Mafic dykes in Variscan tonalites of the Malá Fatra Mts. (Western Carpathians)

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Abstract: Dykes of mafic rocks occur in the Variscan tonalites in the Malá Fatra Mts. They contain numerous xenoliths, or desintegrated parts of the tonalite host rock. Porphyric phases in dykes are mainly clinopyroxenes, while amphiboles, and biotites are less common. On the basis of prevailingly porphyric clinopyroxenes and their chemical composition, we assign these rocks to the group of calc-alkaline lamprophyres. Taking their mineral composition as a criteria we term them as pyroxene spessartites. Preserved mylonites/blastomylonites of these rocks indicate their Late Variscan/Early Alpine age.

Keywords: calc-alkaline lamprophyres, clinopyroxenes, feldspars, petrology.

Introduction

Dykes of mafic rocks located in the pre-Upper Carboniferous complexes of the Central Zone of the Western Carpathians belong to the rock types of scarce occurrence. They are known to occur in the Malá Fatra Mts., Nízke Tatry Mts., Suchý Mts., Považský Inovec Mts. and the Veporic units of the Slovenské rudohorie Ore Mountains, but only in the first two mountains their occurrences are more abundant, while in the others only scarce bodies were reported.

Geological setting

Dykes of mafic rocks are known to occur exclusively in the Variscan tonalite environment. Their thickness is as much as a few meters. On the floor of a productive quarry Dubná Skala near Vrútky there crops out (September 1996) as a few meters thick dyke-like body. Very sporadically observed contacts between mafic veins and the surrounding tonalites are characterized by direct contact planes and as much as 2 cm thick zones of intense chloritization of the host rock. Within thicker veins, the transitions from porphyric and amygdaloidal types into the holocrystalline, evenly granular types in the central parts of veins, can be observed. The dips of dykes are variable, but steep to vertical ones predominate. Characteristic, numerous tonalite xenoliths are randomly distributed not only within individual dykes, but also among the veins in general. The tonalites are intersected by zones of (Alpine) mylonitization and blastomylonitization, in which also the mylonites and blastomylonites of discussed mafic rocks occur. They have a character of distinctly schistose, mostly by naked eyes observed aphanitic fabric.

Characteristic features including the geological setting of dykes and their general petrographic description are presented in a summary paper by Hovorka (1967). This author characterized the dyke rocks in tonalites of this mountain as 4 basic types as follows:

a) porphyric,
b) evenly granular,
c) amygdaloidal,
d) schistose types.

While Ivanov and Kamenický (1957) reported that the rocks under study are akin to cuzelites with some features in common with the odinites and kersantites, Hovorka (1967) described them as transitional rocks of the series porphyrite - lamprophyre (diorite porphyrite - kersantite - spessartite).

To date available general information about the mafic dyke rocks located in the Variscan tonalites of the Malá Fatra Mts. can be summarized as follows:

- discussed mafic rocks are known only from the magmatite/tonalite environment of Variscan age,

- while Ivanov and Kamenický (1957) reported the presence of mafic dykes in both parts i.e. in the group of Veľký Fatranský Kriváň and in the Minčol group, the authors of this paper record only a few occurrences in the Minčol group (Martinské hole ridge),

- described in the mafic dykes are the features of assimilation of surrounding tonalites (Hovorka, 1967) in a processes that at least to some degree modified the composition of the dyke melt,

5 analyses of petrogenic elements (Hovorka, 1967) were used to characterize the composition of mafic dykes. The content of SiO_2 in the analyzed rocks ranges from 44.5 to 50.5 wt. %.

The above summary of information indicates that exact data (REE, analyses of discriminatory minerals in the rocks etc.) which would allow for an assignment of the rocks under study to one of the general magmatic types, or to compare them with those known from the Mesozoic sequences of the Central Zone of the Western Carpathians, are not yet available.

This paper presents the results of study of clinopyroxene, a mineral of genetic importance and of distinctly magmatic origin. On the basis of clinopyroxene composition (zoning, twinning, two generations) we assign these rocks to a magma group and characterize the development of these rocks in time and space.

Mineralogy and petrology

The dyke rocks are dark-green to grey-green, massive, predominantly aphanitic, with evenly granular, less porphyric textures. Most phenocrysts (as much as 5 mm across) are clinopyroxenes, while biotites, amphiboles and plagioclases are of scarce occurrence. However, the latter phases form phenocrysts of microscopic dimensions (as much as 0.5 mm across). Most tonalite xenoliths are partly altered and measure as much as a few cm in diameter. They can best be observed on the cutting, or fracture surfaces. The xenoliths are: a) compact, b) desintegrated (so, that on the flat surfaces, the desintegration planes of xenoliths are evidently visible) and c) epidotized. The latter process affected mainly the original plagioclases in tonalite. Most samples have amygdaloidal structure (amygdales measure as much as 7 mm, but most have 2-5 mm in diameter). In blastomylonites of the mafic rocks, the amygdales have flat, distinctly elongated shape. They are made up of dark-green to almost black, fine-scaly chlorite aggregate, but in thin sections, a carbonate mineral was also identified in the amygdale filling.

