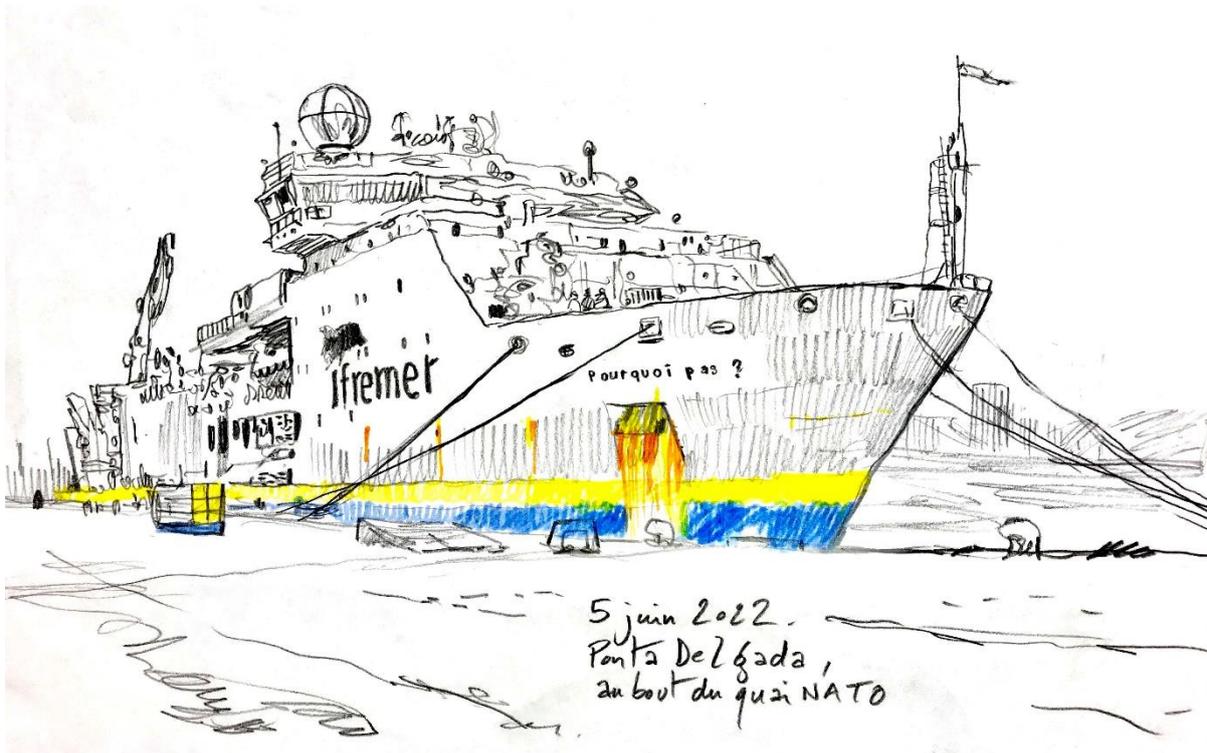




Conservation and restoration of marine ecosystems in the context of deep-sea mining

DEEP REST – First Newsletter



Drawing by the cartoonist Damien Roudeau during the Momarsat 2022 cruise. See more on Instagram – Momarsat. (Credit: Damien Roudeau/Ifremer)

April-September 2022



Editorial – Dear DEEP REST team, I am very pleased to share this very first Newsletter with you and others that are interested in our work. This Newsletter is yours, it is there to share information, questions, adventures ! We will have three issues per year, so keep aside whatever you think would be interesting for this community for the next one! I wish you all a great end of 2022. See you in May, hopefully.

-Jozée

DEEP-REST kick-off meeting

Jozée Sarrazin (Ifremer-coordinator)

The DEEP-REST kick-off meeting was held at the PNBI in Brest May 10-11th 2022. This hybrid meeting gathered 27 on site participants and 16 on-line participants. The first day was spent to present the general objectives of the project and the different Work Packages. Each WP had a one hour slot for presentations. A total of 28 presentations were given by the participants, distributed among the 5 core WPs (WP2-WP6).



Participants to the DEEP REST hybrid kick-off meeting, May 2022, Brest, France. Credit IUEM/Ifremer

Some of the ideas that emerged include: (i) the organisation of a workshop on functional traits by UAveiro (WP2). (ii) A compilation of available data per study site for the 2 ecosystems + identify PIs (WP2). This will also feed D 1.3 (M6) which is the development of a data catalogue. (iii) The organisation of a short series of webinars (on restoration, economy related to mineral resources, connectivity, etc.) in partnership with DOSI (TBD) would be a good way to increase our visibility. (iv) The importance of presenting DEEP REST objectives to Council delegates of each country was raised. (v) We discussed about our future policy briefs (WP6). Several publication supports were mentioned but it is difficult to evaluate which one will have a better visibility. (vi) For outreach activities, a standard presentation about mineral resources for

different audiences will be made. (vii) Several people demonstrated their interest to be part of the editorial board of the future newsletter. A draft template will be send to the team. (viii) Video interviews will be realized to evaluate the knowledge/perception of the general public about deep-sea ecosystems, the presence of resources and their potential exploitation. One person by country would be necessary. The idea is to choose 2/3 questions to ask to different audiences. Video in native language + subtitles in English. Agreement should be signed. A meeting should be organized to agree on the form + procedure & identify questions. The goal of these interviews is simply for communication means. (ix) The AMURE team need some volunteers to update the Diplomasea game towards the topics of deep-sea resource exploitation. 15 persons will be needed to give feedback.

