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THE IDENTIFICATION AND SIGNIFICANCE OF CERAMIC ECOFACTS FROM EARLY IRON AGE NDONDONDWANE, SOUTH AFRICA

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ABSTRACT

This paper reports on some unusual ceramic objects recovered during the most recent excavations at the Early Iron Age site of Ndondondwane in KwaZulu-Natal, South Africa. Our analysis suggests that the objects are a consequence of earthworms and termites living in human activity areas during the occupation of the site. The by-products of this interaction provide indirect sources of evidence for ancient biotic activity at Iron Age sites. In this paper, we discuss the methods used to identify these objects and their ecological and cultural significance. It is stressed that a detailed analysis of these objects provides a zooarchaeological proxy record that can enhance our understanding of local ecological processes, archaeological site formation, and the presence of cultigens on Early Iron Age sites.

INTRODUCTION

Ndondondwane ceramics composed a new stylistic phase in the regional Iron Age ceramic sequence (ca AD790-970). The ceramic typochronology, secured by radiocarbon dates, identified the Early Iron Age occupation of Ndondondwane during the eighth century AD (Maggs 1984c). Further excavation in the early 1980s uncovered a livestock enclosure, iron smelting and ivory working areas near the river, and a contemporary midden to the east of this (Loubser 1993).

Excavations were recently conducted at Ndondondwane from 1995 until 1997, followed by extensive analysis of the recovered artefacts and ecofacts (Greenfield 1996, 1997, 1998, 1999; Greenfield *et al.*1997; Van Schalkwyk *et al.*1997) (Fig. 1). The objective of these excavations was to collect spatially representative samples of data from an Early Iron Age settlement to test models of intra-settlement socioeconomic organization. This site was chosen for study because it was a single-phase settlement occupied for a comparatively short (< 100 years) duration of time. This has resulted in less pronounced settlement drift, or temporal and spatial changes in activity areas, which is uncharacteristic of other Early Iron Age settlements in the region (*e.g.*, Maggs 1984b; Whitelaw; 1994 Lane 1998). As such, Ndondondwane has not experienced many of the same depositional process typical of other multiphase

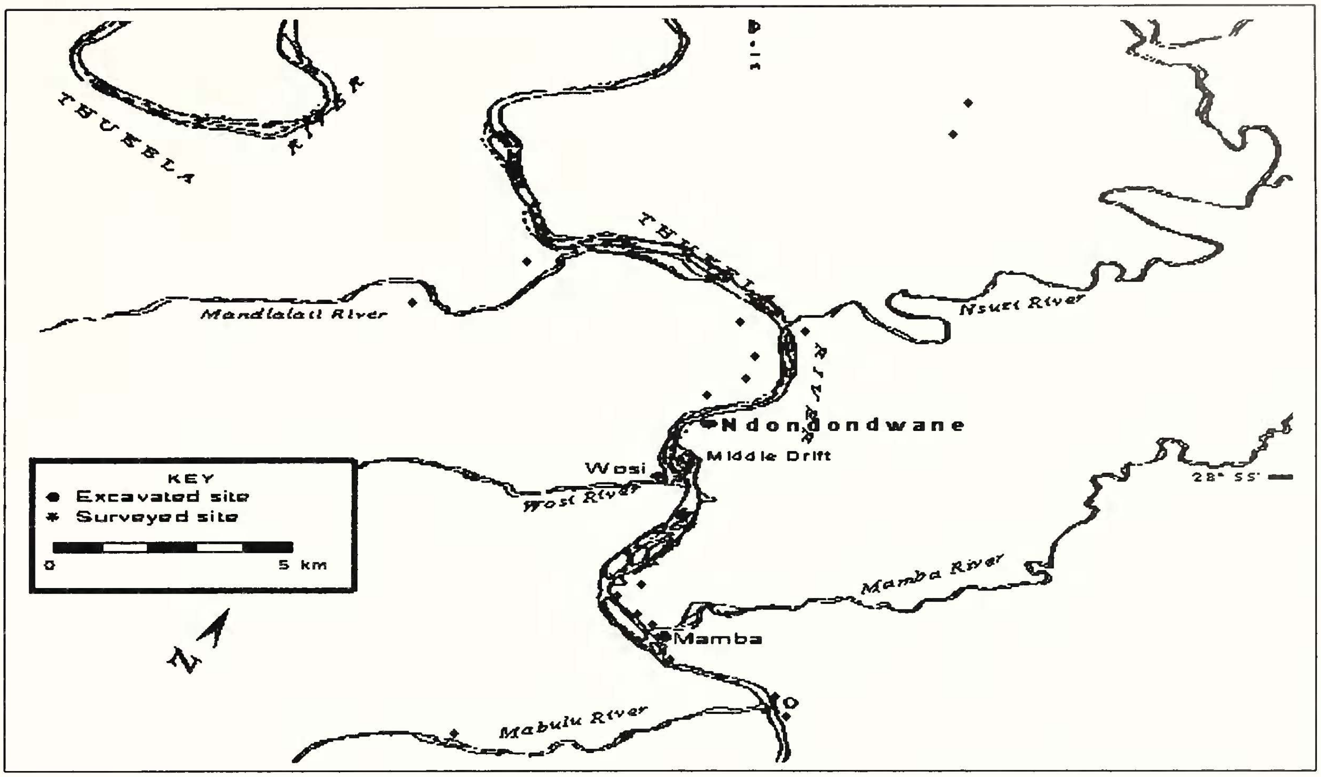

Fig. 1. Map of the Lower Thukela Basin study area and the location of Early Iron Age sites.

Early Iron Age settlements (*e.g.*, Marker & Evers 1976; Hall 1981, 1984; Feely 1987). Because the site held potential to provide a finer 'picture' of both the lateral displacement and vertical superposition of cultural stratigraphy, it was possible to pay more detailed attention to the potential effects non-cultural post burial processes had on the development of the site.

The most recent excavations at Ndondondwane expanded on work in previously excavated areas and investigated new areas of the site (Greenfield 1998, 1999; Greenfield *et al.* 1997; Van Schalkwyk *et al.* 1997). The new excavations have identified a series of spatially discrete activity areas that can be divided into two major zones (Fig. 2): a central zone surrounded by an arc of peripheral activity areas. The central zone is composed of three activity areas arranged about 40 m from each other in a line from north to south: a livestock enclosure (Dung Area), a large hut floor (Transect 1), and an area (Mound Area) reserved for iron smelting, ivory working, and possibly ritual activities (with clay mask fragments, human figurines, *etc.*). Arranged in an arc to the east of the central zone, separated by a large apparently open space of some 100 m, are a series of domestic activity areas (Middens 1 to 3). A fourth activity area used for charcoal and iron ore preparation is located at the southernmost end of the zone.

