Carbon sources and cycling in chemosynthetic ecosystems of the Southern Ocean

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Project outline

When marine organisms die they sink, and some of their organic matter is deposited in sea floor sediments. Understanding the fate of that organic matter is important because long term burial of organic matter is a way of removing carbon from the atmosphere and locking it away. Also, most ecosystems on the ocean floor depend entirely on such sinking organic matter as their food source

Southern Ocean Polychaete

At hydrothermal vents, heated seawater containing dissolved metals and reduced species comes into contact with the seafloor, and unique and interesting suites of microbes have evolved, which can synthesise organic matter from the chemical energy in these hydrothermal fluids. This process, known as chemosynthesis, means that organisms living near to hydrothermal vents have two sources of food; sinking organic matter, and bacteria producing new organic matter at the seafloor.

Hydrothermal vents and chemosynthesis are fairly newly discovered, and we do not yet know which microbes are involved in the production and decay of organic matter. Further, many other organisms live in hydrothermal sediments, and we do not know what types of organic matter they feed on, or how they are arranged in food webs. Finally, we do not know how different types of organic matter (that from the ocean surface and that produced at the sefloor) are cycled and buried in these settings.

This project aims to fill these gaps in our knowledge. To this end, experiments were conducted at diffuse hydrothermal vent sites in the Southern Ocean. Sediment cores were collected, and isotopically labelled algal detritus and chemosynthetic substrates were added to them aboard the ship. The cores were then incubated at seafloor temperature for several days, during which their normal microbial and animal activity continued. At the end of the experiments, samples of sediment, water and animals were preserved. Experiments were conducted at three chemosynthetic sites (two diffuse hydrothermal and one methane seep), as well as one normal deep ocean site. In addition, sediment samples were collected from all sites for identification and quantification of the faunal communities living in the sediment.

This project will involve analysing the samples collected, in order to find identify what types of fauna inhabit Southern Ocean chemosynthetic sites, what they feed on, and how they influence seafloor C-cycling and burial. This will be achieved by extracting and examining the fauna, and then analysing those from experiment for their isotopic compositions. In addition analyses will be conducted for isotopic labels in water samples and in bacterial biomarkers, and thus quantitative C budgets will be constructed and modelled.

Benefits

The successful student will benefit from being part of the River Basins and Processes Management research cluster in the School of Geography and part of Water@leeds. Training at Leeds deals fully with the elements described in the Joint Research Centre statement on skills training for research students. PhD students take modules provided by the staff development unit (e.g. starting your PhD, small group teaching) and a faculty-training course (covering elements such as planning, critical reading and writing, oral presentations, writing research papers). Students present results and receive constructive feedback from peers in a Research Support Group, from colleagues in the River Basins research group, and at a university postgraduate research day.

The nature of the project means that the student will be trained in project specific research methods including macroinvertebrate identification, preparation of samples for isotopic and lipid biomarker analysis, and applied statistics for analysing biological data, both internally and at external workshops. An additional important part of the training will be to attend national and international conferences (e.g. European Geosciences Union, American Society for Limnology and Oceanography) to present results and gain feedback. The student will be encouraged to submit papers for publication during the project.

Requirements

Applicants should have a minimum of a good 2:1 undergraduate degree in environmental science, oceanography, physical geography, geology, or marine biology, or a degree in a fundamental science such as chemistry or biology, plus evidence of interest in environmental topics.

Funding

Suitably qualified applicants may be considered for full-time funding for this project (where eligible) from a range of sources including NERC, departmental and university sources. Self funded students are also welcome to apply for the project. Information on how to apply and funding deadlines can be found on the School's website
http://www.geog.leeds.ac.uk/study/phd/apply.html