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Hydrothermal iron supply to the remote southeast Pacific Ocean

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Iron (Fe) is an essential nutrient for primary production and is known to limit the efficiency of the biological carbon pump over large areas of the ocean. As a non-conservative element with a residence time on the order of decades to centuries in the deep ocean, the distribution of dissolved Fe (dFe; <0.2 µm) in seawater is closely coupled to its sources. Early studies suggested that the dFe supplied from hydrothermal vents is precipitated/scavenged and sedimented close to vent sites. However, it is now known that a significant fraction of dFe supplied from hydrothermal vents is stabilised through organic complexation and/or formation of inorganic colloids and transported 1000's km into the ocean interior. Hydrothermal venting is estimated to supply 4 ± 1 Gmol dFe yr^{-1} to the deep ocean, yet the proportion of this dFe that reaches the euphotic zone and sustains primary production remains unclear.

As part of the Carbon Uptake and Seasonal Traits in Antarctic Remineralisation Depth (https://roses.ac.uk/custard/) programme, we present results from a north-south transect (89° W, 55° S to 89° W, 60°S) comprised of 7 full ocean depth profiles of the poorly studied southeast Pacific Ocean. We observed a significant increase in the dFe concentration (≈0.7 nM, background concentrations ≈0.4 nM) on a shoaling density surface at intermediate depths (2000-4000 m). We combine our observations of dFe with historic ^{3}He profiles to make the case for a hydrothermal Fe source (Fig. 1), despite the considerable distance of our study area (≈ 1500 km) from ridge systems. We further interpret soluble (<0.02 µm) and total dissolvable (unfiltered) iron data, and use particle tracking model results to consider the implications of our study for our understanding of the stability of hydrothermally derived dFe and its transit time to the surface ocean.

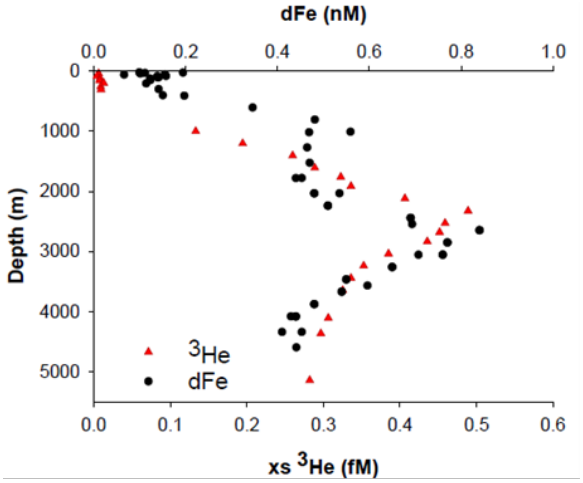

Figure 1. Depth profile of dissolve iron and excess ^{3}He at 89° W, 55° S.