Sea Floor Mining, Results of the MIDAS project and Progress with SEMPIA

Phil Weaver
Seascape Consultants
Romsey, UK
**Main Resources**

**Manganese nodules**
Located in 4000-6000 m wd on abyssal plains
Metals: Ni, Co, Cu, Mn, Mo, Rare Earths
2D deposit on seabed (15-25 kg/m²)
Mine size 63 km² per million tons of mined ore

**Cobalt Crusts**
Mineable deposits 800-2500 m wd on seamounts
Metals: Co, Ni, Cu, Mo, Te, Pt, Rare earths
2D deposit on seabed up to 26cm thick
Mine size 13-38 km² per million tons of mined ore

**Massive sulphides**
Located at 100-5000 m wd on ocean ridges
Metals: Cu, Zn, Au, Ag
3D deposit
Mine size ~ 0.05 km²/ million tons mined ore
Global distribution of massive sulphides

Location of seafloor massive sulphide occurrences with base and/or precious metal enrichment (source GEOMAR; N=82)

Most deposits only sampled at surface hence thresholds of 5 wt.% Cu, 15 wt.% Zn and 5 grams/tonne gold (Au) used in figure.
Massive sulphides – biological characteristics

ON ACTIVE VENTS
• Many endemic species
• High biomass, low biodiversity
• Linear distribution
• Relatively fast regeneration

ON INACTIVE VENTS
• High biodiversity
• Lower biomass
• More widespread distribution?
Planned mining at Solwara 1 by Nautilus Minerals
Sulphide mining on ridges

Technology readiness:

April 2017 Tools arrived in PNG ready for sea trials

Signed contract to hire new ship – to be built in China and rented at $200,000 per day.
Development of the Regulatory Framework for mineral exploitation by the ISA
MIDAS Work Programme

Identifying the scale of the problem
- WP1 Geological impacts
- WP2 Plumes in a dynamic environment
- WP3 Ecotoxicology

Determining the impact and its duration
- WP4 Impact on species connectivity
- WP5 Impact on ecosystem function and services
- WP6 Ecosystem resilience and recovery

Sustainable management: working with industry to find workable solutions
- WP7 Industry management practice
- WP8 Developing protocols and standards

Working with policy to enshrine best practice in law
- WP9 Societal framework and legal instruments

Developing a science/industry interface to deliver new technology to facilitate scientific understanding, monitor impact and ensure compliance

WP10 New monitoring technology

WP11 Project management and coordination
Impacts of Deep-sea Mining

**Light, pollution from ship**
**Trans-shipment plume**

**Returned water plume**

**Noise, vibration**

**Benthic Impacts**
- Large area impacted - nodules, crusts (connectivity, ecosystem function, recovery etc)
- Substrate removal (inc nodules)
- Removal of surficial sediment layer
- Sediment compaction
- Generation of benthic plume
MIDAS research areas: 1) AWI-Hausgarten; 2) Svalbard; 3) N-Atlantic hydrothermal area; 4) Ranfjorden; 5) Black Sea; 6) Palinuro Smnt; 7) Portman Bay; 8) El Hierro; 9) Lucky Strike; 10) Snake Pit; 11) TAG; 12) MAR; 13) DISCOL; 14) Clarion Clipperton Zone
Average concentration generated by *in situ* excavation (mg·L\(^{-1}\))

Results: Excavation plume

Slide courtesy T. Morato U Azores
Average concentration generated by *in situ* excavation (mg·L⁻¹)

Results: Excavation plume
Results: return discharge water

Probability of plumes above a concentration threshold

Slide courtesy T. Morato U Azores
Results: return discharge water

Cross sections of the average plume concentration

Slide courtesy T. Morato U Azores
Overlaying 2D plume simulation outputs with cold-water corals species distribution models

Results: potential impacts

CWC area impacted by sediment plumes → 0.3% - 1.4%

Slide courtesy T. Morato U Azores
Overlaying 2D plume simulation outputs with commercial fish species distribution models

Bottom fish habitat impacted by sediment plumes → 1.5% - 5.0%

Slide courtesy T. Morato U Azores
Overlaying 2D plume simulation outputs with bottom longline fishing effort maps from VMS data

Results: potential impacts

Bottom longline fisheries impacted by sediment plumes → 5.0% - 7.5%

Slide courtesy T. Morato U Azores
Overlaying 2D plume simulation outputs with pelagic longline fishing effort maps from VMS data

Pelagic longline fishing effort impacted by sediment plumes → 10.0% - 17.5%
MIDAS summary publications

Available from www.eu-midas.net
Strategic Environmental Management Planning by the ISA

Suggested environmental assessment levels that could be put in place by the International Seabed Authority

Overarching Strategic Environmental Assessment and Plan

Regional Environmental Assessment leading to Regional Environmental Plan

- Environmental Impact Assessment
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Sets the overall strategy requirements for stakeholders and mode of operation for the whole of the Area

Strategic assessment and plan developed for each region using overarching SEA template

Contractors develop EIAs in line with the regional plan for specific mining projects

