What do we learn from extensional neotectonics in the Western Alps?

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The Western Alps' active tectonics are characterized by ongoing widespread extension in the highest parts of the belt and transpressive/compressive tectonics along its borders. Extension appears to be the dominant process in the present-day tectonic activity in the W-Alps, affecting its internal areas all along the arc. Shortening is limited to small areas located at the outer borders of the chain. Strike-slip is observed throughout the Alpine realm and in the foreland (Sue et al., 1999, 2007; Delacou et al., 2004).

A synthesis of paleostress tensors documents the Neogene extensional structures and exhibits a major orogen-parallel extension with a continuous change in σ3 directions all along the bend of the Western/Central Alps (Champagnac et al., 2006). Minor orogen-perpendicular extension increasing from North to South is also observed. This latter signal correlates with present-day geodynamics as revealed by focal-plane mechanisms analysis and GPS analysis. The current stress-orientation pattern is radial for σ3 in the inner, extensional zones, and for σ1 in the outer, transcurrent/tranpressional zones. Extensional areas are spacially correlated with thick crust, but also with areas showing fast rock uplift. Alpine neotectonics is indeed ruled by buoyancy forces rather than ongoing shortening along the Europe/Adria collision zone. Numerical modeling corroborates this interpretation (Delacou et al., 2005).

Interactions between the different geodynamic processes control the balance between intrinsic and extrinsic dynamics and explain the late tectonic evolution of the belt (Sue et al., 2007). Numerous geodynamic engines are involved in the Neogene to present evolution of the Western and Central Alps, including boundary conditions (collision, rotation, free Ligurian boundary), deep dynamics (buoyancy forces, slab dynamics, crustal delamination, vertical indentation), and surface processes (erosion, mass transfert, post-glacial rebound). Three main processes seem to play a fundamental role in the late tectonic to neotectonic evolution of the Alps. First, the end of the opening of the Ligurian Sea during Late Miocene times would imply a decrease in orogen-parallel extension. Second, a progressive decrease in the rate of continental collision (Europe-Adria) is critical for the change of tectonic regime. The decrease of convergence rates allows buoyancy forces to develop, and to control alpine dynamics. Third, the Pliocene increase of erosion rates implies major geodynamic modifications (Champagnac et al., 2007), which tends to re-equilibrate the alpine orogen in terms of mass transfert, including extensional tectonics.

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