

**WALL STRUCTURE, CHEMICAL ANALYSIS AND THEIR
SIGNIFICANCE IN SYSTEMATIC CLASSIFICATION OF
SOME SENONIAN BIVALVIAN SHELLS FROM ABU-ROASH
AREA , EGYPT**

BY

A.A. Abdel Aal, M. R. Mohammad and A. I. Rezk
Department of Geology, Faculty of Science
Alexandria University, Egypt.

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ABSTRACT

Wall structure and chemical analysis of shells belonging to three Senonian bivalvian families point out to outstanding differences between the families. Family Inoceramidae is completely composed of layers formed by relatively coarse calcitic prisms, accompanied by high concentration of Sr. Family Ostreidae consists of foliated calcite accompanied by high concentration of Mn and Fe. Family Plicatulidae is composed of two layers ; an external one of relatively fine transverse prisms and an internal one formed by aragonitic cross lamellae showing zigzag shape, and is characterized by high concentration of Mg, Si, and Al.

INTRODUCTION

The histolo-chemical correlation is very important in the recent classifications of organisms. The first attempt for such classification was done by Vinogradov [1,2], followed by many attempts by many authors [3 - 8] .

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The study of the bivalvian shell structure is recently dealt with in detail by several authors [8,9] [10-14].

The aim of the present study is to reveal the essential differences in chemistry and structure of shells belonging to three bivalvian families, as a trial to clarify their importance as factors for the systematic classification of the Senonian bivalvian shells.

MATERIALS AND METHODS

The studied shells are collected from the Senonian strata exposed at Wadi El Qurn and Wadi El Hassana, Abu Roash area (Fig. 1). Hundred and fourty one well preserved bivalvian shells are subjected to chemical analysis. The studied shells represent twenty five species belonging to eight genera of three bivalvian families, as follows:

1- Family INOCERAMIDAE Giebel

Inoceramus regularis Quaas

I. digitatus Sowerby

I. lobatus Goldfuss

Inoceramus sp.

2- Family PLICATULIDAE Watson

PLICATULA ferryi Coquand

P. multicostata Forbes

P. hirsuta Coquand

P. numidica Coquand

P. flattersi Coquand

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3- Family OSTREIDAE Lamarck

- Ostrea acutirostris Nilsson
O. lateralis Nilsson
O. bourguignati Coquand
O. peroni Coquand
O. nicaisei Coquand
O. deshayesi Coquand
Ostrea sp.
Lopha dichotoma (Bayle)
Lopha semiplana (Sowerby)
Lopha sp.
Pycnodonta vesicularis (Lamarck)
P. heinzi (Thomas and Peron)
P. Costei (Coquand)
Pycnodonta sp
Exogyra longloisi (Coquand)
Fryphaea sp.

The analysis is done by using the spectrographical method described by Abdel Aal and Frihy [15] (Tables 1 and 2).

Twenty five samples, representing the three mentioned families, are also prepared for wall structure study. They are fixed in epoxy resin, polished and etched by hydrochloric acid (0.1%). Replicas are then taken off from the surface of the etched sections and studied microscopically by transmitted light.

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RESULTS AND CONCLUSIONS

Results of the chemical analysis are shown graphically in figure 2, in which minimum, maximum and arithmetic means of the percentages of Si, Fe, Mn, Al, Mg and Sr in the studied samples of each family are plotted. The graphs show the following:

- 1- Silicon: By using the maximum and arithmetic means, family Inoceramidae is characterized by lower concentration of Si than Plicatulidae and Ostreidae.
- 2- Iron: Family Plicatulidae is characterized by a lower maximum mean of Fe than Ostreidae and Inoceramidae. By using the arithmetic mean, family Inoceramidae is characterized by a lower concentration of Fe than Plicatulidae and Ostreidae.
- 3- Manganese: Family Ostreidae is characterized by higher concentration of Mn than Plicatulidae while the later contains a higher concentration of this element than Inoceramidae.
- 4- Aluminium: Family Plicatulidae is characterized by high concentration of Al, and family Inoceramidae contains a lower amount of this element than Ostreidae.
- 5- Magnesium: By using the maximum and arithmetic means, family Inoceramidae is characterized by high amount of Mg, while family Ostreidae contains a lower amount than Plicatulidae and Inoceramidae.