CERAMIC ECOFACTS

Numerous unusual specimens of baked clay rich soil were identified from the most recent excavations at Ndondondwane (n =150). They were originally thought to be and were catalogued as fragments of "figurines" because of their general similarity to the "figurine legs" reported by Loubser (1993:132-133, fig. 35). However, after closer examination, it was realized that they are not figurines. Instead, many were similar in size and appearance to the "figurines" that fit into reed cross-sections reported by Dreyer (1996:101, fig. 6) at Riet River in the southwestern Free State. Other specimens were much smaller. To aid in the identification of these objects, analysis focused upon the physical and mineralogical properties of the objects and their morphological characteristics.

The objects fall into two morphologically distinct groups with different physical and mineralogical properties. These properties are useful in identifying their origin and explaining their occurrence at Ndondondwane. The prevalence of these particular objects at other Early Iron Age sites is unknown since they have never been described before.

Baked earthworm faecal casts

Properties

Included in the first group are narrow, tapered cylindrical fragments of variable thickness along their extent (Fig. 3A). They range from 15-25 mm in length, centre around 6 mm in circumference, and can taper from a 'head' to a 'tail' often by as much as 2-3 mm. The surface colour of the objects ranges from reddish yellow (Munsell 5 YR 6/6) to light brownish grey (Munsell 7.5 YR 6/2). In cross-section, each has a distinct black-grey 'core effect' surrounded by a ring the same colour as the surface of the objects (*i.e.*,

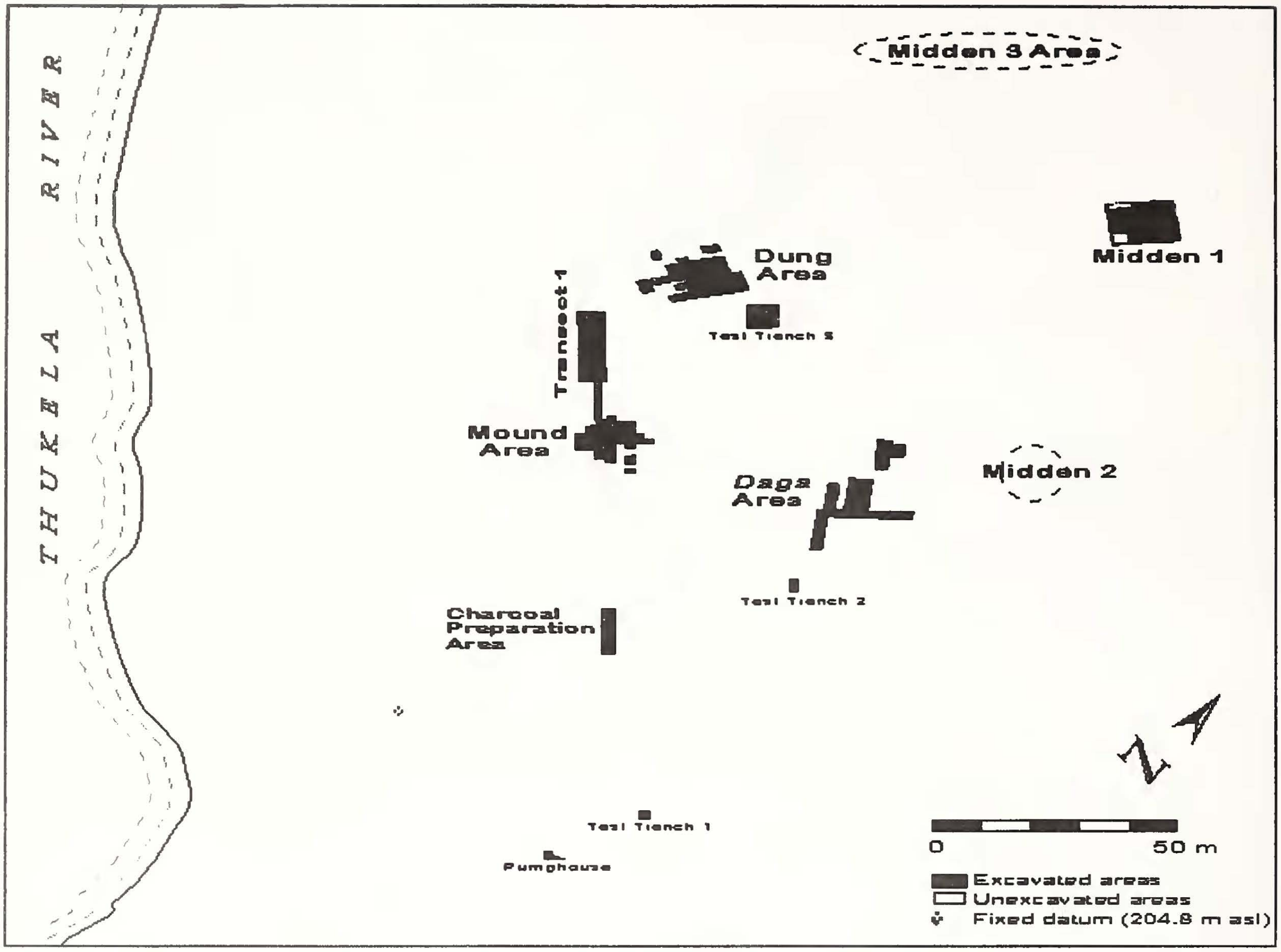

Figure 2. Site plan of Ndondondwane.

biscuit). The objects have no plainly visible mineral constituents. Microscopic inspection distinguished very small (~0,5 mm) white quartz inclusions and elongated voids. The presence of elongated voids points toward organic material, probably plant matter, having been originally present in the clay matrix (Peacock 1977:30-32).

Not all objects that fall within this morphological category were fired soil. Several similar objects had their matrix of consolidated soil completely replaced by calcium carbonate. In these cases, the calcium carbonate was exposed to heat long enough to fuse the matrix.

