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Permo-Triassic stratigraphy of the pelagonian zone in central Evia island (Greece)

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ABSTRACT

A new subdivision of the pre-Jurassic Pelagonian Units in central Evia island is proposed; these units are represented by syn- and post rift sequences, separated by a volcano-sedimentary episode.

The syn-rift sequences comprise Permian siliciclastic sediments in Verrucano tectofacies, (Ano Mavropoulon Formation) and a small carbonate platform (Zigos Limestones) developed from the Permian to the Middle Anisian. The Ano Mavropoulon Fm. is subdivided into three members:

– the lower member (Permian *s.l.*) lying on the basement and characterised by medium-coarse clastic terrigenous sedimentation;

– the middle member (Late Permian) Koprises limestones, made up of shallow-water limestones;

– the upper member (Latest Permian-Early Triassic) comprising clastic terrigenous and minor reworked carbonate sediments.

A regional unconformity (earliest Triassic) separates the Zigos Lm. from the top of the Ano Mavropoulon Fm. The peritidal carbonates belonging to the Zigos Lm. have been subdivided into three lithofacies ranging in age from Spathian to Pelsonian (late Early Triassic to Middle Anisian).

The volcanic episode is well constrained in all the Pelagonian domain. In central Evia, it has been dated from Middle Anisian to Early Carnian. The sub-alkaline to alkaline basalts comprised in the volcano-sedimentary sequence (Volcano-sedimentary Complex) have a within-plate affinity. The volcanism occurs between the syn-rift and post-rift stages, and it is probably not linked to the passive margin evolution proper.

The post-rift sequences are represented by the onset of the Pelagonian platform aggradation ("Pantokrator" Carnian to Middle-Late? Jurassic)

The northern passive margin sequence of Pelagonia (palaeogeographic sense) is interpreted as related to the Maliak ocean opening during the Early Mesozoic.

ZUSAMMENFASSUNG

Die Autoren schlagen eine neue Unterteilung der präjurassischen pelagonischen Einheiten in Zentral-Euboea vor; diese Einheiten entsprechen Syn- und Postrift-Abfolgen, getrennt durch vulkano-sedimentäre Einschaltungen.

Die Synrift-Folgen umfassen permische siliziklastische Sedimente in Verrucano-Tektonofazies (Ano Mavropulon-Formation) und eine kleine Karbonat-Plattform (Zigos-Kalke), die vom Perm bis zum mittleren Anis reichen. Die Ano Mavropulo-Fm. wird in drei Members unterteilt:

– Unterperm (Perm s.l.), das das Grundgebirge überlagert und durch mittel- bis grobklastische terrigene Sedimente gekennzeichnet ist;

– das mittlere Member (spätes Perm), Koprises-Kalk, bestehend aus Flachwasserkalken;

– das obere Member (spätestes Perm bis frühe Trias) umfasst klastisch-terrigene und zu einem geringen Teil umgelagerte karbonatische Sedimente.

Eine regionale Erosions-Diskordanz (früheste Trias) trennt den Zigos-Kalk vom Dach der Ano Mavropulon-Fm. Die peritidalen Karbonate des Zigos-Kalkes wurden in drei Lithofazies unterteilt, die altersmässig vom Spathian bis zum Pelson (späte Frühtrias bis Mittelanis) reichen.

Die *vulkanische Episode* ist im ganzen pelagonischen Bereich klar umrissen. In Zentral-Euboa ist sie als Mittelanis bis frühes Karn datiert. Die subalkalinen bis alkalinen Basalte der vulkano-sedimentären Abfolge (Volcano-sedimentary Complex) haben Züge einer Bildung im Platteninneren. Der Vulkanismus liegt zwischen dem Synrift und dem Postrift-Stadium und ist wahrscheinlich nicht direkt mit der Bildung eines passiven Kontinentalrandes verbunden.

Die *Postrift-Abfolgen* entsprechen dem Beginn der Aggradation der Pelagonischen Plattform ("Pantokrator" Karn bis Mittlerer-Später? Jura).

Die Abfolge des nördlichen passiven Randes von Pelagonia (im palaeogeographischen Sinn) wird hier mit der Öffnung des Maliak Ozeans während des frühen Mesozoikums in Verbindung gebracht.

1. Main topics

In an attempt to refine the paleoreconstructions of the Western Tethys margins from the Late Palaeozoic to the Late Mesozoic, the age and origin of the basal sedimentary sequences of the Internal Hellenides and its Pelagonian Zone is of major importance.

The Internal Hellenides comprise several imbricated tectonic units affected by two main orogenic events. The first one, the so called Eohellenic phase occurred during Late Jurassic-Early Cretaceous time, following the obduction of the Vardar Ocean ophiolites (Jacobshagen et al. 1976). The second event (so called Meso-Hellenic phase) occurred during the Alpine

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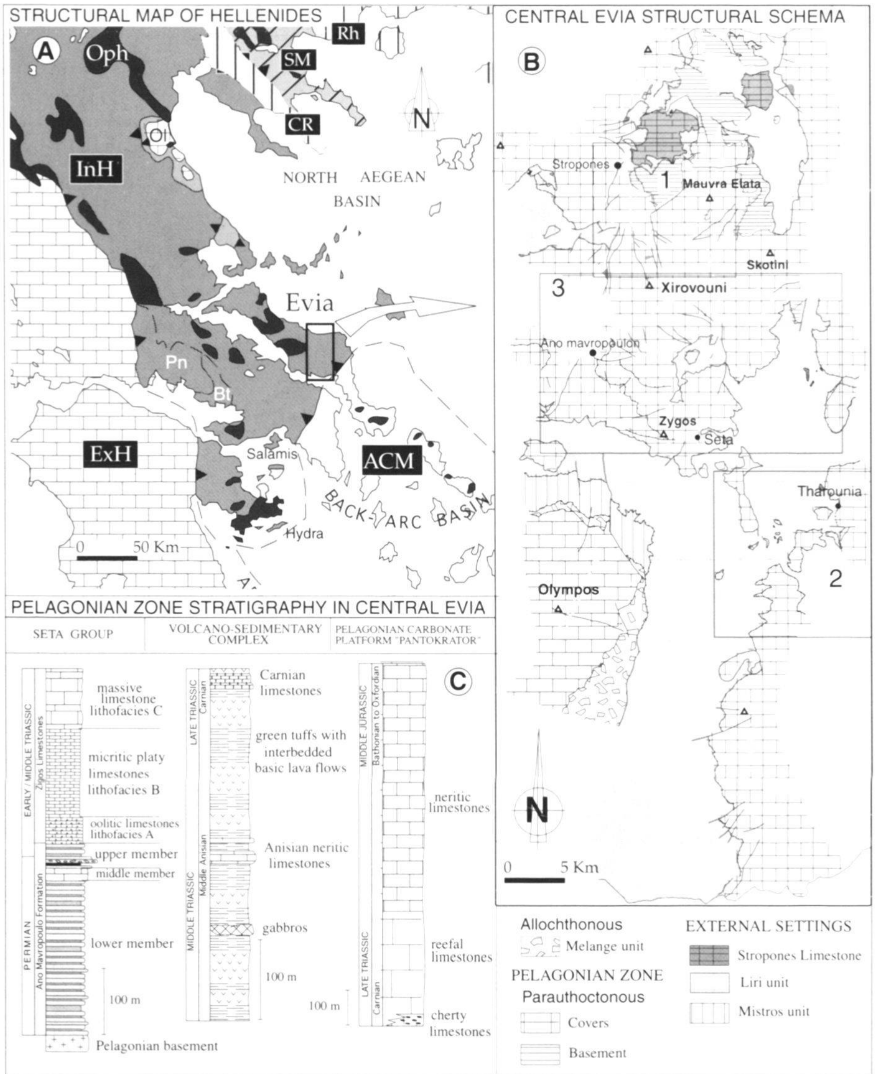

Fig. 1. A: Structural map showing the most distinct tectonic domains in Greece (modified from Papanikolaou, 1989): Internal Hellenides (InH) comprising Circum Rhodope (CR), Serbo-Macedonian (SM) and Rhodope Massif (Rh) as well as the Attica-Cyclades Massif (ACM). The ACM contains elements either of internal and of external nappes. The ophiolitic nappes (Pph) and the external Hellenides (ExH) are also represented. Olympos (Ol), Parnassos (Pn) and Beotia (Bt).
Fig. 1. B: Schematic structural map of the cartographied setting of Central Evia; for sectors B1, B2 and B3 see details in Figs. 4 and 5.
Fig. 1. C: Schematic stratigraphic logs summarising the Permian-Triassic stratigraphy of Central Evia, proposed in this paper.

orogeny and it is related to the final closure of the Vardar Ocean through the Late Paleocene – Late Eocene. A characteristic of the Internal Hellenides is the Late Cretaceous (Cenomanian) transgression sealing the ophiolite obduction (Katsikatsos et al. 1986).

The Pelagonian Zone has been considered a fragment of the Cimmerian Continent which separated the Paleotethys from the Neotethys oceans (Mountrakis 1986). Following the Stampfli et al. (1998) and Vavassis et al. (2000) interpretations we consider the Pelagonia terrane as part of Variscan Europe, characterised by a pre-Alpine crystalline basement of Late Carboniferous age (Papanikolaou & Zambetakis-Lekkas 1980; Mountrakis 1986; Vavassis et al. 2000).

The basal sedimentary sequences of the Pelagonian Zone generally comprise: detrital sediments containing Palaeozoic limestones, Early to Middle Triassic peritidal carbonates as well as Triassic volcanites. A key area, the central part of Evia Island, has been investigated and mapped at the 1:25'000 scale. In this setting the situation is not as simple as described by the previous workers (Guernet 1971; Argyriadis 1978; Sideris 1986). The main changes concern the ages of the series and the structural framework. The Central Evia series were regarded as a single detrital unit containing blocks of Palaeozoic and Triassic limestones. Detailed mapping has shown that we are dealing with different tectonic units.

2. Geology of Evia island

As shown in the structural map (Figs 1A and 1B) the Evia Island consists of a nappe pile coming from different tectonic units; they are briefly described from South to North:

The Attica-Cyclades Massif (ACM) comprises the Ochi, Styra and Almyropotamos Units which have undergone metamorphism in HP/LT conditions in the Eocene as well as Barrowian-type metamorphism and intrusion of granitoids during the Late Oligocene and Miocene (Altherr et al. 1982).

The Liri Unit (Stampfli 1996; De Bono 1998; De Bono et al. 1999) is a Triassic flyschoid sequence cropping out only in central Evia and characterised by the presence of olistoliths, comprising Carboniferous limestones and granitoids. The Liri Unit crops out at the base of the Pelagonian formations, in a tectonic window and its origin is probably more external than the Pelagonian.

The Stropones limestones (Guernet 1978; De Bono 1998; Neligan & Vallotton 1999) have been dated as Liassic and they only crop out in northern central Evia. They underwent a low grade metamorphism (epizone) and are tectonically associated to the Liri Unit.

