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7

Elis, Achaea and Arcadia

This chapter is concerned with the districts of Elis, Achaea and Arcadia in the north-western and central parts of the Peloponnese (Fig. 7.1). As they differ geographically and geologically, they are best dealt with separately.

The western part of the Peloponnese is mostly underlain by the rocks of the Gavrovo and Pindos zones, which are seen also on the island of Corfu and the western part of the Greek mainland. These zones are the 'external' parts of the Hellenic collision zone and are, in essence, parts of the continent that impinged onto the Eurasian mainland. For much of its life the Pindos zone was a deep water trough, distant from land, where deep-water limestones accumulated. This was interrupted twice by deposition of flysch sediments, shed into the basin from adjacent mountain chains produced during regional compression.

The Gavrovo zone, south-west of the Pindos, was for a long time covered by shallow seas, distant from land. Reefs produced by accumulations of bivalve shells, algal encrustations and coral skeletons were eventually converted into limestone. Sedimentation in the Gavrovo zone ended with the deposition of marls and conglomerates. At this time regional compression raised the Pindos zone above sea-level and clastic sediments were shed into the adjacent Gavrovo zone. Finally, Alpine compression during the Eocene period thrust the Pindos zone south-westward over the Gavrovo zone.

As elsewhere in Greece this area was profoundly affected by the great Neogene phase of crustal extension (see Chapter 2). Here the direction of extension varied from north-north-east in the north, to north-east in the west. A series of grabens developed, including the Gulf of Corinth and the plains of Elis.

Elis

Elis is bounded on the north by Achaea, on the east by Arcadia, and on the south by Messenia (Fig. 7.1). Cut off by mountains from the Aegean, it tended to look westwards to the Ionian Sea. Olympia put it on the political map in the seventh century BC, and even in Roman times much of the Mediterranean world came to the games. The northern part, Elis proper, is divided into the Plain of Elis on the west, watered by the Peneios river, and on the east, the foothills of the Arcadian mountains. The Plain is good for livestock, and was traditionally renowned for its horses. It also grows flax and cereals. Further south, watered by the longest river on the Peloponnese, the Alpheios, is the district of Pisatis, which contained the Sanctuary of Olympia. Further still to the south is the district of Triphyllia, reaching as far as the river Neda.

The mountains inland from Elis are dominated by deep-water limestones of the Pindos zone in the east, and flysch of the Gavrovo zone in the west (Fig. 7.1). Neogene extension in a north-east/south-west direction produced the graben that is the broad valley of the Alpheios river, and the strait that lies between the mainland and the island of Zakinthos. A secondary Neogene extension, at right angles to the main direction, produced the north-west coast and plains of Elis, and continues into Achaea (see below).

In Pliocene times the graben of the Alpheios river and the north-west coastal plain of Elis initially sank faster than they could be filled up by sediments delivered by the rivers from the uplifted areas towards the centre of the Peloponnese. In these large bays or estuaries

