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ULTRAMAFIC KNOCKERS AND CR-BEARING MINERALS IN MARBLES OF CENTRAL RHODOPE (N. GREECE) AND THEIR SIGNIFICANCE FOR THE AGE OF SEDIMENTATION

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ABSTRACT

Ultramafic rocks occur in form of cm- to dm-large knockers incorporated in marbles of the upper tectonic unit of central Rhodope, near the contact with the Oligocene granodiorite of Xanthi. They have suffered regional metamorphism and were subsequently affected by contact metamorphism. The following mineral assemblage was identified in these rocks: olivine - serpentine - Cr-spinel - clinopyroxene ± phlogopite ± pargasite ± andradite ± magnetite ± calcite. Within the same marble belt, Cr-bearing minerals occur in a horizon of impure aluminous marbles, near the village Stirigma. These marbles bear the mineral assemblage: calcite ± dolomite - zoisite - anorthite - Ca-amphibole - Cr-Al-spinel - Mg-spinel - chlorite ± corundum ± margarite ± olivine ± phlogopite. Besides Cr-Al-spinel, which is believed to be of detritic origin, also zoisite, corundum and amphibole are rich in Cr. The presence of ultramafic knockers and Cr-bearing minerals, among which detritic Cr-Al-spinel, indicates that during the time of sedimentation a source of ultrabasic rocks should have existed in the neighbouring regions. Since no pre-Triassic ophiolite complexes have been confirmed in the broad area surrounding Greece, the age of the carbonate sediments of central Rhodope, which contain the ultrabasic material may be interpreted as younger than Triassic.

ΣΥΝΟΨΗ

Μικρά αποστρογγυλωμένα τεμάχη υπερβασικών πετρωμάτων, διαστάσεων από μερικά εκατοστά μέχρι μερικές δεκάδες εκατοστά, απαντούν ενσωματωμένα σε μάρμαρα της ανώτερης τεκτονικής ενότητας της Ροδόπης, κοντά στην επαφή με τον Ολιγοκαινικό γρανοδιορίτη της Ξάνθης, στην περιοχή των Κιμμερίων. Εχουν υποστεί την επίδραση της καθολικής μεταμόρφωσης και μεταγενέστερα της μεταμόρφωσης επαφής. Στα πετρώματα αυτά διαπιστώθηκε το ακόλουθο ορυκτολογικό άθροισμα ολιβίνης - σερπεντίνης - Cr-σπινέλιος - κλινοπυρόξενος ± φλογοπίτης ± παργασίτης ± ανδραδίτης ± μαγνητίτης ± ασβεστίτης. Στην ίδια ζώνη μαρμάρων, απαντούν χρωμιούχα (όπως Cr-Al-σπινέλιος) και πλούσια σε χρώμιο (όπως ζοισίτης, παργασίτης, κορούνδιο, χλωρίτης) ορυκτά σε έναν ορίζοντα ακάθαρτων, πλούσιων σε αλουμίνιο μαρμάρων, κοντά στο χωριό Στήριγμα. Η παρουσία των υπερβασικών τεμαχών, καθώς και των χρωμιούχων ορυκτών, μεταξύ των οποίων και Cr-Al-σπινέλιος κλαστικής προέλευσης, προϋποθέτει την ύπαρξη κάποιας πηγής υπερβασικού υλικού κατά το χρόνο της ιζηματογένεσης. Εφόσον στην ευρύτερη

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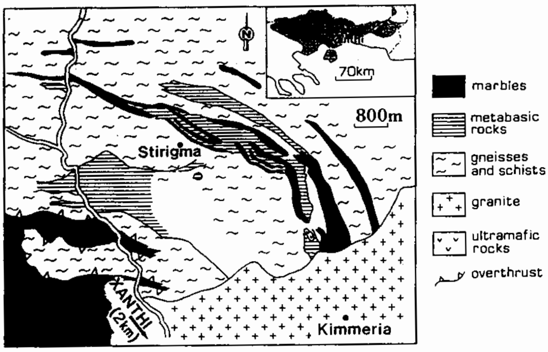

Fig. 1: Geological sketch-map of the studied area which belongs to the upper tectonic unit of central Rhodope. The marble belt - with alterating metabasites - where the ultramafic knockers and the Cr-bearing minerals occur is shown. On the lower left part of the map, marbles of the lower tectonic unit of Rhodope, overthrust by gneisses of the upper tectonic unit of Rhodope, overthrust by gneisses of the upper tectonic unit are shown. In the inset map, the extent of the Rhodope zone and the two tectonic units (from Mposkos & Liati, 1993) are shown.

