The Late Stone Age to Early Iron Age in Hwange National Park, Zimbabwe: Using Archaeology, Soils, Sediments, and Stable Isotopes to Trace Past Peoples and Environments

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ABSTRACT

This study investigated how and why food-producing subsistence was added to traditional foraging economy in northwestern Zimbabwe (south-central Africa) by characterizing the archaeological and environmental record before, during, and after its first appearance. This reconstruction is supported by data from recent archaeological excavations at Impala and Ngabaa Rockshelters, salvage excavation of the Kapula Vlei Early Farming Community site, geomorphological reconnaissance at numerous localities, as well as laboratory categorization and analyses of collected materials.

Hunter-gatherer use of the two rockshelters increased during the mid-to-late Holocene, with the larger Impala Rockshelter used as an aggregation sites where trade items were manufactured, such as microlithic crescents (segments) and ostrich eggshell beads, suggestive of relatively high populations and the growing importance of social networks to cope with the locally unpredictable environment indicated by proxy environmental data. Strontium, carbon, and oxygen isotopes extracted from ostrich eggshell artifacts show that some of the artifacts were imported while others were of local origin. Distinctive animal spoor (footprint) engravings on the sandstone walls of the rockshelters were also created during this aggregation period. However, after ca. 3,000 cal yrs BP, a drought that gripped the region for several hundred years resulted in (1) erosional scouring of many of the surrounding landscape’s basins, (2) wildfires opening up woodlands, (3) localized aeolian reactivation of ancient Kalahari sand dunes, and (4) human abandonment of the large rockshelters until ca. 2,400 cal yrs BP, when smaller groups again began using the area, albeit less frequently. Hunter-gatherer group sizes never again reached their previously large numbers, and after ca. 1,850 cal yrs BP, the smaller Ngabaa Rockshelter was favored. However, as early as ca. 1,900 cal yrs BP, while the environment was recovering from the long drought interval, the first farmers began establishing settled villages in the most arable
valley floors in the study area, even as small family or task groups of hunter-gatherers continued to use small rockshelters in the uplands. This pattern of landscape use persisted until ca. 800 cal yrs BP, when the growing farming populations began to expand into less desirable, but more defensible, valleys, and the material culture of the two groups intermingled, suggesting recurrent contact and cooperation. Hunting-gathering, plant cultivation, and pastoralism provided a broad resource base that benefited cooperating neighbors. The persistence of hunting-gathering was necessary to cope with a volatile climatic regime; however, even mobile, generalized foragers had to largely abandon the region during sustained droughts.

Given that progressively volatile climatic conditions and an increase in drought frequency is expected in southern Africa due to global warming, gaining a better understanding of the environmental and cultural adaptations to previous environmentally stressful conditions is of increasing importance. This study is the first to do so in northwestern Zimbabwe.
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CHAPTER 1. INTRODUCTION

The Later Stone Age (LSA) and Early Iron Age (EIA, also known as Early Farming Community period) encapsulate the period of transition in southern Africa from an exclusively hunting-and-gathering lifeway to hunting-and-gathering with herding, to hunting-and-gathering alongside settled agropastoralism; in other words, the transition from exclusively food gathering to mixed food gathering and food production. This is an important transition. How and why agropastoralism spread reflects not only movement of ideas and/or peoples, but a changing dynamic between people and their environment. Intense use of the landscape in this way alters entire ecosystems while supporting larger human populations that required new sociocultural constructs to organize labor, cope with new ideas of ownership, and manage social and economic disagreements (cf. Marshall & Hildebrand 2002, Huffman 2007).

Many believe that the presence of food production reflects the expansion of Bantu-speaking peoples from the Congo Basin southward. Evidence is mounting that this transition was much more complex than a unidirectional migration of Bantu families into new lands carrying a complete package of techno-material culture, as suggested by Clark (1970), Huffman (1970), Phillipson (1968, 1975, 1976), and others. Rather, both genetic and archaeological data suggest complex interaction between indigenous Khoisan-speaking hunter-gatherers (e.g., San, Basarwa), Bantu-speakers, and the indigenous earliest small-stock herder-foragers (known as Khoekhoe, also Khoisan speakers) (Bisson 1992; Denbow 2008; Denbow & Wilmsen 1986; Smith 1998). Furthermore,
topographic, environmental, and climatic variability across southern Africa played an important role in the local timing and character of this transition.

Environmentally, this dissertation’s study area, Hwange National Park, Zimbabwe, is near the furthest extent of the Intertropical Convergence Zone’s (ITCZ) southwestern incursion. Variations within this atmospheric circulation pattern have dramatic effects on the amount of precipitation the study area receives (Gasse et al. 2008). The amount and type of rainfall, coupled with water table elevations and vegetation cover, affect drainage patterns, erosion, deposition, and soil development (Goulden et al. 2009; Schulze et al. 2001). Surface water availability controls animal distribution (Chamaillé-Jammes et al. 2007) and vegetational cover, and the availability of potable water limits where people can live and in what numbers (cf. Sithole and Murewi 2009).

Knowledge of past environmental conditions is therefore necessary to understand the causal factors of why agriculture and pastoralism were adopted in southern Africa where hunting-and-gathering had prevailed since the dawn of humankind, and also why it was adopted so late in time when compared to northern Africa.

Here I report several types of proxy data collected to provide an environmental baseline, including documentation and sampling of river cuts, manual excavations, and auger cuttings/cores, along with isotope analyses of excavated teeth and ostrich eggshell. These data aid in the development of soil chronosequences across basins to identify periods of landscape stability or volatility reflected by soil development, or erosion and deposition, and changing vegetational communities through time and space. By combining this environmental information with the archaeological record, new insights
are offered to facilitate an understanding of the complexity of cultural innovation or trait dispersal in prehistory.

**Objectives & Research Questions**

The study area, Hwange National Park, is well situated to address various theories regarding the beginning of food production in southern Africa and whether environmental changes affected the timing and distribution of this change in lifeway. However, little previous fieldwork has been accomplished in northwestern Zimbabwe in this period of prehistory. Therefore, the fundamental guiding research questions are simply:

1. What is the character and distribution of the late Holocene archaeological record preceding, during, and after the adoption or introduction of agropastoralism?

2. Can stable isotope analysis of ostrich eggshell beads and fragments be used to determine if specific artifacts are of local origin, and also act as proxy records of past climatic conditions?

3. What environmental and climatic conditions/events are reflected in specific Hwange sediments, particularly rockshelter deposits and auger samples from open-air localities, and do the various records support and expand interpretations based on analysis of basin geomorphology and alluvial stratigraphy?

These questions are the focus of the following three chapters, which are structured as independent journal article submissions. A synthesis of the data from multiple fieldwork and laboratory sources is used to address how environmental conditions and topographic setting affected the timing and nature of agropastoralism’s expansion and any associated
cultural change during the late Holocene in Hwange National Park, and is summarized in the discussion section and concluding chapter.

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CHAPTER 2. LATE HOLOCENE FORAGING AND EARLY FARMING IN NORTHWESTERN ZIMBABWE: EXCAVATIONS AND ANALYSIS OF ROCK SHELTERS AND AN OPEN-AIR VILLAGE SITE

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ABSTRACT

The archaeological record of northwestern Zimbabwe is important to help us understand the character and timing of the expansion of food production into southern Africa. Excavation of two rockshelters, salvage excavations within a river cut vlei, and geoarchaeological survey have established a chronological sequence for this period in Hwange National Park that shows that farmers arrived as early as ca. 1900 cal yrs BP (average calibrated age before 1950 CE using Calib 6.0; Stuiver et al. 2013) to occupy the best arable lands along river valleys. These peoples had combstamped and channeled thickware pottery, copper bangles, and supplemented their crops with hunted local wild game. There is no evidence of direct contact with the indigenous hunter-gatherers, whose numbers had been in decline for several hundred years, either in the farming village site or within the deposits of rockshelters occupied by hunter-gatherers on a sandy bedrock ridge 30 km away. Hunter-gatherers had occupied this ridge since around 6000 cal yrs BP, and the biggest rockshelter had served as a large aggregation site between 4000 and 3000 cal yrs BP, a period of high population and high frequency or duration of use. Finely engraved animal spoor rock art that decorates the walls of the many rockshelters along this ridge dates to this time. This shelter was abandoned after ca. 3000 cal yrs BP,
but beginning ca. 2400 cal yrs BP, the area was occupied again by single families or a few individuals that preferred smaller, more discrete rockshelters. This use continued even as Iron Age peoples moved into the valley below and began building walled villages and platforms on top of Bumbusi ridge. Burnished ceramic wares and a glass bead intermixed with the traditional hunter-gatherer toolkit suggest forager-farmer interaction first occurred after ca. 800 cal yrs BP within this valley.

**INTRODUCTION**

The prehistoric transition from hunting-gathering to food production in sub-Saharan Africa reflects the movement of peoples and ideas that culminate in dramatic differences in how people interact with their environment. Agropastoralism altered entire ecosystems, and larger human populations had to develop new social constructs to organize labor, establish ideas of resource ownership, and manage conflicts (cf. Marshall & Hildebrand 2002, Huffman 2007).

In this study we present data from recently excavated archaeological sites within Hwange National Park in northwestern Zimbabwe (Figure 2-1) and propose a local cultural sequence for mid-to-late Holocene prehistory. The goal is to determine whether agropastoral practices entered the region either as a package (Vogel 1971), or whether they were gradually developed or adopted one element at a time with ceramic manufacture, iron-smelting, keeping livestock, or planting crops being individually selected for inclusion into indigenous culture (cf. Hanotte et al. 2002; Huffman 2007; Kinahan 1996; Phillipson 1977; Sadr and Plug 2001; Smith 2000; Wilmsen 1991).
Study Area

Hwange National Park in northwestern Zimbabwe is well situated to address some uncertainties about initial food production south of the Zambezi River. The park is located less than 75 km southeast of Victoria Falls, upstream of which is arguably the best crossing for animals and people throughout the Upper to Middle Zambezi River Valley (Fagan et al. 1969). In addition, the park straddles the routes proposed for language transmission by Elphick (1977), for ceramic traditions as outlined by Huffman (1996, 2007), and for the introduction of domestic animals as discussed by Bousman (1998) (Figure 2-2).

Cultural change is not the only factor required for the adoption of food production to occur in northwestern Zimbabwe. The presence of tsetse fly (carrier of nagana in animals and sleeping sickness in humans; Gifford-Gonzalez 2000) ebbs or grows with
changing environmental conditions. Subspecies of tsetse fly that most frequently transmit *nagana* are tied to woodland habitat where precipitation levels exceed 635 mm per year (Lambrecht 1970). Therefore Hwange National Park’s average annual rainfall of 620 mm per year (Rogers 1993) is near the lowest range of tsetse fly tolerance. Sustained drought that decreases woodlands also decreases the risk of exposure to disease-vector borne illness for both animals and people; however, food and water stress associated with drought would not likely increase the area’s desirability.

Fig. 2-2. Hwange National Park in relation to proposed migration routes based on linguistic studies, evidence of domestic stock use, and distribution of ceramic types

Alternatively, people may have burned the woodlands that harbor these disease vectors with the intent of not only decreasing the risk of *nagana* and sleeping sickness, but
expanding the grasslands on which domestic stock, particularly cattle, thrive.

Intentional burning may have allowed the introduction of African domestic cattle, sheep, and goats into the study area (Haynes & Klimowicz 2005) while precipitation was still sufficient to irrigate crops of sorghum, pearl millet, groundnuts, and cowpeas. The question of whether or not people began to wield this type of control over the local environment can only be addressed after the region’s cultural and environmental history has been studied.

Previous archaeological research of this time period in northwestern Zimbabwe is sparse, with existing studies tending to emphasize documentation of Later Iron Age structures (e.g., various sites, Garlake 1970; Mtoa Ruins, Hubbard & Haynes 2012; Bumbusi Ruins, Makuvaza, personal communication, 2008), heritage management (McGregor 2005), or Early-to-Late Stone Age task-specific sites found in undated surface contexts (Haynes & Klimowicz 1998; 2005). The LSA assemblages reported from the study area are typical of microlithic (Mode 5; Clark 1970; Phillipson 1976) Wilton-like assemblages, with backed crescents (segments) and trapezoids, microblades, various other microliths, ostrich eggshell beads, and reduction debris from both local and exotic material (Haynes & Klimowicz 2005).

Of Hwange National Park’s previously recorded 115 archaeological sites, which include examples from the Early Stone Age (ESA), Middle Stone Age (MSA), Later Stone Age (LSA), and Late Iron Age (LIA), only one Early Iron Age (a.k.a. Early Farming Community, Mitchell 2002) site has so far been documented (Haynes & Klimowicz 2005). This Early Iron Age (EIA) site is located along Kapula Vlei near the
Lukosi River (Robinson 1966).

In 1962 K. Robinson visited the Kapula Vlei site (Figure 2-1) and conducted a brief test excavation and survey of the downcutting riverbed bisecting it. In the drainage bed he found a few grinding stones and hammerstones, iron slag, and pottery fragments. Of greater interest, he also observed pottery fragments, house daga (a.k.a. daka or dhaka, used to line floors and to cover pole walls, made from a combination of mud and animal dung), and animal bone fragments and teeth eroding from the banks of the Kapula Vlei at depths of up to 42 inches (106.7 cm) below surface. Examination and limited excavation in the track of an old road also exposed ceramic and daga fragments at 12 inches (30.5 cm) below surface. Comparison of the pottery styles from each location lead him to surmise that the material was sufficiently similar to represent one village site. Robinson collected charcoal from 18 inches (45.7 cm) below surface from the Kapula River’s cutbank, which is presumably the same charcoal from which he obtained a radiocarbon assay of 1140+/−90 BP (1005 cal yrs BP, SR-73; Robinson 1966). In addition to 21 pieces of bone, which included antelope and warthog-size animals, 26 ceramic sherds were collected and illustrated in the 1966 report.

Robinson considered the Kapula Vlei ceramics part of the Gokomere tradition, but with greater affinity to examples from the Mabveni site (1770+/−120 BP, 1630 cal yrs BP, SR 43; 1380 +/-110, 1254 cal yrs BP, SR 79; 1365+/−30 BP, 1264 cal yrs BP, Pta 2105; Bousman 1998, Fagan 1965) rather than the Gokomere type site (1420 +/-120 BP, 1285 cal yrs BP, SR 26; Fagan 1965) due to a lighter and thinner fabric and poorly executed decorative motifs (Robinson 1966: 3). However, he described one feature
dissimilar to both Mabveni and Gokomere ceramics: a crenulated rim. This characteristic had been noted in several traditions throughout Zimbabwe, including Ziwa (1650 +/-100 BP, 1473 cal yrs BP, SR17 to 940 +/-100 BP, 821 cal yrs BP, B223; Fagan 1965, Phillipson 1968), Bambata (2140 +/-60 BP, 2066 cal yrs BP, Pta3072 to 1630 +/- 150 BP, 1463 cal yrs BP, M-913 Bousman 1998, Walker 1983), and, in Botswana, at Tsodilo Hills (1225 +/-60 BP, 1112 cal yrs BP, OxA6038; Sealy & Yates 1996).

Based on ceramic analyses, Robinson (1966) believed that the Kapula Vlei ceramic styles were more ancient than the radiocarbon assay he obtained, but accepted the date as an indication that the site was a late phase of the Gokomere Complex with some connection to the Bambata wares. In addition, Robinson proposed that prehistoric pit excavation could explain the various depths of cultural material exposed in the cutbank, but that only detailed archaeological excavation would provide certainty that this was not due to repeated occupation. He concluded that the same sociotechnical complex that typifies the Early Iron Age was practiced at Kapula Vlei, including iron-making, combstamped ceramic manufacture, and agriculture, but combined with the hunting of wild game. No evidence of pastoralism (e.g., signs of kraals, or bones of domestic animals) was reported.

Other archaeological investigations in the park include only one other significant excavation of a late Holocene age site: Bumbusi Cave National Monument (a.k.a. Bumbuzi Cave or Rockshelter). In 1947 Neville Jones and colleagues from Southern Rhodesia’s National Museum excavated this site to assess the cultural affiliation of unique animal spoor engravings (petroglyphs) on the rockshelter’s walls and those of the
surrounding sandstone outcrops along Bumbusi Ridge (Jones et al. 1949). Excavation revealed a surficial 6 inch (15.25 cm) layer that contained “Bantu pottery.” The remaining charcoal- and ash-rich fill below this layer yielded Wilton tools and abrading stones down to bedrock at 4 feet (122 cm) below surface. Bumbusi Rockshelter is encompassed by a later Iron Age village known as Bumbusi National Monument or Bumbusi Ruins. Jones et al. (1949) concluded that the well-executed engravings were undoubtedly associated with the hunter-gatherer culture rather than the later Iron Age inhabitants of Bumbusi Ruins. Recent detailed description and examination of the Bumbusi petroglyphs are reported in Haynes et al. (2011).

After thirty years of paleoenvironmental and archaeological work elsewhere in Hwange National Park, Haynes recognized the importance and archaeological promise of the many rockshelters exposed along Bumbusi Ridge. These rockshelters were created by weathering along ancient bedding planes in the Upper Karoo Sandstone Formation and had the potential for buried cultural debris. Intact, stratified deposits excavated to modern standards could establish a local artifact assemblage chronology to aid the interpretation of open surface sites as well as address the transition from hunting-and-gathering to food production.

In 2007, Haynes and Simon Makuvaza (of the National Museums and Monuments of Zimbabwe) were permitted to excavate a test unit into one of the rockshelters decorated with animal spoor engravings (now known as Impala Rockshelter; Figures 2-1 & 2-3). This test unit revealed 130 cm of fill that included microlithic artifacts characteristic of the Later Stone Age and pottery of Iron Age type. A radiocarbon age on
charcoal from approximately 50 cm below the surface was assayed to 2310 +/- 40 BP (2212 cal yrs BP, Beta-231382), proving the potential for these rockshelters to address questions about Late Holocene lifeways in the area. Based on these results, Haynes obtained funding from the U.S. National Science Foundation and the Wenner-Gren Foundation to conduct more thorough excavations in the rockshelters of Bumbusi Ridge and pursue paleoenvironmental studies throughout the park relevant to this important period.

The archaeological findings of these investigations are reported below, and although much remains to be done, this study is the first to establish a local technological and chronological framework that considers both hunter-gatherers and food producers in order to gauge their interaction with each other and the environment 5,000 to 1,000 years ago.

METHODS

Field Methods

Archaeological fieldwork took place over nine months during the dry seasons of 2008 thru 2010, and included archaeological pedestrian survey of Bumbusi Ridge, excavation in Impala and Ngabaa rockshelters, and salvage excavation of exposed artifacts from Kapula Vlei. Geoarchaeological investigations included stratigraphic documentation and analysis of numerous river cut exposures and auger boreholes, as well as isotopic analyses of groundwater and ostrich eggshell; these latter results will be detailed in future publications.
Survey

A pedestrian survey of Bumbusi Ridge was completed in 2008. Each rockshelter with cultural debris or rock art (e.g., Figures 2-4 & 2-5) was given a reference name. A sketch map of the ridge was constructed using a combination of Global Positioning System (GPS) UTMs and pace-and-compass mapping techniques (Figure 2-6).

Rockshelter Excavation

Two rockshelters were chosen for excavation based on their relatively large size and geomorphic potential for deep, intact sediments. Both have sufficient cover to shelter one or more families from sun during the heat of the day and rain during the wet season. These rockshelters were named based on the dominant type of animal spoor engravings.
depicted on their walls: Impala Rockshelter and Ngabaa Rockshelter (=giraffe in Sesarwa; R. Hitchcock personal communication, 2013).

Any encroaching vegetation was cleared from the rockshelter aprons, just outside of which a datum was established at nearby hardwood trees carved with a “+” to mark the horizontal (N0/E0) and vertical zero (0 cmbd). UTM coordinates of each datum were obtained using a Garmin Vista GPS unit set to average 100 points. A 1-x-1 meter grid was laid out in the cardinal directions to encompass the rockshelter floors. Each rockshelter’s plan and profile maps, which also delineate the grid overlay, were drawn with the aid of a transit. Rockshelter surfaces and walls were photographically

Fig. 2-4. Ngabaa Shelter wall looking southeast (photo by T. Wriston)
documented and a surface sample of assayable and temporally-diagnostic material was collected before excavations began.

The excavation units were chosen based on local geomorphological considerations and/or to capture whether or not different activity areas were represented across the rockshelter. Impala Rockshelter had been previously tested by Haynes and Makuvaza, so re-locating the test pit was required. A three meter long trench perpendicular to the rockshelter’s long axis on the W2 line (Figure 2-7 and Figure 2-8) was excavated by unit/quad/level to encompass the previous test unit and expose the rockshelter’s stratigraphy. Unit S5W1 was chosen due to its potential for intact stratified remains.

Fig. 2-5. Close-up of Zebra Rockshelter wall looking southwest (photo by T. Wriston)
The S5W1 unit is protected from elephant trampling and large animal wallowing by the low roof at the back of the rockshelter and a large boulder that also has many spoor carvings. Originally, a trench line of units parallel to the long axis of Impala Rockshelter on the S2 line was planned, but due to time and material constraints, only units S2W2, S2W5, and S2W8 were excavated. Ngabaa Rockshelter has more limited potential for intact sediment-fill and a single unit (N4E2) was chosen for excavation because of its good potential for depth, as well as the protection provided by an adjacent boulder with spoor engravings and ground cupules (Figure 2-9 and Figure 2-10).
Units measuring 1-x-1 m were dug in 50-x-50 cm quadrants by 5 cm arbitrary levels using hand-tools. Identified features were separately excavated and collected whenever possible. All depths were recorded using a line level tied to the rockshelter’s primary vertical datum to facilitate stratigraphic reconstruction and artifact assemblage association and analyses. Artifacts, features, and large rocks were mapped on each level’s form whenever encountered. Features were also numbered, photographed, and/or drawn on separate forms.

All excavated material was screened through either 1 & 3 mm nested sieves or 2 & 4 mm nested sieves. In this way, six units were excavated (generally to bedrock) in Impala Rockshelter, for a total excavated volume of 5.025 m$^3$. In Ngabaa Rockshelter, a single unit was excavated to bedrock for a total excavated volume of 0.78 m$^3$. A 2-x-1 m unit (08TU1) was excavated into a relatively flat sandy area between the rockshelters (Figure 2-11) to test for the presence of buried cultural material. A total of 1.7 m$^3$ were excavated from this test unit.

Excavated materials were collected and bagged by project, rockshelter, unit, quadrant, depth, artifact type, and material type. All artifacts and ecofacts were cataloged in the field. The high density of recovered cultural debris was unexpected, and because of time limitations, approximations had to be made based on artifact size, quantity, and weight. Many lithic bags exceeded our portable field scale’s range of 500 grams, so actual counts are generally higher than estimated.

A flotation column sample (10 x 20 cm) was collected by 5 cm increments of depth in the northeastern corner of S5W1 in Impala Rockshelter. Sediment samples were
Fig. 2-7. Impala Rockshelter's plan view showing excavated 1-x-1 meter units. The rockshelter's dripline is signified by a dashed line, engravings are drawn to scale, and grinding surfaces are represented by shading.

Fig. 2-8. Impala Rockshelter's profile at W4 line
Fig. 2-9. Ngabaa Rockshelter’s plan view showing excavated 1-x-1 meter unit. Ceiling height drops dramatically to less than 50 cm along the southern portion of the rockshelter. Dripline is represented by a dashed line also collected from each stratum for characterization through laboratory analyses. After bedrock was reached, each wall of every unit’s sidewalls was photographed, mapped, and described. Samples of any visible assayable remains were collected. After all
Fig. 2-10. Ngabaa Rockshelter’s profile along the North 2.9 axis (upper image) and East 2 axis (lower image)

Fig. 2-11. Bumbusi Ridge excavation locales, including Ngabaa Rockshelter, 08TU1 test unit, and Impala Rockshelter
documentation had been completed, all excavated units were backfilled to the surface
level.

Salvage Excavations

While conducting geomorphological reconnaissance of the Kapula River cut in 2008,
pottery, daga, and bone were discovered eroding from a cutbank near where Robinson
(1966) had conducted the test excavations discussed above. Salvage excavations were
undertaken in 2009 and 2010 after photographing and mapping each locale’s profile.
UTM coordinates were obtained for each locus using a Garmin Vista GPS. Each
collected artifact or ecofact was point-plotted on the map, assigned a field number, and
bagged separately. Artifacts and ecofacts from the drainage bottom were bagged together
by associated locales or general area. We salvaged only the artifacts thought to be in
danger of washing away or eroding out of their primary context during the wet season’s
floods since complete data recovery excavations are needed to fully characterize this
village site’s history.

Laboratory Methods

All recovered materials from the archaeological excavations are currently in storage at
Zimbabwe’s Natural History Museum in Bulawayo, except for the flotation column
sample, sediment samples, water samples, and 155 artifacts and ecofacts, including
ostrich eggshell fragments and beads, a microlithic segment of unusual raw material,
ceramic sherds, charcoal samples, and faunal material that were permitted to be exported
for additional testing and analyses. Following completion of analyses, these materials
will become part of the permanent collections curated in Zimbabwe’s National Museum of Human Sciences in Harare.

During 2009 and 2010, a representative sample of the numerous artifact and ecofacts excavated from Impala and Ngabaa rockshelters was analyzed more closely. Quadrant levels associated with assayed material and from various depths were selected for detailed analyses to compare and document any changes through time. The sheer abundance of cultural debris and logistical difficulties hindered progress, but a representative sample was achieved. Future analyses are planned to fully characterize the assemblages and variation across space, specifically to define any task-specific areas within the rockshelters.