Our additional microscopic study (of some 25 thin sections) confirmed that the assignment to the basic rock types as stated at the beginning of this paper, was justified.

Clinopyroxene stands for the principal phyric phase of these mafic rocks. Its distribution in the rocks is random. The crystals are euhedral, as much as a few milimeters across, locally magmatically corroded and of short-prismatic habit. Glomeroblasts of several clinopyroxene crystals were scarcely observed. The cpx crystals have a fresh outlook, but signs of carbonatization may also be observed along the cleavage (110) planes. Optical and microprobe studies confirmed the presence of "hourglass" texture/twinnings of phyric Cpx.

Apart from the distinctly magmatic, phyric Cpx I, the plagioclase, quartz and biotite, which also attain a size of phyric phases (as much as 1, scarcely 2 mm), also occur in the rocks.

Characteristic features of biotite flakes are their freshness and intense brown pleochroism. According to its relative abundance, this mineral belongs to the subordinate category, but in the majority of cases it falls within the category of accessory silicates. Most porphyric plagioclases have a diameter of 2-4 mm, but some may have as much as a few cm (!) across. Their crystal morphology is variable, either euhedral, or irregular. Genetically, they belong to: a) xenocrysts representing desintegrated tonalite or other plutonic rocks xenoliths and to b) magmatic neomorphs. The xenocrysts form the cores of compositionally complicated crystals that were totally replaced by a mixture of fine-grained minerals (biotite, carbonate, quartz, epidote-zoisite group of minerals, chlorite). These irregularly shaped "cores" are overgrown by water transparent plagioclase (An_{30}) characterized by a repeated albitic twinning. It is analogous to the plagioclase crystals that occur as much smaller (2-4 mm) phenocrysts. Together with the distinctly laths-like, and mostly intensively "filled" (desintegrated) plagioclasses of the rock matrix, they are a predominant magmatic phase of the rock. The plagioclase laths in the matrix are either simple, or albite twinned. In most thin sections, the transitional types of plagioclases of magmatic provenance, i.e. fine, slender laths and platelets of plagioclases can be observed, whose size (0.X - 1 mm) indicates a transition to the magmatic, porphyric plagioclases.

Quantitatively, quartz belongs to the accessory mineral phases. Genetically, (it only forms xenocrysts of the porphyric development) it corresponds to xenoliths of magmatic rocks (of tonalitic series!). It is to various degrees corroded, intensively pigmented and narrow reaction rims develop along the quartz crystal margins. Scarce poikiloblasts of apatite and zircon are present in quartz.

The matrix of these mafic rocks is predominated by plagioclase laths and by fine-grained chlorite aggregate, metallic ore pigment and grey, low birefringence mass (recrystallized volcanic glass). Plagioclases are intensively altered into a submicroscopic aggregate of white mica and clay minerals. Sphene, hercynite (?), ilmenite and other metallic ore phases are present in accessory amounts (besides of other above mentioned phases).

Another type is represented by the evenly granular varieties that occur only as the dyke facies of the above type. Besides of predominant clinopyroxenes and platy plagioclases, the rocks also contain monoclinic amphibole with a distinct, green pleochroism that is scarcely segmented to form splinter-like features. These holocrystalline types also contain accessory amounts of biotite, quartz, apatite, sphene, ilmenite and secondary minerals (calcite, chlorite, sericite, minerals of clinozoisite-epidote group).

Amygdaloidal types are the most common variety of the mafic rocks that occur in the Malá Fatra Mts. tonalite. The amygdales measure 5, but sporadically as much as 8 mm across. They are either isometrical, or of a distinctly elongated (biscuit) shape. Their colouration is deep-green to green-black. The amygdale fillings are submicroscopic and granular. They are homogeneous, composed of fine lathy aggregate of intensively pleochroic Fe-chlorite. In other types, compositional zoning of amygdales can be observed; in such case, the amygdale rims are filled up by chlorite with local indications of radial arrangement. Towards the centre of the amygdale a calcite zone occurs, which is scarcely replaced by a quart

