Hotspot ecosystem research and man's impact on European seas

Professor Philip Weaver, coordinater of HERMIONE, discusses some of the key aspects of the project and how it differs from its predecessor, the high profile and highly successful HERMES project

The HERMIONE project sets out to investigate ecosystems at critical sites on Europe's deep ocean margin. Where are these sites of study and why have they been selected?

The project is based around five ecosystems – open slopes and deep basins, submarine canyons, seamounts, cold-water coral reefs, and chemosynthetic environments. HERMIONE study sites are distributed from the Arctic to the Iberian margin and from the mid-Atlantic ridge to the eastern Mediterranean. The sites were selected to encompass a range of environmental influences and ecosystem types. For example, the Arctic Ocean is an area of the world's seas that is thought to be one of the most vulnerable to climate change. The Arctic Ocean study sites were chosen to investigate the potential impacts of climate change on deep sea communities, and on methane-hydrate deposits and their associated communities.

HERMIONE follows on from the Hotspot Ecosystem Research of the Margins of European Seas (HERMES) project which ended in 2009. In what ways does HERMIONE differ in focus to its predecessor?

The HERMES project was able to bring together scientists from a wide range of disciplines, and succeeded in integrating deep sea ecosystem research across Europe. It was a highly successful project that achieved international recognition and gathered a large amount of information on ecosystem distribution and functioning. By reorienting the scientific objectives, HERMIONE is steering the research to outcomes that are highly relevant to current issues. The project places a strong emphasis on assessing the impacts of climate change and human activities on deep sea ecosystems, and by including socio-economists and science policy researchers in the interdisciplinary team, it is aiming to create stronger links between scientific research and science policy.

Can you explain what the HERMIONE GIS portal is and the role it plays for the partners involved?

The HERMIONE GIS portal is an online Geographical Information System tool that enables the visualisation of scientific datasets collected during HERMES and HERMIONE cruises, in combination with published results. Through the archiving of collected data, HERMIONE is creating a fully searchable deep sea ecosystems database (hosted by the World data centre PANGAEA), which is visualised through this portal. The portal displays these data, such as topography, geology, sample locations and habitat type, as a series of layers in a map. This visualisation enables datasets to be integrated and supports a wide range of uses, from allowing easier interpretation of data for both scientists and policy makers, to the planning of upcoming cruises, and the creation of more accessible dissemination products.

How are your results communicated and who are they primarily aimed at?

The communication of scientific results from HERMIONE takes place on several levels and is aimed at the general public, non-specialist end-users such as policy makers, and the wider marine scientist community. The HERMIONE website contains a 'learning' section specifically aimed at the general public to raise awareness of deep sea ecosystems and the threats that they face, while also providing access to higher-level scientific information for scientists and policy makers. Additionally, the website has regular news updates and cruise blogs from current and past HERMIONE research cruises, and provides access to the more than 50 scientific publications in peer-reviewed journals arising from the project so far.

What sort of results are you expecting to achieve by the end of the project's duration?

Several television, radio and newspaper interviews on HERMIONE results have already been produced. In our first year, we have also published 46 papers and have a number of PhD students working on project related research, so we are already making a large impact.

Key results to be delivered include a benchmark assessment of the evidence for the impacts of climate change in Europe's deep seas, and a report on the observed long-term changes in deep sea biological communities. One of the themes cross-cutting HERMIONE research specifically addresses anthropogenic impacts in the deep sea, of which marine litter is an important component. Litter has long been observed by scientists in the deep sea, but prior to the start of HERMIONE there was no standard procedure for logging or categorising observations. A protocol for the qualification and quantification of litter in the deep sea has now been developed by HERMIONE scientists, allowing accurate interpretation of the scale of this impact, which will feed into one of the project's key deliverables: a policy brief on the evidence of anthropogenic impacts in European deep seas.

Delving into the deep

HERMIONE is a new three year EC funded project looking into the functioning and importance of deep sea ecosystems. The findings are expected to inform future science policy in Europe and beyond

THE DEEP SEA covers 70 per cent of the Earth's surface and remains largely unexplored. Over the years it has sparked the imagination of some of the greatest authors, poets, artists and scientists. Recently, this mystery and intrigue has been compounded by the regular discovery of bizarre creatures found using deep sea Remote Operated Vehicles (ROVs).

These findings have served to inspire the public and scientific communities, yet the depths have a greater significance to humanity and the planet. Since 96 per cent of the planet's life-sustaining water is contained in these areas it should come as little surprise that they are absolutely essential to supporting the global biosphere and ecosystem. The deep sea contributes to global biogeochemical cycles which support life on Earth. These areas are home to marine organisms that form the basis of the global ecosystem.