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6- Strontium : Family Inoceramidae is characterized by a higher concentration of Sr than family Plicatulidae, while the later contains higher concentration than Ostreidae.

In brief and concerning only the arithmetic mean, higher concentration of Sr usually associates family Inoceramidae, higher concentrations of Si, Al and Mg associate family Plicatulidae and higher concentrations of Mn and Fe characterize family Ostreidae.

The study of wall structure of the shells reveals the following:

- 1- The representative shells of family Inoceramidae are composed of relatively coarse calcitic prisms extending normal to the surface of the shell wall (Pl. I -a & -b).
- 2- The representative shells of family Ostreidae are completely composed of foliated calcite. This foliated structure consists of adjacent flattened blades. Every blade in one layer is covered by another one from the next layer (Pl. I -c)
- 3- The representative shells of family Plicatulidae are composed of two layers. The external one consists of relatively fine calcitic prisms extending perpendicular to the surface of the shell wall. The internal layer is

composed of aragonitic cross lamellae, arranged in oblique directions forming zigzag structure (Pl. I -d)

The present results exhibit a positive correlation with the previous studies and the systematic classification of both Recent and fossil bivalves. According to Taylor [16], the shells of Ostreacea are composed of foliated calcite.

Maslov [12] mentioned that the shells of Ostrea gigantea, Gryphaea vesicularis and Exogyra sp. are composed of foliated calcite. Abdel Aal [8] indicated that the shells of Liostrea incurva are completely composed of foliated calcite. Abdalla Hegab and Kenawy [14] indicated that the shells of Ostrea nicaisei and Ostrea lameraciana are composed of foliated calcite.

According to Maslov [12] and Abdel Aal [8], the shells of Inoceramus sp. are completely composed of coarse calcitic prisms.

According to Abdalla Hegab [13], the shells of Plicatula sp. are composed of two layers, an external one formed of calcitic prisms and an internal layer composed of aragonitic cross lamella.

From the above discussion, we can conclude that wall structure and element concentrations distinguish notably each of the three studied families; accordingly may have important significance to the systematic classification of the Senonian bivalvian shells. Further studies are recommended for other bivalvian families to get a thorough geochemical

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and structural classification for the bivalvia, in general.

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Plate I

Photographs showing wall structure in sections parallel
to the ventral margins:

- a- Calcitic prisms in Inoceramus regularis Quaas (X 40).
- b- Calcitic prisms in Inoceramus digitatus Sowerby (X 60).
- c- Foliated calcite in Pycnodonta heinzi (Thomas and Peron),
(X 40).
- d- Two layers, external one of calcitic prisms (1) and
internal one of aragonitic cross lamellae (2), in
Plicatula ferryi Coquand (X 40).

