

## Melt transport in the mantle: Transition from dunite channels to pyroxenite dykes in the upper mantle section of New Caledonia

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The highly depleted harzburgite of the Massif du Sud ophiolite of New Caledonia hosts several kinds of orthopyroxenite dikes. One kind, occurring at the top of the harzburgite section, is observed to grade continuously into replacive dunite channels over ~25 m on moving away from the crust-mantle transition.

Major and trace elements in olivine and orthopyroxene were determined by electron microprobe and laser-ablation ICP-MS in the host harzburgite, the dunite-orthopyroxenite channels, and in gabbros from the crust-mantle boundary. The most depleted signatures in terms of P, Y and Ti in olivine and Al and REE in orthopyroxene is observed in the harzburgite. The olivine of the dunite channels have higher P, Y and Ti, consistent with the hypothesis that the dunite channels are the result of melt migration through harzburgite [1]. Along the orthopyroxenite-dunite transition, a further gradual increase in P, Y and Ti in olivine is observed with increasing modal orthopyroxene. The orthopyroxene in the channel is richer in Al and REE than that in the harzburgite, while the Ni content of olivine also increases as its modal abundance decreases, providing evidence for replacement of olivine by orthopyroxene. The olivine and orthopyroxene in cumulus gabbros at the crust-mantle boundary display a further enrichment in the incompatible elements. The field relations, textural evidence, and major and trace element geochemistry in olivine and orthopyroxenes therefore provide evidence that these orthopyroxenites replace a former dunite channel.

The transition from dunite to orthopyroxenite observed in replacive dunite melt channels is interpreted as due to a change in the stoichiometry of the melt/harzburgite reaction with decreasing pressure, as the usually observed reaction of melt + opx → Si-rich melt + ol [1] is reversed. The implied contraction of the primary phase volume of olivine with decreasing pressure may be related to the hydrous nature of the melt.

[1] Kelemen (1990) *J. of Petrology*, **31**(1), 51-98.

## Iron oxides, dissolved silica, and the regulation of marine P concentrations

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We present Fe and P data for iron oxide-rich sedimentary rocks through time, which offer insights into past dissolved phosphate concentrations. There is a significant increase in bulk rock P/Fe ratios in the Cretaceous, a trend which likely reflects increased P sorption onto iron oxides as dissolved silica levels dropped due to the expansion of silica-utilizing phytoplankton. P/Fe ratios in Precambrian and early-middle Phanerozoic iron oxide-rich rocks are similar, which seriously questions the plausibility of a P crisis in the earth's early oceans leading to the delay between the evolution of oxygenic photosynthesis and atmospheric oxygen rise [1]. Since dissolved Si concentrations have decreased through time, higher or comparable P/Fe ratios in Precambrian compared to early-middle Phanerozoic ferruginous rocks suggests elevated dissolved Precambrian P concentrations. Higher dissolved P levels in the Precambrian than in the Phanerozoic may be the result of inhibition of carbonate fluorapatite (CFA) formation due to persistently high levels of carbonate supersaturation. A reexamination of the Precambrian P cycle may also aid in understanding Neoproterozoic oxygen increases. Inhibited CFA formation and a decreased Fe oxide bound-P flux likely allowed for high dissolved P concentrations in Neoproterozoic ferruginous oceans. Ferruginous conditions would have removed trace metal stress on diazotrophic phytoplankton promoting high levels of primary production leading to atmospheric oxygen increases.

[1] Bjerrum, C. J., and D. E. Canfield, (2002), *Nature*, **417**, 159-162.