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Building new crust in a nascent arc setting: the example of the New Caledonia gabbronorites

Arianna Secchiari (1), Alessandra Montanini (1), Delphine Bosch (2), Patrizia Macera (3), and Dominique Cluzel (4)

(1) Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma, Italy , (2) Géosciences Montpellier, Université de Montpellier, France, (3) Department of Earth Sciences, University of Pisa, Italy, (4) Institut des Sciences Exactes et Appliquées, University of New Caledonia

Ancient domains of intra-oceanic arc lithosphere preserved in ophiolites provide the unique opportunity to investigate the first phases of crust generation in nascent arcs. The New Caledonia ophiolite hosts a mafic-ultramafic igneous sequence overlying ultra-depleted harzburgitic rocks, which experienced high melting degrees in a fore-arc setting (Secchiari, 2016). This sequence has been interpreted to represent a crust-mantle transect formed in a nascent arc environment (Marchesi et al., 2009; Pirard et al., 2013). The ultramafic rocks (mainly dunites and wehrlites) resulted from melt-peridotite reactions involving primitive arc tholeiites and boninitic magmas. By constrast, the mafic rocks bear a cumulitic origin and occur as metre-sized sills in the upper part of the sequence.

In this contribution, a comprehensive geochemical and isotopic (Sr, Nd, Pb) characterization of the New Caledonia mafic intrusives will be presented. The mafic rocks are olivine gabbronorites. They are mainly composed ($\simeq$50-80 vol.%) by subhedral Ca-rich plagioclase (An up to 96 mol%). Mg-rich olivine (5-15 vol.%, Fo = 87-89 mol%) is present as irregularly shaped, resorbed crystals. Clinopyroxene (15-20 vol.%) is generally rimmed by interstitial or poikilitic orthopyroxene (5-15 vol.%). Fe-Ti oxides and hydrous phases are remarkably absent. Clinopyroxene shows high Mg# (88-92), coupled with low Al_2O_3 (1.5-2.4 wt%) and negligible TiO_2 and Na_2O contents. Whole rock (WR) compositions are characterised by high Mg# (86-92) and concentrations of incompatible trace elements one order of magnitude lower than arc rocks worldwide. They display LREE-depleted patterns, with nearly flat ($0.82 \leq Dy_N/Yb_N \leq 1.00$), low ($Yb_N$= 0.2-0.9) HREE and positive Eu anomalies. Cpx trace element chemistry mirrors the extreme depleted nature of the WR. By constrast, extended trace element diagrams highlight an enrichment for the most incompatible, fluid mobile elements (FME), namely Pb and Sr, both in WR and Cpx.

Geochemical modelling shows that the putative liquids in equilibrium with the gabbroic rocks are primitive (Mg#= 71.3-75.5) ultra-depleted melts, deriving from melting of a refractory mantle source. The parental melts share some affinities with the most primitive boninites, but they invariably display lower LREE-MREE and FME contents, no Nb depletion and the remarkable absence of Zr-Hf positive anomalies. FME enrichments and high FME/immobile elements ratios recorded by these melts hint the involvement of a subduction-related fluid in the magma genesis of these rock-types. Nd isotopes ($+8.2 \leq epsilon_{Ndi} \leq +9.2$) coupled with Pb isotopic data, extending from DM to Pacific sediments compositions, further support an origin from a subarc depleted reservoir, modified by slab-derived fluids.

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