These properties are useful for reconstructing firing conditions (atmosphere, temperature ranges, and firing duration). Core effects are characteristic of pottery fired below 1000°C. A sharp margin marking the inner core is indicative of incomplete oxidization in soils with high clay content that likely had organic material originally present (Rye 1981:115), which is confirmed by the presence of elongated voids in the fabric. The objects do not exhibit any surface cracking and are rather hard (Mohs 3.5-4). This suggests that chemically combined water in the soil matrix was allowed to escape as steam (Johnson *et al.* 1988). Slow heating rates in low temperature fires, around or less than 500°C, produce such effects.

It appears that these specimens were fired under oxidizing atmospheric conditions at relatively low temperatures, likely less than 500°C. Very small pieces of plant material (perhaps grass or chaff) were probably in the soil matrix when the specimens were subjected to heat. Fires were also likely of long duration – a scenario where fuel was continually added to open fires, as it often is in cooking fires or in some traditional ceramic firing methods. Whatever the precise means, the firing conditions were adequate to decompose the organic constituents in the specimens, and temperatures were sufficient to make them durable by transforming the clayey soil into a low-quality terracotta ceramic. Their morphology and physical properties indicate that they did not result from precisely the same processes that formed all the objects in the second group.

Identification

The first group of objects are identical with consolidated soil of unfired earthworm faecal casts, and were identified as fired casts of earthworm faecal matter. Their diameter varies around a mean of 6 mm, which is the mean size of adult earthworms in this region (Edwards & Lofty 1977).

A general understanding of earthworm behaviour yields some insight into the transformation of the faecal

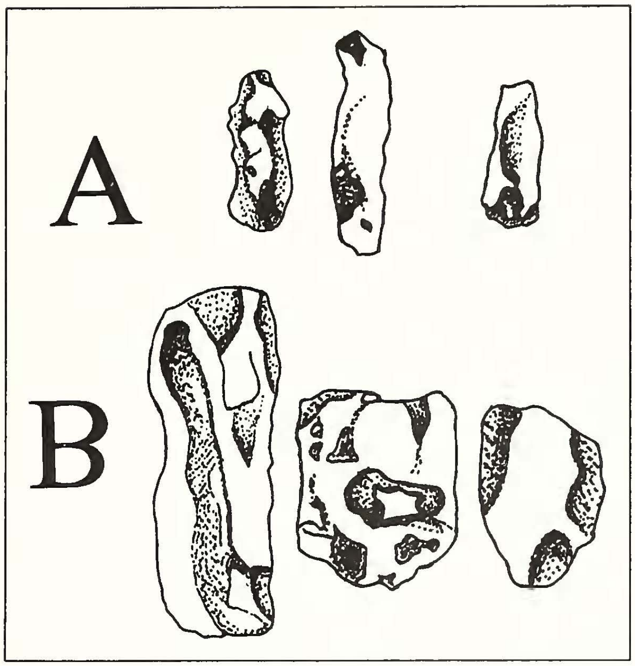

Figure 3. Examples of ceramic ecofacts. A - baked earthworm fecal casts; B - fired *Sorghum* sp. stalk casts.

casts from soil to ceramic. In the process of feeding, earthworms (*Oligochaeta*) ingest soil in order to process organic material. Some species of earthworms live in deep soils and tend to move vertically to and from the surface (*e.g.*, *Lumbricus* sp.), others live within the top 10 cm of soil and prefer horizontal movements, rising only to drop faecal matter and during rains (*e.g.*, *Aporrectodea*). When earthworms rise to the surface to deposit faecal matter, the resulting casts of consolidated soil can become incorporated in fires and/or charcoal/ ash dumps. If a fire is built over the casts, they become trapped within the hot embers. The heat produced under these conditions would be sufficient to bake the consolidated soil. It is because faecal matter is deposited on the surface that it gets baked and is therefore preserved in a terracotta form. The preferred movement and other behaviours of various earthworm species can help isolate those that were present in and contributed to the formation of Early Iron Age soils and stratigraphy.

Site Context

The provenance of the terracotta earthworm casts is important for reconstructing pedogenic changes at the site. The faecal casts recovered during excavation were found at different depths and locations.

A total of 38 faecal casts were found in the plough zone (n=37) and cultural horizon (n=1) of Midden 3. This is a deflated midden that had experienced recent ploughing. Because ploughing tends to dislocate objects from their horizontal context more extensively than from the vertical context (Rick 1976; Roper 1976), it is possible that the faecal casts in this area were not originally located in the cultural deposits and are of later or modern origin. There is no preserved evidence of cultural stratigraphy in this area and it is difficult to confidently assign any of the ecofacts found outside pits to the ancient occupation at the site. The single specimen found in the cultural horizon may also be intrusive.

A further 64 faecal casts were recovered from depths between 30-40 cm in the eastern part of the Dung Area. The most recent excavations have isolated two activity zones in the Dung Area: one used primarily by humans in the east and the other by livestock in the west. A stockade wall divides the two zones, and the stratigraphy in each zone is very different.

In the livestock zone (and within the stockade), four strata have been attributed to two temporal horizons (Fig. 4). Each temporal horizon contains a pair of overlying loose and underlying compact dung. The loose dung strata are mixed with ash and charcoal. The Upper Loose Dung stratum is a mix of dung, small charcoal fragments and ash, while the Lower Loose Dung stratum includes only dung and charcoal fragments. In contrast, both compact dung strata are composed almost entirely of decomposed animal dung, but are not uniform over the entire area. In modern byres, compact dung only forms where livestock tend to cluster in an enclosure, and this is often at the lowest elevation in the byre (in this case, towards the west). Thus, compact dung did not accumulate where human activity occurred.

In the eastern half of the Dung Area, uphill from the Livestock zone, is where human activity is clearly attested and where the fired earthworm casts were recovered. It is termed the human activity zone of the Dung Area because there is evidence for the reworking of iron implements (*i.e.*, charcoal and smithing slag) and the dumping of cultural debris (animal bone, pottery, *etc.*). It is also where meat was roasted on many occasions over a bowl-like depression, resulting in the accumulation of much ash, charcoal, and burnt bone within the depression. Three strata were found in this area (Fig. 4):

1. an Upper horizon of loose fine ash;
2. a Middle horizon of coarser ash, mixed with bone and some charcoal; and
3. a Lower horizon of coarse sediment, mixed with large amounts of charcoal and bone. Ceramics are abundant throughout the deposits.

The Upper horizon in the human zone could not be stratigraphically linked to the livestock zone because previous disturbances had truncated its spatial association. However, the association of the other horizons in the human zone of the Dung Area is clearer. The Middle horizon can be stratigraphically linked to the Upper Loose and Compact Dung horizons in the animal zone (15-35 cm depth), while the Lower horizon is linked to the Lower Loose and Compact Dung horizons (35-60 cm depth).

