The New Caledonia Ophiolite: Multiple melting stages and refertilisation process as indicators for ridge to subduction formation

MARC ULRICH[1,2], CHRISTIAN PICARD[3], STÉPHANE GUILLOT[2], CATHERINE CHAUVEL[2], DOMINIQUE CLUZEL[1] AND SÉBASTIEN MEFFRE[4]

[1]PPME, Université de la Nouvelle-Calédonie, 98851, Nouméa (marc.ulrich@univ-nc.nc)
[2]LGCA (UMR 5025), Université Joseph Fourier, 38000 Grenoble
[3]Chrono-environnement (UMR 6249) - Université de Franche Comté, 25000, Besançon
[4]ARC Centre of Excellence in Ore Deposits, University of Tasmania

The New Caledonia island is a patchwork of sedimentary, volcanic and ultrabasic units. The ophiolite complex consists in a main body in the south of the island and some isolated klippes located along the NW coast. This terrane thrusts the magmatic Poya terrane, essentially made of undepleted MORB with some BABB, OIB and boninites.
Most of the ophiolite consists of highly depleted harzburgites (+/- dunites) with characteristic U-shape REE patterns whose chemical composition indicates a likely formation in a forearc environment. However, the northernmost lherzolites are characterized by spoon-shape REE patterns whose origin remained unclear.

Our new REE data on whole rock and minerals demonstrate the abyssal affinities of the lherzolites. These peridotites are best explained by partial melting in a ridge environment followed by a refertilisation that led to a significant LREE enrichment of the lherzolites. Using equilibrium melting equations, we find that the liquids extracted from these lherzolites are similar to the undepleted MORBs from the Poya terrane. This suggests that the entire sequence could represent the oceanic lithosphere of the South Loyalty Basin (SLB) formed during the Campanian to the late Eocene. In addition, our study shows that the most depleted harzburgites are best modelled by hydrous melting in a forearc environment of a source that had previously experienced depletion in a ridge environment. The melts associated with this second stage of partial melting are similar to the boninites from the Poya terrane.

The occurrence of two types of melting processes in the same ophiolite most probably reflects the transition from accretion to convergence in the SLB during the Late Paleocene, with the initiation of the subduction at (or near) the ridge axis.

From Arthur Holmes to Harry Hess: How melting of the mantle controls amagmatic crustal accretion

S.C. UNSWORTH*, B.J. MURTON AND R.N. TAYLOR

National Oceanography Centre, Uni. Southampton, European Way, Southampton, UK, SO14 3ZH (*correspondence: samwise@noc.soton.ac.uk)

Most models of lithospheric generation at slow-spreading ridges favour the theory that melt is focused diapirically toward segment centres, but there is little agreement on focusing mechanisms, or the scales at which they operate.

We examine these mechanisms in detail, both in magmatic spreading areas and ‘amagmatic’ regions of the Mid-Atlantic Ridge (12º60’N-15º20’N). Here, melt provision is sporadic, and a significant proportion of plate separation is accommodated on low-angle detachment faults, exposing mantle peridotite on the seafloor in oceanic core complexes.

Geochemical analyses of both basalts and peridotites show significant variations along the ridge. Element [8] and trace-element ratios indicate that these variations exist independent of fractionation processes. Pb isotope ratios show a wide variation in initial source compositions over a limited (~15km) geographic extent.

Yb/Lu ratios, taken as a proxy for residual garnet in the melting zone, indicate that amagmatic locations are characterised by high-pressure, low melt fractions. This indicates a short, deep upwelling path (mantle cold spot?) as an explanation for low melt fraction in amagmatic regions. FTIR analysis on basaltic glasses show that mantle hydration also varies along the ridge and that amagmatic positions appear to correlate with ‘drier’ spots in the mantle.

At amagmatic sites we find that low melt fraction basalts correspond temporally with detachment initiation, whilst zero age basalts at the corresponding position on the axis are derived from typically higher melt fractions.

Our geochemical data indicate that magmatic areas tap volatile-rich mantle and have long upwelling paths, producing high melt fraction basalts that are less enriched in incompatible elements than those from ‘amagmatic’ sources. In contrast, ‘amagmatic’ spreading taps drier source mantle over a shorter and deeper upwelling path, producing low melt fraction basalts that are relatively enriched in incompatible elements. We conclude that low melt production at amagmatic regions, resulting directly from mantle compositional characteristics, drives the transition from magmatic to tectonic spreading, and that the low F melts form prior to detachment initiation, but do not necessarily persist during amagmatic spreading.