Artifact Analyses

Lithic debris was sorted by material type, lithic reduction technique (regular/bipolar/bladelet production), and size. Applied categories are defined in Table 2-1. Lithic tools were described by material type, shape, manufacture technique, presence and location of any retouch or usewear, and measured (length x width x thickness). Ceramic material, temper, and decoration were described, and vessel type was noted whenever possible. All collected ceramic fragments were photographed to aid identification and comparison with other site collections. Ostrich eggshell beads were measured, photographed, and categorized by stage of manufacture following Kandel & Conard (2005). Faunal material was sorted to genus whenever possible, but more often to size category. Any modification (e.g., burning or breakage) was noted. Ecofacts were measured, photographed and/or drawn to aid in identification.
Table 2.1. Debitage and tool class definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>size class I</td>
<td>&lt;10 mm in maximum dimension</td>
</tr>
<tr>
<td>size class II</td>
<td>10-25 mm in maximum dimension</td>
</tr>
<tr>
<td>size class III</td>
<td>25-50 mm in maximum dimension</td>
</tr>
<tr>
<td>size class IV</td>
<td>&gt;50 mm in maximum dimension</td>
</tr>
<tr>
<td>primary decortication</td>
<td>&gt;50% cortex on dorsal surface</td>
</tr>
<tr>
<td>secondary decortication</td>
<td>25-50% cortex on dorsal surface</td>
</tr>
<tr>
<td>early core reduction</td>
<td>flat, perpendicular platforms with less than 25% cortex on dorsal face, or cortex on platform, relatively thick with triangular to rectangular cross-section</td>
</tr>
<tr>
<td>interior core reduction</td>
<td>flat, perpendicular platforms with no cortex, relatively thin with lenticular cross-section, flake scars usually parallel to long axis</td>
</tr>
<tr>
<td>biface reduction/thinning</td>
<td>convex longitudinal cross-section, low angle arrises, multiple flake scars from various directions, complex and thin platforms (often crushed/fractured)</td>
</tr>
<tr>
<td>bladelet</td>
<td>length &gt; 2 x width, parallel sides, &lt;25 mm in length</td>
</tr>
<tr>
<td>blade</td>
<td>length &gt; 2 x width, parallel sides, &gt;25 mm in length</td>
</tr>
<tr>
<td>bipolar int. core red</td>
<td>bipolar platforms/crushing, no cortex</td>
</tr>
<tr>
<td>bipolar exterior core reduction</td>
<td>bipolar platforms/crushing, cortex present</td>
</tr>
<tr>
<td>bipolar split cobble</td>
<td>approximately one-half of cobble with &gt;70% cortex on exterior surface and bipolar crushing</td>
</tr>
<tr>
<td>pressure/retouch</td>
<td>roundish (expanding margins) with small platform; usually less than 10 mm in maximum dimension</td>
</tr>
<tr>
<td>shatter</td>
<td>angular, no platform or bulb</td>
</tr>
<tr>
<td>bladelet debris</td>
<td>not parallel sided, but length&gt;2 x width, often with bladelet scars on dorsal surface</td>
</tr>
<tr>
<td>squar edge rejuvenation</td>
<td>has a cone with multiple flake scars emanating from ridge/cone, length &lt; 2 x width, discoidal, removal prepares platform for blade or bladelet production</td>
</tr>
<tr>
<td>geometric</td>
<td>prepared angular shape (triangular to pentagonal), no backing</td>
</tr>
<tr>
<td>backed</td>
<td>regular very steep edge retouch with no usewear, grinding sometimes present</td>
</tr>
<tr>
<td>double backed blade/pt</td>
<td>blade or bladelet with regular retouch along long axis margins, forming a triangular point</td>
</tr>
<tr>
<td>pot lid</td>
<td>no platform, complete rounded spall with possible crazing and reddening due to thermal alteration</td>
</tr>
<tr>
<td>indeterminate</td>
<td>flake fragment, no platform, no cortex</td>
</tr>
<tr>
<td>proximal discard</td>
<td>proximal portion of blade or bladelet with snap fracture break on distal margin</td>
</tr>
<tr>
<td>medial discard</td>
<td>medial portion of blade or bladelet with snap fractured ends</td>
</tr>
<tr>
<td>distal discard</td>
<td>distal portion of blade or bladelet with snap fracture break on proximal margin</td>
</tr>
<tr>
<td>scraper</td>
<td>standardized tool with steep, regular retouch along one or more convex margins</td>
</tr>
<tr>
<td>adze</td>
<td>standardized tool with steep retouch along straight margin, step fractures common</td>
</tr>
<tr>
<td>side scraper</td>
<td>regular steep edge retouch along convex margin of long axis</td>
</tr>
<tr>
<td>end scraper</td>
<td>regular steep edge retouch along convex margin of short axis</td>
</tr>
<tr>
<td>thumbnail scraper</td>
<td>small scraper (less than 25 mm) with near margin ratio close to 1:1</td>
</tr>
<tr>
<td>humped back scraper</td>
<td>scraper with distinct flat-deeply convex cross-section</td>
</tr>
<tr>
<td>lunate scraper</td>
<td>crescent-shaped scraper with retouch along convex margin and use/retouch on straight margin</td>
</tr>
<tr>
<td>bidirectional core</td>
<td>core with flakes only removed from two platforms, often on opposite margins</td>
</tr>
<tr>
<td>bipolar core</td>
<td>core reduced using a hammerstone and anvil technique with platforms (often crushed) on opposite margins</td>
</tr>
<tr>
<td>blade core</td>
<td>core with primarily blade or bladelet flake scars</td>
</tr>
<tr>
<td>conical core</td>
<td>a.k.a. pyramid core, cone shaped, often unidirectional blade core with blades punched from one platform</td>
</tr>
<tr>
<td>flake core</td>
<td>flake used as a core</td>
</tr>
<tr>
<td>multidirectional core</td>
<td>flake scars emanating from three or more margins, core has irregular flaking pattern</td>
</tr>
<tr>
<td>unidirectional core</td>
<td>all flakes removed from platforms on one margin</td>
</tr>
<tr>
<td>core tool</td>
<td>core, secondary use as a tool (e.g. chopper, hammerstone)</td>
</tr>
<tr>
<td>radial core</td>
<td>circular in shape, formed from striking flakes from one circular plane around the core, flake scars meet in center</td>
</tr>
<tr>
<td>hammerstone</td>
<td>cobble with multiple percussion scars clustered within one or more margins</td>
</tr>
<tr>
<td>anvil</td>
<td>large cobble or rock with flat or concave surface with multiple percussion fractures and scars</td>
</tr>
<tr>
<td>tested cobble</td>
<td>cobble remains 70% or more cortex with percussion fractures on various surfaces and/or 1-3 flakes removed</td>
</tr>
</tbody>
</table>
After arriving in the United States, the exported materials were housed in laboratories at the Desert Research Institute (DRI) in Reno, Nevada, and the University of Nevada, Reno. Selected assayable materials were submitted to Beta Analytic, Inc. and the University of Arizona Accelerator Mass Spectrometry Laboratory. A suspected obsidian microlithic segment was sent to Craig Skinner of Northwest Obsidian Research Lab for identification and has been returned after XRF analysis and sampling for hydration rim thickness. A sample of the ostrich eggshell beads was analyzed using a scanning electron microscope (SEM) to identify their structural preservation and manufacture techniques. All exported ostrich eggshell beads were measured and photographed before one-half of each was sacrificed for isotope analyses along with a select sample of ostrich eggshell fragments and teeth. Isotopic samples of teeth were drilled using protocols established by Dr. Stanley Ambrose (personal communication, 2012). Analysis of strontium, carbon, and oxygen isotopes of these ostrich eggshell and enamel samples was undertaken at the University of Illinois and the University of Nevada, Reno’s Stable Isotope Laboratories following established protocols. Samples of ceramic sherds and sand are being analyzed at the Luminescence laboratory at DRI. Many of these results are forthcoming and will be reported in future publications.

RESULTS

Surface survey, salvage excavations, and controlled excavations retrieved an estimated 143,604 artifacts and ecofacts based on our field catalog (Table 2-2). The high artifact density from excavations of the Bumbusi Ridge rockshelters was a surprise, with
densities ranging from around 48 per cubic meter excavated outside of the rockshelters, to between 20,000-to-32,000 artifacts and ecofacts per cubic meter excavated within the rockshelters. In fact, based on comparison between the field catalog and actual sample counted during analyses, even these estimates are 30% or more too low (Table 2-3), bringing the actual number of artifacts and ecofacts collected to probably greater than 186,700. Units and levels with the lowest artifact densities are most accurately reflected in the catalog because they were more likely to be counted directly in the field. In level quad bags with hundreds of artifacts or ecofacts, the cataloger was more likely to enter counts as “100+”, which then were tabulated as 100, thereby underestimating the actual numbers. All surface and salvage collections were analyzed, as was a sample of the abundant rockshelter excavation collections.

**Bumbusi Ridge**

Fourteen features were recorded while excavating in Impala and Ngabaa Rockshelters. Twelve of these are concentrated lenses of charcoal ash found at various depths in both rockshelters. These often include charred nutshell (mongongo and others; Figure 2-12) and burnt bone was noted in some of the features ranging from rodent to zebra-size. A fetal primate burial at 178 cmbd (40 cmbs) within unit S2W5 of Impala Rockshelter was also discovered. Although photographed and illustrated, these extremely fragile bones disintegrated with exposure. Central incisor enamel caps were the most diagnostic element. This fetus was undoubtedly buried (hyenas and jackals scavenge in the area nightly), but its poor preservation makes it difficult to determine whether it was human or baboon. Baboons are common in the area and burial of animals is documented in
Table 2-2. Field catalog totals by location, site, unit, and type

<table>
<thead>
<tr>
<th>Location</th>
<th>Site</th>
<th>Unit</th>
<th>Lithics</th>
<th>Ceramics</th>
<th>Faunal/ Organics</th>
<th>Other</th>
<th>Total</th>
<th>Excavated Volume (m³)</th>
<th>Density (per m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bumbusi Ridge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open area test unit</td>
<td>08TU1</td>
<td>82</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>82</td>
<td>1.7</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Combstamp Rockshelter</td>
<td>n/a</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Daga Rockshelter</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Passageway Rockshelter</td>
<td>n/a</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Impala Rockshelter</td>
<td>surface</td>
<td>--</td>
<td>64</td>
<td>--</td>
<td>--</td>
<td>64</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>S2W2</td>
<td></td>
<td>21249</td>
<td>46</td>
<td>4859</td>
<td>5</td>
<td>26159</td>
<td>1.115</td>
<td>23461</td>
<td></td>
</tr>
<tr>
<td>S2W5</td>
<td></td>
<td>13504</td>
<td>15</td>
<td>7323</td>
<td>21</td>
<td>20863</td>
<td>0.82</td>
<td>25443</td>
<td></td>
</tr>
<tr>
<td>S2W8</td>
<td></td>
<td>18307</td>
<td>116</td>
<td>8494</td>
<td>9</td>
<td>26926</td>
<td>0.93</td>
<td>28953</td>
<td></td>
</tr>
<tr>
<td>S3W2</td>
<td></td>
<td>14697</td>
<td>18</td>
<td>5607</td>
<td>6</td>
<td>20328</td>
<td>0.97</td>
<td>20957</td>
<td></td>
</tr>
<tr>
<td>S4W2</td>
<td></td>
<td>2878</td>
<td>19</td>
<td>4640</td>
<td>3</td>
<td>7540</td>
<td>0.24</td>
<td>31417</td>
<td></td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>11595</td>
<td>22</td>
<td>7641</td>
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<td>19268</td>
<td>0.95</td>
<td>20282</td>
<td></td>
</tr>
<tr>
<td>Ngabaa Rockshelter</td>
<td>surface</td>
<td>--</td>
<td>35</td>
<td>--</td>
<td>--</td>
<td>35</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>N4E2</td>
<td></td>
<td>12722</td>
<td>119</td>
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<td>10</td>
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<td>0.78</td>
<td>28145</td>
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</tr>
<tr>
<td>Kapula River</td>
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<tr>
<td>Drainage Bottom</td>
<td>n/a</td>
<td>--</td>
<td>133</td>
<td>--</td>
<td>7</td>
<td>140</td>
<td>--</td>
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<tr>
<td>Locus 1</td>
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<tr>
<td>Locus 2</td>
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<td>--</td>
<td>13</td>
<td>5</td>
<td>1</td>
<td>19</td>
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<td>Locus 3</td>
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<td>Locus 4</td>
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<td>92</td>
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<td>2</td>
<td>1</td>
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</tr>
<tr>
<td>Drainage Bottom</td>
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<td>--</td>
<td>42</td>
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<td>--</td>
<td>42</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>95034</td>
<td>811</td>
<td>47683</td>
<td>76</td>
<td>143604</td>
<td>7.505</td>
<td></td>
<td></td>
</tr>
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</table>
Table 2-3. Field catalog estimated counts of unit/level/quads subject to sample analyses versus actual counts

<table>
<thead>
<tr>
<th>Unit</th>
<th>Catalog Type</th>
<th>Lithics</th>
<th>Ceramics</th>
<th>Faunal/Organics</th>
<th>Other</th>
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<tbody>
<tr>
<td>08TU1</td>
<td>Catalog</td>
<td>82</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>Analyses</td>
<td>85</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>N4E2</td>
<td>Catalog</td>
<td>1992</td>
<td>50</td>
<td>1570</td>
<td>7</td>
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<tr>
<td></td>
<td>Analyses</td>
<td>1594</td>
<td>67</td>
<td>1665</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-398</td>
<td>17</td>
<td>95</td>
<td>33</td>
</tr>
<tr>
<td>S5W1</td>
<td>Catalog</td>
<td>2060</td>
<td>0</td>
<td>1571</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Analyses</td>
<td>4203</td>
<td>0</td>
<td>3330</td>
<td>73</td>
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<td>Difference</td>
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<td>0</td>
<td>1759</td>
<td>73</td>
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<tr>
<td>Total</td>
<td>Catalog</td>
<td>4134</td>
<td>50</td>
<td>3141</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Analyses</td>
<td>5882</td>
<td>67</td>
<td>4995</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>1748</td>
<td>17</td>
<td>1854</td>
<td>109</td>
</tr>
<tr>
<td>Total</td>
<td>Percent Error</td>
<td>30%</td>
<td>25%</td>
<td>37%</td>
<td>94%</td>
</tr>
</tbody>
</table>

southern Africa by numerous researchers (cf. Kinahan 1991; Orton 2012; Parkington & Fisher 2006; Robbins et al. 2005; Webley 2001). DNA analysis is planned to address whether or not this fetus is human, but if it is, incisor crown development suggests that it was likely a last trimester fetus or newborn (cf. Aka et al. 2009). Slightly more compact sediment was noted underneath the burial along with a few random pieces of lithic debitage. No distinct pit could be discerned in the somewhat termite-disturbed sediments in the burial’s vicinity and no grave goods were discovered; however, the rockfall layer was intact above the feature, suggesting that it pre-dates this roof spall event.
The rockfall layer (Figure 2-12) spans the rockshelter, but is most concentrated in the back units, with fewer rocks and significant bioturbation nearing the rockshelter’s apron. Of interest, a few of the small rocks have partial spoor engravings. In addition, warthog and impala spoor engravings were found on top of a large fallen slab across units S3W2-S4W2 (Figure 2-13). Using a distinct charcoal ash feature on top of the rockfall layer (Figure 2-13), it was possible to obtain a radiocarbon assay that provides a definitive minimum age for the animal spoor engravings in Impala Rockshelter of 2403 cal yrs BP (Beta-275279; Table 2-4).
Even though it is definitive that the engravings pre-date 2403 cal yrs BP, we argue that it is even more likely that the spoor carvings pre-date 3114 cal yrs BP (Beta-249591) based on radiocarbon assayed charred mongongo nuts extracted from a feature immediately below the rockfall layer (Figure 2-12 & 2-13). These charred shell fragments are nearly complete and unweathered despite exposure on the surface within a charcoal ash feature immediately before the rockfall event.
<table>
<thead>
<tr>
<th>Site</th>
<th>Unit</th>
<th>Provenience</th>
<th>Material</th>
<th>Lab Number</th>
<th>Conv. Age</th>
<th>Calibrated Age*</th>
<th>Mean Calibrated Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impala</td>
<td>Rockshelter</td>
<td>level 2</td>
<td>Ostrich Eggshell</td>
<td>AA95091</td>
<td>2141+/-37 BP</td>
<td>2008 to 1689 cal yrs BP **</td>
<td>1849 cal yrs BP cal AD 101</td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>level 2</td>
<td>Charred Wood</td>
<td>Beta-275279</td>
<td>2430+/-40 BP</td>
<td>2460 to 2345 cal yrs BP cal BC 510 to 395</td>
<td>2403 cal yrs BP cal BC 453</td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>level 4</td>
<td>Charred Mongongo Nut</td>
<td>Beta-249591</td>
<td>3000+/-40 BP</td>
<td>3168 to 3060 cal yrs BP cal BC 1218 to 1110</td>
<td>3114 cal yrs BP cal BC 1164</td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>level 11</td>
<td>Charred Wood</td>
<td>AA95088</td>
<td>3366+/-40 BP</td>
<td>3585 to 3472 cal yrs BP cal BC 1635 to 1522</td>
<td>3529 cal yrs BP cal BC 1579</td>
</tr>
<tr>
<td>S2W8</td>
<td></td>
<td>level 13</td>
<td>Charred Wood</td>
<td>Beta-249590</td>
<td>3610+/-40 BP</td>
<td>3907 to 3823 cal yrs BP cal BC 1957 to 1873</td>
<td>3865 cal yrs BP cal BC 1915</td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>level 18</td>
<td>Seed/Nut**</td>
<td>AA95095</td>
<td>3092+/-38 BP</td>
<td>3276 to 3209 cal yrs BP cal BC 1326 to 1259</td>
<td>3243 cal yrs BP cal BC 1293</td>
</tr>
<tr>
<td>S5W1</td>
<td></td>
<td>level 17</td>
<td>Ostrich Eggshell</td>
<td>AA95092</td>
<td>5202+/-43 BP</td>
<td>5912 to 5583 cal yrs BP cal BC 3963 to 3634</td>
<td>5748 cal yrs BP cal BC 3798</td>
</tr>
<tr>
<td>2007 Test Unit (~S2.5 W2.5)</td>
<td></td>
<td>~50 cmbs (found in screen)</td>
<td>Charred Wood</td>
<td>Beta-231382</td>
<td>2310+/-40 BP</td>
<td>2243 to 2180 cal yrs BP cal BC 294 to 229</td>
<td>2212 cal yrs BP cal BC 262</td>
</tr>
<tr>
<td>Ngabaa</td>
<td>Rockshelter</td>
<td>level 10</td>
<td>Charred Wood</td>
<td>AA95090</td>
<td>1879+/-44 BP</td>
<td>1820 to 1707 cal yrs BP cal AD 130 to 243</td>
<td>1764 cal yrs BP cal AD 186</td>
</tr>
<tr>
<td>N4E2</td>
<td></td>
<td>level 12</td>
<td>Ostrich Eggshell</td>
<td>AA95093</td>
<td>1763+/-37 BP</td>
<td>1573 to 1289 cal yrs BP cal AD 377 to 661</td>
<td>1431 cal yrs BP cal AD 519</td>
</tr>
</tbody>
</table>

*1-sigma calibration (68.3%) with greatest relative area under probability distribution reported as cal yrs BP range; Calibrated using Calib 6.0 SHCal04 (McCormac et al. 2004; Stuiver et al. 2013, Stuiver & Reimer 1993)

**OES correction factor (180)+/-120 yrs applied before calibration as per Vogel et al. 2001

***partial acid/base pretreatment required to prevent complete sample destruction
Stratigraphic Context

As the radiocarbon assays show, the upper 10-15 cm of sediment within Impala Rockshelter generally contain material 1849 to 2403 cal yrs BP in age (Table 2-4 & Figure 2-14). Given the relatively loose surface duff in the upper 10 cm, the transition to food production, which may have begun ca. 2000 cal yrs BP in this region, is not represented within any of the well-stratified buried remains so far excavated in Impala Rockshelter.

The lack of sedimentary fill post-dating ca. 2000 cal yrs BP may be due to erosion by runoff that was arrested by the rockfall layer in units close to the rock face; however, we exposed intact ash lenses above the rockfall layer in these units, so this hypothesis is not sufficient. Examination of the deposits below the rockfall layer, where sediments, artifacts, and ecofacts accumulated at a minimal rate of 3 mm/year based on depth of fill and radiocarbon assays, reveals the answer: the primary source of deposition in the rockshelters was anthropogenic charcoal ash and the primary source of fine-grained material (silt, clay, and ash) into the rockshelter sand is cultural activity. Extreme hydrophobicity (water repellant quality) of the ashy sediments supports this hypothesis, as do loamy textures (Figure 2-14) in an environment comprised of weathering Upper Karoo Sandstones and wind-blown Kalahari sand.
Preservation of many discrete charcoal lenses also suggests deposits were created relatively quickly, but even so, no sterile deposits were encountered. The lack of sterile deposits further supports that anthropogenic materials were the primary deposit type and that naturally occurring deposition (outside of roof spall) is minimal during the late Holocene, although some sandy alluvial slopewash and deposition of aeolian fine sand and silt undoubtedly occurred.

Within the rockshelter, termites are also active and introduce biogenic alteration and bioturbation of the sediments near the bedrock contact. It is this activity that makes dating the lowest levels of the rockshelter problematic due to mixing and relatively poor preservation. For example, two radiocarbon assays from 80-85 cmbs (175-180 cmbd)
within S5W1 dated 2505 years apart (Figure 2-14). Granted, each of these materials have their own challenges. The ostrich eggshell bead (5748 cal yrs BP; AA95092) may have been curated for some time before deposition, and/or could have easily moved up through the profile with the aid of termite or other biotic activity. An unidentified seed (likely acacia) was the younger (3243 cal yrs BP; AA95095) of these assays. Although the seed was blackened and appeared charred, pretreatment with acid/base washes quickly began to disintegrate the material (meaning it was not charred, but rather affected by humates), so a partial pretreatment was used, making contamination more likely. In addition, movement of a small seed/nut vertically through the profile by termites or other biota is likely.

The earliest dated cultural remains of Impala Rockshelter is the aforementioned ostrich eggshell bead (Table 2-4). Before this initial deposition, the rockshelter had likely been eroded to bedrock during the early-to-mid Holocene. People began visiting Impala Rockshelter around 6000 cal yrs BP when sediments began accumulating in its basal layers, but the best preserved features and ecofact material was deposited between ca. 3865 and 3114 cal yrs BP when hunter-gatherers were making regular visits that culminated in a deep, dense cultural deposit and perhaps the creation of accurate animal spoor carvings on exposed sandstone surfaces. Similar types of artifacts continued to be deposited until at least 2403 cal yrs BP, but without the dense accumulation of anthropogenic charcoal ash that characterized previous occupations. Visitation by smaller groups or individuals continued as suggested by an OES bead dated to 1849 cal yrs BP; however, the growing presence of agropastoralists is evidenced by Later Iron Age ceramics intruding into the rockshelter’s surficial deposits.
The lack of sediment accumulation in the post-ca. 2403 cal yrs BP deposits is directly linked to the lack of anthropogenic accumulation of charcoal ash, which, like other forms of midden, can serve as a proxy for population (e.g., Jerardino 1996). If these thin cultural deposits were the result of post-depositional deflation above the protection of the rockfall layer, not only would we not have a 2403 cal yrs BP charcoal ash lens preserved above the rockfall layer and near the surface, but we would also expect a sharp increase in artifact density that is not evident.

Just under 60 m to the northwest of Impala Rockshelter, Ngabaa Rockshelter (Figure 2-15) sediments are also charcoal ash-rich, but have a greater contributing ratio of slope washed sand and pebbles. Ngabaa Rockshelter’s floor is undulating with ancient large sandstone roof spalls, and in most areas consists of winnowed rock and gravels. This suggests that erosion plays a bigger part here than the generally soft sediment floor and apron of Impala Rockshelter, or, alternatively, that anthropogenic sediments were never deposited to the same degree. According to radiocarbon ages obtained from unit N4E2, the sediments and cultural debris are also younger than those examined in Impala Rockshelter. Charred wood recovered from near the rockshelter’s floor at 47 cmbs was assayed to 1764 cal yrs BP (AA95090) while an ostrich eggshell bead from around 10 cm deeper was assayed to 1470 cal yrs BP (AA95093). This reversal is likely due to bead movement through the profile. Large bone was found near the bottom of the unit, but proved too perimineralized for assay.
As it stands, the available radiocarbon ages suggest that the entire cultural fill of Ngabaa Rockshelter’s N4E2 is less than ca. 2000 cal yrs BP old. Therefore, we can use the analyzed material from N4E2 to represent the period of initial hunter-gatherer contact with agropastoralism and subsequent adaptations. In contrast, the bulk of fill in Impala Rockshelter reflects hunter-gatherer occupations ca. 6000 to ca. 2400 cal yrs BP, preceding contact with agropastoralism, although minimal deposition continued until ca. 1849 cal yrs BP.

In order to analyze any changes of cultural material over time at Bumbusi Ridge, we separated the materials into five temporal units as detailed in Table 2-5. Examining the amount of rockshelter fill using these categories, we find that during the initial occupation of Impala Rockshelter, termed the Middle Holocene Wilton (MHW), an average of 13 cm$^3$ of fill was deposited per year. If the primary deposition mechanism here is cultural, this suggests significant use of this large rockshelter during this period. However, during the Late Holocene Wilton (LHW) around 87.5 cm$^3$ of fill was deposited per year, indicating much more intense use than before, either due to more frequent
visitation, larger group size, or longer stays. In contrast, the fill accumulation rate drops dramatically for the Post-Wilton (PW) phase to 23 cm$^3$ per year. This drop in fill rate suggest abrupt change in one or all of the variables mentioned above between 3000 and 1850 cal yrs BP. After 1850 cal yrs BP, Impala Rockshelter accumulated little to no anthropogenic fill and was largely abandoned in favor of the smaller, nearby Ngabaa Rockshelter.

During the Early Contact Period (ECP; in this context, the word “contact” refers to prehistoric forager-farmer interactions, not to colonial era contact with Europeans), fill accumulated at Ngabaa Rockshelter at a rate of 48 cm$^3$ per year (after accounting for boulders and termite gallery fill). The fill rate remained relatively constant during the Late Contact Period (LCP), with accumulation at a rate of around 47 cm$^3$ every year. These rates show that the smaller rockshelter was more intensively used after ca. 1850 cal yrs BP than the larger Impala Rockshelter.

