Δελτίο Ελληνικής Γεωλογικής Εταιρίας τομ. XXX/1, 63-67, 1994
Πρακτικά 7ου Επιστημονικού Συνεδρίου, Θεσσαλονίκη, Μάιος 1994

Bulletin of the Geological Society of Greece vol. XXX/1, 63-67, 1994
Proceedings of the 7th Congress, Thessaloniki, May 1994

GEODYNAMIC SIGNIFICANCE OF THE PAIKON MASSIF IN THE HELLENIDES: CONTRIBUTION OF THE VOLCANIC ROCKS STUDIES

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ABSTRACT

The Paikon Massif in the Hellenides consists of thick carbonate sedimentary series containing several intercalations of acid and basic volcanic rocks. The results of petrological and geochemical studies of these volcanic rocks confirm the distinction of two areas. The western area (Paikon zone) mainly consists of abundant island arc tholeiites. However, some samples display an affinity with boninites, and basalts with oceanic ridge affinities have also been found. The acid lavas are very similar to island arc dacites. In the eastern area (margin of the Pre-Peonian zone) basic volcanics are very scarce. The acid rocks consist of rhyolites characterized by high contents in K_2O, Rb, Ba and by an important enrichment in LREE. These data lead to the conclusion that the Paikon Massif can be interpreted as remnants a Jurassic island arc complex separating an eastern marginal basin (the Guevgueli ophiolite) from a western ocean, the prints of which are found in the Almopias zone.

INTRODUCTION

The Paikon Massif in Northern Greece is situated between two ophiolite bearing areas : therefore, its geodynamic significance is of major importance for the understanding of the Alpine history of the Hellenides. It consists of thick carbonate sedimentary series containing several intercalations of acid and basic volcanic rocks. According to Mercier (1966), a fault separates, in this Massif, the Paikon Zone formations from series that are located beneath the Guevgueli ophiolite, and that belong to the Pre-Peonian Sub-Zone. New fossil discoveries lead Godfriaux and Ricou (1991) to propose an alternative interpretation and to consider that the Paikon Massif is an anticlinal window (Fig. 1 and Tabl. 1).

Consequently, the geodynamic significance of the Paikon Massif is still debated:

- it may be interpreted as a Jurassic island arc separating an eastern intra-continental marginal basin which is now depicted as the Guevgueli ophiolite, from a western ocean, the prints of which are found in the Almopias zone (Mercier et al., 1975 ; Bébien et al., 1987);
- it may be a part of the Pelagonian Massif appearing as a window under ophiolites which are present to the East and the West (Godfriaux and Ricou, 1991).

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Table 1: Proposed stratigraphic successions in the Paikon Massif

Mercier (1966)		Godfriaux and Ricou (1991)
Paikon Zone	Pre-Peonian Sub-Zone	Paikon window
Limestones (Cretaceous)	Ghriva limestones (Upper Jurassic)	Upper limestones (Late Jurassic and Late Cretaceous)
Flysch (Lower Cretaceous)		
Khromni spilites-keratophyres	Kastaneri volcano-sedimentary formation (Upper Jurassic)	Kastaneri metarhyolites and metaarkoses (Permian ?)
Gropi limestones (Mesozoic)	Gola Tchouka limestones	Gola-Tchouka-Gropi limestones
Livadia volcano-sedimentary formation		Livadi metapelitic and metavolcanic schists
Gandatch limestones		Pyrgos calcschists and chloritoschists
		Gandach limestones

In a discussion of the geodynamic significance of the Paikon Massif, it seems important to take into account the petrologic characteristics of the abundant volcanic rocks intercalated with the sedimentary formations.

