CONTRIBUTION TO "MURÁŇ" ORTHOGNEISSES IN THE SOUTHERN VEPORICUM BASEMENT ROCKS (INNER WESTERN CARPATHIANS, SLOVAKIA)

M. KOVÁČIK

Geological Institute of D. Štúr, Mlynská dolina 1, 817 04 Bratislava, Slovakia; kovacik@gssr.sk

ABSTRACT: As pre-metamorphic source material of the orthogneisses is suggested a rhyolite-granite comagmatic association. This magmatism, indicating Lower Silurian age, was concurrent with pelitic-psammitic sedimentation and passed in extension tectonic regime on evolved continental crust. Most decisive metamorphic imprint, with local partial melting conditions, took place during the Hercynian regional metamorphic processes.

KEY WORDS: orthogneiss, partial melting, source material, extension, Hercynian, Veporicum Unit

Indroduction

The "Muráň" orthogneiss rock-assemblage cover about 30 km^2 and belong to the lowermost domains of the Southern Veporicum basement. Intercalations of amphibolitic rocks, biotitic gneisses and locally garnet micaschists are integrated with the predominant leucocratic orthogneisses. Original nature of the basement rocks is camouflaged by polystaged history constituted of Hercynian regional dynamo-metamorphism, effects of Carboniferous granitoid intrusions and the Cretaceous metamorphic overprint. The prevalent "Muráň" orthogneiss lithology represents light-coloured, pinkish toned rock with mostly foliated coarse-grained structure, which consists mainly of quartz, albite and usually porphyric K-feldspar. This lithotype was attributed to an older pre-kinematic period of granitic magmatism - labelled as orthogneisses (Zoubek 1932), later designated as "Muráň granite-gneisses" (Klinec 1976). On the contrary, rhyolitic protolith of these rocks was defined and the amphibolite layers were seen as concominant basaltic volcanics (Hovorka et al.1987).

Petrography and bulk-rock chemistry

Porphyric K-feldspars in the predominant orthogneiss-types reach 0.5 - 1 cm in size, whereas the porphyric plagioclases are usually smaller. Homogeneous groundmass of 0.2-0.3 mm grain-size comprise quartz and both the feldspars, too. In complicated textural relations there can be distinguished three or four plagioclase generations. General chemical composition of plagioclase is albitic, but some plagioclase generations containing 10 - 20 % An are not rare. Usually, the orthogneisses are poor in micas content, but fine greenish biotite of extreme ferruginity (e. g. M/MF = 0.15), classified as annite or Al-annite (Guidotti 1984), is rather symptomatic (Tab. 1). Muscovites are also rich in iron content and in K-mica composition diagram (Guidotti 1984) there are plotted in between the phengite and ferri-muscovite end-members. To peculiar accessoric minerals belong allanite, magnetite and tourmaline. The prevailing orthogneisses show peraluminous character and are classified to rhyolites (Fig. 1 A, B) of largely K-rich types (sensu Ewart 1979), which can be ranged to alkaline - with bias to calk-alkaline series. They also show rather higher content of silica (in Fig. 1A some points fall out of classification fields). However, from geochemical point of view, these rock may be alternativelly classified to granites as also show casual Veporicum granites plotted in these diagrammes (crosses in Fig.1).

Indicative, but not prevalent lithotype, is represented by light, non-porphyric finer-grained rocks, usually with lower amount of K-feldspar and with increase of garnet, occasionally allanite, amphibole and epidote. These rocks can be constituted from acidic volcanics or their tuffs and there are provisionally designated as leptynites (term used in descriptive sense). Their bulk-rock chemistry vary between dacite and rhyolite composition (Fig. 1 A, B). The amphibolites yield basaltic composition, which resulted in a common metamorphic assemblage amphibole, plagioclase of andezine composition and unfrequent garnet (up to 5mm in size). A fairly contrasted compositional gap, with the lack of intermediate magmatism, is for this rock-association characteristic.