περιοχή της Ελλάδας δεν έχουν διαπιστωθεί προ-Τριαδικά οφιολιθικά συμπλέγματα, η ηλικία των ανθρακικών ιζημάτων της κεντρικής Ροδόπης που περιέχουν το υπερβασικό υλικό θα πρέπει να είναι τουλάχιστον νεότερη του Τριαδικού.

INTRODUCTION

The Rhodope zone, situated between the Balkanides, to the north and the Dinarides-Hellenides, to the west-southwest, is a sequence of supracrustal rocks of sedimentary and magmatic origin metamorphosed under high pressures and strongly overprinted under medium pressure conditions during Eocene (Liati, 1986). The age of the protoliths remains unknown, due to bad preservation of fossils. Subdivision of the Rhodope zone into two major tectonic units has been suggested both on geological (Papanikolaou and Panagopoulos, 1981) and petrological grounds (Mposkos, 1989). Post-metamorphic, Oligocene magmatism produced a belt of granitoids and of coeval, felsic to intermediate volcanic rocks structurally related to extensional basins widely developed in the Rhodope zone (Maltezou & Brooks, 1992).

Metamorphosed ultramafic rocks, possibly representing parts of dismembered ophiolites, occur in eastern Rhodope, while other less extended outcrops appear in central and western Rhodope. In the study area, north of Kimmeria village, ultramafic rocks extending in an area of ca. 2000m^2, are intercalated with amphibolites, near the contact with the Oligocene granodiorite of Xanthi (Fig. 1). Moreover, ultramafic rocks in form of centimeter- to decimeter-large knockers incorporated in the marbles of this area occur (Fig. 2). Within the same marble belt, Cr-bearing minerals were found in a horizon of impure aluminous marbles, in the vicinity of Stirigma village (Fig. 1).

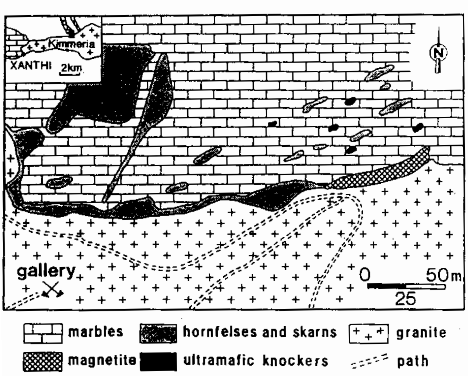

Fig. 2: Geological sketch-map of the eastern part of the contact metamorphic aureole of Kimmeria, where the ultramafic knockers occur in the marbles.

The present paper is dealing with the petrography and mineral chemistry of the ultramafic knockers and of the impure aluminous marbles which contain Cr-bearing minerals and considers also the geochemistry of the ultramafic knockers. Emphasis is given to the implications of the ultrabasic findings for the age of sedimentation in the Rhodope zone.

GEOLOGICAL SETTING

The Rhodope zone in the studied area is composed of metamorphic rocks including quartzofeldspathic gneisses (commonly migmatized), metapelites, amphibolitized eclogites, marbles, ultramafics and calc-silicate rocks. The above regional metamorphic rocks are partly affected by contact metamorphism, due to intrusion of the granodiorite of Xanthi in Oligocene times (Meyer, 1968, Liati, 1986). Two kilometers north of the village of Kimmeria, where marbles are in direct contact with the plutonite, a ca. 300 m wide contact metamorphic aureole is well developed (Fig. 2). In the frame of regional metamorphism, two principal metamorphic events affected the Rhodope: (a) a high-pressure metamorphism of eclogite-facies with peak -minimum-conditions of ca. 12 kbar, locally reaching 18 kbar in central Rhodope (Liati & Mposkos, 1990) and (b) a medium-pressure metamorphism overprinting the high-pressure rocks, characterized by peak PT conditions of 9±1 kbar and 550-650°C, also for central Rhodope (Liati 1986).

