A Geoarchaeological Study of the Middle and Upper Pleistocene Levels at Canteen Kopje, Northern Cape Province, South Africa

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Canteen Kopje, situated in the Northern Cape Province of South Africa, has two main archaeological deposits: alluvial gravels and a mantle of overlying fine sediments known locally as the “Hutton Sands.” This paper focuses on the fine sediments, the three industries contained within them, and the interface with the underlying gravels in an attempt to clarify their formation and transformation. A Fauresmith assemblage is found at this interface; it is thus crucial to understand the processes of deposition and modification at this poorly understood boundary. The methods used in this study involved the analysis of artifact depositional (dip and orientation) and spatial data, artifact condition, raw materials, and assemblage size profiles. Data presented document the mixing between the lowest levels of the fine sediments and the underlying alluvial gravels. This study thus provides important contextual information for the Fauresmith industry at Canteen Kopje. © 2016 Wiley Periodicals, Inc.

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INTRODUCTION

Canteen Kopje, situated within the Vaal River Basin of the Northern Cape Province, South Africa (Figure 1), has been referred to frequently in literature over the last century (e.g., Goodwin, 1934; Van Riet Lowe, 1937; Partridge & Brink, 1967; Helgren, 1977, 1979). However, only recently has more systematic research been pursued (see De Wit, 1996, 2008; Beaumont & McNabb, 2000; McNabb, 2001; Beaumont, 2004a; Gibbon, Leader, & Kuman, 2008, 2009, Gibbon et al., 2009; Forssman et al., 2010; Sarupen, 2010; McNabb & Beaumont, 2011a,b; Chazan et al., 2013; Leader, 2014). The first controlled excavations at Canteen Kopje were conducted by P. Beaumont in Areas 1 and 2 (Figure 1) beginning in 1997 (McNabb & Beaumont, 2011a), and recently in 2007 two new teams began research at the site. This included a collaborating team from Purdue University and the University of the Witwatersrand, starting new excavations at Pit 6 (Figure 1), and a team led by M. Chazan from the University of Toronto (see Figure 1—site A). Overall, this recent research has focused on improving our understanding of the site’s geomorphology, age, archaeology, and site formation history.

Canteen Kopje is unique for an open-air site in southern Africa in that it contains a 7 m stratified sequence of alluvial gravel and fine sediment deposits which preserve two early Acheulean assemblages, overlain by Victoria West Acheulean and Later Acheulean industries, and then by Middle (MSA) and Later Stone Age (LSA) levels (Figure 2; Gibbon, Leader, & Kuman, 2008, 2009; Forssman et al., 2010; Leader, 2014). The typological, technological and contextual nature of these assemblages has been well-documented by several studies (Gibbon, Leader, & Kuman, 2008, 2009; Gibbon et al., 2009; Forssman et al., 2010; Sarupen, 2010; McNabb & Beaumont, 2011a,b; Chazan et al., 2013; Leader, 2014), however until now, little work has focused specifically on assessing the degree to which the fine sediments at Canteen Kopje have been altered and how this has influenced the assemblages contained within.

In this paper, we address the site formation and transformation processes at play in the Later Acheulean to MSA levels that are contained within the fine sediments.
and the top of the gravels. In particular, we address the context of the Later Acheulean levels identified as a Fauresmith industry. Canteen Kopje is one of only a few sites that preserves stratified \textit{in situ} Fauresmith material (Underhill, 2011). In previous research (McNabb & Beaumont, 2011a,b; see Area 1 excavation, Figure 1), the context of this assemblage was not well defined because of its stratigraphic position at the base of the fine sediments and within the contact zone that incorporates the top of the gravels, as the fine sediment component in this excavation had been removed by miners.

The Fauresmith industry has featured prominently in southern African literature over the last several decades, yet defining the industry has been problematic (see Underhill, 2011 for a detailed review). Assemblage descriptions through time have been based primarily upon poor context surface collections, unexcavated samples, or, on those assemblages which “highlight” certain “Fauresmith” components (i.e., small handaxes, see Fock, 1968 specifically, and see Goodwin, 1927, 1929; Goodwin & van Riet Lowe, 1929; Farnden, 1967; Humphreys, 1970; Mitchell, 1998; Klein, 2000; Porat et al., 2010; Underhill, 2011). As a result, reliable details on complete assemblages have not been available until recently. Traditionally, the Fauresmith was considered by most researchers as a transitional industry between the late Acheulean and the MSA (Goodwin & van Riet Lowe, 1929; see Underhill, 2011 for a detailed review). Clark (1959) assigned it to the onset of regional specializations in Africa, and some researchers have placed it in the early MSA (Herries, 2011). More recently, however, dates of ca. 500 ka (thousand years ago) for the Fauresmith at Kathu Pan (Porat et al., 2010) indicate that the industry has some depth of time in the Later Acheulean. Although there is no single type series which can be used to describe the industry, the majority of researchers emphasize the co-occurrence of prepared core technology, points, blades, and small handaxes (Kuman, 2001; Porat et al., 2010).
In addition to Canteen Kopje, sites containing Fauresmith assemblages include: Wonderwerk Cave, Kathu Pan, Rooidam, Pniel, Hopefield, and Bundu Farm (Singer & Crawford, 1958; Fock, 1968; Beaumont, 1990a,c,d, 2004b,c,d; Kuman, 2001; Beaumont & Richardt, 2004; Beaumont & Vogel, 2006; Kilber, 2006; Porat et al., 2010). Although these sites have “improved” contexts, their “Fauresmith” assemblage descriptions are still very limited. However, of all these sites, Kathu Pan provides the most detailed information on Fauresmith technology (Porat et al., 2010). The authors also highlight that the current radiometric ages provided elsewhere for the Fauresmith do not temporally constrain the industry. As a result, there is a great need to obtain radiometric ages from well-defined Fauresmith assemblages excavated from controlled in situ contexts (Porat et al., 2010).