Question of source-material

Concerning the protolith of "Muráň" orthogneisses the original presence of both comagmatic association - plutonic (to hypoabyssal) and volcanic rocks is proposed. Porphyric granitic shape of many orthogneisses and occasional muscovite flakes (up to 1mm) may support interpretation on the behalf of original occurrence of granitic rocks, with a certain tendency to granit porphyries. The acid volcanics ("light leptynites") are prevailingly concentrated in the upper horizons of investigated rock-assemblage. Contact selvage between the "Muráň" orthogneisses rock-assemblage and the gneissic-micaschistose hanging-wall is also characterised by increased abundance of amphibolitic bodies. Expected initial whole rock $^{87}Sr/^{86}Sr$ ratios in orthogneisses are informativelly estimated between 0.714 -0.718 (Kráľ in Kováčik et al. 2001). These isotopic data indicate age of Sr isotopic homogenization at about 420 Ma, which may suggest the time of original magmatic events. On the whole, the "Muráň" orthogneisses were derived from a well-marked crustal source-material and the primary basalts could act as heat source in generation and ascent of acid magma. This kind of magmatism might have taken place in extension tectonic regime founded on evolved continental crust. The Silurian - to Silurian/Upper Ordovician - thermal processes remobilized the pre-Hercynian (possibly the Late-Precambrian) crustal material. Similar provenience is assumed for the more or less concurrently deposited pelitic-psammitic sediments, later metamorphosed into various micaschistose and gneissic rocks.

Polystaged metamorphic history

The subsequent Hercynian tectonometamorphic structures were frequently established on original lithologic relations of the Lower Paleozoic environs. Analogously, the Alpine deformation copied a lot of the older structural inventory. The peak conditions of the Hercynian metamorphism can be related to a partial melting of rhyolitic material. In places, the ductile deformation produces leucocratic coarse-grained melt composed of K-feldspar, quartz, albite (±biotite, tourmaline), which concentrates mostly in fold closures of orthogneisses (Fig. 2). This local melting reminds haplogranitic eutectic system with solidus temperature settled at 630-650°C, either the fluid present or fluid absent melting is considered (Holtz et al. 1992 or Thompson 1982). The pressure conditions is by means of phengite composition in the system Q-Kf-Bt-Mu (Massone, Schreyer 1987) tentatively estimated on 7-8 kb (with a precaution due to a strong compositional dependence between the s.c. Tschermak substitution and the whole-rock composition, Guidotti 1984 a. o.).The Hercynian regional metamorphism of barrovian type is generally identified with the lower and middle amphibolite facies and this event constituted the most decisive metamorphic imprint in the investigated area. Local presence of coarse garnet in amphibolites also reflects the gaining of the amphibolite facies conditions. An open question stems from defining the potential recrystallization and/or metasomatic effects of Carboniferous granitoids upon the analogous leucocratic lithology of the "Muráň" orthogneisses. Only the NE termination of the studied rocks is clearly affected by intrusion of "hybrid" granitoids, which brought about migmatitization features in form of superimposed coarse augen textures in the orthogneisses. Intensive retrogressive effect upon the "Muráň" orthogneiss rock-assemblage show the Alpine regional metamorphism. Penetrative deformations and barrovian metamorphic overprint reaching about 500°C (Kováčik et al. 1996) interacted the pre-Alpine features of the investigated rocks.

REFERENCES

Ewart,A. 1979: A review of the mineralogy and chemistry of Tertiary-Recent dacitic, latitic, rhyolitic, and related salic volcanic rocks. In: Barker, F. (ed.): Tronhjemites, Dacites, and Related Rocks. Elsevier Amsterdam.13-121

Guidotti,Ch.V. 1984: Micas in metamorphic rocks. In Bailey,S.W. (ed.): Micas. Reviews in Mineralogy,13, 357-468

Holtz,F., Pichavant,M., Barbey,P. a. Johannes,W. 1992: Effects of H2O on liquidus phase relations in the haplogranite system at 2 and 5 kbar. Am. Mineral. 77, 1223-1241