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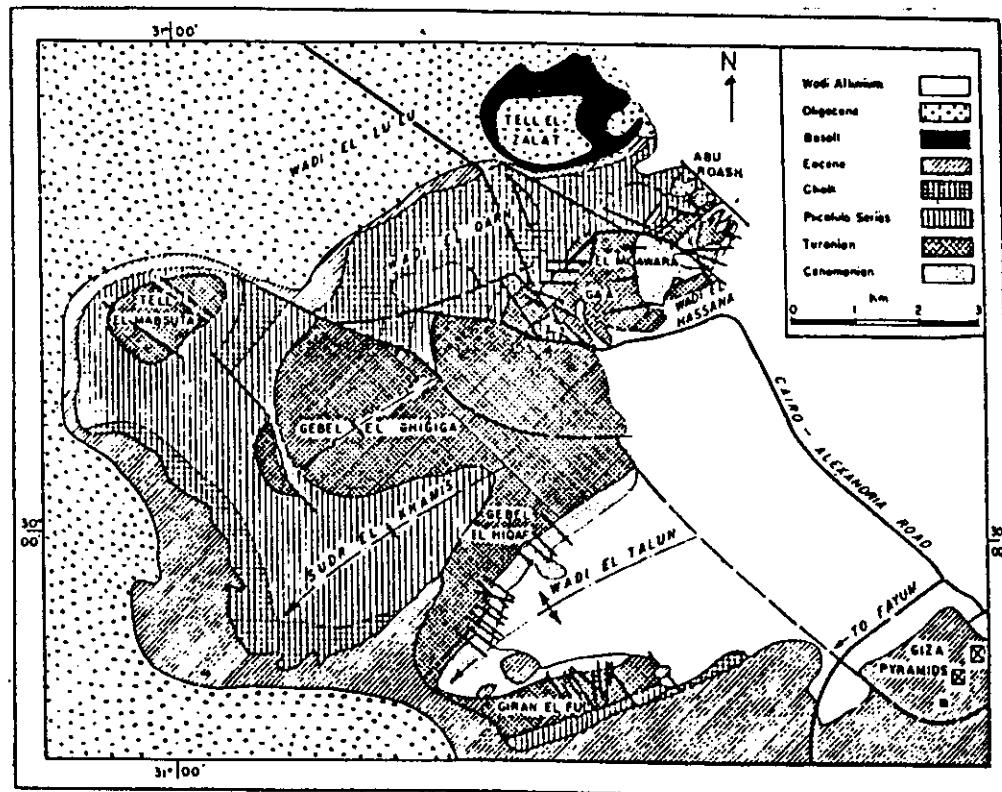


Fig.1: Geological map of Abu Roash area,
(after Said, 1962).

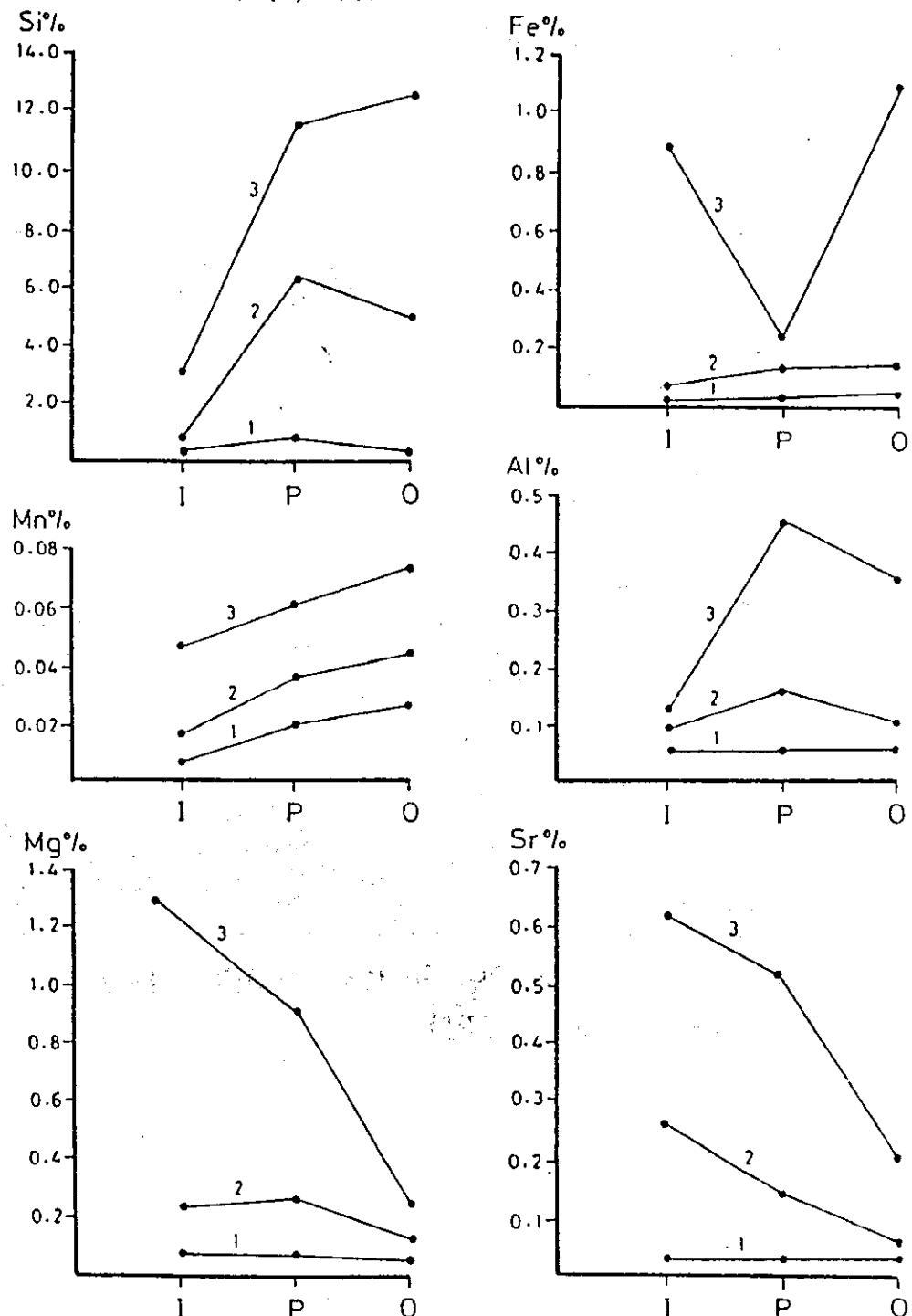
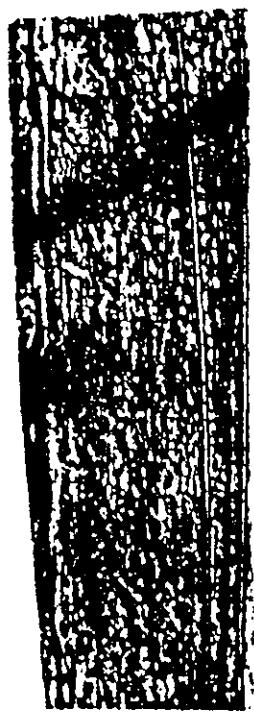


