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Google Earth and GIS reveal settlement patterns associated with stone circles, southern Gauteng, South Africa.

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DECLARATION

I, Stephen Banhegyi declare that the following research is my own original work. This dissertation is submitted to the University of the Witwatersrand in fulfilment of the requirements for the degree of Master of Science. This project has not been submitted to any other academic institution.

Signed:

Stephen Banhegyi

25/08/2014

ABSTRACT

In 2012, stone circles were identified in satellite images of southern Gauteng. This study aims to fill a research gap by documenting the distribution and settlement pattern associated with the recently discovered structures. Google Earth was used to digitise and classify structure types in the Heidelberg area for processing with GIS and spatial statistical software (CrimeStat III). Two areas were surveyed at ground level to record architectural details and features. Soil samples were collected from different structure types for phosphate analysis to reveal activity areas. Control samples were collected from background areas. Nearest Neighbour, terrain and visibility analyses were used to provide an impression of settlement organisation relative to landscape. Results showed that settlements were located on bluffs with commanding views of the surrounding area, yet within 2 to 5 km of arable land and grazing areas. Phosphate concentrations indicated minimal human activity near small stone circles and within dwellings, with higher concentrations located in court-yards, large complex structures and low-walled stone circles. The settlements were protected by hilly terrain with commanding views, yet within close proximity to arable land, suggesting a sedentary way of life. Tying activity areas to architectural types and their distribution provided a means for identifying different architectural types. Further work will be required to reliably establish an historical context for the sites, while tentative results indicate a pattern similar to Later Iron Age hill-top settlements related to the Sotho-Tswana occupation of the area from the late 1700s.

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1 INTRODUCTION

During the late 1960s and early 70s, air photographs played a key role in the discovery of stone-walled structures (SWS) in southern Africa (e.g. Mason 1968; Seddon 1968; Maggs 1972; Taylor 1979). These earlier studies constitute what has been referred to as the Second Systematic phase of Iron Age research (Mason 1986). Based on detailed air photographs, researchers could differentiate architectural styles and link them to archaeological and historically known cultural groups in southern Africa based on oral histories and material culture.

In more recent years Google Earth (GE) has superseded aerial photography's role in site discovery (Madry 2007; MacQuilkan 2009), while Geographic Information Systems (GIS) and spatial statistics software provide new ways of answering archaeological questions based on spatial data and landscape patterns (see Conolly & Lake 2006). Despite analytical advances, the process of classifying different architectural types remains rooted in earlier work, based on etic typologies.

In South Africa GE and GIS have been used to analyse the settlement patterns of pre-colonial structures between Johannesburg and the Vaal River. Recently, Sadr and Rodier (2012) analysed the distribution of several hundred SWS in the Suikerbosrand Nature Reserve. In addition to known architectural types, they identified 116 free standing stone circles in satellite photos of the Suikerbosrand mountain range (Fig 1). This new type was tentatively classified as Group IV and added to their typology, derived from the work of Michael Taylor (1979). When examined on their own, the settlement pattern associated with Group IV appeared to be more egalitarian in comparison to other architectural types with fewer structures and limited access to cultivatable soils (Sadr and Rodier 2012: 1038 – 1039).

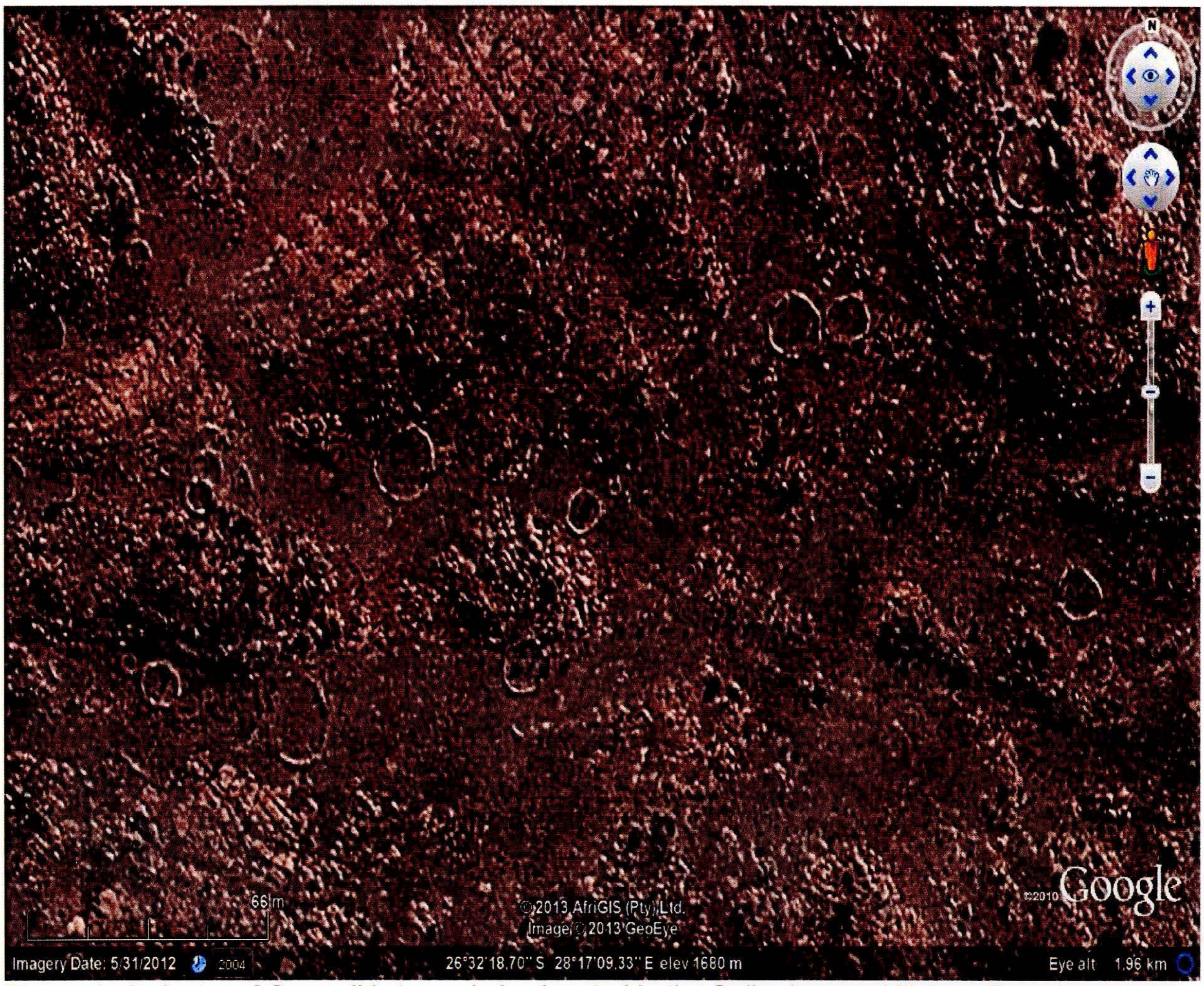


Figure 1: *A cluster of Group IV stone circles located in the Suikerbosrand Nature Reserve.*

1.1 PROBLEM STATEMENT

Along the western coast of southern Africa stone circles are associated with stone tool using hunter-gatherers who adopted a delayed returns subsistence strategy at some point over the last millennium (Noli & Avery 1987; Parsons 2004; Humphreys 2009; Sampson 2009). In the eastern half of southern Africa they are found in the settlements of early farming communities (Summers 1971; Evers 1973, 1975; Mason 1986; Schoeman 2006). While establishing a one-to-one correlation between Group IV and an archaeological culture may not be achieved based on style, identifying their settlement pattern may offer more tangible clues as to their settlement system and identify a historical time-frame for site occupation.

1.2 AIMS AND OBJECTIVES

The purpose of this research is to contextualise Group IV structures in their cultural and natural landscape and to identify elements of their settlement system using spatial information. Results were used to access insights regarding Group IV's settlement system and location in relation to resources, landscape features and other SWS. Focusing on the relationship between the natural environment and the structures helped identify key features influencing the choice of settlement area, such as defence and proximity to resource zones related to the economic activities of farming and herding. GIS and spatial statistical software (CrimeStat) were used to provide both visual and statistical data to describe two sites, SKBR and KD. SKBR is a large cluster of stone circles located in the south on the south facing slopes of the Suikerbosrand mountain range, while KD is located in more open landscape with fewer structures. This comparison will help to identify both general settlement rules and allow for a consideration of how settlements are organised in relation to different landscape features. The two clusters were surveyed for material culture and to identify different architectural types. Soil samples from SWS were tested for phosphates to identify activity areas and middens. The idea was to test whether or not Group IV represented the remains of decentralised individual cattle enclosures, or residential structures such as rondavels or grain bins.

1.3 STUDY AREA

The study area for data collection was restricted to search areas north of the Vaal River over approximately a 1000 square kilometres in southern Gauteng. All visible structures in the area were recorded using GE and classified based on Taylor's typology. Two sites were chosen as focus areas for ground truthing and intensive analysis with GIS and CrimeStat. Excavation and radio-carbon dating of organic materials were not used. The idea was to examine the relationships between settlements and the natural landscape to provide testable hypotheses related to Group IV's settlement pattern and to identify areas of interest for future work. Artefacts and material culture were photographed and their positions recorded using a hand held GPS, but were not collected.

1.4 RATIONALE

The empirical aim of this study is to provide archaeological information on Group IV and provide insights into its settlement system. The methods chosen for the investigation allow for comparisons with previous and ongoing archaeological research in the Highveld area and will ultimately contribute to a growing body of knowledge regarding the archaeology of pre-colonial settlements in southern Africa. While developing scientific knowledge is the primary purpose of this research, there also exists growing interest on the subject of stone-walled structures in the public sphere.

For the most part, the most popular explanations in the public sphere are provided by non-archaeologists (e.g. Hromnick 1981; Tellinger & Heine 2010). These hold much of southern Africa's dry stone-walling to be the products of ancient civilisations, an idea which has persisted for well over a century (Anderson 1887: 255). Brown (1918: 44), like many others of his time, held belief that "prior to the appearance of Europeans, South Africa can hardly be said to have any history". This Eurocentric attitude was similarly perpetuated by the Nationalist government to legitimise minority control of resources in South Africa from the 1940s to the early 90s (see Bonner 2007 for a discussion on 'the myth of the vacant land'). At this time, during the Second Phase of Systematic Iron Age research, nationalist doctrine was focused on mediating knowledge produced in the academic sphere regarding pre-colonial civilisations in South Africa. As such, advancements in the academic sphere held a limited influence on public consciousness, which was more easily influenced by cultural conditioning. It is the resulting gap in public consciousness regarding pre-colonial African civilisations that provides an opportunity for exotic explanations to take root. As such archaeologists and historians have identified the last 500 years in southern Africa as a critical area for research combining multiple strands of archaeological evidence, historical sources, oral traditions and indigenous knowledge to bridge this gap in understanding (Bonner *et al* 2008: 15-16).

1.5 APPROACH

> "If there are connections everywhere, why do we persist in turning dynamic, interconnected phenomena into static, disconnected things? Some of this is owing, perhaps, to the way we have learned our own history"
>
> (Wolf 1982: 4-5).

In Archaeology, landscape fieldwork concerns itself with recording features, earthworks, and settlements with the aim of explaining observed patterns and anomalies (Aston & Rowley 1974: 23). Physical landscapes are constantly shaped and lent character by society and nature over time, forming a background to daily life and human history (Ingold 2000). Approaches such as Time Geography seek to understand human behaviour and modification of the landscape over time (Mlekuž 2010). In this model, time is conceptualised as linear, with events spread across a teleological spectrum. While the impression of linear progression through time is maintained by stories and histories, time in the natural world is cyclical. The cultural and natural landscape and interactions between humans and nature within this diachronic framework culminates in a life, and history of the land itself.

Explicit descriptions of landscapes and their material culture emphasise the context of data as a guiding principle for archaeological explanations (Hodder 1982). In southern Africa, settlement patterns have been described using the Central Cattle Pattern (CCP). The model holds that individual homesteads representing a female area were organised around the chief's central cattle kraal, associated with men's activities and political power (Huffman 2001). For early farmers, cattle constituted a key economic commodity and a symbol of wealth and status and the centrality of cattle to the settlement system is reflected in their settlement pattern.

Different settlement patterns can be seen as emergent properties of cultural evolution within a particular environment through time. While the production and reproduction of cultural artefact and structure types are influenced by tradition and transferred ideas (Whitelaw 2000; Huffman 2007b), micro-conditions in the environment and individual agency play roles in creating novel expressions and cultural forms.

By approaching the landscape as an entity constituted by dynamic interconnected processes over time, specific patterns can be identified for individual settlement areas. Where previous research focused on general inferences at the regional scale this approach utilises GIS to examine relationships at smaller scales to identify general rules and variations in settlement patterns at the inter-site level.

2 SETTING

2.1 NATURAL LANDSCAPE

Since their discovery, hundreds more Group IV structures have been identified in the areas surrounding Heidelberg, covering an area between the mountainous semi-woodland biome of the Suikerbosrand mountains and the surrounding grasslands. The landscape is varied, both ecologically and geologically, ranging from well-wooded mountainous slopes to open sour grasslands dotted with rocky outcrops (Van Wyk 1988). The basin is located between the Vaal River and Johannesburg, in an area previously referred to as the South Western Transvaal. The Suikerbosrand, Blesbokspruit and Bosmanspruit rivers and several small tributaries cut through the area (Fig 2).

The landscape in the area is comprised of craggy rock formations, grassy plains and well wooded kloofs. The vegetation in the more mountainous areas is described as Bankenveld, with tree species including *Celtis Africana, Cussonia Paniculata, Acacia Karoo, Rhus lanceolata and Protea Caffra* (Balkwill 2005). Other plants with medicinal qualities include *Aloe Ferox, Boopane Distica and Withania Somnifera.* Sour grasslands, generally unsuitable for grazing, dominate much of the low lying areas around the Suikerbosrand mountain range (Van Wyk 1988). The best agricultural land is found on the north western edge of the berg (Sadr and Rodier 2012). Much of the low-lying areas have since been converted to transformed range land by modern agriculture.

Geologically the area is made up of two major systems. The Ventersdorp system is characterised by igneous rock types, such as basalt, quartzite and andesitic and porphyritic lavas which formed millions of years ago when molten lava congealed on the Earth's crust. The Witwatersrand system, forming much of the Suikerbosrand mountain range, is made up of sedimentary rocks such as sandstone, shale and conglomerate (Cairincross 2004: 239). The altitude ranges from 1550 m to 1917 m above sea level and annual rainfall is 700 mm on average with most of it falling between October and March (Tyson 1976; GDACE 2007).

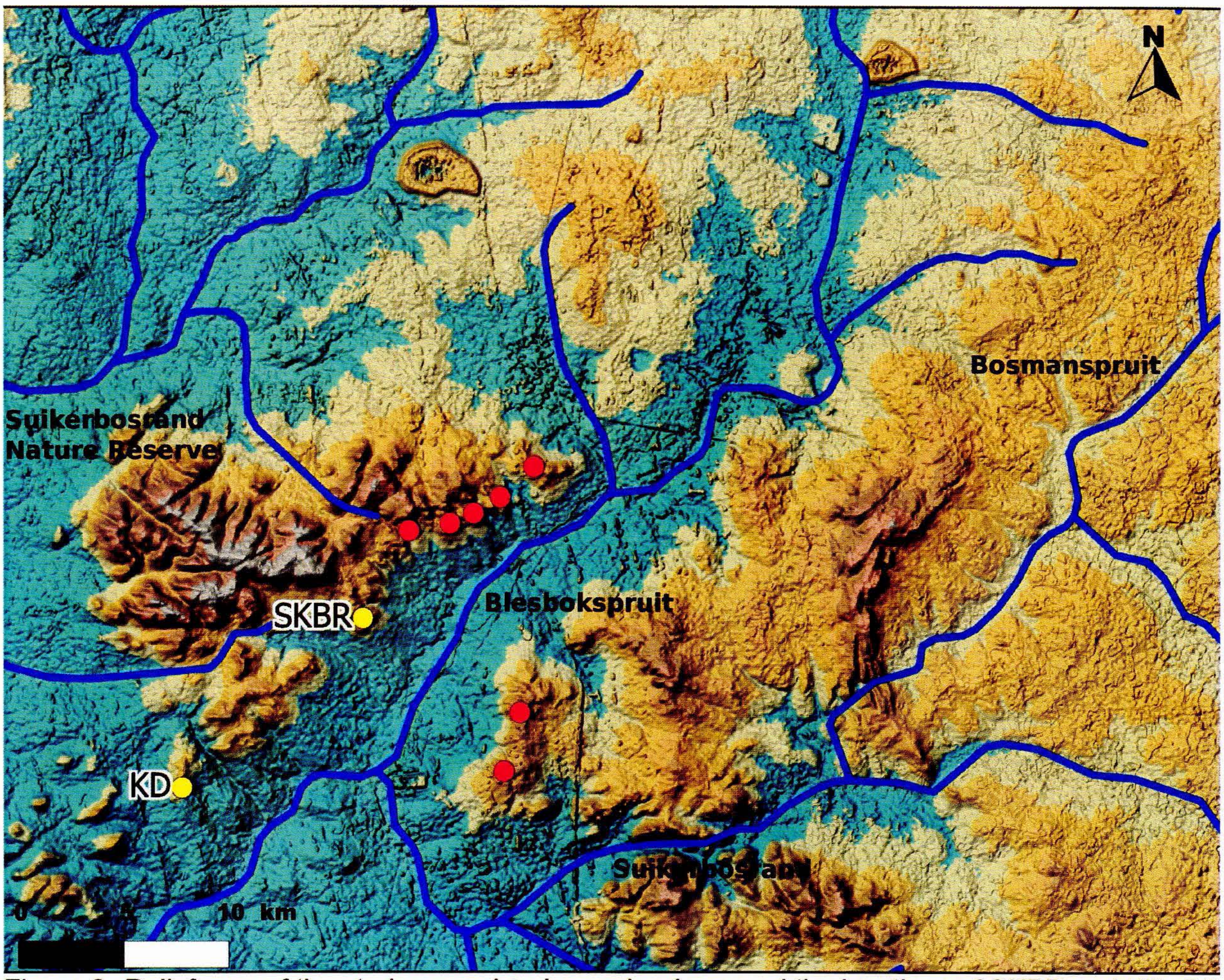


Figure 2: *Relief map of the study area showing major rivers and the locations of SKBR and KD. Other dense clusters of stone circles are shown in red.*

2.2 CULTURAL LANDSCAPE

Over the past 500 years farming and pastoralism became increasingly viable on the South African Highveld (Smith 2005). Climate changes during the Little Ice Age at around 1450 AD resulted in a global drop in temperatures which has been linked to the diffusion of early farming communities from central and East Africa to southern Africa (Huffman 2008). The period is associated with the arrival of Sotho speakers, such as groups ancestral to the Fokeng, who settled around the Vaal River by around 1500 AD. From the 1700s onward Sotho and Tswana speaking immigrants built larger settlements on the Highveld during a period of contact and interaction (Taylor 1979). This lead some marginalised groups to seek more defensive settlement areas in the mountains, while large Tswana capitals were located in more open ground (Boeyens 2000; 2003). During the early 1800s the wars of the Mfecane, literally meaning 'the scattering', disrupted settled life on the Highveld (See Hamilton 1995 for a review). Some of the earliest accounts of the destruction are provided by early travellers and missionaries who had crossed the North of the Vaal River during Great Treks of the 1820s. Large groups of people were assimilated by roving warlords such as Mzilikazi or were forced to wander as refugees.

Mzilikazi is known to have settled in areas North of the Vaal River around Heidelberg between 1823 and 1827 (Becker 1966). Despite being one of his largest, more permanent bases on his flight from his ancestral home in northern Natal, there is little detail of his occupation of the area, other that his policy of 'keeping open land around him' (Rasmussen 1976); a possible reference to removing or assimilating pre-existing Sotho-Tswana populations in the area. Eventually, due to the incursion of Europeans into the area from south of the Vaal River, Mzilikazi was forced to press North toward the Magaliesburg mountains. Here he is reputed to have created larger settlements based on the Zulu military kraal, referred to as the Doornspruit architectural type (Pistorius 1997). Doornspruit architecture does, however, share similarities with Sotho-Tswana architecture, having been built by Nguniised Sotho incorporated into Mzilikazi's fold (Huffman 2007b: 453). Travellers such as Andrew Smith were unimpressed with Mzilikazi's settlements, having been awed by large Sotho-Tswana towns such as Dithakong which was supposedly home to roughly twenty-thousand individuals during the 1800s (Hall 2007).

The events of the Mfecane and the arrival of Europeans and marauding groups such as the Griqua heralded a turning point for settled communities on the Highveld. Scattered refugees were united under the common leadership of figures such as Moshesh who based at his capital of Thaba Bosigo on a large flat topped hill in Lesotho (Heale 1981: 199) and by lesser known chiefs. After the events of the Mfecane some groups such as the Southern Transvaal Ndebele attempted to reoccupy areas of the Suikerbosrand mountain range. Under the leadership of Mabhoko (known to the Boer farmers of the area as Mapog) the community briefly thrived as they re-established old trade routes throughout the Highveld (West & Morris 1976). His was a mixed society of Sotho and Nguni speakers, who became amalgamated into a new group in the wake of the Mfecane.

3 LITERATURE REVIEW

3.1 INTRODUCTION

The body of literature connected to the stone walled settlements of the South African interior is, in may ways, just as vast and varied as the ruins themselves. Sources range from early travel writings and historical documents to academic research. The first section provides a broad description of the time frame associated with stone-walled structures in southern Africa over the last millennium. The second section covers the background to research concerning itself with the study of pre-colonial settlement patterns, much of it rooted in the Iron Age research of the 60s and 70s. Finally I discuss the history of the study area by referring to historical and archaeological sources regarding pre-colonial settlements on the southern Highveld.

3.2 THE IRON AGE

The Iron Age in South Africa is marked by the arrival of metal using agro-pastoralists south of the Shashe-Limpopo confluence at around 200 A.D, partly overlapping with the terminal Later Stone Age (Smith 2005). Chronologically, the Iron Age is divided into early (AD 200 – 900), middle (AD 900 – 1300) and later (AD 1300–1840) periods (Huffman 2007b). The Iron Age also refers to the material, technological and cultural 'package' associated with the life of pre-colonial farming communities (Hall 1987). Some have argued that the expansion of early farmers into the sub-continent cannot be represented by a single cultural package (Boestoen 2007), or "a massive exodus from one area to another" by "large coherent [cultural] groups" (Parsons 2008: 49). Others argue that the appearance of the Iron Age in southern Africa was the product of "...slower and progressive mosaics of immigration, diffusion, invention and admixture" (Lwango-Lwigo & Vansina 1990: 80-81). Despite this at least three dispersals from KwaZulu Natal have been identified archaeologically, with the largest related to the Mfecane (Huffman 1989; 2004).

In recent years, archaeologists and historians have identified the last 500 years in southern Africa as a critical area for research combining multiple strands of archaeological evidence, historical sources, oral traditions and Indigenous knowledge (Bonner *et al* 2008). Based on their distributional analysis of structures south of Johannesburg, Sadr and Rodier (2012) suggested that Group IV structures were probably contemporary with the Group II structures. These are believed to have developed following an increase of political power and wealth in cattle among the Sotho-Tswana of the southern Highveld (Huffman 2007b; Boeyens & Hall 2009).

3.3 MZILIKAZI

During the 1800s, early European missionaries and travellers, such as Robert Moffat and Andrew Smith, provided some of the first written descriptions of Iron Age settlements on the South African Highveld. Many of the written accounts describe dire circumstances including civil warfare, famine, cannibalism and ruined African cities following in the wake of the Mfecane and the Sotho wars of the 1800s. Those who escaped the violence were forced to wander into foreign lands, either as refugees or would-be conquerors, with Shaka and Mzilikazi as some of the most well known.

