# 2nd International Meeting of Early- stage Researchers in Palaeontology

**19-22 May 2017**

**Sigri (Lesvos) Greece**

# FIELD TRIP GUIDE

# Introduction

Lesvos is the third largest island of Greece, covering an area of 1.636 $km^2$, and is located in the northeastern part of the Aegean Sea. Lesvos has a 381 km long shoreline and is gifted with a rich natural and geological environment containing geological monuments of international recognition, landscapes of natural beauty, areas of ecological interest and important cultural monuments. The sum of all these natural characteristics is what contributed in the recognition of Lesvos as an important part of the UNESCO Global Geoparks Network.

The long geological history of Lesvos is reflected upon its complex geological structure and the large number of its geosites. Volcanoes, hot springs/ thermal baths, important fossiliferous sites, large faults and waterfalls are only some of the island's geomorphological features.

Lesvos is also known for its biodiversity. Due to the favorable climate conditions, the flora of Lesvos is rather impressive (more than 1.400 different species and subspecies have been identified in the island), while 6 areas have been characterized as Special Zones for the Protection of Birdlife since more than 300 species of birds have been observed on Lesvos (bird migration, nesting, overwintering, seasonal presence).

Lesvos is the birthplace of many important scientists and artists, with the most famous being the poetess Sappho, the philosopher and naturalist Theophrastus, the poet Alkaios, Pittacus the Philosopher, Terpandros the lyrist and the more recent G. Jakobides and the nobelist poet of the Aegean, Odysseas Elytis.

The island of Lesvos is closely related to the famous ancient philosopher Aristotle, as well. In 347 B.C. Aristotle visited the island and was captivated by its wildlife. He investigated the animal life around the lagoon of Kalloni, while his student, Theophrastus, studied the plants. Both men gave birth to the study of biology with their activities. Theophrastus's botanical studies had a significant influence on medieval science, but he also wrote about ethics, logic, biology, physics, mathematics, astronomy and metaphysics.

# General information on the geographical layout of Lesvos

The western peninsula of Lesvos island is dominated by the imposing Petrified Forest, which has been declared a Protected Natural Monument of Greece since 1985. This part of the island is characterized by volcanic rocks and a dry environment. The dominating mountain mass of this part of the island is Ordymnos, which is actually a volcanic dome, while there is also the giant volcanic crater of Vatoussa. The vegetation of western Lesvos is mostly typical Mediterranean- phryganic, but there are also impressive oak- forests in the area.

The northern part of the island, is full of volcanic formations since Lepetymnos, the most important volcanic center of Lesvos, is located in the area, along with two big volcanic domes, the dome of Profitis Ilias and Vigla. Other volcanic formations are: volcanic erosional structures, volcanic dykes, columnar lavas and volcanic calderas.

In the central part of Lesvos, the main feature is the Bay of Kalloni wetland. The Bay of Kalloni wetland is one of the three “Natura 2000” protected areas of the island (along with the Bay of Geras in the east and the Western Peninsula of Lesvos), showing that Lesvos is special not only as a geomorphological repository but as an area of interest for the study of ecosystems, as well.

The south- eastern part of the island is characterized by the mountain mass of Olympos and the peninsula of Amali (where the city of Mytilene is located). The tectonic draft of the Gulf of Geras is located between them, with its impressive eastern faulted shoreline in the area of Larsos (in the broader area of Geras). The climate of the eastern part of Lesvos is not as dry as the west, having huge olive- groves covering most of its area.

