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Polymetallic nodules are essential for food-web integrity of Pacific abyssal plains

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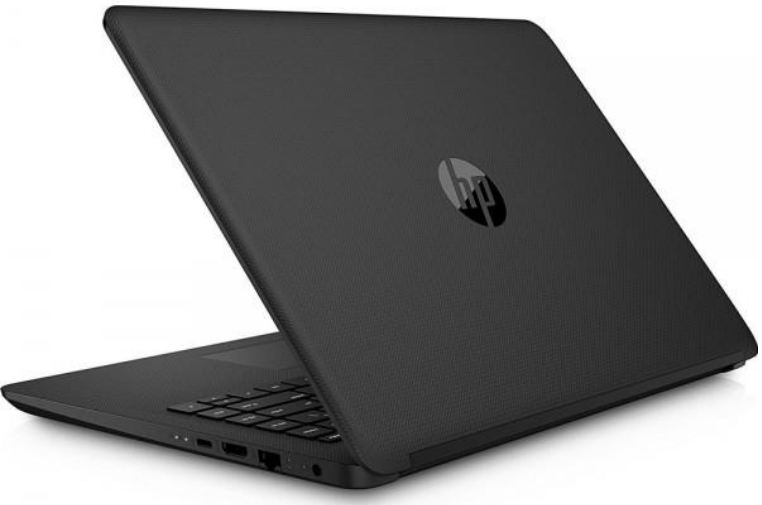
SENCKENBERG world of biodiversity

Deep-sea mining: Why?



- Globally increasing demand for mineral resources, e.g. copper, nickel, rare earth elements
- 90% of land based REE controlled by China

Photos: https://www.elipo.de/elektronik/computer/notebook/laptop-notebook/2988/pc-notebook-laptop-hp-14-bp003ng-14-zoll-1tb-4gb-i5-7200u-win10, https://www.caranddriver.com/features/a26390899/what-is-hybrid-car/

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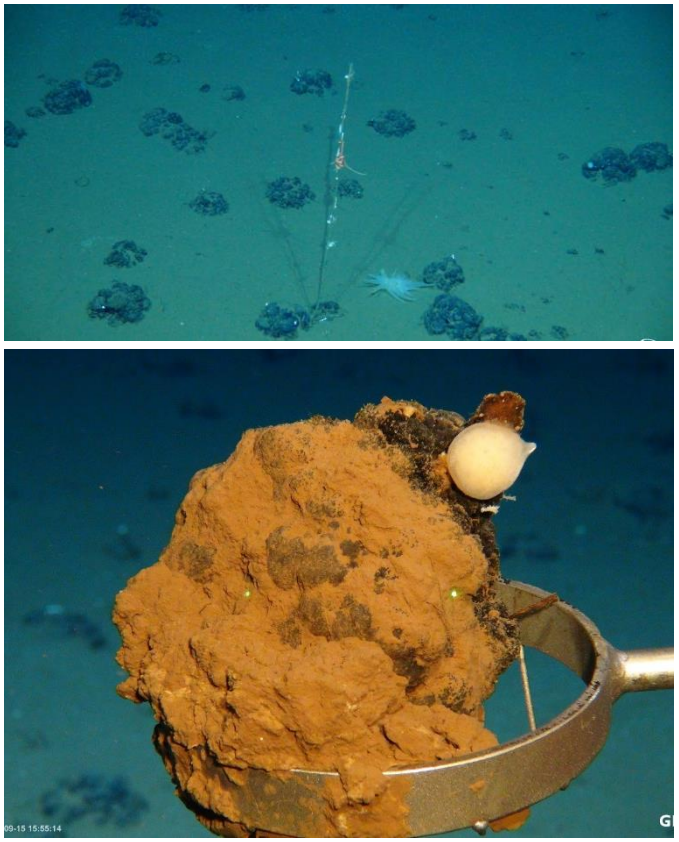
Manganese nodules

- On abyssal plains in 4000-6000m water depth
- Contain more manganese, nickel, cobalt than landbased reserves
- Nodules accrete slowly (rates: mm per million years)