Hovorka,D., Dávidová,Š., Fejdi,P., Gregorová,Z., Határ,J., Kátlovský,V., Pramuka,S. a. Spišiak,J.1987: The Muráň Gneisses of the Kohút Crystalline Complex. Acta Geol. Geogr. Univ. Comen., Bratislava, 42, 5-101

Klinec,A. 1976: Geological map 1 : 50 000 - Slovenské rudohorie - stred, Nízke Tatry - východ. (In Slovak) Publ.GÚDŠ Bratislava

Kováčik,M., Kráľ,J. a Bachlinski,R. 2001: The "Muráň" orthogneisses: contribution to tectonics, origin, metamorphism and Sr-isotopes constraint (Southern Veporicum, Western Carpathians). Slovak Geol. Mag.,7, 207-211

Kováčik,M., Kráľ,J. a. Maluski,H. 1996: Metamorphic rocks in the Southern Veporicum basement: their Alpine metamorphism and thermochronologic evolution. (In Slovak with English summary.) Miner. slovaca,28, 185-202

Le Bas,M.J., Le Maitre,R.W. a. Streckeisen,R. 1986: A chemical classification of volcanic rocks based on the total alcali - silica diagram. J. Petr.,27, 745-750

Massone, H.J., Schreyer,W. 1987: Phengite geobarometry based on the limiting assemblage with K-feldspar, phlogopite and quartz. Contrib. Min. Petr.,96, 212-224

Thompson,A.B. 1982: Dehydratation melting of pelitic rocks and the generation of H2O-undersaturated granitic liquids. Am. J. Sci.,282, 1567-1595

Winchester, J.A. a. Floyd,P.A. 1977: Geochemical discrimination of different magma series and their differentiation products using immobile elements. Chemical Geology,20, 325-343

Zoubek,V. 1932: Compte rendu préliminaire des levers géologiques sur la feuille Velká Revúca (4564). (In Czech with French summary.) Věstník SGÚ,VII, Praha