Industry, NGO and policy actors join first DEEP-REST stakeholder workshop

Manuel Bellanger, Joëlle Richard, Pierre Scemama & Denis Bailly

The first DEEP-REST stakeholder workshop held on May 11th 2022 gathered 53 participants, including experts from industry, environmental NGOs, government officials and policymakers, and researchers from a variety of natural and social science fields. The participants worked in small groups on the identification and prioritization of issues to be considered in conservation and restoration scenarios for deep-sea ecosystems in a context of deep-sea mining. The groups also depicted the landscape of deep-sea mining stakeholders and characterized the relative interest and influence of all the relevant actors. To maximize participation, the workshop operated in a hybrid format where online groups were facilitated with a web-based brainstorming app while on-site participants used the good old-fashioned boards and post-it notes to organize their ideas. This workshop constitutes the first step of the stakeholder consultation process to be carried out within DEEP-REST to integrate stakeholder perspectives and expert knowledge into the research process, as well as to build a shared view of conflict areas, barriers, and opportunities for conservation and restoration.



Workshop participants brainstorming on potential deep-sea mining trigger factors in small groups.
Photo credit: Jozée Sarrazin/Ifremer.



A cruise to study the dynamics of deep-sea vent ecosystems

Jozée Sarrazin & Marjolaine Matabos (Ifremer)

The Momarsat 2022 cruise was held from June 6 to June 27th 2022 on board the French research vessel Pourquoi pas? at the Lucky Strike vent field - northern Mid-Atlantic Ridge - to carry out the yearly maintenance of the EMSO-Azores observatory (<https://www.emso-fr.org/fr/EMSO-Azores>).

Once again and despite a few Covid cases on board, we ensured the turnover of the full platform and sensor arrays and started another year of data acquisition! The team of 30 scientists from Ifremer, CNRS (IPGP, GET, MIO, LPO), University of Western Brittany (UBO) and University of Azores worked together during the 15 Nautille dives to achieve the substantial sampling plan paramount to the long-term monitoring of the vent field. Among this, two experiments that are part of DEEP REST were done. The first one was the follow-up of the 17 quadrats that were deployed in 2017 to track the recovery of faunal communities and environmental conditions after an induced disturbance on three sites from active to inactive areas (see Marticorena et al. 2021 for details). While Marticorena et al. looked at the macrofauna only, a new PhD student has been hired to explore the resilience of meiofaunal communities and compare the recovery patterns between the different faunal compartments (WP4). In the longer term, these data will be used to estimate the resilience of active vent communities after a perturbation, information that will bring important insights to help evaluating the impacts of mining activities on deep-sea fauna. The second experiment was the deployment of 6 new benthic chambers that were designed to inject marked ^{13}C to analyse its incorporation by the vent microbial and faunal communities (WP2). Unfortunately, the prototypes did not work as planned and the experiment will have to be conducted again next year. We also recovered a prototype of our new substratum experiment DEEP SEED that was deployed last year (WP2). We found a few flaws that were corrected in our future smaller versions deployed during the Hermine cruise in August 2022 (see below). We also contributed to the development of new procedures to limit the amount of weights left at the bottom to reduce our environmental footprint on the seafloor. Visit the Facebook page (<https://www.facebook.com/CampagneMomarsat/>) for more detailed information about scientific and technological achievements during the cruise. The EMSO-Azores observatory is part of the One Ocean Network for Deep Observation action of Ifremer endorsed by the UN Ocean Decade program. <https://www.oceandecade.org/actions/one-ocean-network-for-deep-observation/>



The entire team that participated to the Momarsat cruise on the Pourquoi pas? research vessel last June 2022 on the Lucky Strike vent field, (Mid-Atlantic Ridge). Photo credit : Damien Roudeau/Ifremer

Links- Facebook Momarsat22 for the cruise log and Instagram: Momarsat for the drawings

Larval supply and colonisation processes on the Mid-Atlantic Ridge assessed with Deep-Seeds

Florence Pradillon, Marie-Anne Cambon, Jozée Sarrazin (Ifremer)

Understanding how living communities develop and thrive at deep-sea hydrothermal vents remains a major gap in our understanding of the functioning of these ecosystems. Recruitment of new individuals is crucial for population replenishment and depends on the supply of larval stages coming from reproductively active populations occurring locally or regionally. Dispersal of larvae and their ability to settle on the bottom are key steps in the colonisation processes and community resilience, both important for the development of environmental impact mitigation strategies in the context of deep-sea mining.

