Subsistence behaviour at Klasies River during MIS 5d: a taphonomic and taxonomic analysis of fauna from the SBLS layer

Dissertation submitted in fulfilment of the requirements of the Degree of Master of Science in Archaeology at the University of the Witwatersrand

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Plagiarism declaration:

I declare that I am the sole author of this work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted for examination at any other university.

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Signature: 

Abstract

This project entails an analysis of the faunal material from the SBLS layer at Klasies River main site, which correlates with Marine Isotope Stage (MIS) 5d (109ka-96ka). There have been relatively few taphonomic analyses conducted at Klasies River and subsistence behaviours during MIS5d are not well understood. Zooarchaeological analyses are an important aspect of studying subsistence behaviour, and these were used to examine subsistence strategies, occupational intensity and site formation processes occurring at c. 110 ka. To explore subsistence behaviour during this period, a taphonomic and taxonomic analysis of large mammal faunal remains from squares A1 and C1 of the SBLS layer was conducted. The results indicate that: (1), humans are the main accumulators of the fauna; (2) there is evidence of occupational intensity in MIS5d; and (3) that post-depositional site formation processes have had a significant impact on the faunal material in SBLS. Taphonomic analyses show high frequencies of anthropogenic bone surface modifications such as cut and percussion marks, with minimal zoogenic modifications in the squares. Burning and trampling is present in each square. Abrasion is high and is likely related to trampling as bones also have trampling striations. Transverse breakage patterns are also present, and, in combination with trampling and anthropogenic marks, are a strong indicator of intense human occupation. This research adds to the understanding of subsistence behaviour, occupational intensity and site formation at KRM, and in MIS5d more broadly. Middle Stone Age faunal assemblages are often highly fragmented and can present some challenges in faunal analysis. This study shows that highly fragmented faunal assemblages can provide useful taphonomic information, which will add to the growing body of knowledge of early human behavioural modernity in southern Africa.

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"The fool who persists in his folly will become wise" – William Blake.

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Chapter 1: Introduction

1.1 Introduction to Klasies River

Klasies River is a world-renowned archaeological site which has provided a treasure trove of early modern human cultural artefacts, with human occupational history at the main site spanning around 70000 years (e.g., Wurz 1999; Deacon & Wurz 2005; Wurz *et al*. 2018; Reynard & Wurz 2020; Brenner *et al*. 2022; Morrissey *et al*. 2022; Wurz *et al*. 2022). Klasies River Main site (KRM) is uniquely important and archaeologically rich, having yielded rare early modern human remains, providing an essential insight into early modern human behaviour and anatomy (Grine *et al*. 2017). The site is situated on the Tsitsikamma coast in the Eastern Cape province, between Cape St. Francis and Plettenberg Bay (Singer & Wymer 1982; Deacon 1995; Wurz *et al.* 2018) and is part of the Greater Cape Floristic Region (GCFR).

The southern Cape coast is a geographically and archaeologically distinct region. It is also an important region for geographical study, being located at the intersection between two major oceans (Loftus *et al*. 2017; Marean *et al*. 2020). KRM along with several other sites, is situated along the southern Cape coast. The southern cape coastline contains numerous other highly important archaeological sites, including Blombos Cave, Pinnacle Point, Diepkloof rock shelter and Sibudu, which like Klasies River, provide abundant evidence of early innovative subsistence and cultural behaviours. The Klasies River deposits have provided an extensive assemblage of faunal remains (Klein 1976; Van Pletzen 2000; Van Pletzen-Vos *et al*. 2019). The faunal assemblage at KRM shows that a diverse range of large herbivores were regularly exploited, as well as shellfish, seals and smaller bovids, showing that the inhabitants had a diverse diet and means of subsistence procurement (Klein 1976; Van-Pletzen 2000; Van-Pletzen-Vos *et al*. 2019; Reynard & Wurz 2020). This research is a taphonomic and taxonomic analysis focused on the large mammalian fauna from the Silty Black Soils (SBLS) layer from the Witness Baulk in Cave 1A at KRM, dating to Marine Isotope Stage (MIS) 5d, older than 110, 000 years ago [ka]) (Wurz *et al*. 2022). The layer may have been influenced by post-depositional processes, which are taphonomic agents such as humans, animals and insects, as well as natural processes such as fluvial movement. This layer is equivalent to Singer and Wymer's Layer 17b and is especially noticeable for its black colour (Singer & Wymer 1982; Deacon & Geleijnse 1988). The SBLS squares A1 and C1 are the focus of this research, as they are newly excavated by Wurz and the excavation team during the 2020 and 2022 field seasons and have not been taphonomically analysed before.

Taphonomic analysis has been shown to be an important aspect of examining early human subsistence behaviors (e.g., Cain 2005; Faith 2011; Faith 2013; Reynard *et al*. 2016a,b; Thompson & Henshilwood 2014; Reynard & Henshilwood 2017; Dusseldorp & Reynard 2022; Reynard 2022a,b) and may infer human occupational intensity (Stiner 2009; Clark 2011; Clark & Plug 2008; Dusseldorp 2012; Dusseldorp & Langejans 2015; Reynard & Henshilwood 2018; Haaland *et al*. 2021).The faunal assemblage in SBLS may contribute to further understanding human subsistence behaviour and site formation processes at KRM during MIS5d.

1.2 Research Questions

1. Were animals or humans the primary accumulators of the faunal assemblage in the MSA I layer, SBLS, at KRM1 during MIS5d?
2. Does the taphonomic evidence from the faunal assemblage point to occupational intensity in the MSA I at KRM1?
3. In what ways did site formation processes affect the MSA I faunal assemblage in the SBLS layer?
4. What subsistence behaviours could be interpreted based on the taphonomic evidence?

1.3 Aims and Objectives

The aim of this research is to carry out a taphonomic and taxonomic analysis of the large mammal faunal assemblage in the MSA I layer SBLS at KRM cave 1A. The objectives of this study are as follows:

1. To conduct a taphonomic analysis on the large mammal faunal material to diagnose bone surface modifications as anthropogenic, zoogenic or abiotic/natural, to potentially identify the main accumulators of the assemblage in SBLS.

2. To infer subsistence strategies and butchery practices utilised by humans in the MSA I, based on the results of the taphonomic analysis of the SBLS large mammal faunal assemblage.

3. Identify abiotic/natural bone surface modifications, which may infer the ways in which the assemblage was influenced by site formation processes.

1.4 Hypotheses

This study will investigate three main hypotheses:

A. Humans were the primary accumulators of the faunal assemblage, with a minimal role for carnivore activity.

B. There is evidence of occupational intensity during MIS5d at KRM in the SBLS squares A1 and C1.

C. The faunal assemblage in A1 and C1 in SBLS has been significantly affected by post-depositional processes.

1.5 Rationale

Our understanding of human hunting and foraging behaviour in the MSA I is limited. There have been some taphonomic studies at KRM, but few on the MSA I. The faunal material from the MSA I layer SBLS has not been fully analysed, however, preliminary analyses of lithic and shellfish materials from the Wurz excavations indicate that technological and subsistence patterns here are different than in the overlying layers (Bielderman 2021; Lombard 2021; Brenner *et al*. 2022; Wurz *et al*. 2022). MIS5d was a transitional period, alternating from glacial conditions to interglacial, which may have affected human and animal populations in coastal regions, including Klasies River (Marean *et al*. 2010; Reynard & Wurz 2020). It is possible that changes in lithic technology may indicate changes in subsistence and prey accumulation strategies (Wurz *et al*. 2018; Lombard 2021). A taphonomic and taxonomic analysis of the large mammal faunas from the SBLS layer may provide further insight into the causes relating to these changes in subsistence behaviour in the MSA I at KRM. Recent zooarchaeological studies on KRM's MSA II, III and Howieson's Poort (HP) cultural contexts have found evidence of increased human occupation in some layers (Achieng 2019; Lap 2020; Pearson 2021). Lap (2020) found more intensive abrasion and trampling damage in the BOS 3 and SMONE layers, whilst Achieng (2019) found more intense anthropogenic processing in the HP layers YSx5 and CPx4. Pearson (2021) found more evidence of intense occupation in the HP than in the MSA III in her taphonomic study on KRM's large mammal fauna. Further analysis of the faunal assemblage will determine whether these trends are present in the MSA I. A taphonomic and taxonomic analysis of the SBLS layer will infer hunting and butchery practices, site formation, agents of accumulation and changes in occupation levels at KRM and will add to the growing body of knowledge surrounding the southern African MSA and early modern human behaviour.

1.6 Summary and structure

In this chapter, the research questions for this study are stated, the aims and objectives are outlined and three hypotheses presented. The next chapter is a literature review of published papers on the subjects in question, as well as providing a background to KRM and the theoretical framework used in taphonomic analysis. Chapter 3 provides an explanation of the methodology used in identifying taxa, taphonomic agents and to infer butchery practices. Chapter 4 presents the results of the taphonomic analysis including anthropogenic, natural and zoogenic data. Chapter 5 discusses the findings presented in chapter 4 and compares them to other contexts to explore broader patterns of subsistence behaviour. The concluding chapter will assess the three main hypotheses, based on the taphonomic analysis of the fauna in square A1 and C1, as well as briefly addressing limitations in research, and possible future avenues for this research topic.

Chapter 2: Background

2.1 Site background

The Klasies River main site (KRM) is in the Eastern Cape Province of South Africa (Figure 2.1), and forms part of a cultural landscape that has been declared a national heritage site (Wurz *et al*. 2018). Klasies River is a highly important site that contains around 70000 years' worth of evidence of human activity, including lithics and shellfish, an extensive macrofaunal assemblage (Wurz *et al.* 2018; 2022; Ezeimo *et al.* 2024). Klasies River is an essential site in studying the evolution of *Homo sapiens,* modern human behaviour and cognition, and human environmental interaction during the MSA (Ezeimo *et al*. 2024). The site falls within a landscape, the southern cape coast or 'SCC', that contains several other highly important archaeological sites, including Blombos Cave, Pinnacle Point, Diepkloof rock shelter and Klipdrift rock shelter (Figure 2.1b). KRM is made up of two caves (KRM 1 and 2) and two associated overhangs (Caves 1A and 1B; figure 2.1a) and is located within the resource-rich coastal-fynbos biome, wherein many nutritionally valuable plants and animals occur (Wurz 1999, 2000; 2002; Deacon & Wurz 2001; Cowling & Lombard 2002; Reynard & Wurz 2020). The site also contains rare fossils of early modern humans (Grine *et al*. 2017). KRM falls within the year-round rainfall zone, receiving as much as 810 mm per year (Wurz *et al*. 2022), and falls within the eastern fynbos renosterveld fynbos biome (Rutherford & Mucina 2006; Nel *et al*. 2018. During the Late Pleistocene, fluctuating glacial and interglacial periods may have influenced precipitation and environmental productivity along the southern cape coast (Marean *et al*. 2010; Reynard & Wurz 2020). Throughout the Middle Stone Age, while sea level fluctuations occurred, the coast remained relatively close to the site, facilitating access to marine resources such as shellfish. These resources are abundantly represented throughout the occupational sequence (Klein 1976: 81; Deacon & Wurz 2005; Wurz 2012; Brenner *et al*. 2022; Morrissey *et al*. 2022; Reynard 2022a; Wurz *et al*. 2022). Understanding how foragers exploited coastal resources during the Late Pleistocene is an important aspect of studying early modern subsistence behaviour and cognition (Parkington 2001, 2003; Marean *et al*. 2010, Marean *et al*. 2020; Jerardino 2021). A taphonomic analysis of SBLS is the best way in which to understand the subsistence behaviours occurring in MIS5d (Brain 1967; Binford 1981; Potts & Shipman 1981; Blumenschine 1986; Noe-Nygaard 1987; Marean *et al*. 1992; Milo 1998; Egeland 2003; Reynard *et al.* 2016b; Reynard & Henshilwood 2017, 2018; Egeland *et al*. 2024; Ezeimo *et al*. 2024), providing insight into hunting and butchery practices of the lower MSA at Klasies River, a period which has not been fully analysed.

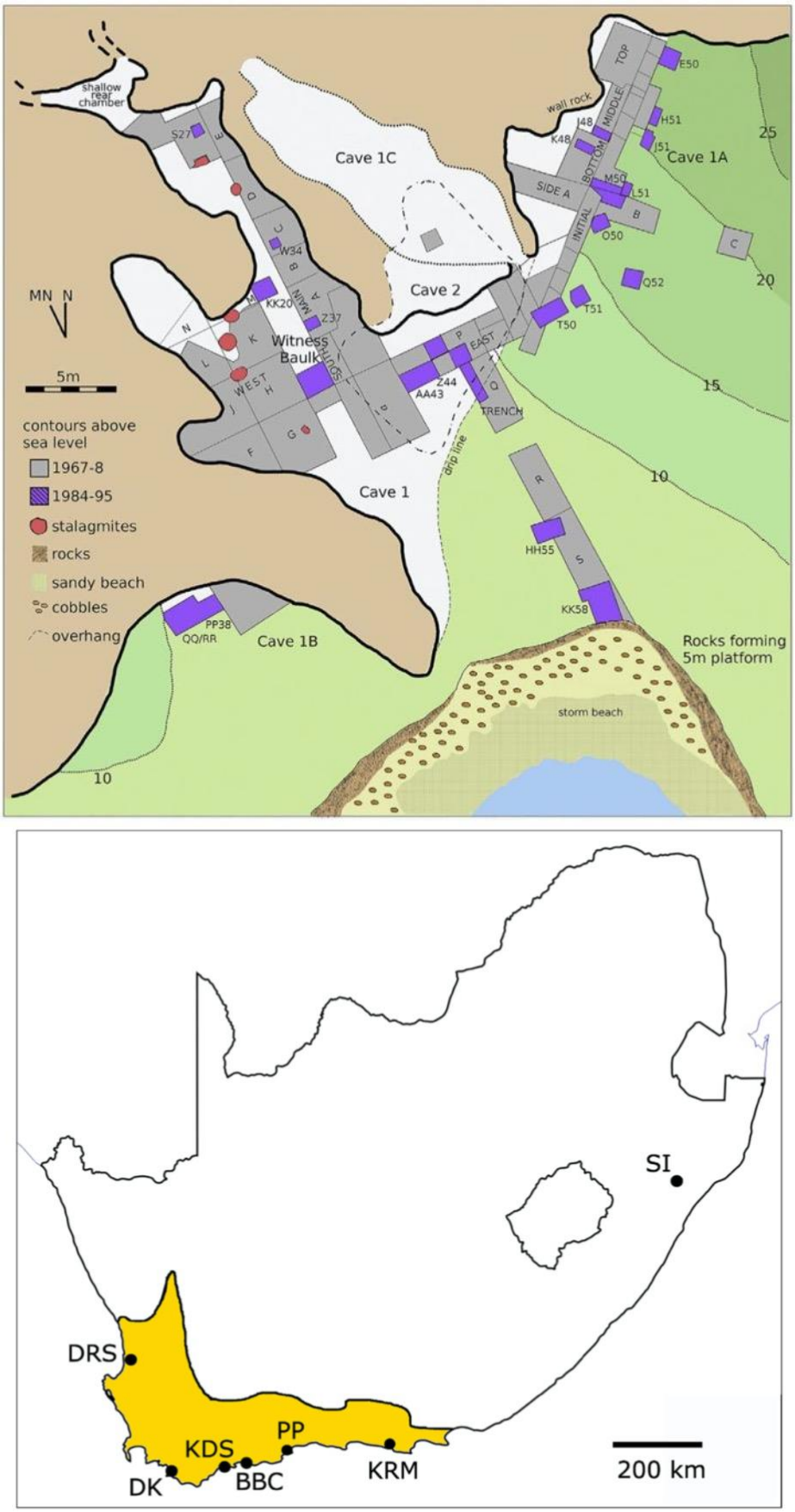


Figure 2.1 a). Plan of main site, Klasies River (Wurz et al. 2018: 104). b) A map of the sites discussed in text (after Reynard & Wurz 2020: 2): Diepkloof rock shelter = DRS, Klipdrift shelter = KDS, Blombos Cave = B. BC, Pinnacle Point = PP, Sibudu = SIb). The yellow area represents the SCC.

2.2.1 Sample stratigraphy and context

Wymer initially excavated the site during the 1960's (Singer & Wymer 1982). This initial excavation grouped the stratigraphy into layers associated with five Middle Stone Age cultural periods (Singer & Wymer 1982). These are the MSA 1, MSA II, Howiesons Poort, MSA III, and MSA IV (Singer & Wymer 1982). An LSA occurrence is also present. These terms are still used today (Wurz *et al.* 2018, 2022). Excavations were then continued by H.J. Deacon from 1984-1995, who grouped the deposits into lithostratigraphic members and correlated these with the layers previously excavated by Singer and Wymer (Figure 2.2). Deacon's excavations were more detailed and of higher resolution than the previous one. His approach to the stratigraphy at the site treated each sedimentary unit as an individual entity recorded separately. He classified the stratigraphy of the site into several members, including the lowest member LBS (Light Brown Sand), the RBS (Rubble Brown Sand), followed by SAS (Shell and Sand), RF (Rock Fall), Upper and the WS (White Sand) members (Deacon & Geleijnse 1988). The SAS member in cave 1 consists of several sub-members. This system is continued by Wurz (Wurz *et al.* 2018). Excavations resumed in 2015, directed by Wurz, and the work is ongoing (Wurz *et al.* 2018; Brenner & Wurz 2019; Brenner *et al.* 2022; Wurz *et al.* 2022). This current field work is focused on recording information on the deposits in the Witness Baulk (WB) inside Cave 1 on the SASL sub-member and underlying LBS members. The SBLS (Silty Black Soils) is underlying the SASL sub member and was excavated as part of the recent work done on the WB by Wurz.

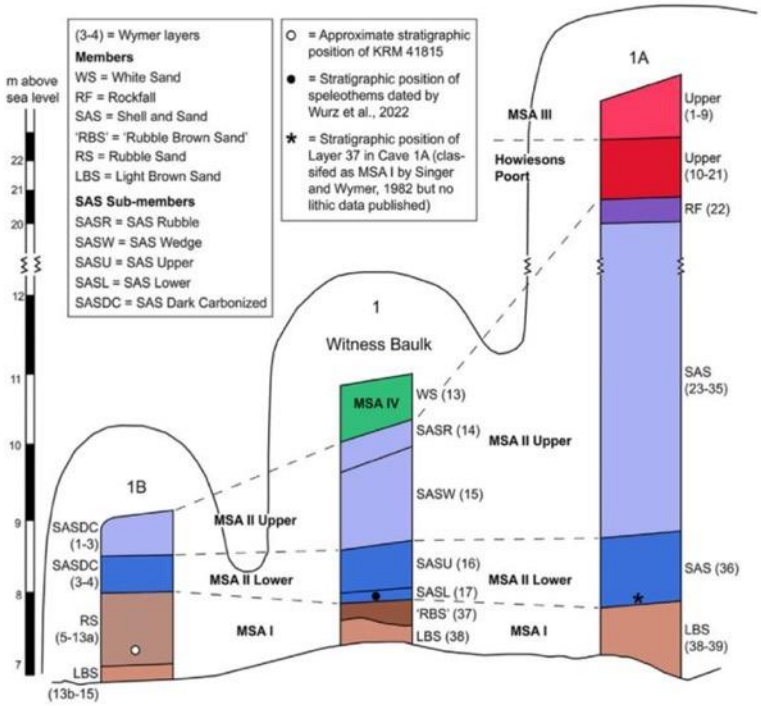


Figure 2.2: The stratigraphy of KRM 1, 1A and 1B. Figure adapted from Morrissey *et al.* 2023: 103414).

2.2.2: The SBLS layer

The SBLS layer is equivalent to Wymer's Layer 37 and represents a separate member (Morrissey *et al.* submitted). It is associated with the MSA I and borders the MSA II Lower, which includes the SMONE and BOS layers (Wurz *et al*. 2022). The lithics in SBLS are MSA I type artefacts (Wurz *et al*. 2018; Brenner *et al*. 2022). The SBLS is characterised by the presence of well-preserved ashes and hearths, with many of the faunal remains showing signs of burning (Wurz *et al*. 2018, 2022). Preliminary investigation shows smaller, thinner, and lighter lithic blanks than found in the two overlying layers, SMONE and BOS (Wurz *et al*. 2018; Lombard 2021; Brenner *et al*. 2022; Wurz *et al*. 2022).

U-Th dating of the Witness Baulk has revealed that the BOS Three layer, at the base of the SASL sub member, to be older than between 110 and 106 ka making the underlying SBLS layer, and underlying LBS member even older (Wurz *et al*. 2022). There seems to be relatively lower shellfish density in the SBLS layer, but with more species diversity (Brenner *et al*. 2022; Wurz *et al*. 2022) and this may also suggest that the sea level was slightly further away at this time, but additional investigation is needed to clarify (Wurz *et al*. 2022).

There is evidence of intense occupation from SMONE to BOS Three with abundant anthropogenic modifications of bone, such as burning and cutmarks, trampling striations, abrasion and high fragmentation (Lap 2020). As the figures below illustrate, lithic and faunal density in SBLS reflects a high level of anthropogenic activity.

The figures below (Figure 2.3; 2.4; 2.5) are models of GIS points taken of piece plotted specimens (>2cm) in square A1 and C1 in SBLS during the 2022 excavation season. Square C1 was chosen as it is opposite to square A1, and is also a hearth feature, with evidence of burned bones and shells. The distribution of bones and lithics are somewhat equal in this layer. The figures are a simple representation of the density of faunal and lithic materials in square A1 and C1.

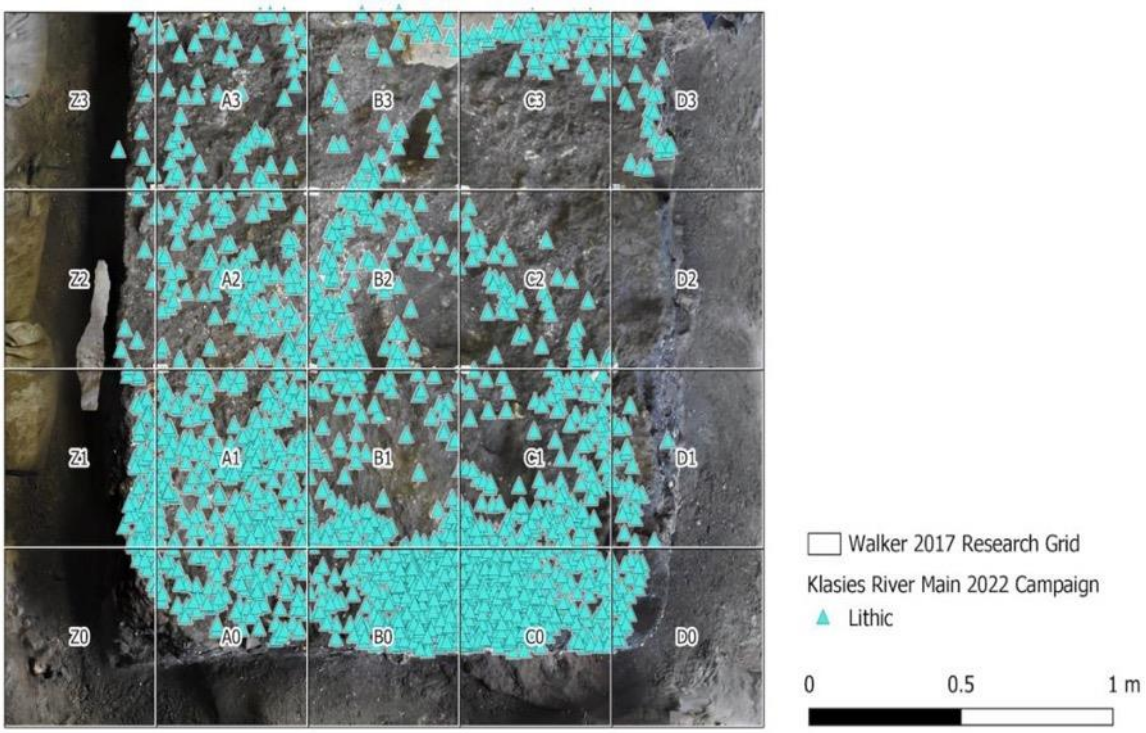


Figure 2.3: A model representing GIS plotted lithic artefacts in SBLS. Credit to T. Siemssen.

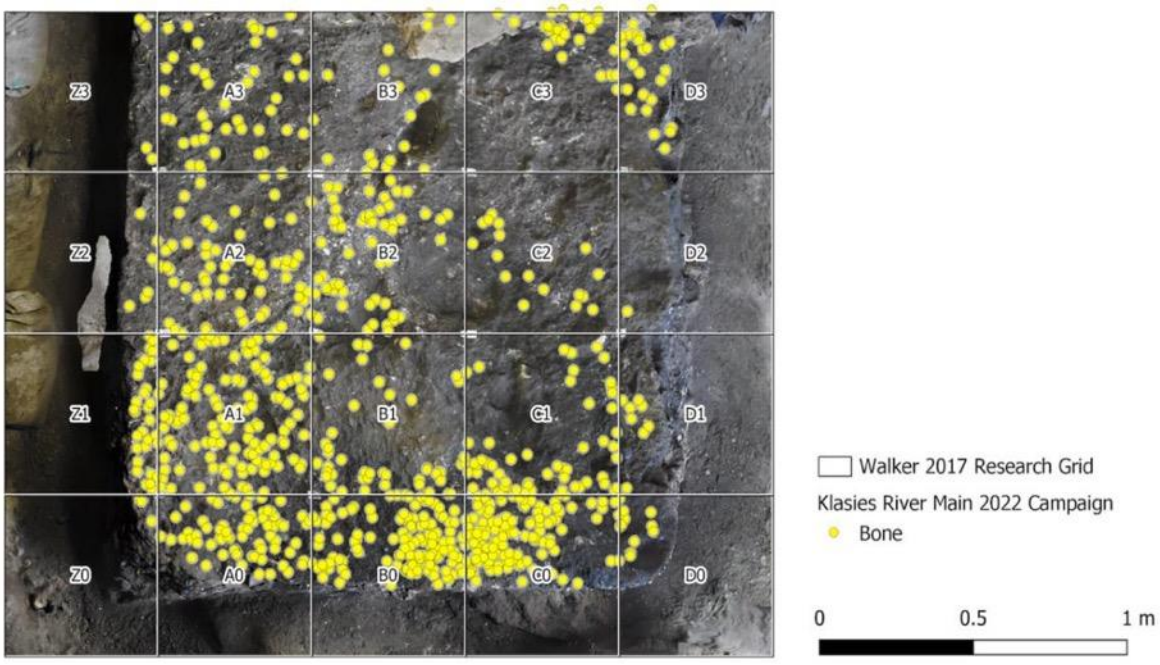


Figure 2.4: A model representing GIS plotted bones in SBLS. Credit to T. Siemssen.

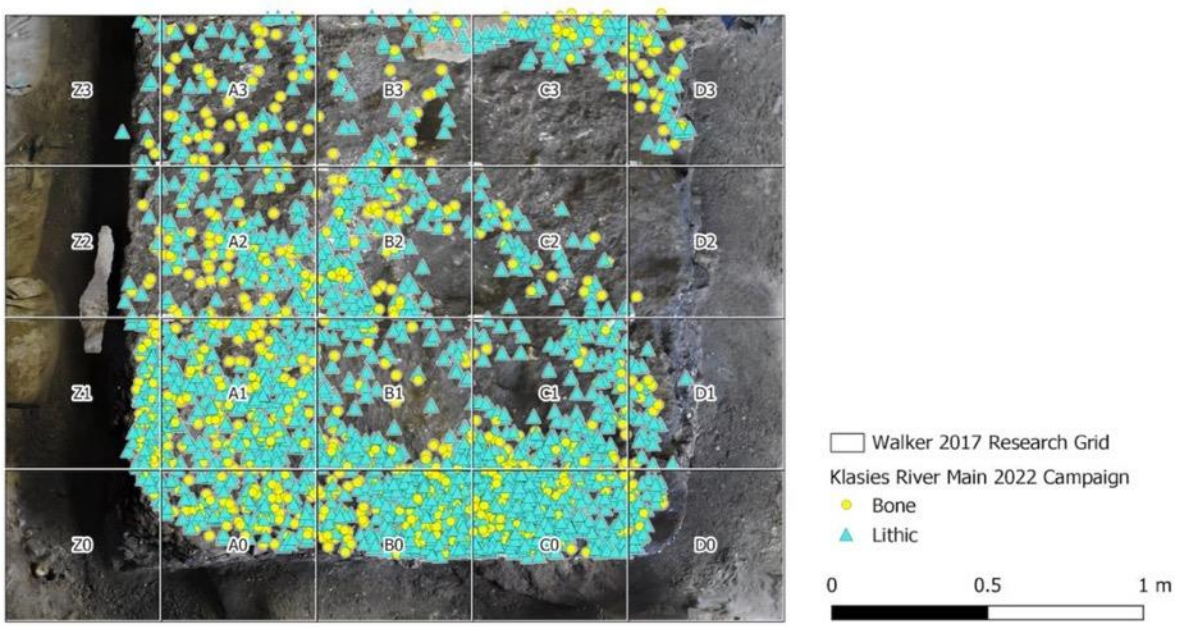


Figure 2.5: A model representing GIS plotted lithics and bones in SBLS. Credit to T. Siemssen.

Figure 2.6: An *in situ* photograph from the excavation of SBLS in 2022, of a bovid mandible in association with lithics and shell in square A1.

2.3: The Southern Cape Coast in the Middle Stone Age

The southern African MSA was an especially important period in the development of *Homo sapiens*. Archaeological sites in the southern Cape region often contain extensive evidence of the early adoption of innovative behaviours such as the early use of pressure flaking (Mourre *et al*. 2010), the heat treatment of rocks (Bentsen & Wurz 2017), beads made of shell (Henshilwood *et al*. 2011), the engraving of ochre at Blombos cave (Henshilwood *et al*. 2011), the crafting of bone tools (Henshilwood & Sealy 1997) and bow and arrow technology (Backwell *et al*. 2008; Lombard & Shea 2021). The southern African MSA also contains the Howiesons Poort (HP) and Still Bay (SB) technocomplexes, unique and innovative industries that show evidence of regional specialisation, innovative technology and highly adaptable behaviours (Deacon & Wurz 2005; Clark & Plug 2008; Henshilwood *et al*. 2011; Porraz *et al*. 2013; Wurz 2013).