Even when artifact and ecofact density per cubic centimeter excavated is compared (Table 2-5), the same trend emerges: a dramatic drop in use during the Post-Wilton phase. However, these data also show that occupation intensity was even lower during the Early Contact phase with subsequent rebound during the Late Contact Period. The LCP increase in artifact and ecofact density is no doubt in part due to deflation of near surface contexts, but level three has nearly the same density of artifacts and ecofacts as surficial level one, so this effect is considered minimal. In fact, we also calculated the density of artifacts and ecofacts over time to subtract sedimentary effects and similar
trends emerged, with by far the most intense use during the Late Holocene Wilton (Table 2-5).

Given that Impala and Ngabaa Rockshelters are only 60 m away from each other, their use during different periods is most likely due to differences in their size and layout. Impala Rockshelter is the largest of all on Bumbusi Ridge. Its overhang covers a wide open floor space (~48 m²) with a few large engraved boulders. This space could easily accommodate three to four families within the dripline, and beyond is a gradual slope onto the apron and surrounding area. In contrast, Ngabaa Rockshelter’s floor space is limited to less than ~25 m² and is dominated by large boulders and hard rubble surfaces. Ngabaa is better suited to provide rockshelter for just a few people or a small single family. In addition, it is a more discrete and defensible space with rock faces on two sides, one of which has a low overhang that might offer emergency protection from

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Rockshelter</th>
<th>Unit</th>
<th>Levels</th>
<th>Artifacts &amp; Ecofacts</th>
<th>Excavated Volume (cm³)</th>
<th>Density per Volume</th>
<th>Density per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Contact Period (LCP)</td>
<td>&lt;800 cal yrs BP (approx.)</td>
<td>Ngabaa</td>
<td>N4E2</td>
<td>1, 2, 3</td>
<td>1,974</td>
<td>37,500</td>
<td>0.053</td>
<td>2.470</td>
</tr>
<tr>
<td>Early Contact Period (ECP)</td>
<td>~800 - 1850 cal yrs BP</td>
<td>Ngabaa</td>
<td>N4E2</td>
<td>5,6,7,8,9,12,14,15</td>
<td>1,365</td>
<td>100,000</td>
<td>0.014</td>
<td>1.300</td>
</tr>
<tr>
<td>Post Wilton (PW)</td>
<td>1850 - 3000 cal yrs BP</td>
<td>Impala</td>
<td>S5W1</td>
<td>2 &amp; 3</td>
<td>767</td>
<td>25,000</td>
<td>0.031</td>
<td>0.667</td>
</tr>
<tr>
<td>Late Holocene Wilton (LHW)</td>
<td>3000 - 4000 cal yrs BP</td>
<td>Impala</td>
<td>S5W1</td>
<td>6,7,8,10,11,12,13</td>
<td>5,128</td>
<td>87,500</td>
<td>0.059</td>
<td>5.128</td>
</tr>
<tr>
<td>Middle Holocene Wilton (MHW)</td>
<td>4000 - 6000 cal yrs BP</td>
<td>Impala</td>
<td>S5W1</td>
<td>16 &amp; 17</td>
<td>1,614</td>
<td>25,000</td>
<td>0.065</td>
<td>0.807</td>
</tr>
</tbody>
</table>
elephants, buffalo, and rhino, as well as quick escape onto the top of the rockshelter or into the adjacent woodlands.

Within the open test unit (08TU1) between the rockshelters (Figure 2-11), deposits were fine to medium sand deposited via alluvial slopewash with some aeolian input. Small charcoal flecks were noticed 5-10 cm below the modern surface along with burnt roots that indicated natural fire activity. However, no temporally diagnostic artifacts were recovered.

**Artifacts**

The extremely high artifact densities within Impala and Ngabaa Rockshelters required a stratified sampling strategy that was affected by both time and access constraints. Therefore, sampling priority was given to units and quadrants with the best stratigraphic integrity and levels that were associated with radiocarbon assays. Level depth was also a consideration, with groups from various depths sampled to allow investigation of any changes through time. Following these guidelines, a total of 11,212 artifacts and ecofacts were analyzed (Table 2-6) at the Natural History Museum in Bulawayo. Therefore, the sample is around 8% of the total collected and sufficient for its initial characterization.

Given the close proximity of the units designated N4E2 in Ngabaa Rockshelter, 08TU1 between the rockshelters, and S5W1 in Impala Rockshelter, the results of their excavation and sample analyses are reported together in the following section, with separation into temporal components (Table 2-5) whenever warranted.
Table 2-6. Bumbusi Ridge analyzed materials

<table>
<thead>
<tr>
<th>Type</th>
<th>08TU1 (2x1 m Unit)</th>
<th>N4E2 (NW Quad)</th>
<th>S5W1 (NE Quad)</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debitage</td>
<td>60</td>
<td>1151</td>
<td>3101</td>
<td>--</td>
<td>4312</td>
</tr>
<tr>
<td>Blade Red. Debris</td>
<td>--</td>
<td>349</td>
<td>862</td>
<td>--</td>
<td>1211</td>
</tr>
<tr>
<td>Cores</td>
<td>20</td>
<td>45</td>
<td>127</td>
<td>--</td>
<td>192</td>
</tr>
<tr>
<td>Hammerstones</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>--</td>
<td>7</td>
</tr>
<tr>
<td>Backed Microliths</td>
<td>--</td>
<td>17</td>
<td>73</td>
<td>--</td>
<td>90</td>
</tr>
<tr>
<td>Scrapers</td>
<td>--</td>
<td>16</td>
<td>12</td>
<td>--</td>
<td>28</td>
</tr>
<tr>
<td>Gravers</td>
<td>--</td>
<td>6</td>
<td>12</td>
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<tr>
<td>Flake Tools</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>--</td>
<td>18</td>
</tr>
<tr>
<td>Ground Stone</td>
<td>--</td>
<td>--</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
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Lithics

Lithic artifacts are abundant and most often made of locally-available raw materials.

Relict river deposits of rounded milky quartz gravels are eroding from the ancient Upper Karoo sandstones that comprise the rockshelters and surrounding bedrock. These quartz gravels rarely exceed 4 cm, but are commonly 2 to 3 cm in diameter and are well-represented in the lithic debris. Bumbusi Ridge also has an abundance of petrified wood, which in some cases are remnant of ancient tree trunks up to 1 m in diameter and several meters long. Fragments up to 20 cm are exposed in the two-track road that transects
across the ridge above Impala Rockshelter. Blocky cobbles of banded ironstone were also found here, as were occasional cobbles of quartzite and metaquartzite.

The immediately available quartz and petrified wood (CCS) make up the bulk of the artifact material types, but an aqua green cryptocrystalline silicate (CCS) was also noted and can be found in pockets within the basalts that bound the Deka River to the northwest 2.85 km (1.77 miles). Chalcedony (CCS) is common and is found in outcrops of hills near the Deka River. Silcrete and quartzites are also frequently encountered in the hills near the river, particularly above the confluence of the Bumbusi and Deka Rivers. Other materials, which may be variations within the petrified wood, include moss agate (CCS) and jasper (CCS). The only exotic lithic material noted in the assemblage was initially classified as obsidian, as mentioned above, but has now been identified as glassy basalt (Craig Skinner and Jeffrey Ferguson, personal communications, 2012).

The types of cores vary widely and reflect different reduction trajectories to adapt to different lithic material qualities (Table 2-7). However, debitage analysis shows that although there is variation in the reduction trajectories, these trajectories eventually converge towards bladelet production.

The bulk of the local quartz gravel cores are bipolar, which is not surprising given their relatively small size, hardness, and difficulty flaking. All cores are generally small, ranging from 9 mm to 75 mm in maximum dimension, but averaging 14.3 mm. In fact, even though knappable raw materials can be found less than 30 to 100 m from the sites, the vast majority of the debitage is already microlithic (<25 mm) in proportion (Figure 2-16).
Table 2-7. Core Type by Material

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A total of seven hammerstones was also recovered from the sampled units. One is CCS and six are quartz or quartzite. These are relatively large and hefty when compared to the cores, with examples up to 71 mm in diameter, and an average size of 31 mm. Three of the hammerstones have been edge sharpened along one or more margins, but also have battered surfaces. This suggests use as a chopper on some margins and use for pounding on others.

Lithic reduction debris was sorted into either debitage or bladelet production debris to account for additional variables of interest in bladelet production. The debitage analyses shows that the primary activity represented is reduction of cores using both
regular end and side struck flake removal, and bipolar reduction (Figure 2-17). The high percentage of pressure/retouch flakes indicates that tool production and backing also took place on site. Blade and bladelet production debris is detailed by level and temporal category within Table 2-8 and accounts for 22% of all lithic debris. Finished, unbroken bladelets (n = 491) make up 9% of this. High quality CCS (e.g., moss agate, chalcedony) is favored in bladelet manufacture, but quartz bladelets are also common. These bladelets were made to be backed and snapped into finished “backed microliths” as detailed in Bousman (2005) and Savage (1983). This trajectory is further supported by the presence of proximal, medial, and distal discard, sometimes with backing. Backed crescents, or segments, are the most common complete backed tool recovered throughout all levels (Table 2-9), and although a few backed bladelets were noted (likely used as cutting instruments, Lombard & Parsons 2008), the prevalence of backed crescents (Figures 2-17 & 2-18) implies that they were the goal for the abundant bladelets produced at these sites. Other backed tools classified as backed geometrics or microliths include petit tranchets, trapezes, and other unusual shapes (e.g., Savage 1983). The only three backed points discovered were from the deepest layers within the Middle Holocene Wilton phase.

Eighteen flake tools showed expedient use, whereas the more standardized tools were classified as scrapers (n=28). A single quartz scraper may have been used also as an adze judging by steep step fractures along one margin. All other scrapers are of high quality CCS (moss agate, chalcedony, and petrified wood) with the majority being small thumbnail scrapers that may have been hafted (Table 2-10). Two lunate scrapers with
Fig. 2-17. Combined debitage types from Bumbusi Ridge analyses separated by size class (I - <10 mm; II - 10 to 25 mm; III - 25 to 50 mm; IV - >50 mm)
Table 2-8. Bumbusi Ridge blade/bladelet production debris with shading representing temporal categories

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<td>backed crescent</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<td>31</td>
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<tr>
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<td>1</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>backed fragment</td>
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<td></td>
<td></td>
<td></td>
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<td>2</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>backed geometric</td>
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<td></td>
<td>1</td>
<td>4</td>
<td></td>
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<tr>
<td></td>
<td>backed microlith (undif.)</td>
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<td>backed proximal discard</td>
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<td>1</td>
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<td></td>
<td>11</td>
<td></td>
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<td>11</td>
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<tr>
<td></td>
<td>double backed blade or point</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td>1</td>
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<tr>
<td>Total</td>
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<td>8</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>90</td>
</tr>
</tbody>
</table>

backing on the curved side and use along the straight margin were also noted. Three larger convex scrapers were present, but even these are 30 mm or less in maximum diameter. A single hump-backed scraper was analyzed and could have been hand held or hafted. In addition to scraping, three tools were also used for other functions. Two have
spurs used as gravers or borers and another, a fragment, has percussion fractures suggesting secondary use as a hammerstone or anvil.

Of the 28 scrapers identified, 18 are various types of thumbnail scrapers. Interestingly, the majority of these are from the LCP phase in Ngabaa Rockshelter, closely followed by the ECP phase counts. None of the thumbnail scrapers were discovered amongst the otherwise dense assemblage from the LHW phase, although both lunate scrapers and two more general scraping tools were noted. In contrast, a relatively wide variety of scraper types is represented during the Middle Holocene Wilton phase (Table 2-10). These data suggest that whatever the thumbnail scrapers were used for was

![Sample of backed microliths](image)

Fig. 2-18. Sample of backed microliths
Table 2-10. Sample analyses of scraper types by level (scraper retouched on both ends and sides unless otherwise noted)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Type</th>
<th>Level</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>2</td>
</tr>
<tr>
<td>N4E2</td>
<td>scraper</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>side scraper</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>thumbnail end scraper</td>
<td>5</td>
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<td>thumbnail scraper</td>
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<td></td>
</tr>
<tr>
<td>S5W1</td>
<td>humpedback scraper</td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>thumbnail scraper</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>thumbnail side scraper</td>
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<td></td>
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<tr>
<td></td>
<td>lunate scraper</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>scraper/other tool</td>
<td>1</td>
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</tr>
</tbody>
</table>

Total 5 2 2 1 7 1 2 2 6 28

LCP  ECP  PW  LHW  MHW

Fig. 2-19. Thumbnail end scrapers with millimeter scale
unimportant during the LHW phase, or perhaps the activity they represent was done outside the sampled area.

Groundstone is found throughout the fill of both rockshelters, but in low quantities. Material types include sandstone, gneiss, dolomite, and quartzite. In addition to the 12 identified lower and upper grinding stones, both rockshelters have bedrock grinding slicks on the large sandstone boulders within the overhangs. A well-formed pestle was discovered within the ECP deposits and may relate to the cupule development of the adjacent boulder in Ngabaa Rockshelter. Five grooved abraders (e.g., Figure 2-20) were discovered within Impala Rockshelter’s fill and were undoubtedly used to smooth bead margins during manufacture, particularly given that the width of the abrading grooves fits the range of diameters (4 to 7 mm) of the finished beads on site. Two relatively small palettes of dolomite and an unidentified material were also recovered, and perhaps used to process the abundant ochre (both limonite and hematite) discovered throughout the deposits. One palette found in the PW deposits is charcoal-stained, but this might be due to the abundant charcoal within the buried sediments and need not be an indicator of use. The other was discovered deep within the LHW deposits and is stained yellow, possibly due to limonite processing. The presence of various types of ochre and the palettes suggests painting activities. There are traces of black, red, orange, yellow, and bluish-white pictographs and paint over petroglyphs on the walls of both rockshelters.

Twelve expedient gravers were noted. These are clustered within charcoal ash and artifact concentrations of features 4 and 13 in the LHW deposits of Impala.
Rockshelter, and within Ngabaa Rockshelter’s LCP phase. This clustering suggests specific processing tasks were performed with these tools, specifically OES bead manufacture given that OES bead preforms are found in the same features. Graver spur diameter varies from 0.5 to 3.5 mm (tapered), with lengths up to 6 mm, but “necking” is common at 1.5 mm from the tip. The opening diameter of the bifacially beveled holes drilled from each face of the OES beads and preforms is between 1.1 and 2.7 mm in diameter. Bead and fragment thicknesses are generally 1.5 mm, but range from 0.8 to 1.9 mm. These data therefore support that the gravers were used to drill holes into OES beads.

![Graved abrader (photo by T. Wriston)](image)

**Fig. 2-20. Grooved abrader (photo by T. Wriston)**

**Faunal**

Fig. 2-21 shows the production stages (Kandel & Conard 2005) represented by 92 ostrich eggshell pieces analyzed from Impala and Ngabaa Rockshelters that include small angular fragments, bead preforms, and finished beads. Bead manufacture occurred at
both Ngabaa and Impala Rockshelters throughout time, as evidenced by gravers and grooved abraders in addition to the OES debris, but with much greater intensity during the Middle to Late Holocene Wilton than later, judging by the number of OES fragments.

Fig. 2-21. Ostrich eggshell beads and production debris split into temporal categories; production stages follow those defined in Kandel & Conard 2005 (0 – indeterminate, 1 – angular blank, 2 – rounded blank, 4 – broken, partially drilled blank, 5 – perforated blank, 6 – broken, perforated blank, 7 – perforated, slightly formed bead, 9 – perforated, almost complete bead, 11 – complete finished bead, 12 – broken finished bead)

There are 35 measurable beads within the sample that range in size from 4.0 to 7.0 mm, with an average diameter of 5.3 mm. Unlike results from other researchers (e.g. Sampson 1974; Jacobson 1987), our data do not show an increase in diameter from before agropastoralist contact to afterwards; rather, the diameters consistently average between 5.0 and 5.5 mm (Figure 2-22).

Modified bone (Table 2-11) is most often medium-to-large long bone splinters with subsequent grinding, shaping, notching, or polish (Figure 2-23). One specimen is a
bone bead preform, and one specimen has incised decoration (Figure 2-24). One ivory fragment was likely used as a blade core, but is very weathered. Of interest, bone tools increase in near surface contexts just as lithic production wanes. Although this could partly be a factor of better preservation later in time, bone points and debris were also discovered in the MHW phase deposits, suggesting that instead an increased use of bone points and poisons for hunting may be the explanation (cf. Bousman 2005).

Animals in the area of Bumbusi Ridge and the Deka River today include: Guinea fowl and numerous other bird taxa, monitor lizard, crocodile, various small lizards, fish, tortoise, terrapin, porcupine, various small rodents such as mice, scrub hare, mongoose, antbear, rock hyrax, klipspringer, steenbuck, duiker, reedbuck, impala, zebra, kudu, waterbuck, buffalo, elephant, wild cat, leopard, lion, spotted hyena, African wild dog, vervet monkey, and baboon. A detailed faunal analysis has not yet been completed and it
is unknown whether or not domestic bovids are present in the assemblage, but they were present in the early historic period before the creation of the National Park (Davison 1996).

<table>
<thead>
<tr>
<th>Unit</th>
<th>Type</th>
<th>Level</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>awl</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td>bone point</td>
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<tr>
<td></td>
<td>incised bone</td>
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<td></td>
<td>modified bone</td>
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<td></td>
<td>notched bone</td>
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<td>1</td>
</tr>
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<td></td>
<td>scratched tortoise shell</td>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>tapered flat-tipped needle</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td>bead preform fragment</td>
<td>1 1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>bone point fragment</td>
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<td>1</td>
</tr>
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<td></td>
<td>bone tool</td>
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<td></td>
<td>modified ivory</td>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>bone point manufacture debris</td>
<td>1 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>14 1 7 6 3 2 4</td>
<td>37</td>
</tr>
</tbody>
</table>

Many of the extant species are present in the archaeological assemblage; however, most bones are mere fragments and were classified only to general size categories (Figure 2-25). Although our preliminary analysis concentrated on basic cataloging of size and determining whether or not a bone was identifiable, a total of 1,791 bones were given general classifications during our initial analysis that are outlined by temporal category in
Table 2-12. No raptor nests or animal dens exist within the overhangs of Impala and Ngabaa Rockshelters, although an unidentified medium sized owl was noted more than once flying near Impala Rockshelter. Carnivores may have visited the rockshelters and deposited some smaller fragmented bones in scat, but we suggest the majority of the bones reflect cultural activity and dietary choices of past human residents, particularly since the bulk of the rockshelter fill is anthropogenic.

Fig. 2-23. Modified bone sample

As shown in Figure 2-25, small (e.g., rock hyrax, klipspringer) and very small (e.g., mouse, lizard, fish) animal remains are most abundant. Medium-size animal (e.g., impala) bones are rarely present in the earliest MHW phase, but reach their greatest numbers during the following LHW phase. Medium animal bones comprise nearly half of the faunal remains during the PW and persist as a relatively minor contribution to the overall diet during the ECP and LCP phases. Large animals (e.g., zebra, large antelope) are again best represented during the LHW phase, with only minor contributions during
the ECP and LCP. No very large animals, such as elephant or giraffe, were discovered in any of the rockshelter fill, except for the fragment of possible elephant ivory mentioned above.

The diversity of faunal debris present suggests a generalized hunting strategy that includes a variety of animals with different hunting return rates and risk. Very small to small animals are plentiful and easy to trap, providing a reliable food source year round. However, the greater presence of medium to large animals during the LHW and PW suggests increased emphasis on hunting to supplement the more reliable small, trapped game.

Many of the bones (n=921) show evidence of burning (Tables 2-12 & 2-13), and some have evidence of digestion (acid etched and/or worn breaks, which may also indicate cooking in a pot), butchery (cut marks), and gnawing. The abundant amount of
Fig. 2.25. Faunal Remains by size and temporal categories

Table 2.12. Preliminary faunal identifications, elements, and modification by temporal category

<table>
<thead>
<tr>
<th>Temporal Category</th>
<th>Faunal ID</th>
<th>Number</th>
<th>Element(s) present</th>
<th>Modification(s) Present</th>
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</thead>
<tbody>
<tr>
<td>LCP</td>
<td>tortoise</td>
<td>112</td>
<td>shell</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>fish</td>
<td>1</td>
<td>operculum (gill cover)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>zebra</td>
<td>21</td>
<td>Indeterminate longbones</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>small bovid</td>
<td>14</td>
<td>humerus, metapodial, Indeterminate longbones</td>
<td></td>
</tr>
<tr>
<td></td>
<td>medium bovid</td>
<td>34</td>
<td>Indeterminate longbones</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>rodent</td>
<td>32</td>
<td>skull frags, Indeterminate longbones</td>
<td>burnt</td>
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<tr>
<td>ECP</td>
<td>tortoise/terrapin</td>
<td>21</td>
<td>shell</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>fish</td>
<td>15</td>
<td>vertebrae, opercula (gill covers)</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>zebra</td>
<td>1</td>
<td>tooth</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>small bovid</td>
<td>22</td>
<td>Indeterminate longbones, tarsals, teeth</td>
<td>burnt</td>
</tr>
<tr>
<td></td>
<td>medium bovid</td>
<td>29</td>
<td>teeth, Indeterminate longbones, metapodial,</td>
<td>cut, burnt</td>
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<td>rock hyrax</td>
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<td>burnt, gnawed</td>
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<td>rodent</td>
<td>4</td>
<td>mandible, Indeterminate longbones</td>
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<td>Condition</td>
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<td>-----------</td>
<td>-------------------------------------------------------</td>
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<td>Monitor lizard</td>
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<td>hemi-mandible</td>
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<td>PW</td>
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<tr>
<td>Tortoise</td>
<td>46</td>
<td>shell, ribs, vertebrae, Indeterminate longbones</td>
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<td>Small bovid</td>
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<td>tooth, phalanx</td>
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<tr>
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<td>82</td>
<td>Indeterminate longbones, tarsal, metapodial,</td>
<td>burnt, gnawed w/punctures</td>
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<td>Rodent</td>
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<td>burnt</td>
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<td>Tortoise/terrapin</td>
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<td>Fish</td>
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<td>burnt</td>
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<td>teeth</td>
<td>burnt</td>
<td></td>
</tr>
<tr>
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<td>130</td>
<td>Indeterminate longbones, ribs, epiphysis, metapodial,</td>
<td>burnt, 1 acid-etched</td>
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</tr>
<tr>
<td>Large bovid</td>
<td>72</td>
<td>vertebrae, phalanx, ilium, ischium, skull frags.</td>
<td>burnt, gnawed</td>
<td></td>
</tr>
<tr>
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<td>burnt</td>
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</tr>
<tr>
<td>Rodent</td>
<td>325</td>
<td>Indeterminate longbones, scapula, vertebrae, ribs</td>
<td>burnt</td>
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<td>Bird</td>
<td>17</td>
<td>furcula, vertebrae, ribs, long bones</td>
<td>burnt</td>
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</tr>
<tr>
<td>MHW</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tortoise</td>
<td>61</td>
<td>shell, Indeterminate longbones, epiphysis, teeth</td>
<td>burnt</td>
<td></td>
</tr>
<tr>
<td>Lizard</td>
<td>25</td>
<td>Indeterminate longbones, ribs, flat bones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium bovid</td>
<td>14</td>
<td>Indeterminate longbones, ribs, flat bones, tooth</td>
<td>burnt</td>
<td></td>
</tr>
<tr>
<td>Rock hyrax</td>
<td>35</td>
<td>Indeterminate longbones, flat bones, teeth</td>
<td>burnt, gnawed w/punctures</td>
<td></td>
</tr>
<tr>
<td>Rodent</td>
<td>28</td>
<td>Indeterminate longbones, ribs, flat bones</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

calcined bone exposed to wood fires exceeding 400 degrees Celsius (Brain 1981) provides proof of cultural modification rather than secondary effects from natural fires.

Of the 99 specimens that are acid etched, most have slightly rounded corners and many are also burnt. These modifications indicate their association with human activity, either directly or indirectly (such as the actions of domestic dogs). Surprisingly only four
cutmarked bones were identified, one small bovid metapodial and three medium-sized bovid longbones. Gnaw marks are most often those of small rodents such as mice, but carnivore punctures are present on eight bones, generally on the articular ends and most of which show signs of burning. This suggests the presence of domestic dogs and argues against deposition by denning carnivores.

Seasonality is difficult to determine until we have detailed faunal and floral identifications, but the presence of the epiphyses of subadult impala indicates fall-to-winter dry season use during the PW since impala are generally lambed in December (Smithers 2000). In addition, the presence of zebra (a grassland species) in this mixed woodland environment also hints at winter use during the ECP and LCP, when zebra move towards reliable water such as local springs and Deka River pools. Lastly, the presence of fish and possible terrapin also suggests fall-to-winter occupation during the ECP and LHW. As the rivers begin to dwindle, fish are stranded in isolated pools where they are easily caught (Interviews with local guides and Park personnel, personal communication, 2010). Fish remains are much more abundant in the LHW deposits than any other time, but they are also found in low numbers of the ECP deposits along with a single specimen from the LCP. Bird remains were only identified from the LHW.

