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COMPOSITION OF PYROXENES IN HORNBLENDITES FROM THE NORTHERN PART OF THE DITRO SYENITE MASSIF

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ABSTRACT

Pyroxene is an essential mineral of olivine-pyroxene hornblendites and plagioclase-pyroxene hornblendites cropping out in the northern part of the Ditro syenite massif. On the basis of microprobe analyses and the IMA classification (Morimoto, 1988; Rock, 1990), Ferroan Diopsides are the most important pyroxenes of the ultrabasic rocks. As alteration products, subsilicic aluminian sodian [Magnesium-rich] Augites and/or subcalcic magnesium-rich Augites can be found in a subordinate amount. Subsilicic aluminian Aluminian Aegirine-Augite can also appear in the marginal parts of the single Ferroan Diopside grains.

INTRODUCTION

The syenite massif of Ditro is situated in the S-SW part of the Gyergyó Alps belonging to the Eastern Carpathians. Diameters of its surface are 19 and 14 km in NW and SE directions, respectively; its are is 225 km^2 including the bordering zones as well.

Several researchers have dealt with mineralogy of the syenite massif, however, there have been only few data on pyroxenes. Streckeisen (1954) published chemical composition of only one pyroxene sample coming from pegmatite nepheline syenites. Several studies (JANOVICI and IONESCU, 1969, 1970; Anastasiu and Constantinescu, 1974, 1981) have dealt with more comprehensive mineralogical research but pyroxenes have not been concerned. One of the most comprehensive mineralogical-petrological report on the syenite massif of Ditro (JAKAB et al., 1987) discussed pyroxenes only on a general level. These mineralogical studies based on mainly microscopic analyses, and served petrographic work. Since petrography of the syenite massif is very complex, there will be sense of single mineralogical studies if petrographic environment is determined in a correct way. Purpose of this paper to determine composition of pyroxenes of ultrabasic rocks (hornblendites) cropping out on the northern part of the Ditro Syenite Massif by microprobe analyses.

PETROGRAPHIC AND OPTICAL FEATURES

Pyroxenes can be found in two groups of hornblendites cropping out in the northern part of the Ditro Syenite Massif, north of the Orotva Brook (PÁL MOLNÁR, 1992). These are: olivine-pyroxene hornblendites and plagioclase-pyroxene hornblendites. Their modal

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quantity ranges fro 10 to 38 % in these rocks. Dominantly, they appear as equigranular, columnar, short prisms, and many cases as inclusions of hornblende or biotite. In thin section, it is colourless, sometime pale green, slightly pleochroic. α=light green - pale bluish green, pale green, β=yellowish green, pale brown, reddish, γ=grayish green, dark green. Optical character is positive. Twins are common. They are generally accompanied by calcite and granular epidote.

MICROPROBE ANALYSES

Microprobe analysis of minerals was performed on the Cameca SX-50 (accelerating voltage: 15kV, sample current: 20 nA) electron microprobe at the University of Berne (Switzerland) by using natural standards.

Concept of the measurements was not only to determine composition of pyroxenes in a single point but to trace the compositional variety by measuring along a selected line in every 50-100 µm. The approximately equivalent values, which represented the same mineral species, were averaged, and the mean values were used in the calculations. Two typical cases were selected amongst the several hundreds measurements. In one case, the pyroxene grain appeared as an inclusion (generally in amphibole) (figure 1), in the second, it could be found as an independent mineral constituent (figure 2). These two representative cases were characteristic for both olivine-piroxene and plagioclase-pyroxenes hornblendites.