The primary target of mining are the so-called “inactive vent areas”, and vent research focus has recently broadened to include an increasing number of observations at inactive vent areas. Several studies have already hinted at the ecological and functional links between active areas and their inactive peripheries, putting into question whether such a dichotomy is valid. Here, we are looking into colonisation processes, considering both active sites and a range of hydrothermal areas lacking high temperature fluid emissions. In order to evaluate the relative contribution of far-reaching mechanisms such as larval supply and local drivers (i.e. environmental filters) acting at settlement in different types of vent habitats, we developed small experimental modules, called Deep-Seeds. Deep-Seeds collect sinking particles and settling larvae within small tube traps while they also provide colonization surfaces (made of slates or oak) for recruitment of organisms (Fig 1B). At each deployment site, two Deep-seeds (one with slates and one with wood) were deployed along with a tilt

current meter, as well as supplementary colonisation modules made of 3 piled basalt plates (Fig 1C). We deployed 15 of them in August 2022 along a hydrothermal activity gradient during the Hermine 2 cruise on board the N/O Pourquoi pas?

6.

The Hermine 2 cruise explored the French licence area, located between 21°N and 26°N along the Mid-Atlantic Ridge. Research objectives included a specific focus on a series of active and inactive hydrothermal mounds in the vicinity of TAG Active mound (Fig 1A). Besides different observations conducted with HOV Nautile on the geology, mineralogy, fluid activity, microbial activity, we deployed our standardized platform Deep-seeds to evaluate colonisation processes at 4 mounds with different age and hydrothermal activity levels.

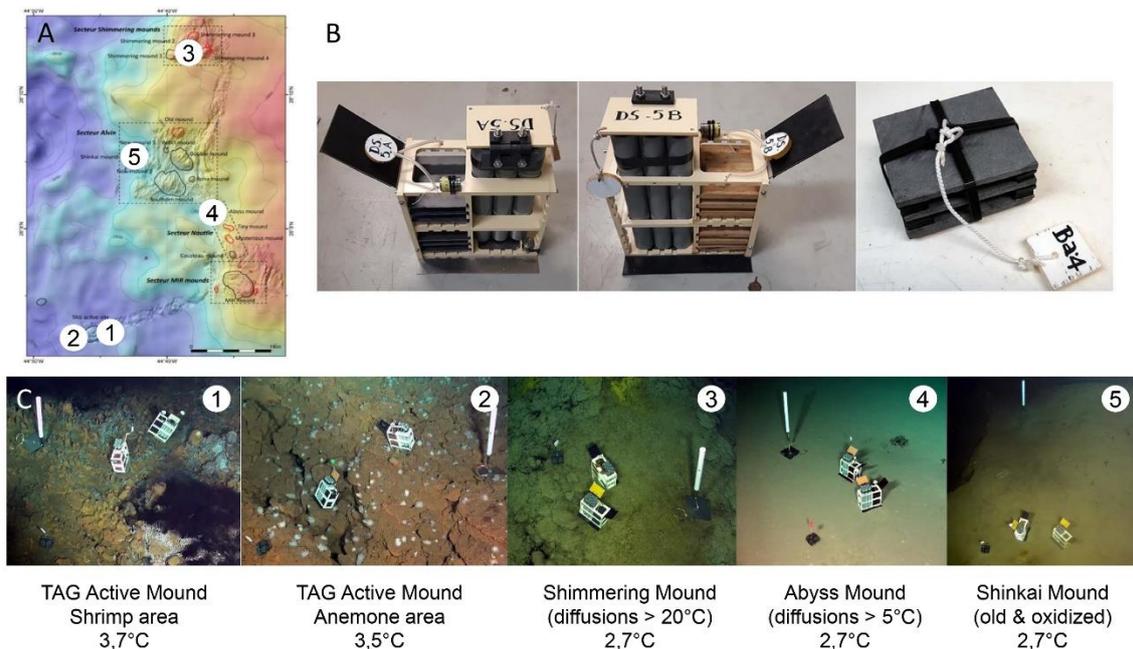


Figure 1. Deployment of Deep-Seeds at 5 sites along a gradient of hydrothermal activity in the TAG district on the Mid-Atlantic Ridge. A) Overview of the TAG district showing where each set of Deep-Seeds is deployed (numbered 1-5 according to the estimated level of hydrothermal activity). B) Deep-Seeds modules equipped with slates (left) or wood (middle), and basalt colonisation plates (right). C) In situ pictures of the 5 deployment sites illustrating the activity gradient from an active high temperature area (left) to an old oxidized mound without temperature anomaly (right). A brief description of the deployment area and the average background water temperature are given under each image. ©Map: E Pelleter, AS Alix/CYBER/lfremere, photos: Bicosse 2 cruise 2018/lfremere.