Despite some faunal indications that suggest fall-to-winter dry season use of the Bumbusi Ridge rockshelters, many of the animals represented in the faunal assemblage are available year round, such as lizards, mice, rock hyrax, klipspringer, Guinea fowl, impala, kudu, reedbuck, and possibly buffalo. Therefore, occupation of the area during the summer rainy season would be possible. The many rockshelters of Bumbusi Ridge
Table 2-13. Number of bones modified by size and temporal category

<table>
<thead>
<tr>
<th>Temporal Category</th>
<th>Size Class</th>
<th>Burnt</th>
<th>Acid Etched</th>
<th>Worn breaks</th>
<th>Cut Marks</th>
<th>Gnaw Marks</th>
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<td>VS</td>
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<td>15</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>S</td>
<td>148</td>
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<td>18</td>
<td>-</td>
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</tr>
<tr>
<td></td>
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<td>1</td>
<td>-</td>
<td>2</td>
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<tr>
<td></td>
<td>L</td>
<td>18</td>
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</tr>
<tr>
<td>ECP</td>
<td>VS</td>
<td>3</td>
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<tr>
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<td>S</td>
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<tr>
<td></td>
<td>M</td>
<td>23</td>
<td>3</td>
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<td>7</td>
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<td>-</td>
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<tr>
<td>PW</td>
<td>VS</td>
<td>2</td>
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<tr>
<td></td>
<td>S</td>
<td>44</td>
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<td>M</td>
<td>51</td>
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<td>L</td>
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<td>-</td>
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<tr>
<td>LHW</td>
<td>VS</td>
<td>163</td>
<td>-</td>
<td>-</td>
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<td></td>
<td>S</td>
<td>214</td>
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<td>5</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M</td>
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<td>6</td>
<td>-</td>
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<td>-</td>
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<tr>
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<td>VS</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>55</td>
<td>18</td>
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</tr>
<tr>
<td></td>
<td>M</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>L</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

would provide reliable protection from summer rains and the ridge’s sandy substrate is well-drained.
Other faunal material (Table 2-14) include several types of gastropod shell, landsnail, and freshwater mussel. Freshwater mussel and gastropods are available along the Deka River downslope and point to foraging along the waterways. Conversely, landsnails are naturally occurring within the rockshelters and may either be intrusive or remains of foodstuffs. Landsnail shell modification is evident in several examples, including one that is ochre-stained and probably used as a palette. Eggshell may also be either naturally occurring or food debris, and is separated from ostrich eggshell based on relative thickness. All of the ostrich eggshell is presumably of cultural origin due to association with other artifacts and habitation debris, and more regular modified pieces are discussed in the previous bead section. The shells may be the remnants of water carriers or bead manufacture.

Floral
Numerous nutshells and seeds were discovered during the Bumbusi Ridge excavations from minimally three different species. Charred mongongo nutshells (*Schinziophyton rautanenii*) are most prevalent, and several concentrations of these were noted amongst the charcoal ash features. Unfortunately, mongongo nuts do not inform as to season of use since they store well over long periods of time and are a year round staple (Lee 1979). Mongongo trees grow on Kalahari sand sediments, and the nearest trees today are about 30 km distant, which may have been the case in prehistory. Nuts may be eaten by elephants and deposited in dung, but it is very unlikely the densities excavated in the rockshelters came from elephant dung. Other nutshells include cf. *Acacia*, and *Commiphora* sp. (possibly the poison grub tree *Commiphora africana*),
Table 2-14. Various shell and floral types from Bumbusi Ridge with colors indicating temporal category

<table>
<thead>
<tr>
<th>Unit</th>
<th>Type</th>
<th>Level</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>N4E2</td>
<td>Eggshell</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Nutshell</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>OES</td>
<td>1</td>
<td>5</td>
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<tr>
<td></td>
<td>shell</td>
<td>75</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>wood</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>S5W1</td>
<td>eggshell</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nut</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>nutshell</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>OES</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>shell</td>
<td>29</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>wood</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Total   |       | 107   | 66    | 124   | 61    | 6     | 219   | 78    | 72    | 56    | 45    | 45    | 4     | 50    | 2     | 12    | 947   |

and possibly *Rhus* sp. The ECP phase is the only period in which nuts or seeds and nutshells are not present. In addition to the food (and poison?) debris, numerous wood species are represented by charcoal, sticks, and some tool fragments. One of these tools pictured in Figure 2-26 may have had several uses, including a needle, drill base, and/or fire starter. This interesting tool is from the LCP phase and of relatively recent age. The majority of other floral material is in a poor state of preservation unless charred.

*Ceramics*

Impala and Ngabaa Rockshelters contain thinwares that are often graphite burnished. These are likely of Late Iron Age origin, but one example from Bumbusi Ridge found in
Combstamp Rockshelter has oblique, poorly executed beadstamping below the flared lip which is bordered by a single channel on the neck (Figure 2-27). The specimen measures 11.5 mm thick, and although it does not resemble the wares documented at Kapula Vlei, it does hint that EIA peoples were present in the area, even if the artifact was a curio or trade item carried there by hunter-gatherers from a nearby EIA settlement. Another unusual sherd found on the surface of Impala Rockshelter has applied lugs with punctate decoration (Figure 2-27).

An opaque blue glass bead was discovered in the uppermost level of Ngabaa Rockshelter, within the LCP phase deposit. The presence of this trade bead further
substantiates the influence of Iron Age peoples on Bumbusi Ridge during this time period.

**Kapula Vlei**

Kapula Vlei’s Early Iron Age village site, first recorded by Robinson (1966), was re-discovered during geomorphological reconnaissance of the drainage cut. Locus 1 (Figure 2-28) was first encountered with nearly complete combstamped and channel ware jars eroding out of the profile beneath daga-lined house floors or storage pits. Various animal bones and teeth were also noted and could be either wild impala and buffalo, or domesticated sheep/goat and cattle. DNA analysis is planned for the cattle-size tooth extracted from 100 cmbs in Locus 1 and radiocarbon assayed to 1119 cal yrs BP (Table 2-15). Further examination of the drainage cut revealed 12 loci of concentrated ceramics and daga scattered along the margins of a 120 m long section of Kapula Vlei. These concentrations are presumably the remnants of Early Iron Age houses and storage pits, based on the ceramic types exposed. In fact, an auger test into one of the alluvial terraces also pulled up EIA ceramic fragments, so subsurface archaeological remains are undoubtedly extensive within this terrace.

Locus 4 (Figure 2-29) is only 35 m upstream from the pictured Locus 1 (Figure 2-28); however, a radiocarbon assay obtained from charcoal between two purposively stacked ceramic pots and another directly on a piece of organic tempered ceramic were much older than the Locus 1 tooth, dating to 1652 cal yrs BP and 1892 cal yrs BP respectively (Table 2-15). The differences in age imply that the site has been occupied
Fig. 2-28. Kapula Vlei Locus 1 upon discovery; trowel at base for scale (photo by T. Wriston)

Table 2-15. Kapula Vlei radiocarbon assays

<table>
<thead>
<tr>
<th>Site</th>
<th>Locus</th>
<th>Provenience</th>
<th>Material</th>
<th>Lab Number</th>
<th>Conventional Age</th>
<th>Calibrated Age*</th>
<th>Mean Calibrated Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapula Vlei</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locus 4</td>
<td>85-87 cmbs</td>
<td>Potsherd</td>
<td>Beta-275280</td>
<td>1990 +/- 40 BP</td>
<td>1926 to 1858 cal yrs BP</td>
<td>1892 cal yrs BP</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cal AD 24 to 92</td>
</tr>
<tr>
<td>Locus 4</td>
<td>85-87 cmbs</td>
<td>Charred Wood</td>
<td>AA95089</td>
<td>1790 +/- 37 BP</td>
<td>1701 to 1603 cal yrs BP</td>
<td>1652 cal yrs BP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cal AD 249 to 347</td>
</tr>
<tr>
<td>Locus 1</td>
<td>100 cmbs</td>
<td>Tooth</td>
<td>AA95094</td>
<td>1253 +/- 43 BP</td>
<td>1176 to 1061 cal yrs BP</td>
<td>1119 cal yrs BP</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cal AD 774 to 889</td>
</tr>
</tbody>
</table>

*1-sigma calibration (68.3%) with greatest relative area under probability distribution reported as cal yrs BP range; Calibrated using Calib 6.0 SHCal04 (McCormac et al. 2004; Stuiver et al. 2013, Stuiver & Reimer 1993)
repeatedly at different times. Luminescence dating of three ceramic sherds is underway to provide additional chronological control for this important EIA site.

The differences between Locus 1 and Locus 4 extend beyond having different ages. There are also some differences in ceramic style motifs, although both have combstamped and channeled wares. In general, Locus 1 wares are of simpler design (Figure 2-30) while Locus 4 has some pots with wavy meanders and stacked motifs (Figure 2-30). In addition, a small copper bangle remnant (Figure 2-31) was discovered in the Locus 4 cutbank. It was manufactured by tightly coiling a flattened copper wire.

Careful examination of the drainage cut revealed strong evidence of Early Iron Age settlement(s), but no lithic debris characteristic of hunter-gatherer occupations. We did not screen samples for the tiny microliths prevalent in the Bumbusi Ridge excavations, but we did examine the bank closely. Preliminary investigations suggest little to no interaction with hunter-gatherers here, or at least none of their material culture is evident. However, we know that occupation of Ngabaa Rockshelter during the ECP would have overlapped with the initial occupation of Kapula Vlei based on our radiocarbon assays.

Sediments within Kapula Vlei are ideal for early dry season farming, with dark, organic-rich clay loam (Figure 2-29) that would slowly release water to crops planted in it. The upper portion of the profile was repeatedly tilled over multiple generations, introducing abundant organic material that gives it a much darker color than other areas in the drainage. This well-developed, naturally flat alluvial terrace was likely a village
and/or field used repeatedly throughout the Early Iron Age. The terrace is now abandoned as the drainage continues to downcut, a process reportedly already underway in the 1960s when local water diversion activity, dam building, and groundwater pumping began in earnest.

![Fig. 2-29. Kapula River Locus 4 stratigraphic profile](image)

A brief foot survey further down the Kapula Vlei, and into the Lukosi River drainage, revealed additional Iron Age sites, with many Late Iron Age ceramic types downslope of the Kapula Vlei and Lukosi River confluence. Local people have suggested that a village site existed near here in 1928 when its inhabitants were forcibly removed during the creation of the National Park’s predecessor Game Reserve, which implies that the area may have been occupied by farmers, and perhaps pastoralists, for many generations before the colonial period.

At the Kapula Vlei site, thickwares dominate, particularly in the site proper, with body wall thickness averaging between 10 and 12 mm. In the drainage bottom, ceramic sherds are more variable, and down river into the Lukosi Drainage system, Late Iron Age ceramics vary from thick to thin, but still average around 9.2 mm body thickness.
The Early Iron Age Kapula Vlei ceramics are twice as thick as Bumbusi Ridge’s Late Contact Period burnished ceramic sherds (with the one exception from Combstamp Rockshelter). In fact, burnished ceramics average half of the thickness of most
combstamped wares no matter where they are found (Figure 2-32). Channeled and stamped motifs, which are the most common, tend to average over 10 mm thick. Plain wares are undiagnostic and have the greatest range of thicknesses.

![Graph showing average and range of wall thickness by ceramic type.](image)

**Fig. 2-32. Ceramic decoration types by average and range of wall thickness**

The earliest ceramics of Kapula Vlei, a settled village site dating to between 1892 cal yrs BP to 1119 cal yrs BP, are thickwares, unlike the contemporaneous ceramics of mobile pastoralists from south and west of our study area, which tend to be thin-walled (Sadr 2008). This may indicate that early agropastoralists in northwestern Zimbabwe had stronger ties to the north and east than to the pastoral foragers found westward.
DISCUSSION and CONCLUSION

Although early radiocarbon assays from Kapula Vlei (EIA; 1892 cal yrs BP, 1652 cal yrs BP, and 1119 cal yrs BP) and late Bumbusi Ridge assays (ECP; 1849 cal yrs BP, 1764 cal yrs BP, and 1431 cal yrs BP) overlap, suggesting that both sites were occupied at the same time, culturally we only see one stamped sherd to indicate possible direct contact between the two occupations, which are separated by less than 30 km. However, by the Late Contact Period regular interaction is evident. During the Late Iron Age walled structures were built at Bumbusi National Monument and people’s use of Bumbusi Ridge culminates in the construction of house platforms atop the ridge that are likely contemporary with construction of Bumbusi Ruins downslope. All evidence of hunter-gatherer activity is limited to the bioturbated near-surface deposits during this time. The deep anthropogenic deposits characteristic of their ancestors were no longer accumulating, suggesting a dramatic change in site use between the Late Holocene Wilton and Late Contact Period. This change from large aggregation sites in big rockshelters to small family units or task groups occupying small, discrete rockshelters began as site visitation and population numbers dropped during and after the Post-Wilton phase 3000 to 1849 cal yrs BP.

The questions remain as to whether these changes resulted from incoming agropastoralists that decimated the local hunter-gatherer populations, either directly, through competition for resources, or via a disease front, or whether the hunter-gatherers themselves adopted agropastoralism. Alternatively, these changes could be unrelated.

Bumbusi Ridge and Kapula Vlei occupy very different positions on the landscape. Bumbusi is a sandy, well-drained ridge with many rock outcrops and overhangs suitable
for spotting game and taking refuge from inclement weather. The Deka River and Bumbusi Springs are less than 3 km downslope and usually provide water year round. Therefore, Bumbusi Ridge is an optimal home base for task specific hunting-and-gathering activities that most likely exploited all of the various microenvironments along the waterways where medium to large game would congregate and be easier to hunt, particularly during the dry season. In addition, fish, terrapin, mussel, and gastropods could be collected. Various plant resources, along with tortoise and guinea fowl, are available within the mixed woodland, and on the top of the ridge where small game such as rock hyrax and lizards could also be easily trapped. Conversely, largely because of the sandy soils on the ridge and its slopes, agriculture was not likely practiced until after the more arable lands were claimed and/or population pressure forced expansion into less desirable and/or more defensible areas. If people were practicing agriculture at Bumbusi, they would have had to hunt and gather wild foods to meet a growing population’s nutritional requirements (cf. Martin 1996). The ridge is better suited for pastoralism than agriculture, but no evidence of kraals was discovered.

In contrast, Kapula Vlei is near the headwaters of a small tributary drainage of the Lukosi River. Well-developed alluvial terraces testify to previous annual flooding here despite the recent downcutting into these old floodplains. During wetter climatic conditions, the flat alluvial terraces may have been ideal for early dry season crops with their clay loams that slowly release moisture to well-adapted crops such as sorghum, cowpeas, groundnuts, and pearl millet (cf. Scudder 1976).

Although no evidence of kraals was discovered at Kapula Vlei, several ovicaprine-size and cattle-size teeth were noted and preliminarily identified as those from
impala and buffalo. DNA testing underway should differentiate whether these teeth are domestic or wild taxa. At a similar site in eastern Zimbabwe, Pwiti (1996) uncovered an early farming village with wild animal food residue where buffalo hunting was of great importance (Plug 1997). Given that the study area is on the environmental cusp of tsetse fly habitat, changing environmental conditions may be reflected in the archaeological record via the presence or absence of domestic animals. The apparent absence of kraals suggests that the area may have been wet enough for *nagana* to persist at levels domestic animals could not survive. However, such wetter conditions would allow more successful dryland farming.

Despite close scrutiny, no evidence of prior (or concurrent) use of the Kapula Vlei site by hunter-gatherers (signified by microliths) was discovered and we suggest that because different parts of the landscape were preferred by each group, little conflict would have occurred during the earliest stages of agriculture in northwestern Zimbabwe. In fact, hunter-gatherer populations, or at least their preference for use of Bumbusi Ridge, had significantly declined during the Post-Wilton phase beginning shortly after ca. 3000 cal yrs BP. So, although it is easy to correlate a decline in hunter-gatherer occupation intensity with the arrival or adoption of agropastoralism, this shift seems to have begun hundreds of years before the earliest evidence of agropastoralism in the region.

The absence of microlithic debris at the Early Iron Age Kapula Vlei site also seems to suggest that indigenous hunter-gatherers here did not become agropastoralists and that, rather, newcomers brought ceramics and domestic crops, and possibly livestock, with them—at least during the earliest Iron Age.
Hunter-gatherer assemblage characteristics changed throughout the mid-to-late Holocene (Table 2-16). During the Middle Holocene Wilton, a broad, generalized strategy is indicated by the greatest variety of tool types throughout all phases. Small and very small animals that were likely trapped made up the bulk of the faunal debris, but medium-sized hunted animals are also represented. Backed crescents are common, but so are scrapers, and bone points and debris are present (Figure 2-33). This suggests multiple tasks (leather- and wood-working) and hunting strategies (crescents or bone points/linkshafts in composite tools) being employed by the people who lived here. The only double backed blades (n=3) were also recovered from these deposits, as were numerous ostrich eggshell beads and manufacturing debris, perhaps an indicator of social adaptations to environmental stressors, such as hxaro trade and networking. During this initial phase of Impala Rockshelter occupation, aggregation of large groups of people (Wadley 1987) is likely judging by their use of a large rockshelter and significant anthropogenic sediment accumulation rates (cf. Jerardino 1996) and artifact and ecofact densities. However, only a few medium-sized animal bones were recovered, which is out of sync with the abundant backed crescents typical of hunting assemblages. This may signal that medium to large game animals were in short supply and difficult to procure, that the use of poisons was not yet practiced by these peoples, or that the backed crescents were manufactured mostly as trade items along with the ostrich eggshell beads.

Use of Impala Rockshelter as an aggregation site intensified into the Late Holocene Wilton, arguably the climax of occupation here with the greatest anthropogenic sediment accumulation, highest artifact and ecofact densities, greater amounts of beads and manufacturing debris, and increased importance of hunting signified by a large
increase in backed crescents (Deacon 1974; Wadley 2000), the presence of a bone point and debris, as well as increased numbers of medium and large sized faunal material. Given the emphasis on hunting-related artifacts in the artifact assemblage, it is likely that the animal spoor engravings, which are often accurate enough to serve as aides in teaching animal tracking, but also frequently stylized or abstract (Haynes et al. 2011), were of great importance during this time. We know that at least some of this rock art was produced before 2450 cal yrs BP due to our date of a charcoal ash lens from above the rockfall layer that contains animal spoor carvings. It is even more likely that the earliest rock art was engraved before 3114 cal yrs BP, which is the age of a mongongo nutshell immediately underneath the rockfall layer. Therefore creation of the animal spoor rock art during the Late Holocene Wilton is well supported.

The Late Holocene Wilton emphasis on hunting, traditionally thought to be a male activity, is accompanied by an increase in bead manufacture, traditionally thought to be a female activity. This suggests use of the rockshelters by family groups rather than gender-segregated task parties. Presumably, any ritual activity surrounding the creation of the rock art may also have included the entire community. In fact, when all of the data are considered, the inhabitants of Bumbusi Ridge had greater diet breadth during the LHW than any other time. They not only hunted but continued to trap, fish, and collect animal foods such as tortoise, eggs, birds, and lizards; they also ate nuts and seeds, and undoubtedly had a staple diet with a diversity of plant foods not well represented in the archaeological record outside of a few ground stones.
### Table 2.16. Summary of cultural materials and inferred activities and subsistence patterns for each temporal component within the study area

<table>
<thead>
<tr>
<th>Temporal Component</th>
<th>Late Contact Period (&lt;ca. 800 cal yrs BP)</th>
<th>Early Iron Age (1900-1000 cal yrs BP)</th>
<th>Early Contact Period (ca. 1850-800 cal yrs BP)</th>
<th>Post Wilton (3000-1850 cal yrs BP)</th>
<th>Late Holocene Wilton (4000-3000 cal yrs BP)</th>
<th>Middle Holocene Wilton (6000-4000 cal yrs BP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>Ngabaa rockshelter</td>
<td>Kapula Vlei field on alluvial terrace</td>
<td>Ngabaa rockshelter</td>
<td>Impala rockshelter</td>
<td>Impala rockshelter</td>
<td>Impala rockshelter</td>
</tr>
<tr>
<td>Landform Features</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>small shelter; rock art; bedrock</td>
<td>small shelter; rock art; bedrock</td>
<td>Impala rockshelter</td>
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</tr>
<tr>
<td></td>
<td>cupules &amp; grinding slicks</td>
<td>cupules &amp; grinding slicks</td>
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<tr>
<td>Component Features</td>
<td>charcoal-ash horizons; charred</td>
<td>charcoal-ash horizons</td>
<td>charcoal-ash horizons</td>
<td>rockfall layer w/engravings;</td>
<td>none preserved due to termite</td>
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</tr>
<tr>
<td></td>
<td>seed/nut concentration at lower contact</td>
<td></td>
<td></td>
<td>charcoal-ash horizons; artifact &amp; bone concentrations; charred nut/seed concentration; fetal burial</td>
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<tr>
<td>Artifact &amp; Ecofact</td>
<td>high</td>
<td>very high</td>
<td>low</td>
<td>low</td>
<td>very high</td>
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<td>Density</td>
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<tr>
<td>Inferred Population</td>
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<td>5 to 20</td>
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<td>Duration of Stay</td>
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<td>seasonal to year round</td>
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<td>Frequency of</td>
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<td>Visitation</td>
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<td></td>
</tr>
<tr>
<td>Key Artifacts</td>
<td>many bone points/tools; single</td>
<td>abundant and varied</td>
<td>many backed crescents; many thumb nail</td>
<td>many backed crescents; few</td>
<td>double backed blades; abundant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>backed crescent &amp; less bladelet</td>
<td>combstamped &amp; channeled</td>
<td>scrapers; many thumb nail scrapers; OES</td>
<td>scrapers; little OES</td>
<td>backed crescents; single bone point;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>production debris; many thumbnail</td>
<td>thick wares; copper</td>
<td>production debris; vertebrate</td>
<td>debris; grooved abraders; upper</td>
<td>several types of scrapers; abundant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>scrapers; OES bead production</td>
<td>bangle; house daga; medium</td>
<td>&amp; large animal bones</td>
<td>&amp; lower grinding stones; palette</td>
<td>OES debris; upper &amp; lower grinding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>debris &amp; gravers; grinding stones;</td>
<td>to large animal bones</td>
<td></td>
<td></td>
<td>stones; palette</td>
<td></td>
</tr>
<tr>
<td></td>
<td>burnished ceramics; glass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bead</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faunal Material</td>
<td>mostly small fauna, some large (zebra)</td>
<td>impala to buffalo size long bones,</td>
<td>mostly small, some medium and large</td>
<td>few bones, but majority are</td>
<td>majority are small &amp; very small</td>
<td>small to very small with a few medium</td>
</tr>
<tr>
<td></td>
<td>and medium size animals; tortoise,</td>
<td>mandible, teeth</td>
<td>(zebra) animals; tortoise/terrapin, fish,</td>
<td>medium-size and small-size</td>
<td>animals; many medium and large</td>
<td>bovid bones; tortoise, rock hyrax, rodent</td>
</tr>
<tr>
<td></td>
<td>fish, rodent</td>
<td></td>
<td>rock hyrax, rodent</td>
<td>animals; tortoise/terrapin,</td>
<td>size animals; tortoise/terrapin, fish,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fish, rock hyrax, rodent, lizard</td>
<td>lizard, rock hyrax, rodent</td>
<td></td>
</tr>
<tr>
<td>Inferred Activities</td>
<td>hunting medium to large game w/</td>
<td>farming, wild game hunting and</td>
<td>trapping, hunting, fishing, collecting,</td>
<td>emphasis on hunting medium</td>
<td>emphasis on hunting medium to large</td>
<td>trapping and collecting very small to</td>
</tr>
<tr>
<td></td>
<td>poison bone points; trapping;</td>
<td>gathering</td>
<td>and gathering</td>
<td>sized game; trapping; collecting</td>
<td>sized game; emphasis on trapping and</td>
<td>small game; hunting scarce game; gathering;</td>
</tr>
<tr>
<td></td>
<td>collecting; limited OES bead</td>
<td></td>
<td></td>
<td>gathering; OES bead manufacture</td>
<td>collecting very small to small game;</td>
<td>frequent OES bead manufacture</td>
</tr>
<tr>
<td></td>
<td>manufacture; trade with local</td>
<td></td>
<td></td>
<td>rock art painting</td>
<td>gathering; frequent OES bead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>agropastoralists or seasonal</td>
<td></td>
<td></td>
<td></td>
<td>manufacture; animal spoor engraving,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>occupation by them</td>
<td></td>
<td></td>
<td></td>
<td>painting</td>
<td></td>
</tr>
</tbody>
</table>

Key:
- **Artifacts**
  - abundant and varied combstamped & channeled thick wares; copper bangle; house daga; medium to large animal bones
  - many backed crescents; many thumb nail scrapers; little OES production debris; vertebrate
  - many backed crescents; few scrapers; little OES debris; grooved abraders; upper & lower grinding stones; palette
  - abundant backed crescents; few bone points/debris; very few scrapers; abundant OES debris; many gravers; upper & lower grinding stones; palette
  - double backed blades; abundant backed crescents; single bone point; several types of scrapers; abundant OES debris; upper & lower grinding stones
  - small to very small with a few medium bovid bones; tortoise, rock hyrax, rodent

- **Faunal Material**
  - mostly small fauna, some large (zebra) and medium size animals; tortoise, fish, rodent
  - impala to buffalo size long bones, mandible, teeth
  - mostly small, some medium and large (zebra) animals; tortoise/terrapin, fish, rock hyrax, rodent, lizard
  - few bones, but majority are medium-size and small-size animals; tortoise, rodent
  - majority are small and very small animals; many medium and large size animals; tortoise/terrapin, fish, lizard, rock hyrax, rodent

- **Inferred Activities**
  - hunting medium to large game w/ poison bone points; trapping; collecting; limited OES bead manufacture; trade with local agropastoralists or seasonal occupation by them
  - farming, wild game hunting and gathering
  - trapping, hunting, fishing, collecting, and gathering
  - emphasis on hunting medium sized game; trapping; collecting; gathering; OES bead manufacture; rock art painting
  - emphasis on hunting medium to large sized game; emphasis on trapping and collecting very small to small game; gathering; frequent OES bead manufacture; animal spoor engraving, painting
  - trapping and collecting very small to small game; hunting scarce game; gathering; frequent OES bead manufacture
In the subsequent Post-Wilton phase, hunting remained important, as signified by the abundance of medium-sized faunal material relative to smaller animals obtained through trapping and capture; however, a dramatic shift in site use occurs during this interval with much less anthropogenic sediment accumulation, lower artifact and ecofact densities, and less bead manufacture. Although people were still occupying the large Impala Rockshelter, the site no longer appears to have been used as an aggregation site, and a shift towards use of Bumbusi Ridge by individual family units and task groups had begun.

