
Dr Jamie C. Woodward, School of Geography, University of Leeds, Leeds, LS2 9JT, UK. E-mail: jamie@geog.leeds.ac.uk TEL/FAX: 0113 233 6838 / 3308

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Chapter 19
Late Pleistocene Rockshelter Sedimentation at Megalakkos

Jamie Woodward

Megalakkos is a small rockshelter which was discovered in 1986 during the geomorphological survey of the tributary stream network in the Lower Vikos Gorge (Bailey, Chapter 1). The site is located in a narrow and steep-sided right-bank tributary ravine about 100 m from the point where it joins the main Voidomatis River approximately 500 m upstream of the Klithi rockshelter. Megalakkos has an opening 4.5 m wide which faces to the southwest and is perched about 10 m above the seasonal stream bed (Fig. 19.1). Today it can only be reached with some difficulty by scrambling up a steep slope. The stream channel drains a fairly narrow and steep catchment whose headwaters lie in the flysch terrain to the west and northwest of the village of Papingon. Stream bed materials include a wide range of particle sizes ranging from coarse (>2 m) limestone boulders derived from rockfalls, angular to sub-angular limestone gravel clasts derived from channel bed and rock bank erosion and rounded flysch gravel and flysch-derived sands and coarse silt. River terraces are not present along the Megalakkos tributary and colluvial material is delivered directly into the channel system from the steep valley sides.

Within the rockshelter a Late Pleistocene and Holocene sedimentary fill attains a thickness of at least 5.3 m and these sediments have been investigated through a combined programme of field-based and laboratory-based analysis. In contrast to the sedimentary sequence at Klithi, natural erosion at the site opening has allowed direct observation of the Megalakkos sequence (Fig. 19.1). This has facilitated detailed subdivision of the sequence and twelve lithostratigraphical units have been identified with only minimal excavation. Four of these sedimentary units contain cultural and faunal remains which indicate a Late Upper Palaeolithic age for part of the sequence, covering a similar time span to the cultural deposits at Klithi.

The presence of ready-made vertical exposures in the Megalakkos fill removed the need to excavate deep trenches or to conduct site drilling to uncover the nature of the stratigraphic record. Good exposure of sections also permitted the use of more detailed sediment sampling strategy and methodology than that employed at Klithi, incorporating textural analysis of the coarse sediment fraction and micromorphological analysis of fine-grained sediments (cf. Butzer 1982, 87). As in the previous chapter, emphasis is placed on the temporal sequence and on establishing the source of the fine sediments. The latter aim is again regarded as an important element in the reconstruction of the transport mechanisms and depositional processes responsible for sediment accumulation and the reconstruction of the wider environmental context.

The sedimentary sequence at Megalakkos provides a valuable local source of comparison with the Klithi rockshelter deposits described earlier (Woodward, Chapter 18). Like Klithi, Megalakkos also presents an opportunity to integrate the study of ‘on-site’ archaeological materials and sediments with the ‘off-site’ Late Pleistocene sediments in the immediate and basin-wide geomorphological environment. The Megalakkos sequence is particularly noteworthy because archaeologically rich sediments, characterized by coarse and angular limestone clasts, are interbedded with highly distinctive fine-grained, archaeologically-sterile deposits. The repeated alternation of markedly contrasting coarse and fine sediment facies at Megalakkos provides an additional contrast to the Klithi sedimentary record. The clear differences in sedimentation style between the Klithi and Megalakkos sites present an unusual opportunity to evaluate the importance of local or site specific environmental factors in controlling the nature of rockshelter sedimentation (cf. Farrand 1985; Woodward 1990).
Field and laboratory methods

The erosive action of natural slope processes has created a useful section in the upper deposits and much of the sedimentary fill is exposed at the cave-mouth (Fig. 19.1; see also Fig. 21.1). The stratigraphical relationships within the site were further explored by means of a narrow (c. 25 cm) trench cut into the central and lower parts of the sequence. This trench was extended laterally in the central part of the sequence to a maximum width of c. 75 cm (see Sinclair, Chapter 21). The stratigraphical relationships within the sedimentary fill were logged, sketched and photographed. The 3.3 m thickness of Quaternary sediments was subdivided into twelve lithostratigraphic units and their sedimentological characteristics were described and logged in the field. Host limestone rock samples were collected from within the sequence and from the shelter walls for lithological and textural analysis. Sediment samples were taken from both the excavated units and the exposed upper section, and where possible sediment samples were taken in vertical columns (cf. Colcutt 1979). Because of the presence of a deep natural section, bulk samples of coarse (>11.2 mm) material were also taken for particle size analysis. This was not possible at Kilithi because of the relatively small samples recovered from the cores (see Chapter 18). Fine fraction sediment samples were also collected for laboratory analysis and samples of charred material were taken for radiocarbon dating. As the fine sediments of interest were

Figure 19.1. An oblique view of the Megalakkos rockshelter looking up from the recent talus slope. The site opening is approximately 4.5 m across. The evolution of the site appears to be related to the erosion of a local structural weakness in the limestone bedrock — enlarged initially by solutional weathering — and later also by physical weathering processes and bedding stress release. Part of the uncremented central portion of the fill has been eroded away leaving a precarious overhang of mildly cemented limestone clasts. Coalett deposition is evident on the sediments and bedrock wall in the upper left of this photograph. The high bedding frequency and brittle nature of parts of the limestone bedrock walls is also apparent. The shallow trench excavated during the 1986 field season is located in the central part of the fill. Sedimentary units are shown on the attached legend.
frequently too compacted for the insertion of Kubiena tins, small blocks of fine-grained sediment were collected for impregnation and subsequent micromorphological analysis. Thin sections were studied under a petrological microscope.

As at Klefti, the lithological composition of the host limestone strata at Megalakkos was examined in a number of ways (see Woodward, Chapter 18 for details). Initial observations on bedrock hand specimens were supplemented by qualitative assessment of rock thin sections viewed under a petrological microscope. Semi-quantitative evaluation of mineralogy was achieved by XRD analysis of both powdered rock samples and their acid-insoluble residues. The proportion of non-carbonate minerals present — a measure of limestone purity — was also determined following dissolution in dilute hydrochloric acid. The particle size characteristics of the acid-insoluble residue of the Megalakkos host rock were also examined in detail using a SediGraph. In addition, the organic content of the fine sediments was estimated by loss on ignition using the procedure described by Cross (1971). For mineralogical analysis by XRD, all bedrock samples were crushed and ground with a mortar and pestle to powders which would pass through a 63 μm sieve. Rockshelter fine sediment samples were also screened through a 63 μm sieve. The bedrock and fine sediment sample powders were mounted as slurries in an acetone solution on circular glass slides (20 mm diameter) and air dried at room temperature (see Woodward et al. 1992). All samples were analyzed under the same instrument conditions using a Philips PW 1700 X-ray generator and PW 1050/25 vertical goniometer. Peak height measurements were recorded for quartz 4.26 Å (100), plagioclase 3.196 Å (002), and calcite 2.995 Å (002) on all diffractogram traces for comparative analysis. While estimates of mineral abundance obtained by this technique are no more than relative and semi-quantitative, they provide an extremely useful means for comparing intersample composition (see Griffin 1971; Wood 1978; Woodward et al. 1992).

