Geophysical Research Abstracts
Vol. 19, EGU2017-10188, 2017
EGU General Assembly 2017

Interplay between deformation, fluid release and migration across a nascent subduction interface: evidence from Oman-UAE and implications for warm subduction zones

Philippe Agard (1), Cécile Prigent (2), Mathieu Soret (1), Stéphane Guillot (2), and Benoît Dubacq (1)
(1) Sorbonne Universités, UPMC Univ Paris 06, ISTEP, UMR UPMC-CNRS 7193, Paris, France (philippe.agard@upmc.fr),
(2) Université Grenoble Alpes, CNRS, ISTerre, F-38041 Grenoble, France

Frozen-in subduction plate interfaces preserving the first 1-2 My of the subduction history are found beneath ophiolites. These contacts are a key target to study the inception of mantle wedge metasomatism and the mechanical coupling between the upper plate and the top part of the sinking slab shortly after subduction initiation.
Combining structural field and EBSD data, detailed petrology, thermodynamic modelling and geochemistry on both sides, i.e. the base of the mantle wedge (Oman-UAE basal peridotites) and the underlying accreted crustal fragments from the subducting slab (metamorphic soles), this study documents the continuous evolution of the plate contact from 1 GPa 900-750°C to 0.6 GPa 750-600°C, with emphasis on strain localization and feedbacks between deformation and fluid migration.
In the mantle wedge, the (de)formation of proto-ultramylonitic peridotites is coeval with mantle metasomatism by focused hydrous fluid migration. Peridotite metasomatism results in the precipitation of new minerals (clinopyroxene, amphibole and spinel ± olivine and orthopyroxene) and their enrichment in FMEs (particularly B, Li and Cs, with concentrations up to 40 times that of the PM). Boron concentrations and isotopes (δ11B of metasomatized peridotites up to +25‰ suggest that these fluids with a "subduction signature" are probably sourced from the dehydrating amphibolitic metamorphic sole.
Concomitantly, deformation in the lower plate results in the stepwise formation, detachment and accretion to the mylonitic s.l. mantle of successive slices of HT metabasalts from the downgoing slab, equilibrated at amphibolite/granulite conditions (900-750°C).
Two major stages may be outlined:
- between ~900 and 750°C, the garnet-clinopyroxene-amphibole bearing sinking crust (with melting < 6 vol%) gets juxtaposed and mechanically coupled to the mantle, leading to the transfer of subduction fluids and metasomatism (possibly into the arc zone ultimately). Deformation is distributed on the ~km scale, typically ~200-500 m thick in the mantle and 100-200 m thick in the slab crust. Dislocation creep is the dominant mechanism in the mantle wedge while, in the lower plate crust, deformation is accomodated by cataclasis and reorientation of amphibole grains and dislocation creep of clinopyroxene. Amphibole LPO suggests that granulite to amphibolite deformation was accommodated by thinning of the crustal fragments accreted to the upper plate (by up to a factor of 5-10).
- between 750-600°C, the plate contact is further deformed (and partially exhumed) with considerable increase in strain localization on both sides, and fluid channelization in the mantle through (milli)metric ultramylonitic shear bands. Strain is accommodated by a change from olivine dislocation to grain size sensitive creep in mantle ultramylonites, and in the footwall by dislocation creep of amphibole and plagioclase (with progressive increase of rigid body rotation).
This example sheds light on the behaviour of warm subductions (e.g., Cascadia, Nankai) where slab material gets amphibolitized at depths of ~40 km, on how fluids are fluxed into the mantle wedge and how mechanical coupling resumes at depth (i.e. beyond those where serpentine is stable). Documented deformation patterns also suggest that, where serpentine is stable in the mantle wedge, deformation should be very localized.