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THE GEODYNAMIC DEVELOPMENT OF THE OLONOS-PINDOS ZONE IN SOUTHWESTERN MESSENIA (GREECE)

P. Neumann*, N. Fytrolakis and W. Zacher***

ABSTRACT

The most southwestern part of the Olonos-Pindos zone, which builds up large parts of the Messenian peninsula, was studied in detail.

In the area east of Finikounda the Pindos Series, 500 to 600m in thickness, has a stratigraphic range from the Triassic to the Middle Eocene. From the bottom to the top the following formations can be distinguished: the Halobia Beds, newly found in two places, comprise the higher parts of the Triassic and reach in their uppermost parts even into the Liassic. They are overlaid by the Drimos Formation, a succession of pelagic limestones and cherts with intercalations of massive lime breccias and calcaren - ites. The neritic carbonate detritus, varying in age from the Triassic to the Upper Jurassic, is derived from the Tripolis platform in the west. The following succession of nodular cherts and radiolarites is of upper Jurassic to Cenomanian age.

The basic cherts can completely be replaced by allodapic limestones of the Drimos Formation. Intercalations of calcarenites within the radiolarites bear orbitolines. The Platy Limestone Formation, consisting mainly of pelagic, micritic and only few detritic limestones, has a stratigraphic range from the Turonian to the Maastrichtian. During the higher Maastrichtian they gradually pass into the heterogeneous formations of the Pindos Tertiary.

The stratigraphy is based on many new findings of fossils within the study area. The Olonos-Pindos nappe is supposed to have been emplaced onto an erosional relief of the Tripolis Unit by gravitational sliding.

During this process the internal structure of the Pindos nappe with upright to inclined and often overturned folds and imbricate thrusts, which generally face westwards, was generated. The western rim of the nappe is formed by a large recumbent anticline, which accounts for the inverse layering in large areas. The Pindos nappe is thrust over the newly found Breccia of Kaplani, the youngest (possibly Miocene) member of the underlying Tripolis Unit. This fossil-free breccia, exclusively consisting of Pindos derived material, is interpreted to represent a kind of debris flow that originated at the leading edge of the westward moving Pindos thrust sheet and was later on overridden. After the emplacement the nappe pile was folded and suffered intensive fracturing from Neogene to recent times.

INTRODUCTION

The Messenian Peninsula is built up by two nappe units. The lower one,

* Dept.of Geology, Technical University Munich,D-85747 Garching
** Dept of Geology, National Technical University Athens, 15780 Zografou

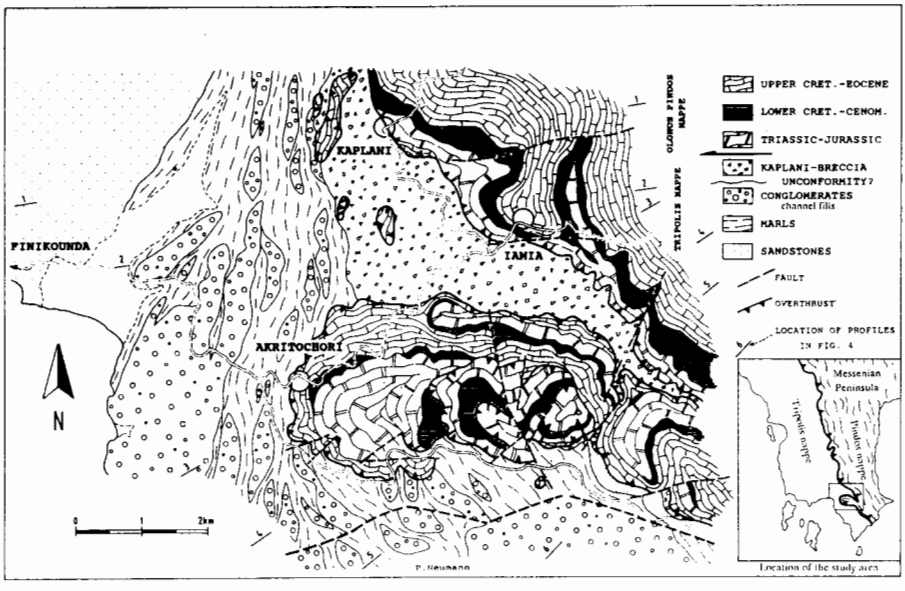

Fig. 1: Simplified geological map of the sturdy area east of Finikounda (southwestern Messenia)

the Tripolis nappe, which crops out in the west, is overthrust by the Olonos-Pindos nappe in the east. A detailed geological mapping (scale 1:10000) carried out at the western rim of the Pindos range was aimed to give new results in stratigraphy and tectonics of the Pindos series, as well as the tectonic development of the nappe pile.

