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# A Phosphate Analysis of Stone-Walled Structures in the Suikerbosrand Nature Reserve

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# A Phosphate Analysis of Stone-Walled Structures in the Suikerbosrand Nature Reserve

**Jesse Ensor-Smith**

Dissertation submitted in partial fulfilment of the requirements of the Degree of Honours in Archaeology of University of the Witwatersrand 2012

DIVISION OF ARCHAEOLOGY

SCHOOL OF GEOGRAPHY, ARCHAEOLOGY AND ENVIRONMENTAL STUDIES

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## Abstract

With the purpose of confirming the “kraal index” created by Sadr and Rodier (2012), a group of stone-walled structures in the Suikerbosrand Nature Reserve were selected for study. Confirming this involved testing for livestock presence in the inner enclosures of Group III stone-walled complexes. Phosphate testing of the inner enclosures revealed the absence of evidence showing the presence of livestock occupation. This may be because of the phosphate testing method used. It may also be because of different culture factors involving the recycling of dung as fuel and kraal maintenance. The probability of each hypothesis is weighed up against the supporting data captured by the phosphate analyses.

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## Acknowledgements

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# Introduction

Many stone-walled structures have been identified in south Gauteng. These pre-colonial structures are important in understanding and reconstructing the cultural landscape in this area. From past work in this field we know that the stone-walled structures date somewhere within the last millennium. This time frame is characterised by the shift from a pastoralist or hunter-gatherer lifestyle to a more permanent one (Huffman, 2007). We can therefore expect to find a landscape scattered with stone-walled structures (Sadr & Rodier, 2012, p. 1034).

With the multitude of stone-walled structures in the area comes the task of classifying them. Both Huffman (2007) and Taylor (1979) have provided good classifications of stone-walled structures in the area. For the purpose of this study the Taylor classification will be used. This research is closely related to that of Sadr and Rodier (2012) in which the same typology was used. A more detailed explanation of Taylor's typology follows in the next chapter. A similar area of research will be used. This is a polygon of land within the Suikerbosrand Nature Reserve termed 'Pam 1'.




**Figure 1 A map showing the location of the Suikerbosrand Nature Reserve in relation to southern Africa. The inset map shows a three dimensional view of the Suikerbosrand, emphasising the type of topography one would expect to find there.**

There are three main groups of stone-walled structures in the Suikerbosrand. Group III structures are being targeted because of their comparatively large number of inner enclosures (Sadr &

Rodier, 2012, p. 1036).Inner enclosures are thought to be associated with livestock pens and for this reason group III stone-walled structures seem to have a much higher “kraal index” or livestock per capita ratio than other structures in the area. The livestock per capita ratio was calculated by dividing the total area of all the inner enclosures in a group III stone-walled complex by the total area of the complex itself. A phosphate analysis of the soil in the inner enclosures will show if this hypothesis is correct.

The use of the words kraal and livestock pen will be used interchangeably in this paper to denote an area where animals are kept. The words complex and homestead will also be used interchangeably to describe a group of stone-walled circles surrounded by a larger perimeter wall.

The study of stone walled structures is rooted in the study of settlement patterns. The distribution of sites within a landscape reveals correlations that can help explain the inner settlement systems. This research aims ultimately to expose the inner complexity of a settlement and not its relation to the landscape. Therefore a completely geographic approach is not appropriate as is used by Sadr and Rodier (2012).

The data in question will reveal an aspect of the social, economic and political complexity that drove these societies. Livestock were a sign of wealth and how livestock were kept has been rigidly defined by previous structuralist based research. Structuration would be used invaluably to interpret the data coming out of this research, but would only serve to confirm it. If livestock were to be kept in a different way to that suggested by such structuralist ideals, this would put a new perspective on the spacial and social organisation of pre-colonial societies.

If the data does deviate from the norm, this may have a number of implications. Variance from the very structured ideas situated in the organisation of pre-colonial settlements may lead to conclusions of agency and individualism. The social implications of families within a settlement keeping or not keeping their own store of livestock may lead us to think of these organised structures at a more individual level.

## Previous Research

The stone-walled structures in the southern Gauteng region have been the subject of much study and have contributed valuably to the understanding of pre-colonial civilisations in South Africa. One of the biggest and broadest studies of the area was done by Thomas Huffman (2007).

Huffman (2007) would associate the structures found in this landscape as belonging to the Iron Age. Putting the stone-walled structures in such a rigid time period has been criticised as this implies a complete shift from a pastoralist or hunter-gatherer lifestyle to a more permanent one. It is most likely that sedentary settlements and nomadic groups coexisted during the Iron Age. This accounts for the variety and quantity of stone walled structures in the region.

The interior of southern Africa has very little to no written history before Victorian times. Conventional historical approaches cannot be applied to southern Africa when trying to learn more of its past. It is for this reason that a more archaeological approach needs to be employed. Maggs (1976) and Mason (1968) proceeded to do this by analysing the stone-walled structures in the southern Highveld.

Fortunately, air photography has been used since the 1960s to map stone walled structures in a large part of South Africa (Hall, 1981; Mason, 1968; Maggs, 1976). Recent improvements on such technology, such as the use of Geographic Information Systems or Google Earth, have produced even better maps of the region. Ground surveys have been done by the likes of Pam MacQuilkan (2010) for even greater resolution.

Mason (1968) began aerial surveys of the southern Transvaal-Northern Natal in 1964, making a count and attempting to classify Iron Age settlements. He draws the very important link between settlement plan and social organisation here. Mason identified 6 237 definitively Iron Age settlements in the areas covered by aerial photography. He managed to classify the structures into five main classes. He defined these classes in terms of the presence of enclosing walls, the nature of the enclosing walls and the nature of the circular structures within the stone-walled complexes.

Maggs' (1976) initial survey involved the use of aerial photography at a scale of 1:36 000. Two major features stood out as definitive features when analysing the stone-walled complexes; the circle was the primary structural element and each settlement was made up of multiple stone-walled complexes. Maggs had identified two elements that Mason (1968) also isolated as defining

features. The nature of the stone circles and the distribution of them within stone-walled complexes is what are used to differentiate different settlement types.

Taylor (1976) fills the gaps between Mason (1968) and Maggs (1976) work on classifying Iron Age stone-walled structures in his Masters thesis based in the Vredefort dome (Sadr & Rodier, 2012, p. 1035). Taylor narrowed down the different possible types of stone-walled structures to three main groups. Group I structures are the simplest in design and organisation. The homestead is surrounded by an outer elliptical wall within which we expect to find a cluster of smaller inner enclosures. Group II structures are completely different in that the outer perimeter is demarcated by a series of c-shaped walls facing inwards. The c-shaped outer wall encloses a central group of enclosures (Taylor, 1979, p. 10).

Group III structures (Figure 2), the main focus of this study, are defined by a continuous or scalloped, similar to group II, outer boundary wall except the enclosures within them seem to have no order. The confusion of inner enclosures is very diagnostic, with an obviously central enclosure being rarely identifiable. Large enclosures sometimes bisect the homestead. Straight walls are also present, linking internal structures and bisecting the homestead (Taylor, 1979, p. 10).

