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Analysis of deformations and crystallizations in the serpentinite massif of Fengtien (Eastern Central Range, Taiwan).

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The Taiwan orogen is caused mainly by the complex interaction (double-verging oceanic and continental subduction) between converging Eurasia and Philippine Sea plates. Today, the orogen culminates in mountain ranges aged a few million years and rising to about 4000 meters above sea-level. In Taiwan, two main zones of serpentinites are recognized: (i) the east Taiwan ophiolite (ETO) and (ii) the Central Range Ophiolite. The latter one is supposed to be related to an old subduction and /or metamorphism of the pre-Tertiary time and overprinted by spreading-subduction-collision-exhumation of the oceanic crust of Eocene to Plio-Pleistocene.
In this range, large serpentinite bodies are common in mountain flanks along the western edge of the Longitudinal Valley, where numerous quarries provide decorative stones and the Taiwan nephrite.
In the Yuli Belt, in the eastern part of the Central Range, serpentinites bodies are embedded in metasediments, metamorphosed during the Miocene and Plio-Pliocene.
In this study, we focus on the Fengtien massif, located in the northern part of the Yuli Belt. This study comprises both (i) a systematic analysis of the brittle and ductile-to-brittle structures carried out in terms of stress tensor reconstruction and (ii) samples collected from faults and veins to be analyzed by means of electron microscopy and microprobe chemical investigations. The aim is to reconstruct the chronology of the tectonic events and the successive mineralogical associations in order to pinpoint the tectono-metamorphic path of this massif.
The first main tectonic phase is a NNW to NS extension, characterized by a ductile behavior of the serpentinite. The deformations include normal shear and ductile-to-brittle flattening. Dark-green to olive-green long fibers of lightly aluminous serpentine are associated with pressure-shadows.
The second phase is also extensive with an average trending extension of NE-SW. The brittle deformation is characterized by numerous normal faults and veins with various infilling: early rare magnesite, more common dolomite associated with green fibers, calcite with blue-green serpentine fibers, but also tremolite, talc with calcite. The serpentinite itself is usually intensively recrystallized and antigorite is ubiquitous.
The third phase is of strike-slip type, indicating a NW- SE direction of compression. No specific crystallization occurs.
Phase 1 may represent either the last stage of the spreading of the South China Sea or events linked to the subduction of the oceanic crust.
The mineralogical evolution from phase 1 to phase 2 demonstrates that the serpentinite bodies were invaded by fluids rich in H2O, CO2, CaO and SiO2, with various proportions between the components. The fluid composition indicates that the serpentinites were probably incorporated or in contact with the metasedimentary sequence of the Tananao schist and quartzites. Phase 2 probably prevailed during the exhumation of the Central Range and may reflect a diapiric movement of the serpentinites bodies toward the upper crust.
Phase 3 is classical and related to the late collisional history of Taiwan.
The alternative model proposes that all three phases of deformation are intimately related to the exhumation of the Central Range under the compressive regime of plate convergence. Phases 1, 2 and 3 may represent the incipient, the intermediate and the final stages of exhumation which correspond to the structural level of the ascent path of mid-to-upper, upper, and uppermost crusts, respectively. The latter model is more favorable, as the ductility of serpentinite straddles across the major P and T regimes of the crust, and the pre-exhumation structural features were largely obliterated and overprinted by later deformations.