Fig. 2-Graphs showing minimum (1), maximum (3) and arithmetic mean (2) of Si, Fe, Mn, Al, Mg and Sr percentages in Inoceramidae (I), Plicatulidae (P), and Ostreidae (O)

Plate I



- b -



- c -

Table 1 : Data of spectral analyses of the studied Coniacian-Santonian bivalvian shell.

Name	Bed No.	Mg %	Al %	Si %	Mn %	Fe %	Sr %
<i>Lopha dichotoma</i> (Bayle)	S ₁	0.15	0.130	12.20	0.042	0.09	0.020
<i>Pycnodonta heinzi</i> (Thomas and Peron)	S ₁	0.24	0.094	11.00	0.048	0.25	0.020
<i>Lucina sabarica</i> Quaas	S ₁	0.08	0.085	0.78	0.030	0.07	0.100
<i>Ostrea</i> sp.	S ₁	0.09	0.072	10.30	0.050	0.03	0.020
<i>Ostrea acutirostris</i> Nilsson	S ₄	0.15	0.110	4.40	0.062	1.10	0.100
<i>Ostrea lateralis</i> Nilsson	S ₄	0.12	0.154	2.80	0.070	0.90	0.050
<i>Ostrea lateralis</i> Nilsson	S ₄	0.11	0.125	5.80	0.070	0.12	0.090
<i>Ostrea bourguignati</i> Coquand	S ₄	0.11	0.115	1.20	0.048	0.45	0.060
<i>Ostrea bourguignati</i> Coquand	S ₄	0.07	0.130	11.10	0.050	0.05	0.012
<i>Ostrea peroni</i> Coquand	S ₄	0.11	0.125	10.60	0.044	0.07	0.020
<i>Ostrea peroni</i> Coquand	S ₄	0.22	0.230	2.40	0.046	0.36	0.200
<i>Ostrea peroni</i> Coquand	S ₄	0.12	0.175	10.40	0.042	0.36	0.030
<i>Ostrea</i> sp.	S ₄	0.12	0.090	1.00	0.042	0.90	0.020
<i>Ostrea</i> sp.	S ₄	0.07	0.085	10.35	0.046	0.36	0.030
<i>Ostrea</i> sp.	S ₄	0.09	0.075	10.40	0.052	0.07	0.020
<i>Ostrea</i> sp.	S ₄	0.07	0.094	1.00	0.058	0.03	0.040
<i>Ostrea</i> sp.	S ₄	0.10	0.115	0.85	0.060	0.06	0.120
<i>Lopha dichotoma</i> (Bayle)	S ₄	0.07	0.080	10.70	0.042	0.06	0.010
<i>Lopha dichotoma</i> (Bayle)	S ₄	0.08	0.080	11.20	0.044	0.25	0.010
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.11	0.100	7.00	0.042	0.07	0.030
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.10	0.094	10.40	0.042	0.12	0.035
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.10	0.130	5.80	0.040	0.80	0.035
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.11	0.125	10.40	0.075	0.12	0.030
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.13	0.125	2.50	0.070	0.10	0.190
<i>Lopha semiplana</i> (Sowerby)	S ₄	0.11	0.230	7.20	0.040	0.54	0.140

