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Prograde and retrograde metamorphic processes in high-pressure subduction zone serpentinites from East Thessaly, Greece

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The East Thessaly region, Central Greece, includes metaophiolitic mélange formations which extend from the eastern foothills of Mt. Olympus and Ossa, throughout the Agia basin, Mt. Mavrovouni (Sklithro region), South Pelion and reaching up to northeast Othris (regions of Aerino and Velestino). They appear in the form of dispersed and deformed thrust sheets having been variably emplaced onto Mesozoic platform series rocks of the Pelagonian tectonostratigraphic zone[1]. These formations consist mainly of serpentinites, as well as metasediments, metagabbros, metadolerites, rodingites, ophicalcites, talc-schists and chromitites.

Based upon petrographic observations, mineral chemistry data and XRD patterns, the subduction zone-related serpentinites from the regions of Potamia, Anavra, Aetolofos and Kalochori-Chasanbali (Agia basin), as well as from the regions of Aerino and Velestino, are characterized by the progressive transformation of lizardite to antigorite and are distinguished into two groups. The first group includes serpentinites from the metaophiolitic formations of Potamia, Anavra, Aerino and Velestino, which are marked by destibillization of lizardite to antigorite, mostly along the grain boundaries of the lizardite mesh textured relics. The presence of lizardite and antigorite in almost equal amounts indicates medium-temperature blueschist facies metamorphic conditions (∼340–370 ˚C; P≈10-11 kbar)[2,3,4]. The second serpentinite group appears in the regions of Aetolofos and Kalochori, characterized by the predominance of antigorite, the minor occurrence of lizardite and the complete replacement of spinel by Cr-magnetite. The absence of metamorphic olivine suggests that these serpentinites were most likely formed at slightly higher temperature and pressure conditions compared to the first serpentinite group, corresponding to medium or high temperature blueschist facies metamorphism (∼360–380 ˚C; P≈12 kbar)[2,3,4]. These metamorphic conditions are highly comparable with the P-T estimates from the East Thessaly metabasic rocks (∼350 ˚C; P≈10-11 kbars)[5], suggesting that the entire metaophiolitic formation underwent blueschist facies metamorphism, comparable with high-pressure metaophiolitic formations appearing in Evia, Attica and the Cyclades. The East Thessaly serpentinites exhibit significantly high PM-normalized Pb, U enrichments and rather high Cs, La, As and Sb concentrations, which are comparable with subduction-related serpentinites, formed after mantle wedge peridotite hydration, and that have interacted with sedimentary derived fluids [2,6,7,8].

These serpentinites were also partly affected by de-serpentinization retrograde metamorphism (estimated at P<8 kbar and T<350 ˚C) which is noticed by the following: secondary crosscuting antigorite veins occasionally with chlorite, coronas of chlorite along Cr-magnetite crystals, appearance of secondary calcite veins and talc. In the Kalochori-Chasanbali area, intense carbonization processes formed ophicalcite breccias enveloped by imbricated serpentinites[9], whereas talc-rich serpentinites appear in the region of Sklithro. Retrograde metamorphism may have occurred during exhumation, possibly within a serpentinite channel[8]. In addition, their retrograde history can also be indirectly identified through the study of their rodingite intrusions and more specifically through the formation of late-stage vesuvianite-rich dykes at low-moderate temperature conditions (T=250-300 ^{o}C) and subsequent derodingitization processes, forming metarodingites. The latter include abundant high-Mg replacive chlorite formed by continuous serpentinization which provided Mg^{2+} to the infiltrating fluids, causing the partial breakdown of Ca-bearing minerals.

References. [1] Pe-Piper & Piper 2002: Borntraeger, Stuttgart, 1-645; [2] Lafay et al 2013: Chem Geol 343, 38-54; [3] Schwartz et al 2013: Lithos 178, 197-210; [4] Guillot, et al 2015: Tectonophysics 646, 1-19; [5] Perraki et al 2002: Geologica Carpathica 53, 164-165; [6] Deschamps, et al 2013: Lithos 178, 96-127; [7] Hattori & Guillot, 2007: G-Cubed 8 (9); [8] Barnes et al 2014: Chemi Geol 389, 29-47; [9] Melfos et al 2009: Geoph. Res. Abst, 11.