The formations of the Pelagonian Zone. The units of the Attica-Cyclades Massif are overthrusted by the formations of the Pelagonian Zone (Renz 1940; Aubouin 1959; Ferrière 1976; Katsikatsos et al. 1986). The Pelagonian Zone begins with a Variscan basement, or Flambouron Unit, mainly composed of ortho- and paragneiss, and granitic intrusions (Skotini granites) of Late Carboniferous age (Yarwood & Aftalion 1976; Katerinopoulos & Marcopoulos 1987; Engel & Reischmann 1998; Reischmann 1998; Vavassis et al. 2000). It is transgressively overlain by clastic sediments (Verrucano facies), by carbonate sediments of Late Permian age, and by Early to Middle Triassic peritidal carbonates, followed by a characteristic Middle-Late Triassic volcano-clastic episode (Guernet 1965b; Pe-Piper 1982; Pe-Piper & Panagos 1989). The volcanics are overlain by a Late Triassic to Middle/Late Jurassic carbonate platform (Celet & Ferrière 1978; Angiolini et al. 1992), locally followed by radiolarites ranging from Kimmeridgian to Tithonian (Baumgartner & Bernoulli 1976). Since the Middle Jurassic this continental margin succession was overthrusted by ophiolites of Vardar origin derived from the East. The so-called Eohellenic orogenic phase was recorded by the arrival of ophiolitic detritus, as well as by the coloured tectonic or sedimentary "mélanges" overlying the radiolarites (Diabase Chert Formation, Pagondas mélange) (Renz 1955; Parrot & Guernet 1972; Baumgartner & Bernoulli 1976; Baumgartner 1985; Robertson 1990). Both the ophiolitic nappe and the platform carbonates were in turn transgressed by upper Cretaceous (Cenomanian-Turonian) shallow-water limestone (Guernet 1975; Katsikatsos et al. 1986; Richter et al. 1996); these were followed by the deposition of terrigenous and calcareous flysch of Palaeocene-Eocene age (Richter et al. 1996).

The Vardar-Axios ophiolites are the uppermost tectonic unit of Evia and consist of broken thrust sheets and detached blocks of ultramafic rocks, gabbros and Middle to Late Jurassic pillows and basalt flows.

The present paper provides an analysis of the Permo-Triassic succession of the Pelagonian Zone of central Evia. The sequences are located above the Carboniferous basement (Skotini Granites) and below the Upper Triassic/Jurassic carbonate sediments belonging to the "Pantokrator" platform.

Permo-Triassic rocks have been subdivided into two new main lithostratigraphic units (Figs. 1C; 2): the Seta Group and the Volcano-sedimentary Complex.

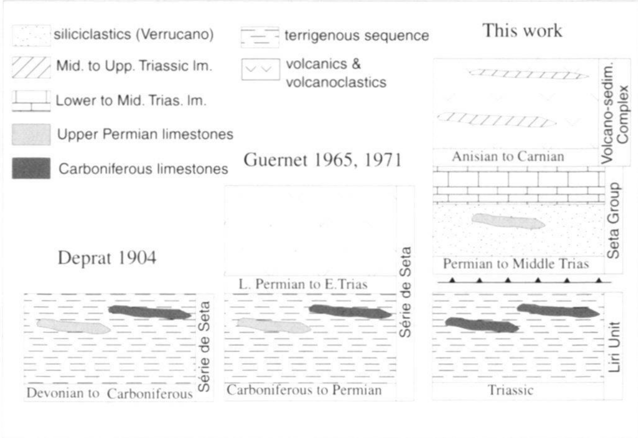

Fig. 2. Pre Norian Units of central Evia: old and new stratigraphic subdivisions.

3. The Seta Group

The name of this newly defined lithostratigraphic unit derives from the little village of Seta (Fig. 1B), where the lithotypes are well exposed and dated.

The Seta Group comprises a Permian siliciclastic detrital body (Ano Mavropoulon Fm.), with interbedded Upper Permian carbonate sediments and the Lower to Middle Triassic peritidal carbonates of the Zigos Lm. (Fig. 1C).

The lower limit is marked by an erosional stratigraphic contact between the clastic Ano Mavropoulon Fm. and the Pelagonian Variscan granites. The upper limit is represented by the first occurrence of volcanic rocks (Volcano-sedimentary Complex) over the Zigos Lm. The whole Group ranges in age from Permian to Anisian.

Deprat (1904) introduced the name "Série de Seta" under which he grouped most of the non-fossiliferous terrigenous lithotypes of the area, doubtfully assigning them to the Devonian. Later, Guernet (1965a, 1967, 1971) described the same series as a continuous Late Palaeozoic-Early (Middle ?) Triassic sequence, bearing epizonal schists with Carboniferous/Permian limestones lenses followed by volcanic basic rocks (Fig. 2).

The old literature considered the lower part of the "Série de Seta" as corresponding to a terrigenous flysch with Carboniferous and Late Permian olistoliths (Liri Unit), which has now been demonstrated of being tectonically underlying the Pelagonian Units (De Bono 1998; De Bono et al. 1999).

3.1. The "Ano Mavropoulon Formation", or the siliciclastic detritism in the "Verrucano facies"

This new formal lithostratigraphic unit takes its name from the Ano Mavropoulon hamlet (Fig. 1B), where the most continuous and "complete" stratigraphic sequence of its upper part is well exposed. The Ano Mavropoulon Fm. (A.M. Fm.) has

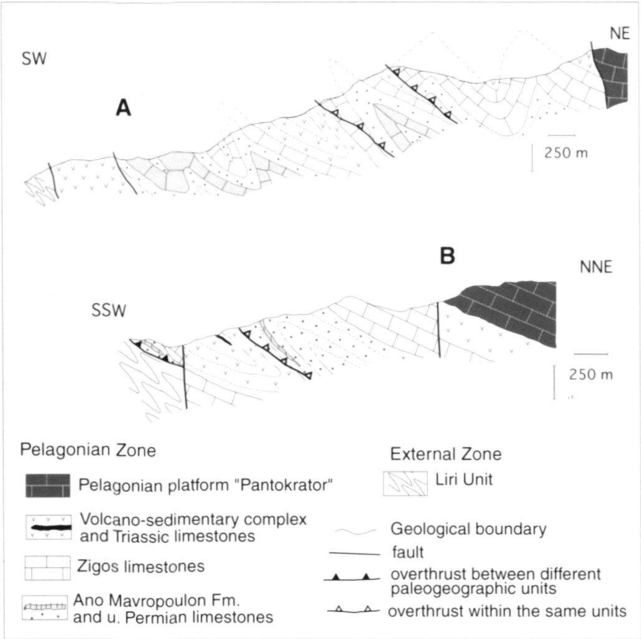

Fig. 3. Geological cross sections. For localisation see fig 4.

been subdivided in three different informal sub-units, based on lithology and palaeoenvironment. The sequence, from bottom to top, consists of the following members:

- the lower member, of quartz conglomerates and sandstones with interbedded red/violet siltstones;
- the middle member (= Koprises limestones), of discontinuous limestone beds of Late Permian age;
- the upper member, bearing sandstones with interbedded red/violet siltstones, shales, calcarenites and carbonate conglomerates in the uppermost part.

The whole area was affected by regional folding and thrusting, which destroyed the original sedimentary continuity (Fig. 3). It is therefore hard to reconstruct the stratigraphic succession and its thickness which is maximum 260 m.

Upper and lower boundaries. The top of the Ano Mavropoulon Fm. is delimited by the lower lithofacies of the Zigos Lm.; the contact is gradual with a progressive increase of the calcareous lithoclasts in the arkose and of the abundant detritus, mainly quartz, in the lower limestone beds.

The localities, in which the formation is best exposed, are the road winding over Ano Mavropoulon (Fig. 4: D14) and the road leading to Ano Seta village (Fig. 4: H17).

The lower contact is marked by an unconformity between the clastic rocks of the lower member and the underlying Skotini granites (2.5 Km SE of Skotini Mt.; Fig. 4: M12).

Petrography. Arenites from both the upper and lower members show similar mineralogical composition and are described together. The petrographic analysis classifies them mainly as arkoses and sometimes as lithic arkoses (QFR diagram). Quartz is the most common mineral and represents 40 to 70% of the framework. Monocrystalline grains with straight extinction prevail over those with undulate extinction and over polycrystalline grains. Some of the monocrystalline lobate grains, without inclusions, can derive from rhyolites. Altered potassium feldspar prevails relatively to plagioclase; the latter shows a "chess-board albite" structure indicative of a possible volcanic origin.

The lithic association is simple and includes volcanic, granitic and minor sedimentary fragments. Granitic rock fragments are made up of quartz-orthoclase-plagioclase-biotite/muscovite. The sedimentary clasts consist of fine quartz-arenites and clay chips. Detrital mica content is generally low, represented chiefly by muscovite. Biotite is frequently replaced by iron oxides. Zircon as accessory mineral is relatively common.

Matrix ranges from 5 to 15% and consists in pseudo-matrix and detrital matrix, made up of muscovite-quartz and calcium carbonate.

Grain roundness is normally sub-angular with medium sorting. All data indicate to low mineralogical and textural maturity.

3.1.1. The lower member

The lower member can be defined as the clastic sediments of Ano Mavropoulon Fm.; it is located between the Skotini granites at the bottom and the Upper Permian carbonates of the middle member.

From bottom to top the lithology of the member can be described as follows:

- white to greenish conglomerates, without evident internal sedimentary structures, directly overlying the granites. They include feldspar clasts and characteristic centimetric red/pink rounded quartz pebbles in a coarse sandstone matrix (e.g. 2.5 Km to the SE of Skotini Mt.; Fig. 4: M12);
- matrix supported conglomerates with well-rounded pluricentimetric pebbles of fine sandstones and quartz arenites;
- white fine to coarse arkoses interbedded with red/violet to green siltstones. The sandstones prevail and commonly show metric layering without other internal structures, (along the new road from Seta to Tharounia; Fig. 5.1: I19); they can sometimes contain conglomeratic horizons;
- sandstones bearing pluri-centimetric to decimetric lenses of upper Permian limestones that have been considered as the upper limit of the lower member.

The thickness of the basal conglomerates ranges from few meters to tens of meters. The thickness of the whole sequence can be estimated to 150–200 m or more.

