Archaeological Reconnaissance for Middle Stone Age Sites Along the Pondoland Coast, South Africa

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ABSTRACT

This paper summarizes the results of a recent survey of the South African "Wild Coast" in Pondoland, Eastern Cape Province. The purpose of the survey was to locate and to describe coastal caves and rock shelters that may contain Early and Middle Stone Age archaeological deposits for future study. The study is part of a much larger research design to understand three basic and interlinked paleoanthropological questions: When did coastal intertidal foraging develop? How did it develop? What role did coastal intertidal foods have on the evolution and survival of early modern humans?

Here, we provide the full results of our multi-disciplinary survey. We describe the archaeology, geology, marine, and terrestrial fauna from four near-coastal rock shelters and one coastal open-air site that we intend to test in the future. We also provide the first direct ages of the coastal red sands that contain *in situ* Early Stone Age Acheulian and early Middle Stone Age flaked stone tools. These optically stimulated luminescence ages show that humans have inhabited Pondoland for over 300,000 years, predating the currently known origins of the modern human lineage and systematic coastal foraging. We also describe the first dated paleoenvironmental sequences for Pondoland, which suggest a shift from C_3 to C_4 vegetation during the middle Holocene. Lastly, we provide comprehensive notes on all sites in Supplementary Online Materials to benefit future studies across the region and document an area that has seen very limited archaeological research.

INTRODUCTION

Detailed archaeological records found in neocoastal caves on the southern and western seaboards of South Africa indicate that early modern humans there had innovated novel social, symbolic, and technological systems to adapt to changing environmental conditions during the Pleistocene (Brown et al. 2009; Brown et al. 2012; Henshilwood et al. 2001; Henshilwood et al. 2011; Henshilwood et al. 2009; Texier et al. 2010). Abundant marine shellfish remains have also been found in many of the same cave deposits, attesting to an equally ancient interest in coastal resources that dates back to at least Marine Isotope Stage 6 (MIS6: 200–130 ka) (Jerardino and Marean 2010; Marean et al. 2007). Highly nutritious and perennial, coastal resources—and especially marine intertidal shellfish—are hypothesized to have aided the cognitive development and survival of early modern humans during the Pleistocene, and these foods may have even influenced the movements of early modern humans out of Africa via coastlines (Broadhurst et al. 2002; Jerardino 2010; Marean 2010; Marean et al. 2007; Parkington 2003).

Yet our understanding of how, when, where, and why coastal foraging developed is still largely incomplete. This is because archaeological records dating to MIS6 when the modern human lineage appears are rare. Many other early sites have been washed out by later periods of high sea levels (Bailey and Flemming 2008; Hendey and Volman 1986). Archaeological and ethnographic studies have also shown that coastal foraging was dependent upon the time it took hunter-gatherers to travel to the coast, typically no further than the distance a person can walk out and back in one day from a base camp (Bailey and Craighead 2003; Jerardino 2003). During glacial periods, eustatic sea levels were generally lower and up to 80,000km² of the South African continental shelf may have been exposed during glacial maxima (Fisher et al. 2010). Although the changes may not have been perceptible within a single lifetime, once-coastal caves gradually became inland locations during the glacial periods. If hunter-gatherers preferred coastal environments and resources during MIS6, then they would have had to move out onto the exposed continental platform to remain within the foraging distance to the coastline with the end result being that those sites would now be submerged under the Indian and Atlantic Oceans.

In 2011, the Pondoland Paleoenvironment, Paleoclimate, Paleoecology, and Paleoanthropology Project (P5) began a search for new research areas along South Africa's coast where long-term and continuous records of modern human evolution and coastal foraging may be found. Preference was given to locations that had narrow continental shelves, which would have limited lateral coastline movements during glacial phases and the concomitant movements of hunter-gatherers. Our search led us to South Africa's eastern seaboard and to Pondoland. Pondoland has dense, highly productive, and ancient indigenous vegetation that are still relied on today for food, medicines, glues and resins, timber, and other uses. Near-coastal rock shelters also are common in the many deeply incised river valleys, which clearly sheltered hunter-gatherers in the past and now protect fragile archaeological deposits. The same river valleys are sources of fresh water and they act as a direct conduit to the coastline for contemporary coastal foragers. Located just offshore, the warm water Agulhas current maintains shellfish colonies and moderates local climates. Most importantly, the continental shelf is <10km wide. Although archaeological sites located on the shelf would have still been lost to subsequent higher sea levels, any site found on or near the modern coastline would have been within the limits of coastal foraging throughout the Pleistocene.

These observations about the area led us to conduct a survey in eastern Pondoland from September to October, 2011. This survey was the first phase of our project, which was designed to explore the area and identify sites that

we believe have the greatest potential for future research. Here, we will describe the archaeology, climate, and environment of Pondoland in the first part of the paper, and, in the second, we will summarize our research findings. The body of the paper will focus on four rock shelters and one open-air archaeological site that we have given the highest priority for future research, but full descriptions of all of our sites and our research methods can be found in the Supplementary Online Materials (SOM). In the final section of this paper, we will return to our initial observations about what makes Pondoland unique, our findings, and briefly lay out a series of empirical questions to guide our future research in the area.

THE RESEARCH AREA
Eastern Pondoland is bordered between the Umzimvubu River at Port St. Johns and the Mtamvuna River, south of Port Edward. The region is inhabited by the amaPondo people who arrived in A.D. 1100–1300 as part of broader settlements by Xhosa-speaking Nguni peoples (Feely 1986). The local amaPondo speak a dialect of Xhosa, called isiMpondo, and they rely on a mixed pastoral and agricultural economy. They still collect shellfish and other coastal resources seasonally (Bigalke 1973; Lasiak 1992; Whitelaw 2009) as well as wild terrestrial plants and animals (Hayward et al. 2005; Kepe 2008; Rose and Guillarmod 1974).

The coastal municipal districts within eastern Pondoland are largely influenced by linear NW-SE trending river valleys. Our 2011 survey encompassed a 180km² area across the Mbizana, Mkambati, and Msikaba districts (Figure 1). The northernmost district, Mbizana, was bordered by the Mtentu River in the south and the Mtamvuna River, which forms the border with KwaZulu-Natal Province to the north. Centrally located in our study region, the Mkambati district was bordered between the Mtentu and Msikaba Rivers. Much of this district is occupied by the Mkambati Nature Reserve, which is managed jointly by the Mkambati amaPondo community as well as the nature reserve staff under the directorate of the Eastern Cape Parks and Tourism Agency. Lastly, the Msikaba district in the south was bordered by the Msikaba River and the Goso Fault. The coastline is part of the Pondoland Marine Protected Area, which was established in 2004.

GEOLOGY
Eastern Pondoland is dominated by Msikaba Formation sandstones that are located primarily within a ~20km wide coastal belt that stretches from Port St. Johns in the south to Margate in the north. The Msikaba Formation is characterized by alternating layers of quartz arenites, conglomeratic quartz arenites, and granule conglomerates that were laid down within a shallow marine or stable shelf environment during the Late Devonian (385–359 Ma) (Kingsley and Marshall 2009). This formation is maximally 900–1,000m thick (Thamm and Johnson 2006), and is believed to be part of the broader Cape Supergroup, though that correlation remains debated (Kingsley and Marshall 2009; Thamm and Johnson 2006).

The Msikaba Formation was intruded by dolerite dykes and sills during the extensive Karoo volcanism in the Jurassic (~183 Ma) (Watkeys 2002). It was subsequently sheared by the movement of the Falklands microplate during the breakup of Gondwanaland (135–115 Ma), which has resulted in an exceptionally narrow continental shelf (Watkeys 2006). Pondoland's shelf is now only ~8km wide, compared to the global average of 78km (Kennett 1982), and it was the primary limitation on Quaternary coastline movements.

Partridge and Maud (1987) suggested that epeirogenic uplifting during the Early Miocene (~20 Ma) and Pliocene (3–5 Ma) raised the southern African landmass ~1,000m from an axis of movement along the Drakensberg escarpment at a rate of 10–50m/My during the Miocene and up to 180m/My during the Pliocene. Erlanger (2011), however, has argued that Pliocene uplift rates near Durban and Port Elizabeth were significantly slower (16.9±1.2m/My at the Sundays River and 10±3m/My near Durban) based on cosmogenic burial ages. The implication of this interpretation is that uplift has been more consistent and slower than previously argued. In Pondoland, the uplift created a stepped landscape of raised neocoastal plains of Miocene and Pliocene age (Bond 2008). Processes of Neogene uplift also have influenced the formation of the modern NW-SE trending drainage network, which is characterized by the poor preservation of on-land sedimentary sequences and the deep incision of east coast rivers (Dingle et al. 1983; Partridge and Maud 2000).

Despite the uplift, the Msikaba sandstones were not significantly deformed or tilted. Brittle fracturing of the competent quartzitic sandstones formed joint patterns that have controlled drainage and exploitation by streams and rivers, creating the prominent gorges and narrow stream channels found today. Erosion of those near-horizontal beds along the coastline or up riverine valleys therefore favored the formation of near-horizontal rock shelters that are primarily lithologically controlled. This pattern differs substantially to the Cape south coast where local sandstone formations were tilted and deformed. Those caves are frequently eroded into angled slip-sheer zones that are filled with less resistant fault breccias (Karkanas and Goldberg 2010). Lithological profiles have been provided for most of our research sites in the Supplementary Online Material, section 2 (**SOM-S2**); each supplement is available as a downloadable pdf (http://www.paleoanthro.org/journal/2013/).

CLIMATE AND ENVIRONMENT
Pondoland's climate is humid-temperate with an average rainfall of 1,200mm, of which 61% falls during austral spring and summer (September to February) (Shackleton et al. 1991). Much of the coastal precipitation is due to the convection of moist coastal air cells that are driven by the warm Agulhas current offshore (Jury et al. 1993; Schumann et al. 1995). The warmest months are January and February and the lowest temperatures are recorded in July and August (Shackleton et al. 1991).

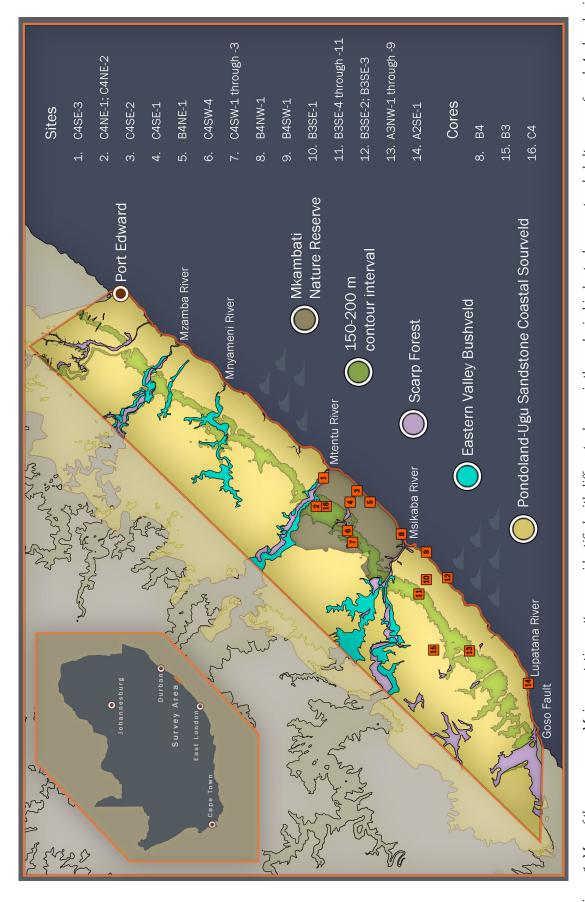The region is part of the Indian Ocean Coastal Belt Bi-

Sites

1. C4SE-3
2. C4NE-1; C4NE-2
3. C4SE-2
4. C4SE-1
5. B4NE-1
6. C4SW-4
7. C4SW-1 through -3
8. B4NW-1
9. B4SW-1
10. B3SE-1
11. B3SE-4 through -11
12. B3SE-2; B3SE-3
13. A3NW-1 through -9
14. A2SE-1

Cores

8. B4
15. B3
16. C4

Port Edward

Mkambati Nature Reserve

150-200 m contour interval

Scarp Forest

Eastern Valley Bushveld

Pondoland-Ugu Sandstone Coastal Sourveld

Mzamba River

Mnyameni River

Mtentu River

Msikaba River

Lupatana River

Goso Fault

Johannesburg

Durban

Survey Area

East London

Cape Town

Figure 1. Map of the survey area. Major vegetation patterns are identified with different colors, as is the geological isohyet where most rock shelters were found. Archaeological sites and core locations are identified on the map and in the legend at right.

ome (IOCB), which stretches along an 800km long coastal strip from the Kei River Mouth northwards to Mozambique (Rutherford et al. 2006b). The biome is subdivided into numerous regions due to localized variations in climate and soils (Shackleton et al. 1991). Eastern Pondoland is part of the Tongoland-Pondoland mosaic of the IOCB. This vegetation mosaic is dominated by edaphic Sourveld grasslands, which means that palatable forage for livestock is available only during the growing seasons (McNabb and Sinclair 2009). Sourveld grasses develop in areas of high moisture availability and on soils derived from quartzite or sandstone, and, across the region, the Pondoland-Ugu Sandstone Coastal Sourveld is restricted to the Msikaba sandstones on the neocoastal peneplain. Woodland thicket called Eastern Valley Bushveld is common in fire-resistant areas such as riverine floodplains while tropical Scarp forests grow along cliffs and in gorges (Rutherford et al. 2006a).

Pondoland's vegetation includes 1 family, 6 genera, and over 50 species of endemic plants (Shackleton et al. 1991). Obiri et al. (2002) have found that 25 local species of trees are still harvested for medicinal purposes, as wood fuel, or for their edible fruit. Kepe (2007) has identified another 23 local plant species that are used for medicinal purposes. There is also a class of wild edible leaves, called *Imifino* in the local amaPondo language, that have high amounts of dietary fiber, micronutrients, antioxidants, and protein (Kepe 2008; Nesamvuni et al. 2001; Odhav et al. 2007; Rose and Guillarmod 1974).