Accordingly, understanding the processes at Canteen Kopje that have affected the fine sediments and underlying gravels is vital. The assemblages at Canteen Kopje provide an important record of hominid behaviors and activities. However, until these assemblages are discussed in light of their spatial, chronological, and functional context, our interpretations are meaningless (Morton, 2004). Understanding the formation and transformation of a site is crucial before behaviors can be inferred from the ever changing archaeological record (Schiffer, 1983; Schick, 1991; Karkanas et al., 2000; Stein, 2001; Morton, 2004). Through the investigation of artifact size distribution, condition, deposition, spatial, and raw material data, we discuss the influence of these processes at play in the Canteen Kopje deposits. The current study provides new data which strengthens the contextual understanding of the Fauresmith assemblage at Canteen Kopje.
BACKGROUND: THE DEPOSITIONAL SEQUENCE AT CANTEEN KOPJE AND CHRONOLOGY

In Pit 6, the top of the sequence has a 60–70 cm thick capping of miners’ dump material which contains a range of disturbed finds; this is underlain by the fine sediments (these fine sediments are known locally as the “Hutton Sands”; however, these will be referred to as “fine sediments” throughout this paper; see Figure 2). The uppermost levels of the fine sediments (70–140 cm) contain a late Holocene LSA assemblage (Forssman et al., 2010) and below it (at 140–170 cm) an MSA assemblage with artifacts that are not diagnostic of any particular phase (Sarupen, 2010). Beneath this MSA level, from 170 to 195 cm, lies the Fauresmith/Later Acheulean assemblage, followed thereafter by the mixed contact zone (MCZ) from 195 to 230 cm. The boundary between the fine sediments and the underlying gravels is unconformable, with the Fauresmith in fine sediments resting on the surface of an alluvial gravel from 230 cm downwards (Figure 2), with a slight dip to the NE of between 5° and 10°. This upper gravel layer, which contains the Victoria West prepared core Acheulean industry, has been dated to the early Pleistocene through the application of cosmogenic nuclide burial dating (Gibbon et al., 2009, 2013; see Leader, 2014 for a detailed report of these underlying gravels). Overall, the stratigraphy of the gravels in Pit 6 is largely similar to the sequence documented by Beaumont (see McNabb & Beaumont, 2011a, b) in Area 1 (Figures 1, 2).

Although our attempts to date the Fauresmith and overlying MSA levels in Pit 6 were not successful (Evans & Cunningham, 2013), it may be possible to provide an age estimate for these deposits based on the work of Chazan et al. (2013). Their results with Optically Stimulated Luminescence (OSL) dating of the sands in their excavation (Figure 1—site A) show that the earliest sand grains began accumulating at ca. 300 ka, which may provide a minimum age for the fine sediment deposit across the surrounding area. Thus, in Pit 6, the Fauresmith assemblage-bearing fine sediments are likely to have started forming by at least ca. 300 ka. It is clear that the erosional disconformity between the uppermost gravel layer and the fine sediment capping in Pit 6 represents a gap in time of hundreds of thousands of years. This is confirmed by the earliest reported date for a Fauresmith assemblage from the nearby site of Kathu Pan, ca. 500 ka (potentially as old as 647 ka; Porat et al., 2010). Other Fauresmith assemblages appear to continue in time to the end of the Earlier Stone Age (Klein, 2000; Herries 2011), which today is considered to be ca. 300–250 ka—namely, Bundu Farm (dated to between 400 and 200 ka), Wonderwerk Cave (dated to between 315 and <195 ka), and Rooidam (dated to >209 ka).

The Fine Sediments

Several studies address the origin and composition of these fine sediments. Originally, Helgren (1977, 1979) argued that the formation and deposition of these sediments was a result of colluvial processes, namely two specific intervals of valley colluviation, termed the Riverton III and early Riverton IV (Beaumont, 1990a). Most recently Chazan et al. (2013) highlight that these sediments are of aeolian origin and comprise yellow to red silty sand; the sand component is proposed to have been introduced locally from the adjacent Vaal drainage system (based on modal grain size data). Bioturbation of the fine sediments at Canteen Kopje has been widely proposed (De Wit, 2008; Chazan et al., 2013; Evans & Cunningham, 2013; Leader, 2014).

The influence of bioturbation

De Wit (2008) highlighted the poorly sorted nature of the fine sediments and suggested that aeolian processes and bioturbation were essential to their alteration. More recently two studies focusing specifically on the dating of these sediments, using OSL techniques, highlight that bioturbation has played a significant role in the reworking of sediments across the site (Chazan et al., 2013; Evans & Cunningham, 2013). Attempts by Chazan et al. (2013) to provide greater chronological resolution for the site’s late Pleistocene/early Holocene assemblages, pertaining to the late MSA or early LSA, were only able to provide rough time estimates (due to the large age scatter caused by the mixing of grains). The attempt by Evans and Cunningham (2013) to date the Pit 6 sediments containing MSA and Fauresmith artifacts show that all four OSL dating results fall within the Pleistocene, but post-depositional movement of sand grains has resulted in over-dispersion percentages that range between 30% and 60%. This is well over the maximum rate of 15% expected for reliable results and directly indicates the mixing of sand grains through bioturbation, probably primarily through insect activity (as demonstrated by Chazan et al., 2013) and potentially also by plant roots. Some dates are also stratigraphically inverted (Evans & Cunningham, 2013).

Bioturbation in these unconsolidated sediments is also likely to have created the vertically stretched distribution of lithics in each of the three assemblages—vertical distribution figures cited above range from ca. 70 cm for the
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LSA, to 30–40 cm for the MSA, and at least 30–40 cm for the Fauresmith with mixing into the top of the gravels. Stretching of lithic assemblages was also noted by Chazan et al. (2013) for their excavation.

Understanding the influence of bioturbation is therefore crucial in order to explain the depositional sequence at Canteen Kopje. The effects of bioturbation have been addressed in a number of studies (Cahen & Moeyersons, 1977; Moeyersons, 1978; Schiffer, 1983; Stein, 1983; Erlandson, 1984; Hofman, 1986; McBrearty, 1990; Vermeersch & Bubel, 1997; Morton, 2004). Termites, plant roots, and burrowing animals are seen as the primary means through which many assemblage contexts are disturbed. McBrearty (1990) and Morton (2004) describe that termite activity can cause the following features in deposits: relict (often fossil) termite remains, no form of microstratigraphy (a single homogenous unit), artifact concentrations which have marked upper and lower contacts, and/or a dispersal of artifacts. Artifact distributions can be affected quite considerably, primarily vertically but also horizontally. Plant roots often result in the mixing of soils and can be considerably destructive to site contexts (Morton, 2004). Personal observations have shown that root systems often entangle artifacts, and the toppling of dead trees can lead to an upheaval of roots containing sediments, causing the local vertical displacement of artifacts. Burrowing animals can cause artifact displacement both horizontally and vertically, leading to the homogenization (or mixing) of site stratigraphy (Erlandson, 1984; Morton, 2004).