Fig. 2-33. Number of scrapers, backed crescents, and bone points in each temporal category

By the Early Contact Period, the large Impala Rockshelter had been largely abandoned by foragers in favor of the smaller Ngabaa Shelter. Artifact and ecofact densities are low during this time, but show a continued reliance on hunting with a significant amount of backed crescents (Figure 2-33) and medium-size animals represented in the faunal assemblage. Scrapers also increase in number while ostrich eggshell bead manufacturing debris is represented in low quantities.
Within the Late Contact Period, the manufacture of backed tools seems to dwindle with only one backed crescent discovered, and although bladelet production continues, it is a lower percentage of reduction debris (18%) than anytime previous (when the numbers ranged from 22 to 28%). In fact, bone points seem to gain favor at the expense of backed crescents (Figure 2-33). Bousman (1998) has suggested that bone points are a more effective delivery method for poison. This would explain why medium and large animal remains are more plentiful in the Late Contact Period as backed crescents decline and bone point production increases. In addition, the number of thumbnail end scrapers point to the growing importance of leather-working (Deacon & Deacon 1980). Higher artifact and ecofact densities suggest increased frequency or duration of use by a few individuals (presumably large groups would have preferred a larger rockshelter). Late Iron Age burnished thinware ceramics are intermixed with the artifact assemblage, and show regular contact between hunter-gatherers and agropastoralists, or regular visitation by the latter. This contrasts with the Early Contact Period, when it appears that hunter-gatherers and agropastoralists were occupying different parts of the landscape with little substantiated contact before ca. 800 cal yrs BP.

The dated (1892 cal yrs BP, 1652 cal yrs BP, and 1119 cal yrs BP) Kapula Vlei thickware ceramics were associated with house floors and storage and/or trash pits exposed in the river cut of a flat alluvial terrace characteristic of settled village life. This differs from the earliest ceramic-bearing sites to the west and south that contain thinwares (Sadr 2008) associated with mobile pastoralists and that date to between c.2500 and 2000 BP in age (cf. Smith 1992 & 2000; Smith et al. 1995; Robbins et al. 2005 & 2008; Walker 1983 & 1985). Therefore, Hwange National Park may contain one of the oldest
Early Farming Communities yet known in south-central Africa, making its future detailed study critical to our understanding of the expansion of agropastoralism that forever changed the dynamic between people and their environments.

Through excavation of two rockshelters, salvage excavation at the earliest farming village so far known in the region, and archaeological survey, we have shown that within our study area, the earliest farmers were likely migrants that brought cereals and thickware ceramics with combstamped and channeled decoration with them. Indigenous hunter-gatherer populations were greatest between 4000-3000 cal yrs BP, when large rockshelters were used as aggregation sites, but began to dwindle after ca. 3000 cal yrs BP, well before our first evidence (1892 cal yrs BP) of EIA peoples in the area. Hunter-gatherers persisted in low numbers in traditional use areas undesirable to incoming farmers looking for arable land, occupying smaller rockshelters than before. During the Late Contact Period, even these areas came to be occupied by Iron Age peoples, but both the material and historical records show that hunter-gatherers survived, continuing to hunt with poisoned bone points rather than backed crescents, and incorporating burnished ceramics and glass beads into their traditional tool kits.

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CHAPTER 3. STABLE ISOTOPE ANALYSES OF OSTRICH EGG SHELL FROM IMPALA AND NGABAA ROCKSHELTERS, HWANGE NATIONAL PARK, ZIMBABWE: IMPLICATIONS FOR SOURCING, HXARO TRADE, AND PALEOENVIRONMENTS

Teresa Wriston and Gary Haynes, University of Nevada, Reno

ABSTRACT

Stable isotope analysis is increasingly being applied by archaeologists seeking to extract as much information as possible from their excavated materials. Strontium isotope ratios ($^{87}$Sr/$^{86}$Sr) can inform about migration or trade, carbon isotope ratios ($^{13}$C/$^{12}$C) can identify the types of foods eaten, and oxygen isotope ratios ($^{18}$O/$^{16}$O) can inform about temperature and precipitation patterns. Here we apply analysis of all three of these isotopes to ostrich eggshell beads, fragments, and teeth excavated from mid-to-late Holocene age contexts of Impala and Ngabaa Rockshelters to aid in environmental reconstruction. We know that ostrich eggshell beads and water containers were used over many years and exchanged during hxaro trade, so we used strontium isotope ratios ($^{87}$Sr/$^{86}$Sr) to identify samples by geographic/lithologic source and delineate those of local, near-rockshelter origin and non-local origin. Non-local samples would confuse our interpretations of the paleoclimatic signature offered by the other isotopes and were disregarded. After limiting our paleoclimatic data to those of near-rockshelter strontium values, carbon and oxygen isotopic ratios show that conditions within our study area have fluctuated widely since the middle Holocene, but that during the Late Holocene Wilton, woodlands and relatively cool conditions persisted for a longer period than any other time.
in our record. However, droughts are also found early in the Late Holocene Wilton and Post Wilton periods. Radiocarbon assay of each ostrich eggshell sample promises to clarify the timing and extent of these conditions. In addition to being a useful delimiter for determining which samples are of local origin, we show that strontium isotope analysis has potential in sourcing ostrich eggshell, which would provide insight of social networks, trade, and population movements across southern Africa.

INTRODUCTION

The widespread use of ostrich (Struthio camelus) eggshell for water containers and bead manufacture in southern Africa is well established (Lee 1979). Ethnographic research has shown that ostrich eggshell (OES) beads, which were often manufactured by women (cf. Marshall 1976), were an important exchange item for the Khoisan speakers of southern Africa during hxaro trade that established social alliances and obligations (Marshall 1976; Mitchell 1996; Wadley 1987; Wiessner 1983). Besides signifying bead manufacture and trade, OES can also be dated by radiocarbon or amino acid racemization, and often serves as the only available dateable material for establishing temporal control for some archaeological sites (Freundlich et al. 1989; Janz et al. 2009; Miller et al. 1992; Robbins 1999; Vogel et al. 2001).

Recently, the value of OES has expanded even further as an important environmental proxy when $^{13}$C/$^{12}$C ($\delta^{13}$C) and $^{18}$O/$^{16}$O ($\delta^{18}$O) analyses are carried out to reconstruct vegetation, temperature, humidity, and precipitation patterns of sites in which shells were discovered (cf., Bousman 2005, Johnson et al. 1997; Johnson et al. 1998; Segalen & Lee-Thorp 2009; Segalen et al. 2002; van der Merwe & Vogel 1983).
Following these examples, we obtained permission to export and analyze some of the ostrich eggshell beads, preforms, and fragments that we excavated from Impala and Ngabaa Rockshelters in Hwange National Park, Zimbabwe. However, given that beads are known trade items, and that water containers could be used for several years before breaking (Lee 1979), we also added analysis of $^{87}\text{Sr}/^{86}\text{Sr}$ ($\delta^{87}\text{Sr}$) to assure that the paleoenvironmental indicators of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ were reflecting the rockshelters’ environmental conditions rather than that of a hxaro trading partner’s homeland. We know that hxaro trade items were commonly traded over 60 km from their source (Wiessner 1982, 1983), which is sufficient within our lithologically-heterogeneous project area to create variation in $^{87}\text{Sr}/^{86}\text{Sr}$ ($\delta^{87}\text{Sr}$) isotope values, particularly since ostrich territories are smaller and usually range from 5 to 24 km$^2$ (Berry & Louw 1982; Sauer & Sauer 1966).

Our results indicate that a significant portion of our OES assemblage is non-local, and furthermore, that a complex approach is required before OES can meaningfully be used to reconstruct any change in environmental conditions of an archaeological site. Although these findings suggest that re-evaluation of previous paleoenvironmental reconstructions that used only $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ may be advisable, they also prove the viability of using $\delta^{87}\text{Sr}$ as a useful tracer in the analyses of ostrich eggshell, and indicate that perhaps greater transport of these items throughout their use life should be expected.

**Strontium Isotopes and Geology**

Strontium isotope ratios of teeth and bones have been used for over a decade to determine human and animal movements over their lifetimes (Balasse & Ambrose 2002; Copeland
et al. 2011; Hodell et al. 2004, Price et al. 2002; Slovak & Paytan 2011). This is possible because bioavailable $\delta^{87}$Sr values vary based on the age and type of bedrock that water travels through and vegetation grows on before ingestion (Beard & Johnson 2000; Bentley 2006; Price et al. 2002; Ericson 1985; Vanhaeren et al. 2004). After ingestion, animal tissue reflect these values. Strontium is a heavy stable isotope and is incorporated as a calcium replacement during tissue formation without isotopic fractionation (Bentley 2006; Blum et al. 2001). Therefore local bioavailable $\delta^{87}$Sr values can be established using the strontium ratios of tooth enamel from small mammals with limited foraging distances (Bentley 2006; Price et al. 2002) because enamel permanently records the value and is resistant to diagenetic alteration.

Strontium has four naturally-occurring isotopes: $^{84}$Sr, $^{86}$Sr, $^{87}$Sr, and $^{88}$Sr. The most abundant of the three non-radiogenic isotopes is $^{88}$Sr (82.53%), followed by $^{86}$Sr (9.87%) and $^{84}$Sr (0.560%; Slovak & Paytan 2011). $^{87}$Sr (7.040%) results from radioactive decay of $^{87}$Rb, which has a half-life of 48.8 billion years (Bentley 2006; Faure and Mensing 2005). Comparing $^{87}$Sr and $^{86}$Sr provides the best analytical precision given their similar abundance ratios, a precision that is required given the long half-life of $^{87}$Rb (Beard & Johnson 2000). Analytical capability of ICP-MS analysis of $\delta^{87}$Sr commonly achieves 0.00001 to 0.00003 per mil. It follows that little variation is expected in the $\delta^{87}$Sr when bedrocks of similar age and lithology are compared. Rather, it takes tens of millions of years of difference in age before significant differences emerge. Within our project area (Fig. 3-1), these great ages are reached, with substrates ranging from mid-Precambrian (~2500 Ma) and Proterozoic (2500-542 Ma) age, to Pleistocene (2.6 Ma) and younger (Sithole 1994). If lithologies are similar, we would expect older bedrock to
have greater $^{87}\text{Sr}/^{86}\text{Sr}$ ratios than younger substrates, but lithology is also important. Different rock types have different initial ratios of Rb/Sr. For instance, basaltic lavas generally have very low Rb/Sr ratios, while sandstone, shale, and granite have very high Rb/Sr ratios (Beard & Johnson 2000).

Impala and Ngabaa Rockshelters are located on Bumbusi Ridge, which is comprised of a sandstone classified as part of the Jurassic-Triassic (251-145.5 Ma) Karoo grits, sandstones, and siltstones (t in Fig. 3-1; Sithole 1994). This formation extends to the northeast and sandwiches pockets of Late Precambrian (~1500-542 Ma) Sijarira red grits, sandstones, shales, and conglomerates (s), gneisses of various age (Gn), and Permian (299-251 Ma) glacial beds, coal measures, mudstones, and sandstones (p). Further east are variously aged Proterozoic (2500-542 Ma) intrusive granites (pG) separated by mid-Precambrian (~2500 Ma) Piriwiri and minor quartzes (w). Small sections of mid-Precambrian (~2599 Ma) Malaputese and Kahire paragneiss, other metasediments, and amphibolite (n) are also found to the east and northeast. Kalahari sand beds of Pleistocene and later age (r) extend to the south (Sithole 1994).

Within 24 km (upper limit of range diameter for most ostriches) of Impala Rockshelter, over one-half of the territory, and nearly all of the natural drainage basin, is Jurassic-Triassic Karoo basalt (Bj; Fig. 3-1). The Jurassic-Triassic Karoo (t) sandstone ridge that divides the local drainage basin where Impala Rockshelter has formed comprises around one-quarter of this territory. Another approximately one-quarter is Permian age sedimentary rocks (p), and the remainder is Late Precambrian Sijarira sedimentary rocks (s). Although animals more naturally follow drainage basins, this shows that a wide range of strontium values occur within a local ostrich nest’s eggs.
However, we can correct for this using the strontium data by including only those with values similar to near-rockshelter contexts.

Values of $\delta^{87}$Sr from the Jurassic-Triassic Karoo basalt (Bj) studied in Botswana and southern Zimbabwe range from 0.704437 to 0.708247, with one sample from northeastern Botswana that is close to our study area that measured 0.704816 (Jourdan et al. 2007). Sixteen subsurface and surface water samples in the Makgadikgadi Depression around 200 km south of our study area have $\delta^{87}$Sr isotope values ranging from 0.720310 to 0.727799, with an average of 0.722087 (Eckardt et al. 2008: 1575). Eckardt et al. (2008) explain this variability as due to the wide heterogeneity of the catchment’s sources, which include thick Kalahari sands to the north and Archaean (formerly Archaeozoic) granite outcrops and Carboniferous-Jurassic sandstone and basalts (Thomas and Shaw 1991). Unfortunately, no $\delta^{87}$Sr values have been determined on the oldest formations to the east of our study area, but we can presume that they would be high given their age and lithology.

**Ostrich Eggshell**

Eggshells are primarily made of inorganic calcite (approximately 96% CaCO$_3$) with small amounts of organic materials comprised mostly of protein (Heredia et al. 2005; Johnson et al. 1998). OES is resistant to post-depositional diagenic change (although contamination of pores is possible), and is considered to accurately reflect its original isotopic composition for at least ca. 20,000 years, if not more (Bird et al. 2003; Brooks et al. 1990; Johnson et al. 1998; Koch 1998; Miller et al. 1991, 1992; Vogel et al. 2001). Strontium is incorporated in the egg’s structure in trace amounts as a calcium replacement due to its chemical similarity (cf., Beard & Johnson 2000). Within studies
of migratory song birds, Blum et al. (2001) have shown that the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of bird eggs are indistinguishable from those of their food sources, supporting that no mass isotopic fractionation occurs as it does within the light stable isotopes (e.g., C, O, N, H). This means that no alteration occurs in the bioavailable $\delta^{87}\text{Sr}/\delta^{86}\text{Sr}$ ingested from food although various food sources may have differing values depending on their substrate and water source.
Ostriches are non-obligate drinkers (although they may drink if water is readily available; Cooper et al. 2010), so the strontium isotope values of their food dominates the isotopic signature of their shell. Milton et al. (1994) found that although ostriches favor C\textsubscript{3} photosynthetic pathway browse (e.g., shrubs and bushes), their diet usually reflects the relative abundance of vegetation in their foraging area. Ostrich range is generally 5 to 24 km\textsuperscript{2} (Berry & Louw 1982; but 84 km\textsuperscript{2} in Namib; Williams et al. 1993), but this may be constricted during laying season. Ostrich prefer open habitats with short forbs and grass cover rather than steep slopes and heavily wooded areas where their predator defenses—great visual acuity and speed—are hindered (Milton et al. 1994). Therefore, if an archaeological site is located on a steep slope in a heavily wooded area, as many rockshelters are, ostrich behavior suggests that OES discovered there are not likely from the immediate area.

Ostriches usually begin laying eggs just before, or at, the onset of the rainy season when fresh greens become available (Sauer & Sauer 1966). During peak laying season wild adult females lay an egg every other day (Jarvis et al. 1985) through several two-to-six-week long laying periods (Bertram 1992; Jarvis et al. 1985; Kennou and Bergaoui 2009), but they may not reproduce during severe droughts (Williams et al. 1993). A wild ostrich hen lays around 32 eggs per season (Jarvis et al. 1985; Sauer & Sauer 1966), distributing them in several nests shared with two to seven other hens (Cooper et al. 2010; Sauer & Sauer 1966). These nests contain between 16 and 23 eggs with incubation lasting 41 to 43 days (Cooper et al. 2010; Kennou and Bergaoui 2009).

These biological and behavioral variables should be considered when interpreting analyses of OES from archaeological sites. For instance, if a human picks up several
eggs from the same ostrich nest, isotopic variability is expected if the area has heterogeneous geology and vegetational communities.

**Carbon Isotopes and Vegetational Community**

Vegetational communities within southern Africa are responsive to changing temperature (Collatz et al. 1998; Esterhuysen & Smith 2003) and fire regime (Keeley and Rundel 2005), and have evolved to use different photosynthetic pathways: C₃, C₄, and CAM. Trees and shrubs in southern Africa generally use the C₃-photosynthetic pathway and have a δ¹³C isotope ratio averaging -26.5 %/oo, whereas the vast majority of grasses often use the C₄-photosynthetic pathway and have a δ¹³C isotope ratio averaging -12.5 %/oo (Bird et al. 2004; Johnson et al. 1997; Peters & Vogel 2005; Wang, et al. 2009). These values are distinctly different (Wynn 2000), and the equation δ¹³C = X(-26.5) + (1-X)(-12.5) can be used to derive the relative contributions of each to the sample material, where C₃ = X and C₄ = 1-X (Cerling & Hay 1986; Johnson, et al. 1998; Segalen, et al. 2002; Von Schirnding, et al. 1982). However, due to fractionation, correction for the trophic level and other biological processes may be required for certain sample materials (Johnson, et al. 1997 & 1998; Segalen, et al. 2002; Von Schirnding, et al. 1982). For instance, OES is enriched by 16.2 %/oo relative to the δ¹³C of an ostrich’s diet (Johnson et al. 1997; Johnson et al. 1998; Von Shirnding & Van Der Merwe 1982).

C₄ plants use water more efficiently than C₃ plants during the dry season in arid environments (Wang, et al. 2010) and have higher photosynthetic rates at high temperatures and high light conditions (Farquhar, Ehleringer, et al. 1989; Farquhar, Hubick, et al. 1989). As a result, C₄ plants are more successful than C₃ plants when growing season temperatures are high and light levels are moderate to high (Sage, et al.
1999; Still and Powell 2010). It follows that C₄ plants do well in grasslands and savannas with limited tree cover (Long 1999). Goodfriend (1999:503) and others (Ambrose 1991; Ambrose and DeNiro 1989; Bird, et al. 2004; Farquhar, Hubick, et al. 1989; Levin, et al. 2006; Wang, et al. 2010; Wynn and Bird 2008) have shown that C₄ plant frequency increases with drier and/or hotter conditions. C₄ plants are also fire-adapted/dependent and can out-compete C₃ grasses and woodlands in a regime with distinct seasonality, such as a monsoon climate with abundant lightning at the end of a dry season (Keeley and Rundel 2005). Using the previous equation and differential success of plants using C₃ versus C₄ photosynthetic pathways during contrasting environmental conditions, we can calculate the relative contribution of each vegetation type to the δ¹³C value of ostrich eggshell and use it as a paleoclimatic indicator.

**Oxygen Isotopes and Temperature & Precipitation**

Ostrich eggshell’s δ¹⁸O levels are related to the water an ostrich ingests directly, or through vegetation. Since ostriches are non-obligate drinkers, the δ¹⁸O oxygen levels are primarily the same as in consumed plant material (Johnson et al. 1997), which in turn correlates to temperature (Burk & Stuiver 1981) and inversely to relative humidity (Forstel 1978; Johnson et al. 1997). Low δ¹⁸O values reflect low temperatures or high relative humidity while high δ¹⁸O values reflect high temperatures or low relative humidity (Johnson et al. 1997). For example, if both δ¹³C and δ¹⁸O values are enriched, then high temperatures, low humidity, and high evaporation rates are expected—conditions in which C₄ plants thrive (cf. Johnson et al. 1997).
METHODS

The 35 ostrich eggshell samples used for isotopic analyses were excavated from the cultural fill of Impala and Ngabaa Rockshelters. The samples were selected in order to represent a range of unmodified fragments, manufacture debris, and finished beads. Some of the finished beads were smooth from wear and most were broken. One rodent tooth extracted from a nearly complete intrusive maxilla discovered during Impala Rockshelter’s excavation was used to establish the local strontium isotope signature. Two ungulate teeth from Kapula Vlei, 30 km distant from the rockshelter, were also included in the strontium isotope analyses to test their origin(s).

Pre-treatment of the shell followed protocol developed by Ambrose (1990) and as adapted by Ambrose and Slater (personal communication, 2012). Only the exterior one-half of the shell was used to avoid the mammillary cone interior (cf. von Schirnding et al., 1982). Initially, the external surface of each OES piece and any visible pores were physically removed using a Dremel tool with a diamond-tipped bit. Sonication within deionized water removed any remaining exterior debris and, after the specimen was dry, around 10 mg of the shell was powdered and separated into two microcentrifuge tubes allocated for $\delta^{87}\text{Sr}$ and $\delta^{13}\text{C}/\delta^{18}\text{O}$ analyses.

The tooth enamel was initially cleaned with a carbide drill tip using a Dremel tool, sonicated and dried, before a 15 mg sample was removed with a diamond burr tip. Any chips were ground using an agate mortar and pestle before placing in a microcentrifuge tube. Organics were removed with a 50% Clorox solution, centrifuged, rinsed, and bathed for four hours in 0.1M of acetic acid per 0.1 mL per 1 mg of sample,
after which the samples were rinsed to neutral. After the acetic acid steps were repeated four times, the sample was freeze-dried and desiccated to reveal the apatite yield.

Strontium samples were analyzed at the University of Illinois department of Geology clean laboratory and Multicollector ICPMS laboratory. The samples were dissolved in 3N HNO₃ before being added to the cation exchange columns loaded with Eichnomn Sr spec resin, which was pre-conditioned. After four washes of 0.3 mL 3N HNO₃, the sample was eluted into a Teflon beaker with 1 ml of 0.05N HNO₃ and 3 ml of distilled water, and then dried. The dry sample was examined for contaminants, and, if any were present, the sample was run through the cation exchange column again. The sample was then dissolved in 0.25 ml of 15N HNO₃ and 2.75 ml of distilled water. The required dilutions vary depending on the amount of strontium in each sample, and so each sample was individually analyzed for the correct dilution ratio to prevent system contamination. Of note, our OES samples varied widely in their required dilution amounts, necessitating more machine time than is normally allocated (Shiel, personal communication, 2012). The strontium isotope ratios were measured using the Nu Plasma HR (#35) multicollector inductively-coupled-plasma mass spectrometer (MC-ICPMS). This instrument reports the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio and standard error. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratio was normalized to the bracketing SRM 987 standard value assuming a true value of 0.710255. Repeated analyses of four samples proved that the machine’s replicability was good—less than 0.00003 variance. Four Coral (0.709180) and three EA (0.708040) secondary standards were incorporated into the sequence, along with blanks, to ensure that contamination had not occurred.
Twenty-seven of the OES samples were analyzed for $\delta^{13}$C and $\delta^{18}$O isotopic ratios using a Micromass Isoprime stable isotope ratio mass spectrometer at the University of Nevada’s stable isotope laboratory. Organics were burnt off at 250°C for one hour before digestion by 0.2 mL of phosphoric acid per 4-6 mg of sample. A lab standard was included for comparison between every three samples to assure accuracy.

In order to make meaningful comparisons of $\delta^{87}$Sr with much larger $\delta^{13}$C and $\delta^{18}$O values on the same graph, we transformed them following Beard & Johnson’s (2000) example of relating $\delta^{87}$Sr to the standard bulk earth value (0.7045). Epsilon ($\varepsilon$) is used preceding the larger isotope to signify that the following transformation has been applied: $\varepsilon^{87}$Sr = $\left([^{87}\text{Sr}/^{86}\text{Sr}]_{\text{measured}}/[^{87}\text{Sr}/^{86}\text{Sr}]_{\text{bulk earth}}-1\right) \times 10,000$.

Cultural periods were delineated using the archaeological record of Impala and Ngabaa Rockshelters and Kapula Vlei. These periods are defined by way of life (hunter-gatherer versus settled village) and temporal controls from most recent to oldest as: Late Iron Age (LIA ~800 to 170 cal yrs BP, referring to the late period of agropastoral communities); Early Iron Age (EIA; ~2000-800 cal yrs BP, referring to the earlier period of agropastoral communities), Late Contact Period (LCP; <~800 cal yrs BP, referring to later contact between hunter-gatherers and agropastoralists), Early Contact Period (ECP; ~1800-800 cal yrs BP, referring to earlier contact between hunter-gatherers and agropastoralists), Post-Wilton (PW; 2400-1850 cal yrs BP, referring to the later period of hunting-gathering characterized by use of microlithic tools), Late Holocene Wilton (LHW; 4000-3000 cal yrs BP), and Middle Holocene Wilton (MHW; 6000-4500 cal yrs BP). Agropastoral communities, often associated with the Bantu migration into southern Africa, engaged in plant cultivation and animal herding, and made use of iron, while
hunter-gatherers are most often associated with Khoisan speakers who relied on stone tools and were highly mobile (Huffman 2007). OES fragments were assigned to each of these cultural periods based on their stratigraphic context and then sorted by depth for graphing purposes.

RESULTS

Strontium isotope analyses reveal that many of the ostrich eggshell fragments, preforms, and beads in our study were not derived from eggs that people had found near Impala or Ngabaa Rockshelters. A modern rodent tooth excavated from Impala Rockshelter had a $\delta^{87}\text{Sr}$ value of 0.725287. This value provides the local bioavailable $\delta^{87}\text{Sr}$ ratio, which most closely matches a tooth from a small ungulate taken from the banks of the Kapula Vlei site, also on the margin of the Karoo sandstone formation (t). None of the OES fragments’ $\delta^{87}\text{Sr}$ values are between 0.725 and 0.726 (Table 3-1).

Carbon isotope values showed a wide range of variation, indicating significant vegetational community change. After adjusting for the carbon isotopic enrichment fractionation of the OES’s inorganic $\delta^{13}\text{C}$, we calculated the percentage of C$_3$ and C$_4$ plants ingested (Table 3-2). High percentages of C$_4$ plants suggest hot and dry conditions, particularly since ostriches preferentially select C$_3$ plants when they are available.

