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Extensional neotectonics around the bend of the western/central Alps: an overview

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The western Alps' active tectonics is characterized by ongoing widespread extension in the highest zones of the belt and transpressive/compressive tectonics at the external limits of the belt. This contrasted tectonics is examined using multidisciplinary approach including seismotectonics, numerical modelling, GPS, morphotectonics, field work, and brittle deformation analysis. Extension appears as the main feature of the current activity in the western Alps, and affects their inner areas as a whole, following the arcuate geometry of the chain. Shortening is limited to local areas at the outer limits of the chain. Strike-slip is observed in the whole Alpine realm. The stress state is confirmed to be radial both concerning $\sigma 3$ in the inner extensional zones, and $\sigma 1$ in the outer transcurrent/tranpressional zones. Extensional areas are correlated with the part of the belt, which presents the thickest crust, as shown by the comparison with the Bouguer anomaly map and the smoothed topography of the belt.

There is a good qualitative coherency between seismotectonic and geodetic approaches, whereas the quantification of the seismic strain in tectonically homogeneous areas shows that only some percent to some tens of percent of the geodesy-related deformation could be explained by the Alpine seismic activity. The low seismic strain rates we obtained in a belt characterized by a high tectonic contrast in a quite limited area, suggests that the Alps are currently in a meta-stable tectonic state, ruled by isostasy/buoyancy forces rather than European/Apulia plate tectonic collision. This

interpretation has been strengthened by numerical modeling, using finite elements codes.

In term of Neogene tectonics, the latest extensional structures in the Alps took place under increasingly brittle conditions, from Miocene to the present-day. A synthesis of paleostress tensors in the whole internal arc provides a wide and homogenous database for the entire bend. The fault pattern crosscuts all the ductile compression-related structures and is associated to the latter tectonic events in the belt during the recent-Alpine history (Neogene times). The determination of paleostress fields, based on the inversion of fault/stria measurements constrains the behavior of this fault system. We observe a major orogen-parallel extension, with a continuous change in $\sigma 3$ directions from ENE-WSW in the Simplon area, to N-S in the Vanoise area and to NNW-SSE in the Briançon area. A smaller signal corresponding to orogen-perpendicular extension, which increases from N to S, could be related mainly to the present-day geodynamics, as revealed by seismotectonics, and partly to the exhumation of the Internal/External Crystalline Massifs. Orogen-parallel extension could be related to the opening of the Ligurian Sea during the Lower-Middle Miocene and to the compression/rotation of the Apulian indenter, following an extrusion-like process.