Investigating the Fauresmith stone tool industry from Pit 4 West at Canteen Kopje, Northern Cape Province, South Africa

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

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Declaration

I, Kelita Shadrach, declare that this dissertation “Investigating the Fauresmith stone tool industry from Pit 4 West at Canteen Kopje, Northern Cape Province, South Africa” is my own unaided work. It is being submitted for the Degree of Master of Science in Archaeology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Kelita Shadrach

31 May 2018, Johannesburg

Abstract

Canteen Kopje has yielded rare *in-situ* assemblages of the Fauresmith, a poorly defined industry often associated with the later Acheulean. The Fauresmith contains precocious developments in technology as early as ~0.5 Ma–features which only become widespread in the ensuing Middle Stone Age. The Fauresmith as a regional industry provides insight into technological practices during the period of significant behavioural diversification associated with archaic *Homo sapiens*. Previous excavations were conducted with relatively low spatial resolution. A new excavation, Pit 4 West, was conducted to investigate the spatial, stratigraphic and contextual association of the Fauresmith horizon in more detail. A multi-disciplinary fine-resolution geoarchaeological approach was applied. A nuanced assessment of the Fauresmith's context was developed, with macroscopic and microscopic analyses allowing for the identification of site formation processes influencing assemblages. The artefact sample size for the site was increased and the presence of diagnostic tools has aided in formally defining the Fauresmith at Canteen Kopje**.**

Acknowledgements

Dr Dominic Stratford (supervisor): Thank you.

"*It seemed to me that a careful examination of the room and the lawn might possibly reveal some traces of this mysterious individual. You know my methods, Watson. There was not one of them which I did not apply to the inquiry. And it ended by my discovering traces, but very different ones from those which I had expected."*

~The Memoirs of Sherlock Holmes

Prof. Kathleen Kuman (supervisor): Thank you.

"At the end of the day, we can endure much more than we think we can."

~ Frida Kahlo

Dr George Michael Leader IV (co-supervisor):

Thank you for giving me this research project, the project has made me a stronger and more independent researcher.

Peter Morrissey: I envy and appreciate your patience.

"Aloe flowering

on rock that once flowed molten

over old sandstone."

~'Strata' by Norman Morrissey

Alice Mullen, Amoret Van Rooyen, Kate Croll, Keneiloe Molopyane, Kalaela Gold & Naudia Yorke:

"Sometimes we feel like and regret being odd balls yet it is our uniqueness that makes each of us fit for our individual purpose in life."

~Prof. Thuli Madonsela

Institutional acknowledgments

This project was conducted over a two-year period at Canteen Kopje, Northern Cape Province, South Africa, a site that the author believes to be one of the most significant Stone Age sites in South Africa, particularly with regard to understanding the Earlier Stone Age period and the significant transition from this period into the subsequent Middle Stone Age, famously known for major hominid cognitive and behavioural developments. The research conducted for this project would not have been possible without the financial support from the National Research Foundation (NRF) and the Palaeontological Scientific Trust (PAST).

The author would like to thank Prof. David Morris from the McGregor Museum, Kimberley, Northern Cape Province for not only saving Canteen Kopje and continuing to protect it from illegal diamond mining but also for always being happy to help with and provide support for this research.

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Dedication

First, I would like to dedicate this dissertation to my dad, Vivian Shadrach. There just isn't a quote that will do, so I will simply say that I love you and I am proud of you.

Secondly, I would like to dedicate this dissertation to myself. I have grappled and grown over the past couple of years and I have been told that self-appreciation is key to surviving.

Lastly, I would like to dedicate this research to Prof. Kathleen Kuman. It has been the greatest privilege to be one of your students and colleagues. I will miss walking into your office and inevitably drinking green tea with you:

"Most people say that it is the intellect which makes a great scientist. They are wrong: it is character."

~Albert Einstein

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Chapter 1: Introduction

In this dissertation the author investigates the context and technological validity of the Fauresmith stone tool industry at Canteen Kopje, Northern Cape Province, South Africa (28°32′35″ S, 24°31′51″ E) (Figure 1.1). Canteen Kopje, near the town of Barkly West, has yielded lithic assemblages from the Later Stone Age through to the Early Acheulean in a sequence of sand and gravel deposits (McNabb & Beaumont 2011 a, b; Leader 2014; Lotter *et al*. 2016). The represented industries include the Fauresmith, and the Victoria West which is an Early Acheulean industry that features prepared core technology (McNabb 2001; McNabb & Beaumont 2011 a, b; Leader 2014; Lotter *et al*. 2016). In the Pit 6 excavation at Canteen Kopje (Figure 1.2) there is mixing between the Fauresmith and the Victoria West within a Mixed Contact Zone at the interface between the gravels and the Hutton Sands (Lotter *et al*. 2016).

The Fauresmith is traditionally described as a regional industry that is associated with the Middle Pleistocene, particularly the late Earlier Stone Age (ESA) and the transition to the early Middle Stone Age (MSA) which is suggested to have occurred ~0.5-0.3/0.25 Ma in South Africa (Porat *et al*. 2010; Herries 2011; Underhill 2011; Lotter *et al*. 2016). Lithic material proposed to be Fauresmith has been of interest to many researchers over the past 100 years as it falls into a special 'gap' in our understanding of the African Stone Age. This gap is filled with both typical ESA Later Acheulean large cutting tools (LCTs) and stratigraphically-associated diagnostic MSA tool types (Underhill 2011; Herries 2011).

Historical examination of Stone Age material in southern Africa was predominantly based on *ex-situ* or surface-scattered material, which lacked contextual integrity and limited studies regarding site context and formation (Goodwin 1927, 1929, 1934; Goodwin & van Riet Lowe 1929; van Riet Lowe 1937; Underhill 2011; Wilkins & Chazan 2012). The Fauresmith still remains a relatively poorly defined and dated industry, primarily due to the limited rare *in-situ* assemblages of Fauresmith material found in South Africa and many of which have contexts that limit dating opportunities (Herries 2011; Underhill 2011). There is an on-going debate regarding the accurate techno-typological description of the industry, with some researchers proposing that the Fauresmith is an ESA to MSA transitional industry, and others suggesting that the Fauresmith is a regional industry belonging to the Later Acheulean techno-complex (Herries 2011; Underhill 2011; Chazan 2015b). Difficulties in dating the open-air Fauresmith-bearing units in the interior of South Africa have led to further confusion and discrepancies between sites (Herries 2011; Underhill 2011; Chazan *et al*. 2013; Evans & Cunningham 2013; Lotter *et al*. 2016).

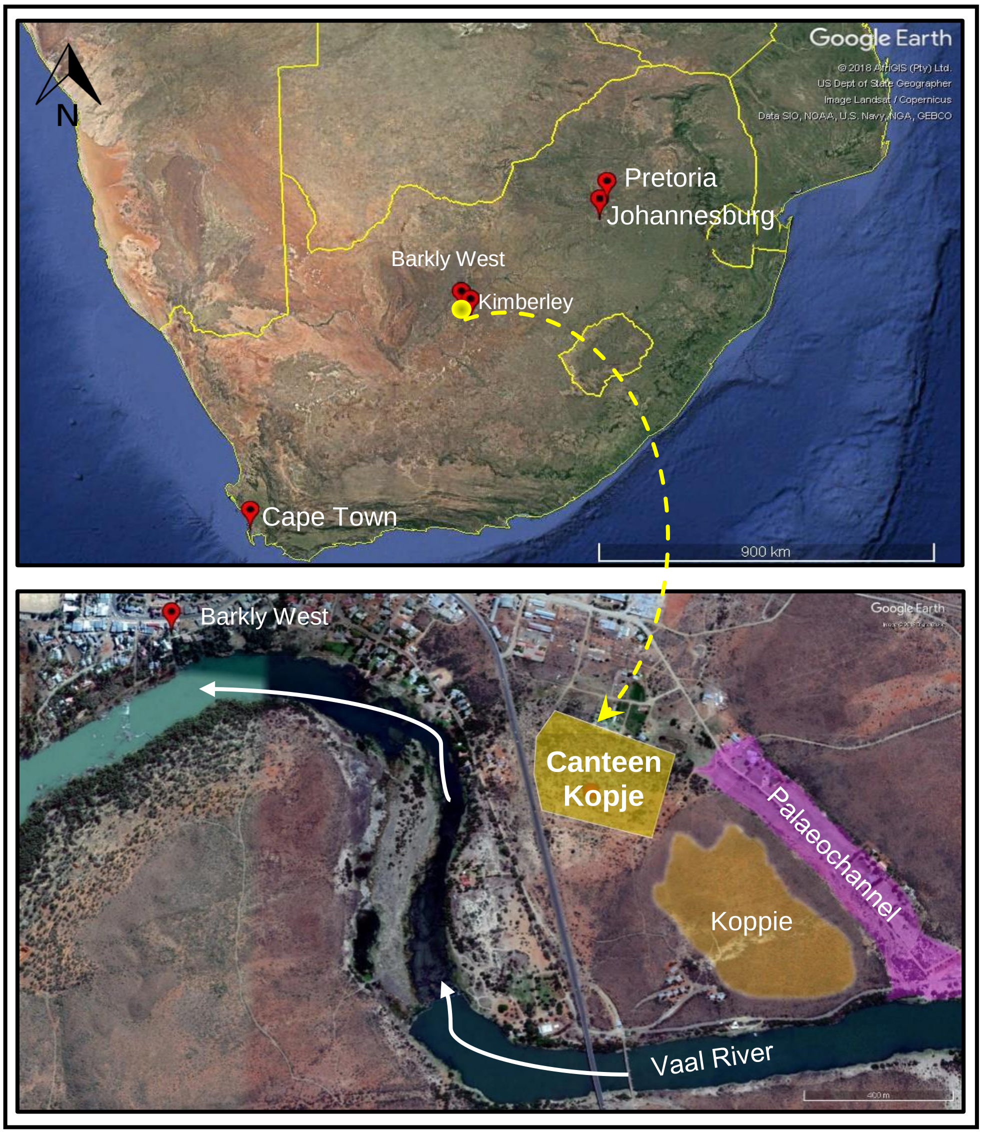


Figure 1.1: A map of South Africa, with the location of Canteen Kopje (28°32'35" S, 24°31'51" E) marked by the yellow solid circle, and an orthographic photo of Barkly West including the Canteen Kopje site and topographical features such as the Vaal River (from Google Earth 2018).

New research and data from Kathu Pan, a site in interior southern Africa with a stratified sequence of material including Fauresmith levels, have provided an age estimate of ~511-435 thousand years (ka) for this contentious, yet significant cultural tradition (Porat *et al*. 2010, Herries 2011). This age now places at least one Fauresmith site within the Later Acheulean, well before the accepted appearance of the MSA in South Africa. Canteen Kopje, with MSA, Fauresmith and Early Acheulean assemblages offers an opportunity to further assess the place of the Fauresmith within the Stone Age in South Africa (McNabb 2001; McNabb & Beaumont 2011a; Lotter *et al*. 2016).

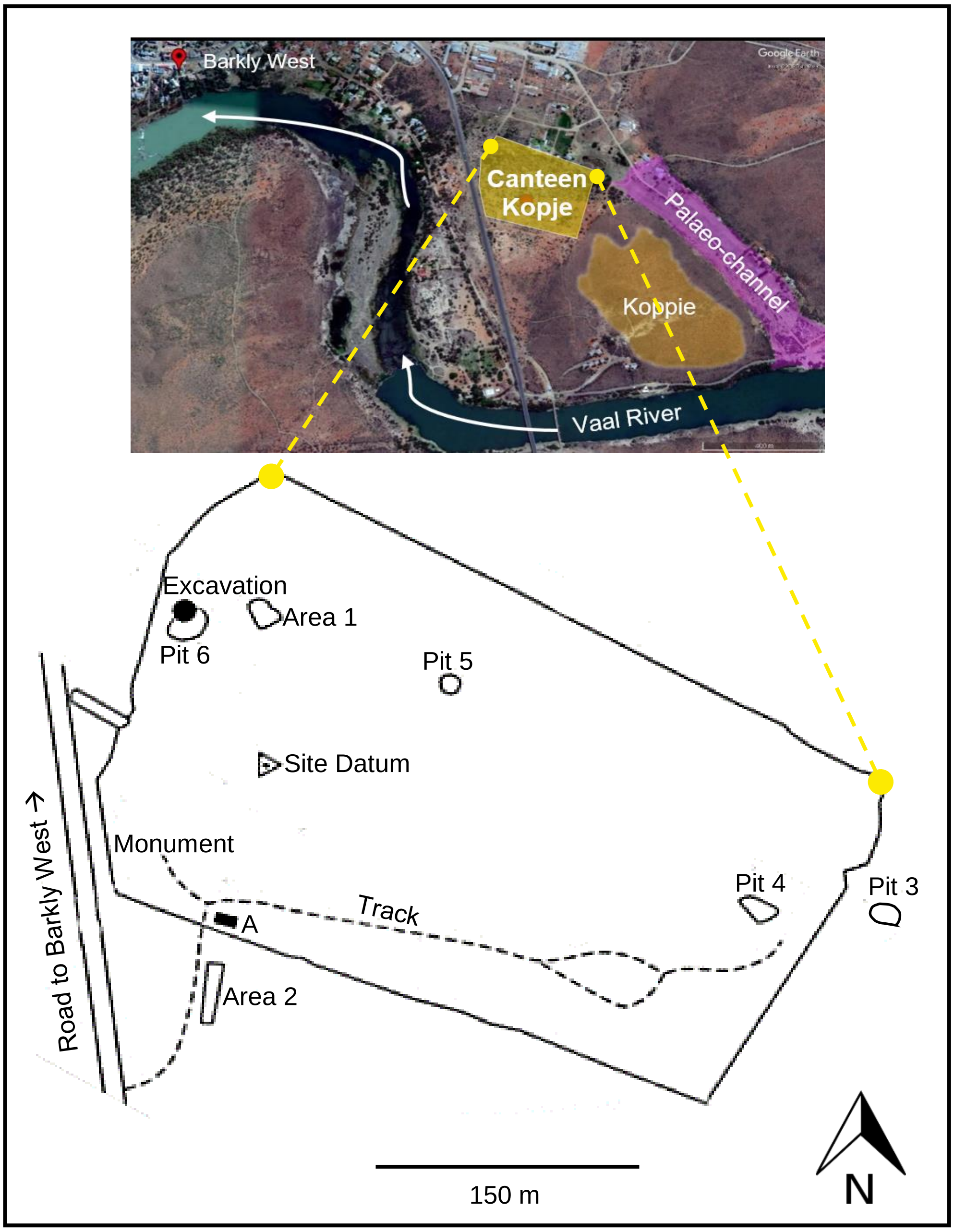


Figure 1.2: The location of Canteen Kopje (from Google Earth 2018) and a map of all excavations and relevant features at Canteen Kopje.

Peter Beaumont began the first controlled excavations at Canteen Kopje in the late 1990's (McNabb & Beaumont 2011a), but the site has been referred to in many research outputs–with more recent ones being based on excavated assemblages and systematic research (Goodwin 1927, 1929, 1934; Goodwin & van Riet Lowe 1929; van Riet Lowe 1937; Partridge & Brink 1967; Helgren 1977, 1979; De Wit 1996, 2008; Beaumont & McNabb 2000; McNabb 2001, Beaumont 2004; Beaumont & Vogel 2006; Gibbon *et al*. 2008, 2009; Forssman *et al*. 2010; Lotter 2010a, b; Sarupen 2010; McNabb & Beaumont 2011 a, b; Chazan *et al*. 2013; Lotter *et al*. 2016).

This dissertation is the result of one of the many research projects that have been conducted by the WITS team that began research at Canteen Kopje in 2007 under the guidance of G.M Leader, R. Gibbon and K. Kuman. The first geoarchaeological study to be conducted on Canteen Kopje Fauresmith material (from Pit 6; Figure 1.2) was published by Lotter *et al*. (2016). However, the research presented in this dissertation is the first to apply a stratigraphically-sensitive multidisciplinary *high-resolution* approach combining geoarchaeological and typological studies at the site. A new excavation (extended from the existing squares of Pit 4; Figure 1.2), henceforth referred to as 'Pit 4 West' (P4W), was conducted from the landscape surface in 2016. This allowed the application of the above-mentioned approach to a sequence that included the Hutton Sands and the top of the gravels, yielding primary data required for both the geoarchaeological and typological analyses conducted for this research.

1.1 Research question

This project attempted to answer the following research question:

> *Is the integrity of the Fauresmith assemblage in Pit 4 West affected by what previous researchers have described as a mixed contact zone (MCZ) that exists at the interface between the Hutton Sands and the gravels?*

1.2 Aims

- The first aim of this research was to excavate a new sample of the Fauresmith industry from the Pit 4 West trench at Canteen Kopje while applying a high-resolution approach to spatial and sedimentological documentation to provide greater contextual sensitivity than previous studies at the site.

- The second aim was to improve our understanding of the integrity of the Fauresmith assemblage from Pit 4 West by analysing the spatial data on artefacts and the sedimentological data. To further clarify the context of the Fauresmith, multiple samples were taken from the exposed sequence of Pit 4 West for OSL dating.

- The third aim was to conduct a typological study (and in future a technological study) of all excavated material from Pit 4 West. This typological analysis, combined with the high-resolution spatial data, has the potential to help the author determine the cultural stratigraphy of Pit 4 West and the Fauresmith's place within this sequence.

1.3 Organisation of the thesis

There is a total of five chapters in this dissertation.

Chapter 1 has provided the research questions and aims.

Chapter 2, Literature Review, describes the historical, archaeological, and geological background of Canteen Kopje and the surrounding Vaal River Basin. This chapter includes a thorough description of the early and more recent archaeological research at the site. The purpose of this chapter is to also provide detailed information pertaining to the Stone Age in South Africa, with specific focus on the Fauresmith industry and the debate over its place within the Stone Age.

Chapter 3, Methodology, introduces the reader to the analytical techniques that were used in this project. This chapter is divided into two sections. The first section provides a description of excavation and recording protocols, geographic information system (GIS) modelling (for fabric analysis) and laboratory-based sedimentological and geochemical analyses. The section also includes discussion of the optically-stimulated luminescence (OSL) dating protocol applied to samples from P4W. The second section provides a description of the typological approach applied to all excavated artefacts yielded from P4W.

Chapter 4, Results, is a report of the geoarchaeological and site formation results, followed by the typological analysis conducted by the author, detailing the lithic study results for the Fauresmith, the Victoria West and other industries/techno-complexes found in P4W.

Chapter 5, Discussion and Conclusion, is the final chapter of the dissertation and provides interpretations of both the geoarchaeological and lithic study results, and the combination of the two datasets to provide a multi-disciplinary study. The Conclusion section specifically summarises the project results, as well as the achievements and the limitations of this research project. Furthermore, the author considers future research directions regarding P4W and new methodologies that can be applied to promote more high-resolution multi-disciplinary research at the Canteen Kopje site.

Chapter 2: Literature Review

This chapter is divided into three sections. The first section is mainly an overview of the South African Stone Age, with some East African and Middle Eastern studies included for comparative purposes. Canteen Kopje is a remarkably rich archaeological site with an extensive sequence that spans >1.5 Ma (Leader 2014). Earlier Stone Age (ESA), Middle Stone Age (MSA), Later Stone Age (LSA) and historical material from the site has been excavated and studied over the past century (Goodwin 1927, 1929, 1934; Goodwin & van Riet Lowe 1929; van Riet Lowe 1937; Partridge & Brink 1967; Helgren 1977, 1979; De Wit 1996, 2008; Beaumont & McNabb 2000; McNabb 2001, Beaumont 2004; Beaumont & Vogel 2006; Gibbon *et al*. 2008, 2009; Forssman *et al*. 2010; Lotter 2010a, b; Sarupen 2010; McNabb & Beaumont 2011 a, b; Chazan *et al*. 2013; Lotter *et al*. 2016). However, emphasis here is placed on the Later Acheulean and the early MSA (eMSA) periods of the Stone Age, because in the debate over the age and classification of the Fauresmith industry, it is associated with one or the other of these periods or considered to be an industry transitional between them (Underhill 2011).

The second section is an overview of the Vaal River Basin geology and past research at Canteen Kopje with focus on the stratigraphy and site formation processes. Lotter *et al*. (2016) recently published the first geoarchaeological study at Canteen Kopje, on the Pit 6 trench. This paper is discussed in detail as it serves as the reference study most relevant to this research project and its aims (clarifying the context of the stone tool assemblages from P4W).

In the third section of this chapter a description of sedimentological, geochemical and dating techniques used in this project is presented, with some South African case studies for reference. The use of these techniques is demonstrated in the chapters that follow. Sedimentological analyses were conducted as a means of describing the macroscopic and microscopic environment in which the stone tools (lithics) from the Canteen Kopje site are preserved. The results of these analyses were used to elucidate the context of artefactual material in P4W.

2.1 Archaeology

2.1.1 The African Earlier Stone Age

The ESA is a prehistoric period that preserves the earliest known evidence of lithic production. It represents a significant cognitive and behavioural threshold that was crossed by past species to become cultural-material-producing hominids. There are three technological complexes associated with this period: the Lomekwian (Harmand *et al*. 2015), the Oldowan (Leakey 1967, 1971; Semaw 2000; Kuman 2014; Kuman & Field 2009) and the Acheulean (Leakey 1967, 1971; Semaw 2000; Lepre *et al*. 2011).

The Lomekwian

The Lomekwian techno-complex from the Lomekwi 3 (LOM3) site, West Turkana, Kenya is the earliest known evidence for lithic manufacturing and is dated to ~3.3 million years (Ma), (Harmand *et al*. 2015). The Lomekwian has been stratigraphically associated with the *Kenyanthropus platyops* species (Harmand *et al*. 2015: 310). This industry is characterised by core reduction dominated by a battering and/or pounding approach, particularly using bipolar and/or passive-hammer techniques. However, free-hand percussion is also evident (Harmand *et al*. 2015). The assemblage from LOM3 is primarily made up of percussors and passive tool types (e.g. anvils), cores, intentional flakes and worked (knapped or battered) cobbles (Harmand *et al*. 2015: 312).

The Oldowan

The Oldowan techno-complex from Gona, Ethiopia is the earliest evidence for Oldowan cultural behaviour and is dated to ~2.6 Ma (Semaw 2000). In South Africa, there are two large Oldowan assemblages. First published is the Oldowan from Sterkfontein Caves site–the richest Oldowan locality in southern Africa– which has been recently dated to ~2.18 Ma (Kuman & Field 2009; Granger *et al*. 2015). Swartkrans now also has a large Oldowan assemblage ca 2.19/1.8 Ma (Sutton 2012; Kuman 2016). Mary Leakey (1967, 1971) ascribed the Oldowan to the *Homo habilis sensu lato* species.

The Oldowan spanned roughly a million years and Oldowan-producing hominids are suggested to have applied knowledge about raw material exploitation and procurement as well as effective flaking techniques (Semaw 2000; Delagnes & Roche 2005; Stout *et al*. 2005). This industry can be described as simple (relative to subsequent industries) core-flake technology with the primary lithic types being cores (knapped cobbles) and sharp-edged flakes (Kuman 2014: 5561).

The Early Acheulean

Unlike the Oldowan the Acheulean represents a progressive period in technological developments and is the longest practiced lithic techno-complex in human prehistory (Semaw 2000; Sharon *et al*. 2011; Kuman 2014). The Early Acheulean is suggested to span between ~1.7 and ~0.9/1.0 Ma and is associated with the *Homo ergaster* species (de le Torre 2009). Mary Leakey (1971) was the first to describe the Early Acheulean based on the EF-HR assemblage from Olduvai Gorge, Tanzania. It is techno-typologically characterised by the practices associated with the development of bifacial (and non-bifacial) large cutting tools, henceforth referred to as 'LCTs' (Leakey 1971; Kuman 2016).

LCTs include the following tool types: handaxes, cleavers and pick-like heavy-duty tools >10 cm in length (Stout 2011; Kuman 2014). Figure 2.1 shows examples of southern African Early Acheulean LCTs, from the Rietputs ACP assemblage (Kuman & Gibbon *et al*. 2018). Raw material influenced the shape and morphology of LCTs, with production being associated with large flake blanks and/or slab/cobble blanks (Jones 1994; Kuman 2014). The handling and manipulation of larger cores by hominids during the manufacture of LCT blanks would have required perceptual-motor organisation more developed than that of preceding techno-complexes (Stout 2011). LCTs represent more standardised core reduction techniques for flake production, as well as the intentional shaping of flakes (Stout 2011).

The earliest evidence for the Acheulean is from the Kokiselei (KS4) site, West Turkana, Kenya and is dated to ~1.76 Ma (Lepre *et al.* 2011). Major Acheulean localities in South Africa include the Vaal River basin cluster of sites such as the Rietputs Formation, dated to ~1.57-1.26 Ma (Gibbon *et al*. 2009; Kuman & Gibbon *et al*. 2018).; Leader *et al.* 2018) and Canteen Kopje, dated to >1 Ma (Leader 2014).

The Cradle of Humankind includes sites that have yielded Early Acheulean material. The major sites are Sterkfontein Caves and Swartkrans with dates ranging between ~1.6 and 1 Ma (Kuman 1998; Kuman and Clarke 2000; Clark 1993; Field 1999). Maropeng also has an expansive Early Acheulean deposit within a deflated (undated) deposit (Pollarolo *et al*. 2010; Moll 2017).

New lithic production techniques appear during the Acheulean, and these demanded more preconception of the finished artefact than Oldowan lithics (Stout 2011: 1053). The Acheulean is a relatively complex technological period as hominids made use of multiple reduction strategies simultaneously. De la Torre's (2009) comparative study between assemblages from the Northern Escarpment (Muguland) and the Peninj sites, Tanzania (~1.5-1.4 Ma), describes the fluid nature of the Acheulean, with two co-existing reduction strategies used to produce different types of lithics. The first is one focused on small-sized flake production (*debitage*) that includes a hierarchical bifacial centripetal method. The second is focused on LCT production and reduction (*chaîne opératoire*) (de la Torre 2009). Stout (2011) further identifies a distinct strategy at Koobi Fora, Kenya that lacks handaxes, but was focussed on the production of single-platform 'Karari scraper cores'.

The advent of the Acheulean is suggested to have "marked a new adaptive grade in human evolution" (Plummer 2004:127) and has been found associated with the hominid species *Homo ergaster* (Kuman & Clarke 2000). *Homo ergaster* is described as having 'sapient-like' post-cranial anatomical features and proportions (Kuman 2014: 8). This development is associated with a shift in behaviour and particularly that of land use by hominids. Unlike preceding periods, the Acheulean is characterised by greater concentrations of artefacts at larger sites over a broader range of more open environments (Kuman 2014). This period of diversification is marked by evidence for the first controlled and deliberate use of fire (Alperson-Afil & Goren-Inbar 2010; Berna *et al*. 2012; Pickering *et al*. 2012). This activity has been identified at East African and South African Early Acheulean sites. Fire use is dated to ~1.5 Ma at Koobi Fora, Kenya (Alperson-Afil & Goren-Inbar 2010) and ~1-1.5 Ma and ~1 Ma at Swartkrans and Wonderwerk Cave, respectively (Berna *et al*. 2012; Pickering *et al*. 2012; Kuman 2014).

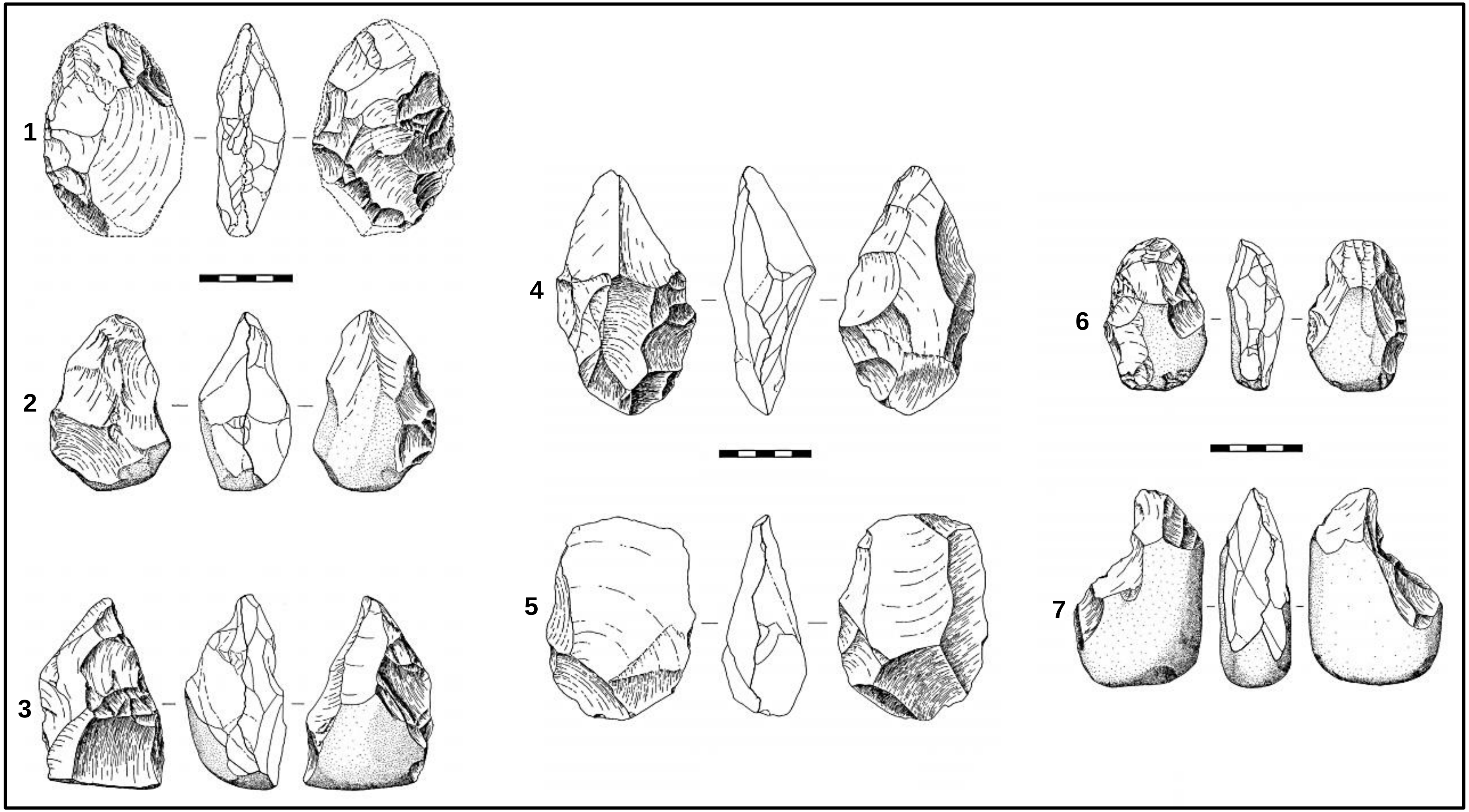


Figure 2.1: Early Acheulean LCTs from the Rietputs ACP assemblage: 1-hornfels handaxe on side-struck flake, 2-lava handaxe, 3-lava pick on cobble, 4-lava handaxe on flake, 5-lava unifacial cleaver on flake (trimming on left bulbar surface), 6-lava handaxe on cobble, 7-lava pick on cobble (from Kuman & Gibbon et al. 2018)., Figure 3 & 4).

The Middle Acheulean

The Middle Acheulean is a period that is suggested to exist between ~1-0.6 Ma (Stout 2011; Kuman 2007). During this period, hominids began to produce LCTs in greater proportions and show increased technical knapping skill (Stout 2011; Kuman 2007). The first use of soft-hammer flaking, and the oldest known prepared core production, occur during the Middle Acheulean (Sharon 2007; White *et al*. 2011; Kuman 2014).

The first prepared core industry, the Victoria West, is dated to older than 1 Ma and has been found in interior South Africa (Stout 2011; Leader 2014). Many researchers have noted the similarity of the Victoria West to the Levallois technique (Clark 2001: 4; McNabb 2001; Beaumont & Vogel 2006; Kuman 2014; Kuman 2016).

The Later Acheulean & Final ESA

The Later Acheulean is suggested to span between ~0.6/0.5 to 0.3/0.25 Ma. This period is marked by greater general knapping skill and more refined techniques (Kuman 2014; Kuman 2016). Later Acheulean producing hominids seem to have been more focused on LCT production and demonstrated greater capacity for identifying and exploiting the best available raw material (Clark 2001). LCTs were more intensively shaped and more standardised and symmetrical (Klein 2000; Kuman 2016*).* The symmetrical shaping (lateral and bifacial) of some LCTs suggest an understanding of the concept of symmetry at this time (McNabb 2001; De Lumley 2009).

This stage of the Acheulean is associated with archaic *Homo sapiens,* a more evolved species than *Homo ergaster* which is associated with the preceding Earlier and Middle Acheulean (Clark 2001; Stout 2002; Kuman 2014; Kuman 2016). Archaic *Homo sapiens* appears to have matured more slowly, which had implications for human behaviour (Kuman 2014). The number of known Late Acheulean sites is significantly higher than sites from earlier stages of the ESA, suggesting that hominids at this time were more successful than their ancestors (Kuman 2014). The first known occupation of caves occurs in the Later Acheulean. Some of the earliest sites (all in South Africa) include: Cave of Hearths at ~0.45 Ma, Montagu Cave <0.6

Ma, and the Olieboompoort rockshelter <0.6 Ma (Kuman 2016). Wonderwerk Cave may also have been inhabited around the same time (Clark 2001; Kuman 2016).

Variability at the end of the ESA

Throughout the Acheulean, hominids were primarily focused on the production of LCTs and (relatively) simple sharp flakes (McPherron 2000; Sharon *et al*. 2011). Although the technical skill of knappers increased during the Acheulean, the same broad technique was used to produce LCTs throughout this period (McPherron 2000; Sharon *et al*. 2011). Variation between assemblages was largely in the form of type proportions and the raw material used (Sharon *et al*. 2011). The morphology of LCTs was often controlled by raw material properties and form (the morphology of available natural material), and by the degree of use, as evidenced by re-shaping due to continued sharpening of pieces (Wynn & Tierson 1990; McPherron 2000).

A higher degree of technological variation is evident in assemblages dating to the late Acheulean, particularly in the production of LCTs (Wynn & Tierson 1990; Clark 2001). Some of this variation is likely due to spatial and temporal differences in the function/use of artefacts, probably driven by environmental conditions (Clark 2001: 7). However, differences in the raw material available at different sites is considered to be a major factor influencing the variety of technological approaches and production techniques utilised during this period (McPherron 2000; Clark 2001: 1). Towards the end of the Acheulean, hominids had the ability to produce lithics on a wide variety of raw materials, including soft and hard rocks with vastly different mechanical properties (Clark 2001).

2.1.2 The Fauresmith & regionalisation

Some intermediate industries that can be viewed as transitional technological traditions develop towards the end of the Acheulean and represent the start of regional specialisations. Some assemblages from the period at the end of the ESA and the ESA/MSA transition are characterised by accelerated changes in human behaviour, as evidenced by greater technological complexity (Kuman 2016).

Regional industries of this kind provide a unique glimpse of the cognitive and behavioural qualities that archaic *Homo sapiens* displayed.

Numerous researchers have debated the place of the Fauresmith within the southern African Stone Age sequence (see Underhill 2011). The 'Fauresmith' was described by Goodwin in 1925 as an “archaeological industry or culture intermediate between the Earlier Stone Age and Middle Stone Age” (Underhill 2011: 15). Clark (1970) placed the Fauresmith within the ‘first intermediate’, which falls between the ESA and MSA. Mason (1961) considered the Fauresmith to be a part of the later Acheulean. Peter Beaumont is one of very few researchers to suggest that at least the final stages of the Fauresmith are related to, if not part of, the MSA (Beaumont & Vogel 2006).

Recent dating of the Fauresmith at Kathu Pan yielded a date of ~500 ka (Porat *et al*. 2010). This suggests an association with the Later and Final Acheulean (Herries 2011; Lotter *et al.* 2016). This makes the Fauresmith contemporaneous with the Kapthurin Formation regarding innovative developments such as blade production (Porat *et al.* 2010). Traditionally, researchers believed blade production to be a development only associated with modern humans (McBrearty & Brooks 2000). It is suggested that the cultural and behavioural advancements represent an increase in more complex skills evidenced for example by the strategy of exploiting organised cores to systematically remove blades (Porat *et al*. 2010: 269; Wilkins & Chazan 2012; Kuman 2014: 16).

It is agreed that the Fauresmith provides insight into the specific (and in this case more precocious) technological practices (van Riet Lowe 1927; 1945; Goodwin 1929; Herries 2011; Underhill 2011) associated with archaic *Homo sapiens* (Herries 2011), which directly preceded modern humans in the archaeological record–a period of significant diversification in both anatomical and behavioural/cultural developments (McBrearty & Brooks 2000). Smaller handaxes, large and/or average sized cleavers, points, blades and prepared cores are the major, but not the only, diagnostic features of assemblages claimed to represent the Fauresmith stone tool culture (Sampson 1974; Herries 2011; Underhill 2011; Wilkins & Chazan 2012; Wilkins 2013; Wilkins *et al*. 2015; Lotter *et al*. 2016). Blades, points and prepared cores appear as early as ~0.5 Ma (Porat *et al*. 2010), but only become widespread in the ensuing Middle Stone Age (MSA) ~0.3/0.2 Ma (McBrearty & Brooks 2000; Lombard 2012; Wurz 2013, 2014; Wadley 2015).

