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ORIGIN AND AGE OF THE VOLCANICS IN THE PINDOS NAPPE OF MESSENIA, GREECE

W. BÜCHL*, W. ZACHER*

ABSTRACT

The volcanics of the Pindos zone in Messenia have a chemism typically found in back-arc basins. The age of the volcanism is determined as Jurassic. The element distribution of the volcanics shows contamination by continental crust. No MORB influence is found in Messenias volcanic rocks. Probably the external slope of the Pindos basin was built of thinning continental crust. New oceanic crust was only formed further to the east in the deeper parts of the basin. Volcanic detritus in Pindos sediments gives evidence for volcanic extrusions.

KEY WORDS: Pindos basin, volcanics, volcanic detritus, back-arc volcanism

1. GEOLOGICAL SETTING

The Olonos - Pindos nappe is the uppermost coherent Hellenic nappe unit of the Peloponnesus. The Pindos nappe consists mainly of deep water sediments, ranging from Triassic to Eocene with a thickness in Messenia of about 600 m of limestones, radiolarites, marls and sandstones (FYTROLAKIS 1971; NEUMANN et al. 1996).

The sediments of the Pindos nappe of the western Peloponnese were deposited on the western (external) slope of the Pindos basin (e.g. DEGNAN & ROBERTSON 1991). West of it the Tripolitza platform was situated. Clastic sediments were redeposited from the platform down into the basin. The former basement of the Pindos sediments is unknown, as it was sheared off during the nappe thrusting of the Hellenides (THIEBAULT 1982).

Volcanics in the sedimentary strata of the Pindos nappe in Messenia were first described by FYTROLAKIS (1971) and later on by RICHTER & LENSCH (1989).

2. COMPOSITION OF THE VOLCANICS

The intrusions are formed as volcanic veins with thicknesses between 30 cm and 1.5 m. The volcanics are of brown to green color, with small, mostly greenish inclusions and bigger white calcites. Due to the occurence of calcite, mostly in the stronger altered samples, it is supposed to be a younger pocket filling. The rock often shows an amygdaloid fabric.

A flow texture of fine plagioclase ledges can be observed in thin section. It contains phenocrysts of plagioclase, olivin, pyroxene and mica. The fine grained, dark matrix is generally altered to chlorite.

3. THE SAMPLES

Samples from 4 outcrops in Messenia were investigated (fig.1).

Outcrop at Kokkino (sample VO).

This outcrop is described by FYTROLAKIS (1971). The outcrop has dissappeared in the meantime. A sample out of a wall at Kokkino was analysed.

* Dept. of Geology, Technical University of Munich, Lichtenbergstraße 4, 85748 Garching, Germany

... The 1.5 m thick vein crops out directly at the thrust plane between the Pindos nappe and the Tripolitza nappe. Next to it Pindos platy limestones and green radiolarite is exposed, but no direct contact could be found. Therefore the age remains uncertain.

Outcrop west of Paneika (sample 56).

In the valley 250 m west of the nearly decayed village Paneika a new outcrop of a volcanic vein was found. The vein strikes northeast to southwest, and dips 5° - 10° to the southeast. It is in direct contact to red Jurassic limestones.

Pebbles of volcanic rock (sample 55).

In a creek south of Agnantio pebbles of volcanic rocks were sampled. These pebbles are very solid and nearly unaltered. Their origin must be in the catchment area of the creek. The creek originates from the western flank of Mt. Lycodymo (959 m), a few kilometers to the north.