Five deployment sites were chosen to illustrate the gradient between active vent areas and old extinct vents (Fig 1C). At TAG, 2 experimental sets were installed at the base of the active mound, close to small smokers inhabited by shrimps, and on oxidized sulphide blocks colonized by vent anemones. Background temperature at each site was higher than ambient deep-sea temperature due to numerous diffusions emerging from base of the mound. Two other sets were deployed at hydrothermal mounds exhibiting discrete low temperature diffusions, namely Shimmering Mound and Abyss Mound, with background equal to the deep-sea ambient temperature. The last set was deployed on Shinkai Mound, an old and oxidized mound where no temperature anomaly was detected.

These colonisation experiments will be recovered in 2023, during the BICOSE 3 cruise. Organisms settled on substrata and larval stages captured in tube traps will be identified. Diversity and abundance of larval and settled communities will be compared between substratum types and sites. Current-meters will provide information on local hydrodynamics during the in-situ deployment, potentially giving hints on larval arrival. This experimental approach will allow us to better evaluate colonisation processes at inactive or low activity sites, estimating the relative contribution of large-scale (dispersal) vs local-scale processes (environmental filters) in each type of habitat, and further assess the functional and biodiversity links between active and inactive sites.

Link: Hermine 2 cruise blog: <https://www.geo-ocean.fr/Campagnes/Campagnes-oceanographiques/Bienvenue-sur-le-blog-de-la-mission-HERMINE2>

Plume hunting along the Mid-Atlantic Ridge

Daphne Couvelier (IMAR)

This August, the iNANO cruise took place on-board the RV Pelagia (64PE509, PI: Peter Kraal, CO-PI's: Martina Preiner, Oliver Plümpfer) visiting the hydrothermal vent fields of Menez Gwen and Rainbow, both south of the Azores. These two vent fields offer very different settings: Menez Gwen is a basalt-hosted site situated at 850m depth, Rainbow is an ultramafic site at 2300m depth. These differences in geology and depth impact fluid composition and result in diffuse venting and more greyish smokers at Menez Gwen and vigorously belching black smokers at Rainbow. Besides the differences in setting, both areas share many species but are characterised by different dominating faunal assemblages: mussel beds for Menez Gwen vents and coral gardens outside of the vent field versus shrimp assemblages for Rainbow vents and sea cucumbers and some solitary corals outside the active areas.



Images from left to right: the mussel beds (*Bathymodiolus azoricus*) and diffuse venting at Menez Gwen hydrothermal vent field (850m depth), shrimp (*Mirocaris fortunata*) at Rainbow hydrothermal vent field (2300m depth) and black smoker plumes and fluid exits at Rainbow. Images © NIOZ-64PE509 iNANO cruise.

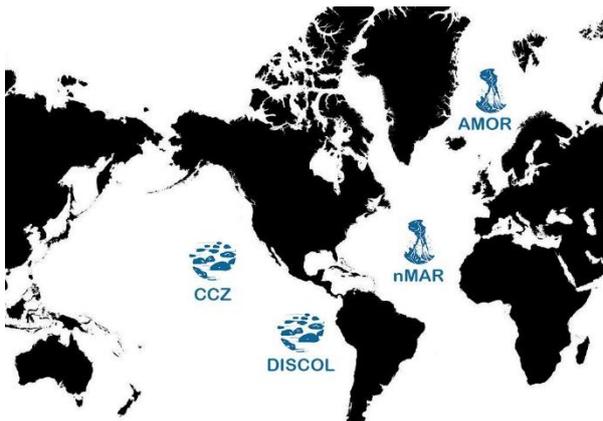
The main purpose of these video transects was to study the active and inactive areas, the shifts in fauna and changes in environmental settings across and beyond the active sites. The transects were planned in such a way that they would complement previous ones and maybe even allow insights in temporal variations over the years. Moreover, to serve the objectives of the cruise, these transects were used for “plume-hunting” and to localise actively venting sites and fluid exits to identify areas for subsequent sampling. These plumes (diffuse at Menez Gwen and black at Rainbow) were then sampled to collect the freshest particles possible to reveal the impact of iron nanoparticles on the ocean biochemistry.

Link- <https://www.nioz.nl/en/blog/blog-i-nano-cruise-exploring-deep-sea-nanomaterials>

Two months at sea – studying the impact of nodule mining and potential restoration

Lilian Boehringer (AWI), Patricia Esquete (University of Aveiro), Sabine Gollner (NIOZ), Matthias Haeckel (GEOMAR), Felix Janssen (AWI), Massimiliano Molari (AWI) & Ellen Pape (Ghent University)

On the 31st of October 2022, an international group of scientists from the projects MiningImpact2 and DEEP REST will embark on the research vessel Sonne to spend 8 weeks on the high seas in the Clarion Clipperton Zone (CCZ) where a nodule collector test was carried out 18 months before at ca. 4200 meters water depth. The main question “*what are the impacts of nodule mining and can these be restored?*” will keep the scientists and ship crew busy. Matthias Haeckel, chief-scientist and coordinator of MiningImpact2, has the mammoth task to coordinate all the scientific work. The main impacts exerted by the nodule collector test comprised habitat removal and modifications, the creation of sediment plumes smouldering the abyssal habitat within and near the trial sites, as well as chemical, light and noise pollution in the water column and at the seafloor. These impacts are expected to lead to major losses of organisms that live on and in the nodules and in the surrounding soft sediments. Furthermore, the impacts could make the area an unsuitable habitat for numerous species for extended periods of time (many hundreds to thousands, or even millions of years). This is obvious for the nodule hard substratum that is removed which will only return on geological time scales (i.e. millions of years), but this is equally true for the soft sediments that are physically and biogeochemically altered.



