Lyell Meeting 2014: Deep-sea chemosynthetic ecosystems: where they are found, how they work and what they looked like in the geological past.

The Geological Society, Burlington House, London
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The discovery of hydrothermal vents astounded scientists during the late 1970s, who as well as finding an entirely new type of ecosystem with vast abundances of a novel fauna, uncovered another chapter in the story of life on our planet: life through chemosynthesis. This revelation sparked a massive research effort to explore, catalogue, and understand the chemosynthetic organisms dependant on hydrothermal vents, as well as those of the more recently discovered methane seeps and organic falls. This one-day meeting was held within the majestic surrounds of Burlington House in London, and featured a multi-disciplinary array of speakers covering the realms of deep-sea biology, ecology, biogeochemistry, ore mineralogy, palaeontology and astrobiology, to look into what we currently know about deep-sea chemosynthetic ecosystems.

Proceedings began with a talk by **Jonathan Copley** (University of Southampton, UK) outlining why we need to go beyond the notion of biogeography in order to understand the ecology of hydrothermal vent ecosystems. Vent faunas are globally partitioned into distinct biogeographical provinces, however these patterns are frequently disrupted by situations where the expected is not observed. Because of this, Jon suggested that perhaps we need to move towards a new system to characterise the distinctiveness of vents, one which takes into account functional zonation of organisms relating to their different trophic approaches. Following this, **Nadine Le Bris** (Université Pierre et Marie Curie, France) provided a perspective on hydrothermal vents as a mosaic of microhabitats shaped by chemistry, whereby vent habitat is essentially a mixing zone with steep gradients which structures vent communities on both spatial and temporal scales. Successional patterns have also been characterised by the study of seafloor eruptions, showing that over time, a species can outcompete another for optimal access to resources. **Richard Herrington** (Natural History Museum, UK) then drew attention to the economic importance of hydrothermal vent deposits and the recent interest in mining these in the deep-sea, which led to a discussion into why we would want to mine the deep-sea when plenty on-land analogues of these systems remain.

Marina Cunha's (Universidade de Aveiro, Portugal) talk on the biogeography of cold seep faunas outlined that seeps also exist within a heterogeneous geochemical environment and can thereby exhibit great variability even on small spatial scales. Like with hydrothermal vents, this leaves seep biogeography difficult to decipher, and Marina suggested that perhaps we need to look at all chemosynthetic habitat types together as the same factors shape their ecology. **Jörn Peckmann** (University of Vienna, Austria) then described how the biogeochemistry of ancient seeps can be resolved, through the use of isotopes and molecular fossils such as lipid biomarkers. These studies have revealed that the anaerobic oxidation of methane, a major process occurring within modern seeps which results in carbonate deposition, is at least 300 million years old.

One very exciting recent discovery is the finding by **Jillan Petersen** (Max Plank Institute for Marine Biology, Germany) and others that as well as hydrogen sulphide and methane, the symbionts of vent animals can also use hydrogen to fuel chemosynthesis. Jillian informed delegates that hydrogen use for energy is emerging to be widespread among vent animals, and that even asphalt may be being employed as an energy source. Following this, **John Taylor**'s (Natural History Museum, UK) overview of chemosynthesis in bivalves revealed that chemosynthetic bivalve groups have evolved on at least eight separate occasions and bear a great diversity of symbionts, owing to the incredible plasticity of their gill tissues.

Whether whale-falls act as ecological and/or evolutionary stepping stones for the dispersal of deep-sea fauna was discussed by **Adrian Glover** (Natural History Museum, UK), who revealed that the use of organic falls for this purpose varies between different chemosynthetic animal groups, and within different polychaete lineages too. **Steffen Kiel** (Universität Göttingen, Germany) then offered a window into the deep-sea chemosynthetic communities of the past: when catshark eggs were laid at the base of tubeworm thickets 120 million years ago, and giant brachiopods occurred in vast numbers but mysteriously disappeared during the Cretaceous.

The final talk of the meeting expanded the search for chemosynthetic ecosystems to outer space, with **Monica Grady**'s (The Open University, UK) review of the best celestial candidates for housing chemosynthetic life. Jupiter's moon Europa shows evidence of convection in the liquid layer below its surface, however any mission to investigate whether this convection could be fuelling chemosynthetic life would first need to overcome the obstacle of breaking through Europa's thick icy surface.

This meeting was an exciting and inspiring venture through the outstanding scientific achievements of deep-sea chemosynthetic ecosystems research to date, with plenty of time for networking and socialising between friends and collaborators united in the study of these remarkable habitats. With the first major project to mine seafloor massive sulphide deposits now moving towards production phase, and the beginnings of gas extraction from methane hydrates, furthering understanding of how these ecosystems may respond to change, as well as how extraction operations should be managed to minimise negative effects, are vital research directions for the future.

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