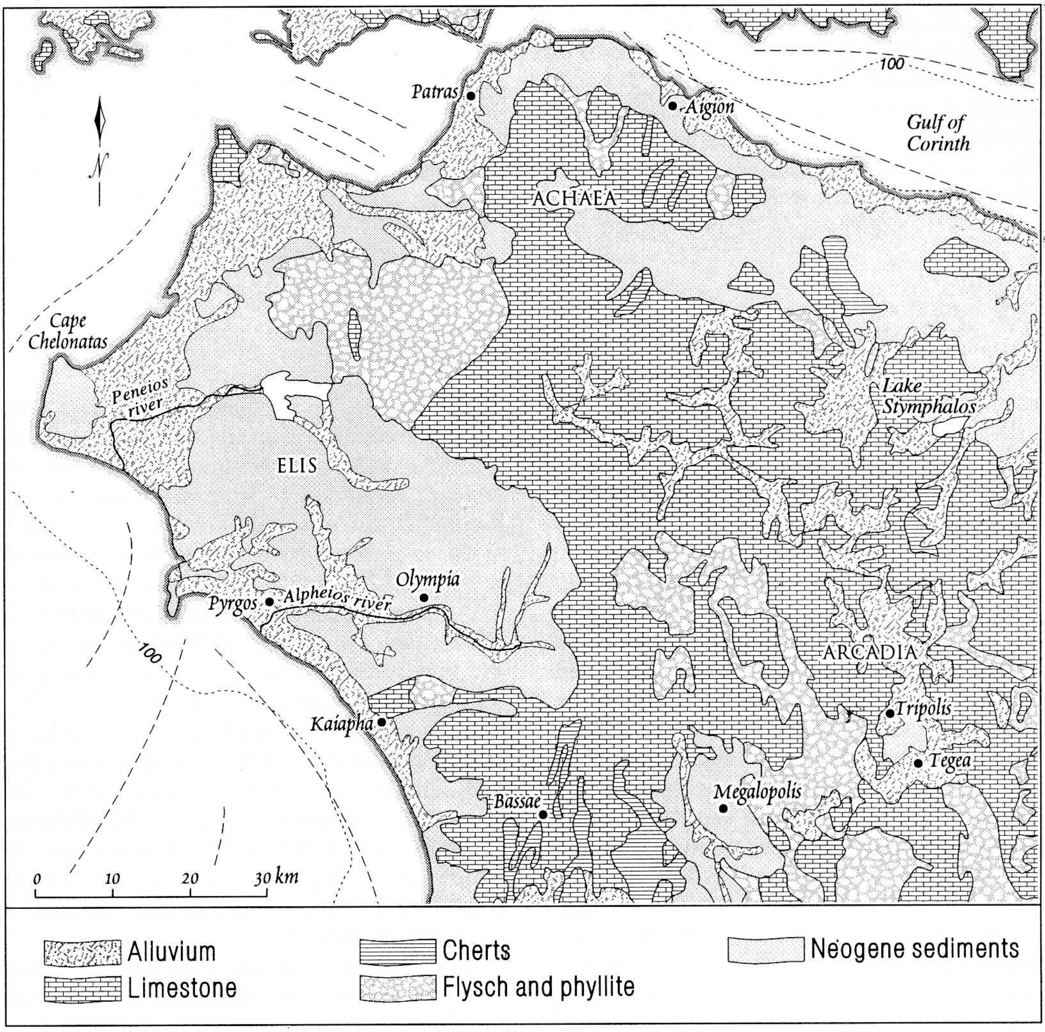

Fig. 7.1. Elis, Achaea and Arcadia.

marine and brackish water sediments were deposited, including the shelly limestones that were used in the construction of most of the buildings at Olympia. Subsidence slowed and/or the sedimentation rate increased during the Pleistocene and the bays became dry land. Recently, these deposits have been uplifted and strongly eroded.

Cape Chelonatas

The Elis Plain comprises a gravel-covered plateau and the alluvial deposits of the Peneios river. The plateau appears to be a Pleistocene erosion surface, originally at sea-level, but now lifted up by tectonic forces. The shoreline probably ran along the edge of this plain in Helladic times and hence the Chelonatas headland was an island.

