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PETROGRAPHICAL CHARACTERISTICS OF DITRÓ (OROTVA) HORNBLENDITES, EASTERN CARPATHIANS TRANSYLVANIA (ROMANIA): A PRELIMINARY DESCRIPTION

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ABSTRACT

During the 150 years the syenite massif of Ditró has been examined by excellent mineralogists and petrographers like HERBICH (1872); KOCH (1880); BERWERTH (1905); REINHARDT (1911); MAURITZ (1909-25); JANOVICI (1932, 1934, 1970); STRECKEISEN (1931-74); CODARCEA *et al.* (1957); ANASTASIU and CONSTANTINESCU (1979-81); JAKAB (1976, 1982, 1986).

Magmatic mass of the massif penetrates the metamorphic rocks of the Tölgyes Series and the Rebra-Barnar Series and the Bretila Series (i.e. Rarau Gneisses and Hagymás Granitoides). Certain parts of the massif are covered by Pliocene limnic sediments (JEKELIUS 1923), Late Pliocene-Early Quaternary gravels (STRECKEISEN 1952) and agglomerates and tuffs as well as the lava layer of the Kelemen-Hargita volcanic range (JANOVICI 1934; SAVUL and KRÄUTNER 1937; RADULESCU *et al.* 1973) (*Fig. 1*).

According to our present knowledge the age of the Ditró syenite massif is between 150—160 and 120—130 My. (BAGDASARIAN 1972; STRECKEISEN and HUNZIKER 1974; MINZATU 1982 and JAKAB 1982).

On the basis of their spatial setting and structure and their petrochemistry as well as relationships to each other, the rocks of the Ditró syenite massif can be divided into several groups. A wide range of variety of the rocks located into a fairly small area suggests different intrusions. Their alkaline character can be attributed to the results of several alkaline-metasomatic phases which touched not only the magmatic-metamorphic complexes found within the massif, but the surrounding rocks, too.

Outcropping of the hornblendites in the basin of the Orotva creek (northern part of the massif) takes a distinctive importance among these groups of rocks. According to the recent — but not proved — theory (JAKAB 1986) the hornblendites are originated by Fe and Mg metasomatism of earlier crystalline rocks which elements derived from the adjacent alkaline environment. It is obvious that further petrological investigations need for the correct genetical estimation of the Orotva creek hornblendites.

INTRODUCTION

The Ditró syenite massif is situated on the northern-northeastern side of the Gyergyó Basin on the southwestern edge of the Gyergyó Alps in the middle part of the Eastern Carpathians (*Fig. 1*). In its northern part (between the Csibi-Jakab creek and Török creek in the Orotva valley) groups of rocks outcrop and they form a succession from the west to the east according to the quantitative decrease of the non-ferrous rock-forming minerals. The Orotva Complex can be subdivided into five groups (ANASTASIU *et al.* 1979. *Fig.* 2) as follows: (1) hornblendites, (2) diorites, (3) monzonites and syenites, (4) foiditic rocks, (5) granodioritic rocks. The aim of this paper is to give a mineralogical and petrographic presentation of

