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THE ULTRAPINDIC ZONE IN GREECE (*)

Nota del Socio PAOLO SCANDONE (**) e di RAJKA RADOIČIĆ (***)

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RIASSUNTO

Viene riesaminata la « zona Ultrapindica » in Grecia che, secondo la definizione originale, dovrebbe corrispondere all'originaria zona di interdigitazione tra ofioliti subpelagoniane e radiolariti pindiche. Le ricerche svolte fanno viceversa ritenere questa zona un elemento dell'originario fianco orientale del bacino del Pindos, adiacente alla piattaforma del Parnaso-Alto Carso e non collegato direttamente alla Tetide centrale. Viene pertanto proposta l'abolizione della « zona Ultrapindica » e la sua fusione con la zona del Pindos. Quest'ultima, inoltre, non rappresentava una « eugeosinclinale », cioè un'area oceanica, ma un bacino intracontinentale. Viene quindi rigettato per le Ellenidi-Dinaridi il modello della coppia « eu-miogeosinclinale ».

ABSTRACT

The « Ultrapindic zone » in Greece is re-examined. This zone, according to the original definition, should correspond to the area of interfingering between the subpelagonian ophiolites and the pindic radiolarites. The Authors, on the other hand, consider this zone as an element of the eastern flank of the Pindos basin, connecting the basin itself with the the Parnasse-High Karst platform. In their opinion the Pindos basin, not directly connected with the central Tethys, did not represent an « eugeosyncline », that is an oceanic area, but an intracontinental basin. The Authors, therefore, refuse the model of the « eu-miogeosyncline » couple which is classical for the Hellenides-Dinarides system.

1. INTRODUCTION

AUBOUIN's model of the geosynclines, partly renewing the former ideas of STILLE, represented a point of reference for many European geologists during the years 1960-65. The model was constructed in the Hellenides (AUBOUIN published his masterly dissertation on Northern Greece in 1959), and was successfully tested in the Dinarides and Apennines (AUBOUIN, 1960), so that in a short time it seemed to have a more general applicability in the Mediterranean Alpine-type mountain systems (AUBOUIN, 1963).

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(**) Istituto di Geologia dell'Università, Largo S. Marcellino 10, 80138 Napoli, Italy.
(***) Zavod za Geol. i Geof., Karadjordjeva 48, Beograd, Yugoslavia.

In 1965 AUBOUIN published *Geosynclines*. The function of this book was to divulgate the model out of Europe, but it was already old when it came out, as the new oceanographic information generated hard criticism against the abstract pictures of the « mio- » and the « eugeosynclines », which had no actualistic counterpart in the world. Above all the interpretation of the ophiolites as witness of ancient ocean floors, brought about a refusal of the picture of a huge submarine flow, and the existence of large overthrusts of oceanic crust fragments upon continental margins was admitted. In Greece, in particular, this interpretation was expressed by BORTOLOTTI, DAL PIAZ & PASSERINI, 1969; TEMPLE & ZIMMERMAN, 1969; 1971; ZIMMERMAN, 1971; BERNOULLI & LAUBSCHER, 1972.

