Long-term Impacts of Deep-Sea Mining

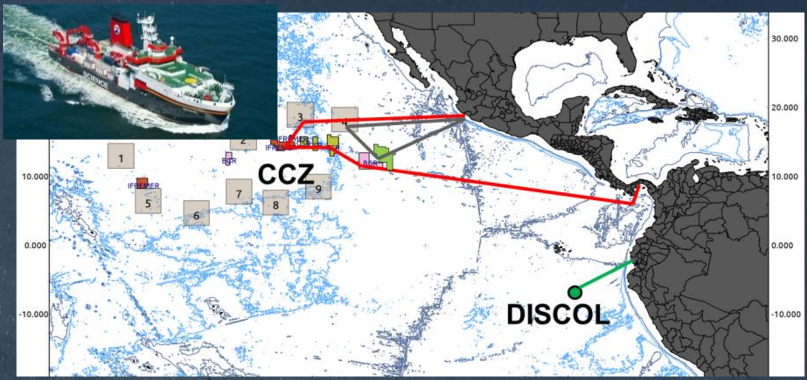
Results of the MiningImpact project

Project Overview, Key Findings and Policy Recommendations.

October 2017

Introduction

The JPIOceans project ‘MiningImpact’ aims to assess the long-term impacts of polymetallic nodule mining on the deep-sea environment. Core to the project have been three 2015 marine research campaigns, conducted in the CCZ and the DISCOL Areas of the Pacific Ocean.



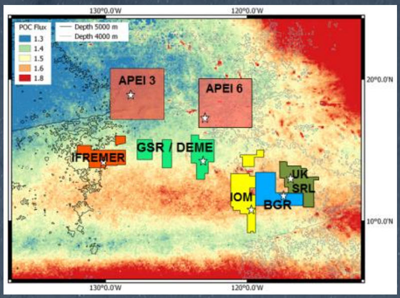
The Clarion Clipperton Zone (CCZ) and Peru Basin DISturbance and reCOLonization (DISCOL) nodule fields of the Pacific Ocean. The key locations visited with ‘RV SONNE’ during the JPIOceans ‘MiningImpact’ project.

CCZ License Areas & APEIs

In the CCZ, ‘MiningImpact’ researchers have investigated ecosystem biodiversity across productivity gradients and species connectivity by comparing observations made in a number of license areas and APEIs 3&6.

In each study area, the abundance and composition of faunal communities, biogeochemical functions, and oceanographic conditions inside and outside of nodule fields, at seamounts, and within and surrounding decade-old disturbance tracks were analyzed.

LEFT: Study areas in the CCZ: APEIs 3 & 6, license areas of France, Belgium, IOM, Germany and the UK.
BELOW: Images taken from disturbed regions within the CCZ, from months to decades after disturbance



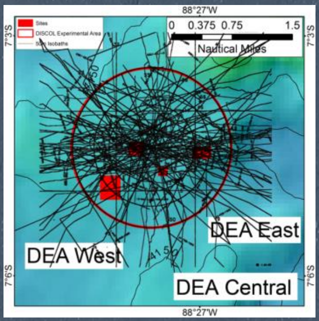
BGR, EBS, 3 years

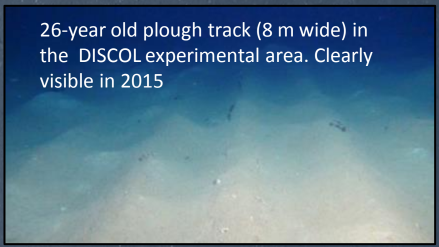
DEME-GSR, dredge, 8 months

IFREMER, OMCO dredge, 37 years

DISCOL Experimental area

In the Peru Basin, a 11-km^2 large nodule field was ploughed in 1989 to mimic deep-sea mining. AUV-based habitat mapping, towed camera surveys, box core sampling and ROV based in-situ investigations were used to investigate long-term changes in microbial and faunal community structure, seafloor integrity and biogeochemical ecosystem functions.





26-year old plough track (8 m wide) in the DISCOL experimental area. Clearly visible in 2015

LEFT: Map of 78 trawls made across the DISCOL region in 1989. Experimental work focused on sampling the range of ploughed , unploughed and reference areas.