Mzilikazi, meaning 'the great road' or 'path of blood', was born in northern Kwazulu-Natal during a time of great political and social instability, later culminating in the widespread conflict of the Mfecane (Rasmussen 1975; Gump 1989). Following the assassination of his father and Shaka's rise to power, Mzilikazi was installed as chief of the Khumalo clan. Mzilikazi was reputed to be a cunning warrior and tactician who made use of the devastatingly effective short stabbing spears and close-combat strategies introduced by Shaka's new military regime (Spring 1993). In 1822 Mzilikazi and a handful of about 300 soldiers were driven out of Kwazulu-Natal after insulting Shaka through an act of defiance (Becker 1966). Using their training to secure resources, power and new clan members through a destructive process of military assimilation, Mzilikazi would form a nation state in the short period between 1822 and 1836.

Authors such as Rasmussen (1975; 1978) and Becker (1966) use historical sources to detail the journey of Mzilikazi into the southern African interior, describing the conquest and subjugation of the various Sotho speaking tribes he encountered. In addition to oral traditions, many European travellers and missionaries describe the aftermath of the Sotho wars in the southern African interior (Lye & Arbor: 1970; Lye & Murry 1980) and provide accounts of his involvement in the events of the Mfecane (Hamilton 1995). As his military ranks and followers grew, Mzilikazi built larger settlements such as the Doornspruit architectural style, similar to Magg's (1976) Type Z, in areas north of Pretoria and west of Rustenburg (Pistorius 1997).

It is often said that Mzilikazi controlled large areas along the Suikerbosrand River from Heidelberg reaching into areas of Vereeniging and the Vredefort Dome, which were occasionally raided by Griqua cattle rustlers from south of the Vaal River (Becker 1966; Rasmussen 1978). As of yet no archaeological evidence has ever been tied to this occupation area. However, both Rasmussen (1977) and Becker (1966) indicate that Mzilikazi chose to keep open land around him while he tended to avoid the mountainous areas, claiming that "[He] was like a blind man feeling [his] way with a stick. We had heard tales of great armies that suddenly popped up from underground or swept down on you from mountains... I had to keep open country around me".

3.4 MOSHESH

Moshesh played a similar role in nation building, uniting refugees from some 13 different tribes scattered by the conflict. Unlike his contemporaries, Moshesh was credited with being a peaceful leader, who sought to establish a safe haven. This aversion to warfare and the need to provide security for his people are largely reflected in the areas where Moshesh chose to settle. His first settlement, Butha-Butha, was established high on a hill top in the Drakensberg mountains. The area was unsafe however, as cattle raids were routinely carried out by other warlords in the area, namely Mantatisi and her son Sekonyela. After a lengthy siege of his stronghold, Moshesh received word of a new safe haven.

> "Moshesh's spies had told him of another great flat topped hill further south, which provided a more permanent refuge. So Moshesh moved his whole tribe again at once. They arrived at night and called it 'Thaba Bosigo', 'the Mountain of Night'. It was a natural fortress, topped with a green plain and its own springs of water, and edged with cliffs. Only a few gullies led to the top, and all except one were so steep and narrow that they could be defended by a handful of men. It was so difficult to climb that many believed it grew taller during the night".
>
> (Heale 1981: 199).

The natural fortress withstood a large attack by the Ngwanye tribe with the help of Shaka's impi in 1827 and successfully repelled an attack by Mzilikzi's Matabele in 1831. Thaba Bosigo was never captured and Moshesh died on the hill in 1870.

3.5 RESEARCH BACKGROUND

3.5.1 FIRST WAVE RESEARCH

For the most part of the early twentieth century, the study of South Africa's indigenous cultures was the domain of anthropology and ethnology. During the 1920s and following decades a series of studies helped to draw attention to the archaeology of early farming communities in southern Africa (e.g. Van Riet Louw 1927; Laidler 1936; Daubenton 1938; Pullen 1942; Schofield 1948). This early phase predominantly followed a culture historical approach, as researchers aimed to reconstruct the peopling of southern Africa by linking historically known groups with sites and material culture, often relying on ethnographic syntheses to interpret finds (e.g. MacGregor 1905; Stow 1905). In this respect ceramic typologies such as Schofield's *Primitive Pottery* provided an early attempt to link ceramic types with historically known cultures.

3.5.2 SECOND WAVE RESEARCH

The decades following the Second World War saw a resurgence in archaeological research. This was in part due to the application of new technologies and technological improvements achieved during the war, particularly in the fields of aviation, optics and image analysis. These new survey techniques led to the discovery of thousands of previously unknown sites. Coupled with the advances in radio carbon dating techniques, such technologies helped to augment settlement pattern studies in southern Africa with research conducted at the regional level (Mason 1962; 1968; Maggs 1972). The research methods and findings from this second systematic phase of Iron Age research are of interest, particularly those dealing with stone-walled structures on the Highveld and surrounding areas.

Aerial survey played an important role in the development of settlement pattern studies in southern Africa between the 1960s and 70s, catalysing a range of regional and multi-scalar studies (e.g. Mason 1968; Maggs 1972; Evers 1973; Taylor 1979; Hall 1981). Vast areas of the South African interior were surveyed from the air, leading to the discovery of thousands of previously unknown sites. This helped to fill a knowledge gap regarding the extent of SWS distributions in South Africa (Summers 1971). Researchers acquired specialised training in the use of stereo spectrography and technical experience not typically received by archaeologists to analyse the photographs.

Mason (1962; 1968) conducted some of the earliest systematic research of pre-colonial structures to the south of the Vaal River during the early 60s. His research demonstrated the effectiveness of aerial photography as a method of site discovery, which proved more effective than other methods, such as direct communication with farmers (e.g. De Jager 1966), chance discoveries and locating sites using historical sources. The scale at which research was conducted enables this regional approach. Mason classified different structure types based on their morphology and organised structures into one of several classes, each with several sub-types.

Mason's typology was later used by Seddon (1968) in a study of SWS from the western Transvaal. In this case Seddon attempted to define the distribution of Mason's classes outside of his original study area. During the 1980s, Mason mapped sites around the Greater Johannesburg area, the results of which culminate in a hefty tome detailing the pre-history of Johannesburg (Mason 1986). The text was originally designed for education purposes and provides detailed air photographs and maps of SWS, discussing their settlement patterns, chronology and cultural links. Details of several excavated stone circles and settlements are also provided, with Radio Carbon dates, for sites near Suikerbosrand, Bruma, Linksfield, Melville Koppies and numerous sites in the greater Johannesburg area.

During the 1970s, Tim Maggs (1972, 1976) surveyed vast areas of the southern Highveld stretching along the Vaal River from western Natal into areas of the Orange Free State. Maggs identified several SWS types similar to those described by Mason. Whereas Mason's typology referred to structure classes and sub-types, Maggs chose the names of permanent landscape features and historically known settlements to name and to define his types. Several type sites were excavated to record their associated material culture, construction method and other archaeological features. In some cases, ethnographic and historical information were available for sites and architectural types. In this respect, Walton's (1949; 1958) descriptions of traditional Sotho architecture provided a framework for understanding the function and relationships between different architectural types within a settlement. Areas for which historical or ethnographic information were available could provide additional chains of evidence to interpret finds and were favoured for excavation. Radio carbon dating and ceramic typologies provided chronological information relating to site occupation and associated cultural links.

Michael Taylor (1979) similarly used air photographs and excavation to investigate stone walled structures located in the Vredefort Dome for his MA thesis. Taylor identified three major structure classes with several sub-types. Examples of each type were excavated to establish a broad chronology for site occupation using radio carbon dating and ceramic sequences. Taylor believed that factors such as organic settlement growth and interaction between different cultural groups were responsible for different architectural types. Like other researchers of his time, Taylor developed his own nomenclature for the purposes of classification. He referred to different SWS 'groups' and linked these to different cultural groups. This attracted subsequent research in the area to test Taylor's proposed cultural links (e.g Loubser 1985; Pelser 2003) and more recently to expand on his survey area, using GIS to identify settlement patterns (Nkhosi-Lesoana 2008; Byrne 2012).

During the 1980s Martin Hall (1981) conducted a spatial analysis of SWS between the White and Black Umfolozi rivers in Kwazulu-natal. Hall's was the first study in South Africa to analyse settlement patterns using Multi Dimensional Mapping (MDM) and mainframe computing to interpret the spatial distribution of sites in relation to resources and landscape features. Hall encountered difficulties in deriving meaningful conclusions using MDM, with the results proving just as difficult to interpret as the raw data. In some respect, this proved a methodological dead end, in no small part due to the technological limitations and expenses associated with mainframe computing. As such, Hall fell back on information from excavated sites and their material culture to derive anthropological conclusions from his data.

3.5.3 THIRD WAVE RESEARCH

The nature of third wave research reflects the maturation of South African Archaeology over previous decades, echoing a similar pattern in the development of Processual Archaeology in the United States (e.g. Clark 1971, Johnson 1999). In many respects, this third wave research can be seen as a continuation of the second phase with no clear division between the two. New approaches, such as system theory and ecological models, and new analytical techniques such as Nearest Neighbour analysis, originally derived from population studies of Clark and Evans (1954) were applied in archaeological studies (e.g Hall 1981). With regards to the development of settlement pattern research, the new human geography of the 70s and 80s also proved influential. The work of synthesis became more important, and more feasible, as authors could draw on the amassed knowledge of previous decades, integrating ethnographic, linguistic and historical evidence to help interpret finds (Hall 1984, Mason 1986; Huffman 2007b). This can be seen as an influence of Processual Archaeology from the US, in its aims to augment the ability of researchers to derive anthropological information from archaeological data while utilising rigorous scientific methods which would allow for the replication of experiments and results.

In the years leading to these studies, Kuper (1980) introduced his model of the Zulu homestead, showing its organisation according to sacred spatial divisions related to status, gender and activity areas. Huffman (1982) adapted Kuper's model to explain spatial organisation in Iron Age settlements, creating the explanatory model known as the Central Cattle Pattern. Much of the early work was typological in nature as researchers took stock of the recent discoveries and classified different structure types based on their morphology.

3.6 CLASSIFICATION

The use of different terminology and modes of classification to define similar and possibly related architectural types may appear counter productive to the aims of providing a coherent understanding of the past. In *Archaeological Typology and Practical Reality*, Adams and Adams (1991: 5) describe the process of classification as both a methodological device and an explanatory principle created for answering questions. Their approach to classification of types in archaeology is more pragmatic than theoretical, with much of the work derived from an on-going dialectic between the Adams brothers, one a professor of Philosophy, the other of Archaeology.

Essentially the process of classification is driven by the need to distinguish different types and establish their relationships with other entities in time and space. From this perspective, classification is a practical method used to ask and answer questions. As such the nature of the typology is closely related to the nature of the question. Thus creating a typology may serve any number of functions, from creating heuristic models to simply organising information to answer a research question. The latter function proved more suitable to the aims of second wave research. The work of synthesis and expanding on this research in the light of new discoveries remains a task for future research.

3.7 STONE-WALL ARCHITECTURE

Megalithic and non-megalithic stone circles have been identified with neolithic settlements both in the northern and southern hemisphere. Stone circles constitute a core schematic component, upon which more complex types are ultimately based (Mason 1986). Circular stone-walling has been identified as hut floor bases in Iron Age settlements (Hall 1984; Taylor 1984), while smaller associated circles mark the bases of raised grain-bins. Known in Sotho as *Difala,* these were used to store and protect grain from termites and evaporation (Murimbika 2006: 76). In this respect the structures may be associated with delayed returns subsistence strategies and a reliance on agricultural production.

Hunting blinds and kraals, also based on a circular design are associated with Later Stone Age tools in areas of the Kalahari and Namibian coast (Parsons 2004). Some are believed to have been used by hunter-gatherers rather than herders (Veldman 2008). While some may have acted as seasonal camps along the coast (Noli & Avery 1976), settlements such as Riet River may be indicative of a shift toward a more sedentary way of life based on delayed returns subsistence (Humphreys 2009).

Early travellers such as Casalis (1861: 109 – 111) described large communities of Sotho, who from about 1850, built immense stone circles of oval huts in mountainous areas of Lesotho (cited in Maggs 1976). Others such as Backhouse (1844: 355) identified cone on cylinder style huts among the Rolong, while Bennie (1956) identified the remains of a large town at Sand River, comprised of low, circular stone walls and kraals. These configurations of densely agglomerated settlements differ from the older pattern of a large central kraal, which gave rise to smaller individual kraals with the breakdown of communal stock holding (Bonner *et al* 2008: 9).

Authors such as Walton (1949, 1956, 1958), used historical and ethnographic information, produced detailed descriptions of stone-wall architecture associated with the communities of the southern Highveld during historical times. Similarly Anderson (1977) provides details of historically known dry-stone wall settlements in East Africa, where different patterns of settlement organisation correlate with different cultural groups. Although not strictly archaeological in nature, the descriptions of settlements and related structure types, provide a means of establishing parallels with the settlements of archaeological cultures. Others such as Murembika (2006) take an ethological approach to defining emic architectural types and their respective functions within settlements, allowing for the identification of prestige and residential areas in addition to features such as grain bins, graves and mourning sites.

On the Highveld dry-stone walled settlements and hill-top sites were built from the 17th century onward. Some of the earliest settlements on the Highveld were built close to rivers in the foothills of broken country such as Olifantspoort 29/72 (Mbenga and Manson 2010: 1-2). These older structures are composed of a circular outer wall and one or more smaller internal circular structures. These are referred to as Group I by Taylor (1979: 10) and Type N by Maggs (1976: 33) and are believed to have evolved into larger, more architecturally complex structures north of the Vaal, referred to as the Klipriversberg Type by Huffman (2007: 38) and Group III by Taylor (1979). Taylor attributes this architectural evolution to contact between Sotho and Tswana immigrants.

In the Vredefort Dome, Taylor believed Group III settlements to be contemporaneous with the large Group II settlements of the Sotho-Tswana such as Molokwane and Kadishwene (e.g. Pistorius 1997; Boeyens & Hall 2009), with both types dating between the 18th to 19th century (Huffman 2007b: 38). Due to differences in the architecture and settlement layout of Group II and III, Taylor proposed that the latter may have been built by Fokeng or Sotho who escaped assimilation by encroaching Tswana prior to the *Mfecane*, with populations taking refuge on defensible hilltop sites (Taylor 1979). In recent years (Byrne 2012) largely confirmed that Group III hilltop sites were relegated to well protected mountainous areas. By comparison, Group II sites, some of which were large enough to deter or repel direct attacks were located in more open landscape (Boeyens 2003), with populations estimated to number in the tens-of-thousands (Anderson 1887).

Traditionally, the reproduction of architectural types by discrete archaeological cultures has been explained in terms of tradition and world view within a predominantly structuralist framework (e.g. Huffman 2007b). Others such as Eglash (1998) argue that the interpolation of geometric shapes, such as the circle, to create more complex architectural types results in the expression of mathematical fractals. While archaeologists have traditionally employed etic systems of classification, understanding the importance and function of different architectural types requires the use of ethnographic parallels to provide information as to their different components and their social and economic importance to the communities which made them. Sophisticated software such as GIS provides several ways of elucidating spatial relationships between structures and landscape features to identify pre-colonial settlement patterns.

4 METHODS

4.1 INTRODUCTION

This section details the methods used to collect data for analysis. Google Earth and ground truthing were used in data collection. A range of techniques was used to analyse data based on GIS packages and supplementary spatial statistics software. Soil samples collected during fieldwork were analysed for soil phosphates to identify activity areas.

4.2 THE GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) was developed as a United States military defence project during the late 1970s, at the height of the Cold War. The system is made up of a constellation of telecommunications satellites, which are used to triangulate the location of an electronic ground receiver. Over following decades GPS saw its use both in civil aviation and the commercial sector leading to the improvement of the technology and its use in archaeological field-work and surveys.

Hand-held GPS receivers require signal from at least three satellites to triangulate its spatial location. Signal from additional satellites can help to improve accuracy. Commercially available hand-held GPS receivers are accurate to within 10 – 20 m and have been widely used in archaeological survey work, while Differential GPS (DGPS) are accurate to within 0.5 to 5 metres and are used in more intensive site mapping projects (Connelly & Lake 2009: 293). While the accuracy of older hand-held units is more suitable for recording general features and structures, newer, more accurate models have been used to record perimeter walling and internal features in pre-colonial structures (e.g. Byrne 2012). While DGPS provides greater spatial accuracy, its benefits are offset by both its cost and the weight of the equipment when compared to hand-held units. As such DGPS is generally more viable for large-scale research projects, where a site can be accurately mapped over the course of a field working season.

4.3 GOOGLE EARTH

> "The archaeologist's dream of flying over a remote research area at will and viewing the landscape with sufficient detail to actually locate individual archaeological sites is now within our grasp."
>
> (Madry 2007: 10).

In recent years Google Earth has been used to locate and classify SWS in the southern Gauteng region as part of an ongoing project called Project KRK. Major roads and rivers were used to delineate the extent of search areas. Boundaries were saved as polygons. Polygons Pam 1, 2, 3 and 4, located in the Heidelberg district, were searched to identify locations with free standing stone circles – the diagnostic marker for the Group IV SWS category originally defined by Sadr and Rodier (2012). Polygons were systematically searched from a 250 m eye-level on a Digital Globe 7 metre true colour image to identify SWS clusters. Cluster locations were saved using place-markers. This survey method has proven to be less time-consuming when compared with methods such as air-photo analysis (e.g. Maggs 1968) and more cost-effective than conventional satellite imagery analysis (Madry 2007). The added benefit of having access to historical imagery in different seasons allows one to check real-time and reduce errors in structure identification.

Place-markers with unique identifying codes were used to tag the locations of individual structures. The perimeter wall of structures was traced using GE's path tool and assigned the same identifying code as their place markers. This process was repeated for all structures within major clusters. Structure outlines were drawn using a single satellite image taken in the dry season to maintain accuracy, as drawing outlines in different sets of imagery for a single area may result in spatial discrepancies. Historical images were used to check the accuracy of outlines as an intermediate step in data recording. Structures could not easily be classified using existing typologies (e.g. Mason 1968; Maggs 1976; Taylor 1979; Hall 1981; Huffman 2007b). Instead, a new typology was used to classify structures based on visible features in satellite images and observations of sites randomly sampled at ground level. Structures were re-classified and outlines altered based on observations.

Place markers and outlines were organised into separate folders according to type and saved as KML files. Although dense vegetation has been noted to negatively impact this recording method (See Byrne 2012), study areas were clearly visible, mitigating the need to record walling at ground level using a GPS. DNR Garmin was used to download and record field data from hand held GPS and to process data gathered using Google Earth before analysis using QGIS. Structure outlines were converted to multi-line polygons and saved using the UTM Zone 35 S projection. These data were saved as ESRI shape files for manipulation in QGIS and CrimeStat.

4.4 CRIMESTAT

CrimeStat is a spatial statistics program developed by Ned Levine and Associates to analyse crime incident locations (Levine 2007). The program itself is intended to be used in conjunction with GIS packages such as ArcGIS, GRASS and QGIS. Although originally designed for law enforcement, CrimeStat can be used as a powerful analytical tool to reveal patterns and elucidate trends in other types of spatially derived data. The latest version of CrimeStat version 3.1 was used to analyse spatial distributions, "hotspots" and to conduct nearest neighbour analysis and hierarchical nearest neighbour analysis of structure types.

Spatial distributions were calculated using projected (euclidean) distance with data units in metres. A reference grid was created using the ASTER 30 m DEM as a reference. The lower left corner of the map's X/Y axis was set as the datum. Measurement parameters were specified in square kilometres for each area. The distance measurement was set to "direct distance" as the indirect (or Manhattan distance) required a value for the area's street network. Estimated street values of 20, 50 and 100 kilometres were tested with an indirect distance and had little effect on the over-all spatial distribution of structure types. Results attained using a direct distance were used. The mean centre and standard distance, standard deviational ellipsis, median centre, centre of minimum distance and convex hulls were computed for structure types based on these parameters. Convex hulls were chosen to show structure distributions over ellipses, as the geometry of the latter is calculated based on 1.5 to 2 standard deviations from the mean, showing a general rather than a specific pattern for clusters.

Using the same parameters for spatial distribution, a Nearest Neighbour analysis was calculated for structures to the K'th order (i.e. K = the number of structures per type). The Nearest Neighbour Index was calculated by CrimeStat by dividing the actual Nearest Neighbour distance by the value expected in a random distribution of points. The average Nearest Neighbour Index was calculated as a Z-score to allow for a risk-adjusted comparison of types based on their clustering or dispersion relative to their proportional deviation from the mean. Z-scores were similarly used to compare area and elevation data. Values indicate whether structure types are more random or more clustered. Nearest Neighbour Index values closer to zero indicate a greater degree of clustering, while those closer to 1 indicate a more random distribution. A Nearest Neighbour Index value of 2.1491 indicates perfect uniform spacing between points. Results were represented on a set of graphs in each focus area for inter-site and intra-site comparison of clustering.

Similarly a Hierarchical Nearest Neighbour Analysis was used to identify first-order clusters of structure types. This provided a means of showing where the majority of structure types tend to occur in the landscape. This was supplemented with a Fuzzy Mode, or F-Mode, "Hot-Spot" analysis with a 50 metre buffer zone around each structure. Structures within 50 metres of each another generated a frequency value based on the number of structures in the immediate area. The frequency value was used to visually represent cluster sizes within settlement areas using QGIS. These results helped to reiterate patterns already evident with a standard nearest neighbour analysis.

4.5 GEOGRAPHIC INFORMATION SYSTEMS

"The application of GIS is limited only by the imagination of those who use it"

-Jack Dangermond: ESRI

An ASTER 30 metre Digital Elevation Model was used to generate a relief map of the study area by using the Terrain Analysis plug-in in QGIS. Contour lines at 10 metre intervals were extracted for relevant settlements from clipped areas of the DEM. Major settlement clusters and SWS polygons were projected in the UTM 35 S co-ordinate system.

Elevation data was used to calculate the ruggedness index (RI) of the landscape using standard QGIS plug-ins. In principle these results would be comparable with a cost-path analysis at the inter-site level, which would show the most cost efficient routes by generating a raster image based on elevation values for each map cell. The latter is a time consuming process requiring the use of a Post-Gres data base. A Ruggedness Index was more suitable for the purposes of this project, allowing me to discuss the settlement pattern within the context of the surrounding landscape by identifying impassible terrain, relatively level areas and potential points of access to the settlements.

Agricultural data, such as structurally favourable soils and areas with good grazing potential, were retrieved from AGIS.gov.za for analysis of site catchment areas. Images were then geo-referenced using control-points taken from the regional maps. 1 kilometre buffers were used to show associations between more discrete features such as slopes, while 2 kilometre dissolved buffers were used to show stone circle distributions in relation to structurally favourable soils and arable land.

The area of polygons were calculated using the FieldCalc, a standard plug-in of QGIS. Polygon centroids were then extracted from polygons to identify the mean centre of the 2 dimensional projections. Elevation samples were obtained from centroids using the Point Sampling tool– a user-created plug-in contributed to the QGIS official repository. These data were displayed as frequency distributions by a number of structures relative to mean elevation and area for comparison between different SWS types and settlements.

Delaunay triangulation was used to identify the spatial relationships between different structure types at the intra-site level. In this case all structure types in the Group IV typology were lumped together and subjected to analysis. This provided a visual representation of an overall pattern for structure placement within the settlements. Results were super-imposed on Ruggedness Index rasters to show the relationship between different structure types in the context of their settlement area.

