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Constraining geochemistry and biological primary productivity in hydrothermal systems via in situ mass spectrometric geochemical mapping

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Hydrothermal vent ecosystems are biological hot spots, supported by chemoautotrophic primary productivity and achieving densities comparable to rainforests. Nevertheless, our understanding of the geochemical factors that govern the distribution of animals and microbes within vents is limited. It is well known that vent endemic organisms are found in specific vent “microenvironments”, and that these microenvironments are distributed –coarsely speaking- in predictable patterns within a vent field. However, the relative differences in activity among these faunal patches, and their role in influencing geochemical flux remains largely unknown due to historical limitations in our ability to sample and quantify geochemical constituents with fine spatial resolution. In particular, the distribution of biologically important volatiles around vent fields is poorly constrained, as is the degree to which their distribution influences the destiny and distribution of organisms. To characterize the relationship between the distribution of volatiles, chemosynthetic microbes, and chemosynthetic symbioses, we generated detailed geo-referenced maps of methane, hydrogen sulfide, carbon dioxide and oxygen (four of the key volatiles that are both vent- and seawater derived) using an in situ mass spectrometer (ISMS). We characterized these concentrations in over 130 spots across three vent sites associated with the mid-Atlantic ridge in the Menez Gwen vent field. We quantified gases in sites ranging from hot fluids to mussel beds, and found notable relationships between the distribution and consumption of hydrogen sulfide and methane and the animal and microbial communities. Finally, we also developed a metabolic energy “map”, which enables us to constrain both the potential energy that is available to these communities as well as the extent to which it is being used, and places constraints on the extent of primary production that can be supported by the realized use of these volatiles.