The Voidomatis basin: an introduction

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Chapter 16

The Voïdomatis Basin: an Introduction

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The first step in placing the archaeological information from Klithi into a broader framework is the examination of the local setting within which the site occurs. The most obvious geographical unit for such purposes is the catchment of the Voïdomatis, and this area, together with some of the adjacent areas such as the Doliana basin to the west, has been the focus for our most detailed palaeoenvironmental and archaeological analysis. The Voïdomatis flows westwards from the highest part of the central Pindus Mountains, then northwestwards towards Albania, extending over a distance of some 30 km and an altitudinal range of more than 2000 m. This results in a considerable diversity of climatic, physiographic, geological and ecological conditions. During the Late Pleistocene, glaciation in the upland areas of the catchment imposed strong controls on local climate, hydrology, geomorphology and vegetation, causing substantial changes in the potential of the landscape for human occupation. The lower reaches of the catchment are dominated by limestone bedrock, and the effects of limestone weathering, tectonic faulting and fluvial erosion have created a large number of caves and rockshelters. Many of these are suitable for human use, and some contain archaeological deposits, offering the potential for comparative analyses of sedimentation and human activities in different localities. The aim of this chapter is, then, to outline the major features of the physical environment in the vicinity of Klithi and the wider Voïdomatis basin, and to provide general descriptions of geological history, geomorphology, climate, vegetation and archaeological sites as an introduction to the more detailed analyses of the following chapters.

Regional geological and geomorphological setting

Many of the features of the Voïdomatis basin are the result of an interplay between local lithological controls and the regional climatic and tectonic history, and it is to the latter that we turn first (for a more detailed discussion of tectonics see Jones & Robertson 1991; King *et al.*, Chapter 28). Epirus has a complex geological history and changing interpretations have been paralleled by the development of plate tectonic theory and associated concepts over the last four decades. In the early 1960s, following the classic work of Aubouin (1959), the structural arrangement of the Hellenide belt was viewed in terms of the development and subsequent deformation of a major geosyncline. Over the next two decades, however, this initial model was modified significantly as new field data became available and the implications of plate tectonic theory attained general acceptance (see Smith & Moores 1974; Smith *et al.* 1979). As a result of this reappraisal, the Epirus region is now regarded as a distal portion of the intricate tectonic terrain that makes up the Alpine Mountain system (Everett *et al.* 1986). Whilst there is little doubt that the structural evolution of northwest Greece is complex, and that processes of crustal deformation continue to the present, details on uplift rates and seismic activity are still under investigation (King *et al.*, Chapter 28).

As a consequence of its tectonic history, the entire region is characterized by intense folding and overthrusting, the direction of compression being from the northeast toward the Ionian Sea. Traditionally, the solid geology of Greece has been divided into twelve geotectonic units and in Epirus these zones are characterized by a series of overlapping lithofacies belts which trend NNW–SSE at right-angles to the general direction of compression and parallel to the present Ionian coastline. The Voïdomatis basin is easily visible on the Landsat image (Fig. 16.1) located due west of the image centre (H12) close to the thrust line separating the Ionian frontal zone and the highest mountains of the Pindus Range. On a regional scale, it is apparent that a close relationship exists between the nature of the individual structural units and the style and patterning of geomorphological features within them. This terrain variability is expressed through inter-unit contrasts in relief, slope angles and drainage geometry and density. The landforms themselves express the structural configuration and lithological composition of each zone and graphically display the tectonic framework of the entire deformed belt (Everett *et al.* 1986). Regional lithology and structure have exerted a strong influence on the geomorphological evolution of Epirus and each structural zone is characterized by differing soils and vegetation as well as slope forms and drainage patterns.

This highly distinctive crustal alignment evolved throughout the Cretaceous and Tertiary periods as a

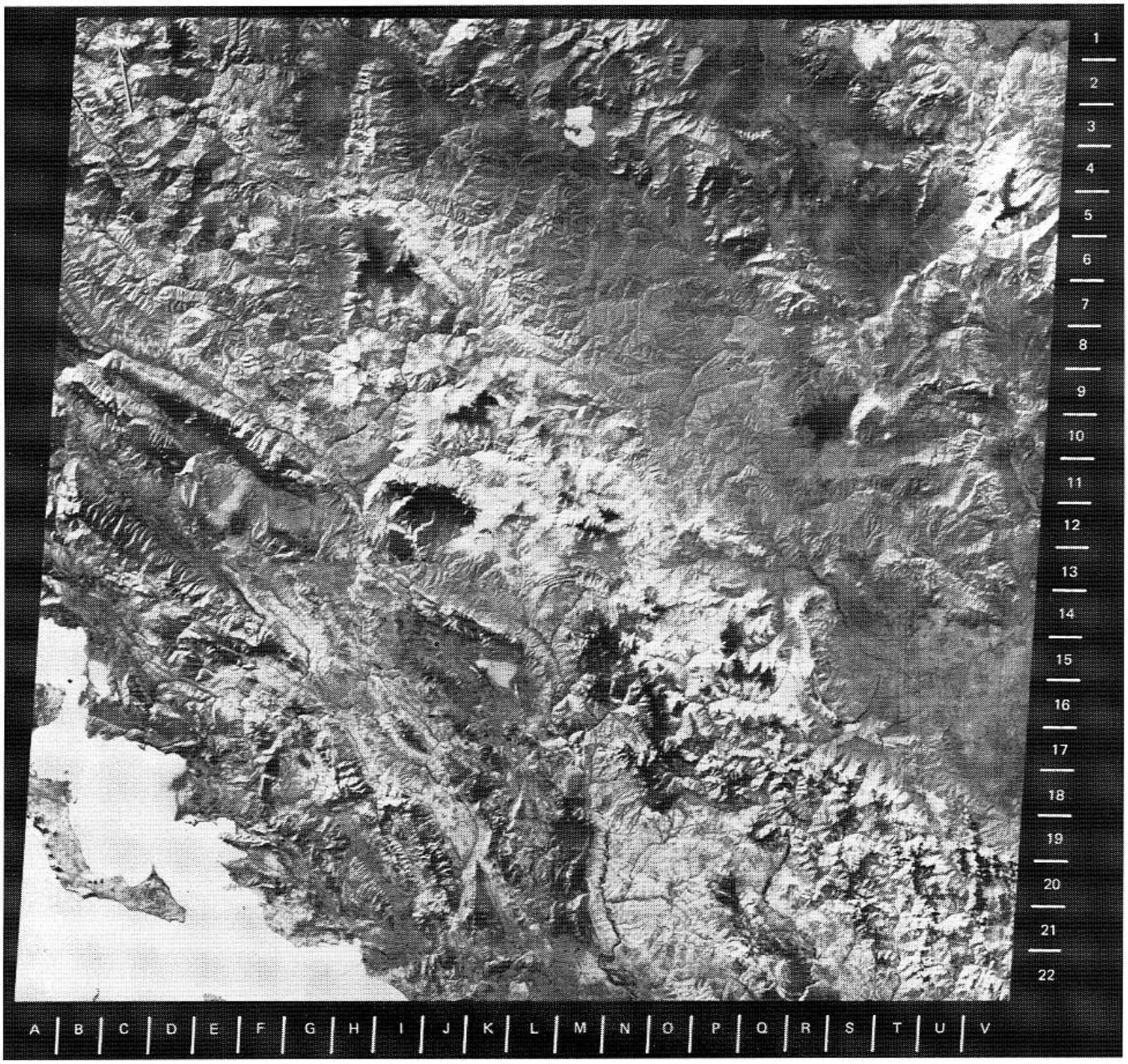

Figure 16.1. *A LANDSAT scene (185 × 185 km) of northwest Greece and southern Albania to illustrate the steepland relief of much of Epirus. The Voïdomatis River basin is located immediately west of the scene centre (H12). Lake Ioannina is situated SSE of the Voïdomatis basin (K15). The highest peaks and karst plateaus of the central montane belt of the Pindus Mountains lie approximately NNW–SSE and bisect this scene from top left to bottom right. The lower part of Kerkyra (Corfu) in the Ionian Sea is also shown.*

succession of compressional features developed (Smith & Moores 1974). In terms of lithology, calcareous, mainly pelagic sediments accumulated across the entire area throughout the Mesozoic era and during the Palaeocene and early Eocene (*cf.* De Mulder 1976). By mid-Eocene times, the Pindus thrust had been initiated and this feature remained active until Oligocene times, leading to the creation of the Pindus Mountains (Clews 1989). During the Oligocene and Miocene epochs, flysch-type sedimentation was dominant and disrupted the extensive carbonate sedimentation which had prevailed since early Mesozoic times. The great thickness of these flysch successions (up to 4000 m in the east of the Ionian zone) indicate the influx of huge volumes of fine-grained, quartz-rich, suspended sediment eroded from the newly uplifted mountain belt. According to Richter *et al.* (1978), flysch deposition ceased in the Aquitanian with the beginning of the main tectogenesis, and Meulenkamp (1985) has described the entire area as a 'mosaic of horsts and grabens'.

The main occurrences of igneous rocks are associated with the Pindus Ophiolite which covers an extensive area in the Aoos River basin to the east of the modern Voïdomatis catchment (IGME 1987; IGRS/IFP 1966). The dominant lithologies here are serpentinite, dunite and tectonized harzburgite and all the available field evidence suggests that only the deepest structural levels of this ophiolite are present. The ophiolite complex is probably continuous at depth below the Meso-Hellenic Trough molasse with the Vourinous and Othris ophiolites together forming a single ophiolite sheet (Smith *et al.* 1979). On exposure to sub-aerial conditions the ophiolite materials can be rapidly broken down by chemical weathering processes. Whilst the modern channel of the Voïdomatis River contains only a very small proportion of ophiolite gravels (see Macklin *et al.*, Chapter 17), the floodplain of the Aoos River to the north and east contains a much greater proportion of ophiolite material.

The drainage basin of the Voïdomatis River (384 km^2) is developed in hard crystalline limestones which are overlain in places by Late Eocene to Miocene flysch rocks — the latter are often tilted and/or deformed. In the southeastern corner of the basin a small portion (*c.* 5 km^2) of the Pindus Ophiolite crops out. In structural terms, the basin is marked by three major NE–SW trending faults which combine to produce the broad 'stepped' relief of the catchment.

The flysch rocks consist of thin bedded (*c.* 10 cm) alternations of fine-grained, clayey siltstones and coarser-grained, siliceous sandstones (Fig. 16.2). The Palaeocene to Upper Eocene limestones which dominate much of the basin are hard, crystalline rocks with occasional bands of chert. In general, these rocks are very pure, with a calcium carbonate content which is typically >99.5 per cent (see Woodward, Chapters 18 & 19). The limestones are dominated by calcium carbonate in the form of calcite and the major non-carbonate minerals are quartz and mica, while the flysch rocks are highly siliceous with significant proportions of plagioclase, calcite, mica and other clay minerals (Woodward *et al.* 1992). The ophiolite material, which occurs as a small, isolated outcrop on the eastern margin of the catchment, delivers coarse gravel-sized clasts of tectonized harzburgite to the main Voïdomatis channel via a small tributary stream. This dark, dense ultramafic lithology has a distinctive mineral assemblage which includes olivine, pyroxene and spinel.

The Epirus landscape is dominated by the uplifted and faulted limestones of the Pindus Mountains, and this uplifted terrain has been deeply incised by a series of steep river systems to form tracts of dramatic steepland topography (see Fig. 16.1). The surface drainage on resistant limestone formations is frequently channelled through ravines and deep gorges whereas the weaker flysch formations are commonly heavily dissected by intermittent headwater streams. This high-relief landscape also encourages sediment transfer by mass movements such as landslips and debris flows, providing large volumes of unconsolidated material for subsequent removal and sorting by fluvial action.

Between these uplifted steepland zones lie fertile low-relief basins of various shapes and sizes such as Ioannina, Doliana and Konitsa. These basins act as sedimentary sinks where lake and alluvial deposits have been preserved. This alternation of terrains gives rise to a 'basin and range' topography across much of the Epirus region (*cf.* Bloom 1991; Macklin *et al.* 1995). It is clear that tectonic or endogenic processes provide the dominant long-term control on drainage network evolution and drainage basin size as well as on the broad pattern of river erosion and sedimentation in the landscape (*cf.* Collier *et al.* 1995; King *et al.* 1994 & Chapter 28; Macklin *et al.* 1995; Mather & Harvey 1995). It is also apparent, however, that climate- and human-induced episodes of river aggradation and incision may be superimposed upon this regional tectonic framework (see Macklin *et al.*, Chapter 17).

