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Thrace, the Dardanelles and Adjacent Islands

To the ancient Greeks the boundaries of Thrace were largely undefined, but it was seen as lying north and east of Macedonia and reaching as far as the Danube and the Black Sea. It thus included what is today north-east Greece, Turkey-in-Europe, and Bulgaria. Much of the western part is wild and mountainous, but is rich in minerals, especially gold, and also timber, cereals and vines. The original people were distinct from the Greeks; they were largely peasants and hunters, and worshipped different gods.

For long the Greeks never penetrated the hinterland, although they planted a few colonies along the coast, whence they bought timber, hired mercenaries and conducted slave-raids. In addition, the people of Thasos exploited the mines of gold and silver under Mt Pangaion at the western end of Thrace. In 342 BC the land was conquered, with difficulty, by Philip II of Macedon, who had his eye on the gold mines. In less than a century it was again independent, until incorporated in the Roman Empire in AD 46. But even the Romans never succeeded in taming the wild Thracians.

Western and central Thrace are dominated by the Rhodope mountains, which rise to 2,278 m and extend into Bulgaria (Fig. 12.1). To the east lie the lowlands of eastern Thrace in Turkey. The Strymon river follows a broad valley, but the other rivers flow in narrow valleys that only open out towards the sea, where the Nestos river has built a considerable delta.

The core of the Rhodope mountains is made up of the Rhodope massif, a series of sedimentary and igneous rocks formed during the Mesozoic or Palaeozoic periods and metamorphosed at high temperatures into amphibolites,

gneisses and marbles. They are divided from the essentially similar rocks of the Serbo-Macedonian massif to the west by the Strymon thrust fault, which runs along the eastern side of the Strymon basin. The age of the initial metamorphism is not clear, but it certainly took place well before the Alpine compressions. The isopic zones of the Hellenides which now make up the Greek peninsula (e.g. Pelagonian, Vardar, etc.) originally lay to the south-west of the massifs as a series of low islands, ridges and ocean floor. The Alpine compressions forced these blocks against the Rhodope and Serbo-Macedonian massifs, which were a more rigid block. Metamorphosed sedimentary and igneous rocks of the Circum-Rhodope zone extend from east of the Serbo-Macedonian massif southwards to the islands of Samothrace and Lemnos, and then north-eastwards to the eastern part of Greek Thrace.

The Eocene period brought a number of changes to this area. When the Alpine compressions ceased the crust was too thick to support its own weight and 'collapsed' along faults to produce overall extension of the crust. This may have been enhanced by the presence of a subduction zone to the south. This extension produced a number of basins, particularly in the east. Initially these basins accumulated only sediments, but soon magmatic activity began. Some of these magmas reached the surface as lavas but others solidified at depths of a few km to produce granites.^{124, 129} The largest volcanic field is near Koityli, and extends for 1,500 square km, mostly on the Bulgarian side of the border. Here most of the rocks erupted as hot volcanic ashes, which welded themselves together to form ignim-

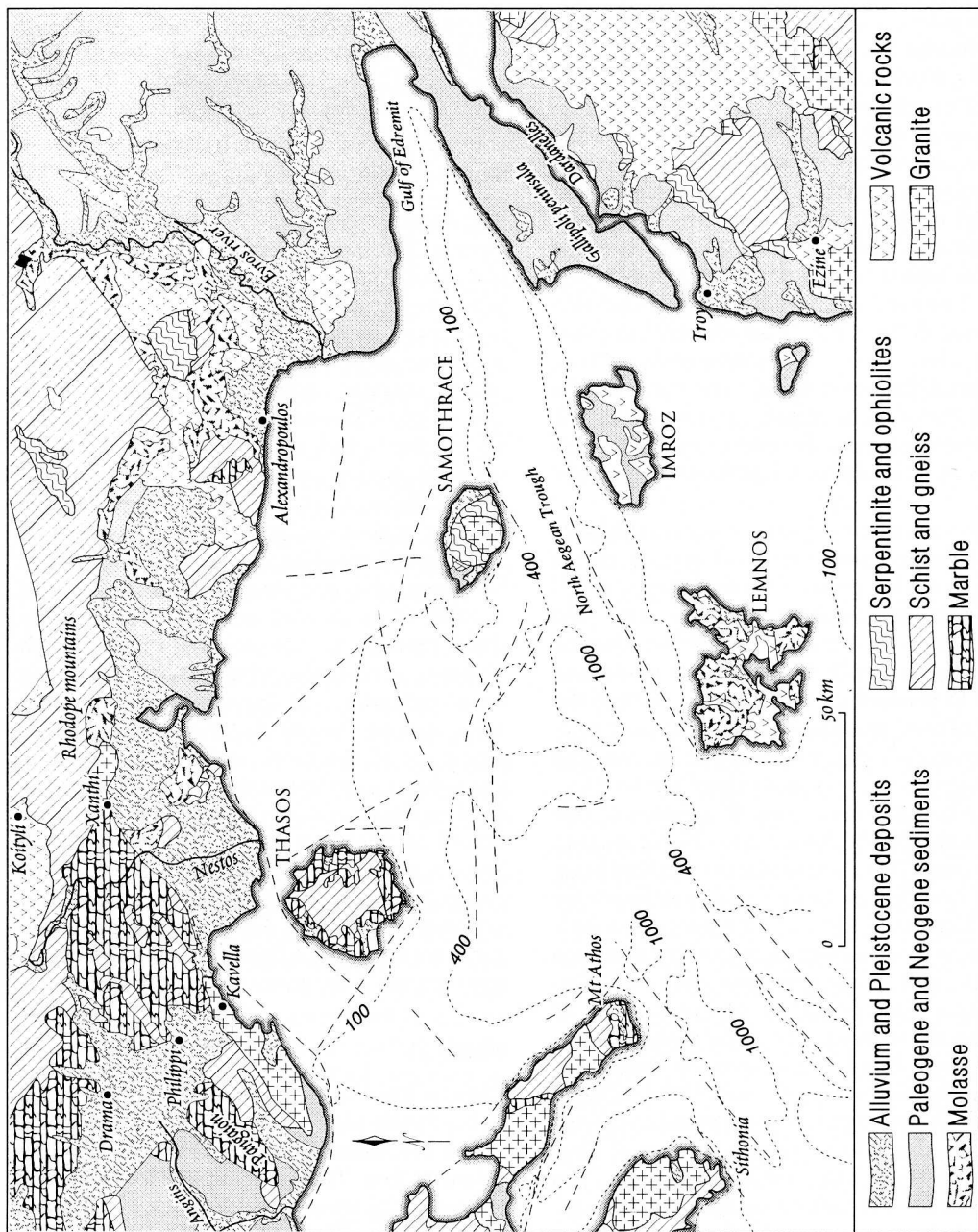


Fig. 12.1. Thrace, the Dardanelles and adjacent islands.

brites. Another similar basin 20 km to the east also extends across the border. Extensive volcanism also occurred at the same time in the area north of Alexandroupolis. By the Miocene period volcanism had migrated to the south (see Chapter 13).