Close to Skotini (Fig. 4: M12), the type locality for the lower boundary, the Ano Mavropoulon Fm. is represented by

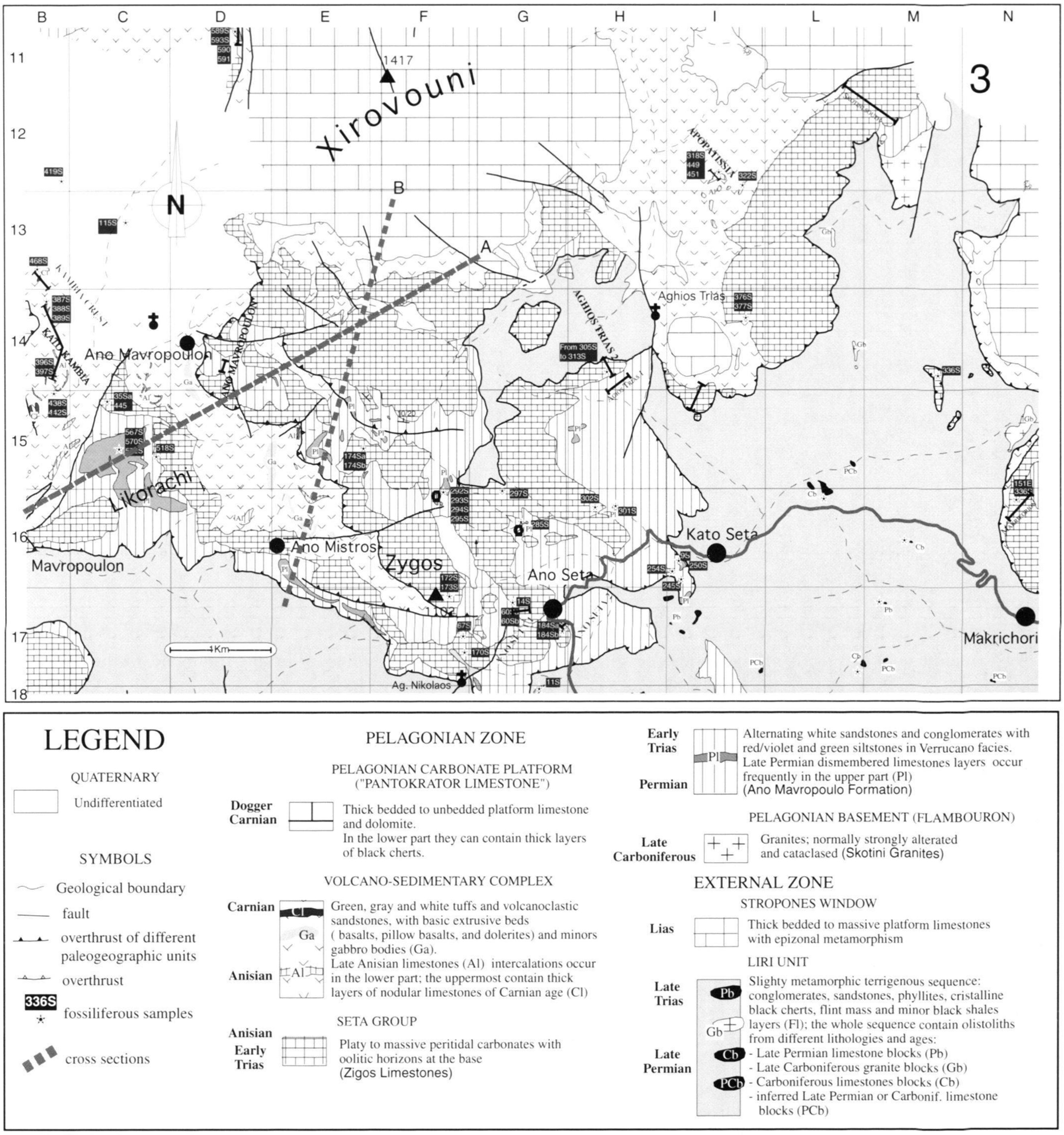

Fig. 4. Geological map of Xirovouni-Seta region (3) showing the Permo-Triassic fossiliferous samples localisation and the sections traces.

oligomictic quartz/feldspar conglomerates erosionally overlying the granites. The clasts of the conglomerates are clearly derived from the nearby granites.

The age of the non-fossiliferous lower part is considered as Permian *s.l.* on the basis of its basal sedimentary contact (unconformity) with the Late Carboniferous Skotini granites (315 to 311 Ma U-Pb; Vavassis et al. 2000) and in comparison with the Hydra Island sequence, where the Lower Permian clastic sediments are found between dated carbonate layers (Grant et al. 1991).

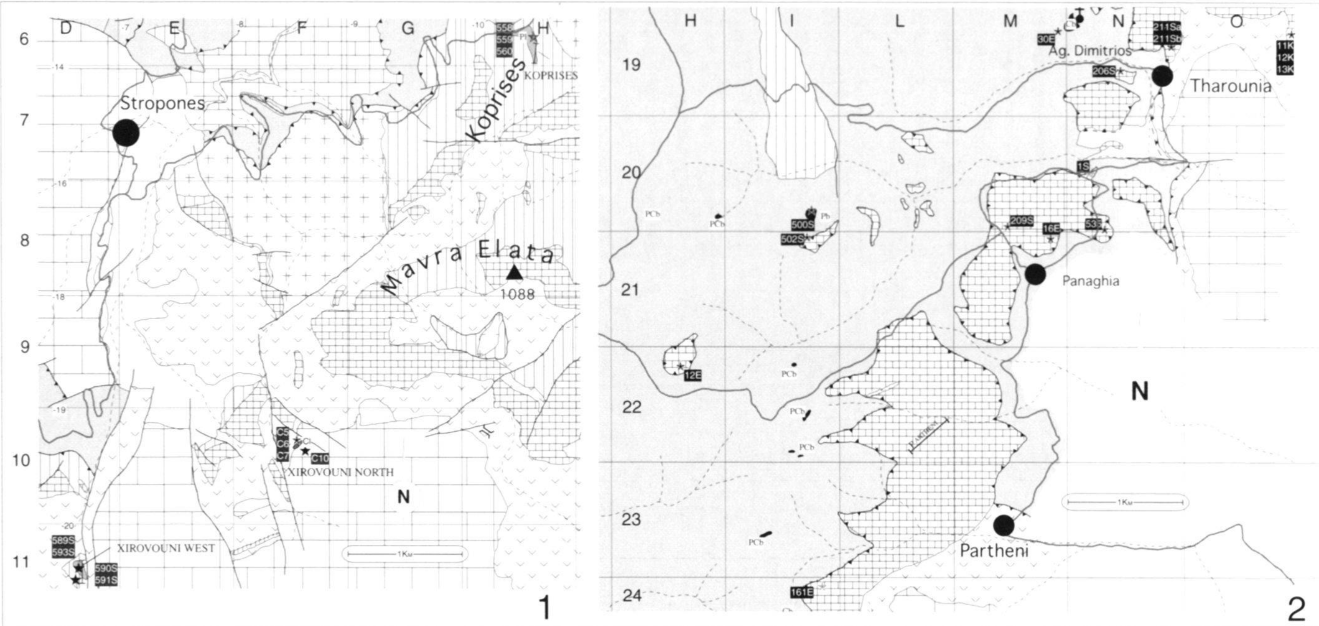

Fig. 5. Geological map of Stropones-Xirovouni (1) and Tharounia-Partheni (2) regions showing the Permo-Triassic fossiliferous samples localisation and the sections traces (for legend see Fig. 4).

3.1.2. The middle member: the Koprises Limestone

The Koprises Lm. are represented by calcareous bodies of Late Permian age, scattered in the upper part of the Ano Mavropoulon Fm. They were first described by Renz (1937, 1955), and dated by the same Author as Permian. The name "Koprises" derives from the crest of the watershed between Stropones and Metochi valleys; the type section is located on the road running along the crest at 700 m of altitude (Fig. 5.1: H6); the thickness of the limestones is variable, ranging from few to 40 m.

From bottom to top, the Koprises type section can be described as follows (Fig. 6):

- sandstones with small lenses of limestone in the upper part (lower member);
- 10 m of dolomites and dolomitic platy limestone with algae, crinoids and gastropods;
- 10 m of massive dolostones;
- 1,5 m of calcarenites with crinoids, algae (Pseudovermiporella) and Tubiphytes; the foraminifers Paraglobivalvulina (Pl. 1, Fig. 10), Globivalvulina, Reichelina (Pl. 1, Fig. 5), Dagmarita, Spandellina (Pl. 1, Fig. 23), Paradagmarita monodi, Agathammina pusilla and Globivalvulina gr. vonderschmitti are also present (samples 558, 559);
- 5 m of micritic and marly limestone with brachiopods, crinoids, bivalves, algae, gastropods (Bellerophon) and Globivalvulina (560);
- about 1,5 m of conglomerate with carbonate pebbles (Ano Mavropoulon Fm.) reworking fragments of the underlying limestones;

The age is Late Permian on the basis of the foraminiferal assemblage.

The relatively rich fauna, especially in algae, points to a favourable depositional environment in clear shallow waters at a considerable distance from contaminating sediments.

Correlations. The best locality of the Pelagonian realm, to make a direct correlation is the Hydra island. The Upper Palaeozoic sequence of Hydra was reinvestigated by Baud et al. (1990) and Grant et al. (1991), and a subdivision into 10 Formations and 4 Groups has been established for the Lower to Upper Permian lithostratigraphic units.

The upper part of the Late Permian is represented in Hydra by the Barmari Group, which comprises the Episkopi and Miras Formations, ranging in age from the Midian to the Dorashamian. In central Evia we have documented only the Dorashamian stage, but we cannot exclude ages older than the latest Permian. Guernet (1971) reported the Murghabian in Likorachi region; Midian was also signalled by Lys (1986), and in North Evia Midian and Djulfian ages were also established (Vavassis pers. com.). We correlate the Koprises Lm. with the Episkopi Fm., even if some differences are recognised, such as the small thickness of the Koprises Lm. and the absence of siliceous sponges responsible for the great amount of chert nodules in the Episkopi Fm.

In the region of Beletzi Mt., Attica, metric lenticular limestone bodies of Dorashamian age were described by Vachard

