MEASURING GROWTH POTENTIAL: A GEO-ARCHAEOLOGICAL STUDY OF SETTLEMENT LOCATION SELECTION AND ASSOCIATED LAND MANAGEMENT PRACTICES IN BOKONI, MPUMALANGA



Lauren Leontine Solomon

A Dissertation submitted to the Faculty of Science, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Science.

Johannesburg, 2016

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



(Signature of candidate)

31st day of October 2016 in Archaeology
Master of Science.

ABSTRACT

The economy of Bokoni was centred on farming, with terrace agriculture playing a fundamental role in the construction and location of village sites. This dissertation examined the recursive relationship between soil chemistry and site location at three Bokoni sites: Doornkop, Khutwaneng and Kranskloof. These sites represent the three different phases of occupation in Bokoni. Analysis focused on the correlation of Ca, Mg, K, P, NH_4, NO_3, CEC and %C to the site contexts. At a macro scale there are substantial similarities with regards to the geology and the soil chemistry; suggesting a strong preference for locating village sites on relatively nutrient rich clay soils. On a more localised scale chemical analysis of the different contexts of these sites (i.e. domestic areas, central enclosures, terraces and non-archaeological areas) explored the agricultural potential of the soil in the various areas. These analyses showed a distinct difference in agricultural potential of soils in stone walled areas. This profile was the result of the nutrient contribution from the underlying soils in combination with either enrichment at the time of occupation, or the ongoing influence of the stone walled structures on the soils. The enrichment of soil in residential sites, whether intentional or accidental, could explain why Bokoni villagers continually reused sites during the earlier part of the sequence, before violence repeatedly disrupted settlement, and thus choice of settlement location, in the area.

I am an African,

I owe my being to the hills and the valleys, the mountains and the glades, the rivers, the deserts, the trees the flowers, the sea and the ever-changing seasons that define the face of our native land.

-Thabo Mbeki

ACKNOWLEDGEMENTS

First, I thank Dr Alex Schoeman for supporting me and supervising my dissertation.

A special thanks to Chris de Jager with helping with the interpretation of my data, and the department of Plant Production and Soil Sciences at the University of Pretoria for allowing me to use the soil laboratory. Charl Herzog, technician in the laboratory, for teaching me how to analyse the soil.

Paula de Carvalho for helping to edit the dissertation and motivating me. Herman Freysan for helping with fieldwork at Kranskloof. Lucas Mathabula, Oupa Mkhabela, Tiffany Henshall and Timothy Marais for helping with fieldwork at Khutwaneng. Michael Mpungose and Gedion Mxomuhle Zulu for helping with fieldwork in Doornkop.

Finally, I would like to thank the farmers, Mr André Schoeman, Mr Nico Cross and Martin Coetzee, for allowing me to collect soil samples on their farms in Khutwaneng. I would also like to thank Mr Marius van Niekerk, the designated manager of the Doornkop Fish and Wildlife Reserve for giving me permission to sample the land. Mr Sean Nielson, for giving me permission to sample Kranskloof.

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Glossary

Calcium	Ca
Magnesium	Mg
Potassium	K
Phosphate	P
Ammonia	NH_4
Nitrate	NO_3
Cation Exchange Capacity	CEC
Organic Carbon Percentage	%C
Soil Layer	Soil horizon defined by texture, colour and rock content
Soil Texture	Consistency of the soil, where soil is loose, clumpy etc.

CHAPTER 1: INTRODUCTION

The stonewalled footprint of Bokoni covered the vast mountainous landscapes of Mpumalanga, from Carolina in the south to Orighstad on the border of the Limpopo province (Delius *et al.* 2012) (Fig. 1.1).

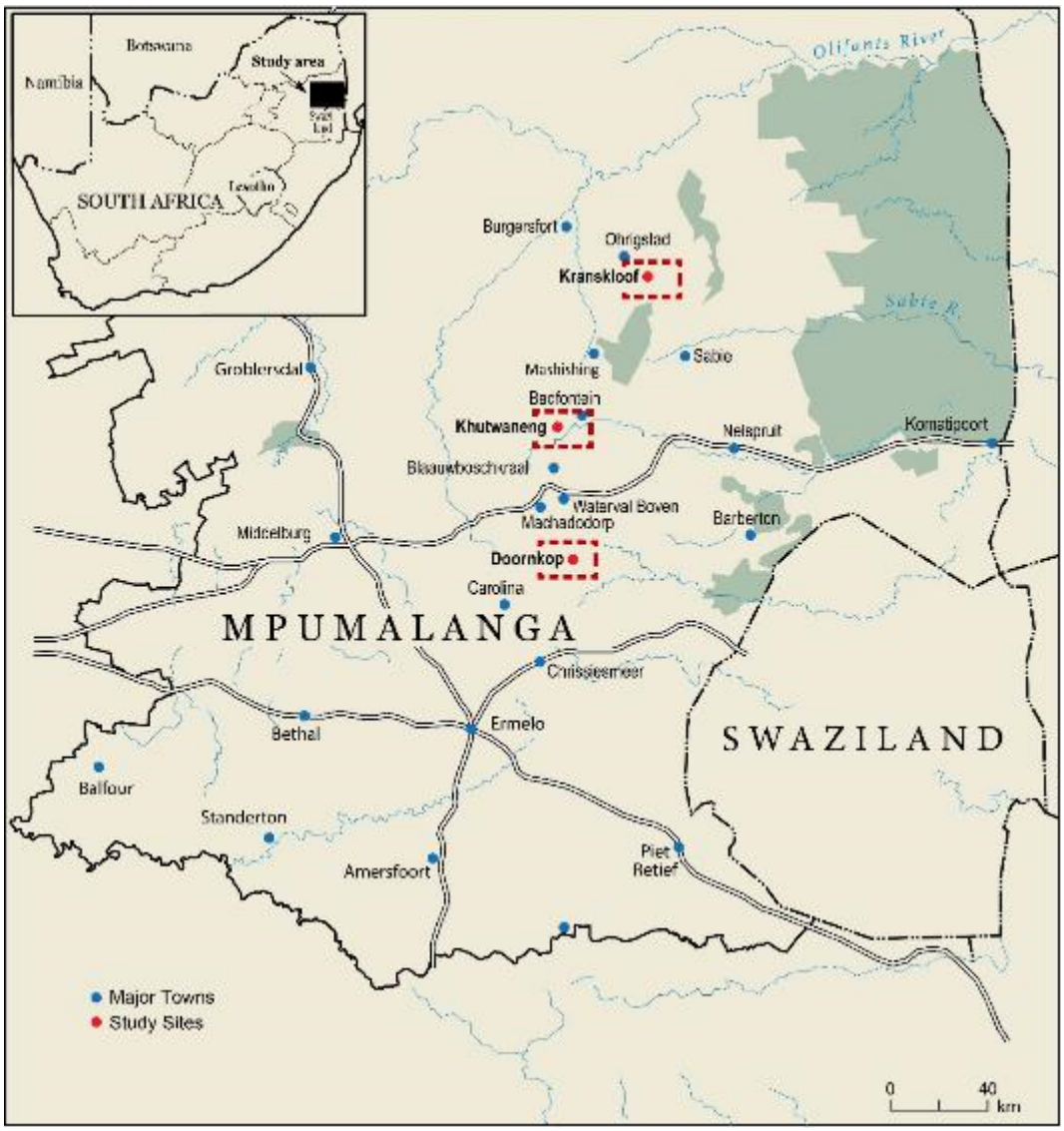


Figure 1.1: Location of sites in Bokoni, Mpumalanga.

Bokoni was one of several pre-colonial regions in sub-Saharan Africa where agriculture was a key economic driver. Archaeological research has focussed on some of these regions such as Marakwet and Pokot, Kenya (e.g. Sutton 1989; Davies 2008, 2009; Westerberg *et al.* 2010), Engaruka, Tanzania (e.g. Sutton 1984; Davies 2010), Nyanga, Zimbabwe (e.g. Sutton 1984; Manyanga and Shenjere 2012) and Bokoni, South Africa (e.g. Delius and Schoeman 2008; Delius *et al.* 2012).

These terraced sites are comparable, because these are all located on hill slopes, as opposed to the lower areas in valleys and flood plains (Sutton 1989; Maggs 2008). Although, all of these societies have an economy based on agriculture, there are also emphases placed on livestock (Maggs 2008; Stump 2010; Delius *et al.* 2012). The main difference between these societies is the use of irrigation. Engaruka, Marakwet and Nyanga have irrigation systems, offsetting periods of drought (Sutton 1989; Westerberg *et al.* 2010). The people of Bokoni, on the other hand, did not use irrigation, because it was not required due to rainfall in the area (Delius and Schoeman 2008; Stump 2010; Westerberg *et al.* 2010).

A number of models have been put forward to explain site selection in these areas. These include soil fertility (Delius & Schoeman 2008; Stump 2010). The significance of soil fertility played in site location cannot be assumed in Bokoni, therefore this needs to be tested and modelled.

In this dissertation I examine the relationship between soil fertility and site selection. This approach, and its parameters, is modelled on research on Polynesian sites, Hawaii, which showed that geological zones, and soils associated with them, influenced people's agricultural choices. Kirch *et al.* (2004), Vitousek *et al.* (2004) and Chadwick *et al.* (2006) chemically analysed the soils to have a better understanding of the Polynesians' agricultural systems. It was found that precipitation, age and composition of the rocks in the given areas, and

elevation were contributing factors to the locations of these sites (Kirch *et al.* 2004; Chadwick *et al.* 2006).

Consequently, this dissertation examined how the land influenced site location and configuration of sites, as well as on how the actions of Bokoni farmers impacted on the land. Following Kirch *et al.* (2004), Vitousek *et al.* (2004) and Chadwick *et al.* (2006), soil chemistry is used as a proxy for these processes, and this dissertation reports on the analysis of the agricultural potential of the soils in different contexts, i.e. domestic areas, central enclosures, terraces and non-archaeological areas. Analysis of phosphate (PO_4), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), ammonium (NH_4), nitrates (NO_3), cation exchange capacity (CEC), and organic carbon percentage (%C), form the foundation of determining the agricultural potential of soils. The chemical analyses are compared to one another to understand how the people of Bokoni influenced the soils.

This dissertation examined the soil chemistry of three sites that represent the four Bokoni occupation phases, which are discussed in Chapter 2. The sites that were sampled and studied are Doornkop, Khutwaneng (Badfontein) and Kranskloof (Fig. 1.1). The southernmost site, Doornkop, forms part of the first Bokoni occupation phase. Here the stone walled homesteads and surrounding terraces have no fixed configuration, or central road system. There are several examples of reuse of abandoned homesteads.

The second phase occupation site is Khutwaneng, in the Badfontein valley. This phase of occupation demonstrates a number of elements of town planning (see Delius *et al.* 2012), including an extensive central road system.

The northern most site, Kranskloof, is situated in a steep valley in the forming part of the Mount Anderson catchment area. This is a third and fourth phase site, materialising the need for refuge during times of conflict (Delius *et al.* 2012). Homesteads are built along the valley slopes and are associated with extensive terracing. The majority of the homesteads are located on the mountain. The Phase 4 refugia at this site are located in the cliffs and on steep-sided isolated hills.

Bokoni people chose these sites because the fundamental socio-political transformations were a key link in the movement of people, away from conflict zones (Delius and Schoeman 2008). However, as the people of Bokoni selected these different sites, it needs to be understood if the sole purpose of these sites were based on moving from conflict areas, or whether soil chemistry played a role.

This dissertation consists of six chapters, including the Introduction. In Chapter 2 a general background is given on the farming communities of Bokoni, and how certain socio-political factors had affected their occupation sequence. This chapter also discusses the importance of agricultural studies in archaeology, as well as the soils and geology one would find in the different Bokoni regions.

In Chapter 3 the dissertation methodology is discussed, focusing on field and laboratory method. The data is reported in Chapter 4. The results are discussed for each sample, before the patterns in the data are highlighted.

In chapter 5 I discuss the significance of the results in the context of the geology of the areas. The second part of the chapter compares the patterns in the data from all three sites.

Chapter 6 summarises the main outcomes of this dissertation, highlights the main achievements and suggests possible avenues to pursue in future research.

CHAPTER 2: BACKGROUND

2.1. The archaeology of farming

Preindustrial settlement distribution patterns are guided by various complex factors (Trigger 1968; Parsons 1972). Environmental factors are prominent (Kirch *et al.* 2004), but others include water availability, soil fertility, natural foods, other resources, level of technology, socio-political and economic factors, ritual practices and ideological beliefs (Weisler and Kirch 1985). For agrarian societies, such as the people of Bokoni, the environmental constraints on crop productivity form part of the fundamental determinants of settlement patterns and settlement location (Kirch *et al.* 2004).

Settlement patterns and methods of cultivation on terraces are part of the configuration of communities, which results in the formation of economic, social and ecological systems (Sutton 1984). The people of Shixini in Willowvale, Eastern Cape for example, balanced gendered duties and their cultivation of crops and holding livestock (McAllister 1989). Livestock was important and kept close to home, even though the primary resources from these were not procured as regularly, and livestock was rarely slaughtered (McAllister 1989). The women managed gardens near their homes, while fields were located further away near the rivers. According to Perkins (1996) this is a common pattern because of the need for the gardens to be close to home, due to a woman having to balance domestic duties with cultivation.

During the mid-20th century Shixini women started to place a greater emphasis on cultivating the gardens as opposed to fields, and gardens grew to as large as 2.42 ha. These were fenced off and consisted of mainly loamy soils which have a greater amount of moister, especially in drought conditions (Talbolt 1988). Talbolt (1988) found that the fields were located on lower yield sandy soils, and thus the

area of cultivation in the fields would be required to be larger than in the gardens for a similar yield. The women often used manure to fertilize their gardens, but not on the fields.

According to Maggs (2008) manuring and the use of technology is a form of intensive agriculture. There are various debates as to what intensive agriculture is and how to classify it. The use of extensive terracing and the large mobilisation of labour does not necessarily qualify as intensive agriculture (Maggs 2008). According to Sutton (1989) agricultural terracing should be viewed as an intensive agricultural practice, because building terraces requires major labour mobilisation and organisation strategies. This involves the initiation of construction, as well as the continued maintenance of these stone walled sites (Stump 2010; Sutton 1989). Sutton (1989) suggests that there is sophisticated and complex reasoning behind building terraces. Stump (2010) further argues that this sophistication, or intensity of the agriculture, influences other aspects of society such as surplus production and size of the population. These, however, do not translate into hierarchical differences in the society of Bokoni. Here, homesteads and cattle enclosures at similar stages in their lifecycles are similar in size throughout the region. The only substantial settlement variation is the number of homesteads in villages, and the density of occupation of these villages (Coetzee 2016).

Kirch *et al.* (2004) and Vitousek *et al.* (2004) examine pre-contact agriculture (before 1778) in Polynesian societies in Hawaii. The location and form of the Polynesian agricultural fields had some similarities with that of Bokoni. The Polynesians placed their fields on the slopes of the volcanoes and chose specific geological areas (Kirch 1991), and also built dry stone walled structures (Kirch *et al.* 2004).

The Polynesian agricultural system mainly emphasised the cultivation of root crops, such as yams, sweet potatoes, and fruits such as bananas. They used terraces to control soil depth and boundaries, with very little evidence of water control (Kirch *et al.* 2004). Irrigation systems were used in dryland agricultural areas with low rainfall in the area (Vitousek *et al.* 2004: 1666). These systems varied between the different geological areas, because older rocks are better suited for drainage, whereas the younger rocks are mainly in the dryland areas (Vitousek *et al.* 2004).

Kirch *et al.* (2004) and Vitousek *et al.* (2004), also explore soil chemistry and how areas differ between archaeological areas and non-archaeological areas. Ca^{2+}, Mg^{2+}, K^{+} and Na^{+} were analysed using ammonium acetate extract, along with cation exchange capacity (Kuo 1996; Kirch *et al.* 2004; Vitousek *et al.* 2004). According to Kirch *et al.* (2004), Lavkulich (1981) measured extractable resin phosphorous. The outcome of these research projects demonstrated that the households were placed in areas with high soil nutrients and are absent from areas where the agricultural potential of soils are low (Kirch *et al.* 2004).

Other factors that played a role are the geology of the different areas, precipitation, age and composition of the rocks in the given areas, and soil depth (Nullet *et al.* 1990; Kirch *et al.* 2004; Chadwick *et al.* 2006). The geology of the area consists mainly of basaltic type lava flows with higher alkali elements, Basanite and Hawaiite. These results are similar to what is found in the Bokoni area, where there seems to be a direct correlation between the locations of the homesteads and geology (Coetzee 2016).

Soil fertility regimes and cropping strategies help to overcome limitations, or capitalise on advantages, of specific areas. Fertilizing soils, for example, can offset low nutrient levels, as well as long term nutrient depletion. Consequently, it has been suggested, that the people of Bokoni may have fertilized fields with

manure and/or ash to optimize crop yields (Maggs 2008: 180; Delius et al. 2012: 411).

Cropping strategies, such as inter-cropping, mono-cropping and mixed-cropping, also help to manage specific nutrient requirements and thus help to improve yields (Smith 2005:45). Legumes, for example fix nitrogen. The need for nutrient supplementation and different cropping strategies depend on the requirements of the crops cultivated. Southern African traditional agricultural practices emphasise the importance of crop varieties such as *Sorghum bicolor* (Sorghum), *Pennisetium glaucum* (pearl or bulrush millet), *Eleusine coracana* (finger millet) and *Zea mays* (maize) (Smith 2005). Each of these would have different cultivation requirements.

Maggs' (2008) comparison between Bokoni, Engaruka in Tanzania, and Marakwet in Kenya shows that these settlements are similar, because all these sites show evidence of agricultural terracing. The terraces in Engaruka and Marakwet, however, were irrigated (Sutton 1989; Westerberg *et al.* 2010). Similarly, the agricultural terracing in Nyanga, Zimbabwe, has been linked to water management. Here stonewalled terracing was used in order to supplement rainfall where large canals were built off streams creating a fail-safe system for irrigation of crops (Sutton 1989: 103).

The terraces in Bokoni, however, are not informed by this rationale. According to Delius and Schoeman (2008); Maggs (2008); Solomon (2012); and Resource management (No date), the current rainfall in the Mpumalanga area is relatively high (ranging between 500 mm and 1600 mm per annum). Hattingh (2014), however, showed through phytolith analysis, that the annual rainfall in the Buffelskloof valley was lower at the time of occupation. This evidence was supported by stable isotope analyses of *Prunas africanus* tree rings (Aub 2014). The rainfall in these areas, however, normally exceed the crop water requirements

for African crops, such as sorghum and millet. Therefore, various questions have arisen as to why agricultural terraces were built in Bokoni.

Delius *et al.* (2012) describe a model where people moved into the new area due to other social pressures. The soil was fertile, but the rocks and the slopes in the area posed an inconvenience as these factors increased the rate of erosion. As a result, the people of Bokoni placed the rocks in terraced lines in order to counter the disequilibrium of the slopes. Soil fertility, and an attempt to increase the permeability of the soils to allow for better water drainage are other possible factors in terrace building (Sutton 1989). In East Africa terraces are built for irrigation use, whereas Bokoni is rain fed.

Solomon's (2012) honours project showed that the villages in the Komati valley were placed on doleritic soils. Dolerite (diabase) weathers into clay-like soils, which are relatively fertile, but do create various problems. The decay of dolerite results in non-ideal Ca-Mg cation ratios (Delius and Schoeman 2008; Rehm 2009). A range of other soil chemistry indicators, however, suggested that the terraced slopes needed to be managed to improve the soil quality. Consequently, Solomon (2012) suggested that terraces were built to improve the drainage, quantity and quality of soils. They might also have assisted in the control of erosion; in ways similar to the Mashishing terraces (see Marker and Evers 1976).

Maggs (2008) suggested that maize might have been a key factor in the development of terraced agriculture, and that maize must have been present in Bokoni as a result of trade with the Portuguese coast. The link between terraces and maize, however, is not clear. Thus far there is no direct scientific evidence for maize in Bokoni, but sorghum and cowpeas have been found in association with house floors south of Alexandriaspruit (Collet 1979; Stump 2010). Furthermore, Hattingh (2014) has found possible sorghum and millet phytoliths in Bokoni terrace samples.

2.2. The Archaeology of Bokoni

Bokoni settlements stretch across the Highveld of the Mpumalanga Province from Carolina, in the southern sections of the province, to the border of the Limpopo province, near Orighstad in the north (Delius *et al.* 2012). Sites occur in a range of topographic contexts, from rolling hills in the south to defensive structures in the northern Kloofs (Delius *et al.* 2012). Irrespective of location, the stone walled ruins of villages and homesteads follow similar layouts, with stone walled enclosures in the centre, and outer walls separating the domestic areas from the terraces. Cattle tracks lead from the homesteads to nearby grazing and water sources.

Recent research suggested that the settlements in the southern part of the region are the oldest, dating to around 1500 AD (for a more detailed discussion of the sequence see Schoeman and Delius 2011; Delius *et al.* 2012). This research derived these earlier dates through relative dating techniques from oral accounts, such as those recorded by Prinsloo (1936) and Pedi traditions. The Pedi traditions recounted that they met SeKoni speaking people in the Crocodile valley, but do not mention the Komati valley. The silence surrounding the southern sites, suggest that the Komati valley sites pre-dates the Crocodile valley occupations encountered by the Pedi (Delius *et al.* 2012).

The different settlement areas have been classified as Phase 1, Phase 2, Phase 3 and Phase 4, according to the social dynamics and construction of the sites (Schoeman and Delius 2011; Delius *et al.* 2012). Phase 1 sites are located in the southern part of Bokoni. There are circular central enclosures in the homesteads and may have additional circular lobes attached to it (Delius *et al.* 2012). These additional lobes are thought to be associated with the amount of wives that were present in the homestead. Consequently, it has been suggested that an analysis of the number of lobes in a homestead could be used to assess the maturity (and

wealth) of a homestead. These central enclosures may be associated with animal husbandry. In one of these villages newer homesteads were built on the fringes, or overlay abandoned homesteads inside villages (Faerch 2012). No structures or features have been found that would suggest distinct political hierarchies (Delius *et al.* 2012).

These Phase 1 sites are located on gentle slopes in open areas, and would not have been easily defendable (Delius and Schoeman 2008; Schoeman and Delius 2011; Delius *et al.* 2012). As these sites were situated along the Komati and Crocodile rivers, trade could easily be established and maintained (Coetzee 2009; Delius *et al.* 2012). Oral records indicate that sites such as Moxomatsi near Belfast was one of the first Bokoni settlements; these however were attacked by 'the Mapono' (possibly Nguni groups) forcing the Bokoni people to move towards Machadodorp and Mashishing (Delius *et al.* 2012: 405).

The Phase 2 settlement layouts of the Bokoni homesteads and villages near Machadodorp and Mashishing are similar to that of Phase 1 sites (Delius and Schoeman 2010; Delius *et al.* 2012). The homesteads continue to comprise of the central enclosure with lobes, and terraces associated with homesteads (Fig. 2.1). The cattle tracks are a distinct feature in these areas, linking homesteads and guiding animals and people between the terraces. Khutwaneng is a large Phase 2 terraced site south of Mashishing. The settlement logic continues to be driven by farming concerns.



Figure 2. 1: Aerial photograph of Bokoni homesteads surrounded by agricultural terraces.

According to Schoeman and Delius (2011); Delius *et al.* (2012) initial conflict was sporadic; allowing people to continue to use open valley Phase 2 settlements to live and cultivate land. However, as the violence escalated, the people of Bokoni were forced to retreat into the kloofs (Delius and Schoeman 2010; Delius *et al.* 2012). Phase 3 settlements were built in more defendable kloofs. It is likely that these sites were initially used as refuges when violent episodes first affected the region. Violence escalated with the arrival of the Ndwandwe and/or Ndebele (see Rasmussen 1978; Delius 1984: 22–29; Schoeman 1997 for a more detailed discussion on the impact of the *mfecane* in the region). The kloofs could not provide refuge to everybody, forcing the people of Bokoni to adopt an array of strategies, including to spread out, and to assimilate with other polities in the area such as the Ndzundza (Schoeman 1997). Those who did find refuge in the kloofs developed extensive defensive stone walls such as the Kranskloof site near

Orighstad (Fig. 2.2). According to Delius *et al.* (2012) these sites were built in the early 1800s during this period of escalated violence.



Figure 2. 2: Extensive stone walled defensive structures at Kranskloof.

The conflict in these areas ended Bokoni independence, and ended the tradition of terraced agriculture in this region of southern Africa (Delius *et al.* 2012). The final phase (Phase 4) of independent Bokoni history saw people reoccupy Phase 3 sites where they found refuge, joining mission stations, or returning to Bokoni settlements with their adopted communities. These returnee settlements, however, were short lived due to the expanding colonial frontier.

Although the socio-political situations created the requirement for the movement of the people in the later phases of the Bokoni sequence, recent research has shown that physical factors played a central role in the location of Bokoni settlements during the earlier phases (Phase 1 and 2). The topography and the geological zones are different between the southern and northern settlements (Delius *et al.* 2012). There, however, are small scale similarities such as swarms of dolerite dykes associated with the intrusion of the Bushveld Complex near Mashishing (Marker and Evers 1976) and in the Komati River valley (Solomon 2012). This may have guided the local choices of settlement relocation on favourable arable land.

2.3. Soil nutrition and potential enhancements

2.3.1. Extractable Nitrogen

The nitrogen (N) cycle in anthropogenic soils gets altered through general land use and land cultivation (Fraser *et al.* 2011). The most influential changes of nitrogen in soil is by the use of animal manure (Choi *et al.* 2006; Bol *et al.* 2008; Senbayram *et al.* 2008; Fraser *et al.* 2011). Maggs (2008) suggested that it is possible that manuring could have been present in Bokoni, and liming (addition of pot ash) often is required for optimal growth for sorghum. Manuring is often needed, because a shortage of plant available nutrients would limit the growth of plants including the yield (Kanstrup *et al.* 2012). In areas such as southern

Zimbabwe manuring was practiced in the dry season (Native commission report in Ranger 1999; Smith 2005), during periods where the land lay fallow between planting seasons, animals were allowed to graze on harvested fields.

According to the Kansas Cooperative Extension Service (1998) sorghum requires continuous nitrogen supplementation throughout its growth. Too much, however, would create problems during the germination phase. Cowpeas (*Vigna unguiculata*) do not require high nitrogen levels, because, it fixes nitrogen from the air. Plants that could fix nitrogen such as cowpeas, and other legumes were planted with staple crops (Krige and Krige 1943). In modern day West Africa, legumes are still planted in rotation with sorghum (Dugje *et al.* 2009).

In order to understand nitrogen additions to cultivated fields one needs to focus on the influences of nitrogen in soil and plants. This is done by looking at $\delta^{15}N$ (stable isotope ratios of $^{15}N/^{14}N$) (Fraser *et al.* 2011). Natural environmental factors have an influence on $\delta^{15}N$ values such as climate, water stress, salinity and soil processes, mineralisation and denitrification (Heaton 1987; Handley *et al.* 1999; Bol *et al.* 2005; Inglett *et al.* 2007; Yousfi *et al.* 2010; Fraser *et al.* 2011).

Land management practices in farming societies are a main factor in success of these societies. As a result plant remains give key information on the practices of these societies (Kanstrup *et al.* 2012). A pilot study by Bogaard *et al.* (2007) focussed on $\delta^{15}N$ ratios in plants, to see if one could identify the intensification manuring, as well as over what period of time. Legumes were also taken into account, where $\delta^{15}N$ signatures were analysed from pulses, host bacteria that allows for N_2 fixation (Virginia and Delwiche 1982; Marshall *et al.* 2007; Fraser *et al.* 2011). The study had found that manuring has a very low effect on pulses. It was theorised that it may be due to the prevalent affect nitrogen fixing has on the soils (Fraser *et al.* 2011). This was especially true in soils with very low nitrate and ammonium availability (Fraser *et al.* 2011). The second aspect that was

focussed on, was the effects of long term manuring compared to short term on cereals.

Short term manuring has shown that there is no significant effect on $\delta^{15}N$ values in cereals (Fraser *et al.* 2011). Manure has a slow release mechanism and is, therefore, considered to be more conducive to long term investment in cultivation (Defra 2010; see Fraser *et al.* 2011 for a more detailed discussion on pulses). Intensive manuring over a short period of time, however, does show similar $\delta^{15}N$ signatures to that of long term manuring (Fraser *et al.* 2011). Long term manuring shows a distinctive mark on $\delta^{15}N$ values and could possibly be significant in archaeological contexts. As a result, one could reconstruct land use in cultivated lands.

Organic matter, such as plants, however, do not preserve well in open air archaeological contexts with acidic soils. This is the case in much of Bokoni, and thus it is necessary to find different ways of analysing plant material. Kanstrup *et al.* (2012) focusses on charred seeds, because these are more formidable against fungal and bacterial attack, but are morphologically damaged and potentially biochemically distorted (Boardman and Jones 1990; Hillman *et al* 1985; Kanstrup 2012) and are more likely to be found in archaeological contexts.

Kanstrup *et al.* (2012) did a pilot study on the effects of charring on isotopic signatures of seeds looking specifically at $\delta^{15}N$. This was based on DeNiro and Hastorf's (1985) assumption that charring had little effect on $\delta^{15}N$ and $\delta^{15}N$ in plants and could be comparable to modern seeds that had not been charred (Kanstrup *et al.* 2012). According to Bogaard *et al.* (2007) charring in different conditions would have very little effect on species identified in the study. Having an understanding of the isotopic signatures in the seed would not only give an indication of $\delta^{15}N$ values but also could give an indication of what the maximum temperature the seeds were exposed to using electron spin resonance spectrometry

(ESR) (Hillman *et al.* 1983; 1985). The study had focussed on the process of charring looking at different variables such as oxygen availability; duration of burning; manuring practices and temperature variation (see Kanstrup *et al.* 2012 for a more detailed discussion on the study).

Preliminary results showed that $\delta^{15}N$ isotopic signatures in seeds are a reliable indicator of manuring in an archaeological context. Commisso and Nelson (2010) and Shahack-Gross *et al.* (2008) found that $\delta^{15}N$ could also be used to show areas where there have been homesteads built; agricultural fields and pastoral lands, by locating areas of animal manure and human faecal matter.

2.3.2. Organic Carbon

The importance of understanding the organic Carbon in soil is necessary, because it informs on the fertility of the soil and the ability to sustain life (Angers and Caron 1998; pers. comm. De Jager 2015). According to Homann *et al.* (2007), sandy soils contains less %C than loamy, clay rich soils, indicating the relationship of soil texture and %C. Organic carbon stabilises soils, by forming aggregates of the soil, protecting it from erosion and alterations of the structure, through rainfall and compaction (Angers and Caron 1998: 55). Soil depth also plays a role in the carbon content of the soil, because the interaction of organic matter decreases by depth (pers. comm De Jager 2015).

2.3.3. pH

Quality of crops are determined by various factors such as micro and macro nutrients. pH is one of the fundamental determinants of crop growth and the yield (White 2006). Sorghum, for example, prefer soils that have a pH ranging at 5.5 –

8.5 (du Plessis 1998), and cowpeas require a more neutral pH of 6 – 7 (Dugje et al. 2009).

2.3.4. CEC

Cation exchange capacity often has a direct relationship with %C, and gives a very good indication of the fertility of the soil. Soares and Alleoni (2008) demonstrated this direct relationship in a study done in Brazil, looking at the relationship of %C and CEC. This study showed that higher CEC and %C values indicates higher soil fertility (Soares and Alleoni 2008).

3.3.5. Particle size distribution

Particle size distribution is essential in order to understand soil, because it creates a better understanding of the soil texture and what types of soil we are working with i.e. sand, silt or clay. The correct identification of types of soils is important because people, water, animals and plant matter, etc. interact differently with different soil types. According to AGRILASA (2004) soil particles are formed in aggregates and in order to determine the soil distribution according size one needs to separate the soil aggregates by chemical and mechanical methods.

2.4. Geology

The geology of Mpumalanga is highly varied and is composed of some of the oldest rocks in the world dating back to 3.7 billion years on the Kaapvaal Craton in the Lowveld (Resource management no date). These are mainly composed of gneiss and granite. Both the Highveld on the escarpment and the Lowveld contain stratum of dolerite, gneiss gabbro, norite, tuff and shale. Bokoni is situated on the Transvaal Supergroup and the Karoo Supergroup (Erikson *et al.* 2006: 237) (Appendix C).

The Transvaal basin was formed between 2 600 and 2 100 million years ago (Resource management No date). The Bushveld Complex later intruded into the Transvaal Supergroup approximately 2 050 million years ago. The Pretoria group consists of sandstone, shale, conglomerates, volcanic rocks, quartzite and carbonate rocks, which were subjected to low grade metamorphism (Erikson *et al.* 2006).

2.4.1. Physical and geological context of Doornkop

Doornkop hill is approximately 1568.50 m above sea level, and is approximately 808.61 m in length along the north eastern slopes, and 900.79 m wide along the western slopes. A section of the hill has recently been quarried for shale in order to construct roads in the Komati Gorge area. Doornkop geology forms part of the Pretoria group of the Transvaal Supergroup (McCarthy and Rubidge 2005). The general geology of Doornkop consists mainly of quartzite, shale and dolerite outcrops (Fig. 2.3), while the hill in itself comprises of shale, with sections of dolerite.

The Doornkop area went through a sedimentation process during the formation of the Pretoria group. Fine sediments, such as fine sand and silt, were deposited during a marine event, creating sandstone and siltstone. These rocks were then metamorphosed through pressure creating quartzite and shales. Once these were formed, a series of dolerite dykes and sills of the Bushveld Complex intruded into the Pretoria group (McCarthy and Rubidge 2005; Norman and Whitfield 2006).

The intrusion of the Bushveld Complex caused major uplift in the eastern parts of the South Africa. As a result, there was an increase of weathering and erosion, in the surrounding areas, to counter balance this uplift event (Norman and Whitfield 2006). Shale erodes relatively easily, whereas quartzite does not. Since there is a

high rainfall in the area of the escarpment around Doornkop, water erosion cut through the underling rocks forming the gorge. This erosion also created unstable slopes and geological features. During the erosion of the geological features, deposition of sediments of the parent rocks occur in these valleys, having a direct influence on the fertility of the soil, due to the minerals in the dolerites and shale in the Doornkop area. The homesteads and the terraces are mainly placed on shale and on dolerite (Fig. 2.3). Some of the non-archaeological zones are also in these geological areas.

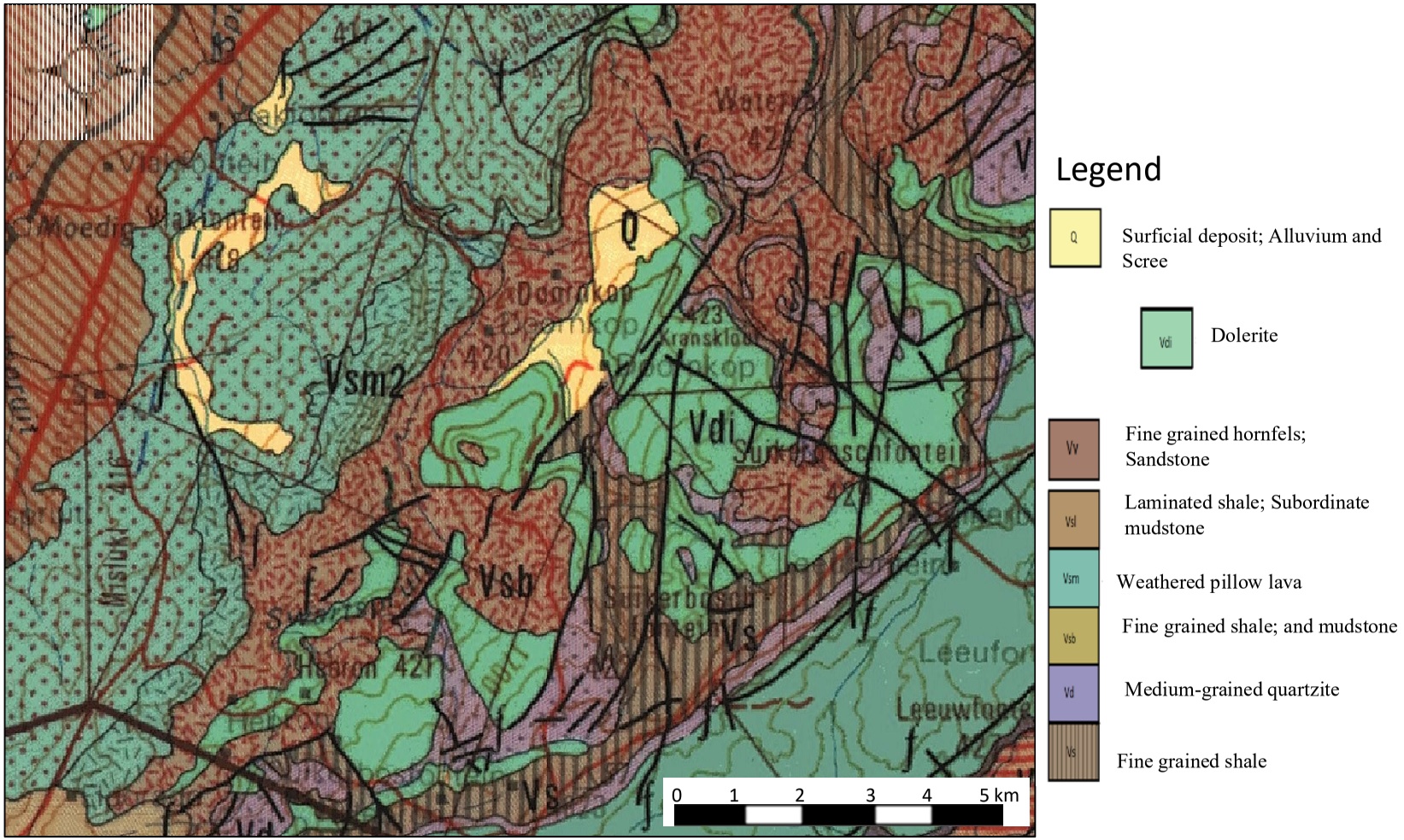


Figure 2. 3: Geology of Doornkop and surrounding areas.

2.4.2. Physical and geological context of Khutwaneng

Khutwaneng is a village located on a long hill in the centre of the Badfontein valley. This site, which was excavated by Collet (1978, 1982), was occupied during Phase 2, and probably Phase 3, of the Bokoni occupation sequence. Today the R36 intersects that site[1] (Fig. 2.4). The Kwena Dam is located south of this site. While the Kwena (formally Crocodile) river runs through the valley, the river is not near this site, but there is a stream at the base of the eastern section of the hill. The stream formed part of the Crocodile River system before the construction of the dam. The site covers approximately 15.86 km^2.



Figure 2. 4: Example of modern interference of Bokoni sites, in Khutwaneng.

[1] On either side of the hill there is a significant amount of contemporary cultivation. As a result, these areas were ignored in this study. Other contemporary roads have been built through the terraces, homesteads and roads of the site in the areas that were studied. A cellular phone tower has been built on the hill, which damaged archaeological features around it.

The geology of Khutwaneng consists mainly of shales and dolerites (Fig. 2.5). The hill, on which the main section of village was built, is approximately 1349.65 m above sea level, and is approximately 5.8 km long. The hill is oblong in shape and is directed from S – NNE. As discussed in chapter two, the Khutwaneng geology forms part of the Pretoria group of the Transvaal Supergroup (Erikson *et al*. 2006).

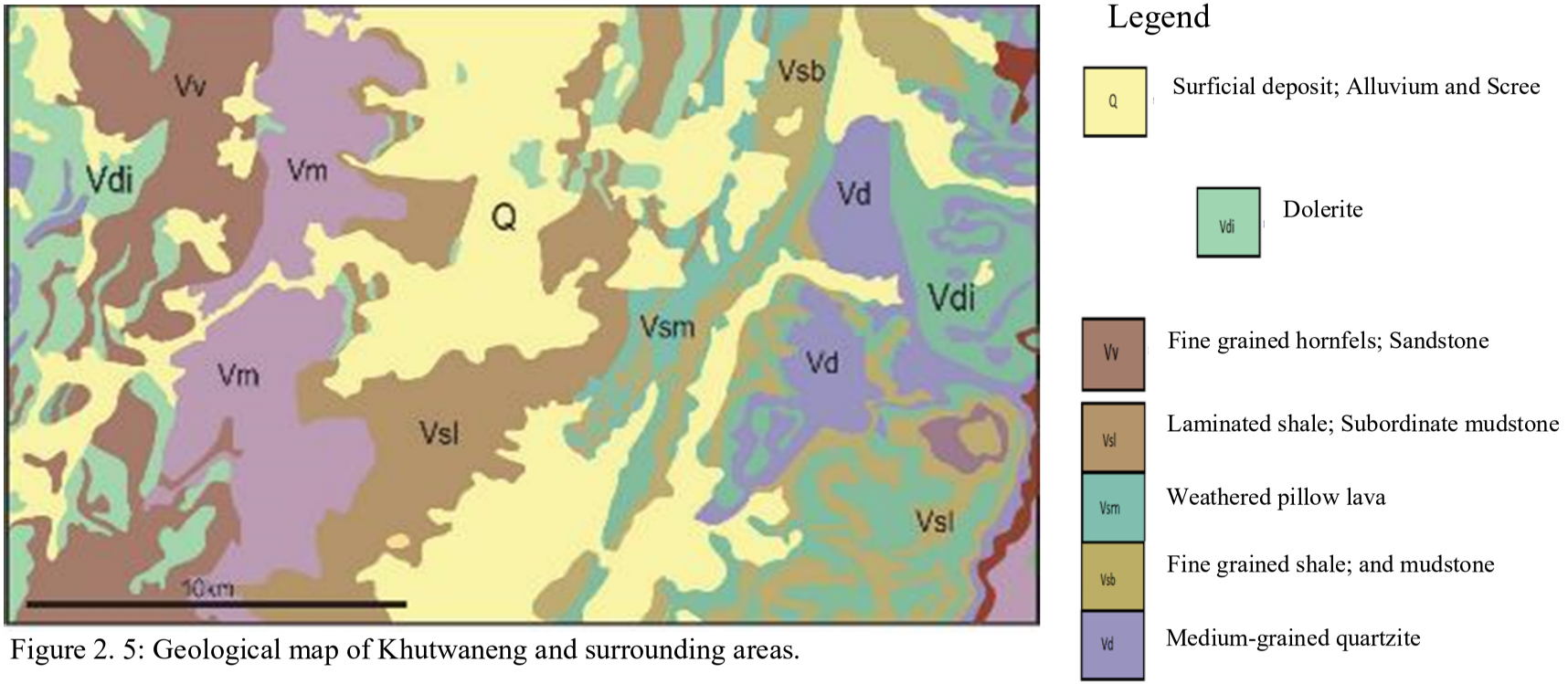


Figure 2. 5: Geological map of Khutwaneng and surrounding areas.

Khutwaneng was shaped by geological processes similar to those described for Doornkop. The hill is predominantly derived from dolerite, but there is also shale present. The surrounding mountains have weather resistant quartzite on the upper slopes, creating a similar erosional pattern to that at Doornkop. Due to the central hill consisting predominantly of dolerite, the homesteads and terraces are constructed on dolerite.

2.4.3. Physical and geological context of Kranskloof

The geology of Kranskloof consists of dominantly quartzite, shale and basalt (Fig. 2.6). The lower section of the valley is dominantly basaltic, and the top of the slopes and the ridges are dominantly derived from shale and quartzite. The ridges of the mountain are approximately 1 769.36 m above sea level, whereas the valley floor is 1 520.04 m above sea level.

The formation of this valley is similar to the processes discussed in Doornkop and Khutwaneng. The basalt in this area suggests that during the influx of the magma in this area of the Pretoria Group, the magma had cooled down more rapidly than the in the other sites. As basalt has the same composition of dolerite, and the difference is cooling rate verses crystal size, it is more than likely that the basalt intruded also during the intrusion event of the Bushveld Complex.

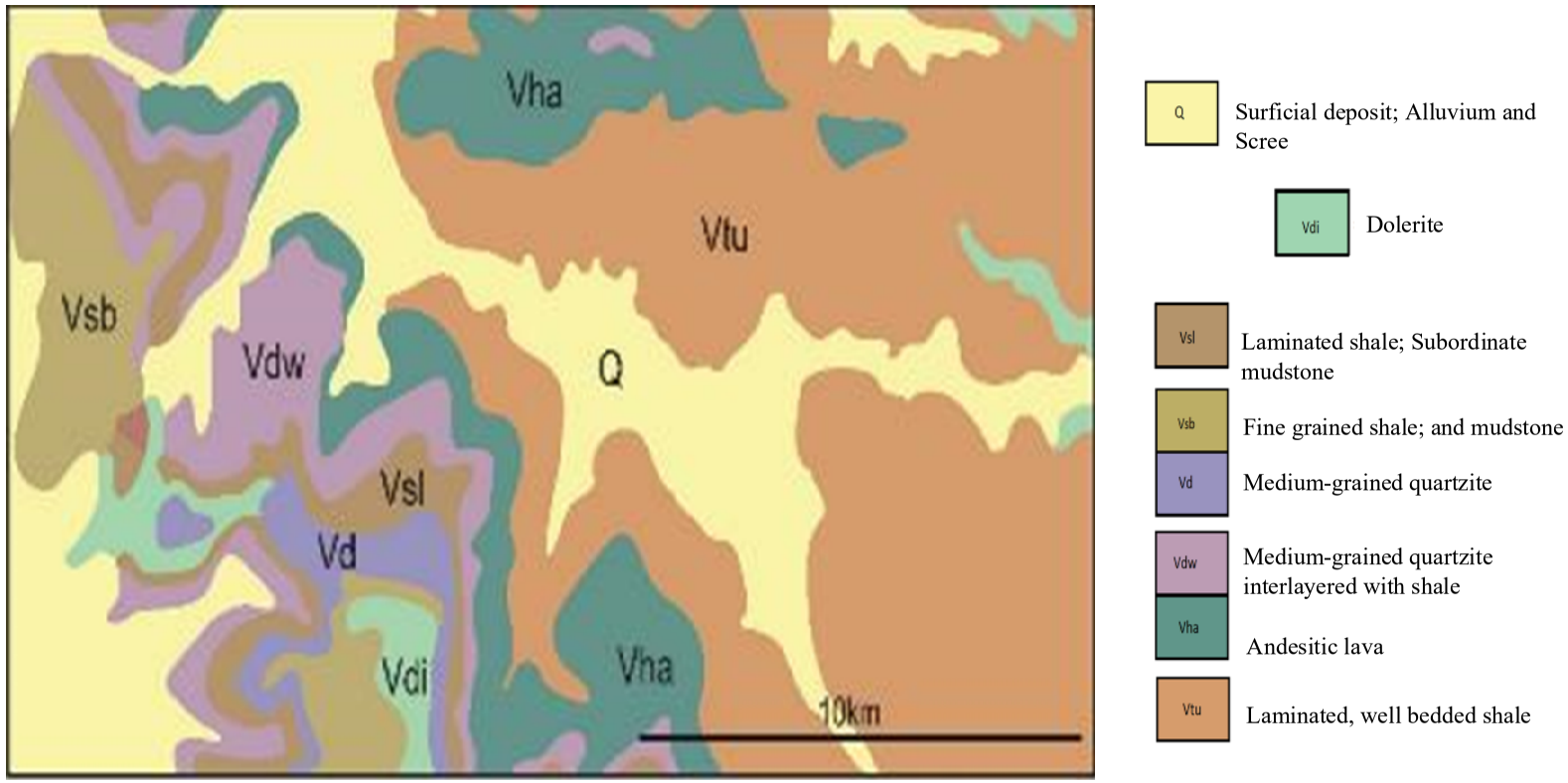


Figure 2. 6: Geology of Kranskloof.

CHAPTER 3: METHODOLOGY

3.1. Site locations

As discussed in chapter 2, the Bokoni occupation sequence has been divided into four phases. Phase 1: demonstrating organic growth of the towns; Phase 2: manifest in planned towns; Phase 3: characterised by defensive structures in Kloofs, and restructured association of terraces and homesteads; and Phase 4: seen in the reoccupation of abandoned areas (Delius and Schoeman 2010) . In order to have a greater understanding of the development of agriculture in Bokoni, this dissertation focused on sites that form part of the first three phases including a component of the fourth phase. These sites are Doornkop (Phase 1), Khutwaneng (Phase 2) and Kranskloof (Phase 3) (Fig. 1.1).

The sites in Bokoni were studied by sampling soils in different contexts on the three sites. These included samples taken inside different areas of the homesteads; the domestic areas (in the outer circle), the central enclosure (inner circles); the terraces, areas surrounding the homesteads, and areas with no visible archaeological evidence (control samples). Areas with distinctly different vegetation and different geological zones were also taken into consideration. Whilst local variation was taken into consideration, the sampling process was kept as consistent as possible.

A standard bucket soil auger was used in order to sample the soils. The auger was 1.5 m in length, and the head was approximately 15 cm in length. First 5 cm of the soil was disregarded, because earlier research (e.g. Collett's 1978) suggested that these are likely to be more recent soil deposits, and thus are contaminated by contemporary factors (vegetation, animal defecation, erosion etc.) (Fig. 3.1). Although it is possible that these factors are present below the 5 cm mark, a

standardisation of sampling was necessary. These excluded soils were labelled as H0.

On average each sample bag had approximately 3-4 kg of soil, in order to ensure there was enough soil for the analysis after being prepared. Each sample location was divided up into different soil layers. This process was based on the colour, and the texture of the soil, and samples were separated into different sample bags. These were marked as H1, H2, H3, etc. dependent on how many soil layers a location had. Some samples were taken as bulk (including all the different layers) when a single sample of the layers would not be large enough for analysis.



Figure 3. 1: Soil profile of soils in Bokoni.

The Auger is a core drilling tool, creating a possibility of contamination of the different samples, because there is very little control over the movement of the soil inside the auger. This was compensated for, by not collecting samples near the contact zones of the different layers. This is sufficient for this research, because this is not a study of the specific layers, but rather the context of the

different sample location and the sites. Therefore, any minor contamination between the layers is minor would not have a significant impact on the study. Another shortfall of using the auger for sampling, is that the contact zones of the soils could not be determined, due to this mixing of soils in the Auger.

3.1.1. Doornkop

Doornkop, located on the Fish and Wildlife Reserve (Doornkop 420 JT), is a Phase 1 site located between Carolina and Machadodorp (Fig. 1.1). Doornkop is located in southern Bokoni in a valley which forms part of a gorge (Fig. 1.1; Fig. 3.2 and Fig. 3.3). This study area is next to Komati Gorge in which was the focus of my honours project. Doornkop homesteads and terraces are mainly concentrated on the central hill. There, however, are isolated homesteads on the surrounding mountains on the western section of the site (Area B) (Fig. 3.2).

The Komati River runs through this site, and continues towards another Phase 1 village in Komati Gorge. The Doornkop site covers approximately 19.54 km^2, and comprises of three different occupation sections: The Doornkop hill; the less dense occupation of the mountain, west of the Komati River; and the southern section of this mountain.

There is a substantial amount of contemporary interference with the site, for example roads have been built through the sites, several holiday cottages are located on the southern end of the Doornkop site, and hiking paths weave through the site. A section of land at the bottom of the main hill, in the north eastern section of the site, have been cultivated in the last 50 years.

The sampling locations were chosen prior to doing field work by using aerial photographs, and Google Earth. The sampling locations were chosen according to

their proximity to the homesteads and associated terraces, and where there has been least amount of human intervention, such as the modern cottages that have been built amongst the homesteads and terraces. Some sampling locations were chosen on site, because there were visible differences in vegetation, or geological zones, that were not picked up through the study of the aerial photographs and Google Earth.

There were 62 samples taken at Doornkop, in 43 locations (Table 3.1). Sampling locations 020 and 021 were located in areas where recent agricultural activity took place (in the last 50 years). This is visible in the distinctly different vegetation and is a contemporary animal grazing area. These samples could be compared to the terraces to examine the impact of recent archaeology on soils because these soils have also been changed by agricultural use. All these samples were compared with one another to gain a better understanding of the area and associated soil chemistry.

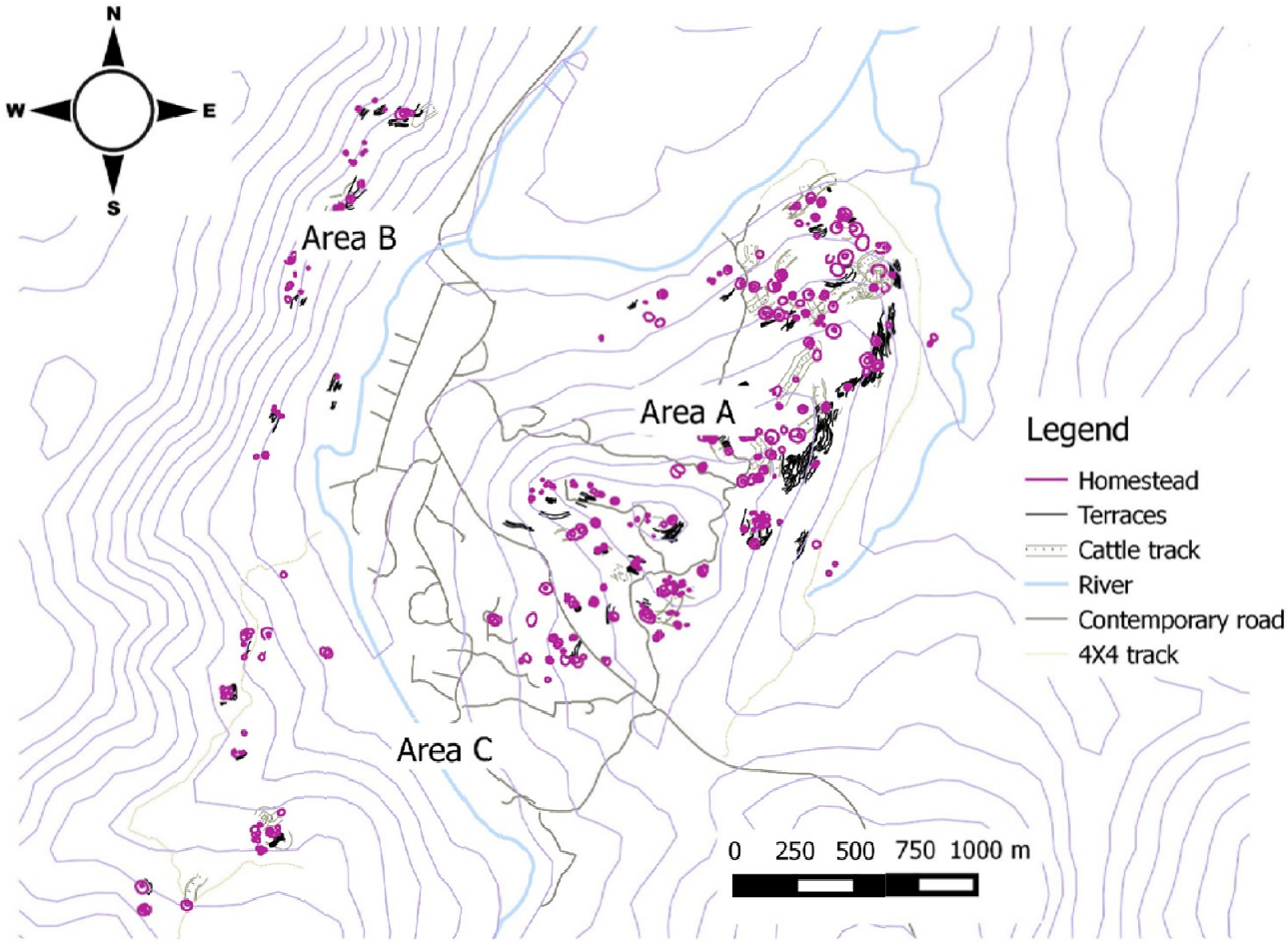


Figure 3. 2: Site map of Doornkop.

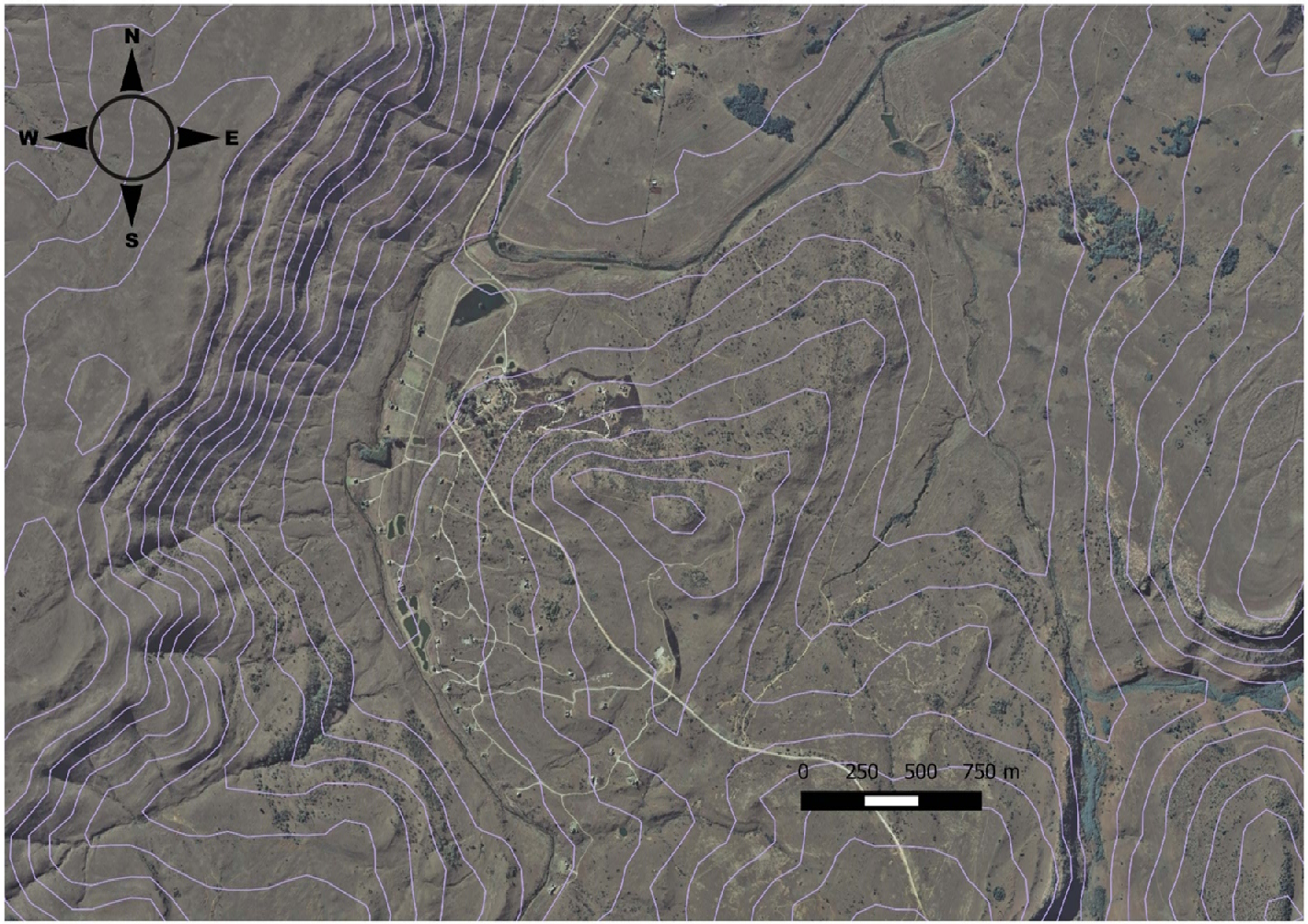


Figure 3. 3: Aerial image of Doornkop

Table 3.1: Sample locations, numbers, contexts and GPS co-ordinates for Doornkop				
Location	Sample #	Context	GPS co-ordinates	
			latitude	longitude
001	1	Domestic	25°56'17.46"S	30°14'49.88"E
002	2	Terrace	25°56'10.80"S	30°14'49.08"E
003	3,4	Central enclosure	25°56'11.22"S	30°14'48.31"E
004	5	Central enclosure	25°55'9.66"S	30°14'15.34"E
005	6	Terrace	25°55'9.12"S	30°14'14.40"E
006	7, 8	Non-Archaeological	20°55'13.04"S	30°14'8.12"E
007	9	Domestic area	25°55'19.19"S	30°14'8.35"E
008	10, 11	Central enclosure	25°55'22.21"S	30°14'4.68"E
009	12	Terrace	25°55'22.81"S	30°14'5.09"E
010	13	Non-Archaeological	25°55'27.82"S	30°14'7.93"E
011	14	Non-Archaeological	25°55'28.27"S	30°14'15.41"E
012	15, 16, 17, 18	Terrace	25°56'11.66"S	30°14'47.35"E
013	19, 20, 21	Non-Archaeological	25°56'22.42"S	30°14'52.96"E
014	22, 23, 24, 25	Non-Archaeological	25°56'2.47"S	30°14'57.75"E
015	26	Non-Archaeological	25°56'2.06"S	30°14'55.38"E
016	27	Domestic area	25°56'5.70"S	30°14'53.89"E
017	28, 29	Terrace	25°56'7.58"S	30°14'53.73"E
018	30	Terrace	25°56'17.12"S	30°14'39.71"E
019	31	Non-Archaeological	25°56'19.15"S	30°14'37.56"E
020	32	Non-Archaeological	25°56'12.42"S	30°15'17.81"E
021	33, 34	Non-Archaeological	25°56'8.17"S	30°15'18.12"E
022	35	Domestic area	25°56'6.64"S	30°15'7.37"E
023	36	Terrace	25°56'7.95"S	30°15'8.16"E
024	37, 38	Non-Archaeological	25°56'9.49"S	30°15'9.73"E
025	39	Non-Archaeological	25°56'11.65"S	30°15'13.65"E
026	40	Central enclosure	25°55'42.17"S	30°15'32.99"E
027	41, 42	Non-Archaeological	25°55'43.50"S	30°15'33.53"E
028	43	Non-Archaeological	25°55'44.86"S	30°15'28.59"
029	44	Terrace	25°55'25.46"S	30°15'21.27"E
030	45	Non-Archaeological	25°55'22.99"S	30°15'23.32"E

Table 3.1: Sample locations, numbers, contexts and GPS co-ordinates for Doornkop				
Location	Sample #	Context	GPS co-ordinates	
			latitude	longitude
031	46	Central enclosure	25°55'22.81"S	30°15'17.22"E
032	47	Domestic	25°55'22.69"S	30°15'15.49"E
033	48, 49, 50, 51, 52	Terrace	25°55'21.23"S	30°15'18.39"E
034	53	Domestic	25°56'19.31"S	30°13'49.50"
035	54	Central enclosure	25°56'19.38"S	30°13'49.85"E
036	55	Non-Archaeological	25°56'27.57"S	30°13'45.56"E
037	56	Terrace	25°56'26.91"S	30°13'47.60"E
038	57	Non-Archaeological	25°56'29.42"S	30°13'48.70"E
039	58	Non-Archaeological	25°56'41.22"S	30°13'35.87"E
040	59	Central enclosure	25°56'56.22"	30°13'33.90"E
041	60	Terrace	25°56'46.93"S	30°13'53.76"E
042	61	Terrace	25°56'47.83"S	30°13'52.99"E
043	62	Non-Archaeological	25°56'50.09"S	30°13'55.92"

3.1.2. Khutwaneng

Khutwaneng is significantly different from Doornkop. It is a Phase 2 site where there is definite town planning. This is apparent in the way the homesteads have been built where there is little to no superposition of the homesteads and a road network links the homesteads (Fig. 3.4 and Fig. 3.5). Khutwaneng is located on the farms Rietfontein 84JT and Klipspruit 89JT, south of Mashishing (Fig. 1.1).

The field work for Khutwaneng was done in conjunction with Tiffany Henshall. Henshall (2016) focuses on the spatial analysis of the homesteads at Khutwaneng. As a result, the field work was done together, complimenting each other. The homesteads that Henshall had chosen to sample and map, by using Google Earth and aerial photographs, were also sampled for soil. Thirty-nine soil locations were sampled at Khutwaneng, and these yielded seventy soil samples (Table 3.2).

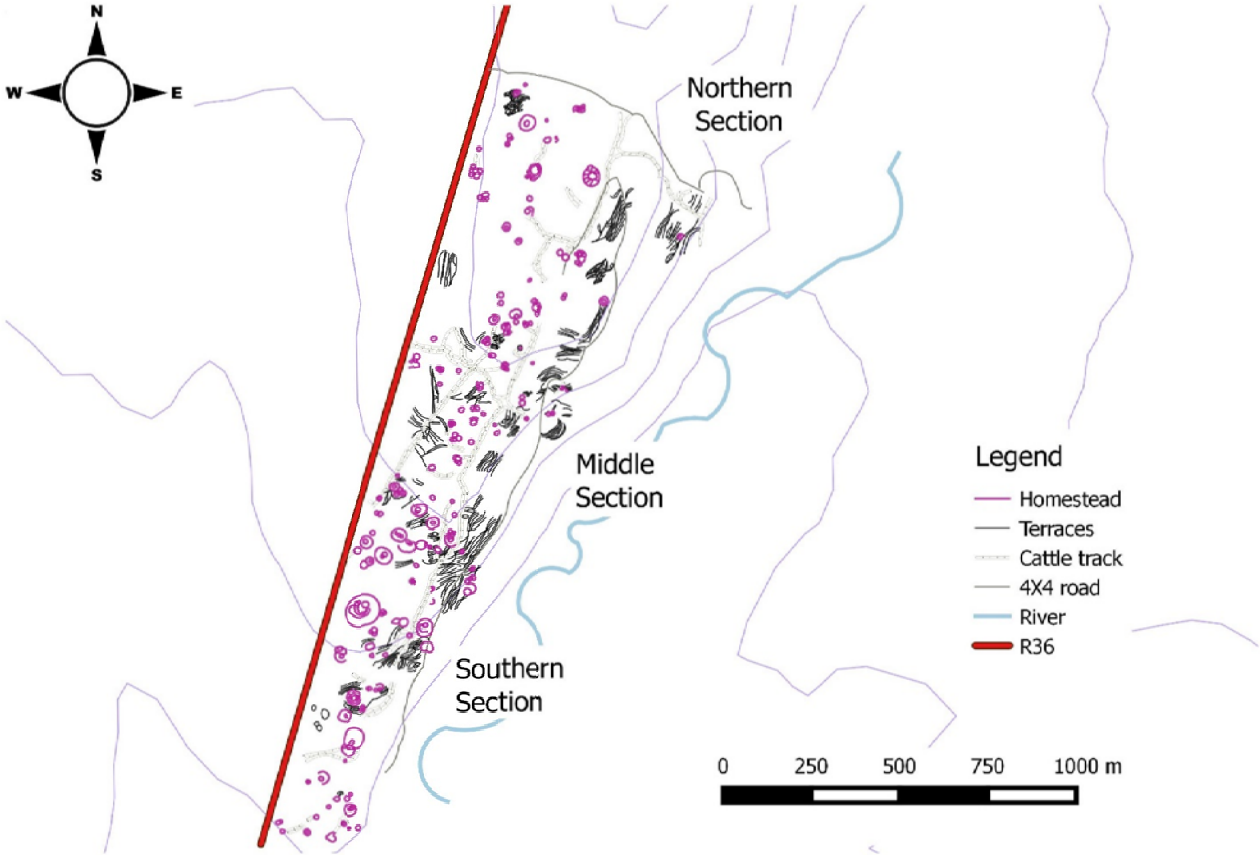


Figure 3. 4: Site map of Khutwaneng

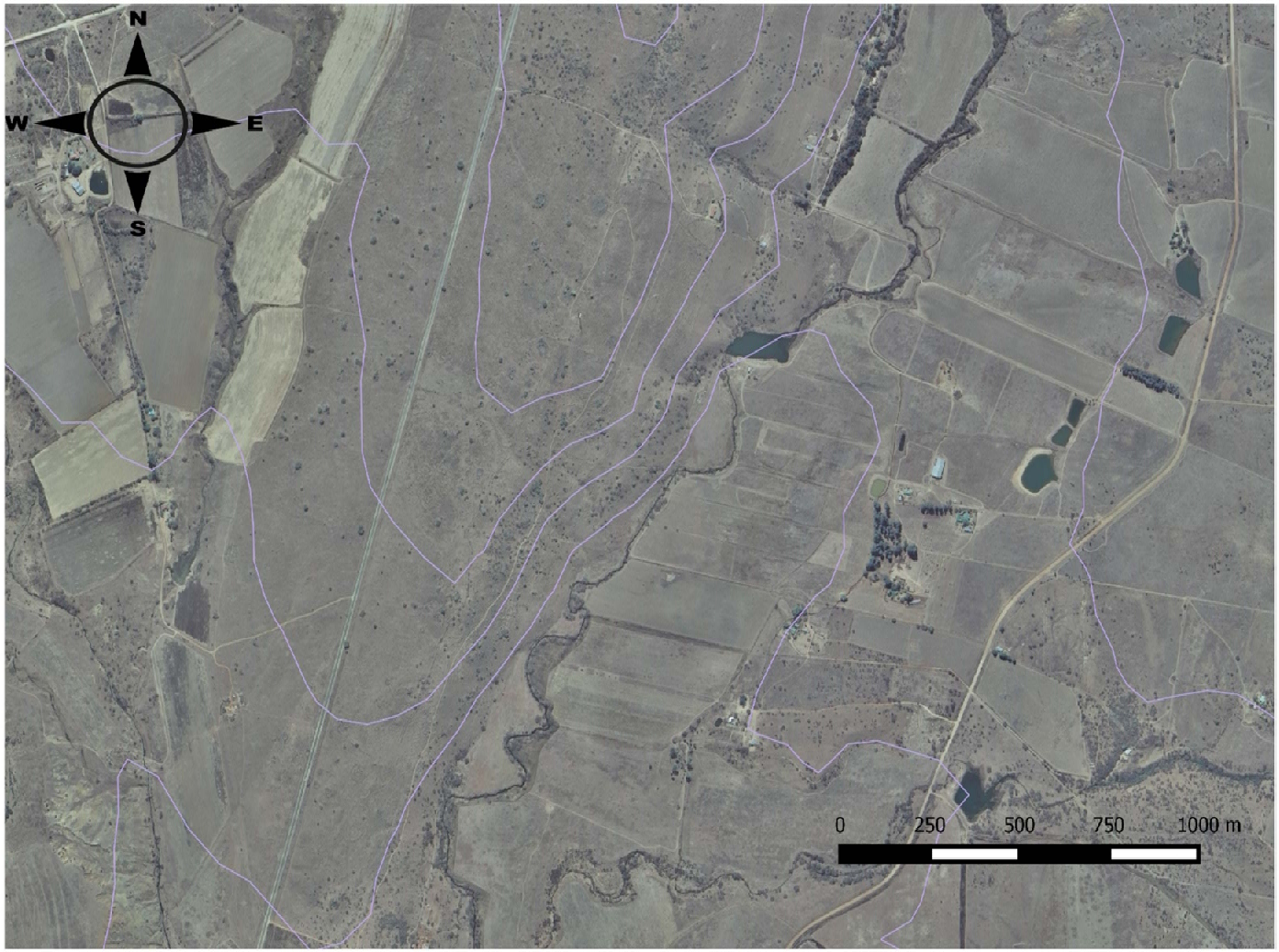


Figure 3. 5: Aerial image of Khutwaneng

Table 3.2: Sample locations, numbers, contexts and GPS co-ordinates for Khutwaneng				
Location	Sample #	Context	GPS co-ordinates	
			latitude	longitude
107	107, 108	Domestic	25°17'23.57"S	30°23'22.75"E
108	109	Central enclosure	25°17'24.15"S	30°23'22.97"E
109	110, 111	Domestic	25°17'24.53"S	30°23'22.98"E
110	112, 113	Terrace	25°17'25.47"S	30°23'23.13"E
111	114, 115	Terrace	25°17'24.90"S	30°23'23.10"E
112	116, 117	Terrace	25°17'22.94"S	30°23'22.66"E
113	118	Terrace	25°17'23.66"S	30°23'22.19"E
114	119, 120, 121	Non-Archaeological	25°17'22.03"S	30°23'26.37"E
115	122	Non-Archaeological	25°17'22.51"S	30°23'27.11"E
116	123, 124	Domestic	25°17'8.40"S	30°23'31.69"E
117	125	Central enclosure	25°17'8.26"S	30°23'31.40"E
118	126, 127	Domestic	25°17'8.41"S	30°23'30.85"E
119	128	Terrace	25°17'8.30"S	30°23'30.56"E
120	129	Terrace	25°17'7.72"S	30°23'30.07"E
121	130	Domestic	25°17'5.56"S	30°23'28.47"E
122	131, 132	Domestic	25°17'5.53"S	30°23'28.13"
123	133, 134	Central enclosure	25°17'5.17"S	30°23'28.11"E
124	135, 136	Terrace	25°17'6.16"S	30°23'28.13"E
125	137, 138	Terrace	25°17'6.00"S	30°23'29.31"E
126	139, 140	Central enclosure	25°16'43.95"S	30°23'47.16"E
127	141, 142, 143	Central enclosure	25°16'43.88"S	30°23'46.84"E
128	144, 145	Domestic	25°16'45.00"S	30°23'46.83"E
129	146	Terrace	25°16'45.45"S	30°23'47.88"E
130	147, 148	Terrace	25°16'45.38"S	30°23'48.87"E
131	149	Terrace	25°16'56.77"S	30°23'36.08"E
132	150, 151	Domestic	25°16'55.69"S	30°23'36.47"E
133	152, 153	Central enclosure	25°16'50.97"S	30°23'39.28"E
134	154, 155	Domestic	25°16'50.91"S	30°23'39.06"E
135	156, 157	Terrace	25°16'51.25"S	30°23'38.57"E
136	158, 159	Terrace	25°16'51.72"S	30°23'38.16"E
137	160, 161	Terrace	25°16'52.20"S	30°23'38.04"E
138	162, 163	Non-Archaeological	25°16'45.12"S	30°23'35.22"E
139	164, 165, 166	Non-Archaeological	25°17'12.90"S	30°23'25.61"E
140	167, 168	Non-Archaeological	25°16'38.16"S	30°23'42.17"E
141	169, 170	Central enclosure	25°16'28.83"S	30°23'40.55"E

Table 3.2: Sample locations, numbers, contexts and GPS co-ordinates for Khutwaneng				
Location	Sample #	Context	GPS co-ordinates	
			latitude	longitude
142	171, 172	Domestic	25°16'28.79"S	30°23'40.87"E
143	173, 174	Terrace	25°16'29.06"S	30°23'39.81"E
144	175	Terrace	25°16'30.18"S	30°23'40.12"E
145	176	Terrace	25°16'30.54"S	30°23'40.59"E

The main challenge with sampling this site was that there were very few areas that were not cultivated or built on by the Bokoni people. The site extends along a hill, where areas with steeper slopes were cultivated. Areas where there is little to no soil were not cultivated, which will be discussed later. The surrounding areas of Khutwaneng have been disturbed with modern day cultivation and, therefore, could not be sampled for control samples. As a result, the Khutwaneng data may be skewed slightly due to lack of control samples in the area.

3.1.3. Kranskloof

The final site, Kranskloof, is a Phase 3 site with components of Phase 4 evidence. Kranskloof is located on Kranskloof 523KT, along the Orighstadrivier (Fig. 1.1). Kranskloof is a very dynamic site and shows various different phases of occupation and social interactions. This is evident by the location of homesteads relative to the terraces, refuge sites on the fissure (Fig. 3.6), and reconfiguration of homesteads from the trademark round homesteads to square buildings. Initially the locations of samples were chosen according to homesteads and their associated terraces, using Google Earth. However, this proved difficult, because, there is a lot of tree cover over the site and homesteads were not as evident as on the other sites.



Figure 3. 6: Refuge site on Kranskloof.

The terraces on this site are extensive compared to the other sites. As a result, the samples were taken by sampling the bottom, middle and the top of terraces, then above and below the terraces where there seemed to be no evidence of archaeological activity. At locations where homesteads were located, samples were taken in the homesteads and around it. In some circumstances the inner circle of the homesteads could not be accessed due to excessive vegetation coverage. This site is also different from Doornkop and Khutwaneng in that the walls of the terraces were at times either badly preserved, or extremely high (Fig. 3.7). In some instances, the homestead walls were two metres high. Overall forty sampling locations were chosen where 44 samples were taken (Table 3.3).



Figure 3. 7: Picture of well preserved high homestead walls with excessive vegetation.

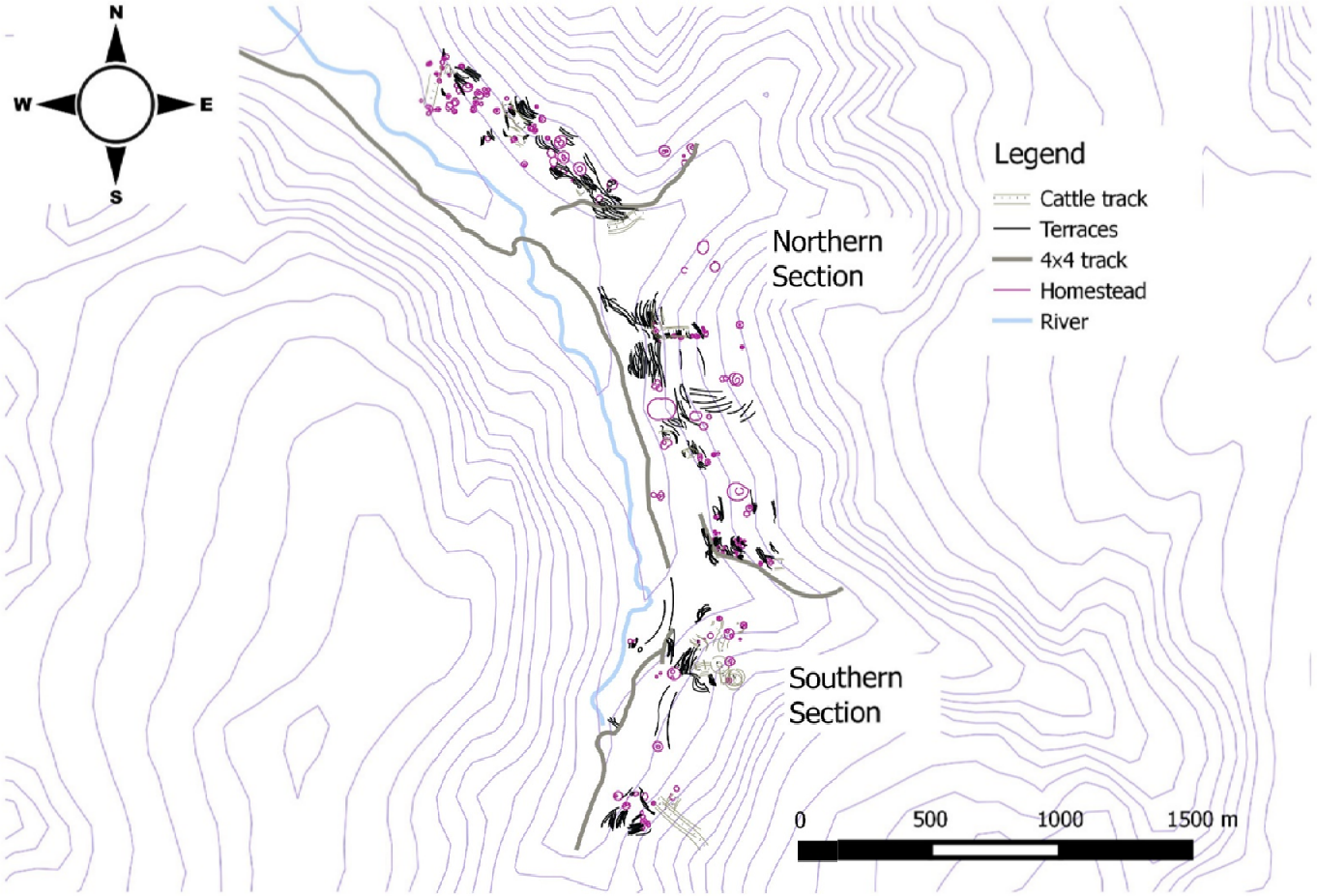


Figure 3. 8: Site map of Kranskloof.

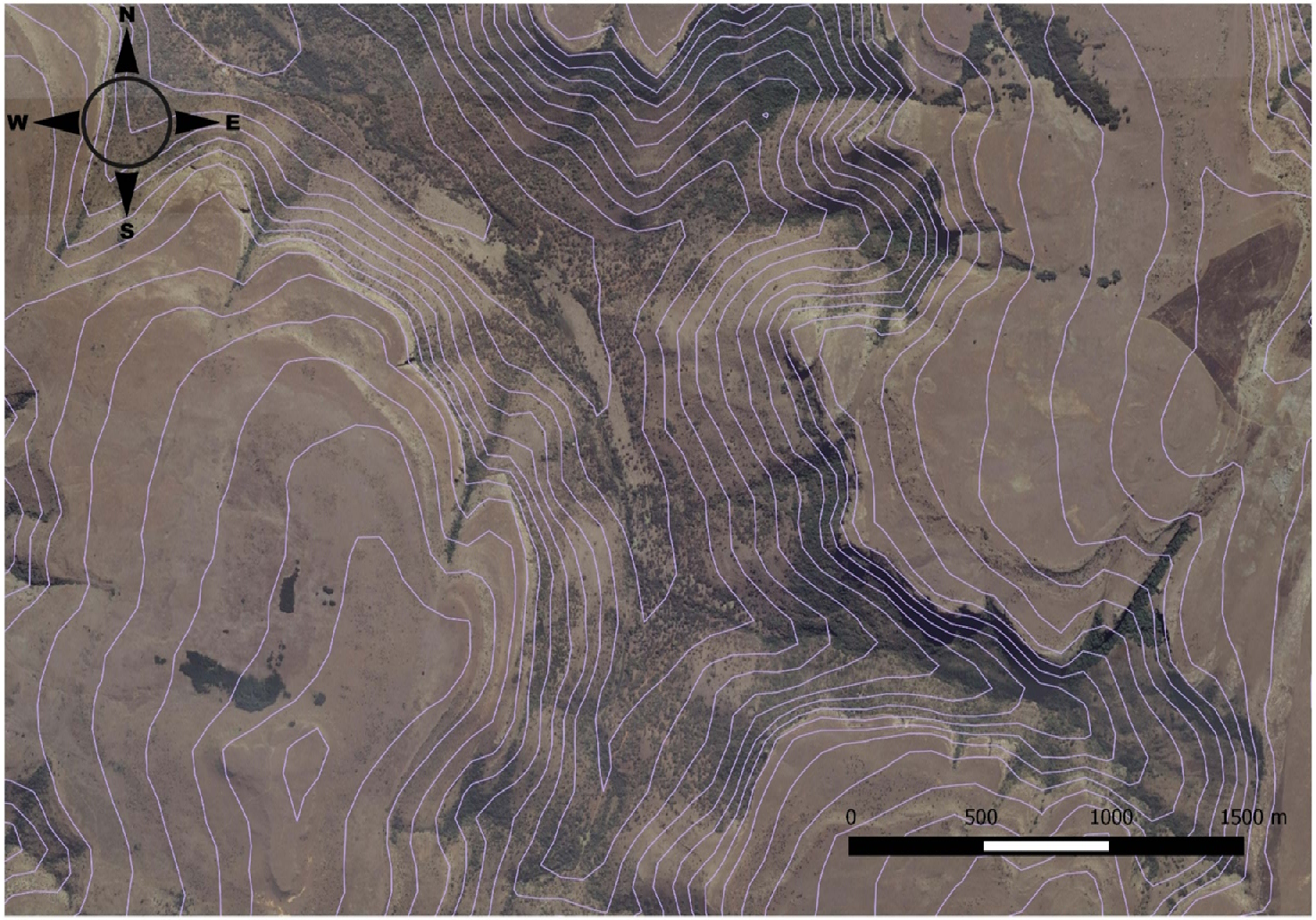


Figure 3. 9: Aerial image of Kranskloof.

