

Thessaly and the Northern Sporades

Thessaly is a land of wide plains and high mountains: Mts Olympos, Ossa and Pelion to the east; Mt Othris to the south and the Pindos range to the west (Fig. 9.1). It is drained by the river Peneios, which rises in the Pindos range and runs south and then east and through the Vale of Tempe between Mts Ossa and Olympos, and into the Thermaikos Gulf. The climate is somewhat continental, and the rich soil supports cattle and sheep in addition to its horses, and produces excellent crops of cereals.

Thanks to its remarkable fertility, the Thessalian Plain was settled as early as the Neolithic period, about 5000 BC. Archaeology and legend agree in placing its greatest days in the Mycenaean period, 1600-1100 BC. Here, the story goes, lived Achilles and his Myrmidons. Here, at Iolkos (modern Volos) Jason was believed to have built the good ship Argo to capture the Golden Fleece. Here archaeologists have found rich Mycenaean tombs and a royal palace. After this, Thessaly was always prosperous, but never again as important.

Most of the older rocks of this region are from the Pelagonian, Sub-Pelagonian and Pindos zones. The Pelagonian zone is now exposed in the northern and eastern parts of the region, from the Gulf of Pagasae (Paragassitikos) north-westward past Mt Olympos (Fig. 9.1). This continental fragment was a ridge or shallow sea for much of its history, hence there was relatively little sedimentation, and the rocks that formed were mostly limestones. However, the older metamorphic core of this ridge is now widely exposed, and is composed of marbles, gneisses and schists (see below). The Sub-Pelagonian zone lies parallel to the Pelagonian zone from Mt Othris to north of Kalambaka. It is the remains of an ancient continental mar-

gin comprising deep-water limestones and the underlying igneous rocks of the adjacent oceanic crust, now altered and slightly metamorphosed. The Pindos zone underlies the south-western part of the region, including Mt Pindos. It started as a deep ocean basin, where limestones accumulated. Later, during the Alpine regional compression, it was filled with flysch sediments shed from the adjacent rising mountain chains. These compressions continued and finally thrust the Pelagonian and Sub-Pelagonian zones south-west onto the Pindos zone in the late Eocene period.

Slightly later, during the Oligocene and Miocene periods, compression changed to extension, with two effects:²⁴⁰ the sedimentary rocks were stripped off the continent along flat-lying normal faults, exposing the core of metamorphic rocks, principally schists and marbles, beneath. Secondly, a trough formed within the mountain chain from Thessaly to Albania. Once formed, the trough immediately started to fill up with sediments shed from the adjacent mountains.¹⁹⁰ Much ended up in the deep water along the centre of the trough. However, some were also deposited at the edges of the trough in alluvial fans and deltas. The speed of erosion, and the short distance of transport of the sediments did not give many opportunities for reduction in size of the sediments, hence conglomerates are especially common. Such sedimentary rocks are called molasse, and up to 5 km accumulated in this region. It is these rocks that crop out in the Kalambaka region (see below). A somewhat similar situation is now present in the Gulf of Corinth.

Neogene stretching affected this region, as elsewhere in the Aegean. North-east/south-

