MESOZOIC OPHIOLITE BELTS OF
THE NORTHERN PART OF
THE BALKAN PENINSULA

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MAIN CHARACTERISTICS OF OPIOLITIC COMPLEXES WITHIN THE EASTERN BRANCH OF THE VARDAR ZONE COMPOSITE TERRANE IN SERBIA

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Ophiolitic complexes of the central axis of the Balkan Peninsula occur as the Vardar Zone (VZ) and Dinaridic ophiolitic belt (DOB), which had different development. Moreover, within the Vardar zone Karamata et al. (1999) separated three parts: the Main Vardar Zone in the east, the Kopaonik block and ridge unit and the western belt of the VZ. Petrological and geochemical characteristics of the ophiolite-related rocks occurring in these units indicate that the unites had different evolution during the closure of the ancient Vardar ocean. This study focuses on the ophiolite-related rocks of the Eastern Vardar Zone.

The eastern branch of the Vardar Zone composite terrane - EBVZCT (Karamata et al. 1994, Resimić-Šarić et al. 2000) is a suture zone of the part of the Vardar ocean, which closed during Jurassic. The main characteristics of the EBVZCT ophiolites are: predomination of igneous members of ophiolites with rare outcrops of peridotites, presence of granoids and intermediate to acid volcanics and Upper Jurassic over-step sequence. A more detailed comparison between the eastern and western branch is described in Karamata et al. (2000), Resimić-Šarić et al. (2000) and Resimić-Šarić et al. (2005).

The EBVZCT ophiolites in Serbia are developed along a N-S striking zone, from the exposures of the Mt. Avala serpentinites (near Belgrade) through the ophiolitic complex of Ždraljica (ŽOC) near Kragujevac up to Kuršumlija ophiolites in south Serbia. The EBVZCT continuation can be followed further to the south in F.Y.R.O.M. (e.g. Ivanovski, 1970) and Greece (e.g. Bébien et al., 1987). Northwards, this zone is represented by the Mures ophiolites in the Apuseni Mountains in Romania (Zacher & Lupu, 1998 and references therein). The main characteristics of the EBVZCT ophiolites will be shown on the example of the ŽOC which is temporarily the most investigated ophiolite complex from the EBVZCT in Serbia.

The ŽOC is built of both tholeiitic and calc-alkaline suites. The tholeiitic suite is predominantly represented by gabbros and diabases. Some rare occurrences of basalts, cummutilitic gabbros, cummutilitic wehrlites and plagiogranites are also found. The deepest part of the complex is represented by serpentinized cummutilitic wehrlites, which developed as rare pods and layers within gabbros. The gabbros are exposed as irregular blocks or sheets of massive and cummutilitic facies. Diabases occur as single dykes or dyke-swarms intruding gabbros or as irregular massive bodies. Basalts mainly appear as pillow lavas and primary and redeposited hyaloclastites. All these rocks show similar mineral composition: plagioclase and clinopyroxene (diopside or augite) and olivine (in peridotites and rare olivine gabbros) are main phases, while accessories are magnetite, sphene and apatite. The whole complex is metamorphosed under the conditions of ocean floor to greenshist facies. Plagiogranites occur as small dyke- or sill-like intrusions and irregular bodies within diabases and fine-grained gabbros. They are composed by albite and quartz,
accessories are magnesiohornblende, magnetite and apatite, while epidote/zoisite and chlorite are secondary products.

