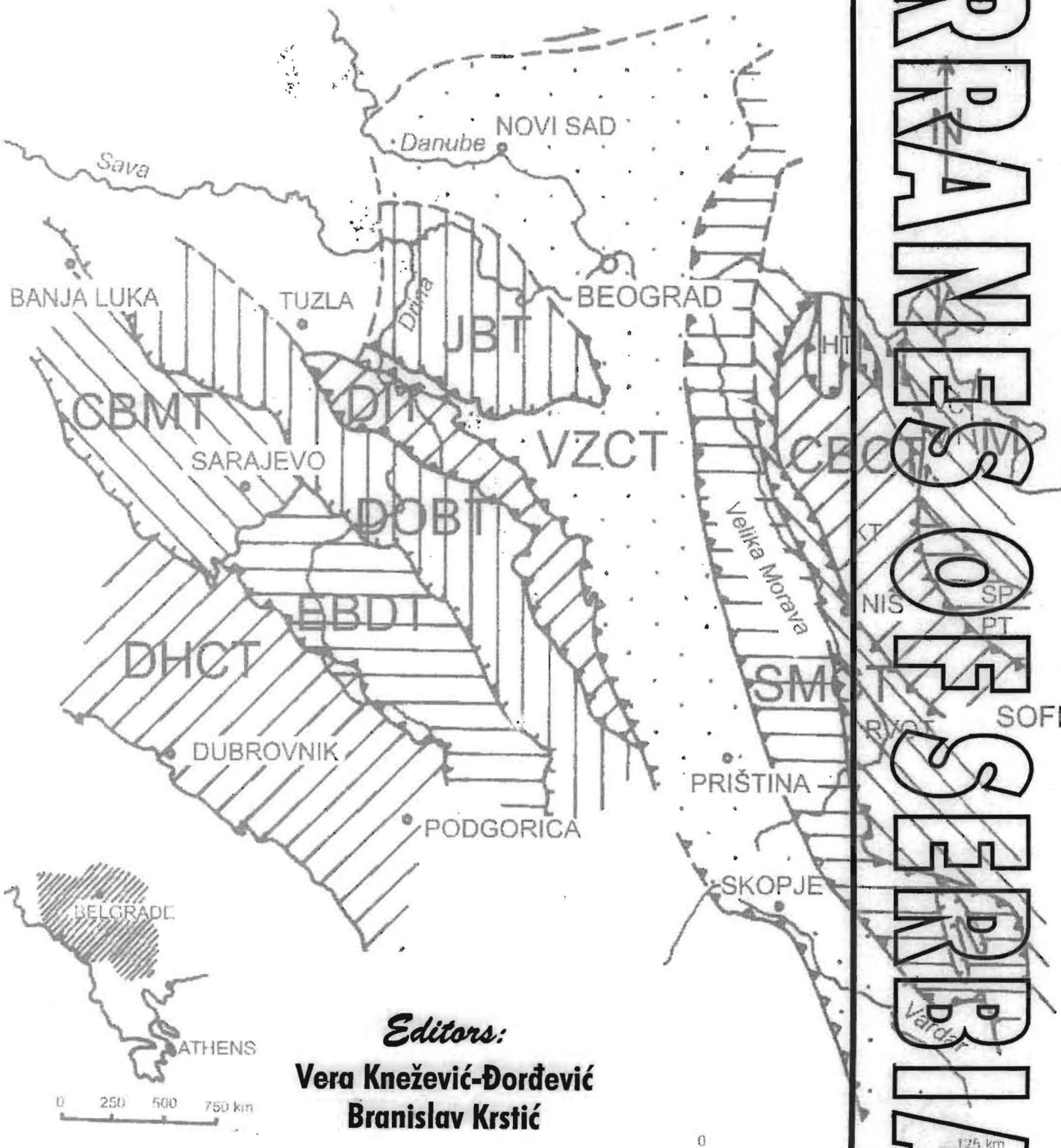
The Formation of the Geologic Framework of Serbia and the Adjacent Regions

Dedicated to Academic Stevan Karamata



Editors:

