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Krivaja – Konjuh Ophiolite Complex in Bosnia and Herzegovina Addition to Study on Mineral Composition of Metamorphic Rocks

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ABSTRACT

The paper gives the results on researches of sporadically and accessory components of the amphibolites rocks in the south rim of the Krivaja – Konjuh ophiolite complex in Bosnia and Herzegovina. By optical analyses and x-ray fluorescene spectroscopy examinations as well as electronic microprobes, it was established that in analyzed amphibolites were sporadically found these: corundum, spinels (chrome spinel, hercinite, chrome hercinite and magnesium-chromites), chlorites (clinochlore and ripidolite), zeolite minerals (thomsonite and mesolite), prehnite, epidote-clinocoisite, analcime, albite and serpentine. Examinations indicated that corundum has been found in amphibolites schists as important, secondary and accessory component in form of grain aggregates, like porphyroblast and root mineral. Corundum porphyroblasts contain small inclusions of clinochlore and tchermakite partially transformed into margarite and anorthite, what was proved by x-ray fluorescene spectroscopy and microsonde analyses. Corundum roots which cut corundum amphibolites rarely appear stretch parallel with pholiatia, and they arouse by post-cinematic secretion. The investigations of flaw minerals covered polarization microscopic examinations, x-ray examinations, and electronic micro-probe cmemical analyses. The flaw minerals found are as follows: prehnite, zeolite minerals including thomsonite, mesolite, epidote-clinocoisite, chlorite, calcite and less frequently plagioclase-albite, anorthite, quartz, corundum and analcime formed in the post-consolidation stage of hydro-thermal activities mainly under low-degree metamorphic conditions. Corundum veins and seams crosscuting corundum amphibolites formed post-kinematic secretion. By the researches on amphibolites rocks, there were established the presence of accessory components, with dominant participation of magnetite, titanite, ilmenite, rutile, zircon, apatite, phlogopite and biotite

Keywords: *BiH, the Krivaja – Konjuh ophiolite complex, amphibolites rocks, secondary components, accessory components, optical, roentgen examinations, microsonde analyses*

1. INTRODUCTION

Researched amphibolites rocks in the south rim of the Krivaja – Konjuh ophiolite complex are characterized by equalized petrographic characteristics with certain structural – texture variations and variations in chemical and modal mineral compound.

On the base of texture and structure characteristics, the following groups of rocks can be set aside:
group with well expressed striped texture and non-matoblastic up to lepidooblastic structure;

group with well expressed striped texture and porphyroblastic structure;
group with massive texture and granoblastic up to porphyroblastic structure.

Previous mineralogical – petrographical examinations established the classification of amphibolites rocks into:

Monomineral amphibolites schists
Corundum amphibolites schists (rarely)
Amphibolites bimineral
Diopside amphibolites schists
Garnet diopside amphibolites slates and bimineral amphibolites schists.

In the frame of varieties of amphibolites rocks in the south rim of the Krivaja – Konjuh ophiolite complex, it was stated that there were differences among associations of amphibolites, pyroxene and garnet mineral associations. Previous researches on amphiboles in amphibolites rocks in the Vijaka region proved that there was possible coexistence of two and more amphiboles. It was also stated that garnets showed great variations in chemical composition as well as amphiboles associated

with garnets. The results on chemical researches of the pyroxene mineral phases from all of amphibolites rocks' varieties are projected on diopside field, clinoenstatite field and close to clinoenstatite field, that is, in border area between clinoenstatite and clinopherosilite.
By these researches established were also chemical variations in plagioclase composition, from plagioclase (oligoclase-andesine) up to plagioclase (bytownite-anorthite).

Laboratory tests have confirmed the presence of numerous secondary and accessory components in the analyzed metamorphic rocks of the area screw. These minerals occur as grain, leafy, radial and radial-fibrous aggregates, but also in the form of coatings and veins.

2. CHARACTERISTIC OF OPHIOLITE AND AMPHIBOLE

Dinaric ophiolite zone extends from Zagreb up to the northwest and across the Banija and Bosnia to Serbia, where it runs continuously in Hellenides. Ofiolitnog rock complexes are related to the internal Dinarides and represent a very complex association of rocks among which are the most characteristic rocks associated with different varieties of gabbros, Dolerite, diabase, amphibolite and spilite and united in the so-called. Diabase - hornfels formation or Jurassic - magmatic - sedimentary formation (Katzer 1906, Ćirić 1954; Pamić, 1964).