Here, as elsewhere in the Aegean, Neogene crustal extension was an important factor in the shaping of the land. In the west the broad valleys of the Strymon and the Angitis rivers are grabens, oriented north-west/south-east, parallel to those of mainland Greece and the Peloponnese. The Prinou basin, to the north of Thasos, seems to run at right-angles to this trend. The northern part of this basin contains the great delta of the Nestos river, but it extends offshore to the south-west, where petroleum has been found. The basin to the east in Turkey is, in essence, a wide graben, but it appears to be slightly older than most in this region as it contains Oligocene sedimentary rocks.

There are many deposits of gold in the rocks of the Rhodope massif, but most of these are too small, or too low grade to be worth mining (but see Mt Pangaion below). However, some gold ore has been eroded and transported, and the gold concentrated by the action of streams and rivers to produce placer deposits. Most of the rivers of northern Greece once had placer gold, but these deposits were easy to extract and were worked out very early (see Chapter 11).

The major, recent tectonic element of this area is the North Anatolian – North Aegean Fault zone. This feature starts near Kariliova, in eastern Turkey, and extends westwards for some 1,200 km.²¹² The western part of the fault now traverses the Aegean as the North Aegean Trough, and terminates near Skiathos. This fault is a plate boundary and now takes up rightward horizontal motion between the Anatolian and Black Sea plates. It originated during the Miocene as a result of the collision between Arabia and Eurasia. Initially the fault had three branches: through the Sea of Marmara, to the north and to the south. The northern branch further splayed out and created a broad region of subsidence, the Thrace basin of north-west Turkey. This branch later became inactive, along with the southern

branch, and activity was concentrated on the central fault. Since inception there has been at least 85 km of rather irregular movement along the fault zone: periods of intense seismic activity, with frequent 6-7 magnitude earthquakes, are separated by quiet periods of about 150 years.²⁴⁵ The last seismic period started in 1939 and continues to the present day.

The Gorge of Stena Petras

The Angitis river (ancient Angista) drains the Drama (Philippi) basin and flows through a spectacular gorge to the Serres basin, where it joins the Strymon river (Fig. 12.1). This region is a horst, formed by the subsidence of the basins on either side. It is made of Rhodope massif marbles, overlain by Neogene marls and other sedimentary rocks. Rapid uplift has caused the bed of the river to cut downwards, incising original meanders into the soft Neogene sediments in the west. However, the eastern part of the gorge, the Stena Petras, cuts through marbles and another mechanism has been proposed: the river originally ran parallel to its present course, but a few hundred metres to the south-east, through Neogene sediments, where it had carved a broad meander.¹⁷ At the same time the river water seeped through fissures in the Rhodope limestone to the north-west. This route was more direct, and hence steeper. With time the fissures developed into caves which finally diverted all the river water, a process termed 'stream auto-piracy'. The roof of the cave became thinned by further erosion and eventually collapsed, leaving the steep-sided gorge we see today. All that remains now of this cave system is the gorge and a natural bridge.

Philippi

Philippi lies about 15 km inland from Kavalla, in the fertile plain of Dato (Fig. 12.1). Here a Greek settlement ('Krenides') was founded by colonists from Thasos about 360 BC to exploit the newly-discovered gold mines of Mt Pangaion nearby. Four years later Philip II of Macedon captured the city, fortified it, and renamed it Philippi after himself. The gold

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mines were intensively exploited and gave Philip a vast income, but were exhausted when the Romans got here in the second century BC. However, Philippi retained its importance as a station on the Via Egnatia, the new Roman road to Byzantium (now Istanbul); it guarded the narrow gap where the road passed between the hill and a marsh.

To the north of Philippi lie mountains of Mesozoic metamorphic rocks, largely marble with minor mica-schists, of the Circum-Rhodope zone: to the south and east opens the wide valley of the Angitis river (Fig. 12.1). This box-like graben was formed by the intersection of north-west and north-east trending faults. It is cut off from the Aegean by a ridge of granite, on which stands the city of Kavalla. The floor of the graben is subsiding at approximately the same rate as it is filling up with sediment, hence much of the valley was marshy until it was recently drained. The partly decayed vegetation accumulated to form deposits of peat covering about 700 square km. Deep down, at the base of these deposits, heat, pressure and time have transformed the peat into lignite, a form of low-grade coal.

The acropolis and other parts of the ancient city were constructed on a small spur of marble, 311 m high, projecting out from the mountains to the north (Fig. 12.2). Most of the actual city was built on a cone of alluvium shed from the valley to the east. This valley was produced by preferential erosion of softer schists.

The water that rises in the springs, from which the original settlement of Krenides took its name, originally fell on the marble hills to the north. The water descended below the surface into fractures and caves and flowed downwards to the valley. Here it is forced to the surface by less permeable mica-schists or by the shallow water-table, and appears as springs.

Mt Pangaion

Mt Pangaion (1,958 m) was famous in antiquity for its oracle of Dionysos and for the gold and silver mines in its neighbourhood, whose production peaked in the reign of Philip II. The

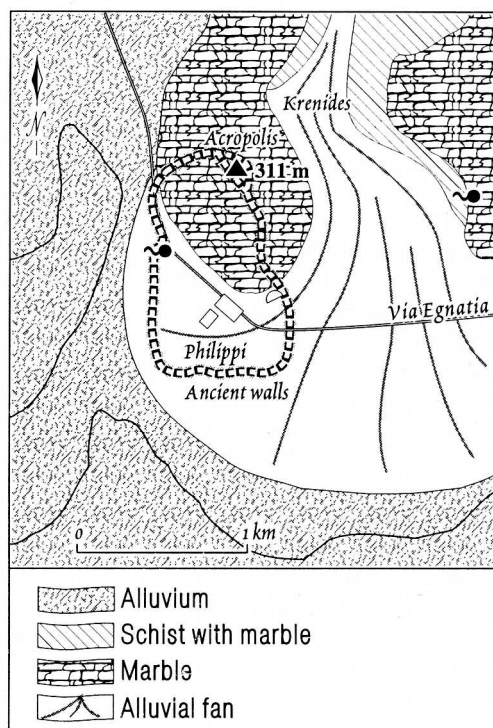


Fig. 12.2. Philippi.

mountain is part of the Rhodope massif, and the Pangaion block has been isolated from the rest of the massif by Neogene faulting, which produced the grabens of the Strymon and Angitis rivers (Fig. 12.1). It is a horst of marbles and gneisses, intruded by a series of granites, with the upper parts dominated by white marble. The gold and silver ores are in quartz veins, together with pyrite and arsenopyrite, in the gneiss.¹⁷² Hot water, probably associated with the metamorphism or the intrusion of the granites, circulated deep into the earth and extracted a number of minerals, including gold and silver, from the surrounding rocks. These minerals were redeposited in veins as the waters cooled. Some gold was also extracted from placer deposits in the surrounding streams and rivers.

