



HERMES

Hotspot Ecosystem Research on the Margins of European Seas

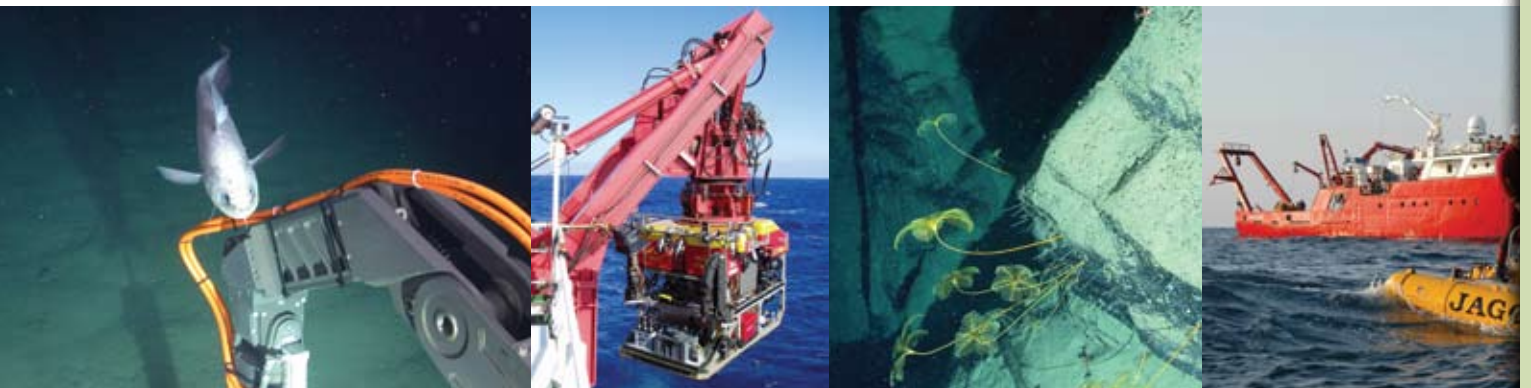
BY PHILIP P.E. WEAVER AND VIKKI GUNN

The European Commission (EC) sponsors research into Europe's continental margins because the marine environment is of critical importance to the European Union: 50% of Europe's territory lies offshore, 25 Member States have coastlines, and more than half of Europe's population lives within 50 km of the coast. Europe relies on the ocean for trade, food, resources, and jobs. The exploitation of the deep sea (beyond the continental shelf) is increasing through bottom trawl fishing and hydrocarbon exploration and production. However, the deep ocean environment is still poorly understood. The deep sea supports the largest biosphere on Earth, regulates climate, and contains vast natural resources. It is estimated that

around 90% of all known species live in the ocean and seas, but within this environment the seabed contains by far the highest biodiversity. There is a clear need to understand this environment and its role in Earth's system more fully and to regulate it for sustainable exploitation before it is too late.

Early in 2000, the EC stimulated marine scientists across Europe by talking of the possibility of a large, multimillion Euro project to investigate deep-sea environments. The Commission's Framework Six Programme, which began in 2002, provided the mechanism to fund such large multidisciplinary "Integrated Projects," and called for building communities of researchers that could focus not solely on research,

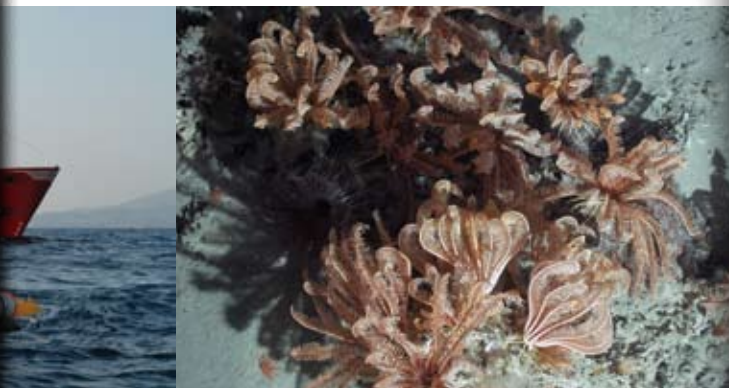
but also engage business partners and develop links to policymakers. The HERMES project emerged with 41 partners from research institutions and nine business partners from 17 countries across Europe and further afield (Box 1). Additionally, HERMES built strong links to intergovernmental organizations ranging from the United Nations Environment Programme (UNEP, which later became a project partner), to nongovernmental bodies such as the World Wildlife Fund (WWF), and to international initiatives such as the Census of Marine Life (CoML). The hydrocarbons company StatoilHydro also took a strong interest in the project, eventually leading to the company's provision of supplementary



funding for complementary studies attached to the main project.

