Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38005

Mobilization of trace metals in deep-sea mining plumes

SCHMIDT KATJA[1], HENKO DE STIGTER[2] AND SOPHIE A. L. PAUL[3]

[1]Federal Institute for Geosciences and Natural Resources
[2]NIOZ Royal Netherlands Institute for Sea Research
[3]GEOMAR Helmholtz Centre for Ocean Research Kiel

Future mining of marine polymetallic nodules has been discussed controversially for decades. Driven by economic and geopolitical factors, the technological development and testing of deep-sea mining equipment has accelerated recently, while impacts and ecosystem responses are still not satisfactorily understood and mining regulations in the Area are not yet in place. One of the environmental concerns about deep-sea mining are ecotoxicological effects in local benthic and pelagic fauna, caused by potentially toxic metals mobilized in operational and discharge plumes.

This study presents results from monitoring of water composition during two *in situ* mining tests conducted in 2021 in exploration contract areas in the eastern Clarion Clipperton Zone (CCZ). Particle plumes were expelled at the back of the nodule collector machine and have been sampled with CTD rosette, ROV-mounted NISKIN water samplers, and *in situ* passive sampling devices using the diffusive gradients in thin films (DGT) technique. Different physical and chemical fractions including the labile-bound metal fraction of As, Cd, Co, Cu, Fe, Ni, Mn, Pb, REY, V, and Zn were determined in the plume waters. At sediment particle loads of up to several milligrams per liter (in comparison, less than 15 micrograms per liter are typical in undisturbed CCZ bottom seawater), we see a significant increase of total dissolved (<0.2 µm) Mn, Co, Ce, and Cu in the plume in comparison to ambient seawater. The DGT-labile fractions of these elements are also significantly enhanced, indicating enhanced availability for transmembrane bio-uptake. In contrast, the mining plumes have shown to act as sink for dissolved Cd, REY, and V in the ocean, with decreasing concentrations as a result of scavenging onto plume particles, a behaviour also known from hydrothermal plumes. The baseline seawater composition that is required to evaluate trace metal behaviour and fate in mining plumes has been obtained during multiple sampling campaigns between 2018 and 2026 and represents a robust dataset useful also for the development of regulatory thresholds. In a setting introducing multiple potential stressors, this study contributes to a better understanding of the distribution and biogeochemical behaviour of trace metals released in deep-sea mining plumes.