Table 3.3: Table showing sample locations, numbers and GPS co-ordinates for Kranskloof				
Location	Sample #	Contexts	GPS co-ordinates	
			latitude	longitude
201	63, 64	Central enclosure	24°58'13.01"S	30°35'2.39"E
202	65	Domestic	24°58'11.02"S	30°35'0.93"E
203	66	Terrace	24°58'4.44"S	30°34'58.94"E
204	67, 68	Non-Archaeological	24°58'31.88"S	30°34'51.19"E
205	69	Terrace	24°58'30.22"S	30°34'47.60"E
206	70	Terrace	24°58'30.13"S	30°34'45.99"E
207	71	Non-Archaeological	24°58'30.03"S	30°34'44.79"E
208	72	Non-Archaeological	24°58'14.74"S	30°35'4.97"E
209	73	Terrace	24°58'13.25"S	30°35'0.09"E
210	74, 75	Non-Archaeological	24°58'11.86"S	30°34'58.22"E
211	76	Terrace	24°58'10.82"S	30°34'57.02"E
212	77	Terrace	24°58'10.87"S	30°34'55.47"E
213	78	Terrace	24°58'8.44"S	30°34'54.07"E
214	79	Non-Archaeological	24°58'6.72"S	30°34'48.69"E
215	80	Terrace	24°58'8.57"S	30°34'49.36"E
216	81	Terrace	24°57'14.42"S	30°34'44.87"E
217	82	Terrace	24°57'13.07"S	30°34'48.14"E
218	83	Non-Archaeological	24°57'9.27"S	30°34'51.32"E
219	84	Non-Archaeological	24°57'3.43"S	30°34'50.56"E
220	85	Non-Archaeological	24°57'7.73"S	30°34'44.95"E
221	86	Terrace	24°57'10.04"S	30°34'44.26"E
222	87	Non-Archaeological	24°57'4.59"S	30°34'40.59"E
223	88, 89	Terrace	24°57'5.60"S	30°34'41.62"E
224	90	Domestic	24°57'6.26"S	30°34'40.47"E
225	91	Domestic	24°57'7.61"S	30°34'40.32"E
226	92	Terrace	24°56'56.16"S	30°34'28.29"E
227	93	Terrace	24°56'57.18"S	30°34'29.27"E
228	94	Domestic	24°56'58.36"S	30°34'28.58"E
229	95	Central enclosure	24°56'58.34"S	30°34'28.47"E
230	96	Central enclosure	24°56'58.31"S	30°34'28.24"E
231	97	Domestic	24°56'58.60"S	30°34'27.31"E
232	98	Central enclosure	24°57'1.14"S	30°34'25.83"E
233	99	Terrace	24°57'34.02"S	30°34'49.53"E

Table 3.3: Table showing sample locations, numbers and GPS co-ordinates for Kranskloof				
Location	Sample #	Contexts	GPS co-ordinates	
			latitude	longitude
234	100	Terrace	24°57'34.19"S	30°34'50.10"E
235	101	Terrace	24°57'33.85"S	30°34'51.46"E
236	102	Terrace	24°57'34.57"S	30°34'53.36"E
237	103	Non-Archaeological	24°57'33.91"S	30°34'54.74"E
238	104	Terrace	24°57'26.89"S	30°34'53.75"E
239	105	Non-Archaeological	24°57'27.04"S	30°34'54.56"E
240	106	Terrace	24°57'27.89"S	30°34'50.69"E

3.2. Soil sampling and analysis

In the field, when each sample was taken, the colour, texture and depth of the soil, rock type and rock composition was noted, in order to ensure a more comprehensive study. The samples were taken when it was not raining, although, there was rain at both Doornkop and Kranskloof during period of sampling. After sampling all the samples were taken to a laboratory in order to conduct the chemical analysis of the soil.

The soils were analysed in the soils laboratory, in the Agricultural Sciences department, at the University of Pretoria. In order to better understand the soil chemistry, the type of micronutrients in the soil were analysed. This also helped to establish if there were fundamental changes to the soil with regards to context, and to establish if there were differences between the sites. A total of 176 soil samples were collected overall from all three sites.

This study was modelled on the research done by Chadwick et al. (2006) and Kirch et al. (2004) in the Polynesian islands. These studies focus on the chemical analyses of agricultural based archaeological sites. This guided what was tested for. My analysis focussed on: extractable inorganic Nitrogen, organic Carbon

percentage (% C), pH, cation exchange capacity (CEC), extractable inorganic phosphorous, and extractable cations. In addition, I conducted particle size analysis. The techniques used are standard components in the methods used in the University of Pretoria Agricultural Sciences soil laboratory that these analyses were conducted.

3.2.1. Soil preparation

The soil was prepared before the chemical analysis could take place. This was done by first drying out the soil allowing for 0% moisture, because moisture in the samples could affect the analysis. Drying was done by laying out the soils in a room with heaters for the duration of two to three days. Once the soil had dried out it was ground with a porcelain mortar and pestle to crush clumps. The limitations of using a mortar and pestle is that it is possible to crush small rocks to the same size of the soil particles and may affect the results, thus this must be done carefully and with precision.

Next the samples were sieved through a 2 mm sieve until a sample of approximately 500 g was obtained. A 2 mm sieve was used to get rid of rock, because, this is the size measurement of a particle considered as soil according to the USDA Soil Taxonomy system. This was found to be a painstakingly slow task, because many of the samples had a large amount of rocks and some 4 kg samples only produced ± 200 g of soil. Sample 8, in the non-archaeological area of Doornkop, is an example of one of these soil samples.

Once the soil had been prepared, it was placed into new sample bags and relabelled with numbers from 1-176, in order to make the lab work easier.

3.2.2. Extractable Inorganic Nitrogen

According to the SSSA (1977) extractable inorganic Nitrogen is defined as Ammonium (NH_4^+), Nitrate (NO_3^-) and Nitrite (NO_2^-) in soil. These are extracted by using a 1.0 mol dm^{-3} KCl solution at room temperature (SSSA 1977). Extractable inorganic Nitrogen informs on the availability of Ammonium and Nitrate in the soil, but does not necessarily pertain to what one would have found when the soils were cultivated. This relates to the fact that Nitrogen readily leaches out of the soil. This, however, still indicates the interactions of nitrogen in the soil and may determine how the homesteads and terraces affect contemporary soils. In order to identify nitrogen levels, and possible fertilization at the time of occupation other analyses would have to take place, such as the study of carbonized seeds, discussed in Chapter 2.

NO_2^- is often found in minimal amounts in soil and only NH_4^+ and NO_3^- were tested for. NH_4^+ and NO_3^- were simultaneously tested by creating a solution, which is placed in equilibrium and then extracted through distillation using steam (AGRILASA, 2004). This method separates NO_3^- from NH_4^+ through volatilisation (evaporation) in a low alkaline solution. The nitrate and nitrite is further reduced into NH_4^+ by using Devarda Alloy (Keeney and Nelson, 1982).

3.2.2.1. Process

Ten grams of soil was weighed into a 100 ml glass bottle container using a Mettler Toledo scale. Fifty millilitres of 1.0 dm^{-3} KCl was then added. The lid was placed on the glass bottle and then placed in a shaker set at 200 oscillations per minute for 30 min. The samples were then filtered into 50ml containers through Whatmann number 2 filter paper in order to ensure a clear solution. As it is possible for there to be traces of NH_4^+ and NO_3^- in the KCl solution, and in the

filter paper, blank control samples were also taken in order to account for this (AGRILASA 2004).

Boric acid indicator solution was used in order to determine the amounts of both NH_4^+ and NO_3^- present in the samples. Ten millilitres of boric acid indicator solution was placed into a 100 ml Erlenmeyer flask marked with volumes of 25 ml and 50 ml. The same was done to a second Erlenmeyer flask. These were labelled as 'A' and 'B', where 'A' indicates NH_4^+ and 'B' indicates NO_3^-. Flask 'A' was placed on exit of the condenser of a steam distillation apparatus. Twenty-five millilitres of KCl soil extract was placed in a distillation flask by using a pipette, and 0.2 g (1 teaspoon) of heavy MgO was added. This was immediately placed in the steam generator, and then distilled.

This liquid was distilled into the Erlenmeyer flask to a volume of 50 ml. The flask was then removed and the flask marked 'B' was placed on the exit of the condenser. The distillation flask was removed and 0.2 g of Devardo alloy was added to it. The flask was then placed back into the distillation machine and distilled to a volume of 50 ml. The initial colour of the Boric acid indicator was a deep purple. Once the samples were distilled into the Erlenmeyer flask the solution changed to a green colour. This solution was then titrated with 0.0025 M of H_2SO_4. The solution changed from green to a permanent purple/pink colour (AGRILASA 2004).

Once the solution was titrated, the amount of H_2SO_4 was noted. As mentioned earlier flask 'A' determines the amount of NH_4^+ - N (where the amount of NH_4 makes up the nitrogen in the soil) and the NO_3^- - N (amount of NO_3^- makes up the Nitrogen in the soil) in flask 'B'. These are then calculated as:

where a titre of 1 cm^3 0.0025 mol dm^{-3} H_2SO_4 = 35µ N, and 10 g of soil was extracted with

$$\mu g\ g^{-1}\ N\ in\ soil\ = \frac{Volume\ H_2SO_4(cm^3) \times 35 \times 50}{Volume\ of\ extract\ distilled\ (cm^3) \times 10}$$

This formula applies to both NH_4^+ - N and NO_3^- -N (AGRILASA 2004).

3.2.3. Organic carbon

The Walkey – Black method of determining the percentage of organic Carbon in the soil is based on Schollenberegers (1927) proposition, that soil can be oxidised through using a hot mixture of Potassium dichromate ($K_2Cr_2O_7$) and Sulphuric acid (SO_4) (AGRILASA 2004: 97).

Once the dichromate has been reduced, it could then be titrated using iron (II) ammonium sulphate ($Fe(NH_4)_2(SO_4)_2$) (AGRILASA 2004). It is thought that the reduced dichromate is the equivalent of Carbon in the soil sample, assuming that the average valence of the organic matter is zero (AGRILASA 2004).

It would be expected that the %C would be relatively high in the homesteads and the terraces, as these areas has increased vegetation. This may be due to the walls protecting the plants from wild fires. This would show higher fertility in these areas.

3.2.3.1. Process

A Mettler scale was used in order to measure 1 g of soil into a 500 ml Erlenmeyer flask. These measurements were noted allowing for a factor of 0.02 g error,

because it is very difficult to get 1 g exactly. Ten millilitres of $K_2Cr_2O_7$ was then added to the soil and swirled in order to ensure that the soil was evenly dispersed in the solution. Twenty millilitres of concentrated SO_4 then was added to the flask. The solution was then swirled in order to disperse the solution at the bottom of the flask.

Once the solution had been left to cool down for 30 min, 150 ml of de-ionised water (H_2O) was added to the flask. Afterwards 10 ml of concentrated ortho-phosphoric acid (H_2PO_4) was added to the flask. 1 ml of %C indicator solution (Barium diphenylamine sulphonate $((C_{12}H_{10}NO_3S)_2Ba)$ was added to the flask. The solution then turned into a brown/orange colour. The reduced dichromate was then titrated with $Fe(NH_4)_2(SO_4)_2$, from a brown/orange colour to a sharp green. The volume of the $Fe(NH_4)_2(SO_4)_2$ was then noted. Three blank samples were done in order to ensure reliable results. The averages of these samples were used in the following formulas in order to calculate the % Carbon:

$$Concentration\ of\ Fe(NH4)2(SO4)2\ mol\ dm^{-3} = \frac{10\ cm^3\ K2Cr2O7 \times 0.167 \times 6}{cm^3\ Fe(NH_4)_2(SO_4)_2}$$

$$Organic\ C\% = \frac{[cm^3\ Fe(NH_4)_2(SO_4)_2\ of\ blank - cm^3\ Fe(NH_4)_2(SO_4)_2\ sample \times M \times 0.3 \times f]}{soil\ mass\ (g)}$$

Where: M = Concentration of $Fe(NH_4)_2(SO_4)_2$ in mol dm^{-3}

f = a recovery factor of 1.3

3.2.4. pH

The pH of the soil was determined by using water (H_2O), at a ratio of 1:2.5 soil to water respectively (AGRILASA 2004). Due to the soils being mostly derived from dolerites, it would be expected that the pH of the soils would be more acidic. The pH is by definition an indication of H+ ion activity on a negative logarithmic scale:

$$pH = -log_{10}(aH^+)$$

3.2.4.1. Process

Ten grams of soil was measured into a 50 ml centrifuge tube with a conical bottom. Twenty-five millilitres of de-ionised water was added to the test tube. The tube was then shaken for 1 min to disperse the soil through the water. The sample was then left to rest for 30 min. Once the soil had been prepared the pH meter was calibrated. This was done by calibrating the meter in buffering solutions of 4.0 and 7.0.

The rod of the pH meter was kept in a KCl solution until used. The rod was then rinsed with H_2O and dried with tissue paper. The rod was placed in the 7.0 buffering solution and calibrated. The rod was then cleaned and dried again, and placed in the buffer solution of 4.0 to complete the calibration. Once this was done the rod was rinsed again then placed into the test tube containing the soil. The rod was left in the solution for approximately 5 min and once the reading stabilised on a figure, the measurement was noted.

3.2.5. Cation exchange capacity (CEC)

3.2.5.1. Process

Step A:

Five grams of soil was measured into a 50 ml centrifuge tube with a conical bottle. The lid was placed on the tube and the mass of the tube, lid and soil was noted. Twenty-five millilitres of 1 M of ammonium acetate (NH_4OAc) was added to the tube, and then closed. The tube was then placed in a horizontal shaker set at 200 oscillations per minute for 60 min, after which it was left to stand overnight.

Step B:

After the sample was left overnight, it was placed into a centrifuge for 10 min at 2500 rotations per minute (RPM). This was done in order to ensure a clear supernatant solution. The solution was then decanted with care so that no soil was lost. The decanted solution was then thrown away. Twenty-five millilitres of 1 M of NH_4OAc was added again into the test tube. The tube was shaken by hand in order to ensure that all the soil was properly dispersed. The sample was then placed again into the shaker for 60 min, and then placed in a centrifuge for 10 min. This solution was then, again, carefully decanted and thrown away.

In other circumstances the solution that is decanted can be used in order to determine the exchangeable cations. In this instance it was not done like this as there were many soil samples and only a maximum of 64 soil samples done at a time although majority of the samples were done in batches of 32 due to daily time constraints.

Step C:

Twenty-five millilitres of 0.1 mol dm^{-3} NH_4OAc was added to the test tube. The soil was then hand shaken again to disperse the soil, then placed in the shaker and the centrifuge as before. The supernatant solution was then decanted into a 100 ml glass storage container, and stored until later.

Step D:

The soil sample was weighed a second time with the lid on the Mettler scale, and the mass was noted. Twenty-five millilitres of 1 M KCl solution was then added to the test tube. The tube was then hand shaken to disperse the soil and then placed in the shaker and centrifuge as before. The supernatant solution was then carefully decanted into a 100 ml volumetric flask. Twenty-five millilitres of 1 M KCl was then added, again, to the test tube and all previous steps were followed. Once the tube had been centrifuged the supernatant fluid was decanted into the 100 ml volumetric flask. The volumetric flask was then filled up to 100 ml with 1 M KCl.

Step E:

Once the NH_4OAc and KCl solutions had been prepared, they were distilled similarly to the extractable inorganic Nitrogen. Two 100 ml Erlenmeyer flasks marked ‘A’ and ‘B’. Where flask ‘A’ was used as the determinant for the ammonium acetate solution and flask ‘B’ for the KCl solution. Ten millilitres of boric acid indicator solution was added into the Erlenmeyer flasks. Flask ‘A’ was placed under the exit of the condenser of the steam distiller. Five millilitres of the 0.1 M NH_4OAc prepared solution was added to a distillation flask by using a pipette and then topped up with 15 ml of distilled water to 20 ml. One teaspoon (2.5 ml) of heavy MgO was added to the distillation flask. This was then

connected to the steam generator and distilled to 50 ml in the Erlenmeyer flask. A blank sample was also done in order to ensure accurate results. This process was repeated with the KCl solution. Except 10 ml of KCl prepared solution was added to the distillation flask and topped up with 10 ml of de-ionised water to 20 ml and then distilled.

Step F:

The solutions in flask 'A' and flask 'B' were then titrated with a 0.05 M of H_2SO_4. The solutions were titrated from a green colour to a permanent pink/purple colour. These volumes were noted and the CEC was calculated using the following formula:

$$CEC = (T_1 \times 20) - (X_2 - X_1) \times 0.2 \times T_2\ cmol(+)kg - 1$$

Where: T1 = titration value for KCl solution

T2 = titration value for NH_4OAc solution

X1 = mass of tube plus soil (g)

X2 = mass of tube plus occluded solution (g)

3.2.6. Extractable Phosphorous

Extractable phosphorous determined by using Bray-1 solution is an extremely important method for assessing cultivated soils (AGRILASA 2004: 50). This is due to the Bray-1 solution extracting the more soluble inorganic Phosphorous. As phosphorus is also an indication of fertility of the soil, by means of manuring and

liming, and the nature in which it readily leaches out of the soil, it is expected that P will be lower in the different areas.

3.2.6.1. Process

The soil was weighed at four grams into a 50 ml centrifuge tube with a conical bottom. A Mettler scale was used at an accuracy of ± 0.2 g. Fifteen millilitre plastic test tubes were prepared with a funnel placed in the test tube. Whatmann no. 2V filter paper was folded and placed into the funnel. Thirty millilitres of Bray - 1 (0.03 M NH_4F in 0.025 M HCl) was added to the test tube. The solution and soil mass was at a ratio of soil/extractant at 1:7.5 (AGRILASA 2004: 52). This is to ensure that there was a thorough extraction of P. The test tube was then closed and shook by hand for 60 seconds. A couple of drops (± 1 ml) of super flock was added to the sample. This ensures the highest amount of extraction of inorganic P. Once the solution was prepared the suspension solution was then filtered into the 15 ml plastic test tube. This was then given to the lab technician to further determine the inorganic Phosphorous.

The determination of the sample was placed in a continuous flow analyser. The readings of the spectrophotometer were then read against a calibration curve to determine the concentration of the phosphorous. This was then placed in the following equation:

$$mg\ dm^{-3}\ P\ in\ soil = \frac{q \times 25}{n}$$

Where: q = the concentration of P read from the calibration curve

n = the mass of the soil

3.2.7. Extractable cations

Extractable cations using ammonium acetate determines the nutrient status of soil (AGRILASA 2004). These include Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Potassium (K^{+}) and Sodium (Na^{+}) cations. Extraction of the phosphorous may be skewed, because the drier the samples are the higher the extractable Phosphorous (AGRILASA 2004). The rate of extraction of these cations is also a function of temperature, therefore extraction should be done around 20 ^{o}C.

3.2.7.1. Process

Five grams of soil with a standard error of 2 mg was measured by using a Mettler Toredo scale into a 50 ml centrifuge tube with a conical bottom. 50 cm^3 of Ammonium Acetate (NH_4OAc) solution was added to the tube and then placed in a horizontal reciprocator shaker at 200 oscillations per minute for 30 min. During this time 15 ml plastic tubes are set up with filters and Whatmann Nr 2 filter paper as discussed previously. The solution was then filtered into the 15ml tubes and the clear superlatant solution was then sent to the lab technician and analysed using an atomic absorption spectroscopy to determine the concentration of the cations. The extractable cations were then determined by the following equation:

$$Ammonium\ acetate\ extractable\ cations = \frac{a \times\ 50\ cm^3}{5\ g} mg\ kg^{-1}$$

Where: a = mg dm^{-3} of Ca, Mg, Na and K in extract

50 = cm^3 of NH_4OAc

5 = mass of soil measured

3.2.8. Particle size distribution

The particle size distribution is measures the sand, silt and clay content in weight percentage. Higher sand content allows for better drainage of the soils, and lower organic content in the soils. Higher clay content retains soil moisture, and also gives an indication of higher organic content of the soil. As the soil is mostly derived from shale and dolerite, it will be expected that the soils will have a higher clay content.

3.2.8.1. Process

Step 1

In order to separate the soil particles, a 250 ml beaker was weighed using a Mettler Toledo scale and the mass was noted. Fifty grams of soil was then measured into the beaker. Ten millilitres of Calgon dispersing solution was added to the beaker and then deionised water was added to easily transfer the mixture into a metal dispersion cup. More water was added to the dispersion cup in order to ensure that the solution mixes well. The cup was then placed in a milkshake mixer and timed for 5 min.

Step 2

Once the mixture had been mixed, the solution was filtered through a 0.053 mm sieve into a 2 L plastic cylinder. The solution was washed into the filter using deionised water. It was essential that all the sediments were washed out of the dispersion cup to ensure accurate results. The soil was continuously washed until the water that was filtering through sieve was clear, meaning that there was no more silt or cay in the filter. The soil that was left in the filter represented the sand

in the sample and was washed into the same 50 ml beaker, ensuring all the sediments are washed through.

The cylinder was then filled up to the 2 L mark and then mixed using a plunger in order to suspend the silt and clay. A blank sample (only deionised water) was also done in order to account for the buoyancy of the water. The cylinder was covered using a watch glass in a room set at a constant temperature of 28 ^{o}C, as temperature is a function of buoyancy. A timer was set for 6.5 hours. The beaker with the sand particles was placed in an oven at 105 ^{o}C overnight, to dry out the sample.

Step 3.a.

Once the 6.5 hour had lapsed a hydrometer was placed carefully into the cylinder in order to not disturb the solution. The clay buoyancy reading was taken from the hydrometer. In order to ensure accurate results, the time that was taken to mix the samples was noted and done in order (from 1 – 28) and the hydrometer readings were taken in the same amount of time as the mixing of approximately 20 min. The room temperature was also noted. Once these readings were taken, the cylinder was then mixed again using the plunger and then left to rest for 45 sec. The hydrometer was placed into the cylinder approximately 30 seconds after the suspended solution had been mixed, so that it stabilised as soon as 45 seconds had lapsed and a reading was taken immediately. This was the clay + silt reading. It must be noted that each time the plunger and the hydrometer was taken out of the cylinder it was washed properly before being placed in the next cylinder in order to ensure that there was no contamination between the samples.

Step 3.b.

Once the beaker containing the sand had been dried out, it was cooled for 30 min then weighed using the Mettler Toledo scale. The time between cooling and the weighing of the beaker should not be more than 2 hours as the sand starts to retain moister from the air. The mass of the beaker + sand was then weighed and the mass was noted. Afterwards the mass of the beaker was subtracted from the second reading to get the mass of the sand.

Step 4

Once all the readings had been taken the different percentages of the distribution of the particles was measured and worked out as a percentage as follows:

1. $Sand\ \% = \big(mass\ of\ beaker\ and\ sand\ (g) - mass\ of\ beaker\ (g)\big) \times 2$

2. $Clay\ \% = 2(a - b) + 4$

   Where: a = the clay reading (6.5 hour reading)

   b = the blank reading

3. $Silt\ \% = 2\big((c - b) - d\big) + 4$

   Where: c = Silt +clay reading (45 s reading)

   $d = a - b$

3.2.8.2.Limitations

There were quite a few limitations to these processes, because it was difficult to maintain the perfect amount of time between the readings. As a result, the percentages are not as always accurate since the percentages did not always add up to 100%. This outcome might also be the result of not removing the organic matter by burning. It was also sometimes difficult to get all the silt and clay to filter through 2 L of water. The temperature of the room was also not always held constant, because whilst I was busy doing my tests temperatures rose to over 32 ^{o}C, which would have a profound effect on the results. As a result, it was necessary to find a solution to correct for temperature discrepancies.

Time also played a factor because it would take approximately 4-5 hours to prepare the samples into the cylinder and then again for the time lapse for measurement of these soil samples. The data, therefore, is not 100% reliable but is included in this dissertation, because it still gives a general indication of what types of soils were present. A better method could have been used such as a Mastersizer.

3.3. Conclusion

Once the samples were analysed, and the results were obtained, interpretation of the results need to happen. In order to do this the samples are compared relative to one another. This will assist in how the different layers differ to one another, and between the different contexts. This is discussed in the following chapter.

CHAPTER 4: RESULTS

This chapter reports on the results of my analysis of Bokoni soils. Results are presented per site, and discussed in terms of the four main use areas: domestic areas of the homesteads, central enclosures, terraces, and non-archaeological zones. The physical context, geology, chemical components of the soil, and geomorphology, such as soil characteristics, are discussed. The descriptions will focus on the most significant results per sample.

4.1. Doornkop

4.1.1. Domestic areas

Six samples were taken from the middle section in the domestic areas of the homesteads. Sample locations were numbered consecutively (e.g. GPS 001, GPS 002, etc.) and were mapped. The domestic areas are located around the central stonewalled enclosure clusters, and often are separated from the surrounding areas with a stone wall (Fig. 4.1, 4.2 and 4.3).

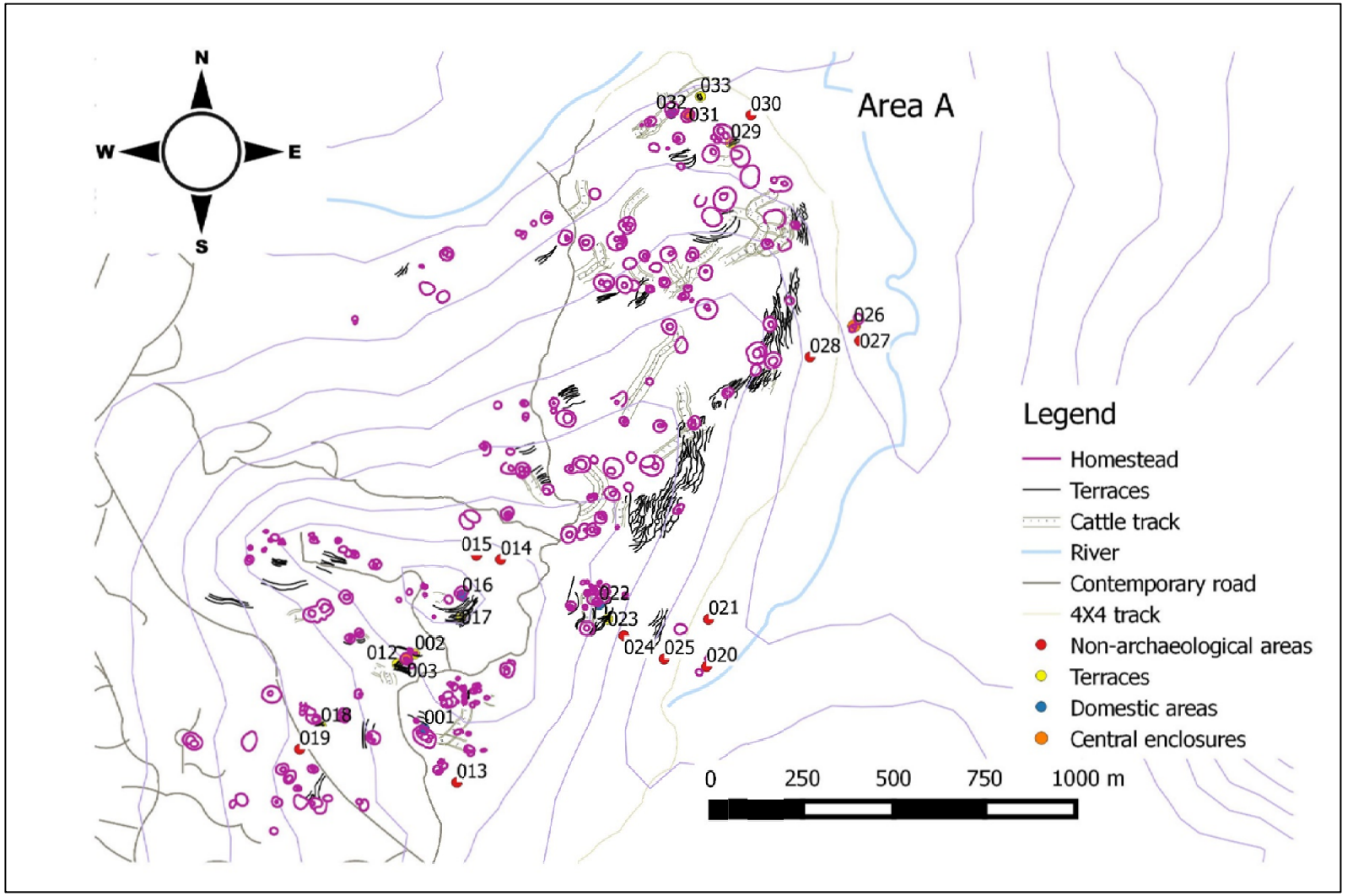


Figure 4. 1: Sampling locations of Area A in Doornkop

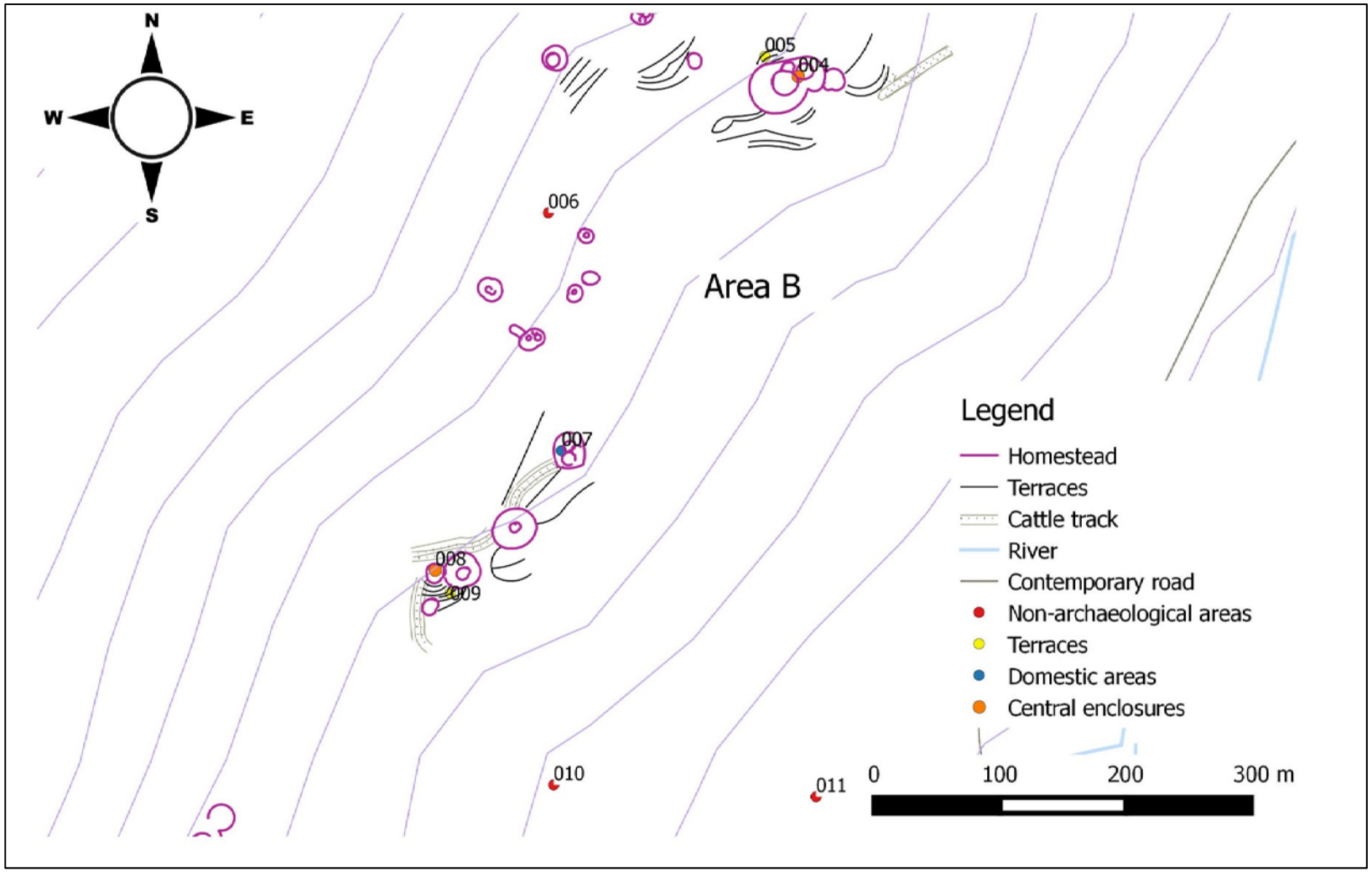


Figure 4. 2: Sampling locations of Area B in Doornkop

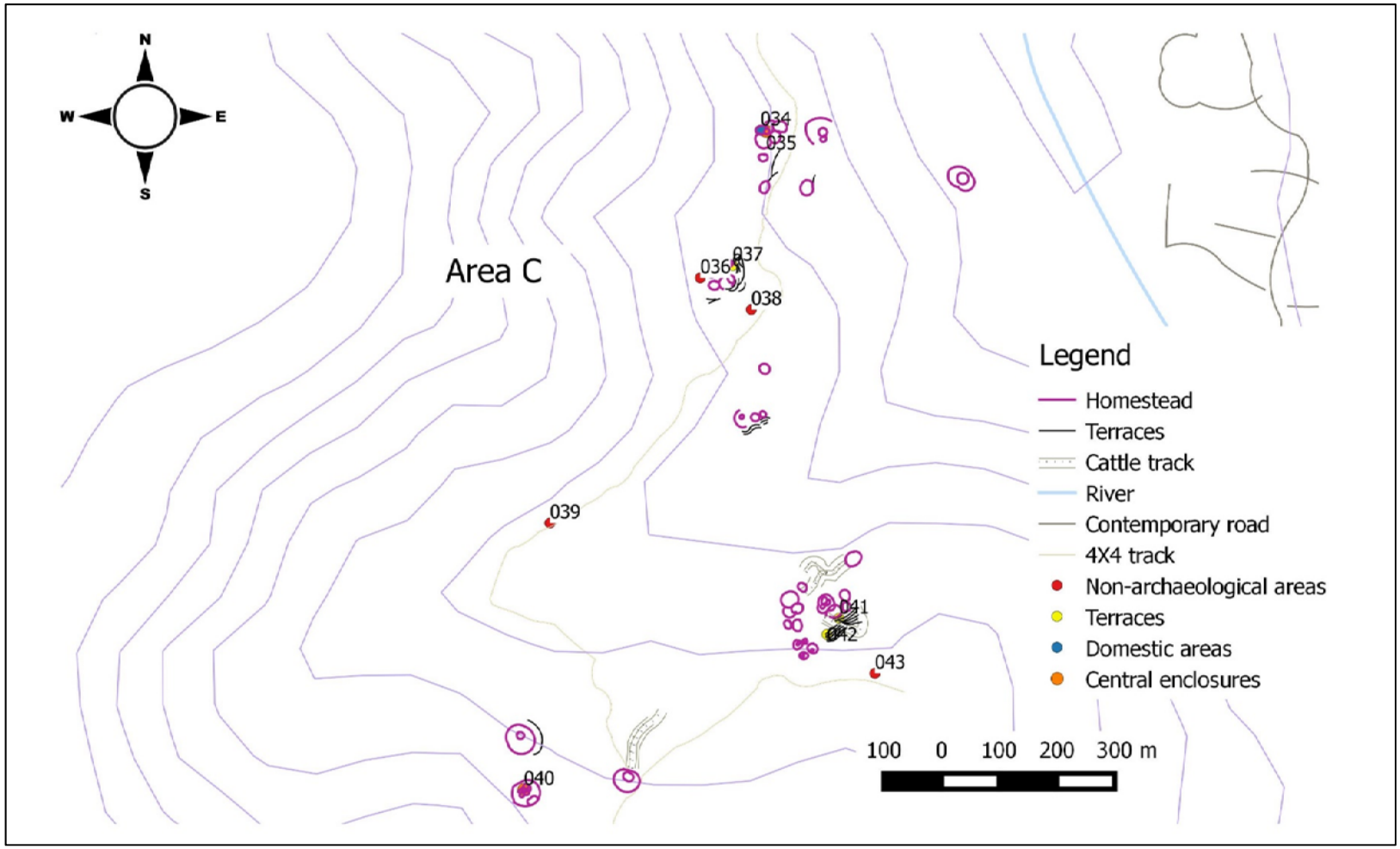


Figure 4. 3: Sampling locations of area C in Doornkop

Location 001

The homestead, in which this sampling site is located, is on the southern section of area A. The homestead has an approximate diameter of 38.77 m and has a lobed inner circle. The southern walls are degraded, and have a contemporary foot path intersecting the homestead. There are terraces at the northern end of this homestead. These may be associated with this homestead. The sample was taken in the north eastern side of the homestead in the outer circle (Fig. 4.1).

Location 001 only consisted of one layer (H1). The exposed modern layer (H0) was dark brown in colour, and was removed at a depth of 0-4 cm. Lab number 1 (H1 of 001) is reddish brown in colour, and was sampled at a depth of 4-19 cm. The soil had a loose texture, but is slightly clay rich (36%). This sample consisted of approximately 70% of rocks which average 10 cm in length. The rocks in this soil layer were mostly degraded dolerite.

Sample 1 has the lowest concentrations of K, 257.69 mg kg^{-1}, 955.26 mg kg^{-1}, and Na, 3.47 mg kg^{-1}, when compared to the rest of the domestic areas. This sample also has a low concentration of NH_4, 0.94 mg kg^{-1}, and the lowest concentration of NO_3, 0.91 mg kg^{-1}, in this sample set. The %C is high at 3.1%. This is also the most acidic sample with a pH of 5.35 (Table 4.1).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
1	001	5.36925	257.691	955.2633	3.474	602.70267	3.100400717	0.945	0.91	45.2222	34.82	36	28	5.35
9	007	2.6085	640.091	2875.963	14.182	1533.1027	2.037484407	0.945	0.91	26.38506	32.5	42	26	6.58
27	016	2.08575	818.591	2248.963	6.82	865.20267	3.160373834	0.875	1.05	45.897032	23.8	44	36	6.47
35	022	2.118	268.291	2201.963	9.962	727.10267	1.896462761	3.22	4.445	31.83984	35.98	50	38	6.56
47	032	2.256	605.391	1734.963	5.695	560.20267	1.866363853	2.59	4.55	34.35932	37.78	24	56	6.36
53	034	5.63325	609.791	1101.963	4.477	507.90267	2.321181074	17.745	14.77	23.62655	34.76	56	0	6.31

Table 4. 1: Chemical signatures of soils in the domestic areas of Doornkop.

Location 007

The homestead, from which this sample was obtained, is located near the ridge associated with area B. Two other homesteads are associated with this homestead. A road runs above these homesteads, linking them. The homestead is approximately 25.78 m in diameter, and comprises a main outer circle, and two smaller inner circles. Terraces run between the two different homesteads and continue further down the hill. The sample was taken in the outer circle, in the western side of the homestead (Fig. 4.2).

Location 007 consisted of one layer (H1). The exposed layer that overlay this layer (H0) was removed from 0-5 cm in depth. Sample 9 (H1 of 007) was dark brown in colour and was sampled at a depth of 5-19 cm. This sample was clay rich (42%) and consists of approximately 1% of rocks.

Sample 9 has the highest concentrations of Ca, 2876.0 mg kg^{-1}, Na, 14.2 mg kg^{-1}, and Mg, 1533.1 mg kg^{-1}, compared to the samples in the domestic areas. The NO_3 concentration for the sample, along with sample 1, is the lowest in this sample set at 0.91 mg kg^{-1}, and has a low concentration of NH_4, 0.94 mg kg^{-1} (Table 4.1).

Location 016

The homestead, at location 016, is near the top of area A. The homestead is approximately 31.31 m in diameter and has a cluster of four inner circles. It has dense vegetation in it. Terraces run down below this homestead. A large homestead is located south west of this homestead, with several smaller homesteads, where the walls seem to have been reused. This homestead also has dense vegetation. The sample was taken in the domestic area on the south eastern side of the central enclosure (Fig. 4.1).

The location 016 sample consisted of two layers (H1 and H2). The H0 layer was removed at a depth of 0-5 cm, and discarded. H1 and H2 were taken as a bulk sample (sample 27), because there was too little soil in each layer to analyse successfully. The soil layers were thin, and has a high concentration of rocks. H1 was sampled at a depth of 5-8 cm, and is dark brown and clay rich (44%) with a loose texture. The soil consisted of approximately 80% of rocks. H2 was sampled at a depth of 8-27 cm, and is reddish brown in colour. The soil has a loose texture and is not very clay rich. This layer has the lowest sand content of 24% compared to the rest of the sample set. This sample was composed of 80% of rocks averaging 20 cm in length.

Sample 27 has the lowest concentrations of P, 2.09 mg kg^{-1}, and NO_3, 1.05 mg kg^{-1}, compared to the rest of the samples in the domestic areas of Doornkop. This sample has the highest concentration of K, 818.59 mg kg^{-1}, and the lowest concentration of NH_4, 0.87 mg kg^{-1}. The %C and the CEC is the highest, compared to the rest this sample set, with values of 3.16% and 45.89 cmol kg^{-1} respectively (Table 4.1).

Location 022

The homestead, in which this sample was taken, is on the south eastern end of the hill, on a plateau on the lower section of the hill in Area A. The homestead is approximately 49.57 m in diameter and has a cluster of three inner circles. There are three homesteads in this area, one further up the hill, and one south from the location 022 homestead. The terraces run down between the three homesteads, and terraces are attached to the northern side of the homestead. A road that runs between the terraces links the homesteads. The vegetation grows on the outline of the outer circle and in the homestead. The sample was taken in the south eastern end of the homestead (Fig 3.1; Fig. 4.1).

Location 022 consisted of 1 layer (H1). H0 was removed at a depth of 0-3 cm. H1 (sample 35) was sampled at depth of 3-22 cm and is dark greyish brown in colour. The sample was slightly clay rich with a loose texture. Fine grass roots, in this area, penetrated all the way to the bottom of this layer until rock was hit.

Sample 35 concentrations for P, 2.09 mg kg^{-1}, K, 268.2 mg kg^{-1}, and Mg, 727.10 mg kg^{-1} are relatively low. The pH of this sample is the least acidic in this sample set, at 6.56 (Table 4.1).

Location 032

The homestead, in which this sample site is located, is on the northern end of the hill of area A, on the bottom of the slope. The gradient of the hill in this section is relatively low. The homestead is approximately 41.42 m in diameter and has four inner circles. A few homesteads are in this area, one being 8.97 m away (location 31). No terraces are directly associated with this homestead. A road runs from the north eastern side of the homestead until it reaches the homestead. The road continues from the south western end of the homestead up the hill. The southern end of the outer circle, in the homestead, was sampled (Fig. 4.1).

Location 032 consisted of 1 layer (H1). The H0 layer was removed to a depth of 0-8 cm. H1 (sample 47) was sampled at a depth of 8-20 cm, and is red in colour. The sample has the lowest clay content (24%) in this sample, and has the highest sand content (37.8%).

Sample 47 has the lowest %C, 1.86%, and the CEC falls in the average of the samples at 34.35 cmol kg^{-1} (Table. 4.1).

Location 034

The homestead, in which this sample site is located, is in area C, further up the hill. There is a road that runs just on the eastern end of the homestead. The homestead is approximately 44.30 m in diameter and has a single inner circle. The homestead is densely covered with vegetation. A few smaller homesteads occur in this area. There are no apparent terraces directly associated with this homestead. A road runs from the south western end of the homestead along the contour of the hill. The western section of the homestead was sampled (Fig. 4.3).

Location 034 consisted of 1 layer (H1). H0 was removed at a depth of 0-10 cm. This depth was mainly due to vegetation in the upper areas. H1 (sample 53) was sampled from a depth of 10-23 cm and is reddish brown in colour. The soil was relatively dry compared to other areas on the site, and has the highest clay content in this sample set (56%). There are approximately 30% of rocks present, and rocks were located at the bottom of this sample layer.

Sample 53 has the highest concentration of P, 5.63 mg kg^{-1}, NH_4, 17.74 mg kg^{-1}, and NO_3, 14.77 mg kg^{-1} in this sample set of the domestic areas in Doornkop. Sample 53 has the lowest Mg, 507.90 mg kg^{-1}, and CEC at 23.6 cmol kg^{-1}in this sample set, and a relatively high %C of 2.32% (Table 4.1).

4.1.2. Terraces

Twenty samples were taken in twelve locations, in the terraced areas. These terraces are associated with the homesteads, and are located on the slopes of Doornkop hill and surrounding mountains. The terraces that were sampled often were found in association of the homesteads that were sampled. Generally, the

terraces were relatively small, however, there are examples of extensive terracing at this site.

Location 002

Sampling location 022 was sampled in a terrace above a homestead, on the south eastern section of area A. A contemporary road is located on the south eastern side of the homestead. A contemporary fire break runs next to the homestead, and through the associated terraces. The homestead associated with this terraced system has two inner circles and a large outer circle, and is approximately 33.03 m in diameter. The terraces continue further down the hill from the south western end of the homestead. These run approximately 24 m down the hill, and are approximately 83.26 m across (Fig. 4.1).

Location 002 only had one layer (H1). The upper layer (H0) was removed at a depth of 0-5 cm. H1 (Sample 2) was sampled from 5-15 cm and was dark brown in colour. It consisted of 60% rocks, and the dominant rock type in this area is dolerite.

Sample 2 shows a relatively high %C of 2.9%, CEC at 51.19 cmol kg^{-1}, and high concentrations of P, 5.70 mg kg^{-1} and Ca, 2313.96 mg kg^{-1}, compared to the rest of samples taken in the terraces of Doornkop (Table 4.2).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
2	002	5.7	247.4	2314.0	5.6	668.9	2.9	2.6	1.3	51.2	27.3	40.0	36.0	5.5
6	005	7.0	268.1	3666.0	13.5	2064.1	1.7	1.1	1.1	32.6	42.7	30.0	30.0	7.2
12	009	2.5	238.4	2520.0	5.6	924.5	2.8	1.0	0.9	47.3	25.6	44.0	34.0	6.2
15	012	2.7	179.0	2015.0	7.6	888.0	2.4	1.1	0.9	59.8	43.5	32.0	28.0	5.6
16	012	2.6	92.9	1934.0	14.8	1173.1	1.8	0.9	0.9	53.0	40.1	36.0	28.0	6.1
17	012	1.7	64.2	2126.0	17.4	1465.1	1.2	0.9	0.7	39.6	35.6	34.0	44.0	6.3
18	012	2.1	46.4	3143.0	36.4	2337.1	0.5	1.0	0.9	39.1	48.9	38.0	20.0	6.6
28	017	3.4	258.1	1045.0	7.2	616.1	3.3	5.8	5.2	46.1	34.2	32.0	30.0	5.8
29	017	2.6	112.3	445.4	25.6	759.1	0.7	9.6	8.3	34.5	8.9	24.0	20.0	6.1
30	018	1.6	234.7	1956.0	3.6	691.3	2.2	4.8	4.3	38.5	43.6	24.0	32.0	6.4
36	023	4.1	136.8	1860.0	9.9	727.9	2.7	5.8	5.5	36.2	28.1	42.0	28.0	5.8
44	029	2.1	238.4	2814.0	12.0	1180.1	1.5	3.1	4.3	46.3	32.9	38.0	38.0	6.2
48	033	1.2	179.4	2202.0	10.2	799.0	1.9	5.9	5.7	33.8	35.8	30.0	40.0	6.4
49	033	1.7	100.4	1823.0	7.9	712.3	1.1	2.8	6.1	32.2	46.6	36.0	46.0	6.6
50	033	1.6	87.3	2088.0	16.1	989.3	1.2	3.0	4.6	27.8	19.5	46.0	-8.0	6.4
51	033	2.0	79.5	2160.0	22.9	1190.1	0.6	2.0	4.3	24.7	9.8	20.0	40.0	6.5
52	033	1.3	76.0	2097.0	27.9	1258.1	0.3	2.6	4.6	40.4	21.9	34.0	54.0	6.8
56	037	1.7	220.0	1795.0	7.1	1013.1	2.1	4.2	4.9	40.6	19.3	36.0	44.0	6.0
60	041	2.2	140.0	1590.0	8.5	811.8	1.9	2.9	7.1	28.2	34.3	24.0	24.0	5.9
61	042	2.9	79.0	1224.0	6.4	624.0	2.3	4.5	7.7	40.1	18.6	32.0	20.0	5.3

Table 4. 2: Chemical signatures of terraces in Doornkop.

Location 005

This sample site is located in a terrace above a homestead, on the north western section of the site in Area B. The farm boundary fence runs through this homestead. A contemporary fire break runs through the homestead. The homestead associated with this terraced system is complex, and there appears to have been multiple occupations in this area. Quartzite occurs in this area, and the boulders are tabular in shape. These quartzites were used to build the walls of the homestead, and the buildings are both square and circular (Fig. 4.4). The homestead is approximately 47.50 m in diameter. There are two terraced systems associated with this homestead. One of the terraced complexes run up the hill, where this sample was taken, and petal shaped terraces continue further down the hill (Fig. 4.2).

H0 was removed at a depth of 0-5 cm. H1 (sample 6) was a distinctly thick layer sampled at a depth of 5-64 cm. This sample was dark brown, clay rich and consisted of 0% rocks. These features were uniform throughout the entire layer.

Sample 6 has the same value for NH_4 and NO_3 at 1.1 mg kg^{-1}, and has the highest Ca value compared to the rest of the terraced samples in Doornkop at 3666.0 mg kg^{-1}. This sample also has the highest concentrations in the terraces at this site for P, 7.00 mg kg^{-1}, and K, 268.09 mg kg^{-1} and is the most acidic sample with a pH of 7.19 (Table 4.2).



Figure 4. 4: Examples of rounded walls, and modified square walls.

H0 was removed at a depth of 0-5 cm. H1 (sample 6) was a distinctly thick layer sampled at a depth of 5-64 cm. This sample was dark brown, clay rich and consisted of 0% rocks. These features were uniform throughout the entire layer.

Sample 6 has the same value for NH_4 and NO_3 at 1.1 mg kg^{-1}, and has the highest Ca value compared to the rest of the terraced samples in Doornkop at 3666.0 mg kg^{-1}. This sample also has the highest concentrations in the terraces at this site for P, 7.00 mg kg^{-1}, and K, 268.09 mg kg^{-1} and is the most acidic sample with a pH of 7.19 (Table 4.2).

Location 009

This sample was taken in the middle section of a terraced system that is attached to the western side of the homestead in Area B. The homestead associated with these terraces forms part of the three homestead cluster, described in location 007. This is the most southerly homestead at location 007, and has a single inner circle. Sampling location 008 was sampled in the central enclosure of this homestead. The homestead is approximately 25.14 m in diameter. The terraces run approximately 23.97 m down the hill. A road runs along the top terraces towards the upper section of the hill, into open land (Fig. 4.2).

H0 was removed at a depth of 0-5 cm. H1 (sample 12) is dark reddish brown and was sampled at a depth of 5-15 cm. This sample has a loose texture and is composed of approximately 60% of rocks. The rock size on average is approximately 10 cm in length.

Sample 9 is slightly acidic with a pH of 6.16, which is consistent with the rest of the samples. It also has a high percentage of clay (44%), and a high concentration of K, 238.39 mg kg^{-1} (Table 4.2).

Location 012

This sample site is located in the middle section of the southern terraced system described in location 002 in Area A (Fig. 4.1).

Four samples were taken at Location 012. H0 was removed at a depth of 0-3 cm. H1 (sample 15) was a relatively clay rich (32%) layer which is dark brown in colour. It was sampled at a depth of 3-8 cm, and consisted of rocks approximately 20-30 cm in length. H2 (sample 16) is also relatively clay rich (36%) but has a distinctive red tone to the dark brown. This sample was taken at a depth of 8-16 cm, and consisted of around 20% of rocks. Sample 17 (H3) was sampled at a depth of 16-24 cm and consisted of 0% rocks. Sample 17 comprised degraded dolerite rock (saprolite). It is powdery and soft in texture and is red, orange and brown in colour. H4 (sample 18) also comprises doleritic saprolite. It is a golden brown colour and has components of the degraded rock in it. It was sampled at a depth of 24-38 cm (Fig. 4.5).

Samples 15 and 16 have higher P and K concentrations compared to the saprolitic samples 17 and 18. The opposite is true for the Ca, Na and Mg readings, for which the concentrations are higher for samples 17 and 18. It should be noted that the lower layers, towards the saprolite, %C values decreases significantly. Sample 15 has the highest CEC at 59.81 cmol kg^{-1} compared to the rest of the samples. Sample 16 has the lowest NH_4 reading of 0.91 mg kg^{-1}, and sample 17 has the lowest NO_3 concentration of 0.7 mg kg^{-1}. Sample 18 has the lowest concentration of K, 46.35 mg kg^{-1}, and the highest Na, 36.35 mg kg^{-1}, and Mg, 2337.10 mg kg^{-1}, compared to the rest of the terraces (Table 4.2).



Figure 4. 5: Soil profile of Sample location 012.

Location 017

This sample site is located in the middle section of a terraced system associated with the homestead sampled at location 016, on the south eastern section of area A. This section of the hill has a distinctly higher gradient. The terraces run approximately 65.15 m down the hill (Fig. 4.1).

H0 was removed at a depth of 0-5 cm. Sample 28 (H1) is a slightly clay rich (32%) layer which is dark brown in colour. It is composed of approximately 40% of rocks and was sampled at a depth of 5-20 cm. Sample 29 is composed of a bulk sample of both H2 and H3, due to these layers having an insufficient volume of soil for analysis. H2 was taken between the depths of 20-40 cm and is composed of an orange doleritic saprolite. H3 is also saprolite, but of a grey colour. This saprolite is derived from the shales in the area. It has a very powdery texture and was sampled at a depth of 40-50 cm.

The percentage of organic carbon is substantially different between the soil, sample 28, and the saprolite sample 29. Sample 28 has the highest %C of 3.32%, in the Doornkop terraces, whereas the saprolite is at 0.66%. There is a significant difference between the micro nutrients of the soil compared to the saprolite. Sample 28 has the lowest Mg concentration of 616.10 mg kg^{-1}, whereas sample 29 has the lowest concentration of Ca, 445.36 mg kg^{-1}. Sample 29 has the highest NH_4 and NO_3 concentrations in this sample set at 9.62 mg kg^{-1} and 8.33 mg kg^{-1}, respectively (Table 4.2).

Location 018

This sample site is located in the upper section of the terraced system, associated with the homestead located above the contemporary main round, on the south eastern section of area A. The gradient is relatively low on this section of the hill. The terraces are attached to the southern section of the homestead and run 24 m down the hill. The homestead has two phases of occupation and is not very distinct (Fig. 4.1).

One sample was taken at location 018. This was a very shallow sample compared to the rest of the terraced samples, as it was only 5 cm thick. H0 was removed at a depth of 0-5 cm. H1 (sample 30) is a slightly clay rich layer with loose soil

present, and was sampled at a depth of 5-10 cm. This sample was reddish brown in colour and had rocks at the bottom coring hole. The sample is composed mostly of sand and silt at 44% and 32%, respectively. It has a low clay content compared to the other samples at 24%.

Sample 30 has the lowest concentration of Na in the terraces with a value of 3.62 mg kg^{-1}. This sample has a high concentration of K, 234.69 mg kg^{-1}, and low concentrations of Ca, 1955.96 mg kg^{-1}, and Mg, 691.30 mg kg^{-1} (Table 4.2).

Location 023

This sample site is located in the lower section of the terraced system, associated with the homestead sampled at location 22 in Area A. The terraces are attached to both homesteads in this area, and have a slight water drop shape. A road runs through the upper section of the terraces attaching the homesteads to each other. The terraces run approximately 71.77 m down the hill (Fig. 4.1).

Location 023 yielded only one sample. H0 was removed at a depth of 0-6 cm. H1 (sample 36) is dark brown in colour and was sampled at a depth of 6-22 cm. The rocks present in this sample were approximately 20 cm in length, and had a very high clay content of 42%.

Sample 36 demonstrated high values for NH_4 and NO_3 with concentrations of 5.81 mg kg^{-1} and 5.46 mg kg^{-1}. This sample has low concentrations of K, Ca, Na and Mg, but a high concentration of P, 4.13 mg kg^{-1} (Table 4.2).

Location 029

This sample site is located in the upper section of the terraced system. The terraces run between two homesteads, either up the hill towards the southern homestead, or down the hill towards the northern homestead in Area A (Fig. 4.1).

One sample was taken at location 029. The H0 was removed at a depth of 0-5 cm. This location is slightly more ambiguous than other areas, and could either be a terrace or a road. Sample 44 (H1) is a dark brown, clay rich layer. It was sampled at a depth of 5-23 cm and consists of approximately 70% of rocks. These rocks have an average length of 1 cm.

Sample 44 has an %C of 1.5%, which is below average. The CEC value, 32.9 cmol kg^{-1}, however, is noticeably higher than most of the other samples (Table 4.2).

Location 033

This sample site is located in a similar context as location 029 in Area A. The homestead, associated with these terraces, is located west of the terraces. It is relatively poorly preserved, with a single inner circle. The road, described in location 32, is located above this homestead (Fig. 4.1).

The sample, which was taken at GPS point 033, was the deepest core taken on the site. It was sampled to a depth of 82 cm. A total of 5 samples were taken at this location. H0 was removed at a depth of 0-6 cm. Sample 48 (H1) is a dark brown layer, sampled at a depth of 6-16 cm. H2 (sample 49) is a slightly clay rich (36%) layer, which is a reddish brown colour, and it was sampled at a depth of 16-26 cm.

Sample 50 (H3) is red coloured soil and was sampled at a depth of 26-44 cm. This sample was noted to consist degraded shale, and has the highest clay content (46%) compared to the rest of the Doornkop terraces. H4 (sample 51) is a shale saprolitic sample that is a distinct grey colour, and has a very soft texture, but has the lowest clay content (20%) in the terraces. This was sampled at a depth of 44-60 cm. Sample 52 (H5) was sampled at 60-82 cm in depth. This soil layer is an orange/grey colour and the saprolite present is grey-white. It is very soft and powdery in texture. The silt content of the saprolitic samples is also notably higher than the upper layers of location 033.

The CEC of samples 48-51 gradually decrease from 33.77 cmol kg^{-1} to 24.66 cmol kg-1. Interestingly, sample 52 has a significantly higher CEC value, 40.43 cmol kg^{-1}. Sample 48 has the lowest P concentration in the terraces with a value of 1.24 mg kg^{-1}. Sample 51 has the lowest CEC, 24.66 mg kg^{-1}, in the Doornkop terraces, whereas sample 52 has the lowest %C of 033% (Table 4.2).

Location 037

This sample site is located in area B, south from locations 007, and 035. The samples were taken in the lower section of the terraces. Two homesteads are associated with these terraces. The northern homestead has multiple inner circles present, whereas the southern homestead has a single inner circle (Fig. 4.2).

Location 037 yielded one soil sample. The roots in this sample had penetrated to the bottom of the sample layer. H0 was removed at 0-6 cm, and contained rocks up to 16 cm in length. H1 (sample 56) is red in colour and has a clay-like texture. The rocks in this sample were up to 10 cm in length.

The P content in sample 56 is low with a concentration of 1.66 mg kg^{-1}. It does, however, have a high CEC value of 40.64 cmol kg^{-1}, and %C of 2.06%. The NH_4, 4.16 mg kg^{-1}, and NO_3, 4.90 mg kg^{-1}, is also relatively high compared to the rest of the terraces (Table 4.2).

Location 041

This sample site is located in area C, south of the homestead. The homestead has dense vegetation in it. There are two other homesteads in this area, with terraces above the homesteads. A road runs between the homesteads, and cut through the terraces. The road has a funnel shaped opening at the bottom of the terraces, suggesting that the cattle grazed in the lower areas of this hill. The soil was sampled in the top section of the terraces (Fig. 4.3).

One sample was removed at location 041. This sample also had deep root penetration and the H0 consisted rocks of up to 13 cm in length. This H0 layer was relatively thick at 0-9 cm, which was mainly due to the rock content and the vegetation in this area. Sample 60 (H1) is red in colour, and clay rich. The rocks in this sample were up to 10 cm in length.

The NO_3 content of this sample is high at 7.14 mg kg^{-1}, but has a low concentration of NH_4, 2.94 mg kg^{-1}. This sample is also more acidic than most of the other samples with a pH of 5.87 (Table 4.2).

Location 042

The terrace positioned at location point 042 is on the other side of the road from location 041 in Area C (Fig. 4.3).

This sampling location yielded only one sample, but this was one of the deepest samples taken for a single layer. H0 was sampled at a depth of 0-7 cm. H1 (Sample 61) is red in colour, and is clay rich at 32%. It was sampled at a depth of 7-40 cm.

Sample 61 is the most acidic sample taken in the terraces with a pH of 5.3. It has distinctly high levels of NH_4, 4.48 mg kg^{-1}, and NO_3, 7.7 mg kg^{-1}, concentrations and a CEC of 40.09 cmol kg^{-1} (Table 4.2).

4.1.3. Livestock enclosures

Nine samples were taken in seven locations in the livestock enclosures. Sample locations were numbered consecutively (e.g. GPS 001, GPS 002, etc.) and were mapped (Fig. 4.1, Fig. 4.2, Fig. 4.3). The livestock enclosures are located in the inner circles. Various homesteads were sampled in the different areas of the site.

Location 003

The homestead, in which this sample site is located, is on the south eastern end of area A. North of the contemporary road that runs through Doornkop. This is the homestead described in samples 002 and 012. The sampled livestock enclosure is a secondary inner circle on the north western side of the primary inner circle (Fig. 4.1).

A high amount of tubers was present in this sample (up to 33%). H0 was removed at a depth of 0-5 cm. Sample 3 (H1) was sampled a depth of 5-40 cm and is dark brown in colour H2 (sample 4) is reddish brown in colour and clay rich. This sample was sampled from 40-68 cm in depth and consisted of approximately 2%

of rocks. There are fragments of dolerite in this sample. The sample taken at this location was the deepest compared to the other samples taken in the livestock enclosures at Doornkop.

The CEC of samples 3 and 4 is amongst the highest in the livestock enclosures at 43.93 cmol kg^{-1} and 60.14 cmol mg kg^{-1} respectively. The NH_4 and NO_3 content is low, and sample 4 has the lowest NO_3 of 0.87 mg kg^{-1}. Sample 3 has the lowest Na, mg kg^{-1}, concentration in the sample set, and sample 4 has the lowest concentration of K at 67.74 mg kg^{-1}. The %C for this sample is also the lowest at 0.94% (Table 4.3).

Location 004

Location 004 is situated in the livestock enclosure that forms part of the anomalous building described in location 005. The central enclosure is located towards the lower end of the homestead. The livestock enclosure had Kikuyu grass present (Fig 4.6), but a sample was taken in this area regardless (Fig. 4.1).

The H0 was 0-5cm thick, and the H1 (sample 5) was sampled at 5-30 cm in depth. There were no rocks present in this sample, and the soil was dark brown in colour. The soil was loose in texture, and did not have a high clay texture. This sample has the highest sand content of 60%, and the lowest silt content of 8%.

The P concentration is substantially higher than that in samples from the rest of the livestock enclosures at 170.03 mg kg^{-1} at Doornkop. Similarly, the Ca content is the highest at 4831.96 mg kg^{-1} (Table 4.3).



Figure 4. 6. Photo of Kikuyu grass in the central enclosure at Location 004.

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
3	003	4.24	476.49	2306.96	4.65	605.80	2.02	0.95	0.91	43.93	40.36	34.00	30.00	5.89
4	003	3.97	67.74	3187.96	24.23	934.70	0.95	1.19	0.88	60.14	55.54	36.00	12.00	6.24
5	004	170.03	490.89	4831.96	9.69	970.70	3.02	0.98	0.95	45.20	62.76	36.00	8.00	7.25
10	008	2.86	592.39	2487.96	8.68	1222.10	2.26	0.91	0.95	45.24	20.26	46.00	38.00	6.30
11	008	2.83	525.49	2020.96	13.80	1419.10	1.30	0.98	0.88	34.21	15.06	56.00	28.00	6.25
40	026	1.63	271.39	1316.96	9.53	578.40	1.32	3.19	5.39	37.05	23.48	30.00	34.00	6.39
46	031	1.71	192.99	1448.96	7.24	602.30	1.61	3.75	4.27	25.63	30.94	64.00	20.00	5.79
54	035	10.79	776.99	3286.96	7.18	726.90	3.47	6.90	3.68	37.00	47.04	26.00	34.00	7.16
59	040	19.57	608.49	3763.96	8.92	621.80	3.57	7.21	15.82	39.66	39.38	18.00	26.00	7.40

Table 4. 3: Chemical signatures of livestock enclosures in Doornkop.

Location 008

Sampling location 008 is located in the homestead associated with the terraces described in location 009. The homestead has a single inner circle, located in area B of Doornkop (Fig. 4.2).

Two samples were sampled at Location 008. The H0 was 0-5 cm thick, and H1 (sample 10) is a very thin layer of 5-10 cm. It is dark brown in colour, and is clay rich (46%), with a loose soil texture. This sample has the highest silt content of 38% in the livestock enclosures of Doornkop. This layer comprised approximately 40% rocks. Sample 11 (H2) is dark red in colour, with the highest clay content (56%) at the site. It was sampled at a depth of 10-38 cm, and only contained 2% of rocks.

The Mg content of samples 10 and 11 is considerably higher than the rest of the samples. Sample 11 has the highest Mg in the livestock enclosures with a value of 1419.10 mg kg^{-1}. Sample 11 also has the highest Na content of 13.80 mg kg^{-1}. These samples have considerably low NH_4 and NO_3 concentrations, where sample 10 has the lowest NH_4, 0.91 mg kg^{-1}, in the sample set. Sample 11 has the lowest NO_3, 0.875 mg kg^{-1}. Sample 10 has a relatively high CEC of 45.23 cmol kg^{-1}, and sample 11, 34.20 mg kg^{-1}, is low in the Doornkop livestock enclosure dataset (Table 4.3).

Location 026

The location 026 homestead is on the north eastern end of area A at the bottom of the hill. The ground is relatively level in this area. This homestead is dilapidated, close to the river. The homestead is approximately 11 m in diameter. The livestock enclosure is in the south eastern section of the homestead, located south

of a larger homestead. This area is located in a section of contemporary cultivated land in Doornkop (Fig. 4.1).

The H0 layer was removed at 0-6 cm. Sample 40 (H1) is a thick layer from 6-32 cm in depth, and is a reddish brown colour. The soil has a loose texture with a relatively high silt content (34%).

Sample 40 has amongst the lowest organic carbon content of 1.31% compared to the other samples in the livestock enclosures. The P, 1.63 mg kg^{-1}, Ca, 1316.96 mg kg^{-1}, and the Mg content, 578.40 mg kg^{-1}, is the lowest compared to the rest of the samples (Table 4.3).

Location 031

The location 031 homestead is below location 032 in Area A. This homestead has two inner circles and is 38.22 m in diameter. There is a road that links this homestead, with the homestead above it. The sample was taken in the eastern inner circle (Fig. 4.1).

One sample was taken at GPS point 031. H0 was removed at a depth of 0-5cm. H1 (sample 46) is a considerably thick layer at 5-31 cm in depth. Sample 46 contains the highest clay content of 64%. It is a red brown colour with 0% rock content.

The pH of sample 46 is the most acidic in the Doornkop livestock enclosure dataset at 5.79. This sample has a relatively low %C of 1.60% and the lowest CEC, 25.63 cmol kg^{-1} (Table 4.3).

Location 035

The homestead from which the location 035 samples was taken was described in location 034 in Area C (Fig. 4.3). This livestock enclosure had an anomalous feature, where there was a small square rock feature inside it that was jutting from the wall.

Sample 54 (H1) was taken at GPS point 031. The H0 was a thick layer from 0-11cm. H1 (sample 54) was sampled from 11-27 cm in depth and consisted of 30% of rocks. It is red brown in colour and has a loose texture. Sample 54 has a sand content of 47.07% which is relatively high compared to the other samples. The rocks found in this sample were an average length of 2-3cm.

Sample 54 has a considerably high %C of 3.47%, and a relatively low CEC of 37.00 mg kg^{-1}. This sample has the highest Na content of 776.99 mg kg^{-1}, compared to the rest of the samples in the livestock enclosures of Doornkop (Table 4.3).

Location 040

Sampling location 040 is positioned in a round enclosure that appears to be a livestock enclosure. At ground level, there appears to be no outer circles, however, on aerial photographs these are visible. This homestead is located in area C of Doornkop, above a 4x4 track, near a lower ridge on the mountain. The homestead consists of four inner circles, and the south eastern circle has a secondary circle inside it. The north western livestock enclosure was sampled. It is densely vegetated (Fig. 4.3).

The H0 was a very mulchy layer that was removed at a depth of 0-6 cm. The H1 (sample 59) layer was light brown in colour and consisted of a loose soil texture. The rocks found in this layer were approximately 20-30 cm in length and roots penetrated into the sample to 10 cm in depth.

This sample has the highest NH_4, 7.21 mg kg^{-1}, and NO_3, 15.82 mg kg^{-1}, content compared to the rest of the samples. The %C is the highest in the livestock enclosures at 3.57%, and a low CEC of 39.66 cmol kg^{-1}. This is the most alkaline sample in the Doornkop livestock enclosures with a pH of 7.4 (Table 4.3).

4.1.4. Non-archaeological areas

All samples classified as non-archaeological samples, are samples that were taken from areas where there is no physical evidence of archaeological materials. These are control samples that give indications of what the areas would be like if there had been no archaeological components, and also may indicate why these areas were not cultivated. Twenty-seven samples were taken in 17 non-archaeological areas.

Location 006

Sampling location 006 was taken below the ridge in area B. This sample site is south of the fault. There are homesteads and terraces lower down the hill, north of this sample (Fig. 4.2).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
7	006	2.36	95.01	3576.96	11.82	1290.10	2.38	0.95	0.91	24.30	15.92	50	32	6.29
8	006	3.06	87.86	3328.96	11.99	1317.10	1.89	1.02	1.05	32.60	12.80	60	28	6.26
13	010	3.11	102.79	3810.96	16.36	1908.10	2.08	1.02	0.98	40.53	17.98	50	32	6.08
14	011	2.81	151.09	3622.96	10.36	1635.10	2.28	0.81	0.91	51.47	19.18	48	32	6.26
19	013	2.29	457.09	792.16	18.57	368.80	2.21	1.02	1.09	32.11	50.16	34	22	6.33
20	013	2.14	440.39	436.86	34.06	354.10	1.76	0.91	0.95	38.83	45.04	30	32	6.22
21	013	4.13	423.19	256.96	63.59	399.40	1.41	0.95	0.95	27.30	30.10	38	40	6.08
22	014	1.74	394.29	1244.96	4.51	525.30	2.89	0.91	1.02	36.93	46.34	28	30	6.13
23	014	1.64	218.79	799.86	16.20	961.20	3.04	0.91	0.95	37.28	28.28	46	28	6.40
24	014	1.80	198.99	928.06	37.95	1376.10	0.69	1.96	0.95	44.29	27.98	46	30	7.08
25	014	1.38	180.29	1005.96	39.05	1456.10	0.26	3.75	0.98	35.40	6.38	40	56	7.36
26	015	2.52	132.29	2234.96	9.59	647.20	2.98	1.09	0.81	34.56	25.82	40	38	6.04
31	019	1.55	147.29	1290.96	12.87	539.00	2.19	9.94	6.55	30.18	35.30	24	38	6.47
32	020	1.18	66.05	1395.96	7.12	464.20	1.17	3.75	4.59	24.61	28.10	40	30	6.32
33	021	0.94	117.29	2253.96	6.59	794.10	1.56	5.95	6.37	39.51	47.04	58	28	6.56
34	021	2.10	90.19	2325.96	9.18	890.50	1.37	4.27	4.31	33.36	42.36	48	6	6.56
37	024	1.64	79.96	1417.96	8.53	752.50	2.02	2.56	5.50	34.82	45.24	32	36	5.77
38	024	2.00	58.99	1139.96	5.37	670.80	1.21	2.98	5.22	31.05	12.62	22	44	5.87
39	025	1.54	79.52	1126.96	12.34	599.40	1.38	3.71	4.47	29.97	54.82	34	36	6.31
41	027	1.99	58.12	1278.96	6.66	434.70	1.03	2.45	4.34	40.89	42.42	32	38	6.14
42	027	1.84	50.30	1424.96	9.58	601.00	1.02	2.28	5.08	32.79	24.82	40	36	6.29
43	028	2.78	58.67	914.76	14.63	453.10	1.96	2.56	5.53	33.51	67.14	40	42	5.47
45	030	2.22	274.19	2231.96	63.74	1366.10	1.49	3.50	5.22	33.85	35.30	28	36	6.39
55	036	2.24	249.59	1247.96	4.55	403.50	2.50	1.51	6.48	30.80	43.62	22	42	6.57
57	038	2.68	195.59	797.76	3.86	391.10	1.62	2.98	9.31	30.64	56.16	62	18	6.39
58	039	3.33	235.29	1245.96	3.96	400.70	2.74	7.95	8.37	30.73	45.96	18	50	5.87
62	043	1.88	179.19	1146.96	14.84	584.90	2.16	4.59	10.47	25.73	48.22	18	18	6.37

Table 4. 4: Chemical signatures of non-archaeological areas of Doornkop.

Two samples were taken from location 006. These are sample 7 (H1) and sample 8 (H2). The H0 layer was removed 0-5 cm in depth. Sample 7 is dark brown in colour, and is clay rich (50%). This layer was sampled at a depth of 5-30 cm, and contains 60% rocks. Sample 8 is a red clay rich layer (60%), at 30-45 cm in depth. This layer comprises 70% rocks. The clay content in both these samples are high, with an average of 55%.

The Ca, 3576.96 mg kg^{-1}, and Mg, 1290.10 mg kg^{-1}, for sample 7 is relatively high compared to majority of the other samples from the non-archaeological areas of Doornkop. The CEC is the lowest in the non-archaeological areas at 243.30 cmol kg^{-1}, whereas, the %C, 2.38%, is high. Sample 8 also has high Mg and Ca levels of 1317.10 mg kg^{-1} and 3328.96 mg kg^{-1}, respectively (Table 4.4).

Location 010

This sample is located on the lower section of area B, 191 m below locations 008 and 009. It is south of the stream that flows along the fault line (Fig. 4.2).

One sample was taken at location 010. H0 was removed at a depth of 0-5 cm. H1 (sample 13) was sampled at a depth of 5-18 cm. The soil texture is relatively loose, and the soil has a high clay content (50%). The soil is dark brown in colour, and is composed of 30% rocks. The rocks on average are 5 cm in length.

The Ca, 3810.96 mg kg^{-1}, and Mg, 190.10 mg kg^{-1}, for sample 13 is the highest compared to rest of the dataset of non-archaeological area in Doornkop (Table 4.4).

Location 011

This sample site is located below location 10, on the northern side of the fault. There is an old quarry, approximately 32.54 m, north of this sample. The Komati River is 44.83 m downslope. There are no distinctive archaeological areas near the location (Fig. 4.2).

H0 was removed at a depth of 0-5 cm. Sample 14 (H1) is a dark brown layer that is clay rich (48%). This sample was taken at depth of 5-14 cm, and is composed of 60% of rocks averaging 5-10cm in length.

Sample 14 has the highest CEC of 51.47 cmol kg^{-1} in the non-archaeological areas of this site. This sample also has a high percentage of %C of 2.28%. The NH_4, 0.80 mg kg^{-1}, concentration is the lowest in this sample set, and the NO_3 is also low with a value of 0.91 mg kg^{-1} (Table 4.4).

Location 013

This sample site is located south east of the homestead at location 001, on the south eastern slopes of the small hill in area A. There is a smaller homestead between these two locations, but there are no archaeological activities directly associated with this location (Fig. 4.1).

Location 013 is distinctly drier than other sample areas on this site. H0 was removed at a depth of 0-4 cm. H1 (sample 19) is dark greyish brown in colour and was sampled between the depths of 4-9 cm. This layer has a rock percentage of 60%, and rocks are an average of 2 cm in length. There are two distinct rock types, dolerite and shale, that are disintegrating in this sample. H2 (sample 20) has

a loose texture and was sampled at a depth of 9-11 cm. This sample is composed of 60% of rocks, with an average length of 1-2 cm. Sample 20 is light brown in colour, and has components of grey saprolite derived from shales. Sample 21 (H3) is a golden brown colour, sampled at a depth of 11-14 cm. This layer is composed of 60% of rocks, and has clay rich, grey/orange saprolite present. This sampling point is distinctly shallower than the rest of the sample locations in Doornkop.

The K levels of all three of location 13 samples are the highest, when compared to the rest of the non-archaeological samples in Doornkop. Sample 19, 457.09 mg kg^{-1}, sample 20, 440.39 mg kg^{-1}, and sample 21, 423.19 mg kg^{-1}, have a decreasing K concentration by depth. Sample 20 has the lowest Mg, 354.10 mg kg^{-1}, concentration in the non-archaeological areas. Sample 21 has the lowest concentration of Ca, 256.96 mg kg^{-1}. Sample 21, in contrast, has the highest P content of 4.13 mg kg^{-1} (Table 4.4).

Location 014

This sample site is located east on the eastern section of area A, on even ground. This is an open grass veldt area, intersected by contemporary foot paths. There are 4x4 tracks lower down the hill, and north of this sample site. There also are homesteads present south of this sample site (Fig. 4.1).

This sampling location was the deepest taken on Doornkop at 1m in depth. Four samples were taken from location 014. The upper layers, H0 and H1, are distinctly drier than H2-H4. H0 has a loose texture, and was removed at a depth of 0–5 cm. H1 (sample 22) is greyish brown in colour with a loose texture. It was sampled between the depths of 5–15 cm. This sample has a rock percentage of 70%, where the rocks vary from 1 cm to10 cm. Sample 23 (H2) was sampled at a depth of 15–30 cm. This sample has a loose texture, and is greyish brown in colour. This layer is composed of 50% of rocks. Sample 24 (H3) is a clay rich layer, which was

sampled at a depth of 30-60 cm. It also has traces of doleritic (orange) and shale (grey) saprolite. Layer 4 (sample 25) is a grey saprolitic layer, which was sampled between a depth of 60–100 cm. It is a very fine, soft layer. It comprises 56% of silt, which is the highest silt content compared to the rest of the non-archaeological samples in Doornkop. Both Samples 24 and 25 have a rock percentage of approximately 20%.

The %C for sample 24 is the highest of all the non–archaeological samples at 3.03%. The NH_4 values are interesting, because samples 22 and 23 have amongst the lowest concentrations when compared to the rest of the sample set. This changes, however, by depth. There is an increase in NH_4 at an exponential rate from sample 22 (0.91 mg kg^{-1}) to sample 25 (3.75 mg kg^{-1}). Sample 25 has the lowest pH in this sample (Table 4.4).

Location 015

This sample site is located amongst trees on the eastern section of area A, west of location 014. There are homesteads located in this area, but these are not directly associated location 15 (Fig. 4.1).

H0 was removed at a depth of 0-3 cm. H1 (sample 26) is reddish brown in colour, and has a loose texture. It was sampled at a depth of 3–22 cm, until there were only rocks at the bottom. This sample comprises 40% of rocks, and these are an average of 20 cm in length.

The Ca levels of sample 26 (2234.96 mg kg^{-1}) is relatively high compared to the rest of the samples taken in this category in Doornkop. It has amongst the highest %C of 2.98%. The NO_3, however, is the lowest with a concentration of only 0.81 mg kg^{-1} (Table 4.4).

Location 019

This sampling location is south west of location 018, below the terraces, and the main contemporary road in Area A. There are also homesteads further down the hill. There is no evidence of activities directly associated with this area. The homesteads are approximately 50 m from this sample location (Fig. 4.1)

Location 019 is situated in an area where there is a lot of foliage on the ground. The H0, therefore, was removed at a depth of 0-10 cm. H1 (sample 31) is reddish brown in colour, and has a loose texture. It was sampled at a depth of 10–22 cm, and included rocks 20 cm in length. A large boulder occurred at the bottom of this sample.

Sample 31 has a relatively low level of P present, at 1.55 mg kg^{-1}. The NH_4 in this sample is the highest compared to the rest of the samples, at 9.94 mg kg^{-1}. The NO_3 levels are also high at a value of 6.55 mg kg^{-1}, which is almost twice the average (Table 4.4).

Location 020

Location 020 is located in a recently cultivated area in Area A. The current manager of Doornkop, Marius van Niekerk, stated that the previous owner of the farm had cultivated this section of the farm. This sample is on the lowest section of the area, in the eastern section of Doornkop (Fig. 4.1).

H0 was removed at a depth of 0-3 cm. Sample 32 (H1) was sampled at a depth of 3-48 cm. This sample is dark brown in colour, and has a loose texture.

Overall the different indicators, that were tested, in this sample has lower than average levels across the board. NH_4, at 3.75 mg kg^{-1}, and NO_3, 4.89 mg kg^{-1}, are the exception (Table 4.4). It should be noted that animal activity is more intense at this location, than other areas of Doornkop.

Location 021

This sample site is located near location 20, also in the area that was cultivated in the last 50 years (Fig. 4.1).

Two samples were collected at location 021. H0 was removed at a depth of 0-5 cm. The difference between H1 (sample 33) and H2 (sample 34), is the rock percentage of each layer. Sample 33 had a rock percentage of 10% and was sampled at a depth of 5-15 cm. Sample 34 had a rock percentage of 70%, and was sampled at a depth of 15-40 cm. Both samples are dark brown in colour and have a loose texture.

The difference in the P levels between the layers varied greatly. Sample 33 has a P level of 0.94 mg kg^{-1}, which is the lowest in the non-archaeological areas in Doornkop, and sample 34 has a concentration of 2.10 mg kg^{-1}. The NH_4 levels for these samples are also high compared to the rest of the samples. A discrepancy that needs to be highlighted is the percentage of the silt vs clay and sand in sample 33 (Table 4.4).

The sand and clay values, 47% and 58% respectively, combined are at a value of 105%. Although minor discrepancies occur due to laboratory conditions most of the samples may exceed 100% in a reasonable margin. In this sample, however, the calculated silt would be expected to be -5%, which is impossible. To add to this problem, the silt measured was 28%, which is substantially higher than what

might be expected. As a result, only the clay content has been taken into consideration.