Table 1 : (Cont.) .

Name	Bed. No.						
		Mg %	Al %	Si %	Mn %	Fe %	Sr %
Lopha sp.	S ₄	0.11	0.100	1.20	0.038	0.60	0.045
Lopha sp.	S ₄	0.11	0.100	0.90	0.030	0.15	0.054
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.08	0.115	10.70	0.045	0.22	0.030
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.10	0.115	2.50	0.044	0.18	0.100
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.08	0.115	12.20	0.044	0.12	0.014
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.12	0.100	1.70	0.048	0.10	0.030
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.13	0.360	4.50	0.042	0.54	0.032
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.11	0.110	10.60	0.044	0.18	0.030
Pycnodonta heinzi (Thomas and Peron)	S ₄	0.10	0.130	1.60	0.052	0.05	0.045
Pycnodonta costei (Coquand)	S ₄	0.12	0.125	2.40	0.046	0.18	0.130
Pycnodonta sp.	S ₄	0.10	0.100	1.20	0.048	0.18	0.020
Exogyra longloisi (Coquand)	S ₄	0.11	0.140	10.20	0.060	0.80	0.020
Exogyra longloisi (Coquand)	S ₄	0.05	0.090	11.20	0.030	0.06	0.014
Exogyra longloisi (Coquand)	S ₄	0.13	0.220	9.90	0.058	0.70	0.020
Gryphaea sp.	S ₄	0.08	0.075	12.00	0.042	0.06	0.010
Gryphaea sp.	S ₄	0.04	0.066	9.20	0.048	0.03	0.014
Flicatula ferryi Coquand	S ₄	0.18	0.110	2.80	0.062	0.18	0.120
Flicatula ferryi Coquand	S ₄	0.90	0.130	5.00	0.038	0.18	0.080
Flicatula numidica Coquand	S ₄	0.25	0.150	4.50	0.036	0.22	0.360
Pycnodonta heinzi (Thomas and Peron)	S ₇	0.08	0.080	9.60	0.044	0.06	0.010
Pycnodonta heinzi (Thomas and Peron)	S ₇	0.08	0.100	11.20	0.042	0.03	0.014
Pycnodonta costei (Coquand)	S ₇	0.12	0.060	0.72	0.046	0.36	0.130
Pycnodonta costei (Coquand)	S ₇	0.08	0.066	10.10	0.046	0.03	0.014
Flicatula ferryi Coquand	S ₉	0.09	0.066	10.20	0.038	0.05	0.014
Flicatula ferryi Coquand	S ₉	0.22	0.170	10.20	0.036	0.18	0.250

Table 1 : (Cont.).