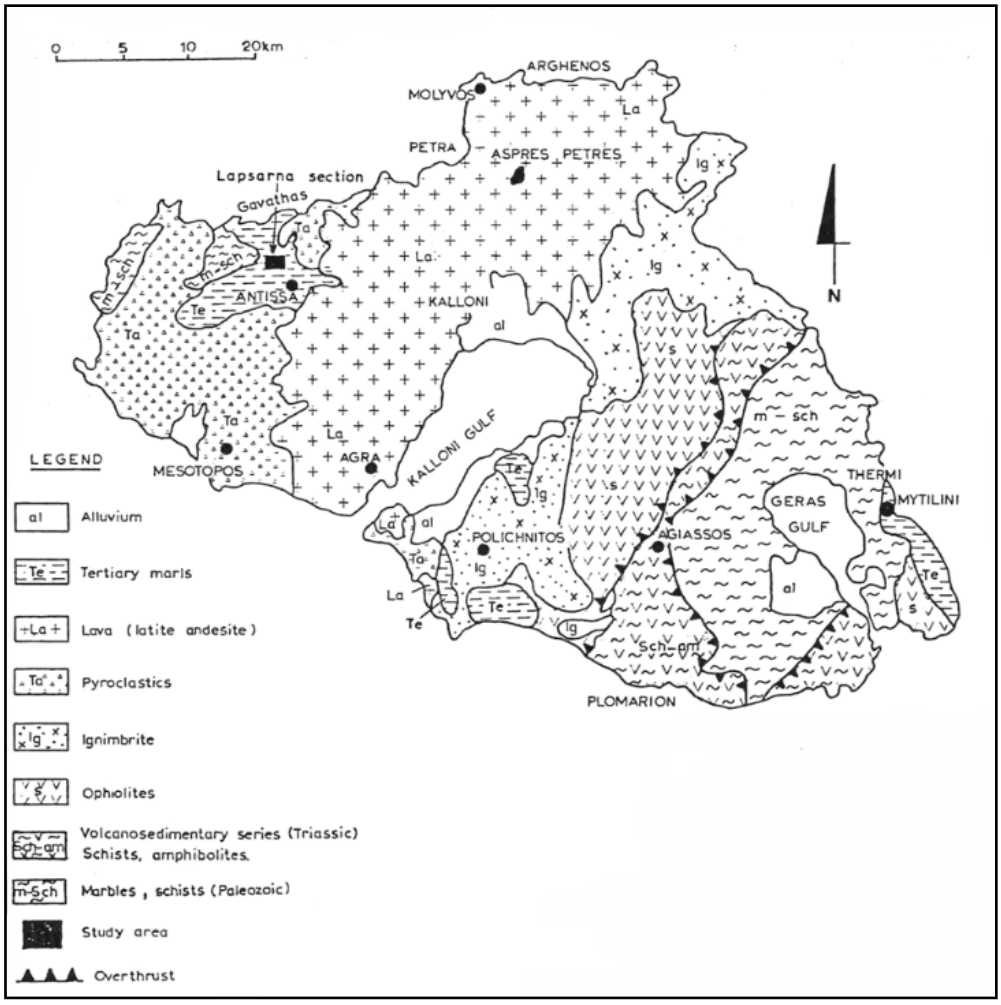
The tectonic window of Olympos.

# The geological history of Lesvos: of rocks and men

Visiting Lesvos, important evidence of the geological history of the Aegean basin for the last 300 million years is revealed. This is why experts, recognizing the value of Lesvos in the protection and enhancement of the world's geological heritage, approved the incorporation of the whole island of Lesvos in the European and Global Geoparks Network creating "Lesvos Geopark" in 2012.

Lesvos Geopark provides information even for the early stages of evolution of the Aegean, when all that was there was a big ocean, the Tethys. The Tethys was an ocean for hundreds of millions of years until it closed 45 million years ago.

At the same time, in the central Aegean there was a mythical land area called Aegiis, which was united with both the Asia Minor hinterland and continental Greece. The Geopark of Lesvos was part of this single land area which was covered by dense tropical – subtropical forests.




Geological map of Lesvos (Kelepertsis & Velitzelos, 1992).

The geological history of Lesvos is inextricably linked with the volcanic activity that took place 21.5 to 16.5 million years ago and led to the creation of the Petrified Forest of Lesvos and large volcanoes, such as those in Lepetymnos, Vatoussa, Agra, Mesotopos and Anemotia. Volcanic eruptions shook the area of modern Lesvos. But the volcanoes were not only cause for destruction, since their activity led to the creation of important geosites and rocks.

The impressive lava domes in Molyvos and Ordymnos and the volcanic neck of Petra have been used by man as locations for the construction, respectively, of the Castle of Mythimna, the Ypsilos Monastery and the Church of Panagia Glykofiloussa, thanks to the resistance of their volcanic materials to weathering.

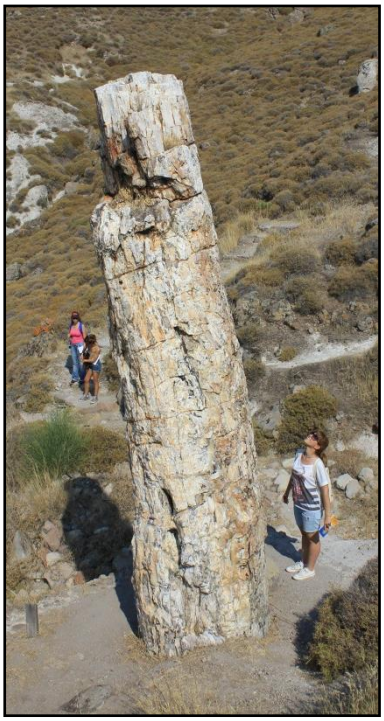
Many minerals and rocks, such as quartz and opal, ignimbrite and andesite, alum, bentonite, lead, zinc, magnesite, constitute valuable natural resources exploited by man over the years. The “alum earth” is a sulphate called alunite, associated with the volcanic activity on Lesvos. It was extracted in ancient times for medical purposes. One of the first natural materials used by man was flint, as evidenced by the archaeological excavations in the area Rodafnidia, near Lisvori. But, one of the first stone tools built and used to grind grains and process the fruit of the olive tree were the millstones made of volcanic rocks, which have played a leading role in the productive economy of the island.

