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# Palaeoenvironments and Cultural Sequence of the Florisbad Middle Stone Age Hominid Site, South Africa

Kathleen Kuman*

*Department of Archaeology, University of the Witwatersand, Wits 2050, Johannesburg, South Africa*

Moshe Inbar

*Department of Geography, University of Haifa, Haifa 31999, Israel*

R. J. Clarke

*Institut für Anthropologie und Humangenetik, Johann Wolfgang Goethe-Universität, Frankfurt am Main, Germany, and Sterkfontein Research Unit, Department of Anatomical Sciences, Medical School, University of the Witwatersrand, Johannesburg 2193, South Africa*

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Florisbad, an open-air spring site with 7 m of strata, has yielded the type assemblage of Middle Stone Age (MSA) fauna, the cranium of an archaic hominid in 1932 and an extensive sequence of MSA artefacts in the 1980s. The cultural assemblages include an early MSA dated broadly to 279,000 ± 47,000 years, a highly retouched form of MSA at 157,000 ± 21,000 years and a minimally retouched, expedient MSA assemblage from a series of occupation horizons at 121,000 ± 6000 years. The latter represents multiple brief visits to a hunting and butchery site on the edge of an active spring pool, where periodic sedimentation gently buried occupation debris in a near-pristine context. Periods of lower spring discharge are represented by organic horizons as swampy vegetation encroached on the springs, while periods of higher spring discharge created pools. Overall the spring sequence indicates low-energy subaqueous environments similar to lakes, ponds or backwater sites. The sequence is characterized by fine sands, silts and clays responsible for the good archaeological preservation.

*Keywords:* FLORISBAD, MIDDLE STONE AGE, ARCHAIC *HOMO SAPIENS*, *HOMO HELMEI*, PALAEOENVIRONMENTS, PLEISTOCENE, FLORISIAN LAND MAMMAL AGE.

## Introduction

In 1981, the National Museum in Bloemfontein (South Africa) began a new series of excavations at the historically important Middle Stone Age spring mound site of Florisbad (Figure 1). The springs were discovered in 1912 as an important palaeontological site (Broom, 1913) and collections of fauna and artefacts were made in 1917, 1926 and 1928 (Dreyer & Lyle, 1931; Hoffman, 1955). In 1932, a large-scale effort by T.F. Dreyer opened up a number of spring vent deposits and uncovered not only many fossils and artefacts of the Middle Stone Age (MSA), but also a hominid cranium and associated tooth (Dreyer, 1935, 1938; Rightmire, 1978; Clarke, 1985). The historical significance of the fauna from this site (Hoffman, 1953; Ewer, 1957, 1962; Hooijer, 1958; Wells, 1962, 1967; Cooke, 1963, 1967) resulted in recognition of the Florisian Land Mammal Age. This period includes species characteristic of MSA fossil assemblages younger than at least 130,000 but perhaps 400,000 years, persisting until the Holocene (Hendey, 1974*a*, *b*; Klein, 1984).

The slightly saline warm springs emerging at Florisbad have a temperature of *c.* 29°C and emit gases containing 70% methane and 10% hydrogen (Rindl, 1915). A cluster of spring eyes at the site runs in a west–north-west line and spring mound deposits consisting of clays, silts and sands up to 12 m thick occur adjacent to the site. Seven meters of stratified deposits occur within the excavation and overlie bedrock of dolerite at the Great Western Eye (Figure 2) and Ecca shale in the Main Excavation (Figure 3). At Florisbad

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*For correspondence at: Dept. of Archaeology, Univ. of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa. Fax: (011) 339–1620; E-mail: 107Kath@Cosmos.Wits.ac.za

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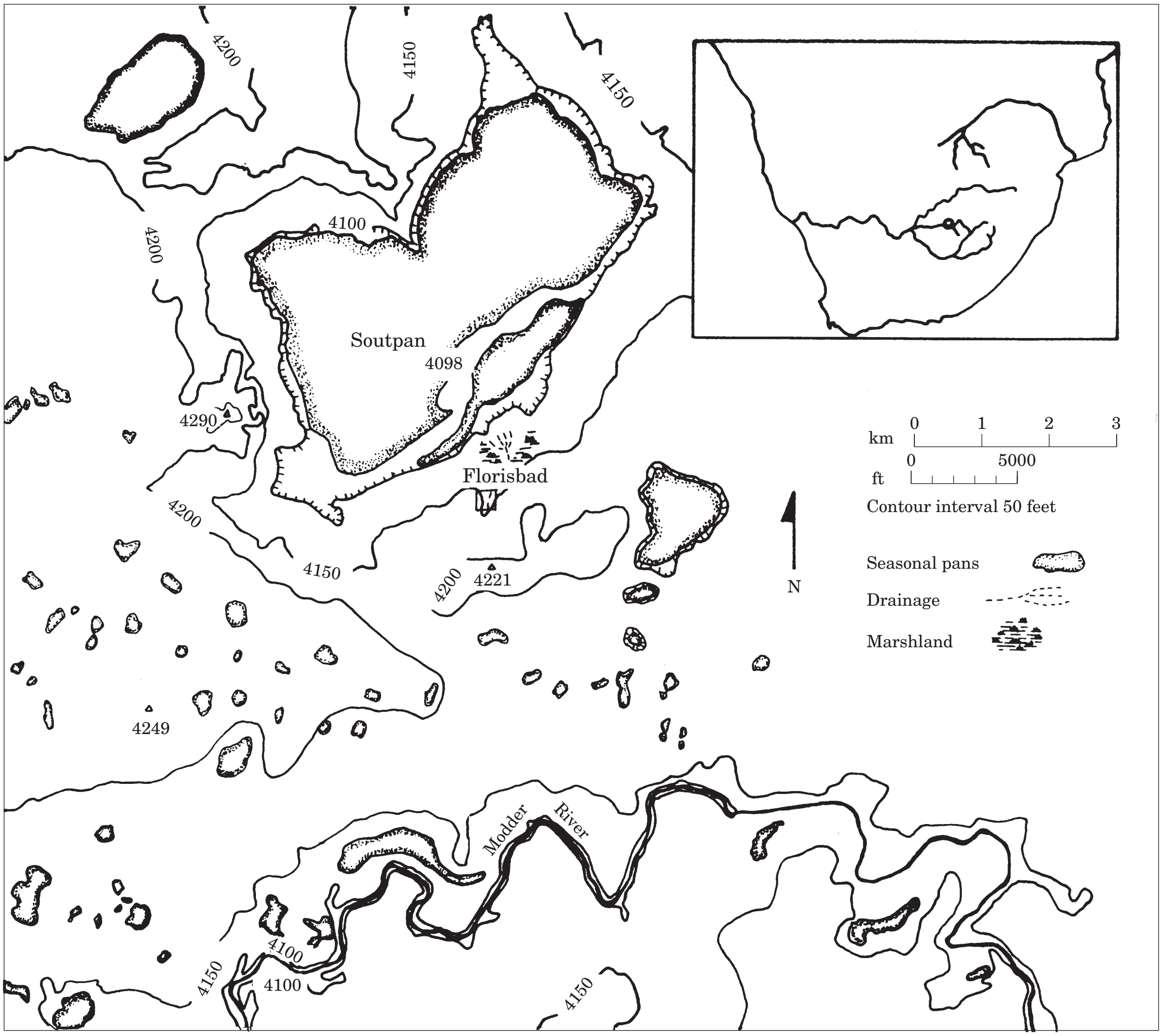

Figure 1. Location of Florisbad (28°46′S, 26°04′E), south-east of the Soutpan lake.

and other locations in the region, such springs emerge at points where intrusions of dolerite have created fissures in the shale. Figure 2 also shows a section through part of one spring vent, the Great Western Eye. Although the base of the spring eye is not seen in this section, the profile clearly illustrates the disturbance which erupting springs cause to overlying stratified deposits. Sand pipes and disturbed sands overlie the eye and preserve exploded blocks of peats and clays.