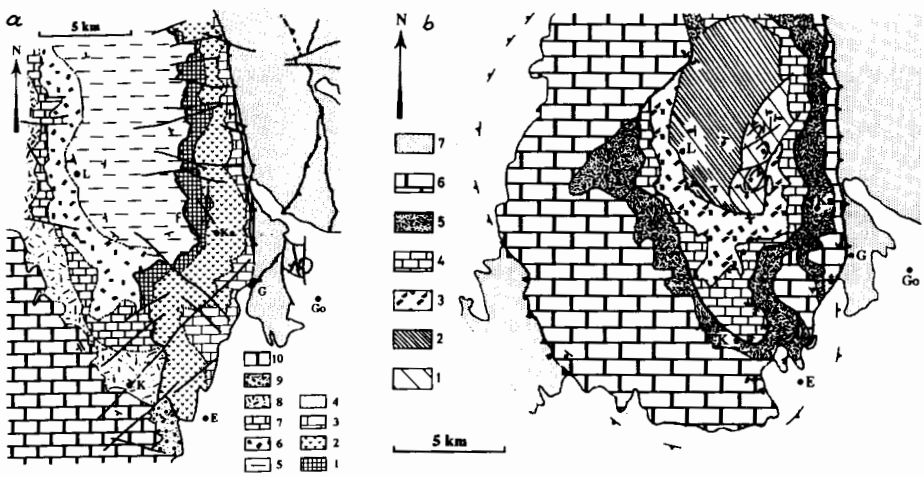

Fig.1: Geological map of the Paikon Massif
a) according to Mercier (1966) - Pre-Peonian sub-zone: 1 - Gola Tchouka limestones; 2 - Kastaneri volcano-sedimentary formation; 3 - Ghriva limestones; 4 - Guevgueli ophiolites. Paikon zone: 5 - Gandatch limestones; 6 - Livadia volcano-sedimentary formation; 7 - Gropi limestones; 8 - Khromni spilites-keratophyres; 9 - Flysch; 10 - Cretaceous limestones.
b) according to Godfriaux and Ricou (1991): 1 - Gandach limestones; 2 - Pirgos calcschists; 3 - Livadi schists; 4 - Gola Tchouka - Gropi limestones; 5 - Kastaneri formation; 6 - Upper limestones; 7 - ophiolites.
E: Elefterochori; G: Ghriva; Go: Goumenissa; K: Khromni; Ka: Kastaneri; L:Livadia.

Table 2: Main characteristics of the volcanic rocks in the Paikon Massif

	Group	Zone or sub-zone (Mercier, 1966)	Formation	Mineralogy	Chemical features	Nature
Acidic rocks	AI	Paikon	Livadia Khromni	quartz + albite + chlorite + phengite ± lawsonite	$Na_2O/K_2O > 0.6$ $6 < Rb < 33$ $0.7 < La/Yb < 1.8$	Acidic differentiates from island-arc series (tholeiitic/boninitic)
	AII	Pre-Peonian	Kastaneri	quartz + K feldspar + muscovite	$Na_2O/K_2O < 0.1$ $121 < Rb < 149$ $12.1 < La/Yb < 18.5$	Anatectic magmas and/or acidic differentiates from calc-alkaline series
Basic and intermediate rocks	BI	Paikon	Livadia Khromni	albite + chlorite + quartz + epidote ± actinolite ±winchite	$0.82 < TiO_2 < 1.03$ $42 < Zr < 50$ $1.5 < La/Yb < 2.2$	Low-K tholeiites similar to island- arc tholeiite
	BII	Paikon	Livadia Khromni	albite + chlorite + quartz + epidote + calcite ± stilpnomelane	$0.47 < TiO_2 < 0.55$ $14 < Zr < 17$ $1.2 < La/Yb < 1.9$	Boninite affinity
	BIII	Paikon Pre-Peonian	Khromni Kastaneri	albite + chlorite + quartz + épidote + calcite	$1.02 < TiO_2 < 1.31$ $69 < Zr < 97$ $2.4 < La/Yb < 3.3$	MORB affinity

VOLCANIC ROCKS IN THE PAIKON MASSIF

Various volcanic rocks are found in different positions in the Paikon Massif.

The Livadia volcano-sedimentary formation includes metabasalts and meta-andesites, associated with less abundant metadacites.