Place markers from locations in and around settlements were used to calculate viewsheds with a user-created viewshed plug-in for QGIS. A view height of 1.75 metres was specified to provide an impression of the visible landscape. This technique has been used to conduct inter-visibility studies on structures at Pompeii (Ellis 2004), Neolithic sites in areas near Avebury in the United Kingdom (Lake and Woodman 2003; Wheatley 1995) and Iron Age settlements in the Vredefort Dome (Byrne 2012).

4.6 GROUND TRUTHING

Two settlement areas, in the Suikerbosrand Nature Reserve and Shickfontein area, were surveyed on foot. Sites were randomly sampled in key areas identified on GE to provide an impression of type variations and more discrete architectural features. Entrance-ways, features and stone circles, too small to be viewed on GE, were recorded using a hand-held GPS. Wall height, state of preservation and construction method were also noted. Artefacts and structures were photographed using a digital camera and their locations were recorded with GPS. These results are supplementary to the discussion of types and their settlement pattern.

Soil samples were collected from several locations around each settlement to test for their phosphate levels. By analysing phosphate content in soils, researchers have been able to identify human occupation of sites (Sjöberg 1976; Schlezinger 2000), identify middens and cultural deposits (Lippi 1988) and define site boundaries (Cavenagh *et al* 1988).

Five milligram soil samples were collected from a shallow depth of 1 – 2 cm below the surface level from the interior of different structure types. Samples were collected from remote locations around each settlement to test for background phosphate concentrations. Sampling locations were recorded with a GPS to provide a spatial reference for each sample, with their corresponding identification code written on each bag. This method provided a means of identifying chemical signatures associated with human and animal activity.

4.7 SOIL ANALYSIS

A Merckoquant phosphate field testing kit was used to determine the orthophosphate concentration in soil samples collected from SWS. Samples were prepared by crushing a 5 ml volume of soil and removing organic matter which would interfere with the readings. The prepared sample was then added to a diluted solution of 5ml 1.4 molar strength Hydrochloric acid and 1ml of distilled water with a phosphate concentration of nil. The solution was then agitated for 2 minutes to allow the sample to be broken down. A test strip was then submerged into the solution for 1 second. After an additional 2 minutes the reagent was added to the test area of the strip and then removed after a further 15 seconds. The resulting colour change was compared to the scale after 60 seconds.

5 RESULTS

This chapter is divided into six sections. The first shows the regional distribution of sites in relation to resources and landscape features, allowing for the identification of preferential settlement areas using agricultural and topological maps. The second recounts the classification process used to generate results and a description of their diagnostic architectural details. The third section reports the diagnostic architectural details of structure types and their variants. The fourth section details the results of the soil phosphate analysis from samples collected from the Suikerbosrand Nature Reserve (SKBR) and Kroondal (KD). The final two sections cover the results of the spatial and view-shed analyses at the intra-site level from SKBR and KD.

5.1 GENERAL LANDSCAPE PATTERNS AND DISTRIBUTION

Agricultural and topological maps were examined in relation to stone circle distributions to provide a general impression of preferred settlement areas and available resources. Applying site catchment analysis to archaeological sites can be problematic where the landscape has been altered due to changes in climate patterns, rain-fall, erosion and anthropogenic activity. For this reason, structurally favourable soils, or soils with the potential for agricultural use, climate permitting, were used in favour of examining sites in relation to the best arable land.

Figure 3 shows stone circles were primarily found in mountainous areas with moderate to steep slopes, with a few isolated structures located on more level terrain. Due to erosion the highland soils in the immediate vicinity of the settlements are relatively poor for cultivation (Fig 4), while structurally favourable soils tend to occur on relatively flat land. Of the 1428 structures, 31% were found to occur within 2 km and 51% within 5 km of soils favouring agriculture. The occurrence of good grazing areas showed the opposite pattern. The best grazing areas were located in high-land areas with 51% of settlements located within 2 km and 59 % within 5 km of the best grazing areas (Figure 5). This suggests a closer association between the location of settlements relative to good grazing areas than structurally favourable soil.

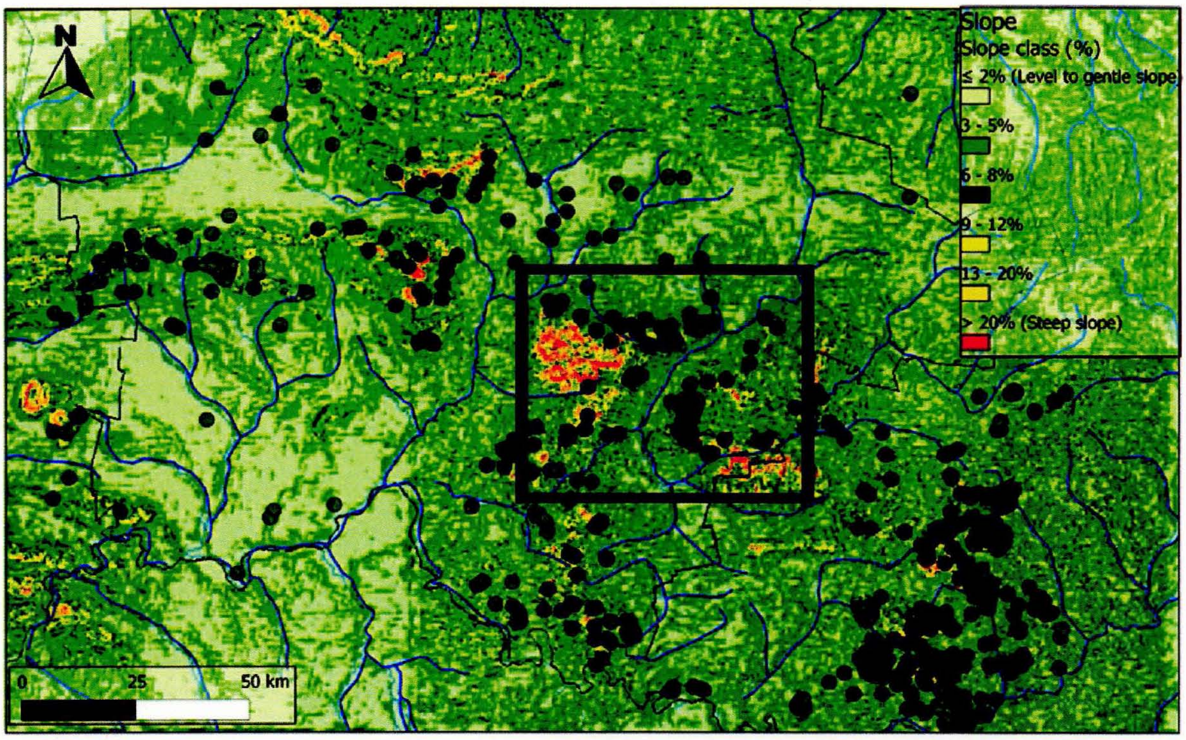


Figure 3: *Distribution of structures relative to slopes. Location of circles marked using 1 kilometre buffers. Area in black shown in Figure 1.*

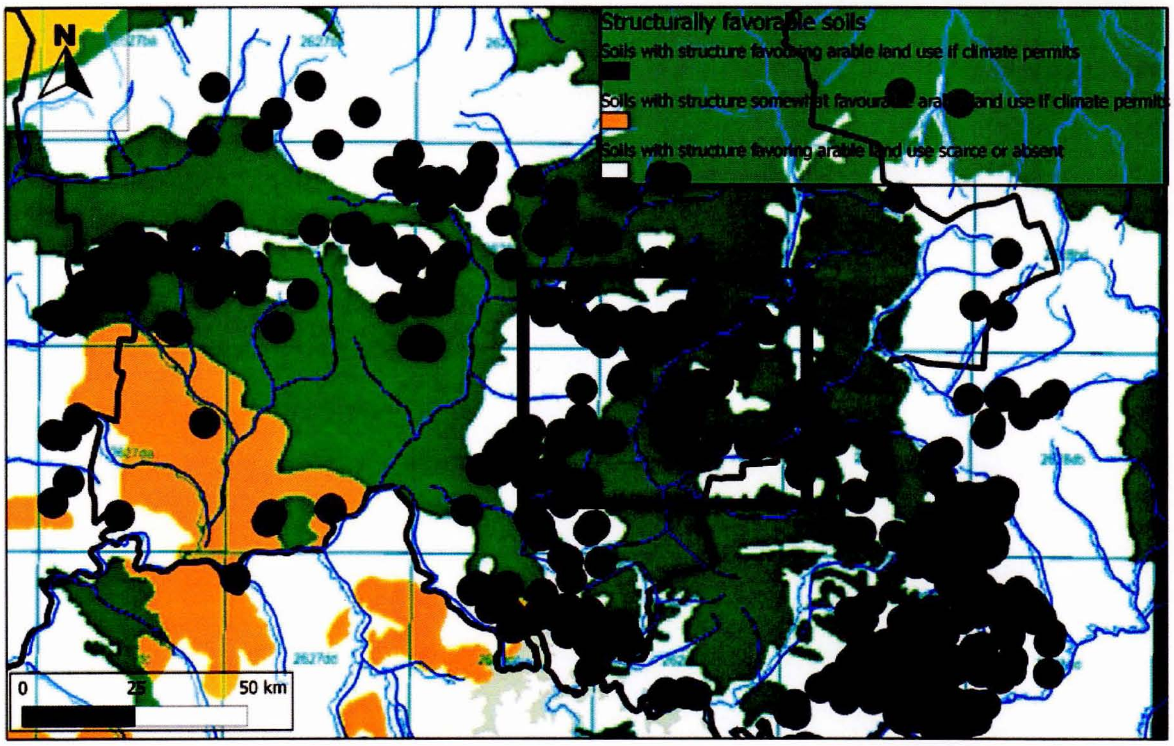


Figure 4: *Location of structures relative to structurally favourable soils using dissolved 2 km buffers.*

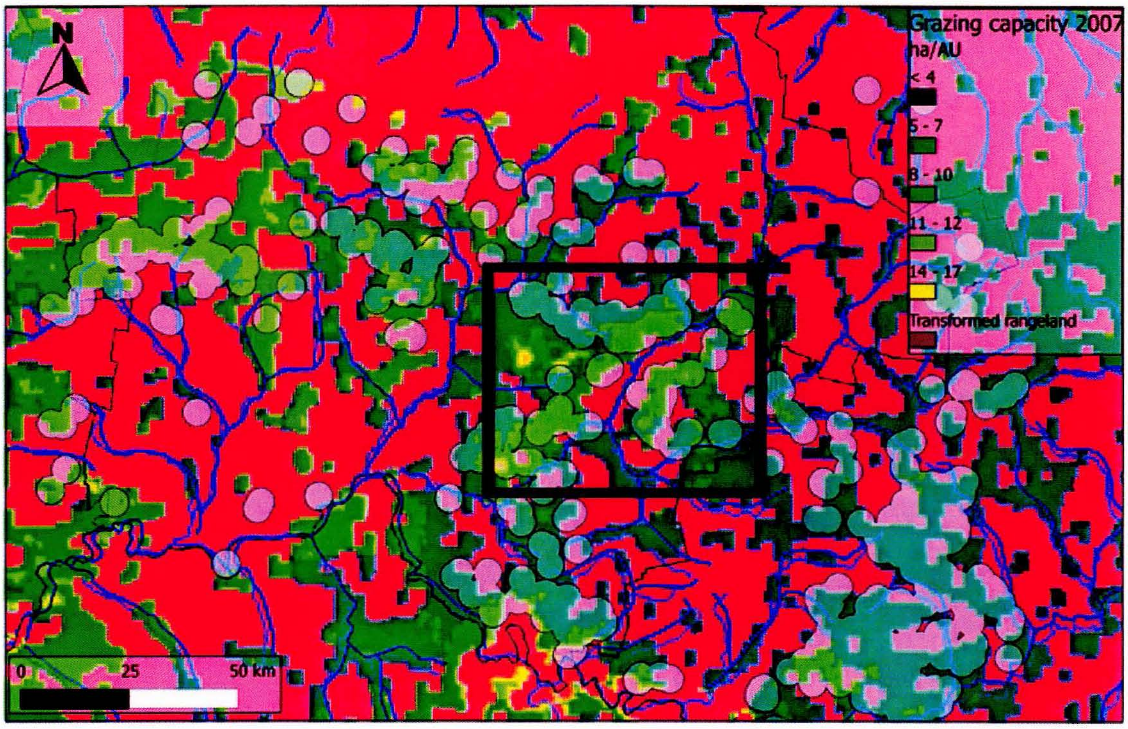


Figure 5: *Map showing distribution of structures in relation to land wit the best grazing potential. Buffers = 2 km.*

A chi square goodness of fit test was used to test the significance of this association. Our null-hypothesis (H_0) thus assumes no significant difference between the observed and expected number of structures within 2 km of grazing areas or arable land. Table 1 shows a value of 46.45 for x^2 which exceeds the critical value of 10.83 in the first degree of freedom where P = 0.001. We thus reject the null hypothesis that there is no relationship between the occurrence of structures relative to agricultural land and grazing areas and therefore assume that these factors are statistically significant in the selection of settlement areas. Indeed the majority of structures which fall outside of this pattern tend to cluster south west of the Suikerbosrand River Basin. Future work will be required to verify if these stone circles relate to a different settlement pattern.

Figure 6 shows the location of structures in relation to woodlands and vegetation using a Normalised Density of Vegetation Index (NDVI). The association between the stone circles and the densely wooded areas is likely a consequence of their location along the well drained mountain slopes. Despite the apparently coincidental nature of this association, access to stone and timber for building material and animals for trapping and hunting may have provided incentive to settle in these areas.

Table 1			
Chi ² goodness of fit test comparing the occurrence of stone circles in relation to favourable soil and grazing areas within 2 km.			
	Structurally favourable soil within 2 km	Grazing areas within 2 km	Total
Observed n SWS (O)	500	740	1428
Expected n SWS (E)	620	620	1428
O-E	-120	120	0
$(O-E)^2$	14400	14400	
$(O-E)^2 / E$	23.225	23.225	$46.45 = X^2$

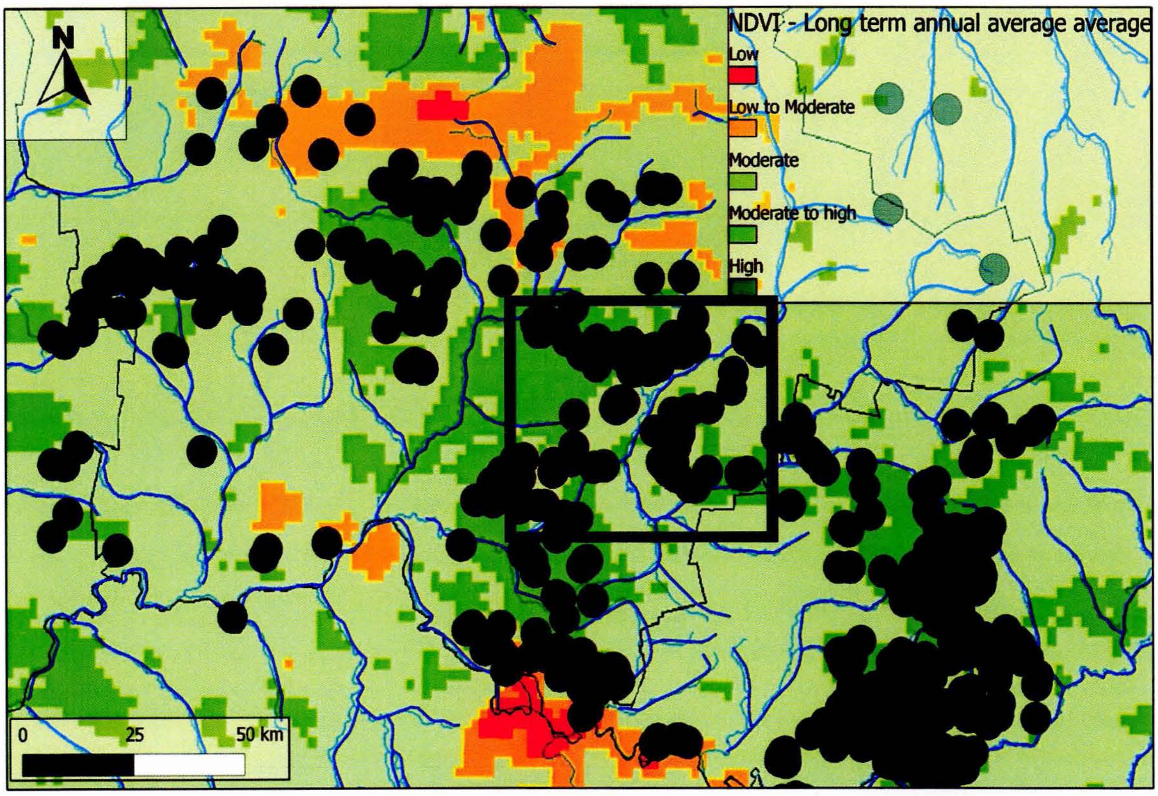


Figure 6: *Map showing distribution of structures relative to average NDVI. Buffers = 1 km.*

5.2 ARCHITECTURAL TYPES

A new typology was created to classify structures based on lessons learned from previous research in the area. Initially, Michael Taylor's typology was used to classify structures based on their visible walling in satellite images.. In a recent set of studies focusing on inter-analyst variability in stone-wall classification, difficulties were encountered in applying the typology to regional data collection in southern Gauteng (MacRoberts 2012; Hunt 2013). Although difficulties are possibly related to factors such as analyst experience and incentive, the lumping and splitting of architecturally similar types. As such, the problem may reside with the use of a pre-defined typology to seriate types in a new research area, rather than Taylor"s typology itself. Instead, diagnostic structure types were defined based on satellite imagery and field observations. These were then compared with architecturally similar structure types to establish possible links. Diagnostic examples of the four major SWS categories are summarised in Figure 7.

Type A, like Sadr and Rodier's Group IV, refers to an individual stone circle of any size. Structures in this class are defined by circular, roughly symmetrical, stone walls and the absence of visible internal structures. Larger Type A's were sometimes accompanied by smaller satellite stone circles, which were also identified as internal features in more complex SWS.

Type B represents a variation on the circular design of Type A. Unlike the latter, the circular component of Type B is a tall, possibly load-bearing, circular wall, to which several smaller structures and partitions are attached. In some respects this type appears reminiscent of structures identified in late farming community sites in KwaZulu-Natal (e.g. Hall & Maggs 1972; Hall 1984).

Type C refers to large, central SWS complexes, comprised of internal features including circular stone enclosures and dividing walls. These are housed within a continuous, irregular perimeter wall. Although difficult do describe based on their confusion of internal structures, these share morphological similarities with Taylor's Group III structures, also referred to as the Klipriversberg Type.

Examples of Type D share similarities with Taylor's Group I and Magg's Type N structures. The most common diagnostic examples are comprised of a circular perimeter wall, enclosing three to four stone circles making up the structure's nucleus. Some Type D structures appear to be amalgamations of this simple design, with two structures conjoining to form a larger structure. Type D structures appeared to be less well preserved based both on their appearance on Google Earth and at ground level.

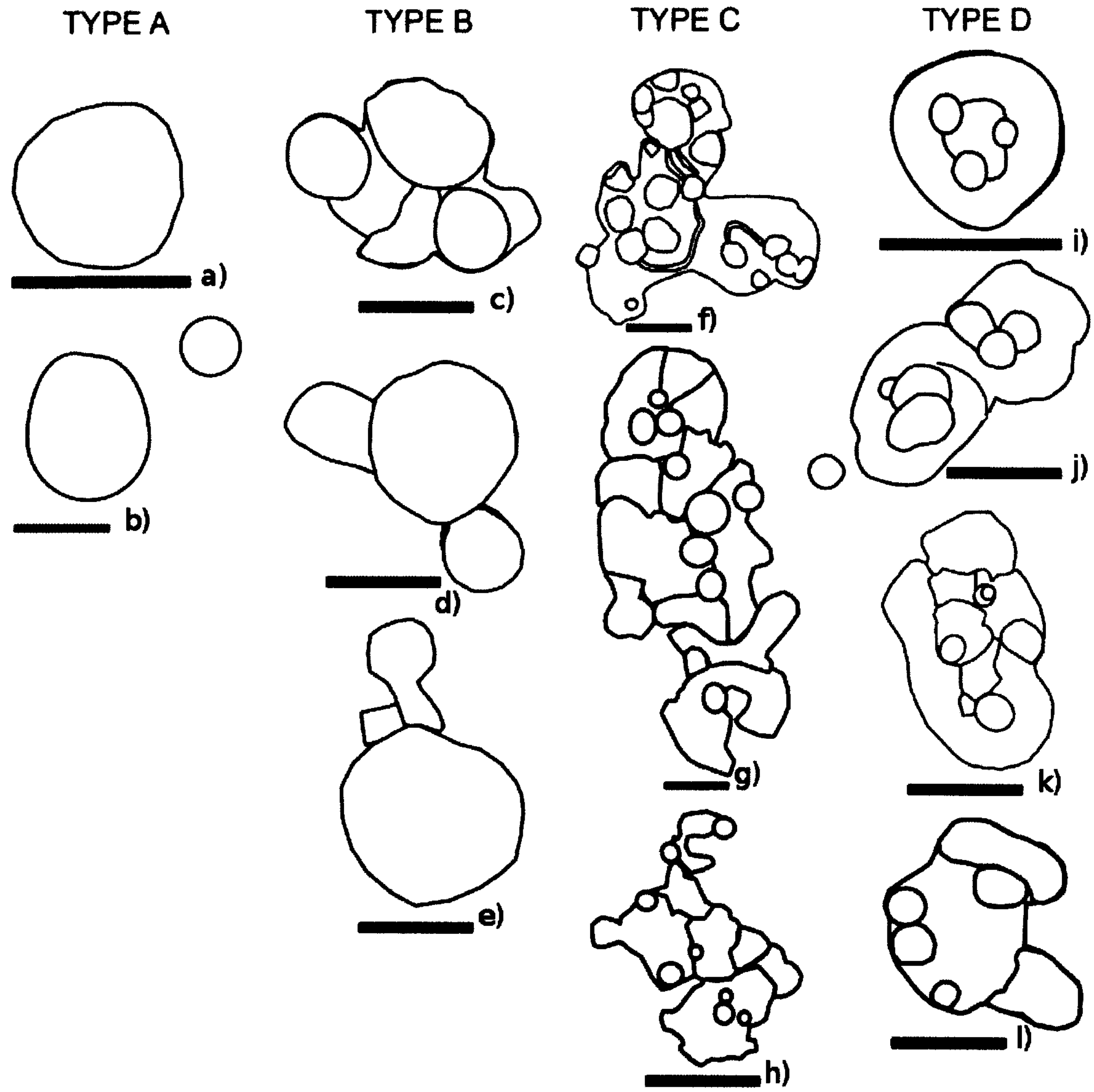


Figure 7: *Type A, B, C and D SWS. All scale bars represent 20 metres. a) single stone circle; b) large circle with smaller circle, sometimes forming clusters; c) irregular Type B with internal structures; d and e) Type B variates with court-yard and secondary structures; f to h) Diagnostic examples of Type C, generally complex with numerous internal enclosures and features; i to l) Diagnostic Type D structures, generally smaller and with fewer internal enclosures compared with Type C.*

5.3 ARCHITECTURAL DETAILS

This chapter summarises the diagnostic architectural details of structures from KD and SKBR. This will allow me to define types based on recurrent features noted during field-work and remote sensing. Construction method, associated material culture and state of preservation are also discussed.