Fig.1

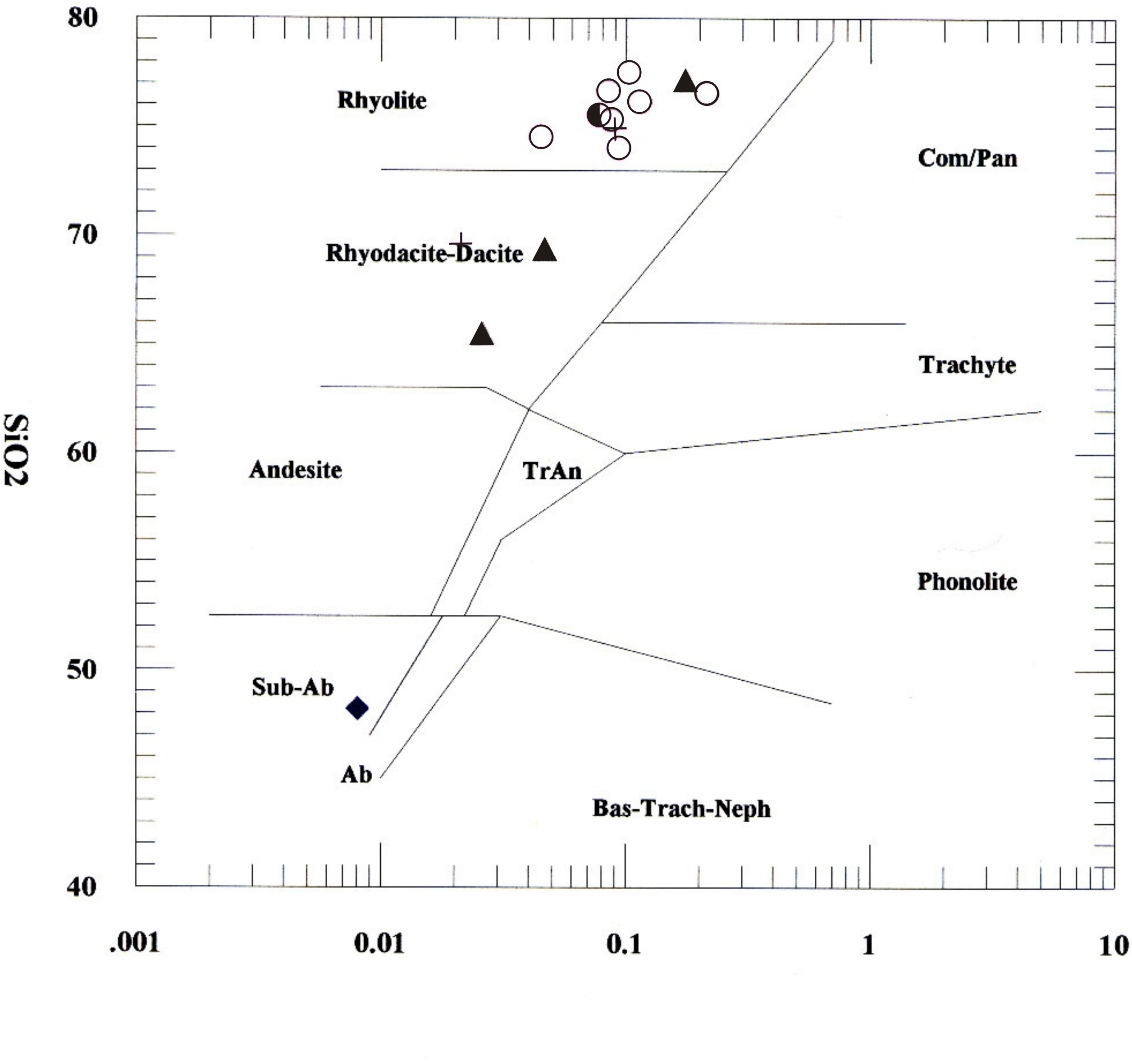
"Muráň" orthogneisses and related rocks in classification diagrammes: **A** (according to Winchester, J.A. , Floyd,P.A. 1977); **B** (Le Bas,M.J. et al. 1986); open circles - principal light coarse orthogneisses, triangles - "leptinites", full diamond - amphibolite, crosses - Veporicum granites for comparison (for further see text)