MSA coastal sites also contain some of the earliest evidence of systematic marine resource harvesting (Thackeray 1988; Langejans *et al*. 2012; Dusseldorp & Langejans 2015; Brenner *et al*. 2022). The wide variety of terrestrial species accumulated at KRM, and other coastal sites on the southern Cape coast shows they were also successful in exploiting land-based resources (Wurz *et al*. 2018; Van-Pletzen Vos *et al*. 2019). In addition to exploiting shellfish and terrestrial fauna, the MSA communities of KRM also regularly harvested starchy geophytes, with evidence of charred parenchyma starches found in hearth features dated ca. MIS5e and MIS4 (Larbey *et al.* 2019). There is abundant evidence of the ability to make fire at will at KRM, which would have been an everyday aspect of life at the site throughout its occupational history (Deacon & Wurz 2001, 2005; Bentsen & Wurz 2017; Larbey *et al*. 2019).There is abundant evidence of human occupation throughout the MSA at the southern Cape coast, which contain highly dense anthropogenic assemblages that provide further understanding of subsistence behaviour during this period. Important MSA sites will be discussed in more detail further on, in order to make broad comparisons between the faunal assemblages at these sites and Klasies River, wherein similar subsistence strategies may have occurred.

2.4 Taphonomy

Taphonomic studies are essential in understanding the processes involved in the accumulation and preservation of faunal remains (Binford 1981; Lyman 1987, 1994; Behrensmeyer *et al*. 2000) which in turn provides insight into human subsistence behaviours and changes in palaeofaunal communities (Klein 1980; Faith 2011; Faith 2013; Reynard & Henshilwood 2017,

2018; Reynard 2022a, b). Taphonomic analysis is an essential aspect of understanding site formation processes, subsistence behavior and occupational intensity (Lyman 1994), as well as providing a reliable means of reconstructing paleoenvironments (Stoetzel *et al*. 2023). Apart from the study of macro fauna, the study of microfauna can provide a means of inferring the timing and duration of occupation of human and non-human carnivores at archaeological sites, layers rich in microfaunal remains are meant to represent periods of low human occupation (Stoetzel *et al*. 2023). Taphonomic studies aim to understand the transition of animal remains from the 'biosphere' into the 'lithosphere' (Efremov 1940: 85) and are concerned with accumulation processes and agents at archaeological sites (e.g., Lyman 1994; Behrensmeyer *et al*. 2000). Taphonomy can be defined as the study of the processes of preservation, and how this affects the kind of information we can extrapolate from the past (Behrensmeyer & Kidwell 1985). Taphonomy is a uniquely interdisciplinary study that allows researchers to analyse the past from multiple perspectives, including behavioral, environmental and spatial analyses (Behrensmeyer 2021; Egeland *et al*. 2024). The goal of taphonomy is to understand the different chemical and biological processes that cause changes in archaeological deposits, and that which affect organic remains, based on taphonomic 'clues' that can aid in identifying these processes (Behrensmeyer 2021).

2.4.1 Taphonomy and subsistence behaviour

The key aim in applying taphonomy to archaeofaunal assemblages is to investigate hominin subsistence behaviours, (Brain 1974; Lyman 1987, 2008, 2010). The role of the zooarchaeologist is to ask questions such as: how large was the prey animal population around the site? How many people could be sustained by this prey population? How many people inhabited the site and for how long? What time of year was the site inhabited? (Noe-Nygaard 1987). Questions such as these are all key aspects of studying the subsistence practices of early modern humans, taphonomic analysis play a crucial role in answering these important questions (Brain 1961, 1974; Klein 1976 Binford 1981; Blumenschine 1986; Marean *et al*. 1992; Lyman 1994; Milo 1998; Munro 2004; Stiner 2009; Thompson & Henshilwood 2011; Faith 2013; Steele & Klein 2013; Steele 2015; Reynard & Henshilwood 2017, 2018; Egeland *et al*. 2024). Taphonomy allows for a multi-perspective approach to the past by analysing the remains of anthropogenic accumulated faunas to understand the ways in which these animals were procured and processed by humans at archaeological sites (Stoetzel *et al*. 2023). Subsistence patterns can be inferred via analysing surface conditions affecting the animal bones, also known as bone surface modifications (BSMs), which will be discussed in the next

section. Taphonomy allows for an understanding of the methods that early human hunters used to capture and butcher prey and infer the ways in which prey animals were utilised at home bases and kill sites (Binford 1981; Noe-Nygaard 1987, 1988; Steele 2015; Thompson *et al*. 2017; Haaland *et al*. 2021). Carcass butchery can reveal a great deal of information about the lives of past people (Steele 2015; Egeland *et al*. 2024). Butchery practices reflect the social, economic, technological and ecological factors that influenced human subsistence in prehistory (Egeland *et al*. 2024). Taphonomic study in zooarchaeology allows for these butchery practices to be brought to light and to be better understood by researchers seeking to understand early modern human diets and complex behaviour (Reynard & Henshilwood 2019). The application of taphonomic analysis to the faunal assemblage in SBLS will therefore be highly informative regarding the butchery practices, subsistence strategies, cognition and environmental interactions of early modern humans at Klasies River during MIS5d, a period which in which few taphonomic studies have been undertaken.

2.5 Bone surface modifications

The study of marks left by stone tools on archaeological faunal remains allows for the interpretation of butchery processes; they can help, for instance, deciphering between hunting or scavenging (Klein 1980; Blumenschine 1986; Blumenschine & Selvaggio 1988; Blumenschine 1989; Blumenschine *et al*. 1996; Milo 1998; Dominguez-Rodrigo 1999; Engeland *et al*. 2024) as well as identifying which parts of the animal carcass were processed by humans (Noe-Nygaard 1977; Binford 1981; Binford 1984; Lyman 1994; Fisher 1995). Zooarchaeological analyses done in conjunction with the study of stone tool assemblages may allow for a comprehensive understanding of human subsistence strategies, as well as economic and social behaviours (Binford 1981; Lyman 1987; Fisher 1995). Bone surface modification (BSM) refers to these markings that are left on the bone surface (Binford 1981; Noe-Nygaard 1977, 1987, 1989). These may occur due to human or animal agents, or natural processes occurring after death and deposition (Lyman 1987, 1994, 2008). They may take the form of acid etching, pits, grooves, cuts, and other markings indicating the kind activities carried out upon the bone surface during and after deposition. Analysing bone surface modifications allows for investigation into subsistence behaviours, site accumulation processes, faunal communities, and the extent of human involvement with a faunal assemblage (Noe-Nygaard 1977; Lyman 1987; Bunn *et al*. 1988; Fisher 1995). Taphonomists have extensively studied the link between bone surface modifications and human subsistence behaviour in archaeo-faunal assemblages (Binford 1981; Bunn 1981; Shipman & Rose 1983;

Turner 1989; Blumenschine & Selvaggio 1988; Olsen & Shipman 1988; Noe-Nygaard 1989; Capaldo & Blumenschine 1994; Klein & Cruz-Uribe 1994; Blumenschine *et al.* 1996).

2.5.1: Anthropogenic bone surface modifications

When correctly identified, BSMs provide a direct link from faunal remains to the agents that accumulated them (e.g., Lyman 1994; Bartram & Marean 1999; Lyman 2008, 2010; Fernández-Jalvo & Andrews 2016; Thompson *et al.* 2017). The identification of these marks, combined with a correct interpretation of the timing of hominin access to a carcass, may allow researchers to separate scavenging from hunting behaviour at fossil sites (Binford 1981; Bunn & Kroll 1986, Bunn *et al.* 1986; Blumenschine 1986, 1989; Marean *et al.* 1992; Dominguez-Rodrigo 1999). This can be achieved through actualistic experiments involving experimentally controlled faunal assemblages, which are open to both predatory and scavenging carnivores (Binford 1981; Blumenschine 1986; Domínguez-Rodrigo 1999a).

Human activity can be reflected on a faunal assemblage ~~in~~ in the form of anthropogenic bone surface modifications. These might be separated from zoogenic marks or those inflicted by carnivores, such as tooth marks (Binford 1981; Brain 1981; Bunn *et al.* 1986; Blumenschine & Selvaggio 1988; Noe-Nygaard 1989; Fernández-Jalvo & Andrews 2016; Moclán & Domínguez-Rodrigo 2018). Anthropogenic bone surface modifications provide a key line of evidence for hominin involvement with a carcass and the stage that this involvement occurred (Binford 1981; Potts & Shipman 1981; Shipman & Rose 1983; Blumenschine 1986; Bunn *et al.* 1986; Fisher 1995; Domínguez-Rodrigo 1999; Marean *et al.* 2010; Thompson *et al.* 2017).

Many archaeo-faunal studies in the 1980s (Potts & Shipman 1981; Blumenschine 1989) have drawn upon Binford's work (e.g., Binford 1981), wherein he outlined the archaeological significance of BSM and fracture patterns as a means of distinguishing hominin from carnivore activity on faunal remains (Binford 1981, 1984). Binford notes that long bones are particularly diagnostic of hominid activity, as they may record butchery marks and fractures related to marrow extraction (Binford 1981; Villa & Mahieu 1991; Fisher 1995). Long bone representation may indicate specific subsistence activities. Mid-shaft fragments are important as the discarding of these elements may result in taphonomic biases that leads to phenomena such as the 'Klasies pattern', discussed below.

Potts' and Shipman's (1981) work on cutmarks made by hominids at Olduvai Gorge in

Tanzania attempted to separate human-inflicted damage to bone from marks caused by other agents such as carnivores, rodents, and trampling. The authors were amongst the first to use microscopic analysis to determine the cause of bone surface modifications while using actualistic faunal samples from a wide range of elements and taxa to reproduce these cutmarks (Potts & Shipman 1981). This study and others (Noe-Nygaard 1977, 1989; Shipman & Rose 1983) established a list of criteria to recognise cutmarks, which most zooarchaeological studies have applied since (Bunn 1982; Blumenschine 1986; Blumenschine & Selvaggio 1988; Blumenschine *et al*. 1996; Milo 1998; Pickering & Egeland 2006; Egeland 2012; Blasco *et al*. 2014; Reynard & Henshilwood 2018). These studies have shown that different types of BSM are morphologically distinct from one another, and with training cutmarks can be distinguished from markings caused by carnivores or natural processes.

2.5.2 Zoogenic bone surface modifications

The frequency and placement of tooth or cutmarks on mid shaft fragments can show whether a carcass was first accessed by humans or carnivores (Blumenschine 1986; Blumenschine & Selvaggio 1988; Blumenschine *et al*. 1996; Lyman 2008, 2010). When a carnivore is the primary predator, tooth marks should be more abundant than anthropogenic modifications (Bunn 1981; Blumenschine 1986; Blumenschine & Selvaggio 1988; Marean *et al*. 1992; Capaldo & Blumenschine 1994; Fisher 1995; Domínguez-Rodrigo 1999; Thompson *et al*. 2017). Studies have shown that carnivore damage mostly appears on or near epiphyses, rather than at the muscle attachments where human inflicted markings often occur (Binford 1981; Potts & Shipman 1981; Blumenschine *et al*. 1996; Dominguez-Rodrigo 1999; Fernández-Jalvo & Andrews 2016). This is because the intact midshaft portions would retain much more nutrient rich marrow than those that had previously been broken open, and so carnivores would spend more time on them, creating more tooth marks (Blumenschine 1986; Blumenschine & Selvaggio 1988; Marean *et al*. 1992; Bartram & Marean 1999; Blasco *et al*. 2014; Fernández-Jalvo & Andrews 2016). Lower frequencies of complete midshafts, and higher numbers of axial fragments are associated with anthropogenic faunal assemblages (Marean *et al*. 1992; Domínguez-Rodrigo 1999; Domínguez-Rodrigo *et al*. 2009; Blasco *et al*. 2014). The presence of low-utility elements such as pelves, phalanges and mandibles with evidence of intensive processing may indicate increased dietary stress (Clark 2011).

2.5.3 Natural modifications, post-depositional taphonomy and site formation processes

Archaeological site formation refers to the post-depositional processes that create and modify archaeological sites over time (Behrensmeyer 1978; Lyman 1994, 2002). Post-depositional processes such as fluvial movement, speleothem formation, sediment compaction, and salt precipitation result in bone surface modifications that are used to study the conditions that have affected the preservation of the assemblage (Behrensmeyer 1978; Lyman 1994, 2002, 2008). These processes can occur due to natural or anthropogenic (cultural) agents (Lyman 1994). Site formation processes can infer post-depositional taphonomic agents (Schiffer 1983). Taphonomy is often applied in archaeology to analyse these post-depositional processes and assess the preservation conditions of archaeological materials (Schiffer 1983; Lyman 1994).

In the 1980s and 1990s, site formation research focused on macroscopic artefacts such as bone, shells and stone tools, which are important aspects of this research, but do not explain the full picture (Shahack-Gross 2017). Villa (1982) stressed that post depositional alterations played a larger role in archaeological site formation than previously imagined, reiterating that vertical displacement of artefacts can still occur when the matrix itself appears undisturbed (Villa 1982: 276). Surface displacement of artefacts, bioturbation, and fluvial movement can all result in the removal of archaeological material from its original context (Villa 1982). The movement of water through a site will result in horizontal displacement, as well as rolled and abraded artefacts (Villa 1982). Soil mixing by animals (bioturbation) can result in disturbance of original context, trampling by humans can result in artefacts being pushed down and intermixed with underlying deposits (Stockton 1973; Yellen 1977). A common type of anthropogenic post-depositional alteration is trampling, which may result in bones that appear polished or abraded (Fernández-Jalvo & Andrews 2016). Burning, as well as water abrasion can result in shiny bones (Fernández-Jalvo & Andrews 2016). Polish on bone has also been correlated with trampling and occupational intensity (Madgwick 2014; Reynard 2014).

In the 1980s, Villa argued that micro analysis and refitting of artefacts would help fit them back into their original context (Villa 1982). The inclusion of microfauna, chemical signatures and stable isotope analysis are essential factors in uncovering the relationship between natural (N-transforms) and anthropogenic (C-transforms) site formation processes (Shahack-Gross *et al.* 2017). This type of research falls within the category of geoarchaeology (Mentzer & Quade 2012). Micromorphological analysis can be used to

analysis thin slices of intact sediment under a powerful microscope to pick up and differentiate microscopic traces of human, animal and natural or abiotic activity (Mentzer & Quade 2012).

It is likely that conditions of high moisture played a role in the formation of the SBLS. Wurz *et al*. (2022) mention that high moisture conditions affected sedimentation deformation in the underlying SBLS (Singer and Wymer layer 37) sediments as suggested by Deacon (Deacon & Geleijnse 1988). This process often results in the rapid growth of gypsum crystals within the pores of the bones (Behrensmeyer 1978). Lightly burned bones are often affected by gypsum (Clark and Ligouis 2010). Gypsum encrustation has been linked to high moisture, followed by drier conditions in other MSA contexts such as Diepkloof and Sibudu (Clark & Ligouis 2010; Steele & Klein 2013), and has also been documented in the BOS 3 and SMONE layers (Lap 2020: 113).

2.6: New methodological approaches to taphonomy

Although the pioneering methods of the researchers of the 1980s and 1990s provided invaluable insights into past human behaviour, they faced limitations that impeded their studies. Some of these limitations were due to the technology available at the time, without high resolution imaging technology, different types of BSMs could be easily confused, especially when the surface condition of bones was poor. The tendency to discard unidentifiable bones was common practice at many sites, including Klasies River during the Singer and Wymer excavations, which resulted in taphonomic biases in which larger animals were overrepresented (Outram 2001; Badenhorst & Plug 2011). Butchering of animals may leave no actual trace, and it can be difficult to identify the types of tools that were used to process a carcass (Badenhorst & Kimambo 2020). The sex of the animal, as well as the skill of the butcher can affect BSM visibility (Badenhorst & Kimambo 2020; Egeland *et al*. 2024). Preservation and taphonomic factors can lead to misleading interpretations of faunal assemblages (Brain 1967). Lab and excavator biases resulted in skewed faunal abundance profiles, leading to some researchers (e.g. Binford 1984) concluding that early modern humans practiced more scavenging than active hunting, due to the lack of high utility elements and the overrepresentation of less desirable elements such as crania and foot bones (Klein & Cruz-Uribe 1996). An example of this is the ‘Klasies Pattern’, which was held as evidence of scavenging behaviour at archaeological sites, which, when revisited by later

studies (e.g. Milo 1998), was found to be a common taphonomic pattern found at archaeological sites throughout the world.

The technological advances of the 21st century have provided new methodology that can aid in taphonomic study and overcome many of the issues discussed above. Poor surface condition and high fragmentation, a common aspect of middle stone age faunas (Thompson & Henshilwood 2011; Steele & Klein 2013; Steele 2015; Reynard *et al*. 2016b; Clark 2019; Discamps *et al.* 2024; Ruebens *et al*. 2024). In archaeological faunal assemblages, 70% or more bone fragments are unidentified to taxa (Ruebens *et al*. 2024), which poses a major problem for archaeologists attempting to study paleoenvironments and reconstructing paleo-faunal communities, important aspects of zooarchaeology. The use of ZooMS, or soft-ionization Mass Spectrometry to identify taxa from unidentifiable bone fragments is a revolutionary new method of taxonomic identification that will assist archaeologists attempting to analyse highly fragmented faunal assemblages, which are often likely to be the norm especially in palaeolithic deposits (Steele & Klein 2013; Ruebens *et al*. 2024; Discamps *et al.* 2024). ZooMS works because collagen protein has been shown to vary by taxa, and these formerly invisible taxa can be identified by peptide fingerprinting (Buckley *et al*. 2009; Ruebens *et al*. 2024). ZooMS, in combination with taphonomic and spatial analysis, can reveal a great deal more information regarding subsistence behaviour than previously realised, and is especially useful in highly fragmented assemblages.

Another new methodology that is being utilised in palaeolithic contexts is the use of 3D morphological analysis to more accurately identify different types of BSMs, which can be difficult when bones have a poor surface condition. Courtenay *et al*. (2020), utilised geometric morphometric methods (GMM) to identify carnivore tooth marks on bones using 3D morphological surface scans in experimental studies on the bones of livestock predated by wolves and dogs, and found 95% accuracy, combined with machine learning algorithms, in differentiating carnivore tooth marks from other BSM types (Courtenay *et al.* 2020). The future of BSM analysis is highly promising when utilising these types of digital morphological analyses, which can eliminate human error by a large degree, and provide clearer pictures of agents of accumulation and modifying agents in archaeofaunal assemblages (Courtenay *et al*. 2020).

The study of microvertebrate or microfaunal assemblages can provide promising insights into spatial and occupational histories at archaeological sites (Lebreton *et al.* 2021; Stoetzel *et al.*

2023). These kinds of studies have been found to be highly useful in understanding stratigraphic context and the timing of early human occupations at numerous sites, including La Roche-à-Pierrot (Saint-Césaire, France), where researchers found a negative correlation between human occupation and micromammal abundances (Lebreton *et al*. 2021). Fernández-Jalvo *et al*. (2022) designed a controlled trampling experiment to assess post-depositional breakage and site formation processes at Wonderwerk Cave, South Africa, with a specific focus on small mammal bones. The experiment was carried out within controlled parameters on modern rodent bones, and then compared to the breakage patterns found at Wonderwerk (Fernández-Jalvo *et al*. 2022). The results of their experiment showed that trampling was a major factor in the high degree of breakage in the assemblage combined with carnivore digestion and excavation taphonomy (Fernández-Jalvo *et al*. 2022). Studies of this nature are highly useful in uncovering taphonomic biases at fossil sites, as well as showing the importance of microfaunal analysis in understanding site formation processes.

Significant progress has also been made within the study of traceology in recent years. Okaluk & Greenfield (2022) carried out macro and microscopic analyses of chop marks on pig and sheep bones, using macroscopic observation in combination with high resolution imaging, and determined metal tools were being utilised at an archaeofaunal assemblage in Göltepe, Turkey. The need for repetition of early actualistic studies, combined with these new technologies, is important for the future of butchery studies and taphonomy (Egeland *et al*. 2024). Butchery studies have the potential to go beyond discussions of subsistence practices and can create discussions surrounding 'expert technical cognition' (Wynn & Coolidge 2014). The frequent butchering of carcasses takes a high level of skill and craft specialisation and may have required apprenticeship and guidance under experts (Egeland *et al*. 2024). Taphonomy in combination with butchery studies can provide further information regarding socially embodied knowledge and the transmission of specialised skills in palaeolithic communities (Egeland *et al*. 2024).

2.7 Taphonomic analyses at Klasies River

At KRM, there have been several taphonomic studies on the site's fauna. The faunal remains from KRM have been the subject of many debates in MSA studies focusing on the hunting ability of early modern humans (e.g. Binford 1984; Milo 1998; Outram 2001) and have been influential in these discussions (Ezeimo *et al*. 2024). Due to the overrepresentation of elements such as crania and phalanges in Klein's sample, Binford (1984) contended that the lower utility elements present at the KRM points to MSA hunter-gatherers being unable to

primarily access higher yield elements such as upper limbs and were instead left with lower yielding elements (head neck, phalanges etc.) pointing to scavenging behaviour (Binford 1984). This was later contested by other studies, including Milo (1998), Bartram and Marean (1999) who maintained that this skeletal profile was a result of taphonomic biases, and not an indication of scavenging behaviour, as previously discussed.

More recent taphonomic studies of the KRM fauna suggests that humans were the primary accumulators of bone in the HP, MSA III and the MSA II lower assemblages (Achieng 2019; Lap 2020; Pearson 2021; Reynard 2022a). In her analysis of the SMONE and BOS layers, Lap (2020), found that humans were the primary accumulators of BOS 3 and SMONE, relating to the MSA II lower. BOS 1 and 2 had more bovid specimens with carnivore tooth-marks (Lap 2020). Lap also found that carnivore activity was highest during occupational hiatuses at KRM (Lap 2020: 113).

There is evidence of frequent percussion modification and marrow extraction in BOS 3 and SMONE (Lap 2020). Abrasion and trampling damage is higher in BOS 3 and SMONE and correlates with higher occupational intensity (Lap 2020). Burning is also common in these layers, which increased fragmentation and reduced element identifiability (Stiner *et al.* 1995; Cain 2005). In her analysis of KRM's HP, Achieng (2019) found that a high level of gastric acid etching (GAE) in the layer YSx5 indicated that KRM 1A was used as a carnivore den in periods with low occupation. She also found more evidence of intense processing in layer CPx4, with low preservation of long bones and more percussion marks (Achieng 2019), which may indicate an aspect of resource intensification in this layer. CPx4 also contains more evidence of heavy burning, in association with a carbon parting (Achieng 2019). This points to a high level of anthropogenic activity (Stiner *et al.* 1995; Cain 2005). In CPx4, 96% of percussion marked specimens are also burned, a direct result of human processing (Achieng 2019). Pearson (2021) found that the MSA III and HP faunal assemblage from higher in the sequence showed different agents of accumulation (Pearson 2021). The MSA III was accumulated by a combination of both hyenas and humans, while the HP sample analysed by Achieng (2019) (layer CPx4) was primarily accumulated by humans.
In both samples, high frequencies of percussion marks and spiralised breakage suggest frequent anthropogenic processing of this faunal sample (Pearson 2021). Burning and trampling in the HP sample further suggests more intense occupation than in the MSA III (Pearson 2021).

Ezeimo *et al.* (2024) conducted a taphonomic analysis on faunal material from KRM Cave 1B. As in the case of KRM Cave 1A, humans are the main accumulators of the faunal assemblage (Ezeimo *et al*. 2024). The assemblage includes small game such as shellfish, tortoises, birds and rock hyraxes, as well as medium to large ungulates, some of which are burned (Ezeimo *et al*. 2024). The low carnivore to ungulate ration further suggests human accumulation of faunal material, the remains are also found in direct association with cultural artefacts (Ezeimo *et al*. 2024). The cultural artefacts include lithics, hearths and burned bones and shellfish (Ezeimo *et al*. 2024).

2.7.1 The Klasies Pattern

An important aspect of studying subsistence behaviour in the MSA was the hunting versus scavenging debate, which was a focus of several studies in the 20th century (e.g. Binford 1984; Klein 1989; Klein & Cruz-Uribe 1984; Milo 1998). The results of these studies became the subject of numerous debates between archaeologists studying the 'Klasies pattern'. The Klasies Pattern refers to a 'head and foot' dominated assemblage (Bartram & Marean 1999). This pattern sparked much debate regarding the cognitive abilities of early modern humans (Turner 1989; Marean & Assefa 1999). Binford (1984) interpreted the Klasies Pattern as scavenging behaviour, as the faunal assemblage at KRM is overly represented by these 'less desirable' elements of crania and lower limbs. Klein and Cruz-Uribe (1995) suggested that MSA hunters were less effective than their LSA counterparts, and therefore preyed upon smaller and more docile animals and scavenged larger more dangerous ones.

Other studies suggest that the Klasies Pattern may have more to do with taphonomic bias than behaviour (Turner 1989; Milo 1998; Bartram & Marean 1999; Marean & Assefa 1999). Microscopic analysis of fauna from KRM by Milo (1998) showed that hominins had regular access to higher yielding elements from bovids of all size classes (Turner 1989). The presence of a stone point embedded in the cervical vertebra of the extinct giant long-horned buffalo (*Syncerus antiquus*) further points to the highly skilled nature of early MSA hunters, who may have systematically processed carcasses in groups (Milo 1998: 125).
The intensive and systematic nature of processing may have left fewer marks on bone and exacerbated post-depositional fragmentation of faunal remains at KRM, and the disposal of many of these fragments by initial excavators, may account for the Klasies Pattern (Milo 1998). Based on ethnoarchaeological studies of Kua foragers of the eastern Kalahari, Bartram and Marean (1999) suggest that post-depositional fragmentation contributed to the

disappearance of less dense elements. Smaller animals are also more likely to disappear from the assemblage, as their bones are naturally less dense and more susceptible to destructive post-depositional processes than bones of larger animals (Klein 1989).

Some have also argued that the highly fragmented condition of faunal remains at KRM suggests humans were the main accumulators (Deacon & Wurz 2005; Reynard 2022a). This is supported by microscopic analysis of marks left on the bones (Milo 1998), with cut marks outnumbering tooth marks. A higher ratio of anthropogenic to zoogenic bone surface modifications is generally correlated with primary carcass access (Blumenschine 1986; Thompson *et al*. 2017). The cut mark data correlates with early access to higher yielding elements (high-utility, meaty bones), most likely inferring hunting behaviour (Marean & Assefa 1999). There is no evidence that MSA groups were deliberately choosing scavenging over hunting, and in fact research shows that active hunting was more common throughout KRM's occupational sequence (Turner 1989; Marean & Assefa 1999; Faith 2008; Wurz 2008; Reynard & Wurz 2020).

2.8 Taphonomic studies at contemporary MSA sites

The middle stone age was a watershed period of innovative behaviours for early modern humans (Wurz *et al*. 2018, 2022). The discussion of early modern behaviours has shifted from debating whether these behaviours *were* modern or not, to questions regarding *when*, *where* and *how* modern human behaviour originated (Stiner 1993; Marean & Assefa 1999; Henshilwood & Marean 2003; Thompson & Henshilwood 2011). The focus has also shifted towards asking questions and researching the development of working memory, symbolism and the development of advanced technology (Henshilwood & Marean 2003; Reynard & Henshilwood 2019). The following case studies of SCC sites provide additional context for faunal exploitation strategies during the MSA and will be compared to the faunal assemblage from KRM1 to highlight differences and similarities between sites.

2.8.1 Blombos Cave

Blombos cave is a highly important MSA site that contains abundant evidence of early modern complex behaviour, including early abstract engravings on ochre (Henshilwood *et al*. 2018), and shell bead ornamentation (Henshilwood *et al*. 2011). As in the case of Klasies River, the site preserves an extensive faunal assemblage (Thompson & Henshilwood 2011). The M1 and part of the M2 phases at BBC is associated with the Still Bay period (dated to

around 72.7kya, 70-76kya), a period of innovative technology and behaviour (Henshilwood 2012; Wurz 2021). Bones in the M1 and M2 are more burned and fragmented, with surface modifications suggesting that most larger mammal bones were accumulated by humans, and possibly more intense occupation (Thompson & Henshilwood 2011). Taphonomic data shows that bones were modified secondarily by carnivores after they had been discarded by humans (Thompson & Henshilwood 2011). Smaller prey was mostly accumulated by carnivores, directly comparable with Pinnacle Point (PP13B) and Die Kelders Cave 1 (Thompson & Henshilwood 2011). As was the case at Klasies River, Pinnacle Point, Boomplaas and Die Kelders, faunal density was higher during MIS5 (Thompson & Henshilwood 2011; Reynard & Henshilwood 2019). Human occupation along the SCC was relatively dense throughout the MSA due to the abundant prey fauna and access to a wide range of terrestrial and marine resources (Marean *et al.* 2000). As with Die Kelders (DK1) and Pinnacle Point (PP13B), size 1 mammals are most well represented in Blombos Cave's faunal assemblage (Marean *et al*. 2000; Thompson & Henshilwood 2011).

2.8.2 Pinnacle Point

There are few MSA sites older than 110ka, but Pinnacle Point Cave 13 B(PP13B) is one of these rare sites (Rector & Reed 2010; Brenner *et al*. 2022; Ezeimo *et al*. 2024). PP13B contains early evidence of human occupation at the Southern Cape coast (Rector & Reed 2010). The macrofaunal assemblage contains a diverse range of terrestrial mammals, including large grazers, small browsers and mixed feeders (Rector & Reed 2010). This indicates a mosaic type environment around Pinnacle Point during the time PP13B was deposited (Marean 2010). The PP30 assemblage was accumulated by carnivores, this is evidenced by the presence of other carnivores, and more diverse species, as well as abundant crania, which humans usually leave at kill sites (Rector & Reed 2010). PP13B also contains early evidence of intensive shellfish exploitation (Marean *et al*. 2007). For these reasons, PP13B is highly comparable with the faunal assemblage at KRM1.