Particular is also the raw material for the creation of the Lesvos ceramics, which have the unique ability to keep water cool. The raw material for their creation is pulverized ignimbrite, a volcanic rock associated with the activity of the large Lepetymnos volcano about 17 million years ago. The ceramics are created with a technique that has remained almost unchanged since the ancient times in the area of Agios Stefanos, in Mandamados.

# The palaeoflora and palaeofauna of Lesvos

In Lesvos, one can find some of the most important fossiliferous sites (of flora and fauna) on a national and global scale.

The *Petrified Forest of Lesvos* dominates the western part of the island and is considered one of the most beautiful and rare monuments of the global geological heritage. The Petrified Forest of Lesvos was created approximately 20 million years ago when volcanic material covered the forest that already existed there, leading to its fossilization. The process was so undisturbed, that many of the fossilized tree trunks were discovered in their original place, still standing atop their root system.



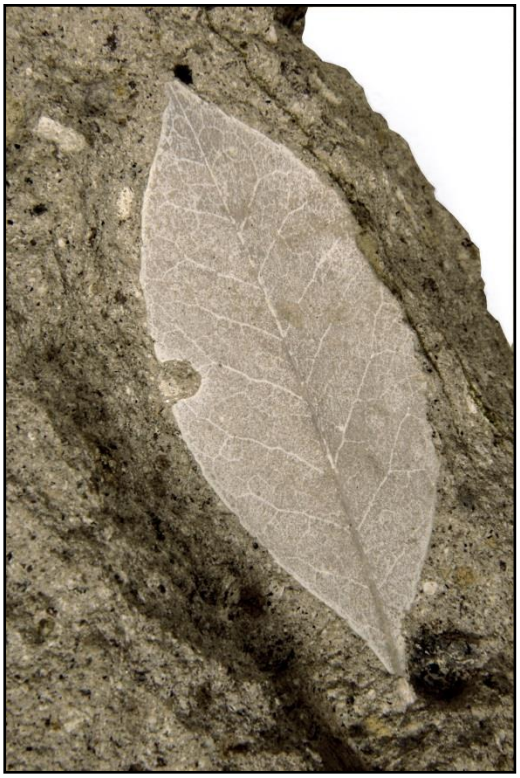
Ancestral form of sequoia tree in the Lesvos Petrified Forest Park.

*Taxodioxylon gypsaceum* tree trunk.

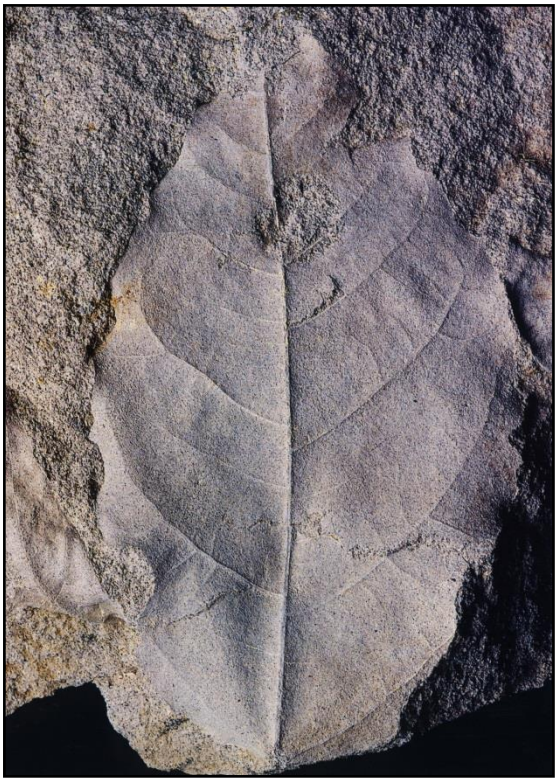
The findings in the Petrified Forest reveal that the area was part of a mixed coniferous and angiosperm forest, along with some pteridofytes.

The conifers include ancestral forms of Sequoia, pine, cypress, yew and other rare species for which there are no modern descendants. Many petrified trunks belong to ancestral forms of the modern species of Sequoia sempervirens, which grows on the west coast of the United States. There have also been identified families of Protopinaceae, which are an ancestral form of modern pine trees, of Cupressaceae and of the rare conifer Kounichamia the Miocene.

