Application to Extend
the LESVOS PETRIFIED FOREST
EUROPEAN and GLOBAL GEOPARK
to include the remaining area of LESVOS ISLAND for
membership in the **European Geopark Network**

LESVOS - GREECE
2009

The Geology of Lesbos island

INTRODUCTION

The island of Lesbos is located in the NE Aegean Sea. It is the largest island in the Eastern Archipelago after Crete and Euboea. It is situated close to the coast of Asia Minor with an area of 1630 sq. km and a population of 90.000 inhabitants.

Lesbos is an island of the sunshine that makes its land fertile with a vast range of vegetation, ranging from the silver olive, the dark green pine and the unique wild flowers. Lesbos' natural beauty, its mythology and history have inspired many poets.

During Cenozoic period Lesbos took its present impressive shape which the famous poet Elytis likened to the leaf of a plane tree. The sea enters deeply into the southern portion of the island and forms two enchanting bays with narrow entrances, namely the Kalloni and Gera gulfs. Small coves and fishing harbours ornament its shores and the headlands that are formed along the coast are most picturesque. Olive and pine trees cover mountains and plains on the central and eastern part of the island while a wide variety of aromatic and medical herbs are also present. 11 millions olive trees produce more than 20.000 tons of olives per year.

Mytilene, the capital of the island, is largely built on the ancient town. It spreads amphitheatrically around the harbour with extension to the north and west highs. On the north of Mytilene the Venetian castle crowns a magnificent pine wood which reaches down to the shore. It is one of the largest mediaeval castles in the Eastern Mediterranean. Places of special interest are the Ancient Theatre with marvellous acoustics, the Archaeological Museum, the Byzantine Museum, Theophilos Museum, Teriade Museum of modern art and some of the monumental churches, having both impressive architectural features and ecclesiastical articles.

On the Northern edge of the island stands the picturesque town of Mythimna (Molyvos) which has been declared a settlement subject to preservation. Its castle crowns it from Byzantine times and makes it even more charming.

On the extreme Western edge of the island lie Sigri and Eressos villages on an area of incomparable wild beauty, where appear large accumulations of fossilised tree trunks comprising the well known «Petrified Forest of Lesbos». The glossiness and the chromatic variety of the petrified pieces is fascinating. On Megalonisi, the island which protects the bay of Sigri, lie some marvellous trunks of petrified trees. In the village of Sigri the small castle built by the Turks in 1757, to protect the fishermen's resort, has been kept in good condition. The Natural History Museum of Lesbos' Petrified Forest is located in Sigri since 1994, in order to undertake scientific research on the natural monument, as well as the preservation and promotion of the Petrified Forest.

Southeast of Sigri lies the beautiful country town of Eressos, birthplace of the famous Sappho. The beach of Eressos out of a dream with clean sand, almost 3 km long and 70 m wide and the outstanding blue of the Aegean, was deemed as the cleanest in Greece.

GEODYNAMICS OF NORTH AEGEAN AREA

From the geological, neotectonic, seismotectonic and geophysical point of view North Aegean and its surroundings have attracted the attention in the last decade. The 300-km long North Aegean Trough (NAT), with a maximum depth around 1900 m, is well defined by the 400-m isobath. It extends from the narrow Saros Trough to the east, as a continuation of the North Anatolian Fault through the Marmara Sea, as far as the Sporades basin in the west. The trough is controlled by en echelon faults, which show normal character as it is derived from the seismic profiles (Biju-Duval, et al. 1972; Lalechos & Savoyar 1979; Brooks & Ferentinos 1980; Lyberis 1985; Roussos & Lyssimachou 1988) and there is also evidence for important dextral strike-slip movement. Lesbos island laying in the North - East Aegean area has a key role in understanding the geodynamics of the area.

Seismological data concerning the spatial distribution of earthquakes and focal mechanisms in the North Aegean area were correlated with volcanism and ore genesis by Papazachos (1976) who showed that there is a possible Benioff zone in the Northern Aegean. This plate is dipping northwards and controlls the morphology and neotectonics of the region as a back-arc domain. Riazkov & Stanov (1989) using seismological, gravitational and magnetic field investigations assumes that a fragment of oceanic type crust exists beneath the North Aegean. They supported again the idea for a weakly active paleosubduction zone.

According to the converging views of many workers, the tectonic regime of this region is mainly extensional accompanied by strike-slip movements (e.g. Papazachos 1976; Lyberis 1985; Simeakis et al. 1989). Figure A.I. shows the main seismotectonic properties of the Aegean area and surroundings (Papazachos et al. 1986).

McKenzie (1972), Dewey & Sengor (1979), Sengor et al. (1985), emphasise the importance of a «Grecian» shear zone, which they think runs along NAT, Central Aegean and Central mainland Greece. Mountrakis et al. (1993) gave evidence that the Southern Thessalia highly active fault zone, which is in the Central mainland of Greece, is probably the continuation of this fault system.

