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PENNINIC OPHIOLITES AT THE EASTERN MARGIN OF THE EINSENBERG-GROUP (FELSŐCSATÁR, W-HUNGARY)

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ABSTRACT

At the Eastern termination of the Alps there are various greenstones of basaltic origin, ultramafitites and a meta-ultrabasic rocks exposed in the tectonic windows of the Eisenberg-Group. The paper gives detailed description of the mineralogy and mineral chemistry of this rock suite.

INTRODUCTION

In the "Rechnitzer Penninikum" (PAHR, 1977, 1980*a*, 1980*b*) there is ample evidence of an igneous activity, the age of wich apparently coincides with the early stage of the Cretaceous sedimentation. Predominant products of this activity are lavas and tuffs of basaltic composition with gabbros and various ultramafics. The magmatic centers were found in Austrian territory, whereas in Hungary mainly pyroclastics were detected by mapping in the areas adjoining the Austro-Hungarian frontier. The original depth and character of the igneous activity is not yet fully disclosed and need more detailed research the first result of wich are presented here.

GEOLOGICAL SETTING

The Eisenberg-Window is built up by Mesosoic metasediments (*i.e.* quartz-phyllites, phyllites, carbonate-phyllites and calcareous shales) with some metamorphic ophiolites (metabasalts, ultramafitites, meta-ultrabasics). Their lithostatigraphic setting was established on the basis of information supplied by outcrops, exploration-drifts and bore holes (SZEBÉNYI, 1948, VARRÓK, 1953, KOTSIS, 1957, 1982, VENDEL and KISHÁZI, 1967, KUBOVICS, 1983). The deepest known members of the sequence are organic-rich graphite-bearing phyllites and quartzphyllites overlain by carbonate phyllites at places with a characteristic conglomerate (the Cák-conglomerate) wich are covered by carbonate phyllites, calcareous phyllites, calcareous shales and crystalline limestone. The uppermost member of the sequence is a thick series of greenschist. The phyllite series contains large complexes of serpentinite to have been intruded in solid state. Along the margins of the serpentinite mass there are meta-ultrabasics of various composition.

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The ophiolites are represented by 1. greenstones, 2 ultramafics (serpentinized), 3. meta-ultrabasites.

1. Greenstones of basaltic origin. These rocks are usually of pale-green color, compact and — at places — exhibit more or less pronounced schistosity. Their major constituents are albite, epidote, tremolite-actinolite and chlorite. The mafic minerals are characteristically poor in iron: both the clinozoizite-epidote and tremolite-actinolite series are represented by their iron-poor members. It is the amount of chlorites wich fluctuates most, also it never exceeds the amount of the afore-mentioned two other components. The only felsic mineral is albite, occurring as large porphyroblasts. Minor components: quartz, titanite as common constituents of sedimentary origin, pyrite slightly altered to limonite and secondary vermiculite, rare carbonate.

On the basis of 28 modal analyses of the basaltic greenstones the mineralogical composition is as follows: albite 30% (19—37), chlorite 18% (6—33), epidote-clinozoizite 23% (5—35), tremolite-actinolite 27% (16—36), titanite 5% (3—6). Detailed mineralogical data (after LORENZ, 1976) are shown *Fig. 1.*

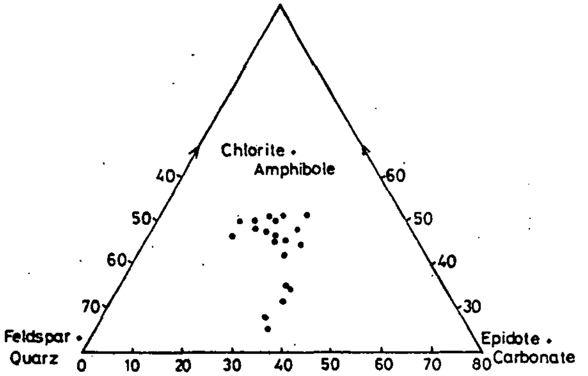

Fig. 1. Mineral composition of basaltic greenstones.

The possible pyroclastic origin of greenstones is reflected also by the relative high fluctuations of some elements from the chemical analyses (e.g. SiO_2, Na_2O). Their whole rock chemical composition is shown in Table 1.

