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MESOZOIC VOLCANISM ASSOCIATED WITH TRIPLE-JUNCTION ZONE OF THE EASTERN CARPATHIANS (UKRAINE)

Abstract: Jurassic volcanic rock series present sequence of tholeitic – calc-alkaline – alkaline composition. Very probably the rocks are cogenetic and related to subduction environment. The published data on their geochemistry comprises major element concentrations. The rough information on trace elements doesn't allow concluding on the origin and evolution of the melts leading to the sequence formation.
Keywords: volcanism, tholeitic – calc-alkaline – alkaline series, subduction, arc island, hot spot, major elements.

INTRODUCTION

The presumable triple-junction zone follows the Pieniny Klippen Belt-Magura basin (first arm), Silesian (second one) and its extension into the Rahiv-Sinaia zone (third one). Jurassic-Cretaceous volcanism is associated with the zone and might be related to major plate reorganization taking place during the Tithonian time (Golonka et al. 2003, Krobicki et al. 2004). The new Atlantic spreading entered the area between the New Foundland shelf and Iberia. The closure of the Meliata-Halstatt Ocean is related to the cessation of spreading in Atlantic Tethys. The Jurassic Alpine Tethys system was abandoned. The change was accompanied by the presumed origination of subduction zone along the margin of Pieniny Klippen Belt Basin. The age, character and polarity of the presumed subduction are not fully explained. We were assuming the southern dipping of the subduction and its location under the southern margin of the Pieniny Klippen Belt Basin. The northern dipping of the subduction and its location under the northern margin of the Pieniny Klippen Belt Basin is also possible.

JURASSIC VOLCANISM – CURRENT STATE OF RECOGNITION AND INTERPRETATION

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Mafic rocks occurring in the East-Carpathian area have been subject of a number of research work done by Ukrainian geologist. Data presented in the publications are limited. A complete and thorough set of analytics of the rocks is deficient. The conclusions are based mainly on major elements and on some selected trace elements variation diagrams. Information about concentration of some trace elements, important for reconstruction of geotectonic event and for magma evolution, is lacking or not published. The isotopic data are not known and not done for all of the volcanic sequences. The Mesozoic volcanic sequences are known from the Chivchin – Rahiv ridge, Uglia, from the Trostianets and Vulhovchik stream troughs, Trans-Carpathian depression (Lomize 1968, Lashkevitsch et al. 1995, Varitchev 1997, Medvedev, Varitchev 2000). Petrography of the volcanic series has been elaborated. The rocks are: from Trans-Carpathian depression (1) – basalts, diabases, picritic tuffs, Uglia (2) – diabases, blocks of ultramafic rocks (lherzolites); Rahiv-Chivchin (3) – basalts; Trostianets (4) - basalts, andesites, trachytes; Vulhovchik (5) – trachydolerites.

The differences in major elements concentrations, the transition trace elements as well as from LILE (trace elements concentrations not published) make possible to discriminate subalkalic tholeitic rocks with similar to MORB pattern (1, 2, 3), which are interpreted as part of ophiolitic sequence (Varitchev 1997; Medvedev, Varitchev 2000), tuffs (1) interpreted as product of an early stage of continental crust destruction, basalts related to continental rift (4), alkalic rocks (5) linked to continental block located between two ocean troughs. Today the Ukrainian Mesozoic volcanics ore located in the relatively small area. This fact as well as similar timing of volcanic events could raise some doubts about the possibility of the existence of so many different geotectonic settings Furthermore the geochemistry points rather to a number of similarities between the sequences (e.g. enrichment in LILE), which in turn are interpreted as factor diversified the origin of the sequences (Varitchev 1995, 1997; Medvedev, Varitchev 2000).

The investigated area, however, represented a rather vast and quite diversified paleogeographic realm during the Jurassic – Early Cretaceous time (Fig. 1). Acccording to Lewandowski et al. (2003) paleomagnetic data from the Ukrainian part of the Pieniny Klippen Belt indicates very fast Jurassic spreading moving tectonic elements hundreds kilometers off European platform. The Jurassic Pieniny Klippen Belt basin constitutes an extention of the Penninic truly oceanic realm (Golonka et al. 2003, Golonka 2004) while the Rahiv-Sinaia zone developed as a rift turning into backarc basin. The Marmarosh Massif represents a continental block between two basins or the arc between Rahiv backarc and Pieniny ocean. During Cretaceous-Cenozoic tectonic process significant shortening took place producing nappes of the present-day Eastern Carpathians.