The faecal casts therefore occur within the lower depths of the Middle horizon (ca 30 cm) and the Lower horizon in the eastern Dung Area (ca 35-60 cm). Each of these horizons are linked to two phases (Upper and Lower) in the development of the livestock byre. The

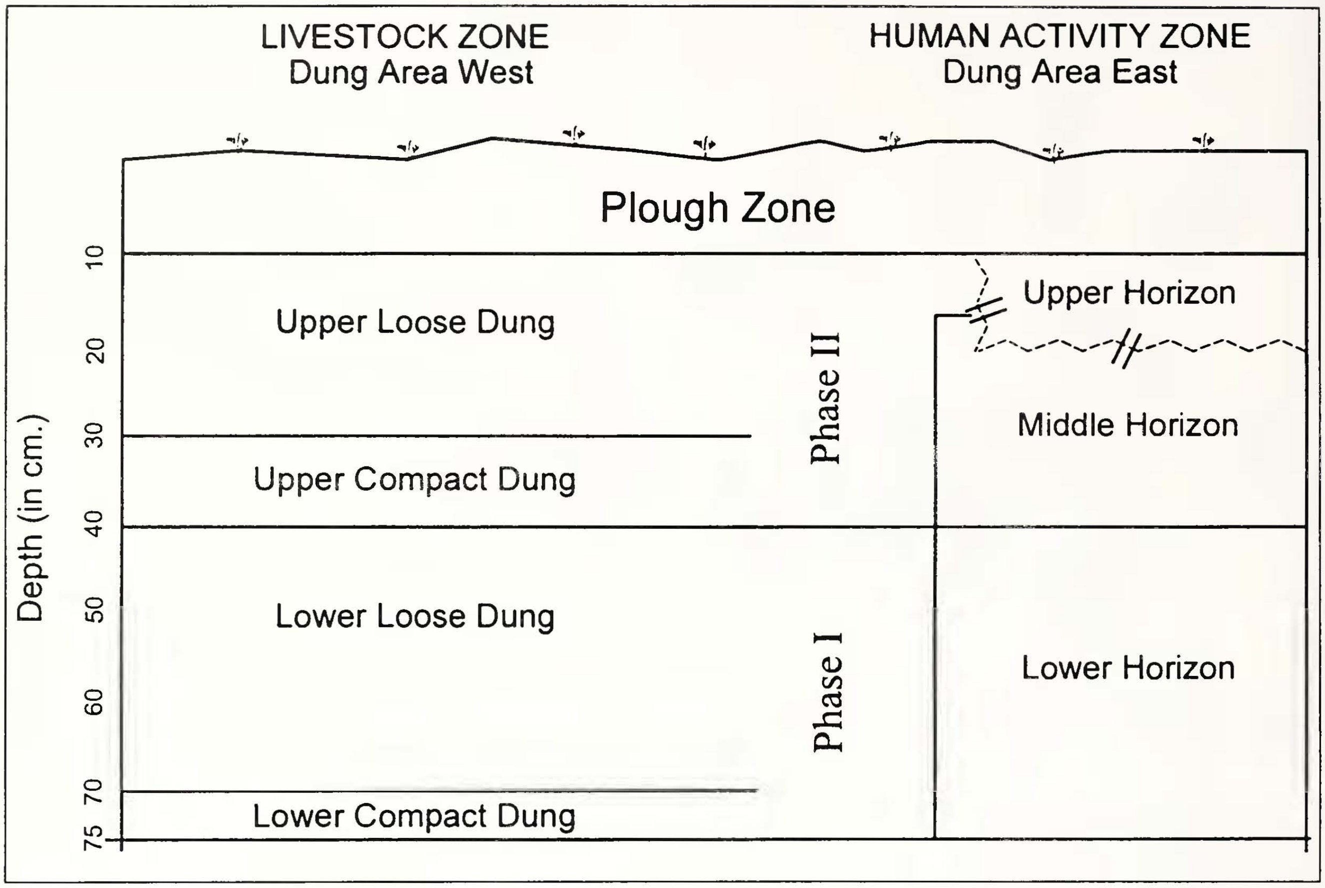

Figure 4. Simplified stratigraphy of the Dung Area at Ndondondwane.

presence of earthworm activity is documented for the entire formational history of this area of the site.

Earthworm Behaviour

Earthworms conduct a delicate balance between temperature, oxygen, nutrition, and density requirements by moving from oxygen deprived environments or inhabiting locales where the topsoil is occasionally mixed, allowing gas by-products to escape. The activity of earthworms would not be out of place in the nutrient rich environment of livestock byre, but it is interesting to observe that the casts are found only in the area with human activities. While the levels of carbon dioxide and other gases may have inhibited earthworm activity in the animal zone where the dung was thickest, particularly on the edges of the byre, this is unlikely for two reasons. First, livestock would have mixed the upper layer of the dung as they moved about the byre, thus releasing gaseous by-products. Second, earthworm faecal casts were not preserved in the livestock zone because no fires were built there.

Because earthworm casts are only deposited on the surface, and because earthworms tend to displace material towards the surface and not the reverse (Edwards &Lofty 1977), it is very likely that these casts were sealed in an archaeological context concurrent with the occupation of Ndondondwane. The casts were probably burnt in the process of either cooking food or smithing iron in the human activity area of the livestock byre. Clearly, these objects provide evidence that earthworms were active in the Dung Area during the occupation (as they are currently), but the unusual relics of their presence were only inadvertently preserved by human activity in the area.

Plant Stalk Casts

Properties

The second group of objects ranges in length from 20 to 40 mm and from 5 to 19 mm in width and have characteristic striations and/or pits running along their extent (FIG. 3B). The surface colours fall under two different hues: specimens are either dark red in colour (Munsell 2.5 YR 3/4, 5/8, 4-5/6) or more reddish yellow in colour (Munsell 5YR 4/1, 5/6, 6/6). There are two fabric types. Some only have small rounded and elongated voids while others have calcite grains and well-rounded quartz and gneiss material (less than 1 mm in diameter). This makes them rather different from Ndondondwane vessels, which primarily have coarse fabrics composed of angular or more rounded quartzite.

