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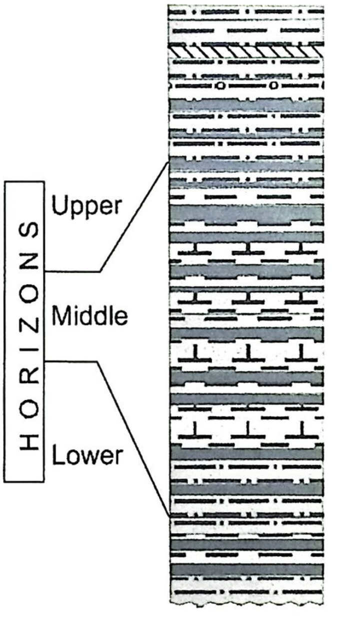

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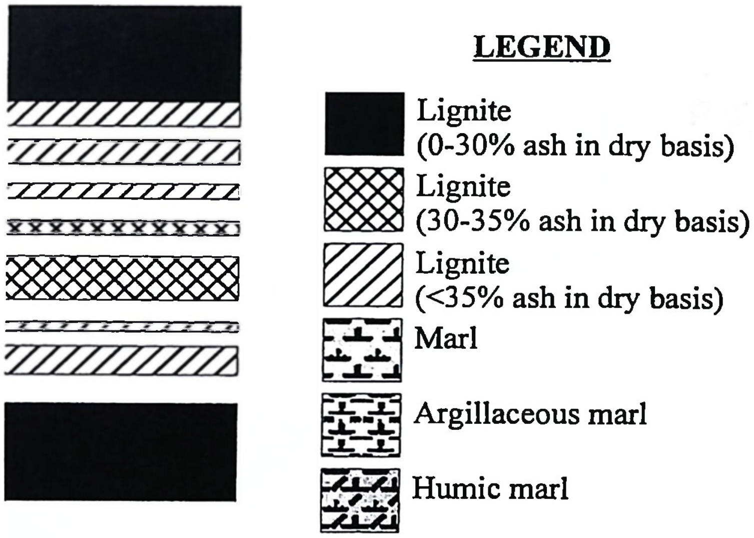
FLORA TERTIARIA MEDITERRANEA VI.7

Two Papers on Greek Browncoals, from Domenikon and Mavropigi – with reconstruction of the paleoenvironment

P. ANTONIADIS, H. GREGOR & E. MAVRIDOU



Addresses of the Authors:

Dr. P. Antoniadis and **Dr. E. Mavridou:** National Technical University of Athens, Department of Geological Sciences, 9 Iroon Polytechniou, 157 80, Zografou, Athens

Dr. Hans-Joachim Gregor: Palaeo-Bavarian Geological Survey, Daxerstr. 21, D-82140 Olching; e-mail: H.-J.Gregor@t-online.de

The authors are members of the Palaeobotanical – Biostratigraphical Workinggroup **PBA** in the Museum Günzburg and in the Naturmuseum Augsburg

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The Seed- and Fruitflora from the Mavropigi Lignite Deposit (Greece) and its paleoenvironmental Interpretation

P. ANTONIADIS, H. GREGOR & E. MAVRIDOU

Addresses of the Authors:

Dr. P. Antoniadis and **Dr. E. Mavridou:** National Technical University of Athens, Department of Geological Sciences, 9 Iroon Polytechniou, 157 80, Zografou, Athens

Dr. Hans-Joachim Gregor, Palaeo-Bavarian Geological Survey, Daxerstr. 21, D-82140 Olching; e-mail: H.-J.Gregor@t-online.de

Summary

The lignite basin of Ptolemaida and the deposit Mavropigi are described in their profile, containing neogene fruits and seeds. These allow the reconstruction of palaecology and palaeclimate of these "Mio-Pliocene" deposits. The examined samples are coming from layers rich in argillaceous lignite and other clayish-marl layers. The results, which are in correspondence with that of other near by lignite fields, providing us with extra information regarding palaeogeography as well as palaeoclimate and stratigraphy.

Zusammenfassung

Das Braunkohlebecken von Ptolemais wird kurz mit der neuen Lignitgrube Mavropigi vorgestellt. Das bearbeitete Material wurde aus den tonigen Lignit- und Flözzwischenschichten einer repräsentative Bohrung entnommen. Der Rahmen der Ablagerungen und die Ansprache der Lignittypen sowie deren Diasporeninhalt (Frucht- und Samenreste) erlauben eine Rekonstruktion der Paläoökologie, des Paläoklimas und geben eine Vorstellung vom Alter der Ablagerungen. Das entnommene Bild ergibt sich- wie auch m.o.w. erwartet- ähnlich mit den benachbarten lignitführenden Gebiete. Das gleiche gilt auch für andere parameter, wie Klima, Paläoökologie und Alter der Ablagerungen.

Key words: Miocene, lignite, carpology, facies

Schlüsselwörter: Miozän, Lignit, Karpologie, Fazies

1. GEOLOGIC FRAMEWORK

The lignite deposit if Mavropigi – Ptolemaida belongs to the lignite basin of Ptolemaida which is part of a tectonic graben that starts from FUROM (Bitola) and continues to the south through the cities of Florina, Amynteon, Ptolemaida, Kozani and Servia in Greece. The basin has a NNW – SSE direction and consists of two basins (PAVLIDIS, 1985).

The objective of this study was to reconstruct the paleoenvironment during formation of the deposit of Mavropigi based on seeds and fruits coming from the interbedded strata, as well as from the poor argillaceous lignite beds. The geology of the region will only be mentioned briefly since the region has been an object of studies for many scientists such as: KARAGEORGIOU E., (1950), PAPASTAMATIOU I., (1952), BETOULIS D., (1956), BRUNN J.H., (1956), ANASTOPOULOS I.X. & KOUKOUZAS C.N., (1972), PAVLIDIS S., (1985), KEFALAS S. & DIAMANTI – XIROPOULOU (1987), KAOURAS G., (1989), ANTONIADIS P., (1992) and ANTONIADIS P. & LAMPROPOULOU E. (1995). More detailed information can be acquired from studies mentioned in the references of this paper.

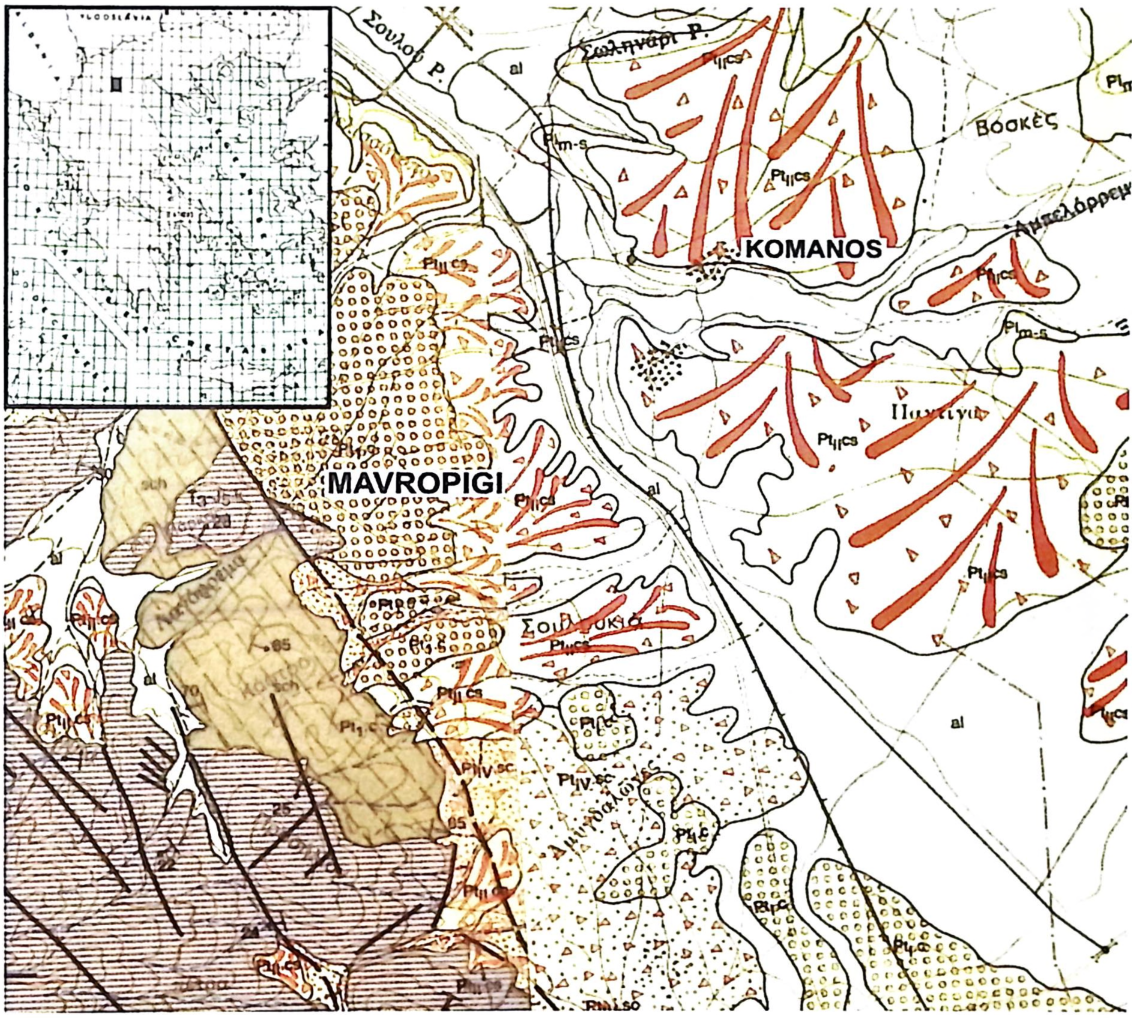

Figure 1: Geological map of Mavropigi deposit, scale 1:50.000 (IGME, Kozani sheet, 1980 and Siatisat sheet, 1982).

al: Resent alluvial deposits, H.lk: Resent lacustrine deposits, H.cs: Talus cones, Pt_{IV}.sc: Scree, Pt_{IV}.t: Tlerrestrial terraces , Pt_{III}.cj: Eluvia, Pt_{II}cs: Breccias, Pt_{I}.l,br: Clays – breccias, Pt_{I}.l: Clays – gravels, Pt_{1}.c: Conglomerates (Proastio formation), Pl_{m-s}: Marls, clays of Pliocene, M_{i}: Conglomerates of Miocene, sch: Ophiolithes . T_3-J_5.k: Trias/Jurassic limestones.