The dating of Florisbad has long been problematic, with attempts at both uranium series and thermoluminescence methods proving unsuccessful (Kuman, 1989: 30; Joubert, 1990). Recently, however, values have been reported with electron spin resonance (ESR) dating of tooth enamel and optically stimulated luminescence (OSL) dating of sediments (Grun *et al.*, 1996). The hominid tooth was thus broadly dated at 259,000 ± 35,000 years, while the earliest layer gave a value of 279,000 ± 47,000 years. Tooth enamel from disturbed spring-vent deposits produced a range from 100,000 to 300,000 years. Even given their wide range of error, these ESR–OSL dates provide a better appreciation of the true antiquity of the site and support the suggestion that the basal units contain an early phase of the MSA (Kuman, 1989). Although the hominid cranium has in the past been referred to archaic *Homo sapiens* (Clarke, 1985; Kuman & Clarke, 1986), recent research demonstrating specific separation of Neanderthals from *sapiens* (Schwartz & Tattersall, 1996; and see Krings *et al.*, 1997) serves as a caution against placing the Florisbad hominid into *Homo sapiens*. It could be close to a species distinct from *Homo sapiens*, such as *H. rhodesiensis*. As only

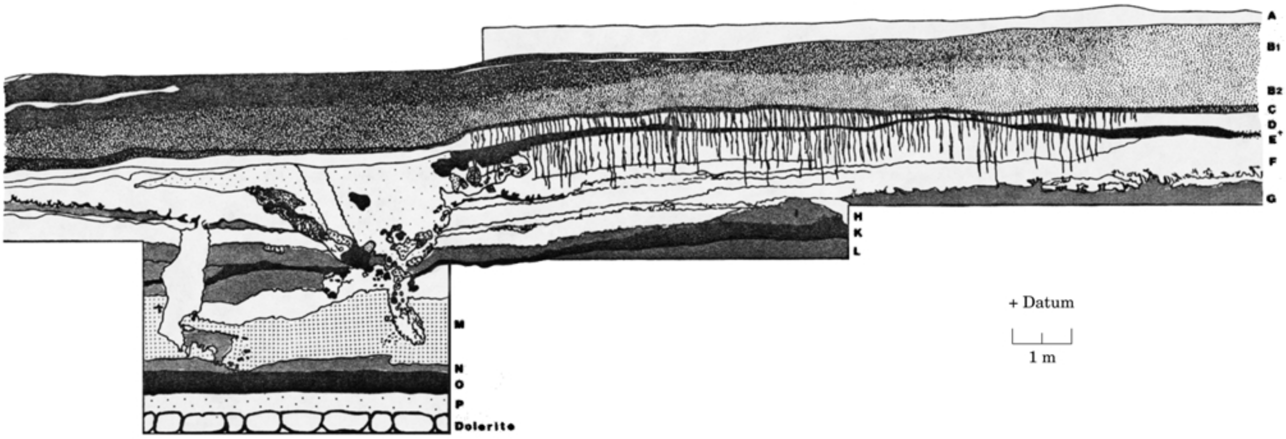

Figure 2. A west wall profile of the Florisbad excavation at the Great Western Eye, beginning at 1·15 m north of datum point and running northwards towards the Main Excavation. Horizontal and vertical scales are the same. Letters correlate with the units in Figure 3: B & C are the Holocene levels; D represents a cultural hiatus which may relate to the Last Glacial Maximum; E–P are Pleistocene MSA Units. The Holocene levels show how thick peaty sediments at the spring gradually change to silty and clayey sands away from the spring eye (+Datum=vertical datum line).

part of the calotte and face is preserved, there is insufficient basis for assigning it to any particular species and perhaps it should for the moment be left as *Homo helmei* (Dreyer, 1935).

The purpose of this paper is to set on record the archaeological findings and palaeoenvironmental analysis of work directed by R. J. C. between 1981 and 1984, which focused on the taphonomic history of the site and the cultural sequence contained in 7 m of deposits adjacent to and north of the western spring vent which yielded the hominid (Kuman & Clarke, 1986; Brink, 1987; Kuman, 1989). In the ensuing years, excavations by the National Museum have continued. Three more test pits have been sunk to bedrock and the important occupation horizons have been opened over a much larger area to retrieve spatial information (Henderson, 1995, 1996; Brink, Henderson & Rossouw, 1996), but the cultural sequence presented here has not altered. In addition, we present sedimentological evidence for palaeoenvironmental reconstruction, which can now be put into the context of recently published research on the regional geomorphology.

## Palaeogeographical Setting

The regional geology and the geomorphology of the Florisbad deposits have been described by Grobler & Loock (1988*a*, *b*) and Loock & Grobler (1988). Through extensive mapping, they demonstrated the existence of a large palaeodrainage system north, north-east and west of Florisbad, which today is evident as numerous pans associated with deflation hollows, aeolian sands and calcretized terraces and pan dunes. Grobler & Loock concluded that the genesis of the Florisbad spring mound is closely linked to Soutpan, a massive pan north of Florisbad which owes its large size and shape to the confluence of three streams. They also argued that the spring mound is a largely aeolian deposit situated in a lunette-shaped dune downwind of Soutpan. Because the prevailing wind direction is from the north-west, dunes in this region form on the south-eastern sides of pans through deflation of pan sediments during dry phases.

At the excavation site, the Florisbad mound consists of 7 m of sands intercalated with silts, clays and organic layers referred to loosely as peats (Figure 3). This alternation of fine sediments with organic horizons was a response to large-scale shifts in climate and moisture during the Pleistocene. Butzer (1984*a*, *b*, 1988) argues that the spring flow has been determined by discharge from a deep-seated regional aquifer which responds in a complex fashion to long-term fluctuations in the water supply. As groundwater travelling along Karoo shales rose to the surface at dolerite intrusions in the shale, periods of higher discharge created sandy pools at the springs. During periods of lower discharge, peaty horizons developed as swampy vegetation encroached on the less active springs. The various peats consist of multiple soils which formed under semi- and subaquatic environments. They became submerged in periods of more active spring discharge and subsequently were buried by ensuing cyclical spring sediments (Butzer, 1984*a*, *b*, 1988). Some researchers have suggested that a Soutpan palaeolake complex may have enlarged to more than twice its present size during humid phases; during arid phases, dense vegetation at the springs was accompanied by pedogenesis, but at the lake shore, carbonate formation occurred and evaporation increased the mineral content of the lake water (Joubert & Visser, 1991; Visser & Joubert, 1991).

| Unit | Terms used historically | Sample | Sediment description | Thickness | Artefactual finds |
|---|---|---|---|---|---|
| A | | | Road rubble | 15–40 cm | |
| Upper B | | T | Cream-coloured silty sand | 15 cm | |
| (upper Peat IV) | Peat IV | S | Pale greyish-yellow silty sand | 15 cm | Sporadic LSA artefacts $N=26$ |
| | | R | Yellow silty sand | 15 cm | |
| | | Q | Pale grey clayey sand and silt | 20 cm | |
| | | P | Grey silty sand | 15 cm | |
| Lower B | Yellowish Sand (1932) | O | Yellowish-grey clayey silt and sand | 20 cm | LSA $N=176$ |
| (lower Peat IV) | Hard Yellowish Ground (1952) | N | Pale yellow silty sand | *c.* 22 cm | |
| C | | MM | Cream-coloured clayey sand and silt with roots | *c.* 18 cm | |
| | | M | Pale brown silty sand with roots (paleosol) | 5–30 cm | |
| D | | L | Cream-coloured silty sand with roots | 5–40 cm | |
| E | Peat III | K | Organic silty sand with roots | 5–50 cm | Decayed MSA artefacts $N=116$ |
| | | J3 | White to pale brown fine sand | *c.* 10 cm | J3–2: $N=51$<br>Decayed MSA |
| F | Grey Sand | J2 | White to pale brown fine to medium sand, cross-bedded | *c.* 20 cm | |
| | | J1 | White to pale brown fine to medium sand | 15–60 cm | J1: $N=1654$<br>*MSA occupation* |
| G | Ash-Grey Sand resulting from organic matter (1952) | II | Black "flame"-structured organic silty sand | 5–35 cm | Occasional finds of F rest on or in surface of G |
| H | | not in present profile | White sands, 2 to 4 layers | 30–75 cm | MSA $N=55$ |
| I | | I | Dark grey organic sand and silt | 10–65 cm | MSA $N=73$ |
| J | | H | White silt and sand | 10 cm | |
| | | G | Dark organic sand and silt | 20 cm | |
| K | Peat II | F | White clayey silt and sand | 10 cm | MSA $N=66$ |
| | | E | Dark organic sand and silt | 10 cm | |
| L | | EE | Grey organic sand and silt | 15–80 cm | MSA $N=54$ |
| M | Green Sand (1932)<br>Blue-Green Clay and Loam (1952) | D | Yellow silty sand with roots | 75–115 cm | MSA $N=120$ |
| N | Peat I | CC | Grey organic silty sand | 10–30 cm | MSA |
| O | | C | Black organic silty sand | 35–60 cm | $N=22$ |
| | Blue Ground (1932) | B | Grey-green sandy silt with some roots | 30–55 cm | MSA |
| P | Brown-Yellow Sand underlain by a Basal Peat and Blue Ground (1952) | A | Green sand silt with roots | 80 cm | $N=15$ |
| Bedrock | | | Shale | | |

