2 May 2024

OceanICU
Understanding Ocean Carbon

Industrial Carbon and Mining

Dr. Richard Sanders
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Thematic Centre
NORCE

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WP5 Lead

Welcome and Thank You for Joining Us Today

Co-funded by the European Union

UK Research and Innovation

This work was funded by the European Union under grant agreement no. 101083922 (OceanICU) and UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee [grant number 10054454, 10063673, 10064020, 10059241, 10079684, 10059012, 10048179]. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Agenda

OceanICU

- Panellist Presentations

  Dr. Richard Sanders

  Dr. Matthias Haeckel

- Questions and Answers

About Today's Format

This webinar is being video recorded

- Cameras & Microphones have been disabled
- Questions posted in the chat will not be included in the video recording so your name will not be displayed.

Questions and Answers

- Please use the chat function to ask any questions you have.
- Questions will be directed to the appropriate panellist by the moderator during the Q&A session.
- Questions & Answers covered during the session, along with any that we did not have time to respond to, will be posted in text form on the OceanICU website; a link will be sent to you in a post-webinar email communication.

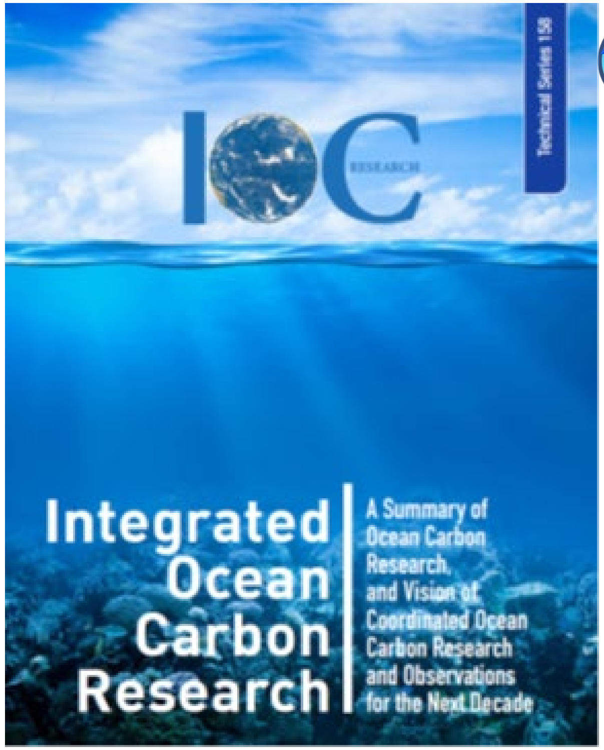
Any problems or comments during or after the session:

Contact: hello@ocean-icu.eu

Climate Change is the single largest issue we face

Fundamentally driven by accumulation of CO_2 in the atmosphere

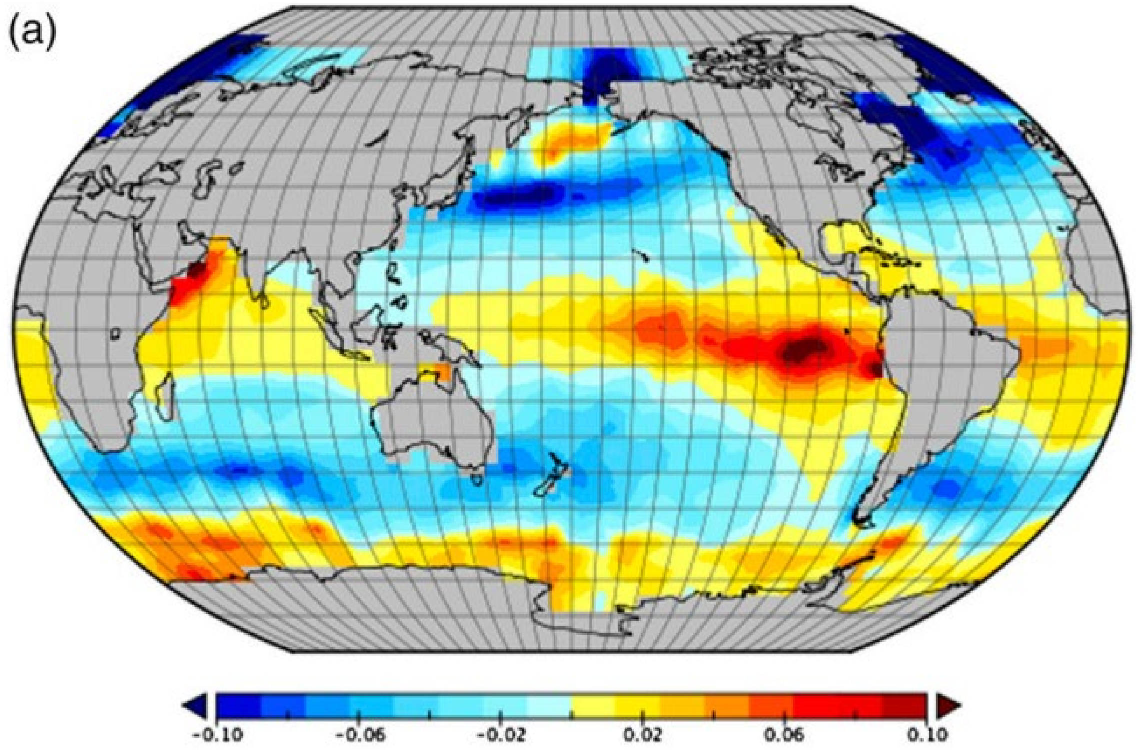
- The EU Green Deal requires us to move towards operating in a carbon neutral way.
- How does this affect ocean users?
- Need to compensate for:
  - Direct effects (e.g. GHG production by shipping)
  - Indirect effects (e.g. disturbances to seabed C storage by mining, disturbances to foodwebs by fishing or mining)
- How large are these indirect effects?
- How do they operate?
- What can we do to reduce or minimise them?



- Will the ocean uptake of anthropogenic carbon dioxide (CO_2) continue as primarily an abiotic[a] process?
- What is the role of biology in the ocean carbon cycle, and how is it changing?
- What are the exchanges of carbon between the land-ocean-ice continuum and how are they evolving over time?
- How are humans altering the ocean carbon cycle and resulting feedbacks, including possible purposeful carbon dioxide removal (CDR) from the atmosphere?

General Strategy

- 1. Define current state of C cycle (provide a baseline)
  - Assess future climate driven change to ocean C cycle
- 2. Quantify key processes relevant to these indirect effects
- 3. Incorporate key processes into models:
  - Evaluate significance
  - Quantify indirect effects
- 4. Build new tools to support decison making:
  - Allow ocean users to estimate C impacts of industry and fishing
- 5. Couple these to future fishing and industrial scenarios
  - Estimate industrial impacts on ocean C cycle



LIMNOLOGY and OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 9999, 2021, 1–26

doi: 10.1002/lno.11709

Toward a better understanding of fish-based contribution to ocean carbon flux

Grace K. Saba,[1*] Adrian B. Burd,[2] John P. Dunne,[3] Santiago Hernández-León,[4] Angela H. Martin,[5] Kenneth A. Rose,[6] Joseph Salisbury,[7] Deborah K. Steinberg,[8] Clive N. Trueman,[9] Rod W. Wilson,[10] Stephanie E. Wilson[11]

mend research priorities. Based on our synthesis of passive (fecal pellet sinking) and active (migratory) flux of fishes, we estimated that fishes contribute an average (± standard deviation) of about 16.1% (± 13%) to total carbon flux out of the euphotic zone. Using the mean value of model-generated global carbon flux estimates,

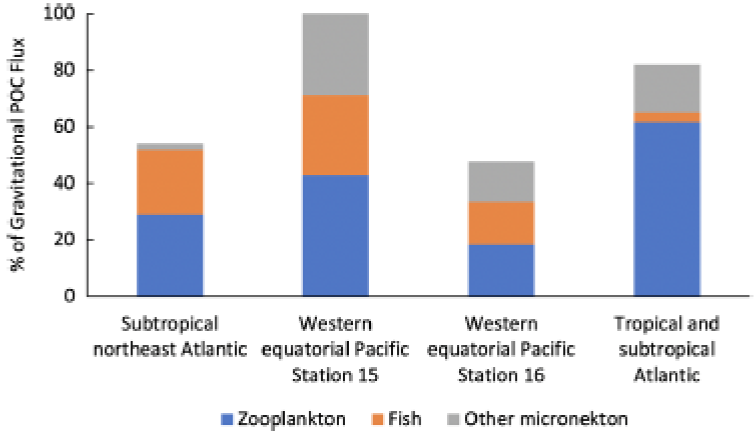


Fig. 2. Comparisons of zooplankton-, fish-, and other micronekton-mediated mean flux equal to % of gravitational (sinking) particulate organic carbon (POC) flux as measured by sediment traps in different oce-

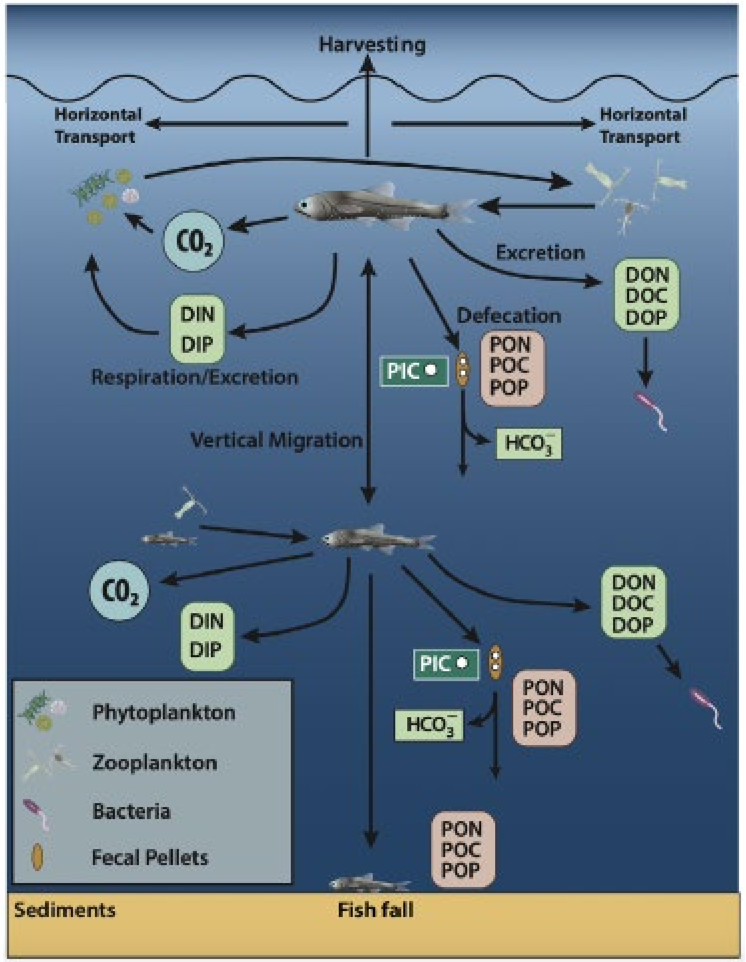
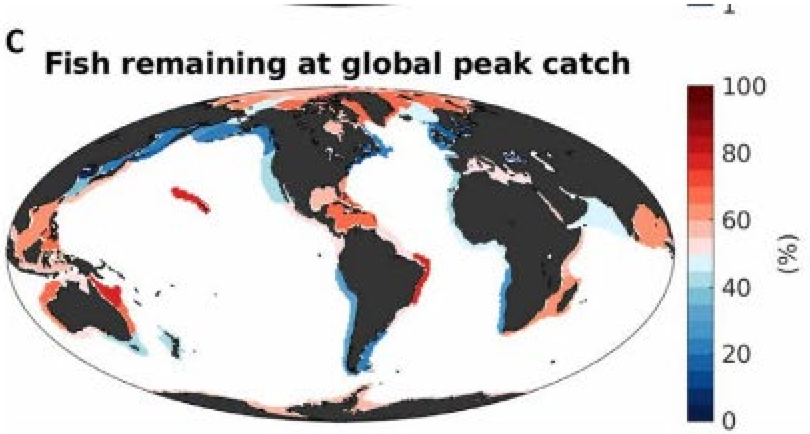