Lithostratigraphy and facies types

Twelve sedimentary units are recognized at Megalakkos (Figs. 19.2-19.4) and are described below in terms of overall texture, matrix colour, nature of unit boundaries and other salient features. Units are described in order of age, beginning with the lowest (Unit 1), and mean unit thicknesses are given in brackets.

**Unit 1 (150 cm)**
Coarse-grained and crudely stratified, angular limestone clasts, with some cobble-sized material. Poorly sorted with red/brown coloured fine matrix but generally matrix poor. Archaeologically sterile. The upper part of this unit was observed in the narrow section in the scree slope in front of the rockshelter opening.

**Unit 2 (70 cm)**
Compacted, stratified, angular limestone clasts. Finer-grained and better sorted than Unit 1. The lower 45 cm of the unit displays a yellow/brown (10 YR 6/6) colour. In the lower part of the unit the limestone clasts are less compacted and are contained within the silt-dominated fine matrix. The upper part of the unit is well bedded and clast supported. Very sharp contact with Unit 3. The upper 25 cm includes a dark grey ash lens and contains archaeological material.

**Unit 3 (35 cm)**
Fine-grained sediment dominated by clayey silt. Occasional, isolated, large angular limestone clasts. Silt (63–2 μm) is the dominant particle size, with some clay grade material. Finely laminated and compacted. Very distinctive unit. Yellow/brown colour (10 YR 6/6). Archaeologically sterile.

**Unit 4 (12 cm)**
Poorly sorted angular limestone clasts supported in a clayey silt

![Figure 19.2. Schematic sections of the sedimentary units in the Megalakkos fill and their stratigraphical relationships. Section I facing southeast, section II facing southwest, section III facing southeast and section IV facing southwest.](image)

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Unit 5 (10 cm)
Fine-grained, clayey silt. Laterally discontinuous unit which is well developed in the southeast facing section. Sharp contact with Unit 4. 10 Y/R 6/6. Archaeologically sterile.

Unit 6 (15 cm)
Coarse, angular limestone clasts, similar grade to Unit 4 and poorly sorted. Matrix supported with a clayey silt matrix. Matrix colour is 7.5 YR 5/8. Ashy component with fine charcoal debris. Cultural and faunal remains.

Unit 7 (20 cm)
Homogeneous olive yellow 2.5 Y 6/6 clayey silt. Limestone clasts absent. Fine laminations. Very sharp contact with Unit 6 and Unit 8. Generally a very distinctive unit. This unit was sampled for micromorphological analysis. Archaeologically sterile.

Unit 8 (15 cm)
Well-rounded alluvial gravel with slight fining upwards. Some traces of imbrication (i.e. a bedding structure where individual clasts have their long axes oriented in the same direction, indicating deposition by flowing water). Brown silty matrix. Maximum clast size 25 mm (intermediate b axis). Flysch-derived fine, flat gravel. Sharp contact with Unit 7. Archaeologically sterile.

Unit 9 (65 cm)
Fine, brown silty matrix-supported deposit with stratified, angular limestone clasts throughout. Slight fining upwards grading into upper Unit. Recent carbonate deposition on the southwest face of this Unit and cementation of limestone fragments. Gradational contact with Unit 8. Archaeological material with lithics and some faunal remains and a large (cobble-sized) rounded flysch pebble probably carried in by hand from the main Voklo- matis floodplain.

Unit 10 (15 cm)
Laterally continuous fine-grained, stoneless, clayey silt. Sharp contact with Unit 11. Carbonate

Figure 19.3. The central and upper section of the Megalakkos sedimentary fill as viewed in the southeast facing section (see Fig. 19.2 section D). Units 4, 5, 6 and 7 are shown in the bottom right of this photograph. Unit 5 (below scale bar) has been partially cemented following calcite precipitation.
deposition on southeast facing section. Evidence for development of a vertical blocky ped structure. Archaeologically sterile.

Unit 11 (50 cm)
Angular limestone fragments. Clast supported and lightly cemented. A finer grade, with a paucity of fine matrix and an increase in sorting, distinguishes this unit from the other coarse units in the sequence apart from Unit 2. The upper part of this unit is weathered and displays three discrete horizons. These indicate partial decalcification of the top few centimetres of matrix and the development of a reddish/brown secondary layer. Sharp contact with Unit 12. Archaeologically sterile.

Unit 12 (75 cm)
Fine-grained clay/silt dominated unit. Laminated and stoneless. Archaeologically sterile.

From the field sedimentary logs summarized above and the section drawings shown in Figure 19.2, four main lithofacies types may be recognized within the Megalakkos sedimentary fill:

1. Facies A. A finely laminated clayey-silt facies. This facies is very distinctive, typically yellow/brown in colour, devoid of coarse material, forming sharp contacts with adjoining units. Units 3, 5, 7, 10 and 12.

2. Facies B. A poorly stratified, matrix supported, angular limestone debris facies characterized by coarse, poorly sorted, angular limestone clasts with a significant proportion of fine 'earthy' clayey/silt matrix. Units 1, 4, 6 and 9.

3. Facies C. A well sorted, stratified, deposit of fine, angular limestone clasts, partly clast supported with a predominantly yellow brown or creamy/brown silty matrix. Units 2 and 11.

4. Facies D. A fine fluvial

**Figure 19.4. The southwest facing section of the excavated trench in the central part of the fill** (see Fig. 19.2 section II). Unit 5 is laterally discontinuous and is recognizable, but not so clearly defined at the back of the trench.
gravel facies containing well-rounded flysch gravel up to 2.5 cm (b axis), largely matrix supported with some evidence of imbrication. Unit 8.