5.3.1 TYPE A

For classification purposes Type A refers to a single stone circle, regardless of size. Despite lumping stone circles of different sizes, field observations indicate several distinct variants of this type, a pattern also visible in the statistical data. The smallest Type A structures measured only a few metres in diameter and were constructed using core-rubble infill with a narrow gap or false entrance way (Fig 8). These smaller structures often occurred in small clusters on koppies and were sometimes associated with larger variations of Type A and B. Surface finds were typically not associated with structures of this type.

Figure 8: *A small Type A stone circle over-looking the surrounding landscape at KD.*

Many of the larger Type A's had relatively low walls with well defined entrance ways which tended to face down slope (Fig 9). While the structures in this class were not contained within a perimeter wall, similar features were observed in larger more complex structures (Fig 10). Type A structures also appeared to be highly symmetrical and were likely created using a standardised building procedure to produce their circular shape (e.g. Anderson 1977).

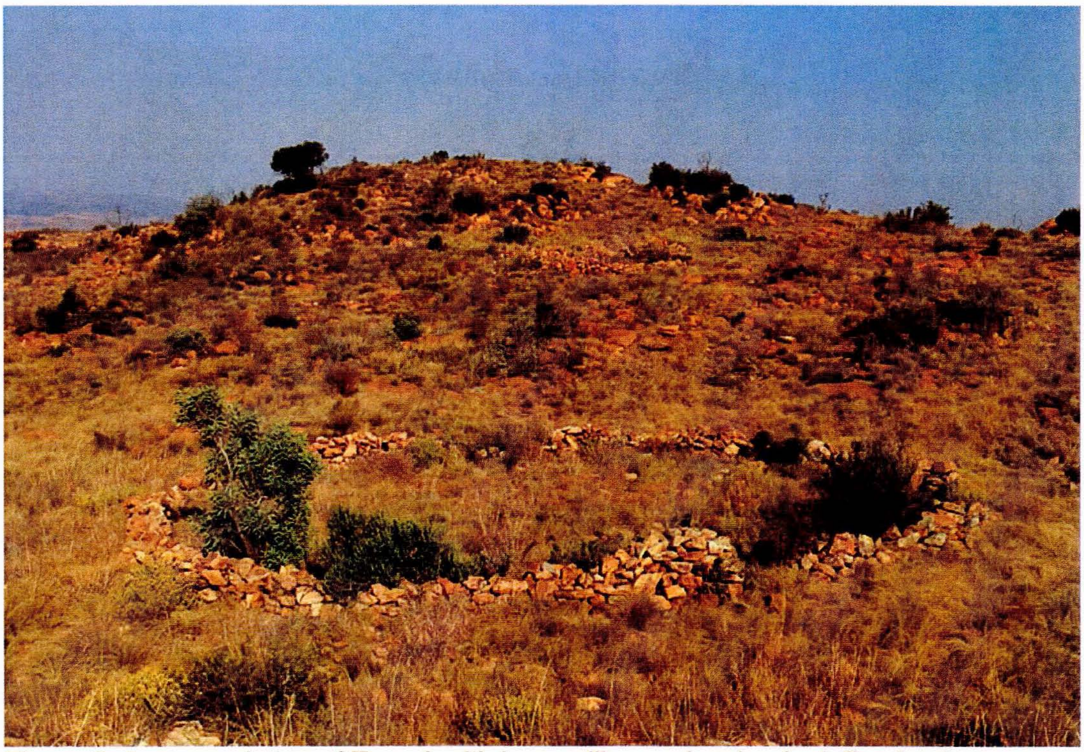


Figure 9: *Large variation of Type A with low-walling and a clearly defined entrance way.*

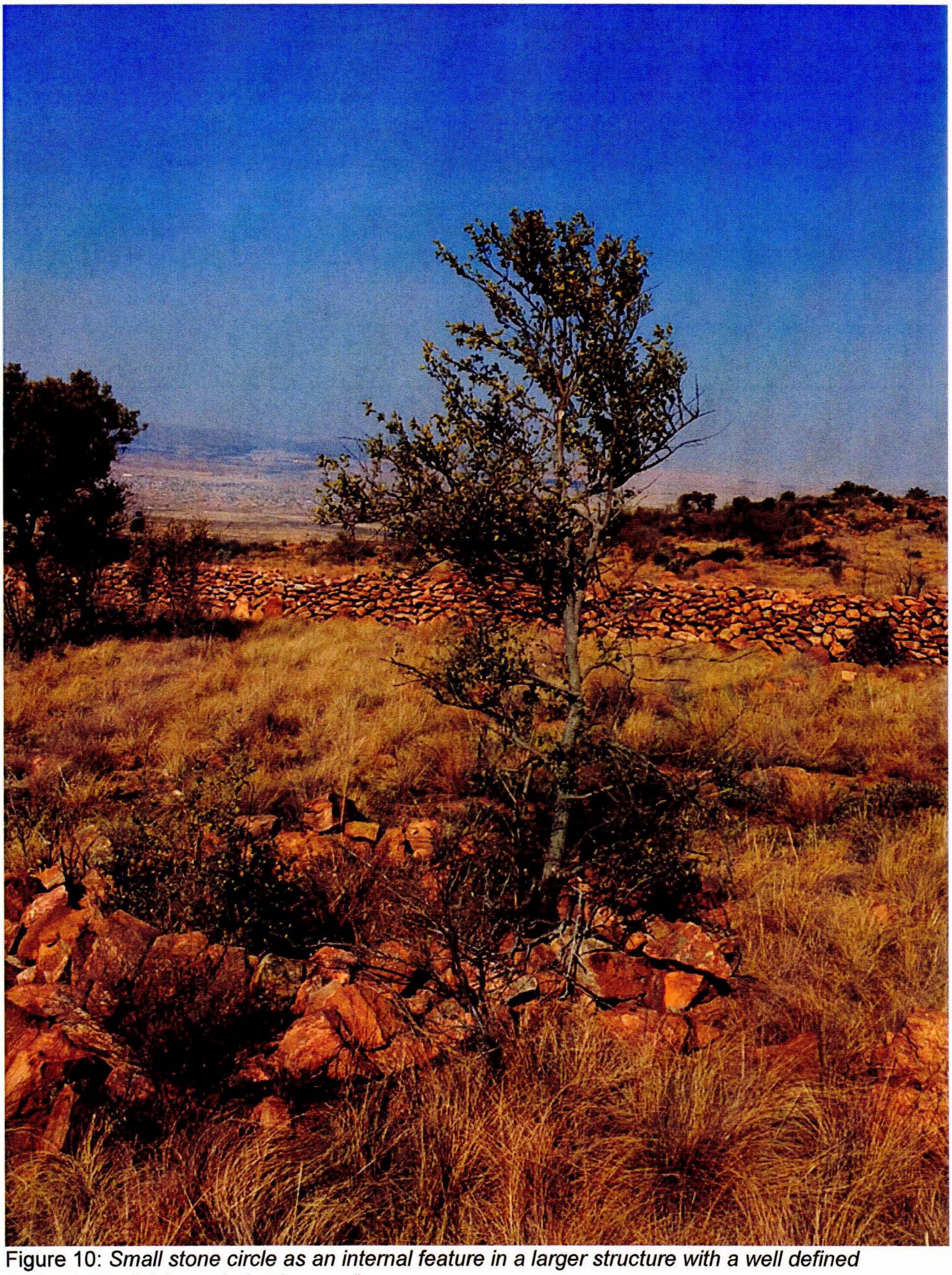


Figure 10: *Small stone circle as an internal feature in a larger structure with a well defined perimeter wall (shown in background).*

5.3.2 TYPE B

Based on a similar circular design Type B showed little visible difference to the large stone circles on satellite imagery save for small secondary structures, and were originally included in Sadr and Rodier's Group IV. Typically, these structures had well built walls, between one and two metres high. To support the load, stone slabs were used to construct a solid foundation shown in Figure 11. The larger, better constructed variations may represent prestige areas in some cases. Unlike the Type A structures, material culture such as pot sherds (Fig 12) and in one case, a tin ingot were found inside the Type B structures (Fig 13). Low courtyard areas were found in many structures of this type, sometimes containing items such as grinding stones and pot-sherds (Fig 14 & 15).

Figure 11: *Large stone slabs were used to create a foundation to bear the load of higher walling.*

Figure 12: *Metal artefact, possibly tin, found in a large Type B structure (KD 8).*

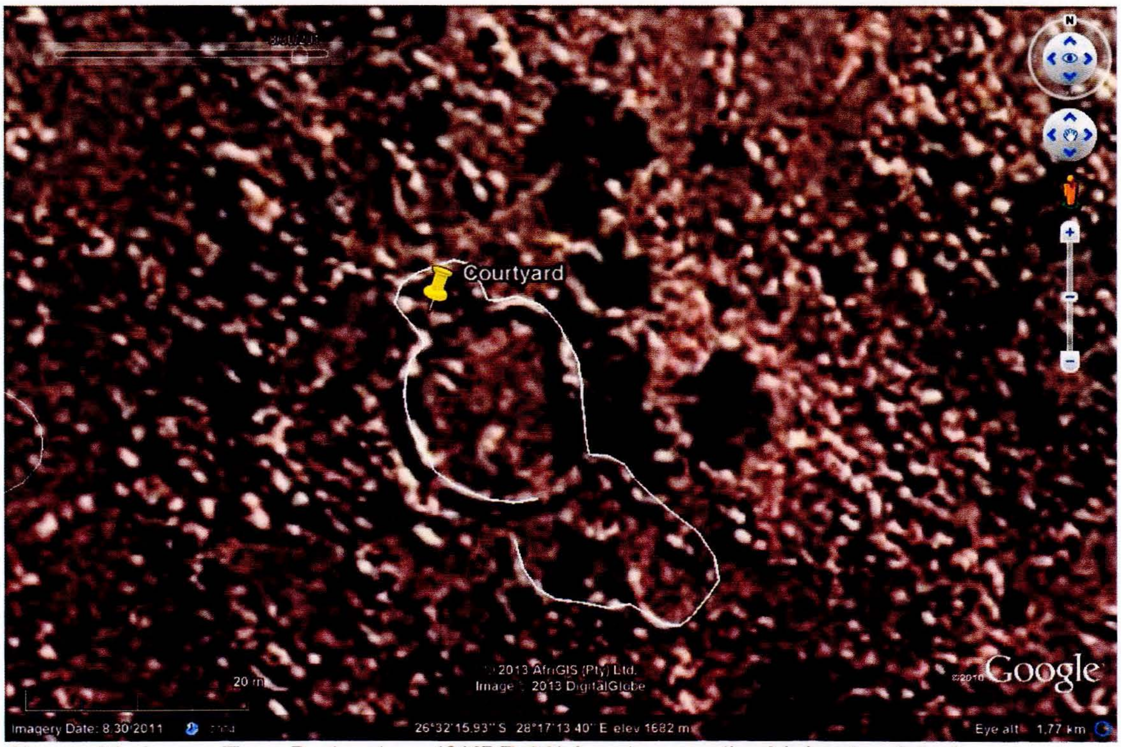


Figure 13: *Large Type B structure (SKBR 83) locate near the highest point of Suikerbosrand's southern hills showing secondary structure and small court-yard area.*

Figure 14: *Large undecorated potsherd found in the interior of structure KD 8.*

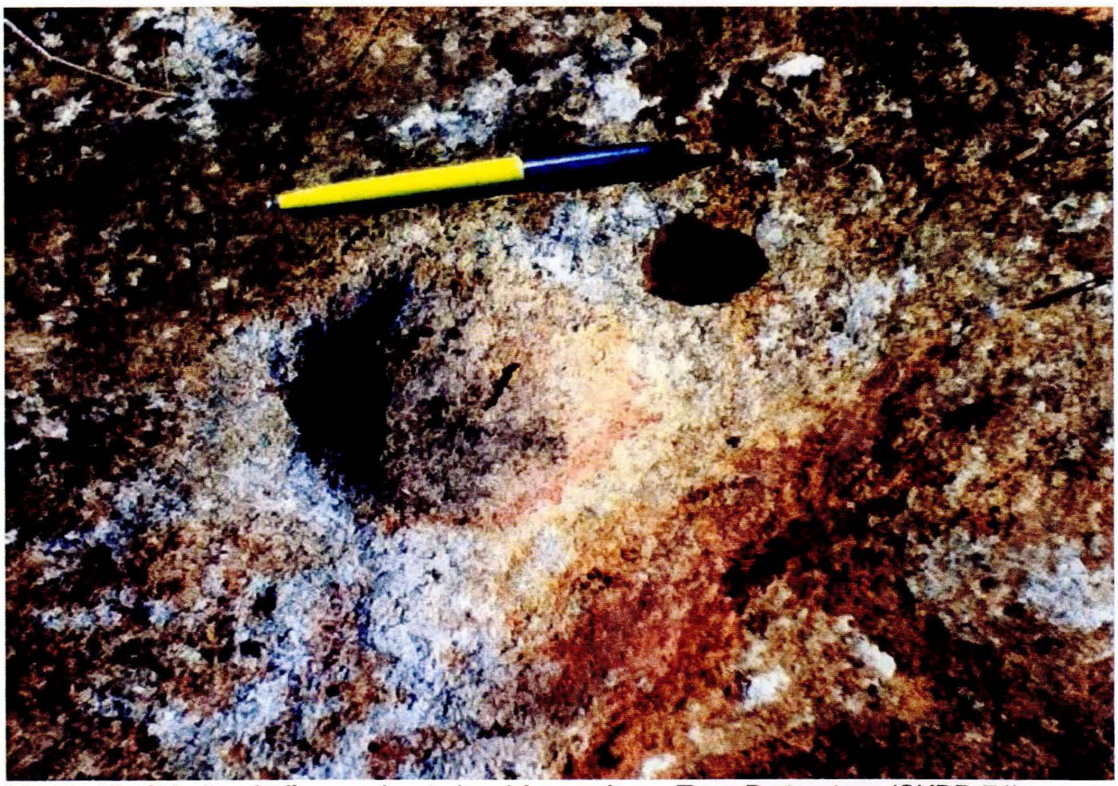


Figure 15: Grinding hollow and pot sherd from a large Type B structure (SKBR 71).

5.3.3 TYPE C

The majority of structures in this class were initially believed to be a variation of Taylor's Group III. Here I refer to them as Type C. Similar construction methods were employed to those described for Type B, while Type C was defined a well built continuous outer wall (Fig 16). Although morphologically different from Types A and B, Type C structures were also relatively well preserved, sometimes containing stone circles similar to Type A. In one instance, an isolated rectangular structure was identified in the northern interior of SKBR 75 as well as the faint cattle track leading to the structures western entrance (Fig 17). Not bearing resemblance to a European structure, similar features are associated with the annual fertility rituals involving animal sacrifice conducted by the village chief (Eglash 1998).

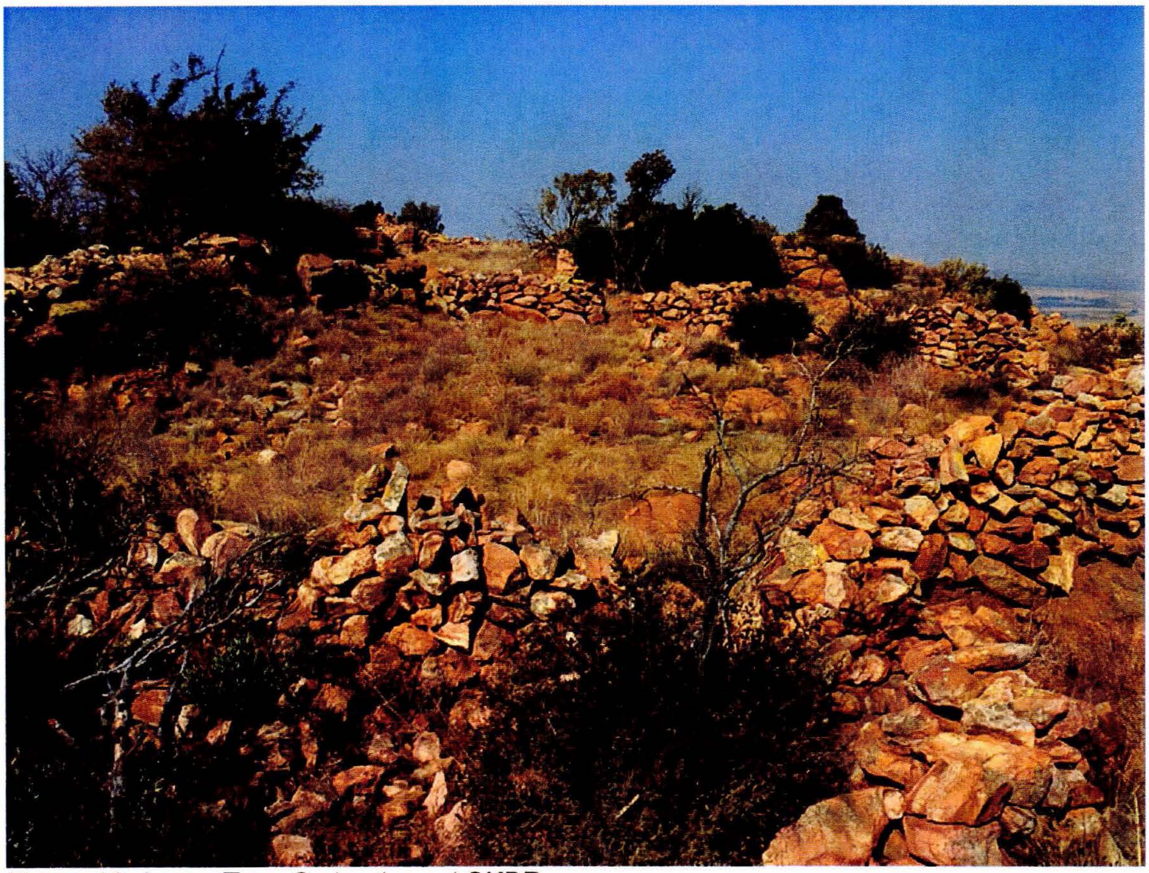


Figure 16: *Large Type C structure at SKBR.*

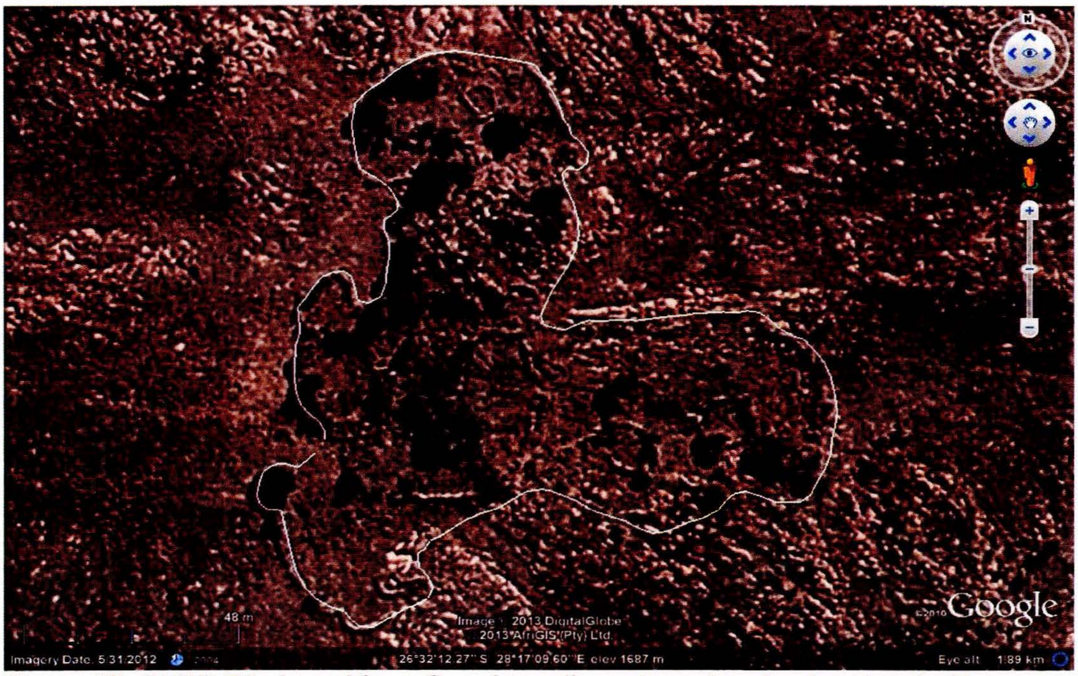


Figure 17: *SKBR 75 viewed from Google earth, rectangular structure located in upper centre of structure. Stone wall alignment on the east entrance appears reminiscent of a cattle track.*

5.3.4 TYPE D

Many of the larger Type D structures at Kroondal were covered with dense vegetation, obscuring low or crumbling walls (Fig 18 & 19). Initially these were thought to be similar to Taylor's (1979) Group I. Smaller variations of Type D, more diagnostic of Group I structures were identified on the periphery of the settlements such as SKBR (Fig 20). In some instances complex Type D structures showed morphological overlaps with Type C structures, similar to the overlap between Taylor's Group I and Group III. The larger structures at KD may have developed following a phase of organic settlement growth, while those at SKBR may indicate an early punctuated occupation of the hills.

Figure 18: *Large Type D structure (KD 21), less well preserved than other types previously discussed.*

Figure 19: *Low-walling of KD 21 inundated with soil and vegetation (shown in background).*

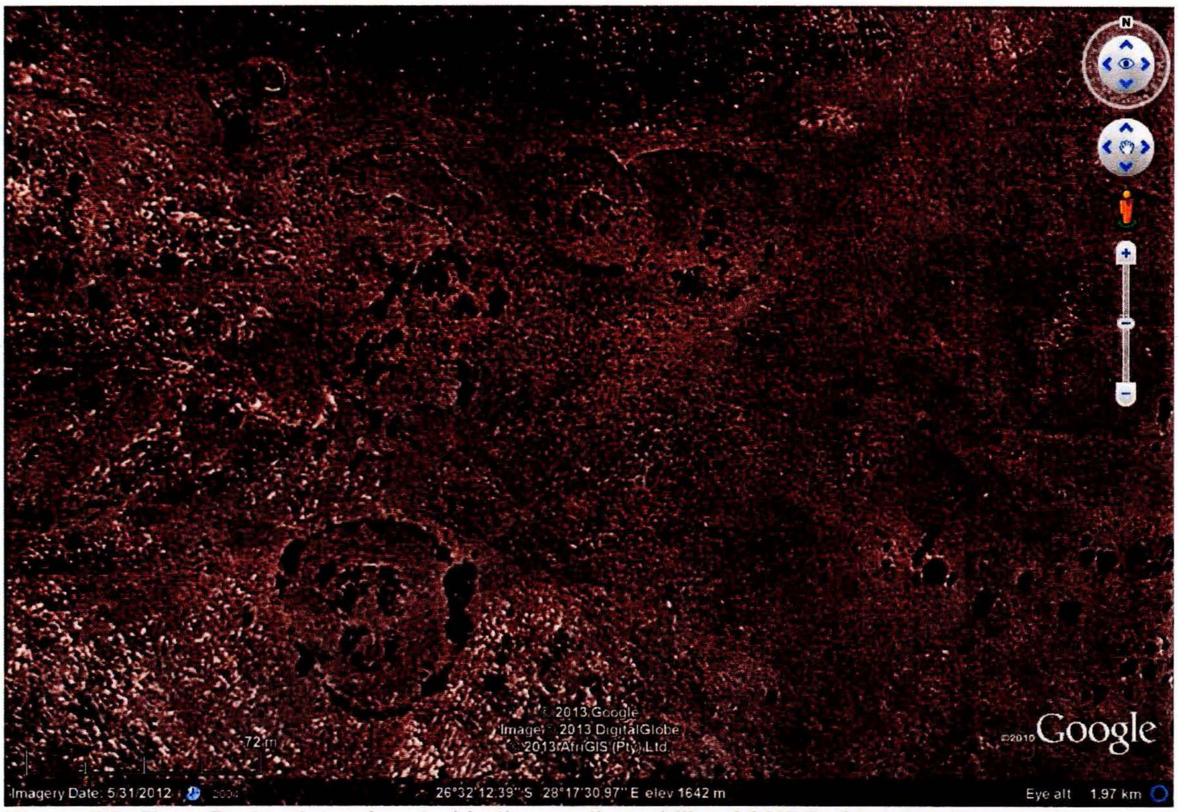


Figure 20: *Type D structures located in the southern hills of SKBR. Structures are more characteristic of Taylor's Group I.*

5.4 SOIL PHOSPHATES AND ACTIVITY AREAS

A Merckoquant phosphate field-testing kit was used to analyse soil samples collected from the internal walling of structures (e.g. Figure 21). The aim was to attain values for Type A and B structures to test if they contained livestock. Samples were also collected from several of the larger Type C structures which showed a likely association with Types A and B, while the more remote Type D structures were not mapped. Results range from one, indicating low or negligible phosphate levels, to seven, the highest reading attainable using the kit.