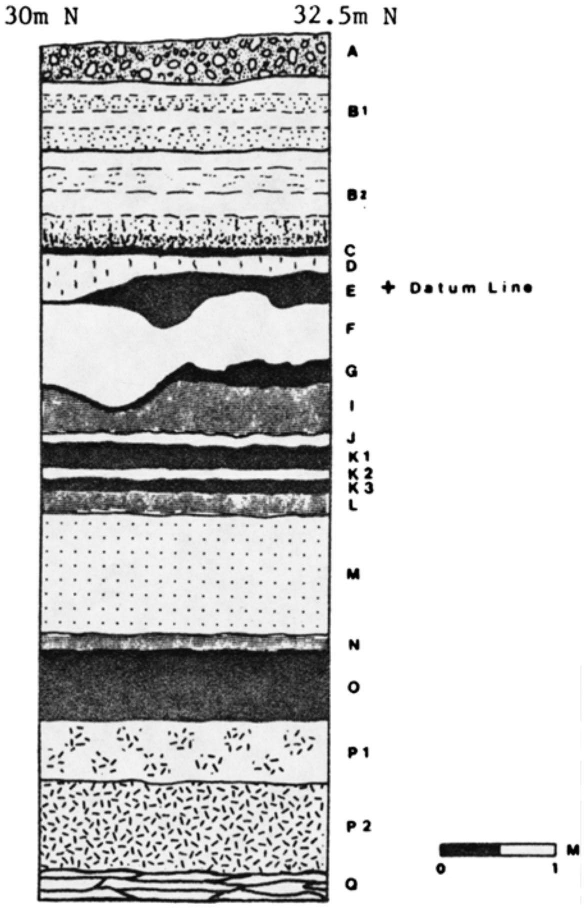

Figure 3. Stratigraphical units and corresponding profile from the deep trench in the Main Excavation (at 30 m north of datum point). The stratigraphical units identified in the 1980s (Column 1) are matched with the terms used by earlier excavators (Column 2). Sedimentological analysis has been performed on samples from stratigraphical subunits (Columns 3–5). The artefact assemblages (Column 6) show a lengthy sequence of MSA in the mid-to upper Pleistocene units and LSA in the Holocene Units. Horizontal and vertical scales are the same.

During periods of the Pleistocene when the water table was high, Florisbad and other springs in the region would have created a lush landscape with pools and streams which connected with the larger palaeodrainage system and with Soutpan. Therefore, the Florisbad spring would have fed its own pools, but at times these may have merged with the Soutpan palaeolake and the larger palaeodrainage system. The revised palynology of Van Zinderen Bakker (1988, 1989, 1995) concludes that during wet phases grasses were dominant, with a lush palaeolake habitat surrounded by semi-desert or treeless grassland. During drier phases, the palaeolake became brackish and its margins were colonized by halophytic (salt-hardy) plants. During the accumulation of the basal units, a treeless alpine grassland implies that sedimentation began first in a cool, moist phase. The pollen profiles and the species composition of the fauna suggested to Scott & Brink (1992) that human occupation would have been prominent in wetter phases.

## New Palaeogeographical Analysis

The hydrology and regional geology of Florisbad suggest that during the Pleistocene a variety of microenvironments existed in response to the waxing and waning of the springs, as well as the expansion and contraction of the lake. A recent sedimentological study (Rubidge & Brink, 1985) supports this interpretation. In 1981, A. Keyser and D. Otto of the Geological Survey assisted our research with the drilling of 31 boreholes to analyse the deposits on and away from the spring mound over a distance of 650 m in the direction of Soutpan, the shore of which is less than 1 km to the north-west at its closest point. With the exception of some broad-scale correlations of limited value, sedimentological analysis showed little correspondence in deposits between even adjacent boreholes, although it did confirm that organic-rich layers were limited to the central part of the site. Sedimentary facies change rapidly across the deposits and wedge out laterally over short distances, which would be expected from microenvironments associated with the springs over time (Rubidge & Brink, 1985).

The new sediment analysis by M. I. is presented in Figure 3 and Table 1 and is based on a complete sequence of samples to bedrock collected by R. J. C. and K. K. from this trench. Four additional trenches to bedrock and closer to the western spring were also dug. They produced very similar sediment samples which, however, were unfortunately lost in shipping. The sediments are composed of silicate minerals and sand grains are of quartz. Grain size and surface properties of the sediments have been analysed following Friedman (1961), Folk (1966), Krinsley & Doornkamp (1973), Tankard (1974), Bull & Goldberg (1985) and El-Ella & Coleman (1985).

*Table 1. Median values for Florisbad sediment samples (μm)*

| Sample | Median | Sample | Median |
|---|---|---|---|
| A | 7 | J | 145 |
| B | 40 | J-1 | 225 |
| Lower C | 49 | J-2 | 145 |
| Upper C | 87 | J-3 | 195 |
| CC | 100 | K | 140 |
| D | 53 | L | 93 |
| EE | 47 | MM | 87 |
| E | 55 | M | 87 |
| F | 40 | N | 61 |
| G | 70 | O | 37 |
| H | 43 | P | 40 |
| I | 61 | Q | 83 |
| II | 87 | R | 93 |
| | | S | 93 |

Grain-size distribution of the sediments shows that most material is fine sand intercalated with silt and clay. Sand layers are more than 10 cm thick, with small cross-bedding features. No thin layers are found, as in yearly or short cyclical deposition systems. Bedding contacts are sharp in the Pleistocene levels, indicating sudden changes in the environmental conditions, such as increase or decrease in the spring water discharge. The archaeology and the available dates suggest a long hiatus in sedimentation for the late Pleistocene and the levels resume in the early Holocene. Bedding contacts in the Holocene levels are more gradational.

There are no stromatolites and no evidence for chemically or biochemically induced precipitation as in hot spring environments (Jones, Renaut & Rosen, 1997). We assume, therefore, that the water palaeotemperature was similar to the present one. Coating of grains is by silica precipitated from evaporating waters. There are no travertine deposits as in carbonate springs (Pedley, 1990) and the different stratigraphic layers reflect changes in the environmental water regime from open lake conditions to vegetated marshland which deposited the peaty layers.

The sand samples are uniform in size distribution and mainly unimodal, although six samples are bimodal. This indicates that most sediments accumulated under uniform environmental conditions, but six of the 26 units accumulated under varying conditions or varying flow strength. Most samples are right-skewed, reflecting deposition in areas of low energy. As most material is in the silt to fine sand range, this points to hydraulic transportation by suspension under low-energy conditions and not as fluvial bedload (Visher, 1969; Friedman & Sanders, 1978; Lambiase, 1980).

The vertical sequence through the strata indicates stages of higher and lower discharge, while variation within the sequence reflects gradual changes in the water discharge and in the extent of the flooded area. Grain size distribution indicates that the Florisbad sediments evolved under several composite geomorphic regimes and that they have not been reworked after deposition. Overall, the interpretation for the springs sequence is one of homogeneous environmental conditions, similar to the low-energy subaqueous environments of lakes, ponds and backwater sites. As the level of discharge at the springs altered over time, the microenvironments sampled in the Main Excavation trench varied from spring eyes to pools, channels and overbank deposits.

Twenty-two samples were selected for scanning electron microscope (SEM) analysis, each being magnified 100 × and 300 × and several 1000 × and 2000 ×. Results on the grain shapes and surface features concur with Grobler & Loock (1988*a*, *b*) and Van Zinderen Bakker (1989) that the spring sediments derive predominantly from an aeolian source. In contrast, Butzer (1988) argues for a source in the decomposition of the underlying Ecca shale and subsurface dolerite rocks through which the springs emerge. He believes that the sub-rounded morphology of the grains is unlikely to be significantly aeolian, with the exception of the Holocene deposits. Indeed, most of the sand is not well rounded but is subrounded. However, subrounded aeolian sands are known to exist, for example, in the Libyan Desert (Krinsley & Doornkamp, 1973: 67). Analysis of sand from the surrounding dunes could resolve this problem more definitively, but other lines of evidence argue for a predominantly aeolian origin for the sediments.

First, grains demonstrating upturned plates are common in the sequence. Such features are created by wind abrasion causing impact between grains (Krinsley & Doornkamp, 1973). Secondly, 78% of the samples are under 100 µm in mean size and are thus within the size range for aeolian sand (Visher, 1969). Thirdly, the unimodal size distributions and the degree of leptokurtosis also support an aeolian source. At the same time, however, we must consider that sediments in more arid environments usually have complex transportation histories which may subject them to recycling by both wind and water. The most plausible scenario for Florisbad is one in which vegetation growing at the springs helped to trap aeolian sediments. These would then be incorporated in the spring sediment load and subjected to other influences, such as water currents and pedogenesis.