In cross section, this group of objects either has a distinct black-grey core effect or a homogenous colouring with no core effect. The darker coloured specimens with a black-grey core effect were incompletely oxidized and probably had organic material present in the matrix. The sharply defined dark grey inner core almost reaches the outer surface suggesting these objects were fired in a reducing atmosphere, cooled rapidly in air and originally contained organics

(Rye 1981: 115). Those without a visible core effect appear to have been almost completely oxidized and may or may not have had organic material present in the original soil matrix. The lighter-coloured specimens have a greyish core with more diffuse margins. This implies they were incompletely oxidized and originally contained organic materials.

This variation suggests that the objects were subjected to different atmospheric conditions: the lighter-coloured ones were subject to an oxidizing atmosphere, but the darker ones were fired in a reducing atmosphere (*i.e.*, oxygen flow was restricted). The nature of the voids indicates that small oolite or limestone fragments (spherical voids) and organics (elongated voids), such as bits of grass, chaff, or straw, composed the original body of the objects before firing (Peacock 1977). Such inclusions will usually burn out around 578°C. It is unlikely that the firing temperature of the objects was any greater than 870°C (Friede 1983; *cf.* also Gosselain 1992).

While the fragments are generally hard (Mohs 4-5), the surface of the darker fragments could be more easily scraped away (Mohs 2.5). Brittleness of the surface is typical of ceramics fired at high temperatures for brief periods (20-30 minutes). These additional data suggest that different coloured specimens were fired at different temperature ranges. Darker-coloured specimens with more brittle surfaces were fired briefly at high temperatures in a reducing atmosphere then cooled rapidly in the open air. The lighter-coloured ones have harder surfaces and are more similar to the fired earthworm casts. These were fired longer in an oxidising atmosphere at lower temperatures. It is also noteworthy that the types of clays present at Ndondondwane (iron-rich kaolin clays) have low shrinkage, and when fired in this temperature range quartz can act to reduce firing shrinkage (Rice 1987:96). This suggests that all of these specimens are at or very near their original dimensions, despite being fired under different atmospheric conditions.

Identification

Similar objects were found in the Riet River excavations (Dreyer 1996:101-102, fig. 5). Dreyer concluded that these were the remains of soil baked after accumulating in plant stalks because they fit within the interstitial spaces within modern reed (*Phragmites* sp.) stalks growing near the site. Therefore, the outer surfaces of these objects are casts of the interior of the particular plant in which they formed. In comparing the Ndondondwane specimens to those from the Riet River excavations, our specimens were observed to be of similar size but with different morphological characteristics. However, the Ndondondwane specimens are larger than the modern reeds in the basin. It is unlikely the Ndondondwane specimens are from modern reeds in the lower Thukela basin because reedswamp comm.-unities (*Phragmites communis*) are heavily stunted due to over-grazing, abrasive river flow, and overuse by the rural population (Van Schalkwyk 1991). Nevertheless, it is most plausible that the archaeological objects from Ndondondwane represent soil baked after accumulating in plant stalks.

Based on these observations, we must also consider the possibility that these specimens represent soil accreted in other plant stalks and are intrusive to the Early Iron Age levels of the site. In his excavations, Loubser (1993:111) observed that modern maize was planted across much of the site. In areas with high ash content or cultural remains (*i.e.*, the Mound Area), a mature maize stand was stunted in height. Even though these mature maize stalks are smaller, the size and morphology of their interstitial spaces still does not match that of our specimens.

The Ndondondwane specimens did not match the morphological characteristics of the interstitial space in other modern maize stalks (*cf.* Freeling & Walbot 1994). The archaeological specimens were somewhat smaller than modern maize. It is unlikely that these specimens came from post-eighteenth century maize stalks because (1) there is no historical or ethnographic evidence for maize cultivation in this area prior to the twentieth century and (2) the specimens are too small to have been accreted in maize and too large to be formed in millet. The specimens best fit the size and shape of the interstitial spaces of sorghum stalks. Consequently, we argue that the composition and morphology of these terracotta objects represent soil baked while within the stalks of a *Sorghum* sp. stand.

Termite Behaviour

One phenomenon in particular seems to us the most plausible explanation for the manufacture of the plant stalk casts. Termites (*Isopteria* sp.) carry soil up the stalk of maize, sorghum, or millet plants while creating runnels (termite burrows). Once abandoned by the termites, these accretions remain within the stalk of the plant. If fired at sufficiently high temperature, the soil-filled stalks bake and drop to the ground. They would then be incorporated into the archaeological site by sediment deposition above them. The result is a ceramic object created as a consequence of termite activity.

Van Schalkwyk and Greenfield observed the results of a similar formation process during the 1995 field season at Ndondondwane. During this first field season, hollow maize stalks still standing in the southeastern area of the site from the 1993-1994 growing season were burnt off prior to survey and excavation. As the stand burnt, the soil termites accumulated in the base of the stalks began to bake and subsequently fell to the ground among the still burning stalks and grasses in the maize stand. The casts were covered over by the maize stalks and grasses creating a rudimentary, but effective, reducing atmosphere. Once the fuel was exhausted, the stalk casts rapidly cooled in the open air. This resulted in very same physical properties described for the archaeological examples above. After being fired, the exterior of the casts permanently took on the characteristics of the interior structure of the maize plant.

The evidence for termite activity at Ndondondwane is extensive. Both modern and ancient mounds or *termitaria* were found on the site. Large modern termite mounds, probably constructed by *Macrotermes subhyalinus* (Coaton *et al.* 1972; *cf.* Meyer 1997), were scattered among the dense brush or at the base of trees covering the eastern half of the site. The bases of ancient *termitaria* were excavated in two areas of the site. Based on their size, they were probably constructed by the same taxon. In the Dung Area at the northeast edge of the human activity zone, the base of a large termite mound extended from just beneath the plough zone deep into the sterile substrate disturbing the cultural horizons in a 2 x 2 m area. It extended to a depth of almost 50 cm beneath the modern surface. The base of another smaller *termitaria* occurred in Midden 3, at the western or down slope edge of the midden. It was found within 10 cm of the surface, and was approximately 1.5 m in diameter. The depth was not ascertained because the midden deposit was deflated and all cultural remains lay within 20 cm of the surface. It is interesting to observe that both of the ancient termite mounds were located on perimeter of human activity areas. This should not be surprising since termites tend to locate their mounds near the bases of trees or stumps (Ferrar 1982; Meyer 1997), which might have been left around the perimeter of different activity areas within the settlement to provide shade.