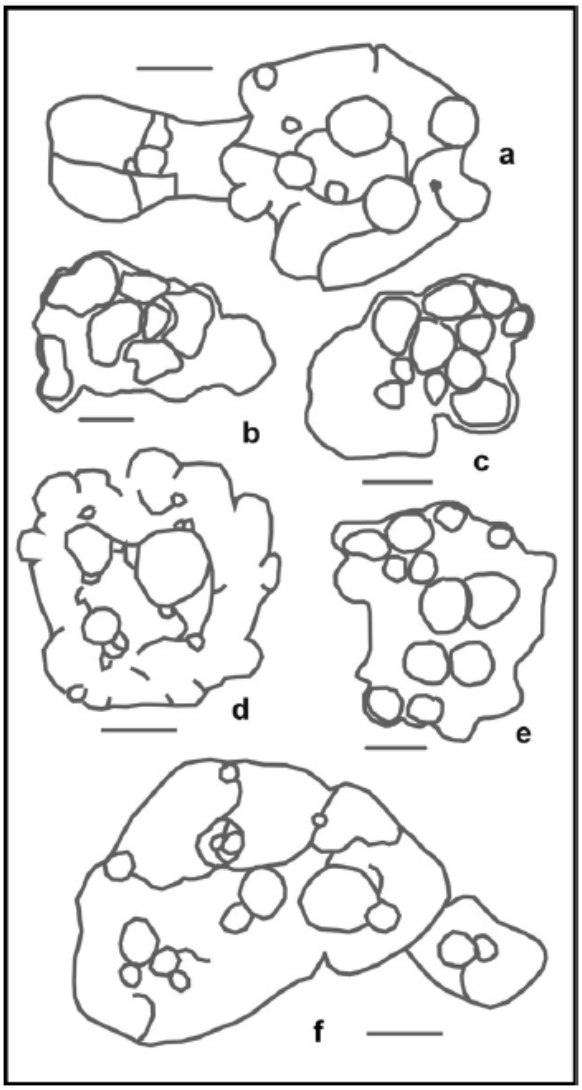



Figure 2 Group III types and varieties. All scale bars represent 20 m. (Sadr & Rodier, 2012, p. 1037)

Sadr and Rodier (2012, p. 1038) note that not all inner enclosures are visible from Google Earth imagery. This is especially problematic in group III structures as large trees grow in and around the walling obscuring much of the detail. In Sadr and Rodier's analysis they calculate a "kraal index" which is the average area of a structure which is covered by inner enclosures. They assume that each inner enclosure is a kraal, and is therefore associated with livestock and livestock wealth. The role of livestock in pre-colonial society was significant, and a fair amount of research has been done on this, especially by Thomas Huffman (2007).

This leads us to the question of what the inner enclosures were used for and if they were all in

fact, “kraals”. The disorderly nature of group III structures makes it very difficult to apply any Iron Age model to these types of homesteads. Applying one model to the problem may not be useful, but a broad knowledge of stone wall usage may shed some light on this issue.

Huffman’s very structuralist approach led him to develop the Central Cattle Pattern. Although this research does not fit into or conform to all the structural ideals that Huffman put forward, his work does give insight into what the stone walled structures may have been used for.

The Central Cattle Pattern describes the presence of cattle kraals within the walls of stone settlements. We then definitely expect to find a presence of livestock in inner enclosures in the archaeological record. The group III structures in focus deviate slightly from Huffman’s model in that they contain no obviously central enclosures. Huffman (2007, p. 38) terms these settlements Klipriviersberg type. In his model the outer scalloped walls mark back courtyards. The small inner enclosures are stock pens, and households are separated by straight walls. Seeing as a central enclosure is usually associated with cattle, it is unclear which inner enclosures were used as livestock pens?

Maggs (1976, p. 319) states that the primary circular structures were used as both huts and livestock pens. A larger central enclosure or a cluster of small circles in the centre of a complex is where we would expect livestock to be kept. This emphasises the importance of livestock within pre-colonial society. It also shows that a cluster of small stone circles, as seen in group III structures, may substitute a large central enclosure for the purpose of keeping livestock.

Mason (1968, p. 178) shares a similar view, proposing that the most central enclosures were used to keep livestock. Mason (1968, p. 179) also identifies that stone-walled structures may be reoccupied. At Klipriviersberg he identifies three separate occupations. The function of inner enclosures could very well change depending on who occupied the settlement.

Walton (1958, p. 133) speaks at length about Sotho cattle-kraals. He states:

> “*Among the southern Sotho the cattle-kraal may be a free-standing stone-walled enclosure, traditionally circular but today more often rectangular, or it may consist of a number of irregular enclosures linked together by common walls. Where the kraal is free-standing the village or homestead cluster plan takes on one of two forms. The kraal may be a large pound, capable of holding all the cattle of the village or homestead, in which case it is placed in a central position with the huts and gardens grouped around it in a circle; or a number of smaller kraals may be associated with the huts and the whole arranged in a circle around a central open space.”*

The second case described by Walton (1958, p. 133) best fits the group III structures being studied. Walton (1958, p. 133) consults a Sotho person on the matter. According to this informant a central kraal represents the older way of constructing a homestead whereas multiple inner enclosures is a newer, more defensively conscious, way of planning a settlement. This may imply that group III structures are more contemporary than group I or II structures. This correlates to Sadr & Rodier (2012, p. 1039) where they speculate that group I structures are the oldest, with both group II and III structures occurring from the seventeenth to nineteenth centuries.

One may wonder who built these structures and if they would have had influence on the meaning and use of the multiple inner enclosures. The area is difficult to study because of the Difaqane wars that probably flushed out a number of cultural groups (Loubser, 1985, p. 81). An oral traditions survey by Legassick (1969) shows that Koena or Fokeng could have inhabited the region. Huffman (2007: 38) is under the impression that the Nguni and Sotho-Tswana cultures, and more specifically the Fokeng, were responsible for the stone-walled structures we see. Mason (1968) and Maggs (1976) speak of southern Bantu societies when referring to the owners of stone-walled structures in the southern Highveld. Taylor (1979) thinks that group I structures were constructed by Sotho speaking immigrants. Group II represented a different set of Tswana speaking immigrants. Group III structures may have been constructed by the descendants of group I people. Their architecture would have been hybridised by the cultural contact with the foreign group II people. Knowing who built the structures impacts little on this study. Once a settlement structure can be determined for group III structures, a more definitive answer to the question of ownership may be found.

All that is left is to validate if the inner enclosures in group III structures were used to keep livestock. For this I employ the method of phosphate testing. The use of phosphate analysis in archaeology was developed in Europe in the 1930s (Jacob Parnell, et al., 2001, p. 857) by Arrhenius (Cavanagh, et al., 1988, p. 92). A group of pioneering scholars discovered that areas of ancient occupation showed an increase in concentration of phosphates. Since then the application of phosphate testing has slowly become a part of archaeological practise, mainly in Europe (Jacob Parnell, et al., 2001, p. 857).

