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L-tectonites and deep mantle wedge deformations in the Limo ultramafic massif (Cabo Ortegal Complex, NW Spain)

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The Cabo Ortegal Complex is one of the Allochthonous Complexes of northwest Iberia. The complexes are variable subducted continental and oceanic lithosphere fragments obducted onto the Gondwana edge during the Variscan orogeny. They comprise a Lower Allochthon, a sandwiched ophiolitic complex, and an Upper Allochthon made of rock units metamorphosed under high-pressure conditions and amalgamated in an oblique subduction/collision orogenic channel. The structurally uppermost high-pressure sheet consists of arc-root lithospheric mantle peridotites that rest on high-pressure granulite facies rocks, eclogites and gneisses with eclogite boudins. The ultramafic rocks outcrop in three major massifs (Limo, Herbeira and Uzal from N to S) and in a number of much smaller klippen structures. They are serpentinized amphibole-bearing harzburgite, chromian spinel- and PGE-bearing dunite, and garnet-bearing massive pyroxenite.

The Limo ultramafic massif has been considered so far as a fairly massive harzburgitic massif without a clear internal arrangement or fabric. However, new field data and microstructural observations show that harzburgites are L-tectonites and that this fabric is recognizable at various scales (from aerial photos to the outcrop and microscopic scales). The structures described form a hm-thick ultramafic tectonite stack which resembles the structural relationships already known in the easternmost sector of the neighbour Herbeira massif.

Subhorizontal mineral and stretching lineations are defined by spinel and orthopyroxene and trend N010º-030ºE. Extremely elongated sheath-like folds bear axes parallel to the lineation and show axial ratios >15, tubular and isoclinal structures in XZ sections and eye- and anvil-structures in structural sections perpendicular to the lineation. Sigmoidal shapes of peridotite foliation trajectories in XZ sections indicate a top-to-the-NNE tectonic displacement of hanging wall blocks (according to present-day geographic coordinates).

Harzburgite mineral constituents (olivine, orthopyroxene, clinopyroxene and spinel form the primary mineral assemblage, whereas serpentine, opaque minerals, amphibole and chlorite are secondary) show a clear lattice-preferred orientation (LPO) in these L-tectonites. Olivine, othopyroxene (enstatite), clinopyroxene (diopside) and amphibole (hornblende) LPOs were studied with the Electron Back-Scatter Diffraction (EBSD) technique. Olivine LPOs show [001] axis concentrations close to the X structural direction whereas poles to {010} planes define girdles normal to the lineation, with submaxima close to Y and Z. This fabric suggests activation of [001]{hk0} slip systems operative under high-temperature deformation at great depth (deep mantle wedge conditions, in our case, though in other lithospheric contexts might correspond to depths of 250-300 km). LPO patterns of primary clinopyroxene show [001] axes parallel to X and {010} pole girdle distributions perpendicular to the lineation. This “L-type” fabric (Helmstaedt et al., 1972) has been often interpreted as due to constrictional deformation. Orthopyroxene LPO patterns show [001] axis submaxima close to the X structural direction and poles to {100} planes close to Z and normal to the lineation. This pattern suggests operation of dislocation creep intracrystalline deformation mechanisms with (100) slip planes parallel to the macroscopic foliation plane <001> Burgers vectors close to the lineation (direction of shear). Amphibolite-facies retrogression stages during exhumation promoted primary clinopyroxene replacement by amphibole, which form thin layers resembling retrogressed pyroxenite layers. Amphibole LPO patterns show [001] axis concentrations close to the macroscopic lineation and poles to {100} planes around Z. This pattern suggests activation of the <001>(100) slip system

at T>650 ºC, although alternative deformation mechanisms (rigid rotation and pressure-solution creep) might have operated as well. LPO asymmetry with respect to the XYZ reference frame always depicts top-to-the-NNE non-coaxial deformation components.