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Geochemical features of the «Plattenkalk» series from the Hordaki area (western Crete, Greece)

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ABSTRACT. — The paper deals with a geochemical study conducted on 28 samples of the «Plattenkalk» series from the Hordaki area, western Crete, Greece. In the lower and middle portions of the sequence, the samples have a granoblastic fabric and an isotropic texture. Instead, in the upper part of the sequence, the texture becomes oriented, probably as a consequence of the overthrust of the Omalos (Trypali) unit over the «Plattenkalk» series. In the rocks, calcite accounts for over 98 vol.% on average. The insoluble residue is represented by quartz, clinochlore, albite, muscovite, hematite, magnetite, ilmenite, apatite, clinozoisite, and very scarce biotite and pyrite. The rocks record greenschist facies metamorphism.

The insoluble residue of the rocks is low ($\bar{x}$ = 1.5 wt%) and consists of SiO_2 (50 wt%), Al_2O_3 (16.5 wt%) and MnO (10.6 wt%), with subordinate $Fe_2O_{3tot.}$ (5.3 wt%), MgO and P_2O_5 (about 3 wt% each), and little TiO_2, Na_2O and K_2O (< 2.0 wt% each). Sr is the most abundant trace element ($\bar{x}$ = 341 ppm). Ba, Zn and Y range between 35 and 22 ppm. Cu, Rb and Zr are scarce (5-13 ppm). The insoluble residue displays rhythmic oscillations with stratigraphy. Its fraction decreases in the upper part of the sequence, indicating diminished detrital input into the sedimentary basin.

Comparisons with the analogous marble from Mani, southern Peloponnesus, show similar petrographic features, but generally different chemical features, indicating that the two groups of marbles are not equivalent.

RIASSUNTO. — Oggetto di questo lavoro è uno studio geochimico di 28 campioni di marmi appartenenti alla serie del «Plattenkalk» ed affioranti in cava presso il villaggio di Hordaki, sulla costa settentrionale di Creta (Grecia). I campioni mostrano struttura granoblastica e tessitura isotropa nella parte basale e media della sequenza, ed orientata in quella superiore. L'orientazione è probabilmente dovuta al sovrascorrimento della unità di Omalos (Trypali) sulla serie del «Plattenkalk». La calcite costituisce circa il 98% in volume nei singoli campioni, mentre il residuo insolubile di questi è formato da quarzo, clinocloro, albite di bassa temperatura, muscovite, ematite, magnetite, ilmenite, apatite, clinozoisite e molto scarse biotite e pirite. I campioni registrano un metamorfismo in facies degli scisti verdi.

Il residuo insolubile è scarso ($\bar{x}$ = 1,5%) ed è composto principalmente da SiO_2 ($\bar{x}$ = 50%), Al_2O_3 ($\bar{x}$ = 16,5%) e MnO (x = 10,6%), subordinati Fe_2O_{3tot} ($\bar{x}$ = 5,3%), MgO e P_2O_5 ($\bar{x}$ = 3% ca. ciascuno), e scarsi TiO_2, Na_2O e K_2O ($\bar{x}$ = < 2,0% ciascuno). Tra gli elementi in traccia il più abbondante è lo Sr ($\bar{x}$ = 341 ppm); seguono Ba, Zn e Y ($\bar{x}$ = 22-35 ppm) e Cu, Rb e Zr ($\bar{x}$ = 5-13 ppm). Il residuo insolubile mostra notevoli oscillazioni ritmiche rispetto alla stratigrafia e tende a diminuire nella parte alta della

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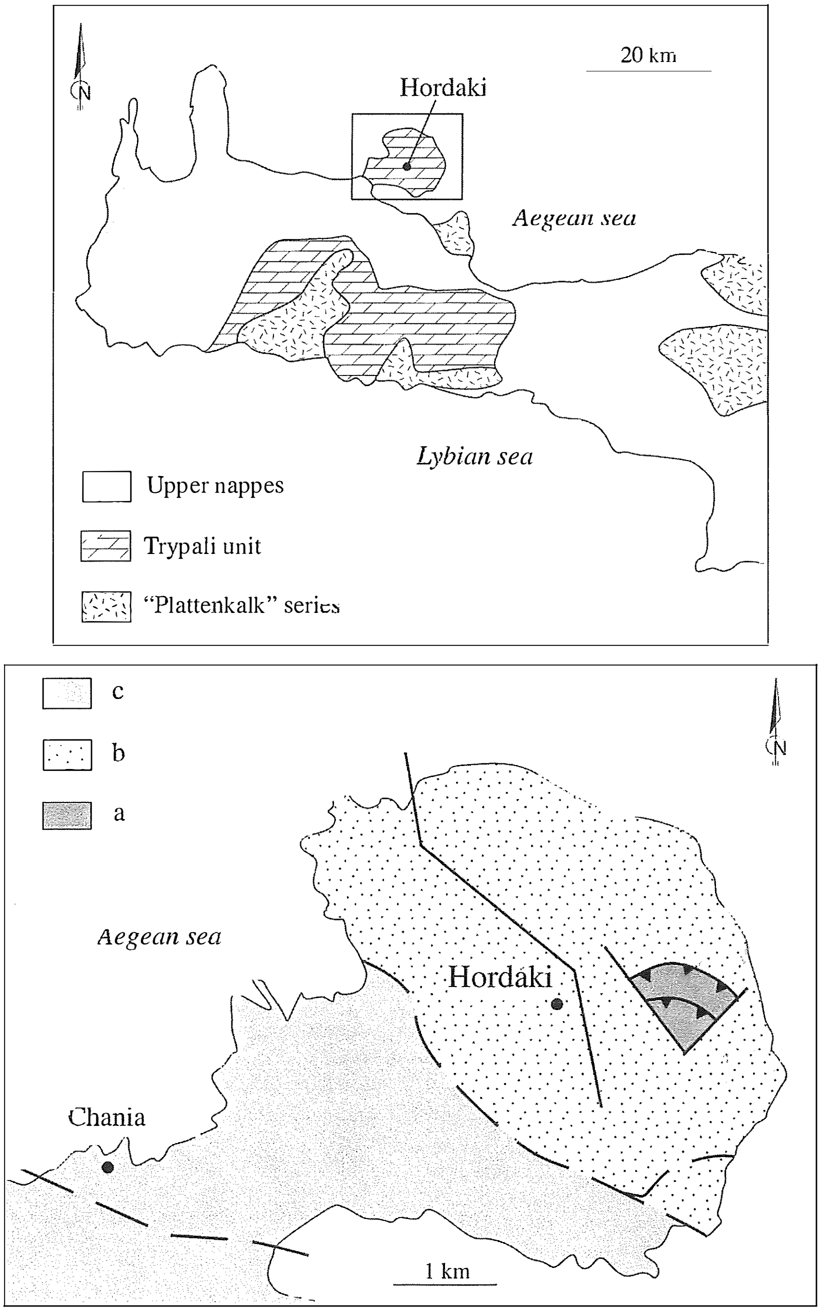