The Angiosperms-flowering plants include representatives of the types of poplar, laurel, cinnamon, plane, oak, beech, palm, alder, brier, maple and walnut. A lot of palm trees have been also identified.



*Laurus primigenia*



*Populus balsamoides.*

The research work of the Natural History Museum of the Lesvos Petrified Forest in the last ten years has revealed different vegetation zones in the area of the Petrified Forest of Lesvos, thus composing the paleoflora that existed in the region 20 million years ago.

The composition of the petrified flora indicates that the Petrified Forest of Lesvos developed in a subtropical climate. This changed suddenly into a continental climate with plants characteristic of the subtropics of Southeast Asia or America.

Concerning the *palaeofauna* of the island, the findings of Lesvos are once again impressive.

In the area of Gavathas (NW Lesvos), a jawbone with 10 molars belonging to the extinct proboscidean *Prodeinotherium bavaricum* was discovered in 1999. This is one of the oldest fossils of terrestrial vertebrates found in Greece and the oldest fossil from the Deinotheriidae family found in Europe. The discovery of such a fossil is important not just because it shows the existence of Deinotheriidae in the area 19 million years ago, but because it proves that the north- eastern Aegean (that was a single land area united with Anatolia, at the

time) was part of a dispersal corridor for animals that migrated from Africa to Europe.

In Lapsarna, another important site located nearby, a rich microfaunal assemblage was discovered in a thin stratigraphical layer dating back to the Early Miocene (but not directly correlated with the layer that yielded the deinothere fossil, because tectonism cannot allow the sedimentary layers to be followed). The material found in Lapsarna consisted of shells from lacustrine and terrestrial gastropods, pharyngeal teeth and otoliths from lacustrine fish, bones from amphibians and reptiles and teeth belonging to taxa such as Chiroptera, Erinaceidae, Talpidae, Soricidae, Muridae and Gliridae.

Moving to the southern part of Lesvos, a site rich in Lower Pleistocene remains was discovered in the village of Vatera. Many of the osteological remains that were found, belonged to primitive forms of vertebrates that used to live in Europe and Asia: *Equus* sp. (horses), *Mitilanotherium* sp. (short-neck giraffes), *Gazella* sp. (gazelles), *Gazellospira* sp. (antelopes), *Leptobos* sp. (oxes), *Nyctereytes* sp. (raccoon dogs), *Meles* sp. (badgers), *Homotherium* sp. (dirk- toothed cats), *Stephanorhinus* sp. (small rhinoceroses), *Anancus* sp.(mastodonts) and *Mammuthus* sp. (an ancestor of the large wholly mammoth). The most important remains from Lapsarna, however, are from a large bipedal macaque (*Paradolichopithecus* sp.) and a two- meter long giant tortoise (*Cheirogaster* sp.). This faunal assemblage proves that the area of Lesvos was still united by land with the Asian continent 2 million years ago and became an isolated island much later.

Photograph from the excavation in Vatera.

## Lesvos: a synthesis of different ecosystems today

Concerning its *flora*, it is estimated that Lesvos includes 1400-1500 plant taxa. This natural richness is partly due to the variety of habitats on the island, the quality of rock formations, the long-term human impact, the proximity to Asia Minor (Turkey) and its geologically recent separation from the eastern Aegean.

The southeastern part of the island is full of olive groves. It is the most extensive system on the island and shows clear differences in altitude, age of trees, their population density and the underlying vegetation.

In the area of Agiasos (SE Lesvos) one can observe the only large chestnut tree forest (*Castanea sativa*) which is found on the island. This is a cultivated area, with rich forest floor and significant regeneration rates. The chestnut trees generally grow in the middle mountainous zone among other deciduous trees.

Extensive forests of trachea pine trees (*Pinus brutia*) are also found on the southeastern part of the island. A second type of pine, the black pine (*Pinus nigra*), forms two smaller forests mixed with trachea pine trees, on top of the Profitis Ilias Mountain of western Lesvos.

An important plant species found in Lesvos is the yellow rhododendron (*Rhododendron luteum*), a rare shrub found in the woods between Parakoila and Anemotia (western Lesvos). The only endemic plant on the island is the Lesbian alyssum (*Alyssum lesbiacum*), while there is a great variety of wild orchids, cyclamens, poppies, crocuses and peonies.