In some parts Dinaric ophiolite zoneis camouflaged with pulled Mesozoic, mainly carbonate rocks and Palaeozoic semimethamorphic rocks. In the ophiolite zone of Dinarides predominate ultramafic rocks (lerzolites, harzburgites, and serpentinites), with subordinate gabbroes, diabases, basalts and spilites. Very rarely one could meet completely preserved ophiolite profiles (Pamić and Desmons, 1989), and more often chaotic relationships, i.e., ophiolite mélange (Dimitrijević, 1973). Ophiolite mélange is made of shale-silt matrix in which predominate smaller or larger fragments of greywacke and ophiolites, and occasionally arise cherts, sediments and limestone blocks of Tithonian age. As the most predominant rocks in the ophiolite mélange there are peridotite fragments and blocks which represent fault blocks, thickness of a few hundred meters up to 2000 m, drawn to the ophiolite mélange (Pamić and Desmons, 1989). So far in the ophiolite mélange and in its matrix have not been found typical fossil remains. On the base of non-typicalfossils it is presumed Jurassic age, which is consistent with available data on the isotopic age, 189-136 Ma (Lanphere *et al*., 1975; Majer *et al*., 1979; Lugović *et al*., 1991). Over Dinaride ophiolite melange zone lie transgressive lower Cretaceous formations of the Pogari formation in which ophiolite rocks are redeposited. In this way, stratigraphically is defined upper limit of the ophiolite mélange. Amphibolite complex has been made of rocks with various metamorphic grades - it means with greenshist facies rocks in the lowest parts whose degree grows towards epidot amphibolites facies, amphibolites facies and to granulite amphibolites facies. Typical amphibolite rock is consisted of amphiboles and plagioclases with different amounts of the subordinate minerals: pyroxene, garnet, quartz, corundum, magnetite, ilmenite, titanite, rutile, spinel, chlorite, zeolitic minerals, prehnite, epidote-clinozoisite, zircon, biotite, apatite and phlogopite.Krivaja-Konjuh ultramafic massif and joined ophiolite with amphibolite covers area of about 500 km^2 and it represents faulted plate that is thick about 2000 m, which overlaps ophiolite melange. In its most part, it is composed of moderately seprentinised porphyroblast lersolite tectonic rocks. In its southeast parts, in the floor, they are composed of different varieties of amphibolite (Figure.1). The most exposed and the greatest belt of amphibolite is located in the area of village Vijaka, about 18 km in the northeast of Vareš. Foliation in amphibolite is parallel foliation of lersolite tectonites. Contact between amphibolite and ophiolite melange is tectonic.

In Vijaka amphibolite complex, the following varieties of the rocks are confirmed: bimineral amphibolite schist, diopside amphibolite schist, garnet-diopside amphibolite schist, mono mineral amphibolite schist and rarely corundum amphibolite schist. Complete amphibolite complex is characterised with presence of the rocks of different metamorphic level together with rocks of green schist facies in their lowest parts which level increases towards epidote amphibolite facies, amphibolite facies to the boundary of granulite amphibolite facies (Pamić et al., 1977; 2001). Zone division from rocks of green schist facies to rocks of granulite-amphibolite facies also indicates variation in composition from potassium plagioclase to anorthite, hornblende to actinolite-tschermakite-edenite to pargasite and garnets enriched with pyroph and almandine component.

Corundum amphibolite occurs only in parts of Vijaka's amphibolite of the greatest range of metamorphism. They are unevenly divided within the zone of emerald green pargasite and edenite-pargasite amphibolite, in over 10 mainly narrow zones that could hardly be represented in the map. Exceptions are localities of Donja Vijaka, Stupčić and Crni potok, where thickness of those zones is exceeding 100 m. As a rule, amphibolites are similar in space and they are connected to narrow and lengthen zones of greatly or completely seprentinised ultramafic accumulations that have bands of inserted amphibolite (Figure.1).