Phosphate analysis has been used successfully as a surveying method. Animal urine and faeces are rich sources of phosphates in soil. It is for this reason that they are used to identify structures in which animals were kept (Chang & Koster, 1986, p. 117).Phosphate testing is well implemented in northern European archaeology as an effective way of carrying out surveys prior to construction. It is a simple and effective way of doing subsurface testing for areas of

archaeological significance. In Sweden for example, total phosphates in an area are determined by setting up a grid system and performing test excavation (Sjöberg, 1976, p. 447).

Phosphate analysis is not only useful for locating archaeological sites but can also prove useful in determining the relationships of areas within a site (Sjöberg, 1976, p. 448). This intra-site analysis is exactly what is needed for the analysis of group III structures in the Suikerbosrand. The technique is very effective in determining "sites" from "background" as demonstrated in an excavation in Greece (Cavanagh, et al., 1988, p. 81). Conway (1983, p. 122) states that phosphate analysis can be used for the distinction of activity areas within the structures of a site.

The model is fairly simple. The amount of phosphate found in soil "on-site" is very high and very low "off-site". A site can be described in this context as any area where organic residue would accumulate (Cavanagh, et al., 1988, p. 92). This may be a living space, courtyard, livestock pen or a midden. Biologically, the phosphates we see are the cellular membranes and other molecular structures left behind from plant matter and food waste (Jacob Parnell, et al., 2001, p. 857).

Chemically, as organic matter from occupation decays the concentration of phosphate increases relative to other elements. This is because both organic carbon and nitrogen are transformed into inorganic forms that are not tightly bound to the soils (Schlezinger & Howes, 2000, p. 479). Carbon is remineralised *in situ* as $CO_2$. Nitrogen is transformed into soluble inorganic forms such as ammonium, nitrate and $N_2$. Organic phosphorous however is mineralised to inorganic phosphate where it is rapidly absorbed by soil particles. Hence we find a much larger quantity of phosphate in soil compared to nitrogen or carbon. In addition to being present in a much larger quantity, phosphates are incredibly immobile in soils. Phosphates cannot be leached from soils because of their tendency to form insoluble molecules. This is true even in tropical acidic soils. Phosphates are unavailable for uptake from vegetation and remain where they were originally deposited (Lippi, 1988, p. 93).

There are a few drawbacks to the use of phospahte analysis. The most obvious is that it is difficult to differentiate livestock occupation from human occupation when only analysing the concentration of phosphate in the soil. When provided with some sort of context, more accurate conclusions can be arrived at. The analysis of organic phosphates may provide us with the contect needed (Schlezinger & Howes, 2000, p. 491). In practice, the methodology is far more complicated than the analysis of inorganic phosphates.

Additionally, phosphates are not completely immune to site formation processes. Phosphates will precipitate in most soils unless they are highly acidic. In calcereous soils with a high pH,

phosphates are precipitated as insoluable compounds. In acidic soils with a pH of less than 5.5 phosphates are not likely to precipitate (Sjöberg, 1976, p. 448). The amount of phosphates one finds in soil may be affected by multiple pH altering processes such as rainfall.

## Methodology

The foundation of this research lies in determining if the inner enclosures of stone-walled structures at the Suikerbosrand Nature Reserve were used to keep livestock. This requires an understanding of the soils within these stone-walled structures. A single technique is being used to analyse the soils. Although this makes the process very simple, any limitations to this method will impact heavily on the results. Sampling took place during the winter July of 2012 at the Suikerbosrand Nature Reserve. The Suikerbosrand Nature Reserve is found just south of Johannesburg near the town of Heidelberg. The reserve is topographically very hilly. The vegetation in the area is of the open grassland type with good grazing potential (Sadr & Rodier, 2012, p. 1034). The open grassland also makes stone-walled structures from aerial photography and Google Earth imagery highly visible.

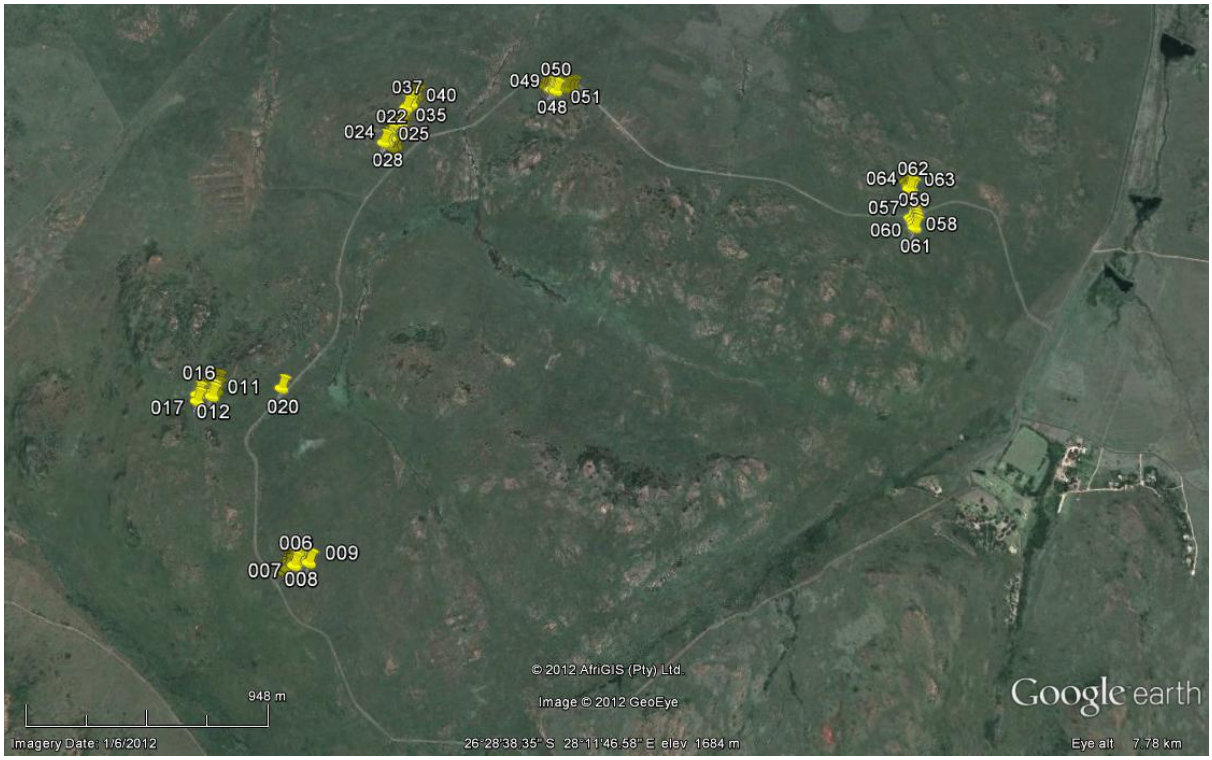



**Figure 3 A map showing the area sampled in the Suikerbosrand Nature Reserve. Each pin represents a soil sample taken and its exact location. The clustering of pins displays how many samples were taken from each homestead. A total of 65 soil samples were extracted. Higher resolution aerial photographs are presented in appendix A.**

An area to be studied in the Suikerbosrand Nature Reserve was predetermined based on the amount of group III structures clustered in an area. Professor Karim Sadr assisted in determining and selecting the group III structures because of his most recent work in the area and his expertise in the Taylor (1979) typology. The exact homesteads to be sampled were not made explicit until in the field. The quantity of homesteads in the area guaranteed the availability of potential samples. The homesteads visited are displayed in figure 3 and were geotagged using a GPS.