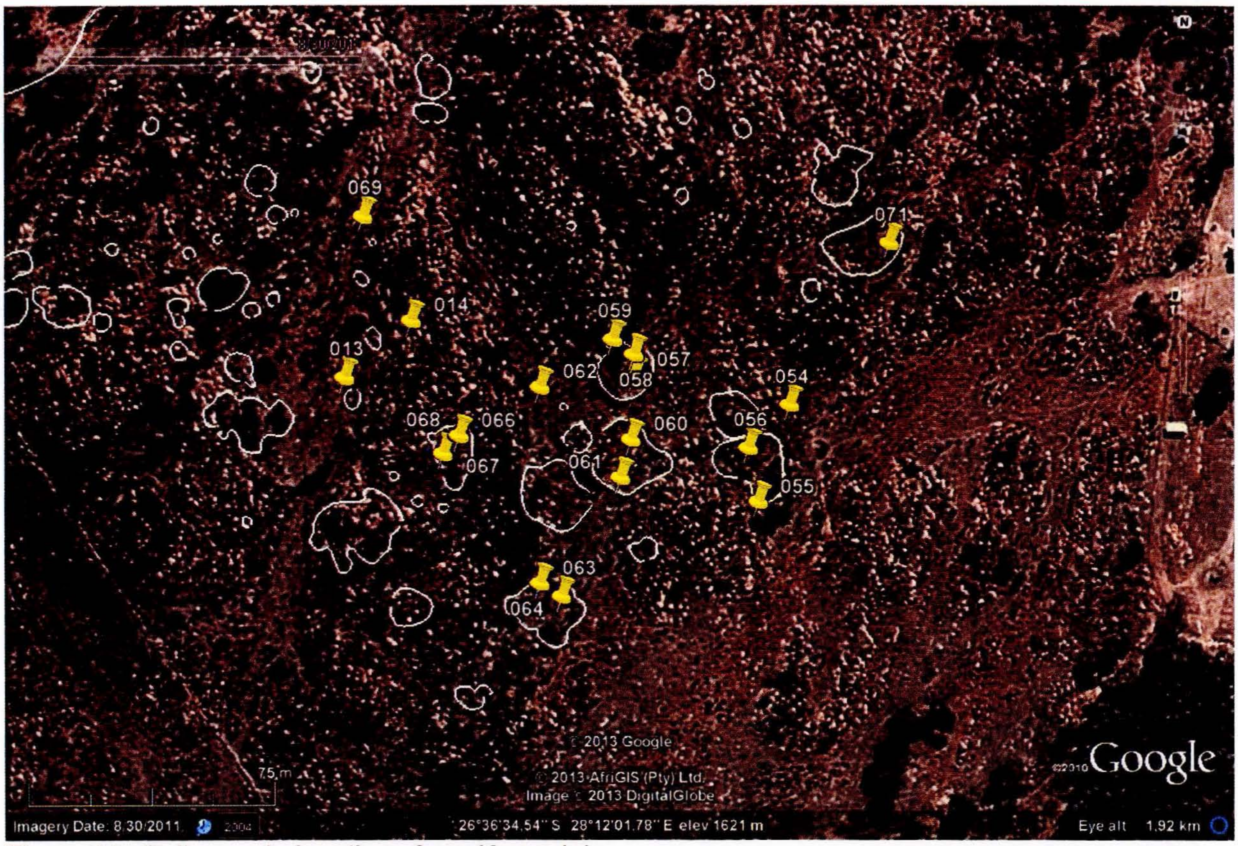


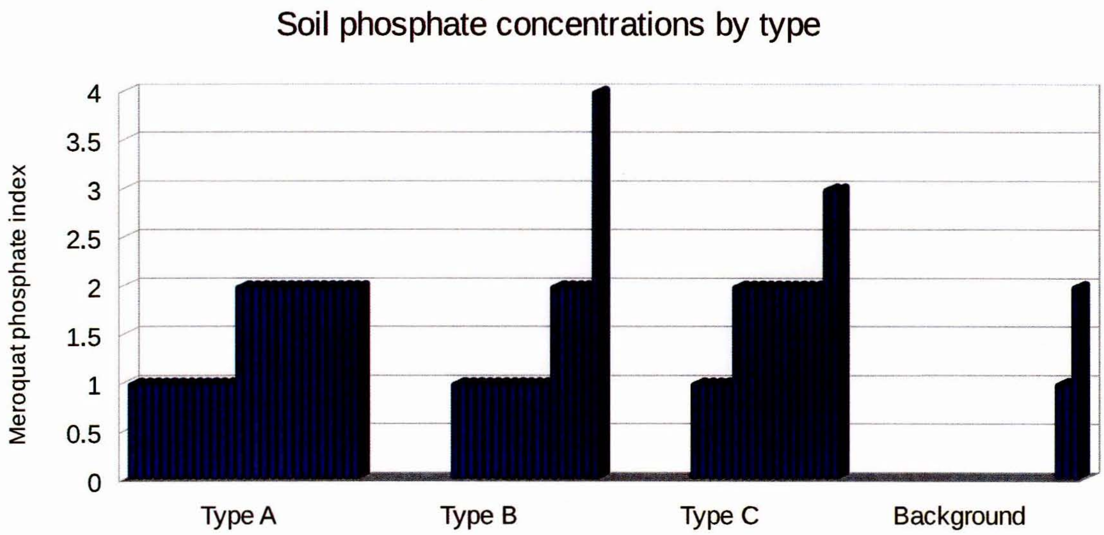
Figure 21: *Soil sample locations from Kroondal.*

Table 2 shows the combined results for the settlements at Suikerbosrand (1 to 53) and Kroondal (54 to 73) with low values for the majority of tests – a pattern similarly encountered by Ensor-Smith (2012) in his analysis of soil phosphates from Group III structures in other areas of the Reserve. Represented visually, results show weak to moderately weak phosphate concentrations in the Type A class, showing little difference from background phosphate levels (Graph 1). Little difference was noted in the values attained for large and small variants of Type A. In contrast, Type B structures showed a more complex pattern, with relatively low readings within the structures and higher readings in the case of courtyard areas (Figure 22). This unanticipated result may warrant more detailed phosphate mapping of the Type B structures in the near future. Type C structures, on average had the highest values indicating more concentrated human or animal activity.

Table 2

Test results from soil phosphate analyses from SKBR and KD.

Sample number	SWS Type	Result	Sample number	SWS Type	Result	Sample number	SWS Type	Result
1	A	1	26	C	2	51	A	2
2	B	1	27	C	2	52	A	2
3	A	1	28	C	1	53	A	2
4	A	1	29	C	2	54	A	1
5	N/A	1	30	C	3	55	A	1
6	A	2	31	N/A	2	56	B	1
7	C	1	32	B	1	57	B	1
8	C	2	33	B	1	58	B	1
9	C	3	34	B	2	59	B	1
10	C	1	35	B	4	60	B	1
11	C	2	36	C	2	61	B	1
12	C	1	37	C	2	62	A	1
13	A	1	38	C	2	63	B	2
14	A	1	39	C	2	64	B	2
15	A	1	40	A	2	65	A	1
16	A	1	41	C	1	66	A	1
17	A	2	42	C	1	67	B	2
18	A	1	43	C	2	68	B	1
19	N/A	1	44	A	2	69	B	1
20	A	2	45	A	2	70	B	1
21	A	2	46	A	2	71	N/A	2
22	A	2	47	B	2	72	D	2
23	A	2	48	A	2	73	B	1
24	A	2	49	A	2			
25	C	2	50	A	2			



Graph *1: Phosphate test results for Structure Types. Weak to moderately weak phosphate concentrations were found in soils from the small stone circles (Type A), while the highest readings were associated with Type B courtyards and Type C internal structures.*

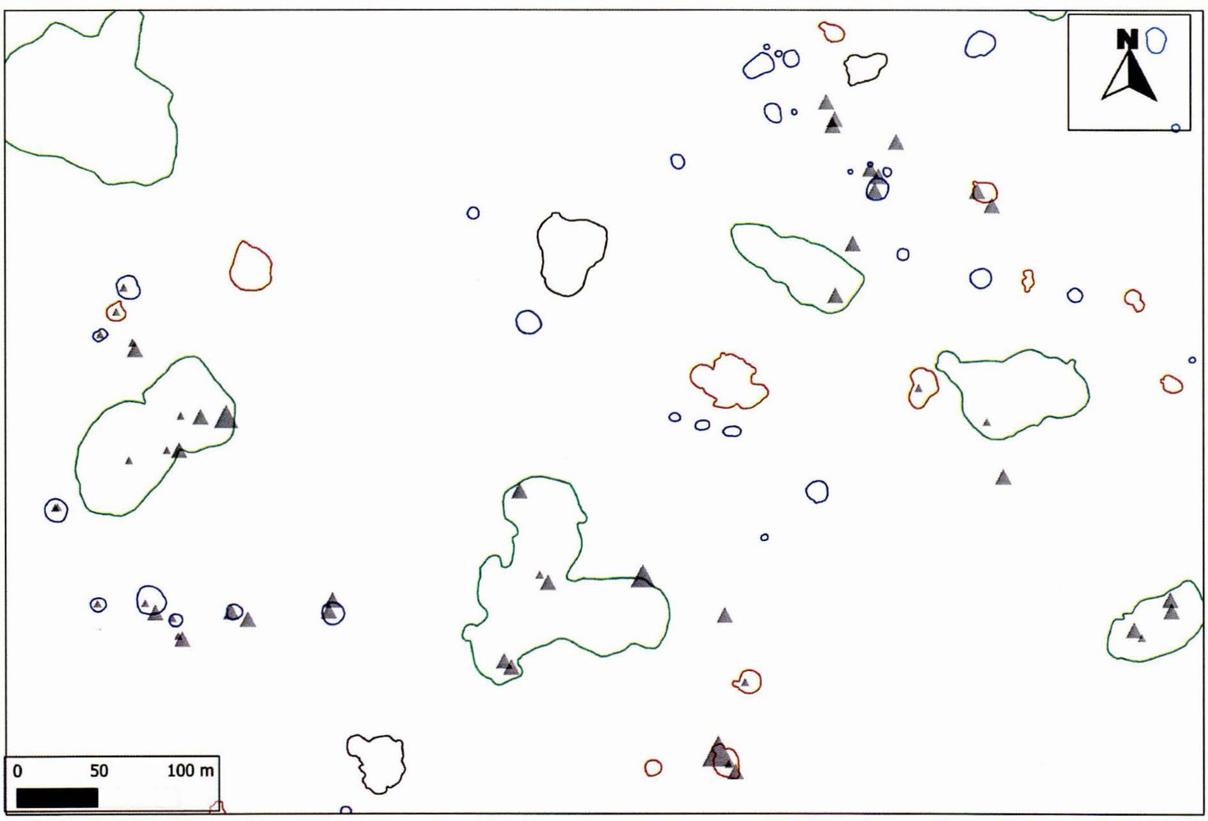


Figure 22: *Map showing structure polygons and phosphate sampling locations at SKBR. The size of grey triangles is proportional to their phosphate reading. Type A in blue, Type C in green and Type B in red.*

6 SUIKERBOSRAND (SKBR)

6.1 INTRODUCTION

The landscape in the SKBR area ranges from well-wooded mountainous slopes to open sour grasslands dotted with rocky outcrops (Van Wyk 1988). Horizontal sandstone deposits of the Witwatersrand Super-group and the igneous Ventersdorp Super-group make up the region's geology (Cairncross 2004). The altitude ranges from 1550 m to 1917 m above sea level and annual rainfall is 700 mm on average with most of it falling between October and March (Tyson 1976; GDACE 2006). To the east is the neighbouring town of Heidelberg, established in 1862 as a trading post by German missionaries.

6.2 STRUCTURE AREA

Polygons were measured using standard vector tools in QGIS to calculate area values for structures. Table 3 shows that the Type A stone circles were on average the smallest structures followed by Type B, while Type C structures were the largest. In many cases the smaller variations of Type A proved difficult to identify on satellite imagery, with 66% of structures ranging from 5 to 100 square metres. Although all were based on a common circular design, Type A showed the most variability in terms of area, indicating multiple size-classes.

Table 3

Size comparison of structure types. Area in square metres.

	Type A	Type B	Type C	Type D
n structures	79	40	15	33
Minimum value	6	47	561	15
Maximum value	456	1059	9065	7419
Average area	94.39	246.07	3645.13	1993.91
Median area	63	178	2649	1587
Standard deviation	92.36	204.71	2573.94	1711.04
Coefficient of Variation	0.98	0.83	0.71	0.85
Total area	7457	9843	54677	65799

6.3 STRUCTURE ELEVATIONS

The point sampling tool was used to calculate the mean elevation of structures using an ASTER 30m Digital Elevation Model. On average Type D structures occurred at lower elevations while other types tended to occur above the 1650 metre contour. The co-efficient of variation indicates that Type D were the most dispersed in terms of elevation while Type C structures were more clustered, showing the least variation. Type A and Type B showed a similar patterning in terms of their average altitude (Table 4). In this case, Type D appears unrelated to other types as they were located at the lowest average elevations, with a few exceptions.

Table 4

Distribution of sites in terms of elevation. Elevation data in metres above mean sea level.

	Type A	Type B	Type C	Type D
n structures	79	40	15	33
Minimum value	1574	1575	1628	1578
Maximum value	1686	1685	1677	1690
Average altitude	1653.46	1652.17	1655.13	1621.88
Median altitude	1659	1656	1657	1614
Standard deviation	24.75	22.64	13.7	32.86
Coefficient of Variation	0.02	0.01	0.01	0.02

6.4 MEAN CENTRES AND CONVEX HULLS

Figure 23 shows the mean centres for all types were located in two areas of the central hill-top. Convex hulls showed Type D to be more widely distributed with numerous outliers in the surrounding area, while Types A, B and C showed considerable overlap on the southern hill. Results show that Type D follows its own distribution pattern, while other types are spatially related.

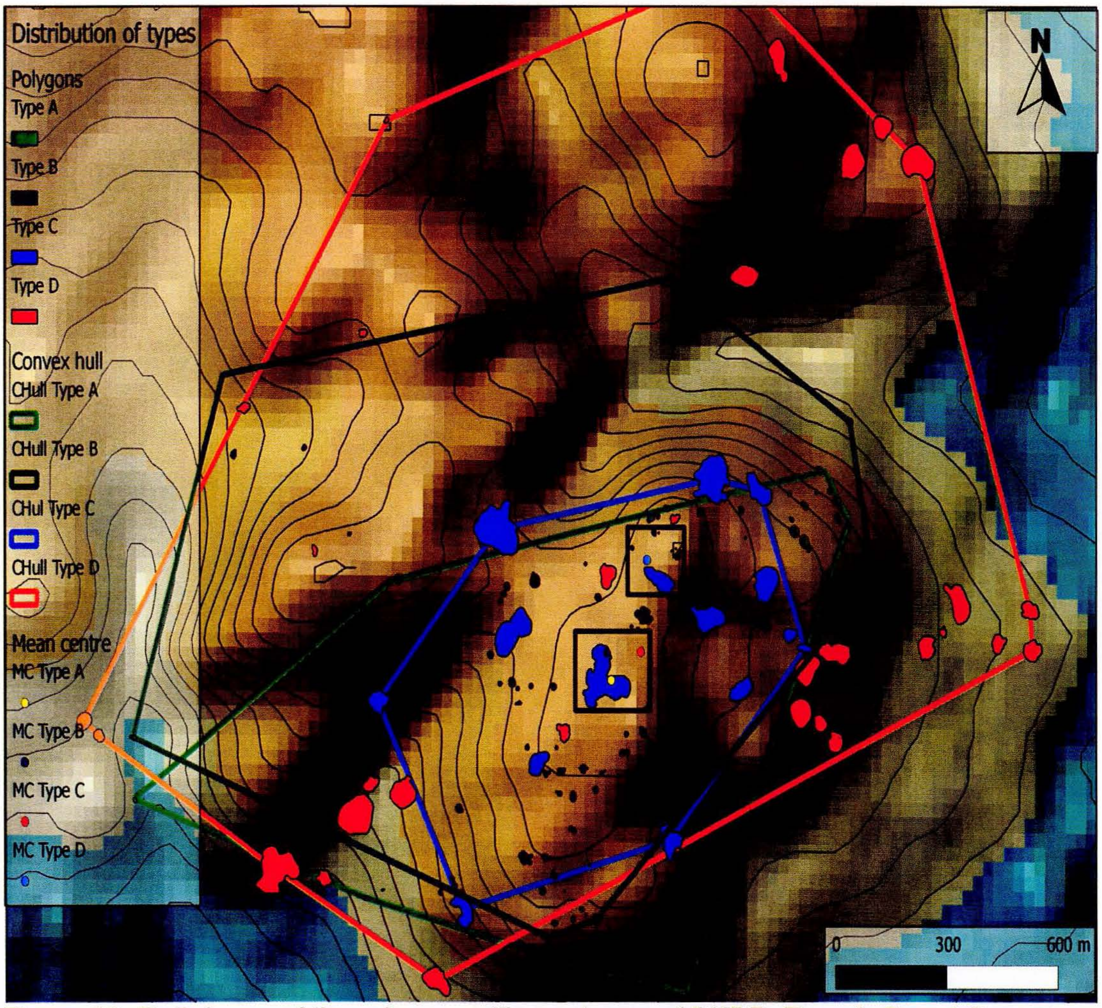


Figure 23: *Relief map of the primary settlement area of SKBR. Type A, B and C mean centres align with a large centrally placed structure (SKBR 75) while the mean centre of Type D is located just North of this location, near a small hilltop within the settlement.*

6.5 CLUSTERING

Clusters were defined using 100 m buffers around the mean centre of types similarly to Sadr and Rodier (2012) where 200 m buffers were used. A smaller buffer zone was used to show more discrete patterning in structure clustering. Table 5 shows that Type A had the lowest mean distance and the most number of clusters with 46.84% of structures in this class found in the densest cluster. Type B showed a similar pattern with the densest cluster partly overlapping with that of Type A. While Type C had the fewest clusters and the greatest observed mean distance, 40% of structures occurred in the densest cluster, showing more regular spacing than other types. In contrast, Type D showed less regular spacing, with small dispersed clusters located outside of the central settlement area. The Z-score, which compared the average Nearest Neighbour Index to a theoretical distribution of random points, showed dense clustering for Type A (-8.04) and more regular spacing for Type C (3.93), while Types B and D were intermediate, with values of -1.62 and -2.48 respectively.

Table 5

Nearest neighbour statistics for structure types. Distance in metres.

	Type A	Type B	Type C	Type D
n structures	79	40	15	33
Observed mean distance	43	114	202	157
Z-Score	-8.05	-1.62	3.94	-2.48
Expected mean distance	82	132	132	204
N 100 clusters	7	5	2	6
n sws in densest cluster	37	17	6	12
% sws in densest cluster	46.84%	42.50%	40.00%	36.36%
av n sws / 100 cluster	11.3	8	7.5	5.5
Nearest neighbour index	0.53	0.87	1.53	0.77

6.6 RUGGEDNESS INDEX AND DELAUNAY TRIANGULATION

A 30 metre ASTER Digital Elevation Model was used to generate a ruggedness index scale raster of the landscape in the immediate settlement area. Lines showing the relative distances between structures were generated using Delaunay triangulation. Figure 24 shows the complex Type C structures evenly spaced on the relatively flat high ground, orbited by satellite Type A and Type B structures. The steep slopes surrounding the settlement and the location of Type D clusters at potential access points on the southern slopes provides an impression of a defensive settlement pattern. While Type D showed a different set of distribution rules, other types were found to aggregate on the flat-topped hill.

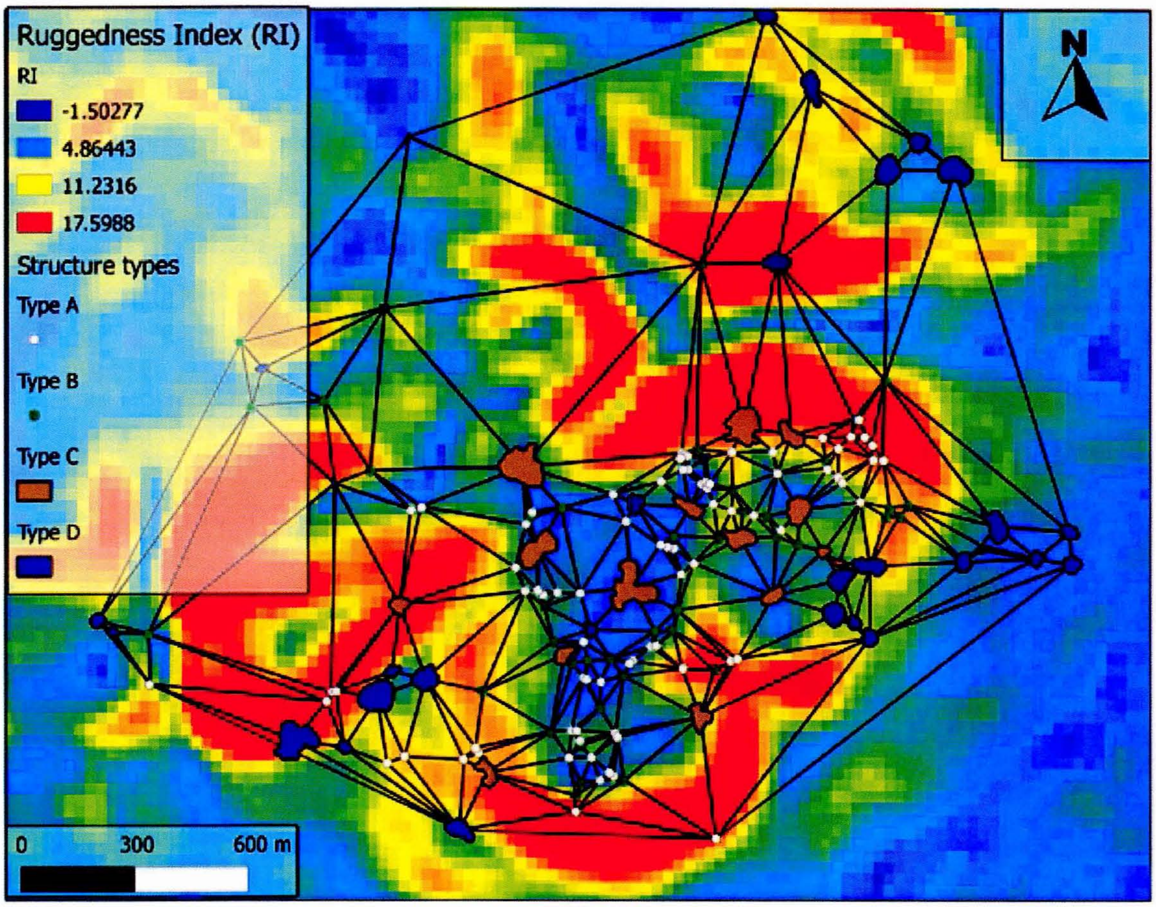


Figure 24: *Ruggedness Index map showing the primary settlement cluster located on relatively flat terrain surrounded by steep slopes*

6.7 VIEWSHED ANALYSIS

A user created viewshed analysis tool for QGIS was used to provide an impression of intra-settlement visibility. Viewshed locations 1 and 2 were selected due to the presence of closely clustered Type A structures overlooking the surrounding structures, while viewsheds 3, 4 and 5 were selected to provide an impression of the settlement's visibility from the Type D structures and low-lying areas around the slopes. Results show visible areas from specific viewpoints as shaded areas with a specified height value of 1.75 metres. Figure 25 shows a high degree of inter-site visibility from viewshed points 1 and 2 with the majority of structures visible from these locations. An impression of the terrain visible to the south of viewshed 1 can be seen in Figure 26.