The HERMES consortium was large enough to enable a fully interdisciplinary approach to ocean margin research, involving expertise in deep-sea biology, geology, physical oceanography, microbiology, and biogeochemistry. Subsets of HERMES researchers previously

Photos from left to right: An inquisitive visitor pays the ROV *Isis* a visit, 4300 m down in the Nazaré Canyon, offshore Portugal. *Image courtesy of NOCS/JC10.* Launching ROV *Isis* in the Gulf of Cádiz. *Image courtesy of NOCS/JC10.* Sea lilies adorn a rocky overhang at 3600 m in the Nazaré Canyon. *Image courtesy of NOCS/JC10.* The manned submersible JAGO in action in the Cap de Creus Canyon, Northwest Mediterranean Sea. *Image courtesy of CSIC.* Crinoids in the Whittard Canyon, Celtic margin. *Image courtesy of NOCS/JC10*



BOX 1: THE HERMES CONSORTIUM

National Oceanography Centre, Southampton, UK (Coordinator)
Institut français de recherche pour l'exploitation de la mer, France
Royal NIOZ, The Netherlands
University of Barcelona, Spain
Hellenic Center for Marine Research, Greece
IFM-GEOMAR, Germany
Consiglio Nazionale della Ricerche, Italy
Alfred Wegener Institute, Germany
University of Tromsø, Norway
National University of Ireland, Galway, Ireland
Friedrich-Alexander University Erlangen-Nuremberg
Universiteit Gent, Belgium
Consejo Superior de Investigaciones Científicas, Spain
Consorzio Nazionale Interuniversitario per le Scienze del Mare, Italy
Max Planck Institute for Marine Microbiology, Germany
Centre National de la Recherche Scientifique, France
Instituto Hidrográfico, Portugal
Jacobs University Bremen, Germany
University of Bremen, Germany
Cardiff University, UK
Institute of Marine Research, Norway
University of Gothenburg, Sweden
University of Southampton, UK
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Italy
University of Birmingham, UK
Netherlands Institute of Ecology, The Netherlands
University of Aberdeen, UK
University of Liverpool, UK
Doyuz-Eykul University Institute of Marine Sciences and Technology, Turkey
Scottish Association for Marine Science, UK
University of Aveiro, Portugal
GeoEcoMar, Romania
Intergovernmental Oceanographic Commission (UNESCO)
Université Pierre et Marie Curie, France
Université de Bretagne Occidentale, France
Institut Scientifique, Rabat, Morocco
Challenger Oceanic, UK
Volcanic Basin Petroleum Research, Norway
Praesentis, Spain
MEDIAN, Spain
MMCD, Germany
Olex AS, Norway
ArchimediX, Germany
Proteus, France
Jobin Yvon, France
Institute of Biology of the Southern Seas, Ukraine
P.P. Shirshov Institute, Russia
Moscow State University, Russia
Odessa National University, Ukraine
United Nations Environment Programme

worked together on projects such as EUROSTRATAFORM (geologists), BENGAL (biologists), and ACES (cold-water corals), to name but a few. However, such a broad multidisciplinary group had never before been brought together in one project. In addition to the marine scientists, socio-economists were engaged to bridge the gap between scientists and policymakers, and ecosystem modelers were included to work toward predictive models that could benefit both communities. The size of the consortium, combined with the quality of the work program, gave partner institutions the necessary leverage to secure national funding and resources, enabling the recruitment of many more PhD students and postdoctoral fellows than would have been possible using EC funding alone. In total, more than 40 postdoctoral fellows and 100 PhD students have worked on HERMES data (see Gunn and Thomsen, this issue), providing these early-career scientists huge opportunities to work in

Philip P.E. Weaver (*p.weaver@noc.soton.ac.uk*) is HERMES Coordinator, National Oceanography Centre, University of Southampton, Southampton, UK.
Vikki Gunn is HERMES Project Manager, National Oceanography Centre, University of Southampton, Southampton, UK.

multidisciplinary teams, both at sea and within partner laboratories, on large-scale projects where their research tangibly contributes to the bigger picture.

Bringing such a large group together (with over 150 participants at annual science meetings) has been challenging but ultimately hugely rewarding. The various teams within the HERMES partnership supported each other, forged new and productive collaborations, broke new ground in interdisciplinary science, and pulled together to attain the common aims of this truly large and integrated project.

The project's leverage has also been very apparent in securing ship time and providing large-scale equipment—both critical for the project's success. Between April 2005 and April 2009, HERMES has enjoyed over 1300 days of ship time, including more than 400 days with a remotely operated vehicle (ROV), autonomous underwater vehicle (AUV), or manned submersible. The project coincided with an increase in the number of ROVs available within Europe, and these have made a huge impact on the quality of the data collected. The majority of HERMES cruises have been manned by scientists from multiple partner institutions, including smaller laboratories and research teams that benefited from

the opportunity to use infrastructure and equipment that otherwise may not have been accessible to them. The multi-institutional and multidisciplinary partnership of HERMES has maximized the value of each cruise by deploying an enormous range of equipment and experiments.