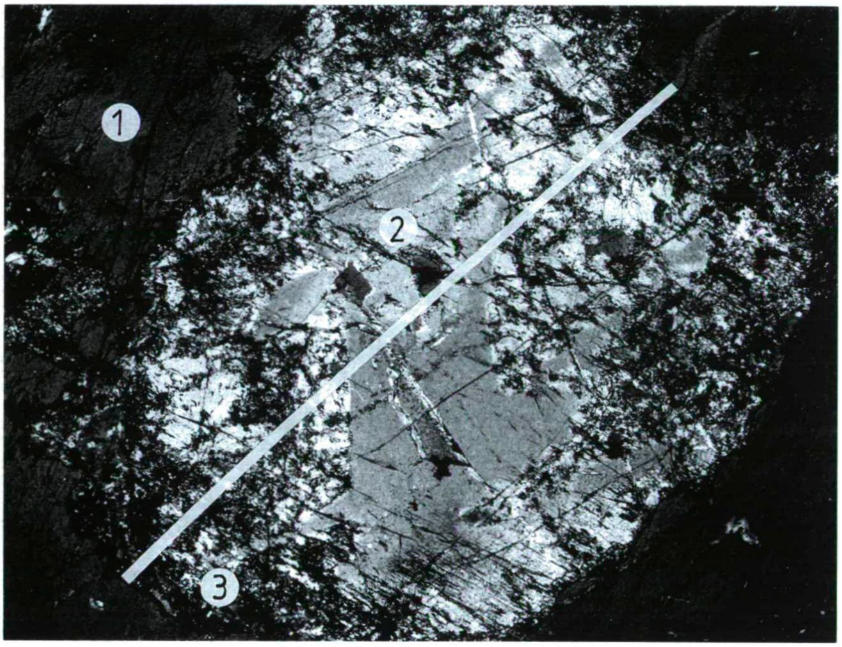

Fig 1. Plagioclase-pyroxene hornblendite
1. ferroan pargasite, 2. ferroan diopside, 3. magnesium-rich augite crown
——— measuring line (x23, crossed polars)

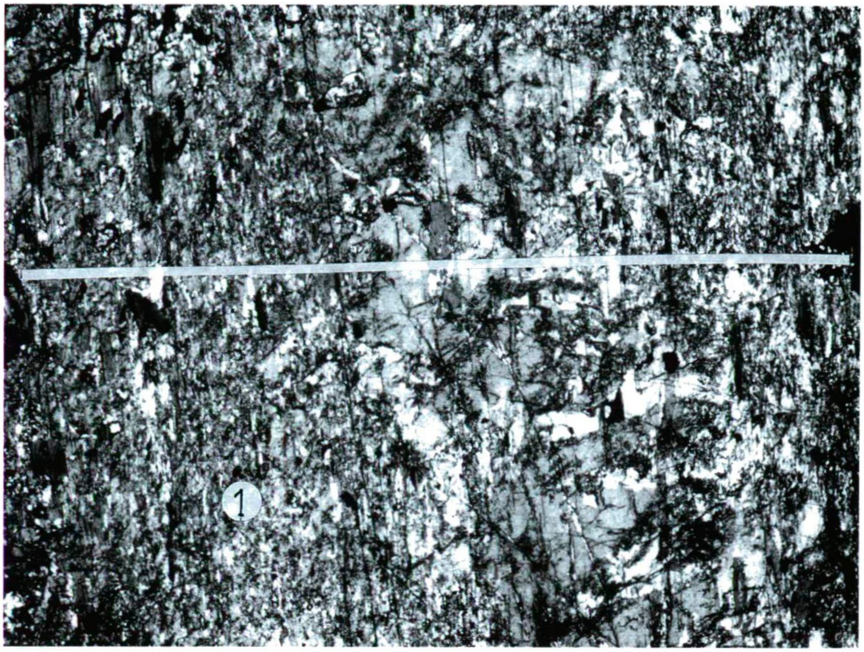

Fig. 2. Olivine-pyroxene hornblendite
1. ferroan diopside (magnesium-rich augite, aluminian aegirine-augite)
——— measuring line (x23, crossed polars)

Determination of the theoretical end-member components calculated from the chemical compositions and order of cations for crystallographic positions was performed by the IMA recommendations (MORIMOTO, 1988; ROCK, 1990). The MINPET 2.0 mineralogical-petrological program (RICHARD, 1988-1995) and the MINPROG chemical program (HARANGI, 1993) was used in the calculations. Calculating method suggested by DROOP (1987) was followed for estimating the values of Fe^{3+}.

Chemical composition and classification of pyroxene appearing as an inclusion of amphibole is shown by table 1 and figure 3, respectively. Figure 4 shows compositional variety of a pyroxene grain along a line. Chemical composition and nomenclature of independent pyroxene crystals can be seen in table 2 and figure 5, respectively. Figure 6 represents its compositional variety along a line.