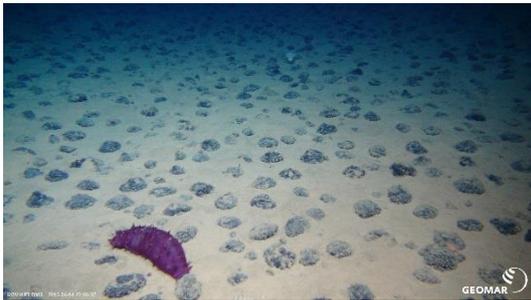
Map of the DEEP REST study areas with nodule (DISCOL & CCZ) and hydrothermal vent (nMAR & AMOR) ecosystems. During this expedition, the Clarion Clipperton Zone (CCZ) will be visited. Map credit: J. Sarrazin/Ifremer.



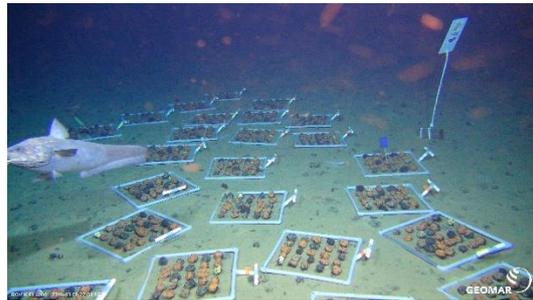
Research vessel SONNE, on which the scientists will spend 8 weeks on the high seas (Photo credit: Manfred Schulz, RV SONNE 242/2, 2015, Max Planck Institute)

In addition to environmental consequences of the collector test, DEEP REST participants will investigate and compare the biodiversity, functioning, and connectivity of biological communities within and across ecosystems in the CCZ, in relation to environmental conditions, and identify potential refuge areas and corridors (WP2). They will further evaluate the recovery potential and resilience of deep-sea communities after test mining disturbance (WP3). Lastly, through experimentation, the effectiveness of different restoration actions on the recovery of deep-sea communities will be explored (WP4). To this end a suite of cutting

edge methods will be applied, including the measurement of *in situ* oxygen consumption and microbial activities, the quantification of abundance and biomass of all benthic size groups, and the study of biodiversity by combining traditional approaches with state-of-the-art molecular methods to sequence environmental DNA and RNA.



Nodule field in the Clarion-Clipperton Zone.
Photo credit: GEOMAR, ROV Kiel 6000.



Substratum experiment to test restoration in the German license area. Photo credit: GEOMAR, ROV Kiel 6000.

The expedition blog link will be installed in October 2022 and will be accessible through the MiningImpact webpage: <https://miningimpact.geomar.de>.



Freya the walrus: a canary in the coal mine?*

Prof. Dr. Ann Vanreusel (Gent University)

The cold euthanizing of an overly brash walrus named Freya has stirred a lot of controversy. Was it necessary to eliminate a 'harmless' animal, a mighty sea giant, a symbol of an extreme ecosystem, in order to safeguard boat owners, but also negligent tourists, from accidents? This is an understandable question and many arguments can be formulated for or especially against it. In this opinion piece, I do not want to dwell more deeply on animal welfare, more specifically the fate of this one walrus. Nor on that of its fellow sufferers such as the unfortunate orca and beluga that recently ended up tired and sick in the Seine 'of all places', the last place you would want to be as an arctic marine mammal, and thus eventually perished after several failed rescue attempts. However, a question I inevitably have to ask myself as a marine scientist is why these organisms turn up in places far away from their original habitat and living conditions, and is this normal? Is the frequency of such strays increasing? Is this more likely to happen to us after Wally turned up in the UK in 2021 and now Freya in Norway? After all, if this becomes a more frequent phenomenon, it must be anticipated in a scientifically based and efficient manner, but above all, the causes of these unfortunate migrations must be investigated. Are these migrations a warning sign, or even more the canaries in the coalmine? Is this not what should be the top priority of current policy: safeguarding the future of our planet from human-induced unliveable conditions for key

