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Antarctic Dry Valleys melt water systems analogues of Martian gullies: characterization of microbial communities and soil properties

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BACKGROUND

Gullies and streams occur in a broad zone, as dark bands, commonly on north-facing slopes, in McMurdo Dry Valleys (MDVs) in Antarctica, despite cold and dry conditions. They originate from surface top-down melting of snow and ice, due to enhanced summer solar insolation and host a biological activity persisting even after water flow in the channel has ceased, surviving long periods of desiccation and extreme cold in a cryptobiotic state. These systems may provide insights into the potential configuration of Mars climate, in which MDV-like ephemeral streams and rivers could have originated through processes related to the presence of liquid water in the recent geological past and could have hosted life forms remained trapped within the gullies. Jezero Crater has been chosen as landing site for Mars 2020, as it is located in a giant basin, once home of a river delta, that could have preserved organic molecules and other potential signs of a hypothetical microbial life from water and sediments that flowed into the crater billions of years ago.

OBJECTIVES

Our multidisciplinary study aims to provide a wide characterization of soil characteristics and microbial communities of these peculiar ecosystems and correlate different information to define which parameters could be uniquely descriptive of the presence and type of colonization.

MATERIALS AND METHODS

Three localities have been selected in Southern Victoria Land for sampling activities (fig. 1 and 2). Bacterial and fungal diversity have been characterized through the metabarcoding analyses of the 16S and the ITS1 rRNA genes regions, respectively. Soil edaphic parameters (pH, relative moisture, C, N, P, Na, K, Mg and Ca content and CEC) and granulometry have been characterized. Laser induced fluorescence spectra were acquired *in-situ* by an in-house developed instrument to detect accessory pigments. The DRIFT (Diffuse Reflectance Infrared Spectroscopy) spectra and digital colorimetric data have been recorded.