Photos: ROV Kiel 6000, Geomar, Germany

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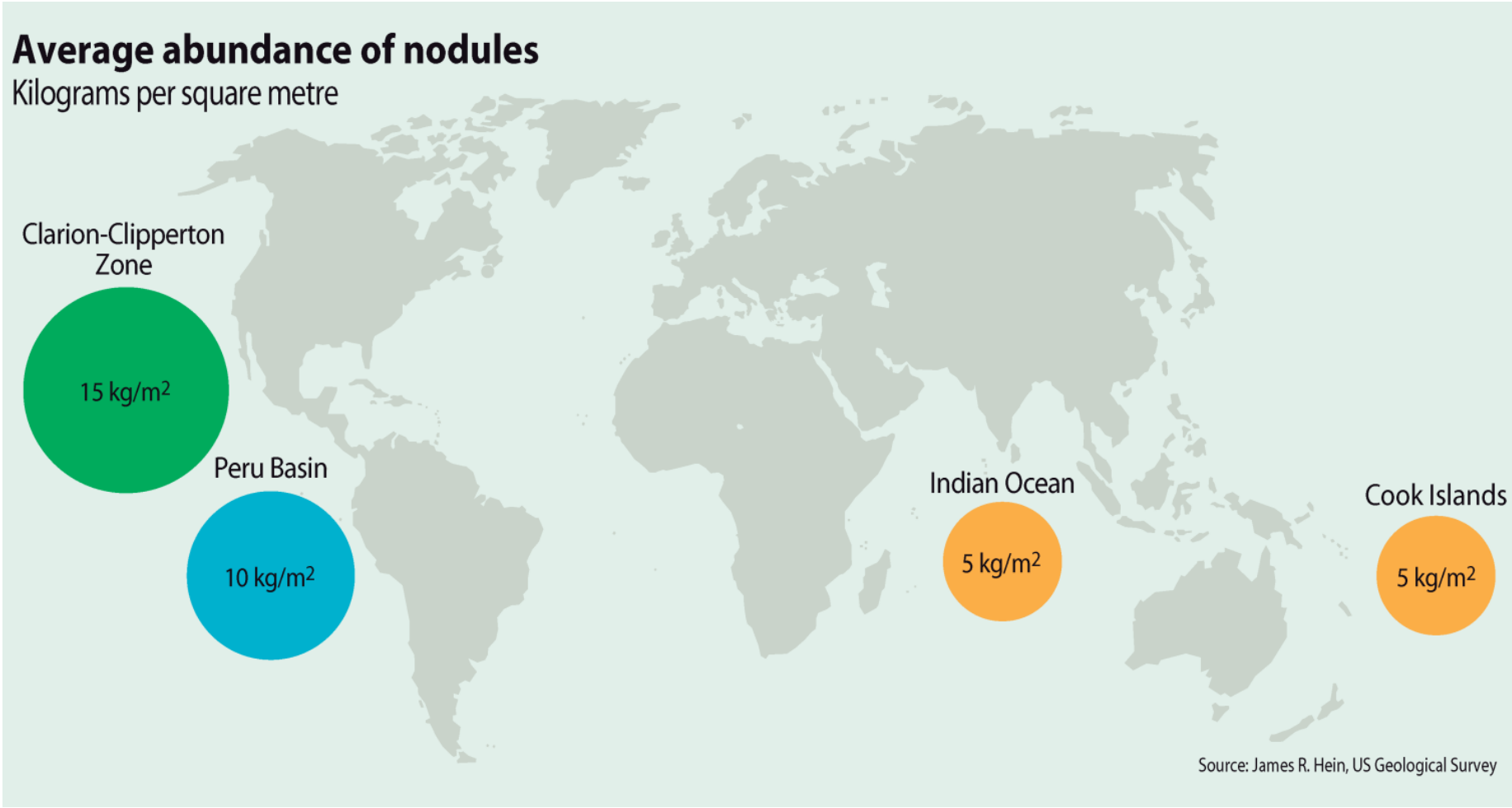
Manganese nodules – global distribution