Pavlides et al. (1990), claims that the recent deformation conditions of the North Aegean area are not very different from those required for a right-lateral transten-sion. Additional evidence for strike-slip faulting on the NAT comes from recalculated focal mechanisms (Kyratzi et al. 1989) and the study of seismic sequences of the last decades (Papazachos et al. 1984; 1995, Rocca et al. 1985, Kyratzi et al. 1989). These focal mechanisms show horizontal or subhorizontal P (compressional) stress axes directed E-W and T (extensional) axes oriented N-S. They show pure dextral strike-slip motions with normal or reverse components. (Fig. A.2)

Geological information relevant to the timing of the onset of the NAT arises from published information on the main neotectonic subsidences of Northern mainland Greece (Psilovikos & Sotiriadis 1983; Koufos & Pavlides 1988). Informations come also from the Neogene stratigraphical and neotectonic studies of the North Aegean islands (Lalechos & Savoyar 1979; Lyberis & Sauvage 1983; Mercier et al. 1989; Simeakis et al. 1989) and from the analogy of similar basins of the Western edge of North Anatolian Fault (Sengor & Catinez 1982; Barka & Kadinsky-Cade 1988). Conclusively, the NAT and the basins of the broader North Aegean region have originated sometime between Middle(?)- Late Miocene and Pliocene.

Mercier et al. (1982) have shown that the North-Eastern Aegean (Thrace and the island of Lesbos) has been affected mainly by extension since Late Miocene. Lyberis (1985) has also shown that the whole North Aegean area has been affected by a prevailing tectonic regime of extension coupled with strike-slip since the Late Miocene, and that it is still active. Simeakis et al.(1989) opine that the NE-SW to E-W striking North Aegean Trough fault zone absorbs the dextral strike-slip motion of the North Anatolian Fault at its western termination.

According to Lyberis (1985) and Mercier et al. (1989) the extension which characterises the area could be distinguished into three tectonic regimes (or phases). These are: (1) A Late Miocene with NW-SE direction of extension, (2) A Pliocene-Early Pleistocene with NE-SW extension, and (3) A Middle-Late Pleistocene (N-S extension). These extensional phases are mainly responsible for the creation of the NAT and the surrounding basins.

GEOLOGY OF LESBOS ISLAND

Lesbos island belongs to the Pelagonian geotectonic zone of Greece which represents fragment of the Cimmerian Continent (Mountrakis 1983; 1992). (Fig. A.2).

The geology of Lesbos has been described by Hecht (1971; 1974; 1975), Pe-Piper (1978), Katsikatsos et al. (1982, 1986). Hecht (1971;1974) presented the geological map of the island (1: 50.000 scale). Chemical analyses of the volcanic rocks have been carried out by Georgalas (1949), Borsi et. al. (1972), Pe-Piper (1978; 1980; 1984) and Pe-Piper and Piper (1980; 1989; 1997).

According to the published data the geological structure of Lesbos Island comprises the following rock-units.

- An autochthonous unit of Permo-Triassic age, including schists, quartzites, metasandstones, phyllites with intercalation of marbles and crystalline carbonates. These rocks are widely extended on the Southeast part of the island, while in the Northwest part they have a rather small extension.
- The allochthonous units that represent remnants of an ophiolitic sequence, comprising basic and ultrabasic rocks and associated deep-sea fine-grained sediments, as well as metamorphic rocks, amphibolites and amphibole schists, metabasites and metasediments, parts of the sole, overthrusted the metamorphic basement. These

alpine and pre-alpine rocks were later covered by Tertiary volcanic rocks and Neogene marine and lacustrine deposits, as well as Quaternary deposits. The Neogene volcanic rocks, dominate the Central and Western part of the island.

The Metamorphic basement

The autochthonous unit, according to Katsikatsos et al. (1982,1986), is a series of formations ranging from Neopaleozoic to Upper Triassic age. It has no strati-graphic unconformities and it consists entirely of metaclastic rocks, crystalline limestones and dolomites. It is characterised by a very low grade metamorphism (Fig.A.4 and A.5).

These rocks dominate on the Southeast part of the island, where the visible thickness, in places, is more than 1.000 m. In the Northwest part of the Island they have relatively small extension (areas of Sigri, Gavathas, Eressos) and they are exposed under the postalpine volcanic rocks and lacustrine deposits.

The metamorphic rocks consist of schists (mainly micaceous, sericitic and chlo-ritic) alternating with metasandstones (mainly arkoses), and quartzites as well as lenses and intercalations of crystalline limestones and dolomites. Generally the extension and the thickness of the carbonate rocks are always limited, except in the upper parts of certain areas, where the carbonates dominate.