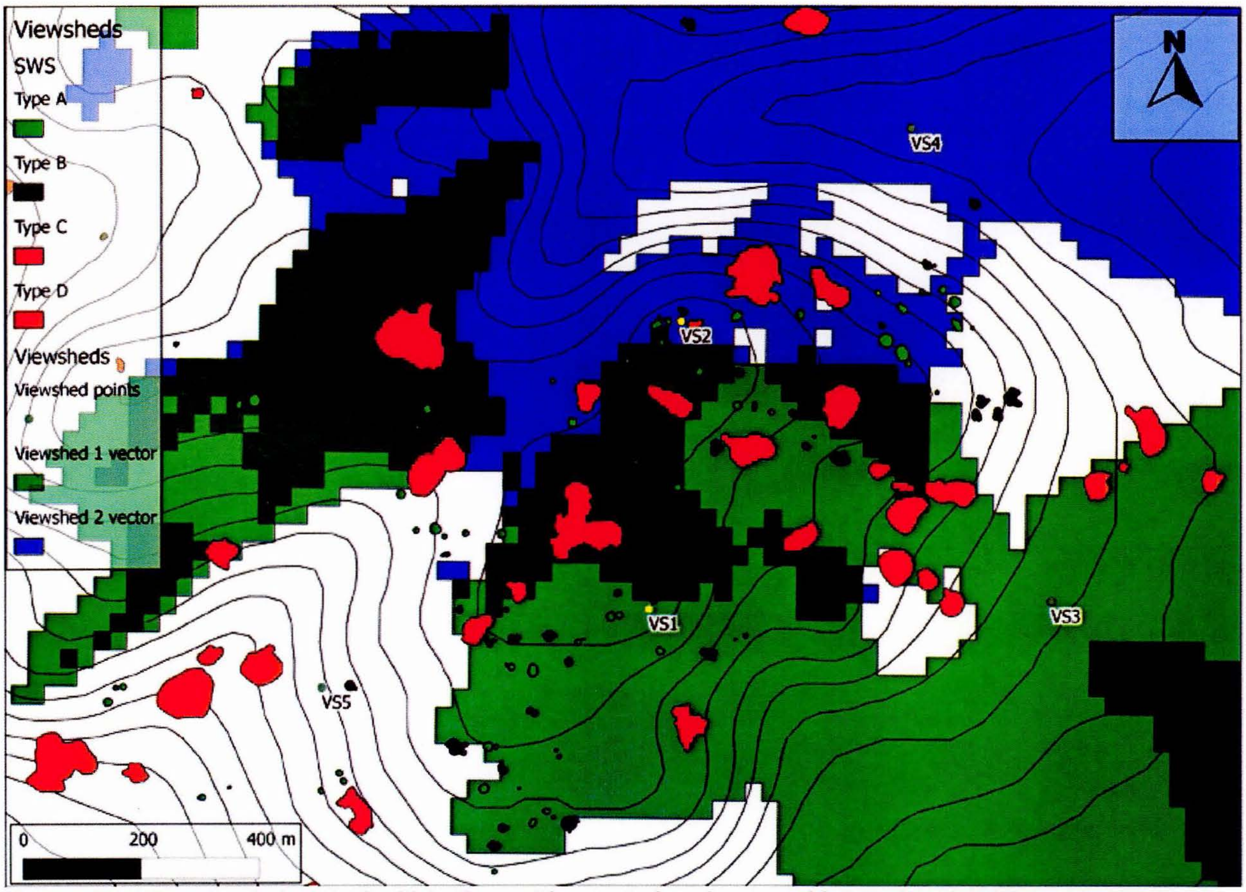


Figure 25: Viewsheds located within the settlement showing good intra-site visibility and visibility of the surrounding landscape. The majority of Types A, B and C were visible from these locations.

Figure 26: *Impression of visible landscape to the south of VS 1, Type A stone circles shown in the foreground.*

Figure 27 shows poor visibility from viewshed 4, located in valley area north of the settlement, while much of this area was shown to be visible from viewshed 2. As shown in Graph 2 viewsheds 1 and 2 provide the best visibility of SWS within the main cluster with 55% of the structures visible from either location. Viewshed 2 provides visibility of 83% of the Type B structures, while less than 5% of the Type B's were visible from viewsheds 3, 4 and 5. Some of the structures on the central hill were visible from viewshed 3, located in the low-lying fields to the south of the settlement, suggesting some inter-visibility between the Type D's and other types. Structures which were theoretically visible from viewshed 4 were, in reality, concealed by vegetation shown in Figure 28.

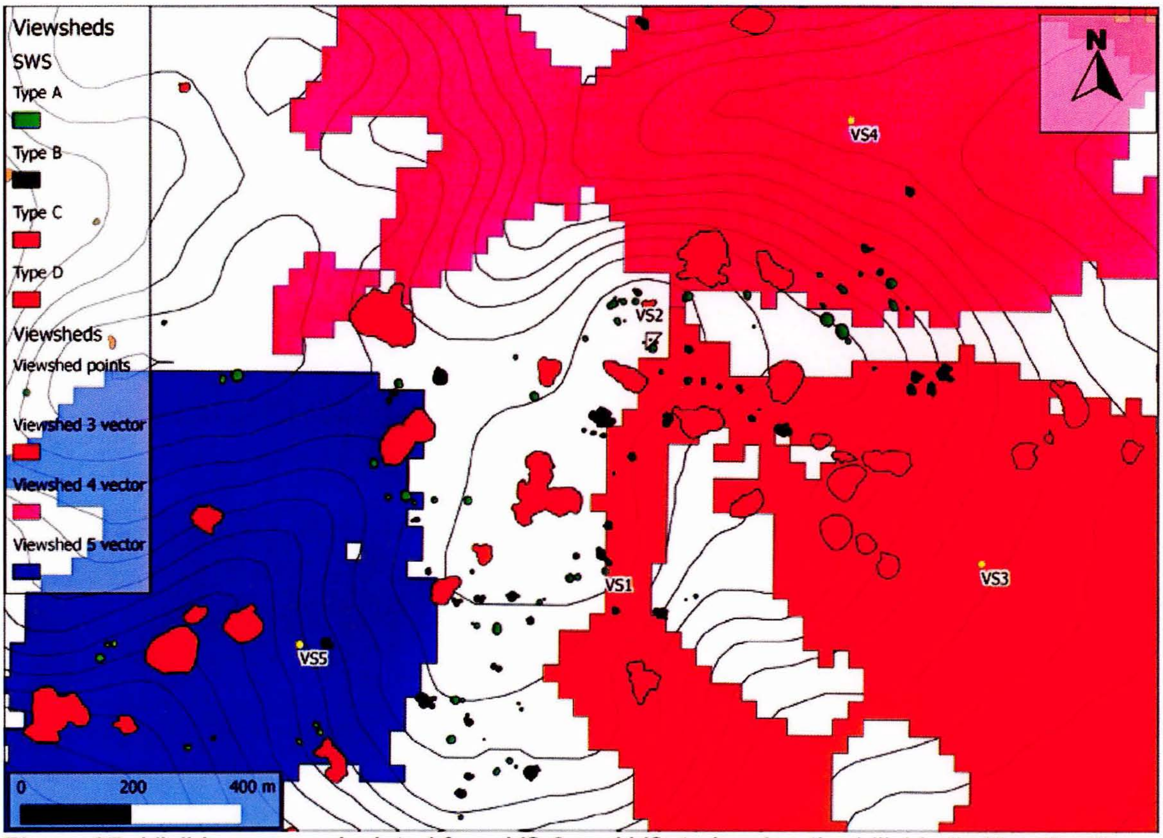
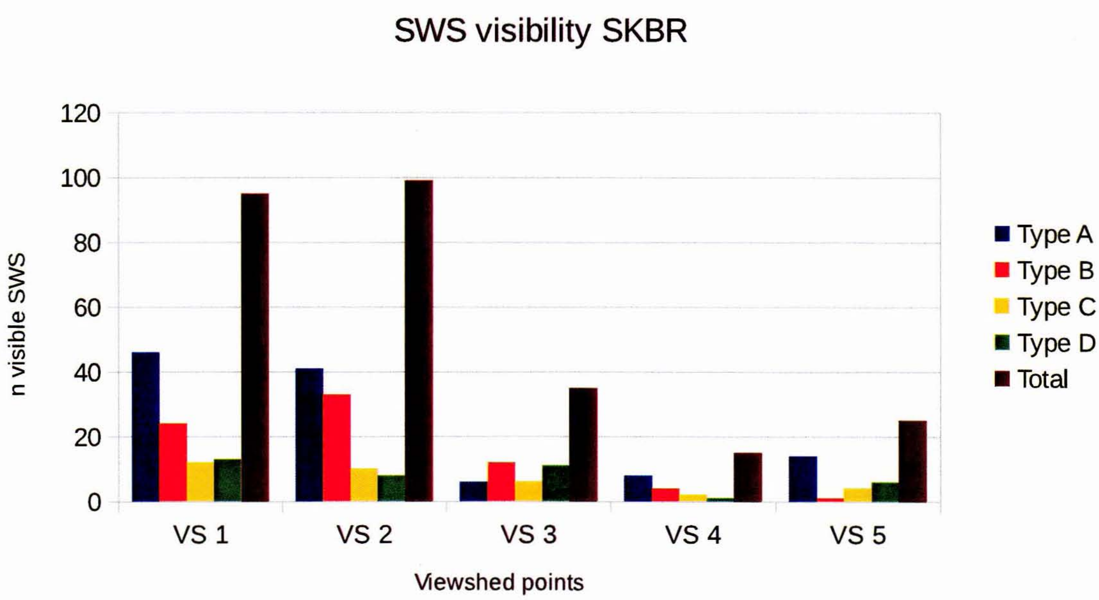


Figure 27: *Visible areas calculated from VS 3 and VS 4 showing the hillside limiting the line of sight from those in low-lying areas.*



Graph 2:*Number of structures visible from viewsheds 1 through 5.*

Figure 28: *Photograph of the northern hillside taken from viewshed 4. The outlines of the two Type C sites which are theoretically visible in Figure 26 are obscured by dense vegetation.*

6.8 SUMMARY

Results from SKBR provide the impression of a densely nucleated defensive hill-top settlement comprised of Types A, B and C. Two size class of Type A structures were identified based on area measurements. Large and small circles, measuring only a few metres in diameter were found to orbit the larger more complex Type C structures providing the impression of a denser concentration of SWS than anticipated. Type D structures appeared to follow a more dispersed pattern around the central hill. These possibly relate to an earlier, more dispersed phase of occupation. The Type A and B structures on the hill also appear to have been visible from clusters of small Type A structures on the high-ground within the settlement, while few structures were visible from viewsheds in low-lying areas. The steep slopes surrounding the flat topped hill were found to provide a natural barrier, limiting access to the central cluster of structures. The integration of the settlement and the landscape creates a natural fortress enclosing a well protected settlement area. Locations such as this are reputed to have been especially important as centres of refuge during times of war and civil unrest.

7 KROONDAL

7.1 INTRODUCTION

Kroondal (KD) is located a short distance from SKBR in an area of flat farm-land broken by hills and scarps. The area is drained by several small tributaries which flow into the Suikerbosrand River a few kilometres to the south. Horizontal sandstone deposits of the Witwatersrand Super-group make up the hillside. Literally translated to English as "Crown-dale", Kroondal was perhaps named for its crown of hills which shelter a series of smaller valleys and stone ruins. Although not as appealing in terms of defence as SKBR, Kroondal is surrounded by large areas of flat farm-land around the small koppie. In this respect, the area may have been more appealing for settlement during times of stability in the region.

7.2 STRUCTURE AREA

Table 6 shows that type D were the largest structures on average, with a total area approximately 100 times greater than Type C. Type A were on average the smallest structures, some barely larger than a few square metres. Due to their small size, many more circles were mapped in the field than could be identified on Google Earth, giving the impression of a much denser concentration of structures than initially expected. The coefficient of variation for Type A is much greater than other types due to the fairly standard size of smaller stone circles comprising the majority of the Type A sample. Similarly to the Type A's at SKBR multiple size classes were identified at Kroondal.

Table 6

Size comparison of structure types. Area in metres squared.

	Type A	Type B	Type C	Type D
n structures	49	24	5	28
Minimum value	2	15	262	526
Maximum value	173	792	4696	21933
Average area	26	205	1945	7175
Median area	14	171	1009	5596
Standard deviation	32.41	165.38	1777.31	5275.7
Coefficient of variation	1.23	0.8	0.91	0.73
Total area	1288	4931	9726	200911

7.3 STRUCTURE ELEVATIONS

Table 7 shows that Types A and B showed a similar pattern in terms of elevation indicated by their averages. The few Type C structures tended to occur at higher elevations, overlooking the surrounding area from one of two hill tops. The larger more complex Type D structures were found to occur at the lowest elevations, with the majority found to cluster in the valleys surrounding the settlement. These Type D structures showed the most variation in terms of mean elevation.

Table 7

Distribution of structures in terms of elevation. Elevation data in metres above mean sea level

	Type A	Type B	Type C	Type D
n structures	49	24	5	28
Minimum value	1595	1597	1615	1557
Maximum value	1639	1630	1639	1636
Average elevation	1614	1613	1627	1606
Median elevation	1616	1614	1632	1605
Standard deviation	9.69	7.62	9.39	18.15
Coefficient of Variation	0.6%	0.5%	0.6%	1.1%

7.4 MEAN CENTRES AND CONVEX HULLS

Figure 29 shows the extent of structure distributions on the farm Kroondal. Types A and B occurred exclusively on inaccessible hilly terrain. The majority of structures were located on the smaller southern hill, indicated by the position of their mean centres. The larger Type C structures occurred on the northern hill, surrounded by numerous large amoeboid Type D structures. These formed a secondary perimeter around the hill.

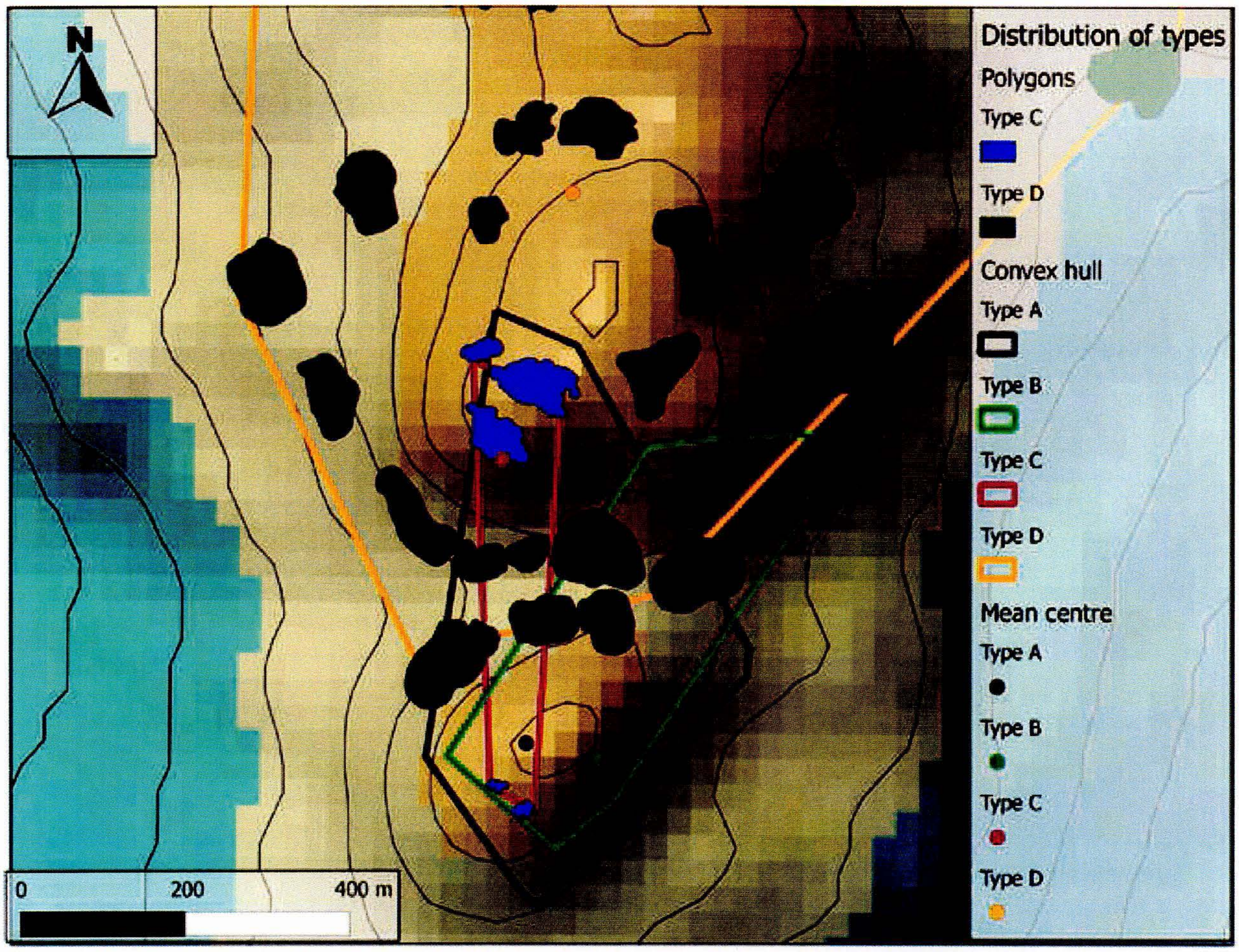


Figure 29: *Relief map of settlement at Kroondal showing the spatial distribution of structures.*

7.5 CLUSTERING

Table 8 shows the distribution of types in terms of clustering. The majority of Type A and B structures were found in a single over-lapping cluster on the southern hill. The Z-scores indicate that Type A showed twice as much clustering than Type B, while Type D showed a more dispersed pattern. Although Type D had the greatest observed mean distance of all types, over 60% of structures fell within the same cluster due to their more regular spacing around the central hill areas. As in the case of SKBR, the Type D structures appeared to be spatially unrelated to other types.

Table 8

Nearest neighbour statistics for structure types. Distance in metres.

	Type A	Type B	Type C	Type D
Observed mean distance	19	33	65	143
Z-Score	-6.839	-3.218	2.138	0.263
Expected mean distance	38	51	43	139
N 100 clusters	2	2	2	3
n sws in densest cluster	46	17	3	19
% sws in densest cluster	93.87%	70.83%	40%	64.28%
av n sws / 100 cluster	24.5	12	0.4	9.3

7.6 RUGGEDNESS INDEX AND DELAUNAY TRIANGULATION

Figure 30 Shows that many of the Type A and Type B structures were located on the southern hill, surrounded by a natural perimeter of steep slopes. The Type A's tended to occur on relatively flat ground, while the majority of Type B's occurred on the south-eastern slopes. The Type C structures are located near the apex of the northern hill's steepest slopes, overlooking the surrounding large Type D structures below. In terms of spatial organisation the structure distributions appear to mirror the pattern of the natural landscape. The utilisation of space differs between the northern and southern portions of the site, with the former showing a more dispersed pattern and the latter more clustered.

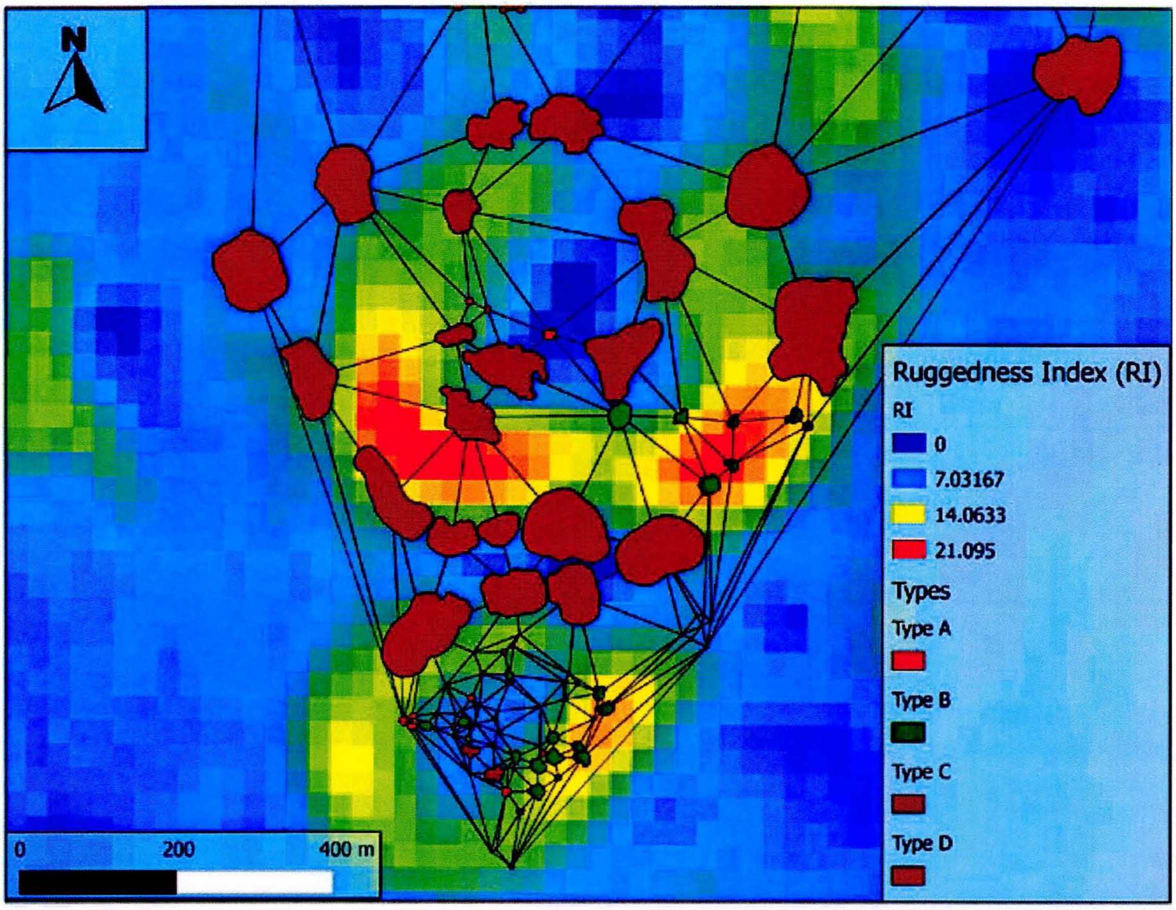


Figure 30: *RI map of structure distributions showing the smaller cluster of Type A and B structures on the southern hill, with the larger Type D structures surrounding the northern hill.*

7.7 VISIBILITY ANALYSIS

Figure 31 shows the calculated visible area from viewshed 1, located in the low lands just east of the southern hill, and viewshed 4, located in the northern hills. While several of the structures are theoretically visible from this position from a 1.75 meter visibility height, results could be misleading for two reasons. Firstly, many of the smaller stone structures blend in to the surrounding hill-side, coloured by the same material as the rocky outcrop. Secondly, the visibility analysis only considers the terrain elevation when calculating viewsheds – in reality, many of the structures on the hillside are obscured by vegetation and slopes (Figure 32). Figure 33 shows that viewsheds 2 and 3 provide substantial inter-site visibility, with commanding views of the surrounding landscape. The majority of Types A, B and C were found to occur in areas with good visibility of the surrounding area (Figure 34).

