The Earlier Stone Age Sequence in the Northern Cape Province, South Africa: New Research at Wonderwerk Cave

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Abstract

Dating the advent of tool using hominins and their subsequent development and dispersion is one of the major challenges facing southern African archaeology. Although relatively well documented in terms of their lithic typology and faunal components, Oldowan and Acheulean assemblages (including the Fauresmith that probably represents a late Acheulean industry transitional to the Middle Stone Age), are not well constrained in time. This limits the nature of comparisons that may be carried out with similar assemblages elsewhere in Africa or abroad.

Wonderwerk Cave (Northern Cape, South Africa) is a unique site in that it offers a long stratigraphic sequence spanning the Earlier Stone Age (ESA), with excellent preservation of organic remains. This paper presents radiometric dates and lithic typology for the ESA levels in Excavation 1 of the site. In addition, results from a geomatetic survey of the cave, botanical, and faunal analyses as well as micromorphological investigations of the ESA levels are reported.

Introduction

Despite a long history of archaeological research on the Earlier Stone Age (ESA) of Southern Africa and abundance of ESA sites (Peringuey 1911, Goodwin and van Riet Lowe 1929, van Riet Lowe 1937, Mason 1962, Sampson 1974, Volman 1984, Klein 2000), it remains a little known time period. This may primarily be attributed to the inconsistent excavation and retrieval techniques practiced, highly variable assemblage sizes, and the fact that many assemblages are derived from unclear or secondary contexts while associated faunal remains are frequently lacking. Furthermore, although a high degree of temporal and spatial variation is now recognized in ESA assemblages elsewhere in Africa, it has not been possible to investigate or refine the extent of this variability with respect to Southern African sites. An even more salient problem has been the absence of a robust chronological framework for this time period in Southern Africa. Due to the difficulty of establishing a chronological framework, research has often relied on tenuous biochronological and archaeological analogies with artifacts and fauna from dated East African sites (Mason 1962, Sampson 1974, Volman 1984, Deacon and Deacon 1999, Klein 1998, 2000, Kuman 1998, Mitchell 2002). With the recent development of new radiometric techniques, Southern African ESA sites can now be dated, offering an unprecedented opportunity to investigate the evolution of this period. The creation of a robust chronological framework with associated lithic typology and biochronology is therefore of utmost importance for archaeological, paleoanthropological, paleontological and paleoclimatological research. Wonderwerk Cave, which serves as the focus of this paper, is a key site for southern Africa as it has the potential to provide a chronological scaffold for the ESA in this region.

Wonderwerk Cave - Background

Wonderwerk Cave, located in the Northern Cape Province of South Africa between the towns of Danielskuil and Kuruman (Fig. 1), is one of the most spectacular cave sites in southern Africa, yielding an impressive and well-preserved occupational sequences from the ESA through to the Later Stone Age (LSA). The cave is over 140 metres long, extending into the eastern flank of the dolomite beds of the Kuruman Hills. It was first excavated by B.D. Malan in the 1940's (Malan and Cooke 1941; Malan and Wells 1943) followed by Peabody in 1948 (Camp 1948). Between 1974 and 1977 Karl Butzer examined material from Malan's excavations and undertook a geomorphological examination of the sections standing at that time (Butzer et al. 1978; Butzer 1984a, b). Intensive excavation was only begun in 1978 by Peter Beaumont of the McGregor Museum (Beaumont 1982, 1990), joined in 1979 by Anne and Francis Thackeray who analysed the LSA lithic and faunal assemblages respectively (Beaumont 1982, 1990, 2004, Beaumont and Vogel 2006; Binneman and Beaumont 1992; Humphreys and Thackeray 1983, Thackeray et al. 1981; Thackeray 1984). Altogether 7 different excavation areas (numbered 1 through 7) were investigated by, Beaumont and colleagues until 1993 (Fig. 2).

Excavations carried out to date in the cave have documented the presence of LSA, Middle Stone Age (MSA), and ESA deposits. The LSA occupants of the cave were also

responsible for rock paintings on the cave walls adjacent to the entrance, as well as engraved stones recovered during the excavations dating from 4,000 to 10,000 BP (Thackeray et al. 1981). Another significant aspect of the Wonderwerk Cave is the superb preservation of organic remains, both faunal and botanical, throughout the sequence (Scott et al. 1995; Van Zinderen Bakker 1982; Thackeray and Brink 2004, Beaumont and Vogel 2006). Possible evidence for management of fire is the presence of fire-shattered stones, ash and burnt bones in the ESA levels of the cave (Beaumont 1990; Beaumont and Vogel 2006).

Throughout the cave there is evidence for ESA as well as sporadic, low density Middle Stone Age (MSA) occupations extending to the rear wall of the cave. The archaeological remains in the middle of the cave are relatively sparse. Here the upper levels are characterized either by extensive ash deposits or dense mats of vegetation.

In the back of the cave, Excavation 6 (Fig. 2), the deposits yielded a Fauresmith lithic assemblage, comprising both blades and handaxes, as well as typologically Levallois points. Of special interest is the nature of this occupation since Excavation 6 receives very little light since it is over 100 meters from the cave mouth. Adding to the enigma of Excavation 6 is the nature of the archaeological material, which includes both flaked material and manuports. The latter include both ironstone slabs and quartz crystals, both of which are present in the area outside the cave and presumably were transported to the rear of the cave by hominins (Beaumont and Vogel 2006). The quartz crystals in the deposits range in size from very large crystals (ca. 10 cm. in length) to very small crystals, and include clusters of crystals. There is no evidence that the crystals were modified in any way. In contrast, many of the the ironstone slabs exhibit flaking while others show faint traces of incision (Fig. 3). Current research aims at determining whether these lines were intentionally incised or are the result of natural processes.

In 2004 a collaborative project was launched in order to provide an absolute chronology for the ESA deposits at Wonderwerk Cave based on the use of multiple dating methods (Paleomagnetism, Cosmogenic Isotopes, Uranium Series, Electron Spin Resonance, Optically Stimulated Luminescence) and to document and analyze the associated lithic, faunal and botanical remains from Beaumont's 1978-1993 excavations. This paper presents the preliminary findings from Excavation 1, located ca. 20 meters from the cave entrance (Fig. 2). In this excavation area, over 2 meters of ESA deposits were identified by Beaumont, overlain by LSA (Thackeray et al., 1981, Humphreys and Thackeray 1983, Thackeray1984, Beaumont and Vogel 2006).