Prior to Alpine mountain building during the Tertiary Period, this region — in common with much

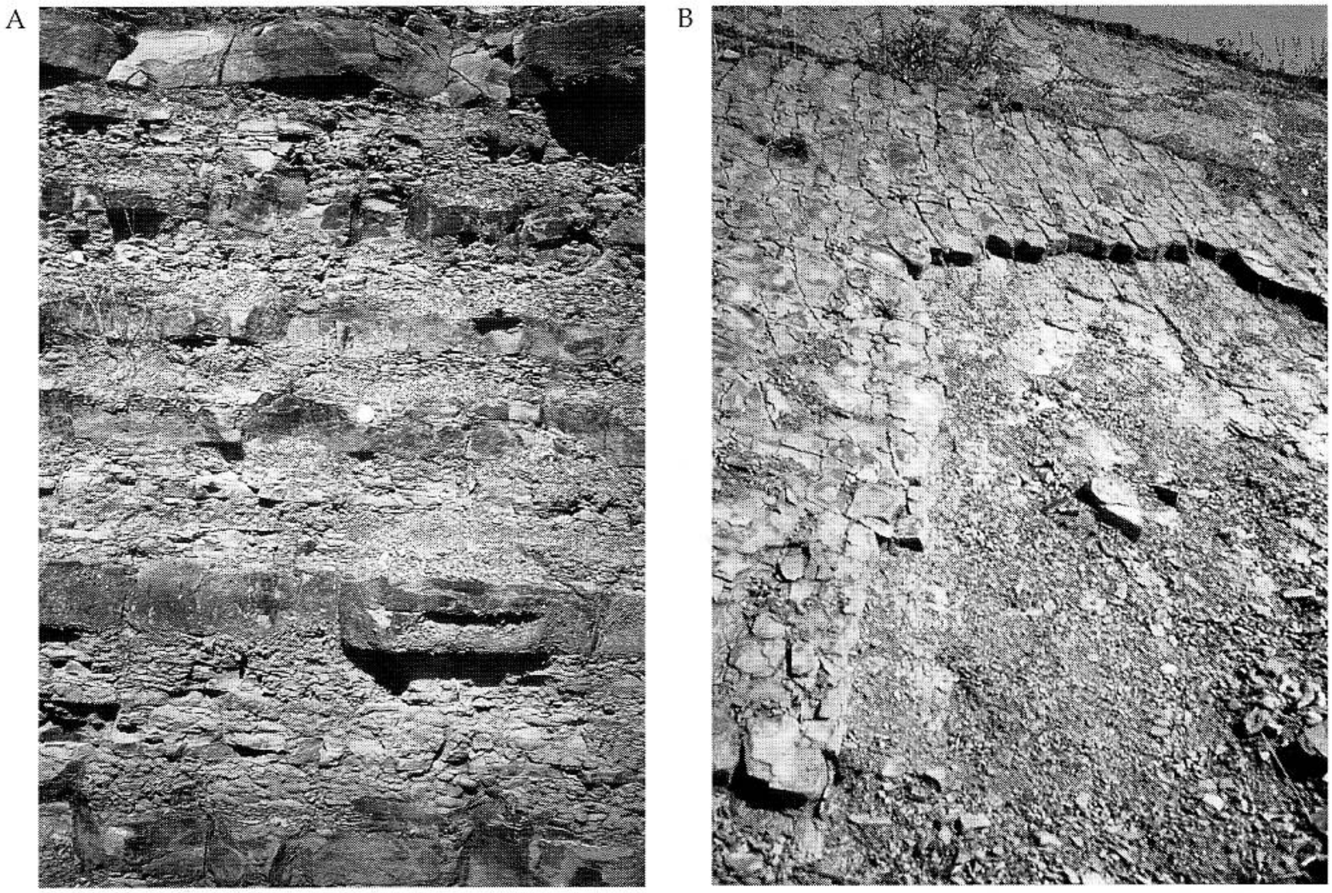

Figure 16.2. *(A) A typical section in flysch bedrock exposed in a road section* c. *1 km from Aristi on the Aristi–Papingon road in the Lower Vikos Gorge. In this section the darker resistant sandstone beds are approximately 10 cm in thickness. (B) Following vegetation clearance and the removal of the coarser sandstone beds, the fissile siltstone beds rapidly break down into sand-sized aggregates and primary fine sand and silt particles. When tilted, these bare rock surfaces encourage rapid runoff and yield large volumes of fine sediment to the karst and fluvial systems. The fractured sandstone bed is* c. *12 cm thick.*

of the Mediterranean zone — formed part of an extensive marine shelf in which limestones were laid down. The break up and deformation of this carbonate basement has produced limestone mountains and tablelands and, where climate and structure have permitted, karstic features have developed. These hard-rock massifs are commonly juxtaposed with flysch formations, as active Late Cenozoic uplift has elevated such highly erodible materials to create slope instability and high rates of erosion in headwater catchments (Woodward 1995). As in other parts of Greece, such as the Peloponnese, where marked contrasts in rates of denudation between resistant limestones and easily erodible flysch formations result in completely different relief (Gaki-Papanastassiou & Maroukian 1995), lithological contrasts have had an important influence on the evolution of the Epirus landscape.

The development of landscapes on hard limestone on the one hand, and flysch or other relatively easily eroded sediment on the other, is of particular significance in the Voïdomatis basin, and bears witness to the contrasting impact of erosive forces on different terrains. While erosion has been exacerbated by human action in more recent times, there is also an abundance of evidence recording extensive stripping of soil mantles and high river sediment loads during the Pleistocene. The thick 'red beds' of Epirus and the ancient braided river deposits preserved in valley bottoms point to significant episodes of hillslope instability and high sediment availability prior to major human vegetation disturbance in the Holocene. In more recent times, however, extensive grazing by sheep and goats and cutting of wood for fuel has led to the removal of

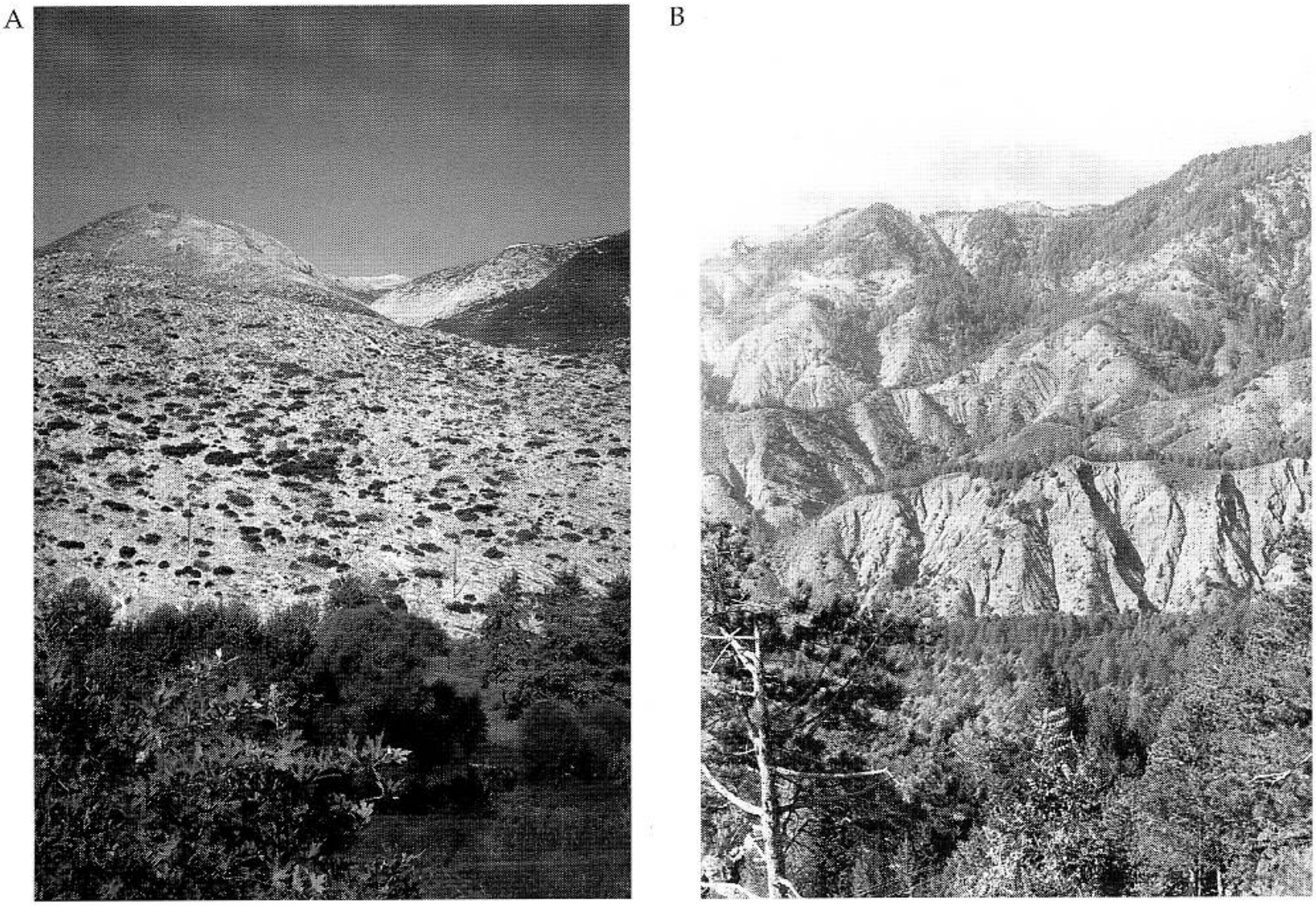

Figure 16.3. *Typical slope forms in Epirus on limestone and flysch bedrocks. (A) A steep slope on hard limestone with a discontinuous soil cover in the headwaters of the Louros River. (B) A heavily dissected flysch terrain east of Konitsa in northern Epirus. Note the difference in vegetation cover between the two slope forms.*

shallow soils from resistant limestones, producing bare rock slopes, while readily-erodible bedrock, including flysch and marl deposits may undergo extensive gullying, slope instability and even badland formation (Fig. 16.3). Such processes deliver large quantities of fine-grained sediment to the fluvial system and these materials may become an important part of alluvial sediments accumulating in the lower reaches of river networks and tectonically-controlled basins (Macleod & Vita-Finzi 1982; Woodward *et al.* 1992; Macklin *et al.* 1995; see Chapter 17).

Climate and hydrology

The climate of Epirus is transitional between central Europe and the Mediterranean with considerable local variability due to contrasts in aspect and relief. The climate of the Voïdomatis basin may best be described as a modified Mediterranean regime since the altitude of the basin (which locally exceeds 2400 m) imparts certain distinctive alpine characteristics and has an important effect on the timing and magnitude of precipitation and stream-channel runoff. The summer months are not as dry as the true Mediterranean coastal belt of southern Greece (Fig. 16.4). Periodic thunderstorms interrupt the summer drought and contribute to a total annual rainfall of *c.* 1000 mm near the Ionian coastal fringe and up to 2000 mm in the upland interior, where much of this rainfall is orographic. As in most mountain environments, the weather is capricious and the diurnal temperature range high (Legge 1972; McNeill 1992).

Streamflow records are not yet available for the Voïdomatis River itself, but a twenty-four year record is available for the Aoos River at the Konitsa bridge gauging station, only *c.* 10 km NNE of the mouth of the Lower Vikos Gorge (Fig. 16.5). It is likely that the annual flow regime of the two rivers is very similar

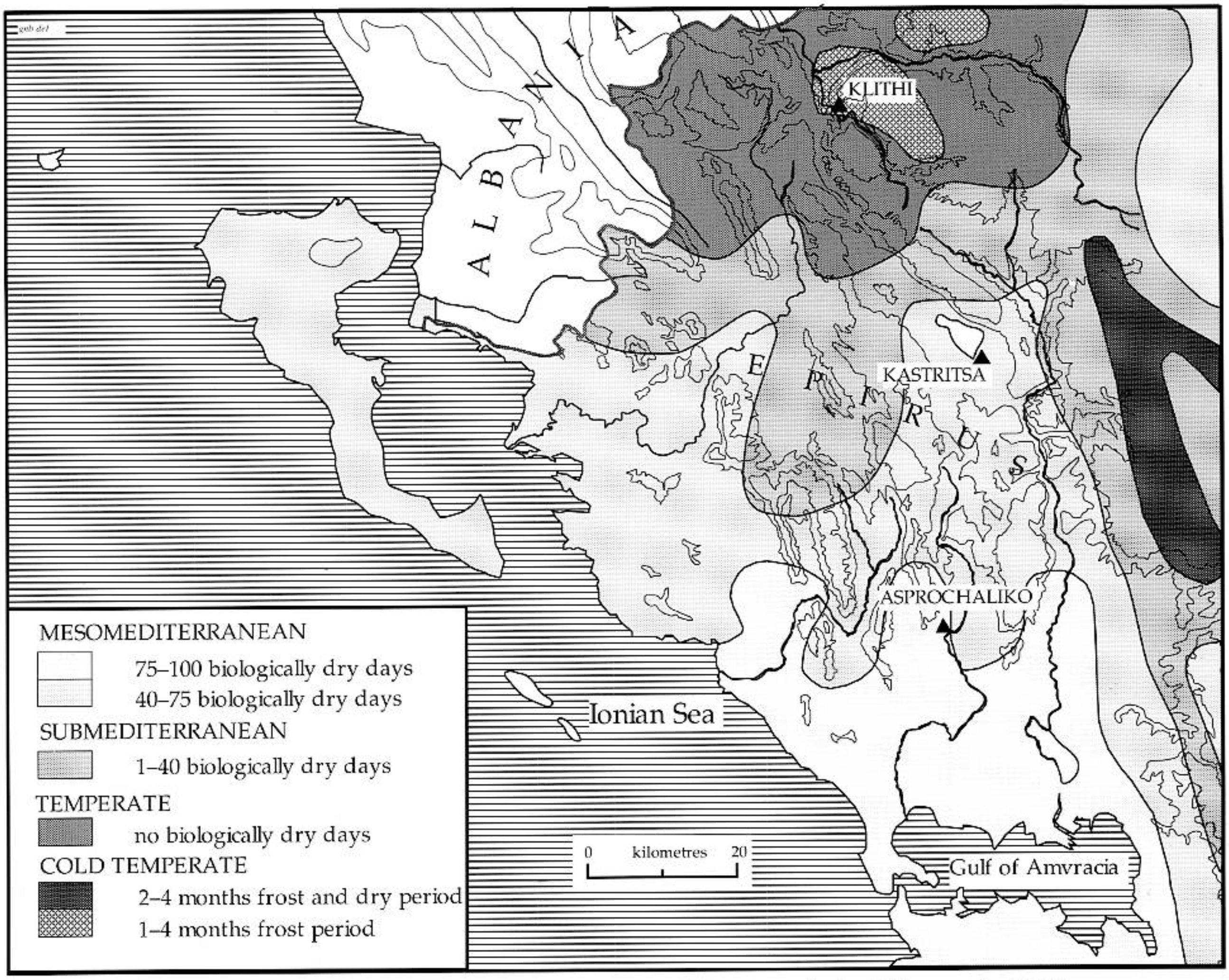

Figure 16.4. *Bioclimatic map of Epirus, showing principal Palaeolithic sites. (After Higgs* et al. *1967.)*