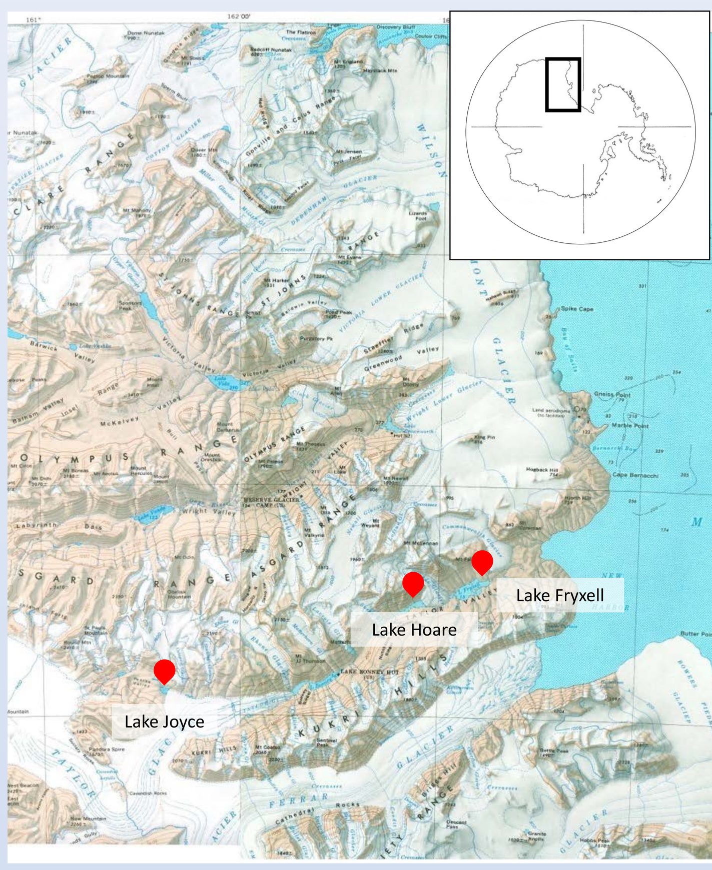

Figure 1. Sampling localities in Southern Victoria Land

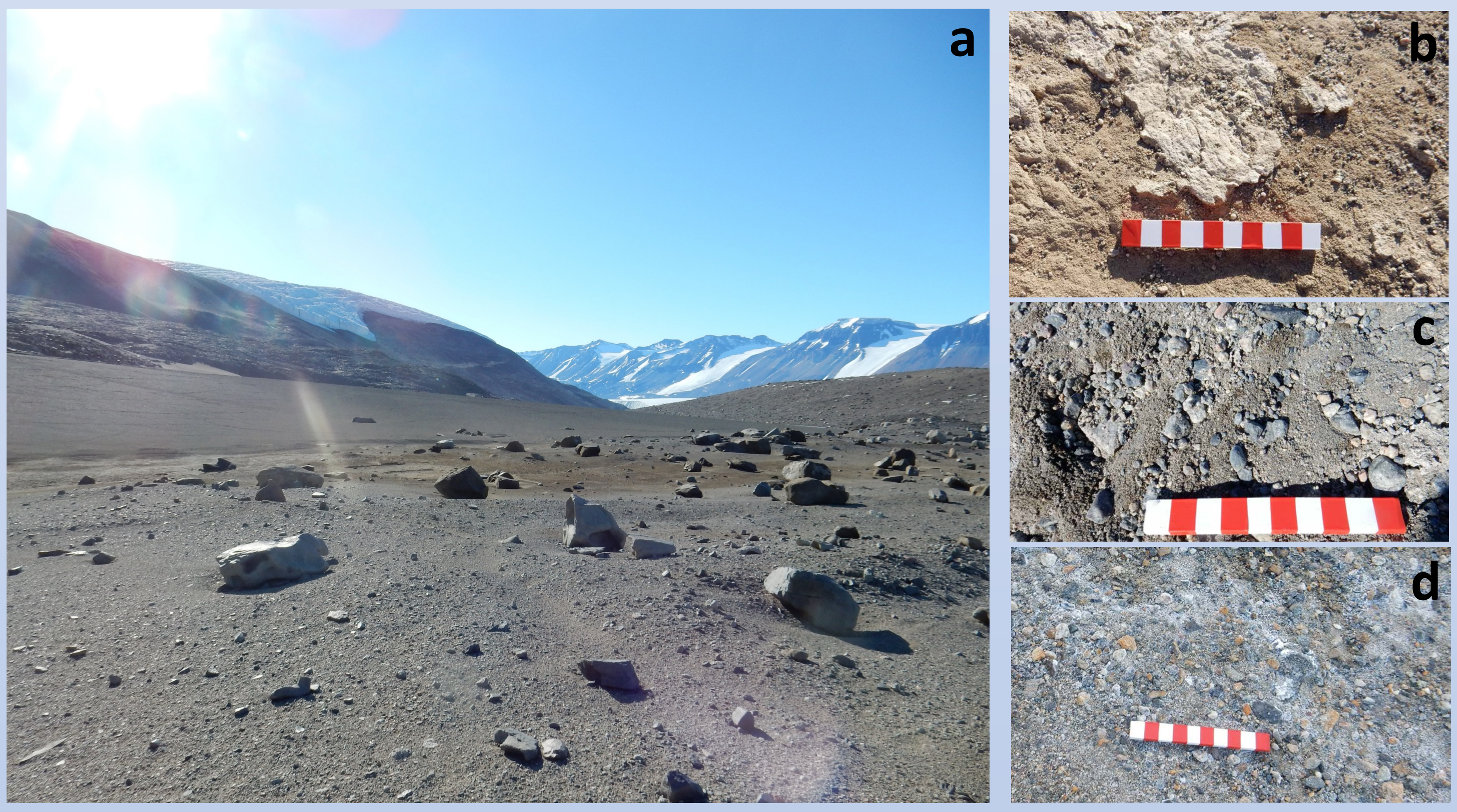

Figure 2. Landscape at Lake Joyce (a) and sampling sites at Lake Joyce (b), Lake Fryxell (c), and Lake Hoare (d). Scale bar 10 cm.