**General bedrock features and site formation**

The limestone bedrock at Megalakkos, as at Klithi, is Palaeocene to Upper Eocene in age. In many places these rocks are tectonically deformed and fractured and often display high bedding and joint frequencies. A typical section in fractured Eocene limestone is shown in Figure 19.5. In contrast to Klithi, where it seems likely that fluvial erosion of the gorge wall was a major factor in site formation, the evolution of the small rockshelter opening at Megalakkos appears to be related to the presence of a local structural weakness which was probably exploited initially by solutional activity and later by chemical and physical weathering processes (cf. Woodward 1990). In general, solutional weathering processes are concentrated along the bedding planes of these hard and low porosity limestones.

**Lithological composition**

A typical XRD pattern for a bulk powdered bedrock sample is shown in Figure 19.6. This indicates that the limestone bedrock is dominated by CaCO₃ in the form of calcite with tiny amounts of detrital quartz. The acid-insoluble residue content of 7 rock samples ranged from 0.34 to 0.89 per cent with a mean content of 0.54 per cent. These limestones are thus >99.4 per cent CaCO₃, and may be classified as extremely pure (cf. Bögli 1980). Three of the insoluble residues from the Megalakkos rock samples were also analyzed by XRD. The insoluble residues are clay-rich (Fig. 19.7) with a mineralogy dominated by quartz and mica. In view of the known tendency of limestones to display lithological uniformity over wide areas, it is not surprising that the host limestone bedrock at Megalakkos and Klithi is very similar in both texture and composition (Fig. 19.7). The lithological character of the flysch rocks of the Lower Vikos Gorge has been described in Chapter 18.

![Figure 19.5. A section in the Palaeocene to Eocene limestone of the Lower Vikos Gorge exposed along the Aristi to Papigko road. Note the often brittle and fractured nature of the limestone bedrock, the local variation in bedding thickness, and the importance of the karst system as a conduit for fine sediment transfer (see also Fig. 19.11).](image)

**Lithological properties and sources of sediments**

**Fine sediment sources**

A large proportion of the Megalakkos sequence is made up of fine-grained material in the silt and clay (<63 μm) size range. This material is present in varying proportions in all the sedimentary units and various properties are summarized in Table 19.1. Non-carbonate silt forms an important component of the fine element of all the units, reaching a maximum of 60.8 per cent in Unit 8. The CaCO₃ content ranges from 25 per cent to 54 per cent with a mean value of 36 per cent. Silts and clays form the interclast matrix within the coarser units where limestone rock fragments form a major component, and they dominate the exclusively fine-grained units.

The provenance of silts and clays in cave and rockshelter environments has generated much debate (cf. Jennings 1985) and this controversy may he usefully compared with the debate surrounding the origin of the Epirus terra rossa soils since it involves an assessment of limestone purity and the geological significance of limestone dissolution products (cf. Macleod 1980; Woodward 1990; Fye 1992).

Both the XRD results and the insoluble residue proportions indicate that, in common with the Klithi sediments, most of the Megalakkos fine sediments are not derived from the limestone bedrock. The bedrock is extremely pure — composed almost exclusively of CaCO₃ (>99.4 per cent) in the form of calcite, with tiny amounts of predominantly clay-grade, quartz and mica (Fig. 19.7). The XRD traces shown in Figure 19.6 demonstrate the relatively simple bulk mineralogical composition of the Megalakkos
Figure 19.6. Typical X-ray diffraction (XRD) traces for powdered (<63 µm) limestone and flysch bedrock samples and the facies A fine sediments (Unit 7) at Megalakkos.

Figure 19.7. Typical particle size distribution curves for the insoluble residue fraction of the host limestone bedrock at Megalakkos (grey line) and Kithi (black line). Note the fine-grained nature of this non-carbonate material and the virtual absence of coarse silt. 4 φ (63 µm) is the sand/silt boundary and 9 φ (2 µm) is the silt/clay boundary (see Table 18.1).
limestone in contrast to the more complex mineral suite found in the overlying flysch strata and the rockshelter fine sediment. The composition of the local flysch strata is identical to that of the Megalakkos fines (Figs. 19.6 & 19.8). The mean insoluble residue content of the Megalakkos limestone is 0.54 per cent. In common with the Kliothi host rocks the paucity of non-carbonate minerals within the Megalakkos limestone and their very fine texture rules out a simple residual origin for the Megalakkos fine sediments. All the sedimentological evidence indicates that these sediments are allochthonous — derived ultimately from sources external to the limestone system. The overlying flysch rocks and soils provided the main source of this material (Woodward 1990). This conclusion is supported by the colour of the fine units - their light-brown or 'buff' colour is similar to that of the alluvial fine sediments of the Kliothi alluvial unit which are largely a byproduct of local flysch erosion (Lewin et al. 1991; Woodward et al. 1992; Macklin et al., Chapter 17). The insoluble products of limestone weathering make only a very minor contribution to these sediments.

The central and upper sections of the sediments described from core Y25 at Kliothi display some lithological and textural similarities to the fine sediments at Megalakkos (see Chapter 18, Table 18.2). In contrast, however, the fine sediment fraction within the basal sections of core Y25 contains a significantly greater proportion of CaCO₃ than the Megalakkos sediments.

Bearing in mind the apparent significance of aeolian processes at Kliothi, it could be argued from a cursory inspection of the fine-grained units (Facies A) that wind action was largely responsible for their transport and deposition. Indeed, Butzer (1971) has argued that aeolian activity is a major agent of fine-sediment deposition in rockshelter and cave-mouth environments. In this respect, it is interesting to note that loose-like sediments which share a number of similarities with the Megalakkos Facies A deposits have been reported in the Doli בנ stream west of the Voidomatis catchment (Sturdy et al., Chapter 20). In very general terms the silty texture, yellow/brown colouration and absence of coarse material in these fine units are features which characterize many aeolian deposits (cf. Brunner & 1980; Pye 1987; Wintle et al. 1984).

The Doli בנ basin loess. Loess has been defined as a terrestrial windblown silt consisting chiefly of quartz, feldspar, mica, clay minerals and carbonate grains in varying proportions (Pye 1984; 1987). The mineralogical and particle size characteristics of the Megalakkos fine units are undoubtedly loess-like in a number of respects. The particle size distribution of typical loess shows a pronounced mode in the range 20–40μm and is positively skewed (Pye 1987).

A number of sedimentological comparisons were made between the Megalakkos sediments and loess samples from an exposure in the Doli בנ basin approximately 15 km west of the Voidomatis basin. Figure 19.9 illustrates the relationship between silt content and CaCO₃ content, and these parameters show a clear separation between the two sample groups. The Megalakkos deposits are generally finer-grained (richer in clay) and contain more CaCO₃ than the Doli Feinstein loess sediments. It is unlikely that these contrasts are primarily a function of post-depositional modifications (cf. Woodward 1990). In addition, the distinctive vertical (prismatic) ped structure frequently present in loess sediments is largely absent in the Megalakkos sequence.