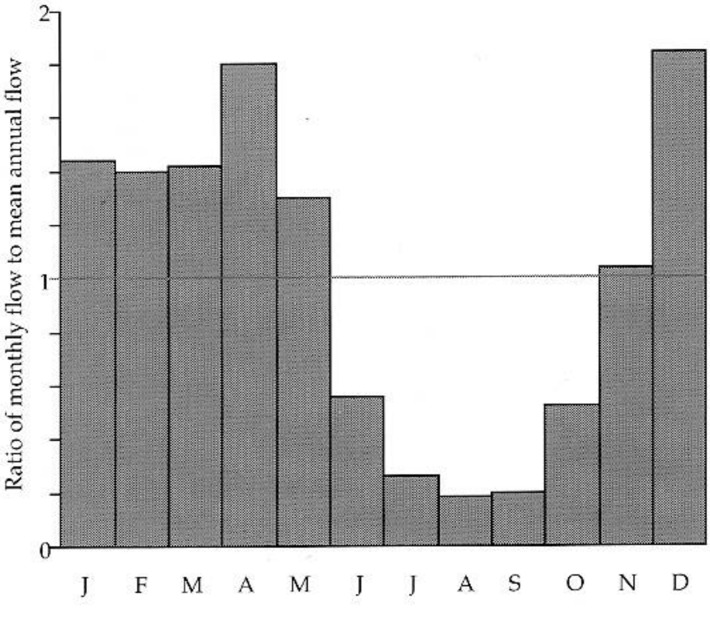

Figure 16.5. *Mean monthly flow of the Aoos River at the Konitsa station, expressed as a proportion of the mean annual flow for the period October 1963 to September 1987 (24.66 $m^3 s^{-1}$). During the five driest months of the year (June to October) the mean monthly flows are well below the mean annual discharge. December is normally the wettest month and the region's river regimes are shaped mainly by the timing and form of precipitation as well as by contributions from snowmelt and karstic storage. (Streamflow data kindly supplied by the Public Power Corporation of Athens.)*

in view of their common watershed and comparable relief and geology. These data highlight the strong contrast between a relatively brief dry summer spell characterized by low discharges and much higher flows during the rest of the year, particularly during March, April and May, when snowmelt forms an important component of the total runoff. Hammond (1967, 16) observes that 'in the winter and spring it is impossible to ford the major Epirus rivers and their tributaries, because the rainfall and snowmelt come down from the limestone massifs in raging torrents' (see also Woodward *et al.* 1995).

Mean July temperatures of 15°C are typical of the highest central montane belt of the Pindus Mountains, although these may rise to 20°C at intermediate altitude. This contrasts with a mean value of 25°C for the western coastal zone and Ionian islands. The highest plateaus and karst ridges of the Pindus Mountains run parallel to the Adriatic and Ionian coasts and lie in close proximity to them. At the coldest time of the year these mountain ranges provide effective shelter for the narrow coastal region against invasions of polar air, and not infrequently, even arctic air (Furlan 1977). Thus, while the nearby city of Ioannina has an average January temperature of *c.* 7.5°C (Lake Ioannina very rarely freezes), it is much colder in the inland montane belt of the Pindus Mountains where freezing winter temperatures are the norm and average January temperatures range from –2.5 to –5°C. Severe winters with prolonged snowcover are typical in the Voïdomatis basin and the highest peaks of the northern Pindus Mountains may have a snow cover until the end of June (Sfikas 1979). Frosts are common from October to May and the freezing temperatures and harsh conditions of the Epirus winter have been well documented. In the winter of 1940–41 the Greek army in northern Epirus had more casualties through frostbite than it had in battle throughout the whole campaign (Hammond 1967, 17).

Physiography of the Voïdomatis basin

The marked regional physiographic diversity in northwestern Greece is mirrored by the juxtaposition, on a more local scale, of equally striking terrain units within the boundaries of the Voïdomatis basin. Five major landscape units, identified on the basis of distinctive geological and topographical associations, have been identified in the catchment (Fig. 16.6).

1. The glaciated Tsepelovon district

The upland (Palaeocene–Eocene) limestone massif in the central part of the basin forms the highest part of the catchment, with elevations locally exceeding 2400 m. In the Tsepelovon district, there is an impressive range of morphological and sedimentological evidence for recent Pleistocene glaciation (Fig. 16.6). Well-developed glacial erosional features such as corries and hanging valleys carved into the limestone bedrock, fringe the stepped, U-shaped valleys of the area. Extensive deposition of glacially modified and transported sediments has produced a distinctive series of morainic lobes with associated glacio-fluvial landforms. These moraines, capped by boulder-strewn surfaces, mantle almost the entire south-facing slopes from above the village of Tsepelovon down into the Voïdomatis valley. Kame terrace features can be identified — these forms have been deeply incised by seasonal, snow-melt fed streams. Natural sections created by small landslips in these limestone dominated moraines appear as distinctive white scars in the landscape.

The glacial history of Greece is not well documented (see Denton & Hughes 1981; Sibrava *et al.* 1986). Although 'moraines des glaciers quaternaires' are marked on the geological sheets for the area, their age and geomorphological significance has only recently been established (Bailey *et al.* 1990; Lewin *et al.* 1991; Woodward *et al.* 1992; 1994; 1995). The original geological survey outlines the broad spatial extent of glacial sediments in the basin (IGRS 1970), but does not attempt to assign these deposits to specific Pleistocene stages (see also Sestini 1933; Pechoux 1970). The Tsepelovon to Skamnelion road provides impressive sections (up to 20 m high) in these glacial deposits (Fig. 16.7). Fresh, largely unweathered sediments form massive diamictons (poorly sorted deposits including a very wide range of particle sizes) of sub-rounded boulder- to gravel-sized material in a distinctive, creamy silty/sand matrix. Close inspection of individual clasts reveals glacially-etched and striated rock surfaces. The brilliant creamy-white colour of these sediments reflects their derivation from the pure local limestone. Isolated pockets of flysch bedrock are also present in this area, accounting for the small flysch gravel and fines component in these sediments.

2. Headwater flysch terrain

Lying below the limits of Pleistocene glacial activity, this distinctive topography is typical of areas underlain by actively eroding flysch strata. Such terrain consists mainly of fairly steep, erosional slopes producing a compact arrangement of short ridge and valley forms (Fig. 16.8). These unstable slopes do not support a continuous vegetation cover and are highly susceptible to rapid runoff during high intensity storms, thus promoting widespread gullying and erosion. In some areas the erodibility of the terrain and the high rainfall totals have combined to produce a badlands topography (see Campbell 1989; Woodward 1995). The flysch rocks consist of fine-grained, quartz-rich sandstones and fissile siltstones (shales) which contain large amounts of easily erodible and transportable fine sediment. This part of the catchment is a major source of fine (suspended) sediment during storm runoff events. The relatively high density, modified dendritic drainage network, may be described as a pinnate drainage pattern (Bloom 1991), since the second order tributaries run parallel and join the main tributary streams at acute angles. This forms a highly effective water and sediment transport system, maximizing sediment delivery during peak flows. This heavily dissected area produces a landform style and texture in stark contrast to the glaciated limestone relief of the Tsepelovon district north of the modern Voïdomatis channel (see Fig. 16.6).

3. The Vikos Gorge

Mount Gamila is arguably the most extensive and most majestic of the Greek mountains (Sfikas 1979). The northern side consists of a range of cliffs which are dissected by deep ravines, whereas the southern flanks slope down gently to an extensive tableland which is cut off abruptly by the great gorge of the Voïdomatis River. This spectacular karst canyon is one of the most impressive topographic features in southeast Europe (Jennings 1985). It

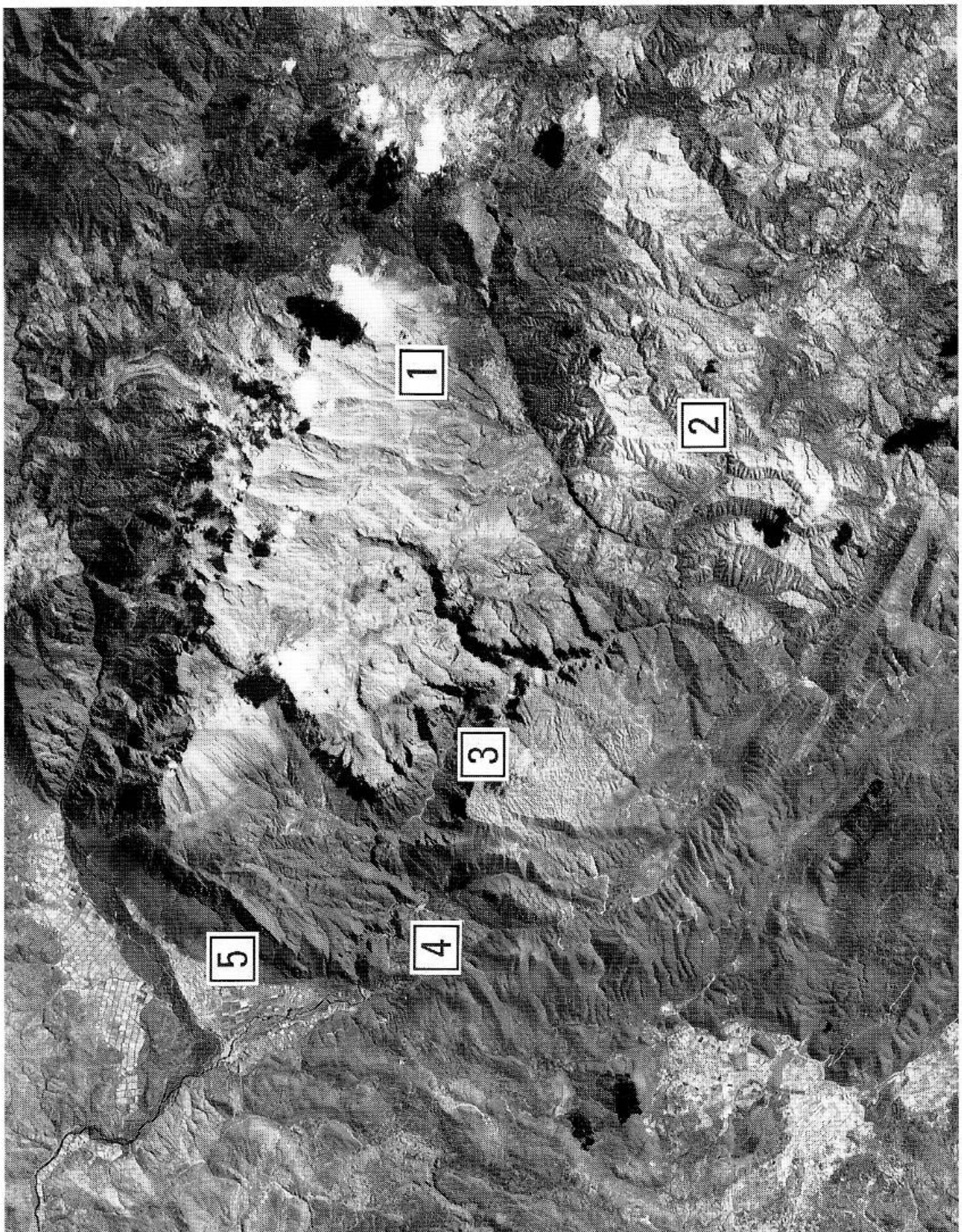

Figure 16.6. *SPOT satellite image of the Voïdomatis River and the Ioannina Lake basin to the southeast. This image provides a useful illustration of the terrain variability in and around the Voïdomatis basin. This scene covers an area of approximately 40 × 28.5 km. Voïdomatis terrain units discussed in the text: (1) Glaciated Tsepelovon district; (2) Headwater flysch terrain; (3) Vikos Gorge; (4) Lower Vikos Gorge; (5) Konitsa basin. Each of these terrains can be identified in the LANDSAT scene of the wider Epirus region (Fig. 16.1).*

is cut into resistant Tertiary and Mesozoic limestones and in places is almost 1000 m deep, yet only about 2.5 km across, with near vertical sides in parts (Fig. 16.9A). The bedrock floor of the gorge, which is locally well exposed in the active channel, is composed of resistant Jurassic carbonates. These rocks form an outcrop up to 700 m thick in the Vikos Gorge, and Palaeocene to Late Eocene limestones (>300 m in thickness) complete the carbonate sequence (Fig. 16.9B).

Large-scale talus cones form an extensive colluvial blanket along the gorge sides. These massive limestone screes are dominated by angular and multifaceted clasts, are locally calcreted and frequently interfinger with the thick veneer of alluvial sediments that mantles the gorge floor (Lewin *et al.* 1991). At the western end of the gorge the presence of a series of talus cones on the right bank indicates that the rockwall is not weathering uniformly over its surface (Fig. 16.6). Preferential erosion of local structural lines of weakness may account for this group of steep debris cones as material is delivered from chutes in the gorge wall. The discontinuity between the talus cone mantles and the floor of the chutes indicates that sediment is delivered to the cones predominantly by rockfall rather than by debris flows. During uplift of the block-faulted terrain, these hard, resistant limestone rocks have restricted slope processes from cutting back the rock walls of the valley sides.

In this part of the basin the active stream flows in a steep boulder-lined channel (Fig. 16.10) where bed material calibre may exceed two metres, indicating the occurrence of very high stream powers, typical of narrow gorge environments during extreme flood discharge events (*cf.* Baker & Pickup 1987).

