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IS THE PAÏKON MASSIF A TECTONIC WINDOW IN THE AXIOS-VARDAR ZONE? (INTERNAL HELLENIDES, MACEDONIA, GREECE)

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ABSTRACT

It has been recently proposed that the Païkon Massif would be a tectonic window beneath a large ophiolitic nappe. This nappe would have been thrust westward from the Guevgueli ophiolitic massif onto the Pelagonian Massif over the Late Cretaceous limestones of the Païkon. This does not appear possible because stratigraphical data show that the ophiolites located west of the Païkon were already emplaced on the Pelagonian Massif at least 30 My before they could have been thrust over the Late Cretaceous limestones of the Païkon. It has been also proposed that the Malarupa-Tzena Massif is not the northern continuation of the Païkon zone but would be a tectonic klippe of Serbo-Macedonian origin thrust over the Guevgueli ophiolites. This appears impossible, because mapping of the Guevgueli ophiolites shows that these ophiolites are not overlain by the Malarupa gneisses but that they do overlie the Malarupa-Tzena Massif.

INTRODUCTION

In the internal Hellenides, the Axios-Vardar zone (KOSSMAT, 1924) is situated between the Pelagonian Massif to the west and the Serbo-Macedonian Massif to the east. In Macedonia, the Païkon Massif (altitude ≈ 1600m) ari-ses in the middle of the Axios-Vardar zone dividing this latter into three main branches (OSSWALD, 1938) which have been named (MERCIER, 1966), from west to east: The Almopias zone, the Païkon zone and the Peonias zone (Fig. 1). Ophiolitic rocks outcrop in the Almopias and Peonias zones. To the west the ophiolites are thrust westward onto the Pelagonian zone. To the east, the ophiolites of the Guevgueli Massif (Fig. 1 and 2A) with an underlying unit of the Peonias zone are thrust westward onto the Païkon Massif (OSSWALD, 1931; MERCIER, 1966). The Païkon Massif and its northern continuati-on, the Malarupa-Tzena Massif have been considered by the ancient authors (KOSSMAT, 1924; OSSWALD, 1931, 1938) as a large bulge in the heart of which the cristalline basement outcrops.

J. MERCIER (1966) has agreed with such a general sketch considering that during the Jurassic, the Païkon zone was a volcanic shelf separating two o-phiolitic basins.

Based on the discovery of Rudistids in two outcrops of marble underlying the Guevgueli ophiolites to the west, GODFRIAUX and RICOU (1991) have drastically reinterpreted the structure of the Païkon Massif proposed by MERCIER (1966) and VERGELY (1984), (Fig. 2A). This has been considered as a double tectonic window:

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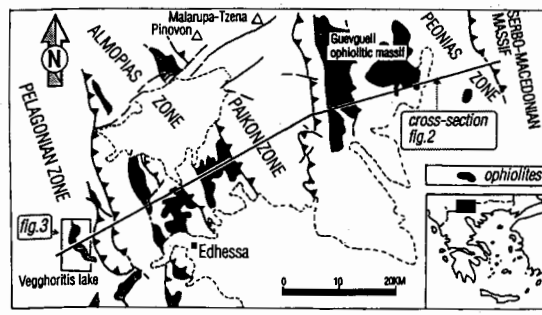

Fig. 1: Structural sketch of the Axios-Vardar zone showing the location of the ophiolitic outcrops in the Peonias, Almopias and E. Pelagonian zones (drawn from the 1/500.000 Geological map of Greece, 1983).

- the lower window is overlain (1, Fig. 2B)with a nappe essentially formed by the Late Cretaceous limestones of the Païkon Massif and an underlying volcanic formation (MERCIER's 1966 spilite-keratophyre and Kastaneri formations, see BEBIEN et al., in the same issue);
- this nappe is itself an upper tectonic window overlain with an ophiolitic nappe (2, Fig. 2B) which groups the ophiolites of the Peonias, Almopias and Eastern Pelagonian zones.

This ophiolitic nappe is supposed to have overthrust the Païkon Massif subsequent to the deposition of its Late Cretaceous limestone cover and to have its roots in the Guevgueli ophiolitic massif.

