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BIOTITES OF THE WEST CARPATHIAN GRANITOID ROCKS: A SURVEY

(Fig. 1)

Biotite and muscovite are characteristic minerals of normal granitoid rocks. They occur together or separately and often indicate different conditions of the genesis of the rock. In the West Carpathian granitoids only biotites have so far been studied.

The division of the rock complex on the basis of petrographical criteria leads to the following results: The most frequent rock type is the biotite granodiorite, sometimes with a subordinate amount of muscovite (often secondary). The primary muscovite is very frequent in leucocratic and more differentiated types. The positions of biotite and muscovite in the parent rock and their relationship to other minerals are not always equal. The results of many experiments threw doubts on the magmatic origin of biotite in palingenic granitoids. These doubts are chiefly based on the higher temperature of biotite melting relative to temperatures at which ultrametamorphic processes leading to partial anatexis occur in the crust (comp. e. g. H. G. F. Winkler — R. Breitbart, 1978).

The chemical composition of biotites studied corresponds in most cases to the composition of the parent rock, preserving the fundamental trend, i. e. the increase in iron content ($Fe_t/Fe_t + Mg$) with the SiO_2 content in the rock. We suppose this fact to be a result of magmatic crystallization of the biotite from the melt. In contrast, P. Fejdi — V. Fejdiová (1981) infer from the charge balance that the biotite of the Sihla-type trondhjemite and Sinec-type granodiorite is a relict mineral oxidized during anatexis.

Figure 1 shows the total chemistry of the West Carpathian biotites in terms of octahedral cations, according to M. Forster (1960). Several conclusions can be deduced from the distribution of the samples studied:
The range of iron-content (along the connecting line Mg — (Fe^{2+} + Mn) is small, whereas the range of Al content (along the connecting line Mg — (Al^{VI} + Fe^{3+} + Ti) is large. With respect to Fe content, the Fe-biotites predominate over Mg-biotites. In relation to the biotites described from the known world's batholiths a shift towards to trivalent octahedral cations (+ Ti) is prominent. In Fig. 1 biotites coexisting with muscovites (open symbol) are distinguished from those occurring separately (full symbol). The former are evidently richer in trivalent cations and Fe^{2+}. It is obvious that the biotites coexisting with muscovite have a higher Al content, which together with the total paragenesis indicates the paraluminous character of the greater part of West Carpathian granitoids. This is consistent with the petrographical features of the granitoids: an increased content of normative corundum and a predominance of rocks with A/CNK > 1 (mol. % $Al_2O_3/(CaO + Na_2O + K_2O)$).

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The extreme position of the leucocratic varieties of the Tríbeč granitoid is also caused by a high content of Fe^{3+}. The higher $Fe^{3+}/Fe^{2+} + Fe^{3+}$ ratio is typical of all West Carpathian granitoids (J. K l o m í n s k ý et al. 1981). We presume that the high portion of Fe^{3+} in biotite can be rather associated with secondary processes (perhaps due to Alpine dynamic metamorphism) than with the primary oxidation of the last crystallization phase of magma.

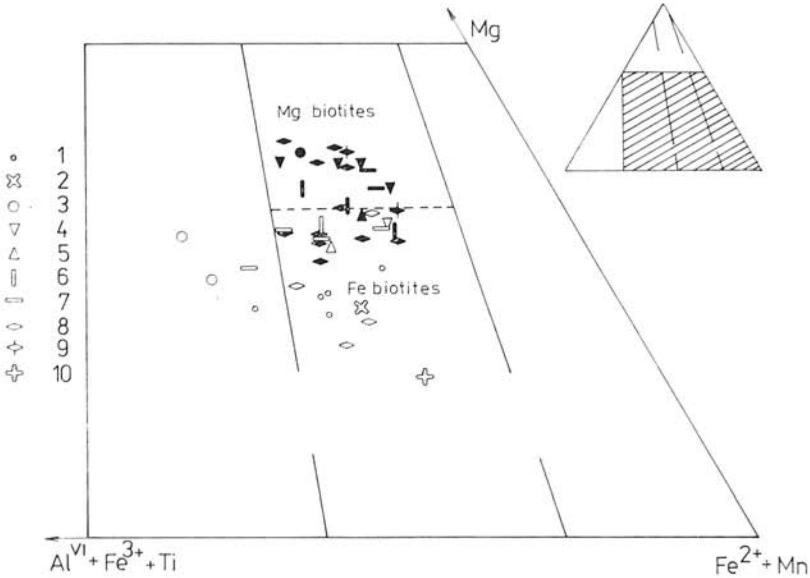

Fig. 1. Biotite composition in terms of octahedral cations Mg – ($Al^{VI} + Fe^{3+}$ + Ti) – (Fe^{2+} + Mn) according to M. F o s t e r (1960). Abb.:
1. Malé Karpaty Mts. (Bratislava massif), 2. Považský Inovec Mts. 3. Tríbeč Mts., 4. Malá Fatra, Mts., 5. Veľká Fatra Mts., 6. Vysoké Tatry Mts., 7. Nízke Tatry Mts., 8. Veporides, 9. Čierna hora Mts., 10. Gemerides.
Open symbols: biotite in assemblage with muscovite.
Full symbols: biotite in assemblage without muscovite.

The comparison of biotites from different massifs shows that their Fe content is controlled by the predominant type of the parent rock in the individual massif. For example, biotites from the granodiorite and trondhjemite of the Sihla type (ZK-28, ZK-82) have $F = Fe_t/Fe_t + Mg = 0.46$, whereas the biotite from the Hrončok type granite has $F = 0.70$. In the Tatride massifs the biotites of the Bratislava massif in the Malé Karpaty Mts. have the highest $F = 0.67$, and the biotites from the Tríbeč tonalite with the highest Al content have $F = 0.48$. The highest $F = 0.77$ was determined in the biotites of the Gemeride granites.

The application of experimental results on biotite and granite systems to the biotites of the West Carpathians makes it possible to draw the following conclusions: Oxidation-reduction relations of the crystallizing magma expressed by the portion of Fe^{3+} in the octahedral layer of biotite as well as the paragenesis of biotite with the Fe and Ti oxides (magnetite, ilmenite) suggest fugacity of oxygen, characterized by Ni-NiO and haematite-magnetite buffers. Most of the samples are characterized by a higher fugacity than that of Ni-NiO buffers; the fugacity, however, is lower than that needed for the generation of primary haematite since biotites coexist with magnetite or ilmenite. In applying the Ni-NiO buffer to the calculation of biotite stability curves (D. R. Wones, 1972) in various West Carpathian rocks, we get temperatures of 700—800 °C and f_{H_2O} values = 60—90 MPa at the intersection with the solidus of the granite minimum for most of the biotites studied (I. Petrík, 1980).

According to the position of biotite in the crystallization succession, the granitoid massifs of the Malé Karpaty Mts. can be distinguished with respect to the water content in magma. On the basis of P. J. Wyllie's data (1977) an increased water content (above 6 %) is probable for the Bratislava massif, whereas the succession established in the Modra massif agrees with experimental results already at 2 % content of water. In the magma of the Bratislava massif the water content was likely to suffice for oversaturation with water vapour, as is also suggested by the increased amount of pegmatites (I. Petrík, 1982).

Biotite and muscovite provide many a valuable information about the conditions under which a rock originated and about processes to which it was exposed. As the presence of water (and its volatile components) is at present regarded as one of the decisive factors controlling the genesis of magma, biotite and muscovite along with hornblende (i. e. water-binding minerals) are of particular importance in modern geodynamic conceptions concerning the genesis of granitoid magmas.

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