Tab. 1 Selected analyses of clinopyroxene

Sample	DS 19/1		DS 29/1							DS 29/3			DS 18/1		DS 18	
Number	1N	1N	2pr	3py	2pr	3py	4m	4m	2pr	3py	2pr	3py	1N	1N	4m	4m
SiO_2	48,98	49.56	48,68	52,54	48,58	52,24	52,21	51,12	49,32	51,75	48,98	52,15	49,42	50,97	50,37	51,28
TiO_2	2,51	2,26	2,20	1,32	2,16	1,22	1,16	1,71	1,95	1,14	2,29	1,27	1,66	1,29	1,78	1,36
Al_2O_3	5,22	5,50	6,22	2,70	6,14	3,09	2,79	3,56	5,54	3,01	6,22	2,86	4,54	3,61	4,62	4,33
Cr_2O_3	0,00	0,10	0,31	0,00	0,00	0,06	0,09	0,00	0,44	0,12	0,32	0,00	0,17	0,19	0,29	0,46
FeO^+	8,30	7,51	7,57	8,34	8,59	7,39	7,60	8,64	7,29	7,50	7,21	8,72	7,55	7,27	7,54	6,87
MnO	0,30	0,26	0,19	0,26	0,26	0,23	0,16	0,23	0,23	0,20	0,22	0,25	0,17	0,17	0,08	0,12
MgO	12,57	13,24	13,08	14,72	12,99	15,01	14,96	13,63	14,01	15,33	13,16	14,20	14,31	15,08	13,35	14,04
CaO	20,35	20,12	20,39	20,24	20,48	19,00	20,20	19,85	19,73	19,42	20,69	19,69	20,18	20,04	21,08	21,35
Na_2O	0,43	0,38	0,68	0,50	0,72	0,47	0,59	0,54	0,62	0,43	0,40	0,31	0,58	0,47	0,44	0,43
K_2O	0,00	0,00	0,00	0,01	0,02	0,01	0,00	0,00	0,00	0,00	0,02	0,00	0,01	0,01	0,02	0,00
TOTAL	98,66	98,93	99,32	100,63	99,94	98,72	99,76	99,28	99,13	98,90	99,51	99,45	98,59	99,10	99,57	100,24
Formula based on 6 O																
Si^{IV}	1,85	1,85	1,82	1,93	1,81	1,94	1,93	1,91	1,84	1,93	1,82	1,94	1,86	1,90	1,87	1,89
Al^{IV}	0,15	0,15	1,18	0,07	0,19	0,06	0,07	0,09	0,16	0,07	0,18	0,06	0,14	0,10	0,13	0,11
Al^{VI}	0,08	0,09	0,09	0,05	0,08	0,08	0,05	0,07	0,08	0,06	0,10	0,06	0,06	0,06	0,08	0,08
Ti	0,07	0,06	0,06	0,04	0,06	0,03	0,03	0,05	0,05	0,03	0,06	0,04	0,05	0,04	0,05	0,04
Cr	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,01	0,00	0,01	0,01	0,01	0,01
Fe^{3+}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Fe^{2+}	0,26	0,23	0,24	0,26	0,27	0,23	0,24	0,27	0,23	0,23	0,22	0,27	0,24	0,23	0,23	0,21
Mn	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00
Mg	0,71	0,74	0,73	0,81	0,72	0,83	0,82	0,76	0,78	0,85	0,73	0,79	0,80	0,84	0,74	0,77
Ca	0,82	0,81	0,82	0,80	0,82	0,76	0,80	0,79	0,79	0,77	0,83	0,78	0,81	0,80	0,84	0,84
Na	0,03	0,03	0,05	0,04	0,05	0,03	0,04	0,04	0,04	0,03	0,03	0,02	0,04	0,03	0,03	0,03

Explanation: 1/N = number in figure symbols/type of pyroxene, N = new formed rims, pr = prismatic sector, py = pyramidal sector, m = microlite

Tab. 2 Selected analyses of feldspars

N. anal.	1	2	3	4	5	6	7	8	9	10	11
SiO_2	67,318	68,322	67,578	66,943	66,607	62,83	63,59	62,33	66,93	65,208	66,07
Al_2O_3	18,161	18,363	17,745	17,748	18,128	22,88	22,00	23,10	17,94	17,447	17,264
FeO^+	0	0	0	0	0	0,00	0,03	0,00	0,00	0	0
CaO	0,224	0,382	0,055	0,198	0,443	5,63	5,23	5,49	0,23	0,003	0
Na_2O	5,342	5,58	5,55	5,473	5,52	7,57	7,91	7,56	0,66	0,532	0,312
K_2O	8,884	7,993	9,152	8,781	8,096	1,48	1,74	1,64	14,06	15,083	15,732
TOTAL	99,929	100,64	100,08	99,143	98,794	100,38	100,50	100,12	99,84	98,273	99,378
Formula based on 8 oxygens											
Si	3,029	3,036	3,04	3,036	3,023	2,786	2,819	2,774	3,052	3,044	3,055
Al	0,963	0,962	0,941	0,949	0,97	1,196	1,15	1,212	0,962	0,96	0,941
Na	0,466	0,481	0,484	0,481	0,486	0,651	0,68	0,652	0,058	0,048	0,028
K	0,51	0,453	0,525	0,508	0,469	0,084	0,098	0,093	0,818	0,898	0,928
Ca	0,011	0,018	0,003	0,01	0,021	0,267	0,248	0,262	0,011	0	0
or	51,69	47,59	51,89	50,86	48,05	8,36	9,58	9,24	92,16	94,93	97,09
alb	47,24	50,51	47,83	48,16	49,76	64,96	66,23	64,77	6,58	5,07	2,91
an	1,07	1,9	0,29	0,97	2,19	26,69	24,19	25,99	1,27	0	0

zose (chalcedony) aggregate in the central parts of the amygdales. Locally, the chalcedony has an indistinctly radial orientation.