4. The Lower Vikos Gorge

Intermediate in relief between the Vikos Gorge (upstream) and the Konitsa Plain (downstream), this reach of the Voïdomatis River is characterized by a series of deeply incised meander bends (Figs 16.11 & 16.12). These perhaps reflect slower uplift than in

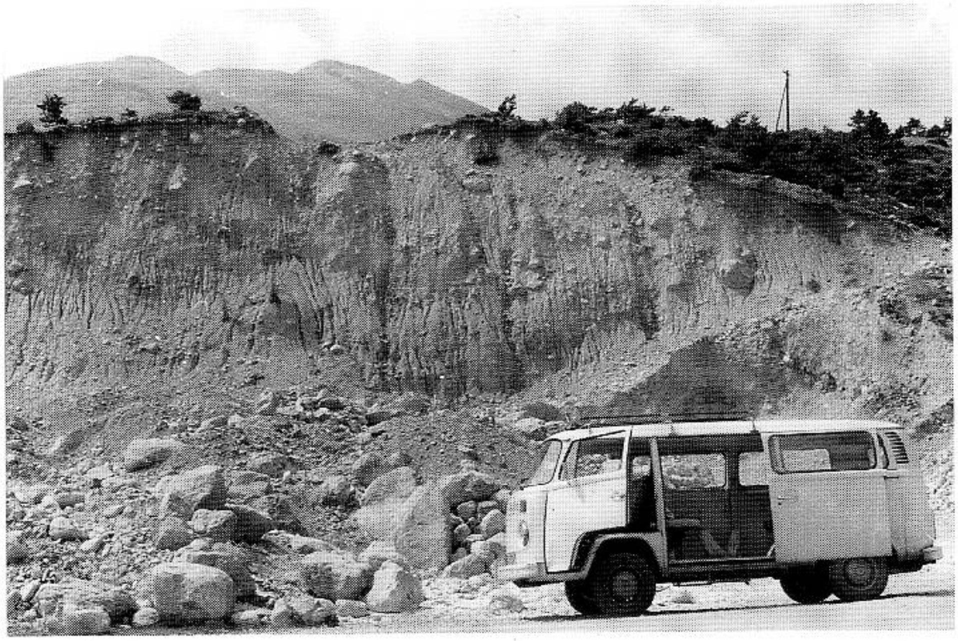

Figure 16.7. *Glacial sediments exposed in a section along the Tsepelovon–Skamnelion road. These are overwhelmingly dominated by limestone-derived material and incorporate all grades of sediment from clay- to boulder-sized particles. They also contain a large proportion of* $CaCO_3$*-rich rock flour.*

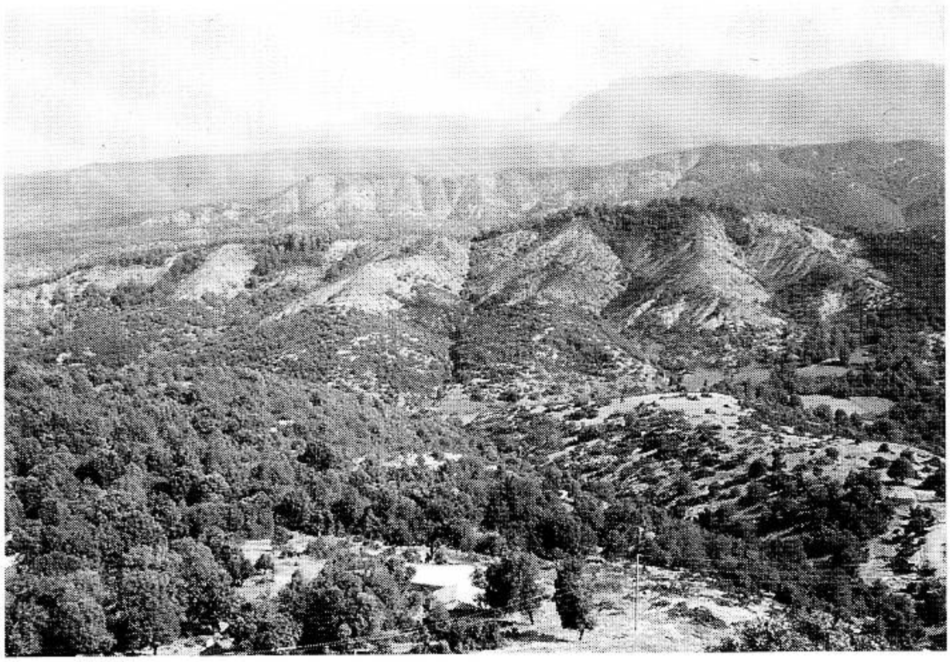

Figure 16.8. *The degraded flysch landscape south of the modern Voïdomatis stream channel in the catchment headwaters. These steep erosional slopes do not maintain an effective vegetation canopy and constitute an extremely fragile ecosystem. The poor vegetation cover on these highly erodible sediments has encouraged the development of a badlands topography. Goat shelter and telegraph pole in foreground for scale.*

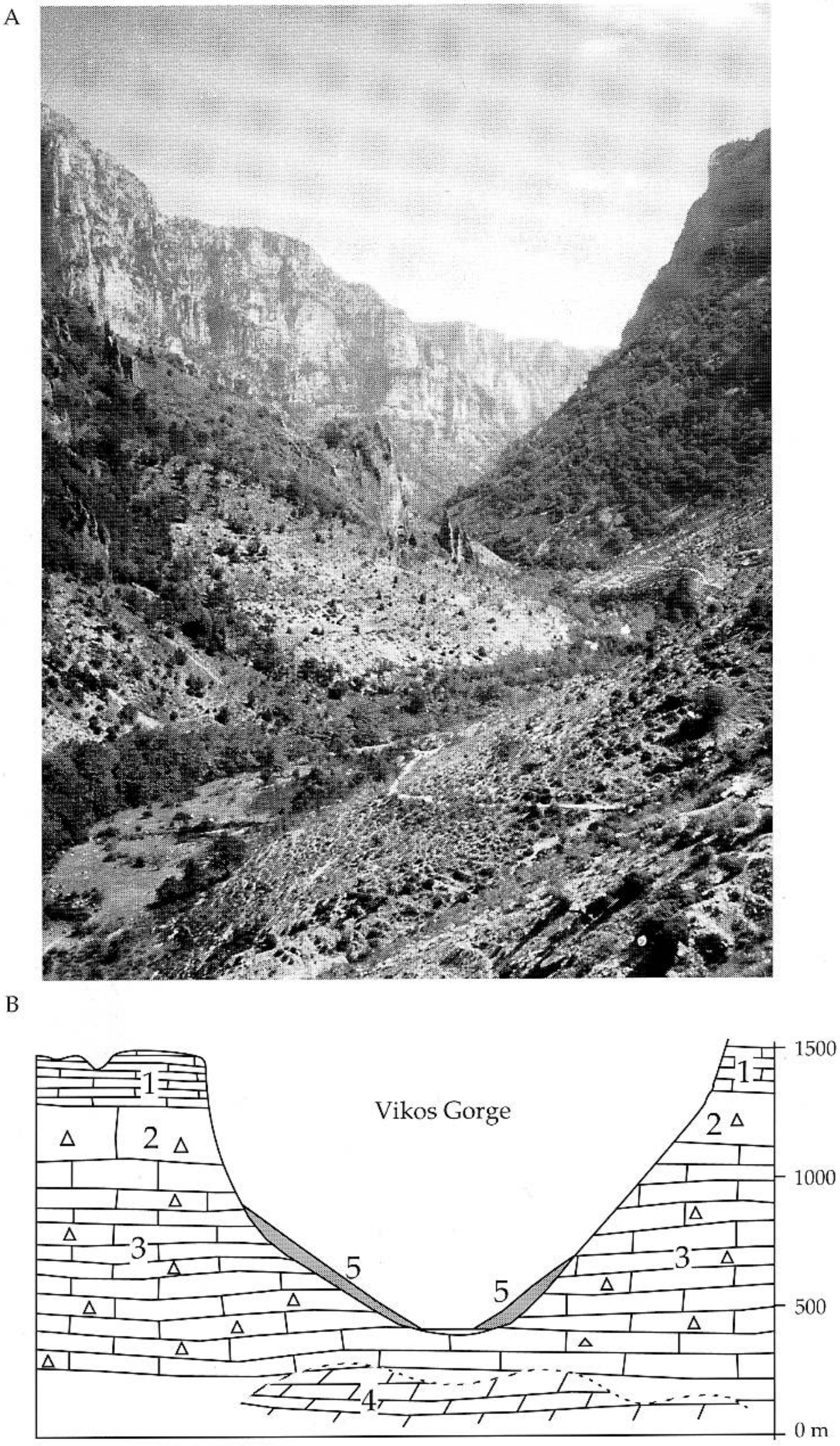

Figure 16.9. *(A) The Vikos Gorge viewed from the western (downstream) end of the canyon near the village of Vikos. The widest parts of the canyon are lined with great thicknesses of coarse-grained colluvial sediments. The basal sections of these talus formations frequently interdigitate with coarse alluvial materials. The course of the modern channel is shaded by a corridor of plane trees. (B) A geological cross section through the main Vikos Gorge (after IGRS 1968): 1. Palaeocene to Eocene limestone; 2. Upper Senonian limestone; 3. Vigla limestone (Lower Senonian); 4. Dolomitic limestone (Lower Senonian); 5. Pleistocene scree sediments.*

Figure 16.10. *The boulder-lined channel of the Voïdomatis River in the main Vikos Gorge. The moss-covered boulders indicate that the coarsest bed materials are moved only during very large flood events.*

Figure 16.11. *View looking westwards into the Lower Vikos Gorge from the Aristi–Vikos road. The Aristi–Papingon road bridge over the Voïdomatis is shown in the bottom left of this photograph. Note the dense vegetation on the flysch slopes either side of the gorge. The sheer limestone cliffs in the vicinity of the Klithi rockshelter can be seen further downstream (compare Fig. 1.1).*

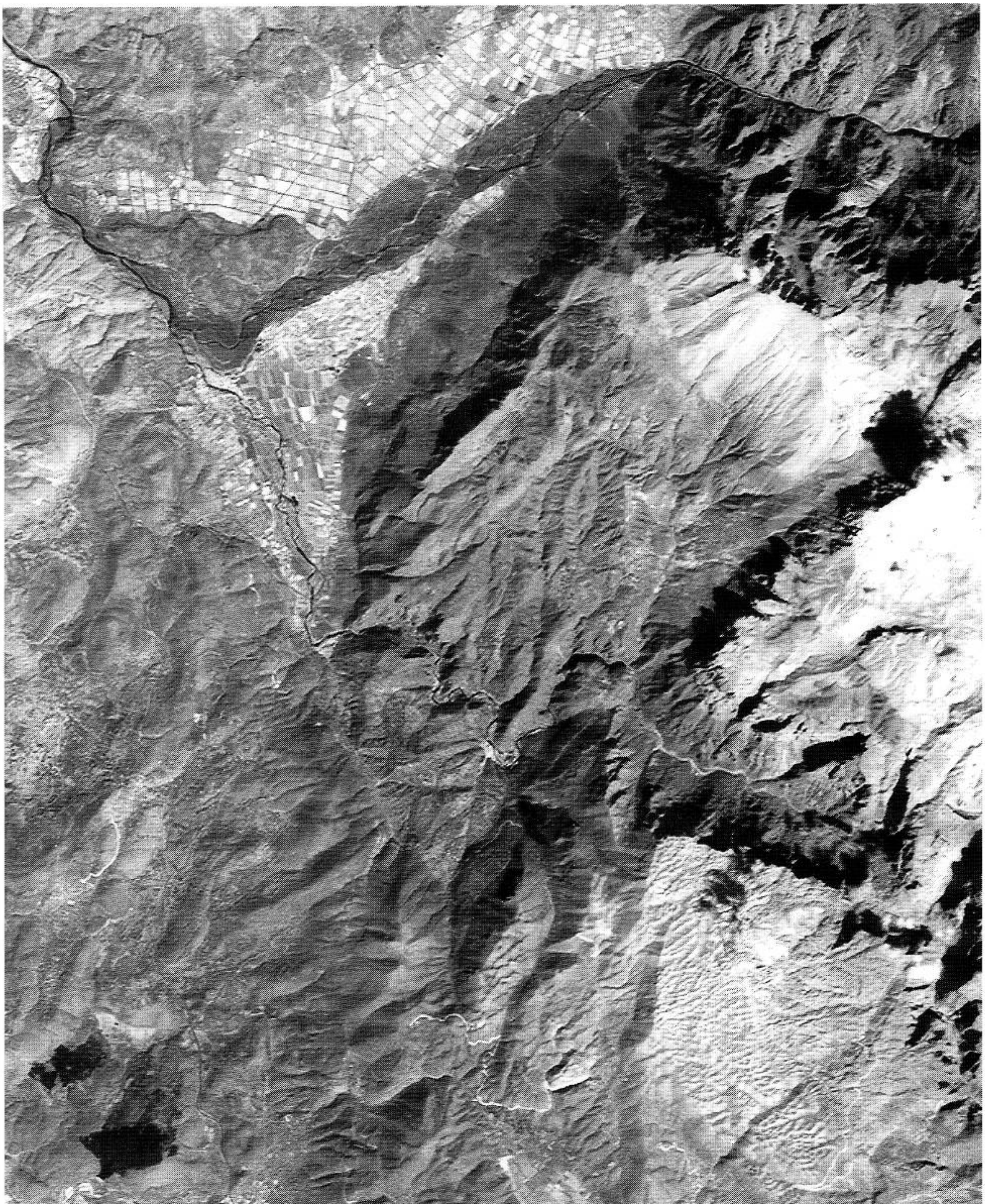

Figure 16.12. *(On left) A SPOT satellite image of the lower basin showing the western end of the Vikos Gorge, the incised meanders of the Lower Vikos Gorge and the Konitsa basin. This scene provides a useful illustration of the topography in the vicinity of the Klithi rockshelter which is located in the centre of this scene. The two major faultlines trending NE–SW mark the upper and downstream ends of the Lower Vikos Gorge and highlight the broad stepped relief of the basin. Both the Voïdomatis and Aoos rivers drain glaciated headwater catchments and both systems exit via fault-bounded limestone gorges onto the Konitsa basin. The Aoos–Voïdomatis confluence in the centre of the Konitsa basin is approximately 5 km from the Konitsa gauging station situated at the downstream end of the Aoos Gorge (see Fig. 16.5). This fluvial system drains into Albania and eventually into the Adriatic Sea.*

