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Alpine collision orogeny: crustal wedging, mantle lithosphere delamination, and isostatic uplift

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Recent compilation of a 3D structural model of the Alpine region documents deep crustal structure dominated by indentation and wedging of lower crustal material varying strongly in stile along the axis of the orogen. High-resolution teleseismic tomography results clearly reveal two separate lithospheric slabs in bipolar geometry beneath the Alpine orogen. In the western and central Alps, the slab shows a tear but is still partly attached to the European lithosphere and dips steeply toward SSW. From beneath the Tauern window on eastward beneath the Eastern Alps, the second slab is attached to the Adriatic lithosphere and gently dips toward NE. During late-Tertiary collision in the central and western Alps, the weight of the pre-collisional oceanic slab and its own negative bouancy forced the lower European lithosphere to delaminate along the Moho and to subduct, while in the Eastern Alps the colder Adriatic mantle lithosphere was forced to delaminate during collision and to subduct below the European lithosphere.

In the western and central Alps the current strain field, as derived by GPS and levelling measurements, documents only minor shortening across the orogen but significant uplift along its central axis. Substantially more horizontal shortening seems to occur, however, in the easternmost part of the Southern Alps while maximum uplift is documented for a broad region along the Rhine-Rhone line and near the Penninic front in the western Alps. Based on a compilation of fault plane solutions for earthquakes recorded over the past 25 years, the Alpine stress field in general nicely corresponds with the regional stress field and with the large-scale geometry of the orogen. Locally, however, stresses vary significantly and show a pattern consistent with tectonic flower

structures and lateral escape in the central part of the orogen and a compressional regime in the more external and internal regions. The seismicity patterns may be correlated with the 3D crustal structure and, in particular, with the lower crustal wedges in the western and central Alps. The Alpine stress and strain fields, however, may be understood in correlation with nowadays mostly isostatic plate forces acting on the lithosphere due to delamination of continental mantle lithosphere.