The gathering in a same formation, the Kastaneri metarhyolites and meta-arkoses, proposed by Godfriaux and Ricou (1991), of the Spilites-Keratophyres series (Khromni volcano-sedimentary series) and the Kastaneri volcano-sedimentary series distinguished by Mercier (1966) is not justified by simple petrographic observations. The Khromni volcano-sedimentary series include abundant metabasalts ("spilites") and metadacites ("keratophyres"), whereas basic volcanics are very scarce in the Kastaneri series, which mainly consists of a thick sequence of metarhyolitic pyroclastic rocks.

Some volcanic intercalations present in the Lower Cretaceous Flysch are not considered in this study.

The main characteristics of the volcanics in the Paikon Massif are summarized in Tabl. 2. All these rocks have suffered important secondary mineralogical and chemical transformations due to metamorphic and weathering processes. It is noteworthy that minerals characteristic of HP-LT metamorphic conditions (winchite, lawsonite...), frequent in the Livadia and Khromni series (Paikon Zone ; Mercier, 1966 ; Baroz et al., 1987), are not observed, as far as we know, in the Kastaneri serie (Pre-Peonian Sub-Zone).

The results of petrological and geochemical studies of the volcanic rocks lead to the recognition of several groups, and are in good agreement with metamorphic data. They confirm the distinction of two areas in the Paikon Massif.

The western area (Livadia and Khromni series) constitutes the Paikon Zone. It mainly consists of abundant and typical island arc tholeiites (group BI). Some samples are however particularly depleted in Zr, Y, Ti and REE and display an affinity with boninites (group BII). Basalts with oceanic ridge affinities have also been found in the Khromni series (group

BIII). The acid lavas are very similar to island arc dacites with a La/Yb ratio close to one (group AI).

The eastern area (Kastaneri serie) corresponds to the west margin of the Pre-Peonian zone. Basic volcanics are very scarce, the only one analyzed sample shows MORB characteristics (group BIII). The acid rocks consist of rhyolites which can be distinguished from the western acid rocks by their high contents in K2O, Sr, Ba and by an important enrichment in LREE (group AII).

Furthermore, the rhyolites of the Kastaneri series have very good geochemical affinity with the Upper Jurassic (Mercier, 1966) Fanos granite and Piyi migmatite associated with the Guevgueli ophiolite, 5-10 km further Est in the Pre-Peonian Sub-Zone. This similarity seems to be confirmed by a preliminary study of zircon typology : crystals comparable to those observed in the Fanos granite and the Piyi migmatite, and characteristic of either calc-alkaline or anatectic rocks (Platevoet and Bébien, 1992), are found in the Kastaneri rhyolites.

On the other hand, acid-basic associations showing some affinities with those observed in the Livadia and Khromni series (Paikon Zone) have been described in the Almopias zone, particularly in the Liki and Klissochori units, in which very low Ti boninite-like basic lavas of probable Upper Jurassic - Lower Cretaceous age are found (Bijon, 1982).

CONCLUSIONS

1 - The petrological differences observed between the volcanic rocks found in the western part (Paikon zone) and eastern part (Pre-Peonian subzone) of the Paikon Massif support the presence of an important discontinuity between these two areas.

2 - Most of the acid and basic rocks from the Paikon zone bear a strong resemblance to basalts, andesites and dacites from intra-oceanic island-arc environments. On the other hand, the abundant rhyolites in the Pre-Peonian sub-zone display characteristics of calc-alkaline or anatectic rocks in continental areas.

3 - According to Godfriaux and Ricou (1991), the slivers of Jurassic limestones which locally crop out within the Kastaneri formation are tectonic slices and do not help in dating this formation. Due to facies similarities, they propose to consider the rhyolite formation of Kastaneri and the superimposed limestones as a permo-mesozoic sequence of Pelagonian type. However, detailed petrological data lead us to underline a strong resemblance between the rhyolites in the Kastaneri formation and the upper Jurassic Fanos granite and/or Piyi migmatite on the one hand, and between volcano-sedimentary formations in the Paikon and the Almopias zones on the other hand.

In conclusion, the Paikon Massif clearly includes remnants a Jurassic island arc complex separating an eastern marginal basin (the Guevgueli ophiolite) from a western ocean, the prints of which are found in the Almopias zone.

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