Fig. 1 – *Up*: Tectonic nappes of western Crete (modified after Jacobshagen *et al.* 1978). Post-Miocene sediments are omitted. Inset map shows the location of the Akrothiri peninsula. *Down:* Simplified geological map of the Akrothiri peninsula (modified after the Geological Map of Crete, Vrisses sheet, IGME) : *a)* «Plattenkalk» series (platy limestones, autochthonous ?); *b)* Omalos (Trypali) unit; *c)* Miocene marly limestones.

sequenza; ciò suggerisce una diminuzione dell'apporto detritico al bacino di sedimentazione.

Infine il confronto con marmi analoghi provenienti dalla penisola di Mani, Peloponneso meridionale, indica caratteristiche petrografiche simili ma composizioni chimiche in media differenti. In base a ciò è possibile concludere che i campioni di Mani e Creta non siano equivalenti.

KEY WORDS: *«Plattenkalk» marbles, Hordaki, Crete, geochemistry, origin*

INTRODUCTION

This paper presents a geochemical study of an outcrop of the «Plattenkalk» series, located in western Crete near the village of Hordaki (fig. 1). The outcrop consists of a sequence of marble layers with metachert nodules of variable size and shape, unconformably overlain by the Omalos (Trypali) unit. Based on the nomenclature proposed by Soujon *et al.* (1998) for the «Plattenkalk» series, the studied outcrop may be attributed to the 4e member of the Aloides formation (Liassic-Eocene), representing the middle-upper part of the series.

The geochemical data of this study were compared with data from the literature (Masi *et al.* 1995) on similar rocks outcropping in the Mani peninsula, southern Peloponnesus, and referred to the «Plattenkalk» series by Thiebault (1977).

GEOLOGICAL SETTING AND SAMPLING

The island of Crete consists of a pile of nappes. Based on their tectonic-stratigraphic position and tectonic-metamorphic history, they may be subdivided into two major groups: lower and upper. According to Fassoulas *et al.* (1994), the Lower Nappes are made up, from bottom to top, of the «Plattenkalk» series and the «Phyllite-Quartzite» formation. Only in western Crete is there an additional nappe: the Omalos (Trypali) unit, which locally lies between the above-mentioned nappes. Some authors (e.g., Jacobshagen *et al.*, 1978; Igme, 1993) assume that the «Plattenkalk» series represents the autochthonous basement of Crete.

The «Plattenkalk» series is composed of marbles, dolostones, platy limestones and «metaflysch» (e.g., Epting *et al.*, 1972; Fytrolakis, 1980; Seidel *et al.*, 1982; Fassoulas *et al.*, 1994) but, in a more restricted sense, the «Plattenkalk» typically refers to platy limestone with secondary chert layers. The «Plattenkalk» series, the age of which ranges from Upper Triassic to Early Oligocene, begins with Norian stromatolitic dolostones, indicating intertidal sedimentation on a continental crust. Subsidence of this continental crust probably started in the Early Jurassic, as evidenced by coarse carbonate breccias passing to channelled and graded calciturbidites, and then to a bedded chert-limestone sequence showing basinal conditions. The latter conditions must have prevailed during most of the Mesozoic, with carbonate deposition throughout the period and occasional disturbances, revealed by slumped chert horizons and channelled calc-siltites. In the Early Tertiary, the type of sedimentation in the «Plattenkalk» basin gradually and irregularly changed, as testified by the deposition of thin, red and green, locally channelled, calc-siltite bands. These alternate with thin-bedded grey limestones, overlain by thin marls or calcareous shales, with burrows and globigerinids of Upper Eocene to Lower Oligocene age, sometimes referred to as «Plattenkalk» flysch (Fytrolakis, 1972; Bonneau, 1973).

As a consequence of the closure of the southern branch of the Tethys ocean, which started in the Late Jurassic, the «Plattenkalk» series underwent tectonic processes. In the Oligocene, a compressional event stacked the series and the other nappes, forming the nappe pile of Crete (e.g., Epting *et al.*, 1972). The series and other Lower Nappes underwent HP/LT metamorphism in the Late Oligocene-Early Miocene; the degree of which increased from western to eastern Crete (Seidel 1978). This compressional event was superimposed by a major Miocene extensional event, which resulted in uplifting of the rocks (Fassoulas *et al.* 1994), which thus underwent retrograde metamorphism in the greenschist facies.

Lastly, the relationship of the «Plattenkalk» series with the isopic zones of the Hellenides is still debated. Comparisons with sequences lying in a similar tectonic position in the Peloponnesus and mainland Greece suggest that the «Plattenkalk» series may be correlated with the Ionian zone (e.g., Bonneau, 1973; Aubouin *et al.*, 1976; Bizon *et al.*, 1976; Thiebault, 1977; Seidel *et al.*, 1982; Igme, 1993). In contrast, Hall *et al.* (1984) report that the series and the Omalos (Trypali) unit have no equivalents in the isopic zones of the Hellenides, and believe that they represent a southern continental margin of Apulia, north of the oceanic crust of Mesogea: the Omalos (Trypali) unit would represent the proximal part and the «Plattenkalk» series the distal part of the basin. Regional geology considerations indicate that the series can only have been situated west or south of the Tripolitza (Gavrovo) and Pindos zones. Lastly, Soujon *et al.* (1998) claim that the series was deposited on the stable but structured shelf of the Adria microplate, being the distal continuation of the pre-Apulian zone.