In these rocks and in several localities and different stratigraphic horizons, a rich fauna of Carboniferous-Permian age was found (Hecht 1972; 1974; 1975, Katsikatsos et al. 1982) consisting of foraminifers, algae, lamellinbranches, gastropods, echinoderms, crinoids and corals.

The Triassic formations represent the upwards normal transition of the Neopaleozoic formations and they are found only in the Southeast part of Lesbos. They consist mainly of schists and metasandstones. Within these formations very thick intercalations of crystalline carbonates usually occur, where fossils of Megalodon have been found by Katsikatsos (Migiros 1994). They are characterised by the presence of breccia and big carbonate blocks, mainly within their upper horizons.

The Ophiolitic sequence

Basic and ultrabasic rocks, associated deep-sea sediments, as well as basic metamorphic rocks, overthrust the metamorphic basement. All these rocks have an allochthonous origin, they are remnants of an ophiolitic sequence and represent fragments of the Neo-Tethyan oceanic lithosphere, which were emplaced on the Pelagonian margin during Mesozoic (Mountrakis et al. 1992).

According to Katsikatsos et al. (1982; 1986), the allochthonous rocks are divided into two tectonic nappes. The lower nappe, comprising Triassic volcano-sedimentary formations and the upper one, comprising ophiolitic rocks (Fig. A.3 and A.4).

The lower nappe, occupies a large area in the Southeast part of the island and its thickness exceeds, in places, 1.000 m. It consists of various types of metabasites, which usually dominate in the upper parts, and metasediments. At the base of the lower tectonic nappe, crystalline limestones and dolomites appear forming lenses and intercalations with schists of various mineralogical composition (chlorite, mica, sericite, e.t.c.) and conglomerates. Characteristic fossils of Lower-Middle Triassic age have been found in the carbonate rocks (Katsikatsos et al. 1982).

The volcano-sedimentary rocks suffered initially a low grade metamorphism in the pumpellyite-actinolite-chlorite zone (Katsikatsos et al. 1982). But in some places the presence of glaucophane, provides a high-pressure metamorphism.

The upper ophiolitic nappe occupies a large area in the Southeast part of Lesbos. Geophysical data indicate that in the central part of the island (Kalloni gulf) the ophiolites are continuous at depth below the Neogene volcanic rocks. The ophiolitic rocks overthrust, in their larger part, the volcano-sedimentary formations and can be divided into two parts, which are in tectonic relation, an upper part which mainly consists of ultramafic rocks (peridotite, pyroxen-peridotite, and olivinite) and a lower part consisting of metamorphic basic ophiolitic rocks. Ultramafic rocks, of various degrees of serpentinization, are intersected by veins of pyroxenites and gabbros. Their thickness exceeds in places 1.000 m. Metamorphic basic ophiolitic rocks, mainly amphibolites and amphibolitic schists, are always tectonically inter-calated with the ophiolitic rocks and the underlying volcanosedimentary formations. Their thickness reaches, in places 300 m.
Both these rock - groups which belong to the ophiolitic tectonic nappe have suffered at least one very low grade metamorphism in the pumpellyite-actinolite-chlo-rite zone, similar to the one that suffered the volcano-sedimentary nappe (Katsikatsos et.al. 1986; Katagas & Panagos, 1979).

The Postalpine volcanics

Neogene volcanic rocks dominate the Central and Western part of the island. Lesbos is part of a belt of late Oligocene to middle Miocene calc-alcaline to shoshonitic volcanism of the Northern and Central Aegean Sea and Western Anatolia.

In the central part of the island there is a series of stratovolcanoes, of basalt, andesite, dacite and rhyolite, termed the main volcanic chain, which extends in a SW-NE direction and includes a probable caldera complex near Vatoussa (Pe-Piper 1978; 1980).

The Oligocene-Miocene volcanic rocks of Lesbos are shoshonitic, with only minor interbedded calc-alkaline andesites. There was minor earlier (21.5 M.a.) and later (16.5 M.a.) calc-alkaline volcanism. Several volcanic formations can be distinguished:

- The Eressos Formation is the oldest igneous formation, composed by porphyritic andesites interbedded with agglomerate and volcaniclastic rocks, dated at 21.5 M.a., by Pe-Piper & Piper (1993). These lavas are 3 to 4 M.a., older than the main volcanic sequence of Lesbos.
- The Skoutaros Formation is a normally magnetised sequence of andesite and basalt flow approximately synchronous with Sigri

pyroclastics and Polychnitos ingnimbrite. In the upper part of the formation pyroxene andesite lavas interbedded with hornblende-biotite dacite lavas and felsic pyroclastic rocks of Sigri pyroclastic Formation.

