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RODINGITE ROCKS IN THE JURASSIC SERPENTINE MASSES FROM THE AREA OF 'RŽANOVO, REPUBLIC OF MACEDONIA

Blažo Boev[1], Vojo Mirčovski[1], Sergej Korikovski[2]

[1]*Faculty of Mining and Geology, Štip, Republic of Macedonia*
[2]*Institute of the Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, Russian Academy of Sciences, Staromonetnyï per. 35, Moscow, 109017 Russia*
e-mail: korik@ igem.msk.su.

A b s t r a c t : Bodies of rodingite rocks have been discovered in the Jurassic serpentinized ultrabasic rocks in the 'Ržanovo nickel mine. Electronic microanalysis and microscopic analyses of rodingites determined the presence of garnet (hydroglossular-hibschite), diopside, chlorite, iron hornblende, actinolite, vesuvian, pumpellyite and prehnite.

Rodingites display gradual transition to associating gabbropegmatites indicating similar chemical composition, the only difference is that rodingites are enriched in CaO, and poor in MgO and FeO.

The pumpellyite + actinolite + chlorite assamblage and the structural-textural characteristics are indicators that rodingites were affected by regional metamorphism in conditions of pumpelite + actinolite assemblage at temperatures from 250 to 300 °C and pressures of 2.5 to 3 kb.

Key words: rodingite; pumpellyite; actinolite; diopside; garnet; pumpellyite-actinolite facies

INTRODUCTION

Rodingite rocks occur in ultrabasic complexes particularly in the parts intensely affected by the process of serpentinization.

Based on data in literature available rodingites in the Republic of Macedonia have been found only in the Ljuboten ultrabasic serpentinized massive (Crnčević et al., 1964).

Activities during the excavation of nickeliferrous ore in the 'Ržanovo mine revealed one meter large bodies of rodingite rocks representing a second occurrence of rodingites in ultrabasic complexes in the Republic of Macedonia. The first data on the petrographic composition of these serpentinized ultrabasic rocks from the area of 'Ržanovo was given by Marić (1931). Data on the geological composition of the terrain, the deposit and the mineralogical characteristics can be found in Ivanov (1960, 1969). Grafenauer and Strmole (1966) carried out mineralogical investigations on the ore from the 'Ržanovo ore series. The degree of metamorphism of lateritic Ni-Fe ores was investigated by Boev and Stojanov (1985). Mineralogical and geochemical investigations in the terrain can be found in the papers of Maksimović (1981), Boev (1982), Boev and Serafimovski (1992), Boev and Lepitkova (1994), Boev and Serafimovski (1995), Boev and Sijakova-Ivanova (1998).

GEOLOGICAL COMPOSITION OF THE 'RŽANOVO AREA

The area of 'Ržanovo is part of the Mount Kožuf massif situated in the south part of the Republic of Macedonia close to the Macedonian–Greek border (Fig. 1). Based on the tectonic regional geologic setting of Macedonia the area under investigation is part of the Vardar zone. It is situated close to the contact between the Vardar zone and the Pelagonian massif in a tectonically active area.

Fig.1. Geographic position of the 'Ržanovo area

The geological composition of the area (Fig. 2) shows that it consists of several litostratigraphic units such as:

– limestones of Alb-Cenomanian age,

– lateritic metamorphosed Fe-Ni ores of Cretaceous age,

– a series of schists presumably of Cretaceous age,

– Jurassic serpentinized ultramafic rocks with gabbropegmatites and rodingites,

– a series of Tertiary volcanic rocks and pyroclasts.