Stratigraphy and Micromorphology

The excavation grid established by Malan in the 1940's, using square yards, was maintained by Beaumont in his subsequent excavations, however depth measurements for the new excavations were metric. Recovery of remains was good since all deposit was sieved using a 1mm mesh (with a 0.5 mm. mesh often placed on top). The retrieved material - organic and non-organic- was bagged with information on square, level and spit

recorded. These collections are now curated at the McGregor Museum (Kimberley, South Africa).

In Excavation 1, Beaumont identified eight ESA archaeological Strata 5-12, ~4 metres thick, overlain by ~3 metres of LSA deposits (Fig. 4). During the 2005 field season, we identified in the main north and east ESA stratigraphic sections in Excavation 1, nine lithostratigraphic units that show only a limited correspondence to the eight archaeological strata identified by Beaumont.

The ESA sediments in Excavation 1comprise soft, powdery, reddish brown bedded silt and sand with localized accumulations of roof spall. They are primarily due to aeolian sedimentation, with some input from the decomposition of the cave roof, introduced organic residues and local reworking by low energy water deposition - the latter is clearly evident in the bottom of the profile in Fig. 4. The role played by water is evident in erosional events are evident such as at the base of Lithostratigraphic Units 3 and the presence of fine laminated silts indicating sheet flow in Lithostratigraphic Unit 9, and by the presence of flowstone and a large speleothem near the cave entrance. There is however no evidence for high-energy water transport strong enough to carry stone artifacts or large bones into the cave.

Spalling of lithic artifacts due to heating to high temperatures is common above Stratum 12 and there is also evidence for burnt bone (Fig. 5). Currently no clearly defined hearths have been identified nor is there data available on the spatial distribution of burnt artifacts and bone. As a result claims for human control of fire during the Acheulian occupation of Wonderwerk remain tentative (but see Beaumont and Vogel 2006).

Samples for micromorphological analysis of sediments were collected from all units following the procedures outlined in Goldberg and Macphail (2003). Analysis of these samples is ongoing but preliminary observations on the samples from the two lowermost Lithostratigraphic Units 8 and 9 are presented here. These descriptions provide a clear sense of the distinctiveness of the basal Unit 9, while Units 8-1 more closely resemble each other.

Lithostratigraphic Unit 8 (Sample 9, Fig. 6): This consists predominately of quartz silt and numerous, rounded aggregates composed of clay and commonly with silt embedded within clay. These aggregates range from pale brown to bright red, with the latter being enriched in iron oxides such as haematite. Diagenesis is striking in the field by the presence or rounded millimeter sized pale yellow to white clusters composed of either carbonated apatite (yellower), or of mixtures of what appears to be opaline silica, aluminum with lesser amounts of potassium (confirmed by FTIR and SEM; F. Berna, personal communication). The latter appears similar to the phosphatized clay in Kebara and Hayonim Caves, Israel (Goldberg and Bar-Yosef 1998), although this awaits confirmation from further mineralogical analyses.

Lithostratigraphic Unit 9 (Sample 10A, Fig. 7): Overall this sediment is much 'fresher' than sample 9 derived from the overlying Unit 8, and diagenetic changes (e.g., phosphates,

silica) are rare to absent, although traces of partially dissolved calcite (microspar) can be found. The sediments below Lithostratigraphic Unit 8 are also redder and appear to contain more hematite within the clasts. Clasts of iron stone and fine quartzite are more prevalent but not abundant (~1-3%). Bedding of quartz silt and clay is prominent – both in the field and in thin section - especially in the upper part, and remnants of bedding and rip-up clasts can be seen throughout many of the slides from Lithostratigraphic Unit 9. Well rounded, quartz-rich soil-like aggregates are common. A few angular pieces of bone were also observed. It is clear that the basal complex of Lithostratigraphic Unit 9 differs from the overlying sediments that comprise compact fine sands.

These preliminary observations illustrate that the Wonderwerk Cave sediments are primarily of windblown origin and, despite diagenesis (exemplified by cementation by calcite and precipitation of nodules of phosphate and amorphous silica) as well as bioturbation (manifest as rodent burrows and erosional episodes) that are evident in the deposit, the microstratigraphy is well preserved in all Lithostratigraphic Units above Unit 9. There is however clear evidence for temporal breaks such that the rate of sediment accumulation within the Cave, although probably slow, cannot be considered as continuous.

Dating

For dating, sediment samples were taken from the freshly cleaned north and east ESA stratigraphic sections in Excavation 1. A paleomagnetic sequence based on 39 oriented samples revealed a series of magnetic normal and reversal events that we interpret, from top to botttom as follows:

Archaeological Strata 5-9: N> Brunhes normal chron (0-0.73 Ma)

Archaeological Stratum 10 Top : R> Matuyama Reverse chron (0.73-0.99 Ma). The R to N transition represents the transition from the Matuyama to the Brunhes chron, but not necessarily the Brunhes-Matuyama Boundary of 0.78 Ma (Baksi et al., 1992).

Archaeological Stratum 10: N> Jaramillo subchron (0.99-1.07-Ma)

Archaeological Stratum 11: R> base of the Jaramillo subchron dating to ~1.1 Ma.

Archaeological Stratum 12: N>top Olduvai subchron (~1.78-1.96 Ma).

This sequence constrains the sampled ESA section in Excavation 1 at Wonderwerk Cave to between ~0.73 to 1.96 Ma. (Ron et al. 2005; Chazan et al. in press).

A single OSL date on a sediment sample from Lithostratigraphic Unit 1 located at the top of the ESA sequence in Excavation 1 gave De values with an average value of 363±28 Gy, which is beyond the saturation values for quartz. Thus the calculated age of 256±21 ka should be considered as a minimum age for the top of the ESA in Excavation 1. This date

is corroborated by two U-series dates on stalagmites of >349ka and >350ka, from archaeological stratum 6 (Beaumont and Vogel 2006).

One cosmogenic date has been obtained for the base of the ESA deposits (archaeological stratum 12). Using a half life of 1.5 Ma an age of 2.0±0.15 Ma was obtained, while use of a shorter half life of 1.36 My (Niishizumi et al. 2007), gave an age of 2.26±0.17 Ma. When the standard deviations are taken into consideration, both ages correspond within 1σ with the Olduvai subchron, and as such place the base of the ESA at ~2 Ma. This corroborates our interpretation of the paleomagnetic chronostratigraphy.

