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Geomicrobiology of Rock Varnish in a natural extreme acidic environment: Río Tinto

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Abstract

Río Tinto is a natural environment due to the microbial activity in the subsurface of Iberian Pyrite Belt (IPB). The river has a high heavy metals concentration in solution and the chemistry of iron in the river maintains a constant pH.

One of the less studied and known niche in the river system is the rock varnish which is clay minerals cemented with Fe and Mn oxides. In these environment, microbial communities are presents and varnish-like materials have great interest in astrobiology.

We are investigating rocks varnish. Analysis with XRD and ICP-MS have been made and biodiversity studied. High-throughput sequencing methods were applied.

1. Introduction

In the XIX century, Alexander von Humboldt reported the first rock varnish in the literature when travelled to South America [10]. Microbiologist have studied rock varnish just only in the last decades. The great interest of these type of rock coatings is its highly oxidative character, the biodiversity present and the biogeochemical cycles on a small scale with tremendous interest in astrobiology [1, 5].

1.1 Rock Varnish

Rock varnish is one type of rock coating found in almost every type of terrestrial weathering. With a thickness of no more than 200 µm, it is composed mainly by clay minerals (Si, Al) cemented on a bedrock with Mn and Fe oxides in variable concentrations with some trace elements in the composition [6]. Categorization and classification in different types the rock varnish from different environments is difficult due to its diversity [8].

1.2 Río Tinto

Río Tinto (located in SW Iberian Peninsula, in the core of the IPB), is an unusual natural ecosystem with unexpectedly high level of microbial diversity. Due to the underground chemolithotrophic microbial activity, a high concentration of heavy metals is in solution (iron can be found above 20 g/l, maintaining a constant acidic pH of 2.3 as a mean) and iron formations such as hematite or jarosite can be found in the river system. For these reasons, Río Tinto is considered a good geochemical and mineralogical Mars analogue [2].

2. Material and Methods

Samples were analyzed mineralogical and chemically using XRD and ICP-MS, trying to separate the brownish cover from the sedimentary bedrock for the analysis. Also, observations were realized in the SEM, analyzing the microstructure.

DNA extraction using approximately 0.5 g of sample in PowerSoil DNA Isolation kit from MoBio was achieved. PCR using the primers 515F and 806R was done, using a common protocol described in the literature for microbiomes from soil [3]. The PCR products were sequenced by Illumina Mi-Seq and the output was processed by QIIME 1.9 [4].

3. Tables

Table 1: Mineralogy obtained by XRD

Quartz
SiO_2
Illite
$(K, H_3O)Al_2Si_3AlO_{10}(OH)_{16}$

Chamosite $(Mg_{5.036}Fe_{4.964})Al_{2.724}(Si_{5.70}Al_{2.30}O_{20}(OH)_2)$

Table 2: Main *phyla* detected by Illumina sequencing

Phylum identified	Relative abundance (%)
Firmicutes	43,7
Proteobacteria	19,5
Actinobacteria	12,4
Fusobacteria	10,4
Bacteroidetes	7,5
Saccharibacteria	1,2
Nitrospira	0,3

4. Summary and Conclusions

This is the first study of rock varnish in an extreme acidic environment. With the data obtained, we hypothesize that our sample is a rock varnish 'type V' in a very particular environment, explaining why Mn oxides have no presence but high content of Fe oxides (table 1). The microbial composition (table 2), reveals the presence of microorganism able to oxidize the Fe and Mn. Bacteria groups reported previously in the literature [7, 9] are presents as well.

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