

Rich deep-sea fauna on polymetallic nodules targeted for mining require strong environmental management actions

An international group of researchers from Germany (Senckenberg am Meer), Belgium (Ghent University), France (Ifremer), and Portugal (MARE/IMAR-Azores and University of Aveiro) has published important results from a recent research campaign to the Clarion Clipperton Fracture Zone (CCZ) in the Central Eastern Pacific. They demonstrate that polymetallic nodule fields are hotspots of abundance and diversity for a highly vulnerable abyssal fauna. The results of this study underline the need for careful considerations of strategies for biodiversity conservation.

The CCZ region is of growing interest to industry because of the high concentration of polymetallic nodules present at abyssal depths (> 4000 m water depth). However, being one of the remotest areas on earth, very little is known about its biodiversity and ecosystem functioning.

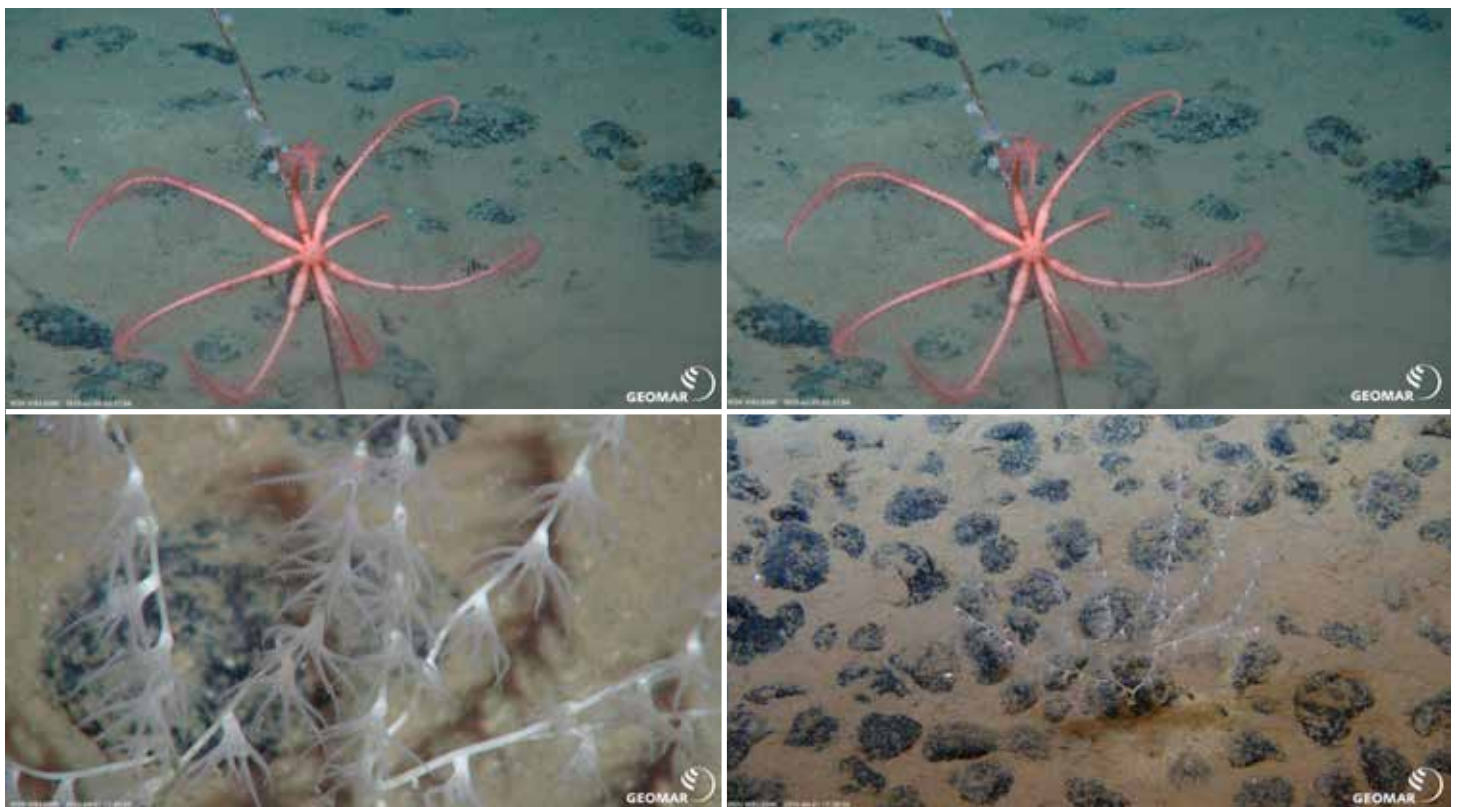
In the context of future exploitation licences issued by the International Seabed Authority (ISA) for the CCZ, the team aboard the German research vessel SONNE investigated the abyssal biota in order to understand potential mining impacts. Based on the first-ever video transects of these

poorly-known abyssal communities, the data show that the fauna associated with polymetallic nodules is more abundant and diverse than in areas with no or sparse nodule coverage - a pattern that is consistent across the four areas licensed for nodule exploration that were visited during the cruise.

The authors also report on the high impact and lack of recovery of fauna on two old trawling tracks and experimental mining simulations carried out up to 37 years old, suggesting that mining impacts may be long-lasting or even permanent. Based on these observations, the researchers argue that preservation zones within mining areas should be established in areas rich in nodules. The results of this study are considered of the highest importance for policy-makers and the industry to incorporate whilst developing mining strategies and policies.