Location 024

Location 024 is situated above terraces, but below the terraced system that was sampled in location 023. There is a geological contact zone just below this location (Fig. 3.1 and Fig. 4.1).

H0 was removed at a depth of 0-4 cm. H1 (sample 37) was sampled at a depth of 4-14 cm. This is a very shallow layer, considering that H2 (sample 38) contains saprolite. Sample 37 is dark brown in colour, and has a loose texture. It contained 30% of rocks. Sample 38 is light brown in colour, and sampled at a depth of 14-34 cm. This sample has a loose texture, and is powdery. It is included 60% - 70% of rocks, containing shale based saprolite.

Sample 37 and sample 38 have relatively low K concentrations, 79.96 mg kg^{-1} and 58.99 mg kg^{-1} respectively, when compared to the average of this sample set. The NO_3 levels for both these samples are higher than the average, for the site. Both these samples are acidic. Sample 37 has a pH of 5.77, and sample 38a pH of 5.87 (Table 4.4).



Figure 4. 7: Soil profile of samples taken at Location 024.

Location 025

Location 025 is situated below the geological contact zone mentioned in the discussion of location 024 (Fig. 3.1 and Fig. 4.1).

H0 was removed at a depth of 0-6 cm. H1 (sample 39) is dark brown in colour, and was sampled at a depth of 4-42 cm. This sample consisted of 30% of rocks.

The P value for sample 39 is 1.54 mg kg^{-1}, which is lower than average in the non-archaeological areas of Doornkop. The %C, 1.37%, and CEC, 39.96 cmol kg^{-1} is also relatively low (Table 4.4).

Location 027

This sample site is located south of location 026, in the recently cultivated section of Doornkop (Fig. 4.1).

H0 was removed at a depth of 0-6 cm. Sample 41 (H1) was sampled from a depth of 6-16 cm, and is a light brown colour. This sample had a soft, loose texture. H2 and H3 were sampled in bulk (sample 42) due to the layers being very similar, except with regards to texture. H2 was sampled from a depth of 16-26 cm and has a loose soft texture, whereas H3 has a clay like texture and was sampled at a depth of 26-50 cm. H2 and H3 are dark brown in colour.

Samples 41 and 42 have very similar chemical signatures. Both samples have lower K concentrations compared to the rest of the samples taken in non-archaeological areas in Doornkop, where sample 42 has the lowest at 50.30 mg kg^{-1}. The Na content is also below average: e.g. sample 41 has a concentration of 6.66 mg kg^{-1}. The %C is low, compared to the rest of this dataset, with sample 41 being at 1.03%, and sample 42 at 1.01%. The CEC content for both these samples is high. Sample 41 CEC levels are the higher of the two, with a capacity of 40.88 cmol kg^{-1} (Table 4.4).

Location 028

This sample site is situated on natural terraces south west of location 027. There are stone walled terraces located further up the hill from this location (Fig. 4.1).

One sample was taken at GPS point 028. H0 was removed at a depth of 0-6 cm. H1 (sample 43) contains light grey saprolite, derived from shales. This sample has a loose powdery texture. Sample 43 was sampled at a depth of 6–22 cm, and had a rock percentage of between 70–80%.

Sample 43 has low concentrations for most of the micro-nutrients. The P concentration, however, is high at 2.78 mg kg^{-1}. The Ca and Mg concentrations are amongst the lowest in the non-archaeological areas of Doornkop, at 58.67 mg kg^{-1} and 453.10 mg kg^{-1} respectively. This sample is the most acidic sample in this data set, with a pH of 5.47 (Table 4.4).

Location 030

This sample site is located on the northern section of the area A, below location 029. Terraces occur above, toward, the north east of this sample. There is no evidence of walling directly associated with this area (Fig. 4.1).

The top layer (H0) was removed at a depth of 0-6 cm. One layer was sampled (sample 45). H1 was sampled at a depth of 6–30cm. This sample is dark brown in colour, and is clay rich. Quartz rocks were found in sample 45.

Sample 45 has relatively high micronutrients. The Ca and Mg concentrations are relatively high at 2231.96 mg kg^{-1}, and 1366.10 mg kg^{-1} respectively. The Na has

the highest concentration compared to the rest of the non-archaeological areas in Doornkop, at 63.74 mg kg^{-1}. The CEC is also high compared to the rest of the samples in this dataset (Table 4.4).

Location 036

This sample site is located above the homesteads, described in location 037, east of the Komati River in Area C. This section has no direct evidence of stone walling or archaeological activities (Fig. 4.3).

The top layer (H0) was removed at a depth of 0-6 cm. H1 (sample 55) has a loose texture, and is light brown in colour. It was sampled at a depth of 6-14 cm, and is the shallowest sampling location in the non-archaeological areas. This sample consists of 70% of rocks, which were on average <1 cm. The sand content of this sample is amongst the highest at 43.62%.

Sample 55 has a low Na concentration (4.55 mg kg^{-1}). The NO_3 concentration has a high concentration at 43.62 mg kg^{-1}. The %C is high at 2.50% (Table 4.4).

Location 038

Location 038 is located below the homesteads and terraces, described in locations 037 and 036 in Area C. There is a distinct difference in vegetation in this area where the grass is distinctly browner than the grass at the homesteads (Fig. 4.3).

One sample (sample 57) was taken at this location. H0 was removed at a depth of 0-5 cm. H1 (sample 57) was sampled at a depth of 5-30 cm, and is brown in colour. It has a loose texture, and has the highest clay percentage (62%) at in the

non-archaeological areas of Doornkop. It comprises of 40% of rocks that are <1cm in length.

Sample 57 has high P and NO_3 concentrations of 2.68 mg kg^{-1} and 9.31 mg kg^{-1}. The Na concentration, however, is the lowest compared to the rest of the samples in the non-archaeological areas of Doornkop, at 3.68 mg kg^{-1} (Table 4.4).

Location 039

The sample site is located along the southern section of area C, adjacent to the fault line. This sample has no evidence for archaeological activity, the nearest being approximately 340 m away towards the east of this sample, where locations 041 and 042 are located. This section of the hill has a high gradient and comprises grass veldt (Fig. 4.3).

H0 was removed at a depth of 0-5 cm. Sample 58 (H1) is brown in colour, and has a loose texture. This sample has the lowest clay content (18%), along with location 043, of the non-archaeological samples in Doornkop. It consists of approximately 70% of rocks, averaging >12cm in length. This sample is located amongst green vegetation, where the soil is noticeably drier.

Sample 58 has high P and K concentrations of 3.33 mg kg^{-1} and 253.29 mg kg^{-1}, respectively. The Na concentration, in contrast, is low at 3.96 mg kg^{-1}. The NH_4 and NO_3 values are relatively at 7.95 mg kg^{-1} and 8.37 mg kg^{-1}, respectively. The %C, 2.74%, is also high, and has an acidity level of 5.87 (Table 4.4).

Location 043

Location 043 is in Area C, situated south east of the terraces described in locations 041 and 042, in potential grazing areas at the time of occupation (Fig. 4.3).

The H0 was removed at a depth of 0-7 cm. H1 (sample 62) was sampled at 7-18 cm in depth, and is brown in colour. At 17 cm, an impenetrable rock layer was encountered. The clay content was measured at 18% (Fig. 4.8).

The P, 1.88 mg kg^{-1}, and CEC, 25.73 cmol kg^{-1}, levels for sample 62 is low, compared to the rest of the non-archaeological samples in Doornkop. The %C is high at 2.16%. NH_4 and NO_3 is high in concentration, where NO_3 has the highest content compared to the rest of the Doornkop non-archaeological samples at 10.47 mg kg^{-1} (Table 4.4).



Figure 4. 8: Soil profile of samples taken at Location 043.

4.2. Khutwaneng

There are over 400 homesteads located in this site, of these approximately 170 are located in the area that was sampled (Fig. 3.1). The 400 homesteads include homesteads on the eastern side of the R36. There are also homesteads in the kloofs in the surrounding hills that are probably associated with periods when people had to take refuge (Delius *et al.* 2012) (Fig. 4.9).



Figure 4. 9: Khutwaneng hill with surrounding defensive kloofs.

The homesteads are built on the slopes, and terraces are attached to them. The gradient of this hill is not as steep as that at Doornkop. The site is navigated through is a central road system that with crossroads, and smaller paths leading off the main roads toward the homesteads. In addition, there is little evidence for borrowing of walls and reuse, which suggests that the site development was planned. The homesteads average 40.29 m in diameter, and most of them are configured in a flower pattern (one large outer wall, with a central inner circle and lobes attached to the inner wall).

4.2.1. Domestic areas

Nineteen samples were taken in the domestic areas of the homesteads, in ten locations. The domestic areas are located around the central stonewalled enclosure clusters, and often are separated from the surrounding areas with a stone wall (Fig. 10; Fig. 4.11; Fig. 4.12).

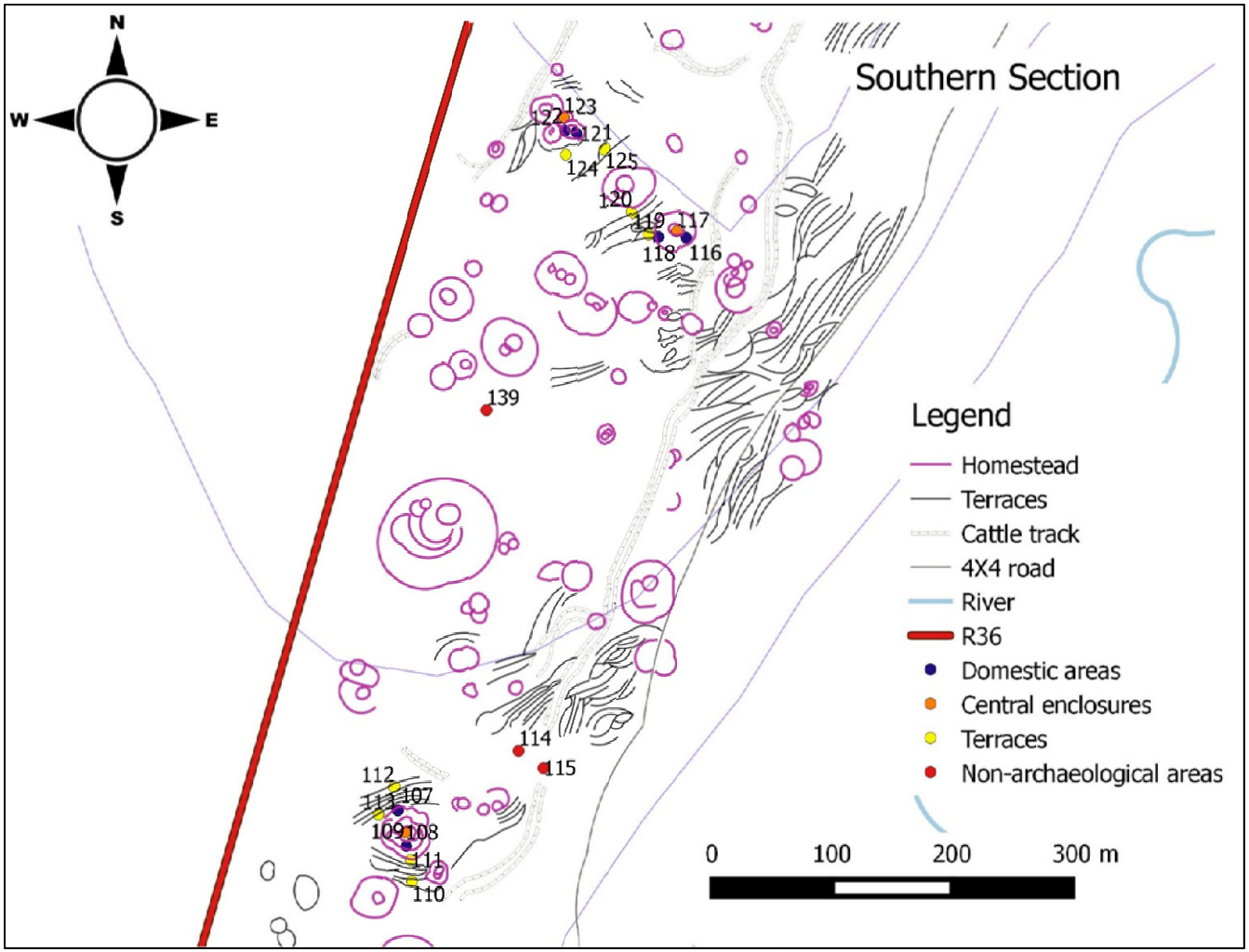


Figure 4. 10: Sampling locations in the southern section of Khutwaneng

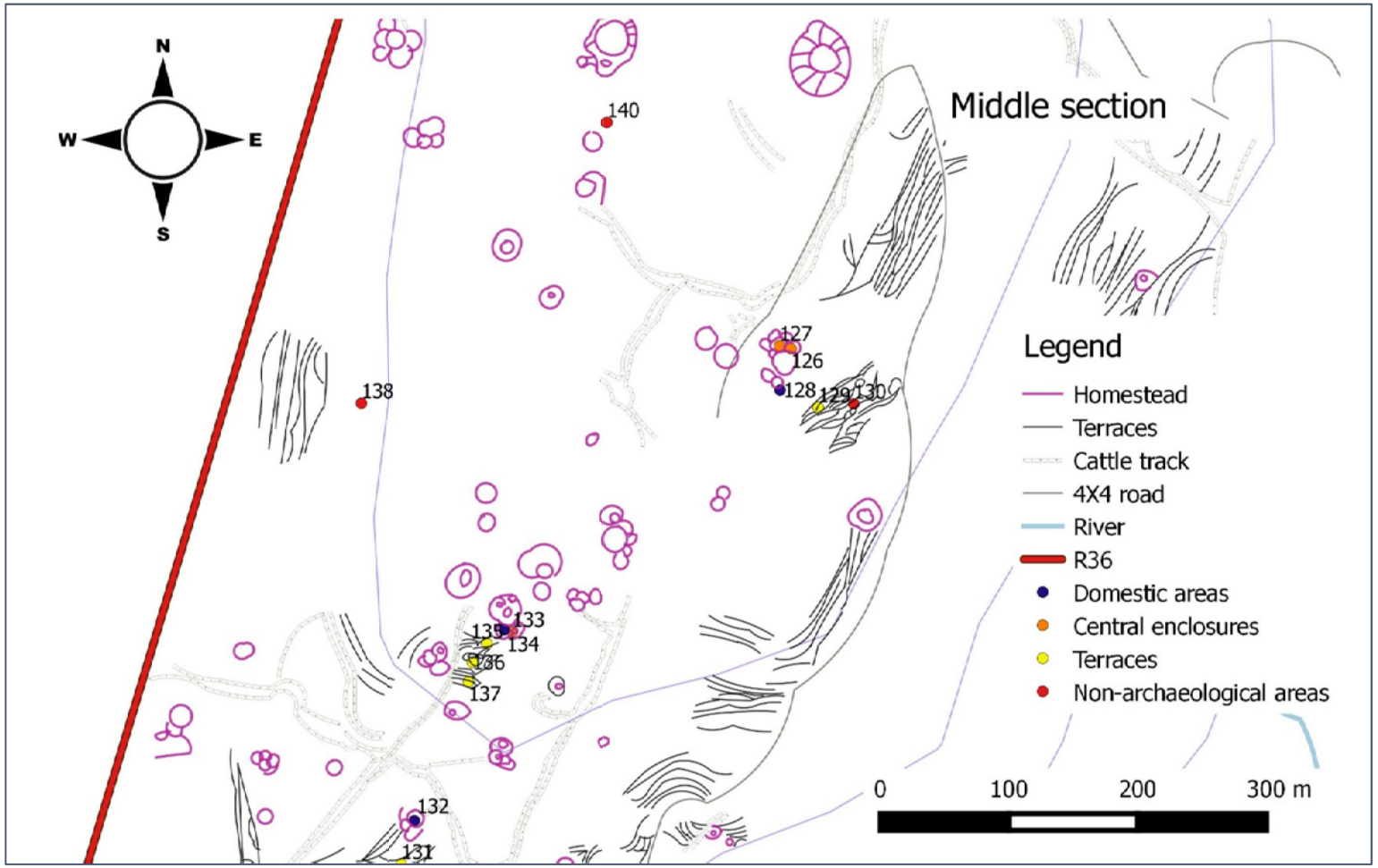


Figure 4. 11: Sampling locations in the middle section of Khutwaneng

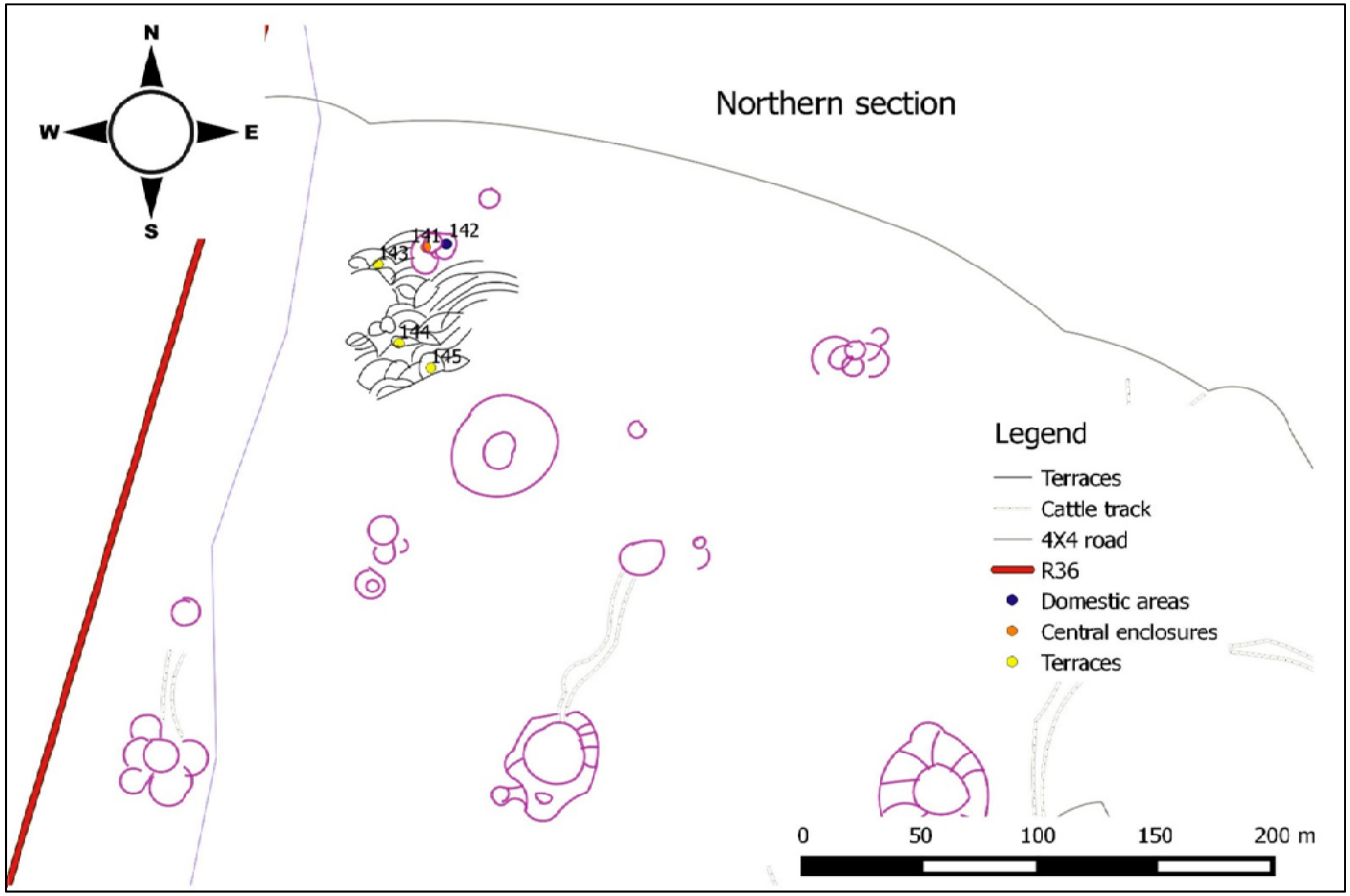


Figure 4. 12: Sampling locations of Northern section in Khutwaneng

Location 107

The homestead, from which this sample was collected in the southern area of the hill. It is approximately 116.51 m from the R36. The homestead is 42.76 m in diameter, and has a central inner circle. There is another inner circle around the central livestock enclosures, which is divided into two semicircles. Between the outer wall and the secondary wall, the area is divided into five sections. The sample was taken from the north western end of the homestead. A road runs along the eastern end of the homestead. Several homesteads cluster around this homestead, which also has terraces above it. The terraces associated with this homestead extend below it until the next homestead (Fig. 4.10).

The H0 was removed at a depth of 0-6 cm. H1 (sample 107) was sampled at 6-20 cm in depth and is dark reddish brown in colour. The soil is slightly clay rich (38%), and has a loose texture. It has the lowest silt (26%). in the domestic areas at Khutwaneng. This sample consists of approximately 2% rocks. The H2 and H3 of this location was analysed in bulk, (Sample 108) due to small amount of soil in these layers. H2 is reddish brown in colour and has a loose texture. This layer was sampled at a depth of 20–25 cm. H3 is orange/brown in colour and was sampled at a depth of 25-30 cm. H3 has similar orange saprolite to that found at Doornkop. This saprolite is a derivative of the dolerite.

Sample 107 has the second lowest concentration of Ca at 2709.96 mg kg^{-1} compared to the rest of the samples in this data set. The NO_3 is also distinctly lower at a concentration of 3.36 kg^{-1}, and is among the more acidic samples with a pH of 5.93. Sample 108 has low concentrations of P, K, NO_3 and CEC. P and NO_3 concentrations are both the second lowest in this sample set with values of 2.27 mg kg^{-1} and 3.01 mg kg^{-1} respectively. The CEC of sample 107 is lowest in the domestic areas of Khutwaneng, with a value of 29.86 cmol kg^{-1} (Table 4.5).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
107	107	2.98275	137.291	2709.963	8.242	821.60267	1.592149174	3.325	3.36	82.3016	28.92	38	26	5.93
108	107	2.271	70.811	3117.963	9.352	956.00267	1.330564782	3.325	3.01	29.8636	23.74	44	36	6.24
110	109	3.9435	146.891	3125.963	9.132	769.80267	2.077571907	3.325	3.29	61.62336	33.54	34	34	5.99
111	109	2.877	81.421	2996.963	9.762	763.40267	1.499444319	2.975	3.99	35.94192	16.16	52	36	6.16
123	116	3.57525	174.591	3120.963	5.902	683.20267	2.231918541	4.27	4.375	66.30782	27.88	34	42	6.08
124	116	16.1325	97.801	3236.963	11.942	721.70267	1.768926953	3.01	3.57	67.1324	30.1	38	36	6.28
126	118	3.48	393.691	2824.963	4.842	604.80267	2.46288068	8.19	6.125	62.35912	23.5	36	42	6.03
127	118	3.0585	255.491	2759.963	3.981	665.30267	0.64038778	4.865	2.975	66.3052	30.08	38	36	5.99
130	121	5.613	612.291	3084.963	9.002	687.50267	3.247749728	17.92	11.2	76.1248	24.86	32	42	5.91
131	122	5.241	591.391	2528.963	6.425	599.20267	2.792761354	5.46	6.44	64.73504	39.78	24	36	5.9
132	122	2.766	618.391	2659.963	6.336	669.10267	1.726961253	5.53	6.195	68.89483	26.3	36	40	6.08
144	128	3.53475	248.791	3163.963	13.482	639.00267	2.36981747	8.54	9.975	69.74007	31.5	38	34	6.16
145	128	3.15675	87.891	3731.963	11.322	820.80267	1.705773081	8.225	10.15	114.48881	38.64	36	28	6.41
150	132	3.357	426.991	2408.963	3.405	612.10267	2.656796094	6.79	5.005	76.31098	33.82	30	32	6.22
151	132	2.03925	169.191	3204.963	9.842	899.40267	1.144589182	3.64	5.355	79.40204	36.14	34	38	6.46
154	134	2.5935	466.791	3491.963	5.579	896.00267	2.728964404	8.68	7.875	94.15934	32.86	34	34	6.66
155	134	2.451	476.991	3228.963	5.963	851.20267	2.520444883	7.875	7.77	91.78544	42.18	24	34	6.51
171	142	10.92	587.391	3667.963	5.206	762.30267	1.75624807	8.155	12.11	57.60016	34.76	30	34	6.34
172	142	6.75225	584.791	2721.963	13.272	786.80267	1.723988336	5.53	7.98	52.71383	15.92	40	50	6.41

Table 4. 5: Chemical signatures of domestic areas in Khutwaneng.

Location 109

This sample is located in the same homestead described in location 107 in the southern section of Khutwaneng (Fig. 4.10). The southern end of the homestead near the outer wall was sampled.

H0 was removed at a depth of 0-3 cm. H1 (sample 110) was sampled at a depth of 3-16 cm and is dark brown in colour. The soil is slightly clay rich (34%) and has a loose texture. This sample consisted of approximately 10% of rocks. Sample 111 (H2) has a similar texture to sample 109, but is red in colour. The H2 was sampled at a depth of 16-40 cm and consists of rocks that were <5 cm. This sample has the highest clay content (52%) in the domestic areas of Khutwaneng.

Sample 110 has a concentration of 769.80 mg kg^{-1}, which is relatively high compared to the rest of the samples. The CEC for this sample is also relatively high at 61.62 cmol kg^{-1}. Sample 111 has a concentration of 81.42 mg kg^{-1} of K, which is second lowest in this data set. The Mg, however, is also relatively high similar to sample 110. The NH_4 is distinctly lower than the rest of the samples with a concentration of 2.975 mg kg^{-1}. Similarly, the CEC is second lowest compared to the rest of the samples, in the domestic areas in Khutwaneng, and almost half the value of the CEC of the H1 (sample 110) at 35.94 cmol kg^{-1} (Table 4.5)

Location 116

The homestead, from which this sample was collected is approximately 557 m north of locations 107 and 109. The homestead is 37.20 m in diameter and has a central inner circle. The homestead has a single central enclosure with terraces running below it. A road which forms the eastern boundary of the homestead, also

runs below it. A small cross road is located near this homestead. From there, the road filters into the homestead south east of this location, and then continues up northwards. The area that was sampled is in the eastern section of the homestead (Fig. 4.10).

Two samples were taken at this location. The H0 was removed at a depth of 0-6 cm. H1 (sample 123) is dark brown in colour and has a soft loose texture. H1 (sample 110) was sampled at a depth of 6-14 cm and is dark brown in colour. Sample 123 (H2) is reddish brown in colour. It was sampled from 14cm and lower. It consists of approximately 5% of rocks.

Sample 123 has a relatively low concentration of Na at 5.90 mg kg^{-1}. The K concentrations for both samples are relatively low, with sample 123 having 174.59 mg kg^{-1}, whereas sample 124 has nearly half of this at 97.80 mg kg^{-1}. Sample 124 has relatively low concentrations of NH_4 and NO_3 at 3.01 mg kg^{-1} and 3.57 mg kg^{-1} respectfully. The P content of this sample is significantly higher than the rest of the samples taken in the domestic areas of Khutwaneng, with a concentration of 16.13 mg kg^{-1}. The CEC of this sample is relatively high at 2.23 cmol kg^{-1} (Table 4.5).

Location 118

Location 118 is located in the lower domestic area on the eastern end of the homestead described in location 116 (Fig. 4.10).

H0 was removed at a depth of 0-4 cm. H1 (sample 126) is dark brown in colour, is slightly clay rich (36%) and has a loose texture. It was sampled at a depth of 4-12 cm with no rocks found. Sample 127 (H2) is reddish brown in colour and is

slightly clay rich (38%) with a loose texture. This was sampled at 12–23 cm in depth and consisted of <5% of rocks.

Both Samples 126 and sample 127 has below average concentrations of Ca at 2824.96 mg kg^{-1} and 2759.96 mg kg^{-1} respectively. Sample 126 has a relatively higher concentration of K at 393.69 mg kg^{-1}, whereas the Mg, 604.80 mg kg^{-1}, concentration is relatively low. It also has a very high concentration of NH_4 at 8.19 mg kg^{-1}. Sample 127 has below average concentrations of P at 3.06 mg kg^{-1}, Na at 3.98 mg kg^{-1}, and NO_3 at 2.97 mg kg^{-1} which is the lowest of all the samples in this data set. Sample 127 also has the lowest %C of 0.64% (Table 4.5).

Location 121

This location was sampled on the southern side of the homesteads. The homestead in which sample location was placed is north west of the homestead, associated with locations 116 and 118, and is 83.21 m from the R36. The soil at the surface is a distinctly different colour from the rest of this domestic area, and is dense with vegetation. Terraces occur from the south east of the homestead. The homestead is approximately 46 m in diameter, and has an indistinct shape (Fig. 4.10).

One sample was collected at location 121. H0 was removed at a depth of 0-4 cm. H1 (sample 130) is dark reddish brown in colour, and is a mixture of sand and clay. H1 was sampled between depths of 4-22 cm, and consisted of approximately 30% of rocks.

Sample 130 yielded noteworthy chemical data. The concentration of K, 612.29 mg kg^{-1}, is the second highest in samples taken in the domestic areas of Khutwaneng. The Na, 9.00 g kg-1, and NO_3, 11.2 mg kg^{-1}, concentrations are also

relatively high. The %C, 3.24%, and NH_4 concentration, 17.92 mg kg^{-1}, are both the highest in the dataset (Table 4.5).

Location 122

Sample location 122 situated in the north western section of the homestead described in location 121 (Fig. 4.10).

H0 was removed at a depth of 0-6 cm. Sample 131 (H1) is dark brown in colour, and was sampled at a depth of 6-16 cm. H1 consists of approximately 30% of rocks, and has the lowest clay (24%) content in the domestic areas of Khutwaneng. The second layer (sample 132) is reddish brown in colour and was sampled at 16-22 cm in depth. The auger reached the bottom of the hole, which was marked by rocks that were 5-10 cm in length. This soil layer had a low sand content of 26.3%.

Samples 131 and 132 have relatively high K content at 591.39 mg kg^{-1} and 618.39 mg kg^{-1} respectively. The K concentration for sample 132 is the highest in this sample set. The Ca in sample 131 is relatively low with a concentration of 2528.96 mg kg^{-1}. The Mg level is also the lowest for sample 131 at 599.20 mg kg^{-1}. This is also the most acidic sample with a pH of 5.9 (Table 4.5).

Location 128

The homestead from which this sample was obtained, is located, near the top of the hill approximately 30 m north east of the cell phone tower. The homestead has two livestock enclosures and has a flower petal shape. It is approximately 59.11 m in diameter. The sample was taken in the domestic area in the southern section of

the homestead, near a distinctive pile of rocks. Agricultural terraces, in association with this homestead run down the hill along natural terrace features (Fig. 4.11).

H0 was removed at a depth of 0-3 cm. Sample 144 (H1) is reddish brown in colour, and was sampled at a depth of 3-14 cm. H1 has a clay content of 38%. Sample 145 (H2) was sampled at a depth of 1-16 cm. This sample is red in colour, and has traces of orange saprolite (dolerite).

Both samples 144 and 145 have high Ca, Mg and NO_3 contents, where sample 145 has the highest concentration of 3731.96 mg kg^{-1} for Ca in the data set. Sample 144, however, has the highest Na content of 13.48 mg kg^{-1}. The CEC for both of these samples are highly contrasted where sample 144 falls in the average of the data set at 69.74 cmol kg^{-1}, and sample 145 has the highest CEC value of 114.49 cmol kg^{-1}. This is an interesting result, because it is expected that the CEC value would decrease with depth, but with this sample there is a large increase. Sample 145 has a very low concentration of K, 87.89 mg kg^{-1}, compared to the rest of the domestic areas (Table 4.5).

Location 132

The homestead in which samples 150 and 151 were taken, is along the north western limb of the central road. The homestead has a flower shape, with one central inner circle and six stone walled circles attached to it. The road associated with homestead is linked to the main road on the north eastern section. The homestead is approximately 36.54 m in diameter. The sample location is located in the northern section of the homestead (Fig. 4.11).

Samples 150 and 151 were taken at location 132. H0 was removed at a depth of 0-3 cm. H1 (sample 150) is dark reddish brown in colour and was sampled at a

depth of 3-16 cm. This sample has approximately <5% of rocks, and has a silt content of 36.18%. Sample 151 (H2) is red and orange in colour (doleritic saprolite) and has a clay content of 34%. This sample was sampled at a depth of 16-23 cm.

Sample 150 has a relatively high K concentration of 426.99 mg kg^{-1}. The Ca and Na levels are, however, the lowest concentrations in the domestic area dataset of Khutwaneng at 2406.96 mg kg^{-1} and 3.41 mg kg^{-1} respectively. Sample 151 consists of the lowest concentration of P at 2.04 mg kg^{-1}. The Mg, however, has a relatively high concentration of 899.40 mg kg^{-1}. The %C, 1.14%, and NH_4 concentration, 3.64 kg mg^{-1}, for sample 151 is relatively low (Table 4.5).

Location 134

The homestead, in which these samples were taken, is approximately 172.77 m north of the main crossroad intersection. The homestead is approximately 37.22 m in diameter, and has an indistinct shape. There is a central inner circle and an outer wall. There are a couple of lobes attached to the central circle. The sample was taken in the southern section of the homestead, with a very small entrance and has two tiers in the enclosure. The terraces run southward below the homestead and has a contemporary road east of it (Fig. 3.2).

H0 was removed at a depth of 0-6 cm. H1 (sample 154) is dark reddish brown in colour and was sampled at a depth of 6-12cm. This sample contains <5% of rocks and has a silt content of 34%. Sample 151 (H2) is reddish brown in colour, and also consists of <5% of rocks. This sample has the highest sand content (42.18%), and the lowest clay content (24%) in the domestic areas of Khutwaneng. This layer was sampled at a depth of 6-20 cm, where an impenetrable rock layer marked the bottom of the sample hole.

Both samples at this location have a very similar chemical composition. The concentration for K is relatively high, where sample 154 has a content of 466.79 mg kg^{-1}, and sample 155 of 476.99 mg kg^{-1}. The %C is also relatively high with an average of 2.62%. The CEC for these samples are also relatively high where sample 154 has a value of 94.16 cmol kg^{-1} and sample 155 a value of 91.79 cmol kg^{-1}. The pH for sample 154 is the most neutral sample at 6.66 (Table 4.5).

Location 142

This sampling location is in the eastern lobe of the homestead, a homestead further north from the rest of the sample sites. There is a contemporary road just north of this sample, and it is approximately 81.92 m from the R36. The homestead is approximately 20.22 m in diameter and has an irregular shape. There is a central inner circle and two lobes around it. It has an indentation in the south eastern end where it seems like be a road entrance. The terraces associated with this homestead run south west (Fig. 4.12).

H0 was removed at a depth of 0-5 cm. Sample 171 (H1) is dark brown in colour and consists of 34.76% of sand and 34% of silt. Sample 172 (H2) consists of the highest silt content (50%) and the lowest sand content (15.92%). This sample is red in colour.

Sample 171 has a relatively high P concentration of 10.92 mg kg^{-1}, K of 587.39 mg kg^{-1}, and Ca of 3667.96mg kg^{-1}. The NH_4 is also relatively high with a concentration of 8.155 mg kg^{-1}, and it also has the highest concentration of NO_3 with a value of 12.11 mg kg^{-1}. The %C, in contrast, is below average with a value 1.77%. Sample 172 also has a relatively high concentration of K, 584.79 mg kg^{-1}, but a below than average value of carbon percentage, 1.72% (Table 4.5).

4.2.2. Terraces

There were 27 samples taken in the terraced areas, in 16 locations. The terraces are associated with the homesteads and are on the slopes. Often, the terraces that were sampled are associated with the homesteads that were sampled.

Location 110

The terraces, in which sample site 110 is located, is associated with the homestead described in locations 107 and 108. This sample location is situated on the lower terrace, just above the homestead below this terraced system. This terraced system is relatively small and extends approximately 20 m below the homestead (Fig. 4.10).

H0 was removed at a depth of 0-4 cm. Sample 112 (H1) is dark reddish brown in colour and is slightly clay rich (36%) with a loose texture. H1 was sampled at a depth of 4-15 cm and consists of approximately 10% of rocks. Sample 113 (H2) is dark brown to red colour and is slightly clay rich (38%) with a loose soil texture. This sample was obtained at a depth of 15-25 cm.

Sample 112 has the second lowest concentration of Ca at 2415.96 mg kg^{-1}. The CEC for this sample is the lowest compared to the rest of the terraces in Khutwaneng, 40.51 cmol kg^{-1}. Sample 113 has a relatively low concentration of P, 1.91 mg kg^{-1}, Ca, 2497.96 mg kg^{-1}, and the lowest concentration of NO_3, 2.31 mg kg^{-1}, compared to the rest of the samples. The Na and NH_4 in contrast both have the highest concentrations compared to the rest of the samples, in this dataset, with values of 10.52 mg kg^{-1} and 36.75 mg kg^{-1} respectively (Table 4.6).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
112	110	3.33	188.69	2415.96	7.94	635.40	2.38	30.45	6.3	40.51	34.32	34	36	5.74
113	110	1.9	120.7	2498.0	10.5	658.1	1.8	36.8	2.3	61.1	21.1	38.0	44.0	6.0
114	111	3.1	346.6	2728.0	9.2	609.3	2.4	3.7	3.1	65.3	38.9	30.0	32.0	6.0
115	111	2.1	131.8	2535.0	7.5	625.7	1.5	3.1	2.7	56.5	16.5	52.0	32.0	6.1
116	112	2.6	303.2	2372.0	4.1	623.5	1.7	2.9	4.4	63.2	37.0	32.0	32.0	6.1
117	112	2.1	100.4	2547.0	6.7	728.0	1.6	2.1	4.0	61.2	25.2	42.0	36.0	6.1
118	113	2.8	215.0	2586.0	9.4	692.8	2.0	3.2	3.4	58.5	24.0	42.0	38.0	5.9
128	119	4.6	167.4	2728.0	7.7	685.9	2.9	9.8	6.4	73.1	35.1	30.0	36.0	5.6
129	120	2.7	258.4	2662.0	4.4	588.5	2.5	8.3	6.0	55.6	35.5	34.0	36.0	6.0
135	124	11.6	542.3	3174.0	4.3	714.9	2.9	15.7	8.4	72.4	40.1	34.0	24.0	6.2
136	124	7.0	433.8	3032.0	7.5	735.0	2.3	7.4	7.2	66.6	21.1	50.0	30.0	6.2
137	125	12.0	374.1	2863.0	5.9	604.4	2.8	10.2	11.1	66.1	39.8	26.0	34.0	6.0
138	125	2.8	50.5	2963.0	9.1	739.8	1.3	7.5	11.4	47.1	38.8	28.0	36.0	6.2
146	129	4.0	274.3	3061.0	6.6	754.3	3.1	8.8	7.5	80.1	30.1	32.0	42.0	6.1
149	131	2.6	83.2	2878.0	4.1	719.5	2.1	4.9	4.3	67.4	45.5	24.0	32.0	6.4
156	135	5.6	176.9	3103.0	4.1	708.2	3.1	4.9	5.2	77.8	23.8	32.0	46.0	5.9
157	135	2.7	78.3	2900.0	7.3	723.0	2.4	3.3	5.3	63.6	36.3	34.0	32.0	6.1
158	136	3.8	124.2	2771.0	6.4	683.7	1.9	4.7	4.5	78.5	36.9	26.0	38.0	6.1
159	136	2.3	88.3	2705.0	9.9	709.3	1.8	3.9	3.3	63.7	45.5	24.0	32.0	6.2
160	137	2.2	114.7	2940.0	3.6	709.5	2.6	4.7	6.3	64.6	37.3	30.0	36.0	6.2
161	137	3.6	299.6	2821.0	3.5	672.5	2.2	5.6	6.2	66.2	44.3	22.0	34.0	6.1
173	143	2.6	99.2	2918.0	7.3	751.2	1.2	7.0	4.9	44.6	33.2	36.0	32.0	6.2
174	143	1.9	68.5	3061.0	9.1	784.0	2.1	5.0	7.1	44.9	22.7	48.0	34.0	6.5
175	144	3.1	141.3	2676.0	5.1	628.8	2.0	6.9	6.1	44.8	36.3	36.0	30.0	6.2
176	145	1.8	134.5	3060.0	4.7	683.0	1.4	5.3	5.6	48.9	19.1	48.0	36.0	6.5

Table 4. 6: Chemical signatures of terraces in Khutwaneng.

Location 111

Samples 114 and 115 were taken from location 111, which is in the same terraced system that was described in location 10. This sample is in the upper section of the terraces, being the second terrace from the homestead (Fig 4.10).

H0 was removed at a depth of 0-5 cm. H1 (Sample 114) is dark brown in colour and consists of 38.86% of sand. There were rocks present, and was it sampled at a depth of 5-9 cm. Sample 115 (H2) is red in colour and has a loose soil texture. This sample has the highest clay content (52%), and the lowest sand content (16.48%) of the samples from the terraces in Khutwaneng. This sample has no rocks present and was sampled at a depth of 9-24 cm.

The K and Na concentrations for sample 114 are relatively high. The NH_4 for sample 114 is relatively low with a concentration of 3.71 mg kg^{-1}. Sample 115 has low concentrations for NH_4, 3.12 mg kg^{-1} and NO_3, 2.73 mg kg^{-1} in this sample set. The %C, 1.46% is also relatively low (Table 4.6).

Location 112

This sample site is located on the south east of the homestead, on the middle section of the terraces. The layout of the homestead, with which this terraced system is associated, is slightly ambiguous, but it seems to have a central inner circle, and five lobes attached to it. It is approximately 37.01 m in diameter. A road leads into the homestead from the east (Fig. 4.10).

H0 was removed at a depth of 0-5 cm. H1 (Sample 116) is reddish brown in colour, and has a soft loose texture. There are <5% rocks present, and the location

was sampled at a depth of 5-16 cm. Sample 117 (H2) is greyish reddish brown in colour and also has a soft loose soil texture. This sample has 40% of rocks present and was sampled at a depth of 16-23 cm.

Sample 116 has a relatively low P and Na content at concentrations of 2.59 mg kg^{-1} and 2371.966 mg kg^{-1} respectively. The Ca content, 2371.96 mg kg^{-1}, is the lowest concentration compared to the rest of the samples taken in the terraces of Khutwaneng. Sample 117 also has relatively low P and K concentrations of 214 mg kg^{-1} and 100.39 mg kg^{-1} respectively. The NH_4 concentration is the lowest at 2.06 mg kg^{-1} (Table 4.6).

Location 113

This sample is located in terraces associated with the homestead described in locations 107 and 109. These terraces are attached to the western section of the homestead (Fig. 4.10).

H0 was removed at a depth of 0-3 cm. Sample 118 (H1) contained no rocks, and it was obtained from a depth of 3-24 cm. H1 is dark brown in colour and has a soft loose texture.

Sample 118 has relatively low concentrations of NH_4 and NO_3 at 3.15 mg kg^{-1} and 3.36 mg kg^{-1} respectively, compared to the rest of the terraced samples in Khutwaneng. The Na content, however, is relatively high with a concentration of 9.42 mg kg^{-1}. The clay content is relatively high (42%), and the sample has a pH of 5.91 (Table 4.6).

Location 119

This sample site is located in the terraces associated with the homestead described in locations 116 and 118. These terraces are, however, attached to the western section of the homestead, not the south (Fig. 4.10)

One sample was taken at location 119. H0 was removed at a depth of 0-4 cm. Sample 128 (H1) contained approximately 30% rocks, and is dark brown in colour. This sample was the shallowest for the terraces in Khutwaneng, where H1 was sampled at a depth of 4-10 cm. There were roots throughout the deposit.

Sample 128 has a relatively high nutritional status with the Na, 7.74 mg kg^{-1}, NH_4, 9.77 mg kg^{-1}, and NO_3, 6.44 mg kg^{-1}, concentrations all reasonably being higher than average. The %C and the CECs are both noticeably higher at 2.89% and 73.14 cmol kg^{-1} respectively. The K content, in contrast, is relatively low with a value of 167.39 mg kg^{-1}. This sample is also the most acidic in the sample set for the terraces, at Khutwaneng, with a pH of 5.62 (Table 4.6).

Location 120

Location 120 is located in the lower section of the set of terraces at location 119 (Fig. 4.10).

H0 was removed at a depth of 0-6 cm. Sample 129 (H1) is a dark reddish brown colour and has a rock content of approximately 30%. H1 was sampled at a depth of 6-16 cm until rocks signalled the lowest point of the core.

Sample 129 has relatively low P and Na concentrations at 2.70 mg kg^{-1} and 4.36 mg kg^{-1}. The Mg content, 588.50 mg kg^{-1}, for this sample is the lowest in this dataset. The NH_4 in sample 129 is relatively high with a concentration of 8.33 mg kg^{-1} (Table 4.6).

Location 124

Location 124, from which samples 135 and 136 were taken, is situated in the top terrace, south of the homestead described in location 121 in the southern section of the site (Fig. 4.10).

H0 was removed at a depth of 0-4 cm. Sample 135 (H1) is dark brown in colour and has a rock content of approximately 10%. It has a slightly silty texture, and was sampled at a depth of 4-6 cm. H2 (sample 136) is reddish brown in colour, and has a clay like texture. It comprises 40% of rocks and was sampled at a depth of 6-19 cm.

Sample 135 has relatively high P, 11.58 mg kg^{-1}, and Mg, 714.3 mg kg^{-1}, concentrations compared to the rest of the terraces in Khutwaneng. It has the highest concentrations of K and Ca, 542.29 mg kg^{-1} and 3173.96 mg kg^{-1} respectively. The %C, 2.88%, and CEC, 72.38 cmol kg^{-1}, are also relatively high. Sample 136 has relatively high Ca, Na, and Mg of concentrations of 3031.96 mg kg^{-1}, 7.48 mg kg^{-1}, and 735.00 mg kg^{-1} (Table 4.6).

Location 125

Location 125 is located on the eastern end of the homestead, in the same terraced system as location 124 (Fig. 4.10).

H0 was removed at a depth of 0-3 cm. Sample 137 (H1) is dark brown in colour and has a rock content of approximately 3%. It has a sand content of 38% and was sampled at a depth of 3-8 cm. H2 (sample 138) is reddish brown in colour and has a slightly clayish loose texture. It comprises of <5% of rocks and was sampled at a depth 8-22 cm. There is also doleritic saprolite present.

Sample 137 has the highest P concentration of 12.00 mg kg^{-1}. The NH_4 and NO_3 concentrations are relatively high at 10.22 mg kg^{-1} and 11.1 mg kg^{-1} respectively. The %C of sample 137 (2.79%), and sample 138 (1.32%), are in contrast. Sample 138 has a relatively low P concentration of 2.84 mg kg^{-1}, and the lowest concentration of K at 50.46 mg kg^{-1}. The concentrations for Ca, 2962.96 mg kg^{-1}, Na, 2962.96 mg kg^{-1}, and Mg, 739.80 mg kg^{-1}, is relatively high (Table 4.6).

Location 129

Location 129 is in the middle section of the site, situated higher up on the terraces on the lower eastern side of the homestead described in location 128. Terraces extend approximately 44.28 m down the hill (Fig. 4.11).

H0 was removed at a depth of 0-5 cm. H1 (sample 146) is brown in colour and has a silt content of 42%. This sample has 60% of rocks at on average a length of approximately 10 cm.

Sample 146 has the highest %C and CEC compared to the rest of the samples in the terraces of Khutwaneng, at 3.13% and 80.13 cmol kg^{-1}. This sample also has relatively high concentrations of Ca, 3060.96 mg kg^{-1}, and Mg, 754.30 mg kg^{-1}. The sample is also relatively acidic with a pH of 6.07 (Table 4.6).

Location 131

Location 131 is located below the homestead described in location 132. These terraces are relatively extensive, extending 48.15 m down the hill (Fig. 4.11).

H0 was removed at a depth of 0-5 cm. H1 (sample 149) is dark reddish brown in colour and is one of two samples that has the highest sand content (45.5%) in the terraces in Khutwaneng. H1 was sampled at a depth of 5-16 cm, and has a rock percentage of <10%. This core section has two more layers that are saprolitic. These were not sampled.

Sample 149 has a relatively low Na concentration of 4.05 mg kg^{-1}. The concentrations for P, 2.62 mg kg^{-1} and K, 83.22 mg kg^{-1}, are also relatively low compared to the rest of the samples in the terraces of Khutwaneng. The Mg, however, is relatively high with a concentration of 719.50 mg kg^{-1}. The %C and the CEC values are relatively high at 2.10% and 67.35 cmol kg^{-1}. It is a less acidic sample with a pH of 6.41 (Table 4.6).

Location 135

This sampling location is situated in the top section of the terraced system associated with the homestead described in location 133. The terraces extend approximately 47.64 m southwards, but the terrace sampled is relatively small (Fig. 4.11).

H0 was removed at a depth of 0-6 cm. Sample 156 (H1) is dark brown in colour, and has <5% of rocks. Sample 156 has the highest silt percentage (46%), and was sampled at a depth of 6-14 cm. Sample 157 (H2) is dark red in colour and was

sampled from a depth of 14-27 cm. H2 has a sandy content (36.28%) and is composed of approximately 30% of rock.

Sample 156 has a relatively high Ca content of 3102.96 mg kg^{-1}, and a relatively low concentration of Na with a value of 4.12 mg kg^{-1}. This sample has a relatively high %C of 3.06%, and a CEC of 77.77 cmol kg^{-1}. Sample 157 also has fairly high organic carbon content of 2.4% and CEC of 63.58 cmol kg^{-1}. The Ca levels, 2899.96 mg kg^{-1}, are relatively high, whereas the K concentration, 78.31 mg kg^{-1}, is relatively low compared to the rest of the sample set (Table 4.6).

Location 136

This sample is located in the middle section of the terraced system describe in location 136. This terrace is smaller than the terrace at location 135 (Fig. 4.11).

H0 was removed at a depth of 0-5 cm. Sample 158 (H1) is dark brown in colour, and was sampled at a depth of 5-10 cm. H1 is composed of 38% of silt. Sample 159 (H2) is reddish brown in colour and was sampled from a depth of 10-27 cm. This sample is composed of <5% of rocks, and has the highest sand content (45.5%) of the terraced samples in Khutwaneng, along with sample 149.

Sample 158 has relatively high Ca, 2770.96 mg kg^{-1}, and Mg, 683.70 mg kg^{-1}, concentrations. The CEC, 78.50 cmol kg^{-1}, and the %C, 1.89%, are in contrast. The CEC is relatively high, but the organic carbon is relatively low compared to the rest of the samples taken in the terraces in Khutwaneng. Sample 159 has relatively high concentrations of Ca, 2704.96 mg kg^{-1}, Na, 9.92 mg kg^{-1}, and Mg, 709.30 mg kg^{-1}. The K concentration, however, is relatively low with a value of 88.26 mg kg^{-1} (Table 4.6).

Location 137

Location 137 is situated immediately below the terrace of location 136. This terrace is noticeably longer than the previous two that were described (Fig. 4.11)

H0 was removed at a depth of 0-5 cm. Sample 160 (H1) is brown in colour, and was sampled at a depth of 5-12 cm. This sample is cay rich and consists of <5% of rocks. Sample 161 (H2) is red in colour and was sampled from a depth of 12-22 cm. This sample is composed of less than 3% of rocks, and has the lowest clay content (22%) when compared to the rest of the samples taken in the terraces in Khutwaneng.

Sample 160 has relatively low K, 114.69 mg kg^{-1}, and Na, 3.60 mg kg^{-1}, concentrations compared to the rest of the samples in the terraces at Khutwaneng. The Ca, 2939.96 mg kg^{-1}, and Mg, 709.50 mg kg^{-1}, concentrations are relatively high. %C, 2.63%, is also relatively high. Sample 161 has the lowest concentration of Na, 2820.96 mg kg^{-1}, compared to the rest of the data for the terraces. The Ca, 2820.96 mg kg^{-1}, and the Mg, 672.50 mg kg^{-1}, are relatively high (Table 4.6).

Location 143

Location 143 is in the lowest terrace associated with the homestead described in location 142. The terraces are not very extensive, being approximately 15.69 m in length (Fig. 4.12).

H0 was removed at a depth of 0-4 cm. Sample 173 (H1) is bright red in colour, and was sampled at a depth of 4-16 cm. This sample is moist, and consists of 36% of silt with no rocks present. Sample 174 (H2) is deep red in colour and was

sampled from a depth of 16-27 cm. This sample has a relatively high clay content (48%).

Sample 173 has the lowest %C of 1.18% compared to the rest of the samples. The CEC, 44.63 cmol kg^{-1}, is also relatively low. The Ca, 2917.96 mg kg^{-1}, and Na, 7.29 mg kg^{-1}, concentrations are relatively high. The Mg concentration, 784 mg kg^{-1}, for sample 174 is the highest compared to the rest of the samples. The Ca, 3060.96 mg kg^{-1}, and Na, 3060.96 mg kg^{-1}, are relatively high, along with the %C, 2.12%. The concentration for P, 1.77 mg kg^{-1}, is very low. Sample 174 has the most neutral pH of 6.52 (Table 4.6).

Location 144

This terraced system is associated with a homestead south of the homestead described in location 142. The homestead is approximately 43.54 m in diameter. The terraces run south west from the homestead. Sample 170 was taken in the top section of the terraces (Fig. 4.12).

H0 was removed at a depth of 0-4 cm. Sample 175 (H1) is bright red in colour, and was sampled at a depth of 4-15 cm. This sample has a dry, slightly clay rich (36%) texture. The soil becomes a deeper red colour with depth, but this may be due to increased moisture.

Sample 175 has a relatively low concentration of P, 3.09 mg kg^{-1}, and K, 141.29 mg kg^{-1}. The %C, 1.98%, and CEC, 44.79 cmol kg^{-1}, is also relatively low (Table 4.6).

Location 145

Location 144 is located north from location 144. This sample is in the upper section of the terraced system (Fig. 4.12).

H0 was removed at a depth of 0-4 cm. Sample 176 (H1) is deep red in colour, and was sampled at a depth of 4-18 cm. This sample has the highest clay content of 48% along with sample 174. Further down the profile the soil becomes moister, until rocks mark the bottom of the coring hole.

Sample 176 has the lowest P concentration of 1.77 mg kg^{-1}. The Na concentration, 4.75 mg kg^{-1}, is relatively high, whereas the Ca concentration, 3059.96 mg kg^{-1}, is relatively low. The %C, 1.4.2%, and CEC, 48.92 cmol kg^{-1}, is also relatively low. Sample 176 has a relatively more neutral pH of 6.5 (Table 4.6).

4.2.3. Livestock enclosures

There were 14 samples taken in the livestock enclosures areas of the homesteads, in 7 locations. Sample locations were numbered consecutively (e.g. GPS 001, GPS 002, etc.) and were mapped (Table 3.3). The livestock enclosures are located in the inner circles. Various homesteads were sampled in the different sections of the site described earlier.

Location 108

Location 108 is in the middle of the livestock enclosures, of the homestead described in Locations 107 and 109 in the southern section of the site (Fig. 4.10).

H0 was removed at a depth of 0-5 cm. Sample 109 (H1) is a reddish brown in colour, and was sampled at a depth of 5-20 cm. The sample is clay rich (42%) with a loose texture. There is approximately 2% of rocks of which there is quartz present.

Sample 109 has a relatively low concentration of P at 4.82 mg kg^{-1}, and a relatively high concentration of Mg, 813.30 mg kg^{-1}. The NH_4, 4.03 mg kg^{-1}, and NO_3, 2.56 mg kg^{-1}, are the lowest concentrations in the livestock enclosures. The CEC is also relatively low with at 57.37 cmol kg^{-1}, along with the carbon percentage of 1.72% (Table 4.7).

Location 117

This sample is associated with the homestead described in locations 116 and 117 (Fig. 4.10). The sampling point is in an area where the soil is significantly darker than in other areas, but looks undisturbed.

H0 was removed at a depth of 0-4 cm. Sample 125 (H1) is a dark brown in colour, and was sampled at a depth of 4-16 cm. The sample is slightly clay rich (32%) with a loose texture, and has the highest silt content of 44% compared to the rest of the samples. There are not a lot of rocks present in the sample, until the bottom of the sample. The rocks are <15 cm in length.

Sample 117 has the highest concentration of P at 13.50 mg kg^{-1} in this sample set. The Na concentration on the other hand is relatively low with a value of 9.46 mg kg^{-1}. The %C, 2.79%, and the CEC, 73.41 mg kg^{-1}, are both relatively high. This sample has a pH of 5.59 which is the most acidic sample in the data set for the livestock enclosures in Khutwaneng (Table 4.7).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
109	108	4.8	299.0	2970.0	5.4	813.3	1.7	4.0	2.6	57.4	23.5	42	36	6.1
125	117	13.5	382.6	2960.0	9.5	637.2	2.8	6.7	4.9	73.4	22.8	32	44	5.6
133	123	4.8	420.3	2568.0	4.4	614.2	2.4	11.2	9.3	66.8	38.5	28	34	6.0
134	123	2.8	255.4	2485.0	4.7	667.8	1.4	6.4	12.5	61.1	17.5	44	42	6.2
139	126	3.0	435.2	2407.0	7.9	539.0	1.8	8.1	5.7	62.8	44.6	36	20	6.2
140	126	6.6	336.9	3118.0	4.3	705.1	1.7	7.6	8.1	59.5	22.1	44	36	6.1
141	127	3.0	472.6	3008.0	7.2	622.8	2.1	16.0	7.0	88.5	44.7	26	30	6.1
142	127	3.1	171.8	4219.0	19.4	904.8	1.4	4.6	5.5	46.4	36.6	34	32	6.2
143	127	3.5	237.0	4683.0	23.4	1016.1	1.1	12.0	8.6	57.4	62.2	16	22	6.3
152	133	2.6	398.7	3128.0	14.9	730.9	2.6	6.2	7.1	80.4	42.1	24	34	6.6
153	133	2.5	391.1	3062.0	11.8	696.4	2.5	6.2	9.1	85.7	51.1	20	30	6.6
169	141	5.1	362.6	3060.0	8.7	835.7	2.7	7.6	10.0	56.0	30.8	32	40	6.1
170	141	4.0	383.0	2716.0	11.4	790.7	3.3	7.3	12.4	51.9	22.3	44	38	6.1

Table 4. 7: Chemical signatures of livestock enclosures in Khutwaneng.

Location 123

This sample is located in the homestead associated with location 124 (Fig 4.10).

H0 was removed at a depth of 0-3 cm. Sample 133 (H1) is dark reddish brown in colour, and was sampled at a depth of 3-14 cm. H1 is composed of 10% of rock. Sample 134 (H2) is red/orange in colour, is quite moist, and was sampled at a depth of 14-22 cm. It has doleritic saprolite present, and is composed of approximately 20% of rocks. This sample has the highest clay content of 44% along with samples 140, and 170, including the lowest sand content of 17.54%, in the livestock enclosures sampled in Khutwaneng.

Sample 133 has a relatively high concentration of K, 420.29 mg kg^{-1}. Ca, 2567.96 mg kg^{-1}, and Na, 4.35 mg kg^{-1}, have relatively low concentrations. Sample 134 has the highest concentration of NO_3, 12.5 mg kg^{-1}, in the livestock enclosure sample set taken in Khutwaneng. The P, 2.84 mg kg^{-1}, and Ca, 2484.96 mg kg^{-1}, is relatively low, along with the %C, 1.38%, and the CEC, 61.10 cmol kg^{-1} (Table 4.7).

Location 126

This sampling point is located in the homestead described in location 128, in the middle section of the site. This sample is taken in the eastern inner circle (Fig. 4.11).

H0 is red in colour with very little organic matter, and was removed at a depth of 0-5 cm. Sample 139 (H1) is reddish brown in colour, and was sampled at a depth of 5-12 cm. H1 is composed of less than 3% of rock, and has the lowest silt

content of 20%. Sample 140 (H2) is dark brown in colour and is composed of less than 5% of rocks. This sample has the highest clay (44%) in the livestock enclosure dataset of Khutwaneng.

Sample 139 has the lowest concentrations of Ca, 2406.96 mg kg^{-1}, and Mg, 539.00 mg kg^{-1}. P, 2.96 mg kg^{-1}, has a relatively low concentration, whereas K, 435.9 mg kg^{-1}, is relatively high compared to the rest of the livestock enclosures in Khutwaneng. Sample 140 has the lowest concentration of Na, in this dataset, with a value of 4.27 mg kg^{-1}. This sample also has below than average %C and CEC at 1.65% and 59.46 cmol kg^{-1} (Table 4.7).

Location 127

This sampling point is located in the western inner circle of the homestead at location 126 (Fig. 4.11).

H0 was removed at a depth of 0-5 cm. Sample 141 (H1) is dark reddish brown in colour. Sample 142 (H2) is a brownish orange colour, with no rocks found. This sample has traces of doleritic saprolite. Sample 143 (H3) is orange in colour (doleritic saprolite) and has a soft texture. This sample has the lowest clay content (16%), but the highest sand content (62.22%) in the livestock enclosures of Khutwaneng.

Sample 141 has the highest concentrations of K, 472.59 mg kg^{-1}, and NH_4, 15.96 mg kg^{-1}, compared to the rest of this sample set. It also has the highest CEC of 88.48 cmol kg^{-1}, and a relatively high %C of 2.13%. Sample 142 has the lowest concentration of K at a value of 171.79 mg kg^{-1}. The %C and CEC is also relatively low at 1.36% and 46.44 cmol kg^{-1}. Sample 143 has the highest concentrations of Ca, 4682.96 mg kg^{-1}, Na, 23.39 mg kg^{-1}, and Mg, 1016.10 mg

kg^{-1}. H3, however, has the lowest %C of 1.07% of the livestock enclosures in Khutwaneng (Table 4.7).

Location 133

This sample is located in the homestead described in location 134 (Fig. 4.11).

Location 133 has three layers where only two layers were sampled. H0 was removed at a depth of 0-5 cm. Sample 152 (H1) is dark brown in colour, and was sampled at a depth of 5-10 cm. This sample has a sand content of 42.14%, and has <5% rocks. Sample 153 (H2) is reddish brown in colour and was sampled at depth of 10-17 cm. The rock content increases at the bottom of this layer and has a sand content of 51.12%. H3 was not sampled due to it being very shallow and would not be enough saprolite to analyse. This layer is orange in colour and derived from dolerite.

Samples 152 and 153 have a similar chemical composition. The P composition for sample 152 is relatively low at 2.61 mg kg^{-1}, whereas sample 153 has the lowest P concentration in livestock enclosure sample set, in Khutwaneng, with a value of 2.53 mg kg^{-1}. K, for both these samples, is relatively high where sample 152 has a concentration of 398.69 mg kg^{-1}. Na is also relatively high where sample 152 has a concentration of 14.92 mg kg^{-1}. The %C and CEC is relatively high. Sample 153 has a relatively high concentration of NO_3 at 9.14 mg kg^{-1}, but has the most neutral pH of 6.63 of the Khutwaneng livestock enclosure samples (Table 4.7).

Location 141

This sampling point is located in the homestead described in location 142 (Fig. 4.12)

H0 was removed at a depth of 0-6 cm. Sample 169 (H1) is dark brown in colour, and was sampled at a depth of 6-12 cm. This sample has a silt content of 40%, and has no rocks present. Sample 170 (H2) is red in colour and was sampled at depth of 12-19 cm. The soil is soft and moist with the highest clay content of 44% along with samples 134 and 140. Rocks were found at the bottom of this sample.

Sample 169 has a relatively high concentration of P, 5.09 mg kg^{-1}. The K concentration is also relatively high with a value of 362.59 mg kg^{-1}. The %C is relatively high at 2.67%, but interestingly the CEC, 56.34 cmol kg^{-1}, is relatively low. Sample 170 has relatively low concentration of P, 3.99 mg kg^{-1}, but the K concentration, 382.99 mg kg^{-1}, is relatively high. The %C, 3.33%, is the highest in the sample set, but the CEC, 51.90, is the lowest in the livestock enclosure sample set in Khutwaneng (Table 4.7).

4.2.4. Non-archaeological areas

There were 13 samples taken in the non-archaeological areas in 6 locations. This site has a significantly low amount of non-archaeological samples due to there being very few areas that seemed relatively untouched.

Location 114

Location 114 is approximately 94 m north east from the homesteads associated with locations 107, and 109, near a homestead with small faint walls. The vegetation in this area is very different, there is shorter grass here compared to the surrounding areas (Fig. 4.10).

H0 was removed at a depth of 0-5 cm. Sample 119 (H1) is dark reddish brown in colour, and was sampled at a depth of 5-15 cm. This sample has a sand content of 38.08%, and has approximately 40% of rocks present. Sample 120 (H2) is brown in colour and was sampled at depth of 15-18 cm. The soil is soft and powdery and has approximately 80% of rocks, of which there is saprolite present. Sample 121 (H3) is red/orange in colour and was sampled at a depth of 18-26 cm. This sample has 36% clay present and has approximately 5% of rocks present. This is a saprolitic sample derived from dolerite.

Sample 119 has the lowest concentration of Ca in this sample set at 2659.96 mg kg^{-1}. This sample, however, has a relatively high Na, 11.94 mg kg^{-1}, concentration. The %C is the highest in this dataset at 3.35%, and a relatively high CEC of 71.51 cmol kg^{-1}. The pH for this sample is also the most acidic sample at 5.68. Sample 120 has a relatively high Na concertation of 11.72 mg kg^{-1}. The %C, 2.43%, for this sample is relatively high, whereas the CEC is relatively low at a value of 53.89 cmol kg^{-1}. Sample 121 has the highest concentration of Na, 14.63 mg kg^{-1}, in the sample set, and a relatively high Mg concentration of 930.60 mg kg^{-1}. The %C is relatively low at 1.98%, but in contrast the CEC is relatively high with a value of 66.69 cmol kg^{-1} (Table 4.8).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
119	114	2.7	138.3	2660.0	11.9	682.6	3.3	2.9	2.9	71.5	38.1	34.0	28.0	5.7
120	114	2.5	86.8	2753.0	11.7	801.8	2.4	2.6	3.9	53.9	34.8	36.0	32.0	6.0
121	114	2.2	55.7	2927.0	14.6	930.6	2.0	2.5	4.4	66.7	23.5	46.0	32.0	6.2
122	115	2.9	61.4	3895.0	12.4	1052.1	2.4	2.3	2.5	69.5	66.1	12.0	24.0	5.8
147	130	3.1	129.0	2858.0	8.1	707.1	2.1	10.0	9.5	72.6	52.8	20.0	18.0	6.3
148	130	1.7	22.0	3413.0	11.2	871.8	1.0	5.3	10.5	69.1	47.1	18.0	38.0	6.4
162	138	2.2	167.3	2949.0	2.8	707.1	1.3	5.2	4.7	47.8	35.8	34.0	32.0	6.1
163	138	2.0	75.1	3412.0	7.5	818.1	2.3	4.3	4.1	46.2	35.8	36.0	30.0	6.4
164	139	2.4	367.0	3834.0	2.5	687.5	1.9	8.7	4.9	48.7	33.0	32.0	38.0	7.0
165	139	2.5	306.5	3524.0	3.4	843.6	1.1	6.8	8.9	51.0	23.4	44.0	38.0	6.8
166	139	2.0	230.9	3569.0	7.7	1023.1	2.0	4.9	6.1	51.7	16.5	50.0	36.0	6.6
167	140	2.5	184.4	2795.0	4.6	677.1	1.0	6.2	5.8	45.8	43.3	26.0	32.0	6.3
168	140	1.6	67.5	3553.0	7.3	863.2	3.2	4.1	3.1	45.5	34.8	30.0	36.0	6.4

Table 4. 8: Chemical signatures of non-archaeological areas in Khutwaneng.

Location 115

Location 115 is a saprolitic sample 25.61 m south east from location 114. There is a geological contact of dolerite and shale between these two locations. There are also approximately terraces 6 m south of this sample (Fig. 4.10).

H0 was removed at a depth of 0-3 cm, and seems to have a high amount of organic matter present. Sample 122 (H1) is greyish brown in colour, and was sampled at a depth of 3-12 cm. This sample has a soft loose texture, and is saprolite derived from shale. H1 has the highest sand content of 66.12%, and the lowest clay and silt content of 12% and 24% respectively.

Sample 122 has the highest concentrations of Ca and Mg at 3894.96 mg kg^{-1} and 1052.10 mg kg^{-1} respectively. This sample also has the lowest concentrations of NH_4, 2.28 mg kg^{-1}, and NO_3, 2.52 mg kg^{-1}, in this sample set (Table 4.8).

Location 130

Location 130 is located approximately 20 m lower down the hill from location 129, in the middle section of the site. It is a natural terrace located in between agricultural terraces (Fig. 4.11)

H0 was removed at a depth of 0-2 cm. Sample 147 (H1) is reddish brown in colour, and was sampled at a depth of 2-12 cm. H1 has a relatively high sand content of approximately 52.82%. Sample 148 (H2) is orange in colour (doleritic saprolite) and was sampled at a depth of 12-15cm. This sample has the highest silt content compared to the rest of the samples at 38%, along with samples 164 and 165.

Sample 147 has the highest concentration of P at 3.08 mg kg^{-1}. This sample also has the highest %C and CEC at 10.01% and 72.55 cmol kg^{-1}. Sample 148 has the lowest concentration of K at 21.95 mg kg^{-1}. On the other hand, the NO_3 concentration, 10.46 mg kg^{-1}, is the highest in this sample set. This sample also has the lowest %C of 0.98%, but a relatively high CEC of 69.12 cmol kg^{-1} (Table 4.8).

Location 138

Location 138 is located between two sets of terraces. This sample is approximately 100 m east of the R36, and approximately 300 m east of the cell phone tower. This area showed no distinct evidence of archaeological activity. The gradient in this area is relatively low, and the terraces are not very distinct, because the walls are not as tall as in other areas. The terraces are outlined with rocks a single layer of rocks which are on average 20 cm long (Fig. 4.11).

H0 was removed at a depth of 0-4 cm. Sample 162 (H1) is dark brown in colour, and was sampled at a depth of 4-11 cm. H1 is a relatively dry sample and has a clay content of 36%. Sample 163 (H2) is red in colour with doleritic saprolite present. This sample was sampled at a depth of 11-23 cm and is a relatively moist, sandy soil.

Sample 162 has relatively high concentrations of P, 167.29 mg kg^{-1}, and Ca, 2948.96 mg kg^{-1}, compared to the rest of the samples. This sample is slightly more acidic with a pH of 6.09. Sample 163 has a relatively low concentration of K, 75.05 mg kg^{-1}, but a relatively high concentration of Ca, 3411.96 mg kg^{-1}. This sample is less acidic than sample 162 with a pH of 6.42. This sample also has an

interesting carbon percentage pattern, where the percentage increase by depth (Table 4.8).

Location 139

Location 139 is located between two homesteads where there are no terraces. It is approximately 190 m south west from the homestead described in location 118. There is no direct evidence suggesting that there were any significant archaeological activities where this sample was taken (Fig. 4.12).

H0 was removed at a depth of 0-4 cm. Sample 164 (H1) is dark brown in colour, and was sampled at a depth of 4-12 cm. H1 is a dry, slightly clay (32%) rich soil, with the highest silt content of 38% along with samples 148 and 165. Sample 165 (H2) is reddish brown in colour, and was sampled at a depth of 12-17 cm. H2 is relatively clay rich (44%) with a loose soil texture. Sample 166 (H3) is red in colour, and was sampled at a depth of 17-26 cm. This sample has the highest clay content of 50% and the lowest sand content of 16.54% compared to the rest of the samples.

Sample 164 has the highest K concentration of 366.99 mg kg^{-1}, and the lowest Na concentration of 2.47 mg kg^{-1}. The Ca for this sample is relatively high with a concentration of 3833.96 mg kg^{-1}. The %C and the CEC is relatively at 1.89% and 48.66 cmol kg^{-1}. This is also the most neutral sample with a pH of 6.99. Samples 165 and 166 have similar concentration patterns as sample 164. The %C increases between samples 165 and 166 from 1.08% to 1.99% (Table 4.8).

Location 140

Location 140 is located below terracing that are not in a range of approximately 20 m. This sample is located approximately 257 m north west of the cell phone tower. This sample is located between homesteads, but does not show any direct evidence of archaeological activities associated with it (Fig. 4.12).

H0 was removed at a depth of 0-6 cm. Sample 167 (H1) is reddish brown in colour, and was sampled at a depth of 6-13 cm. It has a soft texture and is composed of approximately 2% of rocks. Sample 168 is a bulk sample of H2 and H3. H2 is red in colour, and was sampled at a depth of 13-16 cm. It has a low clay content (26%). H3 is red/orange in colour (derivative of doleritic saprolite), and was sampled at a depth of 16-23 cm.

Sample 167 has relatively high concentrations of P, 2.48 mg kg^{-1}, K, 184.39 mg kg^{-1}, and Ca, 2794.96 mg kg^{-1}, compared to the rest of the samples. The concentration of Mg, 677 mg kg^{-1}, is the lowest in the sample set. The %C and the CEC, 1.02% and 45.81 cmol kg^{-1} respectively, are both relatively low. Sample 168 contrasts sample 167 in some aspects. The concentration for P, 1.60 mg kg^{-1}, is the lowest in the data set. The K, 67.52 mg kg^{-1}, is relatively low, whereas the Mg concentration is relatively high with a value of 863.20 mg kg^{-1}. The %C in this sample is very contradicting. The %C is the second highest value of the sample set at 3.24%, whereas the CEC is the lowest in the entire sample set with a value of 45.52 cmol kg^{-1} (Table 4.8).

4.3. Kranskloof

Kranskloof is the Phase 3 site that was studied. This site is located along the R36 Orighstad road, in a valley. There is a dam east of this site called the Orighstad Dam. There is a river that cuts through this valley and through the site. There are several waterfalls in this area. The site is approximately 11 km^2. This only includes the study area, and not the surrounding kloofs (Fig. 1.1)

Towards the eastern side of the site, closer to the R36 there is large amount of contemporary agriculture on the land. There is also a small farm in the entrance of the valley. The rest of the site is relatively untouched. There are, however, a couple of houses in the valley and a small graveyard on the property along the contemporary farm road. One often finds large herds of cattle in the lower parts of the valley, and cattle grazing on the slopes amongst the terraces. Although only the homesteads in the valley were sampled, there are also small concentrations of homesteads on top of the ridges of the valley.

There are over 150 homesteads located in this site (Fig. 3.8, Fig 3.9). The slopes of these hills have a high gradient, and becomes steeper towards the kloofs. The homesteads are built on the slopes where terraces are attached to them. The homesteads are dominantly built on the slopes and the terracing in these areas are extensive, making it difficult to directly associate terraces with the homesteads. There is not a consistent number of homesteads throughout the valley. There are smaller concentrations in various areas. Closer to the river, there are also homesteads present with terraces associated with them. These areas were also sampled in order to have an understanding of the different sections of the valley, with the chemical analysis. There is road system that has been built, where the roads intertwine between the homesteads and the terraces. These roads are a lot more defined in the lower sections of the valley, because the walls are better preserved. The stone walling reaches over 2 m in some areas.

Towards the top of the north eastern hill, there are also extensive roads that run between the homesteads (Fig. 3.8, Fig. 3.9, Fig. 4.14 and Fig. 4.15). In some sections these are more defined than in other areas. The homesteads are generally 35 m in diameter and most of them are developed with the flower petal shape (one large outer wall, with a central inner circle and lobes attached to the inner wall). There are situations where there is an amalgamation of two or three homesteads, with petal shapes in one area. There is also evidence of later reconstruction of some of the homesteads, where the homesteads have been altered from rounded shapes to having square walls (Fig 4.13).



Figure 4. 13: Homestead that has been modified from rounded walls to square walls.

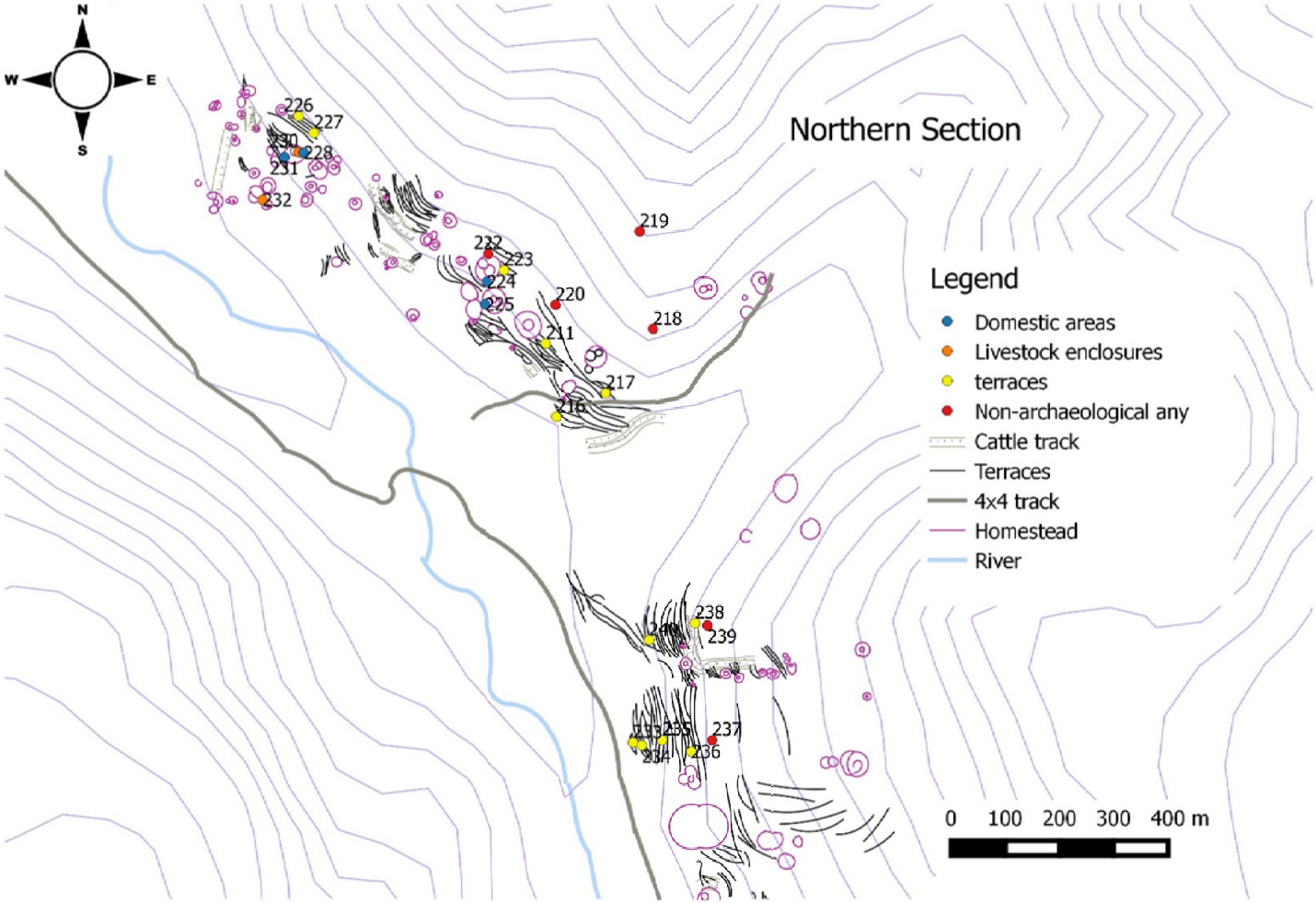


Figure 4. 14: Soil sample location in the Northern section of Kranskloof.

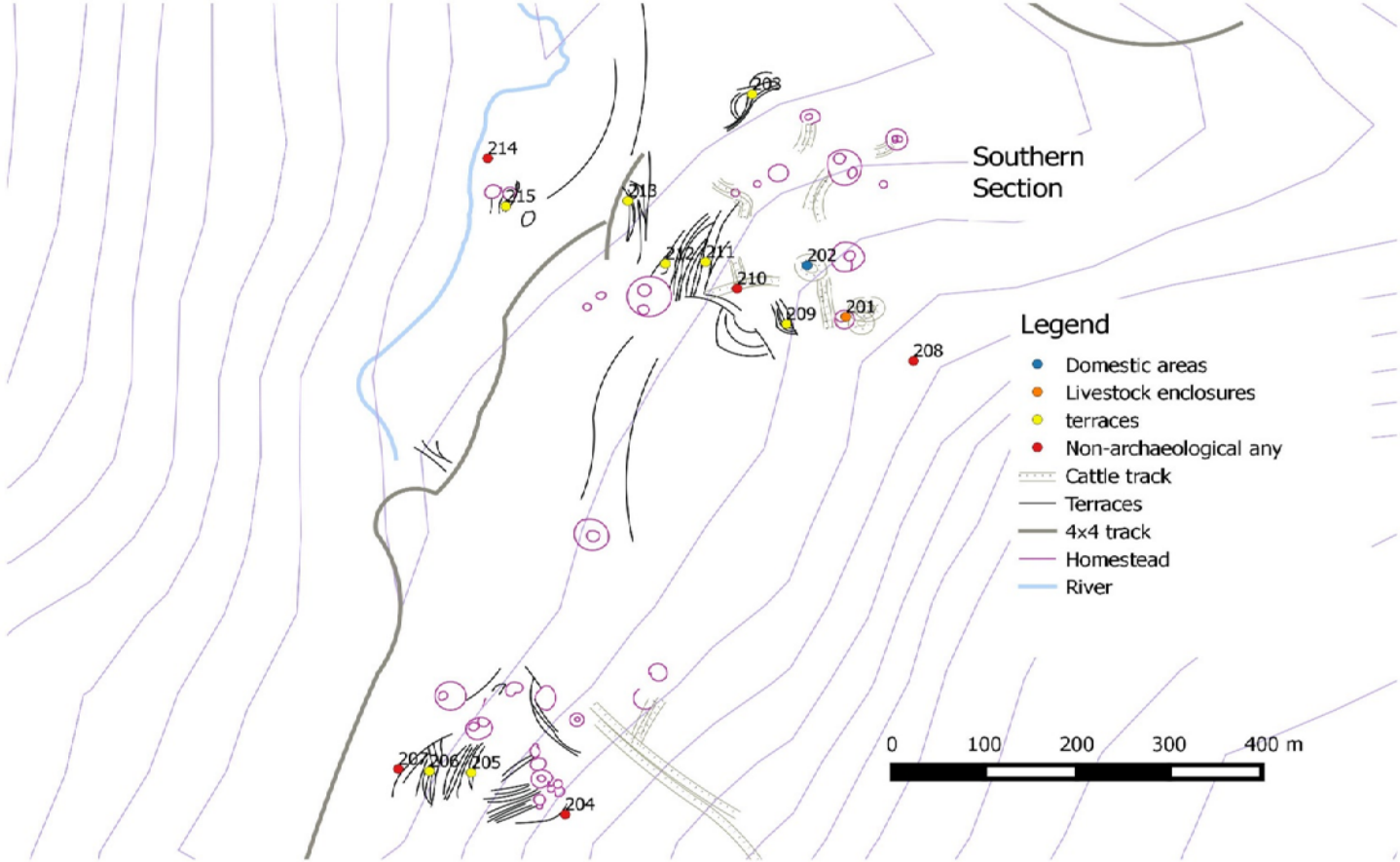


Figure 4. 15: Soil sample location in the southern section of Kranskloof.