Lithic Assemblage

Examination of the entire lithic assemblage from the ESA Archaeological Strata 9-12 in Excavation 1 was undertaken and completed concurrant with the dating. The results of this analysis demonstrate that lithic artifacts are found throughout the ESA sequence in Excavation 1 and are broadly distributed across this area but occur in very low densities (Fig. 8). This contrasts markedly with the dense deposits of archaeological material found in Southern African caves dating to the MSA that are associated with *Homo sapiens* (Deacon and Deacon 1999, Henshilwood et al. 2001, Klein 2000, Marean et al. 2007, Mitchell 2002; Soriano et al. 2007; Vila et al. 2005)

Raw material in all archaeological strata at Wonderwerk Cave is dominated by banded ironstone available immediately outside the cave entrance. Placing these assemblages within the ESA cultural systematics of Southern Africa is hampered by the small size of the Wonderwerk Cave ESA assemblage, the unusual raw material used (banded ironstone), and lack of clarity in the definition of ESA industries and their variants in the region. In publications on Wonderwerk, Beaumont (2004) and subsequently Beaumont and Vogel (2006), list archaeological Stratum 9 as Acheulean and Stratum 10 as Acheulean post-dating the Younger Vall Gravel assemblages according to the latest publication. Archaeological Strata 11-12 were both tentatively indentified as Acheulean. Following the preliminary paleomagnetic dates reported by our team (Ron et al. 2005), Beaumont has acknowledged that Stratum 12 (his Major Unit 9), "may reach back to Olduvai times" (Beaumont and Vogel 2006: 220).

The uppermost archaeological Strata 5-6 were identified by Beaumont (2004) as Late and Middle Fauresmith respectively; Stratum 7 was identified as possibly Fauresmith in the earlier publication and in the later publication as Middle Fauresmith (Beaumont and Vogel 2006: 220). Initially, archaeological Strata 8 was placed with the Acheulean Strata 9-10 but in the latest publication, it is identified as Early Fauresmith/ Late Acheulean (Beaumont and Vogel 2006).

The typical characteristics of the Fauresmith are the co-occurrence of small, broad bifaces, convergent (Levallois) points, prepared cores as well as large (long and narrow) flake-blades. Other distinctive features are low numbers of cleavers, the presence of retouched points, convex edged scrapers, burins and polyhedrals (Söhnge et al. 1937; Clark 1959;

Deacon and Deacon, 1999; Klein, 2000; Beaumont and Vogel 2006). Based on the characteristics of the flake assemblage from Excavation 1, there is little reason to attribute archaeological Strata 5-7 to the Fauresmith. In these Excavation 1 assemblages, there is little evidence for prepared core technology and no evidence of either Levallois flake or large flake-blade production both considered characteristic of the Fauresmith. However, preliminary analysis has shown that both these features are d in other excavated areas within the cave, particularly in Excavation 6 located at the back of the cave (Fig. 2).

Long-term trends in biface morphology are not immediately apparent in the metric analysis of the bifaces from archaeological Strata 5-11 in Excavation 1 (Figs. 9). Although there are some small handaxes in the upper strata (Fig. 9:1) there are no clear trends in the length of bifaces, which contradicts the attribution of the upper strata as Fauresmith on the basis of biface size (Fig.9a). The ratio of B1 (biface breadth 1/5 of the length from the tip) to B2 (breadth 1/5 of the length from the tip) shows wide variation in all strata (Fig. 9b). With one exception, all bifaces in archaeological Stratum 9 show a low ratio of B1/B2 indicating the absence of pointed forms. The same is true for the small sample from archaeological Stratum 11. The ratio of L1 (biface length from the base to the point of maximum breadth) also shows considerable variation within each statum (Fig. 9c).

There appears to be a slight increase in biface thickness beginning in archaeological Stratum 9 (Figure 9d). This supports the general observation that bifaces from below Stratum 8 are less refined then those found above it. Further support for this observation is evident in the clear trend in the ratio between biface length and thickness (Fig. 9e). In this feature there is a clear distinction between archaeological Strata 9 to 11 and the overlying Strata 8 to 5, with the lower units showing a near complete absence of bifaces with a high ratio of length to breadth. Although a diachronic increase in biface breadth has been reported for other South African ESA sites e.g. Cave of Hearths (Mason 1962) and Rooidam (Fock 1968) the implication of this trend needs to be further investigated in relation to raw material, function and chronology. Ongoing research on the lithic assemblage from the Excavation 1 sequence at Wonderwerk is aimed at investigating other trends using more complex attributes such as biface symmetry (McNabb et al. 2004). Figures 10-11 present photographs of three bifaces each from Strata 5-10. These photographs give a sense of the high degree of variability in shape and size of handaxes within each level and the need for more detailed morphological analysis. Although there appears to be a falloff in symmetry of bifaces beginning in Stratum 9 at least one highly symmetrical handaxe is found in Level 10 (Fig. 10: 7). In Stratum 11 there are no symmetrical handaxes (Fig. 12).

In general terms, in the upper archaeological Strata (5-11) of Excavation 1, the character of the lithic assemblages correlates well with the Acheulean (mode 2) with bifaces the dominant tool type but few cores or flakes and no evidence for prepared core techniques. It is important to emphasize that aspects of the Acheulean, such as Victoria West technology and cleavers, which are characteristic of many sites in South Africa, including the Vaal River sites ('Vaal River, Upper Gravels'), are absent from the Wonderwerk assemblage (Klein 2000, McNabb 2001, Mitchell 2002, Sharon and Beaumont 2006).

This characteristic of the Wonderwerk Acheulean may reflect constraints imposed by the raw material most commonly used.

Following the most likely dating scenario, archaeological Stratum 11 at Wonderwerk is coeval with the onset of the Acheulean in East African dated to ~1.6 (Asfaw et al. 1992), as well as with the flake-based Early Acheulean industry of Sterkfontein estimated as ~1.4-1.7 Ma (Kuman and Clark 2000). It is important to emphasize that the Stratum 11 assemblage included only two crudely assymetrical bifaces.

The lowermost 0.4m of the Excavation 1 section, comprising archaeological Stratum 12, displays a normal polarity and has been dated using both magnetostratigraphic and cosmogenic methods to the top of the Olduvai subchron ~1.78-1.9 Ma. Although further cosmogenic dates are needed to corroborate this date, the fact that the two independent dating methods tally so well, lends credence to the results. Furthermore, the associated lithic assemblage from Stratum 12 offers some potentially corroborative insights.

The lithic assemblage from Stratum 12 is small: two cores and 28 very small flakes (<2.5 cm. in maximum dimension) (Figs. 12, 13). The dominance of very small flakes and absence of bifaces does however recall the Oldowan of other Southern Africa sites such as from Members 1-3 at Swartkrans, thought to date to ~1.8-1.0 Ma (Brain and Watson 1992), and Member 5 at Sterkfontein estimated as dating to between 1.7 and 2 million years (Kuman 1994a, b; (Clark 1993, Kuman and Clark 2000). It is interesting that the dominance of small flakes in the Sterkfontein assemblage has been interpreted as evidence that the assemblage was not in primary context. Given the micro-stratigraphic interpretation of the depositional context at Wonderwerk, such a scenario is not tenable. Oldowan assemblages that are dominated by small flakes include Omo 57 and Omo 123 (de la Torre 2004) as well as several Lower Paleolithic sites in Europe and the Middle East (Burdukiewicz and Ronen 2003). If the cosmogenic and paleomagnetic dates are substantiated by our subsequent research, then Wonderwerk Cave is one of the few southern African sites where the shift from the Olduwan to the Acheulean is documented thus offering evidence of early hominin exploitation of caves.

