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The "Muráň" orthogneisses: contribution to tectonics, origin, metamorphism and Sr-isotopes constraint (Southern Veporicum, Western Carpathians)

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Abstract: The studied rocks are supposed to form the bottom part among the basement rock-complexes of the Kohút zone. The field observations revealed some preserved pre-metamorphic lithologic features which are illustrated e.g. by the gradual transition between the "Muráň" orthogneiss body and the gneiss-micaschistose material. This transitional rock pile is enriched in amphibolite and leptynite intercalations throughout almost the whole contact zone. The main Hercynian deformation structures (predominantly foliation planes) are oriented approximatelly in W - E strike, and show a similar direction as the Alpine transpressional fabric. The Alpine deformation of the basement is largely located along the pre-Alpine structural and lithological inhomogeneities. The relative strong Alpine metamorphism reached up to the boundary of the greenschist/amphibolite facies, but did not show the decisive imprint on the rocks under study. Prevailing degree of Hercynian regional metamorphism confines between the lower and the middle amphibolite facies. The peak metamorphic conditions may be identified with local partial melting of the paleorhyolites with temperature estimated at 620-650°C. The preliminary whole rock analyses of Sr isotopic composition and Rb, Sr concentrations from different rock types from "Muráň" orthogneiss rock-complex show distinct isotopic signature. Expected initial $^{87}Sr/^{86}Sr$ ratios are estimated about 0.718 for foliated biotite orthogneisses and 0.714 for porphyric orthogneisses. Strontium evolution diagram suggests different precursor of these rocks, but the time of their Sr isotope homogenisation was generally similar.

Key words: orthogneisses, Hercynian metamorphism, partial melting, Sr isotopes, Alpine overprint, Veporicum Unit

Introduction

The so-called "Muráň" orthogneisses (according to the village Muráň in the centre of their distribution) occupy about 27 km^2 within the basement rocks (Fig.1 for rough location). They are situated in the central part of the Kohút zone of the Southern Veporicum Unit (Fig.1), which, in comparison with other Tatricum and Veporicum regions, underwent the most intensive Alpine metamorphism (Zoubek 1936, Vrána 1966, Vozárová 1990). The metamorphic rock-complexes (Fig. 2) of generally accepted Lower Paleozoic age (e.g. Zoubek 1932, Klinec 1976) suffered the Hercynian regional metamorphism in metamorphic degree ranging from the upper greenschist to amphibolite facies. In many places this regional metamorphism is followed by granitisation in form of intrusive granitic veins and/or contact metamorphic effects. The fundamental mass of granitoids gives Carboniferous age by means of the Rb^{87}/Sr^{86} and U/Pb methods (compiled by Cambel et al. 1990). The predominant geological structures of the Veporicum basement rocks are considered to either Alpine (e.g. Klinec 1966) or alternatively Hercynian phase (Andrusov 1968, Bezák 1994).

The significant NE-SW trending intraveporicum fault, denoted as the Muráň line, detaches the investigated orthogneiss rock-complex and the Mesozoic of the Muráň plateau in the north-west. From the south-east the orthogneisses are roughly confined by Tisovec, Muránska Dlhá Lúka and Muránska Huta village. The characteristic rock types represent light-coloured, pinkish toned rocks with mostly foliated coarse-grained structure. This rock-complex was attributed to an older prekinematic period of granitic magmatism - labelled as orthogneisses, unlike the younger period of granitic intrusions of postkinematic nature, regarding the pre-Alpine deformational structure (Zoubek 1932). Klinec (1976) followed this view and designated these rocks as "Muráň granite-gneisses". On the other side, Kamenický (1973) and Hovorka et al. (1987) stressed a prevailing rhyolitic protolith of investigated rocks by means of geochemical and petrographical study. No equivalents among the Variscan granitoids of Tatricum and Veporicum were find and the Hercynian