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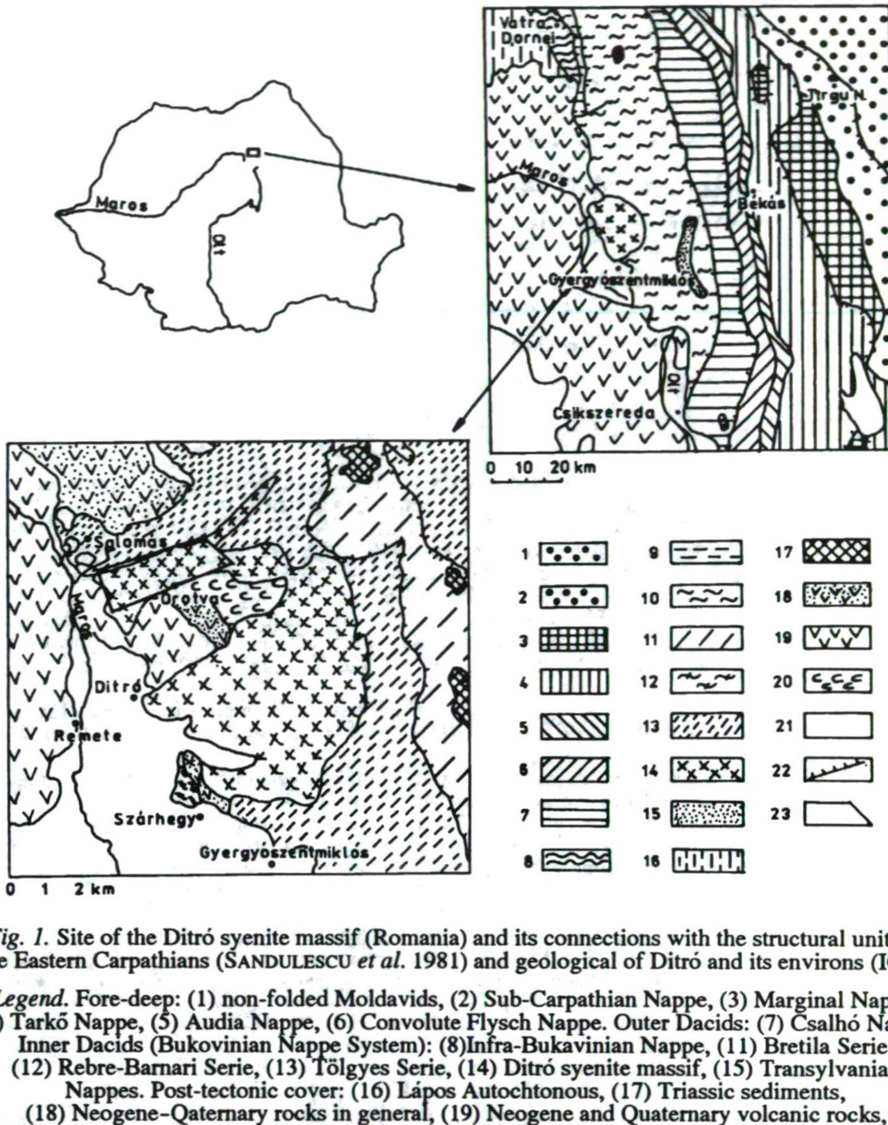

Fig. 1. Site of the Ditró syenite massif (Romania) and its connections with the structural units of the Eastern Carpathians (SANDULESCU *et al.* 1981) and geological of Ditró and its environs (IGC).

Legend. Fore-deep: (1) non-folded Moldavids, (2) Sub-Carpathian Nappe, (3) Marginal Nappe, (4) Tarkő Nappe, (5) Audia Nappe, (6) Convolute Flysch Nappe. Outer Dacids: (7) Csalhó Nappe. Inner Dacids (Bukovinian Nappe System): (8)Infra-Bukavinian Nappe, (11) Bretila Serie, (12) Rebre-Barnari Serie, (13) Tölgyes Serie, (14) Ditró syenite massif, (15) Transylvanian Nappes. Post-tectonic cover: (16) Lápos Autochtonous, (17) Triassic sediments, (18) Neogene-Qaternary rocks in general, (19) Neogene and Quaternary volcanic rocks, (20) Pliocene sediments, (21) Neogene basins, (22) Overthrust zone, (23) Investigated area.

the group of hornblendites, in detail. In the view of this paper the hornblendite group consists of hornblendite rocks containing more than 90 % hornblende minerals as well as their pegmatoidic derivatives (although their mafic content sometimes is smaller than 50 %).

