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Strain localization and fluid infiltration during subduction initiation: the record from sheared mafic amphibolites at the base of the New Caledonian ophiolite

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Most of our knowledge on subduction inception and obduction processes comes from metamorphic soles structurally associated with peridotite tectonites at the base of many ophiolites, and from early-obduction, rarely deformed, magmatic dikes emplaced at different level of the mantle sequence. These dikes record a partial refertilization of obducted ophiolites through subduction-derived fluids. However, these dikes are rarely deformed and/or metamorphosed.

Here, we study the base of the New Caledonian ophiolite, using a combination of structural field studies and petrological–geochemical–geochronological analysis, with the aim of linking deformation and metasomatism through fluid infiltration and recrystallization.

We report the existence of strongly sheared mafic amphibolites within the base of the New Caledonian obducted ophiolite, $\sim$ 50–100 m above the basal thrust contact and < 1000 m below the mantle-crust transition. These $\sim$ N150-striking, hm-long and m- to several m-thick shear bands correspond to former small-scale intrusions (and surrounding peridotites), highly boudinaged and amphibolitized at high temperatures (750–800 ºC), providing evidence that strain localized at the base of the ophiolite.

Mafic protoliths of these amphibolites consisted of plagioclase and orthopyroxene ($\pm$ olivine and calcic amphibole in places). We show that deformation is intimately associated to at least three major stages of fluid infiltration on mafic intrusions. The first stage of deformation and metasomatism coincides with amphibolitization and controlled the later channelization of fluids. The formation of calcic amphiboles records the percolation of Ca and Al-rich aqueous fluids. Amphibole–plagioclase geothermobarometry indicates high temperature and low pressure conditions (i.e. 750–800 ºC; 3–5 kbar). Thermochronological data from hornblende (40Ar/39Ar) suggest that this deformation episode occurred at $\sim$ 55 Ma, coinciding with E-dipping subduction initiation and incipient obduction. The main metasomatic stage is evidenced by a phlogopite-rich matrix wrapping peridotite and amphibolite boudins. The formation of phlogopite records the percolation of alkali-rich aqueous fluids at still high temperature (700–750 ºC). The last metasomatic stage is characterized by infiltration of aqueous fluids at lower temperature (< 500 ºC), in the stability field of talc, chlorite and serpentine, and results in the formation of deformed veinlets wrapping and cross-cutting peridotites boudins.

This study documents a valuable record of refertilization (by successive fluid influx) and progressive deformation to better understang the mechanisms controlling subduction initiation and early obduction of the New Caledonian ophiolite.