But whilst it is known that the deep sea is important to life, this importance is little understood. One project which recently attempted to tackle the knowledge gap was HERMES (Hotspot Ecosystem Research on the Margins of European Seas), funded by the European Commission. Investigating the diverse European deep sea margins, this four year project ended successfully last year. In total, 50 research organisations, universities and small businesses from around Europe and neighbouring countries contributed to the research programme. Over 100 PhDs were completed as part of the project and more than 100 scientific papers were published. Additionally, the project created a groundswell of interest in deep sea scientific exploration when HERMES researchers discovered the first ever multi-cellular animals that can survive without oxygen, changing the way in which we view life on Earth.

HERMIONE: DAUGHTER OF HERMES

Great strides were made during HERMES, yet not only did many questions remain unanswered, but others were born. One of the biggest questions which HERMES dredged up was that of the impact man has had on the deep oceans, and how this affects the global ecosystem.

Attempting to answer this and a number of other significant questions, HERMIONE (Hotspot Ecosystem Research and Man's Impact On European seas) starts where HERMES left off. The Project Coordinator of HERMIONE, which is a three year initiative, is Professor Philip Weaver. He explains what the researchers hope to achieve: "The project aims to improve understanding of sea-floor ecosystems at critical sites around Europe's deep ocean margin". Moreover, HERMIONE aims to uncover how these ecosystems interact with human activities such as fisheries and oil production, and how these human activities affect the ocean-floor ecosystems. "Evidence of climate change and human activities has already been observed in these seemingly remote areas," remarks Weaver, noting why these studies are so important. Indeed, the project findings suggest that litter, chemical contamination and overfishing are having a noticeable impact on marine ecosystems.

HOTSPOTS

HERMIONE researchers will focus on several 'hotspot' ecosystems around Europe's sea margins. A 'hotspot' supports large numbers of species and/or great species diversity and is therefore an important area in supporting marine life. Following on from the HERMES hotspots, researchers will continue to study submarine canyons, open slopes and basins, coldwater coral reefs and chemosynthetic environments. The latter is of particular interest because it is where organisms use oxidation of inorganic molecules or methane as a source of energy, instead of sunlight.

In addition to these hotspots, HERMIONE researchers will also look at seamounts – which are mountains rising from the ocean seafloor that do not break the surface – and hydrothermal vents – where geothermally heated water is emitted from fissures caused by tectonic plate movements.

INVESTIGATING THE DEEP BLUE SEA

HERMIONE scientists will spend over 1,000 days at sea on more than 50 research expeditions around Europe. These expeditions will be equipped with the latest technology to measure, map and study the structure of these hotspot ecosystems.

For example, our view of biological processes in canyons has changed considerably in the last few years due to increased use of submersibles and ROVs and other video-guided technologies. It has become obvious that there is great diversity in canyon fauna since there is a wide diversity in canyon environments. Many aspects of their ecological role and contribution to the whole deep-sea ecosystem functioning remain however unexplored. The diversity of canyon systems makes it difficult to reach generalisations that will be useful in creating policies for whole ecosystem management, without: 1) a comparison of canyons from different biogeochemical provinces and

LANDER RECOVERY

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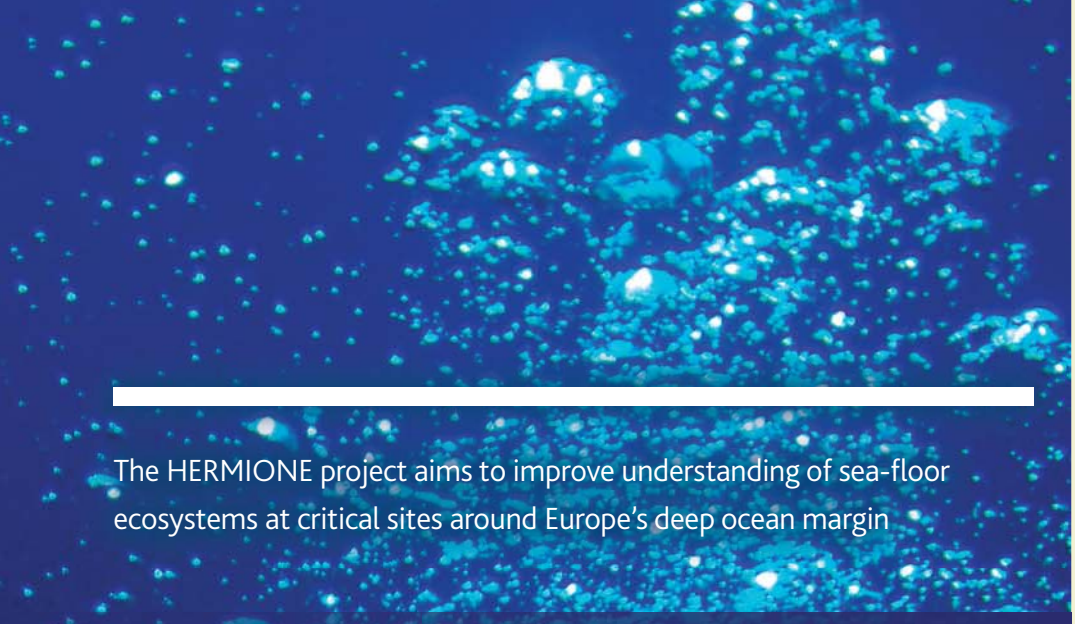