Near the village of Hordaki, the «Plattenkalk» series is exposed for about 70 m and unconformably overlain by the Omalos (Trypali) unit (fig. 2). The series is made up of a rather monotonous sequence of 40-110 cm-thick layers of mainly grey marbles with metachert nodules of variable size and shape. 28 samples were collected from the bottom to the top of the outcrop, with fairly regular

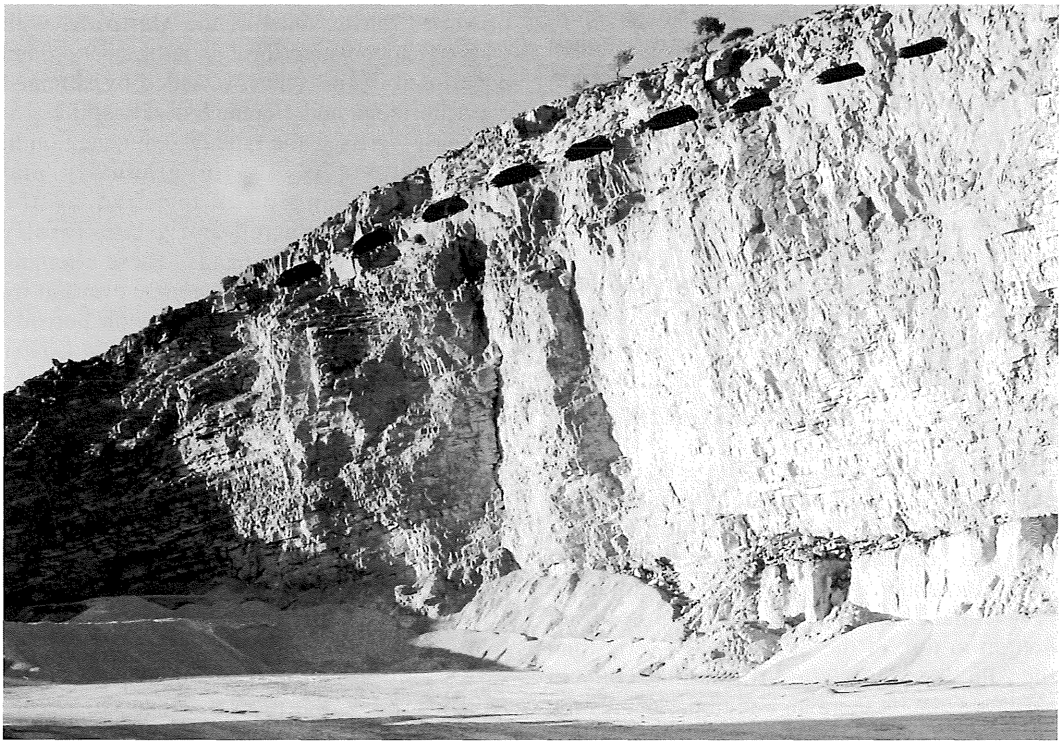


Fig. 2 – View of quarry near village of Hordaki, from where samples were collected. Dotted line: thrust of Omalos (Trypali) unit over «Plattenkalk» series.

spacing of 3 m and an interval of about 10 m between samples 20 and 21, as the outcrop was locally covered by debris. The quite similar Sr-isotope ratios of samples 20 and 21 prove that the two parts of the studied sequence belong to the same formation (Barbieri, pers. comm.).

Analytical procedure

All samples were studied in thin section under the microscope. Chemical compositions were determined by XRF, except for CO_2 plus H_2O obtained by ignition loss. The insoluble residue, derived by dissolving samples with acetic acid, was studied mineralogically by XRD analysis. Analytical uncertainties for XRF and XRD analyses are a few percent. XRF and XRD analyses were performed at the Istituto di Mineralogia, Petrografia e Geochimica of the University of Palermo, and the Dipartimento di Scienze della Terra of the University of Rome «La Sapienza», respectively.

Experimental results

The samples generally show granoblastic fabric with two distinct types of texture : isotropic and oriented. The former (i.e. samples X-1 to X-20) are all from the lower and middle parts of the sequence; the latter, from the upper part (X-21 to X-28), exhibit oriented texture. The isotropic-textured samples are composed of calcite (over 98 vol. %); their non-carbonate fraction is very scarce and composed of quartz, clinochlore, low-temperature albite, muscovite, hematite, ilmenite, magnetite, apatite, clinozoisite, and very little biotite and pyrite. Oriented-textured samples are compositionally quite similar to isotropic-textured ones, except for less plagioclase. Samples X-27 and X-28 contain some dolomite, determined also by XRD analysis.

Table 1 lists major- and trace-element contents of the samples. Fig. 3 shows changes in chemical composition with stratigraphy.

Table 1 indicates that the $CaCO_3$ content of the rocks is greater than 98.9 wt%, except in samples X-3, X-8, X-11, X-14, X-16, X-17, X-22, X-23, X-25 and X-26 ($CaCO_3$ ranges between 93 wt% in sample X-8 and 97.9 wt% in sample X-23).

The insoluble residue, defined as the sum of all oxides except CaO, ranges from 0.33 to 3.98 wt% with an average of 1.5 wt%. It consists of SiO_2 (50%), subordinate Al_2O_3 (16.5%) and MnO (10.6%), minor Fe_2O_{3tot} (5.3%), MgO (3.3%, except dolomite-bearing samples X-27 and X-28 with much higher contents than the other 26 samples) and P_2O_5 (3.1%), and scarce TiO_2 (2.0%), Na_2O (1.6% except sample X-9, containing abundant albite and thus considered scarcely representative of the studied population, and K_2O (1.4%).