Thasos

Thasos, the northernmost of the Aegean islands, is exceptional in its plentiful water supply and consequent luxuriant vegetation, and in its delightful climate. A range of mountains, rising to over 1,200 m, runs across the island from north-east to south-west. From antiquity it has produced metals, marble, timber, wine and olive oil and today grows tobacco.

The earliest inhabitants were Thracians, and it was not till about 700 BC that there was a Greek presence, in the form of colonists from Paros. The colonists grew rich from the gold mines on the island (which, however, were soon exhausted) and on the mainland opposite, under Mt Pangaion. They also produced marble, silver, lead, iron and copper. In 340 BC the island was captured by Philip II of Macedon and remained in Macedonian hands until taken by the Romans in 196 BC. In the Middle Ages it was under Genoese rule, before falling to the Turks in 1455.

The island of Thasos is separated from the mainland by a channel 8 km wide and less than 100 m deep, and is surrounded by a broad, shallow shelf of the sea-floor that continues south to the North Aegean Trough (Fig. 12.1).

Thasos is almost completely made up of gneiss, schist and marble of the Rhodope massif, as on the adjacent mainland to the north (Fig. 12.3).²⁷⁹ These metamorphic rocks started out as a series of sedimentary rocks, such as limestone, dolomite, sandstone and clays together with some volcanic rocks. They have been metamorphosed and deformed several times. The age of the earliest, and most important, metamorphism is not known, but was probably several hundred million years ago. The last metamorphism was associated with the Alpine mountain-building event about 60–35 million years ago.

Faulting about 15 million years ago during the great Neogene extension of the Aegean region dropped down the south-west corner of the island, west of Limenaria, to produce a small basin. Here conglomerates accumulated, formed by the erosion of rocks towards the island's interior. Since then the only sedimen-

tation has been in the lower parts of the river valleys.

The town of Thasos (Limen)

The Greek colonists built a number of cities on the island, of which the principal, also known as Thasos, was on the north-east coast; it possessed two good harbours and a distinctive acropolis with three peaks. It is still the capital and is known either as Thasos or Limen ('The Harbour').

The modern town of Thasos was built on the site of the ancient city, on the western side of a peninsula of gneiss and marble (Fig. 12.4). Gneiss forms the outcrops near the sanctuary in the northern part of the site as well as the slopes of the southern and eastern parts of the city. The western part of the city is built on alluvium deposited by a river that drains the interior of the island.

The acropolis is made of marble, which is slightly more resistant to erosion than the gneiss and hence forms the higher land. The oldest marble quarries on the island are on the westernmost of the three peaks, which form the acropolis.¹¹² These quarries furnished marble for the walls and buildings of the acropolis.

There is an ancient gold mine under the south-west peak of the acropolis, with entrances about 100 m east of the Parthenon Gate and near the Sanctuary of Pan.¹⁸⁵ The ore is in veins close to the contact between the marble and gneiss (see above) and includes quartz, pyrite, limonite and chalcopyrite. At the time of Herodotus it was only second in importance to the mines at Kinyra.

Silver, gold and iron mines

A number of deposits of gold, silver and iron as well as antimony and zinc occur in the western part of the island, along a line from Cape Salonikos to Cape Prinou (Fig. 12.3). These deposits are generally found in intensely fractured dolomite marbles. The ore minerals crystallised from weak, watery solutions that formed during the metamorphism.

Metamorphism tends to produce dryer rocks and the water in the original rocks must

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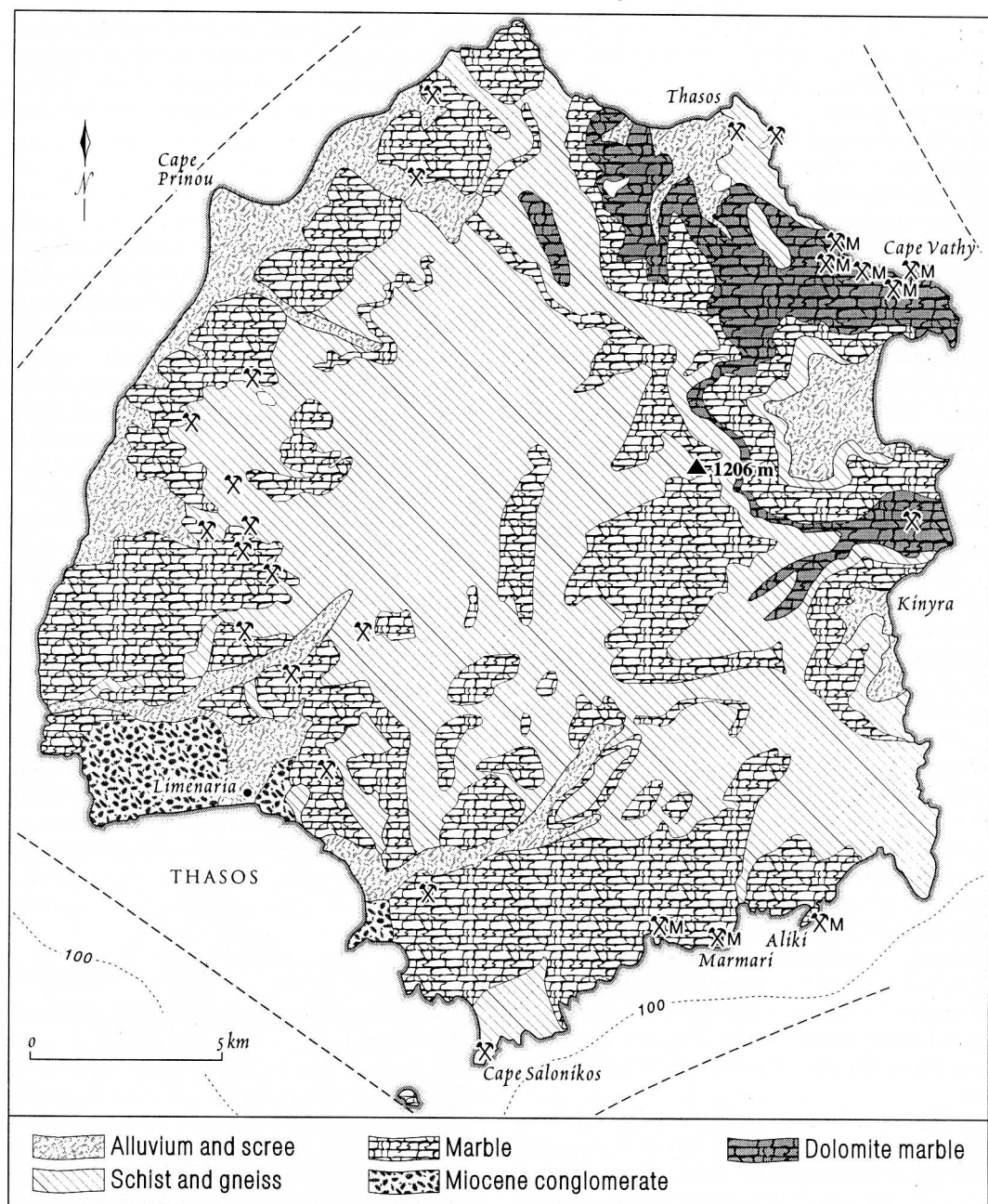


Fig. 12.3. Thasos. Marble quarries are indicated with an 'M'.

escape. The water tends to use any existing channels, such as faults, to escape upwards. In Thasos the major alignment of deposits suggests that there is a major fault that cuts the island and guided the fluids. This water contains many metals in solution, such as lead, zinc, copper and gold. As the fluid rises upwards it cools and minerals start to crystallise. Different minerals will crystallise at different temperatures, giving a series of different mineral deposits. Changes in the chemistry of the host rocks may also cause precipitation of minerals. All the mineral deposits of Thasos were deposited from such watery solutions. The metallic 'flavour' of the deposit depends on the temperature of crystallisation and the chemistry of the rocks. However, almost all deposits tend to be close to faults and also close to changes in the rock composition, such as gneiss-marble.