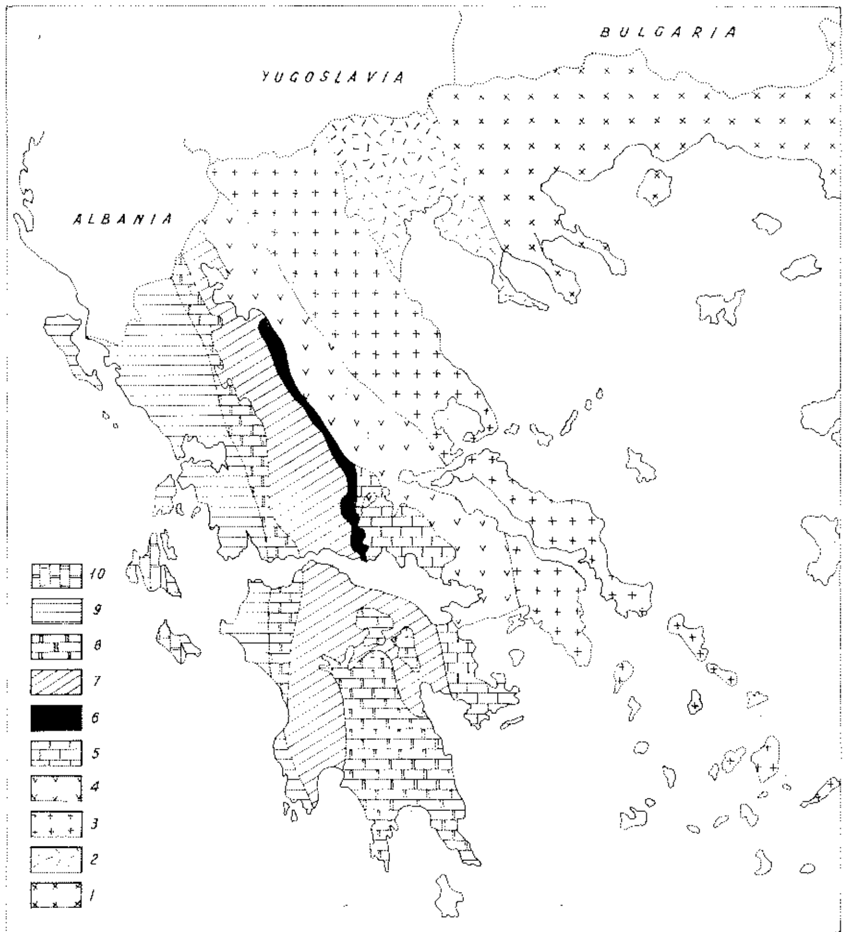

fig. 1 — The isopic zones in Greece, after AUBOUIN *et alii* 1961. 1) The Rodope Zone; 2) The Vardar Zone; 3) The Pelagonian Zone; 4) The sub-Pelagonian Zone; 5) The Parnasse Zone; 6) The Ultrapindic Zone; 7) The Pindos Zone; 8) The Gavrovo-Tripolitsa Zone; 9) The Ionian Zone; 10) The Pre-Apula Zone.

An attempt to conciliate both old and new ideas was made by DERCOURT, 1970, who interpreted the Pindos basin as a «eugeosyncline», that is, an oceanic zone between the Apulia and the Rhodope cratonic areas, and the Ionian and the Peonian basins respectively as a « miogeosyncline » on the Apulia continent and a « miogeosyncline » on the Rhodope continent. This scheme, anyway, instead of explaining the geological facts, is an exercise on bilateral symmetry.

At the present time a considerable confusion reigns in the Hellenic « isopic zones ». As an example we instance the recent paper of DEWEY *et alii* 1973, in which the Pindos zone is confused with the Vardar zone, and moreover the radiolarites of the Pindos zone are identified with the cherts of the *Diabas-Hornstein Formation* of the internal Dinarides.

It is the purpose of the Authors to contribute to a better understanding of the Dinaric-Hellenic isopic zones (fig. 1), starting from a crytical analysis of the data that induced the previous workers (especially RENZ, BRUNN, AUBOUIN, DERCOURT) to construct the classical paleogeographic model of the Hellenides. We start from the « Ultrapindic zone » because of the key position of this element which, according to AUBOUIN's scheme, played the role of connection between the Pindos « eugeosyncline » and the crystalline massifs of the internal Hellenides.

Some students (RYAN *et alii* 1971), attempt to explain in actualistic terms the model of the eu-miogeosyncline couple which should characterize a palinspastic cross section of the Hellenides, all the above assuming the Pindos basin an oceanic zone. Our results make us consider the Pindos basin as an external zone of the Hellenides, without direct connections with the central Tethys, so that we refuse the model of the couple. In this we agree with the ideas of BERNOULLI & LAUBSCHER, 1972.

