Reconstructing Southern and Pacific Ocean deep circulation using Nd isotopes

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The southwestern Pacific is an important region to reconstruct past ocean circulation since it is the entry point for Southern Ocean waters into the Deep Western Boundary Current of the Pacific. The relationship between deep water neodymium and carbon isotopes in the southwestern Pacific, and their comparison to records from the South Atlantic [1] and Indian Ocean [2], have the potential to provide new information about changes in water mass sourcing and nutrient generation along different deep water flow paths in the Southern Hemisphere [3].

Here we present a new Nd isotope record from ODP Site 1123 on the Chatham Rise (42 S, 172 W, 3.3 km-bsl), and glacial-interglacial Nd isotope changes from Chatham Rise transect of four cores, ranging from 1.4 to 4.8 km-bsl. Nd isotopes were measured by three methods, acid-reductive leaching of bulk detritus, mixed planktonic foraminifera which have authigenic coatings, and those which have been reductively cleaned. The foraminifera with authigenic coatings yeild the expected deep seawater Nd isotopic composition, matching nearby water and Fe-Mn nodules measurements, while bulk detrital leachates do not. Reductively cleaned and uncleaned planktonic foraminifera have Nd isotopic compositions within error of each other, suggesting that the host phase of Nd is difficult to remove.

The Nd isotopic composition of ODP Site 1123 changes on glacial-interglacial timescales, recording a deglacial Nd isotopic shift from -5 ε_{Nd} during the Last Glacial Maximum (LGM) to -7 ε_{Nd} during the Holocene. The 'Pacific-like' Nd isotopic compositions during the LGM suggests reduced Atlantic-sourced water, and is also replicated at the deeper CHAT transect cores. The intermediate depth (1 to 2 km-bsl) cores have a more constant Pacific-like sourcing of waters of -4 ε_{Nd} during the deglaciation. The ODP Site 1123 Nd isotope record appears to track, but is offset from, the South Atlantic [1] and Equatorial Indian Ocean [2] Nd isotope records, suggesting that Atlantic-sector deep water changes are propigated through the Southern Ocean.

[1] Piotrowski *et al*. (2005) *Science* **307**, 1933–1938. [2] Piotrowski *et al*. (2009) *EPSL* **285**, 179–189. [3] McCave *et al*. (2008) *QSR* **27**, 19–20, 1886–1908.

Evidence of slab melt transfer in the New Caledonian fore-arc ophiolite

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The highly depleted harzburgite of the Massif du Sud ophiolite of New Caledonia hosts several late intrusive bodies (hornblendites, granitoids, gabbros) in an area expanding from the crust-mantle transition zone to a couple of kilometers under the palaeo-Moho. The absence of relationship with the basement and lateral variations related to the paleo-depth of the mantle suggest an emplacement in an oceanic environment, several millions years prior to the obductive event. The granitoid intrusions of the Massif du Sud ophiolite are the first known reported case of large amount of felsic magma hosted in a sub-arc mantle.

U-Pb dating of the magmatic bodies provides a similar age than igneous zircon cores occuring in the eclogite terrane in the northern part of the island. This overlap of ages suggests that the magmatic activity witnessed in the felsic intrusions within the ophiolite corresponds to arc volcanic events that produced volcanoclastic sediments representing the protolith of New Caledonia eclogite facies rocks.

Magmatic intrusions are all alkali-rich and cover intermediate to felsic compositions. Mg-numbers range from 0.45 to 0.92 and are positively correlated with sodium and silica contents, ruling out that diorites and trondhjemites are related by differentiation processes. Instead we suggest that the high Mg# trondhjemites represent slab melts that interacted with the mantle wedge.

Pyroxenite reaction zones rimming these intrusions show a direct chemical relationship with pyroxenite dykes occuring deeper in the mantle. These dykes are interpreted as feeder conduits for slab melts which accumulate in large pods at the crust-mantle transition.

A study of amphibole trace element composition in the granitoid intrusions also show a link with amphibole-bearing peridotite and mafic rocks which are located in an area of the ophiolite inferred as a near-trench environment. This lateral variation is interpreted as the result of a thermal gradient in the sub-arc mantle. Slab melt metasomatism affects peridotites at subsolidus conditions in colder part of the fore-arc whereas large pockets of melt accumulate under the oceanic crust in hotter parts of the sub-arc mantle.