Fig.2

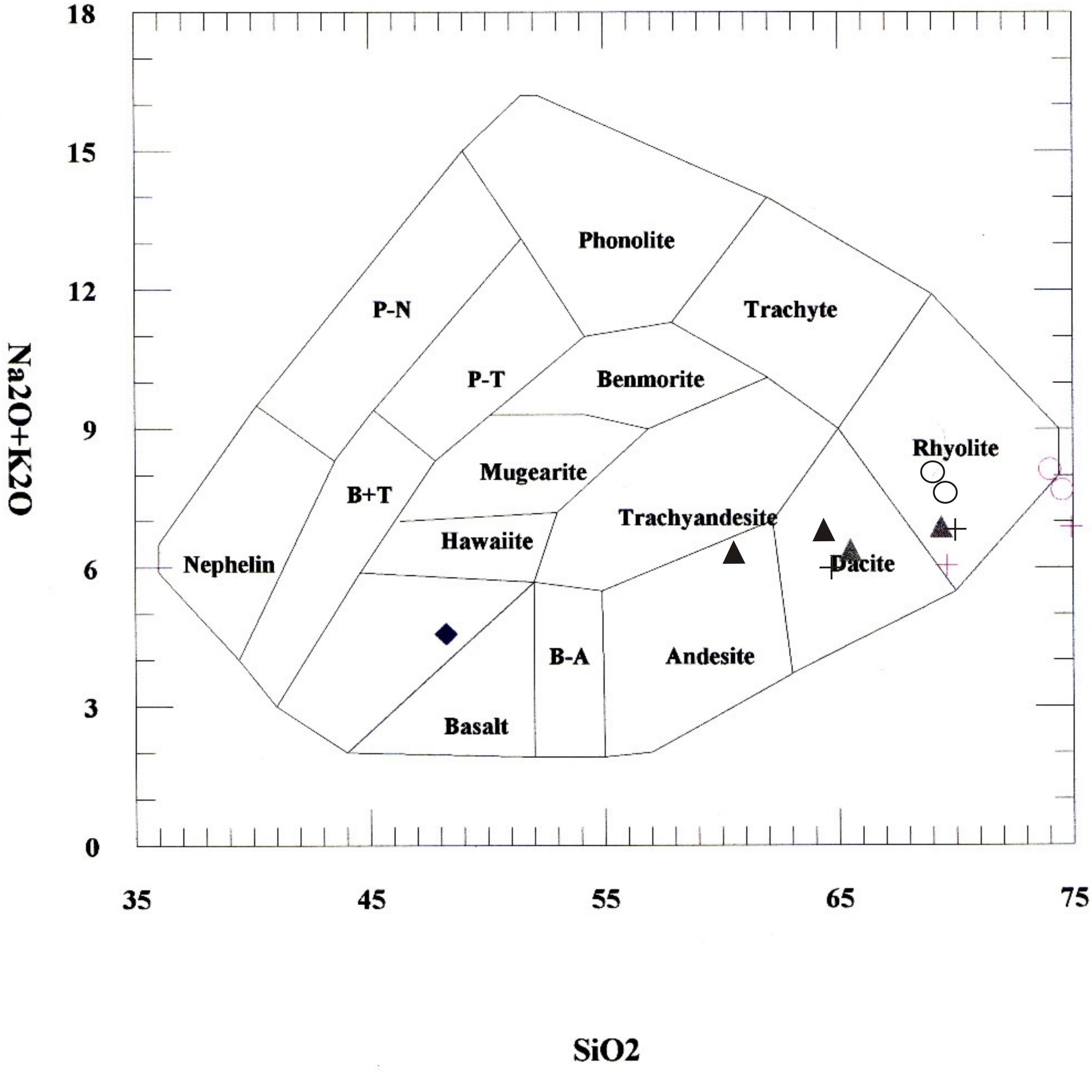
Parcial melting of foliated "Muráň" orthogneisses produces coarse-grained quartz-feldspathic veins and nests, illustrating peak conditions of the Hercynian metamorphism

Tab.1

Chemical composition of representative micas (standardized Kevex analyses) from porphyric coarse-grained "Muráň" orthogneiss



80
70
60
50
40
SiO2
Rhyolite
Rhyodacite-Dacite
Andesite
TrAn
Sub-Ab
Ab
Com/Pan
Trachyte
Phonolite
Bas-Trach-Neph
.001
0.01
0.1
1
10
Zr/TiO2*0.0001



18
15
12
9
6
3
0
Na2O+K2O
35
45
55
65
75
SiO2
Phonolite
P-N
Trachyte
P-T
Benmorite
Rhyolite
Mugearite
B+T
Trachyandesite
Hawaiite
Nephelin
Dacite
B-A
Andesite
Basalt

Tab. 1

Mineral	biotite	biotite	musc.	musc.
SiO_2	34.13	35.02	48.45	46.40
TiO_2	1.66	1.47	0.33	0.00
Al_2O_3	16.48	17.01	27.31	30.09
FeO tot	29.66	29.73	6.02	5.34
MgO	3.08	2.87	1.72	1.01
MnO	0.45	0.50	0.00	0.00
CaO	0.00	0.00	0.00	0.00
Na_2O	0.00	0.00	0.00	0.12
K_2O	9.47	9.44	10.81	10.82
Sum	94.94	96.03	94.66	93.78
	calculated on basis 22 O p. f. u.			
Si IV.	5.53	5.59	6.65	6.42
Al IV.	2.47	2.41	1.35	1.58
Al VI.	0.68	0.79	3.07	3.33
Ti VI.	0.20	0.18	0.03	0.00
Fe2+	4.02	3.97	0.69	0.62
Mn	0.06	0.07	0	0
Mg	0.74	0.68	0.35	0.21
Na	0	0	0	0.03
K	1.96	1.92	1.89	1.91
Ca	0	0	0	0
M/MF	0.156	0.146		