Of little interest for solving the genetic problems are the Alpine recrystallized types (of mylonitic and blastomylonitic character), such as those exposed in a forestry track 2 km SSE of the Kunerád castle, on a slope of the triangulation point 815.1 m, north of Sučany and elsewhere. Their general characteristics are described in the paper by Hovorka (1967).

A characteristic feature of the mafic dykes located in tonalites of the Malá Fatra Mts. is the presence of numerous xenoliths of magmatic rocks of tonalite series. They measure as much as several centimeters across, and many are mechanically desintegrated due to their incorporation into the mafic melt. The desintegration into individual crystals can best be observed on the cutting faces of the rock. As seen in thin sections, this phenomenon is due to fluidal arrangement of lath-like plagioclases in the rock matrix. The desintegration of incorporated xenoliths (of tonalites) took place when they became overheated and the mafic magmatic melt moved within the tonalitic body. Most tonalite xenoliths are to various degrees hydrothermally altered - mainly epidotized (plagioclases and biotite in tonalite). Intense epidotization affects preferably the endocontact zones in individual xenoliths. This is subsequently made up of fine-grained aggregate of epidote minerals. In the plagioclases of tonalite xenoliths, the carbonatization also took place. Of interest is that most xenoliths have in the marginal parts the fan-shaped arrangement of alkaline feldspar needles (Table 2). The needles of alkaline (natrium-potassium) feldspars intimately overgrow with the potassium feldspars. These minerals probably formed due to thermic-metasomatic processes during the interaction between xenoliths and magma. The occurrence of such types of feldspars were not yet reported from the similar rock types.

The above review indicates that most mafic rocks have porphyric textures, ophitic matrix and originally intersertal texture. Local arborescent arrangement of plagioclase laths can be observed. Typical is also the fluidal arrangement of plagioclases in the matrix, as to attain a trachytic features (texture) where the porphyric phases are missing.

Composition of minerals

Genetically, the best evidence for the origin of these rocks can give the clinopyroxenes which occur as a distinctly porphyric phase, as well as a part of the fine-grained matrix. Besides of clinopyroxenes we have also studied the composition of plagioclases.

We used the JEOL Superprobe 733 installed at the Geplogical Survey of the Slovak Republic, Bratislava, operated by Dr. P. Konečný to analyze the above minerals at standard conditions(Tables 1 and 2).

The study of clinopyroxene composition is of importance when the genetic type of magma is to be determined and when the evolution of magma is to be deciphered.

On the basis of geological setting, composition and origin, three types of clinopyroxenes can be distinguished:

- clinopyroxene phenocrysts,
- newly formed rims around older pyroxenes,
- microlites in the matrix.

The pyroxene phenocrysts in the rocks under study are almost always zonal, but the most common zoning is that of the "hourglass" type, while the oscilatory zoning is scarce and relatively indistinct. The sector-like zonal structure is characterized by two distinctly differing sectors, a pyramidal one and a prismatic one. These sectors differ not only optically, but mainly by their chemical composition. Relative to prismatic sector, the pyramidal one is commonly enriched by Si and Mg and depleted by Al, Ti and Fe. This feature is usually explained as the concurrent vector growth of all parts of a crystal, when each plane has its own growth rate and creates the partial equilibria between the crystal surface and the melt (Hollister & Gancarz 1971, Leung 1974). Since the attachment of diopside type units runs relatively easier way, the pyramidal sectors grow faster and the melt at the contact with them grows relatively depleted by Mg a Si. The slower growing prismatic sector is being enriched by other elements, such as Ti, Al, Na and K (locally also Fe). As regards the stability of the crystal structure, the sector zonality represents a disequilibrium state, thus, it is subject to obliteration during later diffusional processes. Its preservation depends on the rate of crystallization and diffusion in the crystal. Hence, the sector-like zonal structure is usually preserved in the fast solidifying rocks, which is the case of mafic dykes located in the Malá Fatra Mts. tonalites.

Of another type are the newly formed rims, or water-transparent margins of large pyroxene phenocrysts (symbol 1). These probably developed immediately prior to the ascension of magma to the surface, under changing pT conditions in a magmatic chamber. Their composition is similar to that of the prismatic sectors.

Yet another type of pyroxenes, typical for the fast-cooling rocks, are the microliths in the matrix. Their shapes are irregular and composition is similar to that of the pyramidal sector. They mark the latest crystallization stage during the ascension of magma towards the surface, i.e., they indicate a reduction of pressure and a relatively fast melting.