Vanreusel, A., Hiliario, A., Ribeiro, P.A., Menot, L. & Arbizu Martinez, P. (2016) Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna. Scientific Reports 6, doi:10.1038/srep26808

Open access online at www.nature.com/articles/srep26808



Above, clockwise from top left: A) Echinoderm specimen on old sponge stalk in polymetallic nodule field; B) Stalked sponge in polymetallic nodule field; C) Soft coral in polymetallic nodule field; D) Detail of soft coral in polymetallic nodule field. Cruise SO-239, coordinated by Senckenberg am Meer, Wilhelmshaven is part of the JPI Oceans Pilot Action on "Ecological Aspects of Deep-Sea Mining" (www.jpio-miningimpact.geomar.de) coordinated by GEOMAR.

Sharing benefits of the common heritage of mankind - is the deep seabed mining regime ready?

By Kristina M. Gjerde

The International Seabed Authority, the body charged with managing mining-related activities in the Area on behalf of all humankind, is currently developing rules to govern mineral exploitation, including a fiscal regime for benefit sharing. A recent article in *Marine Policy* co-authored by two MIDAS participants, Jeff Ardron and Kristina Gjerde, together with Aline Jaeckel, explores the modalities envisioned in the 1982 UN Convention on the Law of the Sea for the sharing of benefits derived from mining, and the challenges currently encountered in creating a fair and equitable system for both present and future generations. The authors point out that in line with the common heritage of mankind principle, in addition to sharing economic benefits, it will be important to build in mechanisms to enhance the participation and capacity of developing states, take into account any financial risks for humankind through the potential loss of natural capital and the related loss of ecosystem services; and address issues of transparency, accountability, inclusivity and compliance monitoring in developing and managing activities related to seabed mining in the Area.

The article is open access only until 3 August 2016: <http://authors.elsevier.com/a/1TChJ,714MRO-8>

New MIDAS publication reveals potential ecotoxicological effects of deep-sea mining

A collaborative research paper, titled *Development of an ecotoxicological protocol for the deep-sea fauna using the hydrothermal vent shrimp Rimicaris exoculata*, resulting from work by colleagues from the University of Algarve, University Pierre et Marie Curie and Ifremer was recently published in the journal *Aquatic Toxicology*. This study assesses the natural background levels of biomarkers in the hydrothermal vent shrimp *Rimicaris exoculata* and their responses to copper exposure at in situ pressure (30 MPa). It further evaluates the effects of depressurization and pressurization of the high-pressure aquarium IPOCAMP.

Specimens of *R. exoculata* were obtained from the chimney walls of the TAG hydrothermal vent site at 3630m depth on the Mid Atlantic Ridge during the BICOSE cruise in 2014. Tissue metal accumulation and a range of biomarkers were measured, including metal exposure, oxidative stress and oxidative damage. Data reveal a higher concentration of Cu in the hepatopancreas and a slight increase in the gills after incubations for both exposed groups. Significant induction of metallothioneins was observed in the gills of shrimps exposed to 4 µM of Cu. Results suggest that the proposed method may be useful to assess toxicity of contaminants in deep-sea species.

Auguste, M., N.C. Mestre, T.L. Rocha, C. Cardoso, V. Cuffe-Gauchard, S. Le Bloa, M.A. Cambon-Bonavita, B. Shillito, M. Zbinden, J. Ravaux and M.J. Bebianno (2016) Development of an ecotoxicological protocol for the deep-sea fauna using the hydrothermal vent shrimp *Rimicaris exoculata*. *Aquatic Toxicology* 175 (2016) 277–285. doi:10.1016/j.aquatox.2016.03.024. http://authors.elsevier.com/a/1SuwJ_OE935G7

For more details please contact the corresponding author, Nelía Mestre: ncmestre@ualg.pt

Left: The Beehive at Snake Pit vent field, 23°N on the Mid-Atlantic Ridge. Image courtesy Ifremer/Victor 6000, Bicosse cruise (2014).

Artistic impressions of seafloor habitats in the Peruvian Basin

The manganese nodules of the Peruvian Basin, as imaged during the recent SO242 cruises, add islands of hard substrate to the flat, soft seafloor. From the late 1980's there have been periodic visits to the DISturbance and Colonization (DISCOL) Experimental Area (DEA) by both the old and new 'RV Sonne' research vessels. These visits repeatedly surveyed an area of seafloor ploughed in 1989 in an effort to experimentally simulate a manganese nodule mining event. On all survey visits, images of the seafloor have been collected, by Remote Operated Vehicles (ROVs), Automated Underwater Vehicles (AUVs), towed camera systems such as the Alfred Wegener Institute Ocean Floor Observation System (OFOS) or by Landers. From these observations, particularly those made within the context of the MIDAS project in 2015, it is clear that these nodules play an important role in supporting a range of fauna. In this illustration, based on images collected during SO242-2 by the AWI OFOS-Launcher system, a range of these common associate fauna are apparent. Unfortunately direct sampling has been insufficient to identify all of the fauna to species level, but from the image data alone a number of important interactions between nodules and fauna, or nodule supported fauna and other fauna, can be seen.

The nodules are most important perhaps because of their provision of a hard surface onto which sessile fauna such as sponges, corals, some polychaetes, crinoids, anenomes and tunicates can settle. The nodules also interact with bottom water flow conditions which increases the hydrodynamic niches available close to the seafloor, which may be of use to mobile fauna. Several species of sizable isopod (some 10s of cm in diameter) were often identified close or on top of nodules, rather than at intermediate locations between nodules.