Surface textures of the sand grains indicate a subaqueous environment. Dissolution traces are on the flat surfaces of grains, which reflects weathering and grain alteration (Le Ribault, 1975). There is also silica deposition on grains due to submersion in the spring waters. Most primary impacts produced by wind-blowing are covered with siliceous deposits, showing that they occurred prior to final deposition in the subaqueous environment. This interpretation is restricted to the stratigraphical sequence from the spring mound, but parallels with local alluvial sediments suggest that the pattern is regional (Butzer, 1984*a*).

## Archaeology

These conditions of low energy sedimentation and the repeated use of the springs by MSA people have resulted in nearly all of the layers preserving archaeological material. Figure 3 shows the 16 lithological units identified in the Main Excavation trench, which range from the later part of the mid-Pleistocene to the recent Holocene. Of the 12 MSA units present, all but one contain artefacts. Thus, most sedimentation events represent times when the springs attracted hominids, although sedimentary units with very small assemblages may reflect periods when the site was less accessible, e.g. swampy backwaters rather than pool margins. The evidence for Pleistocene occupation ends with the MSA in Unit E and archaeological finds only resume with a Holocene Later Stone Age industry known as Lockshoek, currently thought to be contemporary with the Oakhurst industry which dates to between 8000 and 12000 years (Kuman & Clarke, 1986; Wadley, 1993). The continued excavations of Brink & Henderson, which have sunk additional deep trenches and greatly enlarged the Unit F excavation (Brink, Henderson & Rossouw, 1996), show that artefacts are preserved in other parts of the spring mound, although these pits provide only small samples (Brink, pers. comm.).

Figures 4–7 illustrate the most diagnostic artefacts excavated by 1984 (and see Tables 2 & 3). None of the assemblages contradicts an MSA characterization for the entire Pleistocene sequence. Small cores and small cores-on-flakes occur throughout the sequence, which is predominantly in hornfels, and bifaces are absent in the new assemblages. We also did not find bifaces in all other collections stored at the museum (Kuman, 1989: 51–67). While the bulk of the artefacts from the site are medium-sized MSA retouched and unretouched flakes, a striking feature is several large, pointed flake-blades (Dreyer, 1938: plate XXIX, nos. 16–17). Four retouched points and one pointed flake in the museum collections range between 109 and 201 mm in size. Unfortunately, none is from a provenanced context. One large point (no. 16 in Dreyer, 1938) was said to be a "dagger" from Peat III, but the piece has "Peat II" written on it in ink. Only unifacially retouched points occur in both the earlier selected collections and the unselected assemblages in the 1981–1984 excavations.

The early excavators, working between 1917 and 1953, faced difficult conditions, even using convict labour in the 1950 s. They dug trenches to drain the huge volume of spring water which rose as they excavated. Some finds they actually scrounged from the sand with their feet and items were put in their pockets, which mixed contents from the different eastern and western spring vents. In the 1980s, however, we had the benefit of three petrol-driven pumps to control the spring flow. While in use, they enabled us to dig five

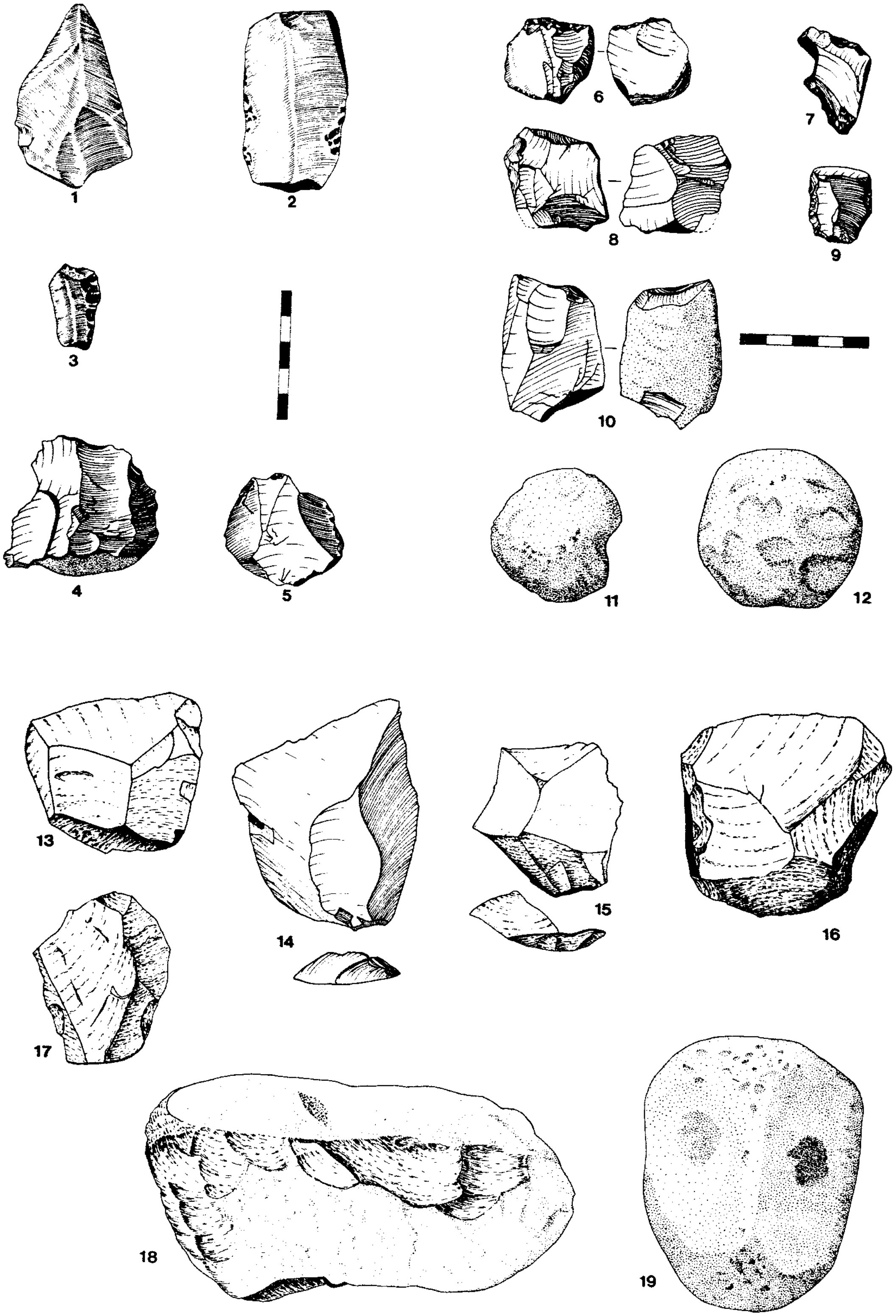

Figure 4. Nos. 1–12: artefacts excavated in the 1980s from the basal units and Nos. 13–19: artefacts excavated from the basal units, 1952–53. Scale in cm.

*Unit P*: No. 1, eroded triangular flake with plain striking platform. No. 2, eroded retouched flake with multi-facetted striking platform. No. 3, eroded sidescraper. No. 4: multiple-platform core. No. 5: thick flake. *Units N–O*: No. 6, scaled piece on a flake with some ventral erosion. No. 7, broken scraper. No. 8, core on a flake. No. 9, sidescraper with multi-faceted striking platform. No. 10, core on a cortical flake. No. 11, decayed stone ball, with eroded hollow on right. No. 12, decayed spheroid.

*1952–53*: No. 13, flake with plain striking platform, igneous stone. No. 14, flake with faceted platform, hornfels. No. 15, flake with multi-faceted platform, igneous stone. No. 16, flake with eroded butt, igneous stone. No. 17, flake with eroded butt, quartzite. No. 18, anvil with dimple-scar, igneous stone. No. 19, dimple-scarred grindstone, igneous stone.

