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Impact of shallow hydrothermalism on lithium content and lithium isotope composition of marine plankton

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The marine lithium (Li) residence time being more than 1 Myr, this trace metal is uniformly distributed in oceanic waters, with a dissolved Li concentration of 26 µM and a Li isotopic composition (δ^7Li) of 31.2±0.3‰. However, marine hydrothermal fluids are a major source of Li and are highly enriched in Li compared to the open ocean (with a low δ^7Li value ~ 8‰). Lithium, as most trace elements, can exert an essential biological role at low level, but becomes toxic in enriched environments. The impact of shallow Li-rich hydrothermal fluids on planktonic species living closeby has not been evaluated thus far, while playing a key role on nitrogen, carbon and iron marine cycles and on phytoplanktonic activity.

During the TONGA expedition in the subtropical South Pacific (Nov. 2019), we collected seawater samples and performed 35 µm and 200 µm plankton net tows following an East-West transect above two active shallow (>500 m) volcanoes associated with hydrothermal activity. This region displays among the highest N_2 fixation rates and has been shown to fertilize surface waters with iron. After developing a specific methodology, we measured Li concentrations and Li isotope composition in planktonic and water samples, using ICP-MS and MC-ICP-MS.

Our results show high and variable Li concentrations in surficial waters (from 26 µM to 200µM), consistent with other proxies of hydrothermal activity. Li concentrations in the Tonga plankton are significant (10-70 µg/g dw), compared to any other marine trophic groups (≤1 µg/g; Thibon et al., 2021). Just above the hydrothermal sites, Li concentrations of the 200 µm plankton increase (up to 120 µg/g dw). Most plankton samples display δ^7Li values lower than seawater. Their isotopic signature may reflect both the contribution from low δ^7Li hydrothermal fluids, and biological or species effects. We are currently investigating these possibilities by analysing the isotopic composition of waters and by comparing our data to quantitative biodiversity indices.

Overall our study unravels the capacity of planktonic species to bioaccumulate Li, confirming the major role of low trophic levels. It also evidences distinct isotopic fractionations in phyto- and in zoo- plankton, when facing Li-rich environments.