As well as these textural and lithological differences between the Megalakkos fine sediments and the Doli Feinstein, the geometry of the site and its local topographic setting combine to create an unfavourable location for aeolian deposition. In contrast to the local setting and aspect of the much larger Kliothi rockshelter, where proximity to a well-developed floodplain system afforded a ready supply of local windblown material, Megalakkos is situated in a narrow and steep-sided tributary ravine and this sheltered setting is not a favourable location for prolonged and repeated episodes of aeolian deposition. Furthermore, the youngest fine unit in the sequence, Unit 12, which is c. 75 cm thick, is unweathered and the top of this unit lies above the upper level of the shelter opening. This unit was probably deposited in Holocene times and may still be accumulating today.

Micromorphology and fine sediment laminations. Close examination of the Megalakkos fine sediments in thin section shows the presence of fine laminae. These laminae can be several millimetres in thickness, which suggests that these sediments were laid down in ponded water under low energy conditions (see Gillieson 1986). Intact sediment blocks were collected from Unit 7 for micromorphological analy-

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**Figure 19.8.** A plagioclase and calcite XRD peak-height plot for 14 bedrock samples (7 limestone and 7 flysch) and the 5 Facies A units in the Megalakkos sequence.

**Table 19.1.** Lithological and textural properties and organic content of the <63 μm fraction of the Megalakkos sediments. The facies groups are also shown. Asterisks indicate the presence of Palaeolithic material.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Facies type</th>
<th>CaCO₃</th>
<th>Insoluble residue</th>
<th>Clay</th>
<th>Silt</th>
<th>Non-carbonate silt</th>
<th>Median size (μm)</th>
<th>Organic carbon %</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 A</td>
<td></td>
<td>86</td>
<td>0.46</td>
<td>23.0</td>
<td>70.2</td>
<td>3.2</td>
<td>8.68</td>
<td>0.08</td>
</tr>
<tr>
<td>11 C</td>
<td></td>
<td>35</td>
<td>0.46</td>
<td>88.8</td>
<td>91.2</td>
<td>3.5</td>
<td>2.46</td>
<td>0.01</td>
</tr>
<tr>
<td>10 A</td>
<td></td>
<td>25</td>
<td>0.25</td>
<td>25.5</td>
<td>75.4</td>
<td>3.66</td>
<td>2.46</td>
<td>0.01</td>
</tr>
<tr>
<td>9 B*</td>
<td></td>
<td>32</td>
<td>0.72</td>
<td>14.2</td>
<td>85.8</td>
<td>3.66</td>
<td>2.46</td>
<td>0.01</td>
</tr>
<tr>
<td>8 D</td>
<td></td>
<td>25</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
<td>2.46</td>
<td>0.01</td>
</tr>
<tr>
<td>7 E*</td>
<td></td>
<td>25</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
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<tr>
<td>5 A</td>
<td></td>
<td>32</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
<td>2.46</td>
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<tr>
<td>4 B*</td>
<td></td>
<td>32</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
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<tr>
<td>3 A</td>
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<td>32</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
<td>2.46</td>
<td>0.01</td>
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<td>2 C*</td>
<td></td>
<td>32</td>
<td>0.72</td>
<td>32.0</td>
<td>68.0</td>
<td>3.66</td>
<td>2.46</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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sis, and the finely laminated graded sediments are shown in Figure 19.10. These micrographs confirm that deposition took place within standing water. Some of the laminae are quite well sorted and are dominated by angular particles of coarse silt-grade quartz (non-carbonate silt) which fine upwards to fine silts and clays. There is some evidence of secondary carbonate deposition.

Deposition of fine-grained infiltrates
A number of studies have documented the process of sediment-laden water percolating through karstic fissures as a significant agent of transport for fine-grained clastic material (Bretz 1942; Bull 1981). This process has also been inferred by several early cave sediment stratigraphers (e.g. Zenne 1946; Schmid 1969), and published studies demonstrate that such sediment-charged flows can produce considerable accumulations of clay-rich laminated sediments. Bretz (1942) recognized the importance of such a mechanism in the Ozark caves in Missouri and more recently Bull (1981), working in Agen Allweid in south Wales, suggested that weather events inject pulses of sediment-rich water down fissures by a translatory flow mechanism into standing water in the caves. These silt clay are commonly laminated, with a tendency to accrete parallel to the bedrock surface. These and other investigations (e.g. Smart et al. 1985) have demonstrated that cave environments not only function as efficient sinks for vast amounts of fine surface-derived material, but they can also display unusual sedimentation mechanisms rarely seen in non-cave environments (Janin & Clark 1993; Jennings 1983).

The Megalakkos fine units were deposited in a cave-mouth environment and not deep in a karstic cavern system where many examples of the above process have been observed. Nevertheless, there is an abundance of evidence in the Voutomatis

Figure 19.9. The proportion of CaCO₃ and silt in the Dolianna basin loess and the sedimentary units at Megalakkos. The mean CaCO₃ content of the Megalakkos fine sediments is 36.2 per cent with a range of 25.0 to 54.0 per cent. In contrast, the mean CaCO₃ content of the Dolianna loess is 14.2 per cent with a range of 4.0 to 24.5 per cent (Woodward 1990).

Figure 19.10.
Micromorphology of the facies A sediments of Unit 7. These sediments are dominated by angular quartz particles, plagioclase feldspar, mica and other clay minerals derived mainly from the overlying flysch rocks and soils. There is also evidence for secondary calcite deposition in desiccation cracks and in voids produced by burrowing fauna. This micrograph illustrates a general fining upward sequence of waterlain fine sands and coarse silt overlain by fine silts and clays separated by a rather sharp boundary in the centre of the photograph. Note the fine laminations in the upper, finer-grained half of the micrograph. Interestingly, these general sedimentary features are similar to those observed in thin sections of the flysch bedrock. (Scale: the white circle in the centre left has a maximum dimension of 5 mm.)
basin to indicate that fine sediment transport through the limestone strata is a significant geomorphological process. For example, sections cut in the Palaeocene–Eocene limestones exposed along the Papingon–Aristi road contain macro-joint structures plugged with fine-grained flysch derived sediment (Fig. 19.11). The Late Eocene–Miocene flysch beds lie conformably over the basin limestones, and these rocks and the soils formed upon them liberate large amounts of easily erodible and transportable silts and clays which can be washed, via sinkholes and joints, into the karst drainage network below. It is worth pointing out that while a surface source for this fine sediment is likely, it does not have to be the product of subaerial erosion processes. Indeed, as Jancin & Clark (1993) have argued for infiltrates in the Tertiary karst of southwest Georgia, some of this fine sediment may have entered the karst system directly from the overlying flysch beds via subterranean feeder pipes. The flysch rocks are the major source of fine sediment (<63 μm) in the contemporary river environment (Woodward et al. 1992) and in many of the colluvial sediments of the catchment.

