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Metamorphic probing of subduction dynamics and rheology

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Understanding subduction dynamics and rheology, and particularly the role of fluids and deformation, strongly relies on integrated tectonic, petrological and geochemical studies able to retrieve from our most direct and reliable natural probes (i.e. preserved metamorphic assemblages) their pressure-temperature-time (P-T-t) evolution.
I first provide two examples of such integrated studies that allow tracking rock trajectories and exhumation dynamics in subduction zones — thanks to the considerable progress made over the last ten years on estimating P-T-t conditions.
The Oman example shows how EPMA mapping and the detailed study of local, low-temperature equilibria help constrain the behaviour and dynamics of upper crustal units during continental subduction, demonstrating the importance of slicing, accretion at depths of $\sim$30 km and short-lived tectonic expulsion. In the Western Alps, the extensive coverage of field exposures by means of the Raman Spectrometry of carbonaceous matter and by dedicated pseudosection modelling allows to identify the existence of tens of km long, fairly continuous slices of downgoing slab exhumed from similar eclogitic depths ($\sim$80 km), and to assess the role of the overall fluid content in enabling their exhumation/preservation.
I then illustrate how metamorphic rocks can provide ideal probes (though still partly to be improved) to address key, large-scale tectonic processes and not 'simply' histories, and do stress the importance of adequate field-based data acquisition. Three examples (and present-day limitations) are reviewed here:
(1) The regional-scale exhumation of blueschists from the downdip end of the seismogenic zone across thousands of kilometers along the Neotethys (at $\sim$1-1.5 GPa, 350°C) is a major geodynamic event providing insights into changes in interplate mechanical coupling and subduction dynamics.
(2) Eclogite breccias recently reported in the Monviso area (W. Alps) allow constraining short-term processes involving seismogenesis, fluid migration (and its duration), fluid fluxes and will help improve our general understanding of the earthquake 'factory' (at $\sim$2.6 GPa, 550°C).
(3) Amphibolite to granulite-facies metamorphic soles (i.e. $\sim$500m thick tectonic slices welded to the base of ophiolites) provide specific insights into the rheology of nascent subduction, as their accretion is restricted to a transient, optimal P-T-t window (at 1$\pm$0.2 GPa, 750-850°C, after < 1-2 My) during which fluid release and infiltration lead to similar effective rheology on both sides of the plate interface (i.e. downgoing crust and mantle wedge). This transient though universal episode maximizes interplate mechanical coupling and ultimately promotes the detachment of the sole from the sinking slab.
For all three examples above, one should emphasize the need for a better assessment of the P-T stability of (the complex solid solutions of) amphiboles, which would represent a major breakthrough for our further understanding of subduction dynamics and rheology.