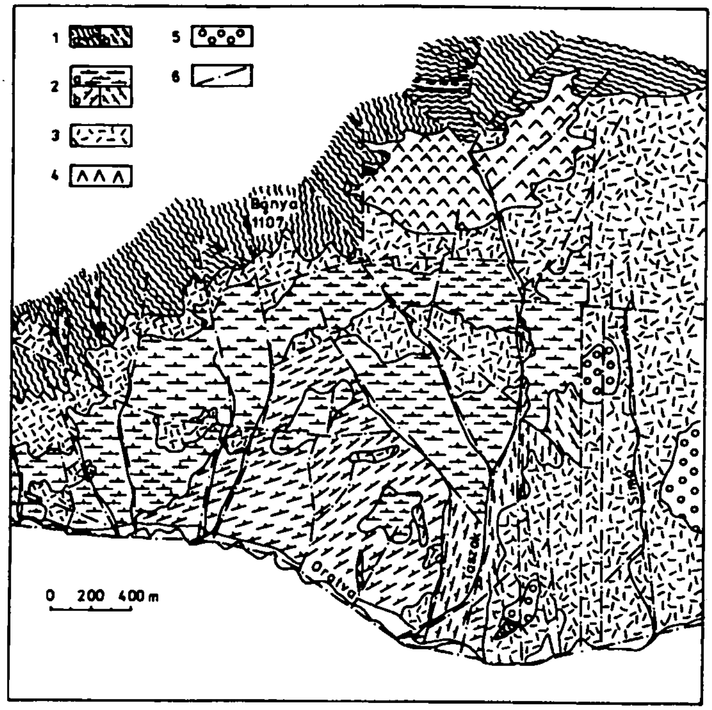

Fig. 2. Geological map of the northern part of the Ditró syenite massif (ZÓLYA, IONESCU, PÁL- MOLNÁR 1988).
Legend. (1-a) Crystalline rocks, (1-b) Black quartzites, (2) Group of hornblendites and diorites: (2-a) non-oriented hornblendites, (2-b) oriented hornblendites, (3) Group of monzonites and syenites, (4) Group of foidites, (5) Volcanogene-sedimentary rocks, (6) Fault.

PETROGRAPHIC CLASSIFICATION OF DITRÓ-OROTVA HORNBLENDITES

Based on their texture the hornblendites are divided into two large groups (CODARCEA *et al.* 1975): (I.) rocks with textural ordering, (II.) rocks without textural ordering. According to their mineral composition and structural characteristics these groups can be subdivided into the types as follows:

I. Hornblendites with textural ordering
1. lineated hornblenbites with microcrystalline structure and abundant sphene content,
2. phanerocrystalline hornblendites with sphene and biotite,
3. sphene- and biotite-free phanerocrystalline hornblendites.

II. Hornblendites without textural ordering
1. sphene- and biotite-free microcrystalline hornblendites,
2. sphene- and biotite-bearing microcrystalline hornblendites,
3. sphene-bearing phanerocrystalline hornblendites,
4. phanerocrystalline hornblendites with biotite,
5. sphene- and biotite-bearing phanerocrystalline hornblendites,
6. olivine-pyroxene hornblendites,
7. pyroxene hornblendites,
8. pegmatoide hornblendites.

PETROGRAPHIC DESCRIPTION OF HORNBLENDITES WITH TEXTURAL ORDERING

These rocks are characterized by parallelly embedded hornblende columns and sphene crystals. By the shape of the rock-forming components their structure is regarded to be a subhedral-allotriomorphic one and the degree of their crystallinity shows a decussate crystalline structure (*Fig. 3*). On the basis of the absolute size of the crystals their structure can be regarded phaneritic (the crystals are visible by naked eye) and aphanitic (microcristalline) ones. The lineation of microcrystalline hornblendites is always determined by sphene crystals while in the phanerocrystalline types it is given by amphiboles (and sphenes and biotites if they are present in the rocks). Origin of erdered texture has been explained by several theories: (a) crystallisation of the rocks under high pressure (IANOVIC 1934), (b) metamorphism which retained the schistosity during the anatectic

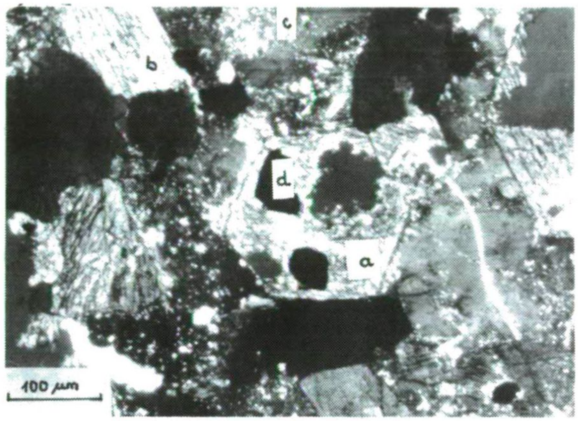

Fig. 3. Hornblendite with textural ordering: (a) hornblende, (b) biotite, (c) plagioclase, (d) magnetite. 28X, +N.

process (CODARCEA *et al.* 1957), (c) metasomatism of crystalline protholith preserving the original schistosity (JAKAB 1986). Modal composition of hornblendites with textural ordering is shown in Table 1.

TABLE 1.

Modal composition of hornblendites with textural ordering

Minerals	volume per cent		
	1	2	3
Hornblende	70—72	80—82	85—86
Plagioclase An 4-58	7—8	2—3	5—6
Orthoclase	1—2	—	—
Biotite+Chlorite	4—5	3—4	—
Titanite	6—7	6—8	—
Apatite	2—3	4—6	4—5
Magnetite	2—3	2—3	3—4

(1) microcrystalline, sphene-bearing hornblendite, (2) phenocrystalline, sphene- and biotite-bearing hornblendite, (3) phenocrystalline, sphene- and biotite-free hornblendite.