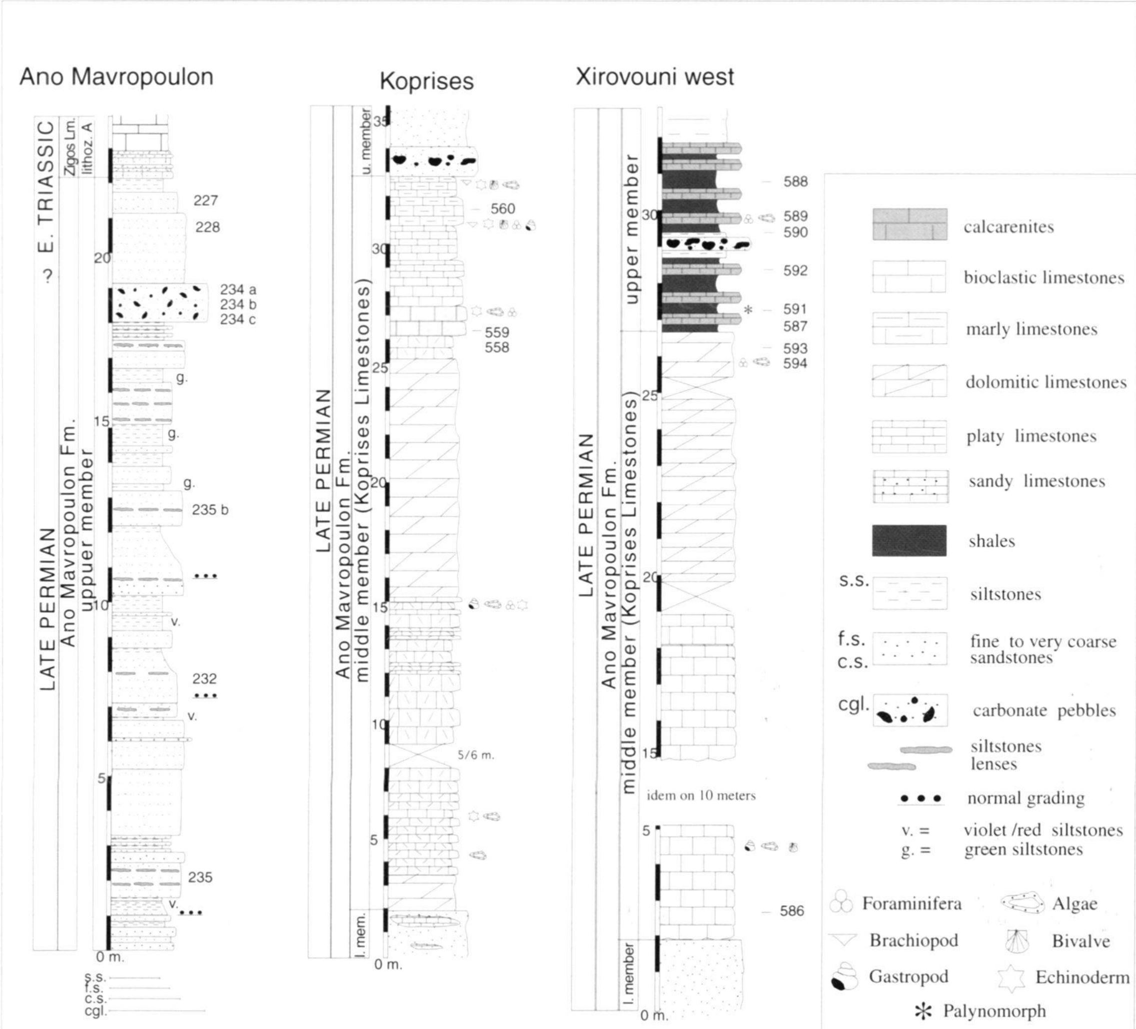

Fig. 6. Permian stratigraphic logs from the Ano Mavropoulon Formation.

et al. (1993). They contain the foraminiferal assemblage with *Palaeofusulina*, *Colaniella*, *Paraglobivalvulinoides*, and are correlated with the Koprises Lm. of central Evia.

3.1.3. The upper member

The upper member can be defined as the clastic episode of the Ano Mavropoulon Fm. located between the Upper Permian carbonates of the middle member and the first strata of the Triassic Zigos Lm.

The upper member mainly consists of white fine to coarse arkoses interbedded with red/violet to green siltstones. The uppermost part is characterised by very rare organic shales, in thin beds, and by calcarenites, and more frequently by discontinuous layers of Upper Permian carbonate conglomerates. A few thin dolostone intercalations also occur inside the siltstones.

Due to folds and local decollement levels (Fig. 3), two incomplete sections are considered:

Ano Mavropoulon section

This section was measured on the road passing over the Ano Mavropoulon village at 820 m a.s.l. (Fig. 4: D14); it consists, from bottom to top, of:

- 3 meters of fine to medium sandstones in 30 cm to 1 m thick strata, alternating with violet siltstones; silts also occur as small lenses in the sandstone beds;
- 4 meters of medium to coarse sandstones in 50 cm to 2 m thick strata;
- 11 meters of normal graded sandstones interbedded with green red/violet siltstones; sometimes sandstones contain small lenses of silts, and show planar and low angle cross lamination;

- 1.2 meters of carbonate pebbles conglomerate, representing a characteristic level in the upper member (see below). The matrix is a very coarse sandstone and the pebbles are pluri-centimetric rounded white to pink limestones;
- 2.5 meters of fine to medium ungraded sandstones;
- 0.5 meters of siltstones passing to sandy limestone corresponding to the first strata of Triassic Zigos Lm.

The best outcrops of the above described carbonate conglomerate are found in the neighbourhood of Ag. Nikolaou chapel, 1 km before the Ano Seta village. This conglomerate is also found overlying with an angular unconformity the Upper Permian bioclastic limestone (along the road Seta-Mistros, about 1 km from Seta). Its deposition is interpreted as related to the tilting of a part of the Koprises Lm. carbonate platform as a consequence of a syn-sedimentary extensional tectonic.

WEST XIROVOUNI SECTION

This key section is localised on the western flank of the Xirovouni massif, near a little pass at 1040 m a.s.l. (Figs 5.1 and 6); above the arkoses of the lower member, and the 25 m of bioclastic and dolomitic limestones of the middle member (Koprises Lm.), the upper member starts with:

- 5 m of organic matter rich black shales bearing cm to dm calcarenite beds and a conglomerate of reworked underlying limestone pebbles. The palynomorphs *Jugosporites delasucei, Calamospora, Protohaploxipinus limpidus, Corisaccetes, Staurosaccites quedritifidus, Falcisporites stabilis, Klausipollenites schaubergeri* (samples 590, 591) have been extracted from the black shales and the calcarenites contain the foraminifers *Hemigordius* (Pl. 1, Fig. 18), *Colaniella parva, Reichelina* (Pl. 1, Fig. 6), *Robuloides lens* (Pl. 1, Fig. 17) and *Tubiphytes* (589, 593);
- red/ violet non fossiliferous siltstones compose the upper part of the upper member.

The age of the upper member of the Ano Mavropoulon Fm., established on the palynological and foraminiferal content, is Late Permian (Djulfian-Dorashamian); in some places, the calcarenites allow to define more precisely a Dorashamian age, with the following assemblage of *Palaeofusulina sinensis* (Pl. 1, Fig. 4), *Palaeofusulina* sp. and *Colaniella parva* (Pl. 1, Fig. 8).

The stratigraphic position of the red/violet siltstones, at the top of the upper member, suggests a Permian or Triassic age; hence the Permo-Triassic boundary might be theoretically placed within the Ano Mavropoulon Fm., as defined here. The first dated strata of the Triassic (Zigos Lm., see 3.2.) occur above the base of the overlying Zigos Lm.; they contain *Meandrospira pusilla* and *Meandrospira cheni* of Early Triassic age.

The sedimentary structures (i.e. low angle cross laminations and pinching out of the sandy bodies in the siltstones) suggest that the depositional environment of the upper member was probably a terrigenous marine flat, affected by waves and current action.

3.1.4. Tectofacies

The "Verrucano"- type Permian detritism found in Evia and elsewhere in the Pelagonia terrane can be interpreted in terms of tectofacies. Its evolution in space and time points towards a geodynamic setting interpreted as the early stages of intracontinental rifting and not as a Variscan molasse.

On the basis of its age, depositional environment, similitude of facies with the Alpine/Apennine classic Verrucano and with regard to the global geodynamic setting of the Pelagonia terrane, we consider the whole siliciclastic detritism of the Ano Mavropoulon Fm. as a typical Verrucano tectofacies, as defined by Cassinis et al. (1979).

3.2. The "Zigos Limestones", or the Early-Middle Triassic limestones of central Evia

The Early-Middle Triassic limestones of central Evia were partially ignored by Guernet (1965a, 1971) and Argyriadis (1978). They were subdivided into two main series by Katsikatsos (1970, 1977), respectively Early-Middle Triassic clastic sediments with volcanics and limestone lenses, and Middle Triassic to Jurassic carbonates. A clear description of the geological context of this mix clastic and carbonate unit from Evia is lacking.

The Zigos Lm. is a new Formation which groups together all the Early to Middle Triassic limestones outcropping in central Evia. Zigos is a small rounded mountain looking over the Ano Seta village (Fig. 4: F17). The Zigos Lm. have been subdivided into 3 different informal lithofacies:

- oolitic limestone;
- micritic platy limestone with sporadic facies variations into lagoonal and nodular limestones.;
- massive limestone.

The age of the lithotypes ranges from Early Triassic to Anisian. Due to tectonics (Fig.3), the thickness is extremely variable, ranging from several meters up to 210 m, and even more (260 m) in a not illustrated section.

Normally the Zigos Lm. outcrops inside the Seta Group or as isolated tectonic klippe over the Liri Unit in the SE part of the mapped area.

Upper and lower boundaries. The lower boundary has been described in chapter 3.1. concerning the Ano Mavropoulon Fm. This limit is always gradual, locally characterised by small lenses of Ano Mavropoulon Fm. sandstones inside the first calcareous beds, and vice versa.

The upper limit is marked by the first occurrence of volcanic material, from the Volcano-sedimentary Complex, inside the Zigos Lm. Frequently this is a sharp limit, sometimes, as in the Kambia region, some Zigos Lm. lenses still occur inside the volcanics.

3.2.1. Lithofacies

Lithofacies A: oolitic limestones
Found at the base of the Zigos Fm., it has a variable thickness ranging from 10 up to about 50 m and generally marks all the contacts with the underlying Ano Mavropoulon Fm.

The "oolitic limestones" are a very good marker of the Zigos Fm. They consist of 0.3 to 1 m thick bedded grey oolitic limestone beds with abundant detrital quartz in the first strata; frequently they are partly or totally dolomitic and sometimes interbedded with calcarenites, or with dark micrites, of the Lithofacies B. Near the Ano Seta village (Fig. 4: G17; Ano Seta 2 section), the "oolitic limestones" show a lateral transition to a black micritic limestone of lagoonal facies. Generally the microfacies consists of oolitic packstones and grainstones with complete recrystallised oolites and of abundant crystals of dolomite. Dasycladacean algae and rare foraminifers also occur. The foraminiferal microfauna is represented by *Meandrospira pusilla* (Pl. 2, Figs. 15-21; samples 12E, 16E, 184Sa, 184Sb, 535S and 305S to 313S), sometimes associated with *Meandrospira cheni* (Pl. 2, Fig. 14; 12E, 16E); the age is Early Triassic (Spathian).

The depositional environment is interpreted as a terrigenous flat, represented by the top of the Ano Mavropoulon Fm., on which oolitic bars develop.

Lithofacies B: micritic platy limestones
The platy limestones is the most characteristic lithotype of the Zigos Lm.; they outcrop practically everywhere in central Evia, especially around Zigos and Kaplos Mts. They directly overlie the oolitic limestone of Lithofacies A and stop under the massive bioclastic limestones of Lithofacies C. Their thickness ranges from 30 up to 70 meters.

Lithofacies B consists of 10 to 50 cm planar beds of dark to light grey micritic limestones. Some marly and oolitic limestone intercalations frequently occur and a secondary progressive dolomitisation is evident. The microfacies chiefly consists of mudstones and wackestones, partially re-crystallised, with isolated oolites, carbonate lithoclasts and foraminifers; rare quartz monocrystalline grains occur. The foraminifers are *Meandrospira pusilla* (samples 172S, 173S), *Meandrospira dinarica* (174Sa, 174Sb), *Meandrospira* aff. *"M." deformata* (174Sa, 174Sb), *Hoyenella* gr. *sinensis* (297S) and *Arenovidalina*? (206S).