Developed by Weaver and Jones for workshop on Deep Sea Mining, Berlin 20 to 24 March, 2017
Polymetallic Nodules Exploration Areas in the Clarion-Clipperton Fracture Zone

Areas under contract and areas reserved for the International Seabed Authority

Contract area or contract approved as of 28 February 2013

- Marawa Research and Exploration Ltd (Kiribati)
- Bundesanstalt für Geowissenschaften und Rohstoffe (BGR; Germany)
- China Ocean Mineral Resources Research and Development Association (COMRA, China)
- Deep Ocean Resources Development Company (DORD; Japan)
- G-TEC Minerals Resources NV (GSR; Belgium)
- Government of the Republic of Korea

- Institut français de recherche pour l'exploitation de la mer (IFREMER; France)
- Interoceanmetal (IOM; Bulgaria, Cuba, Czech Republic, Poland, Russian Fed., Slovakia)
- Nauru Ocean Resources Inc. (NORI; Nauru)
- Tonga Offshore Mining Ltd (TOML, Tonga)
- UK Seabed Resources Ltd (UKSRL, UK)
- Yuzhmorgeologia (Russian Federation)

Reserved area*  Area of particular environmental interest (APEI)**  Exclusive Economic Zones (VLIZ, 2011)

* In the case of polymetallic nodules, the so-called parallel system provides that each application for exploration by a developed State must cover two parts of “equal estimated commercial value”. One part is allocated to the applicant and the other is to become the reserved area, which is set aside for the conduct of activities by the Authority or developing States.

** In July 2012, the Authority adopted an environmental management plan for the Clarion-Clipperton Zone to be implemented on a provisional basis over an initial three-year period. The plan includes the designation of a network of areas of particular environmental interest (ISBA/18/C/22).
Towards a Strategic Environmental Management Plan for the mid-Atlantic Ridge from 32.8° N to 2.4° S

Development of the science case

Focussed on MAR in ABNJ from 32.8° N to 2.4° S
Goal for the SEMP

To protect the natural diversity, ecosystem structure, function, connectivity and resilience of communities while enabling environmentally sustainable use of seabed natural resources.

- Based on best practice and sound science
- Acceptable to the International Seabed Authority
- Acceptable to civil society
- Recognises other sectoral competencies
- A model for other regions within the Atlantic and/or other areas of the World
Timeline for development of the SEMP

**SEMPIA 1** First workshop in Horta from 1-3 June 2015 - to develop a roadmap toward science-based recommendations for a Strategic Environmental Management Plan (SEMP), with emphasis on the design of a spatial network (attended by 39 participants, from 11 nationalities)

- Workshop on Areas of Particular Environmental Interest (APEI) Lisbon 13-15 July, 2016. Focussed on MAR in ABNJ from 32.8° N to 2.4° S
- Data collection and analysis carried out by Duke Univ. and Univ. Azores leading to draft geospatial models
- Assessment of the applicability of criteria for Vulnerable Marine Ecosystems (VMEs) to the SEMP

**Leading to SEMPIA II** – Sintra 2-4 November, 2016 (attended by 44 participants, from 15 nationalities)

- Submission of workshop report and recommendations to the ISA (Legal and Technical Commission) Spring 2017

**Future**

- Subject to LTC approval, negotiations including with stakeholders leading to development of Strategic Environmental Management Plan for the MAR (SEMPIA III)
Conservation targets for a network of APEIs on the Mid-Ocean Ridge

1. The APEI network should protect *at least* 30% of the total management unit. A conservation network incorporating between 30 and 40% of a management area is expected to conserve the majority of species (75%) within the deep North Atlantic.

2. APEIs should be representative of the regional seascape in terms of continuous functions (i.e., depth, POC flux, slope, projected climate change variables).

3. APEI core areas should conserve at least 30% of discrete seafloor features (i.e., seamounts, active and inactive hydrothermal vents, transform faults).

4. The APEI network should protect *at least* 30% of the area of the spreading zone. This spreading zone includes the ridge axis and axial valley.

5. APEIs conditions under predicted climate change scenarios should mimic current conditions as closely as possible.

6. The APEI network should minimize the difference between the length of, and spacing between APEI core areas to the greatest extent possible.

7. Placement of APEIs within the network should capture areas currently thought to be ecologically and/or evolutionarily important.

8. Each APEI must include a core area of sufficient length and width to maintain viable populations and ecosystem function, with an appropriately sized buffer zone to protect core areas from the effects of mining plumes.

9. In addition to protecting active vents within APEIs, *all* active hydrothermal vents and other areas at risk of serious harm should be protected from mining activities using finer-scale, precautionary-based protective measures, which may be area and/or threshold-based, with appropriate buffers.
Conclusions

1. Of the three mineral types Seafloor Massive Sulphides are the most likely to be mined in the North Atlantic.

2. Deep-sea mining is becoming a realistic prospect and may begin in the next few years.

3. SMS mines along the ocean ridges should be relatively small.

4. Plumes however can spread the impact over much larger areas even outside of the licence area.

5. Plumes can have an impact on organisms through the effect of suspended and settling particles and toxicity.

6. A science case is being developed for a management plan for the North Atlantic (32.8° North to 2.4° South).