*Rhododendron luteum.*

Other species found in the countryside of Lesvos are the wild-olive (*Olea oleaster*), myrtle (*Myrtus communis*), oleander (*Nerium oleander*), the strawberry tree (*Arbutus unedo*), the kermes oak (*Quercus coccifera*), the Pink Rock-Rose (*Cistus creticus*), the tree heath (*Erica arborea*), the laurel of Apollo or bay laurel (*Laurus nobilis*), the weaver's broom (*Spartium junceum*), the downy oak or pubescent oak (*Quercus pubesteus*) etc.

In the woods, the olive groves and the plains, many mushrooms, especially the pefkiti or amanites (*Lactarius deliciosus*) grow during autumn months.

Aromatic herbs of all kinds such as oregano, savory, thyme, sage, mountain tea, lavender, peppermint, spearmint, lime leaves, marjoram, lemongrass etc. are in abundance on the island.

Lesvos, however, is not interesting just for botanologists! Its geographical position is the main reason for its rich *fauna*, as well.

The most important mammal of Lesvos is the Persian Squirrel (*Sciurus anomalus*), a species that lives on the coast of Asia Minor. It is known to locals as Galia.

Weasels, ferrets, foxes, hares, hedgehogs, bats and many kinds of mice and rabbits can be found around the rocky islets of the island, composing the population of mammalian fauna.

In recent years, wild boars (*Sus scrofa*), as well as roe deers and deers, live and breed on the island.

In Lesvos there are also the amphibians: green frogs (*Pelophylax bedriagae*), tree frogs (*Hyla arborea*), the eastern spadefoot or Syrian spadefoot (*Pelobates syriacus*) and the green toad (*Bufotes viridis*).

A great variety of snakes, lizards, tortoises and turtles as well as the unique in Greece *Montivipera xanthina* ("Ottoman viper") live in the island of Lesvos creating an interesting herpetofaunal community.

In the wetland of Larsos the existence of the otter (*Lutra lutra*) is certain.

Concerning the birdlife of Lesvos, there are species that are typical of Eastern Europe and the Middle East, such as the Krüper's Nuthatch (*Sitta krueperi*) and Cinereous Bunting (*Emberiza cineracea*). The Krüper's Nuthatch exists only in Lesvos and nowhere else in Europe. It is rare and is mainly found in pine forests, from the sea to the highest peaks, in the area of Mount Olympos, Achladeri and Akrassi (SE Lesvos). The Cinereous Bunting (*Emberiza cineracea*) is rarer and you can observe it in Eressos and Agra (W Lesvos) as well as in Olympus (SE Lesvos).

The ruddy shelduck (*Tadorna ferruginea*) is rare in Greece and nests in the area of Achladeri (in the NE part of the Kalloni Bay wetland).

Other important species are: the black stork (*Ciconia nigra*) with a few couples on the island. They nest in the pine forests in the area of Akrassi, in Achladeri and in Potamia Valley. In Lesvos there are also white storks (*Ciconia ciconia*) that have decreased in recent years.

On the islets of Lesvos the Audouin's gull (*Larus auduini*) nests and reproduces, a priority species, globally threatened, with special arrangements for the protection of its population. We also note the Eleonora's Falcon (*Falco eleonorae*) and the Lesser Kestrel (*Falco naumanni*), a worldwide threatened species which presents an extremely worrying trend.

The mountainous chukar partridge of the island (*Alectoris chuvar*), which is raised as hunting prey, is particularly interesting

The wetlands of Kalloni and Gera are also rich and important ecosystems for birds. Rare aquatic birds nest in the Kalloni Bay, such as Flamingos (pink flamingos), Black-winged Stilt, Pied Avocet, Eurasian Stone-Curlew, Little Bittern, Kingfisher, Collared Pratincole, Western Marsh Harrier, Tern, Little Tern, etc.

Flamingos in the Bay of Kalloni wetland.

Other rare species that nest on the island are: Rüppell's Warbler, Olive-tree Warbler, Olivaceous Warbler, Pied Wheatear, Rufous-tailed scrub Robin, Masked Shrike, Sombre tit, Western rock Nuthatch, Cretzschmar's Bunting, Long-legged Buzzard, Levant sparrowhawk and Alectoris chukar.

# Field trip main stops

1. *Sigri Petrified Forest Park*

The Sigri Park covers an area of 30 $km^2$ to the south of the Natural History Museum of the Lesvos Petrified Forest. It includes important plant fossils and impressive samples of the volcanic rocks that cover the broader area.

The park is an excellent example of a geotope because of its rarity and the great scientific worth of its plant fossils which contain information not only about the volcanic rock, but also about the geological development of the region.

