

Conclusions

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limestones with *Cladocoropsis*, skeletal limestones with chert (Alimnia Member) and skeletal limestones with nummulites of Paleocene to Eocene age. Although these different limestone types occur in isolated masses scattered all over the Oligocene Flysch, they have been grouped together into one single formation (Salakos Limestone, OROMBELLI and POZZI 1967; MUTTI et al. 1970) that was thought to represent one continuous formation of shallow-water limestones. This formation was tentatively attributed by C. RENZ (1929) and by MUTTI et al. (1970) to the Parnasse Zone; but OROMBELLI and POZZI (1967) allocated it to the Gavrovo Zone because it occurs structurally below the Pindos Nappe (Profitis Ilias Group of MUTTI et al.). However, as AUBOUIN and DERCOURT (1970) pointed out, the formations grouped in the Archangelos Group could be derived from different tectonic units and may just represent allochthonous slivers of different origin resting on the flysch.

Of the different lithologies, the shallow-marine Upper Triassic to Liassic limestones that yielded Norian (see p. 58) and Early Jurassic floras (OROMBELLI and POZZI 1967), compare rather well with the Gereme Limestone. On the island of Alimnia these limestones are overthrust on a sequence of cherty limestones with lime turbidites containing displaced *Orbitolina*; this formation in turn recalls the Çal Dağ Limestone. The Paleocene-Eocene nummulite limestones are, however, not represented in the Lycian sequences, except for the nummulite limestones associated with the Atolen Member of the Datça Flysch.

Similar sequences occur, according to OROMBELLI and POZZI (1967) on the island of *Chalki*.

Towards the north-west, the westernmost ascertained occurrences of the Lycian complex are found on the islands Unia Nisia, Avgò and Karavi. Further west no sequences are found that are strictly comparable with the Lycian sedimentary sequences; most analogies, however, present some formations in the southwestern Argolis peninsula. Of these, the facies of the shallow-water to supratidal carbonates of the Upper Triassic–Lower Liassic “Pantokrator Limestone” (SÜSSKOCH 1967) is identical with the one of the Gereme Limestone. Both regions are further characterized by block-faulting and sinking during the Middle to Upper Liassic. Major differences, however, are found from the Middle Jurassic onwards: pelagic and turbiditic carbonate sedimentation in most of the Lycian complexes contrast with sedimentation of radiolarites and volcanic sandstones and the extrusion of basic volcanics in the Argolis (BANNERT and BENDER 1968; AUBOUIN et al. 1970). Associated olistoliths of Jurassic limestones and of serpentinites possibly indicate local compressional movements as early as the latest Jurassic or the Early Cretaceous; such Jurassic compressional movements, however, are not known from the Eastern Aegean Sea until now.

6. Conclusions

Our geological investigations, which were carried out independently from each other, demonstrate the striking similarities between the Mesozoic sequences of three fairly distant areas in the Lycian Taurus and of several islands in the southeastern Aegean Sea (Plate I). In southwestern Turkey these sequences are comprised in a number of thrust-sheets intercalated between an apparently autochthonous sequence in the south and the uppermost unit of the nappe pile, the Peridotite Nappe. Internally

the Lycian nappes are bordered by the Menderes "massif" and the "mesoautochthonous" Oligo-Miocene clastics of the Kale-Tavas Basin. In the Aegean islands the original position of the Lycian sediments cannot be deduced from present-day tectonic relationships but must be inferred from facies comparison with their Taurid or Hellenid equivalents.

The "autochthonous" carbonate platform sequence which appears in the tectonic windows near Göcek along the Turkish coast is nearly identical with the series of the southern Bey Dağları. In the islands of Chamili, Saforà and Di Adelphi, similar types of Mesozoic to Lower Tertiary carbonate rocks have been found and both regions can be interpreted as relatively proximal parts of a carbonatic continental margin. In the Hellenides, such sequences are found in the carbonate platform deposits of the Zante, Gavrovo and Parnasse Zones, and in fact a correlation of the sequences of Chamili, Saforà and Di Adelphi with the Gavrovo and/or the Parnasse Zone seems possible. There exist, however, significant differences between the latter sequences and the autochthonous sequences at Göcek and in the Bey Dağları, illustrating the obliquity of Mesozoic palaeogeography and Alpine tectonic boundaries: the sequences of Saforà and Di Adelphi are characterized by Eocene flysch sediments and are certainly involved in an Alpine nappe edifice similar to that observed for the Gavrovo Zone in Crete (EPTING et al. 1972a, 1972b).