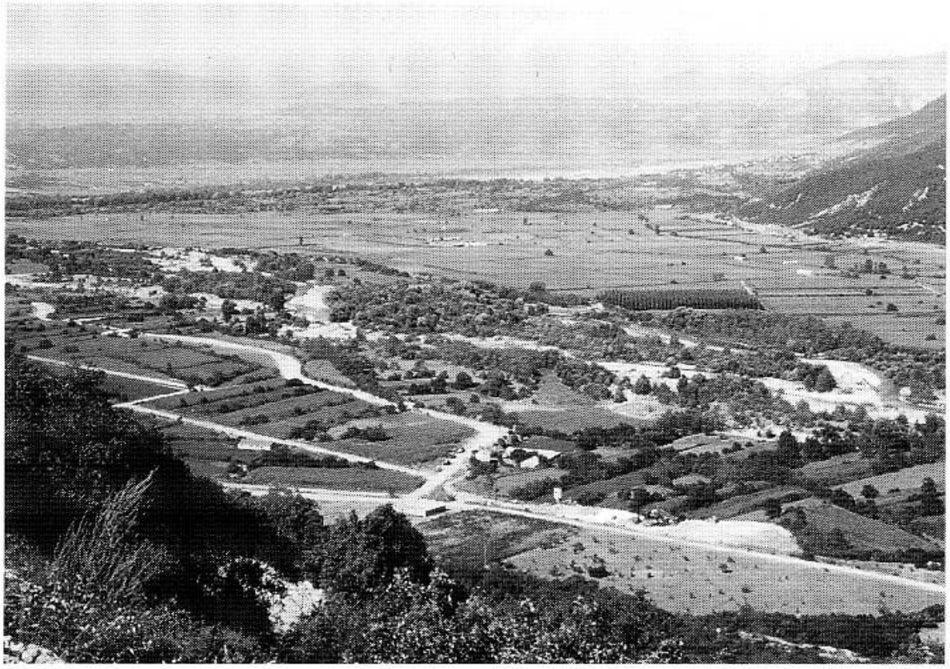

Figure 16.13. *View looking NNE across the Konitsa basin showing the active floodplain of the Voïdomatis River. This fertile alluvial basin is fed with irrigation waters abstracted from the Voïdomatis and Aoos Rivers. The eastern side of the basin is draped by a steep colluvial prism which contains evidence of mass movements including debris flows.*

the main gorge upstream, allowing progressive lateral fluvial erosion of the gorge walls as well as vertical incision. These incised or entrenched meanders may result from headward migration of a nickpoint after base-level lowering (see Chorley *et al.* 1984, 312). At a number of locations in this part of the basin the modern river channel is actively eroding the limestone gorge walls and it is highly likely that the Klithi rockshelter itself, which is located on the outside of a large entrenched meander, is the product of fluvial erosion. Further, in contrast to the deeper Vikos canyon, occurrences of bedrock in the channel are quite rare in the Lower Vikos Gorge and would seem to imply that vertical incision is proceeding at a slower rate along this particular reach of the Voïdomatis River.

The Lower Vikos Gorge is significantly lower (the main gorge walls are about 150–200 m high) and narrower (locally <150 m) than the main Vikos canyon (Fig. 16.11). Flysch rocks overlie the gorge-forming limestones on both sides of the valley, and this accounts for the increase in surface drainage density on the adjacent slopes and the increase in flysch-derived sediment delivery to the main valley floor via a series of small, seasonal streams flowing through steep tributary ravines. The Megalakkos rockshelter is located in such a tributary ravine which joins the main Voïdomatis channel approximately 500 m upstream of the Klithi rockshelter. Small-scale alluvial fans less than 10 m across are locally well developed at a number of tributary junctions (Lewin *et al.* 1991). Large floods generated by torrential rainfall and/or rapid snowmelt can transfer large volumes of coarse angular sediment to the main valley floor. Debris flows are also locally important and coarse-grained alluvial fans may build out onto the modern floodplain and this material is reworked by the main Voidomatis River and incorporated into the main channel sediments.

Slope deposits in this part of the basin are of two main types. Firstly, unvegetated scree slopes and talus cones consisting of openwork (clast supported) coarse limestone clasts of all size grades, from gravel to boulder size, are common on each side of the river channel. These wedges of colluvial debris attain considerable thicknesses and often display local size-sorting. Recent scree deposits do not have a significant fine matrix component. However, tributary-cut sections at a number of sites reveal considerable thicknesses of coarse, colluvial debris with a fine brown, probably flysch-derived, silty matrix filling clast voids. In older sections (probably of Pleistocene age) near the Papingon–Aristi road, this fine matrix has been weathered (rubified) to a reddish silty clay. This part of the river basin provides the main focus for detailed investigation of the alluvial sedimentary record and late Quaternary soil development (see Macklin *et al.*, Chapter 17).

5. The Konitsa basin

The Old Klithonia Bridge spans the Voïdomatis River at the downstream limit of the Lower Vikos Gorge and marks the end of lateral controls which have confined the main channel throughout most of its course. Edged with colluvial sediments, which are particularly well developed on the eastern side of the basin, this is a fault-controlled graben of Tertiary age into which the Voïdomatis and Aoos Rivers flow (Fig. 16.11). On either side of the modern river this broad alluvial plain is mantled with coarse alluvial gravel deposits whose surfaces lie between 5 and 10 m above modern river level. In the absence of detailed borehole records, the full depth of the Quaternary river gravels in this part of the basin is not known, but the geomorphic setting suggests that they may attain a considerable thickness. Here the contemporary channel and floodplain of the Voïdomatis are rarely more than 200 m across (Fig. 16.13). The modern Voïdomatis River bisects the triangular plain and flows roughly NNW to its confluence with the Aoos River in the centre of the basin (see Fig. 16.11).

The present valley-floor environment

The contemporary channel and floodplain system is typical of many steepland karst streams in the Mediterranean region (*cf.* Macklin *et al.* 1995, 18). The steep average slope of the river (0.016) reflects the high relative relief and mountainous headwaters exceeding 2400 m asl. This is a major influence on the geomorphology of the valley floor and on river processes. The active channel and floodplain zone are dominated by landforms comprising coarse-grained bedload sediments dominated by cobbles and boulders derived from the limestone and flysch rocks of the basin. In plan form the Voïdomatis forms a single-channel meandering river and flows through a bedrock gorge which has restricted its lateral development. Fluvial erosion has produced notches in the gorge walls at several sites along the present channel and ancient river-cut features can be observed at higher elevations. Elsewhere the Voïdomatis flows in a self-formed alluvial channel and bank materials are commonly composed of coarse-grained Pleistocene river sediments belonging to the Aristi Unit (see Macklin *et al.*, Chapter 17 for detailed descriptions of this and other alluvial units), colluvial materials, or the recent fine-grained alluvium of the Klithi Unit. The latter sediments form an extensive low terrace which is an important feature of the present valley floor. During flood events these materials are reworked and incorporated into the sediment load of the modern stream. Channel morphology is dominated by coarse gravel point- and side-bar forms, and deep pools which alternate with gravel or cobble riffles. Upstream of the Konitsa basin the present channel is rarely more than 15 m wide and is commonly incised a few metres into the valley floor deposits. The occasional presence of channel margin boulder berms and overbank gravel splays, whose surfaces lie up to a few metres above present river bed level, points to the occurrence of extreme flood flows in very recent times.

Modern vegetation

Epirus is both vegetationally and floristically one of the most diverse regions of Greece and of the Balkan peninsula in general. It is also the most forested region of Greece, and indeed one of the few areas of Europe where forest cover seems actually to be increasing. Under the present prevailing temperate 'interglacial' conditions, it is generally agreed that the 'natural' climax vegetation of this part of Greece would consist of a variety of forest types (Turrill 1929), depending on altitude, aspect and distance from the sea, with more open vegetational conditions restricted to the highest mountain areas, steep unstable cliffs, and seral environments such as marshes and coastal dunes. Clearly this is a theoretical reconstruction and, because of the immense impact of human activities, the nature and distribution of modern vegetation types is very different. Even the composition of existing forests has been greatly affected by direct or indirect human interference. Yet, although vegetation types over the whole region have been substantially modified by human activities, nevertheless a broad zonation, particularly of woodland and scrub vegetation, can be clearly recognized. This zonation has been discussed in detail by Turrill (1929) and is also given in outline in Bottema (1974).

The coastal lowlands to the west (up to about 400 m asl), which are virtually frost-free throughout the year, appear formerly to have supported typical Mediterranean evergreen forests, but these have almost everywhere been destroyed by agriculture and, from Roman times onwards, the demands of the Adriatic timber trade for ship- and house-building, or else they have been degraded by incessant sheep and goat-grazing, burning and culling for firewood, leading to the formation of shrubby maquis communities. The residual flora suggests forests with oaks, particularly the evergreen species holm oak *Quercus ilex* and kermès oak *Q. coccifera*, *Phillyrea media*, *Pistacia lentiscus*, the native wild olive *Olea europaea* and *Arbutus* spp., together with shrubs such as *Cotinus coggyria*, *Erica arborea*, *Spartium junceum*, *Phlomis fruticosa* and *Cistus* spp. In Epirus *Pistacia lentiscus*, *Erica arborea* and *Arbutus* spp. are virtually confined to this zone.

Inland, at altitudes between 400–700 m asl, deciduous tree species become important, particularly deciduous or semi-deciduous oaks such as *Quercus pubescens* and Turkey oak *Q. cerris*, likewise oriental hornbeam *Carpinus orientalis*, terebinth *Pistacia terebinthus*, elm *Ulmus* spp. and maple *Acer* spp. In this zone too much of the forest vegetation has been strongly affected in the past — and still to a decreasing extent today — by burning and grazing, producing shrubby communities that range from maquis to pseudomaquis or shiblyak (Turrill 1929). Some of the evergreen Mediterranean elements are still abundant, notably *Quercus coccifera* and *Phillyrea*, as are prickly shrubs such as junipers *Juniperus* spp. and Christ's thorn *Paliurus spina-christi*. Nevertheless, large or small areas of well-grown woodland can be found, for example as woods that are actively managed for forestry or at least preserved as a supply of timber and firewood, or as groves of trees, particularly stands of ancient oaks, which have clearly been protected by local communities and are often associated with shrines. Another residual site for woodland is in relatively inaccessible gorges where the rivers of Epirus have deeply dissected particular geological formations.

As one moves further from the coast and up into the foothills of the Pindus Mountains, although some of the Mediterranean elements become sparser or confined to sheltered or south-facing slopes, the diversity of the tree and shrub flora increases. Not only are southern European tree species such as *Ostrya carpinifolia*, *Quercus frainetto*, *Q. trojana*, *Tilia tomentosa* and *Acer obtusatum* present, but also trees such as *Carpinus betulus* and shrubs like hazel *Corylus avellana* and *Viburnum lantana*, whose native distribution extends up the Balkan peninsula and into central and even northern Europe. A number of rare Balkan endemic species also occur, the most notable being the horse chestnut *Aesculus hippocastaneum*. The sweet chestnut *Castanea sativa* also occurs, particularly in managed woodland, but should probably be regarded as a very ancient introduction in this area.

In the Pindus Mountains themselves, particularly above altitudes of *c.* 1000 m asl, the mixed-deciduous forests, usually dominated by *Quercus pubescens*, give way to more uniform forests of fir *Abies* and pine *Pinus nigra* (sometimes *P. heldreichii*) or, depending on altitude and aspect, of beech *Fagus sylvatica*. Alpine grasslands occur above the treeline, but it is clear that the altitude of the treeline is very often determined by human activity, since the mountain pastures are heavily grazed and the high-level forests have long been exploited for fuel, some being carefully managed, others ravaged by man and beast beyond any possibility of regeneration.

The Western Zagori

The site of Klithi lies within the Western Zagori, the cluster of ancient villages and their territories occupying the foothills of the northern Pindus mountains between the Doliana basin on the lower western side, where the Kalamas River has its source, and the great cliffs of the Gamila and Astraka in the Tymfi massif. Because of the range of altitude and geology, the vegetation must always have been diverse, at least during Postglacial times.

Large tracts of land within the Doliana basin have only been drained in recent times and are now under intensive cultivation. A century ago much of the area was probably covered in reed swamp and willow scrub. Nevertheless such areas must have been economically important; for example, Aristi, an upland village, has as a detached part of its territory called Limni, a small enclosed basin at lower altitude, again now drained, situated to the north of Kalpaki. Such basins may have held stretches of open water during the winter and spring months, as is still the case with Lake Gramousti on the northern margin of the Doliana basin (Willis 1992a; Chapter 20).

Travelling by road from Kalpaki on the edge of the Doliana basin through the villages of Mesovouni and Aristi, then crossing the Voïdomatis river and its gorge to reach the twin villages of Papingon below Astraka, one passes through a dissected, increasingly steep and rugged, but often densely wooded terrain. Meadows and small cultivated plots are found around the villages, more extensively at lower altitudes, and occasionally along the floors of small side valleys. The bedrock throughout this area is either limestone or flysch, and, particularly in limestone areas, there are still poorly vegetated slopes with scattered grazed scrub. Survey of the woodland vegetation has led to two observations. First there are small but significant differences between the vegetation on limestone and flysch bedrock, although these are obscured where soil and rock material has moved downslope, particularly adjacent to the fault scarps that traverse the area. Secondly there have been considerable recent changes in the physiognomy of these woody plant communities.

