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MESOZOIC ROMANIAN OPHIOLITES: THEIR SIGNIFICANCE IN UNRAVELLING PALEOGEOGRAPHY AND TECTONIC HISTORY

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Ophiolites and related rocks are important indicators in deciphering paleogeography and tectonic evolution of crustal segments. Despite a large variability and overlap in their lithological appearance, petrology and geochemistry it is generally possible to assign individual ophiolite bodies and similar rocks to certain geotectonic environments such as MOR, SSZ or intraplate environments.

Apart from older, pre-Mesozoic ophiolites, Romania is particularly rich in Mesozoic – predominantly Triassic-Jurassic – ophiolites, which occur in a number of different tectonic units. These include:

(1) the Laramian Mures Nappe of the Southern Apuseni Mts. (SAM) including the Austrian Bedeleu and Trascau nappes
(2) the basement of the Transylvanian Depression (TD)
(3) the south-eastern most end of the Pieniny Klippen Belt (PKB), which is often believed of South Penninic origin
(4) the Transylvanian nappes (TN) in the Eastern Carpathians
(5) the Severin Nappe (SN) in the Southern Carpathians
(6) The Ceahlau – Black Flysch Nappes in the Eastern Carpathians.

The most complete and best preserved ophiolites occur in the Mures Nappe of the SAM. They contain ultramafic and mafic cumulates, gabbros, sheeted dikes and basalts, but no mantle tectonites. The basalts, rarely basaltic andesites and even andesites, display mainly a MOR geochemistry with a high amount of Fe-Ti gabbros and Fe-Ti basalts. (Savu, 1982a; Nicolae, 1995; Saccani et al., 2001). Nevertheless, transitional compositions from MORB to SSZ and intraplate basalts occur.

The ophiolites are overlain and intruded respectively by an island arc plutonic (?) and volcanic sequence (Nicolae, 1995; Bortolotti et al., 2002), which is widely distributed in the eastern part of the SAM (Trascau Mts.). The volcanic rocks range from basalts to rhyolites forming dikes, massive lava flows and pillow lavas. Volcaniclastics are common. By contrast to the ophiolites, they exhibit clear signs of a SSZ genesis with low content of HFSE, a negative Nb anomaly and enrichment of LREE over the HREE. They are in turn overlain by thin radiolarite beds and upper Jurassic limestones.

Palaeontological evidence and K-Ar as well as U-Pb data indicate a Middle to Late Jurassic age of the formation of the ophiolites and the island arc sequence (Nicolae 1995, Pana et al. 2002). However, according to Cioflica & Nicolae (1981) the magmatic activity could extend into the Early Cretaceous. To what extent granites, granodiorites and diorites represent the plutonic part of the island arc sequence or are alternatively independent Jurassic intrusions, remains a matter of debate.

The Transylvanian Depression was drilled by a large number of boreholes, from which some reached the pre-Cretaceous basement and consequently basaltic rocks. In particular the deep

well Deleni 6042 and Zoreni 1 drilled each several hundred metres of basaltic and andesitic rocks. The Deleni borehole drill cores form approximately 10% of the whole length of the basalt drilling, i.e. approximately 40m drill cores. The basalts and andesites from the drill cores can be grouped in three petrographic and geochemical entities. All of them, despite small geochemical differences, resemble strongly the basalts and andesites on top of the ophiolites of the SAM and the Trascau Mts. (Ionescu and Hoeck, 2004). From the drill-hole Zoreni 1 a few core remnants are available for investigation. They show boninitic affinities with high SiO_2 and MgO, Cr and Ni but low to very low Ti, Zr, Y and Sm. The REE are depleted, the chondrite normalised pattern is slightly U shaped. All these features highlight the suprasubduction zone character of these rocks.

In particular, the Fe-Ti gabbros and basalts of the ophiolites in the western part of the SAM are associated with a strong positive magnetic anomaly (Besutiu et al., 2004). Such an anomaly is also widespread in the TD. This indicates a continuation of the Fe-Ti rich ophiolites towards the east beneath the TD. They are probably positioned too deep to be drilled, but might in turn be overlain – as in the Apuseni Mountains, by the island arc sequence, which was actually drilled in several boreholes. Thus, the ophiolites and the overlaying island arc lavas can be traced from the Mures valley near Lipova (30km E of Arad) across the TD till approximately 50km ENE Cluj, where the magnetic anomaly terminates.

Only few km further north are the south-eastern most remnants of the PKB exposed near Poiana Botizii. Otherwise rare in the PKB, they contain poorly preserved small layers of basic volcanics and basaltic pebbles in a light grey limestone (Aptychus Limestone) according to Bombita and Savu (1986). In the absence of any analytical data little can be inferred on the provenance of these volcanics.

In the Eastern Carpathians (EC) basalts and ultramafics are found in the Transylvanian nappes (TN) in the tectonic highest position above the Bucovinian nappes (Sandulescu and Russo-Sandulescu, 1981). The major occurrences are Rarau, Haghimas and Persani. They occur partly as olistholites, partly as tectonic slivers. Their age is debatable. At least a large part is Triassic in age, inferred from the close connection to mid-Triassic sediments. By contrast to the Apuseni ophiolites and the Island arc volcanics, the available geochemical analyses (Russo-Sandulescu et al., 1982) from the Haghimas volcanics indicate enriched, rifting(?) basalts. In Rarau they are also enriched but show a transition to MOR type basalts. The ultramafics are predominantly serpentinized lherzolites. From Persani no data are available so far.

The Severin Nappe is sandwiched between the Danubian unit below, and the Getic nappes above contain Mesozoic ophiolites in the Southern Carpathians. They are believed to be Jurassic in age and consist of serpentinized peridotes (mainly lherzolites), rare gabbros and basalts (Savu, 1982b). The latter display geochemically a MOR characteristic and are accompanied by enriched intraplate basalts. In this respect the Severin Nappe ophiolites resemble those from Rarau in the TN, notwithstanding the different tectonic position. The ophiolites from the Severin Nappe are thought to find a continuation in the Ceahlau and Black Flysch Nappes in the Eastern Carpathians. There, blocks of ophiolitic material are found embedded in coarse grained clastic sediments of Late Jurassic and Cretaceous age. Larger, mappable units occur in the N of Romania and in the Ukraine in the continuation of the Ceahlau – Black Flysch units. The Severin - Ceahlau ophiolites are thought to be remnants of an intracontinental oceanic basin within the European margin.

The Apuseni ophiolites, the island arc volcanics west and within the TD the ophiolites from the Transylvanian Nappe and from the PKB(?) are believed to come from a single large oceanic domain, the Neotethys, but represent different portions of the ocean (Sandulescu, 1984). For the basalts from the PKB there are not data available yet for a clear assignment. Regarding the TN basalts and ultramafics, their chemistry and also their in part probable Triassic age are not in favour of a single oceanic source for the basalts and ophiolites from the SAM, the TD, the TN and the PKB. It is more likely, based on available data that the SAM ophiolites and the island arc sequence are a continuation of the Vardar Ocean, which terminates at the northern end of the TD. The "ophiolites" of the TN represent at least partly, a possibly Triassic independent oceanic realm. The possible relation to the Meliata Ocean still remains a matter of discussion.

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