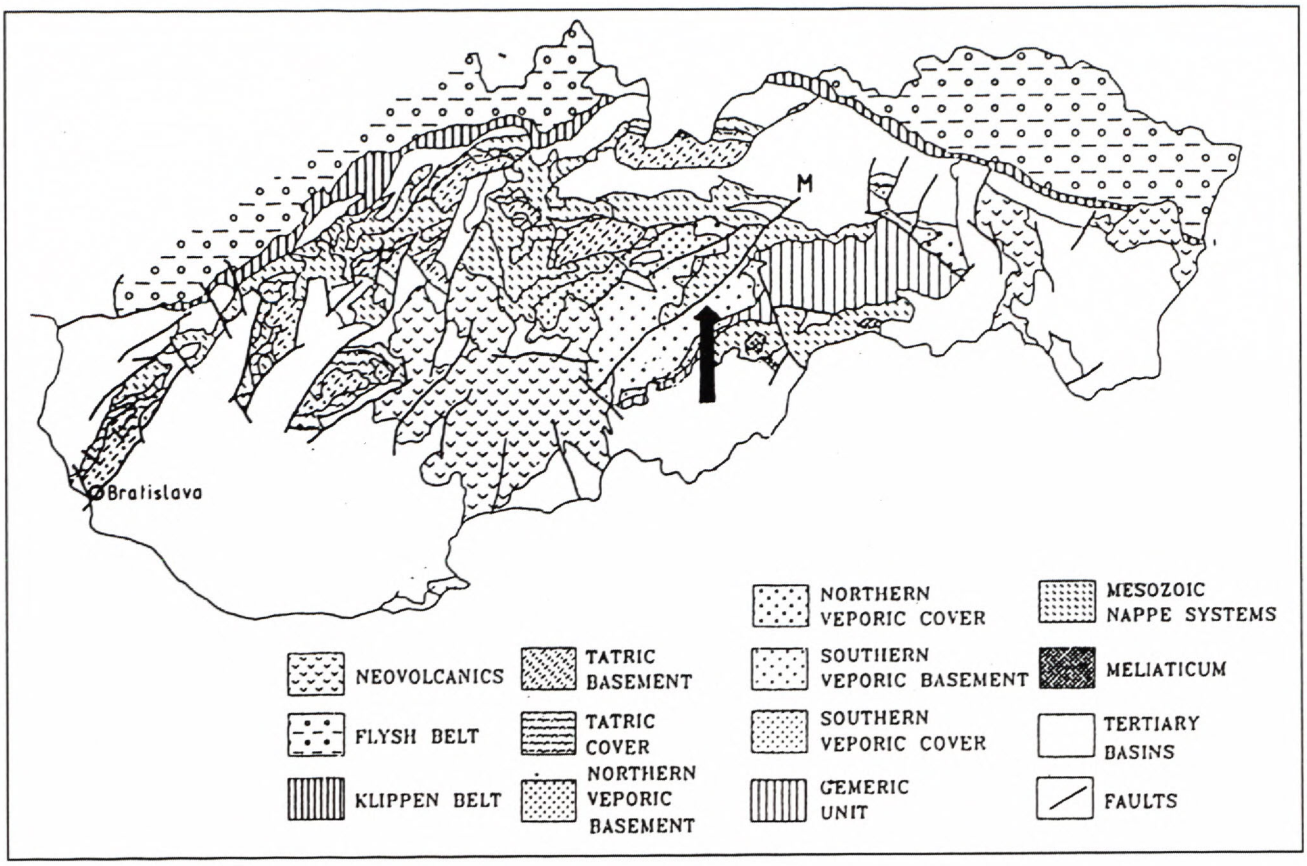


Fig. 1 Slovak territory of the Western Carpathians Mts. on geological scheme; arrow locates the profile on Fig. 2 (M - Muráň line)

metamorphic conditions were constrained at the upper part of greenschist facies to the lower amphibolite facies (Hovorka et al.1987). The amphibolitic layers/lenses and intercalations of biotitic gneisses and locally garnet micaschists associated with Muráň orthogneisses.