2.8.3 Diepkloof rock shelter

At Diepkloof, the lowermost MSA layers have been OSL dated to >110ka (Steele & Klein 2013), while the uppermost MSA layers reach all the way to the late (65-59ka) and post-HP (57-46ka; Porraz *et al*. 2013; Steele & Klein 2013). The MSA faunas are diverse and contain more grazing ungulate species, suggesting a greater role for grasslands during the MSA

(Steele & Klein 2013). Marine species such as intertidal mollusks have been exploited in combination with terrestrial mammals and birds, resulting in a diverse diet and extensive faunal assemblage at the site (Steele & Klein 2013; Texier *et al*. 2010; 2013). The faunal remains are extremely fragmented, with dark staining, and extensive cutmarks, especially on the medium to large sized bovids (Steele & Klein 2013). The association of these remains in direct association with human artefacts and hearth features, directly suggests primary human accumulation (Steele & Klein 2013). Post-depositional processes such as chemical leaching and gypsum growth have exacerbated fragmentation, resulting in many bones shattering due to the growth of crystals within the pores of the bone (Steele & Klein 2013).

Figure 2.7: Specimens showing the condition of bones in the HP layers at Diepkloof rock shelter. Taken from: Steele & Klein 2013, pg. 3455: figure 2.

Image A shows the gypsum encrustation on a steenbok mandible and image B showing the dark staining of bones in this layer. (A corresponds to the intermediate HP layer 'SU Jeff', B is from the intermediate HP layer 'SU OB5'). Bones in a similar condition in SBLS may show that some site formation processes between KRM and Diepkloof are comparable.

2.8.4 Klipdrift rock shelter

The large fauna from the HP layers at Klipdrift rock shelter (KDS) are in a similar condition to the HP layers at KRM (Deacon & Geleijnse 1988), Sibudu (Wadley & Jacobs 2006; Clark & Ligouis 2010) and Diepkloof (Steele & Klein 2013). The highly fragmentary condition of the fauna from the HP layers point to a combination of anthropogenic processing and post-depositional alteration (Reynard *et al*. 2016b). Bones exhibit a high degree of localised burning, suggesting roasting of meat was commonplace in the HP (Reynard *et al*. 2016b). The taphonomic evidence suggests that KDS was utilised as a home base wherein butchery activities were commonplace (Reynard *et al*. 2016b). This is further suggested by the common presence of percussion marks and spiralised breakage on long bones, which points to primary human access and a marrow-based economy (Reynard *et al*. 2016b).

2.8.5 Sibudu

Sibudu cave, like Klasies River, contains a long sequence of MSA deposits, which include the pre-Still Bay, Still Bay industry, Howiesons-Poort industry, post-HP, as well as late and final MSA deposits (Wadley & Jacobs 2006). The oldest MSA phases at Sibudu have been dated to MIS 4 (Wadley & Jacobs 2006). Sibudu also contains rare, preserved bedding made of sedges and other plant material containing insecticidal properties (Wadley *et al*. 2011). The Still Bay (SB) and pre-SB layers contain a heavily burned and fragmented faunal assemblage (Clark 2019). Humans were the primary accumulators, but carnivores played a role in introducing small prey in the upper pre-SB phase (Clark 2019). In the pre-SB, hunters appeared to focus on dangerous prey such as suids, as well as small prey, while focusing more on small game such as the blue duiker in the SB, a potential indicator of remote capture technology (Clark 2019). The high degree of fragmentation may be due to the intense burning occurring throughout the site's occupation (Clark 2019), as burning has been found to promote fragmentation (Stiner *et al*. 1995; Costamagno *et al*. 1998; Clark & Ligouis 2010).

2.9: Subsistence behaviour

2.9.1 Agents of accumulation

The primary accumulators of a faunal assemblage can help distinguish between hunting and scavenging behaviours (Blumenschine 1986; Turner 1989; Milo 1998; Bartram & Marean

1999; Domínguez-Rodrigo 1999a). Primary human access to a carcass is indicated by the presence of extensive anthropogenic bone surface modifications, with minimal carnivore tooth marking on meaty elements such as limb bones (Bunn 1981; Potts & Shipman 1981; Bunn *et al.*1988; Blumenschine & Selvaggio 1988; Marean *et al*. 1992; Milo 1998; Domínguez-Rodrigo 1999; Thompson *et al*. 2017; Dusseldorp & Reynard 2022).

The frequency and placement of tooth or cutmarks on mid shaft fragments can show whether a carcass was first accessed by humans or carnivores (Blumenschine 1986; Blumenschine & Selvaggio 1988; Blumenschine *et al*. 1996; Lyman 2008, 2010; Reynard *et al*. 2016b). When a carnivore is the primary accumulator, tooth marks should be more abundant than if the carnivore was a secondary consumer (scavenger) (Blumenschine 1986; Blumenschine & Selvaggio 1988; Fisher 1995; Thompson *et al*. 2017).

Based on actualistic faunal experiments, Blumenschine (1986) concluded that the consumption sequence of animal carcasses by carnivores generally begins from the hindquarters to the crania, decreasing in the amount of flesh consumed. Blumenschine ascertained that if hominin-inflicted modifications on bone occurred more intensely upon dense, less desirable elements such as the crania and phalanges, they would have had secondary rather than primary access to a carcass (scavenging rather than hunting), as the meatier elements would have been processed by carnivores first, resulting in a higher ratio of carnivore inflicted bone surface modification (BSM) to anthropogenic modifications (Blumenschine 1986). The results of these studies became the subject of numerous debates between archaeologists studying, what became known as, the ‘Klasies pattern’ as discussed previously.

Zooarchaeologists have long studied the link between bone breakage and agent of accumulation in faunal assemblages (Brain 1969; Brain 1974; Binford 1981; Brain Olsen & Shipman 1988; Noe-Nygaard 1989; Lyman 1994; Blumenschine *et al*. 1996; Milo 1998; Marean & Assefa 1999; Outram 2002; Outram *et al*. 2005; Fernández-Jalvo & Andrews 2016). It is important to understand the differences in fracture patterns between bones that have been broken to extract the marrow, and the effects of taphonomic processes such as trampling, which may result in similar patterning (Potts & Shipman 1981; Outram 2002; Fernández-Jalvo & Andrews 2016). Fracture patterns occur due to stress affecting bone during site formation, hunting and processing activities, as well as consumption by both hominins and carnivores, and trampling (Johnson 1985). A key indicator of fresh or ‘green’ bone breakage is the presence of sharp angled and smooth helical fractures, (Villa & Mahieu

1991; Outram 2002). Dry bone breakage, which may occur sometime after death or when bone is heated before marrow extraction, results in straight fractures due to the dried-out nature of the bone surface (Outram 2002). Post-depositional breakage is inferred by the presence of bones broken at a straight angel (a transverse breakage), which is linked to compression and sediment compaction (Villa and Mahieu 1991).

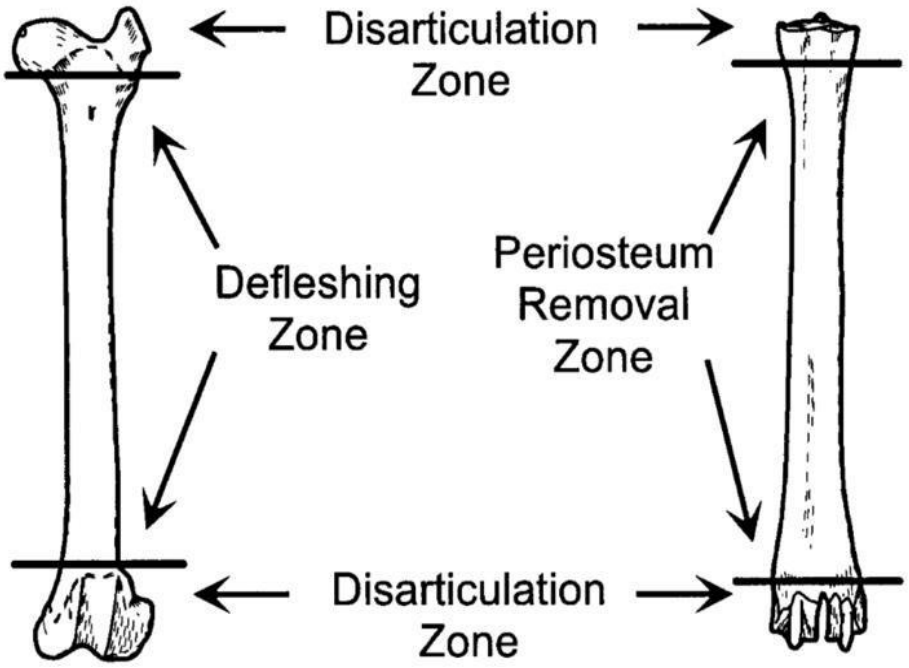


Figure 2.8: Diagnostic zones on long bones where the presence of cut- marks is associated with de-fleshing and disarticulation (Marean and Assefa 1999).

2.9.2: Mortality profiles

Mortality profiles can provide an understanding of the strategies involved in acquiring prey, selection of prey and differential preservation (Steele & Weaver 2002). The abundance of adult individuals in MSA assemblages has been correlated with primary human access to prey animals (Shipman & Rose 1983; Klein & Cruz-Uribe 1984; Steele & Weaver 2002; Stiner *et al.* 2011; Blasco *et al*. 2014). Mortality profiles may also reflect periods of resource intensification (Dusseldorp & Reynard 2022).

The age of an individual can be determined through several means, such as long bone epiphyseal closure and tooth eruption sequences based on standard literature (e.g., Noddle 1974; Klein 1982). Zoologists have studied the link between tooth eruption and wear in

determining the age of an animal (Spinage 1973; Tomé & Vigne 2003). This is useful in an archaeological context as teeth tend to preserve better, and therefore can be used to potentially identify an animal's age, and the type of forage it consumed. Age determination can be achieved through microscopic analysis of teeth, their wear, eruption patterns and measurement of crown heights (Tomé & Vigne 2003). This is especially true in the case of ungulates, as their diet will leave specific traces on their teeth and will be significantly worn down in older individuals (Spinage 1973). The porosity of bone can also be used to determine mortality profiles, as juveniles tend to have more porous bone (Gutiérrez *et al*. 2010), which can be easily identified with a microscope. Mortality profiles can indicate periods of relative economic prosperity (high numbers of prime age prey animals), or economic stress (low number of prime aged individuals, high numbers of older and juvenile specimens). An increased number of juveniles may indicate a period of resource intensification, as juveniles contain less fat, marrow and caloric value than adults, and would not be preferentially selected unless adults had decreased (Dusseldorp & Reynard 2022).

2.10: Occupational intensity

One of the main aims in this study is to determine whether occupational intensity occurred at KRM during MIS5d, based on taphonomic data from the SBLS faunal sample. Occupational intensity refers to periods of increased anthropogenic site use and can be used to determine factors such as social group size, length of stay and the function of the site (Stiner 2009: 13; Conard 2011; Haaland *et al*. 2021). Munro (2004: 7) measures occupational intensity by the number of human hours at a site, occupied per unit of time. An increase in sedentarism and concentrated population is an aspect of occupational intensity (Stiner 2009; Faith 2013; Reynard & Henshilwood 2018; Haaland *et al.* 2021). Increased human site use can be inferred by several methods, which may include analysing the spatial layout of archaeological sites, examining lithic diversity and faunal density (Munro 2004; Stiner 2009; Haaland *et al*. 2021).

Archaeological contexts which contain evidence of specially delegated activity areas suggest long term site use and management (Stiner 2009). This has been documented at Sibudu Cave by Goldberg *et al*. (2009) and Wadley *et al*. (2011). Large hearth features are indicative of repeated episodes of burning and prolonged site usage (Cain 2005; Stiner 2009; Clark & Ligouis 2010). Post-depositional bone breakage and trampling modification are taphonomic measures of occupational intensity (Reynard & Henshilwood 2017, 2018; Dusseldorp & Reynard 2022), as generally these occur due to the accumulated weight of site inhabitants impacting the deposited material, leading to sediment compaction (Villa and Mahieu 1991).

Post-depositional bone breakage often takes the form of transverse or 'dry' fractures (Dusseldorp & Reynard 2022; though not all dry bones will exhibit transverse fractures, e.g. Alhaique 1977). A high frequency of transverse fractures is associated with increased site occupation throughout the early MSA at KRM (Reynard 2022a, b). At KDS, there is more evidence of sedentarism in the Howieson's Poort (HP), which infers higher occupational intensity (Reynard & Henshilwood 2017). Around 20% of the faunal specimens at KDS exhibits polish, which may have been caused by trampling-induced abrasion (Reynard *et al.* 2016b). Lap (2020) found a greater frequency of post-depositional bone breakage in BOS 1 and 2. There is evidence of intense occupation from SMONE to BOS 3, with abundant anthropogenic modifications such as burning and cutmarks, with low frequencies of zoogenic modifications (Lap 2020).

Taphonomic analyses can be used to reconstruct the occupational history of archaeological sites (Faith 2013). Faith's (2013) analysis of the Boomplaas MSA sequence found that taphonomic changes correlated with shifting periods of human occupational intensity (Faith 2013). Higher population densities are correlated with higher frequencies of anthropogenic bone surface modifications, and lower frequencies of zoogenic modifications (Thompson *et al*. 2017). The ratio of anthropogenic to zoogenic bone surface modifications is a good indicator of how intensely a site was occupied (Thompson *et al*. 2017). Trampling modifications are also a good indication of changes in occupational intensities (Reynard 2014). When represented alongside trampling, abrasion (referred to here as 'polish' to distinguish from natural abrasion), can indicate periods of frequent and prolonged trampling, which correlates with extended site usage (Madgwick 2014). Higher lithic artefact diversity is also linked to increased site use (Stiner 2009). The number of lithic artefacts in SBLS (Figure 2.3) is high. All of the processes outlined above are evidence of increased sedentarism and decreased mobility, which suggests more intense periods of site occupation (Haaland *et al.*2021). The abundance of these features in the sample would suggest that occupational intensity occurs in SBLS.

2.11: Hearth activity

Macro and micro-archaeological evidence at KRM shows that hearths were a feature of everyday life throughout the site's occupation (Deacon & Wurz 2005; Bentsen & Wurz 2017; Wurz *et al*. 2018; Larbey *et al*. 2019; Brenner *et al*. 2022; Wurz *et al*. 2022; Morrissey *et al*. 2022, 2023). The use of pyro technology has been linked with the increase of analogical

reasoning (Wadley *et al*. 2009; Bentsen 2013; Bentsen & Wurz 2017). Studies have shown that the cooking of bone and shell was commonplace throughout the MSA (Thackeray 1989; Deacon & Wurz 2005; Clark & Plug 2007; Clark & Ligouis 2010; Wadley 2010; Wadley 2015; Bentsen & Wurz 2017; Wurz *et al*. 2018; Larbey *et al*. 2019; Wurz 2021; Wurz *et al*. 2022; Morrissey *et al*. 2022). Other MSA sites such as Diepkloof, Sibudu, and Blombos cave also contain well preserved hearths and organic materials, as well as highly fragmented faunal assemblages that have been degraded by burning, trampling and soil chemistry (Sievers 2006; Clark & Plug 2008; Sievers & Wadley 2008; Wadley 2010; Wadley *et al*. 2011; Porraz *et al*. 2013; Steele & Klein 2013).

KRM contains several stacked hearths, the products of multiple hearths in the same area throughout the occupational sequence (Deacon 1995; Larbey *et al*. 2019; Wurz *et al*. 2022; Morrissey *et al*. 2023). Dark carbonised layers and ashes that exist in association with combustion features have been argued to be the byproduct of cooking and burning organic materials, including geophytes (Deacon 1995; Larbey *et al*. 2019; Morrissey *et al*. 2023). The SASDC (shell and sand dark carbonised) MSA II sequence in Cave 1B is for example dominated by hearths containing dense anthropogenic material, including burned bone, shell and lithics (Morrissey *et al*. 2022, 2023). Hearths are linked to a wide range of advanced behaviours, from burning and roasting meat (Bentsen & Wurz 2017), heat treating lithics (Wurz 2021), manufacturing hafting adhesive (Wadley 2005; Wadley *et al*. 2009), disposing of waste (Cain 2005), and potentially using bones as fuel (Bentsen & Wurz 2017).
The name of SBLS (silty black soils), comes from the dark, carbonised clay and ash material making up the layer (Wurz *et al*. 2022). SBLS contrasts the SMONE and BOS layers, in that it preserves several in-tact combustion features (Brenner *et al*. 2022; Wurz *et al*. 2022).

2.12: Summary

This chapter provided an overview of the theoretical background to studying subsistence behaviour, post depositional processes and occupational intensity at KRM, which is the focus of this study, applied to the SBLS layer. The general methodology behind taphonomic study is listed, as well as important taphonomic studies widely used in faunal analysis. Occupational intensity and diagnostic criteria are briefly summarised to provide an understanding of the ways in which this can present in archaeological contexts.

Chapter 3: Material and Methods

In this chapter, the sample analysed for this study is described and placed in relation to the greater KRM1 sequence. The methodology used is outlined, and definitions provided for various taphonomic procedures. The reasoning in using these methods is explained below.

3.1: Materials

The macro-faunal sample used in this study is from the SBLS layer of the Witness Bulk excavated during the 2020 and 2022 field seasons. The macro-faunal sample includes all species weighing over 300 grams while alive (Clark 2019). The SBLS falls within the MSA 1 (Wurz *et al*. 2022), and represents a separate member, equivalent to Wymer's layer 37. All the piece plotted faunal material from squares A1 and C1 were analysed. All specimens measuring more than 2cm were individually plotted with GIS coordinates using a total station. Squares A1 and C1 were chosen due to their opposite positioning. C1 was also chosen because it contains an intact combustion feature and is important in studying taphonomy and subsistence behaviour. Excavated material went through dry sieving of meshes of 2 and 5mm, and wet sieving with meshes of 0.5mm (Brenner *et al*. 2022; Wurz *et al*. 2022).

The sample includes both identifiable (ID) and non-identifiable (non-ID) specimens larger than 2cm. Identifiable specimens can be identified to skeletal element and size class (Lyman 2008). Non-identifiable elements cannot be identified to skeletal element or size class and were sorted into fragments > or < than 2cm. Specimens identified to either species or element were included in the taphonomic analysis regardless of if they were <2cm in length. Specimens that did not meet at least one of these criteria were excluded from the analysis and added to the coarse fraction sample. The total sample for each square has been calculated using only specimens that met the criteria outlined above. These specimens were used in taphonomic analysis but only on specimens that retained their cortex.

The fauna from the coarse and fine fraction was counted and weighed, and fragments >2cm were analysed. Each piece plotted specimen and >2cm fragment was microscopically analysed using a Heerbrugg 'Wild' binocular microscope, with low magnification (10 – 40X) using oblique lighting and measured by length in millimeters using a digital caliper. Each sample specimen was individually analysed to study bone surface modifications and post-depositional processes. The bone surface modifications and identified species and elements were recorded in an Excel spreadsheet and the results are presented in Chapter 4. Low element identifiability meant that analysing density mediated attrition in the assemblage was

not viable, and therefore the focus for the macro-faunal specimens in SBLS was on identifying taphonomic agents through the surface condition of the bones.

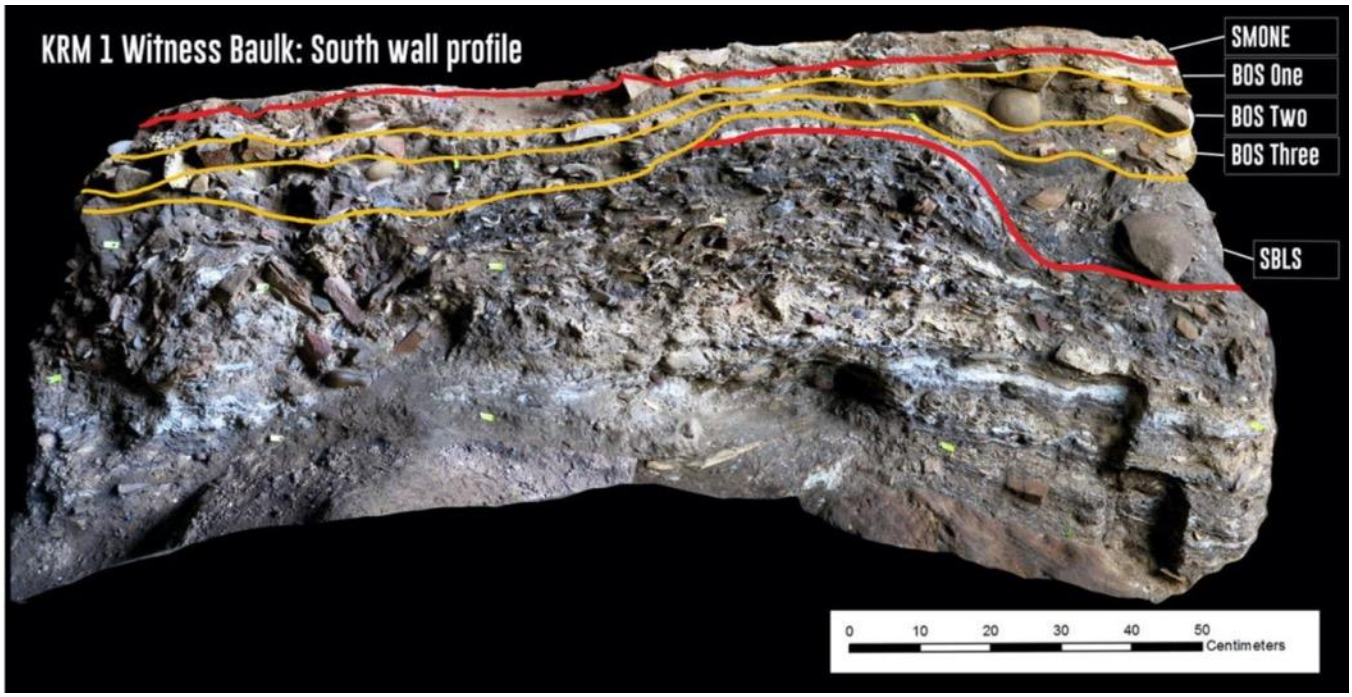


Figure 3.1: The stratigraphy of the 2015-2018 excavation of the Witness Baulk at KRM cave 1 (adapted from Brenner *et al*. 2022: 7).

The chosen sample for this study comes from the portion of the SBLS layer (depicted in relation to BOS and SMONE, in Figure 3.1) which was excavated in 2020 and 2022.

3.2: Quantification

Quantification in archaeo-faunal assemblages is an important aspect of zooarchaeological analysis. To present an accurate picture of the archaeological record, it is important to understand what exactly we are measuring (Lyman 1994). In quantification, *observational units* are directly observed properties such as weight and length (Lyman 1994: 37; emphasis in original). Measuring these observational units by counting the number of specimens and tallying their physical properties, their weights and lengths, can produce *fundamental measurements* of these specimens (Gibbon 1984). The following methodology outlined below is how the sample from square A1 and C1 has been quantified.

3.2.1 Number of identified specimens

The quantification method used in this study is based only on the number of identified specimens (NISP) due to high fragmentation and low amounts of identifiable specimens.

NISP is an observational unit and is an easily observed and direct method of quantification (Lyman 1994a). Fragmentation in the sample was too high, and there were not enough identified skeletal elements to quantify using the minimum number of individuals (MNI) or through other inferential tallies such as the minimum number of elements (MAU). NISP is calculated by counting all specimens; and is a direct tally (Marshall & Pilgrim 1993). NISP is often used in fragmentary assemblages because it is less susceptible to quantification issues that may result from using MNI or MNE values (Grayson 1978; Plug & Plug 1990; Marshall & Pilgrim 1993; Lyman 1994, 2008). NISP has been experimentally shown to rise at lower levels of fragmentation, and then decline at higher levels (Cannon 2013). NISP has been used to quantify faunal abundance in other KRM sequences (Reynard & Wurz 2020; Wurz *et al.* 2022; Reynard 2022a). It should be noted that NISP does not account for post-depositional taphonomic processes such as preservation, fragmentation, element transport, butchery and carnivore damage that may affect this quantified estimate (Klein & Cruz-Uribe 1984; Lyman 2008: 281). NISP is prone to bias due to differential fragmentation and preservation, which can be influenced by post-depositional processes and agents (Assefa 2006; Lyman 1987, 2019). NISP is strongly influenced by fragmentation and may sometimes be misleading, as numerous fragments will be counted separately when they originally belonged to one complete skeletal element (Otárola-Castillo 2010). NISP will often result in much higher numbers of individuals than MNI (Grayson & Frey 2004; Lyman 2019). Fragmentation is directly influenced by density-mediated attrition (Lam *et al.* 1999), which results in larger, denser bones being better preserved than smaller ones (Abe *et al.* 2002). Because larger bones contain more nutrients such as meat and marrow, they will often be more fragmented due to butchery processes, resulting in a bias towards representation of larger bones when calculated with NISP (Marean *et al.* 2001; Abe *et al.* 2002).

The solution to this problem is the identification of anatomical landmarks, and the inclusion of long bones in zooarchaeological quantification (Marean *et al.* 2001; Stiner 2002). The exclusion of long bones in taphonomic analysis results in a reverse utility curve, resulting in a head and foot pattern (Lyman 2019). The influence of density mediated attrition, and the role of post-depositional sedimentology should also be well understood in conjunction with NISP counts to mitigate this biasing tendency (Munro & Bar-Oz 2004). The role of taphonomic agents needs to be studied alongside quantification to provide a more realistic measure of abundance in highly fragmentary assemblages (Plug & Plug 1990).

Because of the small sample size and low element identifiability, NISP is still the best quantification method for this study despite its biasing factor. Post-depositional taphonomy

will be studied in conjunction with this quantification method to create a more realistic estimate of faunal abundance in the sample.

3.3. Faunal density

Specimens included in the sample were individually weighed using an Ohaus scale. These weights (expressed as grams) were recorded in an Excel spreadsheet and used for the density calculation. Faunal density in this study was calculated for each square by dividing the total weight (initially in grams but converted to kilograms) of the faunal specimens (kg) by the total volume (m^3) of excavated sediment (the combined volume (millimeters converted to m^3) from the portions of square A1 and C1 excavated in the 2020 and 2022 field seasons. This is a method used in other faunal studies at KRM (Achieng 2019; Lap 2020; Pearson 2021; Reynard 2022b). The faunal density measured here is volumetric (m3) and is not based on skeletal element density values (as per Lam & Pearson 2005). Volumetric density is a relative measure of abundance and not a direct measure of taxonomic abundance in the sample (Metcalfe & Jones 1988; Madrigal 1998; Lyman 2008). The faunal density from square A1 and C1 was compared to other layers at KRM, namely the SMONE, BOS (Lap 2020), HP and MSA II Lower (Reynard 2022a) layers and is discussed in Chapter 5 (Table 5.1). Faunal density is used to assess the effect of post-depositional destructive processes in the archaeological record (Lam *et al*. 2003: 1701).

3.4: Taxonomic identification

The faunal material was identified to anatomical elements and, where possible, taxa following Driver (2005). Ungulate remains not identified beyond Family were classified into mammalian size classes following Brain (1974). Taxonomic identification was aided by previous studies on the KRM fauna (Reynard & Wurz 2020; Van-Pletzen 2000; Van Pletzen-Vos *et al*. 2019; Reynard 2022a) but draws mainly from the work of Skinner & Chimimbas's (2005) manual on South African mammals. Skinner & Chimimba (2005) provide detailed examples of all southern African mammal taxa and describe all modern specimens of *Bovidae* and their associated location and preferred browse (Skinner & Chimimba 2005: 620-711). Certain species of bovid are unique and can be identified mainly by skeletal element, this identification is based on comparison with the comparative faunal collections at the University of the Witswatersrand's Archaeology Department and Evolutionary Sciences Institute (ESI) as well as the Ditsong National Museum of Natural History in Pretoria, Gauteng. Skeletal elements were identified using established criteria such bone morphology.

Specimens that could not be confidently identified to taxa were designated as small, medium and large mammals (Klein 1976; Van-Pletzen 2000; Reynard *et al.* 2014). Mammal size can be inferred via the size and weight of identified elements, and the cortical thickness of long bones (Reynard *et al*. 2014). These mammalian size classes are correlated with bovid size classes, following Brain (1974), and are used when specimens are identified as bovid but not a particular bovid species.

3.5: Bovid and mammalian size class

Brain (1974) set out to identify bovid size classes for elements that could not be identified to species but have been confidently identified as bovid. Bovid size classes are normally used when analysing ungulate frequencies in an assemblage, but was not viable in this study, as many specimens could not be confidently identified as bovid. Bovid sizes were grouped with mammalian size classes for easier interpretation. Mammalian size classes were grouped into small, medium, and large mammals (Table 3.1). Small mammals are equal to size 1 and approximate the size of a common duiker, medium mammals are equal to size 2 and 3 mammals such as blesbok, wildebeest and roan antelope, large mammals are size 4 mammals such as buffalo and eland (Brain 1974; 1981). Here 'very large' or size 5 mammals are also included. Very large mammals in the sample are most likely to be extinct giant buffalo (*Syncerus antiquus*) based on Klein's (1976) analysis of the KRM fauna. The cortical thickness of unidentified long bones was also used to infer mammal size (following Reynard et al. 2014).

Table 3.1: Bovid size classes with equivalent mammalian size class, following Brain (1974) and Klein (1976).

Bovid size class	Mammalian size class equivalent	Live weight range	Examples of species
BOV I	Small	0-23kg	common duiker
BOV II	Medium	23-48kg	blesbok
BOV III	Medium	84-296kg	wildebeest, roan
BOV IV	Large	300-900kg	buffalo, eland
BOV V (Klein 1976)	Very large	>900 kg	long horned ('giant') buffalo

Table 3.2: The cortical thickness of unidentified long bones and associated mammalian size class (based on Reynard *et al.* 2014).

Mammalian size class	Long bone cortical thickness (*mm*)
Small mammal	<2
Medium mammal	2-5.9
Large mammal	6-19.9

3.6: Taphonomic analysis

To better understand the role of taphonomic agents in the faunal assemblage, an analysis of the surface modifications of bones in square A1 and C1 was carried out. This infers who or what accumulated the faunal remains, and how these remains were affected before and after deposition (Lyman 1994; Fisher 1995; Blumenschine *et al*. 1996; Faith 2013). Bones with a cortical surface were examined to assess surface condition, and anatomical part frequencies were recorded in the faunal database, along with the excavation date, plotted number, and layer for each specimen. Below, a description of the parameters used in assessing bone surface modifications is outlined in the order of surface preservation, fragmentation, fracture patterns, burning and bone surface modifications that have been caused by anthropogenic, zoogenic and natural taphonomic agents. Each type of bone surface modification in each category is briefly described with basic morphological characteristics used to diagnose the taphonomic agent.