Soil samples were to be collected in the field and transported to a lab at the University of the Witwatersrand for analysis. Much research has been done on soil phosphates that involve in-field phosphate tests (Cavanagh, et al., 1988; Lippi, 1988; Rypkema, et al., 2007; Sjöberg, 1976) but the decision was made to do laboratory testing with the rationale of achieving more accurate and more stable results.

At the Suikerbosrand Nature Reserve field soil samples were taken from at least five inner enclosures from a single homestead. The samples were taken from the approximate middle of the enclosure (Figure 4). Soil samples were taken from the sub surface just below the leaf-litter layer. This method has been used and validated by Jacob Parnell, et al. (2001, p. 859) and Cavanagh, et al. (1988, p.70). Because phosphates are so immobile, a subsurface sample is completely adequate. Care was taken to ensure that no plant roots were extracted when collecting soil.

Approximately 10 grams of soil was taken from each inner enclosure and stored in an air tight bag. The bags were labelled according to the GPS waypoint they were located at. Additional samples were taken in the surrounding areas as background readings. Two background readings were taken per homestead, one uphill and one downhill (Figure 4). Two middens were identified in the field. The middens were clear because of bioturbation that had exposed ash and ceramics at surface level. Soil samples were taken from the middens. All samples extracted were marked with a GPS waypoint. A total of sixty five soil samples were taken. Of this total, ten were background soil samples, two were midden soil samples and the remaining fifty three were soil samples taken from internal stone-walled enclosures.




**Figure 4 Google Earth imagery showing how each homestead was sampled. Waypoints 001 – 007 are soil samples of inner enclosures. Waypoint 009 (upslope) and 010(downslope) are soils samples taken from background areas for control purposes. Waypoint 008 is a soil sample taken from a midden identified in the field.**

Unexpected results in the laboratory from the initial soil sampled required that a second expedition to the Suikerbosrand Nature Reserve be taken. The second sampling process was a targetted one, extracting fewer samples but with a definite set of questions in mind. For the second set of samples three inner enclosures were selected from the previously visited homesteads. In each enclosure two samples were taken from the approximate middle, one at sub-surface and the other at 10cm below surface. Additionally, at least two samples were taken from the enclosure perimeter. The samples taken from the perimeter were taken against the stone walls at an upslope and a downslope position. All soil weas taken using the same procedure as the initial collection. Fifteen soil samples were taken during the second field excursion.

The laboratory process was conducted using the Merckoquant® system using a Merck MilliporePhosphate test kit (Figure 5). The process was perfomed as follows:

1. Individual soil samples were sorted and sifted, removing any organic material that may affect the phosphate results.
2. 5 ml of 1.2 M hydrochloric acid was prepared in a small plastic canister.

3. Approximately 1 ml of sifted soil was then added to the hydrochloric acid and swirled for two minutes.
4. A pH-indicator strip was then immersed in the soil and hydrochloric acid solution for one second.
5. Excess liquid was shaken off the indicator strip and one drop of the reagent liquid ($PO_4^{-1}$) was added to the reactive zone on the indicator strip.
6. After fifteen seconds excess reagent liquid was removed from the indicator strip.
7. A period of sixty seconds was required before observing the indicator strip. The colour on the reactive zone on the indicator strip was then compared to the colour scale provided.

The process was repeated yielding various results. The washing of equipment between each soil sample analysis was done using purified water so that the pH of successive tests was not compromised. The method was tested using a soil sample that came from a know midden from the Suikerbosrand Nature Reserve. The control sample was taken on 14th of Septemeber 2011 by Professor Karim Sadr. The control sample yielded positive results showing a high concentration of phosphates.




**Figure 5 The Merck Millipore Phosphate test kit. 1. $PO_4^{-1}$ reagent liquid 2. pH-indicator strips 3. Plaster canister used to create soil and hydrochloric acid solution 4. Provided colour meter 5. pH-indicator strips showing reactive zones at tip.**

## Data analysis

The data collected was based on the colour chart provided in the Merck Millipore testing kit. The colour chart provided a simple scale ranging from one to seven, one being an almost negligible to non-existent phosphate concentration and seven indicating the maximum amount of phosphate concentration.

| Sample no. | Result | Sample no. | Result | Sample no. | Result | Sample no. | Result | Sample no. | Result |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 16 | 1 | 32 | 2 | 47 | 1 | 62 | 1 |
| 2 | 1 | 17 | 6 | 33 | 2 | 48 | 2 | 63 | 1 |
| 3 | 2 | 18 | 2 | 34 | 1 | 49 | 1 | 64 | 2 |
| 4 | 2 | 19 | 5 | 35 | 1 | 50 | 2 | 65 | 1 |
| 5 | 2 | 21 | 2 | 36 | 2 | 51 | 1 | 66 | 2 |
| 6 | 2 | 22 | 1 | 37 | 2 | 52 | 1 | | |
| 7 | 1 | 23 | 1 | 38 | 1 | 53 | 1 | | |
| 8 | 6 | 24 | 2 | 39 | 2 | 54 | 1 | | |
| 9 | 2 | 25 | 1 | 40 | 1 | 55 | 1 | | |
| 10 | 1 | 26 | 1 | 41 | 1 | 56 | 1 | | |
| 11 | 2 | 27 | 2 | 42 | 1 | 57 | 1 | | |
| 12 | 2 | 28 | 1 | 43 | 2 | 58 | 2 | | |
| 13 | 2 | 29 | 2 | 44 | 1 | 59 | 3 | | |
| 14 | 2 | 30 | 1 | 45 | 1 | 60 | 4 | | |
| 15 | 2 | 31 | 2 | 46 | 2 | 61 | 1 | | |

**Table 1 Results of initial phosphate sampling process. The samples are named after the GPS waypoint at which they were extracted. Green highlighted results come from middens. Orange highlighted results come from background control samples. All other results are from internal stone wall enclosures.**

The results of the initial phosphate tests were unexpected and across the board remarkably low (Table 1). The soil phosphate test was checked by reanalysing random samples with different hydrochloric acid concentrations. The results remained the same.

The readings within the inner enclosures of each homestead were very low, peaking at four. The highest result came from one of the lowest points topographically of the sites analysed at waypoint 60. Most other samples varied between one and two in phosphate intensity (Figure 6).