Faunal Remains

Throughout the ESA sequence in Excavation 1, both micro and macro-faunal remains were found in close association with the lithic artifacts. Many of the bones are burnt. The Acheulean fauna exhibits extensive porcupine and carnivore damage, complicating identification of the agents responsible for their accumulation.

As illustrated by Avery (1995, 2006), the microfaunal assemblage from the Pleistocene levels at Wonderwerk is relatively rich, and initial impressions are that the ESA occupation was characterized by an arid savanna vegetation which varied in degrees of openness, with waterside taxa declining in frequency over time. Preliminary identification of macrofauna from the Acheulean through MSA levels (Malan and Wells 1943, Klein 1988, Thackeray and Brink 2004) indicate the presence of several extinct species including two equids- *Hipparion* sp. and the Cape horse (*Equus capensis*), two alcelaphines- *Megalotragus*

priscus and *Damaliscus niro*, as well as the long-horned buffalo *Pelorovis antiquus*. It is important to note that faunal remains are present in the lowest archaeological stratum at the site- archaeological Stratum 12. Preliminary research indicates that equids dominate the basal assemblages while micro-fauna identified from Archaeological Stratum 12 include the gerbil *Tatera* and a macroscelidid elephant shrew.

Due to the long sequence represented in the cave and presence of speleotherms, Wonderwerk offers an excellent laboratory for the study of paleoclimatic change. Studies published to date on the LSA levels include isotopic analysis of fauna (Thackeray and Lee-Thorp 1992), pollen (van Zindren Bakker 1982, Scott et al. 1995, Brooks and Scott in press) and microfauna (Avery 1981). We are now extending these studies to the ESA levels. Preliminary paleoenvironmental findings based on the analysis of microfauna from the ESA levels (Avery 1995) indicate increasing aridity over time.

Conclusion

Wonderwerk Cave is an exciting and unique site which promises to provide the crucial radiometric, lithic typological and biochronological framework currently lacking for the ESA of southern Africa. It will also continue to contribute valuable information on the paleoclimate of the interior of southern Africa, in addition to insights into early symbolic behaviour and the management of fire. Most importantly, it may represent the earliest intentional use of a cave by early hominins.

For all these reasons, we see the preservation and development of the site as a cultural resource as an integral part of the archaeological research at Wonderwerk Cave. Site development and management is being addressed in coordination with the McGregor Museum, the South African Heritage Resources Agency and local municipalities. Together we face the challenge of unraveling what Wonderwerk Cave can tell us about the prehistory of southern Africa, how to make the site accessible to those who wish to visit it and how best to preserve it as a unique historical resource for future generations.

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List of Figures

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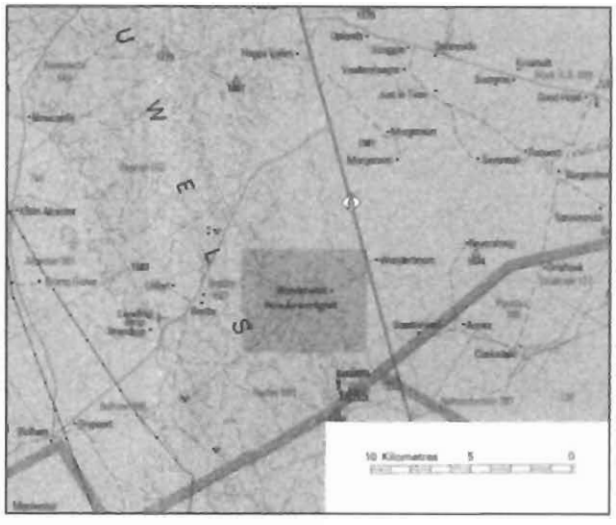
12: Cores and flakes from Wonderwerk Excavation 1. 1: Transversal scraper, Stratum 7; 2: Dejete scraper, Stratum 7; 3: Unretouched flake, Stratum 9; 4: Bifacial core, Stratum 9; 5: Transversal scraper, Stratum 10; 6: Chopper/core, Stratum 10.

13. Lithic artifacts from Wonderwerk Cave Excavation 1 Strata 11-12. 1-2: Bifaces from Stratum 11, 3-4: Small flakes from Stratum 12. Dorsal face on left, ventral face on right, 5: Core from Stratum 12. Scale 3 cm.

12. Scatterplot of length versus width for flakes from Excavation 1, Archaeological Stratum 12

A



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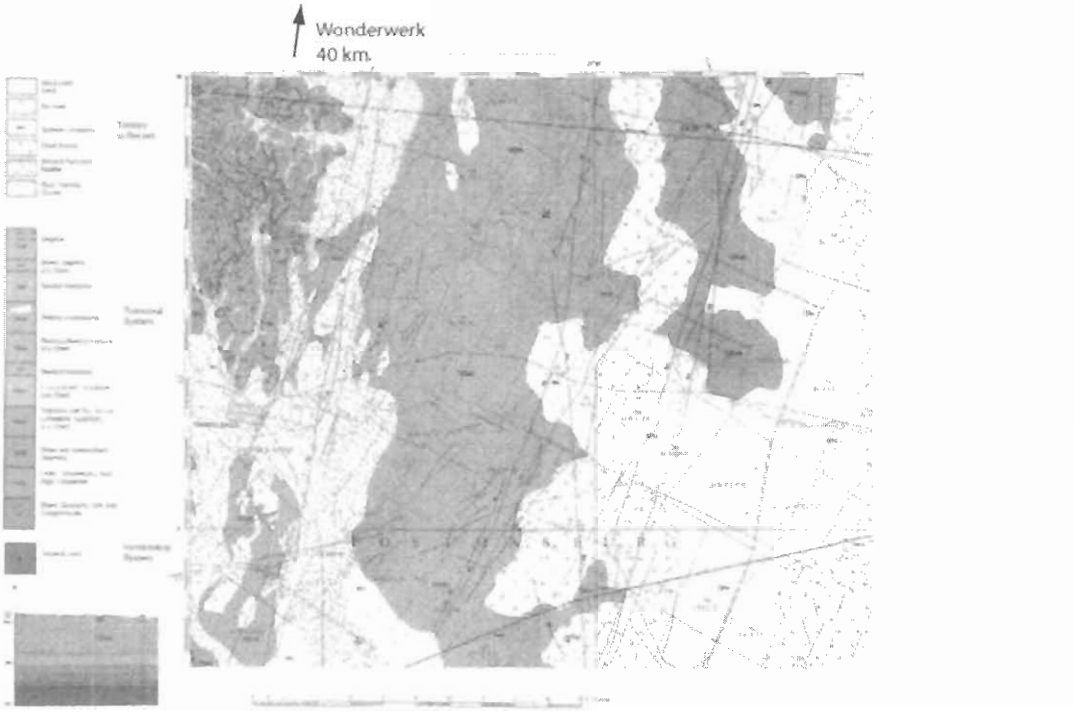

