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Magmatism and tectonics of ophiolites in the eastern part of the Vardar zone, Chalkidiki Peninsula, Northern Greece

Магматизъм и тектоника на офиолити в източната част на Вардарската зона, Халкидически полуостров, Северна Гърция

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Introduction and geological setting

The Vardar zone is a major suture within the Alpine orogenic belt of the inner Hellenides of Northern Greece (e.g. Papanikolaou, 2009), in turn decorated by Jurassic ophiolites that trace the fossil oceanic lithosphere of the Neotethyan Vardar Ocean which closed in Paleocene times. From the west to the east, i.e. between the Pelagonian and the Serbo-Macedonian continental margins where the Vardar Ocean evolved, this zone consists of the Almopias, Paikon and Peonias subzones (Mercier, 1966). Tectonic models of a single or multiple branches of the Vardar Ocean and the development of intra-oceanic island arc systems are still debated (e.g. Ferrière et al., 2016). This study focuses on the Peonias subzone located at the Serbo-Macedonian margin, which is exposed in the Chalkidiki Peninsula of Northern Greece. There, the Guevgueli, Kassandra-Sithonia and Central Chalkidiki ophiolites constitute the Peonias subzone. Excluding the Guevgueli ophiolite, the eastern Peonias subzone is also regarded as the Circum-Rhodope belt (Kauffmann et al., 1976) that surrounds at large-scale the Serbo-Macedonian-Rhodope high-grade basement. The ophiolites of the eastern Vardar zone exposed in the Chalkidiki Peninsula were unified into the Innermost Hellenic Ophiolite Belt, which has been interpreted as an ensialic oceanic back-arc basin formed along a dextral wrench zone (Bébien et al., 1986). Here, the Kassandra and Sithonia ophiolites are studied, together with adjacent units of the Peonias subzone. The main geological units exposed along the Sithonia branch of the Chalkidiki Peninsula (Kockel et al., 1977) include: 1) the high-grade basement of the Serbo-Macedonian Massif, 2) the Upper Triassic–Middle Jurassic metasedimentary rocks (flysch) of the Melissochori Formation, 3) the Jurassic Chortiatis island arc magmatic suite, 4) the Jurassic Sithonia ophiolite, 5) the Upper Jurassic clastic and carbonate rocks, both latter units having equivalents in the Kassandra branch, and 6) the Lower Cretaceous supra-ophiolite platform type carbonates (Ivanova et al., 2015).

Structure

Magmatic structures (i.e. sheeted dykes) in the Sithona ophiolite witness for NE-trending rift axis (N54), while the transform faults and fracture zones sketch NW-SE transcurrent transtension-like propagation of the rift-spreading center at Sithonia that is consistent with a dextral wrench corridor proposed for the ophiolite origin. The Sithonia ophiolite is bounded by thrust and strike-slip shear zones of localized deformation against the Chortiatis island arc magmatic suite, which together with the Melissochori Formation, both demonstrate an internal homogeneous deformational pattern. The tectonic emplacement of the Sithonia ophiolite involved dextral ENE to SE strike-slip sense of shear and SW and NE reverse thrust sense of shear on mostly steep foliation S_1, subhorizontal lineation L_1 and associated variably inclined F_1 fold axes. These structures and kinematics are shared by Chortiatis island arc magmatic suite and the Melissochori Formation. The coexistence of strike-parallel and thrust components of displacement along discrete dextral strike-slip shear zones and internal deformation of the mentioned units is interpreted to result from a bulk dextral transpressive deformation regime developed in greenschist-facies conditions (Bonev, Filipov, 2018).

Geochemistry

The Sithonia ophiolite presents a nearly 2 km thick intrusive-extrusive crustal section (i.e. gabbros, sheeted dykes, pillow lavas and massive lavas), while pillow lavas and massive lavas of thin extrusive section are exposed in the Kassandra ophiolite. The low-K and low-to-moderate Ti tholeiitic mafic-intermediate members (minor acid differentiates) in the crustal section of the Kassandra-Sithonia ophiolites have N- and E-MORB signatures compatible with an origin in a back-arc spreading center (Bonev et al., 2015). The MORB mantle source has received subduction zone input as revealed by LILE and LREE enrichment. A diorite from the Gerakini complex presumably belonging to the Central Chalkidiki ophiolites shows more enriched HFSE and REE patterns relative to MORB and Na-rich character compared to the Kassandra-Sithonia ophiolites. Same composition to the Gerakini diorite is revealed also by a small lenticular granodiorite body further south at Sithonia branch, implying they both exhibits chemical similarity to the Chortiatis island arc magmatic suite instead of an affinity to the Central Chalkidiki ophiolites.

U-Pb LA-ICPMS zircon geochronology

The Sithonia ophiolite crystallization spans from 159 to149 Ma as revealed by gabbro and a late rhyolite cross-cutting the pillow lavas, respectively, while a microgabbroic dyke revealed younger ages of 145 Ma and 140 Ma. An andesite dyke of the Kassandra ophiolite has imprecise crystallization age around 136 Ma. The Chortiatis island arc magmatic suite Gerakini diorite crystallized at 173 Ma, and the granodiorite in the same unit has crystallization age of 160 Ma. Thus, a Late Jurassic ca.10 Ma lasting igneous accretion of the Kassandra-Sithonia back-arc crust within the Eastern Vardar zone is well-constrained, and corroborated by Berriasian–lower Valanginian supra-ophiolite cover limestones (Ivanova et al., 2015). The Gerakini diorite predates the Sithonia ophiolite in which the Chortiatis arc suite supplied Middle Jurassic inherited zircons.

Discussion

The Chortiatis arc compared with arc-related Evros ophiolites of the Circum-Rhodope belt in Thrace region shows the same 173–160 Ma life span and tectonic setting, implying the extension of the arc systems across the North Aegean region. Based on new temporal constraints, a tectonic scenario of Jurassic subduction settings and arc/back-arc systems development and ophiolite formation in the Maliac and Vardar oceanic basins is proposed that also accounts for Late Jurassic–Early Cretaceous continental magmatism in the Serbo-Macedonian-Rhodope margin.

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