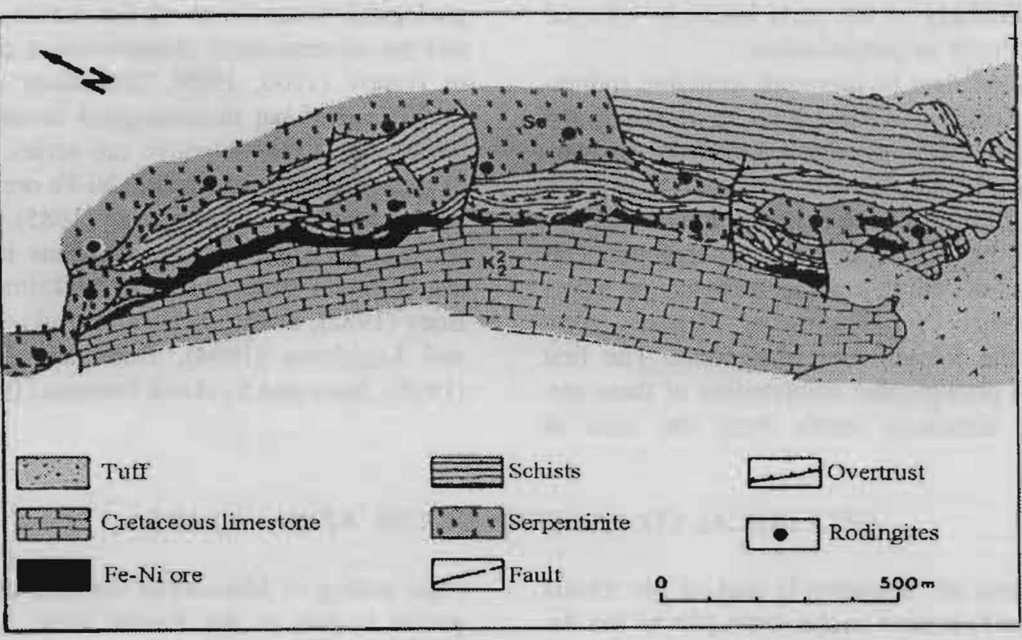

Fig. 2. Geological map of the 'Ržanovo area

Several large dislocations with serpentinized ultrabasic rocks along them intersect the terrain. The area of 'Ržanovo is a thrust zone with a series of parallel thrusts in which serpentinites, schists and marbelized limestones alternate.

Serpentinized ultrabasic rocks in which gabbropegmatites and rodingites also occur are part of the ophiolites of the western portion of the Vardar zone. The ultramafic rocks also host rocks of ultrabasic affinity, dunites and harzburgites affected by serpentinization and are the most common. Basic rocks such as gabbros and diabases also occur.

The spatial distribution and relationship between individual members are not clear as a result of intense tectonic movements.

METHOD OF WORK

Determination of the mineralogical composition of rodingites was carried out with microscope in transmitted light and the method of elctronic microanalysis. The method of electronic microanalysis carried out in the IGEM Institute in Moscow, Russia, determined the chemical composition of mineral phases.

The chemical composition of rodingites and metagabbropegmatites and their surrounding rocks was determined by the method of ordinary silicate analysis.

P–T conditions of regional metamorphism which affected rodingites and gabbropegmatites were determined by geothermobarometric method based on the chemical composition of individual metamorphic minerals.

Rodingites

Rodingite rocks from the 'Ržanovo area are situated mainly in the marginal parts of the serpentinized masses occurring as elongated one meter large blocks of variable thickness and distinct contacts with surrounding serpentinites.

They are hard and tenacious rocks of greater specific weight relative to gabbros. They are grey and grey-greenish to white depending on the garnet and chlorite contents. Their composition consists of hypidiomorphic grains and massive texture.

Microscopic investigations carried out with electronic microanalysis determined the following minerals: garnet (grossular-hibschite), monoclinic pyroxene (diopside), chlorite, amphibole (iron hornblende and actinolite), vesuvianite, pumpelite and prehnite. Garnets mainly substitute earlier plagioclases. Pyroxes are affected by processes of prehnitization, uralitization and chloritization. The relationships between minerals and the presence of pumpelite, actinolite and chlorite in rodingites and gabbropegmatites are indications that these rocks were affected by processes of regional metamorphism.

Such mineralogic composition of the rodingites from 'Ržanovo makes them similar to the rodingites from the Ljuboten serpentine massif. The only difference is that our investigations did not discover any zoisite in the rodingites from 'Ržanovo and no pumpelite and amphibole in the rodingites from the Ljuboten serpentine massif.