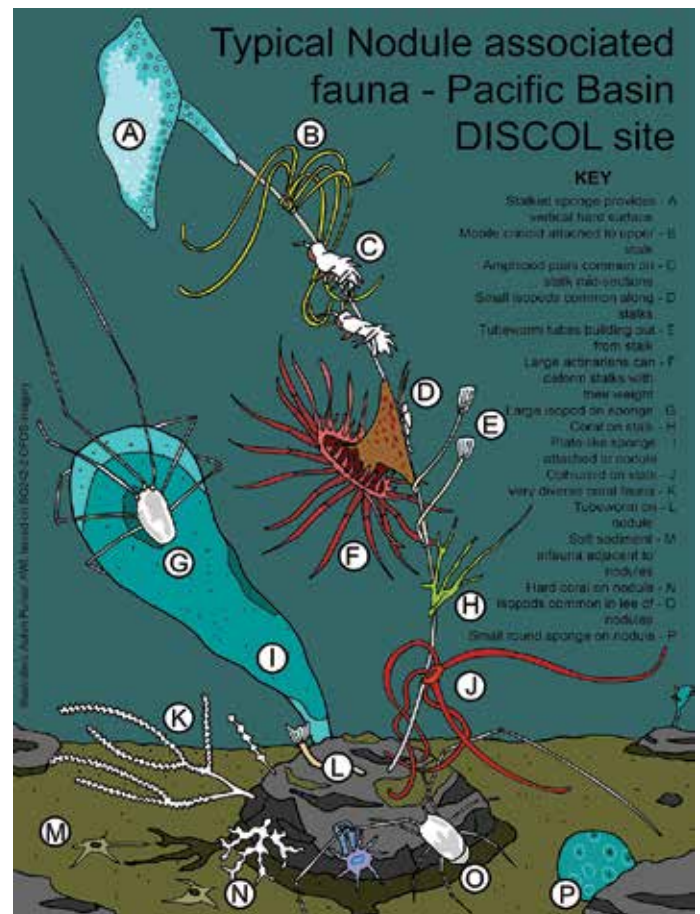
Reasonably abundant in the DISCOL area are stalked sponges, stalked crinoids, small corals and stalked hydrozoans. These, particularly the stalked sponges and stalked crinoids, affix a firm stalk to a nodule and extend the available hard substrate vertically into the water column. As the illustration shows, these stalks can be very densely populated, both during the lifetime of the providing organism, and following its death. Though many species do not seem to be wholly obligate on these stalks, observed abundances are far higher on the stalks than elsewhere for many of the observed fauna. Several ophiuroid species are observed in far higher numbers on stalks than off them, for example. Rather heavy fauna, such as some anenome species, can bend the supporting stalk structure with their weight, but are commonly observed nonetheless. In addition to sessile filter feeders such as polychaetes and corals, these stalks also support mobile

filter feeders such as mobile crinoids.

The diverse interactions of fauna and nodules observed across the DISCOL region during the MIDAS cruises is currently being investigated by MIDAS scientists and other specialist partners. As the MIDAS project enters its final months it is hoped some of these interactions can be compared with those observed from the CCZ nodule areas on the earlier MIDAS cruises. Interestingly, despite the generally similar appearance of the seafloor, and reasonably similar depths, different faunal communities seem to be supported by the nodules.

The loss of the hard manganese nodules from the deep sea seafloor appears from preliminary analysis of 2015 image data to have had an impact on sessile fauna abundances in particular, with abundances observed still lower than pre-ploughing after 29 years. Ideally this data will be fully analysed prior to completion of the MIDAS project.

The full image, shown overleaf, was created by Autun Purser (AWI) based on the SO242-2 OFOS imagery.



Typical Nodule associated fauna - Pacific Basin DISCOL site

KEY

- Stalked sponge provides - A vertical hard surface
- Mobile crinoid attached to upper - B stalk
- Amphipod pairs common on - C stalk mid-sections
- Small isopods common along - D stalks
- Tubeworm tubes building out - E from stalk
- Large actinarians can - F deform stalks with their weight
- Large isopod on sponge - G
- Coral on stalk - H
- Plate-like sponge - I attached to nodule
- Ophiuroid on stalk - J
- Very diverse coral fauna - K
- Tubeworm on - L nodule
- Soft sediment - M infauna adjacent to nodules
- Hard coral on nodule - N
- Isopods common in lee of - O nodules
- Small round sponge on nodule - P