- The Sigri pyroclastics, thickest in the west of the island, are connected with the development of the Petrified forest and are overlain by several sheets of the Polichnitos ignimbrite. The Kapi rhyolite domes are of approximately the same age, of about 17.0 M.a.
- The Polychnitos ignimbrites occur in correlable units 5-30 m thick. Each unit has an upward decrease in size of lithic tephra, often poor welding at the base. Commonly an abundance of glass lenticules or obsidian are present near the base, and good columnar jointing exists at the top of the unit. They are believed to be cooling units. The ignimbrites thin out against both metamorphic basement highs, and the main volcanic chain (where they interbed with volcani-clastic conglomerate).
- The Skalochorion Formation lay in-between the lower Skoutaros Formation and the upper Sykaminea lavas, composed by reversely magnetised intermediate lavas and contain feldspar megacrysts, commonly associated with mafic xenoliths.
- The Sykaminea Formation dominates in central Lesbos and comprise a reversely magnetised stratovolcanic sequence of andesites, dacites and rare rhyolitic pyroclastics, dated at 17.3 M.a. (Pe-Piper 1980).
- The Mytilene Formation, was defined by Pe-Piper (1978; 1980) as local basalt flows that Prager (1966) claimed to overlay Pontian marls. New radiometric data indicate that the Mytilene formation is part of the main sequence of the volcanic activity in Lesbos, dated at 16.8 M.a. (Pe-Piper & Piper 1993), (Borsi, et al. 1972.).
- Mesotopos dykes, dated by Pe-Piper (1978) at 16.2 M.a., are widespread in western Lesbos. Volcanic equivalents are rare or absent.

The impressive in volume and time duration (21.5-16.2 M.a.) volcanic activity in the area left a large number of active surface thermal manifestations and include hydrothermal alterations. The numerous hot springs, various geothermal fields, etc., should be connected mainly to the recent active tectonic activity.

The Neogene marine and lacustrine deposits

A long period of erosion, with deposition of Pliocene marine and lacustrine deposits, preceded the local basaltic andesitic activity of Eastern Lesbos. The Pliocene deposits consist of white marly limestones, partly concretionary and oolithic, intercalated with sandstones, conglomerates, whitish marls and clays containing several shell beds. The total thickness of these sediments is more than 60 meters. Neogene sediments are overline by Pleistocene and Holocene talus and continental deposits, composed by cemented and unconsolidated conglomerates, gravels, grey and red clays and sands.

NEOGENE AND QUATERNARY VOLCANISM IN THE AEGEAN AREA

The Aegean area was characterised since Oligocene by the development of a complex volcanism mostly of orogenic type.

The distribution in time of the volcanism allowed the distinction of two main phases of orogenic volcanic activity well separated in space (Fytikas et al. 1984). The older one was developed from Oligocene to Middle Miocene (Fig.A.7). It generated an andesitic belt trending E-W, essentially located in Northern Aegean Sea from mainland Greece through Central Aegean Sea to Western Anatolia. Radio-metric datings and geological data suggest that the volcanic front of this migrated in time southward (Bellon et al. 1979; Fytikas et al. 1984).

In fact, while the Oligocenic volcanites are found only in the Northernmost sector (Thrace) of the arc, the Miocenic ones are located only in the southern sector (central Aegean Sea).

The products erupted during the Tertiary cycle show the typical character of orogenic associations and calc-alkaline members prevail. However shoshonitic products are present, characterising mainly the final stages of the volcanic activity in different areas. In this sector volcanism definitively ends during Middle Miocene. In fact, younger absolute datings of the southernmost volcanites of the belt (Sky-ros, Euboea) are of 13 M.a. (Innocenti et al. 1981).

The orogenic volcanic activity in the broader Aegean Sea was interrupted during Middle Miocene, it resumed in Middle Pliocene (about 3.5 M.a.) (Kolios et al. 1980) in Southern Aegean Sea in a different zone from that occupied by the preceding belt. It gave rise to a volcanic front (Southern Aegean active volcanic front) extending from Crommyonia, Methana, Milos, till the still active Santorini and Nisyros (Innocenti et al. 1981; 1983, Keller 1982). This volcanism has relatively homogeneous characteristics, quite similar to those typical of calc-alkaline associations of island arcs located on thin continental margins.

Sporadic volcanic episodes in the Aegean area have been dated from Upper Miocene to Quaternary showed peculiar petrogenetic affinity and space distribution. The products of this circle always show covers of limited volumes and generally border the Aegean area. Their composition is alkaline, both sodic and potassic. The sodic parts comprise olivine basalts and hawaiites present in Samos, Patmos, Kaloyeri and Psathoura (Borsi et al. 1972). On the other hand the potassic part comprises shoshonites present in Kos, Patmos, Bodrum, Atalanti-Volos and Voras (Kolios et al. 1980). Limited rhyolitic manifestations, clearly of anatectic origin, are also present (Antiparos).

The complex time-space variations of the Aegean volcanism along with the petrogenetic affinity of the erupted products, can be explained on the basis of the geo-dynamic evolution of this sector of the Eastern Mediterranean Sea (Me Kenzie 1972; 1978).