The Sangoan techno-complex is argued by some researchers to be contemporaneous with the Fauresmith, although it is presently very poorly dated (Barham 2000, 2001; Clark 2001; Kuman 2016). It has been found at sites across south central Africa and is best known at Kalambo Falls in Zambia from an assemblage dating to ca. 0.2 Ma (Barham 2000, 2001; Clark 2001; Kuman 2016). It is characterised by several types of artefact categorised as 'heavy-duty tools' along with limited LCTs (Clark 2001; Barham & Mitchell 2008). The 'heavy-duty tools' include picks (broadly similar to those found in the Acheulean) and core-axes (Clark 2001; Barham & Mitchell 2008). Sangoan assemblages have yielded the oldest known bifacial points (Barham & Mitchell 2008). This techno-complex has been considered to represent a technological/cultural adaptation to forested areas in contrast to the Fauresmith, which largely appears in grassland areas (McBrearty & Brooks 2002). However, it is likely that during the drier periods associated with the Sangoan, the currently forested areas where it is found would have been more open woodland areas (Barham 2000, 2001).

The South African sites (Figure 2.2) described below provide most of the published information on the Fauresmith industry. Some of the assemblages from these sites are small, and the published data are limited. However, these sites yield enough information to be used as reference sites for the Fauresmith industry:

Kathu Pan 1

Stratum 4a of Kathu Pan 1 has yielded a large Fauresmith assemblage which has been dated to 682–417 ka using both OSL and U-series-ESR (Porat *et al*. 2010; Underhill 2011). The age of the assemblage suggests an association with the later Acheulean rather than the MSA for this assemblage, and perhaps for the Fauresmith as a whole (Herries 2011; Lotter *et al.* 2016). In general, the Fauresmith material yielded from Stratum 4a is dominated by banded ironstone raw material and includes Levallois points, convergent or laterally retouched side-scrapers (made on flake blanks), prepared cores, a small number of handaxes, and blades (Beaumont 1990b; Porat *et al*. 2010; Chazan 2015a). The high degree of blade production represented in the assemblage is significant as this technological practice has previously been described as a modern *Homo sapiens* innovation (specifically associated with the MSA) (McBrearty & Brooks 2000).

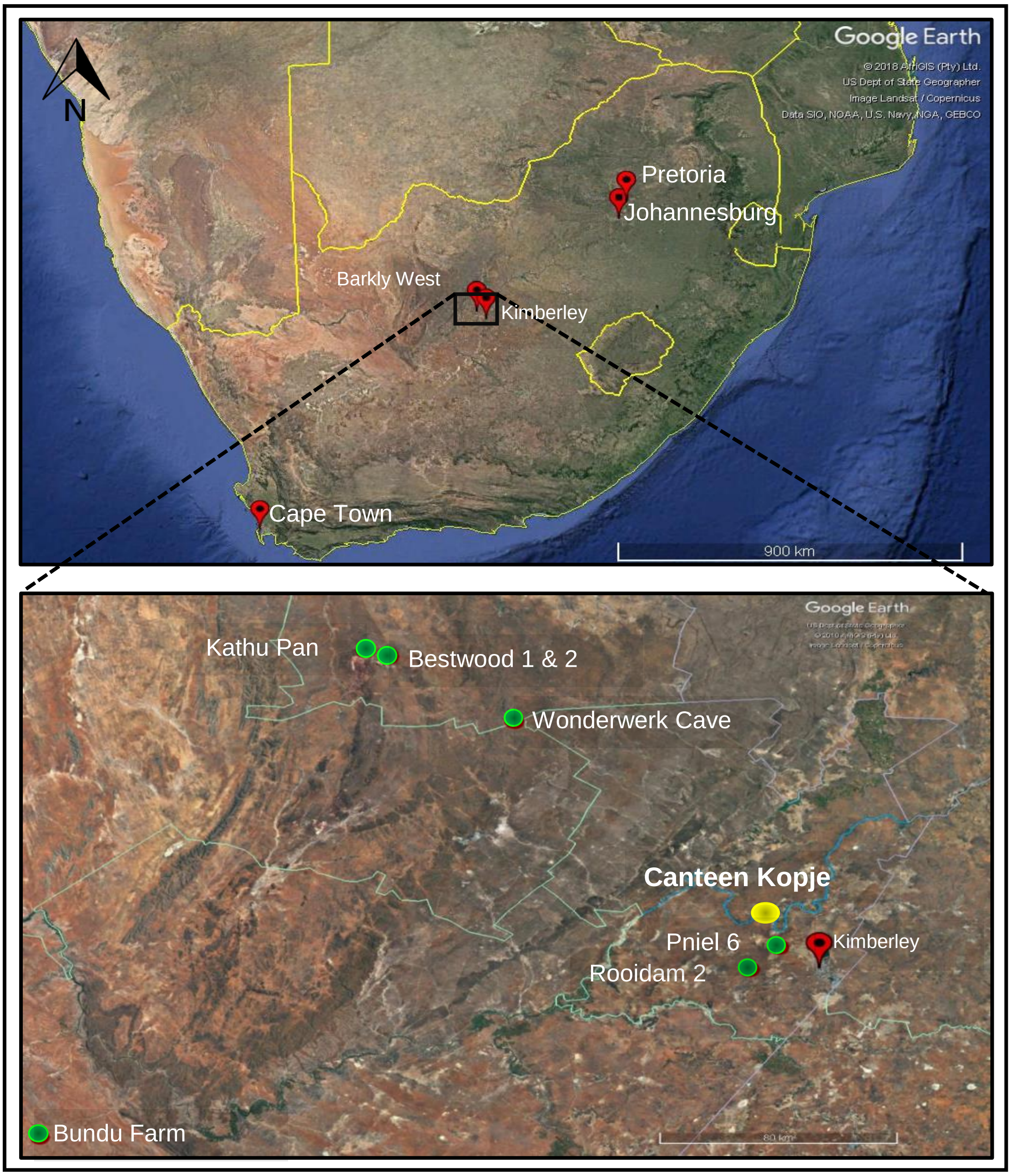


Figure 2.2: The location of known Fauresmith sites in South Africa (from Google Earth 2018).

Technological analysis for the KP-1 Fauresmith blade production was adapted from MSA blade assemblage studies by Villa *et al*. (2005) and Soriano *et al*. (2007). A comparative study with published material from the Kapthurin Formation, East Africa and Qesem Cave, Israel found some similarities between the Kathu Fauresmith and the industries at these sites (Wilkins & Chazan 2012). The reduction strategies that dominate the Kathu Pan assemblage differ from those utilised in the Fauresmith at Canteen Kopje (based on the large Pit 6 assemblage; see Figure 1.2), which appears to be the result of significant raw material differences. Kathu Pan is dominated by banded ironstone, which may present more favourable flaking qualities (Wilkins & Chazan 2012).

Wonderwerk Cave

Wonderwerk Cave Excavation 1 is an extraordinary site as it provides a single *in-situ* stratified sequence representing the full extent of the southern African ESA (Chazan 2015a). Wonderwerk is the only cave context to yield Fauresmith material (Beaumont & Vogel 2006). The concept of inter-assemblage variability is obvious when one compares Wonderwerk to surrounding sites, such as Kathu Pan 1 (Chazan 2015a). Excavation 1 at Wonderwerk Cave contains handaxes which do not decrease in size relative to earlier levels and no associated blade technology (Chazan 2015a). It appears that the Fauresmith is absent from this excavation (Chazan 2015a). However, the Excavation 6 assemblage, which is described as being Fauresmith, contains blades, bifaces and prepared cores (Chazan 2015a). A date of 286-276 ka, using U-series dating, has been suggested for Wonderwerk Cave Excavation 2 (Beaumont & Vogel 2006), which has yielded Fauresmith material comprised of "blades together with large bifaces, prepared cores and unifacial Levallois points" (Porat *et al*. 2010: 270).

Rooidam 1 & 2

Rooidam 1, a pan site which was first excavated in 1964-65 by G.J. Fock (Fock 1968; Butzer 1974), has >18 000 artefacts (classified as Fauresmith based on the presence of handaxes and their morphology), yielded predominantly from Stratum 9 within a 5 m sequence (Beaumont & Vogel 2006). Flakes with facetted platforms and broad bifaces are present at Rooidam 1, along with small numbers of cleavers and choppers (Porat *et al*. 2010). Beaumont & Vogel (2006) suggest that the overlying Stratum 1 does not belong to this regional Fauresmith industry but rather represents a Late Acheulean assemblage based on the presence of prepared cores and blades and the absence of Levallois points. Instead they posit different phases of the

Fauresmith, with Stratum 1 of Rooidam 1 yielding 'Middle Fauresmith', and the nearby site of Rooidam 2 being suggested to have yielded 'Early Fauresmith' evidenced by "a reduced range of scraper and other retouched forms" (Beaumont & Vogel 2006: 223). U-series dating of Rooidam 1 provided a date >174 ka (Szabo & Butzer, 1979), which is suggested to be too young for this Fauresmith site by Beaumont & Vogel (2006) based on their interpretation of the age range of the Fauresmith. Clark (2001) suggests a date of 300-200 ka.

Bundu Farm

Bundu Farm, also a pan site, was excavated from 1998-2003 (Kiberd 2006). Group 4-6 strata are described as containing either a Final Acheulean or ESA/MSA intermediate industry (Kiberd 2006). The flakes from these strata have an average length of 50 mm and are described as mainly end- or side-struck and rhomboid shaped, with radial cores mainly used for flake production (centripetal reduction) (Kiberd 2006; Porat *et al*. 2010). Group 5-6 strata contain an assortment of core tools, in contrast to the overlying MSA Group 2-3 strata, but have also yielded the largest prepared cores compared to other levels, with examples of this core-type displaying extensive preparation and "main striking flake scars" (Kiberd 2006: 195). Group 6 yielded a single biface artefact, with 'flake-blade' sections evident in this horizon and a total of 51 flake-blade artefacts from Group 4-6. Other lithic components recovered from these horizons include "Levallois, irregular and discoidal cores, a small conical core/core tool, modified pebbles, a flat-based high-backed core tool, spheroids, unmodified flakes, bifacially worked points…laterally retouched flakes and chunks, some of which were notched" (Kiberd 2006: 196). Whilst Kiberd (2006) does not classify the assemblage as Fauresmith, it is considered to possibly fit within the industry by other authors (Underhill 2011).

2.1.3 The Early MSA

The MSA is a period of technological developments such as widespread production of blades and points. Although such MSA elements exist as early as ~0.5-0.3 Ma (McBrearty & Brooks 2002; Wurz 2013, 2014; Wadley 2015), they only become widespread in the MSA. In South Africa, the earliest MSA assemblages (dating between ~0.3-0.13 Ma) are included in the informal designation of the early MSA (eMSA) (Lombard *et al*. 2012). The main defining artefact types of the eMSA are discoidal and Levallois prepared cores and blades (Lombard *et al*. 2012; Wurz 2013). Typical Acheulean tool types, such as handaxes, disappear from the human toolkit and are replaced by a variety of prepared core technologies focused largely on blade and point production (McBrearty & Brooks 2002).

The eMSA sites in South Africa include Border Cave, Bundu Farm, Elands Bay Cave, Florisbad, Kathu Pan, Lincoln Cave, Pinnacle Point, Sterkfontein Caves, and Wonderwerk Cave (Lombard *et al*. 2012:139; Schmid *et al*. 2016). The eMSA assemblages from these sites generally have small sample sizes and have seldom been analysed thoroughly (Wurz 2014: 6895).

With regard to East Africa, the Kapthurin Formation, Kenya has yielded eMSA points dated to >285 ka (Henshilwood & Lombard 2013). In Central Africa, the Lupemban Industry is known from several sites dating from ca. 300 ka onwards (Barham 2000, 2002). Lupemban assemblages include bifacial lanceolate points and a range of tools for heavy-duty and light-duty work as well as the first appearance of geometric backed lithics (Barham 2002; Wurz 2014).

2.1.4 Lithic Typology: An Overview

Typology is used for the grouping of lithic artefacts into several types and can be based on their morphology (Krieger 1944), raw material characteristics, size and/or function (Andrefsky 2005: 63). The purpose of a typological approach in stone tool analysis is to diagnostically identify tool types using attributes and thus develop a system to compare assemblages from different sites (de la Torre & Mora 2009: 16). Depending on the focus of the study, and the chosen attributes, typologies can be used, to a certain degree, to interpret or understand the functional and cultural chronology of a region, evidenced by stone tools (Andrefsky 2005: 5).

Francois Bordes' (1961) typology was central to developing typological approaches to lithic studies globally and influenced various researchers working in Africa, including Kleindienst (1962), Clark *et al*. (1966) and Leakey (1967). This led to the seminal typologies for the East African Earlier Stone Age, developed by Leakey (1971) and Isaac (1977).

Mary Leakey (1971: 3) applied typological classifications to Oldowan and Early Acheulean material from Olduvai Gorge Beds I and II, Tanzania. She divided lithic artefacts into three groups: tools, utilised material and debitage. Leakey (1971) further divided tools by size, with material ≥50 mm being termed 'heavy-duty' tools and those ≤50 mm were termed 'light-duty' tools, with some tool types being exempted from this grouping. Leakey (1971) also created categories of tools based on their morphology and other attributes, some of which were used for the typological study conducted for this research and thus will be discussed in further detail in chapters to follow.

Leakey's (1971) typology remains at the core of ESA studies, particularly in East and South Africa, and has been adapted by many researchers. South African examples of typology based on Leakey's work include Kuman's (1994) and Field's (1999) work at Sterkfontein and Swartkrans, Gauteng Province, and Beaumont and McNabb's work on ESA to MSA material in the Northern Cape Province (Beaumont and McNabb 2000; McNabb 2001; Beaumont 2004; McNabb & Beaumont 2011a, b).

The author wishes to stress that the purpose of the typological analysis applied to all excavated lithics from the new Pit 4 West trench was to provide a dataset, based on artefact types, to use for the geoarchaeological study of the stratigraphy at this pit. As mentioned previously, Fauresmith technology is highly debated, and the contexts of many recorded assemblages suggested to belong to this industry are also often disputed. The author had to analyse all material to 1) identify typological trends present throughout the Pit 4 West sequence, and 2) observe if these trends could be stratigraphically isolated and understood within their individual contexts using geoarchaeological data.

A technological study (which considers the production, use and reuse of a tool i.e. behavioural developments) in the lithic assemblage from P4W was not required to complete the above-mentioned goals. However, the author acknowledges and appreciates the importance of a techno-typological approach within lithic studies and the limitations of a purely typological approach for understanding human behaviour and cognition from a lithic assemblage. Therefore, a technological study of the Pit 4 West assemblage will be conducted and published after the submission of this dissertation.

2.2 Geological context

2.2.1 The Vaal River Basin

“No archaeologist can appreciate the stratigraphy and chronology, nor indeed the lithology and typology revealed in the Vaal River valley, if he [or she] is not familiar with the general geological background.” ~ van Riet Lowe (1952: 135)

The first survey of the Vaal River basin, which included reporting on both the geological and archaeological nature of its terraces and the associated artefact-bearing stratified sequence, was conducted in 1936 and 1937 (van Riet Lowe 1952: 135). The geological history of the Vaal River itself is fundamental to understanding the movement of raw material in the system, the original locations of these materials and the most recent context and condition of these materials.

The author primarily provides sedimentological descriptions from van Riet Lowe (1952). Although his interpretations of the fluvial history and formation of the Vaal River are debated, his sedimentological descriptions of the various deposits are still used by researchers and are thus relevant. More recent interpretations regarding the history, formation and chronology of the Vaal River deposits are considerably more nuanced (e.g. Partridge & Brink 1967; Helgren 1977, 1979; De Wit *et al.* 2000; Gibbon 2009; Gibbon *et al*. 2009).

The regional geology of the Vaal basin provides general context to archaeological deposits. However, it is important to note that there is a great deal of variation in the specific geological sequence of any particular location within the basin, and stages may be absent or limited (Gibbon 2009; Gibbon *et al*. 2009). The author recognises the need to balance the broader regional context with site-specific interpretations of context (see sections below). Below the author provides a description of the Vaal River Basin that includes both van Riet Lowe’s (1952) original interpretation of the broader geomorphological model of the region, as well as more recent revisions and corrections pertaining to his original model on the fluvial evolution of the Vaal River, by other researchers (Helgren 1979; De Wit *et al*. 2000; Gibbon 2009).

Pre-Quaternary Period:

The term pre-Quaternary here refers to the geological period/s prior to ~2.5 Ma (Walker 2005). During this time the Vaal River began migrating in a southward direction. This migration was primarily due to the erosion of deposits of the Karoo system, located to the south, that are less resistant than the northern Ventersdorp diabase which underlies the Karoo system (van Riet Lowe 1952: 135). These more resistant sheets of Ventersdorp diabase are gently south-sloping, a characteristic which further aided in the southerly movement of the Vaal River (van Riet Lowe 1952: 137).

The southward migration of the river system resulted in the removal of softer material present in the conglomerates and shales associated with the Karoo sediments to the south (left) bank of the river (van Riet Lowe 1952: 137). This led to residual material remaining, such as 'quartzite, quartz, chert, agate, jasper, banded ironstone and chalcedony rocks' that were far more resistant (van Riet Lowe 1952: 137).

The lithological composition of the Vaal River gravels differs between the upper and lower sections of the system (van Riet Lowe 1952: 138). The geological transformation of the landscape during both tertiary and early quaternary glacial periods (glacial-action) and the post-glacial periods (specifically referring to river-action) resulted in conglomerates containing different components (such as boulders, pebbles or gravels) existing either within the system or near its catchment area. De Wit (2008: 53) states that the dominant andesite component of the gravels is linked to the weathering of Ventersdorp lava bedrock in hills along the Vaal resulting in the colluvial deposition of clasts ranging in size up to large boulders. These conglomerates are often composed of reworked material and thus the source of some of the conglomerates in the river deposits are in regions that are not directly associated with the current river catchment (van Riet Lowe 1952: 137).

Quaternary Period:

The Quaternary is the most recent geological period spanning the last ~2.6 Ma of Earth's history, up until and including present day (Lowe & Walker 1997: 1; Walker 2005). The Quaternary period is made up of two epochs. The first is the Pleistocene, which is the earliest period–beginning ~2.5 Ma and ending ~11,700 thousand years ago (ka) (Walker 2005). This period is most relevant to this research project as the earliest known date for stone tool production by past hominids in South Africa is ~2.18 Ma from the Sterkfontein Caves, Cradle of Humankind, Gauteng Province (Granger *et al*. 2015). The second and shorter epoch of the Quaternary is the Holocene, which begins at ~11,700 ka and is the interval that extends to the present day (Lowe & Walker 1997: 1).

The Vaal River Sequence

Van Riet Lowe (1952) describes the landscape of the Vaal River Valley as containing two main shelves that were cut into the valley over time. The terraced aggradations associated with these shelves are of great significance as they are composed of both coarse and fine deposits that contain stone tool material of different ages. Gibbon (2009) emphasises that the poor chronological framework and lack of absolute dates for the terrace deposits associated with the Vaal River brings earlier fluvial history models into question. The sequence of these terraces will be described below from the oldest, gravel, deposits. Van Riet Lowe (1948) proposed a stratigraphic sequence for the gravels made up of three levels: 'Older', 'Younger' and 'Youngest' gravels. The more recent Hutton/Kalahari Sands have been recognised as the youngest stage of the sequence, overlying the Youngest gravels, and will also be described below. It must be noted that the chronology of local deposits may differ from this sequence and thus an understanding of the local geological context is vital (Gibbon *et al*. 2009).

The Basal Older Gravels and the Older Gravels:

Subsequent to a period of tectonic uplift and wetter conditions during the Miocene (23.03-5.33 Ma) a period marked by "river rejuvenation/incision" (Gibbon 2009: 10) occurred. After the arid period that marked the end of Miocene, another period of incision occurred during the Pliocene (5.33-2.58 Ma), specifically leading to the deposition of large-scale gravel deposits (De Wit *et al*. 2000; Gibbon 2009).

The 'Older Gravels' associated with the Vaal River are divided into two aggradation types by van Riet Lowe (1952: 141). The first form of aggradation is the *in-situ* 'Basal Older Gravels'. This deposit is primarily made up of 90-95% of heavily rolled diabase pebbles and boulders. The diabase pebbles are generally a few centimetres in diameter with the larger boulders reaching much larger dimensions. Quartzite, quartz, indurated-shale, chert, banded-ironstone, jasper, chalcedony and agate primarily constitute the remaining 10-5% of raw material, and are also heavily rolled (van Riet Lowe 1952: 141). The size and shape of the non-diabasic raw material can be compared to that of a 'potato'. In general, it is suggested that this basal level is archaeologically sterile.

The 'Older Gravels' that overlie the basal levels described above are characterised primarily by residual, more resistant non-diabasic raw material, such as quartzite, quartz, indurated-shale, chert, banded-ironstone, jasper, chalcedony and agate. The proportions of these materials contrast greatly to the lower basal gravels, as it is the disintegration and decay of the basal diabase and indurated-shale material that results in the increased presence and redistribution of non-diabasic material in the form of eluvial concentrations ('Older Gravels'), which are associated with a notable increased 'trace' of diamonds (van Riet Lowe 1952: 141 & 142). The term 'eluvial' refers to material being '*in-situ'* or material remaining relatively close to its source, as opposed to being transported by a water, such as in an alluvial deposit. Helgren (1977) describes the Older Gravels as being erratic in expression as they reflect the few depositional remnants of an extended period of time dominated by erosion. Helgren (1977) acknowledges that climate may have been a driver of these events, but that various other factors may have played a larger role.

Over time, the exposed surface of the more resistant Older Gravels (pebble-sized) that were not chemically weathered, or removed previously, became oxidized, leading many researchers to also describe the 'Older Gravels' as either 'Red' or 'Potato' Gravels. In some places, the Older gravels are associated with aeolian-derived Hutton/Kalahari Sands that would have naturally filtered into the gravels during coverage and were also reddened due to oxidation over long periods of exposure (van Riet Lowe 1952: 142).

Historical mining excavations of these Older Gravels, due to its diamondiferous nature, led not only to a profitable diamond-boom but also the destruction of stratigraphy at mined sites and the exposure and removal of prehistoric stone tools.

The Younger Gravels:

The Younger Gravels are made up of deposits of the Riverton and Rietputs Formations (Helgren 1979; De Wit *et al*. 2000; Gibbon 2009). Partridge & Brink (1967) suggest that the Rietputs Formation was formed during a period of semi-arid climate in which multiple shorter humid events occurred (Partridge & Brink 1967). The Younger gravels are divided into three groups: Younger Gravels I, Younger Gravels IIA & B and Younger Gravels III (van Riet Lowe 1952). Helgren (1977) also divides the Younger Gravels into three groups, albeit with different numbering.

Similarly, to the above Basal Older Gravels, The Younger Gravels are primarily made up of 90-95% of heavily rolled diabase pebbles and boulders. The diabase pebbles are generally a few centimetres in diameter with the larger boulders reaching much larger dimensions. Quartzite, quartz, indurated-shale, chert, banded-ironstone, jasper, chalcedony and agate primarily constitute the remaining 10-5% of raw material and are heavily rolled and sub-spheroidal in shape (van Riet Lowe 1952: 143). Similarly, to the description of the Older Basal Gravels, the size and shape of the non-diabase raw material can be compared to a ‘potato’.

Helgren (1977) attributes the large-scale deposition of gravels to a very humid environment with high rainfall, thus resulting in higher river runoff.

Partridge and Brink (1967) have been one of the major critics of the climate-based interpretations provided by researchers such as Söhnge *et al*. (1937); Riet Lowe (1952) and Helgren (1977). In contrast, they suggest that the variations associated with the river deposits are a result of the normal differences that are associated with different stages of a river system, in this case a mature stage. Furthermore, they suggest that a variety of factors including the geomorphic and geological characteristics of the river system at the time influenced the nature of the deposits.

Factors including "tectonics, river capture, variable lithologies and the cyclic passage of knickpoints" (Gibbon 2009: 25).

The Younger Gravels are characterised by a high proportion of stone tool implements. The assemblages associated with Younger Gravel I aggradation are characterised by handaxes and were thus described as being associated with the 'African Chelles-Acheul culture'–what we now refer to as the African Acheulean (van Riet Lowe 1952).

The Youngest Gravels:

After the deposition of the Younger Gravels, heavily calcified sand and limestones covered their upper surface on a regional scale to varying depths (van Riet Lowe 1952: 144). These deposits became eroded, leaving an erosional platform at varying heights above the Younger Gravels. The Youngest Gravels were then deposited on this platform. Van Riet Lowe (1952) associates the appearance of the Fauresmith stone tool culture with this erosive surface of the Youngest Gravels. Note that the Youngest Gravels and the associated erosional surface are not found at Canteen Kopje. The appearance of this deposit is controlled by local palaeo-geomorphology and so may be absent in locations within the Vaal Basin.

The Youngest Gravels are described as 'tributary gravels' and differ lithologically and in form from the Older and Younger Gravel aggradations, as these gravels are derived from Vaal tributaries with different bedrock types (van Riet Lowe 1952: 143). In contrast to the Older and Younger Gravel levels, the Youngest Gravels are primarily made up of 50% diabase material and 50% non-diabasic (mainly indurated shale) raw material. Unlike the Younger Gravels, the constituent material associated with the tributary gravels are either slightly rolled or not rolled and are sub-angular in shape.

Hence the Youngest Gravels, are notably different from the underlying gravel levels described above. They are characterised by the sub-angular shape of constituent material (van Riet Lowe 1952: 144). Considering the sedimentological observations of the Youngest deposits, it is suggested that the conditions associated with its formation was not one of alluvial aggradation but rather "strong sheet erosion or violent eluvial" (van Riet Lowe 1952: 144) aggradation.

The Hutton/Kalahari Sands:

As well as being associated with the Youngest Gravels, the Fauresmith is also found within red aeolian-derived sands, referred to as the Hutton Sands or Kalahari Sands, which densely covered the upper surface of exposed gravels Van Riet Lowe (1952: 144). Chazan *et al*. (2013: 4) describe the Hutton Sands as "yellow to red silty sand" with the latter grain component being derived from the nearby Vaal River. The Hutton Sands contain stone tool implements associated with the ESA, MSA and LSA as well artefacts associated with the historical period in the region, at Canteen Kopje and a handful of other sites.

2.2.2 Canteen Kopje: History of Research

Canteen Kopje is an archaeological site that is situated near Barkly West in the Northern Cape Province, South Africa (Figure 2.3). The illustrious Abbé Henri Breuil, with reference to Canteen Kopje, stated: "You not only have enough artefacts to fill a museum here, but also enough to build the museum" (Clark 1959: 127). The archaeological significance represented by the rich deposit of well-preserved Earlier Stone Age (ESA) artefacts at Canteen Kopje was first recognised in the late 1800's when it was exposed during the historical diamond mining rush that began in the region in 1869 (de Wit 2008). Subsequently, Canteen Kopje was declared a national monument in 1948 because of both the historical diamond mining activity and the geological and archaeological importance of the site (de Wit 2008; Lotter 2010a, b; Kuman 2012).

Since the start of the 20th century numerous researchers have studied the artefactual material yielded from Canteen Kopje (Goodwin 1927, 1929, 1934; Goodwin & van Riet Lowe 1929; van Riet Lowe 1937; Partridge & Brink 1967; Helgren 1978, 1979; De Wit 1996, 2008, Beaumont 2004; Forssman *et al*. 2010; Lotter 2010a, b; McNabb & Beaumont 2011; Lotter *et al*. 2016). However, it was only in 1997 that Peter Beaumont conducted the first controlled excavations of what is described as 'Area 1' and 'Area 2' at Canteen Kopje (McNabb & Beaumont 2011a). Beaumont excavated in 1999 again, and in 2000 with John McNabb. Michael Chazan and his team began excavations at Canteen Kopje in 2007, focusing on the younger levels of the Stone Age sequence (Chazan 2013; Chazan *et al*. 2013) (Figure 2.3).

Research at Canteen Kopje by a University of the Witwatersrand (WITS) team led by G.M Leader, R. Gibbon and K. Kuman began in 2007 (Gibbon *et al*. 2009; Leader 2014). This led to new excavations at the site, to increase lithic samples and improve/refine interpretations regarding stratigraphy and site formation processes (Gibbon *et al*. 2008; Gibbon *et al*. 2009; Leader 2014; Lotter *et al*. 2016; Li *et al*. 2017). These investigations into both the context of artefacts as well as the techno-typological descriptions of the lithics, provide insight into the technological practices and behaviour of hominids on the landscape that we now refer to as Canteen Kopje.

Beaumont (2004a) first recorded diagnostic Fauresmith artefacts in the top 30 cm of the gravel levels that underlie the unconsolidated Hutton Sands in a pit at the site. He also stated that at Canteen Kopje the industry described as Fauresmith has received little attention and required more in-depth investigation.

A geoarchaeological study conducted by Lotter (2010a, b) and Lotter *et al*. (2016) was the first to specifically focus on site formation at Canteen Kopje using some high-resolution techniques. The study was on Pit 6 (Figure 1.2), which comprises a 7 m stratified sequence consisting of aeolian-derived Hutton Sands underlain by earlier alluvial gravels (Beaumont 1999; Gibbon *et al*. 2009; Leader 2014; Lotter *et al*. 2016). A mixed contact zone (MCZ) (approximately 35 cm thick in Pit 6) has developed at the unconformable contact or interface between the Hutton Sands and gravels (Beaumont 2004; McNabb & Beaumont 2011a, b; Lotter *et al*. 2016). The Fauresmith is associated with the MCZ and the base of the overlying Hutton Sands (Lotter *et al*. 2016).

The research completed for this dissertation built on the above past site formation work at Canteen Kopje particularly in Pit 6, by applying a broader multi-disciplinary and more fine resolution approach to the study of the site formation patterns associated with the proposed Fauresmith industry, in a new area of the site.

The gravel deposit that characterises the Canteen Kopje site is suggested to belong specifically to the Younger Gravels aggradation of the Vaal River Basin and is a component of the Rietputs Formation (de Wit 2008). The palaeo-channel to the east of the site (Figure 2.3) is suggested to be responsible for the deposition of the Younger Gravels present in the Canteen Kopje area which contain the early Acheulean layers of the site (Söhnge *et al.* 1937; Helgren 1977; Leader 2014).

There are six cultural layers evident in Pit 6. Figure 2.3 shows the fine sediments, a mixed contact zone (MCZ) at the interface of the fine sediments and the top of the underlying alluvial gravels, which contain the first sands to accumulate at the site ca 0.3 Ma (Chazan *et al*. 2013). A preliminary age for the top of the alluvial gravels is >1 Ma (Beaumont and Vogel 2006; Leader 2014).

The deposit that was most relevant to Lotter *et al*.'s (2016) research was the unconsolidated Hutton Sands (devoid of clasts) which is approximately 2.1 m in thickness (Leader 2014). In Pit 6, the Hutton Sands yielded LSA material from 70-140 cm and MSA material from 140-170 cm (Forssman *et al*. 2010; Sarupen 2010; Lotter *et al*. 2016). Below 170 cm, Fauresmith material is present, with the MCZ extending from 195 cm to 230 cm. Below the MCZ is ca 2 m of an unmixed alluvial gravel that has yielded both the Victoria West Acheulean industry, and below that two Early Acheulean layers >1.5 Ma (Gibbon *et al*. 2013, Leader 2014; Lotter *et al*. 2016).

There are four phases of the Acheulean industry represented by Canteen's archaeological sequence. The fourth and youngest phase of the 'Acheulean' is the *in-situ* Fauresmith horizon which is associated with the basal level of the fine Hutton Sands, resting on and including the mixed contact zone (MCZ) (Lotter *et al*. 2016: 305). The third phase is the Victoria West prepared Core industry–the most widely known industry from Canteen Kopje (Leader 2014)–with an age of >1 Ma. The first two phases are >1.5 Ma and belong to the Early Acheulean (Beaumont & Vogel 2006; Leader 2014).

The Victoria West levels are characterised by rolled artefacts, pebbles and andesite cobbles and boulders (Leader 2014). In contrast, the Fauresmith artefacts are in much fresher, unrolled condition. For the MCZ, Lotter *et al*. 2016 suggest that the irregular top surface of the gravels and bioturbation (insect activity, root growth and possibly tree-throw) are responsible for the mixing of some Fauresmith artefacts into the top 35 cm of the gravels in Pit 6.

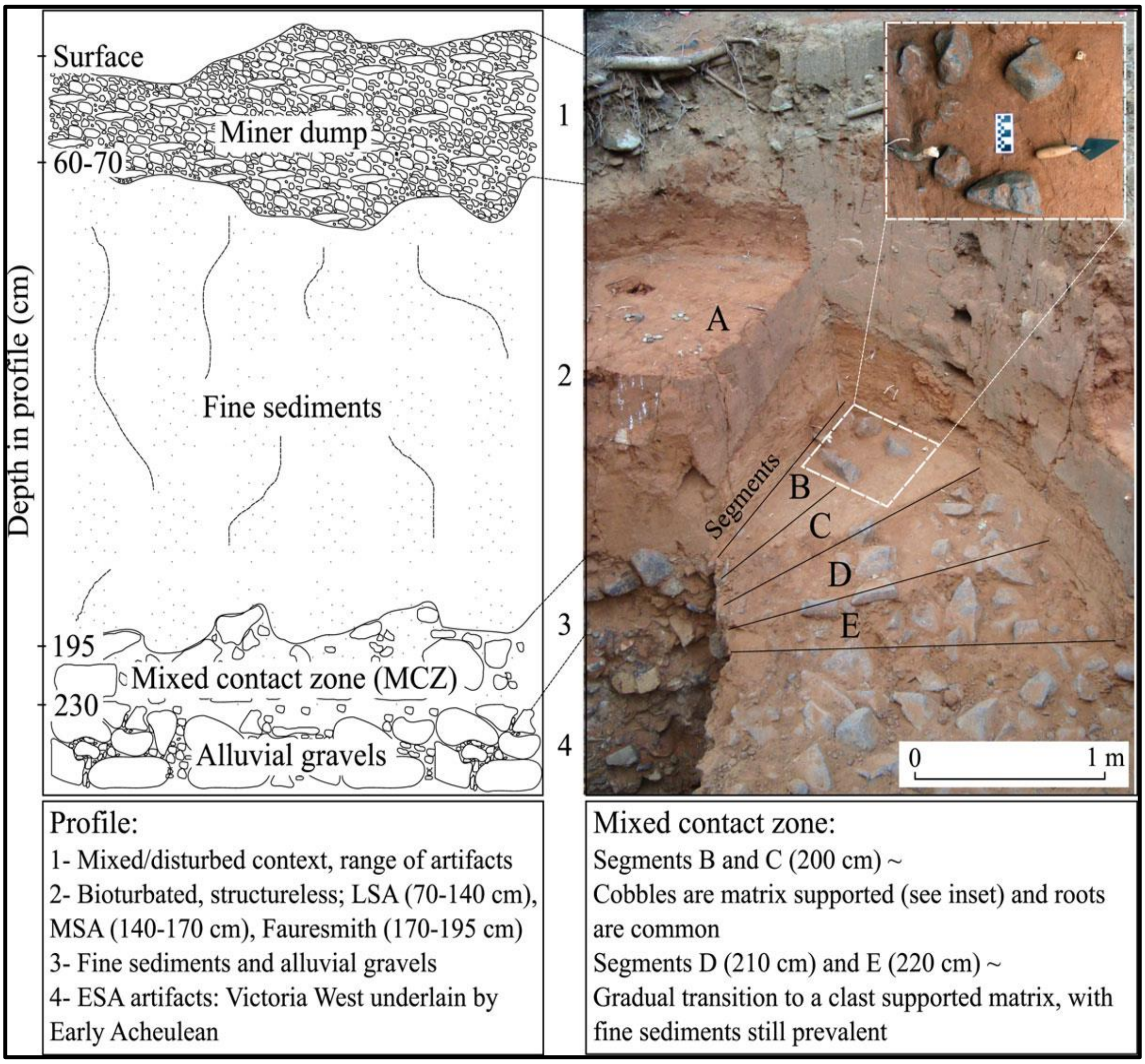


Figure 2.3: The stratigraphic profile of the Canteen Kopje deposits from Pit 6 (left) and a description of the mixed contact zone (right) (from Lotter et al. 2016, Figure 2, 306).

Pit 6 lithic assemblages

Artefacts retrieved from Pit 6 and included in the geoarchaeological study by the WITS team were not discussed in any detail in Lotter *et al*. (2016) but were noted as a Fauresmith assemblage. However, the techno-typological description of this assemblage is under way and the material is confirmed as Fauresmith in nature.

A total of 3335 artefacts was yielded from the Pit 6 excavations at Canteen Kopje (Figure 2.4). The LSA assemblage is made up of 869 artefacts. The MSA assemblage is made up of 806 artefacts. An assemblage of 603 artefacts was recovered from the Fauresmith horizon within the base of the Hutton Sands, with an additional 943 artefacts (potentially Fauresmith) from the mixed contact zone (MCZ). The alluvial gravels assemblage is made up of 194 artefacts excavated from a small portion of the gravel sequence (Lotter *et al*. 2016).