3.6.1: Cortical surface preservation

The surface condition of the bones in the sample was analysed to infer taphonomic post-depositional processes. The specimens were divided into those that retained their cortical surface, and spongy bones, that are bones without a cortex (Morin 2010: 210). The presence of spongy bones may infer frequent episodes of post-depositional burning (Clark & Ligouis 2010). These specimens have been excluded from bone surface analysis and N values have been adjusted accordingly for this aspect of the analysis. Spongy bones have been included here to assess preservation levels in SBLS. Spongy bones were tallied separately from non-spongy bones when bones were studied for surface modification, as they are lacking a cortical surface. The sample analysed for taphonomic bone surface modifications therefore excludes spongy bones, which are again included when analysing burning patterns. Some bone surface modifications such as encrustation, abrasion and weathering can cover the cortex and negatively affect preservation but are also a way to study post-depositional site.formation processes (Behrensmeyer 1978). These types of modifications have been recorded based on how much of the bone surface is affected and are discussed in more detail in the sections below.

3.6.2: Fragmentation

The severity of fragmentation was calculated by measuring the weights and lengths of each specimen in the sample (Klein & Cruz-Uribe 1984; Lyman 2002, 2006), and by studying the breakage patterns on the ends of long bones (Johnson 1985). Previous studies (Reynard *et al*. 2014) have used the length of long bone mid-shaft fragments to assess fragmentation levels in faunal assemblages. Anthropogenic bone breakage often results in similar fragment lengths in different contexts (Villa & Mahieu 1991; Moclán & Domínguez-Rodrigo 2018). Each fragment was measured in millimetres (mm) using a digital calliper and assigned a fragment length code following Driver's (2005) coding scale (Appendix table A1.6). Fragmentary faunal remains can be used when studying site formation and identifying agents of accumulation (Madgwick 2014).

3.6.3: Fracture patterns

The physical state of bones, whether they are fresh, or whether they have been burned or boiled, affects fracture plane morphology (Bunn 1983; Villa & Mahieu 1991; Lyman 1994; Outram 2002; Moclán & Domínguez-Rodrigo 2018). The type of long bone fracture may indicate agents of accumulation, as well as infer post-depositional processes. Villa and Mahieu (1991) as well as Driver's (2005) criteria for diagnosing fracture patterns as eroded, irregular, transverse, or spiral, has been used in this study. Eroded fractures are edges that have been smoothed and rounded, resulting in a worn-out appearance on the edge of the fracture (Driver 2005: 30). Irregular fractures have a jagged or zig-zag appearance (Driver 2005: 30). Green or 'wet' breakage results in spiral or helical fractures a fracture pattern that forms an oblique angle (Villa & Mahieu 1991: 28; Driver 2005: 30). Dry, or transverse, bone breakage results in straight, 90-degree fractures due to the dried-out nature of the bone surface (Outram 2002: 53; Driver 2005: 30). Spiral fractures may appear 'V-shaped' (Driver 2005: 30).

3.6.4: Bone surface modifications

Anthropogenic, zoogenic, and natural BSM on bones in A1 and C1 were analysed. Burning was also analysed to interpret subsistence behaviour and hearth activity. Low frequencies of carnivore tooth marks and higher numbers of anthropogenically modified bones point to periods of higher occupational intensity (Marean *et al*. 2010; Reynard *et al*. 2016b; Thompson *et al*. 2017; Reynard & Henshilwood 2018; Dusseldorp & Reynard 2022).
The differences between hominin-versus-carnivore inflicted damage are now relatively well

understood, and many experimental studies have been undertaken to show differences in hominid and carnivore ravaging marks on bone (e.g., Noe-Nygaard 1977; Binford 1978; Blumenschine 1986; Blumenschine *et al*. 1996; Bartram & Marean 1999; Domínguez- Rodrigo *et al*. 2007, 2009; Moclán & Domínguez-Rodrigo 2018). Anthropogenic markings are caused by hominins and are a result of tool use or burning on bone, while zoogenic markings are caused by the teeth and digestive acids of scavenging animals (Fisher 1995). Microscopic analysis can usually differentiate anthropogenic and zoogenic markings based on criteria such as the shape and location of the bone surface modification (Blumenschine *et al.* 1996; Domínguez-Rodrigo *et al*. 2009; Blasco *et al*. 2014).

Pearson's correlation tests were used to test whether there are significant differences in the frequency of bone surface modifications between squares A1 and C1. This type of statistical analysis was chosen because it is "straight forward and intuitive" (Statistics Solutions 2023). Chi-squared tests are sensitive to sample size and are well suited to small samples (Statistics Solutions 2023). The effect size for Pearson's correlation measures the square root of X^2, divided by the sample size (Wolverton *et al*. 2016; Statistics Solutions 2023). When using statistical analyses in archaeology it is important to remember that these inferences may be trivial in the real world in isolation, the relationship between variables superficial (Cannon 2001; Wolverton *et al*. 2016). It is important to use these correlation tests in combination with an understanding of the taphonomic history of the site and being aware of the processes that have influenced the sample (Wolverton *et al*. 2016). Effect size and actualistic evidence should always be used in conjunction with statistical inferences to provide a meaningful analysis (Wolverton *et al*. 2016).

3.7: Burning

It is possible to distinguish anthropogenic burning from natural or accidental burning by the colour and surface condition of burned bone (Stiner *et al*. 1995; Cain 2005). Burning on bone from natural fire is superficial, only covers part of an element, and does not produce blackened or calcined (white or grey) bones (Cain 2005; Clark & Ligouis 2010). Burned bones found in association with hearths are unlikely to have been burned by natural fires (Clark & Ligouis 2010). Heat alteration was assessed based on colour and texture. Five burning stages were used to describe burned bones (Appendix table A1.1), based on Clark & Ligouis (2010: 2650). Moderately burned bones were coded as 0 and appear brown in colour. Localised burning (code 1) covers only part of the bone surface and is not evenly distributed. Blackened bones were coded as 2, grey bones were coded as 3, completely calcined or

whitened bones were coded as 4. Burning severity frequencies were recorded for both squares to compare burning intensity (Stiner *et al*. 1995). Moderately burned bones include all bones that exhibit brown, black and localised burning patterns, severely burned specimens are all bones exhibiting some form of calcination (Cain 2005; Clark & Ligouis 2010). Pearson's correlation tests were used to examine if any significant differences in burning frequencies exist between squares A1 and C1 (following Lam & Pearson 2005).

3.8: Anthropogenic bone surface modifications

Anthropogenic modifications include marks inflicted by activities such as cutting, chopping, scraping, marrow extraction and filleting (Binford 1981; Bunn 1981; Potts & Shipman 1981; Shipman & Rose 1983; Blumenschine & Selvaggio 1988; Noe-Nygaard 1989; Blumenschine *et al*. 1996; Fernández-Jalvo & Andrews 2016). Anthropogenic BSMs have been classified as cutmarks, slice marks, chop marks, percussion marks, filleting marks, scrape and saw marks. Cutmarks include filleting, slicing, sawing, and scraping marks, each possessing slightly different diagnostic features. Chop marks are linked to percussion and marrow extraction (Outram 2002; Fernández-Jalvo & Andrews 2016). A short description of different types of anthropogenic bone surface modifications is outlined below, with the basic morphological characteristics used to identify them.

Percussion marks appear with irregular striations often resulting from the slipping of a hammerstone upon the bone surface (Capaldo & Blumenschine 1994; Blumenschine *et al*. 1996; Fernández-Jalvo & Andrews 2016). They can appear as notches or pits (Fernández-Jalvo & Andrews 2016). They occur during marrow extraction (Blumenschine & Selvaggio 1988; Capaldo & Blumenschine 1994; Engeland 2003; Galán *et al*. 2009; De Juana & Domínguez-Rodrigo 2011). Percussion marks are classified as mild, moderate, or severe (Blumenschine *et al*. 1996; Fernández-Jalvo & Andrews 2016). Percussion pits have a high breadth/depth ratio, with smaller microstriations, and are orientated transverse to the long axis, occurring in dense superficial patches (Blumenschine *et al*. 1996). They are caused using hammer and anvil technology (Capaldo & Blumenschine 1994; Domínguez-Rodrigo *et al*. 2007) and are affected by bone morphology and placement of the blow (De Juana & Domínguez-Rodrigo 2011).

Animal size and bone density will affect the size of detached percussion flakes, larger percussed bone flakes are associated with larger animals (Galán *et al*. 2009). Percussion

notches appear as semi-circular perforations, with negative flake scars (Blumenschine & Selvaggio 1988; Capaldo & Blumenschine 1994; Fernández-Jalvo & Andrews 2016). They can be differentiated from carnivore tooth marks by their frequency, they occur more often than carnivore tooth marks and are broader and shallower than tooth marks (Capaldo & Blumenschine 1994). Percussion notches may be superficial but may penetrate underlying tissue, depending on the location of the blow (Fernández-Jalvo & Andrews 2016). Trampling can sometimes cause percussion like surface marks but can be distinguished based on the frequency and anatomical location of the markings, which when made by humans will be deliberately placed at specific locations on the bone (Fernández-Jalvo & Andrews 2016: 109).

Cutmarks are linear markings with a V-shaped cross section made by the movement of stone against bone (Fernández-Jalvo & Andrews 2016). They are often deep markings with longitudinal striations placed at the site of muscle attachments and tendons where tools were used to separate meat from bone (Binford 1981; Potts & Shipman 1981; Blumenschine *et al.* 1996; Dominguez-Rodrigo 1999a). Cutmarks are often clustered in subparallel groups (Binford 1981; Blumenschine *et al.* 1996). Micro cut-marks are caused when the sharp tool slips whilst in the cutting process, causing bumpy micro striations (Potts & Shipman 1981; Shipman & Rose 1983; Noe-Nygaard 1989: 472; Fernández-Jalvo & Andrews 2016). Cut marks lack crushing damage (Blumenschine *et al.* 1996) and exhibit low breadth and depth ratio for individual cuts/striae (Blumenschine *et al*. 1996). Cut marks that appear as parallel or sub-parallel bundles across the length of the bone are associated with filleting activity (Noe-Nygaard 1989: 484; Fernández-Jalvo & Andrews 2016). Slice marks are produced by drawing the edge of a sharp tool across the bone surface in a motion continuous with the long axis of the edge, creating fine, parallel striations (Potts & Shipman 1981; Shipman & Rose 1983).Scrape marks are linear markings that are generally quite broad and are caused by the transverse movement of stone parallel to the long axis of the bone in the process of removing skin, fibers, and muscle (Potts & Shipman 1981; Shipman & Rose 1983; Blumenschine *et al.* 1996; Fernández-Jalvo & Andrews 2016). They appear with ‘dimpling’ (Blumenschine *et al.* 1996). Sawing marks are intense cutmarks where the bone is deliberately made to break, usually indicated by several longitudinal marks crossing each other, as the tool is repeatedly moved parallel across its cutting edge upon the bone (Noe-Nygaard 1989; Fernández-Jalvo & Andrews 2016).

3.8.1: Cutmark intensity

Cutmark intensity is the number of cutmarks that occur on an individual bone specimen (Egeland 2003). Variation in cutmark intensities is correlated to factors such as animal body size (Lyman 1987, 1992; Lupo and O'Connell 2002), carcass accumulation strategies (Bunn *et al*. 1988; Marean *et al*. 2000), and individual butchery practices (Egeland 2003). Bone morphology also plays a role in cutmark intensity (Blumenschine *et al*. 1996). Cutmark intensity by individual element was measured by counting the number of specimens with one or more cutmarks, ranging from categories 1-4, 4 being the most severe and exhibiting 4 or more individual cutmarks, following Egeland's (2003) experimental study. It is important to note that cutmark representation is not a direct measure of cutmark intensity (Egeland 2003) because of taphonomic processes and agents that increase fragmentation and erase BSMs (Otárola-Castillo 2010). Cutmark intensity should be analysed in relation to other taphonomic factors to assess butchery intensity in archaeofaunal assemblages (Egeland *et al*. 2024). Actualistic studies in combination with high quality imaging and new technologies such as 3D artefact modelling can be used to better assess the intensity of cutmarks (Egeland *et al*. 2024).

3.9: Zoogenic bone surface modifications

Zoogenic modifications include carnivore gnawing, tooth marks, gastric etching, and deletion of elements (as done by hyaenas). Zoogenic alterations bear distinctive traces that can be differentiated from those produced by humans if studied carefully (Binford 1981; Blumenschine 1986; Noe-Nygaard 1989). Zoogenic modifications take the form of toothmarks, as pits (P) or scores (S), as well as gastric acid etching (GAE). They are marked as absent or present, ranging from mild (1), to moderate (2) to severe (3). A brief description of zoogenic bone surface modifications and their basic diagnostic criteria is provided below.

Insects are a common post depositional taphonomic agent at archaeological sites. Insects such as termites can perforate bone to variable extent (Backwell *et al*. 2012). Bones at numerous archaeological sites have evidence of termite damage, which take the form of star-shaped markings, gnawed edges and sub-parallel striations (Backwell *et al*. 2012). Termites can destroy bone in all stages of preservation, and highly favour thin cortical and spongy bone with some meat and marrow (Backwell *et al*. 2012: 72). Termites also build nests within bone and are known for displacing artefacts around their nesting sites (Backwell *et al*. 2012).

Insect damage to bone results bone surface modifications very different from anything of that made by carnivores or other microfauna (Fernández-Jalvo & Andrews 2016). These markings will not have a floor as they are not caused by individual teeth (Fernández-Jalvo & Andrews 2016).

Toothmarks are marks inflicted by the teeth of humans or other carnivores (Fisher 1995). However, toothmarks are most often caused by other animals. They take the form of pits or grooves. They can be morphologically distinguished from human butchery markings based on factors such as placement, frequency, depth, and what elements they are found (Noe-Nygaard 1989; Fisher 1995; Blumenschine *et al*. 1996; Dominguez-Rodrigo 1999). Tooth marks created by carnivores do not produce the fine parallel striations seen by slicing or cutting (Potts & Shipman 1981; Shipman & Rose 1983). They appear with a U-shaped cross section, appearing as pits, grooves, furrows, and punctures (Blumenschine *et al*. 1996). The internal surface of the bone will show crushing damage, whilst micro striations will be rare (Blumenschine *et al*. 1996). Gnawing is the work of animals, humans, or insects, who leave morphologically distinct patterns on the bone surface (Fisher 1995). Tooth scratches produce rounded perforations with rounded bases, whilst carnivore gnawing produces ones with flat bases (Potts & Shipman 1981). Rodent gnawing is caused by the incisors, which create flatter markings, often creating a similar marking on the other side of the bone resulting from the lower incisors (Fernández-Jalvo & Andrews 2016). Porcupines collect and destroy large bones as they are attracted to the calcium they contain (Skinner & Chimimba 2005).

The placement of toothmarks can also indicate carnivore activity, as they are usually placed at thick medullary and cortical surfaces (Blumenschine *et al*. 1996). GAE results from digestive enzymes or natural enzymes within soil or water. Denoted as 1 = present. Linear markings with a U-shaped cross section are generally the work of animals gnawing bone (Blumenschine *et al*. 1996; Fernández-Jalvo & Andrews 2016). It is important to distinguish between the different teeth (incisor, canine, molar etc) responsible for the markings as this can indicate the type of animal, or if it was inflicted anthropogenically Fernández-Jalvo & Andrews 2016). Canines and molars penetrate deeply into bone, producing conical pits (rounded perforations), and scores (flatter perforations), which arise from carnivore gripping and chewing (Fernández-Jalvo & Andrews 2016). These markings are broader on the surface and narrower internally (Fernández-Jalvo & Andrews 2016).

3.10: Trampling

Trampling is damaging force applied to the bone surface, caused by movement of humans and animals, or sediment compaction. Trampling can be classified as vertical or horizontal movement of the bone within the soil or when lying upon the surface (Olsen & Shipman 1988: 535). Trampling marks can often appear as cut marks, due to rocks scratching and cutting the bone surface because of trampling activity (Olsen & Shipman 1988). However, cut marks are usually far fewer in number, and occur at specific regions of the bone surface, often being parallel to the long axis of the bone, such as at the muscle attachments (Fernández-Jalvo & Andrews 2016). Trampling marks differ from cutmarks microscopically, and can be differentiated when studied carefully, with a trained eye (Domínguez-Rodrigo *et al*. 2009). Marks produced by trampling usually occur randomly across the bone surface (Domínguez-Rodrigo *et al*. 2009; Fernández-Jalvo & Andrews 2016). Trampling is classified as, 1 (mild); 2 (moderate, around ½ of surface); and 3 (severe, covers most of surface). Trampling is categorised as lines (L); pits (P) and scratches (S).

3.11: Natural modifications

Natural modifications occur post-depositionally and allow for an understanding of site formation processes (Behrensmeyer 1978; Lyman 1994). Natural modifications include any modifications caused by natural processes, such as soil chemistry, fluvial movement, sunlight, or plant activity such as root etching (Lyman 1987, 1994). Natural modifications analysed in this study include weathering, root etching, abrasion (polish), encrustation and staining. Natural modifications were marked as mild (1), moderate (2) or severe (3). Pearson's correlation tests were used to examine if any significant differences existed between naturally modified specimens in squares A1 and C1, but only where frequencies were high enough to examine differences.

Behrensmeyer (1978) defines weathering as the destruction of bone surfaces caused by natural chemical processes taking place within the soil and surface of the deposit. Weathering damage is not the same as damage from trampling, fluvial movement, and geochemical processes. Bones can become more weathered when exposed to air than when buried *in situ*, and in some cases, bones can be more affected by weathering in the soils (Behrensmeyer 1978).

Root etching occurs when the roots of plants grow against the bone surface. According to

Fisher (1995), it is relatively easy to identify these markings. They are classified as: 1 (mild, only one marking usually); 2 (moderate, covers half the surface); and 3 (severe, covers most of the surface). Root etching produces linear markings, as well as conical, smoothly rounded perforations upon the bone surface (Fernández-Jalvo & Andrews 2016).Abrasion, or sheen, is generally regarded as any amount of rounding or polishing upon the bone surface, and can occur at the ends as well as the shaft, and can take place upon complete or incomplete bones (Behrensmeyer 1978; Madgwick 2014; Fernández-Jalvo & Andrews 2016). It can occur due to being used anthropogenically as a tool (Fisher 1995) or can occur naturally due to transport and trampling (Madgwick 2014; Fernández-Jalvo & Andrews 2016). It is difficult to tell natural abrasion apart from intentional abrasion, but usually a high level of polish indicates human activity (Madgwick 2014). Abrasion associated with anthropogenic trampling is referred to as polish in this study. Sheen intensity was measured by grouping polished specimens into categories of 1-4, increasing in severity based on how much of the bone surface was polished.

Sediments such as salt or sand may become embedded in the bone surface over time, resulting in encrustation (Behrensmeyer 1978). Encrustation was catalogued as: 1 (mild, < ½), 2 (moderate, ½ - ¾) and 3 (severe > ¾), depending on how much of the bone was encrusted. Waterlogging is denoted a 1 = present. Gypsum encrustation is common in salty sediments, and may point to cycles of waterlogging and drying, as the crystals require both moisture and dryness to grow (Behrensmeyer 1978; Clark & Ligouis 2010).

Staining may be a result of burning, or exposure to environmental factors such as acids, water, and oxygen (Fernández-Jalvo & Andrews 2016). Manganese staining is usually indicated by a uniform darker colour across the bone surface and was denoted as either 1 (small spots present); or 2 (covers most of surface). It can indicate soil conditions and speed of burial, but this can sometimes be misleading. Colour can naturally vary according to species and age of an animal (Fernández-Jalvo & Andrews 2016). Burning can also affect the colour of bones (Shipman *et al*. 1984; Stiner *et al*. 1995; Cain 2005; Clark & Ligouis 2010).

3.12: Summary

The methods used in this study are widely used in taphonomic studies (Bunn et al. 1988; Blumenschine & Selvaggio 1988; Turner 1989; Capaldo & Blumenschine 1994; Cain 2005; Domínguez-Rodrigo *et al*. 2007; Clark 2011; Thompson & Henshilwood 2011; Faith 2013; Reynard *et al*. 2014, 2016a; Thompson *et al*. 2017) and are standardised methods of inferring

taphonomic agents in prehistoric faunal assemblages. Methods of analysis will always have disadvantages but can be generally used to create sound inferences regarding subsistence activity in archaeological faunas.

Chapter 4: Results

This chapter reports on the results of the taphonomic and taxonomic analysis of faunal material excavated from SBLS squares A1 and C1 during the 2020 and 2022 excavation seasons. The taphonomic data is also used to analyse site formation processes. First, the sample is quantified and expressed in terms of lengths, weights and the number of individual specimens (Table 4.1). A list of identified species is provided for each square (Table 4.2), followed by a list of skeletal elements by NISP count (Table 4.5). The results of the taphonomic analyses follow next, which covers anthropogenic, zoogenic and natural bone surface modifications.

4.1: Sample

The faunal sample is highly fragmentary, with most specimens in A1 and C1 measuring around 20-30 mm (Table 4.12; Figure 4.5). The total sample (N) includes all specimens that were identified to element or more than 2cm in length. The coarse material consists of all bones <2cm that could not be identified to element (Table 4.1). The frequencies of identified specimens in squares A1 and C1 are similar (Table 4.1). In A1, bones identified to skeletal element equate to 5.8% (n=105) of the grand total of recovered faunal specimens (N=1808; Table 4.1). In C1, the total number of identified specimens is equal to 5.2% (n=91) of the total sample (N=1741). Bones that measure less than 2cm have been purposefully excluded from the sample used in the taphonomic and taxonomic analyses. Therefore, in A1, the sample total (N) is equal to 311 which equates to 17.2% of the grand total of specimens (N=1808). In C1, the taphonomic sample (N) is equal to 208 specimens, which comprises 11.9% of the grand total of recovered specimens in this square (N=1741).

When combined, specimens deemed viable for analysis from the A1 and C1 sample (n=519) make up 15.5% of the grand total of recovered specimens for both squares (N=3341;Table 4.1) There is a total of 24 specimens without cortical surfaces in each square (spongy bones), which have not been included in the analyses of bone surface modifications. Therefore, in relation to bone surface modification, N=287 (311-24) in square A1, and N=184 (208-24) in square C1 (Table 4.11). Spongy bones will be included when analysing burning patterns in A1 and C1, and the frequencies of burned specimens will be compared to the total sample (N) in each square. The faunal density is provided for each square and is expressed as kg/m^3. The excavated sediment comes from the portions of SBLS that were excavated in 2020 and 2022.

The total volume of excavated sediment in A1 is equal to 0.0290m^3 and 0.0275m^3 in C1. The combined volume for the material excavated from these squares is equal to 0.0565m^3 (Table 4.1).

Table 4.1: Summary of identified and non-identified specimens in squares A1 and C1 in SBLS.

Square	Total no. of recovered specimens	Non-identifiable bones <2cm (%)	Sample analysed >2cm (%)	NISP (%)	Weight (g)	Volume (m^3)	Faunal density (kg/m^3)
A1	1808 (100)	1500 (82.9)	311 (17.2)	105	2376.5	0.0290	82.07
C1	1741 (100)	1533 (88.1)	208 (11.9)	91	1408.5	0.0275	51.3
Total	**3341 (100)**	**3033 (90.8)**	**519 (15.5)**	**196**	**3785**	**0.0565**	**133.4**

4.2: Quantification

4.2.1: NISP according to identified taxa

The NISP for identified species in A1 and C1 is equal to 23 and 19 respectively. Cape fur seal, African penguin, angulate tortoise, and eland have been identified in both squares. There is one porcupine specimen identified in A1 (Table 4.2). An indeterminate small carnivore species is present in A1 and in C1. A1 contains four specimens of an unidentified bird species, and one fish bone belonging to an indeterminate species. A1 also contains one specimen of an unidentified suid species, and one bushbuck (*Tragelaphus scriptus*) specimen. C1 contains two specimens of common duiker (*Sylvicapra grimmia*). There is one identified *Syncerus antiquus* (extinct long horned/giant buffalo) in each square. These were identified based on the comparative faunal collection at the Ditsong Museum of Natural History. Giant buffalo was also identified based on teeth. Identified teeth significantly larger than modern buffalo (*Syncerus africanus*) size were identified as giant buffalo (*Syncerus antiquus*).

Table 4.2: Specimens identified to taxa with NISP count in squares A1 and C1 in SBLS.

Identified species			NISP n (%)	
Order	**Taxa**	**Common name**	**A1**	**C1**
Artiodactyla	*Connochaetes taurinus*	Blue wildebeest	1 (0.3)	-
	Sylvicapra grimmia	Common duiker	-	2 (1.0)
	Tragelaphus scriptus	Bushbuck	1 (0.3)	1(0.5)
Carnivora	*Artocephalus pusillus*	Cape fur seal	4 (1.3)	1(0.5)
	Indeterminate	Carnivore indet.	1 (0.3)	2 (1.0)
Rodenta	*Hystrix africaeaustralis*	Porcupine	1 (0.3)	-
Ruminata	*Tragelaphus oryx*	Common eland	1 (0.3)	3 (1.4)
	Syncerus africanus	African buffalo	-	2 (1.0)
	Syncerus antiquus	Giant buffalo	1 (0.3)	1 (0.5)
Sphenisciformes	*Spheniscus demersus*	African penguin	3 (1.0)	1 (0.5)
Squamata	Indeterminate	Reptile indet.	-	2 (1.0)
Suidae	Indeterminate	Suid indet.	1 (0.3)	-
Testudines	*Chersina angulata*	Angulate tortoise	4 (1.3)	4 (1.9)
Osteichthyes	Indeterminate	Fish indet.	1(0.3)	-
Passeriformes	Indeterminate	Bird idet.	4 (1.3)	-
		Total NISP (%)	**23 (7.4)**	**19 (9.1)**
		Total sample N (%)	**311 (100)**	**208 (100)**

4.2.2: NISP according to mammalian size class

The table below summarises the NISP grouped into mammalian size classes. In both square A1 and C1, size 2 mammals are the most well represented (A1 n=23; C1 n=24), most likely represented by small bovids. Mammal sizes are equivalent to bovid sizes in this study. The size range of mammals is diverse, with small (size 1-2), medium (size 3) and large mammals (size 4 and upwards) being present. The representation of mammal sizes is relatively uniform in A1 and C1. Though these mammals cannot be identified to species, the identified size classes show a variety of different sized mammals being introduced to the site. There is a similar number of large (size 4) mammals (A1 n=13; C1 n=15) and small (size 1) mammals (A1 n=16; C1 n=15) in the sample, different subsistence strategies were potentially being utilised to capture both small and large prey.

Table 4.3: NISP according to mammalian size class in squares A1 and C1 in SBLS.

Square	Size 1	1/2	Size 2	2/3	Size 3	3/4	Size 4	4/5	Size 5
A1	16	5	23	11	18	13	13	6	0
C1	15	0	24	0	17	9	15	4	1

4.2.3: Mortality age profiles

Adult to juvenile representation is highly similar in squares A1 and C1 these squares. Spongy bones were not included in age profiling, as the lack of surface condition or any diagnostic features of these bones makes confident age estimate very difficult. The table below summarises the numbers of adults and juveniles found in the sample. The ratio of adults (A1 n=243; C1 n=159) and juveniles (A1 n=44; C1 n=33) are highly similar in both squares. Both square samples have more adults than juveniles.

Table 4.4: Specimens identified as adult or juvenile in squares A1 and C1 in SBLS.

Square	Adults n (%)	Juveniles n (%)	Sample N (%)
A1	243 (84.7)	44 (15.3)	**311 (100)**
C1	159 (86.4)	33 (17.9)	**208 (100)**

4.2.4: NISP according to skeletal element

The total NISP for specimens identified to element and mammalian size class is equal to 105 in A1, and 91 in C1 (Table 4.1; 4.5), which equate to 5.8% and 5.2% of the total number of recovered specimens by square, respectively. When the total number of specimens in A1 and C1 are combined (N=519), identified specimens are equal to 5.9% of the sample total (Table 4.1). The most represented elements in square A1 and C1 are rib shafts (A1 n=37; C1 n=28), cranial fragments (A1 n=23; C1 n=29), and teeth (A1 n=10; C1 n=6). Long bone elements are not well represented in either square (Table 4.9). There is one innominate specimen in A1, and none in C1. Cranial elements are well represented in both squares (A1 n=22; C1 n=19), while there is a lack of high-utility, meat bearing long bones. The high numbers of cranial bones would represent the Klasies pattern if in combination with a high number of foot bones, such as phalanges. However, these foot bones are not well represented, as with all hind and fore limbs in the sample, and so it cannot be said that the assemblage fully resembles the Klasies pattern. Bone density related attrition is not enough to explain the element representation in square A1 and C1, as vertebra (A1 n=16; C1 n=8) are better represented than dense elements such as phalanges (A1 n=8; C1 n=3).

Table 4.5: NISP count and mammalian size class by skeletal element in squares A1 and C1 in SBLS.