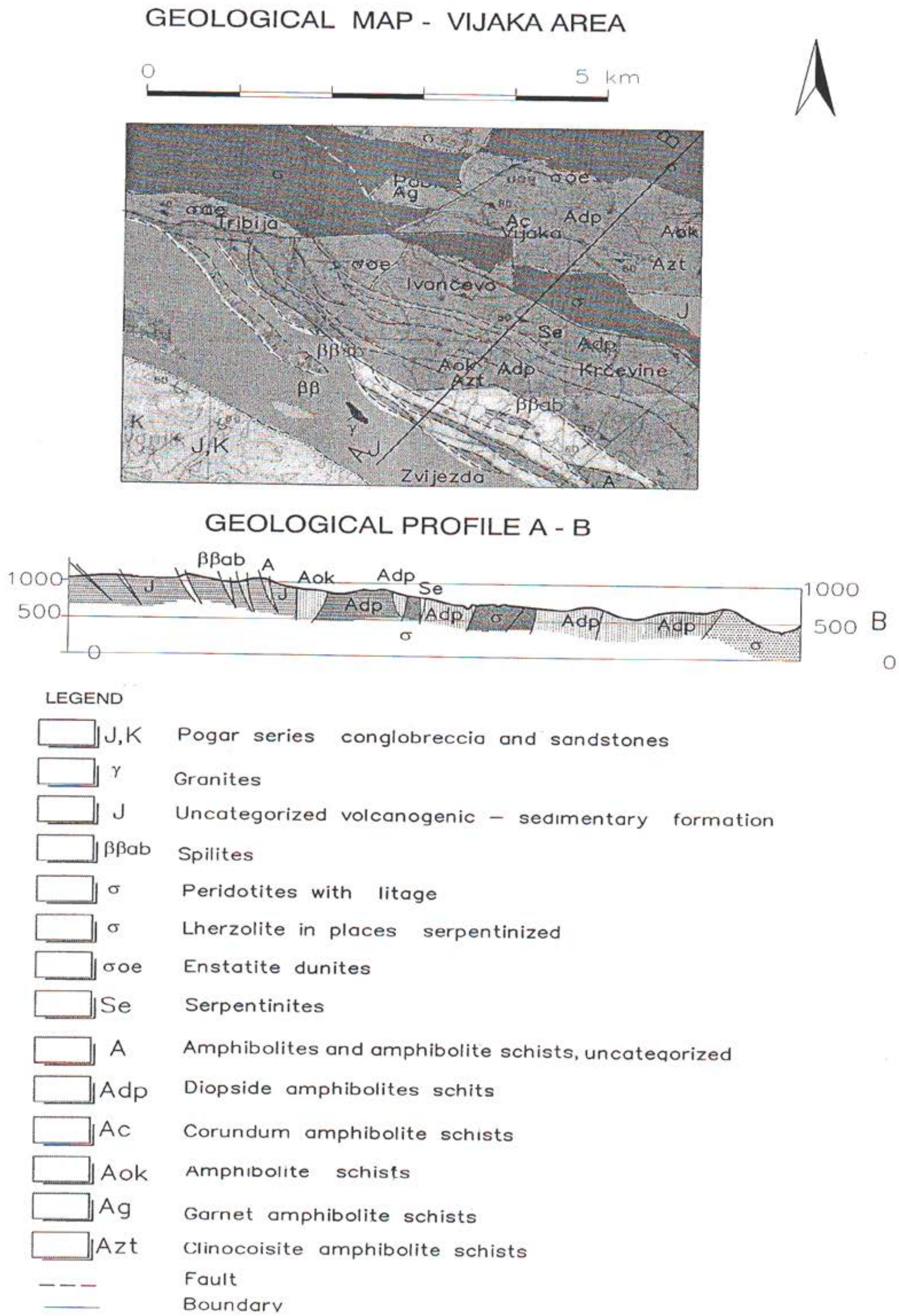

Figure 1 Geological sketch - map of Vijaka area with geological profile (Olujić - Pamić et al.,1958 - 1970).

3. METHODS OF INVESTIGATIONS

On nineteen selected samples of amphibolite rocks from amphibolite zone Duboštica-Vijaka in the south edge of Krivaja-Konjuh massif, detailed optical analyses were done with use of polarisation microscope, chemical analyses of microelements, also microelements of rare grounds, x-ray-florescent spectroscopic analyses, and chemical analyses of minerals (amphibole, garnet, plagioclase, pyroxene, corundum, spinel, chlorite, magnetite, titanite, ilmenite, zeolite minerals, prehnite, rutile, serpentine, olivine, apatite, analcime) with electronic micro sonde. Samples are optically analysed with standard polarisation microscope of brand Leitz, when determined were structural-texture characteristics and mineral composition. Mineral composition of the samples was checked with x-ray analyses with instrument of brand Philips with CuKα rays with graphite monochromator. Noted analyses were completed in Institute for Mineralogy and Petrography in Innsbruck.