Among trace elements, Sr is the most abundant ($\bar{x}$ = 341 ppm), almost exclusively contained in the carbonate fraction. Ba is the most abundant trace element in the insoluble residue, and the second one in whole-rock samples ($\bar{x}$ = 35 ppm). Zn and Y have lower contents ($\bar{x}$ = 27 and 22 ppm, respectively). Cu ($\bar{x}$ = 13 ppm), Rb ($\bar{x}$ = 7 ppm) and Zr ($\bar{x}$ = 5 ppm) are scarce; Ni, Ce and Cr are negligible.

Taking into account compositional variations with stratigraphy, two groups of samples can be distinguished in fig. 3: group A, which includes samples X-1 to X-21, exhibiting wider oscillations of contents, and group B, including the remaining samples, characterized by comparatively smaller content changes. Moreover, the insoluble residue appears to change with rhythmic pulses throughout the sequence, showing peaks in samples X-3, X-5, X-8, X-11, X-14, X-17, X-21, X-22, X-25, X-26 and X-28. As regards major oxides, the trends of SiO_2, Al_2O_3, TiO_2, K_2O are in line with those of the insoluble residue. This finding is in agreement with the fact that these oxides constitute the minerals of the insoluble residue. MgO, MnO and P_2O_5 show many peaks corresponding to those of the insoluble residue; however, the three oxides usually have unrelated peaks. Among trace elements, Rb, Sr, Y, Zr, Cu and Zn generally mimic the trend of the insoluble residue, whereas Ba follows this trend in a limited number of samples.

TABLE 1

Major (wt%) and trace (ppm) element contents of «Plattenkalk» samples from Hordaki area. bdl = below detection limit. Underlined figures are omitted from averages (see text). IR = insoluble residue

Samples	X-1	X-2	X-3	X-4	X-5	X-6	X-7	X-8	X-9	X-10
SiO_2	0.09	0.81	2.09	0.24	0.65	0.61	0.14	2.26	0.27	0.68
TiO_2	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.02
Al_2O_3	0.09	0.29	0.60	0.09	0.25	0.18	0.09	0.78	0.16	0.25
Fe_2O_{3tot}	bdl	0.04	0.14	0.15	0.02	0.02	0.15	0.18	bdl	0.06
MnO	0.09	0.10	0.12	0.08	0.10	0.09	0.09	0.41	0.07	0.07
MgO	bdl	0.04	0.06	0.01	0.39	bdl	bdl	0.14	bdl	0.05
CaO	55.83	55.23	54.22	55.67	55.16	55.42	55.73	53.70	55.26	55.34
Na_2O	0.01	0.01	0.05	0.01	0.01	0.11	0.01	0.01	0.87	0.01
K_2O	bdl	0.04	0.11	bdl	0.02	0.01	bdl	0.11	bdl	0.04
P_2O_3	0.03	0.04	0.03	0.04	0.03	0.02	0.05	0.05	0.06	0.06
LOI	43.82	43.35	42.55	43.69	43.33	43.49	43.74	42.28	43.36	43.44
Total	99.98	99.97	100.00	100.00	99.97	99.97	100.02	99.96	100.07	100.02
Rb	8	3	10	14	10	10	5	7	bdl	5
Sr	218	333	501	278	327	294	249	442	263	316
Ba	1	50	50	bdl	50	bdl	86	50	43	bdl
Ce	1	bdl	1	1	1	1	1	1	1	1
Y	21	20	19	16	22	16	18	32	23	18
Zr	3	5	10	bdl	8	2	bdl	10	bdl	bdl
Cu	14	11	17	10	11	11	14	17	9	11
Zn	22	20	29	22	25	25	21	29	25	25
Ni	1	1	2	1	1	1	1	1	1	1
Cr	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	1
IR	0.33	1.39	3.23	0.64	1.48	1.12	0.55	3.98	1.45	1.24

Samples	X-11	X-12	X-13	X-14	X-15	X-16	X-17	X-18	X-19	X-20
SiO_2	1.48	0.30	0.55	1.88	0.43	1.06	1.67	0.29	0.33	0.41
TiO_2	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Al_2O_3	0.45	0.12	0.09	0.25	0.15	0.15	0.56	0.15	0.13	0.13
Fe_2O_{3tot}	0.39	0.01	0.02	0.28	0.01	0.01	0.42	bdl	0.01	0.14
MnO	0.08	0.12	0.10	0.07	0.15	0.09	0.08	0.12	0.12	0.8
MgO	bdl	bdl	0.12	bdl	bdl	bdl	bdl	bdl	bdl	bdl
CaO	54.60	55.71	55.42	54.60	55.61	55.25	54.40	55.67	55.68	55.54
Na_2O	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
K_2O	0.09	bdl	0.01	0.04	0.01	0.01	0.14	bdl	bdl	bdl
P_2O_5	0.05	0.03	0.02	0.04	0.02	0.03	0.05	0.03	bdl	0.05
LOI	42.85	43.72	43.61	42.85	43.64	43.36	42.69	43.69	43.70	43.59
Total	100.05	100.04	99.97	100.04	100.05	99.99	100.05	99.98	100.00	99.97
Rb	12	3	6	5	10	bdl	11	10	8	bdl
Sr	439	253	270	362	274	195	647	280	263	256
Ba	56	bdl	43	bdl	43	bdl	93	bdl	bdl	19
Ce	1	1	1	bdl	1	1	1	1	1	1
Y	23	24	17	24	20	30	25	18	21	28
Zr	8	5	3	8	5	11	17	bdl	bdl	5
Cu	16	14	12	11	12	10	17	14	14	14
Zn	27	19	28	22	25	24	26	30	24	29
Ni	1	1	1	1	1	1	1	1	1	1
Cr	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
IR	2.60	0.54	0.94	2.59	0.80	1.38	2.96	0.62	0.62	0.84