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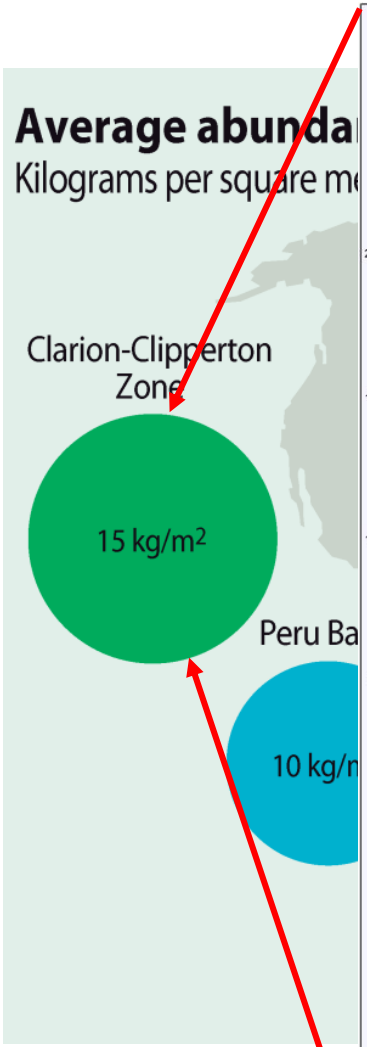
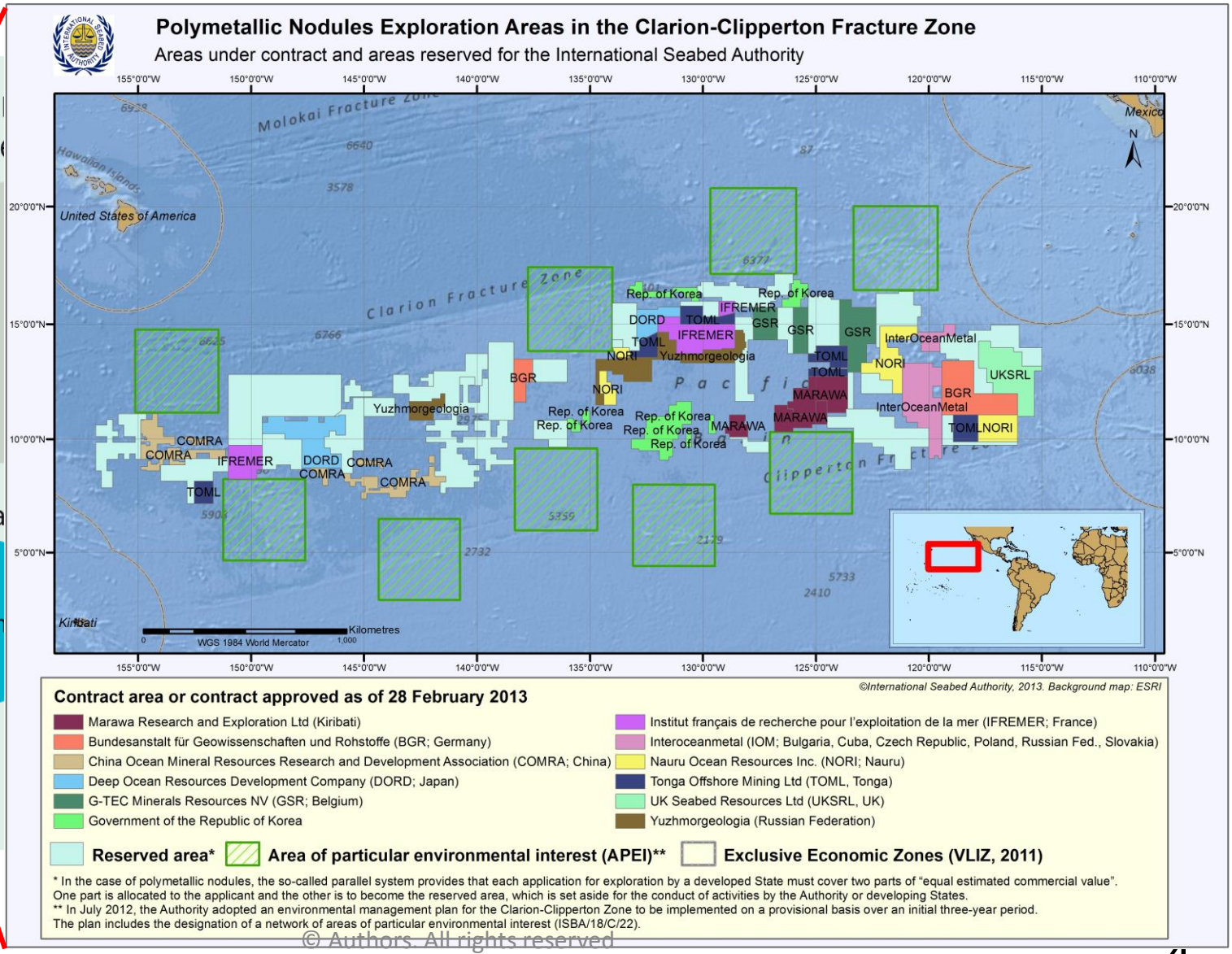
Manganese nodules – global distribution