4.3.1. Domestic areas

There were 5 samples taken in the domestic areas of the homesteads, in 5 locations. The domestic areas are located around the central stonewalled enclosure clusters, and often are separated from the surrounding areas with a stone wall (Fig. 4.9 and Fig. 4.10).

Location 202

Location 202 is in the domestic area of a homestead located on the southern end of the north south limb of the valley, where the second arm of the valley intersects this limb. The area in which this sample site is located, is in an open area, approximately 410 m east of the river. There are several homesteads concentrated in this area, and the walls are dilapidated. There are terraces associated with these homesteads that run down the hill towards the river. The homestead is smaller than the surrounding homesteads with a diameter of approximately 25.71 m. The sample was taken in the eastern end of the homestead. (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm, and is brown in colour. There are approximately 5% of rocks present. Sample 65 (H1) is reddish brown in colour, and is composed of approximately 5% of rocks. There is shale, sandstone and quartzite present in this sample. This sample is poorly sorted with angular rocks which are approximately 2-3 cm in length. This sample is slightly clay rich (32%) and has a loose texture.

Sample 65 has an above average concentration of K, 163.29 mg kg^{-1}, and Ca, 1750.96 mg kg^{-1}, and the highest concentration of Mg at 718.50 mg kg^{-1}. The %C and CEC for this sample is relatively low at 1.64% and 38.36 cmol kg^{-1}

respectively. The NH_4 has a relatively high concentration of 5.14 mg kg^{-1}, but the lowest concentration of NO_3, 6.93 mg kg^{-1} (Table 4.9).

Location 224

This sample is situated in the northern section of site, where the direction of the valley changes from a northern direction towards the west. There is a fault line just north of the homestead, which has very dense vegetation. The homestead is approximately 361.19 m up the side of the mountain from the valley floor. The homestead is approximately 42.54 m in diameter and has inner circles. The construction of the inside of the homestead was very difficult to determine due to the dense vegetation in this homestead. It is situated between terraces and has several homesteads around it. This sample was taken in the southern end of the outer circle (Fig. 4.14).

H0 was removed at a depth of 0-5 cm. Sample 90 (H1) is reddish brown in colour, and is clay rich (48%). This sample has the highest sand content compared to the rest the samples at 69.72%, and has a rock content of approximately 20%.

Sample 90 has various deficiencies in the chemical signatures. This sample has the lowest concentrations of K, 34.49 mg kg^{-1}, Ca, 790 mg kg^{-1}, and Mg, 153.80 mg kg^{-1}, compared to the rest of the samples. The %C including the CEC are the lowest with values of 1.33% and 34.64 cmol kg^{-1} (Table 4.9).

Location 225

This sample is located approximately 20 m south of the homestead described in location 224. This homestead is approximately 32 m in diameter and has a flower

petal shape, with four or five inner circles, and an outer circle. This sample was taken in the south eastern section of the domestic area. The terraces associated with this location extends approximately 36 m down the hill (Fig. 4.14).

The top layer (H0) was removed at a depth of 0-5 cm. Sample 91 (H1) is brown in colour and was sampled at a depth of 5-20 cm. This sample has high clay content of 50%. There were no rocks found in this sample until there was basalt found at the bottom of the sample.

Sample 91 has the lowest concentration of P with a value of 2.47 mg kg^{-1}. It has the highest concentration of K at 1537.96 mg kg^{-1}, and a relatively high concentration of Ca, 1537.96 mg kg^{-1}. The NH_4, 7.60 mg kg^{-1}, is the highest in the sample set and has a relatively high NO_3 with a value of 17.45 mg kg^{-1}. Both the %C and CEC are relatively low at 1.57% and 17.75 cmol kg^{-1}. This sample is the least acidic sample with a pH of 6.3 (Table 4.9).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
65	202	2.61	163.29	1750.96	7.59	718.50	1.64	5.15	6.93	38.36	37.08	32	30	6.1
90	224	4.30	34.49	790.66	4.01	153.80	1.33	3.78	15.19	34.64	69.72	48	20	5.2
91	225	2.47	238.39	1537.96	12.88	292.40	1.57	7.60	17.75	37.71	47.92	50	26	6.3
94	228	5.81	41.30	1142.96	7.08	212.70	1.55	3.33	24.92	47.30	52.66	52	6	4.9
97	231	4.43	46.51	2035.96	10.06	379.40	2.30	4.24	10.61	52.79	37.18	30	50	5.7

Table 4. 9: Chemical signatures of domestic areas in Kranskloof.

Location 228

This sampled is located west of the fault described in sample 224, on a different section of the mountain. This location is approximately 400 m north west of samples 224 and 225. The homestead is approximately 46.50 m in diameter and has one large outer circle. In this there are three main inner circles attached to one another, with smaller walled circles in it. There is a road that runs below the homestead. There are also terraces above the homestead and below it. This sample was taken in the northern end of the homestead, inside of the outer circle, near the inner wall (Fig. 4.14).

The top layer (H0) was removed at a depth of 0-5 cm, and brown in colour. Sample 94 (H1) is brown in colour and was sampled at a depth of 5-20 cm. This sample is composed of the highest clay content of 52%, and the lowest silt content of 6%. There were are approximately 10% of rocks found in this sample.

Sample 94 has the highest concentration of P with a value of 5.81 mg kg^{-1}. NH_4 for this sample is the lowest in this sample set at 3.23 mg kg^{-1}, and has the highest NO_3 content of 24.92 mg kg^{-1}. The %C is below average at 1.56%, whereas the CEC is above average with a value of 47.30 cmol kg^{-1}. The pH for this sample is the most acidic at 4.93 compared to the rest of the samples (Table 4.9).

Location 231

This sample was taken in the southern end of the homestead described in location 228 (Fig. 4.4).

The top layer (H0) was removed at a depth of 0-5 cm. Sample 97 (H1) is reddish brown in colour and was sampled at a depth of 5-30 cm. This sample is composed of the highest silt content 50%, and a low sand content (37%), and the lowest clay content (30%) compared to the rest of the samples in the domestic areas of Kranskloof. There were rocks found at the bottom of the sample.

Sample 97, opposed to sample 90, has the highest nutrient status compared to the rest of the samples. This sample has the highest concentrations of Ca, 2035.96 mg kg^{-1}, and Na, 10.06 mg kg^{-1}, with a relatively high Mg, 379.40 mg kg^{-1} content. The NH_4 and NO_3 concentrations are both relatively low with a values of 4.24 mg kg^{-1} and 10.61 mg kg^{-1} compared to the rest of the results in the domestic areas of Kranskloof. The %C and the CEC are the highest at 2.30% and 52.79 cmol kg^{-1} respectively (Table 4.9).

4.3.2. Terraces

There were 21 samples taken in the terraced areas, in 20 locations. The terraces in this site is very extensive, and are not often directly associated with homesteads. As a result, three different sections of the terraces were sampled, the upper section, middle section, and bottom section of the terraced complex.

Location 203

Location 203 was sampled in the lower section of the mountain approximately 210 m from the sample taken in location 202. The terraces in this section is relatively small and is <17 m downslope west from the homestead it is associated with (Fig. 4.15)

H0 was sampled at a depth of 0-5 cm, and is brown in colour with a relatively organic section. Sample 66 (H1) is reddish brown in colour, and is composed of approximately 50% of rocks which are approximately 10-15cm in length. This sample is slightly clay rich (36%), with a sand content of approximately 38.56%.

Sample 66 has a relatively low concentration of K at 74.80 mg kg^{-1} compared to the rest of the samples in the domestic areas of Kranskloof. The Ca, 2557.96 mg kg^{-1}, and Mg, 974.20, concentrations are relatively high. The %C of this sample is relatively high with a value of 2.25%, whereas the CEC, 36.39 cmol kg^{-1}, is relatively low. NH_4 and NO_3 are relatively high with concentrations of 6.95 mg kg^{-1} and 33.64 mg kg^{-1} respectively. This sample is also less acidic with a pH of 6.39 (Table 4.10).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
66	203	2.08	74.80	2557.96	8.01	947.20	2.22	6.965	33.635	36.39235	38.56	36	16	6.39
69	205	1.93	155.49	2329.96	7.18	588.80	2.26	7.21	10.08	37.37833	36	32	32	6.51
70	206	2.24	69.54	2423.96	7.80	832.80	2.13	8.54	11.375	60.819	28.42	28	30	5.93
73	209	3.08	168.89	1851.96	7.70	711.90	2.34	8.785	6.09	48.17534	38.6	38	26	5.79
76	211	1.89	94.20	2315.96	6.12	684.10	2.07	8.68	7.105	42.7285	34.88	38	30	5.96
77	212	2.91	318.99	2241.96	5.31	526.20	2.80	7.245	20.23	57.9909	34.04	40	36	5.77
78	213	2.17	70.42	3327.96	14.47	1007.10	2.35	5.355	16.765	34.57078	20.94	28	28	6.31
80	215	3.48	32.06	1267.96	7.35	323.50	1.54	6.755	19.32	40.6069	43.76	40	28	5.7
81	216	2.43	42.89	1244.96	17.69	817.40	0.83	3.465	4.305	27.62999	17	44	32	6.31
82	217	2.28	76.01	1792.96	9.48	2209.10	1.24	3.36	3.78	31.882	48.34	28	30	6.31
86	221	2.22	130.49	1868.96	8.36	1232.10	2.02	3.395	19.81	23.0028	55.46	34	30	6.02
88	223	3.03	515.49	1705.96	5.54	338.00	2.17	8.26	55.3	60.73735	57.6	16	26.4	6.16
89	223	3.34	230.39	1665.96	26.52	327.80	1.38	5.67	38.5	40.97995	52.32	42	5.68	6.17
92	226	2.06	50.29	2263.96	10.36	624.70	1.83	3.465	3.22	57.5552	38.58	42	24	6.17
93	227	4.05	72.84	1864.96	10.51	443.90	2.38	4.445	25.935	54.26075	44.9	38	30	5.85
99	233	2.77	79.73	1806.96	6.48	226.80	1.11	4.305	9.415	37.13752	50.14	26	32	5.95
100	234	3.34	338.89	2339.96	6.21	492.10	2.47	4.13	92.89	31.31772	44.58	28	32	5.74
101	235	2.68	435.39	1860.96	3.99	434.90	1.43	5.075	8.33	28.7575	40.42	56	28	5.69
102	236	2.92	57.06	1474.96	8.59	507.90	1.94	3.43	2.975	29.86875	40.26	32	28	6.43
104	238	1.98	72.59	3459.96	14.42	950.90	1.59	3.465	3.29	35.2572	38.96	32	30	6.46
106	240	1.96	92.46	3064.96	11.20	848.20	1.67	3.36	3.045	54.25762	38.3	30	36	6.4

Table 4. 10: Chemical signatures of terraces in Kranskloof.

Location 205

The terraced system in which this sample is located is further in the southern section of the site, on the eastern hill. The terraces are relatively extensive and expand approximately 350 m across, and 75 m down slope. There is a cluster of four homesteads above the terraces. These are built very close to each other, where the walls are shared. This cluster expands approximately 126 m across. Location 205 was sampled in the top section of the terracing and is relatively difficult to dig (Fig. 4.15).

H0 was sampled at a depth of 0-10 cm, and is dark brown in colour with a relatively organic section. This layer is composed of approximately 50% of rocks at 5-10 cm in length. Sample 69 (H1) is dark reddish brown in colour, and is composed of approximately 50% of rocks which are approximately both 1-2 cm and 5-10 cm in length. This sample is slightly clay rich (32%).

Sample 69 has a relatively low P concentration of 1.93 mg kg^{-1}, and a relatively high Ca concentration of 23.29.96 mg kg^{-1}. The %C is relatively high at 2.25%, whereas the CEC is relatively low with a value of 37.37 cmol kg^{-1}. NH_4, 7.1 mg kg^{-1}, is relatively high along with NO_3, 10.83, mg kg^{-1}, if one does not consider the NO_3 outlier of sample 71. This sample is the least acidic sample with a pH of 6.51 (Table 4.10).

Location 206

Location 206 was sampled in the lower section of the same terracing system described in location 205, and is relatively difficult to dig (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 70 (H1) is dark reddish brown in colour, and was sampled at a depth of 5-30 cm. This sample contains approximately 20% of rocks and has a clay rich texture.



Figure 4. 16: Soil profile of samples taken at Location 206.

Sample 70 has a relatively low concentration of K, 69.54 mg kg^{-1}, and relatively high concentrations of Ca, 2423.96 mg kg^{-1}, and Mg, 832.80 mg kg^{-1}, compared to the rest of the samples. This sample has relatively high concentrations of NH_4 and NO_3 at 8.54 mg kg^{-1} and 11.38 mg kg^{-1} respectively in this sample. This sample

also has a relatively high %C, 2.12%, and the highest CEC at 60.81 cmol kg^{-1} (Table 4.10).

Location 209

Sampling location extends below the homesteads described in sample 201. The terraces expand approximately 62 m across and 27 m down the hill in a westerly direction. This sample was taken in the upper sections of this terraced section (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm, and is dark brown in colour. Sample 73 (H1) is dark reddish brown in colour, and was sampled at a depth of 5-20 cm. This sample contains approximately 10% of rocks and has a sand content of 38.6% and a clay content of 38%.

Sample 73 has a relatively high concentration of P, 3.08 mg kg^{-1}, and has relatively low concentrations of Ca, 1851.96 mg kg^{-1}, and Na, 7.70 mg kg^{-1}. The %C is relatively high at 2.34%, as well as CEC at 48.17 cmol kg^{-1}. NH_4, 8.78 mg kg^{-1}, is the highest concentration in this sample and has a relatively low concentration of NO_3, 6.09 mg kg^{-1}. This sample has a pH of 5.79 which is relatively acidic (Table 4.10).

Location 211

This sample is located further west, down the hill from sample 209. This is just below an open area where there is no evidence of archaeological activity. This terraced system extends approximately 125 m down the hill towards a contemporary dirt road that runs along the bottom section of the hill. It does not

seem that there are homesteads directly associated with this terraced system, possibly due to the high gradient of the slope in this section of the hill. Location 211 was sampled in the top section of the terracing system (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 76 (H1) is dark reddish brown in colour, and was sampled at a depth of 5-30 cm. There are a lot of rocks located below the red clay which consists of weathered shale (saprolite).

Sample 76 has relatively low concentrations of K, 94.20 mg kg^{-1}, and Na, 6.12 mg kg^{-1}, and a relatively high concentration of Ca at 2315.96 mg kg^{-1}, compared to the rest of the samples. The concentration for this sample, 1.89 mg kg^{-1}, is the lowest in the sample set. This sample has a relatively high concentration of NH_4 at 8.68 mg kg^{-1}, but a relatively low concentration of NO_3 at 7.10 mg kg^{-1} (Table 4.10).

Location 212

Location 212 was sampled in the middle section approximately 44 m south west of the same terracing system as location 212 (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 77 (H1) was sampled at a depth of 5-30 cm. There are approximately 60% of rocks which are 2-18 cm in length. This sample has the highest silt content in the terraces at 36%.

Sample 77 has relatively high concentrations of P, 2.91 mg kg^{-1}, and K, 318.99 mg kg^{-1}, compared to the rest of the samples. NH_4 and NO_3 are both relatively high with concentrations of 7.24 mg kg^{-1} and 20.23 mg kg^{-1} respectively. The %C is the highest amongst the terraces at 2.79%. This sample also has a relatively

high CEC at 57.99 cmol kg^{-1}. This sample is relatively acidic with a pH of 5.77 (Table 4.10).

Location 213

Location 213 was sampled in the lower section of the same terracing system as location 212. This terrace is located just before the farm road (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 78 (H1) was sampled at a depth of 5-30 cm. There are less than 30% of rocks which are approximately 2-3 cm in length. This sample has a loose texture, and there were rocks found at the bottom.

Sample 78 has relatively high concentrations of P, 2.17 mg kg^{-1}, Ca, 3327.96 mg kg^{-1}, Na, 14.47 mg kg^{-1}, and Mg, 1007.10 mg kg^{-1}, compared to the rest of the samples. K, in contrast, is relatively low with a concentration of 70.42 mg kg^{-1}. The CEC, 34.57 cmol kg^{-1}, is relatively low, whereas the %C is relatively high at 2.34% (Table 4.10).

Location 215

Location 215 was sampled in the terracing system approximately 40 m east of the river. These terraces are located just below an open area, where a new set of terraces begin. This sample is located approximately 132 m west from location 213 (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 80 (H1) is dark brown in colour and was sampled at a depth of 5-40 cm. There were no rocks present in this sample

and the roots penetrated deep into the ground. This sample has a loose texture, with clay content of 40%.

Sample 80 has the lowest concentration of K at 32.06 mg kg^{-1}, and a relatively low Ca, 1267.96 mg kg^{-1}, Na, 7.35 mg kg^{-1}, and Mg, 323.50 mg kg^{-1}. This sample has relatively high concentrations of NH_4 and NO_3 with concentrations of 6.75 mg kg^{-1} and 19.32 mg kg^{-1} respectively. This sample is the most acidic sample with a pH of 5.7 (Table 4.10).

Location 216

Location 216 was sampled in the terraced system possibly associated with location 225. These terraces are expansive and extend approximately 130 m down the hill and area are run approximately 400 m across. This sample is located approximately 250 m south from location 225. This sample is taken in the lower section of the terracing system (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 81 (H1) is reddish brown in colour and was sampled at a depth of 5-30 cm. This sample has a relatively loose texture with a sand content of 17%, and a clay content of 44%. There are approximately 50% of rocks present which are approximately 5cm in length.

Sample 81 has the lowest concentration of Ca at 1244.96 mg kg^{-1}, and a relatively high concentration of Mg with a value of 817.40 mg kg^{-1}. The %C for this sample is the lowest in the sample set at 0.82% and a relatively low CEC at 27.69 cmol kg^{-1} (Table 4.10).

Location 217

Location 217 was sampled in the top section of the same terracing system as location 216. This sample was taken near the erosional wall, above the weathered basaltic layer (Fig. 4.14)

H0 was sampled at a depth of 0-5 cm. Sample 82 (H1) is brown in colour and was sampled at a depth of 5-20 cm. This sample has a relatively loose texture with a sand content of 48.34%, and a clay content of 28%. There are approximately 60% of rocks present which are approximately 2-3 cm in length.

Sample 82 has a relatively low concentration of Ca and the highest concentration of Mg in the dataset with values of 1792.96 mg kg^{-1} and 2209.10 mg kg^{-1} respectively. NH_4 is the lowest in this sample set with a concentration of 3.36 mg kg^{-1}, and a relatively low concentration of NO_3, 3.78 mg kg^{-1}. This sample has a relatively low %C of 1.23% and CEC of 31.88 cmol kg^{-1}. The pH is less acidic at 6.31 (Table 4.10).

Location 221

Location 221 was sampled in the middle section of the terracing system. These are part of the terraced system described in location 116. The terraces in this location extend approximately 60 m further up the hill. This sample is approximately 145 m north west from sample 216 (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm. Sample 86 (H1) is brown in colour and was sampled at a depth of 5-10 cm. This sample has a relatively loose texture with a

sand content of 55.46%, and a clay content of 34%. There are approximately 30% of rocks present.

Sample 82 has relatively low Ca and Na concentrations of 1838.96 mg kg^{-1} and 8.36 mg kg^{-1} respectively. Mg is relatively high with a concentration 1232.10 mg kg^{-1} compared to the rest of the samples. This sample has a relatively high %C of 2.02%, but the lowest CEC in the dataset at 23.00 cmol kg^{-1}. NH_4, 3.39 mg kg^{-1}, is relatively low, whereas NO_3 is relatively high with a concentration of 19.81 mg kg^{-1} (Table 4.10).

Location 223

Location 223 was sampled in terraces associated with location 224. This sample is located outside the eastern end of the outer circle, where terraces are attached to the homestead. These extend upwards, in the fault approximately 60 m from this location (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 88 (H1) is dark brown in colour. This sample has the highest sand content of 57.6% and the lowest clay content of 16%. Sample 89 (H2) is reddish brown in colour and had no rocks present. This sample has the lowest silt content in the terraces at 5.68% and a relatively high clay content of 42%. This sample has a mixture of both soil similar to H1 and clay.

Sample 88 has the highest concentration of K with a value of 515.49 mg kg^{-1}, and a relatively low concentration of Ca at 1705. 96 mg kg^{-1}. This sample also has the second highest concentration of NO_3 at 55.30 mg kg^{-1}, and relatively high concentration of NH_4. The %C, 2.16%, relatively high, along with the CEC, 60.73 cmol kg^{-1}. Sample has a relatively high concentration of P at 3.34 mg kg^{-1}, and

relatively low concentrations of Ca, 1665.96 mg kg^{-1}, and Mg, 327.80 mg kg^{-1}. This sample, in contrast, has the highest concentration of Na with a value of 26.52 mg kg^{-1} (Table 4.10).

Location 226

Sampling location 226 is located in a terraced system in the north eastern section of the valley. The terraced system is approximately 450 m north east from the farm road. The terraces are located above the homestead described in location 229, and extend approximately 35 m up the hill, and 100 m across (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 92 (H1) is brown in colour, and sampled at a depth of 5-20 cm. This sample has the highest clay content (42%), in the terrace of Kranskloof. There are approximately 5 % of rocks present which are around 10 cm in length. The rock found in this area are basaltic.

Sample 92 has a reasonably high concentration of Ca, 2263.96 mg kg^{-1}, and a relatively low Mg content of 624.70 mg kg^{-1}. This sample has relatively low concentrations of NH_4 and NO_3 with values of 3.46 mg kg^{-1} and 3.22 mg kg^{-1} respectively. The %C is relatively low at 1.82%, but the CEC is relatively high at 57.55 cmol kg^{-1} (Table 4.10).

Location 227

Location 227 is located in the same terraced system as location 226. The gradient of the hill is much, at this location, is greater than at location 226 (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 93 (H1) is reddish brown in colour, and was sampled at a depth of 5-30 cm. This sample has a clayish texture, with a sand content of 54.26%. There are approximately 70 % of rocks present which are around 5-10 cm in length. The rock found in this area are shales.

Sample 93 has the highest concentration of P, 4.05 mg kg^{-1}, and relatively low concentrations of K, 72.84 mg kg^{-1}, Ca, 1864.96 mg kg^{-1}, and Mg, 443.90 mg kg^{-1}, compared to the rest of the samples. The NH_4 concentration for this sample is relatively low with a value of 4.44 mg kg^{-1}, whereas NO_3 is relatively high at 22.59 mg kg^{-1}. Sample 93 is relatively acidic with a pH of 5.85 (Table 4.10).

Location 233

Location 233 is located on the hill where the valley bends southwards. The terraces are very expansive in this area, and run approximately 115 m up the hill towards the east. There is a homestead approximately 70 m, intersecting the terraced system, from the lower section of the terraces. This sample is located in the lower section of the terraced system, approximately 43 m east of the farm road (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 99 (H1) is dark brown in colour, and was sampled at a depth of 5-20 cm. This sample has a clayish texture, with a sand content of 50.14%. There are approximately 10% of rocks present, with large rocks at the bottom of this sample.

Sample 99 has relatively low concentrations of K, 79.73 mg kg^{-1}, Ca, 1806.96 mg kg^{-1}, and Na, 6.48 mg kg^{-1}, compared to the rest of the samples. Mg has the lowest concentration in this sample set at 226.80 mg kg^{-1}. The %C is relatively low at 1.10%, along with the CEC of 37.13 cmol kg^{-1} (Table 4.10).

Location 234

Location 234 is located approximately 17 m above location 233. This area is distinctly different, because the walling does not follow the same patterns found in other areas. This could either be regarded as a road or a terrace. The wall is approximately 1.5 m tall (Fig. 4.14).

H0 was sampled at a depth of 0-10 cm. Sample 100 (H1) is dark brown in colour, and was sampled at a depth of 10-15 cm. This sample has a clay content of 28% and a sand content of 44.58%. There were rocks found at the bottom of this sample.

Sample 100 has a relatively low concentration of P at 334 mg kg^{-1}, and relatively high concentrations of K, 338.89 mg kg^{-1}, and Ca, 2339.96 mg kg^{-1}, compared to the rest of the samples. This sample has the highest concentration of NO_3, 92.89 mg kg^{-1}, and a relatively low concentration of NH_4, 4.13 mg kg^{-1}. The CEC for this sample is relatively low with a value of 31.31 cmol kg^{-1}, whereas the %C is relatively high at 2.47% (Table 4.10).

Location 235

Location 235 is located in the middle section of the same terracing system as location 233, just below the homestead described at location 223. There is a distinctly high wall in this area (Fig. 4.14)

H0 was sampled at a depth of 0-5 cm. Sample 101 (H1) is reddish brown in colour, and was sampled at a depth of 5-30 cm. This sample has the highest clay

of 56% compared to the rest of the samples in the terraces of Kranskloof. There are approximately 10% of rocks present, along with lots of roots present.

Sample 101 has relatively low concentrations of P, 2.68 mg kg^{-1}, Ca, 1860.96 mg kg^{-1}, and Mg, 434.90 mg kg^{-1}. This sample has the lowest concentration of this sample set with a value of 3.99 mg kg^{-1}. The %C, 2.68% and CEC, 27.75 cmol kg^{-1}, is also relatively low compared to the rest of the samples (Table 4.10).

Location 236

Location 236 is sampled in the same terraced system as locations 235 and 236. These are the upper section of the terraces, above the homestead (Fig. 4.14). The walls are built very high, and are more defined.

H0 was sampled at a depth of 0-5 cm. Sample 102 (H1) is dark brown in colour, and was sampled at a depth of 5-20 cm. This sample has a relatively loose texture, with a sand content of 40.26% and a clay content of 32%. There are approximately 30% of rocks present.

Sample 102 has relatively low concentrations Ca and Mg with values of 1474.96 mg kg^{-1} and 507.90 mg kg^{-1} respectively. The %C, 1.94%, and the CEC, 29.86 cmol kg^{-1}, is also relatively low compared to the rest of the samples. NO_3 for this sample is the lowest in the sample set with a concentration of 2.97 mg kg^{-1}, and a relatively low NH_4 of 3.43 mg kg^{-1} (Table 4.10).

Location 238

Location 238 is approximately 184 m further north, on the same hill, from samples 233-236. These seem to be in the same terraced system. The terraces extend approximately 180 m down the hill, in a westerly direction. It is ambiguous as to which homesteads are associated with this section of the terraces. This sample is located in the top section of the terraces (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 104 (H1) has a sand content of 39%, a clay content of 32% and a silt content of 30%.

Sample 104 has relatively low concentrations of P, 1.98 mg kg^{-1}, and K, 72.59 mg kg^{-1}, compared to the rest of the terraces. This sample has the highest content of Ca in this data set and a relatively high Mg with concentrations of 3 459.96 mg kg^{-1} and 950.90 mg kg^{-1} respectively. Both NH_4 and NO_3 are relatively low with concentrations of 3.46 mg kg^{-1} and 3.29 mg kg^{-1} respectively. This sample has a relatively high pH of 6.46 (Table 4.10).

Location 240

Location 240 is located in the middle section of the same terracing system as location 238 (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 106 (H1) was sampled at a depth of 5-20 cm, and has a loose texture. This sample has the highest silt content in the terraces at 36% and consists of approximately 30%.

Sample 106 has a relatively low concentration of P at 1.96 mg kg^{-1} in this sample set. The NH_4 concentration for this sample is the lowest in the dataset with a value of 3.36 mg kg^{-1}, and has a relatively low NO_3 content, 3.04 mg kg^{-1}. The %C, 1.67%, is also relatively low, whereas the CEC, 54.25 mg kg^{-1}, is relatively high. This sample is less acidic with a pH of 6.4 (Table 4.10).

4.3.3. Livestock enclosures

There were 5 samples taken in the livestock enclosures areas of the homesteads, in 6 locations. Sample locations were numbered consecutively. The livestock enclosures are located in the inner circles. Various homesteads were sampled in the different sections of the site described earlier.

Location 201

This homestead, in which the sample is located in, is approximately 75 m south east of location 202. This sample has an outer wall and six smaller inner circles in this homestead. The homestead is approximately 68.02 m in diameter, and the sample is located in the north eastern inner circle (Fig. 4.15).

H0 was sampled at a depth of 0-5 cm, and is brown in colour. There are approximately 50% of rocks present. Sample 63 (H1) is reddish brown in colour and was sampled at a depth of 5-30 cm, and is composed of approximately 50% of rocks. There is shale, sandstone and quartz present in this sample. This sample has the lowest sand content of 15.62%. Sample 64 (H2) is red in colour, and was sampled at a depth of 30-40 cm. There were no rocks found in this sample and is composed of 40% of clay.

Sample 63 has relatively high concentrations of Na, 10.75 mg kg^{-1}, and Mg, 932.90 mg kg^{-1}, compared to the rest of the samples in the livestock enclosures. The pH, is relatively acidic at 5.87. The Ca, 2762.96 mg kg^{-1}, and NH_4, 8.05 mg kg^{-1}, both are the highest in this sample set. The %C is also the highest at 2.66%. Sample 64 has the lowest concentration of P, 1.64 mg kg^{-1}, and a relatively low concentration of K, 61.78 mg kg^{-1}, compared to the rest of the samples. The Na and Mg are the highest with concentrations of 15.21 and 1036.10 mg kg^{-1} respectively. This sample has a relatively high pH at 6.31 (Table 4.11).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
63	201	2.61	99.99	2762.96	10.75	932.90	2.66	8.05	11.73	43.92	15.62	28	26	5.87
64	201	1.64	61.78	2141.96	15.21	1036.10	1.18	5.73	9.03	31.42	34.4	40	26	6.31
95	229	2.4	147.0	2726.0	7.5	576.8	1.86	4.6	34.0	46.8	52.5	52.0	32.0	7.4
96	230	4.7	62.2	1582.0	7.4	361.0	0.93	3.9	9.7	47.1	44.1	48.0	46.0	6.4
98	232	5.7	80.9	1059.0	6.2	241.5	1.63	5.6	20.8	46.3	44.8	34.0	28.0	5.4

Table 4. 11: Chemical signatures of livestock enclosures in Kranskloof.

Location 229

This sample was taken in the secondary inner circle, secondary livestock enclosures, of the homestead described in sample 228 (Fig. 4.14).

H0 was sampled at a depth of 0-10 cm, and is a very mulchy organic layer. Sample 95 (H1) is reddish brown in colour and was sampled at a depth of 10-50 cm. This sample has the highest clay content of 52% compared to the rest of the samples in the livestock enclosures of Kranskloof. This, however, may not be a reliable result, because the sand percentage is over 50% and the silt is over 30%. Rocks were found at the bottom of this sample layer.

The concentrations for K, 146.99 mg kg^{-1}, and NO_3 at 33.99 mg kg^{-1}, are the highest in this sample set. The %C is the relatively high at 1.86%, as well as the CEC, 46.77 cmol kg^{-1}. This sample is the most alkaline with the pH of 7.41 (Table 4.11).

Location 230

Location 230 is located in the same homestead as location 228. This sample was taken in the main inner circle, the livestock enclosures (Fig. 4.14).

H0 was sampled at a depth of 0-5 cm. Sample 96 (H1) was sampled at a depth of 5-50 cm. This sample has the highest silt content of 46% compared to the rest of the samples. This, however, may not be a reliable result because the sand percentage is over 44%, and the clay is over 48%. Rocks were found at the bottom of this sample.

Sample 96 has the lowest concentration of K with a value of 62.17 mg kg^{-1}. This sample has the lowest concentrations for both NH_4 and NO_3 at 3.92 mg kg^{-1} and 9.6 mg kg^{-1}. The %C and the CEC contrast, where %C is the lowest in the sample set at 0.96%, and CEC is the highest at 47.09 cmol kg^{-1} in the livestock enclosures of Kranskloof (Table 4.11).

Location 232

Location 232 is a single walled enclosure that extends approximately 27 m in diameter. There are homesteads in the surrounding area. This sample is approximately 95 m west of the homestead associated with location 228 (Fig. 4.14)

H0 was sampled at a depth of 0-5 cm and is dark brown in colour. Sample 98 (H1) is dark brown in colour and was sampled at a depth of 5-20 cm. This sample has the lowest clay and silt content at 34% and 28% compared to the rest of the samples in the livestock enclosures of Kranskloof. These results are more accurate, because the sand content is 44.84% which does not leave a large discrepancy as seen in the other results. There are approximately 20% of rocks in this sample which are relatively small rocks.

Sample 98 has the lowest concentrations of Ca, 1058.96 mg kg^{-1}, Na, 6.20 mg kg^{-1}, and Mg, 241.50 mg kg^{-1}, compared to the rest of the samples. P is the highest value in this sample set with a concentration of 5.72 mg kg^{-1}. The NH_4 and NO_3 concentrations are both relatively high at 5.57 mg kg^{-1} and 20.83 mg kg^{-1} respectively. This sample has the lowest CEC of 46.31 cmol kg^{-1}, and is the most acidic sample with a pH of 5.36 (Table 4.11).

4.3.4. Non-archaeological

There were 12 samples taken in the non-archaeological areas in 11 locations.

Location 205

Location 205 is located approximately 113 m above the terraces described in location. There is a distinct increase in the gradient of the slope in this area (Fig. 4.15).

Two samples were taken at this location, where one sample consists of the first layer, and the other is a bulk sample of H1 and H2. H0 is dark brown in colour and was removed to a depth of 0-10 cm. There are approximately 10% of rocks present where these are less than 3 cm. H1 (sample 68) is reddish orange in colour and was sampled at a depth of 10-25 cm. There are approximately 10% of rocks which are approximately 2 cm in length, and is slightly clay rich (36%). Sample 67 is a bulk sample of H1 and H2. This sample is a mixture of brown, grey and orange soils, which has a relatively loose texture, and has the least amount of clay content (22%) in the non-archaeological areas of Kranskloof. Sample 67 was sample to a depth of 5-30 cm, and consists of approximately 10% of rocks which are on average 3 cm in length. The orange soil in this sample is derivative of basaltic saprolite.

Sample 67 has a relatively low P, 2.02 mg kg^{-1}, and Na, 10.95 mg kg^{-1}, concentrations compared to the rest of the samples. In contrast concentrations for K and Ca are relatively high with contents of 139.49 mg kg^{-1} and 10.95 respectively. Sample 68 also has a relatively low P and K concentrations of 2.11 mg kg^{-1} and 10.95 mg kg^{-1} respectively. This sample also has a relatively high Ca

concertation of 2585.96 mg kg^{-1}, but a relatively low concertation of K with a value of 70.71 mg kg^{-1} (Table 4.12).

Lab #	Location	P mg/kg	K mg/kg	Ca mg/kg	Na mg/kg	Mg mg/kg	% C	NH4 mg/kg	NO3 mg/kg	CEC cmol/kg	Sand %	Clay %	Silt %	pH
67	204	2.02	139.49	2672.96	10.95	950.90	2.19	9.07	8.75	41.61	34	22	32	6.13
68	204	2.11	70.71	2585.96	10.31	1001.10	2.00	4.97	7.00	40.98	38	36	22	5.92
71	207	1.33	56.28	2817.96	14.12	1025.10	1.26	5.36	9.77	66.14	22	32	22	6.1
72	208	2.60	202.39	1816.96	7.88	572.10	3.14	14.14	35.77	40.22	29	34	26	5.37
74	210	2.11	101.49	2796.96	25.53	1318.10	1.83	6.93	9.91	76.29	21	40	58	6.05
75	210	1.96	56.22	3779.96	48.32	2115.10	0.46	1.44	5.32	51.27	28	32	26	6.74
79	214	16.27	1225.96	5.74	221.80	0.82	4.80	8.19	26.02	67.46	34	-1.46	28	6.31
83	218	2.08	30.20	1854.96	21.75	1058.10	1.01	3.40	3.82	34.09	45	36	56	6.4
84	219	2.66	154.79	953.86	11.96	568.50	2.43	51.45	3.50	35.09	39	34	16	5.96
85	220	2.83	56.49	2027.96	20.44	837.30	1.91	3.33	3.78	27.49	27	48	34	6.52
87	222	4.75	113.59	1812.96	9.38	250.30	3.27	3.61	211.79	38.16	58	46	34	4.74
103	237	3.24	50.00	863.26	7.09	234.80	1.94	10.64	3.50	28.08	58	42	0	5.85
105	239	2.72	84.89	2871.96	12.23	837.00	2.50	3.36	3.47	59.05	43	24	40	6.27

Table 4. 12: Chemical signatures in non-archaeological areas of Kranskloof.

Location 207

Location 207 located below the same terracing system as location 204, approximately 36 m east of the river (Fig. 4.15).

H0 was removed to a depth of 0-5 cm. H1 (sample 71) is dark reddish brown in colour with an orange/white component, and was sampled at a depth of 5-10 cm. there are components of both basaltic and shale saprolite.

Sample 71 has the lowest concentration of P, 1.33 mg kg^{-1}, in this sample set, but a relatively high Ca concentration of 27817.96 mg kg^{-1}. The %C is relatively low with a value of 1.25%, whereas the CEC is relatively high at 66.13 cmol kg^{-1} (Table 4.12).

Location 208

Location 208 is located approximately 87 m north east from the homestead described in location 201. This sample is situated below terrace-like structures, but there is no evidence of archaeological structures directly associated in this open area. This location was particularly difficult to dig through due to the rocks present (Fig. 4.15).

H0 was removed to a depth of 0-5 cm. H1 (sample 72) is dark brown in colour and was sampled at a depth of 5-30 cm. There are approximately 40% of rocks which are approximately 20 cm in length, and has a loose texture.

Sample 72 has the highest K concentration, of 202.39 mg kg^{-1}, compared to the rest of the samples. The Na content, 7.88 mg kg^{-1}, is relatively low. The %C is relatively high with a value of 3.14%, but the CEC, 40.22 cmol kg^{-1} is below

average. The NO_3 for sample 72 is the second highest in this data set at 35.77 mg kg^{-1}, along with a relatively high concentration of NH_4, 14.14 mg kg^{-1}. This sample is relatively acidic with a pH of 5.37 (Table 4.12).

Location 210

Sampling point 210 is located in an open area between the terraced locations 209 and 211. There are no terraces or homesteads in this area (Fig. 4.15).

H0 was removed to a depth of 0-5 cm. H1 (sample 74) is dark brown in colour and was sampled at a depth of 5-20 cm. There are approximately 50% of rocks present, and has a cay content of 40% and the lowest sand content in this data set of 21.06%. Sample 75 (H2) is golden brown in colour, and was sampled to a depth of 20-40 cm. There were no rocks present, and has a clay content of 32%. This sample has basaltic saprolite present.

Sample 74 has a relatively low concentration of P, 2.11 mg kg^{-1}, and a relatively high concentration of K mg kg^{-1}. This sample has the highest CEC, of 76.29 cmol kg^{-1}, but a relatively high %C of 1.82%. Sample 75 has relatively low concentrations of P, 1.96 mg kg^{-1}, and K 56.22 mg kg^{-1}. This sample, however, has the highest concentrations of Ca, 3779.96 mg kg^{-1}, Na, 48.32 mg kg^{-1}, and Mg, 2115.10 mg kg^{-1}, compared to the rest of the samples in this dataset. The %C is the lowest at 0.45%, but a relatively high CEC of 51.26 cmol kg^{-1}. This sample is the least acidic sample with a pH of 6.74 (Table 4.12).

Location 214

Location 214 is situated below the terraces described in location 215, east of the river (Fig. 4.15).

H0 was removed to a depth of 0-5 cm. H1 (sample 79) is dark brown in colour and was sampled at a depth of 5-50 cm. There are no rocks present, and the soil has a loose texture.

Sample 79 has the lowest concentration of K, 16.27 mg kg^{-1}, in the non-archaeological areas of Kranskloof. This sample has the lowest CEC, of 26.02 cmol kg^{-1}, and a low %C of 0.82% (Table 4.12).

Location 218

Location 218 is located above the terraces described in location 216. There is a distinct change in vegetation with this area. There is no real evidence of terraces in this location, but there is a homestead approximately 45 m north west from this location (Fig. 4.14).

H0 was removed to a depth of 0-10 cm. H1 (sample 83) is dark brown in colour with a golden tinge, and was sampled at a depth of 10-15 cm. There are approximately 60% of rocks present, of which is either between a length of 1-2 cm or 5-6 cm in length. This sample has a relatively loose texture and has some basaltic saprolite present.

Sample 83 has the lowest concentration of K in this sample set at a value of 30.20 mg kg^{-1}. This sample also has relatively contents of NH_4 and NO_3 with concentrations of 3.39 mg kg^{-1} and 3.81 mg kg^{-1} respectively. The %C 1.00% and a relatively low CEC of 34.08 cmol kg^{-1} (Table 4.12).



Figure 4. 17: Disitinct difference in vegetation in Location 218.

Location 219

Location 219 is located where the gradient of the slope is distinctly low just before a steep hill. There are no archaeological features in this area. Location 218 is approximately 191 m south east from this sampling point (Fig. 4.15).

H0 was removed to a depth of 0-5 cm. H1 (sample 84) is dark reddish brown in colour, and was sampled at a depth of 5-20 cm. There are approximately 50% of rocks present, of which is either between a length of 2-4 cm or 10-15 cm in length. This sample has a relatively loose texture and has basalt boulders present in this area.

Sample 84 has a relatively high P concentration of 2.66 mg kg^{-1}. In contrast this sample has relatively low K, 154.79 mg kg^{-1}, Ca, 953.86 mg kg^{-1}, Na, 11.96 mg kg^{-1}, and Mg, 568.50 mg kg^{-1}, concentrations. The concentration for NH_4, 51.45 mg kg^{-1}, is the highest in this sample set, but in contrast the NO_3 is relatively low with a concentration of 3.5 mg kg^{-1}. The %C for this sample is relatively high, whereas the CEC is relatively low at 35.09 cmol kg^{-1} (Table 4.12).

Location 220

Location 220 is located approximately 15 m above the terraces describe in location 221 (Fig. 4.14).

H0 was removed to a depth of 0-5 cm. H1 (sample 85) is brown in colour, and was sampled at a depth of 5-20 cm. There are approximately 40% of rocks present, of which is approximately 5 cm in length. This sample has a relatively loose texture, with the highest clay content of 48% and has basalt present in this area.

Sample 85 has relatively low concentrations of K, 56.49 mg kg^{-1}, and Mg, 837.30 mg kg^{-1}, compared to the rest of the samples. This sample has the lowest concentration of CEC, 27.48 cmol kg^{-1}, and a relatively low %C of 1.91%. The NH_4 is the lowest in this sample set with a concentration of 27.48 mg kg^{-1}, and relatively low NO_3, 3.78 mg kg^{-1}. This sample relatively more neutral with a pH of 6.52 (Table 4.12).

Location 222

Location 222 is located right above the outer circle of the homestead described in location 224 (Fig. 4.14).

H0 was removed to a depth of 0-5 cm. H1 (sample 87) is dark brown in colour. Has a relatively high clay content of 46% and a low sand content of over 50%.

Sample 87 has the highest P concentration of 4.75 mg kg^{-1} in this dataset, and a relatively low concentration of Ca, 9.38 mg kg^{-1}. This sample has the highest %C of 3.27% and a relatively high CEC of 38.15 cmol kg^{-1}. Sample 87 has the NO_3 is the highest in this sample set with a concentration of 211.79 mg kg^{-1}. This seems highly unlikely considering that the rest of the NO_3 concentrations are much lower and the NH_4 for this sample is 3.60 mg kg^{-1}. This was most probably due to error in the lab. The pH, 4.74, is the most acidic in this sample set (Table 4.12).

Location 237

Location 237 is located approximately 23 m above the terraces described in location 236. There is no evidence of distinct walling in this area (Fig. 4.14).

H0 was removed to a depth of 0-5 cm. H1 (sample 103) is dark brown in colour, and was sampled at a depth of 5-20 cm. There are approximately 70% of rocks present, of which is approximately 15-20 cm in length. This sample has a relatively loose texture with a silt content of 0% and the highest sand content of 58.24%.

Sample 103 has the lowest concentrations of Ca, 863.26 mg kg^{-1}, Na 7.09 mg kg^{-1}, and Mg 234.80 mg kg^{-1}, and a relatively low concentration of K, 50.00 mg kg^{-1}, compared to the rest of the samples. This sample has a relatively high concentration of NH_4, 10.64 mg kg^{-1}, and a relatively low concentration of NO_3, 3.50 mg kg^{-1} (Table 4.12).

Location 239

This sampling location is situated approximately 24 m above location 110. This is above large mafic outcrops, which creates a small plateau (Fig. 4.14).

H0 was removed to a depth of 0-5 cm. H1 (sample 105) was sampled at a depth of 5-15 cm. There are approximately 70% of rocks present, of which is approximately 2-5 cm in length. This sample has a relatively loose texture, and has quartz present.

Sample 105 has a relatively high concentration of Ca at 2871.96 mg kg^{-1}. This sample has relatively low concentrations of K, 84.89 mg kg^{-1}, Na, 12.23 mg kg^{-1}, and Mg, 837 mg kg^{-1}, compared to the rest of the samples. The %C and CEC is relatively high at 2.50% and 59.05 cmol kg^{-1}. The NO_3 is the lowest in the sample set with a concentration of 3.46 mg kg^{-1}, and a relatively low concentration of NH_4, 3.36 mg kg^{-1} (Table 4.12).

4.4. Conclusion

From the data it shows that there are distinct differences between the different contexts of the areas, and the sites. Generally, the soils have similar textures, colour, and depths. In the following chapter, this data will be further discussed

and compared. This will help to creating an understanding of what this data means, and puts it in context.

CHAPTER 5: DISCUSSION

Different socio political conditions prevailed during the four phases of occupation in Bokoni. Consequently, the context in which the sites were constructed was significant. There, however, was some continuity in the farming ideology and approach to settlement in the society (Delius et al 2012). These continuities resulted in similar settlement and farming choices, including the use of stone walling and slopes, throughout Phases 1 to 3. I discuss the continuities and discontinuities later in this chapter. Before comparing the data from the three sites, I discuss the results from each site. The discussion will focus on geographical relations of the samples, and the corresponding contexts, and the different patterns of the sample layer in the data.

5.1. Doornkop

As indicated in previous chapters, Doornkop is a Phase 1 stone walled site. The different contexts of the site show variations in nutrient statuses. This variation aids in our understanding of how the site works, and inform on the thought processes surrounding cultivation. I discuss the Doornkop results per activity area.

5.1.1. Domestic areas

5.1.1.1. Correlations between Ca, K, Na and Mg

When placing the soil sample data in sampling location context, trends become visible. The trends in Ca, K, Na and Mg levels appear to be linked to geographic space. In area A, the top (sample locations 001, 016, 022) and lower (sample locations 032 and 034) end of the hill samples show similar concentrations of Ca,

Mg and Na. K concentrations appear not to be related to geographical space, but samples taken east, and south of the river show similar concentrations (Fig. 5.1.a).

There, however, are distinct correlations shown between Na, K, Mg and Ca levels and the sampling depths (Fig. 5.1.b). The correlation between Na, K and Ca in the domestic areas is positive. The concentrations for these micronutrients peak at 22 cm, and 24 cm. These also have the lowest concentrations at 19 cm and 23 cm. K, however, shows a negative correlation, where the depressions are located at 22 cm and 24 cm, and peaks at 20 cm, 23 cm and 27 cm. These samples are distributed throughout the site, and are not specific to a single area.

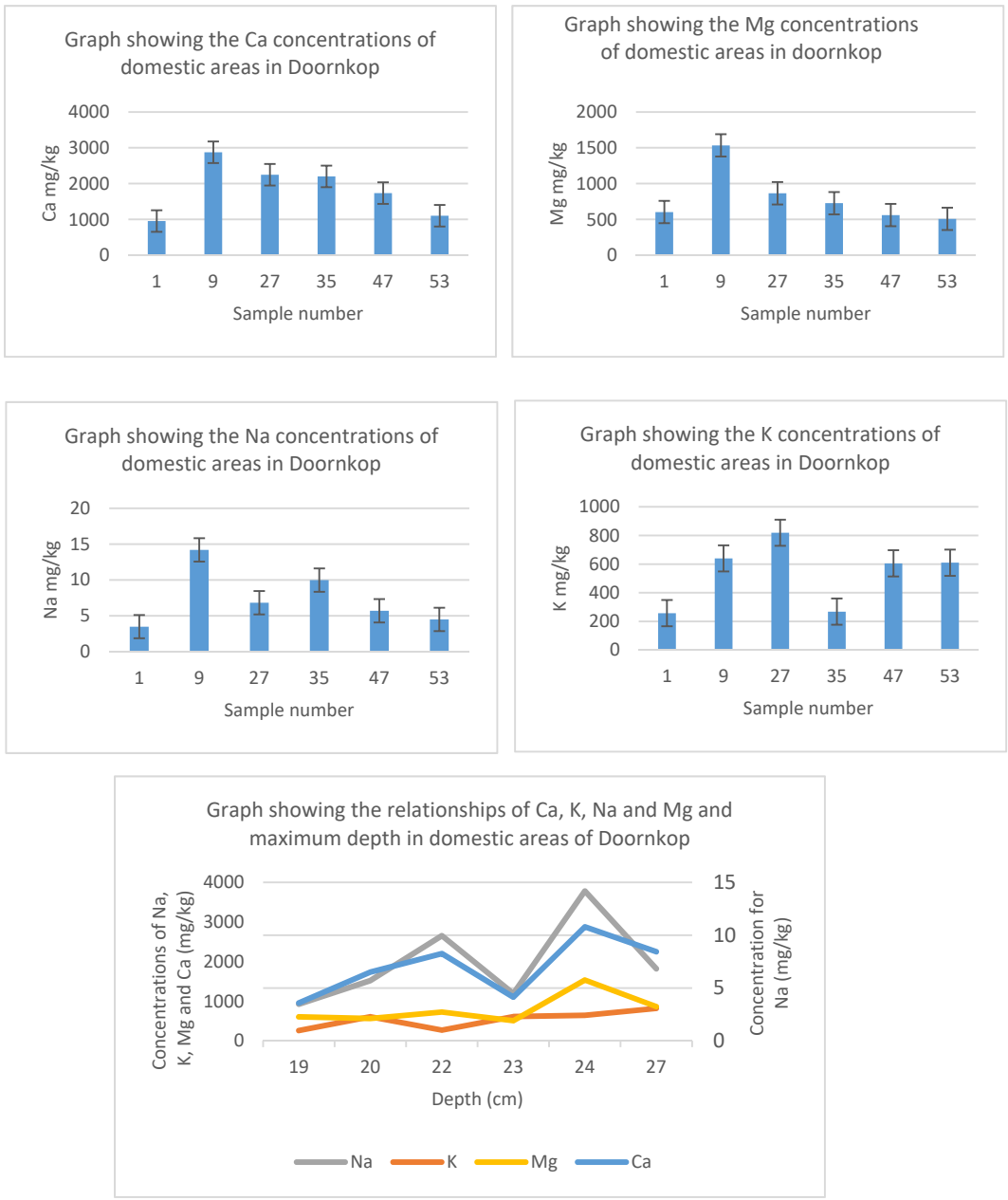


Figure 5. 1: (a) Chemical compositions of Ca, K, Na and Mg relative to one another. (b) Correlations of Ca, K, Na and Mg and maximum depth in domestic areas of Doornkop

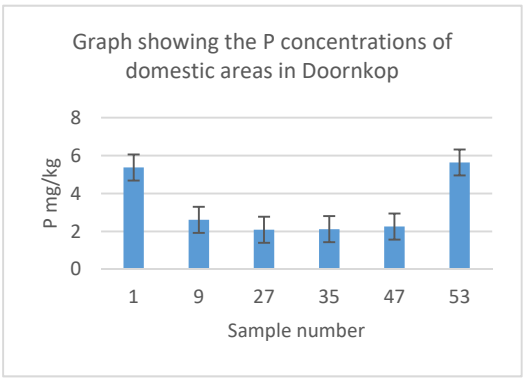
5.1.1.2. Correlations between P, NH_4 and NO_3

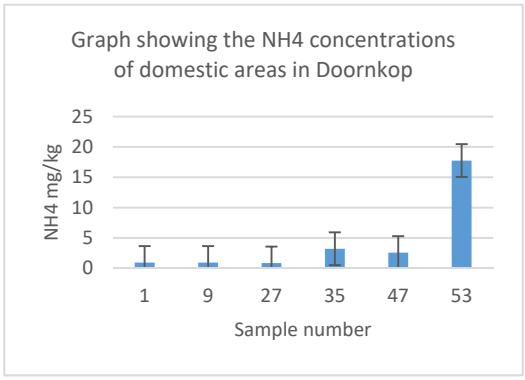
P, NH_4 and NO_3 are all micronutrients that indicate fertility. As discussed earlier, these are often associated with additives such as manuring, and liming with addition of potash. As a result, these are discussed together.

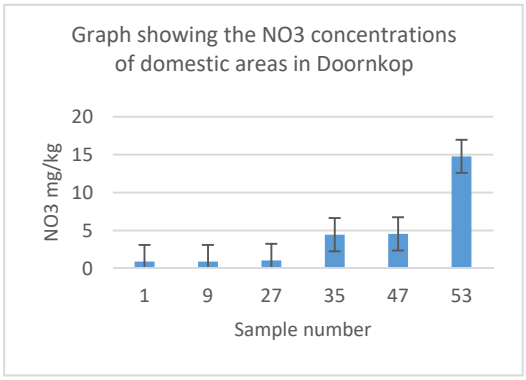
There is a distinct positive correlation between NH_4 and NO_3 concentrations, with the exception of sample 47 (Fig. 5.2.a). The concentrations for the different samples in the domestic areas have similar NH_4 and NO_3 concentrations and increase gradually from sample 1, 9, 27, 35 and peak at sample 53. The NH_4 concentration of Sample 47, however, does not follow this gradual increase, but decreases slightly to (2.59 mg kg^{-1}).

When considering these samples in a geographic context, the P concentration for sample 1 (5.37 mg kg^{-1}), located in the middle section of the hill in area A, is relatively high. Similarly, sample 53 also has a peak P concentration of 5.63 mg kg^{-1}, and is located in area C. The rest of the samples (samples 9, 27, 35 and 47) located on the hill top, and in areas B and C show similar concentrations compared to one another. The samples from the southern section of the site have higher concentrations of P, NO_3 and NH_4. This may indicate higher soil enrichment in this area (Fig. 5.2.a).

There is a distinct peak in concentration at 23 cm in depth, for NH_4, NO_3 and P. A positive correlation between NH_4, NO_3 and P occurs at different depths where the concentrations follow the same trend. At 19 cm in depth NH_4 and NO_3 have distinctly low concentrations, whereas the concentration for P peaks slightly at 5.37 mg kg^{-1} (Fig. 5.2.b).







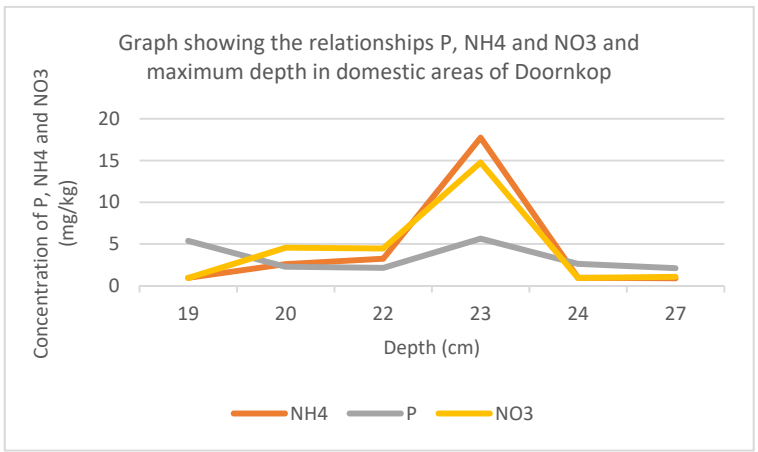


Figure 5. 2: (a) Correlations of P, NH_4 and NO_3 relative to one another. (b) Correlations of P, NH_4 and NO_3 and maximum depth.

5.1.1.3. Correlations between %C and CEC

The %C and CEC levels are discussed together because both reflect organic influences, and thus potential soil fertility (Soares and Alleoni 2008), as discussed

in Chapter 2. There is a direct correlation between %C and CEC with regards to geographical space. The upper section of the hill in area A (samples 1 and 27), have distinct peaks in CEC and %C (Fig 5.3.a).

A negative correlation is visible when comparing sample depth to the CEC and %C (Fig. 5.3.a). The overall general trend is a decrease in the CEC and %C by depth from 19 cm -22 cm. At 23 cm in depth the CEC stops decreasing and starts increasing, whereas the %C starts to decrease at this point. At 24 cm there is an increase in both %C and CEC at a high gradient (Fig. 5.3.b). This increase may be due to bioturbation in these areas.

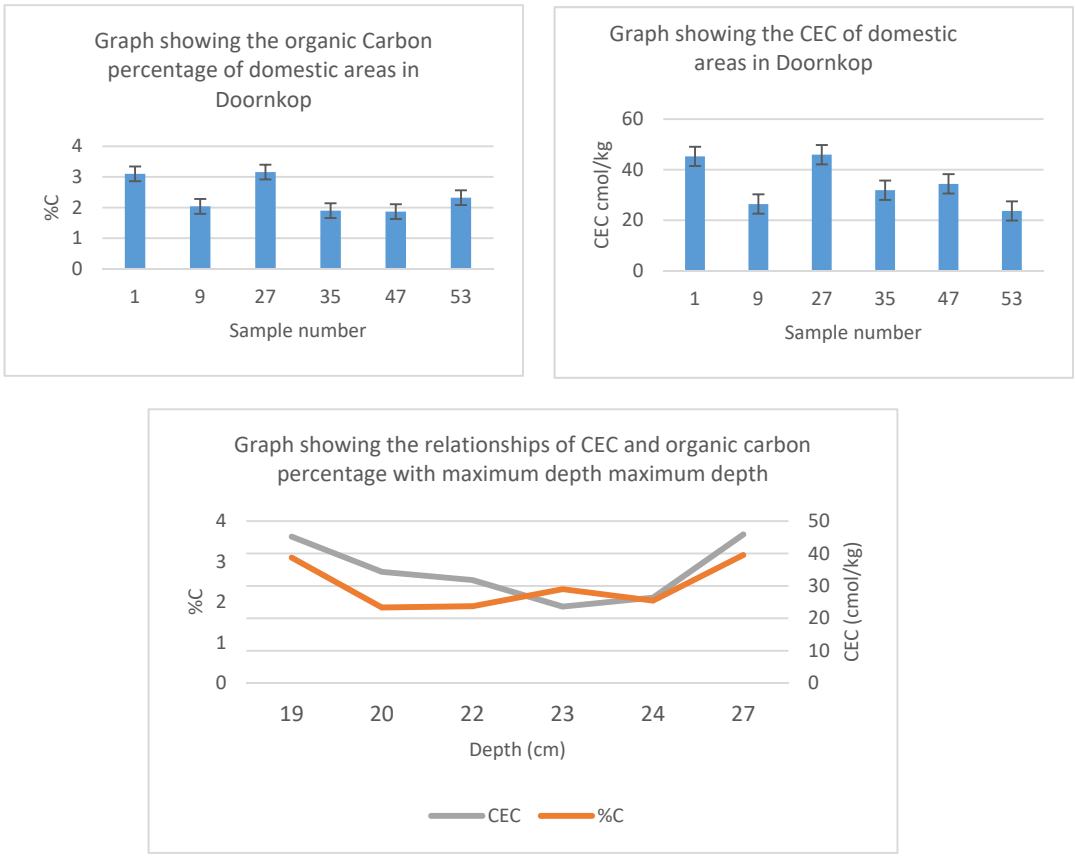


Figure 5. 3: (a) Correlation between CEC and %C in domestic areas of Doornkop. (b) Correlations of CEC and %C with maximum depth.

5.1.1.4. Clay percentage and pH

The clay content throughout the domestic areas is relatively constant with the exception of samples from the lowest section of the hill and the southern location (Fig. 5.4.a). As discussed earlier, sample 47 has anomalous NH_4, NO_3, CEC and %C contents (Fig. 5.2 and Fig. 5.3). This correlation may point to the influence of the clay on these chemical concentrations[2]. The clay content fluctuates in the domestic areas with depth (Fig. 5.4.b). The pH values, on the other hand, stay relatively consistent (Fig. 5.4.c).

[2] The correlation between clay percentage and depth, however, should be interpreted with caution, due to the impact that location, slopes and differential particle movement may have on these factors.

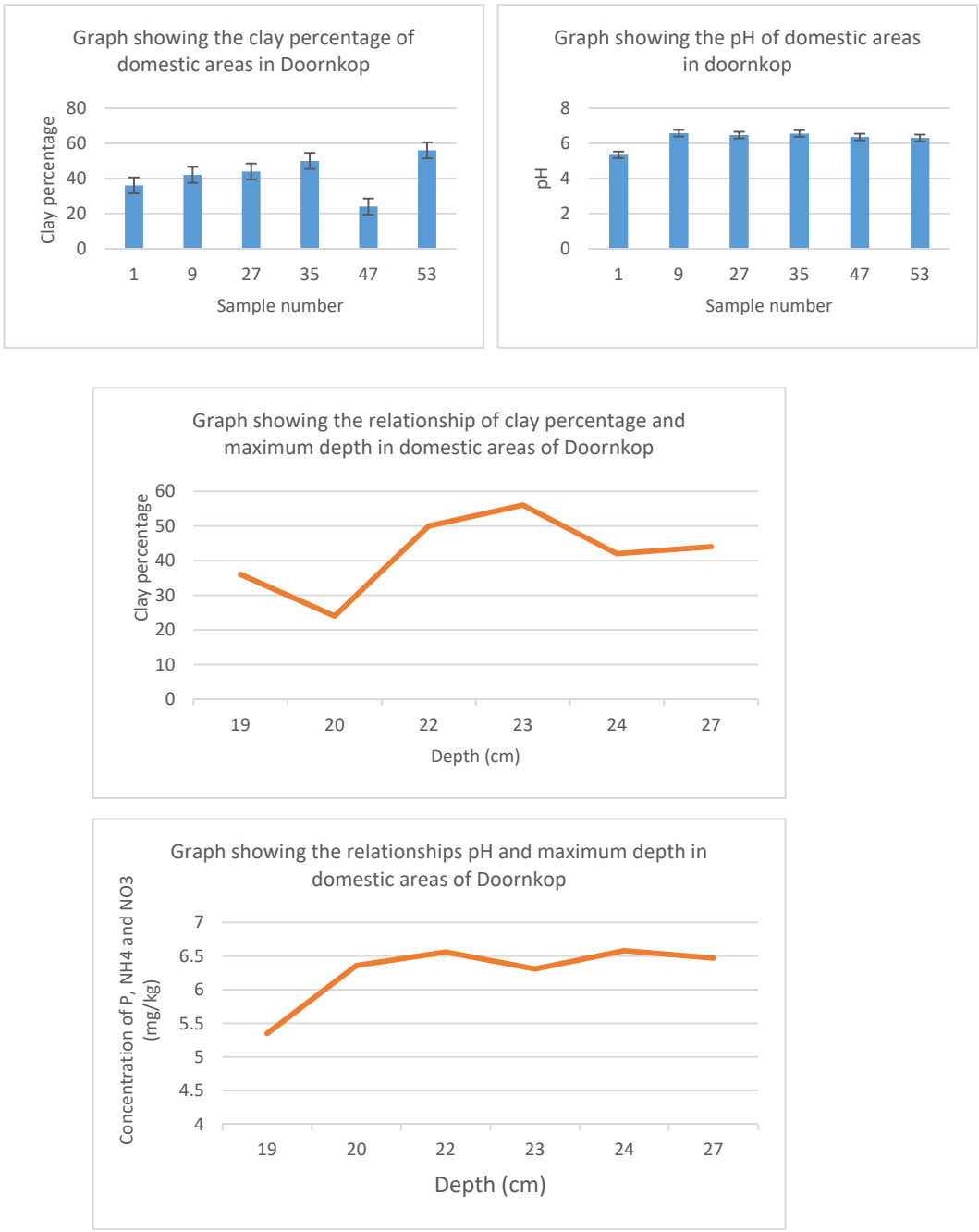


Figure 5. 4: (a) Relationship between clay percentage and pH in domestic areas. (b) Relationship of clay percentage and maximum depth. (c) Relationship of pH and maximum depth.

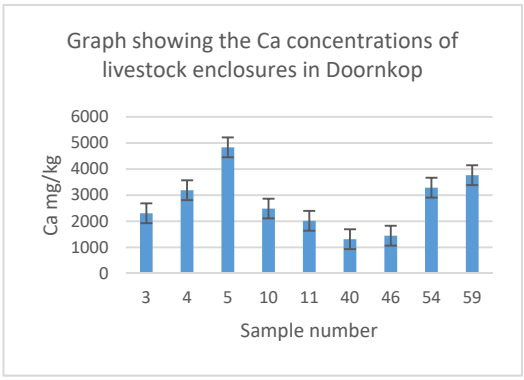
5.1.2. Central enclosures

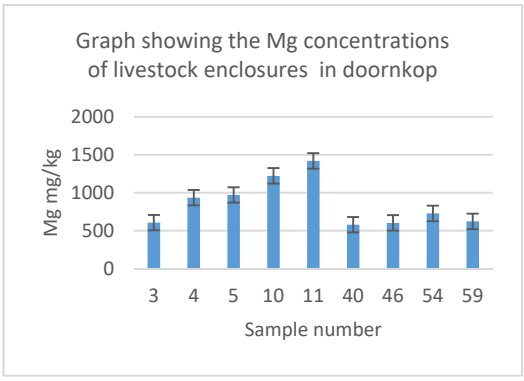
5.1.2.1. Correlation between Ca, K, Na and Mg

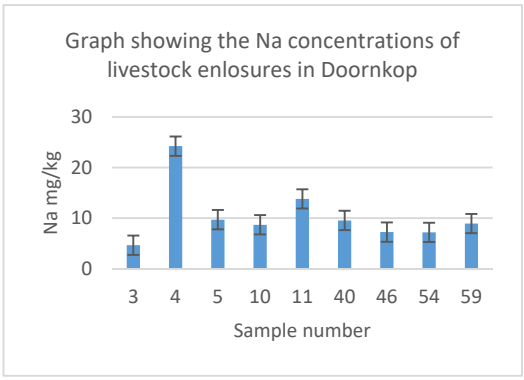
The correlations between Ca, K, Na and Mg in the central enclosures are not as clear as in the homesteads (Fig. 5.5). The Ca and Mg levels do not show a clear correlation to one another. The Na and K also do not show distinct correlations.

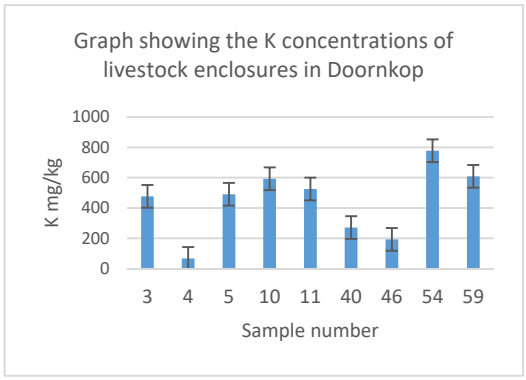
While, very few trends were evident in the soil chemistry of the central enclosures, the concentrations of the different samples fluctuate with depth[3] (Fig. 5.5.b). The Ca, K, Na and Mg concentrations show a general trend of decreasing nutrient values with depth for H1 samples, with the exception of sample 5. Sample 5 shows a distinct peak in Ca, Na and Mg concentrations at 30 cm.

[3] Depths include H1 and H2 material









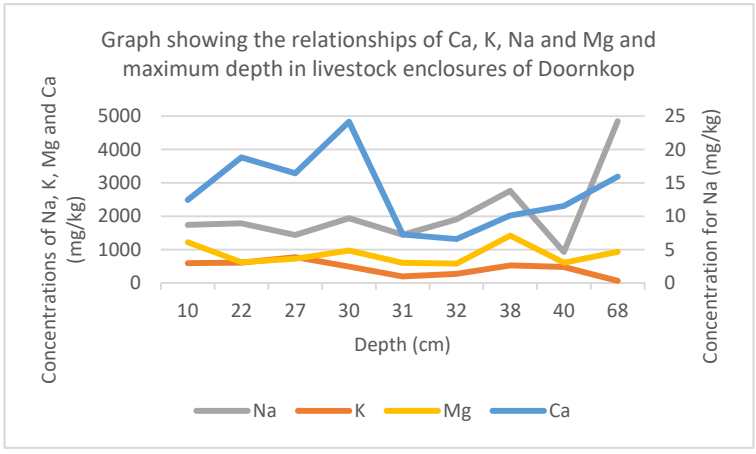


Figure 5. 5: (a) Correlations of Ca, K, Na and Mg in livestock enclosures of Doornkop. (b) Correlations of Ca, K, Na and Mg and maximum depth.

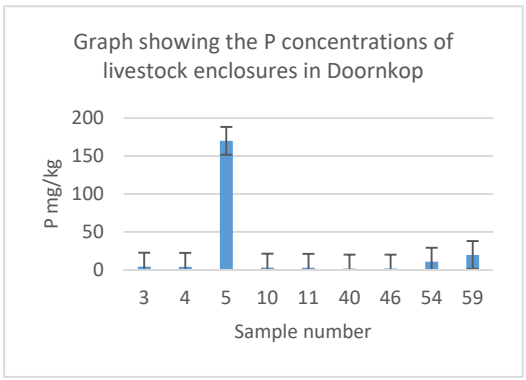
5.1.2.2. Correlation between P, NH_4 and NO_3

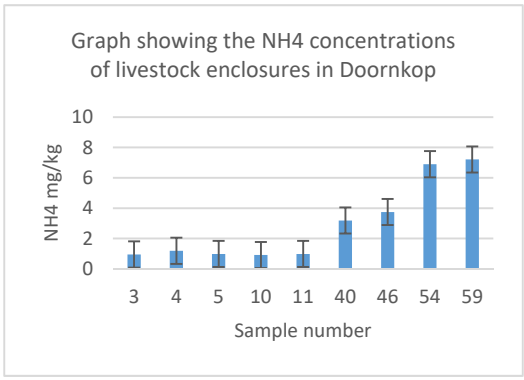
Central enclosure NH_4 and NO_3 values for samples 3 to 40 correlate. This correlation changes for samples 46, and 54, because the NH_4 increases significantly, while the concentration of NO_3 decreases between these samples. There is a distinct spike in both concentrations for sample 59, located on the southern end of the site.

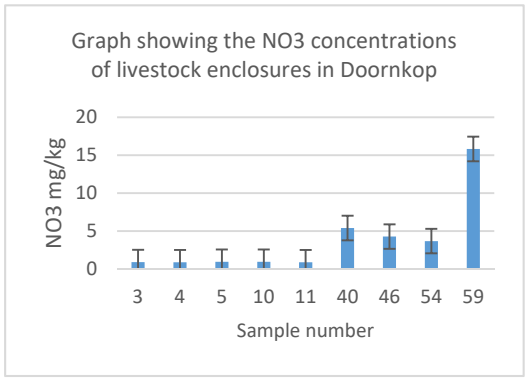
The samples taken on the hill (3 and 4), as well as samples taken from the western section of the site (Area B), have relatively low NH_4 and NO_3 concentrations. The samples on the outskirts of the hill (40 and 46) show a slight increase in NH_4 and NO_3. A distinct spike occurs in NH_4 concentration of samples from the southern section of the site (samples 54 and 59).

P concentrations are relatively consistent throughout the site with the exceptions of samples 5, 54 and 59. The southern section of the site also shows slightly elevated P concentrations (Fig. 5.6.a).

The general trend shows a decrease in the concentrations with depth, which would be expected, as external factors decreases by depth. When focussing only on the samples taken at H1, the correlation is more distinct, with the exception of sample 5, where there is a distinct decrease in concentration with depth (Fig. 5.6.b). The depths between 38 cm and 68 cm show distinctly lower concentrations (Fig. 5.6.b).







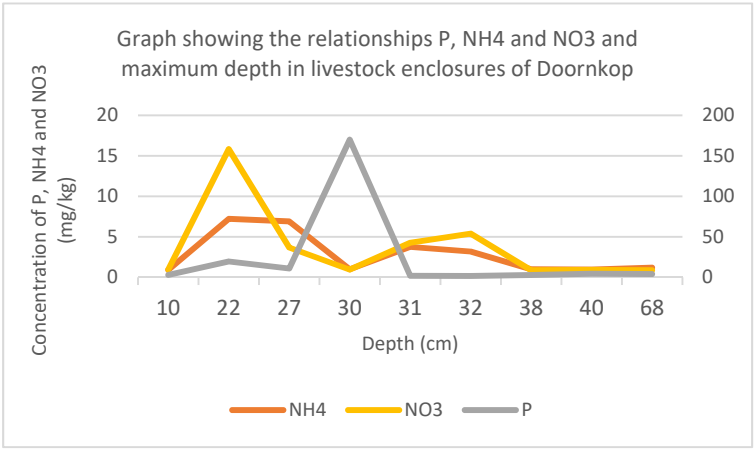


Figure 5. 6: (a) Correlations of P, NH_4 and NO_3 in livestock enclosures of Doornkop. (b) Correlations P, NH_4 and NO_3 and maximum depth.

5.1.2.3. Correlation between %C and CEC

There are distinct correlations between %C and CEC when evaluated against geographic location. The samples taken on the lower sections of the hill have elevated CEC contents. The levels are higher in area B. The pattern in %C concentrations are different, with the southern section of the site, having higher percentages of organic carbon, and lower percentages on the lower sections of the hill (Fig. 5.7.a).

In general, %C and CEC decreases with depth (Fig. 5.7.b). When only focussing on the samples taken in H1, the correlation between %C and CEC is distinct, with a general decrease in depth, and then slight peak at 40 cm (Fig. 5.7.b)

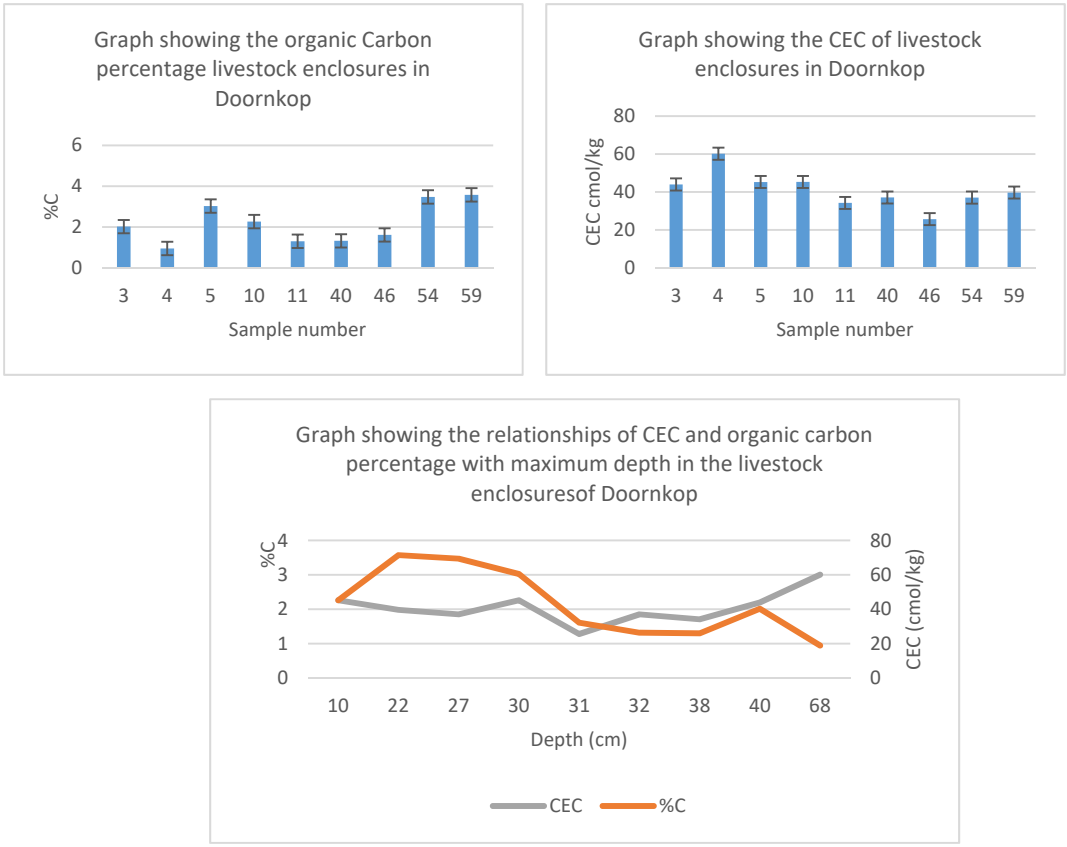


Figure 5. 7: (a) Correlations of CEC and %C in the livestock enclosures of Doornkop. (b) Correlations of CEC and %C with maximum depth.

5.1.2.4. Clay percentage and pH

The clay percentage for the central enclosures varies by location. Generally, the clay percentages are similar, with the exception of the southern section of the site, and on the lower parts of the hill (Fig. 5.8.a). There are continuous fluctuations in the clay content, so depth does not seem to influence the clay content in the central enclosures (Fig. 5.8.b). When focusing on H1, there is a steady increase in clay content from 22 cm to 31 cm, and then it declines with depth (Fig. 5.8.b).

The pH remains relatively consistent and displays an acidic content (Fig. 5.8.a). There is a general increase in acidity with depth. At 31 cm (sample 46) there is a

distinct dip in the pH level. The saprolitic sample also displays a slight decrease in acidity to a pH of 6.24 at 68 cm in depth (Fig. 5.8.c).

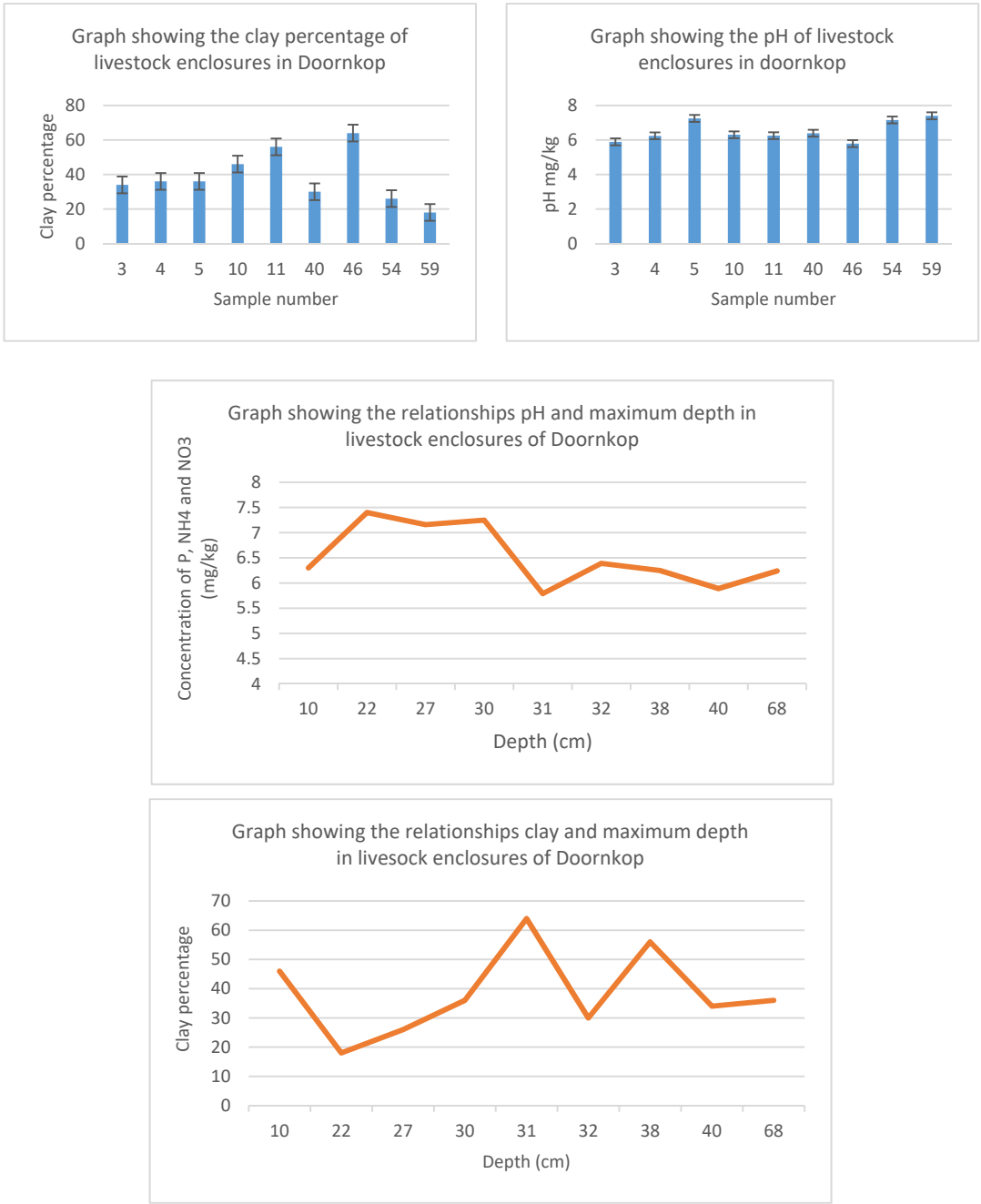


Figure 5. 8: (a) Relationship of clay percentage with pH in livestock enclosures of Doornkop. (b) Relationship of pH and maximum depth. (c) Relationship of clay and maximum depth.

5.1.3. Terraces

5.1.3.1. Correlation between Ca, K, Na and Mg

In the terraces of Doornkop the Ca concentrations has a general correlation with Mg. These are distinct for samples 6, 18 and 44, where there is a peak in Ca and Mg concentrations. The Na concentration also peaks for sample 18. K, however, has an opposite trend where the concentrations decreases significantly for these samples (Fig. 5.9.a).

The general trend, when comparing depth to soil chemistry, shows a general increase in Mg, Na and Ca by depth. The Na concentrations displays a more distinctive linear trend, in increasing Na concentration with depth, than both Mg and Ca. Ca has a lower positive linear gradient with increasing depth. There is a slight decrease in K concentration with depth. Samples below H1 show the same trend in Mg, Na and K. The Ca levels, however, decrease in concentration with depth (Fig. 5.9.b).