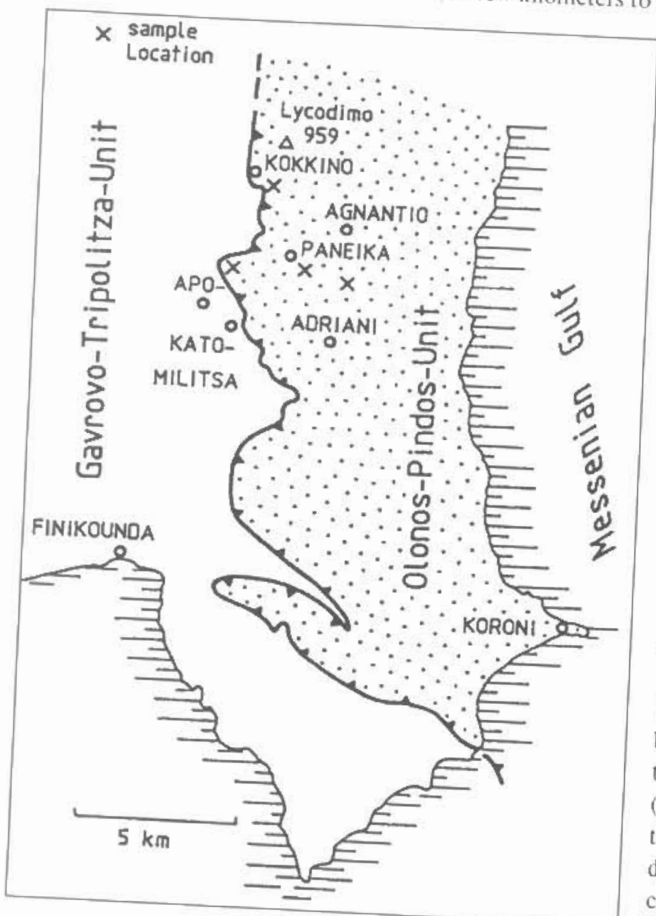

Fig. 1: Sketch of E-Messenia with sample locations (x).

4. TECTONO-MAGMATIC DISCRIMINATION

The element distribution of the samples was determined using X-ray-fluorecence. Because of the alterations of some samples, immobile trace elements were used for discrimination (Mn, P, Ti, V, Y, Zr).

The discrimination diagram of PEARCE & CANN (1973) using Ti, Y and Zr was used as a first overview. The samples show a calcalcaline chemism, which excludes within-plate volcanism. The discriminations after WINCHESTER & FLOYD (1976) and (1977) confirm this result.

The discrimination according to MULLEN (1983) was used for basalts and basaltic andesites (fig.2). In this diagram the samples plot in the fields of boninite (MnO-rich basalts) and the island-arc tholeiites. This is typical for volcanism at destructive plate margins, which corresponds with the results of PIPER & PE-PIPER (1991).

According to SHERVAIS (1982) Ti/V-plots can be used for determination of the tectonical position. The samples plot in the field of back-arc volcanism. The Ti/V-ratio ranges between 25 and 48. This confirms the existence of a back-arc volcanism in the Messenian Pindos nappe.

To examine the influence of oceanic or continental crust on the ascending magma, the discrimination diagram Zr/Y-Zr after PEARCE & NORRY (1979) was used (fig. 3). High Zr/Y-ratios or high Zr indicate contamination by continental crust. The same effect is caused by high amounts of terrigenous sediment, which is subducted with a descending plate. This high Zr/Y-ratio is different to other analysis in the Pindos zone, e.g. the samples of PIPER & PE-PIPER (1983).

