



Microbial life in volcanic/geothermal areas: how soil geochemistry shapes microbial communities

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Extreme environments, such as volcanic/geothermal areas, are sites of complex interactions between geosphere and biosphere. Although biotic and abiotic components are strictly related, they were separately studied for long time. Nowadays, innovative and interdisciplinary approaches are available to explore microbial life thriving in these environments. Pantelleria island (Italy) hosts a high enthalpy geothermal system characterized by high CH₄ and low H₂S fluxes. Two selected sites, FAV1 and FAV2, located at Favara Grande, the main exhalative area of the island, show similar physical conditions with a surface temperature close to 60°C and a soil gas composition enriched in CH₄, H₂ and CO₂. FAV1 soil is characterized by harsher conditions (pH 3.4 and 12% of H₂O content); conversely, milder conditions were recorded at site FAV2 (pH 5.8 and 4% of H₂O content). High methanotrophic activity (59.2 nmol g⁻¹ h⁻¹) and wide diversity of methanotrophic bacteria were preliminary detected at FAV2, while no activity was detected at FAV1⁽¹⁾. Our aim was to investigate how the soil microbial communities of these two close geothermal sites at Pantelleria island respond to different geochemical conditions. Bacterial and Archaeal communities of the sites were investigated by MiSeq Illumina sequencing of hypervariable regions of the 16S rRNA gene. More than 33,000 reads were obtained for Bacteria and Archaea from soil samples of the two sites. At FAV1 99% of the bacterial sequences were assigned to four main phyla (Proteobacteria, Firmicutes, Actinobacteria and Chloroflexi). FAV2 sequences were distributed in the same phyla with the exception of Chloroflexi that was represented below 1%. Results indicate a high abundance of thermo-acidophilic chemolithotrophs in site FAV1 dominated by *Acidithiobacillus ferrooxidans* (25%), *Nitrosococcus halophilus* (10%), *Alicyclobacillus* spp. (7%) and the rare species *Ktedonobacter racemifer* (11%). The bacterial community at FAV2 soil is dominated by the methanotrophs (~40% of the reads) *Methylocaldum gracile*, *Beijerinckia* sp. and *Methylobacterium* sp.. The Archaea assemblages are similar in both sites and dominated by the moderately thermophilic chemolithotrophic ammonia-oxidating candidate species *Nitrososphaera gargensis*, in the phylum Thaumarchaeota. Volcanic/geothermal activities represent a complex phenomenon, this shaping different and peculiar microbial niches even at adjacent sites. Lower pH, higher water, NH₄⁺ and H₂ content are probably the discriminating factors that prevent methanotrophy at FAV1 and favor chemolithotrophy. Site FAV2 hosts an extraordinary diversity of methanotrophs due to large supply of CH₄, scarce presence of inhibitors of methanotrophy (H₂S and NH₃) and slightly acidic soil pH. This study integrates geochemical and biological information to move a step ahead in the still scarce knowledge on the complex ecology of microbes living in geothermal sites and their interactions with the geosphere.

⁽¹⁾Gagliano et al., 2014 Biogeosciences, 11, 5865–5875