Little is known about the long-term vegetation history of the area. Charcoal and palynology analysis from Sibudu cave and the iSimagoliso wetland park in KwaZulu-Natal to the north of our study area respectively showed that that area was dominated by evergreen forests (primarily *Podocarpus* sp.) during warmer, wetter periods of the Late Pleistocene (Allott 2006; Finch and Hill 2008). Periods of decreased moisture content, including the Last Glacial Maximum (27–14 ka), were characterized by forest retreat and grassland / shrubland dominance. Coastal lakes like Eteza and Sibaya as well as wetlands in KwaZulu-Natal serve as archives for Holocene vegetation and climate dynamics (Finch and Hill 2008; Neumann et al. 2010; Neumann et al. 2008; Turner and Plater 2004). An overview is given in Scott et al. (2012). More details about regional paleoenvironments and paleoclimates are provided here in the Discussions and Conclusions.

Acocks (1953) believed that the current grasslands were secondary-growth from widespread deforestation and burning after the arrival of Iron Age pastoralists. Finch and Hall (2008) and Neumann et al. (2010), more recently, have argued that the development of open woodland savanna during the Late Holocene at iSimagoliso and Lake Eteza, respectively, also might have been due to disturbance by fire and deforestation by Iron Age pastoralists. Feely (1980, 1985, 1986; Feely and Bell-Cross 2011) and Granger (Granger et al. 1985) have challenged the idea that the current grassland distribution is anthropogenic rather than edaphic, arguing that the grasslands predated pasto-ral settlements into the region.

ECOLOGY

Africa is well known for its large mammal species diversity (Olff et al. 2002; Prins and Olff 1998) whose distribution patterns are influenced by habitat heterogeneity, forage quality, forage quantity, vegetation density, facilitation, competition, predation, access to surface-water, and anthropogenic impacts (Cromsigt et al. 2009; du Toit 1995; Fritz 1997; Owen-Smith 1987; Smit 2011). The diversity of Pondoland's terrestrial fauna reflects the heterogeneous environmental zones in this area (Hayward et al. 2005). Grazing mammals are common to the grasslands on the raised coastal plain. Suids and browsing bovids frequent more closed environments like thickets. The coastal and scarp forests provide habitats for canids and felids as well as some small bovids.

Holocene and Late Pleistocene fauna assemblages from Sibudu cave north of Durban show a diverse fauna, some of which are now extinct from the region (Clark and Plug 2008; Plug 2004). Historical European observations record the presence of African buffalo (*Syncerus caffer*), eland (*Tragelaphus oryx*), African elephant (*Loxodonta Africana*), hippopotamus (*Hippopotamus amphibus*), oribi (*Ourebia ourebia*), red hartebeest (*Alcelaphus buselaphus*), and southern reedbuck (*Redunca arundinum*), although these species are now locally extinct (Skead 2007). A number of species (mainly large herbivores) have been reintroduced to Mkambati Nature Reserve since 1979 (de Villiers and Costello 2006).

Pondoland's marine ecology is heavily influenced by the warm waters of the southerly-sweeping Agulhas current whose core lies just offshore of the shelf break (Schumann 1987). For example, population genetic studies of South African brown mussel (*Perna perna*) show a 2.9% mtDNA sequence difference between the east and south coasts that has been attributed to population divergence due to the influence of the Agulhas current (Zardi et al. 2007). The regional intertidal habitat falls within the east coast biogeographic province (Bustamante and Branch 1996). Offshore and intertidal primary production rates are relatively low on the east coast due to the warmer, nutrient-depleted, waters of the Agulhas current (Bustamante et al. 1995). The core of the Agulhas current is several degrees warmer than neighboring waters and the sharpest temperature gradient is on the inshore boundary (Pearce 1977). Widening of the shelf south of East London produces an inshore temperature gradient and relatively small, but persistent, upwelling (Schumann 1987). The upwelling, lower surface water temperatures, and surface winds stimulate spawning in east coast intertidal filter-feeders like *Perna perna* (Lasiak and Dye 1989). Due also to the influence of water temperature, the region has greater marine species richness compared to the south or west coasts, but the total biomass is smaller and many tropical species are inedible (Tittensor et al. 2010). Many intertidal species like the Natal rock oyster (*Sacostrea cuccullata*) have Indo-Pacific origins and have traveled southward with the Agulhas current (McClurg 1987; Schumann 1987).

Intertidal communities are stratified vertically according to wave forces, immersion times, thermal conditions, nutrients, and sub-aerial climates (Menge and Branch 2001). Archaeological shellfish assemblages therefore show where in the tidal zone coastal contemporary and past collectors were foraging (Voigt 1973a, b). The lower intertidal boundary is shared with the sublittoral fringe that occupies the zone between low spring and low neap tidal heights. The sublittoral fringe is exposed only during extreme low tide events. Along the east coast, this zone is populated by corraline algae, seaweed (e.g., *Hypnea spicifera*), and filter feeders including red bait (*Pyura stolonifera*) and brown mussel (*Perna perna*) (Branch et al. 2010). Above the sublittoral fringe is the stratified eulittoral zone that is commonly referred to in South Africa as the Balanoid zone due to the presence of filter feeding barnacles. The lowest eulittoral area lay between low neap tide and low spring tidal heights. This area is dominated by the highly territorial pear limpet (*Scutellastra cochlear*) that grazes on corraline crust (*Spongites yendoi*), and it is locally referred to as the "Cochlear zone." In the Eastern Cape, *Scutellastra argenvillei*, zoanthids, sponges, and *Perna perna* are also common in this zone. Mid-eulittoral areas are commonly known as the Lower Balanoid zone, which occurs between mid-tide and low neap tidal heights. Dense beds of *Perna perna* and zooanthids are common, as well as sponges, seaweeds, and algae. The Eastern Cape has a uniquely stratified upper eulittoral zone (Upper Balanoid), which occurs between high neap tide and mid-tidal heights. The lower two-thirds of this zone is populated by herbaceous grazing limpets (*Scutellastra granularis, Cymbula oculus*, and other large limpets), tube worms, algae, and barnacles. The upper one-third of this zone is characterized by a distinct belt of Natal rock oyster (*Scutellastra culcullata*). Lastly, the highest intertidal area is the Littorina zone, which is submerged only by high spring tides. The most common species to this zone are periwinkles (*Littorina karussi, Littorina africanus*, and *Echinolittorina natalensis*).

PRIOR ARCHAEOLOGICAL RESEARCH

South Africa's eastern seaboard has remained largely inconspicuous in discussions about early modern humans and coastal foraging. Sibudu rockshelter, Border cave, and Umhlatuzana, all in the province of KwaZulu-Natal, have provided the bulk of information about Pleistocene foragers from the region (Beaumont 1978; d'Errico et al. 2012; Kaplan 1990; Rightmire 1979; Wadley and Jacobs 2004, 2006). Yet, none of these sites is located coastally and the dearth of knowledge is even greater to the south in places like Pondoland (Feely and Bell-Cross 2011; cf. Mitchell 1998)[1].

Prior research in Pondoland has focused largely on early Iron Age settlements and a handful of inland Later Stone Age (LSA) sites (Feely 1980, 1985, 1986; Feely and Bell-Cross 2011; Granger et al. 1985). Rock shelters are common in the area, yet 1934 was the first, and last, time that archaeological deposits from a local rock shelter were described from Pondoland (Chubb et al. 1934). There are no published MSA sequences and save for a single, casual reference to 'fossil dunes' on the Msikaba River (Davies 1982), there are no published ESA sites either. The area is believed to have been largely avoided during the Iron Age (Feely 1986; Prins and Strever 1987) and influential researchers like Davies (1950: 118) found Pondoland unpromising for earlier ESA and MSA occupation because rock types for tool production were found only in coastal exposures.

The only published excavation of a local rockshelter in Pondoland was conducted in 1932 by E. C. Chubb, who excavated the low lying 'Strandloper' cave at the mouth of the Mngazana River (Chubb et al. 1934). That sequence showed stratified layers of shell and ash as well as sterile sands. Organic preservation was attested by multiple human burials. However, the low elevation of the cave (~2m above spring high tide), its proximity to the ocean, and the presence of fish bones and pottery within the sequence all suggest a late (almost certainly post Last Interglacial or even mid-Holocene) age for those occupations.

Further abroad, there are several rockshelters with MSA sequences. One rock shelter in Alfred County was excavated in the early 20th century, but its location has since been lost (Mitchell 1998). The lithic assemblage is preserved in the British Museum, however, and it has been shown to include stone tools attributed to the MSA and LSA, including diagnostic tools that have been classified as Howieson's Poort MSA, generic MSA, Oakhurst/Robberg LSA, and post-classic Wilton LSA (Mitchell 1998).

Umhlatuzana rockshelter in KwaZulu-Natal contains a well-dated and long-term MSA sequence (Kaplan 1990; Mitchell 1998). The rock shelter is located in Natal Group sandstones west of Durban, approximately 100m above the Umhlatuzana River and ~500m above sea level (Kaplan 1990). The site was excavated by Kaplan in 1985 and the excavations reached a maximum depth of 2.6m (Kaplan 1989, 1990). The original radiocarbon assay of 16 samples showed that the sequence spanned 50,219±4,999 cal BP (Level 23) to 2,971±84 cal BP (Level 2) (Kaplan 1990; Lombard et al. 2010). OSL analysis has now pushed that chronology back to 70.5±4.7 ka (Lombard et al. 2010). The archaeological sequence spanned the MSA and LSA, and it included stone tools diagnostic of the MSA Howieson's Poort and all the major industrial components of the LSA except for the Wilton (Kaplan 1989, 1990). Serrated "pre-Howieson's Poort" bifaces have more recently been assigned to the MSA Still Bay Industry by Lombard et al. (2010). However, the Umhlatuzana late and terminal Pleistocene levels, excavated in spits, are compromised by rotational slipping and mixing making the site a less than ideal case study for detailed, long-term behavioral change in the Stone Age.

The Shongweni rockshelter is located approximately 25km from Umhlatuzana on the Mlazi River. Excavations at Shongweni were conducted by Davies in the 1970's (Davies 1975), revealing a discontinuous archaeological sequence characterized by a younger facies no older than the middle Holocene and an older facies dating from the Early Holocene and Terminal Pleistocene. The younger archaeological facies was associated with Wilton LSA stone tools, fruiting inflorescences from three grass species, and shell fragments

from two fruit species (Davies and Gordon-Gray 1977).

Located to the northeast in Natal province, Holly shelter was excavated in the 1950's by Cramb who identified two primary stratum within the ~1 meter of deposits (Cramb 1952). The Upper Stratum contained undecorated pottery, human skeletal remains, and LSA stone tools made on quartz. A point and blade-based MSA industry that was manufactured from hornfels was identified in the Lower Stratum underneath. A radiocarbon sample from the Lower Stratum (18,200±500 ^{14}C yr BP) is likely a minimum age for these deposits (Cramb 1961).

Another well-dated MSA sequence comes from Sibudu rockshelter, which was excavated first in 1983 by Mazel (Wadley 2001) and subsequently excavated by Wadley since 1998 (Wadley 2001, 2002; Wadley and Jacobs 2004, 2006). The rock shelter is located 15km inland on the uThongathi River. The MSA sequence spans ~2.5m and has been intensively dated using single aliquot and single grain OSL, showing that the deposits range from 38±2.6 ka to 77.2±2.1 ka (Jacobs et al. 2008a; Jacobs et al. 2008b; Wadley and Jacobs 2006). The lithic assemblages have been assigned to the Pre-Still Bay, Still Bay, Howieson's Poort, Post-Howeison's Poort, late MSA, final MSA, and Iron Age. Organic preservation is excellent, including evidence of early bedding (~77 ka) (Wadley et al. 2011); bone tools (61–65 ka) (Backwell et al. 2008); seeds (Sievers and Muasya 2011; Wadley 2004); and shell beads (d'Errico et al. 2008). Charcoal identification has enabled paleovegetation reconstructions (Allott 2004, 2005, 2006).

Early Stone Age (ESA) tools have been recorded from multiple inland areas, primarily north and west of Durban in Kwa-Zulu Natal. Site locations include the Tugela River valley (Davies 1951b), the Umbava and Umsindusi River Valleys (Davies 1951b), and Port Shepstone (Davies 1949). ESA tools also have been documented on near-coastal raised beaches and terraces (Davies 1951a, 1954, 1970). Sedimentary deposits containing Acheulian artifacts around Port Durnford in KwaZulu-Natal have been dated to the Middle Pleistocene via mammalian biostratigraphy (Hendey and Cook 1985; Hobday and Orme 1974). Luminescence dating of a peat layer within the formation has yielded an age of 70±5 ka (Oschadleus et al. 1996) that also corresponds to a shift in pollen spectra from open marshland to terrestrial *Podocarpus* forest (Scott et al. 1992). One of the most concentrated assemblages of ESA artifacts have been documented from the rubified coastal dunes that are found northwards from the Msikaba river mouth (Davies 1949,1951b,1982). Kuman and Clarke (2005) have documented ESA tools, fossil teeth, and petrified wood from similar coastal red dunes in northern Pondoland, which contain handaxes, picks, cleavers, choppers, and core-scrapers that they have identified with the ESA Sangoan Industry (Clark 1974).

In summary, almost nothing is known specifically about eastern Pondoland's history predating the Iron Age. What little is known about the regional prehistory is focused mainly in KwaZulu-Natal to the north and there are no published coastal MSA assemblages anywhere in the area. Attention has rarely been given to coastal ESA sites

either (but see Kuman and Clarke 2005). Yet what evidence that does exist hints at a very long and rich cultural record in the region. Our survey in 2011 therefore set out to provide modern documentation of coastal sites that may contain archaeological sequences dating to the Pleistocene.