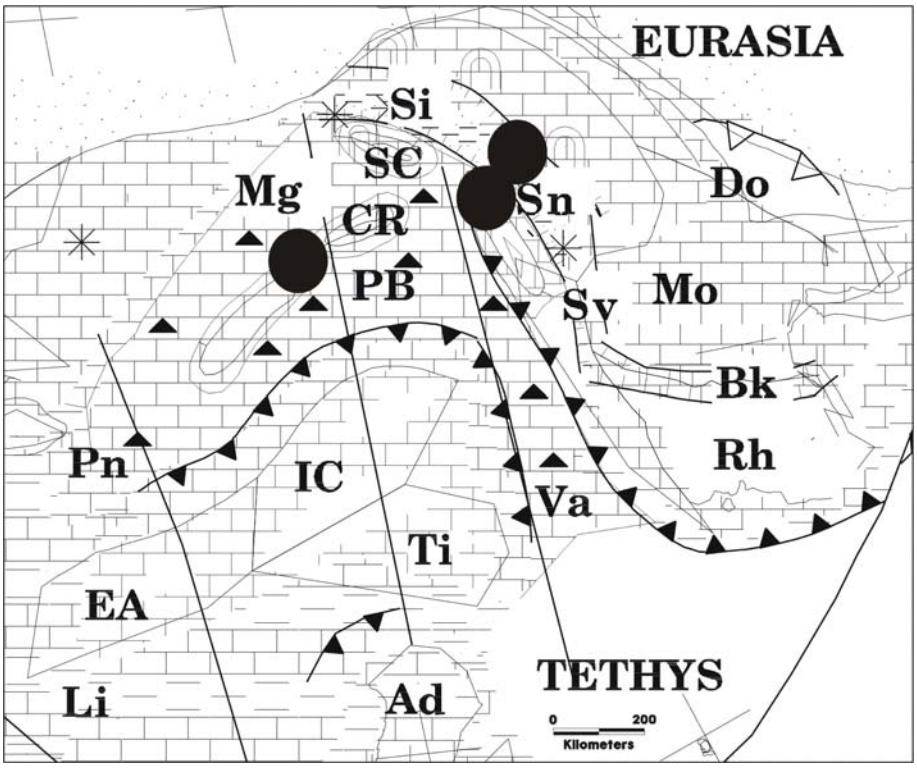

Fig. 1. Palaeogeography of the circum-Carpathian area during latest Late Jurassic–earliest Early Cretaceous; plates position at 140 Ma. According to Golonka et al., (2003). Modified. Large black dotes depicting the paleogeographic positions of the described .Abbreviations of oceans and plates names: Ad – Adria (Apulia), Bk – Balkan rift, CR – Czorsztyn Ridge, Do – Dobrogea, EA – Eastern Alps, IC – Inner Carpathians, Mg – Magura Basin, Mo – Moesia plate, PB – Pieniny Klippen Belt Basin, Pn – Penninic Ocean, Rh – Rhodopes, SC – Silesian Ridge (Cordillera), Si – Silesian Basin, Sn –Sinaia Basin, Sv – Severin Basin, Ti – Tisa plate, Va – Vardar Ocean.

MAJOR ELEMENTS GEOCHEMISTRY

Over ninety analyses (major elements) from outcrops within all volcanic areas have been published (Lashkevitsch et al. 1995). We arranged the data using two differentiation indexes: SiO_2 and Mg number defined as Mg/(Mg+Fe). The most informative for the melts evolutions have been presented below (Fig. 2). The scatter of the data within some single series is rather big. Despite of it, all the igneous rock series seem to be cogenetic, but lherzolites. Ultramafic rocks only on some of the diagrams form consistent trend with the volcanic rock suites. The composition of the volcanic rock suites changes from tholeitic, through calc-alkaline, till alkaline (plot alkalis vs silica). On the AFM diagram (not shown) the data plot along TH/CA line. The rocks are sodium rich. Using K_2O vs SiO_2 four subdivisions could be recognised: low K, calc-alkaline, high K calc-alkaline and shoshonitic.

