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Environmental impacts of polymetallic nodule mining – results from an industrial collector trial

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In 2021 a pre-prototype collector machine for mining of polymetallic nodules was tested in contract areas of the International Seabed Authority in the Clarion-Clipperton Zone. The independent European research project MiningImpact monitored this first industrial trial with expeditions in spring 2021 and fall 2022. Seafloor impacts were categorized into “collector impact”, i.e. where the collector removed nodules, surface sediment, epi- and endofauna, and “plume impact”, i.e. where suspended sediment was deposited onto the seafloor surrounding the mining area. Substantial sediment deposition was observed within the first 500 m, fading out with increasing distance, but visually still identifiable on AUV photos in distances of 2-3 km [1]. To allow impact assessment against natural baseline variability, an unaffected “reference” about 10 km away was also sampled.

Compared to the pre-impact situation, the collector impact site is characterized by strongly reduced meio-, macro, and megafauna abundances and diversity, diffusion of oxygen into the sediment, low microbial metabolic rates, decreased organic carbon content and lability. Hence, the biogeochemical data indicate strongly inhibited organic matter remineralization rates in the surface sediments, thus supporting previous model predictions [2,3] suggesting that recovery of biogeochemical processes and fluxes needs several thousand years, because it is essentially controlled by the re-establishment of the reactive (bioturbated) surface layer through sedimentation of labile organic matter. In contrast, slightly increased meiofaunal abundances were found in the plume impact site [4] that persisted also 1.5 years later. These coincide with slightly elevated oxygen consumption rates in the deposited blanketing layer.

This presentation will provide an overview on the observed immediate and short-term impacts as well as the expected long-term consequences of deep-sea mining operations on the abyssal polymetallic nodule ecosystem with a particular focus on biogeochemical processes.

References

[1] Gazis et al. (2025) Nature Communications 16, 1229. doi:10.1038/s41467-025-56311-0.

[2] Haffert et al. (2020) Biogeosciences 17, 2767-2789. doi:10.5194/bg-17-2767-2020.

[3] Volz et al. (2020) Biogeosciences 17 (4), 1113-1131. doi:10.5194/bg-17-1113-2020.

[4] Lefaible et al. (2024) Frontiers In Marine Science 11, 1380530. doi:10.3389/fmars.2024.1380530.