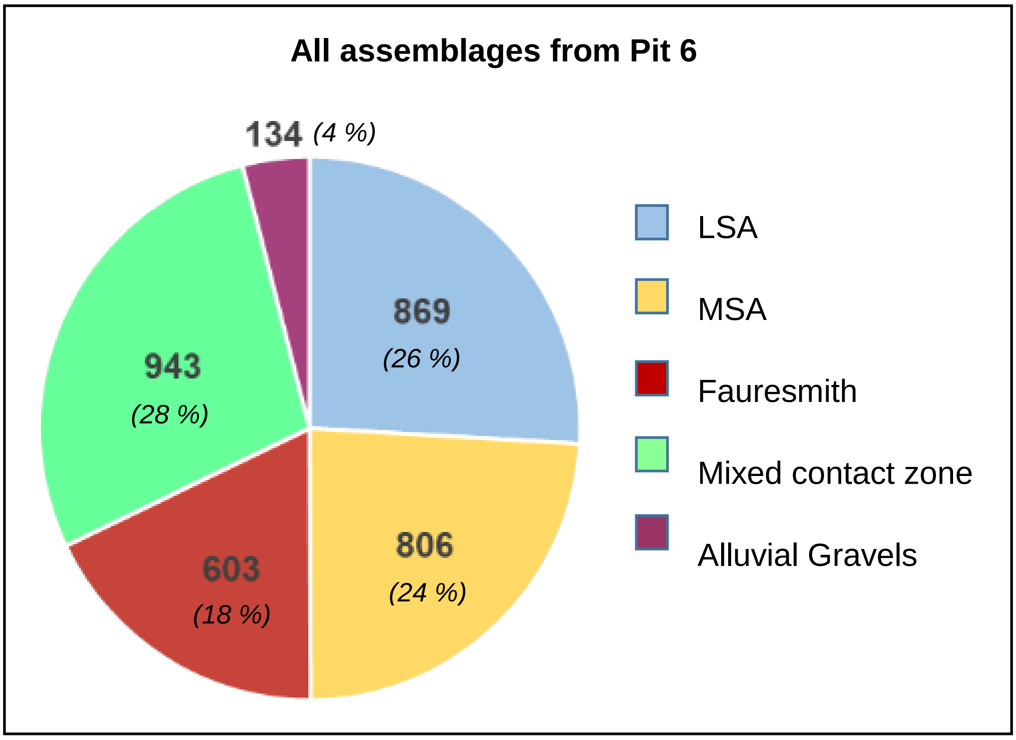


Figure 2.4: A pie graph showing technological assemblages yielded from Pit 6 (n=3355).

Size profiles

Assemblage completeness can be determined by the different size profiles represented at a site (Schick 1987; Kuman *et al*. 2005). Size profile data can be used to determine whether artefact patterns are associated with hominid behaviour and activity, such as technological manufacturing and use practices, and/or or site formation processes such as post-depositional disturbances (Schick 1991: 79-105). The lithic data from the various Pit 6 assemblages, discussed below, show a difference in size profiles stratigraphically (Figure 2.5). The LSA assemblage is comprised of more than 70% of material <20 mm, and no artefact in the LSA level is recorded as being >160 mm (Forssman *et al*. 2010). Within the MSA assemblage, artefacts <20 mm in size make up almost 70% of the assemblage and are defined as small flaking debris (SFD) (Sarupen 2010). The Fauresmith in Pit 6 is dominated by 59% SFD which, in addition to the well-preserved condition of artefacts, suggests that the integrity of the assemblage has not been heavily compromised by post-depositional process (Lotter *et al*. 2016). Within both the MSA and Fauresmith levels, some artefacts are >180 mm, although these are rare occurrences. In contrast to these overlying assemblages, the MCZ assemblage comprised only 29% of material

<20 mm and the assemblage yielded from the alluvial gravels contained only 8% of material <20 mm (Lotter *et al*. 2016). Within the gravels, artefacts >200 mm are common. Figure 2.5 demonstrates the size profiles of the various assemblages excavated in Pit 6 through the Hutton Sands and into the underlying gravels.

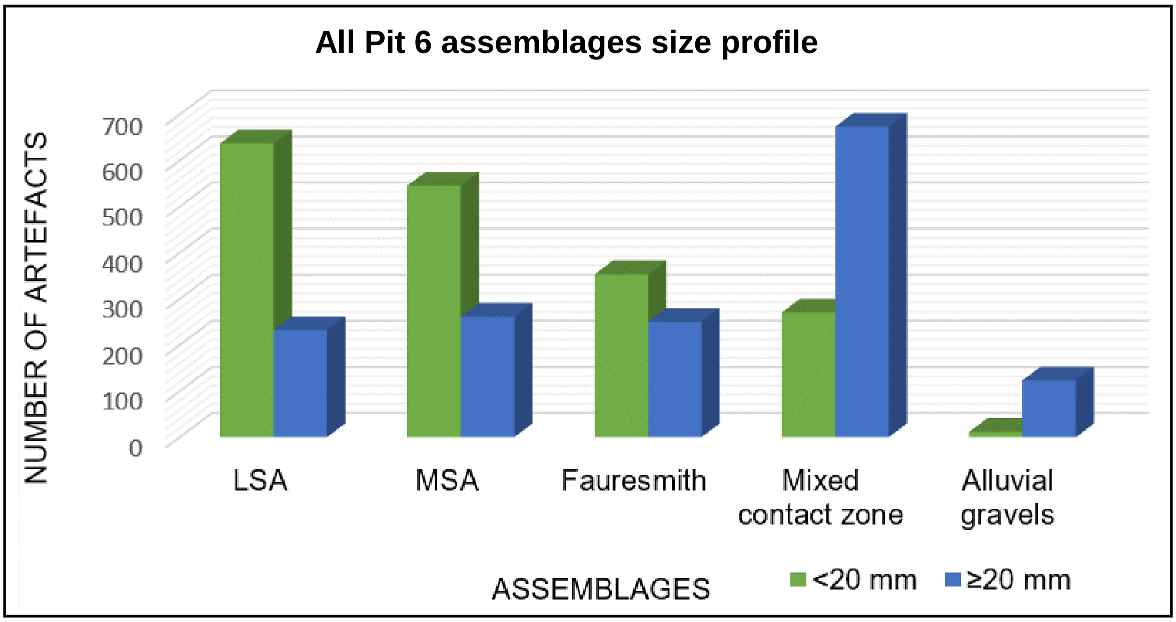


Figure 2.5: A bar graph showing the <20 mm and > 20 mm size profile categories present in each assemblage yielded from Pit 6.

Raw material

Figure 2.6 demonstrates the different raw material proportions of the various assemblages excavated in Pit 6 as reported in the above references. Raw material is one of the single most significant factors influencing tool production. The availability of raw material on the landscape and its structural attributes (minerology, size and shape) affects the form and size attributes of artefacts (Sharon 2008: 1329-1343). The LSA is made up of 56% fine-grained raw materials, 37.1% Ventersdorp lava and 5.2% quartz. The MSA assemblage is made up of 49.5% ‘fine-grained’ raw material, 31.8% Ventersdorp lava and 11.5% quartz. At both Canteen Kopje and other sites, the Fauresmith has been associated with a diverse range of raw material types including quartz, quartzite and ‘finer-grained’ raw material (crypto-crystalline rocks, hornfels, cherts, agates, chalcedonies and banded ironstone) (Wilkins & Chazan 2012; Lotter *et al*. 2016). The Pit 6 Fauresmith assemblage (excluding artefacts from the MCZ) comprises 45.9% ‘fine grain’ material and 41.8% Ventersdorp lava. Within the MCZ assemblage, 37% of artefacts are on Ventersdorp lava and 49.5% are on 'fine-grained' materials. In the gravels, Ventersdorp lava makes up 61.2% of the assemblage.

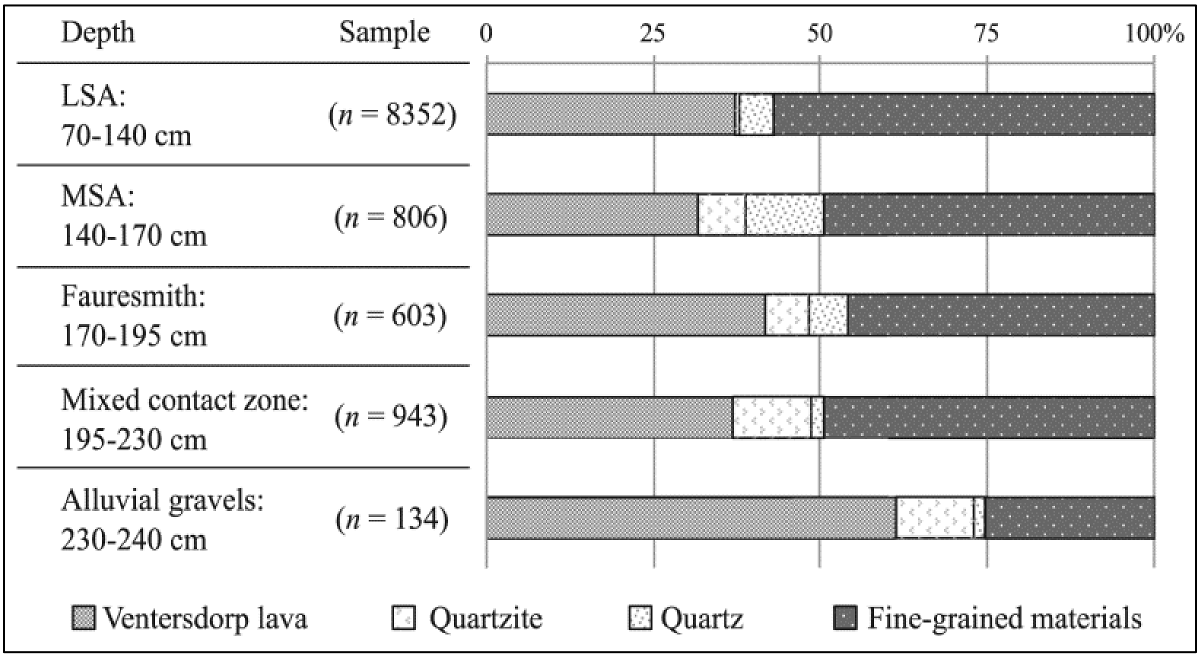


Figure 2.6: Raw material proportions for the respective assemblages from Pit 6 (from Lotter et al. 2016, Figure 6. 314).

Artefact condition

Figure 2.7 demonstrates the different proportions of artefact conditions in the various assemblages excavated in Pit 6. The concept of 'artefact condition', in both Lotter *et al*.'s (2016) study and in this research, relates to the surficial weathering states of lithic artefacts. The degree of abrasion of an artefact's surface can be linked to potential post-depositional mechanisms associated with the movement of artefacts (Shea 1999: 192).

Lotter *et al*. (2016) only provide artefact condition data for the Fauresmith, MCZ and alluvial gravel levels in Pit 6. Within the Fauresmith-bearing portion of the Hutton Sands, only 2% of artefacts were described as heavily weathered/abraded. The majority (56%) of Fauresmith artefacts are classified as fresh/unabraded. The assemblage extracted from within the MCZ comprised 51% heavily weathered/abraded. The slightly weathered/abraded proportion was 24%, and fresh/unabraded proportion constituted 25%. The degree of weathering/abrasion increased notably with depth below surface. The alluvial gravel assemblage is characterised by a large proportion of heavily weathered/abraded artefacts (76%), with only 6% of the assemblage classified as fresh/unabraded (Lotter *et al*. 2016: 312-315). A high percentage of heavily abraded at this stratigraphic level suggests the 'movement and mixing' (of an abrasive-nature) within the gravels.

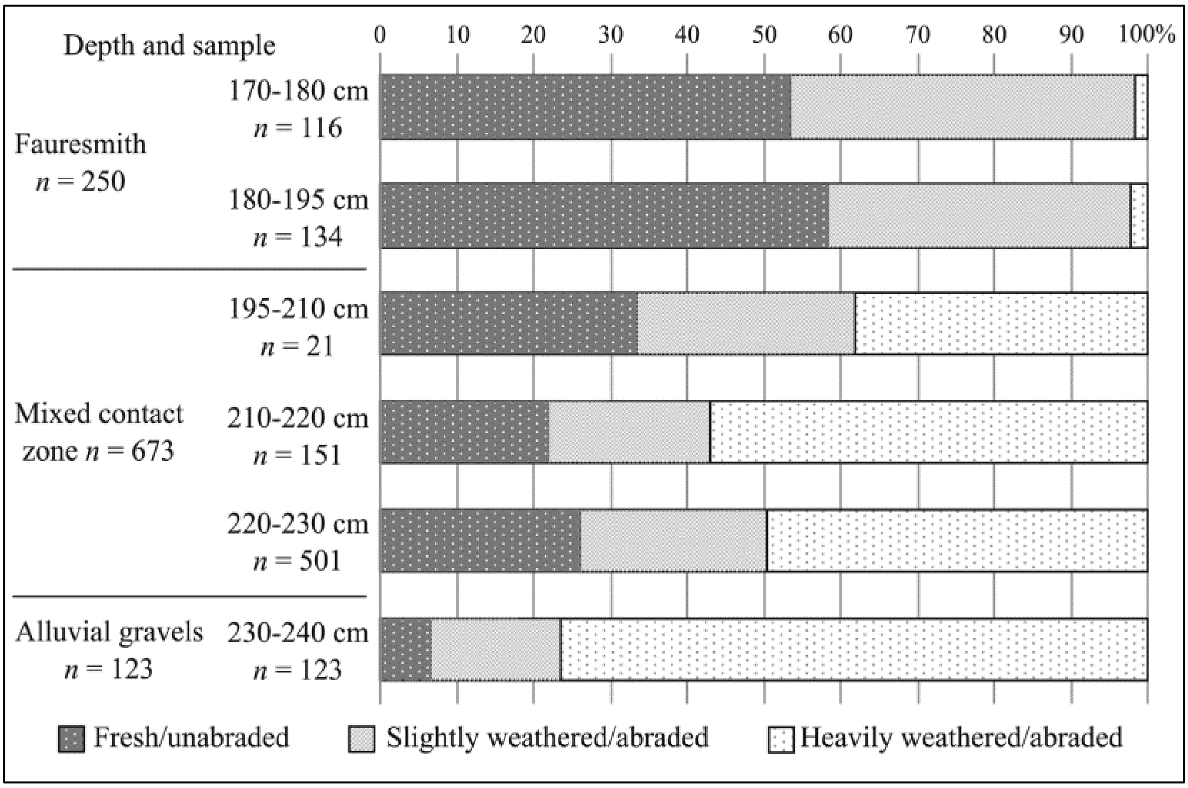


Figure 2.7: Artefact condition distributions for the Fauresmith, mixed contact zone and alluvial gravel assemblages from Pit 6 (from Lotter et al. 2016, Figure 7., 315).

2.3 Sedimentological and geochemical methods: An overview

2.3.1 Sedimentological analysis

The analysis of sediments in the field (*in-situ*) is a vital component of understanding the context of an archaeological deposit (Goldberg & MacPhail 2006). The evaluation of site stratigraphy and the sedimentological properties of stratigraphic units provide the researcher with valuable data on site formation. Data collected in the field include colour, texture, sorting, erosive and depositional structures, sediment composition, and many other properties (Goldberg & MacPhail 2006).

The collection of sediment samples from various strata at an archaeological site allows for further data to be obtained in a laboratory environment–data that is not easily observed in the field. Types of data analysed in the laboratory include mineralogy, particle shape and particle size and the proportion of moisture, organic and inorganic content within samples. These attributes, along with the field data, provide the researcher with an insight into the depositional environment of and post-depositional processes affecting sediments. This in turn allows the determination of potential modifications to archaeological assemblages and thus an understanding of their integrity.

Geoarchaeological studies combining field and laboratory methods have been applied to few open-air sites in southern Africa but have yielded important contextual data for those sites. South African sites to which these methods have been applied include: Doornlaagte and Rooidam (Butzer 1974), Florisbad (Kuman *et al*. 1999), Kudu Koppie (Pollarolo *et al*. 2010), Canteen Kopje (Chazan *et al*. 2013; Lotter *et al*. 2016), and Maropeng (Morrissey 2015; Morrissey *et al*. in prep.)

2.3.2 X-ray fluorescence (XRF)

XRF analysis is focused on geochemical compositions. The purpose of using XRF is to statistically understand the different proportions of different geochemical components present in a sediment samples.

Pillay *et al*. (2000) serve as an example of the application of XRF at a South African site. Iron Age pottery samples from two coastal sites, Mzonjani and Emberton Way, and two inland sites Nanda and KwaGandaganda, were used. The result of the study concluded that specimens recovered from coastal locations and associated with coastal populations originated from an inland source based on the comparison of the chemical composition of the clay in the pottery to known clay-beds (Pillay *et al*. 2000: 61). Whilst this example is based on ceramics, the concept of provenance studies is relevant to this research project. The presence and proportions of minerals within a stratigraphic profile can be used to identify the source/s–or the provenances–of the sediment (Pillay *et al*. 2000; Shackley 2011: 36) and be used to inform us on site formation processes.

The differences between geochemical components/elements can be suggestive of varying depositional environments, as well as the extent of mixing stratigraphically. Therefore, XRF analysis has the potential to provide important information about the similarities and differences between environments represented in sediment samples taken from various levels in a sedimentary profile, as well as the contextual integrity of the deposits.

2.3.3 Optically-stimulated Luminescence (OSL) dating

Optically stimulated luminescence (OSL) dating has become a common and often essential aspect archaeological research. OSL dating makes use of quartz and/or feldspar in sediments and serves as an alternative option for dating sites that lack preserved organic material that would be used for relative or radio-carbon dating (Chazan *et al*. 2013: 12).

There have been two attempts at yielding OSL dates from Canteen Kopje, by Evans & Cunningham (2013) and Chazan *et al*. (2013). Evans & Cunningham (2013) previously dated samples from Pit 6; however, due to the poor conditions of the samples taken from the Hutton Sands (which were also not collected by Evans & Cunningham but by G. Susino), the dating process was not successful. A high over-dispersion rate was recorded in the samples and indicated heavy bioturbation.

Chazan *et al*. (2013) had more success with dating sediments in the unstructured Hutton Sands at Canteen Kopje because they applied single grain analysis. The dating of samples from Pit CK-21 yielded results that were not able to provide a date for the late MSA to early LSA located at the 'lower component' of the Hutton Sands sequence, which was the main aim of their dating attempt. This was due to high over-dispersion in the samples associated with these levels. However, sampling from the interface between the Younger Gravels and the overlying Hutton Sands did provide a dominant age population of ~300 ka (Chazan *et al*. 2013: 12). This provides a minimum date for the Younger Vaal gravels at this location and, potentially, a date estimate for the Fauresmith, which has been associated with this interface or 'mixed contact zone' in past studies (Beaumont 2004; Lotter *et al*. 2016).

As is clear from this discussion, besides the Fauresmith being poorly defined, it is also poorly dated. Therefore, the author pursued OSL dating to gain some chronological control for the ESA to MSA archaeological levels in the new Pit 4 West excavation, with the primary aim being to obtain a date for the Fauresmith. This could help to supplement the date obtained by Chazan *et al*. (2013) for Canteen Kopje and provide further data towards an age range for the Fauresmith across interior southern Africa.

Chapter 3: Methodology

The Methodology chapter is divided into four sections. The first section, 'Excavation methodology', is an in-depth description of the fine resolution excavation protocol applied to the Pit 4 West (P4W) excavation. The second section, 'Recording methodology', is a detailed description of the various techniques used to document the excavation and artefact extraction both geoarchaeologically and archaeologically, in the effort to optimise geospatial control. The third section, 'Lithic analysis methodology', provides the reader with the typology used to analyse and classify the stone tool material yielded. The final section, 'Sediment sampling and analyses', provides the various protocols followed for the different sampling and analyses of sedimentary material at various resolutions for a diverse range of data.

3.1 Excavation methodology

As mentioned in previous chapters, earlier excavations at Canteen Kopje have been conducted at relatively low resolution. Macroscopically, the sands capping the gravels contain little visible stratigraphy. In addition to this, a high rate of bioturbation, principally from root growth and insect activity, has affected assemblage integrity to some degree, especially at the contact between the sands and the gravels. However, despite these factors, there is a clear archaeo-stratigraphy in which different techno-complexes are evident within the sequence. The presence of three different industries in sequence in the sands conforms to identification of Fauresmith, MSA, and LSA.

The degree of resolution applied to an excavation and the documentation of a site is directly correlated to the quality and quantity of yielded data (Lyman 2012: 212). In order to investigate the context of the 'Fauresmith' and the other excavated industries from the new excavation. A finer resolution approach (than previously used) was adopted. This approach has allowed the author to yield macro-stratigraphic data, micro-stratigraphic data and geochemical data. The combination of which provides a dataset that shows diverse depositional and post-depositional features affecting assemblages in various ways and at different scales. The finer the resolution used to document an excavation, the more precise information regarding the provenience of the artefact/s, features and strata will be. The term ‘provenience’ referring to the ‘x, ‘y’ and ‘z’ dimensions of an artefactual or depositional feature, as well as its association within the geological/stratigraphic sequence at a site (Lyman 2012: 212). The new excavation was conducted with fine geospatial resolution in a multi-disciplinary, stratigraphically sensitive approach, particularly in the contact zone between the upper sedimentary unit (sands) and the lower sedimentary unit (alluvium), to provide greater contextual control over this important stratigraphic feature. This feature, referred to as a ‘mixed contact zone’ in previous studies (Lotter *et al*. 2016), has yielded Fauresmith artefacts in Pit 6. These artefacts are described in Chapter 2.

3.1.1 Excavation protocol

The new excavation that was conducted for this research project will henceforth be referred to as ‘Pit 4 West’ (P4W). P4W is a rectangular trench that was dug using the southern wall of the previously excavated Pit 4 (unpublished). The choice to investigate P4W for this project was guided by the discovery of a small refined handaxe in fresh condition that was excavated from the top of the gravels, suggesting the Fauresmith may be present there (Leader & Kuman, pers. comm. 2015). The extension of the existing excavation began in May and June of 2016.

May and June 2016

On May 25th the vegetation and miners’ debris were removed from the landscape surface to expose a 3 m^2 area on the southern edge of Pit 4, and a 2x1 m line grid was laid down and divided into two 1x1 m squares named ‘Square 1’ and ‘Square 2’, respectively (see Figure 3.1 & 3.2).

This first phase of the P4W excavation focused on digging the upper sedimentary unit at the site, which is the Hutton Sands. As described in Chapter 2, other excavations at Canteen Kopje have yielded LSA and MSA material from the Hutton Sands (Partridge & Brink 1967; Butzer *et al*. 1973; Helgren 1978, 1979; Beaumont 1990a, 2004; De Wit *et al*. 1997; De Wit 2008; McNabb & Beaumont 2011). Based on personal communication with Leader & Kuman about the adjacent Pit 4 excavation, it was agreed that the LSA and MSA sample in that particular locality was not very rich compared to Pit 6. Hence the author adopted a lower-resolution approach for these levels of the Hutton Sands, digging in 10 cm spits with artefacts and/or features being documented stratigraphically. However, artefacts (>20 mm) and natural rock (>40 mm) were recorded *in-situ* using the total station and then removed and stored as per the protocol discussed in the following sections. The Hutton Sands is massive in structure and this approach allowed the author to record artefact horizons and isolated artefacts at fine resolution despite the unit they were contained in being visibly unstratified.

Figure 3.1: A photograph of Pit 4 west showing each excavation square.

Sieving and sorting of collected sediment in buckets were conducted 10 m from the site on a spoil heap. Each bucket of excavated material was dry sieved through 2 mm mesh once the excavator filled the buckets. Sieve residue was hand-sorted to optimise the recovery of any small flaking debris (<20 mm). No wet sieving was conducted due to the lack of biological material (such as bone) and the consolidated nature of the sediment at the site. Sieved artefacts were placed in individual bags, which were labelled according to their excavation date, square and spit level. The screening of all material was conducted and overseen by both the author and her supervisors.

October 2016

The second phase of the P4W excavation was conducted from 1st-10th October and focused on excavating and recording the denser gravel horizon below the Hutton Sands, which has yielded stratigraphically associated Fauresmith and Victoria West material at Canteen Kopje (Leader 2014; Lotter *et al*. 2016).

The vertical limit of the excavation was determined by observing the maximum depth of the MCZ as indicated by the presence of relatively 'fresh' artefacts associated with the rounded gravels containing the Victoria West industry (Leader 2014; Lotter *et al*. 2016). The excavation then continued 20cm below the depth of the last 'fresh' artefact found in the gravels to ensure the MCZ was spatially constrained (Figure 3.2).

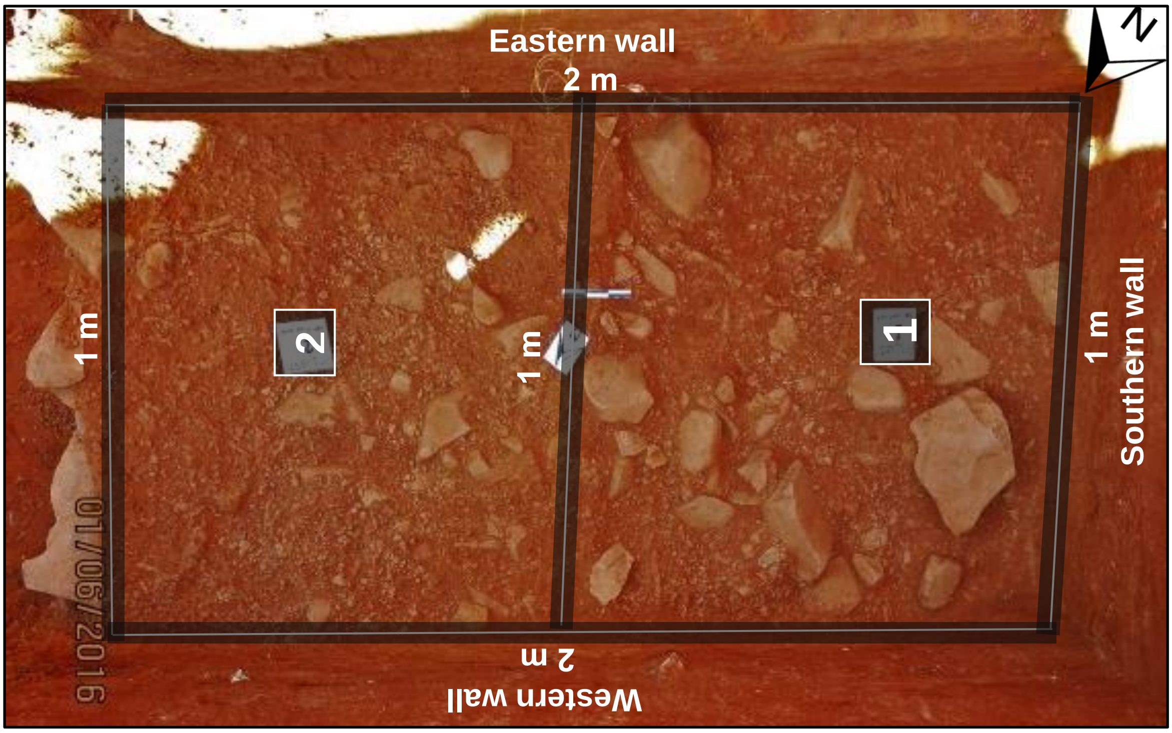


Figure 3.2: A schematic view of the exposed alluvial gravel unit in Pit 4 west and the excavation walls and squares. The angle of the photograph results in some dimension distortion, however this is not the case.

3.2 Recording methods

This section will provide the protocols followed by the author to document and manage the archaeological and geospatial (stratigraphic) digital datasets for this research project.

3.2.1 Total station

The total station protocol used for this research project was slightly modified from that presented in McPherron (2005) (Figure 3.3). This project made use of a Nikon Nivo 5C total station to digitally document the distribution of all artefacts >20 mm recovered, including those assigned to the Middle Stone Age and Fauresmith, and rolled/abraded Victoria West material within the potential MCZ excavated from P4W (Figure 3.4).

Specific criteria were adhered to in order to yield as fine resolution *in-situ* data as possible. The primary focus of this research project was one of context (of the Fauresmith). Context is associated with and influenced by site formation processes at Canteen Kopje. Below are the categories of features that were recorded using a total station, some of which will be discussed in further detail in following sub-sections:

- Both natural stones, and unnaturally occurring anthropogenically transported or modified stones, henceforth referred to as ‘artefacts’ or ‘lithics’, were recorded using the total station. Each category has its own size thresholds (≥20 mm for artefacts and ≥40 mm for natural clasts) that allowed the author to standardise the data being collected.
- Importantly, as described in the previous section, stratigraphic boundaries and features (e.g. concentrations of clasts) were recorded, particularly within the Hutton Sands (when visible) and at the interface between the sands and the underlying alluvial gravels.
- Each bucket of sediment was documented as a single point using the total station. The point was recorded at the central depth of the relevant square after the bucket was filled. This allowed for the SFD collected from each sieving batch to be related to the depth and spatial data of its relevant bucket point.
- Sediment samples were recorded by the central depth of each sample. Multiple samples were taken from along and across the sands and gravel unit. Sediment sampling and analysis is discussed in detail in Section 3.5.
- Other non-artefactual plotting categories not discussed above included: the excavation grid, datum levels, daily depths, and bioturbation features such as roots, termite and bird tunnels, and cracks. Recording features indicative of

bioturbation is important because it is these features that can affect the weathering and movement of artefactual material within the deposit. By recording these data, the author was able to identify the relationship between macroscopically obvious areas of bioturbation and artefacts in the same area.

Geographic information system (GIS)

Artefact orientation and gradient data were collected to better understand the fabric of the different deposits in P4W and how they are potentially related.

Points recorded by the total station were plotted on a local grid. All artefacts were plotted and thus provide the first ‘x’, ‘y’ and ‘z’ model for material at various stratigraphic contact points. This was done to help determine the exact position of fresh *vs.* abraded artefacts in the potential MCZ, where some Fauresmith artefacts may occur in the top of the gravels (as in Pit 6) (Lotter *et al*. 2016). High resolution ‘z’ (vertical position) readings are necessary for understanding the position of lithic industries within P4W in the broader Canteen Kopje geomorphological model.

Fabric Analysis

In this section, the term ‘clast’ is used as a collective term to refer to both natural stones and artefacts alike. The orientation and dip of clasts within a deposit are affected by a range of depositional mechanisms, such as colluvial or alluvial activity (Goldberg & MacPhail 2006: 42-71, 88-89).

High resolution recording has provided new insight into the mixed context of P4W, as clast organisation within the deposits not only indicates if there is bioturbation (as in Pit 6) (Goldberg & MacPhail 2006: 24), but it also clarifies the extent of the mixing by identifying the clast organisation of Fauresmith material in the MCZ in the top of the alluvial gravels.

For this reason, deposit fabric data were collected by recording the dip and orientation of clasts. A single point (P) was plotted for artefacts <40 mm and a maximum of 6 points (A, B, C, D, P, TP) was plotted for artefacts >40 mm. Clasts that were ≥40 mm in length with a ≥1.6:1 elongation index (maximum length (points A to B) /maximum width ratio (points C to D)) were specifically recorded for fabric analysis, following Stratford (2011) and Bertran & Texier (1995).

```
=IF(D3>D4,MOD(DEGREES(ATAN2((C4-C3),(B4-B3))),360),MOD(DEGREES(ATAN2((C3-C4),(B3-B4))),360))
```

NUMBER	X	Y	Z	BEARING	DIP	DESCRIPTION
CLAST1A	2878783.297	-73500.704	1443.017	50.63	27.27	FABRIC CLAST
CLAST1B	2878783.219	-73500.768	1443.069			FABRIC CLAST

```
=DEGREES(ATAN2(SQRT((B4-B3)^2+(C4-C3)^2),ABS(D4-D3)))
```

Figure 3.3: An example of the application of the formula adapted from McPherron (2005) used to calculate the bearing and gradient of the example CLAST1 (from Shadrach 2015).

Figure 3.4: Total station recording at Pit 4 West: a) the Nikon total station over the master datum; b) the master datum; c) a view of the total station in relation (general distance and depth) to the excavation.

3.3 Lithic analysis method

Stone artefacts, or what has traditionally been described as 'chipped stone' (Holmes 1894), serve as a proxy for hominid behaviour (see Chapter 2). Yerkes & Kardulias (1993: 90) describe the four primary objectives of lithic technologists as follows:

1) Identifying artefacts which have been produced by hominids.
2) Developing a timeline of stone tool production, which includes the procurement and transportation of raw material as well as the manufacturing and use of tools.
3) Identifying and documenting the changes associated with tool morphology and function through time.
4) Recognising and promoting stone tools as cultural material, indicative and representative of human development and chronology.

3.3.1 General attributes

The quantitative and qualitative attributes that were recorded for each artefact excavated from P4W by the author are presented in Table 3.1. Table 3.2 provides the specific tool type classifications used in the typological study for this project that were applied to artefacts from all industries and stratigraphic units.

Table 3.1: Quantitative and qualitative lithic attributes.

Attributes	Cores	Flakes	Formals
Maximum length	x	x	x
Maximum thickness	x	x	x
Technological length		x	x
Technological width		x	x
Facets		x	x
Number of flake scars	x		
Number of flake scars ≥10 cm	x		
Damage	x	x	x
Calcium-carbonate coating	x	x	x
Surface condition	x	x	x
Blank type			x
Edge length			x
Butt plan			x
Tip plan			x
Raw material	x	x	x
Weight	x	x	x

3.3.2 Typological classification

Table 3.2: Lithic typology classifications.

Tool type	Classification
Cores	
Single platform	Flaked unidirectional using a single surface as a flaking platform
Polyhedral	Flaked from three or more platforms from different directions
Kombewa flake-core	Contains two platforms or two ventral surfaces
Casual	Have one or two flake removals
Split cobble	A broken cobble, potentially through bipolar percussion
Core fragment	Broken pieces of core missing diagnostic information regarding what type of core it belonged to
Multifacial	Multiple removals from different faces and directions
Bidirectional	Flaked from two directions only
Flakes	
Complete	Maintains all technological features
Incomplete	Usually maintains a platform or enough for a measurement
Flake fragment	Pieces of flakes that generally lack a platform
Spilt	Split down the centre or laterally
Débordant	Also referred to a core-edge flake, it is associated with platform rejuvenation
Kombewa	Contains two platforms or two ventral surfaces
Blades	
Complete	Flake length=Width x 2 minimum
Incomplete	Usually maintains a platform or enough for a measurement
Blade fragment	Flakes that generally lack a platform but maintain enough length to be a blade
Formal tools	
Cleaver	Generally has a wide/broad straight cutting edge
Handaxe	Bifacial with a convergent tip shape (pointy) due to shaping and thinning
Retouched flake	Secondary trimming on one or more edges of a flake
Retouched kombewa flake	Secondary trimming on one or more edges of a kombewa flake
Retouched débordant	Secondary trimming on one or more edges of a débordant flake
Retouched incomplete flake	Secondary trimming on one or more edges of an incomplete flake
Retouched blade	Secondary trimming on one or more edges of a blade
Chunks	Blocky, angular form
Small flaking debris (SFD)	Lithic material (debitage) with dimensions less than 20 mm.

The purpose of conducting a lithic typological study was to try to isolate the different industries that were within the P4W excavation and, based on these observations, compare the lithic dataset to the spatial dataset produced for this research. This was done based on past studies such as Sarupen (2010) who describes the Middle Stone Age (MSA) from the site, Leader (2014) who discusses the Victoria West industry from the site, and Lotter *et al*. (2016) who attempted to distinguish the Fauresmith from the Victoria West. Lotter *et al*. (2016) primarily distinguish between the Fauresmith and the Victoria West based on artefactual abrasion/weathering states, suggesting that more heavily weathered/abraded artefacts were Victoria West-derived and fresher pieces belonged to the Fauresmith. For this research project, the author used Lotter *et al*.'s (2016) criteria.

3.4 Sediment sampling and analytical methods

In this section the author describes the sampling methods and analyses that are focused on sedimentary deposits in Pit 4 West (P4W). Bulk sediment samples were taken for laboratory-based sedimentological and geochemical analysis. Sediment cores were taken from the main western profile of P4W as dating samples. Block sediment samples were taken as micromorphology samples. In the sections below, an in-depth description of the protocols for each sedimentary technique and study, described above, is provided.

3.4.1 Macroscopic (*in-situ*) analysis

Sediment samples were collected to provide fine granulometric data pertaining to visible facies and potentially non-visible microfacies in P4W (Goldberg & MacPhail 2006: 38-40). A combination of the two datasets has the potential to provide fine resolution information regarding the depositional and post-depositional (e.g. erosion, bioturbation) processes, often associated with sandy terrains, affecting the integrity of artefactual material (Goldberg & MacPhail 2006: 140-150).

The standard *in-situ* description of the following visible variables/properties of sediment was recorded for all stratigraphic units and facies using a customised recording sheet (see Table 3.3): colour, texture, moisture, structure, consistency, voids, stratigraphic contact, clast size and shape, sorting, bioturbation. The macroscopic description of these attributes follows Goldberg & MacPhail (2006: 321-328). Documentation procedures for each of these are described below:

- Colour: Documented by using the Munsell description. The moist colour was recorded for each sample, as opposed to their dry colour.
- Texture (grain size (Goldberg & MacPhail 2006: 13)): Documented by using "finger texturing" (Goldberg & MacPhail 2006: 327). Texture descriptions include one or a combination of the following terms: silt, clay, loam, sand.
- Moisture: Documented by describing the deposit as moist or dry. This could also be included in the 'consistency' column on the recording sheet (Table 3.3).
- Structure: Structure descriptions include one or a combination of the following terms: granular, blocky, prismatic, columnar, platy, single grained, massive.