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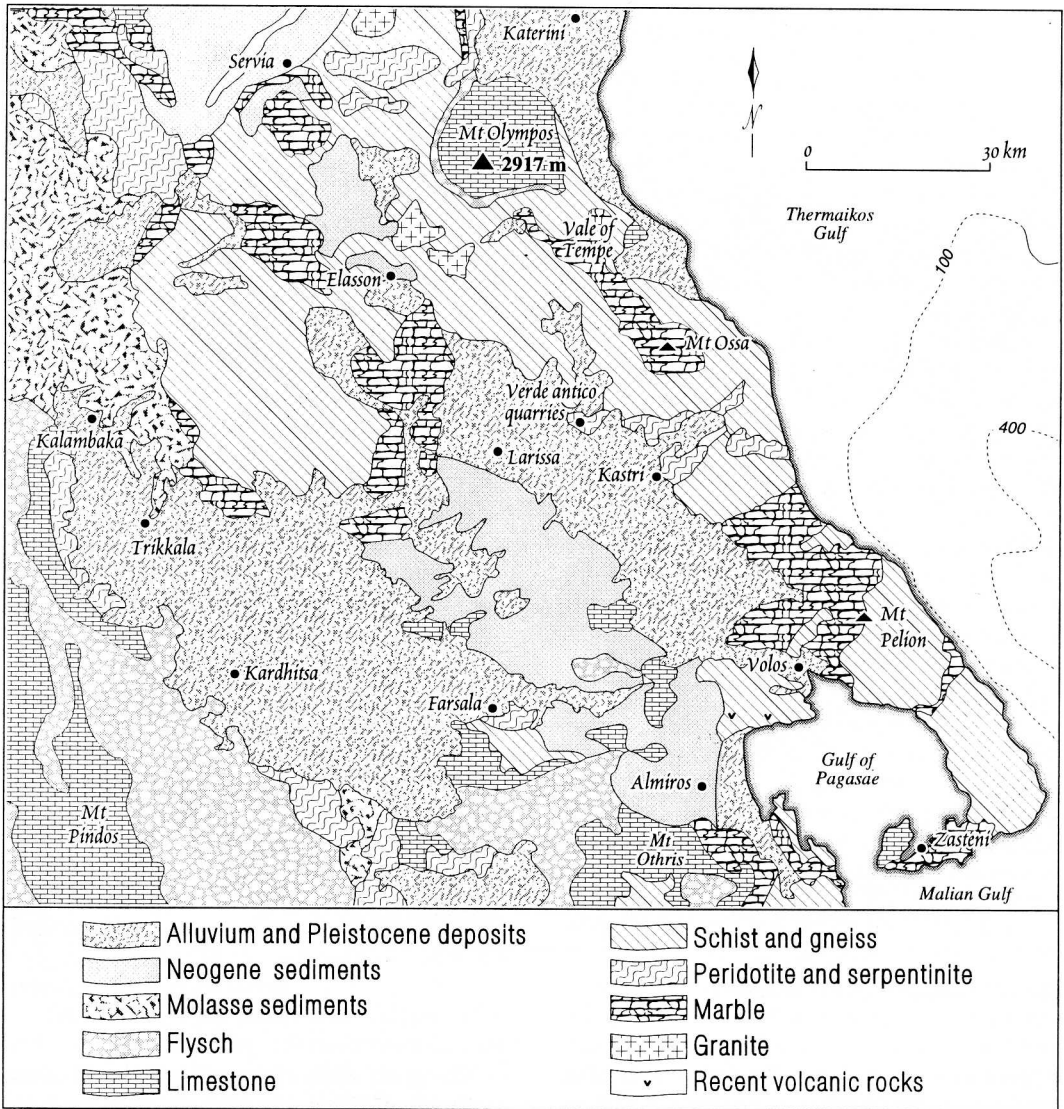


Fig. 9.1. Thessaly.

west tension produced a series of horsts and grabens parallel to the earlier isopic zone boundaries. A high horst from Mt Olympus to Mt Pelion and a lower horst from Almiros to Kalambaka separate two broad interior grabens and the Thermaikos Gulf graben. The fertility of these valleys reflects the rich alluvium shed from the surrounding mountains and the abundant, perennial water supply.

Kalambaka and the Meteora

The Meteora form one of the most remarkable sights in Greece. The word means 'suspended in mid-air', and refers to the lofty pinnacles rising up from a remote corner of the Thessalian Plain to a height of 450 m, topped in many cases by monasteries. The earliest were built in the fourteenth century by monks who