While walking along the pathways which have been carved out of the hillside, visitors can admire the most valuable finds within the park which are the petrified tree root systems. Root systems of numerous trees have been uncovered well-preserved and in a full stage of development. These roots serve as proof that the trees were petrified in situ. Impressive standing coniferous and angiosperm trunks (*Pinoxylon paradoxum*, *Pinoxylon* sp., *Pinus* sp.) emerging from the layers of volcanic ash and displaying their varied coloration can also be viewed. Sections of a number of fallen petrified trunks have been transferred to the park facilities.

2. *Kalloni Bay wetland*

The Gulf of Kalloni is the largest of the two natural bays of Lesvos. It is located in the central part of the island with a SW-NE orientation. It has an elongated shape with a length of about 20 km and a width of 10 km. It is shallow, with an average depth of 10 m and deepens towards its exit, with a maximum depth of 25 m. It is connected to the waters of the Aegean with a narrow channel, with 4 km length and 1-2 km wide. All these characteristics of its entrance cause the isolation of the bay from the Aegean Sea, giving it particular characteristics., The smaller main rivers of the area outflow in the northern part of the bay, depositing large quantities of portable material in the bay, thus contributing to its shallow depth.

The small inflows of nutrients from the drainage basin area seem to favor the growth of phytoplankton, increasing its biodiversity. The most important marine plants in the bay are *Posidonia oceanica* meadows. Concerning the coastal vegetation *Juncus* spp, *Salicornia* spp. and *Tamarix* spp. are some of the most common aquatic plants found in saline marshes, while in freshwater areas we encounter clusters of reed (*Phragmites australis*) and grasses.

In the gulf there is an abundance of mesozooplankton (zooplankton with a size of 0.2-20 mm) as well, while there are also bivalves, gastropods and cephalopods. Undoubtedly, the most important and most famous fishing

product in the Gulf is the Kalloni sardine, or “papalines”, as the locals call it. Another important fishing product of the gulf is the big shrimp (gabari). Finally, in the area around the bay one can encounter seals and dolphin populations.

In the area nesting or passing species that are threatened and / or uncommon for Greece and Europe. Indicatively, we mention: Flamingos (pink flamingos), Black-winged Stilt, Pied Avocet, Eurasian Stone-Curlew, Little Bittern, Kingfisher, Collared Pratincole, Western Marsh Harrier, Tern, Little Tern, etc.

3. *Barbayannis Ouzo Liquor Distillery and Museum, Plomari*

The Barbayannis family has been passionately pursuing perfection in the taste of greek ouzo and preserving the traditional distillation techniques for five generations. As a result, the Barbayannis name is identified throughout the world for its prime Greek Ouzo, the finest Greek liquor beverage.

Today, in the picturesque settlement of Plomari, Lesvos, technology harmoniously co-exists with history and tradition. The Ouzo Liquor Museum was founded to express the love and passion the Barbayannis family has for the production of ouzo.

The Ouzo Liquor Museum is located next to the modern, privately-owned distilleries of the Barbayannis ouzo production facilities.

In the ouzo liquor museum visitors can see the original equipment used to bottle and label the famous Ouzo Barbayanni Blue, as well as the first alembic, constructed in 1858 in Constantinople, used for testing century-old secrets and techniques, and to compose the recipes of the Barbayannis family. The Ouzo Liquor Museum respectfully embraces tradition and is the home of the secret of the quality and taste found in Greek Ouzo Barbayanni.

The Barbayannis Ouzo Museum includes a visitor’s centre and a gift shop. Audio-Visual shows are conducted in English and Greek. Wine–tasting tours are provided.

# Important geosites of the Lesvos Geopark across the field trip route

Except from the main sites of the field trip, the attendants will have the chance to see some of the many impressive geotopes of the Lesvos Geopark while travelling in- between the three main stops.

## *Sigri Petrified Forest Park- Kalloni Bay wetland:*

<u>New fossil sites on the road between Sigri and Antissa</u>

During the opening of the new road connecting the villages of Sigri and Antissa, the excavations performed by the Natural History Museum of the Lesvos Petrified Forest staff brought to light some very promising and scientifically important findings.

Dozens of large petrified tree trunks, fragments of fossilised tree trunks and root systems and branches of conifers and angiosperms such as pines, oaks, sequins, palm trees, cypress trees as well as volcanic layers rich in a wide variety of leaves such as laurels, cinnamon trees, walnuts and many more, testify to the existence of an extensive subtropical forest in the area.

This is the largest retrieving and protective excavation so far in Greece, both in terms of the area it covers and in the number of its finds.

Ipsilou dome- columnar lavas

With its characteristic conical shape, the volcanic dome of Ordymnos dominates the western peninsula. Formed 16.5 million years ago, it consists of two domes. The northern dome is dominated by columnar lava forms, which were created by the sudden cooling of flaming lava. The southern dome is crowned by the Ypsilou Monastery.