Majority of the rocks consist of prismatic hornblende. Dicroism of these minerals shows light brown-redbrown or sometimes light brown subordinately slightly greenish brown colour (*Fig. 4*). It can include apatite by a poikilitic way as well, but in most cases the apatite develops among mafic minerals.

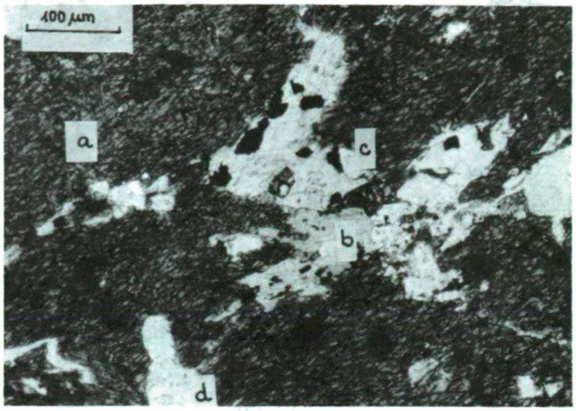

Fig. 4. Hornblendite with textural ordering: (a) hornblende, (b) chloritized biotite, (c) apatite, (d) sphene. 28X, 1N.

Biotite can be found only in closely intergrowth with hornblende and due to the chloritization its dicroism is light brown or green-striped dark brown. It contains sphene and apatite as inclusion. The biotite plates quite often are bended or smashed and always altered. Result of this alteration is a greenish-blue mineral: the pennine. Biotite-pennine changes are always accompained by the occurrence of small sphene crystals which are embedded in the cleavage planes of the biotite or they are in an aggregate form.

Leucocratic minerals are presented by anhedral feldspars. Their polysynthetic twins are sometimes strongly vavy (*Fig. 5*). It is conspicuous that the anorthite content of the plagioclase feldspars of these hornblendites are 4–58 percent (CONSTANTINESCU, ANASTASIU 1977). We think to be a higher anorthite content

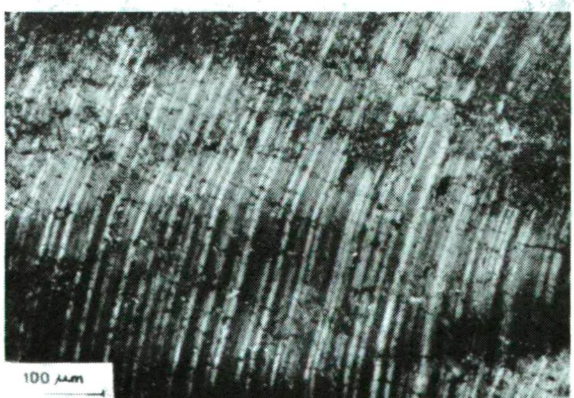

Fig. 5. Hornblendite with textural ordering: plagioclase with strongly vawy polysynthetic twins. 28X, +N.

in them. Some feldspars are sericitized or epidotized or zoisitized (*Fig. 6*). Orthoclase also occurs in very small amount. Sometimes orthoclase-microcline plates dotted by small albite crystals are also recognizable (antiperthite, *Fig. 7*).

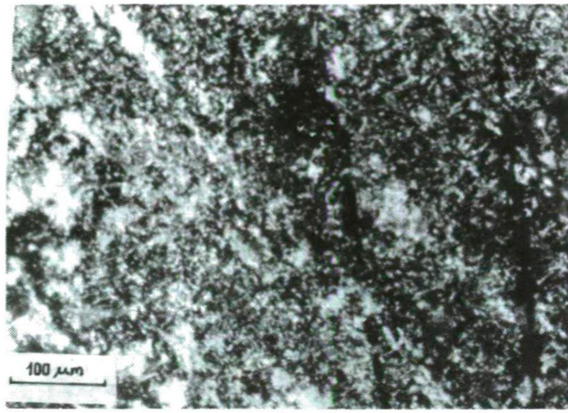

Fig. 6. Hornblendite with textural ordering: sericitized and epidotized feldspars. 28X, +N.