Table 3.3: In-situ field recording sheet.

Excavator Name:		Date:	Site:	
Deposit	Example	Sediment/Horizon 1	Sediment/Horizon 2	Sediment/Horizon 3
Name/Location	*Facies I/STKMH1*			
General				
Colour	Dark Brown Red			
Munsell	10R 3/3			
Support	clast			
Void space	high			
Structure	granular			
Consistency	loose			
Stratified	no			
Sorting	poor			
Upper contact	conformable			
Lower contact	erosion			
Clasts				
Frequency	high			
Size range (mm)	50-400			
Shape	angular/subangular			
Fragmentation?	highly fragmented			
Association	irregular			
Grading	regular			
Matrix				
Origin	allogenic			
Texture	silt loam			
Consolidation	low			
Grading	inverse			
Artefacts/Fossils/Roots/Burrows				
Presence	artefact & fossil			
Frequency	low			
Size range (mm)	<50			
max root depth				
Bone fragmentation	highly fragmented			

- Consistency: Consistency descriptions include one or a combination of the following terms: loose, friable, firm, extremely firm.
- Voids: Documented by describing visible pore space or porosity.
- Stratigraphic contact: Contact descriptions include one or a combination of the following terms: nonconformity, angular unconformity, disconformity, conformable, gradational contact.
- Clast size: Documented by using the total station. However, macroscopically, clast size was determined using the following grade terms (Table 3.4):

Table 3.4: Wentworth scale (from Wentworth 1922, Table 1, 381).

The Grade Terms		
The Pieces	The Aggregate	The Indurated Rock
Bowlder	Bowlder gravel	Bowlder conglomerate
256 mm.		
Cobble	Cobble gravel	Cobble conglomerate
64 mm.		
Pebble	Pebble gravel	Pebble conglomerate
4 mm.		
Granule	Granule gravel	Granule conglomerate
2 mm.		
Very coarse sand grain	Very coarse sand	Very coarse sandstone
1 mm.		
Coarse sand grain	Coarse sand	Coarse sandstone
1/2 mm.		
Medium sand grain	Medium sand	Medium sandstone
1/4 mm.		
Fine sand grain	Fine sand	Fine sandstone
1/8 mm.		
Very fine sand grain	Very fine sand	Very fine sandstone
1/16 mm.		
Silt particle	Silt	Siltstone
1/256 mm.		
Clay particle	Clay	Claystone

- Clast shape: Documented by using the following categories (see Figure 3.5):

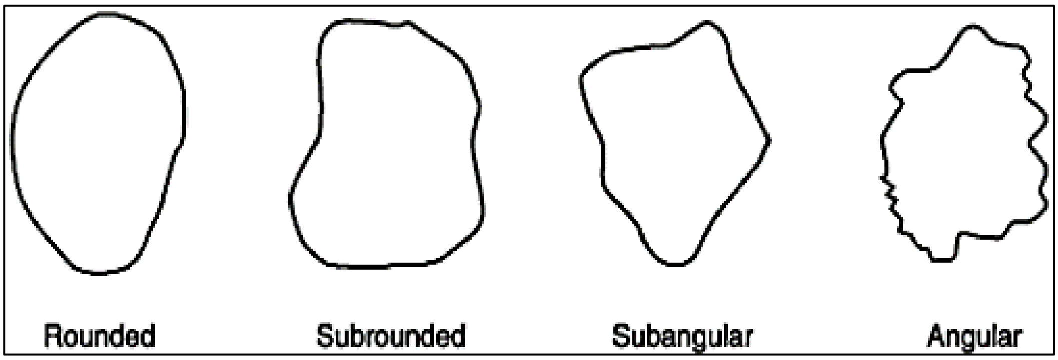


Figure 3.5: The categories used to classify in-situ clast angularity (from Mazzullo & Graham 1988, Appendix I: Figure 3, 54).

- Sorting: Documented by identifying the proportions and number of various size classes within a deposit. See Figure 3.6 below:

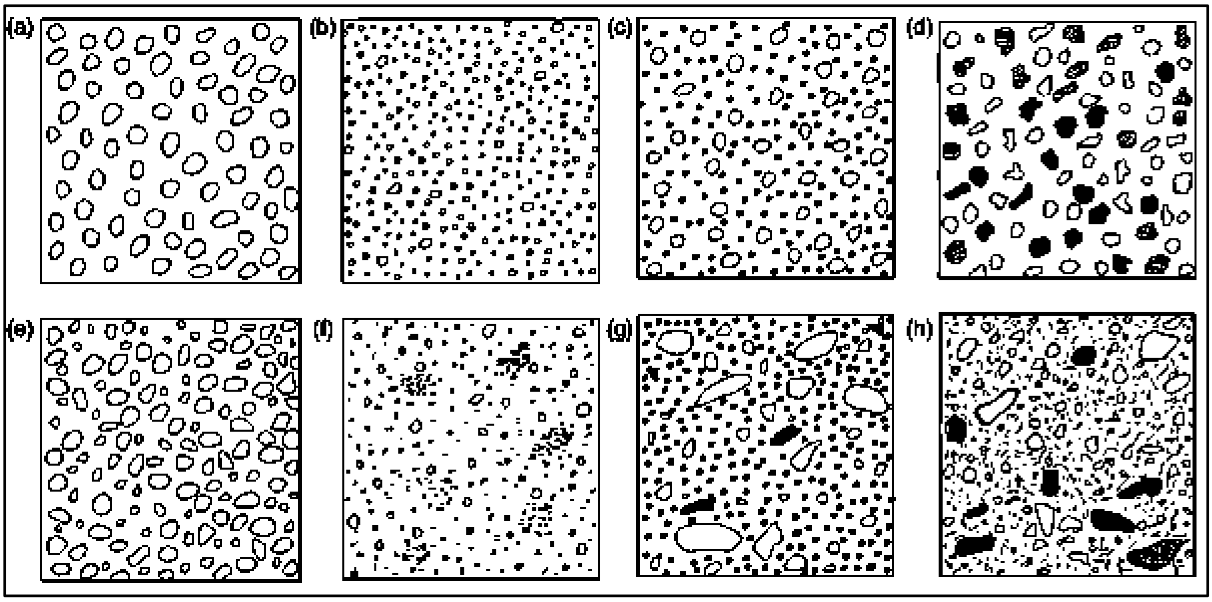


Figure 3.6: Sorting categories: (a) well-sorted sand; (b) well-sorted silt; (c) bimodal: well-sorted silt and sand; (d) well-sorted sand of varying composition; (e) moderately sorted sand; (f) poorly sorted silt; (g) bimodal: poorly sorted sand in a well-sorted silt; (h) unsorted (from Goldberg & MacPhail 2006, Figure 1.2., 17).

- Bioturbation: Documented by describing potential post-depositional features. This description generally includes a variation or combination of the following features: animal and/or insect burrows and/or tunnels, root activity, cracks.

- Erosional features: The presence (or absence) of features indicative of erosional events caused by any natural or anthropogenic process. The identification of such features is important as they indicate the removal and redistribution of material and the potential creation of "gaps" in the sedimentary and archaeological sequences.

3.4.2 Laboratory analysis

Laboratory analysis of the samples follows various authors (Heiri *et al*. 2001; Goldberg & MacPhail 2006) and includes loss on ignition (LOI), granulometry (sediment particle size) and particle shape, and x-ray fluorescence (xrf) geochemical analysis.

Sampling

A total of 20 bulk samples from P4W were taken for this project over three trips to Canteen Kopje between June 2016 and March 2017. The protocol for taking sediment samples and analysing them primarily followed Goldberg and MacPhail (2006). In regard to extracting bulk samples, loose sediment from various locations in the excavation was collected, using a trowel, and placed into transparent plastic bags. Each sample location was recorded using a total station and each bag was labelled with the date, deposit, square and relevant total station details. This ensured that any data collected in the laboratory could be related to a specific vertical and horizontal location within the excavation.

Moisture content preparation

Moisture content analysis followed a standard protocol that is generally used by most laboratories. The following sediment preparation protocol was applied for the moisture content analysis of all 20 samples (see Table 3.5 for recording sheet):

1) Each sediment sample was sieved through 1mm mesh.
2) Each foil container was weighed and documented.
3) Approximately 15 g was taken from each sample and transferred into individual foil containers.
4) The sediment-bearing foil containers were placed in an oven set to 90 ºC for 18 hours. The main purpose for using this protocol was to extract moisture from the samples using a relatively low temperature over a long period of time to avoid removing anything other than water.
5) Once each foil container was removed from the oven, each one was weighed, and each weight was documented.

Organic content preparation

The LOI protocol, pertaining to organic carbon used for this research project was adapted from Heiri *et al*. (2001). The samples that had undergone moisture content analysis where used in this analysis. The steps that were followed for sediment preparation are presented below and were conducted in the Sediment laboratory in the Bernard Price building at the University of the Witwatersrand (see Table 3.3 for recording sheet):

1) After all moisture content samples were weighed, the samples were transferred from their foil containers into ceramic crucibles, which were weighed prior to the transfer.
2) The combined weight of the crucibles and their contents was recorded, as some sediment loss would have occurred during the transfer.
3) Heiri *et al*. (2001: 108) proposes that 550ºC be the set temperature for the muffle furnace. The recommended period for samples to be exposed to 550ºC is a minimum of 4 hours.
4) The author would like to state that, based on previous experience, the muffle furnace's internal temperature increases notably once the set temperature is reached. In order to avoid the material being unnecessarily exposed to temperatures significantly high than required, the sediment-bearing crucibles were placed into a muffle furnace that was set to 450 ºC for eight hours.
5) In total the samples were in the muffle furnace for 11 hours. It took approximately one hour for the muffle furnace to reach 450 ºC. Once 450 ºC was reached the samples remained in the muffle furnace for eight hours at this temperature. After these eight hours, the muffle furnace was switched off and the samples remained inside for two more hours as the muffle furnace was too hot to remove the crucibles immediately.
6) Once each crucible was removed from the muffle furnace, each one was weighed and the LOI (grams and percentage) was documented.

Inorganic carbon content preparation

Analysis of inorganic carbon followed an adapted form of the protocol developed by Heiri *et al*. (2001). The samples that had previously undergone moisture content analysis and organic carbon content analysis were used in this analysis.

1) Heiri *et al*. (2001) proposes that 950 ºC be the set temperature for the muffle furnace. The recommended period for samples to be exposed to 900 ºC is two hours (Heiri *et al*. 2001: 108). As stated above, based on the author's previous experience, the muffle furnace's internal temperature increases notably once the set temperature is reached. In order to avoid the material being unnecessarily exposed to temperatures significantly high than required,

the sediment-bearing crucibles (air-cooled after the organic content analysis) were placed into a muffle furnace that was set to 900 ºC.

2) In total the samples were in the muffle furnace for 5 hours. It took approximately one hour for the muffle furnace to reach 900 ºC. Once 900 ºC was reached the samples remained in the muffle furnace for two hours at this temperature. After these two hours the muffle furnace was switched off and the samples remained inside for two more hours, as the muffle furnace was too hot to remove the crucibles.
3) Once each crucible was removed from the muffle furnace, each one was weighed and the LOI (grams and percentage) was documented.

Table 3.5: Loss on ignition (LOI) recording sheet for inorganic content for all nine XRF samples. All weights were recorded to the first two decimal places.

Pit 4 West XRF samples - LOI Inorganic Content						
Sample	Crucible weight (g)	Sub-sample weight (g)	Combined weight (g)	After LOI combined weight (g)	Weight lost (g)	LOI %

Particle size: Mastersizer 3000 protocol

Identifying particle size distributions is significant because inferences regarding the level of sorting (uniformity of particle size) in a deposit can be made, particularly informing us about the depositional or post-depositional processes (e.g. erosion and/or transportation) that may have resulted in said distributions (Goldberg & MacPhail 2006: 89, 336).

A Mastersizer 3000 laser diffraction particle size analyser was used to analyse particle size for this research project. The Mastersizer is located in the Sediment laboratory in the Bernard Price Building at the University of the Witwatersrand and was used by the author in May 2017.

The sub-samples used for particle size are the same samples that underwent both moisture and organic content analysis. These samples were already unconsolidated and as mentioned in the previous section, were originally sieved through a 2 mm sieve, so any gravel particles that may have resulted in a major size or weight difference were removed (as to not clog the Mastersizer's tubes).

Presented below is the preparation protocol followed by the author:

1) A small amount of the sediment was placed into a small beaker.
2) Water was added using a syringe to make a paste.
3) The sediment paste was slowly added to a large beaker of water on the Mastersizer platform until the required obscuration was reached.
4) The Mastersizer software was run.

There are 18 lasers in the Mastersizer 3000. The dispersant used was unpurified tap water. The Mastersizer was set on five measurement cycles (five "snapshots" provide a better representation). Three cycles of cleaning are conducted after the measurement cycles are completed. The process ends on a single degasing cycle.

The Standard Operating Procedure (SOP) properties are presented in Figure 3.7 below:

Particle Name	Silica (RI 1.544, AI 0.001)
Dispersant Name	Water
Particle Absorption Index	0.001
Weighted Residual	0.22 %
Analysis Model	General Purpose
Particle Refractive Index	1.544
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Sensitivity	Enhanced

Figure 3.7: The Standard Operating Procedure (SOP) used for Pit 4 West samples.

Microscopic sediment analyses

Particle shape, specifically angularity/roundness and sphericity (Figure 3.8), can be relevant in determining the source and transport processes of the material (Bullock *et al*. 1985: 29). The term sphericity refers to the overall form of a particle, not necessarily its edges (Bullock *et al*. 1985: 32). The roundness or smoothness of a particle refers to the surface of the particle. This is significant because the surface of a particle could determine various processes that may have affected a particle. For example, a rough surface may indicate weathering, whereas smoothness may indicate depositional, erosional or transportation processes (Bullock *et al*. 1985: 32).

Angularity/roundness and Sphericity were documented using a customised recording sheet, designed specifically for this research project by the author (Table 3.6). Analysis of all twenty bulk sediment samples was conducted by the author in the microscope room in the Origins Centre at the University of the Witwatersrand. An Olympus BX41 microscope was used for this analysis. Below is a description of the data recorded for each microscopic sample (see Table 3.6):

- Particle size range: Size descriptions was provided using the scale on the microscope, in microns.
    - Percentage (proportion) of the clast ranges.
- Angularity/roundness: Angularity/roundness descriptions include one or a combination of the following terms (Figure 3.5 & 3.8): rounded, sub-rounded, sub-angular, and angular.
    - Percentage (proportion) of the shape angularity/roundness categories.
- Sphericity: Sphericity descriptions include one or both of the following terms (Figure 3.8):
    - High sphericity percentage (proportion).
    - Low sphericity percentage (proportion).
- Percentage (proportion) of grains cemented onto one another.
- Lithology:
    - Percentage (proportion) quartz.
    - Percentage (proportion) feldspar.
- Sorting category
- Organic Material: Presence or absence.
    - Percentage (proportion) of organic material presence.

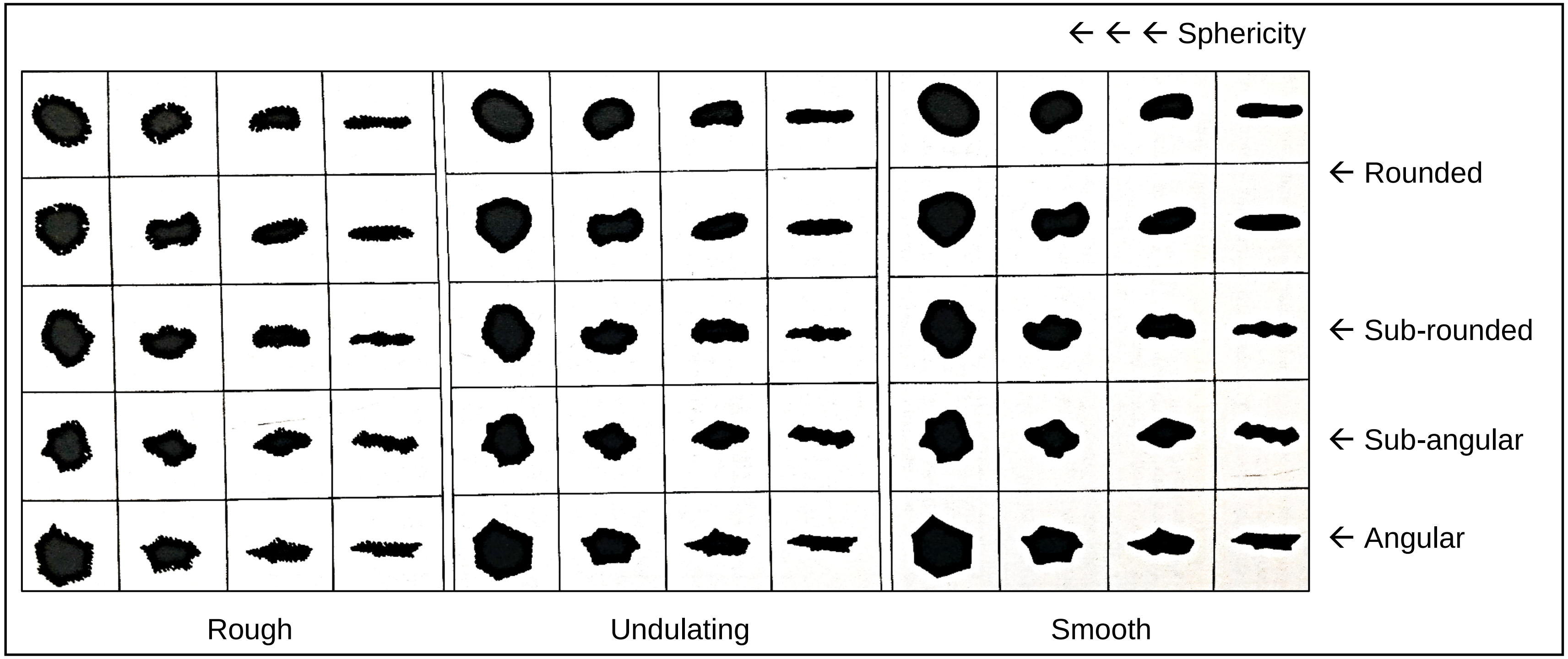


Figure 3.8: Sphericity and roundness categories combined with roughness versus smoothness categories (from Bullock et al. 1985, Figure 31, 31).

Table 3.6: Microscope recording sheet for Pit 4 West samples.

Date:								Sample:								
Clast		Shape				Texture		CaCo3		Lithology		Cement %	Fragmentation %	Sorting	Organic	
Size range		Angularity		Roundness			%									%
							%									%
	%		%		%		%		%		%					%

3.4.3 X-ray Fluorescence (XRF) Spectrometry

X-ray fluorescence spectrometry (XRF) was applied to nine sediment samples extracted from the nine OSL core holes (CNK1-CNK9) in P4W, discussed previously. The author felt that geochemical analysis of the sediments directly associated with the OSL samples would serve as supporting data for interpretations made based on any OSL dates yielded. In addition to this, mineralogy was also applied as a means of identifying the constituent material in various deposits, which could provide an indication of possible sources for this material.

XRF is generally a non-destructive form of chemical composition analysis (Shackley 2011: 8-9). "X-rays are a short wavelength (high energy-high frequency) form of electromagnetic radiation inhabiting the region between gamma rays and ultraviolet radiation" (Shackley 2011: 16).

Sampling protocol

The preparation of the samples before XRF analysis was conducted by the author. Prior to XRF analysis, the inorganic content (calcium carbonate ($CaCo_3$)) of each sample was recoded. The loss on ignition (LOI) protocol used for this research project was adapted from Heiri *et al*. (2001). The protocol followed for XRF organic content sample preparation is the same as that presented in the previous 'Inorganic carbon' section, with slight differences presented below:

1) Each sediment sample was sieved through 106 µm mesh, as opposed to a 1 mm mesh.
2) A total of exactly 5 g, as opposed to 15 g, from each sample was transferred into individual crucibles.
3) The last step in this protocol was to transfer a total of between 0.9-1g of each sample to a new individual labelled bag for XRF analysis

The recording sheet presented as Table 3.5 was used to document all XRF LOI measurement.

The XRF analysis of the sediment samples was conducted by Marlin Patchappa from the Earth Lab associated with the School of Geoscience and will be presented in the Results Chapter of this dissertation. The data was collected and the recorded chemical element/compound proportions were compared between samples using bar graphs.

3.4.4 Optically Stimulated Luminescence (OSL) dating

Optically Stimulated Luminescence (OSL) dating was attempted on samples from P4W. Previous attempts for different stratigraphic levels and areas of the site have varied in success (Chazan *et al*. 2013; Evans & Cunningham 2013). Providing a date for the Fauresmith horizon would help contextualise the Fauresmith chronologically and clarify the relationship between what has been suggested to be the Fauresmith, the overlying Middle Stone Age and the underlying early Acheulean (Victoria West) (Sarupen 2010; Leader 2014; Lotter *et al*. 2016).

Furthermore, a date for the Canteen Kopje Fauresmith would allow for more meaningful comparison with other dated sites, particularly Kathu Pan, which is also in the Northern Cape Province and is suggested to contain a Fauresmith horizon (Wilkins & Chazan 2012; Porat *et al*. 2010). A successful date was achieved for the Kathu Pan 1 site by pursuing single grain luminescence measurements, “using the OSL signal and the single aliquot regenerative dose (SAR) protocol” (Porat *et al*. 2010: 282), as opposed to multiple grain luminescence measurements.

Sampling protocol

In total nine sediment cores were extracted by M. Evans and C. Stewart (both of whom conducted the dating), with assistance from the author, from along and across the western profile of P4W in March 2017. The sampling technique for this section followed Duller (2008) and is presented below (see Figure 3.9 a, b):

1) Samples were taken from locations with limited visible bioturbation and other disturbances. This included root activity, termite activity, bird burrows, cracks and leaching and bleaching.
2) The profile was cleaned to remove the outer 5 cm layer of sediment, in order to reduce any contamination.
3) The outer end of each sample tube (roughly 30 cm in length) was plugged with bubble-wrap and covered with duct-tape to stop the sediment from being exposed to sunlight, whilst the inner end was in the profile.
4) The tubes were hammered into the selected sample locations. This was done as carefully and quickly as possible to limit sediment displacement within the profile due to the impact.

5) Once the length of the tubes was in the profile their positions were documented and then they were removed by loosening the sediment around the tubes to make pulling each tube out easier.
6) The inner end of each tube was plugged with bubble-wrap and heavily duct-taped to stop the sediment from being exposed to sunlight.
7) Each tube was labelled, and an arrow was drawn to show the orientation (exposed end *versus* unexposed end) of the sample.
8) *In-situ* gamma-ray spectrometry measurements were yielded from each sample hole using a gamma-ray spectrometer subsequent (see Figure 3.9 a, b).

Figure 3.9: a) OSL sample holes CNK1-CNK9 in the western profile of Pit 4 West as well as the gamma-ray spectrometer in CNK5 b) all nine OSL samples subsequent to removal. The profile wall is 163.25 cm.

Chapter 4: Results

The Results chapter is divided into five sections. The first section, ‘Stratigraphy and Spatial Results,’ is a description of the stratigraphic characteristics of the sequence in Pit 4 West (P4W) and the spatial distribution and orientation (fabric data) of clasts extracted from it. The second section, ‘Sedimentological Results,’ provides results of both the macroscopic and microscopic analysis of collected sedimentary material. The third section, ‘Lithic Typological Results,’ is a description of the typological data pertaining to all excavated artefacts and industries from P4W. The fourth section, ‘Lithic Spatial Results’, provides the spatial distribution of artefacts and the position and contact points of various stone tool industries, which was used to aid in the analysis and classification of all stone tool material yielded. The fifth and final section, ‘OSL Dating Results’ is a report on the outcomes of the multi-grain dating of the nine relevant sediment samples described in Chapter 3.

4.1 Stratigraphy and Spatial Results

The reason that the location of P4W was chosen for this project, and the research purpose of excavating the site, have been described in both the previous Introduction (Figure 1.2) and Methodology Chapters (Figures 3.1 and 3.2).

The excavation of P4W that was conducted for this research project has exposed a stratigraphic sequence that differs from those described in published studies on the Canteen Kopje site. As stated in the previous chapter, the term ‘clast’ is used as a collective to refer to both natural stones and lithics, unless stated otherwise. All clasts ≥4 cm were recorded using a total station (refer to section 2.3.1 for detailed protocol) to collect deposit fabric data (dip and orientation), to gain insight and an understanding of the site formation process associated with P4W.

4.1.1 Pit 4 West Stratigraphy Results

Four sedimentary units were identified in P4W. All of these were studied and sampled. Figure 4.1 shows the four stratigraphic units that were exposed and excavated from the P4W site for this project. The units are named as follows: The

Hutton sands (HS), Pebble Layer 1 (PL1), Pebble Layer 2 (PL2) and Gravel Unit (GU).

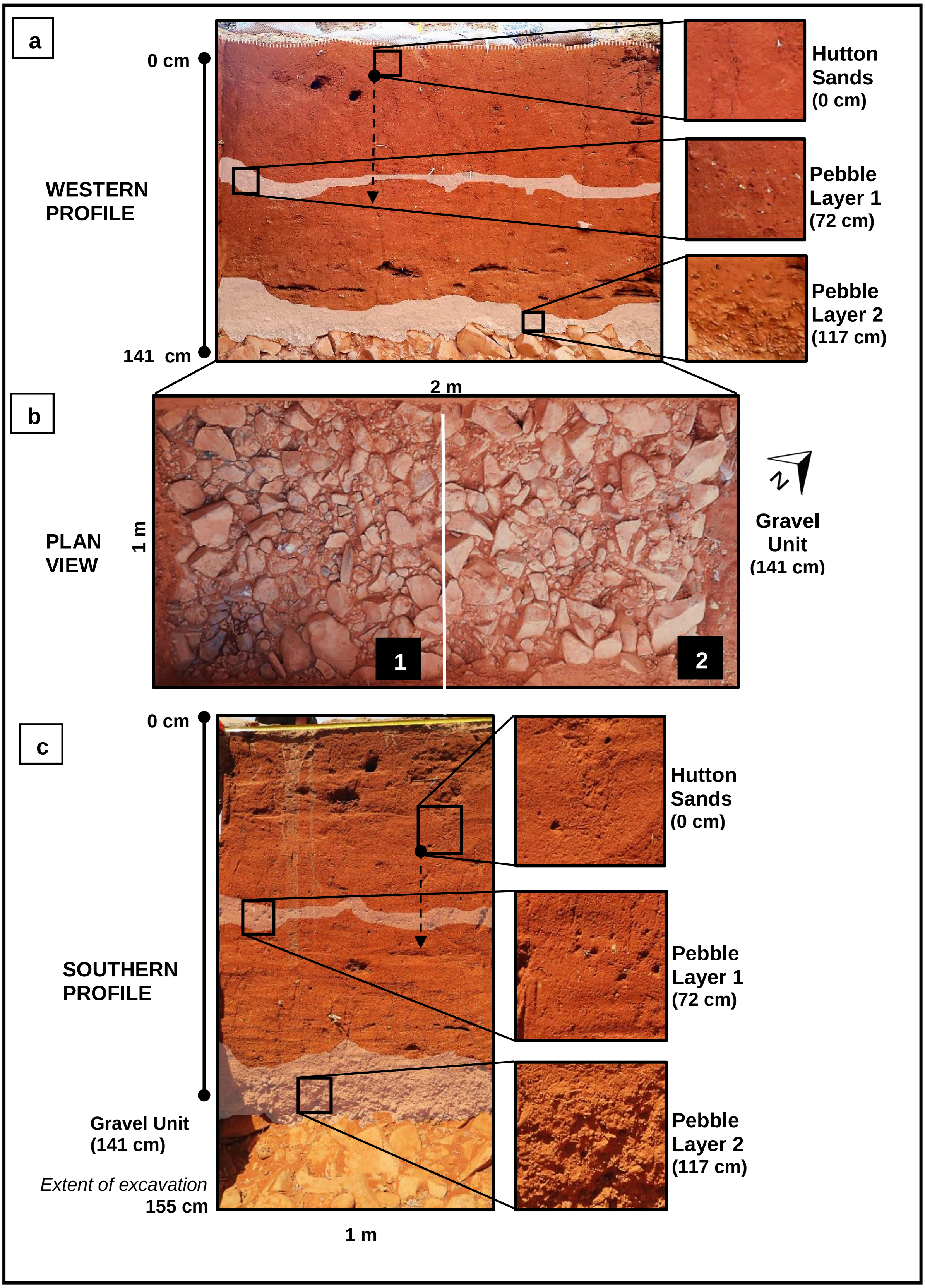


Figure 4.1: The completed Pit 4 West excavation: a) the main, western profile, b) the plan view of the two excavated squares 1 and 2 c) the southern profile. The measurements pertain to the depth of the upper surface of each deposit relative to the landscape surface. The full excavation depth is 155 cm.

The full excavation depth reached for this research project was 155 cm, and the units identified by the author differ in regard to both sedimentary and archaeological material. No faunal material was identified or extracted from P4W due to the unfavourable preservation conditions at the Canteen Kopje site.

- The HS extend from the top of the excavation (0 cm) to 72 cm below the surface. The sands are characterised by aeolian-derived fine to coarse sands. The artefactual material recovered from HS increases with depth but is not significant within the top 72 cm of P4W. Bioturbation, in the form of plant root and animal (bird and insect) activity, is pronounced in this unit as it is associated with the landscape surface and is therefore not heavily consolidated.
- At 72 cm below the surface PL1 is found. It is characterised by granule and pebble-sized gravel. This pebble unit is thin and clasts within the layer are relatively dispersed, with minimal overlapping of material. The pebble unit, although scant, did occur across the full lateral extent of the excavation and was thus identified as a layer rather than a lens. Artefact concentration is low within this unit.
- The HS continue beneath PL1, and extend to a depth of 117 cm.
- Underlying the sands at 117 cm deep is PL2, which is the third sedimentary unit identified. It is primarily characterised by pebble-sized gravel with a high concentration of artefactual material. Bioturbation is pronounced in this unit, due to this sedimentary unit being characterised by uncemented clasts and soft sediment infilling (associated with the pebble pieces), as well as its paraconformable lower contact surface with GU.
- The fourth and final sedimentary unit identified in P4W is GU, which starts at 141 cm below surface. This unit is characterised by cobble and boulder gravels with a high concentration of larger artefactual material. Bioturbation within this unit is present, but due to the highly consolidated and, for the most part, heavily cemented nature of the gravels, root and animal activity is limited.

4.1.2 Deposit Fabric Results

As mentioned in the previous Methodology Chapter, the purpose of collecting and analysing fabric data is to 1) identify artefact orientation and gradient trends and 2) using this data to try improve interpretations of the fabric of the different deposits in the P4W excavation and how these deposits relate to one another which provides further insight into the site's formation processes.

The fabric data results presented in Figure 4.2 shows the data associated with the recorded dip of clasts that had the dimension requirements needed to record fabric data (refer to the previous Methodology Chapter for the protocol associated with collecting fabric data).

Figures 4.2, 4.3 and 4.4 provide different visual representations of the dip and orientation of clasts in P4W. They show that there are multiple peaks in the orientation. There is no dominant trend in the orientation of the clasts. The dominant trend is that the dip of the clasts is relatively shallow but a significant number of clasts have a steeper dip. No vertical clasts were recorded. The data suggests that the fabric is relatively disorganised with the dip and orientation varying greatly.

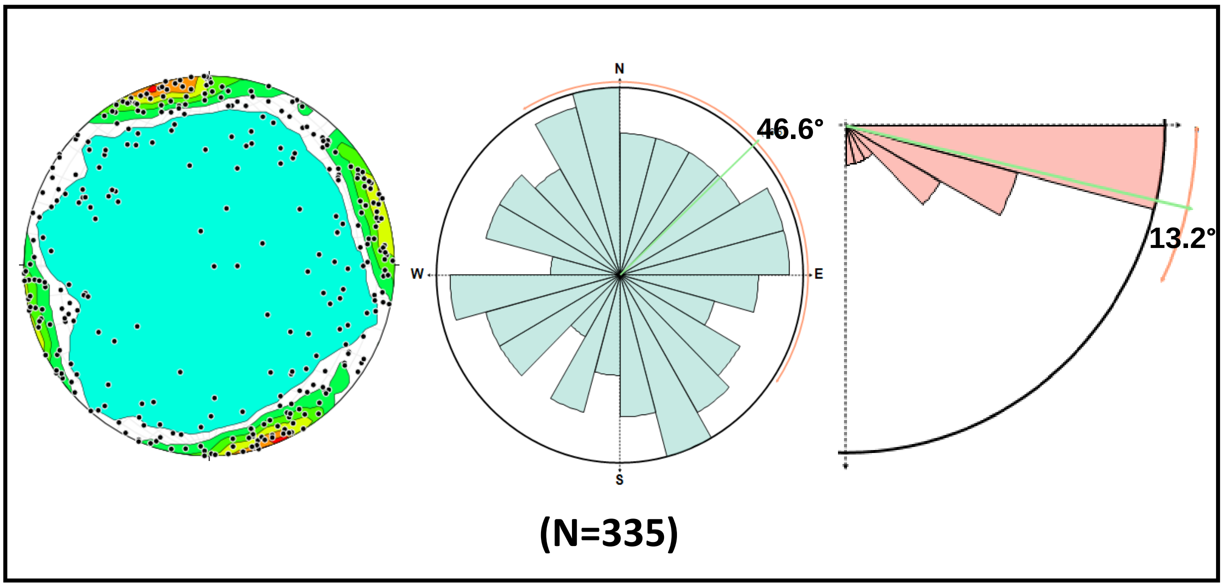


Figure 4.2: Clast fabric data from Pit 4 West shown in the form of a Stereonet showing dip and orientation (left), a Rose diagram showing orientation (middle) and a quarter Rose diagram showing dip angle (right).

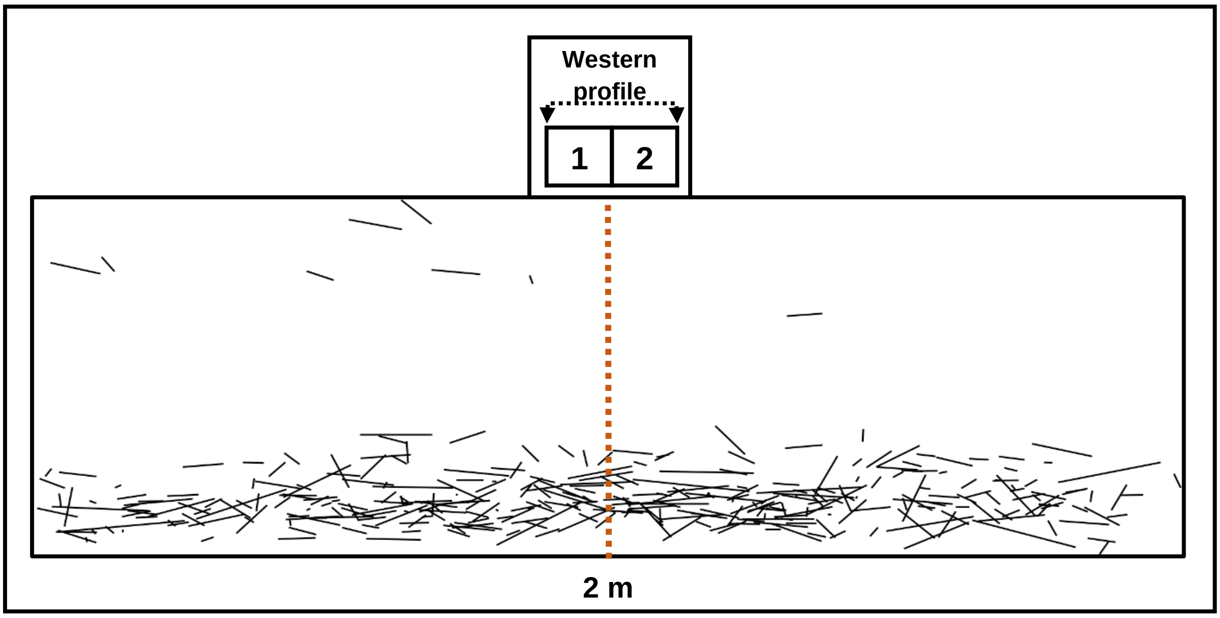


Figure 4.3: The dip of natural and artefactual clasts from the Pit 4 West Western Profile. Each line corresponds to the long axis of a clast (A-B total station points).