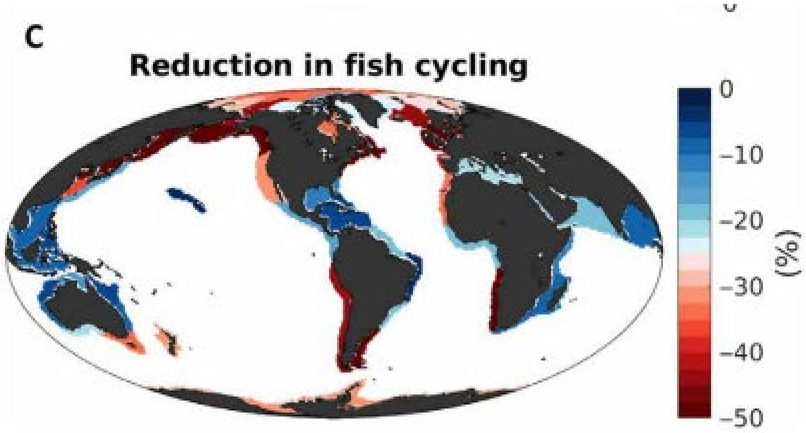
Fig. 1. Conceptual diagram highlighting the mechanisms by which fishes contribute to the biological carbon pump and nutrient cycling.

Estimating global biomass and biogeochemical cycling of marine fish with and without fishing

DANIELE BIANCHI, DAVID A. CAROZZA, ERIC D. GALBRAITH, JÉRÔME GUIET, AND TIMOTHY DEVRIES Authors Info & Affiliations

cycling rates. The pre-exploitation global biomass of exploited fish (10 g to 100 kg) was 3.3 ± 0.5 Gt, cycling roughly 2% of global primary production (9.4 ± 1.6 Gt year^{-1}) and producing 10% of surface biological export. Particulate organic matter produced by exploited fish drove roughly 10% of the oxygen consumption and biological carbon storage at depth. By the 1990s, biomass and cycling rates had been reduced by nearly half, suggesting that the biogeochemical impact of fisheries has been comparable to that of anthropogenic climate change. Our results highlight the importance of devel-



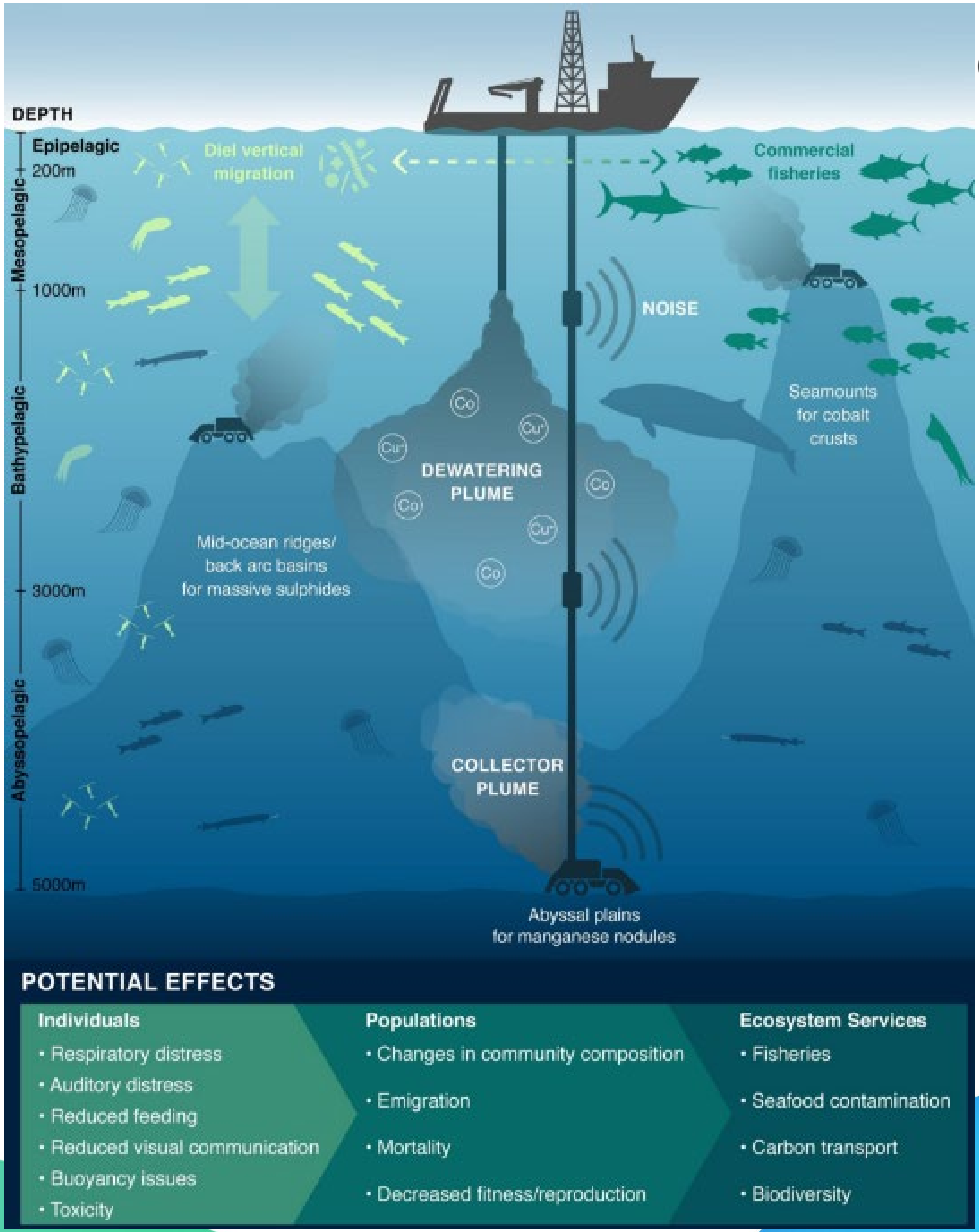


Industrial processes

Midwater ecosystems must be considered when evaluating environmental risks of deep-sea mining

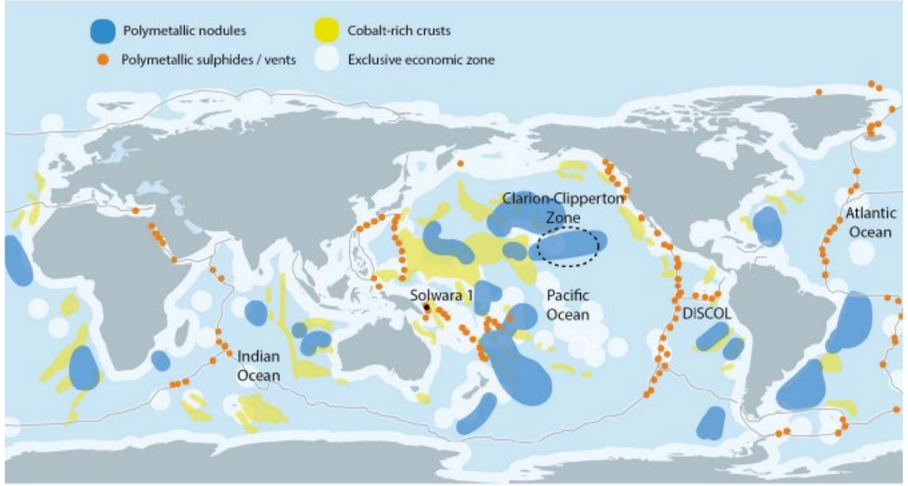
Jeffrey C. Drazen, Craig R. Smith, Kristina M. Gjerde, +15, and Hiroyuki Yamamoto Authors Info & Affiliations

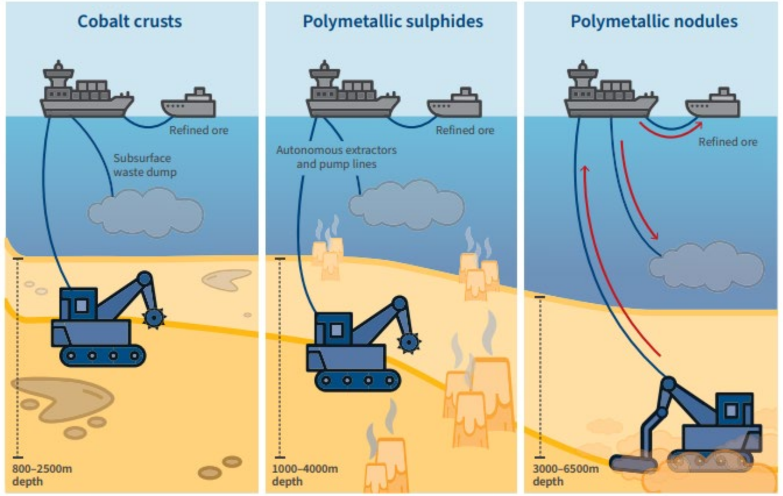
July 8, 2020 | 117 (30) 17455-17460 | https://doi.org/10.1073/pnas.2011914117



Commissioned by
HIGH LEVEL PANEL for A SUSTAINABLE OCEAN ECONOMY

Figure 1. Distribution of Polymetallic Nodules, Polymetallic Sulphides and Cobalt-Rich Crust Resources in the Deep Sea





Source: Modified from Fleming et al. 2019.

Article | Published: 19 August 2020

The future of food from the sea

Christopher Costello, Ling Cao, Stefan Gelcich, Miguel Á. Cisneros-Mata, Christopher M. Free, Halley E. Froehlich, Christopher D. Golden, Gakushi Ishimura, Jason Maier, Ilan Macadam-Somer, Tracey Mangin, Michael C. Melnychuk, Masanori Miyahara, Carryn L. de Moor, Rosamond Naylor, Linda Nøstbakken, Elena Ojea, Erin O'Reilly, Ana M. Parma, Andrew J. Plantinga, Shakuntala H. Thilsted & Jane Lubchenco

The future of food from the sea

Nature **588**, 95–100 (2020) | Cite this article

Matters Arising to this article was published on 09 March 2022

scenarios to estimate future seafood production. We find that under our estimated demand shifts and supply scenarios (which account for policy reform and technology improvements edible food from the sea could increase by 21–44 million tonnes by 2050, a 36–74% increase compared to current yields. This represents 12–25% of the estimated increase in all meat

WP7 Decision Support Tools

OceanICU

- Most people making decisions are not experts:
  - Investments
  - Medical pathways
  - Pensions
- Complex tradeoffs involved.
- How do I balance increased fishing revenue vs improved C storage ?
- Need for simple tools that draw on complex models and deep understanding.
- What will be the impact of a particular fishing or exploitation scenario in 2050 on carbon storage in a climate which has changed?