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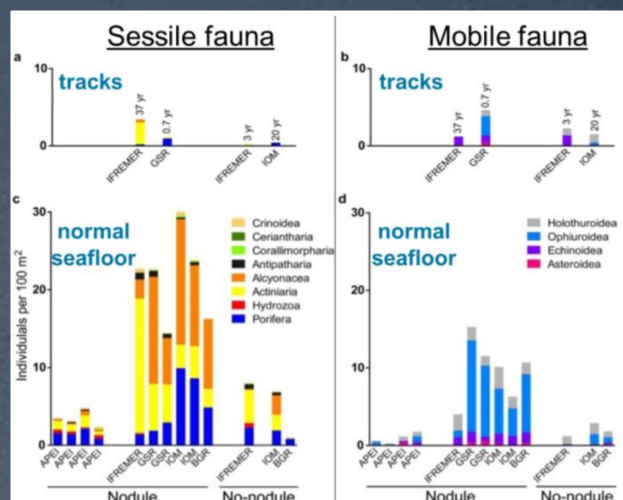
NWO Netherlands Organisation for Scientific Research · Federal Ministry of Education and Research · belspo · Flanders State of the Art · FORMAS · FCT Fundação para a Ciência e a Tecnologia · JPI OCEANS · The Research Council of Norway

Scientific results
Overview

- Nodule ecosystems support a highly diverse fauna of sessile and mobile species.
- Faunal communities & environmental parameters show a high variability even on a very local spatial scale.
- Benthic fauna communities differ significantly between seamounts and nodule habitats.
- Loss of seafloor integrity by nodule and sediment removal generally reduces population densities and ecosystem functions. Biogeochemical remineralization processes (see next page) and the productivity of the benthic community are both impacted by nodule removal.
- Disturbance impacts on nodule ecosystems last for many decades, affect numerous ecosystem compartments and functions.

Scientific results
Megafauna abundance CCZ

Within MiningImpact, faunal abundances were compared across license areas in the eastern CCZ and APEIs. Normal nodule-covered seafloor was observed to have a higher abundance of both sessile and mobile fauna than areas with no nodule coverage. Revisits to historically disturbed areas where nodules were removed from the surface showed abundances to remain reduced, despite the intervening years (‘tracks’ below).



Epifauna communities have not recovered in the decade-old disturbance tracks (low biodiversity, very low abundances), with densities observed in 2015 lower than those observed in association normal deep-sea floor in CCZ areas, both those with and without seafloor nodule concentrations (Vanreusel et al., 2016, Sci. Rep. 6).

Scientific results
Stalked structures

Within all the nodule abundant ecosystems visited within the MiningImpact project, stalked biogenic structures have been abundant habitat components.

Within the surveyed locations, a number of crinoid, sponge and coral species grow up to ~1 m above the seafloor on biogenic stalks.

During life, and following death, these stalked features provide a useful substrate for other fauna.

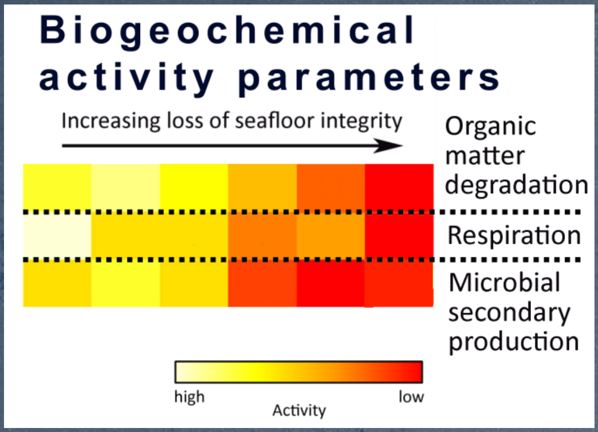
These stalks are commonly removed during disturbance events.

Barnacle and ophiuroid utilising a sponge stalk in the DISCOL region.

Stalked structures also provide key habitat resources for some larger mobile megafauna for periods of their lifecycle. Here, an octopod was observed brooding eggs on a stalk in the DISCOL area.

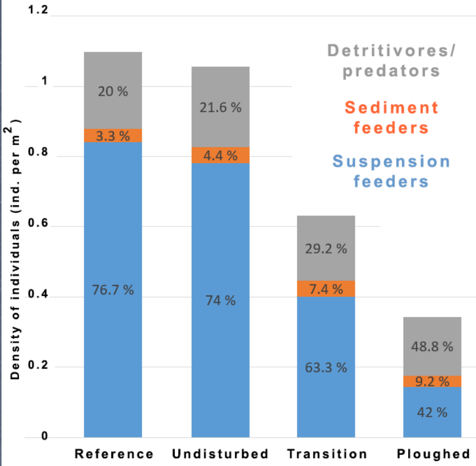
Scientific results
Biogeochemical activity

ROV based studies carried out in-situ demonstrated that with increasing levels of physical seafloor disturbance, biogeochemical activity within the upper seafloor sediments (as characterised by organic matter degradation, respiration and microbial secondary production, see below) were progressively reduced. The most disturbed seafloor areas, such as the EBS trawled areas, plotted to the right on the below chart, with undisturbed sediments in the reference areas plotting to the left.



