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Seismic stress/strain fields vs. Neogen tectonics around the bend of the western/central Alps

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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 [Sue et al., 1999, Delacou et al, 2004]. This contrasted tectonics is examined using a global synthesis of 389 reliable focal mechanisms covering the whole belt. In term of deformation state, an original method of regionalization allowed us to precisely map the different tectonic modes in the belt. 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 s3 in the inner extensional zones, and s1 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 quite good qualitative coherency between seismotectonic and geodetic approaches (Calais et al., 2002). To compare the seismic strain with the overall geodetic strain, we attempted to quantify the seismic part of the deformation. In each sub-area tectonically homogeneous, we computed the total seismic moment tensor, and the associated yearly seismic strain rate. This rate allows to compare different areas of the belt, in which the seismic catalogue may cover various range of time. Thus we can estimate the seismic strain per sub-area in the whole belt. Only some percent to some tens of percent of the geodesy-related deformation could be explained by the alpine seismic activity. This rises up the issue of aseimic deformation in the Alps. The low seismic strain rates we obtained in a belt characterized by

a high tectonic contrast in a quite limited area, could suggest that the Alps are currently in a meta-stable tectonic state, ruled by isostasy/buoyancy forces rather than European/Apulia plate tectonic collision. In term of Neogen tectonics, the latest extensional structures in the Alps took place under increasingly brittle conditions, from Late Oligocene - Lower Miocene to the present-day. A synthesis of paleostress tensors in the whole internal alpine arc (Champagnac et al., 2004) provides a wide and homogenous database (312 paleostress tensors) for the entire bend. The fault pattern crosscuts all the ductile compression-related structures and thus postdates the ductile deformations: it 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 constrain the behavior of this fault system. We observe a major orogen-parallel extension, with a continuous change in s3 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-Midlle Miocene and to the compression/rotation of the Apulian indenter, following an extrusion-like process.

REF: Calais et al., 2002, Geology, 30-7, 651-654; Champagnac et al., 2004, submitted to Tectonics; Delacou et al.,2004 GJI 158, 753-774; Sue et al., 1999, JGR, 104, 25611-25622.