In summary, the Megalakkos clayey-silts are the product of a low energy sedimentation mechanism associated with local hydrological pathways within the karst drainage system. This flysch-derived material is transferred through the subterranean drainage network within pulses of sediment-laden waters and accreted within shallow pools of standing water. The bulk of this material is similar to the non-carbonate silt material found in the Kithi rockshelter sequence described in the previous chapter, although it seems likely that a proportion of the clay material at Kithi is a product of aeolian deposition. The Megalakkos rockshelter has served as an effective location for the deposition and storage of detrital fine sediments for a considerable part of Late Glacial and Holocene time. As the Megalakkos tributary is only some 500 m upstream of Kithi, these two sites highlight the importance of local site-specific factors such as aspect, exposure and hydrology in controlling sediment source and depositional style within the rockshelter environment.

Coarse sediment properties
The particle size distributions of the units containing a significant proportion of coarse angular limestone clasts are shown in Figure 19.12. The inter-unit variations in coarse fraction calibre fall into two categories:

1. Units 2 and 11 are clearly composed of finer grained limestone clasts than the other coarse units. These units are quite well sorted, do not contain material larger than 64 mm (~6), and at least 75 per cent of their constituent clasts are finer than 32 mm (~5). These units fall within the Facies C grouping.
2. In contrast, Units 4, 6 and 9 are not well sorted, they all contain a significant proportion of material coarser than 64 mm and most of the coarse clasts are larger than 32 mm (Fig. 19.12). These are all Facies B units.

This sub-division excludes Unit 1, which was observed and sampled in the shallow stepped trench located outside the rockshelter opening, and has thus been influenced by colluvial materials and processes operating outside and above the cave-mouth environment.

Assuming these coarse sediments are largely derived from weathering of the surrounding bedrock walls and ceiling, it is necessary to consider the factors which have contributed to produce this coarse material and the inter-unit variation in size distribution. Thanks to the high quality exposures at Megalakkos, the full lateral extent of many of the units could be observed, and it was therefore possible to confirm that these size distributions are broadly representative of the overall texture of the sampled unit.

It is generally accepted that in climates characterized by numerous freeze-thaw cycles, frost weathering (frost splitting/wedging) plays a dominant role in the production of angular rock fragments. In practice, however, in the rockshelter or cave-mouth environment, it is often extremely difficult to differentiate between the relative impact of different processes of debris formation (Colcutt 1979; Farrand 1983; Bailey & Woodward, Chapter 4). In the evaluation of a site history it is important to consider the evidence for regional and local geomorphological change and attempt to integrate all sources of palaeo-environmental information.

It is clear from the glacial geomorphological evidence that, in comparison to present conditions, the Vorokathis basin was subjected to a more severe climatic regime during the end of the Last Glacial period. Summer (and probably winter) temperatures would have been much reduced to allow glaciers to develop and a precipitation supply must have been available to feed the snowfield above Tsapelovon (Bailey et al., Chapter 16). This cool and moist climate would have encouraged numerous freeze-thaw cycles, producing favourable conditions for rock fragmentation (Selby 1993).

Figure 19.11. Close-up of a section in the local limestone of the Lower Vikos Gorge exposed along the Kapingon to Aristi road. This narrow karst passage is plugged with fine-grained (infiltrated) sediments.
Bedrock walls may also be destabilized by tectonic phenomena creating rock faces which are already extremely unsound, jointed and microfissured (DeWolf 1988). This is particularly evident in the Mediterranean region where tectonic activity has produced intensely folded and deformed limestone strata which offer brittle rock walls to sub-aerial weathering processes. This important factor, which is widely evident in the Vourvouras basin (Fig. 19.5) would have aided rock reduction processes by frost weathering during glacial periods. It seems likely that the bulk of the massive talus cones, particularly well-developed in the Vikos Gorge, is a legacy of glacial periods. In summary, those parts of the limestone strata of the Vourvouras basin which have been subjected to tectonic weakening present brittle bedrock faces with increased susceptibility to fragmentation — especially by frost weathering processes. During prolonged episodes of cold, harsh climate similar to those conditions which produced glaciers and the striking glacial topography of the Tsepelovos district, freeze-thaw weathering mechanisms would have been the major agent of rockwall attack.

As Ollier (1975) has stated, weathering produces rock fragments of many kinds and some may be distinguished genetically, such as frost-riven fragments which are very angular. The presence of angular clasts is not unequivocal evidence of frost action, however. Both the high joint frequency in the Megalakkois rock walls and ceiling and their rather brittle condition would render them susceptible to solutional and/or frost attack as well as destabilization by tectonic activity (Farrand 1985). The predominance of sharp and angular multifaceted clasts, however, is indicative of frost splitting processes rather than solutional attack, since the latter process tends to produce rounded clast edges (Goldberg 1972; Laville et al. 1980). It thus seems likely that frost weathering processes are the dominant mechanism of coarse sediment production in the Megalakkois sequence. Seismic events are also clearly capable of liberating angular rock material from the bedrock walls and ceiling, and this process may be responsible for producing some of the coarsest sediment particles within the sequence including the isolated limestone blocks >128 mm in size (cf. Farrand 1985). It is difficult, however, to imagine a tectonic event which could produce the finer-grained and well sorted coarse particles of Facies C (Unit 11 and the upper part of Unit 2) (Figs. 19.2 & 19.3).

**Discussion and unit comparisons**

**Facies types and matrix texture**

Figure 19.13 shows the relationship between the silt/clay ratio and median grain size for the fine fraction component in the Megalakkois Units. The four facies types are also shown. These data show that the particle size characteristics of the fine sediment fraction also vary significantly through the vertical sequence. The silt/clay ratio ranges from 1.62 to 10.3, and the median grain size of this fraction ranges from 5.37 φ to 7.71 φ (Table 19.1). The sedimentary units are richer in clay and finer overall to the bottom right of the diagram. This plot forms an interesting complement to the coarse fraction data in Figure 19.12, as

**Figure 19.12.** Histograms showing the particle size distribution of the coarse sediment fraction >8 mm (intermediate axis) for the Facies B and Facies C sediments. The data for Unit 1 are based on a small sample because of the narrow excavation trench and limited exposure at the base of the sequence.
the finer scree beds, Facies C (Units 2 & 11), contain a coarser, silty matrix yet the fine beds of Facies A (Units 3, 5, 7, 10 & 12) are generally richer in clay, and have finer overall particle size distributions. The Facies B sediments (Units 4, 6 & 9) have more normal coarse fraction distributions and the textural character of the matrix is intermediate between the two other groups (Figs. 19.12 & 19.13).