3.1 Results on chemical researches of mineral phases

Results on dotted analyses

Corundum

Corundum appears in pargasite and edenite pargasite amphibolites schists in the Vijaka region in more than 10 mainly narrow zones that hardly can be cartographic shown. Exceptions are localities of Donja Vijaka, Stupčić I and Crni potok in which thickness of these zones are over 100m. These zones were linked with narrow and expensed zones of stronger or weaker serpent ultramafics rocks. Corundum in stated amphibolites rocks appear as porphyroblast, size up to several cm as important, secondary and accessory component of amphibolites.
Chemical compound of corundum is determined by electronic microsonde analyses and roentgen fluorescent spectroscope analyses (macro elements and microelements) .

It was established, by the microsonde analyses, that corundum porphyroblasts contain small inclusions of chermakite hornblende and plagioclase-anorthite with retrograde margarite (Table 1) what points out its post-cinematic crystallization.

Analyzed amphibole, appeared as part that fits into corundum, belongs to tchermakite hornblende.

The presence of clinochlore fit-parts in corundum was confirmed by the roentgen examinations of corundum's mineral compound.

Amphibole analyses were done by the computer program according to IMA recommendation (AMPH – IMA 1997, A. Moggesie, K. Ettinger, B. E. Leake & R. Tessadri) on 23 O and 13 e CNK and on mol participation of components in amphiboles. Analyses of plagioclase and micas– margarite were counted according recommendation of HYPER – FORM (S. Borg, A. Moggesie & E – Bjerg, 1991). Plagioclase formula estimation was done on the base of 8 O and micas– margarite on the base of 22 O.

Corundum's chemical composition determined by the roentgen fluorescent spectroscope is characterized with presence of admixture around 23 %. Increased content of SiO_2 (11,6 %), MgO (1,6 %), CaO (2,93 %) and Na_2O (0,50 %) is a result of presence of tchermakite hornblende, plagioclase, margarite and clinochlore inclusions.

By the electronic microsonde analyses it was established that total content of Fe was expressed as FeO is 0,25 %. The content of Ti as TiO_2 is 0,07 %. Analyzed corundum sample doesn't contain MnO.
As of microelements, Cr and Cl have the greatest values. Of mobile microelements, these are Ba and Sr, and of imobile elements, Cr, Ni, V and Co has the greatest values.

The content of Cr is 1030 ppm, much lower content of Ba (69 ppm) and Sr (64 ppm), what is possible to explain by the presence of small inclusions of plagioclase in corundum.

Spinel

Chemical analyses of spinel in amphibolites rocks, tectonitic peridotites and cumulate gabbros and peridotites were estimated on the base of 32 O. The results are shown in table 1. Spinels in amphibolites rocks of the Vijaka region are: chrome spinel, hercinite, chrome hercinite, magnesium-hercinite and magnesium-chromites. Chrome spinel and chrome hercinite appear in amphibolites slates and hercinite in garnet diopside amphibolites schists. The presence of magnesium-hercinite was established in garnet-diopside-hypersthenes amphibolites schists, and magnesium-chromites in edenite amphibolites schists. Chrome hercinite with content of titan TiO_2 (0,05-0,15 %) with slight variation of chrome content Cr# and low content of nickel 0,38 % NiO. Al chrome spinel with content of titan 0,01-0,11 %

TiO_2, with nickel concentration 0,07-0,68 % NiO and with variation of chrome participation Cr# (15, 79-23, 15 %).

Titanite

Chemical analyses of titanite were estimated on the base of 18 O and the results were shown in table 1. Titanite appears as inclusions in plagioclase garnet rock and hornblende granitites.

Magnetite

Chemical analyses of magnetite were estimated on the base of 32O. The results were shown in table 1. Magnetite appears in association with orthopyroxene and plagioclase in kelyphitic rim of grt-pl-px schists. It also appears in association with plagioclase, orthopyroxene, pyrite, spinels and rutiles in kelyphitic rim of grt-di-hy amphibolites schists.

Ilmenite

Chemical analyses of ilmenite were estimated on the base of 6 O. Appearances of ilmenite together with chlorites and titanites as inclusions were established in plagioclase garnet rocks and in pl-grt-ho-di schists. Ilmenite comes in association with garnets, orthopyroxenes, plagioclases and thomsonite in kelyphitic rim of gr-pl-px schists.

