An Investigation of Temporal Change in Lithic Technology at Grassridge Rockshelter, Eastern Cape South Africa

Dissertation presented for the degree of Master of Science (M.Sc.)

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1. Introduction

Fewer archaeological studies in southern Africa have focused on inland sites as compared to coastal or near coastal ones and this is particularly true for studies that have been dedicated to the lithic assemblages that chronologically follow the Howiesons Poort. The Grassridge Rockshelter (GRS), located in the interior region of the Eastern Cape of South Africa, is a multi-component site that presents a rich high-resolution stratigraphy that interchanges with periods of hiatuses between the Late Pleistocene (LP), Terminal Pleistocene (TP) and Mid-Holocene (MH). Through the works of the Grassridge Archaeological Palaeoenvironmental Project (GAPP), the LP has been dated to about ~43000 years ago, the TP dates to ~13000 years ago and the MH dates to ~7000 years ago (Collins et al. 2017; Ames et al. 2020). The research presented here enables us to delve into the GRS lithic assemblages of these time periods to observe and describe any lithic trait changes.

The aim of this thesis is to analyse the similarities and differences between the LP and TP, as well as the TP and MH lithic assemblages to better understand the behaviours of toolmakers, also referred to here as knappers, in these time periods at GRS. The analyses use raw material type choices and numerous lithic tool typologies as proxies. Also considered in this study are tool traits that include platform treatment, external platform angle, platform thickness, early/late debitage exploitation, length over width ratio, profile, and width over thickness ratio. The frequencies of each tool trait are arranged into Tostevin's (2012) system of knapping behaviours categorized into three domains, namely Platform Maintenance, Direction of Core Exploitation and Dorsal Surface Convexity, to demonstrate the changes in lithic organization. By determining the differences and similarities in knapping behaviours and understanding how these behaviours interact with each other, we can consider various explanations – environmental, economic, and sociocultural - for these observations.

To reach these explanations, I first describe GRS as a site by outlining its stratigraphy and location in relation to biomes, yearly precipitation, and raw material availability. Dr Opperman's 1979 excavations of GRS are summarized to detail the history of recording at the site. This is followed by the summary of the excavations done by the Grassridge Archaeological and Paleoenvironmental Project since 2014 that have modified our understanding of the site. The vegetation and fauna around GRS are listed as well as the artefact types that were uncovered at the site. These deposits are generally compared to the nearby neighbouring sites of northern Eastern Cape, Colwinton and Bonawe, to give a broad context of the activities of the region. In my review of literature, I focus on the foundations of lithic assemblages and industries and how stone tools have been defined throughout history. My research focuses on the Late and Terminal Pleistocene and Holocene deposits preserved at GRS. I then consider some aspects of social learning and cultural transmission that may have contributed to the formation of these assemblages. As the interpretation of cognition and social behaviour through lithics is difficult, I discuss some of the fallacies that surround stone tool assemblages which include the "finished artefact fallacy".

I then delve into the methods I have applied to this study to depict the raw material use and dominant lithic traits of each assemblage and how they interact. The results of this will illustrate the lithic typologies that will help define the assemblages of the LP, TP, and MH. The discussion begins by comparing the high frequencies of hornfels in each assemblage and explores the availability of hornfels sources around GRS and its quality. The discussion further explores how knappers interacted with their landscapes and how that relates to the artefact types they produced. It is highlighted that the distances of raw material sources influence the efficiency of a tool that is determined by the amount of tool retouch and sharp edge. I then explore tool morphology and assemblage variability to showcase how the platform maintenance choices interact to determine tool mass in the lithics observed at GRS. Core reduction and social relatedness is examined to reveal the TP and MH populations as having more similar tool-making preferences than the LP and TP populations. The idea of independent innovation versus cultural transmission within the contexts of economic, environmental, and socio-cultural activities is then investigated for these findings.

2. Grassridge Rockshelter

2.1 Site context and history

Located at 31°34'12"S and 26°51'08"E in the interior region of the Eastern Cape (Figure:1), GRS is a multicomponent site which is nestled within the Stormberg Mountains at about 1500 m above sea level and approximately 80 km northwest from the Great Kei River and 200 km from the Indian Ocean (Collins et al. 2017). The location of GRS places it within the grassland biome and on the edge of the Karoo region, influenced by summer rainfall with a precipitation of 400 – 600 mm/year (Opperman 1987; Ames et al. 2020). The shelter is formed in the sandstone and dolerite inclusions which underwent metamorphism resulting in hornfels inserts (Collins et al. 2017; Ames et al. 2020). These rock formations create a shelter with the dimensions; 45m in length and 10m in depth (Figure 2; Opperman 1984).

GRS presents stratigraphy (Figure 3, 4 and 5) with repeated occupational breaks from the end of the Pleistocene to the middle of the Holocene with a marked occupation break during the late Holocene (Opperman 1987; Ames et al. 2020). The stratigraphy has three sets of occupational layers that are separated by two hiatuses with a third hiatus extending to the present (Collins et al. 2017). The three sets of occupational layers are of three Pleistocene (0.5 - 0.8m in depth) and five Holocene (0.5 – 0.7m in depth) layers that make up a deposit that is 1.5m thick, including 0.1 - 0.3m thick flowstone (Opperman 1987; Ames et al. 2020). The eastern side of the back wall of the shelter has a group of preserved paintings that are somewhat indistinct as well as some rock art on the large rocks in the front of the shelter (Opperman 1984). The main lithic raw materials found at GRS during a foot survey within 2km of the shelter in 2018 for this thesis were chalcedony, dolerite and hornfels which are readily found in the area.

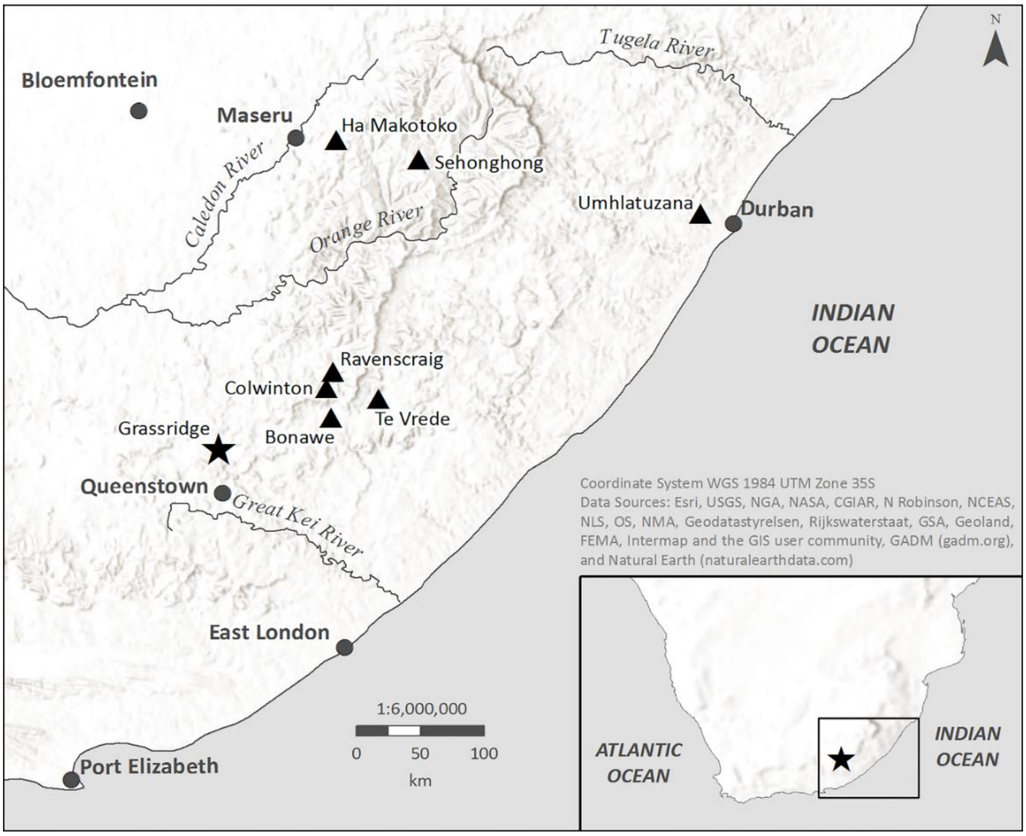


Figure 1: Map displaying the location of Grassridge Rockshelter, Eastern Cape (Collins et al. 2017).

2.2 Opperman's excavations

As part of an extensive field programme based at the University of Fort Hare, the site was originally excavated by Dr Hermanus Opperman in 1979 revealing 1.5 m in depth of stratigraphic layers rich in artefact deposits with the use of a 3 x 2 m trench (Figure 3; Opperman 1987; Collins et al. 2017). These stratigraphic layers were separated into two major components – the Later Stone Age (LSA) component that was dated 7000 to 6000 years ago and the Middle stone Age (MSA) component that was dated to 36000 years ago near the bedrock (Ames et al. 2020).

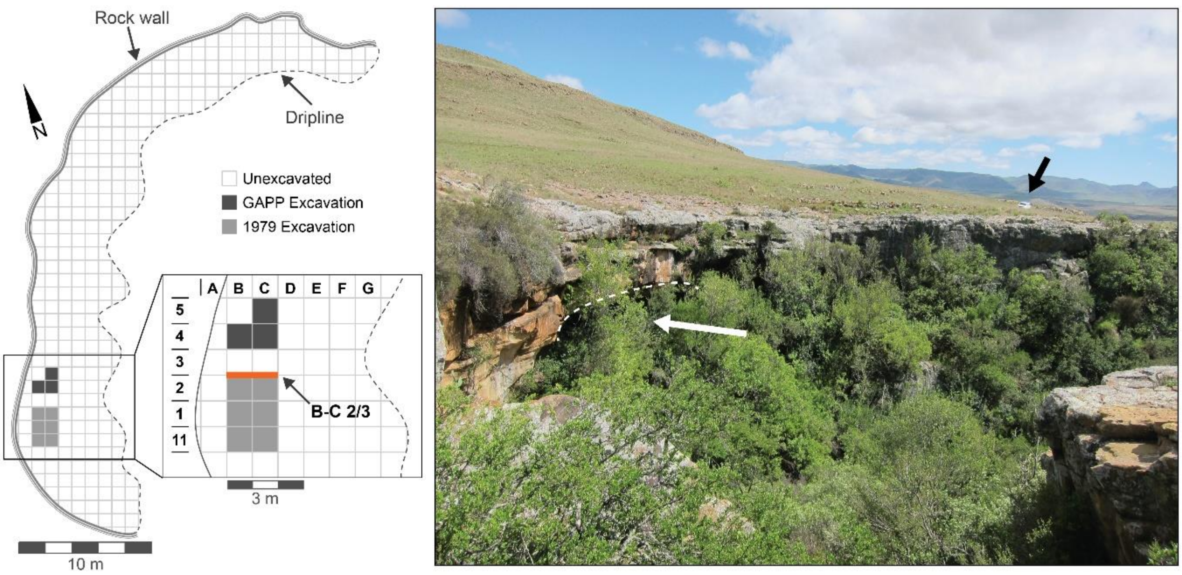


Figure 2: Plan view of Grassridge excavations (left) & photograph of the Grassridge shelter (right) (Collins et al. 2017).

Opperman identified five stratigraphic units within the LSA component (from top to bottom); VB which consists of grey-brown compact loam, dark brown sandy loam- BR, HSK that consists of dark brown sand and AS that is identified as a fine loose sand (Figure 4). Layer LBS lies above a flowstone that is about 1-3cm thick (Ames et al. 2020). With layer VB being the youngest, it is preceded by layer BR and HSK all of which exhibit smaller scrapers mostly featuring end retouch (Opperman 1987). The AS and LBS layers, with LBS being the older, exhibit larger scrapers that are divergent in form and mostly feature side retouch and end retouch (Opperman 1987).

Opperman (1988) identified three MSA stratigraphic layers that are distinguished based on soil colour changes (Opperman 1988). The latest layer is GS which is preceded by layer VGS and layer KGS that lies on bedrock. Layer KGS is described as a brown hardened sandy layer that contains stone artefacts, charcoal, and faunal remains (Opperman 1988). In comparison to that, layer VGS had nearly the same frequency of stone artefacts but a lower occurrence of faunal remains with light brown sand (Opperman 1988). Layer GS which is made up of compact brown sand exhibited the highest frequency of stone artefacts of all three layers (Opperman 1988). The stone artefacts found in the MSA deposit included flakes and blades with parallel convergent sides, unretouched points, and chunks larger than 10mm in dimension (Opperman 1988). Also found were bone artefacts, ornaments of shell and ostrich eggshell beads from the LSA deposits (Opperman 1987). Most notable is the high number of pieces of ostrich eggshells amounting to 4707 fragments including preforms that indicate that bead making was an important activity at GRS (Opperman 1987).

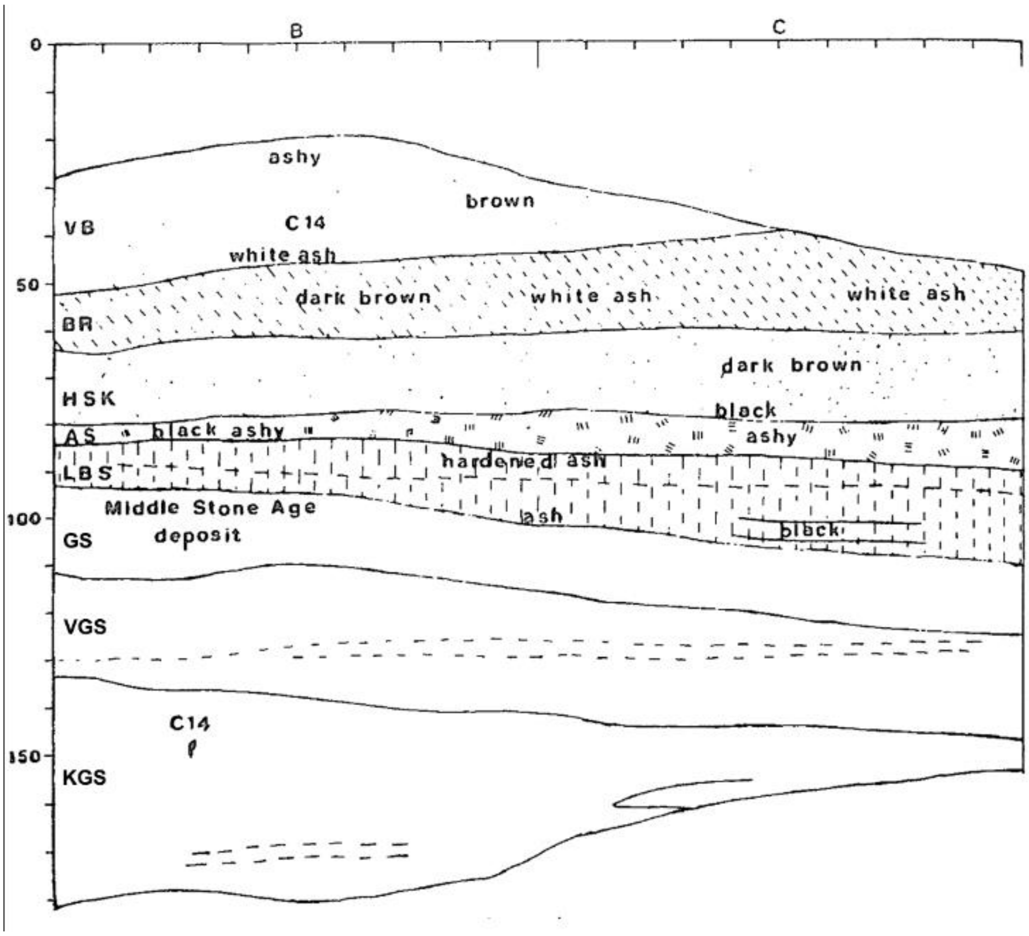


Figure 3: Stratigraphy sketch from Opperman's 1979 excavation (Ames et al. 2020).

2.3 GAPP excavations

The Grassridge Archaeological and Paleoenvironmental Project (GAPP) resumed work at GRS in 2014 with a reanalysis, survey and excavation revealing additional Pleistocene and Holocene archaeological material (Collins et al. 2017). GAPP's excavations initially comprised of a 2m x 1m trench of Squares B4 and C4, with a third 1m x 1m square, C5 was opened in 2016 (Collins et al. 2017). The GAPP reanalysis, including significant additional dating shown here by Figure 4 and 5, distinguished the stratigraphy into three components instead of the two distinguished by Opperman as explained in Table 1 from Ames et al. (2020).

