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MAGMATISM, METAMORPHISM AND METALLOGENY OF THE VARDAR ZONE AND SERBO-MACEDONIAN MASSIF

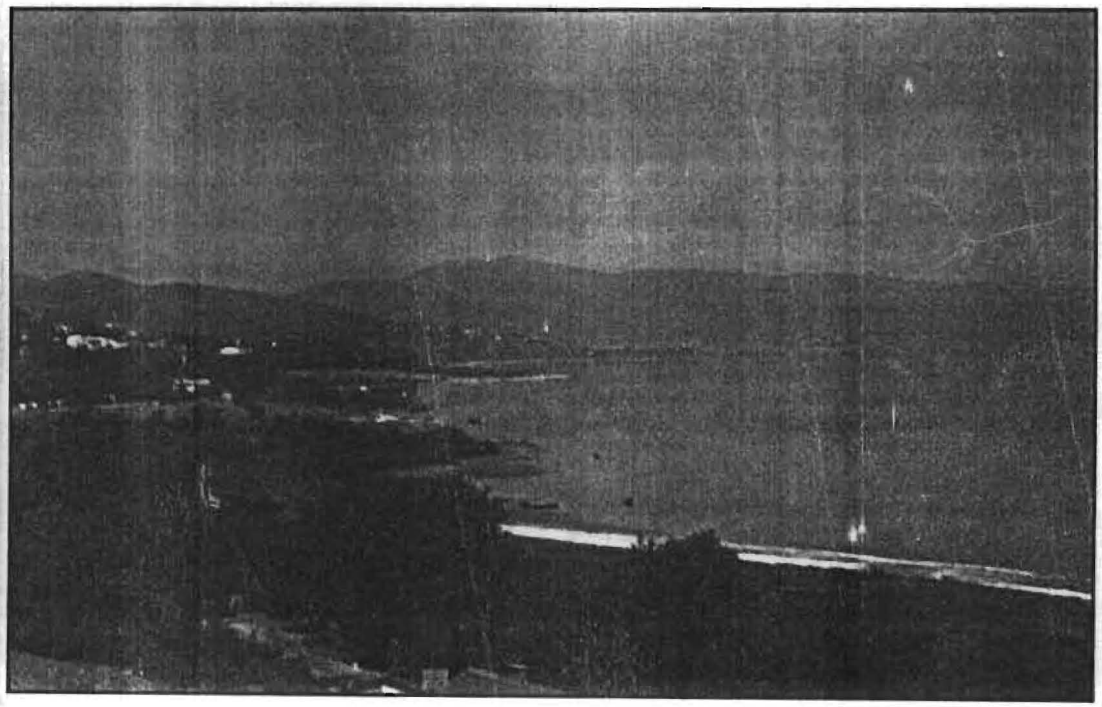

PLATE TECTONIC ASPECTS OF ALPINE METALLOGENY IN THE CARPATHO-BALKAN REGION

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Prograde formation of Clinopyroxene - Plagioclase Symplectites in Garnet - Clinozoisite Amphibolites of the Ograzden Complex, Macedonia

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Abstract

Prograde clinopyroxene - plagioclase symplectite, composed of pyroxene of 2 to 24 % jadeitic component and albite - oligoclase (1-20 % An) is determined in garnet - clinozoisite amphibolites of the Ograzden complex. It formed by decomposition of primary hornblende and clonozoisite by the reaction:

$$Hbl^1 + Czo + Qtz \rightarrow Cpx^2 + Ab\text{-}Olg^2 + Grt \text{ (its prograde outer rim)} + H_2O$$

P - T conditions of formation of Cpx^2 - Pl^2 symplectite are estimated based on Grt - Hb, Grt - Cpx geothermometers and Grt - Cpx - Pl - Qzt geobarometer that gave T of 560 - 650 °C and P of 10 - 11 Kbar.

Key Words: Clinopyroxene - plagioclase symplectite, amphibolite, garnet, hornblende, plagioclase.