Name	Bed No.	Mg %	Al %	Si %	Mn %	Fe %	Sr %
Plicatula ferryi Coquand	S ₉	0.25	0.080	10.10	0.022	0.10	0.054
Plicatula ferryi Coquand	S ₉	0.07	0.066	10.20	0.026	0.03	0.014
Plicatula ferryi Coquand	S ₉	0.56	0.450	3.90	0.052	0.12	0.520
Plicatula hirsuta Coquand	S ₉	0.30	0.400	2.40	0.030	0.12	0.140
Plicatula multicostata Forbes	S ₉	0.07	0.025	0.58	0.020	0.06	0.130
Plicatula mamidica Coquand	S ₉	0.11	0.085	1.50	0.044	0.25	0.035
Plicatula flattersi Coquand	S ₉	0.11	0.080	11.20	0.036	0.03	0.020
Ostrea deshayesi Coquand	S ₉	0.07	0.100	12.20	0.042	0.03	0.015
Lopha semiplana (Sowerby)	S ₉	0.12	0.115	11.30	0.054	0.09	0.030
Pycnodonta heinzi (Thomas and Peron)	S ₉	0.04	0.070	11.20	0.056	0.03	0.010
Pycnodonta heinzi (Thomas and Peron)	S ₉	0.04	0.085	12.00	0.040	0.04	0.014
Plicatula ferryi Coquand	S ₁₄	0.15	0.130	2.00	0.034	0.12	0.040
Ostrea acutirostris Nilsson	S ₁₄	0.11	0.120	12.20	0.040	0.45	0.030
Ostrea lateralis Nilsson	S ₁₄	0.10	0.120	10.70	0.042	0.04	0.010
Ostrea sp.	S ₁₄	0.11	0.170	10.70	0.040	0.06	0.014
Ostrea sp.	S ₁₄	0.06	0.094	11.30	0.040	0.03	0.014
Lopha dichotoma (Bayle)	S ₁₄	0.07	0.070	10.30	0.038	0.03	0.014
Lopha dichotoma (Bayle)	S ₁₄	0.04	0.066	10.30	0.042	0.03	0.020
Lopha semiplana (Sowerby)	S ₁₄	0.08	0.070	8.50	0.044	0.06	0.015
Lopha sp.	S ₁₄	0.07	0.070	10.40	0.050	0.03	0.014
Lopha sp.	S ₁₄	0.04	0.066	11.20	0.044	0.03	0.020
Pycnodonta heinzi (Thomas and Peron)	S ₁₄	0.04	0.110	12.20	0.044	0.04	0.020
Pycnodonta heinzi (Thomas and Peron)	S ₁₄	0.09	0.120	11.20	0.044	0.32	0.020
Gryphaea sp.	S ₁₄	0.08	0.070	3.50	0.040	0.04	0.020
Gryphaea sp.	S ₁₄	0.10	0.070	10.40	0.040	0.07	0.014

Table 2: Data of spectral analyses of the studied Campanian bivalvian shells.