Inside Lithofacies B, two thin and discontinuous layers of black micritic or nodular limestones interfinger with the platy limestones. The Lagoonal limestone (5 up to 15 m thick) is represented by black to dark grey laminated platy limestones, with terrigenous intercalations and bioturbations. They normally outcrop in the lower part of the lithofacies, especially in the Seta region (sections of Ano Seta 1 and 2; Fig. 4: G17). They have given a foraminiferal assemblage that comprises *Meandrospira pusilla* (samples 60Sa, 60Sb, 115S), *Meandrospira dinarica* (Pl. 2, Fig. 11; 115S), *Meandrospira* aff. *"M." deformata* (Pl. 2, Fig. 6; 115S), and *Glomospira* (211Sa, 211Sb).

Nodular limestone beds were first described by Guernet (1971), who called them "calcaires léopard" and indirectly dated them as Permian. The Nodular limestone (5 up to 15 m thick) consists of 5 to 20 cm thick beds of grey to pale red micritic limestone nodules contained in a mud matrix. The calcareous strata are often interbedded with fine graded arenites and contain frequently iron sulphurs; sometimes they are associated with dark bioclastic platy limestone rich in bivalves and Dasycladacean algae (samples 35S, 445S). The nodular limestone normally occurs at the base of the lagoonal limestone and, in the Ano Mavropoulon region, at the bottom of the Volcano-sedimentary Complex. No conodonts have been found and the only fossiliferous sample (14S) contains *Meandrospira pusilla*.

The foraminiferal assemblages of Lithofacies B are characteristic of the Anisian and range from the Aegean to the Pelsonian.

An open lagoon environment of deposition is suggested for the platy limestone of Lithofacies B.

Lithofacies C: massive limestone
The massive limestone is bounded at the top by the Volcano-sedimentary Complex and at the base by the platy limestone of Lithofacies B. The typical outcrops are sited in the area of Partheni (north of Tharounia), between Makrichorion and Manikia, and north of Skotini Mt. Due to tectonic deformations, three incomplete sections have been studied (Fig. 7): Aghia Trias 2 (Lithofacies A and B; Fig. 4: H14), Ano Seta 1 and Ano Seta 2 (Fig. 4: G17). The lithology is represented by massive recrystallised limestone, often dolomitic, white to light grey and sometimes pink in colour. The basal part is frequently coarse bedded, with rare marly thin intercalations; the strata contain some crinoids, algae and bivalves fragments. They are characterised by the absence of terrigenous material. The thickness of Lithofacies C varies from 20 up to 90 m.

The microfacies vary from micrite or dismicrite to biosparite, with wackestones to packstones textures. The massive limestone contains the following foraminiferal assemblage: *Meandrospira dinarica* (samples 11K, 12K, 13K, 151E, 336S), *Meandrospira pusilla* (336S), *Pilammina densa* (Pl. 2, Fig. 5; 12K, 11K), *Pilammina* (151E, 13K), *Meandrospira* (161E), *Endotriadella* and *Glomospira* (376S). The age of Lithofacies C is Middle Triassic (Aegean to Illirian).

The depositional environment is referred to an external carbonate platform (or carbonate ramp).

The age given by the microfaunal assemblages ranges from Spathian to Pelsonian for the Zigos Lm. and the lower part of the Early Triassic cannot be attested by the foraminifers. A general lacuna from Dorashamian to Spathian was recognised for the same kind of limestones elsewhere in the Pelagonian realm, especially well constrained in the Hydra island (Angiolini et al. 1992). Therefore it is assumed that the lower part of the Early Triassic is lacking in central Evia, and a Spathian to Pelsonian age is the most realistic interval for the Zigos Lm.

3.2.2. Correlations

Lithological and faunal similarities suggest a possible correlation between the Zigos Lm. and the Eros Lm. (Romermann 1968) of Hydra island. The Eros Lm. (Spathian to Pelsonian) is subdivided by Angiolini et al. (1992) into four lithofacies, from bottom to top: the lower lithofacies, Eros Limestones *s.s.*, the Dark member and the upper lithofacies. The lower lithofacies, consisting of grey oolitic limestone bearing quartz grains, can be correlated with the Lithofacies A of the Zigos Lm. The Eros Limestones *s.s.*, can be related to the Zigos Lm. Lithofacies B, while for the Lithofacies C we cannot find a clear correlation inside the Eros Limestones.

In Attica (Beletzi and Parnis Mts), it is possible to propose some correlation (Lithofacies A and B), only restricted to the lower Triassic carbonates. During the Anisian, the sedimentation became more pelagic than in central Evia, and nodular limestone and cherty limestone were deposited, associated with tuffs (Clément 1968, 1976).

In the Beletzi Mt. area, the Early Triassic is represented by sandy limestone resting on reddish sandstones and siltstones (Clément 1976). Oolitic limestone overlie the sandy limestone in Parnis Mt. region, or rest directly over the Upper Permian/Lower Triassic detrital formations, as in the case of the Stephani-Mandra Unit.

In the Perani area of Salamina island (Vavassis & De Bono, pers. observ.) oolitic limestone followed by platy limestone rest over clastic sediments similar to the Ano Mavropoulon Fm. Verrucano facies.

The Pelagonian Lower (?) Middle Triassic Units found in south-eastern Othrys (Ferrière 1976, 1982) are represented by platy crystalline limestone, overlying the Upper Palaeozoic/Lower Triassic schists. The Maliak Units comprise oolitic limestone and massive dolomite (Pirgaki and Garmeni-Rachi Units) are generally dated from Early Triassic to Anisian (Ferrière 1982).

The Lower-Middle Triassic limestones of the "Chainon d'Oréokastro" belong to the "Vardarian" Peonia zone (Mercier & Vergély 1995). They were subdivided by Baroz et al. (1990) into five lithofacies that display strong similarity with the Zigos Lm.

4. The Volcano-sedimentary Complex

The Pelagonian zone is characterised by (Early ?) Middle-Late Triassic intense volcanic activity (Guernet 1965b; Katsikatsos 1970; Kauffmann et al. 1976; Pe-Piper 1982; Pe-Piper & Panagos 1989; Pe-Piper & Mavronichi 1990; Pe-Piper 1998). The geotectonic affinity and related geodynamic interpretation of the Hellenic Triassic igneous rocks still remain a controversial problem that will be discussed in the conclusions.

Volcanic rocks and associated sediments of central Evia have been grouped here in a new unit called Volcano-sedimentary Complex; it has been re-dated in this work, starting from the Anisian and locally lasting up to the Carnian. It comprises mainly tuffs interbedded with thick limestone beds of different facies and ages and shows sporadic basalt flows, pillow lavas, dolerites and gabbros (Fig. 1C).

The lower limit is represented by the first occurrence of volcanic material over the Zigos Lm.; the upper limit is delimited by the first strata of Upper Triassic limestones of the Pelagonian platform of "Pantokrator". The analysed Triassic volcanic rocks (De Bono 1998) fall into the group of alkaline to sub-alkaline basalts typical of within-plate environments, as already demonstrated by Pe-Piper & Panagos (1989).

4.1. Sedimentary carbonate layers

Inside the Volcano-sedimentary Complex, two kinds of carbonate rocks layers have been found, permitting to date more precisely the whole complex from Anisian to Early Carnian. The Volcano-sedimentary Complex was previously reported to be of Early-Middle Triassic age by Katsikatsos (1970), Christodoulou & Tsaila-Monopolis (1972), Kauffmann (1978), Katsikatsos et al. (1986) and of Ladinian-Carnian age by Guernet (1965b).

4.1.1. Anisian limestones

Normally they outcrop as small folded lenses (few dm to 20 m thick), close to the base of the Volcano-sedimentary Complex. The Anisian limestones are well exposed in the Apopatissia area and in the NE of the Mavropoulon village.

APOPATISSIA SECTION

Small lenses of white limestone are visible on the slope located in the NNE side of the Aghia Trias church. A dirt road reaches them. The section has been traced at the top of the first lens along the road, at 920 m a.s.l. (Fig. 4: I12). The outcrops mainly consist of massive partially dolomitic limestone; from bottom to top the section shows (Fig. 7):

- 15 m (or more) of white to grey massive partially dolomitic limestone bearing small crinoids and the foraminifers *Meandrospira dinarica, Meandrospira* and *Glomospira* (samples 318S, 451S);
- 0.5 m of green tuffs;
- 0.5 m of carbonate conglomerate;
- 1.5 m of bioclastic micritic limestone bearing bivalve fragments (monogenic bio-accumulation);
- 0.3 m of green tuffs;
- 0.2 m of bivalve packstones with interbedded thin tuffaceous layers;
- 0.3 m of conglomerate reworking carbonate pebbles from the dolomitic limestone and the bivalve packstones;
- greenish tuffs.

The microfossils content is characteristic of the Anisian.

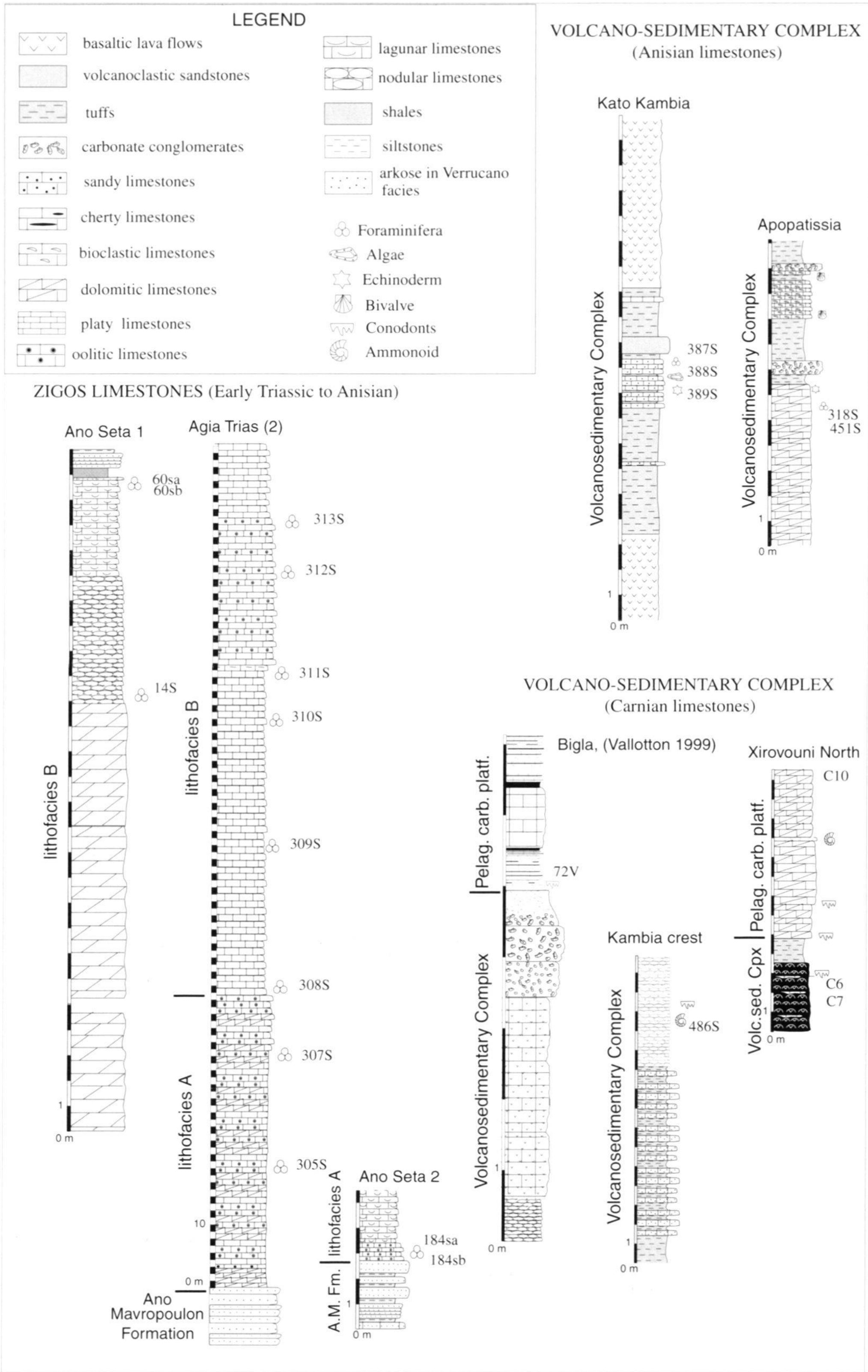

Fig. 7. Triassic stratigraphic logs from the Zigos Limestones and the Volcano-sedimentary Complex.