Rutile

Chemical analyses of rutile were estimated on the base of 2 O. The results were given in the table 1. Rutile comes as fit-part in porphyroblasts of garnets in grt-di-hy amphibolites schists and in association with plagioclase, orthopyroxenes, magnetite, spinels and pyrites in kelyphitic rim of the same rocks.

Analcime

Chemical analyses of analcime were estimated on the base of 7 O. The results of chemical examinations were given in table 2. Analcim appears as accessory ingredient in garnet-diopside amphibolites schists.

Apatite

Chemical analyses of apatite were estimated on the base of 26 O, OH, F, and Cl. The results of chemical analyses were given in table 1. Apatite together with phlogopite appears as inclusions in amphibolites.

Post-metamorphic events

Exploring the root minerals in basic magmatic rocks and amphibolites of some ophiolite areas, J.Pamić and authors (1979) were established that root minerals of amphibolites are in fact identical with diabase-dolerite-gabbros rocks. Three characteristic ingredients are the most common among them: prehnite, epidote-clinocoisite and tremolite and of zeolite minerals noticed were but very rare thomsonite and lomontite. Šibenik and associates (1980/81) have opinion that the origin of tremolite in diabases and amphibolites in contact zone with serpentinites, can be brought in connection with hydrothermal metamorphism of smaller masses of peridotites, i.e. for basic magmatism that gave diabase rocks. In further considerations of root minerals' genesis accepted were the possibilities of their origin through direct hydrothermal crystallization or through crystallization from solutions which increased the content of calcium, potassium, aluminum and silicium mainly on the base of change of plagioclase minerals from magmatic rocks through which cuts the circulation was done.

Root mineral paragenesis from amphibolites rocks can serve as the base for consideration of post-consolidation changes which happened on them before their placement into today's position. Post-consolidation changes in amphibolites rocks happened in P-T conditions which belong to zeolite and grinschist facies. (Pamić et al., 1979).

Our researches on root minerals in amphibolites rocks in the Vijaka region have shown the presence of prehnites, albites, epidote-clinocoisites, analcime and fiber zeolite-thomsonite and mesolite. Beside above given minerals, corundum appears in amphibolites rocks as root mineral making independent monomineral roots stretching parallel with foliation in pargasite and edenite-pargasite amphibolites schists.

Zeolite minerals (thomsonite and mezolite)

Clinocoisite appears together with zircon in plagioclase garnet rocks. Thomsonite appears in garnet-diopside-hypersthenes amphibolites schists, garnet-plagioclase-pyroxene schists, and actinolite, edenite and diopside amphibolites schists. In the garnet-plagioclase-pyroxene schists, thomsonite appears in association with titanite and ilmenite. In garnet-diopside amphibolites schists mezolite appears. Up to now, in Bosnia and Herzegovina mesolite has been found in only one place and that

together with natrolite in cracks of Jablanica's gabbros, about which Trubelja and associates (1974 and 1976) have written.
Mesolite from Jablanica's gabbros was researched by roentgen, but the chemical examinations on mezolite have not been done yet.
Chemical examinations of tomsonite were estimated on the base of 80 O, and of mesolite on 30 O. The results are shown in table 2.

Prehnite

In amphibolites rocks in the Vijaka region prehnite appears as crack mineral. Prehnite has been widely spread as a product of partially alteration of basic plagioclases and rarely of total alteration. Microsonde chemical analyses established prehnite inclusions in amphibole in porphyroblastic hornblende granitites. Chemical analyses of prehnite were estimated on the base of 24 (O,OH) and were shown in table 2.

Chemical variations' dependence in mineral compound regarding to changes of metamorphism's conditions

According to MODY et al. (1983) fO_2, determines the stability of other minerals in paragenesis of maphite rocks such are: titanite, epidote, ilmenite, magnetite, rutile and hematite. In experiments conducted by MODDY et al. (1983) paragenesis Ttn-Ilm-Mgt is presented when fO_2 is in values that are determined by QFM and NNO puffers. At QFM puffers, titanite appears as low-temperature product while ilmenite and magnetite as high-temperature products. It is very likely that from the beginning the conditions were suitable for QFM and NNO puffers (the most often conditions in crust), and yet with introducing metasomatic reactions it changes toward HM puffer. It happens together with appearance of mineral from the group of epidote-clinocoisite and with appearance of titanite on lower temperatures in garnet paragenesis and appearance of reaction membrane around ilmenite inside the amphibolites paragenesis.
Clinocoisite and titanite show great impact on composition of amphiboles and on composition of plagioclase. The content of Ti and Mn reduces with Fe enrichment of rock as a result of increase of modal composition of rutile, titanite or Fe – Ti oxides. The analyses of oxidation proportion in rock shows that the rock behaves like closed system in regard to oxygen during the first phase of metamorphism, but it changes in later phases when fugacity grows.

