Geophysical Research Abstracts,
Vol. 11, EGU2009-2138, 2009
EGU General Assembly 2009

The role of Jurassic ocean-continent transition zones in the architecture of the Western Alps

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The influence of rift-related structures on the architecture of orogens is being increasingly recognized, especially in mountain belts that experienced low degrees of deformation/metamorphism and no or little arc magmatism during orogenesis. In areas affected by high pressure metamorphism, long lasting, complex deformation histories have the potential to significantly modify the initial geometry of the collided margins, thus hindering the recognition of pre-orogenic structures.
Despite these potential limitations, in the highly deformed Western Alps the characteristic lithostratigraphy of Ocean-Continent Transition Zones (OCT) can still be recognized in three key-areas: (1) the Canavese Zone, (2) the Zermatt-Saas Zone, which is part of the Piemonte Zone, and (3) the Versoyen Unit, belonging to the Valaisan Domain. These areas are characterized by the presence of exhumed serpentinized mantle, directly overlain by pelagic sediments and/or a few meters of tectono-sedimentary breccias. Slices of continental basement ranging in thickness from a few tens to several hundreds of meters are often located along the serpentinite-sediment interface. Cataclasites, fault gouges and ophicalcites are typically observed within the basement units, especially in the proximity of the contact with the overlying tectono-sedimentary breccias and post-rift sediments. No traces of brittle deformation are found in the post-rift sediments. The lithostratigraphy observed in the Canavese, Piemonte and Versoyen Zones, together with the presence of detachment-related rock types and of continental basement slices, which are comparable to the continental allochthons described from present-day passive continental margins, suggests that these domains may sample Tethyan OCT's. A pre-Alpine juxtaposition of serpentinites, continental basement, breccias and post-rift sediments is also indicated by similar Alpine Pressure-Temperature-time-deformation histories recorded by the different rock types, even though Alpine deformation has locally resulted in minor reworking of the contacts between the continental basement units and the surrounding rocks. Therefore, the Canavese, Piemonte and Versoyen Zones were originally located along thinned continental margins and were probably associated with regional-scale detachment faults.
The crucial importance of these detachment faults for the evolution of the Western Alps is indicated by the significant metamorphic gaps observed across such pre-alpine structures. The Canavese OCT separates the Adriatic plate, which underwent only phrenite-pumpellyte Alpine metamorphism, in its hangingwall from the Sesia Zone, which experienced pressures up to 2.0 GPa, in its footwall. The Piemonte OCT, instead, experienced pressures up to 3.2 GPa, significantly higher than the overlying Blueschist Piemonte Unit, with pressures in the 1.0-1.3 GPa range. The Versoyen OCT, similarly, underwent eclogite facies metamorphism at P=1.5 GPa, higher than the overlying, low-grade Zone Houlliere (P=0.5 GPa), which belongs to the Briançonnais domain.
We suggest that the regional scale Tethyan detachments associated with the Canavese, Piemonte and Versoyen OCT's facilitated the underthrusting of rock units that were originally located in their footwall to (ultra-)high-pressure depths. Furthermore, the extensional reactivation of those structures probably played an important role also in the subsequent exhumation of the OCT's back to the surface. The high strains related to Alpine shearing were not necessarily accommodated along the Tethyan detachments themselves, but were rather distributed over broader areas, up to a few hundreds of meters in thickness, with complex Alpine kinematics. Locally, this allowed for the rare preservation of primary contact between exhumed mantle, continental allochthons, tectonosedimentary breccias and post-rift sediments.