ARCHAEOLOGICAL SITES

Our survey methodology is described in detail in the SOM, section 1 (**SOM-S1**). During the survey, we recorded 28 rockshelters ranging in size from 9.5m to >100m long (mean=33.8m, s.d.=26.4). Seaside caves and rockshelters were rare because of the flat-lying lithology (n=1, A2SE-1). Rock shelters were located primarily adjacent to river channels and we believe that fluvial erosion was the primary site formation process. Only three rockshelters appeared to be actively forming near the water line of contemporary streams (A3NW-3 ,-4. -5). These shelters each had water-scoured floors with a thin veneer of sandy sediments and no visible archaeological remains. The remaining 26 rockshelters were all located 10m or higher above existing stream channels and thus they were less susceptible to flooding. Seventy-nine percent of shelters also were located within a regional isocline located between 150m and 200m above sea level. We believe the isocline followed a lithological stratum of relatively softer sandstones that were more susceptible to erosion and rock shelter formation (see Figure 1).

Though the bedrock geology differed across the study area, most of the rockshelters appear to have been incised within trough cross-bedded or feldspar-rich ancient marine facies that were bounded by more resistant massive quartz arenites. Five shelters had either rocky floors or floors composed of white, heavily eroded roof spall, which were in all cases visibly archaeologically sterile (A3NW-2, A3NW-6, B3SE-9, B3SE-10, B3SE-11). Twenty rock shelters had visible archaeological remains, including abundant surficial lithics and faunal remains. Shellfish remains were found at every site with visible archaeology except B4NW-1, which we believe either predates coastal foraging or the open-air sediments have been decalcified (see below). Pottery was also recorded at 17 sites, iron slag was recorded at two sites, and glass was found at only a single site. Detailed descriptions about each site are provided in **SOM-S2**. Here, we will only describe four rockshelter sites that we believe are the most promising for future research:

A2SE-1

This site was located near the base of the Mlambomkulu River at Waterfall Bluff, 3km south of the Lupatana gorge in the Msikaba district (see Figure 1). It was the only site we found that was located directly on the coast. The rock shelter was ~70m long, 10m deep, and it was located ~20m above the waterline. Wave cut ledges and notching across the cliff face suggested that the rock shelter formed by marine erosion during a past high sea stand. The southern edge of the site appeared to have been subsequently expanded via corrasional back-rearing from the Mlambomkulu waterfall (see **SOM-S2-1**).

Geology

The erosion of the cavity followed bedding planes and primary sedimentary structures within the Msikaba sandstones (see SOM-S2-2). The basal unit within the shelter was a relatively high angle (20°) bed with planar stratification.This was overlain by a trough cross-bedded, heavily eroded layer composed of moderately-sorted quartz. The lithology graded into alternating beds of tabular, resistant quartz arenites reminiscent of the basal strata.

The seaward margin of the site was demarcated by vegetated colluvial deposits that sloped to a modern rocky intertidal bench. Shellfish are currently found in abundance along the rocky shoreline today and their remains, as well as stone tools, were frequently found scattered across the front slope of the site. Within the rock shelter, the edge of the vegetation coincided with a linear, shallow depression and lightly cemented sediments that demarcated the drip line. The rock shelter floor was dry. Fallen roof blocks were also frequently found on the surface.

We identified multiple sediment facies, many of which were lightly cemented sands. The thickest sediment deposit was located at the deepest and most protected part of the shelter. The actual depth of the sediment wedge is currently unknown, but we estimated that it was conservatively between 0.9–2.5m. This measurement is based on a 6° westerly slope of the bedrock seen in the rockshelter roof and a maximum floor cutting coincident with the height of the drip line. Several naturally-eroded sections in the center of the rockshelter showed *in situ* shellfish fragments, ash, and charcoal. Further details and illustrations of the geology can be found in SOM-S2.

Fauna

Terrestrial fauna remains were well-preserved at A2SE-1 (SOM-S2-3). The majority of these faunal remains were fragmentary shaft fragments or other unidentifiable pieces. Two mandible fragments were observed, both from bovids (sp. unident.), with the smaller belonging to a size 1 mammal and the larger belonging to a size 2 mammal. We also documented an astragalus from a size 2 bovid (sp. unident.) and a heavily fragmented tooth from either a size 4 bovid or equid (sp. unident.).

There were also abundant marine fauna (SOM-S2-4). The species from A2SE-1 are overwhelmingly found in rocky shore environments today, but one sand clam specimen (*Tivela polita*) was also found. *Tivela polita* burrows in fine, clean sand just below low tide on high energy beaches. Limpet taxa appeared to be the most common, but brown mussels (*Perna perna*) were also abundant. Limpet species included *Cymbula miniata*, *Cymbula oculus*, *Scutellastra argenvillei*, and *Scutellastra cochlear*. These shellfish were probably collected during low tides, such as monthly spring low tides, due to their distribution in lower intertidal and shallow subtidal zones (Branch et al. 2010).

Artifacts

Stone artifacts have been grouped into site-specific "components" based on techno-typological characteristics. We were able to recognize at least two stone tool components at A2SE-1 (SOM-S2-5). The presumably youngest component was characterized by the use of hornfels cobbles and shale slabs for the manufacture of large, often cortical, irregular, and casually-struck flakes. A few of these flakes had steep adze-like lateral retouch and marginal trimming suggesting possible heavy-duty utilization. Microlithic tools were not present, but we did find one dihedral burin and several pieces of systematically-flaked glass. The second, presumably older, component was characterized by flakes showing parallel, sub-parallel, and centripetal flake scars and very little evidence for platform preparation or edge retouching. The predominant raw material for these artifacts was hornfels.

THE A3NW COMPLEX, CHAMBER 8

The A3NW site complex was located approximately 3km inland within the upper Mkweni River valley in the Msikaba district (see Figure 1). This section of the river likely formed along a gap-dyke with secondary trellis fracturing. This has resulted in the formation of an almost perfectly straight 1.2km sheer canyon trending NW-SE that ended in a 90° turn SW. The rockshelters (A3NW-1 to A3NW-9) were located along the canyon walls, and they were cut at a similar elevation across an area of <0.5km. Sites A3NW-1, -2, -6, and -7A had archaeological remains whereas sites A3NW-3, -4, -5, and -7B were sterile. Detailed descriptions of each of these sites can be found in SOM-S2. Here, we will focus on A3NW-8 and A3NW-9, which we believe most suit our future research objectives.

Geology

A3NW-8 was the southernmost chamber of a sinuous >150m long erosional cavity that included A3NW-7A/B to the northwest. Overall, the incision was highly irregular and it cross-cut stratigraphic beds (SOM-S2-12). At the top of the sequence in chamber A3NW-7A was a bed of quartz arenite. Chamber 7A was 24m long and it was incised into trough cross-bedded sandstones and an underlying sandstone facies that was characterized by herringbone trough-cross bedding. The floor of A3NW-7A was a quartz arenite. A buttress of rock separated chamber A3NW-7A from 7B (SOM-S2-13).

Chamber A3NW-7B was the largest rockshelter incision within our study area. By itself, it was 93m long and we estimated that it spanned >30m vertically (SOM-S2-14A, B, C). The stratigraphic sequence on the northern edge of chamber A3NW-7B showed that the incision occurred primarily within herringbone and low-angle trough cross-bedded strata. The base of the sequence in this area coincided with thick tabular beds of quartz arenite.The floor of chamber A3NW-7B then dropped steeply (~45°). Here, the incision had concentrated primarily within a facies of planar-bedded quartz arenites that was overlain by alternating strata of pebble conglomerates and finely laminated quartz arenite beds. In most locations the planar quartz arenites bracketed stratigraphic sequences because they are more resistant to erosion, unlike the trough-cross bedded

facies and beds with a higher percentage of a more erodible composition. The impressive cross-cutting into the massive arenites here, however, suggested that they may have been removed by a very high energy meander in the river.

Intensive scarring on the cliff face between A3NW-7B and A3NW-8 showed that there was a vertically-congruous, lateral continuity to the incision. However, chamber 8 was separated from A3NW-7B by a >10m high ledge. Chamber A3NW-8 is 28m long and 8.5m deep. The rockshelter was incised into low-angle trough cross-bedded beds that overlie a quartz arenite. The cutting was capped by tabular planar-bedded quartz arenites, which likely related to the capping quartz arenites in A3NW-7A.

The interior rockshelter floor in A3NW-8 was open, flat, and dry (SOM-S2-19 and S2-21). The drip line was located approximately 5m from the rear wall of the shelter, and beyond this was a ~2.5m grassy slope before the cliff edge. The Mkweni River was approximately 30m below. The sediment wedge within the site was expected to be between 0.7m and 2.3m deep. This estimate was based on a 10° SW inclination of the hard rock strata as it projected from the rockshelter mouth where the underlying bedrock was observed. The sediments were grouped into two facies—the greyish silts were mainly associated with a berm of shellfish and archaeological remains that was backed up against the rear wall of the site. Inside this berm, the shellfish appeared to be mainly rocky intertidal species, namely *Perna perna*, as well as multiple species of limpets, but no oyster. Indigenous pottery, hammerstones, assorted lithics, and rubbed ochre were also found within the berm. Darker, organic-rich sediments were located elsewhere throughout the shelter, but best represented along the drip line.

OSL Dating
We took one sediment sample for Optically Stimulated Luminescence dating (OSL) from A3NW-8. Collection and analytical methods can be found in SOM-S1. We collected the sample from an anthropologically sterile layer ~20cm below the sediment surface. The sample was located within a natural erosional face at the drip line in front of the rockshelter. We believe the sediments are part of a laterally continuous sedimentary facies across the site. The OSL analysis and calculated single-grain ages are provided below.

Fauna
Terrestrial faunal remains were present at A3NW-8, but not as abundant as at other sites. During our survey of the site we were able to identify a right astragalus from a size 4 bovid (possibly eland, *Taurotragus oryx*), which has been heavily burnt (SOM-S2-22). All other faunal remains were non-identifiable fragments from size 1 and size 2 animals. Marine fauna at A3NW-8 was dominated by rocky intertidal species (SOM-S2-23). Brown mussel (*Perna perna*) was most common, but numerous limpet species were observed, including *Cymbula miniata*, *Cymbula sanguinans*, *Cymbula oculus*, and *Scutellastra cochlear*. Except for *Cymbula oculus*, which is found in the mid-shore, these species are all found in lower intertidal and shallow subtidal environ-

ments (Branch et al. 2010), so they were probably collected during low tides or monthly spring low tides. Three whelk taxa were also identified, including *Burnupena cincta*, *Charonia lampas pustula*, and *Argobuccinum pustulosum*.

The *Scutellastra cochlear* specimens were largely subadult, which was a demographic pattern noted across multiple sites (A3NW-7; B3SE-2; B3SE-3; B3SE-8; C3SW-1). Subadult *Scutellastra cochlear* often live on top of adults until they can find free rock space where to settle (Branch and Branch 1992). Therefore, we currently believe that their inclusion in these archaeological contexts probably resulted from the primary collection of adult specimens.

Artifacts
A3NW-8 had the highest density and diversity of surficial lithics of all the sites we recorded. The lithics were made from at least six different raw materials including quartzite, quartz, cryptocrystalline silicate (CCS) nodules, slate, and hornfels. There were a few distinct and recognizable lithic patterns at A3NW-8, divisible into four broad components. These are listed here in their presumed chronological order from oldest to youngest. Component one was characterized by flakes with evidence of prepared core flaking—some with high flake scar counts—pointed, platform and multi-directional cores. Parallel-sided flakes, elongated blades, core trimming elements, biface thinning flakes, and unretouched convergent flakes, some showing signs of platform preparation and convergent flake scar patterning, are presumably associated with this component (SOM-S2-26 to 28). A section of the artifacts in this component showed signs of heavy weathering indicating possible age differences between them, but they were most common in the natural erosional section at the drip line, which may also account for their weathered appearance (SOM-S2-29).

The second component was characterized by heavily-reduced, macrolithic flakes struck from hornfels cobbles and slate slabs. Circular and side scrapers, as well as heavily edge-damaged spoke shaves and adzes were associated with this component (Deacon 1984) (SOM-S2-25A). Microlithic tools made primarily on CCS and quartz crystal characterized the third, and presumably later, component at the site (SOM-S2-24). The most recent component was comprised of large, casually-flaked scrapers made on hornfels cobbles and slate slabs. Similar tools were noted elsewhere in the landscape at sites with only pottery remains and are believed to belong to a more recent occupation of the site.

THE A3NW COMPLEX, A3NW-9
Site A3NW-9 was located approximately 40m southeast of A3NW-8 (see Figure 1). The site was set back from the Mkweni canyon edge by ~10m and it was located within Eastern Valley Bushveld thicket (SOM-S2-41). The shelter was ~30m long and ~5m deep.

Geology
The incision of A3NW-9 was capped by planar quartz arenties and primary cutting occurred within tabular, quartz-rich conglomerate and quartz arenites composed of clasts

with a dominant 'very coarse sand' grain size. The base of the sequence was composed of low-angle trough cross-bedded quartz arenites. The sediment wedge within the site was projected to be up to 2.8m deep. This was based on a 10° SW inclination of the hard rock strata relative to exposed bedrock below the grassy slope ~12m in front of the rockshelter (SOM-S2-40).

The rockshelter floor was dry and composed of light brown silty-sands. Fallen roof blocks were visible throughout the site. A termite mound was present in the center of the site near the drip line. Beyond the drip line, the sediments had a noticeably darker color, and were more organic-rich on account of the vegetation.

Fauna

Terrestrial fauna were present on the surface of A3NW-9, but the specimens were all heavily weathered and fragmentary (SOM-S2-42). We were able to identify the left acetabulum of an equid (sp. indet.) as well as the right femur from a scrub hare (*Lepus saxatilis*). The observed marine intertidal taxa from A3NW-9 were primarily from rocky intertidal environments. The complete catalog of observed shellfish is provided in SOM-S2. The assemblage was dominated by brown mussel (*Perna perna*). Limpets were also common and recognized specimens included one intertidal (*Cymbula oculus*) and two shallow subtidal taxa (*Cymbula sanguinans* and *Scutellastra cochlear*), as well as the subtidal species, *Scutellastra tabularis*. However, all photographed specimens of *Scutellastra tabularis* were young adults, which can also be collected in the low intertidal zone. One chiton species was also identified to the class level (*Polyplacophora*) and the cowrie *Cypraea annulus* also was documented.