The geochemical data are published by Resimić (2000) and Resimić-Šarić et al. (2004), who recognized a tholeiitic affinity of these rocks. Relatively uniform Zr/Y (around 2.5) and Ti/Y (around 240) ratios suggest a MORB character (Saunders & Turney, 1984). However, on V vs. Ti (Shervais, 1982) and Nb*2-Zr/4-Y (Meshede, 1986) diagrams these rocks occupy both MORB and VAB fields. This feature is compatible with the plots based on clinopyroxene chemical compositions, such as Ti+Cr vs. Ca (Letterier et al., 1982) and F, vs. F2 (Nisbet & Pearce, 1977) diagrams. On most variation diagrams plagiogranites plot in the continuation of the trends displayed by the basic rocks. It indicates that they are the most evolved members of this suite. According to (Y+Nb) vs. Rb and Y vs. Nb (Pearce et al., 1984) discrimination diagrams they show an ORG affinity. Geochemical modelling suggests that the most primitive rocks of the tholeiitic suite could have originated from 10-15% non-modal batch melting of a spinel-herzolite (Opx20.5Cpx18.5Sp25.5) source (Resimić-Šarić et al., 2004). The most important process of magma modification was fractional crystallization (F=0.6), with the fractionating assemblage:

\[ P_{52.5}^{\text{Cpx}_{25.5}}O_{26.5}^{\text{Ol}_{25.5}}\text{Ti}_{26.5}^{\text{Ap}_{25.5}}\text{Mg}_{16.5}. \]

The calc-alkaline suite is composed of intermediate and acid members, mostly intrusives - leucocratic granodiorites and granites and rare quartz diorites and quartz monzodiorites, within the ŽOC and granitoids, and acid volcanics - dacites and quartz keratophyres - within the Kuršumija ophiolitic complex. These rocks intrude the gabbro-diabase complex. The main minerals are quartz, orthoclase, plagioclase, rare biotite, muscovite and hornblende. Accessories are zircon, apatite, rare sphene and magnetite. Secondary phases are albite, sericite, epidote, chlorite. Detailed investigation of this suite is in progress.

The calc-alkaline rocks have higher LILE and higher LILE/HFSE ratios in comparison to tholeiitic plagiogranites. The leucocratic granodiorites and granites, which are similar in composition and geotectonic setting to granitoids of Furka in F.Y.R.O.M (Šoptrajanova, 1967) and Fanos in Greece (Christofides et al., 1990), are mostly peraluminous. On trace element discrimination diagrams they show syn- to post-collisional character (Harris et al., 1986, Pearce et al., 1984). However, rare occurrences of quartz diorites and quartz monzodiorites are metaluminous and are more akin to VA-granitoids implying a pre-collisional geotectonic setting.

K/Ar age determinations were done for a set of whole rock samples and mineral separates from both suites. Amphibole from a calc-alkaline quartz diorite sample revealed the oldest age of 168.4 ± 6.7 Ma (sample V-306/7), which can be considered as the age of intrusion of the quartz diorite magma. The emplacement of the ophiolitic complexes is evidenced from geological data – both ŽOC and KOC are associated with a Middle/Upper Jurassic diabase-chert formation (Marković et al., 1968, Dolić et al., 1981), while the overstep sequence is represented by Tithonian limestones and Lower Cretaceous paraffysisch (Marković et al., 1968; Dolić et al., 1981). Furthermore, the age determinations of the Fanos granite (148 ± 3 Ma - K/Ar on biotite; Spray et al., 1984 and 150 ± 2 Ma - K/Ar, Rb/Sr on biotite; Borsi et al., 1966, 158 ± 1 Ma, SHRIMP data on zircons, Anders et al., 2005), which is compositionally similar to the leucocratic granitoids of Ždraľjica, indicate that a syn- to post-collisional magmatic phase followed the emplacement of ophiolites.

Although all available data at the moment do not give unambiguous solution, some conclusions could be summarized:

- The ophiolitic complex of Ždraľjica belongs to the eastern branch of the Vardar Zone composite terrane.
- Geochemical characteristics of the basic members sugest both tholeiitic MOR and/or VA-affinity. Intermediate and acid members are calc-alkaline, metaluminous (quartz diorite) pre-collisional as well as peraluminous (leucocratic granites and
granodiorites) syn- to post-collisional. The presence of VA-granitoids could indicate that some parts of the ZOC are relics of an immature island arc.
- The emplacement of the ZOC occurred during Middle/Upper Jurassic.

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References