TABLE 1: *continued*

Samples	X-21	X-22	X-23	X-24	X-25	X-26	X-27	X-28	$\bar{x}$	±	σ
SiO_2	0.65	1.19	0.87	0.34	0.89	0.91	0.24	0.24	0.77		0.60
TiO_2	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.004
Al_2O_3	0.18	0.31	0.24	0.14	0.23	0.26	0.11	0.08	0.23		0.17
Fe_2O_{3tot}	0.02	0.08	0.03	0.01	0.03	0.03	bdl	bdl	0.08		0.12
MnO	0.33	0.10	0.12	0.10	0.10	0.12	0.09	0.07	0.11		0.07
MgO	bdl	0.08	0.24	bdl	0.17	0.02	0.59	1.13	0.05		0.02
CaO	55.30	54.95	55.12	55.65	55.19	55.16	55.04	54.45	55.17		0.52
Na_2O	0.07	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.02		0.12
K_2O	0.01	0.06	0.04	0.01	0.03	0.04	bdl	bdl	0.03		0.04
P_2O_5	0.04	0.04	0.02	0.03	0.02	0.03	0.01	0.02	0.03		0.01
LOI	43.40	43.12	43.24	43.67	43.31	43.30	43.87	43.96	43.38		0.41
Total	100.02	99.97	100.00	99.98	100.00	99.99	100.00	100.00	100.00		0.03
Rb	9	9	7	6	7	8	8	3	7		3
Sr	320	459	371	354	492	501	257	1677	341		320
Ba	45	86	37	bdl	56	50	79	44	35		22
Ce	1	bdl	1	1	1	1	bdl	bdl	1		0
Y	25	23	24	22	20	27	21	19	22		4
Zr	bdl	5	8	8	9	14	3	69	5.4		14
Cu	12	11	15	15	16	15	16	12	13		3
Zn	30	51	26	30	35	30	35	26	27		8
Ni	1	1	1	1	1	1	1	1	1		0
Cr	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl		bdl
IR	1.92	1.09	1.59	0.66	1.05	1.44	1.09	1.59	1.46		0.90

DISCUSSION

The two different textures of the samples may be correlated with their different stratigraphic positions. Oriented-texture samples come from the upper part of the sequence, below the overthrust of the Omalos (Trypali) unit. Therefore, the thrust probably caused the deformation of the rock texture from isotropic to oriented.

Apart from texture, the studied rocks show quite homogeneous geochemical and petrographic features, defining the samples as calcitic marbles. Assuming that metamorphism was isochemical, the following observations may be made: *i)* Sr contents are lower than the average value (450 ppm; Wedepohl, 1974) of pre-Tertiary marine carbonates and higher than that of platform carbonates (e.g., Renard, 1979); *ii)* Mn and Cu contents are similar to those of marly limestones, and higher and lower, respectively, than those of platform carbonates (Bencini and Turi, 1987; Buscail and Monaco, 1987). These features, together with the presence of metachert nodules and the scarcity of the insoluble residue, indicate that the rock protoliths were pelagic carbonates.

The very scarce detrital input into the sea basin – with relatively high contents of Y and Zr and very low Cr and Ni – indicates that it derives from the erosion of continental crust. Moreover, as the insoluble residue in the upper part of the sequence shows smaller oscillations than in the lower part, there is evidence that the detrital input into this portion of the basin must have decreased with time. The cause of this decrease is not known: perhaps a more arid climate, and/or decline in tectonic activity, and/or increased distance of the basin from the continental margin.

The trends of Cu, Zn and Sr (generally carried by the carbonate fraction, especially Sr) also match the trend of the insoluble residue. This finding may be explained as follows : these elements were first adsorbed on to clay minerals derived from the mainland and then released, being able to enter the carbonate fraction of the rocks during diagenesis and/or