2. THE ULTRAPINDIC ZONE ACCORDING TO AUBOUIN

In continental Greece two ophiolite axes have been distinguished (BRUNN, 1956): the Vardar and the Subpelagonian axes. The latter originated, according to AUBOUIN, from a huge Upper Jurassic submarine flow along the flexure connecting the Pelagonian massif and the Pindos basin (1). The Pindos basin should represent the « eugeosyncline » of the Hellenides system, bordered northeastward by the Pelagonian crystalline massif and southwestward by the Gavrovo ridge. The latter separated the Pindos « eugeosyncline » from the Ionian « miogeosyncline » (fig. 2).

(1) AUBOUIN also recognized scattered outcrops of basic rocks of Upper Triassic-Lower Jurassic age in Western Pindos, and interpreted them as submarine flows along the flexure connecting the Gavrovo ridge and the Pindos basin.

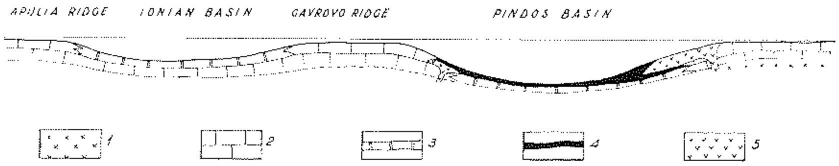

fig. 2 — A palinspstic cross-section through the Hellenides during Jurassic, according to AUBOUIN, 1959. 1) crystalline rocks of the Pelagonian Zone; 2) neritic limestones; 3) pelagic limestones; 4) radiolarites; 5) ophiolites.

According to this scheme the ophiolites become wedge shaped westward, interfingering with the radiolarites and the associated microbreccias.

During Cretaceous a tectonic phase strongly deformed and displaced the most internal, northeastern zones; Upper Cretaceous neritic limestones transgressed unconformably upon the subpelagonian ophiolites, while in the Pindos basin continuous pelagic sedimentation persisted.

The intermediate zone, in which the characters of the Pindos zone and that of the Subpelagonian zone converge, is called the *Ultrapindic zone* (2) (fig. 3).

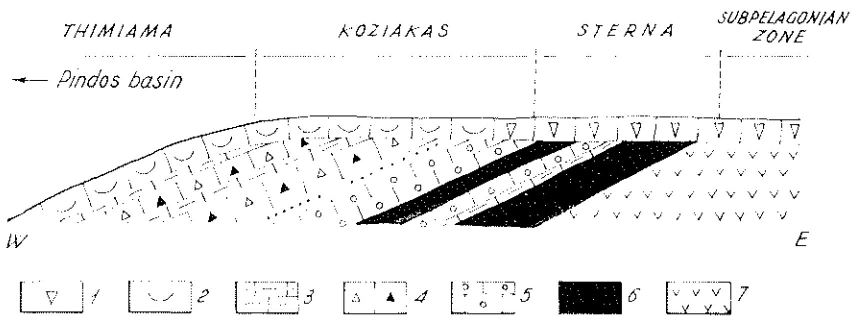

fig. 3 — After AUBOUIN, 1959. In the Koziakas and the Sterna dominions the characters of the Pindos Zone and the characters of the Sub-Pelagonian Zone converge. These dominions are called the Ultrapindic Zone. 1) Rudistid limestones; 2) limestones with fragments of Rudistids; 3) cherty limestones; 4) calcareous microbreccias; 5) oolitic calcarenites and calcareous breccias (Koziakas); 6) radiolarites; 7) ophiolites.

3. RE-EXAMINATION OF THE « ULTRAPINDIC ZONE »

The most representive sections of the « Ultrapindic zone » are exposed in the Koziakas Mountains, near the Trikkala Plain. Southwards the « Ultrapindic zone » has been recognized in Etolia by CELET, 1962, but the characters here are quite different and not so representative as in Koziakas.