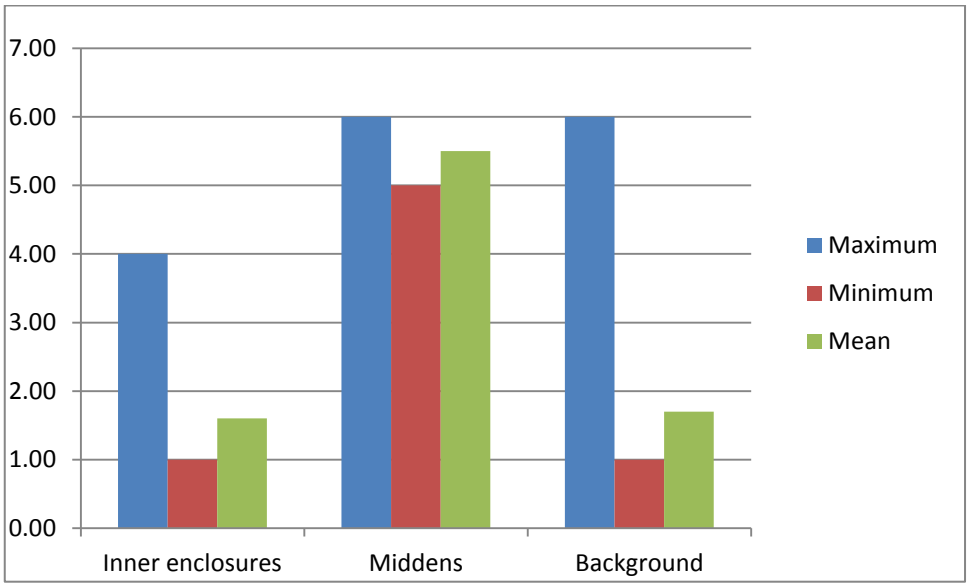



**Figure 6 Column chart summarising initial phosphate readings at the Suikerbosrand Nature Reserve**

The middens identified in the field yielded the highest results as expected. This correlates well with the midden control sample supplied from the same area. Interestingly, the highest inner enclosure result, waypoint 60, readings came from a homestead about 10 m in proximity to the control midden sample.

The background control samples yielded very low phosphate results as expected. There was however one exception. An anomalous background soil sample taken upslope from a homestead at waypoint 17 returned a very high phosphate concentration. No midden or high inner enclosure reading was found near this sample making it a very isolated incident.

The nature of the preliminary results made it necessary to conduct a second field excursion to the Suikerbosrand to extract more samples in the hopes of eliminating variables. The exact same field and laboratory techniques were used to achieve the following results:

| Sample no. | Result | Sample no. | Result | Sample no. | Result |
|---|---|---|---|---|---|
| 1 - Deep | 2 | 5 | 1 | 9 | 4 |
| 1 - Surface | 1 | 6 - Deep | 1 | 10 - Deep | 1 |
| 2 | 4 | 6 - Surface | 1 | 10 - Surface | 2 |
| 3 | 1 | 7 | 1 | 11 | 3 |
| 4 | 1 | 8 | 7 | 12 | 1 |

**Table 2 Results of secondary phosphate tests. The samples marked "Deep" and "Surface" represents the depth test analysis. All other values are from soil samples taken from inner enclosures near the perimeter wall. The highlighted phosphate results represent samples taken from the downslope side of the inner enclosure.**

The depth test yielded very low results, similar to that of the initial inner enclosure phosphate readings (Table 2). As explained in previous chapters, depth should have no effect on phosphate concentration as the phosphate preserved in soils is very immobile. The depth test results should then be expected to mimic the inner enclosure phosphate results as they were both taken from the middle of the enclosures.

The samples taken from the edge of the inner enclosures tested slightly higher than anywhere else. It is also interesting to note that samples taken from the downslope side of the inner enclosures consistently showed higher phosphate readings (Table 2). The average phosphate reading from the edges of inner enclosures were higher than that of the initial inner enclosure results (Figure 7).

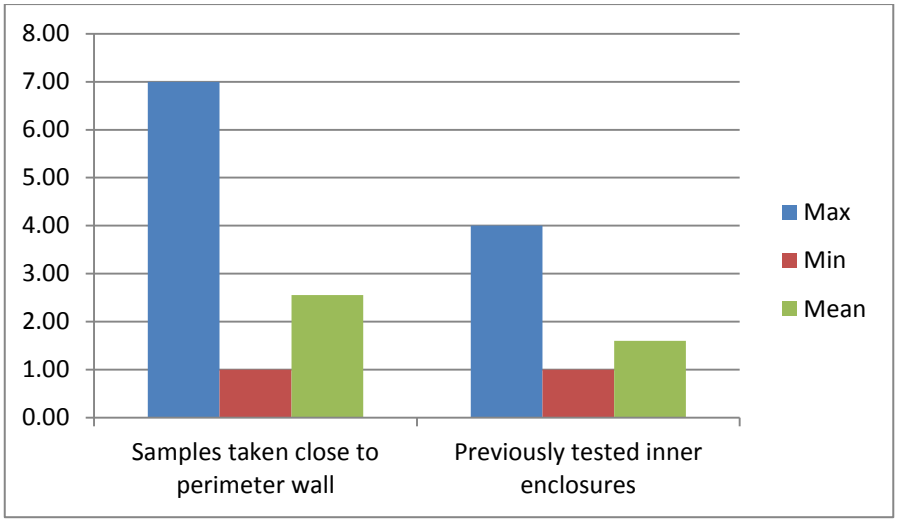



**Figure 7 Column chart comparing the initial results from the Suikerbosrand to the soil samples tested around the perimeter of inner enclosures.**

## Discussion

The phosphate content in soils has been used to determine population size, the intensity of the settlement and the duration of occupation (Sjöberg, 1976, p. 448). It may be possible to infer such information from these results based on the intensity of phosphate concentration according to the colour chart provided.

The fact that the phosphate results obtained were very low makes this extremely difficult. The question of whether or not the inner enclosure of homesteads were occupied by cattle or not has been replaced with the question of why there are no phosphates present in the homesteads at all.

From the initial batch of phosphate results it could be concluded that very little to no livestock was kept in the stone-walled settlements. This seems highly improbable as the Iron Age is known for settlement patterns involving kraals and cattle pens (Huffman, 2007; Maggs, 1976; Walton, 1956).

We know that phosphate readings should be found in the presence of both livestock and human occupation. Inorganic phosphates in soil originate from the deposition of organic phosphate. An unfortunate reality surrounding phosphate tests is that is has been primarily used to for locating and delimiting archaeological sites. It is therefore sufficient that a phosphate test only indicates

high concentrations and not much else, independent of phosphate testing technique (Perrson, 1997, p. 442).

The nature of the original organic phosphates cannot be easily determinded. It is possible and has been demontrated to analyse organic phosphorous in the presence of other organic molecules to determine the nature of occupation (Schlezinger & Howes, 2000, p. 491). The soil samples were taken from a random selection of inner enclosures at homesteads. Some presence of occupation should exist, and not only in middens.

In previous chapters the affect of soil pH on phosphate content was discussed. The pH of soil may be altered by rain in the area. The Suikerbosrand recieves about 650 – 750 mm of rainfall per year (Sadr & Rodier, 2012, p. 1034) and so this must be put into consideration. Even though the application of the chemical analysis of phosphates has been successful in many geological settings that have been subject to depositional processes, the best results are found in calcerous soil (Jacob Parnell, et al., 2002, p. 381). It may be the case that the soils in the Suikerbosrand are not ideal for accurate chemical analysis.