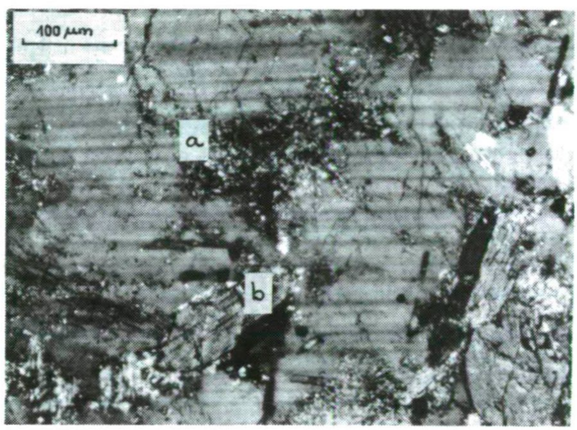

Fig. 7. Hornblendite with textural ordering: (a) antiperthite, (b) biotite. 28X, +N.

Feldspathoides are not characteristic in these rocks.

The sphene always shows two generation origin. The first generation sphene is larger euhedral characteristically rombic sometimes feather-shaped yellowish-brown crystal which is often twinned (*Fig. 8*). The large sphene crystals can include small euhedral amphibole inclusions. Second generation of sphene occurs as small grain in the hornblendites but it mostly appears in altered biotite plates (*Fig. 9*).

The apatite is a quite frequent component of these rocks. They always form euhedral crystals as inclusions found in any other minerals (*Fig. 10*). Magnetite is also not rear and it forms irregular or rounded grains (*Fig. 11*). Based on shape and orientation of these accessory minerals a probable sequence of their crystalli-

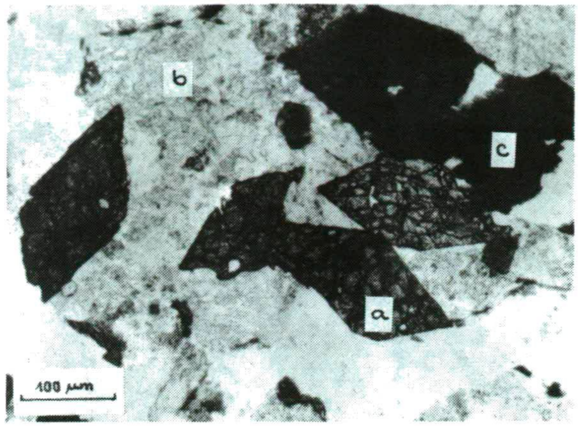

Fig. 8. Hornblendite with textural ordering: (a) sphene, (b) feldspar, (c) biotite. 28X, 1N.

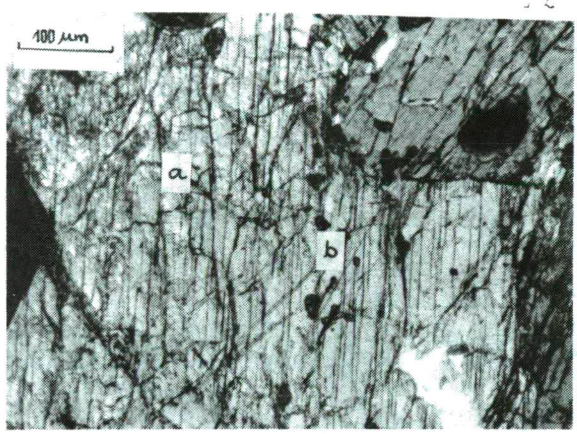

Fig. 9. Hornblendite with textural ordering: (a) biotite, (b) second generation sphene. 28X, 1N.

Fig. 10. Hornblendite with textural ordering: apatite. 28X, +N.

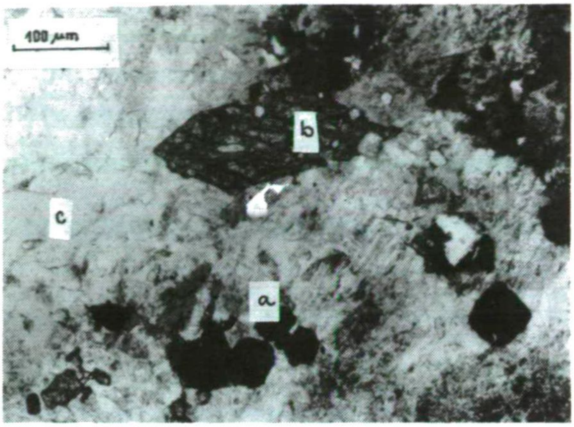

Fig. 11. Hornblendite with textural ordering: (a) magnetite, (b) sphene, (c) feldspar. 28X, 1N.

zation can be supposed, as follows: apatite, magnetite, first generation sphene, hornblende, biotite, second generation sphene and plagioclase.