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(2) AUBOUIN, 1959 sometimes uses the term « zone » and sometimes the term « sub-zone ». For simplicity we shall always use the term « zone ».

Our purposes were to re-examine all the key outcrops of the « zone » to verify:

1. the stratigraphy of the Koziakas section;

2. the interfingering between the subpelagonian ophiolites and the pindic radiolarites;

3. the unconformity of the Upper Cretaceous neritic limestones upon the Upper Jurassic-Lower Cretaceous radiolarites and microbreccias of the « Ultrapindic zone ».

3.1. Stratigraphy of the Koziakas section.

The Koziakas Mountains consist of a complex system of *Schuppen* thrust southwards. Because of the close folding and faulting it is very difficult to reconstruct the original stratigraphy. The best section is exposed along the Portaikos Valley, and it has been used by Aubouin for the reconstruction of the Koziakas sequence (fig. 4 and fig. 5).

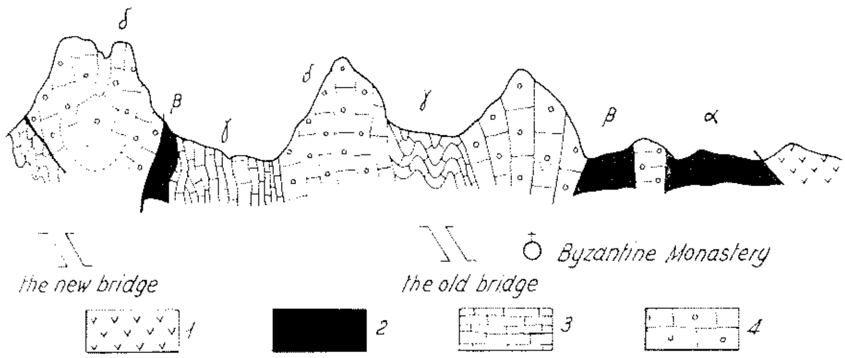

fig. 4 — After Aubouin, 1959. Cross-section through the Koziakas Mountains along the Portaikos River. 1) ophiolites; 2) radiolarites; 3) cherty limestones; 4) oolitic calcarenites and calcareous breccias; see fig. 5.

A careful re-examination of this profile induced us to a very different interpretation of the structure, and of course to a different reconstruction of the sequence (fig. 6 and fig. 7).

Our reconstructed sequence is the following:

1. lime mudstones with chert in bands and nodules (60-80 metres).

Fossils: *Halobia* sp., Radiolaria and sponge spicules.

Age: Upper Triassic;

2. gray and red cherty lime mudstones, with interbedded graded calcareous microbreccias and allodapic limestones (35-50 metres).

Fossils: Radiolaria and sponge spicules. In the microbreccias *Galeanella tollmanni*, *Vidalina martana*, *Involutina* sp., *Ammobaculites*, fragments of algae and echinodermata.

Age: Lower and Middle Liassic;

3. intraformational conglomerates (0-15 metres);

4. graded calcareous breccias and microbreccias, and alternating grey and red lime mudstones and allodapic limestones (20 metres).

Fossils: Radiolaria, sponge spicules and pelagic pelecypods. In the microbreccias arenaceous foraminifers, fragments of algae and echinodermata.

Age: Upper Liassic;

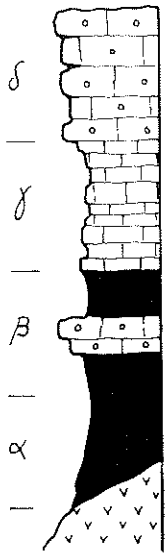

fig. 5 — After AUBOUIN, 1959. Reconstructed sequence of the Koziakas Mountains. Max. thickness 500 metres. Radiolarites, stratigraphically overlying ophiolites; radiolarites and intercalated calcareous microbreccias; radiolarian cherts, pelagic limestones and calcareous microbreccias; oolitic calcarenites and calcareous breccias.