Gabbropegmatites

Gabbropegmatites occurring as elongated intrusions (veins) are also found in association with rodingites. Gabbropegmatites are seldom found fresh. They occur as alterated rocks displaying transition to rodingites owing to the process of rodingitization that they underwent. They are coarse-grained rocks with monoclinic system reaching 30 cm in size. They are predominantly made up of basic plagioclase and monoclinic pyroxene with minor amphibole, prehnite and chlorite. Pyroxenes were affected by the processes of chloritization and prehnitization. Plagioclases are also affected by alteration processes with sporadic occurrences of prehnite. This is an indication of encipient rodingitization of gabbropegmatites.

Chemical composition of rodingites

The chemical composition of rodingites is shown in Table 1. The chemical composition of gabbropegmatites as well as that of serpentinized harzburgites and dunites are also given for correlation purposes. Chemical analyses clearly indicate that with regard to the chemical composition rodingites show great similarity to gabbropegmatites. The greatest difference between the two types of rocks

Table 1

Chemical composition of rodingites, gabbropegmatites, and serpentinized harzburgites and dunites

	Rodingites	Metagabbro-pegmatites	Harzburgite serpentinized	Dunite serpentinized
SiO_2	47.89	48.31	37.81	45.06
TiO_2	0.22	0.07	0.07	–
Al_2O_3	13.54	15.61	5.09	–
Fe_2O_3	1.78	–	5.61	3.49
FeO	1.72	6.56	1.92	3.85
MgO	1.83	5.68	36.51	33.98
CaO	31.61	17.51	0.33	0.45
Na_2O	0.03	0.04	0.13	0.01
K_2O	0.01	0.02	0.06	0.06
P_2O_5	0.20	0.13	–	0.09
H_2O	–	–	12.75	12.46
L.I.O	0.90	5.15	–	–
Total	99.73	99.08	100.28	99.45

is in the increased amount of CaO in rodingites relative to gabbropegmatites. There is no significant difference in other component parts except for the small difference in the amount of MgO, Al_2O_3 and FeO in gabbropegmatites. Based on the chemical composition it can be inferred that rodingites were formed as a result of postmagmatic calcic metasomation which supplied CaO to rodingites and extracted MgO and FeO causing the process of rodingitization of gabbropegmatites.

Chemical composition of the minerals

Chemical composition of clinopyroxene

The chemical composition of the clinopyroxene is shown in Table 2. Based on the chemical composition clinopyroxene was determined as diopside (Fig. 3).

Table 2

Microprobe analyses of clinopyroxenes from rodingites of 'Ržanovo

	Sample					
Analyses	126/2	126/4	126/4/1	126/4/2	126/7	126/8
SiO_2	52.31	53.83	53.66	54.24	53.98	53.56
TiO_2	0.0	0.02	0.0	0.06	0.0	0.0
Al_2O_3	0.48	0.13	0.05	0.015	0.41	0.24
FeO^*	12.46	5.49	6.19	5.79	4.86	6.49
MnO	0.07	0.04	0.10	0.08	0.36	0.10
MgO	10.73	15.14	14.65	14.43	14.95	14.30
CaO	23.43	23.31	25.20	25.22	25.18	24.93
Na_2O	0.48	0.0	0.10	0.0	0.17	0.27
K_2O	0.01	0.0	0.0	0.0	0.0	0.05
Total	99.97	97.96	99.95	99.97	99.91	99.94
O = 6						
Si	1.985	2.028	1.987	2.011	1.991	1.984
Al^{IV}	0.015	0.0	0.002	0.0	0.009	0.010
Al^{VI}	0.007	0.006	0.0	0.007	0.009	0.0
Ti	0.0	0.001	0.0	0.002	0.0	0.0
Fe	0.386	0.143	0.191	0.179	0.150	0.201
Mn	0.002	0.001	0.003	0.003	0.011	0.003
Mg	0.607	0.850	0.809	0.797	0.822	0.790
Ca	0.953	0.941	1.000	1.002	0.995	0.990
Na	0.035	0.0	0.007	0.0	0.012	0.019
K	0.0	0.0	0.0	0.0	0.0	0.002
Cations	4.00	4.00	4.00	4.00	4.00	3.998
Wo	48.670	47.872	49.906	50.561	50.300	48.888
En	31.013	43.263	40.368	40.252	41.553	39.816
Fs	20.317	8.865	9.725	9.187	8.146	10.295