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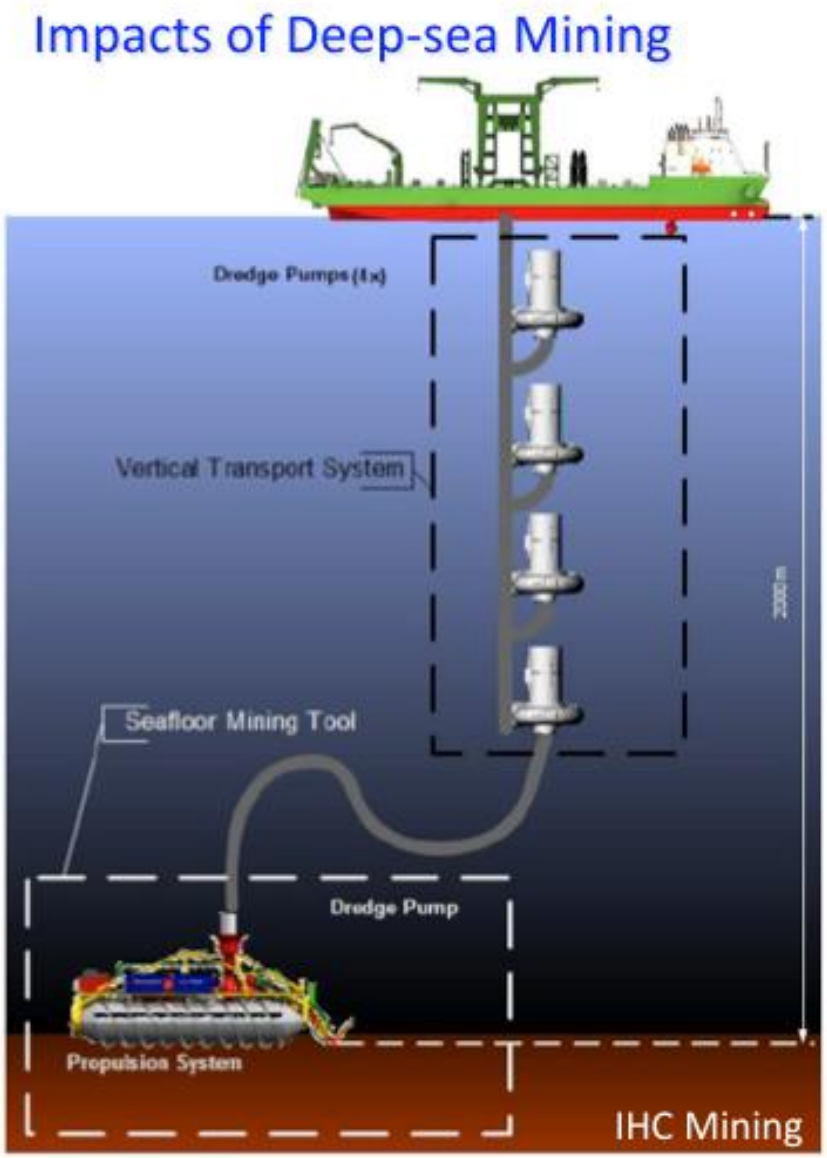
Mining of polymetallic nodules