Decision Support Tools for Better, Faster

expert.ai

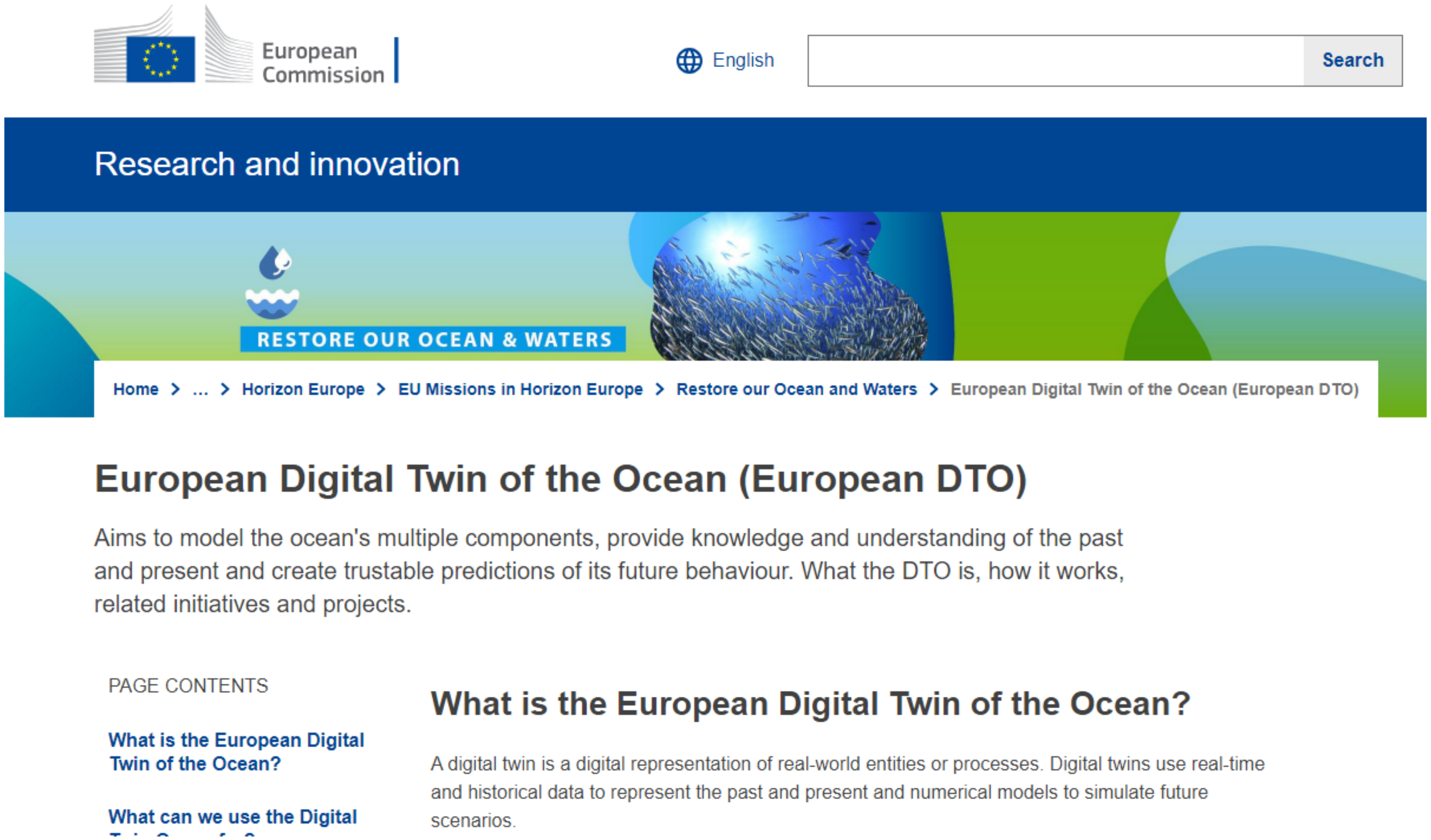
Why expert.ai? Learn Platform Sol

What is a decision support tool?

A Decision Support Tool is a software developed to support analysts and decision makers in making better decisions, faster. Regardless of your industry, the technical, economic, human, and even social factors that a business may face each brings its own unique costs, values and feasibilities. Making the right decision and choosing the proper course of action can be challenging, especially if the decision makers don't have all the possible data available at their disposal. This issue can still be complex even when decision makers have some insights, but without software that can make connections between the data, it's difficult to see the full picture. Decision support tools that merge deep analysis with powerful prediction capabilities can help companies improve the way they approach information, insights and the contexts that surrounds them.

Decision Support Tools

- Lead by Jorn Bruggeman, WP7 Lead, (B&B)
- Designed to fit into European Digital Twins of the Oceans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Research and innovation

RESTORE OUR OCEAN & WATERS

Home > ... > Horizon Europe > EU Missions in Horizon Europe > Restore our Ocean and Waters > European Digital Twin of the Ocean (European DTO)

European Digital Twin of the Ocean (European DTO)

Aims to model the ocean's multiple components, provide knowledge and understanding of the past and present and create trustable predictions of its future behaviour. What the DTO is, how it works, related initiatives and projects.

PAGE CONTENTS

What is the European Digital Twin of the Ocean?

What can we use the Digital

What is the European Digital Twin of the Ocean?

A digital twin is a digital representation of real-world entities or processes. Digital twins use real-time and historical data to represent the past and present and numerical models to simulate future scenarios.

OceanICU
Understanding Ocean Carbon

Environmental impacts of deep-sea mining

Matthias Haeckel

GEOMAR

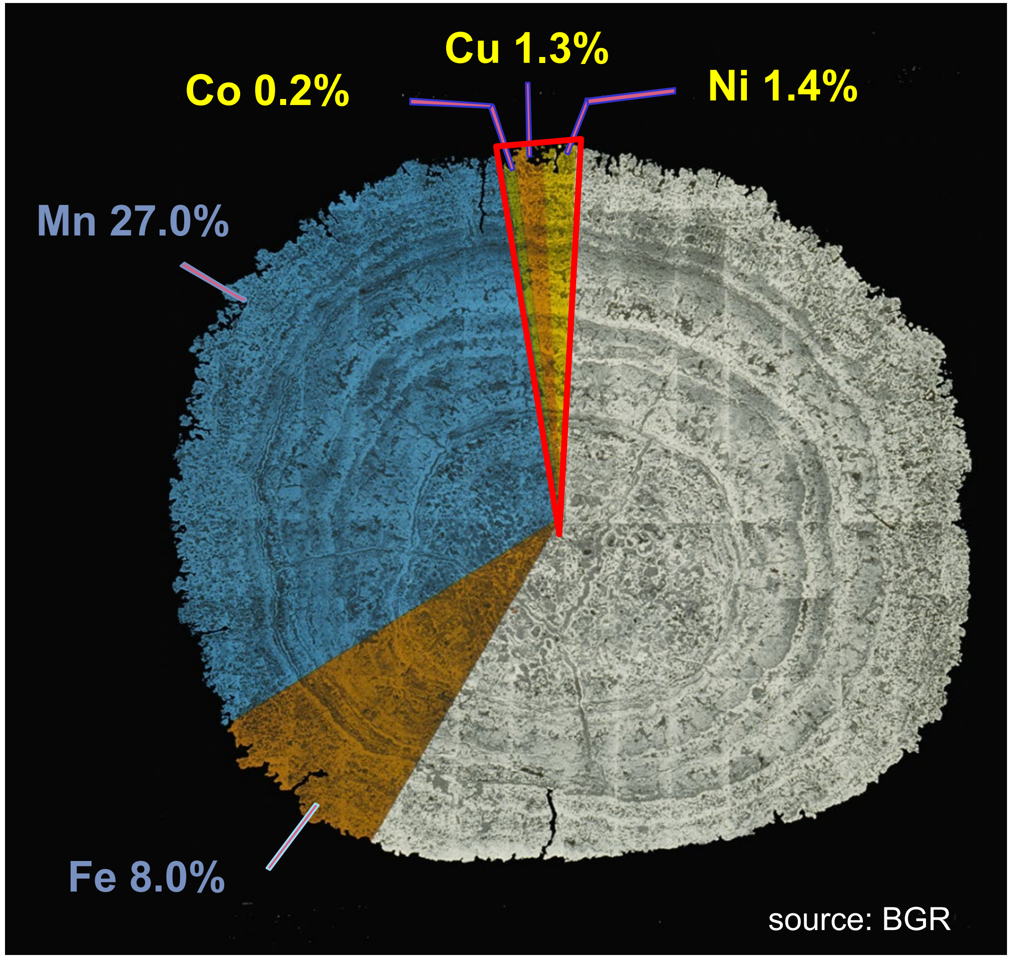
Webinar, 2nd May 2024

OceanICU has received funding from the European Union
HORIZON EUROPE Programme under Grant Agreement No.101083922

Marine Mineral Resources in the Deep Sea

OceanICU

Average composition of polymetallic nodules



important trace metals: Li, Mo, REE

main metals of interest: **~3 % Ni – Cu – Co**

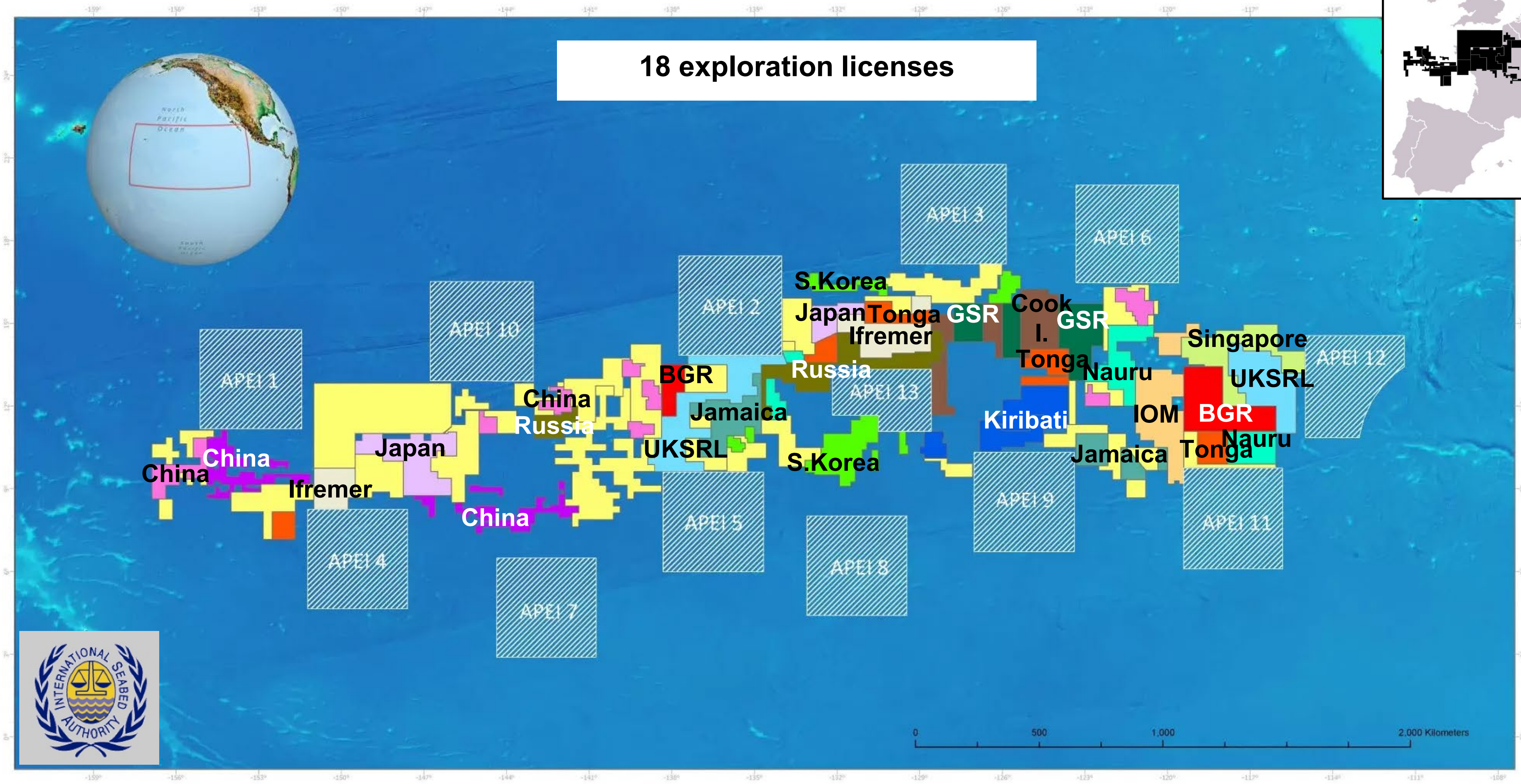
global estimate: 3-5x more Co+Ni than all land reserves
33% of all Cu