The ancient miners tended to exploit the upper parts of the mineral deposits where oxidation by the air and water changed the original mineralogy, and increased the concentration of metals in the ore. Thus at Thasos the mineral cerussite was mined for lead.^{75, 214, 274}

The gold mines near Kinyra, visited by Herodotus in the fifth century BC, were considered the most important, although there were others.⁴⁸ Much of the gold occurs in veins and layers rich in iron and copper sulphides, but modern investigations have found the highest concentrations in sediments filling cavities in the marble.^{273, 285} These cavities form by solution of the carbonate minerals in percolating rainwater, exactly as caves form in limestones. Streams that run through these passages wash in gold-bearing sediments. This process is very similar to that which forms placer gold deposits.

The iron deposits of Thasos have a long history of exploitation: in Palaeolithic times red ochre (hydrated iron oxide) was extracted for cult purposes.²⁸⁴ Its underground exploitation produced one of the largest Palaeolithic mines in Europe. From the ninth century BC onwards extraction of iron ore for the production of metal became important. Sources were limonite/haematite ores, associated with other sulphide ores (see above) and beach sands rich in

magnetite and ilmenite (iron-titanium oxide).

Many of the ancient mines were reopened during the nineteenth century for the exploitation of zinc and antimony, elements little used in antiquity.

Marble quarries

Thasos was well-known in antiquity for its white marble, known to the Romans as *Marmor Thasium* and to modern Italian masons as *Marmo Greco Livido*. Typically coarse-grained and translucent, it was quarried at many places on the east coast (see below). In Greek times it was used for architecture and sculpture, and in the seventh and sixth centuries BC Thasos maintained a flourishing school of sculpture. In the third and second centuries BC Thasian marble was extensively used for new buildings in the Sanctuary at Samothrace. In Roman times it was particularly in demand for sarcophagi.

The earliest marble quarries are a series of small shallow pits on the westernmost peak of the acropolis of Thasos town (Fig. 12.4).^{112, 147} Quarries at Cape Phanari, immediately to the east, are much larger, with faces up to 50 m long. The floors of these quarries, and many others along the coast, are presently under-

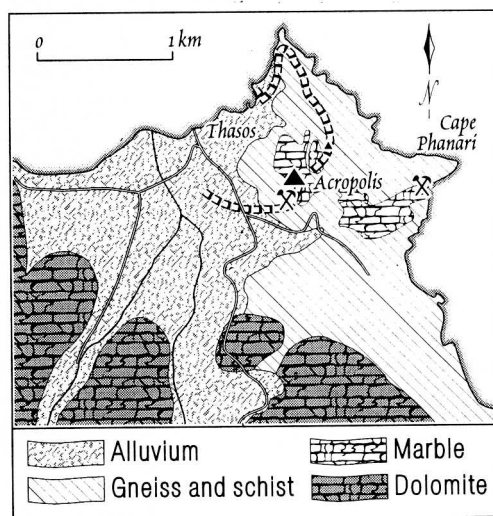


Fig. 12.4. Thasos town.

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water, indicating that sea-level has risen since ancient times. The marble here is made of very large crystals of calcite, with minor graphite colouring the grey marbles. Other ancient quarries north-west of Cape Vathy have been partly destroyed by modern exploitation. However, some ancient quarries can be seen, partly submerged, along the coast, containing many unfinished pieces of sculpture. The marble is made of relatively fine-grained dolomite rather than the coarse calcite seen in the other quarries. This is to be expected as dolomite normally tends to be more fine-grained than calcite after metamorphism under the same conditions. This is the only place in the Eastern Mediterranean where dolomitic marble was exploited in antiquity.¹¹²

The largest ancient quarries on the island, and indeed some of the largest exploited in antiquity, were on the south-eastern coast at Alikí (Fig. 12.3). They were first operated in the sixth century BC when the temples on Thasos were constructed. By Roman times Alikí marble was one of the most popular in the empire. A rise in sea-level in the seventh century AD drowned some quarries, but production continued until Ottoman times. Here the marble is in beds up to 300 m thick and is faintly banded.¹¹² The layers slope at about 15° towards the sea, facilitating extraction of the blocks of marble. The marble here is made of calcite, with traces of graphite in the greyish bands, as well as quartz and mica.

Samothrace

The island of Samothrace, a strange and lovely place, was a religious and commercial centre from very early times. Its importance was largely due to its situation on the sea-lane between Greece and the Bosphorus and thence to the Black Sea. It has one small harbour, Kamariotissa, on the western tip; but it is well-watered and produces much fruit and (as it always has) the best onions in Greece. In the centre Mt Phengari ('The Mountain of the Moon') rises steeply to a height of 1,664 m. From the summit, according to Homer, the god Poseidon watched the battle raging on the Plain of Troy. Samothrace was first inhabited

by Thracians from the mainland, who were joined by Greeks in about 700 BC from the island of Lesbos. It rapidly grew rich from its situation and its fertile soil, and from the Mystery Religion of the Great Gods, which was celebrated at Palaeopolis.

Samothrace is set on the southern edge of a broad shelf, less than 100 m deep, which extends all the way to Thrace (Fig. 12.1). The steep slopes of the south-eastern coast continue underwater to depths of about 1,000 m in the North Aegean Trough, an extension of the North Anatolian Fault zone which divides the European tectonic plate from the Turkish and Aegean plate to the south. This fault is very active, accounting for the many earthquakes in this region. The island itself is a horst, probably related to movements along the North Aegean Trough.

The oldest rocks exposed on Samothrace are a series of Late Jurassic ophiolite suite rocks, mostly metamorphosed gabbros and slate, with minor Late Jurassic-Cretaceous limestones and marbles (Fig. 12.5).^{54, 265} These rocks are part of the Circum-Rhodope belt, a series of sedimentary and metamorphic rocks thrust over the Rhodope massif, which continues into eastern Thrace. Mt Phengari, the highest point of the island, is dominated by metamorphosed gabbro.