A1 Element	Size 1	1/2	Size 2	2/3	Size 3	3/4	Size 4	4/5	Size 5	NISP n (%)
Cranium			2	3	1	2	1			9 (2.9)
Mandible			1	1			1			3 (1.0)
Teeth	2		1	1		2	3	1		10 (3.2)
Skull										**22 (7.1)**
Ribs	6	4	9	3	4	8	2	2		38 (12.2)
Vertebra	2	0	3	1	7	1	1	1		16 (5.1)
Axial										**54 (17.4)**
Carpal			2							2 (0.6)
Humerus			1	1			1			3 (1.0)
Metacarpal							1			1 (0.3)
Radius										-
Ulna				1						1 (0.3)
Fore limbs										**7 (2.2)**
Pelvis		1								**1 (0.3)**
Astragalus										-
Calcaneum	1		1		1					3 (1.0)
Femur	1									1 (0.3)
Metatarsal										-
Patella								1		1 (0.3)
Tarsal					1					1 (0.3)
Tibia	1				1					2 (0.6)
Metapodial			1		1		1			3 (1.0)
Phalange	3		2		1		1	1		8 (2.6)
Sesamoid					1		1			2 (0.6)
Hind limbs										**21 (6.8)**
Total NISP (%)										**105 (33.8)**
Total sample N (%)										**311 (100)**
C1 **Element**	**Size 1**	**1/2**	**Size 2**	**2/3**	**Size 3**	**3/4**	**Size 4**	**4/5**	**Size 5**	**NISP n (%)**
Cranial	1				6		2			9 (4.3)
Mandible	1								1	2 (1.0)
Teeth	1		1			1	3			6 (2.9)
Horn core						2				2 (1.0)
Skull										**19 (9.1)**
Ribs	3		13		5		4	3		28 (13.5)
Vertebra	2		3		2	1				8 (3.4)
Axial										**36 (17.3)**
Carpal					1					1 (0.5)
Humerus			1		1					2 (1.0)
Metacarpal	1				1	5				6 (2.9)
Radius	6				1					7 (3.4)
Ulna										-
Fore limbs										**17 (8.2)**
Pelvis										**-**

Astragalus										-
Calcaneum										-
Femur			1							1 (0.5)
Metatarsal										-
Patella										-
Tarsal	2		1							3 (1.4)
Tibia			3				2			5 (2.4)
Metapodial	3						2			5 (2.4)
Phalange	1		1					1		3 (1.4)
Sesamoid							2			2 (1.0)
Hind limbs										**19 (9.1)**
Total NISP (%)										**91 (43.7)**
Total sample N (%)										**208 (100)**

4.2.5: Skeletal part profiles by mammalian size class

4.2.5.1: Square A1

Table 4.6 summarises identified skeletal elements that have been classed as small, medium or large mammals in square A1 in SBLS. Cranial and axial elements are well represented, and meat bearing limb bones are underrepresented. The assemblage in square A1 is mostly made up of medium sized mammals (n=65). Small mammals are secondly most represented (n=21), and large mammals follow behind (n=19). The frequencies of skeletal part representation are calculated in comparison to the total number of identified elements in the sample (A1 n=105; C1 n=91). Percentages have been rounded up to the nearest whole for Figure 4.1 and 4.2. See tables 4.5 and 4.6 for actual frequency.

Table 4.6: Skeletal parts and mammalian size class in square A1 in SBLS.

Square A1				
Skeletal part	**Mammalian size class NISP (%)**			**Skeletal parts in sample N (%)**
	Small	**Medium**	**Large**	
Skull	2 (1.9)	14 (13.3)	6 (5.7)	22 (20.9)
Axial	12 (11.4)	36 (34.3)	6 (5.7)	54 (50.9)
Fore limbs	0 (0)	5 (4.8)	2 (1.9)	7 (6.6)
Pelvis	1 (0.9)	0 (0)	0 (0)	1 (0.9)
Hind limbs	3 (2.9)	4 (3.8)	1 (0.9)	8 (7.5)
Distal limbs	3 (2.9)	6 (5.7)	4 (3.8)	13 (12.3)
Total NISP (%)	**21 (20.0)**	**65 (61.9)**	**19 (18.1)**	**105 (100)**

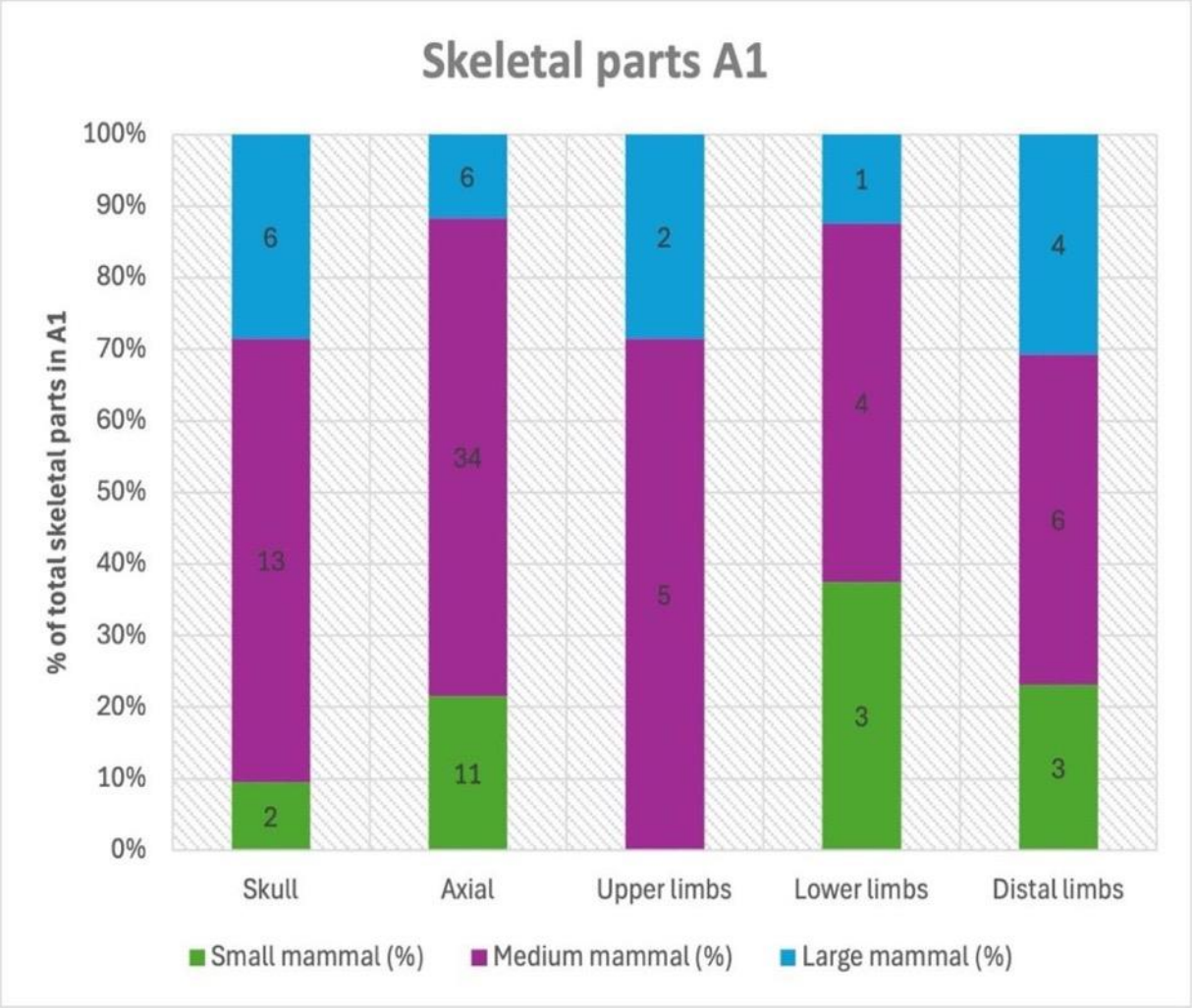


Figure 4.1: Skeletal parts in square A1 assigned to mammalian size class. NISP in columns.

In square A1, cranial fragments are the most common type of skeletal element identified across all size classes, with most cranial bones belonging to medium sized mammals (Figure 4.1). Axial elements were the second most common element, limb bones were not highly represented in any size class. There were no upper limbs belonging to small mammals, there are more large mammal limbs in A1. Large mammals were not highly represented in this square and are most often identified as cranial and axial fragments.

4.2.5.2: Square C1

In square C1, cranial and axial fragments are well represented, as discussed in the previous section. There is a higher number of upper limb bones found in this square (n=17) than in A1 (n=7). All skeletal parts are best represented by medium sized mammals (n=50) as shownbelow (Table 4.7) in C1. This is followed by small mammals (n=21), and finally by large mammals (n=20). The frequencies of small, medium and large mammals are relatively

similar in A1 and C1, both squares contain more medium sized mammals than small or large ones.

Table 4.7: Skeletal part and mammalian size class in square C1 in SBLS.

Square C1				
Skeletal part	**Mammalian size class NISP (%)**			**Skeletal parts in sample N (%)**
	Small	**Medium**	**Large**	
Skull	3 (3.3)	10 (11.0)	6 (6.6)	19 (20.9)
Axial	5 (5.5)	24 (26.4)	7 (7.7)	36 (39.6)
Fore limbs	7 (7.7)	10 (11.0)	0 (0)	17 (18.7)
Pelvis	-	-	-	-
Hind limbs	2 (2.2)	5 (5.5)	2 (2.2)	9 (9.9)
Distal limbs	4 (4.4)	1 (1.1)	5 (5.5)	10 (0)
Total NISP (%)	**21 (23.1)**	**50 (54.9)**	**20 (21.9)**	**91 (100)**

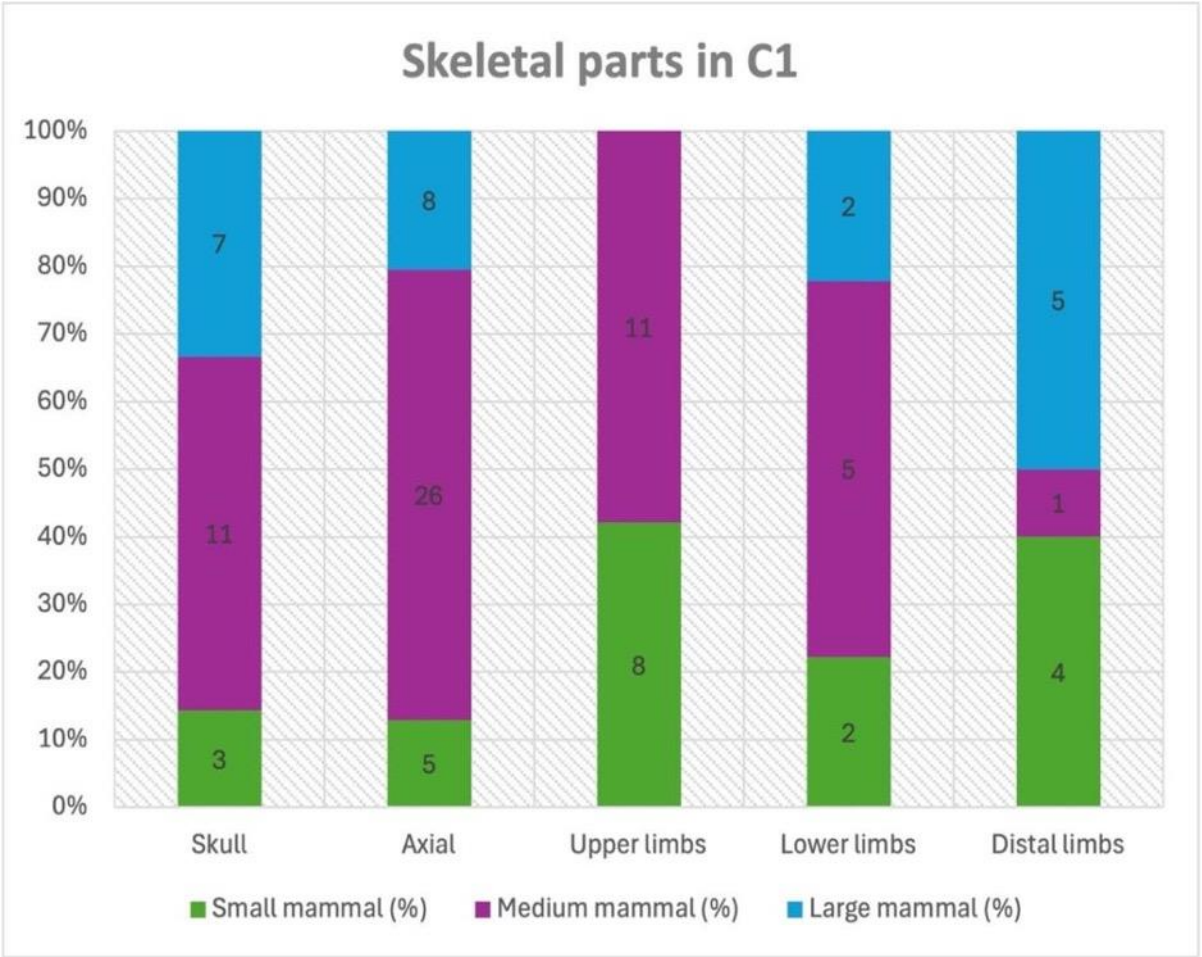


Figure 4.2: Skeletal parts in square C1 in SBLS assigned to mammalian size class. NISP in columns.

In square C1, medium mammals are the most common, and are mostly represented by

cranial, axial and upper limb bones. Small mammals are best represented by upper limb bones. Large mammals are most identified by axial elements. Distal limbs are not common, mostly belonging to large mammals (5% of NISP = 109).

4.2.6: Mammalian size class by unidentified long bone cortical thickness

The cortical thickness of unidentified long bone fragments has been measured according to Driver's (2005) method, and have been classed as small, medium or large mammals based on these measurements (following Reynard *et al.* 2014). In both squares, the best represented cortical thickness measurement is between 2 and 5.9mm (Table 4.8), which equates to medium sized mammals (Reynard *et al.* 2014). There are two specimens with a cortical thickness equating to large mammal size (CT = 6-19.9mm) in A1 (Appendix table A1.6). Long bones with a cortical thickness measuring 2-3.9mm are the most common in C1. There is one large mammal specimen with a cortical thickness of 6-7.9mm in C1. There are no unidentified long bones with a cortical thickness exceeding level 4 in either square A1 or C1.

Table 4.8: Mammalian size class based on unidentified long bone cortical thickness in squares A1 and C1 in SBLS (after Reynard et al. 2014).

Square	**Mammal size class by unidentified long bone cortical thickness (*mm*)**			**Total N (%)**
	Small mammal (%)	**Medium mammal (%)**	**Large mammal (%)**	
A1	2 (8)	21 (84)	2 (8)	**25 (100)**
C1	-	19 (95)	1 (5)	**20 (100)**

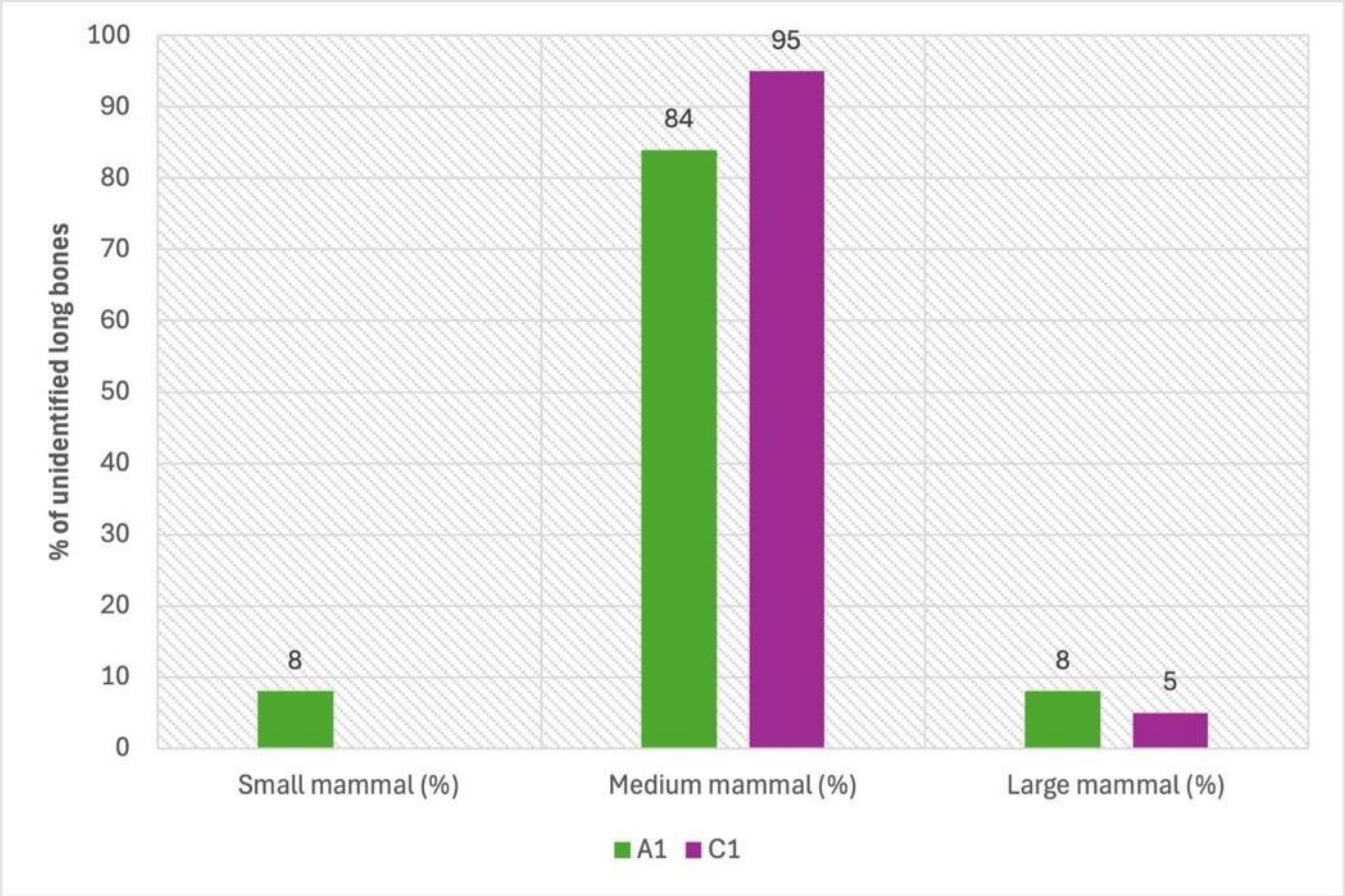


Figure 4.3: Unidentified long bones in squares A1 and C1 in SBLS assigned to mammalian size class via cortical thickness measurement (mm). Frequencies above columns.

The cortical thickness measurements of unidentified long bones in squares A1 and C1 show that most of these unidentified specimens belong to medium sized mammals (following Reynard *et al*. 2014). Small mammals are not well represented when using this method and are not present in C1 when using the cortical thickness of unidentified long bones in this square. The frequencies (A1 = 84%; C1 = 95%) of medium sized mammals in A1 and C1, according to cortical thickness, are relatively similar (Figure 4.3). Square A1 and C1 contain equal frequencies of small and large mammals according to unidentified long bone cortical thickness (Table 4.8). The results of these measurements correlate with the rest of the sample which suggest that the sample is best represented by medium sized mammals in both squares.

4.2.7: Unidentified and identified long bones and mammalian size class

Unidentified (non-ID) and identified long bones (ID) have been used to infer mammalian size classes in square A1 and C1. In both squares, identified and unidentified long bones, are best represented by medium sized mammals (Table 4.9). The frequencies of long bones to non-long bones are calculated by square (A1 N=311; C1 N=208). The last row represents the total (N) for the combined A1 and C1 sample (N=519) and the combined frequency of long bones to non-long bones in the total sample. In A1 and C1 long bones (ID and non-ID) are not as well represented as other elements (Table 4.9), but square C1 contains slightly more long bones than A1 (Figure 4.4).

Table 4.9: The proportion of identified long bones to other skeletal elements (non-LB) in squares A1 and C1 in SBLS.

Square	Long bone n (%)	Non-LB n (%)	Sample N (%)
A1	44 (14.1)	267 (85.5)	**311 (100)**
C1	52 (25.0)	156 (75.0)	**208 (100)**
Total N (%)	**96 (18.5)**	**423 (81.5)**	**519 (100)**

Table 4.10: Identified (ID) and non-identified (non-ID) long bones assigned to mammalian size class in squares A1 and C1 in SBLS.

Square	ID long bone			Non-ID long bone		
	Small n (%)	Medium n (%)	Large n (%)	Small n (%)	Medium n (%)	Large n (%)
A1	5 (1.6)	9 (2.9)	5 (1.6)	2 (0.6)	21 (6.7)	2 (0.6)
C1	14 (6.8)	11 (5.3)	7 (3.4)	-	19 (9.1)	1 (0.5)

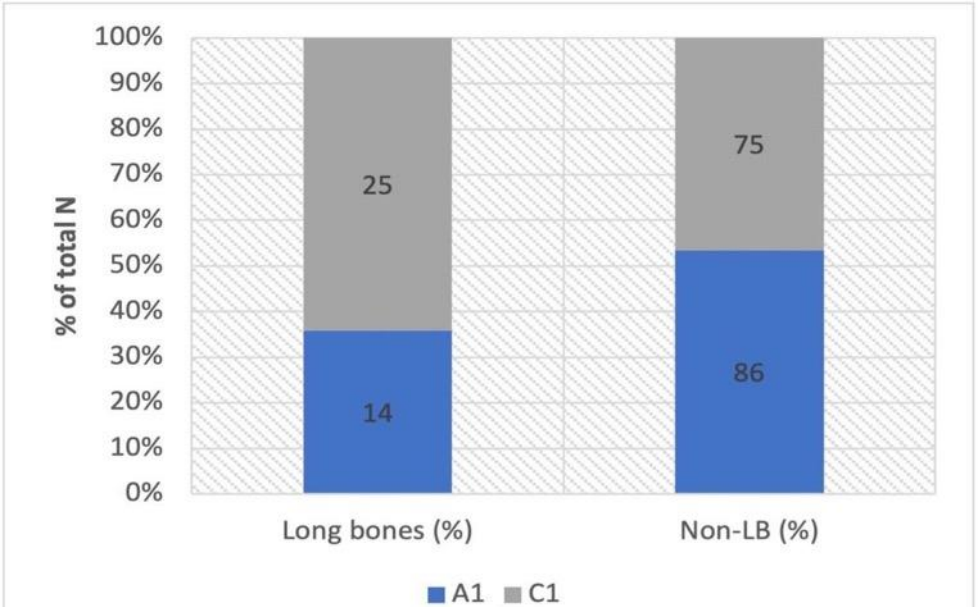


Figure 4.4: The representation of long bones to other elements (non-LB) in squares A1 and C1 in SBLS. Percentages rounded to nearest whole number.

The proportions of long bones relative to other elements is relatively similar in each square (Table 4.9), but there are more long bones present in C1 (n=52) than in A1 (n=44). A1 has a slightly larger sample size (N=311) than C1 (N=208), when compared, long bones are better preserved in square C1.

4.3: Taphonomic analysis

4.3.1: Preservation

The sample analysed in this study is made up of specimens >2cm and specimens that can be identified to skeletal element (A1 N=311; C1 N=208). Specimens that are smaller than 2cm in length as well as unidentifiable to element have been purposefully excluded and counted as coarse fraction (Table 4.1). The surface condition of the specimens in this sample were analysed to post-depositional processes that may have affected bone preservation (Behrensmeyer 1978; Behrensmeyer *et al*. 2000), as well as inferring taphonomic agents based on the type of modifications (anthropogenic, zoogenic or abiotic). The table below (4.11) has been provided to show the proportion of spongy bones to the rest of the sample used in studying bone surface modifications. The surface condition of bones in these squares do not indicate any corrosion due to natural chemical processes, such as manganese staining or gastric acid etching (GAE), as these modifications only occur in very low frequencies (Table 4.29).

Table 4.11: Specimens viable for BSM analysis in squares A1 and C1 in SBLS.

Square	Total sample N (%)	Spongy bones N (%)	Specimens with cortical surface N (%)
A1	311 (59.9)	24 (7.7)	287 (55.3)
C1	208 (40.1)	24 (11.5)	184 (35.4)
Total sample N (%)	**519 (100)**	**48 (9.2)**	**471 (90.7)**

4.3.2: Fragmentation

The NISP divided by the total number of fragments in each square is <1% (Table 4.12). Fragments in A1 and in C1 are similar in length, the average length in A1 is 31.9mm and 30.4mm in C1. Generally, both squares contain a similar amount of faunal material, and the fragmentation levels appears similar in terms of the length and weight of individual specimens. The median value for both squares is also almost exact, with a median length of 28.7mm in A1, and 28.0mm in C1. The range of fragment lengths is equal to 87.9mm in A1, and 137.6mm in C1. The measurements of bone fragments in A1 and C1 are highly similar.

Table 4.12: Summarised measurements of specimens in squares A1 and C1 in SBLS.

Square	Total no. of specimens by layer	Total sample N (%)	Total weight per square (*g*)	Average weight per specimen (*g*)	Average length (*mm*)	Median length (*mm*)	Length range (*mm*)	NISP/total no. fragments
A1	**1808 (100)**	**311 (17.2)**	2376. 5	1.31	31.9	28.7	87.9	0.0492
C1	**1741 (100)**	**208 (11.9)**	1408.5	0.81	30.4	28.0	137.6	0.0470

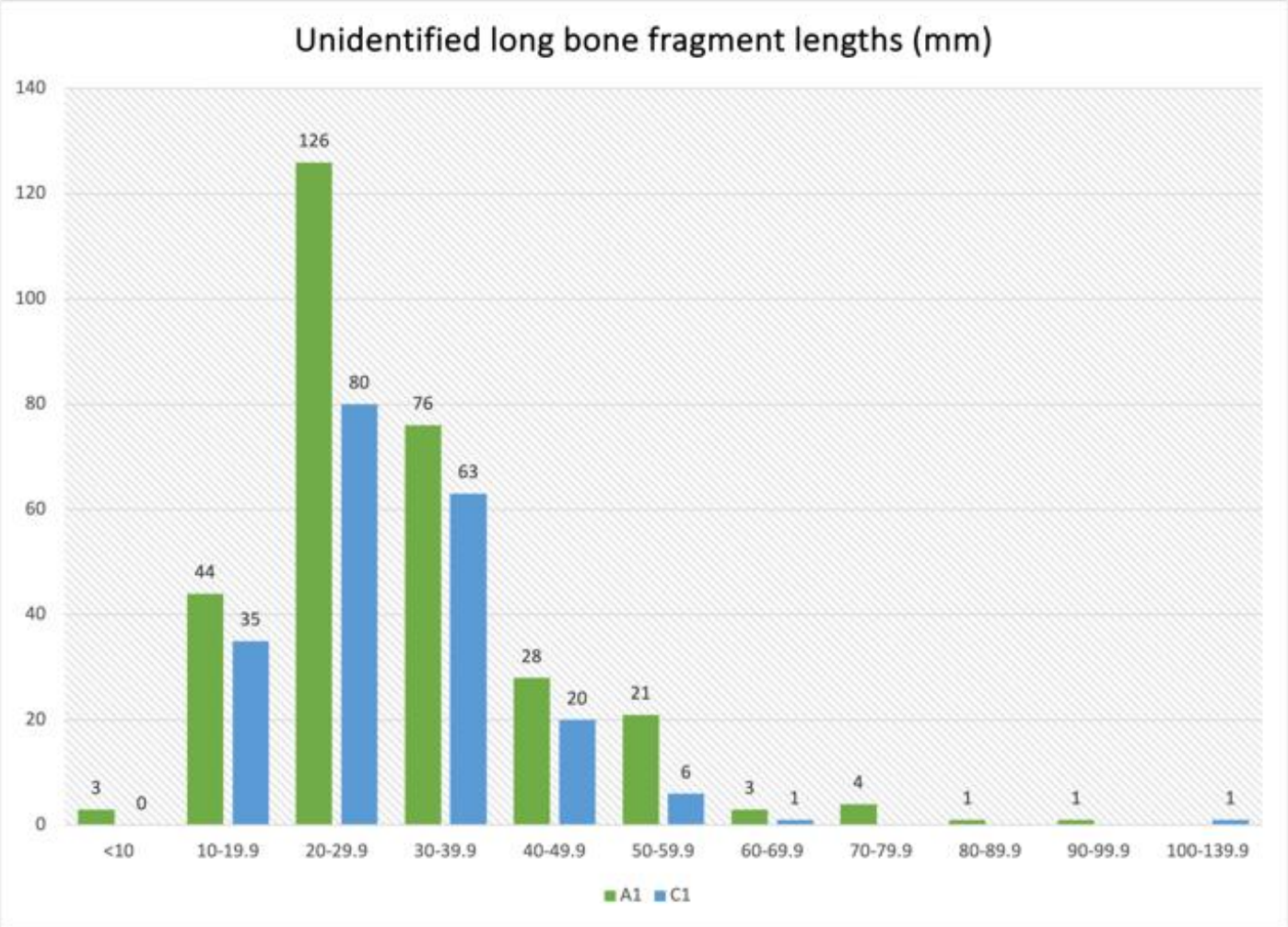


Figure 4.5: The lengths (mm) of all bone specimens in the sample in squares A1 and C1 in SBLS.

Most of the bone fragments in the A1 and C1 sample measure around 20-29.9mm (Figure 4.5). Fragments measuring 30-39.9mm are also well represented. There are two individual fragments in each square that measure 90-99.9mm. Overall, the size of bone fragments in A1 and in C1 are very similar, with the average fragment being equal to 31.9mm in A1, and 30.4mm in C1.

4.3.3: Long bone breakage patterns

Table 4.13 summarises the type of breakage patterns recorded on all long bone specimens in square A1 and C1 in SBLS. The frequencies below are calculated in relation to the number of identified (ID) and unidentified (non-ID) long bone ends in the sample (A1n=72; C1 n=114). Spiral fractures are the most common breakage patterns on long bone in A1 (n=44; 61.1%) and in C1 (n=87; 76.3). Transverse fractures are the second most represented type of long bone breakage in A1 (n=10; 13.9%) and C1 (n=19; 16.7%).

Table 4.13: Long bone breakage patterns (ID & non-ID) in square A1 and C1 in SBLS.

Square	**Breakage pattern**				**No. of long bone ends in sample n (%)**	**Total sample N (%)**
	Spiral n (%)	**Transverse n (%)**	**Irregular n (%)**	**Eroded n (%)**		
A1	44 (61.1)	10 (13.9)	9 (12.5)	9 (12.5)	**72 (100)**	**311 (100)**
C1	87 (76.3)	19 (16.7)	0 (0)	8 (7.0)	**114 (100)**	**208 (100)**

4.4: Bone surface modifications

4.4.1: Burning

In A1, 30.2% (n=94) of bones in the total sample (N=311) are burned (Table 4.14). The most common type of burning is brown burning which represents 15.8% (n=49) of the total sample this square. Localised burning is second most represented, equating to 9% (n=28) the A1 sample. Severe burning (black, grey and white) is not highly represented. There is one calcined or whitened specimen in A1. In C1, 55.3% (n=115) of the bones in the sample (N=208) are burned. The most common type of burning in C1 is brown, representing 28.4% (n= 59) of bones in this square. Localised burning is the second most common type of burning and represents 14.9% (n=31) of bones in the C1 sample. There are no calcined

bones in C1, but this square does contain higher numbers of blackened bone than in A1. In both A1 and C1, the most represented burning pattern is burned brown (level 0). This is followed by localised burning (level 1). C1 contains a higher number of burned bone than A1. In A1 and C1, mild to moderate burning (levels 0-1) is most common, while severe burning is not as well represented. Pearson's correlation test indicates that there is a significant difference in burning frequencies between square A1 and C1 (χ^2=32.551; df = 1; p< 0.001). Out of the combined total sample for square A1 and C1 (N=519), burned bones are equivalent to 40.3% (N=209).