The study of pyroxene composition is of great importance when the origin of the protolith is to be determined. In the classification diagram (Morimoto et al. 1988, Fig. 1), some figurative points for selected clinopyroxenes fall within the field of augite, while the others fall within the field of diopside (especially microliths, newly-formed margins and prismatic sectors). Generally, the distribution of figurative points of clinopyroxenes from the samples studied differs from that of the clinopyroxenes that occur in Mesozoic alkaline basalts of the Malá Fatra Mts. (Hovorka & Spišiak 1988, hatched field). In the Ti:Al diagram (Fig. 2), the figurative points of clinopyroxene analyses are widely scattered indicating relatively good correlation be-

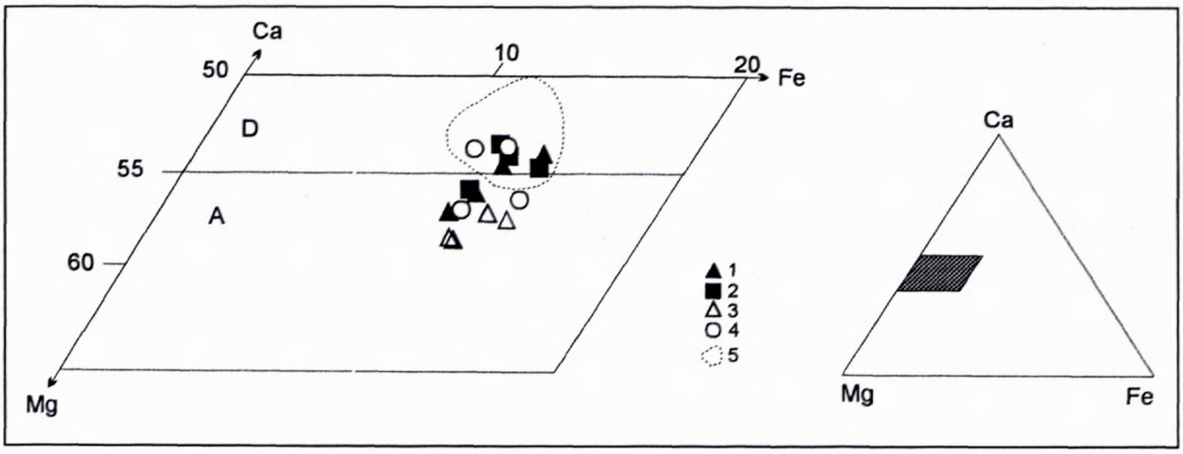


Fig. 1. Classification diagrams of clinopyroxenes (Morimoto et al. 1988). 1 - 4 = analyses of clinopyroxenes from Table 1; 5 - field of clinopyroxenes from Mesozoic basanites (Hovorka - Spišiak 1988; A= augite, D = diopside.

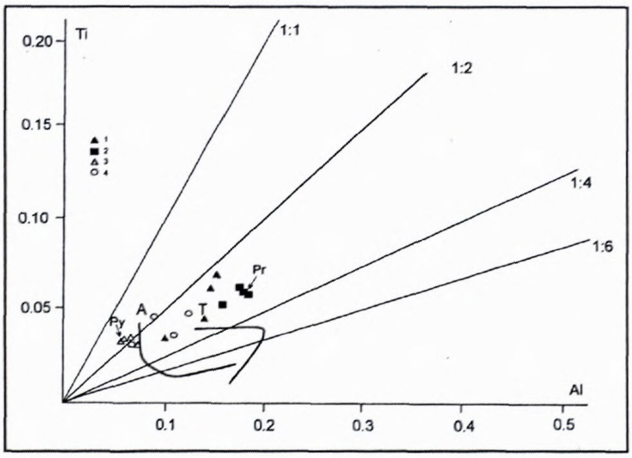


Fig. 2. Ti vs. Al in pyroxenes; plotted field show the maximum content of Ti in tholeiitic basalts (T) and the minimum content in alkaline basalts (A) (fields after Maruyama 1976 in Takeda 1984), 1- 4 analyses of clinopyroxenes from Table 1, m Py = pyramidal sector, Pr = prismatic sector

tween Ti and Al. Projections of mean analytical points approach the Ti:Al ratio of 1:3, whereas the individual types, or parts of clinopyroxenes have different projections. Relatively lowest contents of Ti and Al have the pyramidal sectors and microliths, while the prismatic sectors and newly-formed Cpx have relatively highest contents. To classify the clinopyroxenes more precisely, we used the diagram showing the dependence SiO_2 vs. Al_2O_3 (Fig. 3).

In this diagram, the projection points of analysed samples fall within the fields S and A, i.e., in the field of low, or normal alkalinity rocks. Almost all analyses fall within the field coincident with the field of clinopyroxenes of the oceanic floor basalts.

Therefore, a mechanical application of any of the discrimination diagrams without taking account of the given geological position, would probably be a failure. The of the Veľká Fatra Mts. (Hovorka & Spišiak l.c.) are projections of the clinopyroxenes from the Mesozoic basalts - distinctly different and located exclusively within the field of increased alkalinity rocks (field P). Recently, Letterier et al. (1982) attempted to statistically classify the Cpx from basalts of various provenances. In the classification diagram (Fig. 4), the projection points of clinopyroxene analyses appear in the field of calc-alkaline basalts Cpx. Such position would comply with the geochemical classification of basalts from which the pyroxenes in question were derived.