We must note, however, that plant stalks may be preserved in much the same way as the earthworm faecal casts if crop stubble was collected for domestic fuel after harvest. In this case, the soil-filled stalks would be subjected to low temperature, oxygen-rich fires for a relatively long duration of time. Such a scenario would account for the differences observed in the colour, hardness, and surface texture of the stalks described above, as well as where they were found (discussed below). Either of these processes, which combine termite activity and heat, can preserve evidence of *Sorghum* production at sites.

Site Context

The plant stalk casts, which can now be described more properly as fired casts of *Sorghum* stalks, were recovered from two groups of contexts at the site:

1. From modern or uncertain provenance in the plough zone of Midden 3. A number of stalk casts found in Midden 3 (n=20) were covered by a shallow plough zone (~5 cm). These stalks were found in the same strata as the earthworm faecal casts described above. It is also possible that the stalks in Midden 3 were not originally located in the cultural deposits in the area.

2. From stratified contexts at the site. Specifically, stalk casts were found in the cultural horizons of Transect 1 (n=1) 80-90 cm from the surface; the Dung Area (n=1) in the Middle Horizon, 30-40 cm from the surface; the cultural horizon (n=2) 10-15 cm below surface, and Pit 2 (n=1) in Midden 3; and in the cultural horizon of Midden 1 (n=1) some 15 cm below the surface. Only the objects from these contexts can be placed with any degree of certainty within the Ndondondwane occupational phase.

Based on these data and observations, we propose that the stalks of *Sorghum* represent the crops cultivated by the inhabitants of Ndondondwane. Regardless if the fields were burnt intentionally or as a consequence of wild fires, the fired sorghum stalks recovered at Ndondondwane were subsequently deposited in nearby charcoal/ash dumps located in the livestock enclosure (e.g., from a thin ash lens in the Upper Compact horizon in the Dung Area – Greenfield et al. 1997, 1998; van Schalkwyk et al. 1997) and nearby residential middens, probably after preparing fields for a new planting season.

DISCUSSION

The presence of fired plant stalks and earthworm faecal matter at Ndondondwane tends to confirm the observation that not all Iron Age ceramic objects may be the result of human manufacture. Human activity may only be secondary or tertiary to the creation of the final product. In the above discussion, it was stressed that people were not purposefully involved in manufacturing the objects, but cultural activity may have indirectly played a role in their preservation. Thus, the terracotta earthworm faecal casts and sorghum plant stalk casts can properly be termed ecofacts in more than one sense of the term: they are preserved evidence of plant remains and invertebrate faunal activity, and have contributed towards understanding the nature of soils and sediments in riverine contexts, particularly when they have been subjected to heat input by domestic or grass fires. To this point, the discussion had focused on the genesis of the ceramic ecofacts. These objects also have several important implications for Iron Age research in this region, which are discussed next.

Identification

The methods used to identify these objects should be of considerable interest to archaeologists working in southern Africa and in subtropical climatic regimes elsewhere. Such objects likely form part of recovered archaeological assemblages, but have not been previously recognized. It is worthwhile to make the effort to identify them because of the wealth of information that they can provide about a site and its history.

It is particularly important to make the effort to identify such ecofacts, especially in those areas with either a poor history of botanical recovery due to methodology or preservation conditions. For example, at Ndondondwane, carbonised millet seeds were found (Maggs 1984c). Despite the extensive flotation of the ash deposits at Ndondondwane, no carbonised sorghum seeds have yet been identified (T.Jongsma, pers. comm. 2000). It would appear that any potential evidence was incinerated. More broadly, only 36 Iron Age sites throughout eastern and southern Africa have reported evidence of preserved grains (Reid & Young 2000). It would appear that even though the conditions for the preservation of carbonised grains may exist on such sites, they are not always likely to be found. Other more indirect sources of information must therefore be sought.

To identify the ceramic ecofacts, two sources of information were drawn upon.

1. Ceramic Classification. The analysis of the ceramic data from the excavation at Ndondondwane included all ceramic objects – from vessels to figurines to the more enigmatic objects discussed in this paper. If this assemblage had been examined using traditional methods of ceramic analysis in southern Africa these objects would not have been identified. It is noteworthy that many of these objects were identified or recovered from previously excavated areas. Further, a consideration of the mineralogical composition and morphology of the Ndondondwane ceramic assemblage allowed the fired plant stalks and earthworm faecal matter to be singled out as atypical objects in this and other ceramic assemblages in the region. A more detailed consideration of the physical properties of the stalk and faecal casts permitted a reconstruction of the probable conditions under which the objects were transformed from the clayey soils characteristic of the site into low-quality terracotta ceramics.

2. Field Observations. Dreyer's (1996) astute observations at Riet River provided that starting point to begin thinking about the origins of the ecofacts. Subse-quently, the burning of the old maize stand in preparation for excavations at Ndondondwane in 1995 yielded unexpected insights into the processes that formed the archaeological plant stalk casts found at Ndondondwane. While fired casts might immediately be seen as "curiosities" of common biotic activity at subtropical archaeological sites, they also have taphonomic and behavioural significance.

Pedogenic and Depositional Processes

The ecofacts identified at Ndondondwane provide evidence for ancient biotic activity at Iron Age sites. They are an under-investigated proxy record of the pedogenic and depositional processes affecting these settlements.

Pedogenic Processes

Earthworms and termites change the nature of the soil they inhabit. Both taxa consume soil and excrete or regurgitate it. Earthworms help to keep soil horizons soft, while termites make it more compact.

Earthworms burrow by pushing soil aside or consuming the soil before them. They either leave their castings behind or on the surface. In effect, earthworms displace soil by consuming it and excreting as they move vertically and horizontally through soil horizons. The excreted soil is crumbly and helps to form the A soil horizon. They keep the A soil horizon from becoming too compacted (Wood & Johnson 1978; Stein 1983). Since earthworms will pass soil material in an area through their system every few years, they effectively churn the soil of an area over time. While some earthworm species in the region, such as the common dew worm (*Lubricidae* sp.), prefer deep soil and vertical movement, other species such as the African nightcrawler (*Eudrilus eugeniae*) or the manure worm (*Eisenia foteida*) inhabit shallower depths and tend to move horizontally (see Edwards & Lofty 1977). Earthworms with shallow burrowing behaviour were found across the site of Ndondondwane during excavations. The Dung Area stratigraphy is such that there is no substantial mixing or blending of the various strata, except at the northern edge where a termite mound was found. In this one location, the strata were obliterated by termite activity. Although earthworms were present in the eastern Dung Area of Ndondondwane, it appears that their activity did not substantially alter the archaeological stratigraphy in the area. Therefore, the African nightcrawler and manure worm are the best candidates for the species once active at Ndondondwane.