Plus disposal of wastes from mineral processing

Light, pollution from ship

Returned water plume

Noise, vibration

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

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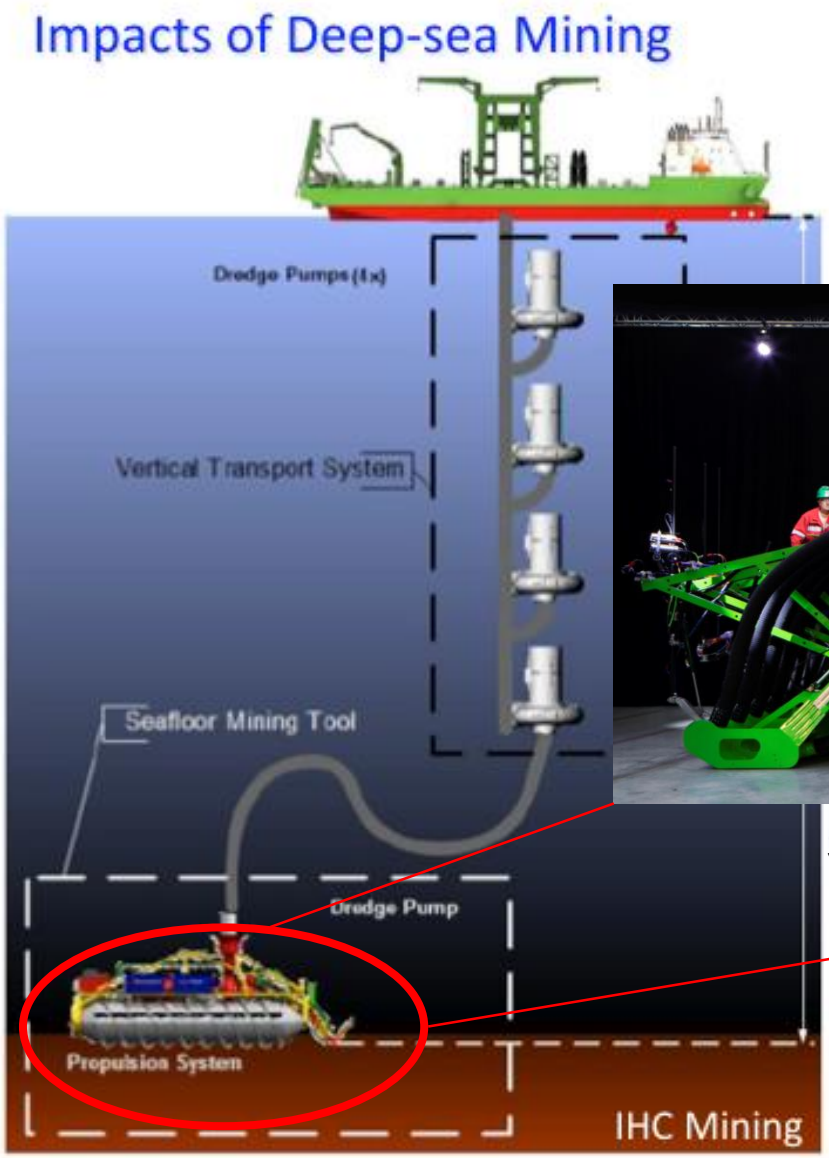
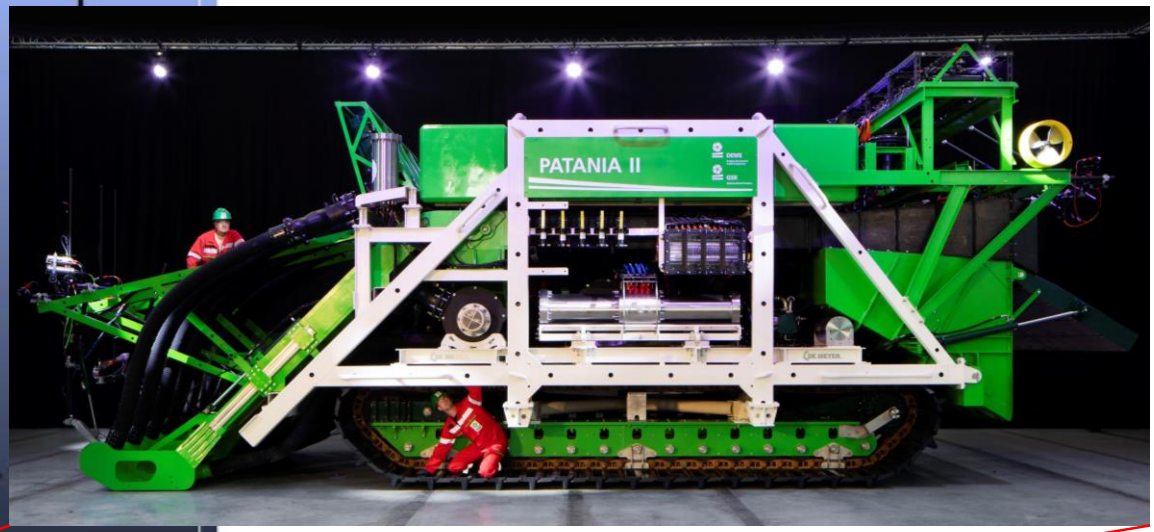
Source: Blue Nodules (https://www.blue-nodules.eu)