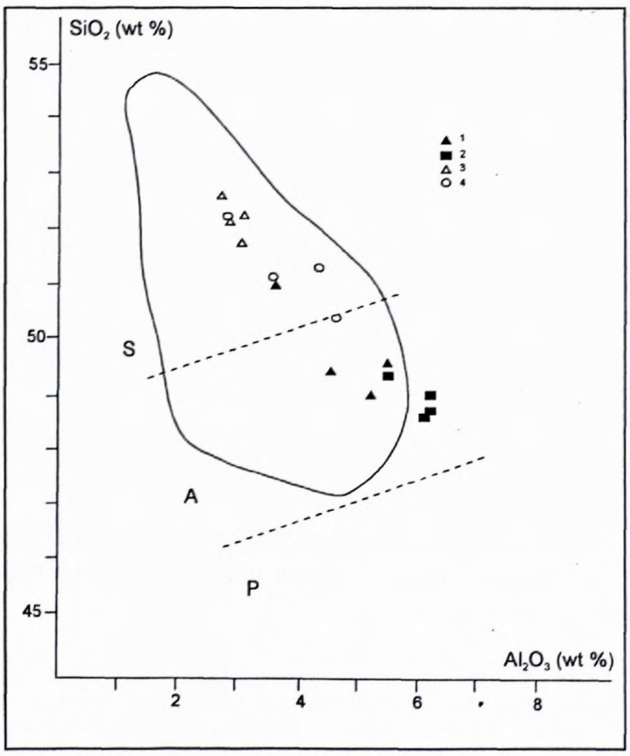


Fig. 3. Diagram SiO_2 vs Al_2O_3 in pyroxenes; boundaries according to Le Bas (1962): S - clinopyroxenes from low alkalinity rocks, A - clinopyroxenes from normal alkalinity rocks, P - clinopyroxenes from increased alkalinity rocks, plotted field - clinopyroxenes in oceanic floor basalts. 1- 4 analyses of clinopyroxenes from Table 1.

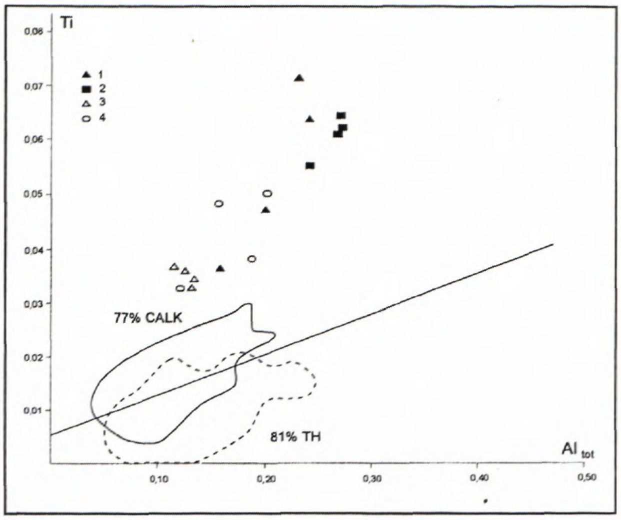


Fig. 4 Discrimination diagram of clinopyroxenes after (Letterier et al. 1982). TH -field of tholeiitic basalt clinopyroxenes, CALK - field of calc-alkaline basalt clinopyroxenes. 1- 4 analyses of clinopyroxenes from Table 1

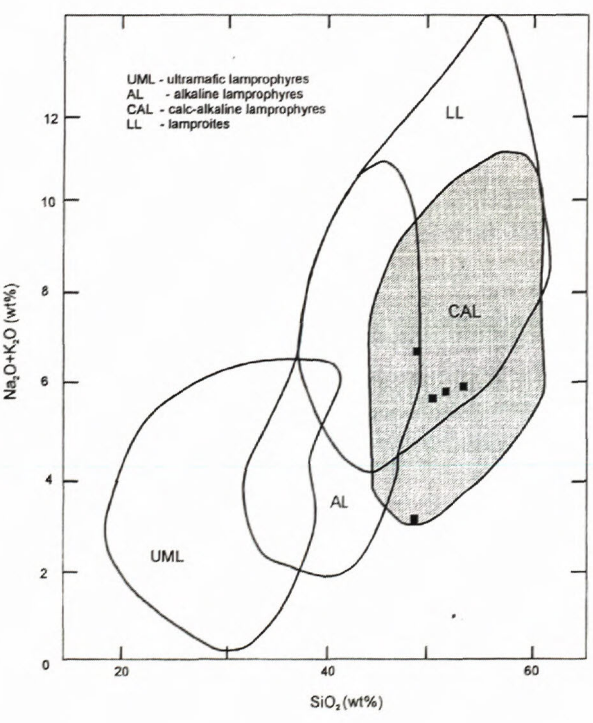


Fig. 5. (K_2 $O+_{NaO}$) vs. SiO_2 plot of lampropyres. Field of lamprophyres according to Rock (1987). Analyses of dykes from Table 3.