The deposition of the exclusively fine-grained (Facies A) units, when the production of limestone debris temporarily ceased, resulted in sediments that are clay rich (all silt/clay ratios <3) with a mean clay content of 30 per cent. In contrast, the deposition of Units 2 and 11 (Facies C) produced a fine matrix of coarser grade dominated by silt-sized material with a mean clay content of 13.4 and 8.8 per cent respectively (Table 19.1). The clay contents of the Facies B sediments (Units 5, 7 & 9) lies between these two extremes. These latter units are characterized by matrix-rich accumulations of coarse, angular limestone clasts and are the source of most of the excavated archaeological material.

Tributary flood sediments: Unit 8. The sediments of Unit 8 represent the only evidence of alluvial deposition within the rockshelter by the adjacent tributary stream, and are composed largely of fine-grained river-borne gravel, silts and clays with different textural characteristics from the rest of the fill. The flood event responsible for the inundation of the site resulted in an aggradation of small well-rounded, flysch-derived alluvial gravels, and this material contains clasts up to 2.5 cm in size with some evidence of imbrication. These deposits are identical to the modern sediments on the bed of the tributary. The sediments of Unit 8 probably represent a single high magnitude flood event and demonstrate that the tributaries in the Lower Vikos Gorge were delivering flysch-derived alluvial sediments to the main channel system after c. 16 ka. It is not possible to estimate the precise level of the tributary stream bed at this time, as major flood events in narrow ravines are commonly accompanied by very large increases in river level. It is, however, likely that the Megalakkos tributary bed was at a higher level than at present since the surface of the Vikos Unit of the main Voidomatis system is up to 7 m above the contemporary stream bed (Macklin et al., Chapter 17).

Dating

Four AMS radiocarbon dates have been obtained from charred material within the Megalakkos sequence (Table 19.2). Although the radiocarbon dates obtained from sedimentary Units 2 and 4 are inverted, they are in good agreement with the dated archaeological horizons at Klithi, where 24 AMS radiocarbon dates demonstrate that occupation took place between c. 17 ka and 10 ka, with the bulk of the dates falling between 16 ka and 14 ka (Chapter 2).

These dates and the similarity of the faunal and lithic assemblages at the two sites suggest that cultural activity at Megalakkos took place during approximately the same interval as at Klithi.

The date of 8800 ± 100 from Unit 6 (Facies B), which is associated with a typical microlithic flint assemblage (of Klithi type) is, however, confusing. Taken at face value it appears to be too young — if this date were correct it would represent the youngest lithic assemblage in the Voidomatis basin by 2000 years. The modern date from Unit 11 is clearly too young — these sediments are overlain by Unit 12, which is approximately 0.75 m in thickness, is composed of laminated fine-grained (Facies A) sediments, and probably represents a considerable period of time. Furthermore the nature of the Unit 11 sediments

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![Figure 19.13. The relationship between median grain size (\(\phi\)) and silt-clay ratio of the <63 \(\mu\)m fraction of the Megalakkos Units. The Facies C group includes three samples from Unit 11.](image)

<table>
<thead>
<tr>
<th>Material</th>
<th>Date (yr BP)</th>
<th>Standard deviation</th>
<th>Sedimentary unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charred bone</td>
<td>1002</td>
<td>0.8%</td>
<td>Unit 11</td>
</tr>
<tr>
<td>Charred seed</td>
<td>105</td>
<td>0.9%</td>
<td>Unit 11</td>
</tr>
<tr>
<td>Charred bone</td>
<td>8800</td>
<td>100</td>
<td>Unit 6</td>
</tr>
<tr>
<td>Bone</td>
<td>16,410</td>
<td>164</td>
<td>Unit 11</td>
</tr>
<tr>
<td>Charred bone</td>
<td>15,410</td>
<td>210</td>
<td>Unit 2</td>
</tr>
</tbody>
</table>
suggests that they may be terminal Pleistocene cold climate sediments, and a modern date is thus highly unlikely. The seed from which this date was obtained may have been introduced by recent geomorphological or biological processes. It is clear that more dates are needed from the Megalakkos sequence to clarify its chronological relationship with the sediments at Klithi and with Late-Glacial events in the catchment. Additional samples submitted for dating, however, have failed to yield sufficient carbon even for AMS dating.

On the basis of radiocarbon dating, archaeological equivalence, and lithological similarities, the bulk of the Megalakkos sequence (Units 2 to 9) can be correlated with the central and upper sections of core Y25 at Klithi. It is notable that both sites contain a significant component of flysch-derived fine sediment. With the commencement of Palaeolithic occupation of Klithi and Megalakkos after c. 16 ka, the erosion and transfer of flysch-derived silts and clays through the karst system assumed greater importance, and this process had a profound impact upon the nature of rockshelter sedimentation in the Lower Vikos Gorge. It is notable that the cultural horizons at both sites contain a significant component of allogetic fine sediment although the ratio of aeolian to infiltrated sediment contrasts markedly between the two rockshelters.

Post-depositional alterations

Natural alteration
The bulk of the Megalakkos sediments has not been significantly altered by post-depositional processes. An important secondary feature in the sequence is the result of cementation processes which have selectively brecciated a section of the fill (cf. Bull 1983), particularly part of Unit 9. This calcite deposition has preferentially affected the northwest face of the site (Fig. 19.3) and seems to be taking place under modern conditions. Its selective operation along the west side of the bedrock wall and sediments is probably related to very local hydrological pathways. As mentioned previously, there is also some micromorphological evidence to suggest that secondary carbonate deposition has taken place within some of the Facies A Units (Fig. 19.10). In view of the importance of water-laid sedimentation at Megalakkos and the clear evidence of carbonate deposition within many of the units, it seems reasonable to conclude that the emergence of karst waters at Megalakkos has had a much more important influence on site sedimentation than at Klithi. It is evident that the local hydrogeology and related water quality parameters (such as suspended sediment and solute concentrations) have had a profound impact upon both primary and secondary sedimentation processes at Megalakkos. Indeed, it seems likely that the hydrogeological features of the host bedrock were also a major factor in site formation. By contrast, at Klithi, it appears that the behaviour of the Voidomatis River and the lithology of its suspended sediment load were major determinants of rockshelter sediment properties.