Name	Bed No.	Mg %	Al %	Si %	Mn %	Fe %	Sr %
<i>Pycnodonta vesicularis</i> (Lamarck)	S ₁₆	0.10	0.070	0.70	0.038	0.06	0.054
<i>Pycnodonta vesicularis</i> (Lamarck)	S ₁₆	0.11	0.085	1.15	0.040	0.09	0.030
<i>Pycnodonta vesicularis</i> (Lamarck)	S ₁₆	0.10	0.085	6.00	0.032	0.04	0.050
<i>Pycnodonta costei</i> (Coquand)	S ₁₆	0.11	0.075	0.90	0.044	0.06	0.050
<i>Erogyra longloisi</i> (Coquand)	S ₁₆	0.10	0.075	0.76	0.026	0.06	0.100
<i>Gryphaea</i> sp.	S ₁₆	0.19	0.066	0.90	0.038	0.06	0.130
<i>Inoceramus lobatus</i> Goldfuss	S ₁₆	0.24	0.075	2.25	0.018	0.03	0.530
<i>Inoceramus lobatus</i> Goldfuss	S ₁₆	0.15	0.075	0.44	0.012	0.02	0.580
<i>Inoceramus lobatus</i> Goldfuss	S ₁₆	0.16	0.072	0.46	0.009	0.02	0.620
<i>Inoceramus lobatus</i> Goldfuss	S ₁₆	0.24	0.072	1.00	0.008	0.06	0.620
<i>Inoceramus lobatus</i> Goldfuss	S ₁₆	0.56	0.080	0.44	0.008	0.03	0.570
<i>Inoceramus digitatus</i> Sowerby	S ₁₆	0.29	0.070	1.95	0.018	0.03	0.330
<i>Inoceramus digitatus</i> Sowerby	S ₁₆	0.82	0.072	0.46	0.014	0.02	0.450
<i>Inoceramus</i> sp.	S ₁₆	0.15	0.070	0.80	0.012	0.05	0.030
<i>Pycnodonta vesicularis</i> (Lamarck)	S ₁₇	0.08	0.080	0.70	0.030	0.05	0.040
<i>Pycnodonta vesicularis</i> (Lamarck)	S ₁₇	0.11	0.090	0.78	0.028	0.03	0.130
<i>Pycnodonta heinzi</i> (Thomas and Peron)	S ₁₇	0.04	0.072	0.72	0.040	0.02	0.014
<i>Ostrea nicaisci</i> Coquand	S ₁₇	0.11	0.120	0.60	0.032	0.10	0.030
<i>Ostrea nicaisci</i> Coquand	S ₁₇	0.11	0.120	0.20	0.030	0.10	0.014
<i>Erogyra longloisi</i> (Coquand)	S ₁₇	0.11	0.140	5.00	0.028	0.36	0.050
<i>Gryphaea</i> sp.	S ₁₇	0.19	0.072	0.95	0.025	0.15	0.100
<i>Gryphaea</i> sp.	S ₁₇	0.10	0.072	10.35	0.027	0.10	0.040
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.15	0.075	0.64	0.020	0.12	0.035
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.72	0.085	0.90	0.022	0.32	0.100
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.08	0.085	0.48	0.018	0.07	0.200
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.24	0.090	0.78	0.011	0.03	0.200
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.08	0.075	0.40	0.013	0.03	0.045
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.11	0.080	0.48	0.012	0.05	0.130
<i>Inoceramus regularis</i> Quaas	S ₁₇	0.11	0.080	0.44	0.016	0.05	0.340

Table 2 : (Cont.) .