On limestone substrates the trees and shrubs and the ground flora tend to be slightly more diverse than on flysch (though in either case diversity is much greater than in any woodland communities in northern Europe). In many stands the dominant trees are *Phillyrea media*, *Quercus coccifera* and *Carpinus orientalis*, but in others the deciduous oak *Quercus pubescens* is plentiful. Other trees present include *Pistacia terebinthus*, *Acer campestre* and *A. monspessulanum*, *Ostrya carpinifolia*, *Fraxinus ornus*, *Ulmus* sp. and sometimes *Cercis siliquastrum* and *Celtis australis*. In sheltered gullies less common trees such as *Tilia tomentosa* and *Acer obtusatum* may be present. The associated shrubs, seldom forming a true shrub layer, are also diverse with, amongst others, *Corylus avellana*, *Cornus mas*, *Prunus spinosa*, *Pyrus* spp., *Malus sylvestris*, *Crataegus monogyna* and *Juniperus* spp. What is clear is that most of the dominant trees are multi-stemmed and ring-counts show that their main stems are only between 10–20 years old. Larger older trees do exist within the woods, with thick single trunks (for example, *Acer* spp.), but these usually show signs of once having been repeatedly pollarded at heights of *c.* 2 m above ground level. The conclusion must be that about twenty years ago these woodland areas were heavily browsed scrub, gnawed down to less than a metre in height, in which only resistant species such as *Quercus coccifera*, *Phillyrea* and *Carpinus orientalis* could easily survive. The trees would form a mosaic of clumps separated by almost bare ground. In places where goat browsing is still intense, and this pattern can still be seen (Fig. 16.14), a few other trees and shrubs can just about survive though almost smothered within the densely branched and stunted clumps of the dominants. Virtually none of the woody species are able to flower or set fruit under these conditions. The rapid decline in traditional goatherding, as young people have left the land for city life has allowed the trees to grow up and spread out to form a canopy. Subsidiary species have also been able to grow up, or have been brought in by bird dispersal, enriching the diversity.

To some extent the same process must have taken place on flysch soils, but in many places the woodland dominants are now *Quercus pubescens* and perhaps the Turkey oak *Q. cerris*. *Phillyrea* and *Q. coccifera* are seldom abundant and often confined to woodland margins, along with another browsing-tolerant species *Paliurus spina-christi*. Most of the subsidiary trees and shrubs found in the limestone woodland communities, including *Carpinus orientalis*, are actually present in the flysch woodlands, but in sparser quantity, the exception being *Cornus mas* which may be abundant. Although the older oaks are multi-stemmed and pollarded trees are also present, there is often active regeneration of *Quercus pubescens*. In the absence or sparsity of the evergreen *Phillyrea* and *Quercus coccifera* light can penetrate to the woodland floor and probably encourages germination. Quite well-developed oak woodland is present on flysch in the neighbourhood of Kipi and many other places and also on the Triassic strata outcropping in the Doliana basin, where *Quercus trojana* is also an important species.

The explanation for differences in regeneration cannot simply be the edaphic preferences of *Phillyrea* and *Quercus coccifera*. There are still sites on flysch, particularly close to villages or along well-used tracks, where these species are clearly dominant. A better explanation might be that many flysch areas simply did not suffer such an intensity of grazing activity, perhaps because from a nutritional point of view it was always better to pasture sheep and goats for a longer period on limestone terrain if that was also locally available (Sturdy *et al.*, Chapter 30). This might have enabled deciduous oaks to maintain a competitive advantage on flysch soils over the kermès oak and *Phillyrea*. Another point is that with flysch soils so obviously susceptible to erosion on sloping ground, over-use by stock would clearly damage the extent of the resource, whereas limestone areas do not degrade in the same very visible way.

The Vikos Gorge

Botanically the most important feature of the area is the Vikos Gorge, together with the Aoos Gorge which lies to the north of the Gamila. It should be noted that there are other gorges in the area, notably the Kalamas Gorge actually within the Doliana basin, and the Gormos Gorge that adjoins it to the north-west. Neither of these gorges are on the scale of the Vikos Gorge, but they are nevertheless deep, to a large extent inaccessible and provide a refuge for woodland and cliff-face plant communities, but they are at a much lower altitude and lack the physical connection with the high Pindus that has made both the Vikos and Aoos Gorges so floristically rich.

Although vegetation conditions in the Vikos Gorge are now very different from what they were during the Late Glacial period, it is worth describing the main features of the present-day vegetation and the historical and physical processes that have shaped it, because these have a bearing on the special nature of the gorge as a habitable environment.

Vegetation surveys were carried out in the lower Vikos Gorge primarily between 1984 and 1987, usually during the months of July and August, so that much of the herbaceous plant cover was already becoming desiccated, but the area was also visited in May 1977. The upper Vikos Gorge around Monodendri and Kipi was examined in particular in July 1992, a year when spring and early summer were unusually wet, so that the vegetation was unusually fresh compared with previous years. Additional information has been obtained from what are basically floristic lists (Polunin 1980; Strid 1986; 1991; and P. Authier pers. comm.), since the Vikos Gorge, together with the neighbouring Aoos Gorge and the limestone cliffs of the northern Pindus, form a veritable 'Mecca' for amateur and professional botanists because of their floral richness. Here, however, only the main features of vegetation stands are mentioned rather than exhaustive listing of species present.

The floodplain of the Voïdomatis consists partly of the active channel with its poorly vegetated bars and gravel spreads, usually consisting of coarse- to medium-sized rounded cobbles, partly of abandoned gravel spreads at much the same level, which have been colonized by willows or other trees and shrubs, over which a thin soil begins to develop in favourable areas, and partly by the slightly higher surface of the Klithi Unit, about 3 m above river-bed level, the youngest (late Holocene) unit of the alluvial fill

Figure 16.14. *Bushes of kermès oak (*Quercus coccifera*), close to the village of Doliana. These have been stunted by intensive goat browsing. Note the ring of bare ground which separates each bush.*

of the gorge (Macklin *et al.*, Chapter 17). In fact all these surfaces are regularly covered by the winter and spring floodwaters of the modern river.

On the bare gravels of the banks and bars of the river sprout young bushes and seedlings of the willows *Salix eleagnus* and *S. alba* and plane *Platanus orientalis*, perhaps regenerating from the severed roots of trees long swept away. Some bars are partly stabilized by clumps of *Petasites hybridus* and *Calamagrostis*, otherwise the vegetation is restricted to scattered plants of ruderal or marsh species. Where the floodplain has been abandoned, thickets of willow or alder *Alnus glutinosa* may grow up into floodplain woodland or a less dense woodland dominated by *Platanus* may emerge and a thin soil develop over the cobbles. The regular flooding carries in a large range of fruits and seeds of both woodland and open-ground species, so that eventually patchy shrub and herb layers develop, but this is subject to frequent grazing and browsing by the flocks of goats that pass daily along the valley-floor from spring to autumn. The trees include very stunted specimens of *Quercus coccifera* and *Carpinus orientalis*, both goat-tolerant, together with seedlings of *Cercis siliquastrum*, *Pistacia terebinthus*, *Sorbus* sp. and bramble *Rubus fruticosus agg*. Stagnant pools of water may persist for much of the summer. The older surface of the Klithi Unit (Macklin *et al.*, Chapter 17) provides more varied habitats with woodlands such as those just described or patches of open grassland, possibly developing on spreads of finer-grained alluvium, and probably encouraging its deposition during floods. These grassland areas, such as those around the camp-site near the Agii Anargyri monastery, partly shaded by large plane trees, are clearly very important to domestic animals. Nearby, isolated trees such as specimens of *Acer monspessulanum* have been pollarded, presumably to provide an occasional but readily available emergency supply of green foliage for goats. These grasslands have a rich and diverse flora of grasses and other herbs, though sometimes invaded by bracken *Pteridium aquilinum*. In spring and early summer they are bright with the flowers of anemones and of many species of bulbous plants and wild orchids.

In some places on the edges of the floodplain and particularly on the steep lower slopes a rather dense multi-stemmed, thorny scrub has developed, consisting primarily of *Phillyrea media*, *Quercus coccifera* and *Carpinus orientalis*. By 1987 these bushes had grown to be 8–10 m tall, with the appearance of an even-aged stand. Tree-ring counts confirmed that the upright stems were about 10 years old at that time. The interpretation is that until about 1977 these trees were contained by heavy browsing pressure to heights of less than a metre. This suggests that the pattern of vegetation cover, and indeed the whole appearance of much of the Lower Vikos Gorge may have changed dramatically in the last 20 years.

Associated with this regeneration of woodland within the Lower Vikos Gorge has been the appearance within lightly grazed areas of the floodplain of young seedlings of a great variety of trees and shrubs, many of which (for example the horse chestnut *Aesculus hippocastaneum* and the silver fir *Abies alba* (or possibly the hybrid *A. borisii-regis*) are not represented in the present floodplain woodland by mature flowering and fruiting adult specimens, or seldom so. Apart from the extraordinary botanical richness of the gorge, reflected too in the herb flora, this emphasizes two further points: (1) the role of seasonal river floods in distributing fruits and seeds from upstream; and (2) the role of the steep cliffs along the whole gorge and perhaps even more importantly of the densely wooded and almost impenetrable side valleys of the upper Vikos Gorge as refugia for these woody plant species.

The cliffs of the gorge not only support scattered stands of trees, high and impregnable to the efforts of even the most determined goats, but also a rich herb flora, in part of shade-tolerant woodland species, in part of open-ground alpine species. These contain many local rarities and some endemic species, as also do the cliffs of Astraka 1500 m higher. Today these cliff localities act as refugia from the destructive forces of browsing, grazing and human deforestation, both for woodland and open-ground species, a role also reinforced by the climatically sheltered nature of the gorge with its many aspects and the moderating and freshening influence of the river below. It is probable that these same sites were available as potential refuges for woody and herbaceous plants during the glacial stages, when climatic conditions were generally more hostile, and large populations of agile and voracious herbivorous mammals such as ibex and chamois, as shown by the Klithi excavations, were present in the area.

Archaeological sites

Systematic surveys at various stages in the course of the project, particularly in 1987 and 1992, have explored most areas of the catchment, including a search for open-air finds as well as rockshelters (Fig. 16.15). Particular attention was devoted in 1992 to river courses in order to identify rockshelters, and to three other types of locations: (1) the heavily eroded, red, gravelly fan deposits which are found extensively in the middle reaches of the Kalamas, and north of the Doliana basin towards the Albanian border; (2) 'strategic' locations (ridge-tops and routeways) in and around the Pedina basin, which forms a potentially important intermediate grazing basin between the lowlands of the Doliana and Ioannina basins, on the one side, and the high summer grazing territories on the Gamila mountain massif, on the other, which were exploited from known sites such as Klithi (see Sturdy *et al.*, Chapter 30); (3) the edge of the flysch basin east of the village of Kipi, where a series of ridge tops and valley-edge locations were searched, as an exercise in the testing of a 'negative' area of occupation (see also Bailey *et al.*, Chapter 27 for further discussion of site survey in flysch areas and for sites discovered outside the Voïdomatis catchment).

Coverage is by no means exhaustive, however. Even such a definable target as the discovery of rockshelters in the Vikos Gorge is open to considerable uncertainty. Different pathways through the deep central portion of the gorge offer different perspectives, and visibility can be affected by such imponderables as seasonal vegetation cover, light conditions and the time of day, while local information can be invaluable. We were told of several rockshelters in the main Vikos Gorge which were theoretically visible, but which we would not have spotted if they had not been drawn to our attention. Within the deepest sector of the Vikos gorge, the side gorges of Megas Lakkos and Mezaria are of potential interest but have not yet been explored. Steep slopes, thick vegetation, difficulties of access, and the absence of any significant finds in the rockshelters of the main gorge nearby have dissuaded us from giving priority to the search of these side gorges.

Many of the rockshelter sites are empty of deposit, and appear not to have been used except perhaps fleetingly in recent periods. Other sites have signs of prehistoric occupation but no clear indication of age, while some have yielded diagnostic Upper Palaeolithic artefacts. There are also a number of open-air sites, mostly surface finds, the age of which is difficult to establish with confidence (Table 16.1). The most important sites in this category, because they have given radiometric dates, are the flints exposed in the eroded section of the Aristi Unit by the Old Klithonia Bridge, just downstream of the Boïla rockshelter (Macklin *et al.*, Chapter 17).

Rockshelters

Klithi is one of at least 26 rockshelters within the Voïdomatis basin, distributed throughout the limestone areas of the catchment in physiographic zones 3, 4 and 5, from the edge of the Konitsa basin to the edge of the flysch terrain near Kipi. The rockshelter sites with indications of prehistoric occupation fall into two main groups, one in the Lower Vikos Gorge associated with Klithi, and a second group near the village of Kipi in the upper reaches of the Vikos Gorge where it opens out into flysch terrain.