The top of Unit 10 contrasts with the earlier fine beds in terms of its structure. This unit is characterized by a blocky ped structure which can be indicative of moisture deficiency (Birkeland 1984). The significant clay content of these sediments aids in the development of such ped structures, as clay mineral shrinkage accompanies dehydration. Unit 10 forms a very sharp contact with the overlying scree deposit and its distinctive structure may reflect desiccation and the onset of more arid conditions. The break in water-laid fine sediment deposition at the Unit 10/Unit 11 contact provides further support for this interpretation (Fig. 19.14).

The development of horizontal zonation at the top of Unit 11 provides the only indication of post-depositional chemical weathering in the sedimentary column. The unweathered matrix of Unit 11 is generally a creamy/light brown colour. This has been pedogenically altered, through partial decalcification, to a slightly reddened surface layer overlying a grey/brown horizon. This feature is not observed elsewhere in the sequence and could be the product of an increase in the solvent capacity of the moisture percolating into the sediments. This change in chemistry may reflect the influence of atmospheric precipitation locally seeping into the site possibly via the hole in the site ceiling.

Apart from these modifications, the most striking post-depositional change is the extensive erosion of the fill itself. The central part of the sequence has been eroded away leaving the precarious overhang formed by the mildly cemented Unit 11 (Fig. 19.3).

Human impact
The sedimentary units containing archaeological material are all dominated by coarse, angular limestone clasts. The matrix within these units is primarily flysch-derived fine sediment containing an abundance of fine charcoal fragments and some lithic and faunal debris. In general, there has not been any significant human impact upon the sedimentation style or physical properties of the deposits at
Megalakkos. Accordingly, the organic content of the Megalakkos sediments is quite low (Table 19.1) averaging 0.07 per cent for the Facies A sediments and 0.1 per cent for the Facies B sediments associated with human occupation. Organic material is similarly present in greater quantities in the cultural horizons within the Kithi rockshelter sediments. In contrast to Kithi, the sedimentological evidence at Megalakkos, e.g. distinctive and undisturbed sedimentary units, and presence of archaeologically-sterile units, suggests that the site was not a focus of intensive and prolonged occupation, and this is consistent with the archaeological evidence (Sinclair, Chapter 21).

Controls on sedimentation style and palaeoenvironmental implications

In palaeoclimatic terms, the observed variations in sedimentation style can be interpreted in at least two ways. Firstly, it is possible that the main influence on sedimentation style was local and regional climatic variability. Therefore, the sequence records episodes of freeze-thaw activity when sedimentary units consisting of coarse and angular limestone rock fragments derived from weathering of the site walls and ceiling were deposited. These deposits are present in two main types. They occur as crudely stratified and poorly sorted sediments in an abundant clay-rich matrix (Facies B). These sediments could indicate cold and humid conditions. Limestone clasts are also found in fairly well-sorted and finer-grained coarse units — characterized by a less extensive, predominantly silt-grade fine matrix (Facies C). These sediments may indicate the presence of cold and dry conditions. The archaeological material in the site is concentrated in the Facies B deposits and the upper 25 cm of Unit 2 (Table 19.1).

A particularly distinctive feature of the sedimentary fill is the recurrence of discrete, stoneless beds of clayey-silt (Facies A). These clay-rich units are normally interbedded within the coarser facies and record intervals of ponding in the site, when large amounts of clay-grade, allogetic material were able to accumulate, and freeze-thaw weathering was retarded. These sediments may indicate the presence of milder and more humid conditions than those of Facies

Figure 19.14. Part of the northwest facing section in the Megalakkos fill (scale bar in cm). This part of the sequence is comparatively free from calcite cementation. This section shows the clay-rich facies A sediments of Unit 10 and its sharp upper contact with Unit 11 (Facies C). The contact between these units marks a significant change in sedimentation style. The deposition of water-lain clays and silts ends, and is followed by the accumulation of a considerable thickness (c. 0.75 m) of frost-riven, angular limestone clasts. These units are both archaeologically sterile.
B and more humid conditions than those of Facies C. Because of their small size and irregular shape, discrete clay particles have very low fall velocities and will remain in suspension even in very slow-flowing waters. Thus, the deposition of Facies A sediments requires the presence of standing water in the rockshelter to facilitate sedimentation of the large clay fraction in these units and to permit the development of laminations and fining-upward features. The absence of coarse limestone clasts in these units suggests either that freeze–thaw processes were not important at this time or that these sediments accreted very rapidly. The considerable thickness of Units 3 and 12 in particular, and Unit 7 do not favour the latter interpretation. In addition, the very low energy conditions under which these sediments developed and the delicate sedimentary features highlighted by the micromorphological observations are probably not indicative of a rapid sedimentation rate within a rockshelter environment. In summary, these sediments suggest the presence of humid conditions in the site with the presence of pools of standing water and with freeze–thaw activity much reduced or absent. Unit 12 is at least 75 cm in thickness and forms the uppermost unit in the Megalakkos fill. This unweathered and uncompacted unit is probably of Holocene age (Woodward 1990) and supports the hypothesis that the fine units in the sequence accumulated under fairly moist and temperate conditions not dissimilar to those of the present day.

Alternatively, rather than invoking changes in Late Glacial climate, we might argue that part of the variability within the sequence represents fluctuations in the supply of fluvially-derived fine sediment in response to local karst hydrological dynamics. The opening and closing of sediment-caked karst fissures — the influence of which could have been sufficient to overprint local and regional climatic influences — is one possibility. Such a theory implies that the observed inter-unit variations in the ratio of fine and coarse sediment components would simply be a consequence of changes in the rate of fine sediment supply. However, such an explanation is unlikely in view of the repeated alternation of sedimentation styles producing sedimentary units of comparable thickness implying a fluctuating climatic control rather than internal karst dynamics. The temporary plugging and clearing of underground limestone conduits is unlikely to be evenly spaced in time. Furthermore, the supply and movement of sediment and water to and through the karst system is often intimately linked to climate as this largely controls surface hydrology and vegetation cover (cf. Ford & Williams 1989; Gillieson 1986; White 1988).

