

16

Crete

Crete is the largest of the Greek islands. It is dominated by a mountainous spine comprising the White Mountains (Lefka Ori) in the west, Ida (Psiloritis) in the centre, Dikte in the east, and the Sitea Range in the far east. On much of the north side of the island the mountains slope gently down to the sea, whereas the south coast is steeply precipitous, except for the Mesara valley. In the mountains are a number of upland plains.

In antiquity the climate may have been slightly wetter than it is now, as Crete was one of the granaries of the Roman Empire. Today the principal crops are the olive and the vine, with (in suitable places) citrus and other fruits. Plastic greenhouses are especially common. Similarly, the mountain slopes were once rich with timber; but now they are clothed in scrub (phrygana, maquis). However, a recent reduction in subsistence agriculture, and hence in grazing, has started to change the vegetation once again: trees and other wild plants have increased, together with the risk of fires.²²⁸ In fact, since the original fauna is extinct, Crete may now be less grazed than it has been for millions of years.

Effectively blocking the southern end of the Aegean, Crete has always looked east to Asia Minor and south to Libya and Egypt (Plate 16A). From its proximity to these more advanced cultures, around 6000 BC, it became the home of the earliest European civilisation. The first settlers were farmers and stock-breeders from western Turkey. They lived in well-built houses and used tools and weapons of polished stone; soon they were making pottery. About 3000 BC the Bronze Age was brought to Crete by new settlers from the same region. Bronze now replaced stone for tools and weapons, and

there were other major advances. This brilliant civilisation, which lasted till about 1100 BC, was named Minoan by Arthur Evans, the excavator of Knossos, after the legendary King Minos. At about 2000 BC, palaces were built at Knossos and other centres. They were destroyed by an earthquake or a series of earthquakes around 1700 BC and replaced by grander palaces, whose ruins we see today at Knossos, Phaistos, Mallia, Zakros and Chania (Kydonia). This is the period to which we should ascribe the later Greek legends associated with Knossos. Around 1450 BC all these palaces, except Knossos, were destroyed by fire, and it is generally believed that Knossos was captured by invaders from Mycenae, who ruled all Crete from there, having destroyed the other palaces to stifle any resistance. The palace of Knossos was itself destroyed by fire some time later, but the Minoan civilisation continued at a lower level until 1100 BC, to be followed by a Dark Age. There was a revival about 900 BC, which did not last. From 500 BC and throughout the Roman and Byzantine periods Crete was a political and cultural backwater. The last period of comparative greatness was when it was occupied by the Venetians between AD 1204 and 1669. Many of the sites included here are illustrated, together with brief geomorphological descriptions, in *The Aerial Atlas of Ancient Crete*.¹⁸⁷

Crete is part of the Hellenic arc, a series of islands and shallow waters which stretches from the Peloponnese to Turkey. This arc formed in response to the subduction of the African plate beneath the Aegean (see below). Thus the channel to the west of Crete is only 600 m deep and that to the east scarcely deeper at 1,000 m. To the north of Crete, beneath the

16. Crete

Cretan sea, the sea-floor slopes gently down into a broad basin with depths up to 2,200 m. This basin is a young feature, formed by back-arc spreading as the subduction zone rolled back towards the south. However, it is not floored by true deep ocean crust, as is found, for example, behind the Japanese islands, but by thin continental crust. North of the basin lie the Cyclades, including the volcanic islands of Thera and Milos. South of Crete the sea-floor descends steeply, over a distance of 5-10 km, along a series of east-west normal faults, into water mostly more than 2,000 m deep. The north-south asymmetry of the topography of the sea-floor mirrors that of the intervening land (see below). Further south is a series of three deep trenches that mark the location of strike-slip faults. Further south still lies the broad Mediterranean Ridge, which is a compressive feature formed in front of the subduction zone. Finally we reach Africa, 300 km south of Crete.

The basement of Crete consists of a stack of nappes representing rocks from several different environments (Fig. 16.1). They were originally distributed over a horizontal distance of several hundred kilometres, but were stacked into a pile about 6 km thick during the Alpine compression.¹⁴¹ The 'Plattenkalk' series of rocks, probably part of the Ionian zone, is the lowest unit and may be in, or close to, its original location. It comprises limestones and dolomites, with minor phyllites, and is of Triassic to Oligocene age. The characteristic rock is Plattenkalk, a platy limestone with abundant layers and nodules of chert, which formed in the deep waters of an open ocean. The overlying nappe, the 'Phyllite', is dominated by phyllites and quartzites, with minor limestones, marbles and other rocks and is of Permian to Triassic age. These rocks formed near a continent in shallow water. The nappe was broken up during emplacement so that it is now a melange, or chaotic mixture of blocks ranging in size from centimetres to hundreds of metres, set in fine-grained sediments or phyllites. Towards the base of the nappe temperatures were sufficient for metamorphism to produce marbles. The next nappe, the Tripolitza, comprises Jurassic to Eocene shal-

low-water limestones, overlain by flysch sediments. It is part of the Gavrovo zone. These rocks remained as a rigid block during deformation. The next nappe, the Pindos, is comprised of similar rocks, except that the limestones formed in deep waters. The uppermost nappe is dominated by ophiolite-suite rocks and represents one or several disrupted sections of ocean floor and their overlying sediments thrust up onto the continental crust.

The rocks of these nappes were originally deposited to the north of Crete. Compressional movements started in the Late Jurassic with the emplacement of the uppermost nappes. The pile migrated to the south as it acquired the lower nappes, finally reaching Crete during the Oligocene.²⁶

The fragmentation of Crete into fault-bounded blocks started during the Miocene, about 12 million years ago, when roll-back of the subduction zone towards the south commenced (see Chapter 2). This led to a broad zone of extension behind the arc, where the crust was stretched by up to a factor of two.¹⁷⁶ This extension produced a series of grabens and horsts which give the island its rugged topography.

Most of the grabens occur in the northern part of the island, forming the lowlands south of the principal cities of Crete. It is only in central and eastern Crete that the grabens extend through to the south coast. The rest of this shore is bordered by the horsts, which plunge steeply into the sea. At this time the horsts were islands and the grabens were shallow seas where sedimentary rocks, such as conglomerates, impure sandstones, shales and marly limestones, accumulated. By the Mid-Pliocene most of Crete was lifted up and became dry land.