2. SERPENTINITES

Serpentinites are medium green, blackish-green rocks with Al-bearing antigorite and lizardite as major constituents. Monomineralic serpentinites are rare. They usually contain minor components as talc or fibrous silica minerals (lussatite, chalcedony). At places relict aggregates of olivin, grains of ilmenite, magnetite and chromite also occur.

There were no relict pyroxenes in any of the Hungarian rocks, whereas in Austria W. POLLAK (1962) identified ones in the Badersdorf serpentinite. The antigorite-lizardite aggregates, however, nicely preserve the shape of the olivine grains.

Chemical analyses of some selected samples are shown in Table 2. That clearly

Table 1

Chemical composition of the greenschists of the Eisenberg Group

	1	2	3	4	5	6	7	8	9	10	11	12	13*
SiO_2	47.25	48.76	49.85	51.80	42.40	53.60	53.11	48.26	45.73	48.67	50.57	48.84	38.75
TiO_2	1.52	1.57	1.57	2.33	0.92	0.95	0.69	1.57	1.12	1.60	1.20	1.13	6.23
Al_2O_3	16.23	13.77	17.40	14.02	17.26	19.58	16.55	16.77	17.04	15.75	13.83	17.68	13.55
Fe_2O_3	10.36	7.80	9.94	8.23	10.55	9.61	2.33	7.80	7.13	1.00	0.90	2.24	8.83
FeO_3	—	3.32	—	—	—	—	6.02	3.72	3.38	—	7.09	4.65	8.50
MgO	6.55	7.60	7.55	10.45	11.30	3.15	7.60	7.60	8.50	9.84	5.58	6.45	5.29
MnO	0.32	—	0.29	0.12	0.28	0.34	—	0.27	0.15	—	0.15	0.12	0.19
CaO	9.30	7.57	6.60	9.46	7.95	6.10	9.54	7.57	11.95	7.84	12.16	12.56	11.25
Na_2O	3.11	3.42	2.41	0.18	1.34	2.56	0.22	3.42	2.70	2.94	4.49	2.77	1.95
K_2O	0.65	0.75	0.28	0.37	0.47	0.55	0.14	0.65	0.18	0.57	0.13	0.05	0.26
H_2O	4.95	3.23	4.32	3.36	7.27	3.67	0.45	2.73	2.20	2.77	2.61	1.43	5.03
Σalk	3.76	4.17	2.69	0.55	1.81	3.11	0.36	4.07	2.88	3.51	4.62	2.82	2.21

1—9 Felsőcsatár; 10 Badersdorf; 11 Pinkatal-Burg; 12 Woppendorf; 13* crossit-greenschist Felsőcsatár

Table 2

Chemical composition of the Felsőcsatár serpentinites

	1	2	3	4	5	6	7	8	9	10
SiO_2	39.30	37.85	39.28	36.31	39.05	36.45	36.86	38.80	46.00	56.3
TiO_2	0.19	0.06	0.01	0.01	0.02	0.01	0.01	2.67	0.10	0.1
Al_2O_3	4.58	6.05	1.52	1.63	1.69	1.28	1.28	1.53	2.52	1.0
Fe_2O_3	10.28	10.98	8.52	7.45	7.19	4.50	6.86	12.32	1.40	1.9
FeO	—	—	—	—	—	—	—	—	4.40	3.5
MgO	29.45	30.91	36.83	35.45	36.45	33.62	32.85	27.90	32.30	26.3
MnO	0.10	0.09	0.08	0.14	0.08	0.25	0.19	0.13	0.10	—
CaO	1.32	0.90	0.91	1.06	0.91	3.54	1.84	4.41	—	0.8
Na_2O	—	0.38	0.14	—	0.39	0.64	0.24	0.14	—	—
K_2O	—	0.26	0.32	—	0.12	0.43	0.30	0.53	0.05	—
H_2O	13.41	12.32	12.32	17.02	14.10	17.02	19.10	11.15	12.90	9.8

indicate the peridotitic pyroxenitic character of the parent rock: sample No. 9 is unusually low in CaO, wich calls for orthorhombic pyroxenes and olivine to be supposed as parent minerals (neither monoclinic pyroxenes nor Ca-amphiboles could provide for such a Ca-poor mineral assemblage when metamorphosed). The normativ composition of their protolith rock (calculated on dry basis) probably comprises forsterite-rich olivine (cca 30 percent) and bronzitic pyroxene (cca 70 percent).