2. PRE – TERTIARY

The underlying series consists of rich in mica crystallic schist, ophiolites of pre-Mesozoic age, as well as of gray crystallic and mainly dolomitic limestones of Mesozoic age.

3. TERTIARY

In the area of interest and in this region in general, Tertiary is represented only from Neocene sediments. Sediments of paleo – Tertiary (Paleogene) age do not exist and even if they were formed they were eroded afterwards. Therefore, the sediments of this basin are firstly of Neogene age and secondly of Quaternary age.

For practical reasons, Neocene sediments and the Pleistocene overlying strata are divided in two series according to KOUKOUZAS et al., (1979), and this division is used in the present paper. Only the upper series is of importance for the economic geology point of view and therefore this is divided in three individual layers (lower, middle, upper).

The lower layer consists mainly of sands, in places argillaceous, while moving towards the overlying layer they are turning to sandy clays. The sediments of this layer have sub – yellow to sub – green color.

The upper layer (which lies above the lignite beds) consists of alternations of carbonate, sandy and argillaceous beds, as well as of marls and cays often rich in organic materials. In many cases only one part of this layer occurs and this is due to Neocene tectonic activity, which resulted in the intense surface relief of the region. The lower part of this layer (closer to the lignite beds) consists of sub – white to light gray marls with a characteristic sandy bed operating a guide for our researches. At the lowest part of this layer intermediate strata of sandy clays and sands often appear, while towards the upper part, red loam with coarse-grained gravels or sub – green sandy clays with or without coarse-grained sand also interpose.

The middle layer consists of lignite horizons of various thickness and expansion, alternating with sediments such as locally sandy gray marls and clays.

Towards the overlying layer Neocene sediments occur, which consist mostly of transition forms from clay to marl, while, at the same time, the percentage of sand

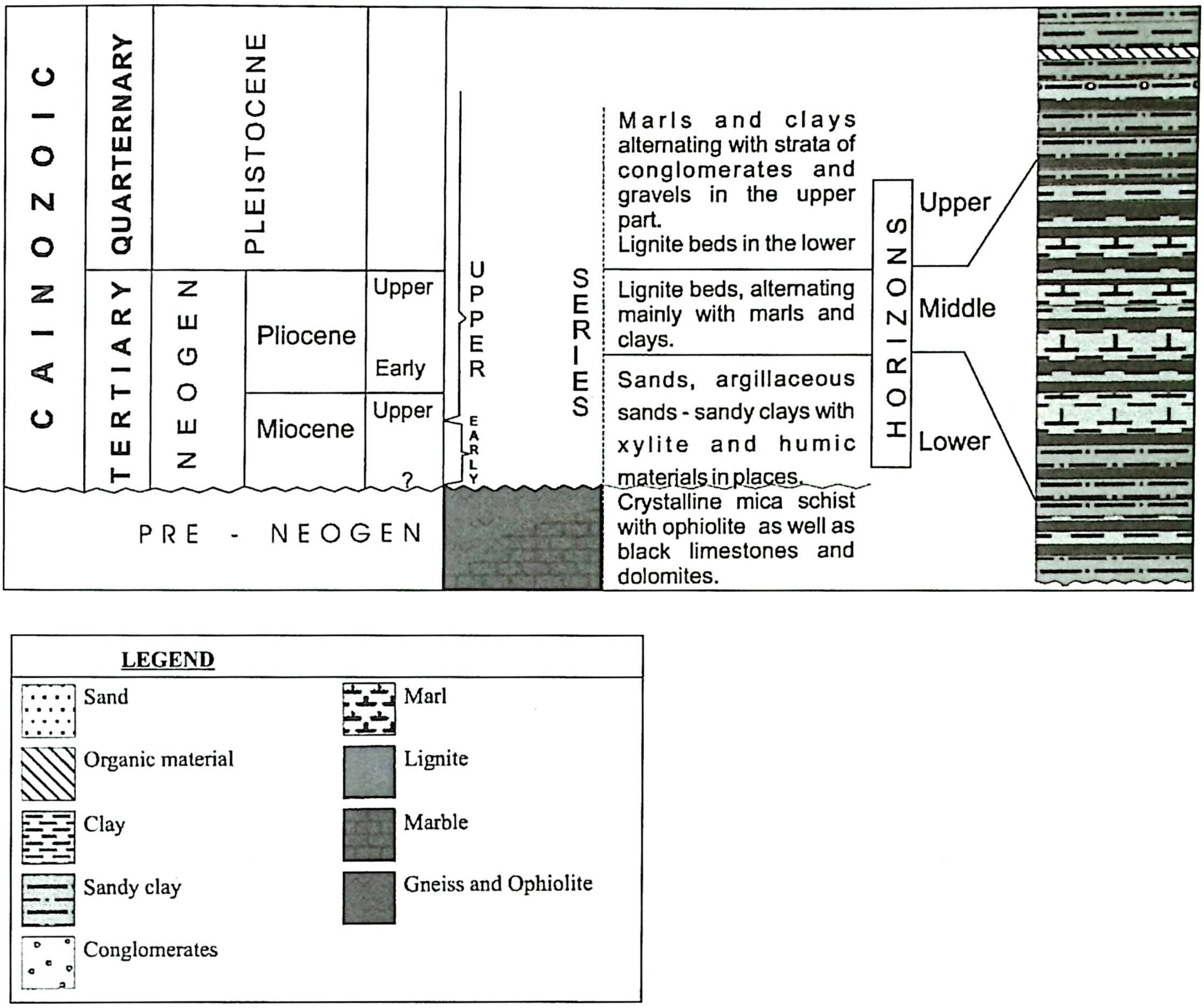

Figure 2. Stratigraphical column of geological layers of the region.

increases when moving upwards. The color of these strata is gray to sub – green and the thickness is also varying due to pre – Pleistocene tectonics. The lignite beds are of Miocene age or Pliocene when referring to the xylite horizons. Corresponding beds are also mentioned from ANTONIADIS P. & RIEBER E. (1997) for Lava – Servia deposit. According to IOAKIM (1981), the middle part is of Pliocene age while the upper part of the layer of the terrestrial – limnic deposit was formed in the upper – Pliocene. Above the last series of Quaternary fluvial – terrestrial deposits were formed.

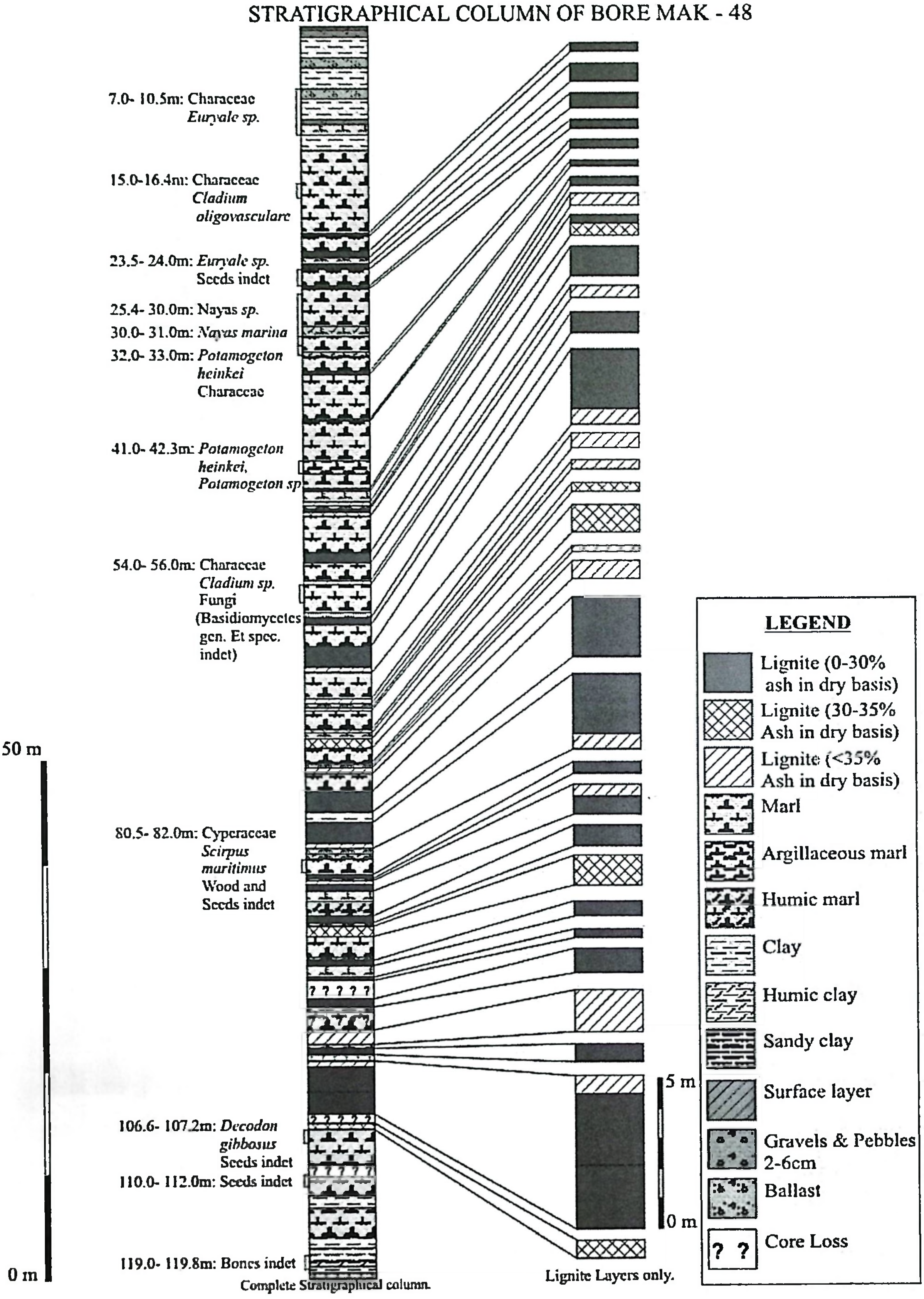

Figure 3. Stratigraphical column of borehole MAK-48.

Table 1: Seeds and Fruits from Mavropigi – Borehole MAK-48

Fungi : -	
Algae :	
Characeae	
Spermatophyta	
Gymnospermae ? *Pinus* sp.	
Angiospermae	
Monocotyledonae	
– *Najas* sp.	(5x)
– *Najas* marina	
– *Cladium* sp.	
– *Cladium oligovasculare*	
– *Scirpus maritimus*	
– *Potamogeton* sp.	
– *Potamogeton heinkei*	
Dicotyledonae	
– *Euryale* sp.	(2x)

Other "indet" findings :

Flora : woods, seeds, roots and other plant remains.