Two granite intrusions in the central and southern parts of the island are about 28 million years old. Volcanic rocks are widespread and were erupted in two episodes, before and after the granites. In Late Eocene times (42-35 million years ago) volcanic ashes were erupted. This magmatism was related to extension of the crust following thickening during the Alpine compressions.¹²⁹ These rocks are now deeply weathered and/or altered by fumaroles. Volcanism restarted about 20 million years ago with the eruption of andesites, rhyodacite and trachyte lava flows and domes. Again, the volcanism may have been related to crustal extension or possibly to subduction of oceanic crust to the south.

Pliocene to recent marine deposits at lower elevations complete the map.⁵⁴ A hot spring on the north coast near Loutra is related to one of the deep horst-faults that have elevated the

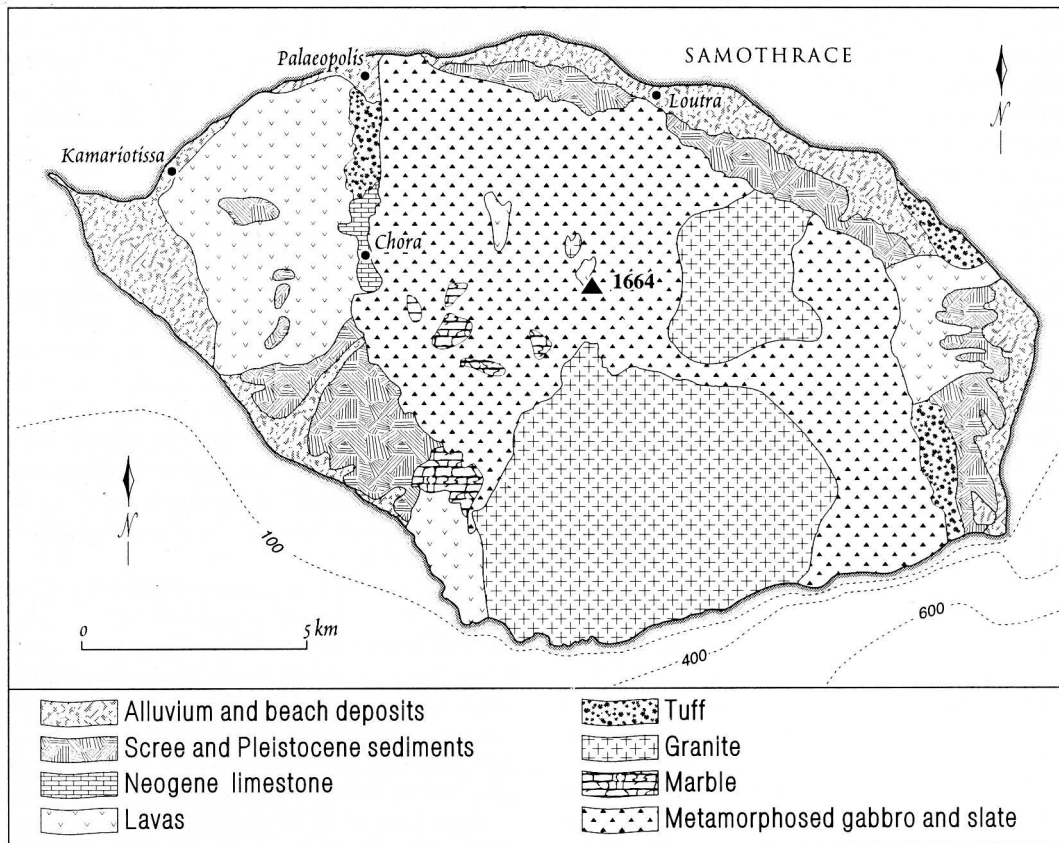


Fig. 12.5. Samothrace (after 54).

island above the surrounding sea-floor. This spring is said to have medicinal properties and has been frequented at least since Byzantine times.

Palaeopolis

The first settlement on Samothrace was located at Palaeopolis because of the presence of springs and a small cove. However, it is better known for the ruins of the Sanctuary of the Mysteries. The Mysteries were available to all, men and women, slave and free; they offered to the initiate good fortune in this life, especially when braving the dangers of the sea, and life and happiness after death. The Sanctuary was specially honoured and beautified by Alexander the Great, his successors and finally the

Romans. In AD 200 it was badly damaged by an earthquake but was soon restored. Nevertheless, decline set in soon afterwards, and towards AD 400 the Sanctuary was closed on the official adoption of Christianity.

The lower parts of steep hill west of the Sanctuary are underlain by grey-green slates, formed by the metamorphism of clay-rich sediments (Fig. 12.6). Further east are a series of metamorphosed basalts and gabbros. Both rocks are part of the ophiolite complex. Breccias formed from the metamorphosed basalts, now cemented by red chalcidony and green chlorite, occur sporadically and are probably associated with a major north/south fault that defines the western edge of the ophiolite massif in the central part of the island. The springs are probably also related to this fault.

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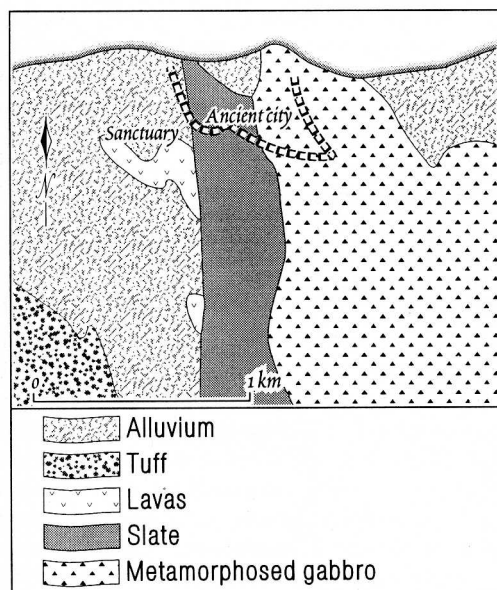


Fig. 12.6. Palaeopolis.

Much of the Sanctuary is underlain by an Eocene volcanic rock, rhyodacite porphyry, which also crops out sporadically all over the western part of the island. This rock contains large crystals of white sanidine, pink orthoclase, as well as plagioclase, biotite and hornblende. The overall colour varies from grey to green-grey and red-grey, depending on the amount and character of the alteration. It was used for the construction of buildings as well as altars. Other construction materials include local yellow limestone and white marble from Thasos.

Lemnos

The island of Lemnos, situated in the centre of the north Aegean, is almost bisected by two large bays. The western half, which is hilly rather than mountainous, is barren; the eastern half, lower-lying and more fertile, grows a certain amount of corn and vines. But the chief product of Lemnos, from antiquity onwards, was Lemnian Earth (see below).

There are many legends associated with Lemnos: the god Hephaestus (Vulcan) set up

his forge here when thrown out of Olympos; Jason and the Argonauts were welcomed by the Lemnian women, who had recently murdered their husbands and were looking for male company.

To turn to history, the prehistoric site of Poliochni (its ancient name is not known) was of great importance. This city closely resembled the First and Second Cities of Troy (3000-2300 BC), and was even more magnificent. Later, Lemnos seems to have been inhabited by Thracians, then in the fifth century BC by people apparently related to the Etruscans of central Italy. Their capital, Hephaestia to the Athenians, was on the Bay of Pournia. Finally, it was from Mudros that the British Expeditionary Force set out for the disastrous Gallipoli campaign in 1915.