For much of historical time the Peneios

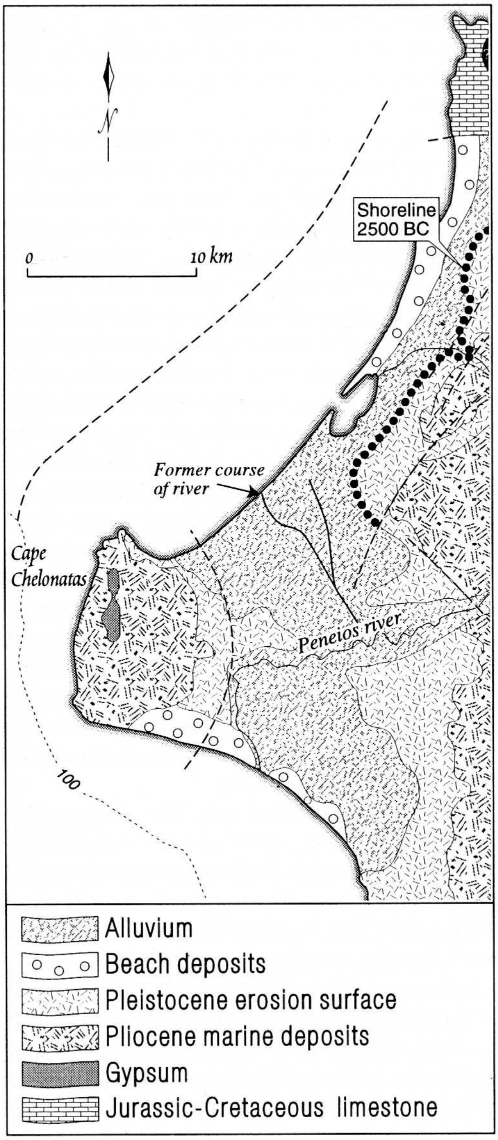

Fig. 7.2. Western Elis (after 148 and other sources).

river flowed north of the Chelonatas headland, depositing large amounts of sediments along the north-west coast. However, during the eighteenth century the river naturally shifted course to its present position south of the headland. This shift has starved the north-west coast of sediment and it is now being eroded.[148]

The westernmost part of the Peloponnese, Cape Chelonatas, is a series of low hills topped by the Frankish castle of Chlemoutsi (Fig. 7.2). This headland is a horst of Pliocene marine sediments, including gypsum, similar to those to the east on the other side of the graben.

Olympia

The panhellenic sanctuary of Zeus at Olympia takes its name from Mt Olympos in north Greece. It is situated in a lush green valley at the confluence of the river Alpheios and its tributary the Kladeos (Fig. 7.1). The site was first occupied in about 3000 BC. From 776 BC Greeks from all over the Greek world assembled every four years to worship Zeus and to participate in the Olympic Games. The Games were held regularly until AD 393 when the Sanctuary was closed by the Christian Emperor Theodosius I. In 426 Theodosius II ordered the destruction of the Sanctuary; the process was completed by two terrible earthquakes in 522 and 551 (Plate 7A), followed by floods, landslides, and the attacks of the Vandals.

The most famous buildings were the temples of Hera (Heraion) and Zeus. The temple of Hera was built in about 650 BC of local shelly limestone, replacing an earlier building of wood and mud brick. The temple of Zeus was built between 466 and 456 BC of the same local limestone, faced with a marble stucco. The sculptures and the original roof-tiles were of Parian marble, but later some tiles of Pentelic marble were used as replacements. About 430 BC the sculptor Phidias made the colossal gold and ivory cult-statue of Zeus, a masterpiece which was one of the Seven Wonders of the Ancient World.

Olympia was built on the flood plains of the Alpheios and Kladeos rivers (Figs. 7.1, 7.3). The hills around the site are made of geologically young (Late Pliocene) uncemented sands, silts, clays and conglomerates. The best-known part of this unit is the Hill of Kronos which rises steeply to the north of the site. It is made of yellow, uncemented sands, which have been eroded to an angle steeper than their angle of rest and are only held in place by the trees. As a result there are numerous small landslides