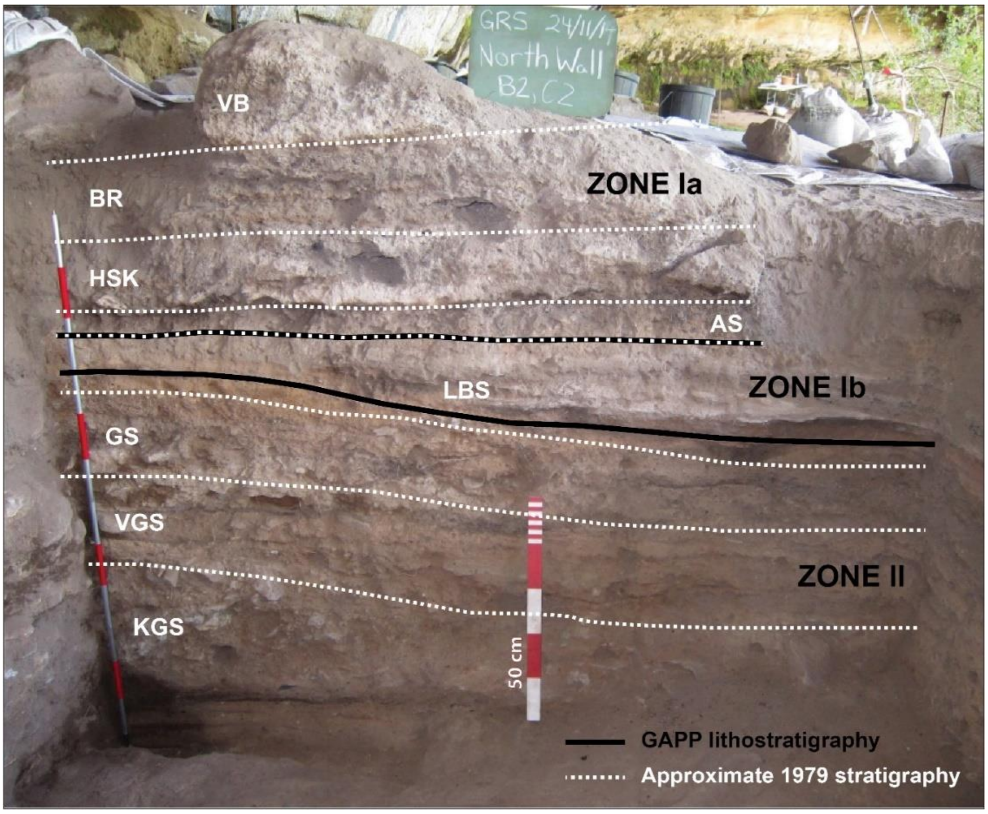
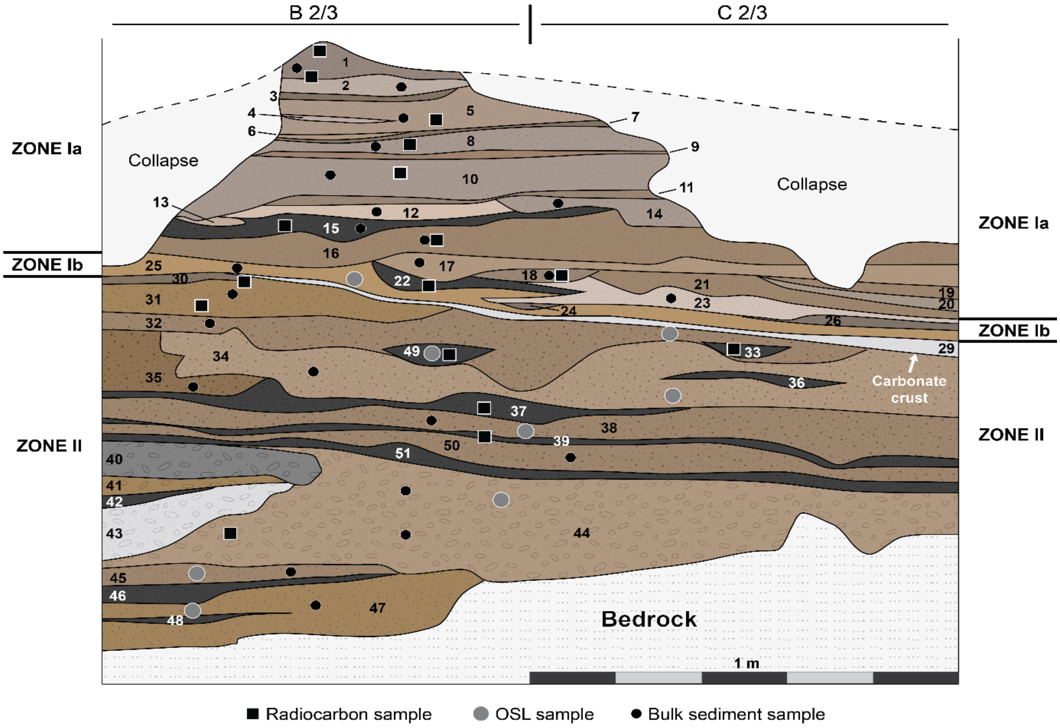


Figure 4: Photograph displaying Grassridge Rockshelter stratigraphy Grassridge Rockshelter,Eastern Cape (Ames et al. 2020).



Figures 5: Drawing displaying the stratigraphy of square B2/3 and C2/3 at Grassridge Rockshelter, Eastern Cape (Ames et al. 2020).

According to the GAPP lithostratigraphy, units VB, BR, HSK and AS were grouped into Zone 1a and unit LBS solely formed Zone 1b (Ames et al. 2020). This distinction comes from the abrupt transition in sediment that separates Zone 1a from Zone 1b (Ames et al. 2020). Layer LBS was later determined to comprise both Holocene and Pleistocene sediments (Ames et al. 2020). Upon reanalysing the stratigraphy, GAPP found that the lower boundary of layer LBS may cross the carbonate crust that distinguishes the two stratigraphic components depicted by Opperman (Ames et al. 2020). The GAPP lithostratigraphy grouped units GS, VGS and KGS into Zone 2 which is separated from Zone 1 (a and b) by the flowstone (Ames et al. 2020). The revised stratigraphy at GRS thereby consists of three sets of occupational layers which are distinguished by two occupational hiatuses, the Late Pleistocene – Zone 2, Terminal Pleistocene – Zone 1b and Mid-Holocene – Zone 1a (Collins et al. 2017). These three occupational groupings are dated: LP (43000 – 28000 years ago), TP (13500 – 11600 years ago) and MH (7300 – 6800 years ago) as expressed in Table 2 in Ames et al. (2020). Lying between the LP and TP occupations is a hiatus spanning 14500 years and between TP and MH occupations lies a hiatus spanning 400 – 500 years (Collins et al. 2017; Ames et al. 2020). Overlaying the MH occupations is the third hiatus reflected in shallow, 2.5cm thick, surficial deposits without artefactual materials (Ames et al. 2020).

The age estimates place the LP occupations within MIS 3 and place the TP and MH occupations within MIS 1, all when paleoclimates shifted from cool and dry to then warm and moist (Barham & Mitchell 2008; Ames et al. 2020). During MIS 1, climate conditions changed following the transition from the Last Glacial Maximum event about 29000 - 19000 years ago (Hughes et al. 2022). Temperatures became somewhat warmer with moister conditions taking hold alongside increases in summer rainfall (Barham and Mitchell 2008; Ames et al. 2020). It is important to note that the MH sediments of the southwest portion of the shelter were formed during intensively repetitive hearth construction, the results of which would possibly be the abrading of some of the TP deposit (Ames et al. 2020). We would then need to be cautious in our interpretations of the MIS 1 being fully depicted by the studied stratigraphy and recognize that the pulsing observed was possibly magnified by these hearth constructions (Ames et al. 2020).

2.4 Summary

Opperman (1984) notes a time lapse between the LSA and MSA layers indicated by the hardness of the older deposits compared to the looser earlier deposits. The mixture of LSA and MSA sediments and artefact materials in layer LBS suggested a slow build-up of deposits to Opperman (1984). This was also supported by the GAPP reanalysis, although there was uncertainty as to how the lower boundary of layer LBS relates to the 1979 stratigraphy demarcation of the same layer (Ames et al. 2020). GAPP depicted the lower boundary of LBS as cutting through Opperman's depiction of the same layer with the hardened ash feature being along the midsection (Figures 3, 4 and 5). This then means that the Zone 1b/2 boundary sits below the carbonate crust (Ames et al. 2020).

Though the Pleistocene and Holocene stratigraphic layers are nearly the same in thickness, the Holocene deposition occurred in a span of 500 years whereas the pulsed deposits of the Pleistocene occurred in a time span of about 16900 years (Ames et al. 2020). The LP deposits have a thickness of 85 cm with a sedimentation rate of approximately 0.06 mm/year (Ames et al. 2020). The TP deposits have a thickness of 10 cm with a sedimentation rate of 0.05 mm/year (Ames et al. 2020). The MH deposits have a thickness of 60 cm with a higher rate of sedimentation of 1.1 mm/year (Ames et al. 2020). It should be noted, however, that because these broad occupation spans were themselves episodic, the sedimentation rates are averaged indications of actual sedimentation through occupation rates.

The *Cymbopogon* (lemongrass), *Olea africana* (wild olive tree), *Kiggelaria africana* (wild peach tree) and *Diospyros lycioides* (blue bush/star-apple/monkey plum) are some of the plants that have been identified within the GRS region and occur in warm and temperate regions (Opperman 1987). The dry *Cymbopogon-Themeda* grass genera also known as the Tsomo Grassland which surrounds the Tarkastad Montane Shrubland region in which GRS is situated, attracts grazers and other territorial species throughout the year (Opperman 1987; Ames et al. 2020). Initial assessments of the fauna found in the Holocene occupations reveal the presence of *Pelea capreolus* (grey rhebok), *Raphicerus campestris* (steenbok), *Redunca fulvorufula* (mountain reedbuck), *Antidorcas marsupialis* (springbok), *Sylvicapra grimmia* (common duiker) as well as larger ungulates such as equids, alcelaphines (wildebeests) and species of small rodents and carnivores (Collins et al. 2017). The faunal remains noted by Opperman (1988) in the Pleistocene occupations, both LP and TP, comprise one *Pronolagus crassicaudatus* (a Natal red rock hare), six *Alcelaphus/Connochaetes* (hartebeest or wildebeest) and one *Redunca arundinum* (reedbuck). The frequency of faunal remains found in the layers of the Pleistocene occupations is much smaller than that found within the Holocene occupations (Opperman 1988).

Also found were bone artefacts, ornaments of shell and ostrich eggshell beads from the Holocene occupations as well as some ceramic sherds and rock art on the large rocks in the front of the shelter (Opperman 1987; Ames et al. 2020). Ochre fragments that were excluded from the inventory were found. (Opperman 1987; Collins et al. 2017). Most notable is the high number of pieces of ostrich eggshells amounting to 4707 fragments including preforms that indicate that bead making was an important activity at GRS (Opperman 1987).

A shift from big game to small game hunting between the MSA and LSA deposits was recognized at GRS with a considerably high minimum number of animals during the Holocene period in comparison to other nearby northern Eastern Cape sites like Colwinton and Bonawe (Opperman 1984). The main raw materials found at GRS were chalcedony, dolerite and hornfels which are readily found with great ease in the area. GRS exhibits a high stone artefact presence in relation to Colwinton and Bonawe (Opperman 1987), with a sample of n = 53801 stone tool pieces related to flaking episodes. Of the occupation layers found at GRS, the LSA layers were noted by Opperman (1987) as having the highest frequency of stone artefacts per unit volume.

In later chapters I report on the analysis of stone artefacts excavated by the GAPP team during their 2016 excavations using only the materials from square B4. This square includes the occupations of the MH, TP, and LP. The analysis will utilize the methodology and terminology outlined in chapters 4, 5 and 6 to showcase macro and micro knapping behaviours that result in stone tool assemblages.

3. Terminological Background

3.1. The Middle Stone Age and The Late Pleistocene

The Middle Stone Age (MSA) was initially defined by Goodwin (1928) who identified it as comprising triangular flakes with convergent dorsal scars and facetted platforms. Prior to the establishment of the MSA, the South African archaeological record was divided into the Earlier Stone Age (ESA) which included Stellenbosch and Fauresmith industries and the Later Stone Age (LSA) that included Still Bay, Wilton, and Smithfield industries. Further study led Goodwin to conclude that the then LSA group consisted of technologically and typologically distinct industries. The LSA was then further partitioned to consist of only the Wilton (possessing small crescents and small scrapers) and the Smithfield (duck-bill shaped end-scrapers) as these industries appeared to be relatively younger than the ESA (consisting of large cutting tools) and the Still Bay (exhibiting bifacial points) (Volman 1981). Goodwin then assembled the Still Bay and other less established industries, all of which notably differed from the ESA and LSA, into what would be known as the MSA (Klein 1975). The MSA therefore, was initially considered to be a transitional period from the ESA to the LSA with each technocomplex reflecting a technological shift from core tools to flake tools to micro tools. The MSA was regarded as comprising flake tools and large flake blades that were often used with or without retouch (Deacon & Deacon 1999) or derived from radial and discoidal core types (Clark 1999). Even though Goodwin (1929) was able to distinguish the ESA, MSA and LSA typologically, he was under the impression that there was possibly temporal overlap between the three kinds of assemblages.

Goodwin made some astute observations on the variability within the MSA designation, with the identification of four variants which he named; the Glen Grey Falls Industry, the Pietersburg, the Still Bay and the Howiesons Poort along with some other variants that he considered to be offshoots from the main four (Goodwin & van Riet Lowe 1929). By naming these variants after their places of discovery, Goodwin (1928) not only suggested that the MSA assemblage was heterogenous through time but, through space as well. Stratigraphy, however, could not support the evidence for some of these variants as Goodwin’s collections were without context (Klein 1975). It was only 40 years after Goodwin had published his works on the MSA that the idea of variation within the MSA was revisited with supporting evidence from excavated MSA sites with well recorded stratigraphy (Klein 1975). Within this same 40-year period, three notable conferences were held that deliberated over and called into question the uses of this culture-stratigraphic schema citing that there was a lack of quality in its definitive application (Volman 1981).

Goodwin's classification of industries was entrenched in the notion that variation existed in the presence and absence of certain tool types such as bifacial points, burins, crescents, and so on. This "index fossil" approach characterized temporal and spatial patterning within the distribution of these tools, much as the presence of segments was considered indicative of an assemblage being Howiesons Poort (Volman 1981). Bishop and Clark (1967:893) stated that an industry is "represented by all the known objects that a group of prehistoric people manufactured in one area over a span of time". Through the progression of research, it has become apparent that there is no clear distinction in industries as there is a higher degree of continuity amongst the stone tool groupings of the ESA, MSA and LSA (Phillipson 2005). Goodwin did suggest that stone tool techniques seen as phenotypically dominant in one period were often foreshadowed in the previous (Herries 2011). This makes the groupings of assemblages into industries more arbitrary than definitive.

As the accumulation of MSA site observations rose, it became apparent that the interpretation of variability was problematic in some instances while in others it seemed reasonable to some extent. In several ways, recent research has seemingly outgrown Goodwin and Van Riet Lowe's initial defining criteria of the MSA by revealing it rather to be a continuous range of sequences through space and time (Phillipson 2005). Archaeologists deemed it better to interpret assemblages as geographical and temporal phases rather than industries or "variants" (Volman 1981). These sequences are better considered as technological patterns of stone tool traditions that have so far presented themselves with varied regional and chronological intensities. An additional resolution to the "index fossil" issue has been to consider the frequencies of other assemblage features such as raw material granularity, blades and cores which provides a more holistic view of assemblages in terms of knapping behaviour.

The MSA was initially equated to the Middle Palaeolithic in Europe as it presented a similar adoption of flake and prepared core technology (Jacob et al. 2008). Partly through climatic correlations with the East African archaeology, southern African MSA dates lengthened from 9000 – 8000 years ago to about 24000 – 10000 years ago (Jacob et al. 2008). Well into the 20th century, carbon-based chronologies pushed and expanded MSA dates further back in time to ~40000 – 10000 years ago (Jacob et al. 2008). The MSA chronology was further extended by utilizing dating methods outside of radiocarbon dating such as Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL) dating which situated the MSA between 300000 to 25000 years ago in southern Africa and to about 20000 years ago in some regions that include eastern Africa (Lombard et al. 2012; Dusseldorp et al. 2013).