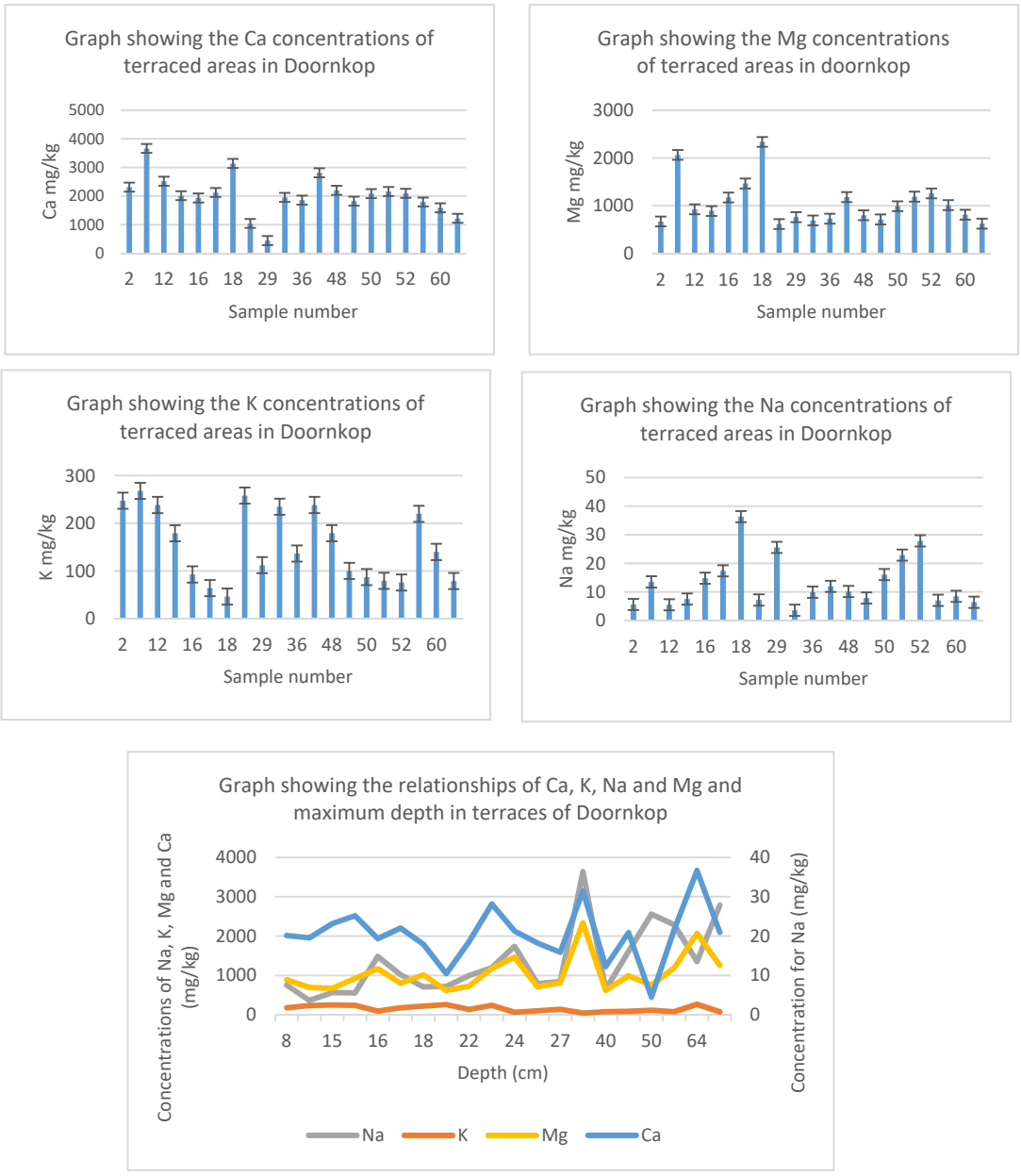


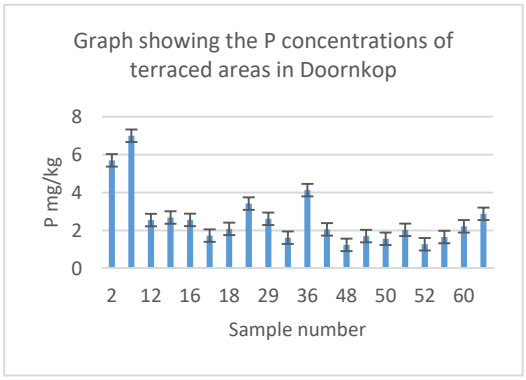
Figure 5. 9: (a) Correlations of Ca, K, Na and Mg in terraces of Doornkop. (b) Correlations of Ca, K, Na and Mg and maximum depth.

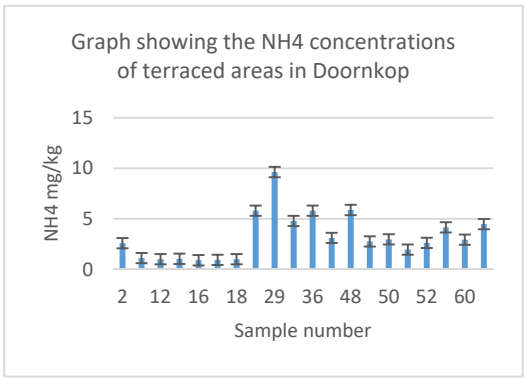
5.1.3.2. Correlation between P, NH_4 and NO_3

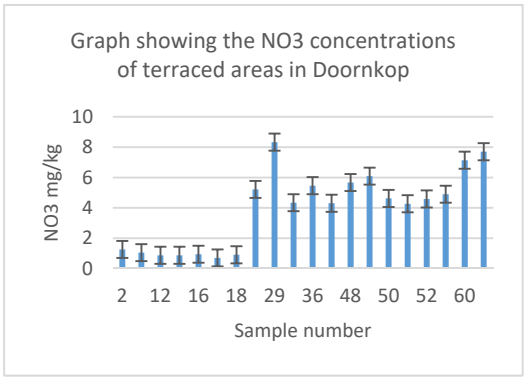
In general, the concentrations of NH_4 and NO_3 display similar correlations to one another. P concentrations, however, display an inverse correlation to both NH_4

and NO_3. Samples locations 002, 012, 017, 018 and 023 from the middle section of the hill, did not demonstrate a clear pattern. The samples from the northern section of the hill (samples location 029 and 033) have below average concentration of P, but seem to be enriched in NO_3. The eastern section of the site (sample locations 005 and 009) has relatively low concentrations of both NH_4 and NO_3. The P content in the terrace associated with the anomalous homestead (sample 6) has a very high concentration of P of 7.00 mg kg^{-1}. The southern section of the site (sample locations 037, 041 and 042) is also enriched in NO_3 (Fig. 5.10.a).

NH_4 and NO_3 concentrations show a general trend of increasing content with depth. The trend for the concentrations for P remains consistent with depth (Fig. 5.10.b). NO_3 and P concentrations increase by depth in H1. The NH_4 concentrations increase less drastically in H1 (Fig.5.10.b).







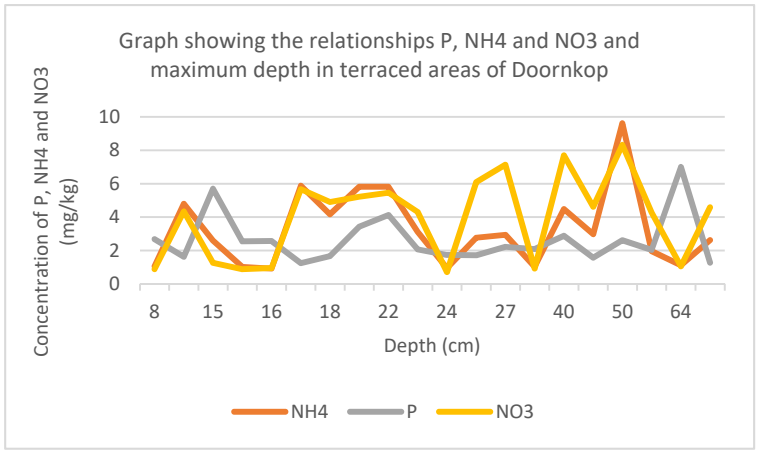


Figure 5. 10: (a) Correlations of P, NH_4 and NO_3 in terraced areas in Doornkop. (b) Correlations P, NH_4 and NO_3 and maximum depth

5.1.3.3. Correlation between %C and CEC

The correlation between CEC and %C on the terraces is not as distinct as the domestic areas. The %C and CEC values are peak on the upper section of the hill. The lower, northern section of the hill displays a similar trend for both CEC and %C, both of which are slightly depleted (Fig. 5.11.a).

The general trend in the CEC and %C values is a steady decline in the percentage and capacity with depth. H1, for both CEC and %C, demonstrate a slight decline with depth. In the layers below H1, there is a distinct decline in %C with depth. The lower %C values are directly correlated with the lowest layers that were sampled (Fig. 5.11.b). This shows that the organic materials are not transported into the lower layers.

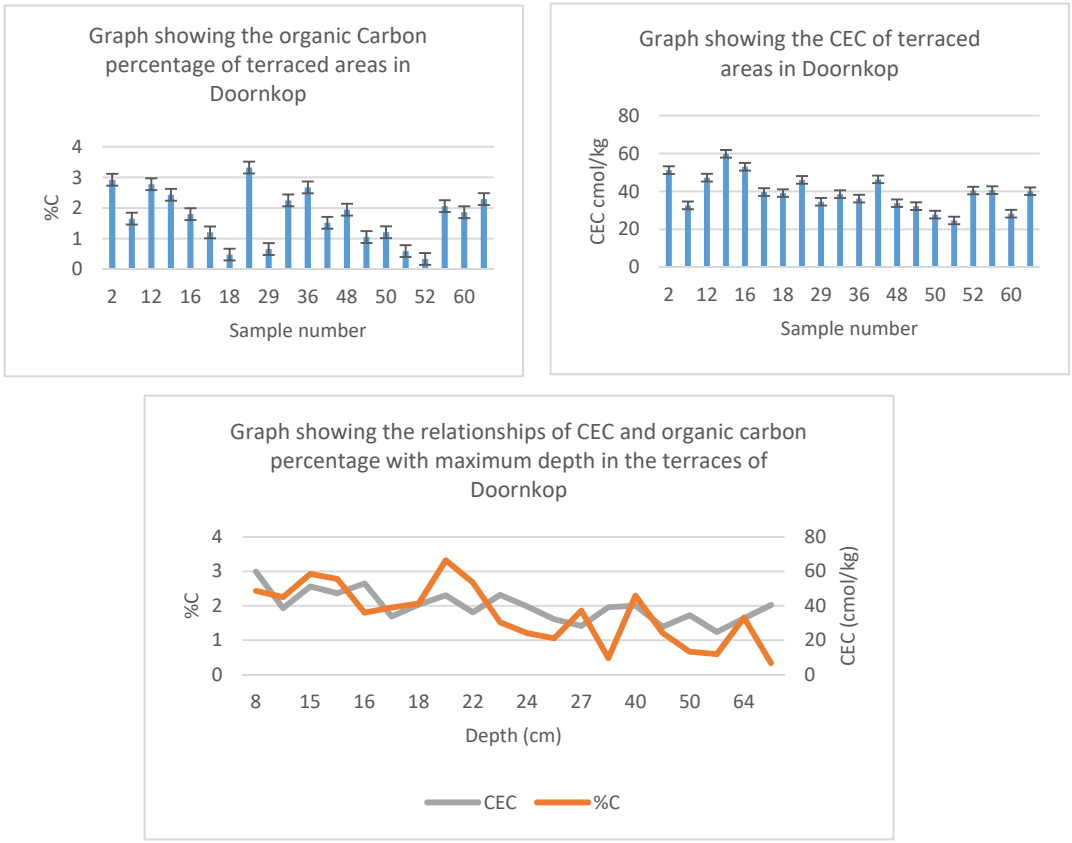


Figure 5. 11: (a) Correlations of CEC and %C in the terraces of Doornkop. (b) Correlations of CEC and %C with maximum depth.

5.1.3.4. Clay percentage and pH

The clay percentage in the upper section of the hill varies, but in general where the clay percentage is relatively high, the pH is more acidic, and vice versa. This may be due to the clay minerals releasing specific protons that have a distinct pH (Soil classification workgroup 1991: 216). The clay percentage then decreases with decreasing elevation. The western section of the site shows a similar correlation between the pH and clay percentage. The clay percentage in the terrace (sample 12) associated with the older Bokoni homesteads is higher, and is also more acidic than the terrace associated with the anomalous homestead (sample 6). The south western section of the site has a slightly different pattern. The clay content in this area is relatively moderate, and has a more acidic pH (Fig. 5.12.a).

When comparing the different layers and depth, the trends are very similar. The general trend for pH is a decrease in acidity with depth. The clay percentage shows the opposite trend. The highest level of depletion, for both pH and clay percentage, is at 40 cm in depth (Fig. 5.12.b).

The general trend in H1 is an increase of pH with regards to depth, where the clay content decreases with depth (Fig 5.12.c). Similarly, the samples taken below the H1 shows a decrease in clay percentage, and increase in pH with depth.



Figure 5. 12: (a) Relationship of %C and pH of terraced areas in Doornkop. (b) Relationship of %C with maximum depth. (c) Relationship of pH and maximum depth.

5.1.4. Non-archaeological areas

Samples from non-archaeological areas are control samples. As discussed in the methodology chapter the data from these areas reflect on the natural agricultural potential of the soils in areas where there is no evidence of human interference.

5.1.3.1. Correlation between Ca, K, Na and Mg

The area B displays elevated Mg and Ca concentrations, as opposed to the rest of the areas of Doornkop. There is a positive correlation between Mg and Ca. K concentrations show a general negative correlation to Ca and Mg. The north western area is depleted in K, and the top of the hill is more enriched. The K concentration generally decreases as one moves down the hill. The southern section of the hill also shows enrichment in K concentrations. The overall Na concentration, in the non-archaeological areas, is relatively depleted (Fig. 5.13.a).

The correlation of depth with Ca and Mg concentrations shows that there is a slight increase of these nutrients with depth (Fig. 5.13.b). The K shows a distinctive decline in concentration with depth, whereas, Na is relatively constant with three distinct peaks at 14, 30 and 60 cm. When focussing only on H1, the trends are different. There is a distinct decline in concentration of Ca, Mg and K. The Na, however, shows an increase in concentration. There are no distinct trends in location and H1 concentrations with depth. The only area that shows distinctive peaks in Mg and Ca, is the north western section of the site, with associated depletion of K and Na in this area (Fig. 5.13.a).

The results from layers below H1 demonstrate an increase in Mg and Ca with depth. The Na, however, has a distinct decrease in concentration until 50 cm,

along with K. These trends may speak to the lower layers being closer to the bedrock.

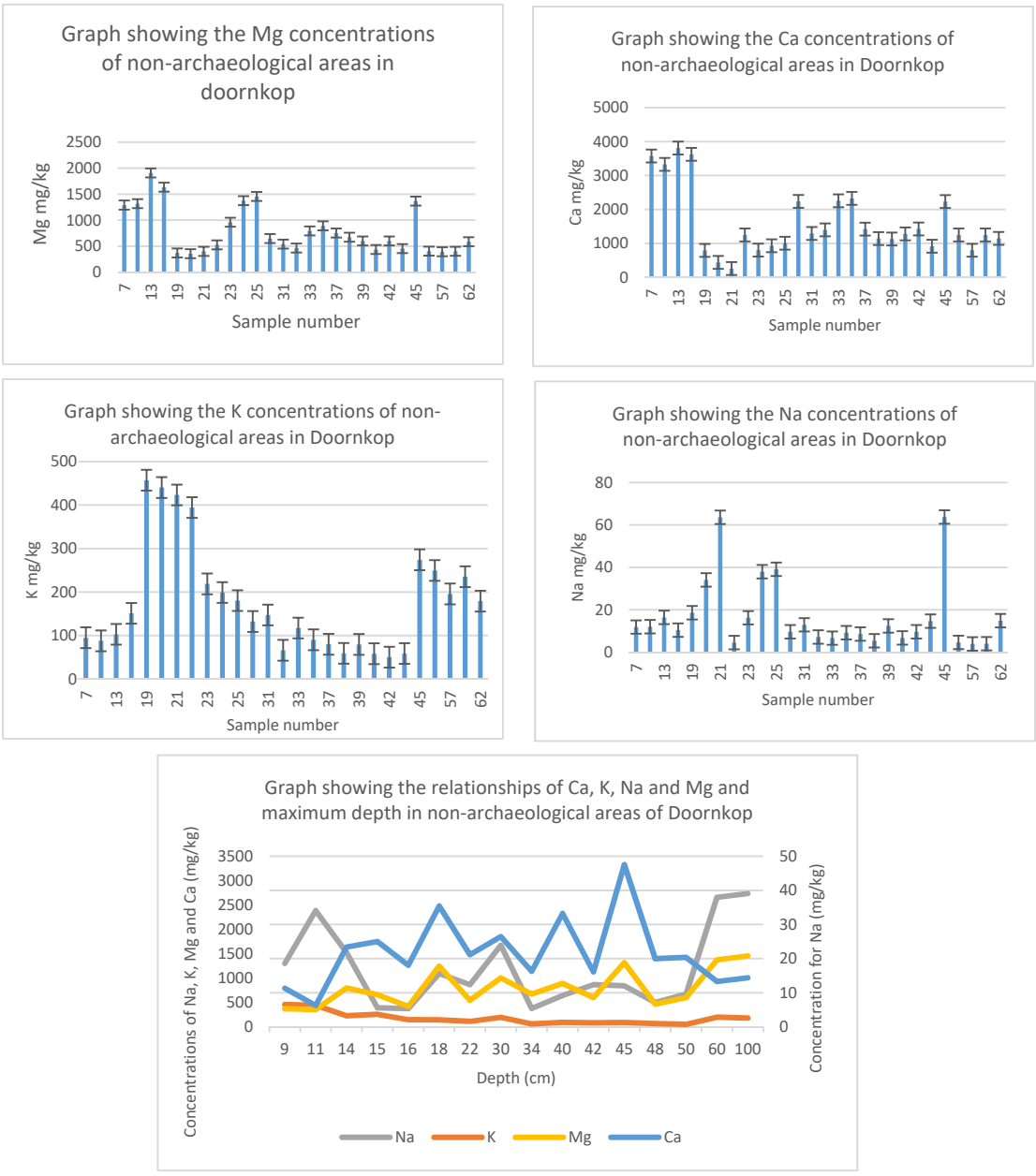


Figure 5. 13: (a) Correlations of Ca, K, Na and Mg and maximum depth in non-archaeological areas of Doornkop. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.1.3.2. Correlation between P, NH_4 and NO_3

The NO_3 and NH_4 concentrations show similar trends, where the north western and top sections of the site show relatively depleted concentrations. There is a distinct increase in these concentrations when moving down the slope. The southern section of the site shows a distinct increase in NO_3 concentrations, and a slightly heightened concentration of NH_4. The P, however, shows relatively similar concentrations of throughout Doornkop (Fig. 5.14.a).

NH_4 and NO_3 show a general increase in concentration with depth. The P concentration, however, decreases with depth (Fig. 5.14.b). The H1 layers have variable concentration with depth. There is, however, a noticeable increase in NH_4 and NO_3 in H1, and a decrease in P concentrations. The layers below H1 demonstrate a more consistent trend with depth. There is again an increase in NH_4 with depth, and decreasing NO_3 and P concentration (Fig. 5.14.b).

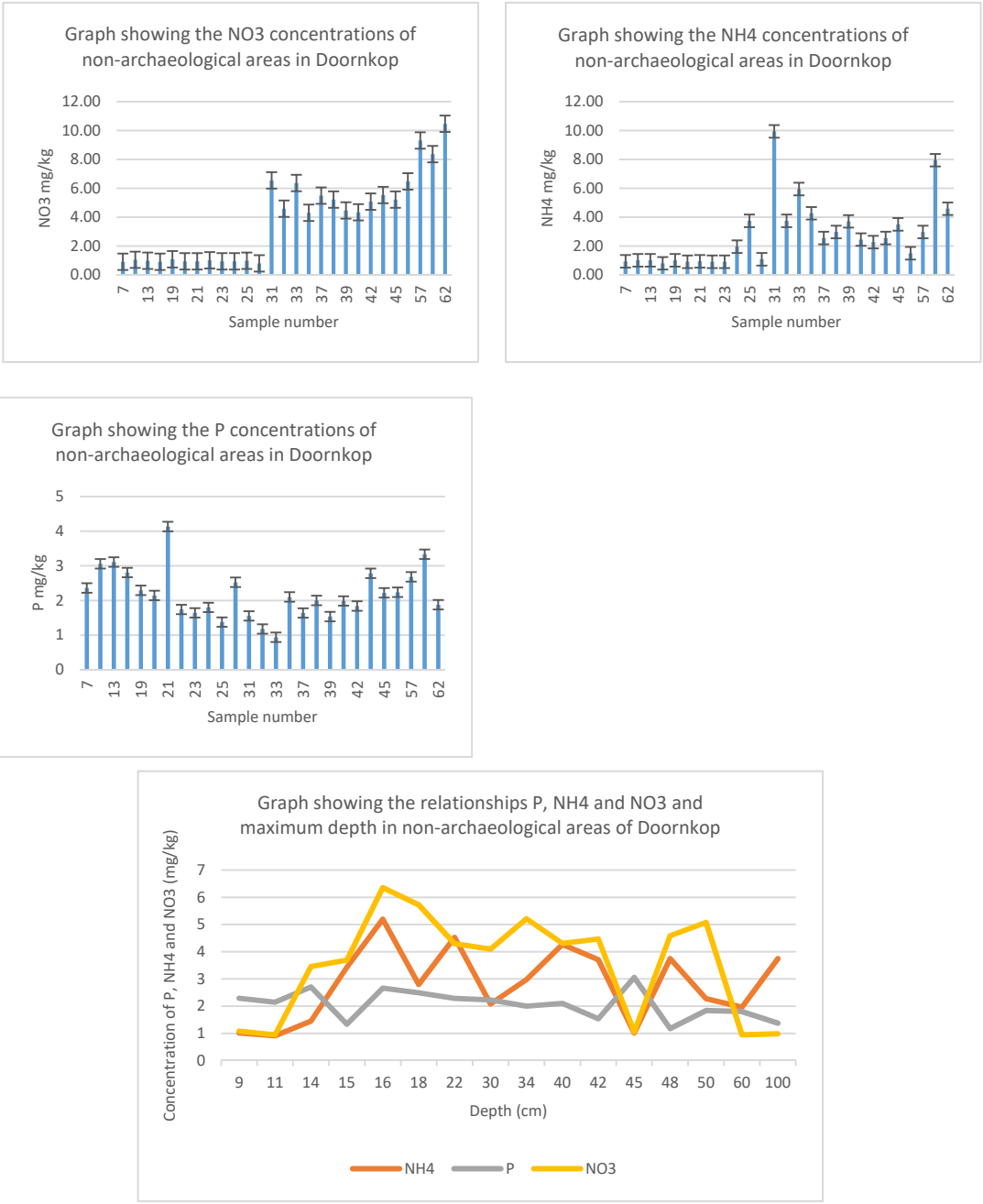


Figure 5. 14: (a) Correlations P, NH_4 and NO_3 in non-archaeological areas of Doornkop. (b) Correlations P, NH_4 and NO_3 and maximum depth

5.1.3.3. Correlation between %C and CEC

There is no apparent geographical location correlation between %C and CEC in the non-archaeological areas of Doornkop. The western section of the site demonstrates relatively low CEC levels, and the %C in this area is moderate. The %C and CEC in the top section of the hill is relatively high. The CEC consistently average in the lower and the south western section of the site. The %C, however, demonstrates relatively low percentages in the lower section of the hill, and fluctuates in the south western section of the site (Fig. 5.15.a).

There is a relatively consistent decrease of both %C and CEC with increasing depth (Fig. 5.15.b). The H1 layers show similar trends of decreasing CEC and %C with depth. The layers below H1 show a very slight upwards trend with increasing depth for CEC, and a distinct decrease in %C (Fig. 5.15.b).

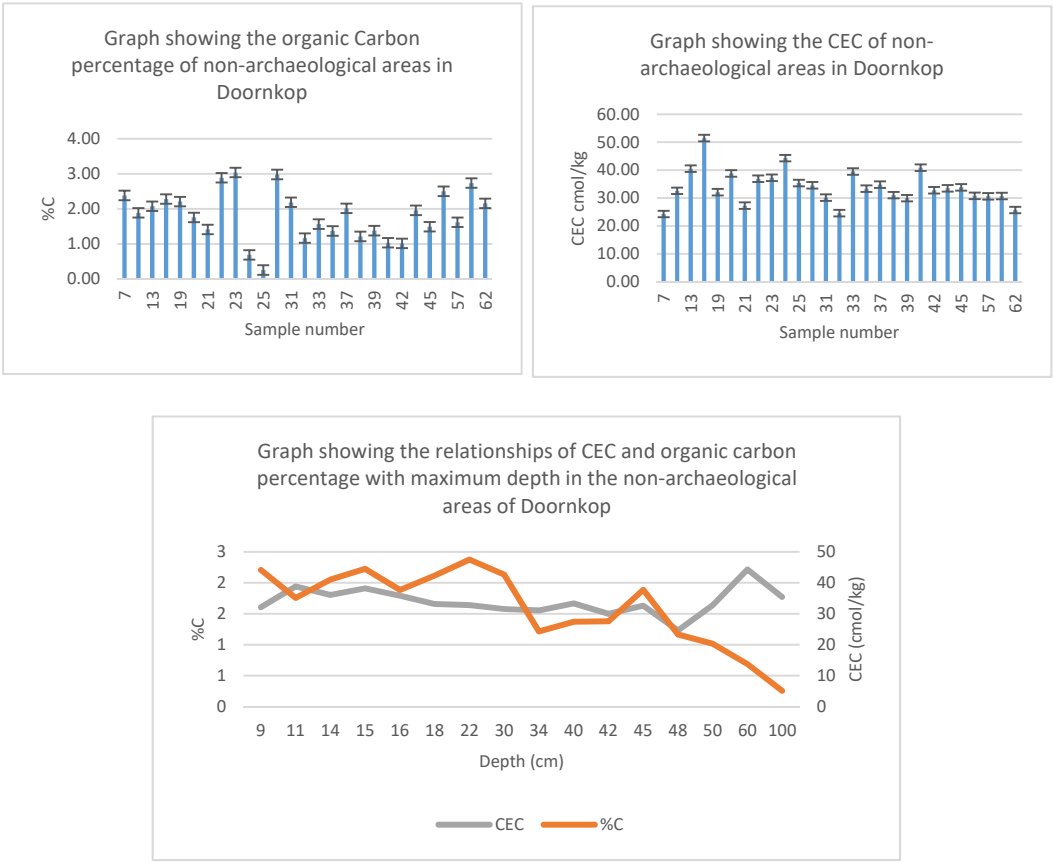


Figure 5. 15: (a) Correlations of CEC and %C in the non-archaeological areas of Doornkop. (b) Correlations of CEC and organic carbon percentage with maximum depth.

5.1.1.4. Clay percentage and pH

The clay percentage and the pH do not show a distinct correlation such as the one described in the terraced areas. The non-archaeological areas are generally acidic, with slightly more alkaline samples located on the top of the hill in the lower layers. The clay percentage varies greatly between the different areas. The western section of the site is slightly more clay rich, whereas the hill is less so. There is a slight peak on lower eastern section of the hill. The south western section of the site also generally has a low clay content (Fig. 5.16.a).

The pH and clay percentage increases with depth. The pH shows two correlations to the saprolitic samples. The distinct decline in the pH at 11, 22, and 34 cm (samples 20, 43, and 34 respectively) is associated with saprolitic samples. The opposite is shown with saprolitic samples at 14, 60, and 100 cm (samples 21, 24, and 25 respectively). Both these trends are localised on the middle to upper section of the hill, with the exception of sample 41. The clay percentage shows no distinctive correlation, to the location, depth or pH of the area (Fig 5.16.a).

The pH and clay percentage both increase with depth in H1, pH less so. The clay percentage demonstrates the staggered trend in H1 (Fig 5.16.b). The layers below H1 show a distinct increase in both pH and clay percentage. The clay and pH correlation shows a positive correlation (Fig 5.16.c).



Figure 5. 16: (a) Relationship of clay percentage non-archaeological areas of Doornkop. (b) Relationship of clay percentage with maximum depth. (c) Relationship of pH with maximum depth.

5.2. Khutwaneng

Khutwaneng forms part of the second and possibly third phases of occupation in Bokoni. As discussed earlier, Khutwaneng is a stone walled site which demonstrates elements of town planning of the site, such as the central village road.

5.2.1. Domestic area

5.2.1.1. Correlation between Ca, K, Na and Mg

In Khutwaneng, there is no direct correlation between Ca, K, Na and Mg with geographical space in the domestic areas. The Ca and Mg stays relatively consistent throughout the site, and have a positive correlation. K and Na concentrations are more varied throughout the site, with no direct correlation of space. K and Na have a negative correlation (Fig. 5.17.a).

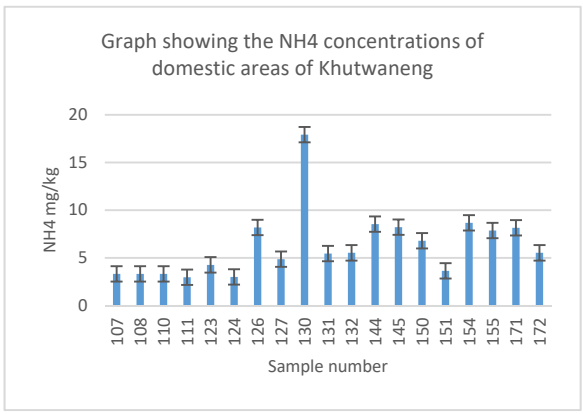
Although there seems to be a positive correlation between Ca and Mg and geographical space, these have a negative correlation with depth. Ca concentration decreases with depth, whereas Mg concentrations increase. Similarly, to Doornkop, the Na levels increase exponentially with depth. K, however, has a distinct drop in concentration with depth (Fig. 5.17.b).

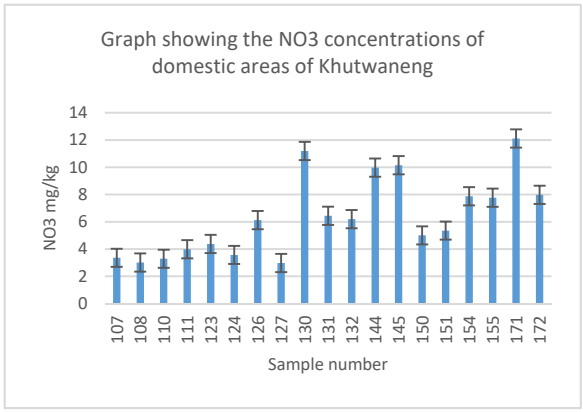


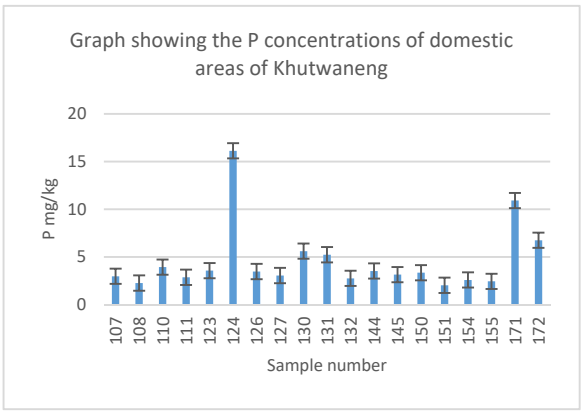
Figure 5. 17: (a) Correlations of Ca, K, Na and Mg in domestic areas of Khutwaneng. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.2.1.2. Correlation between P, NH_4 and NO_3

Khutwaneng displays relatively consistent concentrations of P, NH_4 and NO_3 throughout the sampling area. There are some exceptions with regards to peaks in these concentrations. These, however, do not necessarily correlate with geographical space, but with localised trends (Fig. 5.18.a). The concentrations for all three of these compounds decrease with depth, at a relatively similar gradient. These trends correspond with the notion that P, NH_4 and NO_3 are all derived from organic materials, and an increasing depth results in a decrease in organic activity (Fig. 18.b).







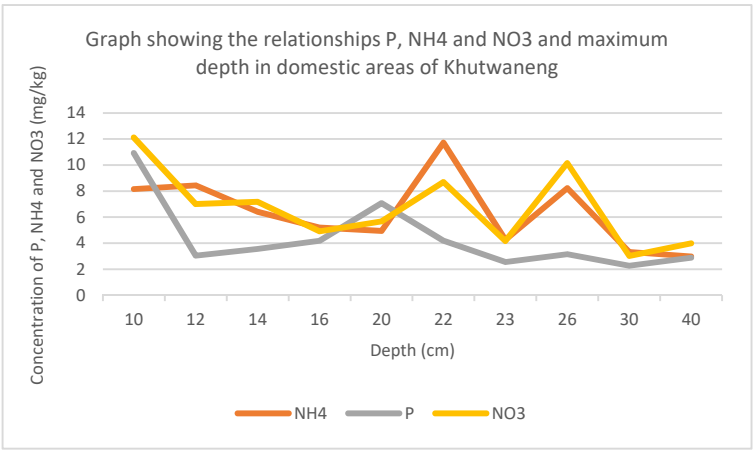


Figure 5. 18: (a) Correlations P, NH_4 and NO_3 in domestic areas of Khutwaneng. (b) Correlations P, NH_4 and NO3 and maximum depth.

5.2.1.3. Correlation between %C and CEC

Both the %C and CEC, in the domestic areas of Khutwaneng, demonstrate similar trends as what was found at Doornkop. The %C decreases consistently with each layer throughout the site, where organic material decreases with depth. The CEC shows the opposite trend where the potential for fertility increases with depth in most of the areas of the sites. The distinct peak at sample 145, at a capacity of 114.49 cmol kg-1, demonstrates a saprolitic sample in the northern section of the sampling area (Fig. 5.19.a).

Although there is a trend in the individual samples, in which the CEC seems to increase with each layer, the overall capacity for fertility decreases with depth. The %C shows a much higher negative gradient with increasing depth than the CEC. These trends are consistent when isolating the different layers (Fig. 5.19.b).

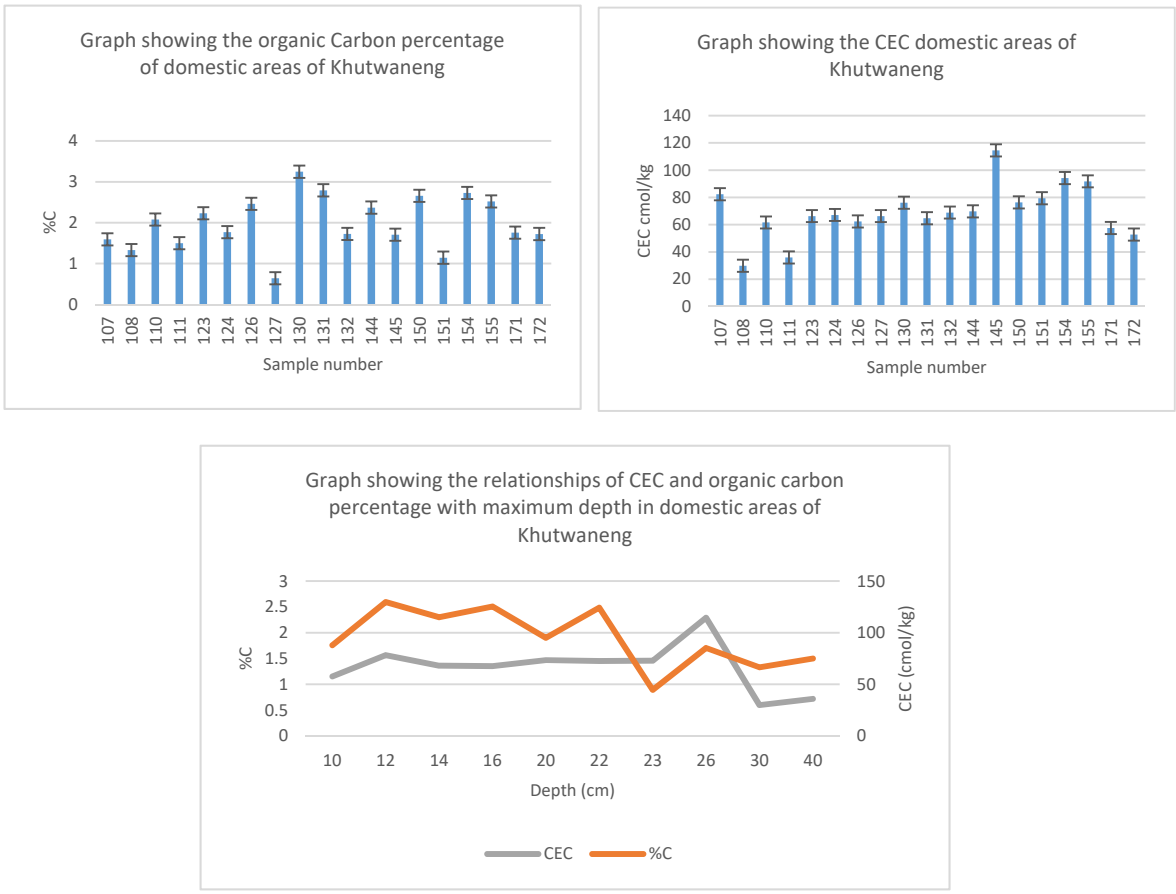


Figure 5. 19: (a) Correlations of CEC and %C domestic areas of Khutwaneng (b) Correlations of CEC and %C with maximum depth.

5.2.1.4. Clay percentage and pH

There are large variations in clay percentage and pH throughout the domestic areas. The clay percentage, however, does not have a distinct pattern with regards to area. The pH of these soils, however, is less acidic in the northern section of the site. There is a positive correlation with regards to the clay percentage and the pH, where the upper layers have lower clay percentage, and are more acidic. The only exception is that of the coring location of samples 154 and 155 (Fig. 5.20.a).

The clay percentage has a relatively high positive gradient with regards to depth, in which increasing depth has an increase in clay percentage. The pH also has a slight positive gradient, with the soil becoming less acidic, and more neutral with depth. When isolating the different layers, however, there is a distinct increase in acidity with depth[4] (Fig. 5.20.b).

[4] This refers to the separation of H1, and combined layers below H1.

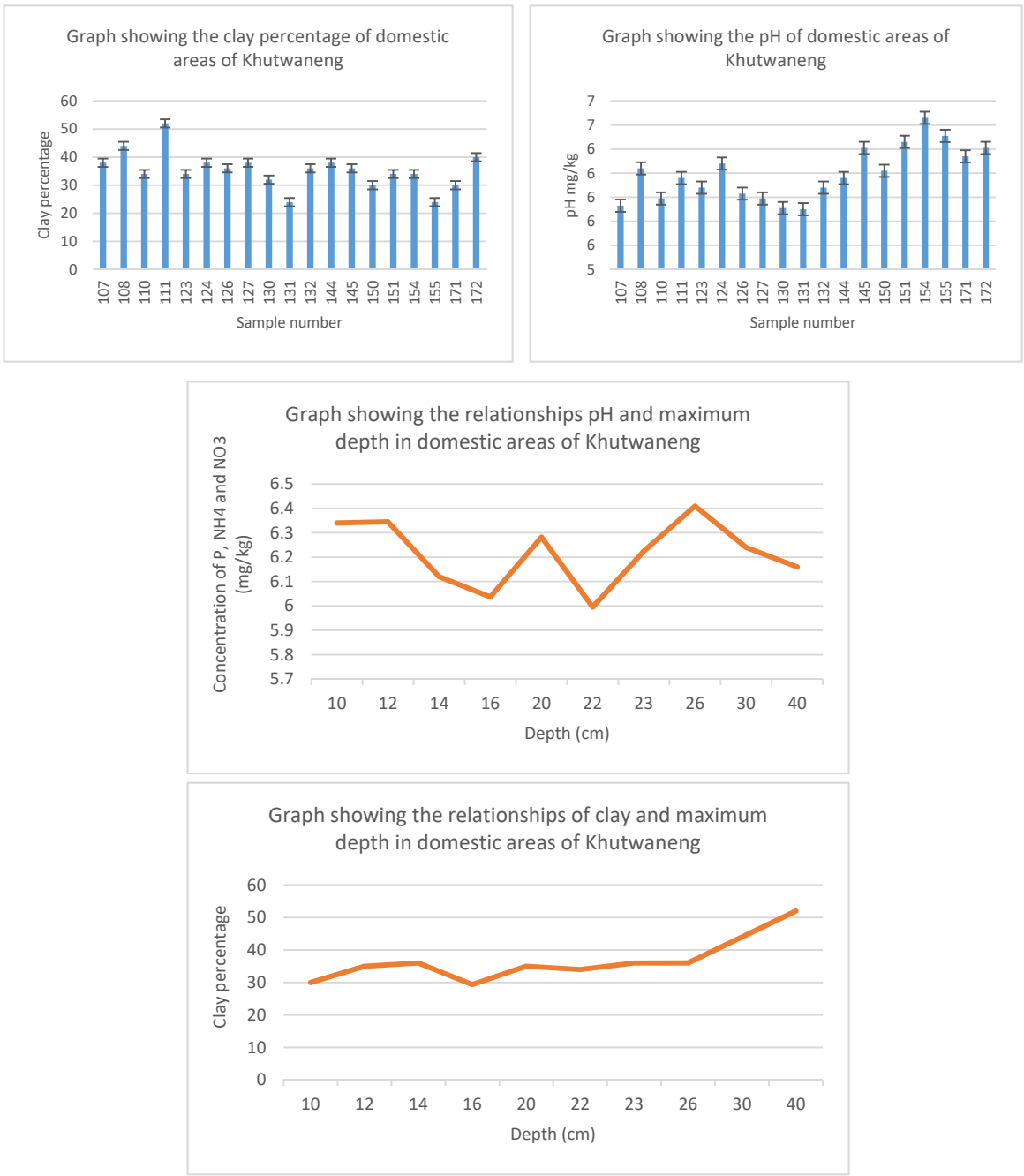


Figure 5. 20: (a) Relationship of clay percentage and depth in domestic areas of Khutwaneng. (b) Relationship of pH and maximum depth. (c) Relationship of clay percentage.

5.2.2. Central enclosures

5.2.2.1. Correlation between Ca, K, Na and Mg

There is a distinct positive correlation between Mg and Ca throughout the central enclosures at Khutwaneng. These correlations, however, do not correlate with regards to geographical space. This may be due to the sampling area being only on a single hill, with the same rock types throughout the site, even though the samples are spread over 2 km from each other. The main trend that follows the concentrations of these micronutrients, is that the Ca and Mg content increases in the lower layers. This pertains to the fact that dolerite is rich in Mg and Ca (Best 2003; Blatt *et al.* 2006), and the lower layers are closer to the parent material (Fig. 5.21.a).

Na and K also have a positive correlation where the lower layers tend to have higher concentrations, as opposed to the top layers. This is a relatively consistent trend throughout the site. Similarly, to the Ca and Mg, there is no consistent correlation between geographic space and the concentration of these micro-nutrients (Fig. 5.21.b).

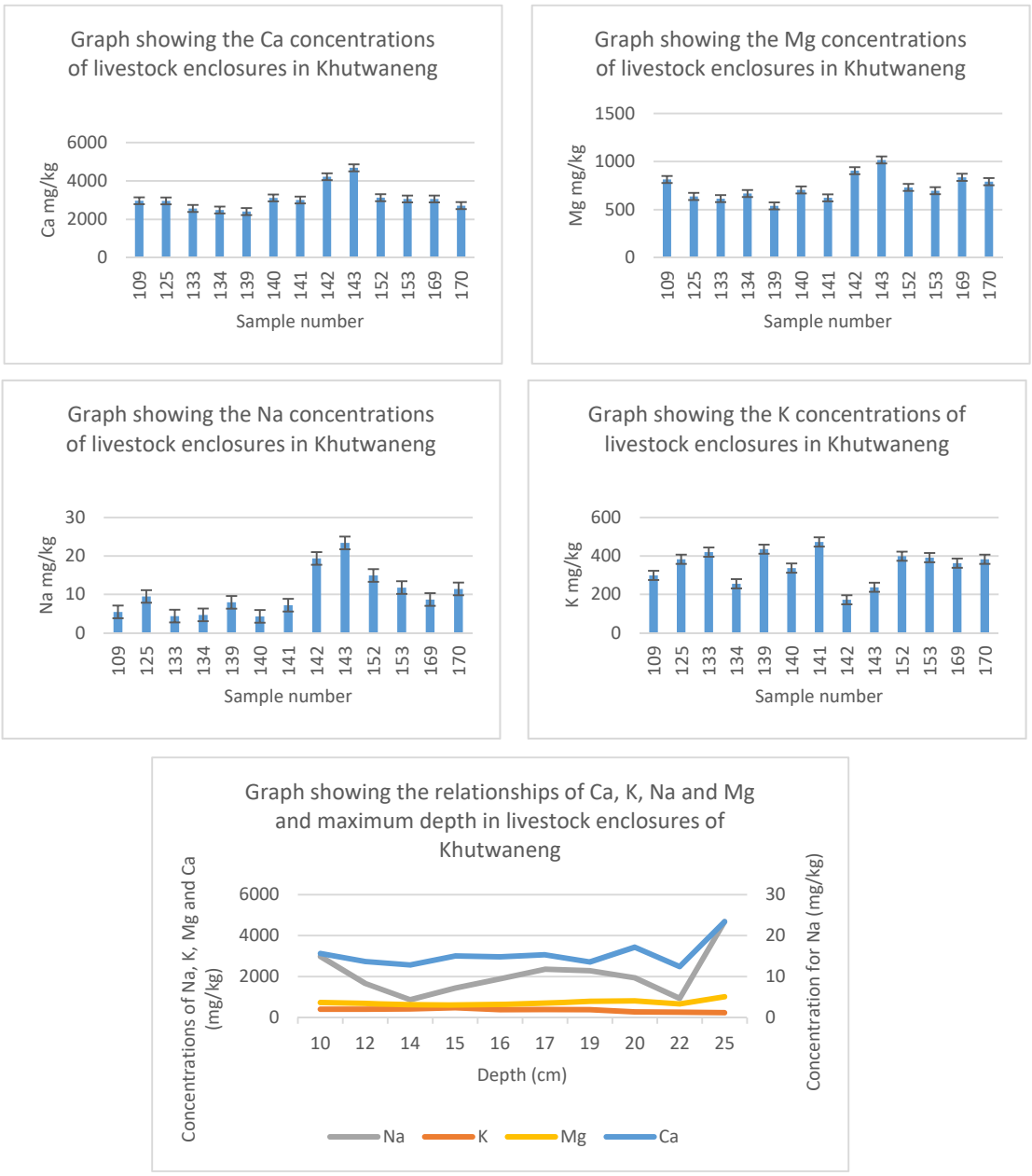
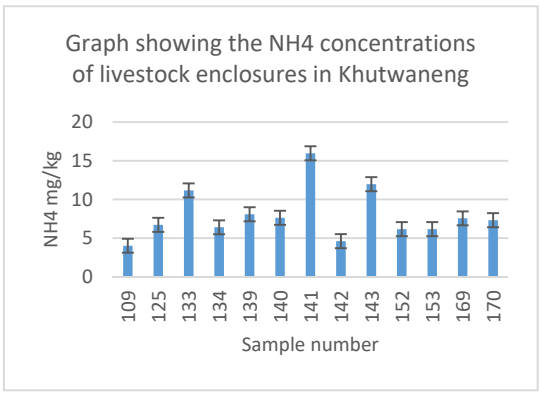


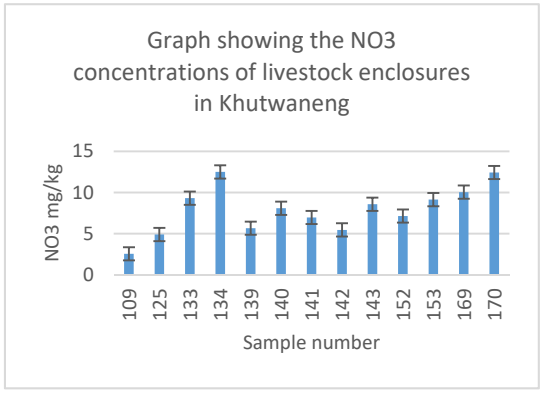
Figure 5. 21: (a) Correlations of Ca, K, Na and Mg in livestock enclosures of Khutwaneng. (b) Correlations of Ca, K, Na and Mg and maximum depth.

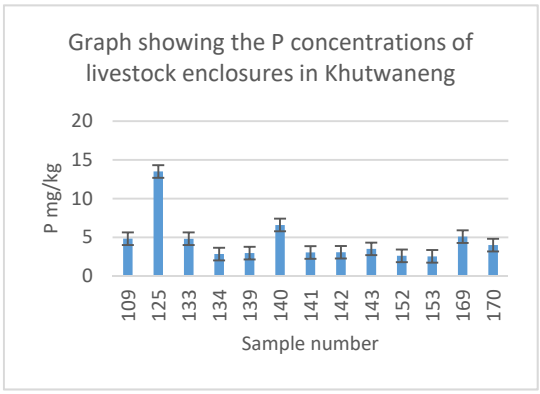
5.2.2.2. Correlation between P, NH_4 and NO_3

The relationships between P, NH_4 and NO_3 are not clear. The P concentration is relatively consistent throughout the site, and there are no specific patterns that relates to geographic space. Sample 125 shows a distinct peak in P in the central enclosure, which may be due to a localised enhancement of the soil. The NH_4 and NO_3 also vary throughout the site and do not have a distinct correlation with regards to geographic space. P and NH_4 have a more negative correlation (Fig. 5.22.a).

NH_4 and P have a similar correlation with regards to depth. The concentrations for these compounds displays a relatively low gradient of decreasing concentration with depth. This correlation changes when separating the layers. The NH_4 concentrations display the same pattern when separating H1 and the layers below H1. The concentrations for P, however, change quite drastically with a high positive gradient of increasing concentration with depth. Similarly, with regards to concentrations for NO_3. There is a slightly positive gradient with an increasing concentration with depth. The NO_3 displays a different pattern in the different layers, where in both H1 and the layers below H1, demonstrate high decrease of concentration with depth (Fig. 5.22.a).







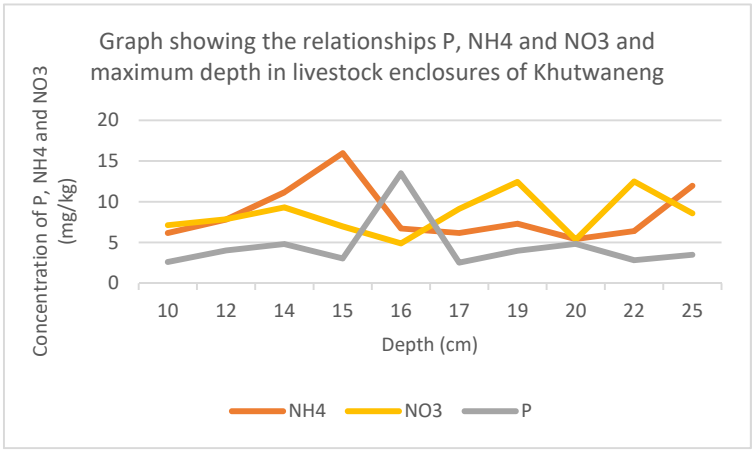


Figure 5. 22: (a) Correlations of P, NH_4 and NO_3 in livestock enclosures of Khutwaneng. (b) Correlations P, NH_4 and NO_3 and maximum depth.

5.2.2.3. Correlation between %C and CEC

The %C and CEC show similar results in the southern half of the sampling area. Both of these analyses demonstrate a decrease in percentage and %C in the lower layers. In the northern half of the site, the correlation between the percentage and capacity displays an opposite trend, where the %C decreases with depth and the CEC increases in the lower layers (Fig. 5.23.a).

The CEC and %C have a similar trend with depth, where the %C and fertility capacity decreases with depth at a moderate rate. In H1 the %C and CEC still decreases, where the CEC has a much smaller negative gradient. The layers below H1, however, show a much greater decrease by depth for both these elements analysed, %C decreases at a higher rate (Fig. 5.23.b).

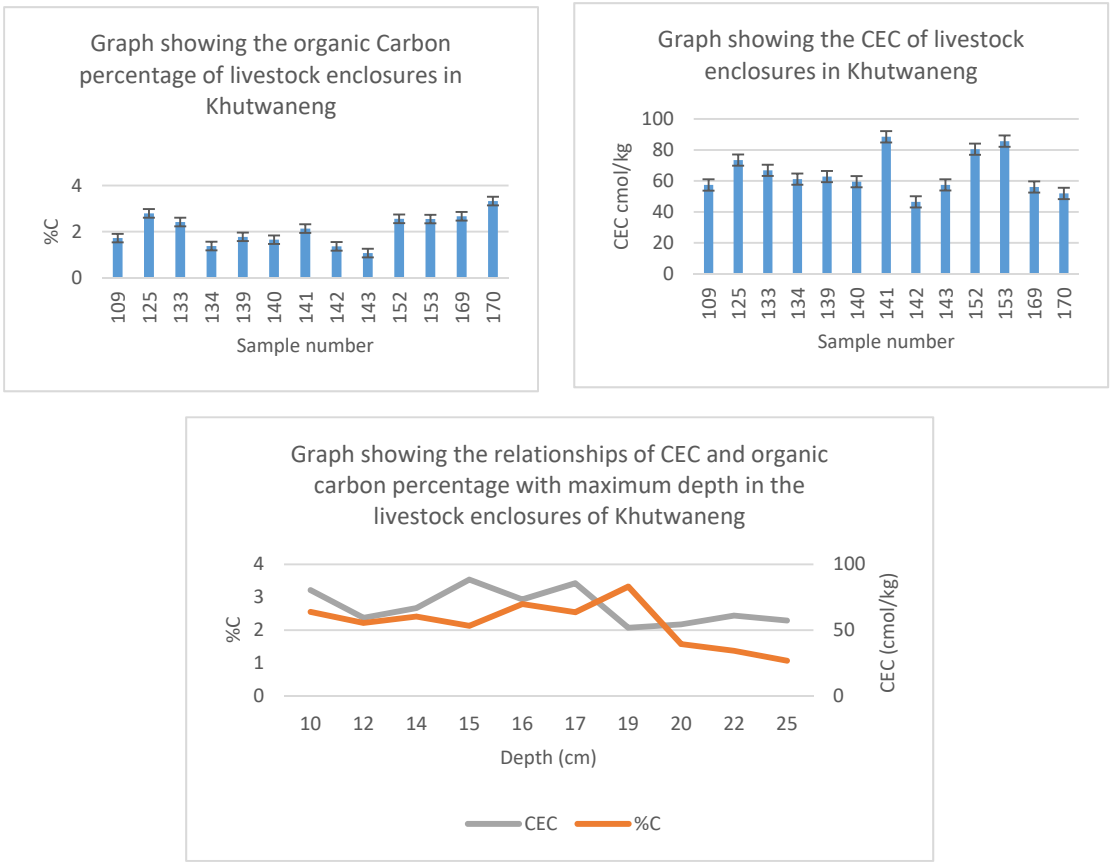


Figure 5. 23: (a) Correlations of CEC and %C in the livestock enclosures of Khutwaneng. (b) Correlations of CEC and %C with maximum depth.

5.2.2.4. Clay percentage and pH

There is no apparent correlation between the pH and clay percentage with geographic space. The clay percentage does, however, increase in the lower layers, whereas the pH stays consistent (Fig. 5.24.a). The pH has a slight negative gradient indicating that the soil becomes more acidic with depth. When isolating the different layers, the gradient is much greater and the soil becomes more acidic at a higher rate (Fig. 5.24.c).

The clay percentage shows an increase in clay content with depth. The gradient in both the overall comparison and H1 samples are similar and relatively high. In the layers below H1, however, shows a decrease in clay content with depth (Fig. 5.24.b).



Figure 5. 24: (a) Relationship of pH and clay percentage in livestock enclosures of Khutwaneng. (b) Relationship of pH and maximum depth. (c) Relationship clay percentage and maximum depth.

5.2.3. Terraces

5.2.3.1. Correlation between Ca, Mg, K, and Na

The correlation between Ca, Mg, K and Na is not very clear. There is also not a direct correlation with geographic space for any of these cations. The concentration of K, however, decreases in the lower layers, with the exception of one sample, which is consistent with the rest of the results in Khutwaneng. Mg has the opposite trend compared to K. The lower layers have a higher concentration of Mg compared to the top layer. The Na content also increases in the lower layers compared to the higher layers. This goes in hand with the fact that the parent material is mafic. Ca, on the other hand, does not show a consistent pattern between the different layers (Fig. 5.25.a).

The general trend, for Ca and K, shows a slight rate of decline in concentration with depth. This stays consistent for K between the different layers. The Ca concentration shows the same trend in H1, but the content increases with depth in the layers below H1. The Mg and Na content increases with depth, with Na having a high positive gradient. In H1, the gradient for Na, is very slight, and indicates a decrease in Na with depth, whereas in the layers below H1 shows the opposite trend. The Mg shows a consistent trend of increasing concentration with depth in both regards, however, the Mg content is higher in the lower layers (Fig 5.25.b).

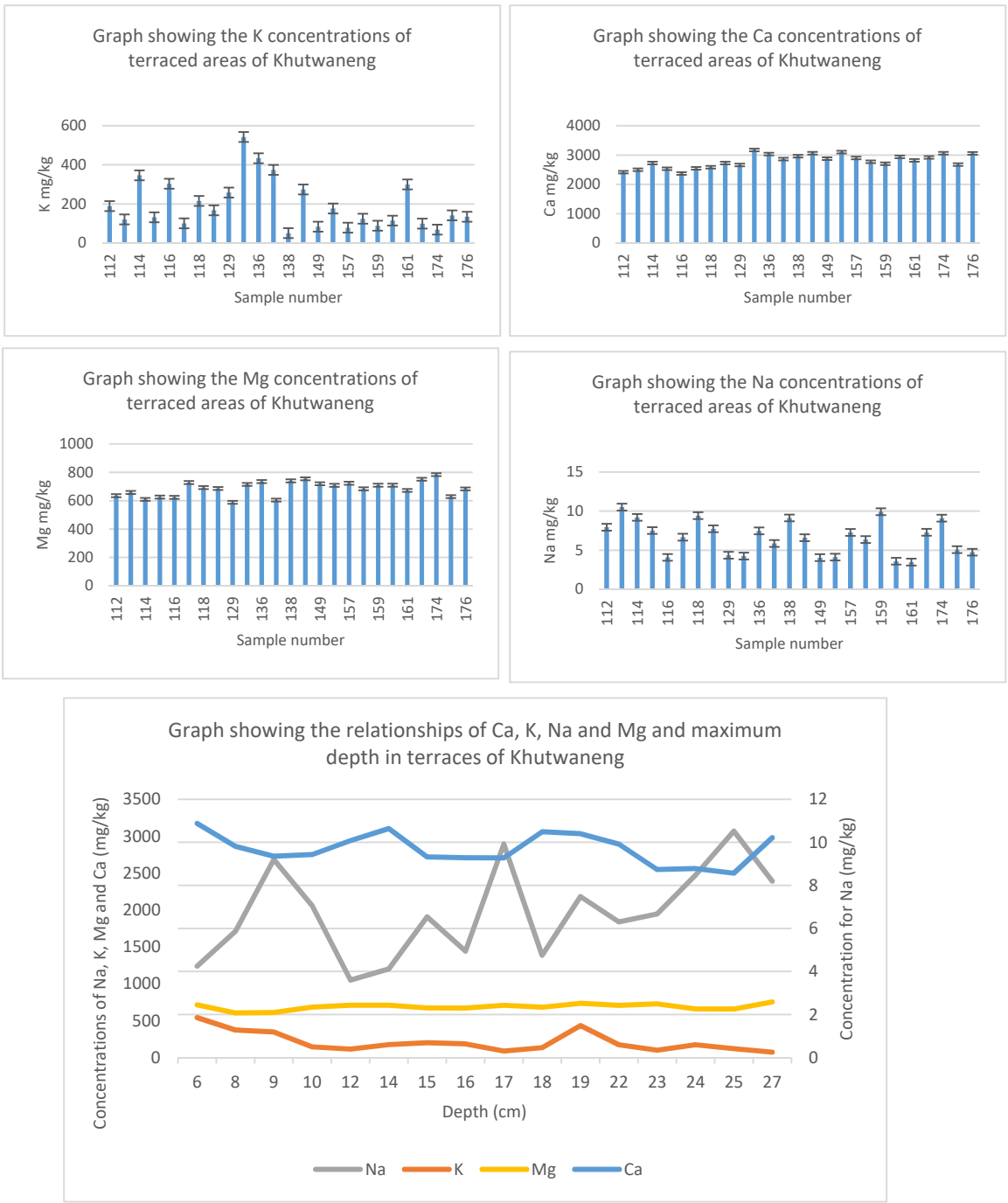
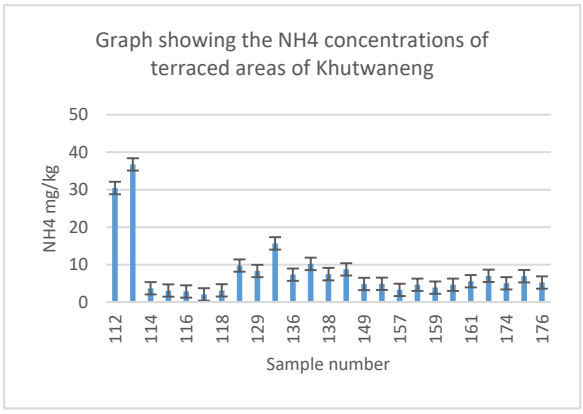


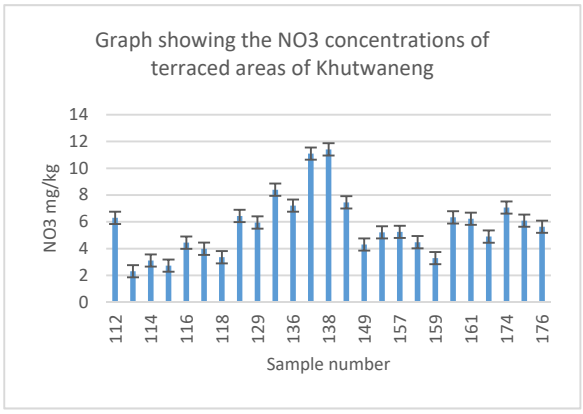
Figure 5. 25: (a) Correlations of Ca, K, Na and Mg in terraces of Khutwaneng. (b) Correlations of Ca, K, Na and Mg and maximum depth.

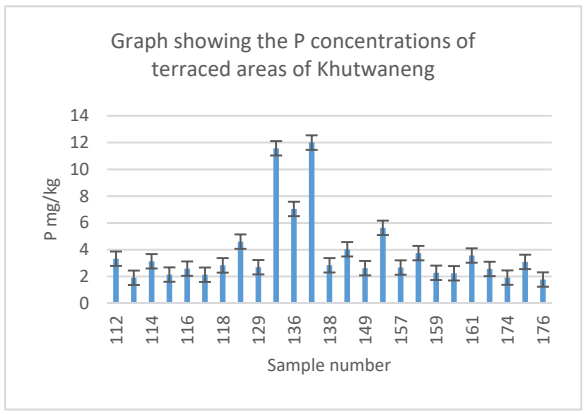
5.2.3.2. Correlation between NH_4, NO_3 and P

NH_4, NO_3 and P have a very similar correlation. Both compounds demonstrate a higher concentration with in the upper layers, and decrease in the lower layers. P does not show a direct correlation with regards to area, whereas NO_3 displays a higher concentration in the middle section of the sampling area. With the exception of samples 112 and 113, the NH_4 concentration in the southern section of the site shows a depletion of NH_4 content (Fig. 5.26.a).

The concentration of NH_4, NO_3 and P decreases with depth, at a relatively slow rate. These results are reflected in the H1 layers, where NH_4 and NO_3 has a higher negative gradient. In the layers below H1, both NO_3 and P decrease slightly with depth, whereas NH_4 shows a distinct increase with a higher gradient. This result is anomalous because one would expect for the concentration to decrease in the lower layers, as organic matter is not as present as in the top layers (Fig. 5.26.b).







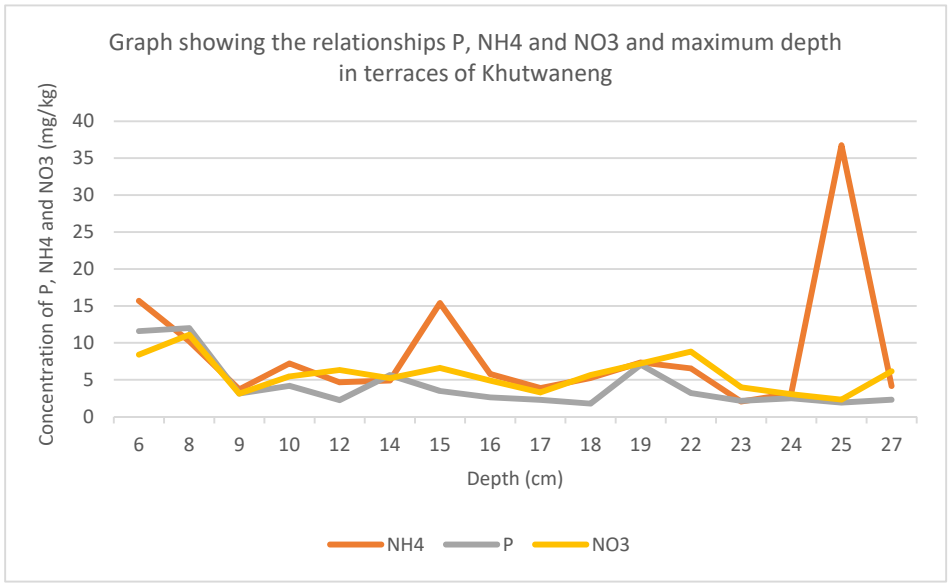


Figure 5. 26: (a) Correlations P, NH_4 and NO_3 in terraces of Khutwaneng. (b) Correlations P, NH_4 and NO_3 and maximum depth.

5.2.3.3. Correlation between %C and CEC

The %C and CEC shows a similar correlation, where both the concentration and fertility capacity decreases in the lower layers in most instances (Fig. 5.27.a). This follows the same rationale that %C and CEC have a direct correlation (de Jager, pers. comm. 2015). There is, however, no direct correlation between %C and CEC with regards to geographic space. These do, however, decrease with depth in the overall context and in H1. The layers below H1 show a distinctly different pattern, where the CEC decreases with depth and %C increases (Fig. 5.27.b). This result is anomalous when compared to the rest of the trends and may need to be interpreted with caution, as it is expected that organic influences would be more active in the shallower depths.

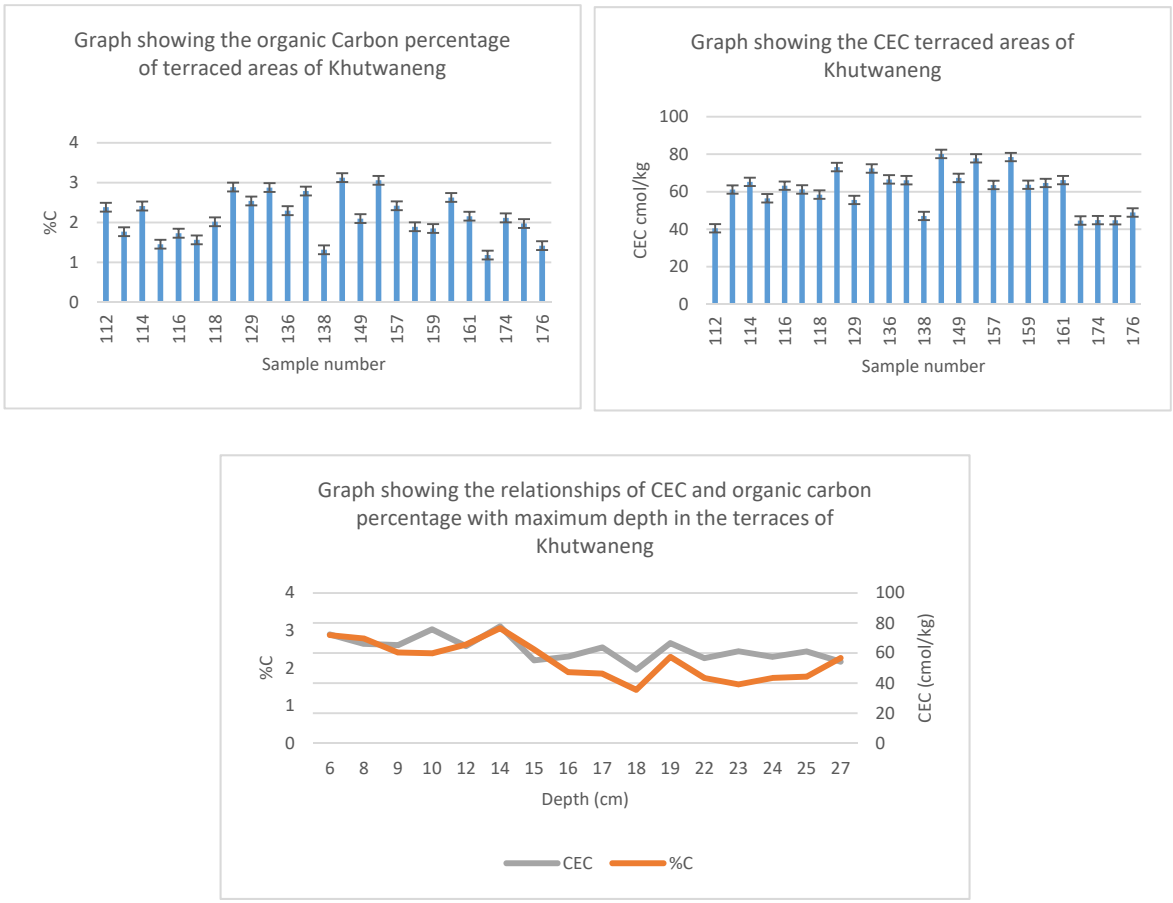


Figure 5. 27: (a) Correlations of CEC and %C in the terraces of Khutwaneng. (b) Correlations of CEC and %C with maximum depth.

5.2.3.4. Clay percentage and pH

The clay percentage and pH seem to have a direct correlation when compared to each other. In instances where the clay percentage increases with depth, the soil becomes less acidic, and vice versa (Fig. 5.28.a). The overall trend in the terraces of Khutwaneng, is that the clay percentage is higher in the lower layers, making these less acidic[5] (Fig. 5.28.b and Fig. 5.28.c).

[5] This includes results with depth in the overall results, H1 and layers below H1



Figure 5. 28: (a) Relationship of clay percentage and pH of terraced areas of Khutwaneng. (b) Relationship of pH and maximum depth. (c) Relationship clay percentage with maximum depth.

5.2.4. Non-archaeological areas

5.2.4.1. Correlation between Ca, Mg, K and Na

Ca, Mg and Na all have the same trend in the non-archaeological areas of Khutwaneng. These cations demonstrate an increase in concentration when going into the lower layers of the sample. The Ca and Mg have a fairly consistent concentration throughout the site, whereas the Na concentrations vary. The middle, and northern section of the site is relatively depleted in Na. K shows the opposite trend, with decreasing concentration in the lower layers. Overall the northern and southern sections of the site are relatively depleted in K, whereas the middle section is enhanced (Fig. 5.29.a). The middle section of the site only has a single core, and may not necessarily represent this entire section of the hill.

The Mg, Ca and K all have a general trend of decreasing concentration with depth, whereas Na has a relatively high increase in depth. This trend is consistent in H1, with a higher rate of depletion in Ca concentration with depth. The Mg concentrations in the layers below H1 increase slightly with depth (Fig. 5.29.b).

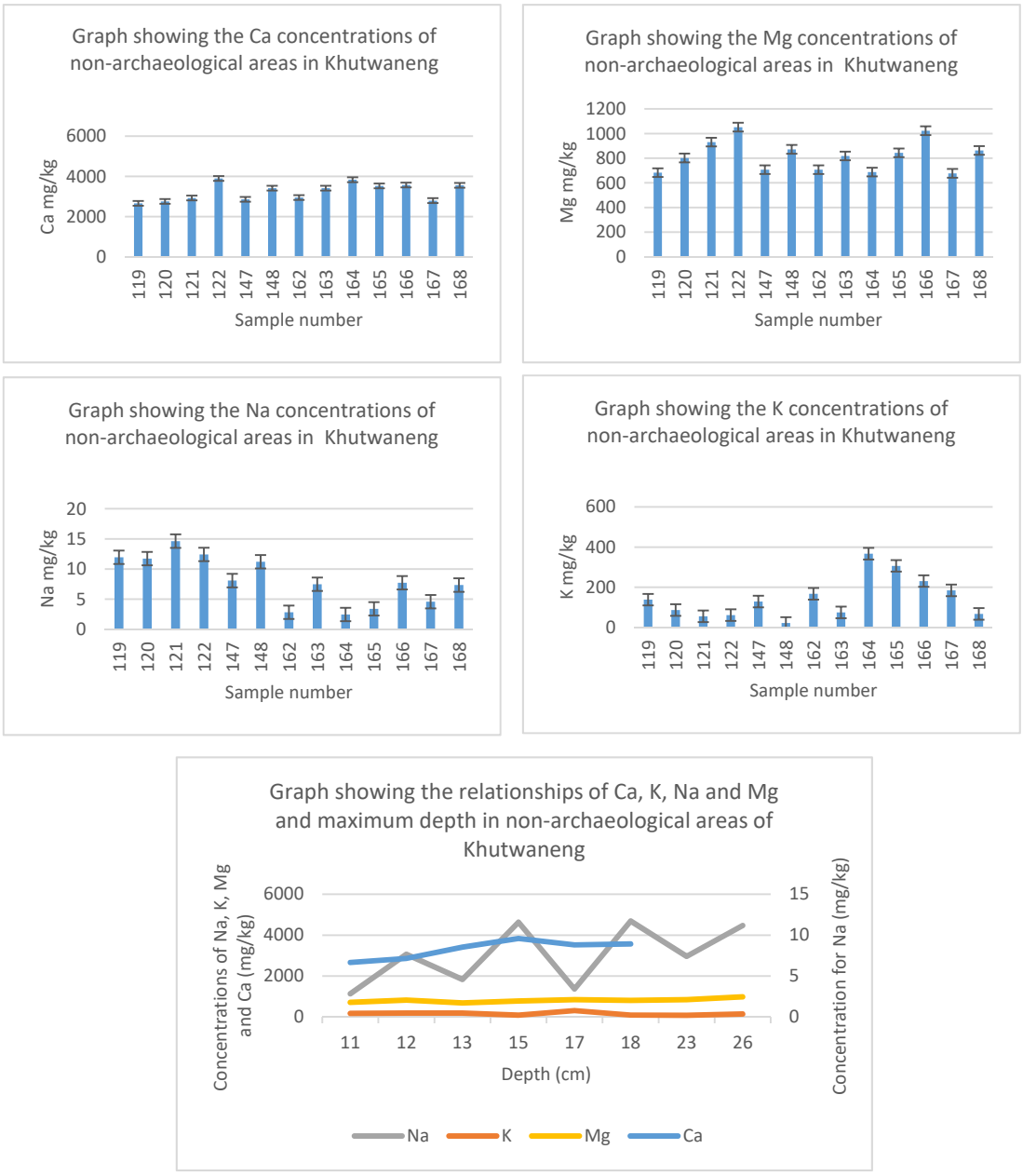


Figure 5. 29: (a) Correlations of Ca, K, Na and Mg in non-archaeological areas of Khutwaneng. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.2.4.2. Correlation between NH_4, NO_3 and P

NH_4 and NO_3 are relatively depleted in the southern section of the site. There is, however, no direct correlation between the three compounds, as the variations are

not consistent between the compounds different compounds. Both NH_4 and P decrease in concentration in the lower layers, whereas NO_3 displays an increase. This trend for NH_4 and P demonstrates enrichment of the shallow areas of the soil samples (Fig. 5.30.a). Although this is apparent in the non-archaeological areas, it must be membered that other factors affect these, such as vegetation in the area and animals grazing on this land.

Although there seems to be a trend in the lower layers and the concentrations of these compounds, the content in the soil decreases with depth. NH_4 displaying a greater negative gradient (Fig. 5.30.b).

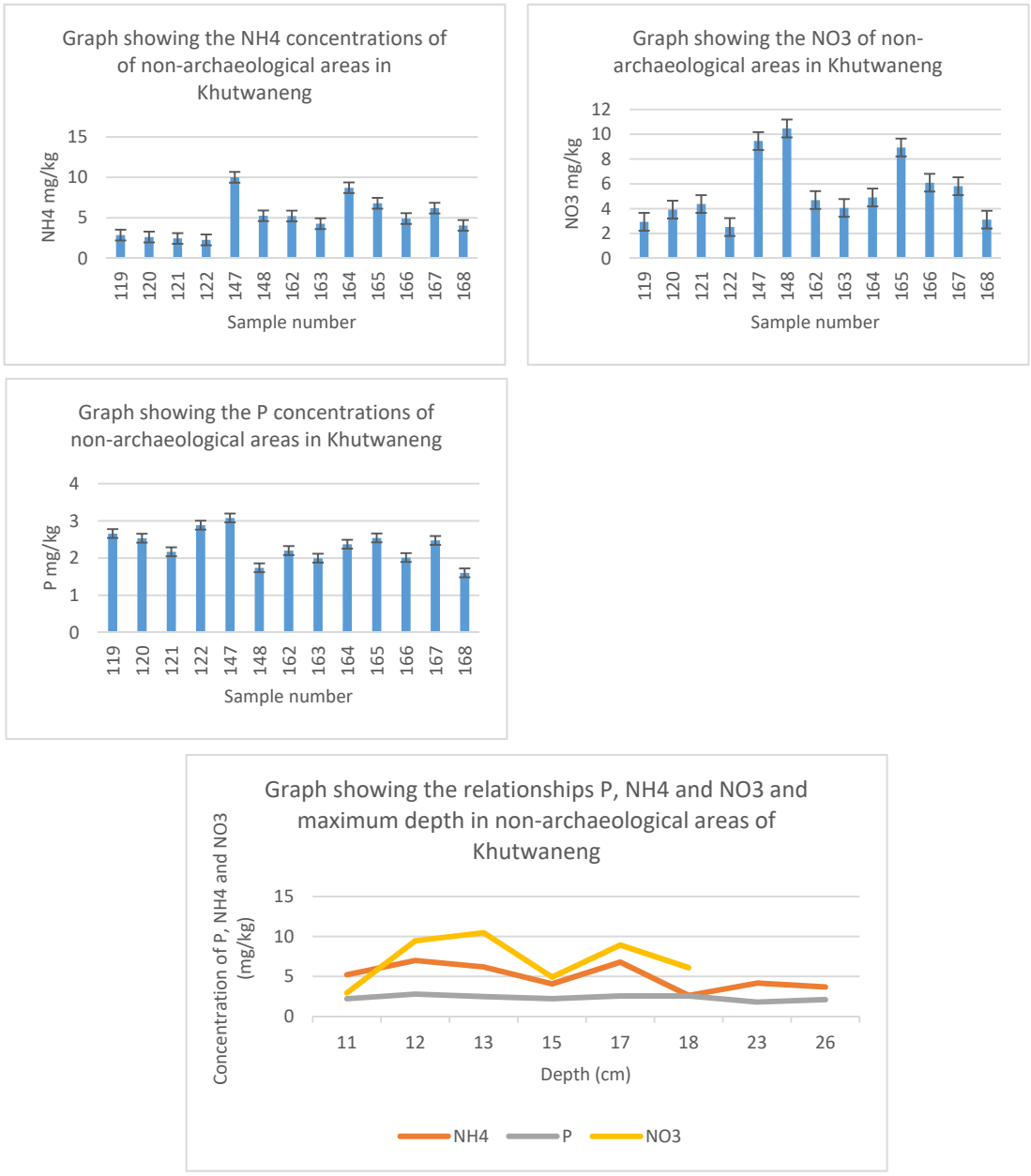


Figure 5. 30: (a) Correlations P, NH_4 and NO_3 in non-archaeological areas of Khutwaneng. (b) Correlations P, NH_4 and NO_3 and maximum depth.

5.2.4.3. Correlation between %C and CEC

The %C and CEC does not display a correlation, as one would expect. The %C decreases in the lower layers, due to lack of organic matter in the lower layers. The CEC shows a variation in these patterns. Overall the middle to northern

section of the sampling area demonstrates generally low in fertility capacity (Fig. 5.31.a). The %C and CEC have a distinctly different correlation with depth.

The %C increases with depth in H1 and the lower layers. The CEC, however, decreases with depth, which is the opposite pattern from %C. The only difference is that in the layers below H1 there is a slight increase in fertility capacity with depth (Fig. 5.31.b).

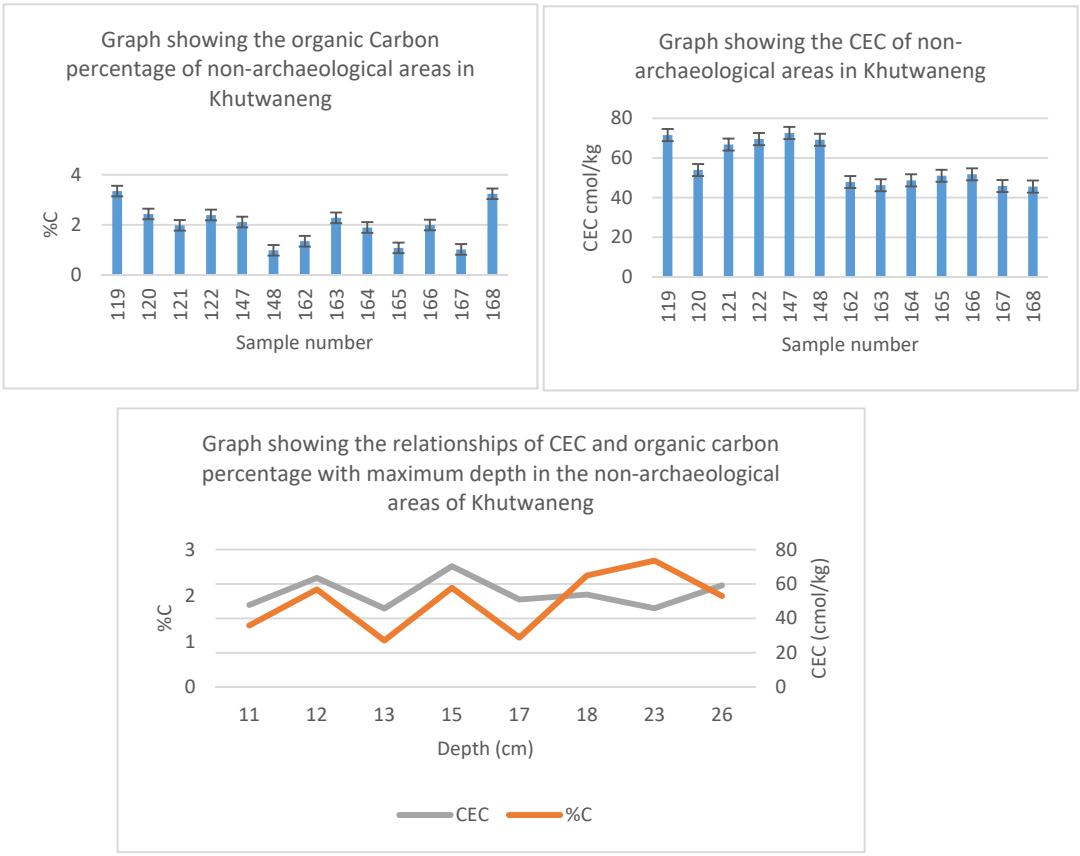


Figure 5. 31: (a) Correlations of CEC and %C in the non-archaeological areas of Khutwaneng. (b) Correlations of CEC and %C with maximum depth.