During much of the Pleistocene sea-levels were much lower than at present (see below) and wide beaches were exposed. Winds passing over these beaches picked up shell fragments and transported them inland to produce dunes of calcareous sand.^{196,282} Percolating water then cemented the sand with calcite into a porous, soft, eolian, calcareous sandstone locally called ammodha. This rock was extensively used for construction as it is easily cut, though not

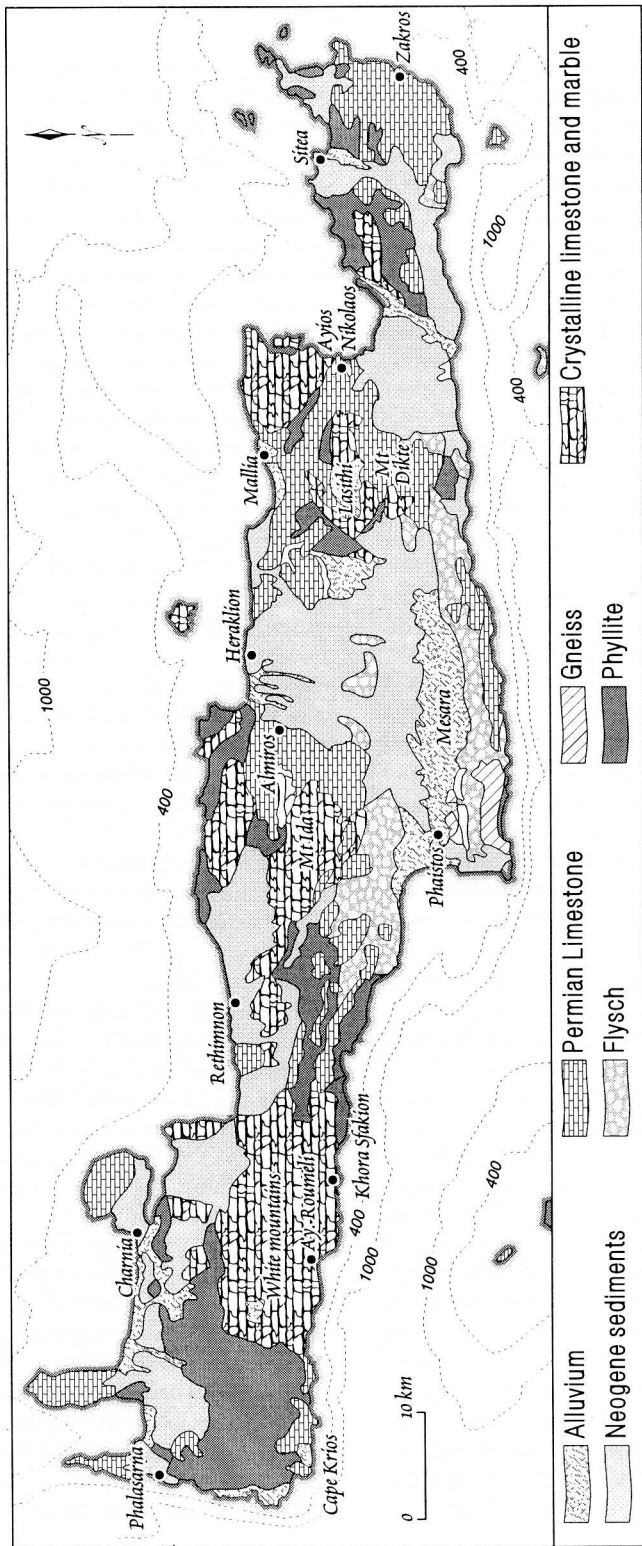


Fig. 16.1. Crete.

always very durable.

To turn to the Pleistocene fauna, the island was inhabited by deer, elephant and dwarf hippopotamus. These animals may have been exterminated by the earliest human inhabitants of the island and replaced with domestic grazing animals.

Crete, like the rest of the Aegean region, shows much evidence of earlier sea-levels different from the present level.^{222, 223} This variation records movements of the height of the land with respect to the sea. In many areas and on short time scales such movements are dominated by tectonic forces. The shoreline of the western part of Crete records one of the most important of these sea-level changes.²²² There, a block about 200 km long subsided in a series of about ten movements from about 2000 BC to AD 200. These movements were reversed by a major, rapid uplift of up to 10 m sometime between AD 430 and 580. The maximum uplift was in south-western Crete around Cape Krios. It has been suggested that similar uplifts as far away as Israel were part of the same event. It is interesting to note that there are no historical records of this event in the area of maximum uplift, but a major earthquake in AD 551 is known to have caused drastic damage further east, and may have been associated with the uplift. Elsewhere in Crete movements have been less pronounced. The coasts of central and eastern Crete appear to have subsided by 1-2 m since antiquity, except on the south-east coast where sea-level has not changed significantly.²²³

The relationship between the huge Late Bronze Age eruption of Thera and the widespread and roughly contemporary destruction of the palaces on Crete has been hotly debated. Volcanic ash, presumably from the Minoan eruption on Thera, has been found on Crete, but not in well-defined layers.²⁷⁸ Hence it is impossible to correlate these ash falls with archaeological data. Archaeomagnetic dating of mud walls fired during the burning of the Minoan palaces and of the volcanic ash of the 'Minoan' eruption on Santorini suggests that this destruction was synchronous with the eruption,⁶⁷ but evidence from pottery suggests that there was a significant time difference.

However, these destructions may not have been directly related to the volcanic effects of the eruption, but only to the earthquakes and tsunamis that commonly precede and accompany major eruptions.

The proximity of a plate margin to the south means that earthquakes are relatively common here, especially along the strike-slip faults in the trenches to the south of Crete. One of the most devastating historical earthquakes occurred in AD 365, probably to the south of Crete. The ensuing tsunami caused the loss of thousands of lives and extensive damage throughout the eastern Mediterranean.²⁰¹

Weathering of the limestones produces a thin terra rossa that is not particularly fertile, and has commonly been eroded from the steep slopes of the hills. In contrast the Neogene sediments, particularly the marls, produce a brown fertile soil (rendzina) that was also favoured elsewhere in Greece during the Bronze Age. This soil was particularly important in this region as the river-plains, which are normally the most fertile areas, are not extensive on Crete.