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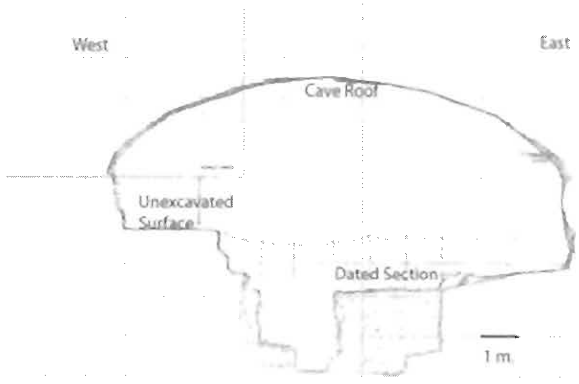
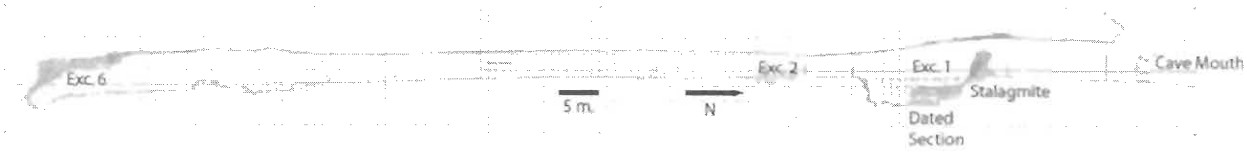
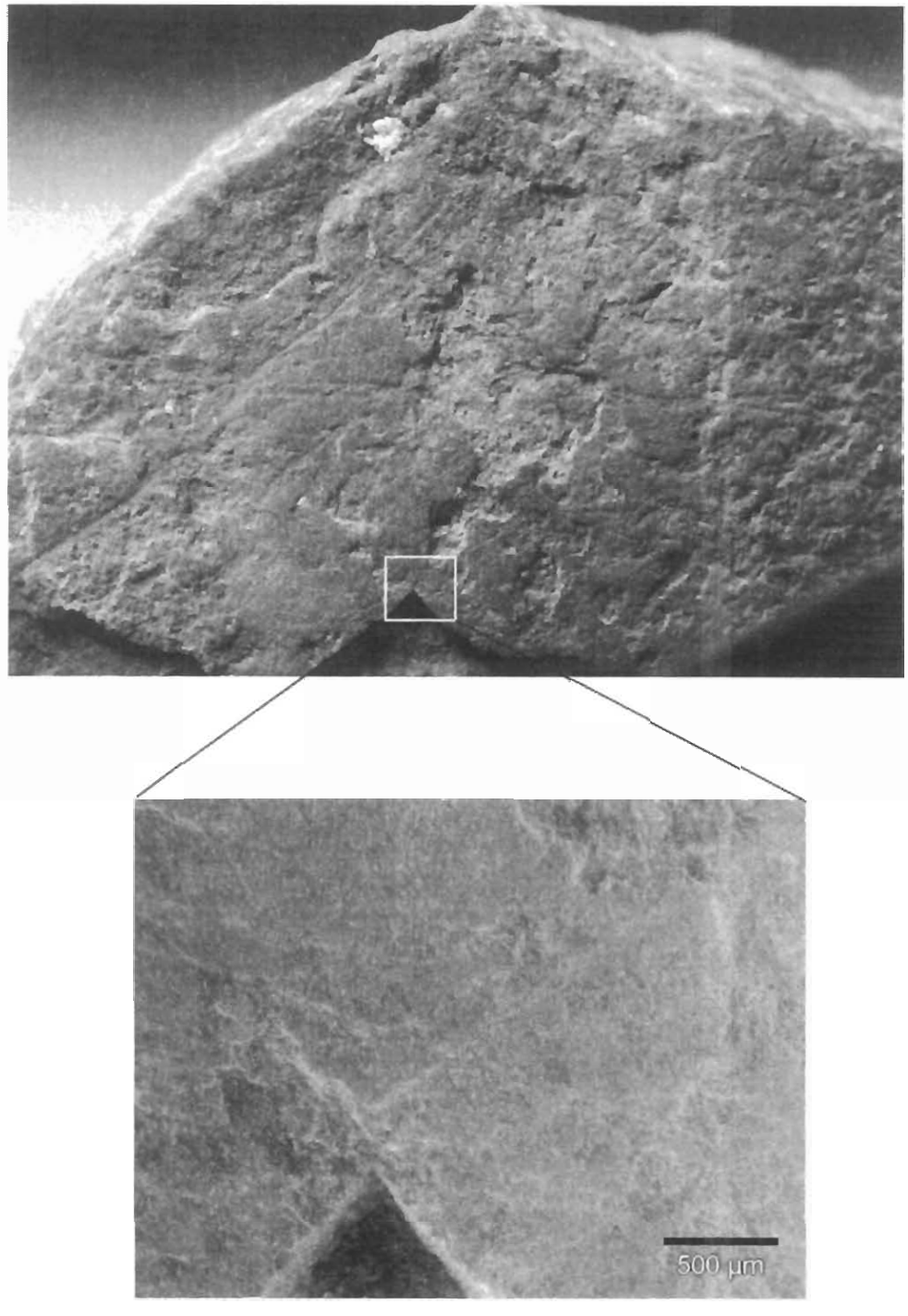
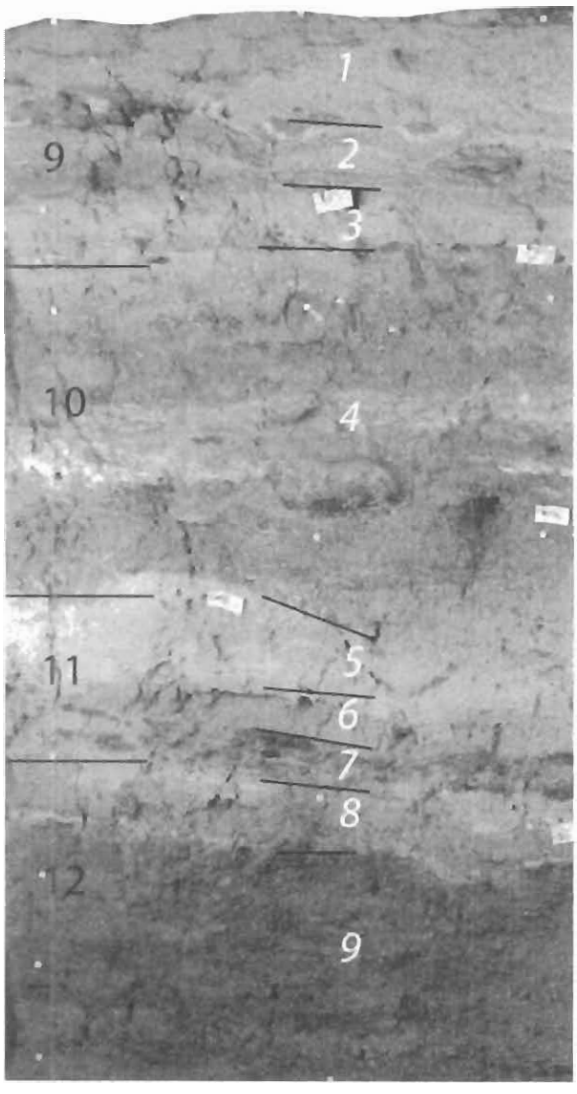