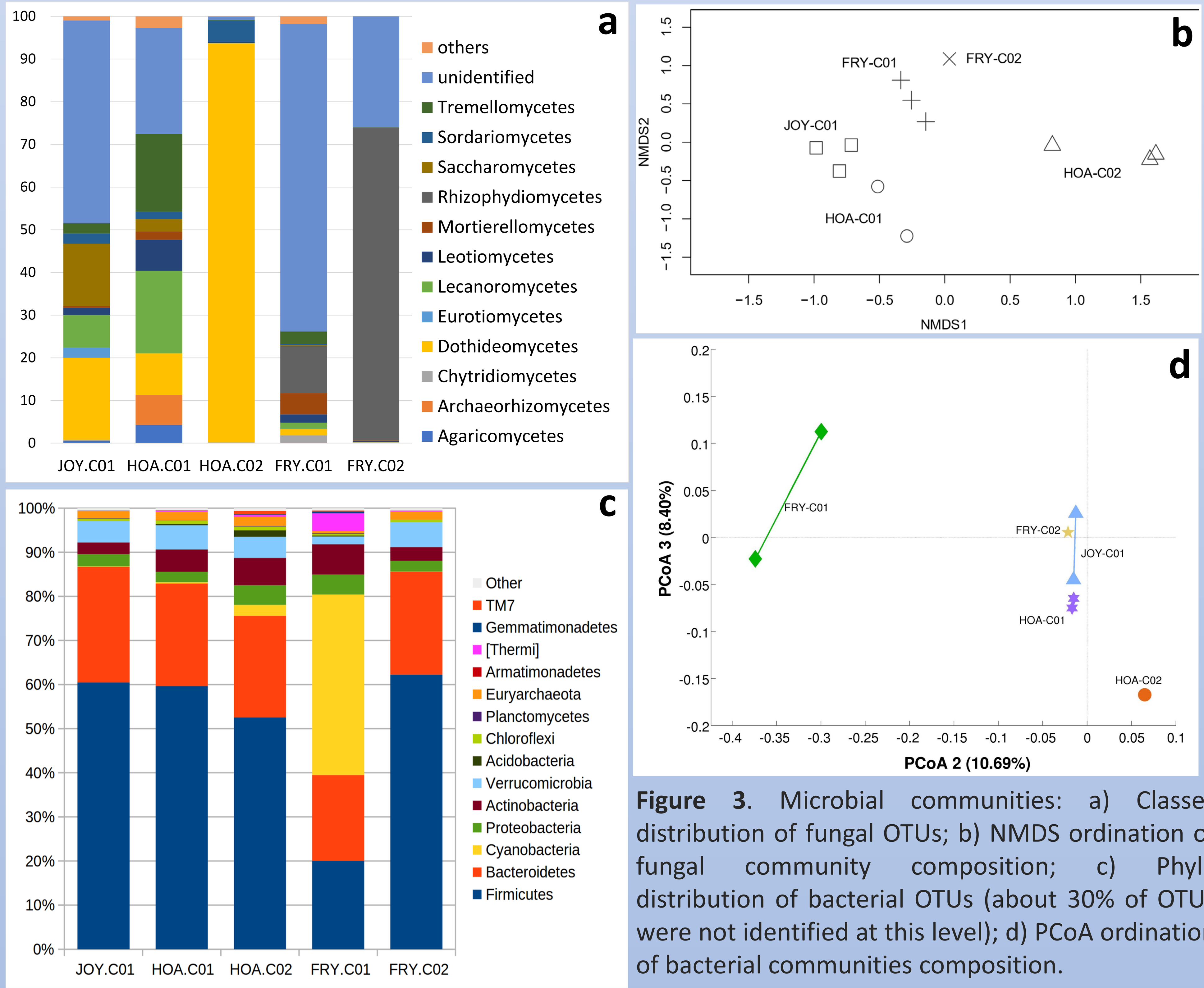

Figure 3. Microbial communities: a) Classes distribution of fungal OTUs; b) NMDS ordination of fungal community composition; c) Phyla distribution of bacterial OTUs (about 30% of OTUs were not identified at this level); d) PCoA ordination of bacterial communities composition.