The dominant component is the diopside (Ferroan Diopside) in both cases. In a subordinate amount, Augite (subcalcic magnesium-rich Augite, subsilicic aluminian sodian magnesium-rich Augite) and aegirine-augite (subsilicic aluminian Aluminian Aegirine-Augite) also occurs. Augite surrounds diopside like a crown in both cases (figures 1 and 2), however, aegirine-augite is characteristic for the marginal parts of the independent pyroxene grains, only (figure 6). It can be seen in figures 4 and 6 that augite also appears in the core of the pyroxene but along the cracks, only. Therefore, proportion of iron and alumina continuously increases from the diopside to the aegirine-augite, and sodium appears in the independent pyroxene grains. Proportion of magnesium can be regarded to be constant in the diopside-augite system.

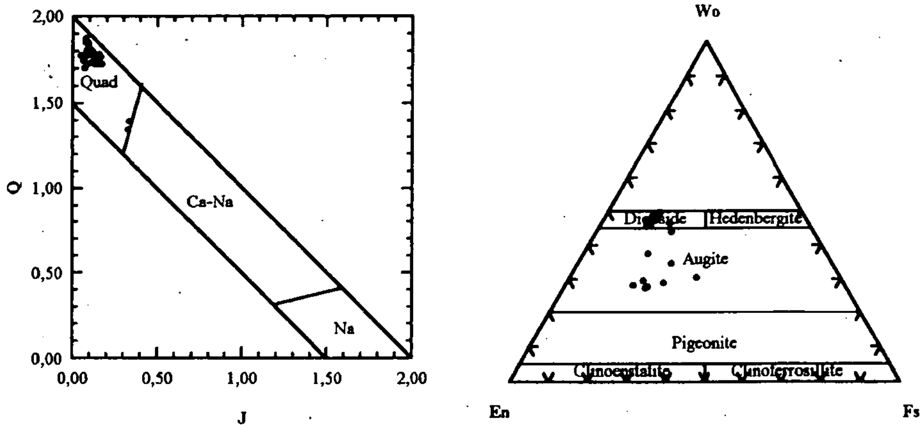

Fig. 3. Ca-Mg-Fe (Quad) clinopyroxenes occurring as inclusions in amphiboles of olivine-pyroxene and plagioclase-pyroxene hornblendites (MORIMOTO, 1988)

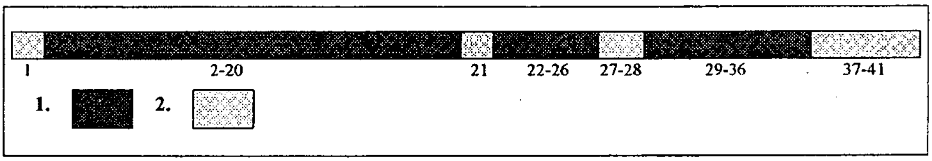

Fig. 4. Compositional variety of a pyroxene grain in amphibole along a measuring line
1. ferroan diopside, 2. subcalcic magnesium-rich augite

CONCLUSIONS

Pyroxenes of the studied ultrabasic rocks (olivine-pyroxene hornblendites, plagioclase-pyroxene hornblendites) are uniformly ferroan diopsides, which turns into magnesium-rich augites and aluminian aegirine-augites toward the margin of the grains.

Composition of clinopyroxenes is a sensitive indicator for the nature of the magma and the history of the crystallization. The above presented detailed microprobe analyses serve as a preliminary study for the petrogenesis of ultrabasic rocks of the Ditro Syenite Massif.