Paleogeographic and sedimentary evolution characterize most of the sedimentary sequences of the Lycian Nappes as continental margin associations (BERNOULLI and JENKYNs 1974) and kinematic inversion clearly places them to the south of the oceanic ophiolite zone now represented by the Peridotite Nappe. Among the different Mesozoic sequences of the Lycian Nappes, the Köyceğiz sequence shows the largest regional extension. This sequence is characterized 1. by the sinking of a former carbonate platform during the Middle to Late Liassic, followed by the deposition of pelagic and turbiditic limestones up to the Cenomanian, and 2. by Turonian to Upper Cretaceous, possibly Lower Tertiary flysch and wildflysch and the sedimentary emplacement of the Diabase Nappe. The sequence of Köyceğiz correlates extremely well with the sequence at Bodrum and both sequences are evidently derived from the same palaeogeographic realm. In the southeastern Aegean Sea the reconstruction of the stratigraphic sequence is greatly hampered by the small and discontinuous outcrops, but the different associations observed fit surprisingly well into the Köyceğiz series. Comparison with available data in the literature demonstrates the extension of the same palaeogeographic unit on the Datça Peninsula, the islands of Symi, Tilos, Chalki and possibly on Kos and Rhodes. Within this broad palaeogeographic realm flysch sedimentation seems to start later during the Cretaceous towards the south (Datça, Tilos) and is possibly also ranging higher up into the Lower Tertiary towards the exterior of the zone.

In the context of continental Greece, part of the Lycian sediments could be compared with the sedimentary sequences bordering the Parnasse platform internally in the Argolis peninsula. The original relations between the Lycian Nappes and the Menderes "massif" (Pelagonian realm) are still ambiguous.

Although detailed correlation of palaeogeographic and tectonic units between the Hellenides and the Taurides are still not established, some of the major features appear to be very similar (BRUNN 1960). If the Vardar Zone finds its prolongation to

the northeast of Izmir, then the Menderes "massif" is very likely to be homologous to the Pelagonian basement nappe. Externally, both metamorphic complexes dip below the tectonically emplaced ophiolites and the contact is sealed in both cases by the thick sequences of the postorogenic conglomerates of the "Sillon Mésio-hellénique" and the Kale-Tavas Basin (BRUNN 1960). In both cases this implies the emplacement of composite nappes on the more external zones (BERNOULLI and LAUBSCHER 1972).

Despite this gross-correlation of megatectonic units, no uniform picture of the development of both segments of the orogen can be reconstructed: it appears that tectonic boundaries are discordant in space and time, and that younger tectonic zones cut discordantly through the foreland. Whereas in northern Greece a major tectonic phase with the emplacement of an ophiolite nappe during the Early Cretaceous seems to be well established, no direct proof of this phase has been discovered until now in the Lycian Taurus. On the other hand, the emplacement of the Diabase Nappe and the Peridotite Nappe on the Intermediate Complex during the latest Cretaceous to Early Tertiary seems to coincide with only a relatively minor phase in the Vardar Zone and along the internal margin of the Pelagonian Zone (MERCIER 1966). This phase can therefore only loosely be compared with the Paleogene orogeny in Greece with its emplacement of the composite Pelagonian Nappe. A possible equivalent of the latter, however, could be represented by the emplacement of the composite Lycian nappe edifice on the Eocene flysch unit of eastern Lycia (equivalent of Pindos flysch?). In fact, in both regions the Eocene emplacement of nappes is followed by differential vertical movements dissecting and deforming the nappe edifice and leading to the intramontaneous basins of the "Sillon Mésiohellénique", the Salonica and Kale-Tavas Basins. Finally, the important post-Burdigalian phase with the emplacement of the composite Lycian nappe edifice on the "autochthonous" foreland, is represented in Greece only by the decollement nappes in the most external zones of western Greece (Ionian Zone, Gavrovo Zone).

The overall similarities between the general disposition of the Hellenides and the southwestern Taurides may result from a similar succession of analogous tectonic phases, although the time of occurrence of these phases differ widely. It is still uncertain whether major discrepancies in the evolution of the two segments of the arc reflect selective preservation of different documents or whether the kinematic evolution is highly discordant with time and space.