Figure 2: Garnet porphyroblasts in prenitezed plagioclases

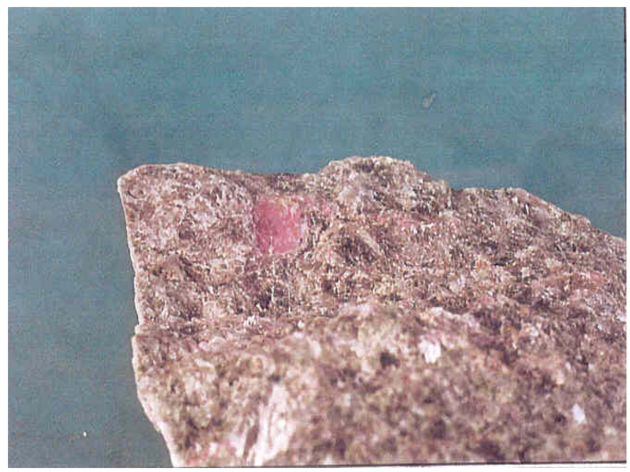

Figure 3: Corundum-bearing amphibolites. Size of corundum grain in middle is apprimately 2 cm.

Figure 4: Garnet –diopside amphibolites slate cute with roots full of clinozoisite and prehnite.

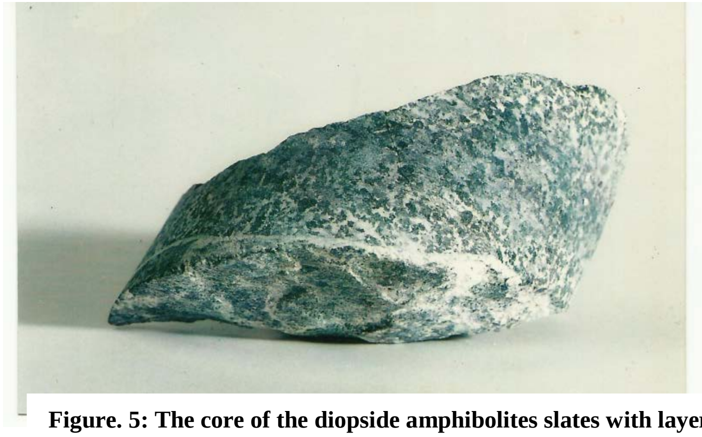

Figure. 5: The core of the diopside amphibolites slates with layers of zeolite minerals (the hole BS-1/99; 14, 3-15m).

Table 1: Selected Chemical Analyses of Spinel, Chlorite, Titanite, Magnetite, Apatite, Rutile and Mica-Margarite