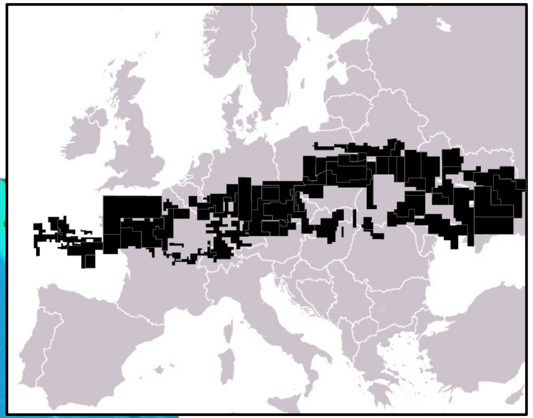
For economic reasons mining operations need to collect 2-3 Mio t of nodules per year
=> mining area 200-300 km^2/a

5 mines would contribute 10% Ni, 25% Co, <1% Cu to today's global production, but saturate the Mn market

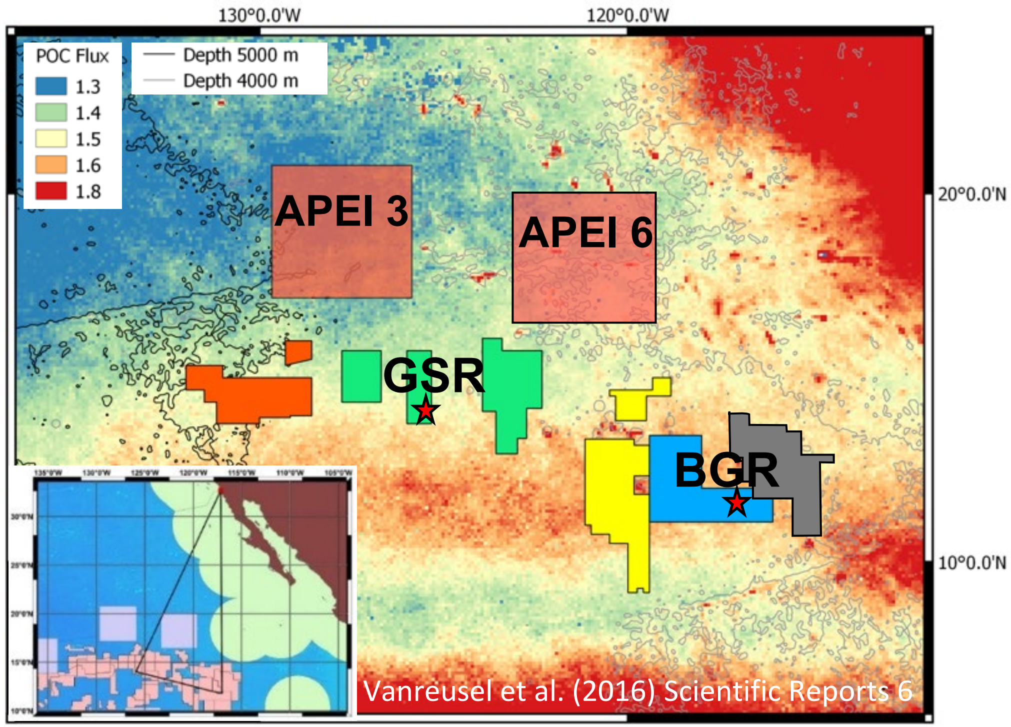
typical land deposits: 1% Cu or 1% Ni or <1% Co

Exploration areas for polymetallic nodules in the Clarion-Clipperton Fracture Zone

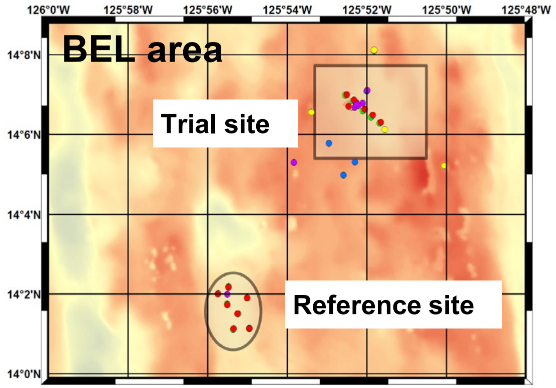


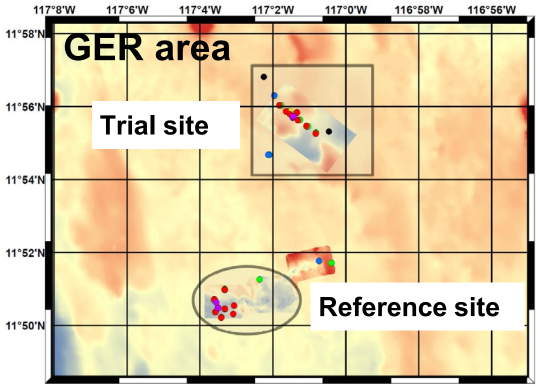


Independent scientific research on impact of a nodule collector trial



BEL and GER areas have different environmental conditions



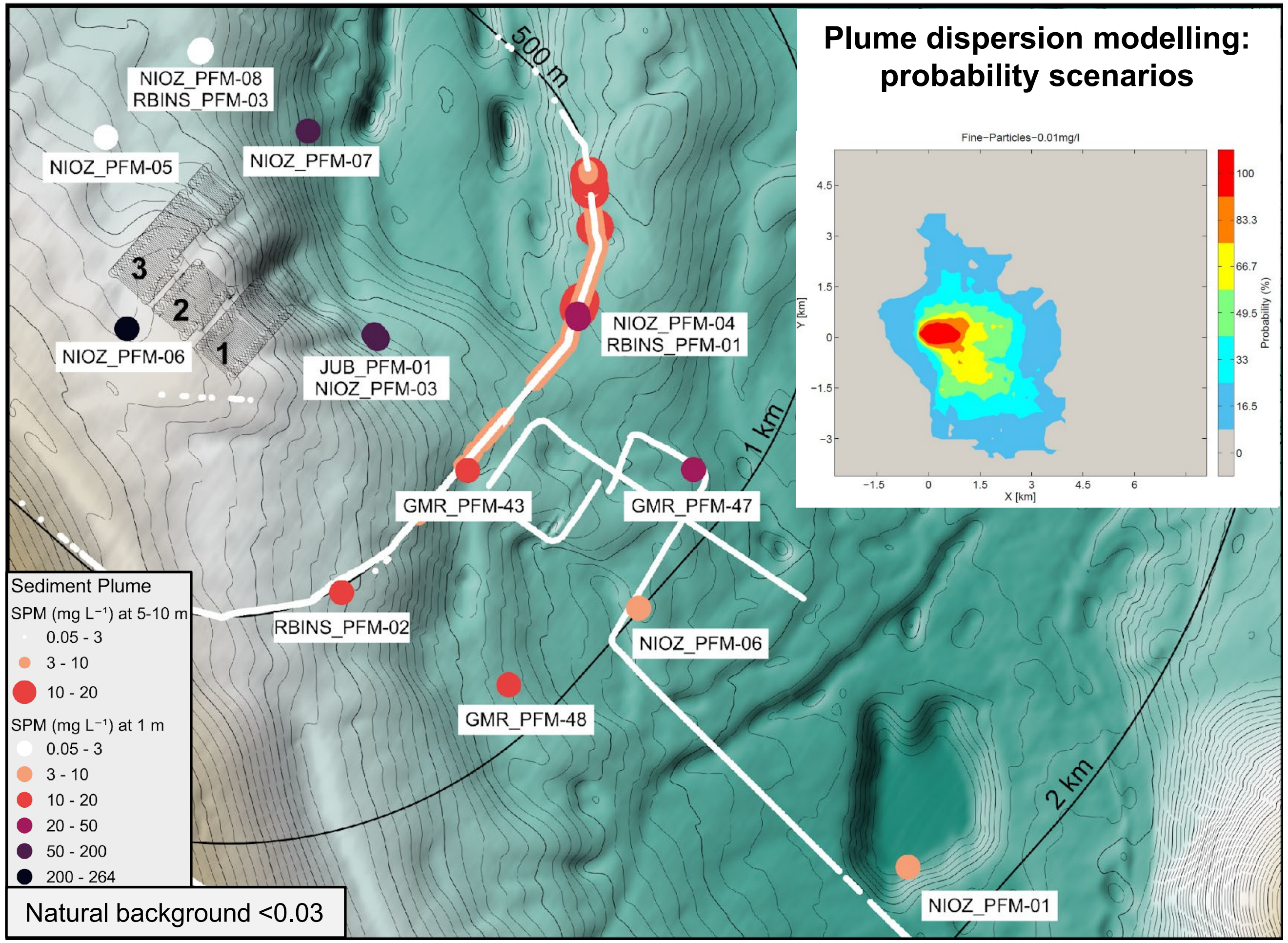


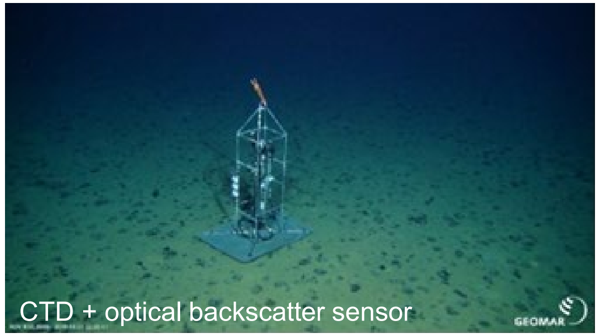
SO268 (2019)
Baseline
Reference + trial sites

