The environmental effects of seabed mining: aspects of the New Zealand experience

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Presentation Outline

• Background
  – resource context in New Zealand

• Science requirements
  – General needs to support exploration phases

• Current minerals research
  – Developing risk assessment
  – Developing impact assessment

• Environmental management issues
  – Lessons learnt from DSM applications
Offshore Resources

Conventional & non-conventional hydrocarbon
- Oil and gas
- Gas hydrates

Minerals, placer deposits and nodules
- Ironsands
- Massive sulphides
- Phosphate nodules
- Cobalt-rich crust
- Manganese nodules
Deep-sea Minerals

- **Seafloor Massive Sulfides**
  Kermadec & Colville Ridges
  1000-2000 m
  Gold, copper, lead, zinc and silver
  Vent fauna, corals, sponges

- **Ironsands & other placer deposits**
  West Coast – 30,000 km²
  100-150 m
  Fe for steel production
  Resource estimate > 850 million t.
  Bryozoa, infauna soft sediment

- **Phosphorite nodules**
  Chatham Rise, 4500 km² licensed area
  300-400 m
  Phosphate for fertiliser
  Resource estimate > 100 million t
  Corals, sponges on nodules
Environmental considerations

- Fauna of each resource type can be very different
  - Vent fauna (SMS), bryozoan beds & infaunal nematodes (FeS), nodule corals and sponges (PN)
- Hence need to consider impacts on the different habitats separately
  - Different depths meaning different faunal communities
  - Different technology and hence disturbance characteristics
  - Different vulnerabilities of fauna
Deep-sea mining impacts
The EEZ Act (2012)

- Purpose of the act is “to promote the sustainable management of the natural resources of the exclusive economic zone and continental shelf.” (But not fisheries…)

- The importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes

- The importance of protecting rare and vulnerable ecosystems and the habitats of threatened species

- Underlying concept is sound environmental management, with a strong scientific basis
Science in DSM management process

New Zealand EEZ Act Impact Assessment

**ERA**
(Ecological Risk Assessment)
- Risk scoping (level I)
- Advanced ERA (level II)
- Identify threats
- Ask the right questions!

**EIA**
(Environmental Impact Assessment/Statement)
- Focus on main risks
- Ecosystem approach
- Cumulative impacts
- Other activities
- Spatial scale variability
- Traditional knowledge

**EMP**
(Environmental Management Plan)
- Monitoring programmes
- Adaptive management options
- Appropriate spatial and temporal scale

Integration across the multiple environmental components of DSM mining
Ecological Risk Assessment

• Initial scoping
  – Prior to prospecting/exploration
  – Expert panel (Level 1, qualitative)
    • Likelihood-consequence approach common, rank scores
Ecological Risk Assessment

• Initial scoping
  – Prior to prospecting/exploration
  – Expert panel (Level 1, qualitative)
    • Likelihood-consequence approach common, rank scores

• Advanced
  – Typically Level 2 (semi-quantitative)
  – Uses information from exploration
  – Contributes to EIA
  – Ecological traits approach developed
    • addresses FUNCTION rather than species composition
    • estimates COMMUNITY-level risk rather than species
  – Two stages:
    • evaluate sensitivity to disturbance (vulnerability)
    • evaluate recovery from disturbance (productivity)
Ecological traits

• Focus is on the **ecological role** of a taxon
• 365 taxa (from Family to species)
• Sensitivity
  – Adult size (5 categories)
  – Environmental position (6 categories)
  – Living habitat (10 categories)
  – Feeding habit (10 categories)
  – Mobility (3 categories)
  – Structural fragility (3 categories)
• Recoverability
  – Longevity (5 categories)
  – Reproductive frequency (3 categories)
  – Development type (4 categories)
  – Mobility (adult, juvenile) (10 categories)
  – Adult-juvenile interactions (3 categories)

SMS sensitivity decision tree
Sensitivity differences

- Faunal communities at active hydrothermal sites (SMS) more sensitive than at inactive or background sites (left panel)
- Depends on the mix of species, and abundance of sensitive taxa (right panel)
- Work in progress…
DSM-EIA science guidelines

- Existing standards and guides
  - Literature review of environmental management frameworks (O&G, coastal, ISA)
- Environmental Impact Assessment
  - Template and guidelines
The EIA template and guidelines

- Intended to apply
  - To IAs in New Zealand
  - EIAs internationally (especially SW Pacific)
- Align with ISA EIS framework (2012)
- Not prescriptive, but generic guide
  - Aid in consistency of format and information
- Each template heading is expanded
- Living document
  - Discussion govt agencies
  - Current revision

Expansion of template
4. Description of existing physico-chemical environment
  4.1 Key messages
  4.2 Regional Overview
  4.3 Meteorology and Air Quality
  4.4 Geological setting
  4.5 Physical and geomorphic setting
  4.6 Water quality
  4.7 Sediment characteristics
  4.8 Natural hazards
  4.9 Noise
  4.10 Greenhouse gas emissions/climate change issues
  4.11 Summary of existing physical environment

