Metamorphic evolution of the Cerro del Almirez ultramafic rocks (Betic Cordillera, South Spain): a proxy to dehydration processes taking place during subduction

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Serpentinites are the main carriers of water in subduction zones. The dehydration reaction of antigorite (releasing up to ~ 9 wt % H_2O) affects the composition and rheology of the plates, induces intermediate-depth earthquakes in the slab and plays a fundamental role in the production of arc lavas and in the transference of elements between different domains. The Cerro del Almirez ultramafic massif is the only known locality where the arrested dehydration front due to antigorite breakdown at high pressure conditions has been preserved (Padrón-Navarta et al., 2010). Since the work by Trommsdorff et al. (1998) these outcrops have revealed as a unique setting to investigate the prograde metamorphic evolution from antigorite serpentinite to chlorite harzburgite and its various implications. Atg-serpentinite preserves both prograde mineral assemblages and subduction-related structures. Prior to breakdown, antigorite is Al-rich and exceptionally ordered from a microstructural point of view. Transitional lithologies occur as well preserved layers in between Atg-serpentinite and Chl-harburgite all along the devolatilization front. The gradual disappearance of antigorite leads to the final prograde assemblage in Chl-harzburgite with two contrasting textures: granofelsic (with coarse, round olivine) and spinifex-like (dentritic-like, cm-sized olivine and orthopyroxene) that occur as interspersed, m-sized boudins. We ascribe these textures to shifts of the growth rate ultimately controlled by variations of the excess fluid pressure and the hydrodynamics of fluid expulsion. Fluids chanelling is evidenced by the occurrence of grain-size reduction zones, a few mm to meters wide, with roughly planar conjugate structures. We interpret them as brittle structures generated by hydrofracturing by overpressure fluids in a compressional setting in an otherwise almost impermeable peridotite. This might be an essential mechanism in the first stages of fluid flow through the coldest parts of top-slab mantle in subduction zones. The main geochemical effects of dehydration are, on the one hand, the loss of LREE–MREE, water, and sulfur, which can contribute to ^{18}O, D, and ^{34}S enrichments and oxidation of the sub-arc mantle wedge. On the other hand, Chl-harzburgite is enriched in Ti and the most compatible HREEs (Tm, Yb and Lu) as well as in Th, U, Nb, Ta, Pb, Sr due to fluid circulation in an open system, and thus contributing to their recycling in deep regions of the mantle.

Trommsdorff V., López Sánchez-Vizcaíno V., Gómez-Pugnaire M.T. & Müntener O. 1998. High pressure breakdown of antigorite to spinifex-textured olivine and orthopyroxene, SE Spain. Contrib. Mineral. Petrol., 132, 292-302.

Padrón-Navarta J.A., Tommasi A., Garrido C.J., López Sánchez-Vizcaíno V., Gómez-Pugnaire M.T., Jabaloy A., Vauchez A. 2010. Fluid transfer into the wedge controlled by high-pressure hydrofracturing in the cold top-slab mantle. Earth Planet. Sci. Lett., 297, 271-286.