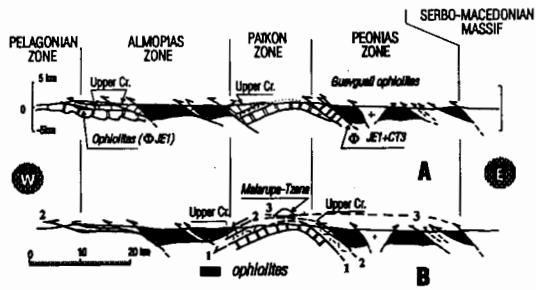

Fig. 2: Schematic cross-section of the Axios-Vardar zone A: drawn from Vergely (1984) modified; B: Godfriaux and Ricou's (1991) interpretation: the lower window is overlain (1) by a nappe essentially formed by the Late Cretaceous limestones of the Païkon Massif plus an underlying volcanic formation; the ophiolites are thrust westward (2) from the Guevgueli ophiolitic massif onto the Almopias and E. Pelagonian zones over the Late Cretaceous of the Païkon Massif; the Malarupa-Tzena massif is a tectonic klippe of Serbo-Macedonian origin overthrusting (3) the ophiolitic nappe.

Moreover, the Malarupa-Tzena Massif is no longer considered as the northern continuation of the Païkon zone but as an uppermost metamorphic nappe which overthrusts the ophiolitic nappe (3, Fig. 2B). In such a structural sketch the Païkon Massif is considered to belong to the Pelagonian domain and the Malarupa-Tzena Massif to the Serbo-Macedonian domain; thus, this ophiolitic nappe is interpreted as the suture of a single ophiolitic (oceanic) basin resulting from the superimposition of a Serbo-Macedonian continental margin onto a Pelagonian continental margin.

THRUSTING OF A LARGE OPHIOLITIC NAPPE OVER THE LATE CRETACEOUS LIMESTONES OF THE PAÏKON MASSIF?

May have been the western Almopian and Eastern Pelagonian ophiolites with their Late Cretaceous sedimentary cover thrust from the Peonias zone (Guevgueli ophiolitic massif) over the Païkon zone after the Late Cretaceous A simple examination of the stratigraphical legends of 1:50.000° geological maps of Edhessa sheet (MERCIER and VERGELY, 1984) and Arnissa sheet (MERCIER, VERGELY and GALEOS, 1988) allows to answer this question.

- The Late Cretaceous uppermost limestones of the Païkon Massif countain a Foraminifera fauna of Late Maestrichtian age (≈ 70 My): *Globotruncana contusa*, G. gr. *contusa-caliciformis*, G. gr. linnei-pparenti, *G. linnei*, *G. arca* (MERCIER 1968, p. 237; MERCIER and VERGELY, 1984). Thus, thrusting of an ophiolitic nappe over the Païkon Massif should have to occur sub-sequent to ≈ 70 My (Fig. 2B).

- West of the Païkon Massif, the ophiolites overthrust a Pelagonian substratum made of marbles, quartzites, tuffs and pyroclastic breccia of Triasic-? Jurassic age. East of the Vegghoritis lake (Fig. 3), Late Cretaceous limestones transgressively overlap both the ophiolites and their substratum, sealing the thrust.

The base of the Late Cretaceous formation is made of a calcareous sedimentary breccia countaining Rudistids *(Vaccinites atheniensis)* of Late Santonian - Early Campanian age (≈ 83 ± 3My), (MERCIER, 1968, p. 313-317) and of limestones interbedded within conglomerates and reworked tuffs containing *Actaeonella* sp. and *Cyclolites* sp.. To the south, the base of this transgressive Cretaceous formation becomes older; it is formed with conglomerates and sandy limestones which countain a microfauna of Vraconien (Upper Albian) age (≈ 100My): *Rotalipora appenninnica*, *Nezzazata simplex* (MERCIER and VERGELY, 1988). Thus, thrusting of the ophiolitic nappe upon the eastern Pelagonian zone is previous to ≈ 100My and probably previous to the Late Aptian - Early Albian (≈ 110-115My).

Therefore we must conclude that the ophiolites of the eastern Pelagonian zone and those of the western units of the Almopias zone were already located west of the Païkon Massif 30My, or more, before they could have been thrust from the Peonias zone over the Late Cretaceous limestones of the Païkon Massif. Thus these ophiolites cannot have been thrust from the regions

Fig. 3: Geological sketch drawn from the 1/50.000 Geological map (Arnissa sheet) showing the Late Cretaceous formations transgressively overlaping both the E. Pelagonian ophiolites and their substratum (1: Trias-? Jurassic marbles; 2: ophiolites (serpentinites); 3: tuffs and pyroclastic breccias; 4: Late Cretaceous transgressive formations; 5: Quaternary; 6: base of the transgressive Cretaceous formation; 7: faults; 8: thrusts.

located east of the Païkon Massif subsequent to the Late Cretaceous and consequently the Païkon Massif cannot be a tectonic window beneath a large ophiolitic nappe as proposed by RICOU and GODFRIAUX (1991). Thrusting of such an ophiolitic nappe from the east of the Païkon Massif, if existed, might have necessarily taken place before the deposition of the Mid-Late Cretaceous limestones of the Païkon Massif. We have not retain this latter solution (MERCIER, 1966) because there are no remnants of such an at least 4km thick ophiolitic nappe under the Uppper Jurassic-Early Cretaceous and Mid-Late Cretaceous limestones of the Païkon Massif.