The age of the protoliths of the metamorphic rocks of Rhodope is unclear. Kozhoukharov & Timofeev (1980) report some Precambrian microphytofossils from the Bulgarian Rhodope, while Ancirev et al. (1980) note the presence of some molluscs of Middle Ordovician to Lower Carboniferous age. However, the interpretation of these findings is highly disputable.

Regarding the age of metamorphism, according to K-Ar radiometric data, medium-pressure metamorphism is of Eocene age (40-45 Ma; Liati, 1986; Celet & Clement, 1991). Higher dates of 78 to 95 Ma (middle to upper Cretaceous) reported by Liati (1986) for hornblendes (predominantly kelyphitic) of partially amphibolitized eclogites may correspond to the time of early exhumation characterized by the formation of various symplectitic textures. Although the high-pressure metamorphism was not radiometrically dated, it should not deviate significantly from the mid- to upper Cretaceous stage of early exhumation, as indicated by the rapid exhumation rate in the Rhodope (Mposkos and Liati, 1993). If this assumption is true, then the time difference between high-pressure metamorphism and medium-pressure overprint is ca. 50 Ma, which is similar to the 40-60 Ma time interval between the metamorphic events of high-pressure and medium-pressure reported for other overprinted high-pressure terrains (e.g. Caledonides, Alps, Variscides; Carswell and Cuthbert, 1986). Likewise, Celet and Clement (1991) interpret K-Ar data from metamorphic rocks of Rhodope by two metamorphic events, one of lower-upper Cretaceous and a second of Palaeocene-early Eocene age, while Arnaudov et al. (1990), based on lead isotopes in K- feldspars and U-Pb on zircons from migmatites, report model ages ranging between 63 and 32 Ma. All these radiometric data support participation of the Rhodope in the Alpine orogeny. Also Burg et al. (1990) suggest that both regional metamorphism and deformation may be Cretaceous in age, on account of geological and tectonic criteria in the Bulgarian part of Rhodope.

MODE OF OCCURRENCE OF THE ULTRAMAFIC KNOCKERS AND OF THE IMPURE MARBLES

Metamorphosed ultramafic rocks occur in form of rounded knockers, a few tens of centimeters large incorporated in marbles, near the contact with the Oligocene granodiorite of Xanthi, 1.5 km north of the village of Kimmeria (Fig. 2). In the same area, a borehole through the marbles has drilled 1.2m of ultramafic material within the carbonates. The ultramafic rocks have suffered regional metamorphism together with the marbles and were subsequently affected by contact metamorphism, due to the granodiorite intrusion. The host marbles belong to the upper tectonic unit of Rhodope and, together with alternating amphibolites and metapelites, form a ca. 11 km long belt, locally reaching 1.5-2 km in thickness (Fig. 1). Cr-bearing minerals occur in places within this marble belt. They are best developed in an horizon of impure marbles rich in Al-minerals, near the village Stirigma.

PETROGRAPHY AND MINERAL CHEMISTRY

1. Ultramafic knockers

The ultramafic knockers in the marbles of Kimmeria are characterized by the following mineral assemblage:

olivine - serpentine - Cr-spinel - clinopyroxene ± phlogopite ± pargasite ± andradite ± calcite ± magnetite

Not all of the above minerals are products of regional metamorphism. Contact metamorphism and metasomatism resulted in both the formation of new minerals in the ultramafic rocks, as well as modification of the chemical composition and texture of the primary, regional metamorphic assemblage. Textural evidence allows us to recognize among the mineral constituents of

Table 1: Representative electron-microprobe data on clinopyroxene, chlorite, olivine and Cr-spinel from the ultramafic knockers.