5.2.4.4. Clay percentage and pH

Generally, the pH of the soils becomes less acidic with an increase of clay percentage (Fig. 5.32.a). Overall the clay percentage increases in the lower layers,

making the soil less acidic. There is no direct correlation with regards to clay content, pH and area. The clay percentage increases with depth, making the samples in the top layer less acidic (Fig. 5.32.b). This trend stays consistent until one studies the layers below H1. The clay percentage continues to increase, whereas the pH changes from acidic to more basic (Fig. 5.32.c).

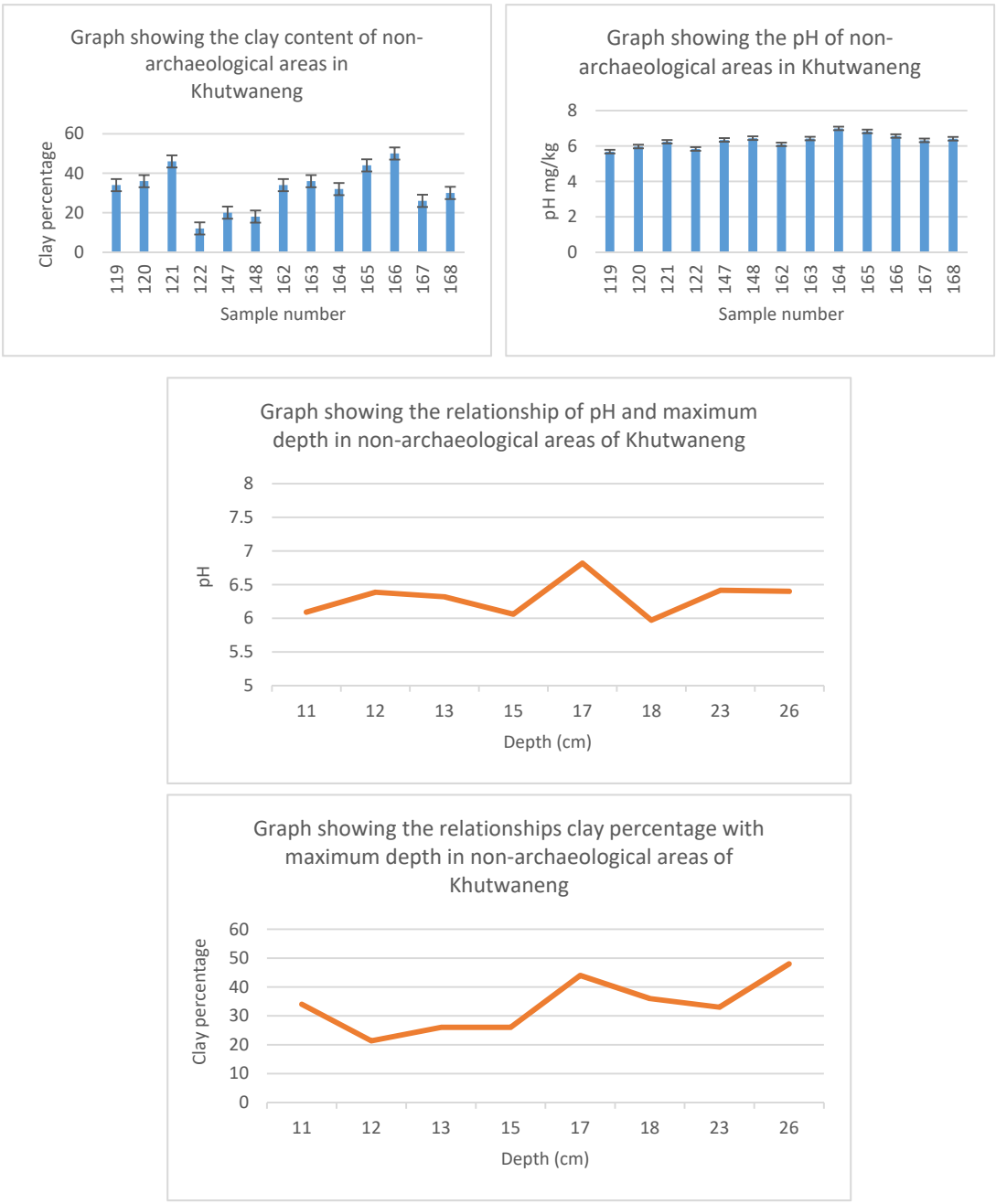


Figure 5. 32: (a) Relationship of pH and clay percentage in non-archaeological areas of Khutwaneng (b) Relationship of pH and maximum depth. (c) Relationship of clay percentage with maximum depth.

5.3. Kranskloof

Kranskloof forms part of the final Bokoni occupation phases. The Phase 3 and Phase 4 stone walled site shows a slightly different correlation between homesteads and terraces.

5.3.1. Domestic areas

Spatial correlations of these nutrient indicators cannot be decisively determined due to the limited number of samples taken from domestic areas in this site, and does not necessarily represent the different sections of the site.

5.3.1.1. Correlation between Ca, K, Na and Mg

The levels of Ca, Mg, K and Na, follow a similar trend. Depletion and enrichment of all these cations are apparent, with Mg being more conservative. The sample in the southern section of the site (sample 65) shows an enrichment in these nutrients, and the northern samples show variations in concentration, which is unrelated to area (Fig. 5.33.a). The Ca and Na results show an increase in concentration with depth, where Na has a higher positive gradient. K, and Mg have the opposite correlation, where these nutrients decrease rather consistently with depth (Fig. 5.33.b).

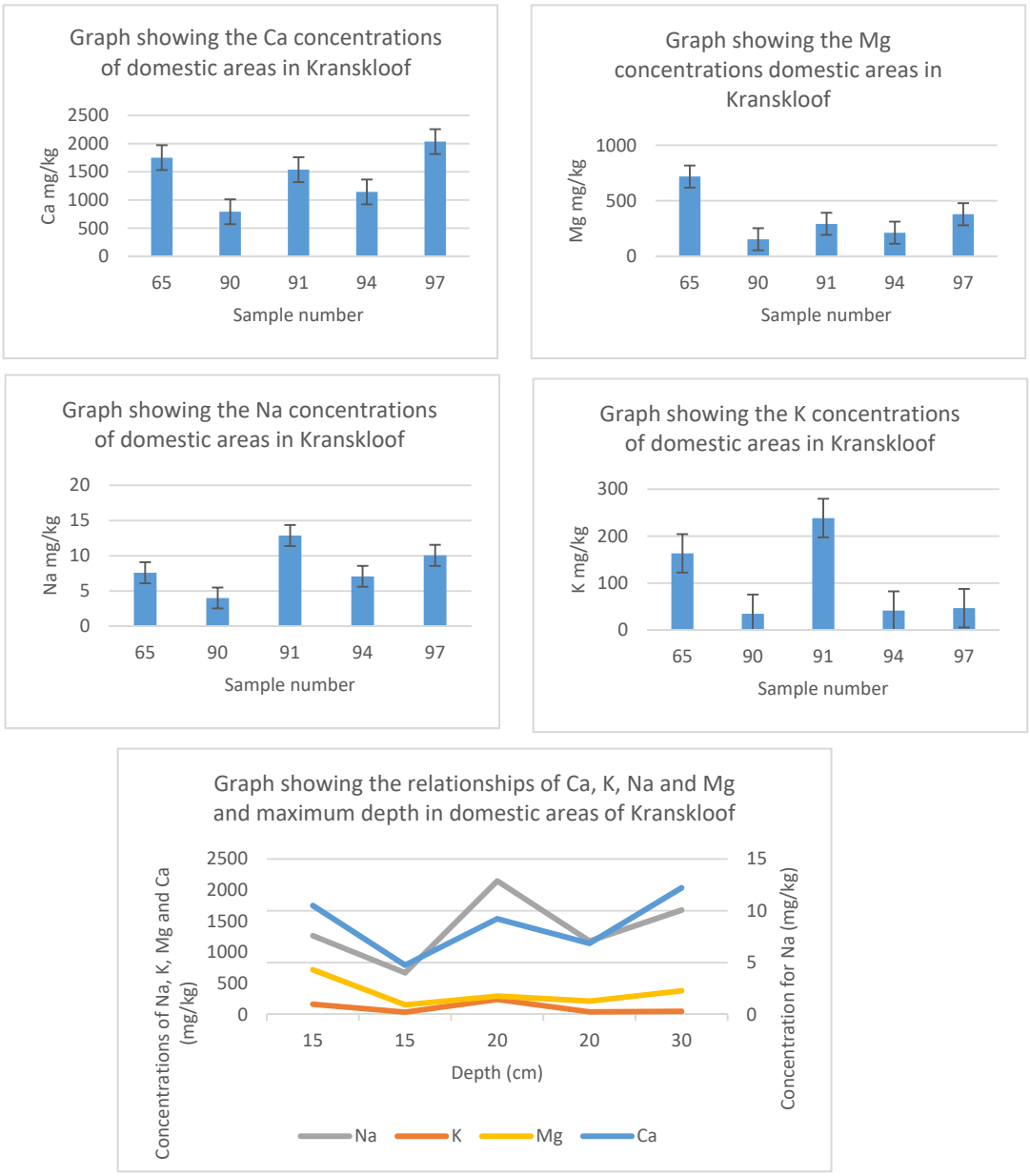


Figure 5. 33: (a) Correlations of Ca, K, Na and Mg in domestic areas of Kranskloof. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.3.1.2. Correlation between NH_4, NO_3 and P

There are no distinct trends in NH_4, NO_3 and P with regards to geographic space. The different indicators vary from sample to sample, inconsistently to one another. The most consistent result is that of sample 91, which shows moderate

concentrations of these nutrients (Fig. 5.34.a). There is a clear enhancement in NO_3 in this area, where there is an increase in concentration with depth. P also increases with depth, but at a much lower rate. The concentration of NH_4, however, decreases with depth at a relatively low gradient (Fig. 5.34.b).

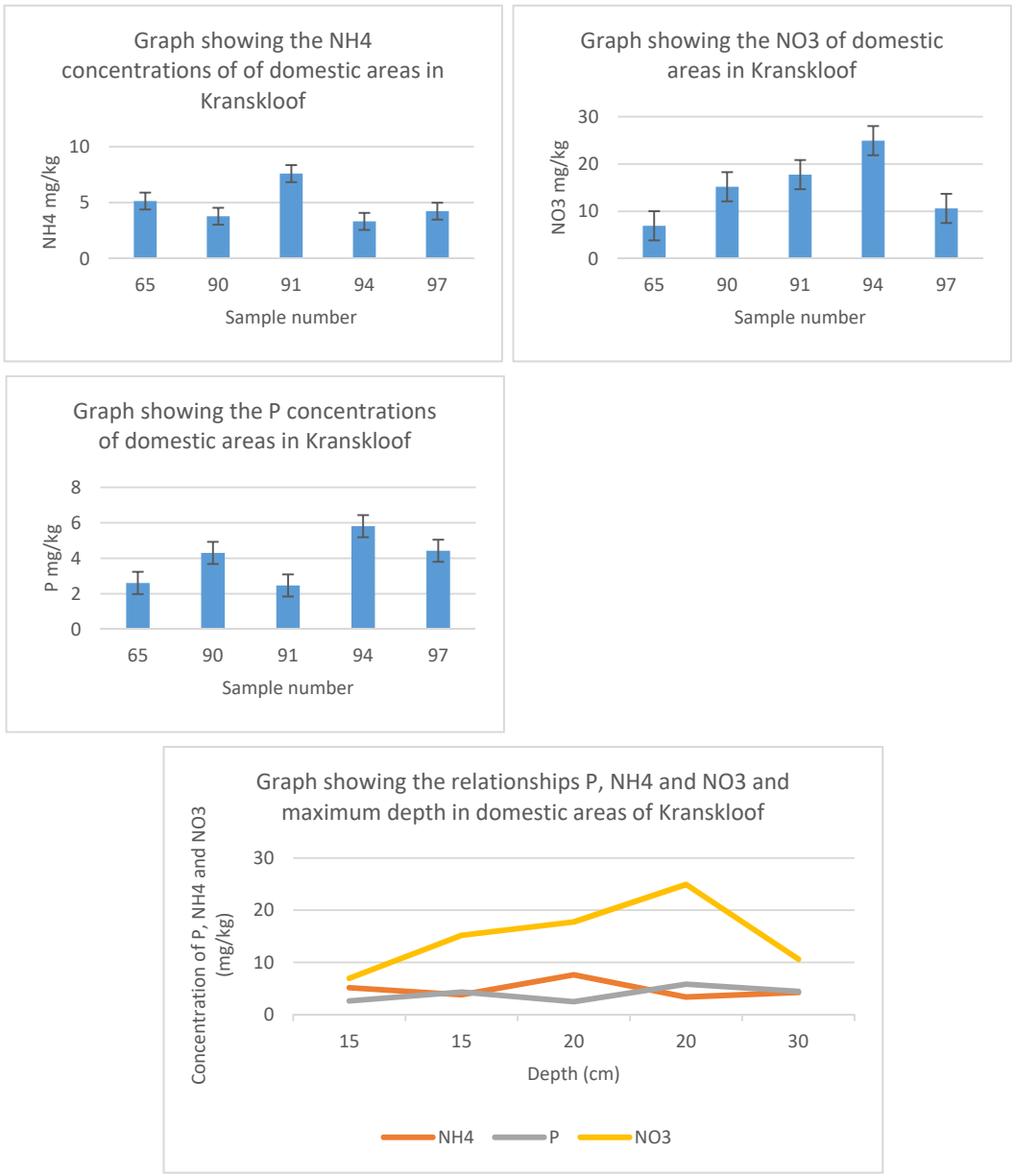


Figure 5. 34: (a) Correlations of P, NH_4 and NO_3 in domestic areas of Kranskloof (b) Correlations of P, NH_4 and NO_3 and maximum depth

5.3.1.3. Correlation between CEC and %C

The different areas in which the domestic areas had been sampled, is relatively consistent with regards to %C and CEC with the exception of sample 97 (Fig. 5.35.a). The general trend in the site shows a positive correlation between %C and

CEC. Interestingly, the %C and CEC both increase with depth (Fig. 5.35.b). This trend, for the CEC, would be expected because it is a general trend at the other sites. The %C, however, would be expected to decrease with depth due to the decrease in organic material. This discrepancy may be due to the fact that this site may be richer in organic material.

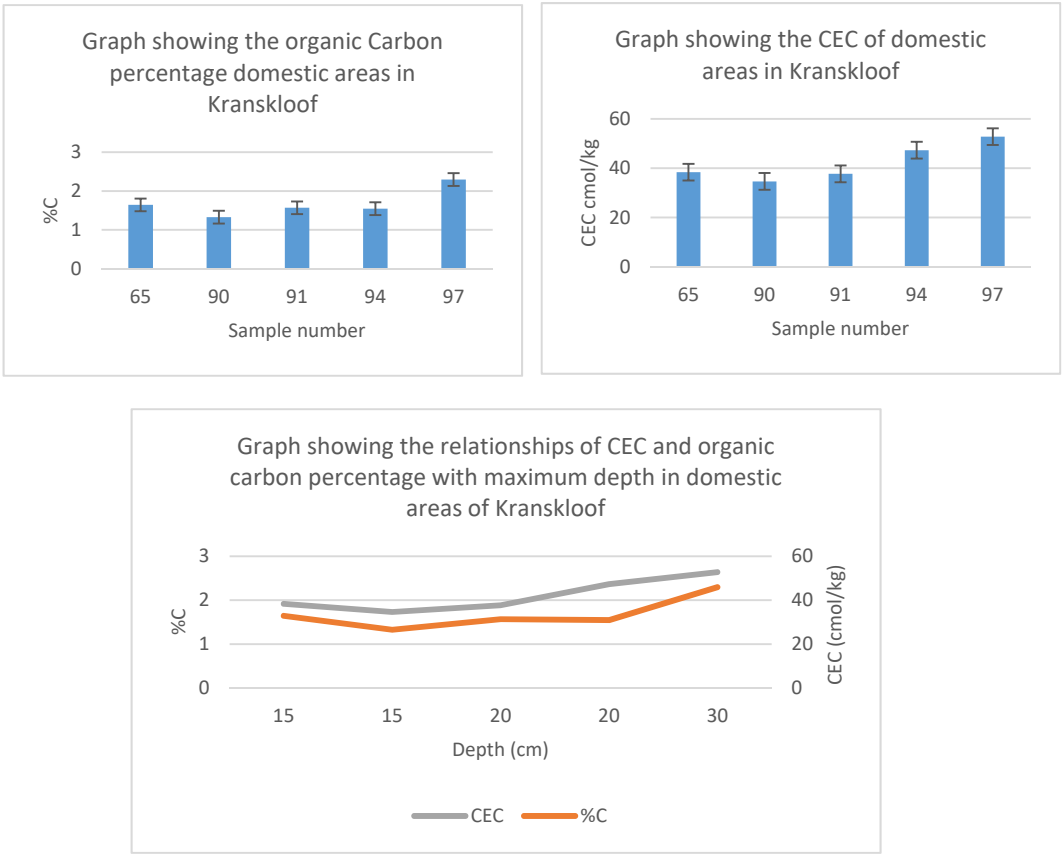


Figure 5. 35: (a) Correlations of CEC and %C in domestic areas of Kranskloof (b) Correlations of CEC and %C with maximum depth.

5.3.1.4. Clay and pH

The clay percentage and pH readings in the domestic areas in Kranskloof have no apparent correlation with each other or with regards to area (Fig. 5.36.a). The pH varies with depth, but trends towards becoming more acidic with depth. The clay

percentage increases from 15 cm to 20 cm, and then drops suddenly at 30 cm. As a result, the general trend shows a more consistent clay percentage with depth (Fig. 5.36.b).

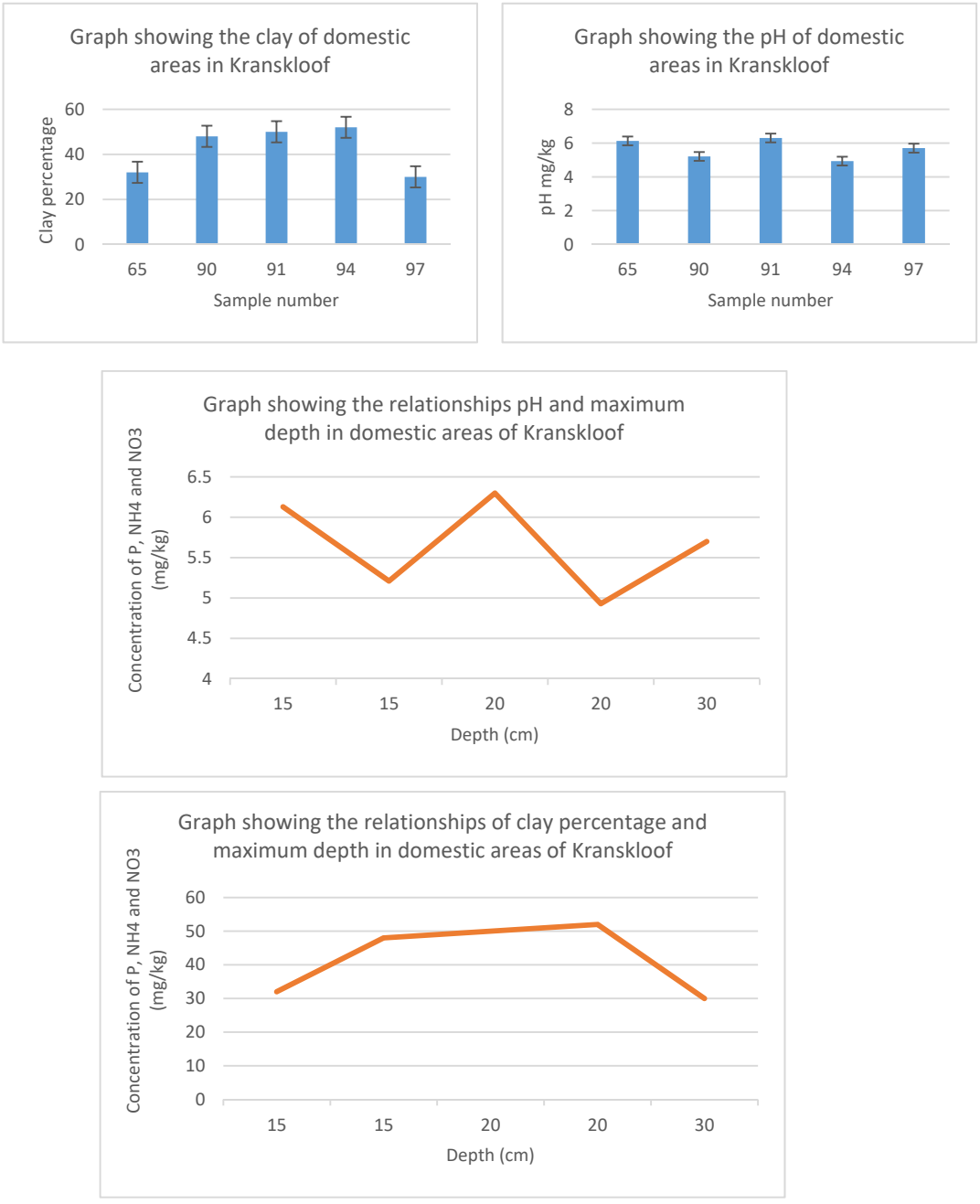


Figure 5. 36: (a) Relationship of pH and %C in domestic areas of Kranskloof. (b) Relationship of pH and maximum depth. (c) Relationship of pH and maximum depth.

5.3.2. Central enclosure

Only one sampling location was located in a central enclosure in the southern section of the site, making it impossible to interpret trends. Similarly, only one location had two sampling layers, samples 63 and 64, located in the southern section of the site. This also is not a statistically valid, but does allow us to consider what the correlation may be between the different layers.

5.3.2.1. Correlation between Ca, K, Na and Mg

The most distinct correlation, in the central enclosures, is between Mg and Na. The southern sample shows an increase in concentration in the lower layer, and is more enhanced. The northern section of the site is more depleted. Both Ca and K decrease in concentration in the lower layer of the southern coring sample. There is no distinct trend in the northern section of the site (Fig. 5.37.a).

The general trend for Mg, K and Na indicate a decrease in concentration with depth. Ca, however, increases in concentration. There is a distinct peak in Mg and Na, and decline in Ca at 40 cm (Fig. 5.37.b). This should be noted because this is the maximum depth at which the second layer could be sampled (sample 64), indicating a similar trend to that found in the other sites, where there is an increase in mafic material with depth.

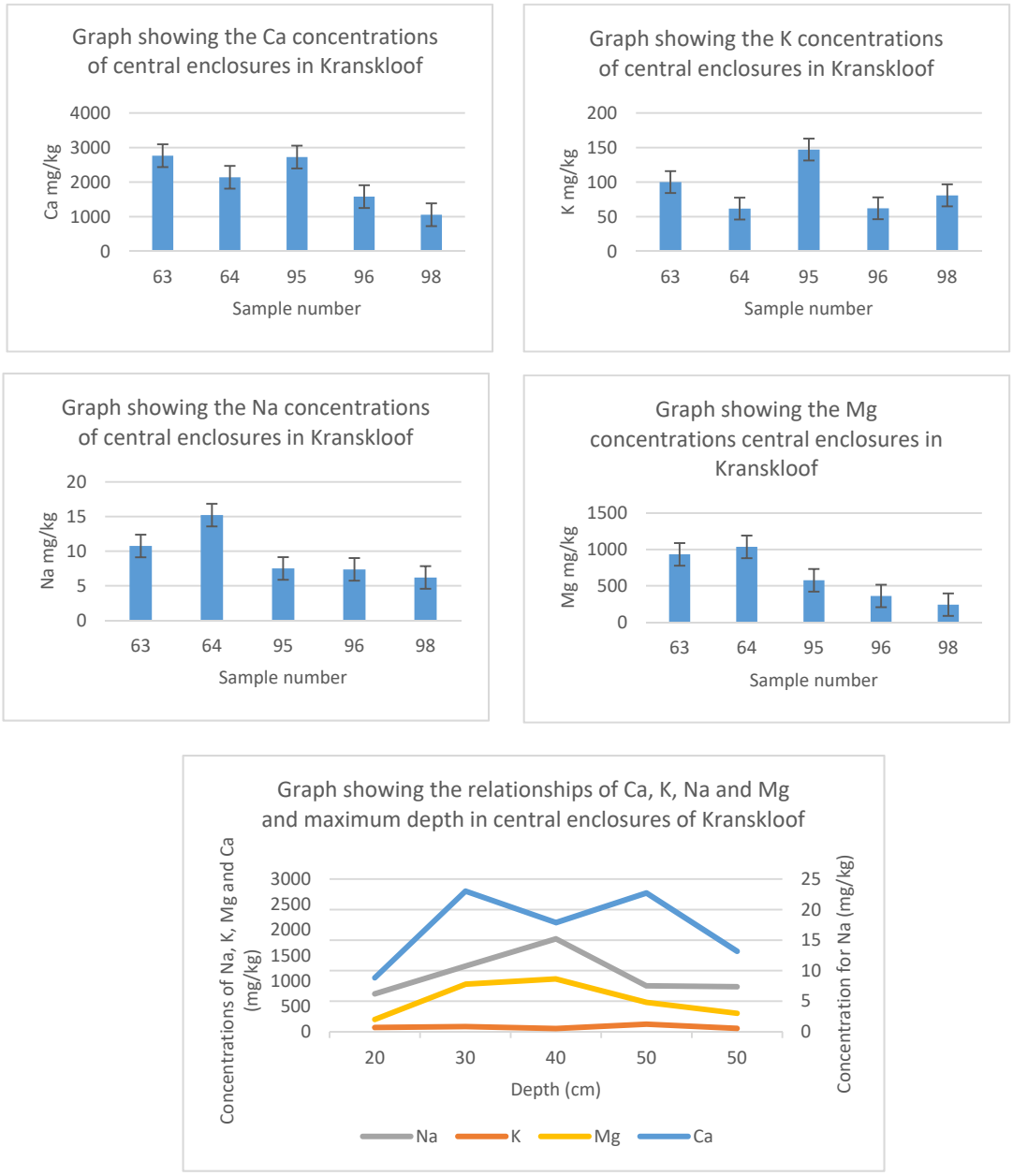


Figure 5. 37: (a) Correlations of Ca, K, Na and Mg in central enclosures of Kranskloof. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.3.2.2. Correlation between NH_4, NO_3 and P

Generally, the central enclosures show depletion in NH_4, NO_3 and P. All three demonstrate a decline in concentration in the lower layer, with no apparent trend spatially (Fig.5.38.a). These results follow on the idea that the manure may have

been removed from the central enclosures and used as sources of fuel and soil nutrient enhancement (Schoeman, in prep). These compounds also become depleted with depth, with NO_3 at a lower rate. Again, at 40 cm there is a distinct depression in concentration of these samples in relation to the second layer, demonstrating the lack of organic material in the lower soil layers (Fig. 5.38.b).

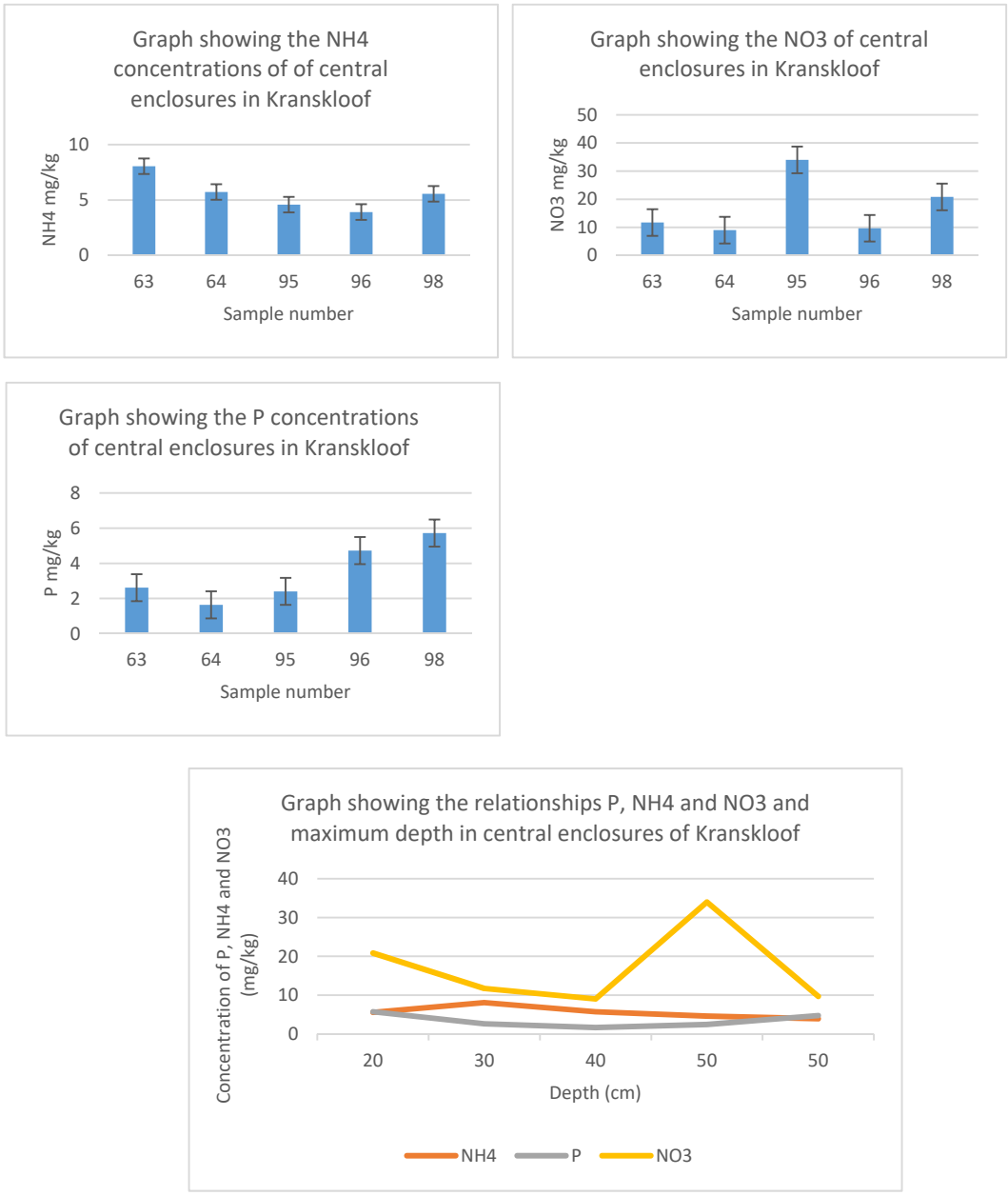


Figure 5. 38: (a) Correlations of P, NH_4 and NO_3 in central enclosures of Kranskloof (b) Correlations of P, NH_4 and NO_3 and maximum depth.

5.3.2.3. Correlation between %C and CEC

The CEC of the central enclosures are relatively high, and consistent throughout the site with the exception of sample 64. This sample also shows a distinct decline

in %C as well, with relation to the lower layer. The %C, however, does not stay consistent throughout the samples and does not have a direct correlation with CEC (Fig. 5.39.a). With regards to depth, %C and CEC have a negative correlation where %C decreases with depth, and the CEC increases (Fig. 5.39.b). This follows the same trends that have been noted in the different sites.

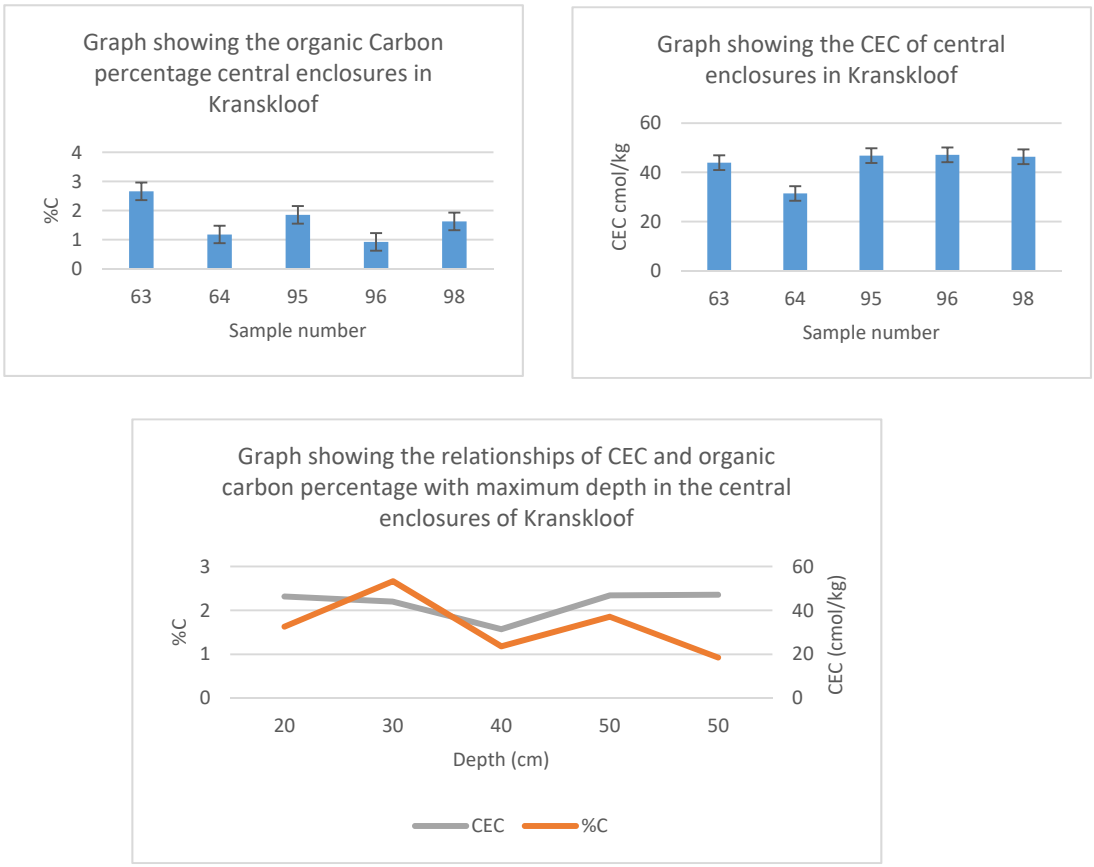


Figure 5. 39: (a) Correlations of CEC and %C in the central enclosures of Kranskloof. (b) Correlations of CEC and %C with maximum depth.

5.3.2.4. Clay percentage and pH

Clay and pH have a positive correlation, where when clay percentage increases the soil becomes more alkaline (Fig. 5.40.a). There is no direct correlation with

space, but there is an indication that the clay percentage increases with depth, and so the soils become more alkaline (Fig. 5.40.b and Fig. 5.40.c).

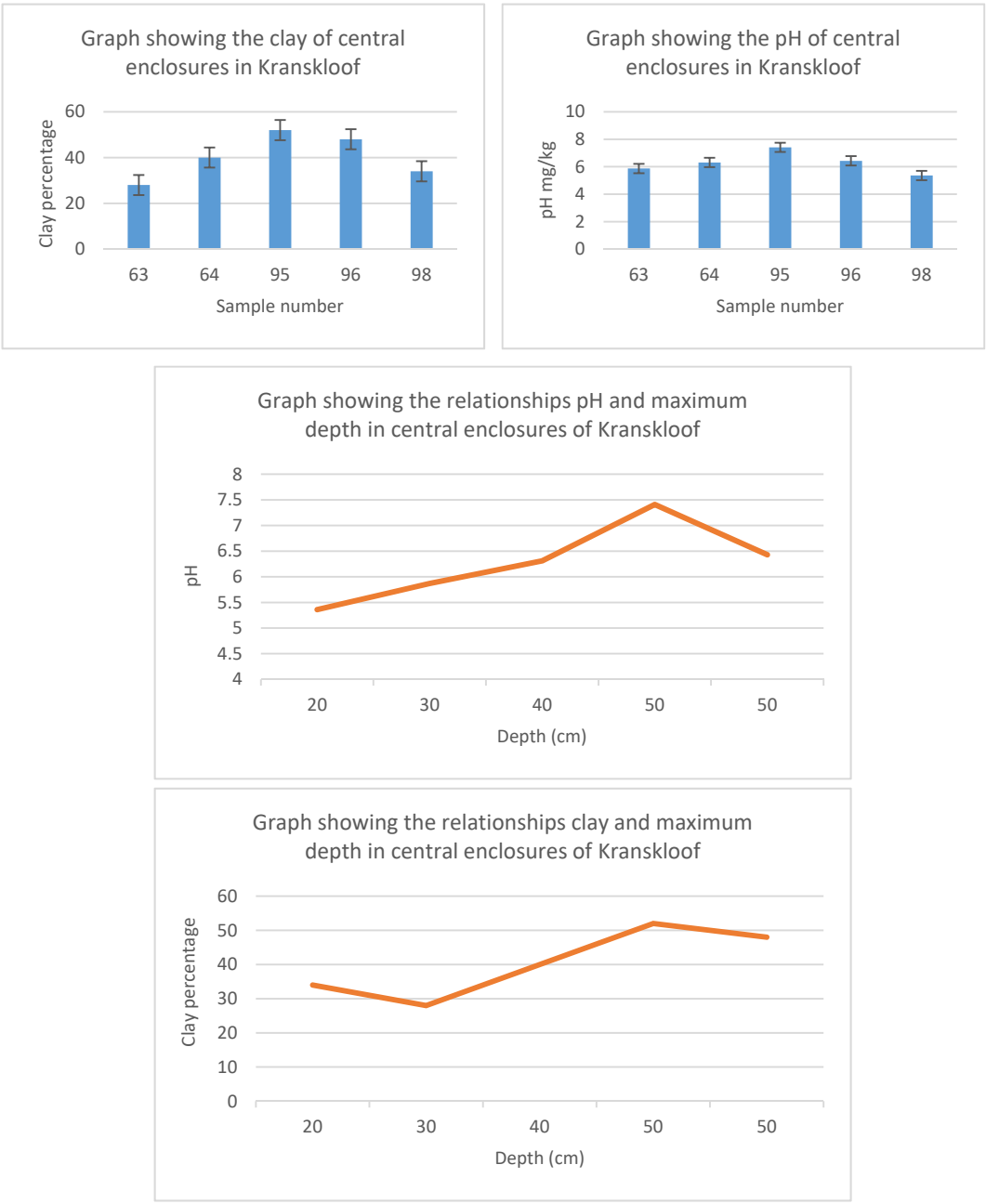


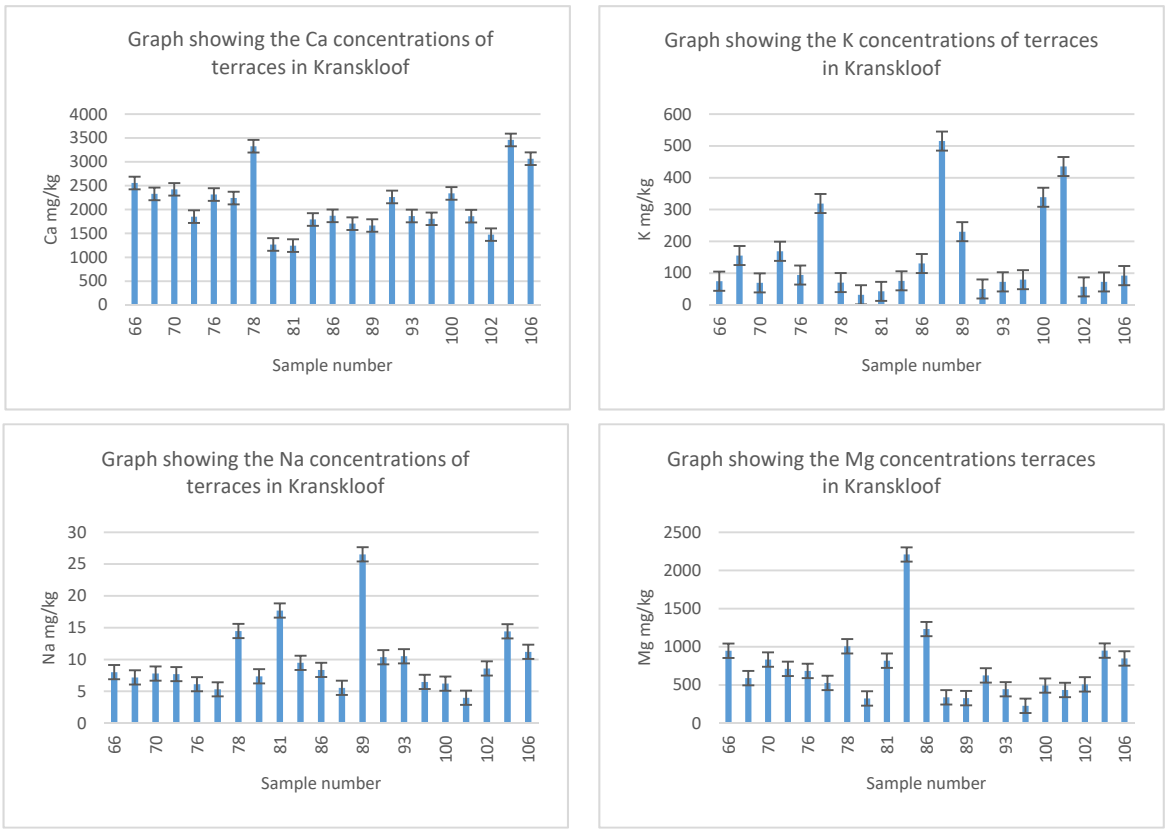
Figure 5. 40: (a) Relationship of pH and clay percentage in central enclosures of Kranskloof. (b) Relationship of pH and maximum depth. (c) Relationship of clay percentage and maximum depth

5.3.3. Terraces

5.3.3.1. Correlation between Ca, Na, K and Mg

Throughout the site, the terraces are relatively depleted in K, Na and Mg. These results vary slightly throughout the site. With regards to the southern section of the site, the soils are slightly more enriched in Ca. Mg and Na have a relatively positive correlation, whereas the K concentrations are the inverse of these two. Ca does not necessarily have a direct correlation with Mg, K, and Na, with regards to area (Fig. 5.41.a).

Overall, Ca, Mg and K concentrations decrease with depth at a relatively low gradient, with K more so. This result for Mg contradicts the general trend when compared to the rest of the results found in the different site, but follows the general trend in Kranskloof. Na concentrations, however, increases with depth with a relatively high gradient (Fig. 5. 41.b).



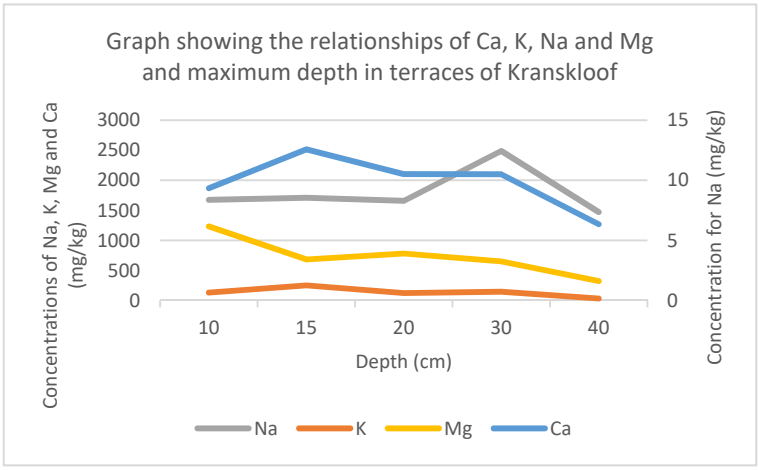
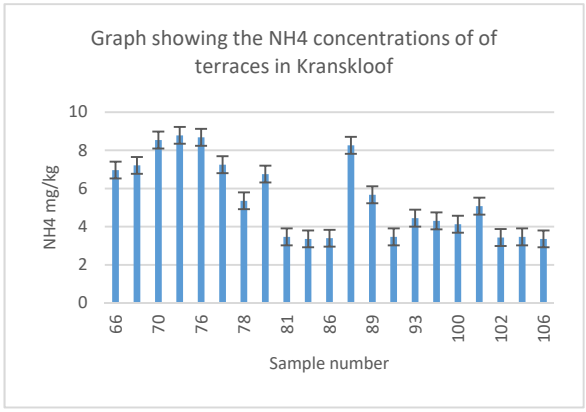


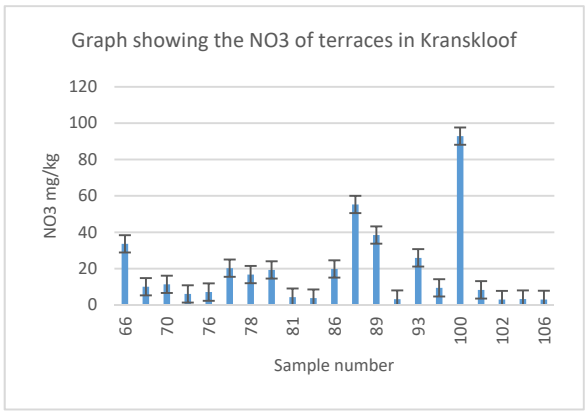
Figure 5. 41: (a) Correlations of Ca, K, Na and Mg in terraces of Kranskloof. (b) Correlations of Ca, K, Na and Mg and maximum depth.

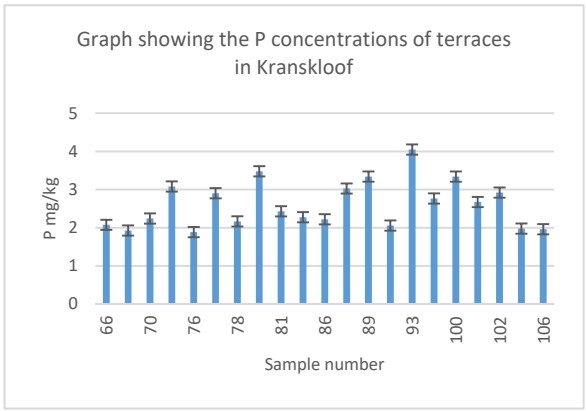
5.3.3.2. Correlation between NH_4, NO_3 and P

The terraces at Kranskloof have relatively enhanced levels of P and NH_4 compared to NO_3. There is no direct trend, with regards to geographic space, in P and NO_3 concentrations. NH_4, however, is enhanced in the southern section of the site. NH_4 and P have a more positive correlation with one another, whereas NO_3 is the inverse of the two (Fig. 5.42.a). These results demonstrate a possible enhancement of N and in the soils. This, however, should be treated with caution because the NO_3 results do not necessarily reflect it.

In general, there is depletion of NH_4 and NO_3 with depth, which follows the assumption of a decrease in organic material with depth. Interestingly, the P concentrations increase with depth. Although this is a contradictory result, because P normally decreases with depth, the domestic areas in Kranskloof follow the same pattern (Fig. 5.42.b). This may be as a result of liming in these areas with the use of potash (Leckacz 2002), unintentionally in the domestic areas from the use of fuel in these areas.







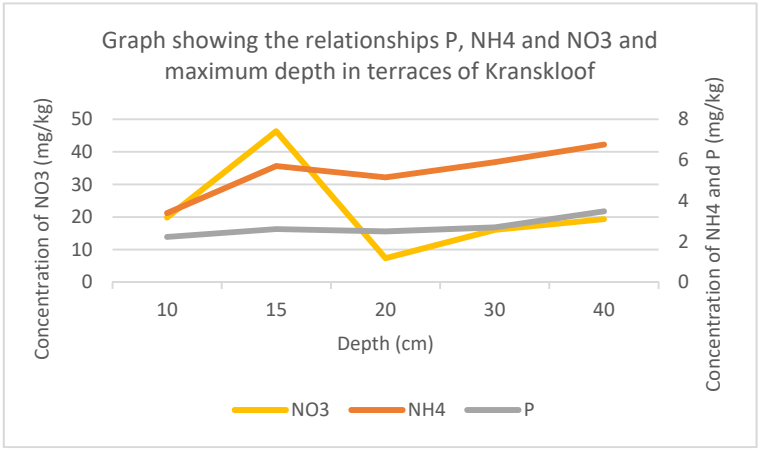


Figure 5. 42: (a) Correlations of P, NH_4 and NO_3 in terraces of Kranskloof. (b) Correlations of P, NH_4 and NO_3 and maximum depth.

5.3.3.3. Correlation between CEC and %C

The CEC and %C has a relatively positive correlation with geographical space. This pattern, however, is not consistent throughout the site. The northern section

of the site has a relatively low %C and CEC, whereas the southern section is relatively high (Fig. 5.43.a). Samples 88 and 89, H1 and H2, show a decrease in both %C and CEC in the lower layers (Fig. 5.43.b).

Although the spatial trend is relatively similar, the correlation with depth is different. The %C decreases with depth, which follows the general trend of the site. The, CEC, however, increases with depth which is consistent with the general results found (Fig. 5.43.b).

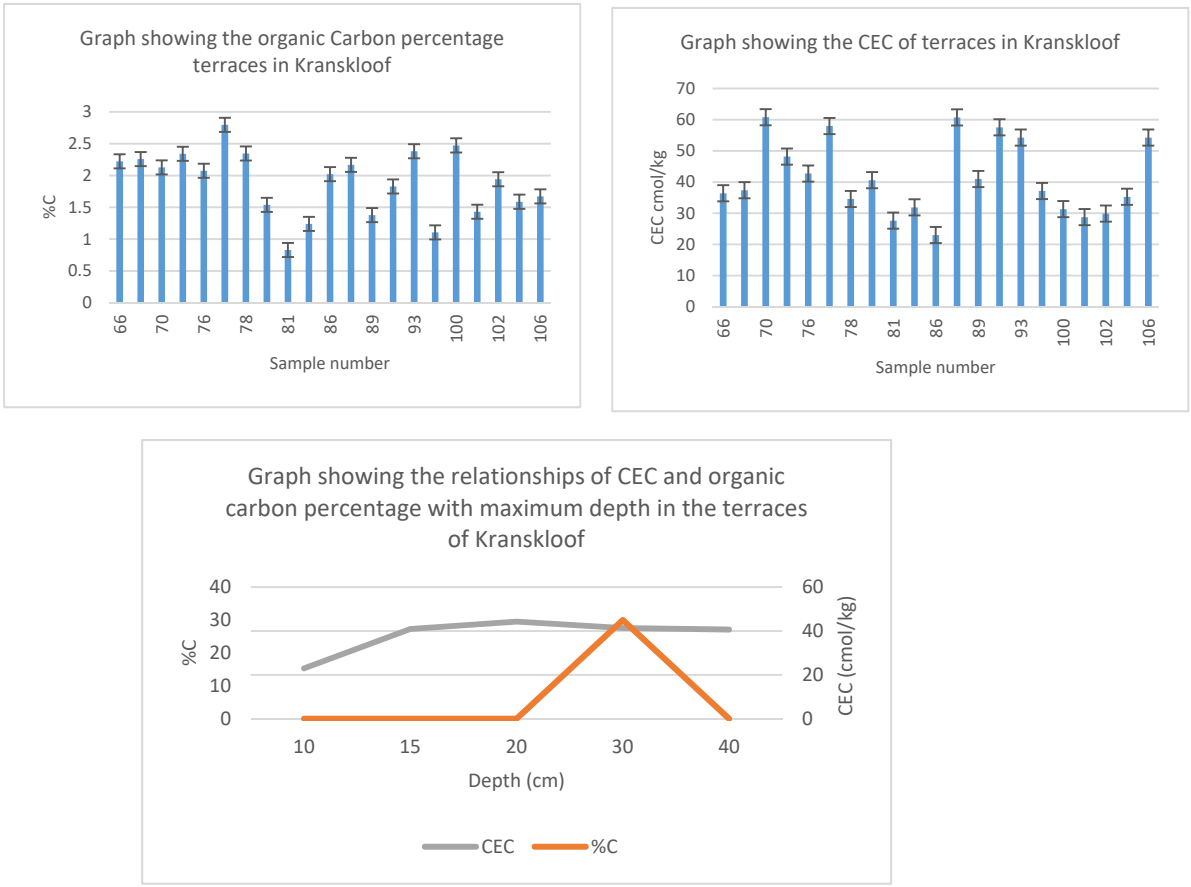


Figure 5. 43: (a) Correlations of CEC and %C in the terraces of Kranskloof. (b) Correlations of CEC and %C with maximum depth.

5.3.3.4. Clay percentage and pH

The clay percentage and pH have a positive correlation, where the acidity of the soil is higher with an increase in clay percentage. Overall the middle section of the site has a higher pH, is more alkaline, than in other areas of the site (Fig. 5.44.a). With regards to depth, the soil becomes more acidic and, therefore, the clay percentage increases with depth (Fig. 5.44.b).

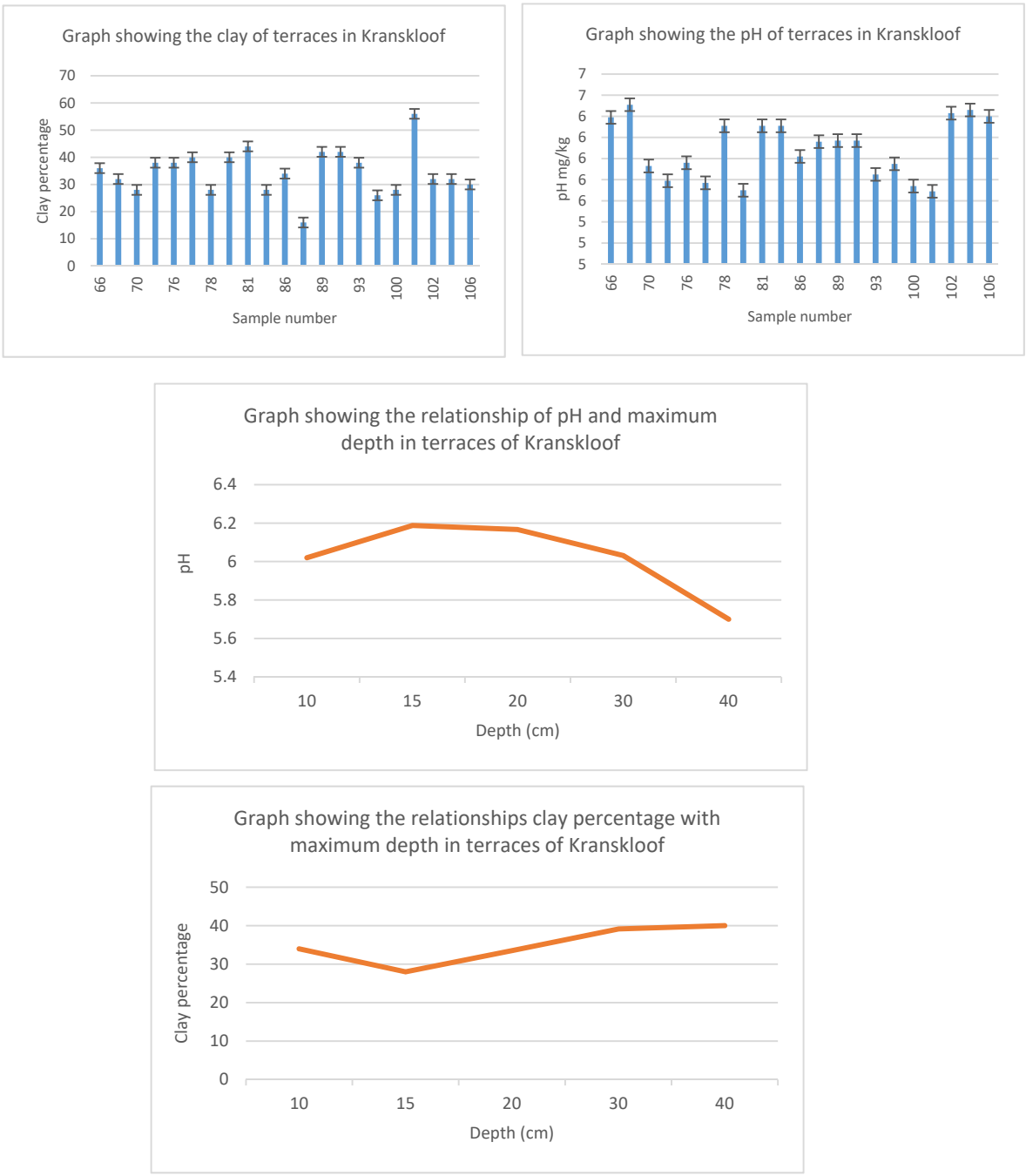


Figure 5. 44: (a) Relationship of pH and clay percentage in terraces of Kranskloof. (b) Relationship of pH and maximum depth. (c) Relationship of clay percentage and maximum depth.

5.3.4. Non-archaeological areas

5.3.4.1. Correlation between Ca, K, Mg and Na

The soils in the southern section of Kranskloof, in the non-archaeological areas, are enriched in Ca and Mg. The site is overall depleted in K and Na. Ca, Mg and Na all have a positive correlation throughout the site, where the lower layers show an increase in concentration for each of these nutrients. The K, however, has the opposite correlation and increases closer to the surface. The sample taken near the river, sample 79, shows depletion in all four nutrients (Fig. 5.45.a). This may inform the reasoning behind why the terraces and homesteads were concentration the hills as opposed to the valley floor.

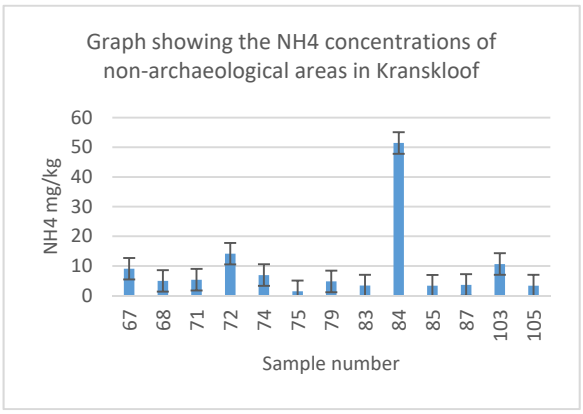
The concentrations for Ca, Mg, Na and K remain relatively the same with depth. K has a more consistent trend, whereas Mg and Na increases very slightly with depth. Ca, however, decreases slightly with depth. At 40 cm there is a peak in Mg, Ca and Na concentrations. This may be due to the fact that the sample taken at this maximum depth is a basaltic saprolite sample (Fig. 5.45.b).

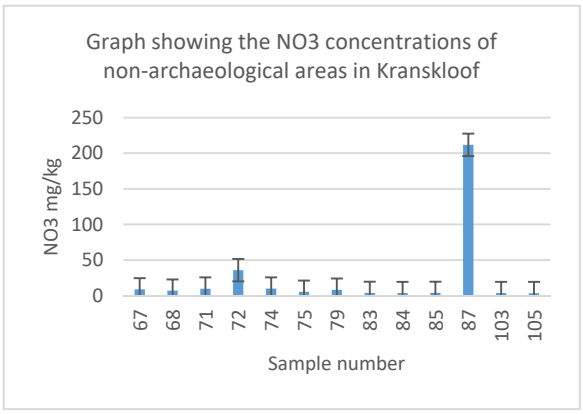


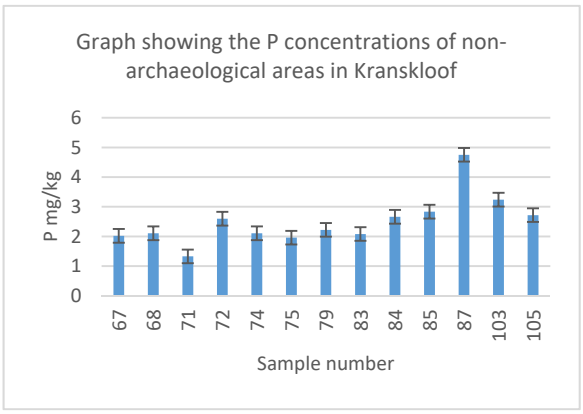
Figure 5. 45: (a) Correlations of Ca, K, Na and Mg in non-archaeological areas of Kranskloof. (b) Correlations of Ca, K, Na and Mg and maximum depth.

5.3.4.2. Correlation between NH4, NO_3 and P

The soils, in the non-archaeological areas, are especially depleted in NH_4 and NO_3 throughout the site. The southern section less so. The P concentrations throughout the site are relatively consistent with the northern section of the site being more enriched (Fig. 5.46.a). This distinct depletion in NH_4 and NO_3 in this site indicates that the soil does need to be enriched in order for crops to grow. The NH_4 and P concentrations stay relatively consistent with depth. (5.46.b).







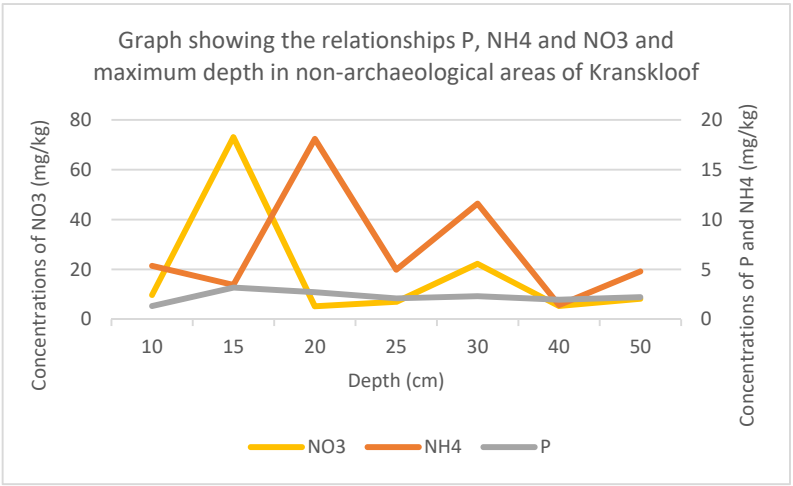


Figure 5. 46: (a) Correlations of P, NH_4 and NO_3 in non-archaeological areas of Kranskloof. (b) Correlations of P, NH_4 and NO_3 and maximum depth.

5.3.4.3. Correlation between CEC and %C

There is a relatively positive correlation between %C and CEC throughout the site, with the exception of the southern section. This area has a relatively high CEC, with the %C being relatively low. Although, a consistent trend is a decrease in both these fertility indicators in the lower layers (Fig. 5.47.a). As seen throughout Kranskloof, the CEC decreases in depth along with the %C. The saprolitic samples, however, show a distinct peak in the CEC (Fig. 5.47.b).

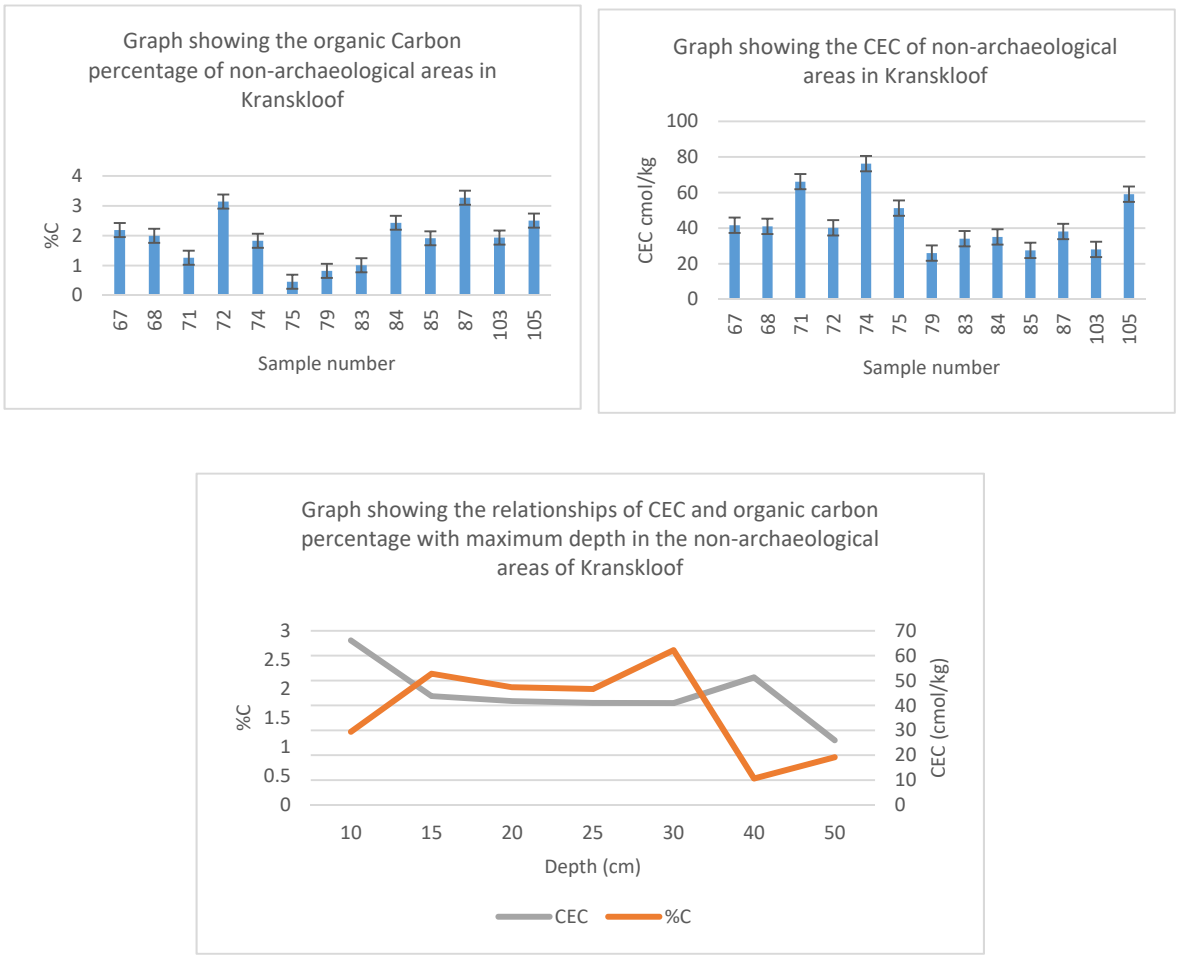
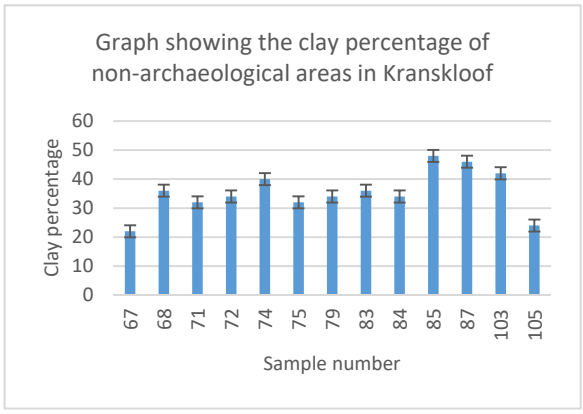
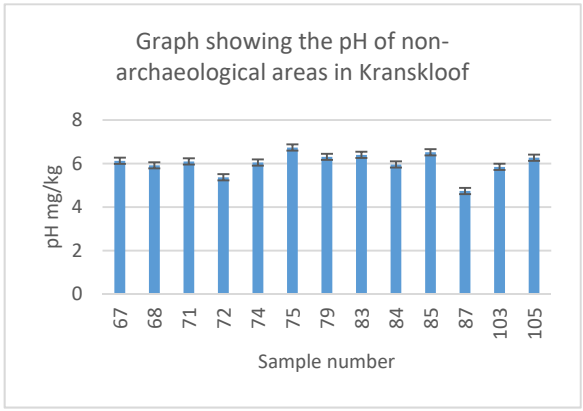


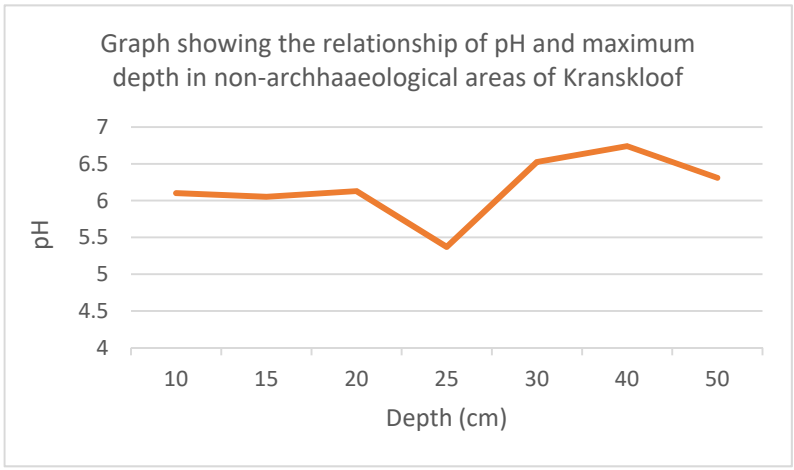
Figure 5. 47: (a) Correlations of CEC and %C in the non-archaeological areas of Kranskloof. (b) Correlations of CEC and %C with maximum depth

5.3.4.4. Clay percentage and pH

The northern most section of the site has a higher clay percentage than the rest of the site. The pH is not consistent through the site, and does not demonstrate a direct correlation between the clay percentage and area (Fig. 5.48.a). The depth comparison, however, shows a direct correlation between pH and clay percentage, where the soil is more acidic with a higher clay percentage. The clay percentage decreases with depth with a medium gradient, and the pH becomes more basic (Fig. 5.48.b and 5.48.c).







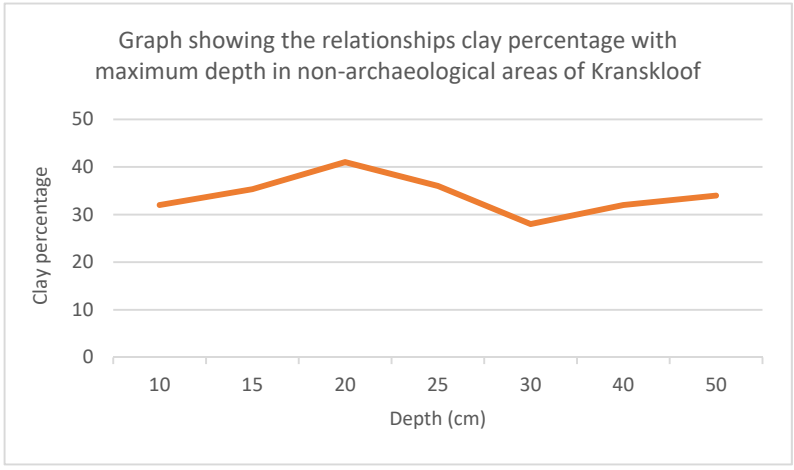


Figure 5. 48: (a) Relationship of pH in non-archaeological areas in Kranskloof. (b) Relationship of pH and maximum depth. (c) Relationship of clay percentage and maximum depth.

5.4. Parent materials – all 3 sites

Following Chadwick *et al.* (2006), the comparisons done need to have a point of reference in order to understand how the soils have changed, both naturally and anthropogenically. In order to do this Chadwick *et al.* (2006) analysed samples of the parent material (the rocks in the area). I focus on the saprolitic samples as representative of the parent material in the area. As discussed earlier the saprolites are derived from three types of parent material, dolerite, basalt (orange saprolite) and shale (grey saprolite).

5.4.1. Dolerite and Basalt

Dolerite and basalt are mafic igneous rocks that form part of the scale between basalt and gabbro. These are derived from the same magmatic compositions but have different crystal sizes due to rate of cooling (Cairncross 2004: 248). Gabbro is dominantly composed of plagioclase, orthopyroxene, and clinopyroxenitic (Best 2003: 22; Blatt *et al.* 2006: 39). Solomon (2012: 23) identified similar minerals in the dolerites, at a neighbouring farm to Doornkop - Komati Gorge. Olivine was also noted in these samples. All of these minerals are mafic minerals, with the exception of plagioclase, which is an aluminosilicate.

The chemical compositions of these minerals in dolerite and basalt give an indication of what one would expect in the saprolite, and eventually soils. Olivine, $(Mg, Fe)_2SiO_4$, can either be iron or magnesium rich, similarly with orthopyroxene, $(Mg, Fe)SiO_3$. Clinopyroxene, $(Ca, Mg, Fe)_2(Si, Al)_2O_6$, however also contains calcium and aluminium. Plagioclase, $(Na, Ca)(Si, Al)_4O_8$, is an alkali mineral (Soil Classification Working Group 1991) is not a mafic mineral because it does not contain Mg or Fe (Best 2003: 23). According to Best (2003) dolerites have low SiO_2, Na_2O, and K_2O in weight percentage.

5.4.2. Shale

Shales are metamorphosed sedimentary mud rocks. They are derived from clay minerals, and are rich in nutrients (Blatt *et al.* 2006). These clay minerals may include smectite, which follows diagenetic alteration into illite. Smectite is a clay mineral group which contains Mg and Fe, and either Na or Ca. These form part of hydrous aluminium silicates (Britannica 2015). Illite is a mineral that forms through diagenesis of smectite. Illite is a potassium aluminosilicate, a micaceous mineral. Other clay minerals include: kaolinite, $Al_2(Si_2O_5)(OH_4)$; quartz, SiO_2; feldspar, i.e. plagioclase; muscovite, $KAl_2(AlSi_3O_{10})(OH)_2$; biotite, potassium, iron, magnesium or aluminium aluminosilicate; hornblende, iron or magnesium rich amphibole, pyroxenes etc. (Best 2003; Blatt *et al.* 2006). These minerals are determined by the compositional material of the original mudstone. From these chemical formulas, one would expect the shale compositions of the different areas to be rich in K, Fe, Mg and Ca.

5.5. Context comparisons

5.5.1. Doornkop

Saprolite was sampled from the central enclosures, terraces and non-archaeological areas. No saprolitic samples were obtained from the domestic areas, but since the soils in these areas are derived from the same parent materials, some of the results could be inferred. The inferences, however, need to be treated with caution.

Ca

The Ca concentrations in the different areas of Doornkop vary greatly. The Central enclosures have the highest average Ca concentration of 2683.09 mg kg^{-1}, with a standard error of 425.90, which is reflected in the doleritic saprolite. The non-archaeological areas show a lower Ca concentration with an average of 1838.01 mg kg^{-1} with a standard error of 215.42 (Fig. 5.49).

These results indicate that there may have been enrichment of the soils with human activities. It must, however, be noted that the Ca concentration in the saprolitic samples in the central enclosure is much greater than in the normal soil layers, which suggests depletion of Ca with the formation of the soils. This pattern of depletion of Ca levels during the formation of the soils may not be present in the shale saprolite, because the non-archaeological areas show a significant increase in Ca (Fig. 5. 49).

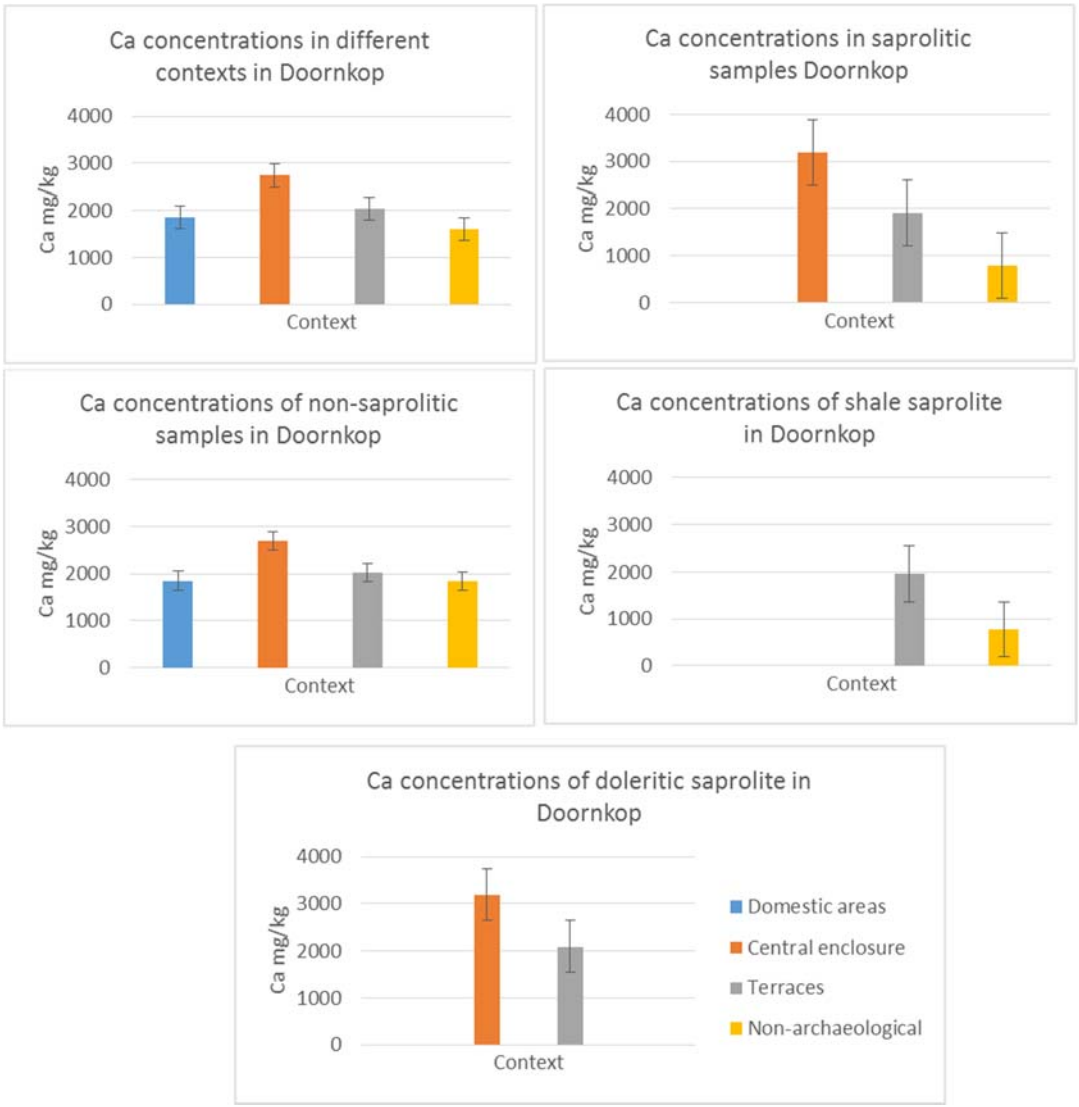


Figure 5. 49: Ca variations in different contexts for Doornkop

Mg

The Mg levels in the non-archaeological areas show a similar trend. It may be significant, however, that the saprolite analysed here is formed from shale, and therefore may have lower Mg levels from the potential lack of mafic minerals present. Similarly, the terraces indicate high levels of Mg in the dolerite saprolite, because these are derived from mafic materials. The terraces in the non-saprolitic layers have the highest average of Mg at 803.55 mg/kg with a standard error of

97.57. The results obtained for the Mg does not necessarily indicate that human activities influenced the soils (Fig. 5.50).

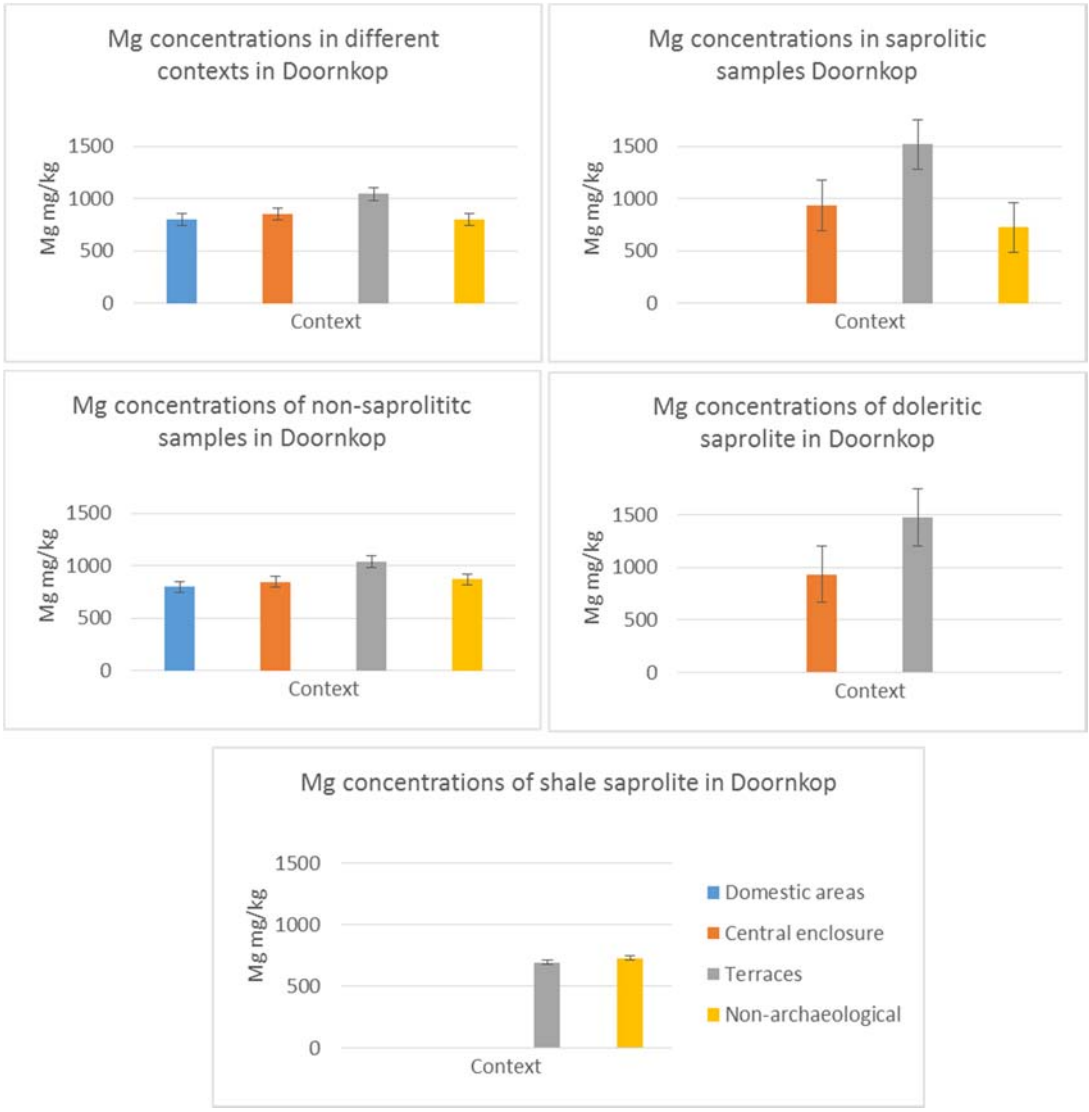


Figure 5. 50: Mg variations in different contexts for Doornkop.

K

The K concentrations in the anthropogenic soils show a very clear difference with regards to possible enrichment with human activities. The K levels in both dolerite and shale derived saprolite, is much lower in comparison to the central

enclosures and domestic areas. The non-archaeological areas show a depletion of K, along with the terraces, when compared to the saprolitic samples. Although, the saprolite K concentration in the non-archaeological area is lower than the terraces, the opposite is true in the soil layers (Fig. 5.51).