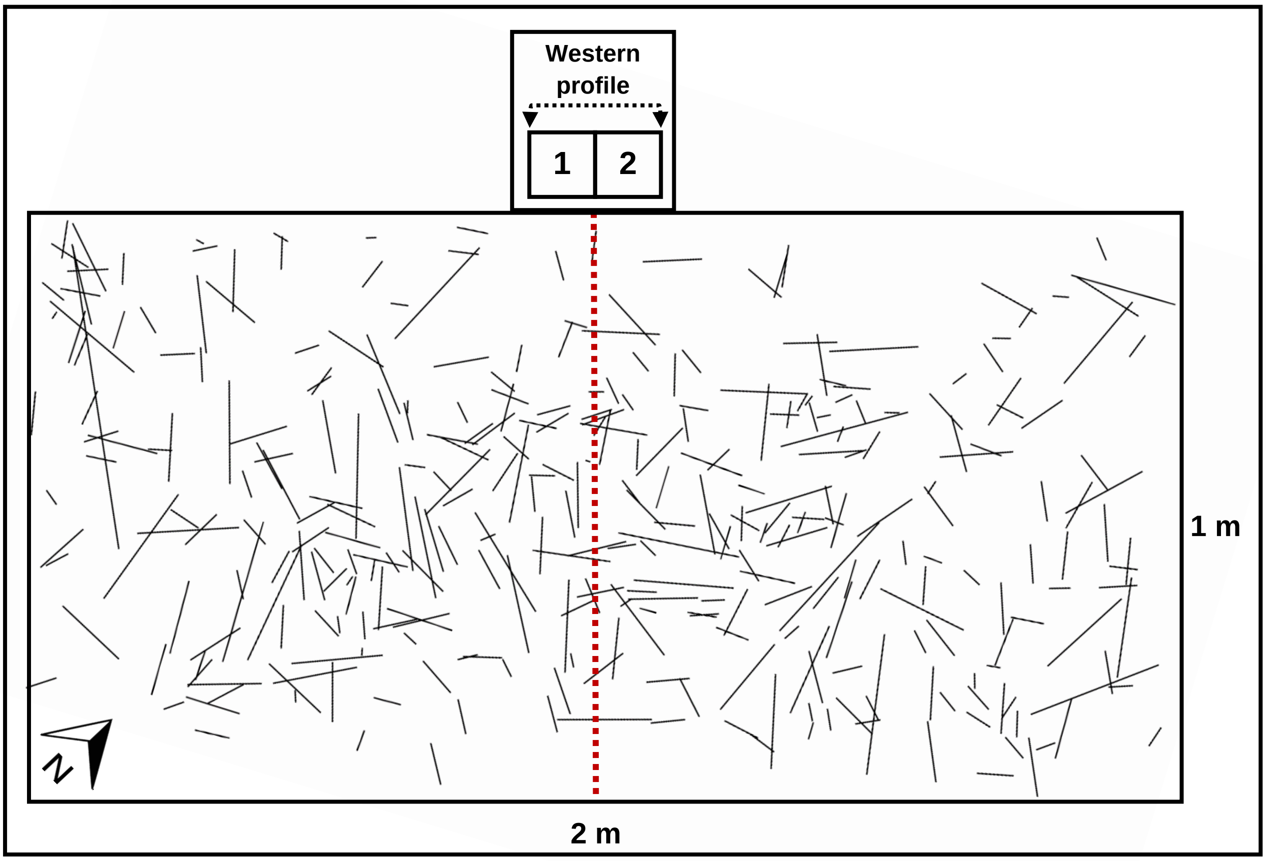


Figure 4.4: The orientation of natural and artefactual clasts from the Pit 4 West excavation. Each line corresponds to the long axis of a clast (A-B total station points).

4.2 Sedimentology

4.2.1 Macroscopic (*in-situ*) Results

The macroscopic descriptions of the excavated deposits are presented in Table 4.1. As stated previously, four sedimentary units were identified in P4W: The units are named as follows: the Hutton sands (HS), Pebble Layer 1 (PL1), Pebble Layer 2 (PL2) and the Gravel Unit (GU).

All the sedimentary units identified in P4W are the same colour according to the Munsell colour chart. None of the units are stratified or graded. The finer sediment within the HS, PL1, PL2 deposits is of aeolian origin, whereas the lowest unit, GU contains sediment that is alluvial in nature. The lower contact of the overlying HS with PL1 and the lower contact of PL1 with the underlying HS component is conformable. The lower contact between PL2 and the GU is para-conformable due to the irregular surface of the GU deposit. The void space present in each deposit also increases stratigraphically, with it being limited in the HS but fairly high in the GU. The frequency and size of clasts increase drastically moving downwards through the units. The shape of clasts is generally either sub-rounded or well-rounded in PL1, PL2 and GU. The consistency of all the deposits is high except for PL2 in which the matrix is loose. Bioturbation occurs in all four units at varying degrees. Artefacts are present in all units, but the density increases stratigraphically, with a low density in the HS and a very high density in the GU.

4.2.2 Laboratory Results

Loss on Ignition

A total of 18 sediment samples were taken in the field and analysed for this research project, as shown in Figure 4.5 and described below (see Methodology Chapter for all the protocols followed for the different sedimentological analyses used).

Moisture was noticeably present in all samples and throughout all stratigraphic units. However, it varied in proportion stratigraphically. PL2 (117-141 cm) has the highest proportion of moisture. Organic material is present in all samples and stratigraphic units, and is relatively consistent throughout. Inorganic carbon is present in all samples and units but has the greatest proportion in GU (144-155 cm).

Table 4.1: Macroscopic sedimentary properties of the units identified in Pit 4 West.

General	Colour	Munsell	Support	Void space	Structure	Consistency	Stratified	Clast Sorting	Upper contact	Lower contact
HS	Dark Red	2.5YR 4/8 RED	Matrix	Low	Massive	Compacted	No	N/A	Surface	Conformable
PL1	Dark Red	2.5YR 4/8 RED	Matrix	Low	Sorted Gravel	Compacted	No	good	Conformable	Conformable
PL2	Dark Red	2.5YR 4/8 RED	Matrix	High	Massive	Loose	No	poor	Conformable	Para-conformable
GU	Dark Red	2.5YR 4/8 RED	Clast	Very high	Gravel	Cemented	No	good	Para-conformable	N/A

Clasts	Frequency	Size range (mm)	Shape	Grading
HS	Very low	0.25-64	Flat	No
PL1	Moderate	5-64	Sub-rounded	No
PL2	High	64	Well Rounded	No
GU	Very High	≥256	Sub-Rounded	No

Matrix	Origin	Consolidation
HS	Aeolian	High
PL1	Aeolian	High
PL2	Aeolian	High
GU	Alluvial	Very high

Artefact/ bioturbation	Presence		Frequency		Artefact size range (mm)
HS	Artefact	Animal & root activity	Low	High	10-30
PL1	Artefact	Animal & root activity	Low	Moderate	10-40
PL2	Artefact	Animal & root activity	High	High	20-150
GU	Artefact	Animal & root activity	Very High	Moderate	20-400

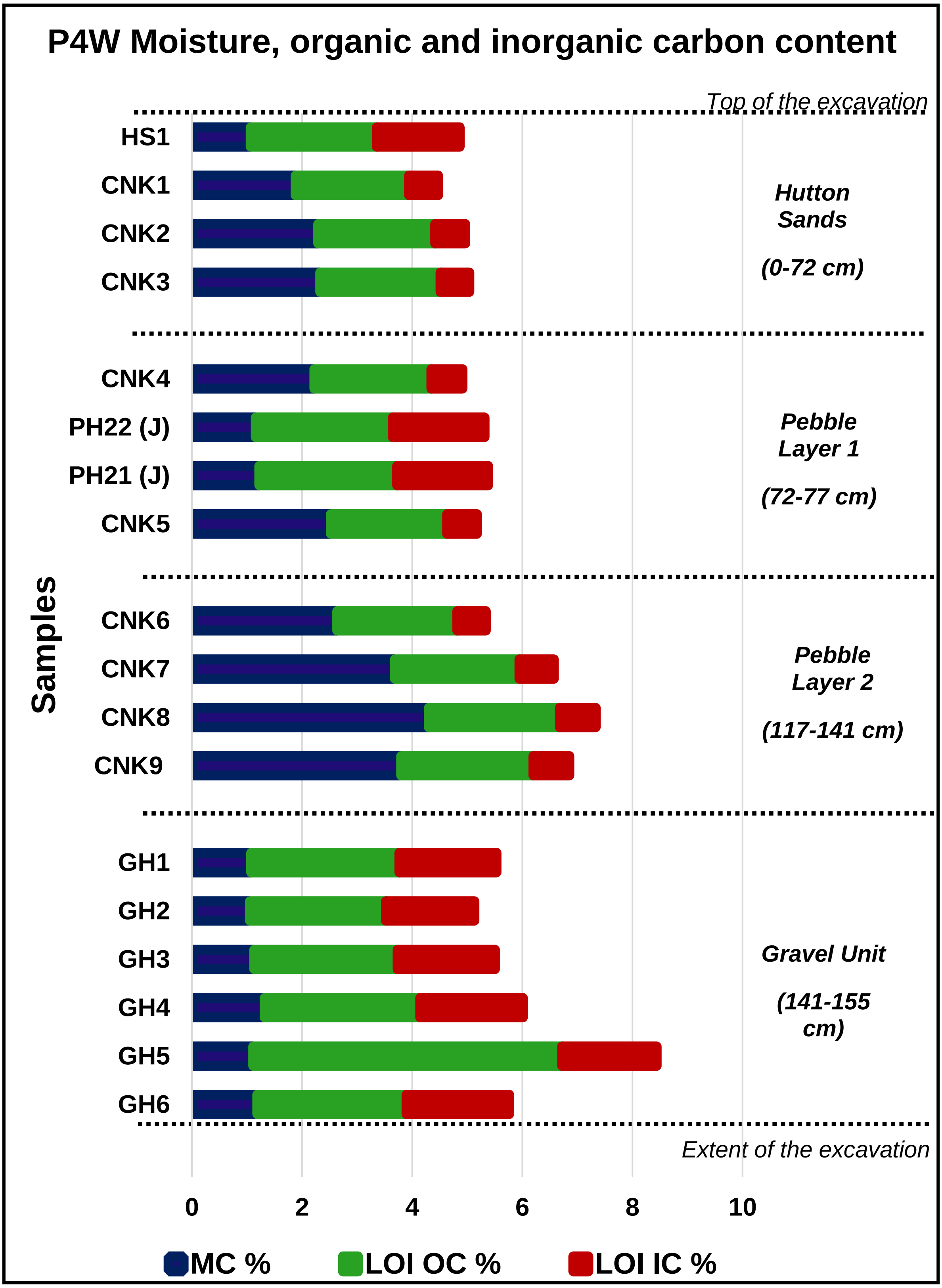


Figure 4.5: Shows the moisture, organic carbon and inorganic carbon content of each of the 18 sediment samples taken from the Pit 4 West excavation.

Particle size

For all 18 samples and across all stratigraphic units the textural classification of the sediment samples varies mainly from very coarse sand to medium silt, as shown in Figure 4.6 (see the Methodology Chapter for the Mastersizer 3000 protocol, which was used to collect the particle size data for this project).

The samples are dominated by sand sized grains, especially medium and fine sand, with limited silt and clay proportions (Figure 4.6). In terms of textural classification, the samples are all either Fine Sand or Medium Sand and range from moderately to poorly sorted. The distribution curves for all the samples are presented in Appendix 1.

Particle shape

Table 4.2 displays the particle shape data for all 18 sediment samples in stratigraphic order (see the Methodology Chapter for the microscopic protocol which was used to collect this data).

The major particle shapes were sub-angular and sub-rounded within all samples. There was little variation between sedimentary units. With regard to the proportions of sphericity (high *vs*. low) and texture (smooth *vs*. undulating) there is great variation but no discernible trend. For all samples quartz was the only mineral identified. This is mentioned because different mineral grains are associated with different shape and textural characteristics.

4.2.3 X-Ray Fluorescence Results

Figure 4.7 shows the results from the nine samples (CNK1-CNK9) that were geochemically analysed using X-Ray Fluorescence (XRF). The nine samples were taken from across and along the western profile of P4W. XRF samples could not be taken from with the GU level but two samples were taken from the interface between PL2 and GU, and thus sediments from GU were sampled to a degree. Therefore, all the stratigraphic units are represented to some degree.

The major components throughout all nine samples and stratigraphic units are the following, in order of dominance: SiO_2 (Silicon dioxide), Al_2O_3 (Aluminium Oxide), LOI (loss on ignition: including organic and inorganic carbon) and FeO (Iron Oxide).

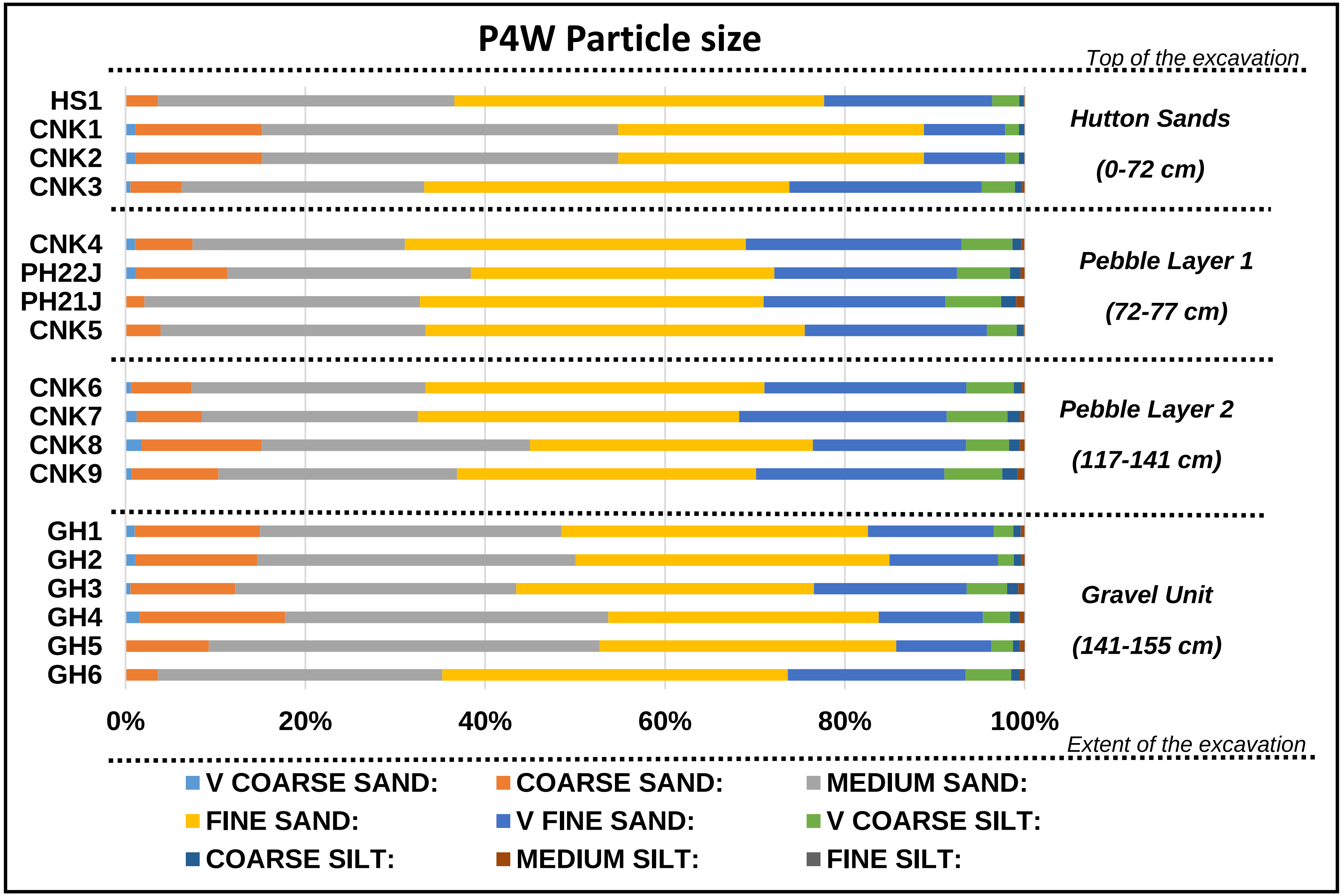


Figure 4.6: Sediment particle size data for all 18 samples taken from Pit 4 West. Note that the samples have been presented in stratigraphic order.

Table 4.2: Sediment particle shape data for all 18 samples taken from Pit 4 West. Note that the transition of colours from the top down represent the change in the stratigraphic units: Hutton Sands, Pebble Layer 1, Pebble Layer 2 and the Gravel Unit.

Sample	Size range (μm)	Angularity/ Roundness	Sphericity (high) %	Sphericity (low) %	Texture (smooth) %	Texture (undulating) %	Lithology
HS1	10-300	Sub-angular	40	60	80	20	Quartz
CNK1	10-300	Sub-angular	40	60	80	20	Quartz
CNK2	10-400	Sub-rounded	90	10	90	10	Quartz
CNK3	10-500	Sub-angular	10	90	70	30	Quartz
CNK4	10-300	Sub-rounded	70	30	90	10	Quartz
PH21 (J)	10-200	Sub-angular	50	50	60	40	Quartz
PH22 (J)	10-200	Sub-angular	50	50	60	40	Quartz
CNK5	10-200	Sub-rounded	90	10	90	10	Quartz
CNK6	10-200	Sub-rounded	80	20	90	10	Quartz
CNK7	10-500	Sub-rounded	80	20	95	5	Quartz
CNK8	10-300	Sub-angular	40	60	70	30	Quartz
CNK9	10-150	Sub-angular	70	30	60	40	Quartz
GH1	10-300	Sub-angular	60	40	70	30	Quartz
GH2	10-350	Sub-angular	50	50	70	30	Quartz
GH3	10-200	Sub-rounded	50	50	80	20	Quartz
GH4	100-200	Sub-rounded	80	20	95	5	Quartz
GH5	10-200	Sub-rounded	40	60	90	10	Quartz
GH6	10-200	Sub-rounded	60	40	80	20	Quartz

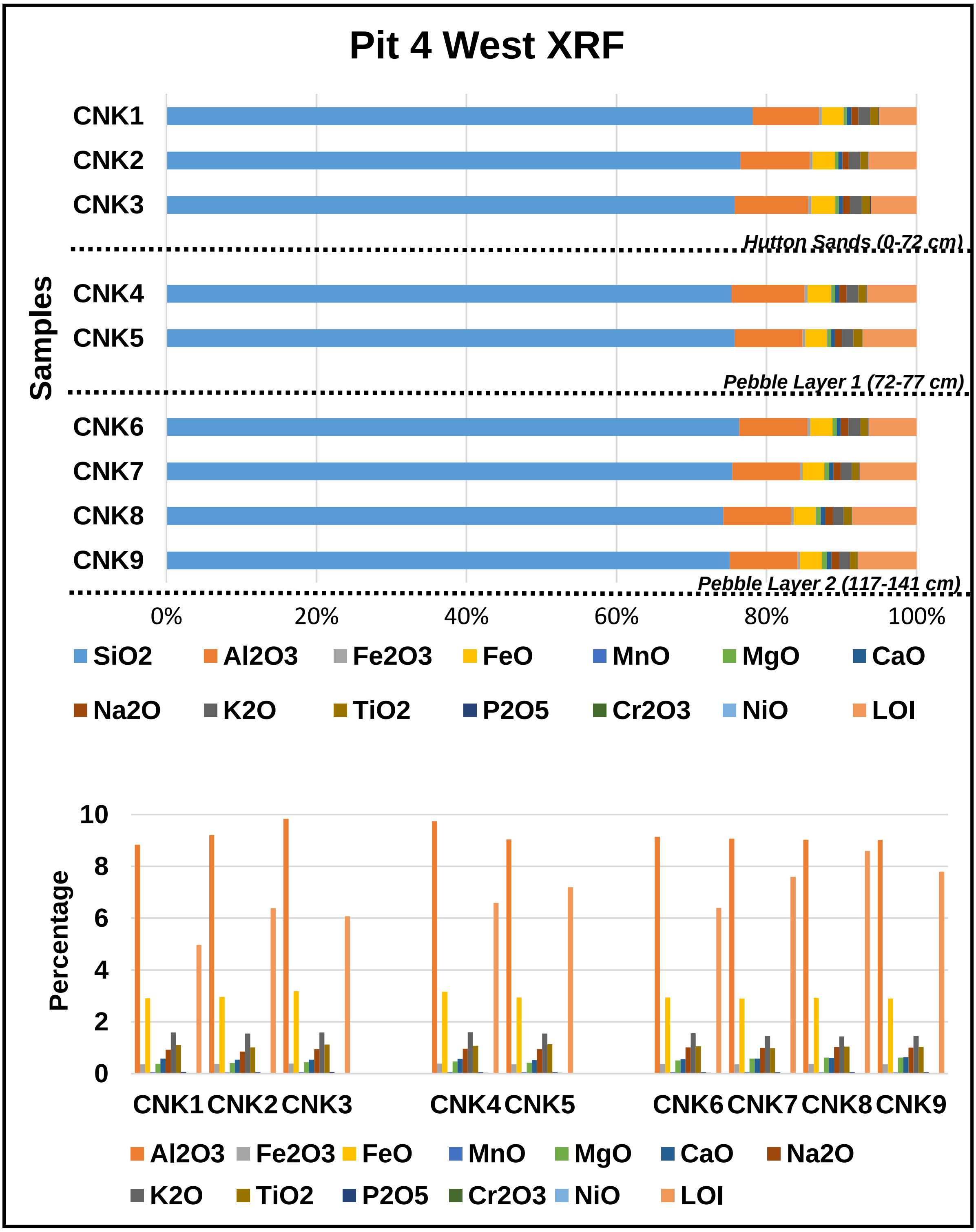


Figure 4.7: X-Ray Fluorescence data for only nine samples (CNK1-CNK9) taken from the Pit 4 West Western profile.

4.3 Lithic Results

The following results relate to the typological and raw material data collected from all excavated and recorded artefacts from P4W (Table 4.3) The sub-sections in this section include information on the full P4W assemblage, individual industries and their respective attributes. As mentioned in the Literature Review and Methodology Chapters, the author acknowledges that a typological study limits data collection, particularly that which is associated with statistical validity. However, to successfully meet the objectives of this project only a typological study was required to aid in answering the research question.

Table 4.3: The full Pit 4 West assemblage (n=1201 lithics) industries, tool types and size profiles.

Artefact Type ≥ 20 mm	MSA	%	Fauresmith	%	Victoria West	%
Chunks	0	0.00	13	4.08	17	7.00
Flake fragments	4	30.77	98	30.72	64	26.34
Split flakes	0	0.00	18	5.64	4	1.65
Incomplete flakes	2	15.38	63	19.75	39	16.05
Complete flakes	6	46.15	101	31.66	103	42.39
Incomplete Blades	0	0.00	2	0.63	0	0.00
Completeblades	1	7.69	5	1.57	1	0.41
Retouch pieces	0	0.00	7	2.19	0	0.00
Cores	0	0.00	0	0.00	0	0.00
Core fragments	0	0.00	2	0.63	3	1.23
Polyhedral	0	0.00	1	0.31	0	0.00
Single platform	0	0.00	3	0.94	0	0.00
Fractured Cobbles	0	0.00	1	0.31	1	0.41
Multifacial	0	0.00	1	0.31	2	0.82
Kombewa	0	0.00	0	0.00	1	0.41
Casual	0	0.00	0	0.00	4	1.65
Bidirectional	0	0.00	0	0.00	2	0.82
Large cutting tools	0	0.00	0	0.00	0	0.00
Handaxes	0	0.00	1	0.31	0	0.00
Cleavers	0	0.00	3	0.94	2	0.82
≥20 mm Total	**13**	100.00	**319**	100.00	**243**	100.00
Small Flaking debris <20 mm	**Hutton Sands**		**PL2**		**GH1**	
<20 mm Total	**506**		**75**		**45**	
Total assemblage	**1201**					

A total of 1201 lithic artefacts (see Table 4.3 above) were yielded from P4W. Of the 1201 lithic artefacts yielded, 575 are ≥20 mm. A total of 13 lithics ≥20 mm were identified as belonging to the Middle Stone Age (MSA), based on the raw material and lithic descriptions provided by Sarupen (2010). This MSA assemblage primarily comprised flake fragments and complete flakes. A total of 319 lithics ≥20 mm were identified as belonging to the Fauresmith industry (see Chapter 3, Section 3.3). These are primarily complete flakes, flake fragments and incomplete flakes. A total of 243 ≥20 mm lithics were identified as belonging to the Victoria West stone tool industry. The majority of these are complete flakes and flake fragments.

Small flaking debris (SFD) could not be allocated to specific industries as it was collected in sieved material. Although there are total station points for each sieved bag, the points do not represent the quantity of artefacts recovered (e.g. one total station point for one bucket of excavated material does not provide enough spatial resolution as there may be numerous SFD pieces within a bucket). For this reason the author has provided the SFD data in Table 4.3 using stratigraphic allocations as the spatial data only allows for that limited relation to be made. Of the 1201 lithic artefacts yielded from P4W, a total of 526 lithic artefacts are <20 mm. The Hutton Sands yielded 506 <20 mm pieces. Pebble Layer 2 yielded 75 pieces <20 mm, and the Gravel Unit yielded 45 <20 mm pieces.

4.3.1 MSA

As mentioned above the total MSA assemblage is 13 artefacts. The most common type is complete flakes (n=6). There are four flake fragments and two incomplete flakes. A single blade completes the assemblage. No cores or retouched pieces were excavated from the MSA. Figure 4.8 shows some of the complete flakes from this level and provides an indication of the size range of MSA complete flakes from P4W.

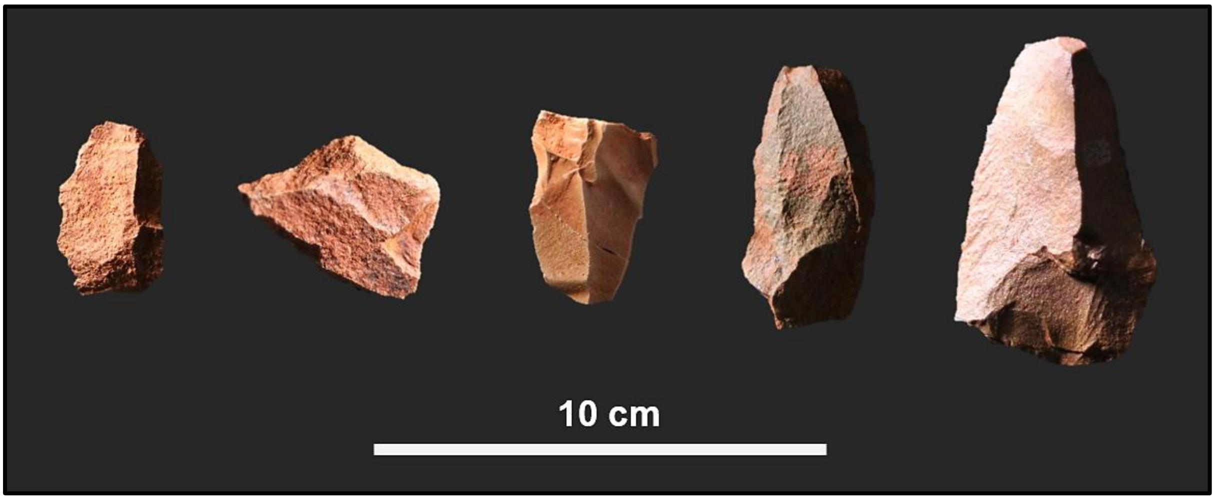


Figure 4.8: Middle Stone Age ≥20 mm complete flakes. Numbers from left to right: 80, 50, 34, 77, and 51.

4.3.2 Fauresmith

Cores

A total of eight cores/core fragments excavated from P4W were classified as belonging to the Fauresmith Industry. The most common type is single platform cores (n=3), followed by core fragments (n=2). One of each of the following types were recovered: polyhedral core, fractured cobble and multifacial core. Figure 4.9 provides several examples of cores from the Fauresmith level as well as an idea of the size range of Fauresmith cores.

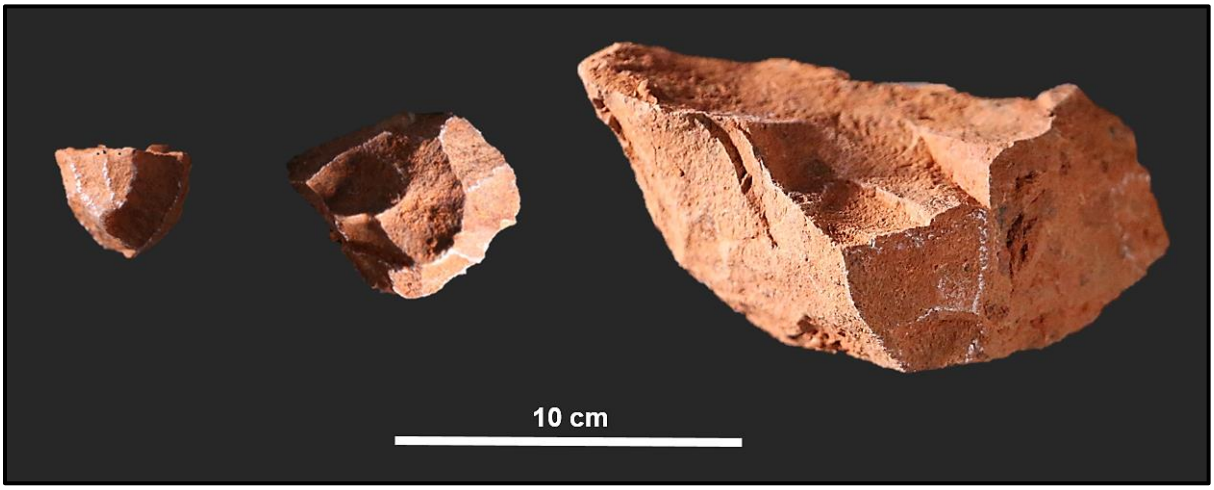


Figure 4.9: Examples of Fauresmith cores. Numbers from left to right: 68, 211, and 123.

Flakes and Blades

The total number of flakes (complete, fragmented and incomplete) from the Fauresmith is 280. This includes 101 complete flakes and 98 flake fragments. Incomplete flakes and split flakes are less numerous, at 63 and 18 respectively. Seven blades, including five complete blades and two incomplete blades, were assigned to the Fauresmith. Figure 4.10 provides an example of some of the different flakes recovered and recorded, as well as an example of a Fauresmith blade.

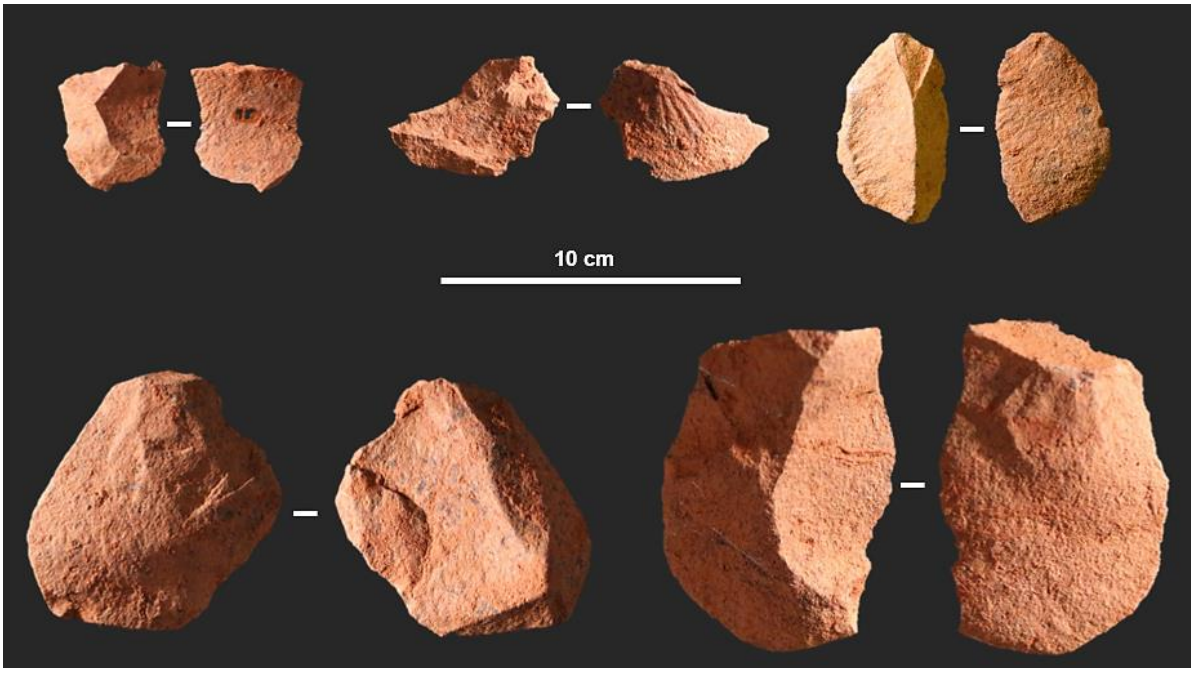


Figure 4.10: Examples of Fauresmith ≥20 mm complete flakes. Numbers clockwise from top-left: 98, 168, 411, 91, and 669.

The author has included the débordant (core edge) complete flake (Figure 4.11) as this type is diagnostic of either Levallois reduction or the presence of radial cores and thus is a significant type to have yielded. All nine excavated débordant flakes were included under the general complete flakes category provided in Table 4.3. All débordant flakes recovered from P4W were assigned as belonging to the Fauresmith industry based on analysis and provenance. Figure 4.11 provides an example of the different forms of débordant flakes as well as their size range.

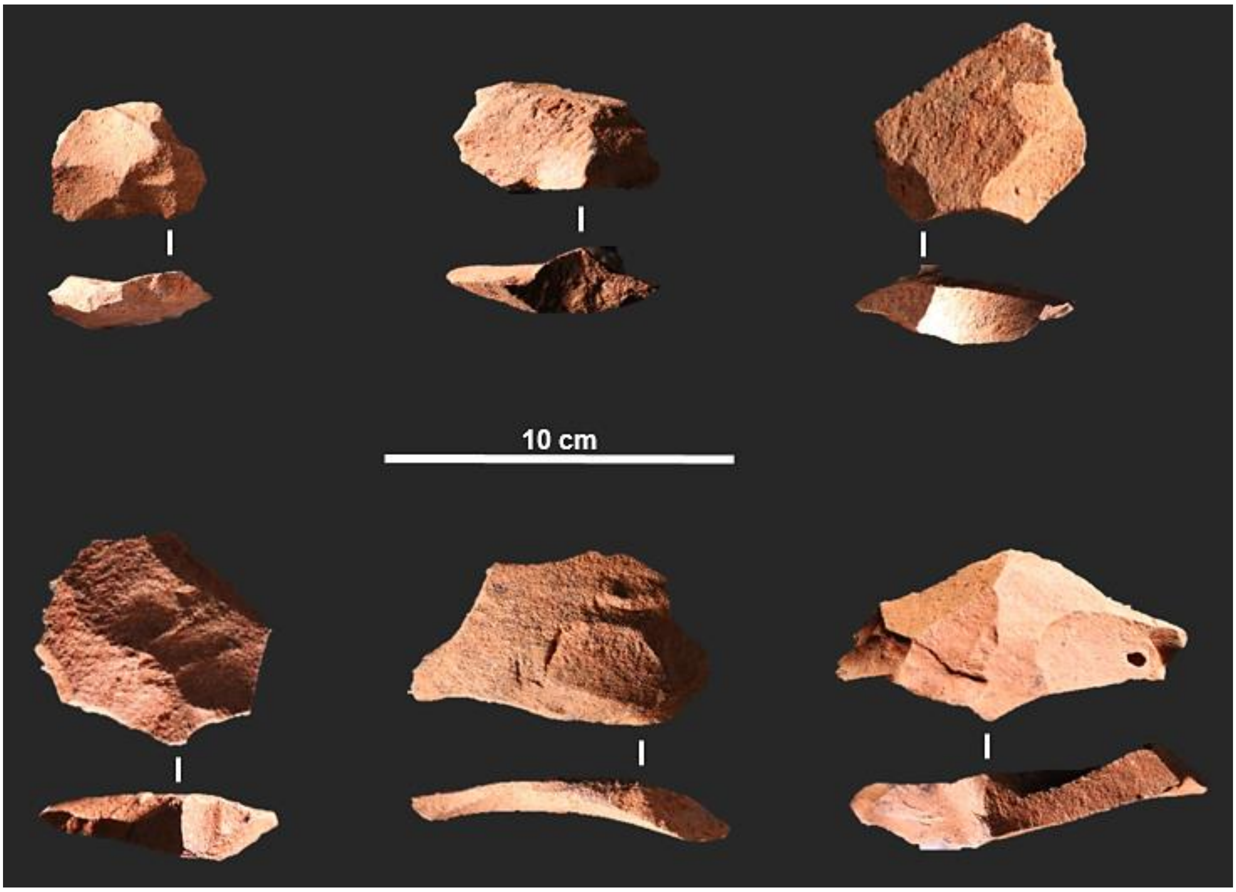


Figure 4.11: Examples of Fauresmith ≥20 mm complete débordant (core edge) flakes. Numbers clockwise from top-left: 304, 457, 167, 55, 534, and 40.

Formals

LCTs

Four Fauresmith LCTs were recovered from P4W. This included two cleavers, a single ‘small’ handaxe and a single ‘small’ cleaver. The LCTs presented in Figure 4.12 differ in visual presentation as they were 3D scanned rather than photographed, due to their diagnostic significance for the classification of the assemblage as Fauresmith. Figure 4.12 shows all four Fauresmith LCTs and highlights the difference in their dimensions and morphology.