species, including first and foremost humans, but also marine mammals such as the beluga, orca and walrus? Polar regions are undergoing strong and rapid climatic changes, accelerating the melting of ice shelves and glaciers and drastically reducing the ice-associated habitat of many polar species. This has undeniable consequences for humans and animals. Changing migrations and animal behaviour can provide insights into changing living conditions and act as rapid indicators. Walruses typically migrate throughout the year in search of suitable feeding grounds, often concentrating on sea-ice close to the coast where their food is available. Recently, due to the lack of sufficient sea-ice, walruses are increasingly gathering on ice-free shores, forcing them to travel longer distances to find their food. This forced shift in habitat could have important consequences and affect their populations in the short term. Also, the recent emergence of new maritime routes, is rapidly increasing commercial shipping in the Arctic, threatening with even more disturbance to these polar marine populations. These activities are also associated with an increased risk of shipping accidents releasing oil or other pollutants into Arctic seas, as well as noise pollution. Walruses produce many sounds, such as grunts, clicks and underwater songs, which are used for social interactions, including mating and contact between mother and calf. These sounds overlap with the frequencies from shipping noise, as well as oil drilling and other human activities at sea.

Like the toothed whales Belugas and Orcas, both top predators, walruses have an important role in the Arctic ecosystem. As walruses root about the seabed in search of cockles and mussels, their main food source, they remove large quantities of prey from the seabed, influence the size structure of mussel populations, and create new microhabitats for other organisms. The Atlantic population of walruses is estimated at around 20 000 individuals, and is listed as a 'near threatened' species on the IUCN (International Union for the Conservation of Nature) red list.

The Freya phenomenon has rightly received a lot of media attention. The nuance I want to make is that it is not so much the culling of an individual animal that should concern us, but rather the changes that natural ecosystems are undergoing at an accelerating pace and how, charismatic or otherwise, key species are once again bringing us face to face with the fact that critical habitats such as Arctic summer pack ice are doomed to disappear in the very short term and action is needed now to address climate change by banning fossil fuels, sooner rather than later.

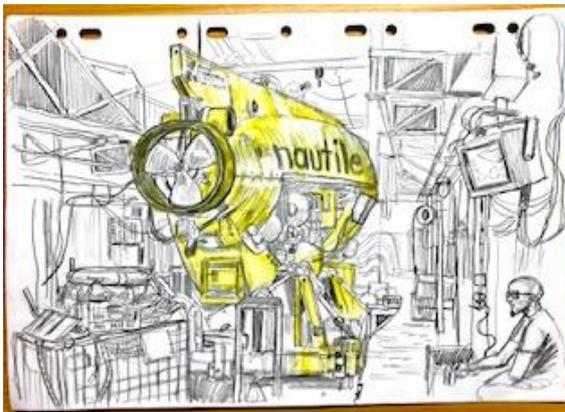
** DeepRest Principal Investigator in WP3, Prof. Ann Vanreusel, was contacted by one of Belgium's most respected news outlets "De Standaard" to provide a commentary on the recent euthanizing of Freya the walrus in Norway. In this opinion piece, she not only offers her reflection on this singular incident, but considers a broader perspective of what such events are signalling, and what needs to be done to prevent them.*

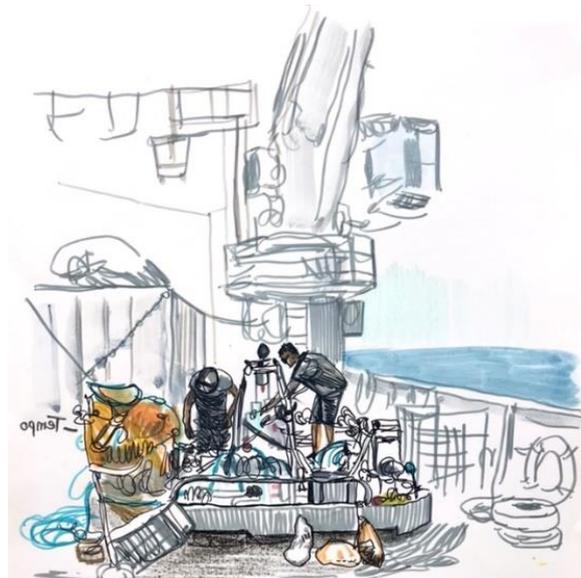


A journey between two deep-sea scientists, a seaman and a cartoonist

Marjolaine Matabos, Damien Roudeau, Nicolas Le Roy & Jozée Sarrazin (Ifremer)

The presence of Damien Roudeau, a cartoonist all along the Momarsat 2022 cruise contributed to reinforcing the synergy between all on-board teams. Through hundreds of illustrations, the artist described and shared the adventure of scientists, pilots and crew members working together towards a common objective: enhance our knowledge about deep-sea ecosystems. After this month-long journal, a comic book story will be prepared (to be released at the end of 2024, WP6, D6.3) to embody the scientific, environmental and financial stakes of the quest for rare earth elements and strategic minerals through this mission. This journey was initiated several years ago by researchers M. Matabos and J. Sarrazin during a conversation with N. Le Roy, a seaman of the Pourquoi pas?, all concerned by environmental issues related to the sea. You can have a look at the Instagram pages (Momarsat) to get an illustrated overview of the cruise. A presentation will be made at the COMMOCEAN meeting in Sète at the beginning of December 2022 (Matabos & co-authors). At the same meeting, J Sarrazin & co-authors will be presenting a conference entitled: Coupling “arts & sciences”: inspiration and innovation to increase ocean literacy.





