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Geochemical, geophysical and biological features of Black Point shallow hydrothermal vent at Panarea island (Italy)

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Shallow Hydrothermal Vents (SHVs) are fluid emission spots in which water dynamics are characterised by interactions between seawater and free gas due to low hydrostatic pressure. This characteristic marine environment represents a peculiar natural laboratory where the study of geo-biological conditions needs a multidisciplinary approach to better understand the extreme ecosystem dynamics.

Although many studies have been already performed on physical-chemical conditions, analysing major chemical species, just a few studies have adopted multidisciplinary approaches, giving a broader and more detailed view of the observed phenomenon.

We propose a multidisciplinary study carried out in the period May-August 2022, based on the geophysical, geochemical and biological analysis of Black Point (23m b.s.l.), a hydrothermal spring belonging to the system located at about 2 miles off the coast of Panarea island (Aeolian Archipelago, Italy). Here a multiparametric seafloor observatory is installed (IPANEMA Project funds), equipped with chemical-physical sensors, a hydrophone and a seismometer. The area is periodically monitored by scientific divers performing discrete geochemical sampling, in addition, acoustic radiation studies are regularly conducted close to the emission, to characterise their acoustic signatures and peculiarities in turn. The gained expertise has led to the development of custom algorithms to perform spectral analysis of the acoustic features.

Comparing the variation of the flux, investigated through the inversion of acoustic energy (radiated in the band [35 - 55] Hz likely associated with the mass flux variation), with fluctuations related to the environmental seafloor temperature, both series exhibit synchronous relative maxima over the investigated period.

Coupling these trends with geochemical and biological variations in terms of Minor, Trace elements and Rare Earth Elements (REEs) concentrations and in the microbial community, simultaneous variations have been highlighted as well.

In detail, the highest concentrations of minor elements (Al, Fe, Mn), trace elements (As, V) and REEs

correspond to spectral energy and temperature peaks. Moreover, pH is inversely correlated to Fe, Al and Mn, indicating its role in dissolution/precipitation of Fe, Al and Mn oxy-hydroxides; inversely, REEs are positively correlated to Fe, Al and Mn indicating the role of the oxy-hydroxide ligands in fractionation of these elements, as a consequence, REEs patterns shapes show LREE depletion (Lan/Ybn < 1).

Furthermore, the composition and diversity of microbial communities were investigated by extracting metagenomic DNA from different matrices (vent fluid, marine sediment near the vent and seawater at a short distance from the vent) and through the next-generation sequencing of a bacterial marker gene (16S rRNA gene). The results show significant differences in the microbial community between the samples and in the two samplings (May and August), especially in the fluid vent. These results are in accordance with the geochemical flux variations and the seafloor temperature, suggesting that each sample carries its specific bacterial fingerprint and the microbial community changes depending on the physicochemical conditions.

This study confirms the importance of a multidisciplinary approach as the key to highlight different features of SHVs and how geo-biological fields are strictly linked in extreme environments.