Fauna: Cocoons, fish teeth, bones, insects, coproliths and gastropods.

Petrographic findings worth mentioning : Pyrite (Framboids).

Petrographic findings in lignite worth mentioning : Fusinite charcoal.

4. QUATERNARY

At the beginning of Quaternary (lower Pleistocene) intense tectonic activity took place resulting into the formation of grabens and horns. The same tectonic activity is obvious on the surface since erosion affected areas of high altitude and coarse-grained materials gathered in lower areas. Therefore, sediments of fluvial – terrestrial origin of various grading materials are unconformable with the Neocene strata below. These sediments consist mainly of red loam and gray to sub – green sandy clays and argillaceous sands as well as of carbonate pebbles.

Table 2: Depth of findings from Borehole MAK-48.

Depth	Number of finding	Description
119,3 – 119,8	12	Bones
110,0 – 112,0	11	Calcitic remains
106,6 – 107,2	10	?
80,5 – 82,0	9	Wood, seed indet. *Scirpus maritimus*
54,0 – 56,0	8	*Cladium* sp. Fusit
41,0 – 42,3	7	*Potamogeton* sp. *Potamogeton heinkei*
32,0 – 33,0	6	*Potamogeton heinkei*
30,0 – 31,0	5	*Najas marina* Indet
25,4 – 30,0	4	*Najas* sp.
23,5 – 24,0	3	*Najas* sp.
7,0 – 10,5	1	Characeae

5. THE FOSSIL DIASPORES (pl. 1)

<u>1. Fungi</u>
Basidiomycetes gen. et spec. indet.

<u>2. Algae</u>
2.1 Characeae
Some gyrogonites were found in the samples, but the preservation allows no determination.

3. Spermatophyta
<u>3.1 Gymnospermae</u>
3.1.1 ? *Pinus* sp.
A single seed resembles the simple eggshaped seeds from pine cones.

<u>3.2 Angiospermae</u>

3.2.1 Monocotyledonae
Najadaceae
Najas sp.
Some parts of this plant are badly preserved and not further determinable.
Najas marina
Surely we have a lot of typical endocarps from this vcommon waterplant
Cyperaceae
Cladium sp.
Some nutlets from the genus are broken and abraded and we only can say, they resemble somewhat the next species.
Cladium oligovasculare
This species is very common in Tertiary sediments, especially in Germany, Czechia and Poland.
Scirpus maritimus
Nutlets from Cyperaceae are common in the Tertiary
Potamogetonaceae
Potamogeton sp.
Some broken endocarps resemble those of *Potamogeton.*
Potamogeton heinkei
P. heinkei is an index fossil for Tertiary horizons.

3.2.2 Dicotyledonae
Nymphaeaceae
Euryale sp.
Euryale is mostly found in Pliocene sediments.

6. STRATIGRAPHICAL REMARKS:
It is hardly possible to say something about the age with such a poor flora, especially from water- and reed-facies. But on the other hand we can try tu use the Computeranalysis from GÜNTHER & GREGOR (1989-2002) to understamd the profile. In GÜNTHER & GREGOR (2002) we have some important taxa:
Scirpus maritimus: well known from the Greek Megalopolis and the polish Mizerna, in both cases Upper Pliocene/Pleistocene (ibid. 130)
Potamogeton heinkei: only from Miocene (Middle M.) localities (ibid. 108).
Najas marina: typical Pliocene (ibid. 90).
Cladium oligovasculare: also known from Greece, from Kythira and Aliveri – a long stratigraphical sequence (ibid. 36).
Putting together we have surely Pliocene conditions in this flora.

7. PALAEOECOLOGY AND PALAEOCLIMATE:
Palaeoecologically we see like always in the Upper Tertiary of Greece a dominance of water plants, sourrounded by reed facies – only drier elements are nearly missing

Water plants: Characeae, Najas,Potamogeton, Euryale

Reed plants: *Cladium, Scirpus*

Dry habitat: *Pinus*, Fungi

The climate we cannot reconstruct, but *Cladium* normally grows under well climatic conditions. As we know from other floras of the Neogene, we have to expect a Virginia or Cfa-climate, a warm-temperate or subtropical climate (the same in two systems). Today there is a Cs-climate in the Mediterranean, ranging to a Cfb-climate in the North of Greece.

To all the above mentioned data there is the following literature for Greece and adjacent areas:

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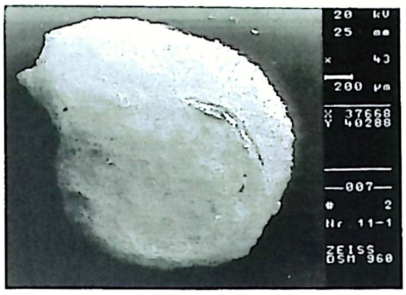
Plate

The fossil fructifications on the following plates were fotographed by TA Mrs. H. Reiser from the Institute of Geology at the University of Munich.

Plate 1

Fig. 1: *Potamogeton heinkei* - endocarp
Fig. 2: *Cladium oligovasculare*
Fig. 3: Surface view of Fig. 2
Fig. 4: *Potamogeton heinkei*
Fig. 5: Surface picture of Fig. 4
Fig. 6: *Potamogeton heinkei*
Fig. 7: Surface picture of Fig. 6
Fig. 8: *Potamogeton heinkei*
Fig. 9: Surface picture of Fig. 8
Fig. 10: *Potamogeton heinkei*
Fig. 11: Surface picture of Fig. 10
Fig. 12: *Potamogeton* sp.– endocarp with stylar end
Fig. 13: Surface picture of Fig. 12
Fig. 14: Surface picture of Fig. 12
Fig. 15: *Potamogeton* sp. – broken endocarp

Plate 1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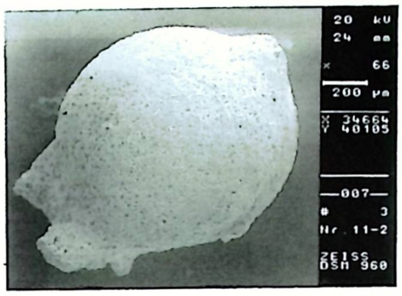
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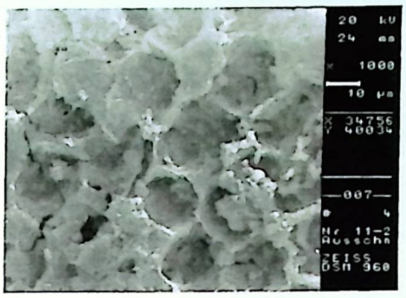
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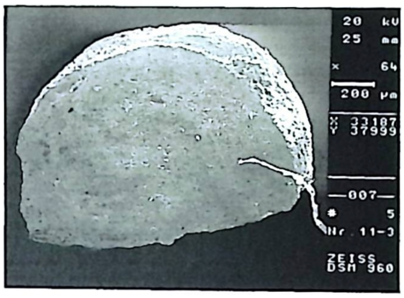
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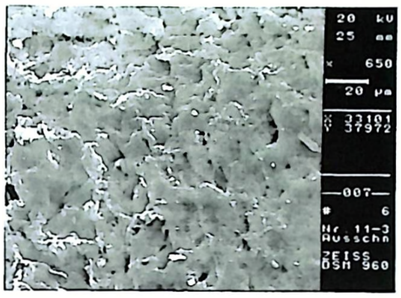
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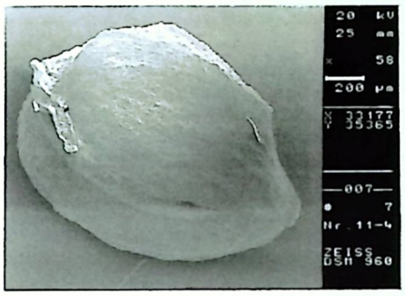
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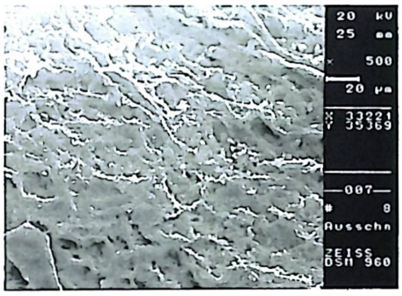
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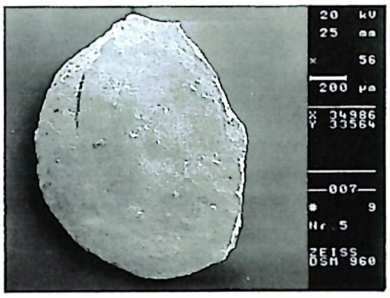
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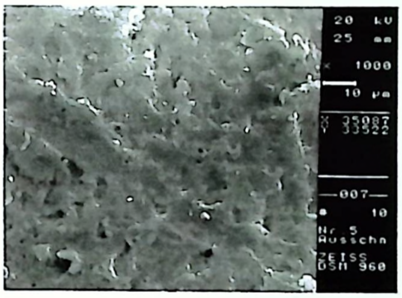
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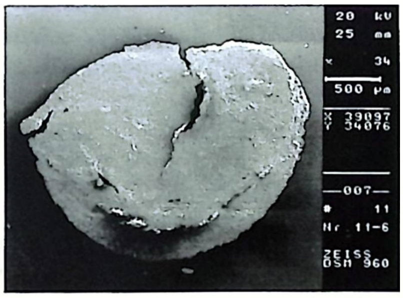
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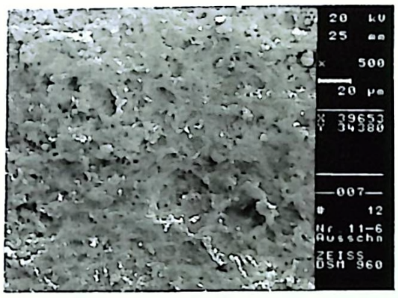
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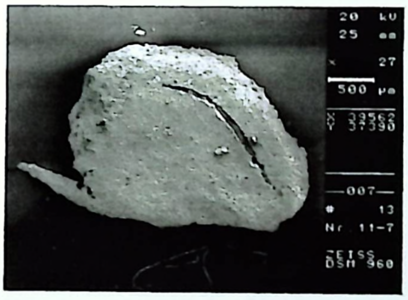
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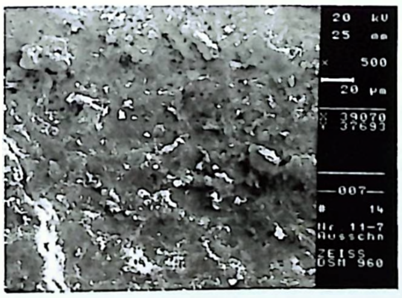
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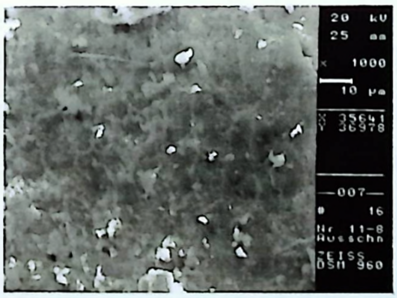
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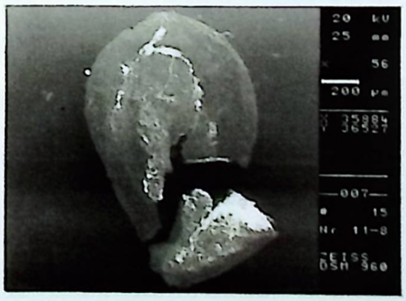
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Paleoenvironmental Interpretation Based on Seeds and Fruits of the Domenikon Lignite Deposit (Thessaly, Greece)