Europe's deep ocean margins cover an area of three million square kilometers and extend some 15,000 km, from the Arctic in the north to the Mediterranean in the south, and from the Atlantic in the west to the Black Sea in the east. HERMES could not study the whole margin, so key "biodiversity hotspots" were identified where the work could be concentrated. These hotspots included cold seeps, cold-water coral locations, carbonate mounds, canyons, and anoxic environments where the geosphere and hydrosphere influence the biosphere through escape of fluids, presence of gas hydrates, and flow of deep-water currents. HERMES also investigated open slopes adjacent to these hotspots in order to compare them to the background, although these slope areas can also be disturbed by landslides or strongly affected by ocean currents. The project's seven main study areas are:

1. The Nordic margin, representing a cold-water end member with



(Left) *Gorgonocephalus* at 1200-m water depth in the Whittard Canyon, offshore Southwest UK. Image courtesy of NOCS/JC10.
(Right) Sampling coral graveyards in the Gulf of Cádiz. Image courtesy of MARUM

- potentially environmentally stressed ecosystems in a hydrocarbon province
2. The Porcupine/Rockall margin, rich in giant carbonate mounds with luxuriant coral reefs and canyon systems
 3. The Portuguese margin, home to vast submarine canyon systems
 4. The Moroccan margin of the Gulf of Cádiz, with its specialist seabed communities on mud volcanoes
 5. The western Mediterranean, bounded by the sills of Gibraltar and the Sicilian Channel, with large contrasts between the strongly Atlantic-influenced southern area and the areas to the north where influence from European rivers is highly significant and has changed dramatically in just a few decades
 6. The eastern Mediterranean study area, dotted with areas of cold seeps on the Mediterranean ridge, together with unique but poorly understood ecosystems driven by events such as intermittent deep-water formation
 7. The Black Sea, a unique environment for the study of microbial ecosystems thriving in permanent anoxia

This issue of *Oceanography* presents some of the many highlights of the HERMES project. They include, among other no less significant results:

- increased knowledge of submarine canyons and the heterogenous habitats they sustain (Tyler et al.)
- identification of cold water cascading in the Gulf of Lion, its impact on the shrimp fishing industry, and the susceptibility of the process to climate change (Canals et al.)
- the discovery that ecosystem functioning and efficiency on continental margins increases exponentially in

deep-sea ecosystems characterized by higher biodiversity (Danovaro et al.)

- work on cold-water coral reefs that has shown the importance of the reef mass itself in distributing organic matter (Lavaleye et al.)
- many new discoveries about the distribution of cold-water coral reefs, including in the central Mediterranean where they were previously believed to be rare (Freiwald et al.)
- measurement of rates of subsurface fluid flow and methane release at some mud volcanoes and cold seeps (Foucher et al.)
- identification of a vast heterogeneity of cold seep habitats and faunal assemblages, on scales of tens to hundreds of meters (Vanreusel et al.).

Results from all of these studies have contributed to better understanding of ecosystem food webs, which are explored from a modeler's perspective by Soetaert et al.

One of the great strengths of the HERMES project has been its ability to bridge the gaps among policymakers, nongovernmental organizations, and HERMES scientists. The HERMES project was designed to provide the scientific knowledge base that will support policy decisions concerning the sustainable management of Europe's natural offshore resources and to contribute to the success of a holistic approach to European maritime governance (see Grehan et al., this issue). There has been a necessary learning curve for all concerned, with scientists learning to make their research more relevant and policymakers learning to put their problems directly to scientists. A number of discussion sessions involving policymakers, nongovernmental

organizations, deep-sea industry representatives, and HERMES scientists have been very successful in identifying some key issues that will need to be taken forward in subsequent projects. These issues include the need for holistic, long-term research strategies to answer societal needs and to support deep-sea governance. Key knowledge needs for policy and management include interdisciplinary and multisectoral research to fill management gaps, such as integrated management, environmental impact assessments, strategic environmental assessments, spatial planning, marine protected areas, and implementation of a precautionary approach. Research must also be conducted to illustrate for policymakers and stakeholders the impact of good management decisions and practices, and the value of deep-sea ecosystems to society (Armstrong et al.). This cross-sectoral community will be important in the development and implementation of the European Maritime Policy and Marine Strategy, and for responding to the EU Habitats directive. Finally, the research community has a key role in making science visible to the wider public, and raising awareness among the public and policymakers (see De Mol et al. and Gunn and Thomsen).

HERMES has made a significant start in integrating research across a range of disciplines and across a wide range of European institutions, and in addressing the societal issues mentioned above. Testament to the success of the project is the inclusion of HERMES in the European Commission's list of the Top 40 projects funded under its Framework Six Programme. 