Epidote veinlets are frequent in the hornblende minerals. Sometimes an epidote excess prevails in the whole rocks forming interstitial fillings or irregular nests between larger crystals. In the chlorite-epidote associations microgranular albite also occur as veinlets cutting calcite crystals. Simultaneous presence of plagioclase (An 86–88) and the albite (CONSTANTINESCU, ANASTASIU 1977) disturb the determination of the order and circumstances of the crystallization. Spatial relationships of these minerals and their relations to other minerals suggest a secondary character of the albite.

Existence of second generation sphene and chloritized biotite as well as frequent epidotization and low anorthite content of the plagioclase, moreover the infrequent presence of the albite and presence of orthoclase and microcline are in close genetical connection with each other. Considering the alkaline character of the whole Ditró Massif, these fhenomena originated from rearrangement of Na, Ca and K content i.e. probably a powerful alkaline metasomatism took place (PÁL-MOLNÁR 1988).

PETROGRAPHIC CHARACTERIZATION OF HORNBLENDITES WITHOUT TEXTURAL ORDERING

It is characteristic that amphibole crystals of the rock-types show a non-oriented arrangement. According to their structure they can be divided into three sub-types: (1) rocks having a phaneretic structure (sometimes in pegmatoidic development characterized occasionally by several cm large amphibole and sphene prisms), (2) rocks consisting of small microgranular crystals, (3) rocks show a porphyric character (larger amphibole and biotite crystals are embedded among smaller rock-forming minerals).

According to the degree of crystallinity they may be docrystalline; in accordance with the shape of crystals they could be subhedral sometimes anhedral; and regarded their size they are phaneritic or microcrystalline rocks.

Varieties listed at the beginning of this sub-chapter No. II, all of them up to the olivine-pyroxene hornblendites have same mineralogical composition to that of hornblendites having oriented texture. The single distinctive criterium is the orientation of the minerals. Their modal composition can be seen in Table 2. Olivine-pyroxene hornblendites and pyroxene hornblendites as well as pegmatoidic hornblendites differ from them both in modal composition and stucture.

TABLE 2.

Modal composition of hornblendites without ordering

Minerals	volume per cent					
	1	2	3	4	5	
Hornblende	87—90	83—84	80—82	68—70	66—68	65—67
Actinolite	—	—	—	—	13—15	—
Biotite	—	2—3	—	6—8	1—2	14—16
Plagioclase An 4-58	5—6	2—3	2—3	8—10	—	6—7
Titanite	—	5—6	8	—	5—6	4—5
Apatite	3—4	2—4	4—6	8—10	7—8	2—3
Chlorite	—	—	—	—	4—6	—
Sericite	—	—	—	3—4	1	2—3
Carbonate	—	—	—	—	2—3	1
Magnetite	2—4	0—3	2—3	—	0—1	0—1

(1) microcrystalliner, sphene- and biotite-free hornblendite, (2) microcrystalline, sphene- and biotite-bearing hornblendite, (3) phanerocrystalline, sphene-bearing hornblendite, (4) phanerocrystalline, biotite-bearing hornblendite, (5) phanerocrystalline, biotite- and sphene-bearing hornblendite.

Olivine-pyroxene hornblendites have a poikilitic structure. Their modal composition is shown in Table 3 and *Fig. 12*. The amphiboles are brown hornblendes shown a considerable dichroism and they are often penetrated by sagenite lattices.

TABLE 3.

Modal composition of olivine-pyroxene hornblendites

Minerals	volume per cent
	6
Hornblende	45—50
Pyroxene	11—38
Olivine	3—21
Biotite	1—2
Plagioclase, An 58	5—25
Apatite	1—2
Opaque, other	1—10

The pyroxenes are Ti-augites which forms equigranular crystal inclusions in the hornblende or biotite grains. Olivine crystals also appear as inclusions of hornblendes forming rounded irregular grains and most frequenly they are transformed into antigorite. The plagioclase (An 58, CODARCEA *et al.* 1957) form euhedral and