Table 4.14: Burning patterns in squares A1 and C1 in SBLS.

Square	**Burning stages**					**No. of burnt remains n (%)**	**Total number of specimens N**	**% of sample total**
	Brown n (%)	**Localised n (%)**	**Black n (%)**	**Grey n (%)**	**White n (%)**			
A1	49 (15.8)	28 (9.0)	11 (3.5)	5 (1.6)	1 (0.3)	**94 (100)**	**311**	**30.2**
C1	59 (28.4)	31 (14.9)	23 (11.1)	2 (0.9)	0 (0)	**115 (100)**	**208**	**55.3**
Total N (%)	**108**	**59**	**34**	**7**	**1**	**209 (100)**	**519**	**40.3**

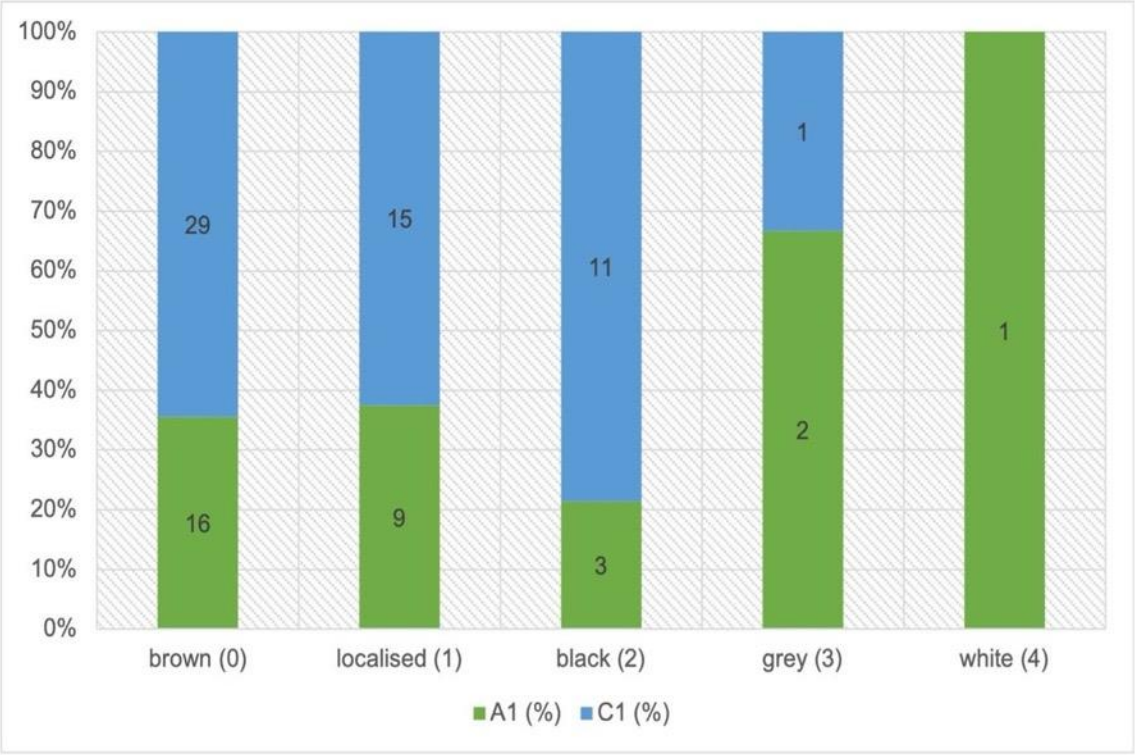


Figure 4.6: Burning patterns in squares A1 and C1 in SBLS.

Overall, there are more burned bones in square C1. In both squares, mild to moderate (0-2) burning is the most common, most bones are burned brown and exhibit localised burning (Figure 4.6). Square C1 contains the most blackened bones (11%; n=23). A1 contains the only calcined specimen in the sample. Burning patterns in each square are similar.

4.4.2: Burning intensity

In square A1, 28.3% (n=88) of the total sample (N=311) exhibit mild to moderate burning patterns. See appendix B (B1.5) for an example of a blackened and encrusted bone in square C1. Here, severely burned bones are all bones that are burned grey and white. Spongy bones are also indicative of frequent burning activity (Clark & Ligouis 2010), and there are a number of these in each square (Table 4.11). Most bones in square A1 and C1 are moderately burned, severe burning is not highly represented, equating to 1.5% of the total sample (N=519). This may be due to taphonomic factors, as severely burned bones are fragile and not likely to survive post-depositional fragmentation (Clark & Ligouis 2010). A Pearson's correlation test indicates that there is no significant difference in burning intensity between square A1 and C1 (χ^2=0.430; df=1; p= .51195).

Table 4.15: Burning intensity (following Stiner et al. 1995) in squares A1 and C1 in SBLS.

Burning intensity level	A1 (%)	C1 (%)	Grand total burned specimens N (%)
Moderately burned (0-2)	88 (28.3)	113 (54.3)	201 (38.7)
Severely burned (3-4)	6 (1.9)	2 (1.0)	8 (1.5)
Total burned specimens N (%)	**94 (30.2)**	**115 (55.3)**	**209 (40.3)**

4.4.3: Anthropogenic bone surface modification

A total of 287 specimens from A1 and 184 specimens from C1 were assessed for BSM (Table 4.16). Anthropogenic modifications are well-represented in both squares. In A1, 25.1% of all bones with a cortical surface (n= 72) have been anthropogenically modified, and in C1, 30.9% of bones with a cortical surface (n= 57) have anthropogenic alteration. In A1, percussion marks are slightly more common than cutmarks. In C1, there are higher frequencies of bones with percussion marks, equating to 20.1% of all bones with a cortical surface (n=184). In A1, percussion marks occur on 13.9% of bones with a cortical surface (n=287). The frequency of cutmarks is very similar in A1 (11.1%) and in C1 (10.7%). In both A1 and C1, percussion marks are the most represented anthropogenic BSM. Pearson's correlation tests have shown that there is no significant difference in cutmark

($\mathcal{X}^2$=0.009; df=1; p= .924559) and percussion ($\mathcal{X}^2$= 3.123; df=1; p= .77218) frequencies between square A1 and C1.

Table 4.16: Anthropogenic bone surface modifications in square A1 and C1 in SBLS.

Square	Anthropogenic bone surface modification		No. specimens with both modifications n (%)	Total anthropogenic modifications by square n (%)	Total sample analysed by square N (%)
	PM n (%)	CM n (%)			
A1	40 (13.9)	32 (11.1)	5 (1.8)	**72 (25.1)**	**287 (100)**
C1	37 (20.1)	20 (10.7)	3 (1.6)	**57 (30.9)**	**184 (100)**

4.4.4: Percussion marks

Percussion marks are more highly represented in both squares than cutmarks. The frequency of cutmarks in each square is roughly similar, representing 11.1% of specimens with a cortical surface in A1, and 10.7% in C1. Overall, the frequencies of anthropogenic BSM in A1 and C1 are higher than zoogenic modifications (Figure 4.7).

Table 4.17: Percussion pits verses percussion notches in squares A1 and C1 in SBLS.

Square	Percussion pits n (%)	Percussion notches n (%)	Total percussion modifications n (%)	Total sample analysed by square N (%)
A1	32 (11.1)	8 (2.8)	**40 (13.9)**	**287 (100)**
C1	30 (16.3)	7 (3.8)	**37 (20.1)**	**184 (100)**

4.4.5: Cutmark intensity

Most of the bones in square A1 and C1 do not have more than one cut mark per specimen (Table 4.18). C1 has more specimens that have three (3) or more individual cut marks. This square also contains a giant buffalo (*Syncerus antiquus*) mandible that has been extensively processed and has several deep striations across the bone surface (Appendix B1:1). There is one specimen in A1 that has been intensely cut marked. The table below summarises the number of cutmarks per individual specimen in squares A1 and C1. Frequencies have been calculated in relation to the total sample (N) analysed for bone surface modifications in squares A1 and C1 (Table 4.11).

Table 4.18: Cutmark intensity per specimen in squares A1 and C1 in SBLS.

No. of cut marks per specimen	Square	
	A1 n (%)	C1 n (%)
1	20 (7.0)	11 (6.0)
2	7 (2.4)	5 (2.7)
3	2 (0.7)	4 (2.2)
4	1 (0.3)	0 (0)
Cut marks in sample n (%)	**32 (11.1)**	**20 (10.7)**
Sample total N (%)	**287 (100)**	**184 (100)**

4.6: Skeletal part profiles

4.6.1: Anthropogenic bone surface modifications

4.6.1.1: Square A1

Percussion marks occur most often on axial elements, which are the most common type of skeletal part in square A1 (Table 4.5). Anthropogenic modifications occur more often on specimens that are not identified to element (Table 4.19).There are low frequencies of lower and distal limb bones with anthropogenic modification, and no modified pelvic bones. Bones with both a cut and percussion mark are equal to 1.8% (n=5) of the total sample in A1.

Table 4.19: Anthropogenic bone surface modifications by skeletal part in square A1 in SBLS (cutmark=CM; percussion mark = PM). Based on NISP values for skeletal elements in square A1 (Table 4.5).

Square A1			
Skeletal part	**Anthropogenic Modification**		**Skeletal parts with both modifications n (%)**
	CM n (%)	**PM n (%)**	
Skull	2 (0.7)	2 (0.7)	1 (0.3)
Axial	9 (3.1)	12 (4.2)	3 (1.0)
Upper limbs	1 (0.3)	-	-
Pelvis	-	-	-
Lower limbs	3 (1.0)	1 (0.3)	1 (0.3)
Distal limbs	1 (0.3)	3 (1.0)	-
Modified skeletal parts n (%)	**16 (15.1)**	**18 (17.0)**	**5 (1.8)**

4.6.1.2: Square C1

Percussion marks are more common than cutmarks in square C1 (Table 4.20). Upper limbs (n=7) display the most percussion modifications, followed by axial bones (n=6). Cutmarks occur most often on upper limb bones in C1 (n=4). Skeletal parts with both a cut and percussion mark are very low, equating to 1.6% (n=3) of the sample in C1.

Table 4.20: Anthropogenic bone surface modifications by skeletal part in square C1 in SBLS (cutmark=CM; percussion mark=PM). Based on NISP values for skeletal parts in square C1 (Table 4.5).

Square C1			
Skeletal part	**Anthropogenic Modification**		**Skeletal parts with both modifications n (%)**
	CM n (%)	**PM n (%)**	
Skull	2 (1.1)	3 (1.6)	1 (0.5)
Axial	1 (0.5)	6 (3.3)	1 (0.5)
Upper limbs	4 (2.2)	7 (3.8)	-
Pelvis	-	-	-
Lower limbs	2 (1.1)	2 (1.1)	1 (0.5)
Distal limbs	-	1 (0.5)	-
Modified skeletal parts n (%)	**9 (4.9)**	**19 (10.3)**	**3 (1.6)**

4.4.6: Zoogenic bone surface modifications

The most represented zoogenic bone surface modification in A1 and C1 are tooth marks (Table 4.21). Gastric acid etching is present, but uncommon. Zoogenic modifications represent 4.9% (n=14) of all bones with a cortical surface in A1 (n=287). In C1, zoogenic modifications occur on 7.6% (n=14) of all bones with a cortical surface (n=184). The most well represented zoogenic modification in each square are tooth marks, GAE is not well represented in either square but is slightly more common in square A1. A Pearson's correlation test indicates there is no significant difference between zoogenically modified specimens between square A1 and C1 ($\mathcal{X}^2$= 1.495; df=1; p = .221416), and no difference in tooth marked specimens ($\mathcal{X}^2$= 3.095; df=1; p=. 07852) between each square.

Table 4.21: Zoogenic bone surface modifications in square A1 and C1 in SBLS.

Square	**Zoogenic bone surface modification**		**No. specimens with both modifications n (%)**	**Total zoogenic modifications by square n (%)**	**Total sample analysed by square N (%)**
	TM n (%)	**GAE n (%)**	-		
A1	10 (3.5)	4 (1.4)	-	**14 (4.9)**	**287 (100)**
C1	13 (7.1)	1 (0.5)	-	**14 (7.6)**	**184 (100)**

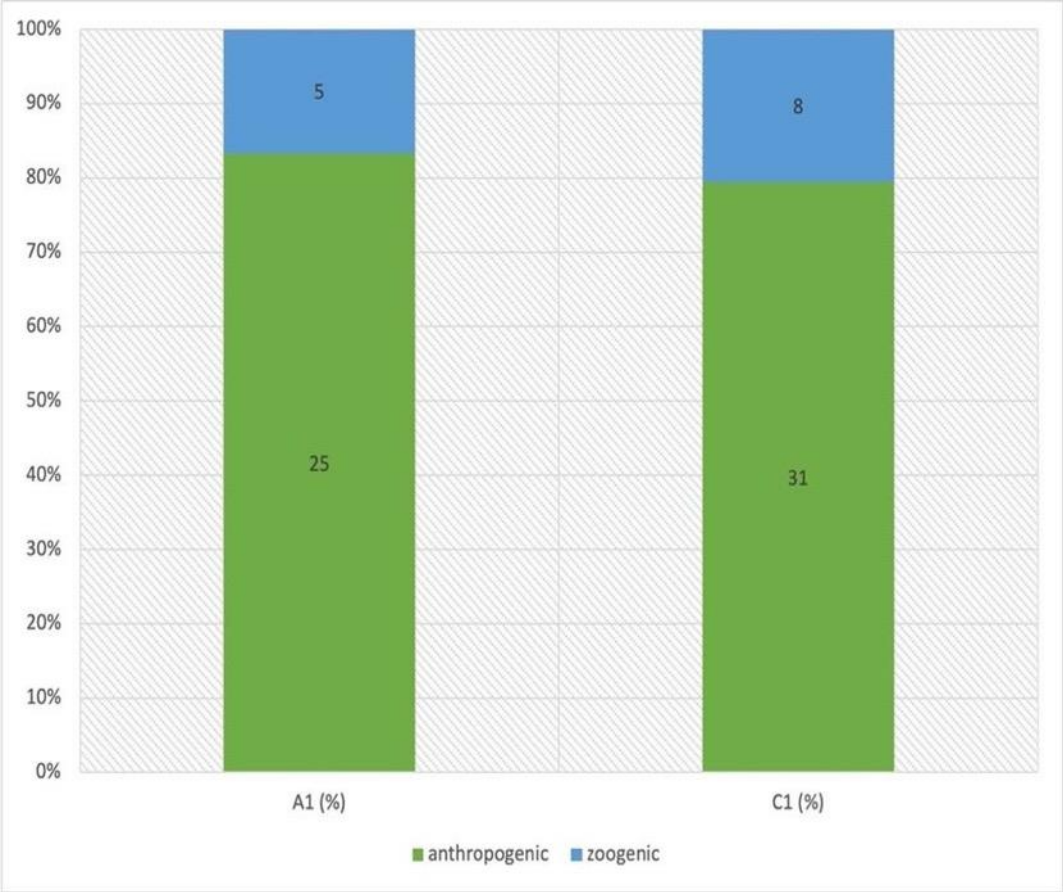


Figure 4.7: Anthropogenic and zoogenic bone surface modifications in squares A1 and C1 in SBLS.

Anthropogenic bone surface modifications are more frequent in both squares than zoogenic modifications. In square A1, 25.1% (n=72) of bones in the sample (N=287) have been anthropogenically modified. In comparison, 4.9% (n=14) of specimens have evidence of zoogenic modification. In square C1, 31% (n=57) of bones in the sample are anthropogenically modified, and 8% (n=14) of specimens are zoogenically modified. The frequencies of both anthropogenic (Table 4.16) and zoogenic modification (Table 4.21) in A1 and C1 are broadly similar. There is higher zoogenic activity in C1, but similar levels of anthropogenic processing to square A1 (Figure 4.7). Zoogenic modifications are not as well represented as anthropogenic modifications in either square A1 or C1.

4.4.7: Zoogenic modifications by skeletal part

4.4.7.1: Square A1

In square A1, zoogenic modifications only occur on axial elements and represent a combined total of 1% of the NISP (n=106). Toothmarks occur more often than GAE. There

are no specimens with both toothmarks and GAE in A1**.**

Table 4.22: Zoogenic modifications by skeletal parts in square A1 in SBLS (too mark=TM; gastric acid etching=GAE). Based on NISP values for skeletal elements in square A1 (Table 4.4).

Square A1			
Skeletal part	**Zoogenic Modification**		**Skeletal parts with both modifications n (%)**
	TM n (%)	**GAE n (%)**	
Skull	-	-	-
Axial	2 (0.7)	1 (0.3)	-
Upper limbs	-	-	-
Pelvis	-	-	-
Lower limbs	-	-	-
Distal limbs	-	-	-
Modified skeletal parts n (%)	2 (0.7)	1 (0.3)	0 (0)

4.4.7.2: Square C1

In square C1, zoogenic modifications occur most frequently on axial elements, making up 2.2% (n=4) of the total BSM sample in C1 (n=184). Skull and lower limb elements exhibit an equal amount of zoogenic modification. Gastric acid etching (GAE) is not highly represented in C1 and does not occur on any identified skeletal elements. There is one (1) upper limb bone with zoogenic modification in C1 (Table 4.23).

Table 4.23: Zoogenic modifications by skeletal part in square C1 in SBLS (tooth mark=TM; gastric acid etching=GAE). Based on NISP values for skeletal elements in square C1.

Square C1			
Skeletal part	**Zoogenic Modification**		**Skeletal parts with both modifications n (%)**
	TM n (%)	**GAE n (%)**	
Skull	2 (1.1)	-	-
Axial	4 (2.2)		-
Upper limbs	1 (0.5)	-	-
Pelvis	-	-	-
Lower limbs	2 (1.1)	-	-
Distal limbs	-	-	-
Modified skeletal parts n (%)	**9 (4.9)**	**0 (0)**	**0 (0)**

4.4.8: Anthropogenic modifications by mammalian size class

The frequencies of anthropogenic modifications by mammalian size class have been calculated to show whether small, medium or large mammals display the highest amounts of anthropogenic modifications (Table 4.24). In both squares, medium sized mammals are most often anthropogenically modified. In square C1, large mammals (6.0%; n=11) show slightly higher frequencies of anthropogenic modification than large mammals in A1 (3.1%;n=9). Frequencies (%) are calculated in relation to the total number of specimens selected for taphonomic analysis in each square (A1 n=287; C1 n=184).

Table 4.24: The frequency of anthropogenic modifications on small, medium and large mammals in squares A1 and C1 in SBLS.

Square	**Mammalian size class and anthropogenic modification**			**Specimens identified to mammalian size class with anthropogenic modifications n (%)**	**Sample total N (%)**
	Small n (%)	**Medium n (%)**	**Large n (%)**		
A1	10 (3.5)	14 (4.9)	9 (3.1)	**33 (11.5)**	**287 (100)**
C1	6 (3.3)	12 (6.5)	11 (6.0)	**29 (10.1)**	**184 (100)**

4.4.9: Percussion and cutmark representation by mammalian size class

In square A1, cutmarks occur more frequently on small mammal bones than percussion marks. Percussion marks occur more often on medium and large sized mammals in A1. In C1, cutmarks occur most frequently on large mammals, and percussion marks occur more on small and medium sized mammals in this square. Small mammals exhibit the highest frequency of percussion modification in C1. Percussion modifications are slightly higher than cut marks in both squares. Frequencies (%) are calculated in relation to the total sample (N) selected for taphonomic analysis in each square (A1 n=287; C1=184).

Table 4.25: Cut mark (CM) and percussion mark (PM) representation by mammalian size class in square A1 and C1 in SBLS.

Mammalian size class	**A1**		**C1**	
	CM n (%)	**PM n (%)**	**CM n (%)**	**PM n (%)**
Small mammal	6 (2.1)	3 (1.0)	3 (1.6)	6 (3.3)
Medium mammal	6 (2.1)	14 (4.9)	3 (1.6)	4 (2.2)
Large mammal	6 (2.1)	8 (2.8)	5 (2.7)	4 (2.2)
Total	**18 (6.2)**	**25 (8.7)**	**11 (6.0)**	**14 (7.6)**

4.4.10: Zoogenic modifications by mammalian size class

In square A1, there is one small, medium and large mammal with a zoogenic marking

(Table 4.26). Zoogenic modifications are low in both squares. Medium mammals in square C1 are most often zoogenically modified (n=3; 1.6% of 184). Frequencies (%) are calculated in relation to the total sample selected for taphonomic analysis in each square (A1 n=287; C1 n=184).

Table 4.26: The frequency of zoogenic modifications on small, medium and large mammals in squares A1 and C1 in SBLS.

Square	Mammalian size class and zoogenic modification			Specimens identified to mammalian size class with zoogenic modifications n	Sample total N (%)
	Small (%)	Medium (%)	Large (%)		
A1	1 (0.3)	1 (0.3)	1 (0.3)	**3 (1.0)**	**287 (100)**
C1	3 (0.7)	5 (2.7)	1 (0.5)	**9 (4.9)**	**184 (100)**

4.4.11: Toothmark and gastric acid etching (GAE) representation by mammalian size class

Gastric acid etching is not present on any bones that have been classed into mammal sizes in either square A1 or in C1. GAE is present in the samples, but upon bones that could not be identified to skeletal element (Table 4.20). In A1, tooth marks only on medium sized mammals (n=2; 0.7% of 287). In C1, tooth marks occur most often on medium sized mammals (n=5; 2.7% of 184).

Table 4.27: Tooth mark (TM) and gastric acid etching (GAE) representation by mammalian size class in squares A1 and C1 in SBLS.

Mammalian size class	A1		C1	
	TM n (%)	GAE n (%)	TM n (%)	GAE n (%)
Small mammal	1 (0.3)	-	3 (0.7)	-
Medium mammal	1 (0.3)	-	5 (2.7)	-
Large mammal	1 (0.3)	-	1 (0.5)	-
Total	**3 (1.0)**	**0 (0)**	**9 (4.9)**	**0 (0)**

4.4.12: Trampling Modifications

Bones in SBLS squares A1 and C1 contain evidence of trampling damage (Table 4.28). In A1, 12.7% (n=36) of the sample selected for taphonomic analysis (n=287) has been modified via trampling. Trampling scratches are better represented (n=23) than trampling lines (n=13) in this square. In C1, 10.3% (n=19) of the sample selected for taphonomic analysis (N=184) have trampling damage. Square A1 has a slightly more trampled bone

than C1. A Pearson's correlation test indicates there is no significant difference in trampling frequency between square A1 and C1 ($\mathcal{X}^2$=0.534; df=1; p= .464705).

Table 4.28: Trampling modifications in squares A1 and C1 in SBLS.

Square	**Trampling modification**		**Total trampling modifications by square n (%)**	**Total sample analysed by square N (%)**
	Lines n (%)	**Scratches n (%)**		
A1	13 (4.6)	23 (8.1)	**36 (12.7)**	**287 (100)**
C1	9 (4.9)	10 (5.4)	**19 (10.3)**	**184 (100)**

4.4.13: Natural modifications

The table below summarises the number of specimens in each square that exhibit natural bone surface modifications (Table 4.29). Figure 4.8 represents the frequency of natural modifications for BSM analysis (N=287) exhibit a sheen or 'polish' (Table 4.29; 4.30). Table 4.30 summarises the intensity of sheen present on these specimens. Manganese staining is very low, representing 1.1% (n=3) of bones in the A1 BSM sample. In square A1, 26.4% (n=75) of bones in the selected sample (n=287) are encrusted. In C1, sheen is well represented and is present on 38.6% (n=71) of the selected sample (N=184). Manganese staining is the least common type of natural bone surface modification affecting 1.1% (n=2) of the chosen taphonomic sample in C1 (n=184). In C1, 15.8% (n=29) of bones in the sample (n=184) are encrusted. Pearson's correlation tests indicate that there are no significant differences in polish ($\mathcal{X}^2$= 2.352; df=1; p=0.125148) and encrustation ($\mathcal{X}^2$= 7.009; df=1; p= 0.008106) between squares A1 and C1. Frequencies (%) are calculated in relation to the sample chosen for bone surface modification analysis in A1 (n=287) and C1 (n=184).

Table 4.29: Natural bone surface modifications in square A1 and C1 in SBLS.

Square	Natural bone surface modification						Total natural modifications by square n (%)	Total sample analysed by square N (%)
	Polish n (%)	Encrusted n (%)	Rounding n (%)	Weathering n (%)	Root etched n (%)	Manganese staining n (%)		
A1	91 (31.7)	75 (26.4)	8 (2.8)	7 (2.5)	8 (2.8)	3 (1.1)	**192 (66.9)**	**287 (100)**
C1	71 (38.6)	29 (15.8)	5 (2.7)	7 (3.8)	13 (7.1)	2 (1.1)	**127 (69.0)**	**184 (100)**

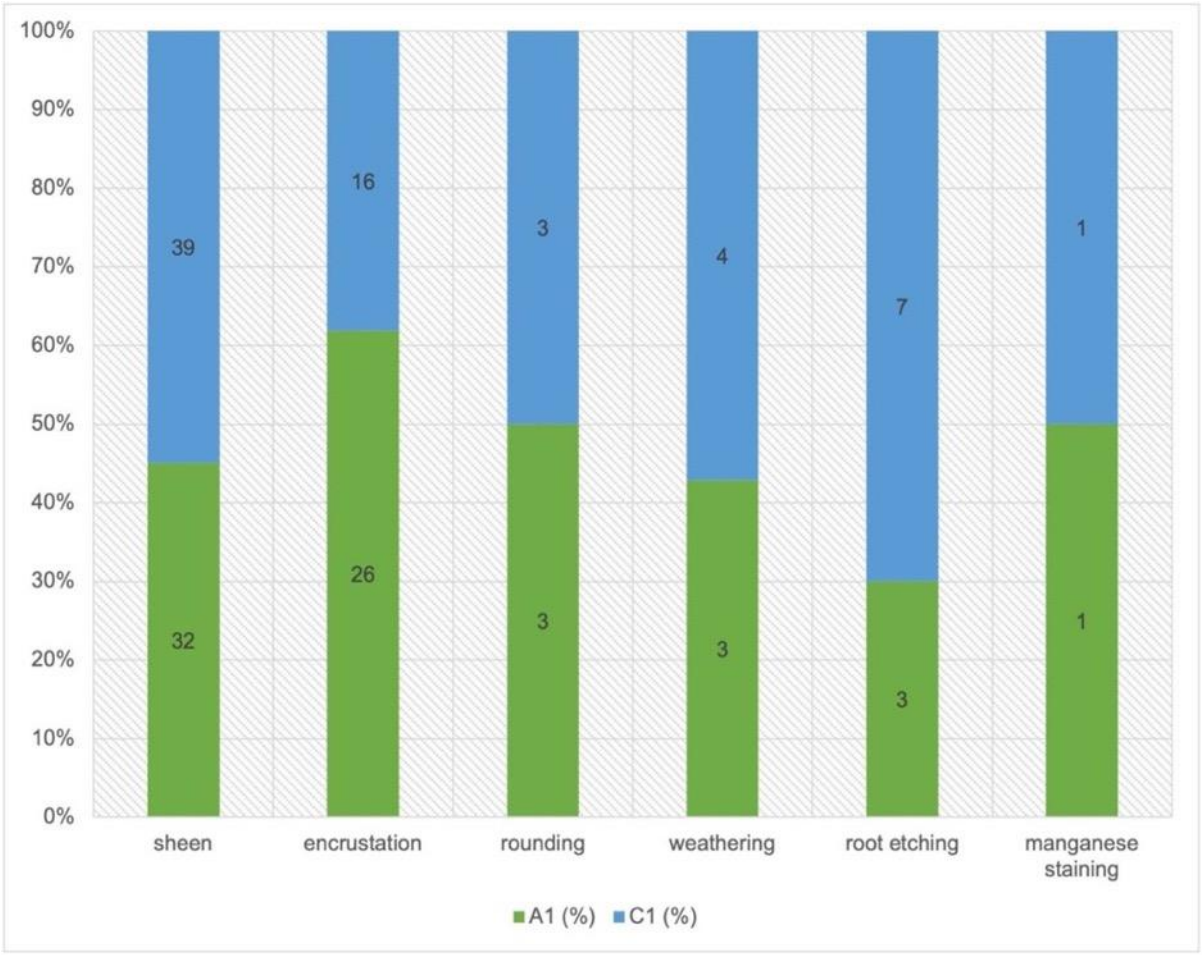


Figure 4.8: Natural bone surface modifications in squares A1 and C1 in SBLS.

Natural modifications such as rounding, weathering, root etching and manganese staining do not occur in high frequencies. Bones in both squares are however commonly encrusted and polished (See appendix B1.2 for an example of an encrusted bone in A1; and B1.4 for a specimen with sheen or abrasion in C1). The sample in A1 and C1, respectively, is most affected by anthropogenic bone surface modifications (Figure 4.7).

4.4.14: Sheen intensity

In squares A1 and C1, most specimens are mildly polished (Table 4.30, below). There are C1 (n=6). Frequencies of polished specimens are similar in each square. Frequencies (%) are calculated in relation to the sample chosen for bone surface modification analysis in A1 (n=287) and C1 (n=184).

Table 4.30: Sheen intensity in squares A1 and C1 in SBLS.

Sheen level	A1 n (%)	C1 n (%)
1	42 (14.6)	53 (28.8)
2	25 (8.7)	12 (6.5)
3	18 (6.2)	4 (2.2)
4	6 (2.1)	2 (1.1)
Total no. of polished specimens n (%)	**91 (31.7)**	**71 (38.6)**
Total sample N (%)	**287 (100)**	**184 (100)**

4.5: Summary and conclusion

The sample used in this analysis is the faunal material excavated during the 2020 and 2022 excavation periods, from square A1 and C1 in SBLS. To be included in this sample, bones had to either be larger than 2cm in length or be identifiable to skeletal element. Bones that did not meet one of these criteria were added to the coarse fraction. The total sample (N) in square A1 and C1 is equal to a total of 311 and 208 specimens respectively (Table 4.1). When analysing bone surface modifications, spongy bones were excluded from this tally (Table 4.12), and therefore the sample selected for BSM analysis is equal to n=287 in A1, and n=184 in C1. The specimens were quantified by counting the number of identified specimens only, as the identified skeletal parts are too low to calculate useful minimum numbers of individuals (MNI) or the minimum number of elements (MNE). NISP values are provided for the specimens that could be identified to taxa (Table 4.2), as well as for the identified skeletal elements (Table 4.6). Species identifiability is low in both squares, and skeletal elements are dominated by a preponderance of axial and cranial fragments, and a lack in meat-bearing limb bones (Table 4.6). Mammalian size classes have been calculated using the cortical thickness measurements of unidentified long bones, which are summarised in Table 4.8. A taphonomic analysis has been carried out to infer agents of accumulation, subsistence behaviour and site formation in A1 and C1. The preservation and fragmentation present in the sample is discussed by expressing the surface condition, and the average length and weight of each specimen, as well as the breakage patterns most highly represented on long bones in each square (Table 4.11). The frequencies of

anthropogenic, zoogenic and natural bone surface modifications and burning are reported in this chapter (Table 4.16; 4.21; 4.29).

