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The role of shallow intraplate hydrothermal fluxes on the marine dissolved iron inventory and global primary production: A Kama’ehuakanaloa (Lōʼihi) Seamount case study

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The supply of dissolved Fe (dFe; <0.2um), an essential micronutrient for key cellular processes, from hydrothermal vents to the marine environment has been the subject of extensive research over the past decades. However, most of this work has focused on the supply of dFe from high-temperature, mid-ocean ridge systems and has largely neglected potential contributions from intraplate, hot spot vents located on the interior of tectonic plates. Intraplate systems vent at depths between 35-1500m, shallower than typical depths of venting (>2000m) for ridge-crest environments. Therefore, Fe derived from intraplate vents may have a greater likelihood to reach the surface ocean and stimulate primary productivity. Here, we explore the contribution of intraplate hydrothermalism to the oceanic dFe inventory using the Kama’ehuakanaloa (formerly Lōʼihi) Seamount as a case study. We report a novel dataset of vent fluid measurements (NASA SUBSEA) from the active vent field Pele’s Pit, at the summit of the seamount, together with near- and far-field water-column measurements (GEOTRACES GP15) to evaluate dFe transformations downstream (~500km) from the source. Parameters measured within both vent fluid and seawater samples include dFe concentration, dissolved manganese concentration, and stable dFe isotopes; excess helium-3 and ultrafiltered soluble Fe (sFe; <0.003um~10kDa) concentrations were measured in downstream samples. The near-field water column samples show an anomalously high sFe component of the dissolved phase within Pele’s Pit. Concomitant isotopically light Fe isotope compositions from within Pele’s Pit indicate that this Fe is predominantly in the form of reduced Fe(II). As the Kama’ehuakanaloa plume ages downstream, substantial dFe is removed via scavenging, and colloidal Fe (0.003-0.2um) becomes dominant in the dFe that persists. Downstream dFe isotope data suggest that persistent dFe is probably ligand-bound. Global dFe biogeochemical modeling shows that dFe from Kama’ehuakanaloa has a substantial influence on the Fe inventory of the subsurface North Pacific; however, it does not significantly influence surface primary productivity, because modeled nitrogen drawdown is negligible. We conclude that dFe released from Kama’ehuakanaloa Seamount contributes to the global marine Fe inventory, implying that other similarly understudied low-temperature, shallow, intraplate hydrothermal vents should also be considered in estimates of global hydrothermal Fe supply.