The presence of two well distinct and orogenic belts suggests that their genesis is correlated to two different subduction phases (Fytikas et al. 1984).

The older one was located in Central Aegean Sea and ended with the Oligo-Miocene continental collision well shown by the Hellenides tectonic series (Inno-centi et al. 1981).

The Southward migration of the Neogene volcanic front is considered to be the surface expression of an increase in the angle of subduction which took place after the continental collision phase. The exhaustion of the penetrative push of the African plate, combined with the gravity effect exercised on the old subducted plate caused the sinking and the detachment of the subducted plate.

On the contrary, the South Aegean active volcanic arc is related to a new subduction episode triggered south of the Aegean.

NEOTECTONICS

Kinematic analysis carried out in Lesbos, showed that several successive tectonic events took place during Cenozoic. The neotectonic stress pattern in the area was determined with quantitative methods using tectonic striations and other kinematic indicators. Taking into account published results of regional neotectonic studies in the North Aegean (Mercier et al. 1989; Pavlides et al. 1990) as well as local studies (Dotsika et al. 1994) is inferred that Lesbos suffered at least three post-volcanic tectonic events since Miocene.

- The first one produced E-W to ENE-WSW trending sinistral strike-slip faults in the Late Miocene.
- The second one occured during Pliocene and caused NW-SE trending normal faults and NNE-SSW trending sinistral strike-slip faults.
- Finally, the orientation of the strain ellipsoid changed during Pleistocene and an extentional event in the N-S direction took place. It produced E-W trending normal faults and the reactivation of the pre-existing structures. This tectonic regime seems to be still active in the area (Papazachos et al.1990).

GEOCHEMICAL EXPLORATION

Geothermal investigations in Lesbos island since the late 1960s have been provided a large number of data. Lesbos island has several thermal manifestations linked to extentional active faults that act as channels for the ascent of deep thermal fluids. Fytikas et al. (1989) carried out detailed geochemical exploration aimed at evaluating the potential geothermal resource of the Lesbos island.

Water classification

The water have been classified by means of the Langelier - Ludwig (LL) compositional pyramid and its relevant cross - sections. Figure A.lOa shows a square section perpendicular to the axis of the pyramid. The correlation plot of Fig. A.10b. is equivalent to a triangular cross -section whose trace is the left top corner-right bottom corner diagonal of the square section of Fig. A. 10: hence the two axes of this plot comprise two edges of the LL pyramid.

The unified parameters, i.e. Na plus K, Ca plus Mg and HCO_3 plus SO_4, have been examined through binary diagrams, not reported here. The following six hydrogeochemical types have been recognised.

- Alkaline earth bicarbonate (salinity 3-12 meq 1-1, temperature 10-30 °C): it includes most of the sampled waters; this type is related to shallow circuits and owes its origin to the interaction of meteoric waters with volcanic rocks.
- Magnesium bicarbonate (salinity 20-30 meq 1-1, temperature 15-22 °C): it originates through the interaction of meteoric waters, at shallow depth, with the peridotitic bodies and the metamorphic basement. The rapid reaction with water of the magnesium silicates (mainly forsterite and enstatite) which make up the ultramafic rocks is responsible for the magnesium bicarbonate composition of these waters, as recognised by Barnes et al. (1967, 1978).
- Sodium bicarbonate (salinity 10-25 meq 1-1, temperature 15-25 °C, except two samples where temperature measured at 31 and 38 °C); the origin of this hydrogeochemical type is related to the interaction, at shallow depth, of meteoric waters with acid volcanic rocks.
- Alkaline earth sulfate (salinity 3-24 meq 1-1, temperature 15-24 °C); it comprises 13 samples (9% of total), 5 of which are acid (pH 3.3-3.8). The reaction of H_2S-bearing gases with shallow waters explains the origin of these acid samples, while the interaction of shallow meteoric waters with hydrothermalized rocks accounts for the genesis of the other samples.
- Alkaline chloride (salinity approximately 400 meq 1-1 temperature 66.9-86.0 °C); it comprises the thermal waters of Polychnitos, Lisvori and Argenos, which are related to a relatively deep hot circulation. Existing isotopic data (Enel, 1978; Papastamataki and Leonis 1982, 1985) indicate that Polychnitos, Lisvori and Argenos thermal systems are fed by meteoric waters, as opposed to the con elusions reached by Dominco and Papastamataki (1975) on the basis of the Na/Cl ratio. Delta-D values are around -33%o at Polychnitos and Lisvori, and around -28 %c at Argenos; a limited oxygen shift is observed in all three thermal sites. Mixtures of these thermal waters and shallow bicarbonate waters have been observed near Stipsi (sample collected from a 154 m deep borehole) and Eftalou (sample collected from a thermal spring). The meteoric waters most likely also feed these thermal systems, although no relevant isotopic data are available.
- Alkaline earth chloride; it consists of only two samples (temperature 18 and 21°C, salinities 44 and 15 meq 1-1) whose origin and role in the hydrogeological framework of the region are difficult to assess.