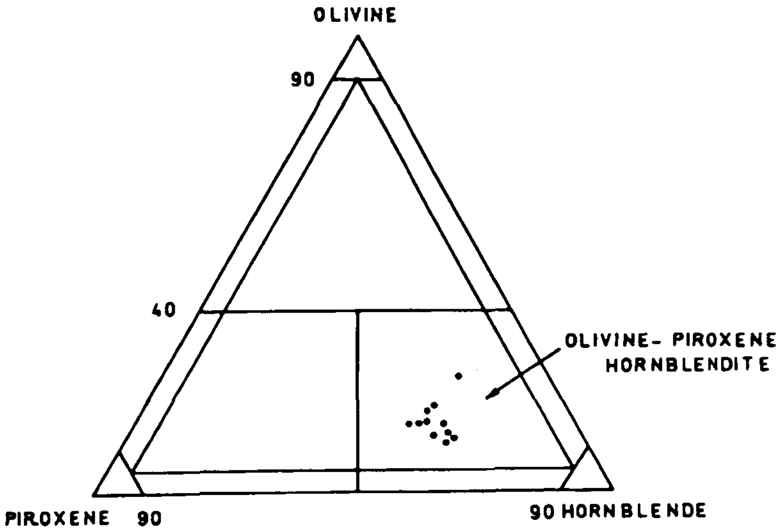

Fig. 12. Classification of ultramafic rocks containing hornblende: olivine-pyroxene hornblendite (after STRECKEISEN 1974).

well developed crystals which are surrounded by hornblende prisms. On the basis of microscopic study the following sequence of crystallization has been found: apatite, magnetite, olivine, augite, plagioclase, hornblende and finally the biotite.

Pyroxene-hornblendite rocks have allotriomorphic structure which is formed by rounded and foiled shape of the rock-forming minerals. The thick prismatic pyroxene crystals surrounded by feldspars show an euhedral habit, only. Modal composition of these rocks are shown in Table 4 and *Fig. 13*. Hornblendes having

TABLE 4.

Modal composition of pyroxene hornblendites

Minerals	volume per cent		
		7	
Hornblende	58—60	54—56	64—66
Actinolite	2—3	4—5	—
Biotite	10—12	30—32	—
Pyroxene	10—12	12—14	20—22
Titanite	4—5	—	5—6
Plagioclase An 0-30	10—12	—	—
Epidote	2—3	—	—
Sericite	1—2	—	—
Apatite	1—2	—	5—6
Magnetic, other	2—3	—	6—7

a light brown-dark greenish brown dicroism the most developed crystals are in this rock-type. The greenish colourization appearing on the edges of the hornblende crystals can be regarded supposedly as an initial actinolitization (*Fig. 14*). Their perforated character is given by the biotite, apatite, sphene and pyroxene inclusons.

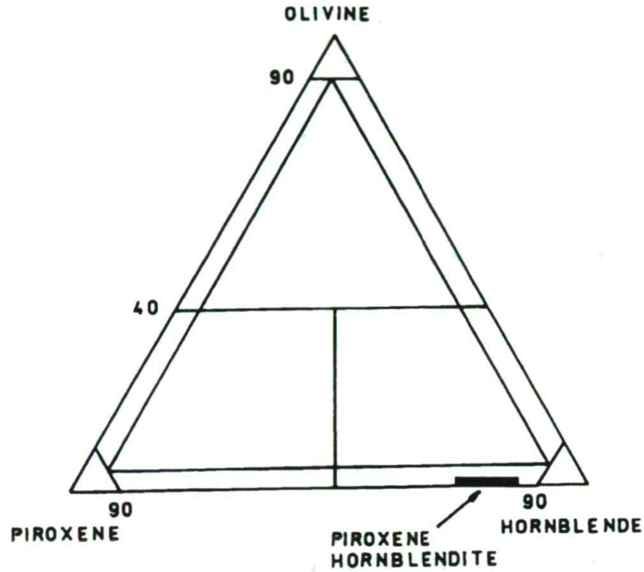

Fig. 13. Classification of ultramafic rocks containing hornblende: pyroxene hornblendite (after STRECKEISEN 1974).

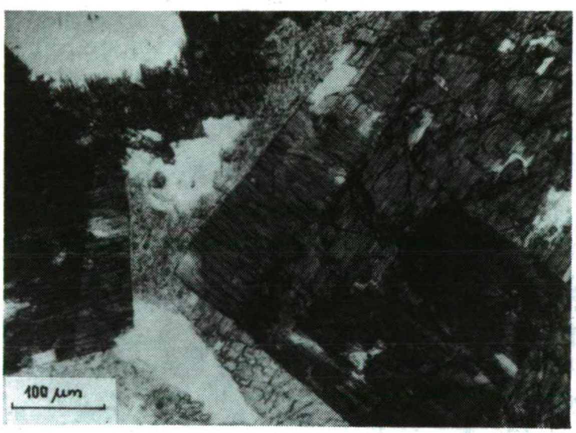

Fig. 14. Pyroxene hornblendite: slightly actinolitized hornblende. 28X, 1N.