Phalasarna

The ancient port of Phalasarna was constructed at the base of the Gramvousa peninsula, a large block of Jurassic limestone (Fig. 16.1). The peninsula terminates to the south in a series of low hills, mostly composed of Miocene limestone and marl, part of an ancient graben.

The acropolis stood on a steep-sided hill of Jurassic massive grey limestone, which is a fault-bounded block of rock similar to that of the peninsula to the north (Fig. 16.2). The hills immediately to the east are a complex mixture of limestone, marble and schist. A narrow strip along the coast is covered by Pleistocene 'fossil' sand dunes. This sandstone, locally called *amoudha*, was used extensively for the construction of the ancient town and harbour as it was much more easily cut than the grey limestone. The ancient quarries can be seen to the south-west and south-east of the ancient port (Plate 16B).

This area was uplifted in the fifth or sixth

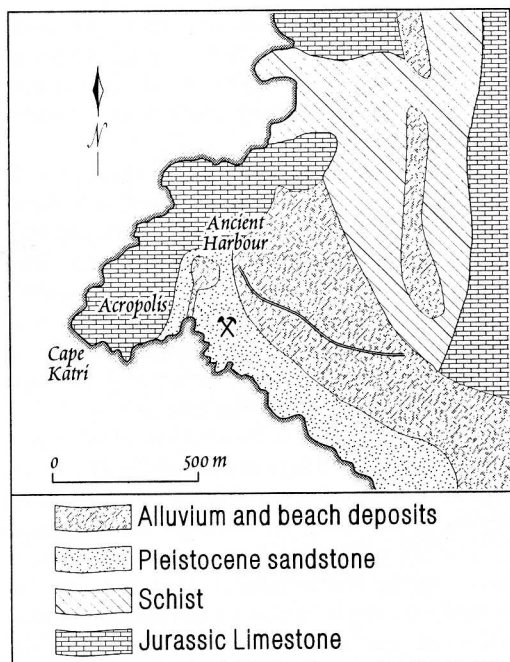


Fig. 16.2. Phalasarna.

century AD by about 7 m, possibly during a single earthquake (see above). Evidence for this uplift can be seen in the harbour, which is now dry and far above sea-level; in the floor of the ancient quarries to the south of the town, which must have originally been close to sea-level; and in well-developed notches in the cliffs and raised wave-cut platforms around Cape Katri. Another old sea-level stand can be seen at an altitude of about 15 m.

The White Mountains and Samaria Gorge

The White Mountains are a horst, dominated by limestones (Fig. 16.1). The lowest rocks are a series of Jurassic-Eocene platy limestones of the 'Plattenkalk' series which are exposed in the centre of the mountains, on either side of the Samaria Gorge. Triassic-Jurassic limestones have been thrust over the top of these rocks, and are exposed in the east and west.

A number of gorges cut through the White Mountains to the Libyan sea, the most famous

of which is Samaria Gorge (Fig. 16.3). The commonly held view is that these gorges originated as faults which were enlarged by flowing water. There is, however, no evidence of major faulting in the Samaria Gorge and it is more likely that the gorges are related to the rapid uplift of the White Mountains. Small streams, formed at an early stage, would have cut deeply into the mountains as they rose up, to keep pace with the uplift. There is abundant evidence in the area for this rapid uplift, such as raised sea-level stands and dissected river gravels (see below).

The Samaria Gorge trail starts at a saddle above the Omalos Plain, a polje or small basin draining internally into sinkholes. Such basins may provide much of the water for karst springs in the valleys below. The saddle is made of Jurassic-Eocene (?) platy limestones, which are relatively resistant to erosion. The trail descends the rear wall of a steep amphitheatre which has been excavated out of Permian-Triassic (?) phyllites, with minor limestones and sandstones which are generally softer than the limestones to the north.

Just above the chapel of Ayios Nikolaos a spring-fed stream joins the valley from the left. These waters are depositing yellow travertine which has sealed the bed against infiltration. Calcite is also being deposited on leaves in the stream, starting the process of fossilisation. Further down the stream disappears at the point where all the travertine has been deposited and hence the bed is not sealed against infiltration.

The bed of the valley near the former village of Samaria is filled with river gravels cemented together to give a conglomerate similar in appearance to concrete. These rocks were transported by the river and cemented by minerals precipitated from groundwater as it rose up and evaporated below the surface during a period of greater rainfall. They have been dissected by the present river, showing that there has been recent uplift of the area.

Just below Samaria the trail re-enters the 'Plattenkalk' cherty limestones first encountered in the saddle at the trailhead. This rock is resistant to erosion, which accounts for the change from the wide valley above Samaria to