*Total Fe as FeO

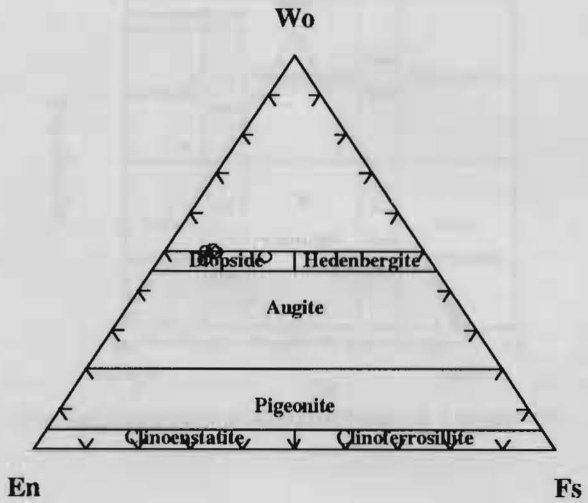

Fig. 3. Classification of pyroxenes on the Ca-Mg-Fe ternary diagram of Subcommittee of pyroxene (1988)

Chemical composition of garnet

The chemical composition of garnet was investigated in three grains along profile in order to determine their homogeneity. Data obtained indicate that there are no significant deviations in the chemical composition from centre to periphery and the grains display fairly homogenous composition. Grossular is the predominant component part (Gros – 97.007 – 83.148), then follows Alm (16.298 – 2.793), whereas other component parts are much less common (Fig. 4). The chemical composition of garnets is shown in Table 3.

Table 3

Microprobe analyses of garnets in rodingites from 'Ržanovo

Analyses	Sample							
	126/4	126/6		126/7		126/8		
	r	c	r	c	r	c	m	r
SiO_2	39.41	38.97	37.79	38.23	38.10	39.17	38.97	39.41
TiO_2	0.10	0.12	0.0	0.0	0.04	0.04	0.0	0.05
Al_2O_3	19.95	21.17	22.18	16.48	17.82	21.45	20.65	20.55
FeO^*	4.12	2.70	1.42	8.98	7.06	2.30	3.08	3.62
MnO	0.08	0.017	0.03	0.02	0.13	0.03	0.12	0.19
MgO	0.04	0.0	0.02	0.16	0.06	0.08	0.0	0.12
CaO	36.26	36.83	38.52	35.76	36.76	36.87	37.08	35.99
Total	99.96	99.96	99.96	99.63	99.97	99.94	99.90	99.93
O = 12								
Si	2.991	2.945	2.841	2.949	2.194	2.955	2.881	2.986
Al^{IV}	0.009	0.055	0.159	0.051	0.086	0.045	0.119	0.014
Al^{VI}	1.774	1.829	1.804	1.446	1.519	1.861	1.679	1.820
Ti	0.006	0.007	0.0	0.0	0.002	0.002	0.0	0.003
Fe	0.262	0.171	0.089	0.579	0.452	0.145	0.190	0.229
Mn	0.005	0.0	0.002	0.001	0.008	0.002	0.193	0.012
Mg	0.005	0.011	0.002	0.018	0.007	0.009	0.0	0.014
Ca	2.949	2.982	3.102	2.955	3.012	2.980	2.937	2.922
Alm	8.122	5.394	2.793	16.298	12.979	4.627	5.735	7.221
Gross	91.578	94.262	97.077	83.148	86.582	95.025	88.456	91.969
Pyrope	0.141	0.0	0.070	0.518	0.197	0.287	0.0	0.427
Spess	0.160	0.344	0.060	0.037	0.242	0.061	5.809	0.384

* Total Fe as FeO; c – core; m – middle; r – rim.