West
East
Cave Roof
Unexcavated
Surface
Dated Section
1 m.

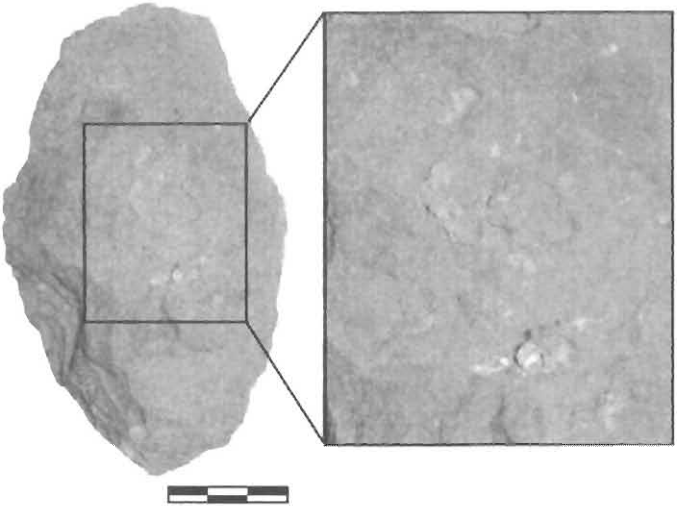
A


Exc. 6
5 m.
N
Exc. 2
Exc. 1
Stalagmite
Cave Mouth
Dated
Section

B


500 µm


Arch.
Strata
Lithostratigraphic
Units
1
2
3
4
5
6
7
8
9
9
10
11
12



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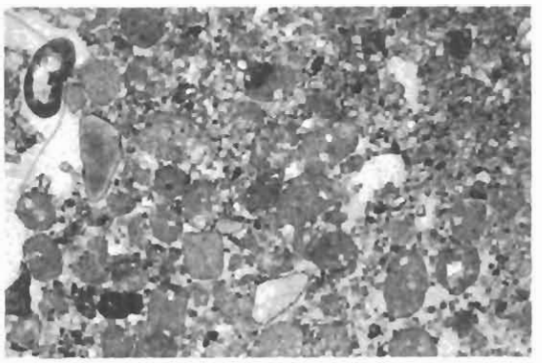

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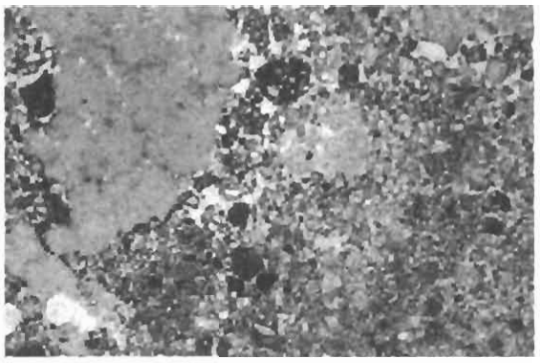

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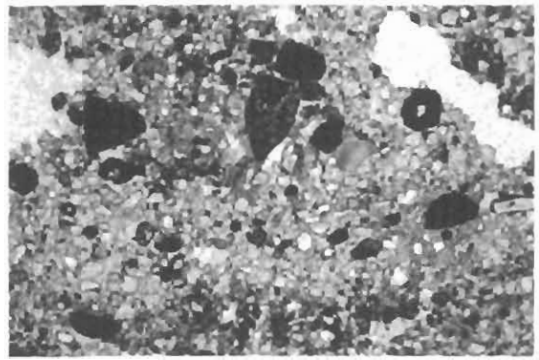

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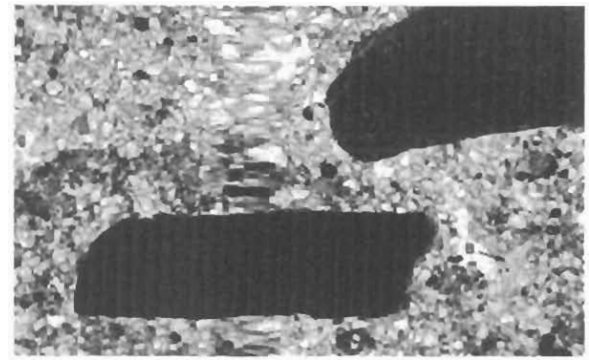

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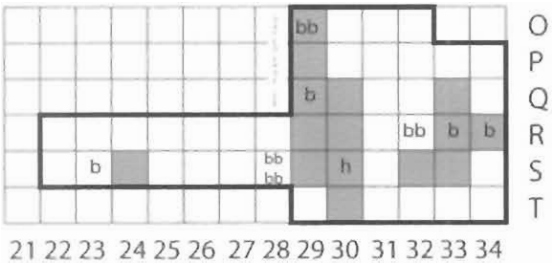
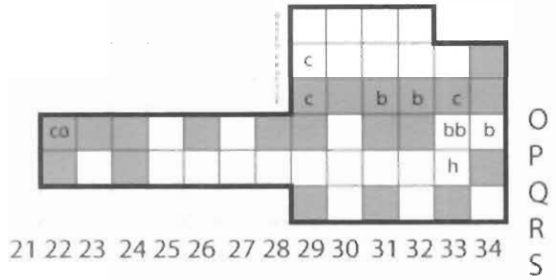