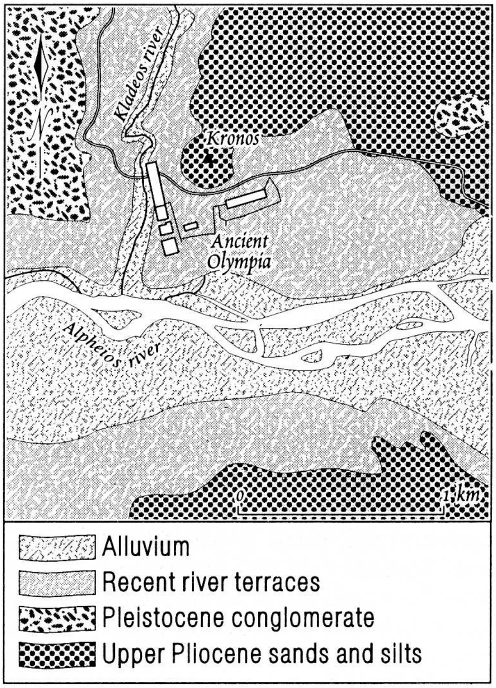

Fig. 7.3. Olympia.

along the lower slopes, especially along the modern road-cut, but they have not moved far. Similar landslides probably contributed to the burial of parts of the site adjacent to the hill, especially when the loosened material was further redistributed by surface water. The substantial retaining wall behind the Treasuries indicates that landslides from the Hill of Kronos were also a problem in ancient times. However, the amount of material shed from Mt Kronos was not sufficient to bury the site and most of the sediment must have been supplied by the rivers.

There have been many explanations for the deposition of alluvium here. Catastrophic draining of a temporary lake in the Feneos polje, 70 km to the north-east, is recorded to have produced flooding at Olympia (see Achaea), but it seems unlikely that significant amounts of sediment could have been deposited so far away.[148] Increased erosion during the fifth to seventeenth centuries has also been blamed for deposition of alluvium on the site.[277] But it is also possible that the burial was part of a cycle of sedimentation controlled by the interaction between the Kladeos and Alpheios rivers.[131]

The Alpheios, the major river of this basin, here occupies a bed about one kilometre wide. When it meanders near its southern limit the Kladeos must flow a further kilometre to join it, compared to when it is at its northern limit. A long river bed creates a shallow slope, so water flows more slowly. In these conditions sediments tend to be deposited and then form an alluvial fan upstream from the confluence of the rivers. A fan of this type from the Kladeos buried Olympia. Since then the Alpheios has migrated north and the bed of the Kladeos has become shorter. The more rapidly moving waters have now eroded the alluvial fan deposited earlier, and cut a 5-6 m deep trench which is the present bed of the river.

The form and position of the stadium suggest that it may have evolved from a natural feature: a channel of the Alpheios, when it was at its northern limit, would have had a similar orientation and topography. Such channels are abandoned when the river shifts, commonly abruptly, following a storm.

The buildings of Olympia, like the temples of Hera and Zeus, were mostly constructed from Pliocene and Pleistocene shelly limestones, or occasionally sandstones, deposited in the basin. The quarries were near the Sanctuary, on the opposite side of the Alpheios.[49]

Intense earthquakes are relatively common at Olympia, because of its tectonic setting and the local geological conditions. Unlike many sites in the Aegean, Olympia was built on river sediments rather than solid rock. Such sediments can resonate during earthquakes, amplifying seismic vibrations and considerably increasing the destructive force of earthquakes. This was well-known in antiquity and precautions were taken to mitigate the effects of severe earthquakes. The columns of the temples and other buildings could not be protected against violent shocks. The columns, thirteen on either side and six at the ends, collapsed during the earthquakes of AD 522 and 551, and can still be seen where they fell (Plate 7A).

The Springs of Kaiapha

Two thermal springs rise 15 km south of Olympia (see Fig. 7.1).[1] The northern spring issues at about 36°C from a limestone cave, known in antiquity as the Cave of the Anigrian Nymphs. It is about ten metres deep and lined with flowstone, which is not caused by the spring itself but by seepage through the roof. Two faults, which can be traced into the limestone overlying the cave, probably guide the waters to the surface. The springwater contains about 30% seawater and issues from the rear of the cave, accompanied by a small amount of the gas hydrogen sulphide. This gas has reacted with the limestone to produce crystals of gypsum, which line the deepest part of the cave.