Models for sediment deposition

The work of Chazan et al. (2013) provides an important insight into the depositional events which led to the formation of the fine sediments at Canteen Kopje. Their study provides evidence for depositional events at 300 and 165 ka; the fine sediments then remained exposed to bioturbation until much later (23–26 ka; Chazan et al., 2013). Most significant is that their data suggest evidence for a “multiple episode” depositional model (Chazan et al., 2013). If deposition of these sediments occurred as a single event, bioturbation would have been constrained to only the upper levels within these sediments (Chazan et al., 2013). Chazan et al. (2013) also considered a single depositional event model for the site but did not favor this explanation. Additional support for “multiple episode” deposition is provided by De Wit (2008), based on the description of several mottled horizons (which are seen as having been deposited at different periods) and by Beaumont (2004a), based on palaeosol preservation.

METHODOLOGY

Excavations through portions of the fine sediments and upper gravels at Canteen Kopje were conducted at Pit 6, within an already established radial excavation (Figure 1, see Forssman et al., 2010 for a detailed discussion of this excavation). Excavations within the fine sediments proceeded in 5 cm spits, which increased to 10 cm spits in the gravel layer due to the presence of large cobbles and boulders. All excavated sediment was screened using both 4 and 2 mm sieve mesh, and all artifacts ≥20 mm in size were 3D point-plotted using a total station. In addition, all artifacts and natural clasts ≥20 mm were analyzed with a Brunton compass for dip angles and long axis orientations (readings relate to magnetic north) to investigate depositional patterns (e.g., those created by alluvial processes).

The analysis of clast orientation is a well-established method for distinguishing depositional processes. Depositional patterns within alluvial sequences and a range of other process-derived deposits have been dealt with by many authors (e.g., Krumbein, 1939; Andrews & Smithson, 1966; Tandon & Kumar, 1981; Butler, 1982; Schiffer, 1983; Yagishita & Jopling, 1983; Petts & Foster, 1985; Bluck, 1987; Deitrich, 1987; Naden & Brayshaw, 1987; Schick, 1991, 1997; Petraglia & Potts, 1994; Evans, 2000; Bridge, 2003; Morton, 2004; Millane, Weir, & Smart, 2006; Kostic & Aigner, 2007; Hodge, Brassington, & Richards, 2009). According to Petts and Foster (1985), these patterns (dip directions/orientations and angles, called imbrication) occur as a result of the final stages of artifact (or clast) deposition; if flow regimes are sufficiently low, imbrication will be absent (Deitrich, 1987). Long axis orientation of clasts is regarded as being the primary indicator of fluvial flow (Schick, 1991), whereas dip is used to assess the intensity (as fluvial scour, under the base of an artifact, will give rise to steeper angles in higher energy conditions within easily erodible substrates) and direction of fluvial flow, and also, to question the redistribution of assemblage components (such as small debitage; Schick, 1991; Petraglia & Potts, 1994; Morton, 2004).

In addition, Schick (1984, 1991) highlights the size patterns that are created when an assemblage is affected by fluvial flow. Sites affected by moderate-to-intense fluvial flow will exhibit: a loss of assemblage components (especially small flaking debris <20 mm, or SFD), a differential re-deposition of assemblage components based on size, and the retention of some SFD (except where fluvial flow is intense). Sites exposed to minimal/moderate fluvial flow will preserve most of their original assemblage components (differentially, based on artifact size and densities), will frequently have portions of the site completely
devoid of lithic material, and will have a differential relocation of assemblage components beyond the original site boundary (points of reaccumulation where flow is reduced).

Laboratory analysis involved the recording of artifact maximum lengths for the study of assemblage profiles. Experimental knapping studies by Schick (1987, 1991, 1997) and by Kuman and Field (2009) provide modern analogues to interpret assemblage profiles in archaeological deposits; their experiments demonstrate what types, sizes, and distributions of flaked material should characterize a site of primary knapping activity. As such, assemblage profiles should be dominated by a high percentage (60–87%) of SFD provided that stone knapping occurred within the catchment of the site, that the deposit has been minimally affected by natural processes, and that the sieve mesh used in excavations is no larger than 4 mm (Schick, 1997; Kuman & Field, 2009). Deviations in the above pattern may be the result of lithic influx (transporting in of manufactured lithics), removal (through fluvial winnowing), or re-deposition of sorted material by fluvial forces (Schick, 1991). Additional modification of assemblage components, beyond fluvial or cultural processes, could include both aeolian (and aeolian-derived sediment processes) and less-intense movement by water, such as sheetwash (Schiffer, 1983; Schick, 1984, 1987, 1991, 1997; Kandel, Felix-Henningsen, & Conard, 2003; Morton, 2004).

Additional lab analysis involved the assessment of artifact raw material type (all pieces) and condition (excluding SFD). Artifact condition was established using a system adapted from Shea (1999). This system was best suited to the depositional context of Canteen Kopje as it allowed for the assessment of both minimally and highly weathered/abraded pieces. The term weathering here refers to the chemical decay/breakdown of raw materials (artifacts), whereas abrasion refers to a “wearing down” of artifact surfaces/edges caused specifically by either the movement of the artifact over an abrasive surface/medium, or the movement of an abrasive medium over the artifact surfaces/edges. No attempt was made to distinguish between these different conditions so the following collective types were utilized: heavily weathered/abraded pieces (distinct rounding/modification of edges and ridges), intermediate or slightly weathered/abraded pieces (less-intensive rounding/modification of edges and ridges), and fresh or unabraded pieces (little to no edge/ridge modification, sharp angular edges). The following raw material types were recorded during artifact classification: Ventersdorp lava, quartzite, quartz, fine-grained materials (cryptocrystalline silicates, including all cherts, agates and chalcedonies, and hornfels).