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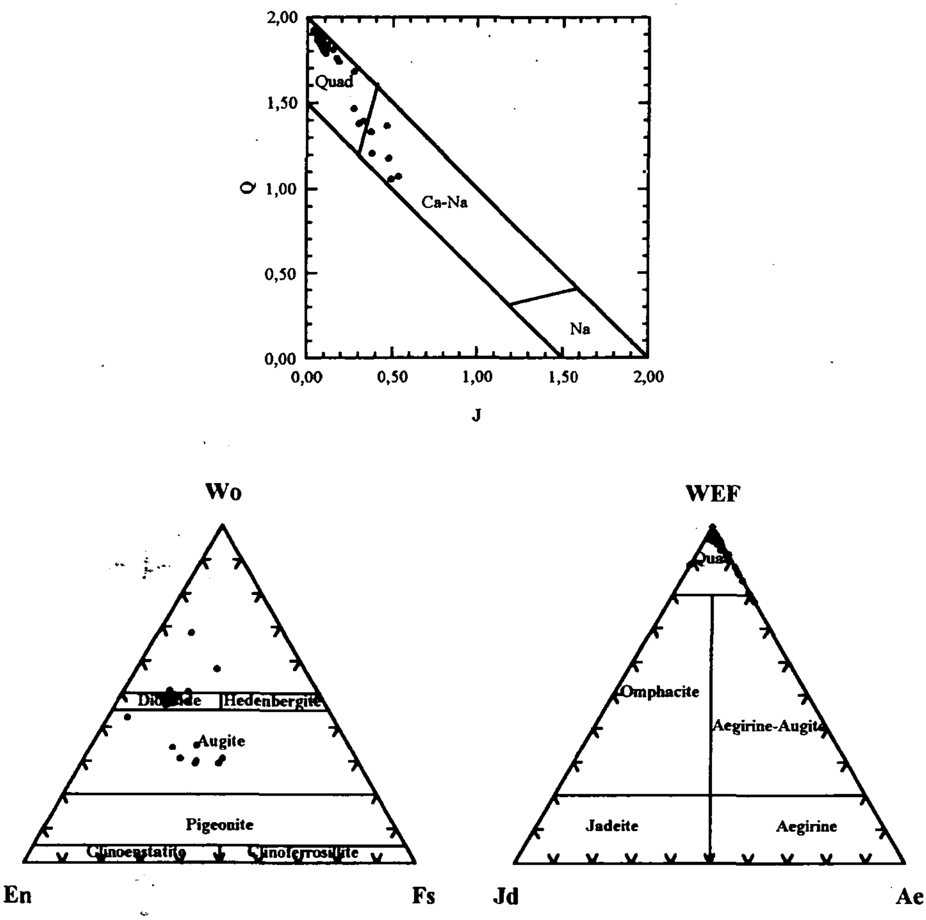

Fig. 5. Ca-Mg-Fe (Quad) and Ca-Na pyroxenes occurring as independent grains in olivine-pyroxene and plagioclase-pyroxene hornblendites (MORIMOTO, 1988)

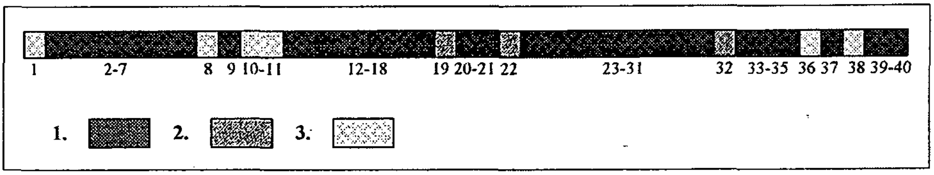

Fig. 6. Compositional variety of an independent pyroxene grains along the measuring line
1. ferroan diopside, 2. subsilicic aluminian sodian magnesium-rich augite, 3. subsilicic aluminian Aluminian aegirine-augite

Representative chemical composition of pyroxenes occurring as inclusions of amphibole
Sample ÁGKT 6547 - plagioclase-pyroxene hornblendite, Orotva, Pietraria de Sus Brook