About 1 km south another sulphurous spring issues from the base of the hill in the Cave of Yeranion. This spring is much cooler, about 27°C, and is probably a mixture of deeply-circulating thermal waters and cool groundwater, with little seawater.[1] The walls of the cave are also coated with gypsum crystals, but these are much smaller than in the northern cave.

Achaea

The province of Achaea extends along the south shore of the Corinthian Gulf (Fig. 7.1). It consists of a narrow coastal plain, backed by the northern slopes of the Arcadian mountains. It is bounded on the east by Corinthia, on the south by Arcadia, and on the west by Elis.

The plain is very fertile, producing fruit, vines and olives; it is broken up and watered by numerous streams, most of which dry up in the summer. The higher slopes carry forests of oak and conifer. The coast is low-lying, with only one good harbour, at Patras.

Little is known of the early history of Achaea, but archaeology has established its importance in Mycenaean times (1600-1100 BC). Later, in the Classical period, Achaea became a federal league of twelve small towns until the fourth century BC. Helice, the sanctuary and meeting place of the Achaean league, was destroyed by a tsunami in 373 BC (see below). In the third and second centuries BC, however, a reconstituted Achaean League became the principal power in Greece until it was swallowed up by the rising power of Rome.

The high mountains to the south, and those west of Patras, are dominated by deep-water limestones of the Pindos zone (Fig. 7.1). However, farther north the rocks, and the overall shape of the land, have been controlled by Neogene extension. The most important morphological feature of the area is the Gulf of Corinth. This graben started to form about ten million years ago and is still active (see Chapter 5). The western part of the Gulf of Corinth is, more accurately, a half-graben, as only the southern edge is descending along a fault.[114] The northern edge is more like a hinge. Initially the graben was much wider, and extended 15-20 km further south than the present coastline. During the Pliocene and early Pleistocene marine sediments were deposited in this trough. The graben migrated to the north in more recent geological time, uplifting these sediments to form much of the hilly area south of the Gulf.

Near Patras the tectonics have a different character: extension, or possibly strike-slip faulting, took place at right angles to the main direction. This produced an offset in the Gulf of Corinth, parallel to the coast of Elis to the south. The hills to the west of Patras are a block of Cretaceous and Jurassic limestone raised up by the combination of these two extensions. There are two prominent terraces near Patras, at 270 and 80 m.[220] The upper terrace is probably the top of deltas that were deposited in the Gulf of Patras when it was a lake, about 250,000 years ago (see Chapter 5).

Recent earthquakes along the faults of the Gulf of Corinth graben are concentrated towards the eastern end, along the northern shore and around the town of Aigion. Many earthquakes, notably those in 373 BC and AD 1402, were accompanied by tsunamis.[192]

The earthquake and tsunami of 373 BC was also responsible for the destruction of the city of Helice, whose exact location is still unknown, as nothing remains. It was probably 7 km west of Aigion, on the western gulf. Contemporary writers noted that wild animals and insects left the city during the five days preceding the earthquake, and this has often been cited when premonitory animal behaviour is discussed. The earthquake probably occurred on the southern graben fault:[184] this fault was reactivated in AD 1881, when it produced a scarp 2 m high and 13 km long. The city was submerged by movements on the fault, and its destruction was completed by the tsunami and further earthquakes along this fault. It is estimated that a total of 6.5 m of movement has taken place during the past 5,000 years.

Arcadia

The department of Arcadia, in the centre of the Peloponnese, is completely surrounded by a ring of high mountains. Much of it is drained by the river Alpheios and its tributaries; frequently the rivers, with no outlet above ground, disappear through sink-holes.

The most prosperous part in antiquity consisted of the eastern plains which, in spite of extremes of climate, grew vines, wheat and barley. Here were the substantial cities of Orchomenos, Mantinea and Tegea. The west is rough upland, and good for little but livestock. Here the shepherds worshipped the pastoral god Pan. Arcadia never achieved political importance, but was well known for its pastoral setting, and secondarily for the mercenary activities of its inhabitants. Their dialect, related to Cypriote, was the only version of Greek in the mainland which can be directly traced to the language of the Mycenaeans.

