Test-mining (TM): environmental and technical aspects

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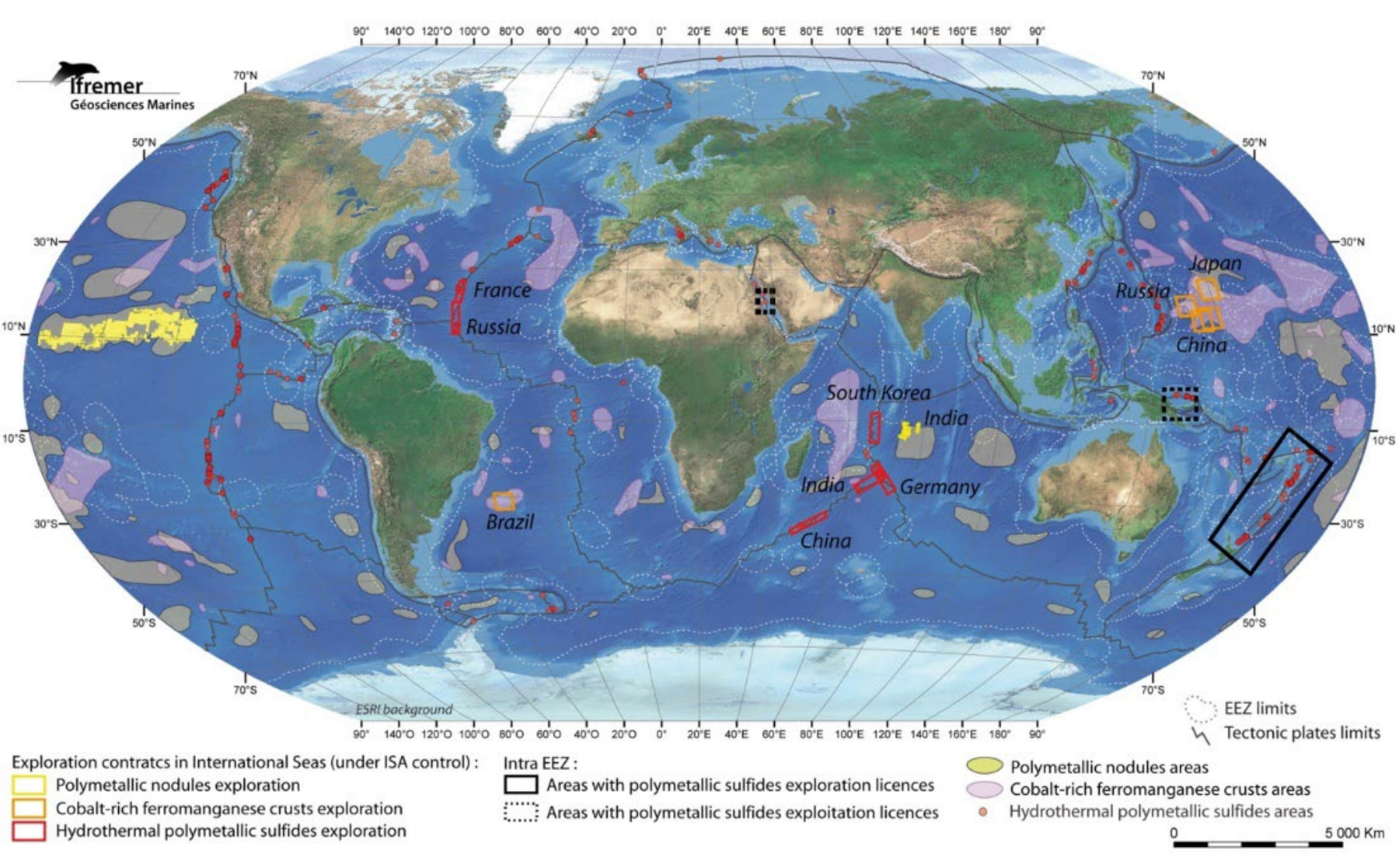
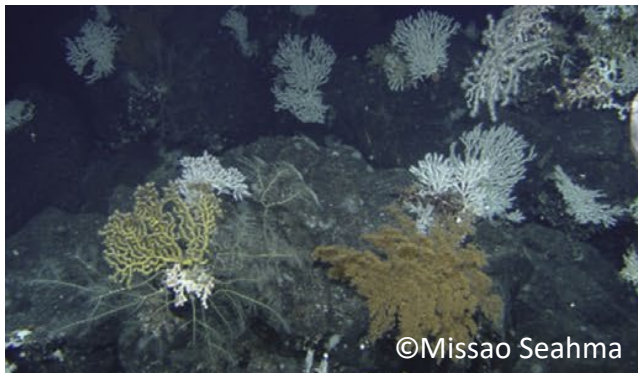
Deep-sea mineral resources