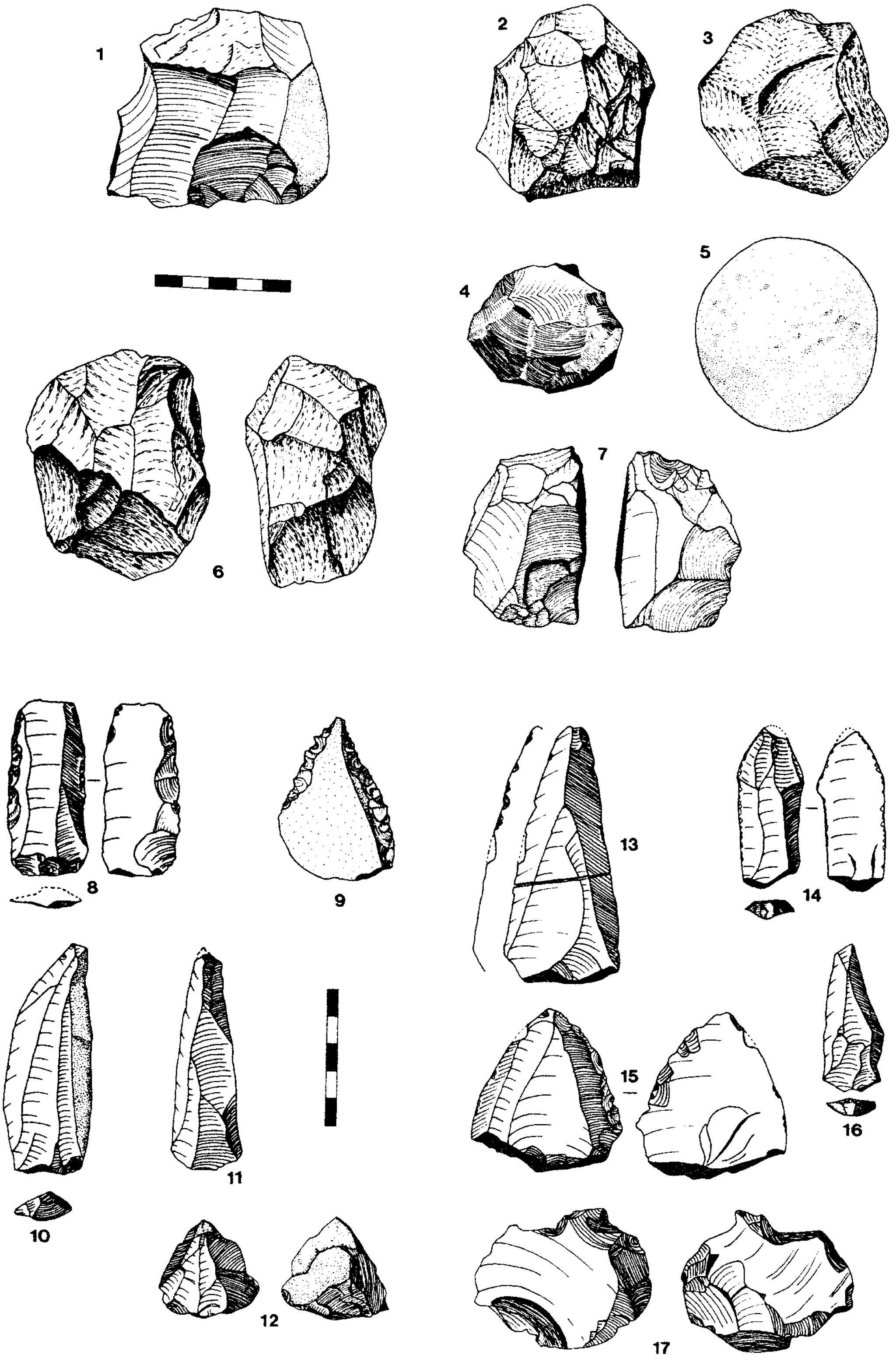

Figure 5. Nos. 1–7: artefacts excavated from the basal units, 1952–53 and Nos. 8–17, artefacts excavated in the 1980s. Scale in cm.

*1952–53*: No. 1, multiple-platform core, hornfels. Nos. 2–4, multiple-platform cores, igneous stone. No. 5, stone ball, igneous stone. No. 6, multiple-platform core, approaching radial working, igneous stone. No. 7, multiple-platform core, silcrete?

*Unit M*: No. 8, bifacially retouched blade with plain striking platform and retouch exposing fresh surface. No. 9, denticulated unifacial point on a cortical quartzite flake. Nos. 10–11, triangular blades. No. 12, single-platform core.

*Units K–L*: Nos. 13, 14 and 16, triangular blades with multi-faceted platforms from Unit K. No. 15, retouched triangular flake with multi-faceted platform from Unit L. No. 17, core on a flake from Unit L.

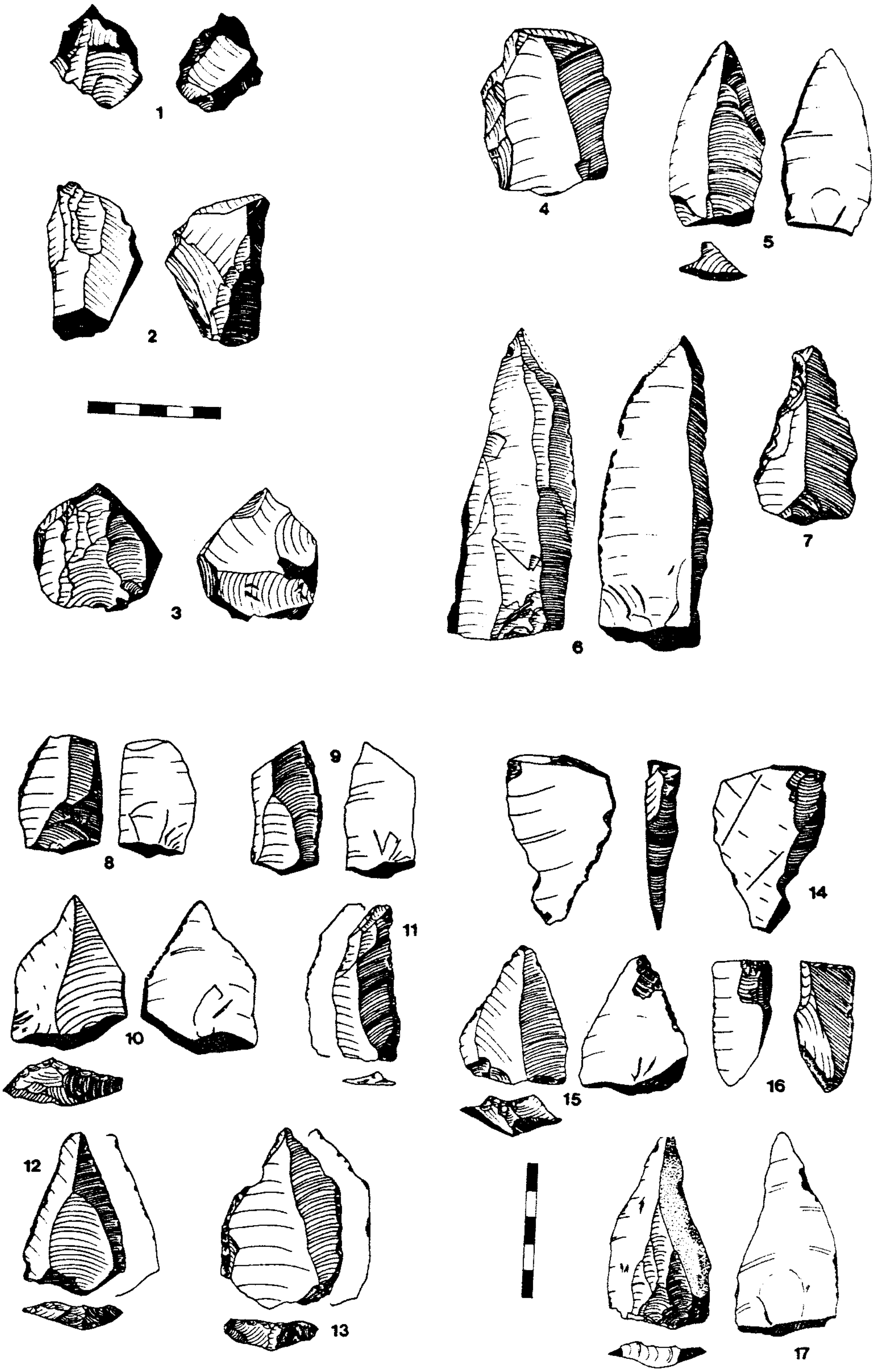

Figure 6. Artefacts excavated in the 1980s. Scale in centimeters.

*Unit I*: Nos. 1 and 3, multiple-platform cores. No. 2, opposed-platform core.

*Unit H*: No. 4, core on a flake. No. 5, backed cutting tool. No. 6, naturally backed knife, unretouched and utilized. No. 7, notched scraper.

*Unit F occupation horizons*: Nos. 8–9, sidescrapers. Nos. 10–13, backed cutting tools. Nos. 14 & 16, burins. Nos. 15 & 17, formal tools, possibly cutting tools.