Mining of polymetallic nodules





Source: DEME Group (https://www2.deme-group.com)

Source: Blue Nodules (https://www.blue-nodules.eu)

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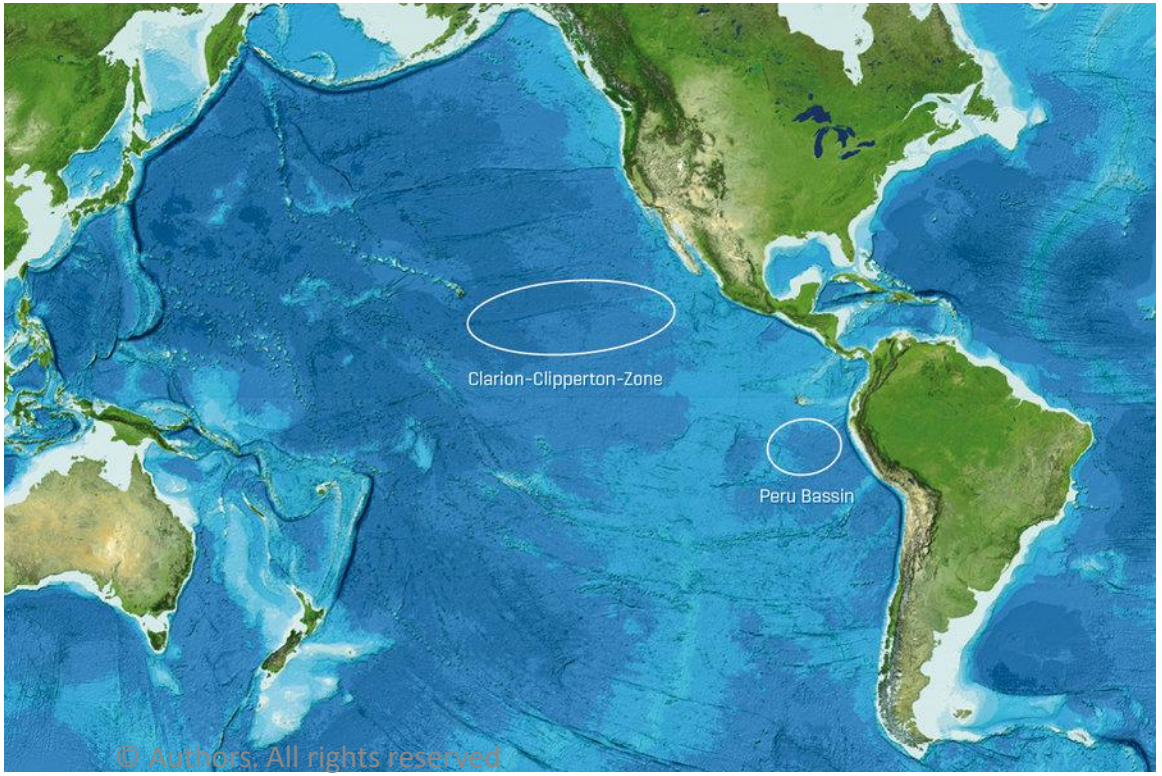
Research question