Summarising previous observations, it can be said that there are basically two families of waters:

- rather saline alkali chloride waters or relatively high temperature;
- cold or slightly thermal bicarbonate and sulfate waters.

The first are of deep origin and the second of relatively shallow origin. Mixing of the two has been recognised only near Stipsi and Eftalou.

The geographical distribution of these hydrogeochem-ical types is shown in Fig.A.11.

THE PETRIFIED FOREST OF LESBOS

The area enclosed by the villages of Eressos, Antissa and Sigri, exposes large accumulations of fossilised tree trunks comprising the Petrified Forest of Lesbos. Isolated plant-fossils have been found in many other places of the

island, including the area of Mythimna and Polichnitos (Velitzelos and Zouros 1997).
The formation of the Petrified Forest is directly related to the intense volcanic activity in Lesbos island during late Oligocene - middle Miocene. In particular, it is related to the volcanic ash and pyroclastic materials erupting during the various episodes-phases. These materials covered entirely the vegetation of the area with a great quantity of fine, mainly volcanic, material.

The rapid covering of tree trunks, branches, and leafs lead to isolation from atmospheric conditions. Along with the volcanic activity, hot reach in SiO_2 solutions penetrated and impregnated the volcanic materials that covered completely the tree trunks. Thus the major fossilisation process started with a molecule by molecule exchange of the organic plant by inorganic materials. In the case of the Petrified Forest of Lesbos, the fossilisation was perfect due to favourable conditions. Therefore morphological characteristics of the tree trunks such as the annual rings, barkers, as well as the internal structure of the wood, are all preserved in excellent condition. From the orientation of the trees we can presume also the direction of movement of the pyroclastic flow units (from E to W).

The study of the fossil tree trunks, leaves and seeds gives useful data about the Palaeoflora, the climate and the relative age of the Petrified Forest in Lower Miocene. In addition to the large number of fossilised leaves, the genus or the species of the trees, can also be determined from the micro-analysis of the internal structure of the fossil wood. The erect trunks, the roots and branches of many trees, give evidence that the fossilisation took place in situ.

Despite the fact that the systematic study of the Petrified Forest has not yet been completed, the classification of the fossils allows certain conclusions to be drawn. All of the genera and species determined, belong to higher plant groups: Angiospermae and Gymnospermae. Complete development of the flora was achieved in the presence of Angiosperms, the most evolved plants.

From phytogeographical point of view the above mentioned plants can be distinguished into two main groups. The first group contain subtropical plants like Laurus (laurel), Cinnamomum (cinnamon), whose related species are actually developed in the forests of South-Eastern Asia. The second group includes plants which prefer mild temperatures like Alnus (alder), Carpinus (hornbill), Populus (poplar), Querqus (oak), Pinus (pine), Taxodioxylon gypsaceum (sequoia), etc. Related vegetation flourishes today in the warm continental zones of South-Eastern Asia and North America (Velitzelos 1988; 1993, Velitzelos & Gregor 1990, Suss & Velitzelos 1994).

A comparison of the stratigraphic expanse of the plant fossils with other European flora and with the Palaeoflora of Greece leads to the conclusion that the Palaeoflora of Lesbos developed during Lower Miocene, under subtropical or warm temperate seasonal climatic conditions.

The high proportion of upright petrified tree trunks, with well preserved roots in the fossilised soil, allows us to infer that the petrified forest of Lesbos island represents a complete autochthonous (fossilised in situ) ecosystem.

The Fossilised Forest was developed during the time period from the end of the Late Oligocene to Lower - Middle Miocene (ca. 20-15 million years before present), in contrast to most well known fossilised forests on Earth, which developed in earlier geological periods. According to recent data, the composition of the fossil flora is characterised by a high proportion of angiosperms (flowering plants) and gym-nosperms (conifers), and a low proportion of Pteridophytes (ferns). The silicified tree trunks and their organs - especially the wood - are very well preserved. Furthermore, fossilised leaves, cones and seeds provide the raw data for important scientific studies. Taxonomic study of the flora shows that they do not grow today in the Mediterranean, but only in tropical to subtropical regions such as Asia and Central America. (Velitzelos 1988; 1993).

All of the above mentioned criteria certify that the Petrified Forest of Lesbos represent an important stage of the earth's evolutionary processes. It is considered a unique natural geological monument offering rare scientific data as no other analogous monument from this time period and stage of plant development exists.

The Greek State recognised the exceptional palaeontological and geological value of this unique natural monument. In order to protect the Petrified Forest and ensure its proper management, five terrestrial and marine areas with fossil accumulations, as well as all the isolated fossils were declared as Protected Natural Monument with a special Presidential Decree (443 /1985).