Konitsa basin and Lower Vikos Gorge

Out on the edge of the Konitsa plain is the Agios Menas rockshelter (so called after the village within whose territory it is located). It has an opening 7 m

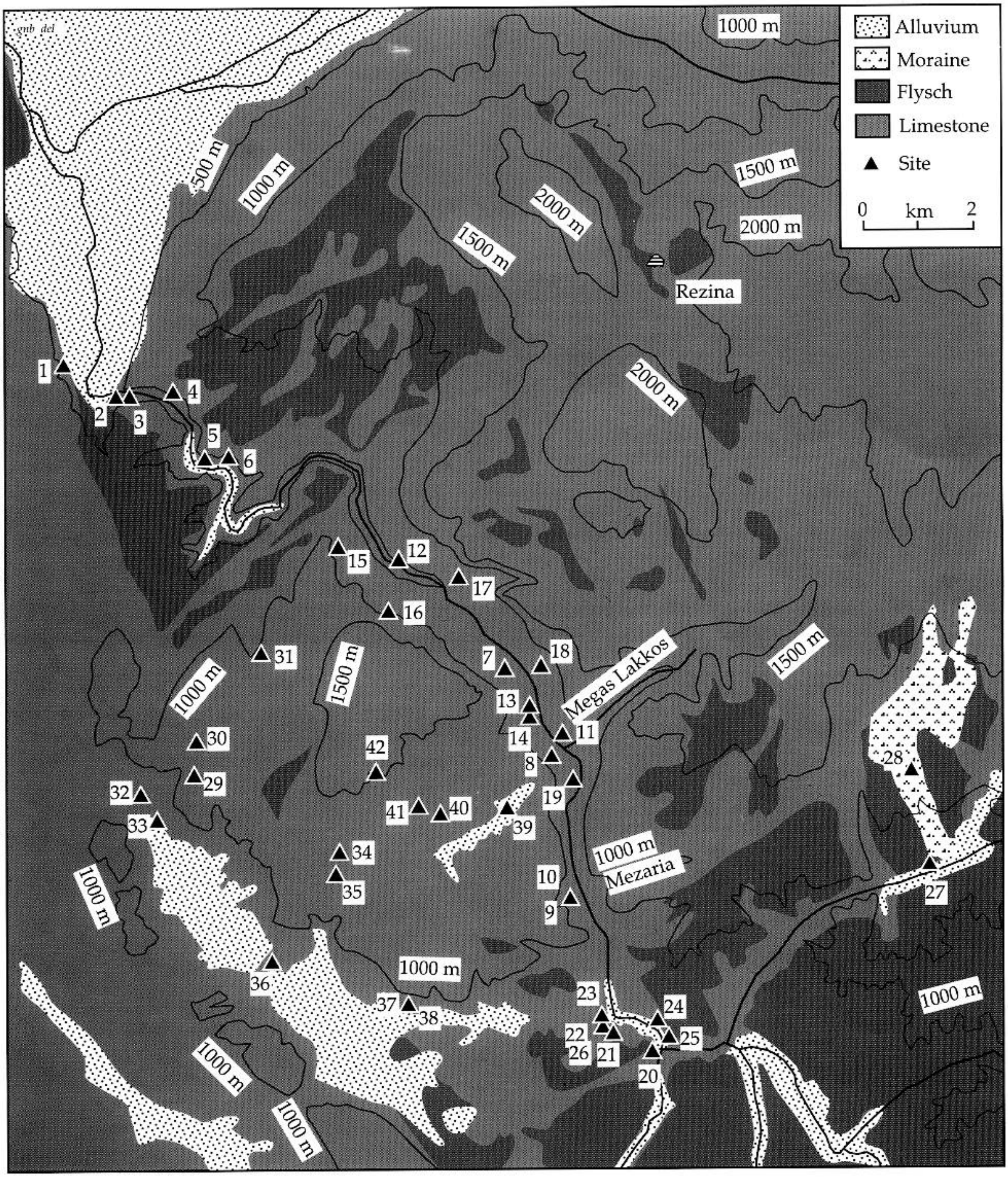

Figure 16.15. *Distribution of archaeological sites in the Voïdomatis basin. Site numbers refer to Table 16.1.*

wide and faces east-northeast, looking out over the plain (Fig. 16.16). The site was visited by Higgs in the 1960s (Higgs & Vita-Finzi 1966). Since that time a new road has been built across the mouth, obscuring any deposits outside the dripline. Inside the shelter large blocks have fallen from the ceiling, but intact

Table 16.1. *List of sites in the Voïdomatis catchment.*

O = Open-air site, R = Rockshelter. Local altitude is the height of the site above the adjacent valley floor. Width, Depth and Height are the gross dimensions of rockshelter openings. Data missing or not recorded are indicated by – . Names in brackets are the local names for rockshelters, where known. Numbers after rockshelters, or numbers in brackets after open-air sites, are the local identifiers used at the time of survey. Map no. refers to Figure 16.15. * = many artefacts resulting from excavation.

		Longitude	Latitude	Map no.	Altitude (m asl)	Local altitude (m)	Width (m)	Depth (m)	Height (m)	No. of artefacts
KONITSA PLAIN										
Agios Menas	R	20°39.50'E	39°58.2'N	1	420	–	7	7	5	3
LOWER VIKOS GORGE										
Old Klithonia Bridge	O	20°40.0'E	39°58.0'N	2	410	10	–	–	–	6
Boïla	R	20°40.0'E	39°58.0'N	3	410	10	20	3	10	*
Klithonia	R	20°40.5'E	39°58.0'N	4	415	20	5	5	5	1
Klithi	R	20°41.0'E	39°57.5'N	5	430	30	30	10	10	*
Megalakkos	R	20°41.5'E	39°57.5'N	6	430	10	5	3	5	*
VIKOS GORGE (CENTRAL)										
Rockshelter 2 (Dragousiani)	R	20°44.7'E	39°55.5'N	7	540	7	60	4	4	4
Klima	O	20°45.4'E	39°54.8'N	8	540	–	–	–	–	1
Rockshelter 6	R	20°45.4'E	39°53.4'N	9	700	30	15	3	9	1
Rockshelter 7	R	20°45.4'E	39°53.5'N	10	710	35	30	8	20	1
Vikos Site 8	O	20°45.5'E	39°54.4'N	11	730	50	–	–	–	3
Supplementary List of Rockshelters										
Rockshelter 1	R	20°43.4'E	39°56.6'N	12	540	40	10	3	4	–
Rockshelter 3	R	20°45.0'E	39°55.1'N	13	600	30	6	4	10	–
Rockshelter 4	R	20°45.0'E	39°55.1'N	14	600	30	3	3	3	–
Rockshelter 8	R	20°42.5'E	39°56.7'N	15	1000	500	10	–	15	–
Rockshelter 9	R	20°43.3'E	39°56.0'N	16	900	400	10	2	2	–
Rockshelter 10 (Cochista)	R	20°44.2'E	39°56.5'N	17	*c.* 950	*c.* 350	–	–	–	–
Rockshelter 11 (Greksta)	R	20°45.2'E	39°55.5'N	18	*c.* 900	*c.* 300	–	–	–	–
Rockshelter 12 (Kapnismeni)	R	20°45.3'E	39°54.7'N	19	620	40	6	3	7	–
VIKOS GORGE (UPPER)										
Kipi 1 (Kokoris)	R	20°46.4'E	39°51.8'N	20	730	10	20	10	12	5
Kipi 2	R	20°45.9'E	39°52.0'N	21	720	12	10	12	10	1
Kipi 4	R	20°45.8'E	39°52.1'N	22	720	7	12	6	4	144
Kipi 5	R	20°45.8'E	39°52.1'N	23	740	25	10	2	2	5
Kipi 3	R	20°46.4'E	39°53.0'N	24	720	–	8	2	3	–
Kipi 6	R	20°46.5'E	39°51.9'N	25	730	–	8	4	8	–
Kipi 7	R	20°45.8'E	39°52.1'N	26	720	7	10	3	–	–
HEADWATER FLYSCH										
Tsepelovon	O	20°49.9'E	39°53.5'N	27	880	–	–	–	–	3
Tsepelovon fan	O	20°50.0'E	39°54.0'N	28	1100	–	–	–	–	1
PEDINA										
Elafotopos	O	20°41.0'E	39°54.5'N	29	1120	–	–	–	–	6
Drabala 1	O	20°41.0'E	39°54.8'N	30	1140	–	–	–	–	4
Drabala 2	O	20°41.9'E	39°55.5'N	31	1040	–	–	–	–	5
Pedina (P0)	O	20°40.0'E	39°54.2'N	32	850	–	–	–	–	2
Pedina (P1)	O	20°40.2'E	39°53.8'N	33	850	–	–	–	–	10
Pedina (P2)	O	20°42.5'E	39°53.5'N	34	1310	–	–	–	–	6
Pedina (P3)	O	20°42.4'E	39°53.4'N	35	1290	–	–	–	–	4
Pedina (P4)	R	20°41.5'E	39°52.5'N	36	850	2	12	15	12	?1
Pedina	R	20°43.4'E	39°52.2'N	37	860	20	4	1	2	1
Pedina	R	20°43.4'E	39°52.2'N	38	860	–	–	–	–	1
Tsouknida 1	O	20°44.6'E	39°54.1'N	39	1290	–	–	–	–	5
Tsouknida 2	O	20°43.6'E	39°53.9'N	40	1360	–	–	–	–	3
Tsouknida 3	O	20°43.5'E	39°54.1'N	41	1380	–	–	–	–	16
Episkopou	O	20°43.0'E	39°54.0'N	42	1520	–	–	–	–	1

scree deposits are present and artefacts of Upper Palaeolithic type have been reported including backed bladelets.

The Boïla shelter is just inside the mouth of the gorge close by the old bridge and faces north-north-east (Fig. 16.17). The opening here is about 20 m wide with quite a shallow overhang and a scree deposit sitting on top of a river terrace comprising the Aristi unit (Macklin *et al.*, Chapter 17). The site was first noted by Derek Sturdy in 1970. In 1992 the Ephoreia of Speleology began a programme of excavation (Kotjabopoulou *et al.*, Chapter 22).

Within the Lower Gorge proper, the key sites are Klithi and Megalakkos. Other shelters are present, but these are small, at low level liable to flooding, or bare of deposit. The first shelter inside the gorge, upstream of Boïla, is small and of little significance: its only claim to mention is the discovery of a worked flint artefact on the surface. Klithi is undoubtedly the largest rockshelter of the group with the largest and most obviously intact deposit. Its use as a winter shelter for goats in recent times also attests to its superior attractions. Notwithstanding its position in a narrow gorge with cliffs rising to 300 m above the site (frontispiece, vol. 1), it would have been easily approachable on foot from a number of directions during the period of prehistoric occupation. There are several routes near Klithi which provide steep but passable access from the valley bottom to the heights above the site and thence to the gentler slopes between Old Klithonia and Papingon. The higher slopes on the opposite side of the river near Agios Menas can be similarly reached without difficulty. It should also be emphasized that when the site was occupied, the river was flowing at a higher level than today, and the valley floor was broader and more easily negotiable (Macklin *et al.*, Chapter 17). All these factors make Klithi an attractive shelter for occupation, and an obvious first choice for investigation, as the results of excavation have amply demonstrated.

Megalakkos is about 400 m east of Klithi in a narrow, steep-sided tributary stream and some 100 m upstream of its junction with the main river. The shelter is about 10 m above the local stream bed, which today is dry in summer, and at about the same height above the main river as Klithi (Fig. 16.18). Otherwise it is very different from Klithi, with a small shelter opening about 5 m wide which faces southwest. The site was discovered by John Lewin and Mark Macklin in 1986 during the couse of survey of the valley-fill sequence (Macklin *et al.*, Chapter 17). The deposit is about the same depth as at Klithi but has been heavily eroded and partially cemented to reveal a standing section readily available for inspection and sampling with minimal excavation. The upper part of the deposits has been undercut by erosion to form an overhang. Megalakkos is of particular interest because the archaeological deposits

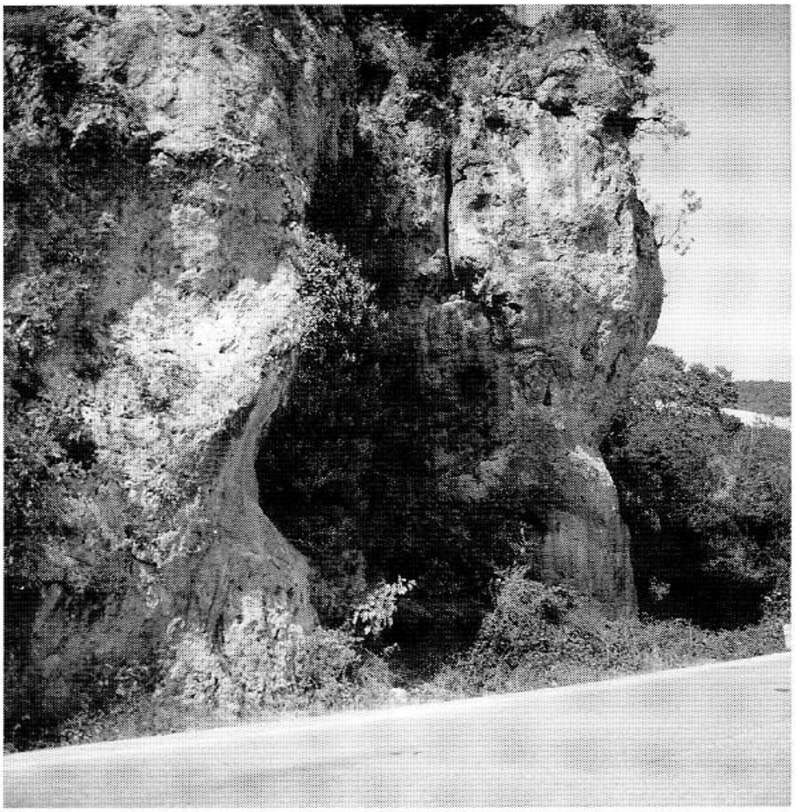

Figure 16.16. *General view of the Higgs rockshelter (Agios Menas) on the side of the main Ioannina–Konitsa road, looking west.*

Figure 16.17. *General view of the Old Klithonia Bridge, looking southeast from the right bank of the Voïdomatis at the mouth of the Lower Gorge. The cliffs visible beyond the trees are directly above the Boïla rockshelter opening, which is hidden from view. The dated open-air sites exposed in the section of the Aristi Unit are just beyond the right of the picture.*