Artifacts

The artifacts at this site were generally heavily weathered and they were lower in density than those at site A3NW-8. The surface material consisted of three artifact components, all of which were made mostly from hornfels. The first, and presumably oldest component, showed signs of the heaviest weathering and was made up mostly of cores with irregular and centripetal flake scar orientations, large and irregular parallel-sided flakes and a large naturally backed elongated flake (SOM-S2-45). Very little distinguishable retouch was noted on these flakes and platforms were too heavily weathered for meaningful descriptions to be made. The second component was characterized by a variety of formal scraper types and a heavily worked adze. The final component contained relatively fresh non-microlithic hornfels cobble-flaked materials (SOM-S2-44 and 46).

C4NE-1

Site C4NE-1 was located near the northern boundary of the Mkambati Nature Reserve, approximately 5km inland (see Figure 1). The site was located <1km SW of the Four Falls, which were multiple high waterfalls that emptied into the Mtentu River. This site had one of the most accessible routes to fresh water. It was cut into a rocky outcrop adjacent to a shallow NW-SE trending drainage ~100m away. The front

of the rockshelter was covered by an isolated, dense strand of Eastern Valley Bushveld thicket (SOM-S2-116). Sourveld grasses were nearby (SOM-S2-114). The site was 27m long and ~10m wide (SOM-S2-118). However, the last 2–3m of the site had been infilled nearly to the shelter roof.

Geology

The rockshelter was incised primarily into low-angle trough cross-bedded sandstones (SOM-S2-120). The sediment wedge within the shelter appeared to be thickest near the rear wall of the site where a ~60–80cm high mound had built up, partially obstructing the last 2–3m of the shelter. The thickness of the sediment wedge was estimated to be between 1.9m at the rear of the shelter and around 1m near the mouth. This estimate was based on a 10°–12° dip in the bedrock strata relative to a naturally exposed section at the dripline at the shelter mouth (SOM-S2-119).

The rockshelter floor was dry and composed of lightly-cemented silty-sands (SOM-S2-115). Four sediment facies were recognized across the site. Interpreted to be the lowest (visible) stratigraphic unit, Facies 1 consisted of dusky brown to dark moderate-brown, poorly sorted silty sands. Those sediments were exposed in a naturally-eroded section at the drip line of the site underlying Facies 2. Facies 1 sediments included clasts that ranged from silt-sized to granules of very coarse sand that were composed of quartz and quartz arenite fragments. The relationship between Facies 1 and the bedrock or cave floor is unknown.

Facies 1 shared a sharp contact with overlying Facies 2. These sediments were lightly cemented fine sands and silts with olive grey to pale yellowish-brown coloration. Facies 2 was best seen in the erosional section along the drip line, but it also appeared to be visible below, and surrounding, multiple fallen roof blocks on the shelter floor. Cementation of these sediments is suspected to have been caused by dissolution of $CaCO_3$ from shell fragments. Facies 2 is estimated to be minimally 40cm thick, and based on rockshelter sediment depth projections, may be upwards of 1m deep. Facies 3 sediments appeared to be stratigraphically above Facies 2, but otherwise shared color, texture, and compositional characteristics.

Based on field relationships and stratigraphic position, Facies 4 sediments are presumably the youngest currently recognized in the shelter. Facies 4 was characterized by an unconsolidated berm of pale to dark yellowish brown sandy silts that had accumulated along the rear wall of the shelter to create a ~60–80cm high berm. These sediments appeared to have relatively high clay content, but the texture was composed mainly of silt-sized particles.

Fauna

Surficial terrestrial fauna were reasonably well preserved at C4NE-1 (SOM-S2-121). We were able to identify a metatarsal, right humerus, left scapula, and phalanx from adult bovid ranging from size 1 to size 4 animals (sp. indet.). We also observed the ulna and left femur from an adult scrub hare (*Lepus saxatilis*).

The observed marine invertebrate taxa from C4NE-1

were primarily from rocky mid- to lower-intertidal environments. Limpet species were common to each of the recognized sedimentological facies, but they were most common in Facies 4, which was the berm against the rear rockshelter wall. The observed limpet assemblage included taxa from the mid-intertidal to shallow subtidal zones (*Cymbula oculus* and *Cymbula sanguinans*). Several specimens of young adult *Scutellastra tabularis* were also noted, which can also be collected in low intertidal areas (SOM-S2-123).

Brown mussel (*Perna perna*) also was observed in large quantities across different sedimentological facies. Several turban snails (*Turbo coronatus*) were also recorded. Natal rock oyster (*Sacostrea cuccullata*) was found only in Facies 4. The Natal rock oyster forms a conspicuous belt on the upper mid-tidal, settle wave washed rock platforms and also estuaries where it can tolerate low salinities. This species also settles on other shells and mangrove roots (Kilburn and Rippey 1982).

Artifacts

C4NE-1 contained a particularly rich and diverse artifact spectrum on its surface and eroding from its exposed sections. The site contained at least four components, broadly consistent with the sedimentological sequence at the site. Component 1 was characterized by a series of large, irregular, parallel-sided flakes with predominantly cortical platforms and little platform preparation, and made mostly on shale. A single tool showed signs of distal retouching to form a pointed end, but retouch was otherwise rare on these specimens (SOM-S2-127: D). Single platform and multidirectional cores as well as rejuvenation flakes showing centripetal flake scars were associated with this component (SOM-S2-126). Component 2 was characterized by large macrolithic flaked materials, with a high degree of cortical retention, including two large scrapers with steep adze-like distal and lateral retouch made mostly on hornfels and shale materials. The best example of these types of artifacts can be found at site C4SW-1 (SOM-S2-150). The flakes in this component were predominantly side-struck and a single casually-flaked cobble was the only evidence of a core type associated with these lithics. Component 3 was characterized by microlithic materials flaked mostly on CCS, quartz, and shale materials (SOM-S2-125). The only retouched pieces found were small end and sidescrapers and two large adzes, one with a concavity resembling a spokeshave. Component 4 was made up mostly of freshly flaked macrolithic material and ground stone, possibly associated with the few pottery fragments found on the surface of the shelter (SOM-S2-124).

B4NW-1

Local amaPondo women seasonally collect different species of intertidal shellfish today (Lasiak 1992), dumping the remains into modern middens near to contemporary homesteads. Elsewhere, light density shell scatters are common across the landscape. We found five sites that had shell in addition to fauna or other anthropogenic materials such as flaked or ground stone tools, ochre, ceramics, iron, or wood. These kinds of assemblages frequently contained oyster and ceramics, suggesting a relatively recent age.

Site B4NW-1, however, was unique among the open-air assemblages. This coastal site was located near the north shore of the Msikaba River mouth within the Msikaba Nature Reserve (see Figure 1). The site was a coast-parallel vegetated dune with a naturally-eroded face on the seaward margin that had exposed two stratified, rubified palaeosols and three sedimentary units which were interpreted to be stratigraphically higher than the basal palaeosols. No lithified aeolianites were visible. The western margin of the site was bounded by a wetland (SOM-S2-103).

Geology

The lowermost unit, Facies 1, was a rhizolith-rich paleosol (SOM-S2-103). This Facie was composed of supermature, highly rubified, sandy sediments and heavy minerals, and it dipped ~10° seaward. The upper paleosol, sedimentary Facies 2, at B4NW-1 was medium orange to brown in color and consisted of quartz, feldspar, and heavy minerals. It was well sorted and layered into north-south oriented beds 3–12cm in thickness. Facies 2 dipped ~5° to the east (seaward). The lower paleosol (Facies 1), at least, was truncated by a well-sorted, very fine-grained, massive sand layer on the seaward margin. This unit (Facies 3) was not laterally extensive. Sediment Facies 4 consisted of very dark brown to black soil with a high percentage of organic material. This sediment was waterlogged, very fine grained, and it was exposed on the seaward slope of this locality. Facies 5 was composed of greyish-brown fine- to medium grained sand. It was very well sorted and flanked the seaward margin of Facies 4.

OSL Dating

We collected three OSL samples from archaeologically-sterile natural sections within Facies 1 and 2. Two samples were analyzed with the third being retained for future study. Sample #46 was collected from a ~0.5m high erosional face within Facies 2. Sample #44 was collected from underlying Facies 1. The OSL analysis and calculated single-grain ages are provided below.

Artifacts

Sedimentary Facies 1 was associated with abundant stone tools made mostly from siltstones, hornfels, baked shale, quartz, and quartzite. Two lithic components, possibly belonging to the same industry (see discussion section) were recognized on this surface. The first was a large cutting tool component characterized by an assortment of large unifacial and bifacial tools such as core axes, picks, and cobble cores or choppers (SOM-S2-111). The second component was characterized by a number of prepared cores, convergent flakes, and large blades (SOM-S2-108 to S2-110). The variable weathering states of these lithic materials indicated that some older materials may be mixed together with *in situ* materials in a deflated surface context (SOM-S2-106). The initial stages of core reduction were present at the site with a high number of cortical flakes present.

In order to standardize the recording procedure in this very large area, a 1.5m x 1.5m square was strung out in an area with an average lithic density on the upper paleosol. The material found within this square was recorded to assess the average density of artifacts on this surface (SOM-S2-107). Within the demarcated area, a total of 50 stone artifacts above 2cm in maximum dimension were recorded. Extrapolating outwards to the entire paleosol, and assuming a relatively equal surface distribution of artifacts, we can expect somewhere in the range of 158,000 lithics on this surface. The mapped exposure contained a variety of lithic debitage size classes and flaked materials, some of them with relatively fresh edge morphologies, which suggested that there may be some integrity to the collection of lithics documented here. However, the assortment of flaked cobble materials, large bifacial tools, and smaller flaked artifacts suggested that deflation has mixed materials here somewhat. No refits were noted in this particular section although there were refits found elsewhere on this upper paleosol.

REGIONAL STONE ARTIFACT GROUPS

We observed technological and typological similarities within site-specific lithic assemblages during the survey. Site-specific "Components" have been grouped into regional "Groups," which are summarized below to set up an interpretive framework and describe preliminary spatial variations. It is important to note that these regional groups are not based on excavated materials and they are all currently undated. We have identified five Groups, described below from oldest to youngest:

Group 5 (B4NW-1)

These artifacts were subdivided into two sub-Groups—Group 5a was characterized by large, prepared cores, and radial flakes (Figure 2), while Group 5b was characterized by large bifacial hand axes, cleavers, and picks (Figure 3). It is possible, given the co-occurrence of large, radially-flaked and prepared cores with heavy duty tools elsewhere in Africa (McBrearty 1981), that these two Groups can be grouped together. We believe the two luminescence ages we obtained from paleosol sediments at B4NW-1 (see below) bracket the Group 5a artifacts and provide a minimum age estimate for the Group 5b materials.

Similar-looking Group 5a and 5b artifacts have been described from this region since the early 20th century (Davies 1949, 1951b, 1982). These sites are located frequently on exposed coastal paleosols like site B4NW-1. To the north of Mkambati, for example, stone artifacts found on the surface of the coastal Berea Red Sands have been identified to the ESA Sangoan Industry by Kuman and Clarke (2005). The Sangoan is believed to be a Late Acheulian expression of regional specialization with an emphasis on heavy-duty core tool production, and it may be transitional between the ESA and the MSA (Clark 1974; Cornelissen 1995; McBrearty and Brooks 2000). The presence of convergent flakes and large blades in association with prepared cores and hand axes, cleavers, and picks at B4NW-1 is also reminiscent of sites found elsewhere in southern Africa with assemblages that span the ESA and the MSA, including Kathu Pan, Wonderwerk Cave, and Cave of Hearths in South Africa, as well as Kalambo Falls in Zambia (Beaumont and Vogel 2006; Chazan et al. 2008; Clark 1974; Herries 2011; McNabb and Sinclair 2009; Porat et al. 2010; Wilkins and Chazan 2012). However, we cannot identify the B4NW-1 assemblage more precisely until we collect a larger artifact sample size and clarify the stratigraphic context of the artifacts.

Group 4

Group 4 exhibited many of the characteristics of generic blade and flake-based technologies common to the Middle Stone Age of southern Africa, with none of the formal tool types associated with either the Still Bay or Howieson's Poort technologies. A single distal fragment of a bifacial point found in an otherwise ceramic and macrolithic context in site C4SE-3 hints at possible Still Bay-like materials in the landscape, but this cannot be confirmed yet. We recognized two internal subdivisions within Group 4 due to subtle variations in the character of the site-specific assemblages. Chronological relationships between these subdivisions are currently unknown. Group 4a (A2SE-1; A3NW-1; A3NW-8; A3NW-9; B3SE-4; B3SE-7; B3SE-8; C4NE-1; C4SW-1; C4SW-4) was characterized by small and well-formed blades, well-worked, small volumetric cores, radial and single platform cores, a high number of prepared platforms, and frequent bifacial thinning debris, all in varying states of weathering (Figure 4). Flakes within this Group had a generally straighter profile, some platform preparation, and showed a high degree of core rejuvenation flaking. Almost no formal tools were noted in this Group. Group 4b (A3NW-1; A3NW-9; B3SE-4; B3SE-8; B4NW-1; C4NE-1; C4SW-1) represented site-specific assemblages that contained flakes and blades that were generally more weathered, elongated, wider, and curved in profile with relatively little platform preparation and retouch (Figure 5). Centripetal, single platform cores and rare prepared cores also were found with these assemblages. No formal tools belonging to this Group have been found thus far. The absence of any formally retouched artifacts makes assigning and relatively dating these materials difficult at present.