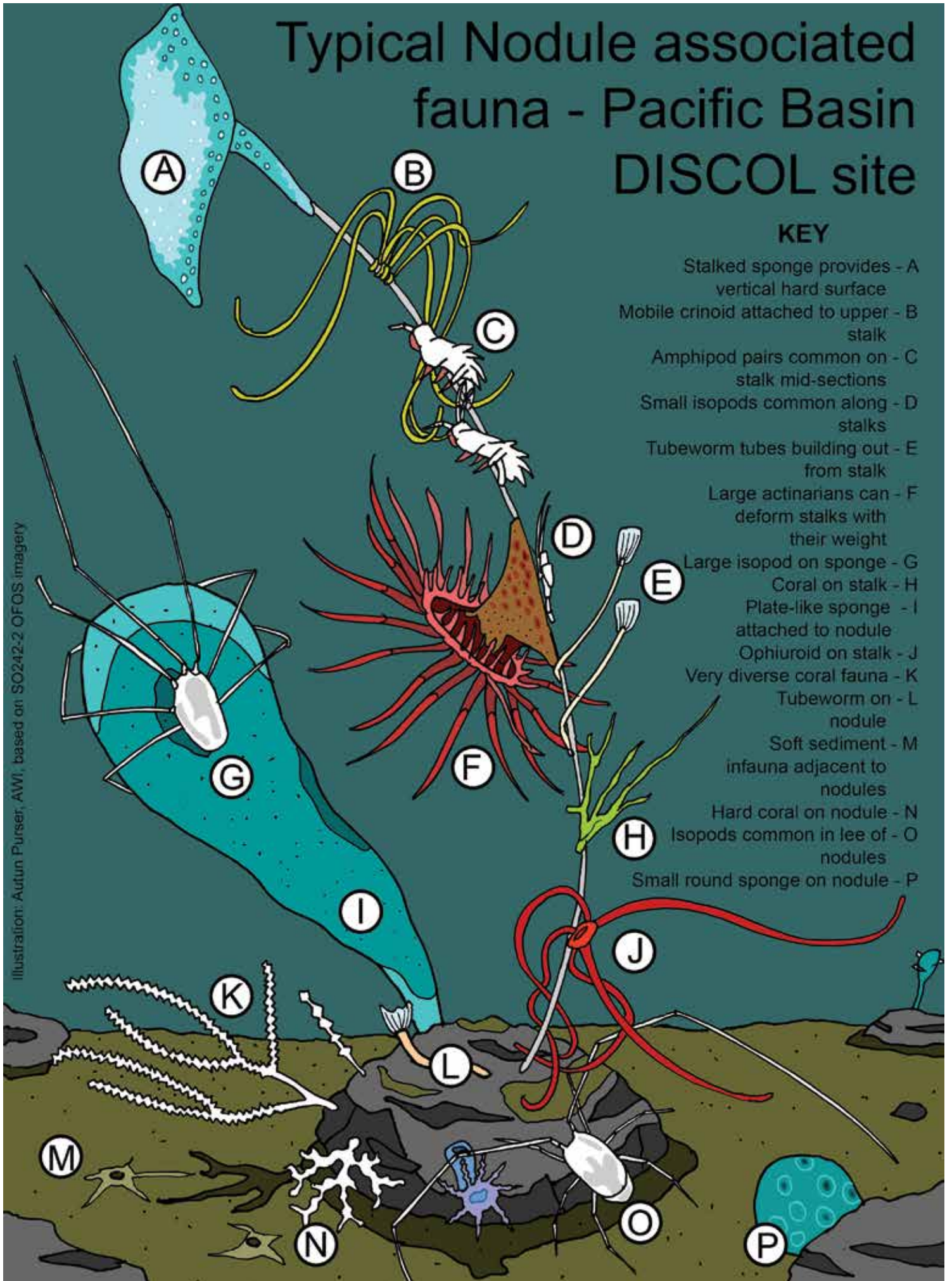


Illustration: Autun Purser, AWI, based on SO242-2 OFOS imagery

Lost and found in the Atlantic Ocean: MIDAS researchers help out TREASURE colleagues in race to save runaway lander

Lagrangian models are not only good at simulating the dispersal of mining plumes and larvae in a virtual ocean, they also prove handy for tracking objects in real life, as recently demonstrated by the successful salvage of a runaway bottom lander.

In the early hours of 2 May 2016, a stream of alerts received via satellite link warned NIOZ biologists Gerard Duineveld and Marc Lavaley that one of their bottom landers was floating at the surface 250 nautical miles southwest of the Azores. The lander, equipped with CTD, current meter, sediment trap and time-lapse baited video camera, had been deployed in April 2015 in 2100 m water depth on the Mid Atlantic Ridge near the Rainbow hydrothermal vent field, as part of the Dutch TREASURE project. Along with two other landers and one mooring deployed in the same area, it was meant to be recovered in July 2016 by the Dutch RV Pelagia. For unknown reasons this lander had prematurely released its anchor and had surfaced. Urgent action was needed to salvage it.

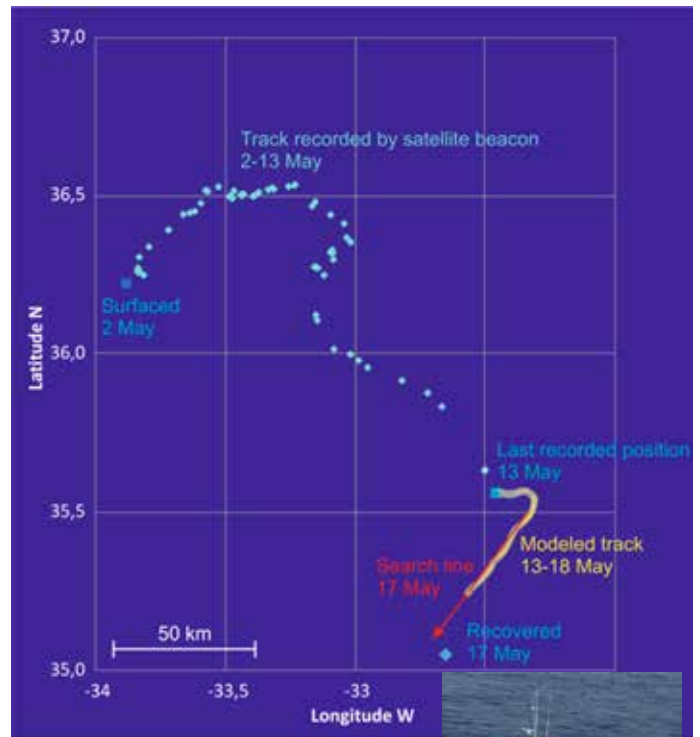
U-Azores biologist Telmo Morato, called in for assistance, was quick to find a skipper based on the Azorean island of Faial who was willing to sail out with his fishing vessel to rescue the lander. Many days of precious time was lost, however, as storm depressions swept over the Azores, forcing skipper Jorge Gonçalves to wait for a window of calm weather. Far out at sea, in the meantime, the lander was drifting 10 miles per day along an irregularly meandering track. The chances of ever finding the costly equipment back depended heavily on how long the batteries of the satellite beacon would last. Without regular updates of the lander's position, a rescue action would almost certainly be doomed to fail.