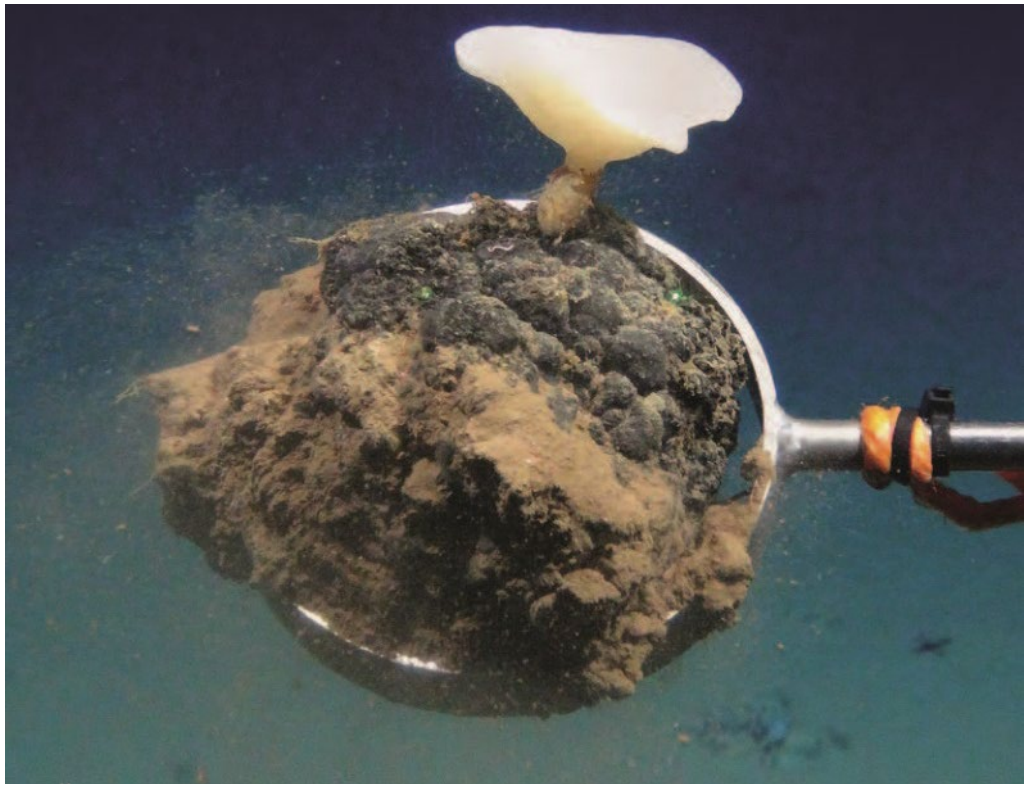
polymetallic nodules/abyssal plains, polymetallic sulfides/hydrothermal vents, cobalt-rich crusts/seamounts





Focus of this workshop: polymetallic nodules

- The technologies used for mining will be very different for nodule, sulfides and crust mining.
- The ecosystems are very different, requiring different considerations with regards to spatial and temporal scales of TM



Life at nodule fields

Vanreusel et al. 2016

On nodules: sponges, corals, anemones,…
In nodules: nematodes, copepods,..
In sediments: bristle worms, nematodes, copepods,…
In the water column: fish, jellyfish,…

-> many unknown species, very high biodiversity
-> often local distribution of species
-> ecosystem function of nodule not fully resolved

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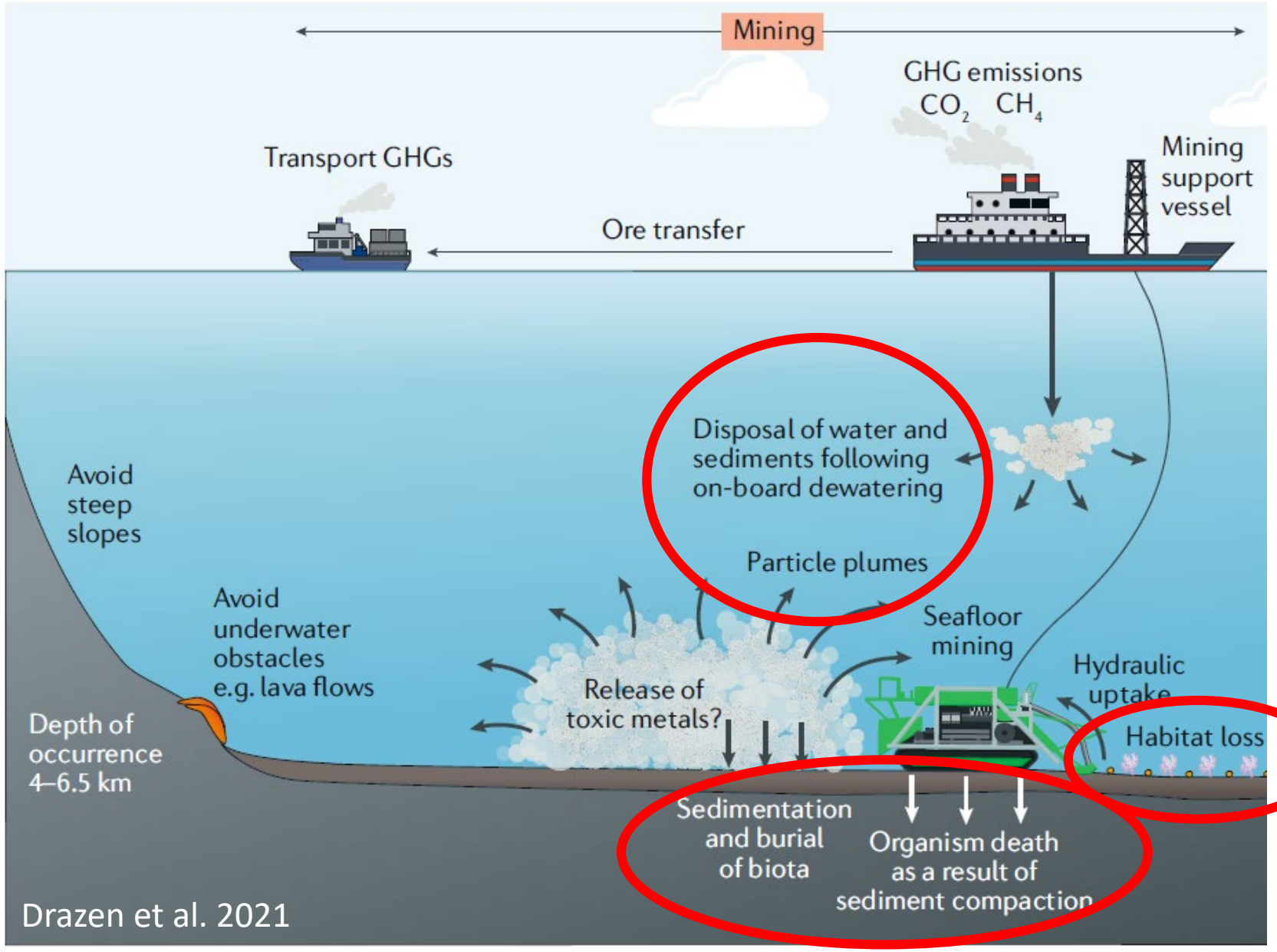
Drazen et al. 2021