Group 3 (A3NW-1; A3NW-8; A3NW-9; B3SE-4; C4NE-2; C4SE-3)

Group 3 materials are characterized by large circular, side and D-shaped scrapers, as well as elongated, naturally backed flakes often with steep adze-like edge wear and commonly made on side-struck hornfels cobbles (Figure 6). Assemblages with similar attributes have elsewhere been referred to as terminal Pleistocene non-microlithic or Oakhurst LSA (Deacon 1984). Oakhurst assemblages are typically dated to between 7 and 12 ka elsewhere in South Africa and have been recorded at the possibly nearby Alfred County Cave (Lombard et al. 2012). Group 3 materials are possibly associated with the Oakhurst techno-complex found elsewhere in southern Africa, and, in Pondoland, these artifacts appear to be frequently found together with
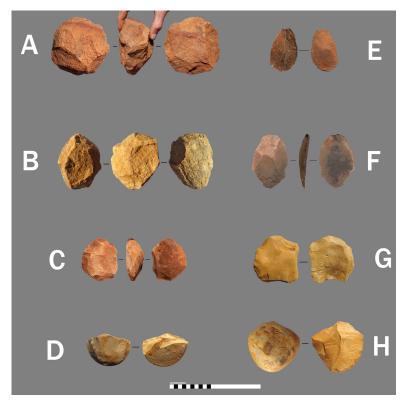
Figure 2. Lithic Group 5a artifacts. (A) radial core, B4NW-1; (B) quartz conglomerate radial core, B4NW-1; (C) prepared core, B4NW-1; (D) single platform cobble core, B4NW-1; (E) partially cortical flake, B4NW-1; (F) thinning flake, B4NW-1; (G) prepared core, B4NW-1; (H) cobble core with limited radial flaking, B4NW-1.

shellfish remains. Conspicuously absent thus far are traces of the microlithic bladelet-based Robberg LSA assemblages, which have been found to precede Oakhurst assemblages elsewhere in the Eastern Cape and Lesotho (Deacon 1984; Mitchell 1988; Wadley 2000).

Group 2 (A3NW-8; B3SE-4; B3SE-8; C4NE-1; C4SE-3; C4SW-4)

Group 2 was characterized by microlithic, CCS-dominated assemblages that included diagnostic small thumbnail scrapers, rare bladelets, and small, heavily-reduced cores that resemble materials ascribed to the Holocene microlithic Wilton LSA (Figure 7). The small size (<3cm) of most of these scrapers, but absence of backed artifacts, suggests a potential mid-late Holocene age for these materials. Wilton LSA assemblages are common on the South African Cape coasts and Lesotho, but are notably absent from the Umhlatuzana sequence (Deacon 1984; Lombard et al. 2012). Similar Holocene microlithic materials have been recognized elsewhere in KwaZulu Natal (Mazel 1999). Wilton assemblages tend to date between <2 and 8 ka elsewhere in South Africa, depending on assemblage characteristics and compositions (Lombard et al. 2012). The highest ochre concentrations found during the surveys have come from sites with the presence of Assemblage 2 materials and rock art (e.g., A3NW-8). While a connection between these two cannot be demonstrated at the moment, this does present an interesting avenue for future research in the area.

Group 1 (A2SE-1; A3NW-1; A3NW-7; A3NW-8; B3SE-2; B3SE-3; B3SE-4; B3SE-7; B3SE-8; B4NE-1; C4NE-1; C4NE-2; C4SE-3; C4SW-1; C4SW-4)

The lithics were macrolithic, opportunistically-flaked, and dominated by the use of hornfels and shale for stone tool production (Figure 8). The few formal tools present consisted of various types of large scrapers and heavy-duty tools including upper and lower grinding stones. These materials are distinct from Group 3 in their lack of characteristic round, end, and D-shaped scrapers, as well as adzes. However, lithics from both of these Groups show a distinct heavy-duty utilization pattern on the tool edges. Ceramic fragments were also found in association with artifacts that we have associated with Group 1. Thick-walled, coarse tempered, and rarely decorated sherds were found more often at rockshelter sites further inland (A3NW-7; B3SE-2; B3SE-8; B4NE-1; C4NE-1; C4NE-2; C4SE-3; C4SW-3; C4SW-4). Thin-walled, lugged, and punctate-decorated shards were found at the coastal sites (B3SE-2; B3SE-3). The presence of two, possibly separate, expressions of ceramic LSA materials in the region might suggest the presence of herder and hunter-gatherer communities producing similar lithic and different ceramic materials, but in different sections of the landscape. These are referred to as Groups 1a and 1b until a more detailed understanding of these materials is available. Based on current evidence it is believed that Group 1 may be associated either with the ceramic LSA hunter-gatherer or herder communities. However, the
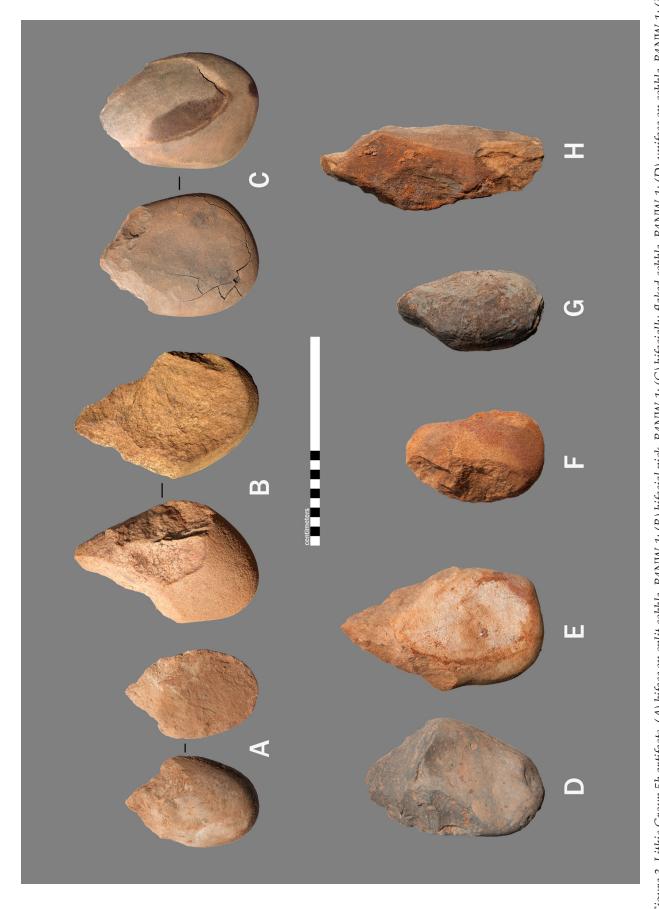
Figure 3. Lithic Group 5b artifacts. (A) biface on split cobble, B4NW-1; (B) bifacial pick, B4NW-1; (C) bifacially-flaked cobble, B4NW-1; (D) uniface on cobble, B4NW-1; (E) biface on cobble, B4NW-1; (F) uniface on cobble, B4NW-1; (G) heavily-weathered bifaces, B4NW-1; (H) bifacial pick, B4NW-1.
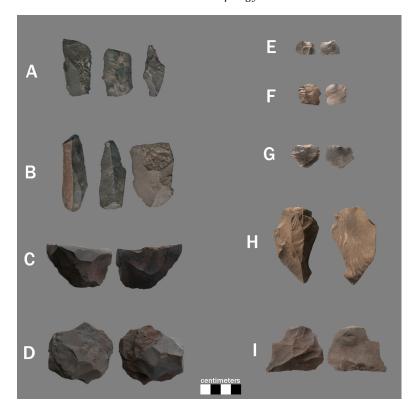
Figure 4. Lithic Group 4a artifacts. (A) assorted blades, B3SE-7; (B) assorted blades, B3SE-7; (C) multi-directional core, A3NW-8; (D) multi-directional core, A3NW-8; (E) core maintenance flake, C4SW-4; (F) core maintenance flake, C4SW-4; (G) core maintenance flake, C4SW-4; (H) flake, A2SE-1; (I) core maintenance flake, C4SW-4.

difficulties in distinguishing archaeological sites attributed to hunter-gatherers and herders are well documented in southern Africa (Cornelissen 1995). Evidence of herding communities using stone artifacts has been documented from the broader region (Mazel 1999), but not yet in Pondoland. The macrolithic Group 1 materials documented here are similar to finds in KwaZulu Natal with the notable absence of worked bone materials (Mazel 1999). Elsewhere in South Africa, assemblages of this nature have been typically dated less than 2 ka (Lombard et al. 2012).

PALEOENVIRONMENTAL SAMPLES AND GEOCHRONOLOGY
Throughout the survey we collected sediment from three cores and collected two sediment sub-samples for radiocarbon dating from one of these cores. We also collected seven sediment samples for optically stimulated luminescence (OSL) dating. The sediment cores were located in target areas where past environmental dynamics may be expected—such as contemporary borders between forests and grasslands—as well as areas that are currently well within single environmental zones, like grasslands.

OPTICALLY STIMULATED LUMINESCENCE DATING
Six sediment samples were submitted for OSL dating to the Luminescence Dating Laboratory at the University of Wollongong. Our intentions were to obtain range-finder OSL ages for three different sites (C4NE-1, A3NW-8, and B4NW-1) that we felt were promising for future excavations. The OSL samples were collected only from archaeologically-sterile, sedimentary deposits and in natural erosional sections at these sites. The analysis relied on a combination of single aliquot and single grain OSL measurements, and a full account of the OSL methods is provided in SOM-S1. The final ages are listed in Table 1. A brief description about the context of each sample is provided below:

Site C4NE-1: Samples 5, 6, and 7 were collected from sterile sediments within natural exposures at the front of the site. The samples targeted different strata seen within the sections. The samples are expected to provide minimum age estimates for the different archaeological sediments.

Site A3NW-8: Sample 36 was collected from dark, organic-rich, archaeologically-sterile sediments in a natural exposure in front of the rock shelter. We expected the sample to provide a minimum age estimate for the archaeological sediments.

Site B4NW-1: Samples 44 and 46 were collected from archaeologically-sterile sections in the paleosols at site. Sample 44 was collected from Facies 1, whereas sample 46 was collected from Facies 2. We believe that these two OSL samples bracket some of the MSA artifacts found at the site, but they may only provide a minimum age estimate for the ESA artifacts.
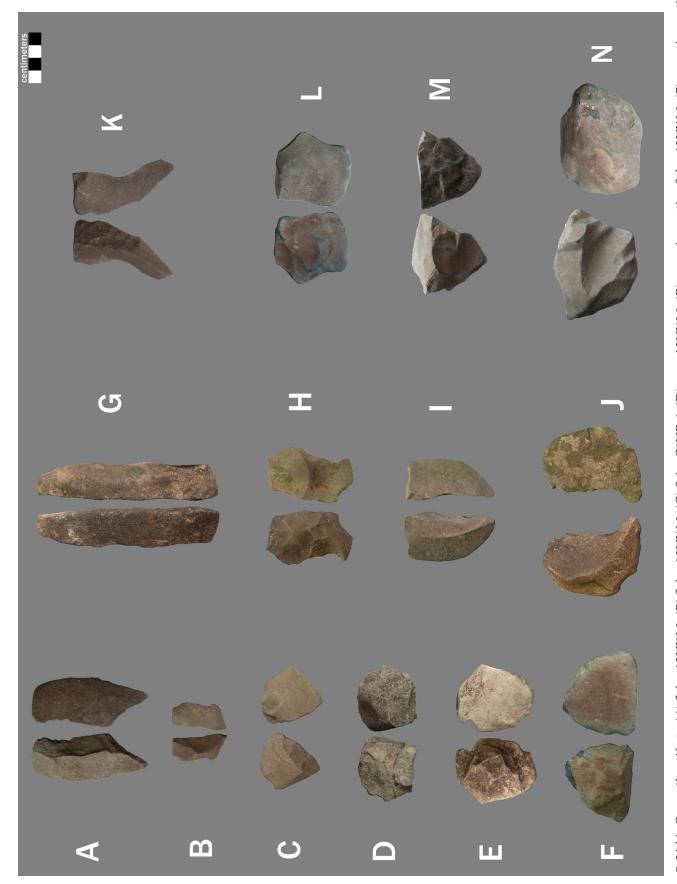
Figure 5. Lithic Group 4b artifacts. (A) flake, A3NW-9; (B) flake, A3NW-9; (C) flake, C4NE-1; (D) core, A3NW-9; (E) core rejuvenation flake, C4NE-1; (F) core rejuvenation flake, A3NW-9; (G) possible naturally-backed knife, A3NW-9; (H) biface thinning flake, C4NE-1; (I) flake, C4NE-1; (J) flake, C4NE-1; (K) flake, C4NE-1; (L) flake, A3NW-8; (M) single platform core, A3NW-8; (N) bi-directional core, A3NW-8.
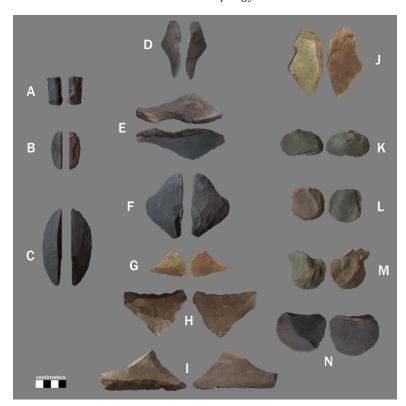
Figure 6. Lithic Group 3 artifacts. (A) scraper, A3NW-1; (B) scraper, A3NW-1; (C) scraper, A3NW-1; (D) scraper, A3NW-8; (E) scraper, A3NW-8; (F) scraper, A3NW-1; (G) end scraper, C4SE-3; (H) adze, C4NE-2; (I) adze, C4NE-2; (J) side scraper, C4SE-3; (K) scraper, A3NW-9; (L) scraper, A3NW-9; (M) scraper, A3NW-9; (N) scraper, A3NW-8.
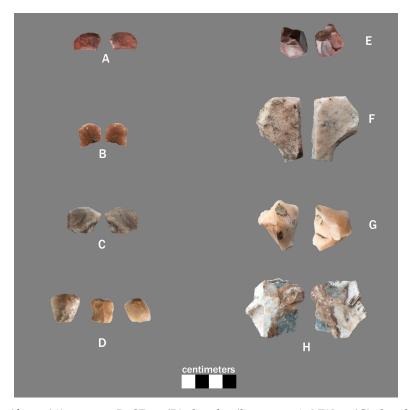

Figure 7. Lithic Group 2 artifacts. (A) scraper, B3SE-8; (B) thumbnail scraper, A3NW-8; (C) thumbnail scraper, A3NW-8; (D) thumbnail scraper, A3NW-8; (E) core, B3SE-8; (F) core fragment, A3NW-8; (G) core, A3NW-8; (H) core, A3NW-8.
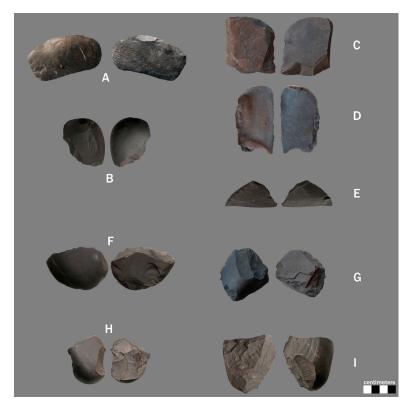
Figure 8. Lithic Group 1 artifacts. (A) flake on cobble, A2SE-1; (B) cobble core, C4SW-1; (C) scraper, A3NW-1; (D) scraper, A3NW-1; (E) scraper, C4SW-1; (F) cobble core, C4SW-1; (G) cobble core, A3NW-1; (H) cobble core, C4SW-1; (I) cobble core, C4SW-1.