Voulgaris gorge (Vatoussa)

The gorge of the Voulgari River is an impressive ravine carved out of the northwest side of the Vatoussa volcanic crater.

Vatoussa spheroidal erosional landforms

Spheroidal weathering of volcanic rocks occurs along the road between Vatoussa and Skalohori. The cooling of the lava mass causes exfoliation. These formations consist of concentric shell surfaces of the lava rock, made by differential stresses within the rock caused mainly by chemical weathering.

Anemotia volcano

Volcanic lava flows were spilling onto pyroclastic rocks, serving as a witness of volcanic activity in Anemotia.

Filia dyke

The volcanic dyke of Filia is a distinctive landform created by more recent volcanic activity (which began 17 million years ago) on Lesvos. It was formed by the penetration of dacitic lava into the existing volcanic rock.

“Candles” volcanic erosional structures

Landforms of volcanic rocks, namely eroded columnar joints, are found west of the Limonos Monastery.

## *Kalloni Bay wetland- Barbayannis Ouzo Liquor Distillery and Museum, Plomari:*

Ophiolite tectonic nappe

The presence of ophiolitic rocks in Lesvos is a witness to the enormous geological changes in the Mediterranean region. These rocks were formed from magma rising from the bottom of the Tethys Ocean. The collision of the Eurasian and African tectonic plates led to the destruction of the ocean and the placement of the ocean floor rocks on top of the continental margin of Eurasia. Pine forests now grow over the ophiolite rocks in Central Lesvos.

Larsos fault

One of the active faults on Lesvos, the Larsos fault, has created an impressive fault scarp engraved with the traces of the tectonic shift. The south part has sunk to form the marshlands of the Evergetoula delta. A water transport channel, which is part of the Roman Aqueduct of Mytilene, was curved into the surface of the Larsos fault.

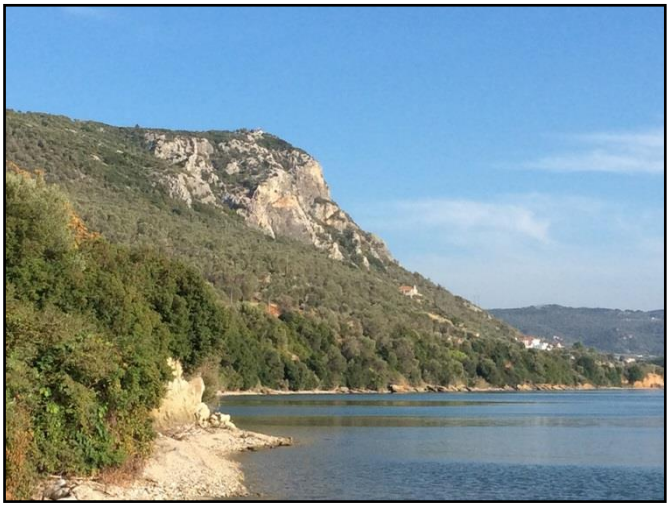
Tria Marmaria- Kryfti gorge

The gorge of the Panagia Krifti was curved out of metamorphic rocks. It is connected with the large thrust fault and placement of ophiolites onto the basement rocks of Lesvos. The steerp cliffs of the southern coasts of Lesvos have been formed due to the faults and the intense tectonic movements. Moreover, the hot springs in Krifti owe their creation to the fact that rain water penetrates deep into the earth's crust through these faults and rises to the surface again.

## *Barbayannis Ouzo Liquor Distillery and Museum, Plomari-Mytilene:*

Gulf of Gera fault

Major geological fault lines created the tectonic submergence of the Gulf of Gera. The NW- SE faults of the bay of Gera form a zone which is of particular importance because of its proximity to the city of Mytilene. The maximum potential of an earthquake is 6.5 Richter. Along these faults, extending south to the village of Loutra and north to the village of Pigi, hot springs appear in the Therma region of the Gulf of Gera.



Alyfanda dyke

An impressive example of the penetration of magmatic material into older metamorphic basement rocks of Lesvos appears in Pagani. The walls of the quarry show the dyke penetration of volcanic material into a thick layer of crystalline limestones, which does not reach the surface as it is covered by a top layer of limestone.