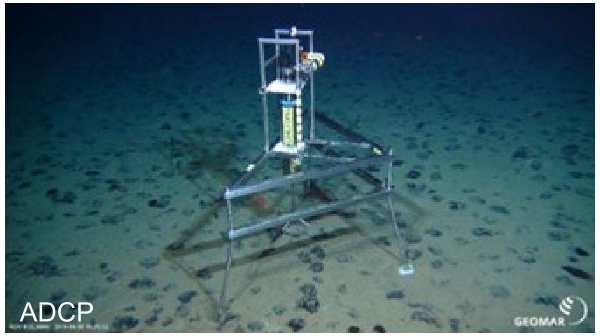
IP21 (2021)
pre- and post collector trial

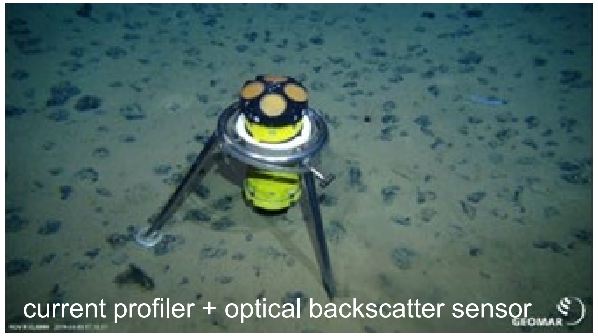
SO295 (2022)
Ref + trial sites
1.5 yr after trial

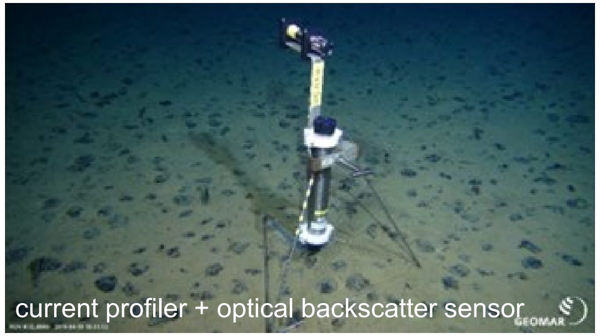
Sediment plume dispersal + deposition









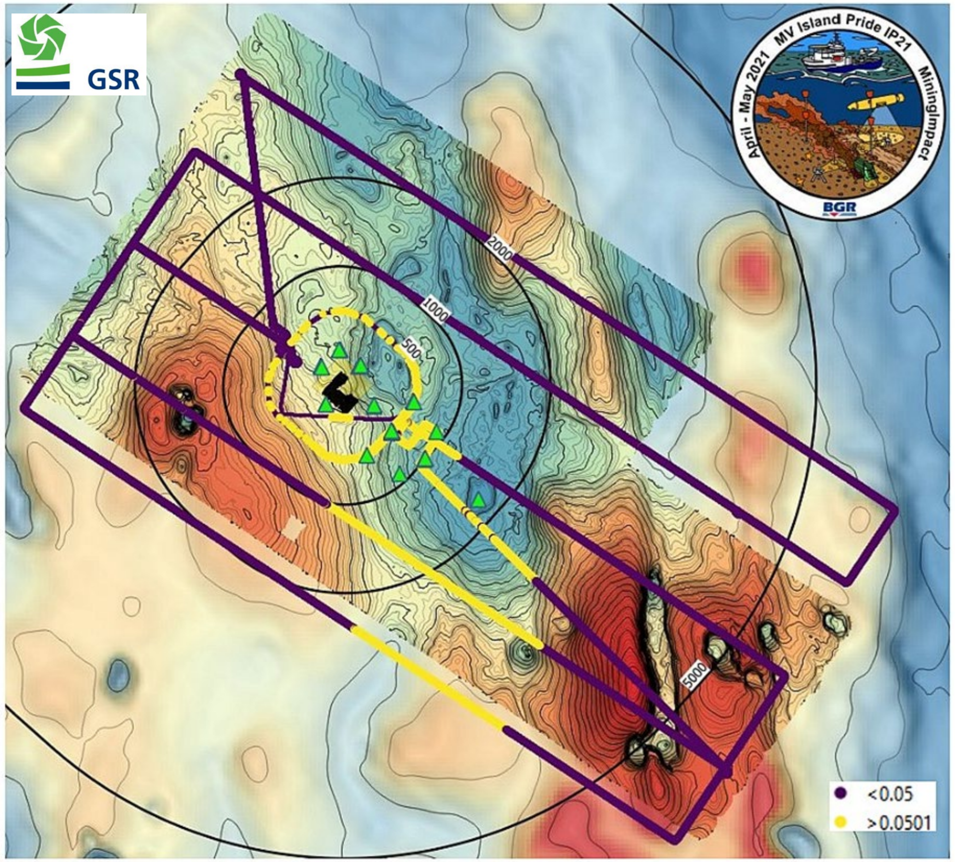


50 acoustic + optical sensors on 20 platforms (intercalibrated to quantify particle concentrations)

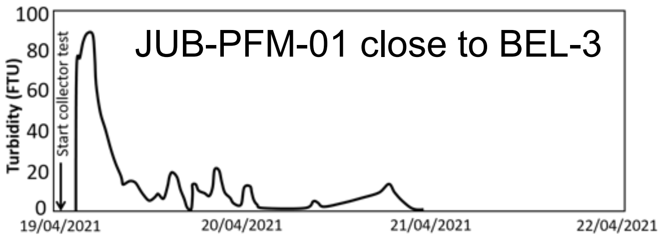
Gazis et al. (accepted), Purkiani et al. (unpublished)

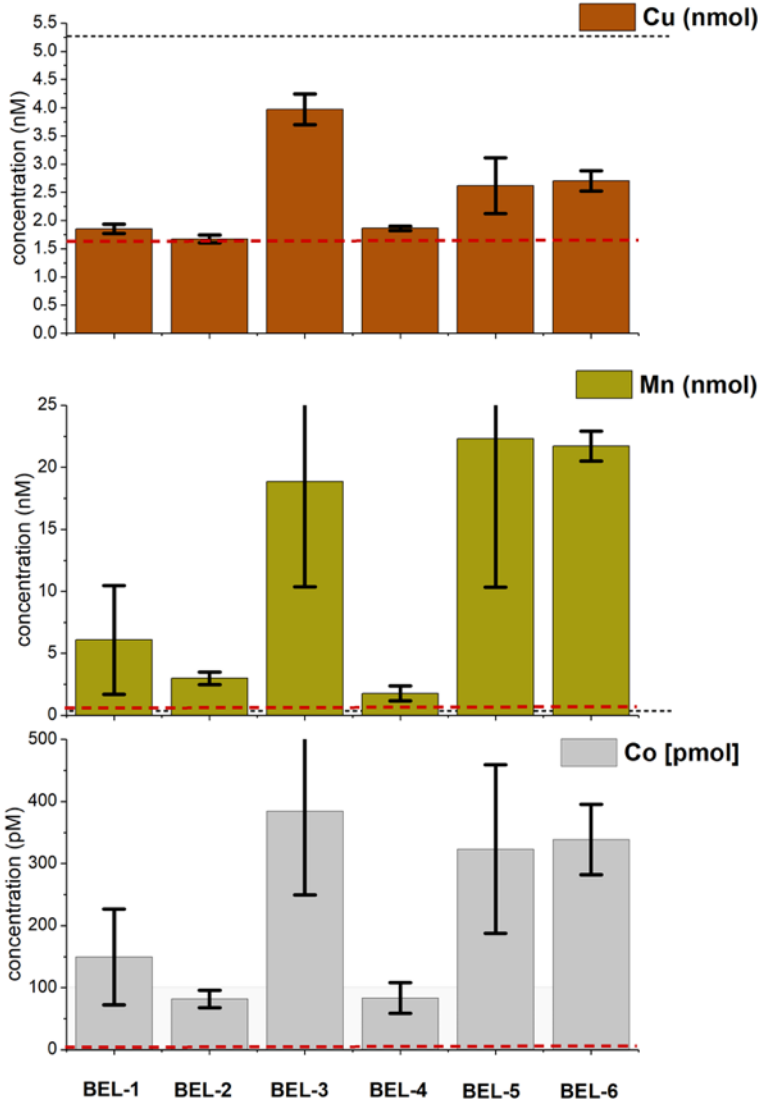
Sediment plume dispersal + deposition

AUV survey at 5/10/30 m above seafloor monitored turbidity in the bottom water



Gazis et al. (accepted)