TABLE 1. OSL AND RADIOCARBON AGES*.

Site	Sample Number	Dating Method	Final Age, ka
A3NW-8	36	Single Grain OSL	1.8±0.2
B4NW-1	44	Single Grain OSL	300±24
B4NW-1	46	Single Grain OSL	133±11
C4NE-1	5	Single Grain OSL	1.9±0.2
C4NE-1	6	Single Grain OSL	3.5±0.3
C4NE-1	7	Single Grain OSL	3.3±0.2

Site	Sample Number	Dating Method	Final Age, cal. Yrs. BP
Core C4	15	AMS Radiocarbon	660–540
Core C4	19	AMS Radiocarbon	5440–5090

*Summary of optically stimulated luminescence and radiocarbon ages discussed in the text. Full details about the methods used to calculate these ages are provided in SOM-S1.

RADIOCARBON DATING

Two bulk sediment samples from core C4 were sent to Beta-Analytic Inc. in Miami, FL for AMS radiocarbon dating. Radiocarbon pretreatment and analytical methods are described in SOM-S1. The radiocarbon and calibrated ages are listed in Table 1.

Sample #19 was taken from sediment at ~150cm below surface. The conventional radiocarbon age was measured at 4,580±30 BP, which intercepted the INTCAL09 (Reimer et al. 2009) calibration curve in four places. The final, calibrated 2-sigma age range is therefore 5,440–5,090 cal BP. This age provides a minimum middle Holocene date for Group 1 where phytolith morphotypes associated with C_3 grasses were common.

Sample #15 was collected from sediment at ~70cm below surface. The conventional radiocarbon age was calculated to be 600±30 BP and it intercepted the INTCAL09 curve in three places. The final, calibrated 2-sigma age range is 660–540 cal BP. This sample provides a maximum age estimate for the dominance of C_4 grasses in the area.

SEDIMENT CORES

We collected three vertical transects of sediment within our study area to capture a first-look at past vegetation dynamics. Locations of the sediment cores are provided in Figure 1 and none of the cores sampled archaeological deposits. Sediment from each core was subdivided for pollen and phytolith analysis, as well as a witness sample that is now kept in Cape Town, South Africa. Detailed information about the coring methods, as well as notes about each core, are described in SOM-S1. A brief description of each core is provided below:

Core B3 (6528353 N; 771828 E; Zone 35S) was located in the Lambazi area of Msikaba, approximately 5.5km inland. The area was covered by sourveld grasslands. We collected five samples to a maximum depth of 1.0m below surface before hitting impenetrable rock. The sediments were all similar-looking sandy loam. The samples from this core have been archived but not studied further and so are not included in the analysis presented here.

Core B4-2 (6528353 N; 771828 E; Zone 35S) was located at the edge of a marsh on the inland edge of the rubified paleosol where site B4NW-1 was located. We originally tried to core within the marsh, assuming better preservation there, but those sediments were too saturated and we could not control for cross-sample contamination. Therefore, we moved to dry land at the edge of the paleosol. We collected 28 sediment samples up to a depth of 5.6m below surface. The samples show that we traversed multiple paleosol and dune facies. The lowermost sediments were increasingly moist.

Core C4 (6539764 N; 214670 E; Zone 36S) was located in the northern part of the Mkambati Nature Reserve 2.5km from sites C4NE-1 and C4NE-2. The core was located in a grassland pasture adjacent to a shallow drainage, but it was within 0.5km of the Mtentu scarp forest. We collected 17 sediment samples up to a maximum depth of 3.4m below surface.

PHYTOLITH ANALYSIS

Sediment cores C4 and B4-2 were checked for plant phytolith remains. Phytolith preservation in B4-2 was poor due to dissolution. Phytolith preservation was excellent in the upper section of core C4, and the uppermost sediments had the greatest phytolith concentrations, ranging from 3.5 to 3×10^6 per 1g of sediment. The full phytolith methods and analysis can be found in SOM-S1. Samples from the base of core C4 yielded smaller phytolith concentrations ranging from 40 to 10×10^4 per 1g of sediment. Organic carbon also decreased with depth, and similar trends in phytoliths and organic carbon have been observed in other soil profiles studies (Alexandre et al. 1997; Blecker et al. 2006; Jones and Beavers 1963). The coarsest sediment fraction was noted in the lowermost samples where large phytolith morphotypes, such as bulliform cells, were most common and related to a lower presence of small morphotypes such as short cells. Because the sampling of core C4 did not hit bedrock this differential proportion between large (>40μm) and small (<10μm) morphotypes might imply some degree of phytolith translocation in these lowermost samples. Phytolith translocation has been observed in other terrestrial soil profiles around the world (Alexandre et al. 1997; Fishkis et al. 2010; Fishkis et al. 2009; Piperno and Becker 1996).

The phytolith assemblage showed differences in the number and relative percentage of morphotypes, which indicates vegetation flux. We have divided the samples into three groups based on the similarities of the phytolith assemblage that allowed us to characterize different vegetation types. Samples from the lowest portion of the sediment core (samples 23–28) have been omitted from the analysis due to the very low number of preserved phytoliths.

PALYNOLOGICAL ANALYSIS

Full details of the palynological methods used are described in SOM-S1. Pollen, algae, fungi, and spores were identified using the pollen reference collection at Forschungsstelle für Paläobotanik, Münster, and references (Beug 2004; Bonnefile and Riollet 1980; Gelorini et al. 2011; Moore et al. 1999; Scott 1982; Van Zinderen Bakker 1970).

We aimed at counting 400 terrestrial pollen grains per sample. Palynomorphs were identified in sufficient numbers up to depths of 270cm below surface. However, samples below 180cm only yielded ~200–300 palynomorphs, even after using the complete residue for pollen analysis. Pollen grain preservation and the curve of Varia (crumpled pollen grains) was uniform throughout the profile, but pollen concentration decreased with depth, which is a pattern similarly seen in other studies in terrestrial soils (Davidson et al. 1999; Dimbleby 1961; Gavin and Brubaker 1999). Overall, the pollen profile was rather uniform with the exception of a higher degree of grasses between depth of 250–270cm and minor changes within the percentages of some trees and herbs. Apart from a slight decrease at the top of the profile, grass pollen dominated the sequence (70–90%). Pollen of Asteraceae, *Scabiosa*, and *Cephalaria* were the second largest group of herb pollen. Indicators point to an open grass-dominated landscape, trees were only rep-

resented to a lesser degree in the pollen diagram. Pollen of *Podocarpus*, *Euphorbia*, the neophyte *Pinus*, diverse Sapotaceae, *Grewia*, *Heteromorpha*, and other trees and shrubs appeared in low numbers. The pollen record was complemented by spores of cryptogams (i.e., *Mohria* and *Ophioglossum*) and a variety of fungal remains. Pollen of *Pinus*, although more abundant in the upper 40cm of the profile, did occur throughout the core sediments, clearly pointing to a certain degree of contamination, probably during the coring process. We avoided a pollen zonation due to the low number of samples.

PALEOENVIRONMENTAL INTERPRETATIONS

Our sediment core represents the first diachronic paleoenvironmental sequence in Pondoland. The phytolith and pollen analyses were complementary, with the former providing details mainly about grass discrimination between C_3 and C_4 plants and the latter providing details about plant species. Our interpretations remain tentative until we have a better understanding of how palynomorphs and pollen were transported through soil via water (downwash) or by bioturbation (compare Davidson et al. 1999). Detailed knowledge of local soil properties like water content, pH, and soil fauna also is needed because oxidation can destroy palynomorphs and high alkalinity conditions, together with water flow, degrade phytoliths. Long-term experiments in European podzoles and peats have shown variable degradation of pollen and spores from similar sequences (Havinga 1984), but no comparable data are available for South African soils and pollen types or phytoliths.

In our study, we recognize that the preservation of pollen and phytoliths decreased with depth. This phenomenon has been recorded in other studies of pollen (Dimbleby 1961) and phytoliths (Alexandre et al. 1997; Blecker et al. 2006; Jones and Beavers 1963). No major pollen fluctuations were observed and the amount of crumpled / badly preserved palynomorphs (Varia) did not increase with depth, which suggests that there is not differential preservation of specific pollen types. Increasing frequencies of weathered phytolith morphotypes up to depths of 130cm, and an overall low phytolith recovery, mostly of large morphotypes, below 210cm suggests influences related to bioturbation and translocation (compare Piperno 2006). Contamination of the pollen record is shown by neophytic pine pollen throughout the profile. *Pinus* was introduced by European settlers only in the 17th century.

The questionable preservation, contamination, and bioturbation within our core sediments has led us to interpret our paleoenvironmental findings cautiously and tentatively until further studies can be undertaken. Therefore, the synthesis of paleoenvironmental changes provided below should be seen only as a model to test against future studies. Accounting for external influences such as wind, water, and erosion, we also assume that pollen in our record is of local origin whereas the phytoliths are representative of the immediate vegetation (Albert et al. 2006). The pollen and phytolith data have been grouped below by depth based on paleoenvironmental interpretations made from these data. Diachronic changes in pollen and phytolith types, core depth, and sediment type are also provided in Figure 9.

1. **(270cm to 220cm)**: Grass pollen decreases in these samples from 90% to 70%. Pollen from Asteraceae (an indicator for rather dry conditions), *Scabiosa*, and *Cephalaria* increase. Low numbers of phytoliths, however, preclude identification of grass type. Grasslands were clearly pre-established at this time.

2. **(220cm to 190cm)**: Grass pollen levels are around 70%. *Euphorbia* pollen increase slightly until 190cm. *Euphorbia* occupies various habitats (Pooley 2003) and is therefore generally not suitable for paleoecological interpretations (Scott 1982). However, it may represent succulents being adapted to periodic or seasonal droughts. *Pseudoschizaea*, most probably of algal origin, might also signal seasonal desiccation, especially when Asteraceae are also high (~10%) (Carrión 2002). Trapeziform and irregular psilate phytolith morphotypes are also common. Trapeziforms are exclusively ascribed to temperate C_3 Pooideae grasses (Barboni et al. 2007), whereas irregular psilates are generally produced in the wood/bark of dicotyledonous trees (Albert et al. 1999). Therefore we interpret the pollen and phytolith assemblages at this time to suggest C_3 grasslands with occasional woody/shrubby vegetation.

3. **(190cm to 60cm)**: Grass phytoliths and monocotyledonous phytoliths remain high, but C_3 phytolith morphotypes decrease. The first appearance of Chloridoideae phytoliths from 120cm upwards suggests that C_4 grasses are becoming more common in the area. The presence of Chloridoideae phytoliths suggests lower precipitation at this time because they are a drought-resistant group of C_4 grasses (Twiss et al. 1969). *Ascolepis* (a C_4 Cyperaceae) pollen and spores of bryophytes suggest local wetness, although spores of *Mohria* and *Ophioglossum* might point to seasonal desiccation (Scott 1982). Pollen of *Grewia* and *Acalypha* appear for the first time.

Dicotyledonous phytoliths also increase (up to 9%) in this section of the core. The most common dicotyledonous morphotypes were ellipsoid rugulate, spheroid psilate and rugulate, and parallelepiped blocky. Sclereids, hairs, and platelets that are diagnostic of dicotyledonous leaves were also observed. The increased presence of dicotyledonous phytoliths might be indicative of an expansion in woody/shrubby vegetation at this time, considering that grasses produce 20 times more phytoliths than wood and bark of dicotyledonous trees in other regions (Albert and Weiner 2001; Piperno 2006). The pollen record also shows rather high percentages of Asteracea, *Cephalaria*, and *Scabiosa* above 150cm.
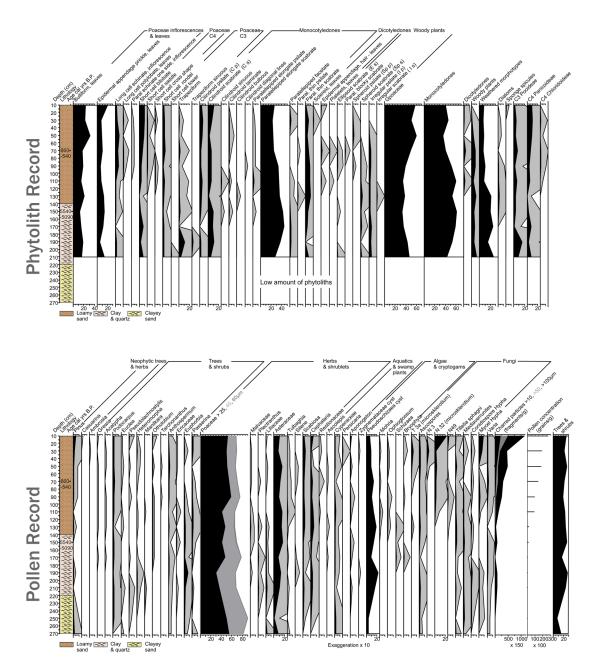
Figure 9. Phytolith and pollen records from Core C4. The phytolith records (top) show a change from phytoliths representative of C₃ Pooideae grasses to C₄ Panicoideae grasses ~190cm below surface. The pollen records (bottom) provide details about specific plant species that were present in the area and fluctuations between grassland and woody vegetation.

