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Nickel isotope systematics of seafloor hydrothermal systems: new constraints on hydrothermal fluxes of Ni to the ocean

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Seafloor hydrothermal activity at mid-ocean ridges and ridge-flanks is one of the fundamental processes controlling the exchange of heat and chemical species between seawater and ocean crust. While it has long been established that hydrothermal vents represent an important source of many elements to the oceans, and constitute an important sink from the overlying water column for others, the impact of seafloor hydrothermal systems on the oceanic cycling of Ni and its isotopes remains largely overlooked. Here, we aim to address two fundamental questions that pertain to the elemental and isotope budget of Ni in the ocean: i) do high- and low-temperature hydrothermal fluids represent a significant source of Ni to the ocean ?; ii) what is the global importance of scavenging of oceanic Ni to Mn oxide-rich proximal hydrothermal deposits ?

We investigated two contrasting environments, in particular low-temperature vents from Kamaʻehuakanaloa seamount (Hawaii), and both high- and low-temperature hydrothermal systems from the TAG area on the Mid-Atlantic Ridge. We show that, while the general depletion of Ni in high-temperature hydrothermal vents suggests only minor hydrothermal input, volcanic seamount may provide previously unrecognized sources of isotopically heavy Ni to the ocean. In particular, Kamaʻehuakanaloa vent fluids yielded δ^{60}Ni values ranging from near-crustal values at 0.09‰ to heavier composition at 1.56‰, and Ni/Mn ratios of about 0.10 mol/mol, which is more than two orders of magnitude higher than for ultramafic-hosted vent systems. We also show that δ^{60}Ni values of nearly all Fe-Si-Mn-rich inactive hydrothermal deposits from the TAG area have heavier isotopic composition than previously reported for hydrothermal deposits [1], ranging from -0.24 ‰ to 1.10 ‰, therefore overlapping with Ni isotope composition of both abyssal pelagic sediments and hydrogenetic FeMn deposits [2,3]. Our findings prompt for a significant update of the modern ocean Ni isotope mass balance budget, and also highlight the need for a better understanding of the mechanisms of Ni isotope fractionation in hydrothermal systems.

[1] Gueguen et al. (2021) *Chem. Geol.*, 560: 119999

[2] Fleischmann et al. (2023) *EPSL*, 619: 118301

[3] Gueguen and Rouxel, (2021) *Chem. Geol.*, 563: 120050