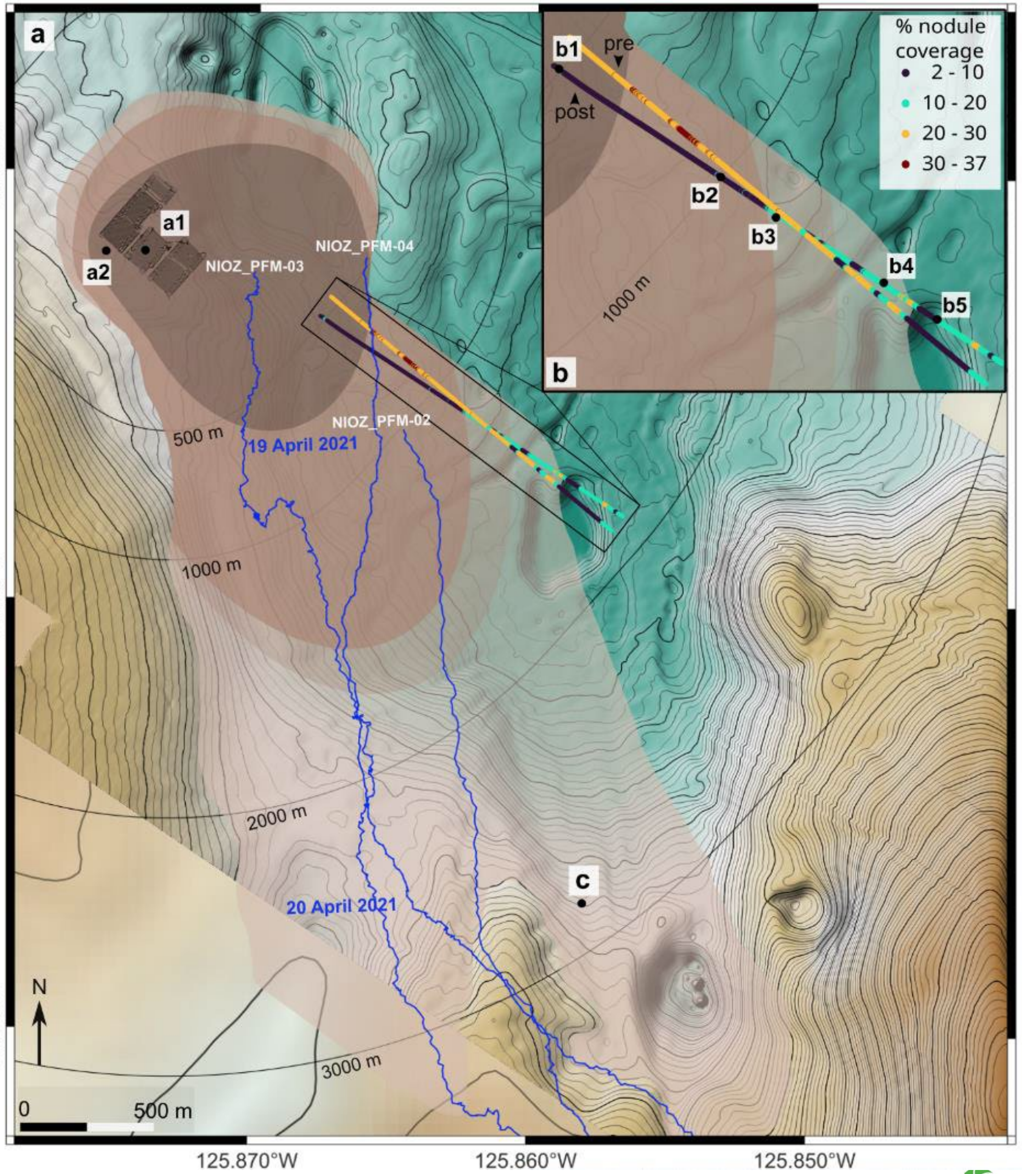


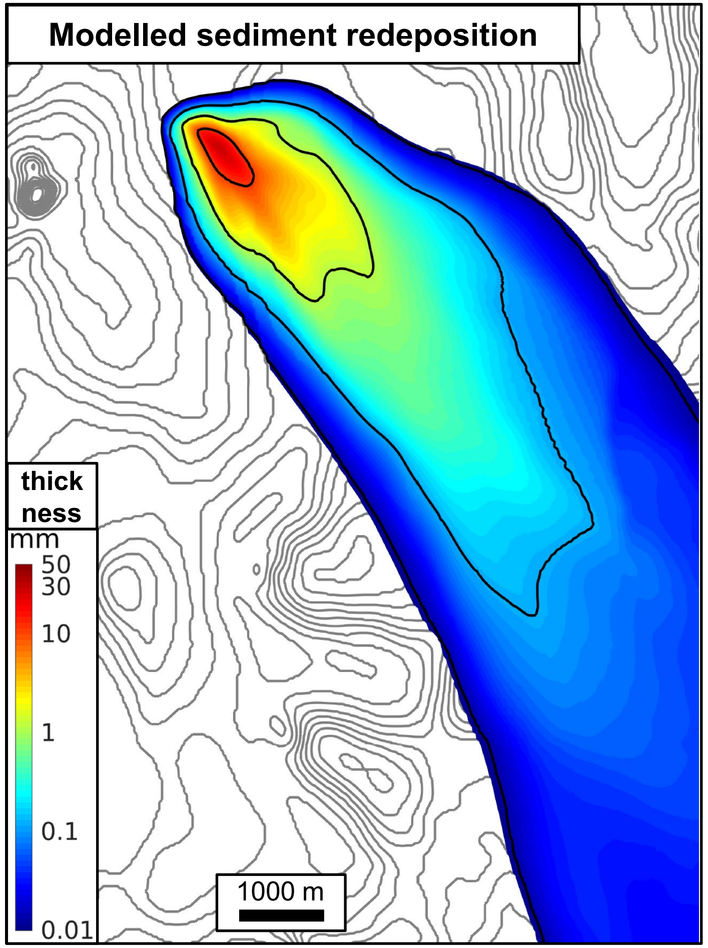


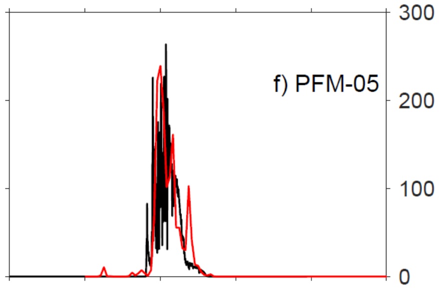
Release of metals in the sediment plume (DGT measurements)

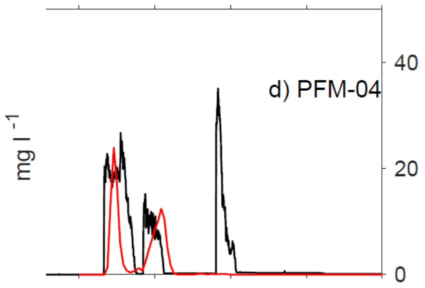
Schmidt et al. (unpublished)

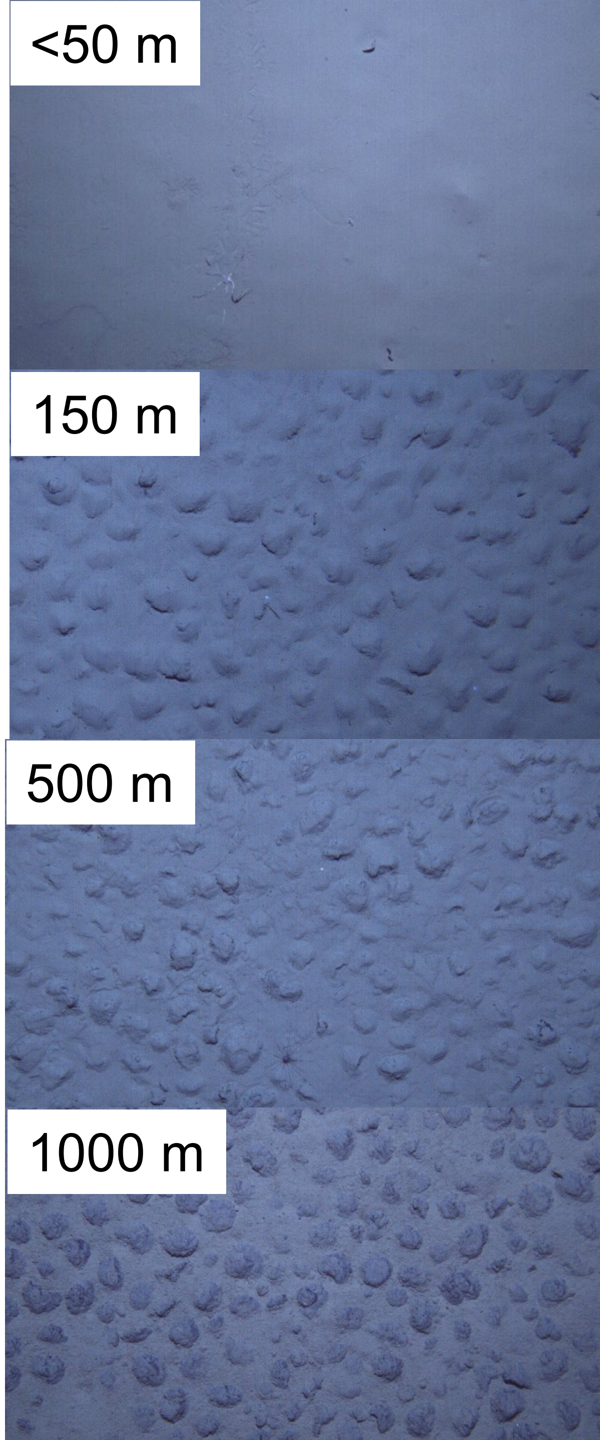
Sediment plume dispersal + deposition











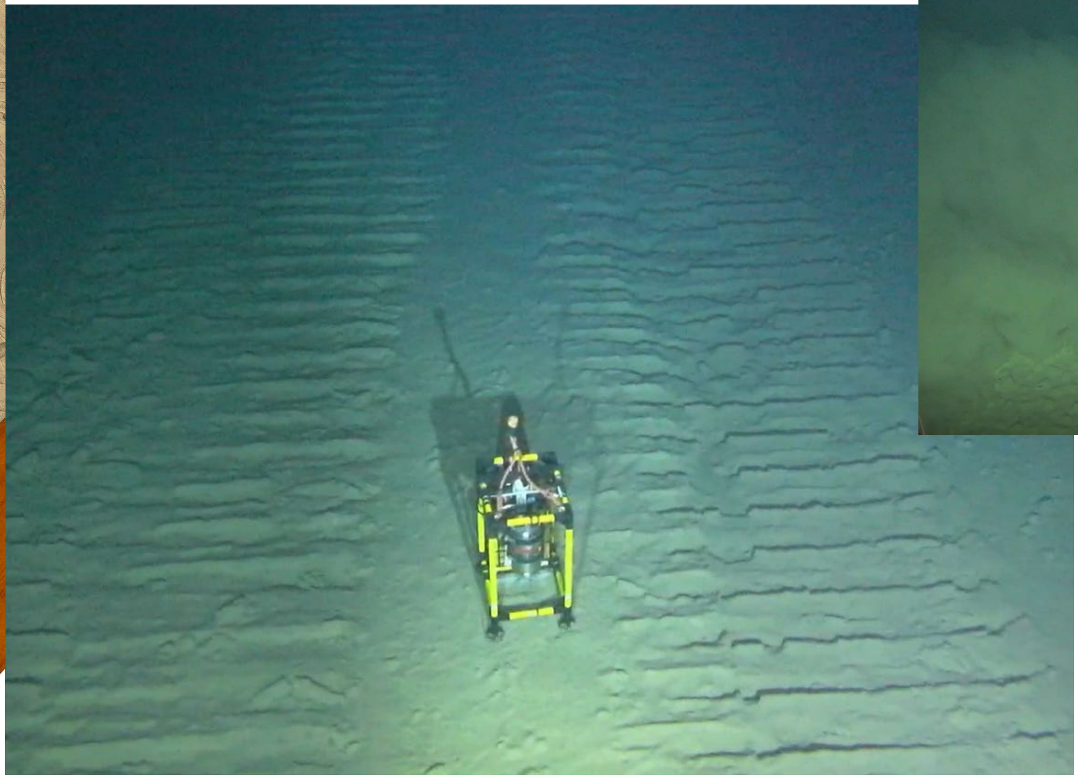
Gazis et al. (accepted), Purkiani et al. (unpublished)