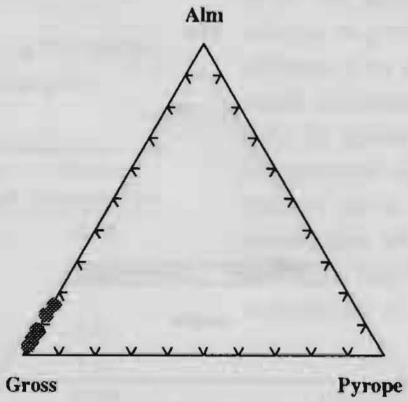

Fig. 4. Composition of garnets from rodingites

Chemical composition of amphiboles

The chemical composition of amphiboles is shown in Table 4. Because of their chemical composition amphiboles belong to calcite amphiboles. Amphibole in rodingites was classified as actinolite, and that in metagabbros was classified as Fe-hornblende (Leake, 1978) (Fig. 5).

Table 4

Microprobe analyses of Ca-amphiboles from rodingites (126/2) and metagabbro (126/5) of 'Ržanovo

Sample	126/2		126/5		
Analyses	Act	Act	Fe–Hbl	Fe–Hbl	Fe–Hbl
SiO_2	51.39	53.39	45.01	44.64	44.81
TiO_2	0.02	0.10	0.58	0.57	0.87
Al_2O_3	3.23	2.78	8.25	8.18	7.70
FeO	18.39	12.88	23.75	23.59	24.77
MnO	0.07	0.07	0.17	0.16	0.21
MgO	12.07	17.15	7.54	7.48	6.96
CaO	11.85	11.01	11.35	11.28	11.30
Na_2O	0.63	0.43	1.33	1.32	0.03
K_2O	0.08	0.0	0.08	0.08	0.11
Total	97.73	97.81	98.06	97.30	97.70
O = 23					
Si	7.607	7.632	6.850	6.877	6.865
Al^{IV}	0.393	0.368	1.150	1.123	1.135
T-site	8.00	8.00	8.00	8.00	8.00
Al^{VI}	0.170	0.100	0.328	0.361	0.254
Ti	0.002	0.011	0.066	0.000	0.100
Fe^{2+}	2.141	1.107	2.613	2.569	2.406
Fe^{3+}	0.023	0.127	0.282	0.353	0.650
Mn	0.009	0.000	0.000	0.000	0.000
Mg	2.663	3.655	1.711	1.718	1.590
C-site	5.00	5.00	5.00	5.00	5.00
Mn	0.009	0.008	0.022	0.021	0.027
Fe	0.112	0.305	0.128	0.117	0.118
Ca	1.879	1.686	1.851	1.862	1.855
Na	0.000	0.000	0.000	0.000	0.000
B-site	2.00	2.00	2.00	2.00	2.00
Na	0.181	0.119	0.392	0.394	0.009
K	0.015	0.000	0.016	0.016	0.021
A-site	0.196	0.119	0.408	0.410	0.030
Sum. cat.	15.196	15.119	15.408	15.410	15.030

*Total Fe as FeO

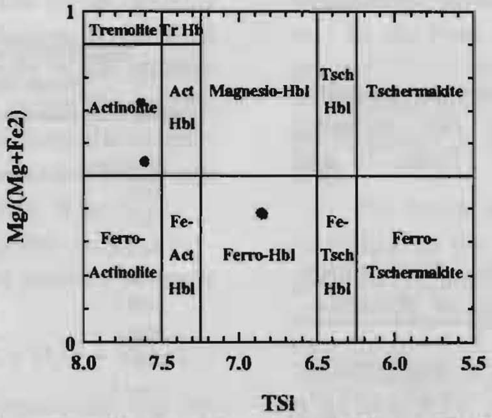

Fig. 5. Classification of the amphiboles (B. Leake, 1988)

Chemical composition of chlorites

The chemical composition of chlorites is shown in Table 5. Because of their chemical composition they are classified as the brunsvingite-piccnochlorite-clinochlorite series (Hey, 1954).