Table 3 Chemical analyses of rocks

	Malá Fatra				
	1	2	3	4	5
SiO_2	44,46	45,22	45,91	48,46	50,47
TiO_2	1,60	2,00	2,60	2,50	1,60
Al_2O_3	15,30	16,13	13,62	15,71	14,92
Fe_2O_3	4,29	3,28	2,71	2,31	1,92
FeO	7,68	7,39	6,20	5,73	6,72
MnO	0,16	0,20	0,15	0,15	0,14
MgO	5,86	4,07	5,70	5,37	5,25
CaO	9,15	8,01	8,89	8,04	7,86
Na_2O_3	2,00	4,15	3,46	3,59	3,93
K_2O	0,80	2,05	1,70	1,85	1,66
P_2O_5	0,43	0,36	0,47	0,38	0,28
H_2O^+	3,56	6,36	8,37	5,31	4,98
H_2O^-	0,12	0,10	0,12	0,13	0,13
CO_2	4,72	0,34	0,32	0,27	0,28
spolu	100,13	99,66	100,22	99,8	100,14

1 – Ivanov and Kamenický, 1957
2 – ridge Kalužná, Hovorka, 1967
3 – N of Sučany, Hovorka, 1967
4 – Dubná Skala near Vrútky, Hovorka, 1967
5 – Dubná Skala near Vrútky, Hovorka, 1967

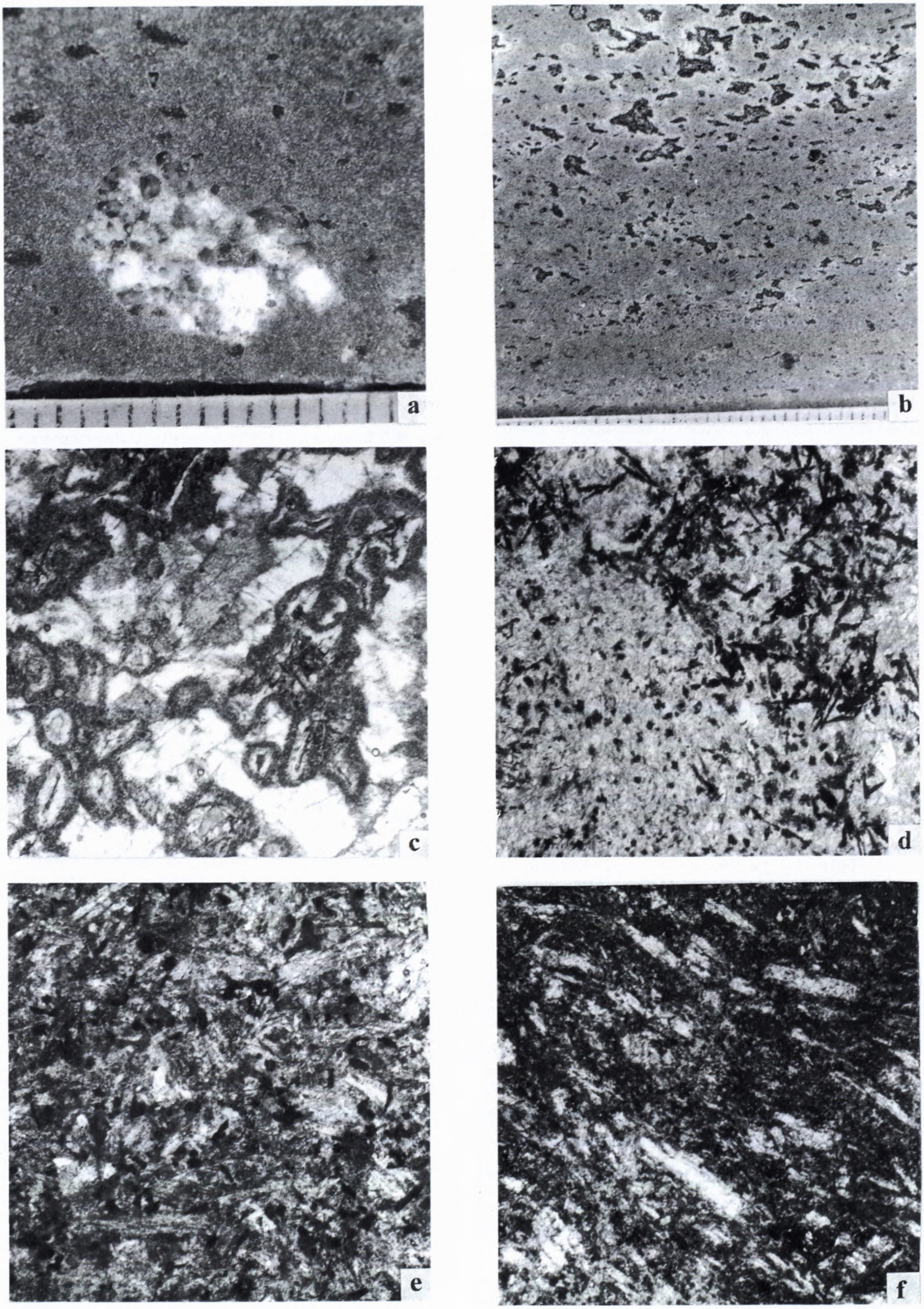
Geochemical features

In spite of the fact that the basaltic dykes use to be strongly altered, we attempted to determine the character of basaltic magma from the analyses of freshest samples. We used the published analyses (Table 3), recalculated them to fit the waterless form and plotted them in the classification diagram for dyke rocks (Fig. 5, Rock 1987). The projection points for analyses of dyke rocks of the Malá Fatra Mts. lie within the field of calc-alkaline lamprophyres. This classification complies with the character of clinopyroxenes, thus, we can assume that they are calc-alkaline dyke (lamprophyric) rocks.