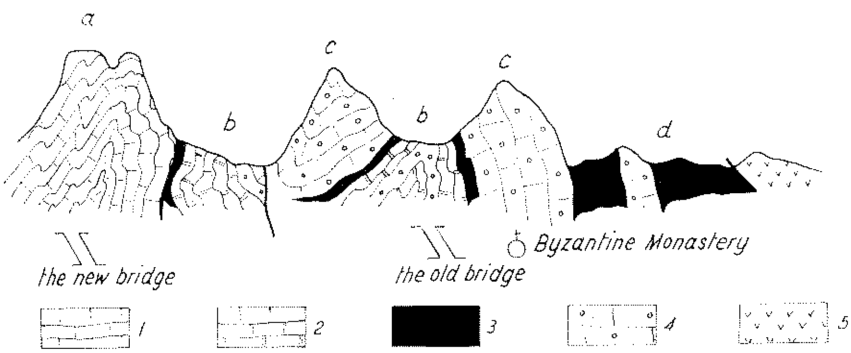

fig. 6 — Cross section through the Koziakas Mountains along the Portaikos River. 1) *Halobia* limestones; 2) cherty lime mudstones, fine graine graded calcarenites intraformational conglomerates, cherts; 3) radiolarites; 4) calcareous breccias and microbreccias; 5) ophiolites: *a*) Triassic, *b*) Liassic, *c*) and *d*) Dogger and Malm.

5. reddish and greenish cherts (about 30 metres, not well exposed).

Fossils: Radiolaria.

Age: probably Dogger;

6. calcareous graded breccias (35 metres).

Fossils: *Protopeneroplis striata*, *Trocholina* spp., Textularidae, Lituolidae, *Taumatoporella parvovesiculifera*, fragments of algae.

Age: Dogger-Malm;

7. alternating Radiolarian cherts, siliceous claystones and graded calcareous microbreccias (about 200 metres).

Fossils in the microbreccias: *Protopeneroplis striata*, *Trocholina* sp., *Kurnubia* sp., Textularidae, fragments of algae.

Age: Malm.

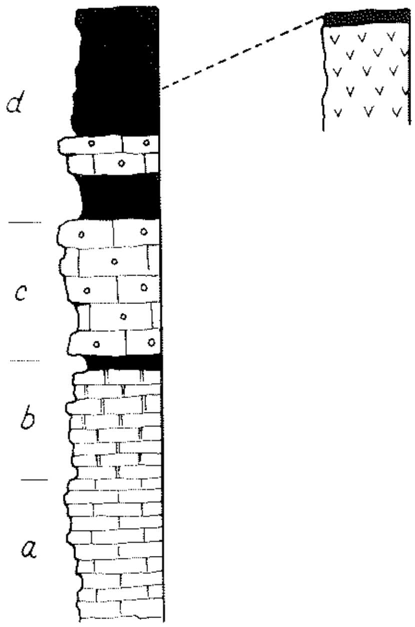

fig. 7 — Reconstructed sequence of the Koziakas Mountains from the cross-section of the Portaikos River. Thickness about 400 metres. Simbols see fig. 6. *a*) Triassic cherty limestones; *b*) Liassic cherty limestones, fine grained graded calcarenites, intraformational conglomerates and cherts; *c*), *d*) Dogger-Malm calcareous breccias and microbreccias and radiolarites.

3.2. Interfingering radiolarites-ophiolites.

In the Koziakas region Aubouin describes some outcrops of « ophiolites » interbedded with Upper Jurassic radiolarites and associated limestones and calcareous microbreccias. An examination of the outcrops shows that these basic rocks, petrographically different from the true ophiolites, are interbedded with limestones of Liassic and not Upper Jurassic age. This Liassic volcanism is quite common, although witnessed by scattered outcrops, in the whole Pindos zone. We have also found similar situations in the « Ultrapindic zone » at Vardoussia, where lava flows are interbedded within Liassic limestones.