	Clinopyroxene				Chl
	E-20			B124	E-20
	1(c)	2(r)	3(c)	4(r)	5
SiO_2	51.4	54.7	53.3	54.6	34.9
TiO_2	0.52	-	0.40	-	0.09
Al_2O_3	3.99	0.83	2.06	0.65	12.0
Cr_2O_3	0.51	0.34	0.12	-	0.19
Fe_2O_3	-	-	0.77	0.52	-
FeO	3.26	1.90	1.08	1.13	3.90
MnO	-	-	-	0.05	0.04
MgO	14.2	15.9	16.7	17.5	35.7
CaO	25.9	26.2	25.9	25.3	-
Na_2O	-	-	-	0.15	-
K_2O	-	-	-	-	0.58
Total	99.78	99.87	100.33	99.85	87.36
Cations per	6(O)				28 (O)
Si	1.893	1.994	1.933	1.984	6.600
Al^{iv}	0.107	0.006	0.067	0.016	1.400
	2.000	2.000	2.000	2.000	8.000
Al^{vi}	0.066	0.030	0.022	0.012	1.258
Ti	0.015	-	0.011	-	0.013
Cr	0.015	0.010	0.003	-	0.021
Fe^{3+}	-	-	0.021	0.014	-
Fe^{2+}	0.101	0.058	0.033	0.034	0.616
Mg	0.779	0.864	0.903	0.946	10.100
Ca	1.024	1.022	1.008	0.984	-
Na	-	-	-	0.003	-
K	-	-	-	-	0.141

	Olivine	
	E-20	
	6	7
SiO_2	41.4	42.2
FeO	8.29	6.37
MgO	0.19	0.25
MnO	50.1	50.2
Total	99.98	99.02
Cations per	4(O)	
Si	1.006	1.021
Fe	0.168	0.129
Mn	0.004	0.005
Mg	1.988	1.812
Fo	91.5	93.3
Fa	8.5	6.7

	Cr-spinel	
	E-20	
	8	9
Al_2O_3	41.9	42.5
Cr_2O_3	20.8	19.7
Fe_2O_3	8.50	9.06
FeO	8.50	8.05
MnO	1.49	1.54
MgO	18.9	19.1
Total	100.14	99.95
Cations per	4 (O)	
Al	1.369	1.382
Cr	0.455	0.430
Fe^{3+}	0.176	0.188
	2.000	2.000
Fe^{2+}	0.198	0.186
Mn	0.035	0.036
Mg	0.780	0.786

Abbreviations: (c):core, (r):rim, (O):oxygen atoms, Chl:chlorite, Fo:forsterite, Fa:fayalite.
Note: FeO in chlorite refers to total iron as FeO.

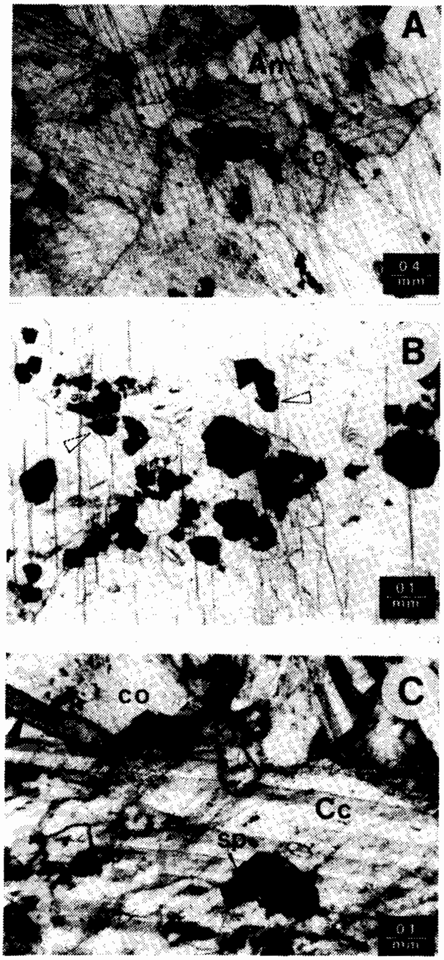

Fig. 3: Photomicrographs of the impure aluminous marbles. (A): Disseminated grains of Cr-Al-spinel (brown spinel) in the carbonate matrix (Cc) and partly enclosed in anorthite (An). (B): Cr-Al-spinel (brown spinel) enclosed in anorthite. Lighter-coloured crystals, marked by the arrows, correspond to spinel poorer in Cr (green spinel). (C): Green spinel (sp) in the carbonate matrix (Cc). On the upper part of the photograph, corundum (co) surrounded by a reaction rim of green spinel (marked by the arrow) is observed. See also text and Table 2, for details.

the ultramafic rocks andradite and calcite as having formed during the contact metamorphic event, due to temperature increase and infilttration of metasomatic fluids. Recrystallization of clinopyroxene and olivine is ascribed partly to contact metamorphism. Microprobe data on mineral constituents of the ultramafic rocks are listed in Table 1.