The formation of the major constituents of these ultrabasic rocks (*i. e.* antigorite, lizardite and secondary magnetite) and the alteration of the serpentine minerals into talc and local silification of the serpentinite can be reconstructed and deduced from the equation (KUBOVICS, 1983):

$$12\,(Mg, Fe)_2SiO_4 + 12\,H_2O + O_2 \rightarrow 3\,Mg_6Si_4O_{10}OH_8 + 2\,FeFe_2O_4$$

Talc occurs mainly along the margins of the serpentinite bodies, thus reflecting the late metamorphic-metasomatic character of talc formation. It is accompanied by silica minerals and carbonates indicating that talc itself was formed by metamorphic-metasomatic alteration also of serpentinites of ultramafic origin. It seems to be highly probable, however, that the reaction producing talc took place at a temperature somewhat higher than that of serpentinization (KUBOVICS, 1983):

$$12\,Mg_{1,5}FeO_{0,5}Si_2O_6 + 6\,H_2O + O_2 \rightarrow 6\,Mg_3Si_4O_{10}(OH)_2 + FeFe_2O_4$$

It can be supposed that the proportion of ferrous iron in the original pyroxene was somewhat higher than indicated by the equation above and thus the alteration may have resulted in the release of silica, which then contributed to the formation of talc and to silification. During serpentinization of the ultrabasites also some chlorites (chloritites, chlorite-schists) were formed in the marginal parts, the character of which is a sensitive indicator of the varying nature of the metamorphism.

The chlorite schists consist mainly of Mg-rich chlorite minerals of various iron content, part of which can be deduced from the original material of the parent ultrabasics (particularly when locally within the ultramafic suite the presence of some Al-rich rocks, such as hornblendites, can be supposed).

Hornblendites often forming the marginal facies of peridotite-pyroxenite complexes offer an attractive explanation for the formation of the chlorite-schists by their metamorphic alteration.

This idea seems to be supported by the presence of titanite-chlorite, a peculiar variety of chlorite-schists in the area concerned (see also below).

3. META-ULTRABASICS

According to the latest results of mapping in the Felsőcsatár area there are titanium- and iron-bearing meta-ultrabasics of various origin in the scree covering the SE slopes of the Nagyvilágos-hill. As to petrology they are titanite-crossitites (1, 2, 3) titanite-chloritites (4) and crossite-epidote-greenstones (5).

The titanite-crossitites consist of alkali-amphiboles of centimeter size with titanite-pseudomorphs after ilmenite. There is an inverse relationship between crossite, epidote, chlorite and albite: the less the percentage of crossite the higher the percentages of epidote+chlorite+albite. It is remarkable that as to composition most crossite crystals are inhomogeneous and along their cleavage planes sometimes even glaucophane may occur.

The titanite-chloritite consist of titanite and rhipidolithe with accessory magnetite and apatite in certain varieties (Table 3).

TABLE 3

Modal analysis of meta-ultrabasic rocks

	1	2	3	4	5
Crossite	70	40	33	55	
Albite	5	12	7	18	
Epidote	3	13	13	6	
Titanite	21			21	35
Magnetite		2		1	10
Chlorite		2	10		54
Ilmenite	1	2			1
Leucoxene		29	36		
Calcite			1		

Mineralogical and chemical variations of the above described mteamorphics are supposed to be due to the inhomogeneous nature of metamorphism on the one hand and to the differences between the equilibrium states of the parent mineral assemblages on the other. This means that chemical changes of metamorphic origin did most probably not affect the studied igneous complex as a whole. Unlike normal ultrabasics all the investigated titanite-crossitites are of a definite tholeiitic character wich suggest a hornblendite or some similar ultramafic rock as the parent material. All evidences point to the fact that the formation of the ultrabasics in the Hungarian part of the Rechnitzer Penninikum must have taken place under rather unusual conditions.

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