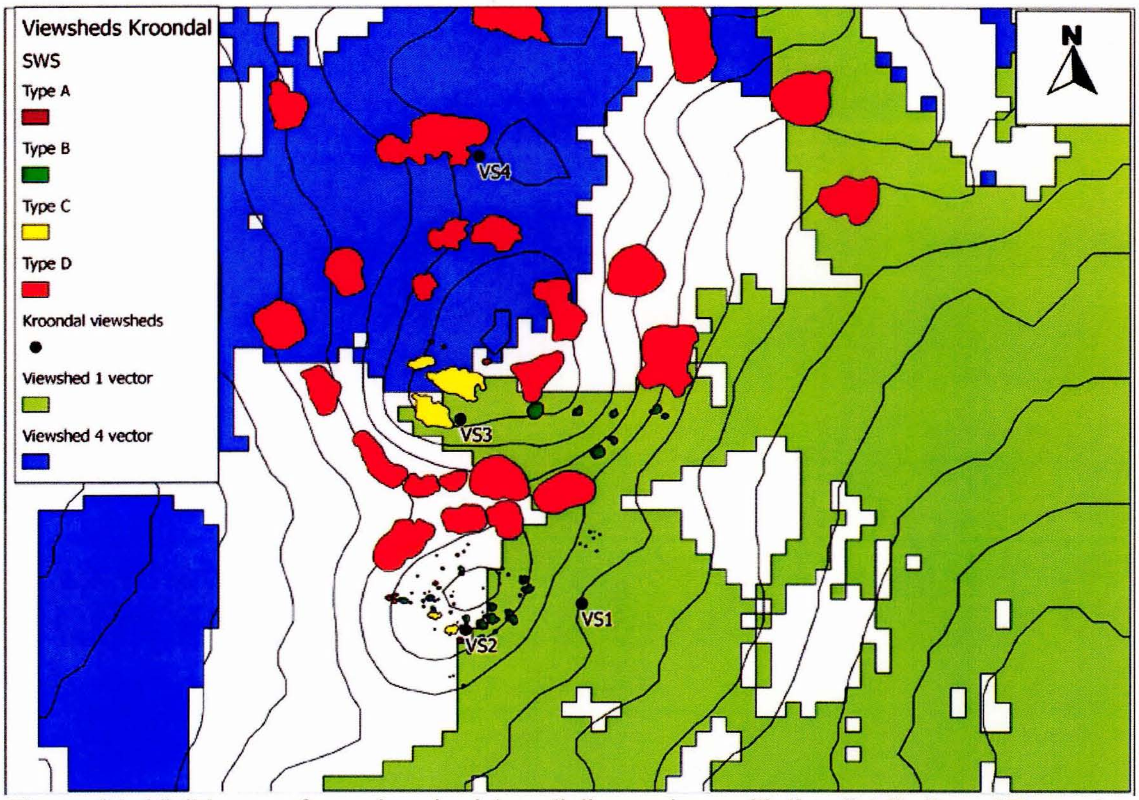


Figure 31: *Visible area from viewshed 1 partially overlaps with the distribution of Types A and B while the northern Type D structures are visible from viewshed 4.*

Graph 3 shows that viewshed points 2 and 3 offer the best visibility of structures within the settlement. All Type B structures were visible from viewshed 2, while none were visible from viewshed 4, a pattern similarly observed at SKBR. The smaller stone circles located at viewshed 2 (also visible in Figure 34) would have clear visibility of the Types A, B and C. Again, Type D, while visible from viewshed 3 and 4 were less well concealed than other types.

Figure 32: *Photograph of the hill area taken from the general location of VS 1 with a low section of stone walling in the foreground. Structures on the distant hill are hardly visible.*

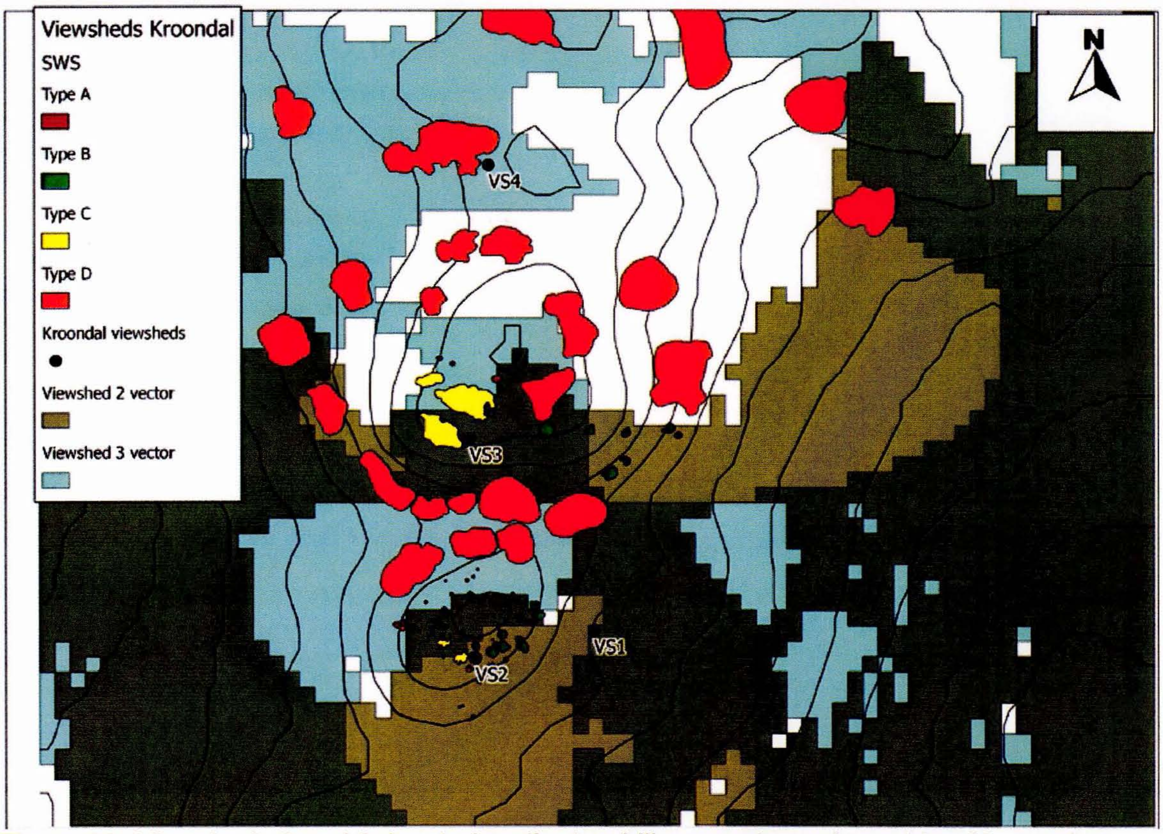
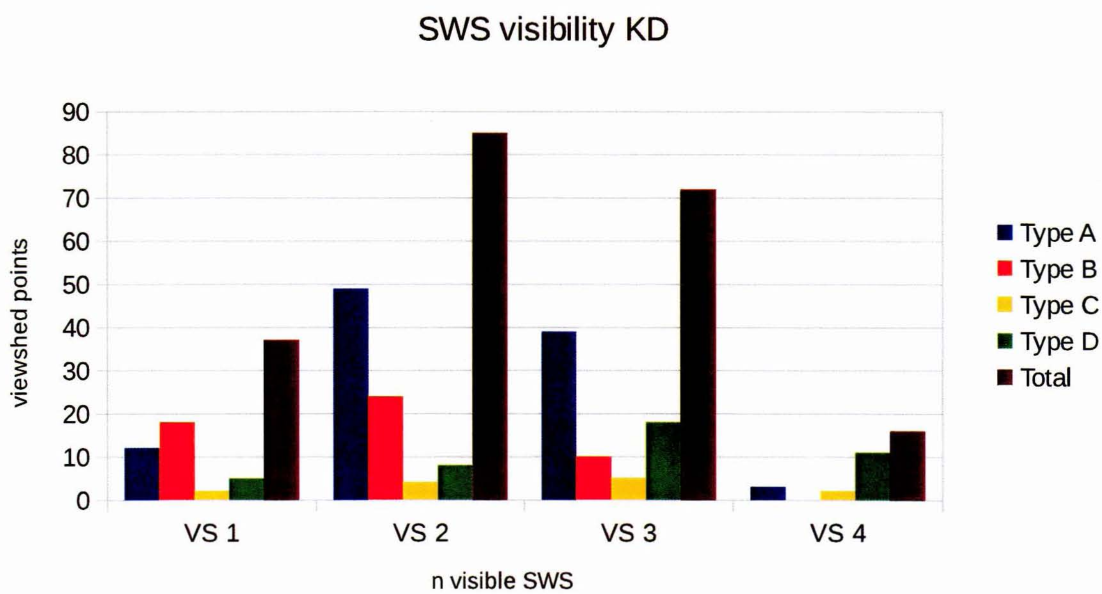


Figure 33: *Viewsheds 2 and 3, located on the two hill areas showed considerable overlap, providing visibility of many of the structures and the surrounding area.*

Figure 34: *Photograph taken from viewshed 2 showing the landscape visible to the south of Kroondal. Stone walling located in the mid-ground area.*



Graph 3: *Number of structures visible from viewsheds 1 through 4.*

7.8 SUMMARY

Results from Kroondal showed Type A and B structures to be more densely clustered than at SKBR, with only a few Type C structures on the high ground. These too were clustered around the more limited hilly areas within the vicinity of the settlement. Similarly to SKBR, small Type A clusters on the high-ground provided substantial visibility of Type B structures as well as many of the Larger Type A's while these were barely visible from viewshed points outside of the settlement. Again Type D appeared to follow a different distribution pattern located around the central hills. In this instance, however, the Type D's appeared to encircle the central hills, forming a buffer zone. It is possible that the more open fields around the site proved favourable for earlier occupation of the area leading to organic settlement growth, rather than a punctuated occupation as hypothesised at SKBR. The area would have proved less favourable as a defensive strong hold during later periods although dense clustering of Types A and B in the hills indicate that the area was utilised for defensive purposes at some point. Establishing a possible economic relationship between Kroondal and SKBR in terms of production at the former and the centralisation of political power at the latter remains a task for future research.

8 DISCUSSION

INTRODUCTION

> "Just as distance makes the hills so much lovelier, so time spins a veil from all its lost years, and the past is obscured by its softness. The passions of men become mellowed; their lives seem much more simple, their problems much easier. The deeper one looks, the softer the vision, the dimmer the outline. In the end only mystery and legends are left, like shadows, lingering on the horizon's rim of the secret land of forgetfulness".
>
> -T.V. Bulpin, *Natal and the Zulu Country*

Whether written or by word of mouth, knowledge of the world is constructed and transmitted through story. For South Africa the process of colonisation was entangled with creating stories centred around the lives of European colonists, their battles, their history; their South Africa. In the early 20th century the construction of a Europeanised history of South Africa was more important than understanding the past of cultural groups such as the Sotho, Tswana and Zulu. Indeed these categories were created merely to differentiate these African antagonists, relegating their part in shaping the country's cultural landscape to something of an after-thought. Even with the archaeological study of pre-colonial settlement patterns from the 1950s onward, the achievements of non-European societies were downplayed during the times of the National Party.

Apropos Bulpin's quote we are left with more and more mysteries as legends slowly die away. As time marches on the few stories which remain are slowly forgotten and it is left to the archaeological imagination and dedicated researchers to reconstruct southern Africa's forgotten past. New storytellers also emerge to fill the vacuum in public consciousness, often utilising the same tired exotic explanations which proved popular over a century ago. It is perhaps a testament to the vast rift scarred into public consciousness that these popular explanations still hold a prominent place in the mind of the general public.

Much of the early research to deal with settlement patterns in southern Africa was catalysed by the use of aerial photography. Google Earth fulfilled a similar role in structure identification and classification in this study. By using GIS to measure the spatial distribution and patterning of structures I was able to define major clusters and identify relationships between structure types and landscape features. Although only four major types were identified, more subtle variations emerged as a result of using spatial statistical tests. The use of GE and GIS enabled me to identify inter-site and intra-site patterning, the process of classification and sub-dividing types based on style and function proved challenging. Only in hindsight did the more subtle variations of architectural types become apparent.

8.1 LANDSCAPE PATTERNS

The location of Group IV clusters along the eastern hills of the Suikerbosrand mountain range indicates that well protected hilly terrain was favourable for settlement. Sotho-Tswana communities north of the Vaal are known to have built large aggregated settlements on hilltops from 1750 as a response to social conflicts preceding the Mfecane (Huffman 2007a). However, the idea that people fled to the hills during periods of increased social tension and conflict, only partially explains the choice to settle in such areas. Indeed sites such as SKBR and its neighbours are located on land with high grazing potential, between 7 and 8 ha/Au in their immediate vicinity, and agricultural soils located in the low-lands around the berg (AGIS 2007). While less mountainous grazing areas existed around KD, the site was surrounded by a greater area of farmland. The presence of building materials and timber in the surrounding hills also provided incentive to build settlements close to the Suikerbosrand mountain.

Access to both farmland and grazing areas around the settlements would suggest a subsistence strategy relying both on farming and herding. Alternatively, good grazing areas may have been the product of anthropogenic activities such controlled burning and alteration of the environment by keeping cattle there in the first place. Conditions would have been favourable for farming and herding following the warmer wetter period after the Little Ice Age of the 1400s (Tyson & Lyndesay 1992) and during a phase of increased rainfall during the 1800s when maze was cultivated by Sotho-Tswana around the Suikerbosrand (Huffman 2007a: 453).

8.2 GROUP IV

Within the Suikerbosrand River basin many of the stone circles originally identified as Group IV were found to cluster on defensive high-ground positions, their distribution overlapping with that of larger more, complex structures. The inter-site spatial patterning of the stone circles in relation to other SWS at SKBR and KD indicates they were likely part of an occupation phase associated with hill-top aggregation.

The more complex structures were morphologically similar to Taylor's (1979: 10) Group III, also referred to as Klipriversberg Type structures (Huffman 2008) and are easily differentiated from Group II on GE, as they lack a continuous scalloped perimeter walling (Sadr & Rodier 2012). Group III is believed to have been built by the descendants of Sotho speakers such as the Fokeng or Kwena, while Group II represented the large towns built by Tswana speaking immigrants such as the Rolong (Taylor 1979; Loubser 1985). While contemporary with Group II from the 1700s onwards, Group III settlements are thought to have been occupied by mixed Sotho-Tswana societies who settled in mountainous terrain for protection (Taylor 1979; Huffman 2008). Although similarities were noted between the more complex structures and known types, structures were classified according to my own typology to elucidate their inter-site settlement patten. Here I use to term Group IV to refer to a number of related architectural types and subtypes, referring to Group I and Group III structures as Type D and Type C respectively.

8.3 ARCHITECTURAL TYPES AND SETTLEMENT PATTERNS

The stone circle is to the African settlement what the square or rectangle is to a European settlement, and are thus common to a number of types which do not necessarily share the same function. It stands to reason that the stone circles which originally defined Group IV do not constitute a single functional type, but rather represent a building schematic common to several different functional types.

Two distinct size classes were identified in the Type A category of stone circles, including small circles only a few metres in diameter and larger circles with an area of several hundred square metres. Many of the smaller circles were not visible on GE imagery and were recorded in the field. Numerous authors have noted similar structures in Late Iron Age sites (e.g. Schapera 1943; 1953; Maggs 1979; Hall 1981). These features are commonly associated with residential areas, marking the bases of rondavels (Mason 1986) and several grain bins, known as *difala* in seSotho, kept in the rear courtyard (Taylor 1984: 249; Murimbika 2006: 209). This would suggest a delayed returns subsistence strategy related to farming, with each household producing and storing some of its own grain.

Yet this one-to-one correlation of small Type A structures with grain-bins does not suitably explain why small stone circles were also found on the periphery of both SKBR and KD, located on high ground positions overlooking the surrounding area and on small hilltops within the settlements. Indeed, if all the smaller varieties of Type A were grain bins, the location of distant outliers would appear counter productive to protecting grain surplus. Since 1824 guns were used by Griqua cattle raiders to harass Nguni cattle outposts north of the Vaal and later during the 1830s when Boers entered the area during the Great Trek. As late as the 1860s Boer commandos encountered large independent 'mountain strongholds' in the southern Transvaal defended by Africans equipped with fire arms (Laband 2005: 65) although no strongholds of this type have been identified in the Suikerbosrand. If the Type A outliers were indeed built as gun emplacements, this would suggest a relatively late occupation of sites such as SKBR and KD or a subsequent military occupation of the sites by the Boers or the British.

Type B structures represent a larger variation of the stone circle design, often with attached secondary structures and small stone circles. These were found to overlap with the distribution of Type A structures at SKBR and KD. The presence of artefacts such as ceramic vessels and tin within the Type B structures suggests that they were occupied by people rather than animals. The discovery of what appeared to be a tin ingot at KD 3 may indicate that the settlements had been involved in long distance trade and exchange, either directly or indirectly, with sites hundreds of kilometres in the north such as the Rooiberg and Waterberg, although excavation and additional evidence is required to substantiate this possibility. Type B structures likely represent larger well built homesteads, or prestige dwellings suggesting a form of social hierarchy.

At SKBR the median centres for Types A, B and C clustered on the largest structure in the settlement; SKBR 75. The centrality of this structure indicates that it was a place of importance to the hill-top occupation phase, and likely marks the location of a royal kraal. The chiefs kraal is considered a male area associated with political power and decision making and was typically the first structure to be built in a settlement. The area immediately surrounding the central kraal is considered a woman's area composed of individual huts (Loubser 1985; Huffman 2007a). Low concentrations of phosphorus in Type A structures and higher concentrations in Type C, although relatively weak, may be taken to confirm this settlement organisation based on the centrality of cattle, both physically to the settlement's organisation, and economically as a commodity and symbol of political power.

The low concentrations of soil phosphates measured within the Type A and Type B structures support the idea that at least some of the larger types constituted residential areas as the interior of residential structures were kept scrupulously clean, while organic materials would have been discarded in midden areas outside of the structures. The orientation of entrance ways, usually facing down slope would have accommodated drainage and prevent flooding of homes during heavy rains, a pattern observed by Hall (1981). These middens were not identified due to the sampling strategy, which was employed to test if Type A structures housed livestock. This assessment fits the pattern identified at SKBR, possibly indicating a later phase of population growth during the hilltop aggregation phase, similarly noted at Klipriversberg Type settlements (e.g. Taylor 1984; Huffman 2008). The steep slopes surrounding the site at SKBR and the relative dispersion of homesteads, concealed on the flat hill, perhaps offered sufficient protection for the population to settle in the open. The over-all organisational structure of the settlement bears an uncanny resemblance to the Central Cattle Pattern identified at Broederstroom by Huffman (2007: 157).

Type D structures showed a morphological overlap with Type C, reminiscent of similarities between Taylor's Group I and Group III. At SKBR these occurred lower down the slopes, away from the settlement on the hill and are more typical of the non-defensive distribution of older Group I sites. This may relate to an earlier punctuated occupation of SKBR, although this idea remains speculative given the lack of other evidence to support this claim. Due to the lack of space on the high ground at KD, it would appear that earlier Type D structures were built to form a settlement barrier along the crown of hills which make up its settlement area. These large elongated structures encircle a small central hill area. Although similar to the Type C structures from SKBR, these were classified as Type D to establish a continuum with their counterparts and acknowledging some degree of organic settlement growth at KD. Walton's (1956: 1) description of Sotho villages "merging imperceptibly into the background" comes to mind, for although the Type D's were not located on a central hill like SKBR, they do make use of the hill side for concealment. Here the pattern related to the centrality of a single large kraal was not identified.

The emergence of complex societies seldom occur in isolation (Calabrese 2000: 207) and settlements develop though time as a result of economic synergy. The centrality of SKBR to other Group IV clusters and its high proportion of structures suggests that the area was of some importance and possibly represents a regional centre in the valley area. Less centralised settlements such as KD may have been integrated into a regional system of settlements possibly playing a role in economic production such as farming, with similar sites described as storage koppies where grain would be intermediately stored before being redistributed (Summers 1971).

Although Sadr and Rodier brought attention to the stone circles which they classified as Group IV, others such as Mason, Maggs and Hall had identified similar structures in LIA settlements. In the Western half of SA, stone circles are associated with the settlements of LSA herders and foragers also built during the last millennium. Similarities in the construction of circular structures might suggest some degree of interaction or assimilation of hunter-gatherer groups in the area. Other researchers have shown that in cases, such as the Sotho Tswana, hunter-gatherers had been assimilated into their society, performing tasks such as herding, hunting and rain-making (Sadr & Plugg 2001; Delius & Shcoeman 2008). This cultural mixing is supported by genetic evidence which shows high concentrations Khoisan DNA in Sotho-Tswana communities on the Highveld (Soodyal & Jenkins 2007).

8.4 A LATE IRON AGE OCCUPATION?

Several culturally, though not politically homogeneous groups such as the "Kwena, Ngwato, Ngwaketse, Hurutshe and Tlhapeng and four groups of Rolong" were settled in the south western Transvaal by the 1800s (Laband 2005: 39). Early travellers such as Casalis (1961: 109) mention large Sotho communities who built immense circles of oval huts on hillsides in the Transvaal during the 1850s. Others such as Robert Moffat determined that some of these communities numbered in the thousands, possessing vast herds of cattle "covering the hilltops like mist" (cited in Hall 2007: 170-171). Mzilikazi also exercised caution around mountainous areas during his occupation around the Vaal River from 1823 to 1827, for fear of armies of Sotho who "swept down from the mountains" (Rasmussen 1977: 17). It is unknown if sites such as SKBR and KD had been conquered during Mzilikazi's time. Following Rasmussen's map showing the Ndebele occupation of the area, Mzilikazi chose to expand west, avoiding areas of the Suikerbosrand inhabited by groups such as the Khudu, and chose to pass far west of the mountains upon leaving the area.

During the wars of the Mfecane the Sotho-Tswana began to adopt the short stabbing spear and small unit tactics of the Nguni in favour of ranged weaponry such as the throwing spear (Spring 1993). Perhaps this transition represents both a conservative answer to resource shortages during periods of conflict, as new spears would need to be created to defend hilltop settlements, and as a result of contact with Nguni speakers. In later instances it was contact with Boer settlers, Griqua raiders and British military which introduced fire arms to the Sotho-Tswana living north of the Vaal River. Although little known, some settlements adopted the new weaponry as an answer to defending their hilltop positions, fulfilling the role of the throwing spear. It is perhaps adaptiveness and resourcefulness which allowed such settlements to survive as late as the early 19th century. While further evidence is required to verify that some Type A stone circles may have been used as gun emplacements viewshed analysis of clusters at the intrasite level hint at this possible function. Consequently the terminal occupation of sites such as SKBR and KD might have been considerably recent. Imagining that knowledge regarding these places, their names, their history and their people have been forgotten in such a short space of time is alarming, yet commonplace for researchers focusing on the last 500 years of southern African archaeology.