Level 9



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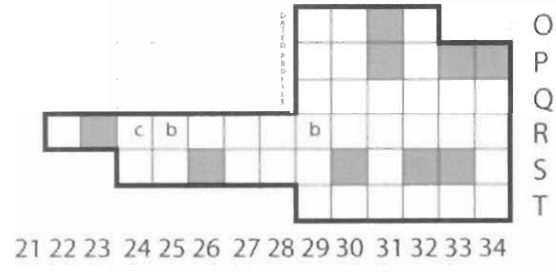
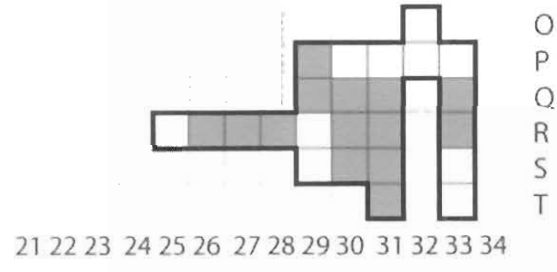


Layer 11



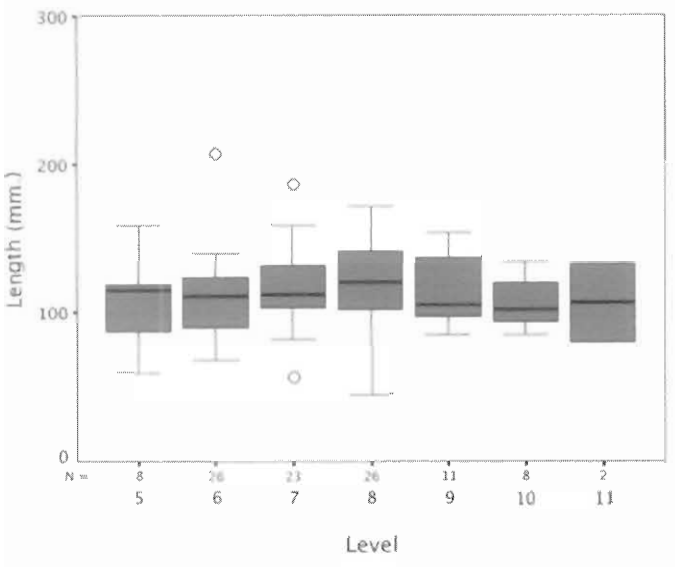
Layer 12

c Chopper
b Biface
co Core

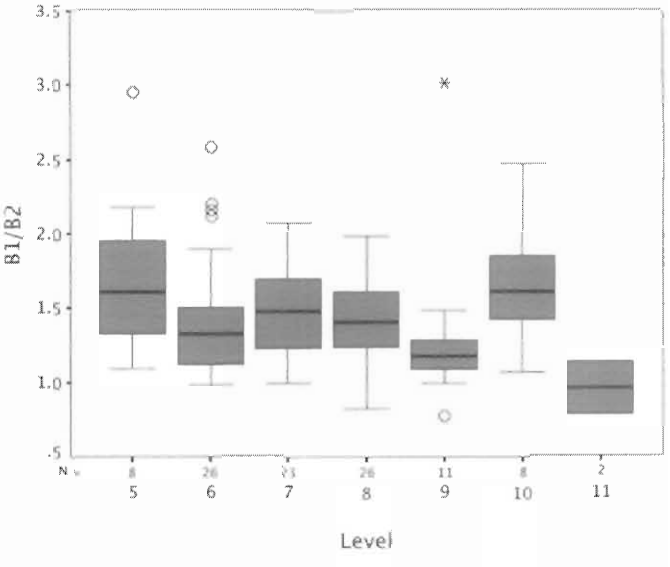
Cave Mouth

1 yard

Shaded Squares Indicate One or More Flakes
Heavy Black Line Indicates Limit of Excavation


Length (mm)
300
200
100
0
N =
8
26
23
26
11
8
2
5
6
7
8
9
10
11
Level

A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3.0
2.5
2.0
1.5
1.0
.5
N =
8
26
23
26
11
8
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6
7
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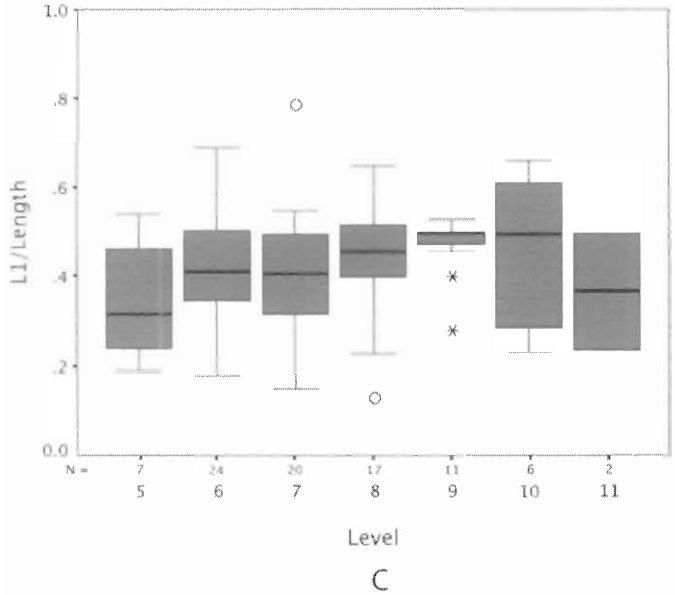
9
10
11
Level

B


L1/Length
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20
17
11
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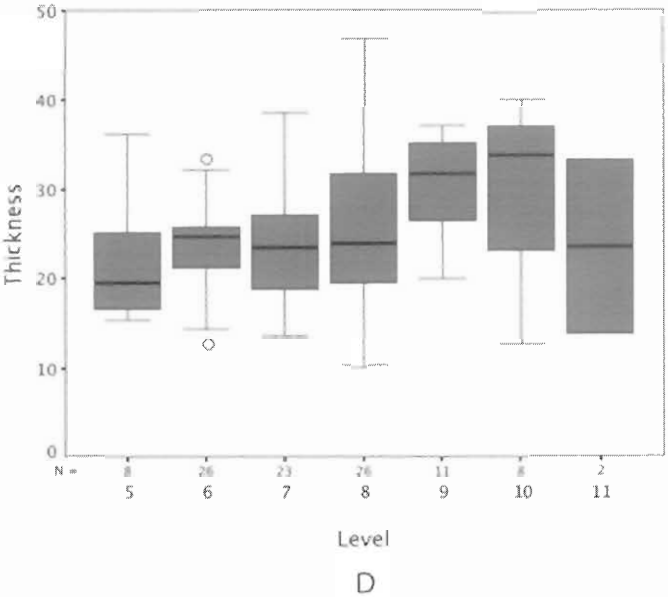
2
5
6
7
8
9
10
11
Level