The absence of phosphate in the soils at the Suikerbosrand may not be a flaw in testing techniques but may in fact be a function of past cultural practise. Walton (1956) has written extensively on the nature of African villages from the Late Stone Age into the Iron Age. In his description of Sotho cattle kraals, he mentions that the stone structures often had built in drainage openings on the downward side (Walton, 1956, p. 153). In the field surveys of the Suikerbosrand drainage openings are difficult to spot. This is because the walls tend to collapse over an extended period of time, with only the general structure being preserved.

The use of drainage openings in cattle kraals has implications in the archaeological record, one being the preservation of inorganic phosphate molecules. The ability for organic waste to be transported out of an inner enclosure frequently decreases the time organic phosphorous has to transform into its more immobile, inorganic state.

We cannot attribute the lack of phosphate concentration to slope wash alone. Rain water can only account for a small amount of organic matter transport out of a kraal. Walton (1956) also writes that the cattle pen was the domain of the men. The women were only allowed to enter the kraal to dig out the dung. This would account for a large percentage of possible organic material transport. The dung was made into rounds cakes and placed on the top of the walls to dry for fuel (Walton, 1956, p. 153).

Maggs (1976) observed the same practise in his book on the Iron Age communities of the southern Highveld. He looks at Sotho practise in Lesotho to understand the cattle kraals maintenance practised by a more contemporary society. Accumulated dung tends to have a consistency rather similar to peat (Maggs, 1976, p. 133) and similarly, in contemporary society, the dung is cut into blocks and is stacked on the top of walls to dry.

In an additional contemporary example, Maggs writes that another group of the Sotho population collects dung and forms them into flat, oval cakes. The cakes resemble very closely the ones described by Walton (1956). The cakes in this case are built into neat domes to dry.

The reason for the collection and drying of dung has been stated as the same in all of the above cases. The availability of fuel in the southern Highveld and in large parts of southern Africa is very low. The nature of the grassland and Savannah type environments is that of sparse tree distribution. The lack of trees led Iron Age communities to depend on dung for fuel. In Maggs' (1976) description of the recycling of dung he refers to the Sotho speaking populations inhabiting the southern Highveld. Walton (1956) attributes the practise to Sotho speaking people but also includes the Natal Nguni. The practise of drying and burning dung seems to be a widespread one.

The Suikerbosrand lies within a grassland environment. Very few trees scatter the hilly landscape making sources of fuel vary scarce. If we look at Taylor's typology and his analysis of it, we see that group III structures are the creation of a hybridised society, the product of the original group I inhabitants and the group II immigrants. It would be no surprise if the population responsible for group III structures also used livestock dung as a source of fuel.

After identifying this very probable possibility, it seemed necessary to conduct further tests in the Suikerbosrand Nature Reserve. In the Iron Age, hoes would have been used to loosen the accumulated material from the floor of livestock enclosures (Maggs, 1976, p. 133). It was hypothesised that removal very close to the wall would have proved difficult, perhaps leaving some organic material behind. For this reason, soil samples were taken from the perimeter of the inner enclosures.

The results were only partially conclusive. The samples taken in close proximity to the stone walls did produce higher phosphate concentration readings. The average amount of phosphate found increased by one whole unit of magnitude from the initial inner enclosure results (Figure 7). The results would be far more conclusive if the sample size were bigger. A single result at waypoint number 8 yielded the highest phosphate concentration of all soil samples taken. The possibility that dung was removed from livestock pens is plausible and should not be ruled out.

Of the three inner enclosures where perimeter samples were taken, all three showed that downslope samples produced the highest phosphate readings. This may indicate that the use of drain openings (Walton, 1956, p. 153) was not practised. Slope wash, trampling and the physical process of removing dung from the enclosure could have produced an accumulation of organic material close to the downslope walls.

The variable of soil sample depth was double checked by taking samples from inner enclosures at different depths. A sample was taken at a sub-surface level, using the method used for all samples collected for this study, and another sample was taken 10 cm below the surface at the same point. This procedure was done three times. The results only confirmed previous literature. The phosphate concentrations varied insignificantly at different depths, exhibiting the immobile nature if inorganic phosphates in the soil column.

## Conclusion

Physical artefacts are one of the primary tools in understanding past societies. They are evidence of occupation. The artefacts themselves give us information on what activities were being done in specific areas. The problem with physical artefacts is that their distribution is sparse and infrequent. Their existence relies on their ability to be preserved in a variety of environments. Thankfully, current modern advancements allow archaeologists to detect ancient occupation using chemical analyses.

A method used and refined since the 1930s was employed in this study to confirm the presence of livestock in group III stone-walled structures in the Suikerbosrand Nature reserve. The results achieved were unexpected, but still valuable. Using a simple phosphate test unveiled key information about the stone-walled structures analysed. What it failed to do was to definitively answer the question of whether or not livestock were kept within these structures.

When using phosphate analysis, not as a delimiting tool but rather as an analytical one, I believe the method to be too limited, supply a very narrow amount of information. To use phosphate analysis to its full potential the process needs to be done in conjunction with other methods, a view shared by Persson (1997, p. 443):

> *"Combined with geophysical methods, such as magnetometry, conductivity measurements and ground penetrating radar, the test strips can play an important part in integrated archaeological prospection."*