KATO KAMBIA AREA

This region is accessible trough the dirt road starting from a chapel located about 500 meters in the ESE side of the Kato Kambia hamlet (Fig. 4: B14). The area is characterised by discontinuous metric beds of limestone intercalated inside the volcano-clastic sandstones and tuffs (Kato Kambia section; Fig. 7). The carbonate layers are thin bedded grey sandy to marly limestone with sporadic cm thick reddish cherts nodules. They contain crinoids, algae and a typical Anisian (probably Pelsonian) foraminiferal assemblage with *Pilammina densa* (Pl. 2, Figs 1–4, 7, 8; samples 387S, 388S, 389S, 396S), *Pilamminella grandis* (Pl. 2, Figs 9, 10; 388S), *Meandrospira dinarica* (438S, 442S), *Meandrospira* (438S, 442S) and *Glomospira* (438S, 442S).

4.1.2. Carnian limestones

The uppermost part of the Volcano-sedimentary Complex is characterised by the occurrence of thin layers of pelagic limestone often associated with carbonate detritism. The pelagic deposits generally consist of nodular white to reddish limestone and intra-pillow micrite.

Three key areas have been investigated as follows.

XIROVOUNI NORTH

The outcrop is sited at 780 m a.s.l. on the road along the North side of Xirovouni massif (Fig. 5.1: F10). It marks the stratigraphic boundary between the Volcano-sedimentary Complex and the overlying carbonates of the Late Triassic/Jurassic Pelagonian platform (Fig. 7).

The last volcanic rocks are represented by weathered reddish pillow lava (spilites) with intra-pillow sediments, associated with tuffs; the intra-pillow sediments consist of centimeter lenticular bodies of white to greenish micritic limestone bearing a conodonts fauna: *Gladigondolella tethydis* (Pl. 3, Fig. 2), *Gladigondolella malayensis* (Pl. 3, Fig. 4), *Paragondolella foliata* (Pl. 3, Figs 3, 9, 12), *Sephardiella mungoensis* (Pl. 3, Figs 7, 11), and *Paragondolella* (samples C6, C7).

The base of the Pelagonian platform here consists mainly of dolomitic calcarenites and rare nodular limestone beds containing ammonite and belemnite fragments. Both lithologies give a conodont assemblage that comprises *Gladigondolella malayensis* (Pl. 3, Figs 5, 10; C10).

KAMBIA CREST

This section is situated NE of Kato Kambia hamlet at 700 m a.s.l., on the crest between Kambia and Mavropoulon valleys (Fig. 4: B13). From base to top, it consists of:

- tuff passing gradually to about 10 m of normal graded bedded red calcarenites, interbedded with volcano-clastic sandstones and reddish tuff;
- 6–8 m of red and white nodular limestone bearing rare ammonite fragments and *Paragondolella* (sample 468S).

BIGLA

This detailed section has been studied by Neligan & Vallotton (1999). The first 5 m consist of:

- 0.6 m of nodular limestone with volcanic matrix;
- 3 m of greenish limestone bearing volcanic elements, in 1 m thick beds;
- 2.5 m of coarsening upwards conglomerates reworking calcareous and volcanic clasts.

The top of the section is represented by the occurrence of sediments belonging to the Pelagonian platform. They comprise platy limestone with black recrystallised cherts in 2 to 10 cm thick beds. The platy limestone give a conodont assemblage with *Gladigondolella tethydis* (Pl. 3, Fig. 1) and *Paragondolella* (sample 72V) of Early Carnian age.

5. The Pelagonian upper Triassic-Jurassic carbonate platform: the "Pantokrator" limestone

The name "Pantokrator" was used by Romermann et al. (1981) for the Triassic limestones in Hydra island. Renz (1955) defined its stratigraphic range as Late Triassic to Early Jurassic and mentioned the similarity with the Late Triassic limestones of the Central Argolis Peninsula. We keep the name "Pantokrator" for our upper Triassic-Jurassic carbonate platform, though it was originally proposed for the Ionian Zone.

This formation has not been the subject of detailed studies in this work; we have only dated the first strata overlying the Volcano-sedimentary Complex.

In central Evia, the "Pantokrator" Triassic-Jurassic carbonates consist of (from bottom to top):

- grey to white massive reef limestone with intercalations of dolomitic limestones, in places brecciated (Servouni and Manikia areas); in the area of Lamari and close to the Tharounia village, the base of "Pantokrator" is characterised by several meters of cherty limestone and black cherts;
- thick to medium bedded dark grey limestone and dolomites that contain sporadic layers rich in Lithiotidae and small Megalodontidae;
- medium bedded limestone bearing oolites and *Cladocoropsis*.

The total thickness of the formation has been estimated about 600–800 m.

The Late Triassic/Jurassic period is characterised throughout the "Pantokrator" limestone by a very shallow restricted carbonate platform environment.

In the Xirovouni North and Bigla sections (Fig. 7), the first strata of the "Pantokrator" have been dated by the conodonts *Paragondolella tethydis* and *Paragondolella*. This assemblage indicate a Carnian age.

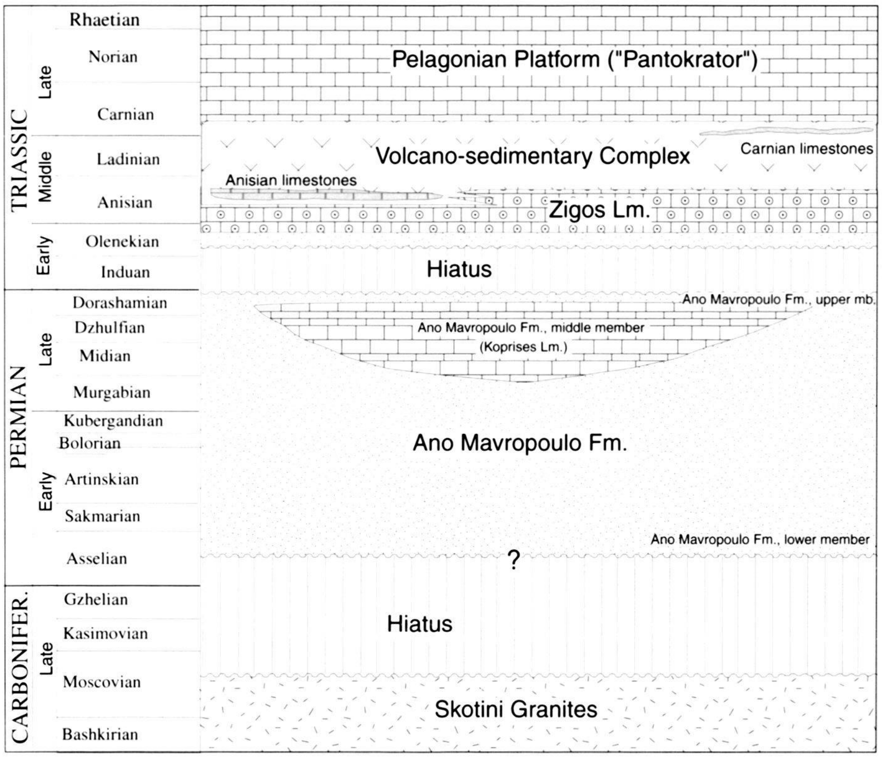

Fig. 8. Geo-history of central Evia Permo-Triassic Units (Geological scale of C.A. Ross et al. 1994).

6. Stratigraphic synthesis

The central part of Evia island consists of different sequences of Pelagonian affinity that have been subdivided into two new main lithostratigraphic units: the Seta Group and the Volcano-sedimentary Complex; the latter unit is overlain by the Carnian to Jurassic Pelagonian platform called "Pantokrator" limestone. A scheme of the Permo-Triassic stratigraphy of central Evia is given in Fig. 8.

The Seta Group comprises the Ano Mavropoulon Fm. (new formal name) ranging in age from Early to Late Permian (Early Triassic ?), and the Zigos Lm. (new formal name) from Early Triassic (Spathian) to Anisian (Illyrian). Between the two formations a regional unconformity separating the latest Permian from the Induan has been detected.

The Ano Mavropoulon Fm. has been subdivided into three members:

- the lower member, of Permian s.l. clastic sediments in Verrucano tectofacies, resting directly on a Variscan basement made up of granitoids;
- the middle member, characterised by the presence of Late Permian (Murgabian ? to Dorashamian) shallow-water carbonates here called Koprises Lm.;
- the upper member, mainly containing the same elements as the lower member and an horizon of carbonate breccia. It ranges in age from latest Permian to middle Early Triassic (?).

The lower to middle Triassic peritidal carbonates belonging to the Zigos Lm. have been subdivided into three informal lithofacies (Fig. 9):

- Lithofacies A, of oolitic grainstone, Lower Triassic (Spathian) in age;
- Lithofacies B, of micritic platy limestone, Middle Triassic (Aegean to Pelsonian) in age;
- Lithofacies C, of massive micritic limestone and dolomites, Middle Triassic (Aegean to Illyrian) in age.

The Volcano-sedimentary Complex has been re-dated, it starts in the Middle Anisian and locally lasts up to the Early Carnian. It mainly comprises tuffs interbedded with thick limestone beds of different facies and ages and it shows sporadic basalt flows, pillow lavas, dolerites and gabbros. Whole rock geochemistry on lavas and gabbros suggests a within-plate tectonic environment for this complex.

The overall picture of the Late Palaeozoic (northern) margin of Pelagonia displays a palaeogeographic organisation characterised by various environments such as: continental to marine with siliciclastic sedimentation, back-reef internal carbonate platforms, reefal limestones, external open sea carbonate platforms, slopes with turbidites and olistostromes. This organisation, together with an extensional palaeotectonics, is interpreted as the result of a syn-rift stage leading to a subsequent passive margin stage during Triassic times.