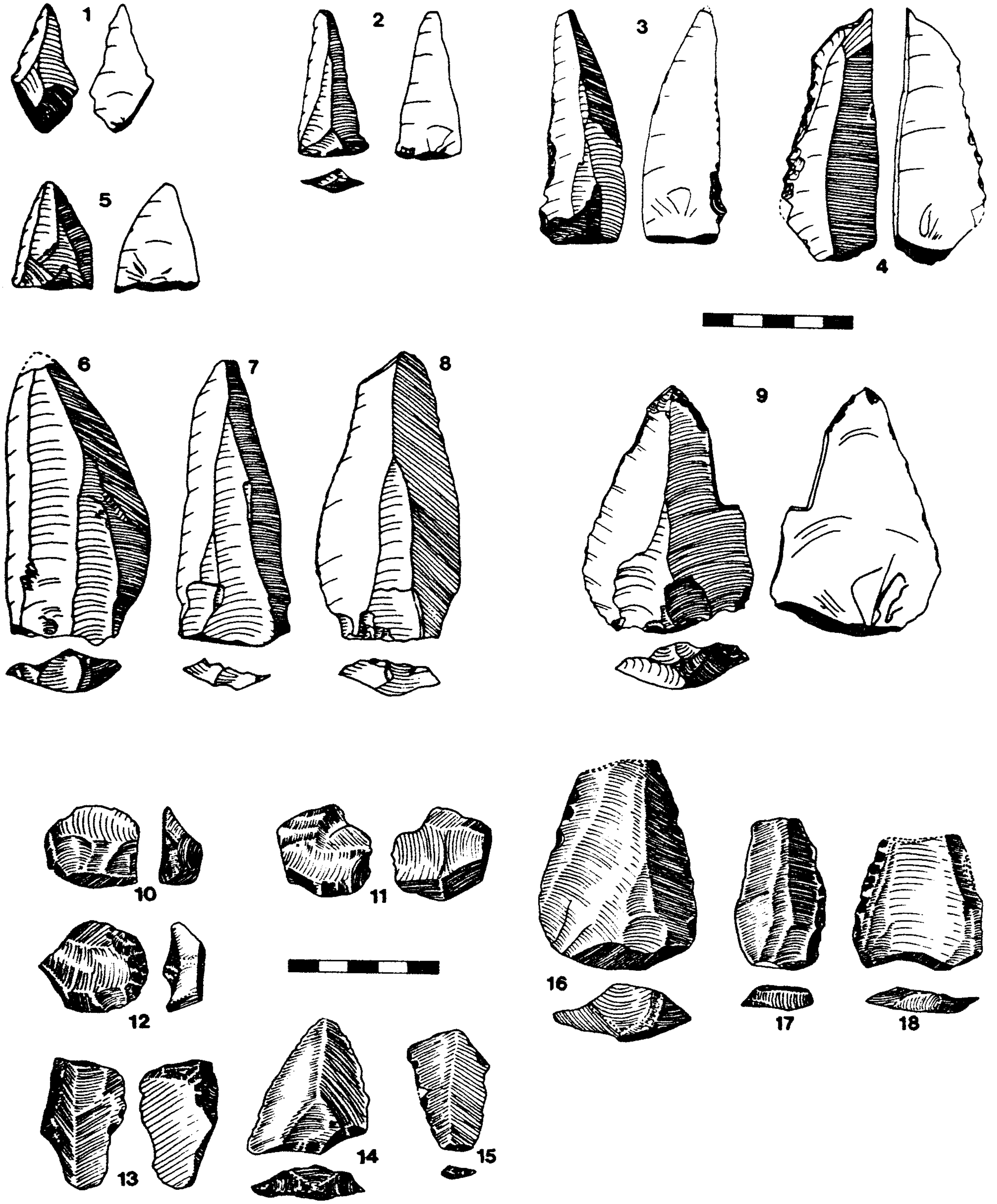

Figure 7. Artefacts excavated in the 1980s. Scale in cm.
*Unit F occupation horizons*: Nos. 1, 2, 5, 6, 7 and 8, triangular flakes and blades. Nos. 3, 4 and 9: formal tools, probably cutting tools. *Unit E*: Nos. 10–12, small cores. No. 13, burin. Nos. 14–16, triangular flakes with multi-faceted platforms. Nos. 17 and 18, retouched flakes.

deep trenches to bedrock. When the pumps were turned off, however, water rose in the trenches to the level of the water table, which in 1984 was between Peats I and II.

### *The early MSA*

The basal deposits are Units N, O and P, which should be closest in age to the origin of the springs *c.* 279,000 ± 47,000 years (Grun *et al.*, 1996). The artefacts we excavated from these levels (Figure 4, Nos. 1–12) are few and not very informative, although they appear to be MSA. However, another collection (Figure 4, Nos. 13–19 and Figure 5, Nos. 1–7) made by Meiring (1956) has traits which are compatible with the early MSA in southern Africa. There are only a few sites in southern Africa which are considered to be early MSA because their ages are estimated at >130,000 years (Volman, 1981, 1984). The currently identified assemblages do not have any special characteristics but are generally described as rather informal flake-tool kits which lack bifaces. Heavily retouched pieces and retouched points are absent, while there is a higher incidence of multiple-platform cores, small, broad flakes and flakes with intersecting dorsal scars (Volman, 1981, 1984). These traits indicate less emphasis on the prepared core technique than is common in subsequent MSA assemblages, in which pointed flakes receive more emphasis.

In Meiring's assemblage excavated from the basal layers, 75 artefacts and 19 natural stones have been identified (Kuman, 1989: 51–68). Similar to our material excavated in the 1980s, this is also a small sample but the assemblage does show certain differences when compared to the remainder of the old collections or to the large assemblage from our excavation of Unit F. First, it has a higher percentage of broad, side-struck flakes. Multiple-platform cores dominate the group and more large cores are present. Secondly, the raw materials are more varied. In contrast to the almost exclusive use of hornfels in higher levels, Meiring's collection has a majority of pieces in igneous rocks as well as a handful in quartzite and other rocks not readily identifiable (Kuman, 1989: 65). The 37 artefacts from our excavation of Units N, O and P are all in hornfels, but the sample is small.

Although these traits suggest that the industry in the basal units differs with the overlying assemblages at Florisbad and has some similarity to the early MSA elsewhere in southern Africa, the MSA here is so regionally variable that the most important criterion should, above all, be the age of the deposit. With the new dates for the earliest Florisbad sediments at >200,000 years, the best criterion for an early MSA assessment is met.

### *MSA, Units M–G*

Above the basal layers lies Unit M, a silty sand which contains an assemblage of typically MSA artefacts (Figure 5), Nos. 8–12), including two small cores 38 and 42 mm long. Our excavated sample of 120 pieces is large for the small size of the trench. In the 1952–1953 excavation, Hoffman retrieved artefacts from an *in situ* level a few inches from the top of this unit. His account and a study of this assemblage have been published by Sampson (1972: 102–105, 1974: 202–205), who listed 130 formal tools, 13 cores and an unspecified amount of "waste". Sampson (1974) termed these artefacts the "Florisbad Industry"—the first sealed, unselected industry of highly retouched MSA for the region. Medium-length sidescrapers dominate this collection and blade dimensions characterize the majority (Kuman, 1989: 85–89). The age of this unit published by Grun *et al.* (1996, the olive-green sand) is 157,000 ± 21,000 years. However, the margin of error in this date is large and the sedimentary unit is thick (75–115 cm), which suggests that the date should be regarded as a general figure.

Above Unit M, Units H, I, K and L produced small samples of artefacts with some characteristic MSA types (Figure 5, Nos. 13–17 and Figure 6, Nos. 1–7). Unit H was not present in the Main Excavation trench and its sample of 55 artefacts derives from an intact layer adjacent to the Great Western Eye. No dates are presented by Grun *et al.* (1996) for these levels. Finds in the thin organic layer of Unit G appear to be limited to its upper portion and probably derive from Unit F. The site was then probably too swampy to be occupied.

### *MSA occupation horizons, Unit F*

The smallest error value for the dated sequence is achieved in Unit F, dated to 121,000 ± 6000 years (Grun *et al.*, 1996). Being above the water table, Unit F was excavated to the full extent of the 8 × 20 m grid of the Main Excavation and thus delivered a very informative assemblage. The unit is up to 90 cm thick and consists of three subunits (sampled as J1, J2 and J3) of fine to medium, white to pale brown sands, with J2 showing clear cross-bedding. J2 and J3 together contain only a small number of decayed MSA artefacts. The preservation in J1, however, is excellent. By early 1984, we had excavated 1651 hornfels artefacts, two dolerite stone balls, one hammerstone, 15 manuports and 573 specimens of bone. The thickness of J1 varied from 15 to 60 cm, but finds were distributed over a depth of 45 cm.