Contents page
Executive summary
Non-technical summary
1. Introduction
2. Policy, legal and administrative context
3. Project description
4. Description of the existing physico-chemical environment
5. Description of the existing biological environment
6. Description of the existing onshore environment
7. Description of the existing socio-economic environment
8. Consultation
9. Assessment of impacts on the physical environment and proposed mitigation
10. Assessment of impacts on the biological environment and proposed mitigation
11. Assessment of impacts on the onshore environment and proposed mitigation
12. Assessment of impacts on the socio-economic environment and proposed mitigation
13. Recommendations for monitoring
14. Glossary
15. Study team
16. References
17. Appendices

Baseline scientific requirements for DSM

- Science guidelines
  - Commercial operators
  - Research agencies
- Collaborative with EU/SPC (Fiji) and NIWA (NZ)
- Define a Marine Scientific Research Plan for minerals exploratory phase
  - Baseline survey
  - Monitoring activities
- So EIA adequately informed
- Describes current “best practise” science
<table>
<thead>
<tr>
<th>Aspect</th>
<th>Reason</th>
<th>Main Parameters</th>
<th>Sampling</th>
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</thead>
<tbody>
<tr>
<td><strong>Geology</strong></td>
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<tr>
<td>Topography</td>
<td>Seabed characteristics, identification of habitats for assessment, survey stratification, selection of test and control areas</td>
<td>Bathymetry, morphometry, seafloor type</td>
<td>Multibeam echosounder, dredges, box-corer, drilling equipment</td>
</tr>
<tr>
<td>Backscatter</td>
<td>Seabed characteristics, identification of habitats for assessment, survey stratification, selection of test and control areas</td>
<td>Acoustic reflectivity</td>
<td>Multibeam echosounder</td>
</tr>
<tr>
<td>Sub-seafloor</td>
<td>Petrology, geochemistry, and mineralogy for resource characterisation</td>
<td>Penetration layers, rock properties, mineral and chemical composition,</td>
<td>Seismic, drilling, rock sampling (dredges, coring)</td>
</tr>
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<td><strong>Sediment characteristics</strong></td>
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<tr>
<td>Sediment properties</td>
<td>Sediment plume dynamics</td>
<td>Sediment and pore water measurements: Water content, grain size, specific gravity, porosity, depth oxic layer, carbon content, chemical composition (trace and heavy metals)</td>
<td>Box corer or multicorer</td>
</tr>
<tr>
<td>Bioturbation rates</td>
<td>Natural mixing of sediments</td>
<td>Bioturbation depth, faunal zonation, Pb210 activity</td>
<td>Corer samples</td>
</tr>
<tr>
<td>Sedimentation rates</td>
<td>Distribution and concentration of natural suspension, settlement rates</td>
<td>Particle flux, suspended particle concentrations, settlement rates</td>
<td>Moorings and sediment traps</td>
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<td><strong>Seafloor community</strong></td>
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<tr>
<td>Megafauna</td>
<td>Impacts on benthic communities</td>
<td>Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)</td>
<td>Photographic surveys from ROV/towed camera; direct sampling dredge/sled/trawl</td>
</tr>
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<td>Macrofauna</td>
<td>Impacts on benthic communities</td>
<td>Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)</td>
<td>Box corer or multicorer, epibenthic sled</td>
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<td>Scavenger/demersal fish</td>
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<td>Species composition, distribution, abundance</td>
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Is the science good enough?

- TTR and Chatham Rock Phosphate applied for mining licences in 2014, spending something like 80 and 25 million euros on exploratory surveys and background work.
- First applications under new EEZ environmental legislation.
The NZ EPA decisions and lessons

• A complex of environmental, social, economic and cultural issues involved in DMC decisions
  – Focus on EIA, lack of SEA, consultation issues etc
• Key scientific issues arose
  – Inadequate description and treatment of **scientific uncertainty** (how uncertain, what to do about it)
  – Limited characterisation of **ecosystem structure and function** – moving beyond partial community descriptions
  – Inadequate **assessment of impacts** (especially indirect effects such as footprint and intensity of sediment plumes-modelling but no ground-truthing)
  – Insufficient detail in some aspects of **monitoring plans** and **adaptive management** regime not sufficiently robust
Conclusions

• Each deep-sea mineral resource has its own faunal characteristics, every situation is different
• Complex array of impacts, direct and indirect, that require extensive multidisciplinary research and assessment
• Nothing new, same issues as terrestrial/inshore situations
• But, the deep sea will always be data-limited, difficult research
• Effective EIA needs strong ERA component
• Open 4 dimensional system, clear need for ecosystem approach, that integrates benthic and midwater components across physical, oceanographic and biological elements
• Functional/Community level approaches rather than species
• Precaution will require managing high uncertainty
• Spatial management at early stage, coupled with adaptive management and strong monitoring systems
A challenging and daunting task...
Arigato gozaimasu

• This presentation has used material from NIWA research projects funded by the New Zealand Ministry of Business, Innovation and Employment: in particular NIWAs Vulnerable Deep-Sea Communities (DSCA), Kermadec Minerals (COPR) and Enabling Management of Offshore Mining (EMOM) projects.

• The EMOM project is collaborative between NIWA, Cawthron, Victoria University of Wellington, and Focus Group.

• SOPAC-EU DSM project has strong collaborative links also.

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