Scientific results
Feeding strategies

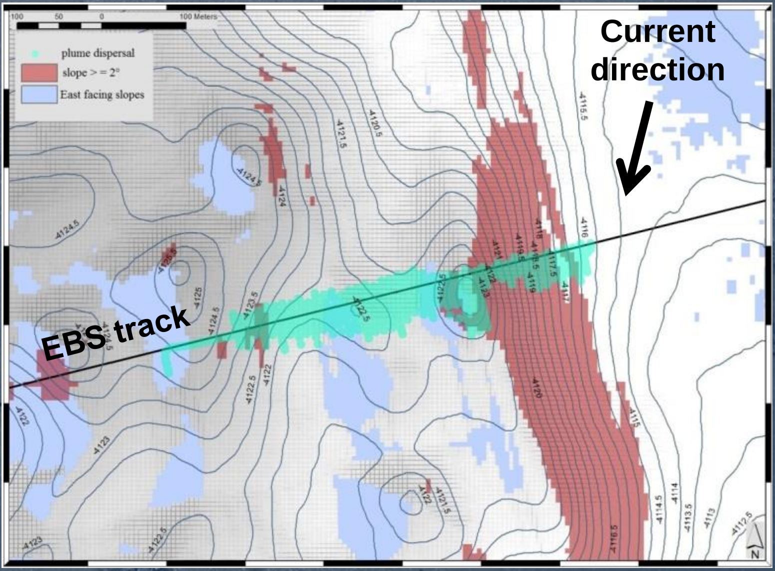
In addition to the loss of epifauna and sessile fauna, even on decadal scales following nodule removal from the sediment surface, shifts in community structure have been identified during the MiningImpact project. In undisturbed regions suspension feeding was the predominant mode of life observed. The percentages of sediment feeders (deposit feeders) and detritivores were higher in regions of the DISCOL site from which nodules had been ploughed into the sediments than in undisturbed regions.



Scientific results – Plume monitoring

Many species inhabiting manganese nodule abundant ecosystems are slow growing filter feeders. There is therefore a concern that exposure to considerably elevated concentrations of resuspended and resettling sediments resulting from mining activity may impact on these organisms. Within the MiningImpact project the distance to which resuspended sediment travelled was investigated in experimental CCZ trawls.

Sponge smothered by sediment, in close vicinity to a disturbance track.



AUV-based map of the resettled sediment that was suspended by an epibenthic sledge (EBS) deployment and smothered the adjacent nodule habitat. The green area was blanketed by several millimeters of sediment approx. 30 m north and up to 100 m south of the disturbance track. The impacted area depends on ocean bottom currents, local bathymetry, and the height of the sediment plume.

Policy Recommendations

- Conservation areas need to match habitat characteristics of mined areas (e.g. ocean productivity, nodule coverage, community composition) to preserve abyssal biodiversity in the CCZ and protect specific vulnerable or important ecosystems.
- Seamounts and APEIs alone cannot be expected to compensate for biodiversity and ecosystem services lost by mining operations: additional marine protected areas are needed.
- ISBA documents on methods & parameters for baseline studies and monitoring need to be revised to current state-of-the-art science in a transparent and open way.
- Minimizing of large-scale impacts requires careful and adaptive spatial planning of mining operations, establishment of a network of representative preserved areas, and development of low-impact equipment.
- Environmental management plans should consider multiple impact and preservation reference zones (IRZ & PRZ) for each mining area to deal with uncertainties in sediment plume dispersal and natural variability in the deep sea, to facilitate monitoring of environmental impacts and adaptive management efficiently.
- Appropriate monitoring technologies to assess mining impacts and natural spatial & temporal variability are available, but knowledge exchange between industry and science needs to be strengthened to ensure best methodologies are ready for industry use.
- Indicators of ecosystem health and threshold values for “harmful effects” on the environment need to be defined as well as rules for avoiding or mitigating them (e.g. following the UN SDGs, EU MSFD or IPBES documents).
- Assessment of environmental & societal risks needs to be fed into improved legislation.
- Transparent, independent scientific assessment of deep-sea mining operations and transparent data policies need to be secured.

Environmental monitoring of a future mining test

- Testing of state-of-the-art and novel monitoring technologies (e.g., in situ sensors & platforms, rapid impact assessment tools, databases and annotation systems, predictive numerical models) and appropriate monitoring strategies & concepts including a cost-benefit analysis.
- Raising of technical-readiness-levels of monitoring technologies (currently TRL 3-5) to allow for low-cost & low-maintenance deployment and feasible non-expert data evaluation by industry.
- Testing of concepts for environmental management and monitoring plans (EMMP), including e.g. multiple and different impact and preservation reference zones (IRZ & PRZ).
- Testing of mitigation options (exploitation technology & spatial planning) and restoration measures.

Schematic of a real-time mining monitoring concept, utilizing an autonomous vehicle for seafloor and plume mapping

- Application of developed monitoring standards & protocols for quantifying and assessing the spatial and temporal footprints of impacts (sediment removal & compaction, dispersal of the suspended sediment plume, blanketing of the seabed inside & outside the mined area, acoustic noise of mining operations).
- Updating of environmental risk scenarios and feedback into improved international legislation as well as political & public discussion on deep-sea mining.

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