Hydrothermal fluxes of trace metals (such as Zn and Fe) into surface waters along the Kermadec Intraoceanic Arc

CHARLOTTE KLEINT1,2*, WOLFGANG BACH2, SYLVIA G. SANDER3,4, REBECCA ZITOUN3, ROB MIDDAG5, PATRICK LAAN5 AND ANDREA KOSCHINSKY1,2

1Department of Physics and Earth Sciences, Jacobs University Bremen gGmbH, Campus Ring 1, 28759 Bremen, Germany, (*c.kleint@jacobs-university.de)
2MARUM, University of Bremen, 28359 Bremen, Germany
3Department of Chemistry, University of Otago, PO Box 56, Dunedin 9054, New Zealand
4Present address: Marine Environmental Studies Laboratory, IAEA – Nuclear Applications, 98000 Monaco, Principality of Monaco
5Royal Netherlands Institute for Sea Research (Royal NIOZ), P.O. BOX 59, 1790 AB Den Burg, Texel, Netherlands

Hydrothermal vent systems at intraoceanic arcs are located in much shallower water depth. Therefore, their hydrothermal plumes may reach surface waters and directly supply essential micronutrients into the photic zone, such as Fe and Zn, which are usually strongly depleted in surface waters.

The active hydrothermal vent system Macauley, located in ~350 m water depth at the Kermadec intraoceanic arc, was sampled in 2016/2017 during expedition SO253. Plume surveys indicated strong plume signals for dissolved Fe, Mn, Cu and Zn (up to 1.2 µM, 1 µM, 160 nM, 150 nM, respectively) close to the source in 300 m water depth. With distance from the vent, the metal concentrations decrease, as to be expected, however, Zn/Fe ratios increase (from 0.12 close to the source to ~ 2.3 in a few km distance). It is known that hydrothermal Fe is stabilized in its dissolved form by organic and inorganic ligands or in nanoparticulate form and may thereby be transported over long distances, contributing to the global oceanic Fe cycle. At Macauley, the persistence of a distinct Zn plume signal with distance from the source may be due to higher solubility of Zn and possible additional stabilization through organic complexes. Similar trends for Fe and Zn were observed at Brothers Volcano, another active vent system located along the Kermadec Arc, but in ~1600 m water depth.

Our study highlights the importance of shallow arc hydrothermalism for fluxes and the biogeochemical cycle of trace metals as potential micronutrients or toxins into the ocean.