Following Beard & Johnson (2000), we transformed the $\delta^{87}\text{Sr}$ values and further divided them by 10 to usefully compare them with $\delta^{18}\text{O}$ isotopes values and the percentage of C$_4$ plants ingested (Figure 3-2). Figure 3-2 shows that all three isotopes often co-vary. This suggests that the paleoenvironmental signature offered by $\delta^{13}\text{C}$ and
### Table 3-1. Stable isotope measurements

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Table 3-2. Relative percentage of $C_3$ and $C_4$ plants digested for each OES sample

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<th>diet $\delta^{13}C$ (-16.2 $%_{o}$)</th>
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$\delta^{18}O$ are in part the result of the samples being from different locations on the landscape, and presumably in different vegetational communities. Therefore, we used the local biologically available strontium, along with topographic variations surrounding the
rockshelter, to decide which isotopic values are from the vicinity of the rockshelter and are comparable with each other.

Fig. 3-2. Comparison of strontium and oxygen isotopes with %C₄ vegetation consumed over time

Bumbusi Ridge, on which Impala Rockshelter is located, has a steep southern slope, and the entire ridge is covered in open woodland. Ostrich prefer open grassland environments within bottomlands due to their reliance on their acute vision and great speed for evading predators. Therefore, based on ostrich behavior and local topography, we should not expect an ostrich nest on the slope near the rockshelters, but rather on the more gradual slopes below and/or bottomlands where the Deka River slices through basalt bedrock. However, even if these bottomlands are within an ostrich territorial range (24 km²) that includes the rockshelter, they reflect a different vegetational community composition that confounds paleoenvironmental interpretation of fluctuating δ¹³C and
$\delta^{18}O$ values. Because we are interpreting the fluctuations as an indicator of climate change, we need to disregard fluctuations due to different vegetational community configuration.

Fortunately, given the distinct lithologies of the bottomland basalts and upland sandstone, we can infer that values near or lower than the local bioavailable Sr value of 0.725 are likely from the gradual slope below the rockshelter. We also expect that the local OES would be more abundant than exotic material. The distribution of generalized $\delta^{87}$Sr values (Fig. 3-3) shows that most values of $\delta^{87}$Sr from the rockshelter’s OES fall between 0.719 and 0.726, which encompasses the locally bioavailable strontium level of 0.725287. Therefore, we used this range of $\delta^{87}$Sr values to represent near-rockshelter material. Higher values may reflect lithologies to the east that include gneisses and granites of great age with vegetational communities that differ from those in the local sandy substrate. Lower values likely reflect mixing with the relatively young basalts to the north and west. As a result, the $\delta^{13}$C values of these different vegetation communities are not directly comparable to those found at the rockshelter regardless of whether or not they could be encompassed within the ostriches’ foraging territory. The two outliers above 0.738 $\delta^{87}$Sr are samples from different positions of the same large ungulate tooth recovered from Kapula Vlei. Distinct from the rest of our samples, these values support that this large ungulate formed its teeth while grazing on either non-local foods, or exclusively on plants growing on ancient substrates to the east.
If we compare isotope values for only those having a near rockshelter δ⁸⁷Sr signature, the strontium isotope line flattens while the %C₄ grasses still vary, reflecting local paleoclimatic conditions (Fig. 3-4).

**DISCUSSION**

By using strontium values as a control for the types of substrates ostriches forage in, we can attain a more accurate paleoenvironmental signature from δ¹³C and δ¹⁸O isotopic values. This is due to the correlation of lithology, topography, and vegetation communities within our study area. In addition, if an ostrich drinks from streams coming through different bedrock types, the δ⁸⁷Sr signature will be contaminated and interpretations of δ¹⁸O isotopic signatures will not directly reflect plant water ingested by these non-obligate drinkers, but rather that of surface water. By categorizing groupings of δ⁸⁷Sr, we can also include paleoenvironmental data from other locations, with the acknowledgement that we are assuming that the correlation of lithology, topography, and...
vegetational communities holds true in many different landscapes. For instance, within our samples, a lower value grouping of 0.714-0.717 δ⁸⁷Sr was noted. This cluster of lower values is well represented and probably derives from the bottomlands below the rockshelters where δ⁸⁷Sr values are more heavily influenced by basalt substrates. By plotting these lower values below those of our near-rockshelter isotopes, we can correlate the two and extend our paleoenvironmental interpretations (Fig. 3-5).

![Impala & Ngabaa Shelters, local Sr Bracket](image)

**Fig. 3-4.** Near rockshelter isotopic variation of OES from cultural fill of Impala Rockshelter

Based on Fig. 3-5, early in the Middle Holocene Wilton period low temperatures favored C₃ woodlands. This was followed by a dramatic increase in C₄ grasses and high temperatures; however, towards the end of the Middle Holocene Wilton approximately 4500 cal yrs BP, C₃ woodlands expanded and temperatures were low. At the beginning of the Late Holocene Wilton (ca. 4000 cal yrs BP), C₃ woodlands and low temperatures
still prevailed, but conditions changed to high temperatures accompanied by a dramatic increase in C₄ grasses. This trend reversed twice more during the LHW, ending the period (ca. 3,000 cal yrs BP) with conditions slightly favoring C₄ grasses, but with lower temperatures. Of interest, there was a sustained cool period through the middle of the Late Holocene Wilton when fluctuations tended to be less dramatic and during which woodlands and relatively cool conditions prevailed. At the onset of the Post Wilton period (shortly after ca. 3000 cal yrs BP), the rockshelters were abandoned, a rockfall layer capped Impala Rockshelter, and Ngabaa Rockshelter was scoured to bedrock. This suggests a hot, dry, and volatile climatic regime that was ideal for wildfire. Within the Post Wilton period, which began with a rebound of C₃ woodlands and lower temperatures, conditions quickly worsened, and C₄ grasses comprised more of the ostrich
diet than any other time represented. High temperatures, low humidity, and high evaporation rates are the likely cause. In other words, much of the Post Wilton cultural period can be characterized by drought. Beginning in the Early Contact Period (ca. 1850 cal yrs BP), conditions again began to improve, with an expansion of woodlands and lower temperatures.

The addition of strontium to our isotopic analyses of OES has resulted in a smaller data set from which to interpret past environmental conditions, but one that is more accurate. Furthermore, the strontium isotope values hold promise for sourcing studies. Until we are able to process additional samples, concentrating on surface water within this lithologically heterogeneous area, we can use basic bedrock geology and age, coupled with our known values from this study and others regionwide, to derive some preliminary trajectories of OES movement. In general, OES with values less than 0.719 are most likely from the north and northwest of Impala Rockshelter, where relatively young basalts (Bj) are common. OES samples in the range of 0.719 to 0.726 may come from the Karoo age sedimentary package, such as Bumbusi Ridge and nearby units predominantly found to the east and southeast of Impala Rockshelter, or even Kalahari sands to the south. Values greater than 0.726 most likely come from the mid-Precambrian age lithological units or older. These are found around 40 km east of Impala Rockshelter, and in strands further to the northeast (Fig. 3-1). Further work is needed to test the validity of these speculations, but this is a promising first step to use OES as a traceable material.

Initially, we expected some pattern of $\delta^{87}$Sr variation to follow the reduction sequence of bead manufacture, with either finished beads or unmodified fragments
dominating local material. However, this pattern did not emerge (Fig. 3-6), and, rather, fragments, preforms, and finished beads are just as likely to exhibit a non-local $\delta^{87}$Sr value as a local one. This is perhaps because OES is light and easy to carry long distances (particularly as a water container) and that bead manufacture was occurring at the rockshelters, contributing lost beads and fragments, in addition to those broken during the manufacturing process.

**CONCLUSION**

We found the addition of $\delta^{87}$Sr isotope analysis essential to accurate interpretation of the regularly analyzed $\delta^{13}$C and $\delta^{18}$O isotopes. $\delta^{87}$Sr aids in the identification of non-local samples that should be disregarded in reconstructions of local paleoclimate, but may be of interest in studies of social networks and population movements. $\delta^{87}$Sr isotopic analysis holds great promise for sourcing OES beads and fragments. Strontium values of our geologically heterogeneous study area provide distinct, identifiable signatures and establishment of a $\delta^{87}$Sr basemap throughout southern Africa would allow study of migration and trade patterns through time. Creating this basemap within an area with such wide breadth of bedrock types and ages may best be accomplished following Voerkeilus (2010) and de Villiers et al. (2000), who used water samples from various headwaters to provide the average available strontium from local bedrock. This method would result in a biologically relevant map of strontium values available within drainage basins and foraging areas. This basin-wide scale can be easily coupled with site-specific strontium values derived from the enamel of small mammals with limited foraging distance.
Our strontium isotope data also call into question the presumption that there is a limited time span between procuring OES, processing, and deposition within archaeological sites (cf. Freundlich, et al. 1989; Janz, et al. 2009; Orton 2008; Sandelowsky 1971). Although the bulk of the OES materials were found to be of near local origin, 36% were not. This cautionary result suggests that OES may travel much
further and over longer periods of time than previously recognized. The addition of
radiocarbon assay or amino acid racemization of each OES fragment and bead would
usefully identify material that was recycled or traded over great time depths. The
addition of temporal control for each isotopic signature would also allow greater accuracy
in the paleoenvironmental interpretations, particularly since OES fragments can easily
move within loose cultural fill. Increasing sample sizes would also bolster our
confidence in the paleoenvironmental interpretations from isotopic analyses of OES.

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CHAPTER 4. SEDIMENTS, SOILS, AND THE PERSISTENCE OF FORAGING IN A FARMER’S WORLD: A GEOARCHAEOLOGICAL STUDY OF THE MID-TO-LATE HOLOCENE IN HWANGE NATIONAL PARK, ZIMBABWE

Teresa Wriston and Gary Haynes, University of Nevada, Reno

ABSTRACT

The economic transition from foraging to food production in south-central Africa is still not well understood. This paper describes geoarchaeological studies in Hwange National Park, Zimbabwe, which is situated on hypothesized migration and diffusion routes connecting the earliest center of agropastoralism in central Africa with the southern African subcontinent. Geomorphological reconnaissance and stratigraphic documentation of 20 natural river cut exposures, 26 auger cores, and two hand-dug geologic units, along with archaeological excavations at two rockshelters and an open-air site, provide data about specific localities best suited for early attempts at agriculture, and predict the likelihood of finding preserved sediments of appropriate ages. Three of six localities examined were suitable for farming ca. 2000 $^{14}$C yrs BP (ca. 1912 cal yrs BP; all radiocarbon ages that follow calibrated to 2-sigma 95% mean probability value using Calib 7.0; Stuiver et al. 2013) due to their proximity to water, their loamy alluvial deposits, and varied topography. An Early Farming Community (Early Iron Age) site is known at Kapula Vlei, where despite erosion, downcutting, channel switching, and cut-and-fill sequences, the broad basin’s fill retains cultural materials characteristic of this early farming period. Hunting-gathering and agropastoralism co-existed for the past two millennia, preserving a broad and flexible resource base from which neighborly relations
between hunters and farmers may have buffered the ebb and flow of disease vectors and unpredictably variable rainfall of this region.

**INTRODUCTION**

This study uses geologic and geomorphic evidence, such as, sediments, soils, and isotopes to reconstruct the environment and landscape between ca. 3.5 and 0.5 ka in northwestern Zimbabwe. This time period encompasses the adoption and eventual dominance of agropastoralism over hunting-and-gathering. How and why plant cultivation and/or pastoralism spread is complex and varies by locality. Minimally, the environmental conditions had to be able to support agriculture and domestic animals, and cultural negotiations were necessary between the native hunter-gatherers and newly arrived farmers. The increased landscape alteration by agropastoralists, who cleared fields, created irrigation systems, built housing and storage structures, and herded and corralled domestic animals, required labor by relatively high populations. These factors result in greater archaeological visibility and changing landscape dynamics that are reflected in the geomorphic record.

This study gathered basic information about the distribution and type of bedrock, soils, and sediments that would have impacted early farmers’ decisions. Using these data as an environmental proxy, we reconstruct major periods of landscape stability and erosion, and the type of floral cover on dated soils through time. These data are combined with recent archaeological finds to suggest environmental pre-conditions for farming and pastoralism’s success in this dynamic region.
Background and Sampling Strategy

Our study area is directly within at least one of several hypothesized southward expansion routes of agropastoralism and human movements from core areas in central Africa (e.g., see Huffman 2007). Plant farming and pastoralism (known together as agropastoralism) were relatively late adaptations in southern Africa when compared to the northern extent of the continent, where they occurred as early as 10 ka (Van Zinderen Bakker, 1976). As Gifford-Gonzalez (2000) suggested, this delay in the south is partly due to the disease vectors found in the wooded areas, including tsetse fly and mosquitoes that respectively carry sleeping sickness (nagana in animals) and malaria. These vectors often foiled European colonists’ plans for expansion (cf. Chapman, 1971; Holub, 1975), and continue to be a threat to the health of both man and beast when, after a drought, wet conditions and woodland expansion occur (cf. Endfield et al., 2009). Therefore, the initial adoption of agropastoralism in our study area, situated near the recent boundary of tsetse fly habitat (cf. Cechi 2008), would have had to take place within an environmental window suited for both sufficient precipitation for crops to survive, but sufficiently dry to minimize woodland cover and suppress the risk from disease vectors.

Physiography and Sediment Sampling

Hwange National Park straddles the watershed between the Zambezi Basin to the north and the Makgadikgadi pans of Botswana’s Kalahari Desert to the south. The northern portion of the park has undulating topography with drainages cutting into bedrock ridges of basalt, sandstone, granite, gneisses, and various other materials (Fig. 4-1). The bulk of the sandstones and basalts are of the Jurassic-Triassic age Karoo Formation, whereas the gneisses, granites, shales, and various other materials are of much greater age, ranging
from Permian to mid-Precambrian (Sithole, 1994). The central and southern portion of the park is covered with red Kalahari sand sheets separated by long linear dunes. These dunes were formed during the Pleistocene and have been sporadically reworked during Holocene dry periods (Stokes et al., 1998; O’Connor & Thomas, 1999).

Agricultural success or failure is dependent on a location’s temperature, precipitation and its character, substrate, amount of solar radiation, and topography (Martin et al., 1976; Norman et al., 1984). These characteristics also affect soil properties, famously outlined by Jenny (1941) to be a function of regional climate, biota, relief, parent material, and time. Jenny (1941) also proposed that the study of relict soils can therefore be of help in reconstructing the environmental factors affecting their formation. However, Butzer (1984) recognized that the amount of precipitation (regional climate in Jenny’s formation factors) actually has the greatest geomorphic impact in southern Africa, even though response to excessive or insufficient amounts varies depending on the history of each drainage system, which has unique local threshold and response levels often dependent on parent material and biota.

Northwestern Zimbabwe is near the southern extent of the Intertropical Convergence Zone (ITCZ), which impacts rainfall amount and distribution. Precipitation falls here between November to March, while during the rest of the year surface waters are consumed, used for irrigation, evaporated, or absorbed, leaving few, if any, sources of water until rains come again. This wet-and-dry season distribution of rainfall creates annual short term drought signatures within the geomorphic record (cf. Thomas & Burroughs, 2012); however, long droughts are frequent, and when drought extends over
several years, significant geomorphic response, such as deflation and scour of slopes and alluvial basins, is likely. The mean annual rainfall in the park is around 620 mm/year (Rogers, 1993), but annual values and distribution are erratic and unpredictable (Nyamapfene, 1991). For instance, between 1918 and 1990, annual rainfall at Main Camp ranged from 335.6 mm to 1159.8 mm (Rogers, 1993).

Parent material and substrate variation interact with rainfall distribution and abundance to influence which crops will succeed or fail. Quartz sands are largely inert (Norman et al., 1984) and are not good hosts for plant nutrients or ion exchange. Basic volcanic rocks, such as basalt, contain the full range of the earth’s crustal elements and weather to clay, allowing good soil development and high plant productivity due to the abundance of available nutrients (Limbrey, 1975; Bell, 1982). Conversely, granite rocks and quartz sand, comprised of relatively coarse, weather-resistant minerals, have less variety and abundance of essential minerals and nutrients required by plants (Limbrey, 1975; Bell, 1982). Erosion also redistributes nutrients through the drainage system, enhancing the fertility of valley floors and river floodplains while depleting the uplands (Limbrey, 1975).

It follows that the geology of the National Park controls much of its soil and vegetation characteristics. Nyamapfene (1991) classifies the soils of Hwange National Park as regosols in the Kalahari sands, lithosols in the basalts and sandstones of its northwestern margin, and as fersiallitic soils (a Zimbabwe-specific soil categorization similar to alfisols) in the paragneisses and granites of its northeastern portion. Both regosols and lithosols are not suited for farming due to either their lack of fine material or
shallow nature. In contrast, fersiallitic soils have well-developed B-horizons/structure and tend to be very fertile due to a high field capacity and good drainage.

The unimodal distribution of annual precipitation within southern Africa creates especially challenging conditions for farmers, who have learned to use sediment texture and topographic position to their advantage. For instance, modern Gwembe Tonga people of the middle Zambezi River plant wet season crops that grow during the rains in well-drained, sandy soils high on the landscape, while water-tolerant crops are planted along river ways (Scudder, 1971, 1976). With the onset of the dry season, loamy soils on alluvial terraces are again planted in hopes that the water absorbed during the wet season by the clay loams slowly releases to the crops, allowing their maturation under dry conditions. Scudder (1971, 1976) noted that the gardens on alluvial terraces were most valued because they could be cropped twice per year. Local topographic relief that allowed flexible field placement above the river was also desired. These strategies of mid-twentieth century farmers allow us to speculate which substrates and topographic locations would be preferred during different parts of the year or during different environmental conditions, but require basic knowledge of which types of substrates are available throughout the region. It was for these reasons that a sampling program across the study area was undertaken to (1) characterize sediments and soils along the rivers and vleis, and (2) perform stratigraphic sampling of archaeologically-rich upland and mid-land settings via augering.
Isotope Sampling

We also sampled for stable isotopes from stratified or dated materials to use as proxy data about past floral conditions and climate. Plants use three different photosynthetic pathways: C₃, C₄, or CAM (Crassulacean Acid Metabolism). C₃ plants produce a compound with three carbon atoms in the initial CO₂-fixation of atmospheric CO₂, whereas C₄ plants produce a compound with four carbon atoms. CAM plants, which vary
the compound produced depending on environmental aridity, are not common in our study area and are unlikely to significantly alter the isotope signature ratio. The $\delta^{13}C$ isotope ratio is significantly different for plants that use C$_3$ (-26.5 $\%$ in southern Africa) and C$_4$ (-12.5 $\%$ in southern Africa) pathways, allowing calculation of the relative contributions of each to a $\delta^{13}C$ isotope value of soils and sediments.

Trees and shrubs in Africa use the C$_3$ photosynthetic pathway, whereas grasses predominantly use the C$_4$ photosynthetic pathway (Wang, et al., 2009). C$_4$ plants use water more efficiently than C$_3$ plants, particularly during the dry season in arid environments (Wang, et al., 2010). C$_4$ plants also have higher photosynthetic rates at high temperatures and under high light conditions (Farquhar et al., 1989a; Farquhar et al., 1989b). As a result, C$_4$ plants are more successful than C$_3$ plants when growing season temperatures are high and light levels are moderate to high (Sage et al., 1999; Still & Powell, 2010). In other words, C$_4$ plants do well in grasslands and savannas with limited tree cover (Long, 1999). In addition, Goodfriend (1999:503) and others (Ambrose & DeNiro, 1989; Farquhar et al. 1989b; Ambrose, 1991; Bird et al., 2004; Levin et al. 2006; Wynn & Bird, 2008; Wang et al., 2010) also showed that C$_4$ plant frequency increases with drier and/or hotter conditions. C$_4$ plants are also fire-adapted/dependent and can out-compete C$_3$ grasses and woodlands in a regime with distinct seasonality, such as a monsoon climate with abundant lightning at the end of a dry season (Keeley & Rundel, 2005). Esterhuyson & Smith (2003) state that in Africa a maximum of 25 degrees C (77 degrees F) and a minimum of 8 degrees C (46 degrees F) are necessary to sustain C$_4$ grasses. If temperatures are lower than this during the growing season, C$_3$ woodlands
will begin to encroach upon C₄ grasslands (Esterhuysen & Smith, 2003). If they are higher than this, C₄ grasses will still outnumber C₃ plants. In addition, increases in mean annual precipitation (MAP) are strongly correlated to decreases in vegetation δ¹³C due to an increase in tree (C₃) cover. Conversely, decreasing the precipitation increases the amount of C₄ cover and enriches δ¹³C (Still & Powell, 2010). It is for these reasons that δ¹³C can be used as a paleoclimatic indicator. In addition, an increase in C₄ plants, which include the indigenous staple crops of millet and sorghum, and the introduced staple maize, may also signal the adoption of agriculture.

Archaeological Sampling

The earliest evidence of nomadic hunter-gatherers in Hwange National Park dates to the Early Stone Age (Haynes & Klimowicz, 1998), and some semblance of this hunting-and-gathering way of life (albeit with major technological and evolutionary advances), continued to be practiced there into the historic period. Impala and Ngabaa Rockshelters, which are situated atop a sandstone ridge overlooking the Deka River and along the northern boundary of the study area, were first occupied around 6 ka (Wriston & Haynes, unpublished data) when relatively large forager groups began to use the area, leaving characteristic microlithic tools and manufacturing debris behind in the rockshelters and open-air locations, along with a generalized tool kit and ostrich eggshell beads. Human use of the rockshelters intensified 4-3 ka, and unique, finely-engraved animal spoor (footprint) carvings that cover much of the rockshelters’ sandstone walls were likely created during this time, as suggested by an engraved slab within a rockfall layer dated to between 3000+/−40 ¹⁴C yr BP (Beta249591; 3168-3060 cal yrs BP; Calib 7.0; Stuiver et
al. 2013) and 2430+/-40 $^{14}$C yr BP (Beta-275279; 2460-2345 cal yrs BP; Calib 7.0; Stuiver et al. 2013) (Wriston & Haynes, 2009). However, beginning around 1,850 cal yrs BP, hunter-gatherer occupation of the study area had shifted from large aggregate groups to small family or task groups (Wriston & Haynes, unpublished data). The use of these rockshelters by smaller groups of hunter-gatherers continued even as a new cultural adaptation in the area took hold in the lowlands, namely agropastoralism.

Within Hwange National Park, the earliest evidence of agropastoralism is within Kapula Vlei, which was first described and assayed to 1140+/-90 $^{14}$C yr BP (SR-73; 1094 to 921 cal yr BP; Calib 7.0; Stuiver et al. 2013) by Robinson (1966). Examination of the area during 2008 revealed numerous pots and daga-lined structures exposed in the river cut along a stretch of well-developed soil in nearly flat, expansive alluvial terraces (Fig. 4-2). We conducted salvage excavations that recovered ceramics, charcoal, animal teeth, and animal bone. A bovine tooth recovered from locus 1 was assayed to 1253+/-40 $^{14}$C yr BP (AA95094), or 1179 to 1069 cal yr BP (Calib 7.0; Stuiver et al., 2013). Two radiocarbon assays of ceramic temper and charcoal from nearby locus 4 dated to 1990+/-40 $^{14}$C yr BP (Beta-275280; 1931 to 1864 cal yr BP; Calib 7.0; Stuiver et al. 2013) and 1790+/-40 $^{14}$C yr BP (AA95089; 1705 to 1611 cal yr BP; Calib 7.0; Stuiver et al. 2013) respectively. The locus 4 dates are some of the earliest in the region for settled village life, making our understanding of this basin, and the variables that drew agriculturalists here, especially important.
METHODS

Geomorphological reconnaissance focused on identifying basic geology and landforms within the study area and characterizing sediments and soils of Holocene age, particularly near known archaeological sites. This documentation was most successfully accomplished by examining incised seasonal tributaries and rivers. Selected stratigraphic profiles were photographed, point-plotted using a hand-held Garmin eTrex Vista unit, drawn and described. Descriptions included: topographic position, vegetation cover, any disturbances, strata identification and the nature of their upper and lower boundaries, Munsell color (dry and moist), effervescence with 10% HCl, sediment texture (following USDA), likely depositional environment, the relative amount of organic material, gravel abundance, clast lithology, roundness, and size, and a general description. Twenty
natural exposures, 26 auger samples, and two hand-dug units were described and/or sampled.

At Josivanini Dune, two units were hand-excavated on the upper portion of a large, stabilized linear dune. One of these units was excavated to 2 m below surface, and the other to 4 m below surface. Samples were retrieved every 50 cm down the face for Optically Stimulated Luminescence (OSL) dating. Charcoal for radiocarbon assay was retrieved from these two sand units by sieving excavated materials through a 3 mm mesh screen or collecting directly from the wall profile.

Selected landforms were hand augered and sediment was described. Each auger location was mapped using UTMs obtained from a Garmin eTrex Vista GPS unit. A photograph of the location and topographic and vegetation description provide contextual information. Each sample was excavated using a sand bucket attachment that was emptied onto plastic sheeting, forming a column of subsurface stratigraphy that was then photographed and described. A tape measure was used to determine the depths below surface for each bucket. Maximum depth was determined when it was no longer possible to retrieve material. Generally, this was due to reaching bedrock, calcrete, large gravel, or rocks.

Samples of buried soil horizons, other strata of interest, and charcoal were collected from both river cuts and augered materials for laboratory analyses and AMS radiocarbon assay to aid in the establishment of chronostratigraphic units and correlation between basins. A portion of these samples was exported to the United States for laboratory analyses. Sediment analysis was completed at the Desert Research Institute Soils Laboratory while radiocarbon assays were processed at either the University of
Arizona’s Radiocarbon Laboratory or Beta Analytic, Inc. For radiocarbon assay, both sediment and humate fractions were analyzed to identify any contamination. Although the results are generally similar between the two, the oldest was selected as being the likelier age and having the correct δ¹³C value, as discussed below (cf. Walkington 2010).

Another aspect of the field investigations was archaeological excavation into the cultural fill of Impala and Ngabaa Rockshelters. Six 1-x-1 m² units were excavated to bedrock within the rockshelters, which was reached at 97 cmbs (centimeters below surface) in Impala Rockshelter, and 78 cmbs in Ngabaa Rockshelter. Archaeological fill was used to date the documented stratigraphic units. In open ground between the two rockshelters a 2-x-1 m unit was excavated down to 85 cmbs before reaching bedrock. Salvage excavations of cultural materials exposed in the Kapula River cut and in danger of washing away during the rains were also completed after detailed mapping at each locus or artifact concentration. These archaeological excavations are reported in detail elsewhere (Wriston & Haynes, 2009).