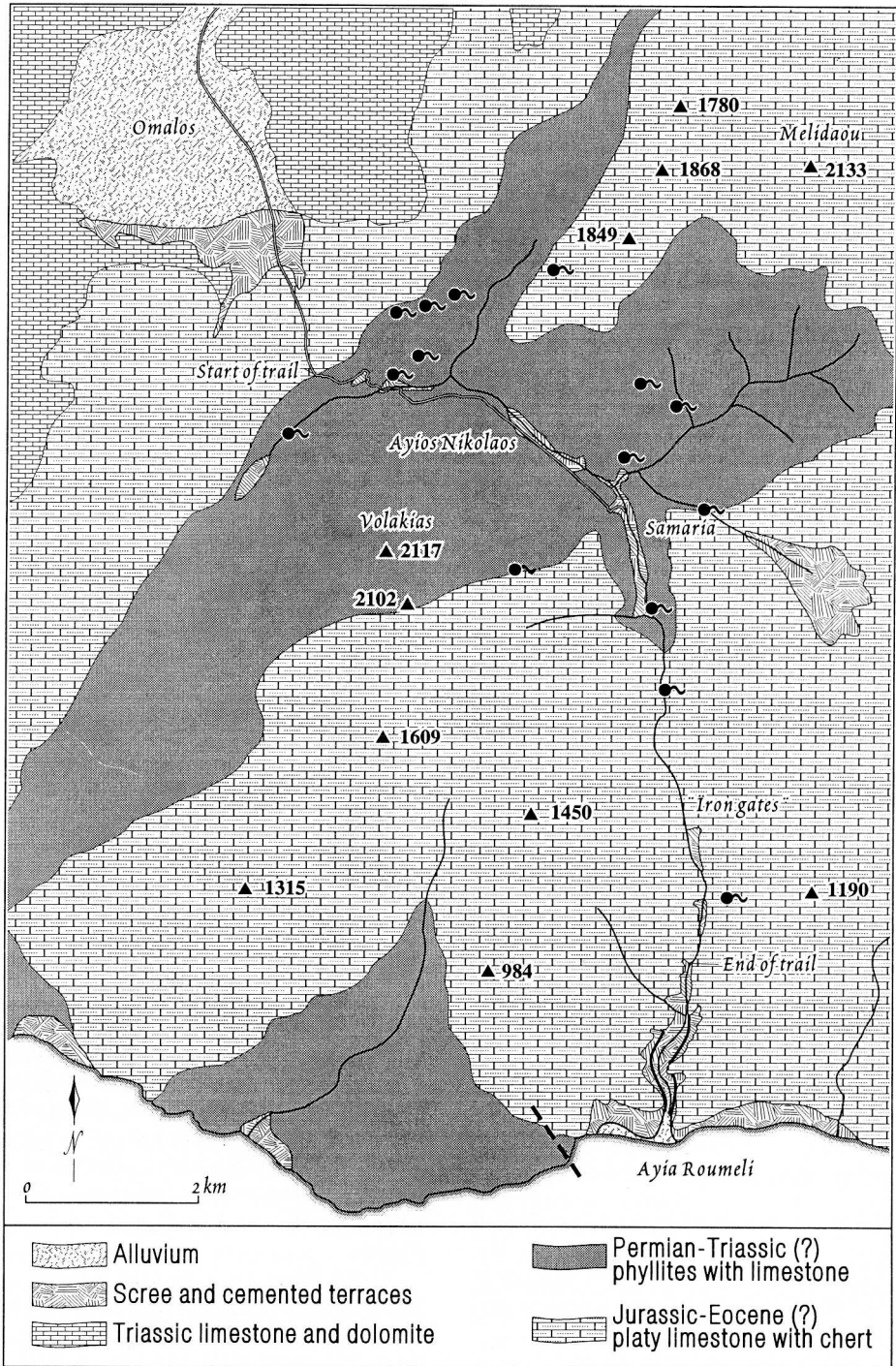


Fig. 16.3. Samaria Gorge.

the steep-sided main gorge below. These limestones contain abundant chert and have been slightly metamorphosed and complexly folded. If the valley follows a fault, then it is here that we would expect to see the evidence, in the form of closely-spaced joints parallel to the valley. But these are not present, and hence it is not likely that there is a fault here.

The coast from Ayia Roumeli eastwards to Khora Sfakion shows much evidence for recent uplift, with well-developed sea-level stands at about 5, 10, 20 and 40 m. The highest is at a break in the slope above a series of cliffs. The stand at 5 m is related to the major uplift event in the fifth-sixth centuries AD which raised up the harbour of Phalasarna (Plate 1A).

Chania

Modern Chania occupies the site of ancient Kydonia (Fig. 16.1). There was a strong Minoan presence here from 4000 BC until 1100 BC and there may have been a palace, probably where the Venetian Kastelli now stands. Under the Venetians, as La Canea, it regained something of its earlier importance and between 1898 and 1971 it was the capital of Crete.

Chania lies in a small, asymmetrical graben between the White Mountains to the south and the hills of the peninsula of Akrotiri to the north-east. Both these uplands are dominated by Triassic-Cretaceous limestones. The graben itself is lined with Miocene marls and limestones, commonly covered with a thin veneer of Quaternary terra rossa soils. The city itself is constructed on Miocene marls and Pleistocene alluvial deposits. To the west of Chania lies Souda bay, which is a small graben.

The Spring of Almiros

An important spring at Almiros, 8 km west of Heraklion, has been known since Minoan times (Fig. 16.1). It is the largest spring in Crete (4,000-30,000 litres per second) and feeds a river for its 5 km passage to the sea.¹⁷⁷ A peculiarity of this spring is its variation in salinity with discharge: at times of maximum flow it is almost fresh, but when the discharge

is reduced its salt content can approach half that of seawater.

The spring discharges from the base of a hill, along the trace of the western fault of the Heraklion graben. The water comes from two sources: rainwater and seawater. This volume of freshwater requires a catchment area of at least 300 square km, in the limestone hills to the west and south-west. This enormous mass of limestone extends offshore to the north and is riddled with caves and fissures. Seawater drains into the limestone through fissures in the sea-floor.

The driving force for the circulation of the rainwater is clear: water descends under gravity from the mountains until its passage is blocked by the high water-table of the Neogene graben sediments and it appears from the ground as a spring. For the seawater the case is a little more complex: seawater is more dense than freshwater, hence if two columns of water are at the same pressure at a depth of several hundred metres and are interconnected, the seawater column would be several metres lower than the column of freshwater. If the freshwater column has an outlet below this height, then the seawater will flow 'uphill' to dilute the fresh water and issue from the spring. A similar effect occurs on the island of Kephallinia.

Knossos

Knossos is situated 5 km south of Heraklion, on the Kairatos stream (Figs. 16.1, 16.4). The palace is the largest and most famous of the Minoan palaces. Minos was, according to legend, the King of Knossos. It was his Queen who gave birth to the monstrous Minotaur, killed by Theseus with the aid of the Princess Ariadne. Minos' architect, Daedalus, having incurred his master's displeasure, flew out of Knossos with his son Icarus on home-made wings.