The anhedrally shaped feldspars are observable as interstitial fillings among melanocratic minerals. The albite-oligoclase are normally non-twinned or occasionally exists a recognizable polysynthetic twinning. They contain a great number of euhedral and small prismatic pyroxene inclusions. The thick prismatic rock-forming pyroxenes are presented by augites (*Fig. 15*). The first generation sphenes form well-developed sometimes slightly weathered crystals. The biotite is also well-developed and second generation sphenes appear between the plates. The interstitial apatites show anhedral shape but there are euhedral apatite inclusions

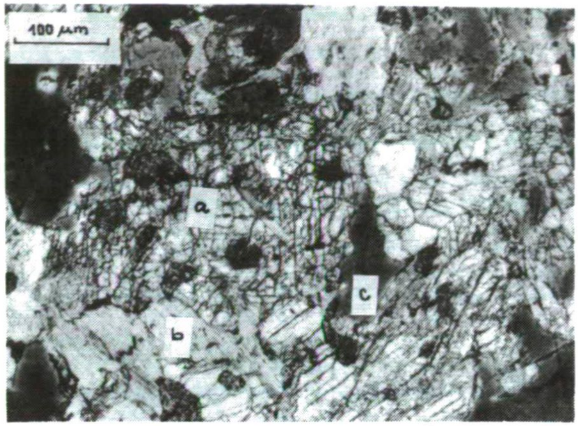

Fig. 15. Pyroxene hornblendite: (a) augite, (b) biotite, (c) chlorite. 28X, 1N.

in the melanocratic minerals. Magnetite occurs either in the form of large irregular grain penetrated by acicular apatite or as small euhedral crystal.

Pegmatoidic hornblendites are represented by smaller and bigger nests or lenses situated irregularly mostly in the microcrystalline hornblendites. Their extent can also reach 100—200 m. Petrographically they are composed by fairly well-developed hornblende and sphene crystals as well as biotite plates which are embedded into a slightly sericitized and non-twinned albite-oligoclase groundmass (CODARCEA *et al.* 1957). Locally small carbonatic patches are also recognized in them (*Fig. 16*). The biotite plates often contain fibrous rutile inclusions as a network originated by rutile twin-law (sagenite lattice).

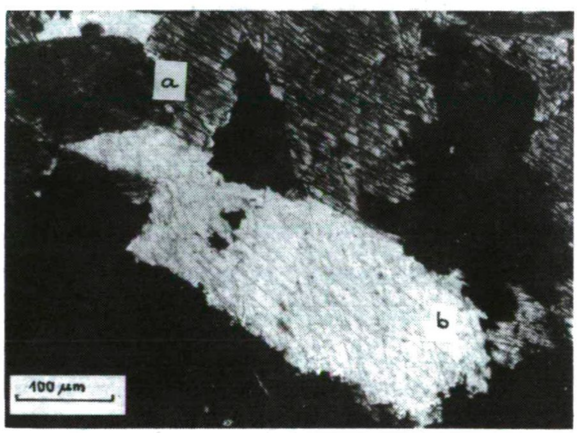

Fig. 16. Pegmatoidic hornblendite: (a) hornblende, (b) calcite. 28X, +N.

TABLE 5.

Modal composition of pegmatoidic hornblendites

Minerals	volume per cent
	8
Hornblende	30—75
Biotite	2—8
Plagioclase An 9-18	8—50
Apatite	10—12
Titanite	3—8
Carbonate	2—3
Sericite	1
Opaque	0—6

CONCLUSIONS

The first exact petrographic classification of the Northern Hornblendite Group of Ditró syenite massif is carried out in this paper. The groups of above-mentioned form not to sharply definable petrological units in space. Transitions or definite boundaries between the rock types equally occur. Genetic interpretation is missing yet. This reviewed mineralogical-petrographic description of Ditró (Orotva) hornblendites indicates magmatic-metasomatic processes in their development. However, a detailed genetical analysis requires an exact knowledge of spatial and temporal connections of these groups as well as determination of tectonic character and cycle of events in the massif. Most important tasks is to produce sufficient proofs for this analysis by systematically carried out investigations.

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