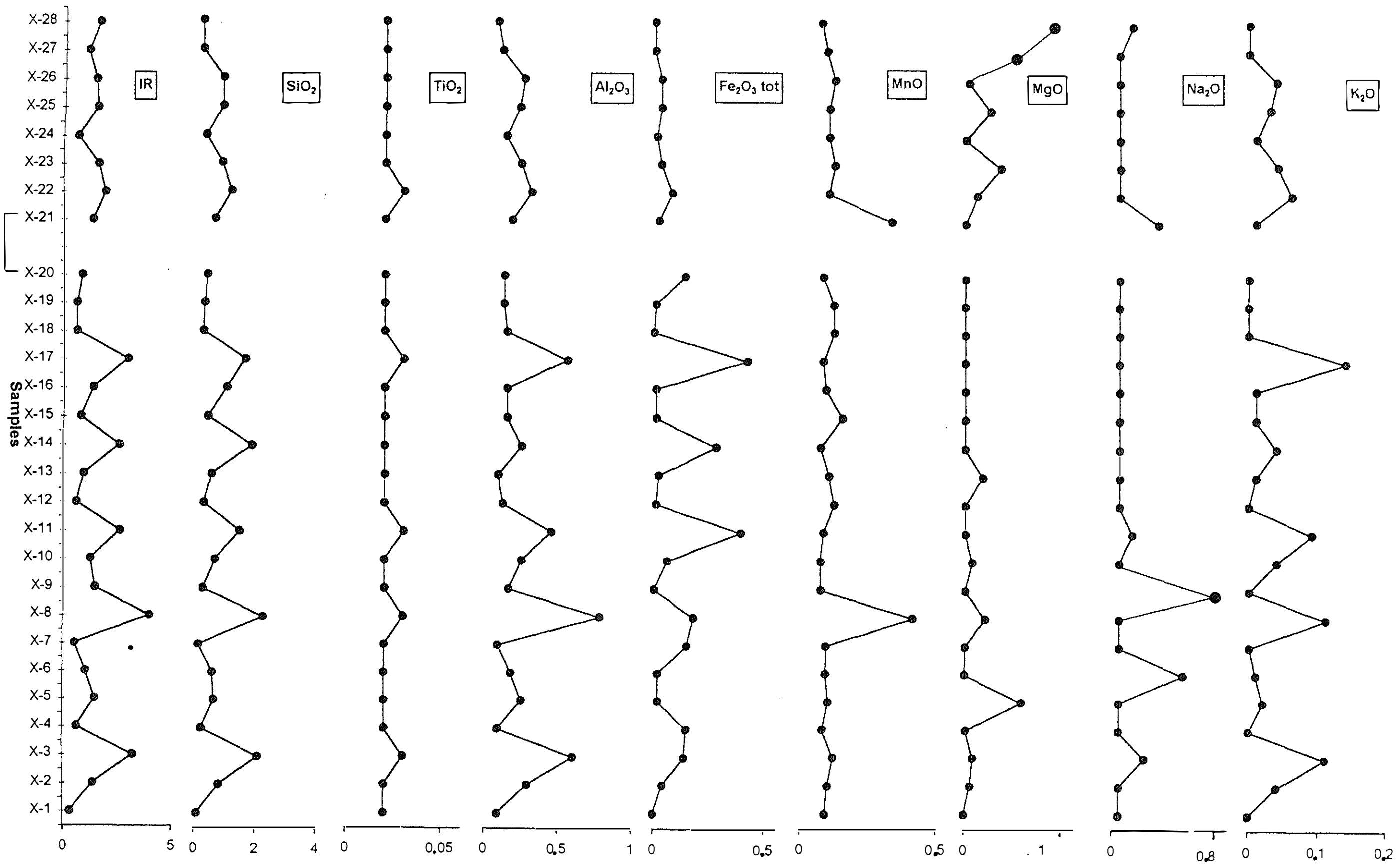
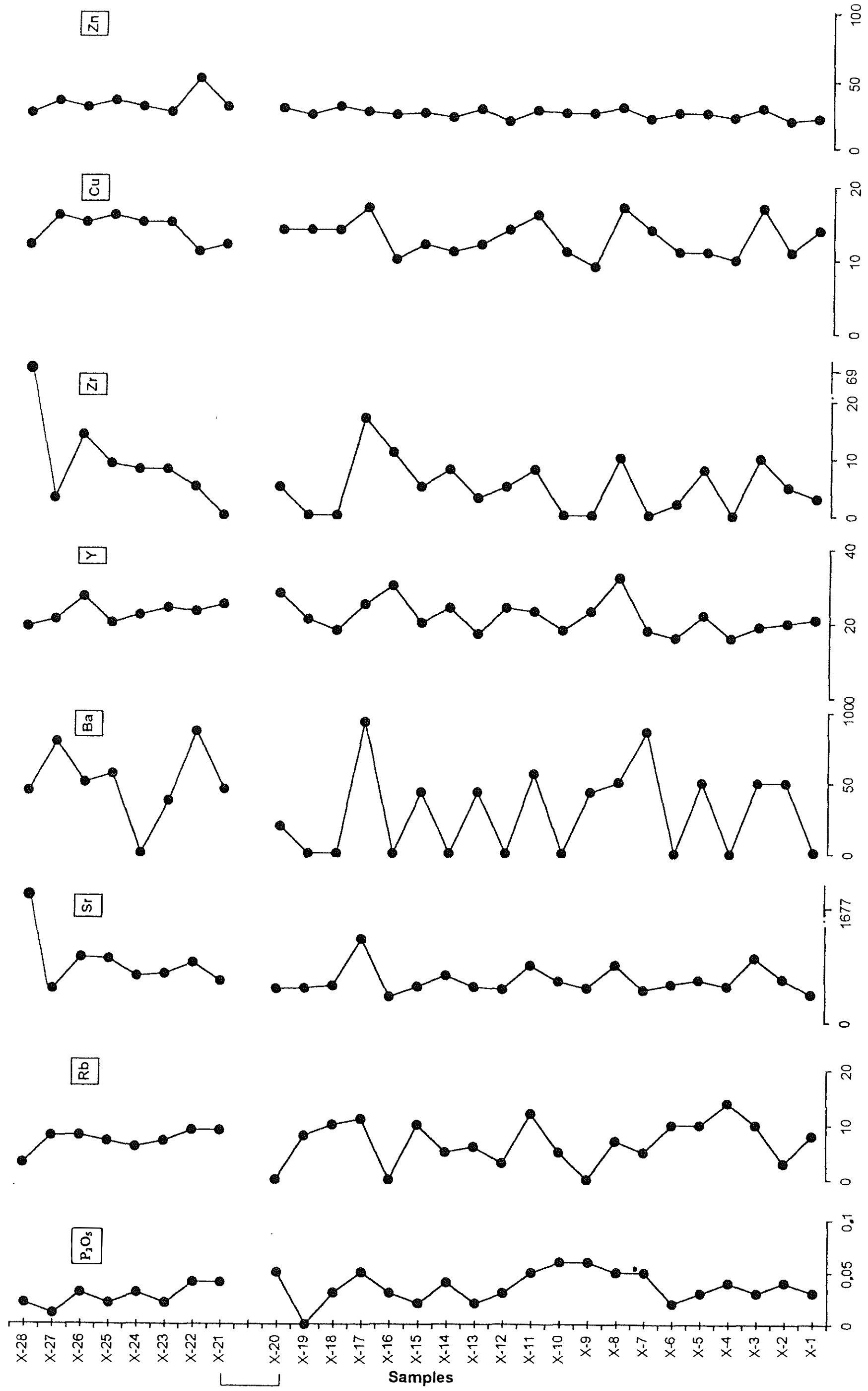


Fig. 3 – Variations of chemical compositions of «Plattenkalk» samples from Hordaki area with stratigraphy. Oxides and trace elements expressed in wt% and ppm, respectively.