The sharp contacts between the fine units and those units dominated by limestone debris indicate a relatively rapid shift in sedimentation style. The regular occurrence of these distinctive units requires the repeated operation of a particular assemblage of environmental conditions, i.e. humid conditions to produce sediment-laden karst drainage waters and standing water in the site, as well as a milder climate to repress freeze–thaw activity. On balance, the orderly and repeated fluctuation in sedimentation style is more likely to be a response to changing climatic factors rather than solely a product of local karst dynamics. If it is assumed that, as at Klithi, the end of Palaeolithic occupation at Megalakkos was between about 13 ka and 10 ka, then Unit 11, which effectively seals the archaeological horizons and implies a return to colder conditions, may be time-equivalent to the Younger Dryas Event (see Bailey et al. 1990; Woodward 1990). Overall, then, the sediment variations at Megalakkos suggests a climatic sequence which began with cold and dry conditions (Unit 2). The date at the top of this unit of 154 ka suggests that this climatic episode might represent the tail end of maximum glacial conditions, with archaeological evidence of occupation coming in at the very end of this period, while the radiocarbon date from Unit 4 suggests slightly earlier occupation at c. 16.1 ka. The initial occupation of the site was followed by a period of perhaps 5000 radiocarbon years of generally milder climate which fluctuated between colder conditions (Facies B sediments) and warmer and wetter conditions (Facies A sediments). This was terminated by a return to colder and drier conditions (Unit 11), tentatively associated with the Younger Dryas. It is important to note that the Last Glacial Maximum in the Pindus Mountains could not have been characterized by arid conditions as ice build up and glacier expansion at this latitude requires a plentiful supply of effective precipitation (cf. Sugden & John 1976; Woodward et al. 1994; 1995). In the absence of other sources of evidence, it is not possible to attach absolute values for ambient temperature and precipitation conditions for the Late Pleistocene from the rockshelter sedimentological data, which can give, at best, only indications of relative climatic changes.

Conclusions

The deposition of sediments eroded from flysch bedrock and soils and washed down into the karst drainage system is a distinctive feature of the sedimentary fill at Megalakkos. The accumulation of these
flysch-derived clay-rich sediments in shallow pools of standing water after c. 16 ka may have been linked to a warmer climate and an increase in precipitation during the deglaciation of the catchment. This interpretation receives support from the core sequence at Klithi where a cessation in aeolian dust deposition in core Y25 is coeval with the initial occupation of the site around 16 ka to 15 ka. Unfortunately, this interpretation cannot be corroborated by pollen data from Megalakkos itself, because preliminary studies showed that pollen had been introduced post-depositionally into these fine-grained sediments by biological activity (Willis, Chapter 20). At the same time, it is now well established that cave sediments are not an ideal medium for pollen studies (see Turner 1985) because of problems of differential preservation and the unknown residence times for pollen grains derived from within the karst system. Mineralogical analyses have demonstrated that these fine sediments, in common with a significant proportion of the sediments at Klithi, are derived from local flysch rocks and soils and are not the products of limestone dissolution. Micromorphological investigations have corroborated earlier field observations and confirmed that these sediments are infiltrates which were laid down in standing water and not windblown sediments.

The alternation of fine and coarse sedimentary units in the Megalakkos sequence records a period of fluctuating environmental conditions after c. 16 ka during the Late Glacial period. The archaeologically sterile sediments of Unit 11 may record a return to cold conditions at the end of the Late Glacial period. This event may be equivalent to the Younger Dryas cold phase, although this will only be confirmed by more detailed dating evidence.

In relation to the alluvial sedimentary record discussed in Chapter 17, the greater part of the sedimentary fill at Megalakkos probably accumulated during the deposition and subsequent incision of the sediments of the Vikos alluvial unit. The composition of Unit 8 demonstrates that flysch-derived alluvial sediments were being delivered to the Voidomatis River between c. 15 ka and 12 ka via the tributary systems of the Lower Vikos Gorge. This is in accord with the composition of the fine sediments of the Vikos Unit (which contain a significant flysch component) and the inferred riverine/aeolian origin for part of the fine sediment within the middle and upper sections of core Y25 at Klithi (Woodward, Chapter 18).

The Klithi core record described in the previous chapter shows that the texture and lithology of the rockshelter sediments at Klithi have changed markedly during the Late Pleistocene. At Megalakkos, limited human use of the site has allowed preservation of a detailed (perhaps intact) primary sedimentary record that suggests the local environment was not constant during the period of Palaeolithic occupation, alternating between episodes of relatively warm and wetter climate and cold and humid conditions. An interesting feature of the Megalakkos fill is that the archaeological material begins in the upper 25 cm of Unit 2 and ends in Unit 9, and this represents almost 2 m of deposition. The sediments associated with human occupation at Klithi are also approximately 2 m in thickness. In contrast to Megalakkos, however, post-occupation and Holocene sediments at Klithi are not well developed and it is not clear whether this represents a real hiatus in deposition or levelling of the site in recent times (see Bailey & Woodward, Chapter 4).

In addition to broadly similar lithic and faunal assemblages, the limited number of radiocarbon dates from the archaeologically-rich sedimentary units suggests that the timing of human occupation at Megalakkos was broadly equivalent to the neighbouring rockshelter site of Klithi. The date of 8.8 ka in Unit 6 seems too young for the stratigraphic context, but since it is on a piece of burnt caprid bone, it indicates some human activity at this time. Unfortunately it has proved impossible to obtain additional dateable material from Unit 6, or from the stratigraphically younger Unit 9, which also contains archaeological material, to establish the upper chronological limit on human occupation at Megalakkos. Thus it remains unclear how much later than c. 15 ka human use of the site persisted into the Late Glacial.

Given the palaeoclimatic interpretation of the Megalakkos sediments, it would appear that the most favourable window of opportunity for Palaeolithic occupation in the lower Voidomatis valley occurred in conditions intermediate between the cold and drier climate of the Last Glacial Maximum and of the Younger Dryas, on the one hand, and the warm and wet conditions of the Holocene (and perhaps of the milder episodes of the Late Glacial indicated by the Facies A sediments at Megalakkos), on the other hand. It is difficult to resolve further the relationship between human occupation and climatic fluctuations. The absence of archaeological remains in the Facies A fine-sediment units may reflect a temporary reduction in human presence in the wider Voidomatis basin because of vegetational changes associated with milder climatic conditions that inhibited ibex-hunting, or quite simply the fact that the Megalakkos rockshelter itself became unsuitable for occupation.
because of damp conditions and standing pools of water. Progressive incision of the local tributary stream in the Late Glacial may also have made the site increasingly difficult of access. The absence of archaeological materials during the renewal of coarse sediment deposition in Unit 11 may simply reflect the unsuitability of the site for human use at this time because of reduced headroom within the shelter itself and a steep slope in front of the site, rather than the onset of colder climatic conditions. Here, as at Klithi, the evidence for assessing the impact of environmental and climatic changes on human occupation in the closing few millennia of the Last Glacial period and the period of transition to Holocene conditions is tantalizingly incomplete.

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