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Subduction and exhumation structures preserved in Cerro del Almirez HP metaserpentinites (Betic Cordillera, SE Spain)

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The Cerro del Almirez massif (Nevado-Filábride Complex, Betic Cordillera, SE Spain) is composed of antigorite serpentinite and chlorite harzburgite separated by a thin reaction front in a paleo-subduction setting. Structural analysis of ultramafic lithologies and metasedimentary host rocks provides information on the tectonic evolution of this massif during prograde metamorphism in a subduction zone and during subsequent exhumation.

Here we report for the first time HP structures related to a subduction event underwent by ultramafic rocks of the Nevado-Filábride Complex. The oldest subduction-related structures are preserved in Atg-serpentinites: a penetrative S1 foliation and associated L1 stretching lineation were formed in a non-coaxial regime with a top-to-the-W sense of shearing. This planar linear fabric is crosscut by olivine $\pm$ Ti-clinohumite veins formed during the prograde breakdown of brucite and pre-metamorphic clinopyroxene at temperatures ranging from 465 to 500 ºC [1]. Veins occur as a system of decimetric long joints, some of them hybrid open and sheared veins with associated drag folds. They recorded embrittlement processes due to the release of 6% vol. H_2O of the rock. S1 foliation can, however, be simultaneous with or be overgrown by olivine and/or tremolite porphyroblasts, product of the prograde reaction Di + Atg $\rightarrow$ Fo + Tr + H_2O, which occurred at T > 600 ºC and P = 1.7-1.9 GPa [1]. Generation of S1/L1 fabric was followed by static annealing at ca. 680 ºC and 1.6-1.9 GPa [2]. The S1/L1 fabric in Atg-serpentinite is crosscut by the Atg-out isograd and overgrown by the Atg-serpentinite dehydration products that gave place to Chl-harzburgite. Peak metamorphic conditions of the Chl-harzburgite assemblage reached 680–710 ºC and 1.6–1.9 GPa [3]. Prograde Chl-harzburgite is crosscut by sets of conjugate zones associated to grain-size reduction of olivine grains [3]. These grain size reduction zones are interpreted as brittle structures generated by hydrofracturing by overpressure fluids in a compressional setting with a roughly subhorizontal $\sigma 1$ and low differential stresses.

Structures related to the exhumation process are mainly preserved in the metasedimentary host rock, where a recurrent sequence is recorded of non-coaxial deformations and folding. Firstly, a S2/L2 planar-linear fabric developed within shear zones dominated by a non-coaxial regime with a top-to-the-west sense of movement in a compressive regime. Metamorphic peak conditions deduced for the schists are lower in temperature (560-590 ºC) but similar in pressure (1.3-1.9 GPa) than the ultramafic rocks in contact with them, thus indicating that a major shear zone at the base of the ultramafic massif was active during D2 deformation. The superposed thin tectonic units stacked during D2, including the rigid Chl-harzburgites, were subsequently affected by N-vergent folds.

[1] López Sánchez-Vizcaíno V. et al., (2009): Breakdown mechanisms of titanclinohumite in antigorite serpentinite (Cerro del Almirez massif, S. Spain): a petrological and TEM study. Lithos, 107, 216–226.
[2] Padrón-Navarta J.A. et al., (2012): Plastic deformation and development of antigorite crystal preferred orientation in high-pressure serpentinites. Earth and Planetary Science Letters, 349-350, 75–86.
[3] Padrón-Navarta J.A. et al., (2010): Fluid transfer into the wedge controlled by high-pressure hydrofracturing in the cold top-slab mantle. Earth and Planetary Science Letters, 297, 271–286.