**Table I** Total assemblage samples, by size, for the excavations at Canteen Kopje.

<table>
<thead>
<tr>
<th>Assemblage</th>
<th>Level (cm)</th>
<th>&lt;20 mm</th>
<th>≥20 mm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSA</td>
<td>100–140</td>
<td>637</td>
<td>232</td>
<td>869</td>
</tr>
<tr>
<td>MSA</td>
<td>140–170</td>
<td>545</td>
<td>261</td>
<td>806</td>
</tr>
<tr>
<td>Fauresmith</td>
<td>170–195</td>
<td>353</td>
<td>250</td>
<td>603</td>
</tr>
<tr>
<td>MCZ</td>
<td>195–230</td>
<td>270</td>
<td>673</td>
<td>943</td>
</tr>
<tr>
<td>Alluvial gravels</td>
<td>230–240</td>
<td>11</td>
<td>123</td>
<td>134</td>
</tr>
</tbody>
</table>

**RESULTS**

Excavations through portions of the fine sediments and upper gravels at Canteen Kopje have yielded an assemblage of 3355 artifacts (Table I). In addition, 274 dip and orientation readings and 292 point plot readings were obtained during the excavations (only data most pertinent to the levels in question will be presented). All MSA data presented here were obtained during a separate study (spatial and depositional data were not obtained; Sarupen, 2010).

**Assemblage Size Profile Data**

Figure 3 illustrates the size distributions of material for the respective assemblages in Pit 6. To assess the level of variability in these size distributions, Kruskal–Wallis (KW) tests were performed (summarized in Table IIa and b). There is a difference in the proportions of material between the upper levels with LSA, MSA, and Fauresmith, compared to the lower MCZ and alluvial gravels (Table IIa; \( n = 3355; P = 0.000 \)). In the LSA levels, over 70% of the entire assemblage falls within the <20 mm category. Small sizes are typical of LSA industries, but the presence of lithics <20 mm shows that the respective levels have not lost much material. The MSA levels have only slightly less than 70% SFD preserved, which shows relatively good retention of material and minimal disturbance to the deposit. The Fauresmith levels comprised 59% SFD. In contrast to these upper levels, the lower MCZ and coarse alluvium (230 cm downwards) contain greatly reduced SFD percentages (29% and 8%, respectively). In terms of the range of artifact sizes (>20 mm), the LSA levels appear to show the most restricted distribution of larger artifacts (none >160 mm, to be expected), whereas the MSA and Fauresmith levels have a fuller range (up to >180 mm) of pieces >20 mm, albeit small quantities of each. The coarse alluvium has its largest quantity of material >20 mm, with many larger pieces reaching >200 mm in length (Figure 3). Table IIb confirms that there is a statistically significant difference
Artifact Depositional and Spatial Data

Dip and orientation analysis for the LSA, MCZ, and alluvial gravels is shown in Figure 4 (an insufficient number of readings were obtained for the Fauresmith levels). Table III provides a statistical assessment of these variables for the three assemblages. A Rayleigh test of uniformity was performed to assess whether the assemblage data are uniformly distributed (random) or whether there is a tendency for data to cluster (nonrandom, directed; McPherron, 2005; Bernatchez, 2010; Oestmo et al., 2014). A significant value ($P < 0.05$) indicates a preferential orientation (in one or more directions); the $Z$-value indicates how great the clustering of data is around the mean vector (the larger the value, the more likely the data are nonuniform in distribution).

Long axis orientation readings for the LSA show northerly and easterly components (Figure 4). The highest frequency of readings occurs between 320–350º and 65–80º. In addition, the lowest frequency of readings occurs between 180º and 320º. Table III supports a significant clustering of the data suggesting a nonrandom distribution ($n = 140; Z = 9.066; P = 0.0001$). Figure 4 shows that dip angles are most common between 5º and 15º (>40 readings) with others prevalent between 15º and 25º (>20 readings). The Rayleigh $P$ and $Z$ values for the LSA dip data show a very strong

Table II  Artifact size distribution Kruskal–Wallis test statistical data for the upper and lower assemblages (a), and all assemblages (b).

<table>
<thead>
<tr>
<th>Assemblage</th>
<th>Sample</th>
<th>Mean Rank</th>
<th>Test Statistics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper (LSA, MSA and Fauresmith)</td>
<td>$n = 2278$</td>
<td>1423.99</td>
<td>Chi-square ($\chi^2$)</td>
<td>593.221</td>
</tr>
<tr>
<td>Lower (MCZ and alluvial gravels)</td>
<td>$n = 1077$</td>
<td>2215.26</td>
<td>Degrees of freedom (df)</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>$n = 3355$</td>
<td>2215.26</td>
<td>Asymptotic significance ($P$)</td>
<td>0.000</td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSA</td>
<td>$n = 869$</td>
<td>1324.85</td>
<td>Chi-square ($\chi^2$)</td>
<td>669.050</td>
</tr>
<tr>
<td>MSA</td>
<td>$n = 806$</td>
<td>1415.40</td>
<td>Degrees of freedom (df)</td>
<td>4</td>
</tr>
<tr>
<td>Fauresmith</td>
<td>$n = 603$</td>
<td>1578.35</td>
<td>Asymptotic significance ($P$)</td>
<td>0.000</td>
</tr>
<tr>
<td>MCZ</td>
<td>$n = 943$</td>
<td>2146.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvial gravels</td>
<td>$n = 134$</td>
<td>2697.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$n = 3355$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
clustering, suggesting a nonuniform distribution of the data (Table III).

Long axis orientation readings obtained for the MCZ are random (Figure 4). The highest frequency of readings occurs between 285° and 290° (n = 4); the remaining readings occupy almost all cardinal directions ranging from 0° to 350°. Table III supports the uniform distribution of the MCZ orientation data (n = 92; Z = 0.242;
Artifact dip and orientation Rayleigh test statistical data for the LSA (n = 140), MCZ (n = 92), and alluvial gravels (AG) beneath 240 cm (n = 50).

<table>
<thead>
<tr>
<th>Assemblage</th>
<th>Orientation</th>
<th>Dip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Vector (°)</td>
<td>Circular SD (°)</td>
</tr>
<tr>
<td>LSA (n = 140)</td>
<td>32.323°</td>
<td>94.791°</td>
</tr>
<tr>
<td>MCZ (n = 92)</td>
<td>193.28°</td>
<td>139.647°</td>
</tr>
<tr>
<td>AG &gt; 240 cm (n = 50)</td>
<td>73.646°</td>
<td>81.343°</td>
</tr>
</tbody>
</table>

$P = 0.785$). Additional dip angle data show that there is a large proportion (40%) of material which has a 0–10° dip, with the remaining pieces (60%) exhibiting dips between 10° and 45° (Figure 4). Table III data show a significant clustering of the dip readings, suggesting a nonuniform distribution of the data ($n = 92$; $Z = 87.166$; $P < 0.0001$).