About 6000 BC Neolithic settlers arrived from western Turkey and founded what was arguably the oldest town in Europe. Three thousand years later another wave of Asiatic immigrants introduced a Bronze Age civilisation now called Minoan. The first palace was

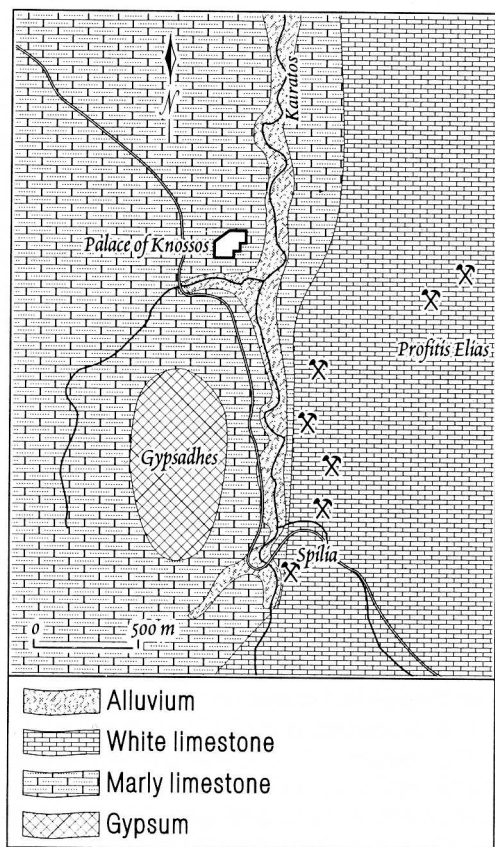


Fig. 16.4. Knossos (after 195, 234). Cretaceous limestone is exposed on the northern slopes of Profitis Elias, just off the north-east corner of the map.

built in about 2000 BC on the ruins of the older settlements and Knossos became a sort of royal capital. When this palace was destroyed by an earthquake in 1700 BC, a new and even more magnificent one arose on its ruins, the remains of which we see today. This is the setting for the legend. It was known as the Labyrinth ('The House of the Double-axe'), a name that came to mean a maze. About 1450 BC Knossos was apparently captured by Mycenaean Greeks from the mainland who ruled all Crete from here. Some time later, perhaps about 1300 BC, their palace was burned down and was never rebuilt.

The site of Knossos lies in the fertile lowlands of a small stream, the Kairatos, within

the broad Heraklion graben (Fig. 16.1). The valley of the Kairatos is itself a half-graben within the larger graben. The eastern side, which follows the course of the Kairatos, is a fault and the land to the west has hinged downwards like a trap-door. The Kairatos rises from springs near Arkhanes to the south and was probably perennial in antiquity. The proximity of this river, together with local springs and a high water-table, make this area well-watered by the rather dry Cretan standards.

A grey to dark grey Cretaceous limestone crops out to the north-east of Knossos, on the northern slopes of Mt Profitis Elias (250 m). This rock is strong, as it has few holes, and a similar rock was used extensively by the Minoan masons elsewhere. However, at Knossos it was less important for construction than other rocks.^{195, 234}

The rest of the region around Knossos is underlain by Neogene sedimentary rocks. To the west of the Kairatos they comprise soft marly limestones locally known as 'kouskouras'. Most of Mt Profitis Elias is underlain by white, sometimes shelly limestones, locally known as 'poros'. These rocks were quarried extensively from pits and underground workings for the construction of the palace. Such workings can still be seen in the Spilia area to the south of Knossos, where they are now used as storehouses.¹⁹⁵ As at many other Minoan sites, eolian sandstone was also used, but its source is unclear.

The hill of Gypsadhes to the south of Knossos is partly made up of gypsum, which formed when the Mediterranean dried up about 6 million years ago. Bands in the rock formed during deposition and were folded later by tectonic forces. The presence of calcite or dolomite impurities in some samples increases their strength and resistance to erosion. Gypsum was used extensively in the construction of the palace, but only where it was not exposed to the rain, as it is soluble in water. The finer-grained varieties of gypsum were used for facing stones and for some floor slabs, whereas the coarse-grained varieties were used in some columns. Gypsum blocks uncovered by the excavators and left open to the weather have lost over one centimetre of material in 30 years. The ancient

gypsum quarries on Gypsadhes were visible at the time of the excavations, but have now been refilled. Gypsum from these quarries, or possibly other Cretan quarries, was also used at Akrotiri in Thera.⁹⁸ The clay used by the Minoans of Knossos probably came from the Kairatos valley, 2 km south of the palace.¹³⁰

Mt Ida

Mt Ida (or Psiloritis, 'the high one') is the highest mountain in Crete at 2,456 m (Fig. 16.1). High up are two large caves which were used in antiquity for religious purposes. The Idaean cave on the east side at 1,540 m was sacred in Minoan times and later became the most famous of all the Cretan caves (Fig. 16.5). Zeus was believed to have been brought up here, having been removed from the Dictaeon cave (see Psykhro cave below) as a baby to

ensure his safety. Worship seems to have been continuous from the fifteenth to the sixth centuries BC. The cave consists of an enormous grotto 30 m wide and 10 m high, with a smaller grotto leading out of it.⁸² The Kamares cave is on the south slope of Ida at 1,524 m (Fig. 16.5). It was a sacred place for the rulers of Phaistos, who could see its enormous mouth from the palace. It was in use from 2000 to 1700 BC, and was then deserted. Possibly the entrance was blocked by the earthquake which destroyed the palace. The offerings recovered were mostly the beautiful polychrome pottery of the first palace, the so-called Kamares ware.

Mt Ida is a horst bounded to the south by the Mesara graben and to the east by the Heraklion graben (Fig. 16.1). The block has been tilted as the highest land is in the south and it slopes gently towards the north. The mountain is largely composed of limestone from two different nappes. The western parts, including the summit, are dominated by Plattenkalk marble-limestone (Jurassic-Eocene). To the east Tripolitza limestones (Jurassic-Eocene) have been thrust over the Plattenkalk.

This mountain is the only part of the Aegean islands with sufficient relief to have been glaciated.⁸¹ Features typical of valley glaciers, such as sharp mountain peaks, cirques and U-shaped valleys, can be seen on at elevations above 2,200 metres. The glaciation happened during the coldest part of the last glacial interval, about 20,000 years ago.

The road to the Idaean cave passes across the plain of Nida, a polje with an altitude of about 1,400 m (Fig. 16.5).⁸¹ The cave itself is 140 m above the plain, close to a thrust fault that separates the overlying Jurassic Tripolitza limestones from the underlying Plattenkalk marble. The normal fault that defines the western edge of the polje also passes close to the cave. Groundwater circulating along these faults, or adjacent parallel joints, dissolved the limestone and enlarged the passages to produce the cave.