Radiocarbon sample #19, which was taken from sediment at 150cm below surface, provides a cursory age range of the paleoenvironmental changes between 190cm and 60cm. Keeping in mind the uncertainties with the core sediments, pollen, and phytoliths, the interpreted changes from a suggested open C₃ grassland to a semi-open C₄ grassland with increasing woody/shrubby vegetation would have occurred prior to 5,540–5,090 cal yrs BP.

4. **(60cm to 0cm)**: Grass phytoliths were most com-

mon (up to 50%) with abundant bulliform cells and prickles, which make up ~30% of all contemporary grass morphotypes. Short cell phytoliths, which are also formed in grasses, were also common (~15%) and dominated by bilobate morphotypes. Bilobate phytoliths are found in C₄ Panicoid grasses, which are widespread in the area today (Shackleton et al. 1991). Their presence may signal the development of contemporary vegetation patterns. Monocotyledonous phytoliths were also observed in large quantities with cylin-

droids rugulate and parallelepiped elongates rugulate as the most representative morphotypes, making up to ~40% of the total phytolith record. Phytoliths from dicotyledonous plants were also noted, although in fewer number.

A minimum age of the development of the contemporary C_4 Panicoid grassland is provided by radiocarbon sample #15 (70cm below surface), dated 660–540 cal yrs BP. Neophyte pollen also increases above 70cm with *Casuarina* and *Ambrosia* (introduced from Australia and North American, respectively; Neumann et al. 2008) being found in the core sediments for the first time. Fungal remains strongly increase, especially microsklerotia, which are formed during periods of environmental stress as a survival structure.

DISCUSSION AND CONCLUSIONS

Our survey provides the first modern archaeological dataset on coastal occupations in Pondoland that predates the Iron Age, ca. 2,000 years ago. This new dataset adds 20 rock shelters and 5 open-air sites with Stone Age assemblages to a catalog that once included only a single rock shelter with Stone Age artifacts[2]. We have found abundant marine mollusk shells in association with stone tools and terrestrial faunal remains. Many of the stone tools that we observed appear to be characteristic of lithic traditions dating from the Terminal Pleistocene, and Early and Middle Holocene (Oakhurst and Wilton technologies, respectively), attesting to human occupations at those times. We also found surface collections of MSA artifacts in association with marine shellfish remains, which would imply coastal occupation during the Pleistocene. The Later Acheulian materials documented at site B4NW-1 push this occupation back even further in time. Our preliminary single-grain OSL ages are the first direct dates of the paleosols in the region and they provide a minimum age of early human occupation here by ~300 ka. Our sediment cores are also the first diachronic paleoenvironmental sequences in the area. In spite of the complex problems encountered during our study, primarily since we used terrestrial soils as an archive, the pollen and phytolith analyses support the antiquity of the grasslands and these analyses have given us the first indication that there may have been a shift from C_3 to C_4 vegetation in the past. Drawing upon our empirical observations we conclude by laying out several research questions and working hypotheses to guide our future work in the area.

QUESTION 1: DO THE ESA AND EARLY MSA ARTIFACTS AT B4NW-1 PREDATE COASTAL INTERTIDAL FORAGING?

One of the primary goals of the P5 research project is to better understand the history and development of coastal foraging, and its influence on modern human evolution, by finding early and continuous archaeological records in areas where there were negligible coastline movements. The ESA and early MSA flaked stone artifacts that we documented at site B4NW-1 were unique to the survey because they were the oldest documented archaeological materials and were located directly on the coast, but they were not visibly associated with any marine shellfish remains. Given the coastal locality of B4NW-1, and the commonality of shell found at all other nearby inland sites, the lack of shellfish leads us to hypothesize (1) that the site's sediments may have undergone diagenetic alteration, which have removed the shell; (2) that the site predates coastal intertidal foraging; or, (3) that the foraging radius of ESA groups was different to that observed in ethnographic and much more recent archaeological cases (<10km).

We can approach the first hypothesis by examining the local geography and geomorphology of B4NW-1. The continental shelf in this location is only 7.5km wide. The limited lateral shoreline movements across this narrow shelf tend to cause east coast dune systems to accrete vertically rather than penetrate far inland (Cawthra et al. 2012; Porat and Botha 2008). The sub-tropical climate also accelerates erosional and deep weathering processes, which have partly obscured primary sedimentary features of Late Cenozoic successions. Botha and Porat (2007) have documented dominant chemical changes to East Coast solumn via soil degradation, erosion, and vegetation cover. The manifestation of these processes is evident in our OSL samples from B4NW-1. Incised gullies in the outcrop attributed to rainwater flow over a relatively steep slope have likely disrupted the uppermost stratigraphy in these deposits. A bimodal age distribution within OSL sample 44 (Facies 1) is interpreted to reflect particle mixing with grains from overlying Facies 2 as a result of erosion in the surface and sub-surface layers of this unit. Shellfish remains are more susceptible to physical erosion and chemical dissolution than related organic materials such as bone (Erlandson 2001). Thus we cannot discount the possibility that the absence of shellfish remains may be attributed to environmentally-driven decalcification or erosion to the sedimentary stack at B4NW-1. These erosional processes may also imply that the ESA and MSA artifacts are resting on the same surfaces likely as the product of deflation, though this remains to be tested.

It is also possible that the artifacts at B4NW-1 either predate marine resource use or they were never co-associated with marine foraging trips. Ethnographic sources have shown that hunter-gatherers require knowledge about lunar phases and their influence on tidal cycles in order to schedule foraging trips to the coast and access intertidal areas safely (Bowden et al. 2012; Meehan 1982; Moss 1993). A rudimentary understanding of these phenomenon is believed to have been utilized by Middle Pleistocene hunter-gatherers ~162 ka to acquire shallow rocky intertidal species at cave PP13B, South Africa (Jacobs 2010; Marean et al. 2007). Yet species common to the deepest and most unreachable intertidal areas are not found consistently in the archaeological records across South Africa until 90 ka (Marean 2011). This time lag is hypothesized by Marean (2011) to show the evolution of modern working memory and executive functions to maximize intertidal foraging times and rates, which enabled the development of a true coastal dietary adaptation. By implication then, a

fully modern cognition would be prerequisite to the development of a true coastal adaptation, but it may not have been necessary when humans first started eating sea foods and they were only picking from the shallowest and most accessible intertidal areas.

Exaptation of aquatic resources that are rich in essential brain-specific nutrients (namely polyunsaturated fatty acids, iodine, and iron) has attracted a lot of attention primarily because of the selective advantage that these foods are assumed to have given early hominins towards developing and supporting larger brains (Broadhurst et al. 2002; Crawford et al. 1999; Cunnane 2010; Cunnane and Stewart 2010). Lacustrine fish remains with cut marks and associated stone tools have been found at multiple early *Homo* sites dated between 1–2 Ma across eastern Africa (Braun et al. 2010; Stewart 1994). These findings suggest that early hominins might have favored wetland environments and that they were aware of aquatic foods as early as the Pliocene (Stewart 2010). Shellfish have also been found associated with Acheulian stone tools at several sites in France (e.g. Terra Amata; Grotte du Lazaret; Romandils), but there is little direct evidence to suggest that those shellfish were actually eaten (Colonese et al. 2011; Erlandson 2001). More compelling evidence can be found at Bajondillo Cave, Spain, showing that Neanderthals occasionally collected and ate intertidal shellfish as early as ~150 ka (Cortes-Sanchez et al. 2011). There are even contemporary observations of Chacma baboons (*Papio ursinus*) and Burmese long-tailed macaques (*Macaca fascicularis aurea*) exploiting coastal intertidal zones for shellfish during low tides (Gumert and Malaivijitnond 2012; Hall 1963). But even if hominins who were manufacturing late ESA or early MSA stone tools could have been capable of foraging for intertidal resources, a larger question remains—could we identify these behaviors in the archaeological record if we found them?

There really is no good analogy to characterize hominin behavior during the earliest phases of coastal foraging, or how these behaviors could be preserved in the archaeological record. Comparisons to non-human primates must be made cautiously since only limited primate groups seem to consume shellfish and the frequency of consumption is highly irregular (Gumert and Malaivijitnond 2012; Hall 1963). Our knowledge of the full spectrum of ethnographic and archaeological shellfish collection strategies worldwide is also incomplete. Thus we may not even have data comparable to late ESA and early MSA coastal foraging strategies, if they ever existed.

Yet what is so compelling about non-human primates, as opposed to the many other non-hominid species that collect shellfish, is that some populations of long-tailed macaques have been observed using stone hammers, shell picks, and anvils to break shellfish from rocks and to crack open shells (Gumert et al. 2011; Gumert and Malaivijitnond 2012). Human coastal foragers also use their hands, rocks, and metal tools to break or pry off shellfish. Stone tools also have the added advantage of often being preserved longer in the archaeological record. Characteristic damage to the edges of shell harvested with metal tools (particu-

larly to limpets) have also been reported by Bigalke and Voigt (1973). Blunter stone tools might be expected to increase medial and anterior shell fractures to sever the byssal threads attaching the shellfish to rocks. Though this idea remains untested, an analogous taphonomic pattern can be found in long-tailed macaques who selectively choose shellfishing stone tools for size, weight, and morphology. Their precision axe-hammers are reported to be smaller, lighter, and pointed compared to pounding hammers, held with a precision grip, and having a unique use-wear pattern (Gumert et al. 2009). The hinges of bivalves are frequently broken by the macaques to get at the fleshy interior and detached specimens are pounded open on anvils (Gumert and Malaivijitnond 2012).

Like many modern coastal foragers that snack on shellfish during collecting trips (Bigalke 1973; Lasiak 1992), long-tailed macaques and Chacma baboons tend to consume shellfish immediately and in the intertidal zone (Gumert et al. 2011; Gumert and Malaivijitnond 2012; Hall 1963). Whereas the foraging patterns of ESA and early MSA hominins are still poorly understood, the faunal assemblage from Qesem Cave, Israel, suggests that ESA groups were highly mobile and transported only high food value body parts back to residential base camps (Stiner et al. 2009). Thus, if shellfish were consumed during the ESA then it is possible that it was a more opportunistic food source and eaten only on the spot. This could be another reason why shellfish remains are absent from B4NW-1.

Comparisons between the ethnographic, archaeological, and primatological records of intertidal foraging therefore reveal some commonalities that may hint at the characteristics of the earliest intertidal foraging strategies. In microtidal environments such as Pondoland, some upper intertidal areas may even be accessible outside of low tide during neaps. Therefore, it is possible that the earliest intertidal foraging developed as an incidental and opportunistic foraging strategy that was not unlike non-human primate exploitation of intertidal molluscs during low tides today (Davidge 1978; Gumert and Malaivijitnond 2012; Hall 1963). This implies that the earliest intertidal foraging would have been facilitated purely by happenstance to low tides or available shellfish beds. Drawing on these observations, we therefore propose the following working model that characterizes our expectations of what an archaeological site dating from this earliest phase of early human intertidal foraging may look like:

- **Intertidal fauna will be limited to the Littoral and Upper Balanoid zones.** Non-human primates exploit shellfish taxa overwhelmingly from Upper Intertidal environments, and namely the Littoral and Upper Balanoid zones, because these areas are the easiest to access. A similar pattern is seen in Middle Pleistocene archaeological marine faunal assemblages (Cortes-Sanchez et al. 2011; Marean et al. 2007). Therefore, our first expectation is that early shellfish collectors also were limited to upper intertidal areas.

- **The shellfish taxa are likely to be dominated by**

the species that provided the greatest biomass per ease of acquisition. In our study area we think that the earliest assemblages would be dominated largely by upper intertidal oysters (*Sacostrea cuccullata*) and to a lesser extent, brown mussel (*Perna perna*). The Natal rock oyster, *Sacostrea cuccullata,* occupies a characteristic band in the Upper Balanoid zone on the East Coast that is easily accessed at low tide (Branch et al. 2010). We believe that *Sacostrea cuccullata* may have been exploited very early for the same reasons that long-tailed macaques focus on oysters today—they are easy to get to and they are easily harvested with basic stone tools.

We also suggest that daily exposure to coastal environments over time would have led to a greater awareness of coastal rhythms. As this awareness of tides and lunar cycles developed, deeper shellfish taxa like *Perna perna* may have become more easily accessible. *Perna perna* is the most commonly collected shellfish in Pondoland today (Kyle et al. 1997; Lasiak 1991,1992; Lasiak and Dye 1989); it is the dominant marine taxa in the Sibudu cave marine fauna assemblage (Plug 2006); and, it was one of the most commonly collected shellfish by Pleistocene hunter-gatherers on the south coast of South Africa (Jerardino and Marean 2010; Langejans et al. 2012; Thackeray 1988). The abundance of *Perna perna* and its ability to be harvested quickly and in large quantities therefore may have also made it a desirable food source. However, because it grows in deeper intertidal areas around the Lower Balanoid zone, we believe that *Perna perna* initially was the secondary prey choice early on because it was harder to reach than the oyster beds.

QUESTION 2: WHAT OTHER PLANT AND ANIMAL RESOURCES WERE AVAILABLE TO HUNTER-GATHERERS IN PONDOLAND DURING THE MIDDLE AND LATE PLEISTOCENE?