Olivine is rich in forsterite component and is partly altered to serpentine.

Cr-spinel has a deep brown colour and occurs in abundance, in form of disseminated grains. It is possible that the composition of primary Cr-spinel has been modified, both during regional and contact metamorphism.

Clinopyroxene is a diopside with relatively high Cr-contents. It is characterized by pronounced zoning, the core being richer in Al, Cr and Ti compared to the rim. It seems that during contact metamorphism, recrystallization accompanied by metasomatism led to changes in the chemical composition of the clinopyroxene rim.

Chlorite is rich in Mg and is characterized as clinochlore.

2. Impure (aluminous) marbles containing Cr-bearing minerals

These marbles are characterized by the following mineral assemblage:

zoisite - anorthite - calcite - dolomite - Ca-amphibole - Cr-Al-spinel - Mg-spinel - chlorite ± corundum ± margarite ± olivine ± phlogopite

Microprobe data on mineral constituents of the aluminous marbles are given in Table 2.

Spinel occurs in brown- and green-coloured crystals either disseminated in calcite or as inclusions in anorthite (Fig. 3). Brown spinel is a Cr-Al spinel with Cr_2O_3 contents ranging between 10.8-17.6 wt% (analyses 6, 7 and 8 of Table 2). It is locally quite abundant (Fig. 3A,B). Green spinels,

Table 2: Representative electron-microprobe data on phlogopite, zoisite, margarite, chlorite, amphibole, Cr-Al-spinel and corundum from the impure aluminous marbles.

	Phl	Chl	Zoi	Mar	Amph
	S-52		S-54		
	1	2	3	4	5
SiO_2	37.6	28.3	38.6	29.8	39.9
TiO_2	0.49	0.16	-	-	0.77
Al_2O_3	19.3	23.5	31.3	50.3	19.4
Cr_2O_3	0.21	0.26	1.14	0.22	0.57
Fe_2O_3	-	-	2.04	-	4.18
FeO	5.98	6.03	-	0.30	2.09
MnO	0.10	-	-	-	0.04
MgO	22.0	28.9	-	0.31	14.5
CaO	0.23	-	24.6	12.0	12.8
Na_2O	0.45	-	-	1.01	1.70
K_2O	7.95	-	-	0.02	0.46
Total	94.31	87.15	97.68	93.96	96.41
Cations per	22 (O)	28 (O)	12.5 (O)	22 (O)	23 (O)
Si	5.370	5.381	2.971	4.009	5.742
Al^{iv}	2.630	2.619	0.029	3.991	2.258
	8.000	8.000	3.000	8.000	8.000
Al^{vi}	0.627	2.663	2.805	3.983	1.032
Ti	0.053	0.023	-	-	0.083
Cr	0.024	0.039	0.069	0.023	0.065
Fe^{3+}	-	-	0.119	-	0.487
Fe^{2+}	0.715	0.961	-	0.031	0.217
Mn	0.012	-	-	-	0.005
Mg	4.684	8.194	-	0.060	3.111
Ca	-	-	2.024	1.720	1.974
Na	0.126	-	-	0.260	0.474
K	1.450	-	-	0.004	0.084

	Cr-Al- Spinel				Co
	S-52		S-54		
	6	7	8	9	10
Al_2O_3	54.5	46.5	46.0	60.1	98.3
TiO_2	-	-	-	-	0.05
Cr_2O_3	10.8	17.6	17.0	6.07	1.79
Fe_2O_3	0.05	0.71	2.07	0.94	0.16
FeO	23.1	26.4	25.3	17.8	-
MnO	0.34	0.21	0.20	0.17	-
MgO	11.3	8.47	9.39	15.5	-
Total	100.09	99.89	99.96	100.58	100.30
		cations	per	4 (O)	
Al	1.764	1.582	1.567	1.856	
Cr	0.235	0.401	0.388	0.126	
Fe^{3+}	0.001	0.017	0.045	0.018	
	2.000	2.000	2.000	2.000	
Fe^{2+}	0.530	0.636	0.602	0.389	
Mn	0.008	0.005	0.005	0.004	
Mg	0.463	0.364	0.405	0.607	
	1.001	1.005	1.012	1.000	