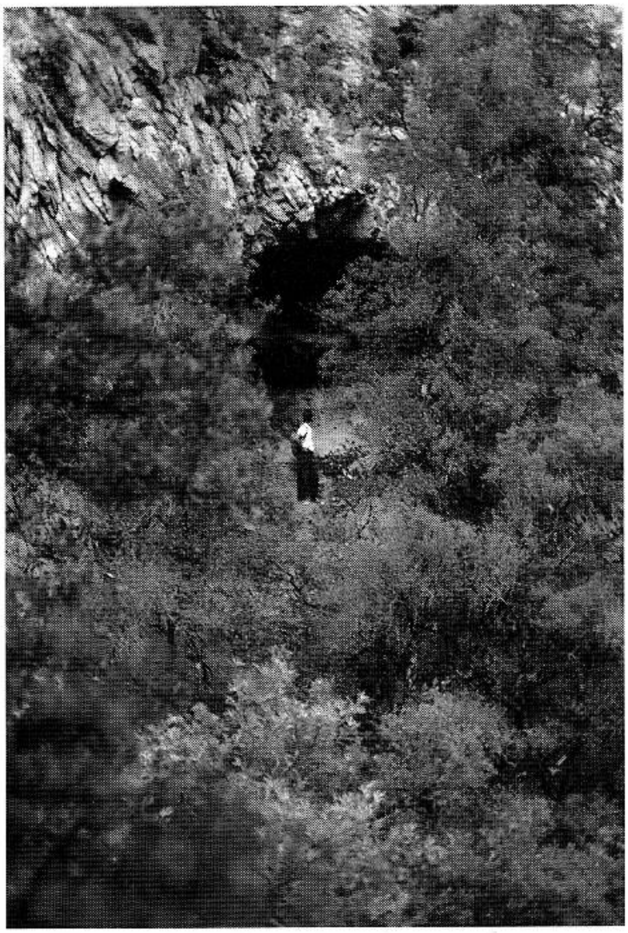

Figure 16.18. *General view of the Megalakkos rockshelter from immediately below the shelter opening.*

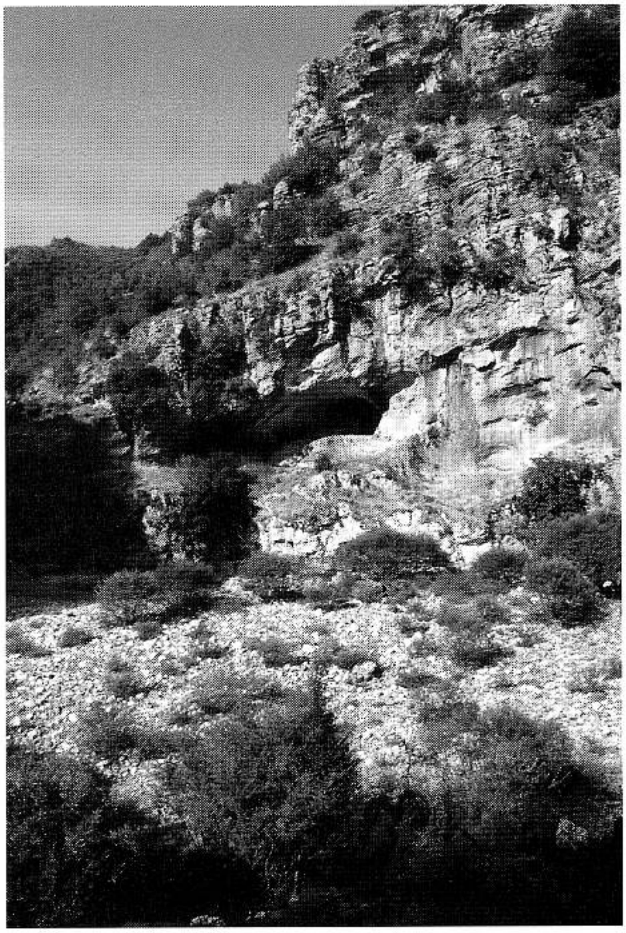

Figure 16.19. *General view of the Kokoris rockshelter near Kipi. The dry river-bed of the Voïdomatis is in the immediate foreground.*

cover a similar time span to those at Klithi but show significant differences in sedimentology (Woodward, Chapters 18 & 19) and cultural content (Sinclair, Chapter 21).

The Kipi group

Kipi 1 is opposite the old bridge of Kokoris, close to the modern road from Pedina to Tsepelovon (Fig. 16.19). The shelter opening is about 20 m wide by 10 m deep and 12 m high. There are at least 3 types of deposit here: a heavily cemented and eroded deposit, now existing only in small patches cemented to the back wall, but containing worked flint (undiagnostic of period though possibly Upper Palaeolithic) and bone fragments, from which we have attempted to obtain radiocarbon dates but without success; a second cemented and partially eroded deposit on the lower floor of the shelter, which appears to be more extensive but culturally sterile, and a loose brown deposit on the lowest part of the shelter floor which has been partly disturbed and removed by recent use as an animal shelter.

An additional 6 rockshelters are located further downstream, 3 of which have definite indications of prehistoric use. The most promising is Kipi 4 (Fig. 16.20). This is an east-facing shelter with two openings, the larger of which is about 15 m wide and 3 m deep, and some 6 m above the present river bed. There are traces of eroded and cemented deposit on the back wall which appear to be sterile, but in front of the opening there is a talus deposit of loose, brown sediment, which is about 5 m deep and extends some 15 m in front of the overhang. Numerous flint artefacts were found on the surface of the talus and one or two pieces under the overhang.

Kipi 5 is about 50 m downstream of Kipi 4 and some 25 m above the present river bed, close to the old bridge which linked the villages of Vitsa and

Koukouli. The opening is 10 m wide by 2 m deep with a 2 m high ceiling. The bedrock of the shelter and the slope in front of it are steeply angled. There are pockets of sediment on the slope in front of the overhang containing flint artefacts including a patinated backed bladelet, but there appears to be very little remaining *in situ* deposit.

Kipi 2 is a solution cavity with a steep talus

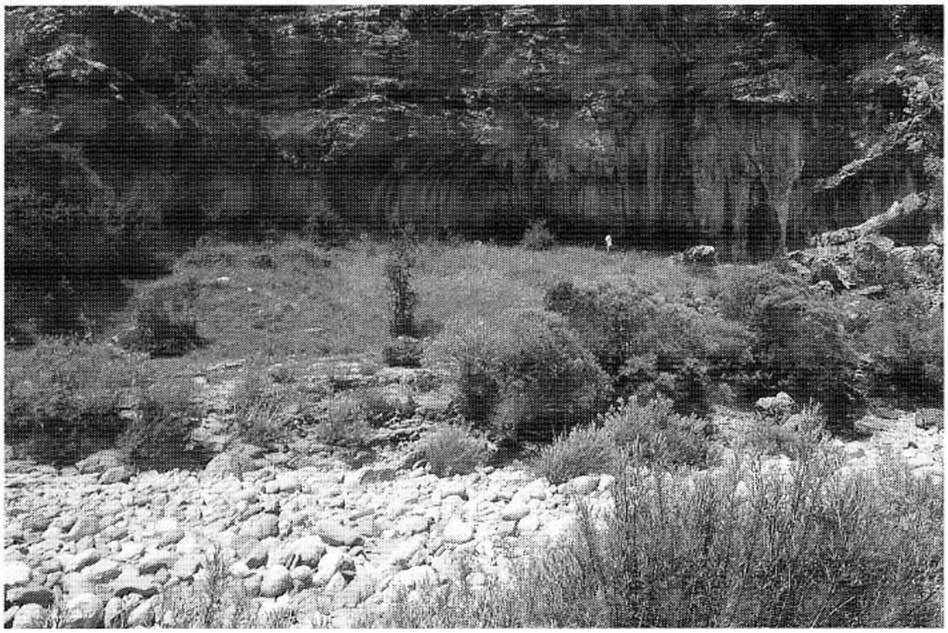

Figure 16.20. *General view of the Kipi 4 rockshelter. The Voïdomatis river-bed is in the foreground.*

Figure 16.21. *Section downstream of Boïla showing a thin lens of soil and charcoal marking exposure of flint artefacts within sandy sediments in the upper section of the Aristi Unit: left-hand picture shows general view looking east (Derek & Carolyn Sturdy); right-hand picture shows close-up of section with slope deposits stratified on top of the fluvial sediments. The artefact-bearing horizon is the dark line about one third of the way down the shepherd's staff and to its right.*

slope of jumbled stones and boulders and little sign of cultural material apart from one struck flint found on the surface.

In all cases the deposits have been subject to a variety of disturbing and destructive processes, including human disturbance at Kipi 1, and are vulnerable to further disturbance. The Kipi sites are of particular interest because they represent a focus of activity at the upstream end of the Vikos Gorge where it opens out to more accessible terrain, and in this sense they are closely analogous to the group of sites centred on Klithi. They differ from the Klithi group in being at higher altitude. Also Kipi 1 and Kipi 4 are too low above the present river level to have been used during the Last Glacial period when the stream bed would have been considerably higher than the present. These are clues to the possible presence of late Upper Palaeolithic or even post-Upper Palaeolithic cultural material in these deposits, but this possibility will only be resolved by future excavation.

Open-air sites

Two open-air sites with a small number of artefacts have been located in river-terrace deposits about 50 m downstream of Boïla, just beyond the old bridge (Gillespie *et al.* 1985; Bailey *et al.* 1990). The first of these comprises a handful of flints in a thin ashy lens within a soil horizon exposed in a section of sandy, slack water river sediments now exposed some 8 m above the present river channel (Fig. 16.21). The site was discovered by Derek Sturdy and Derrick Webley in 1983 (Bailey, Chapter 1) and has yielded two series of radiocarbon dates (Gowlett *et al.*, Chapter 2), respectively of about 11,000 BP (from charcoal) and 15,000 BP (from the humic acid fraction of the charcoal samples). Lower down in the same terrace sequence is a lens of similar sandy sediments sandwiched between typical gravels of the Aristi unit (Fig. 16.22). A flint artefact and a red deer mandible were recovered from the sandy lens by John Lewin and Mark Macklin in 1986 (Bailey, Chapter 1), and the red deer mandible has yielded an ESR date of about 25,000 years (Macklin *et al.*, Chapter 17).

There is also a group of sites in and around the Pedina basin. These sites are of uncertain age and significance but are worth brief comment because the Pedina basin forms a potentially important intermediate grazing basin between the lowlands of the Doliana and Ioannina basins, on the one side, and the high summer grazing territories on the Gamila mountain massif, on the other, which were exploited from known sites such as Klithi and possibly from Kipi.

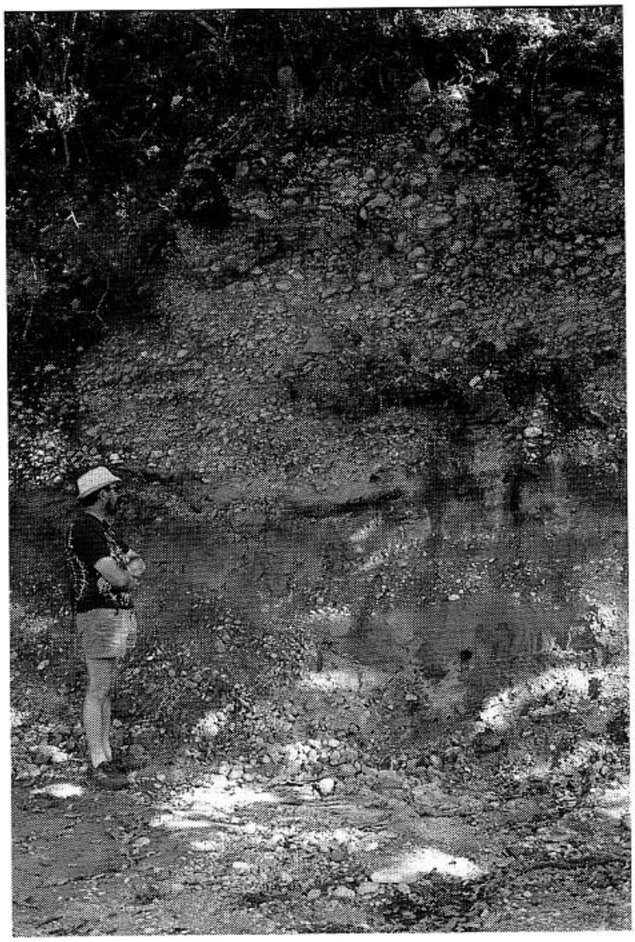

Figure 16.22. *Section of Aristi Unit downstream of Boïla showing exposure of sandy lens from which the ESR-dated red deer mandible and artefact were recovered, next to the folded arms of the human figure (John Lewin). This section is immediately below that illustrated in Figure 16.21. The sandy lens is of similar composition to the sandy sediments in the Figure 16.21 section.*

None of these finds provides unambiguous indications of age, and the material could well be post-Palaeolithic. In view of the strategic location and ecological potential of this intermontane valley system, further investigation would be desirable. Perhaps the best prospect for providing further information is the small rockshelter (site 13, Table16.1). This is a small west-facing rockshelter in the middle of the Pedina basin, about 2 m above the valley floor, and by the side of the road from Kato Pedina to Monodendri. The shelter opening is about 12 m wide by 15 m deep, with a hole in the roof, and has been used in modern times as an animal shelter. In front of the opening is a nettle-covered talus at least 1 m thick. The site has been visited on a number of occasions since at least 1983, but has failed to give unambiguous surface indications of archaeological potential.

Comparisons

It should be emphasized that the group of sites as a whole offers interesting opportunities for the analysis of inter-site variation at a local scale within a single valley-catchment. Such comparisons may reveal a wider range of variation than might be apparent from the study of individual sites, and an important control on the interpretation of both archaeological and sedimentological data. This opportunity was recognized at an early stage, but practical and permit constaints have so far limited comparative investigations to Klithi and Megalakkos, while excavation of Boïla has recently got under way, and preliminary findings are reported later (Kotjabopoulou *et al.*, Chapter 22).

In a more general sense the evidence at present available emphasizes another point of importance. There are a considerable number of cave or rockshelter sites within the valley as a whole. Not all are listed here, and some can be ruled out as improbable locations for prehistoric occupation because of difficulties of access, poor shelter, or small size. However, it is clear that the location of sites with prehistoric occupation is not simply a function of the location of caves and/or rockshelters. Nor are the sites that were occupied of equal weighting. Some, such as Klithi, appear to have been preferred sites in the sense of being the focus of repeated or prolonged visits, while others were less so. Clearly the evaluation of the comparative weighting to be placed on each site is problematic in view of the limited number of sites that have been excavated. The point, however, is that the data as a whole provide considerable evidence for variation in the use of particular rockshelter locations — or in the geological conditions that favour survival of evidence — and opportunities for identifying the factors underlying such variability.