P. ANTONIADIS, H. GREGOR & E. MAVRIDOU

Addresses of the Authors:

Dr. P. Antoniadis and **Dr. E. Mavridou:** National Technical University of Athens, Department of Geological Sciences, 9 Iroon Polytechniou, 157 80, Zografou, Athens

Dr. Hans-Joachim Gregor: Palaeo-Bavarian Geological Survey, Daxerstr. 21, D-82140 Olching; e-mail: H.-J.Gregor@t-online.de

Summary

The lignite basin of Elassona and the deposit Domenikon are described in their geological framework and their lignite types and their fossil plant material. The latter allow to reconstruct palecological and palaeclimatological ideas about these "Miocene" deposits. A list of fossils, seeds and fruits that were collected from different depths of bore MAK-48 is presented. Most of these findings are characteristic for certain paleoenvironments in which peat formation can develop. The results of the study can be compared with that of a paleogeographic research (ANTONIADIS et al. 2002) that was made based on palynology.

Zusammenfassung

Das Braunkohlebecken von Elassona wird kurz mit der neuen Lignitgrube Domenikon vorgestellt. Rahmengeologie und Ansprache der Lignittypen sowie die begleitenden Frucht- und Samenreste erlauben nähere Aussagen zur Paläoökologie, dem Paläoklima und dem Alter der Ablagerungen. In der vorhandene Arbeit wird referiert über pflanzlichen Fossilresten die hauptsächlich aus Sporen und Früchte bestehen, die aus den tonigen Lignit- und Flözzwischenschichten entnommen sind. Die meisten Fossilien sind charakteristisch für bestimmten Ablagerungsgebieten und deshalb zu Rekonstruktion des Ablagerungsraumes weitgehend geeignet. Die Ergebnisse sind mit denen der auf palynologischen Daten basierte Arbeit (ANTONIADIS et al. 2002) gut vergleichbar.

Key words: Miocene, lignite, carpology, facies

Schlüsselwörter: Miozän, Braunkohle, Karpologie, Fazies

1. Introduction

The lignite basin of Elassona is located in N. Thessaly and is the south part of a tectonic graben that starts from Monastiri (Bitola – Former Yugoslavic Republic of Macedonia) and continues through the cities of Florina, Amynteon, Ptolemaida and Servia in Greece (Figure 1).

The basin of Elassona consits of two sub basin; those of Domenikon and Amourion, with the second being located further SW than the first one. The Domenikon sub basin lignite reserves are estimated at about 130 x 10^6 tn, while for

Amourion sub basin, that lignite reserves are much smaller, are estimated at about 10 x 10^6 tn.

Domenikon deposit opening took place during explorations on the second half of the '90's and is considered as one of the most important lignite deposits in Greece, while it is remarkable that 75% of electric energy in Greece is covered by lignite combustion.

Samples were taken from representative drillhole in the lignite basin of Domenikon and the objective of the study was to reconstruct the paleoenvironment for the formation of the strata that host the lignite depositon on the basis of paleobotanical data (coming from seeds and fruits found in sediments). Conclusions about the climate of those times, as well as for the rulling ecosystems can also come up for the same period.

2. Geologic Framework

The Neogene basin of Elassona is the south part of the tectonic graben located close and north from the city of Larissa (capital of Thessaly). The basin consits oftwo sub basins; the eastern (ENE) and the western (WNW).

The lignite deposit of Domenikon occurs in the aria in between the villages Evangelismos – Blaxogiani – Pretorion – Domenikon – Lefki. The basin belongs to the Pelagonic geotectonic zone and the lignite beds are found in the Neogene, between upper Miocene and overlying fluvial – limnic sediments of Pliocene age (Figures 2 & 3. DEMETRIOU & GIAKKOUPIS, 1998).

The lignite beds are alterating with the interbedded strata of clay, marl and their transitions, while in selected places with sandstones and other coarse grained sediments. The Domenikon deposit comparing with other deposits of the same depth has less but thicker lignite beds (between 15m to 20m). The strata that underlie the Neogene formations consists of a conglomerate bank which lies above gneiss and mica-schist.

The basement of the young – Tertiary formations is composed from Paleozoic gneiss as well as from neo – Paleozoic schist and gneiss. Both strata are revealed from an autochthonous marble formation. The pre – Carboniferous starts with ophiolithes and a thick granite bed, both covered with gneiss.

The Mesozoic (lower and middle Triassic) begins with gneiss, marble and schist gneiss and continues with a marble strata of middle Triassic and Jurassic. At the

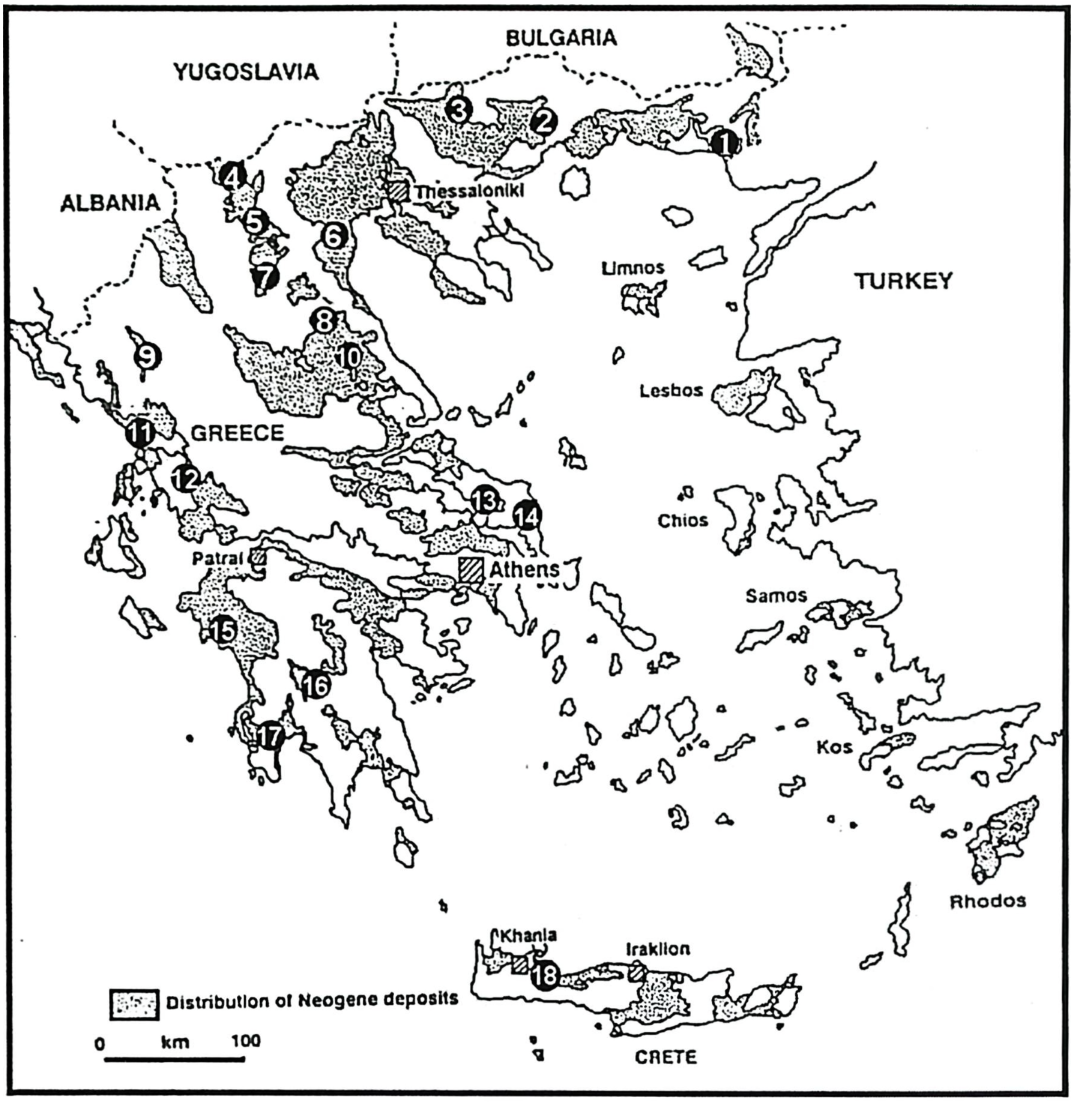

Figure 1. Map of Greece showing the distribution of Neogene basins and Neogene to Pleistocene lignite deposits :

1-Alexandroupoli, 2-Drama, 3-Seres, 4-Achlada, Vevi, 5-Vegora, Ptolemais, 6-Moschapotamos, 7-Lava, 8-Elassona, 9-Ioannina, 10-Larissa, 11-Preveza, 12-Ka-touna, 13-Psacha, 14-Aliveri, Kymi, 15-Pirgos, 16-Megalopolis, 17-Chomatero, Koroni, 18-Chania.

studied area there is absence of Cretaceous and Paleogene, meaning that even if sedimentation took place at that times, all sediment strata have suffered erosion.

The overlying (Pleistocene) strata that lie above the Neogene lignite beds, form coarse grained sediments (coarse grained sands, gravels, breccias) that are connected mainly with calcite and clay. Conglomerates and breccias form banks of 2,5m thick, while total thickness of formation is about 15m.