The MSA and LSA both occur over the Late Pleistocene period (~129000 – 11700 years ago) which has been marked by an increase in technological and symbolic complexity. This observed increase in complexity resulted in a myriad of toolkit phases that, for spatio-temporal recognition purposes, have been identified as: MSA I or MSA 2a (Klasies River unit), MSA II alternatively known as MSA 2b (Mossel Bay unit), Still Bay, Howiesons Poort, "post-Howiesons Poort", "late MSA" and "final MSA" (Singer & Wymer 1982; Mackay et al. 2014). It is also important to note that the phases that follow the "final MSA" namely, early LSA and Robberg also occur within the Late Pleistocene but will be discussed in the next section (2.2). The frequent occurrence of lithic typological characteristics over large areas are used to identify these phases. Some of these characteristics include raw material selection, knapping systems and implement types (Mackay et al. 2014). MSA I, MSA II, the Still Bay (SB) and Howiesons Poort (HP) phases have all been the focus of much of the archaeological research in the past 50 years (Lombard 2005; Minichillo 2006; Jacobs et al. 2008; Villa et al. 2010). The same has yet to be said of the phases that postdate the HP. As of now, these phases utilize catch-all labels to group the lithics in a semi-scientific manner (Will et al. 2014).

More pertinent to this paper are the phases that succeeded the HP or otherwise collectively known as the "post-HP" (Will et al. 2014). Due to the current informal use of this term, "post-HP" not only refers to the earlier phases of the Marine Isotope Stage (MIS) 3 observed in the period between 60000 - 25000 years ago, but it also serves as the label for the sole unit that immediately follows HP at about 58000 years ago (Will et al. 2014). Located in the eastern region of southern Africa, at a long-sequenced cave site of Sibudu, Wadley and Jacobs (2006) distinguish the singular unit "post-HP" followed by the "late MSA" at ~48000 years ago which in turn is superseded by the "final MSA" at ~38000 years ago. Wurz (2013) denotes the lithic technologies that occur between 58000 and 45000 years ago as the "post-HP" which she described as having points that are often unifacially retouched with faceted platforms as seen at Klasies River (Singer & Wymer 1982), Umhlatuzana (Kaplan 1989), Rose Cottage Cave (Wadley 1993), Diepkloof (Porraz et al. 2008), Sibudu Cave (Wadley

2005), Klein Kliphuis (Lombard et al. 2012) and Border Cave (Villa et al. 2012). This understanding of the “post-HP” is also supported by Lombard et al. (2012) who followed up with a “final MSA” interpreted date of 40000 – 20000 years ago. It was associated with a wide variety of point types that were hollowed-based and either bifacial or unifacial (Lombard et al. 2012). Alternatively, at Border Cave Beaumont (1978) noted that it was the early LSA (ELSA) that appeared at ~40000 years ago presenting with a significant number of MSA typified features plus small irregular microlithic quartz flakes produced by bipolar reduction with a small yield of retouched tools including *outils écaillées*. Villa et al. (2012) extended the ELSA date at Border Cave to ~43000 years ago to include microlithic blades that along with small flakes, may have been hafted with bark resin to *Podocarpus* (yellowwood) wood shaped into handles. It is quite evident that the schema used to divide the Late Pleistocene into identifiable phases persist in varying sequences in different sites (Mackay et al. 2014).

It has been suggested that the transition from MSA to LSA may not have been a swift one as the MSA may have persisted longer in more isolated interior regions (Thackeray 1992; McCall & Thomas 2009) while in others the MSA terminated or rather decreased in morphological frequency much more rapidly. This lends itself to further inconsistencies within the sequences seen across southern Africa where the continuity of technological elements is concerned. The need for further spatio-chronological study is highlighted by Wurz (2013:9) stating that technological trends (where bladelets, scrapers, denticulates and retouched points form part of toolkits) were more apparent in MIS 4 (74000 - 61000 years ago) than in other periods most likely due to a higher degree of critical examination being focused on MIS 4. These technological elements have been noted in MIS 8 (~300000 – 245000 years ago), MIS 7 (244000 – 191000 years ago), MIS 6 (190000 – 131000 years ago) and MIS 5 (130000 -75000 years ago). Utilizing the assemblage from Umhlatuzana in KwaZulu Natal, Kaplan (1989) suggested that the MSA/LSA boundary did not reflect a sudden change in trends but rather a broad continuity in toolkit transitions. Deducing from the works of Kaplan (1989) and Clark (1997) as well as a few others working from various sites (Singer & Wymer 1982; Deacon & Deacon 1999; Mitchell 2002; Wadley 2005), McCall and Thomas (2009) surmised that the terminal MSA phase which consisted of retouched points and backed tools with Levallois techniques persisted until 28000 years ago in the eastern region of southern Africa.

3.2. The Later Stone Age and The Terminal Pleistocene

In most parts of southern Africa, the transition from MSA to LSA took place between about 40000 -18000 years ago (Clark 1999; Deacon & Deacon 2003; McCall & Thomas 2009; Dusseldorp et al. 2013), apart from Border Cave which saw the appearance of the ELSA considerably earlier at ~43000 years ago (Villa et al. 2012). This transitional phase is marked by the expansion of LSA lithic production techniques integrated with MSA formal tools (Clark 1999). Rose Cottage Cave exhibits a discrete industry within 20000-year-old levels that cannot be identified with the current defining criteria of the MSA or the LSA but can be described as transitional (Clark 1999).

These observed changes in the tools are associated with changes in other facets of hunter-gatherer material culture. The stylistic features that distinguish the LSA subdivisions represent the way in which people living in the region over a period preferred to make their stone tools (Deacon & Deacon 1999). Each of the LSA subdivisions group together assemblages in which the frequency, size, and style of certain formal tools as well as the raw materials selected, and the shape of the flake blanks are broadly similar. LSA people are mostly thought to have made microlithic tools and large scrapers and adzes, few of which flake and bladelets would receive secondary retouch (Deacon & Deacon 1999). The innovations associated with the LSA include microliths which measure < 25mm with some of them being fixed to handles with mastic (Deacon & Deacon 1999). Bored stones that function as digging-stick weights, grooved and engraved stones, painted stones, polished bone tools as well as decorative items, rock art and formal graves are found in stratigraphic layers that are both MSA and LSA (Deacon & Deacon 1999). The origins of these innovations are unclear as several of these features, such as engraved and painted stones, stone tools fixed to handles, decorated ostrich eggshells and polished bone tools are found within MSA and LSA assemblages (Deacon & Deacon 1999). These innovations may not be innovations but are items that have become increasingly common.

As mentioned in subsection 3.1, the ELSA (40000 – 18000 years ago) and Robberg (18000 – 12000 years ago) phases occur within the Late/Terminal Pleistocene (Lombard et al. 2012). The ELSA period highlights the beginning of the co-existence of both the MSA and LSA assemblages, as these seem to overlap during this period. Based on techno-typology, the MSA to LSA transition was a moderate occurrence that saw an increasing shift to LSA lithic production with the preference for MSA techniques still evident (Clark 1999). It is often unclear whether assemblages seen between 40000 – 18000 years ago represent an actual archaeological phase or if it is simply a mixture of LSA and MSA artefacts (Dusseldorp et al. 2013). This is a contentious period, as there are few assemblages that date to this time and dating methods have not yielded consistent results (Wadley 1993).

Wadley (1993) concisely assesses three interpretations of this period, one of which being a non-microlithic MSA assemblage that survived until about ~20000 years ago, the second being that no MSA/LSA boundary really exists at that point in time and the third being Beaumont's (1978) description of the Border Cave assemblage that suggests that the ELSA appeared at ~39000 years ago. Some evidence for the MSA surviving until much later in the Late Pleistocene has already been touched on in subsection 3.1 as indicated by the "final MSA". A few of the sites that present these late MSA dates in the eastern regions of southern Africa are Sehonghong, Rose Cottage Cave and Grassridge Rockshelter (Wadley 1993). Some Robberg assemblages have been recorded featuring significant macrolithic elements further highlighting how MSA technology persisted till much later in the record (Dusseldorp et al. 2013).

The idea of the MSA/LSA boundary being blurred stems from the apparent overlap of MSA and LSA markers, where LSA labelled tool techniques (i.e., bladelets of single platforms and bipolar cores) are observed earlier in the MSA (Kaplan 1989). This suggests that the MSA and LSA tools had co-existed rather than there being an abrupt transition. Kaplan's (1989) notion of this has been met with some doubt following the slumping of the deposits at Umhlatuzana (Wadley 2005). In some respect, if it is true that macrolithic elements considered to be MSA technology are recorded in the LSA periods and microlithic elements considered to be LSA technology are recorded in the MSA periods then the suggestion of the existence of an MSA/LSA boundary is weakened. Beaumont (1978) at Border Cave initially classified the ELSA as the MSA/LSA transition. In some texts the ELSA is documented as exhibiting small irregular flakes and blades, non-microlithics, low quantities of formal tools, small bipolar cores as well as scrapers, scaled pieces, microliths and non-facetted platforms (Beaumont 1978; Wadley 1993; Deacon & Deacon 1999; Barham & Mitchell 2008; Villa et al. 2010; Lombard et al. 2012). The high variability of tools within this time period has been a source of dispute in what exactly constitutes the ELSA. In part with having unstandardized characteristics, this assemblage also has been given an informal designation (Lombard et al. 2012).

The Robberg, in contrast to the ELSA, has been documented as having a more definitive and punctuated occurrence in South Africa as well as Lesotho and Swaziland (Barham & Mitchell 2008). The assemblage was named after the Robberg Peninsula, with Nelson Bay Cave being the site where the industry was first officially recognized (Wadley 1993). The Robberg assemblage in most sites has a relatively high incidence of small bladelets averaging about 16 mm long (with some exceptions being Elands Bay Cave, Siphiso, Byneskranskop and Kangkara), bladelet cores that are often single-platform or flat and significantly few standardized retouched tools such as small scrapers, segments and backed bladelets (Wadley 1993; Deacon & Deacon 1999; Phillipson 2005; Barham & Mitchell 2008).

With respect to raw material, quartz, silcrete and other cryptocrystalline rocks were preferred as opposed to macrocrystalline ones such as sandstone (Deacon & Deacon 1999; Low 2019). Sites like Sehonghong and Rose Cottage Cave boast a significant frequency of flake-blades, also small (Wadley 1993). In numerous texts the Robberg is described as a bladelet-rich industry due to its high frequency of small blades. At Umhlatuzana, however, Kaplan (1989) makes the distinction between an early Robberg occurring before 13000 years ago with the common use of bipolar flaking, and a later Robberg seen between 13000 - 9000 years ago with naturally backed knives. Low (2019), using Klipfonteinrand Rockshelter information supported this distinction by stating that the differences between the early and later components in the Robberg lies within the raw material selection and artefact size.

3.3 The Later Stone Age and The Holocene

The more widely accepted date that saw a significant decrease in the presence of Robberg tools (12000 years ago) also saw the ushering in of its Holocene LSA successor, Oakhurst (Albany). However, at Klipfonteinrand Rockshelter in the eastern Cederberg, Western Cape, the Oakhurst phase is seen to replace the Robberg at ~14400 years ago while in the south-eastern region the Robberg persisted until 9500 years ago (Barham & Mitchell 2008; Mackay et al. 2020). The Oakhurst is generally considered to be present from 12000 – 7000 years ago and differs from the Robberg in demonstrating a preference for larger flakes and formal tools as opposed to bladelets (Deacon & Deacon 1999; Barham & Mitchell 2008; Lombard et al. 2012). These preferences are reflected in the Oakhurst being considered as a non-microlithic, bladelet-poor industry (Wadley 1993). The most notable lithics are large D-shaped scrapers, adzes and naturally backed knives with the most consistently dominant raw material within the Oakhurst phase being quartzite (Deacon & Deacon 1999).

There is a technological transition at ~8000 years ago, with the appearance of small scrapers (commonly thumbnail-shaped) and a variety of backed tools and segments in high frequencies that characterises the Wilton (8000 - 4000 years ago) (Deacon & Deacon 1999). Often described as the Holocene microlithics, the Wilton assemblage exhibits small and standardized bladelets with the increased use of finer grained raw material (Barham & Mitchell 2008). In the LSA as in the MSA, these apparent subdivisions seemingly group together assemblages across space and within time periods by use of frequency, size, style, and raw material of certain formal tools. These groups are then considered as complexes and/or traditions that formed part of the expressions of the cultural groups throughout the landscape. The following section explores possible ideas around lithic expressions through the approach of cultural transmission and social learning (Eerkens & Lipo 2007).

3.4 Social Learning and Cultural Transmission

Artefact dimensions, including form, function and style have traditionally been used to establish chronologies by comparing similarities in assemblages (Eerkens & Lipo 2007). The arguments follow that, artefacts that display many similarities were manufactured at similar times in the past. These similarities develop into sequences which are then comparable across space and over time. To better understand why artefacts exhibit similarities, variability, and relatedness in dimensions, we also need to understand why artefacts change, a question which is the focus of cultural transmission theory (Eerkens & Lipo 2007). Evolution functions through three components being transmission, generation of variation and variant differentiation (Lewontin 1974). Evolutionary theory operates within the framework that the relation between artefacts is most likely caused by the exchange of information through social learning. A society’s ecological success is majorly dependent on the efficiency of information transmission necessary for cumulative culture (Fogarty et al. 2015).

Inheritance materializes through two mechanisms namely, genetics and culture, the latter being the impression on behavioural traits within cultural transmission (Eerkens & Lipo 2007). Cultural traits can both shape and be shaped by genetic evolution resulting in a relationship between tool making and cognition (Morgan et al. 2015). Culture is prominent in the generation of human behaviour and cultural transmission theory serves as a means of joining the measure of behavioural similarity and depictions of historical relatedness. Historical relatedness and behavioural similarity are key aspects in material culture studies making cultural transmission theory appropriate for this archaeological investigation.

Convergence in evolutionary studies serves as a phenomenon where similar behaviour may evolve in different groups independently to solve similar needs, shying away from historical relatedness (Eerken & Lipo 2007). This can also be explained by the organism-in-environment system which sees skill acquisition as a dynamic process of learning how to act to resolve a problem (Stout 2002).

As information is acquired through constantly changing worldviews, modified under individual perception, and passed on, a complex interaction between individual experimentation (i.e., innovation) and social learning (i.e., copying/teaching) takes place to produce the extensive cultural and social behaviours which we interpret from human material remains (Eerkens & Lipo 2007). The best-preserved of these material remains being stone tools, means that stone tool assemblages are an excellent candidate for investigating Palaeolithic behaviour and cognition (Stout 2002). Sites with long archaeological sequences and high-resolution chronologies have the potential to track continuity and change in cultural information transmission through populations over long periods of time. Though GRS is not a site that has a long archaeological sequence with consistent occupation, its use in this research has the propensity to showcase cultural transmission between the three stone tool assemblages.

The incorporation of multiple techniques to produce lithic technologies implies that tool making was learned and required considerable practice (Morgan et al. 2015). The exchange of raw materials over long distances and stylistically distinct categories of tool production showcase evidence of symbolism within cultures and linguistics in the transmission of traditions (d'Errico et al. 2003). Emulation or copying is considered by Morgan et al. (2015) to be the minimal form of transmission while teaching, which would require speech and symbolic gesturing, is regarded as the pinnacle. Manufacturing techniques that reflect social value more so than utilitarian function represent symbolic behaviour and require language to be maintained as a tradition within a given society (d'Errico et al. 2003). Some of these behavioural performances include complex burials, use of pigments, rock art and engraving of stones. System manufacture that is learned by non-linguistic emulation often presents standardised products mostly within dominant items (Noble & Davidson 1991).

As with other technical skills, stone knapping being a learned skill occurs within highly structured social and physical contexts (Stout 2002). These contexts are shaped by genetic diversity and the adaptive behaviours that are influenced by what Stout (2002) refers to as "organism-in-environment system" (Stout page 694:2002) which incorporates thinking and performance. Considering these dynamics, it would be too simplistic to advocate for a co-evolutionary relationship between toolmaking and cognition. The Pleistocene period sees the intensification of genetic diversity and adaptive behaviours with the emergence of speech, new forms of cognitive reasoning, projectile tool technology and environmental ecological subsistence strategies (Tostevin 2012). Archaeology, though sometimes lacking in fossil evidence, provides a means to interpret these important and complex evolutionary questions with the use of sound methodologies and objective definitions. Even though stone tools provide an alternative to the assessment of cognitive complexity, the quantification of behavioural complexity has been difficult to achieve (Muller et al. 2017). Studies of lithic tools which partly reflect social behavioural performances across time and space have the propensity to inform on the cultural frameworks and evolution of technical acts of past populations.

