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Chemical characterization of plumes generated during deep-sea mining of polymetallic nodules from the eastern Clarion-Clipperton Zone

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Deep-sea mining of polymetallic nodules is on track to become commercialized in the next few years. However, scientific understanding of mining's environmental impacts on the seafloor and the water column is only beginning to emerge, making each investigation of this new industry critical. In the fall of 2022, The Metals Company and its engineering partner Allseas held a ten-week pilot mining test in the NORI-D lease region on the eastern edge of the Clarion-Clipperton Zone, while scientists gathered data. During a deep-sea mining operation, two particle-rich plumes are generated. There is a benthic plume directly above the seafloor, which originates from both the harvester vehicle driving over the seabed and from an initial filtering process within the vehicle, which dispels sediments out the back. There is also the formation of a midwater plume, derived from a shipboard "dewatering" process that retains economically-viable nodules while releasing unwanted sediments, nodule fragments, and seawater back into the ocean; The Metals Company released this "dewatered" slurry at ~1250 meters. During these pilot mining trials, we collected seawater samples of the plumes using a trace metal-clean rosette and Niskin bottles mounted to ROVs with the ultimate goal of characterizing the spatial extent and chemical composition of the plumes. Additional samples were collected directly from the pipes carrying the nodule slurry onto and off of the mining vessel. Here we present novel chemical data from the plumes and pipes, including dissolved macronutrients (nitrate, phosphate, silicate), dissolved total and methyl mercury, dissolved and particulate trace metals (Fe, Mn, Co, Ni, Cu, Zn, Pb, Cd), total suspended solids, and water column properties. These parameters are compared to baseline conditions measured in the NORI-D lease region in 2021-2022 to discern the magnitude of change induced by trial mining plume generations. Investigating these parameters provides a snapshot of the environmental conditions in the immediate aftermath of mining, and by combining them with other chemical speciation data in the future, we will have the ability to elucidate how long components will stay in suspension, which is critical for unraveling the long-term impacts of deep-sea mining.