IS THE MALARUPA-TZENA MASSIF AN UPPERMOST METAMORPHIC NAPPE OF SERBO-MACEDONIAN ORIGIN?

RICOU and GODFRIAUX (1991) have not observed the super imposition of the metamorphic rocks upon the ophiolites because the contact between the Malarupa-Tzena Massif and the Guevgueli ophiolites is situated north of the border. Therefore their arguments are deduced from the interpretation of the 1:500.000° Geological map of the S.F.R. Yougoslavia (1970) and from KOSSMAT's (1924) observations; these would indicate that the Guevgueli ophiolites lie below the gneisses of the Malarupa Massif. KOSSMAT's descriptions of the Malarupa-Tzena series have been misinterpretated. KOSSMAT (1924, p. 111 and following) described the following formations from bottom to top : granitic gneisses, micaschists, the Tzena-Malarupa marbles, the Porta formation (MERCIER's 1966 Kalivia Socrati micaschists, Tzena cipolins and marbles, Porta formation respectively) and the Bratocilo limestones the age of which is attributed to the Trias. KOSSMAT precised that «northward, the whole series dips under the gigantic area of diabases» [= Guevgueli ophiolites], (in German «Gegen Norden taucht die ganze Schicht-folge unter das riesige Diabasgebiet», p. 113). He emphasized that the «huge vault of the underground massif [= Tzena-Malarupa Massif], the eastern part of which is downthrow, is burried under the eruptive masses [= Guevgueli ophiolites], (in German: «mächtigen Grundgebirgsgewölbes dessen Ostseite abgesunken und unter den Eruptivmassen gebraten ist», p. 111).

This is also clearly drawn on the KOSSMAT's (1924) map, the OSSWALD's (1931) 1:300.000° geological map of Greek Macedonia and on the POLIC et al's (1952) 1:50.000° geological map of Demir Kapija. These maps show that the northern periclinal termination of the Malarupa-Tzena-Porta bulge dips northward under the Guevgueli ophiolites. Clearly the Malarupa-Tzena Massif cannot be considered as a klippe which overthrusts the Guevgueli ophiolites because these latter overlay this massif. A geological section made by one of us (MERCIER, 1966, p. 148, Fig. 48) from the bottom to the summit of the Malarupa-Tzena Massif is in agreement with such a conclusion.

CONCLUSIONS

Indeed the discovery of outcrops of Cretaceous limestones (GODFRIAUX and RICOU, 1991; MOULAS, 1992) on the eastern flank of the Païkon Massif is of high interest. It needs a reinterpretation of the tectonic emplacement of the Guevgueli ophiolites and of the underlying formations on the eastern flank of the Païkon Massif (MERCIER, 1966). Possibly, this indicates important reactivations subsequent to the Late Cretaceous of older thrusts as suggested by P. VERGELY (1984) (see Fig. 2A, CT3 reactivation i.e. of

Late Eocene-Early Oligocene age), reactivations which have been neglicted by J. MERCIER (1966). Yet, the being of a large ophiolitic nappe with its Late Cretaceous sedimentary cover which would have been thrust westward from the Guevgueli ophiolitic massif onto the Pelagonian Massif over the Païkon (RICOU and GODFRIAUX, 1991) does not appear possible. This is merely because the ophiolites located west of the Païkon were already emplaced on the eastern Pelagonian zone 30My, or more, before they could have been thrust over the Late Cretaceous limestones of the Païkon Massif. Moreover it appears impossible, that the Malarupa-Tzena Massif with its Late Cretaceous limestone cover (Pinovon fm.) is a metamorphic tectonic klippe of Serbo-Macedonian origin overlying an ophiolitic nappe. This is because mapping of the Guevgueli ophiolitic massif shows that these ophiolites are not overlain with the Malarupa gneisses but that they do overlie the Malarupa-Tzena-Porta Massif.

In summary, stratigraphical and mapping data do not support the being of the Païkon upper tectonic window overthrust by a large ophiolitic nappe nor that of a Malarupa-Tzena metamorphic tectonic klippe of Serbo-Macedonian origin overthrusting such an ophiolitic nappe. We discuss the being of the Païkon lower tectonic window elsewhere (see BEBIEN et al. in the same issue).

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