	1-Sp rub	2-Sp jezgro	3-Chl	4-Chl	5-Ttn	6-Mgt	7-Ap	8-Ru	9-Mrg
SiO_2	0, 10	0, 07	32, 12	36, 17	30, 91	0, 42		0, 39	30, 13
TiO_2	0, 00	0, 02	0, 00	0, 02	30, 36	10, 39		98, 86	0,31
Al_2O_3	60, 12	60, 21	16, 42	20, 26	5, 58	2, 09			49, 95
Cr_2O_3	0, 28		0, 02	0, 35	0, 31	0, 22			
Fe_2O_3	2, 43	2, 88	0, 00	0, 00		45, 79			
FeO	28, 16	25, 37	15, 19	14, 93	4, 44	38, 55	0, 30	1, 12	0, 11
MnO	0, 33	0, 55	0, 22	0, 15		0, 71	0, 00		0, 26
MgO	8, 12	9, 79	22, 73	13, 39	1, 37	0, 47			0, 30
CaO	0, 05	0, 03	0, 39	0, 90	24, 93	0, 24	55, 69	0, 12	13, 58
Na_2O	0, 00	0, 00	0, 14	0, 07	0, 09	0, 09			0, 76
K_2O	0, 07	0, 02	0, 02	0, 17	0, 10	0, 07	0, 13		0, 00
ZnO	0, 59	0, 34	0, 00			0, 08			
NiO	0, 00	0, 14	0, 00			0, 19			
P_2O_5							41, 32		
Cl							1, 44		
H_2O+			12, 75	13, 86	1, 26	0, 00	1, 08		0, 00
H_2O-			0, 01						4, 50
TOTAL:	**100, 24**	**99, 42**	**100, 01**	**100, 27**	**99, 26**	**99, 31**	**99, 96**	**100, 57**	**99, 90**
Si	0, 022	0, 016	6, 163	7, 098	3, 732	3, 524		0, 005 Si	4, 015 Si IV
Al	15, 528	15, 495	1, 837	0, 902	0, 765	0, 000			3, 985 AlIV
Al			1, 876	3, 783		0, 276	0, 000	0, 002 Cr	8, 000 T site
Cr	0, 049			0, 109	0, 059	0, 000			
F^{+3}	0, 400	0, 474	2, 188			0, 000		0, 986 Ti	3, 861 Al VI
Fe^{+2}	5, 160	4, 632	0,000	2, 449	0, 408	0, 059	0, 037	0, 012 Fe^{+2}	0, 031 Ti
Mn	0, 062	0, 101	0, 035	0, 025		0, 000			0, 012 Fe^{+2}
Mg	2, 652	3, 186	6, 448	3, 909	0, 228	0, 009			0, 029 Mn^{+2}
Ti		0, 003	0, 000	0, 003	2, 71	3, 385			0, 060 Mg
Ca	0, 012	0, 007	0, 080	0, 189	3, 224	0, 274	10, 002	0, 002 Ca	3, 993 O site
Na			0, 052	0, 027	0, 021	0, 700			1, 939 Ca
K	0, 020	0, 005	0, 049	0, 043	0, 016	0, 010			0,196 Na
Zn	0, 095	0, 065				0, 018			
Ni		0, 024				0, 047			
P							5, 977		
Cl							0, 792		
OH			16, 310	16, 000			1, 071		
Total	**24, 000**	**23, 998**			**11, 164**	**24, 001**			

*Legend: 1,2 – spinel; 3 –chlorite as inclusion in amphibolites; 4-chlorite as inclusion in garnet; 5-titanite; 6-magnetite; 7-apatite;8-rutile; 9- margarite as inclusion in corundum

Table 2: Selected Chemical Analyses of Crack (Flaw) Minerals in Amphibolites Rocks in the Vijaka Region

	1-Tmp	2-Tmp	3-Tmp	4-Mes	5-Prh	6-Prh	7-Prh	8-Prh	9-Ana
SiO_2	41, 97	42, 72	37, 43	42, 94	42, 97	43, 55	42, 54	43, 13	53, 94
TiO_2			0, 00	0, 16	0, 00	0, 08	0, 08	0, 04	23, 79
Al_2O_3	27, 24	27, 98	30, 24	27, 06	23, 67	23, 19	23, 60	23, 70	0, 60
Cr_2O_3	0, 21		0, 14	0, 00	0, 00	0, 02	0, 12	0, 12	
Fe_2O_3	0, 27		0, 42	0, 79	1, 00	0, 84	1, 29	1, 09	0, 60
FeO				0,00	0, 31	0, 26	0, 40	0, 34	0, 24
MnO			0, 06	0, 09	0, 13	0, 11	0, 04	0, 00	
MgO				0,14	0, 05	0, 01	0, 04	0, 12	
CaO	11, 18	10, 64	13, 75	9, 88	27, 06	27, 12	27, 49	27, 07	0, 12
Na_2O	4, 71	4, 71	3, 80	4, 68	0,04	0, 15	0, 00	0, 07	11, 09
K_2O	0, 03	0, 00	0, 00	0, 11	0, 06	0, 10	0, 18	0,00	0, 52
H_2O	13, 51	13, 41	13, 30	13, 54	4, 43	4, 44	4, 46	4, 45	8, 71
TOTAL:	**99, 12**	**99, 46**	**99, 24**	**99, 39**	**99, 67**	**99, 87**	**100, 24**	**100, 13**	**99, 01**
Si	22, 431	22, 756	20, 347	8, 569	5, 952	6, 021	5, 885	5, 946	1, 985
Al	17, 174	17, 423	19, 437	6, 361	1, 924	1, 979	2, 115	2, 054	1, 031
Al	0, 000		0, 000	0, 000	1, 820	1, 797	1, 732	1, 796	
Cr	0, 177		0, 122	0, 000	0, 000	0, 000	0, 134	0, 000	
F^{+3}	0, 108		0, 049	0, 118	0, 104	0, 087	0, 008	0, 113	0, 166
Fe^{+2}	0, 000		0, 000	0, 000	0, 036	0, 030	0, 008	0, 039	0, 007
Mn	0, 000	0, 000	0, 028	0, 015	0, 015	0, 013	0, 046	0, 000	
Mg				0, 042	0, 010	0, 002	0, 005	0, 024	
Ti				0, 024	0, 000	0, 008	0, 000	0, 004	
Ca	6, 399	5, 937	7, 948	2, 112	4, 014	4, 013	4, 072	3, 997	0, 005
Na	4, 878	4, 789	1, 922	1, 810	0, 011	0, 040	0, 031	0, 018	0, 791
K	0, 020	0, 000	0, 000	0, 028	0, 011	0, 008			0, 024
OH					4, 096	4, 090	4, 113	4.090	2, 083
H_2O	24, 090	23, 910	23, 710	19, 079					