The bedrock here closely resembles that of much of the central Peloponnese. Cretaceous deep-water limestones of the Pindos have been thrust over flysch and Mesozoic shallow-water limestones of the Gavrovo zone (Fig. 7.1). The latter can be seen through windows in the overlying Pindos where it has been removed by erosion. Neogene faulting produced a series of grabens in the eastern part of the region. These grabens make up the interior plains of eastern Arcadia and most are poljes, i.e. they are drained internally by sink-holes (Fig. 7.4). Most of the poljes were originally valleys that drained westwards into the Alpheios river. During the Neogene period erosion of the river beds was unable to keep up with tectonic uplift and the valleys become isolated. The waters ponded until they were able to widen existing fissures and escape underground.

The only waters that continue to flow westwards are those of the north-west poljes. Most of the water that enters the Feneos sink-holes reappears at the Ladon spring, near Likouria, whereas that from the Hotoussa sink-hole reappears at the Panagitsa and Daras springs.[182] All these springs feed the Ladon river, a tributary of the Alpheios. The connection between the Feneos sink-hole and the Ladon spring was well known in antiquity.[148] Several times the Feneos sink-hole was blocked and the polje became a lake. When it finally drained the flood was felt as far away as Olympia.

Water from all other poljes ultimately discharges into the Gulf of Argos. The Stymphalos polje in the northern part of Arcadia contains the only permanent lake in the region. At present the two major springs of the polje, Stymphalos and Kephalari, are fed by water from Mt Ziria to the north. The water accumulates in Lake Stymphalos, which is drained by a large, gate-like sink-hole. The water finally discharges from springs in the Argolid (see Chapter 5). Several attempts have been made to reduce the amount of marshy land in the valley; the earliest consisted of a canal cut between the spring and sink-hole. About AD 125 this arrangement was improved by the construction of a tunnel through the hills to the south, draining the spring waters into the Scotini polje. By the fifth century the tunnel had become blocked and the polje flooded, but it was repaired in AD 1885 and is still in use today.[182]

The Scotini and Alea poljes also feed the springs of the western Argolid, including the large spring at Kephalari (not to be confused with the Kephalari spring in the Stymphalos polje). The Alea polje periodically becomes a lake as drainage is insufficient to cope with the winter rains.

The largest polje is that around Tripolis. The northern part is a flat, treeless plain drained by five major sink-holes. The Kapsia sink-hole has an extensive cave system at least 2.5 km long that connects to the nearby Paleochori cave. In antiquity the city of Mantinea

