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UHP metamorphism in the Western Mediterranean : A tale of a Tethys fragment (Edough Massif, NE Algeria) and its geodynamic consequences

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The Edough Massif of NE Algeria is part of the Maghrebides, a peri-Mediterranean Alpine belt that extends from Morocco to Tunisia. The belt resulted mainly from the eastward retreat of the Tethyan slab and from the drift of continental fragments, some of which finally collided with the north African margin. In this study we report the recent discovery of metamorphic diamonds (5–30 μm in size) included in a garnet megacryst and identified by Raman spectroscopy and the characteristic sharp band at 1332 cm^{-1} for crystalline diamond. The studied megacryst was taken from a weathered actinolitite horizon inserted within a major mylonite–ultramylonite band, which outcrops at the base of an allochtonous oceanic unit thrust onto the African paleomargin. The host garnet is almandine-dominant with a sharp increase in grossular component in the rim and is rich in exsolution of small acicular rutile needles. Major and trace elements show a gradual but significant zonation from core to rim characterized by a decrease in HREE, Y and Mn, typical of a prograde growth in a closed system. Trace element analyses of large prismatic rutile (up to 300 μm) indicate that the host metamorphic rock was a mafic protolith of MORB affinity and the Zr-in-rutile thermometry indicates a temperature range of 724–778°C for rutile growth. U-Pb analyses of these large rutile crystals provide an age of 32.4 $\pm$ 3.3 Ma interpreted as dating the prograde subduction stage of the mafic protolith. Minute zircons ($\leq$ 30μm), disseminated in the garnet, display a multifaceted appearance and low Th/U ratios consistent with a metamorphic origin. The lack of HREE depletion in these zircons indicates that their metamorphic growth was not coeval with garnet. U-Pb analyses and Ti-in-zircon thermometry indicate they nucleated at 20.9 $\pm$ 2.2 Ma during near isothermal decompression related to exhumation of the UHP units. This study allows bracketing the age of UHP metamorphism in the Western Mediterranean to the Oligocene/early Miocene, thus unambiguously relating UHP metamorphism to the Alpine history. We suggest that the mafic protolith originates from the subducted retreating Calabrian branch of the Tethyan slab, that broke or tore, and which fragments were dragged upward and thrusted onto the North African margin, shortly before the formation of the Edough dome. Exhumation of these UHP units is coeval with the counter clockwise rotation of the Corsica-Sardinia block, which is associated to the extensional opening of the Ligurian Sea as a result of slab rollback (Faccenna et al., 2001). The early Miocene exhumation of the UHP units, which were detached from the downgoing plate, most likely resulted simultaneously from subduction rollback that was driven by slab pull.