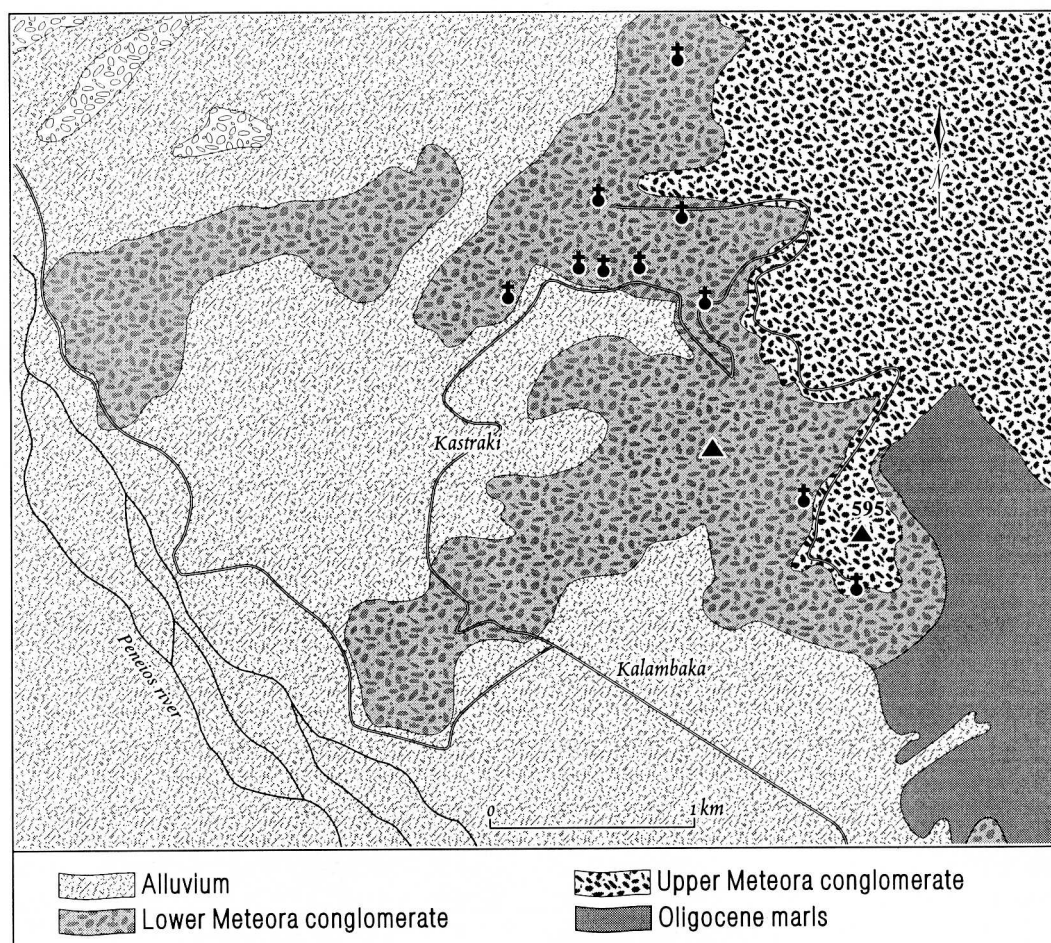


Fig. 9.2. Kalambaka and the Meteora.

wished to worship God and mortify their flesh, far from the world below. In their heyday there were 24 monasteries, perched on their almost inaccessible pinnacles and reached by means of rickety ladders or in baskets suspended from ropes. Today only five are occupied, and these can now be reached by steps cut in the rock.

The valley of the Peneios river, south of the Meteora cliffs, is an asymmetrical graben, formed during the Neogene stretching of the Aegean region (Fig. 9.1). The south-western side of the graben is a fault, but much of the movement on the other side has been accommodated by bending of the rocks.

The great cliffs and stacks of the Meteora are made of Oligocene-Miocene conglomerate with layers of sandstone and shale (Fig. 9.2, Plates 9A, 9B).¹⁹⁰ The steepest parts of the cliffs are dominated by conglomerate of the Lower Meteora formation. Many different rock types are represented in the pebbles of this rock, including limestone, marble, serpentinite and metamorphic rocks, all set in a hard greenish matrix. These rocks are spectacularly cross-bedded, typically descending at an angle of 15-20° to the south-west.

Some of the highest parts of the cliffs, together with the area covered with vegetation to

the north-east, are made of a slightly different type of conglomerate, together with layers of sandstone and marl, called the Upper Meteora formation. These rocks were deposited on top of the Lower Meteora formation following a short period of erosion. They are more easily eroded, which is why they form better soils, and have been removed from most of the rocks near the escarpment. They are also well-bedded, but the beds are almost horizontal or descend in the other direction from the Lower Meteora conglomerates, towards the north-east.

These conglomerates formed from sediments deposited in the deltas of streams flowing south-westward from the mountains. As the delta built up, southward-flowing streams cut down into the existing deltaic sediments, forming wide channels, that were later also filled with sediments. The combination of these processes has created the pattern of beds that we see today.

The rocks of the Meteora have acquired their striking shapes through weathering, along almost horizontal and vertical planes, and erosion.²⁹³ Although the conglomerate resists weathering, the gently sloping layers of sandstone and marl are easily altered. These tend to erode, ultimately isolating blocks of rock at the top of cliffs and creating rounded boulders that appear to have been carefully balanced on the underlying pinnacles. Less extreme erosion of these layers on cliffs produces overhangs or caves.