Lemnos stands on a shallow underwater plateau, an extension of the Turkish coast 60 km to the east (Fig. 12.1). Indeed, 20,000 years ago, when sea-level was much lower than it is now, Lemnos was not an island but a peninsula of the Turkish coast. This underwater plateau descends steeply to the north-west to the North Aegean Trough (see below). To the south and south-west the sea-floor shelves gently away.

Lemnos is unusual amongst the Aegean islands in that the oldest rocks exposed are Eocene to Oligocene sandstone and marl (Fig. 12.7). These rocks, known as molasse, were deposited on land, or in shallow lakes, adjacent to a rising mountain range.⁵³ Rocks with a similar origin are found in central Macedonia and crop out at the Meteora.

Although the blacksmith god Hephaestus is associated with the island there is no evidence of recent volcanic activity. However, about one third of the island is now covered with volcanic rocks, which started to erupt during the Early Miocene, about 20 million years ago. This volcanism continued for about 2 million years, and was roughly contemporary with widespread volcanism on Lesbos, other islands and, most importantly, western Turkey.⁹⁰ Most of the volcanic rocks are andesites and dacites. Lava domes and flows predominate in the west, especially near the port of Myrina. Tuffs are more common in the central and eastern parts of the island.

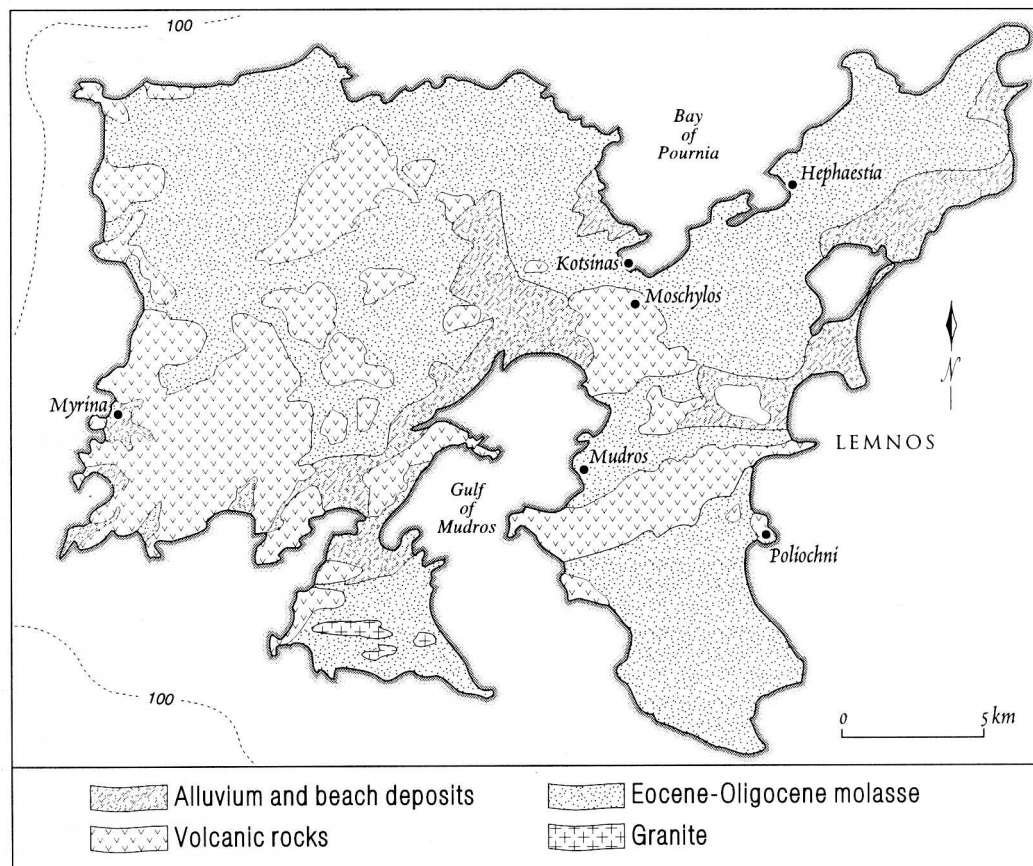


Fig. 12.7. Lemnos (after 53).

The port of Myrina (formerly Kastro) is completely surrounded by ancient volcanos: the small headlands to the north and south are both lava domes, and there are flows towards the interior. The ancient site of Poliochni was also constructed on a small headland of volcanic rocks, in this case tuffs and not lavas.

The bays of Mudros and Pournia are not volcanic in origin, but are probably tectonic features produced by north-east/south-west faults, probably splays of the North Aegean Trough. Similarly the hot springs on this island are not related to the volcanism as this ceased much too long ago. Instead they are produced by the deep circulation of water in faults.

Although few earthquakes are centred di-

rectly beneath Lemnos, the North Aegean Trough to the north is an active transform fault and produces many earthquakes, some of them strongly felt on Lemnos.

Lemnian Earth

Lemnian Earth is a red loose sediment, which occurs at Moschylos near the Bay of Pournia (Fig. 12.7). It was widely exported from antiquity down to the nineteenth century for its medicinal properties, and is still used locally. It was known to the Romans as *Terra Sigillata* or 'stamped earth', as it was made into little cakes, stamped with the head of Artemis.

Lemnian Earth is a form of ochre, a material rich in hydrated iron oxides, deposited from

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former springs. Rainwater falling on the nearby volcanic tuffs soaked into the rock and broke down the minerals. Iron was liberated and dissolved in the water. Where the springs debouched the iron was oxidised by the air and precipitated as ochre. Similar ochre springs have been culturally important in many parts of the world.

The Dardanelles and the Sea of Marmara

The recent geological history of north-west Turkey has been dominated by the effects of movements along the North Anatolian Fault, which now runs under the Sea of Marmara and north of the Dardanelles (Figs. 12.1, 12.8). This fault divides the European plate to the north from the Anatolian plate, which comprises most of Turkey, to the south. It has dominantly horizontal motion (strike-slip), but where it crosses the Sea of Marmara a change in direction of the fault has produced extension. This has produced a rapidly subsiding graben (basin) in the northern part of the sea, with a maximum depth of 1,000 m, which has accumulated some 3-4 km of sediments during the

Neogene period.⁷⁹ Islands in the southern part of the sea (including Marmara) are made of granite and metamorphic rocks, including marble, hence the name of the sea.

The main branch of the North Anatolian Fault zone does not go through the Dardanelles, as might be expected, but instead passes to the north, across the neck of the Gallipoli peninsula and into the Gulf of Edremit (Saros). The Dardanelles probably follow another old, inactive splay of the fault.

During the last glacial period, when sea-level was more than 100 m below the present level, the Black Sea and the Sea of Marmara were freshwater lakes, and the Dardanelles were a valley down which flowed a great river that drained these lakes. This changed about 10,000 years ago when rising sea-levels turned the Dardanelles into the open marine channel that we see today. However, several major rivers flow into the Black Sea and there is a swift current down the Dardanelles into the Mediterranean Sea.

