Is there a Variscan subduction zone in the External Western Alps? New insights from mafic HP relics in migmatites

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The metamorphic allochthonous units of the Variscan Belt contain numerous bodies of eclogite and high-pressure (HP) granulite. Although some of these HP rocks belong to well-defined oceanic or continental subduction systems, many of them currently occur as isolated lenses scattered over wide areas within migmatites of the crustal root, whose geodynamic significance remains unclear. They might represent the relics of one or multiple subduction zones separating small continental plates from Gondwana, but the lateral continuity of these subductions remains elusive and has been a matter of debate over the past decades. Alternatively, they may be derived from the crustal root of a large orogenic plateau, equilibrated at HP-HT conditions during crustal thickening stages. Focusing on the Variscan crust of the External Crystalline Massifs of the western Alps (ECM), this presentation aims to discuss the geodynamic setting associated with Variscan HP-HT metamorphism and the subsequent exhumation of these HP rocks. In-situ U-Pb dating of zircon and rutile in retrogressed eclogites, combined with thermobarometric analysis indicate the existence of a Visean (ca. 340-330 Ma) HP-HT stage at ca. 650–750°C and 1.4–1.8 GPa recorded all over the ECM (Jacob *et al.*, 2021, 2022; Vanardois *et al.*, 2022). This HP stage shortly follows a period of extension in a continental back-arc setting during the late Devonian – Tournaisian (ca. 370–350 Ma), which is characterized by opening of small basins and low-K calc-alkaline to tholeitic magmatism. No previous Devonian events have been identified. The age and P-T data thus suggest that HP-HT metamorphism in the ECM is related to the closure of these Devonian basins, in a transitional setting between continental subduction and collision. Exhumation has occurred from the middle to the late Carboniferous (ca. 335–300 Ma) in a broad transpressional setting associated with longitudinal flow of the partially molten crust. Most of the HP relics are juxtaposed with lower pressure crustal rocks within kilometer-wide, transcurrent shear zones. In the ECM, these shear zones form an anastomosed network, which corresponds to an orogen-scale dextral transcurrent corridor deeply rooted in the lower crust and probably in the upper mantle, which channelized exhumation of lower crustal rocks. These results question the significance of similar eclogites in surrounding Variscan massifs usually interpreted as ancient oceanic sutures.

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