Retouched pieces

There is a total of seven retouched pieces that were assigned to the Fauresmith. These retouched pieces include: two retouched flakes, two retouched blades, one retouched kombewa flake, one retouched débordant and one retouched incomplete flake. Figure 4.13 provides two examples of retouched pieces from the assemblage.

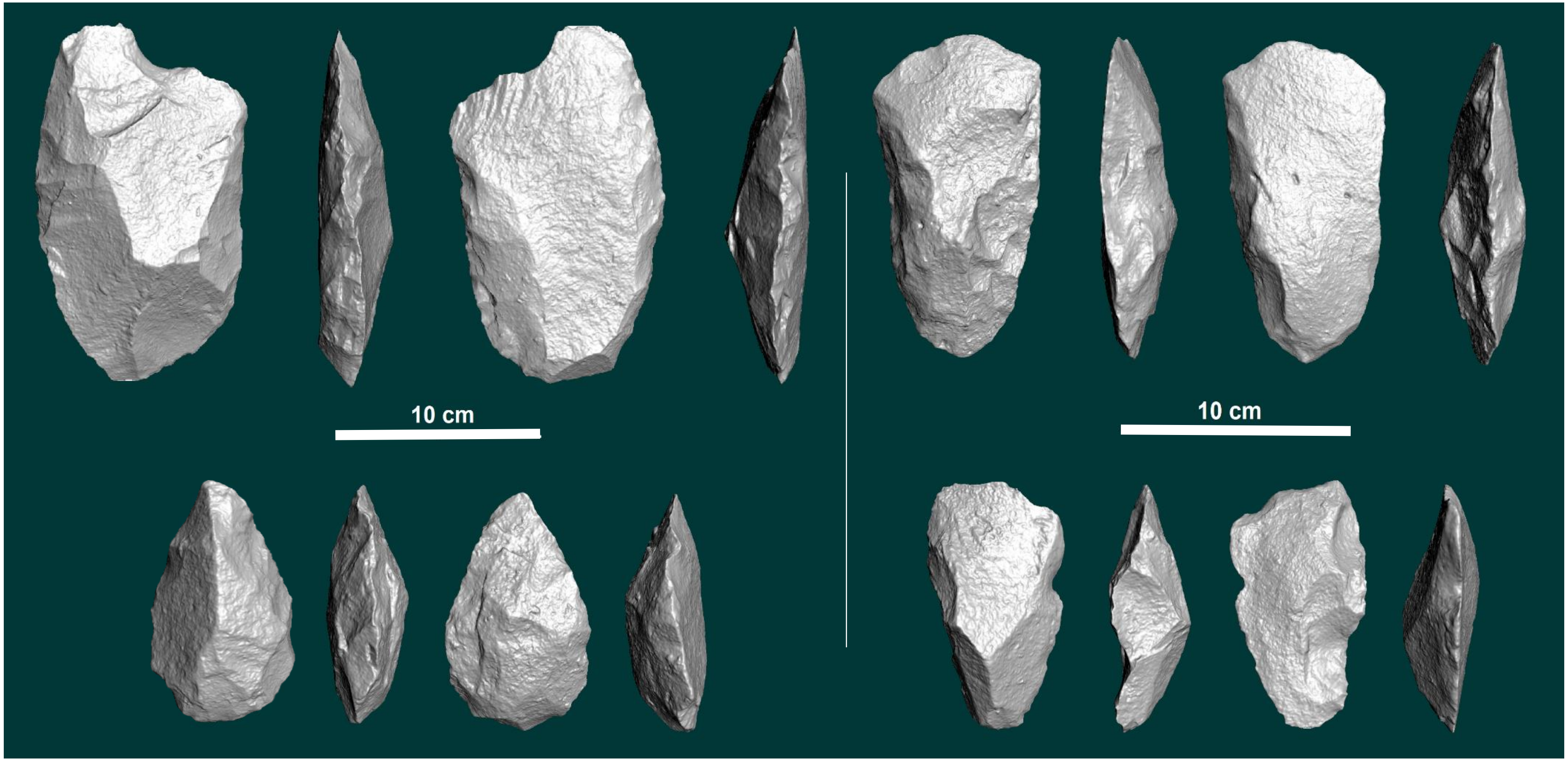


Figure 4.12: All Fauresmith large cutting tools. Clockwise from top-left: cleaver (no. 74), cleaver, (no. 133), cleaver (no. 593), and a small handaxe (no. 113).

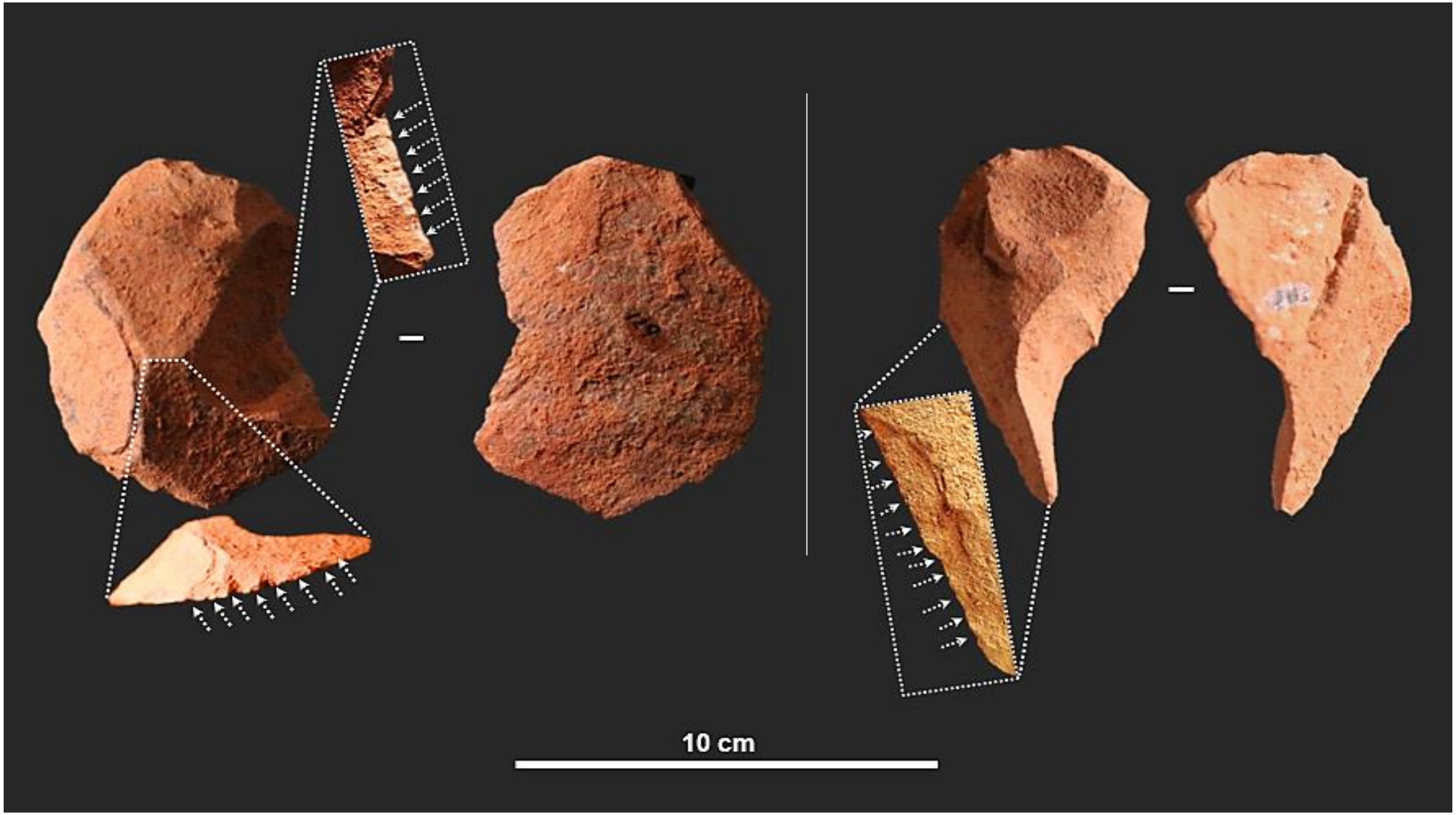


Figure 4.13: Examples of ≥20 mm retouched Fauresmith pieces. No. 129 (left), and No. 105 (right).

4.3.3 Victoria West

Cores

In total, 13 cores/core fragments excavated from P4W were classified as belonging to the Victoria West industry. The most common type is casual core (n=4), followed by core fragment (n=3). Two of each of the following types were excavated: bidirectional cores and multifacial cores. One fractured cobble and one kombewa core were also recovered. Figure 4.14 (left) provides an example of a Victoria West core (bidirectional) and illustrates the large volume of these cores compared to the previously described Fauresmith cores (see Figure 4.9 above).

Flakes and Blades

The total number of flakes (complete, fragmented and incomplete) from the Victoria West is 210. This includes 103 complete flakes and 64 flake fragments. Incomplete flakes and split flakes constitute 39 and 4, respectively. Only one blade was recovered from the Victoria West. Figure 4.14 (right) shows several Victoria West flakes, and as with the cores, reflects the larger dimensions of these flakes compared to the previously described Fauresmith flakes (Figures 4.10 and 4.11).

LCTs

Only two Victoria West LCTs were recovered from P4W. Both of which are cleavers, included in Figure 4.15. Compared to the Fauresmith LCTs (see Figure 4.12 above), one notices a difference in preservation, shape and the possible improvement in the quality of LCT production in P4W.

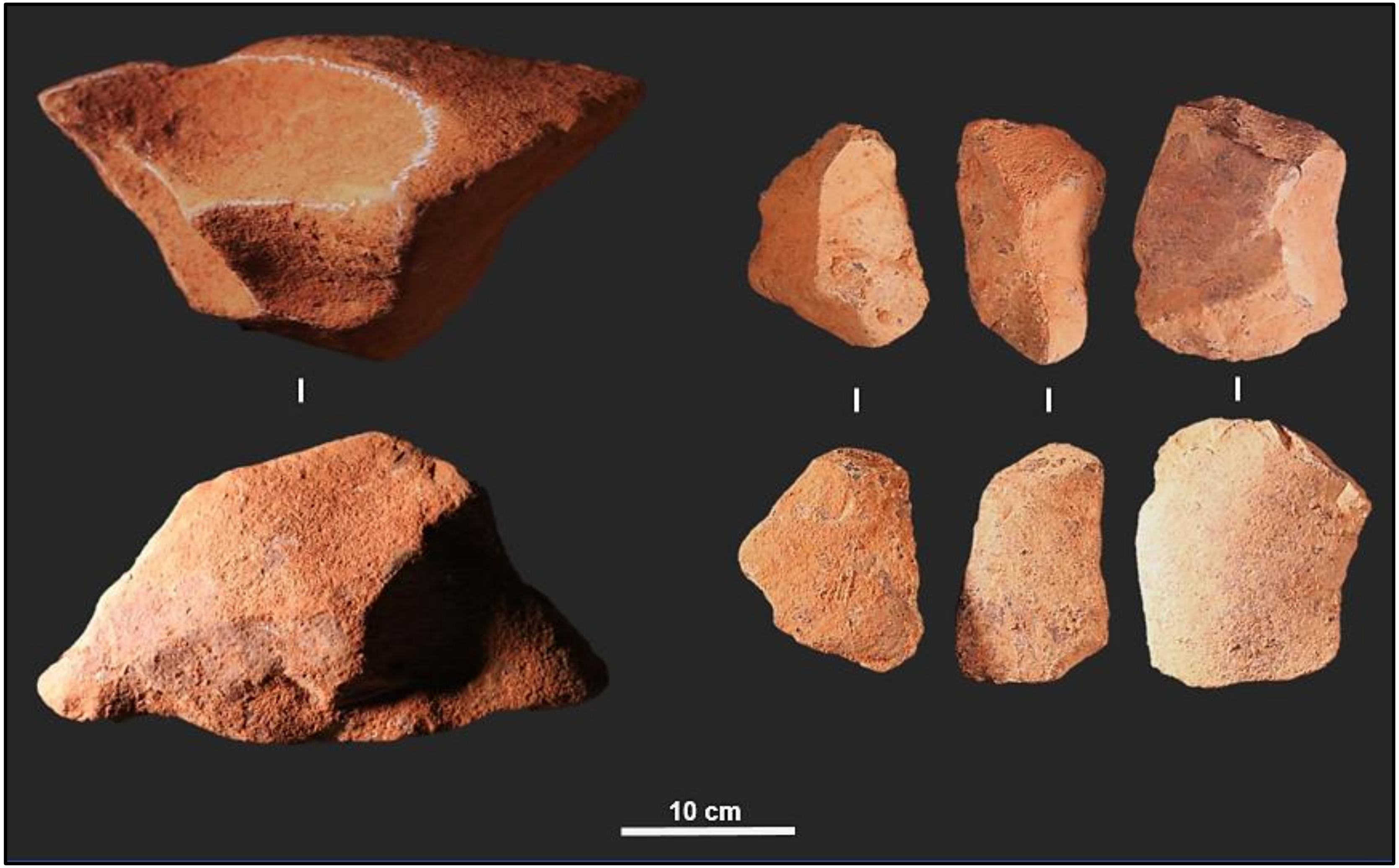


Figure 4.14: An example of a Victoria West core (left, no. 371): and examples of ≥20 mm Victoria West complete flakes (right). From left to right: no. 585, no. 465, no. 335.

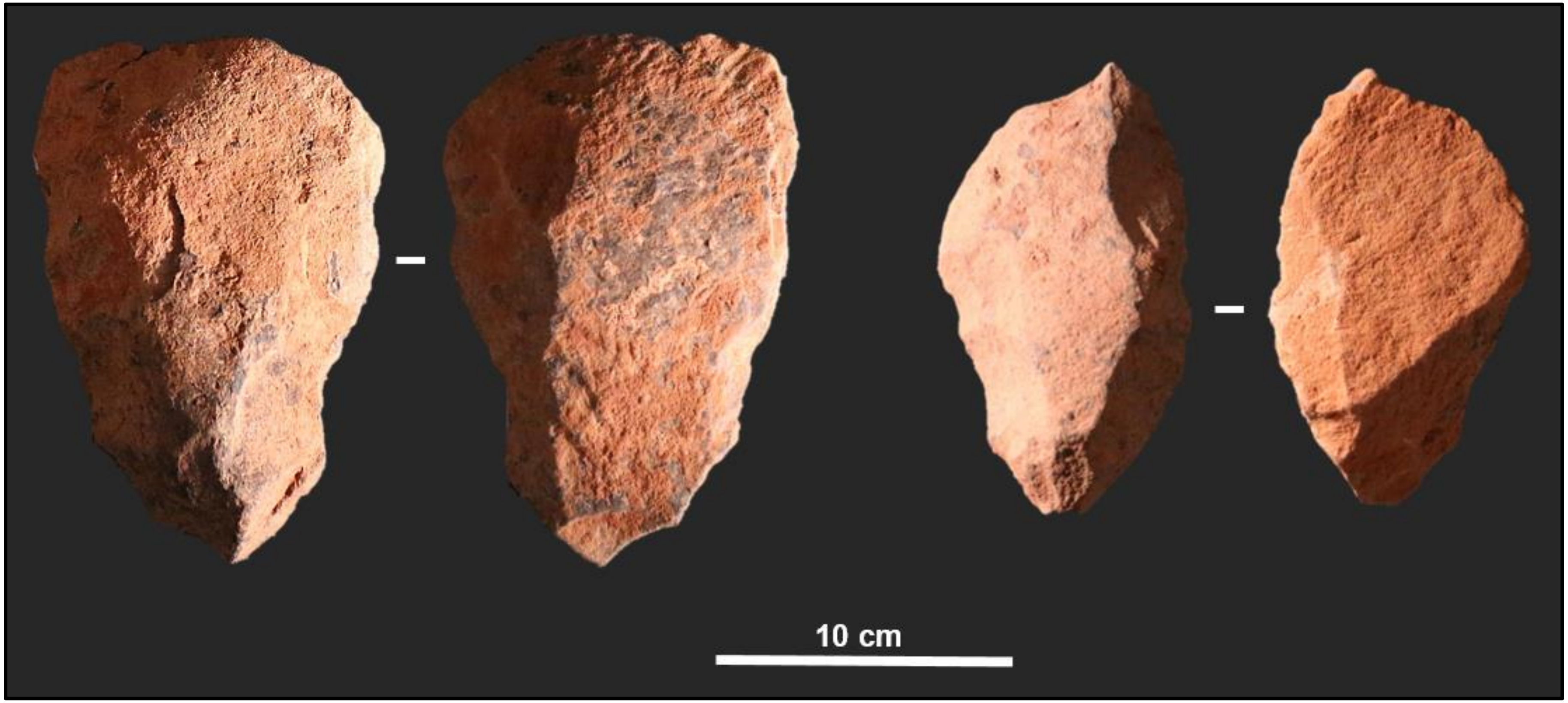


Figure 4.15: All Victoria West cleavers, left to right: no. 475 and no. 260.

4.3.4 Artefact Condition

≥20 mm Artefact Raw Material Results

For the overall P4W assemblage Ventersdorp lava is the dominant raw material type (Figure 4.16). The raw material most dominant in the MSA is Quartzite, followed by Ventersdorp Lava and cryptocrystalline silicate (CCS). The Fauresmith is dominated by Ventersdorp lava, with 298 of the 319 artefacts in the assemblage being produced from this raw material. The Victoria West, similarly to the Fauresmith, is almost exclusively Ventersdorp lava, with 233 of the assemblage's 243 artefacts being produced on this material.

Raw Material ≥ 20 mm	MSA	%	Fauresmith	%	Victoria West	%
Ventersdorp Lava	4	30.77	298	93.42	233	95.88
Quartzite	5	38.46	8	2.51	2	0.82
Quartz	0	0.00	1	0.31	0	0.00
CCS	4	30.77	11	3.45	4	1.65
Hornfels	0	0.00	1	0.31	4	1.65
Total	**13**	**100.00**	**319**	**100.00**	**243**	**100.00**

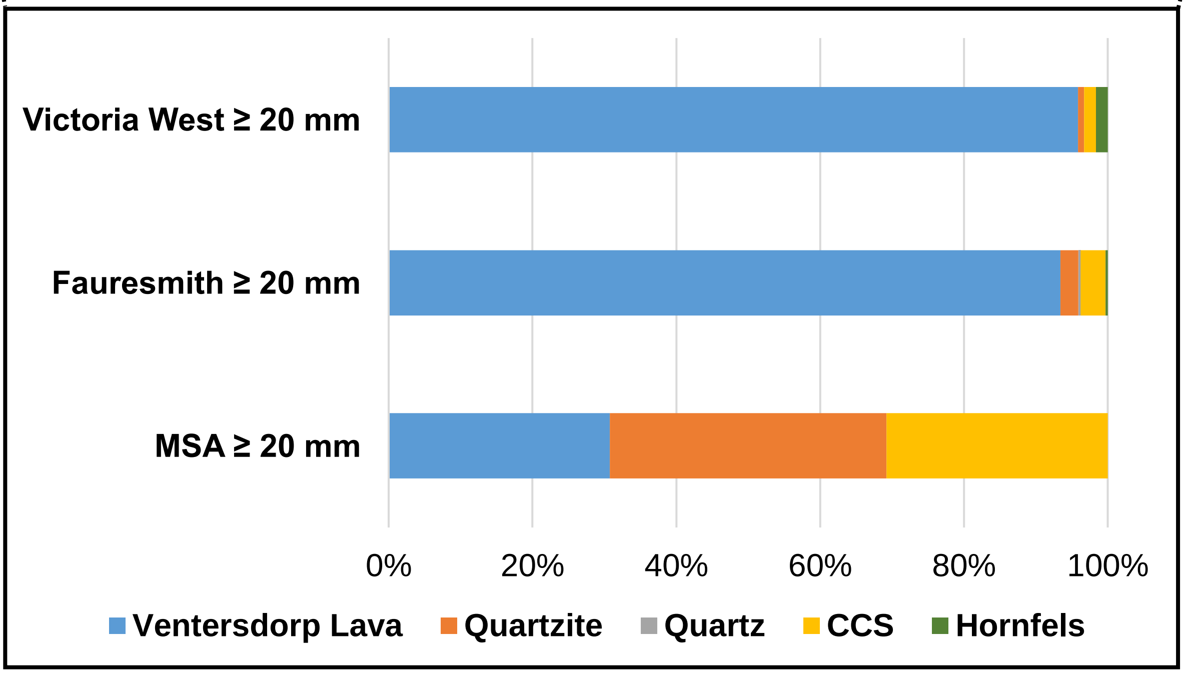


Figure 4.16: The proportions for the MSA, Fauresmith and Victoria West of the five lithic raw material types identified in the combined Pit 4 West assemblage.

≥20 mm Artefact Abrasion Results

In general, the abrasion state of artefacts degrades from fresh to heavily weathered moving down stratigraphically (see Figure 4.17 below). The MSA, which as previously discussed is not dominated by Ventersdorp lava, is relatively fresh. The Fauresmith is dominated by Ventersdorp lava and includes almost 80% fresh or slightly weathered artefacts. In contrast, the underlying Victoria West industry has a more than 90% of weathered and heavily weathered artefacts collectively.

Abrasion State ≥ 20 mm	MSA	%	Fauresmith	%	Victoria West	%
Fresh/unabraded	11	84.62	96	30.09	0	0.00
Slightly Weathered/abraded	0	0.00	155	48.59	15	6.17
Weathered/abraded	1	7.69	63	19.75	121	49.79
Heavily Weathered/abraded	1	7.69	5	1.57	107	44.03
Total	**13**	**100.00**	**319**	**100.00**	**243**	**100.00**

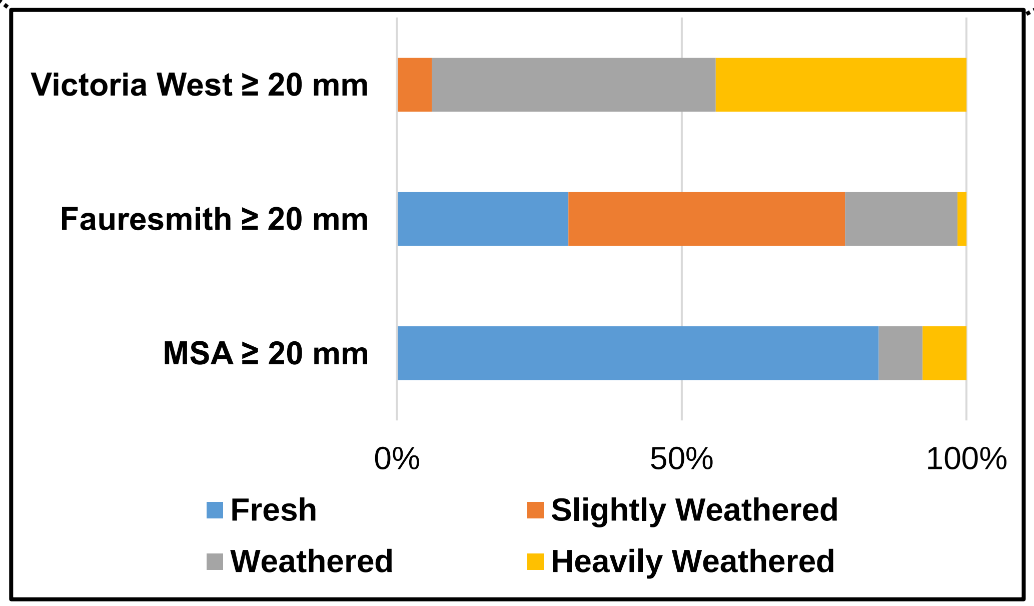


Figure 4.17: The proportions of different artefact weathering states within the different assemblages excavated from Pit 4 West.

≥20 mm Artefact Exfoliation Results

The proportion of exfoliation of artefacts varies considerably by industry as shown in Figure 4.18. Exfoliation is entirely absent in the MSA assemblage and is the highest in the Victoria West assemblage at almost 42%. Only 12% of Fauresmith artefacts are exfoliated.

Artefact Damage ≥ 20 mm	MSA	%	Fauresmith	%	Victoria West	%
Exfoliated	0	0.00	39	12.23	102	41.98
Not Exfoliated	13	100.00	280	87.77	141	58.02
Total	13	100.00	319	100.00	243	100.00

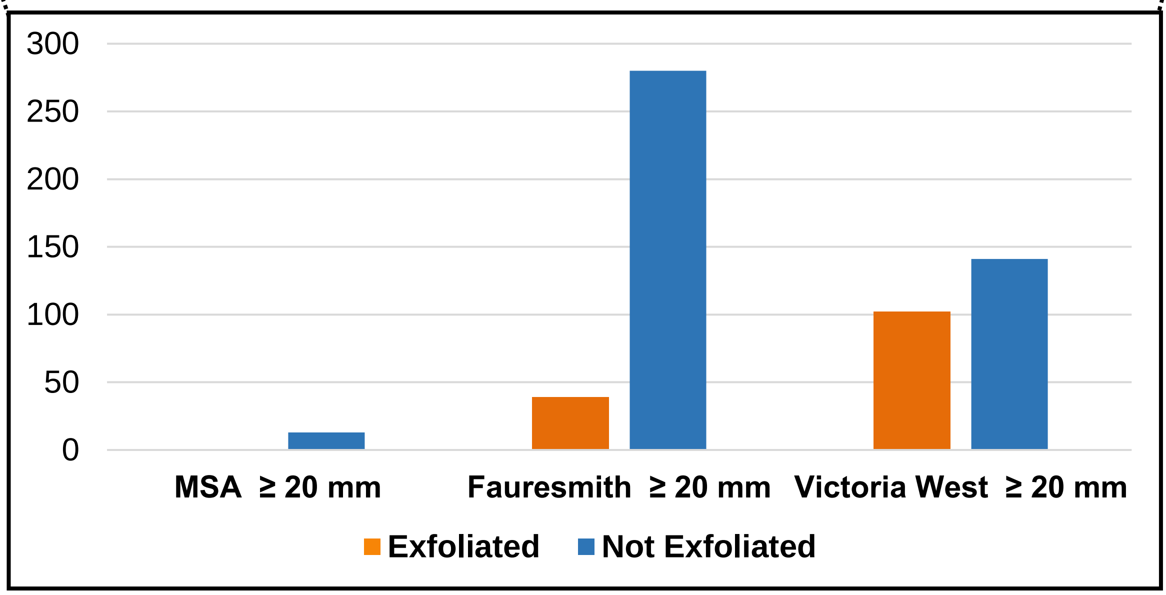


Figure 4.18: The number of exfoliated and non-exfoliated artefacts within the MSA, Fauresmith and Victoria West from Pit 4 West.

≥20 mm Artefact coating calcium-carbonate (CaCo3) Results

The amount of calcium-carbonate coating (henceforth referred to calcrete) present on artefacts yielded from P4W increases stratigraphically moving downwards as shown in Figure 4.19. It is limited in the MSA, increases significantly in the Fauresmith and sees another marked increase in the Victoria West, which contains the largest number of artefacts that are heavily cemented.

≥ 20 mm Artefact Calcrete	MSA	%	Fauresmith	%	Victoria West	%
0. 0	8	61.54	39	12.23	18	7.41
1. 1-25	4	30.77	131	41.07	64	26.34
2. 26-50	0	0.00	84	26.33	67	27.57
3. 51-75	1	7.69	33	10.34	48	19.75
4. 76-100	0	0.00	32	10.03	46	18.93
Total	**13**	**100.00**	**319**	**100.00**	**243**	**100.00**

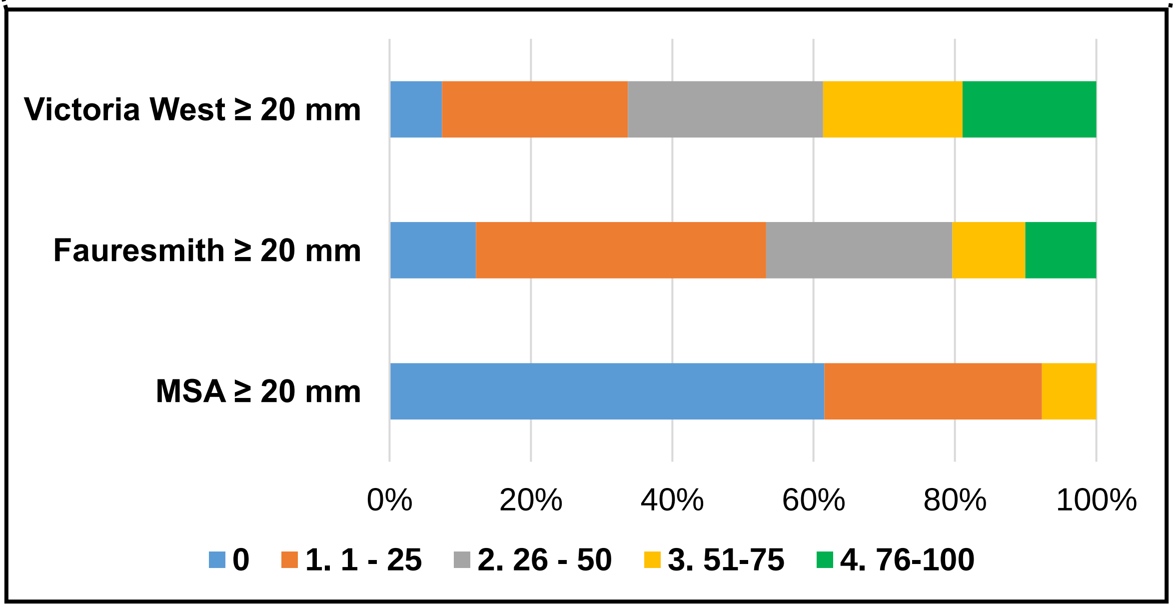


Figure 4.19: The proportion of artefacts within Pit 4 West that fall within the five categories of calcrete presence and coverage.

4.4 Lithic Spatial Results

The following GIS models are specifically associated with the lithic industries in P4W (Figure 4.20). The main purpose of these results is to present the reader with the stratigraphic relationship between the different technological industries from P4W. The spatial models provide the reader with a geographically-accurate visual representation of how the different industries have interacted or mixed with one another, as well as the provenance and placement of different types of stone tool technology (≥20 mm) within P4W.

All P4W Lithic Industries: Western Profile

In profile shown in Figure 4.20, there is a clear separation between an upper level containing MSA and some Fauresmith artefacts, and the lower PL2 and GU which contain Fauresmith and Victoria West. The industries appear mixed in the lower part of the profile, but this is partly due to the undulating surface of the contact between GU and PL2.

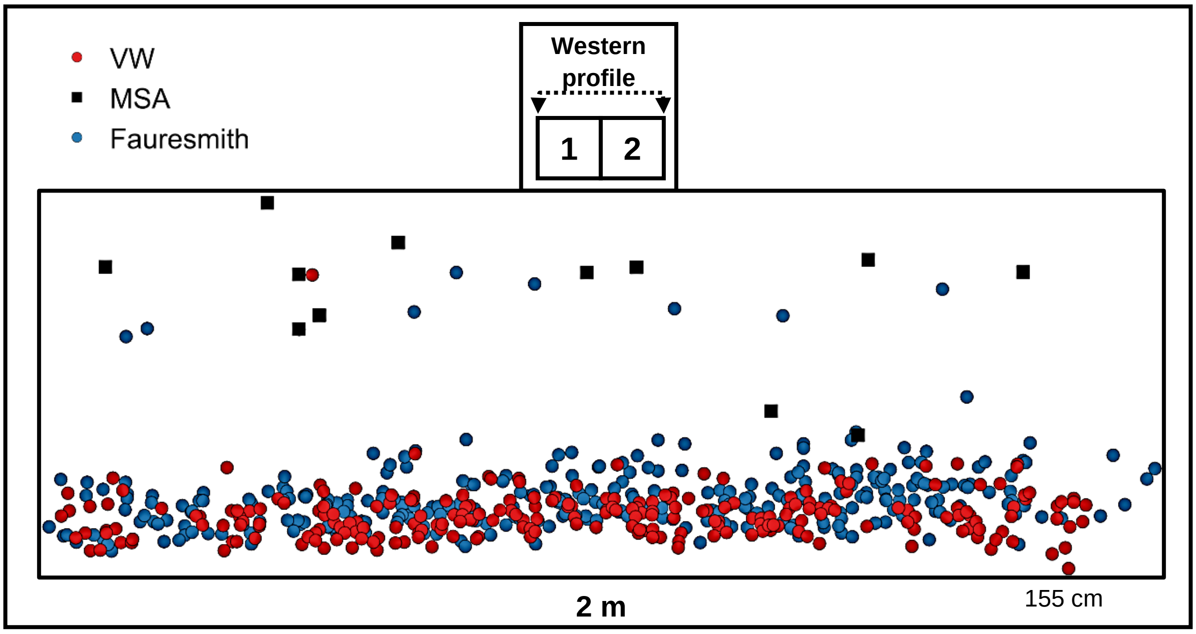


Figure 4.20: A GIS model of the vertical and horizontal distribution of MSA, Fauresmith and Victoria West artefacts within Pit 4 West.

All P4W Fauresmith and VW Lithic Types: Western Profile

Victoria West incomplete flakes and Fauresmith incomplete flakes are dominant types stratigraphically (Figure 4.21). Victoria West cores and Fauresmith cores occur sporadically and are rare features. There is no discernible spatial change in artefact types.

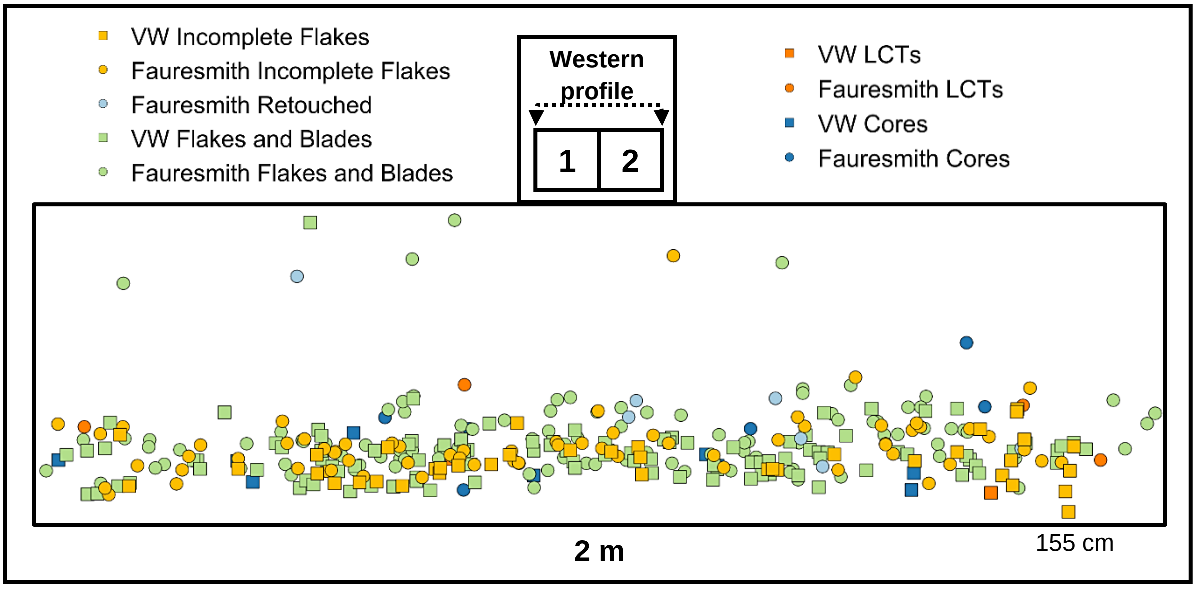


Figure 4.21: A GIS model of the distribution of different artefact types within the Fauresmith and Victoria West industries in Pit 4 West.

P4W Fauresmith Abrasion Model: Western Profile

The abrasion state of Fauresmith artefacts generally degrades moving down through the profile (Figure 4.22). However, there is still a great deal of 'mixing' in terms of the presence of different abrasion states within the same part of the profile despite the trend towards greater abrasion nearer the base of the excavation. The only heavily abraded artefacts are near the lower limit of the Fauresmith.

P4W Victoria West Abrasion Model: Western Profile

The GIS model of Victoria West abrasion state shows the co-occurrence of artefacts with various degrees of weathering (Figure 4.23). There is no clear vertical trend in abrasion, largely due to the limited number of unabraded artefacts.