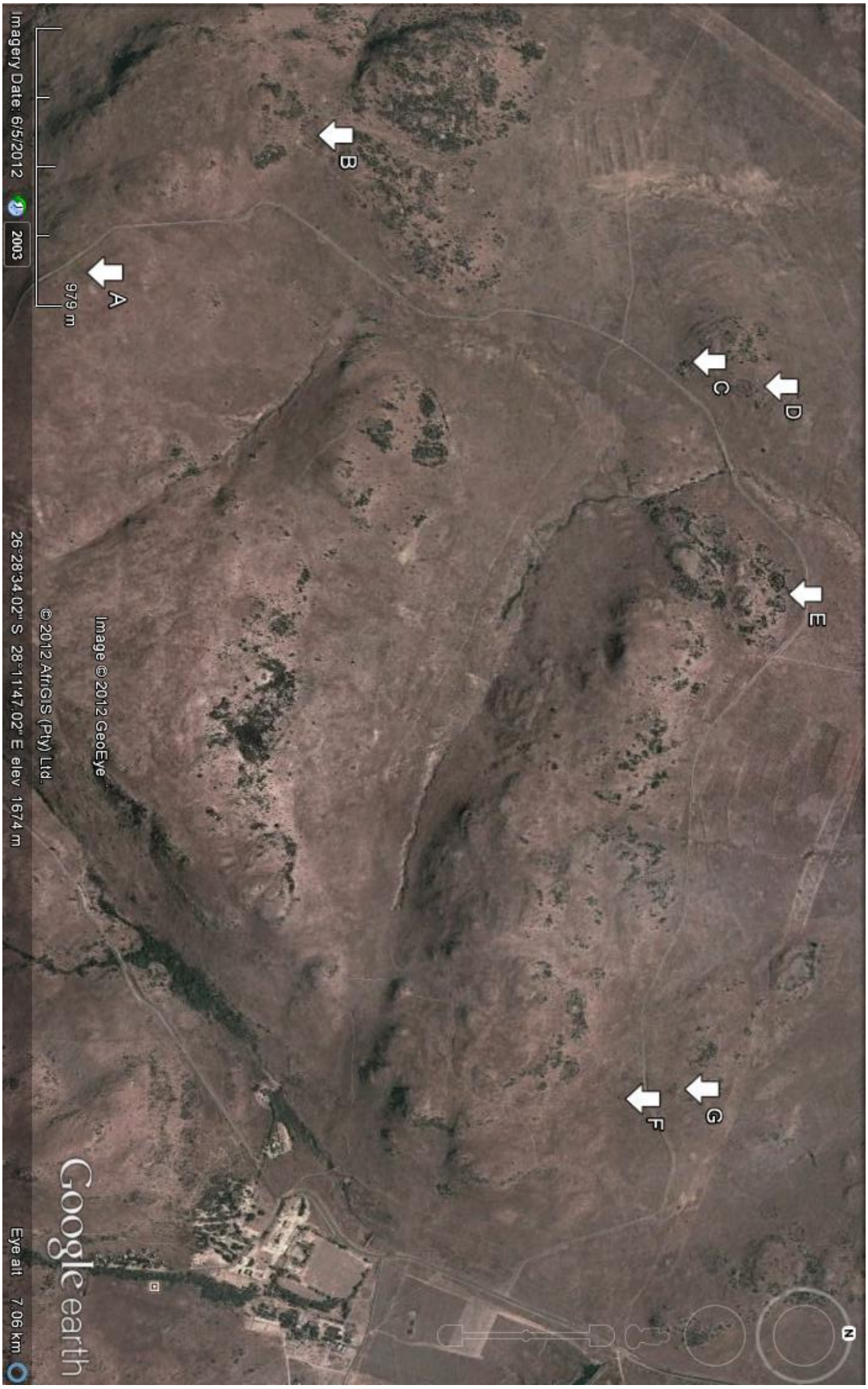
The data exposed through this study has indeed revealed an aspect of the social, economic and political complexity of this past society. The absence of phosphates has brought to attention the diversity of the Iron Age. Pre-colonial structures have been heavily studied as an attempt to reconstruct the cultural landscape in southern Africa. The unexpected phosphate results at the very least show how diverse of a landscape it was. Assigning specific typologies to certain structures with rigid means of classification in a way takes the human element out of our past. The diversity shows how interaction can create unpredictable hybrid cultures that do not fit the structuralist ideals that dominate Iron Age research.

Many opportunities for further research can evolve from this study. A similar study has not been carried out on the nearby group I and II structures in the area. A direct comparison of phosphate data could draw conclusions of inter-society relationships or evolving patterns. The phosphate testing technique could be enhanced by gaining knowledge of the environment. The nature of the soils present including their relative acidities would aid in refining the process, producing more accurate results.

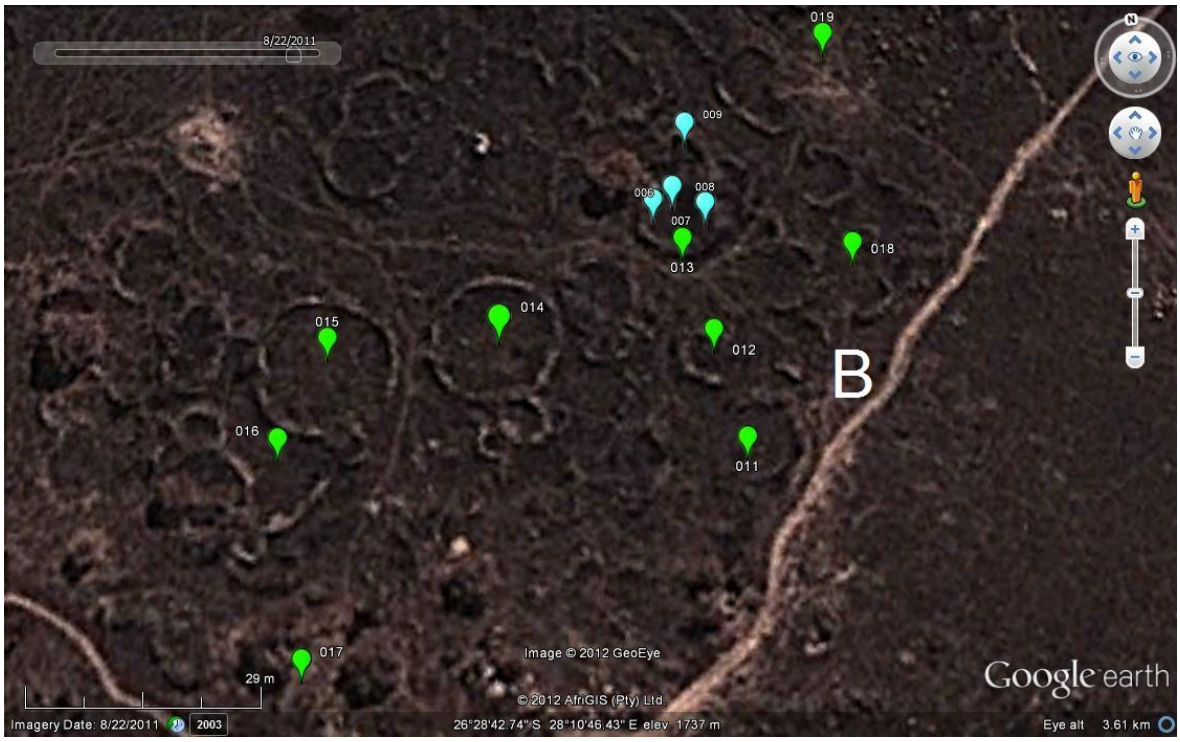
# Appendices

Appendix A

A map of the area studied in the Suikerbosrand Nature Reserve with zoomed sections of the stone walled complexes sampled. The zoomed images show how the soil samples were taken. Green pins indicate the first group of samples taken from the reserve and the blue pins represent the second group of samples collected. The pin numbers can be correlated to Table 1 and Table 2 in the main text.