Zn
Cu
Zr
Y
Ba
Sr
Rb
P_2O_5
X-28
X-27
X-26
X-25
X-24
X-23
X-22
X-21
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X-19
X-18
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Samples

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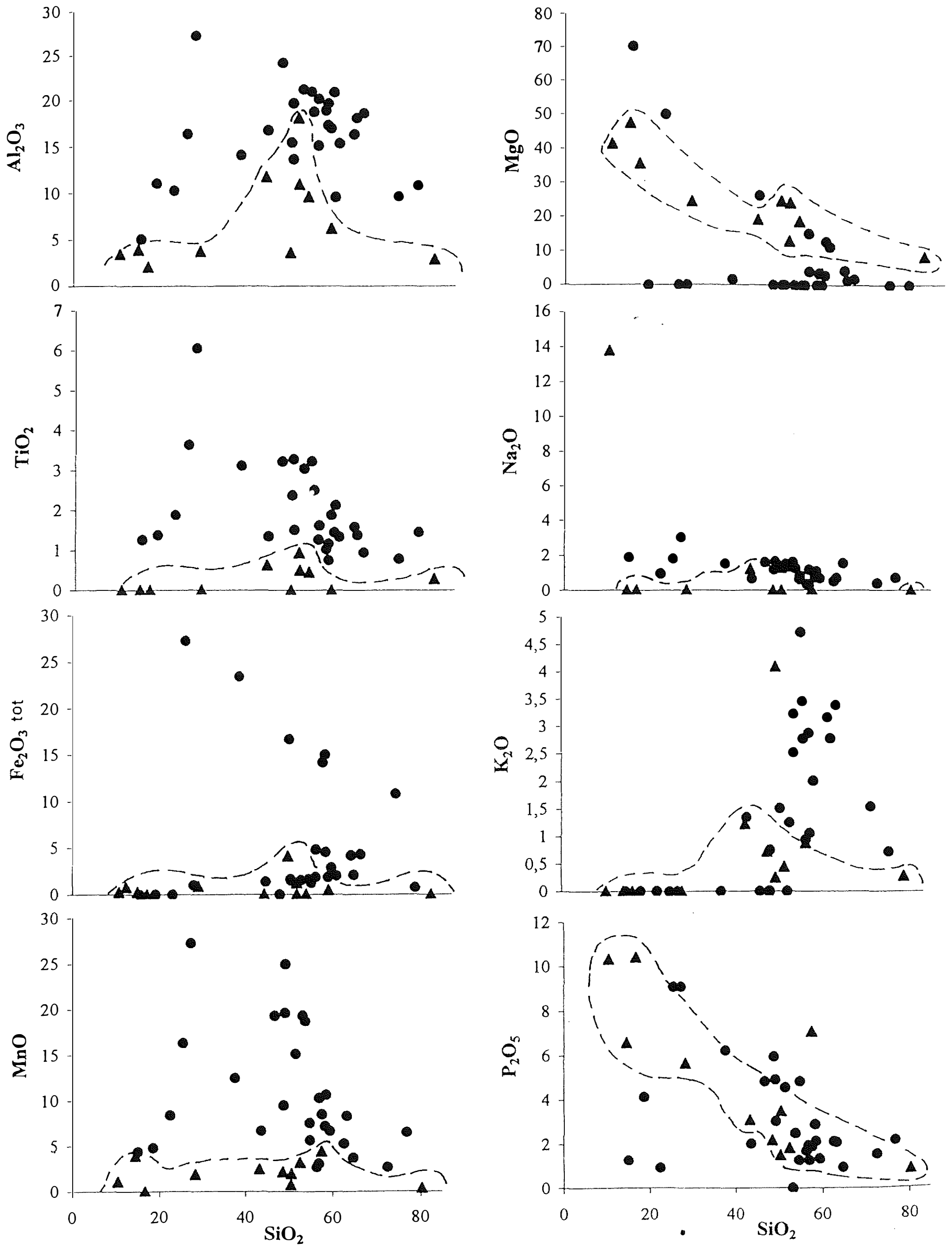

Fig. 4 – Comparisons of chemical composition of «Plattenkalk» samples (full dots) from Hordaki area and grey marbles (full triangles) from Mani peninsula, southern Peloponnesus. Field of Mani samples is contoured by dashed line. Oxides and trace elements as in fig. 3.