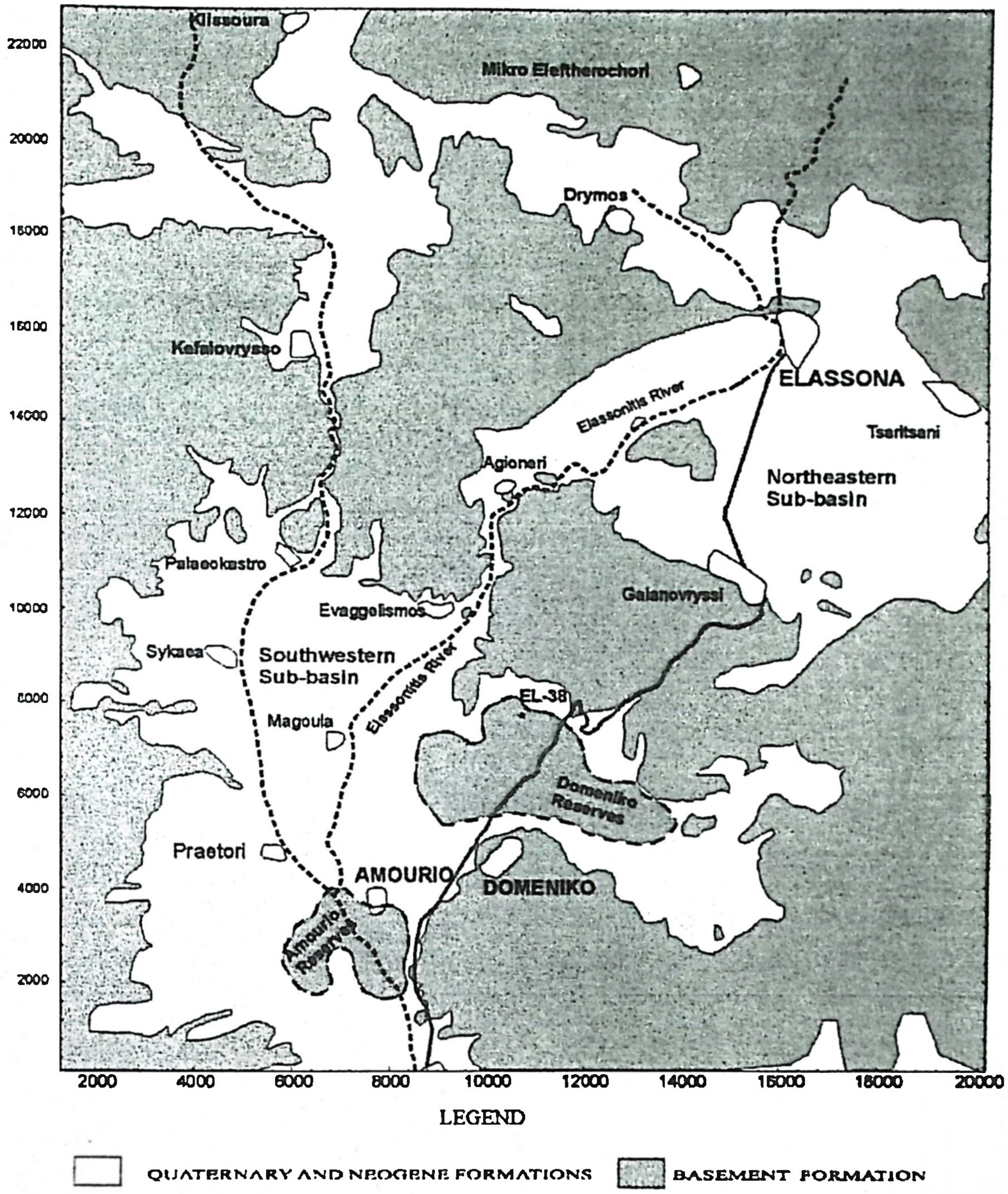

Figure 2. Geological map of Elassona coal basin (DEMETRIOU & GIAKKOUPIS, 1998).

Strata of Quaternary age come next, that consist of clays and sands with coarse grained strata of the same thickness (about 15m), while fluvial – terrestrial deposits lie above. The material of the above strata is mainly of loose texture, in the form of conglomerates and breccias coming from gneiss and schist gneiss and having total thickness of 80m.

Holocene deposits consist of scree (in the form of small terraces) and talus cones, as well as of alluvial deposits about 25m thick. Fluvial – limnic deposits without a lateral continuity also occur and consist of sands, clays and coarse grained materials.

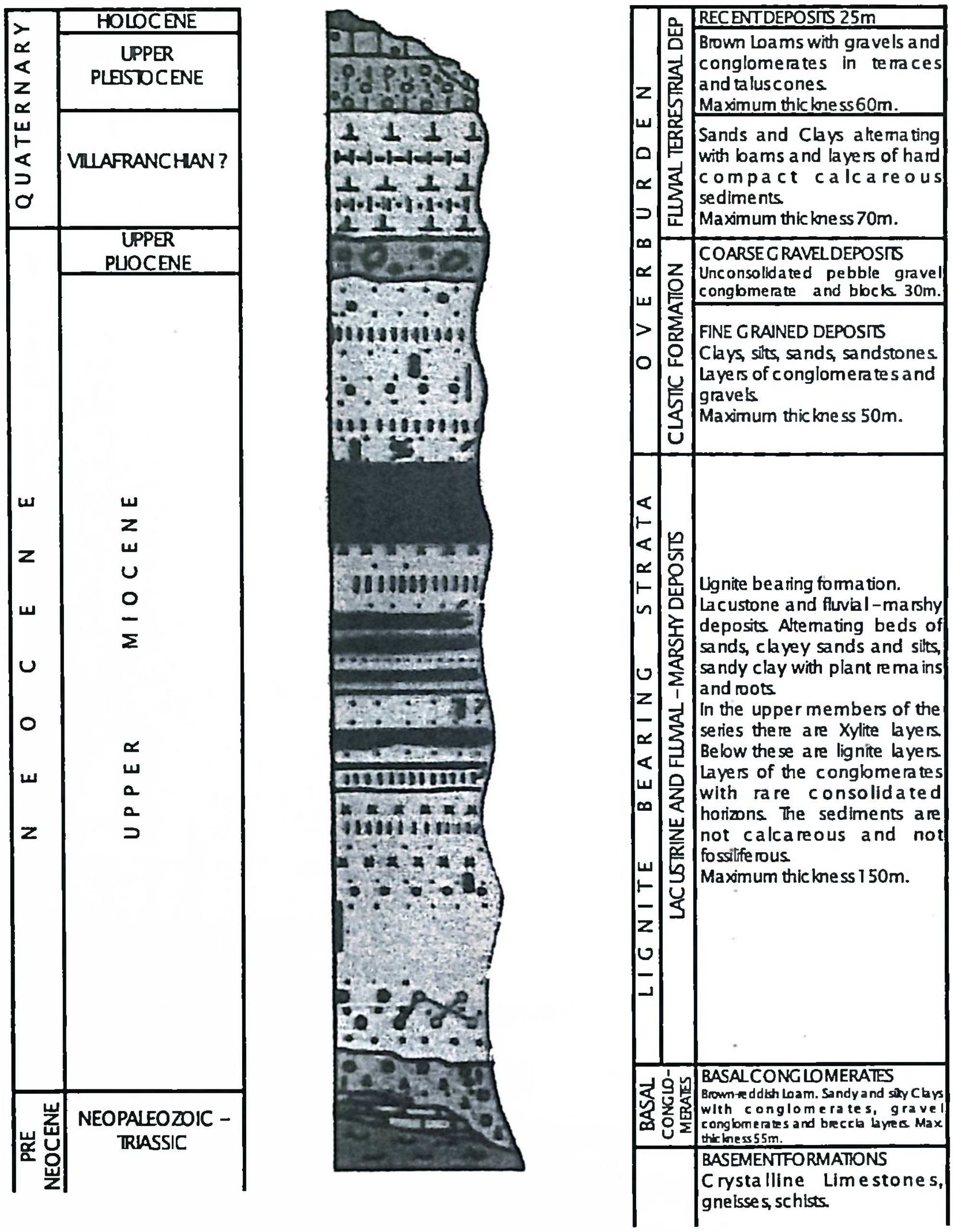

Figure 3. Stratigraphy Column of Tertiary and Quaternary sediments of Elassona coal basin (DEMETRIOU & GIAKKOUPIS, 1998).

3. Lignite series

The Neogene lignite beds, mainly consisting of xylite, are alternating in most cases with gray clays locally enriched in sand. Strata of marls and sandstones also occur. The number of lignite beds is bigger than that of the other lignite deposits of the area with thickness varying from few centimeters to 10m (at the lower part) and 20m (at the upper part). Out of all the lignite beds, six (6) are considered as pay beds. The two ones have total thickness of 10m at the upper part and 15m at the lower (Figure 4. Profil of borehole EL – 65)

Lignite is of xylitic form, relatively hard with mean moisture ~43%, while the results of all the other proximate analyses are listed in Table 1 below:

Table 1. Results of Proximate analysis		
Ash + CO_2	Dry basis	28%
Volative matter	Dry basis	42%
C : fix	Dry basis	29,5%
S (Total)	Dry basis	1,5%
S (Combastible)	Dry basis	0,7%
Mean as-is Calorific Value		~2.250 (Kcal/Kg)

4. The fossil plants (pls. 1-4)

There is abundant literature about fossil diasporas - fruits and seeds - of Greece – here are some of the most important publications:

ANTONIADIS, P.A. & GREGOR, H.-J. 1996; ANTONIADIS, P.A., BLICKWEDE, H. & LAMPROPOULOU, E. (1996); GOLDACKER, B., JÜRGENLIEMK, P., KLÜMANN, H., WOITH, H. & GREGOR, H.-J. (1985); GREGOR, H.-J. & VELITZELOS, E. (1986); GREGOR, H.-J. & VELITZELOS, E. (1987); GREGOR, H.-J. (1978); GREGOR, H.-J. (1980); GREGOR, H.-J. (1982); GREGOR, H.-J. (1990); GREGOR, H.-J., MARTINETTO, E. & VELITZELOS, E. (1993); GÜNTHER, Th. & GREGOR, H.-J. (2002); VELITZELOS, E. & GREGOR, H.-J. (1985); VELITZELOS, E. & GREGOR, H.-J. (1986); VELITZELOS, E. & GREGOR, H.-J. (1987).