Chapter 5: Discussion

5.1: Introduction

This study investigated three hypotheses, namely, the identity of the primary accumulators of the assemblage, whether there is evidence of occupational intensity during MIS5d at KRM 1, and the degree of post depositional site-formation processes and the effect on the faunal assemblage in A1 and C1 in SBLS. Based on the results provided in the previous chapter, these hypotheses have been answered as follows: (1) The assemblage has been primarily accumulated by humans, with a minimal role for carnivore activity, (2) there is evidence of intense occupation during MIS5d, (3) post-depositional processes have had a significant effect on the faunal assemblage. The results of the taphonomic and taxonomic analyses are discussed in this chapter with the aim of providing evidence for the confirmation of the three hypotheses outlined above.

5.2: Agents of accumulation

The low frequency of zoogenic modification compared to anthropogenic modifications places human agents as the main accumulators of the assemblage. Zoogenic modifications (Table 4.20) occur less frequently than anthropogenic modifications (Table 4.16). The highly fragmented condition of the bones in A1 and C1 also points to anthropogenic accumulation (Outram 2002; Reynard & Henshilwood 2018). Neither tooth marks nor gastric acid etching (GAE) is well represented in square A1 or C1 (Table 4.21; 4.22). When looked at in combination with higher frequencies of anthropogenic modifications (Figure 4.7), this indicates a minimal role for carnivore accumulation in the SBLS layer and a greater role for human activity.

Data from previous studies on KRM's fauna (Klein 1976; Milo 1998; Bartram & Marean 1999; Deacon & Wurz 2005; Wurz *et al*. 2018; Van-Pletzen 2000; Van-Pletzen Vos *et al*. 2019; Reynard & Wurz 2020; Reynard 2022a) shows that human inhabitants at the site were actively hunting animals of various sizes and introducing them to KRM1 for further processing. Studies have found that KRM's HP, MSA II and MSA I layers have been primarily accumulated by humans (Achieng 2019; Lap 2020; Pearson 2021; Reynard 2022b), while there is more evidence of carnivore accumulation in the MSA III layers (Reynard 2022b). The evidence found in this study correlates with previous studies of

KRM's fauna.

There are more adults than juveniles in both squares (Table 4.4), which has been interpreted as evidence of primary human access to the accumulated fauna (Klein & Cruz-Uribe 1984; Blasco *et al*. 2014; Dusseldorp & Reynard 2022). Adults represent 84.7% (n= 243) of the total sample (N=311) in A1 and 84.4% (n=159) of C1 (N=208). However, juveniles in A1 (15.3%; n=44) and C1 (17.9%; n=33) represent a significant proportion of specimens in the samples. The presence of juveniles indicates an aspect of seasonality and may point to a specific time of year in which these animals were hunted and may indicate hunter-gatherers occupied the site during the summer months (Blasco *et al*. 2014), during which young bovids are common. The wide age range for prey may point to social hunting techniques and seasonal occupation at KRM (Blasco *et al*. 2014). Increased site occupation may be related to the abundance of prey during the summer and spring months at KRM, where large grazing herds offered human hunters more encounters with these animals (Blasco *et al*. 2014). Most of the juveniles are also medium to large mammals. Optimal foraging theory (OFT) predicts that adults would be preferred to juveniles because of their size and therefore their caloric value (Dusseldorp 2010; Dusseldorp & Reynard 2022). Sub-adult medium and large mammals may require a similar amount of effort to capture and process (Blasco *et al*. 2014) but would result in a similar caloric value to adults and could explain the reason for their abundance in the sample (Blasco *et al*. 2014; Dusseldorp & Reynard 2022). The mortality profile is adult dominated, but the inclusion of juveniles suggests targeted social hunting during summer and spring months at KRM.

5.3: Taphonomic analysis

5.3.1: Anthropogenic Modifications

Anthropogenic bone surface modifications occur in squares A1 and C1 in similar frequencies (Table 4.16). BSMs such as trampling, burning, cut and percussion marks are well represented in squares A1 and C1, and strongly correlate with a high level of anthropogenic activity (Domínguez-Rodrigo *et al*. 2007; Marean *et al*. 2010; Thompson *et al*. 2017; Reynard & Henshilwood 2018). Lithic density is high in SBLS, and the artefacts appear morphologically different to those in the overlying layers, and emphasise smaller, thinner blade technology (Brenner *et al*. 2022). A tip cross sectional area analysis of the SBLS lithics by Lombard (2021), has found that points are midway between darts and

javelins, possibly suggesting changes in prey accumulation strategies (Lombard 2021; Wurz *et al*. 2022).

5.3.1.1: Cutmarks

The presence of cutmarks on meat bearing elements suggests that these bones were introduced to the site by human activity (Bunn 1981; Potts & Shipman 1981; Bunn *et al*. 1986; Blumenschine 1986, 1988; Marean *et al*. 1992; Domínguez-Rodrigo 1999; Domínguez- Rodrigo *et al*. 2007; Galán *et al*. 2009; Fernandez-Jalvo & Andrews 2011). See appendix B (B1.3) for an example of a cut mark on a giant buffalo (*Syncerus antiquus*) patella in square A1, and for a giant buffalo mandible with evidence of intense processing in square C1 (B1.1). Generally, ungulates would not have enough flesh on bones to warrant further processing if the remains had been scavenged from carnivore kills (Domínguez-Rodrigo 1999). Cut marks occur most often on rib shaft fragments in square A1, and account for 11.3% (n=12) of the samples analysed for BSM (N=287). According to Blumenschine's (1986) study on carcass consumption sequences, large carnivores will consume the visceral organs underneath the ribcage second in succession after first consuming meat from the hindquarters (Blumenschine 1986). Extensive cut and percussion marks on rib shafts may suggest humans accessing the nutritionally valuable internal organs underneath, which may point to primary carcass access (Blasco *et al*. 2014).

Following axial elements, cutmarks also occur on distal limbs, lower limbs, upper limbs, and cranial fragments in lower frequencies in both A1 and C1 (Table 4.18; 4.19). In A1, cut marks appear most often on axial elements (Table 4.18). In C1 (Table 4.19), cutmarks occur most often on upper limbs (n=7) and represent 3.8% of the total BSM analysis sample (N=184). A preponderance of cut marks on limb bones indicates a role for filleting or skinning (Noe-Nygaard 1977; Binford 1981; Shipman & Rose 1983; Blumenschine & Selvaggio 1988; Capaldo & Blumenschine 1994; Pickering & Egeland 2006; Galán *et al*. 2009; Blasco *et al*. 2014).

5.3.1.2: Percussion marks

Percussion modifications affect 13.9% (n=40) of the total sample (N=287) in A1. They occur on cranial, distal, and lower skeletal parts in lower frequencies (Table 4.18). Percussion marks occur more often than cut marks in both squares. In A1, percussion modifications occur mostly on medium sized mammals (n=14), and most often on axial elements (n=12).

Square C1 exhibits a higher frequency of percussion modification than A1 relative to sample size (Table 4.19). Percussion marks occur most frequently on upper limbs in C1 (3.8%, n=7) and is followed by rib shaft fragments (3.3%). In C1, small animals exhibit the most percussion modifications (n=6). Percussion damage results from the use of hammerstone techniques to break open bones and extract the nutritionally rich marrow, fat, and bone grease inside (Blumenschine & Selvaggio 1988; Turner 1989; Villa & Mahieu 1991; Capaldo & Blumenschine 1994; Blasco *et al*.2014; Moclán & Domínguez-Rodrigo 2018). Long bones are most often used for marrow extraction (Outram 2002). Percussion modification is a good indicator of anthropogenic activity (Blumenschine & Selvaggio 1988; Blumenschine 1995; Galán *et al*. 2009; Blasco *et al*. 2014; Moclán & Domínguez-Rodrigo 2018) and will also result in a higher number of fragments in an assemblage. In assemblages where frequent percussion activity took place, long bones will be severely splintered, and mid-shafts a common occurrence (Outram 2002).

5.3.2: Fragmentation

All bones in SBLS A1 and C1 are highly fragmented (Table 4.12). Long bone fragments average no more than 20-30mm (Figure 4.5) and are represented by majority spiralised fractures, followed by transverse breakage patterns (Table 4.13). The length of the fragments correlates with anthropogenic bone breakage via hammerstone or hammer and anvil technique (Binford 1984; Domínguez-Rodrigo *et al*. 2009; Galán *et al*. 2009; Moclán & Domínguez-Rodrigo 2018). Long bone mid-shaft splinters are common in KRM cave 1 and cave 1A (Van-Pletzen 2000; Van-Pletzen Vos *et al*. 2019), suggesting anthropogenic bone breakage was commonplace (Binford 1984; Domínguez-Rodrigo *et al*. 2009; Moclán & Domínguez-Rodrigo 2018). A high level of anthropogenic activity usually results in a fragmentary faunal assemblage (Clark & Plug 2008; Moclán & Domínguez-Rodrigo 2018). This can be a result of prolonged burning (Cain 2005; Bosch *et al*. 2012, trampling and abrasion (Behrensmeyer 1988; Madgwick 2014; Moclán & Domínguez-Rodrigo 2018), marrow extraction (Outram 2002, 2004), and discarding of bones into hearths (Cain 2005), which have been recorded at contemporary MSA sites such as Diepkloof (Steele & Klein 2013), Sibudu (Clark 2011; Wadley 2010), Pinnacle Point (Thompson *et al*. 2017) and Klipdrift shelter (Reynard *et al*. 2016b; Reynard & Henshilwood 2017). At Sibudu, fragmentation has resulted in 0.58% of the post- HP MSA II being identifiable to element (Clark & Plug 2008). At Diepkloof, many bones have been completely disintegrated due to high *in situ* fragmentation (Steele & Klein 2013).

The frequency of natural corrosive processes such as gastric etching and manganese staining are low, making up a very small percentage of bone surface modifications (Table 4.29). The fragmentation in the assemblage is related to anthropogenic processing activities, evidenced by the higher representation of cut and percussion marks compared to zoogenic marks (Figure 4.7). High fragmentation can also influence BSM representation (Moclán and Domínguez-Rodrigo 2018).

5.3.2.1: Fragment Lengths

Anthropogenic bone breakage often results in a higher frequency of splintered bones that are taxonomically unidentifiable, but which are diagnostic of anthropogenic subsistence behaviour (Moclán & Domínguez-Rodrigo 2018). Moclán & Domínguez-Rodrigo's (2018) experimental study on anthropogenic bone breakage, show that hammerstone breakage is most likely to generate bone fragments that measure around 20-29.9 mm or less (Figure 5.1). A similar pattern is found in square A1 and C1 in SBLS, wherein the most highly represented fragments in the taphonomic are 20-30mm in length (Figure 4.5). The lengths of fragments, in combination with high frequencies of percussion marks strongly suggests anthropogenic bone breakage in SBLS. Anthropogenic bone breakage may result in similar fragmentation patterns across different sites. The most common fragment lengths that Lap (2020) found in her study of the SASL layers SMONE and BOS 3 is fairly similar to the lengths of fragments in SBLS. Lap found that the SMONE and BOS 3 layers had more evidence of occupational intensity and higher frequencies of anthropogenic bone surface modifications. A similar breakage pattern in SBLS may suggest that these processes were also occurring in this layer.

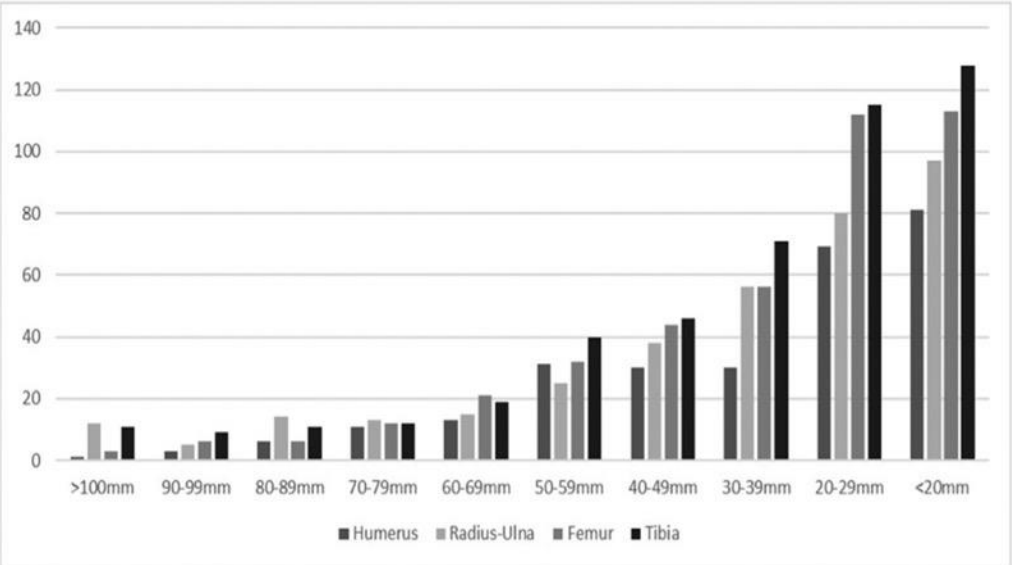


Figure 5.1: A figure representing bone fragment lengths (mm) in Moclán & Domínguez-Rodrigo (2018: 5).

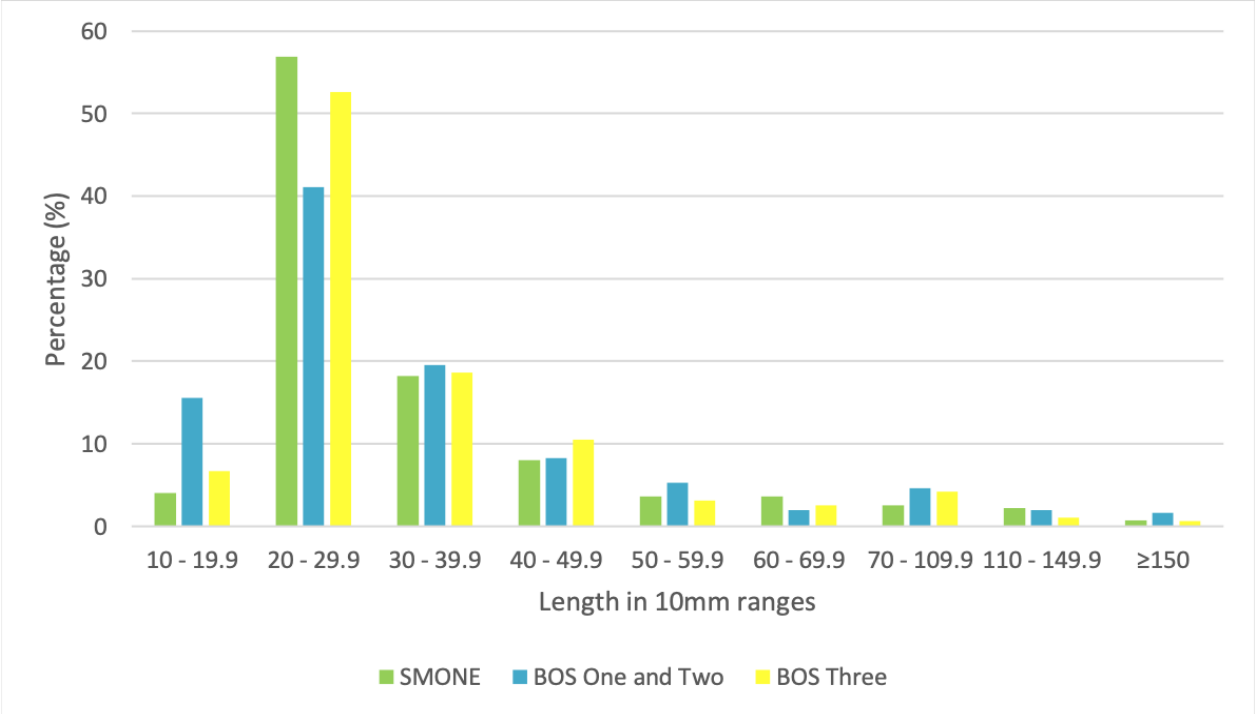


Figure 5.2: Lap's (2020) figure representing the length of bone fragments (mm) in her SMONE and BOS sample.

5.3.2.2: Skeletal element representation

It is common for MSA faunal assemblages to yield very low frequencies of identified specimens (Outram 2002). In SBLS, the number of identified specimens by element (Table 4.5) in relation to the total sample is low (Table 4.1). Medium mammals are well represented in both squares, but C1 contains more small mammals than A1 (Table 4.6; 4.7).

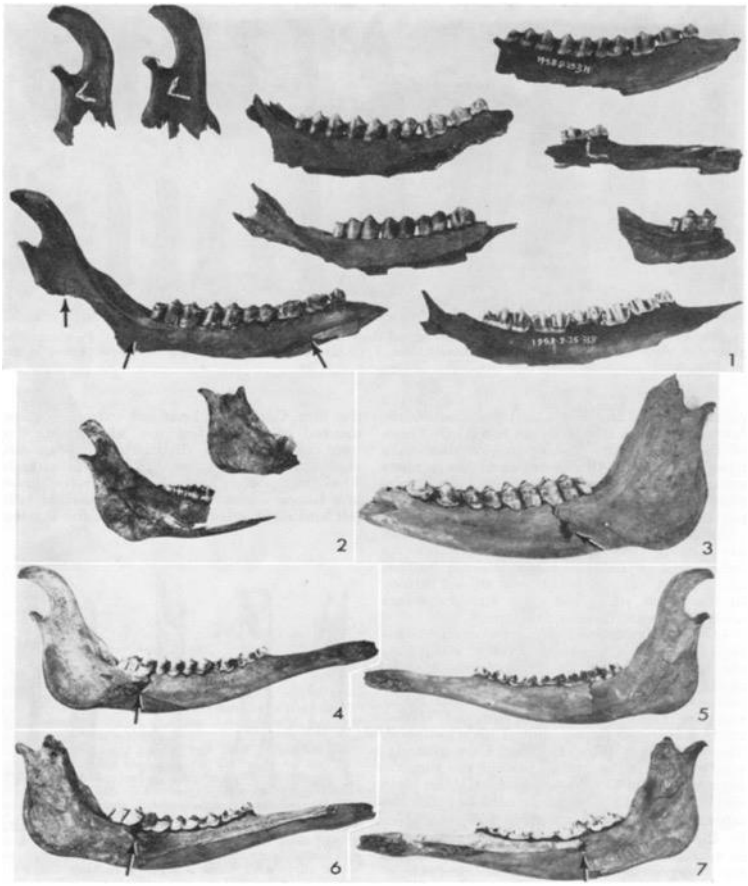
The best represented skeletal parts in the SBLS sample are axial elements – mostly represented by rib shafts – followed by cranial fragments , including mandible, tooth, and skull fragments (Table 4.5). Distal limbs are not well represented in either A1 or C1, upper limbs are slightly more common but relatively scarce in comparison to cranial and axial skeletal parts (Table 4.5). The sample contains a preponderance of cranial and axial bones, and a lack of high-utility, meat bearing elements. This may point to a bias in carcass transport (Schoville & Otárola-Castillo 2014), or post-depositional taphonomic factors (Milo 1998).

Long bones are underrepresented in A1 and C1 (Table 4.10) and are mostly diagnosed as mid-shaft fragments; epiphyseal ends are almost entirely absent from this sample. Lap (2020) found a similar pattern in BOS 3; wherein long bone shaft splinters and percussion

modifications indicate an importance of marrow extraction as a subsistence practice. Achieng (2019) found a similar occurrence in the Klasies HP layer CPx4, wherein complete long bones were underrepresented, with higher frequencies of percussion marks (Achieng 2019: 72). Long bone mid-shaft fragments are common throughout the KRM sequence, and are well represented in cave 1, cave 1 A, and in the AA43/Z44 layers (Van-Pletzen Vos *et al*. 2019). Usually, anthropogenic faunal assemblages have low complete limb bone representation, because of humans breaking bones for marrow access (Dusseldorp & Reynard 2022). However, carnivore ravaging can result in similar destructive patterns on long bones (Marean 1991; Marean & Spencer 1991), but the ratio of carnivore to anthropogenic modifications can indicate whether human or animals were responsible for this type of breakage (Thompson *et al*. 2017). Marrow extraction, evidenced by high numbers of percussion modifications and was also a significant subsistence practice found in the SMONE and BOS 3 layers in Lap's (2020) study.

5.3.2.3: Skeletal part frequencies and transport decisions

There are more cranial fragments assigned to medium mammal size class than large in both squares (Table 4.6; 4.7), which may infer that kill sites were close enough for the complete transport of medium-bodied prey, and that larger animals were being encountered at further distances, suggesting differential size class transport. If kill sites are too far from the site, a lack of large mammal cranial bones would be expected (Schoville & Otárola-Castillo 2014). The frequent occurrence of crania in A1 and C1 (Table 4.5) suggests kill sites were relatively close to KRM1 during MIS5d. However, cranial bones are dense (Lyman 1994; Outram 2002) and preserve better than some elements. Post-depositional processes may explain the overrepresentation of cranial fragments. The small sample size limits the interpretation of the transport of medium and large mammals, as it is possible that post-depositional fragmentation may have resulted in the preferential destruction of smaller mammal bones. These smaller bones may have also been more affected by anthropogenic processing such as percussion and burning which increase fragmentation. A larger sample size is needed to make sound conclusions regarding transport of large mammals at KRM in MIS5d.



Noe-Nygaard (1977: 223) studied marrow extraction and breakage patterns of red deer mandibles, illustrating how these parts would have been broken open to extract the residual marrow. This process generates a high number of cranial fragments.

Figure 5.3: Marrow extraction on red deer mandibles from Noe-Nygaard (1977).

The presence of a giant buffalo (*Syncerus antiquus*) is indicated by a mandible in square C1, which has evidence of intensive processing in the form of several deep cut and chop marks across its surface (Appendix B1.1). Milo's (1998) study on KRM's fauna found that the roasting of heads may have occurred, based on burning patterns on cranial remains. Cutmarks on cranial bones may point to tongue removal (Brain 1967; Reynard 2022a).

The high representation of cranial, rib and long bone shaft fragments indicates that anthropogenic processing activity is common in SBLS. Long bones that had been stripped of flesh may have been further fragmented by boiling in water to cook bone grease (Lupo & Schmidt 1997; Outram 2002) or split open to access marrow (Outram *et al*. 2005). The lack of complete long bones in comparison to the rest of the sample (Table 4.8; Figure 4.4) in A1 and C1 may indicate a high level of anthropogenic processing of these elements. Scavenging animals, such as the porcupine from square A1, may have contributed to the disappearance of some skeletal elements, but only once they were disposed as food refuse

(Bunn *et al.* 1986, 1988; Blasco *et al.* 2014).

5.3.2.4: Fracture patterns

Long bone fractures are most represented by spiral breaks in A1 and C1 (Table 4.13), which points to fresh or 'green' bone breakage (Noe-Nygaard 1977; Myers *et al.* 1980; Johnson 1985; Blumenschine & Selvaggio 1988; Marean & Spencer 1991; Marean *et al.* 1992; Outram 2002; Outram *et al.* 2005; Domínguez-Rodrigo *et al.* 2009). Anthropogenically accumulated faunas can exhibit a preponderance of long bones with spiral fractures (Outram *et al.* 2005), but carnivore bone breakage can also result in spiral fractures (Marean & Spencer 1991; Marean *et al.* 1992; Cleghorn & Marean 2007). Primary anthropogenic accumulation is inferred when specimens have more anthropogenic than zoogenic bone surface modifications (Thompson *et al.* 2017). In square A1, 61.1% (n=44) of long bones exhibit spiral breakage patterns. In C1, 76.3% (n=87) of long bones have spiralised breakage (Table 4.13).Transverse fractures on long bones also occur in A1 and C1 (between 13.9% for A1 and 16.7% for C1), but in relatively lower proportion than spiral breaks. Transverse fractures are associated with post-depositional breakage, which may be due to trampling and sediment compaction (Villa and Mahieu 1991). Eroded ends occur on 12.5% (n=9) long bones in A1, and 7% (n=8) long bones in C1. Eroded ends occur due to post depositional processes such as erosion via wind and water (Esteban-Nadal *et al.* 2010).

5.3.3: Burning

Burning is present in both squares, affecting 30.5% (n= 94) of all specimens (N=311) in A1, and 55.5% (n= 115) in C1 (N=208). Most burned specimens exhibit mild and localised burning (Table 4.14). Indirect burning can occur on bones which are lying underneath hearth features, and may appear as moderately burned, or brown in colour (Stiner *et al.* 1995; Cain 2005; Clark & Ligouis 2010; Bosch *et al.* 2012). In A1 and C1, 24 individual specimens have been counted as spongey bone in each square and are not viable for analysing BSM (Table 4.10). However, these specimens have been included in the burning tallies. Spongy bones can potentially indicate the use of bone fuel (Costamagno *et al.* 2005; Clark & Ligouis 2010). Square C1 has been identified as a hearth feature and aligns with Deacon's characterization of Klasies hearths as small, lenticular, ash-filled depressions (Deacon & Wurz 2001, 2005; Larbey *et al.* 2019).

In SBLS, most bones are moderately burned. Localised burning is represented in both squares, with 9% (n= 28) in A1, and 14.9% (n= 31) in C1. Localised burning has been linked to roasting (Cain 2005), Heating of bone to extract marrow has been shown experimentally (Outram 2004) to produce very low degrees of burning damage and may explain the presence of mildly burned bones in square A1 and C1 (Table 4.14). The !Kung San have been observed boiling the bones to then suck out the marrow (Yellen 1991: 13), and this can also be achieved by exposing long bones to direct heat (Outram 2004). In the post-HP MSA layers at Sibudu, more than half of the bones in each assemblage exhibited moderate burning (Clark & Ligouis 2010). Localised and moderate burning is well represented at Klipdrift shelter (Reynard *et al*. 2016a) and Blombos cave (Thompson & Henshilwood 2011).

Blackened bones represent 3.5% of the sample in A1, and 11.1% in C1. There are some calcined (burned white) bones in A1 (n=6). The presence of any blackened or white bone indicates that these bones were burned through anthropogenic activity (Cain 2005). See appendix B (B1.5) for a blackened and encrusted bone in square C1. A1 contains more calcined bones (grey to white), which is associated with prolonged fire exposure (Stiner *et al.* 1995; Clark & Ligouis 2010). It is possible that C1 had originally contained many more burned bones, and that the most severely burned specimens disintegrated over time, as burned bones are more fragile and brittle (Stiner *et al.* 1995). Bone burning in A1 and C1 is related to anthropogenic activity, whether intentional roasting or due to bones lying in and around the hearth feature (Clark & Ligouis 2010; Bosch *et al*. 2012). Higher burning frequencies have also been noted by Lap (2020) in the BOS 3 layer.

Square C1 contains one of the SBLS layer's hearth features (Bentsen 2014; Wurz *et al*. 2018, 2022; Brenner *et al*. 2022; Morrissey *et al.* 2023). C1 contains abundant burned shells, stones and rubified stone. Frequent hearth use may have contributed to the intense fragmentation in SBLS. Incidental burning would have likely been a common occurrence, especially around the hearth (Cain 2005; Bosch *et al*. 2012). When excavating the SBLS layer in 2022, rubified or burned stones (Bentsen & Wurz 2017) were common and were intermixed with burned bone and shell. The rubified stone suggests this was an area cooking with hot stones could have taken place (Mentzer 2014; Goldberg *et al*. 2017; Bentsen & Wurz 2017: 110). Heat affected quartzite has also been found in the SMONE layer (Wurz *et al*. 2018). The intense use of a site can be inferred based on frequent burning and hearth activity (Stiner 2009), and repeated heating episodes have been linked to large group size, and longer stays at a site (Bentsen & Wurz 2017: 111).

Figure 5.4: Rubefied stone in association with a bovid mandible fragment in square C1 in SBLS.

Figure 5.5: Rubefied stone in association with lithics and bone in square C1 in SBLS.

5.4. Species representation

Although the species identification in A1 and C1 is low (Table 4.2), there are some species which can provide information regarding subsistence practices at the site. Mammal sizes generally correlate with feeding types, as larger mammals tend to be grazers, while smaller bodied mammals generally feed on browse and shrubbery (Skinner & Chimimba 2005). A short description of the few identified species found in A1 and C1 is provided below to discuss subsistence behaviour in relation to species representation.

In A1 and C1, Cape fur seals are represented in low frequencies (combined NISP=5). Cape fur seals are indigenous to the coastal areas of southern Africa (Skinner & Chimimba 2005). The breeding grounds of these mammals are situated on offshore rocky outcrops, or sometimes on flat sandy beaches (Skinner & Chimimba 2005) and may have been reachable at low tide.

The presence of seal in the assemblage suggests Pleistocene seal breeding grounds were within reach of KRM1 during the summer months, or that the rocky islets that adults made use of were also close to the site. Wash-ups are common during the breeding season, and it is likely inhabitants of the site took advantage of this opportunity to easily access highly valuable fat and blubber (Klein & Cruz-Uribe 1996). This correlates with opportunistic encounters by foragers during wash-ups, but more cannot be said without a higher NISP count. Seals are well represented throughout the MSA II Lower (Reynard 2022a), and an abundance of Cape fur seals has also been recorded in the SASL and SASU sub-members in KRM1's Witness Baulk (Wurz *et al*. 2018). In A1, there is one specimen of African porcupine. Porcupines occur in most habitats throughout southern Africa and prefer caves for shelter. This individual most likely died naturally, and its remains were mixed in with the anthropogenically accumulated faunal material over time. Porcupines may have acted as post-depositional agents by modifying bones through chewing and gnawing, which they have been known to do as they seek out calcium contained with bone (Skinner & Chimimba 2005).