Vera Knežević-Đorđević

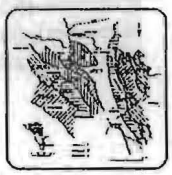
Branislav Krstić

Faculty of Mining and Geology, University of Belgrade

Committee for GEODYNAMICS of the Serbian Academy of Sciences and Arts

II TERRANES OF SERBIA

TERRANES OF SERBIA
Eds: Knežević, V. & Krstić, B.
pp. 173-178, Belgrade, 1996



THE AMPHIBOLITE ROCKS SOUTH-WEST OF THE VILLAGE OF MITRAŠINCI, THE SERBO-MACEDONIAN MASSIF, REPUBLIC OF MACEDONIA

Vojo Mirčovski[1], Blažo Boev[1], Orce Spasovski[1]

[1]Faculty of Mining and Geology, Štip, Republic of Macedonia

Abstract: *An elongated zone of amphibolite rocks with iron-titanium mineralization was discovered in the Precambrian metamorphic complex southwest of the village of Mitrašinci.*

Based on their mineralogical and chemical composition two types of amphibolites were distinguished: garnet-cummingtonite or iron-titanium as well as garnet-biotite or aluminium-sodium type. The amphibole of the cummingtonite types was determined for the first time by our investigations.

The mineral assemblages and the chemical composition of the horblende, garnet and biotite indicate that the main metamorphic phase took place under conditions of almandine amphibolite facies at T of 550 ± 50 °C and P from 4 to 6 kbar.

KEY WORDS: amphibolite, garnet, hornblende, cummingtonite, biotite, metamorphism

1. INTRODUCTION

Two stratigraphic horizons of metamorphic rocks developed in elongated zones with NW-SE strike can be seen in the Precambrian metamorphic complex of the Serbo-Macedonian massif south-west of the village of Mitrašinci, near the town of Berovo (Fig. 1).

The paper deals with the amphibolite rocks of the deeper stratigrafic level along the Kobilski Rid to Gromadna strike in which iron-titanium mineralization can be found. The amphibolite rocks in this horizon were determined as a zone which is 5 to 6 km (thick about 200-250) long and 20 to 300 m wide. The zone lies concordantly within gneisses with sharp relations except in zones of feldspatization where the transition is gradual. (DUMURDŽANOV et al. 1978)

The first data about the degree of metamorphism, the petrological and mineralogical charcateristics in the terrain and further afield were given by SIMIĆ & SIMIĆ (1963). The authors also mention the presence of glaucophane, tremolite and lawsonite close to the ore bodies with titanium-magnetites, but they were not determined by our investigations.

2. APPLIED METHODOLOGY

In addition to standard field and mesoscope investigations, microscopic-petrographic studies, electronic microprobe, X-ray examinations and thermobarometry method were also applied in our investigations.

3. PETROGRAPHY

Two types of amphibolites were distinguished in the investigated area by macroscopic and microscopic examinations: garnet-biotite poor in iron titanium minerals and garnet-cummingtonite which are ore-bearing and contain iron-titanium.

3.1. Garnet-biotite amphibolites

Garnet-biotite amphibolites are midium to large-grained rocks (up to 2 mm in size) of dark to light green colour with massive to poorly schistose but porphyroblastic and nonmetalloblastic texture. They contain smaller amounts of iron-titanium minerals and host elongated lenses of garnet-cummingtonite amphibolites as main bearers of iron-titanium mineralization. They are built of hornblende, garnet, biotite, albite, epidote, chlorite, quartz, apatite, magnetite and ilmenite.

Hornblende is a dominant mineral and comprises 50-60 % of the total rock mass. Microscopic examinations distinguished two types of hornblende. The first type appears as large porphyroblasts of 2 mm in size, unoriented and

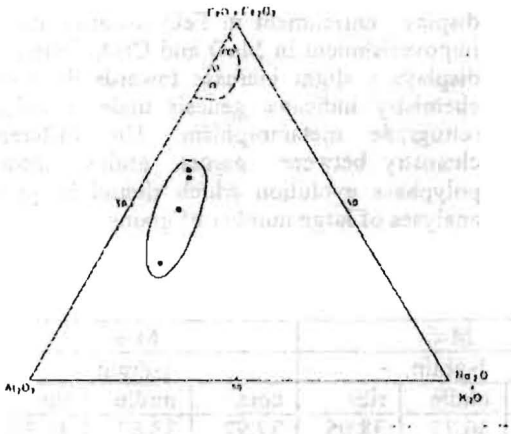


Fig.2. Diagrame of the petrochemical discrimination of the amphibolites sdudied; LEGEND: open circles - garnt-cummingtonite amphibolites, filled circles - garnet-biotite amphibolites

Garnet appears as rounded grain forms which, unlike garnet from garnet-biotite amphibolites, is extremely broken and transform to small cummingtonite prisms but rarely to chlorite.