Weathering also occurs along almost vertical joints in the rocks, creating the pinnacles and steep cliffs. The grandeur of the scenery is partly due to the wide spacing of the joints, up to 100 m, which has defined large, resistant blocks of rock. The paucity of joints in these rocks is because they have never been deeply buried. There are two intersecting sets of joints, oriented north-west/south-east and north-east/south-west. Weathering along these joints, and erosional removal of the material by streams and torrents has formed the jagged landscape of the Meteora.

Mt Olympos, Mt Ossa and Mt Pelion

The mountain ranges of Olympos, Ossa and Pelion run in an almost continuous chain along the western shore of the Thermaikos Gulf (Fig. 9.1). Mt Olympos (2,917 m), in the north is the grandest and highest mountain in Greece. There were many other mountains of this name in Greece and Asia Minor, but this was by far the most famous. It was revered by many as the home of Olympian Zeus and the other gods and goddesses. Others believed that they lived in the sky above Olympos; a belief which gave rise to the legend that the Giants tried to storm Heaven by piling Ossa on Olympos and Pelion on Ossa, an idea without geological support. Olympos was also associated with the Muses. Ossa (1,978 m) was venerated as the home of the Nymphs and from its western slopes the Romans and Byzantines obtained the ornamental green stone known today as Verde Antico (see below). Pelion (1,651 m) is the most fertile of the three mountains, and was believed to be the home of the mythical man-horse hybrids, the Centaurs.

The Olympos-Ossa-Pelion range is a Neogene horst between the Larissa graben to the west and the huge Thermaikos graben to the east (Fig. 9.1). Much of the latter lies under the waters of the Thermaikos Gulf, but continues to the north-west into the Plain of Thessaloniki.

The massif of Mt Olympos is a tectonic window, or hole in the Pelagonian zone, through which we can see the rocks of the underlying Parnassos zone. The surrounding Pelagonian zone rocks consist of a series of thin nappes of ophiolites, gneiss, schist and less metamorphosed sedimentary and volcanic rocks, that continue southwards to the Pelion peninsula. Ascending the mountain, we actually descend the geological succession and pass over a thrust fault into the Parnassos zone. The massif is dominated by a series of Upper Triassic to Eocene limestones in the north-east that pass eventually, in the west and south, into Eocene flysch. The remarkable relief of Mt Olympos is partly due to recent uplift, and partly due to the more resistant nature of its bedrock, limestone, as compared to that of the surrounding

gneisses. Mt Olympos, together with Mt Ida on Crete, are the only parts of Greece that were glaciated.

The summit of Mt Ossa is made of marble, but the lower slopes are dominated by schist (Fig. 9.1). Serpentinite (see below) only occurs in the low lands to the south of the mountain. Although the northern part of Mt Pelion is also made of erosion-resistant marble, the peninsula is dominated by schist, which yields a much more fertile soil than marble. In addition, here water does not disappear into the ground but runs along the surface where it can be more readily exploited.

Verde Antico quarries

Verde Antico ('Ancient Green') is the name given by Italian masons, from the Renaissance onwards, to a green rock that was first used in the first century AD, but was most popular in the fifth/sixth centuries, after the Imperial Porphyry quarries in Egypt closed (about AD 450). Its ancient name was *Marmor Thessalicum* or *Lapis Atracius*. It is still quarried today. The quarries lie on a small hill beneath the western slopes of Mt Ossa, just north of the village of Chasambali (Fig. 9.1).

Verde Antico is a conglomerate composed of rounded serpentinite and marble blocks set in a fine-grained matrix of similar composition (Fig. 9.3).^{132, 162} The rock is layered, with contrasting sizes and compositions of clasts in the different beds. The blocks were transported by water, but could not have travelled far as serpentinite is a very soft rock. This rock therefore probably formed very rapidly in a broad river valley surrounded by high mountains of serpentinite, part of an ophiolite complex. This rock was not formed recently, but probably during the Tertiary period and is a variant of the molasse seen in the Meteora. The geological term for this rock is *ophicalcite*, a confusing name as the main mineral is not calcite, but serpentinite and the amphibole actinolite.