Coincidence or not, on Friday 13 May the dreaded scenario became true: while weather forecasts finally were improving, the satellite beacon expired. As a last recourse, U-Azores oceanographer Manuela Juliano was called in for help. Would she by any chance have an ocean circulation model running for the Azores region, which might predict the track of the lander? Not by chance but thanks to her modeling work in MIDAS she did. And while skipper Jorge headed out with his small fishing vessel toward the approximate lander position, Manuela made her Lagrangian model simulate the track of a 1000 virtual landers swarming out and dispersing in the meanders and eddies of the Azores Current. A search line, running through the center of the simulated swarm, was then communicated via satellite telephone to the skipper.

On Tuesday 17 May, when the ship was approaching the end of the search line, the satellite beacon that had been dead for more than three days miraculously revived and transmitted a single position, which turned out to be less than four miles away from the search line. Within an hour the ship reached the location and there the bright orange flag marking the lander

was soon sighted. With skill and ingenuity the 650 kg structure was hoisted on board the small fishing vessel, thus ending its errant journey of approximately 180 miles across the ocean.

On behalf of the TREASURE team a huge thank you to the heroes of this story: Telmo Morato, Manuela Juliano and Jorge Gonçalves and crew of FV Manuel da Arriaga!



Images, top: Plot showing the lander's drift. Bottom: rescue mission completed! The lander is recovered by the fishing vessel Manuel da Arriaga (inset)

Aligning project development, technology and ecosystem needs in deep-sea mining

A workshop on 'Aligning project development, technology and ecosystem needs in deep-sea mining' was hosted by Royal IHC at the Oude Bibliotheek Academy, Delft in The Netherlands on 20 April 2016. The workshop was organised by IHC on request from the EU in order to bring together professionals in the technology and the environment fields from the FP7 Blue Mining and MIDAS projects. The objectives of the workshop were to discuss deep-sea ecosystem needs with respect to deep-sea mining activity, consider ways to tackle potential environmental impacts, and to examine opportunities for the application of the 'Exploration, Environment and Development Decision (DEED) Framework' in deep-sea mining projects.

MIDAS has identified a number of environmental impacts of deep-sea mining that have the potential to be reduced through the improved design of mining technology and methods. Examples of the impacts include the loss of ecosystem integrity in the mined areas and under areas impacted by the benthic plumes generated at the seabed. Many of these impacts can be controlled with the nodule collector technology, e.g., by separating the loose sediment from the nodules at the seabed and employing methods to reduce the benthic plume. Pilot

mining is necessary to test the performance of the equipment, the mine plan and to assess environmental impact.

A mining project can only be successful when sufficient confidence is achieved. Resource estimates need to have high levels of confidence at different stages of a project to ensure accurate decision making. Minimum standards for exploration results, including resource and reserve definitions are set in internationally accepted codes. However, there are no accepted standards for integrated management of projects.

Protocols and standards for environmental management of deep-sea mining are needed. The DEED Framework addresses the integration of the exploration, environment and development programmes of a deep-sea mining project into one systematic decision-making process. The establishment of best practice criteria for the assessment of a project enables transparency and communication among different stakeholders. The framework also provides a practical overview of the life cycle of a project and the environmental requirements, which can assist the development of regulations and the development of deep-sea mining.



Above: Snapshots from the joint Blue Mining- MIDAS workshop on Aligning project development, technology and ecosystem needs in deep-sea mining.

Deep sea mining: Exploring the unknowns

NGO stakeholder conference, Brussels, 26 April 2016

Seas At Risk, in partnership with the Deep Sea Conservation Coalition, hosted a multi-stakeholder event to explore the present status and future of deep sea mining. This event is a contribution to the MIDAS stakeholder engagement programme

Some 70 participants from industry, government, European institutions, NGOs and the scientific community came together for a lively debate around the need for deep sea mining, the current technological and regulatory state of play, and the knowledge gaps that prevent us from understanding the full potential impacts of this industry.

In the morning, a panel of experts considered the need for deep sea mining and the application of the 'precautionary principle'. The sector was considered in the context of commitments to a circular economy, as well as projected future global demand for raw materials. In the afternoon, a second panel outlined what we already know and research under way about the sector's potential environmental impacts. Woven into this discussion, the experts considered the future prospects for commercial exploitation and the regulations for exploitations being put in place by the International Seabed Authority. The audience participated actively throughout the day, with open moderated dialogue between stage and floor.

The event signifies the highest level meeting of stakeholders at the EU level yet on the topic of deep sea mining, confirming the interest of a broad cross-section of stakeholders in connecting

around this topic and exposing the gaps in knowledge that need to be bridged. It further demonstrated the speed at which technology and industry are progressing towards actual mining activities, even while the International Seabed Authority is in the process of developing exploitation regulations.

While views differed on whether deep sea mining is inevitable (in light of the increasing demand for materials driven by global growth), there was some consensus around the fact that despite recent strides, we do not yet know enough about the ways in which deep sea environments function. All agreed that the EU has a significant role in facilitating the further research needed. On the regulation side, most agreed the need for a stringent application of the precautionary and 'polluter pays' principles and, all accepted that the ISA was the correct body to develop a codified international regulatory framework, with EU involvement. There were however concerns about the enforcement of the regulatory framework, and the level of engagement of ISA member states in the existing processes.