3.5 Fallacies Surrounding Stone Artefacts and Assemblages- A subsection inspired by Harold Dibble.

There are some points in archaeological lithic analytics where interpretive methods could be considered assumptive. Dibble et al. (2017) identifies these problematic areas as being the definition and conceptualization of stone tool items and their relation in archaeological groupings such as assemblages/industries/techno-complexes. Archaeologists have distinguished stone tools by shape for which they then assign modes of utilization. Identifying a stone tool morphologically and linking it to specified mode of function raises issues in several ways.

For one, the state of a stone tool can be altered by sharpening and remodification about as many times as it is picked up throughout its lifespan (Dibble et al. 2017). Any number of lithic morphologies or shapes can be repurposed for any single task. Secondly, a single lithic morphology can be used for various tasks as demonstrated by ethnographic studies (Dibble et al. 2017). This illustrates that the intrinsic characteristic of a stone tool cannot simply be reduced to the shape of it but possibly the edge quality and/or size are the primary factors (Dibble et al. 2017). All of this leads us to the understanding of the "finished artefact fallacy" where the morphology of a stone tool is probably never in its final and "finished form" with an exclusive purpose because its form and function is fluid (Davidson & Noble 1989; Dibble et al. 2017).

The popular understanding of a stone tool assemblage is that the accumulation of the objects found was achieved by the disposal of them taking place in a confined space of time resulting in a stratigraphic occupation (Dibble et al. 2017). Archaeologists then assume the tendency of addressing these accumulations as somewhat isolated representations of periodic performances that took place in the past. Narratives then ensue, including the categorization of site type (i.e., kill or residential site) based on inferred activities of hominin groups or even an individual and together with their perceived landscape movements (Dibble et al. 2017).

With a more careful perception of lithic assemblages, the fallacies that arise result from the neglect of the many other processes that could occur to yield the contents of stratigraphic sequences. As fluid as a sole stone tool can be within its lifespan, so too can an assemblage with the continual addition and removal of objects –those objects themselves being picked up and remodified while some are picked up and never returned – throughout the formation of the assemblage (Dibble et al. 2017). As assemblages form within or rather alongside the deposition of sediment, additional geological processes such as erosion and weathering occur resulting in the shifting/removal of objects and the altered physical state of the objects through wear and breakage that all ultimately affect the composition of the assemblage (Dibble et al. 2017).

As previously mentioned by Dibble et al. (2017), there have been ethnographic studies that have shown that the edge characteristics of a tool were more regarded than the overall shape of the tool. Rezek et al. (2018) support that the amount of sharp working edge derived from a stone has evident adaptive advantage over other stone tool morphologies and production techniques. It has been widely considered that the sharpness of stone tool edges reduced costs in time and energy for hominins while providing access to resources and increasing their overall fitness within prehistoric environments (Blumenschine & Pobiner 2007; Zink & Liebermann 2016). In addition to these advantages, the increased amount of sharp edge per size of a tool is linked to the reduced cost of lithic raw material resource acquisition and transport (Rezek et al. 2018).

The characteristics of lithic raw material – i.e., hardness, crystal form and cleavage/fracture - serve as factors in the knappability of tools and have the propensity to dictate the quality of sharp edge achieved. These characteristics are pertinent to the efficiency and durability of a tool (Gummesson et al. 2017). It has been shown that for a knapper to increase the amount of sharp edge, the platform angle would have to be increased without increasing the platform depth (Rezek et al. 2018). A minimised platform depth results in smaller flakes and minimum raw material utilized to achieve maximum sharp edge. The geographical distribution patterns of raw material sources account for the mobility and procurement strategies seen in hominin groups/individuals (Gummesson et al. 2017). Thus, if knappers were in favour of a sharp edge then reduction in raw material waste whilst maximising sharp edge and minimization of the amount of raw material transported would be obvious benefits.

In addressing some of these fallacies of lithic assemblages, a considerable amount of effort has been made by researchers to integrate sophisticated quantitative methods that account for lithic variation in raw material selection and reduction strategies. Though various paradigms can be employed within these quantitative research methods, standard units of technological attributes are utilized (Scerri et al. 2015). Technological units form knapping sequences that can be identified through the examination of tool manufacture. Analysing stone tools on the level of technological traits or attributes instead of the overall shape enables an investigation to bypass the issues of lithic fallacies. Quantifying platform maintenance and observing how platform angle, platform depth (thickness) and platform treatment relate to length and width helps focus an investigation on the characteristics of a stone tool. With the inclusion of other composite features such as raw material and dorsal scar direction, proxies for knapping behaviour can be established to demonstrate lithic variability and central tendency (Tostevin 2012). Depending on the research question, analytical paradigms can be followed (using statistical models) to analyse lithic proxies along their morphological diversity, mechanical relationships, and reduction sequences to better understand the character of lithics chronologically and geographically (Iovita 2011; Tostevin 2012; Scerri et al. 2015). This is the program that will be followed in this study, utilizing Tostevin’s (2012) methodology on three GRS lithic assemblages.

4. Methods

The lithic sample (n= 3824) presented here is from the GAPP 2014 - 2016 excavation in GRS and comes from the 1m x 1m square B4 only. This square captures MH, TP, and LP occupations. The sample was partially analysed in 2015 by Collins et al. (2017) and the resulting observations have been incorporated into the results of this thesis. This partial analysis was of piece-plotted stone tools from the TP and MH occupations. My analysis includes all the LP and TP, as well as a sample of the MH sieved stone tools. Analyses were not performed on all MH sieved stone tools due to time constraints. To ensure fair statistical testing between the LP, TP, and MH occupations, the database was filtered to exclude the piece-plot stone tools that shared the same contexts with the sieved stone tools that were not analysed. Each lithic artefact is identified by the context and spit from which it was excavated, whether having been piece-plotted or sieved. During analysis, the lithic artefacts are then more specifically identified using a coding system with each stone tool assigned a unique identity number. The lithic artefacts are also studied using typological assignment and a metrical analysis, thus making the overall methodology used a combination of qualitative and quantitative observations.

In categorising and deriving information from the lithic material, the Pinnacle Point 5 - 6 Lithic Analytical Methods with trait interpretations defined by Wilkins et al. (2017) were used. The Pinnacle Point 5 - 6 Lithic Analytical Methods includes more than 90 lithic trait definitions that were collected from the study of the North Long Section of Pinnacle Point 5 - 6 and then developed into a coding scheme. This coding scheme is then used in conjunction with an open-source data entry program known as E4 designed by Shannon McPherron and Harold Dibble (https://www.oldstoneage.com/osa/tech/e4/). The use of the trait definitions programmed into E4 allows for a standardized approach to the analysis of the lithic material and a minimized rate of error.

A part of standardization of error is attributed to how the traits are organized as categories within the program. With the use of a configuration file, variables to be entered are specified and requested by type, be it text or numeric. The categories are arranged in a manner that complements the program’s ability to skip certain variables based on values entered in preceding variables in accordance with conditional statements. The first few categories determine the identifying variables such as site, square, quad, context, and spit names along with the date of analysis, unique item number and researcher name. Then these are followed by several categories that determine primary typologies such as raw material and lithic artefact type, completeness, retouch presence and cortex area. These variables, excluding raw material type, lead to conditional variables. Based on these primary typology inputs, the analyst is led into numerous categories that determine secondary typologies and metrical variables guided by an altering control flow. In instances when the analyst is unable to identify a certain attribute, “indeterminate” is offered as an input in relevant categories. All the recorded information is automatically saved by the program as a MicroSoft Access file to be statistically worked on with the use of MicroSoft Excel and the Past program.

Within this analysis, I have made use of the extensive/full and the simplified version of the E4 coding scheme, (the extensive version for piece plotted lithics and the simplified version for the sieved lithics). The simplified version differs from the extensive version in that it excludes some of the secondary typological and metrical variables. Some of these subcategories include completeness, cortex shatter, evidence of post depositional burning, dorsal scar count, profile shape, flake termination type, platform width, angle and delineation as defined by Soriano and Villa et al. (2007), diagnostic impact fractures as defined by (Fischer et al. 1984) and Volman type as defined by the (Volman 1981) paper. The decision to use the simplified E4 version was taken because the assemblages contain large amounts of smaller debitage pieces and with its use, the analysis was significantly completed within the time constraints of this master’s thesis. Even though a subsample of the traits from both versions will be featured in the analysis, to record all the sub-categorical traits will prove useful in future inter- and intra- site comparative studies. All observations will also contribute to the Eastern Cape lithic database. The characteristics used within the encoding scheme are those that typify Howiesons Poort assemblages but for this analysis, LSA typological terms and traits such as retouched piece, scraper, adze, and bored stone typology were added to the data base. With respect to material management, about 80% of plotted lithics were washed with the other 20% set aside for residue analysis for future projects.

This research also incorporates the lithic analytical method presented by Tostevin (2011) as it utilizes the typological and metrical variables already present in this data to attempt to answer the bigger questions on lithic cultural diffusion within and between human groups. To do this, the Tostevin (2011) approach works to characterize each technical choice within the reduction sequence by means of its variability in the assemblage. It is through the measurement of variability of traits in the sequence that it is possible to conduct a culture evolutionary study of how knapping behaviours can change through time (Tostevin, 2011).

This views technological sequences as reactions to situations encountered in the stages of production, use and discard within tasks conducted in the environment. To determine cultural transmissions through knapping behaviours, the study must utilize the smallest units of analysis focused on the morphological observations of the artefacts (Tostevin, 2011). These small units of analysis must not only serve as measurable artefact features for archaeologists to repeat across numerous assemblages, but they must also serve as proxies for what a learner knapper saw as they observed a teaching knapper during the process of transmission (Tostevin, 2011).

Tostevin (2011) considers these measurable artefact features to represent clusters of knapping choices which when made on a flake-by-flake basis are called *tactical choices* whereas when made once or twice per core can be called *strategic choices*. He then grouped both types of knapping choices as *knapping domains* (Tostevin, 2011). Platform thickness, exterior platform angle and platform preparation fall under tactical choices and together compose the *platform maintenance domain*. The length/width ratio which reflects the longitudinal extent of the surface of a flake, the width/thickness ratio which reflects the vertical convexity of the mass removed, the cross-section type which represents the number of dorsal ridges that define convexity, as well as the lateral edge type that represents the longitudinal shape of the surface and finally the profile type that reflects the curvature of the core surface all amount to the five variables that make up *dorsal surface convexity domain*. The five variables of dorsal surface convexity are also considered by Tostevin (2011) to fall under tactical choices.

The cluster of choices that are thought to be made within core reduction have been termed by Tostevin (2011) as the *core modification domain* and *direction of core* exploitation. Core modification is the decision of raw material orientation as a core and the responsive methods of repairing and upholding convexities (Tostevin 2011). Direction of core exploitation depicts the dominant directions of debitage removal during the early and late stages of core exploitation grounded in the review of the correlation of length with dorsal scar patterns of debitage (Tostevin 2011). Tables for dorsal scar patterns by blank length quartiles depict dominant core exploitation directions in bold. Dorsal scar pattern values that are within 10% of each other in each intra-quartile are identified as central tendency of that group (Tostevin 2012). For this study I have applied the platform maintenance domain, the dorsal surface convexity domain without the cross-section and lateral edge type, and the direction of core exploitation but excluded the core modification domain. These exclusions exist because these choice analyses exceeded the scope of this study, but their absence does not affect the overall integrity of the study as Tostevin (2011) has shown that there is relative functional independence between the domains. These paradigms of analysis will be applied to the comparison of the LP to the TP assemblage, and the TP to the MH assemblage.

In addition to the desktop computer that was used to record the observations through the E4 program, the other apparatus used include electronic callipers, scale, and a magnifying glass. The comparative portion of the study will encompass the use of the Chi-square and t-test statistical measurements that will feature the raw material types, retouched tool frequencies, blade frequencies as well as the blade technological width frequencies. Statistical tests will also be used to measure the variabilities within the knapping domains of platform maintenance, dorsal surface convexity and direction of core exploitation which stem from the Tostevin (2012) middle-range approach. Tostevin (2012) notes that it is acceptable to test non-normally distributed variables with a student’s t-test. This is even in despite of its mathematical derivation from the assumption of normalcy (Tostevin 2012). It is important to mention that all the Chi-square tests that appear in this thesis were conducted under the 95% confidence level.

The comparison of raw material count will provide a sense of the occupants’ interaction with the landscape of the site in relation to procurement. There is a high presence of hornfels outcrops at the GRS site that occur alongside Karoo dolerite inclusions from which it develops under high temperatures (Collins et al. 2017). Other raw material types from the Karoo region around GRS include chalcedony and quartz-rich sandstones. The results of this raw material comparison could also highlight how hominin procurement strategies relate to raw material economy with respect to knapping quality and durability.

Retouched tools will be further explored with regards to the presence of scrapers, backed tools and segments. Cores were quite few and not closely studied in this thesis as they fell outside the scope of this research. It is possible that with the small sample of cores and retouched tools exhibited in this study, that these tools were being made at GRS but were migrated to secondary locations. Two of the three GRS time periods of this research are of the LSA according to the dating. It is imperative that this study explores the nature of the Terminal Pleistocene and Mid-Holocene phases to discern their relatability to the various industries (e.g., eLSA, Robberg, Oakhurst, etc) from neighbouring sites that have already been established. Part of this will also include the analysis of the size of the blades by statistically comparing the technological width frequency and width/thickness ratio to determine whether they are microlithic, smaller than 12mm in width (Pargeter 2016), as this is characteristic of the LSA. In a broader sense, the frequency of blades in relation to flakes will be analysed as an indication of whether the assemblages are blade rich.

The statistical analysis will inform the study of the knapping behaviours of the occupants of the three assemblages and how they compare across time. According to Tostevin (2012) the platform treatment domain is associated with the mass of the blank removed from a core. Platform preparation informs the exterior platform angle which when coupled with platform thickness control the length and thickness of the resulting blank removed. The dorsal surface convexity system relates to the shape of the blanks removed (Tostevin 2012). The recording of dorsal scar pattern is notably a small sample and due to weathering and mechanical damage, the dorsal scar patterns were undetermined. The length/width ratio known as the longitudinal convexity indicates whether we are observing flakes or blades within the assemblages which aligns itself with the blade frequency comparisons. Length/width ratios of 2 or higher are indicative of blades as blades are twice as long as they are wide. The width/thickness ratio or the vertical convexity inform the study of the thickness of the blank tools in the assemblages. The direction of core exploitation explores the variability that results from different employments of blank removal techniques relative to core rotations (Tostevin 2011). This serves as an indicator of the stylistic preferences of the knappers from these three time periods.

5. Results

5.1 Assemblage Descriptions

Late Pleistocene (~43000 – 28000 years ago)

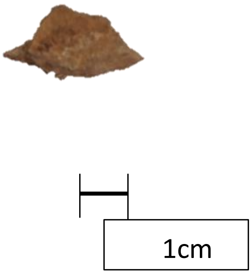
The analysis includes 1757 Late Pleistocene (LP) lithics. Raw material selection for the LP assemblage focuses on hornfels (78%, n=1370/1757, Table 1) and dolerite (7%, n=119/1757), with lower frequencies of sandstone (5%, n=92/1757), chert (0.9%, n=15/1757), and chalcedony (0.05%, n=1/1757). The LP assemblage primarily represents a flake-based industry. With the exclusion of shatter pieces (n=906), the assemblage consists of 46% complete flakes (n=391/851) and 37% flake fragments amounting to 317/851 (Table 1). Blade and blade fragments make up 16% (n=135/851) of the assemblage (Table 1). Blade widths smaller than the bladelet cut-off size of 12mm (Pargeter 2016) make up 33% of the blades measured (Figure 7). Included in the assemblage is a single hornfels retouched piece (0.12%, n=1/851) that was classified as indeterminate. There are 65 unretouched points (7.7%, n=65/843) found in this assemblage. Cores are rare (0.23%, n=4/851) and are all made of hornfels.