Abbreviations: Phl:phlogopite, Chl:chlorite, Zoi:zoisite, Mar:margarite, Amph:amphibole, Co:corundum.
Note: FeO in phlogopite and chlorite refers to total iron as FeO.

usually with a colourless rim, are characterized by lower Cr contents usually around 6 wt% (analysis 9 of Table 2). Green spinel has been observed also as a rim around corundum (Fig. 3C). In this case, it is a reaction product of corundum+dolomite (Nitsch et al., 1985, Liati, 1988). As such, it has been described also in aluminous dolomitic marbles of Naxos (Jansen et al., 1978). This spinel is the poorest in Cr. The high Cr content, especially in brown spinels, indicates a detritic origin for them and presupposes the existence of an already emerged source rock of ultrabasic composition, during sedimentation in the Rhodope.

Zoisite has a pale green colour, in hand specimen and reaches a few centimeters in length. It is commonly associated with calcite and anorthite (see Liati, 1988, for details). It is rich in Cr, which accounts for the green colour of the mineral. Cr_2O_3 contents are commonly around 1.2 wt%. Pure anorthite and amphibole are locally abundant. Amphibole occurs either as disseminated grains or, locally, in aggregates. It is very rich in Al (maximum Al_2O_3=19.4 wt%) and contains appreciable amounts of Cr. Chlorite is widespread. It occurs either as medium- to coarse-grained colourless isolated flakes or is associated with margarite or olivine. It is Mg-rich (clinochlore) and contains also some Cr. Corundum is rare and occurs as isolated crystals in the carbonate matrix. It is coarse-grained, often with

Table 3: Representative chemical analyses of the ultramafic knockers

(wt%)	E-20	B-124	(ppm)	E-20	B-124
SiO_2	44.8	38.6	Cr	2750	1500
TiO_2	0.25	0.22	Co	31	31
Al_2O_3	2.10	1.99	Ni	1060	1065
Fe_2O_3	3.11	4.57	Cu	47	258
FeO	2.62	1.91	Zn	140	215
MnO	0.18	0.28	Rb	19	3
MgO	24.7	27.9	Sr	72	39
CaO	14.8	12.9	Ba	117	20
Na_2O	0.39	0.09	Pb	11	10
K_2O	0.67	0.09	Th	4	5
P_2O_5	0.05	0.06	Zr	31	30
H_2O	4.66	7.37	Nb	-	1
CO_2	0.53	3.63	Y	5	5
Total	98.86	99.61			

numerous fractures and contains many inclusions of zoisite. It is also rich in Cr, which accounts for its red colour. Margarite occurs in fan-shaped aggregates associated with anorthite, zoisite and chlorite.

GEOCHEMISTRY OF THE ULTRAMAFIC KNOCKERS

Whole rock analyses of the ultramafic knockers of Kimmeria were performed for major and trace elements. The chemical analyses of two representative samples are listed in Table 3. As is shown by the chemical analyses, the major element concentrations deviate from the typical ultrabasic composition. This is attributed to modification of the primary composition due to mobilization of elements (mainly addition of Ca from the host marbles) during both regional and contact metamorphism and metasomatism. Nevertheless, the ultrabasic character of the ultramafic rocks examined is clearly demonstrated by the high Cr and Ni contents, which are typical for ultrabasic rocks. It is worthmentioning that in the area of Kimmeria, dark coloured knockers of magnesian skarns which have an appearance similar to that of the ultramafic rocks described above occur in the same marbles and may, at first sight, be mistaken as ultramafics. These rocks are products of contact metamorphism of originally dolomitic marbles, they consist commonly of olivine (forsterite), Mg-spinel, phlogopite, calcite, and dolomite but lack any Cr-spinel. Moreover, the Cr content of the whole rock is very low.

SIGNIFICANCE FOR THE AGE OF SEDIMENTATION IN THE RHODOPE

Untill recently, Rhodope was believed to represent a very old (Precambrian) microblock which played the role of a "Zwischengebirge" between the Balkan belt, to the north and the belt of Dinarides-Hellenides, to the south. The view that the Rhodope participated in the Alpine orogeny was already suggested by Kronberg et al. (1970), on account of comparative criteria (fold tectonics and deformation style) with the neighbouring Circum Rhodope Belt and later by Burchfiel (1980). Regarding the age of the protoliths, it remains uncertain due to lack of fossils. Fossil findings reported so far are, as already mentioned, baddly preserved and their interpretation is disputable.