Termites displace soil by moving it from one place to the next in the process of constructing *termitaria*. They bring fine earth subsoil fractions to the surface and mould structures from the soil and organic matter. During the construction of the above and below ground extensions of *termitaria*, termites consolidate the soil. Termites make a paste of soil, saliva, and a sticky solution secreted by the frontal gland. In effect, the soil and organic particles are glued together to form a dense hard matrix. The subsurface extensions of *termitaria* are often preserved on archaeological sites and are easily identified as a dense hard matrix similar to dried cement. New termite mounds are created every few years, and tend to be relocated in relatively close proximity to abandoned ones (Lee & Wood 1971; Wood & Johnson 1978). Therefore, termites can modify the entire soil of an area over a period of time (McBrearty 1990). An illustration of the effect of termites on cultural strata comes from the Dung Area and Midden 3. The cultural strata in those parts of the Dung Area and Midden 3 where termite mounds were identified were obliterated.

Depositional Processes

Beyond the mixing and movement of soil done by earthworms and termites, they can also have a profound effect upon the preservation of archaeological artefacts and features. This is particularly true of earthworms.

Earthworms affect archaeological deposits in four ways. They may create false artefact concentrations by moving archaeological debris down to the bottom of the zone they live in (Limbrey 1975; Butzer 1982). They may bury objects by depositing faecal casts on the surface, slowly burying debris lying on the surface (Limbrey 1975; Butzer 1982; Stein 1983). Some estimates suggest that earthworms can drop as much as 9,600 kg of casts on hectare of surface annually (Wood & Johnson 1982:548, 552). Such action is capable of burying surface material rapidly, preserving its original location. However, this behaviour does not have the same effect on heavier objects as it does on soil. Other field research suggests that certain species of earthworms will blur the distinctions between different sediments and deposit boundaries, but they will not displace material greater than 10-20 mm in diameter (Stein 1983:284, 286). Additionally, earthworms alter texture and chemistry of soils and can destroy ecofacts such as carbonised seed remains by eating them as they move through soils. In some cases, this may explain the paucity of certain seed types recovered in Iron Age archaeological contexts.

Despite the fact that earthworms can move substantial quantities of soil in an area over time, there is little evidence for the formation of overlying sediments above the final occupations. This is simply due to the ecology of the species present. Sediment was moved more laterally than vertically. This is particularly visible in the Dung Area stratigraphy where there was no substantial mixing or blending of the various strata, except at the northern edge where a termite mound was found.

At this point, the best *direct* evidence for earthworm activity comes from the Dung Area. It is certainly not speculative to infer the importance of earthworm activity in decomposing organic debris in the middens. However, it is unknown what effect such activity would have on the arrangement of debris within storage and refuse pits. Potentially, such biotic activity could inhibit our ability to distinguish between episodes of pit use and the discard of cultural debris, making it difficult or impossible to link the use history of different domestic middens to each other and other activity areas in a site.

Termites may also preserve the general location of artefacts. Artefacts are often frozen in place as *termitaria* are built around them. Features, however, are usually destroyed as termites bring up soil and organic material in order to create *termitaria* (McBrearty 1990). They can carry soil grains and similarly sized organic materials to the surface from as far down as 2 m (Wood & Johnson 1978).

It is noteworthy, however, that little is known yet about the effect earthworm and termite activities may have had in all areas of the settlement. Changes in soil texture and colour are deceptively subtle at Ndondondwane within the identified soil horizons, apart from middens. Yet, in middens, where much accumulation of organic debris is found, erosion, deflation, modern ploughing, and other taphonomic processes often masked any direct indication of biotic activity. Although earthworms and termites were present at dondondwane, it appears that their activity did not substantially alter the archaeological stratigraphy of the site. The forces of down slope erosion and deposition of sediments on the more gently sloping terrain along the river valley bottom are more pronounced. Upslope, cultural deposits are very shallow (within 5 cm of the surface), while down slope they can be buried as deep as 1 m. However, earthworm and termite activity may differentially affect sites located in other southern African ecozones (*e.g.*, coastal littoral, highveld) that have experienced different natural and cultural taphonomic post-burial processes. Ultimately, we cannot assume that there are direct links between the patterning of artefact and feature distributions on Early Iron Age sites and human behaviour. Such linkages must be demonstrated on a case-by-case basis by considering the physical and biological processes that affect the movement and positioning of artefacts, ecofacts, and features within the three-dimensional context of a site.

CONCLUSIONS

Despite the relatively common occurrence of earthworms and termites at many archaeological sites throughout the world, the gap in archaeological literature on this subject indicates that the ecofacts resulting from their activity are often overlooked or otherwise considered of little analytical importance. In southern Africa, the systematic collection of artefacts and ecofacts has created an abundant material record that yields evidence of both human activities and environmental conditions at sites. Since ecofacts such as those discussed above are likely being recovered from other Early Iron Age sites, it is quite necessary that their presence and location be noted and their significance evaluated. In this paper, we have stressed that a detailed analysis of these objects provides a proxy record that can enhance our understanding of local ecological processes, archaeological site formation, and subsistence.

A new class of evidence that helps identify the presence of burrowing invertebrates on sites was presented. This has also led to the discovery for the first time of sorghum as a cultivated grain crop at the site of Ndondondwane. Botanical analyses of carbonised seed remains had not previously identified this important staple crop at this site. It is now known that both sorghum and bulrush millet (*Pennesitum typhoides*) were cultivated at Ndondondwane.

Termites and earthworms can be important agents of postburial modification of artefacts, ecofacts, and sediments. They destroy but they also can preserve evidence of cultural behaviour. Most research on the effects of burrowing activity at archaeological sites is cast as cautionary tales. The mixing and churning of soils by animals are often viewed as barriers impeding a "correct" interpretation of past cultural activity. In this article, we have instead demonstrated how the identification of indirect evidence of burrowing activity may also be instructive about the formation of archaeological deposits and preservation of Early Iron Age cultigens in eastern South Africa. Issues surrounding site formation and intra-settlement organization continue to pose major problems for understanding the social and economic organization of early farming communities in southern Africa. We hope to have shown that alternative, indirect sources of evidence may also play an increasingly important role in resolving these issues.

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REFERENCES

Binford, L.R. 1964. A consideration of archaeological research design. American Antiquity 29:425-451.

Butzer, K.W. 1982. Archaeology as human ecology: method and theory for a contextual approach. Cambridge: Cambridge University Press.

