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LPO patterns of successive equilibrium mineral assemblages in eclogites from Cabo Ortegal (NW Spain): a witness of a polyphasic high-pressure ductile deformation process

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The Cabo Ortegal Complex, one of the Allochthonous Complexes of NW Iberia, contains subducted continental and oceanic lithosphere fragments obducted onto the Gondwana edge during the Variscan orogeny. It comprises a Lower Allochthon, a sandwiched ophiolitic complex, and a HP Upper Allochthon made of arc-root lithospheric mantle peridotites, HP granulites, eclogites and HP gneisses amalgamated in an oblique subduction/collision orogenic channel.

Taking into account deformational features observed in eclogites, two lithotypes are differentiated: (1) massive eclogites and (2) mylonitic eclogites deformed under eclogite-facies conditions. Massive eclogites exhibit an oriented granonematoblastic microstructure defined by garnet and oriented omphacite, with minor amounts of oriented quartz, rutile, zoisite, amphibole and phengite. The planolinear fabric is parallel to the observed compositional banding. Mylonitization preferentially affected kyanite-bearing eclogites and gave rise to ductile shear zones around the massive lithotypes or along the contacts with the bounding units. They consist of primary garnet and oriented omphacite, kyanite and minor amounts of amphibole, zoisite, quartz, rutile and phengite, defining the macroscopic foliation and stretching lineation. This planolinear fabric is parallel to the mylonitic fabric of the deformed lithotypes and to that observed in the massive eclogites. Foliation shows an average orientation of 50º/290º with a N000-020ºE trending subhorizontal lineation.

The Cabo Ortegal eclogites recorded a high-pressure polyphasic metamorphic evolution coeval with two deformational phases: D1 and D2. D1 planolinear fabrics are preserved in the massive lithotypes and within garnet porphyroclasts of the mylonitic eclogites. D2 fabrics developed within the above-mentioned shear zones, presumably during amalgamation of the HP units in a subduction channel.

Electron Back-Scattered Diffraction (EBSD) analysis of eclogite quartz, omphacite, kyanite and zoisite shows that clinopyroxene, kyanite and zoisite from eclogites affected by both D1 and D2 show equivalent LPO patterns. Poles to the {001} planes for omphacite and kyanite and to the {010} planes of zoisite cluster around the X structural direction. The corresponding LPOs point to plastic intracrystalline deformation by dislocation creep in both deformational phases, although other mechanisms such as anisotropic growth and diffusive mass transfer cannot be discarded. Strain accommodation would have been operative under constriction conditions, as attested by "L-type" fabrics (Helmstaedt et al., 1972) of omphacite. Quartz in massive eclogites shows LPOs with two submaxima, one close to the Y structural direction and the other one around X, indicating active {m}<a> and {m}[c] intracrystalline slip systems, respectively. However, quartz in mylonitic eclogites displays LPOs with a unique maximum around Y, pointing to {m}<a> intracrystalline slip. This slip system change might be due to significant decrease in T, from high-T deformation conditions during D1 to intermediate conditions during D2, along with a likely increase in the strain rate. These results are consistent with available thermobarometric data. Asymmetry of the LPO diagrams for all the HP phases with respect to the macroscopic XYZ reference frame indicates top-to-the-NNE non-coaxial components of the deformation.