Discussion and conclusions

Although, the laboratory investigations were made (Hovorka, 1967) and the results summarized in this paper are available, an essential problem remains how to classify and call the mafic rocks in question. Considering the analyses made after the removal of visible tonalite xeno-liths or their desintegrated parts, undoubtedly, these rocks belong to the mafic group (Table 2). Another point is that in accord with the content of K_2O and Na_2O/K_2O ratio, the analyzed mafics should be ranked with the natrium series. Using the recently valid discrimination criteria (TAS diagram, Le Maitre et al., 1989) they are subalkaline rocks of basaltic and/or trachybasaltic type.

a) Partly desintegrated tonalite xenolith in lamprophyre. Scale = 1 mm. Sample: DS-13/1.
b) Size of irregular chloritic and calcite-chlorite amygdales grows towards the dyke margin (in Fig. upwards). Scale = 1 mm. Sample: DS-23.
c) Incipient melting of tonalite xenolith in lamprophyre. Sample: DS-26/4; magn. 45x, X pol.
d) A plane of recrystallized amygdale with isometric metallic ore minerals; ilmenite platelets predominate in the matrix of lamprophyre. Sample: DS-26/4; magn. 45x, X pol.
e) Subophitic structure of lamprophyre. Sample: DS-18/2; magn. 45x, X pol.
f) Fluidal arrangement of plagioclase laths in lamprophyre. Sample: DS-13/1; magn. 45x, X pol.
g) Development of needle-like alkaline and potassium feldspars at the margins of a plagioclase in the xenolith. Sample DS-22 magn. 45x, X pol.
h) Development of needle-like alkaline and potassium feldspars (radially arranged) at the margins of a plagioclase in the xenolith. Sample DS-22 magn. 45x, X pol All samples come from the Dubná Skala quarry near Vrútky.


a
b
c
d
e
f

According to currently effective classifications (Le Maitre et al. 1989, Rock 1991, Woolley et al. 1996), the lamprophyres of the calc-alkaline group are characterized by porphyric black micas and by amphiboles, or pyroxenes that also occur in the rock matrix. The calc-alkaline porphyries are characterized by the presence of calc-alkaline feldspars (1.c.).

We assume that broad platelets of Plg I of distinctly magmatic origin are characteristic for only a relatively small part of thin sections of mafic rocks. This is also a characteristic feature of the porphyry, or porphyrite rocks (gabbro porphyrites). However, this finding applies to only a small part of rocks, while the others do not contain porphyric plagioclases, but the porphyric clinopyroxenes instead. Such types (with fine pseudomorphs after olivine) have the composition similar to odinite. However, the international classification recommends not to use this term (Le Maitre 1989). Lack of good exposure of individual dykes of mafic rocks in the mountains in question does not allow to define the spatial relationships between the mafic varieties containing scarce, fine, porphyric plagioclases or porphyric clinopyroxenes, respectively, but it does allow to take the mineral composition of most mafic dykes that occur in the Variscan tonalites of the Malá Fatra Mts. as a criteria to assign them to the group of calc-alkaline lamprophyres. Since the clinopyroxene is its predominant porphyric phase we coin the term pyroxenic spessartite.

The amygdaloidal development of most mafics, with the amygdales measuring 5, but sporadically as much as 8 mm across, indicates an emplacement of the magmatic melt during its consolidation shallow beneath the surface. At the same time, the character of xenoliths indicates that these were incorporated in the mafic melt within the tonalite body, hence, the xenoliths of the lower horizons of the continental type of crust are missing.

Subalkaline character of the mafic melt proper, evidenced not only by its chemical composition, but also by the composition of magmatic clinopyroxenes (Table 1), rules out the existence of any genetic relationship between the mafic dykes and the effusives/extrusives that occur in some Mesozoic units of the Central zone of Western Carpathians, because the latter have a distinctly alkaline character (Hovorka and Spišiak 1988).

Calc-alkaline character of the magma of mafic dykes eliminates their genetic linking with the products of alkaline volcanism in the Mesozoic units of the Western Carpathians (Hovorka-Spišiak 1988, Spišiak - Hovorka 1997). Absence of others but tonalitic types of xenoliths indicates that the magmatic reservoir of mafic rocks was adjacent to magmatic reservoir of tonalites, or to its basal part, respectively. Thus, we can visualize the enclosing tonalites and mafic dykes in them as reverberations of magmatic activity (generation of tonalites) that took place during the Variscan period. In tis process, the mafic dykes filled the contraction joints in the cooling tonalitic body. Therefore, we can consider the tonalites and the mafics in these mountains as consanguinic rocks. To verify these findings, an exact geochronological dating of both, dykes and tonalites, should be made.

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