3.3. Unconformity of the Upper Cretaceous neritic limestones.

In the Koziakas region Aubouin distinguishes two different kinds of Upper Cretaceous calcareous sediments:

1. Thimiama limestones;
2. Sterna limestones.

The Thimiama limestones, consisting of *Globotruncana* lime mudstones and interbedded graded breccias, form a system of *Schuppen* at the front of Koziakas, and are interpreted by AUBOIN as the original uppermost part of the Koziakas sequence, which was detached and which slid away from its base during the Upper Cretaceous tectonic phase.

The Sterna limestones, consisting of white, more or less crystalline, massive limestones, are interpreted as the prosecution toward the Pindos basin of the subpelagonian Rudistid limestones, which should overlie the ophiolites and the most eastern sediments of the « Ultrapindic zone » unconformably.

A careful examination of the Koromilia region induced us to recognize that the Sterna limestones are in reality fluxoturbidite breccias filling deep erosional channels in the « ultrapindic » radiolarites and associated graded microbreccias, and that they are always in tectonic contact with the ophiolites. Therefore the Sterna limestones are not neritic deposits stratigraphically overlying both ophiolites and radiolarites, but are deep sea turbidite sediments belonging to the flank of the Pindos basin.

The age of the Sterna limestones is unknown. Probably they belong to the uppermost Jurassic-lowermost Cretaceous, because of the stratigraphic position on top of the Upper Jurassic radiolarites. Erosional gaps between radiolarites and Sterna limestones are possible, anyway, so that the latter may be also younger.

At present the Thimiama limestones are an open problem. Three possibilities of interpretation remain:

1. the Thimiama limestones were the original prosecution of the Koziakas sequence;

2. the Thimiama limestones were originally a more distal, external element, in respect to the Koziakas;

3. the Thimiama limestones were originally an internal, eastern element, in respect to the Koziakas.

Looking at the geometry of the *Schuppen*, the third hypothesis seems to be the most probable.

4. REINTERPRETATION OF THE AVAILABLE DATA

We have seen that the existence of a « Ultrapindic zone » was based upon:

1. the interfingering radiolarites-ophiolites;

2. the unconformity of Upper Cretaceous neritic limestones on ophiolites and radiolarites;

that is upon a convergence of the characters of the Subpelagonian zone and of the Pindos zone.

The new available data demonstrate the inconsistence of these assumptions, so that the reasons for the existence of an « Ultrapindic zone » according to the original definition fail. We have seen, on the other hand, that the Koziakas sequence is not limited to the Upper Jurassic and to the Lower Cretaceous, but ranges from the Upper Triassic to the uppermost Jurassic-lowermost Cretaceous, or also up to the uppermost Cretaceous, if the Thimiama limestones belong to the Koziakas sequence. From the Lower-Middle Liassic a shallow water carbonatic area supplied the Koziakas zone, with fragments of neritic limestones and bioclasts from the east. Southwards the « Ultrapindic zone » is well known as far as the Vardoussia region. Here the supply area is exposed in the Parnasse Mountains (Parnasse zone). Northwards the « Ultrapindic zone » does not outcrop in Greece, being buried by the ophiolite nappes; probably it outcrops in Albania, but the scarce information does not allow a certain individuation. The « Ultrapindic zone », with characters identical to those in Vardoussia, outcrops in Southern Yugoslavia near Kotor, where it is known as the Vrmc zone. Also here the supply area, the High Karst zone, outcrops and corresponds perfectly to the Parnasse zone. Therefore it seems that the High Karst-Parnasse carbonatic platform was a first order element in the paleogeography of the Dinarides-Hellenides (BERNOULLI & LAUBSCHER, 1972), bordering the Pindos basin along its internal side.

In conclusion we consider the Vrmc, Koziakas and Vardoussia zones (the « Ultrapindic zone ») as the eastern flank of the Pindos basin, connecting the basin itself with the High Karst-Parnasse platform. Consequently we suggest the abolition of the « Ultrapindic zone ».

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