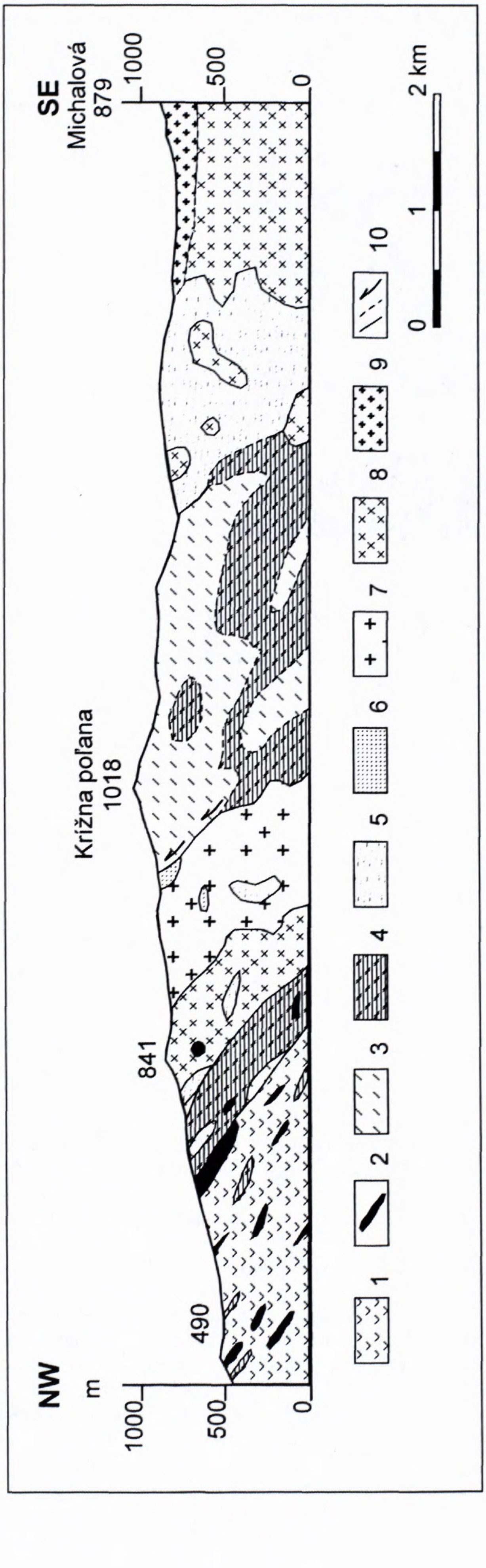
Results

Field observations

Recent mapping works, with respect to the Hercynian and the Alpine deformation history, have indicated some regularities, which should be referred to a pre-metamorphic volcano-sedimentary arrangement of the Lower Paleozoic lithological units. The geological profile (Fig. 2), directed transversaly to the general regional structure, illustrates the main relations of the basement units between the Muráň fault and the belt of granitoids rimming the high-grade Veporicum basement from the south. The "Muráň" orthogneisses are supposed to represent the lowermost part of the basement rock pile in this area. They are more or less regularly rimmed by gneissic-micaschistose horizon (including various metavolcanites, graphitic metaquartzites, serpentinised ultrabasic rocks a.o.), which gradually passes in biotitic gneisses and migmatites. Locally, porhyric granite (Fig. 2, column 7) penetrated into the above metamorphics and some dark biotite "hybridic" granitoids formed partly in its marginal parts. The contact selvage between the Muráň orthogneisses and gneissic-micaschistose horizon is also characterised by increased abundance of amphibolitic bodies and fine-grained light leptynites. Thus, the pre-Alpine tectonometamorphic structures are frequently based on original lithological relations in the Lower Paleozoic environs. Analogously, the dominant W-E directed Alpine deformation copied a lot of the Hercynian structures.