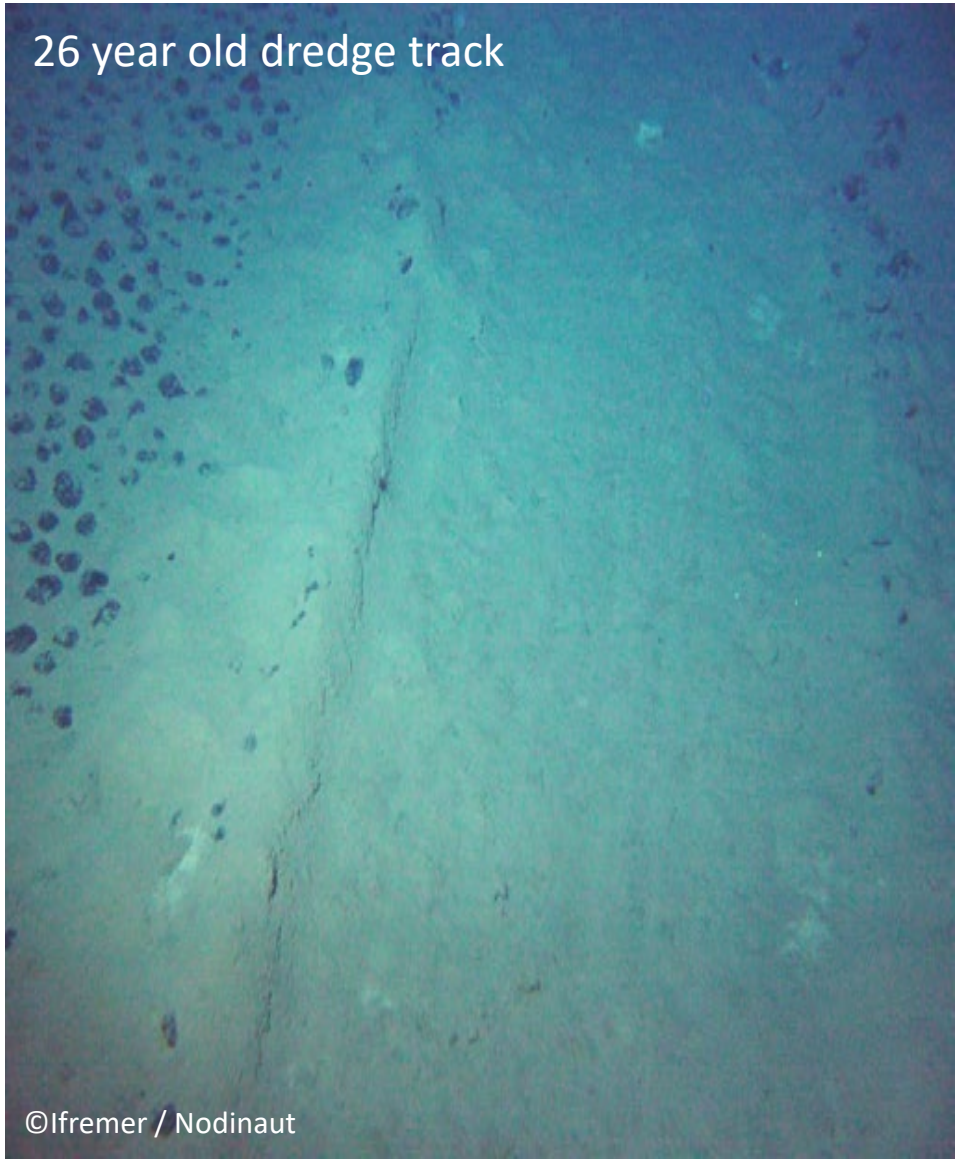
Environmental mining impacts*



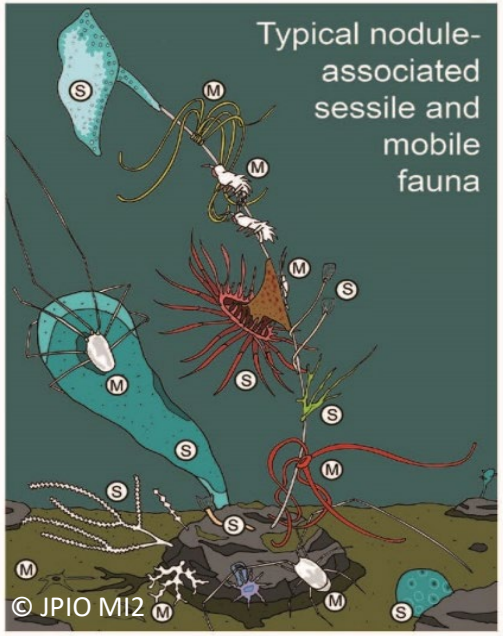
- Habitat loss (nodules & sediments)
- Collector vehicle plume
- Discharge plume
- Noise
- Light

*Current techniques; keep in mind change of scale under BAT and different mining techniques!