Introduction

Ograzden Precambrian metamorphic complex is situated in Eastern Macedonia on the border between Republic of Macedonia and Bulgaria. Based on the tectonic regional setting of Macedonia after Arsovski (1995) it is part of the Serbo - macedonian masiff. This paper deals with amphibolites of Golem Trebomir, south - east of Pehcevo and River Zamenicka sout - east of Berovo, 2 km above the flow into Ratevsko leake.

The amphibolites occurs as bodies up to a few dozen meters thick in biotite - muscovite and garnet - mica gtneisses.

One of the most typical types of reaction textures in crustal eclogites is clinopyroxene - plagioclase symplectites, which develop by replacing omphacite during uplift. However, we determined that similar symplectites in garnet omphibolite of the Ograzden Complex could former by another way: owing to the prograde decomposition of hornblende.

Genesis and P - T Condition of Prograde Clinopyroxene - Plagioclase Symplectite

The amphibolites are composed of hornblende, garnet, clinozoisite, plagioclase, quartz, rutile, ilmenite, and sometimes, kyanite, which display equilibrium realations with one another. No traces of earlier omphacite were detected, even in the form of small relics. Neverthaless, the rocks contain fine - grained clinopyuroxene - plagioclase symplectites, which account for up to 20 - 40 % of the rock. The symplectites show apparently reaction relationships with the primary hornblende, particularly in contact with quartz and garnet the symplectites resorb large Hb^1 grains in the margins and forms "bays" in them in places, the syumplectites bear merely minor relics of hornblede or clinozoisite. An even younger type of reaction textures is thin rims of blue - green hornblende (+ plagioclase) around garnet grains at their contacts with Cpx - Pl symplectites.

The primary green Ca - amphibole belongs to the hornblende - edenite series: $(Na + K)_A \leq 0.5$, $X_{Fe} = 0.25 - 0.50$. Relatively large grains of primary Pl are composed of albite to oligoclase (5 - 15 % An). The garnet always, even when armored with Hbl^2 - Pl^2 rims, has a clear prograde zoning (Fig. 1), with the pyrope content increasing by 7 - 13 % rimward and simultaneously decrcreasing grossular and spessartine contents.

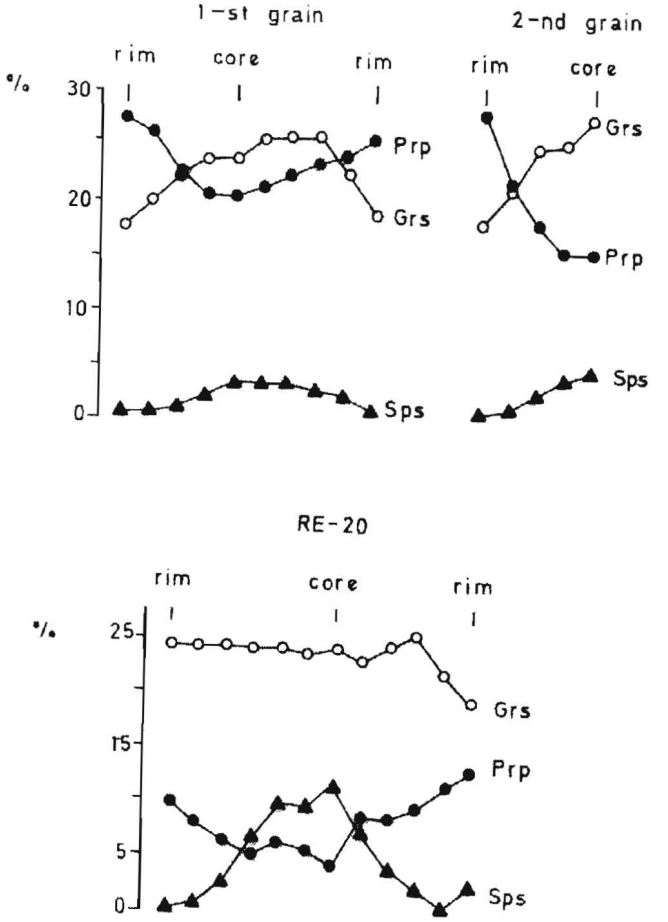

Fig. 1. Prograde zoning in garnets surrounded by thin hornblende ± plagioclase rims in garnet - clinopyroxene amphibolites.