The high K levels in the domestic areas and central enclosures may be due to activities such as cooking, burning fuel (i.e. dung and wood) and other materials, creating potash. This results in creating a liming agent that both neutralises the soil and adds additional nutrients to the soil such as K and P (Leckacz 2002; Lerner 2000; Risse *et al.* 2012). From the results shown in the saprolite, the terraces and non-archaeological areas, Doornkop is generally depleted in K (Fig. 5.51). This would indicate that during the occupation of this site, additional K nutrients would have been required to ensure high yields and healthy crops.

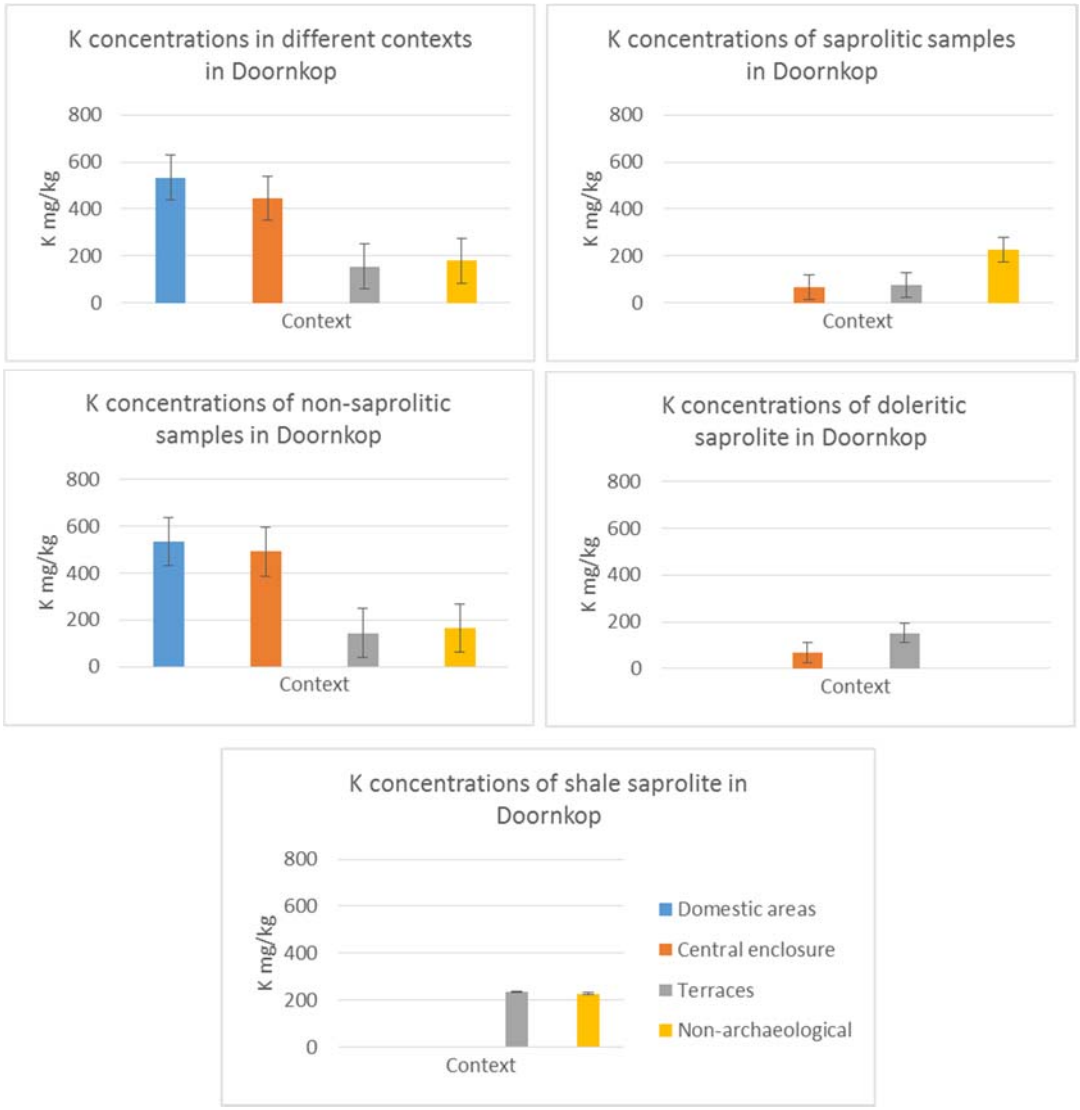


Figure 5. 51: K variations in different contexts for Doornkop.

Na

The patterns in the Na levels in Doornkop, are very different to that of the K. It is clear that the saprolite in this area is Na rich, where the shale in the non-archaeological area has the highest concentration of Na. The doleritic saprolite in the central enclosures and terraces are high. This is an interesting result, as it was described earlier that dolerite is often depleted in Na2O (Best 2003). This may, however, indicate a high occurrence of plagioclase in the dolerite. The non-

archaeological areas have the highest Na levels at 12.53 mg kg^{-1} with a standard error of 2.72. This may be due to the high concentration in the shale saprolitic samples. The rest of the areas demonstrate lower concentrations of Na, with the domestic areas being the lowest at 7.44 mg kg^{-1} with a standard error of 1.63 (Fig. 5.52).

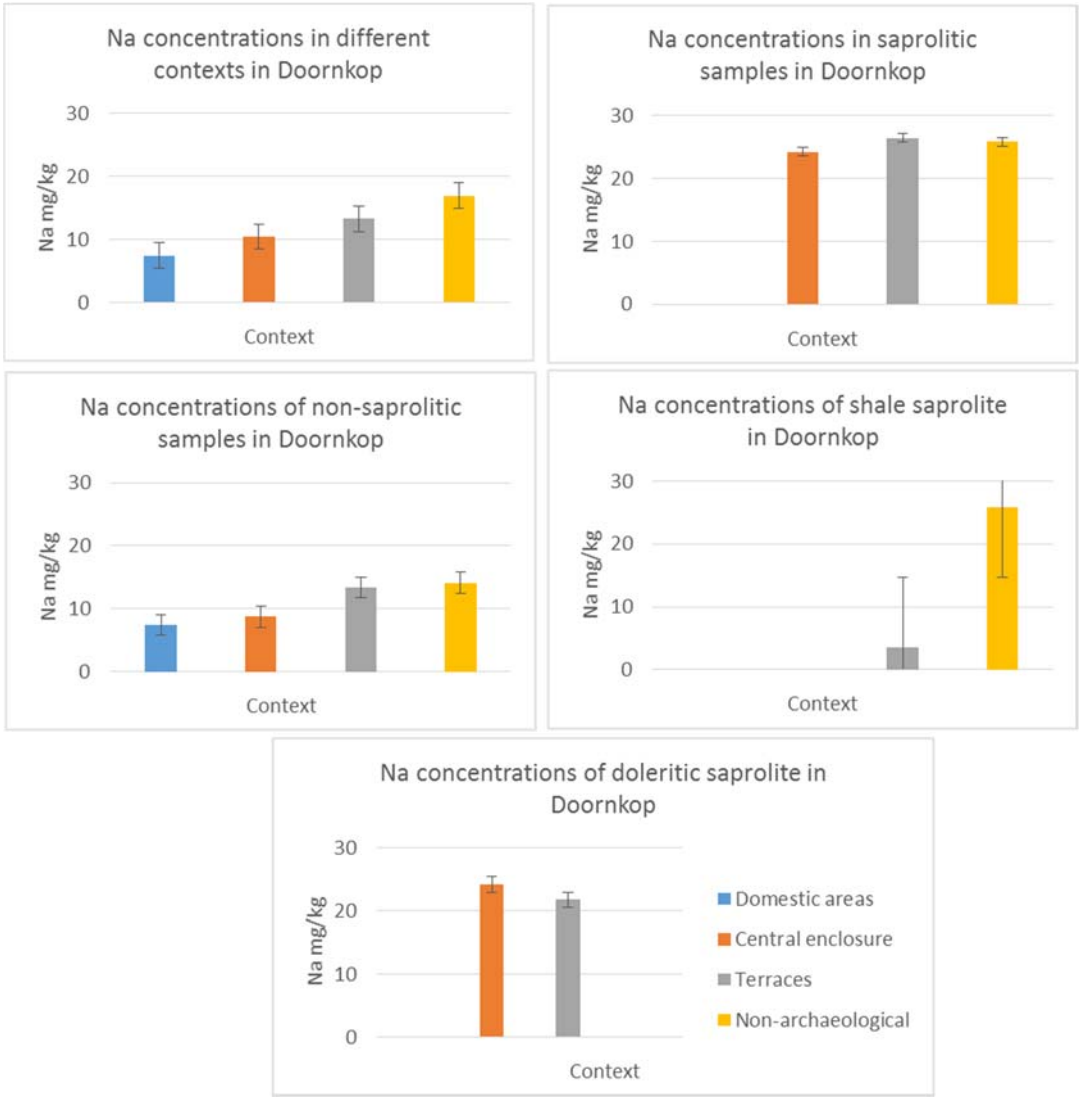


Figure 5. 52: Na variations in different contexts for Doornkop.

P

As discussed earlier, dolerite also has very low concentrations of PO4 similar to Na2O in weight percentage (Best 2003). This is apparent in the saprolitic samples, as well as the soil layers. P-testing in soils has become a very important way of indicating how P is depleted in soils due to rainfall (Daly and Casey 2005). According to (Hattingh 2014), the Komati Gorge photoliths she analysed indicated that the time of occupation of these sites, the climate conditions suggested high rainfall and temperatures in the area. Hattingh also stated that these results were a confirmation to climatic studies done by Mucina and Rutherford (2006).

This information is important because this affects the P concentration in the soils. The saprolitic samples indicate a low concentration of P due to the parent material. This allows the assumption that the soils would then also be depleted in these nutrients. This will also be exacerbated with the high rainfall in the area at the time of occupation until contemporary times. The overall results of the Doornkop site show a depletion of P in the domestic areas, terraces, and non-archaeological areas. The central enclosures, however, indicate a very high concentration of P at 26.71 mg kg^{-1} with a standard error of 20.59 (Fig. 5.53). Again, this data is interesting because it has been suggested that the dung was removed from the central enclosures in order to fertilise the crops in the terraces, as well used as fuel in the domestic areas (Solomon 2012: 37).

Manure has a preservation effect on P where it reduces the runoff of soluble P (Mukhtar *et al.* 2003). Thus if dung had been removed, one would expect relatively low P, NH4, and NO_3 concentrations in these soils as the source of these nutrients are being removed and placed in other areas. This appears to not be the case. These results also indicate a need for supplementing nutrients in the non-central enclosure areas.

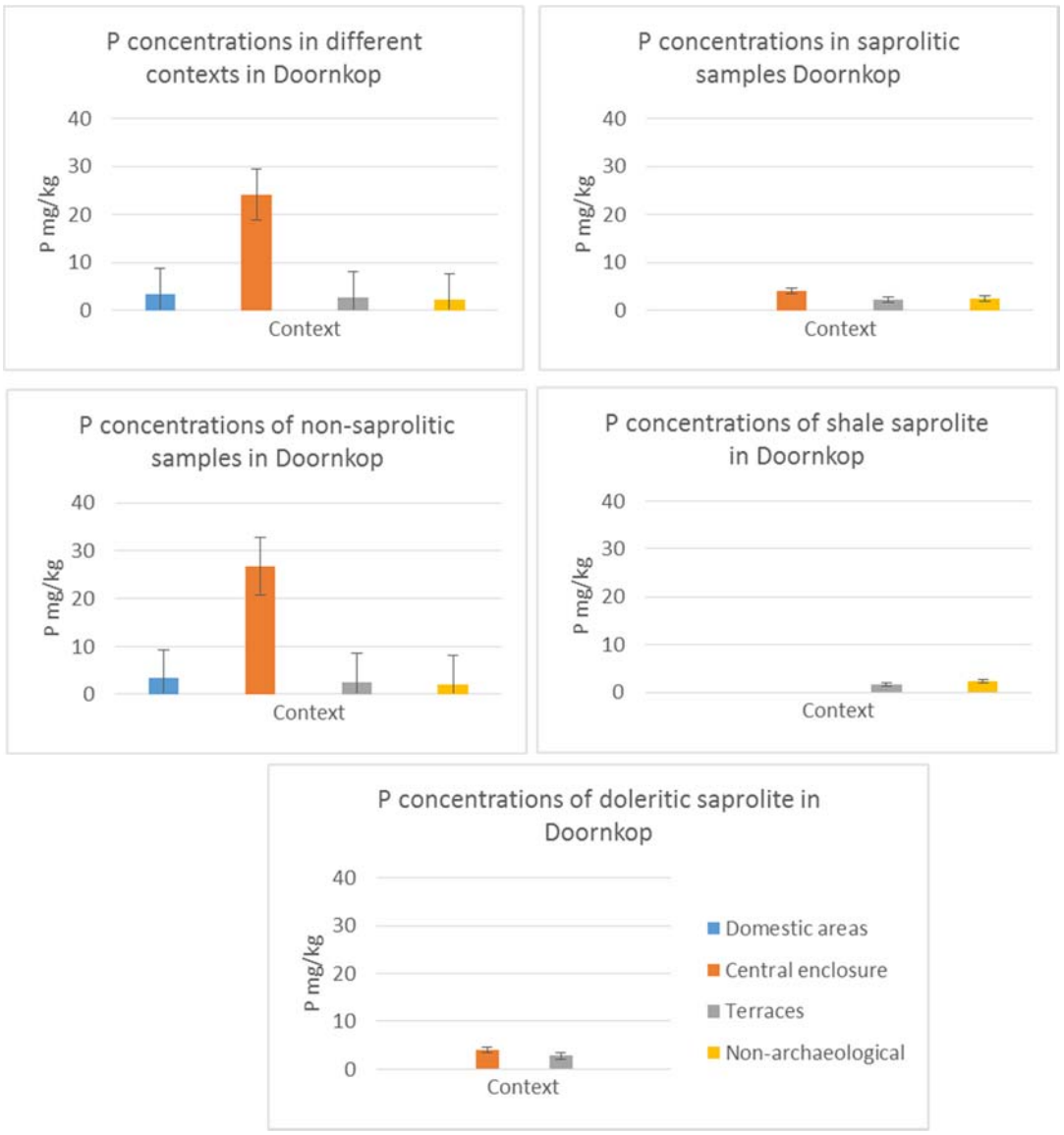


Figure 5. 53: P variations in different contexts for Doornkop.

NH_4 and NO_3

Following the results of P, the NH_4 and NO_3 levels would be expected to have similar trends. This, however, is not the case. The domestic areas indicate a much higher concentration of NH_4 and NO_3 than in other areas. N, however, does not preserve well in soils. As a result, these NH4, NO3 and P cannot be used in archaeological contexts, through soil chemical analyses, and other methods should

be used in order to determine this at the time of occupation. These results do, however, suggest how the soils interact with the homesteads, terraces and non-archaeological areas, because these influences would be present irrespective of human activity. The saprolitic samples have much higher concentrations of NH_4 than in the conventional soils (Fig. 5. 58), along with relatively high NO_3 contents in these areas (Fig. 5.54). This is anomalous because the minerals present in the shales and dolerite do not contain N and P.

These results do, however, indicate the soil in Doornkop is depleted of NH4, which, would have been needed by certain precolonial crops cultivated in the region. Hattingh (2014) found phytoliths similar to sorghum at Komati Gorge. According to Usman *et al.* (2013: 6447) *S. bicolor* requires 102 kg/ha of N to have a grain yield of 3 t/ha. The terraces in Doornkop, however, only contains 14.90 kg/ha of NH_4, and 19.49 kg/ha of NO_3 assuming a bulk density of 1.5 g cm^{-3}. This demonstrates insufficient concentrations of N in this area. Although this may not reflect the levels at the time of occupation, it still suggests that these soils needed extra nutrition in order to allow for sustainable yields of crops. As these results do not reflect the actual ammonium nitrates results of the time of occupation, other areas need to be investigated such as δ15N signatures in charred seeds (Fraser *et al.* 2011; Kanstrup *et al.* 2012).

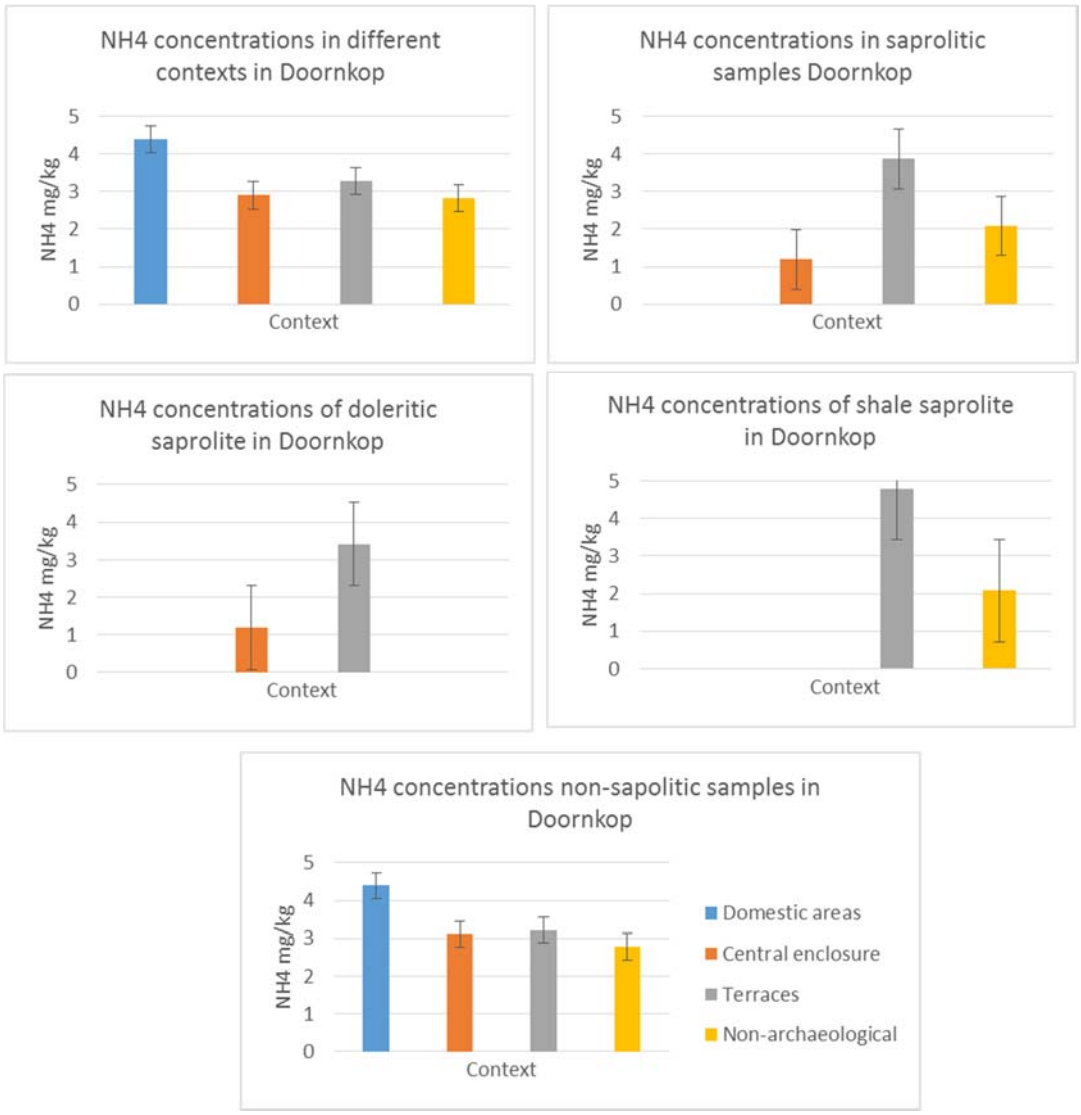


Figure 5. 54: NH_4 variations in different contexts for Doornkop.

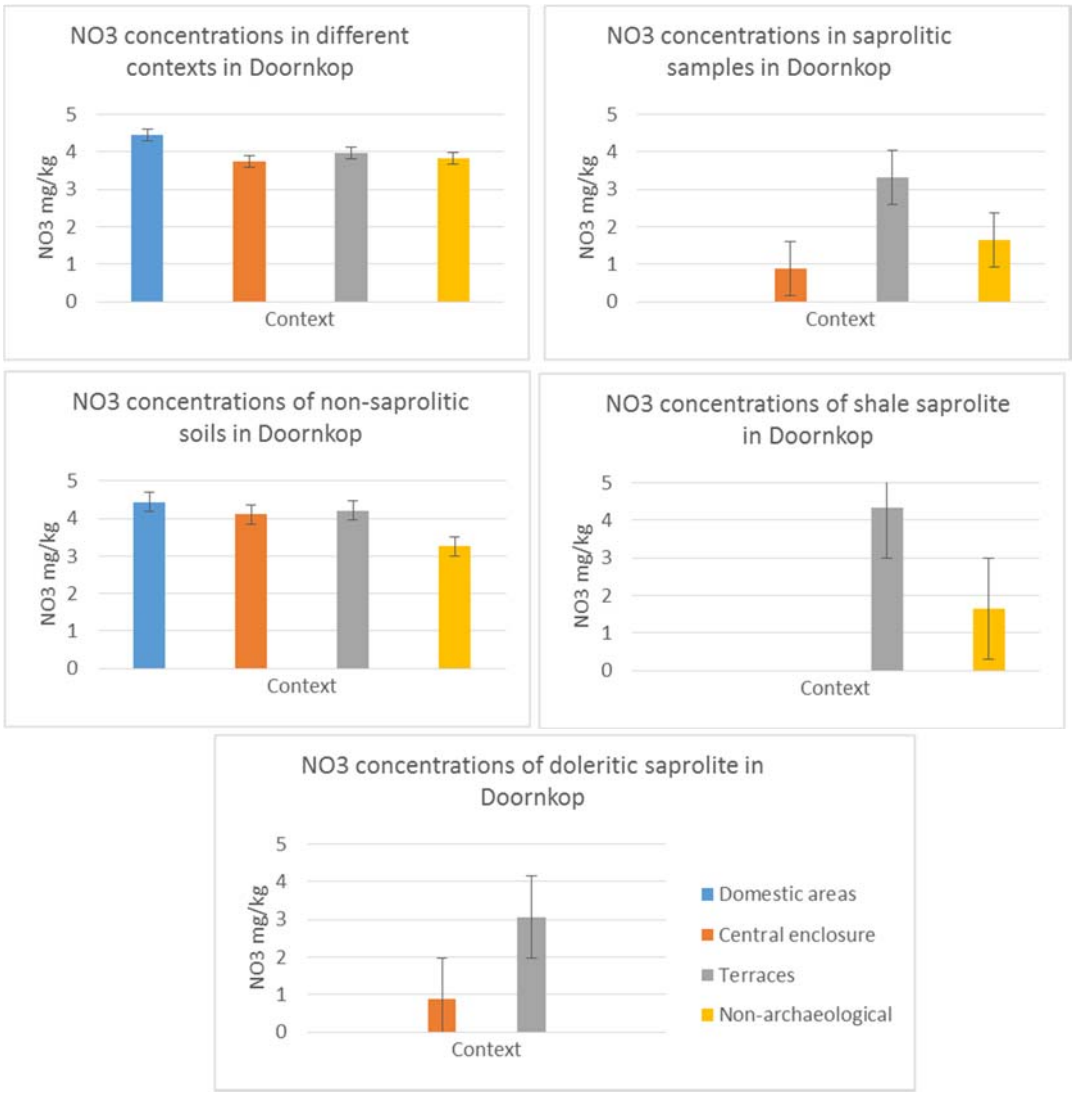


Figure 5. 55: NO_3 variations in different contexts for Doornkop.

5.5.2. Khutwaneng

There are some significant trends in these areas that are comparable with Doornkop. This, however, will be discussed later in the chapter. The saprolitic samples, in Khutwaneng, consist mainly of dolerite and shale. The non-archaeological samples have one shale saprolite sample (sample 122). This is problematic as this is not statistically valid, and does not represent the site. As a result, this needs to be omitted, but does indicate that there is shale on the site. The terraces, also, only have a single saprolitic sample (sample 138), and cannot be used as a comparative statistic as it only represents a single area of Khutwaneng. It will be regarded as a reference for the terraces, but will not be used as a representative for the terraces.

Ca

The Ca concentrations in Khutwaneng are very similar in the different contexts. The saprolitic samples in the central enclosures has the highest Ca concentration at 3795.63 mg kg^{-1} with a standard error of 1158.54. The non-saprolitic samples, also, has higher Ca concentrations of 2899.66 mg kg^{-1} with a standard error of 249.14. The terraced saprolitic sample has the lowest concentration. The soil layers in the non-archaeological areas is the lowest (Fig.5.56). This may demonstrate an enhancement of Ca in the terrace, and depletion in the non-archaeological areas. It needs to be remembered, that the non-archaeological areas have minimal amount of samples taken, due to there being few areas that were not cultivated or built on.

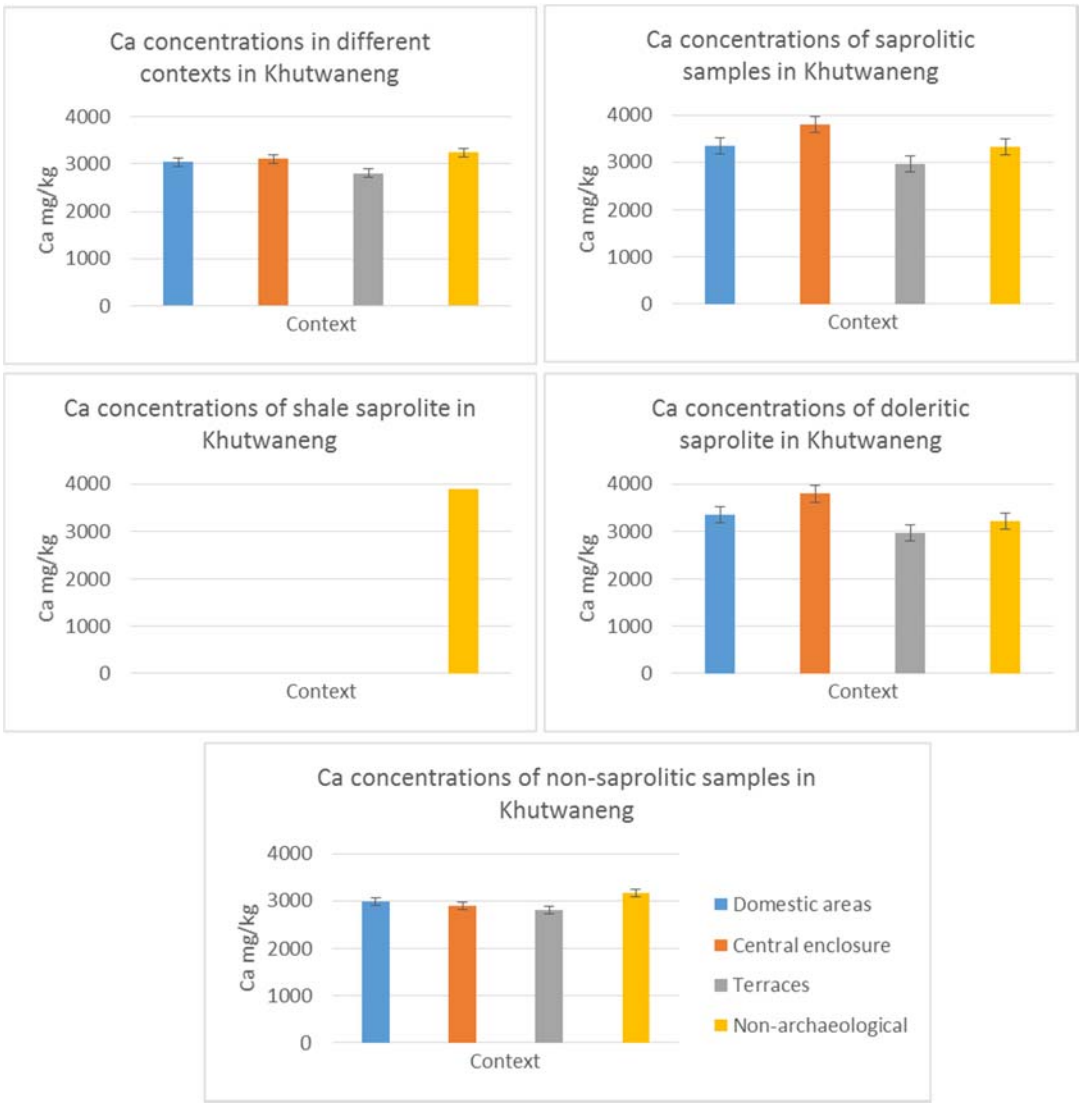


Figure 5. 56: Ca variations in different contexts for Khutwaneng.

Mg

The Mg levels in the saprolite between the different contexts are relatively similar, where the terraced sample has the lowest concentration of 2 962.96 mg kg^{-1}, and the domestic areas have the highest average of 3 351.633 mg kg^{-1} with a standard error of 263.50. All the different contexts show depletion in Mg in the soil layers from the saprolite. This may be due to the parent material being rich in Mg, and leaches readily out of the soil layers (Fig. 57).

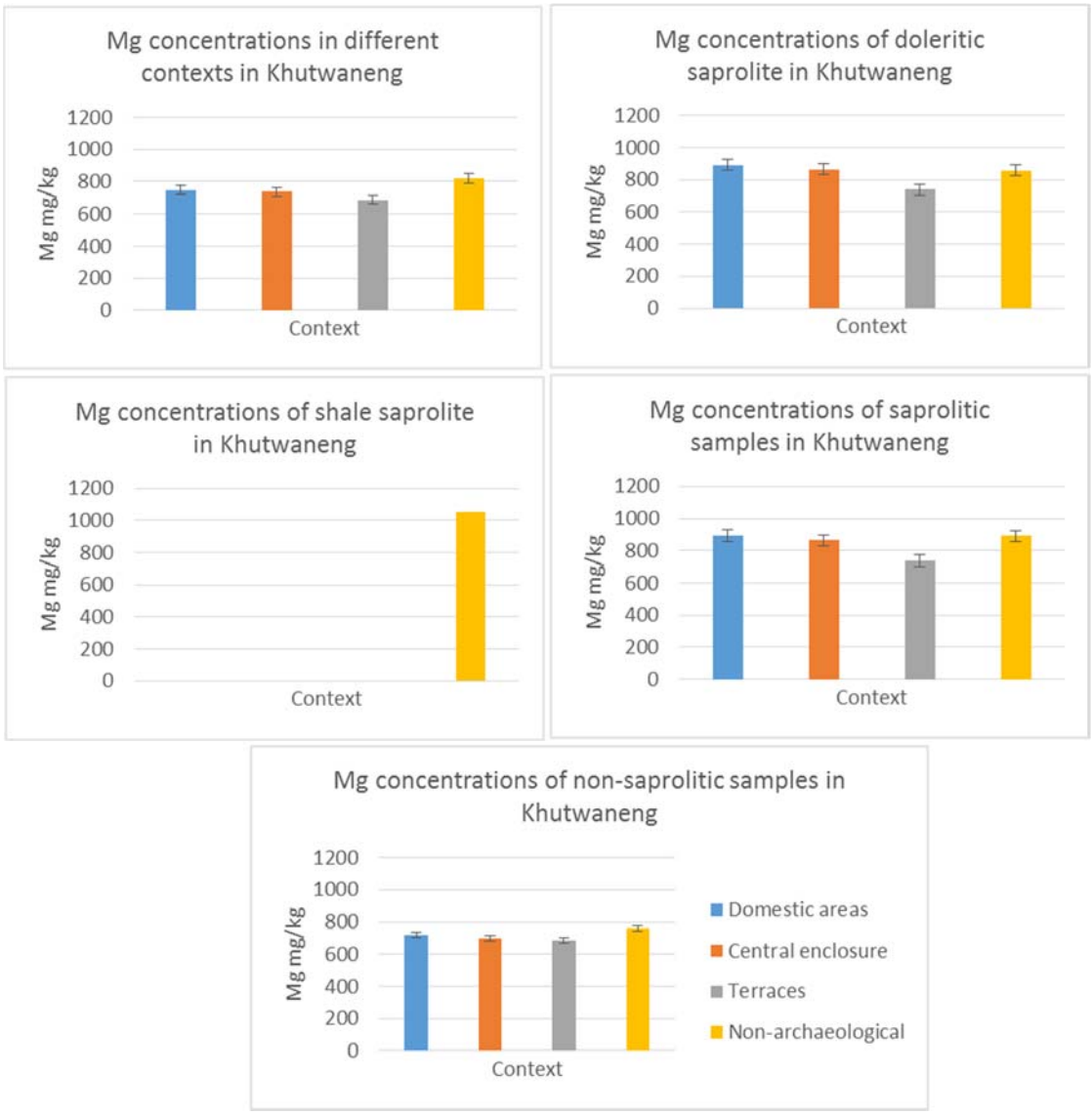


Figure 5. 57: Mg variations in different contexts for Khutwaneng.

K

The K levels in the anthropogenic areas, where domestic activities are dominant, demonstrate an enhancement of these nutrients. The domestic areas have an average concentration of 368.81 mg kg^{-1} with a standard error of 140.6, and a saprolitic average of 109.23 mg kg^{-1} with a standard error of 40.65. This distinct enhancement may be due to the domestic activities as described earlier, where

unintended liming may occur from creating potash. This enhances the K and P in the soil, as described earlier in this chapter (Leckacz 2002; Lerner 2000; Risse *et al.* 2012). The central enclosures have the highest concentration of K in both the saprolite, at 221.39 mg kg^{-1} with a standard error of 43.92, and the soil layers, 388.19 mg kg^{-1} with a standard error of 49.20. The terrace sampled, as well as the non-archaeological areas have distinctly lower concentrations of K in the soil samples. This indicates that the areas are not subject to soil enrichment such as living areas and livestock areas, have depleted K values. These areas, therefore, need to be enhanced in order to have ideal concentrations of K for crop growth (Fig. 58).

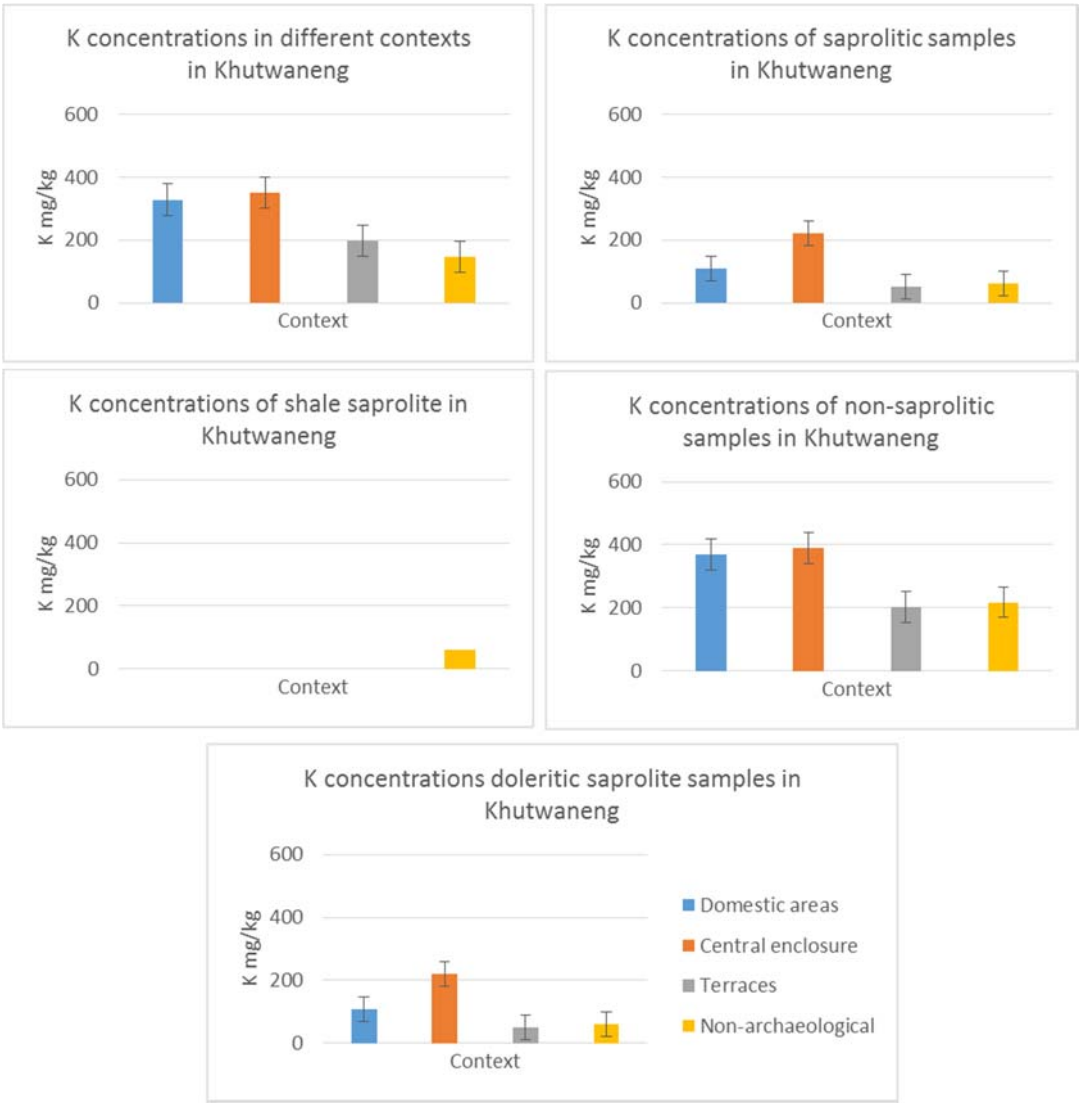


Figure 5. 58: K variations in different contexts for Khutwaneng.

Na

The Na show the opposite trend, compared to K. The Na content, of the doleritic saprolite in the Central enclosure, is distinctly higher than the other contexts. The average concentration this Na in this context is 15.80 mg kg^{-1} with a standard error of 9.86, whereas the soil layers only has a concentration of 8.54 mg kg^{-1} with a standard error of 7.86. For the terraces, and the non-archaeological areas, the

opposite is true. The domestic area also shows a slight depletion of Na in the soil layers when compared to the doleritic saprolite (5.58).

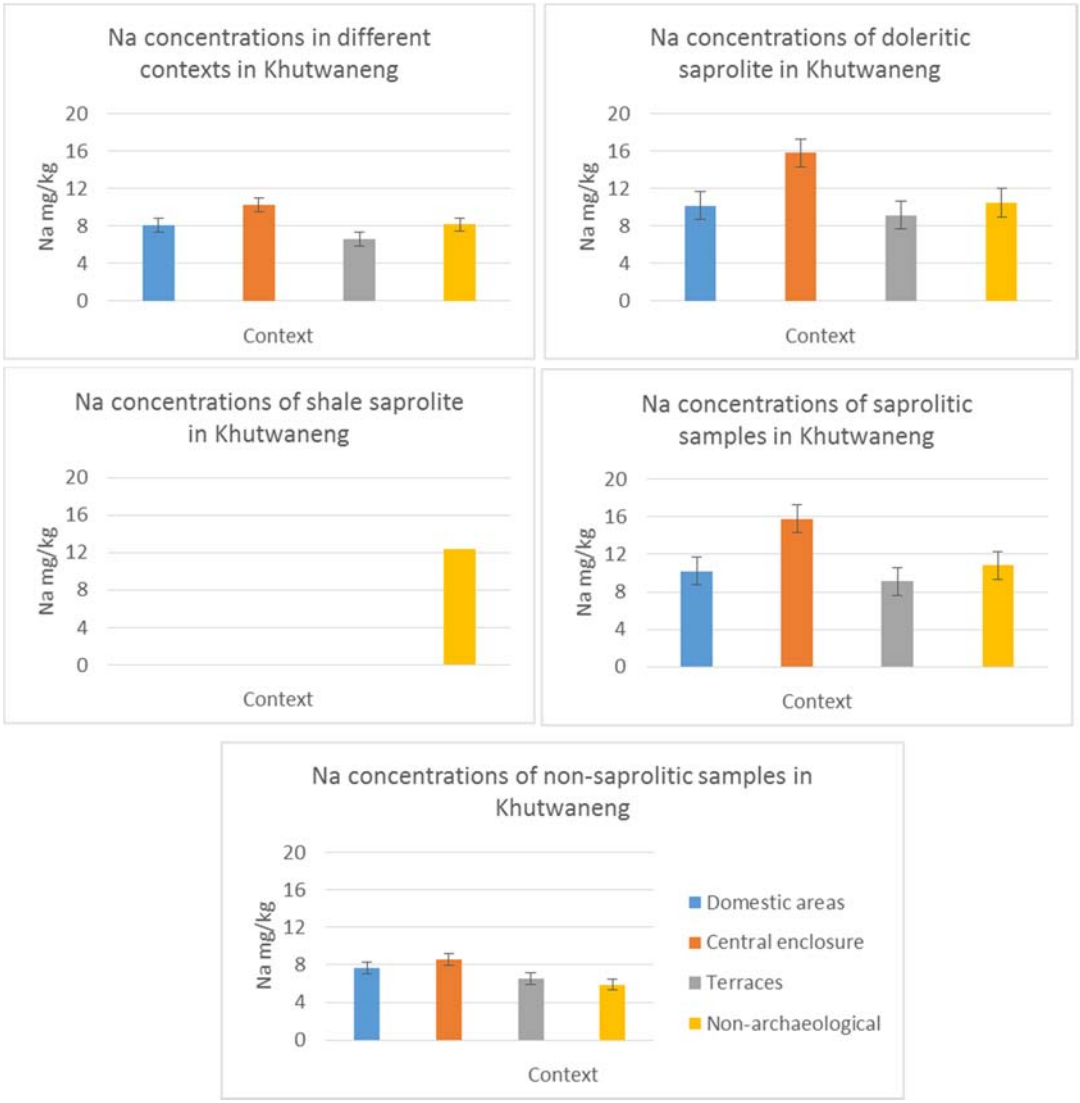


Figure 5. 59: Na variations in different contexts for Khutwaneng.

P

The P concentration of the doleritic saprolite in Khutwaneng is low throughout the site. The Central enclosure has the highest concentration of 3.14 mg kg^{-1} with a standard error of 0.34. The lowest concentration is in the non-archaeological areas

with a concentration of 2.01 mg kg^{-1} with a standard error of 0.16. These results show a fairly consistent concentration of P in the doleritic saprolite. The soil layers in the anthropogenic areas, i.e. domestic, central enclosures and terraces, have higher concentrations of P than the doleritic samples. The non-archaeological area also has a slightly elevated P concentration, but is significantly lower than the other areas sampled. The domestic areas and the central enclosures have distinctly higher concentrations of P of 4.95 mg kg^{-1} with a standard error of 2.65, and 5.00 mg kg^{-1} with a standard error of 3.26. These higher concentrations may be due to the unintentional fertilisation of these areas through domestic activities and from livestock in the central enclosures (Fig. 59). These would result in liming and manuring of the soil as described earlier in this chapter (Leckacz 2002; Lerner 2000; Risse *et al.* 2012).

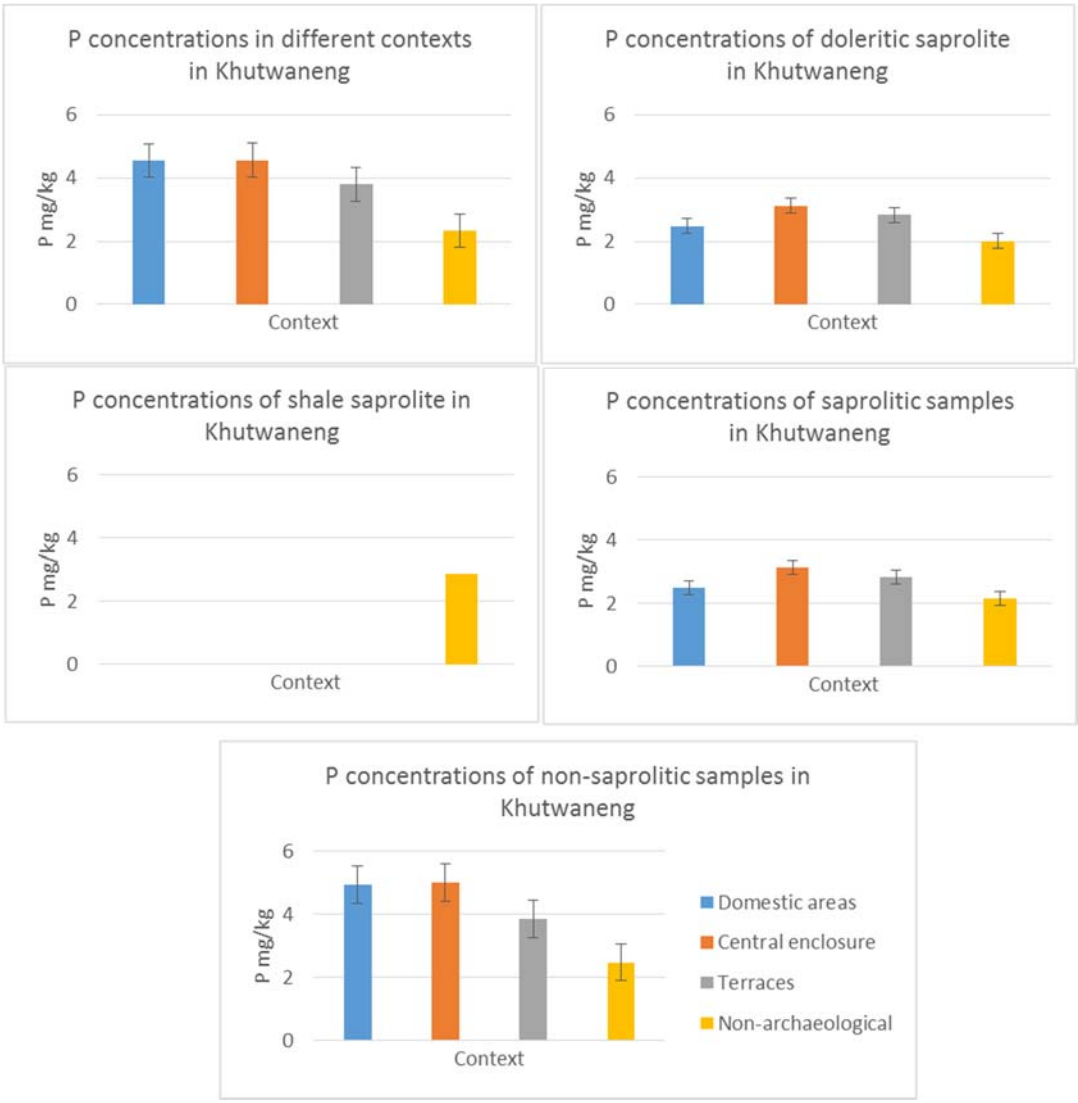


Figure 5. 60: P variations in different contexts for Khutwaneng.

NH_4 and NO_3

Similar to Doornkop, the saprolitic samples in Khutwaneng have relatively high concentrations of NH_4 and NO_3. This is not expected, as dolerite does not compose of minerals with N, NH_4 or NO_3. All four contexts show an enrichment of NH_4 in the soil layers when compared to the saprolitic samples. The NO_3 shows the opposite correlation with the exception of the non-archaeological areas.

Although these results are obtained in a younger site compared to Doornkop, interpretation of these results should be done cautiously, due to N leaching readily out of soils, and do not preserve in archaeological N levels (Fig. 60).

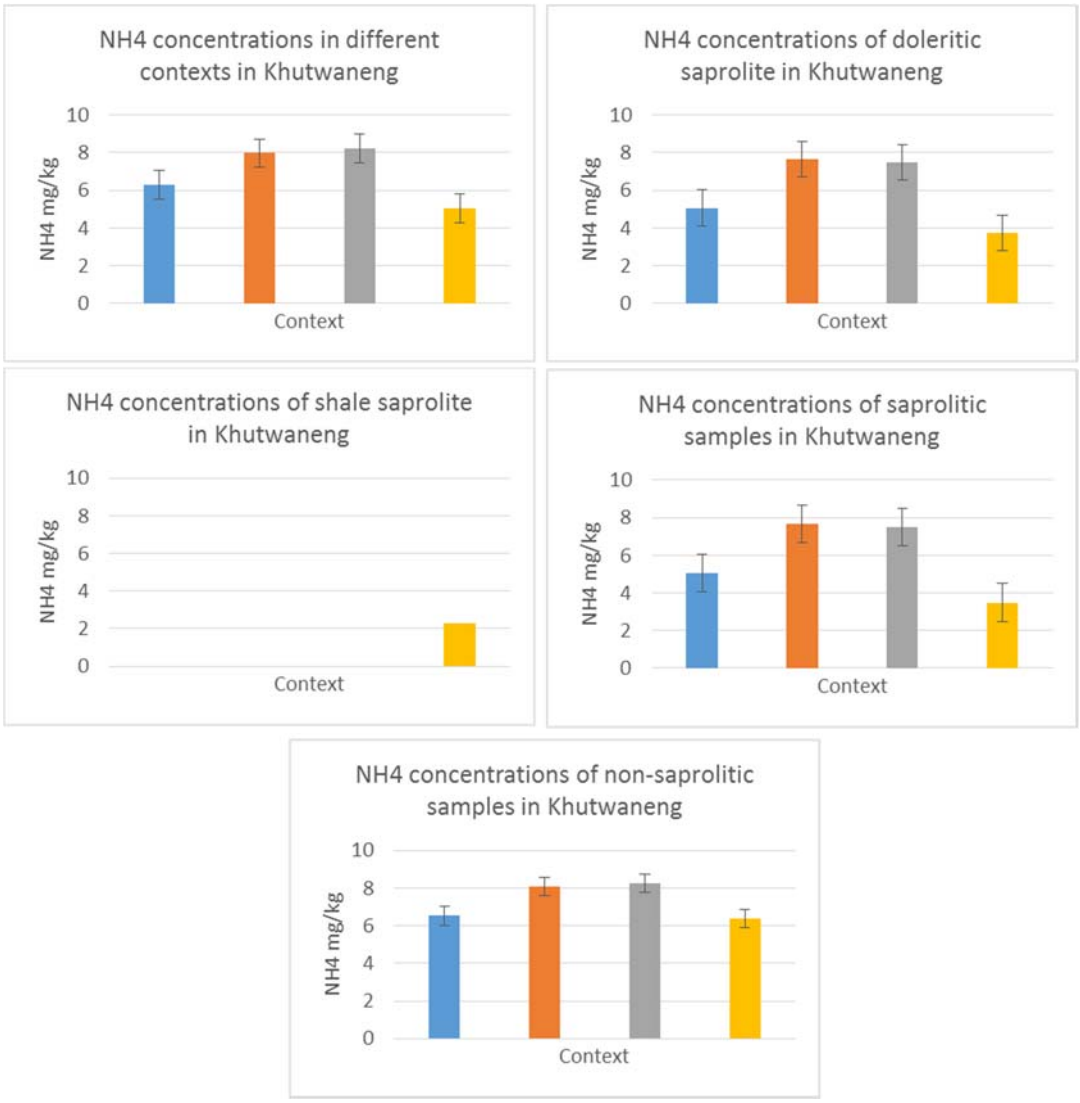


Figure 5. 61: NH_4 variations in different contexts for Khutwaneng.

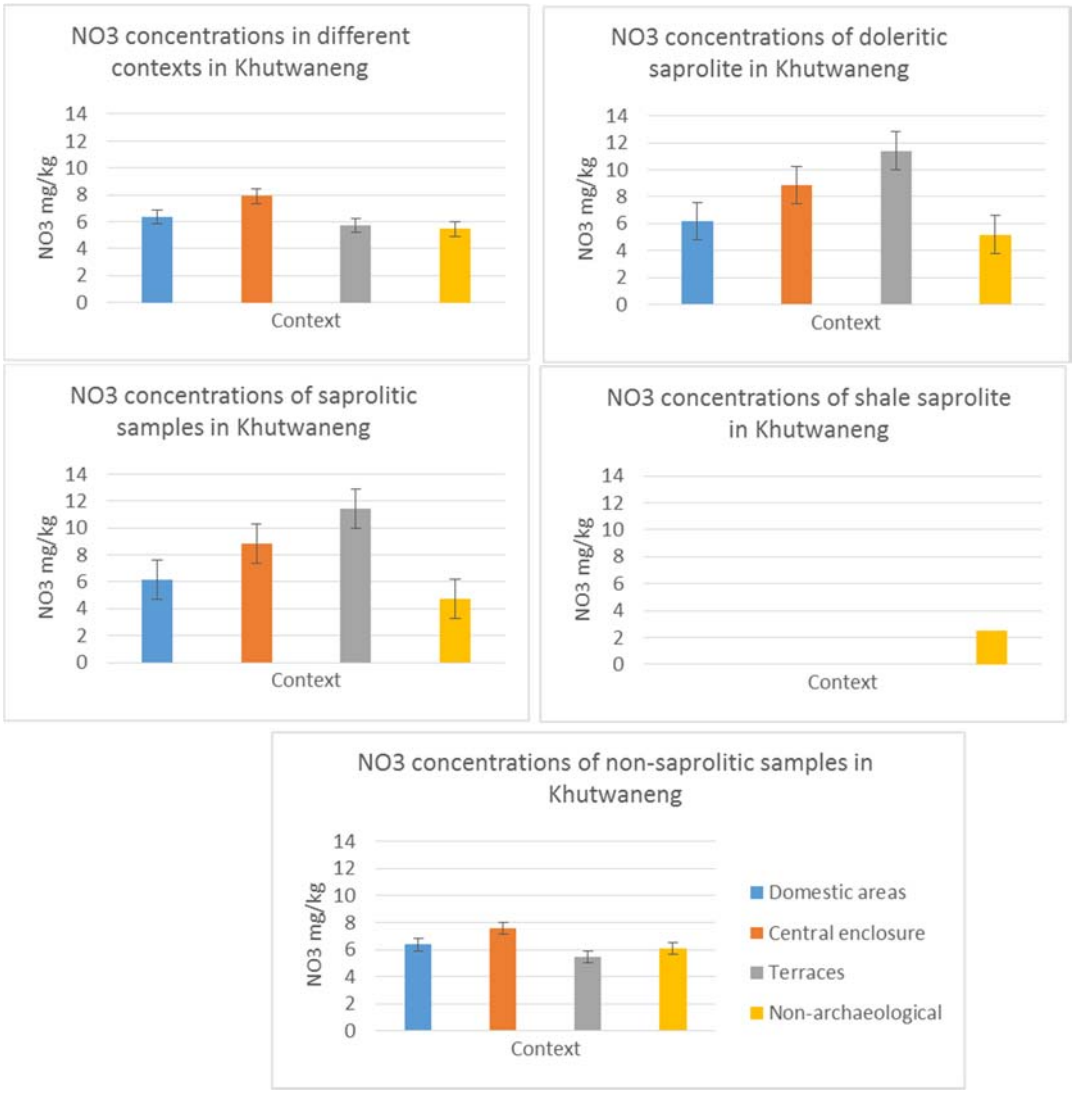


Figure 5. 62: NO_3 variations in different contexts for Khutwaneng.

5.5.3. Kranskloof

Most of the soil samples, and saprolitic samples that were collected at Kranskloof were in the basaltic regions of the site. This was confirmed with localised geological mapping. There is also shale present on the site, and two shale saprolitic samples were taken in the terraces. Three doleritic saprolite were taken in the non-archaeological areas.

Ca

The shale and doleritic saprolite show a difference in Ca concentration. The doleritic saprolite has a notably higher concentration of Ca, 3 090.30 mg kg^{-1} with a standard error of 347.36, in the non-archaeological areas than the shale in the terraces, 2 083.96 mg kg^{-1} with a standard error of 232.00 (Fig. 5.63). This distinctly high concentration in the basalt may be due to high concentrations of clinopyroxene or plagioclase that one would find in basalt (Best 2003; Blatt *et al.* 2006).

Comparing these saprolitic samples to the soil layers, there is a distinct depletion in Ca in areas where the parent material is basaltic. The terraces show a slight enrichment in Ca, when compared to the shale saprolite, at 2135.02 mg kg^{-1} with a standard error of 239.73. The central enclosures and terraces have slightly higher concentrations of Ca than the non-archaeological areas and the domestic areas, with the terraces being the highest (Fig.5.63).

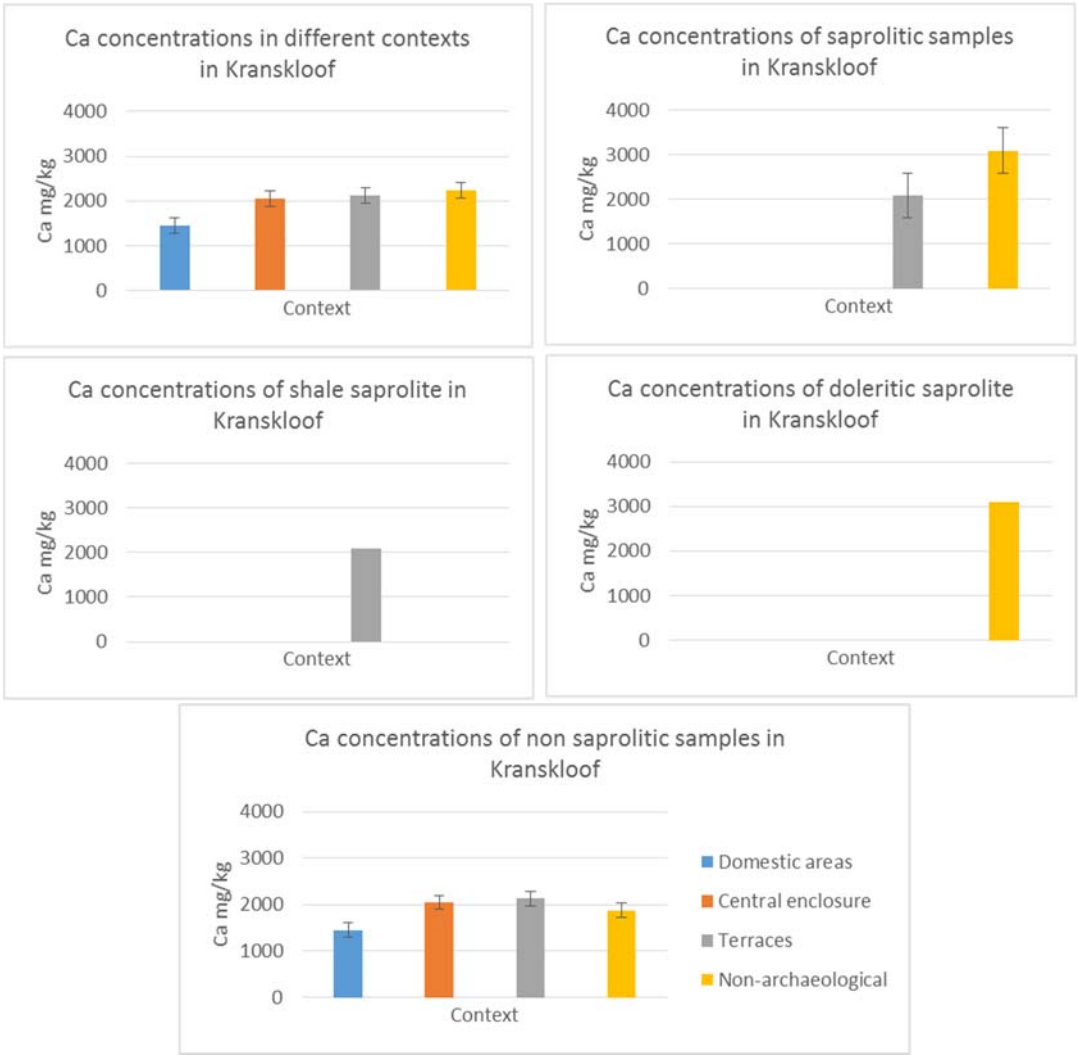


Figure 5. 63: Ca variations in different contexts for Kranskloof.

Mg

Similarly, to the Ca concentrations, the Mg content in the basaltic saprolite is considerably higher than that of the shale saprolite. This may be due to the mafic minerals such as orthopyroxene, olivine and clinopyroxene in the basalt (Best 2003; Blatt *et al.* 2006). There is also a distinct depletion in Mg in the soil layers when compared to the doleritic saprolite. The terraces have the highest

concentration of Mg at 719.97 mg kg^{-1} with a standard error of 171.92. The domestic areas have the lowest concentration with 351.36 mg kg^{-1} with a standard error of 99.33. The terraces are richer in Mg than the non-archaeological errors. But, due to the fact that the domestic areas and the livestock enclosures being depleted in Mg this may indicate that this is not necessarily intentional (Fig. 64).

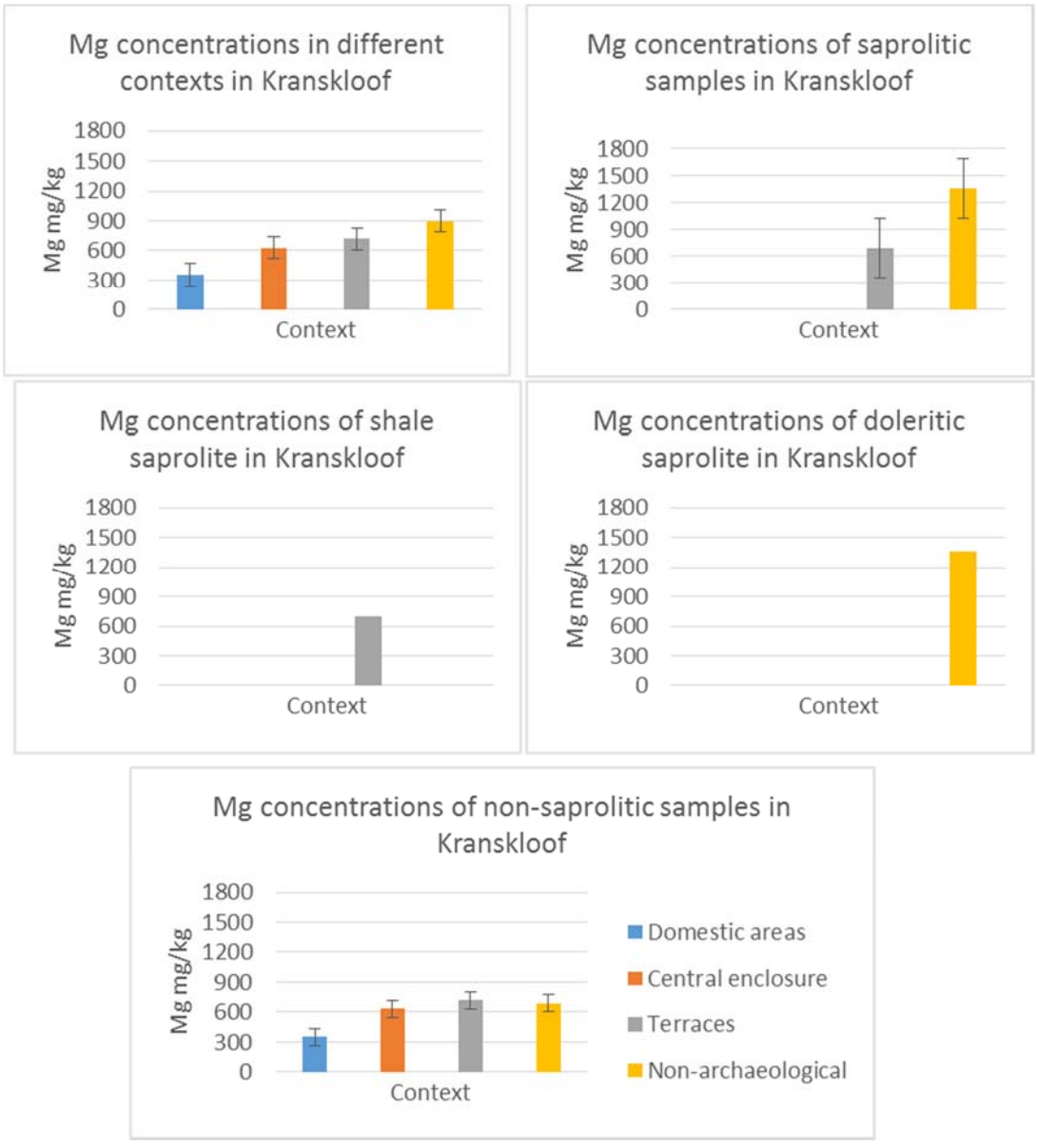


Figure 5. 64: Mg variations in different contexts for Kranskloof.

K

The K concentration is significantly higher in the shale, 131.55 mg kg^{-1} with a standard error of 37.35, than in the basalt, 84.00 mg kg^{-1} with a standard error of 27.75. This may be due to influences of nutrients in the sediments that the shale comprises of before lithification and metamorphism. The terraced soil samples also had high concentrations of K, which may be the influence of the shale, but also could be due to possible anthropogenic enhancements of the soil. This may be confirmed by the domestic areas having a higher concentration of K than the non-archaeological areas and central enclosures, due to unintentional liming (Fig. 65).

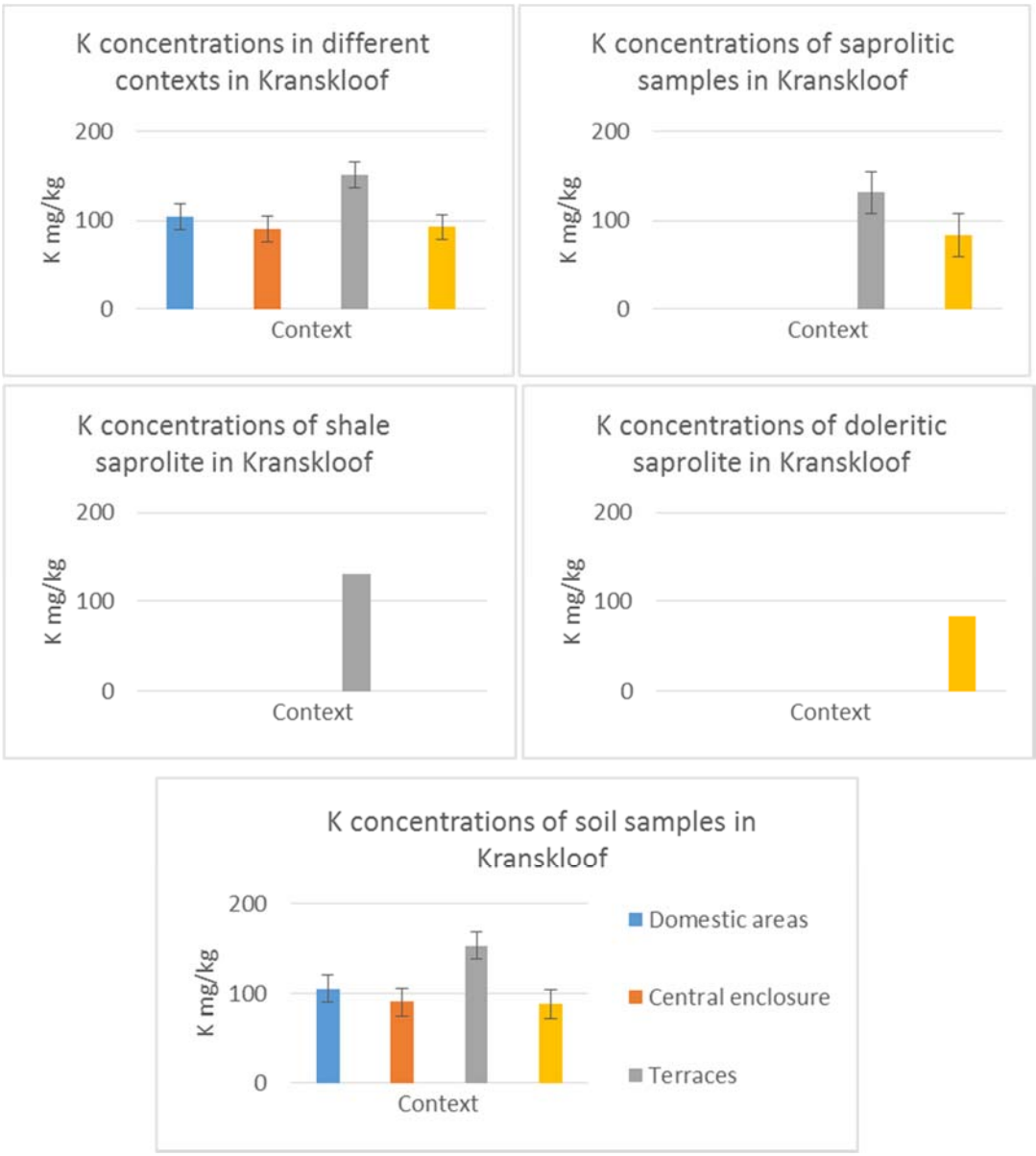


Figure 5. 65: K variations in different contexts for Kranskloof.

Na

The Na concentrations for the basaltic saprolite are significantly higher than in the shale samples. The basaltic Na concentration is at 24.47 mg kg^{-1} with a standard error of 11.96, whereas the shale only has a concentration of 6.91 mg kg^{-1} with a standard error of 0.79. The non-archaeological soils demonstrate a large depletion

in Na because it only has a concentration of 13.23 mg kg^{-1} with a standard error of 2.17. These concentrations remain relatively consistent throughout the different contexts, demonstrating no significant enhancement of the anthropogenic areas, but in fact depletion in Na concentration (Fig. 5.66).

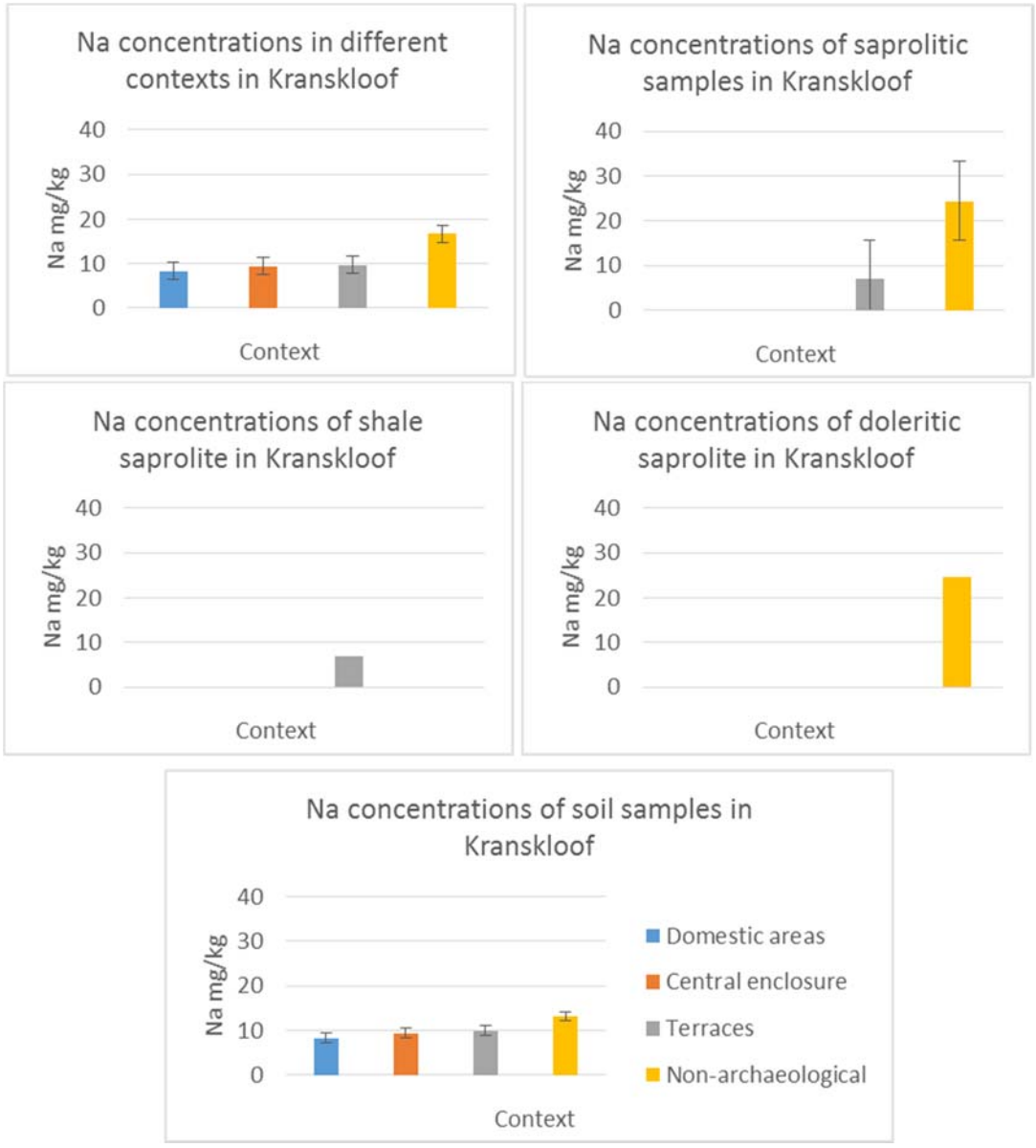


Figure 5. 66: Na variations in different contexts for Kranskloof.

P

The P concentrations in the shale saprolite are relatively higher than the basaltic saprolite. The domestic areas and the livestock enclosures have higher concentrations of P than in the terraces and non-archaeological areas. This informs the idea that the domestic areas had been enriched in this nutrient due to activities and unintentional liming from creating potash. This also plays a role in the idea that the central enclosures may have been used for livestock, as manure contributes P to the soil. The terraces and the non-archaeological areas are both depleted in P when compared to the domestic areas. As a result, it may have been important to enhance the soils by placing manure and potash in the soils in order to have good quality crops and high yields (Fig. 67).

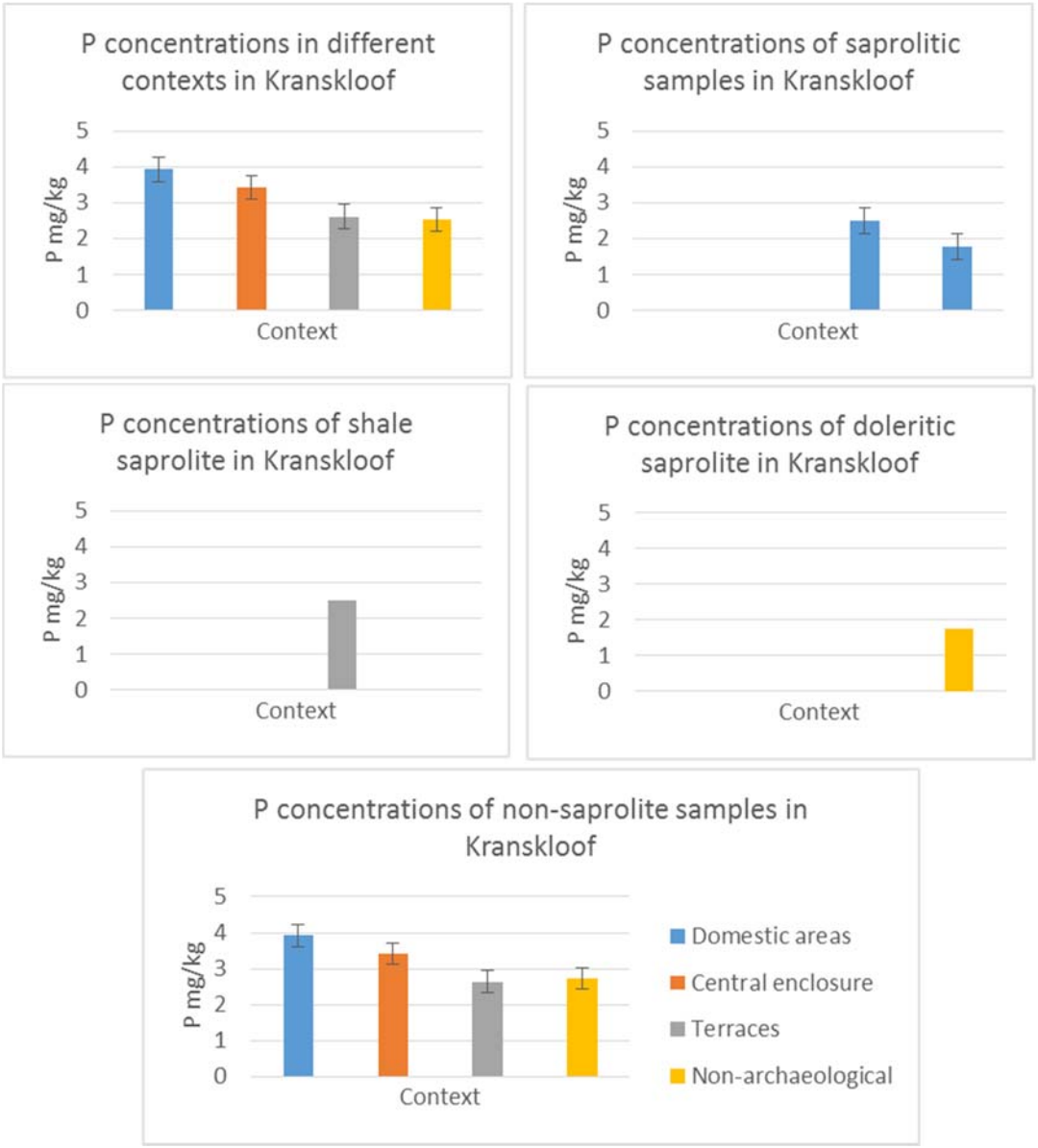


Figure 5. 67: P variations in different contexts for Kranskloof.

NH_4 and NO_3

The NH_4 and NO_3 results are relatively strange compared to what one would expect. The NH_4 concentrations in the shale are relatively higher than expected, this is also apparent in the basaltic saprolite. This is due to the fact that N is not present in the minerals which one would expect to find in shale and basalt, as described earlier. When comparing the different contexts to one another, the non-

archaeological areas have high concentrations of both NH_4 and NO_3 at 10.66 mg kg^{-1} with a standard error of 4.67 and 29.07 mg kg^{-1} with a standard error of 20.54, respectively. The domestic areas, central enclosures and terraces are relatively depleted in both these compounds, with the central enclosure being slightly higher in NH4, and terraces with NO_3 (Fig. 5.57).

These results are opposite to what one would expect as it would be thought that the anthropogenic areas would have higher concentrations, especially in the central enclosures. These results demonstrate possible depletion in the anthropogenic soils in comparison to the non-archaeological areas.

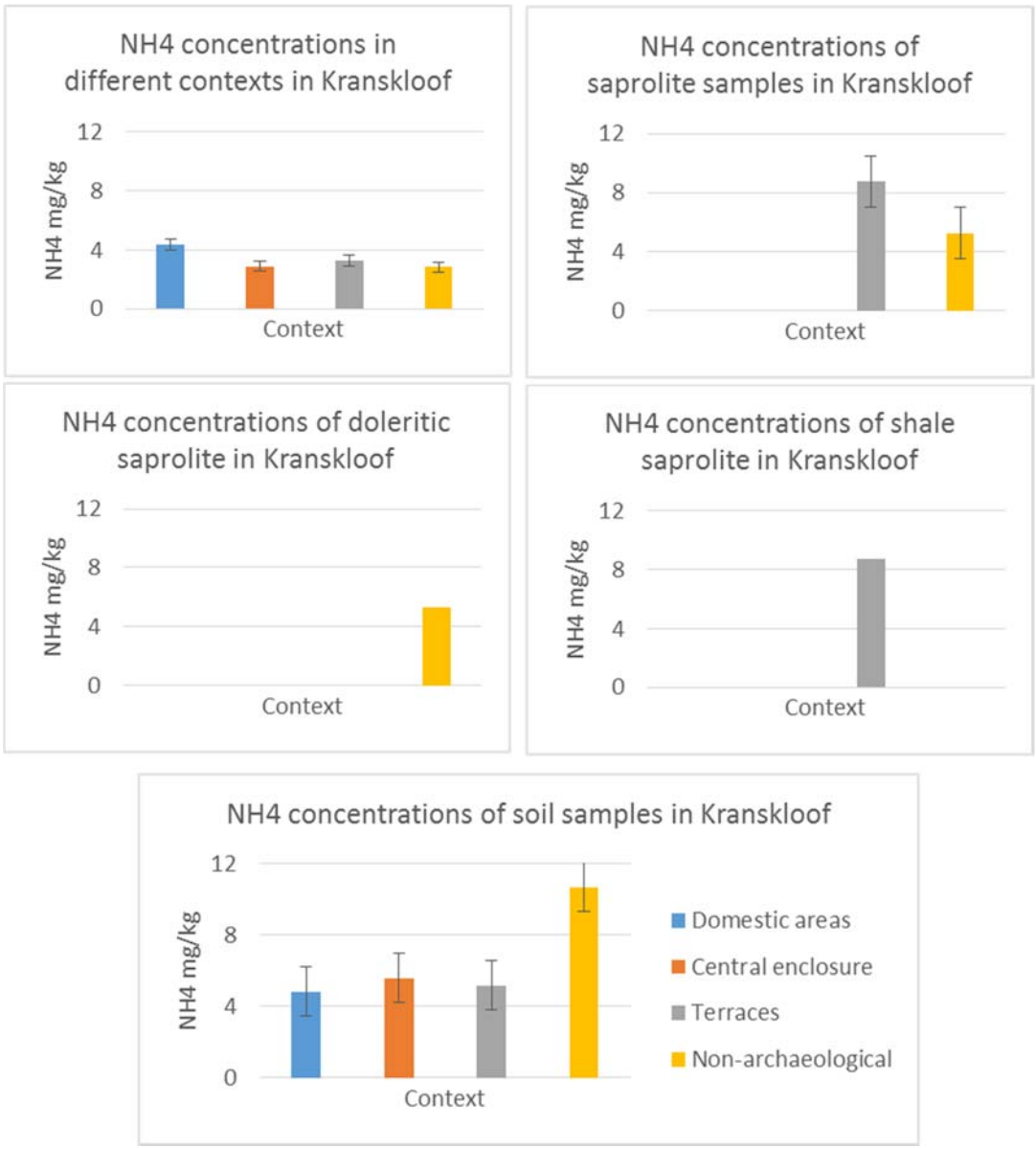


Figure 5. 68: NH_4 variations in different contexts for Kranskloof.