The hills on either side of the Dardanelles are made of Late Tertiary sediments, deposited when this area was below sea-level. The

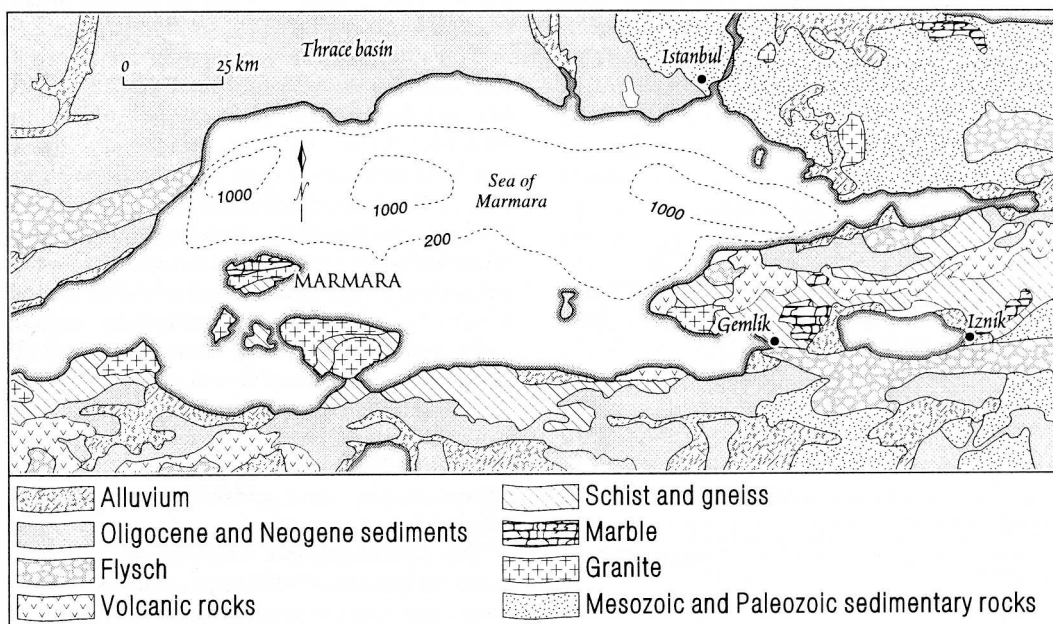


Fig. 12.8. The Sea of Marmara.

shapes of these hills are the results of erosion produced during the great fluctuations in sea-level throughout the last few million years.

The generally low-lying northern margins of the Sea of Marmara are made of Oligocene and Neogene sedimentary rocks deposited in the Thrace basin. The steeper relief to the south is underlain by schists, gneisses, marbles and granites. Miocene volcanic rocks are also abundant here.

Marmara island

The city of Proconnesus (now Marmara), in the south-west of Marmara island, was founded from Miletus about 700 BC and continued into the Middle Ages, thanks to abundant supplies of excellent marble on the island (Figs. 12.8, 12.9). The quarries, mostly on the north-east coast near Saraylar,¹⁶ were exploited from the sixth century BC, but not intensively until the foundation of Constantinople in AD 330 and for the next three centuries.

The marble was known to the Romans as Marmor Proconnesium or Cyzicenum, from the city of Cyzicus on the adjacent mainland. It was very popular in antiquity as it has widely-spaced joints and hence could be extracted in large blocks. The most common type, used for architecture and sarcophagi, is coarse-grained

and greyish-white, with parallel bands of blue or grey. A plain bluish-white variety was used for sculpture. A third variety, pure white and fine-grained, was suitable only for mosaics, as it is always badly cracked. The age and origin of the marble deposits are unknown.

Troy

The ancient city of Troy, or Ilion, was situated at a strategic point on the Dardanelles, known in antiquity as the Hellespont (Fig. 12.1). It is represented today by a low mound, known as Hissarlik or Truva, on a plateau bounded by the Kara Menderes river (ancient Scamander) and the Dümrek stream (ancient Simois). The mound constituted the entire Bronze Age city, but was only the acropolis of the Greek and Roman cities.

The most important legend is that of the Trojan War, as narrated by Homer in the *Iliad*: King Priam lived here with his queen and fifty sons. His son Paris brought the fair Helen here after abducting her from her husband Menelaus in Sparta. The ensuing war, fought for her recovery, lasted ten years and was won by the Greeks by means of the stratagem of the wooden horse.

The site has been occupied for a long time: the first city dates from about 3000 BC. This city was destroyed in 2500 BC and replaced by another, which was much more magnificent. The vast amount of gold plate and jewellery found there has led to the belief that there were local sources of gold, but they have not yet been identified. The next important stage was the sixth city, which was built about 1800 BC and destroyed, perhaps by an earthquake, around 1250 BC. It was a grand place, with well-built walls, wide streets and strong towers, and probably corresponds, in part at least, to Homer's Troy. Alexander the Great captured the city in 334 BC, and it achieved a degree of greatness that lasted under the Romans till at least the sixth century AD.

The site of ancient Troy lies 30 m above sea-level on a bluff of Neogene sediments between the Kara Menderes river and Dümrek stream (Fig. 12.10). These rivers rise in the hills of Paleozoic and Mesozoic metamorphic

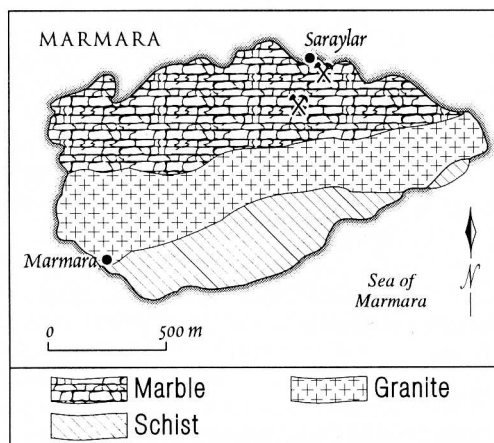


Fig. 12.9. Marmara.

12. Thrace, the Dardanelles and Adjacent Islands

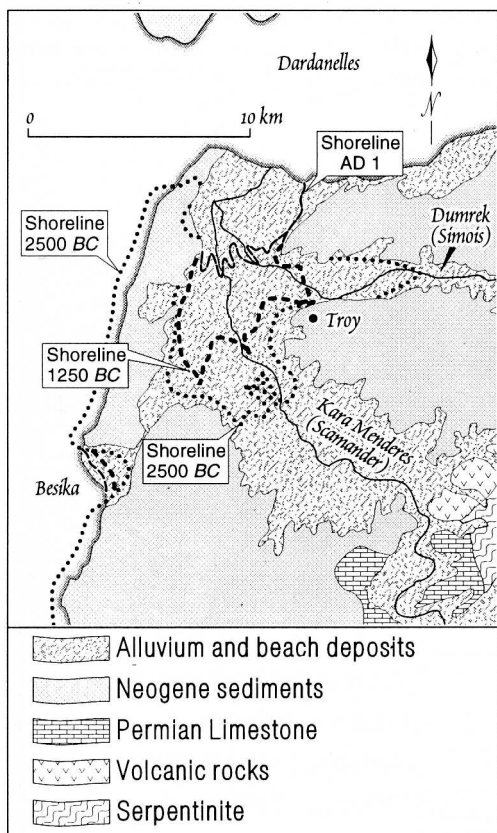


Fig. 12.10. Troy (after 154 and other sources).

rocks and ophiolites, and Tertiary volcanic and plutonic rocks towards the interior. They flow out onto a low plateau, commonly 60 to 125 m above sea-level, composed of Neogene sediments deposited in an earlier graben parallel to the present Dardanelles. A recent intensive drainage programme to stabilise the bed of the Kara Menderes has almost eliminated the floods that regularly turned this valley into a lake. However, this has also made it more difficult to understand the role and importance of sediments deposited by the river.