Further information, including a full report of the event and links to speakers' presentations is available online at www.seas-at-risk.org/20-blue-growth/640-deep-sea-mining-exploring-the-unknowns.html



EcoMine II workshop: Balancing ecological risks and economic benefits of deep-sea mining

by Stefanie Kaiser, SGN and Ashley Rowden, NIWA

A joint German-New Zealand workshop, funded by the Federal Ministry of Education and Research – BMBF, was held at Senckenberg, Wilhelmshaven, 14 – 16 June 2016. The EcoMine project was initiated in summer 2015 with the aim of establishing long-term collaboration between Germany and New Zealand in relation to the environment and management implications of deep-sea mining. A first workshop (EcoMine I) was organised at NIWA (Wellington) in September 2015 by Malcolm Clark and Ashley Rowden, and included participants from New Zealand governmental departments, industries (Chatham Rise Rock Phosphate Ltd.) and science, with MIDAS partners SGN and BGR as German representatives. During EcoMine I plans for collaborative research and information sharing were developed and tasks divided between project partners. Now in June 2016, researchers from both countries have gathered in Germany to evaluate the status of activities and coordinate further research efforts. Besides EcoMine project partners, participants also included scientists from GNS (NZ), MARUM and Jacobs University Bremen. In the course of the EcoMine II meeting the most recent results were presented from MIDAS, JPIOceans and the NZ equivalent EMOM (Enabling

Management of Offshore Minerals) projects. Discussions then focused on outlining research questions and grant proposals, in particular to develop a proposal for a joint German-NZ voyage, in order to carry on MIDAS and EMOM efforts to the next level.

A MIDAS side-meeting was organised by SGN to exchange information on recolonization and recovery after disturbance in New Zealand and the DISCOL area respectively, which will feed into WP6.



Connecting Connectivity in the Clarion-Clipperton Zone

Adrian Glover, NHM

Researchers from across Europe meet at the Natural History Museum in London to discuss and integrate new molecular biodiversity data from the world's largest deep-sea mining exploration zone. Over the course of three days in May 2016, 32 scientists worked on one of the most difficult problems in deep-sea environmental management: the regional biodiversity, connectivity and biogeography of the Clarion-Clipperton Zone (CCZ).

Jointly organised under the auspices of the MIDAS project and the JPIO project on *Ecological Aspects of Deep-sea Mining*, with input from the International Seabed Authority (ISA) and the ABYSSLINE consortium, the meeting was developed to bring together principal investigators, post-doctoral researchers and PhD students from recent EU-led projects in the CCZ. The focus was on presenting new molecular-based data that have been collected in a series of recent expeditions linked to the MIDAS and JPI-Oceans projects.



It has been widely recognised that a major problem in the development of environmental guidelines for both mineral exploration and exploitation in the CCZ is the lack of regional-scale baseline data on species-level biodiversity, biogeography and connectivity (e.g. ISA 2014 & 2015, Seascape Consultants 2014). New molecular-based assessments of CCZ biodiversity (e.g. Janssen et al. 2015, Glover et al. 2016a) are starting to offer new data from within contractor exploration zones, and provide an opportunity to integrate data into a synthetic regional-level approach.

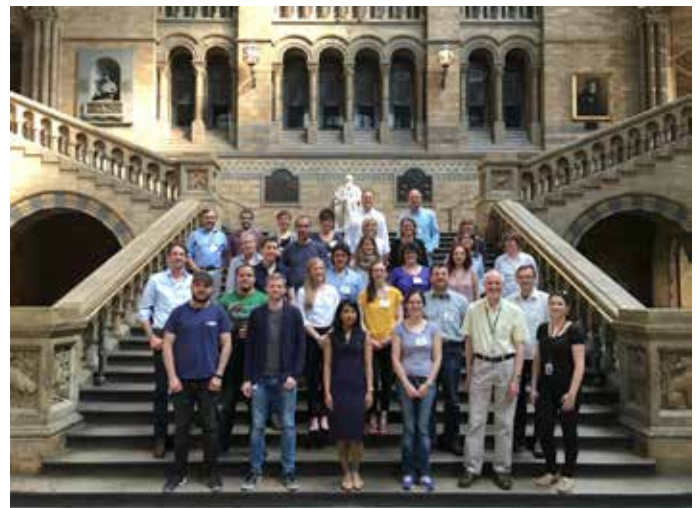
The workshop was organised around three topics: (1) new molecular data on species taxonomy and distributions within and between CCZ exploration zones, (2) new intra-specific population genetic data on 'target taxa' and (3) broader-scale (ocean-basin and global) biogeographic data based on both traditional morphological information and molecular data. The scope of the discussions focused taxonomically on metazoan animals and foraminiferal protists, in particular on

meiofaunal (e.g. copepods and nematodes) and macrofaunal (e.g. polychaetes, isopods and molluscs) size classes for which there are the most data, while some new data are starting to appear on the larger megafaunal animals which are difficult to sample in the CCZ (e.g. holothurians and corals).

On 10 May 2016, the workshop opened with overviews from the main EU-sponsored sampling projects in the CCZ. This was followed by a presentation from the ISA on ongoing policy needs and implications, and a presentation from an industry perspective from UK Seabed Resources Ltd. These latter talks were designed to focus the scientific discussions planned for the second day on stakeholder needs and perspectives.