Petrography and source material

The predominant light coarse-grained orthogneiss consists mainly of quartz, albite and K-feldspar, which is usually porphyric. Characteristic greenish biotite yields extreme ferruginity (e. g. M/MF = 0.15) and tends to field of annite (Al-annite) according to the classification of Guidotti (1984). Such kind of biotites are not common in standard Carboniferous Inner Western Carpathian granitoids (Ďurkovičová 1967, Petrík 1980). On the whole, the "orthogneissic" lithotypes are poor in micas content. The peculiar accessoric minerals are allanite, magnetite and tourmaline. Indicative, but not prevalent lithotype, is represented by light, non-porphyric finer grained rocks which structure can be either massive or foliated with biotite. They are composed of the same assemblage as the previous type, though the K-feldspar is scarce (also in the groundmass) and mineral content is richer in garnet, epidote-allanite, biotite and scarce amphibole. This rock-type has a characteristics of leptynite (term used in descriptive sense according to e.g. Pfeiffer et al. 1985, Suk



1979) and it could be constituted from acidic tuffs and/or rocks of dacitic (rhyodacitic) composition. As to question of the protolith we preferred the conception about the acid paleovolcanics, mostly of rhyolitic composition (Hovorka et al. 1987). However, the widespread coarse porphyric orthogneisses of a granitic shape can be more likely attributed to concomitant granite porphyries.

Hercynian metamorphism

Based on mineral assemblages of adjacent garnetiferous metapelites (±staurolite, rarely kyanite), intercalated amphibolites (±garnet) and garnet leptynites the predominant constraints of Hercynian regional metamorphism are identified as lower to middle amhibolite facies. However, the peak conditions of the Hercynian metamorphism can be related to a partial melting of the paleorhyolites. In places, the ductile deformation produces leucocratic coarse melt segregating frequently in meso-scaled fold closures (Fig. 3). Similarly as to the source rock this melt composed of K-feldspar, quartz, albite (±biotite, tourmaline) reminds haplogranitic eutectic system, which solidus temperature is constrained at about 620-650°C (Tuttle, Bowen 1958, Johannes, Holtz 1991) in water saturated conditions. The pressure conditions may be 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). Apart from this approach, the poorly indicative reaction system in the widespread orthogneisses hardly allows to establish the reliable p-T conditions of the polymetamorphic history. More attention has to be paid to intercalated metapelites, mainly in order to genuine distinguishing of the separate metamorphic events. The arduous problem stems from defining the "postkinematic" Carboniferous granitoids, which could potentially penetrate into the analogous leucocratic lithology of "Muráň" orthogneisses.

Fig. 2 Geological profile indicates the lowermost position of orthogneisses. The Paleozoic geological boundaries between the basic litological units are mostly tectonised during the Cretaceous collision.
1) "Muráň" orthogneiss rock-complex; 2) amphibolites; 3) garnet micaschists; 4) garnet biotite gneisses; 5) biotite gneisses, migmatites; 6) graphitic metaquartzites; 7) porphyric granites; 8) "hybrid" granitoids; 9) fine-grained leucogranites; 10) geological boundaries: observed, approximated, sense of reverse fault movement

Fig. 3 Local partial melting of foliated type of "Muráň orthogneiss". The coarse-grained quartz-feldspathic melt formed in a dynamic regime and concentrates mostly in fold closures