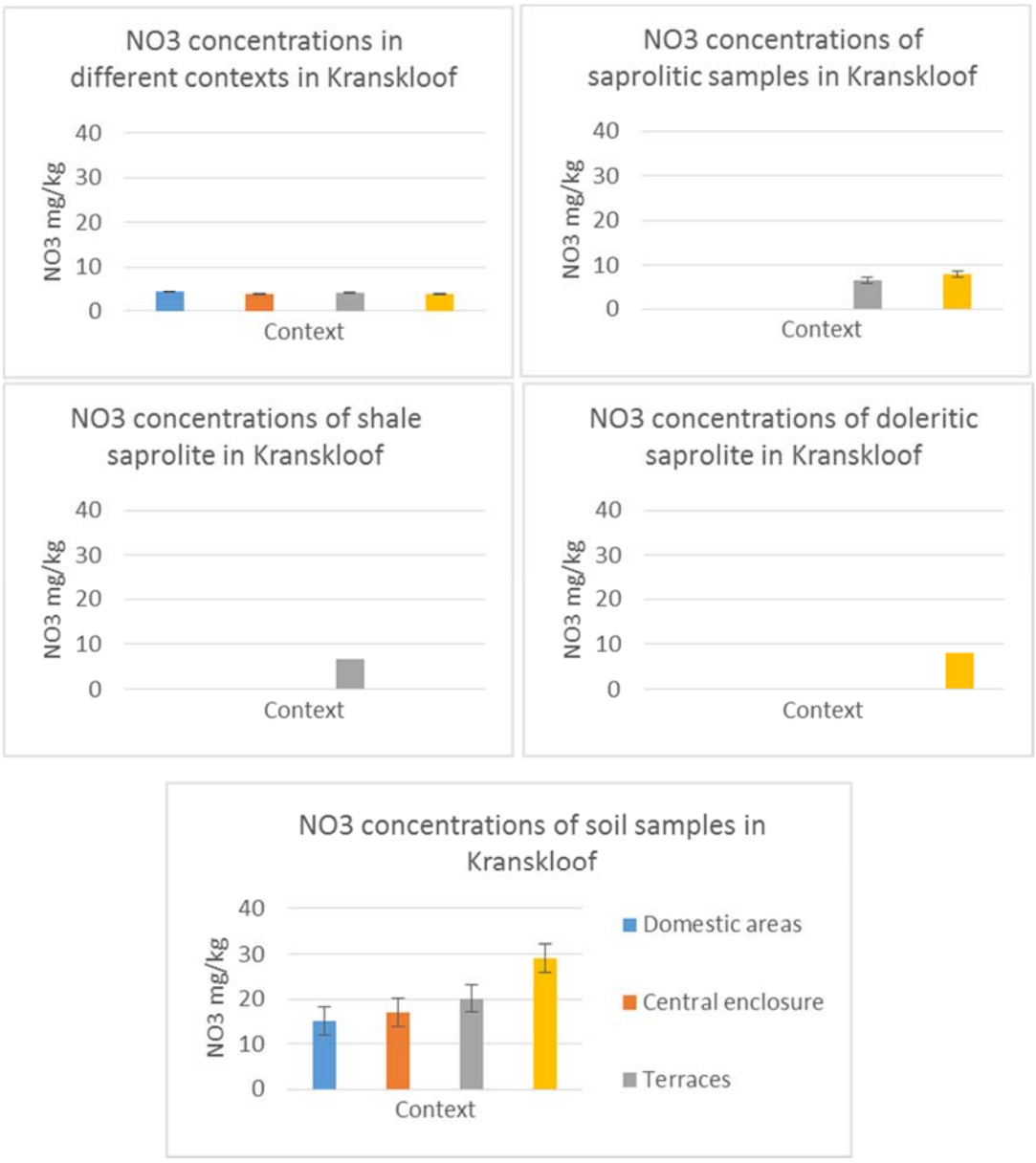


Figure 5. 69: NO_3 variations in different contexts for Kranskloof

5.6 Conclusion – all 3 sites

All three sites have relatively similar geographical features and geological zones. Each one of the sites is located on mafic igneous material, i.e. basalt and dolerite, as well as on shales. From the saprolitic samples it was clear that the parent

material does influence the fertility of the soil, and possibly people's choices on the localities of their homesteads and terraces.

The land management practices, along with the similarities and differences between different anthropogenic areas, as well as anthropogenic and non-archaeological soils, help to demonstrate how activities in these areas influenced the soils.

From the results obtained at Doornkop, Khutwaneng and Kranskloof it is clear that certain nutrients have been affected by the construction of the homesteads and terraces. There may also be evidence of residual nutrients from the time of occupation such as K and P, however, less so for K in Kranskloof.

The depth to nutrient status analysis has also given great insight on how nutrients interact with the different layers of soil. The CEC in Doornkop and Khutwaneng show a direct link in increased potential for fertility in saprolite vs other layers. These results are interesting because it has been discussed that CEC normally is linked to the %C in soils and, therefore, an increase in the one would have a positive correlation to the other. The %C also demonstrated logical results, where, with increased depth there is a depletion of organic matter. Kranskloof follows the expected logic, with regards to the correlation between CEC and %C.

It is likely that the central enclosures were livestock pens. Excavations in central enclosures at Komati Gorge, however, did not yield dung. Consequently, Schoeman (in prep) suggested that the dung from the central enclosures was collected and used as fuel for fires. This idea is further supported by the high concentrations of P and K in the domestic areas. Burning manure, and other materials would have a liming effect on these areas, and would, therefore, enhance the soils in these nutrients unintentionally, as discussed earlier in this chapter. The

soil chemistry in Kranskloof does confirm this interpretation as the domestic areas are also enhanced in K and P.

Soil chemistry

The soil chemistry data from Doornkop and Khutwaneng demonstrate that there are influences of nutrient enrichment in the anthropogenic areas, whether is residual or on going due to the stone walled structures.

CHAPTER 6: CONCLUSION

Agriculture plays a fundamental role in the economic life of the people of Bokoni. As a result, it is imperative to understand how factors influenced the way people interacted with the land, and how people's choices had an impact on the land. In order to understand these influences a chemical analysis was done on the soils on three different sites. These were sampled in different contexts in order to do a comparative analysis in order to understand what influenced people's decisions.

6.1. Achievements

One of the most important results from this dissertation is that the people of Bokoni intentionally or unintentionally enhanced the soil through activities in the homesteads. The most distinctive feature of the people's choices were the soil types and geology of the different areas. These stayed consistent throughout the different phases of occupation and socio-political changes during the occupation of Bokoni.

Overall, this dissertation has been able to show possible trends in the soil chemistry and the different contexts. This, however, is not explicit, and further analyses will need to be done in order to confirm these trends.

Further research needed to deepen the understanding of these areas, relate to the use of manure and potash to improve the agricultural potential of the soils. Possible avenues for this include isotope analyses of the seeds found on the sites. This is possible because as discussed earlier the seeds preserve the NH_4 and NO_3 content of the soils at the time of cultivation, which could indicate the use of manure.

A large amount of data was collected for this dissertation, and could be used in further research, for example an in depth study of the geographical relationship and the chemical data could help to understand the genesis of the soil, and how the stone walls contributed to the soil chemistry. Furthermore, an in depth micromorphology study could deepen our understanding of site formation.

6.2. Limitations and challenges

One of the main challenges to this study was the different site contexts. The soils were mostly shallow, making sampling complicated. In addition, the different site contexts, and related shallow soils, resulted in inconsistent numbers of coring holes in the different contexts of each site, making it difficult to give concrete conclusions to how these different areas relate to one another.

The inconclusive results, with regards to the particle size analysis, has also created a gap in the research and would have to be pursued in future research as all aspects of the soils need to be understood.

6.3. Further research

Isotope analysis of the seeds (discussed in the literature review) could deepen the understanding of these areas, and help to establish if manure and potash was used to improve the agricultural potential of the soils. As discussed earlier, the seeds preserve the NH_4 and NO_3 content of the soils at the time of cultivation, indicating the potential intensification of the use of manure.

Further analyses of other minerals such as Zn, Fe, Cu etc. would also be essential in order to understand the soils. I was unable to do these type of analyses due to insufficient funds.

XRF analysis on the clay soils, and the parent material, i.e. the rocks, might further increase the accuracy of the data. Since studying the saprolite (and not the parent rock itself) could result in a margin of error, as these may have interacted with the overlying soils and contaminating the soils.

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Appendix A:

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
Doornkop	001	H0		Domestic	Within Outer North Eastern side of of outer circle	Dark Brown	Organic layer	0-4					
	001	H1	1			Reddish brown	Clayish loose soil	4-19	70	Degraded dolerite	~10		
	002	H0		Terrace	Above homestead. Distinct vegetation anomaly, Yellow flowers all dead whereas in and around homested alive (photo)		Organic layer	0-5					
	002	H1	2			Dark Brown		5-15	60	Dolerite			
	003	H0		Kraal	Inside secondary North western inner circle, Tubers present at approx 33%			0-5					
	003	H1	3			Dark Brown	Clay rich	5- 40					
	003	H2	4			Reddish brown	Clay rich	40-68	2	Traces of dolerite			orange
	004	H0		Homestead (Kraal)	Annomolous building, differernt rock type, Flat rocks used and Kukuyu grass present. Building has square areas as well as round walls			0-5					
	004	H1	5			Dark Brown	Loose soil with a little clay	5-30	0				
	005	H0		Above homestead possibly within a				0-5					
	005	H1	6			Dark brown	Clay rich	5-64	0			rocks at bottom	
	006	H0		Non Archaeological				0-5					
	006	H1	7			Dark Brown	Clay rich	5-30	60				
	006	H2	8			Red	Clay rich	30-45	70				
	007	H0		Domestic area				0-5					
	007	H1	9		Western side of the homestead	Dark Brown	Clay rich	5-24	1				
	008	H0		Kraal				0-5					
	008	H1	10			Dark Brown	Slightly clay rich Loose soil	5-10	40				
	008	H2	11			Dark red	Clay rich	10-38	2				
	009	H0		Terrace				0-5					
	009	H1	12			Dark Brown Red	loose soil	5-15	60		~10		
	010	H0		Non Archaeological				0-5					
	010	H1	13			Dark Brown	Loose soil with a little clay	5-18	30		~5		
	011	H0		Non Archaeological	Near River			0-5					
	011	H1	14			Dark Brown	Clay rich	5-14	60		5-10		
	012	H0		Terrace				0-3					
	012	H1	15			Dark Brown	Clay rich	3-8			20-30		
	012	H2	16			Dark Brown Red	Clay rich	8-16	20				
	012	H3	17			Red Orange Brown	Clay rich	16-24	0				Orange

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	012	H4	18			Golden Brown	Slightly clay rich Loose soil	24-38				Rock disintergrating	Orange/ Yellow
	013	H0		Non Archaeological	Distinctly drier than in other areas			0-4					
	013	H1	19			Dark greyish brown	Loose soil	4-9	60		~2	Two distinct rock types which are disintergrate	
	013	H2	20			Light brown	Loose soil	9-11	60		1-2		Grey
	013	H3	21			Golden Brown	Loose soil	11-14	60			Hit rock at bottom, Soil distinctly shallower	Orange Grey
	014	H0		Non Archaeological				0-5					
	014	H1	22			Greyish brown	Loose soil	5-15	70		1-10	dry soil	
	014	H2	23			Brown	Loose soil	15-30	50				
	014	H3	24			Red/ Orange	Clay rich	30-60	20				Grey/ Orange
	014	H4	25			Grey	Clay rich	60-100	20				Grey
	015	H0		Non Archaeological	In amongst trees			0-3					
	015	H1	26			Reddish brown	Loose soil	3-22	40		~20	Hit rock at the bottom	
	016	H0		Domestic area?	SE of central enclosure, Bulk sample			0-5					
	016	H1	27			Dark brown	Slightly clay rich Loose soil	5-8	80				
	016	H2				Reddish brown	Loose soil	8-27	80		~20		
	017	H0		Terrace				0-5					
	017	H1	28			Dark Brown	Slightly clay rich Loose soil	5-20	40				
	017	H2	29		Bulk	Orange	Clay rich	20-40					Orange
	017	H3				Grey	Clay rich	40-50					Grey
	018	H0		Terrace				0-5					
	018	H1	30			Reddish brown	Slightly clay rich Loose soil	5-10				Hit rock at bottom	
	019	H0		Non Archaeological				0-10					
	019	H1	31			Red brown	Loose soil	10-22			~20	Large boulder	
	020	H0		Non Archaeological	Sample taken within ecently cultivated area, vegetation is distincly different to the rest of the farm			0-3					
	020	H1	32			Dark brown	Loose	3-48				Hit rock at bottom	

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	021	H0		Non	Recently cultivated land			0-5					
	021	H1	33	Archaeological		Dark brown	Loose	5-15	10				
	021	H2	34			Dark brown	Loose	15-40	70				
	022	H0		Domestic area	Inside southern side of homestead			0-3					
	022	H1	35			Dark greyish brown	Slightly clay rich Loose soil	3-22				Slightly dry, roots penetrating all the way till rock at bottom	
	023	H0		Terrace				0-6					
	023	H1	36			Dark Brown		6-22			~20		
	024	H0		Non	Bellow terrace above geological contact zone			0-4					
	024	H1	37	Archaeological		Dark Brown	Loose	4-14	30			Very shallow	
	024	H2	38			Light brown	Loose	14-34	60-70				Grey
	025	H0		Non	Below geological contact zon			0-6					
	025	H1	39	Archaeological		Dark Brown	Loose, becomes more clay rich at the bottom	6-42	30				
	026	H0		Kraal	Delapitated homestead, found close to rhe river,			0-6					
	026	H1	40		anomolous to the rest	Redish brown	Loose	6-32					
	027	H0		Non				0-6					
	027	H1	41	Archaeological		Light brown	Loose soft	6-16					
	027	H2	42			Dark brown	Loose	16-26					
	027	H3				Darl brown	Clay rich	26-50					
	028	H0		Non	Natural terrace			0-6					
	028	H1	43	Archaeological		Light grey	Loose	6-22	70-80			Seems like digging through rock	Grey
	029	H0		Terrace/ Cattle				0-5					
	029	H1	44	track		Dark brown	Clay rich	5-23	70		~1		
	030	H0		Non				0-6					
	030	H1	45	Archaeological		Dark brown	Clay rich	6-30		Quartz/			
	031	H0		Kraal				0-5					
	031	H1	46			Red brown	Clay rich	5-31	0				
	032	H0		Domestic	Insde southern end of Outer circle, hit domestic floor			0-8					
	032	H1	47			Red	Clay rich	8-20					
	033	H0		Lower terrace				0-6					
	033	H1	48			Dark brown	Clay rich	6-16					
	033	H2	49			Reddish brown	Clay rich	16-26					
	033	H3	50			Red	Clay rich	26-44					
	033	H4	51			Orange brown	Clay	44-60		Grey			
	033	H5	52			Orange grey	Clay	60-82		White/grey			
	034	H0		Domestic	Within inner outer circle, eastern end f homestead			0-10					

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	034	H1	53			Reddish brown	Loose	10-23	30			Dry soil, hit rock at bottom	
	035	H0		Kraal	Kraal has an anomolous feature, Square rock building			0-11					
	035	H1	54			Red brown	Loose	11-27	30		2-3		
	036	H0		Non	Above two homesteads			0-6					
	036	H1	55	Archaeological		Light brown	Loose	6-14	70		<1		
	037	H0		Terrace				0-6			~16		
	037	H1	56			Red	clay rich	16-18			~10	roots penetrate until bottom	
	038	H0		Non	Bellow homestead and terraces, with a distinct			0-5					
	038	H1	57	Archaeological	difference in vegetation (brown grass vs green	Brown	Loose	5-30	40		<1		
	039	H0		Non				0-5					
	039	H1	58	Archaeological		Brown	Loose	5-16	70		>12	Dry soil green vegetation	
	040	H0		Kraal?	Witihin round enclosure, built with flat rocks possibly mud stone. No Outer circle		Thick mulchy	0-6			20-30	Root penetrate 17 cm into ground	
	040	H1	59			Light brown	Loose soil	6-22					
	041	H0		Terrace				0-9			13		
	041	H1	60			Red	Clay rich	9-27			10	Deep root penetration	
	042	H0		Terrace	On the other side of the cattle track from 041, terraces			0-7					
	042	H1	61		aren't built with as high walls	Red	Clay rich	7-40					
	043	H0		Non	Grazing land above terraces			0-7					
	043	H1	62	Archaeological		Brown	Clay rich	7-18				Hit rock bottom	
Kranskloof	TT1	H0		Terrace		Brown		0-5	50				
	TT1	H1	63			Red Brown		5-30	50	Shale, Sandstone, Quartz			
	TT1	H2	64			Red		30-40	0				
	MT1	H0		Terrace		Dark Brown		0-5	5			Angular/poorly sorted	
	MT1	H1	65			Red Brown	Clay rich		5	Quartzite, Shale, Sandstone	2-3		
	LT1	H0		Terrace		Dark Brown with Organic matter	Organic						
	LT1	H1	66			Red Brown	Clay rich soil with Organic layer	5-15	50		10-15		
	AT2	H0		Non Archaeological	The gradient of the slope is distinctly greater, there are no terraces at this point	Dark Brown with Organic matter	Organic	10	10		>3		

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	AT2	BULK	67			Dark Brown - Mixture of Brown and white	Loose soil	0-10	10		~3		
	AT2	H1	68			Orange	Clay rich	10-30	10		~2		Orange (Basaltic/doleritic)
	TT2	H0		Terrace	Very difficult to dig	Dark Brown with Organic matter	Organic	0-10	50		5-10		
	TT2	H1	69			Dark Brown red	Clayish	10-20	70	Quartz	1-2/5-10		
	LT2	H0		Terrace				0-5					
	LT2	H1	70			Dark Brown red	Clay rich	5-30	20				
	BT2	H0		Terrace				0-5					
	BT2	H1	71			Red Brown\White Orange Component		5-10					Orange\ white
	AT3	H0		Non				0-5					
	AT3	H1	72	Archaeological	Terrace type structure further up from this point, difficult to dig due to rocks	Dark Brown	Loose soil	5-30	40		~20		
	TT3	H0		Terrace		Dark Brown with Organic matter	Organic	0-5	40				
	TT3	H1	73			Red Brown		5-20	10			Large Rocks at the base	Green
	BT3	H0		Non	Open area between terraces			0-5					
	BT3	H1	74	Archaeological		Dark Brown		5-20	50				
	BT3	H2	75			Golden brown		20-40	0				olden Brown (orange)
	TT4	H0		Terrace				0-5					
	TT4	H1	76			Dark Brown/Red	Clay rich	5-30		shale, Sandstone weathered matrix		Lots of rocks below red Clay	Shale/sandstone
	MT4	H0		Terrace				0-5					
	MT4	H1	77				Loose soil	5-20	60		2-18		
	LT4	H0		Terrace	Lower Terrace before the road			0-5					
	LT4	H1	78				Loose soil	5-30	<30		2-3	Rock at the bottom	
	RIV1	H0		River	next to river below terraces	Dark Brown	Loose soil	0-5	0				
	RIV1	H1	79			Dark Brown	Loose soil	5-50	0				
	T5	H0		Terrace	Part of terraces near the river, just below a open area where new terraces begin			0-5					
	T5	H1	80			Dark brown	Loose soil	5-40	0			Roots penetrate deep into the ground	
	LT6	H0		Terrace				0-5					

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	LT6	H1	81			Reddish brown	Organic material, Loose soil	5-30	50		~5		
	MT6	H0		Terrace	Taken from erosional wall, taken above the weathered basaltic layer			0-5					
	MT6	H1	82			Brown		5-20	60		2-3		
	AT6	H0		Non Archaeological	Above terraces, distinct change in vegetation, there is no real evidence of terraces but could have been eroded away.			0-10					
	AT6	H1	83			Dark brown with golden tinge	Loose soil	0-15	60		1-2, 5-6		
	NAE1	H0		Non Archaeological	The gradient of the slope is distinctly less, just before a steep uphill			0-5					
	NAE1	H1	84			Dark red brown	Loose soil	5-20	50	Basaltic boulders	2-4, 10-15		
	AT7	H0		Non Archaeological				0-5					
	AT7	H1	85			Brown	Loose soil	5-20	40	Basalt	~5		
	MT7	H0		Terrace				0-5					
	MT7	H1	86		First obvious terrace, howeve there are terraces above	Red Brown	Loose soil	5-10	30				
	H1AOC	H0		Homestead 1 above outer circle			Organic material, Loose soil						
	H1AOC	H1	87			Dark brown							
	H1EOC	H0		Homestead 1 above Eastern side of outer circle	Looks like a terrace attached to the homestead.								
	H1EOC	H1	88			Dark Brown							
	H1EOC	H2	89			Reddish brown	Topsoil and clay		0				
	H1SOC	H0		Domestic	Homestead 1 Southern outer circle								
	H1SOC	H1	90			Reddish brown	Topsoil and clay		20				
	H2NOC	H0		Domestic	Homestead 2 Northern end, inside of the outer circle								
	H2NOC	H1	91			Brown	Topsoil	5-20	0			Basalt found at the bottom	
	T8	H0		Terrace	Just above homestead			0-5					
	T8	H1	92			Brown	Clay rich	5-20	5	Basalt	10		
	T9	H0		Terrace	Just above homestead, the gradient higher than at sample T8			0-5					
	T9	H1	93			Reddish brown	Topsoil and clay	5-30	70	Shale	5-10		
	H3NOC	H0		Domestic	Homestead 3 Northern side of Outer circle Near inner wall (Tracks)	Brown		0-5					
	H3NOC	H1	94			Brown	Topsoil and clay	5-20	10				
	H3I1	H0		Homestead 3 Inner circle 2 (Secondary kraal)		Mulchy organic layer		0-10					
	H3I1	H1	95			Reddish brown	Clay rich	10-50				Rocks found at bottom (Paving?)	
	H3I2	H0		Homestead 3 Inner circle 2 (Kraal)				0-5					
	H3I2	H1	96				Clay rich	5-50				Rocks found at bottom	

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	H3SOC	H0		Domestic	Homestead 3 Southern side of outer circle		Loose soil	0-5					
	H3SOC	H1	97			Reddish brown	Loose soil	5-30				Rocks found at bottom	
	H4	H0		Homestead 4	Only an outer wall	Dark Brown	Loose soil	0-5					
	H4	H1	98			Dark Brown	Loose soil	5-20	20			Small rocks	
	LT10	H0		Terrace				0-5					
	LT10	H1	99			Dark Brown	Clay rich	5-20	10			Large rock at bottom	
	UKNI	H0		Unknown Walling	Wall is 1.5m tall (Drawing of shape of wall) Photo 995 & 996			0-10					
	UKNI	H1	100			Dark brown		10-15				Rocks at bottom	
	MT10	H0		Terrace	Just below Homestead 1 outer circle. Wall is very high (photo 999)			5-0					
	MT10	H1	101			Reddish brown	Clay rich	5-30	10			Lots of roots present	
	TT10	H0		Terrace	Terrace built very high and are more defined			0-5					
	TT10	H1	102			Dark Brown	Loose soil	5-20	30				
	AT10	H0		Non Archaeological				0-5					
	AT10	H1	103			Dark Brown	Loose soil	5-20	70		15-20		
	TT11	H0		Terrace									
	TT11	H1	104										
	AT11	H0		Non Archaeological	Above the Mafic rocks			0-5					
	AT11	H1	105				Loose soil	5-15	70	Quartz	2-5		
	MT11	H0		Terrace				0-5					
	MT11	H1	106				Slightlyclay rich Loose soil	5-20	30				
Khutwaner	107	H0		Domestic	Northern end of Homestead			0-6					
	107	H1	107			Dark brownish red	Slightlyclay rich Loose soil	6-20	~2				
	107	H2	108			Reddish brown	Slightlyclay rich Loose soil	20-25					
	107	H3				Orange-brown	Slightlyclay rich Loose soil	25-30					Orange
	108	H0		Kraal	Mddle of Kraal			0-5					

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	108	H1	109			Reddish brown	Slightlyclay rich Loose soil	5-20	2			Quartz	
	109	H0		Domestic	Southern end near the wall			0-3					
	109	H1	110			Dark Brown	Slightlyclay rich Loose soil	3-16	10				
	109	H2	111			Red	Slightlyclay rich Loose soil	16-40	<5				
	110	H0		Terrace	Lower Terrace below Homestead			0-4					
	110	H1	112			Dark Reddish Brown	Slightlyclay rich Loose soil	4-15	10				
	110	H2	113			Dark brown to red	Slightlyclay rich Loose soil	15-25					
	111	H0		Terrace	Second terrace directly below Homestead 2			0-5					
	111	H1	114			Dark brown		5-9	present				
	111	H2	115			Red	Slightly clay rich Loose soil	9-24	0				
	112	H0		Terrace	Top terrace on the Eastern side of Homestead 2			0-5					
	112	H1	116			Reddish brown	Soft loose soil	5-16	<5				
	112	H2	117			Greyish reddish brown	Soft loose soil	16-23	40				
	113	H0		Terrace	Middle Terrace East of Homestead			0-3					
	113	H1	118			Dark brown	Soft loose soil	3-24	0				
	114	H0		Non Archaeological	Near a homestead with small faint walls in the vicinity. Vegetation is different, shorter grass than surrounding area			0-5					
	114	H1	119			Dark Reddish Brown		5-15	40				
	114	H2	120			Brown	powdery	15-18	80				present
	114	H3	121			Red		18-26	5				Red/orange
	115	H0		Non Archaeological			Organic	0-3					
	115	H1	122			Greyish brown	Soft loose soil	3-12					Grey
	116	H0		Domestic area	Eastern end of Homestead			0-6					

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	116	H1	123			Dark brown	Soft loose soil	6-14					
	116	H2	124			Reddish brown			<5				
	117	H0		Kraal	Soil significantly darker than in other areas			0-4					
	117	H1	125			Dark Brown	Slightly clay rich Loose soil	4-16			>15	Not many rocks until bottom of core sample	
	118	H0		Domestic area	Lower domestic area on eastern side of homestead 4			0-4					
	118	H1	126			Dark brown	Slightly clay rich Loose soil	4-12	0				
	118	H2	127			Reddish brown	Slightly clay rich Loose soil	12-23	<5				
	119	H0		Terrace	Top terrace just below homestead. Very shallow till hit rocks at bottom			0-4				Rocks at bottom, roots running throughout the layer	
	119	H1	128			Dark brown	Minimal sand	4-10	30				
	120	H0		Terrace	Lower Terrace below Homestead 4			0-6				Rocks at the bottom	
	120	H1	129			Dark Reddish Brown		6-16	30				
	121	H0		Domestic area	Southern side of homestead, near HS3TP1 with very different colour soil, darker brown			0-4					
	121	H1	130			Dark Reddish Brown	Mixed clay with sand	4-22	30				
	122	H0		Domestic area				0-6					
	122	H1	131			Dark Brown		6-16	30				
	122	H2	132			Reddish brown		16-22			5-10	Rocks at the bottom	
	123	H0		Kraal				0-3					
	123	H1	133			Dark reddish brown		3-14	10				
	123	H2	134			Red orange	Soft moist	14-22	20				red orange
	124	H0		Terrace	Just below Homestead 3			0-4					
	124	H1	135			Dark brown	Slightly silty	4-6	10				
	124	H2	136			Reddish brown	Clay like soils	6-19	40				
	125	H0		Terrace	Eastern end of Homestead			0-3					
	125	H1	137			Dark brown		3-8	3				

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	125	H2	138			Reddish brown	Slightly clay rich Loose soil	8-22	<5				Orange
	126	H0		Kraal		Red	Not much organic	0-5					
	126	H1	139			Reddish brown		5-12	<3				
	126	H2	140			Dark brown			<5				
	127	H0		Kraal				0-5					
	127	H1	141			Dark reddish brown	Clay rich						
	127	H2	142			Red and orange	Mixture between orange/brown		0				Orange
	127	H3	143			Orange	Soft soil						Orange
	128	H0		Domestic area	Pile of rocks in this area, possibly a hearth?			0-3					
	128	H1	144			Reddish brown		3-14					
	128	H2	145			Red	Clay	14-26					Orange
	129	H0		Terrace	Higher up on terraces, Lower eastern side of			0-5					
	129	H1	146		homestead 8	Brown			60		10		
	130	H0		Terrace	In between agricultural terraces, lower down the hill			0-2					
	130	H1	147			Reddish brown		2-12					
	130	H2	148			Orange		12-15					Orange
	131	H0		Terrace				0-5					
	131	H1	149			Dark reddish brown		5-16	<10				
	131	H2	No samp			Red	soft	16-23	<5				
	131	H3	No samp			Yellowish orange		23-26					Orange
	132	H0		Domestic area				0-3					
	132	H1	150			Dark Reddish brown		3-16	<5				
	132	H2	151			Red orange		16-23					Orange
	133	H0		Kraal				0-5					
	133	H1	152			Dark brown		5-10	<5				
	133	H2	153			Reddish brown		10-17				Hit rock at the botom	
	133	H3	No samp										Orange
	134	H0		Domestic area	Entrance very small, two tiers in enclosure			0-6					
	134	H1	154			Dark Reddish Brown		6-12	<5				
	134	H2	155			Reddish brown		6-20	<5			Hit rock at the bottom	
	135	H0		Terrace	Top terracing, small		Organic	0-6					
	135	H1	156			Dark brown	clay rich	6-14	<5				
	135	H2	157			Dark red		14-27	30				
	136	H0		Terrace	Lower terracin, smaller			0-5					
	136	H1	158			Dark brown		5-10					

Site Name	GPS point	Sample number		Location	Site description	Field description							
		In field	In lab			Soil Colour	Soil type	Depth	% rock	Rock type	Rock Size (cm)	Rock and root Description	Saprolite
	136	H2	159			Reddish brown		10-17	<5				
	137	H0		Terrace	Lower long terrace below 136			0-5					
	137	H1	160			Brown	Clay rich	5-12	<5				
	137	H2	161			Red		12-22	<3				
	138	H0		Non	Below terrace			0-4					
	138	H1	162	Archaeological		Dark brown	Relatively dry	4-11					
	138	H2	163			Red	Relatively moist	11-23					Orange
	139	H0		Non	Between two homesteads, no terracing			0-4					
	139	H1	164	Archaeological		Dark brown	Dry clay rich	4-12					
	139	H2	165			Reddish brown	Slightly clay rich Loose soil	12-17					
	139	H3	166			Red	Clay rich	17-26					
	140	H0		Non	Below terracing, no terracing within 20m			0-6					
	140	H1	167	Archaeological		Reddish brown	Soft	6-13	2				
	140	H2	168			Red	Clay rich	13-16					
	140	H3				Red/ Orange	Clay rich	16-23					Orange
	141	H0		Kraal	inside homestead 9			0-6					
	141	H1	169			Dark brown		6-12	0				
	141	H2	170			Red	Soft moist	12-19				Hit rocks at the bottom	
	142	H0		Domestic area	Within homestead 9								
	142	H1	171			Dark brown							
	142	H2	172			Red	Clay						
	143	H0		Terrace	Bottom terrace			0-4					
	143	H1	173			Bright red	Moist	4-16	0				
	143	H2	174			Deep red		16-27					
	144	H0		Terrace	Middle terrace			0-4					
	144	H1	175			Bright red	Dry clay rich	4-15				Soil becomes a deeper red colour but possibly because it becomes more moist	
	145	H0		Terrace	Top terrace			0-4					
	145	H1	176			Deep red		4-18				Soil becomes moist lower down, hit rocks at bottom	

Appendix B

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
Doornkop	001	H0															
	001	H1	1	5.37	257.69	955.26	3.47	602.70	3.10	0.95	0.91	45.22	34.82	36.00	29.18	28.00	5.35
	002	H0															
	002	H1	2	5.70	247.39	2313.96	5.63	668.90	2.92	2.59	1.26	51.19	27.30	40.00	32.70	36.00	5.52
	003	H0															
	003	H1	3	4.24	476.49	2306.96	4.65	605.80	2.02	0.95	0.91	43.93	40.36	34.00	25.64	30.00	5.89
	003	H2	4	3.97	67.74	3187.96	24.23	934.70	0.95	1.19	0.88	60.14	55.54	36.00	8.46	12.00	6.24
	004	H0															
	004	H1	5	170.03	490.89	4831.96	9.69	970.70	3.02	0.98	0.95	45.20	62.76	36.00	1.24	8.00	7.25
	005	H0															
	005	H1	6	7.00	268.09	3665.96	13.52	2064.10	1.66	1.12	1.05	32.64	42.66	30.00	27.34	30.00	7.19
	006	H0															
	006	H1	7	2.36	95.01	3576.96	11.82	1290.10	2.38	0.95	0.91	24.30	15.92	50.00	34.08	32.00	6.29
	006	H2	8	3.06	87.86	3328.96	11.99	1317.10	1.89	1.02	1.05	32.60	12.80	60.00	27.20	28.00	6.26
	007	H0															
	007	H1	9	2.61	640.09	2875.96	14.18	1533.10	2.04	0.95	0.91	26.39	32.50	42.00	25.50	26.00	6.58
	008	H0															
	008	H1	10	2.86	592.39	2487.96	8.68	1222.10	2.26	0.91	0.95	45.24	20.26	46.00	33.74	38.00	6.30
	008	H2	11	2.83	525.49	2020.96	13.80	1419.10	1.30	0.98	0.88	34.21	15.06	56.00	28.94	28.00	6.25
	009	H0															
	009	H1	12	2.55	238.39	2519.96	5.56	924.50	2.78	1.02	0.88	47.25	25.62	44.00	30.38	34.00	6.16
	010	H0															
	010	H1	13	3.11	102.79	3810.96	16.36	1908.10	2.08	1.02	0.98	40.53	17.98	50.00	32.02	32.00	6.08
	011	H0															
	011	H1	14	2.81	151.09	3622.96	10.36	1635.10	2.28	0.81	0.91	51.47	19.18	48.00	32.82	32.00	6.26
	012	H0															
	012	H1	15	2.68	178.99	2014.96	7.55	888.00	2.43	1.05	0.88	59.81	43.54	32.00	24.46	28.00	5.62
	012	H2	16	2.56	92.85	1933.96	14.81	1173.10	1.80	0.91	0.95	52.96	40.10	36.00	23.90	28.00	6.09
	012	H3	17	1.73	64.15	2125.96	17.40	1465.10	1.21	0.95	0.70	39.62	35.58	34.00	30.42	44.00	6.32
	012	H4	18	2.08	46.35	3142.96	36.35	2337.10	0.48	1.02	0.91	39.09	48.88	38.00	13.12	20.00	6.63
	013	H0															
	013	H1	19	2.29	457.09	792.16	18.57	368.80	2.21	1.02	1.09	32.11	50.16	34.00	15.84	22.00	6.33

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	013	H2	20	2.14	440.39	436.86	34.06	354.10	1.76	0.91	0.95	38.83	45.04	30.00	24.96	32.00	6.22
	013	H3	21	4.13	423.19	256.96	63.59	399.40	1.41	0.95	0.95	27.30	30.10	38.00	31.90	40.00	6.08
	014	H0															
	014	H1	22	1.74	394.29	1244.96	4.51	525.30	2.89	0.91	1.02	36.93	46.34	28.00	25.66	30.00	6.13
	014	H2	23	1.64	218.79	799.86	16.20	961.20	3.04	0.91	0.95	37.28	28.28	46.00	25.72	28.00	6.40
	014	H3	24	1.80	198.99	928.06	37.95	1376.10	0.69	1.96	0.95	44.29	27.98	46.00	26.02	30.00	7.08
	014	H4	25	1.38	180.29	1005.96	39.05	1456.10	0.26	3.75	0.98	35.40	6.38	40.00	53.62	56.00	7.36
	015	H0															
	015	H1	26	2.52	132.29	2234.96	9.59	647.20	2.98	1.09	0.81	34.56	25.82	40.00	34.18	38.00	6.04
	016	H0															
	016	H1	27	2.09	818.59	2248.96	6.82	865.20	3.16	0.88	1.05	45.90	23.80	44.00	32.20	36.00	6.47
	016	H2															
	017	H0															
	017	H1	28	3.42	258.09	1044.96	7.20	616.10	3.32	5.81	5.22	46.05	34.16	32.00	33.84	30.00	5.81
	017	H2	29	2.61	112.29	445.36	25.57	759.10	0.66	9.63	8.33	34.52	8.86	24.00	67.14	20.00	6.13
	017	H3															
	018	H0															
	018	H1	30	1.62	234.69	1955.96	3.62	691.30	2.25	4.80	4.34	38.54	43.62	24.00	32.38	32.00	6.37
	019	H0															
	019	H1	31	1.55	147.29	1290.96	12.87	539.00	2.19	9.94	6.55	30.18	35.30	24.00	40.70	38.00	6.47
	020	H0															
	020	H1	32	1.18	66.05	1395.96	7.12	464.20	1.17	3.75	4.59	24.61	28.10	40.00	31.90	30.00	6.32
	021	H0															
	021	H1	33	0.94	117.29	2253.96	6.59	794.10	1.56	5.95	6.37	39.51	47.04	58.00	-5.04	28.00	6.56
	021	H2	34	2.10	90.19	2325.96	9.18	890.50	1.37	4.27	4.31	33.36	42.36	48.00	9.64	6.00	6.56
	022	H0															
	022	H1	35	2.12	268.29	2201.96	9.96	727.10	1.90	3.22	4.45	31.84	35.98	50.00	14.02	38.00	6.56
	023	H0															
	023	H1	36	4.13	136.79	1859.96	9.94	727.90	2.67	5.81	5.46	36.16	28.06	42.00	29.94	28.00	5.79
	024	H0															
	024	H1	37	1.64	79.96	1417.96	8.53	752.50	2.02	2.56	5.50	34.82	45.24	32.00	22.76	36.00	5.77
	024	H2	38	2.00	58.99	1139.96	5.37	670.80	1.21	2.98	5.22	31.05	12.62	22.00	65.38	44.00	5.87
	025	H0															
	025	H1	39	1.54	79.52	1126.96	12.34	599.40	1.38	3.71	4.47	29.97	54.82	34.00	11.18	36.00	6.31
	026	H0															

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	026	H1	40	1.63	271.39	1316.96	9.53	578.40	1.32	3.19	5.39	37.05	23.48	30.00	46.52	34.00	6.39
	027	H0															
	027	H1	41	1.99	58.12	1278.96	6.66	434.70	1.03	2.45	4.34	40.89	42.42	32.00	25.58	38.00	6.14
	027	H2	42	1.84	50.30	1424.96	9.58	601.00									
	027	H3							1.02	2.28	5.08	32.79	24.82	40.00	35.18	36.00	6.29
	028	H0															
	028	H1	43	2.78	58.67	914.76	14.63	453.10	1.96	2.56	5.53	33.51	67.14	40.00	-7.14	42.00	5.47
	029	H0															
	029	H1	44	2.06	238.39	2813.96	11.97	1180.10	1.52	3.12	4.31	46.33	32.90	38.00	29.10	38.00	6.19
	030	H0															
	030	H1	45	2.22	274.19	2231.96	63.74	1366.10	1.49	3.50	5.22	33.85	35.30	28.00	36.70	36.00	6.39
	031	H0															
	031	H1	46	1.71	192.99	1448.96	7.24	602.30	1.61	3.75	4.27	25.63	30.94	64.00	5.06	20.00	5.79
	032	H0															
	032	H1	47	2.26	605.39	1734.96	5.70	560.20	1.87	2.59	4.55	34.36	37.78	24.00	38.22	56.00	6.36
	033	H0															
	033	H1	48	1.24	179.39	2201.96	10.17	799.00	1.95	5.88	5.67	33.77	35.84	30.00	34.16	40.00	6.39
	033	H2	49	1.71	100.39	1822.96	7.92	712.30	1.05	2.77	6.09	32.19	46.58	36.00	17.42	46.00	6.58
	033	H3	50	1.56	87.29	2087.96	16.09	989.30	1.21	2.98	4.62	27.75	19.50	46.00	34.50	-8.00	6.38
	033	H4	51	2.03	79.52	2159.96	22.89	1190.10	0.59	1.96	4.27	24.67	9.80	20.00	70.20	40.00	6.48
	033	H5	52	1.27	75.99	2096.96	27.87	1258.10	0.33	2.63	4.59	40.44	21.94	34.00	44.06	54.00	6.77
	034	H0															
	034	H1	53	5.63	609.79	1101.96	4.48	507.90	2.32	17.75	14.77	23.63	34.76	56.00	9.24	0.00	6.31
	035	H0															
	035	H1	54	10.79	776.99	3286.96	7.18	726.90	3.47	6.90	3.68	37.00	47.04	26.00	26.96	34.00	7.16
	036	H0															
	036	H1	55	2.24	249.59	1247.96	4.55	403.50	2.50	1.51	6.48	30.80	43.62	22.00	34.38	42.00	6.57
	037	H0															
	037	H1	56	1.66	219.99	1794.96	7.09	1013.10	2.06	4.17	4.90	40.65	19.30	36.00	44.70	44.00	6.00
	038	H0															
	038	H1	57	2.68	195.59	797.76	3.86	391.10	1.62	2.98	9.31	30.64	56.16	62.00	-18.16	18.00	6.39
	039	H0															
	039	H1	58	3.33	235.29	1245.96	3.96	400.70	2.74	7.95	8.37	30.73	45.96	18.00	36.04	50.00	5.87
	040	H0															

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	040	H1	59	19.57	608.49	3763.96	8.92	621.80	3.57	7.21	15.82	39.66	39.38	18.00	42.62	26.00	7.40
	041	H0															
	041	H1	60	2.22	139.99	1589.96	8.47	811.80	1.86	2.94	7.14	28.24	34.32	24.00	41.68	24.00	5.87
	042	H0															
	042	H1	61	2.88	78.96	1223.96	6.41	624.00	2.29	4.48	7.70	40.09	18.56	32.00	49.44	20.00	5.30
	043	H0															
	043	H1	62	1.88	179.19	1146.96	14.84	584.90	2.16	4.59	10.47	25.73	48.22	18.00	33.78	18.00	6.37
Kranskloof	TT1	H0															
	TT1	H1	63	2.61	99.99	2762.96	10.75	932.90	2.66	8.05	11.73	43.92	15.62	28.00	56.38	26.00	5.87
	TT1	H2	64	1.64	61.78	2141.96	15.21	1036.10	1.18	5.73	9.03	31.42	34.40	40.00	25.60	26.00	6.31
	MT1	H0															
	MT1	H1	65	2.61	163.29	1750.96	7.59	718.50	1.64	5.15	6.93	38.36	37.08	32.00	30.92	30.00	6.13
	LT1	H0															
	LT1	H1	66	2.08	74.80	2557.96	8.01	947.20	2.22	6.97	33.64	36.39	38.56	36.00	25.44	16.00	6.39
	AT2	H0															
	AT2	BULK	67	2.02	139.49	2672.96	10.95	950.90	2.19	9.07	8.75	41.61	34.02	22.00	43.98	32.00	6.13
	AT2	H1	68	2.11	70.71	2585.96	10.31	1001.10	2.00	4.97	7.00	40.98	38.26	36.00	25.74	22.00	5.92
	TT2	H0															
	TT2	H1	69	1.93	155.49	2329.96	7.18	588.80	2.26	7.21	10.08	37.38	36.00	32.00	32.00	32.00	6.51
	LT2	H0															
	LT2	H1	70	2.24	69.54	2423.96	7.80	832.80	2.13	8.54	11.38	60.82	28.42	28.00	43.58	30.00	5.93
	BT2	H0															
	BT2	H1	71	1.33	56.28	2817.96	14.12	1025.10	1.26	5.36	9.77	66.14	22.12	32.00	45.88	22.00	6.10
	AT3	H0															
	AT3	H1	72	2.60	202.39	1816.96	7.88	572.10	3.14	14.14	35.77	40.22	28.86	34.00	37.14	26.00	5.37
	TT3	H0															
	TT3	H1	73	3.08	168.89	1851.96	7.70	711.90	2.34	8.79	6.09	48.18	38.60	38.00	23.40	26.00	5.79
	BT3	H0															
	BT3	H1	74	2.11	101.49	2796.96	25.53	1318.10	1.83	6.93	9.91	76.29	21.06	40.00	38.94	58.00	6.05
	BT3	H2	75	1.96	56.22	3779.96	48.32	2115.10	0.46	1.44	5.32	51.27	27.64	32.00	40.36	26.00	6.74
	TT4	H0															
	TT4	H1	76	1.89	94.20	2315.96	6.12	684.10	2.07	8.68	7.11	42.73	34.88	38.00	27.12	30.00	5.96
	MT4	H0															
	MT4	H1	77	2.91	318.99	2241.96	5.31	526.20	2.80	7.25	20.23	57.99	34.04	40.00	25.96	36.00	5.77
	LT4	H0															

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	LT4	H1	78	2.17	70.42	3327.96	14.47	1007.10	2.35	5.36	16.77	34.57	20.94	28.00	51.06	28.00	6.31
	RIV1	H0															
	RIV1	H1	79	2.22	16.27	1225.96	5.74	221.80	0.82	4.80	8.19	26.02	67.46	34.00	-1.46	28.00	6.31
	T5	H0															
	T5	H1	80	3.48	32.06	1267.96	7.35	323.50	1.54	6.76	19.32	40.61	43.76	40.00	16.24	28.00	5.70
	LT6	H0															
	LT6	H1	81	2.43	42.89	1244.96	17.69	817.40	0.83	3.47	4.31	27.63	17.00	44.00	39.00	32.00	6.31
	MT6	H0															
	MT6	H1	82	2.28	76.01	1792.96	9.48	2209.10	1.24	3.36	3.78	31.88	48.34	28.00	23.66	30.00	6.31
	AT6	H0															
	AT6	H1	83	2.08	30.20	1854.96	21.75	1058.10	1.01	3.40	3.82	34.09	45.24	36.00	18.76	56.00	6.40
	NAE1	H0															
	NAE1	H1	84	2.66	154.79	953.86	11.96	568.50	2.43	51.45	3.50	35.09	39.24	34.00	26.76	16.00	5.96
	AT7	H0															
	AT7	H1	85	2.83	56.49	2027.96	20.44	837.30	1.91	3.33	3.78	27.49	26.72	48.00	25.28	34.00	6.52
	MT7	H0															
	MT7	H1	86	2.22	130.49	1868.96	8.36	1232.10	2.02	3.40	19.81	23.00	55.46	34.00	10.54	30.00	6.02
	H1AOC	H0															
	H1AOC	H1	87	4.75	113.59	1812.96	9.38	250.30	3.27	3.61	211.79	38.16	57.98	46.00	-3.98	34.00	4.74
	H1EOC	H0															
	H1EOC	H1	88	3.03	515.49	1705.96	5.54	338.00	2.17	8.26	55.30	60.74	57.60	16.00	26.40	22.00	6.16
	H1EOC	H2	89	3.34	230.39	1665.96	26.52	327.80	1.38	5.67	38.50	40.98	52.32	42.00	5.68	20.00	6.17
	H1SOC	H0															
	H1SOC	H1	90	4.30	34.49	790.66	4.01	153.80	1.33	3.78	15.19	34.64	69.72	48.00	-17.72	20.00	5.21
	H2NOC	H0															
	H2NOC	H1	91	2.47	238.39	1537.96	12.88	292.40	1.57	7.60	17.75	37.71	47.92	50.00	2.08	26.00	6.30
	T8	H0															
	T8	H1	92	2.06	50.29	2263.96	10.36	624.70	1.83	3.47	3.22	57.56	38.58	42.00	19.42	24.00	6.17
	T9	H0															
	T9	H1	93	4.05	72.84	1864.96	10.51	443.90	2.38	4.45	25.94	54.26	44.90	38.00	17.10	30.00	5.85
	H3NOC	H0															
	H3NOC	H1	94	5.81	41.30	1142.96	7.08	212.70	1.55	3.33	24.92	47.30	52.66	52.00	-4.66	6.00	4.93
	H3I1	H0															

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	H3I1	H1	95	2.41	146.99	2725.96	7.50	576.80	1.86	4.59	33.99	46.77	52.46	52.00	-4.46	32.00	7.41
	H3I2	H0															
	H3I2	H1	96	4.72	62.17	1581.96	7.36	361.00	0.93	3.92	9.70	47.09	44.08	48.00	7.92	46.00	6.43
	H3SOC	H0															
	H3SOC	H1	97	4.43	46.51	2035.96	10.06	379.40	2.30	4.24	10.61	52.79	37.18	30.00	32.82	50.00	5.70
	H4	H0															
	H4	H1	98	5.72	80.93	1058.96	6.20	241.50	1.63	5.57	20.83	46.31	44.84	34.00	21.16	28.00	5.36
	LT10	H0															
	LT10	H1	99	2.77	79.73	1806.96	6.48	226.80	1.11	4.31	9.42	37.14	50.14	26.00	23.86	32.00	5.95
	UKNI	H0															
	UKNI	H1	100	3.34	338.89	2339.96	6.21	492.10	2.47	4.13	92.89	31.32	44.58	28.00	27.42	32.00	5.74
	MT10	H0															
	MT10	H1	101	2.68	435.39	1860.96	3.99	434.90	1.43	5.08	8.33	28.76	40.42	56.00	3.58	28.00	5.69
	TT10	H0															
	TT10	H1	102	2.92	57.06	1474.96	8.59	507.90	1.94	3.43	2.98	29.87	40.26	32.00	27.74	28.00	6.43
	AT10	H0															
	AT10	H1	103	3.24	50.00	863.26	7.09	234.80	1.94	10.64	3.50	28.08	58.24	42.00	-0.24	0.00	5.85
	TT11	H0															
	TT11	H1	104	1.98	72.59	3459.96	14.42	950.90	1.59	3.47	3.29	35.26	38.96	32.00	29.04	30.00	6.46
	AT11	H0															
	AT11	H1	105	2.72	84.89	2871.96	12.23	837.00	2.50	3.36	3.47	59.05	43.04	24.00	32.96	40.00	6.27
	MT11	H0															
	MT11	H1	106	1.96	92.46	3064.96	11.20	848.20	1.67	3.36	3.05	54.26	38.30	30.00	31.70	36.00	6.40
Khutwaneng	107	H0															
	107	H1	107	2.98	137.29	2709.96	8.24	821.60	1.59	3.33	3.36	82.30	28.92	38.00	33.08	26.00	5.93
	107	H2	108	2.27	70.81	3117.96	9.35	956.00	1.33	3.33	3.01	29.86	23.74	44.00	32.26	36.00	6.24
	107	H3															
	108	H0															
	108	H1	109	4.82	298.99	2969.96	5.43	813.30	1.72	4.03	2.56	57.37	23.48	42.00	34.52	36.00	6.13
	109	H0															
	109	H1	110	3.94	146.89	3125.96	9.13	769.80	2.08	3.33	3.29	61.62	33.54	34.00	32.46	34.00	5.99
	109	H2	111	2.88	81.42	2996.96	9.76	763.40	1.50	2.98	3.99	35.94	16.16	52.00	31.84	36.00	6.16
	110	H0															
	110	H1	112	3.33	188.69	2415.96	7.94	635.40	2.38	30.45	6.30	40.51	34.32	34.00	31.68	36.00	5.74

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	110	H2	113	1.91	120.69	2497.96	10.52	658.10	1.77	36.75	2.31	61.13	21.10	38.00	40.90	44.00	5.99
	111	H0															
	111	H1	114	3.14	346.59	2727.96	9.20	609.30	2.41	3.71	3.12	65.25	38.86	30.00	31.14	32.00	6.03
	111	H2	115	2.15	131.79	2534.96	7.52	625.70	1.46	3.12	2.73	56.49	16.48	52.00	31.52	32.00	6.10
	112	H0															
	112	H1	116	2.59	303.19	2371.96	4.09	623.50	1.73	2.87	4.45	63.20	36.96	32.00	31.04	32.00	6.08
	112	H2	117	2.14	100.39	2546.96	6.67	728.00	1.57	2.07	3.99	61.21	25.24	42.00	32.76	36.00	6.09
	113	H0															
	113	H1	118	2.84	214.99	2585.96	9.42	692.80	2.02	3.15	3.36	58.46	24.00	42.00	34.00	38.00	5.91
	114	H0															
	114	H1	119	2.66	138.29	2659.96	11.94	682.60	3.35	2.87	2.94	71.51	38.08	34.00	27.92	28.00	5.68
	114	H2	120	2.53	86.77	2752.96	11.72	801.80	2.43	2.63	3.92	53.89	34.82	36.00	29.18	32.00	5.97
	114	H3	121	2.17	55.74	2926.96	14.63	930.60	1.98	2.45	4.38	66.69	23.46	46.00	30.54	32.00	6.24
	115	H0															
	115	H1	122	2.88	61.43	3894.96	12.41	1052.10	2.39	2.28	2.52	69.47	66.12	12.00	21.88	24.00	5.83
	116	H0															
	116	H1	123	3.58	174.59	3120.96	5.90	683.20	2.23	4.27	4.38	66.31	27.88	34.00	38.12	42.00	6.08
	116	H2	124	16.13	97.80	3236.96	11.94	721.70	1.77	3.01	3.57	67.13	30.10	38.00	31.90	36.00	6.28
	117	H0															
	117	H1	125	13.50	382.59	2959.96	9.46	637.20	2.79	6.72	4.90	73.41	22.78	32.00	45.22	44.00	5.59
	118	H0															
	118	H1	126	3.48	393.69	2824.96	4.84	604.80	2.46	8.19	6.13	62.36	23.50	36.00	40.50	42.00	6.03
	118	H2	127	3.06	255.49	2759.96	3.98	665.30	0.64	4.87	2.98	66.31	30.08	38.00	31.92	36.00	5.99
	119	H0															
	119	H1	128	4.61	167.39	2727.96	7.74	685.90	2.89	9.77	6.44	73.14	35.08	30.00	34.92	36.00	5.62
	120	H0															
	120	H1	129	2.70	258.39	2661.96	4.36	588.50	2.54	8.33	5.95	55.60	35.54	34.00	30.46	36.00	5.95
	121	H0															
	121	H1	130	5.61	612.29	3084.96	9.00	687.50	3.25	17.92	11.20	76.12	24.86	32.00	43.14	42.00	5.91
	122	H0															
	122	H1	131	5.24	591.39	2528.96	6.43	599.20	2.79	5.46	6.44	64.74	39.78	24.00	36.22	36.00	5.90
	122	H2	132	2.77	618.39	2659.96	6.34	669.10	1.73	5.53	6.20	68.89	26.30	36.00	37.70	40.00	6.08
	123	H0															
	123	H1	133	4.81	420.29	2567.96	4.35	614.20	2.42	11.17	9.31	66.80	38.48	28.00	33.52	34.00	6.03

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	123	H2	134	2.84	255.39	2484.96	4.66	667.80	1.38	6.41	12.50	61.10	17.54	44.00	38.46	42.00	6.17
	124	H0															
	124	H1	135	11.58	542.29	3173.96	4.25	714.90	2.88	15.68	8.40	72.38	40.08	34.00	25.92	24.00	6.16
	124	H2	136	7.05	433.79	3031.96	7.48	735.00	2.30	7.35	7.21	66.57	21.14	50.00	28.86	30.00	6.16
	125	H0															
	125	H1	137	12.00	374.09	2862.96	5.87	604.40	2.79	10.22	11.10	66.13	39.80	26.00	34.20	34.00	5.99
	125	H2	138	2.84	50.46	2962.96	9.13	739.80	1.32	7.49	11.41	47.09	38.76	28.00	33.24	36.00	6.24
	126	H0															
	126	H1	139	2.96	435.19	2406.96	7.94	539.00	1.77	8.09	5.67	62.81	44.60	36.00	19.40	20.00	6.16
	126	H2	140	6.59	336.89	3117.96	4.27	705.10	1.65	7.63	8.09	59.46	22.10	44.00	33.90	36.00	6.07
	127	H0															
	127	H1	141	3.05	472.59	3007.96	7.18	622.80	2.13	15.96	6.97	88.48	44.66	26.00	29.34	30.00	6.08
	127	H2	142	3.07	171.79	4218.96	19.35	904.80	1.36	4.62	5.46	46.44	36.60	34.00	29.40	32.00	6.20
	127	H3	143	3.50	236.99	4682.96	23.39	1016.10	1.07	11.97	8.58	57.38	62.22	16.00	21.78	22.00	6.29
	128	H0															
	128	H1	144	3.53	248.79	3163.96	13.48	639.00	2.37	8.54	9.98	69.74	31.50	38.00	30.50	34.00	6.16
	128	H2	145	3.16	87.89	3731.96	11.32	820.80	1.71	8.23	10.15	114.49	38.64	36.00	25.36	28.00	6.41
	129	H0															
	129	H1	146	4.03	274.29	3060.96	6.60	754.30	3.13	8.75	7.46	80.13	30.06	32.00	37.94	42.00	6.07
	130	H0															
	130	H1	147	3.08	128.99	2857.96	8.08	707.10	2.11	10.01	9.45	72.55	52.82	20.00	27.18	18.00	6.34
	130	H2	148	1.74	21.95	3412.96	11.21	871.80	0.98	5.25	10.47	69.12	47.14	18.00	34.86	38.00	6.44
	131	H0															
	131	H1	149	2.62	83.22	2877.96	4.05	719.50	2.10	4.87	4.31	67.35	45.50	24.00	30.50	32.00	6.41
	131	H2	No														
	131	H3	No														
	132	H0															
	132	H1	150	3.36	426.99	2408.96	3.41	612.10	2.66	6.79	5.01	76.31	33.82	30.00	36.18	38.00	6.22
	132	H2	151	2.04	169.19	3204.96	9.84	899.40	1.14	3.64	5.36	79.40	36.14	34.00	29.86	30.00	6.46
	133	H0															
	133	H1	152	2.61	398.69	3127.96	14.92	730.90	2.56	6.16	7.14	80.45	42.14	24.00	33.86	34.00	6.57
	133	H2	153	2.53	391.09	3061.96	11.77	696.40	2.55	6.16	9.14	85.69	51.12	20.00	28.88	30.00	6.63
	133	H3	No														
	134	H0															

Site Name	GPS point	Sample number		Chemical analysis													
		In field	In lab	P	K	Ca	Na	Mg	% Carbon	NH4	NO3	CEC	Sand	Clay	Silt calculated	Silt measured	pH
	134	H1	154	2.59	466.79	3491.96	5.58	896.00	2.73	8.68	7.88	94.16	32.86	34.00	33.14	34.00	6.66
	134	H2	155	2.45	476.99	3228.96	5.96	851.20	2.52	7.88	7.77	91.79	42.18	24.00	33.82	34.00	6.51
	135	H0															
	135	H1	156	5.64	176.89	3102.96	4.12	708.20	3.06	4.90	5.22	77.77	23.80	32.00	44.20	46.00	5.87
	135	H2	157	2.68	78.31	2899.96	7.28	723.00	2.42	3.29	5.25	63.58	36.28	34.00	29.72	32.00	6.11
	136	H0															
	136	H1	158	3.75	124.19	2770.96	6.37	683.70	1.89	4.66	4.48	78.50	36.88	26.00	37.12	38.00	6.07
	136	H2	159	2.28	88.26	2704.96	9.92	709.30	1.85	3.89	3.29	63.69	45.50	24.00	30.50	32.00	6.24
	137	H0															
	137	H1	160	2.25	114.69	2939.96	3.60	709.50	2.63	4.66	6.34	64.63	37.34	30.00	32.66	36.00	6.16
	137	H2	161	3.57	299.59	2820.96	3.48	672.50	2.16	5.60	6.23	66.19	44.26	22.00	33.74	34.00	6.07
	138	H0															
	138	H1	162	2.20	167.29	2948.96	2.82	707.10	1.35	5.22	4.69	47.83	35.80	34.00	30.20	32.00	6.09
	138	H2	163	2.00	75.05	3411.96	7.48	818.10	2.28	4.27	4.06	46.22	35.78	36.00	28.22	30.00	6.42
	139	H0															
	139	H1	164	2.37	366.99	3833.96	2.47	687.50	1.89	8.72	4.90	48.66	32.96	32.00	35.04	38.00	6.99
	139	H2	165	2.54	306.49	3523.96	3.40	843.60	1.08	6.79	8.93	50.98	23.44	44.00	32.56	38.00	6.82
	139	H3	166	2.01	230.89	3568.96	7.72	1023.10	1.99	4.90	6.09	51.70	16.54	50.00	33.46	36.00	6.56
	140	H0															
	140	H1	167	2.48	184.39	2794.96	4.58	677.10	1.02	6.20	5.81	45.81	43.28	26.00	30.72	32.00	6.32
	140	H2	168	1.60	67.52	3552.96	7.34	863.20	3.24	4.06	3.12	45.52	34.80	30.00	35.20	36.00	6.41
	140	H3															
	141	H0															
	141	H1	169	5.09	362.59	3059.96	8.66	835.70	2.67	7.56	10.05	56.04	30.84	32.00	37.16	40.00	6.07
	141	H2	170	3.99	382.99	2715.96	11.42	790.70	3.33	7.32	12.43	51.90	22.32	44.00	33.68	38.00	6.12
	142	H0															
	142	H1	171	10.92	587.39	3667.96	5.21	762.30	1.76	8.16	12.11	57.60	34.76	30.00	35.24	34.00	6.34
	142	H2	172	6.75	584.79	2721.96	13.27	786.80	1.72	5.53	7.98	52.71	15.92	40.00	44.08	50.00	6.41
	143	H0															
	143	H1	173	2.57	99.19	2917.96	7.29	751.20	1.18	7.04	4.90	44.63	33.22	36.00	30.78	32.00	6.21
	143	H2	174	1.92	68.49	3060.96	9.10	784.00	2.12	5.04	7.07	44.87	22.72	48.00	29.28	34.00	6.52
	144	H0															
	144	H1	175	3.09	141.29	2675.96	5.08	628.80	1.98	6.93	6.09	44.79	36.34	36.00	27.66	30.00	6.16
	145	H0															
	145	H1	176	1.77	134.49	3059.96	4.75	683.00	1.42	5.25	5.64	48.92	19.12	48.00	32.88	36.00	6.50

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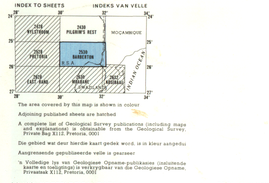
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GEOLOGICAL SURVEY
GEOLOGIESE OPNAME
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Printed and published in the Republic of South Africa by the Government Printer, Pretoria, 1986
Gedruk en uitgegee in die Republiek van Suid-Afrika deur die Staatsdrukker, Pretoria, 1986

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The area covered by this map is shown in colour

Adjoining published sheets are hatched

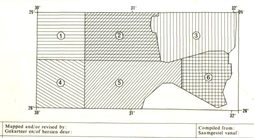
A complete list of Geological Survey publications (including maps and explanations) is obtainable from the Geological Survey, Private Bag X112, Pretoria, 0001

Die gebied wat deur hierdie kaart gedek word, is in kleur aangedui

Aangrensende gepubliseerde velle is gearseer

'n Volledige lys van Geologiese Opname-publikasies (insluitende kaarte en toeligtinge) is verkrygbaar van die Geologiese Opname, Privaatsak X112, Pretoria, 0001

SOURCE OF GEOLOGICAL DATA — BRON VAN GEOLOGIESE GEGEWENS



Area Gebied	Mapped and/or revised by: Gekarteer en/of hersien deur:	Compiled from: Saamgestel vanaf:
1	M. R. Sharpe and personnel of the Geology Department of the University of Pretoria, 1977 M. R. Sharpe, personeel van die Departement Geologie van die Universiteit van Pretoria, 1977	Field sheets/Veldkaarte, 1:50 000
2	A. P. G. Slabaga, J. S. van Zyl and/en G. K. Joubert, 1934–1937; M. P. Mulder and/en W. J. Verwoerd, 1954–1955; C. P. du Plessis, 1981–1982	Published map/Gepubliseerde kaart 27, Volume 1, 1:25 000, 1960 Field sheets/Veldkaarte, 1:50 000
3	I. C. Schutte and/en A. R. Chalmers-Armstrong, 1979	Field sheets/Veldkaarte, 1:50 000
4	C. P. du Plessis, 1976	Field sheets/Veldkaarte, 1:50 000
5	G. K. Joubert, O. R. van Eeden, P. J. Rossouw, D. J. L. Visser, A. P. G. Slabaga, J. S. van Zyl and/en J. J. Taljaard, 1950–1951	Published map/Gepubliseerde kaart Barberton, 1:50 000, 1956
6, 7 and/en 2	M. J. Viljoen, R. P. Viljoen and personnel of Johannesburg Consolidated Investment Co. Ltd, 1966–1969 M. J. Viljoen, R. P. Viljoen, personeel van Johannesburg Consolidated Investment Co. Bpk, 1966–1969	Field sheets on various scales/Veldkaarte op verskeie skale

Compiled by: F. Wolfaren and F. J. Hartzer
Saamgestel deur: F. Wolfaren en F. J. Hartzer

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REFERENCE — VERKLARING

- International boundaries — Internasionale grense
- Provincial boundaries — Provinsiale grense
- Railways — Spoorweë
- Narrow gauge railways — Smalspoorlyne
- Service railways — Diensspoorlyne
- Power lines — Kraglyne
- Arterial roads — Hoofverkeerspaaie
- Main roads — Grootpaaie
- Secondary roads — Sekondêre paaie
- Other roads — Ander paaie
- Tracks and footpaths — Dowwe paaie en voetpaaie
- Game- and nature-reserve boundaries — Wildtuin- en natuurreservaatgrense

ECONOMIC DATA — EKONOMIESE GEGEWENS

- Mine in production / Myn in produksie
- Mineral occurrence / Delfstofvoorkoms
- Chrysotile asbestos / Chrisotielasbes
- Silver / Silwer
- Arsenic / Arseen
- Gold / Goud
- Barytes / Bariet
- Bismuth / Bismut
- Refractory flint clay / Vuurvaste vuurklei
- Chromium / Chroom
- Copper / Koper
- Iron / Yster
- Fluorspar / Vloerspaat
- Mine not in production / Myn nie in produksie nie
- Mercury / Kwik
- Magnesite / Magnesiet
- Manganese / Mangaan
- Verdite / Verdiet
- Nickel / Nikkel
- Mineral pigment / Mineraalpigment
- Lead / Lood
- Platinum-group metals / Platinumgroepmetale
- Stone aggregate / Steenaggregaat
- Talc and pyrophillite / Talk en pirofiliet
- Vanadium / Vanadium
- Zinc / Sink

GEOLOGICAL LEGEND — GEOLOGIESE LEGENDE

- Exposed geological contact / Blootgestelde geologiese kontak
- Concealed geological contact / Bedekte geologiese kontak
- Strike and dip of bed, dip in degrees / Strekking en helling van laag, helling in grade
- Synform / Sinform
- Antiform / Antiform
- Fault / Verskuiwing
- Shear zone, cataclased and silicified / Skuifsones, gebreksuiwer en gesilisifiseer
- Mylonitization / Milonitisasie
- Linear features inferred from aeromagnetic data / Lineêre verskynsels afgelei van lugmagnetiese gegewens
- Undifferentiated linear features (including dolerite, diabase, quartz gabbro and quartz diorite dykes) / Ongedifferensieerde lineêre verskynsels (insluitende doleriet-, diabaas-, kwartsgabbro- en kwartsdioriet-gange)
- Site of geological interest / Plek van geologiese belang

Contour interval 50 metres — Kontoertussenruimte 50 meter

1:250 000
Kilometres 10 0 10 20 30 Kilometers

Heights are to ground level in metres
Hoogtes is na grondhoogte in meter

Gauss conform projection. Central meridian 31° east. Clarke 1880 spheroid.
Gauss se konforme projeksie. Middermeridiaan 31° oos. Clarke 1880 sferoïed.

The grid lines of the South African co-ordinate system are indicated in the margin by short black ticks at 50 000 metre intervals, with co-ordinate values in units of 10 000 metres in blue

Die ruitlyne van die Suid-Afrikaanse koördinaatstelsel word in die kantlyne aangedui deur kort swart strepies, 50 000 meter van mekaar met koördinaatwaardes in eenhede van 10 000 meter, in blou

The boundaries of Registration Divisions are defined by heavy brown lines and the corresponding letters thereof are shown in the margin opposite each degree square

Die grense van Registrasie-afdelings word deur dik bruin lyne aangedui met die ooreenstemmende letters in die kantlynte teenoor elke graadvierkant

REFERENCE — VERKLARING

- Post offices, police stations and stores — ....Poskantore, polisiestasies en winkels
- Schools, churches and hotels — ....Skole, kerke en hotelle
- Mission stations — ....Sendingstasies
- Huts — ....Hutte
- Trig. Beacons with heights and numbers — ....Trig. Bakens met hoogtes en nommers
- Perennial pans — ....Standhoudende panne
- Non-perennial pans — ....Nie-standhoudende panne
- Dry pans — ....Droë panne
- Pipelines and canals — ....Pyplyne en kanale
- Perennial rivers — ....Standhoudende riviere
- Non-perennial rivers — ....Nie-standhoudende riviere
- Marshes and vleis — ....Moerasse en vleie
- Waterpoints — ....Waterbronne

Based on the 1:250 000 Topo-Cadastral series of South Africa, published by the Chief Director of Surveys and Mapping, Mowbray
Geology compiled from the latest available data
Drawn by H. M. J. van Rensburg, Geological Survey, Pretoria
F. Coetsee—Control Industrial Technician—Cartography
Copies of the Map and Explanation are obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001, and the Chief Director, Geological Survey, Private Bag X112, Pretoria, 0001
Gebaseer op die 1:250 000-Topo-Kadastrale reeks van Suid-Afrika, gepubliseer deur die Hoofdirekteur van Opmetings en Kartering, Mowbray
Geologie saamgestel vanaf die jongste beskikbare gegewens
Getekes deur H. M. J. van Rensburg, Geologiese Opname, Pretoria
F. Coetsee—Beheerwerktechnikus—Kartografie
Eksemplare van die Kaart en Toeligting is verkrygbaar van die Staatsdrukker, Bosmanstraat, Privaatsak X85, Pretoria, 0001, en die Hoofdirekteur, Geologiese Opname, Privaatsak X112, Pretoria, 0001

LITHOLOGY

- Q — Surficial deposit, alluvium and scree / Oppervlakafsetting, alluvium en puin
- Jd — Dolerite; where necessitated by scale, shows as (——) / Doleriet; waar daar skaal genoodsaak, aangetoon deur (——)
- JHg — Granophyre / Granofier
- Jk — Granophyric gabbro, olivine gabbro, feldspathic gabbro / Granofiriese gabbro, olivengabbro, veldspatiese gabbro
- Jt — Pink, medium-grained quartz feldspar granophyre, microgranite, syenite / Pienk, middelkorrelige kwarts-veldspatgranofier, mikrograniet, sieniet
- Jz — Red to light-brown, fine-grained rhyolitic lava, porphyritic rhyolite and tuff / Rooi tot ligbruin, fynkorrelige riolietiese lawa, porfiriëse rioliet en tuf
- Jl — Green, fine-grained mafic lava, locally porphyritic, amygdaloidal in places, interlayered with rhyolite, especially near the top / Groen, fynkorrelige mafiese lawa, plek-plek porfiriëe, amandelhoudend op plekke, tussen-gelaagd met rioliet, veral naby die bokant
- Jc1 — Cream-coloured, fine-grained, massive sandstone / Roomkleurige, fynkorrelige, massiewe sandsteen
- Jc — Red and white, fine-grained, argillaceous sandstone / Rooi en wit, fynkorrelige, kleiige sandsteen
- Pr — Quartzite, cross-bedded sandstone, pebbly near its base, gritty sandstone, shale / Kwartsiteie, kruisgelaagde sandsteen, rolsteenlaag naby basis, growwe sandsteen, skalie
- P-S — Undifferentiated Karoo Sequence below Jt / Ongedifferensieerde Dwenveiging Karoo onder Jt
- Pd — Shale / Skalie
- Mr — Green to blue-green, medium- to fine-grained gabbro, olivine gabbro and quartz gabbro / Groen tot blougroen, medium- tot fynkorrelige gabbro, olivengabbro en kwartsgabbro
- Md — Dark-green, coarse-grained olivine diorite / Donkergroen, growwkorrelige olivienoriet
- Ms — Pink to red, coarse-grained hornblende-biotite granite / Pienk tot rooi, growwkorrelige hornblende-biotietgraniet
- Vdg — Medium- to coarse-grained gabbro and norite with subordinate anorthosite / Middel- tot growwkorrelige gabbro en noriet met ondergeskikte anortosiet
- Vdn — Medium-grained anorthosite, norite, gabbro; Merensky reef (——); chromitite layer; upper groep (——), middle group (——), lower groep (——) / Middelkorrelige anortosiet, noriet, gabbro; Merenskyrif (——); chromitietlaag; bogroste groep (——), middelgroep (——), onderste groep (——)
- Van — Fine-grained norite; pyroxenite (——) / Fynkorrelige noriet; pirokseniet (——)
- Vdi — Diabase; where necessitated by scale, shown as (——) / Diabaas; waar daar skaal genoodsaak, aangetoon deur (——)
- Vdb — Black to dark-green, fine-grained, flow-banded andesitic lava, amygdaloidal and with scoriaceous flow tops / Swart tot donkergroen, fynkorrelige, vloeigelaagde andesitiese lawa, amandelhoudend en met skuimerige vloeioppervlaktes
- Vdn — Fine-grained hornfels with abundant sedimentary structures, quartzite unit near the base / Fynkorrelige hornfels met volop sedimentêre strukture, kwartsietenheid naby die basis
- Vda — Cream, medium- to fine-grained, cross-bedded quartzite with interlayers of purple-weathering arenite and shale and thin conglomerate layers / Room, middel- tot fynkorrelige, kruisgelaagde kwartsiet met tussenlae van persverweerende areniet en skalie en dun konglomeraatlae
- Vn — Fine-grained hornfels with ripple-marks, mud cracks and cross-bedding, overlain by medium-grained arenite / Fynkorrelige hornfels met riffelmerke, modderkrake en kruisgelaagdheid, oerie deur middel-korrelige areniet
- Vi — Medium-grained, cross-bedded and ripple-marked feldspathic quartzite, thin conglomerate layers and gritty lenses / Middelkorrelige, kruisgelaagde en gerriffelde veldspatiese kwartsiet, dun konglomeraatlae en growwe lense
- Vv — Fine-grained hornfels with sedimentary structures near the top and base, layers of silt and sandstone and minor layers of carbonate and calc-silicate rocks / Fynkorrelige hornfels met sedimentêre strukture naby die bokant en basis, lae van silkssteen en sandsteen en ondergeskikte lae van karbonaat- en kalksilikaatgesteentes
- Vmg — Pure, coarse-grained, white quartzite containing sporadic impersistent shale layers in places, upper part comprising interlayered shale, siltstone and quartzite, lower part clayey
- Vm — Sulwer, greyhaarsteine, wit kwartsiet wat plek-plek nie-deurlopende skalielae bevat; bogroste gedeelte bestaan uit tussengelaagde skalie, silkssteen en kwartsiet, onderste gedeelte skalie-agtig
- Vdq — Greenish, fine-grained, laminated shale and subordinate mudstone, interlayered carbonate layers rare, hornfels in places / Groenagtige, fynkorrelige, gelamineerde skalie en ondergeskikte moddersteen, tussengelaagde karbonaatlae seldsaam, hornfels op plekke
- Vui — Greenish, fine-grained, laminated shale and subordinate mudstone, interlayered carbonate layers rare, hornfels in places / Groenagtige, fynkorrelige, gelamineerde skalie en ondergeskikte moddersteen, tussengelaagde karbonaatlae seldsaam, hornfels op plekke

LITHOLOGIE

- Vwl — Grey, white and brown, medium- to fine-grained quartzite, hitapathic quartzite, greenish intermediate lava / Grys, wit en bruin, middel- tot fynkorrelige kwartsiet, veldspatiese kwartsiet, groenerige, intermediate lawa
- Vg — Dark-green, fine- to medium-grained, intermediate lava, sandstone, grit, arkose, conglomerate / Donkergroen, fyn- tot middelkorrelige, intermediêre lawa, sandsteen, gristeen, arkose, konglomeraat
- Rm — Coarse-grained, porphyritic, pelassic granite / Growwkorrelige, porfiriëse, kalsiumhoudende graniet
- Rs — Syenogranite / Sinograniet
- Rs — Granodiorite / Granodioriet
- Rg — Leucocratic pelassic granite / Leukokratiese kalsiumhoudende graniet
- Zb — Granodiorite / Granodioriet
- Zg — Grey to white, coarse-grained biotite granite; weakly porphyritic (——); very strongly porphyritic (——); veined by granodiorite (——); biomodal porphyritic granite veined by granodiorite and strongly porphyritic granite with large phenocrysts (——)
- Zs — Grys tot wit, growwkorrelige bietiegraniet; swak porfiriëse (——); baie sterk porfiriëse (——); geaar deur granodioriet (——); bimodale porfiriëse graniet geaar deur granodioriet en sterk porfiriëse graniet met groot eerstelinge (——)
- Zum — Potassic gneiss and migmatite with some phenocrysts (——); strongly porphyroblastic; veined by granodiorite (——) / Kaliumhoudende gneis en migmatiet met enkele eerstelinge (——); sterk porfiroblastiese; geaar deur granodioriet (——)
- Zmg — Tonalitic migmatite and gneiss / Tonalitiese migmatiet en gneis
- Zbg — Biotite-hornblende gneiss / Bietiet-troudhoemelgneis
- Zh — Hornblende-biotite granite / Hornblendebietiegraniet
- Zr — Gedic porphyry / Kalkhoudendeone porfier
- Zp — Serpentinised dunite, harzburgite, orthopyroxenite and websterite, gabbro and anorthosite / Geserpentiniseerde duniet, harzburgiet, ortopirokseniet en websteriet, gabbro en anortosiet
- Zmb — Basaltiese, grit, conglomeraat, skalie, subgrywwacke, phyllite / Sandsteen, gristeen, konglomeraat, skalie, subgrywwa, filliet
- Zj — Shale, subgreywacke, sandstone, quartzite, phyllite, jaspilite, ferruginous shale, basaltic lava / Skalie, subgrywwak, sandsteen, kwartsiet, filliet, jaspiliet, ysterhoudende skalie, basaltiese lawa
- Zmc — Shale, quartzite, conglomerate, jaspilite / Skalie, kwartsiet, konglomeraat, jaspiliet
- Zfs — Undifferentiated Zmb to Zmc / Ongedifferensieerde Zmb tot Zmc
- Zt — Trachytic tuff, agglomerate, lava, tuffaceous greywacke, conglomerate / Tragiliese tuf, aggiomeraat, lawa, tuffagtige grywwak, konglomeraat
- Zs — Siltstone, shale and subordinate greywacke, banded ferruginous chert, trachytic tuff / Silkssteen, skalie en ondergeskikte grywwak, gestreepte ysterhoudende chert, tragiliese tuf
- Zhb — Greywacke and shale with interlayers of chert and ferruginous chert / Grouwak en skalie met tussengelaagde chert en ysterhoudende chert
- Zf — Undifferentiated Zfs to Zfh / Ongedifferensieerde Zfs tot Zfh
- Zz — Mafic and felsic lava, tuff, agglomerate, chert, shale, carbonate rocks, ultramafic lava / Mafiese en felsiese lawa, tuf, aggiomeraat, chert, skalie, karbonaatgesteentes, ultramafiese lawa
- Zgk — Mafic and felsic lava, tuff, agglomerate, pillow breccia, shale, komatiitic lava; porphyry (——) / Mafiese en felsiese lawa, tuf, aggiomeraat, kussingbreksie, skalie, komatiitiese lawa; porfier (——)
- Zph — Mafic to felsic volcanic rocks, porphyry, shale, komatiitic lava, rhyodacitic tuff and agglomerate; chert-carbonate layers (——) / Mafiese tot felsiese vulkaniese gesteentes, porfier, skalie, komatiitiese lawa, riodasitiese tuf en aggiomeraat; chert-karbonaatlae (——)
- Zhk — Basaltic and peridotitic komatiite, tholeiite, chemical sediment / Basaltiese en peridotitiese komatiiet, tholeiiet, chemiese sediment
- Zf — Various mafic and ultramafic schists interlayered with banded iron formation and ferruginous chert, shale and grey chert; acid to intermediate volcanic rocks / Verskeie mafiese en ultramafiese skiste tussengelaagd met gestreepte ysterformasie en ysterhoudende chert, skalie en grys chert; suur tot intermediêre vulkaniese gesteentes
- Zt — Undifferentiated Zfh to Zfl / Ongedifferensieerde Zfh tot Zfl

* Name not yet approved by SACS
Naam nog nie deur SAKS goedgekeur nie

INTRUSIVE ROCKS — INTRUSIEWE GESTEENTES

- Jd — Tshelwane Granophyre / Tshelwanegranofier
- JHg — KOMATIPOORT SUITE* / SUITE KOMATIPOORT*
- Mt — Timbavati Gabbro / Timbavatigabbro
- Mz — Steelpoort Park Granite* / Steelpoortparkgraniet*
- Mb — LEBOWA GRANITE SUITE / GRANIETSUITE LEBOWA
- Vdj — Dcjate Subsuite / Dcjate Subsuite
- Vdr — Dwars River Subsuite / Subsuite Dwarsrivier
- Vun — RUSTENBURG LAYERED SUITE / GELAAGDE SUITE RUSTENBURG
- Vbs — Shelter Norite / Shelternoriet
- Vs — BUSHVELD COMPLEX / BOSHEUWEL KOMPLEKS
- Vs — RUSTENBURG LAYERED SUITE / GELAAGDE SUITE RUSTENBURG
- Rm — Mpageni Granite / Mpagenigraniet
- Rk — Kaap Zyn Doorns Syenite* / Kaap Zyn Doorns-sieniet*
- Rs — Salisbury Kop Granodiorite / Salisbury Kop-granodioriet
- Rg — Hebron Granodiorite* and others / Hebrongranodioriet* en ander
- Zn — NELSPRUIT SUITE* / SUITE NELSPRUIT*
- Zs
- Zk
- Zn
- Zmb
- Zmm
- Zmf
- Zmg — Kaap Valley Granite / Kaap Valley-graniet
- Zs
- Zu

GEOLOGICAL SEQUENCE — GEOLOGIESE REEKSVOLGORDE

QUATERNARY / KWATERNÊR				Q
JURASSIC / JURA				Jj
TRIASSIC / TRIAS				Jt
PERMIAN / PERM				Js
			Jezini	Jj
		LEBOMBO	Letaba	Jl
			Clarens	Js
			Undifferentiated Karoo (P-S) / Ongedifferensieerde Karoo (P-S)	P-S
		ECCA	Vryheid	Pv
			Dwyka	Pg
MOKOLIAN / MOKALIUM				
VAALIAN / VAALIUM				
			Duitstroom	Vdn
			Rooitenbek	Vb
			Steenkampsberg	Vsg
			Nederhorst	Vn
			Lakenvalei	Vl
			Vermoet	Vr
			Magaliesberg	Vm
			Silverton	Vs
			Daspoort	Vd
			Strubenkop	Vs
			Dwaalheuwel	Vdw
			Rekpoort	Vha
			Boshoek	Vb
			Timeball Hill	Vt
			Roiihoogte	Vr
		CHUNIESPOORT	Malmani (Vmd)	Vmd
		WOLKBERG	Black Reef / Swartrif	Vbr
			Upper part / Boonste deel	Vwu
			Lower part / Onderste deel	Vwl
			Godwan (Vg)	Vg
BANDAIN / BANDIUM				
SWAZIAN / SWAZIUM				
		MODDIES (Zm)		Zmb
			Bavianskop	Zl
			Joe's Luck	Zm
		FIG TREE (Zf)	Clutha	Zfs
			Schoongezicht*	Zk
			Belvue Road	Zt
			Sheba	Zr
		Geluk	Zwartkoppie	Zs
			Kromberg	Zgk
		INVERWACHT	Hooggenoeg	Zph
			Kamati	Zhk
		Tjakastad (Zh)	Theespruit	Zf
				Zgg
				Zh
				Zfl