Depositional data for the alluvial gravels beneath the 240 cm level show a strong easterly component in orientations (Figure 4). The highest frequency of readings ($n = 6$) occurs between 45°–50°, 110°–115°, and 165°–170°; a limited number of readings occur between 205° and 340°. Table III Rayleigh Z and P values support the nonuniform distribution of the data ($n = 50$; $Z = 6.662$; $P = 0.001$). Dip angle data readings are most frequent between 10° and 30°. Table III dip data also support a non-random clustering of these readings.

Artifact spatial data ($n = 97$) for the fine sediment and alluvial gravel interface are presented in Figure 5. Figure 5a shows the distribution of artifacts, by size, indicating that there is a higher frequency of smaller artifacts (20–59 mm category) within the MCZ than in the lower lying alluvial gravels. The remaining size categories appear to show a random spatial distribution within both the MCZ and gravels. Figure 5b shows the distribution of artifacts by condition. For the alluvial gravels from 230 cm downwards, there is a clear dominance of heavily weathered/abraded pieces (only three pieces occur beneath the 230 cm level which are fresh/unabraded and slightly weathered/abraded). The MCZ shows a mix of artifact condition types, which appear to be random in distribution.

**Raw Material and Artifact Condition Data**

Raw material and artifact condition data are presented in Figures 6–8 and Tables IV–VII. Figure 6 shows that the LSA levels 70–140 cm (data from Forssman et al., 2010) have the highest proportion of fine-grained raw materials (56.8%). Ventersdorp lava accounts for 37.1%, followed thereafter by quartz (5.2%). The underlying MSA levels are also dominated by fine-grained materials (49.5%), followed thereafter by Ventersdorp lava (31.8%). The greatest quantity of quartz is also found in these levels (11.5%). The Fauresmith assemblage also shows that fine-grained materials are dominant (45.9%). Ventersdorp lava for these depths increases to 41.8%, and quartz and quartzite are similar in their distributions (5.6% and 6.6%, respectively). Table IVa data confirm that the distribution of raw materials in these upper assemblages is significantly different ($KW; n = 9761; P = 0.000$).

For the remaining assemblages (MCZ vs. gravels), the raw material distributions differ when compared with one another (Table IVb; $KW; n = 1077; P = 0.003$). Ventersdorp lava only accounts for 37% within the MCZ, whereas for the gravels it is the dominant raw material (61.2%). Fine-grained materials dominate in the MCZ with 49.5%, and the remaining quartz and quartzite percentages between these two samples are largely similar. Table IVc data confirm the significant difference in these raw material distributions, with depth ($KW; n = 10,838; P = 0.000$).

Artifact condition by raw material for the Fauresmith and MCZ is shown in Tables V and VI. The Fauresmith raw materials show a clear absence of heavily weathered/abraded pieces (fine-grained materials highest at 2.5%). The majority therefore comprises fresh/unabraded and slightly weathered/abraded material, collectively 98% for Ventersdorp lava, 97.5% for the fine-grained materials, and 100% for both quartz and quartzite (Table V). From these data, it appears that there is little difference in artifact condition by raw material. However, for the MCZ, Table VI shows that there are much larger proportions of heavily weathered/abraded material, most specifically for Ventersdorp lava (59.9%, with only 11.2% comprising fresh/unabraded). Fine-grained materials are also dominated by heavily weathered/abraded pieces, coupled with a similar proportion of fresh/unabraded pieces (43.8% and 43.1%, respectively). Quartz and quartzite are the least weathered/abraded pieces for these levels (Table VI).

Artifact condition for the Fauresmith, MCZ and alluvial gravel assemblages is presented in Figures 7...
and 8. Figure 7 illustrates that the Fauresmith has a high concentration of fresh/unabraded pieces (56%). Slightly weathered/abraded pieces account for 42% and the remaining 2% are heavily weathered/abraded. In contrast, the MCZ is dominated by heavily weathered/abraded pieces (51%); fresh/unabraded pieces account for only 25%. Figure 8 illustrates the change in weathered/abraded pieces by depth, most important for the Fauresmith and MCZ levels. The Fauresmith levels are clearly dominated by fresh/unabraded and slightly weathered/abraded pieces (collectively 98.3% for 170–180 cm and 97.8% for 180–195 cm). For the MCZ, high percentages (collectively 62%) of fresh/unabraded and slightly weathered/abraded pieces can be found between 195 and 210 cm; heavily weathered/abraded pieces account for 38% of the sample for these levels (a large increase compared to the 2.2% from 180 to 195 cm). With depth, this percentage of well-preserved material decreases considerably. At a final depth of 230–240 cm, 76% of the assemblage is heavily weathered/abraded with only a small percentage of fresh/unabraded material (<10%). A comparison of artifact condition by depth
is summarized in Table VII; these results show that there is a significant difference in artifact condition with depth (KW; \( n = 1046; P = 0.000 \)).

DISCUSSION

Assemblage Profiles

Assemblage integrity at Canteen Kopje has been shown to vary with depth (Figure 3; Tables IIa and b). The upper LSA levels have a high portion of small material (SFD > 70%), and orientation data for pieces in these levels show preferred orientations toward the north and east (dip data also show a strong clustering; Table III). High levels of preservation are to be expected of a low-energy, aeolian environment (where the removal of material is minimal). According to Schick (1987, 1991, 1997) and Kuman and Field (2009), this layer would appear minimally affected by transformation processes, provided knapping occurred in the area. A recentration of this SFD by moderate or intense fluvial flow appears unlikely although there is a clustering in orientation and dip data. However, without a more detailed assessment of these dip and orientation readings, across a greater area of the excavation, conclusions can only be tentative. The young age of this assemblage (A.D. 1436–1870) coupled with its microlithic characteristic may also account for this high preservation (see Forssman et al., 2010). It is also still possible for these levels to have been affected by processes which do not result in a complete removal of this smaller material; such processes would most likely also account for the complete lack of stratigraphy in the fine sediments. This appears to be the result of bioturbation, noted by several studies (De Wit, 2008; Forssman et al., 2010; Chazan et al., 2013).