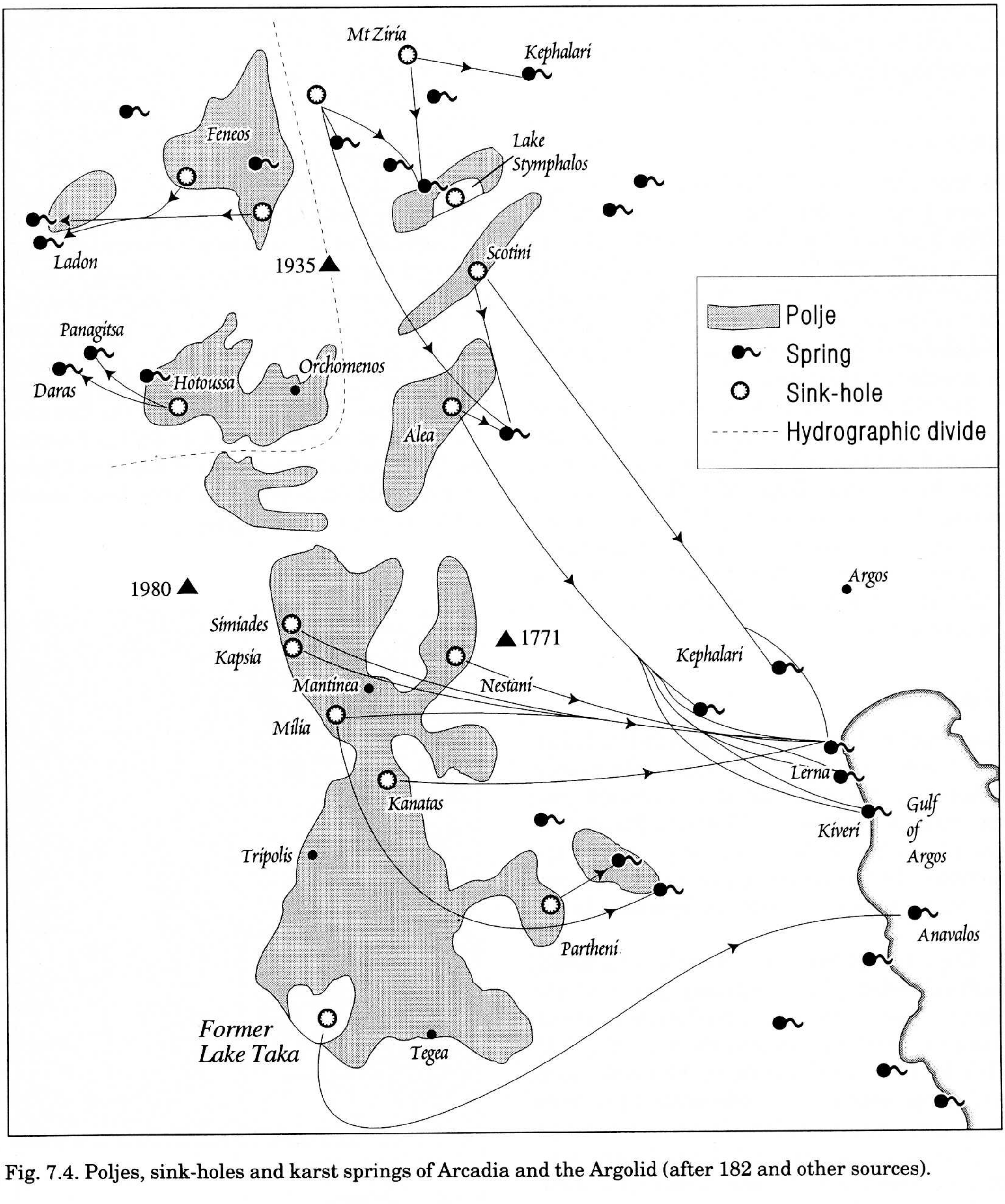

Fig. 7.4. Poljes, sink-holes and karst springs of Arcadia and the Argolid (after 182 and other sources).

stood here, and control of the sink-holes was very important. During one conflict, the sink-holes were blocked and the plain flooded. The mud-brick walls disintegrated and the city was taken. Today, the Kanatas sink-hole receives the sewage waters of the town of Tripolis, most of which are discharged into the Gulf of Argos at the Kiveri spring.

Waters from the southern part of the polje drain into the Taka sink-hole on the southern margin. They finally discharge directly into the Gulf of Argos at the submarine spring

Anavalos.[182] This alluvial plain was formerly a seasonal lake, until the sinkhole was cleaned out during the early part of this century.[182]

Tegea

As the most powerful city state in Arcadia, Tegea long resisted Sparta, but during the Peloponnesian War, in the late fifth century BC, it had perforce to ally its their ancient enemy. The city was most famous for the temple of Athena Alea, the finest in the Peloponnese. It was decorated with sculptures of marble of local origin.

The quarries for this marble, a sparkling greyish-white with a medium to fine grain, are situated on the northern slopes of Mt Parnon, near the modern village of Doliana, some 10 km south-east of Tegea (Fig. 7.1). The deposits are large, extending to 5 km by 1 km, but the marble was not much used outside Arcadia, owing to the difficulties of transporting it in Classical times.