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REFERENCES

- ABBATE, E., BORTOLOTTI, V., and PASSERINI, P. (1970): *Olistostromes and Olistoliths*, in: SESTINI, G. (editor): *Development of the Northern Apennines Geosyncline*. Sediment. Geol. 4, 521–557.
- ARGYRIADIS, I. (1967): *Sur le problème des relations structurales entre formations métamorphiques et non métamorphiques en Attique et Eubée*. C. r. Acad. Sci., Paris, D 264, 438–441.
- AUBOUIN, J. (1958): *Essai sur l'évolution paléogéographique et le développement tecto-orogénique d'un système géosynclinal: le secteur grec des Dinarides (Hellénides)*. Bull. Soc. géol. France (6) 3, 731–749.
- (1959): *Contribution à l'étude géologique de la Grèce septentrionale: les confins de l'Epire et de la Thessalie*. Ann. géol. Pays hell. 10, 1–403.
 - (1960): *Essai sur l'ensemble italo-dinarique et ses rapports avec l'arc alpin*. Bull. Soc. géol. France (7) 2, 487–526.
 - (1963): *Esquisse paléogéographique et structurale des chaînes alpines de la Méditerranée moyenne*. Geol. Rdsch. 53, 480–534.
 - (1965): *Geosynclines*. Developments in Geotectonics. Vol. 1 (Elsevier, Amsterdam).
 - (1973): *Paléotectonique, tectonique, tarditectonique et néotectonique en Méditerranée moyenne: à la recherche d'un guide pour la comparaison des données de la géophysique et de la géologie*. C. r. Acad. Sci., Paris 276, 457–460.
 - (1973): *Réflexion sur le problème tectonique des ophiolites: son aspect dans les Dinarides*. Int. Symp. "Ophiolites in the Earth's Crust", Moscow. 31 May to 12 June, Acad. Sci. USSR.
 - (1973): *Réflexion sur le problème tectonique des ophiolites: son aspect dans les Dinarides*. Réunion annuelle des Sciences de la Terre, Paris, 19–22 mars; Soc. géol. France.
- AUBOUIN, J., BONNEAU, M., CELET, P., CHARVET, J., CLÉMENT, B., DEGARDIN, J. M., DERCOURT, J., FERRIÈRE, J., FLEURY, J. J., GUERNET, C., MAILLOT, H., MANIA, J., MANSY, J. L., TERRY, J., THIÉBAULT, F., TSOFLIAS, P., and VERRIEZ, J. J. (1970): *Contribution à la géologie des Hellénides: le Gavrovo, le Pinde et la zone ophiolitique subpélagonienne*. Ann. Soc. géol. Nord 90/4, 277–306.
- AUBOUIN, J., BRUNN, J. H., CELET, P., DERCOURT, J., GODFRIAUX, I., and MERCIER, J. (1963): *Esquisse de la géologie de la Grèce*. Livre à la mémoire du prof. Paul Fallot. Mém. h.s. Soc. géol. France 2, 583–610.
- AUBOUIN, J., and DERCOURT, J. (1965): *Sur la géologie de l'Egée: regard sur la Crète (Grèce)*. Bull. Soc. géol. France (7) 7, 787–821.
- AUBOUIN, J., and DERCOURT, J. (1970): *Sur la géologie de l'Egée: regard sur le Dodécanèse méridional (Kasos, Karpathos, Rhodes)*. Bull. Soc. géol. France (7) 12, 455–472.
- AYRTON, S., VERNET, J. P., and WOODTLI, R. (1966): *Observations sur un gisement de latérite près de Gökceovacik köy (SW de la Turquie)*. M.T.A. Enst. Bull. 67, 105–109.
- BANNERT, D., and BENDER, H. (1968): *Zur Geologie der Argolis-Halbinsel (Peloponnes, Griechenland)*. Geol. Palaeont. 2, 151–162.
- BECKER-PLATEN, J. D. (1970): *Lithostratigraphische Untersuchungen in Känozoikum Süd-West Anadolien (Türkei)*. Beih. Geol. Jb. 97, 244 p.
- BERNOULLI, D. (1971): *Redeposited Pelagic Sediments in the Jurassic of the Central Mediterranean Area*. Ann. Inst. Geol. Publ. 54/2, 71–90.
- (1972): *North Atlantic and Mediterranean Mesozoic Facies: a Comparison*. Init. Rep. Deep Sea Drilling Proj. 11, 801–871.