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Complex stress field pattern in the southwestern Alpine Arc inferred from new seismotectonic data

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Recent studies in the French Alps have revealed that during Post–Oligocene times, extensional stresses spread across the entire internal arc while contractional stresses accentuated at the periphery of the external arc. This pattern is still active and is illustrated by relatively intense and irregular shallow crustal seismicity, the focal mechanism solutions of which are in agreement with GPS data.

This study focuses on the NW-SE trending southernmost tip of the western Alpine arc. 32 new focal mechanisms have been computed, completing the available database (1989-1996 from Sue et al, 1999) up to 2002, in order to precise the current deformation pattern and to understand the relationships between compressional and extensional sectors. The seismicity of this southernmost branch has been relatively poorly studied, in spite of its key setting: 1) It is the most seismically active part of the Alps, where the map projections of the Briançonnais and Piemontais seismic arcs are superposed; 2) Alpine structures are oriented NW-SE, contrasting with NE-SW to N-S strikes further north, and complete the arc-shaped belt geometry; 3) Internal zones display a reduced width, being pinched between the external Argentera crystalline massif and the internal Dora-Maira crystalline massif.

Ongoing extension is clearly confirmed in the studied southern branch, as previously highlighted further north, but with a more pronounced tendency toward strike slip in the Briançonnais zone. The latter is affected by E-W extension with the minimal principal stress axis $\sigma 3$ remarkably stable in the entire studied area. Due to the arcuate geometry of the belt, this direction appears nearly perpendicular to the belt axis in its northern part and becomes almost parallel further south. Structural heritage, sustained by NW-SE axial lineaments, may have controlled the direction of extension. A high shape ratio $\phi = [(\sigma 2 - \sigma 3)/(\sigma 1 - \sigma 3)]$ of the stress ellipsoid could be calculated by inverting Briançonnais focal-mechanism solutions. This allows to attribute the observed coexistence of extensional and strike-slip solutions to permutations between the principal stress axes 1 and 2. In addition, the direction of extension computed in the Briançonnais zone is compatible with the compression undergone by the Provence fold-thrust belt in the south-western foreland of the Alps. The complex stress pattern in the NW-SE Briançonnais zone could result from interference between a local extensional stress field affecting the internal zones of the Alps and a far field compressional stress field due to plate convergence.