C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23
26
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8
2
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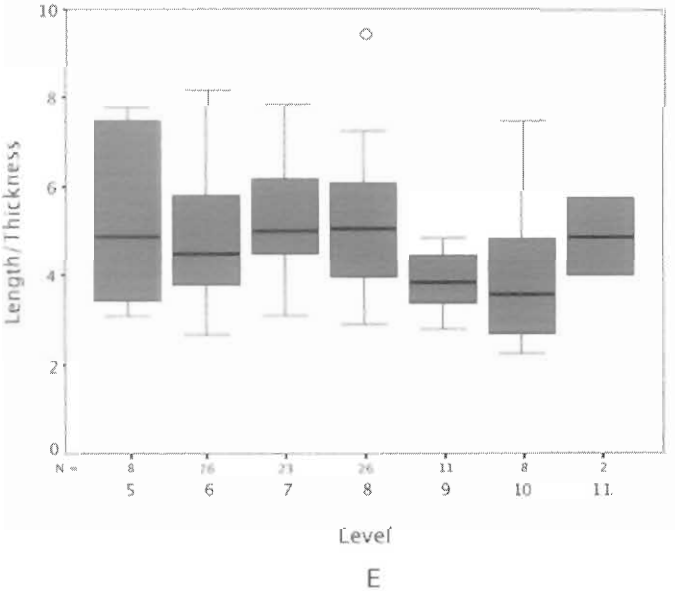
10
11
Level

D


Length/Thickness
10
8
6
4
2
0
N =
8
26
23
26
11
8
2
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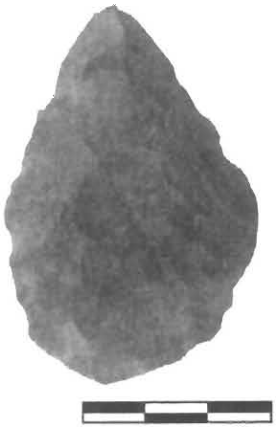
6
7
8
9
10
11
Level

E



1

2

3

4

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1

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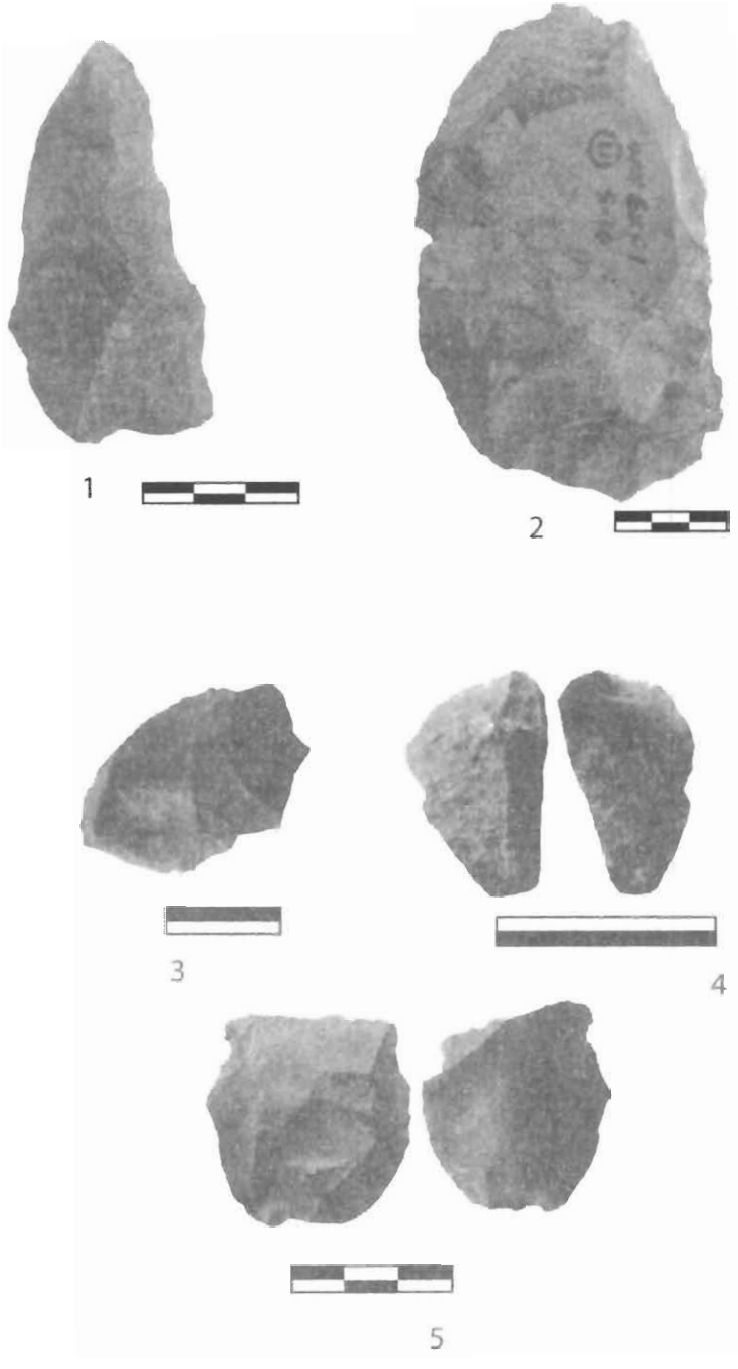
9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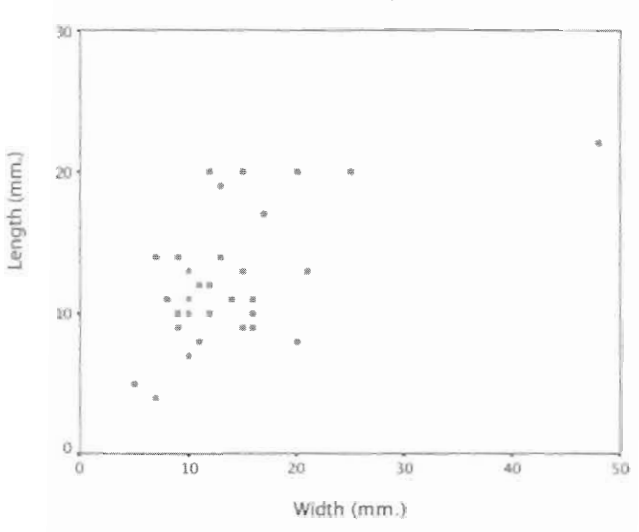
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Width (mm.)