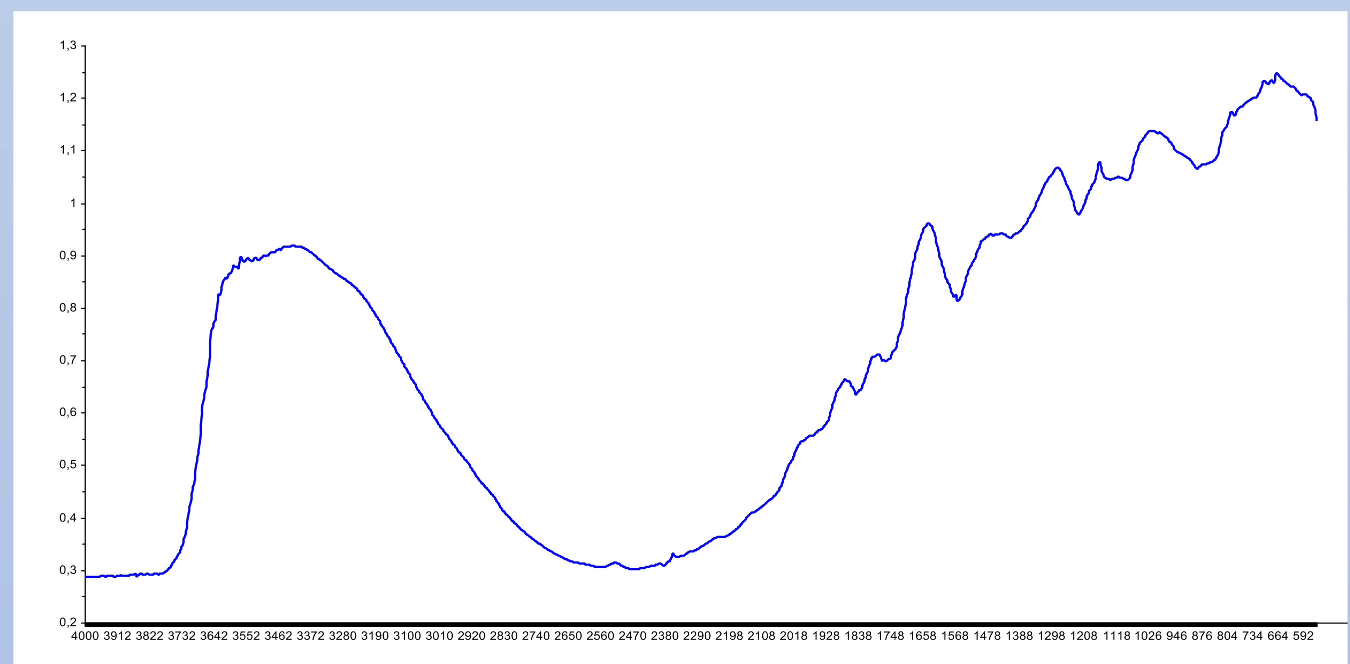

Figure 4. Example of a FTIR spectrum (Lake Fryxell C01 sample).