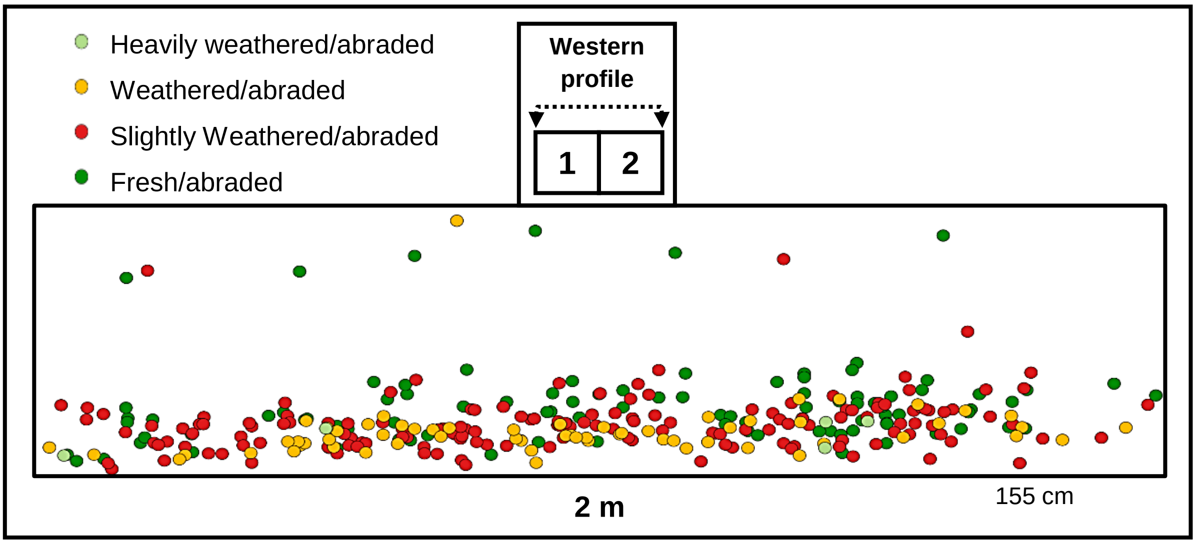


Figure 4.22: A GIS model of the distribution of Fauresmith artefacts within Pit 4 West according to abrasion state.

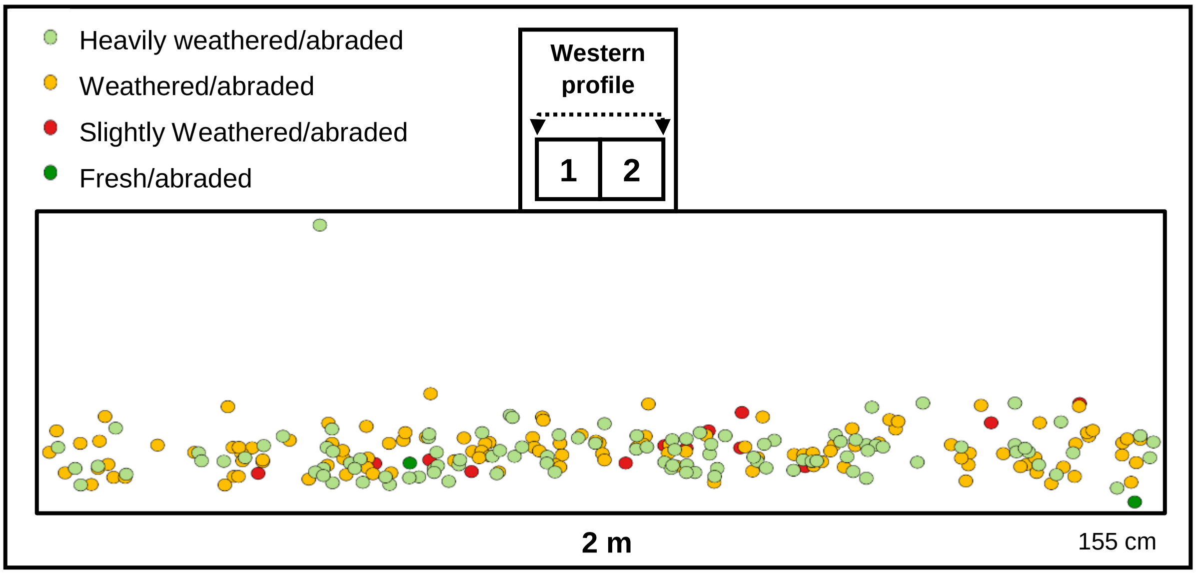


Figure 4.23: A GIS model of the distribution of Victoria West artefacts within Pit 4 West according to abrasion state.

P4W Fauresmith Exfoliation Model: Western Profile

The exfoliation of Fauresmith artefacts in Pit 4 West is rare and largely constrained to the lower reaches of the Fauresmith industry (Figure 4.24). There is no obvious horizontal spatial pattern in the distribution of exfoliated artefacts.

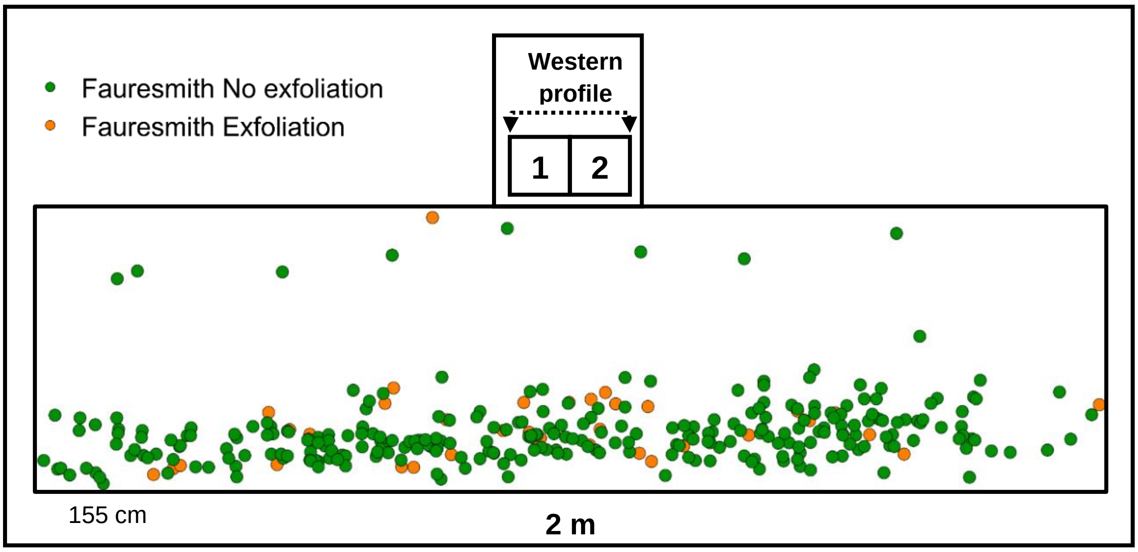


Figure 4.24: A GIS model of the distribution of exfoliated and non-exfoliated Fauresmith artefacts within Pit 4 West.

P4W Victoria West Exfoliation Model: Western Profile

As with the Fauresmith artefacts, exfoliated and non-exfoliated Victoria West artefacts are found throughout the extent of the industry in Pit 4 West (Figure 4.25). The entire Victoria West assemblage is heavily affected by exfoliation.

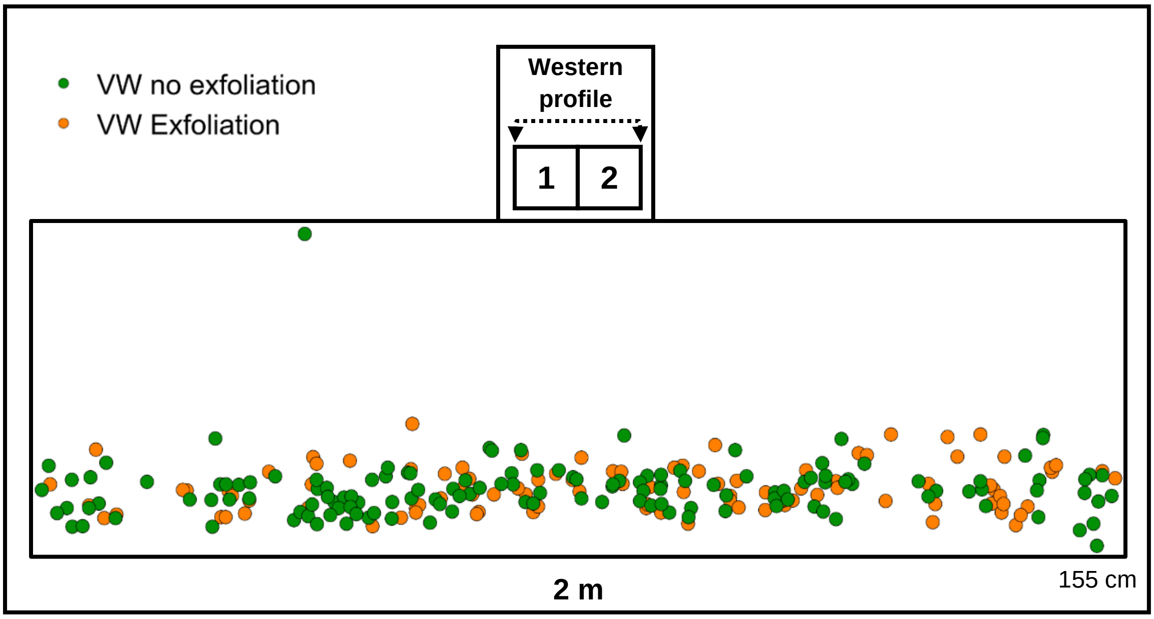


Figure 4.25: A GIS model of the distribution of exfoliated and non-exfoliated Victoria West artefacts within Pit 4 West.

P4W Fauresmith Calcrete Model: Western Profile

The presence and coverage of calcrete on Fauresmith artefacts in P4W varies considerably (Figure 4.26). Within PL2 and GU, there is no discernible spatial patterning in calcrete presence and coverage as a variety of states are found in association.

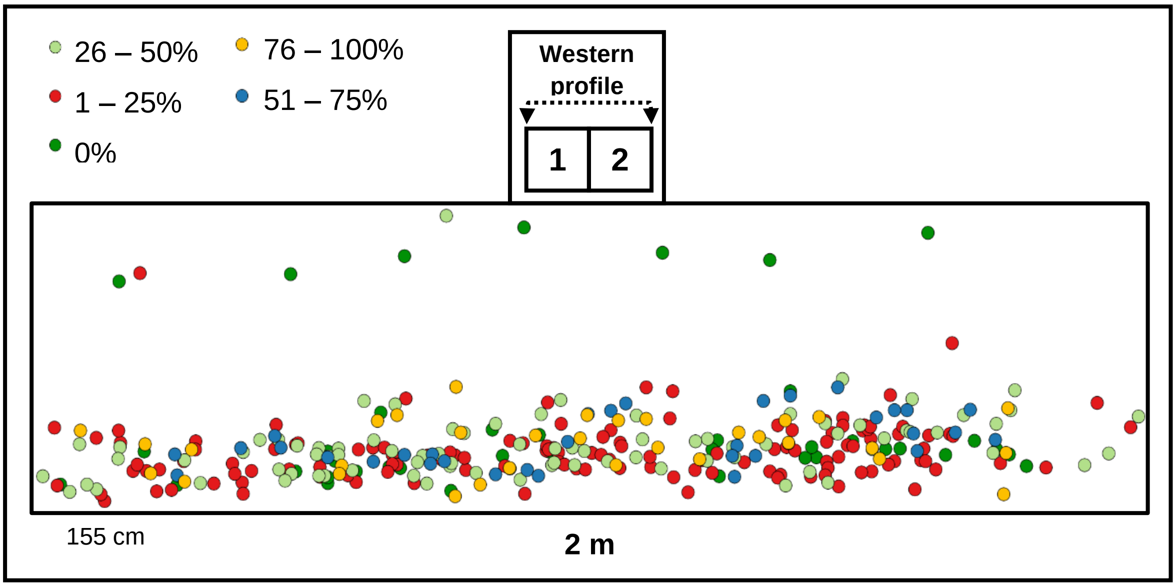


Figure 4.26: A GIS model of the distribution of Fauresmith artefacts within Pit 4 West according to categories of calcrete coverage.

P4W Victoria West Calcrete Model: Western Profile

The proportion of calcrete on Victoria West artefacts various greatly as shown in Figure 4.27.

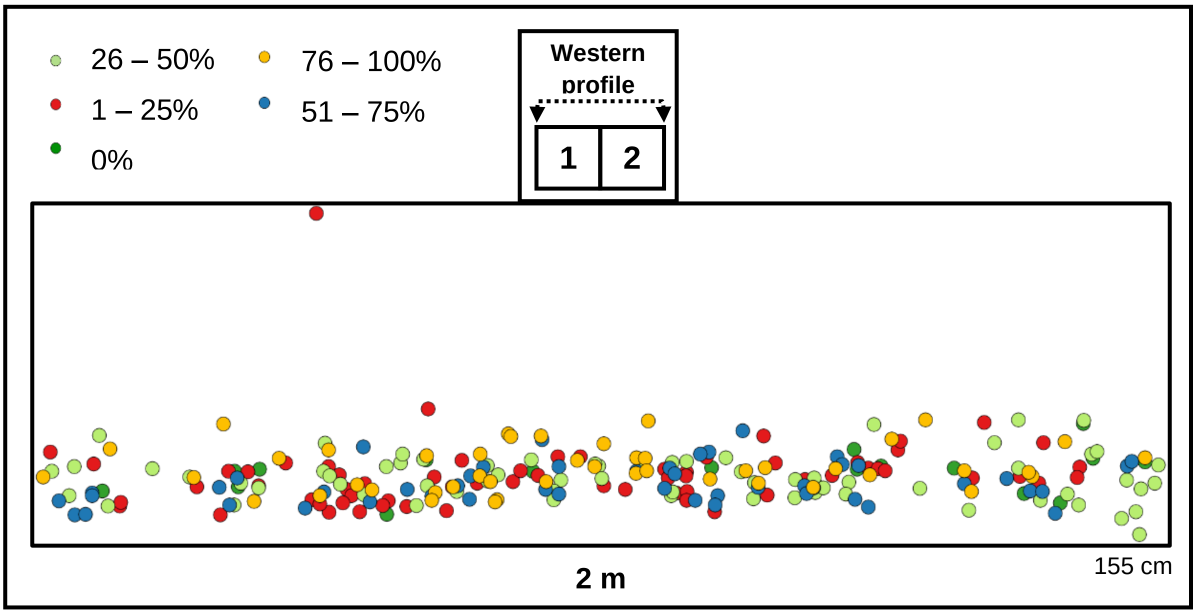


Figure 4.27: A GIS model of the distribution of Victoria West artefacts within Pit 4 West according to categories of calcrete coverage.

All P4W Fauresmith & Victoria West ≥20mm Artefacts: Plan view

Figure 4.28 shows the plan view of the surface of the Fauresmith and Victoria West artefacts. This plan view does not include any MSA artefacts. The purpose of this model is to provide a visual understanding of the stratigraphic positioning of Fauresmith and Victoria West artefacts relative to one another. Whilst there are notable clusters of Fauresmith artefacts around some Victoria West artefacts, the overall pattern is relatively mixed in plan view.

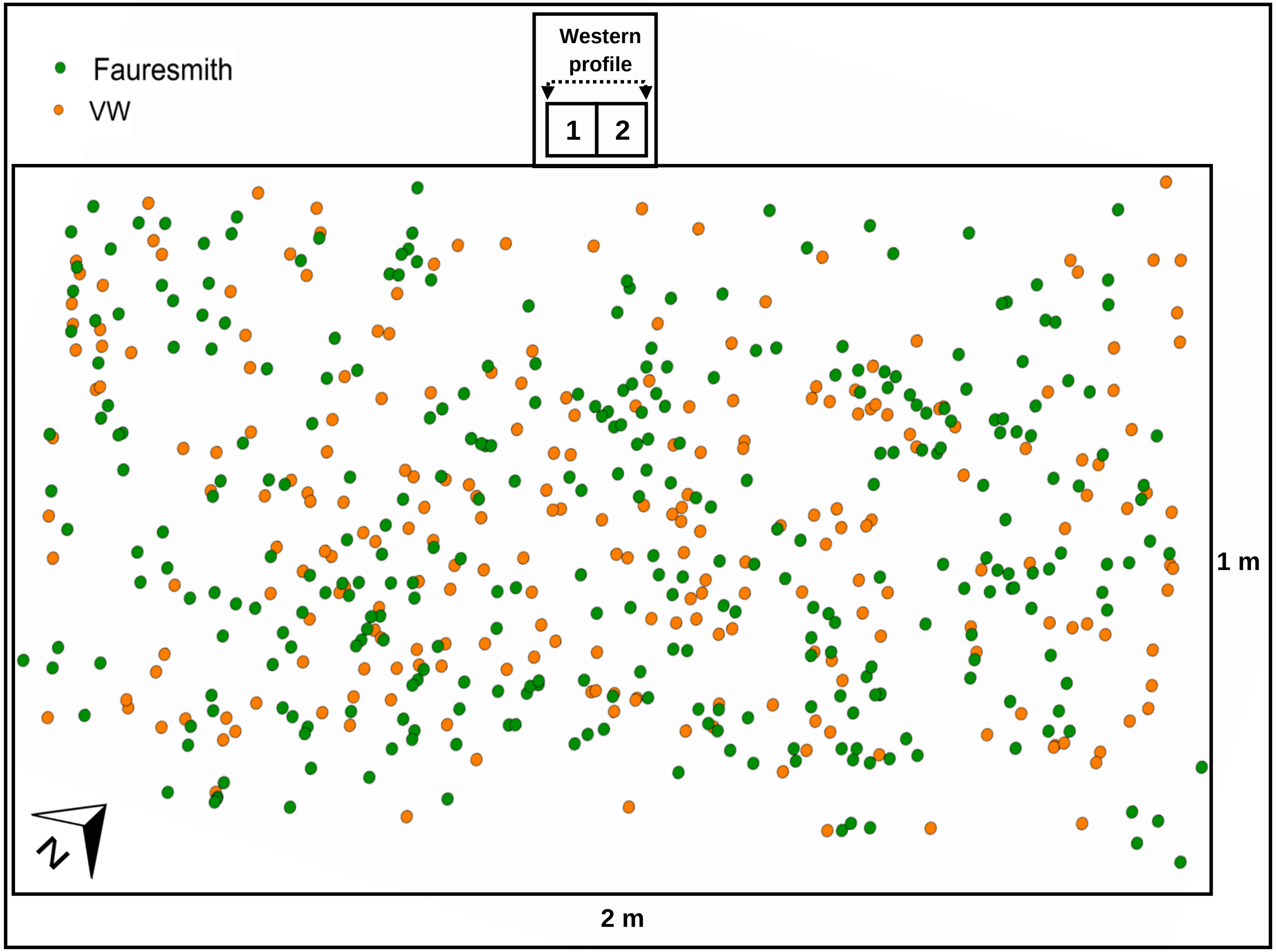


Figure 4.28: A plan-view GIS model of the distribution of Fauresmith and Victoria West artefacts (>20 mm) in Pit 4 West.

4.5 OSL Dating Results

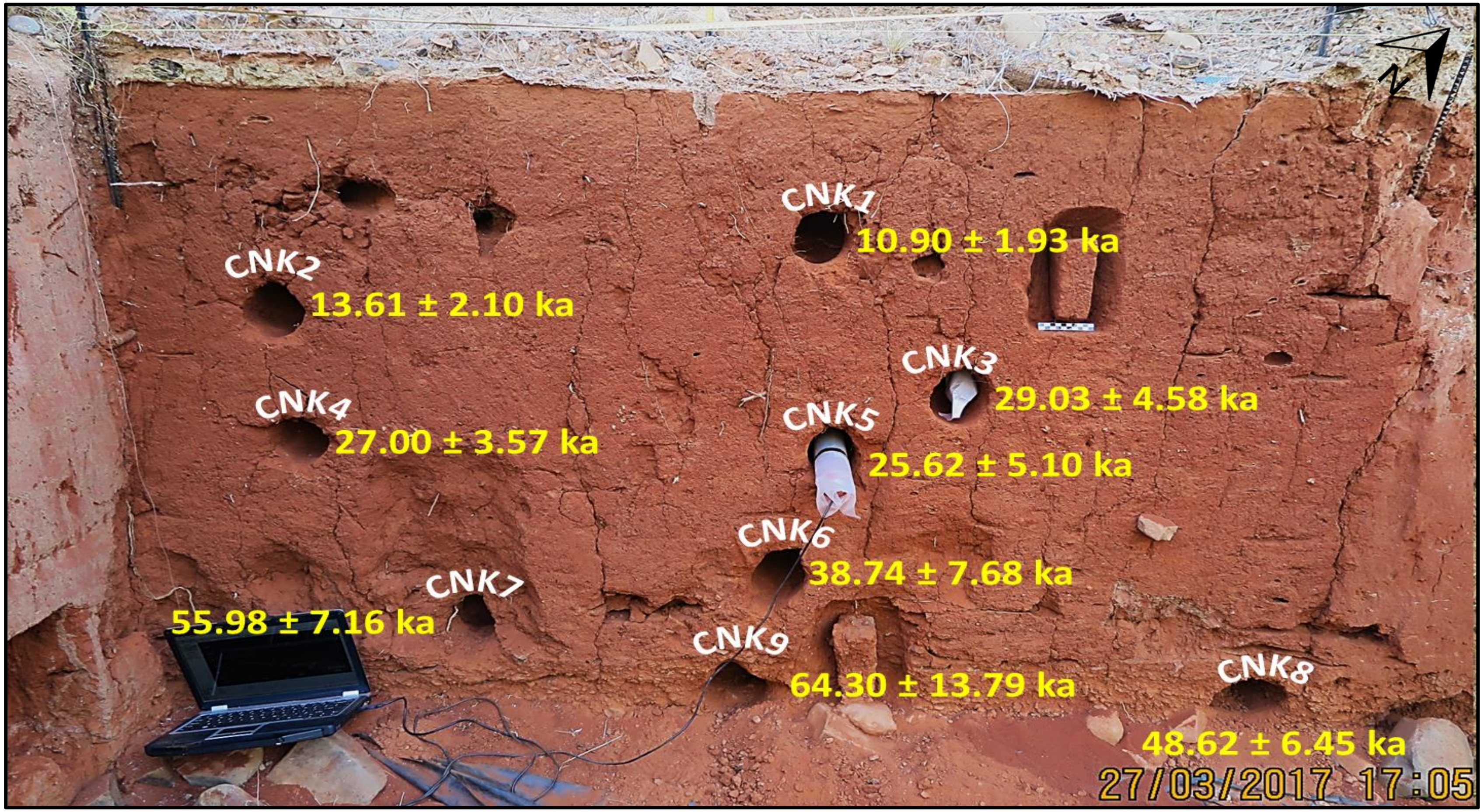


Figure 4.29: Optically stimulated luminesce (OSL) dating samples holes with their corresponding multi-grain OSL dates for Pit 4 West.

The results of OSL dating, presented in Figure 4.29 above, of the P4W excavation show a general increase in age moving down through the sequence. The ages are younger than the Fauresmith is suggested to be associated with. As mentioned in Chapter 3, no dating sample could be taken from within the Gravel Unit. However, CNK8 and CNK9 were both taken within PL2 as close to the top of GU as possible. Sample CNK9 provides a date of 64.30±13.79 ka for the lower part PL2 where the Fauresmith is found. These multi-grain dates are being used as minimum dates for P4W.

Chapter 5: Discussion & Conclusions

5.1 Discussion

A Fauresmith level does exist in Pit 4 West (P4W) and artefacts were identified as belonging to this industry through typological analysis, the results of which were presented in Chapter 4. It was possible to distinguish Fauresmith from Victoria West artefacts based on several properties (see Chapter 3, Section 3.3) and the associated provenance of the artefact.

The Fauresmith at P4W does not represent a knapping workshop due to the lack of cores present at the site, this contrasts with the Fauresmith assemblage from Pit 6 which has yielded many cores. However, unlike Pit 6, P4W has yielded four relatively fresh and complete large cutting tools (LCTs): two large cleavers and a 'small' handaxe and cleaver. Smaller LCT's have been typically described as being associated with the Fauresmith in literature (see Chapter 2 and references Goodwin 1925, 1929; van Riet Lowe 1927, 1945; Herries 2011; Underhill 2011; Wilkins & Chazan 2012).

The mixed contact zone (MCZ), which is described as associated with the lower Fauresmith material in Pit 6 by Lotter *et al*. (2016), is located between Pebble Layer 2 (PL2) and the Gravel Unit (GU) in P4W not between the Hutton Sands and the GU like in Pit 6. The presence of Pebble Layer 1 (PL1) and PL2 provides a new, different stratigraphic model than those previously described from other pits, which may suggest extremely localised depositional events and thus greater variability (refer to Chapter 4, Figure 4.1. for a visual aid).

The *surface* integrity or preservation of the Fauresmith artefacts has been affected by chemical weathering that occurs particularly with artefacts that are stratigraphically associated with the irregular surface of the gravels. Lotter *et al*. (2016) emphasises the role that the irregular surface of the gravels (and bioturbation) has on the mixing of artefacts in Pit 6's MCZ.

In P4W, the Fauresmith is not always characterised by fresh artefacts and not all Victoria West artefacts are heavily weathered/rolled. Exfoliation affects both Fauresmith and Victoria West artefacts lower down in the sequence but both industries are less effected by exfoliation higher up in the deposit. The exfoliation of, and presence of calcium-carbonate coating (described as calcrete in this dissertation) on, artefacts increases drastically as one moves down into the GU. The most consistent and rational reason for an increase in chemical weathering which led to high proportions of exfoliation, as well as an increase in calcrete that cemented most of the material between 117-155 cm, is the presence of water. It is possible that rain would have leached (and could continue to leach) the $CaCO_3$ from the overlying softer Hutton Sands (HS). The reprecipitation of the $CaCO_3$ results in the coating of the surface of artefacts, particularly collecting at the largely impenetrable Gravel Unit (GU) contact due to gravity. The Middle Stone Age (MSA) assemblage seems to not be affected by exfoliation or abrasion/weathering, suggesting that the HS associated with it had either not been deposited during periods of significant leaching or during periods of the water table level fluctuating. The water table is still visible at Canteen Kopje and one can occasionally find open pits at the site that have a higher water level than other locations of the site, where the water table is not exposed. With regards to the possibility of an increasing water table level, the MSA level may have already been established during these periods of fluctuation but it remained stratigraphically higher than the water table. It is important to note, however, that the MSA assemblage from P4W is small and thus interpretations regarding technological and site formation processes associated with it, is limited.

Overall, the author suggests that continuous leaching of $CaCO_3$ and multiple phases in which the water table would have risen and submerged the GU and PL2 deposits and then dropped again over many episodes over a very long period, is responsible for the heavy calcification present in P4W. This explanation not only clarifies the high proportion of exfoliation and calcrete coverage of P4W lithics, but it also explains why the assemblage from Pit 6 does not reflect these same trends despite the pits being only several hundred meters away from one another (pers.obvs and K. Kuman pers.comm. 2018).

Despite the surface condition of Fauresmith artefacts being affected by their stratigraphic position and contact with water, the high proportion of calcrete, compression from the HS sediment above the Fauresmith level and the large gravels below it, have provided enough support for minimum displacement of artefacts.

Macroscopic analysis and GIS data support the above statement. The data collected regarding organic material (microscopic and loss on ignition data) suggests that the possibility of vertical or horizontal displacement due to bioturbation or root activity was in fact limited, a conclusion that macroscopically seemed unlikely but at a finer resolution proved correct.

The young OSL dates reflect a very high overdispersion which indicates the mixing of sand grains within the deposit. However, any mixing of artefacts within the HS appears to be limited. It is possible that there is a selective movement of smaller sediment particles by bioturbatory processes that does not seem to displace larger clasts (including lithic artefacts).

Bioturbation is a major issue at Canteen Kopje, with many publications attributing poor data to the influence of bioturbation. The author suggests that PL1 has formed as the result of bioturbation, specifically termite activity. Termites displace sediment as they move, creating tunnels in the sedimentary structure. Although sediment particles are removed and redistributed, larger clastic material, such as the angular gravels in PL1, are not removed but are redistributed. These clasts do not remain *in-situ* and accumulate as the sediment is removed, forming a thin, poorly sorted clast-supported pavement (D. Granger pers.comm. 2018).

However, bioturbation does not seem to be a major factor that has influenced the Fauresmith assemblage in P4W. The author suggests that perhaps the HS and PL2 deposits served as a barrier that protected the Fauresmith from being displacement by bioturbation processes.

Bioturbation in the form of animal activity or root activity is most likely to occur in soft, unconsolidated units. Naturally, the processes or energies associated with deposition of the HS and PL2 deposits would affect the degree of bioturbation that occurs. There is little evidence for root activity and thus any bioturbation that occurred seems to have been at a relatively minor scale. Unlike Pit 6, which is suggested to potentially have been influenced by tree-throw, there is no evidence for this in P4W, with no major sediment displacement.

The author suggests that PL2 is an alluvial lag deposit, as the clasts found within this deposit are classified as alluvial pebbles based on their size, shape and rolled surface texture. The following sequence of depositional and erosional events is what we interpret for the formation of the current PL2 deposit (D. Granger pers.comm. 2018):

- PL2 represents a relatively low energy deposit (compared to the underlying Victoria West-bearing gravels).
- This alluvial layer was deposited on top of the GU and consisted of alluvial sands with a pebble component.
- After this deposition, the alluvial sands originally associated with PL2 were eroded away.
- The larger clasts within the deposit, namely the pebbles, were left as a lag deposit and thus are still present.
- Over time, the HS that is now present across the site, was deposited over the residual pebbles. This has formed the matrix that is currently associated with PL2 and Fauresmith artefacts, as the more recent sand filled into voids between pebbles and artefacts and onto the underlying GU's irregular surface.

This theory is further supported by the macroscopic and microscopic data presented in Chapter 4. PL2 is unstratified, has a loose consistency, with clasts being well-sorted and the matrix being poorly sorted. The low energy deposition of the HS on top of PL2 would have covered the deposit with minimal disturbance to the artefactual assemblage. The author emphasises the significant unconformity at the lower contact of the HS with the upper contact of the PL2.

Based on the above sequence of events and the described macro- and microscopic data, the author proposes two scenarios for the chronology of the Fauresmith level vs. PL2:

1) Fauresmith artefacts were deposited onto the irregular surface of the Victoria West-bearing alluvial gravels (GU) and thereafter, the initial deposit of alluvial sand with a pebble component was deposited onto the Fauresmith level. Over time, the erosion of the alluvial sands not only removed this element but resulted in the formation of a deflated surface, that comprised Fauresmith artefacts being stratigraphically associated with the alluvial lag (pebble) deposit. The Hutton Sands was deposited onto this deflated surface and sand filtered down and filled in voids within the lag.
2) The alluvial deposit (that comprised both sands and a pebble component) was deposited onto the irregular surface of the Victoria West-bearing alluvial

gravels (GU) and during this deposition, Fauresmith artefacts were intermittently discarded onto this new alluvial surface. Over time, the erosion of the alluvial sands not only removed sediment but also resulted in the formation of a deflated surface. This deflated surface or pavement comprised stratigraphically associated Fauresmith artefacts and alluvial pebbles (lag deposit). This deflation resulted in not only the pebble component being heavily exfoliated, but also the exfoliation of some artefacts. Over time, the Hutton Sands was deposited onto this deflated surface and sand filtered down and filled in voids within it.

Despite the matrix in both the HS and PL2 being aeolian-derived (according to past literature), the author suggests that a significant thickness of HS was deposited on top of PL2 within a relatively short period of time. This rapid deposition would have provided a compact deposit that also provided enough deposit above the Fauresmith (and stratigraphically associated Victoria West material to a certain degree) to reduce the influence of bioturbation (refer to Chapter 4, Figure 4.1. for a visual aid). The HS at Canteen Kopje is not stratified, which may be due to post-depositional mixing. The HS would have been deposited over multiple episodes to develop the depth that it is currently at, which has further protected the lower deposits/artefacts from the effects of bioturbation.

The author, based on the field and laboratory data, suggests that the HS represent a low energy deposit; PL1 represents a high energy deposit of very short duration that introduced limited material to P4W; PL 2 is a relatively high energy deposit, which is likely to have occurred over a longer period than PL1 due to it being considerably thicker; the GU represents a very high energy deposit that was capable of moving and depositing boulder-sized clasts. This deposit was accumulated over a relatively long period of time.

5.2 Conclusion

The data that were collected, analysed, and presented by the author in the previous Results Chapter provide a conclusive but complex answer to the research question for this project. Yes, the integrity of the Fauresmith has been, and is potentially still being, affected by the 'mixed contact zone' at the interface between the Hutton Sands and the underlying gravels in P4W.

However, the author believes that the term 'integrity', based on this research, pertains to a myriad of factors (which can be present/relevant at varying degrees), some of which have become clearer and others that were not initially anticipated. Furthermore, the term 'mixed contact zone' (MCZ), although first used by Lotter *et al*. (2016) to describe the Pit 6 stratigraphy, can be used at the Canteen Kopje site to not only describe the Pit 6 stratigraphy (described in Chapter 2) but also an interface that involves different deposits than it was previously used for, as in the case of P4W.

The integrity of the Fauresmith has been affected by several processes. However, the effects of these processes have been limited by a combination of factors relating to the depositional environment and post-depositional (after the deposition of the Fauresmith) processes.

1) The undulating surface of the gravel unit at the interface between PL2 and the GU influenced the position of Fauresmith material when it was deposited. Vertical and horizontal displacement of artefacts would have been limited by the presence of the irregular surface and large size of the gravels, preventing a high degree of filtration of Fauresmith material into the gravels.
2) The rapid deposition of PL2 onto the Fauresmith may have slightly redistributed some artefactual material within the deposit. However, it effectively capped the Fauresmith, constraining the potential vertical movement of lithic artefacts through bioturbation and thus providing an environment conducive to maintaining the integrity of the assemblage.
3) The gentle deposition of the HS above PL2 would have caused little to no disturbance to PL2 and the underlying artefactual material. The thickness of the sands, built up over multiple events over a long period of time, would have further protected the Fauresmith from the effects of bioturbation.
4) Chemical processes at the interface between the gravels and PL2 caused some chemical damage (exfoliation) to Fauresmith artefacts. This is related to the movement of water within the deposit because of changes in the position of the water table and the percolation of meteoric water.

The data suggest that the Fauresmith from P4W is (for the most part) in, or very near, primary context. Although this assemblage has been influenced by site formation processes, it maintains a fairly high degree of integrity and can be considered representative of human activity at this location.

Despite the success of this project in providing sedimentary context to the Fauresmith Industry (and other Industries/techno-complexes) in P4W, further research is needed at this location. The planned micromorphological analysis of thin section samples will provide an even greater understanding of the context. Multi-grain OSL dating has been shown to be largely ineffective in the Hutton Sands due to their mixed nature (see Evans & Cunningham 2013; Porat *et al*. 2013). The application of single-grain OSL dating to the samples from P4W is likely to provide a better estimate for the age of the Fauresmith (Chazan *et al*. 2013). Given the poor state of dating of the Fauresmith (Herries 2011), a date from P4W will be extremely valuable.

A technological analysis, to be conducted by this author on the Fauresmith assemblage, will allow the characterisation of the Fauresmith from P4W. This will allow the comparison of the P4W assemblage with other technologically-analysed Fauresmith assemblages, namely from Kathu Pan (Wilkins & Chazan 2012) and Canteen Kopje Pit 6 (currently being analysed by M. Lotter and K. Kuman).

It is important to note that Canteen Kopje is a seemingly complex site with localised site formation processes and thus a single project, based on a single excavation, cannot provide adequate geoarchaeological context for the entire site. The author suggests that a landscape scale test-pitting study be conducted to understand variation in site formation processes at Canteen Kopje.

Reference List

Alperson-Afil, N. & Goren-Inbar, N. 2010. *The Acheulian Site of Gesher Benot Ya'aqov, Vol. II, Ancient Flames and Controlled Use of Fire*. New York and London: Springer.

Andrefsky, W. 2005. *Lithics: Macroscopic Approaches to Analysis.* Cambridge: Cambridge University Press.

Barham, L. 2000. *The Middle Stone Age of Zambia, south central Africa*. Bristol: Western Academic and Specialist Press.

Barham, L. 2001. Central Africa and the emergence of regional identity in the Middle Pleistocene. In: Barham, L. & Robson-Brown, K. (eds.) *Human Roots: Africa and Asia in the Middle Pleistocene*: 65–80. Bristol: Western Academic and Scientific Press.

Barham, L. 2002. Backed tools in Middle Pleistocene central Africa and their evolutionary significance. *Journal of Human Evolution* 43: 505–683.

Barham, L. & Mitchell, P. 2008. *The First Africans: African Archaeology from the Earliest Toolmakers to Most Recent Foragers*. Cambridge: Cambridge University Press.

Beaumont, P.B. 1990a. Canteen Koppie (Klipdrift). In: Beaumont, P.B. & Morris, D. (eds) *Guide to the Archaeological Sites in the Northern Cape*: 14–16. Kimberley: McGregor Museum.

Beaumont, P.B. 1990b. Kathu Pan. In: Beaumont, P.B. & Morris, D. (eds) *Guide to the Archaeological Sites in the Northern Cape*: 75–100. Kimberley: McGregor Museum.

Beaumont, P.B. 1999. Northern Cape. *INQUA XV International Conference Field Guide*. Kimberley: McGregor Museum.

Beaumont, P.B. 2004. Canteen Kopje. In: Morris, D. & Beaumont, P.B. (eds) *Archaeology in the Northern Cape: Some key sites*: 26–30. Kimberley: McGregor Museum.

Beaumont, P.B. & McNabb, J. 2000. Canteen Koppie: the recent excavations. *The Digging Stick* 17(3): 3–7.

Beaumont, P.B. & Vogel, J.C. 2006. On a timescale for the past million years of human history in central South Africa. *South African Journal of Science* 102: 217–228.

Berna, F., Goldberg, P., Horowitz, L. K., Brink, J., Holt, S., Bamford, M. & Chazan, M. 2012. Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape province, South Africa. *Proceedings of the National Academy of Sciences* 109: E1215–E1220.