The δ¹³C isotope ratio determined during the radiocarbon dating procedures was used to calculate vegetation types that contributed to each samples soil carbon. As mentioned above, this ratio is significantly different for C₃ (trees and shrubs) and C₄ (grasses) photosynthetic pathway plants, allowing us to calculate the relative contributions of each to the soil sample (Cerling & Hay, 1986; Wynn, 2000). Using the average African δ¹³C isotope ratio in C₃ plants as -26.5 ‰, and C₄ plants as -12.5 ‰ (Bird et al., 2004), we calculated the contribution of each plant type, given that C₃ = X and C₄ = 1-X in the equation: δ¹³C=X(-26.5) + (1-X)(-12.5) (Von Schirnding et al., 1982; Johnson et al., 1998; Segalen et al. 2002).
RESULTS

Sample Locations and Descriptions

Of the 48 stratigraphic sample locations, six (Fig. 4-3) are detailed here as representative of each general area.

Fig. 4-3. Locations of stratigraphic profiling and augering (black circles) within Hwange National Park (black line) plotted on landsat imagery
Bumbusi River Area

The Bumbusi River empties into the Deka River on the northern boundary of the study area. The Deka holds water most of the year within large pools cut into the basalt bedrock, creating habitat for fish, crocodile, and hippopotamus. Near-modern sand bars and terrace remnants were discovered along the Deka, but most deposits have been scoured from the channel. However, the Deka’s tributaries, such as the Bumbusi River, have better potential to provide stratigraphic evidence of past environments due to the presence of buried soils and pockets of deposition. During the extended archaeological excavations at nearby Impala and Ngabaa Rockshelters, numerous samples were obtained from Bumbusi River terraces, slopes between the river and Bumbusi Ridge, and promising sediment catchments further to the west (Fig. 4-4).

Fig. 4-4. Landsat Bumbusi area and profile BR10-3a upper profile (250 cm in height)
### Table 4-1. Lower Bumbusi River stratigraphic profile description (Br10-3a)

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth (cm)</th>
<th>Soil Horizon</th>
<th>Field Texture</th>
<th>Description</th>
<th>Dep/Landform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-25</td>
<td>AB</td>
<td>sandy clay</td>
<td>10YR5/3d; 10YR4/2m; NE w/10% HCl; sparse shrub veg; wk sab; gradual lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>2</td>
<td>25-60</td>
<td>A8qb1</td>
<td>loamy clay</td>
<td>10YR4/1d; 10YR3/1m; VSE w/10% HCl; wk sab; abrupt lb; org-rich</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>60-88</td>
<td>Bwb1</td>
<td>sandy clay</td>
<td>10YR5/3d; 10YR4/2m; SLE w/10% HCl; wk sab; some ox mottles; abrupt lb</td>
<td>alluvial terrace</td>
<td></td>
</tr>
<tr>
<td>88-100</td>
<td>C</td>
<td>sand &amp; gravels</td>
<td>7.5YR5/5d&amp;m; NE w/10% HCl; loose med-coarse sand; ox mottles; distinct bedding planes; channel deposit; undulating, abrupt lb</td>
<td>channel bed</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>100-115</td>
<td>Ab2</td>
<td>sandy clay</td>
<td>10YR5/3d; 7.5YR4/2m; NE w/10% HCl; wk columnar; wk gley; thin clay films; some charcoal flecks; gradual lb</td>
<td>ponded water</td>
</tr>
<tr>
<td></td>
<td>115-135</td>
<td>Aqb2</td>
<td>clay</td>
<td>10YR4/2d; 7.5YR3/1m; NE w/10% HCl; mod sab; abrupt lb; some charcoal flecks</td>
<td>ponded water</td>
</tr>
<tr>
<td></td>
<td>135-160</td>
<td>C</td>
<td>sand &amp; gravels</td>
<td>7.5YR5/5d&amp;m; NE w/10% HCl; loose; abrupt lb; some charcoal flecks</td>
<td>channel bed</td>
</tr>
<tr>
<td>4</td>
<td>160-175</td>
<td>Ab3</td>
<td>clay</td>
<td>10YR5/2d; 10YR3/1m; NE w/10% HCl; wk columnar; wk gley; thin clay films; some charcoal flecks; gradual lb</td>
<td>ponded water</td>
</tr>
<tr>
<td></td>
<td>175-190</td>
<td>A2b3</td>
<td>clay</td>
<td>10YR4/1d; 10YR3/1m; NE w/10% HCl; mod sab; abrupt lb; org-rich; many charcoal flecks</td>
<td>ponded water</td>
</tr>
<tr>
<td></td>
<td>190-200</td>
<td>C</td>
<td>loamy sand</td>
<td>10YR3/2d&amp;m; NE w/10% HCl; loose; abrupt lb; coarse sand &amp; pebbles</td>
<td>channel bed</td>
</tr>
<tr>
<td>5</td>
<td>200-235</td>
<td>Atqb4</td>
<td>clay</td>
<td>10YR3/2d&amp;m; NE w/10% HCl; wk sab; abrupt lb; many charcoal flecks</td>
<td>ponded water</td>
</tr>
<tr>
<td>6</td>
<td>235-270</td>
<td>Atkb5</td>
<td>loamy clay</td>
<td>10YR4/1d&amp;m; 10YR7/2d&amp;m nodules &amp; stringers; STE w/10% HCl; st sab; gradual lb</td>
<td>ponded water</td>
</tr>
<tr>
<td></td>
<td>270-295</td>
<td>Btkb5</td>
<td>loamy clay</td>
<td>10YR4/2-7/2d; 10YR3/2-4/3m; nodules &amp; stringers; VE w/10% HCl; mod sab; bands created by precipitation zones</td>
<td>alluvium w/groundwater</td>
</tr>
<tr>
<td></td>
<td>295-305</td>
<td>C</td>
<td>loamy sand</td>
<td>10YR5/3d; 10YR3/3m; STE w/10% HCl; medium sand; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>7</td>
<td>305-400</td>
<td>Btkb6</td>
<td>sandy loam</td>
<td>10YR5/3d; 10YR3/2m; STE w/10% HCl; massive; hard; gradual lb</td>
<td>alluvium w/groundwater</td>
</tr>
<tr>
<td></td>
<td>400-415</td>
<td>C</td>
<td>loamy sand</td>
<td>10YR5/2d; 10YR3/2m; VSE w/10% HCl; massive coarse sand &amp; pebbles; gradual lb</td>
<td>channel bed</td>
</tr>
<tr>
<td></td>
<td>415-430</td>
<td>C2</td>
<td>sandy loam</td>
<td>7.5YR3/2m; saturated; VSE w/10% HCl; oxidized zone above water table; loose when moist</td>
<td>alluvium w/groundwater</td>
</tr>
<tr>
<td></td>
<td>430</td>
<td>water</td>
<td></td>
<td>groundwater table, basalt bedrock nearby</td>
<td></td>
</tr>
</tbody>
</table>

Bumbusi Ridge is comprised of sandstone, and the Bumbusi River has cut a gorge through the ridge and the basalts that outcrop upstream of its confluence with the Deka River. The majority of the deposits along the Bumbusi River are cumulative, and within the river’s lower section they form a sequence of organic-rich standing water deposits.
with upper weathered zones commonly separated by channel bed sands and gravels (Fig. 4-4; Table 4-1). Inspection of the area for channel meandering both on the ground and from satellite images revealed no relic scrolls. Rather, these deposits represent wet-and-dry cycles, when seasonal ponding accumulated organic material in fine sediments. After the water receded, these deposits weathered subaerially.

The alluvial terraces are up to 4 m above the channel bottom, but within the surrounding Bumbusi slope deposits, bedrock is generally less than 60 cmbs, with localized deposits of up to 200 cmbs before impenetrable material was reached using a hand auger. The deepest deposits encountered within this basin are near the geologic contact of the dipping basalt and sandstone bedrock exposed in the Bumbusi River (Fig. 4-5).

Within an augured sample (10-A12) west of the Bumbusi River, a grassy swale was tested and found to have loamy sand in the upper 55 cmbs, loamy clay and clay below 55 cmbs, CaCO$_3$ nodules and calcrete below 130 cmbs, and was too indurated to auger at 180 cmbs (presumably just above bedrock). East of the Bumbusi River on the flank of Bumbusi Ridge (10-A14 thru 10-A20), the slopes are underlain by loose, quartz-dominated alluvial red sand with little to no soil development. Impala and Ngabaa Rockshelters are situated on the rocky upper slope of the ridge, and their fill is comprised of anthropogenic charcoal ash, artifacts, and rockfall. The rockshelters had been scoured to bedrock before mid-to-late Holocene human occupation led to an accumulation of 80 to 97 cm of anthropogenic fill (Wriston & Haynes, 2009).
Deposits underlying the Bumbusi River terraces show some evidence of human impacts, including an upper leached zone possibly the result of historic irrigation or waterway modification, and a lithic flake discovered in an auger sample from 180 cmbs, suggesting prehistoric use of the area. Before the Bumbusi River became entrenched, its alluvial terraces likely had potential for agricultural use. The availability of surface water most of the year, the loamy sediments, and varied topography and sediment types over a short distance offers flexibility in field placement across various elevations and substrates to increase the odds of success in this volatile environmental regime. However, the majority of the area has shallow soils inundated during the wet season, or is sandy, and therefore not as nutrient rich as other basins. These factors could have lessened the Bumbusi River basin’s overall appeal to early plant cultivators.

Fig. 4-5. Lower Bumbusi River with bedrock exposure and extant ponds

*Kapula Vlei*

Kapula Vlei is the grassy and seasonally inundated land adjacent to the Kapula River channel, which is itself usually dry most of the year. The river is a headwater tributary
that drains into the Lukosi River just before the Lukosi cuts through a sandstone ridge, forming a relatively deep gorge downstream. Within the Kapula Vlei basin, two seasonal headwaters drain its southern portion. One emerges from granite kopjes (South African term for a small hill) located to the south, and the other (the current trunk of the Kapula River) from the ancient mudstones and glacial deposits to the southwest. Evidence of repeated channel cut-offs, and cut-and-fill sequences, show that the location of these two drainage’s confluence has changed many times during the history of the basin. Presently, they join below the recorded archaeological site of Kapula Vlei, but granitic material 2 km upstream hints at earlier confluences there, on the opposite side of the valley.

Meander scrolls that cut tightly through the south-central portion of the basin also (Figure 4-6) show that a change in the amount of water, its velocity, and/or sediment load has occurred given that the modern channel is relatively straight and entrenched. This change may have resulted from tectonic activity or an increase in climate volatility, with punctuated flood events rather than gentle precipitation throughout the rainy season. However, channel alteration could also have resulted from prehistoric agricultural practices and/or historic activities in the area. Landscape alterations since the park’s creation include dam-building, emplacement of a water pump to feed nearby Masuma Dam, and creation of two different campgrounds—one of which was abandoned during the 1980s when the drainage repeatedly downcut, making access impossible (Anon. National Park staff member, personal communication, 2008). The artificial concentration of wildlife at a pumped water source during the dry season may also be affecting erosion rates and sediment load by lowering the groundwater levels, encouraging concentrated
overgrazing and vegetation destruction, and increasing trampling and bioturbation, particularly by elephants.

The soils and sediments exposed in Kapula River cutbanks are variable due to the history discussed above, but we focused on documenting the dark, organic-rich soils near the Early Iron Age village exposed at the Kapula Vlei Site. Within the site itself, pots were found eroding out of prehistorically excavated pits (see Fig. 4-2) beneath a strongly-developed Ap horizon of clay loam with discreet daga-lined floors exposed around 20 cmbs. At approximately 45 cmbs, the Ap horizon transitions into a Bt horizon that, albeit obviously formed on a medium sand substrate, still forms a ribbon more than 5 cm long due to the clay and sesquioxide accumulation. Below 82 cmbs is a channel bed deposit of an ancient loamy subangular and subrounded coarse sand, which by 100 cmbs has granular structure and many CaCO₃ nodules and stringers. Of note, a significant amount of time is missing between the Bt horizon and the much older relic channel sands.

Upstream of the Kapula Vlei Site, soils are also organic-rich sandy-to-clay loams in the cut’s upper portion (Fig. 4-6; Table 4-2). The deep A-horizon here may be due to human tilling and organic-enrichment; however, grassland soils also commonly exhibit a thickened A-horizon (Martin et al., 1976), and given the dense modern grass cover, this may be a natural phenomenon. Several cumulative horizons evident in the area merge into the upper profile layers due to pedogenic alteration, and sand lenses deposited by migrating prehistoric rills and channels occasionally can be discovered within the otherwise loamy sediments. KR08-3’s profile section has a distinct shelf formed at the contact above the same ancient sands described for the Kapula Vlei site. Due to
differential resistance along an aquitard boundary, this shelf hangs over the undercut sands below, a process accentuated by elephant-digging along this transition, presumably for minerals that precipitate due to the change in sediment texture (Fig. 4-6).

Alluvial terraces within Kapula Vlei are generally around 280 cm above the channel bottom. Historic channel incision of over 1 m implies that recent land use changes, such as groundwater pumping for Masuma Dam, may be altering the local base level/groundwater table. However, more work needs to be done in order to determine whether this land use, changing climatic conditions, or tectonic activity, is causing the downcutting (Figure 4-7).

Although the nutrient rich sandy-to-clay loams, thriving vegetation, and local topographic and substrate variety suggest that agriculture would be successful at Kapula Vlei (as it was in the past), the lack of surface water during the dry season would make
Table 4-2. Kapula River (Kr08-3) stratigraphic profile description

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth (cm)</th>
<th>Soil Horizon</th>
<th>Field Texture</th>
<th>Description</th>
<th>Dep/Landform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-35</td>
<td>A</td>
<td>loamy sand</td>
<td>10YR5/3d; 10YR3/2m; STE w/10% HCl; wk sab; grassy surface; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>2</td>
<td>35-55</td>
<td>Ab1</td>
<td>sandy loam</td>
<td>10YR3/2d; 10YR3/1m; STE w/10% HCl; wk sab; organic-rich; poorly sorted; gradual lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td></td>
<td>55-69</td>
<td>Btkb1</td>
<td>clay loam</td>
<td>10YR5/2d; 10YR3/2m; STE w/10% HCl; compact; s sab; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>3</td>
<td>69-72</td>
<td>C</td>
<td>coarse sand</td>
<td>10YR4/3d&amp;m; NE w/10% HCl; clean quartz sand; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>4</td>
<td>72-105</td>
<td>ABkb2</td>
<td>clay loam</td>
<td>10YR3/1d; 10YR2/1m; VSE w/10% HCl; wk sab; slightly gleyed; gradual lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>5</td>
<td>105-115</td>
<td>BCb2</td>
<td>clay loam</td>
<td>10YR4/2d; 10YR3/2m; SLE w/10% HCl; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>6</td>
<td>115-127</td>
<td>ABBb3</td>
<td>sandy loam</td>
<td>10YR3/3-4/2d; 10YR3/2m; VSE w/10% HCl; shallow soil on top of loamy sand overbank deposit; org rich on top grading to sand below; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>7</td>
<td>127-145</td>
<td>Ab4</td>
<td>sandy loam</td>
<td>10YR3/2; 10YR3/2m; VSE w/10% HCl; shallow soil; org rich; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>8</td>
<td>145-160</td>
<td>C</td>
<td>loamy sand</td>
<td>10YR3/3d; 10YR3/2m; SLE w/10% HCl; abrupt lb; some termite concretions</td>
<td>channel bed</td>
</tr>
<tr>
<td>6</td>
<td>160-180</td>
<td>Ab5</td>
<td>loam</td>
<td>10YR3/2d; 10YR3/2m; SLE w/10% HCl; wk ab w/thin silica coatings; gradual lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>9</td>
<td>180-190</td>
<td>Bqb5</td>
<td>clay loam</td>
<td>10YR4/2d; 10YR3/2m; SLE w/10% HCl; ab peds w/silica coatings; gradual lb; targeted elephant diggings</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>10</td>
<td>190-225</td>
<td>Bq2b5</td>
<td>clay loam</td>
<td>10YR3/2d; 10YR3/2m; SLE w/10% HCl; very hard wedge to platey peds w/silica coatings; abrupt lb; targeted elephant diggings</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>7</td>
<td>225-295</td>
<td>C</td>
<td>loamy sand</td>
<td>7.5YR3/2d; 7.5YR3/2m; NE w/10% HCl; termite-affected; ab structure; wk silica films; oxidized</td>
<td>channel bed</td>
</tr>
<tr>
<td>8</td>
<td>295+</td>
<td>C</td>
<td>sand &amp; gravels</td>
<td>7.5YR3/2d; 7.5YR3/2m; NE w/10% HCl; termite-affected; ab structure; wk silica films; oxidized</td>
<td>channel bed</td>
</tr>
</tbody>
</table>


permanent villages here difficult to sustain under modern conditions. In fact, there has been some difficulty finding enough groundwater to abstract for the Masuma Dam reservoir (Anon. National Park staff, personal communication, 2009).
Deteema

The Deteema area (Fig. 4-8) was not extensively sampled, but is included here because it provides a unique example of CaCO₃-rich deposits associated with seep or spring activity. The Deteema basin is within Permian-age mudstones, shales, glacial deposits, and sandstones bordered by dolomite dikes and gneisses of various ages (Sithole, 1994). It is characteristically different from other basins we visited because it has a possible spring head less than several hundred meters upstream. Surrounding the drainage, dense grasslands are well populated by various ungulates and a large baboon troop that also uses the seep below Dtma09-1. Unfortunately, a bull elephant chased us away before a detailed profile description could be completed, but Fig. 4-8 shows the multiple bands of light colored, deep sediments with compact structure, zones of dense CaCO₃ accumulation, and some manganese stains on peds within the lower strata. The terrace cutbank is up to 4 m above the channel, which is locally very steep-sided and narrow. The cutbank has groundwater seeping from a stratigraphic break at its base.
Although the deposits exposed in the Dtma09-1 stratigraphic profile would not be conducive to productive agricultural development, the presence of an active seep during the dry season, and thriving grasslands at higher topographic locations nearby, imply that plant cultivation may have been successful on the surrounding slopes and nearby plains.

*Fig. 4-8. Landsat Deteema sample location left, stratigraphic profile Dtma09-1 right (325 cm in height above trowel at base)*

**Sinamatella**

The Sinamatella River winds its way across a wide alluvial plain below a sandstone mesa where a camp has been established for tourist lodging and game viewing. In addition to this sandstone, which locally contributes a significant amount of alluvium and colluvium, the geologic substrate includes Permian-age mudstones, sandstones, shales, and coal seams (Sithole, 1994). These old, relatively soft deposits are eroding, leaving more resistant remnants of Jurassic-Triassic age sandstone high above the gradually lowering plain (Fig. 4-9). Vegetation here is rather sparse woodland with an understory of thin grasses.
Three profiles were examined that reveal three buried soils (Fig. 4-9; Table 4-3). A relatively recent alluvial overbank deposit in the upper 10 cm overlies the uppermost soil. All of the soils are formed on these overbank alluvial terrace deposits that are separated by channel bed sands and gravels. The soil between 10-60 cmbs is relatively strongly developed whereas the two lower soils have been partially truncated by channel scour. At the base of the profile, large rocks are found above a calcrete layer. Near the river, vegetation is relatively dense, and roots, rootlets, and termite activity are common.

Fig. 4-9. Landsat Sinamatella sample locations left; Sin08-3 profile right (200 cm measuring stick)

It is unlikely that the Sinamatella area would have been targeted by early agriculturalists. The steep slopes of the sandstone scarp and relative flat plain below do not provide flexible topographic options for agricultural field placement and the deposits tend to be sandy, nutrient-poor, and porous. No evidence of prehistoric farming has been reported from the locale. However, during our early dry season fieldwork we did see
occasional pools of water above the calcrete layer within the river bottom, which could have been used by prehistoric pastoralists for livestock-watering.

**Table 4-3. Sinamatella River cut stratigraphic profile description (Sin08-3)**

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth (cm)</th>
<th>Soil Horizon</th>
<th>Field Texture</th>
<th>Description</th>
<th>Dep/Landform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-10</td>
<td>C</td>
<td>sandy loam</td>
<td>7.5YR4/2d; 7.5YR3/2m; NE w/10% HCl; surface duff</td>
<td>alluvium</td>
</tr>
<tr>
<td>2</td>
<td>10-50</td>
<td>A8b1</td>
<td>loam</td>
<td>7.5YR5/2d; 7.5YR3/2m; NE w/10% HCl; org rich; compact; st sab; many animal burrows; gradual lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td></td>
<td>50-57</td>
<td>BCb1</td>
<td>loam</td>
<td>7.5YR6/2d; 7.5YR3/2m; NE w/10% HCl; compact sab; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>3</td>
<td>57-85</td>
<td>C</td>
<td>loamy sand &amp; gravel</td>
<td>7.5YR6/2d&amp;m; NE w/10% HCl; bedded gravels &amp; coarse sands; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>4</td>
<td>85-115</td>
<td>C</td>
<td>sandy loam</td>
<td>7.5YR5/2d; 7.5YR5/2m; NE w/10% HCl; ox motting; abrupt lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>5</td>
<td>115-135</td>
<td>Ab2</td>
<td>sandy loam</td>
<td>7.5YR5/2d; 7.5YR5/2m; NE w/10% HCl; gradal lb</td>
<td>alluvial terrace</td>
</tr>
<tr>
<td>6</td>
<td>135-155</td>
<td>Bqb2</td>
<td>loamy sand</td>
<td>7.5YR6/2d; 7.5YR4/4m; NE w/10% HCl; wk sab w/silica films; medium-sand substrate; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>7</td>
<td>155-160</td>
<td>C</td>
<td>sand &amp; gravel</td>
<td>7.5YR5/2d&amp;m; NE w/10% HCl; loose; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>8</td>
<td>160-180</td>
<td>A8b3</td>
<td>loamy sand</td>
<td>7.5YR5/2d; 7.5YR4/4m; NE w/10% HCl; medium sand substrate; abrupt lb</td>
<td>channel bed</td>
</tr>
<tr>
<td>9</td>
<td>180-205</td>
<td>C</td>
<td>sand &amp; gravel</td>
<td>7.5YR5/2d&amp;m; NE w/10% HCl; bedded with subangular rocks up to 8 cm; abrupt lb</td>
<td>channel bed</td>
</tr>
</tbody>
</table>

Shumba

Shumba is a sink for much of the central portion of the study area, where waters begin to drain southward towards the Kalahari. Standing water is common in natural pans, but pumping of underground water now assures that resident hippopotamus have plenty of water. The substrate at Shumba is loose aeolian Kalahari sand (Sithole, 1994).

Grasslands dominate the vegetation with sparse clusters of trees concentrated on local high points.
A single sediment sample (10-A23) was augered in the sand sheet above the Big Shumba pan (Figure 4-10; Table 4-4). A thick, well-developed, organic-rich soil extends throughout the upper 150 cm. Organic and aeolian accumulation on this persistently developing grassland soil continues to thicken it. Pedogenesis has apparently kept pace with the aeolian deposition, suggesting no severe droughts have decreased the vegetation, or increased the depositional rate of sand accumulation, beyond a maintainable threshold. Below 150 cmbs, the sediments transition to what appears to be clean white quartz sand. However, silica and calcium carbonate coat the well-rounded quartz grains and are forming nodules in this seasonally saturated sediment.

The relatively loose sand at Shumba would not be able to sustain early plant cultivation due to limited nutrient availability, little topographic relief, and seasonal inundation. However, livestock may have been pastured there by village farmers who had
fields located elsewhere. No evidence of agropastoralism has been found at the locale, but Later Stone Age lithics are not uncommon on ground surfaces.

Table 4-4. Shumba 10-A23 stratigraphic profile description

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth (cm)</th>
<th>Soil Horizon</th>
<th>Field Texture</th>
<th>Description</th>
<th>Dep/Landform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-69</td>
<td>A</td>
<td>sand</td>
<td>10YR4/2d; 10YR3/2m; NE w/10% HCl; poorly sorted; loose</td>
<td>aeolian</td>
</tr>
<tr>
<td></td>
<td>69-125</td>
<td>Bw</td>
<td>clayey sand</td>
<td>10YR4/3d; 10YR3/2m; NE w/10% HCl; wk irregular peds w/silica; oxidized</td>
<td>aeolian</td>
</tr>
<tr>
<td></td>
<td>125-178</td>
<td>BC</td>
<td>sandy loam</td>
<td>10YR4/3d; 10YR3/2m; NE w/10% HCl; wk irregular peds w/silica; clear round quartz sand</td>
<td>aeolian</td>
</tr>
<tr>
<td>2</td>
<td>178-213</td>
<td>C</td>
<td>sandy loam</td>
<td>10YR6/3d; 10YR4/2m; NE w/10% HCl; redox mottling; clear round quartz sand; gley</td>
<td>aeolian</td>
</tr>
<tr>
<td>3</td>
<td>213-392</td>
<td>C</td>
<td>loamy sand</td>
<td>10YR8/2d; 10YR9/3m; STE w/10% HCl; silica nodules w/CaCO3 coatings; clear round quartz sand</td>
<td>aeolian</td>
</tr>
</tbody>
</table>

\[ \text{d} - \text{dry, m} - \text{moist, HCl} – \text{hydrochloric acid, NE} - \text{noneffervescent; VSE} – \text{very slightly effervescent, SLE} – \text{slightly effervescent, STE} – \text{strongly effervescent, VE} – \text{violently effervescent, veg} – \text{vegetation, wk} – \text{weak, sab} – \text{sub-angular blocky, lb} – \text{lower boundary, org} – \text{organic, mod} – \text{moderate, ox} – \text{oxidation, vs} – \text{very strong, vvs} – \text{very very strong, s} – \text{strong, vw} – \text{very weak} \]

**Josivanini Dune**

Two units were hand-excavated into the upper slope of one of the long, linear, stabilized dunes shown in Fig. 4-11. One of these was excavated down to 4 m below surface, and the other to 2 m. Charcoal and bulk samples for sieving were collected from the profiles. OSL samples were also taken, which are still being analyzed. Little soil development was revealed within the units (Fig. 4-11; Table 4-5), but several horizons were noted based on color changes, differences in compaction, and/or charcoal accumulation. Based on these slight differences, relic surfaces or erosional unconformities were provisionally noted at 90 cmbs, 160 cmbs, and 193 cmbs. These transitions reflect periods of dune reactivation often associated with fire, drought, and high winds (Lancaster, 1988; O’Conner & Thomas, 1999; Stokes et al., 1998; Haynes & Klimowicz, 2005). Wild fires left relatively large chunks of charred wood now buried in the dune, with a small sample
Fig. 4-11. Landsat Josivanini sample locations left, Jos Sand Unit 1 profile right (200 cm wide, 400 cm deep)

identified as coming from the same tree taxa found there today. These pieces of charcoal are especially common in discontinuous lenses at around 110 cmbs.