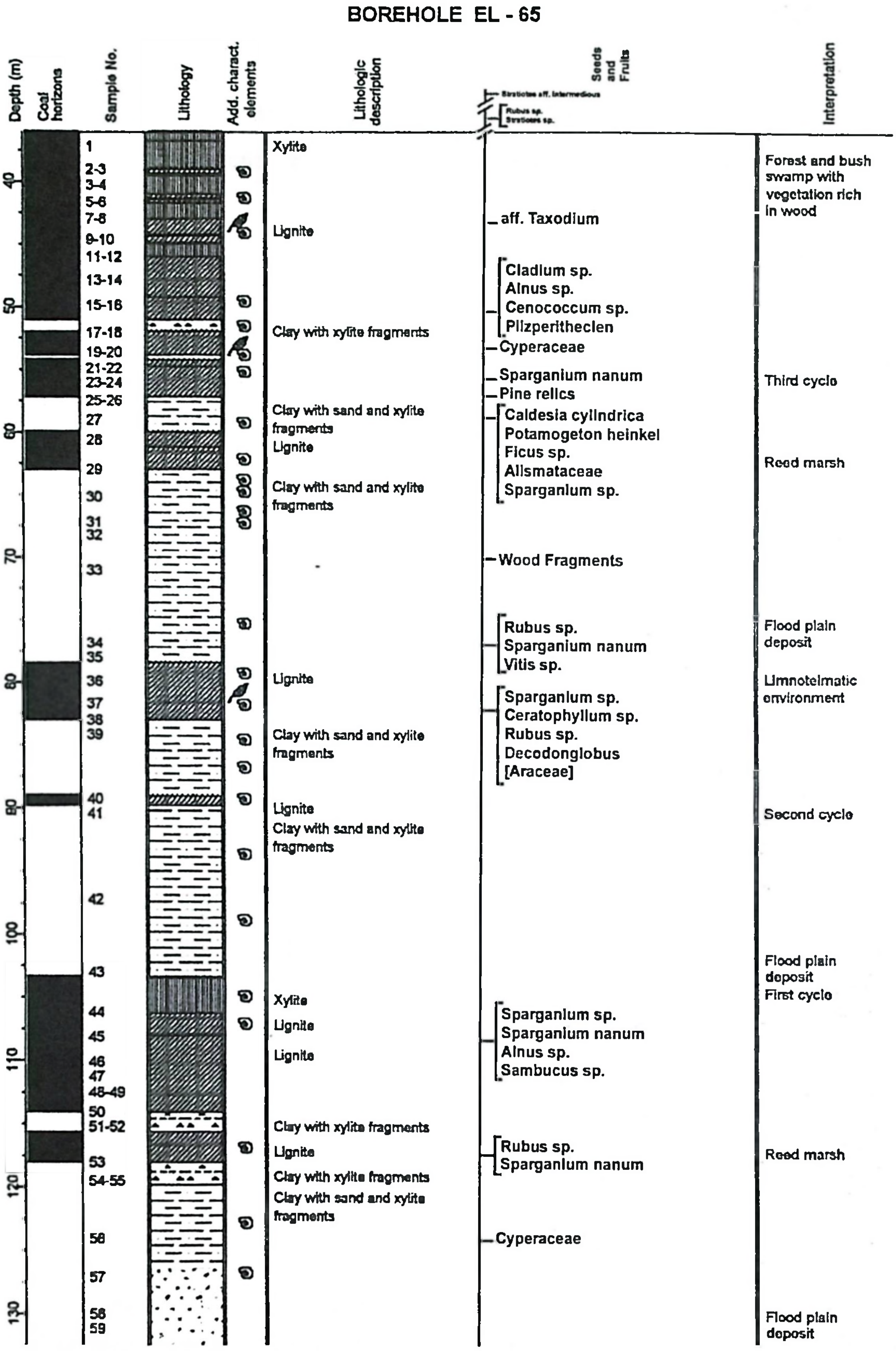

Figure 4. Profil of borehole EL – 65

The fossil plant remains are not very abundant, but table 3 gives an impression about the number of specimens per taxon.

Table 2. The three main Lignite Horizons (A,B,C) with fossil plant remains

C_3	• *Stratiotes* aff. *intermedius* • *Rubus* sp. • *Stratiotes* sp.	} Overlaying Formations
C_2	• *Taxodium* sp. • *Cladium* sp. • *Alnus* sp. • *Cenococcum geophilum* • Cyperaceae • *Sparganium nanum*	} Upper Lignite Horizon (C)
C_1	• *Caldesia cylindrica* • *Potamogeton heinkei* • *Ficus* sp. • Alismataceae • *Sparganium* sp.	Upper Lignite Horizon Underlying series
B_2	• *Rubus* sp. • *Sparganium nanum* • *Vitis* sp.	Middle Lignite Horizon Overlying series }Middle Lignite Horizon (B)
B_1	• *Sparganium* sp. • *Ceratophyllum* sp. • *Rubus* sp. • *Decodon globosus*	Middle Lignite Horizon Underlying series
A_3	• *Sparganium* sp. • *Sparganium nanum* • *Alnus* sp. • *Sambucus* sp.	} Lower Lignite Horizon (A)
A_2	• *Rubus* sp. • *Sparganium nanum*	} Underlying Formations of all Lignite Horizons
A_1	• Cyperaceae	

The following table 4 allows to get an impression about the systematic composition of the taxa, together with the palaeoecological background, concerning water plants, those of the reed or drier environments.

Table 3: Seeds and Fruits from Domenikon – Borehole EL – 65

Fungi : *Cenococcum geophilum* Pilzperithecie (indet)	(2x) (1x)
Algaea : Characeae	(2x)
Spermatophyta	
Gymnospermae – aff. *Taxodium*	 (1x)
Angiospermae	
Monocotyledonae – *Sparganium* sp. – *Sparganium nanum*	 (4x) (5x)
Najadaceae – *Najas* sp. Cyperaceae – *Cladium* sp.	 (1x) (3x) (1x)
Hydrocharitae – *Stratiotes* sp. – *Stratiotes aff. intermedius*	 (3x) (1x)
Potamogetonaceae – *Potamogeton heinkei* – *Potamogeton* sp.	 (1x) (1x)
Alismateceae	(1x)
Caldesia cylindrica	(1x)
Dicotyledoneae – cf. *Actinidia* sp. – *Vitis* sp. – *Ceratophyllum* sp. – *Rubus* sp. – *Sambucus* sp. – *Decodon globosus* – *Alnus* sp. – *Euryale* sp. – *Batrachium* sp. – *Ficus* sp. (Ranunculaceae)	 (1x) (1x) (1x) (4x) (1x) (1x) (2x) (1x) (1x) (1x)

Table 4: Systematic list of plant taxa from Domenikon with palaeoecological data.

Fungi:	
Cenococcum geophilum	Dry land
Perithecia of fungi (indet)	
Algaea	
Characeae	Open water

Continuing table 4

Spermatophyta	
Gymnospermae	
aff. *Taxodium* sp.	Wet, humid places

Angiospermae	
Monocotyledonae	
Sparganiaceae	
Sparganium sp.	Reed facies near water
Sparganium nanum	
Hydrocharitae	
Stratiotes aff. *intermedius*	Open water
Stratiotes sp.	Open water
Najadaceae	
Najas marina.	Open water
Cyperaceae	
Cladium sp.	Reed facies near water
Potamogetonaceae	
Potamogeton heinkei	Open water
Potamogeton sp.	Open water
Alismataceae	
Alismateceae gen. et spec. indet.	Open water
Caldesia cylindrica	Reed facies near water

Dicotyledonae	
Actinidiaceae	
cf. *Actinidia* sp.	Dry ground, liana
Vitaceae	
Vitis sp.	Dry ground, liana
Ceratophyllaceae	
Ceratophyllum sp.	Open water
Rosaceae	
Rubus sp.	Dry ground, liana, bush
Caprifoliaceae	
Sambucus sp.	Dry ground, bush
Lythraceae	
Decodon globosus	Wet places, swamps
Betulaceae	
Alnus sp.	Wet places, swamps
Nymphaeaceae	
Euryale sp.	Open water
Ranunculaceae	
Batrachium sp.	Reed facies near water
Moraceae	
Ficus sp.	Dry ground

5. Reconstruction of the palaeoenvironment during formation of the deposit

When we have a look on the table with the plant taxa it is obviously, that the dominant types are those of water plants, followed by reed and marsh plants and then some riparian accompanying taxa (see GREGOR 1982):

water plants: Characeae, *Stratiotes, Najas, Potamogeton, Caldesia, Ceratophyllum, Euryale, Batrachium*

reed and marsh plants: *Taxodium, Sparganium, Cladium, Alnus*,

riparian accompanying taxa: *Actinidia, Vitis, Rubus, Decodon*

somewhat drier conditions: *Ficus, Cenococcum*

lianas and bushes: *Vitis, Actinidia, Rubus, Decodon*

So we can reconstruct an open water biotope (how large we have no idea), surrounded by reed-facies and some marsh plants, the banks of the river grown by trees with a lot of lianas and with some bushes.

Running through the profile we see, that the habitat was nearly always wet and the river banks were farther away. The occurrence of *Ficus, Taxodium, Actinidia* and *Decodon* allows to get an imagination of the climate – it was a typical Tertiary Cfa- or Virginia-climate, as we have in nearly all Greek floras.

The age can be estimated as Miocene s.l., because *Caldesia cylindrica* and *Potamogeton heinkei* are index fossils. *Stratiotes intermedius* seems to be a bit more a "Pliocene" type, but we do not know, where it comes from.

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Plates

The fossil fructifications on the following plates were fotographed by TA Mrs. H. Reiser from the Institute of Geology at the University of Munich.