Ethnographic sources have documented annual movements of hunter-gatherer bands to collect seasonal plant and animal resources for food, medicines, and raw material (Kelly 1995). Studies of coastal foragers have even shown that their residential mobility can be influenced strongly by the type, predictability, and seasonal abundance of resources, influencing whether groups stay at the coast year-round or travel widely along the coast and inland (Chase et al. 1981). These variations underscore the importance of couching studies about the origins and development of coastal foraging within the broader Pleistocene paleoscape, focusing on how hunter-gatherer bands moved around the landscape, what terrestrial and marine plant and animal resources they collected, and how those resources were influenced by climatic and environmental changes (Marean 2011).

Pondoland's vegetation is tightly packed into a narrow coastal zone, which makes it an ideal place to study how

Pleistocene hunter-gatherers may have utilized different resources spatially and seasonally. Edible berries, fruits, seeds, and underground storage organs, as well as plants useful for medicinal applications, poisons (for hunting), and hide tanning, have been recorded in the local grassland, thicket, and scarp forest vegetation (Van Wyk and Gericke 2000). The grasslands are also home to grazing mammals that would have been a useful food source for hunter-gatherers, whereas suids, browsing bovids, canids, and felids are more common in closed environments such as thickets or scarp forests. The predominant location of rock shelters within the river valleys would have made these places centrally located to each of the vegetation zones and their plant and animal resources, as well as to perennial fresh water streams. The same river valleys would have provided a direct conduit to the coastline. Unfortunately, due to a lack of data sources there is no way of knowing right now if Pondoland's current vegetation patterns, plants, and animals were similar in the Pleistocene. Discrepancies between small-scale (i.e., large area) climatic model predictions and regional data sources complicate this problem because they are unable to resolve if the eastern seaboard was generally cooler and drier during glacial phases. Here, we review the current paleoclimatic and paleoenvironmental evidence for and against cooler and drier conditions on the east coast during glacial phases and we speculate how these synoptic conditions would have affected local hunter-gatherer resources.

During glacial phases, expansion of Antarctic sea ice is believed to have pushed the oceanic subtropical front and the atmospheric polar front northward so that the zone of wet westerly winds crossed southern Africa (Bard and Rickaby 2009; Collins et al. 2012; Stuut et al. 2004). Simultaneously, northern hemisphere high latitude forcing drove the Intertropical Convergence Zone (ITCZ) poleward, displacing the subtropical high pressure zone to the south (Johnson et al. 2002; Schefusz et al. 2011). Under these conditions, paleoclimatic models hindcast strengthened westerlies and southeast trade winds during glacial phases, increasing austral winter precipitation in a southwest-to-northeast gradient across South Africa (Cockcroft et al. 1987; Stuut et al. 2004; Tyson 1986; Van Zinderen Bakker 1976). However, the latitudinal position and intensity of the westerlies, and these influences on austral winter and summer rainfall, are still debated (Chase and Meadows 2007; Gasse et al. 2008). Conflicts with the winter-rain model, such as evidence for increased coastal summer rainfall during glacial phases on the south coast (Bar-Matthews et al. 2010; Sealy 1996), point to as-yet unaccounted variability.

Following contemporary paleoclimatic modeling, the predicted increases in winter rain during glacial periods may have corresponded with largely cooler (5–6°), drier conditions on the eastern seaboard, and also decreased summer rainfall (for a summary of models, see Chase and Meadows 2007). Glacier expansion in the Lesotho highlands is now attributed to strengthened winter rainfall at these times (Mills et al. 2012) and cold, dry air may have drained from the Drakensburg highlands onto the eastern

seaboard during the winter months (Eeley et al. 1999). The Agulhas Current has also been estimated to be weaker and shallower during glacial phases, resulting in lower inshore Sea Surface Temperatures (SSTs) that would have contributed towards the decreased austral summer rainfall (Prell et al. 1980). As a consequence of the apparently cooler and drier conditions, paleoenvironmental models have predicted grassland expansion across KwaZulu-Natal at the expense of intensely fragmented and reduced indigenous forests (Eeley et al. 1999). Paleoenvironmental reconstructions by Partridge et al. (1999) using multi-proxy sources even predict the presence of steppe-like vegetation during glacial maxima, implying xerophilous plants and arid conditions from the Lesotho highlands eastward to the Pondoland coastline.

However, synthetic reconstructions of east coast paleoclimates, such as those provided by Partridge et al. (1999) or Chase and Meadows (2007), must be treated cautiously because none of these models use data points that are within several hundred kilometers of the eastern seaboard. High-resolution coupled climate models that can capture the influence of the Agulhas Current, topography, and summer rains also have not been developed yet. Thus, a great deal of climatic uncertainty remains on the east coast. In fact, local paleoenvironmental records would suggest little, if any, grassland expansion across coastal KwaZulu-Natal and Pondoland during glacial phases. One 342 ka pollen record derived from a marine core in the upstream Agulhas Current in the Delagoa Bight east of Maputo (MD96-2048) shows that the Natal landscape was composed of *Podocarpus* mesic forest and tended towards mountainous scrubland with Fynbos affinities (e.g., Ericaceae, Restionaceae, Asteroideae) during glacial periods (Dupont et al. 2011). At Port Durnford, a pollen sequence overlaying a peat layer dated to 70±6 ka via ^{230}Th/^{234}U shows that the local environment transitioned from open marshland to *Podocarpus*-dominated forest during the Last Glacial (Oschadleus et al. 1996; Scott et al. 1992). *Podocarpus* pollen is also common in a sediment core from the Mfabeni peatland, 230km SW of core MD96-2048. There, cool and wet conditions from ~44–24 ka are interpreted to show a majority component of *Podocarpus* and minor components of Poaceae and Cyperacea pollen, leading the authors of the study to suggest that the glacial landscape was composed of regional forests with nearby patches of grasslands (Finch and Hill 2008). The Sibudu rock shelter archaeobotanical and faunal records provide another data point on the landscape, approximately 200km south of the Mfabeni peatland. Multiple species of sedges (*Cyperus* sp., *Cladium mariscus*), rushes (*Juncaceae* sp.), and aromatic leaves (*Cryptocarya woodii*) from bedding bundles indicate that woodland and riparian environments were located near the rock shelter ~77 ka (Sievers and Muasya 2011; Wadley et al. 2011). By ~65 ka, the mammalian faunal and archaeobotanical assemblages are overwhelmingly dominated by species representative of modern *Podocarpus* forests with a minority component from drier, open grasslands (Allott 2006; Clark and Plug 2008; Sievers 2006). Open grassland-adapted grazing taxa

and the preserved fruits and seeds from deciduous plant taxa suggest increasingly arid conditions after ~58 ka. However, the concurrent presence of forest, as well as open woodland/grassland species remains and preserved charcoal, shows that Sibudu rock shelter was still located near to patches of evergreen riverine forest until at least 38 ka (Allott 2006; Clark and Plug 2008). Analysis of the ecological conditions that influence modern plant distributions found in the Sibudu paleobotanical record has led Bruch et al. (2012) to conclude that Late Pleistocene winters were colder and drier than today, but summer precipitation and temperature should have been similar to today.

The presence of glacial mesic forests, scrubland, and riparian environments from KwaZulu-Natal north to Limpopo implies that current model predictions may underestimate paleoclimatic variability on South Africa's east coast. It is important to note that some vegetation classes, such as grasslands, also cannot be predicted by climate alone, so fire and herbivory effects must also be taken into account (Bond 2008). During the Pleistocene the main driver of fire frequency was probably thunderstorm activity. Fire reduces plant biomass and it can replace trees with grasslands (Bond et al. 2005) or shrubby plant species, as has been documented at Mkambati Game Reserve (Shackleton et al. 1991). It is important to understand these kinds of processes alongside climatic variability because studies of modern forest fauna suggest that the resilience of scarp forests and Afrotemperate forests in Pondoland and KwaZulu-Natal made them important ecological refugia during the Last Glacial Maximum (Lawes et al. 2007). Any changes in the climatic or fire regime also would have affected the environmental zones that supported Pleistocene hunter-gatherers' floral and faunal food bases.

Could it be possible then that precipitation rates on the eastern seaboard were sustained or relatively greater than arid inland areas during glacial phases? Speculating about more humid conditions would not necessarily contradict current models that advocate increased winter rain and decreased summer rains during glacial phases. On the one hand, winter rainfall may have been brought to the area by cut-off low pressure systems that could have been influenced by the northerly shift in the zone of wet westerly winds during glacial phases (F. Englebrecht, personal communication). On the other hand, if winter rainfall systems expanded along a SW-NE gradient during glacial phases (Chase and Meadows 2007), austral summer rainfall systems, advected coastal air cells, or both could have been present, albeit limited to only a very narrow band on the coastline where the forests are also most common.

Today, all of South Africa's indigenous forests grow in areas with high water availability. Forests need >525mm mean annual rainfall in strong winter rainfall areas and >725mm mean rainfall in strong summer rainfall areas (Mucina and Geldenhuys 2006). Until recently, paleohydrology records were lacking for the east coast. However, Fe/K ratios from a new marine core (CD154-17-17K) collected ~120km east of East London provides a clear record of local paleohydrological conditions over the last 100 ka

(Ziegler et al. 2013). Fe/K is a ratio of sediment weathering where intensely weathered sediments are linked to humid locations and less-weathered sediments are linked to drier areas (Govin et al. 2012). East coast drainage basins rarely extend 200km inland, providing a maximum limit inland to the hydrological changes.

The contribution of terrigenous sediments to core CD154-17-17K is believed to derive from the Kei River northwards to major drainage systems within our study area because of the southerly influence of the Agulhas Current. Therefore, this core is assumed to be a direct proxy for terrestrial, coastal hydrological conditions in our study area. The humid pulses seen in the Fe/K ratios co-occur with North Hemisphere cold events suggesting a regional teleconnection between the location of the ITCZ, subtropical front, Indian Ocean anticyclone, and Atlantic meridional overturning circulation (Ziegler et al. 2013). The records also show that there was sufficient atmospheric humidity to support riverine systems during glacial periods, implying a sustained source of fresh water in rivers for hunter-gatherers. But most importantly, the CD154-17-17K record strongly suggests that the last glacial-interglacial cycle in Pondoland was characterized by climatically variable conditions and not prolonged aridity.

On the one hand, the current paleoclimatic models of winter rainfall project more arid conditions along the eastern seaboard during glacial periods of the Pleistocene, yet none of these models actually draw on data from the region. On the other hand, data drawn directly from east coast sources suggests that there may have been increased humidity in the region during glacial periods, yet data are still very limited spatially and temporally. If either of these synoptic conditions were present on the east coast during the Pleistocene, then it is plausible to speculate that there would have been different influences on the local paleoenvironments, paleoecology, and resources—both terrestrial and marine—that may have been available to past hunter-gatherers.

For example, what may have Pondoland looked like if winter rainfall dominated the glacial phases, air temperatures were 5–6° C cooler than today (Holmgren et al. 2003), and more arid conditions were experienced across the eastern seaboard (Chase and Meadows 2007)? We speculate that low CO_2 levels (Indermühle et al. 2000) would have contributed towards forest fragmentation and contraction into riverine valleys at the expense of grasslands, which would dominate the landscape. Poaceae pollen and mixed C_3-C_4 phytolith morphotypes may have occurred in higher frequencies because cooler temperatures and winter rain limits the distribution of C_4 plants, despite low CO_2 concentrations (Scott 2002). Alternatively, Shackleton et al. (1991) have proposed that sourveld grasslands may develop into bushveld / shrubland with fynbos affinities, which is similar to the pattern found by Dupont et al. (2011) in Maputo. Therefore, the landscape may have tended towards a mixed grassland / bushveld with fynbos taxa including Asteracoids and Ericoids. Edible geophytes such as *Watsonia* and corms, known from Terminal Pleistocene archae-

ological deposits at Strathalan Cave B near Maclear (East Cape Province), imply that this food resource expanded in sync with the grasslands during earlier glacial periods (Opperman and Heydenrych 1990). Arid grazing taxa should dominate archaeological faunal assemblages, and mixed feeders that move between grassland and thicket should also be present in faunal assemblages. Due to generally arid conditions, archaeological occupations should also be more restricted to areas surrounding the remaining flowing rivers. Lastly, intertidal shellfish productivity may have been boosted by 2–3° C cooling of the Agulhas Current as suggested by SST proxies (Caley et al. 2011; Dupont et al. 2011).

However, a 2–3° C drop in Agulhas Current surface water temperatures may have still maintained the land-sea thermal gradient that drives coastal precipitation today (Jury et al. 1993) if ambient air temperatures also dropped 5–6° C (Holmgren et al. 2003). Multiple SST records even show that the Agulhas Current warmed by 4° C during glacials (Martinez-Mendez et al. 2010), which would have only increased the land-sea thermal gradient and, therefore, coastal advected precipitation. A southeasterly shift in the South Indian Ocean anticyclone due to the poleward movement of the ITCZ during glacials could have also increased austral summer rainfall in eastern South Africa (Wells and Wells 1994; Ziegler et al. 2013). Under these conditions, Pondoland could have experienced similar to slightly drier conditions than today, which would have supported a mixed open grassland / semi-closed woodland. Varying densities of mesic evergreen forests would have been concentrated in fire and wind-protected river valleys along the coastline, while Bushveld thicket would have been present in rain-sheltered valleys. C_3 Pooideae grasses may also dominate inland and on top of the raised coastal platform, whereas C_4 Panicoid grasses would be present in coastal areas during humid times, giving way to C_4 Chloridoid grasses during periods of aridity. Grazing taxa would be found in greater frequencies inland where the landscape was more open. Mixed feeders would be more common in coastal sites alongside greater frequencies of suids and browsing bovids that live in more closed environments. Lastly, increased river discharge would have provided more opportunities for fresh water from perennial streams. Riverine rock shelters in woody valleys therefore would have been ideal habitation spots for hunter-gatherers as they migrated across the landscape, providing easy access to each of the main environmental zones. The river valleys may have even acted as direct conduits to the coastline, allowing easy access to intertidal zones and resources.

ENDNOTES

1   We have chosen to focus on sites that are as close as possible to the coast and to Pondoland. Therefore, we have omitted Border Cave from this discussion because it is located >500km from the study area and nearly 100km inland.
2   This tally does not include archaeologically-sterile rockshelters.

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