will be determined by measuring differences in $^{34}S$ between the sulphate in the inflow and outflow solutions. We expect our results to further help in the targeting of sampling sites in the search for traces of life on Mars.

References: