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Fossil bivalves in the Rainbow area: new insight into the diversity and evolution of chemosynthetic communities.

Franck Lartaud (1,2), Marc de Rafelis (2), Crispin Little (3), Germain Bayon (4), Benoît Ildefonse (5), Jerôme Dyment (6), and Nadine Le Bris (1)

(1) UPMC Univ Paris 06, CNRS FRE 3350, Lab. Ecogéochimie des Environnements Benthiques, Banyuls-sur-mer, France (franck.lartaud@obs-banyuls.fr), (2) UPMC Univ Paris 06, UMR 7193, ISTeP, Lab. Biominéralisations et Environnements sédimentaires, Paris, France, (3) School of Earth and Environment, University of Leeds, Leeds, UK, (4) Département Géosciences Marines, Ifremer, Plouzané, France, (5) Université Montpellier 2, UMR 5243 Géosciences, Montpellier, France, (6) Institut de Physique du Globe de Paris, Géosciences Marines, Paris, France

Hydrothermal circulation at ultramafic-hosted sites supports a large variety of high- and low-temperature hydrothermal vents and associated ecosystems. Along the Mid-Atlantic Ridge (MAR), different types of habitats for chemosynthetic-based organisms have been identified in a serpentinization context, e.g. the high temperature vents at Rainbow and Logatchev, and the low temperature, off-axis Lost City vents. Each displays a certain degree of isolation and endemic taxa. Much remains to be understood about the temporal dynamics and biogeography of these communities over geological time scales.
During the MOMARDREAM_08 cruise, numerous dead bivalve shells and associated carbonates were dredged from close to the active Rainbow vent field (36°N). These fossils point to past hydrothermal activity on top of a heavily sedimented ultramafic structure, 2.5 km east of the Rainbow field (site Clamstone) at $\sim$25 kyr, and on the slope of the same structure, 1.2 km north-east to Rainbow field (site Ghost City) at $\sim$110 kyr.
The younger site is characterized by abundant shells of the vesicomyid bivalve genus Phreagena, previously unknown from the MAR, distributed over a large area and associated with rarer specimens of the thyasirid bivalve Thyasira. The shell isotopic signatures of the burrowing species Thyasira suggest an exposure to 13C-depleted sediment pore water DIC, resulting from methane oxidation. Conversely, Phreagena shells are enriched in 13C, more consistent with a higher contribution of seawater derived DIC at the sediment-water interface.
At the older site, Ghost City, specimens of the mussel Bathymodiolus aff. azoricus are abundant and co-occur with a few specimens of Phreagena and Thyasira. The low δ13C values in the Bathymodiolus shells from Ghost City also suggest a contribution of depleted DIC from oxidized methane. Furthermore, several mineralogical evidences suggest that low-temperature serpentinization metal-depleted and alkaline fluids similar to Lost City fluids would fuel these dense high biomass assemblages. The carbonate pieces enclosing the mussel shells at this site are morphologically similar to those described at Lost City, depleted in metal sulphides characterizing high temperature mineral deposits, and contain mineralogical features that might be associated with methane and hydrogen rich alkaline fluids.
These chemosynthetic communities were present on the MAR for at least 110,000 years, with abundance and diversity significantly different from the living vent communities at Rainbow, Lost City or Logatchev.
Ultramafic hosted hydrothermal circulation makes available a range of electron donors, such as methane, sulphide, and possibly hydrogen, to autotrophic symbionts in a wide variety of different habitats both on sediment cover and mineral hard substrates. Our results confirm that diverse chemosynthetic species, from both vent and seep genus, can form high biomass assemblages in these various habitats (not only high temperature ones). Owing to their expected widespread spatial distribution and their geochemical diversity, low temperature serpentine-hosted habitats might have played, therefore, a major role in the ability of chemosynthetic fauna to disperse over ocean basin scales.