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P-T paths of ophiolite-related metamorphic rocks from the Dinaride ophiolite zone in Bosnia

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The Dinarides, an Alpine mountain chain in south-eastern Europe, is characterized by complex fold, thrust, and imbricate structures. Partially dismembered ophiolites, a regular part of the Inner Dinarides, are considered as separate ultramafic massifs. The large Krivaja-Konjuh ultramafic massif (KKUM) within the Dinaride Ophiolite Zone (DOZ), composed of tectonic spinel lherzolite, occurs as NE-dipping thrust sheet underlain by gradually decreasing, up to 1200 m thick, high- to medium-grade metamorphic rocks. The metamorphic rocks geochemically resemble MORB-like rocks with tholeiitic signature. Such metamorphic rocks, which originated from cumulate gabbro and/or troctolite, are mainly represented by granulite and amphibolite varieties (subordinate eclogite and epidote-amphibolite facies metamafic rocks are also present) with various proportions of amphibole, plagioclase, pyroxenes (diopside and hypersthene), garnet, corundum, sapphirine, spinel and quartz. These rocks vary in textures (granoblastic, porphyroblastic and nematoblastic) and grain size (coarse- to fine-grain varieties).
Conventional thermobarometry of garnet- and clinopyroxene-bearing amphibolites directly beneath the contact to the overlying peridotite resulted in peak pressure (P) – temperature (T) conditions of 10-12 kbar (depth of ca. 35–40 km) and 745-830°C. Those amphibolites without clinopyroxene but with garnet experienced peak conditions of 7 kbar and 630°C. Amphibole + plagioclase amphibolite gave temperatures of 670-730 °C and lowermost-grade amphibolites yielded peak temperatures of 550°C. These estimates are thought to reflect the metamorphic conditions during the Late Jurassic obduction of the hot upper mantle part of the KKUM onto the ophiolite mélange. The hot obducted ultramafic fragments acted as a heat source for metamorphism that transformed cumulate gabbroic protolith into high- to medium-grade amphibolites and granulites.
P-T pseudosections constructed for various metamorphic rock types in the MnNCFMASHTO system, contoured by mineral isopleths and modes, combined with chemical zonation of garnet (elucidated by X-ray mapping), succession of accessory Ti-minerals (ilmenite -> rutile -> titanite) and textural features (particularly occurrence of complex kelyphite textures around garnet and clinopyroxene) gave us important clues for P-T paths (re)constructions. The petrographic details and mineral chemistry point to composite clockwise P-T paths characterized by high-temperature high-pressure conditions (ca. 20 kbar, 700 °C for garnet- and amphibole-bearing metaperidotite), followed by significant pressure decrease to medium-pressure values accompanied by temperature increase to > 830 °C. Such a composite P-T path can be interpreted in the frame of Late Jurassic to Early Cretaceous regional geodynamic processes that involve collision at the edge of the Adriatic microplate, intra-oceanic NE-dipping subduction and underplating of mafic cumulate rocks under the hot upper mantle part of the KKUM and subsequent erosional events. Processes of the final emplacement of the KKUM metamorphic rocks must have been terminated in Early Cretaceous times as indicated by amphibolite fragments in the adjacent Pogari Formation overlying the ophiolite mélange.
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