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Transfer of subduction fluids and strain localization into the mantle wedge during nascent subduction

Cécile Prigent (1), Stéphane Guillot (1), Philippe Agard (2), Damien Lemarchand (3), Mathieu Soret (2), and Marc Ulrich (4)

(1) Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, 38000 Grenoble, France, (2) Sorbonne Université, CNRS-INSU Institut des Sciences de la Terre Paris, ISTeP UMR 7193, F-75005 Paris, France, (3) Laboratoire d'Hydrologie et de Géochimie de Strasbourg, EOST-CNRS-UMR 7517, Université de Strasbourg, France, (4) Institut de Physique du Globe de Strasbourg, EOST-CNRS-UMR 7516, Université de Strasbourg, France

The basal part of the Semail ophiolitic mantle was (de)formed at relatively low temperature (LT) directly above the plate interface during "nascent subduction" (the prelude to ophiolite obduction). This subduction-related LT deformation was associated with progressive strain localization and cooling, resulting in the formation of porphyroclastic to ultramylonitic shear zones prior to serpentinization.

Using petrological and geochemical analyses (trace elements and B isotopes), we show that these basal peridotites interacted with hydrous fluids percolating by porous flow during mylonitic deformation (from $\sim$850 down to 650°C). This process resulted in 1) high-T amphibole crystallization, 2) striking enrichments of minerals in fluid mobile elements (FME; particularly B, Li and Cs with concentrations up to 400 times those of the depleted mantle) and 3) peridotites with an elevated δ11B of up to +25‰. These features indicate that the metasomatic hydrous fluids are most likely derived from the dehydration of subducting crustal amphibolitic materials (i.e. the present-day high-T sole).

The rapid decrease in metasomatized peridotite δ11B with increasing distance to the contact with the HT sole (to depleted mantle isotopic values in <1km) suggests an intense interaction between peridotites and rapid migrating fluids ($\sim$1–25my^{-1}), erasing the initial high-δ11B subduction fluid signature within a short distance. The increase of peridotite δ11B with increasing deformation furthermore indicates that the flow of subduction fluids was progressively channelized in actively deforming shear zones parallel to the contact. Taken together, these results also suggest that the migration of subduction fluids/melts by porous flow through the subsolidus mantle wedge (i.e. above the plate interface at sub-arc depths) is unlikely to be an effective mechanism to transport slab-derived elements to the locus of partial melting in subduction zones.