The Kamares cave, although only 4 km south of the Idaean cave, is situated on the southern face of the mountain (Fig. 16.5). The geological environment is similar to that of the Idaean cave; the same thrust fault separates

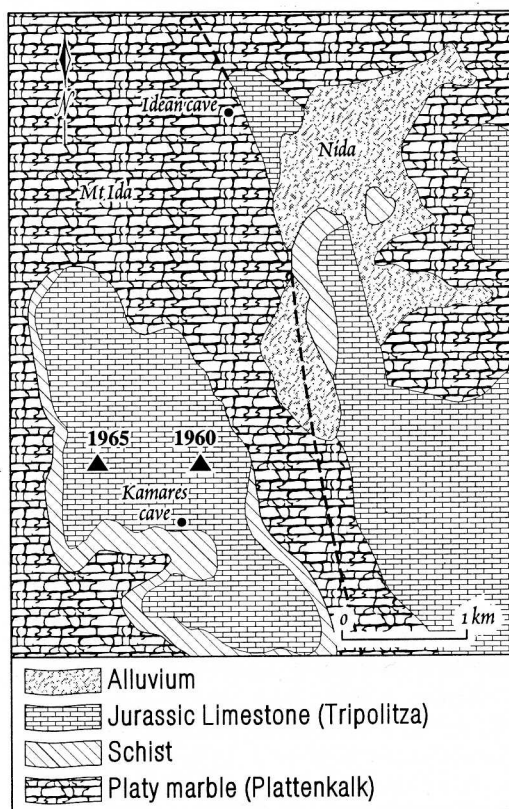


Fig. 16.5. Mt Ida and the Kamares and Idaean caves.

outliers of Tripolitza limestone from the underlying Plattenkalk schist and marble. Similarly, this fault has been enlarged to form the cave.

The Mesara plain, Phaistos and Ayia Triada

The Mesara Plain is a long strip running east from the Gulf of Mesara, between Mt Ida, to the north, and the Asterousia Mountains to the south (Fig. 16.1). Watered by the Geropotamos river, it is probably the most fertile area in Crete: olives, fruit and vegetables are grown.

Thanks to its rich soil, this plain was settled very early, possibly about 4000 BC, and these earliest settlers have left once-rich communal tombs for us to see. When, about 2000 BC, the first palace was built at Phaistos, this became the capital of the Mesara. Although less celebrated in legend, this palace was quite as grand as that at Knossos. Destroyed by an earthquake about 1700 BC, it was rebuilt on an even grander scale. Destroyed again about 1450 BC, this is the palace which we see today, slightly restored by the excavators.

Associated in some way with the second palace was the royal villa at Ayia Triada, 3 km to the west. Later, Gortyn became the principal city of the Mesara, and in 68 BC the Romans made it the capital of their new province of

Crete and Cyrene.

The Mesara plain is a graben, the only major one on Crete that runs east-west, and the only one that breaches the south coast (Fig. 16.1). It is floored by with low hills of Miocene to Pleistocene sedimentary rocks mostly deposited by the rivers that drain the mountain horsts to the north and south. Periodically, sea-level changes or subsidence have caused inundations by the sea. One such inundation occurred at the end of the Miocene when the Mediterranean was below present sea-level and largely a desert. Evaporation of the sea-water produced thin deposits of gypsum.

The ancient site of Gortyn is situated on the northern edge of the graben, close to the fault. The acropolis hill, and Mt Profitis Elias to the east, are made of Cretaceous-Oligocene sandstone-flysch, partly covered by Pleistocene conglomerate. The hills to the north and west, beneath Mt Ida, are underlain by Miocene marls and other sediments, including gypsum.

The Cave of Gortyn (or Labyrinth), about 3 km west of the site, is a Minoan gypsum mine, possibly enlarged from a natural cave. About 2.5 km of tunnels, mostly 2.5-4 metres high, were excavated, and many of the surfaces were sculpted with columns, seats and altars.⁵⁸ The underground source ensured a supply of unaltered gypsum. The gypsum here is well

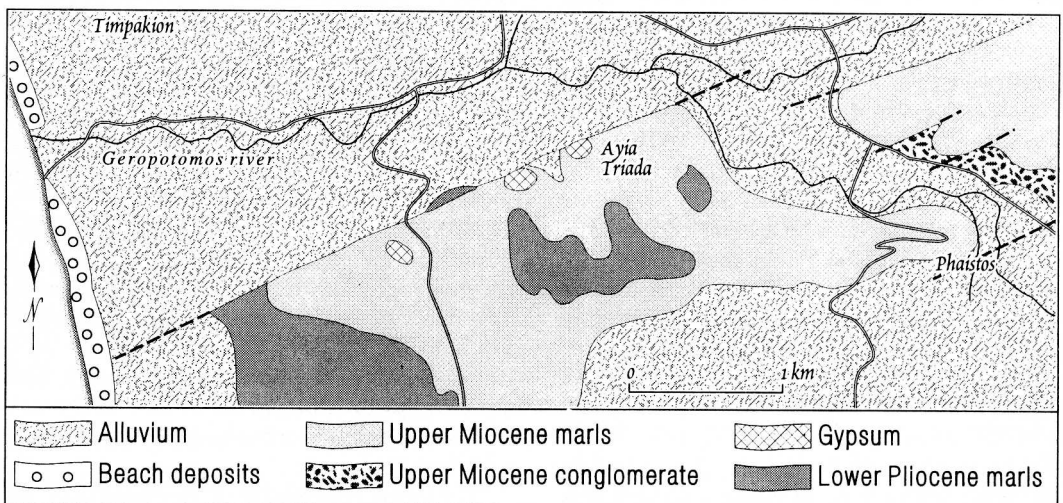


Fig. 16.6. Phaistos and Ayia Triada. The ancient port near Kommos lay 2 km to the south of the map edge.

laminated, fine-grained and contains calcite, making it much harder than pure gypsum rock. The cave is now sealed off to visitors.

