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Off-axis alteration of oceanic crust may partially buffer [Ni] and

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For fifty years, researchers trying to construct a steady-state budget model for nickel, a bioessential trace metal in the oceans, have struggled to find a solution that fits all observations. While previous efforts focused on processes and reservoirs within the river-ocean-sediment system, here we demonstrate that off-axis hydrothermal circulation through oceanic crust is likely a substantial source of Ni that should be included in future budget models. This flux was recently deemed negligible[1], but our new data provide new evidence to the contrary.

We measured [Ni] and ^{60}Ni in 10- and 13-meter sediment cores that extend nearly to the basalt-sediment interface where oceanic crust is of Eocene age. We found that the bottom of each core has been enriched in Ni by upward diffusion of crustal fluids with heavier isotopic compositions than those of the overlying sediments. These fluids represent enormous amounts of solution (~10^{15}–10^{16} kg/yr) advecting through ~3–65 Ma oceanic crust[3]and emerging at discharge seamounts[2].

With available constraints on [Ni] and ^{60}Ni of such fluids, we estimate that the off-axis, hydrothermal Ni flux to the ocean could be between half and 3 times the riverine input flux of 3.7x10^{8} mol/yr[1] and also as much as ~1/2 of the output flux into Mn-rich, abyssal sediments predicted by multiplying the Ni/Mn ratio in such sediments by the global Mn output flux (2.1x10^{9} mol/yr[1]). These estimates are large enough to warrant inclusion of off-axis, hydrothermal fluids in box models of the Ni cycle. Because these fluids are roughly comparable in isotopic composition to the oxic, Mn-rich sediment sink, we can construct an array of balanced budgets by allowing those two fluxes to vary in tandem. Additionally, the off-axis, hydrothermal flux of Ni may be sufficient to partially buffer [Ni] and ^{60}Ni of global seawater over long timescales, as it does for some other elements, *e.g.*, oxygen[4], Mg[5], Ca[5], and Mo[6].

[1] Fleischmann et al., 2023, doi:10.1016/j.epsl.2023.118301
[2] Coggon et al., 2010, doi:10.1126/science.1182252
[3] Fisher and Wheat, 2010, doi:10.5670/oceanog.2010.63; Wheat et al., 2002, doi:10.1016/S0016-7037(02)00894-3
[4] Gregory and Taylor, 1981, doi:10.1029/JB086iB04p02737
[5] Kump, 2008, doi:10.1029/178GM14
[6] Chen et al, 2026, doi:10.1016/j.gca.2026.01.054