Although the Unit F sands are fine to medium in grain size, it is of interest that they are the coarsest sediments in the sequence. To Butzer (1988: 188), these moderate to high energy conditions suggest not a closed pond but a more extended lake, representing not more than ten millennia. Butzer also describes the deposit as "interlaminated with organic material and fine sands, arranged in wavy-bedded laminasets", which in combination with "the coarse grade of the sands precludes other than a spring origin" of a secular or seasonal nature. Our analysis agrees with this interpretation and points to a series of short-term occupations taking place on the shore of a spring-fed lake where gentle wave action buried the debris. We disagree with Visser & Joubert (1991), who interpret this phase as fluvial. Although the sediment grain sizes may be within the fluvial range, the microstratigraphical variability and lamination with fine sands and organic matter argue for a spring origin.

Most of the bone in the Unit F occupations consists of comminuted and dispersed fragments characteristic of human butchery and although the bone is in poor and friable condition, a few cut marks have been documented by Brink (1987). Of the nine species of fauna present, the majority belongs to bovid species with a body mass below 100 kg, which suggests hunting rather than scavenging (Brink, 1987). However, the partial remains of hippos are thought to result from natural deaths which were probably scavenged (Henderson, 1996). The 15 manuports are mainly igneous cobbles and several blocky slabs, most of which appear to lie in pairs for use in butchery (Kuman, 1989: 103–104). Such a function has been documented by Brain (1976: 102), who observed the Hottentots of Namibia using stone hammers and anvils in butchery and marrow extraction.

A well-preserved hearth with a flat base was excavated along the western wall of the excavation. The feature consisted of a clearly defined area of burnt sand 1 × 1·5 m in dimension, embedded with numerous fragments of charcoal and a few fragments of burnt bone. Only three clusters of charcoal fragments and two other pieces were found in other areas of the Unit F excavation, but these were isolated finds not embedded in burnt sand.

The nine species of mammals identified by Brink (1987) indicate a long-term accumulation at the springs. This is confirmed by the distribution of the artefacts over a depth of 45 cm of deposit. Conjoining artefacts (Figure 8) point to multiple occupations, rather than to the displacement of a single horizon in vertical space: 17 out of 18 sets of refitted artefacts exhibit only minor displacement in depth levels. The range of displacement is from 0 to 13 cm in 17 cases, with an average displacement of 5 cm. The eighteenth set was unusual in being displaced by 19 cm, but as these two pieces lay close to each other in horizontal space, this anomaly could have been due to some form of bioturbation. The overall good integrity of the deposits is matched by the horizontal distances between refitted artefacts, which are consistent with the dimensions of scatters produced by experimental flaking of stone (Kuman, 1989: 149–160). The artefacts are in sharp condition and have no significant signs of surface abrasion or other natural damage. The hornfels has a light grey powdery patina typical of indurated shale found in a spring context where oxidation is accompanied by hydration (Goodwin & van Riet Lowe, 1929: 295). If the artefacts had lain exposed on a dry land surface for a length of time, oxidation of the iron content would have produced hornfels of a different colour, varying from khaki to other rusty hues (Goodwin & van Riet Lowe, 1929).

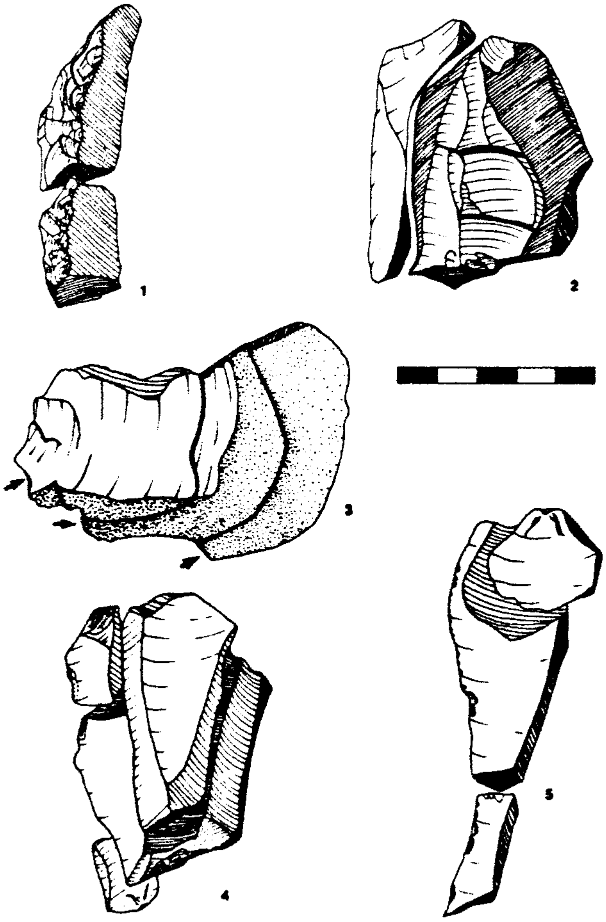

Figure 8. Several of the 18 sets of conjoining artefacts from the Unit F occupation horizons. Scale in cm. No. 1, a core rejuvenating flake in two halves. No. 2, a core with conjoined flake at left. No. 3, three flakes with cortex (platforms indicated). No. 4, a prepared core for triangular flake, with three conjoing flakes (a triangular blade, a flake on bottom left, and an incomplete flake at top left). No. 5, ventral view of a triangular blade in two parts with conjoined bulbar flake from knapping shatter.

The large number of artefacts is another indication that material accumulated during repeated visits to the site because of good access to game. For a number of reasons, the artefacts do not indicate a single long-term occupation but rather the periodic flaking of stone to use in an expedient manner. First, the assemblage is dominated by small material (Table 3), with 67% classed as small flaking debris under 20 mm in size (including 40% under 10 mm). Another 3% of material is probably also flaking debris—chunks and core trimming and rejuvenating flakes. Secondly, there are few formal tools and little variety in the tool types present. Ethnographical research shows that long-term occupations tend to produce a greater variety of tool types because of the variety of activities likely to take place over time (Yellen, 1977: 76–77, 82, 107; Binford, 1978:

*Table 2. Artefacts excavated from units below the occupation horizons*

| | Unit | | | | | | |
|---|---|---|---|---|---|---|---|
| | H | I | K | L | M | N–O | P |
| Formal tools | | | | | | | |
| Retouched points | | | | | 1 | | |
| Notched scrapers | 1 | | | | | | |
| Backed cutting tools | 1 | | | | | | |
| Bifacially retouched flakes | | | | 1 | | | |
| Bifacially retouched blades | | | | | 1 | | |
| Scrapers | | | | | | 2 | 1 |
| Miscellaneous retouched pieces | | | | | | 1 | 1 |
| Broken retouched pieces | | | | | 1 | | |
| Other | | | | | | | |
| Naturally backed knives (unretouched but utilized) | 1 | | | | | | |
| Complete flakes >20 mm | 14 | 27 | 21 | 12 | 27 | 6 | 2 |
| Complete flakes <20 mm | 4 | 11 | 8 | 11 | 11 | | |
| Incomplete flakes >20 mm | 20 | 10 | 10 | 8 | 15 | 5 | 3 |
| Incomplete flakes, chips <20 mm | 10 | 20 | 26 | 20 | 55 | 3 | 3 |
| Core trimming flakes | 2 | | | | | | 3 |
| Chunks | 1 | 2 | | | 6 | | 1 |
| Stone balls | | | | | | 1 | |
| Spheroidal polyhedrons | | | | | | 1 | |
| Scaled pieces (*outils écaillés*) | | | | | | | 1 |
| Hammerstones | | | 1 | | | | |
| Cores | | | | | | | |
| Single platform | | | | | 2 | | |
| Multiple platform | | 2 | | | 1 | | 1 |
| Opposed platform | | 1 | | | | | |
| On flake | 1 | | | 2 | | 2 | |
| Totals | 55 | 73 | 66 | 54 | 120 | 22 | 15 |

490–491). The location of the site on the edge of a spring is also not ideal for long-term occupation but is more consistent with a special-purpose activity (Kuman, 1989: 112–113). There are 14 formal tools present (Figure 6, Nos. 8–17 and Figure 7, Nos. 1–9), two of which are burins, while the rest are minimally retouched or heavily utilized flakes. Their mean length is 62·5 mm, with a range from 43 to 81 mm. In addition, 39 flakes show edge damage interpreted as use-wear. Similar to the formal tools, these flakes have a mean length of 60 mm, although the range is from 32 to 110 mm. The majority of formal tools and utilized flakes have dorsal–ventral edge wear consistent with use in a longitudinal cutting action (Tringham *et al.*, 1974; Frison, 1979; Lawrence, 1979; Keeley, 1980: 36–38 and see Odell, 1981: 203; Kuman, 1989: 134–138). Thus with both the formal and informal tools, a variety of uses is represented but cutting functions appear to be dominant. Although it is difficult to prove the butchery function of these flakes in the absence of micropolish analysis (to which the hornfels is not amenable), the sharp condition of the artefacts argues against natural damage to the flakes and the association with comminuted bone and with anvils supports the interpretation that cutting tools represent a significant function within the assemblage.