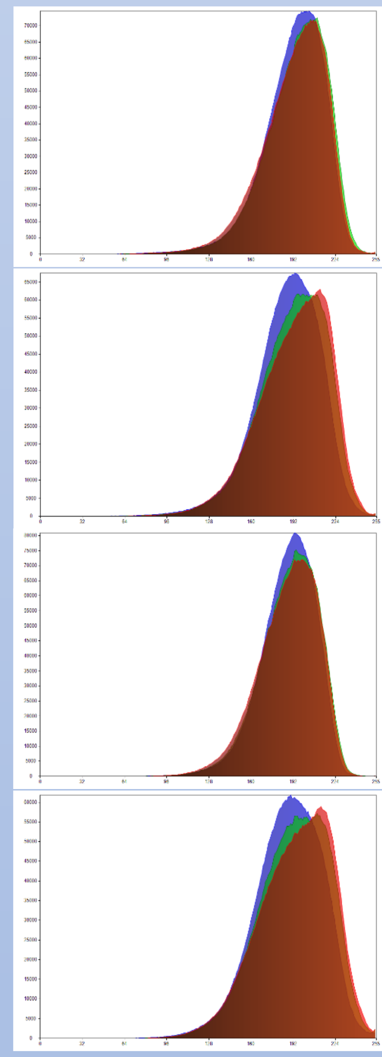

Figure 5. Example of RGB components distributions (Lake Fryxell C01 sample).

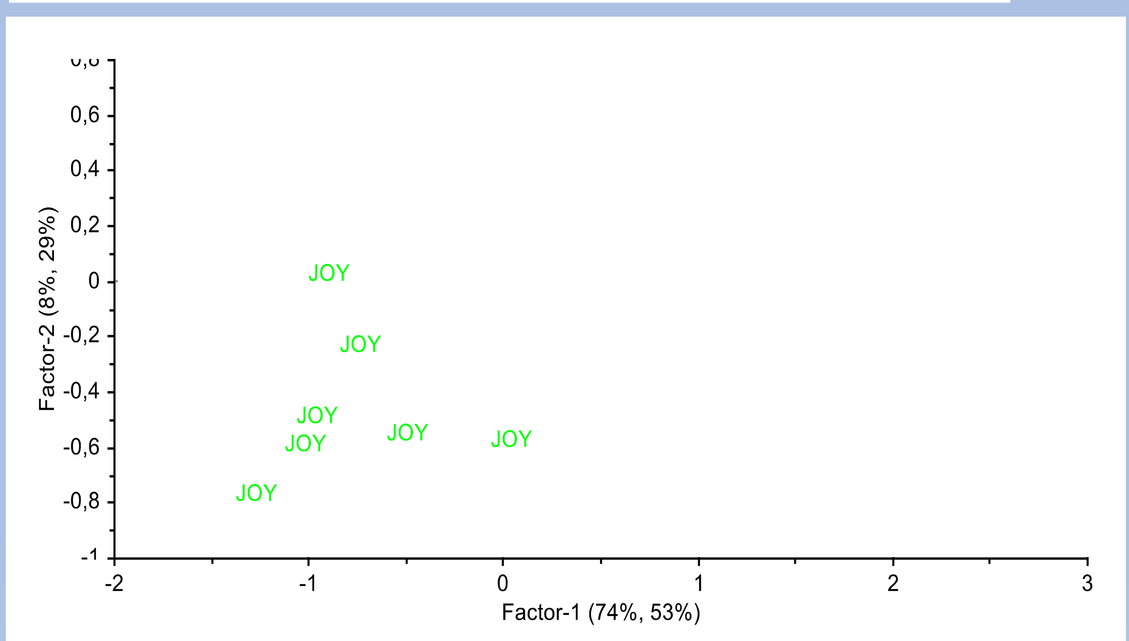

Figure 7. Score plot from PLS regression between the FTIR spectra and the Chroma in CIE L*C*h color model with D65 (daylight) illuminant, observer at 10°.