Name	Bed No.	Mg %	Al %	Si %	Mn %	Fe %	Sr
<i>Inoceramus regularis</i> Quens	S ₁₇	0.14	0.080	0.62	0.014	0.03	0.2
<i>Inoceramus regularis</i> Quens	S ₁₇	0.07	0.080	0.44	0.014	0.04	0.4
<i>Inoceramus regularis</i> Quens	S ₁₇	0.15	0.070	0.72	0.014	0.06	0.1
<i>Inoceramus regularis</i> Quens	S ₁₇	0.14	0.070	0.46	0.018	0.12	0.3
<i>Inoceramus regularis</i> Quens	S ₁₇	0.18	0.085	0.90	0.030	0.06	0.5
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.18	0.060	1.30	0.018	0.05	0.2
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.20	0.066	0.62	0.016	0.03	0.1
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.82	0.085	2.10	0.042	0.12	0.2
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.14	0.075	0.46	0.018	0.07	0.3
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.18	0.110	1.14	0.012	0.06	0.3
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.12	0.080	0.92	0.018	0.03	0.4
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.19	0.096	0.72	0.012	0.04	0.6
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.15	0.075	0.94	0.008	0.18	0.3
<i>Inoceramus digitatus</i> Sowerby	S ₁₇	0.18	0.080	0.80	0.008	0.04	0.4
<i>Inoceramus lobatus</i> Goldfuss	S ₁₇	0.24	0.072	0.80	0.030	0.25	0.0
<i>Inoceramus lobatus</i> Goldfuss	S ₁₇	1.20	0.070	1.90	0.030	0.10	0.1
<i>Inoceramus lobatus</i> Goldfuss	S ₁₇	0.66	0.094	1.00	0.026	0.04	0.2
<i>Inoceramus lobatus</i> Goldfuss	S ₁₇	0.44	0.080	0.44	0.018	0.03	0.5
<i>Inoceramus lobatus</i> Goldfuss	S ₁₇	0.13	0.075	0.30	0.012	0.09	0.1
<i>Inoceramus</i> sp.	S ₁₇	0.15	0.075	0.48	0.015	0.80	0.0
<i>Inoceramus</i> sp.	S ₁₇	0.16	0.080	1.60	0.028	0.25	0.0
<i>Inoceramus</i> sp.	S ₁₇	0.19	0.094	2.00	0.030	0.90	0.0
<i>Inoceramus</i> sp.	S ₁₇	1.30	0.085	2.00	0.036	0.12	0.0
<i>Inoceramus</i> sp.	S ₁₇	0.27	0.094	1.50	0.030	0.12	0.3
<i>Inoceramus</i> sp.	S ₁₇	0.09	0.070	0.90	0.028	0.05	0.0
<i>Inoceramus</i> sp.	S ₁₇	1.20	0.070	0.40	0.018	0.07	0.1
<i>Inoceramus</i> sp.	S ₁₇	0.11	0.085	0.78	0.016	0.07	0.1
<i>Inoceramus</i> sp.	S ₁₇	0.08	0.075	0.40	0.018	0.03	0.2
<i>Inoceramus</i> sp.	S ₁₇	0.09	0.080	0.60	0.013	0.03	0.1
<i>Inoceramus</i> sp.	S ₁₇	0.18	0.075	0.40	0.011	0.02	0.4
<i>Inoceramus</i> sp.	S ₁₇	0.15	0.080	0.50	0.011	0.03	0.3
<i>Inoceramus</i> sp.	S ₁₇	0.10	0.072	1.20	0.019	0.07	0.3

Table 2 : (Cont.) .

Name	Bed No.	Mg %	Al %	Si %	Mn %	Fe %	Sr %
Inoceramus sp.	S ₁₇	0.08	0.094	3.30	0.046	0.06	0.035
Inoceramus sp.	S ₁₇	0.11	0.072	0.72	0.020	0.04	0.030
Inoceramus sp.	S ₁₇	0.15	0.085	2.40	0.024	0.04	0.120
Inoceramus sp.	S ₁₇	0.29	0.100	1.25	0.030	0.07	0.480
Inoceramus sp.	S ₁₇	0.15	0.110	0.80	0.014	0.09	0.100

فوائد تركيب الجدار والتحليل الكيميائي في تصنیف بعض
اصداف محاريات العصر السینوپي من منطقة أبو رواش
د. عبد العال أبو العلا عبد العال
د. محمد رمضان محمد و السيده / عفاف ابراهيم رزق
قسم الجيولوجيا ، كلية العلوم ، جامعة الاسكندرية

يشتمل هذا البحث على دراسة تركيب الجدار ودراسة التركيب
الكيميائي لاصداف ثلاث عائلات من المحاريات من العصر السینوپي .
اشتهرت هذه الدراسة ان جدار اصداف عائلة *Inoceramidae* يتكون من
طبقات منشوريه من معدن الكالسيت ذات تركيز عال نسبياً من عنصر الاسترونشيوم
وان جدار اصداف عائلة *Ostreidae* يتكون من طبقات رقيقة من معدن
الكالسيت ذات تركيز عال نسبياً من عناصر المanganiz والحديد . اما جدار اصداف
عائلة *Plicatulidae* فيتكون من طبقتين ، الطبقة الخارجيه عباره عن
منشورات من معدن الكالسيت ، بينما تتكون الطبقة الداخلية من رقائق مقاطعه
من معدن الاراجونيت ذات تركيز عال من عناصر الماغنيسيوم والسيликون والالمونيوم