Quartz, biotite and chlorite are common minerals, but less common with respect to the garnet-biotite type amphibolites.

Ore minerals are very common and in several cases were dominant in the rocks. According to SPASOVSKI (1993) the most common minerals are magnetite, titanium-magnetite and ilmenite, whereas pyrrhotine, pyrite, chalcopyrite, cubanite, hematite and limonite are present in small amounts.

4. CHEMICAL COMPOSITION

The chemical composition was determined in 4 samples of garnet-cummingtonite amphibolites and 4 samples of garnet-biotitic amphibolites. The results obtained are shown in Table 1. The analyses indicate that the amphibolites do not possess homogenous composition and the difference in both types is obvious. The analyses also display difference in composition between individual samples of the same type of amphibolites. The most important difference is that garnet-cummingtonite amphibolites (analyses M-4, M-6, M-18 and M-19) are poor in SiO2 , Al2O3 , Na2O and CaO and rich in FeO, Fe2O3 and TiO2 relatively to garnet-biotitic amphibolites.

Based on the aforementioned differences two petrochemical types can be distinguished: Fe - Ti amphibolites which contain from 32.6 to 60.4 % $FeO + Fe_2O_3$ and 32. - 12.8 TiO_2 as well as Al-Na amphibolites which contain 10.29 to 21.63 % $FeO + Fe_2O_3$ and 1.5 to 5.73 % TiO_2, but small amount of Al_2O_3 which ranges from 10.70 to 16.30 % and Na_2O which ranges from 2.40 to 4.70 %. The distinguished petrochemical types are illustrated in three-component digram (Fig. 2).

Their chemical composition indicates that they also originate from basaltic rocks rich in iron and titanium and the difference in their chemical composition is due to their (magmatic ?) polyphase evolution.

Table 1. Chemical composition of the amphibolites (%)

Sample	M-4	M-6	M-18	M-19	M-8	M-9	M-10	M-13
SiO_2	37.90	40.26	14.40	14.80	43.56	46.07	50.15	46.77
TiO_2	3.20	5.60	12.80	12.50	5.73	2.60	1.50	3.60
Al_2O_3	3.68	5.54	3.69	3.10	16.30	12.05	15.70	10.70
Fe_2O_3	14.78	11.76	30.96	32.21	6.10	4.91	2.47	6.23
FeO	26.35	20.60	29.44	28.79	13.66	16.72	7.82	12.52
MnO	2.11	1.36	0.73	1.07	0.61	1.02	0.18	1.10
MgO	6.47	5.05	2.40	1.97	1.41	4.70	6.16	3.12
CaO	3.10	6.57	2.42	2.19	6.05	6.06	9.97	9.37
Na_2O	0.21	0.92	0.34	0.28	4.73	2.78	3.45	2.40
K_2O	0.13	0.29	0.48	0.76	0.29	0.90	0.87	0.53
P_2O_5	0.30	0.27	0.49	0.29	0.26	1.09	0.19	1.93
H_2O^+	1.40	1.88	1.67	1.68	1.28	1.41	1.32	1.88
H_2O^-	0.11	0.15	0.04	0.06	0.16	0.05	0.11	0.14
Sum.	99.74	100.24	99.86	99.70	100.14	100.35	99.89	100.29

(XRF) Methode

5. CHEMISTRY OF MINERALS

The chemistry of minerals was studied in IGEM Institute at the Russian Academy of Science, Moscow in close cooperation with S. Korikovsky .

5.1. Garnets

The chemical composition of the analysed garnet grains is given in Table 2 . The composition shows that the analysed grains do not have homogenous composition.