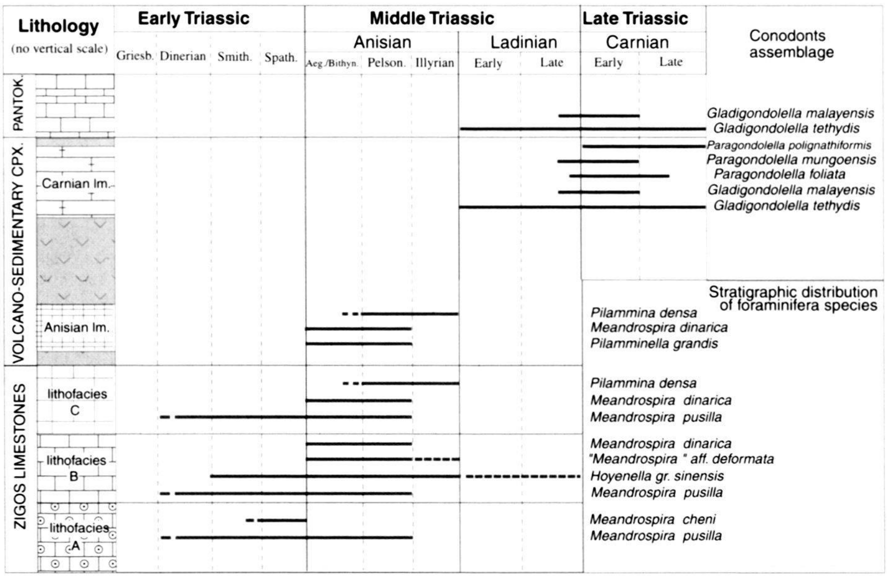

Fig. 9. Foraminifers and conodonts repartition in the Triassic Pelagonian Units.

7. Permo-Triassic geodynamic evolution of the northern margin of Pelagonia

We interpret the Permo-Triassic sedimentary sequences of the northern margin of the Pelagonian terrane as the consequence of the rifting and spreading of the Maliak oceanic basin.

7.1. *Early Permian to Early/Middle Triassic: rift stage*

The Permian evolution of the margin is well recorded by the sequences of Hydra Island. They are characterised by the succession of four main events, reflecting extensional tectonic with block-faulting, tilting and erosion (Baud et al. 1990; Grant et al. 1991).

The older event was characterised by transgressive-regressive episodes with the onset of two small carbonate platforms ranging from Late Asselian to Artinskian. It could be interpreted as a pre-rift sequence, transgressive on the Variscan crystalline basement (e.g. central Evia).

The second event (Late Artinskian to Murghabian) can be considered as marking the onset of the rift stage. It is accompanied by the tilting of part of the pre-existing platforms and resulted in the subsequent deposition of the Riga Fm. This formation consists of decametric to hectometric lenses of coarse conglomerate/breccia reworking Early Permian limestones, quartzites and chert clasts. From a geodynamic point of view it can be compared with the Permo-Carboniferous Sexten and Tarvis breccias of the Carnic Alps and Dolomites (Flügel & Kraus, 1986), corresponding to the erosion of the rift shoulders. A regressive episode follows the Riga Fm., represented by continental alluvial fan and it is in turn overlain by an extensive carbonate platform during the Late Murghabian.

The last two events during the Midian and Dorashamian were characterised by several transgressive-regressive episodes. The sedimentation, controlled by extensional tectonics (e.g. unconformity and coarse detrital deposition in Early Midian) takes place in different environments like continental alluvial fan, sabkha and carbonate platforms, marking a mature stage of syn-rift deposition and continuing rift shoulder erosion.

More proximal sequences, with respect to Hydra, are found in the carbonate sediments of Evia Island, represented by the onset of a small carbonate platform during the Midian/Dorashamian. The presence of carbonate breccia, angular unconformity and olistoliths is interpreted as the result of a syn-sedimentary extensional tectonic.

The most distal part of the margin during the Late Permian/Early Triassic can be represented by the olistostrome sequences found in Salamis Island. As proposed by Papanikolaou & Baud (1982) it can be interpreted as belonging to a mobile, extensive context related to a rifting stage.

During the end of the Dorashamian, a terrigenous clastic sedimentation preceded the regional unconformity at the Permian-Triassic boundary (Angiolini et al. 1992). There are not enough data to propose a direct relation between this unconformity and the thermal expansion due to the Meliata break up, located to the north of the Maliak domain (Kozur 1991). In any case, after this regressive episode a general thermal subsidence takes place involving all the Early/Middle Triassic platforms.

Late Early Triassic/Middle Anisian is characterised by the rising and growing of several carbonate platforms and by pelagic sedimentation starting in Anisian for the most internal zones.

In the external parts of the margin, the sedimentation is represented by peritidal carbonate, (e.g. the Zigos Lm. of central Evia), reflecting a palaeogeographic environment comprising an open lagoon and an external platform. The sedimentation remains neritic, the subsidence moderate and the thickness of the platforms limited.

In more distal domains (Hydra Island; Angiolini et al. 1992) the well-developed platforms (e.g. Eros Lm.) recorded an increase of the subsidence, presenting a typical thermal decay.

The most distal sequences of the margin, represented by the Maliak Units, record a pelagic carbonate sedimentation through the whole Anisian (Ferrière 1982).

7.2. The Middle Triassic volcanic event and sea-floor spreading

This event touches the Internal Hellenides as well as the Dinarides and the South Alpine domain. Regarding its origins several hypotheses have been formulated. According to Pe-Piper (1998) the alkaline (and minor sub-alkaline) volcanic rocks belonging to the Pelagonian zone can be derived from a mantle plume related to the Triassic rifting. We showed here that the rifting was mainly Permian however oceanisation in the Maliak domain only took place in Middle Triassic (see below). The origin of the plume could also be the consequence of the slab detachment of the subducted Paleotethys ocean under Pelagonia (Stampfli et al 1998; De Bono 1998; Vavassis et al. 2000).

This subduction is considered as the main factor responsible for the Late Paleozoic to the Early Mesozoic evolution of the Pelagonia terrane; the principal consequence is the opening of the Maliak back-arc basin, obviously in two stages, one Permian the other in Mid-Triassic.

Subsidence patterns for Hydra Island (Angiolini et al. 1992) show a strong increase of subsidence during the Middle Anisian. This can be interpreted as the beginning of the second phase of rifting.

7.3. Early Middle Triassic to Jurassic: passive margin stage

As mentioned above, in Hydra Island a period of high subsidence took place since Middle Anisian. It is represented by the progressively deeper facies overlying the Eros Limestones, continuing through most of the Jurassic (Angiolini et al. 1992).

In more proximal parts of the Pelagonian zone (e.g. central Evia), the high rate of subsidence was balanced by the carbonate sedimentation, as witnessed by the Carnian onset of the "Pantokrator" platform, lasting until the Late Jurassic.

The most distal sequences of the margin, represented by the Garmeni-Rachi and Loggistion Units of Maliak affinity (Ferrière 1982) remained pelagic through the Triassic and Jurassic.

The Loggistion Unit comprises Ladinian radiolarites resting on pillow lava. The volcanic rocks were reinvestigated by Lefèvre et al. (1993) and related to a N-MORB to T-MORB affinity. Unfortunately, the poorly constrained geochemical data of Lefèvre et al. do not permit to regard them as original remnant of the Maliak oceanic crust.

In the Parnassos zone, located in more proximal position with respect to Pelagonian, the sedimentation begins only in Late Triassic (Celet 1962, 1979). It is interpreted as a structural high related to the rift shoulder relief.

Acknowledgements

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Plate 1

Late Permian foraminifers from the Ano Mavropoulon Fm. (Seta Group)

Fig. 1.	Staffellidae; sample 254S
Fig. 2.	*Dunbarula*; sample 254S
Fig. 3.	*Codonofusiella*; sample 254S
Fig. 4.	*Palaeofusulina sinensis* Sheng.; sample 293S
Fig. 5, 6.	*Reichelina*; (5): sample 558B; (6): 589
Fig. 7.	*Tetrataxis*; sample 294S
Fig. 8.	*Colaniella parva* (Colani); sample 570
Fig. 9•.	*Palaeofusulina*; sample 254S
Fig. 10*.	*Paraglobivalvulina*; sample 558B
Fig. 11* - 15*.	*Globivalvulina* gr. *vonderschmitti*; (11, 12, 15): sample 250S; (13): 11S; (14): 9S
Fig. 16*.	*Neoendothyra reicheli* Reytlinger; sample 285S
Fig. 17*.	*Robuloides lens* Reichel; sample 589
Fig. 18*, 19*.	*Hemigordius*; (18): sample 589; (19): 250S
Fig. 20*, 21*.	*Abadehella*; sample 294S
Fig. 22[.	*Paradagmarita monodi* Lys; sample 558A
Fig. 23*.	*Spandelina*; sample 559A

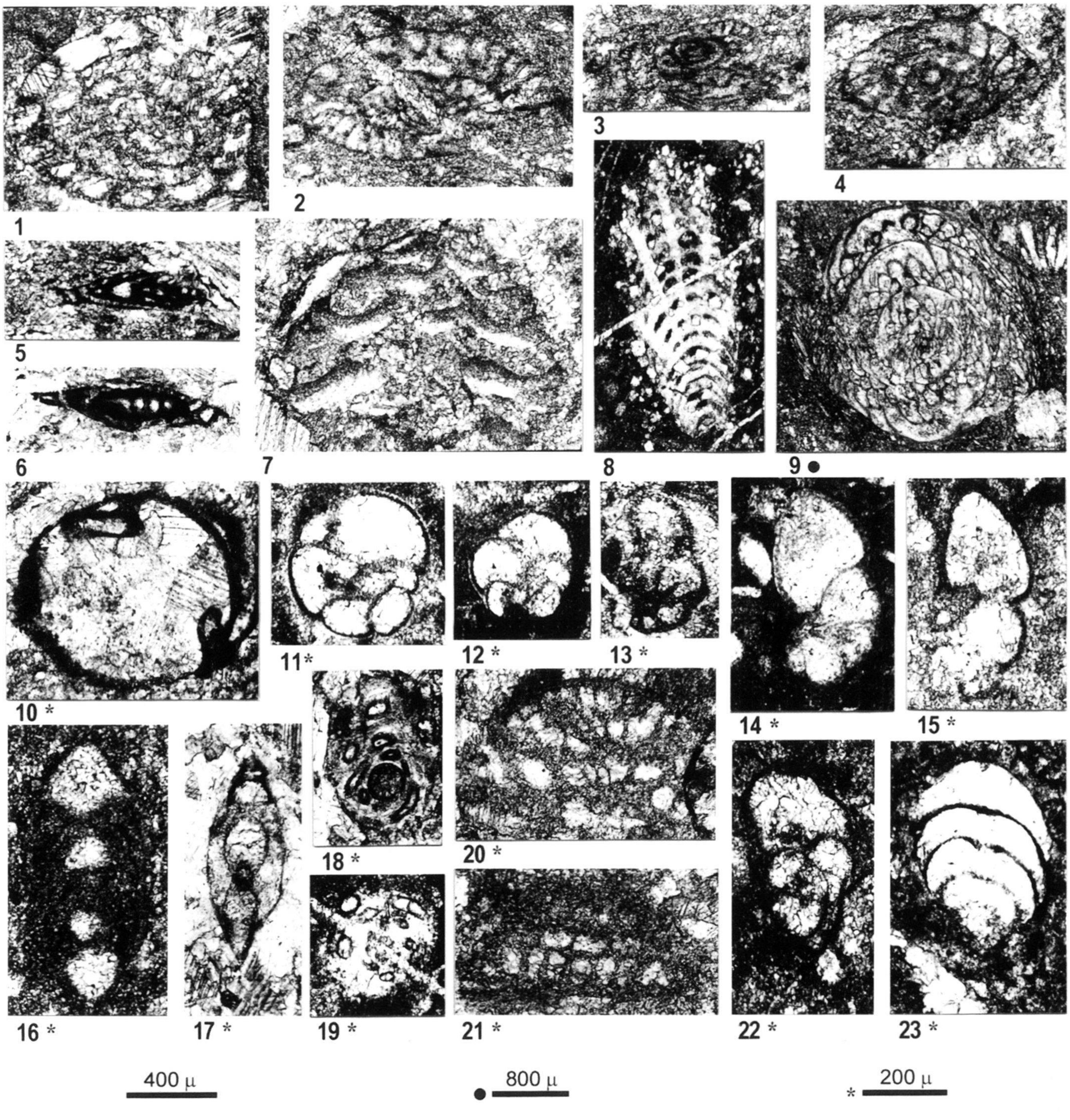

Plate 2

Early-Middle Triassic foraminifers from the Zigos Limestones (Seta Group)