The Cpx - Pl syplectite consists of pyroxene with 2 - 24 % Jd (Fig.2) and albite oligoclase (1 - 20 % An). The composition of plagioclase in the groundmass of the amphibolites and in the Cpx - Pl symplectite occurs to be similar.

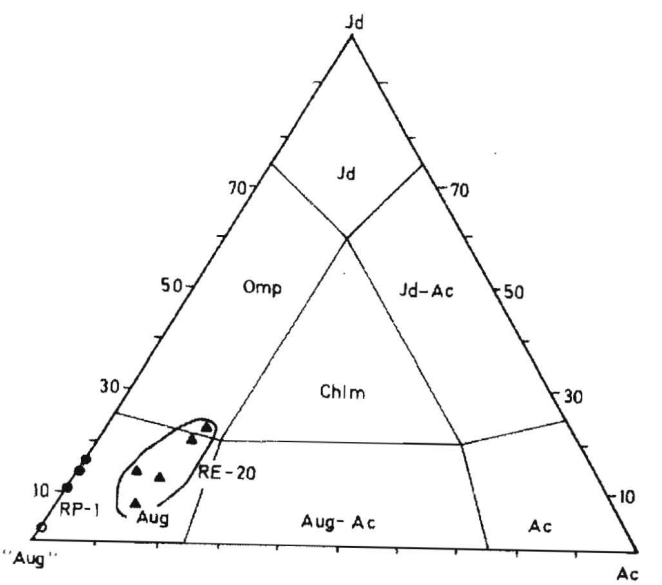

Fig.2. Composition of the - secondary Cpx^2 from Cpx^2 - Pl^2 symplectites around the primary Hbl^2 in garnet - clinopyroxene amphibolites from the Ograzden complex: 1 - s. RP - 1, 2 - s, RE - 20.

The absence of omphacite relics inside the Cpx - Pl symplectites, their apparenly reaction rlationships with the primary Hbl^1, and the only prograde type of garnet zoning, even in rocks with up to 50 % symplectite by volume, are indicativbe of the origin of the symplectite by the decomposition of Hbl^1 and Czo: Hbl^1 + Czo + Qtz → Cpx^2 + Ab - Olg^2 + Grt (its prograde outer rim) + H_2O. The possibility of such a reaction presenting is illustrated by the ACM plots, projected from the point of albite - oligoclase, presenting the mineralogy of two studied samples (Fig.3).

The P - T estimates of the prograde stage, obtained by the Grt - Hbl and Grt - Cpx thermometers are as follows:

Temperature: Grt (rim) + Hbl^1 ⇒ 580 - 560 °C (Powell, 1985)

Grt (rim) + Cpx^2 (from symplectite) ⇒ 630 - 650 °C (Powell, 1985).

Pressure: Grt (rim) - Cpx^2 - Pl^2 - Qtz barometer (Eckert et al. 1991) ⇒ 10 - 11 Kbar.

Microprobe studies of $Hbl^2 \pm Pl^2$ rims around the garnet, at its contacts with Cpx - Pl symplectite, yielded unexpected results. The Ca - amphibole in these rims affiliates with the pargasite - hastingsite series: $(Na + K)_A > 0.5$, $X_{Fe} = 0.42 - 0.59$. The plagioclase inclusions in the Hbl rims appeared to be much richer in Ca (andesine - labradorite, 42 - 52 % An in sample RP - 1) than plagioclase in the groundmass or in the Cpx - Pl symplectites.