5.2. Amphiboles

Chemical composition of amphiboles was examnined in 4 samples and results obtained indicate that they contain two types of amphiboles. Results of their chemical composition are given in Table 3. Based on LEAKE, et al., (1978) Classification of Amphiboles they were determined as cummingtonite and ferro-ferroan hornblende (Fig.3). It can be found only in ore-bearing amphibolites which indicates that the environment rich in FeO was favourable for the development of this mineral.

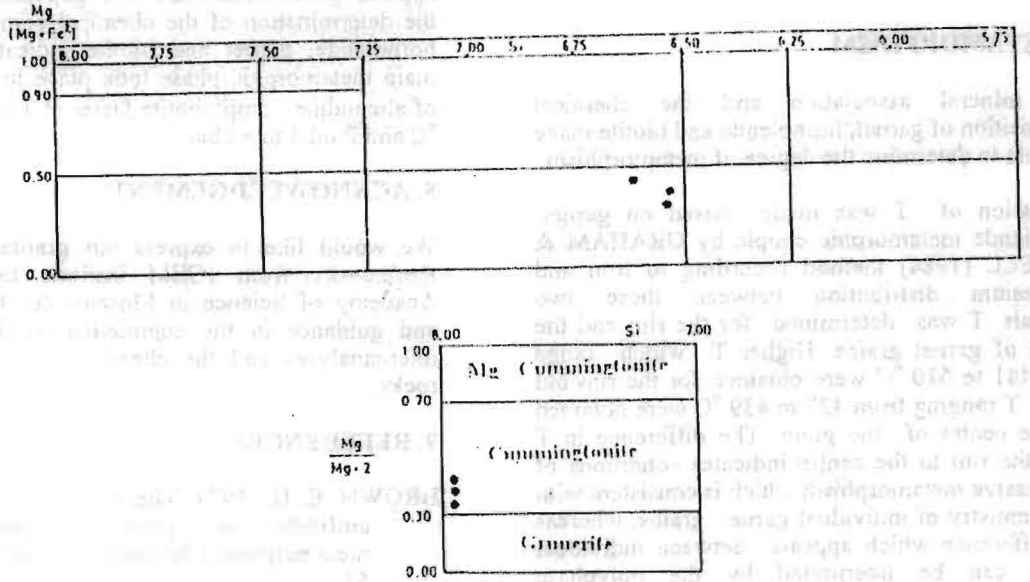


Fig. 3. Clasification of amphiboles. Leake (1978)

5.3. Plagioclases

Chemical composition of plagioclases was examined in one sample of garnet-cummingtonite amphibolites and the results obtained show that this type contains albite with 0.5 to 0.9 % anorthite component (Table 4, sample M-9). The small number of examined grains does not allow determination of more basic plagioclase.

Table 4. Chemical compositon of biotite, chlorite and albite

Samle	M-19	M-9	M-19	M-9	M-9	
	Biotite	Biotite	Chlorite	Chlorite	Albite	Albite
SiO2	34.69	35.61	24.23	27.02	68.62	68.28
TiO2	2.40	2.40	0.12	0.25	0.00	0.00
Al2O3	14.44	14.61	19.07	19.94	20.41	19.79
FeO	27.89	24.86	34.45	29.76	0.00	0.13
MnO	0.17	0.09	0.35	0.35	0.00	0.00
MgO	7.23	9.02	9.43	11.90	0.00	0.00
CaO	0.01	0.00	0.00	0.01	0.11	0.18
Na2O	0.09	0.19	0.08	0.05	11.04	10.43
K2O	9.45	9.63	0.01	0.51	0.00	0.00
Sum	96.37	96.41	87.66	89.79	100.18	98.83
	22 (O)		28 (O)		8 (O)	
Si	5.495	5.544	2.701	2.843	2.981	3.001
Ti	0.286	0.281	0.010	0.020	0.000	0.001
Al	2.696	2.681	2.205	2.472	1.045	1.025
Fe	3.695	3.237	3.211	2.618	0.000	0.005
Mn	0.023	0.012	0.033	0.031	0.000	0.000
Mg	1.707	2.094	1.567	1.866	0.000	0.000
Ca	0.002	0.000	0.000	0.011	0.005	0.008
Na	0.028	0.057	0.017	0.010	0.930	0.889
K	1.910	1.913	0.001	0.068	0.000	0.000
Ab					99.50	99.10
An					0.50	0.90