In addition, trampling may also have modified these layers. Several studies discuss the effect of trampling (Schiffer, 1983; Villa & Courtin, 1983; Gonzales et al., 1985; Nielsen, 1991; Vermeersch & Bubel,
Experimental studies by McBrearty et al. (1998), Gonzales et al. (1985), Nielsen (1991), and Vermeersch and Bubel (1997) establish patterns in downward artifact movements in sediments; this will vary due to sediment type and the density, shape and size of the artifacts themselves. A size sorting of materials (as different sized pieces are differentially relocated), both vertically and horizontally, is possible (Nielsen, 1991); however, trampling seldom results in the removal of material, rather, it merely displaces it (Morton, 2004). For the LSA levels, future research should focus specifically on identifying any artifact damage which could indicate the influence of trampling; however, it is highly possible that assemblage components were worked into the surface sediments by trampling (hence promoting initial downward artifact movement/burial).

Assemblage integrity for the MSA levels is high based on the SFD component, the full range of artifact sizes (which refutes lithic influx), and the variety of artifact types (such as core trimming elements; Sarupen, 2010) which indicate primary knapping (Figure 3). If minor redistribution of the SFD did take place, it would have been by processes of bioturbation and/or low-energy sheetwash (Schiffer, 1983; Morton, 2004). Trampling could also have played a role in the initial downward movement of artifacts; however, artifact damage studies on these levels are needed to confirm such findings.

Assemblage integrity for the Fauresmith levels is somewhat different from the overlying MSA and LSA assemblages. Overall, the SFD component is slightly low, at 59% (Figure 3); this falls just below the low end of the range established in experiments by Schick (1987) using a 4 mm sieve mesh (60%) and well below the figure established by Kuman and Field (2009) using 2 mm mesh (87%). Artifacts for these levels include a high representation of cortex on flakes, as well as core rejuvenation elements (including partial core tablets; Kuman et al., in prep.). Based on these assemblage components, off-site lithic manufacture does not appear to have been significant. Possible reasons for a slightly low SFD component are dilution by mixing of larger pieces from the gravels below, minor loss of SFD by sheetwash, or changes in site function over time. Such changes may relate specifically to the sites use as a knapping (factory) area; during the Fauresmith there may have been greater variability in such use, leading to a lower SFD distribution for these levels.
The MCZ and alluvial gravels have even more reduced SFD components (Figure 3). Most significant is the almost complete absence of SFD in the gravels. This is further supported by Leader (2014) in which mention is made of the significant absence of this smaller material within the gravels because the alluvial gravels have been deposited within a high-energy environment. Interestingly, the SFD component for the MCZ is higher relative to the alluvial gravels, supporting that the MCZ contains mixed contents from the Fauresmith above.

**Evidence for Bioturbation in the MCZ**

Artifact spatial, condition, and raw material data for the Fauresmith and MCZ highlight the mixing of some Fauresmith assemblage components into the MCZ horizon. The Fauresmith extends from 170 cm below datum down to the top of the gravels at 195 cm, and it is mixed into the top 35 cm of the gravels (down to 230 cm). Fresh/unabraded pieces are more prominent from 195 to 210 cm, within the MCZ, when compared to the underlying 230–240 cm level (Figure 7). The underlying gravels appear undisturbed by bioturbation. Table V shows that the level of mixing between the Fauresmith in the fine sediments (170–195 cm) and the lower MCZ is low, due mainly to the limited distribution of heavily weathered/abraded pieces for these levels, irrespective of raw material type. Table VI, however, shows a very different pattern. Within the MCZ, the increase in heavily weathered/abraded pieces thus highlights the movement and mixing of pieces from the alluvial gravels (as this heavily weathered/abraded component cannot be derived from the overlying fine sediments where fresh material is the norm). The top 35 cm of the gravels thus include a mix of alluvially deposited artifacts and younger Fauresmith pieces from the aeolian sediments. This is further supported by Figure 5 which indicates a mix of fresh and heavily weathered/abraded pieces within the MCZ; it is clear that the fresh pieces are derived from the upper fine sediments, whereas the weathered/abraded pieces are from the gravels.

We believe the most likely mechanism through which artifacts would come to rest within the gravels is the deposition of Fauresmith artifacts on the irregular gravel surface with a shallow sediment covering and bioturbation, primarily caused by extensive plant root action and possible tree falls. Bioturbation would only have been possible provided the deposition of the fine sediments occurred during multiple events, as proposed by

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**Table IV** Artifact raw material by depth Kruskal–Wallis test statistical data (test statistic values include chi-square, degrees of freedom, and asymptotic significance); upper assemblages comparison (a), lower assemblages comparison (b), and all assemblages comparison (c).

<table>
<thead>
<tr>
<th>Assemblage</th>
<th>Sample</th>
<th>Mean Rank</th>
<th>Test Statistics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSA</td>
<td>n = 8352</td>
<td>4919.02</td>
<td>$\chi^2$</td>
<td>19.652</td>
</tr>
<tr>
<td>MSA</td>
<td>n = 806</td>
<td>4797.25</td>
<td>df</td>
<td>2</td>
</tr>
<tr>
<td>Fauresmith</td>
<td>n = 603</td>
<td>4466.31</td>
<td>$P$</td>
<td>0.000</td>
</tr>
<tr>
<td>Total</td>
<td>n = 9761</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCZ</td>
<td>n = 943</td>
<td>548.46</td>
<td>$\chi^2$</td>
<td>8.528</td>
</tr>
<tr>
<td>Alluvial gravels</td>
<td>n = 134</td>
<td>472.44</td>
<td>df</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>n = 1077</td>
<td></td>
<td>$P$</td>
<td>0.003</td>
</tr>
<tr>
<td>(c)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSA</td>
<td>n = 8352</td>
<td>5560.58</td>
<td>$\chi^2$</td>
<td>155.172</td>
</tr>
<tr>
<td>MSA</td>
<td>n = 806</td>
<td>5440.94</td>
<td>df</td>
<td>4</td>
</tr>
<tr>
<td>Fauresmith</td>
<td>n = 603</td>
<td>5062.53</td>
<td>$P$</td>
<td>0.000</td>
</tr>
<tr>
<td>MCZ</td>
<td>n = 943</td>
<td>4600.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvial gravels</td>
<td>n = 134</td>
<td>3865.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>n = 10,838</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table V** Artifact condition by raw material for the Fauresmith levels (VL = Ventersdorp lava, Qtz = quartzite, Qtz = quartz, FG = fine-grained materials).