Flakes and blades were primarily removed from core surfaces with bi- and unidirectional flake scars (n=99, Table 2). This strategy was employed from early to late in the reduction sequence, as indicated by dorsal scar pattern frequencies, which are similar for large and small blanks. It is noted that this sample size is small. The LP assemblage shows that 60% of the platforms predominantly have no preparation, with 33% of the platforms having residual faceting and 7% of the platforms were facetted with the negative bulb of percussion intact (n=588). Considered thick and steep, the platforms on average measured at 6.3mm (standard deviation:3.19mm, n=206) with external platform angles of 94° on average (standard deviation:15.2°, n=207). Blank profiles are mostly flat (46%, n=78) and curved (39%, n=65) with 15% (n=25) being twisted. The blanks have a width to thickness ratio of 3.4 and a length to width ratio of 1.7. This results in mostly elongated flakes with 27% of these blanks measuring higher than the laminarity of 2 which is a blade cut-off. The laminarity and vertical convexity in this assemblage results in thick and long blanks.

Table 1: Late Pleistocene raw material types by artefact classes.

	Chalcedony	Chert	Dolerite	Hornfels	Ind	Other	Quartz	Sandstone	**Total**
BladeBladefragment		1	3	127				4	**135**
CompleteFlake		6	27	300	34	8		16	**391**
Core				4					**4**
FlakeFragment		4	8	290	8	3		4	**317**
HammerManuportGrindstone						3			**3**
RetouchedPiece				1					**1**
Shatter	1	4	81	648	89	13	2	68	**906**
Total	**1**	**15**	**119**	**1370**	**131**	**27**	**2**	**92**	**1757**

A



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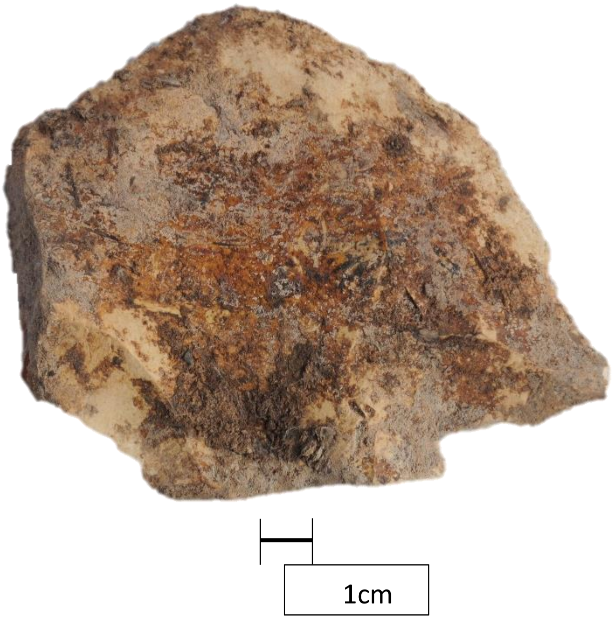

C

Figure 6: Late Pleistocene hornfels flake, A- dorsal view & B- platform view; Late Pleistocene hornfels flake, C- dorsal view & D- platform view.

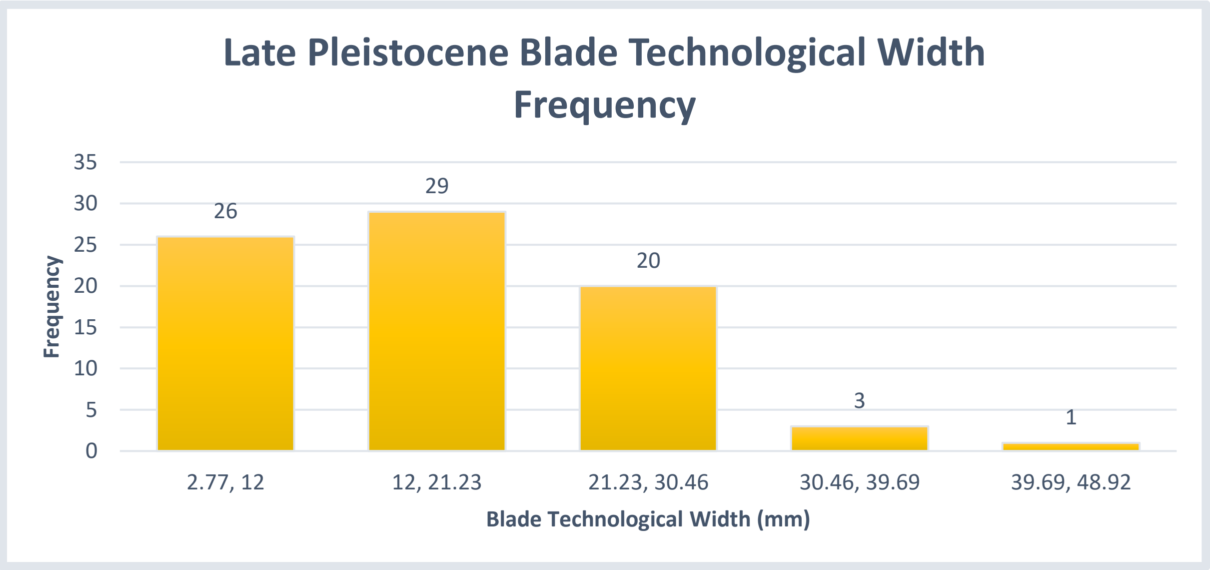

Figure 7: Frequency histogram of blade technological width (min. and max. values in mm) in the Late Pleistocene.

Table 2: Late Pleistocene dorsal scar pattern by blank maximum length (mm) in quartiles (highest frequencies of early & late exploitation in bold).

Dorsal Scar Direction		>58.5mm (Q1)	41.1 – 58.5mm (Q2)	31 – 41mm (Q3)	<31mm (Q4)	Total
Bidirectional	n	6	10	6	12	34
	%	18	29	18	**35**	100
Bi or Uni	n	14	10	11	8	43
	%	**33**	23	26	19	100
Radial	n	1	0	3	0	4
	%	25	0	75	0	100
Subradial	n	3	5	3	4	15

	%	20	33	20	27	100
Unidirectional	n	1	0	1	1	3
	%	**33**	0	33	**33**	100

Terminal Pleistocene (13500 – 11600 years ago)

The analysis includes 638 Terminal Pleistocene (TP) lithics. The TP assemblage has a strong emphasis on hornfels (92%, n=587/638, Table 3), with the second most utilized raw material being dolerite (3%, n=21/638). Following dolerite, chert and chalcedony are present in slightly lower proportions of 2% (n=10/638) and 1% (n=8/638) respectively. This assemblage, excluding shatter (n=240), is primarily flake-based with a large presence of complete flakes (52%, n= 205/398) and flake fragments (36%, n=145/398). The TP assemblage has 1% (n=4) cores, 2 of which are manufactured from chert, 1 from hornfels and 1 from another raw material that could not be identified. Blades and blade fragments amount to 10% (n=39/398). The images below illustrate some of the flakes and blades found in these occupations (Figure 8). Blades with technological widths smaller than the 12mm bladelet cut-off (Pargeter 2016) amount to 64% (Figure 9). The assemblage has unretouched points present at 7% (n=27/389). Retouched tools (1%, n=4/389) which are all made from hornfels are typologically identified as being 1 side-scraper, 2 minimally retouched tools, and 1 indeterminate.

Blanks from later in the reduction sequence predominantly have subradial dorsal scarring while larger blanks from earlier in the reduction sequence predominantly have radial dorsal scars (n=19, Table 4). This very small sample size shows that there is a shift from radial to subradial flaking as core reduction proceeds. Platforms were mostly prepared prior to removal with (39%, Table 7) having residual preparation without a negative bulb of percussion and 22% being facetted with bulbs of percussion. Non-prepared platforms made up 39% of the assemblage. Blank platform thickness averages at 5.26mm (standard deviation: 3.61mm, n=45) while the exterior platform angles have a mean measurement of 69.4° (standard deviation:11.6°, n=42). These TP platforms are therefore relatively acute and moderately thick. The dominant profile shape of the resulting blanks is flat (75%, n=36, Table 7) while 17% (n=6) are twisted and 8% (n=8) are curved. The blanks have a mean width to thickness ratio of 4.9 (standard deviation:2.6, n=35) and have a length to width of 1.3 (standard deviation:0.6, n=225). Only 10.7% of the blanks measure above the blade length to width ratio of 2. Both the vertical convexity and laminarity results in wide and short blanks.

Table 3: Terminal Pleistocene raw materials by artefact classes.

	Chalcedony	Chert	Dolerite	Hornfels	Ind	Other	Quartz	**Total**
BladeBladefragment		1	2	36				**39**
CompleteFlake	4	3	2	193	2	1		**205**
Core		2		1		1		**4**
FlakeFragment	2		4	137	1	1		**145**
HammerManuportGrindstone				1				**1**
RetouchedPiece				4				**4**
Shatter	2	4	13	215	3	2	1	**240**
Total	**8**	**10**	**21**	**587**	**6**	**5**	**1**	**638**

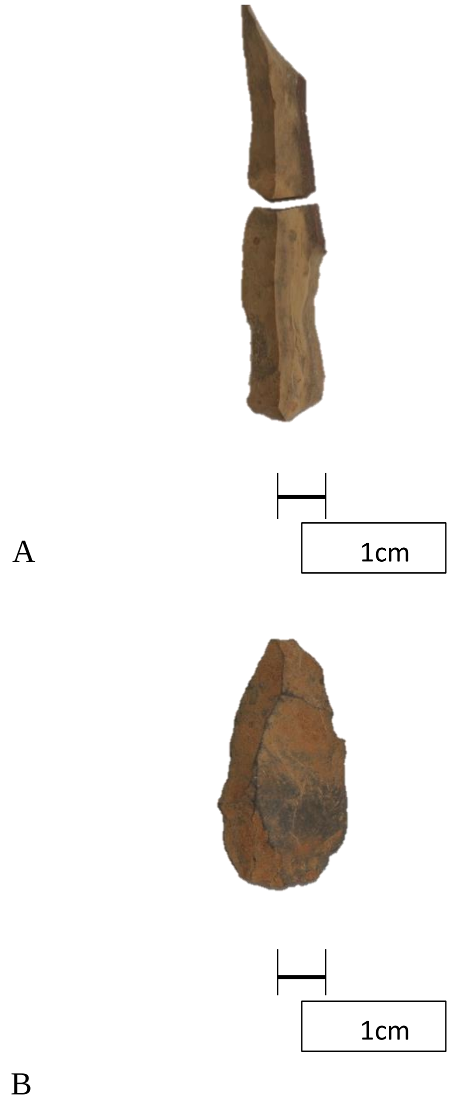

Figure 8: Terminal Pleistocene A- dorsal view of hornfels blade; Terminal Pleistocene chert blade, B- dorsal view.

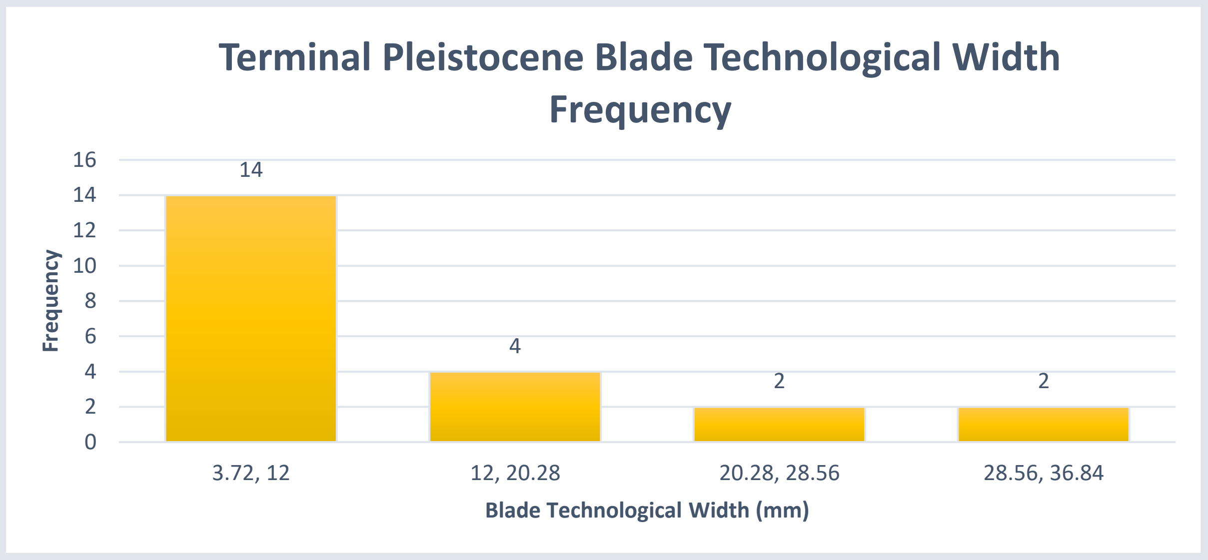

Figure 9: Frequency histogram of blade technological width (mm) in the Terminal Pleistocene.

Table 4: Terminal Pleistocene dorsal scar pattern by blank maximum length (mm) in quartiles (highest frequencies of early & late exploitation in bold).

Dorsal Scar Direction		>58mm (Q1)	42 – 58mm (Q2)	36 – 42mm (Q3)	<36mm (Q4)	Total
Bi or Uni	n	0	2	2	0	4
	%	0	50	50	0	100
Radial	n	4	2	1	0	7
	%	**57**	29	14	0	100
Subradial	n	0	0	0	2	2
	%	0	0	0	**100**	100
Unidirectional	n	1	1	1	3	6
	%	16.7	16.7	16.7	50	100

Mid-Holocene (7300 – 6800 years ago)

The analysis includes 1429 Mid-Holocene (MH) lithics. The MH assemblage is flake-based with most of the tools made of hornfels (92%, n=1310/1429, Table 5), and secondarily chert at 5% (n=75/1429). Smaller quantities of chalcedony (0.8%, n=11/1429) and dolerite (0.3%, n=5/1429) raw materials are represented in this assemblage. Excluding shatter (n=619), the predominant artefact classes are flake fragments at 51% (n=411/810) and complete flakes (39%, n=316/810). The MH assemblage had 0.5% (n=4) cores identified with three being hornfels and one being quartz. Blade and blade fragments amount to 9% (n=73/810) of the assemblage. Figure 10 illustrates two of the lithic artefacts found in the MH assemblage. Of the blade technological widths measured, 78% were below the 12mm bladelet cut-off (Pargeter 2016) (Figure 11). The assemblage has n=4 (0.5%) retouched tools, all from hornfels and typologically identified as being 2 end-scrapers, 1 esquilles piece and 1 notched piece. Unretouched points comprise 5% (n=43/800) found in the assemblage.

Maximum tool length by dorsal scar direction indicates that tool blanks were reduced from cores mainly using subradial and unidirectional flaking in early debitage and bi-and unidirectional flaking in the late debitage (n=13, Table 6). The sample size for complete blanks in this analysis is very small. Of the platforms identified (n=334, Table 7), 22% were facetted with a visible bulb of percussion, 39% had residual faceting without a bulb while 39% were not prepared. The platforms are quite thick measuring at 6.3mm on average (n=27, standard deviation: 4.2). The external platform angles measure at a mean of 68.5° (standard deviation: 6.8, n=25). The blanks show profiles that are flat (79%, n=23), curved (10%, n=3) and twisted (10%, n=3). The width to thickness ratio has a calculated result of 4.3 (n=24, standard deviation: 2). The length to width ratio of the blanks is calculated at 1.4 (n=355, standard deviation: 0.7) with 11% of the blanks being identified as blades at a ratio of 2 and above. Both the vertical convexity and laminarity show that the blanks are moderately wide and short.

Table 5: Mid-Holocene raw material types by artefact classes.