Both Phaistos and Ayia Triada were constructed on opposite ends of a low hill of Late Miocene and Pliocene marls and limestones, originally deposited on the floor of the graben and subsequently uplifted and eroded (Fig. 16.6). Gypsum occurs as layers and conglomerates within the marls. That used in the palace was extracted from quarries south-west of Phaistos and near Ayia Triada. Some of this material may have been exported to Mycenae.⁹⁸

The steep slopes south of Phaistos and north of Ayia Triada are fault scarps, formed by recent movements of east-west faults parallel to the sides of the graben. The faults partly accommodate the continuing subsidence of the graben. The Geropotamos river cuts diagonally across this fault block and has produced the steep slopes to the north of Phaistos.

Part of the site is covered with caliche. This layer is hard and not very permeable, so that groundwater is conserved underneath it. Wells still visible on the site have been cut through the caliche to tap the underlying groundwater.

Although the ancient geography of the Geropotamos valley has not been investigated, the sea probably reached the fault-scarp that runs just to the north of Ayia Triada at some time since the last glaciation. However, this was almost certainly before human occupation of this region.

The Minoan site of Kommos, a few kilometres south of the mouth of the Geropotamos river, was the port of Phaistos and Ayia Triada. It was built on a low ridge of Neogene marls, protected from erosion by a layer of fossiliferous limestone. At first glance the exposed site, beside a sandy beach, seems totally unsuitable for a harbour, but in antiquity the geography was a little different.¹⁸³ Submerged notches indicate that in antiquity sea-level was 3-4 metres lower than at present. The coast lay 80 m to the west and a small reef, now 300 m offshore, was an islet 130 m long. The protection from the prevailing winds that this reef afforded the harbour may have been augmented by a sand-spit. By Roman times the

land had sunk, so that the sea was only 1.2 m below its present level, with a corresponding retreat of the coast and shrinking of the islet.

Skoteino cave

One of the most impressive caves in Crete is located near Gouves, between Mallia and Heraklion. The Cave of Skoteino descends from a small hollow in a low plateau south of the main highway (Fig. 16.1). The bedrock here is Cretaceous grey limestones of the Tripolitza zone. The striking location of the cave, on a almost flat surface, shows that it started as a doline on the plain and subsequently developed into a sink-hole. The main chamber of the cave is large and extends for at least 160 m downwards at four different levels. The cave was one of the most important sanctuaries in Crete and huge quantities of broken pottery can still be seen there.

Mallia

The palace of Mallia lies on alluvium close to the coast beneath the Late Triassic to Cretaceous limestone of the Dikte Mountains (Figs. 16.1, 16.7). Along the coast to the north a low ridge of Cretaceous limestones underlies the necropolis of Khrysolakkos, and forms the sea-cliffs. Pleistocene fossil sand-dunes (ammoudha) cover parts of this ridge, as well as the coast to the west.

The palace was largely built of ammoudha from the fossil dunes. The quarries lay beside the beach, to the west of the palace for about 2.5 km.²⁸² One of the larger quarries was at Mill Point, 800 m north-west of the palace.

Mallia today lies on an open bay, without protection for small vessels, but in antiquity the geography may have been a little different. The floors of some of the ammoudha quarries are submerged about one metre indicating a rise in sea-level. In addition, it is possible that the swampy area 500 m north-west of the palace was once a harbour, now filled in by alluvium.¹⁸⁷

The hard limestones of Khrysolakkos initially seem to be a poor choice for a necropolis. However, these rocks have prominent vertical

16. Crete

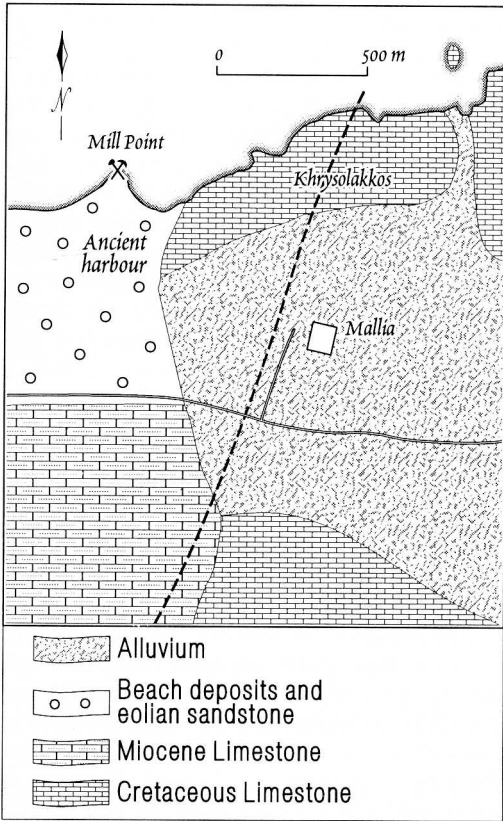


Fig. 16.7. Mallia.

joints that have been deeply weathered. Communal burials were made in these natural trenches during Minoan times.¹⁸⁷

Mt Dikte

Mt Dikte, like the other major mountain ranges of Crete, is comprised of a lower series of Plattenkalk limestones, over which has been thrust a series of Jurassic-Eocene Tripolitza limestones (Fig. 16.1). The detailed structure of the mountains is very complex as they are much faulted.

The Lasithi plain

Lasithi is a polje, or internally draining plain with an altitude of about 850 m, within the northern slopes of Mt Dikte (Fig. 16.1). The

plain is extremely productive thanks to the fertility of the soils and the shallowness of the water-table.

The plain is a small graben produced during the Neogene extension of the island. The surrounding hills are made of a lower nappe of schist, phyllite and quartz, over which have been thrust Triassic-Jurassic limestones and dolomites.

Sediments washed down from the surrounding mountains accumulated in a shallow, seasonal lake that formerly occupied this valley. The lake was drained by a large swallow-hole near the western end. Accumulation of the sediments eventually filled in the lake to a level above that of the swallow-hole, but springtime flooding was a problem until the construction of drainage ditches in the seventeenth century. The sink-hole is readily visible beneath the hill of Kato Metokhi, but its entrance is choked with large boulders. Without doubt there is an extensive cave system beneath here.

Psykhro cave

The Psykhro cave, overlooking the Lasithi plain, was possibly the famous Dictaeon cave of Classical times where, according to legend, Zeus was born. It seems to have come into use about 1700 BC, when the Kamares cave was deserted, and to have continued without a break down to the sixth century BC, with a brief revival in the Roman period. It was re-discovered in 1883. It is composed of an upper and a lower grotto. In the latter were found some 500 offerings in gold, bronze and other materials, many of them wedged in crevices in the stalactites which fill the grotto.