The origin of these $Hbl^2 \pm Pl^2$ rims can be interpreted in two ways: (1) as a retrograde hydration reaction and (2) as an isothermal, or even prograde, reaction at decreasing pressure (during uplift). The latter mechanism is supported by the strong increase in Ca content of the plagioclase in the rims and by the preservation of progade zoning in the garnet grains, in spite of their apparent resorption durin the formmation of the reaction rims. Conceivably, the growth of the Hbl^2 - Pl^2 rims was stimulated by Na metasomatism, in as much as the secondary Hbl^2 + Pl^2 assamblage is higher in Na than the earlier Grt + Cpx paragenesis, in tis case (Fig.3), the reaction that resulted in Hbl^2 - Pl^2 rims could be as follows: Grt + Cpx rim Cpx - Pl symplectite) ± Na2O + H2O → $Hbl^2{}_{Prg + Hst}$ + Pl.

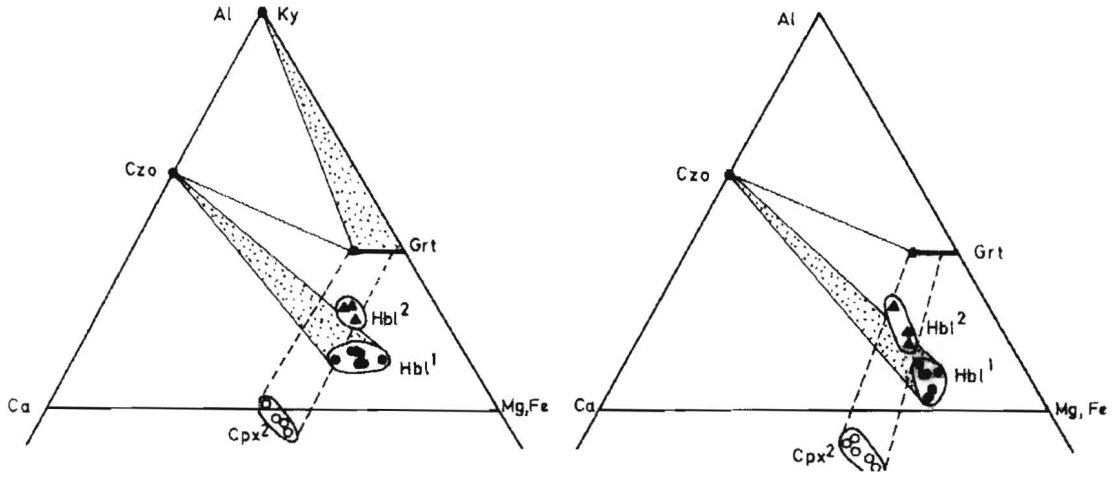

Fig. 3. Associations and composition of minerals in Grt - Cpx amphibolites containing 2 types of reaction structures: 1) Cpx^2 - Pl^2 symplectites (reaction Hbl^1 + Czo + Qtz → Cpx^2 + Grt (its the prograde rim) + Pl^2 + H_2O; 2) $Hbl^2 \pm Pl^2$ rims around Grt (reactioon Grt + $Cpx^2 \pm Na_2O + H_2O \rightarrow Hbl^2{}_{Prg + Hst} + Pl^2$.

Unexpectedly, this interpretation found support in geothermometric data. Provided both mineralas (Hbl^2 and Grt) were equilibrated during the repplacement of the garnet by hornblende rims, the temperature is estimated at 700 °C (Powell, 1985), i.e., it is a higher temperature than that during the prograde stage (estimated by the Grt_{rim} + Hbl^1 pair). However, one can be cautious with this the temperature estimate form the equilibrium between the margin of Grt and the Hbl reaction rim is far from being proved.

Conclusion

It is apparent from the example just discussed that the origin of Cpx - Pl, and even Hbl - Pl symplectites and reaction rims, which is commonly interpreted as a retrograde process in eclogites (Eclogite Facies Rocks, 1990) can also occur in other ways, during an increase of the temperature at a constant, or decreasin pressure. Similar replacement textrures of primary hornblende by Cpx - Pl symplecites were documented in eclogite - amphibolites of the Sieggraben Unit in the Eastern Alps (Putis and Korikovski, 1993), where this process takes place simultaneously with a common decomposition of the primary omphacites.

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