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GEOTECTONIC POSITION OF THE SO-CALLED "PIENINY MTS. ANDESITES"

Abstract: The geotectonic setting and *en echelon* position of the dykes array of the Pieniny Mts. andesites is related to the NW-SE dextral shear zone called the Dunajec Fault. This deep, mantle rooted tectonic zone is in coincidence with the SE continuation of the Kraków-Myszków tectonic zone being the contact of the Upper Silesian and Małopolska Blocks.

Keywords: andesites, deep fault zone, Outer Carpathians, Pieniny Klippen Belt

INTRODUCTION

Till present, andesites occurring in the vicinity of Szczawnica, due to their location as well as origin have been related with the Pieniny Klippen Belt (PKB). This resulted by distinguishing the so-called Grajcarek Unit by Birkenmajer (1979), comprising deposits formed in the Magura Basin northwards of the Czorsztyn Basin, which during the Laramian phase had retro-arc thrusting on the PKB. According to this concept, the Klippen units should lie below the Grajcarek Unit. Structural analysis of the PKB in the Małe Pieniny Mts. shows that in fact the Klippen Units are overthrusted on the Magura Unit (Jurewicz 1997). As a result, the Grajcarek Unit is incorporated in the Magura Unit and the northern boundary of the PKB should be moved to the south, to the contact with the Klippen units. Andesites from the Grajcarek Unit, assigned by Birkenmajer (1979) to the PKB thus belong solely to the Magura Unit.

Andesite volcanism of the area, K-Ar dated at 12.5-10.8 Ma (Birkenmajer, Pécskay 1999), has been linked with the so-called Pieniny Andesite Line (PAL), running WNW-ESE, sub-parallel to the PKB and joining the Odra fault (Birkenmajer *et al.* 1987, Birkenmajer 2003). After Birkenmajer, Pécskay (1999) the andesites are considered to be the products of hybridisation of primary mantle-derived magma during its ascent along tension fissures that opened in the down-going slab of the North-European Plate.

This paper is focused on showing the relation of the andesitic dykes to a deep fracture zone in the basement, which in the case of the Outer Carpathians is the down-going North-European Plate.

GEOTECTONIC POSITION OF THE PIENINY MTS. ANDESITES

Field investigations and analysis of geophysical data show that the andesitic dykes can be connected with a deep fault zone called the Dunajec Fault. Fragment of this fault was described by Birkenmajer (1979) as a right strike-slip fault shifting the northern margin of

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the PKB in the eastern side by ca. 700 m south-eastwards. The SE continuation of this deep fault zone could be recognized in the vicinity of Ružbachy where is marked of travertine. – Northward of the PKB, this fault could be responsible for the disturbance in the course of izobathes of the Magura Nappe overthrust, well-visible on the map of Oszczypko-Clowes, Oszczypko (2004). Eastwards from the Dunajec Fault, the Magura Nappe is thicker (*op.cit.*), whereas to the west an elevation of some older structures can be observed in the Szczawa tectonic window (the Grybów Unit beneath the Magura Nappe). A similar situation is in the southern prolongation of the Dunajec Fault, where the Ružbachy slice emerges from under the Central Carpathian Palaeogene. This fault can be correlated with the NW-SE oriented, multiple activated Kraków-Myszków strike-slip zone, which separates the Małopolska and the Upper Silesian Blocks and which could be a part of a larger one – Szczecin-Kraków-Prešov fault zone (Żaba 1996, Buła *et al.* 1997). The strong mantle helium signature documented in mineral waters, e.g. in the vicinity of Szczawnica by Leśniak *et al.* (1997) could be connected with this zone.

Fig 1. Deep fault zones in the vicinity of Szczawnica and their relation to andesite occurrences at Wżar Mt and Bryjarka Mt, northwards of Pieniny Klippen Belt.

The chemical composition of the Pieniny Mts. andesites has been compared with the chemical composition of calc-alkaline rocks, numerously occurring within the Carpathians. The comparison has been based on chemical composition of 12 samples of the Pieniny Mts. andesites analysed in Acme Analytical Laboratories Ltd., and on literature data (Pin *et al.* 2004, Seghedi *et al.* 2004). The systematic position of the Pieniny andesites changes from Al-rich basalts, through basaltic andesites to andesites (op. cit.), therefore for comparison with the Pannonian Basin area only calc-alkaline rocks with the composition changing from andesitic basalts to andesites have been selected (Seghedi *et al.* 2004).

The carried out analysis documents the large similarity of the chemical composition of andesites from both areas in relation to the main as well as trace elements (Fig. 2). On discrimination diagrams (Wood 1980, Meschede 1986), used for determining the geotectonic environment of andesite formation, both andesites lie in the same fields.