Fig. 1–5, 7, 8.	*Pilammina densa* Pantic; (1-3): sample 387S; (4, 8): 388S; (5): 12K, initial part; (7): 389S1
Fig. 6*.	*Meandrospira* aff. "*M.*" *deformata* Salaj; sample 115S
Fig. 9, 10.	*Pilamminella grandis* (Salaj), sample 388S
Fig. 11* – 13*.	*Meandrospira dinarica* Kochanky-Devide & Pantic; (11): sample 115S; (12, 13): 17Eb
Fig. 14*.	*Meandrospira cheni* (Ho); sample 12E
Fig. 15* – 24*.	*Meandrospira pusilla* (Ho); (15, 20): sample 309S; (16, 17, 21): 12E; (18): 307S; (19): 302S; (22): 605S; (23): 115S; (24): 102E1
Fig. 25*.	*Spirorbis*; sample 313S

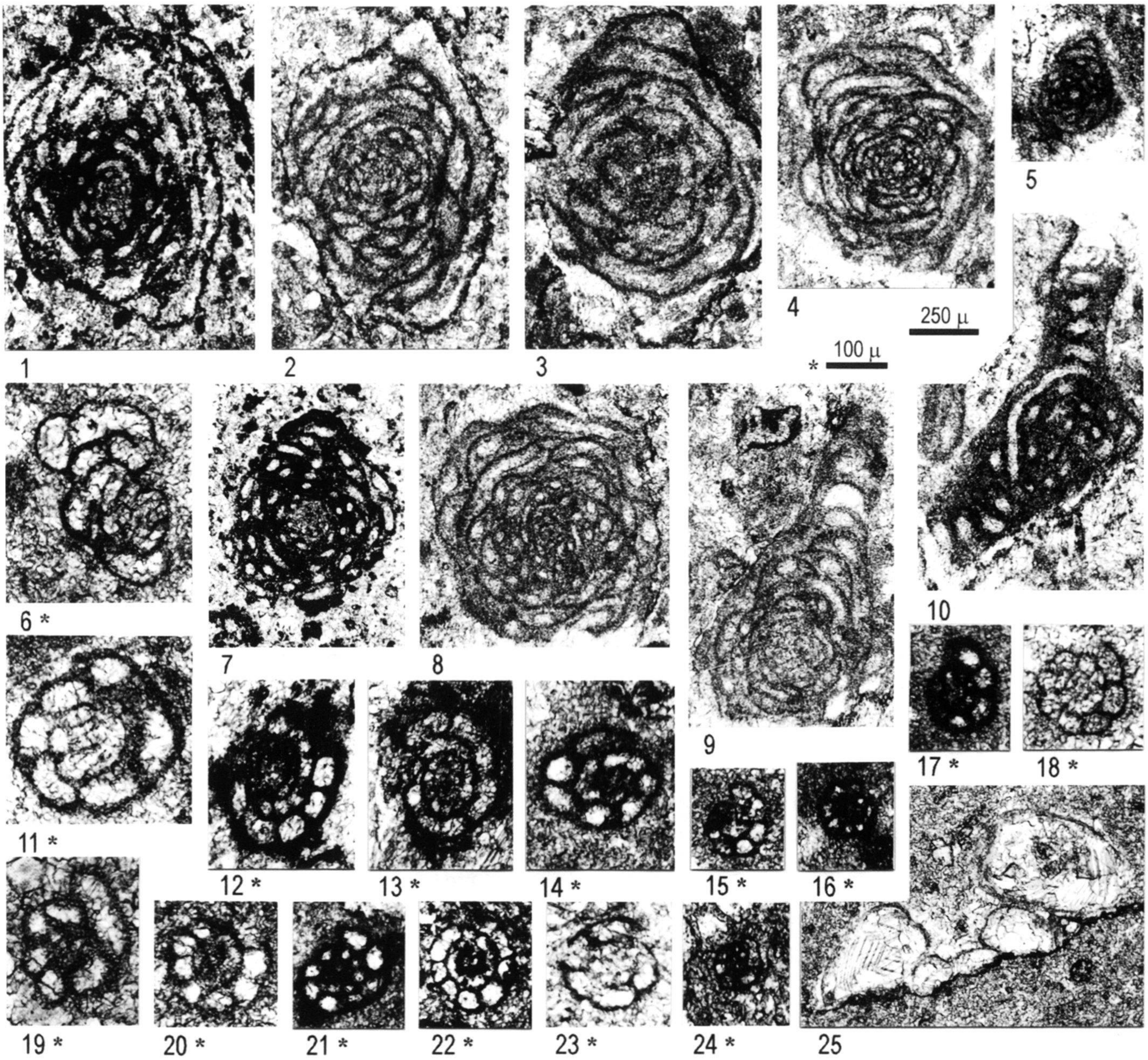
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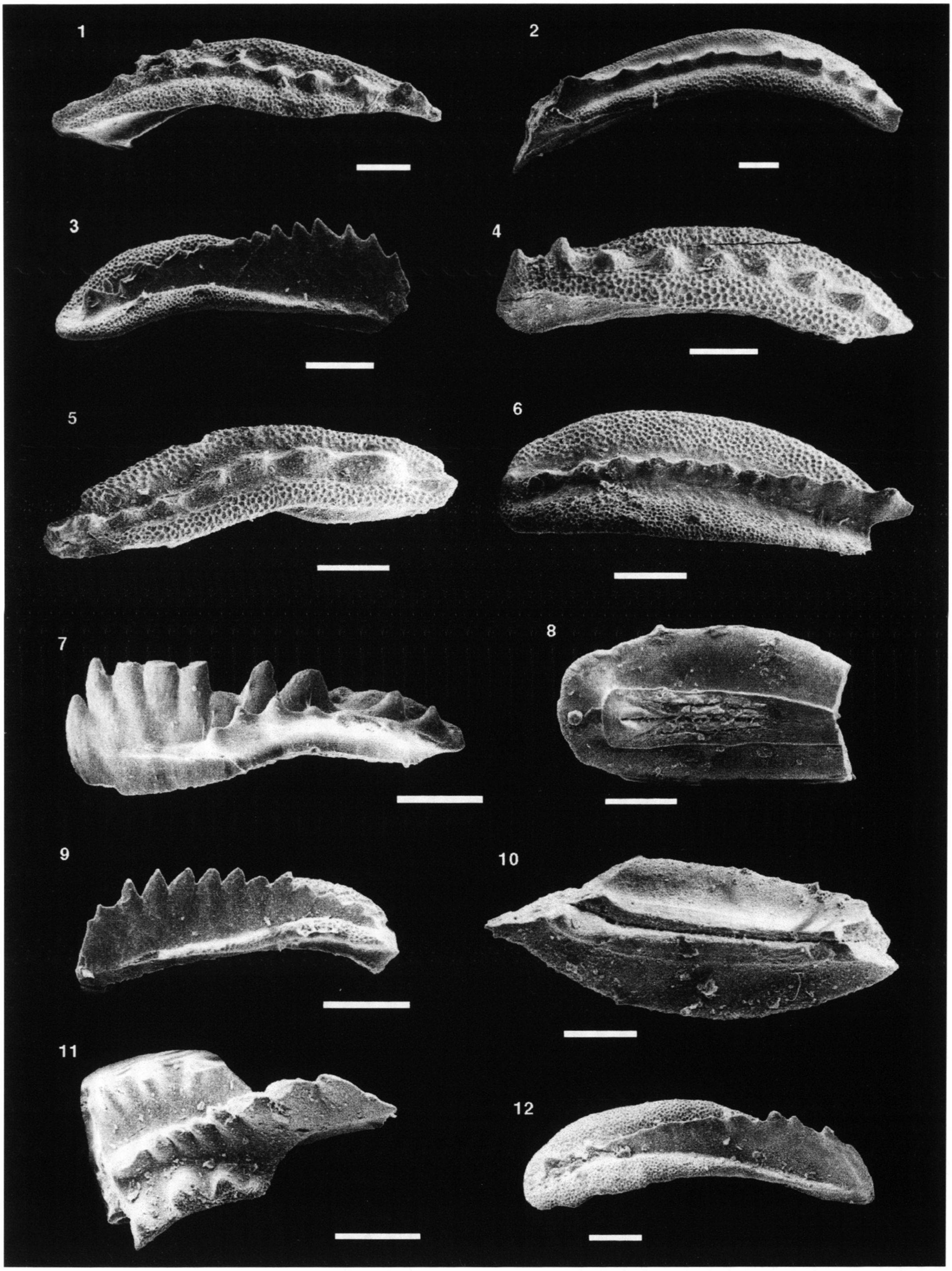
Plate 3

Triassic conodonts from the Volcano-sedimentary Complex and from the "Pantokrator" limestone

Fig. 1.	*Gladigondolella tethydis* (Huckriede); sample 72V
Fig. 2.	*Gladigondolella tethydis* (Huckriede); sample C7
Fig. 3, 9.	*Paragondolella foliata* (Budurov); sample C7
Fig. 4.	*Gladigondolella malayensis* (Nogami); sample C7
Fig. 5, 10.	*Gladigondolella malayensis* (Nogami); sample C10
Fig. 6.	*Paragondolella* sp., juvenile specimen; sample 35
Fig. 7.	*Sephardiella mungoensis* (Diebel); sample C6
Fig. 8.	*Paragondolella* sp.; sample 35
Fig. 11.	*Sephardiella mungoensis* (Diebel); sample C7
Fig. 12.	*Paragondolella foliata* (Budurov); sample C6

Scale bars represent 100 microns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