Roman, Byzantine and modern quarries all lie in the same region, on the southern slopes of the hill. The age of the quarries can be determined from the method used to extract the rock: hammers, chisels and wedges were

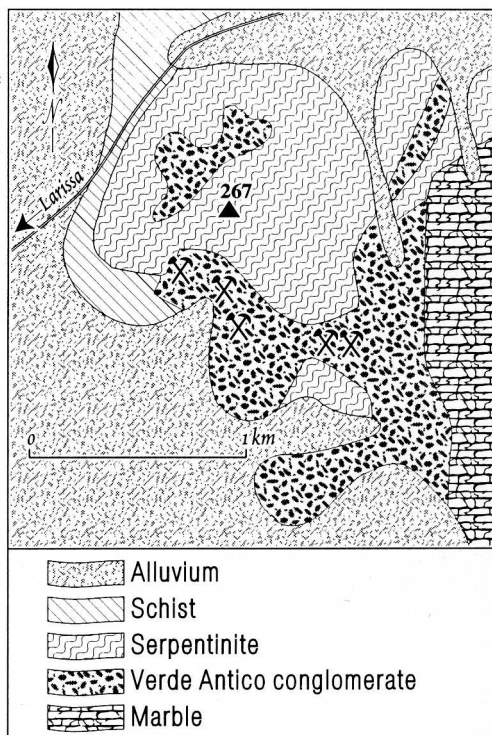


Fig. 9.3. Verde Antico quarries (after 132).

used in antiquity, producing uneven, 'pecked' surfaces. However, in recent quarries wire-saws have been used, producing large, flat surfaces. In such quarries the structure of the rock is beautifully exposed.

Marble quarries

There are ancient marble quarries near the village of Kastri, 25 km east of Larissa (Fig. 9.1, Plate 10A). The quarries lie in a small block within a large area of serpentinite. They produced a medium-grained marble ranging in colour from white to blue-grey, which was used in Byzantine times. Ancient marble quarries near the bay of Zasteni, on the north slope of Mt Tissaion south-east of Volos, produced a better quality of marble, paler and finer-grained. These quarries were exploited in Classical and Byzantine times.⁵²

Vale of Tempe

The Vale of Tempe is a deep, narrow valley through which the Peneios river leaves the Plain of Larissa for the sea (Fig. 9.1). The steepest part, to the north-east, cuts through marble, whereas the gentler slopes further south-west are made of schist. The valley follows a north-east/south-west fault, which was probably recently active. This fault runs parallel to the major strike-slip North Aegean Fault zone to the south (see Chapter 12), which terminates against the mainland, and the Vale of Tempe fault may receive part of this movement (see Volos below). It is possible that the route of the river predates the formation of the Olympos-Ossa range, and that erosion by the river has kept pace with the rising mountains, to give this deep valley.

Volos

The city of Volos is located near the southern end of a graben that extends parallel to the coast, from Larissa in the north, to the Gulf of Pagasae in the south (Fig. 9.1). An earthquake zone extends from the gulf westwards towards Trikkala. This zone partly takes up movements on the North Aegean Fault zone which terminates in the sea to the east.

Near Volos the floor of the graben has been lifted up, so that soft Neogene sediments are less common and older metamorphic rocks dominate the surrounding hills. These basement rocks consist of Triassic-Jurassic marbles, together with schists and gneisses, probably of similar age. Initial metamorphism was in the greenschist facies, followed by high-pressure blueschist facies. There are small deposits of bauxite within the marbles.

There are a number of young, small cones and flows of andesite and latite in this region, dated between 3.4 and 0.5 million years. They are considered to be the northernmost part of the South Aegean volcanic arc, but on a local scale they are probably related to the graben which extends east-west from the strait between Euboea and the Pelion peninsula to the Malian Gulf and beyond into mainland Greece. The deep faults of this graben cut the crust and

provided an access route for magmas generated deep within the mantle by partial melting of the subducted plate.

Northern Sporades

Skiathos, Skopelos and the smaller islands to the east are the uppermost parts of a horst extending eastwards from the Pelion peninsula (Fig. 9.4). The overall tectonic situation is rather confused here: the major North Aegean Fault zone comes down from the north-east and terminates against these islands and the mainland. The strike-slip movement of this fault is transferred in a complex way to a number of less important faults that cut across the mainland to the trench on the other side of the Ionian islands. This horst is probably related to the redistribution of these movements. The tectonic setting of Skyros is different from that of the other Northern Sporades, but it is not easy to relate to any large-scale geological features.

Skiathos and Skopelos continue the geology of the Pelion peninsula to the west: Skiathos is made of schists and gneiss whereas Skopelos is dominated by marble. Later on flysch was deposited on the metamorphic basement of these islands. Cretaceous limestone occurs in eastern Skopelos and becomes the dominant rock in the smaller islands to the east.