Sample ÁGKT 6547: 41 measuring points by 50 μm		
	average of the points 2-20, 22-26 and 29-36	**average of the points 1, 21, 27, 28 and 37-41**
SiO_2	53.07	51.85
TiO_2	1.00	0.61
Al_2O_3	2.58	4.93
FeO	7.11	13.40
MnO	0.29	0.52
MgO	14.50	14.36
CaO	22.84	12.48
Na_2O	0.56	0.76
K_2O	-	0.31
SUM	101.95	99.22
Cations		
T site		
Si^{4+}	1.9261	1.9360
AlIV	0.0739	0.0640
Fe^{3+}	-	-
TOTAL	2.000	2.000
M1 site		
AlVI	0.0364	0.1529
Fe^{3+}	0.0213	-
Ti^{4+}	0.0273	0.0171
Cr^{3+}	-	-
Zr^{4+}	-	-
Ni^{2+}	-	-
Mg^{2+}	0.7843	0.7991
Fe^{2+}	0.1307	0.0309
Mn^{2+}	-	-
TOTAL	1.000	1.000
M2 site		
Mg^{2+}	-	-
Fe^{2+}	0.0638	0.3875
Mn^{2+}	0.0089	0.0164
Ca^{2+}	0.8881	0.4992
Na^{2+}	0.0393	0.0697
TOTAL	1.000	0.973
Σ OX	6.000	6.000
End - members		
ZrAe	-	-
Ae	2.130	-
Jd	1.800	7.165
Nept	-	-
Kosm	-	-
Ka	0.890	1.686
CaTi	5.460	3.516
CaCr	-	-
CaTs	1.840	8.553
Ess	-	-
Jo	-	-
Di	74.810	39.248
Hd	6.700	-
En	-	-
Fs	6.370	3.176
Fs-En	-	36.657
	IMA name: Ferroan DIOPSIDE	**IMA name:** [subcalcic magnesium-rich] AUGITE

TABLE 2

Representative chemical composition of the independent pyroxene grains
Sample ÁGKT 6706 - olivine-pyroxene hornblendite, Orotva Brook, gallery VI.

Sample ÁGKT 6547: 40 measuring points by 100 μm			
	average of the points 2-7, 9, 12-18, 20, 21, 23-31, 33-35, 37, 39 and 40	**average of the points 19, 22 and 32**	**average of the points 1, 8, 10, 11, 36 and 38**
SiO_2	52.34	45.35	40.48
TiO_2	1.12	2.48	3.06
Al_2O_3	2.99	11.25	12.58
FeO	6.85	11.13	16.74
MnO	0.25	0.20	0.43
MgO	13.97	13.41	9.78
CaO	23.63	14.11	11.22
Na_2O	0.70	1.85	2.72
K_2O	0.03	0.08	1.47
SUM	101.88	99.86	98.48
Cations			
T site			
Si^{4+}	1.9004	1.6682	1.5317
AlIV	0.0996	0.3318	0.4683
Fe^{3+}	-	-	-
TOTAL	2.000	2.000	2.000
M1 site			
AlVI	0.0282	0.1560	0.0927
Fe^{3+}	0.0600	0.1736	0.4710
Ti^{4+}	0.0305	0.0686	0.0870
Cr^{3+}	-	-	-
Zr^{4+}	-	-	-
Ni^{2+}	-	-	-
Mg^{2+}	0.7560	0.6018	0.3493
Fe^{2+}	0.1253	-	-
Mn^{2+}	-	-	-
TOTAL	1.000	1.000	1.000
M2 site			
Mg^{2+}	-	0.1334	0.2023
Fe^{2+}	0.0227	0.1688	0.587
Mn^{2+}	0.0077	0.0062	0.0137
Ca^{2+}	0.9192	0.5560	0.4548
Na^{2+}	0.0505	0.1356	0.2704
TOTAL	1.000	1.000	1.000
Σ OX	6.000	6.000	5.999
End - members			
ZrAe	-	-	-
Ae	5.050	13.560	27.043
Jd	-	-	-
Nept	-	-	-
Kosm	-	-	-
Ka	0.770	0.620	1.370
CaTi	6.100	13.720	17.402
CaCr	-	-	-
CaTs	2.820	15.600	9.271
Ess	0.950	3.800	18.812
Jo	-	-	-
Di	71.780	22.480	-
Hd	10.270	-	-
En	-	13.340	20.232
Fs	2.260	-	-
Fs-En	-	16.880	4.620
	IMA name: Ferroan DIOPSIDE	**IMA name:** subsilicic aluminian sodian [Magnesium-rich] AUGITE	**IMA name**: subsilicic aluminian Aluminian AEGIRINE-AUGITE

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