Coaton, W.G.H., Sheasby, J.L., Ruelle, J.E. 1972. National survey of the Isoptera of southern Africa. Cimbembasi Memoir No. 2. Windhoek: Windhoek State Museum.

Dreyer, J.J.B. 1996. Clay "figurines" from the Riet River: a case of natural site formation. Southern African Field Archaeology 5:99-102.

Edwards, C.A. & Lofty, J.R. 1977. Biology of earthworms. Second edition. London: Chapman and Hall.

Feely, J.M. 1987. The early farmers of Transkei: Southern Africa before AD 1870: Oxford: BAR International Series 378.

Ferrar, P. 1982. The termites of the Savanna Ecosystem Project study area. Pretoria: Cooperative Scientific Programmes, Council for Scientific and Industrial Research.

Freide, H. 1983. Laboratory investigations of Transvaal Iron Age Pottery. Archaeological Research Unit, Occasional Papers 10. Johannesburg: University of the Witswatersrand.

Freeling, M. & Walbot, V. (eds). 1994. The maize handbook. New York: Springer-Verlag.

Gosselain, O. P. 1992. Bonfire of the enquiries. Pottery firing temperatures in archaeology: what for? Journal of Archaeological Science 19:243-59.

Greenfield, H.J. 1996. Report on activities during the summer of 1995. University of Manitoba Newsletter 6:9-11.

Greenfield, H.J. 1997. Research report on activities during the summer of 1996. University of Manitoba Newsletter 7:11-12.

Greenfield, H.J. 1998. 1998 preliminary report on the 1997 summer field season at Ndondondwane. University of Manitoba Newsletter 9:6-8.

Greenfield, H.J. 1999. Summary of the 1998-1999 University of Manitoba research on the Early Iron Age site of Ndondondwane. University of Manitoba Newsletter 10:1-3.

Greenfield, H.J., van Schalkwyk, L.O. & Jongsma: T.L. 1997. Ndondondwane: preliminary report on the 1995 survey and excavations. Nyame Akuma 47:42-52.

Hall, M. 1981. Settlement patterns in the Iron Age of Zululand: an ecological interpretation. Oxford: British Archaeological Reports International Series 119.

Hall, M. 1984. Man's historical and traditional use of fire in southern Africa. In Booysen, P.D.V. and Tainton, N. M. (eds) Ecological effects of fire in South African ecosystems. Berlin: Springer-Verlag.

Johnson, J.S., Clark, J., Miller-Antionio, S., Robins, D., Schiffer, M. B., and Skibo, J.M. 1988. Effects of firing temperature on the fate of naturally occurring organic matter in clays. Journal of Archaeological Science 15:403-414.

Klapwijk, M. 1973. An Early Iron Age site near Tzaneen, N. E. Transvaal. South African Journal of Science 29:19-23.

Lane, Paul J. 1998. Engendered spaces and bodily practices in the Iron Age of Southern Africa. In Kent, S. (ed.) Gender in African prehistory. Walnut Creek: AltaMira Press.

Lee, K. E. and Wood, T. J. 1971. Termites and soils. New York: Academic Press.

Limbrey, S. 1975. Soil science and archaeology. London/New York: Academic Press.

Loubser, J.H.N. 1993. Ndondondwane: the significance of features and finds from a ninth-century site on the lower Thukela river, Natal. Natal Museum Journal of Humanities 5:109-151.

McBrearty, S. 1990. Consider the humble termite: Termites as agents of post-depositional disturbance at African archaeological sites. Journal of Archaeological Science 17(2):111-144.

Maggs, T. 1984a. Iron Age settlement and subsistence patterns in the Tugela River Basin, Natal. In Hall, M., Avery, G., Wilson, M. L. (eds) Frontiers: southern African archaeology today. Oxford: British Archaeological Reports International Series 207.

Maggs, T. 1984b. The Iron Age sequence south of the Zambezi. In Klein, R.E. (ed) Southern Africa prehistory and paleoenvironments. Rotterdam: A. A. Balkema.

Maggs, T. 1984c. Ndondondwane: a preliminary report on an Early Iron Age site on the lower Tugela River. Annals of the Natal Museum 24(1):71-93.

Maphumulo, P. 1986. Middledrift archaeological sites: soil survey. Eshowe: KwaZulu Government Service, Department of Agriculture and Forestry.

Marker, M. & Evers, T.M. 1976. Iron Age settlement and soil erosion in the eastern Transvaal: South Africa. South African Archaeological Bulletin 31:153-165.

Meyer, V.W. 1997. Distribution and density of mound-building termites in the Northern Kruger National Park. Pretoria: Department of Nature Conservation.

Peacock, D. P. S. 1977 Ceramics in Roman and Medieval archaeology. In Peacock, D. P. S. (ed.) Pottery in early commerce. London: Academic Press.

Reid, A. and Young, R. 2000. Pottery abrasion and the preparation of African grains. Antiquity 74:101-111.

Renfrew, C. and Bahn, P. 1991. Archaeology: theories methods and practice. New York: Thames and Hudson.

Rice, P.M. 1987. Pottery analysis: a sourcebook. Chicago/London: University of Chicago Press.

Rick, J.W. 1976. Downslope movement and archaeological intrasite spatial analysis. American Antiquity 41:133-144.

Roper, D.C. 1976. Lateral displacement of artifacts due to plowing. American Antiquity 41:372-375.

Rye, O.S. 1981. Pottery technology. Washington: D.C.: Taraxacum.

Stein, J.K. 1983. Earthworm activity: a source of potential disturbance of archaeological sediments. American Antiquity 48:277-289.

Van Schalkwyk, L.O. 1991. Society in transformation: Early Iron Age mixed farming communities in the lower Thukela basin: Zululand. Unpublished MA thesis: University of Cape Town.

Van Schalkwyk, L. O., Greenfield, Haskel J., and Jongsma, Tina L. 1997. The Early Iron Age site of Ndondondwane, KwaZulu-Natal, South Africa: preliminary report on the 1995 excavations. Southern African Field Archaeology 6(2):61-77.

Whitelaw, G.D. 1994. KwaGandaganda: settlement patterns in the Natal Early Iron Age. Natal Museum Journal of Humanities 6:1-64.

Wood, W.R. and Johnson: D.L. 1982. A survey of disturbance processes in archaeological site formation. In Schiffer, M.B. (ed.) Advances in archaeological method and theory, Vols. 1-4. New York: Academic Press.