The second day got off to a surprising start with the workshop participants having to make their way through a museum filled with a large film production team from Universal Studios filming 'The Mummy' starring US actor Tom Cruise. Several of the workshop group met Mr Cruise acting in the central hall beneath the statue of Charles Darwin and inadvertently found themselves as extras in the production. After this slight delay, the somewhat star-struck group then got down to work, with the main data sessions of the workshop. An impressive array of new data were presented from recent cruises and subsequent analyses, principally from the eastern CCZ focussed around the exploration zones of the UKSRL (UK), BGR (Germany), IFREMER (France), GSR (Belgium) and IOM (Bulgaria, Cuba, Czech Republic, Poland, Russia and Slovakia). New DNA sequence data were presented from all these regions, from a wide range of taxa and across sampling sites at spatial scales of 60 to 1300km.

A common theme that emerged from the data sessions was that the majority of teams are now using DNA sequences from typical invertebrate genetic markers (e.g. COI, 18S, 16S, 28S) to delimit 'species' based on either 'barcoding-gap' analysis and/or phylogenetic reconstruction using additional published sequences (Glover et al. 2016b). These 'species', referred to by several teams as "Molecular Operational Taxonomic Units"



(MOTUs) were then examined for their distributional range, and in some instances particularly abundant species (target taxa) selected for more detailed population genetic study. Examination of morphology within DNA-delimited species was then also providing valuable biogeographic data to enable in some instances comparisons within or even between ocean basins.

The final day of the workshop was designed to utilise the combined knowledge around the table to create a matrix of ongoing and planned work activities (e.g. manuscripts in preparation, intended grant proposals and future cruises). An impressive list of planned publications was generated that included 44 planned scientific papers for the next 3 years from the workshop. The creation of this list also highlighted many options for collaboration, including both specimen and data sharing amongst academic and contractor-led projects. In addition, discussion was focused onto the generation of workshop outputs, in particular a published and open workshop report and the potential for a synthetic paper highlighting selected new data. It was agreed to produce a workshop report containing a useful overview of background, discussion areas, ongoing and planned activities and workshop recommendations of particular value to stakeholders such as regulators (ISA) and Sponsoring States and industry. In a small and short breakout group, Principal Investigators met to discuss the potential for

a synthetic paper cutting across several work programs and agreed to produce an outline to circulate amongst the group.

References

Glover AG, Wiklund H, Rabone M, Amon DJ, Smith CR, O'Hara T, Mah C and Dahlgren TG, 2016a. Abyssal fauna of the UK-1 polymetallic nodule exploration claim, Clarion-Clipperton Zone, central Pacific Ocean: Echinodermata. *Biodiversity Data Journal*, e7251.

Glover AG, Dahlgren TG, Wiklund H, Mohrbeck I and Smith CR, 2016b. An End-to-End DNA Taxonomy Methodology for Benthic Biodiversity Survey in the Clarion-Clipperton Zone, Central Pacific Abyss. *Journal of Marine Science and Engineering*, 4, 2.

ISA, 2014. Workshop on taxonomic methods and standardization of macrofauna in the Clarion-Clipperton Fracture Zone. <https://www.isa.org.jm/workshop/workshop-taxonomic-methods-and-standardization-macrofauna-clarion-clipperton-fracture-zone>.

ISA, 2015. Workshop on taxonomic methods and standardization of meiofauna in the Clarion-Clipperton Fracture Zone. <https://www.isa.org.jm/workshop/workshop-taxonomic-methods-and-standardization-meiofauna-clarion-clipperton-zone-dec-2015>

Janssen A, Kaiser S, Meissner K, Brenke N, Menot L and Martinez Arbizu P, 2015. A Reverse Taxonomic Approach to Assess Macrofaunal Distribution Patterns in Abyssal Pacific Polymetallic Nodule Fields. *PLoS ONE*, 10(2): e0117790,

Seascope Consultants, 2014. Review of Implementation of the Environmental Management Plan for the Clarion-Clipperton Zone.

A call to the international community to “map the gaps”

Members of GEBCO, the General Bathymetric Chart of the Ocean, have made a resounding call to develop modern maps of the ocean floor around the world. Less than 15% of the ocean has been mapped to modern standards, leaving large parts of the ocean represented by single points measured by ancient mariners using lead-weighted ropes.

At the Forum for Future Ocean Floor Mapping in Monaco (15-17 June 2016), over 150 senior representatives, scientists, scholars and business associates from major ocean related organisations endorsed the objective of Seafloor 2030 – that the comprehensive mapping of the entire ocean floor was possible by the year 2030.

At the Forum, GEBCO - the world's only international body mandated to map the ocean floor - called for the sharing of bathymetric information to create, for GEBCO, a global baseline bathymetric database. It also called for greater access to the tools and technology, particularly for developing and coastal nations, to make a comprehensive database possible. Sharing of data is essential to achieve this ultimate objective.

At the meeting, held under the auspices of GEBCO and The Nippon Foundation, MIDAS partner Kristina Gjerde (Wycliffe Management) delivered a keynote presentation on “*The relevance of mapping to conserving the ocean beyond national boundaries.*” Other speakers included Bob Ballard, who discovered the wreck of the Titanic, and Simon Winchester, author of books on the Atlantic and Pacific oceans.



Above: The blue areas of the oceans have not yet been mapped with the most modern, high resolution technologies (image courtesy Thierry Schmitt/SHOM).