I. STRATIGRAPHY OF THE PINDOS SERIEs

During the fieldworks several sections within the Pindos Series were recorded and compiled to one representative profile (fig.2).- The new stratigraphic classification mainly based on new findings of microfossils led to a subdivision into seven formations. In its most southwestern outcrops considerable differences in thickness and facies of the Pindos Series compared to other sections in Messenia (see THIEBAULT, 1982) or the northern Peloponnesus (see FLEURY, 1980) can be recognized. The whole Pindos Series (Triassic to Middle Eocene) reaches only a thickness of 500 to 600 m at a maximum. Younger formations than Middle Eocene are absent.

1.Stratigraphic column

Halobia Bed Formation

This formation, which represents the base of the series, was only known further in the north. In two places, west of Iamia, Halobias were found. A cf. Vidalina martana in outcrops with lithological equivalent strata makes it likely that the formation even reaches into the Liassic.

Drimos Formation

At the base pelagic, micritic limestones with shell-banks and cherts can be found. Allodapic limestones are present throughout the whole formation,

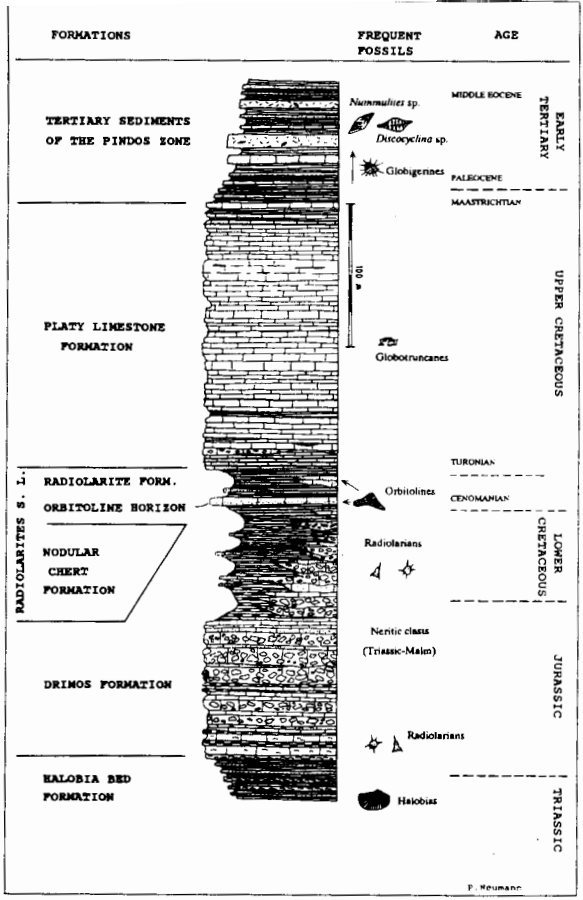

Fig. 2: Stratigraphical column of the Pindos series in southwestern Messenia, east of Finikounda.

but are increasingly dominant in the higher parts. Fine- to coarsegrained calcarenites and massive lime breccias can be observed. Both consist of mainly neritic carbonate detritus with fragments of fossils,which vary in age from the Triassic (e.g. Involutina sinuosa) to the Middle and Upper Jurassic (e.g. Cayeuxia sp.) and perhaps the Lower Cretaceous. The source area is probably the Tripolis platform, which was adjacent to the west throughout Mesozoic times.

Nodular Chert Formation

A series of light coloured, thin bedded cherts developing on top of the Drimos Formation indicates the shift to siliceous sedimentation in lower cretaceous to cenomanian times. The cherts interfinger with calcarenites and -rudites of the Drimos Formation and can even be completely replaced by them.

Radiolarite Formation

A series of typical red radiolarites marks the upper parts of the Lower Cretaceous and the Cenomanian. Allodapic limestones, mostly very fine- to coarsegrained calcarenites, are still present, coarse breccias are absent. They appear as thin layers interlaminated with green clays or even as

