**MiningImpact**

*Environmental Impacts & Risks of Deep-Sea Mining*

---

**Phase 1**

Jan 2015 – Dec 2017  
(25 partners / 11 countries)  
~14.5 Mio€  
(funding: ~11.2 Mio€, incl. ship time)

**Phase 2**

Aug 2018 – Feb 2022  
(30 partners / 9 countries + ISA)  
~17 Mio€  
(funding: ~11 Mio€, incl. ship time)

**Coordinator:** Matthias Haeckel, GEOMAR

Belgium: UGent, RBINS  
France: IFREMER  
Germany: GEOMAR, MPI, SGN, JUB, UBremen, AWI, BGR, UBielefeld, CAUKiel  
Italy: UNIVPM  
Norway: DNVGL, NIVA, UNEP GRID-Arendal, UResearch, NTNU, SNF, IRIS, UiB  
Poland: UWr, USzczecin  
Portugal: UAv, IMAR, CIIMAR, UAveiro, IPMA  
Romania: Geoecomar  
Sweden: UGothenburg  
The Netherlands: NIOZ, UU, TUDelft  
United Kingdom: USOU, NHM, NOCS, HWU  
The International Seabed Authority
Impacts of polymetallic nodule mining

- Removal of nodules & 10 cm of seafloor
- Generation of sediment plume that will resettle & blanket the seafloor
- Discharge of sediment waste from surface platform / riser pipe

- Loss of habitat
- Loss of species & genetic diversity
- Loss of ecosystem structure & functions
- Change of surface sediment characteristics & processes

Oebius et al. (2001) DSR II 48
1. Deep-sea ecosystems associated with polymetallic resources support a highly diverse fauna.

2. Deep-sea faunal communities show a high variability on small and large spatial scales, but their connectivity over relevant scales for reference zones and for conservation remains unknown.

3. Temporal variations of faunal abundances remain unknown due to the lack of long-term ecological time series.

4. Loss of seafloor integrity by removal of nodules and surface seafloor reduces population densities and ecosystem functions (e.g. nutrient remineralization, microbial growth, bioturbation activity).

5. Disturbance impacts last for at least many decades (e.g. biogeochemical processes will take >50 years to recover).

6. Sediment plumes will likely blanket the seafloor up to several tens of kilometers outside the mined area.

→ Minimizing the large-scale impacts will require careful adaptive spatial planning of mining operations and development of low-impact equipment.

→ Environmental management plans need to address current uncertainties of the sediment plume dispersal and spatial variability of the abyssal ecosystem that exists also on local scale.

Boetius & Haeckel (2018) Science 359
Outreach activities

• European Maritime Day (May 2016)
• Panel discussion UN World Ocean Day (June 2016)
• Side event at the ISA (July 2016)
• Discussion panel at EU Parliament (Nov 2016)
• BMBF Year of the Oceans 2016/17
• Video installations of artist Armin Linke 2017/18
• Stakeholder Events at the NHM London (Oct 2017) + RBINS (Sep 2018)

• TV documentaries: Arte, Leschs Kosmos, ZDF KiKa
• Interviews for radio stations, newspapers, journals, web blogs
• Presentations for general public (e.g. Kiel Week)
Key Objectives MI2

- Develop + test monitoring concepts and strategies for deep-sea mining operations
- Develop standardization procedures for monitoring and definitions for indicators of a good environmental status
- Investigate potential mitigation measures, such as spatial management plans of mining operations and means to facilitate ecosystem recovery
- Develop sound methodologies to assess the environmental risks and estimate benefits, costs and risks
- Explore how uncertainties in the knowledge of impacts can be implemented into appropriate regulatory frameworks

WP1  Biodiversity, connectivity, resilience
WP2  Fate and toxicity of the sediment plume
WP3  Biogeochemistry + ecosystem functioning
WP4  Data and sample management
WP5  Project dissemination and coordination
CCT1  Plume monitoring + habitat mapping
CCT2  Disturbance effects in time and space
CCT3  ERA & policy recommendations
MiningImpact 2 will conduct an independent scientific assessment of the collector trial of DEME-GSR Monitoring program is not part of GSR’s obligation to monitor their trial. All project data will be published in open-access databases (PANGAEA).
German + Belgian license areas in the CCZ

SO268: 17 Feb – 22 May 2019
follow-up cruise: early 2021
• ROV Kiel 6000 (+ 2 elevators) and AUV Abyss
• CTD/water sampler for deployments in the water column and plume sampling
• GC, TV-MUC, BC, in situ pumps to sample sediments and fauna
• 4 benthic landers with ADCPs, OBSs, turbidity sensors, time-lapse cameras, hydrophones
• 6 Moorings + 4 sediment traps
• ROV-operated in situ experimentation (benthic chambers, microprofiler, PC etc)
• Parasound + Multibeam (EM 122 + EM 710) systems and underwater positioning systems
Understand fate of particles and effective footprint in space and time
⇒ requires multiple-year time-series of bottom currents
⇒ characterization of particle size distributions, aggregation, settling velocities
⇒ develop appropriate numerical models
Array of >50 optical/acoustic sensors will be deployed on ~20 different platforms (landers, moorings, tripods) guided by numerical simulations and existing baseline data.
Possible layout of plume sensor grid (not to scale)
German license area (11° 56′ N / 117° 1′ W)

Trial site

Reference site
## Preliminary Cruise Schedule

**DEME-GSR (GSRNOD19)**

14/17 Feb – 1 May (San Diego)

<table>
<thead>
<tr>
<th>Plan A2</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **ecotox/foodweb**
- **baseline ref**
- **baseline trial**
- **Manzanillo**
- **arrive BE claim**
- **leave BE for GER claim**
- **put down sensors**
- **start trial + plume BE**
- **start trial + plume GER**
- **end trial**
- **end plume monitor**
- **impact assessment BE a**
- **impact assessment BE b**
- **pickup sensors**
- **restoration experiment**