How important are trophic and non-trophic interactions between taxa and between taxa **and** polymetallic nodules in two nodule-rich areas in the Pacific Ocean?



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(Stratmann et al. in prep.)

Data compilation

Systematic literature review

Novel high-resolution seafloor images

Database of species living in abyssal plains (+/- attached to nodules/ other organisms)

(Stratmann et al. in prep.)

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Trophic interaction matrix

Identify feeding preferences of each species ← "WoRMS" + "FishBase"

↘

Binary trophic interaction matrix: connecting all compartments via all trophic links to prey/ food sources

(Stratmann et al. in prep.)

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Non-trophic interaction matrix

- Obligatory non-trophic relation: species ↔ nodule; species ↔ species

- Facultative non-trophic relation: species ↔ nodule; species ↔ species

Photos: ROV Kiel 6000, Geomar, Germany

(Stratmann et al. in prep.)

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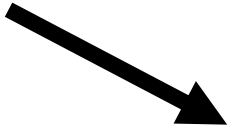
Assessment of absence of nodules/ specific faunal compartments

Remove nodule compartment from non-trophic interaction matrix



All compartments directly depending on nodules are removed

All compartments linked to removed compartments via trophic/ non-trophic interactions are removed

(Stratmann et al. in prep.)

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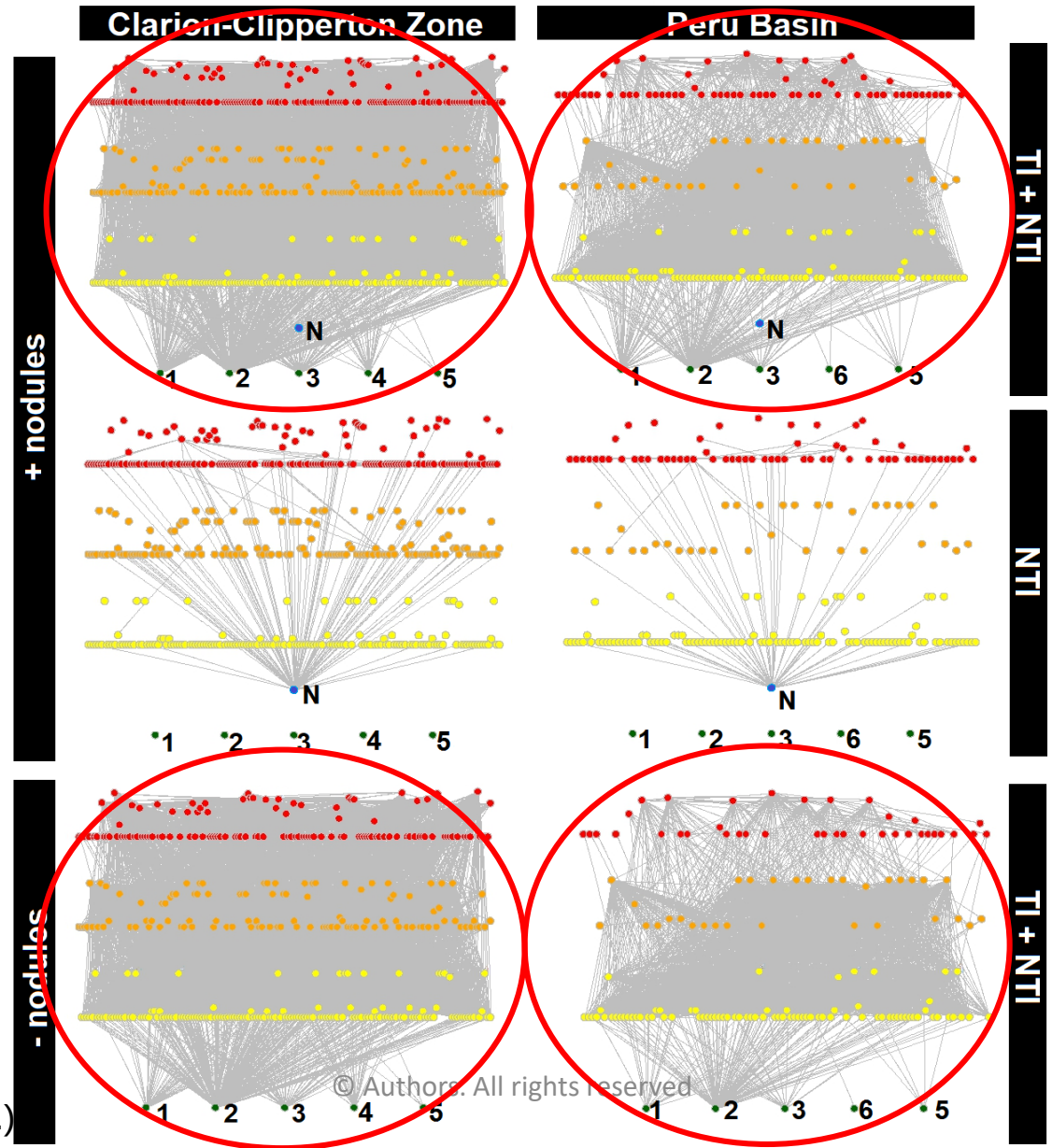
Results

yellow = meiofauna
orange = macrofauna
red = megafauna