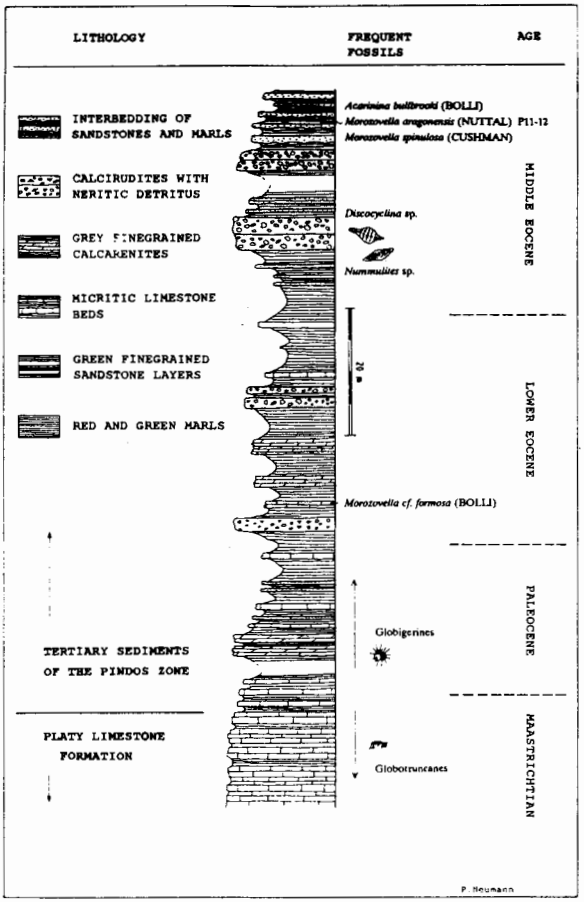

Fig. 3: Detailed lithological column of the Pindos Tertiary in southwestern Messenia; section along the road from Kaplani to Falanthi.

thick beds. One bed is graded and up to 1,5 m thick and rich in silicified neritic fossil detritus. Orbitolines, fragments of rudistes and inocerams are very common. This turbiditic bed refers to the "Orbitoline horizon" described by RENZ (1955).

Platy Limestone Formation

Whithin the Turonian siliceous sedimentation ceases and the deposition of the cream to rose coloured platy limestones starts. This upper cretaceous succession contrasts with the Drimos formation in so far that pelagic, micritic limestones predominate. Calciturbitides and breccias, though present, are becoming unimportant.

Tertiary sediments of the Pindos Series

A complete section of this heterogeneous series does not exist within the area shown in the map in fig.1, but few kilometers north (fig.3).

In Maastrichtian times the succession gradually evolves from the platy limestones by an increase of rather thick marly layers. Green and red marls are interbedded with micritic and arenitic limestones and mostly thin-bed-ded, finegrained, green to brownish sandstones.

In the middle and upper parts massive calcirudites are intercalated. These breccias consist of neritic carbonate detritus and redeposited fossils like Nummulites sp. and Discocyclina sp.. The section ends in the Middle Eocene with an interbedding of marls and sandstones showing solemarks.

2.Results and interpretation

In the study area the Pindos series starts within the Triassic and extends at least to the Middle Eocene. Twice during the sedimentary record, at the bottom and at the top, terrigeneous influence, i.e. sandstones interbedded with marls, can be recognized. The so-called "Premier Flysch du Pinde" (AUBOUIN,1957), which is also described to consist of sandstones, is missing in southernmost Messenia except for calcarenites, e.g. the "Orbitoline horizon". Allodapic limestones are present throughout the whole formation, especially within the Jurassic and Lower Cretaceous. Thus accumulation close to the edge of the Tripolis carbonate platform with transport from west to east must be assumed (see also RICHTER et al.,1993 a).

Volcanites, as described in other areas, i. e. near Militsa, north of the study area (see RICHTER et al.,1989) are absent, with the exception of

detritus within the allodapic limestones, which is likely to be of volcaniclastic origin.

The heterogeneous succession of tertiary sediments, which can rarely be found in complete sections, is a compilation of what FYTROLAKIS (1971) called "Transition beds" and "Second Pindos Flysch". It can be discussed whether a real Pindos flysch is replaced by those sediments, or is missing for tectonical or erosional reasons. Taking the latter possibility into account, a Pindos flysch in the sense of SEILACHER (1967) does not start earlier than in the Middle Eocene in the study area. The "basic sandstone succession" (after RICHTER et al.,1993b), that marks the start of the flysch facies within the Pindos Series except for the Eastern and Western Peloponnesus, is missing.

II.STRUCTURAL DEVELOPMENT OF THE PINDOS AND TRIPOLIS NAPPE

Concerning its lateral extension and width of transport of up to 100 km on the Peloponnesus the Pindos nappe is a rather thin thrust sheet. Thus gravitational sliding has caused nappe transport and forming of the internal structures.

1.Structural pattern of the working area

The Pindos nappe crops out in two separate ranges east of Akritochori. Both ranges represent the limbs of an anticline that was generated by thrustfolding with NW-SE trending axes. Cross folding of the nappe pile can also be recognized. The Pindos nappe is thrust over the tertiary sediments of the Tripolis nappe, which is covered by its youngest member, the Breccia of Kaplani, over large areas.

2.Gravity induced internal structure of the Pindos nappe

The heterogeneous strata sequence of the Pindos nappe was intensively deformed by folds and thrusts. The dominant features are upright to inclined or often overturned folds of all scales and imbricate thrusts. Due to transport at a superficial level folding axes scatter considerably, but show a maximum trending NNW-SSE to NW-SE. Most of the folds and thrusts are facing southwestward, which is the direction of transport, though backthrusting and -folding, as well as distinct crossfolding are present.