9 CONCLUSION

Google Earth, GIS and CrimeStat proved useful in identifying spatial relationships between SWS while soil phosphates were used to differentiate kraals from homesteads. Reference to earlier work was required to make sense of these patterns. Results showed that Group IV, as it was originally known, is rather an architectural type or schematic common to several functionally different types which are spatially related to a larger group of structures characteristic of hilltop aggregation sites. Similar sites are known to have occurred from 1750 well into the 1800s and were likely settled by groups encompassed by the blanket category of Sotho-Tswana. The identification of what appeared to be gun emplacements suggest a relatively late occupation date for sites such as SKBR and KD. Further work will be required to test these ideas and adequate dating of the stone walling remains a task for future research. The identification of a royal kraal at SKBR and its centrality to other settlements in the Suikerbosrand River valley also presents an opportunity for more intensive research at the site.

10 RETROSPECT AND FUTURE DIRECTIONS

Stone circles and famous megalithic stone circles, such as Stone Henge, have always held a certain element of mystery for many, myself included. Perhaps this is due to the juxtaposition of the known and unknown within their form. Their circular shape, while instantly recognisable and familiar, meets our eye like a mysterious stranger from a distant time. The prospect of basing a masters dissertation around the Group IV stone circles identified by Karim Sadr and Xavier Rodier thus provided a platform pursue both my own personal interests, while focusing on a subject matter closer to home.

As is often the case, formulating a literature review and conducting background research was the point of departure. During the early stages of this process it became apparent that stone circles were too widespread, both as a design principle in traditional African architecture and as features in archaeological sites, to act as typological markers for discrete cultural groups. Their supposed functions also appeared to be myriad, ranging from grain bins, dwellings and animal enclosures, to hunting blinds, firing positions and lookout points.

Initially soil samples were gathered from the stone circles to test if they were used as animal enclosures. Since livestock, cattle in particular, played an important role in the well-being of settlements, soil samples from the Type A and B stone circles, as well as a few of the Type C structures were analysed. Although a relatively simple process, the results did not show the kind of strong, definitive patterns one had hoped for. A weak pattern showed that higher concentrations of soil phosphate were present in the large, central Type C structures, while samples from the mid point of Type A and B structures were generally lower. The general pattern showed that the central Type C structures were more likely to have housed animals, while the surrounding Type A and B structures, it would appear, did not. A more thorough sampling strategy of diagnostic structure types may help to achieve a higher resolution of activity area patterning. This would require more precise spatial information than can generally be provided by hand-held GPS and would either require more precise spatial referencing, provided either by a DGPS or a Total Station. Whether this would yield more definitive patterns remains to be tested.

Constructing a typology of structures based on field observations and Google Earth imagery was one of the more challenging aspects of the project. This was mainly due the question of inter-analyst variability, and whether or not results could be replicated by another researcher using the same classification system. Classification can serve many different roles depending on our research aims and the questions we ask of our data. From a heuristic standpoint a typology is treated as an end product of careful scientific observation, providing a model for understanding worldly phenomena. Achieving this goal is impossible without post-experimental revision, peer-review, re-testing and the gift of hind-sight. Indeed, the types defined by a researcher only become meaningful when their nomenclature enters into wider academic discourse, resulting in conversation and critique to test and refine our models. Pigeon-holing ones observations using pre-defined criteria can prove useful to a point, but it is also necessary to to make room for our own observations, so as to avoid stale scholasticism.

The use of Google Earth and GIS appear to have potential for studying settlement patterns within the context of the greater landscapes in which they occur. While familiar with Google Earth and its use in data collection, I had relatively little experience with GIS software. This represented somewhat of a challenge, due to the software's steep learning curve. Fortunately, QGIS and its contributors helped to mitigate this, providing access to a host of different analytical packages and course material. As a community driven project based of Free and Open Source Software (FOSS), QGIS is regularly updated with analytical packages and user created tutorials making the software relatively easy to learn.

A GIS based approach helped to consolidate the spatial relationships between structures and the natural landscape, while revealing something of the landscape patterns and exploitable resources within their catchment area. This process can potentially be used to identify areas of interest and provides us with a roadmap for further possible future work.

Given the patterns identified at KD and its location on private property, one does not foresee the same potential for research at the site when compared with SKBR. More traditional methods such as excavation and test pits to uncover material culture and datable material are the logical next step for providing information on SKBR's sequence of occupation. OSL dating of ceramics can help to provide minimum dates for the walling, as the radio-carbon dates associated with terminal Iron Age occupation sites are generally too young to be accepted with confidence. Comparing the hill-top cluster to the low-lying, possibly older, Type D structures may help to provide an impression of changing landscape use strategies in response to social, economic changes over time. An added benefit of SKBR's location on a national reserve means that it can be preserved for future generations as a heritage site.

Here, only two sites have been examined in detail. Thousands more have since been identified throughout the mountainous landscape of southern Gauteng. As such there is still much potential for GIS based research in the area. Further work in the area will allow us to identify broader regional patterns of occupation over time and contribute to a growing body of scientific data.

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12 APPENDIX

12.1 RAW DATA: SKBR SWS

Code	Site Number	Type	[illegible]	Structure size (m^2)	[illegible]	[illegible]	n secondary structures	[illegible]
SKBR	1	Type B	Not visible	48	1636	not visible	1	1
SKBR	2	Type D	North	510	1637	not visible	Not visible	Not visible
SKBR	3	Type B	Not visible	203	1632	3-4	2	1
SKBR	4	Type B	North-east	107	1649	0	2	0
SKBR	5	Type D	North	271	1669	2	1	0
SKBR	6	Type D	North	225	1688	3-4	1	0
SKBR	7	Type B	Not visible	47	1685	2-3	1	0
SKBR	8	Type A	Not visible	128	1686	3-4	2	1
SKBR	9	Type A	Not visible	331	1685	3	0	0
SKBR	10	Type C	North-east	9065	1666	8	0	0
SKBR	11	Type A	North	50	1666	1	0	0
SKBR	12	Type B	North	105	1665	1	2	0
SKBR	13	Type A	West	169	1666	0	1	0
SKBR	14	Type B	Not visible	598	1665	9	1	1
SKBR	15	Type C	North	5634	1662	6-8	6	0
SKBR	16	Type A	South-east	161	1655	1	1	0
SKBR	17	Type C	South-east	1892	1642	7-9	1	0
SKBR	18	Type D	South-east	1127	1590	5-7	3	1
SKBR	19	Type D	North	577	1584	4-5	2	1
SKBR	20	Type B	East	138	1575	2	1	0
SKBR	21	Type A	North-east	71	1574	2	1	0
SKBR	22	Type D	Not Visible	7419	1578	4-5	0	0
SKBR	23	Type A	Not Visible	152	1607	0	0	0
SKBR	24	Type A	Not visible	54	1604	0	0	0
SKBR	25	Type A	Not visible	83	1604	0	0	0
SKBR	26	Type D	North-east	952	1579	6-8	1	0
SKBR	27	Type D	South-east	6152	1599	10-12	0	0
SKBR	28	Type A	North	92	1583	1	1	1
SKBR	29	Type A	Not visible	20	1594	1	1	0
SKBR	30	Type D	North	2689	1597	5-7	0	0
SKBR	31	Type C	North-east	2455	1628	7-8	0	0
SKBR	32	Type A	South-west	63	1617	0	0	0
SKBR	33	Type A	South-west	93	1626	0	1	0
SKBR	34	Type A	Not visible	78	1628	0	0	1
SKBR	35	Type B	Not visible	233	1637	2	1	0
SKBR	36	Type D	Not visible	3288	1612	4-6	1	1

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	n internal structures	n secondary structures	n courtyards
SKBR	37	Type D	South	958	1606	3-4	1	1
SKBR	38	Type A	South-west	46	1634	0	1	0
SKBR	39	Type B	North-east	233	1647	2	2	1
SKBR	40	Type B	Not visible	141	1648	2	1	0
SKBR	41	Type A	Not visible	108	1647	1-4	0	0
SKBR	42	Type A	North-east	74	1649	1-3	0	1
SKBR	43	Type A	South-west	17	1646	0	0	0
SKBR	44	Type B	Not visible	499	1646	3	1	1
SKBR	45	Type A	South-east	23	1595	0	0	0
SKBR	46	Type C	South-west	2662	1644	10-12	1	0
SKBR	47	Type A	West	27	1657	0	0	0
SKBR	48	Type A	East	14	1657	0	0	0
SKBR	49	Type A	Not visible	7	1651	0	0	0
SKBR	50	Type A	North	168	1652	1-3	0	0
SKBR	51	Type B	North	165	1655	3-4	1	0
SKBR	52	Type A	Not visible	22	1655	0	0	0
SKBR	53	Type A	East	40	1659	0	0	0
SKBR	54	Type A	North	174	1659	2	2	0
SKBR	55	Type B	Not visible	645	1657	3-4	3	1
SKBR	56	Type B	North	157	1664	3-4	2	0
SKBR	57	Type A	North-east	250	1668	0	1	0
SKBR	58	Type A	North-east	80	1668	0	1	0
SKBR	59	Type A	South-west	9	1668	0	1	0
SKBR	60	Type B	North-east	127	1668	2-3	1	0
SKBR	61	Type C	North	1843	1670	4-5	1	1
SKBR	62	Type B	Not visible	78	1668	1	1	0
SKBR	63	Type B	Not visible	76	1662	1	1	0
SKBR	64	Type B	North	159	1669	2-3	2	0
SKBR	65	Type A	South-west	31	1672	0	0	0
SKBR	66	Type D	East	914	1673	4-5	0	0
SKBR	67	Type A	East	67	1655	0	0	0
SKBR	68	Type A	East	259	1659	2-3	1	1
SKBR	69	Type A	North-east	53	1662	0	2	0
SKBR	70	Type A	North	63	1670	0	1	0
SKBR	71	Type A	North-west	7	1670	0	0	0
SKBR	72	Type A	West	41	1665	0	0	0
SKBR	73	Type D	Not visible	1604	1668	3-4	1	0
SKBR	74	Type A	Not visible	175	1670	1	0	0
SKBR	75	Type C	West	8575	1677	14-16	1	0
SKBR	76	Type B	Not visible	81	1678	0	0	0
SKBR	77	Type A	South	155	1675	0	0	0
SKBR	78	Type A	Not visible	96	1665	0	0	0
SKBR	79	Type A	South	112	1676	0	2	0

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	n internal structures	n secondary structures	n courtyards
SKBR	80	Type B	North	361	1653	2-4	2	1
SKBR	81	Type A	West	7	1642	0	0	0
SKBR	82	Type A	Not visible	32	1646	1	0	0
SKBR	83	Type B	South-west	379	1678	2	1	1
SKBR	84	Type B	South-west	178	1676	1-3	1	1
SKBR	85	Type A	North	14	1674	0	0	0
SKBR	86	Type A	South-east	142	1670	0	0	0
SKBR	87	Type A	Not visible	55	1674	1	0	0
SKBR	88	Type A	North-east	45	1674	1	0	0
SKBR	89	Type A	Not visible	28	1674	0	0	0
SKBR	90	Type B	North	1059	1674	4-6	2	0
SKBR	91	Type A	North	58	1671	0	0	0
SKBR	92	Type A	Not visible	98	1676	1	0	0
SKBR	93	Type A	Not visible	8	1677	0	0	0
SKBR	94	Type A	Not visible	203	1673	1	2-3	0
SKBR	95	Type A	Not visible	8	1673	0	0	0
SKBR	96	Type A	North	13	1673	0	0	0
SKBR	97	Type A	South	82	1674	0	1	0
SKBR	98	Type B	East	126	1674	0	1	0
SKBR	99	Type A	Not visible	227	1670	1	0	0
SKBR	100	Type C	North	6875	1659	12-14	0	0
SKBR	101	Type D	South	365	1675	2-3	0	0
SKBR	102	Type A	South	6	1680	0	0	0
SKBR	103	Type A	South	7	1680	0	0	0
SKBR	104	Type A	North	23	1679	1	0	0
SKBR	105	Type A	North	152	1680	0	0	0
SKBR	106	Type A	North	42	1677	0	0	0
SKBR	107	Type B	North-east	161	1674	2-3	1	1
SKBR	108	Type A	North-east	127	1669	0	0	0
SKBR	109	Type B	Not visible	327	1666	2	0	0
SKBR	110	Type C	North	3490	1660	6-8	0	0
SKBR	111	Type B	North	67	1666	1	2-3	0
SKBR	112	Type A	North	62	1664	0	0	0
SKBR	113	Type B	North	104	1662	2-3	1	0
SKBR	114	Type B	Not visible	104	1654	0	1	0
SKBR	115	Type A	Not visible	10	1657	0	0	0
SKBR	116	Type B	South	516	1647	4-5	0	0
SKBR	117	Type C	North	2012	1650	4-6	1	0
SKBR	118	Type C	South	809	1644	4-5	0	0
SKBR	119	Type C	Not visible	561	1640	0	0	0
SKBR	120	Type D	Not visible	3033	1636	4-6	0	0
SKBR	121	Type D	Not visible	2814	1631	4-6	0	0
SKBR	122	Type D	Not visible	999	1628	2-3	0	0

Code	Site Number	Type	Entranceway orientation	Structure area (m²)	Mean elevation	n internal structures	n secondary attachments	n courtyards
SKBR	123	Type D	South	1435	1617	5-6	0	0
SKBR	124	Type D	South	2988	1631	4-5	0	0
SKBR	125	Type C	North	3679	1657	8-10	0	0
SKBR	126	Type A	Not visible	17	1662	0	0	0
SKBR	127	Type A	Not visible	155	1658	0	0	0
SKBR	128	Type C	North-west	2649	1651	5-6	0	0
SKBR	129	Type A	South	61	1643	0	0	0
SKBR	130	Type A	East	182	1638	2	1	0
SKBR	131	Type B	East	62	1645	2	1	0
SKBR	132	Type A	West	429	1649	1-3	1	0
SKBR	133	Type A	East	456	1651	2-3	1	0
SKBR	134	Type A	South	75	1651	0	0	0
SKBR	135	Type A	North	30	1649	0	0	0
SKBR	136	Type B	East	230	1640	4-5	0	0
SKBR	137	Type B	Not visible	301	1636	3-4	1	0
SKBR	138	Type B	Not visible	268	1630	2-4	1	0
SKBR	139	Type B	North	624	1626	3-4	1	1
SKBR	140	Type A	Not visible	20	1629	0	0	0
SKBR	141	Type A	East	241	1634	3-4	0	0
SKBR	142	Type A	South	268	1628	2-3	0	0
SKBR	143	Type A	South-east	121	1625	0	0	0
SKBR	144	Type A	West	45	1628	0	0	0
SKBR	145	Type B	South-east	178	1621	2-3	1	0
SKBR	146	Type A	West	18	1618	0	0	0
SKBR	147	Type B	South	214	1596	0	0	0
SKBR	148	Type D	North	1738	1603	Not visible	1	0
SKBR	149	Type D	Not visible	216	1600	Not visible	1	0
SKBR	150	Type D	Not visible	15	1598	0	0	0
SKBR	151	Type D	West	3424	1595	5-8	0	0
SKBR	152	Type D	North	1042	1590	3-4	1	0
SKBR	153	Type D	South-west	1587	1586	4-5	0	0
SKBR	154	Type D	North-east	1328	1583	4-6	0	0
SKBR	155	Type B	North-east	323	1623	3-4	1	0
SKBR	156	Type D	North	2661	1614	4-5	0	0
SKBR	157	Type D	South	3787	1624	6-7	0	1
SKBR	158	Type D	South	4770	1612	5-6	1	0
SKBR	159	Type D	South-east	1920	1617	Not visible	0	0
SKBR	160	Type D	North	2926	1659	5-6	1	0
SKBR	161	Type D	Not visible	1957	1653	3-5	0	0
SKBR	162	Type D	North	108	1690	1	1	0
SKBR	163	Type C	South	2476	1677	5-6	0	0
SKBR	164	Type B	North	186	1670	2-3	2	0
SKBR	165	Type B	West	235	1650	Not visible	2	0

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	# internal structures	# secondary structures	# courtyards
SKBR	166	Type A	West	75	1664	Not visible	0	0
SKBR	167	Type A	Not visible	152	1670	2-3	1	0

12.2 RAW DATA: KD SWS

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	[illegible]	n secondary structures	[illegible]
KD	1	Type A	West	30	1602	0	0	0
KD	2	Type B	North	286	1612	Not visible	1	0
KD	3	Type B	West	276	1609	5-6	1	1
KD	4	Type B	West	153	1609	2	1	0
KD	5	Type B	West	326	1614	5-6	1	0
KD	6	Type B	North	287	1616	4-5	0	0
KD	7	Type A	West	46	1616	0	0	0
KD	8	Type B	East	195	1618	2	1	0
KD	9	Type B	North	152	1618	3-4	2	0
KD	10	Type A	South	5	1618	0	0	0
KD	11	Type A	South	7	1618	0	0	0
KD	12	Type C	South	378	1615	4-5	2	0
KD	13	Type A	North	4	1618	0	0	0
KD	14	Type A	East	20	1620	0	0	0
KD	15	Type A	North	19	1620	0	0	0
KD	16	Type A	North	12	1621	0	0	0
KD	17	Type A	West	2	1621	0	0	0
KD	18	Type B	South	256	1611	2-3	0	0
KD	19	Type B	North	15	1616	1	1	1
KD	20	Type D	North	7690	1604	9-11	0	0
KD	21	Type D	North	4086	1606	Not visible	0	0
KD	22	Type D	Not visible	4046	1609	8-10	0	0
KD	23	Type D	South-west	7333	1604	7-8	0	0
KD	24	Type D	West	8003	1611	8-10	0	0
KD	25	Type D	South	1669	1605	Not visible	0	0
KD	26	Type D	South	2457	1602	5-6	0	0
KD	27	Type D	West	5409	1600	7-8	0	0
KD	28	Type B	East	507	1604	2-3	0	0
KD	29	Type B	South	175	1605	2-3	1	1
KD	30	Type B	North	96	1597	0	1	1
KD	31	Type B	North	263	1597	2-3	1	0
KD	32	Type B	North	168	1615	2-3	1	0
KD	33	Type B	South	232	1626	3-4	2	1
KD	34	Type B	Not visible	792	1630	2-3	0	0
KD	35	Type D	East	5533	1636	4-5	0	0
KD	36	Type A	North	173	1639	0	0	0
KD	37	Type C	Not visible	4696	1639	7-9	0	0
KD	38	Type C	Not visible	3381	1634	6-8	0	0
KD	39	Type D	West	4755	1594	4-6	0	0

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	n. internal structures	n. secondary structures	n. courtyards
KD	40	Type C	East	1009	1632	4-5	0	1
KD	41	Type A	East	47	1636	0	0	0
KD	42	Type A	Not visible	70	1631	0	0	0
KD	43	Type D	West	7090	1592	6-7	0	0
KD	44	Type D	North	5660	1603	7-9	0	0
KD	45	Type D	North-west	1924	1623	5-7	0	0
KD	46	Type D	South	3321	1619	7-8	0	0
KD	47	Type D	South-west	4777	1626	11-13	0	0
KD	48	Type D	South	7313	1631	7-8	0	0
KD	49	Type D	North	8659	1612	7-9	0	0
KD	50	Type D	South	11988	1599	6-8	0	0
KD	51	Type D	Not visible	7993	1578	5-6	0	0
KD	52	Type D	North-west	10024	1593	6	0	0
KD	53	Type D	East	18977	1610	9-11	0	0
KD	54	Type D	South-west	14583	1618	20-24	0	0
KD	55	Type D	West	5276	1600	4-5	0	0
KD	56	Type D	West	16607	1627	7-8	0	0
KD	57	Type D	North	1425	1635	5-7	0	1
KD	58	Type D	East	21933	1617	14-16	0	0
KD	59	Type D	West	526	1569	2-3	1	0
KD	60	Type D	East	1854	1557	6-7	0	0
KD	61	Type A	East	5	1603	0	0	0
KD	62	Type A	West	8	1603	0	0	0
KD	63	Type B	West	51	1610	2-3	1	1
KD	64	Type A	Not visible	100	1614	2-3	0	0
KD	65	Type A	Not visible	7	1615	0	0	0
KD	66	Type C	Not visible	262	1618	4-5	2	1
KD	67	Type B	South	56	1619	2-3	1	1
KD	68	Type A	Not visible	20	1616	0	0	0
KD	69	Type A	South	23	1614	0	0	0
KD	70	Type B	North	164	1614	3-4	0	1
KD	71	Type A	South	76	1609	Not visible	0	0
KD	72	Type A	North	91	1610	2-3	0	0
KD	73	Type A	West	92	1609	3-4	1	1
KD	74	Type A	North-east	11	1613	0	0	0
KD	75	Type B	South-east	33	1616	2-3	1	1
KD	76	Type A	Not visible	9	1616	0	0	0
KD	77	Type B	South	128	1619	3-4	1	0
KD	78	Type A	South	5	1619	0	0	0
KD	79	Type A	South	16	1619	0	0	0
KD	80	Type A	South	10	1619	0	0	0
KD	81	Type A	North	17	1614	0	0	0
KD	82	Type A	South	58	1617	0	0	0

Code	Site Number	Type	Entranceway orientation	Structure area (m^2)	Mean elevation	n internal structures	n secondary structures	[illegible]
KD	83	Type A	North	22	1619	0	0	0
KD	84	Type A	West	3	1619	0	0	0
KD	85	Type A	North	23	1619	2-3	0	0
KD	86	Type A	South	41	1621	0	0	0
KD	87	Type B	North	85	1621	2-3	1	0
KD	88	Type A	East	8	1613	0	0	0
KD	89	Type A	Not visible	33	1616	0	0	0
KD	90	Type A	Not visible	17	1614	0	0	0
KD	91	Type A	North	9	1614	0	0	0
KD	92	Type A	West	4	1623	0	0	0
KD	93	Type A	East	3	1620	0	0	0
KD	94	Type A	South	11	1621	0	0	0
KD	95	Type A	West	14	1621	0	0	0
KD	96	Type A	West	18	1618	0	0	0
KD	97	Type B	South-west	196	1612	3-4	1	1
KD	98	Type A	East	24	1611	0	0	0
KD	99	Type A	West	14	1598	0	0	0
KD	100	Type A	Not visible	12	1598	0	0	0
KD	101	Type A	North	10	1595	0	0	0
KD	102	Type A	South-west	7	1596	0	0	0
KD	103	Type A	Not visible	11	1596	0	0	0
KD	104	Type A	Not visible	2	1596	0	0	0
KD	105	Type A	Not visible	19	1599	0	0	0
KD	106	Type B	Not visible	39	1609	2-3	1	0

ORDER OF PROCEDURE

10 DECEMBER 2014 AT 13:00

The audience will rise as the academic procession enters the hall and will remain standing until the Vice-Chancellor is in place.

The Wits Choir will perform

The Vice-Chancellor will constitute the congregation

The Vice-Chancellor will welcome the graduands, diplomates and guests

Professor Mark Solms, Chair of Neuropsychology at the University of Cape Town and Groote Schuur Hospital, will address the congregation

Conferment of degrees and granting of diplomas and certificates

The President of Convocation will address the graduates

The Vice-Chancellor will dissolve the congregation

The audience will stand while *Ihele* is played

Members of the audience are requested to stand while the academic procession leaves the hall and not to leave the hall before the end of the ceremony.

IMPORTANT NOTICE
In the event of load-shedding or power cuts, the Great Hall may become totally dark for a few seconds until the generator comes into operation.