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How subduction initiation proceeds: deformation and fluid migration across nascent, warm plate boundaries

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Frozen-in subduction plate interfaces formed during the first 1-2 My of the subduction history are preserved at the base of ophiolites. They allow to study the inception of mantle wedge metasomatism and the interplate mechanical coupling shortly after subduction initiation, when crustal pieces get stripped off the slab: they are precious witnesses of how subduction overcomes mantle resistance and develops.

Combining structural field and EBSD data, detailed petrology, thermodynamic modelling and geochemistry on both sides, i.e. at the base of the mantle wedge (basal ophiolitic peridotites) and the underlying accreted crustal fragments from the subducting slab (metamorphic soles), this study documents the continuous evolution of the plate contact and (focused) fluid transfer from 1 GPa 900-750°C to 0.6 GPa 750-600°C. Results obtained across the Oman-UAE territory, combined to available data worldwide, reveal how strain progressively localizes to allow subduction progress.

Peridotite metasomatism (through precipitation of new minerals, enrichment in FMEs, B concentrations and delta11B values) results from the interaction with “subduction fluids” derived from the dehydrating metamorphic sole, while coeval deformation in the lower plate results in the stepwise formation, detachment and accretion to the mylonitized mantle of successive slices of HT metabasalts from the downgoing slab.

These findings have implications (i) for the behaviour of warm subductions (e.g., Cascadia, Nankai) where slab material gets amphibolitized at depths of ∼40 km, (ii) for fluid fluxes into the mantle wedge and (iii) illustrates how mechanical coupling resumes at depth (i.e. beyond those where serpentine is stable).
These informations are also set back in the context of spontaneous vs. induced subduction initiation and allow to discuss how intraoceanic subduction initiation (leading to ophiolite generation) may differ from subduction initiation at (stretched) continental margins.