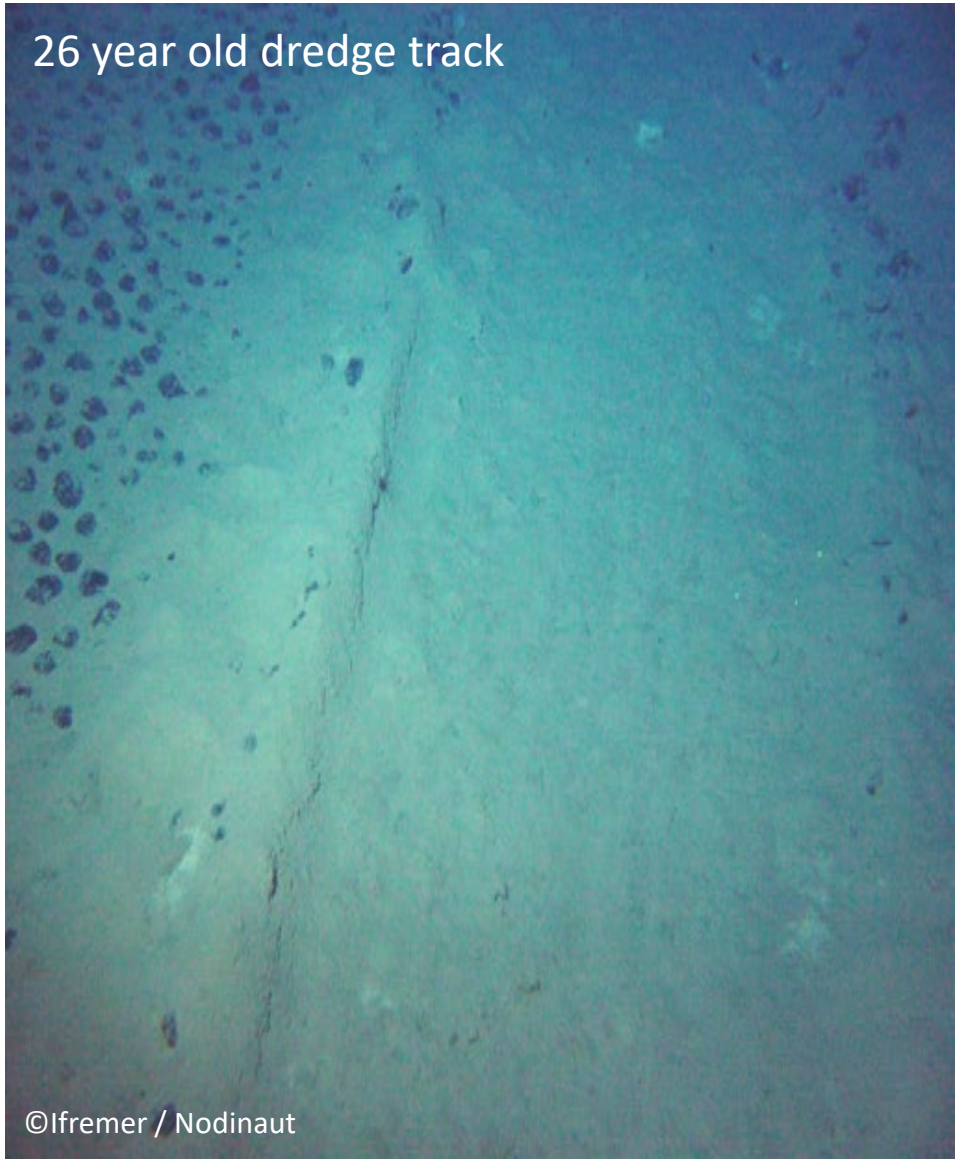
Mining impact & **time scales**



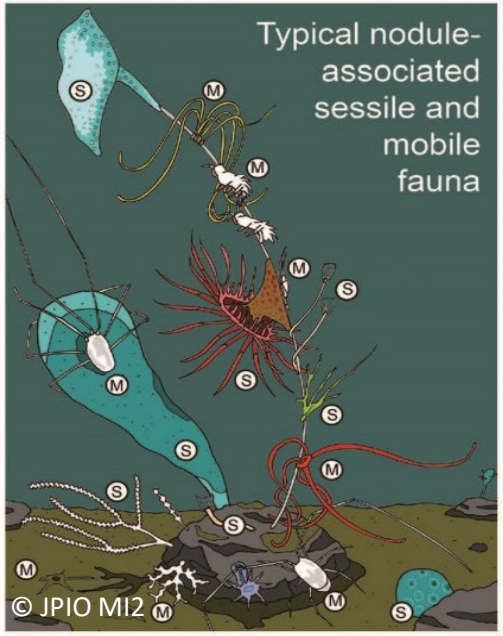
- **Removal of nodules** = removal of nodule-dependent microbes and animals on million year scale at the mined location
  (nodule growth rate ~ a few mm per million years)
- **Sediments modified** for very long time scale; changes in biodiversity & function for >30 years & potentially 10000s years
  (sedimentation rate ~1 cm per 1000 years)
- **Plume in water column:** duration? chronic effects?
- **Noise & light:** as long as mining operations last