The HERMIONE project aims to improve understanding of sea-floor ecosystems at critical sites around Europe's deep ocean margin

topographic settings; 2) coordinated, interdisciplinary projects relating the fauna to environmental variables regulating their distributions; 3) surveys taking into account, natural or anthropogenic factors, that disturb life in canyons. Professor Weaver is in no doubt of the wider impact of this research: "These unique ecosystems need investigation and protection because of their fragility to pollution and disturbance e.g. through bottom trawling," he asserts.

COMBINING DISCIPLINES

Getting a full picture of how submarine ecosystems function is an incredibly complex process involving numerous disciplines. Biologists, ecologists, microbiologists, biogeochemists, sedimentologists, physical oceanographers, modellers and socio-economists are all involved in the project. This highly interdisciplinary approach is necessary to understand the biodiversity, adaptations, interconnections and biological capacities of these environments.

For example, the study of just one ecosystem requires the relationships between multiple components to be examined, as Weaver elucidates: "The behaviour of a fish or location of a cold-water coral reef cannot be explained by purely biological observations, but needs input from, say, scientists studying ocean currents, sediment mobility and water properties such as nutrients and oxygen".

However, collaboration extends beyond individual researchers or individual organisations. HERMIONE is intrinsically linked to HERMES researchers as well as a number of other European and international projects, including The Deep-Sea and Sub-Seafloor Frontiers project (DS3F) which provides a pathway towards sustainable management of oceanic resources on a European scale (see following article, pages 76-8) and the Global Ocean Biodiversity Initiative project (GOBI).

DISSEMINATION AND LEARNING

Researchers behind HERMIONE are aiming to communicate their deep sea findings to three major communities both in Europe and worldwide:

• The Scientific Community

Project researchers are archiving and publishing their data on the open source Geographical Information System (GIS) PANGAEA, which acts as an online library for Geoscientific & Environmental data

• The General Public

Non-specialists will get to learn about HERMIONE research through exhibitions and displays at four aquaria in the UK, Greece and Italy. In addition, project leaders are developing online resources, including a website with a dedicated area for the general public

• Policy makers

As is always the case with scientific research, transferring sound findings into political changes is a difficult task. The project does however have a team dedicated to providing accurate information to science policy makers, as Weaver explains: "A science-policy panel (SPP) has been set up. Socio-economists within HERMIONE use this SPP to ensure that accurate and reliable scientific data is provided".

GAUGING SUCCESS

With such a large project, involving considerable funding and multiple research partners, gauging whether HERMIONE is achieving its aims is important. "Success will be measured in the number and quality of the scientific papers, in the strength of the links to policy makers, in the response of the public to our presentations in the aquaria and in the number of PhD students we train," explains Weaver.

Those behind the project hope that this multi-pronged approach both to growing the research field, and dealing with how the results of HERMIONE are used, will mean that issues surrounding the human impact on the deep sea will become both public and political.

INTELLIGENCE

HERMIONE

HOTSPOT ECOSYSTEM RESEARCH AND MAN'S IMPACT ON EUROPEAN SEAS

OBJECTIVES

HERMIONE investigates the functioning of deep-sea ecosystems in European waters, many of which are being affected by climate change and impacted through fishing activities, seabed installations and pollution. Ecosystems include cold-water corals, canyons, cold and hot seeps, seamounts and open slopes/basins. The project provides a discussion platform between scientists, stakeholders and the public.

CONSORTIUM

38 partners from 14 countries

FUNDING

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EC Contribution: 7 998 955 euros

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PROFESSOR PHILIP WEAVER is a Professor at the National Oceanography Centre, Southampton, with 30 years experience in marine science working on sediment transport in the deep-sea and latterly on biosphere geosphere interactions. He has coordinated a number of EU projects that have investigated deep-sea ecosystems, including policy advice. He currently coordinates the HERMIONE project that is investigating deep-sea ecosystems and Man's impact.