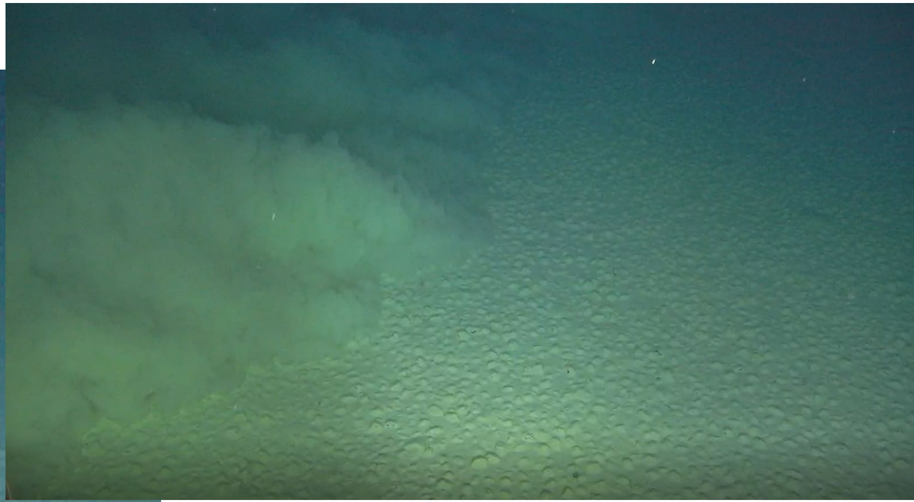
Sediment plume dispersal + deposition

Collector areas: BEL 37,000 m^2 GER 22,000 m^2

Plume deposition area is several times larger than Collector area

GSR



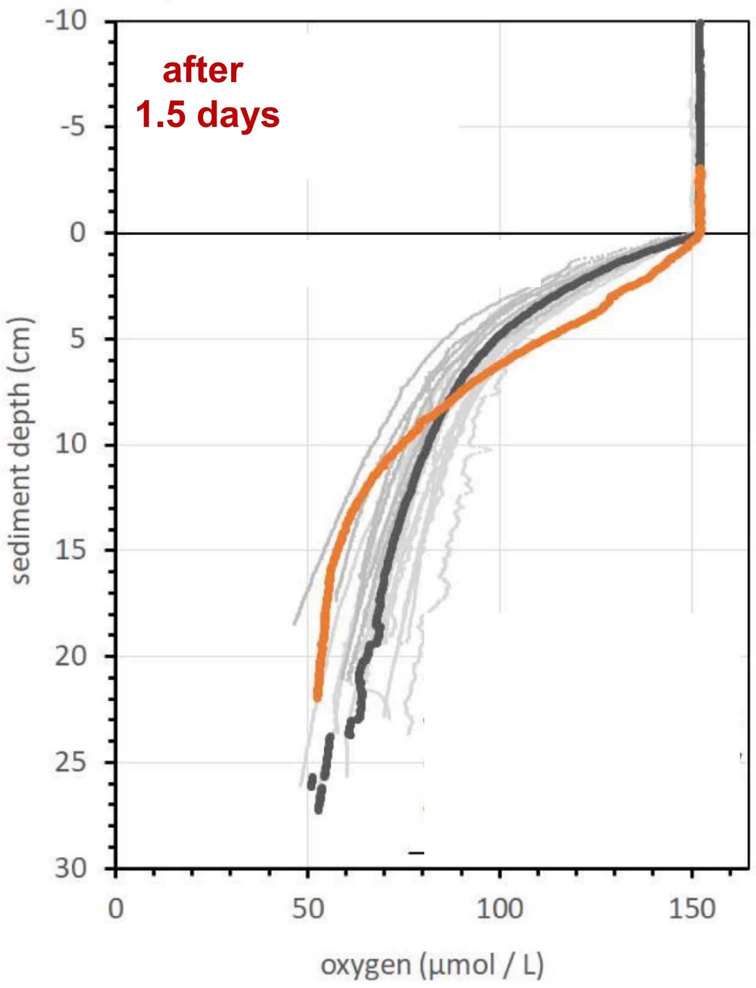


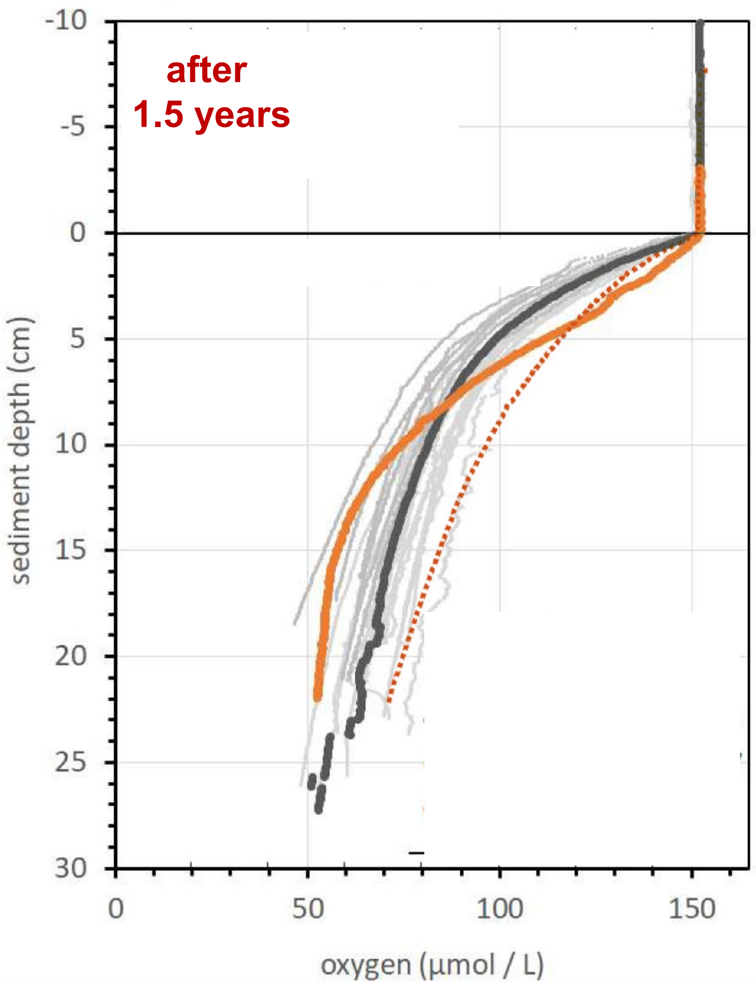
BGR

- Removal of 4-8 cm of surface sediment => redeposition of 2-3 cm inside+vicinity
- Sediment plume remained mainly close to the seafloor (<10 m)
- Far-field transport in low concentrations with bottom currents (~4 km in 24 h)

Impacts on biogeochemical processes

Collector impact site: removal of reactive surface layer => O_2 diffusing into sediment



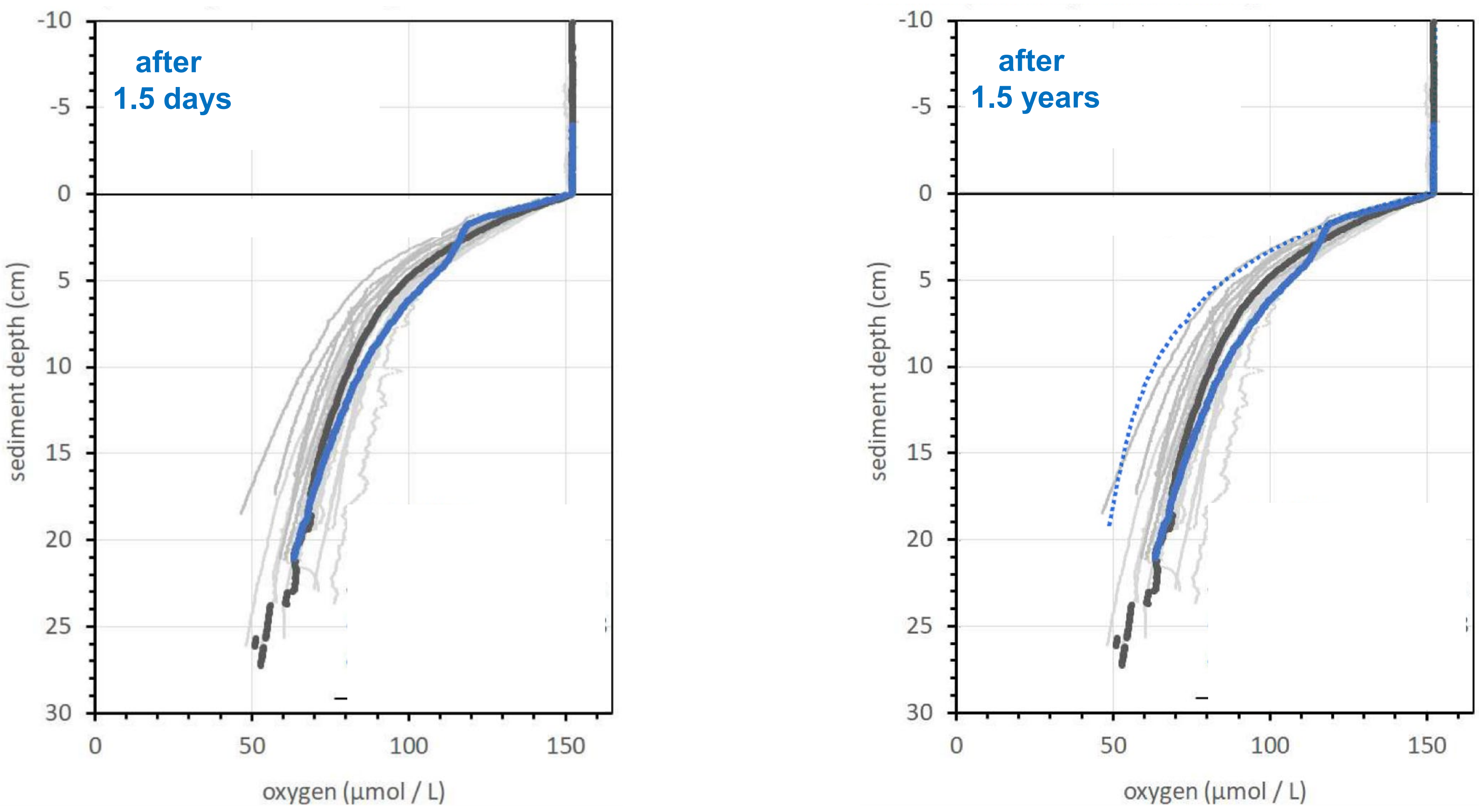


no microbial POC remineralization and no bioturbation

Janssen et al. (unpublished)