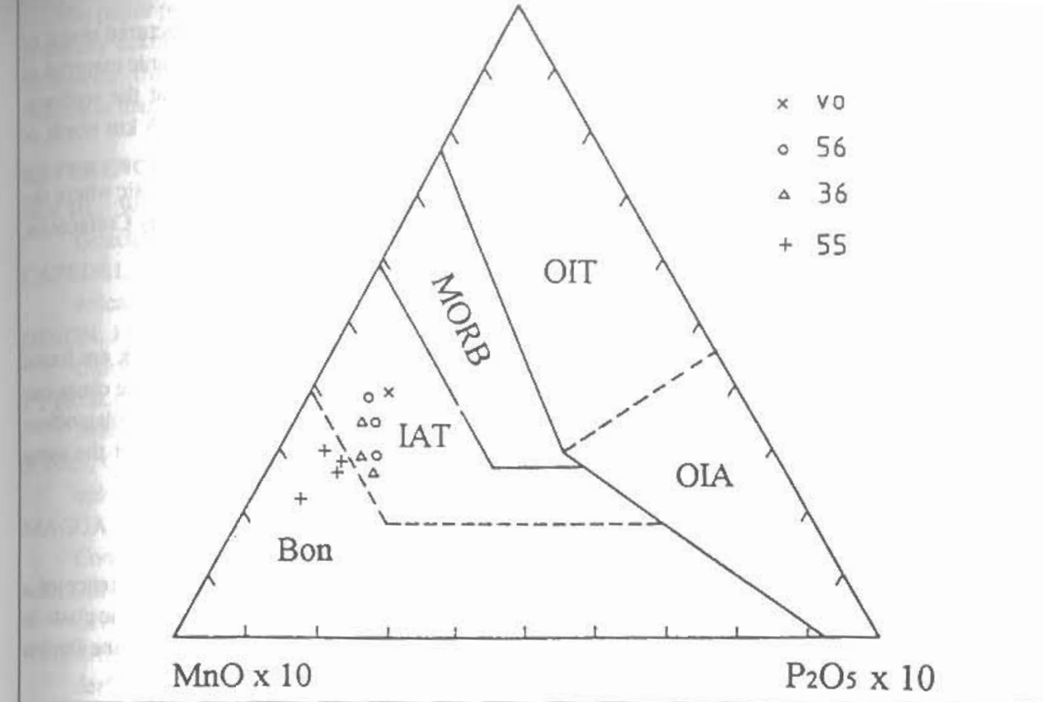

Fig. 2: Discrimination diagram according to Mullen (1983). CAB: calc alkali basalts, IAT: island arc tholeiites, OIA: ocean-island alkali basalts, MORB: Mid-ocean-ridge basalts, OIT: ocean-island tholeiites. The samples plot in the fields of boninites and island-arc tholeiites. Figure taken from Rollinson (1993).

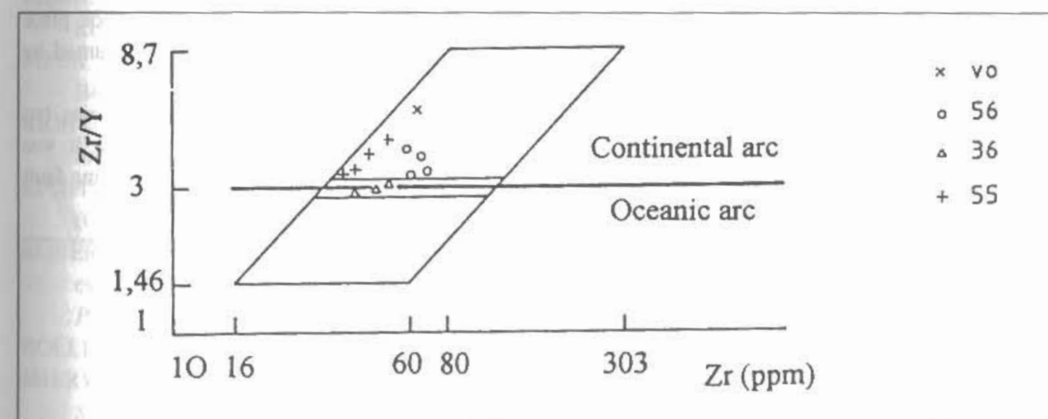

Fig. 3: Discriminination diagram according to Pearce & Norry (1979). The Zr/Y - Zr-ratio shows the influence of continental or oceanic crust to rising volcanics. The samples plot in the continental field.

5. ALTERED VOLCANIC DETRITUS IN PINDOS SEDIMENTS

Yellow-green minerals are frequently found in the sedimentary rocks of the Pindos nappe from the Late Triassic. These mineral inclusions are between 0.2 and 2 mm in diameter. They belong to three groups of minerals:

Chlorite group

These minerals are alteration products of mafic volcanics and volcanic glasses. The fractured shape of the minerals indicates an origin as submarine volcanic glasses. The redeposition of this volcanic material as detritus in mass flow deposits on the slope shows that volcanics must have taken place at the seafloor. RICHTER & LENSCH (1989) decribe pillow structures in volcanics at Paleo Loutro, about 25 km north of Militsa.