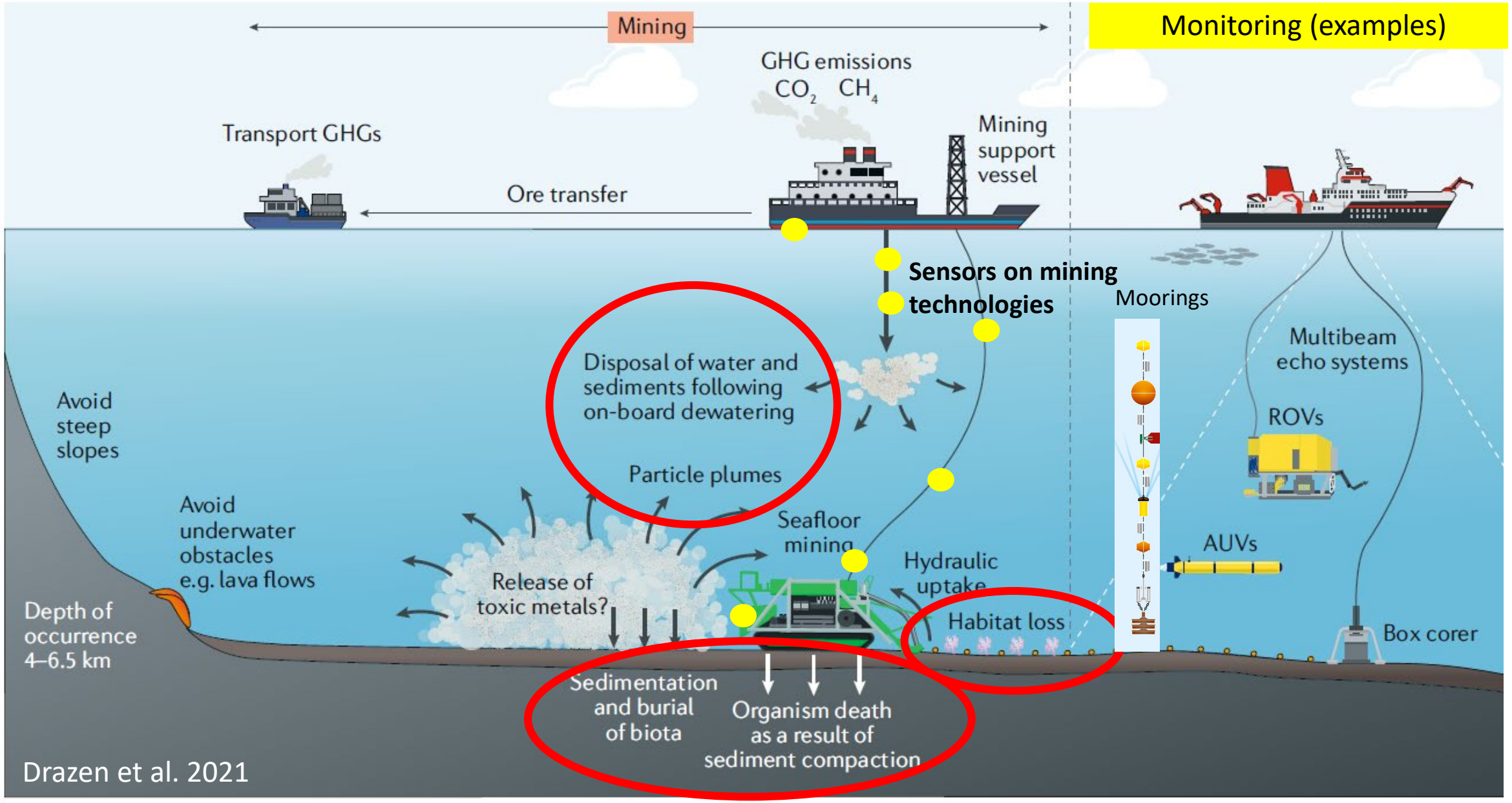
Mining impact & **spatial scales**



- Habitat loss: at mined location
- Collector vehicle plume: beyond mined location on the seafloor and at least several meters into water column (seafloor currents & topography)
- Discharge plume: pending on discharge depth, speed, currents
- Noise: 100ds of km beyond mined area
- Light: local



Environmental impact & Monitoring

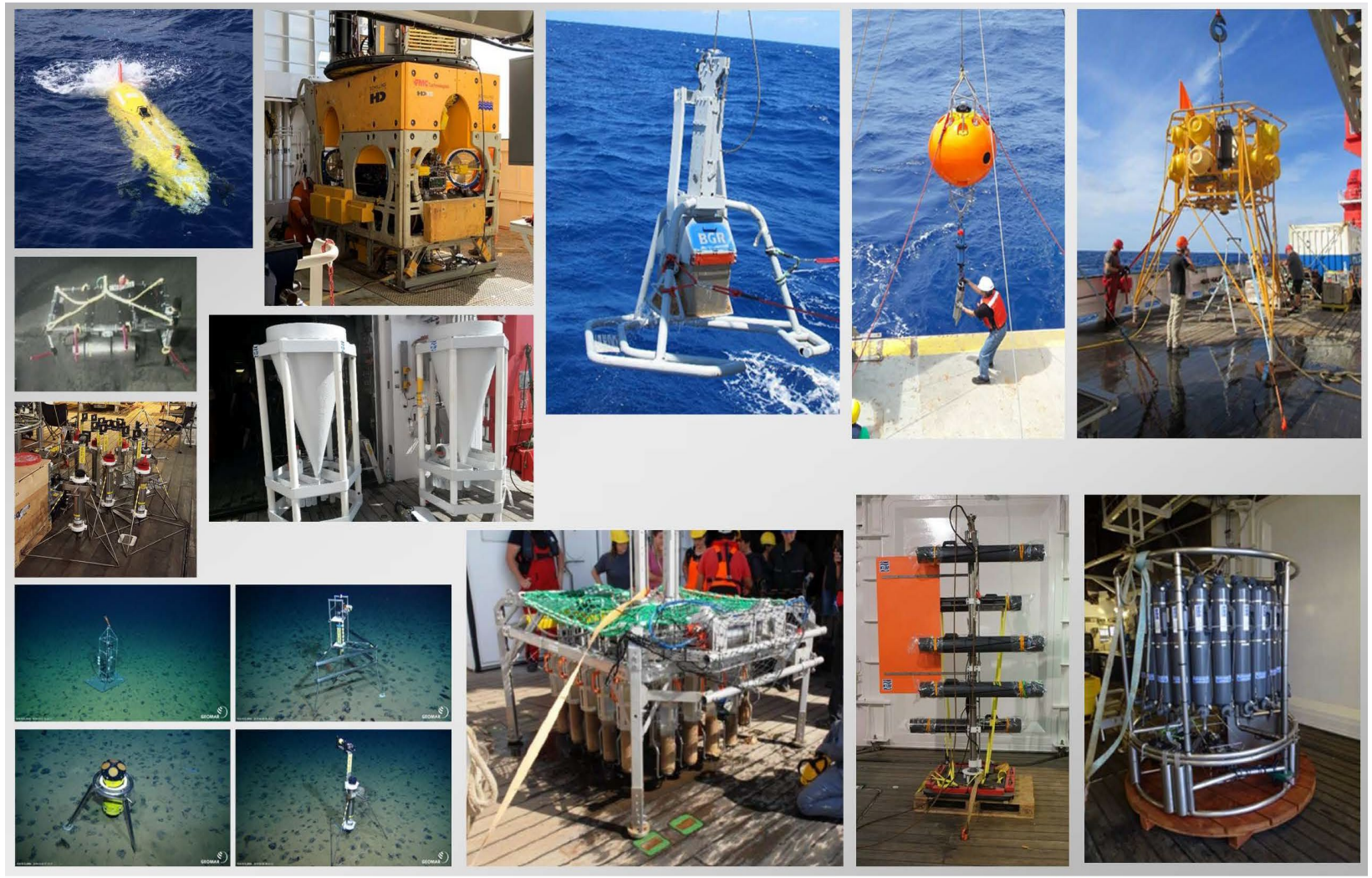


Monitoring impact during and after test-mining

(1) What parameters need to be monitored?
(2) Where need the parameters be monitored?
(3) When and how long should the impact and effect be monitored?