The ultrabasic rocks and Cr-bearing minerals described in the present study are of great importance as far as the sedimentation age of Rhodope is concerned. The significance of these findings arises from the fact that the presence of ultrabasic knockers incorporated in the marbles, as well as of Cr-rich minerals (among which Cr-spinel of detritic origin) in the same marbles indicates that an ultrabasic source rock should have existed nearby, during the time of sedimentation. Outcrops of dismembered ophiolites in the Rhodope are known from the eastern part, where they form the largest occurrences, as well as from the central and western parts. In contrast to the other ophiolitic zones of Greece (those of Axios (or Vardar) and Pindos-Vourinos-Othrys-Argolis-Crete), the ophiolites of Rhodope have been poorly examined. Geophysical and geological data suggest that the ophiolites of

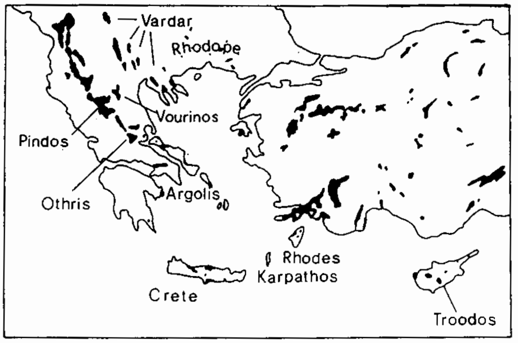

Fig. 4: Distribution of Mesozoic ophiolitic rocks in Eastern Mediterranean (from Smith & Woodcock, 1982 and Koepke et al., 1985).

eastern Rhodope are thin tectonic slices emplaced along thrusts with a northern direction of transport (Ivanov, 1988; Maltezou & Loucoyannakis, 1992). Both the formation age and the time of emplacement are yet poorly constrained.

The actual arrangement of ophiolites in the Eastern Mediterranean region represents sutures of the Tethys. In Greece, such sutures are the ophiolite belt of Axios (Vardar) and that of Pindos-Vourinos-Othrys-Argolis-Crete (Fig. 4) which have been studied in detail, especially during the last decades. The formation age of these ophiolites, including their extension into Yugoslavia, is late Middle Triassic (see Robertson and Dixon, 1984, for a review). Younger ages (Late Cretaceous) are reported for the ophiolites of Rhodes (Hatzipanagiotou, 1983; Koepke et al., 1985) and Karpathos which are believed to represent the southwestern extension of the late Cretaceous ophiolite belt of the Taurides (Koepke et al., 1985). An overview of the formation age of the ophiolites in the broad areas surrounding Greece, reveals that the existing ophiolite sutures represent oceans opened during the Triassic or later (Sengor, 1979, Sengor et al., 1984 and references therein). No pre-Triassic ophiolite complexes have been confirmed within the Alpine system. It should be noted, however, that in the suture zone of Northern Anatolia, the Minor Caucasus and the Southern Caspia palaeozoic ophiolite complexes are locally preserved (Adamia et al., 1981 and references therein).

Therefore, as there is no evidence that oceanic crust older than Triassic existed in the broad area of Greece and its surrounding areas, the age of the ophiolite source which provided the ultrabasic material to the carbonate sediments of Rhodope should be considered as younger than Triassic.

CONCLUSIONS

The findings of ultrabasic knockers and Cr-bearing minerals in the impure marbles described in this study favor the view that the sedimentation age in the Rhodope may be Mesozoic. Although the marbles bearing the ultrabasic knockers and the Cr-bearing minerals occur in a restricted extent, their presence may be relevant for the age of sedimentation. Considering current views of a Rhodope participating actively in the Alpine orogeny and not representing an old stable microblock (e.g. Liati, 1986, Ivanov, 1988, Burg et al., 1990), the findings described in the present paper may lead to a new frame of ideas regarding also the age of sedimentation. These findings should be considered as a motive for questing for further evidence which could support a Mesozoic age of sedimentation in the Rhodope zone.

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