478 network compartments, connected with 9386 trophic & non-trophic links

- nodules: ↓20% compartments, ↓20% links



TI = trophic interaction
NTI = non-trophic interaction

N = nodule

208 network compartments, connected with 3131 trophic & non-trophic links

- nodules: ↓26% compartments, ↓37% links

(Stratmann et al. in prep.)

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Results

Clarion-Clipperton Zone

- Highest impact taxa: Porifera *Hyalonema* sp. and *Caulophacus* sp. → loss of 10 compartments each

- Most connected taxa: no loss of other compartments

Peru Basin

- Highest impact taxon: Porifera *Hyalonema* sp. → loss of 9 compartments (4% of all faunal compartments)

- Most connected taxa: no loss of other compartments

Photos: ROV Kiel 6000, Geomar, Germany

(Stratmann et al. in prep.)

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Discussion/ Conclusion

- Removal of stalked Porifera had largest impact on network properties (→ “highest impact taxa”)

  ↘

  Sponges host commensal faunal communities
  - filter/ suspension feeders
  - scavengers
  - predators

Photos: ROV Kiel 6000, Geomar, Germany, AWI-OFOS, AWI, Germany

(Stratmann et al. in prep.)

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Discussion/ Conclusion

- Removal of stalked Porifera had largest impact on network properties (→ “highest impact taxa”)

Absence of polymetallic nodules due to deep-sea mining leads to depreciation of biodiversity (only local or globally?).

Photos: ROV Kiel 6000, Geomar, Germany, AWI-OFOS, AWI, Germany

feeders
- scavengers
- predators

(Stratmann et al. in prep.)

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