Impacts on biogeochemical processes

Plume impact site: thick sediment deposition => increased O_2 consumption

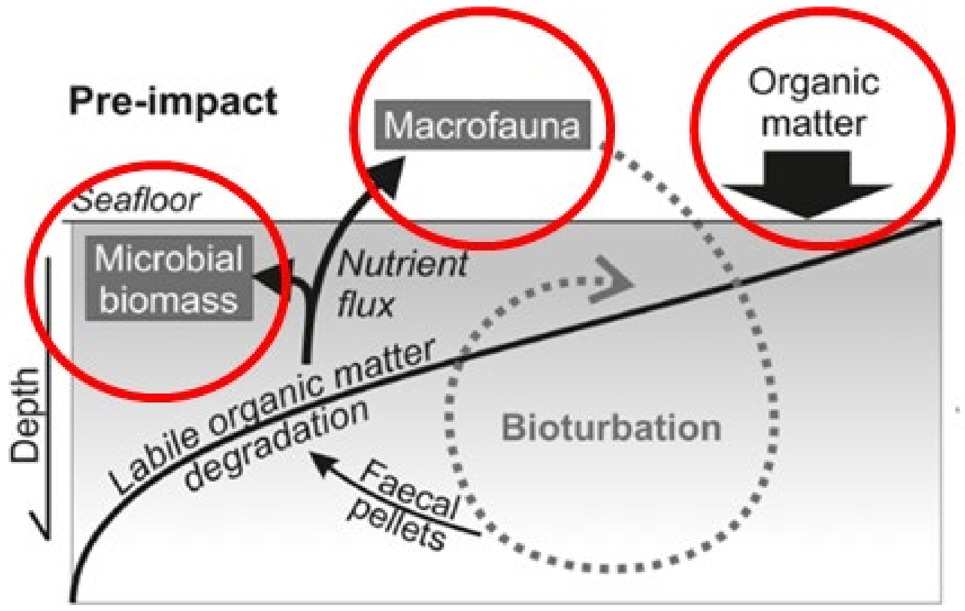


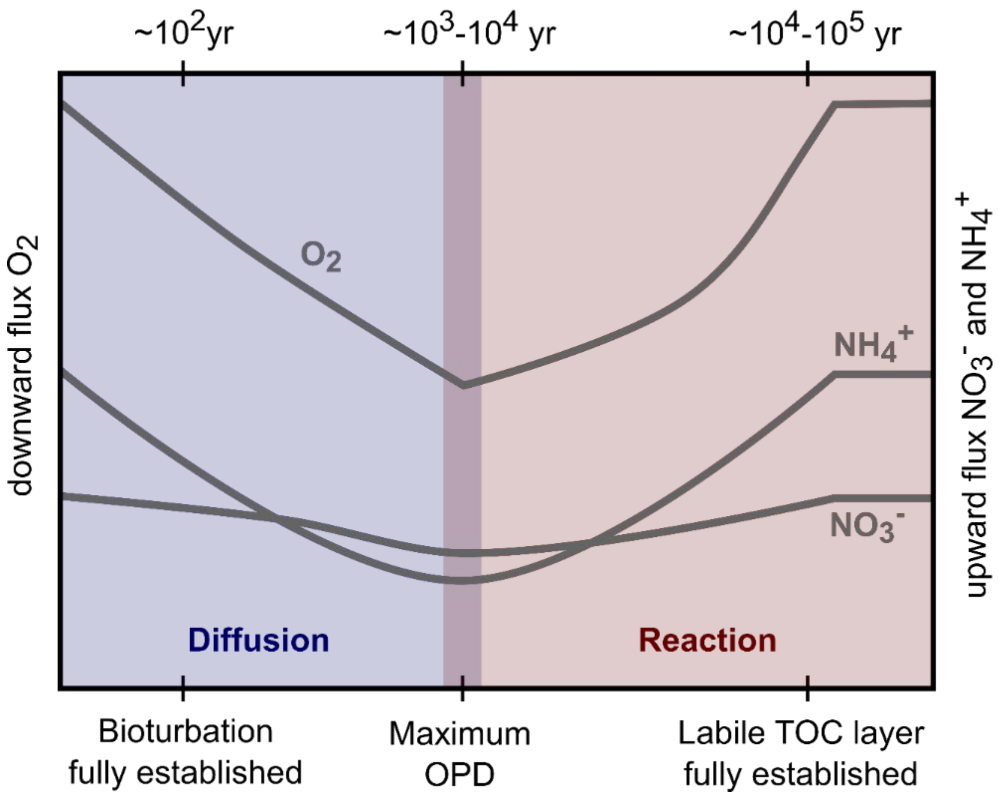
Indication that deposited fauna did not survive nodule collection and redeposition?

Janssen et al. (unpublished)

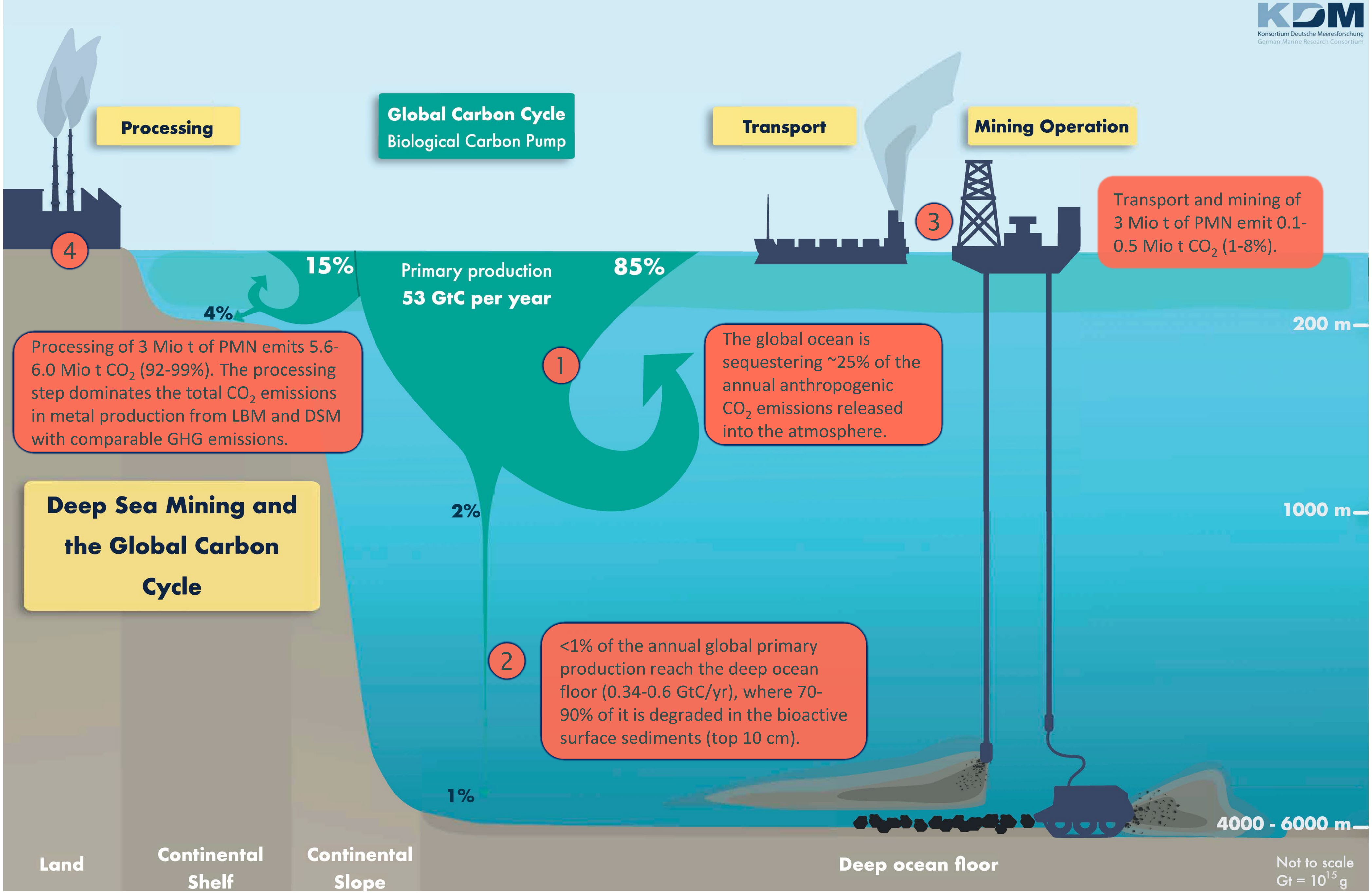
Impacts on benthic ecosystem functions

- Benthic processes will only recover on millenial time scale after removal of biologically active surface layer in the course of polymetallic nodule mining (on 200-300 km^2 per year and operation)

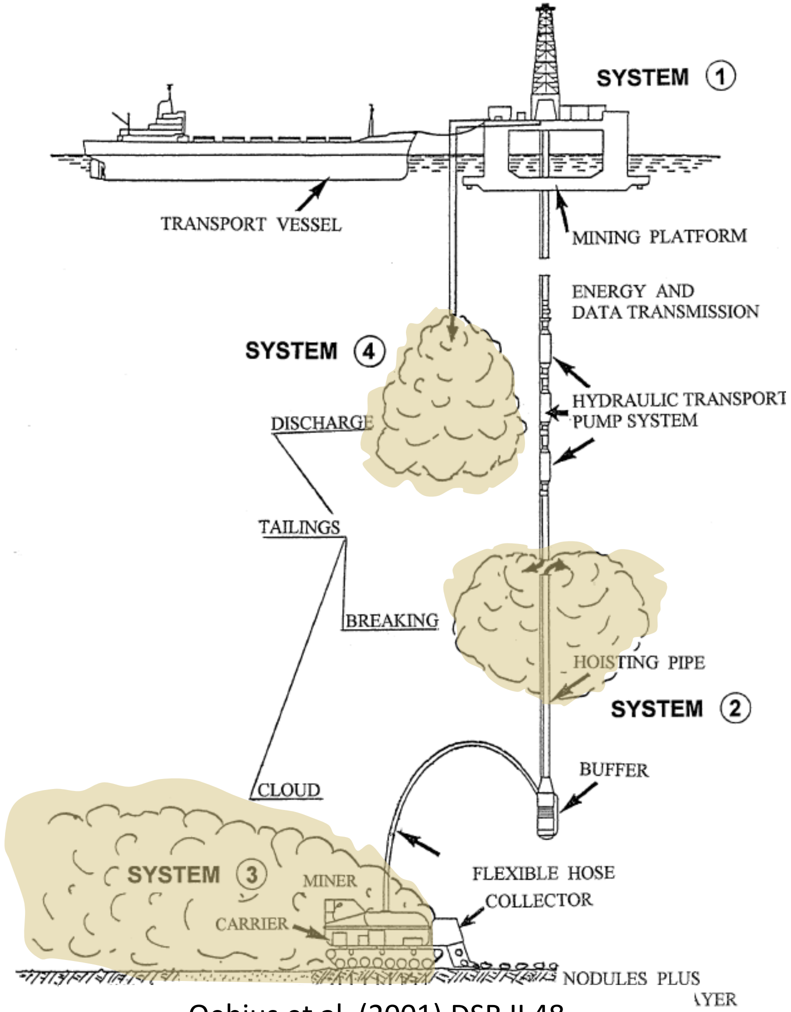




Haeckel et al. (2001), König et al. (2001), Haffert et al. (2020), Volz et al. (2020), Vonnahme et al. (2020)


Processing
Global Carbon Cycle
Biological Carbon Pump
Transport
Mining Operation
4
15%
Primary production
53 GtC per year
85%
3
Transport and mining of 3 Mio t of PMN emit 0.1-0.5 Mio t CO_2 (1-8%).
4%
Processing of 3 Mio t of PMN emits 5.6-6.0 Mio t CO_2 (92-99%). The processing step dominates the total CO_2 emissions in metal production from LBM and DSM with comparable GHG emissions.
1
The global ocean is sequestering ~25% of the annual anthropogenic CO_2 emissions released into the atmosphere.
200 m
Deep Sea Mining and the Global Carbon Cycle
2%
1000 m
2
<1% of the annual global primary production reach the deep ocean floor (0.34-0.6 GtC/yr), where 70-90% of it is degraded in the bioactive surface sediments (top 10 cm).
1%
4000 - 6000 m
Land
Continental Shelf
Continental Slope
Deep ocean floor
Not to scale
Gt = 10^{15} g

Industrial deep seabed mining scenarios



Oebius et al. (2001) DSR II 48

Industrial-scale PMN mining operations in the CCZ
(~200 km^2/a per operation):

- 1 / 5 / 20 parallel mining operations for 1 / 10 / 50 years
- Dispersal of collector plume at seafloor
- Dispersal of return waste discharge in water column in 100 / 1000-1500 / >4000 m water depth
- Interaction of sediment plume with carbon pump processes

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Understanding Ocean Carbon

Thank you

Questions & Answers

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Upcoming OceanICU Webinars

August:

- Wider Society, Educational Pathways and Atlas of the seas

September:

- Decision Support Tools linked to AMEMR

October:

- Ocean Acidification

Check our website and Social Media for additional information

OceanICU

Do you work in a blue economy industry such as fishing, mining, offshore renewable energy, tourism or oil and gas?

Are you a manager, decision-maker, scientist or policy-maker?

Or are you a citizen interested in climate change and its relationship with a sustainable blue future?

If any of these apply to you, why not join us?

Get in touch via the sign-up form to join our stakeholder panels.

SIGN UP

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Thank You!

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