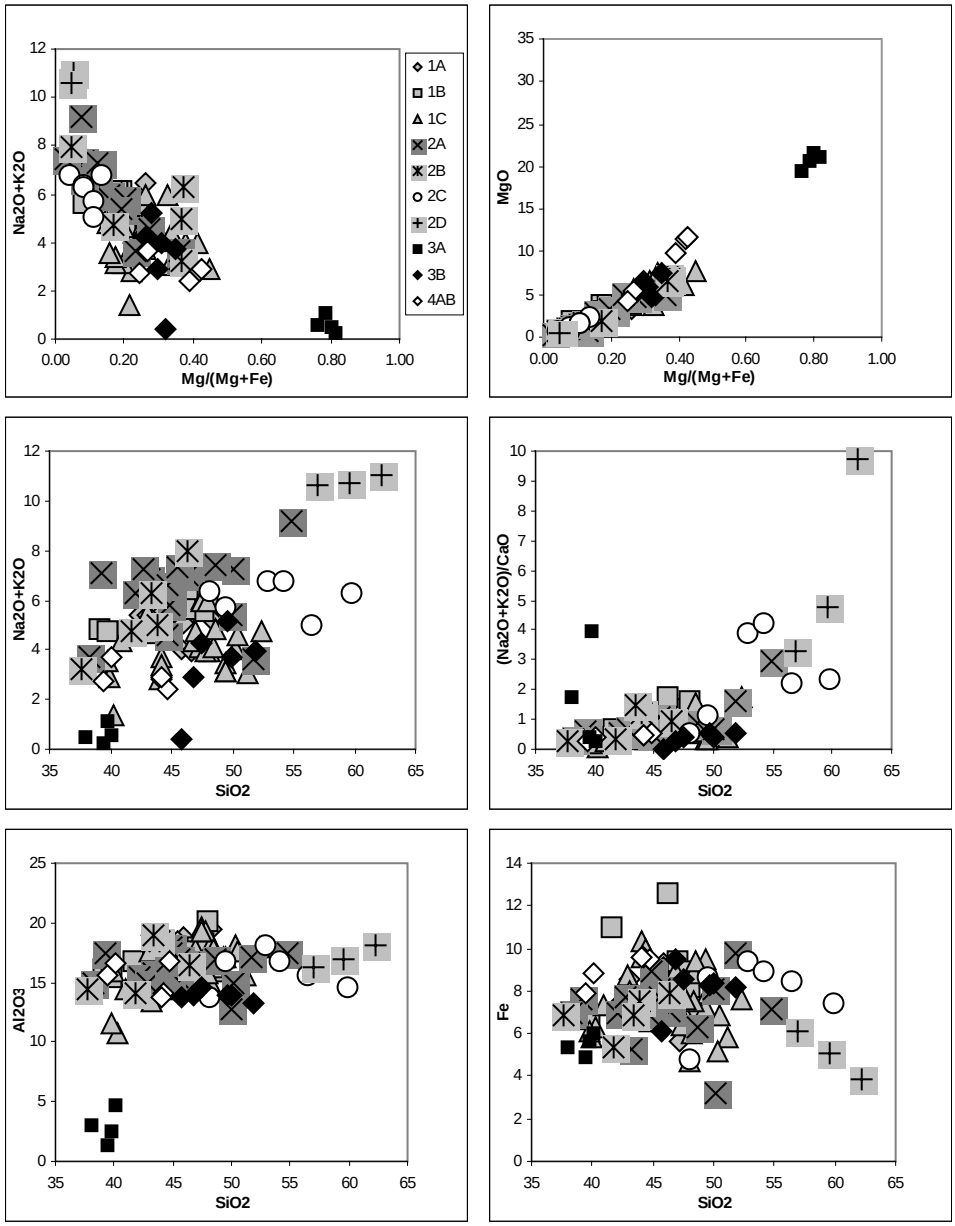

Fig. 2. Plot of major element concentration vs melts differentiation indexes. Explanations: Chivchin – Rahiv ridge 1A - plagiobasalts, 1B - metaplagiobasalts, 1C - diabase, Trostianets 2A - basalts, 2B – clast-basalts, 2C - andesites, 2D - trachites, Uglia 3A – ultramafic rocks (lherzolite), 3B - diabase, Trans-Carpathian depression 4AB - basalts, diabases, picritic tuffs (rock description after Lashkevitsch et al. 1995).

Mostly the mafic rocks are alumina-rich. Iron and titanium (not shown) display incompatible behaviour (enrichment) at the very beginning of differentiation. The Fe-Ti phases crystallization seems to be suppressed. The trend changes with differentiation progress (rapid elements depletion).

CONCLUSIONS

The limited amount of data, especially lack of trace elements concentrations prevents any more precisely concluding about melts origin and evolution leading to the rock series formation. Varitchev (1997) short conference paper points to trace elements pattern specific for MORB, subduction and continental rift settings. Part of the volcanic series he interprets as ophiolitic complex. Lherzolites being not cogenetic with the suites are an argument against the later hypothesis. Major elements data and rough information about trace elements (LILE enrichment in most of the rock suites) allow correlating the whole sequence with progressively evolved subduction (very probably island arc) environment (TH-CA-A trend). The rock sequences follow also paths typical for OIB environment. It could point to hot spot activity within area. Today, the Levantine (e.g. Dead Sea) hot spot volcanics and Northern Aegean volcanics are located at the same latitude and longitude as the Eastern Carpthan latest Jurassic Earliest Cretaceous basalts (Golonka 2004). The scantiness in the data doesn't allow concluding, whether some of the series could be related to back arc (for instance those reported by Varitchev op.cit. as MORB type).

The published data permit formulating many questions. No one of them could be answered successfully without additional research work concentrated on precise evidence of geochemistry of the rocks.

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