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Lithosphere-scale anatomy of a collisional orogeny: the Alps and their forelands

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During the development of the tectonically complex Alpine arc several continental and oceanic plates were amalgamated. Analyses of crustal structures, derived from modern fieldwork, and geophysical deep sounding of the lithosphere-asthenosphere structure were combined into transects through the Alps and their forelands (Schmid et al. 2005a,b). Particularly high-resolution teleseismic tomography, together with the correlation of tectonic units along strike, revealed a far more complex 3D geometry of the Alpine orogen than hitherto believed. The inferred substantial along-strike changes are illustrated by 5 lithosphere-scale transects, which also incorporate results of multi-national seismic profiling (ECORS-CROP, NFP-20 and TRANSALP).

In the Western Alps, the European Plate was subducted beneath the Adriatic micro-plate. The generally SE directed subduction of the European continental lithosphere can be followed along strike and into the most complete transect across the Alps located at the transition between Western and Eastern Alps. Further eastwards, the subduction angle gradually gets steeper and finally vertical under the westernmost part of the Eastern Alps (western Tauern Window and Giudicaria lineament). Quite unexpectedly, some 50 km further to the east the subducted continental lower lithosphere forms part of the Adriatic lithosphere and dips NE beneath the European Plate. This documents bipolar present-day slab geometries beneath the Alpine Orogen.

Major along-strike changes are also reflected in fundamental changes in the geometry and timing of nappe stacking. The West-Alpine nappe stack was severely overprinted by late stage (post-35 ma) west-directed indentation of the Adriatic micro-plate. The central profile is characterized by an impressive amount of Tertiary N-S-shortening, asymmetric and top-N initially, but completely reworked into a bi-vergent orogen dur-

ing late-stage back thrusting and retro-thrusting. The easternmost transect is characterized by a very thick pile of Austroalpine nappes, floating on European crust. This nappe stack, formed during 2 subsequent orogenies, a Cretaceous and a Tertiary one, is presently found in an upper plate position with respect to the Southern Alps. This due to a fundamental change in the 3D lithospheric configuration, that initiated at around 20 Ma ago and which was triggered by the retreat of the European subduction slab into the Carpathian loop.

References:

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