Drawing examples from the Momarsat cruise. Credit: Damien Roudeau/Ifremer.

Up-coming events:

- ❖ An “art & science” workshop for undergraduate and graduate students during the weekend of the 1st of October. (J Sarrazin & Teatr PIBA)
- ❖ The theatre play DONVOR about deep-sea ecosystems will be shown in Landivisiau (France) October 13 & 14 and in Morlaix (France) November 16th. The play will be preceded by conferences for college and university students while scientists will also interact with the public after the plays. (J Sarrazin/PM Sarradin)

IceAGE vent fields – Nights at the Museums

Saskia Brix, Jenny Neuhaus, James Taylor (Senckenberg Institute)

To kick off the “Im Tiefenrausch – Film unter Wasser” (In the depths of rapture – film under water) exhibition at the German Film Institute and Film Museum, Frankfurt (DFF), running 01.07.2022 – 08.01.2023, the IceAGE team sent various film material and pre-recorded interviews to include in the exhibition. On World Ocean Day (6th June), IceDivA PhD student Jenny Neuhaus (DZMB, Senckenberg) participated in the grand opening, being interviewed alongside Henry Knauber (Senckenberg, Frankfurt) and Dr. Tina Kaiser (University of Marburg) to discuss the role of media in the depiction of the underwater realm, and its realism therein, as well as the work and environments that take place in real world science. IceAGE/IceDivA will return with active participation during the closing event (07.01.2023) with Dr. James Taylor and Dr. Saskia Brix being part of an open panel session to questions from the general public on their work and the IceAGE vent fields.



Exhibition at the DFF Frankfurt, Germany. IceAGE/IceDivA display shown including interview of Dr. James Taylor (DZMB, Senckenberg).
Photo credit: Jenny Neuhaus.



Photographer Solvin Zankl and Dr. Saskia Brix (DZMB, Senckenberg) discuss the underwater realms around Iceland at the Schlaues Haus "IceAGE" exhibition in Oldenburg, Germany.
Photo credit: Saskia Brix.

Also in the world of outreach, the opening of the photo exhibition "IceAGE" on Tuesday, September 20, in the Schlaues Haus, Oldenburg, Germany, took place. The exhibition showed photographs by award-winning underwater photographer Solvin Zankl, who accompanied an expedition team from the Senckenberg am Meer institute. The exhibition showed the underwater world around Iceland, including the IceAGE vent field, as part of the IceAGE project. The aim was to understand what exactly influences the distribution of species in this sensitive region and what role climate change plays in this. The photographs can now be seen in the Schlaues Haus from September 20th to December 30th. The exhibition was opened with the presence of the photographer on Tuesday, September 20th 2022, at 7 p.m. and is open Monday to Thursday from 9 a.m. to 5 p.m. and Friday from 9 a.m. to 4 p.m. by December 2022.

Links : <https://www.museumsufer.de/de/ausstellungen-und-veranstaltungen/ausstellungen/im-tiefenrausch-film-unter-wasser/> and <https://www.schlaues-haus.de/events/begegnungen-2022-island-iceage-die-fantastische-unterwasserwelt-vor-island/>



Congratulations to Ugo Massé for his Master's internship!

Ugo Massé, Manuel Bellanger, Joëlle Richard, Pierre Scemama, and Denis Bailly
(AMURE/UBO)

Ugo Massé, Master student at AgroParisTech, did his internship at AMURE – University of Brest, from March to August 2022. He defended his work on the issues relating to the protection of deep-sea environments and to deep seabed mining on September 15th, 2022.



Abstract of Ugo's report: With the fight against climate change and the stated desire to switch from fossil fuels to renewable energies, metals are necessary resources to lead the energy and ecological transition. However, the decline in their accessibility on land and the estimated needs to achieve the goals set by nations are turning some economic and political actors towards the minerals located at the bottom of the ocean, up to several thousand meters deep. Due to the particular location of resources, their exploration and exploitation are managed by an authority acting under the aegis of the United Nations, the International Seabed Authority (ISA). This authority is currently in the process of developing the mining code, which will govern the exploitation of resources of the Area (seabed outside national jurisdictions). In a context where the beginning of the exploitation of polymetallic nodules and polymetallic sulphides of the Area seems closer and closer, the issues relating to such an activity are numerous and the start of operation remains uncertain. Identification of potential triggers and brakes at the start of exploitation in deep water is necessary for the development of an appropriate governance framework in a political-legal context particularly complex related to the location of these resources. This situation led to the establishment of the following problem: How to identify and prioritize the issues, triggers and barriers related to seabed mining?