Table 5

Microprobe analyses of chlorites from rodingites of 'Ržanovo

	Sample								
Analyses	126/2	126/4	126/4/1	126/5	126/6	126/7	126/7/1	126/8	126/8/1
SiO_2	28.77	30.08	29.31	26.07	28.73	30.83	32.34	30.00	28.06
TiO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.12	0.09	0.0
Al_2O_3	18.43	17.76	19.38	19.60	19.14	17.72	17.56	17.37	18.98
FeO^*	23.42	16.93	17.43	30.78	18.89	13.06	9.54	18.43	21.52
MnO	0.12	0.29	0.03	0.37	0.61	0.25	0.22	0.32	0.22
MgO	17.66	22.17	21.47	11.10	20.78	24.89	27.76	21.35	19.04
CaO	0.03	0.45	0.28	0.09	0.04	0.19	0.18	0.05	0.10
Na_2O	0.17	0.18	0.15	0.16	0.29	0.24	0.14	0.01	0.17
K_2O	0.04	0.0	0.0	0.02	0.08	0.01	0.03	0.01	0.0
Total	88.64	87.86	88.05	88.19	88.56	87.19	87.89	87.62	88.09
O = 28									
Si	5.907	6.030	5.864	5.630	5.788	6.093	6.210	6.068	5.755
Al^{IV}	2.093	1.970	2.136	2.370	2.212	1.907	1.790	1.932	2.245
Al^{VI}	2.364	2.223	2.430	2.614	2.329	2.212	2.181	2.206	2.339
Ti	0.0	0.0	0.0	0.0	0.0	0.0	0.017	0.014	0.0
Fe	4.022	2.838	2.917	5.559	3.183	2.159	1.532	3.118	3.691
Mn	0.021	0.049	0.005	0.068	0.104	0.042	0.036	0.055	0.038
Mg	5.406	6.626	6.404	3.573	6.241	7.333	7.947	6.438	5.822
Ca	0.007	0.097	0.060	0.021	0.009	0.040	0.037	0.011	0.022
Na	0.068	0.070	0.058	0.067	0.113	0.092	0.052	0.004	0.068
K	0.010	0.0	0.0	0.006	0.021	0.003	0.007	0.003	0.0
Cations	19.898	19.902	19.874	19.908	20.000	19.886	19.809	19.849	19.980
Fe/Fe + Mg	0.43	0.30	0.31	0.61	0.34	0.23	0.16	0.33	0.39

*Total Fe as FeO

Chemical composition of pumpellyite, prehnite and vesuvianite

Among other minerals present in rodingites the chemical analyses carried out included pumpellyite (Table 6), prehnite (Table 7) and vesuvianite (Table 8).

Table 6

Microprobe analyses of pumpellyites from rodingites (126/2) and metagabbro 126/1 of 'Ržanovo

	Sample				
Analyses	126/1	126/1/1	126/1/2	126/2	126/2/1
SiO_2	36.11	37.71	37.34	38.05	37.63
TiO_2	0.04	0.0	0.06	0.12	0.05
Al_2O_3	29.00	25.16	26.63	25.99	25.79
FeO^*	2.91	4.32	4.13	3.26	4.18
MnO	0.13	0.15	0.09	0.10	0.04
MgO	1.32	2.38	1.30	2.89	2.45
CaO	23.49	23.21	23.27	22.92	22.55
Na_2O	0.36	0.0	0.29	0.13	0.0
K_2O	0.08	0.0	0.04	0.01	0.0
Total	93.44	92.93	93.15	93.35	92.76
O = 14					
Si	6.581	6.944	6.853	6.924	6.914
Al	6.224	5.456	5.756	5.570	5.581
Ti	0.005	0.0	0.008	0.0	0.017
Fe	0.444	0.665	0.634	0.496	0.642
Mn	0.020	0.023	0.014	0.015	0.006
Mg	0.359	0.653	0.356	0.784	0.671
Ca	4.587	4.579	4.576	4.469	4.439
Na	0.127	0.0	0.103	0.046	0.0
K	0.019	0.0	0.009	0.002	0.0