RESULTS

The metabarcoding analyses of soil samples from MDVs showed a diversity higher than expected, with 21987 and 292 OTUs for Bacteria and Fungi respectively, and richness ranging from 2962 to 4859 OTUs and from 7 and 122 OTUs, respectively. The composition of the communities resulted well differentiated (fig. 3). In particular, at class level, the second sample of Lake Hoare was the most differentiated for Fungi, while at phylum level the first sample of Lake Fryxell was the most different for Bacteria. For fungal communities, we highlighted a dominance of saprotrophic and lichen forming organisms in all samples. These data on fungal and bacterial communities diversity and composition will be related to the edaphic characteristics (data not shown), the FTIR spectra (fig. 4), the soil colorimetric data (fig. 5), and the laser induced fluorescence spectra of soil pigments (fig. 6). Preliminary analyses showed a strong correlation between the FTIR spectra and some soil colorimetric indices, suggesting these latter as good predictors of soil chemical characteristics (fig. 7).

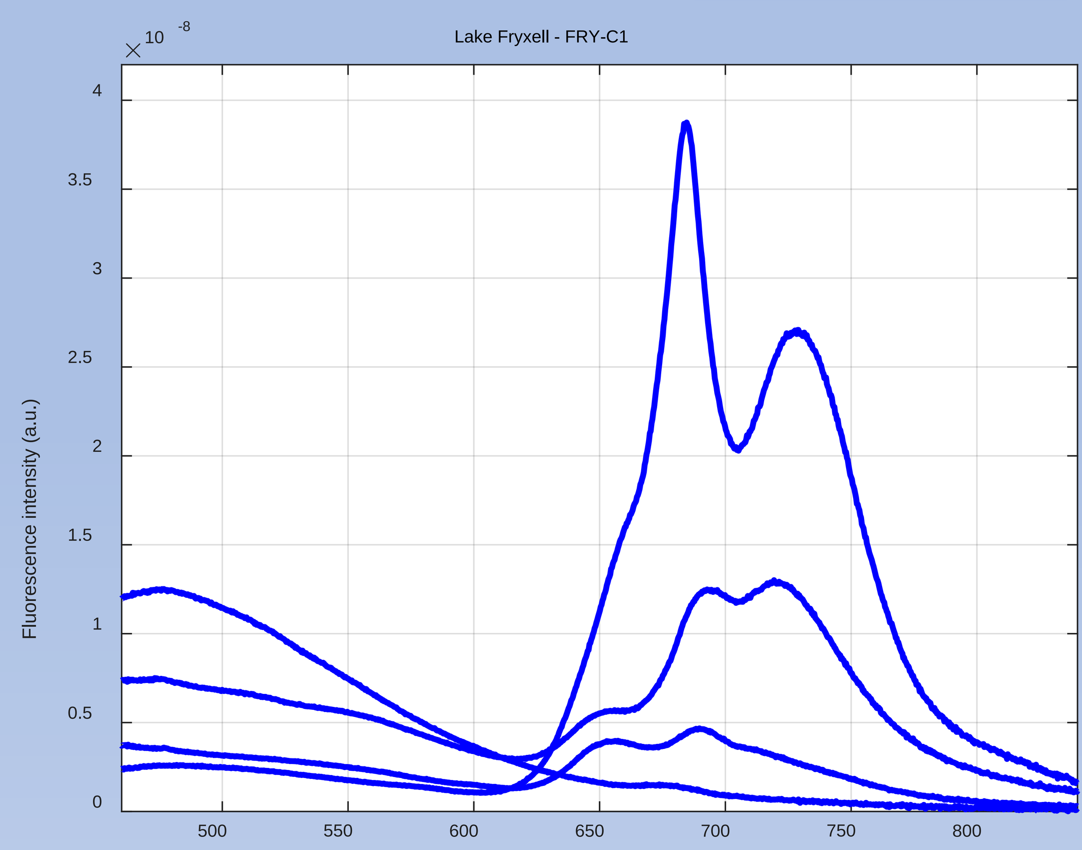

Figure 6. Laser-induced fluorescence spectra (Lake Fryxell C01) showing the typical fluorescence bands of chlorophyll (680&730 nm) and phycocyanin (660 nm).

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