Examples:

- Habitat (nodule & sediment) removal
- Plume dispersal
- Noise propagation
- Effects on sediment properties/biogeochemistry
- Effects in biodiversity
- Effects on ecosystem function
- Effectiveness of mitigation actions



https://miningimpact.geomar.de/miningimpact-2

6 groups: 2 question rounds (for each round 30 minutes to discuss)

Round 1:

Question Topic 1: Purpose of Test Mining

Do you agree with the purpose of TM as stated in the draft Schedule/Reg 48 ter/Reg 48 ter alt?

Questions Topic 2: Monitoring of Test Mining

Does the standard of draft EMMP apply fully to TM?
Is an own EMMP standard for TM needed?
How long should monitoring occur after TM?
Only validation, or also compliance and long-term monitoring?
PRZ and IRZ for each TM site?

Round 2:

Questions Topic 3: Scales of Test Mining

What technical components need to be considered and what is the scale of technical components?
What is the time scale of TM?
What is the spatial scale of TM?
Should a TM standard include qualitative descriptions ("criteria") and/or concrete numbers for time/spatial/tonnage scales?

Question Topic 1: Purpose of Test Mining

Do you agree with the purpose of TM as stated in Schedule/Reg 48 ter/Reg 48 ter alt?
Are there additional purposes in your view? Are there too many purposes?

Draft Schedule:

"Test Mining" means an in situ testing that do not have harmful effects on the marine environment of the integrated system of all equipment and all related process steps (e.g. including collector, raiser and release techniques) for Exploitation activities in a Contract Area under appropriate technical, spatial and temporal conditions which allows the Test Mining for the provision of evidence to support the information provided by an applicant in its application for a Plan of Work for Exploitation, and to assist the Commission and the Council in its evaluation of the application against the criteria contained in Regulation 13 and 15."

Test-mining purpose: Draft **Regulation 48 ter**

The purpose of the Test-Mining is to validate that the proposed mining equipment is technically appropriate and the effects of the Exploitation activity, in particular with regard to the Protection of the environment, [do not harm the marine environment and] operates as described in the Environmental Impact Statement/Plan of Work.]

Test-mining purpose: Draft **Regulation 48 ter alt**

The purpose of the Pilot Mining is to validate that the proposed mining equipment is commercially and technically appropriate and the effects of the activity, in particular with regard to the Protection of the environment, operates as described in the Environmental Impact Statement/Plan of Work.

Q1: Do you agree with the purpose of TM as stated in Schedule/Reg 48 ter/Reg 48 ter alt?

Are there additional purposes in your view? Are there too many purposes?

TM demonstrates, under appropriate technical, spatial and temporal conditions:

- No harmful effects on the marine environment arise from TM and PoW
- Ability to carry out integrated system test of all equipment & related process steps
- Evidence to support the information of a PoW application

<u>To discuss these questions you may consider:</u>

what measurable TM criteria are needed to be in line with the purpose of TM?

-Safety of operations is demonstrated

-Ability to monitor is demonstrated

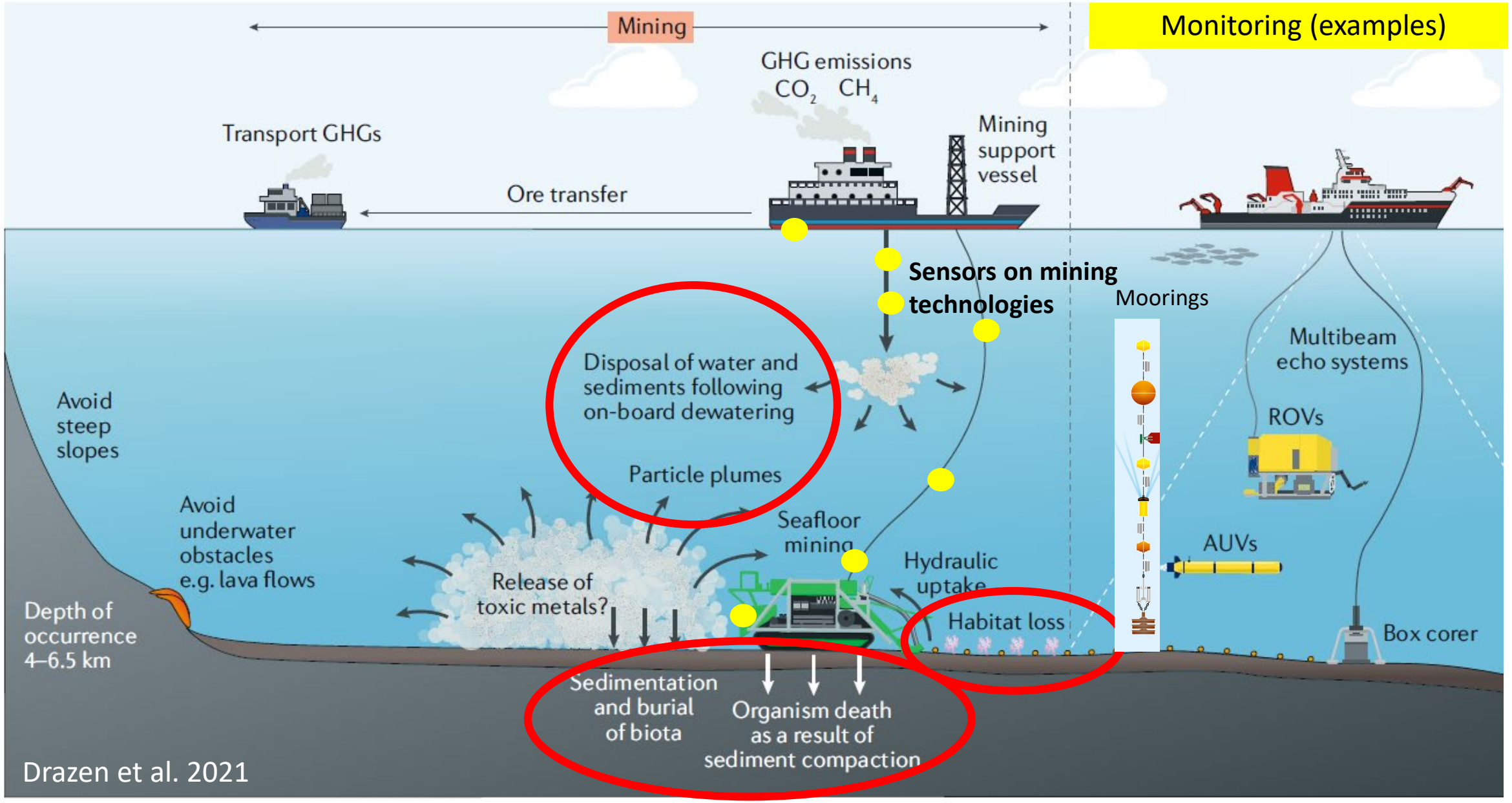
-Effectiveness of monitoring plan is demonstrated