* Total Fe as FeO

Table 7

Microprobe analyses of prehnites from rodingites from secondary veins of 'Ržanovo

	Sample		
Analyses	126/5	126/5	126/5/1
SiO_2	37.76	43.84	43.72
TiO_2	0.05	0.07	0.87
Al_2O_3	25.55	24.32	23.81
FeO^*	4.82	0.19	0.38
MnO	0.21	0.0	0.0
MgO	1.97	0.11	0.0
CaO	23.02	26.65	26.85
Na_2O	0.18	0.15	0.04
K_2O	0.01	0.0	0.02
Total	96.57	95.33	95.69
O = 12			
Si	2.966	3.293	3.281
Al	2.364	2.149	2.102
Ti	0.003	0.016	0.049
Fe	0.316	0.012	0.024
Mn	0.014	0.0	0.0
Mg	0.232	0.012	0.0
Ca	1.940	2.145	2.159
Na	0.028	0.022	0.044
K	0.001	0.0	0.002

* Total Fe as FeO

Table 8

Microprobe analyses of vesuvianites from rodingites of 'Ržanovo

	Sample		
Analyses	126/4	126/4/1	126/8
SiO_2	38.12	37.73	36.61
TiO_2	0.21	0.18	0.20
Al_2O_3	18.91	17.60	16.92
FeO^*	4.09	6.61	4.81
MnO	0.15	0.23	0.0
MgO	0.64	0.99	2.25
CaO	34.72	34.13	36.65
Na_2O	0.0	0.13	0.06
K_2O	0.0	0.0	0.0
Total	96.84	97.60	97.50
O = 38			
Si	9.553	9.516	9.270
Al	5.576	5.221	5.038
Ti	0.039	0.035	0.038
Fe	0.854	1.389	1.015
Mn	0.032	0.084	0.0
Mg	0.241	0.374	0.854
Ca	9.324	9.223	9.943
Na	0.0	0.064	0.030
K	0.0	0.0	0.0

* Total Fe as FeO

P-T conditions of metamorphism

The Pm + Act + Chl mineral paragenesis discovered in rodingites and gabbropegmatites is an indication of the conditions for regional metamorphism in pumpellyite-actinolite facies (Hashimoto, 1966). According to the degree of metamorphism this facies represents the transition from the very low to low degree metamorphism or the transition from pumpellyite-prehnite quartz facies to greenschist facies (Winckler, 1979).

Mineral parageneses, chemical composition of individual important metamorphic minerals and their reaction curves of stability were used during the determination the P-T conditions of metamorphism.

The chemical composition of actinolite was used in estimating the pressure. The Brown geobarometer (1977) yielded P ranging from 2.5 to 3 kb.

Diegel and Ghent (1994) give a model for P-T stability of minerals in the prehnite-pumpellyite facies with a transition towards the greenschist facies in metabasic rocks from the vicinity of Flin Flon – Manitoba, Canada, with Phr + Pmp + Act + Ep assemblage. The model is given for the CMASH-CO_2 system by the calculation for multiplied isobaric T-XCO_2 and P-T diagrams.

The mineral assemblage in the metarodingites and metagabbropegmatites in 'Ržanovo is identical to the one found in metabasic rocks in the vicinity of Flin Flon – Manitoba, Canada, except for epidote. Thus, the P-T conditions obtained from the investigations carried out on the assemblages in Canada can be used for comparison in the case of 'Ržanovo.

The development of the Pmp-Act mineral parageneses according to the present authors is given by the reaction:

$$Cal + Chl + Qz = Pmp + Act + H_2O + CO_2 \quad (1)$$

The P from 2.5 to 3 kb determined for the rocks from the 'Ržanovo Pmp + Act paragenesis is stable at T of around 250 °C.