Bertran, P. & Texier, P-J. 1995. Fabric Analysis: Application to Paleolithic Sites. *Journal of Archaeological Science* 22: 521–535.

Bordes, F. 1961. Typologie du Paléolithique ancien et moyen. Publications de l'Institut de Préhistoire de l'Université de Bordeaux, Mémoire n° 1.

Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G. & Tursina, T. Handbook for soil thin section description. Wolverhampton: Waine Research.

Butzer, K.W. 1974. Geo-archeological interpretation of Acheulian calc-pan sites at Doornlaagte and Rooidam (Kimberley, South Africa). *Journal of Archaeological Science* 1: 1–25.

Butzer, K.W., Helgren, D.M., Fock, G.J. & Stuckenrath, R. 1973. Alluvial terraces of the lower Vaal River, South Africa: a reappraisal and reinvestigation. *The Journal of Geology* 81(3): 341–362.

Chazan, M. 2013. Review: A Report on the Archaeological Assemblages from Excavations by Peter Beaumont at Canteen Koppie, Northern Cape, South Africa. By John McNabb & Peter Beaumont. B.A.R. International Series 2275. University of Southampton Series in Archaeology 4. Archaeopress, Oxford, 2011. Journal of African Archaeology 11: 281–283.

Chazan, M. 2015a. Technological Trends in the Acheulean of Wonderwerk Cave, South Africa. *African Archaeological Review* 32: 701–728.

Chazan, M. 2015b. The Fauresmith and archaeological systematics. In: Runge, J (ed.) *Changing Climates, Ecosystems and Environments within Arid Southern Africa and Adjoining Regions:* 59–69. London: CRC Press.

Chazan, M., Porat, N., Sumner, T.A. & Horwitz, L.K. 2013. The use of OSL dating in unstructured sands: The archaeology and chronology of the Hutton Sands at Canteen Kopje (Northern Cape Province, South Africa). *Archaeological and Anthropological Sciences* 5: 351–363.

Clark, J.D. 1959. *The prehistory of Southern Africa*. London: Penguin Books.

Clark, J.D. 1970. *The Prehistory of Africa*. London: Thames and Hudson

Clark, J.D. 1993. Stone artifact assemblages from members 1-3, Swartkrans Cave. In: Brain, C.K. (ed.), *Swartkrans. A Cave's Chronicle of Early Man*: 167–194. Pretoria: Transvaal Museum.

Clark, J.D. 2001. Variability in primary and secondary technologies of the Later Acheulian in Africa. In: Milliken, S. & Cook, J. (eds) *A Very Remote Period Indeed*: 1–18. Oxford: Oxbow Books.

Clark, J.D., Cole, G. H., Isaac, G. L. & Kleindienst, M. 1966. Precision and definition in African archaeology. South African Archaeological *Bulletin* 2(83): 114–121.

de la Torre, I. 2009. Technological strategies in the lower pleistocene at Peninj (west of Lake Natron, Tanzania). In: Schick, K. & Toth, N. (eds.) *The Cutting Edge: New Approaches to the Archaeology of Human Origins*: 94–113. Indiana: Stone Age Institute Press.

de la Torre, I. & Mora, R., 2009. Remarks on the current theoretical and methodological approaches to the study of early technological strategies in Eastern Africa. In: Hovers, E. & Braun, D.R (eds) *Interdisciplinary approaches to the Oldowan*: 15–24. Dordrecht: Springer.

De Lumley, H. 2009. The emergence of symbolic thought: the principal steps of hominisation leading towards greater complexity. In: Renfrew, C. & Morley, I. (eds) *Becoming Human: Innovation in Prehistoric Material and Spiritual Culture*: 9–28. New York: Cambridge University Press.

De Wit, M.C.J. 1996. The distribution and stratigraphy of inland alluvial diamond deposits in South Africa. *Africa Geoscience Review*, Special Edition 3: 19–33.

De Wit, M.C.J. 2008. Canteen Kopje at Barkley West: South Africa's First Diamond Mine. *South African Journal of Geology* 111: 53–66.

De Wit, M.C.J., Marshall, T.R. & Partridge, T. C. 2000. Fluvial deposits and drainage evolution. In: Partridge, T. C. & Maud, R. R. (eds) *The Cenozoic of Southern Africa*: 55–72. New York: Oxford University Press.

Delagnes, A. & Roche, H. 2005. Late pliocene hominid knapping skills: the case of Lokalalei 2C, West Turkana, Kenya. *Journal of Human Evolution* 48: 435–472.

Duller, G.A. 2008. Single-grain optical dating of Quaternary sediments: why aliquot size matters in luminescence dating. *Boreas* 37(4): 589–612.

Evans, M. & Cunningham, A. 2013. Optically Stimulated Luminescence dating report: Canteen Kopje project. Unpublished manuscript. Johannesburg: University of the Witwatersrand Archaeology Department.

Field, A.S. 1999. An Analytical and Comparative Study of the Earlier Stone Age Archaeology of the Sterkfontein Valley. Unpublished MSc dissertation, University of the Witwatersrand, Johannesburg.

Fock, G.J. 1968. Rooidam: a sealed site of The First Intermediate. *South African Journal of Science* 64: 153–158.

Forssman, T., Kuman, K., Leader, G. & Gibbon, R. 2010. A Later Stone Age Assemblage from Canteen Kopje, Northern Cape. *South African Archaeological Bulletin* 65(192): 204–214.

Gibbon, R.J. 2009. The fluvial history of the lower Vaal River catchment. Unpublished Ph.D. Dissertation, University of the Witwatersrand, Johannesburg.

Gibbon, R.J., Leader, G.M. & Kuman, K. 2008. Canteen Kopje-SAHRA report for 2007–2008. Unpublished manuscript. Johannesburg: University of the Witwatersrand Archaeology Department.

Gibbon, R.J., Granger, D.E., Kuman, K., & Partridge, T.C. 2009. Early Acheulean technology in the Vaal River gravels, South Africa, dated with cosmogenic nuclides. *Journal of Human Evolution* 56: 152–160.

Gibbon, R.J., Granger D.E., Kuman, K., Leader, G.M., Lotter, M.G. & Forssman, T. 2013. Isochron burial dating of the Earlier Stone Age deposits at Canteen Kopje, South Africa. Paper presented at the Association of Southern African Professional Archaeologists Biennial Conference, Gaborone, Botswana.

Goldberg, P. & MacPhail, R.I. 2006. *Practical and Theoretical Geoarchaeology*. Oxford: Blackwell Publishing.

Goodwin, A.J.H. 1927. South African archaeology. *Man* 27: 29–31.

Goodwin, A.J.H. 1929. The Stone Ages in South Africa. *Africa: Journal of the International African Institute* 2: 174–182.

Goodwin, A.J.H. 1934. Some developments in technique during the Earlier Stone Age. *Transactions of the Royal Society of South Africa* 21: 109–123.

Goodwin, A.J.H. & Van Riet Lowe, C. 1929. The Stone Age cultures of South Africa. *Annals of the South African Museum* 27: 1–289.

Granger, D.E., Gibbon, R.J., Kuman, K., Clarke, R.J., Bruxelles, L. & Caffee, M.W. 2015. New cosmogenic burial ages for Sterkfontein Member 2 *Australopithecus* and Member 5 Oldowan. *Nature* 522: 85–88.

Harmand, S., Lewis, J.E., Feibel, C.S., Lepre, C.J., Prat, S., Lenoble, A., Boës, X., Quinn, R.L., Brenet, M., Arroyo, A. & Taylor, N. 2015. 3.3-million-year-old stone tools from Lomekwi 3, West Turkana, Kenya. *Nature* 521(7552): 310–315.

Heiri, O., Lotter, A.F. & Lemcke, G., 2001. Loss on ignition as a method for estimating organic and carbonate content in sediments: reproducibility and comparability of results. *Journal of Paleolimnology* 25(1): 101–110.

Henshilwood, C.S. & Lombard, M. 2013. Becoming Human: Archaeology of the Sub-Saharan Middle Stone Age. In: Renfrew, C. & Bahn, P. (eds) The Cambridge World Prehistory, Volume 1. Cambridge: Cambridge University Press.

Helgren, D.M. 1977. Environmental stratigraphy of the relict alluvia and terraces along the lower Vaal River, South Africa. *Palaeoecology of Africa and the Surrounding Islands* 10: 163–170.

Helgren, D.M. 1979. *River of diamonds: An alluvial history of the lower Vaal Basin, South Africa*. Chicago: University of Chicago.

Herries, A.I.R. 2011. A chronological perspective on the Acheulean and its transition to the Middle Stone Age in Southern Africa: The question of the Fauresmith. *International Journal of Evolutionary Biology*: 1–25.

Holmes, W.H. 1894 Natural history of flaked stone implements. In: Wake, C.S. (ed.) *Memoirs of the International Congress of Anthropology*: 120–139. Chicago: Schulte.

Jones, P.R. 1994. Results of experimental work in relation to the stone industries of Olduvai Gorge. In: Leakey, M.D. & Roe, D.A. (eds.), *Olduvai Gorge, Vol V: Excavations in Bed III, IV and the Masek Beds, 1968–1971*: 254–298. Cambridge: Cambridge University Press.

Isaac, G.L. 1977. *Olorgesailie*. Chicago: University of Chicago.

Kiberd, P. 2006. Bundu farm: a report on archaeological and palaeoenvironmental assemblages from a pan site in Bushmanland, Northern cape, South Africa. *South African Archaeological Bulletin* 61: 189–201.

Klein, R.G. 2000. The Earlier Stone Age of Southern Africa. *South African Archaeological Bulletin* 55: 107–122.

Kleindienst, M.R., 1962. Components of the East African Acheulian assemblage: an analytic approach. In: *Actes du IVeme Congres Panafricain de Préhistoire et de L'étude du Quaternaire* 40: 81-105. Musée Royal de l'Afrique Centrale Tervuren (Belgique).

Krieger, A.D. 1944. The Typological Concept 1. *American Antiquity* 9(3): 271–288.

Kuman, K. 1994. The Archaeology of Sterkfontein: past and present. *Journal of Human Evolution* 27, 471–495.

Kuman, K. 1998. The Earliest South African industries. In: Petraglia, M., Korisettar (eds.) Early Human Behavior in Global Context: the Rise and Diversity of the Lower Palaeolithic Record: 151–186. London: Routledge Press.

Kuman, K. 2007. The Earlier Stone Age in South Africa: site context and the influence of cave studies. In: Pickering, T.R., Schick, K. & Toth, N. (eds) *Breathing Life into Fossils: Taphonomic Studies in Honor of C.K. (Bob) Brain*: 181–198. Indiana: Stone Age Institute Press.

Kuman, K. 2012. Review: A report on the archaeological assemblages from excavations by Peter Beaumont at Canteen Koppie, Northern Cape, South Africa. *Azania: Archaeological Research in Africa* 47(4): 531–533.

Kuman, K. 2014. The Acheulean Industrial Complex. In: Smith, C. (ed) *Encyclopedia of Global Archaeology*: 7–18. New York: Springer.

Kuman, K. 2016. Development of the archaeological record in southern Africa during the Earlier Stone Age. In: Knight, J. and Grab, S. (eds) *Quaternary environmental change in southern Africa: physical and human dimensions:* 349–370. Cambridge: Cambridge University Press.

Kuman, K., Inbar, M. & Clarke, R.J. 1999. Palaeoenvironments and cultural sequence of the Florisbad Middle Stone Age hominid site, South Africa. *Journal of Archaeological Science* 26: 1409–1425.

Kuman, K. & Clark, R.J. 2000. Stratigraphy, artifact industries and hominid associations for Sterkfontein, Member 5. *Journal of Human Evolution* 38, 827–847.

Kuman, K. & Field, A.S. 2009. The Oldowan industry from Sterkfontein Caves, South Africa. In: K. Schick & N. Toth (eds.) *The cutting edge: New approaches to the archaeology of human origins*: 151–169. Indiana: Stone Age Institute Press.

Kuman, K., Gibbon, R.J., Kempson, H., Langejans, G., Le Baron, J.C., Pollarolo, L. & Sutton, M. 2005. Stone Age signatures in northernmost South Africa: early archaeology of the Mapungubwe National Park and vicinity. In D'Errico, F. & Backwell. L. (eds) *From Tools to Symbols, From Early Hominids to Modern Humans:* 163–182. Johannesburg: Witwatersrand University Press.

Kuman, K. & Gibbon, R.J. 2018. The Rietputs 15 site and Early Acheulean in South Africa. *Quaternary International*.

Leader, G.M. 2014. New excavations at Canteen Kopje, Northern Cape Province, South Africa: A techno-typological comparison of three earlier Acheulean assemblages with new interpretations on the Victoria West phenomenon. Unpublished doctoral dissertation, University of the Witwatersrand, Johannesburg.

Leader, G.M., Kuman, K., Gibbon, R.J. & Granger, D.E. 2018. Early Acheulean organised core knapping strategies ca. 1.3 Ma at Rietputs 15, Northern Cape Province, South Africa. *Quaternary International*.

Leakey, M.D. 1967. Preliminary survey of the cultural material from Beds I and II, Olduvai Gorge, Tanzania. In: Bishop, W.W. & Clark, J.D. (eds) *Background to Evolution in Africa*: 417–446. Chicago: University of Chicago Press.

Leakey, M.D. 1971. *Olduvai Gorge. Excavations in Beds I and II, 1960-1963, Vol. III*. Cambridge: Cambridge University Press.

Lepre, C.J., Roche, H., Kent, D.V., Harmand, S., Quinn, R.L., Brugal, J-P., Texier, P-J., Lenoble, A. & Feibel, C.S. 2011. An earlier origin for the Acheulian. *Nature* 477: 82–85.

Li, H., Kuman, K., Lotter, M.G., Leader, G.M. & Gibbon, R.J. 2017. The Victoria West: earliest prepared core technology in the Acheulean at Canteen Kopje and implications for the cognitive evolution of early hominids. *Royal Society open science* 4(6): 170288.

Lombard, M., Wadley, L., Deacon, J., Wurz, S., Parsons, I., Mohapi, M., Swart, J. & Mitchell, P. 2012. South African and Lesotho Stone Age sequence updated (I). *South African Archaeological Bulletin* 67: 123–144.

Lotter, M.G. 2010a. A geoarchaeological study of upper strata at Canteen Kopje, Northern Cape Province, South Africa: Site formation in the Pleistocene levels. Unpublished honours dissertation, University of the Witwatersrand, Johannesburg.

Lotter, M.G. 2010b. An assessment of possible palaeo-flow patterns in the alluvial gravel sequence of the Lower Vaal River at Canteen Kopje, Northern Cape Province, South Africa. Unpublished report, University of the Witwatersrand, Johannesburg.

Lotter, M.G., Gibbon, R.J., Kuman, K., Leader, G.M., Forssman, F. & Granger, D.E. 2016. A Geoarchaeological Study of the Middle and Upper Pleistocene

Levels at Canteen Kopje, Northern Cape Province, South Africa. *Geoarchaeology: An International Journal* 31*:* 304–323.

Lowe, J.J. & Walker, M.J.C. 1997. Temperature variations in NW Europe during the Last Glacial–Interglacial transition (14–9 14C ka BP) based upon the analysis of coleopteran assemblages—the contribution of Professor G.R. Coope. *Quaternary Proceedings* 5: 165–175.

Lyman, R.L. 2012. A historical sketch on the concepts of archaeological association, context, and provenience. *Journal of Archaeological Method and Theory* 19: 207–240.

Mason, R. 1961. The Acheulian Culture in South Africa. *South African Archaeological Bulletin* 16: 107–111.

Mazzullo, J. & Graham, A.G. 1988. *Handbook for shipboard sedimentologists*. Ocean Drilling Program, Technical Note 8.

McBrearty, S. & Brooks, A.S. 2000. The revolution that wasn't: a new interpretation of the origin of modern human behavior. *Journal of Human Evolution* 39: 453–563.

McNabb, J. 2001. The shape of things to come. A speculative essay on the role of the Victoria West phenomenon at Canteen Koppie, during the South African Earlier Stone Age. In: Milliken, S. & Cook, J. (eds) *A Very Remote Period Indeed:* 37–41. Oxford: Oxbow Books.

McNabb, J. & Beaumont, P. 2011a. *A report on the archaeological assemblages from excavations by Peter Beaumont at Canteen Koppie, Northern Cape, South Africa*. Oxford: BAR International Series.

McNabb, J. & Beaumont, P. 2011b. Excavations in the Acheulean Levels of the Earlier Stone Age Site of Canteen Koppie, Northern Cape Province, South Africa. *Proceedings of the Prehistory Society* 78: 51–71.

McPherron, S.J.P. 2000. Handaxes as a measure of the mental capabilities of early hominids. *Journal of Archaeological Science* 27(8): 655–663.

McPherron, S.J.P. 2005. Artefact orientations and site formation processes from total station proveniences. *Journal of Archaeological Science* 32: 1003–1014.

Moll, R.M. 2017. A technological study of the lithic artefacts from the Earlier Stone Age site of Maropeng in the Cradle of Humankind, Gauteng, South Africa. Unpublished MSc dissertation, University of the Witwatersrand, Johannesburg.

Morrissey, P. 2015. A geoarchaeological investigation of the Earlier Stone Age site at Maropeng in the Cradle of Humankind. Unpublished BSc Honours dissertation, University of the Witwatersrand, Johannesburg.

Morrissey, P., Moll, R.M. & Stratford, D.J. In preparation. A landscape-scale study of the distribution and formation of the Earlier Stone Age deposit at Maropeng in the Cradle of Humankind.

Partridge, T.C. & Brink, A.B.A. 1967. Gravels and terraces of the lower Vaal Basin. *South African Geographical Journal* 49: 21–38.

Pickering, T.R., Sutton, M.B., Heaton, J.L., Clarke, R.J., Brain, C.K. & Kuman, K. 2012. New stratigraphic interpretations and hominid fossils from Swartkrans Member 1 (South Africa). *Journal of Human Evolution* 62: 618–628.

Pillay, A.E., Punyadeera, C., Jacobson, L. & Eriksen, J. 2000. Analysis of Ancient Pottery and Ceramic Objects Using X-Ray Fluorescence Spectrometry. *X-Ray Spectrometry* 29: 53–62.

Plummer, T. 2004. Flaked stones and old bones: Biological and cultural evolution at the dawn of technology. *Yearbook of Physical Anthropology* 47: 118–164.

Pollarolo, L., Susino, G., Kuman, K. & Bruxelles, L. 2010. Acheulean artefacts at Maropeng in the Cradle of Humankind World Heritage Site, Gauteng Province, South Africa. *South African Archaeological Bulletin* 65: 3–12.

Porat, N., Chazan, M., Grun, R., Aubert, M., Eisenmann, V. & Horwitz, L. 2010. New radiometric ages for the Fauresmith industry from Kathu Pan, southern Africa: Implications for the Earlier to Middle Stone Age transition. *Journal of Archaeological Science* 37: 269–283.

Sampson, C. G. 1974. *The Stone Age Archaeology of Southern Africa*. New York: Academic Press.

Sarupen, A. 2010. Analysis of Middle Stone Age lithic artefacts from Canteen Kopje, Northern Cape, South Africa: Typology and technology. Unpublished honours report, University of the Witwatersrand, Johannesburg.

Schick, K.D. 1987. Modelling the formation of Early Stone Age artifact concentrations. *Journal of Human Evolution* 16: 789–807.

Schick, K.D. 1991. On making behavioural inferences from early archaeological sites. In: Clark, J.D. (ed.) *Cultural beginnings*: 79–107. Bonn: Dr. Rudolf Habelt GMBH.

Schmid, V.C., Conard, N.J., Parkington, J.E., Texier, P.J. & Porraz, G., 2016. The 'MSA 1' of Elands Bay Cave (South Africa) in the context of the southern African Early MSA technologies. *Southern African Humanities* 29(1): 153–201.

Semaw, S. 2000. The world's oldest stone artefacts from Gona, Ethiopia: their implications for understanding stone technology and patterns of human evoluation between 2.6-1.5 million years ago. *Journal of Archaeological Science* 27: 1197–1214.

Shackley, M.S. 2011. *X-Ray Flourescence Spectrometry (XRF) in Geoarchaeology*. New York: Springer.

Shadrach, K. 2015. Clarifying the distribution of the Oldowan stone tool assemblage found within the underground chambers of the Sterkfontein Caves, South Africa. Unpublished BSc Honours dissertation, University of the Witwatersrand, Johannesburg.

Sharon, G. 2007. *Acheulean Large Flake Industries. Technology, Chronology, and Significance*. Oxford: British Archaeological Report S1701

Sharon, G. 2008. The impact of raw material on Acheulian large flake production. *Journal of Archaeological Science* 35: 1329–1344.

Sharon, G., Alperson-Afil, N. & Goren-Inbar, N. 2011. Cultural conservatism and variability in the Acheulian sequence of Gesher Benot Ya'aqov. *Journal of Human Evolution* 60: 387–397.

Shea, J.J. 1999. Artifact abrasion, fluvial processes, and "living floors" from the Early Palaeolithic site of Ubeidiya (Jordan Valley, Israel). *Geoarchaeology: An International Journal* 14: 191–207.

Söhnge, P.G., Visser, D.J. & Van Riet Lowe, C. 1937. *The Geology and archaeology of the Vaal River Basin. Memoirs of the Geological Survey of the Union of South Africa* 35. Geological Survey: Cape Town.

Soriano, S., Villa, P. & Wadley, L. 2007. Blade technology and tool forms in the Middle Stone Age of South Africa: the Howiesons Poort and post-Howiesons Poort at Rose Cottage Cave. *Journal of Archaeological Science* 34(5): 681–703.

Stout, D. 2011. Stone toolmaking and the evolution of human culture and cognition. *Philosophical Transactions of the Royal Society B* 366: 1050–1059.

Stout, D. 2002. Skill and Cognition in Stone Tool Production: An Ethnographic Case Study from Irian Jaya. *Current Anthropology* 43(5): 693–722.

Stout, D., Quade, J., Semaw, S., Rogers, M.J. & Levin, N.E. 2005. Raw material selectivity of the earliest stone toolmakers at Gona, Afar, Ethiopia. *Journal of Human Evolution* 48(4): 365–380.

Stratford, D. 2011. Cave excavation: some methodological and interpretive considerations. *Cave and karst science* 38(3): 111–116.

Sutton, M. 2012. The Archaeology of Swartkrans: Members 1 and 4. Unpublished PhD thesis, University of the Witwatersrand, Johannesburg.

Szabo, B.J. & Butzer, K.W. 1979. Uranium-series dating of lacustrine limestones from pan deposits with final Acheulean assemblage at Rooidam, Kimberley district, South Africa. *Quaternary Research* 11: 257–260.

Underhill, D. 2011. The study of the Fauresmith: A review. *The South African Archaeological Bulletin* 66: 15–26.

Van Riet Lowe, C. 1937. The Archaeology of the Vaal River Basin. In Söhnge, P.G., Visser, D.J. & Van Riet Lowe, C. (eds) *The Geology and Archaeology of the Vaal River Basin. Memoirs of the Geological Survey of the Union of South Africa.* 35: 61–131. Geological Survey: Cape Town.

Van Riet Lowe, C. 1945. The evolution of the Levallois technique in South Africa. *Man* 45: 49–59.

Van Riet Lowe, C. 1952. The Vaal river chronology. *South African Archaeological Bulletin* 7: 135–149.

Villa, P., Delagnes, A. & Wadley, L. 2005. A late Middle Stone Age artifact assemblage from Sibudu (KwaZulu-Natal): comparisons with the European Middle Paleolithic. *Journal of Archaeological Science* 32: 399–422.

Wadley, L. 2015. Those marvellous millennia: the Middle Stone Age of Southern Africa. *Azania: Archaeological Research in Africa* 50(2): 155–226.

Walker, M.J.C. 2005. *Quaternary dating methods*. Chichester: John Wiley and Sons.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. *The Journal of Geology* 30(5): 377–392.

White, M., Ashton, N. & Scott, B. 2011. The emergence, diversity and significance of mode 3 (prepared core) technologies. In: Ashton, N., Lewis, S. & Stringer, C. (eds.) *Developments in Quaternary Science, the Ancient Human Occupation of Britain*: 53–65. Amsterdam: Elsevier.

Wilkins, J. 2013. Technological change in the early Middle Pleistocene: the onset of the Middle Stone Age at Kathu Pan 1, Northern Cape, South Africa. Unpublished PhD thesis, University of Toronto.

Wilkins, J. & Chazan, M. 2012. Blade production ~500 thousand years ago at Kathu Pan 1, support for a multiple origins hypothesis for early Middle Pleistocene blade technologies. *Journal of Archaeological Science* 39(6): 1883–1900.

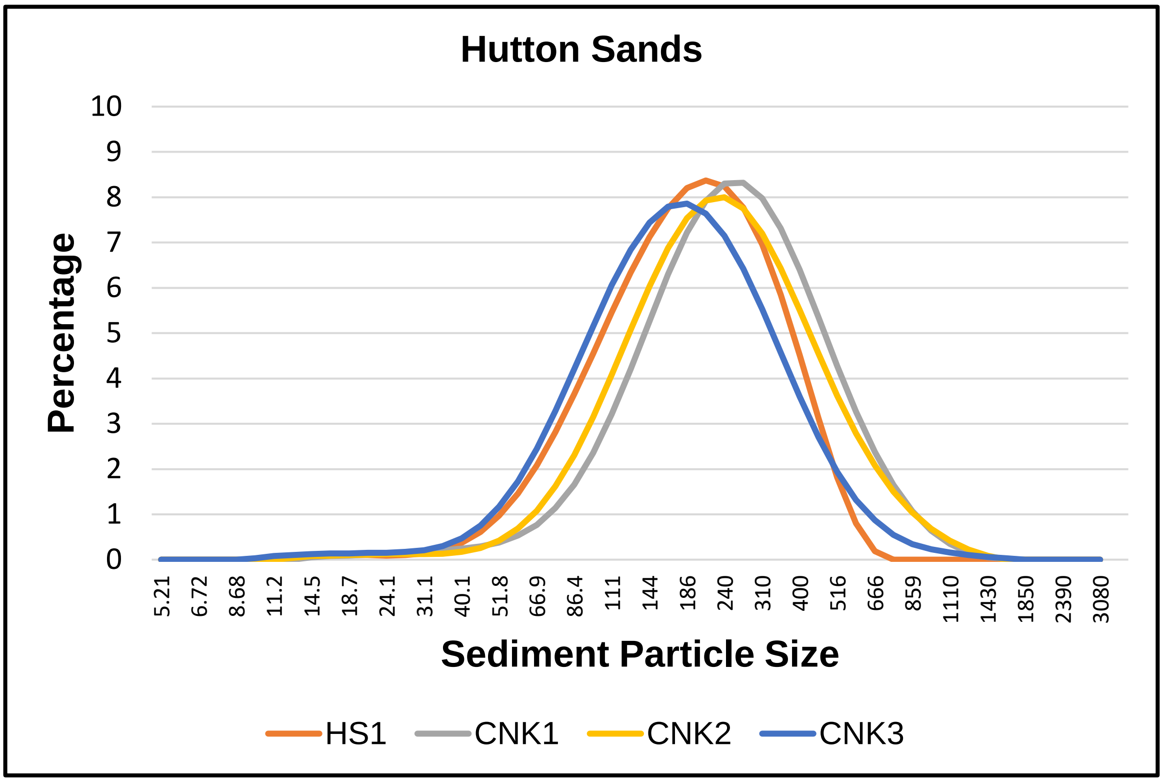
Wurz, S. 2013. Technological trends in the Middle Stone Age of South Africa between MIS 7 and MIS 3. *Current Anthropology* 54 (Supplement 8): S305–S319.

Wurz, S. 2014. Southern and East Africa Middle Stone Age, geography and culture. In Smith, C. (ed.) *Encyclopedia of Global Archaeology*: 6890–6912. New York: Springer.

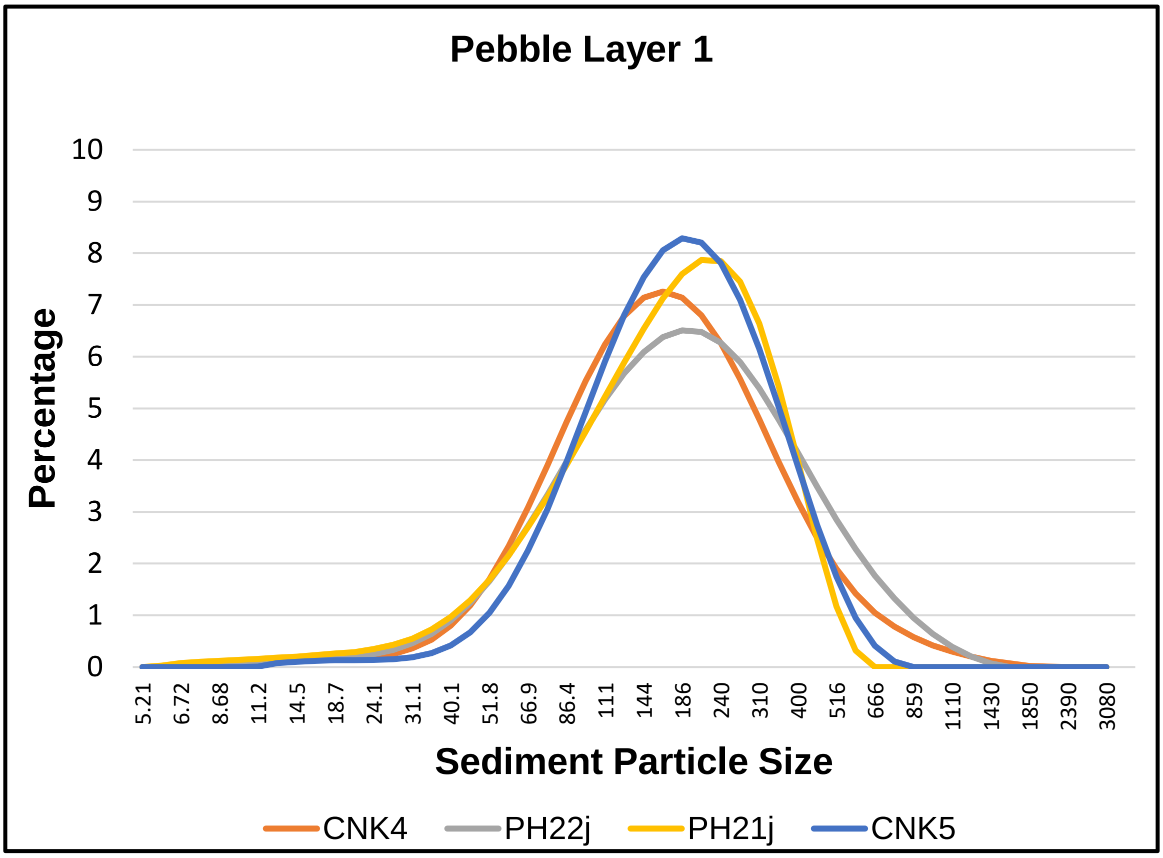
Wynn, T. & Tierson, F. 1990. Regional comparison of the shapes of later Acheulian handaxes. *American Anthropologist* 92: 73–84.

Yerkes, R.W.& Kardulias, P.N. 1993. Recent developments in the analysis of lithic artifacts. *Journal of Archaeological Research* 1(2): 89–119.

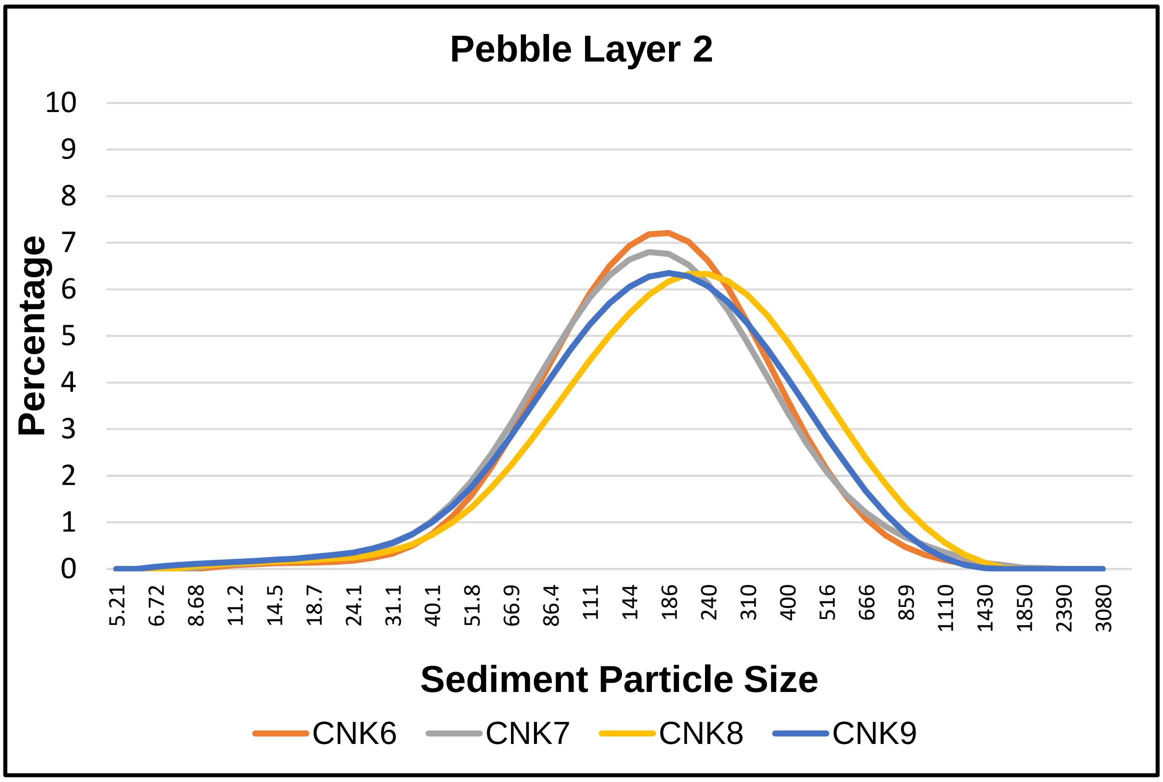
Appendix A



Line graphs showing the particle size distribution of all sediment samples from the Hutton Sands deposit from Pit 4 West analysed using the Mastersizer 3000.



Line graphs showing the particle size distribution of all sediment samples from the Pebble Layer 1 deposit from Pit 4 West analysed using the Mastersizer 3000.



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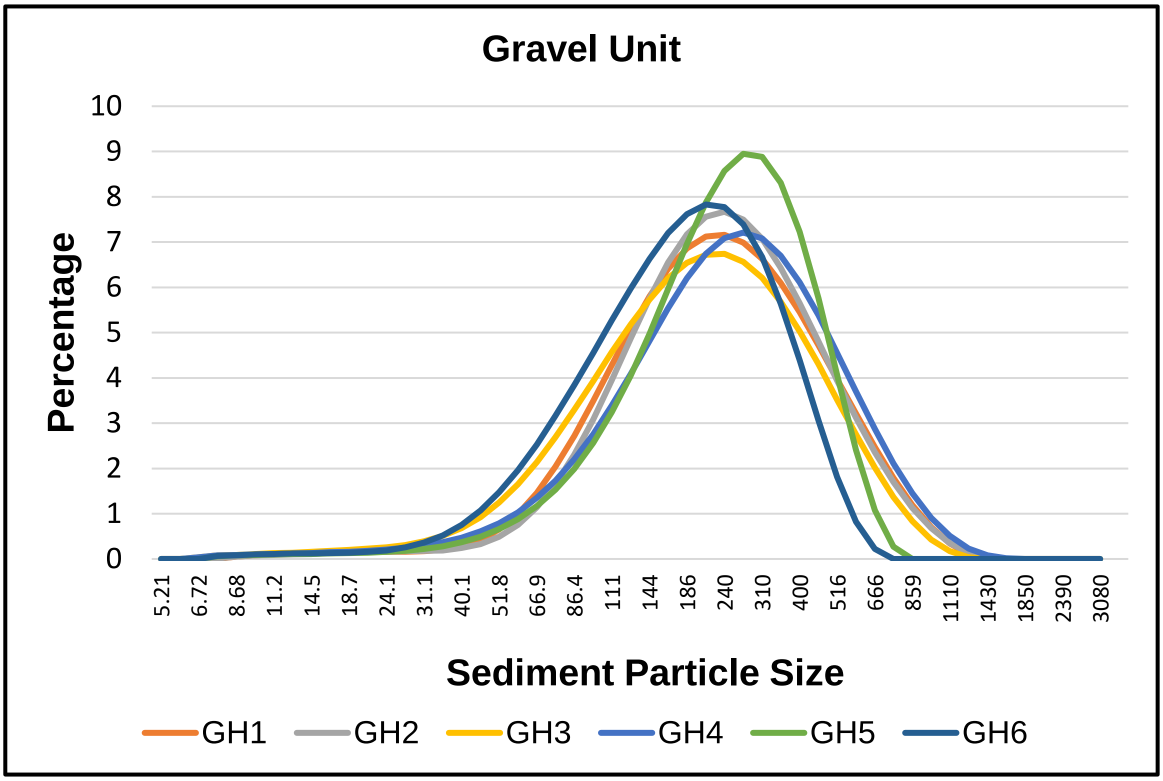

Line graphs showing the particle size distribution of all sediment samples from the Gravel Unit deposit from Pit 4 West analysed using the Mastersizer 3000.