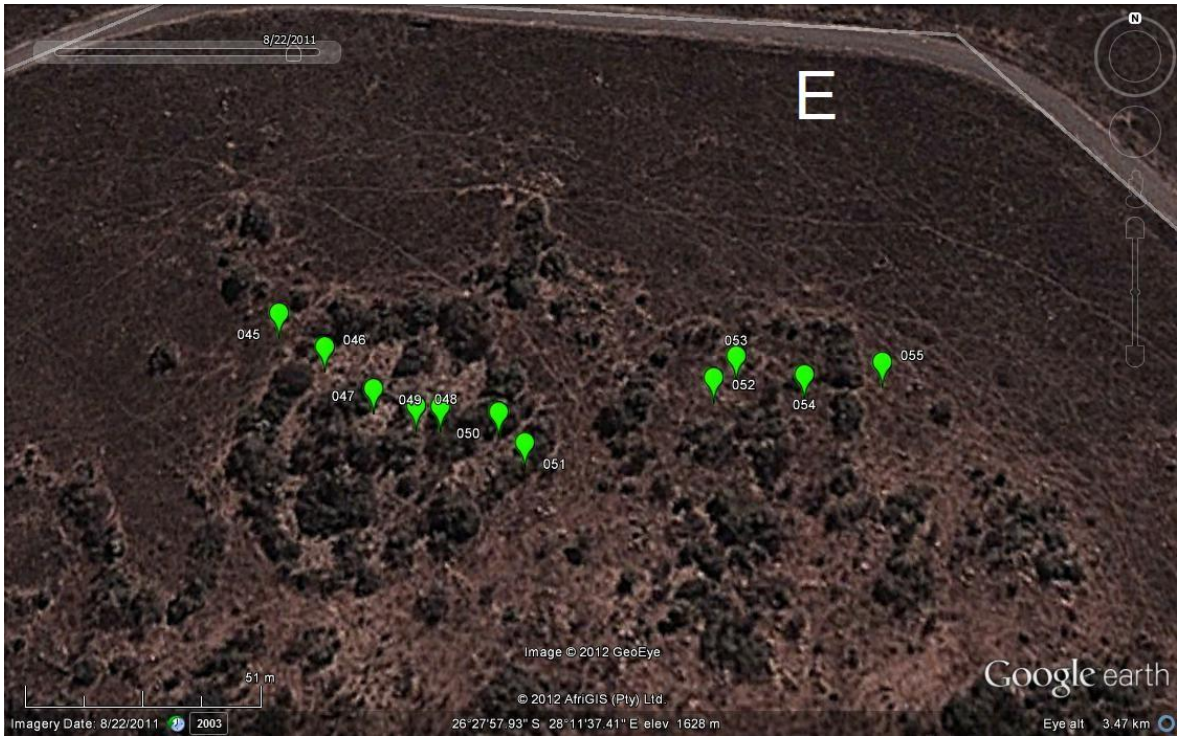

A
B
C
D
E
F
G
979 m
Image © 2012 GeoEye
© 2012 AfriGIS (Pty) Ltd.
Google earth
Imagery Date: 6/5/2012
2003
26°28'34.02" S 28°1'47.02" E elev 167.4 m
Eye alt 7.06 km

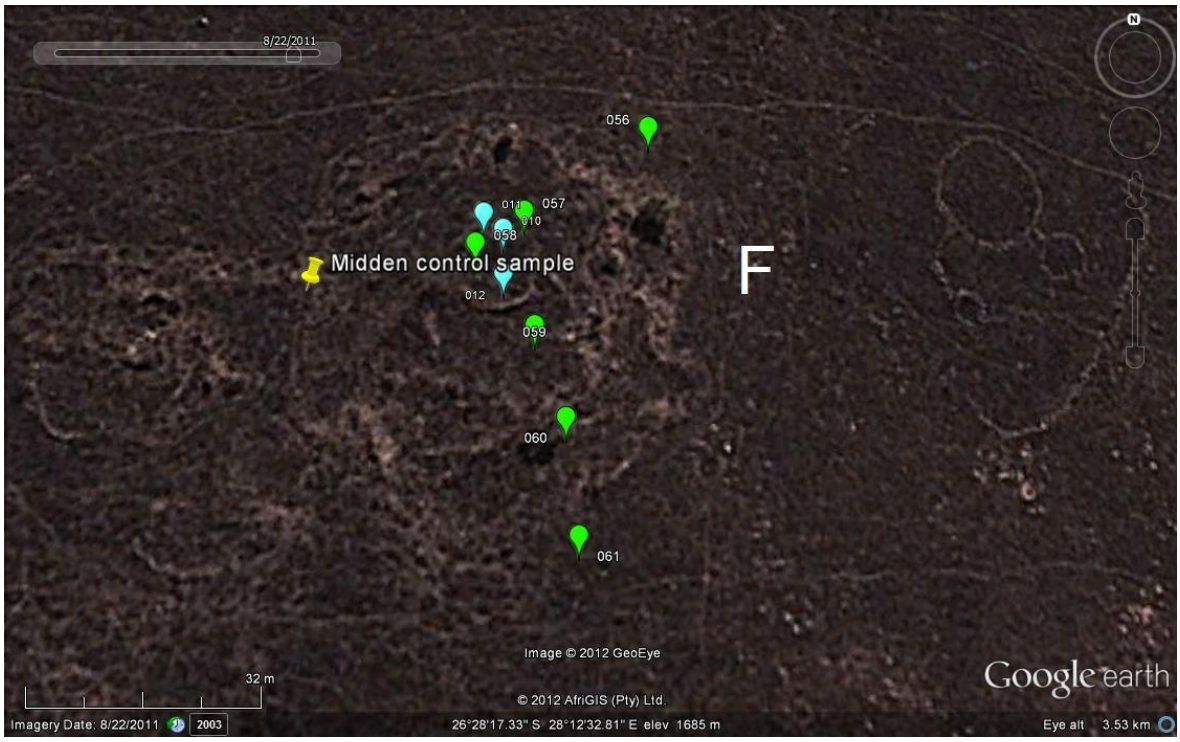

8/22/2011
2003
2012
008
002
001
003
004
007
005
004
006
A
003
001
005
002
010
Image © 2012 GeoEye
34 m
© 2012 AfriGIS (Pty) Ltd.
Imagery Date: 8/22/2011
2003
26°29'05.28" S 28°11'00.61" E elev 1769 m
Eye alt 3.66 km
Google earth


8/22/2011
019
009
006
008
007
013
018
014
015
012
B
016
011
017
Image © 2012 GeoEye
29 m
© 2012 AfriGIS (Pty) Ltd.
Imagery Date: 8/22/2011
2003
26°28'42.74" S 28°10'46.43" E elev 1737 m
Eye alt 3.61 km
Google earth


8/22/2011
2003
2012
035
034
032
031
033
C
022
021
024
023
026
028
027
025
030
Image © 2012 GeoEye
029
© 2012 AfriGIS (Pty) Ltd.
35 m
Imagery Date: 8/22/2011
2003
26°28'05.81" S 28°11'12.39" E elev 1647 m
Eye alt 3.46 km
Google earth


8/22/2011
2003
2012
044
043
042
D
041
040
038
039
037
Image © 2012 GeoEye
© 2012 AfriGIS (Pty) Ltd.
27 m
Imagery Date: 8/22/2011
2003
26°28'00.93" S 28°11'14.55" E elev 1641 m
Eye alt 3.42 km
Google earth


8/22/2011
E
045
046
047
049
048
050
051
053
052
054
055
Image © 2012 GeoEye
51 m
© 2012 AfriGIS (Pty) Ltd.
Google earth
Imagery Date: 8/22/2011
2003
26°27'57.93" S 28°11'37.41" E elev 1628 m
Eye alt 3.47 km


8/22/2011
056
011
057
010
058
Midden control sample
012
F
059
060
061
Image © 2012 GeoEye
32 m
© 2012 AfriGIS (Pty) Ltd.
Google earth
Imagery Date: 8/22/2011
2003
26°28'17.33" S 28°12'32.81" E elev 1685 m
Eye alt 3.53 km


8/22/2011
2003
2012
G
066
065
064
063
062
Image © 2012 GeoEye
© 2012 AfriGIS (Pty) Ltd.
54 m
Imagery Date: 8/22/2011
2003
26°28'12.58" S 28°12'33.05" E elev 1673 m
Eye alt 3.60 km
Google earth

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