Plate 1

Fig. 1: *Sparganium nanum* – broken fruit
Fig. 2: Surface magnification

Fig. 3: *Najas marina - seed*
Fig. 4: Surface magnification

Fig. 5: *Euryale* sp. - seed
Fig. 6: Surface magnification

Plate 1

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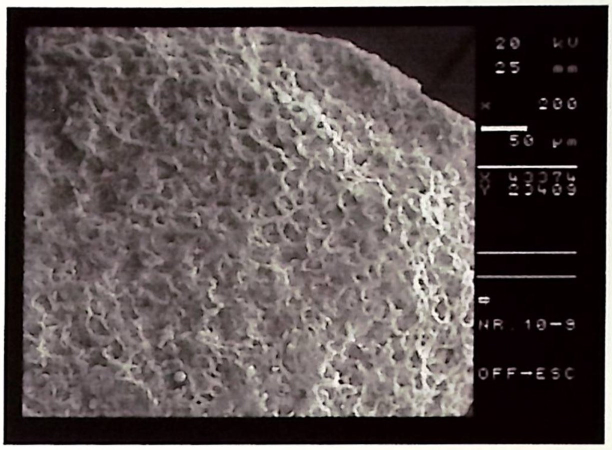

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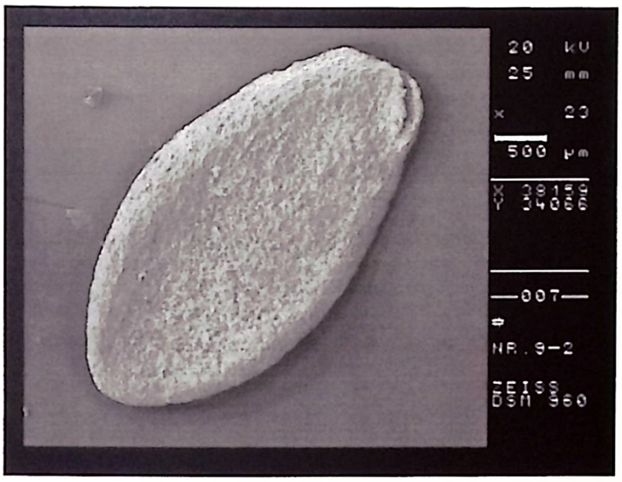

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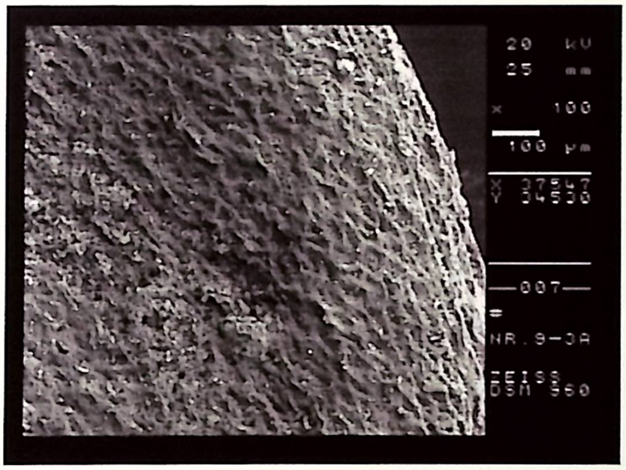

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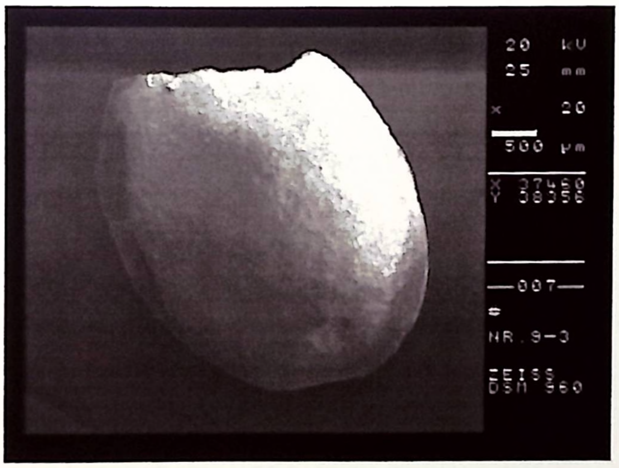

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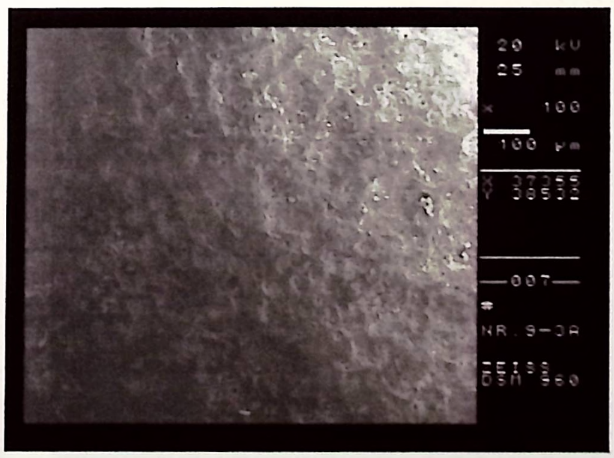

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Plate 2

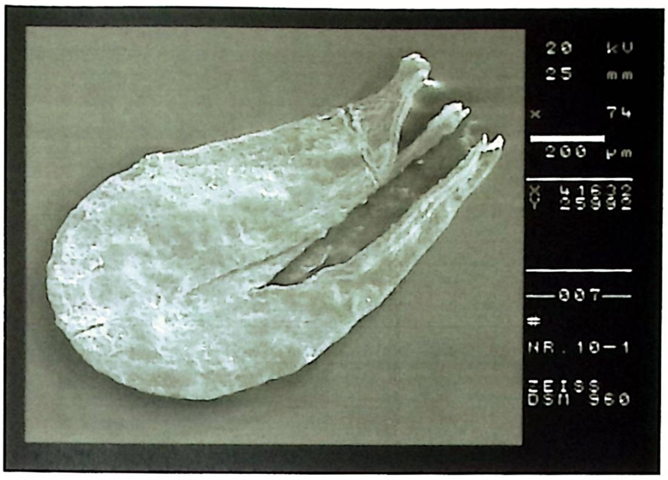
Fig. 1: Alismataceae gen. et spec. indet., fruitlet burst open

Fig. 2: *Caldesia cylindrica - fruit*
Fig. 3: Surface magnification of stylar region

Fig. 4: Cyperacean fruitlet
Fig. 5: Surface magnification of crest

Fig. 6: *Stratiotes* sp. – broken seed

Plate 2



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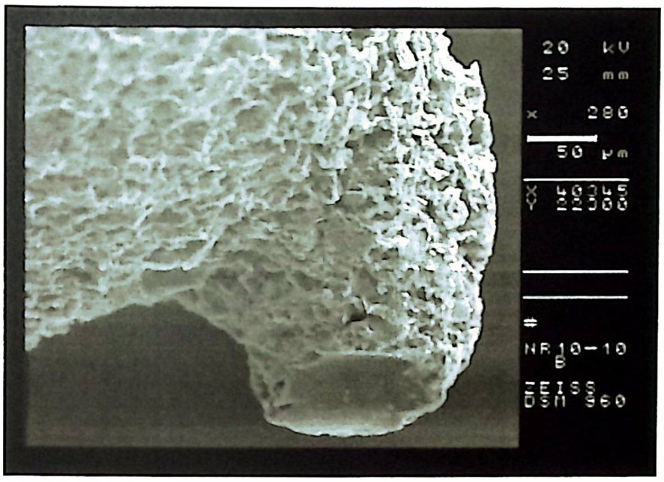

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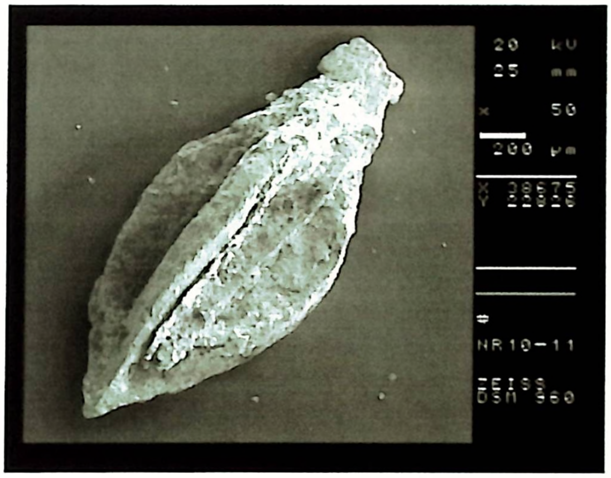

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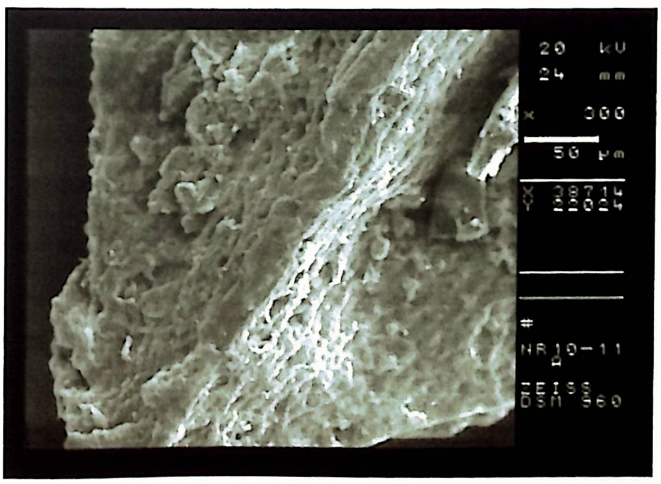

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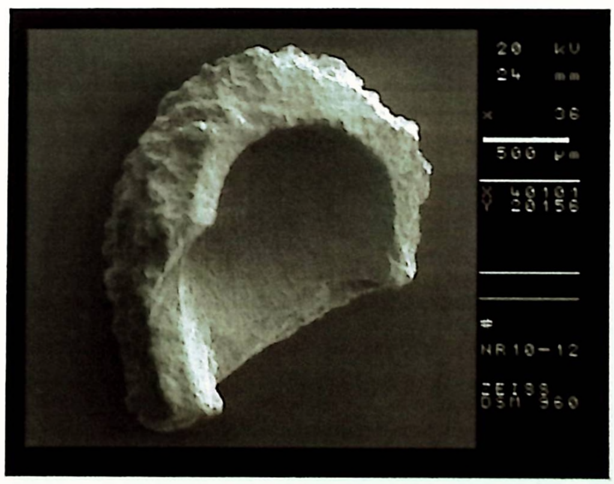

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Plate 3

Fig. 1: *Stratiotes* sp. - surface magnification of cell layers of testa

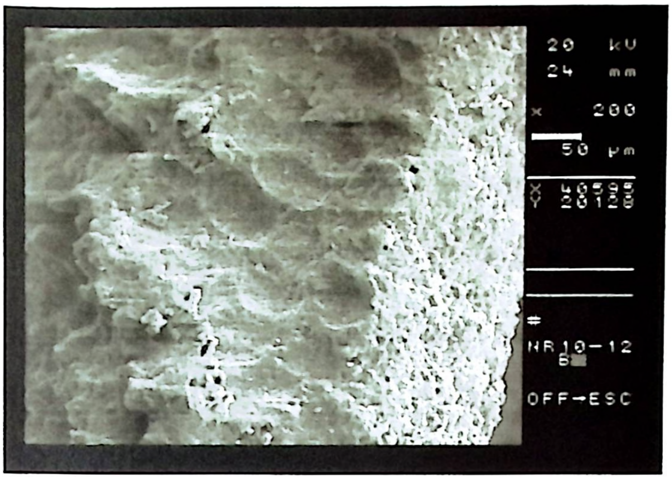
Fig. 2: *Ficus* sp. - fruit

Fig. 3: *Rubus* sp. - endocarp

Fig. 4: Cyperaceae (aff. *Scirpus* sp. vel *Dulichium* sp.) - fruitlet
Fig. 5: Surface magnification with prominent cell walls