Although literature reviews exist on the subject of the issues, barriers and obstacles relating to seabed mining, these are concentrated generally on a few aspects, such as environmental, social, or legal. Through this research question, this work mobilizes the PESTEL analysis framework (for political, economic, social, technological, environmental and legal), originally used in the industry and business sector, to identify the potential triggers and barriers related to seabed mining stated in the literature in order to conduct more comprehensive coverage.

In addition, the work applies this analytical framework to a stakeholder workshop organized as part of the DEEP REST research project mobilizing the expertise of the stakeholders for the identification of the issues. The actors mobilized belong to the categories of industry, non-governmental organizations, environmental organizations, academic researchers, political authorities and decision-makers.

The results relating to the identification of the main triggers and obstacles to seabed mining obtained by the two methods (literature review and stakeholder workshop) present many commonalities. Regarding the results obtained during the workshop, the request for minerals (and access to them) and profitability of operations are the potential economic triggers most mentioned. The main obstacles to seabed mining are the social and environmental externalities. As such, establishing a social license operations and filling gaps in environmental knowledge may be required for operations to start. The challenge of technological feasibility, the movements in favour of a moratorium on exploitation and the drafting of the mining code by ISA also emerge from the literature and the workshop. However, some notable differences appeared between the literature review and the actor workshop, with, for example, the mention of the “counter-lobbying” of the terrestrial mining industry by some participants in the workshop, and inconclusive operating pilot projects or with environmental impacts too important.

The main limitation identified with the use of the PESTEL analysis framework is related to the fact that certain factors are sometimes found in more than one category, making it difficult to conduct an in-depth analysis of the relative importance of the different categories of factors identified in literature and by actors. The small number of participants in the group of authorities and political decision-makers during the workshop also constitutes a limit to the results. Conducting individual interviews with actors not present during the workshop would allow to deepen the identification of the issues. Nevertheless, this work shows that the approach allows an initial identification and prioritization of the issues to be considered in scenarios on the possible modalities of implementation of seabed mining in relation to the conservation and restoration of deep-sea ecosystems.

Alicia Veillot, a PhD student working on colonization processes on the Mid-Atlantic Ridge



Alicia in front of the binocular. Photo credit: Valérie Ferchaud.

Alicia VEUILLOT is a PhD Student on benthic ecology at the Deep-Sea laboratory (LEP, Brittany) supervised by Jozée Sarrazin, Marie-Anne Cambon and Florence Pradillon. After a bachelor's degree in ecology (Haute-Savoie), and a master's degree in functioning and management of marine ecosystems (Boulogne-sur-mer) with several short oceanographic missions in the coastal environment and a 6-month internship in the LEP, Alicia is continuing to do research. Her thesis is COLONIZE: Colonisation processes at the periphery of hydrothermal vents: zones that are potentially targeted for their mineral resources. She should take part in the BICOSE 3 campaign in winter 2023. She is working on two vent fields forming part of the French exploration license area: TAG and Snake Pit (Mid-Atlantic Ridge) where artificial substrates (slate, wood, bone and synthetic sponge) were deployed from 2014 to 2018. Her main objective is to study colonization of microorganisms, meiofaunal and macrofaunal compartments, with the aim of assessing the colonizing potential of artificial substrates and thus promote the ecosystemic restoration in the event of mining. Besides this, Alicia is involved in outreach projects and scientific communication such as "Les Cordées de la Réussite", "Immersion Sciences" and "Festival Grand Océan".



Our new advisory board is composed of: Samantha Smith, David Billet, Luciana Genio and Claire Armstrong. You can see their profiles on the web site and contact them directly by using their mailing list: advisory_board_deep-rest@listes.ifremer.fr. Thanks to all of them to be part of our great project!

The **consortium agreement** has been sent to all DEEP REST partners, please make sure that your law department had a look and agrees. It would be nice to have it signed soon.

The **data management plan** also needs your input. Please take a few minutes to identify the data you will be using during this project.

Communication tools

Web site: <https://deep-rest.ifremer.fr/>

Mailing to deep-rest organization team (WP1): deeprest2022@gmail.com

General DEEP REST mailing list: deeprestall@listes.ifremer.fr

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Please cite DEEP REST in your acknowledgements (publications, conferences, activities)

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Check new **Marine Spatial Planning IOC-UNESCO guide** that was recently published. This guide builds on the inputs, experiences and lessons learned provided by the MSPglobal community through all activities organised or supported by the Intergovernmental Oceanographic Commission of UNESCO and the European Commission's Directorate-General for Maritime Affairs and Fisheries between 2017 and 2021, in the context of the Joint Roadmap to accelerate marine/maritime spatial planning processes worldwide. References: UNESCO-IOC/European Commission. 2021. MSPglobal International Guide on Marine/Maritime Spatial Planning. Paris, UNESCO. (IOC Manuals and Guides no 89)

Link - <https://ioc.unesco.org/our-work/guidance-marine-spatial-planning>

Next DEEP-REST meeting will be in the Azores during the spring, we will keep you posted!