Tortoise is present in each square. The species is most likely angulate tortoise (*Chersina angulata),* which are widespread throughout southern Africa, and are common in fynbos and mesic thicket regions (Thompson & Henshilwood 2014). In South Africa, angulate tortoises are a common element of MSA faunal assemblages and are widely represented in Holocene

assemblages as well (Klein *et al*. 1999; Thompson & Henshilwood 2014). A1 contains one specimen of an unidentified suid species. Although there are not enough diagnostic criteria on the specimen to provide species identification, it is likely to be a bush pig, which are common in forest and thicket environments (Skinner and Chimimba 2005). Though eland are common in MSA faunal assemblages (Klein 1976; Van- Pletzen Vos *et al.* 2019; Reynard & Wurz 2020; Reynard 2022a), in SBLS, the representation of eland is low in both squares (Table 4.2). One small carnivore specimen in C1 has a percussion mark. The presence of anthropogenically modified carnivores remain could suggest that carnivores were exploited for food or skins (Stiner 1993) and the use of trap and snare technology (Wadley 2010; Dusseldorp & Reynard 2022), but the sample size is too small to confirm this. More specimens are needed to confidently say whether remote capture technology was utilised at KRM in MIS5d, it is possible these animals were drawn to the site because of food waste.

5.5: Site formation processes and bone surface modifications

Post-depositional taphonomy is the study of the processes that alter archaeological deposits. Faunal remains are susceptible to further modification after they have been discarded as refuse. A combination of anthropogenic activities such as burning, trampling and bone breaking, and encrustation, have played a significant role in affecting the condition of the SBLS bones. The bones in A1 and C1 have been affected by post-depositional breakage and are commonly encrusted and polished (Table 4.29) Rounding, weathering, root etching and manganese staining have also been recorded in small percentages (Table 4.29). The low frequency of natural modification, with high frequencies of anthropogenic BSMs, suggests higher occupation in SBLS. The bones in SBLS are dark brown in colour. Soil blackening can be caused by mineral staining (Shahack-Gross *et al*. 1997). The dark colour of the bone is due to the blackened soils, which contain the ashes of burned organic materials such as geophyte starch remains (Larbey *et al*. 2019), burned bones, shells, carbonized clay, and charcoal (Behrensmeyer 1978; Mentzer 2014; Goldberg *et al.* 2017; Larbey *et al*. 2019; Wurz *et al*. 2022; Morrissey *et al*. 2023).

It is highly likely that zoogenic agents such as small carnivores and insects altered the faunal assemblage, in conjunction with human activity. The sharing of space between humans and animals results in complex faunal assemblages that are shaped by the actions of different taphonomic agents (Cleghorn & Marean 2007; Faith *et al*. 2007). Animals are often drawn to sites with human debris, such as discarded animal bones (Cleghorn & Marean 2007).

Scavengers such as hyenas and porcupines can result in the destruction or removal of bones, hyenas are able to swallow bones whole (Faith *et al*. 2007), and porcupines gnaw on bone for calcium (Skinner & Chimimba 2005). Bioturbation or soil mixing, the burrowing of small animals or insects, has been known to displace artefacts and affect stratigraphy (Villa 1982; Gutiérrez *et al*. 2016). Small carnivores also remove bones from the site (Gutiérrez et al. 2016). Insects such as termites sometimes create nests within bones, which will extensively damage the bone and sometimes destroy it (Backwell *et al*. 2012). The faunal profile in SBLS may not exclusively be evidence of human activity, but also contain evidence of post-depositional alteration by zoogenic agents. It is important to be aware of factors that can create taphonomic bias when studying site formation processes.

Natural (abiotic) processes have affected the faunal assemblage in SBLS. This layer may have been influenced by high moisture conditions, as perhaps evidenced by the degree of encrustation of bones in A1 and C1 (Table 4.29). The movement of water may horizontally displace artefacts and may also result in rolled and abraded bone and shell (Villa 1982). Water displacement can result in high artefact concentration within one location (Villa 1982).

Lightly burned bones have been found to be more susceptible to encrustation (Clark & Ligouis 2010) and this may have played a role here. In square C1, there is a bone that is both blackened via burning, as well as encrusted (Appendix B: B1.5). In highly alkaline soils, salt crystals can form, flaking and splitting bone when rapid growth occurs (Behrensmeyer 1978). During periods of net evaporation, salts present in the soil and ground water will precipitate and encrust bones lying in direct contact with the deposit (Behrensmeyer 1978; 1988). Wurz *et al*. (2022: 18) found that the heating and precipitation of secondary salts has affected the lowermost Witness Baulk deposits. Gypsum requires both moisture and dryness to form properly (Schiegl & Conard 2006). Gypsum growth could therefore indicate conditions of high moisture, followed by drier periods.

There is evidence of trampling damage in both squares (Table 4.28), along with transverse fractures (Table 4.13). Transverse fractures usually occur when a dry bone is broken, often resulting from sediment compaction (Villa & Mahieu 1991) and may be caused by people walking over the deposited material, causing *in situ* fragmentation and compression over time (Dusseldorp & Reynard 2022; Wurz *et al*. 2022). Trampling abundance may indicate periods of higher occupation (Reynard & Henshilwood 2018). Bones can become abraded or ‘polished’ through continued trampling over an extended period (Brain 1967; Behrensmeyer 1978; Madgwick 2014; Reynard 2014; Reynard & Henshilwood 2018). Abrasion on bones

occurs through the erosion of the surface through physical force (Brain 1967; Bromage 1984) and appears as a smooth and glossy polish (Behrensmeyer 1990). Intense abrasion can be the result of frequent trampling (Madgwick 2014). Some matrices can result in bones being more affected by trampling and abrasion (Andrews & Fernàndez-Jalvo 2003; Madgwick 2014), burning can also result in bone sheen and polish (Reynard 2014). At Klipdrift shelter, around 20% of the assemblage is abraded, trampling is well represented and used to explain the fragmented assemblage (Reynard *et al*. 2016b). An assemblage with high frequencies of polished bones and transverse fractures points to the possibility of occupational intensity in SBLS. Human trampling can affect the vertical placement or artefacts, heavier artefacts will usually be pushed downwards by the weight of human site occupants (Villa 1982).

Site formation processes are jointly affected by natural, zoogenic and anthropogenic agents (Villa 1982). These sediments are artefacts of human site occupation (Shahack-Gross 2017). The analysis of macroscopic artefacts in conjunction with an understanding of the site's microstratigraphy will provide contextual information regarding site formation processes, agents of accumulation, and the relationship between artefacts and their associated sediments (Mentzer & Quade 2012; Shahack-Gross 2017).

5.6: Bone surface modification comparison with other layers at KRM

To determine if similar processes are occurring in other layers at KRM1 excavated by Wurz, Pearson's correlation tests were carried out to compare the SBLS MSA l sample from A1 and C1, the BOS and SMONE layers (Squares B2 and C1) (Lap 2020; Reynard 2022a), and the HP (Reynard 2022a). The results show some similarities between bone surface modifications in SBLS, and the other layers sampled here. Table 5.1 is a summary of the frequencies of burning, percussion, cut marks, trampling and encrustation in the other KRM layers. The faunal density and total number of specimens (N) in each layer is also provided for comparison. It appears that similar processes can be seen occurring in SBLS, BOS1 and 2, and SMONE.

Table 5.1: BSM frequencies and faunal density of the SBLS, SMONE, BOS and HP layers.

Sample	Burning (%)	Percussion (%)	Cutmark (%)	Trampling (%)	Encrustation (%)	Polish (%)	Density (Kg/m^3)	Total N	Source
SBLS	209 (40.3)	78 (15.1)	52 (10.0)	55 (10.6)	104 (20.1)	162 (31.2)	133.4	519	This study
SMONE	115 (41.9)	52 (19.6)	36 (13.5)	13 (4.7)	30 (9.9)	49 (17.9)	56.7	274	Lap (2020)
BOS 1&2	134 (44.2)	30 (10.7)	35 (12.5)	26 (8.6)	30 (9.9)	24 (8.0)	141.8	303	Lap (2020)
BOS 3	299 (62.7)	58 (13.2)	52 (11.6)	47 (9.9)	34 (7.1)	71 (14.9)	159.1	477	Lap (2020)
HP	720 (31.2)	251 (10.9)	58 (2.5)	411 (17.8)	NA	NA	9.6	2305	Reynard (2022a)

5.6.2: SBLS vs. SMONE

There are similar processes occurring in SBLS, and the SMONE layer (Table 5.2, below). There are no significant differences in frequencies of burning, cutmarks, percussion, and between the two samples. This suggests a similar level of anthropogenic activity occurring in SBLS and SMONE. There is a significant difference in the frequency of polished and trampled bones between the two layers, SBLS has significantly higher frequencies of polishing (31.2%) and trampling (10.6%) than SMONE (polish = 17.9%, trampling = 4.7%).

Table 5.2: Pearson correlation tests comparing bone surface modification frequencies between SMONE (Lap 2020) and SBLS.

BSM	Significant difference	Chi-squared test result
Burning	No	X^2= 0.213; df=1; p= .643079
Cutmark	No	X^2= 2.182; df= 1; p= .139591
Encrustation	No	X^2= 0.726; df= 1; p= .394068
Percussion	No	X^2= 2.600; df= 1; p= .106851
Polish	Yes	X^2= 16.319; df= 1; p= <0.005
Trampling	Yes	X^2= 7.835; df=1; p= .005123

5.6.2: SBLS vs. BOS 1&2

There are similar frequencies of anthropogenic modifications such as burning, cutmarks and percussion between SBLS and BOS 1 and 2 (Table 5.3). There is also no significant difference in trampling frequency between the two layers. There is a significant difference between encrustation (20.1%) and polish (31.2%), SBLS has higher frequencies of these BSM than BOS 1 and 2 (encrustation = 9.9%, polish = 8.0%). This suggests different site formation processes occurring in SBLS to BOS 1 and 2.

Table 5.3: Pearson's correlation tests comparing BSM frequencies between BOS 1& 2 (Lap 2020) and SBLS.

BSM	Significant difference	Chi-squared test result
Burning	No	X^2= 1.230; df=1; p= .267314
Cutmark	No	X^2=1.116; df=1; p= .290707
Encrustation	Yes	X^2=14.272; df=1; p= .000158
Percussion	No	X^2=2.958; df=1; p=.085467
Polish	Yes	X^2= 58.980; df=1; p= <0.001
Trampling	No	X^2= 0.848; df=1; p= .35698

5.6.3 SBLS vs BOS 3

There is a significant difference in burning between BOS 3 and SBLS (Table 5.4). There is a higher percentage of burned bone in BOS 3 (62.7%) than in SBLS (40.3%). SBLS has higher frequencies of encrustation and polish than BOS 3 (encrustation = 7.1%, polish = 14.9%), but there are no significant differences between cutmarks, percussion marks and trampling frequency between SBLS and BOS 3. This suggests different site formation processes occurring in SBLS, and possibly a greater role for hearth and other burning activity in BOS 3.

Table 5.4: Pearson's correlation tests comparing BSM frequencies between BOS 3 (Lap 2020) and SBLS.

BSM	Significant difference	Chi-squared test result
Burning	Yes	X^2= 49.968; df=1; p= <0.001
Cutmark	No	X^2= 0.797; df=1; p= .371991
Encrustation	Yes	X^2= 34.711; df=1; p= <0.001
Percussion	No	X^2= 0.667; df=1; p= .413913
Polish	Yes	X^2= 36.982; df=1; p= <0.001
Trampling	No	X^2= 0.149; df=1; p= .698824

5.6.4. SBLS vs Howiesons Poort

There are significantly differences between burning, cutmarks, percussion and trampling modifications between SBLS and the Howiesons Poort (Table 5.5). SBLS contains higher frequencies of burned (40.3%), cut marked (10%) and percussed (15.1%) specimens than the HP sample (Reynard 2022a), but the HP has a higher frequency (17.8%) of trampling than SBLS (10.6%), suggesting a greater role for post-depositional breakage, and possibly

more intense occupation in the HP.

Table 5.5: Pearson's correlation tests comparing BSM frequencies between the KRM Howiesons Poort (HP) and SBLS.

BSM	Significant difference	Chi-squared test result
Burning	Yes	X^2= 15.659; df=1; p= .000076
Cutmark	Yes	X^2= 63.704; df= 1; p= < 0.001
Percussion	Yes	X^2= 7.052; df= 1; p= .007916
Trampling	Yes	X^2= 16.087; df= 1; p= .000061

These results suggest that there are mostly similar processes occurring, with some notable differences between the samples. BOS 3 contains the highest percentage of burned bones (62.7%) in the sample, while SBLS have 40.3% of specimens with burning damage.

Anthropogenic BSM frequencies are similar between SBLS and the other layers (except for the HP sample, see table 5.5), suggesting similar anthropogenic processes. There are generally significant differences between polish, abrasion and encrustation when comparingSBLS to the other layers at KRM. This may point to different site formation and post- depositional processes occurring in SBLS.

5.7: Occupational Intensity

The taphonomic analysis of the faunal sample from squares A1 and C1 points to occupational intensity occurring in SBLS. These surface conditions affecting bones in these squares are widely correlated with more intense anthropogenic site use (Munro 2004; Stiner 2009; Haaland *et al*. 2021). Several studies on the southern Cape coastal MSA have used faunal taphonomic modifications to infer intense site occupation (Clark & Plug 2008; 2011; Dusseldorp 2012; Faith 2013; Dusseldorp & Langejans 2015; Reynard & Henshilwood 2017, 2018).

The surface modifications affecting bones in the sample are indicative of frequent anthropogenic activity in SBLS. They suggest that frequent post-depositional breakage and burning was commonplace. The sample in A1 and C1 contain similar frequencies of long bones with transverse fractures (Table 4.13). Transverse fractures, percussion marks, abrasion, trampling striations, burning and the presence of spongy bone are represented in the sample, and are evidence of occupational intensity in SBLS. Spongy bones suggest frequent burning within in one area (Clark & Ligouis 2010), which suggests spatial organization (Munro 2004; Goldberg *et al*. 2009) and extended site occupation (Haaland *et al*. 2021). Bones in this sample exhibit both trampling striations and are often polished

(abraded). Shiny or 'polished' bones are used as an inference for frequent and intense trampling (Madgwick 2014; Reynard 2014).

Achieng (2019) found that in the KRM HP layer CPx4, higher frequencies of transverse fractures correlate with increased occupation. This layer also exhibits heavy burning (Achieng 2019). Intense burning is linked to an increase in occupational intensity in Sibudu's HP layers (Clark & Ligouis 2010). At Klipdrift Shelter and Blombos Cave, occupational intensity is associated with higher frequencies of polished and trampled bones (Reynard *et al.* 2016a; Reynard & Henshilwood 2017). The results of the taphonomic analysis of bones in squares A1 and C1 indicates good evidence of occupational intensity in SBLS, based on the most common bone surface modifications in each square. These include high frequencies of bones with transverse fractures, polish, burning and percussion marks, with low frequencies of carnivore tooth marks or gastric acid etching, which are evidence of extended site usage.

5.8 Summary and conclusion

The results indicate that the faunal assemblage in SBLS squares A1 and C1 was primarily accumulated by humans, with a minimal role for carnivore activity. This has been observed in other layers at KRM1, such as BOS 3 (Lap 2020), SMONE (Lap 2020), and the early HP layer CPx4 (Achieng 2019). The study contributes to previous studies at KRM (Milo 1998, Bartram & Marean 1999; Deacon & Wurz 2005; Wurz et al. 2018; Achieng 2019, Van-Pletzen Vos *et al*. 2019; Lap 2020; Reynard & Wurz 2020; Pearson 2021; Reynard 2022a,b; Ezeimo *et al*. 2024),which found that humans were the primary accumulators of the large mammal fauna, were actively hunting mostly prime-aged adults of all size classes, and were exploiting a large range of prey, with some periods being intensely occupied. Humans in MIS5d exploited terrestrial and marine species with a specialized lithic toolkit (Lombard 2021).

Percussion and cut marks, burning and spiral fractures are well represented, and anthropogenic modifications are substantially higher than zoogenic BSM in the SBLS. The Klasies pattern does not occur, the assemblage is represented by an abundance of axial and cranial bones, with low frequencies of complete and partially complete long bones, and low numbers of dense foot bones (Table 4.9). Moderate and localised burning is common, suggesting roasting of meat and bones was a regular activity (Clark & Ligouis 2010). The most common type of bone surface modification in A1 and C1 is percussion (Table 4.16),

which is linked to intense marrow extraction. Spiral fractures are the most common breakage type (Table 4.13) suggesting fresh bone breakage. Zoogenic modifications are low (Table 4.20), showing that this assemblage is primarily anthropogenic. The absence of complete long bones, and the preponderance of mid-shaft fragments points to a high level of anthropogenic activity in A1 and C1. The relatively low frequency of large crania in comparison to small and medium cranial bones may suggest further travelling distances for hunters in this period, but the small sample size inhibits further interpretation.

Bones in SBLS have been affected by post-depositional processes of alternating periods of moisture and drying, which resulted in high frequencies of gypsum encrustation (Table 4.29), suggesting an important role for post-depositional site formation processes in this layer. A1 and C1 also exhibit high frequencies of trampling and abrasion, which generally point to higher occupational intensities, The condition of bones in the SBLS is evidence of some level of occupational intensity. The bones are extremely fragmented (Table 4.12), resulting in a taphonomically poor species profile (Table 4.2), identifiable elements (Table 4.4) are also uncommon relative to the faunal density of the A1 and C1 (Table 4.1). The small sample size and high degree of fragmentation required the use of NISP as the only quantification method, which limits the study as it does not consider the effect of taphonomy and post-depositional processes on the representation of specimens in the assemblage.

Frequent burning episodes are linked to intensive site use (Clark & Ligouis 2010). Trampling is present in both squares (Table 4.28), and can be inferred based off transverse fractures, trampling striations and polished bone, which are highly represented. Highly polished bones are correlated with continual trampling events (Madgwick 2014; Reynard 2014). Increases in trampling has been linked to occupational intensity in other contexts at KRM (Reynard 2022b). It follows that occupational intensity was a factor in SBLS based on the data analysed in this study, which has resulted in an intensely fragmented faunal assemblage, with high frequencies of percussed, cut, burned and trampled bone.

Chapter 6: Conclusion

In this concluding chapter, the outcomes of the analysis are summarised regarding the hypotheses stated in chapter 1. The next section (6.2) will address the limitations of this study, and the last section will discuss future avenues of research of the MIS5d period at KRM.

6.1: Hypothesis outcomes

This study aimed to test three hypotheses:

A. *Humans were the primary accumulators of the faunal assemblage, with a minimal role for carnivore activity:*

The frequency of anthropogenic to zoogenic modifications places humans as the main accumulators of the faunal assemblage in SBLS squares A1 and C1. Anthropogenic modifications greatly outnumber zoogenic marks, which make up <5% of surface modifications in each square, whilst the most represented BSM in both squares is percussion marks. There is very little evidence of gastric acid etching, and low amount of tooth marked specimens, which are minimal when compared to anthropogenic cut and percussion marks. Anthropogenic BSM occur on mammals of all size classes which indicates primary access and active hunting taking place. Zoogenic modifications occur in low frequencies, and most often on small to medium mammals, which suggests minor carnivore scavenging activity in square A1 and C1. The taphonomic evidence supports the hypothesis that humans were the primary accumulators of the faunal assemblage in SBLS. This evidence correlates with previous studies at KRM which suggest that humans played an active role in the accumulation of the large mammal fauna at the site.

B. *There is evidence of occupational intensity during MIS5d at KRM in the SBLS squares A1 and C1:*

Based on the taphonomic analysis, there is evidence of occupational intensity in the SBLS. This is due to relatively high frequencies of trampling, abrasion, burning and percussion modifications present in the sample. Higher frequencies of anthropogenic BSMs indicate periods of intensive site occupation. Localised burning is common, with several more intensely burned specimens also present. C1 contains a hearth parting, and this combined with the presence of burned bone suggests cooking and roasting meat and bone was commonplace. Trampling marks, in combination with high frequencies of polished bones, further suggests that KRM was intensely occupied in MIS5d. High fragmentation and an abundance of bones with anthropogenic modifications and trampling marks suggest high

occupation levels in this period. Juveniles are relatively common in A1 and C1, which indicates an aspect of seasonality and possibly some resource pressure. The combined taphonomic data supports the hypothesis that occupational intensity did occur during MIS5d at KRM, in the SBLS.

C. Post-depositional processes have significantly affected the faunal assemblage in A1 and C1 in SBLS:

The taphonomic analysis has shown that square A1 and C1 have been affected by post-depositional processes, suggesting a spatial continuity of site formation occurring in SBLS. A combination of anthropogenic, zoogenic and natural processes has had different degrees of influence on the assemblage. The representation and correct identification of BSM may have been affected by post-depositional taphonomy. Post-depositional fragmentation can greatly affect the identity of taphonomic agents as many natural modifications can erase anthropogenic bone surface modifications. There are high frequencies of polished and trampled bones in both squares, which point to post-depositional breakage caused by trampling and sediment compaction. Abrasion also obscures BSMs and can alter interpretations of anthropogenic behaviour. Polish on bone surfaces is well correlated with prolonged trampling activity but may also suggest high moisture conditions and water flow, which can result in abrasion. Trampling and sediment compaction may have also led to the vertical displacement of heavier artefacts in SBLS. Gypsum encrustation is highly represented in A1 and C1 and outnumbers all other natural BSM. Gypsum crystallization occurs in sediments which have been exposed to cycles of waterlogging and drying, and suggests fluctuating moisture levels at KRM1, which could have been influenced by the regional climate and changes in precipitation levels. The high frequencies of trampling and abrasion indicate that post-depositional breakage has affected bones in SBLS, the high level of gypsum encrustation suggests the site was influenced by increased moisture levels, with frequent episodes of burning, increasing the growth of gypsum within the bones. This confirms the hypothesis that square A1 and C1 are both affected by post-depositional site formation processes.

6.2: Limitations

The limitations of this study are due to the small sample size, as well as the high level of fragmentation, which made identifying taxa and skeletal elements difficult. Quantification was limited to NISP alone, due to the intensity of the fragmentation, and the lack of identified elements. The lack of identifiable elements also meant that it was not possible to analyse density mediated attrition, to add to the understanding of fragmentation in SBLS. The high

fragmentation contributed to the erasure of BSM. The small fragment sizes made it difficult identify the placement of cut and percussion marks which negatively affects interpretation of butchery practices. Many bones were also highly polished, which also results in BSM erasure. Overall, the main limitation in this sample is high fragmentation, which made all aspects of taphonomic and taxonomic analysis more challenging. The limitations of the study can be overcome with technology such as ZooMS, which will help identify species even in highly fragmentary assemblages. Bone surface modification analysis can also be aided with the use of 3D imaging to help identify BSMs better when faunal samples are fragmented, which they most often are. In future studies, AI learning models could be trained to identify BSMs on specimens with poor surface condition. Different disciplines in archaeology such as geoarchaeology and archaeobotany should be utilised in conjunction with zooarchaeology when studying subsistence behaviour, as new perspectives will come from different approaches to MSA research.

6.3: Future avenues of research

To date, a full analysis of the SBLS layer has not been undertaken. This would be the first step in understanding the processes occurring at KRM during the lowermost MSA l and the upper MSA I during MIS5d. The lithic assemblage in SBLS points to different subsistence behaviour in the MSA I. An analysis of the lower MSA I may shed light on these different behaviours and will add to the growing body of knowledge around the MSA. Research questions surrounding the MSA such as where and when the origin of modern innovative behaviours occurred may be answered by a full taphonomic analysis of the SBLS and the underlying layers. The artefact density for lithics, bone and shellfish is high in SBLS, and a full taphonomic analysis of all squares in this layer would be highly beneficial in attempting to answer questions regarding early modern behaviour, working memory and cognition. Once SBLS has been fully analysed, it can then be compared to other samples from contemporary layers from other sites. Further examination of occupational intensity in SBLS is warranted. The faunal assemblage from SBLS and underlying layers can provide essential insights in understanding early modern human hunting and foraging behaviour. Faunal data would benefit from micromorphological, and isotope analysis and these methods should be applied to the SBLS assemblage in future studies. 3D modelling and AI trained learning programs could be applied to future studies at KRM to enhance taphonomic analysis and provide further insight into human subsistence behaviour in the southern African MSA.

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Appendix A:

Table A1.1: Burning Codes (Following Clark & Ligouis 2010: 2650).

Burn colour code	Description
0	Burned brown
1	Localised burning (< half of specimen burned on certain locations)
2	Burned black
3	Burned grey
4	Burned white or 'calcined'

Table A1.2: Weathering stages (following Behrensmeyer 1978).

Level	Description
1	Cracking (mild to moderate)
2	Cracking and some flaking
3	Cracking and significant flaking.

Table A1.3: Abrasion levels (following Behrensmeyer 1978).

Level	Description
0	smooth
1	Beginning of sheen upon bone surface
2	More than ¼ of surface with sheen
3	Around ½ surface with sheen
4	More than half of surface covered with sheen.
5	Highly polished, likely anthropogenically modified. Sheen covers most of surface.

Table A1.4: Shaft length scale (following Driver 2005).

Level	**Percentage of total length**
1	<25
2	25-50
3	>50
4	>75

Table A1.5: Shaft circumference scale (following Driver 2005).

Level	**Circumference of diaphysis (percentage)**
1	<50
2	>50
3	100 (complete)

Table A1.6: Assigned length codes for sample fragments >2cm in squares A1 and C1 in SBLS.

Code	**Fragment (*mm*)**	**A1**	**C1**
1	<10	3	0
2	10-19.9	44	35
3	20-29.9	126	80
4	30-39.9	76	63
5	40-49.9	28	20
6	50-59.9	21	6
7	60-69.9	3	2
8	70-79.9	4	0
9	80-89.9	1	0
10	90-99.9	2	1
11	100-139.9	0	1

Table A1.7: Cortical thickness of long bone fragments in squares A1 and C1 in SBLS.

Code	**CT (*mm*)**	**A1**	**C1**
1	>2	2	0
2	2-3.9	10	11
3	4-5.9	11	8
4	6-7.9	2	1
5	8-9.9	0	0
6	10-11.9	0	0
7	12-13.9	0	0
8	14-15.9	0	0
9	16-17.9	0	0
10	18-19.9	0	0

Table A1.8: Terms used to describe age, fusion and siding of specimens in this study.

Description	**Recorded as…**
Fusion	F = fused, J = just fused, U = unfused, B = neonate, I = indeterminate, N = absent
Age (determined by fusion and porosity)	A = adult, J = juvenile, F = fetus, O = older adult
Siding	L = left, R = right, U = unknown, I = irrelevant.

Table A1.9: Frequencies of identified and unidentified specimens assigned to mammalian size class in squares A1 and C1 in SBLS.

A1				
Mammal size	**Identified n**	**%**	**Unidentified n**	**%**
Small	5	1.7	5	1.7
Medium	9	3.1	3	1.0
Large	5	1.7	4	1.4
C1				
Mammal size	**Identified n**	**%**	**Unidentified n**	**%**
Small	14	7.6	-	-
Medium	11	5.9	-	-
Large	7	3.8	2	1.1

Appendix B:

Images captured with a Dino-Lite Pro AM4113T 1.3MP Digital USB Microscope, with Dino-Lite software (version 2.3.1; 2023) for Apple. Input magnification for all specimens = 11.6mm.

Figure B1.1: Intense cutmarks on a giant buffalo (*Syncerus antiquus*) mandible (Plot no. 12238) in square C1 in SBLS.

Figure B1.2: Encrustation on the end of an unidentified long bone fragment (Plot no. 13818) in square A1 in SBLS.

Figure B1.3: A cut mark on a giant buffalo (Syncerus antiquus) patella (Plot no. 11254) in square A1 in SBLS.

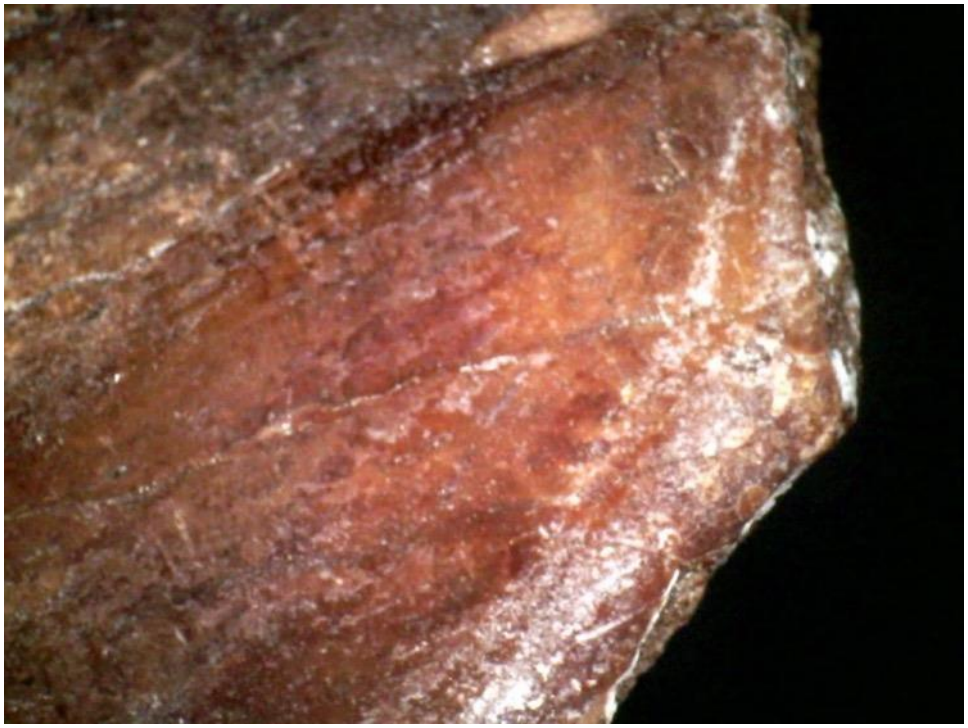

Figure B1.4: An unidentified long bone fragment (Plot no. 14009) with a polished/abraded end in square C1 in SBLS.

Figure B1.5: An unidentified long bone (Plot no. 9857) burned black and encrusted in square C1 in SBLS.