

# Iron isotope constraints on the sources and fate of iron from shallow hydrothermalism in the Tonga region

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Numerous works underline the importance of hydrothermal sources on the supply of micro-nutrients to the ocean [1]. This theme was at the core of the multidisciplinary TONGA project [2], which brings together 90 scientists from 19 international institutions, geochemical oceanographers, physicists, biogeochemists, biologists and modelers, around such sources in the Tonga-Kermadec arc region in the southwest Pacific. The oceanographic cruise took place in 2019. The project's originality was its focus on shallow sources (~200m depth) which greatly enhanced their potential biological impact [3], unlike the hydrothermal sources at mid-ocean ridges typically located around 2500 m depth and below.

Isotopic compositions and iron concentrations of dissolved iron in the water column were measured at 4 full depth stations, upstream of the Tonga arc, just above a hydrothermal site, and downstream of it. The results demonstrated the significant impact of a shallow hydrothermal source on dissolved iron concentrations with a maximum concentration of ~23 nmol.kg<sup>-1</sup> (at 180 m depth). This dissolved iron concentration maximum was rapidly diluted, decreasing by a factor of 3, over a distance of just ~600m. Isotopic compositions ranged from -0.4 to +0.9 per mil ( $\delta^{56}\text{Fe}$  relative to IRMM-14) across all stations. The shallow hydrothermal sources exhibited slightly positive signatures of approximately +0.3 per mil, in contrast to the typical signatures observed in deeper hydrothermal sources.

The discussion will explore the variations in isotopic compositions observed during the dilution of the plume and the transfer of dissolved iron to the surface, aiming to provide insights into the processes that govern the removal and/or preservation of iron in solution in this environment.

[1] Resing, J. A., Sedwick, P. N., German, C. R., Jenkins, W. J., Moffett, J. W., Sohst, B. M., & Tagliabue, A. (2015). *Nature*, 523(7559), 200–203.

[2] Guieu C., Bonnet S. (2019) TONGA 2019 cruise, RV L'Atalante, <https://doi.org/10.17600/18000884>

[3] Bonnet, S., Guieu, C., Taillandier, V., Boulart, C., Bouruet-Aubertot, P., Gazeau, F., ... & Tilliette, C. (2023). Natural iron fertilization by shallow hydrothermal sources fuels diazotroph blooms in the ocean. *Science*, 380(6647), 812-817. <https://doi.org/10.1126/science.abq4654>