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# 2nd International Meeting of Early- stage Researchers in Palaeontology

## FIELD TRIP
## Monday 22 May 2017

### *Stop 1: Sigri Petrified Forest Park*

Important geosites on the Sigri - Kalloni Bay route:

1. New fossil sites on the road between Sigri and Antissa
2. Ipsilou dome- columnar lavas
3. Voulgaris gorge (Vatoussa)
4. Vatoussa spheroidal erosional landforms
5. Anemotia volcano
6. Filia dyke
7. “Candles” volcanic erosional structures

### *Stop 2: Kalloni Bay wetland*

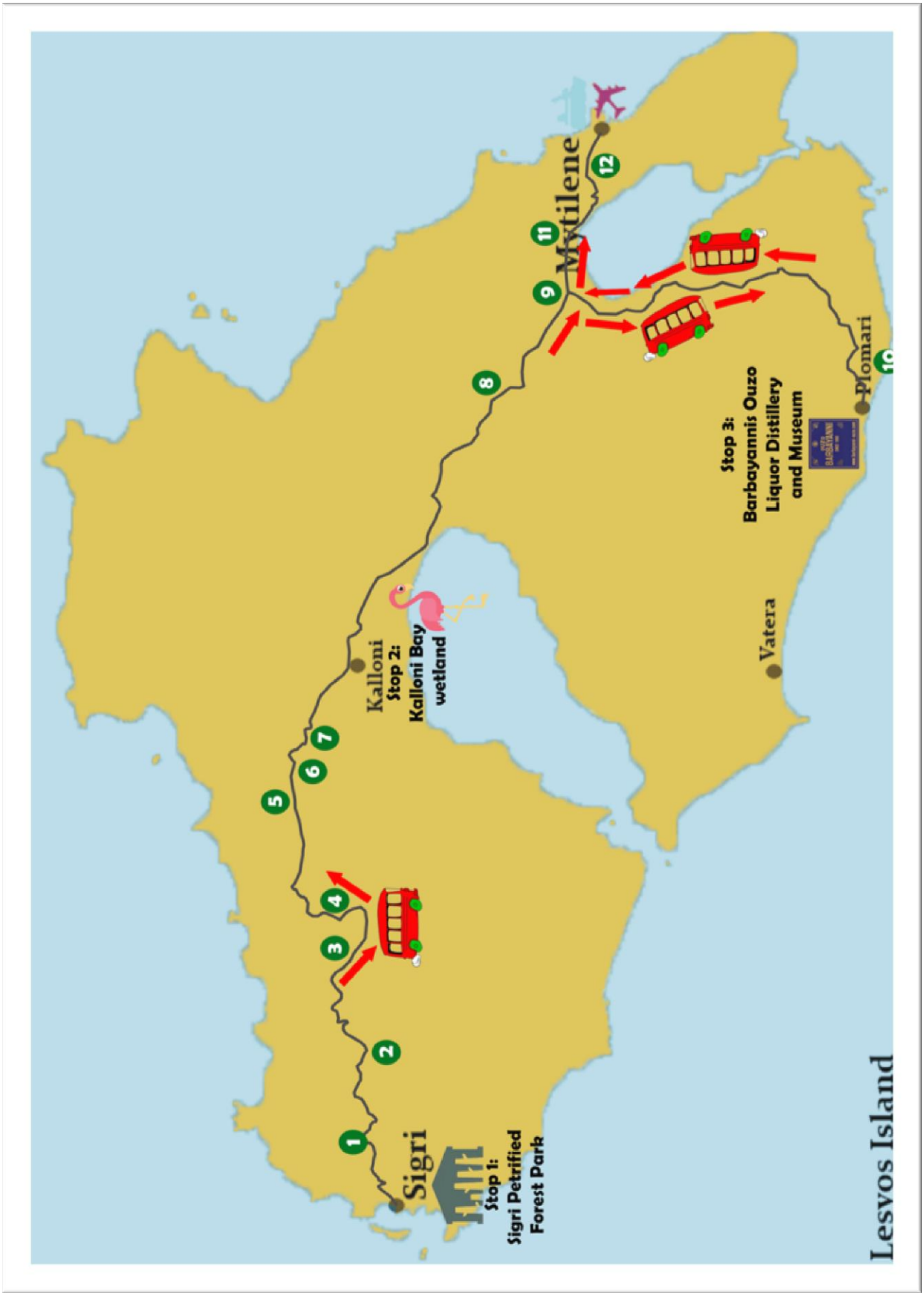
Important geosites on the Kalloni – Plomari route:

8. Ophiolite tectonic nappe
9. Larsos fault
10. Tria Marmaria- Kryfti gorge

### *Stop 3: Barbayannis Ouzo Liquor Distillery and Museum, Plomari*

Important geosites on the Plomari- Mytilene route:

11. Gulf of Gera fault
12. Alyfanda dyke


Lesvos Island
Sigri
Stop 1:
Sigri Petrified
Forest Park
Kalloni
Stop 2:
Kalloni Bay
wetland
Mytilene
Vatera
Plomari
Stop 3:
Barbayannis Ouzo
Liquor Distillery
and Museum
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## Contributors

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