Fig. 6: *Batrachium* sp. - seed

Plate 3



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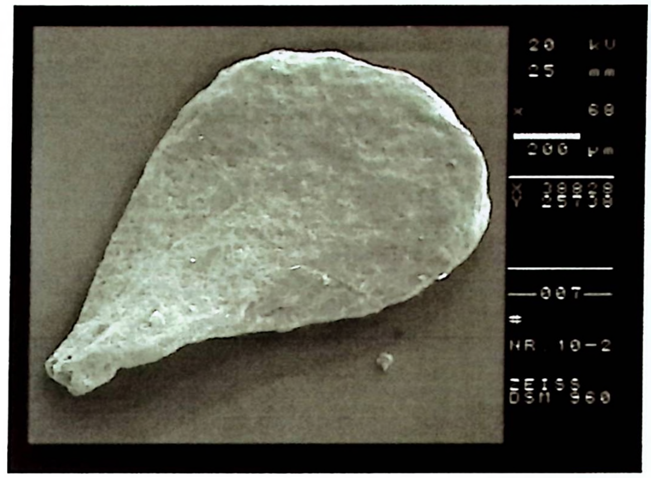

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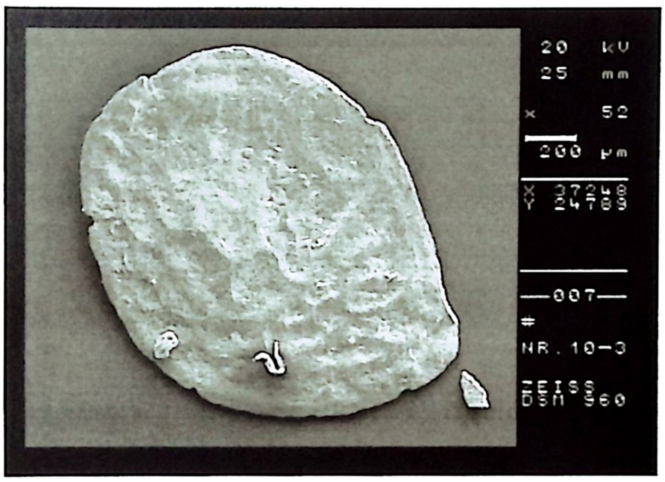

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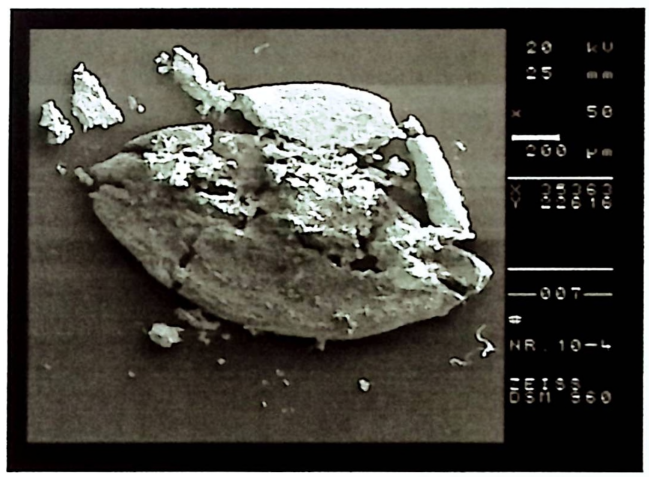

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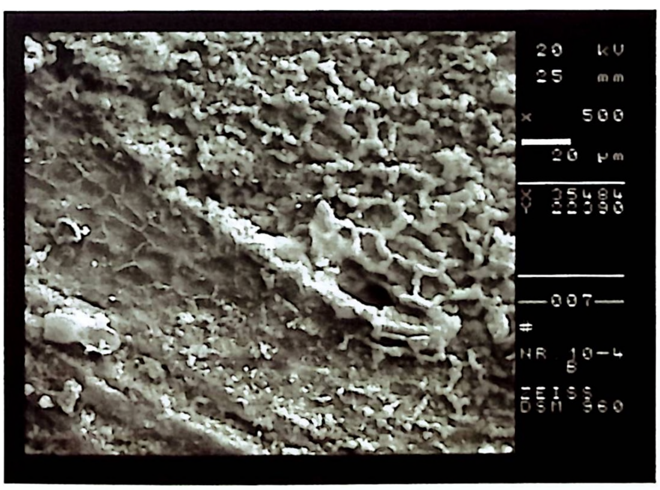

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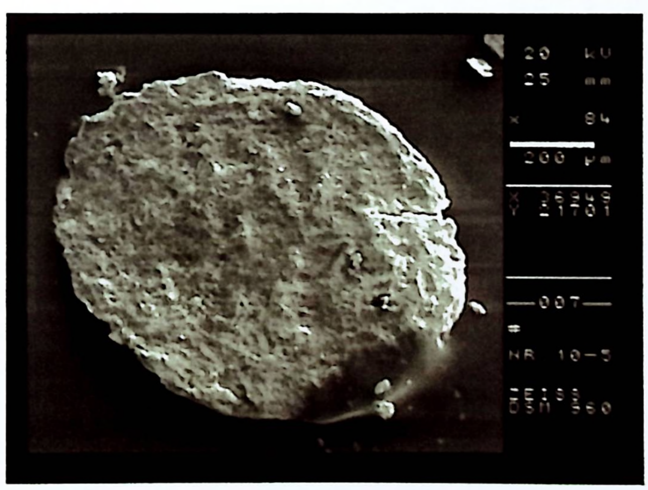

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Plate 4

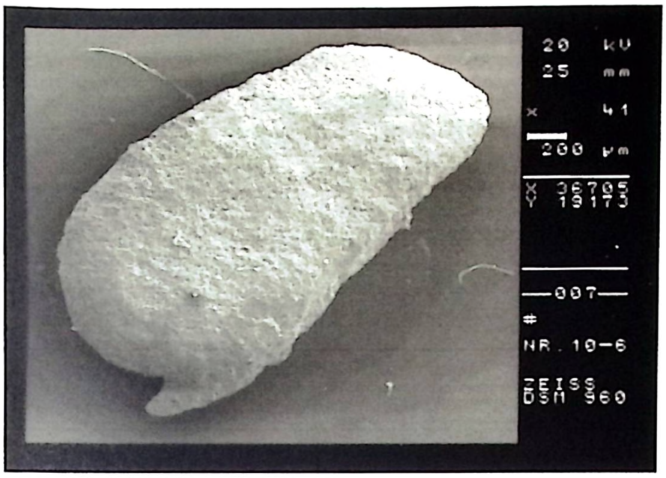
Fig. 1: *Caldesia cylindrica* – endocarp smooth
Fig. 2: Surface magnification in stylar region

Fig. 3: *Caldesia cylindrica* – cross section
Fig. 4: Magnification with cell structure of testa (left) and inner surface (right)

Fig. 5: *Caldesia cylindrica* – endocarp egg-shaped with one rib

Fig. 6: *Caldesia cylindrica* – endocarp elongated with two ribs

Plate 4



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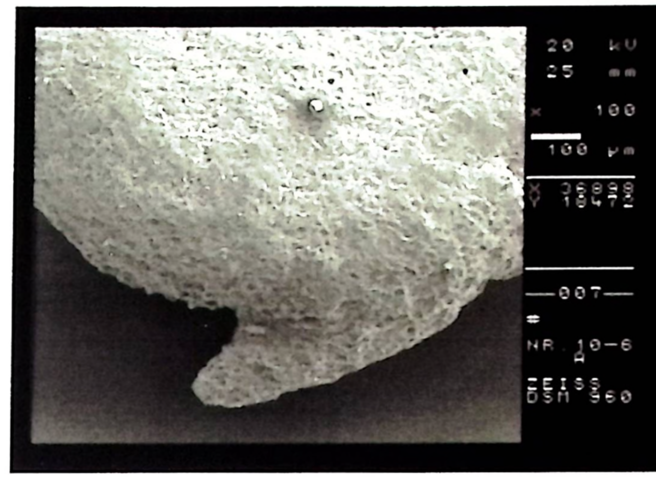

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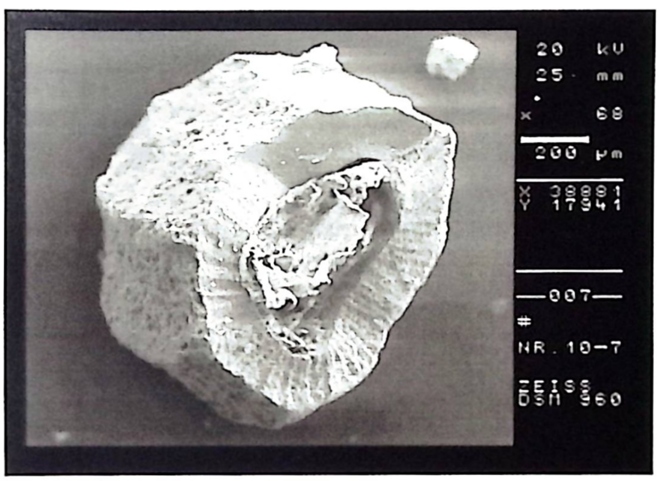

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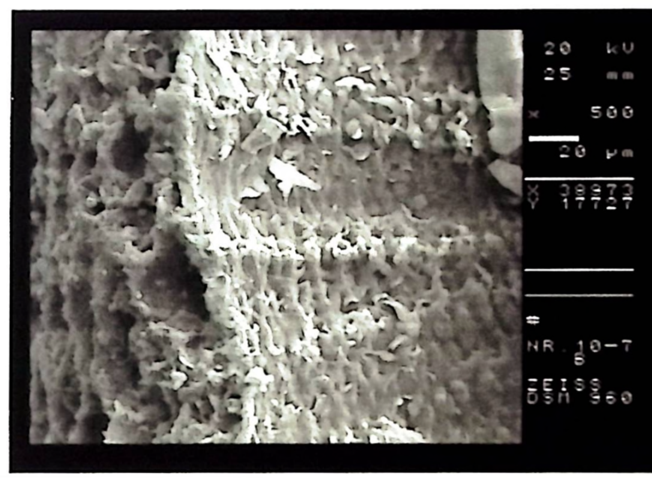

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