	Chalcedony	Chert	Dolerite	Hornfels	Ind	Other	Quartz	Sandstone	Total
BladeBladefragment	1	3		68	1				**73**
CompleteFlake	8	13		295					**316**
Core				3			1		**4**
FlakeFragment	1	10	2	392	1		4	1	**411**
HammerManuportGrindstone				1		1			**2**
RetouchedPiece				4					**4**
Shatter	1	49	3	547		1	18		**619**
Total	**11**	**75**	**5**	**1310**	**2**	**2**	**23**	**1**	**1429**

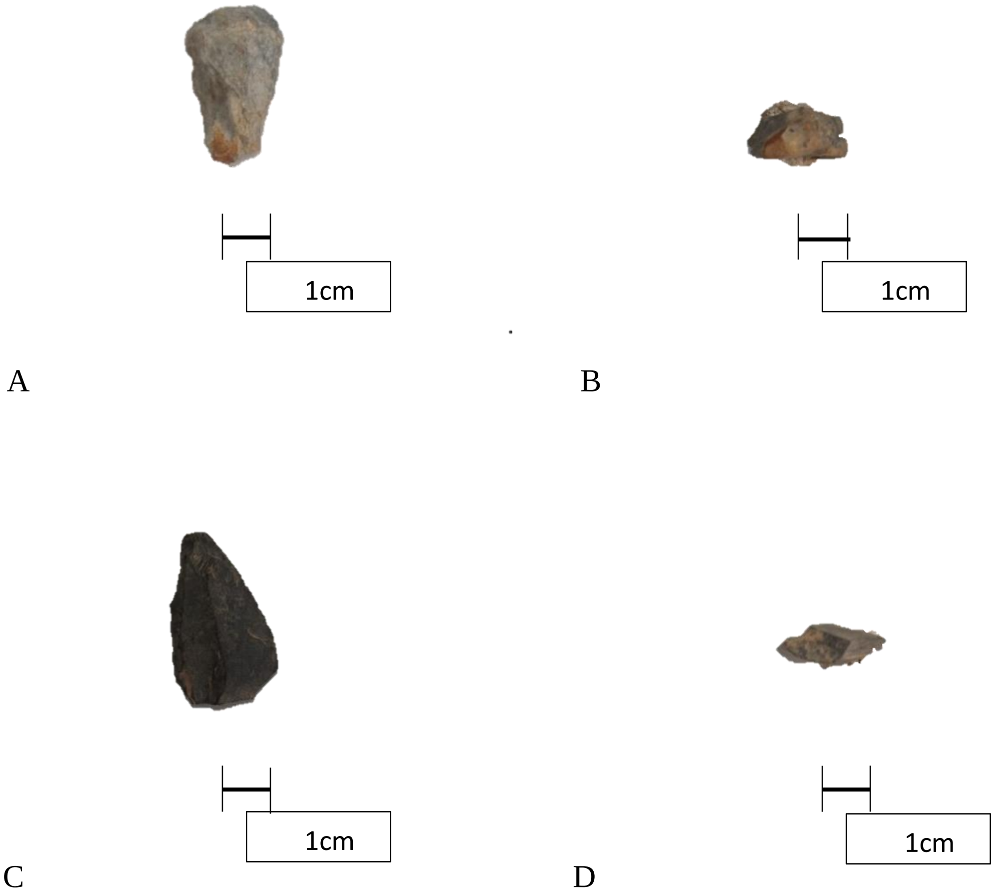

Figure 10: MH hornfels elongated end-scraper, A- dorsal view & B- platform view; MH hornfels flake, C- dorsal view & D- platform view.

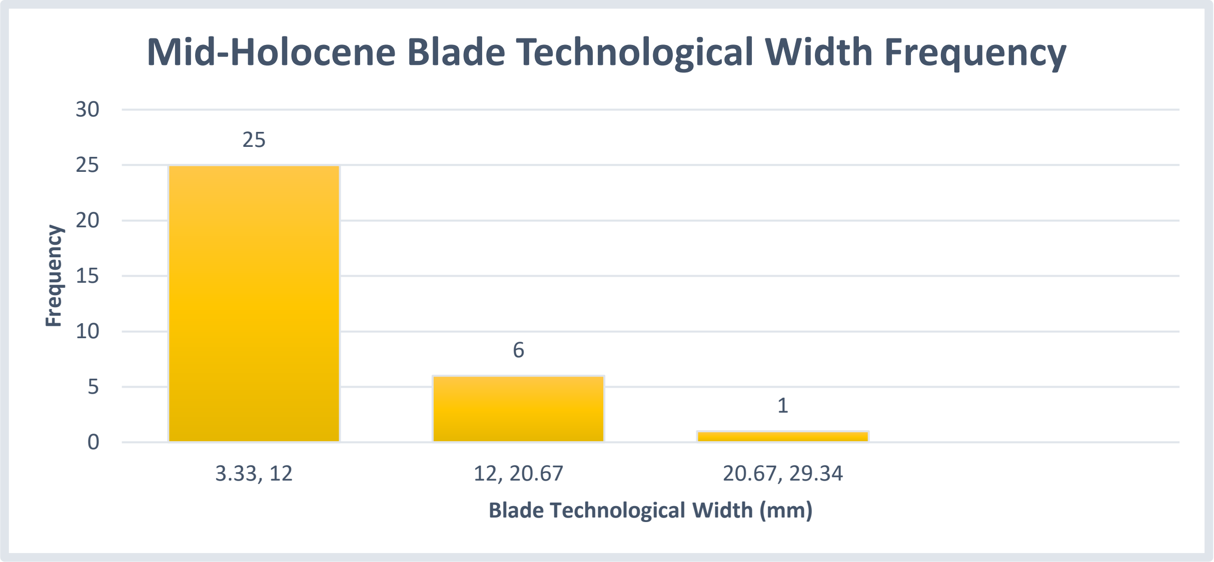

Figure 11: Frequency histogram of blade technological width (mm) in the Mid-Holocene.

Table 6: Mid-Holocene dorsal scar pattern by blank maximum length (mm) in quartiles (highest frequencies of early & late exploitation in bold).

Dorsal Scar Direction		>47.4mm (Q1)	42 – 47.4mm (Q2)	38 – 41.9mm (Q3)	<38mm (Q4)	Total
Bidirectional	n	0	0	0	1	1
	%	0	0	0	**100**	100
Bi or Uni	n	0	0	0	1	1
	%	0	0	0	**100**	100
Radial	n	0	1	0	0	1
	%	0	100	0	0	100
Subradial	n	2	2	1	0	5
	%	**40**	40	20	0	100
Unidirectional	n	2	0	1	2	5
	%	**40**	0	20	40	100

5.2 Comparing Raw Material Use

Hornfels raw material is the most utilized in the LP (78%), TP (92%), and MH (92%) assemblages (Figure 10). Dolerite is the second most abundant raw material in the LP (7%) and TP (3%) assemblages while chert is the second most dominate in MH assemblage (5%). There are some visible raw material sample trends through time from the LP assemblage through to the TP and the MH assemblages. There is an increase of chert lithics - 0.9% in the LP assemblage, 1.6% in the TP assemblage, and 5.2% in the MH assemblage. Another raw material that increases through time is quartz – 0.11% in the LP assemblage, 0.16% in the TP and 1.61% in the MH assemblage. Exhibiting an opposite pattern is the decrease of dolerite lithics – 6.8% in the LP assemblage, 3.3% in the TP assemblage, and 0.3% in the MH assemblage. The MH and LP assemblages exhibit a presence of sandstone lithics at <1% and 5% respectively while the TP assemblage has none. A Chi-squared test yielded a result of Chi^2= 467.16, df=14, p= <0.001, which indicates that there is a significant difference in the frequency of raw material between the three time periods.

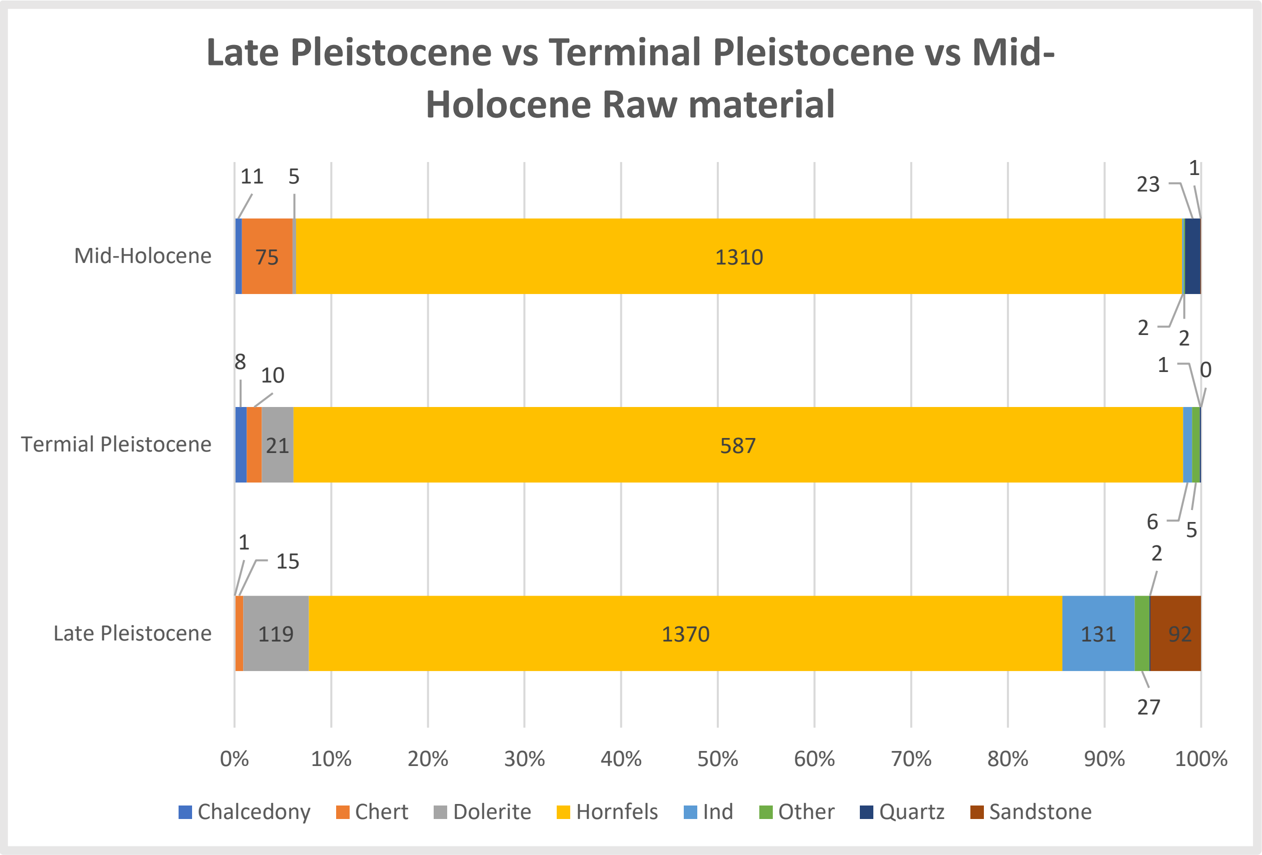

Figure 12: Stacked bar graph depicting Late Pleistocene, Terminal Pleistocene, and Mid-Holocene raw material counts.

5.3 Comparing Blank Production Choices

Table 7 presents a comparison of platform maintenance, direction of core exploitation and dorsal surface convexity system domains between the three time periods. Each period assemblage is compared to that which precedes it.

Table 7: Pair-wise comparison of blank production choices for the Late Pleistocene, Terminal Pleistocene, and Mid-Holocene.

Knapping Domains		Late Pleistocene	Terminal Pleistocene	Mid-Holocene
	Platform Treatment	Facetted with Bulb: 7% Not Prepared: 60% Residual Facet without Bulb: 33%	Facetted with Bulb: 22% Not Prepared: 39% Residual Facet without Bulb: 39%	Facetted with Bulb: 31% Not Prepared: 18% Residual Facet without Bulb: 51%

Platform Maintenance		n=588	n= 334 **p= 0.002**	n=655 **p=0.004**
	External Platform Angle (degrees)	Mean: 94.04 s.d.: 15.2 n= 207	Mean: 69.38 s.d.: 11.63 n= 42 **p=<0.001**, t=1.67, df=73	Mean: 68.48 s.d.: 6.82 n= 25 p=0.34, t=1.66, df=65
	Platform Thickness (mm)	Mean: 6.25 s.d.: 3.19 n=206	Mean: 5.26 s.d.: 3.61 n=45 **p=0.048**, t=1.67, df=60	Mean: 6.33 s.d.: 4.17 n=27 p=0.14, t=1.68, df=49
Number of differences/ 3 steps			3/3=1	1/3=0.33
Direction of Core Exploitation	Early Debitage Exploitation	**Bi- and Unidirectional**	Radial	**Subradial and Unidirectional**
	Late Debitage Exploitation	**Bi- and Unidirectional**	Subradial	**Bi- and unidirectional**
Number of differences/2 steps			2/2= 1	2/2= 1
Dorsal Surface Convexity System	Length/Width Ratio	Mean: 1.69 s.d.: 0.9 n=460	Mean: 1.32 s.d.: 0.58 n=225 **p=<0.001**, t=1.65, df=631	Mean: 1.37 s.d.: 0.67 n=355 p=0.2, t=1.65, df=523
	Profile	Flat: 46% Curved: 39% Twisted 15% n=168	Flat: 75% Curved: 8% Twisted: 17% n=36 **p=<0.001**	Flat: 80% Curved: 10% Twisted: 10% n=29 p=0.34
	Width/Thickness Ratio	Mean: 3.4 s.d.: 1.59 n=173	Mean: 4.92 s.d.: 2.63 n=35 **p=0.001**, t=1.68, df=39	Mean: 4.31 s.d.: 2 n=24 p=0.16, t=1.67, df=56
Number of changes/3 steps			3/3=1	0/3=0
Total Difference: LP vs TP			3	
Total Difference: TP vs MH				1.33

Platform Maintenance Domain

Platform Treatment:

Of the LP assemblage, 7% of the platforms are facetted with a negative bulb of percussion, 60% are not prepared and 33% have residual faceting without a bulb (n=588, Table 7). Within the TP assemblage, 22% of the lithics are facetted with bulbs, 39% are not prepared while 39% have residual facet without a bulb (n=334, Table 7). The MH blanks feature 31% of platforms that are facetted with a bulb, 18% that not prepared and 51% that have residual faceting without a bulb (n=655, Table 7). A chi-squared test indicates a significant difference between LP and TP platform treatment ($Chi^2=12.24$, $p= 0.002$, $df=2$, $\alpha=0.05$). Faceting is more frequent in the TP than the LP. Significant differences were also present when comparing the frequencies of platform treatment choices for the TP and the MH assemblages, ($Chi^2=11.2$, $p= 0.004$, $df=2$, $\alpha=0.05$), with the MH exhibiting more frequent platform preparation.

External Platform Angle:

The LP blanks had the highest exterior platform angle mean at 94.04° (standard deviation:15.2°, n=207), which is followed by the TP mean of 69.38° (standard deviation:11.63°, n=42) and with the lowest mean is the MH toolkit with a mean of 68.48° (standard deviation:6.82°, n=25). Using a t-test, a comparison between the LP and TP showed a significant difference ($t=1.67$, $p= <0.001$, $df=73$). The difference between the TP and MH is not significant ($t=1.67$, $p=0.34$, $df=302$).

Platform Thickness:

The LP blanks had the highest platform thickness mean at 6.25mm (standard deviation:3.19, n=206), the TP blanks had the lowest mean at 5.26mm (standard deviation:3.61, n=45) and finally the MH platform thickness mean is higher at 6.33mm (standard deviation:4.17, n=27). A t-test indicates that the difference between the LP and TP is significant ($t=1.67$, $p=0.048$, $df=60$); the difference between the TP and MH is not ($t=1.68$, $p=0.14$, $df=49$).

Subtotals of the number of differences with each step of the platform maintenance domain between the LP and TP yield a three out of three result (Table 7). The number of differences between the TP and MH added up to one out of three. In sum, the differences in platform maintenance choices between the LP and TP assemblages (100%) are greater than those between the TP and MH assemblages (33%).

Core Modification Domain

The direction of core modification domain consists of two steps, early debitage exploration and late debitage exploration. Within the LP stone tools (Table 2), a considerable amount of early debitage were either bidirectionally or unidirectionally modified on the core. The early debitage of the TP (Table 4) were mostly modified radially and within the MH assemblage (Table 6), blanks were modified subradially and unidirectionally. The late debitage blanks of the LP are mostly modified bidirectionally and unidirectionally. Blanks found in the TP occupations are mostly modified subradially. Lastly, a considerable number of blanks from the MH assemblage had bi- and unidirectional modification. The dorsal scar patterns of the LP and TP assemblage have no similarities in both the early and late debitage. The blanks of the TP and the MH assemblage have no similarities in both the early and late debitage. The subtotal of the dorsal scar pattern differences in early and late debitage between the LP and TP amount to 2 out of 2 and between the TP and MH amount to 2 out of 2. This means that the choices in direction of core exploitation differ between the LP and TP assemblages (100%) while also differing between the TP and MH assemblages (100%).