At the peak of the last glaciation, 20,000 years ago, when sea-level was about 120 m below the present level, these rivers were tributaries of a great river that drained the ancestral Black Sea, then a lake, and flowed

down the Dardanelles to the Aegean Sea. The beds of these tributaries were deeply incised into the plain.^{154, 229}

The waning of the Ice Age produced rapidly rising sea-levels, and by 8000 BC the Dardanelles had become marine. At this time the valley of the Kara Menderes river was a broad, low-lying plain. Further rises in sea-level caused the sea to encroach up the river valleys, reaching a maximum around 5000 BC. At this time the lower 15 km of the Kara Menderes was a shallow muddy and sandy estuary. From then on sea-level, now almost stable, could not keep pace with the rising of the floor of the valley produced by deposition of sediments from the rivers: the river delta began to recover lost ground and advanced towards the Dardanelles.

At the end of the first settlement, about 2500 BC, the city was surrounded on three sides by a broad sandy and muddy estuary which abounded in fish and shellfish. At the time of the Trojan War (if it actually occurred), about 1250 BC, the delta had advanced towards Troy and lay to the south-west. It is possible that there were low-lying swamps around the base of Troy at this time. If the Trojan War did take place, the battles must have been fought south and west of the city, on the plain of the river delta. By Strabo's time (first century BC/AD) Troy was about 3 km inland, but there remained a sandy estuary to the north. Since then the delta has advanced further to the north, until prevented from further advance by the erosive effects of the currents that flow along the Dardanelles. The long history of deposition of sediments in the valleys, as the delta advanced, means that any ancient settlements on the flood plain will have been deeply buried by at least 10 m of sediment.

The story of infilling of a bay was repeated at Besika, 10 km south-west of Troy (Fig. 12.10).¹⁵⁵ In antiquity the bay here may have been sufficiently deep to provide an alternative access to Troy, and may have been used by the Greeks in the Trojan war.

Istanbul and the Bosphorus

The city strategically placed on the borders of Europe and Asia and at the junction of the Sea of Marmara and the Bosphorus, was known successively as Byzantium, Constantinople and Istanbul (Figs. 12.8, 12.11). Roughly triangular in shape, it is bounded on the west by Thrace, on the south by the Sea of Marmara, and on the north-east by the superb deep-water harbour known as the Golden Horn.

Under the name of Byzantium, it was founded as a colony of the Greek city of Megara about 650 BC and grew rich from agriculture and the plentiful fish of the Bosphorus. It endured Persian occupation in the sixth century BC, and was incorporated in the Roman Empire in AD 73. In AD 330 the Emperor Constantine the Great rebuilt and fortified the city as eastern capital of his newly-Christianised Roman Empire, and it soon acquired the name of Constantinople, after its founder. It remained the capital of the Eastern Roman (Byzantine) Empire until the Turkish conquest of 1483. Thereafter, until 1923, it was the capital of the Turkish Empire.

The Bosphorus is 0.5-3 km wide and 50-120 m deep. It is an ancient river valley, probably formed during the Pleistocene, when sea-level was much lower. At that time the Black Sea was a lake which drained, along the Bosphorus, into the Sea of Marmara lake. The Golden Horn was a tributary valley. Rising sea-levels drowned these valleys and they probably became marine around 8000 BC.

Istanbul is largely built on Devonian sediments, including dark grey and black limestones, which continue to the north on either side of the Bosphorus, almost to the Black Sea (Fig. 12.11). Here Late Cretaceous volcanic rocks crop out on either side for about 3 km. Palaeozoic sedimentary rocks also continue to the east, where they are cut by two granite intrusions. To the west of Istanbul the Palaeozoic rocks descend below Tertiary sedimentary rocks which are a peripheral part of the Thrace basin.

The main construction material for Istanbul during Roman and Ottoman times was the

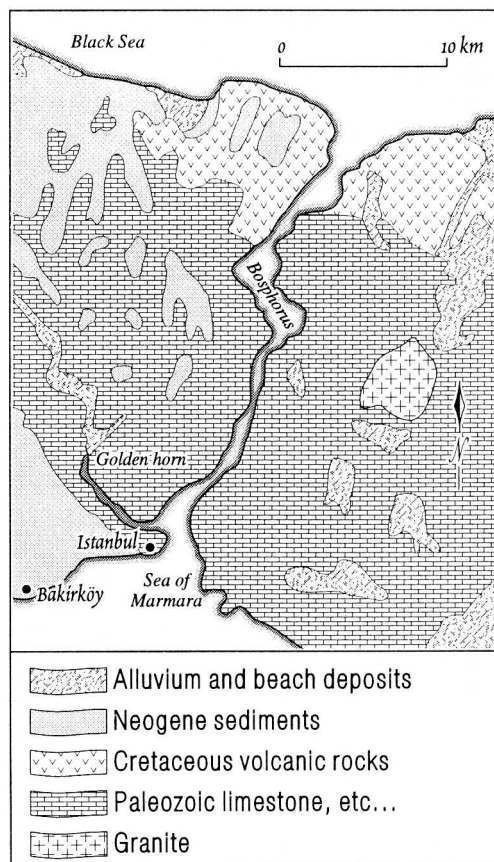


Fig. 12.11. Istanbul and the Bosphorus.

Bakirköy limestone. This grey, fossiliferous limestone of Miocene age was extracted from extensive quarries about 10 km west of the city centre, now buried under urban developments.⁸⁰ Marble from Marmara island was also used extensively, as well as decorative conglomerates from Hereke (Herakleia) and Karacabey, and red fossiliferous limestone from Gebze, south-east of Istanbul.

The Black Sea is a remnant of an oceanic basin that formed in Cretaceous time between a continental land-mass to the north and an island arc to the south, rather like the Japan Sea today. Alpine compressions destroyed part of the basin, and turned the island arc into the Pontide mountains south of the Black Sea. Since the formation of the

12. Thrace, the Dardanelles and Adjacent Islands

Black Sea Basin about 15 km of sediments have been deposited here.¹⁰⁴ The Black Sea receives much more water from its rivers than

is lost from evaporation. The excess flows down the Bosphorus to the Sea of Marmara, creating an important current.