The break down of the Pmp + Chl paragenesis is given by the reaction:

$$Pmp + Chl + Qz = Ep + Act + H_2O \quad (2)$$

Since epidote was not found in our case it would mean that the maximum P-T stability of Pmp + Chl assemblage was not reached so that the assemblage would break down and yield epidote. At P from 2.5 to 3 kb the Pmp + Chl assemblage is stable at T of around 270 to 280 °C.

Nitsch (1971) gives the following P-T data for the reaction (2): 345 ± 20 °C / 2.5 kb, 350 ± 20 °C / 7 kb.

The break down of the Prh + Chl assemblage according to the opinion of the present authors is given by the reaction

$$Prh + Chl + Qz = Ep + Act + H_2O \quad (3)$$

The lack of epidote in the rocks from 'Ržanovo is an indication that P-T conditions were not sufficient enough for the break down of the Prh-Chl assemblage. For pressure of 2.5 to 3 kb the assemblage is stable at temperature of around 280 °C.

From what was said above one can arrive at the conclusion that metarodingites and metagabbropegmatites investigated were metamorphosed at temperatures between 250 to 300 °C and pressures of 2.5 to 3 kb.

CONCLUSION

Based on investigations carried out the following conclusions can be drawn:

– Since rodingites display transition to gabbropegmatites there is no doubt that they were formed by gabbropegmatite alteration. They formed during medium temperature process of rodingitization by recrystallization of gabbropegmatite bodies. Rodingitization took place with the supply of calcium to rodingites or Ca-metasomation and extraction of Mg and Fe from them.

– Rodingites are simillar in composition to gabbropegmatites, differing only in the higher CaO and the lower MgO and FeO contents. They display significant variation in the chemical composition from surrounding serpentinized ultrabasic rocks.

– Pumpellyite, actinolite and chlorite found in rodingites indicate that the rocks were affected by the process of regional metamorphism in a pumpellyite-actinolite facies at temperatures from 250 to 300 °C and pressures from 2.5 to 3 kb.

The successive order of formation of mineral phases in rodingites depending on the individual phases is given in Table 9.

Table 9

Dependence between individual phases and minerals

Stages	Rodingitizations	Pum-Act facies
Minerals		
Diopside	----------------------	
Garnet	----------------------	
Actinolite		----------------------
Fe-hornblende	----------------------	
Pumpellyite		----------------------
Prehnite	--------	----------------------
Chlorite		----------------------
Vesuvianite	----------------------	

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Резиме

РОДИНГИТСКИ СТЕНИ ВО ЈУРСКИТЕ СЕРПЕНТИНСКИ МАСИ ОД ПОДРАЧЈЕТО НА 'РЖАНОВО

Блажо Боев[1], Војо Мирчовски[1], Сергеј Кориковски[2]

[1]Рударско- геолошки факултет, Штип, Република Македонија.
[2]Институт за геологија, рудни наоѓалишта, петрографија, минералогија и геохемија, Руска академија на науките, Старомонетни пер. 35, Москва, 109017 Русија.

Клучни зборови: родингит; пумпелит; актинолит; диопсид; гранат; пумпелит-актинолитска фација

Во јурските серпентинизирани ултрабазични стени во рудникот за никел 'Ржаново се пронајдени метарски тела од родингитски карпи. Со електронска микроанализа и со микроскопски испитувања во родингитите се одредени следните минерали: гранат (хидрогросулар-хипшит), диопсид, хлорит, железна хорнбленда, актинолит, везувијан, пумпелит и пренит.

Родингитите покажуваат постепен преод кон габропегматитите кои се во асоцијација со нив, а со нив имаат и сличен хемиски состав со таа разлика што родингитите се збогатени со CaO, а осиромашени со MgO и FeO.

Минералната асоцијација пумпелит, актинолит, хлорит, како и структурно текстурните карактеристики укажуваат дека родингитите се зафатени со регионален метаморфизам во услови на пумпелит-актинолитската фација при T од 250–300 °C и P од 2,5–3 kb.