<table>
<thead>
<tr>
<th>Fauresmith:</th>
<th>Slightly Weathered/ Abraded</th>
<th>Heavily Weathered/ Abraded</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>170–195 cm</td>
<td>(n = 250)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VL</td>
<td>59.7</td>
<td>38.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Qtz</td>
<td>93.7</td>
<td>6.3</td>
<td>0</td>
</tr>
<tr>
<td>Qtz</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FG</td>
<td>40.5</td>
<td>57.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MCZ:</th>
<th>Slightly Weathered/ Abraded</th>
<th>Heavily Weathered/ Abraded</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>195–230 cm</td>
<td>(n = 673)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VL</td>
<td>11.2</td>
<td>28.9</td>
<td>59.9</td>
</tr>
<tr>
<td>Qtz</td>
<td>63.3</td>
<td>17.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Qtz</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FG</td>
<td>43.1</td>
<td>13.1</td>
<td>43.8</td>
</tr>
</tbody>
</table>

**Table VI** Artifact condition by raw material for the MCZ levels (VL = Ventersdorp lava, Qtz = quartzite, Qtz = quartz, FG = fine-grained materials).

<table>
<thead>
<tr>
<th>Assemblage</th>
<th>Slightly Weathered/ Abraded</th>
<th>Heavily Weathered/ Abraded</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>195–230 cm</td>
<td>(n = 673)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VL</td>
<td>11.2</td>
<td>28.9</td>
<td>59.9</td>
</tr>
<tr>
<td>Qtz</td>
<td>63.3</td>
<td>17.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Qtz</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FG</td>
<td>43.1</td>
<td>13.1</td>
<td>43.8</td>
</tr>
</tbody>
</table>
Chazan et al. (2013), and that initially a shallow covering of sediment would have been deposited facilitating the downward growth of roots into the alluvial gravel surface (which would have resulted in the mixing of the deposit). Sediments would then have been continually reworked through time during subsequent fine sediment deposition, giving rise to the vertical distribution that is evident today (Figure 5). Additional disruption would also have been caused by termites (evident at the site today) and animal burrowing.

The data provided here offer evidence for a multiple episode depositional model and suggest that single episode deposition of the fine sediments at Canteen Kopje would have been implausible as it would have prevented the mixing of Fauresmith artifacts into the top of the gravels. A long time-averaged accumulation for the Fauresmith is likely, and it is also possible that some Fauresmith pieces were deposited directly onto the irregular gravel surface, prior to fine sediment deposition. However, it is clear that a large proportion of the Fauresmith assemblage was deposited within and during the deposition of the fine sediments as many are fresh in condition (Kuman et al., in prep.). Trampling damage, which would be common on pieces exposed at the gravel surface (prior to the onset of fine sediment deposition), is also uncommon. This coupled with the position of the unaltered Fauresmith levels (higher up between 170 and 195 cm) supports that deposition could have occurred both before but definitely during fine sediment accumulation.

### Table VIII Abrasion by depth for the 210–250 cm levels.

<table>
<thead>
<tr>
<th>Level</th>
<th>Fresh</th>
<th>Slightly Abraded</th>
<th>Abraded</th>
<th>Very Abraded</th>
<th>Heavily Worn</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>210–220 cm</td>
<td>78.3%</td>
<td>67.8%</td>
<td>30.9%</td>
<td>3.0%</td>
<td>0.7%</td>
<td>n = 389</td>
</tr>
<tr>
<td>220–230 cm</td>
<td>4.3%</td>
<td>27.8%</td>
<td>12.6%</td>
<td>0.9%</td>
<td>0.4%</td>
<td>n = 158</td>
</tr>
<tr>
<td>230–250 cm</td>
<td>0%</td>
<td>0%</td>
<td>2.3%</td>
<td>1.7%</td>
<td>2.7%</td>
<td>n = 368</td>
</tr>
<tr>
<td>Total sample</td>
<td>19 (82.6%)</td>
<td>86 (95.6%)</td>
<td>178 (45.8%)</td>
<td>223 (5.6%)</td>
<td>409 (3.8%)</td>
<td>n = 10,734</td>
</tr>
</tbody>
</table>

Reproduced with permission from Leader (2014). Shaded cells highlight notable percentage differences.

### Table X Flake platform facets for the 210–250 cm levels.

<table>
<thead>
<tr>
<th>Level</th>
<th>Plain (%)</th>
<th>Two Facets (%)</th>
<th>Multiple Facets (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>210–220 cm</td>
<td>77</td>
<td>20</td>
<td>3</td>
<td>n = 67 (100%)</td>
</tr>
<tr>
<td>220–230 cm</td>
<td>91</td>
<td>4</td>
<td>5</td>
<td>n = 33 (100%)</td>
</tr>
<tr>
<td>230–250 cm</td>
<td>93</td>
<td>4</td>
<td>3</td>
<td>n = 96 (100%)</td>
</tr>
</tbody>
</table>

Reproduced with permission from Leader (2014). Shaded cells highlight notable percentage differences.

Tables VIII–X present original data obtained from a separate study focusing on the 210–250 cm levels in Pit 6 (Leader, 2014). Table VIII shows artifact condition by depth, most interestingly highlighting that for an assemblage with a total sample of 15,227 pieces, 82.6% of the entire fresh component comes from the upper 210–230 cm; slightly abraded pieces account for 95.6% from these same levels (combined, 93% of all the freshest pieces occur from 210 to 230 cm; Leader, 2014). These patterns are not dissimilar to those presented in Figures 6 and 7, where fresh assemblage components were shown to decrease with depth within the MCZ, dropping off significantly after 240 cm.

