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Brittle deformation and kinematic along major detachment fault in a fossil oceanic core complex: evidences from the Chenaillet ophiolite

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The Chenaillet ophiolite, located South of Montgenèvre (France) in the western French-Italian Alps, is considered as a well-preserved ocean floor fragment of the Alpine Tethys (Chalot-Prat GSA 2005). This ocean floor sequence consists in mostly small conic volcanoes overlying tectonically exhumed gabbro and mantle peridotite as usually observed at the mid-oceanic ridge of a slow spreading ocean. The gabbroic and peridotitic basement belongs to an oceanic core complex crosscut by several detachment faults striking N110-N150° and dipping eastward and related high-angle normal faults, striking mainly N110-N130° and dipping mainly westward.
Our tectonic analysis yields extensional stress tensors with sigma 3 oriented N30° on average. This paleostress orientation would be contemporaneous of extension and enlargement of the Tethys lithosphere at the ridge axis. In the NE part of the ophiolite, several kinematic criteria indicate a second tectonic stage associated to compression stress tensor with sigma 1 oriented N30°. This event is characterized by the reactivation on reverse faults with slight displacement along former high-angle normal faults. These localized reverse faults, active in a compressional regime, postdate the extensive regime.
Detailed petrological and deformation studies were performed on a well-preserved detachment fault between a serpentinite hangingwall and a gabbro footwall. In going towards the major fault plane, deformation increases from proto- to ultra-mylonitic on the serpentinite side (15 m thick) and from proto-cataclastic to micro-brecciated on the gabbroic side (5-8 m thick).
Numerous quartz veins (1-3 cm thick; > 10 m in length) crosscut this large deformed zone, all the more numerous as they are close and parallel to the fault plane. These sharp veins reflect a fragile deformation event during which an important siliceous fluid circulation took place along the detachment fault and these opened veins. Serpentinization of the mantle peridotite is known to release a lot of silica (10-13% SiO_2 from the whole rock). The silica richness of the fluids could be linked to mantle serpentinization at greater depth. The absence of carbonate (ophicalcite) usually filling fault planes and cracks within the mantle basement asks the question about the differences between their conditions of formation.
A thin basaltic dyke (12 cm thick) crosscuts this deformed and brecciated zone on both sides of the fault plane. It is itself brecciated from place to place. Basalt clasts indicate a syn-detachment formation of the dyke.
These new observations highlight the major role of tectonic constraints on mantle lithosphere with formation of detachment and high-angle faults, which induce in turn important fluid and magma transfers through the oceanic mantle.

Chalot-Prat F, 2005. An undeformed ophiolite in the Alps: field and geochemical evidences for a link between volcanism and shallow plate tectonic processes. In Plates, Plumes & Paradigms, edited by G.R. Foulger, D.L. Anderson, J.H. Natland and D.C. Presnall, Geological Society of America, Special Paper 388, 751–780.