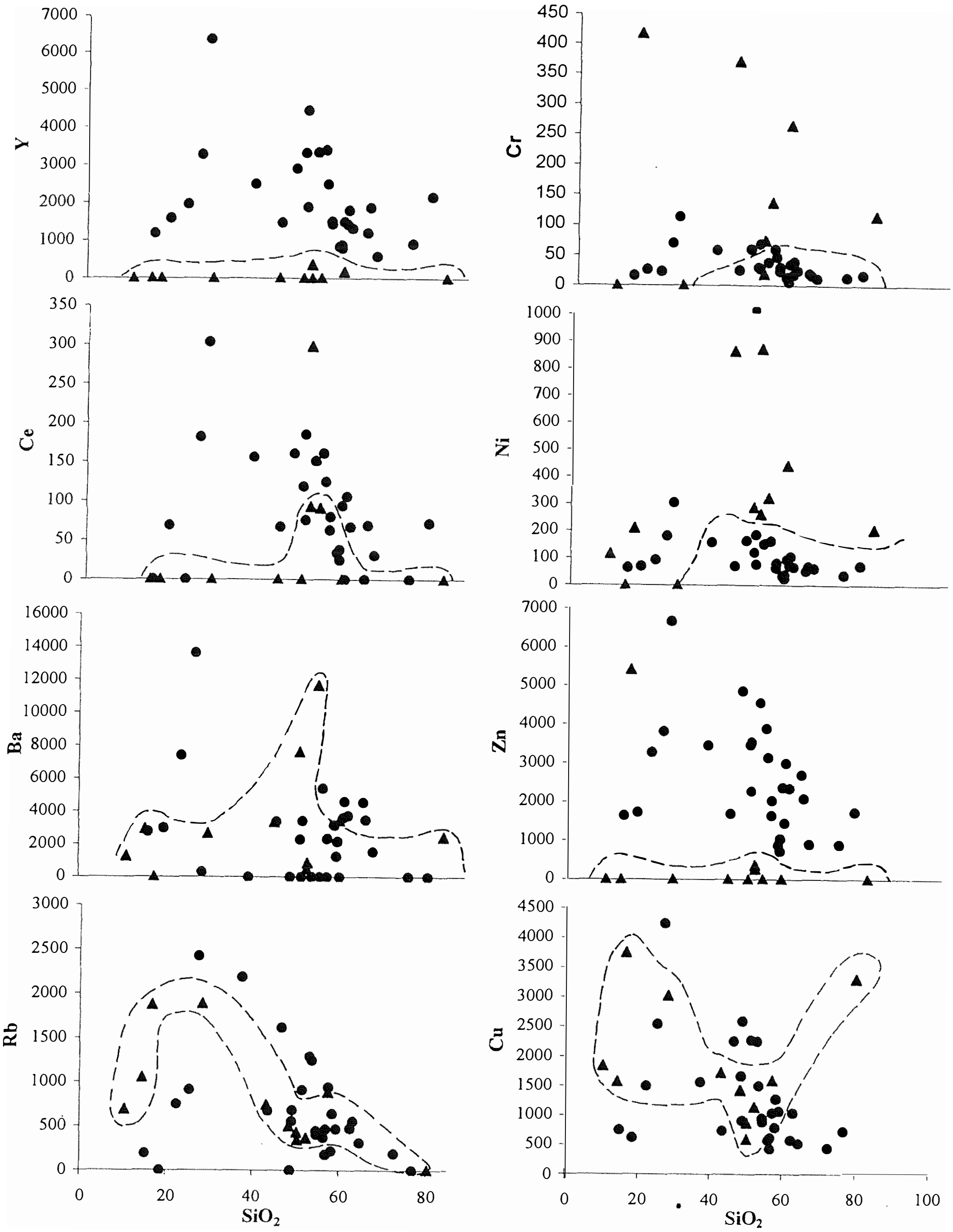

Fig. 4

metamorphism. Lastly, as the trends of MgO, MnO and P_2O_5 match the trend of the insoluble residue only in part, this may be due to the fact that the two former oxides are contained above all in the carbonate fraction and the third one mainly derives from organic materials.

COMPARISON WITH GREY MARBLE FROM MANI

Among the rocks outcropping in the Mani peninsula, southern Peloponnesus (Masi *et al.* 1995), representing the entire sequence from the Triassic to the Oligocene, only the grey marble compares with the studied samples in terms of appearance, mineralogical and petrographic features, except for insoluble residue contents. Comparisons of the chemical composition of the two groups of rocks are shown in Table 2 and graphically presented for all samples in fig. 4, which plots the contents of all oxides and trace elements, except CaO and Sr, against SiO_2 . The Cretan samples appear to be enriched in Al_2O_3, MnO, Na_2O, K_2O, $Fe_2O_{3tot.}$, TiO_2, Zr, Ce, Zn and Y with respect to the Mani samples, with a similar SiO_2 range in the insoluble residue. In contrast, the Cretan samples are depleted in MgO, Ni, Cu and Cr and the ranges of P_2O_5, Ba and Rb are not discriminant. As a whole, the two groups of rocks do not appear to be equivalent. This is tantamount to stating that they probably did not belong to the same basin. This conclusion agrees with the hypotheses of Hall *et al.* (1984) and Soujon *et al.* (1998), who consider that the «Plattenkalk» series is unrelated to the Peloponnesian rocks.

TABLE 2

Comparison of average chemical composition of «Plattenkalk» samples from Hordaki area and grey marbles from Mani peninsula, southern Peloponnesus. Oxides and trace elements expressed as wt% and ppm, respectively.

	Cretan rocks		Manian rocks	
Samples	$\bar{x}$	± σ	$\bar{x}$	± σ
SiO_2	0.77	0.60	1.01	1.03
TiO_2	0.02	0.01	0.02	0.04
Al_2O_3	0.23	0.17	0.19	0.28
Fe_2O_{3tot}	0.08	0.12	0.26	0.10
MnO	0.11	0.07	0.03	0.02
MgO	0.05	0.09	0.37	0.26
Na_2O	0.02	0.02	0.02	0.04
K_2O	0.03	0.04	0.03	0.06
P_2O_5	0.03	0.01	0.06	0.03
Rb	7	3.6	10.8	4.68
Sr	431.3	187	502	200
Ba	30	30	39.2	33.4
Ce	1	0.39	2.7	4.6
Y	22	4	2	0.6
Zr	5.4	4.6	bdl	bdl
Cu	13	2.5	30.4	28.6
Zn	27	6	5.18	9.49
Ni	1	0.19	8	10.26
Cr	bdl	bdl	3.64	3.29
IR	1.46	0.90	1.98	1.61

CONCLUSIONS

This paper presents a geochemical study conducted on 28 samples of metalimestones of the «Plattenkalk» series from the Hordaki area, western Crete, Greece. In the lower and middle partions of the sequence, the samples have granoblastic fabric and an isotropic texture. Instead, in the upper part of the sequence the texture becomes oriented, probably as a consequence of the overthrust of the Omalos (Trypali) unit over the «Plattenkalk» series.

Assuming that metamorphism was isochemical, the very scarce amount of the insoluble residue, the presence of chert nodules and the contents of Sr, Zn and Cu validate the pelagic nature of the protolith. Due to the relatively high contents of Y and Zr and the negligible contents of Ni and Cr, the insoluble residue is thought to originate from weathering of continental crust.

The distribution of the insoluble residue through the stratigraphy shows rhythmic oscillations, especially in the lower and central parts of the outcrop. This finding supports the hypothesis of periodical refilling of the basin by detrital input from the mainland. Refilling decreased with time, owing perhaps to a slower erosion rate and/or to increased distance between basin and mainland.

Comparisons of the studied rocks with similar lithotypes from the Mani peninsula, southern Peloponnesus, show petrographic correspondence but, on average, not full chemical correspondence. Hence, the two series do not appear to be equivalent. This conclusion is consistent with the hypotheses of Hall *et al.* (1984) and Soujon *et al.* (1998), who consider that the «Plattenkalk» series is unrelated to the Peloponnesian rocks.

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