Technological analysis conducted by Leader (2014) on assemblage components is highlighted by Tables IX and X. Flake dorsal scar patterns (modified from McNabb & Beaumont, 2011a) for the upper 210–230 cm levels indicate a different distribution compared to those for the...
underlying Victoria West levels (Table IX; an increase in “Y,” one central ridge, two converging ridges, and one offset ridge patterns is present); Leader (2014:218; author’s note in parenthesis) provides two possible reasons as to why this may have occurred: “First, there is an advancement in this assemblage, in the knapping techniques, which would provide more organized dorsal patterns” and “second . . . admittedly the more likely explanation, is the mixing from the upper [fine sediment] levels.” The mixing of Fauresmith assemblage components into these upper levels is directly responsible for the increased appearance in these dorsal scar patterns in the MCZ. This is supported furthermore by Table X, highlighting that the greatest number of flakes with two facets occurs in the uppermost 210–220 cm level. The Fauresmith assemblage at Canteen Kopje is more advanced in preparation and appearance than that which occurs lower down within the unmixed alluvial gravels. It is clear from Leader (2014) that on aspects of both technology and artifact condition, mixing of assemblage components has occurred within the upper 210–230 cm levels.

The influence of fluvial forces on the fine sediment assemblages at Canteen Kopje appears to be absent. Figure 4 suggests that fluvial forces are not likely to have altered the MCZ levels significantly, post-deposition, although bioturbation may have disturbed these patterns to some extent. The relatively high proportion of SFD in the MSA levels and the small size of the LSA material reflect good site context and the absence of fluvial forces. A more detailed investigation into the preferential orientation of pieces in the LSA levels is needed before conclusions can be made. Overall, there are no dip and orientation trends exhibiting flow patterns or velocities and fluvial site modification is unlikely (the fine sediments also show no form of bedding/cross-bedding that would be indicative of fluvial flow).

In contrast, additional research carried out by D. Granger, R. Gibbon, and M. Lotter on the underlying alluvial deposits (Figure 4) illustrates that there are significant trends in both the dip and orientation of artifacts and natural clasts beneath the 240 cm level (Table III; Figure 4). This finding further supports the argument that the interface of the upper gravel and lower fine sediments has been bioturbated, disturbing the original depositional fabric.

**Model for the Formation of the Canteen Kopje Deposits**

Figure 9 illustrates, in sequence, the series of depositional, formational, and transformational steps which have led to the formation of the Canteen Kopje deposits (Pit 6); erosion and deposition would have continually affected all of these levels throughout their deposition/formation:

- The alluvial gravels are deposited during the early Pleistocene (Gibbon et al., 2013); clasts and artifacts retain a distinct fabric and the deposit has a slope of between 5° and 10° (Figure 9a).
- Bioturbation and selection by hominids of raw materials for knapping disturbs the upper gravel surface (imbrication patterns). Alluvial and/or colluvial sediments may have repeatedly covered and recovered these exposed gravels (Figure 9b).
- The fine sediments start to accumulate by at least ca. 300 ka (Chazan et al., 2013); some Fauresmith artifacts may have been deposited upon the irregular gravel surface prior to fine sediment deposition, but most were deposited on top of the fine sediments that formed a covering over the gravels. Artifacts then became worked into the sediment. Trampling may have played a role in the initial downward movement of pieces into the fine sediments as the site is frequented by knappers; sheetwash may have caused the removal of some of the smallest assemblage components (Figure 9c).
- Continual bioturbation causes sediment mixing in these levels, most specifically, through the growth of roots downwards into the upper gravel layers. Over time, Fauresmith artifacts are stretched throughout the lower fine sediments. Repeated mixing leads to the formation of the MCZ (fine sediments with gravels). Possible tree falls further promote the mixing of the fine sediments and gravels. The mixing of assemblage components also promotes dilution of the SFD for these levels (Figure 9d).
- Fine sediments are further deposited within which the younger MSA material accumulates. Bioturbation continues and trampling may have assisted in downward artifact movements (Figure 9e).
- As these sediments are reworked reconsolidation occurs, allowing for the stretching of assemblage components in vertical and horizontal space (Figure 9f).
- A similar sequence of events can be seen with the deposition of the LSA assemblage (between A.D. 1436 and 1870; Forssman et al., 2010; Figure 9g).
- The assemblage is stretched as bioturbation reworks the sediments. This extensive bioturbation causes some (minor) mixing between the MSA and LSA assemblages in the 130–140 cm level (Forssman et al., 2010; Figure 9h).
The final surface overburden layer covering much of the Canteen Kopje site is deposited through the actions of diamond miners in the late 1800s. This overburden contains a full mix of sediment from the underlying deposits (Figure 9i).

**SUMMARY AND CONCLUSION**

The objective of this study was to determine the processes of site formation and disturbance affecting Stone Age assemblages in the fine sediments which disconformably
overlie ancient alluvial gravels at Canteen Kopje. All three Stone Age assemblages in the fine sediments have undergone a degree of vertical movement that we attribute largely to bioturbation by roots and insects, but three distinct industries are nevertheless represented in terms of technology and raw material proportions. The LSA (100–140 cm below datum) is very young, at ca. 450 years. It contains the largest proportion of fine-grained raw materials (Forssman et al., 2010). MSA levels occur from 140 to 170 cm and are dominated by fresh crypto-crystalline and hornfels lithics, with Ventersdorp lava comprising 31.8% (Sarupen, 2010). The Fauresmith levels (170–195 cm) contain a higher proportion of Ventersdorp lava and a slightly more reduced SFD component.

The Fauresmith levels were found to be mixed through bioturbation into the top 35 cm of the gravel deposit. This is supported by both the mixed distribution of fresh and weathered/abraded artifacts within the upper alluvial gravel layers, and the presence of dip and orientation readings which are random regardless of a clearly visible dip in the gravel deposit (coupled with distinct clast imbrication below the 240 cm level). We argue that this would only have been possible through extensive root action in the sediments and surface of the gravels; in addition, this would only have been possible with slow, punctuated deposition of the fine sediments across the site.

This research allows us to now isolate the Fauresmith assemblage and describe another variant of this important industry, which in this case appears to be a form of final Acheulean transitional to the MSA. We provide data to argue that the Fauresmith artifacts do not belong to the alluvial gravels, which are considerably older, but to the younger fine sediments that lie unconformably on the surface of the gravels. The detailed typological and technological analysis of the Fauresmith assemblage will be the subject of a separate paper (Kuman et al., in prep.).

Most important is that new data provided here show conclusively that mixing between these upper fine sediments and underlying alluvial gravels has occurred. This paper provides the first ever documentation of mixing between Vaal Gravels, dated to the later early Pleistocene, and fine sediments (Hutton Sands), probably dating to ca. 300 ka, in which the Fauresmith industry at Canteen Kopje is contained.

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