The size of the mineral inclusions in the sediments increases from the Triassic to the Jurassic where the maximum in number and size up to 1 mm is reached. They become smaller again in the Early Cretaceous, and disappear in the Late Cretaceous.

6. CLASTS OF VOLCANICS IN JURASSIC LIMESTONES

In the allodapic limestones of the Jurassic Drimos formation components of volcanic rock are found together with carbonatic clasts. They are variably altered and reach diameters up to 1 cm. These clasts can be found only in the Jurassic sediments. These components show the same flow texture of plagioclase ledges in a fine chloritic matrix as the rocks in the volcanic veins. Therefore we conclude that the same volcanism has produced the volcanic veins and the volcanic clasts in the Jurassic limestones.

7. DISCUSSION

The chemism of the volcanics in the Pindos zone in Messenia is an indication for the existence of a back-arc volcanism. The contact of a volcanic vein on the one hand, and the inclusions of volcanic clasts in Jurassic limestones on the other hand, determines the age as Jurassic. The mineral inclusions in the Pindos sediments shows that the volcanic activity started in the Triassic and ended during the Cretaceous.

A MORB volcanism in the Pindos zone, assumed by several authors (RICHTER & LENSCH 1989, CAPREDI et al. 1997), was not found in Messenia. In contrast, the influence of continental crust is obvious. The Messenian Pindos zone belongs to the external slope of the Pindos basin. Therefore thinning continental crust at the transition to the Tripolitza platform can be assumed as former basement of the Pindos sediments in Messenia. The formation of new oceanic crust (ROBERTSON et al. 1991) took place only in the deeper parts further to the east in the basin. A continental influence is also assumed by MAGGANAS et al. (1997) for volcanics at the eastern slope of the Pindos basin.

The volcanic detritus in Pindos limestones shows that magma occured not only in volcanic veins, but also escaped onto the seafloor. Together with clastic material from the Tripolitza platform it was redeposited into the deeper parts of the basin. Probably the magma ascended along deep reaching fault zones, which separated the Pindos back-arc basin from the Tripolitza platform.

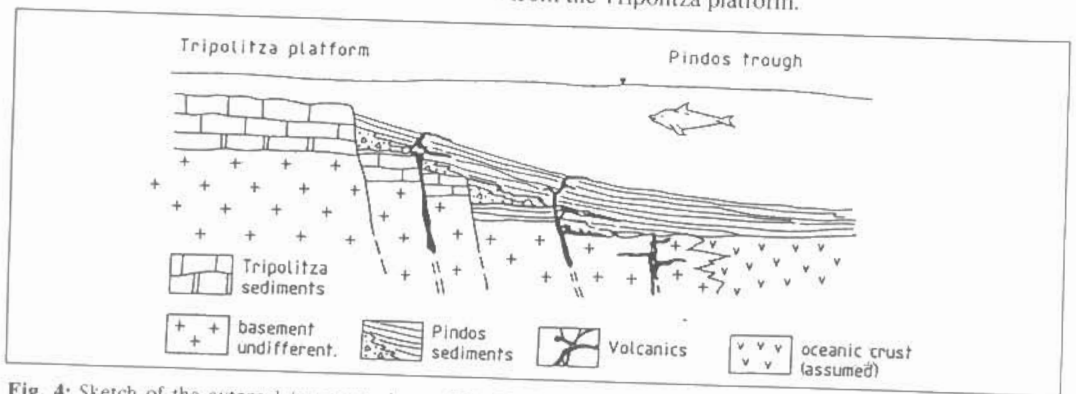

Fig. 4: Sketch of the external (western) slope of the Pindos basin, a passive continental margin, where the Pindos sediments of Messenia were deposited. The oceanic crust below the central Pindos basin and a subduction zone at the eastern margin is assumed according to literature (e.g. Robertson et al. 1991).

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