The need for further research and protection of the fossils led to the establishment of the Natural History Museum of Lesbos' Petrified Forest in 1994. Its scope is to undertake scientific research on the Petrified Forest as well as to preserve and to promote this monument. In addition the Museum will organise special environmental education programs in order to cultivate a widespread sense of respect to the Earth's Heritage and the Natural monuments, among young students.

Further research in the Petrified Forest will provide new data concerning the volcanology, stratigraphy, palaeoecology, palaeontology, palaeoclimatology and palaeogeography of the Southeast Mediterranean, at the Cross-roads of Europe and Asia.

REFERENCES

Berger, W., 1953. Jungtertiare Pflanzenreste aus dem Gebiet der Agais (Lemnos Thessaioniki), *Ann. Geol. des Pays Hellen.,* 15, 34 - 54.
Borsi, S. Ferrara, G. Innocenti, F. and Mazzuoli, R., 1972. Geochronology and petrology of recent volcanics in the Eastern Sea (West Anatolia and Lesvos island). *Bull. Volcanol,* 36, 473-496.
Cordell, L. and McCafferty, A. E. A terracing operator for physical property mapping with potential field data. Geophysics, 53, 365-374, 1989
Dotsika E., Fytikas M., Mountrakis D. Papageorgiou F. and Zouros N., 1995. Geothermal exploration in Myti-lene area (Lesvos isl. Greece). Proceedings of the World Geothermal Congress 1995.2, 989-994.
Enel 1978: Geothermal reconnaisance study of the Lesbos island-General Report
Fliche, P., 1898. Note sur les bois fossiles de Metelin. In L. De LAUNAY, Etudes geologiques sur la Mer Egee. *Ann.Min.* 2.
Fytikas, M., Innocenti, F., Manetti, P., Mazzuoli, R., Peccerillo, A. and Villari, L., 1984. Tertiary to Quaternary evolution of volcanism in the Aegean region. Geol. Soc. London, Spec. Publ., 17: 687-699.
Fytikas, M., Kavouridis, T., Leonis, C. and Marini, L., 1989. Geochemical exploration of the three most significant geothermal areas of Lesbos island, Greece. Geothermics, Vol.18, No. 3, pp. 465-475.
Gartzos, E., K. and Migiros, G. 1992: Study of the amphibolitic rock unit in Lesvos Island Ann. Geol. de Pays Hellen., in press.
Hamburg Universitat-I.G.M.E. Gravity survey on the island of Lesvos, 1981.
Hecht, J. 1972 :Geological map "Plomari - Mytilini" sheet.sc 1:50.000,1.G.M.E.
Hecht, J. 1974 .-Geological map "Polichnitos" sheet, sc 1:50.000,1.G.M.E.
Hecht, J. 1975 :Geological map "Eressos" sheet, sc 1:50.000,1.G.M.E.
Hilderbrand, T.G. FFTFILL: A filtering Program based on two-dimensional Fourier analysis. U.S.G.S. Open-file report 83-287, 1987.
Katagas, c. and Panagos, a. 1979: Pumpelyite-Actinolite and Greenschist Facies metamorphism in Lesvos Island. THPH, 261, 235-254.
Katsikatsos, G., Mataragas, D., Migiros, G., Triantaphyllis, E., 1982. Geological study of Lesvos Island. I.G.M.E.dnternal report) Athens. 95p.
Katsikatsos, G., Migiros, G., Triantaphyllis, M. and Mettos A. 1986. Geological structure of the internal Hel-lenides (East Thessaly - Southwest Macedonia, Euboea Attica northern Cyclades islands and Lesvos) I.G.M.E. *Geology and Geophysical research,* Sp. issue, 191-212.
Kelepertsis, E., Velitzelos, E., 1992. Oligocene swamp sediments of Lesvos Island, Greece. *Facies,* 27, 113 -118. Krausel, R., 1965. The petrified forest of Lesvos. (Report)
Mercier, J.L., Sorel D. Vergely, P. and Simeakis, K. 1989. Extentional tectonic regimes in the Aegean basins during the Cenozoic. *Basin Res.,* 2, 49-71.
Migiros G., Pavlopoulos A. (1992): Introduction to the Geology of Lesvos island - Description of the itinerary. Guide Book for the field trip to Chios - Lesvos, 6th Cogress of Geological Society of Greece - IGCP Project 276, pl7 - 27.

Mountrakis, D. 1983. Structural geology of the North Pelagonian zone s.l. and geotectonic evolution of the internal Hellenides. Unpubl. Habilitation, Univ. Thessaioniki, 283.