Megalopolis

Megalopolis ('Big City') was founded in 371 BC in the south of Arcadia on the river Helisson, a tributary of the Alpheios. It was created from the amalgamation of 40 villages by Epaminondas of Thebes to be a bulwark against the Spartans. In this aim it succeeded for well over a century, until sacked by the Spartans in 222 BC.

The city was built in the centre of a small, fault-bounded plain, between flysch of the Gavrovo zone to the east, and Cretaceous limestones of the Pindos zone to the west (Fig. 7.1). This basin has existed since Pliocene times, and large amounts of sediments have been deposited here in shallow lakes and swamps. Lignite, a low-grade coal, formed here from accumulated plant remains. This rock is quarried in one of the largest operations in Europe and used to generate electricity.

Bassae

The Temple of Apollo Epikourios at Bassae, situated at an altitude of 1,131 m on the bare and windswept slopes of Mt Paliavlakhitsa (ancient Mt Kotilion) was built between 430 and 400 BC on the site of an earlier temple (Fig. 7.5). The Temple incorporated a number of unusual features, including the earliest recorded Corinthian capital. At first sight it appears to be comparatively well preserved, but was in fact seriously damaged in the Middle Ages, by people who tore the masonry apart to steal the metal clamps. Eventually, in AD 1811, the surviving sculptures were removed.

The bedrock beneath the temple is siliceous limestone of Late Cretaceous age. This rock is finely bedded and strongly jointed and folded, giving a low strength inadequate for fine construction. It was only used as rubble beneath parts of the foundations, and from the warping of the building appears to have been inadequate even for that purpose.[12, 46]

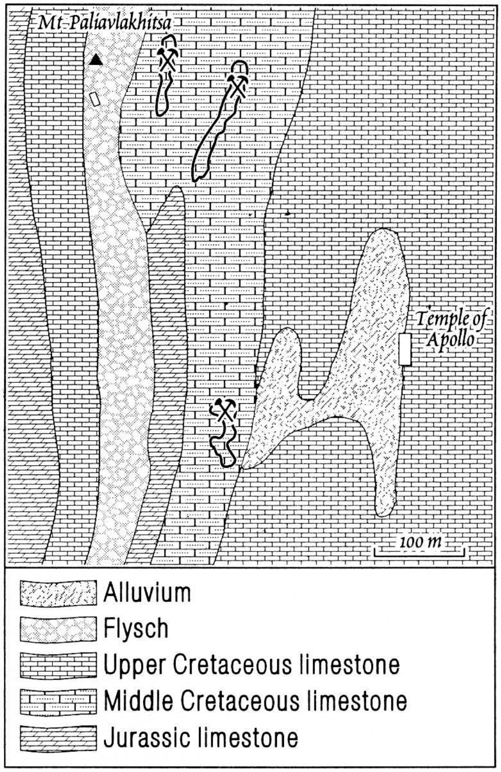

Fig. 7.5. Bassae (after 46 and other sources).

Most of the superstructure of the temple was built of slightly older, Mid-Cretaceous limestone that crops out in a band west of the temple. This limestone is purer, less folded and jointed than the bedrock beneath the temple, and so provided a much stronger rock, although still with well-developed bedding. The quarries for this limestone can be seen 200 m south-west and 300 m north-west of the temple.

The builders of the temple set the bedding so as to maximise the strength of the blocks. In a harsh climate, such as here, one of the most important mechanisms of rock weathering is the freezing and thawing of water absorbed into cracks, such as the bedding planes. The columns have best resisted weathering because the layering was oriented more or less horizontally, and hence little water was absorbed. The lintels were set with the layers in a vertical orientation, and hence have suffered most since the loss of the roof allowed water to penetrate.

The sculptures, architectural details, ceiling coffers and roof-tiles were made of white marble. Many sources have been suggested, but geochemical and textural evidence suggests that it came from near Marmari in the Mani (see Laconia).[45]