-Effective protection of the marine environment from harmful effects is demonstrated

-Data that can inform threshold development are provided

-Data needed for upscale modelling in PoW are provided

Monitoring to provide evidence



Questions Topic 2: Monitoring of Test Mining

Does the standard of draft EMMP apply fully to TM?
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How long should monitoring occur after TM?
Only validation, or also compliance and long-term monitoring?
PRZ and IRZ for each TM site?

To discuss the TM monitoring questions you may consider:

Reg 48 ter

5. [Before commercial mining may commence in accordance with Regulation 25], a validation monitoring system shall be established by the Contractor, in line with the Environmental Management and Monitoring Plan, in order to monitor whether the requirements of the Plan of Work are complied with.

Schedule:

"….under appropriate technical, spatial and temporal conditions which allows the Test Mining for the provision of evidence to support the information provided by an applicant in its application for a Plan of Work for Exploitation,…."

Discussing potential criteria for TM monitoring:

Ability of continuous and real time monitoring is proven.

Ability to inform test-mining study and thus the EIS and thus PoW.

Ability to relocation of monitoring equipment is proven.

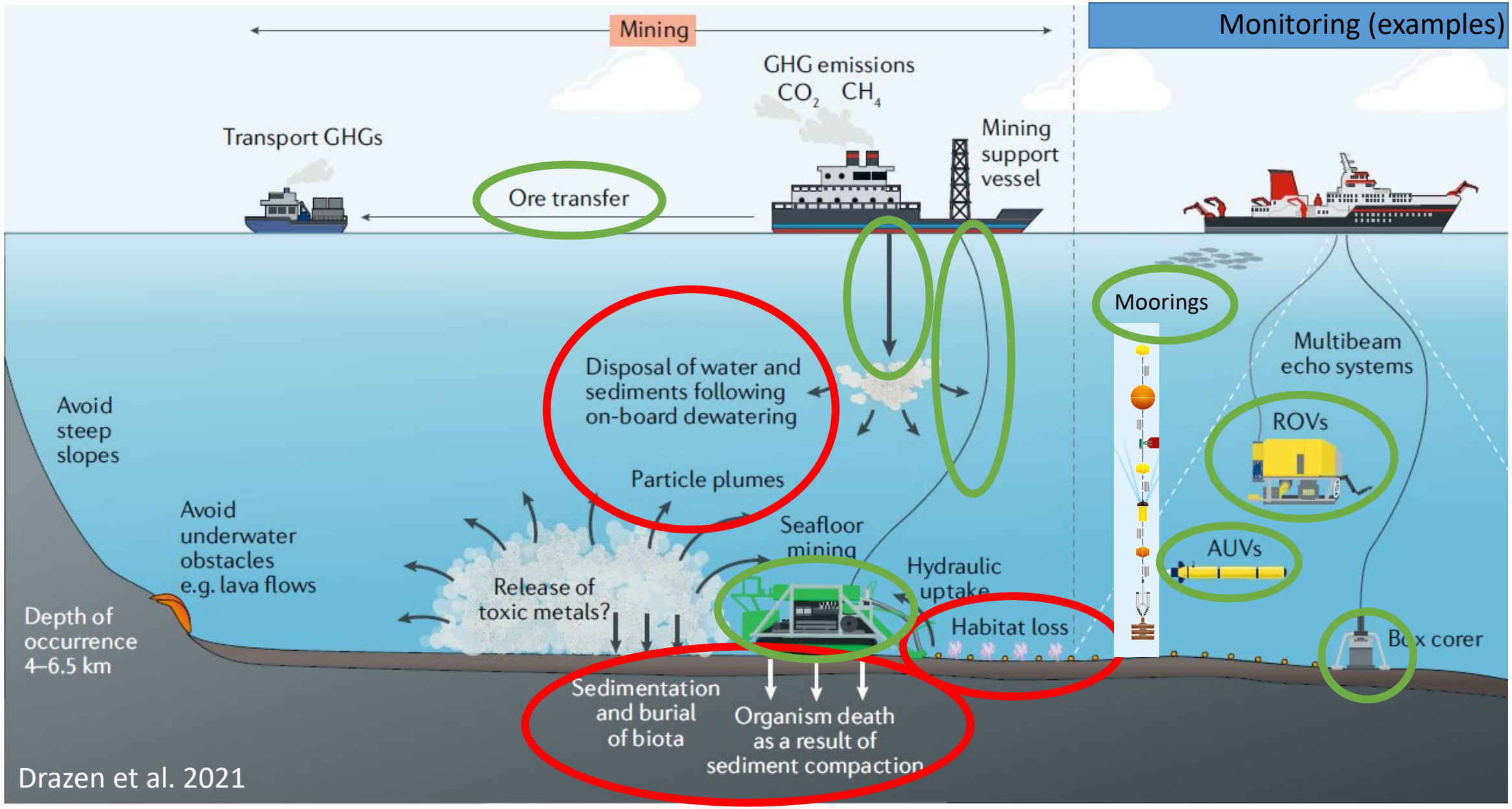
ISBA/27/C/6

Draft guidelines for the preparation of Environmental Management and Monitoring Plans