The NE' range exposes an upright Pindos sequence with W-facing folds, which contrasts with the SE'limb of the thrust anticline, where inverse layering can be recognized. Large recumbent anticlines frame the southwestern trace of the Pindos nappe, inverse limbs crop out over large areas.

Folding interacted with internal thrusting with the effect that the folds are often dissected by thrusts. Fig.5 shows a simplified profile section of the actual profiles in fig.4.

3.Internal structure of the Tripolis nappe

The Palaeogene sediments of the Tripolis Series, mainly sandstones, marls and conglomerates, were folded during the emplacement of the Pindos nappe and during the later thrustfolding. In addition the moving nappe caused tectonical wedges to shear off and to be dragged along the thrust plane.

4.The breccia of Kaplani

At the base of the Pindos nappe, marking the thrust plane, the youngest member of the Tripolis nappe, the Breccia of Kaplani, is found. This massive, hard, fossil-free and polymict breccia is widespread, yet not omni-

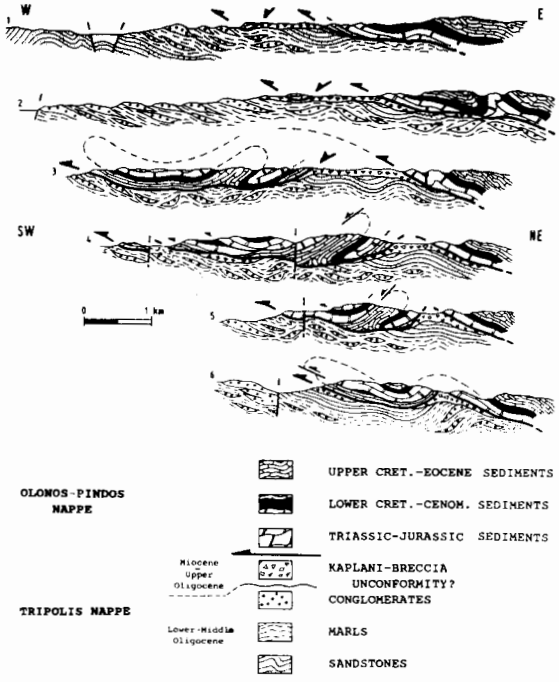

Fig. 4: profiles; (location see fig. 1)

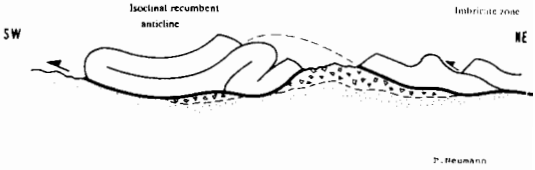

Fig. 5: Simplified structural sketch.

present, and reaches thicknesses of up to 100m or more. It exclusively consists of Pindos derived detritus, such as cherts of divergent colours, radiolarites, micritic limestones containing globotruncanes and fossiliferous calcarenites and -rudites. Though the clast association varies, the spectrum is often dominated by upper cretaceous and tertiary sediments of the Pindos series.

With grain sizes varying from sand to boulder-sized blocks (up to several meters), the breccia shows poor sorting. Stratification cannot even be recognized. Grain support, dense packing of the exclusively angular clasts, pressure solution and sparitic cementation are characteristic of the fabric.

It can be discussed whether some of the Pindos klippes might be components of the Breccia of Kaplani.

5. Interpretation and discussion

The emplacement to the southwest by gravitational forces caused the internally contorted, sometimes chaotic structure of the Pindos nappe. Heavily folded thrust slices developed, the most western one representing a recumbent anticline. Subsequently thrust folding and intensive fracturing took place until recent times.

Folding, uplift and erosion of the Tripolis Series prior to thrusting can be asssumed (see profiles in fig.4), referring to RICHTER(1974) and TEMPLE(1968), who suggests "...that the allochthon is resting on an eroded surface."(p.694).

The breccia of Kaplani is interpreted as a kind of debris flow deposit that originated at the leading edge of the moving thrust sheet and which

was overridden later on. Assuming an erosional relief made up by gentle swells and troughs, which trapped the detritus, the varying thickness of the breccia can be explained. In the Vassilikou-Ithomi area of northern Messenia KATSIKATSOS (1980) describes the "Siltitic-sandy horizon with olistholiths", which is interpreted quite similarly. Since the Tripolis sediments within the study area comprise the Lower and Middle Oligocene, the breccia is possibly of upper oligocene or even miocene age and synchronous to overthrusting.

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