The cave opens from a broad arch half-way up the hillside south of the village of Psykhro and follows close to the thrust fault that divides the underlying phyllites and the overlying limestones. The cave originated when groundwater, descending in the limestone, encountered the less permeable phyllites and was channelled horizontally towards the surface. This flow slowly dissolved the limestone and excavated the cave. It was aided by periodic collapses of the roof.

The cave descends steeply to pools about 65 m below the entrance. The cave is richly decorated with stalagmites and stalactites, but many of these were formed in an earlier, wetter period, perhaps before the ice age, and little new material is now forming. Activity was probably much greater in antiquity as many cult objects were found encased in stalagmites.

Ayios Nikolaos

The town of Ayios Nikolaos is largely built on late Triassic to Late Jurassic limestones and dolomites (Fig. 16.1). These rocks were overlain by marls in Pliocene times and subsequently faulted. The 'bottomless' Lake Voulismeni is funnel-shaped and descends to a depth of 64 m. It is an ancient sink-hole formed in the limestone when sea-level was much lower than at present, during either the Late Miocene or glacial periods. It developed by the action of groundwater descending a fault that bounds a block of Pliocene marls to the south of the lake.

An important brackish spring, named Almyros, flows about 1 km south of Ayios Nikolaos.¹⁷⁸ The water of this spring comes from both the rain and the sea, which are mixed in caves beneath the peninsula, similar to the Spring of Almiros near Heraklion.

Rods of Digenis quarry

There are few exploitable deposits of good quality marble on Crete. The only ancient marble quarry found so far lies 3 km north of the village of Chamezi and 7 km west of Sitea.⁷¹ The quarry is known as the Rods of Digenis, from the presence of several unfinished columns at the site. The outcrop is rather small, a lens-shaped mass 60 by 30 m, and the marble varies from a breccia at the margins through a red-veined variety to pure white at the centre. The host rock is a green to reddish phyllite, of the Phyllite nappe. The quarry was exploited in Greek, rather than Roman times, for blocks and columns of both white and red-veined marble, but their destination is unknown.

Zakros

The palace known today as Zakros (in antiquity Dikta or Dikte) lies at the eastern end of Crete in a harsh and barren landscape, whose only redeeming feature is an excellent harbour, Kato Zakros (Fig. 16.1). Above the palace is the substantial village of Ano or Eparo (Upper) Zakro, where there are good springs, possibly piped to the palace in antiquity. The two villages are joined by a deep and picturesque 'Gorge of the Dead', named after the Minoan burial caves in the cliffs.

The site was probably settled about 3000 BC. A palace was built about 2000 BC; like other Cretan palaces it was destroyed by an earthquake about 1700 BC and replaced by a grander version. The excellent harbour and its proximity to Egypt and Western Asia brought great prosperity. This palace in its turn, was burnt down in about 1450 BC and never reoccupied.

The village of Ano Zakro, 5 km east of the palace at Kato Zakro, is set in a north/south valley, probably a graben formed by the east/west extension that has affected most of Crete. It is floored by Miocene conglomerates and other sediments. To the east the range of hills parallel to the coast is dominated by Triassic-Eocene dark limestones, which pass up into Eocene flysch sediments (sandstone, conglomerate, marl and shale). A syncline near the palace has brought the flysch sediments down to sea-level, where they have been partly eroded by the sea to form the bay (Fig. 16.8).

The sinuous form of the Gorge of the Dead was formed as follows: initially a stream meandered across an almost flat plain and rapid uplift of this area caused the stream to cut downwards, rather than sideways, incising the meanders into the block of rock as the gorge.

The palace of Zakros was constructed at the foot of a low ridge of sandstone and marl (flysch). In front is a small, fertile alluvial plain, between the bay and the exit of the gorge. Abundant springs near the site are probably fed from waters flowing underground down the gorge. The builders of the palace used several different types of local hard and soft limestone, but the most important material was ammoudha. This Pleistocene sandstone

16. Crete

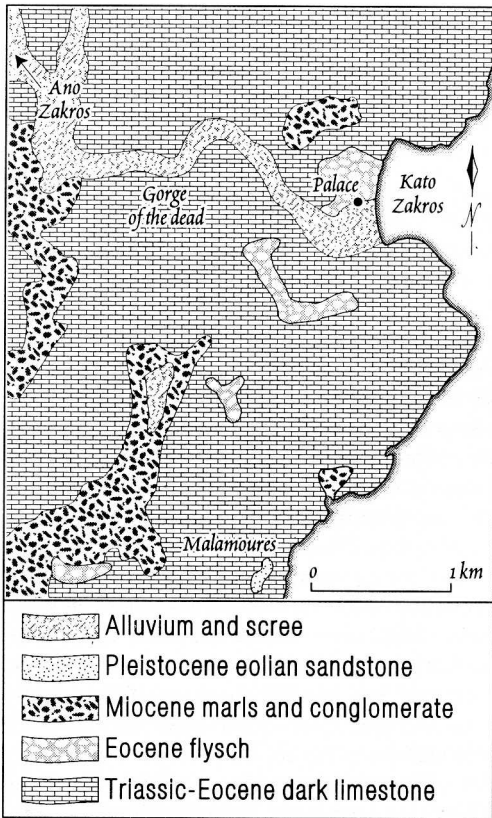


Fig. 16.8. Kato Zakros and the Minoan Palace. Ano Zakros lies about 3 km west of the edge of the map.

was extracted from coastal quarries near Pelekita, 3 km to the north, and Malamoures, 2 km to the south. Another major quarry at Ta Skaria, 10 km to the north, provided building material for the Minoan town of Roussolakkos, near Palaeokastro.¹⁹⁶

This region has subsided by at least 1 m, and possibly 2-3 m, since antiquity. Hence the site is now commonly waterlogged, and the ancient fields may be up to 2 m below the present surface. With the sea-level 2-3 metres lower the stream that leaves the gorge may have flowed within well-defined banks, and hence been less prone to catastrophic floods.¹⁸⁷