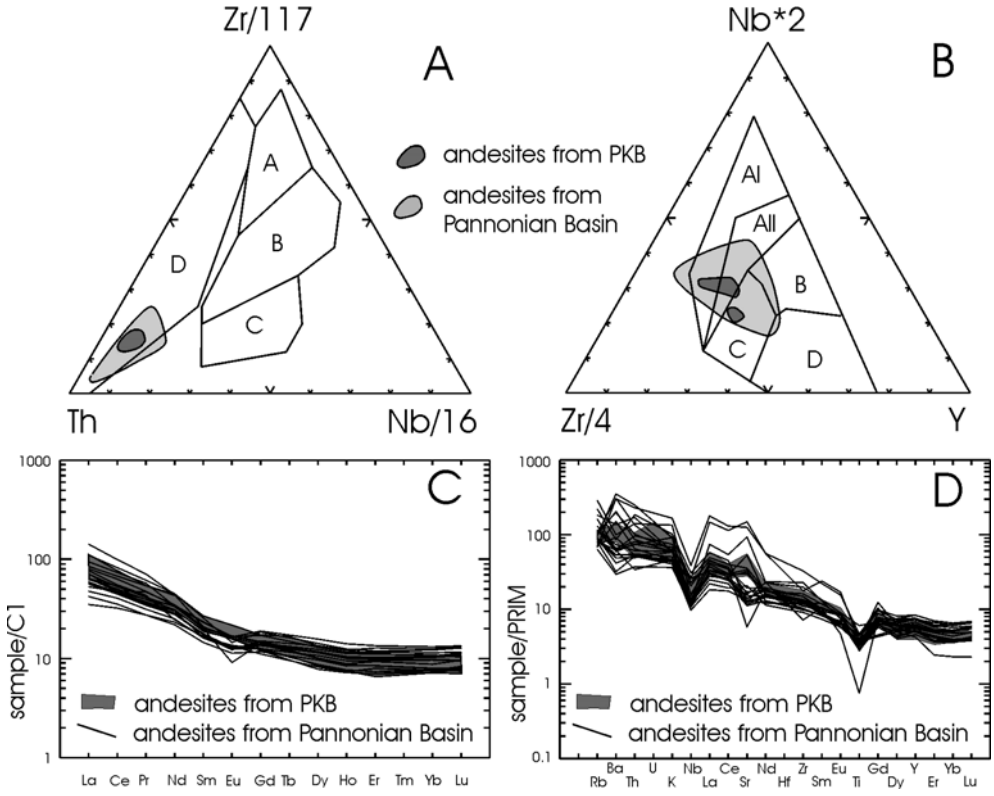

Fig 2. Chemistry of calc-alcaline rocks (andesites, basaltic andesites) from PKB (Pieniny) and Pannonian Basin. Chemical data covered in the data set include, 12 analyses of the Pieniny Mts. andesites performed in ACME, 6 analyses of andesites form PKB and 21 analyses of the Pannonian Basin andesites from Pin *et al.* (2004) and Seghedi *et al.* (2004), respectively. **A** - Th-Zr-Nb discrimination diagram of Wood et al. (1980); **B** - Zr-Nb-Y discrimination diagram of Meschede (1986); **C** - C1 chondrite normalised REE plot for andesites from PKB and Pannonian Basin; **D** - trace element variation plot for andesites from PKB and Pannonian Basin. Normalisation values for C1 chondrite and primitive mantle (PRIM) was taken from Sun, McDonough (1989). Abbreviations for diagram of Wood (1980): A - N-type MORB, B - E-type MORB and tholeiitic WPB and differentiates, C - Alkaline WPB and differentiates, D - Destructive PMB and differentiates. Abbreviations for diagram of Meschede (1986): WPA (Al, All), WPT (All, C), P-MORB (B), N-MORB (D), VAB (C, D). WPB - within-plate basalts, PMB - plate-margin basalts, MORB mid-ocean ridge basalts, VAB - volcanic arc basalts, WPA - within plate alkaline basalts, WPT - within plate thol

The Pieniny andesites in comparison to the andesites from the Pannonian Basin are characterised by a low relation of $^{147}Sm/^{143}Nd$ isotopes (Pin *et al.* 2004), very close to their content in the upper part of the continental crust of the Carpathian basement (Mason *et al.* 1996). Pin *et al.* (2004) interpret the Pieniny Mts. andesites as a result of crystallisation of

small amounts of magma, formed due to partial melting of continental crust rocks (most probably amphibolites or magmatic calc-alkaline rocks).

Geochemically, the Pieniny Mts. andesites are most similar to andesites from the Apuseni Mts. area, from the central part of the Pannonian Basin. Andesites from both localities (Fig. 2) are characterised by distinct positive Ba and Sr anomalies, contrary to the calc-alkaline rocks linked with the marginal parts of the Inner Carpathian Mts. (Seghedi *et al.* 2004). According to the latter, the differentiation of magmatic rocks in the vicinity of the Apuseni Mts. is linked with the generation of magma from continental crust, caused by decompression along the boundary of two blocks in the basement of the Pannonian Basin (ALCAPA and TISIA), resulting from their rotation in a transtensional regime.

Typical geotectonic environments of andesite formation are subduction zones. Fluids released during dehydration of the subducted oceanic crust are responsible for intense partial melting of rocks above the subduction zone. The Pieniny Mts. andesites occur within the Magura Nappe, that is northwards from the PKB and the subduction zone linked with it. Based on the absolute age of andesites (12.5-10.8 Ma – Birkenmajer, Pécskay 1999) it can be assumed that the North-European Plate was located in this interval both in the basement of the Outer Carpathians and the PKB. This points to the post-collision character of the andesites. The geometric relation of the andesite dykes with the postulated deep fault zone (Dunajec Fault) and geochemical data (Pin *et al.* 2004) allow to link the origin of the Pieniny Mts. andesites with decompression caused by shear movement within the deep mantle rooted tectonic zone in continental crust (*op.cit.*), which can be the SE continuation of the Kraków-Myszków zone.

CONCLUSIONS

The geotectonic setting of the Pieniny Mts. andesites is related rather to deep, mantle rooted tectonic zone than to subduction processes. The dykes array has an *en echelon* position to this dextral shear zone called the Dunajec Fault. This zone might be the SE prolongation of the tectonic contact of the Upper Silesian and Małopolska Blocks (Kraków-Myszków zone).

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