Skyros

Skyros is the largest and most easterly of the Northern Sporades. It is divided by a narrow isthmus into a fertile northern half and a more mountainous southern half (Fig. 9.5). A Mycenaean presence between 1600 and 1100 BC is attested archaeologically and confirmed by legend. Here Achilles is said to have hid, disguised as a woman, to avoid the Trojan war; and here Theseus was murdered. Skyros must have been rich in the early Bronze Age, as much gold jewellery has been found in tombs of 1000-700 BC. But the chief attraction today is the tomb of the poet Rupert Brooke, who died and was buried here in 1915.

Skyros lies on an isolated underwater plateau, separated from the other Northern

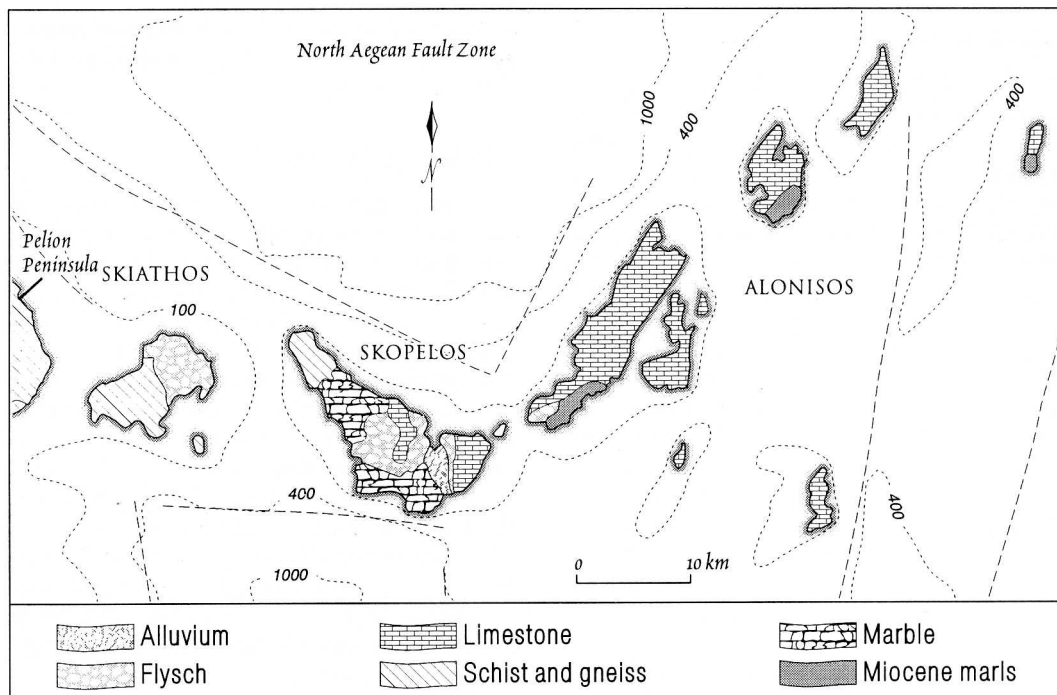


Fig. 9.4. The Northern Sporades.

Sporades by a series of north/south submarine grabens. To the south is one of the north-east/south-west shear zones that cut up the central part of the Aegean plate. The island itself is almost completely bisected by two faults parallel to this shear zone, which lie under alluvium in the 'waist' of the island.

The lowest exposed rocks are Middle Triassic-Early Jurassic marbles and schists of the Pelagonian zone.¹²⁶ The marbles are resistant to erosion and make up the hill of Marmari, north-west of Linaria, and Mt Kokhilas (782 m) on the southern part of the island. Schists underlie the lower hills between Skyros and Linaria. Over these rocks has been thrust a slice of metamorphosed ancient oceanic crust, both ophiolite and the overlying sediments. Finally Late Cretaceous limestones were thrust over the whole package.

Andesite lava domes and flows were erupted about 15 million years ago in the

north-central part of the island.⁹¹ At about the same time the north-east part of the island dropped down below sea-level and sediments were deposited there. Later this region was lifted up forming the fertile plains on the north-east coast. Skyros town lies partly on beach deposits and partly on a small basin of alluvium on a plateau of schist. Behind the town rise hills of serpentine and marble.