Legenda: 1, 2, 3-tomsonite; 4-mesolite; 5,6,7,8-prehnite; 9-analcime

4. CONCLUSION

It is confirmed with these researches, that the Vijaka amphibolites complex is characterized with presence of rocks with various metamorphic grades and that with rocks of grinschist facies in lower parts which grade grows toward epidotic amphibolites facies, amphibolites facies to border of granulites amphibolites facies. Amphibolites' rocks are in community with various types of tectonic peridotites, cumulative peridotites, gabbros and rocks of Jurassic volcanogenic-sediment formation.
Frequent layering of amphibolites rocks with ultramafic rocks points on their genetic mutual relations, what was also confirmed by P-T estimations as well as radiometric determinations, which are in accordance to regional thermobarometric calculations for metamorphic rocks DOZ.

On the base of results on mineralogical-petrographical researches, amphibolites rocks are classified into five sub-groups: monomineral amphibolites schists and rare corundum amphibolites schists, then amphibolites bimineral, diopside amphibolites schists, garnet diopside amphibolites schists and bimineral amphibolites schists.

Knowing the type of amphibole and variations in its chemical composition, and by that, variations in optical characteristics, it enables establishing of processes that had developed in geological history.

In analyzed amphibolites rocks sporadically appear: corundum, spinels (chrome spinels, hercinite, and chrome hercinite and magnesium chromites), chlorites (clinochlore and ripidolite), zeolitic minerals (thomsonite and mesolite), prehnite, epidote-clinocoisite, analcime, albite and serpentine.

Prehnite, zeolitic minerals, epidote-clinocoisite, analcime and albite appear also as root mineral in analyzed amphibolites rocks in the Vijaka region, what points on post-consolidation changes which happened in these rocks before their layering in present level.

Corundum appears in pargasites and edenite-pargasite amphibolites schists as important, secondary and accessory ingredient. Corundum porphyroblasts can reach the size of 2 cm, and contain small inclusions of clinochlore and tchermakite, which is partially transformed into margarite and anorthite what was proved by x-ray fluorescene spectroscopy and microsonde analyses. Subordinated are corundum roots and small roots that cut corundum amphibolites, and they originated by the post-cinematic secretion.

Concerning the accessory ingredients, dominant is participation of magnetite, titanite, ilmenite, rutile, zircon, apatite, phlogopite and biotite.
Clinocoisite and titanite show great impact on the structure of amphiboles as well as plagioclase. The content of Ti and Mn decrease as rock enriches with Fe, what is the result of the increase of modal structure of rutile, titanite or Fe-Ti oxide.

Corundum edenite pargasite amphibolites schists and pargasite amphibolites schists are put in the very inside parts of the Vijaka amphibolite complex which is touched by the metamorphism of the highest level in amphibolites – granulites facies conditions.

It is obvious that under the same PT conditions corundum was also formed as rock petrogen ingredient which is sin-cinematic real. Corundum porphyroblasts grew similar to post-cinematic grade which followed the main deformation. After the exhumation and consolidation of the Krivaja – Konjuh ultramafic massif and the Vijaka amphibolites complex, in later post-cinematic stadium secondary.

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