Dorsal Surface Convexity System Domain

Length to Width Ratio:

The LP assemblage has a mean length to width of 1.68 (standard deviation:0.9, n=460) and the TP assemblage a mean of 1.32 (standard deviation:0.58, n=225). A t-test indicates significant difference (t=1.65, p=<0.001, df=631). The MH assemblage has a length/width ratio mean of 1.37 (standard deviation:0.67, n=355) that is not significantly different from the TP (t=1.65, p=0.2, df=523).

Profile Shape:

In the LP assemblage, 46% of the complete blank profiles are flat, 39% curved and 15% twisted (n=168). The TP assemblage consists of 75% flat blanks, 8% curved and 17% twisted (n=45). MH blanks are comprised of 80% of flat profiles, 10% curved profiles and 10% twisted profiles (n=29). Based on a chi-squared test, the difference in profile shape between the LP and TP is significant (p=<0.001, Chi-square:27.5, df:2); the TP exhibits a higher frequency of flat blanks. Comparing the profile shapes found in the TP assemblage against the MH assemblage, the chi-squared test revealed that the difference was not significant (p=0.34, Chi^2:2.1, df:2).

Width to Thickness Ratio:

The LP assemblage has a mean width/thickness ratio of 3.4 (standard deviation:1.59, n=173), while the TP assemblage has a mean ratio of 4.92 (standard deviation:2.63, n=35) and a mean ratio of 4.3 in the MH assemblage (standard deviation:1.99, n=24). A t-test between the ratios of the LP and TP assemblages illustrated a significant difference with a p-value of 0.001 (t=1.68, df=39). The t-test comparing the ratios of the TP and MH assemblages resulted in a p-value of 0.15; the width/thickness ratios of the two assemblages have no significant difference (t=1.67, df=56). The subtotals of the three steps between the LP and the TP assemblages amount to three out of three while between the TP and MH assemblages amounted to zero out three. In sum, the dorsal surface convexity system between the LP and the TP differed by 100% but does not differ between the TP and MH assemblages (0).

Calculating the total measure of difference in blank production, the resulting amount for the LP and TP is 3 out of a maximum difference of 3, while between the TP and MH the amount is 1.33 out of 3. The comparison between the LP and TP assemblages indicates substantial differences in all domains. The comparison between TP and MH assemblages, however, exhibits much more similarity, with only a few differences with respect to platform preparation and direction of core exploitation.

6. Discussion

It is important that I recognise that some of these samples are significantly small, but it was also important that I include them to illustrate Tostevin's (2011) approach. It would have been better to have a larger sample size, but due to time constraints it was not possible to do so. This thesis has been an exercise of learning a particular technique and applying it to three stone tool assemblages from GRS and it was still possible to achieve this with the small sample sizes. It is in this spirit that the discussion and conclusion are presented as demonstrations.

The raw material analysis and comparison between LP and TP, and MH reveals the use of six identified materials to produce stone tools. Hornfels dominates all three assemblages with frequencies of 92% seen in both the TP and MH assemblages while the LP assemblage has a frequency of 78%. Though the following frequencies are not high, the second most dominant raw material in the LP and TP assemblages is dolerite, which contribute 7% and 3%, respectively. Raw material sources are considered by Andrefsky (2009) to be in close proximity if they are less than two days walk from the residential location and the abundance of hornfels in the immediate surrounding area of GRS would make it easily accessible to tool makers (Collins et al. 2017; personal observation made during site visit in 2018). Opperman (1984) reports the presence of hornfels associated with dolerite inclusions that can be found at about 200m – 5km from the GRS rockshelter. Aspects of raw materials, in particular source proximity and rock quality, play an important role in the manner with which toolmakers organize their lives regarding lithic technology.

Hornfels from this region is a rock that ranges in granularity from fine to very fine (Opperman 1984). The fine granularity of hornfels make it a smooth and brittle stone that can be easily knapped to manufacture sharp-edged stone tools – a desirable quality for blades and other cutting tools (Wadley & Kempson 2011). The disadvantage of hornfels is that it is more prone to breakage and edge fracturing. In contrast, dolerite is a tough and rigid stone with a rough textured surface that makes it difficult to knap (Wadley & Kempson 2011). Its hardness enables it to sustain less breakage resulting in stone tool products better at retaining usable edges. The MH assemblage differs from the LP and TP assemblages in that chert at 5% is the second most dominant material used in the production of stone tools. Chert is a cryptocrystalline silicate that is a brittle rock which tends to fracture conchoidally to form sharp edges (Wadley & Kempson 2011). This durable material is sometimes used to produce cutting tools and arrowheads and, in some instances, treated with heat. The other three raw materials identified, quartz, sandstone, and chalcedony are found in very small proportions of 5% or less in all three assemblages.

The costs of procuring hornfels compared to the benefits of using hornfels in stone tool making can be evaluated by grading the quality of hornfels and factoring in its high availability at GRS. The notable increase in hornfels from the LP, TP to the MH assemblages could show increased preferences in the quality of hornfels and its easy accessibility at the site. It is possible to rationalise the high frequencies of hornfels in the three assemblages by considering these benefits in comparison to any perceived costs. The LP assemblage demonstrates higher raw material variability with the least amount of hornfels while the TP and MH assemblages have a higher presence of hornfels. The MH assemblage demonstrates an even higher presence of siliceous raw materials since it is dominated by both hornfels and chert and therefore has the lowest raw material variability. MH toolmakers could have preferred these raw materials for their propensity to produce sharp-edged tools. Further understanding of the tool types produced and their relation to sharp edge, can provide further insight into raw material selection and the choices knappers made to achieve those features.

Artefact types and landscape interactions

When stone tool knappers consider rock quality, two features namely fracture predictability and durability, are evaluated (Wadley & Kempson 2011). These features help determine blank morphology and quality which ultimately dictates the rate of use wear. Fracture predictability and raw material durability could contribute to how well artefact types are formed and how long they last during use. Once these features are adequately associated with certain raw materials, it is then the availability of these good-quality raw materials that influences the kinds of stone tools produced at a site (Andrefsky 1994). Flakes are the most common artefact type in all three assemblages at GRS, as indicated in the categories of complete flakes and flake fragments (Tables 1, 3 & 5). The sums of the two categories show flake frequencies of 83% in the LP assemblage, 88% in the TP assemblage and 90% in the MH assemblage. These high frequencies show that the populations of all three assemblages mainly focused on flake production, with the populations of each assemblage increasingly intensifying flake manufacture through time.

The converse becomes true for blade production with blade presence decreasing through time. The highest frequency of blade and blade fragments at 16% is seen in the LP assemblage, followed by the TP assemblage with 10% and the MH assemblage with 9%. Of these flakes and blades, the proportion of unretouched points for each assemblage are as follows; 7.7% - LP, 7% - TP and 5% - MH. Very few retouched tools were identified, with each assemblage containing 1% or less. Cores are seen in very low numbers in each assemblage and like retouched tools, cores register at 1% or less. The nearly negligible amounts of retouched tools suggest that the stone-tool using groups from all three time periods at GRS largely produced informal tools.

Andrefsky (1994) details informal tools as situational tools that are expediently produced as a response to environmental conditions. As a result, these tools lack signs of rejuvenation as they require a lower amount of effort in their production. A shortage of tool re-use at the site is a contributor to low frequencies of retouched tools. Assemblages accumulate informal tools as artefacts are discarded without being resharpened. The absence of lithic conservation is argued to relate to foragers having access to an ample source of raw material (Barton & Riel-Salvatore 2014). Andrefsky (2009) reinforces this idea with findings that suggested that toolmakers within close proximity to raw material sources tended to discard impact damaged hafted bifaces without resharpening. This means that retouch intensity has been shown to have direct correlation with defined distances to each raw material source (Andrefsky 2009; Barton & Riel-Salvatore 2014).

Assemblage compositions and artefact densities likely reflect forager mobility and provisioning patterns that are influenced by rockshelters, bodies of water and raw material source availability. As has already been established, GRS is a rockshelter site located within a 200m – 5km radius of numerous hornfels outcrops and dolerite inclusions and about 20km from the Orange River watershed (Collins et al. 2017; Ames et al. 2020). There was a stream that ran near the GRS rockshelter during the three time periods that is now currently located in the Kei River watershed (Ames et al. 2020). These features would make GRS a prime location as it provides access to key resources that also included a variety of vegetation (lemongrass, wild peach, and wild olive trees) and fauna (rock hare, springbok, and wildebeest) for possible gathering and hunting.

GRS exhibits a pulsed occupational sequence that is characteristic of the Pleistocene and Holocene record seen across the grassland region, with the Pleistocene occupations being of a longer duration than the Holocene occupation. The stratigraphy at GRS consists of three sets of occupational layers that are separated by two hiatuses (Collins et al. 2017). There is a depositional hiatus between the LP and TP occupations that roughly coincides with MIS 2 (Ames et al. 2020). The LP occupational layers analysed in square B4 occur during MIS 3 and have a sediment volume of about $0.85m^3$ followed by a hiatus spanning 14500 years (Collins et al. 2017; Ames et al. 2020). The two sets of occupational layers that follow had accumulated within MIS 1 and include, the TP occupational layers, of which about $0.15m^3$ have been excavated in B4. A hiatus of ~4000 – 5000 years ensues, and then is followed by the MH deposit, of which ~$0.6m^3$ have been excavated in B4 (Collins et al. 2017). The LP has low intensity occupations with a deposit that is mostly geogenic spanning 1500 years, as does the TP, although it occurs over a shorter time span of 2000 years (Ames et al. 2020). The MH deposit differs from those of the LP and TP in that it is a 500-year period of intense occupation with highly anthropogenic sediments (Ames et al. 2020). GRS demonstrates a shift from low occupational intensity in the Pleistocene to high occupational intensity in the Holocene, with the MH occupations having the highest artefact density. Overall, GRS has a high density of stone tools and faunal remains, with a stone tool artefact frequency that is higher than the neighbouring northern-Eastern Cape sites Bonawe and Colwinton (Opperman 1987).

Further analysis of blades through the frequencies of technological widths allows for the detection of lithic miniaturization in the three assemblages. This is especially important because the African archaeological record from the Late Pleistocene through to the Holocene demonstrates an increasing prevalence of microlithic tools (McCall & Thomas 2009; Pargeter 2016). The first bars of the histograms group the technological width measurements from minimum value to 12mm and the bars that follow increase in 10mm increments to the maximum value (Figure 7, 9 & 11). The LP blades and blade fragments had the lowest occurrence of bladelets at 33%, followed by the TP blade sample with 64% and topped by the MH with 78%. This increase of bladelets through time is noteworthy when considering that the frequencies of blades and blade fragments were observed decreasing through time. T-tests conducted between the LP and TP assemblages and the TP and MH assemblages showed that there was a significant difference in the technological widths of the blades found in the LP and TP assemblages. The blade sizes of the TP assemblage share similarities with those of the MH assemblage.

These trends suggest that in the production of blades, tool-making groups were focusing more on bladelets while tasks at the site were likely creating less of a demand for blade manufacturing. GRS assemblages, especially of the TP and MH, contain unretouched miniaturized tools that have also been documented in other southern African sites dating to MIS 1 (Pargeter 2016). The increase in bladelet production was likely favoured by, amongst other factors, the perceived economic cost and benefits seen through raw material acquisition and transport where small tools that result in sharper cutting edges are more effective and efficient (Bamforth & Bleed 1997; Rezek et al. 2018). However, all three assemblages at GRS are flake-based and therefore the flake components of each assemblage also need to be considered in detail.

Tool morphology and assemblage variability

As the surface which receives the blow to detach a blank, a platform's morphology has a direct influence on the size and geometry of the blank itself (Rezek et al. 2018). The three variables (platform treatment, external platform angle and platform thickness) within platform maintenance are analysed to determine the morphologies of the striking surfaces in the three GRS assemblages. These technological attributes serve as standard units of analysis within the morphological diversity and the reduction sequences expressed in the GRS lithic assemblages, to address the lithic fallacies as mentioned in Dibble et al. (2017). Platform preparation alters the angle of the platform prior to the removal of the blank (Tostevin 2012). There were significant increases in platform preparation from the LP through to the TP until the MH at GRS. The MH assemblage has the highest platform preparation frequency at 82%, with the LP and TP having platform preparation frequencies of 40% and 61% respectively (Table 7).

As the least prepared platforms at GRS, the LP blanks had the most obtuse external platform angles at a mean of 94.04°. With the increase of platform preparation, external platform angles became increasingly acute with TP platforms amounting to a mean of 69.38° and 68.48° being the mean in the MH assemblage. The platform angles of the LP assemblage were significantly different from those of the TP assemblage while the TP and MH platform angles were not significantly different. The depth at which the knapper chooses to strike the platform is the platform thickness (Tostevin 2012). Blanks in the LP assemblage had the highest platform thickness mean of 6.25mm while the TP and MH blanks had means of 5.26mm and 6.33mm, respectively.

The external platform angle and platform thickness are independent variables that act together as the most significant determinants of the blank mass and size (Tostevin 2012). Having observed a shift in GRS tool forms with the occurrence of each assemblage from thick and long (LP) to short and very thin (TP), and then backtracked to moderately thin and moderately short (MH), it would appear that tool miniaturization was an occurrence at GRS. The increase of bladelet frequencies through time discussed earlier coincides with the miniaturization of blanks evident in the TP and MH assemblages. The miniaturization of lithics is a systematic production of smaller tools that can be distinguished as purposeful manufacture through systematic technological intent (Pargeter 2016). Microlithization more notably develops in the Late Pleistocene becoming prominent in the Holocene of southern Africa (Deacon & Deacon 1999; Clark 1999; Pargeter 2016). GRS seems to reflect the progression of microlithization between the LP and TP assemblages but then slightly regresses with the accumulation of the MH assemblage. There is a suggested relationship between these smaller technologies and the human demographics, mobility patterns and subsequent subsistence strategies seen during this time (Clark 1999; Pargeter 2016).

Core reduction and social relatedness

Core surface morphologies, being the surface area and surface convexity, contribute significantly to the outline shape of the resulting blank which does not affect the efficacy of the tool (Tostevin 2012). The rotation of the core during reduction is determined using these attributes depending on what the knapper’s desired outcome is. It is this desirability that Tostevin (2012) states is the measurement of the degree of social relatedness between groups of knappers, in this case being the LP, TP and MH knappers. How blank length correlates with blank dorsal scar patterns allows for the interpretation of the dominant directions of blank removal from the early to the late stages of core exploitation (Tostevin 2012). LP knappers were mostly consistent in their core reduction strategies by mostly utilizing bi- or unidirectional flaking in both the early and later stages of exploitation. Knappers of the TP assemblage utilized radial flaking for early exploitation and then transitioned into utilizing subradial flaking in the late exploitation of cores. MH knappers utilized subradial or unidirectional flaking in early exploitation and then slightly shifted into utilizing bi- or unidirectional faking in the late exploitation of cores.

Examining the intervening blank length ranges in the LP (Table 2), the second quartile shows an increase in subradial reduction with a spiked increase in radial reduction of cores in the third quartile. Length by dorsal scar cross-tabulation of the LP blanks demonstrates a strong incidence of both bi- and unidirectional reduction as a preferred strategy in the assemblage overall. The TP assemblage shows a consistent dominance of bi- or unidirectional reduction in the second and third quartiles (Table 4). The MH assemblage exhibits a dominance of radial reduction in the second quartile while the third is dominated by both subradial and unidirectional reduction (Table 6). Cross-tabulation of this assemblage demonstrates that MH knappers preferred unidirectional reduction overall. Cross-tabulation analysis suggests that the LP populations had core exploitation preferences that were like those of the TP populations, whereas the TP and MH populations had slightly different domineering preferences of exploiting cores.

The final steps that contribute to determining the morphology of tool cutting edge are analysed here as length/width, profile type and width/thickness. The length/width ratios which are understood as being the laminarity of debitage within the dorsal surface convexity system differ significantly between the assemblages of the GRS LP and TP. The LP debitage mostly has moderate laminarity (1.7) which differs significantly from the TP debitage that mostly has low laminarity 1.3, similar to the MH debitage (1.4). The LP knappers were making tools that were significantly longer and this coincides with the result of the LP assemblage having the highest frequency of blades. The profile types of the three assemblages depict a trend through time as the frequencies of flat profiles increase with each successive occupation. As the assemblage with the lowest frequency, the LP (46%) differs significantly from the TP assemblage (75%). The profile frequencies of the TP and MH assemblages were found to be similar with the MH assemblage having the highest frequency (80%).