Mountrakis D., Kilias A., Pavlides S., Zouros N., Spyropoulos N., Tranos M. & Soulakelis N. (1993): Field study of the highly active fault zone Southern Thessalia. Proceedings of the 2nd Geophysical Congress, v. 2, 603-616.

Papastamataki and Leonis 1982; 1985. Geochemical Research for Geothermics in Lesbos Area, I.G.M.E.

Papazachos, B.C., Kyratzi, A.A., Hatzidimitriou P.M. and Karakostas B.G. (1986). Seismotectonic properties of the Aegean area that restrict valid geodynamic models. Wegener/Medlas Conf. Athens may 14-16, 1986, 15pp.

Papazachos, B., Kyratzi, A. and Papadimitriou E. 1991. Regional focal mechanisms for earthquakes in the Aegean Area. *PureAppl. Geophys.,* 136, 405-420.

Papazachos, B., and Hatzidimitriou P. (1996). Seismotectonic properties of the Aegean area and the seismicity of Lesvos isl. Proceedings of the 1st Symposium on the Petrified Forest. Mytilene 27-28 April, 1996 (In press).

Pavlides, S.B., Mountrakis D., Kilias A. and Tranos, M. 1990. the role of strike-slip movements in the extentional area of the Northern Aegean (Greece). A case of transtensional tectonics. In: M. Boccaletti & A. Nur (Ed.) Active and Recent Strike-slip Tectonics, *Ann. Tectonicae,* 4 (2),196-211.

Pe-Piper, G. 1978. Cenozoic volcanic rocks of Lesvos island. Thesis, Univ. of Patras, p.365.

Pe-Piper, G., 1980. Geochemistry of Miocene shoshonites, Lesvos, Greece. Contrib. Mineral. Petrol., 72:387-396.

Pe-Piper, G., 1984. Zoned pyroxenes from shoshonite lavas of Lesvos, Greece: inferences concerning shoshonite petrogenesis. J. Petrol., 25:453-472.

Pe-Piper, G. and Piper, D.J.W., 1980. Paleomagnetic stratigraphy of the Miocene volcanic rocks of Lesvos. VI Colloquium on Geology of the Aegean Region, Izmir, Turkey, pp. 511-516.

Pe-Piper, G. and Piper, D.J.W., 1989. Spatial and temporal variation in Late Cenozoic back-arc volcanic rocks, Aegean Sea region. Tectonophysics, 169: 113-134.

Pe-Piper, G. and Piper, D.J.W., 1997. The volcanic stratigraphy of Lesvos, Greece. Neues Jahrb. Geol. Palaon-tol.(in press)

Suss, H. & Velitzelos, E., 1993. Eine neue Proto-Pinaceae der Formgattung Pinoxylon KNOWLTON emmend. READ, P. parenchymatosum sr. nov., aus tertiaren Schichten der Insel Limnos, Griechenland. *Feddes Repertorium,* 104, 335 - 341

Suss, H. & Velitzelos, E., 1994a. Ein neues fossiles Koniferenholz, Taxoceoxylon biseriatum sp. nov., aus tertiaren Schichten der Insol Lesvos, Griechenland. *Feddes Repertorium,* 105, 5-6, 257 - 269.

Suss, H. & Velitzelos, E. 1994b. Zwei neue tertia re Holzer der Gattung Pinoxylon KNOWLTON emend. READ aus dem Versteinerten Wald von Lesvos, Griechenland. Feddes Repertorium, Berlin, 105, 7 - 8, 403 - 423.

Velitzelos, E., 1988. The Petrified Forest of Lesvos. Mosion, Magasin Olympic Airways, February 88, 60 - 73. Velitzelos, E.1993. Neue palaofloristische Daten zu kanophytischen Floren Griechenlands. Doc. nat., 78,1 -17.
Velitzelos, E., Petrescu, I., Symeonidis, N., 1981a. Tertiare Pflanzenreste von der agaischen Insel Lesvos (Griechenland). Cour.Forsch. Inst. Senckenberg, 50,49 - 50.
Velitzelos, E., Petrescu, I., Symeonidis, N., 1981b. Tertiare Pflanzenreste aus Agais. Die Makroflora der Insel Lesvos (Griechenland). *Ann. Geol. Pays Hellen,* 30, 500 - 514.
Velitzelos, E., Symeonidis, N. 1978. Der verkieselte Wald von Lesvos (Griechenland) ein Naturschutzebiet. Vortag - Kurzfassung beim Arbeitskreis Paleobot., Palynol., 17, 19.
Velitzelos, E., Gregor, H.-J., 1990. Some aspects of the Neogene floral history in Greece. *Rev. Paleobot. Palynol.* 62, 291 - 307.]
Velitzelos, E., Zouros N., 1997. The Petrified Forest of Lesvos - Protected Natural Monument
Webring, M. Semi-automatic Marquardt inversion of gravity and magnetic profiles. U.S.G.S., Open-File report 85-122,1985