The need for greater political support through UN organisations and the G7 was highlighted to increase resources for this ocean mapping task. Many noted that ocean mapping could complement the United Nations Atlas of the Oceans and Goal 14 of the Sustainable Development Goals (SDGs) – to conserve and sustainably use the world's oceans, seas and marine resources

Details of the discussions, and the presentations and posters are available at www.iho.int/mtg_docs/com_wg/GEBCO/FOFF/index.htm

MIDAS Final Meeting: 3-7 October 2016, Gent

The final meeting of the MIDAS project will take place in Gent, Belgium during the week 3-7 October 2016. Hosted at the University of Gent in the historic Het Pand building (pictured right), the meeting will comprise a session for MIDAS partners only on Monday 3 October, followed by 3 days of open meeting where MIDAS results will be showcased to a broader audience. Friday 7 October will be a day aimed at policy makers, NGOs and other stakeholders where will present a synthesis of our results and facilitate a discussion forum.

Registration details and further information about the conference programme will be available on the MIDAS website in due course. Attendance at the meeting will be free of charge, but all participants must register in advance.



MIDAS demonstration cruise

During July 2016 the technology and protocols field testing cruise will take place aboard the RV Pelagia (right) in the Azores. The main purpose of the cruise is to evaluate and compare the efficacy of selected habitat mapping technologies, and to carry out a number of monitoring studies with relevance to WP3 (Ecotoxicology) and WP6 (Ecosystem resilience and recovery). The cruise objectives are to assess monitoring technologies at a location typical of a mining site in accordance with industry best practice. The cruise will last for eight full days' survey and will utilise an industry-standard ROV, a Seaeye Cougar XT. The cruise will incorporate the following studies:



1. In situ study of the feasibility of cold-water corals transplantation techniques for the active restoration of coral populations impacted by mining activities;
2. In situ study of the potential for recovery of metal-contaminated cold water corals;
3. In situ study of the recovery ability of cold-water coral communities from a simulated sediment discharge;
4. Optical baseline and post impact change detection study – possibly both 2D and 3D;
5. 2D habitat mapping and mosaicking;
6. 3D seabed mapping.

The 2D optical habitat mapping data will be post-processed by a number of different systems, and quantitative comparisons will be made of the efficacy of different survey methods. Analyses of biological data should determine fauna-habitat relationships, spatial distribution and species accumulation curves. Ecotoxicology studies of motile fauna around Condor Seamount will also be carried out.

MIDAS at the ISA Annual Session: 20 July 2016

MIDAS will hold a side event at this year's annual session of the International Seabed Authority, which runs for two weeks in Kingston during July. The side-event will take place at lunchtime on 20 July, and will feature speakers Phil Weaver (Seascope), Kristina Gjerde (Wycliffe) and Dan Jones (NERC).

This event will provide an opportunity for MIDAS to present some of its results and to offer its assistance in the ongoing process to develop the exploitation regulations. MIDAS has already presented some of its results at the Griffith University Law School and International Seabed Authority Workshop on Environmental Assessment and Management for Exploitation of Deep Seabed Minerals, that was held in Australia during May 2016. Dan Jones (NERC), Dave Billett (DSES) and Kristina Gjerde (Wycliffe) attended this event.

MIDAS workshop on environmental management of deep-sea mining

A workshop on the environmental management of deep-sea mining was held at NOC in Southampton on 28-30 June 2016, hosted by MIDAS Work Package 8. It included scientists from the other work packages, along with some industry partners and policy/legal experts.

WP8 is tasked with documenting the best environmental practice for exploitation of deep-sea minerals and developing a set of tools to be used by industry to improve the environmental sustainability of their operations. These tools will cover the overarching environmental management of the mining project, including impact assessment and monitoring, at both project and regional scales. The focus of this workshop was to conduct a trial implementation of the draft guidelines and tools to

ensure the approach is realistic and suitable for deep-sea mining projects.

The tools were tested using a comprehensive nodule mining scenario developed as part of WP7, using industry data and advice. Workshop discussion sessions involved applying the tools to the scenario, to identify gaps, inconsistencies and other areas for improvement in the draft protocols. This feedback was captured as written comments from attendees. Quantitative survey data was collected using 'ask-the-audience' type electronic voting, which gave real-time feedback to the attendees. The outputs of the workshop will be summarised in a report and will be used to improve the environmental management tools, both deliverables for WP8.

Below: WP8 workshop participants at NOC



Deep-Sea Mining Risk Assessment Survey

One planned output from MIDAS WP8 is a regional risk assessment for deep-sea mining in areas of the ocean beyond national jurisdiction. MIDAS has joined forces with the Global Ocean Biodiversity Initiative (www.gobi.org) to undertake this assessment for polymetallic nodules, cobalt crusts, and seafloor massive sulphides.

We are very pleased that Prof. Cindy van Dover (Duke University, USA), together with researchers Phil Turner and Austin Smith, are able to spend some time at NOC this summer, where they are working with Daniel Jones and Jen Durden. As part of their collaboration they have developed an online questionnaire. This ecosystem-based survey approach assesses habitat vulnerability and is modelled after Halpern et al. (2007). This is a high-level scoping approach, with key objectives being to rank potential risk sources in terms of severity and consequences of impact, and to rank habitat vulnerability. Like much of the MIDAS work, it will also expose critical knowledge gaps.

It is important that MIDAS team members from all work packages who have expert knowledge of one or more deep-sea ecosystems contribute to the survey. The MIDAS team has gained considerable expertise during the program; it is important that we capture this new knowledge and insight to the best extent that we can. The survey is open to all other experts who have in-depth knowledge of the relevant deep-sea ecosystems.

If you wish to complete the survey please visit: https://duke.qualtrics.com/jfe/form/SV_1SrnJHTnMP4Frkp