The width/thickness ratios of the GRS assemblages result in the same variability patterns seen in the laminarity and profile knapping steps. T-tests show that the width/thickness ratios of the LP assemblage differ significantly from those of the TP while the MH assemblage width/thickness ratios demonstrates similarity with the TP. The LP debitage are the thickest (3.4) as opposed to the very thin debitage of the TP (4.9) and MH debitage (4.3). Throughout the analyses and statistical tests of the three GRS assemblages, the summation of each knapping domain distinguishes the amount of variation between each assemblage. The cumulative measure of difference for the blank production and tool kit morphology between the LP and TP assemblage is 3 out of 3, whereas between the TP and MH the difference amounts to 1.33 out of 3. With these sums we can observe that there is higher variability between the LP and TP assemblages while there is greater similarity between the TP and MH assemblages. With respect to core reduction strategies, this indicates a higher degree of social relatedness between the TP and MH populations than the LP and TP populations.

According to Tostevin (2012), another knapping domain is tool kit morphological choices. Tool kit morphological choices feature width/thickness ratios and profile types whereas blank production behavioural choices feature length/width ratios and all the steps within direction of core exploitation and platform maintenance (Tostevin 2012). In the comparison of the LP and TP assemblages, we have observed differences in both tool kit morphological choices. This high variability in tool kit morphological choices suggests that a break in tradition is more likely the case in the succession observed between the LP assemblage and the TP assemblage (Tostevin 2012). The only instances of variability observed between the TP and MH assemblages were within the blank production behavioural choices (platform treatment and direction of core exploitation) but were still showing a higher number of similar blank production choices compared to the tests between LP and TP assemblages. This higher number of similar blank production choices suggests that cultural transmission is more likely the effect observed in the succession between the TP and MH assemblages (Tostevin 2012).

Independent innovation or cultural transmission

In response to novelties, the LP and TP assemblages demonstrate a degree of variability as well as an extensive time gap that would suggest that social relatedness between the two assemblages was minimal. The LP assemblage demonstrates greater raw material variability and significantly lower bladelet frequency. There is a depositional hiatus of 14 500 years at GRS between the LP and TP assemblage that may contribute to the differences in knapping behaviours observed. In addition to there being differences in raw material procurement, artefact class and tool kit morphology, differences in blank production are also evident. The term independent innovation suggests individual experimentation and to consider the TP assemblage as an occurrence isolated from the existence of the LP assemblage lends itself to some challenges. Any innovation is thought to be made up of pre-existing components and that it does not materialise without having any antecedents (Barnett 1953; Eerkens & Lipo 2007). While the TP assemblage differs from the LP assemblage by 8 out of the 8 traits considered in this investigation, the assumption that the TP toolmakers were independent innovators is not a safe one. It would be more appropriate to say that the social relatedness between the LP and TP populations at GRS is not fully reflected considering the depositional hiatus between the two assemblages.

The TP populations at GRS appear to have produced stone tools that were more similar to those of the MH population. The TP and MH populations were much closer in time with a depositional hiatus of about 4300 years between them, so we could expect to see more cultural transmission and overlap of knapping technique between the assemblages. Of the 8 knapping steps investigated, the TP and MH assemblages share similar practices in 5 steps. As TP populations seem to have deviated from the lithic production practices exhibited by the LP populations by demonstrating higher platform preparation frequencies, sharper angled platforms, thinner platforms, lower tool laminarity, thinner blanks and higher frequencies of flat profiled blanks, the MH populations deviated further within that trajectory by demonstrating even higher platform preparation frequencies.

The Grassridge lithic assemblage as a result of economic, environmental, and socio-cultural activities

The low intensity occupations seen in LP and TP periods followed by the high intensity occupations of the MH at GRS suggests that there was either a difference in the organization of activities or a difference in population size or the combination of both. This increase in occupation intensity goes together with increases in livelihood activities such as hunting and lithic tool production. The higher frequencies of both faunal remains and stone tool artefacts found in the MH occupations support this notion (Opperman 1987; Ames et al. 2020). There are very low frequencies of retouched tools in all three time periods at GRS which is argued to negatively correlate to artefact density and the high raw material abundance demonstrated at GRS (Andrefsky 2009; Barton & Riel-Salvatore 2014). Retouch is considered one of the criteria for formalized tools, as is core preparation. While the three GRS assemblages seem to demonstrate low retouch frequencies, they also demonstrate an increase in prepared platforms with the succession of each assemblage. Core preparation, as an aspect of formal tool technology, seems to have been more preferred than tool retouch by the populations and could reflect socio-cultural systems taking precedence over economical strategies.

The tool knappers' increasing preference for core preparation could still be linked to economical strategies of raw material use if microlithization is demonstrated in the GRS assemblages. Platform preparation is associated with microlithization as an economical raw material use strategy through the reduced cost of raw material resource acquisition and transport (Rezek et al. 2018). The benefits of this strategy are also highlighted through the increased production of sharp edge per tool size, so basically creating the most amount of sharp edge while using the least amount of raw material. The LP seems to have produced the most amount of sharp edge despite being the largest tools in size. The TP assemblage were the smallest tools and are estimated to have produced the least amount of sharp edge. The MH tools being moderately small in size, produced a moderate amount of sharp edge.

The amount of microlithization within each successive GRS assemblage does not demonstrate an increase through time. Though microlithization increases within the transition between the LP and TP assemblages, the MH assemblage has an increase in tool size while still being smaller than that of the LP assemblage. This is a result of the interaction between platform thickness and the external platform angle and how they fluctuate in each assemblage. In the succession from the LP to TP, a decrease in both platform thickness and external platform angle is observed. The LP assemblage demonstrates mostly right-angled platforms with moderately thick platforms while the TP assemblage demonstrates a nearly 30° decrease with a 1mm decrease. The MH platform angles decrease further by a single degree but have an increase in platform thickness that is a fraction higher than the LP platforms. It is with the engagements of these variables that the blank masses demonstrate a non-linear progression through time at GRS.

The GRS occupations do not fully demonstrate the described criteria of the technocomplexes that have been associated with them. It is because of this, that GRS assemblages can be considered as expressions of cultural groups within the organism-in-environment system where the ‘final MSA’, Oakhurst and Wilton indicators are present, but variability persists due to population genetic diversity and adaptive behaviours that are shaped by social and physical contexts (Stout 2002). This is a thinking and performance model in which stone tool knapping is likely to have been learned and culturally transmitted. GRS exhibits the highest amount of variability between the LP and TP assemblages whereas other southern African sites exhibit marked differences between Pleistocene and Holocene assemblages (Mitchell et al. 1998; Lombard et al. 2012). The stone tool sample analysed from GRS for this study depicts the MSA/LSA transition more distinctly than it does the Pleistocene/Holocene transition. This is evident in the number of differences in blank production and tool kit morphology where between the LP and TP the total is 3 out of 3 and 1.33 out of 3 between the TP and MH. The socio-cultural influence on the similarities seen between the TP and MH assemblages is emphasised by the high number of stylistic preferences that were maintained in both assemblages despite the absence of early Holocene deposits in GRS. This suggests that the existence of social relatedness in the region at large through which the cultural transmission of these preferences is plausible.

GRS consists of a pulsed occupational sequence that is similar in character to several southern African sites recorded within the Pleistocene and Holocene periods (Mitchell et al. 1998; Ames et al. 2020). Each occupational pulse seen in GRS is associated to an established stone tool technocomplex (Ames et al. 2020). The GRS LP occupation, dating ~43000 – 28000 years ago, exhibits low quantities of formal tools with a 60% presence of non-facetted platforms. The assemblage mostly consists of blanks with a moderate laminarity which fits the dimensions of flake-blades. These flake-blades were consistent with little to no retouch. Core reduction is mainly bi-directional and there is a presence of bladelets. These indicators characterize the LP assemblage as being final MSA-like (Wadley 1993; Mackay et al. 2014; Ames et al. 2020). The GRS LP dates correspond with the southern African inter-site patterning of the final MSA emergence within the summer rainfall zone (Mackay et al. 2014).

The GRS TP occupation dating from 13500 – 11600 years ago contains large scrapers and lacks segments. It also exhibits a significant increase in bladelet product from its MSA predecessor. LSA populations are mostly associated with microlithic tools, scrapers, and low frequencies of retouch (Deacon & Deacon 1999). This LSA assemblage has very few flakes and blades with retouch and blanks that through length/width and width/thickness measurements are calculated to be the smallest of the three assemblages, though not entirely microlithic. There was increased platform preparation in this assemblage. Though GRS has slightly older dates, it is rather inconclusive to say that these TP tools are consistent with an Oakhurst or a Robberg designation (Barham & Mitchell 2008; Lombard et al. 2012; Ames et al. 2020).

The GRS MH occupation dates from 7300 – 6800 years ago and contains relatively small end-scrapers, an increase of standardization of bladelets (though not too high in frequency) and the highest frequency of finer grained raw material. With these characteristics, the MH occupation draws parallels with Wilton technocomplexes (Deacon & Deacon 1999; Barham & Mitchell 2008). Collins et al. (2017) concluded that the transition between Oakhurst and Wilton was best related to the MH assemblage using only a sample of plotted finds. This differs from my finding as my MH sample includes both plotted finds and sieved material.

Ames et al. (2020) correlates the MH occupation to the expansion and intensification of Wilton observed in sites such as Rose Cottage Cave, Sehonghong, Tloutle and Fish River.

GRS has demonstrated several changes across the MSA/LSA transition and the Pleistocene/Holocene transition. Climate conditions are shown to have changed across the MSA/LSA transition (Barham & Mitchell 2008; Ames et al. 2020). The LP period experienced cool and dryer conditions while the TP and MH periods experienced warmer and wetter conditions (Barham & Mitchell 2008; Ames et al. 2020). Subsistence strategies, particularly in hunting, differed across the MSA/LSA transition (Opperman 1984). There was a preference for medium to large sized animals during the MSA occupations and a preference for small to medium sized animals in the LSA occupations of GRS (Opperman 1988; Collins et al. 2017). The MH occupations exhibited more anthropogenic sediments, whereas the LP and TP occupations appeared more ephemeral (Ames et al. 2020). This artefact density difference along the Pleistocene/Holocene transition could have been influenced by reorganized and increased activities possibly due to larger MH populations (Ames et al. 2020). Raw material selection, blank tool production and tool kit morphology have been shown to differ across the MSA/LSA transition by the TP assemblage being closer related to the MH assemblage than it is to the LP assemblage. The lithic technological organization at GRS demonstrated the highest frequency of changes across the MSA/LSA transition, which due to the time difference between the MSA and LSA deposits suggests a greater difference of cultural systems.

7. Conclusion

The square B4 sample studied for this thesis, through metrical analysis and the Tostevin (2012) methodology, has shown the similarities and differences of these three GRS time periods. The characteristics of these lithic deposits have been observed through knapping behaviours and raw material selection to better understand how they relate to one another. It has been with the quantitative methods used on these observed knapping behaviours that are based on the lithic traits, that this thesis has addressed the issue of the "finished artefact fallacy" (Dibble et al. 2017). The GRS assemblages which were grouped by stratigraphy, were analysed outside of any defined techno-complexes or lithic industries and were only related to the "final MSA", Oakhurst and Wilton techno-complexes to link GRS to the greater archaeological record. This approach has helped define each assemblage phenotypically to better gauge the lithic expressions of the tool makers and the larger contexts in which the assemblages occurred.

The Tostevin (2012) methods of analysing knapping behavioural attributes that I have applied to the GRS assemblages have demonstrated how lithic attributes interact together under sociocultural influences. As geometric variables, external platform angle and platform thickness have had direct effect on the size of the blanks removed and the amount of tool sharp edge produced. Across the three assemblages, external platform angles went from being high to being decreased and were kept at a relative plateau while the thickness of platforms started off high, decreased and were increased again. Observing how the external platform angles did not increase to increase the amount of sharp edge and how platform thickness did not decrease through time, suggests that the maximum amount of sharp edge per tool size was not a highly desired outcome of stone tool production. Each of the three GRS populations appear to have prioritized sharp edge amount and tool size differently in a non-linear evolutionary pattern.

The LP population selected for large blanks which coincides with the macrolithics that are more common with MSA assemblages. These LP tools also exhibited the most amount of sharp edge between the three GRS assemblages. The TP population produced the smallest blanks with the least amount of sharp edge and the MH population produced moderately small blanks with a moderate amount of sharp edge. If the earliest assemblage in GRS is the only one that has maximised on the production of sharp edge, then it would be safe to suggest that as this feature demonstrates a change across the MSA/LSA transition, it is likely that sociocultural factors were an influence. Seeing as sharp edge per tool size acts to reduce the cost of stone resource acquisition, retouch maintenance and transport, the variability in sharp edge production at GRS could possibly be a by-product of other intentions not related to raw material conservation as raw material is abundant at GRS. Size and shape which are also directly affected by the manipulation of exterior platform angle and platform thickness, form part of the culturally influenced geometrics of stone tools within technocomplexes. This highlights stone tool knapping as a complex multi-behavioural activity that each GRS chronological group experienced in nearly unique contexts.

The expressions of dorsal scar directions by blank length suggest that the TP and MH populations had more social relatedness than the LP and TP populations did. Direction of core exploitation operates to determine the outline shape of the resulting tool through the interaction of core surface area and convexity (Tostevin 2012). Seeing as the outline shape of a tool is one of the markers for technocomplex compositions, the knapper's determination of core exploitation would be in part influenced by sociocultural preferences. This suggests that the TP and MH populations shared some similar sociocultural preferences, and this is also evident in the high similarity of raw material composition between the two chronological groups. Raw material physical properties such as hardness and cleavage affect core morphology with which direction of core exploitation is decided. If rocks are procured in differing sizes of unworked nodules due to fracturing in different ways and are also worn out at varying use-rates, then the selection of rocks would be of consideration depending on the class of tools being produced. This is likely to provide context for the greater variability seen between the LP and TP than between the TP and MH in regard to raw material selection and direction of core exploitation as the LP technocomplex is a MSA assemblage while both the TP and MH technocomplexes are LSA assemblages.

Using the Tostevin (2012) model I have suggested that the transition from the LP to the TP assemblage was a novelty event while the transition from the TP to the MH assemblage was a transmission event. Being that the MSA/LSA transition occurs between the LP and TP assemblages, it would seem reasonable to say that a considerable number of shifts in the lithic elements are present to demonstrate a novelty event. In a sense, the innovation here lies not in the actual techniques being newly found but in the changed intensities of these techniques which ultimately makes them novelties. Much like Kaplan (1989) stated, the MSA/LSA boundary reflects a broad continuity in assemblage transitions where lithic elements are present in both assemblages but in varying frequencies. The social relatedness between the

TP and MH assemblage is evident in the minimal tool knapping differences described above. The cultural transmission of tool knapping information through social learning is thereby more strongly related. The higher tool knapping differences between the LP and TP assemblages are based on the contrasting cultural preferences of the MSA and LSA toolmaking peoples.

This study has incorporated raw material counts, artefact class analysis and the methods of Tostevin (2012) to facilitate the breakdown of lithic techniques to their knapping elements to create a greater understanding of the variabilities we see between these three chronological groups. The different frequencies of each knapping element and how they interact with each other within the assemblages has helped dissect how the assemblages may have developed through contexts of environmental, economic, and sociocultural factors. This has provided substantial material for the comparison of variability through time at the GRS site. Having depicted knapping behaviours and assemblage variability at a single location, it would be interesting to see this investigation replicated in other sites especially in the Eastern Cape region to gauge the level of diffusion across space. This would further bolster our understanding of knapping behaviours in varying technocomplexes.

The Eastern Cape archaeological record has the propensity to grow further with the methodologies demonstrated in this study. The use of stone tool features as analysis units to depict knapping behaviours allows archaeologists to objectively expand the comprehension of lithic technology across time and space without the possible hindrance of arbitrary groupings of tools. Once more southern African sites undertake this approach, the understanding of the formation of assemblages under the influence of environmental, economic, and sociocultural factors is feasible. With this study, I have taken advantage of this analytical method while still making the link to the more universally understood technocomplexes for archaeological record relatability. It is important to note that some sampling issues did occur, though statistically accounted for in this study. The currently attained data at GRS has demonstrated the dynamic adaptability and fitness of hunter-gatherer groups within lithic technology organization alone and future developments in lithic study as well as other material culture domains will further depict the past peoples' landscape prowess. As more sites are discovered and the current analysis methods are improved upon, we will be able to piece together the southern African archaeological record.

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