The variegated marble of Sykros was popular in Roman times. It is a breccia, with blocks of white, beige and red marble and limestone in a fine-grained red matrix. The rock was re-metamorphosed and slightly deformed after formation of the breccia. The ancient quarries lie on the southern part of the island, near the bays of Tris Boukes and Renes, and on the adjacent island of Valaksa.⁵² Today this marble is extracted from a quarry between Tris Boukes and Renes.

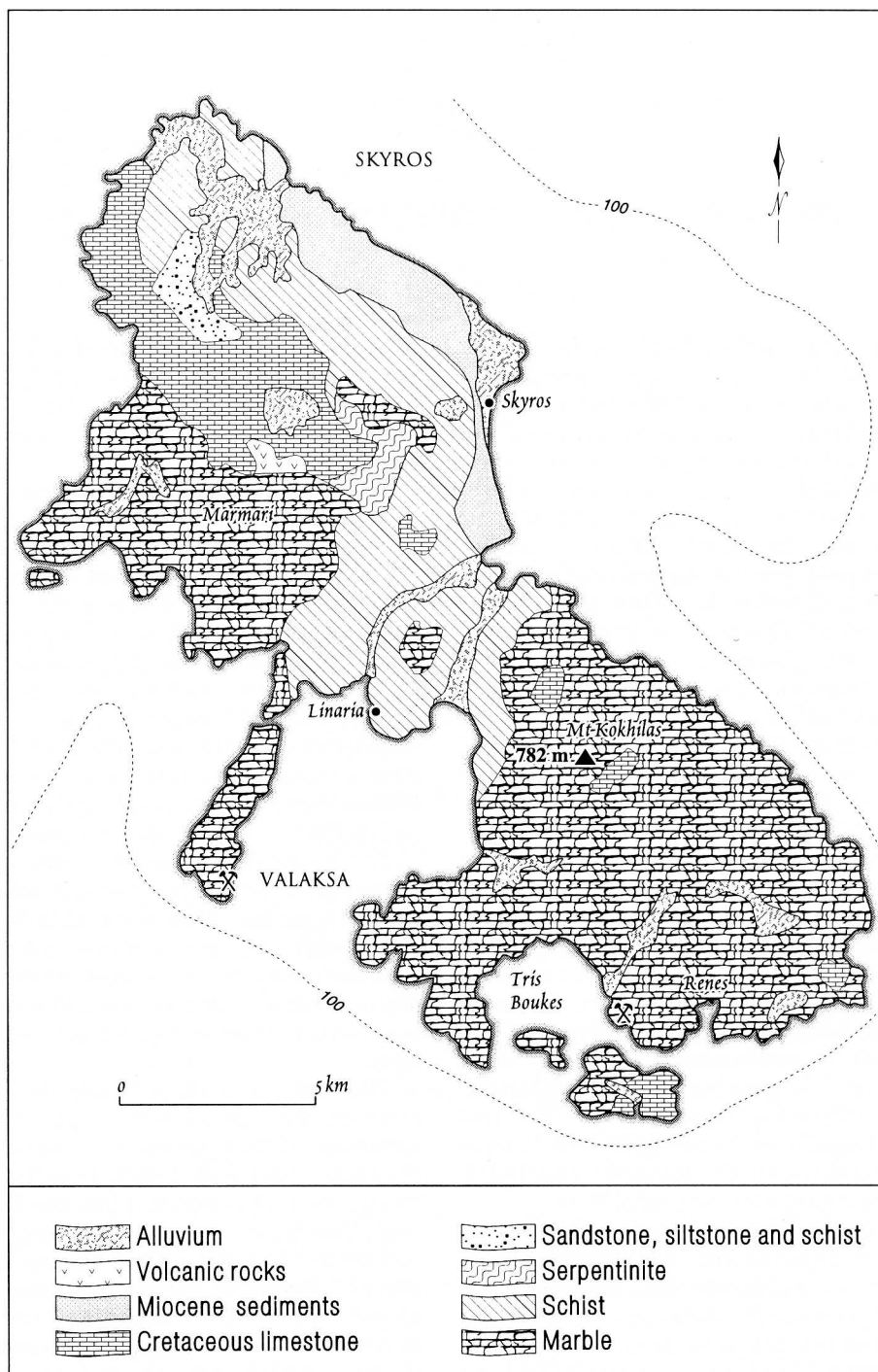


Fig. 9.5. Skyros. Only the modern quarries have been indicated.