40. The EMMP should describe the types of monitoring to be used through the various phases of exploitation. Types of monitoring include:

- **Validation monitoring**: this monitoring should take place at the commencement of the project or activity **and involves intensive, real-time and comprehensive monitoring to validate assumptions made in the baseline/EIA/EIS phase of the project**. Upon the completion of the validation monitoring period, the operation may enter into a "steady state" compliance monitoring period;
- **Compliance monitoring**: this monitoring should be implemented throughout the project's operations to monitor the prescribed mitigation measures and assess whether the measures are effective in reducing the impacts to acceptable levels. **This monitoring should be conducted periodically**, the timing of which will vary from project to project (but which will be agreed with the Authority and set out in the EMMP). It should be used to **check that the levels of specific environmental parameters are consistent with applicable regulations**, standards, guidelines and contractual obligations. This type of monitoring will assist applicants/Contractors carrying out performance assessments (see section III.F below).
- **Long-term monitoring**: monitoring of Environmental Effects **should continue after completion of operations**. This monitoring will be a continuation of some aspects of the compliance monitoring components, but likely with adjusted frequency and timescale. The details of long-term monitoring will be developed in accordance with the Closure Plan. Applicants and Contractors should refer to the standards and guidelines on Closure Plans for further guidance.

Defining scales of TM



Drazen et al. 2021

Questions Topic 3: Scales of Test Mining

What technical components need to be considered and what is the scale of technical components?

->What criteria define the scale of TM equipment?

What is the time scale of TM?

->What criteria define the minimum and maximum time scale for TM?

What is the spatial scale of TM?

What criteria define the minimum and maximum spatial scale for TM?

Should a TM standard include qualitative descriptions (“criteria”) and/or concrete numbers for time/spatial/tonnage scales?

What technical components need to be considered and what is the scale of technical components?

Purpose: Validation of the technical readiness, proofing the limited risk of accidents & allowance of upscaling.

Is an integrated technical component testing needed or are single components sufficient?

What technical components should be tested?

- Collector system
- Riser system
- Discharge system
- Transport system at surface from surface production vessel to surface transport vessel
- Monitoring equipment

(-> Do you agree with these components? Why/Why not? Do we miss a component?)

What scale of TM components?

->What criteria define the scale of TM equipment and monitoring equipment?

Criteria:

-The technical dimension of TM are appropriate to allow upscaling

-The components have the same working mode

(-> Do you agree with these criteria? Why/Why not? Do we miss criteria?)

Think about/discuss examples: e.g. allowed: smaller collector vehicle; Not allowed: Different extraction techniques of collector (mechanical vs hydraulic pick up); Different speed/volume of discharge plume that would affect plume behavior and footprint; Different discharge plume height

What is the time scale of TM?

->What criteria define the minimum and maximum time scale for TM?
(-> do you agree with these criteria, why/why not, do we miss criteria?)

Criteria for technical readiness:

-demonstrate that the technical components (TM & monitoring) work on a continuous basis
-demonstrate the technical components (TM & monitoring) can be moved from one location to the next

Criteria for effective protection of the marine environment:

-is limited to a maximum specific time to avoid potential chronic effects (e.g. during plume dispersal)

Criteria for upscaling:

-time is long enough to measure effects
-time is long enough to allow for upscaling (input of data into models to provide evidence for longer scale)
-time considers seasonality (e.g. of currents etc.) to allow for upscaling

Examples why continuous operations with regards to technical risks:

Vehicle: no accidents: risks e.g. clogging of components and change is seafloor plume
Riser-system: e.g. no leaking
Ship-processing and return plume: no accidents, e.g. no overflow on board of the vehicle
Nodule-transport from surface production to transport vessel: no accidents, e.g. accidental loss of nodules, risk analyses of radioactive nodule processing for crew
Monitoring systems (such as moorings) can be lost during recovery, it needs to be demonstrated that the contractor has the capacity to recover and redeploy.

Q4: What is the spatial scale of TM?

What criteria define the minimum and maximum spatial scale for TM?
(-> do you agree with these criteria, why/why not, do we miss criteria?)

Criteria technical readiness:

-Consideration of different topography (inclination of seafloor), resource density, bathymetry, and substrate types (less applicable for CCZ; more for SMS and crusts that are not considered here; grain size of sediments, different hard substrates) and how this impacts technical operations at sea.

Criteria effective protection of the marine environment:

-Spatial scale that is small enough to ensure the effective protection of the marine environment from harmful effects.

Problem: no thresholds in place for e.g. habitat removal that would directly relate to spatial scale.

Criteria for upscaling:

-Size that it large enough to allow for upscaling (input of data into models to provide evidence for larger scale)
-Mining pattern is similar to full-scale operation

Q5: Should a TM standard include qualitative descriptions ("criteria") and/or concrete numbers for time/spatial/tonnage scales?

Example: How is time-scale related to spatial scale and tonnage of collected nodules?
Assumption: Test collector width of 12-16 m with a driving speed of 0.3-0.5 m/s: area of 3.6-8 m2/s

30 days: 9.3-20.7 km^2 (3.05x3.05 – 5.3x5.3 km^2) => nodules at 15kg/m^2: 140-420 kt
3 months: 28-62.2 km^2 (4.55x4.55 – 7.9x7.9 km^2) => nodules at 15kg/m^2: 311-933 kt

Note: 15kg/m^2 for average CCZ; but typically, 20-25kg/m^2 (e.g. GSR, BGR)
Note: assuming a size of about 10 km^2 for each mining field, and a time-scale of 3 months, ability to replace equipment needs to be demonstrated

Thought-experiment: Is a maximum of e.g. 75 km^2 still ensuring effective protection of the marine environment?
-75 km^2 would be equivalent to 1‰ of the exploration contract area
-is 1 ‰ permanent loss of all ecosystem function associated to nodules acceptable?
-would 75 km^2 e.g. cause already species extinction?
-NOTE: this does not consider impacts beyond the mined area (plume, noise)
-NOTE: this assumes that nodules are everywhere equally (which is not the reality)

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