Fairly rapid burial of the occupation debris is evident when tests for site disturbance are applied (Isaac, 1967; Schick, 1986). The size distribution of artefacts shows a complete and undisturbed accumulation: there is a full range of flake sizes, as well as a majority of small flaking debris under 20 mm (Figure 9) Artefact orientations show a bimodal pattern for pieces over 40 mm size: 29% of alignments are east–west and 23% are north–south (Kuman, 1989: 161–165). This pattern indicates that artefacts in an east–west orientation have stabilized primarily transverse to the current direction and secondarily in parallel alignment with the current (Schick, 1986), which would have been towards the north as the active spring lay south of the occupation. Artefacts were thus affected by the spring flow and made in-place adjustments, but velocity was not strong enough to winnow the site of small debitage. Tests for the dipping of artefacts, effected usually through trampling in a soft substrate or through sediment scour at the upstream side of pieces (Behrensmeyer & Boaz, 1980: 87; Schick, 1986), were also negative: a majority of artefacts had a horizontal position and no clear preference was present in dips for the rest of the assemblage (Kuman, 1989: 165–167). A similar pattern was also present for the faunal specimens, 66% of which were in a horizontal position (Brink, 1987: 97).

The preservation and burial of the J1–Unit F occupations are thus ideal and the site is in a primary, if not also a near-pristine, context. This is no doubt due to the gentle and periodic sedimentation attributable to the springs and the lack of post-depositional

*Table 3. The Unit F artefact assemblage*

| Artefact type | *N* | Total | Category | Percentage |
|---|---|---|---|---|
| Whole flakes <10 mm | 97 | | | |
| Chips <10 mm | 565 | | | |
| Whole flakes 10–20 mm | 212 | | | |
| Chips 10–20 mm | 231 | | | |
| | | 1105 | Flakes and chips <20 mm | 67 |
| Incomplete flakes >20 mm | 123 | | | |
| Split flakes >20 mm | 12 | | | |
| | | 135 | Incomplete flakes >20 mm | 8 |
| Complete flakes >20 mm | | | | |
| Irregular flakes | 191 | | | |
| Triangular flakes | 12 | | | |
| Triangular blades | 50 | | | |
| Flake-blades | 76 | | | |
| | | 329 | Complete flakes >20 mm | 20 |
| Core trimming flakes | 24 | | | |
| Core rejuvenating flakes | 3 | | | |
| Chunks | 28 | | | |
| | | 55 | "Waste" | 3 |
| Cores | 10 | | | |
| Core fragments | 3 | | | |
| | | 13 | Cores and core fragments | 1 |
| Retouched flakes and blades | | | | |
| Cutting tools | 10 | | | |
| Sidescrapers | 2 | | | |
| Burins | 2 | | | |
| | | 14 | Formal tools | 1 |
| Stone balls | 2 | | | |
| Hammerstones | 1 | | | |
| | | 3 | Other | |
| | | 1654 | Total | 100 |

disturbance in layers not affected by spring eye eruptions. Although this pattern is only established for the one sedimentary unit, it is likely that at least some of the other artefact assemblages were accumulated under similar conditions.

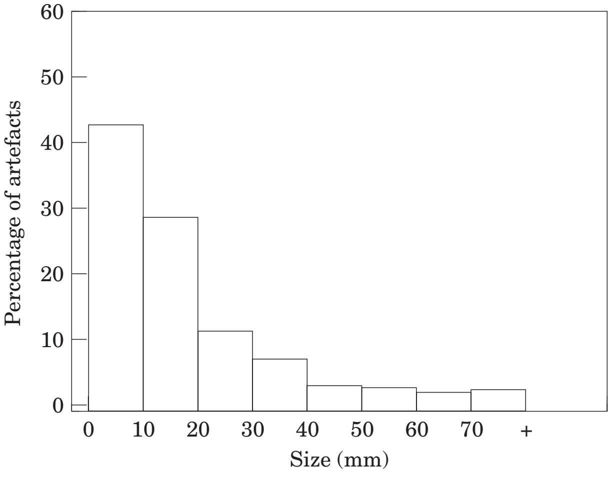

Figure 9. Size profile of the Unit F artefact assemblage ($N$=1563).

### *The uppermost MSA level, Unit E*

The equivalent of Peat 3 is Unit E, which is the final MSA unit. The 116 artefacts in these levels are decayed but include three or four triangular flakes and 10 faceted striking platforms (Figure 7, Nos. 10–18). A date of 19,530 ± 650 years was obtained in 1954 with the early solid carbon technique, which is therefore only a minimum age. Following Unit E, there is a long hiatus in the cultural sequence represented in Unit D. The early part of the Later Stone Age (LSA) is absent and we do not know if the site was uninhabited or if there were poor depositional conditions or a later erosion of deposits. It is likely that the severe climatic conditions of the Last Glacial Maximum had a role to play in this hiatus.

### *The Later Stone Age levels*

The first LSA level represented is the Lockshoek Industry in lower Unit B, a local variant of the Oakhurst Complex (or Smithfield A), which is dated between 8000 and 12,000 years elsewhere in the country (Wadley, 1993). Three $^{14}$C dates from Unit C, a paleosol at the base of lower Unit B, fit within this time span at 8790 ± 70, 10,000 ± 100 and 11,700 ± 110 years (Kuman & Clarke, 1986), but dates for organic matter from such swampy deposits are often difficult due to contamination by successive generations of plants.

## Conclusions

A long sequence of MSA occupation at the Florisbad springs is recorded in over 7 m of sands, silts and clays intercalated with four major horizons of organic sediments. The MSA sequence begins with early MSA assemblages broadly dated to 279,000 ± 47,000 years (Grun *et al*., 1996), which show some differences in raw materials with the overlying assemblages. These levels also appear to show less emphasis on prepared core technique, if the material excavated by Meiring (1956) is well provenanced and representative. The overlying assemblages are MSA but, with two exceptions, the samples are too small to characterize the industry. The first exception is from Unit M, dated to 157,000 ± 32,000 years (Grun *et al*., 1996), which has a proportion of heavily retouched artefacts. The second exception is from Unit F, which has a large assemblage of expedient, lightly retouched MSA types and utilized flakes, dated to 121,000 ± 6000 years (Grun *et al*., 1996). The expedient, special-purpose nature of these horizons could account for the low incidence of retouch and it would be premature to assume that more heavily retouched flakes are absent from this phase of the MSA. The sequence ends with a layer of decayed MSA artefacts which are beyond the range of $^{14}$C dating. From the small samples of artefacts in all but two of the units, it is not yet possible to describe any particular cultural sequence for the site. However, the provenanced material does document a generalized form of MSA with formal tools of medium size. No very small-sized tools are present, as are documented, for example, at cave sites such as Rose Cottage Cave or in Howieson's Poort assemblages (Volman, 1984; Wadley & Harper, 1989). Several very large points and blades retrieved in past decades are not provenanced and have not yet been duplicated in excavated samples.

Florisbad owes its long depositional sequence to spring activity which incorporated and reworked much aeolian sediment mobilized during dry phases. The springs supported vegetation which, over time, trapped aeolian sediments and incorporated them in the springs' sediment load. Overall, the sediments indicate a low-energy subaqueous environment similar to lakes, ponds or backwater sites. Even the coarsest sands in the sequence have preserved a series of primary context MSA horizons in Unit F, representing multiple short-term occupations on the shore of a lake which focused on the hunting and butchery of medium-sized bovids and possibly the scavenging of hippo carcasses (Kuman & Clarke, 1986; Brink, 1987; Henderson, 1996). Burial of these occupations was periodic and gentle enough to preserve even the most delicate chipping debris.

Clearly, there were fluctuations in the level of spring discharge over time. Variations within sedimentary units reflect both the intensity of the spring discharge and the extent of the flooded area, corresponding to different microenvironments over time. Pools would have existed when the springs were very active, while swamps and bogs would have encroached during drier phases, creating at times the peaty palaeosol horizons. The new dates for Florisbad (Grun *et al*., 1996) now provide a chronological framework for these climatic shifts and a better appreciation of the antiquity of the associated hominid cranium, as well as the first good placement of the MSA artefact sequence in time.

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