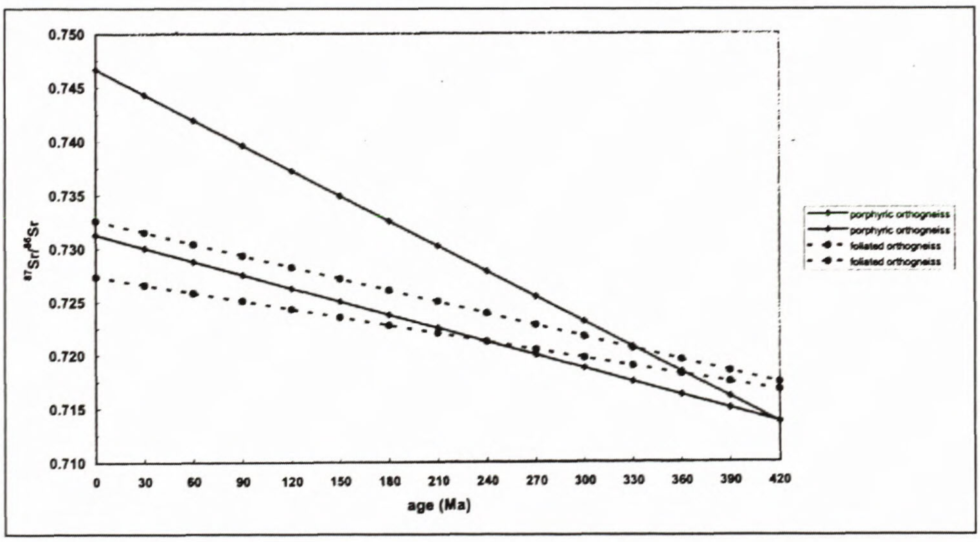


Fig. 4 Strontium evolution diagram for coarse porphyric orthogneisses (full lines) and foliated biotitic orthogneisses (broken lines). The lines roughly indicate equal time of Sr isotope equilibration but geochemically and isotopically different sources of rocks

Alpine overprint

The temperature of the Alpine regional metamorphism of the investigated area was estimated at about 500°C or locally even higher (Kováčik et al.1996). This is also supported by the only Cretaceous age obtained from rejuvenilated pre-Alpine amphibole comming from an amphibolite body inside the "Muráň" orthogneiss rock-complex. The Alpine semi-ductile deformation led to reactivation of the Hercynian foliation planes and developed pronounced shearing planes along the orthogneiss-amphibolite boundaries. This process is also associated with striking phlogopite accumulation in amphibolites.

Some deformations of shear-band type (marked by sericite), lineation associated with cleavage planes and symptomatic quartz ribbons represent the newly-formed Alpine structures. Generally, the Alpine reworking shows retrogressive effects upon the studied rocks, though these processes are not fully understood (Alpine deformation vs. newly-formed mineral assemblages and relation to Late Cretaceous thermal metamorphism a.o.). The relative younger brittle fault planes in orthogneiss lithologies were occasionally healed by black quartz-tourmaline veins, which gave further evidence about an eminent Alpine circulation of fluids in the basement rocks.

Preliminary Sr-isotopes study

Whole rock analyses of Sr isotopic composition and Rb, Sr concentrations from different rock types from "Muráň" orthogneisses rock-complex have shown distinct isotopic signature. The Rb/Sr ratios in two porphyric orthogneisses range between 1.04 - 1.95, in two with biotite foliated orthogneiss samples they range between 0.63 - 0.93, respectively. Strontium evolution diagram (Fig. 4) suggests different precursor of these rocks, but time of their Sr isotope homogenisation was generally similar. Expected initial $^{87}Sr/^{86}Sr$ ratios are estimated at about 0.718 for foliated biotitic orthogneisses and 0.714 for porphyric orthogneisses. This brings about further evidence that "Muráň" orthogneisses can not be paralellised with any Hercynian granitoids in the Western Carpathians realm. The analyses of amphibolite and leptinite occuring inside the predominant orthogneisses yielded natural Sr isotopic composition around 0.709. These data probably rebound of partial equilibration of original isotopic signature with their surroundings, considering their expected age and today Rb/Sr ratio (0.03 - 0.05). The process is indicated by apatite-whole rock isochrones which demonstrate different apparent "mineral ages".

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