Agriculture could not be supported at Josivanini due to the lack of nutrients in this deep unconsolidated clean quartz sand with limited and seasonal surface water. The dune is currently covered in mixed Zambesi Teak woodland. No archaeological evidence from any period has been found on dune crests such as the Josivanini locality, but Stone Age

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Depth (cm)</th>
<th>Soil Horizon</th>
<th>Field Texture</th>
<th>Description</th>
<th>Dep/Landform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-10</td>
<td>A</td>
<td>loamy sand</td>
<td>10YR/4/4d; 10YR/3/2m; NE w/10% HCl; loose med rounded quartz sand; many charcoal flecks; gradual lb</td>
<td>aeolian</td>
</tr>
<tr>
<td></td>
<td>10-90</td>
<td>C</td>
<td>loamy sand</td>
<td>5YR/5/4d&amp;m; loose; NE w/10% HCl; fine to medium round quartz sand w/sesquioxides &amp; clay films; many termite runs and roots; gradual lb</td>
<td>aeolian</td>
</tr>
<tr>
<td>2</td>
<td>90-160</td>
<td>C</td>
<td>loamy sand</td>
<td>5YR/6d; SYR/4/4m; NE w/10% HCl; relatively compact; dense charcoal lense; many termite runs and root casts; abrupt lb</td>
<td>aeolian</td>
</tr>
<tr>
<td>3</td>
<td>160-193</td>
<td>C</td>
<td>loamy sand</td>
<td>SYR/8d; 2.5YR/4/4m; NE w/10% HCl; loose fine to medium round quartz grains with sesquioxides &amp; clay films; gradual lb</td>
<td>aeolian</td>
</tr>
<tr>
<td>4</td>
<td>193-200</td>
<td>C</td>
<td>loamy sand</td>
<td>SYR/8d; 2.5YR/4/4m; NE w/10% HCl; charcoal throughout; loose fine to medium round quartz grains with sesquioxides &amp; clay films</td>
<td>aeolian</td>
</tr>
</tbody>
</table>

lithics do occur around many of the interdunal troughs in the region. In addition, some of the seasonal pans have very small numbers of very Late Iron Age/Recent potsherds around them, which may indicate brief occupations by livestock herders or foragers using ceramics in the last two centuries (Haynes & Klimowicz, 1998).

**Geochronology**

Twenty-three radiocarbon assays are reported in Table 4-6. Materials were preferentially selected for analysis based on their potential for providing important temporal control of stratigraphic layers traceable across different landscapes (e.g., soils) and association with archaeological materials. Many of these ages were calculated from bulk sediment samples’ humate and residue fractions. These pairs were compared, and whichever provided the oldest age (generally the humate fraction) was accepted as the most reliable. This is because contamination by older carbon is less likely than by younger carbon (Holliday, 1995, 2004; Margin & Johnson, 1995; Walkington, 2010).

As the radiocarbon ages show (Table 4-6), the majority of the sediments within the study area date well within the past one and a half millennia, which is too recent to address the earliest evidence of agropastoralism and settled village life, given the earlier dates from the Kapula Vlei Early Iron Age site (Wriston & Haynes, 2009). This means that many of the sedimentary basin fills exposed within the natural river cuts have accumulated only within the relatively recent past. In addition, when these sediments are directly on top of bedrock, sediment packages of the appropriate age to address this period are missing. Determining what caused the scouring within these bedrock-
Table 4-6. Radiocarbon assayed material from stratigraphic profiles

<table>
<thead>
<tr>
<th>Area</th>
<th>Lab #</th>
<th>Locale</th>
<th>Depth (cmbs)</th>
<th>Material</th>
<th>$\delta^{13}$C</th>
<th>%C3</th>
<th>%C4</th>
<th>$^{14}$C age BP</th>
<th>+/− cal yrs BP*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapula River</td>
<td>AA95089</td>
<td>KRI4</td>
<td>85-87</td>
<td>charcoal</td>
<td>-24</td>
<td></td>
<td></td>
<td>1,790</td>
<td>37 1654</td>
</tr>
<tr>
<td></td>
<td>AA95105</td>
<td>KR08-3</td>
<td>95</td>
<td>sediment</td>
<td>-14.3</td>
<td>13</td>
<td>87</td>
<td>380</td>
<td>35 396</td>
</tr>
<tr>
<td></td>
<td>AA95105h</td>
<td>KR08-3</td>
<td>95</td>
<td>humates</td>
<td>-14.9</td>
<td>17</td>
<td>83</td>
<td>292</td>
<td>34 311</td>
</tr>
<tr>
<td></td>
<td>AA95094</td>
<td>KRL1</td>
<td>100</td>
<td>bovine tooth</td>
<td>-6.6/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AA95106</td>
<td>KR08-3</td>
<td>185</td>
<td>sediment</td>
<td>-18.1</td>
<td>40</td>
<td>60</td>
<td>825</td>
<td>35 705</td>
</tr>
<tr>
<td></td>
<td>AA95106h</td>
<td>Kr08-3</td>
<td>185</td>
<td>humates</td>
<td>-15.5</td>
<td>21</td>
<td>79</td>
<td>1,009</td>
<td>34 859</td>
</tr>
<tr>
<td>Bumbusi River</td>
<td>AA95102</td>
<td>Br08-3</td>
<td>50-70</td>
<td>sediment</td>
<td>-18.3</td>
<td>41</td>
<td>59</td>
<td>284</td>
<td>34 302</td>
</tr>
<tr>
<td></td>
<td>AA95102h</td>
<td>Br08-3</td>
<td>50-70</td>
<td>humates</td>
<td>-16</td>
<td>25</td>
<td>75</td>
<td>408</td>
<td>34 431</td>
</tr>
<tr>
<td></td>
<td>AA95100</td>
<td>10-A8</td>
<td>57-64</td>
<td>sediment</td>
<td>-19.1</td>
<td>47</td>
<td>53</td>
<td>278</td>
<td>34 295</td>
</tr>
<tr>
<td></td>
<td>AA95100h</td>
<td>10-A8</td>
<td>57-64</td>
<td>humates</td>
<td>-17.4</td>
<td>35</td>
<td>65</td>
<td>398</td>
<td>34 407</td>
</tr>
<tr>
<td></td>
<td>AA95103</td>
<td>Br08-3</td>
<td>145-150</td>
<td>sediment</td>
<td>-15.9</td>
<td>24</td>
<td>76</td>
<td>487</td>
<td>35 504</td>
</tr>
<tr>
<td></td>
<td>AA95103h</td>
<td>Br08-3</td>
<td>145-150</td>
<td>humates</td>
<td>-19.4</td>
<td>49</td>
<td>51</td>
<td>549</td>
<td>34 529</td>
</tr>
<tr>
<td></td>
<td>AA95101</td>
<td>10-A8</td>
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<td>-15</td>
<td>18</td>
<td>82</td>
<td>812</td>
<td>35 700</td>
</tr>
<tr>
<td></td>
<td>AA95101h</td>
<td>10-A8</td>
<td>170-183</td>
<td>humates</td>
<td>-15.4</td>
<td>21</td>
<td>79</td>
<td>863</td>
<td>34 728</td>
</tr>
<tr>
<td></td>
<td>AA95096</td>
<td>Br09-1</td>
<td>205</td>
<td>charcoal</td>
<td>-23.9</td>
<td></td>
<td></td>
<td>573</td>
<td>36 539</td>
</tr>
<tr>
<td></td>
<td>AA95104</td>
<td>Br08-3</td>
<td>300</td>
<td>sediment</td>
<td>-18.4</td>
<td>42</td>
<td>58</td>
<td>1,347</td>
<td>35 1228</td>
</tr>
<tr>
<td></td>
<td>AA95104h</td>
<td>Br08-3</td>
<td>300</td>
<td>humates</td>
<td>-18.1</td>
<td>40</td>
<td>60</td>
<td>1,466</td>
<td>35 1328</td>
</tr>
<tr>
<td>Deteema</td>
<td>AA95107</td>
<td>Dtma09-1</td>
<td>335-345</td>
<td>sediment</td>
<td>-15.6</td>
<td>22</td>
<td>78</td>
<td>2,206</td>
<td>39 2176</td>
</tr>
<tr>
<td></td>
<td>AA95107h</td>
<td>Dtma09-1</td>
<td>335-345</td>
<td>humates</td>
<td>-17.4</td>
<td>35</td>
<td>65</td>
<td>2,133</td>
<td>36 2068</td>
</tr>
<tr>
<td>Sinamatella</td>
<td>AA95108</td>
<td>Sin08-L3</td>
<td>140-145</td>
<td>sediment</td>
<td>-20</td>
<td>54</td>
<td>46</td>
<td>3,580</td>
<td>38 3819</td>
</tr>
<tr>
<td></td>
<td>AA95108h</td>
<td>Sin08-L3</td>
<td>140-145</td>
<td>humates</td>
<td>-17.2</td>
<td>34</td>
<td>66</td>
<td>2,902</td>
<td>37 2978</td>
</tr>
<tr>
<td>Josivanini</td>
<td>AA95097</td>
<td>JosSu2</td>
<td>110</td>
<td>charcoal</td>
<td>-23.7</td>
<td></td>
<td></td>
<td>2,574</td>
<td>38 2606</td>
</tr>
<tr>
<td></td>
<td>AA95098</td>
<td>JosSu2</td>
<td>110</td>
<td>charcoal</td>
<td>-27.3</td>
<td></td>
<td></td>
<td>415</td>
<td>35 445</td>
</tr>
</tbody>
</table>

*Mean probability 2-sigma (95%) calibration; calibrated using Calib 7.0 SHCal13 (Stuiver et al. 2013)
**Bovine tooth corrected by 10.5% for fractionation/trophic level (DeNiro & Epstein 1978; Lee-Thorp et al. 1989)

Constrained tributaries requires that we look in different systems for other lines of evidence. For instance, at Josivanini, dune building and wildfires occurred near the same
time as scouring in the Bumbusi Basin. These processes can be satisfactorily explained as the effects of sustained drought and erratic rainfall, although another possibility is that early farmers de-stabilized sediments in their attempts to farm this new territory and set fires to clear the area of tsetse fly-infested woodland habitat (cf. Haynes & Klimowicz, 2005).

DISCUSSION

Soil Stratigraphy and Landscape Evolution

Although sediments of the appropriate age to address the earliest days of agropastoralism have not been preserved in much of the study area, some important chronostratigraphic trends did emerge from the sampling project. As Fig. 4-12 shows, representative samples from the six different localities in Hwange National Park can be related by comparing common stratigraphic markers (e.g., soils, unconformities) and radiocarbon ages.

Within the Bumbusi River and Kapula River basins, the alluvial sequences correlate well, with periods of stability marked by weak, but identifiable soil development at ca. 400 $^{14}$C yrs BP (408 cal yrs BP), 550 $^{14}$C yrs BP (532 cal yrs BP), and between 860 and 1000 $^{14}$C yrs BP (732 and 857 cal yrs BP; Fig. 4-12). Within this region, soil development often indicates greater than average rainfall received in incremental amounts during the growing season. Therefore, these periods of soil development are interpreted as mesic intervals when the landscape stabilized. However, these soils are often separated by flood and channel deposits that indicate climatic volatility and possible drought.
Within the upper Bumbusi River, a piece of charcoal dating 573 $^{14}$C yrs BP (539 cal yrs BP) was found on top of a well-cemented bedded gravel that contained a secondarily-deposited levallois-like (Middle Stone Age) lithic flake. If these temporal indicators are accurate, the sediments from a time range of 30,000 years or more are missing. Another illustration of this is seen at the archaeological site just upstream from the upper Bumbusi River sampling locus, where Late Iron Age ceramics are intermingled with a Middle Stone Age lithic assemblage. Further downstream, late Holocene sediments began accumulating on top of Pleistocene-age sediments (red in color, strong cementation) around 1500 $^{14}$C yrs BP (1352 cal yrs BP).

The youngest dated soil in the Bumbusi River Basin is ca. 400 $^{14}$C yrs BP (408 cal yrs BP) in age. This soil is overlain by another, younger soil that is likely several hundred years old and is comprised of fine-grained overbank alluvium. However, the current channel is 4 m below this ca. 200 year old overbank deposit. What this suggests is that at least 2 m of downcutting has occurred during the past two centuries within the Bumbusi River. Based on historic accounts of Kapula Vlei, we know this to be true there: 1 to 2 m of downcutting has occurred since the 1960s (Anon. National Park staff, personal communication 2008) (Fig. 4-7).

At Deteema, abundant material has accumulated over the past 2200 $^{14}$C yrs (2164 cal yrs BP), including standing water deposits, channel fill, and overbank alluvium. Deposits at Sinamatella are more conservative, and a date of 3580 $^{14}$C yrs BP (3819 cal yrs BP) on a soil around 120 cmbs suggests relatively low sedimentation rates and little potential for preservation if cultural deposits exist, particularly within the channel gravels.
between 55-75 cmbs. Within Josivanini Dune, horizonation is slight but detectable.

Radiocarbon ages of 2574 $^{14}$C yrs BP (2606 cal yrs BP; Table 6) and 2730 $^{14}$C yrs BP (2805 cal yrs BP; Haynes unpublished data) from chunks of charcoal burned during wildfires, combined with re-activation of the dune and deposition of around 120 cm of aeolian sand, suggest that drought and volatility characterize this time period. Another date of charcoal was stratigraphically reversed, but given that it is directly dated to 415 $^{14}$C yrs BP (445 cal yrs BP), we know that a wildfire also burned here during that time, even while soils were forming within the loamy sediments of Bumbusi River and Kapula Vlei. This may reflect increased fuel loads coupled with normal dry season aridity and ignition. Within the Shumba deposits, no indicators of environmental change are evident, and soil development has kept pace with the aeolian accumulation above the waterlogged sands within this sink.

General characterization of changing vegetation patterns due to changing environmental conditions can be calculated using the $\delta^{13}$C values of the radiocarbon assays. Within Bumbusi River, conditions around 1466 $^{14}$C yrs BP (1324 cal yrs BP) are relatively mesic (60% $C_4$ plants) compared to 863 $^{14}$C yrs BP (728 cal yrs BP), when the percent of $C_4$ grasses increases to 79% (Table 4-6). However, the 863 $^{14}$C yrs BP (728 cal yrs BP) layer also had a lithic flake in the auger bucket, and the increase in the percentage of $C_4$ plants here may reflect farming of $C_4$ crops rather than a climatic signature. By 549 $^{14}$C yrs BP (529 cal yrs BP), conditions again became more mesic, with $C_4$ plants dropping down to 51% of the vegetation cover. Within Bumbusi basin, the ca. 400 $^{14}$C yrs BP (408 cal yrs BP) soil ranges from 65-75% $C_4$ plants, suggesting
warmer conditions than at 549 $^{14}$C yrs BP (529 cal yrs BP), but a more mesic period than 
at 863 $^{14}$C yrs BP (728 cal yrs BP).

At Kapula Vlei, C$_4$ plants dominate throughout, making up 79% of the plant cover 
at 1009 $^{14}$C yrs BP (859 cal yrs BP) and 83% of plant cover at 380 $^{14}$C yrs BP (396 cal 
yrs BP). At Deteema and Sinamatella, we do not have a sequence to compare change 
over time, but at Deteema the 2206 $^{14}$C yrs BP (2176 cal yrs BP) sediments are 
comprised of 78% C$_4$ plants, while at Sinamatella at 3580 $^{14}$C yrs BP (3819 cal yrs BP), 
C$_4$ plants made up only 46% of the vegetation. Given modern vegetational characteristics 
of these areas, these values likely reflect the different substrates and topography of their 
respective systems rather than broad scale climatic changes.

**Archaeological Implications**

Geomorphological investigations in Hwange National Park have revealed several trends 
important in our search for the earliest evidence of agropastoralists in the area. Although 
pockets of preserved sediments and soils of this age exist, such as at Kapula Vlei, they 
are not widespread, and may be missing completely from the Bumbusi River basin. 
Based on Scudder’s (1971, 1976) study of the Gwembe Tonga people, key environmental 
variables that determine agropastoralist success include: the amount of precipitation, 
variance in sediment textures and topographic positions for fields in relatively close 
proximity to each other, and, most importantly, loam alluvial terraces. Given these 
criteria, Shumba, Sinamatella, and Josivanini would not have been attractive locations for
Fig. 4-12. Stratigraphic correlations across the study area
the cultivation of plants by early farmers, whose minimal preference would have been alluvial valleys with loamy sediments and varied topography. Insufficient information has been collected at Deteema to judge whether or not this area would have drawn early agropastoralists, but given that reliable surface water seems to be available year round here, and that it has deposits of appropriate age, it should be investigated further. The Bumbusi River drainage basin may have drawn early agropastoralists to the area given the relatively reliable waters, loamy sediments, varied textures, and elevational gradients. However, most of the uplands are too sandy for plant farming. In addition, before around 1500 \(^{14}\text{C}\) yrs BP (1352 cal yrs BP), sediments have been scoured from the basin, taking any evidence with them. Also, excavations in nearby Impala and Ngabaa Rockshelters did not find any evidence of Early Iron Age cultural markers, such as combstamped ceramics, within the hunter-gatherer assemblage dating to this time (Wriston & Haynes, unpublished data).

Given the evidence presented, the focus of investigations seeking archaeological materials created by the earliest agropastoralists in the region should focus in the Kapula Vlei area and other localities with similar characteristics elsewhere in northwestern Zimbabwe. Furthermore, we speculate that sites similar to Deteema also have the potential to reveal as yet undiscovered Early Iron Age archaeological and sedimentological deposits. Of course, additional stratigraphic documentation and analysis are needed to determine the nature of the seep at Deteema, characterize the deposits, and inspect the surrounding slopes.
Overview

Within Kapula Vlei, pits dating to between 1990 and 1790 $^{14}$C yrs BP (1901 and 1654 cal yrs BP; Wriston and Haynes, unpublished data) were apparently excavated into the same soil as those dated ca. 1200 $^{14}$C yrs BP (1061 cal yrs BP), suggesting surficial stability over this time. However, preceding the earliest farmers occupation, the dune accumulations at Josivanini beginning around 2730 $^{14}$C yrs BP (2805 cal yrs BP; Haynes, unpublished data) and extending later than 2574 $^{14}$C yrs BP (2606 cal yrs BP) show that the climate was volatile. Volatility is also evident in the scouring of upper, bedrock-constrained tributaries such as the Bumbusi River. Fortunately, Kapula Vlei is within a broad basin with abundant fill, making degradation and erosion of all its fill much less likely. During modern times, the lack of surface water during the dry season (outside of the pumped Masuma Dam) would make year-round occupation difficult, even if the crops grew well here during the wet season and a second cropping from the clay loam alluvial terrace was possible. It follows that at ca. 1200-1100 and 1990-1790 $^{14}$C yrs BP (ca. 1061-963 and 1901-1654 cal yrs BP), less distinct seasonality in rainfall distribution and more mesic conditions were necessary to successfully farm the area and maintain permanent villages. We have not yet discovered any direct archaeological evidence of early livestock herding (pastoralism) associated with these settlements. Plug (1997) suggested that agricultural villages in northeastern Zimbabwe did not keep domestic animals due to disease vector prevalence, and instead relied on hunting, most particularly of buffalo. This adaptation may have been preferred by early plant farmers in today’s Hwange National Park, where game is plentiful.
CONCLUSION

In this study, we show how understanding the geomorphic system is essential to focusing future research strategies. Tremendous landscape evolution has occurred in Hwange National Park over the past three millennia due to drought, which likely began around 2730 $^{14}$C yrs BP (2805 cal yrs BP) and continued for several hundred years. This drought may have depleted disease vectors and woodlands within the study area and caused downcutting and scour of drainage basin fill. By the time the earliest agropastoralists arrived ca. 1990-1790 $^{14}$C yrs BP (1901-1654 cal yrs BP), conditions had become more mesic, with sediment fill beginning to accumulate and soil development beginning as early as 1466 $^{14}$C yrs BP (1324 cal yrs BP), even in bedrock-constrained upper tributaries such as the Bumbusi River. Although early agropastoralists’ land use in this volatile climatic regime may have contributed to some of the subsequent downcutting and channel switching, the landform reshaping was more likely caused by natural climatic variability, given the nature of the system.

In 1928, when the precursor to today’s Hwange National Park, the Wankie Game Reserve, was created, both agropastoralists and hunter-gatherers were still using the area. This suggests that people with very different resource procurement systems may have minimized risks and benefited by participating in interdependent trade and social interactions. This is an efficient strategy in a drought-prone area with numerous factors largely out of anthropogenic control (cf. Ellis & Swift, 1988; Homewood, 1994; Dublin, 1995; Sullivan, 1999; Laris, 2003), such as disease outbreaks, drought, and famine. Perhaps for these reasons, as Smith (2000) and others have discussed, there was never a complete abandonment of hunting-and-gathering or foraging activities even as new
people or new ideas were introduced into the area. Hybrid ways of life with pastoro-foragers (Elphick, 1977; Wilmsen, 1989, 1991; Kinahan, 1991), pastoro-fishermen, pastoro-miners, agropastoralists, and specialized pastoralists and agriculturalists all co-existed and often traded foodstuff and other services (e.g., Goula in Clark, 1976).

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CHAPTER 5. DISCUSSION AND CONCLUSIONS

DISCUSSION

This dissertation investigated how and why food production, or agropastoralism, spread into northwestern Zimbabwe. The research objectives were to: 1) establish the character and distribution of the late Holocene archaeological record before, during, and after the adoption or introduction of agropastoralism; 2) determine whether strontium isotope analysis of ostrich eggshell beads and fragments can be used to determine which of these artifacts are of local origin so that the carbon and oxygen isotope ratios of those same materials can be used to determine past climatic conditions; and 3) establish what environmental and climatic conditions or events are reflected in the Hwange rockshelter deposits, basin geomorphology, alluvial stratigraphy, and augered sediment samples. My findings indicate that food production was introduced while hunter-gatherer populations were low and when the landscape was recovering from a long drought. Summary findings of each article are outlined below.

Within Chapter 2, the local archaeological signature and chronological record was determined using data from controlled excavation of Impala and Ngabaa Rockshelters on Bumbusi Ridge and salvage excavation 30 km away at the Kapula Vlei open-air site. The bulk of the fills in Impala and Ngabaa Rockshelters are anthropogenic and of hunter-gatherer origin. Impala Rockshelter is relatively large and was occupied as early as 6000 cal yrs BP, with increasing use that culminated in it serving as an aggregation site for a number of families ca. 4-3000 cal yrs BP, and creation of the unique animal spoor engravings on the rockshelter walls. Abandonment after ca. 3000 cal yrs BP is marked
by the lack of rockshelter fill until ca. 2450 cal yrs BP, when infrequent use began, continuing until ca. 1850 cal yrs BP, when Impala Rockshelter was abandoned in favor of the nearby smaller Ngabaa Rockshelter that began accumulating anthropogenic fill at this time.

The archaeological assemblages of these rockshelters can be characterized as typical of Wilton-like microlithic industries that relied on composite technology. Detailed analysis of tool type variation and frequencies were described and indicate the relative importance of large or medium game hunting versus small game gathering, leather work, and ostrich bead manufacture through time. During the past ca. 800 years, there was a relative increase in bones of medium and large sized game that corresponded with the growing importance of bone point technology at the expense of microlithic crescents, implying advances in the use of poison-tipped bone points to hunt game (cf. Bousman 1998) at the same time that incorporation of Late Iron Age artifacts, such as ceramics, regularly began to occur. Agropastoralists expanded into the Bumbusi area around this time, and eventually built a stonewalled village now recorded as Bumbusi National Monument on the slope a short distance below the rockshelters that incorporated outlying walled platforms along the ridge and basin perimeter. However, the village at Bumbusi was occupied well after farming had been first introduced to the area, as indicated by data from the Kapula Vlei site, which was possibly established by 1900 cal yrs BP.

The Kapula River cut bank revealed evidence of a settled village, use of copper bangles, and an assortment of comb-stamped, bead-stamped, and channeled thickware ceramics, similar to Early Iron Age ceramics found elsewhere in southern Africa.
Although wild game hunting by these early farmers is indicated by animal bones and teeth exposed in the stream cut bank, no evidence of domesticated animals has so far been firmly identified. In addition, a notable lack of microlithic material, ostrich eggshell beads, or other Wilton-like materials that would indicate contact with native hunter-gatherers, suggest that the Kapula Vlei site’s early farmers were indeed migrants rather than Khoisan hunter-gatherers that decided to farm.

Chapter 3 established a new application of ostrich eggshell strontium isotope analysis to help define which of these artifacts are of local origin. The results show that strontium isotope analysis can be used in this way and holds promise in sourcing ostrich eggshells from prehistoric sites as strontium isotope basemaps are established using data signatures from both water and small animal remains that can be compared to ostrich eggshell strontium results. For my paleoenvironmental reconstructions, I discarded the extra-local ostrich eggshell data as revealed by the strontium study, and undertook an analysis of stable carbon and oxygen isotopes to characterize past vegetational communities and climatic conditions surrounding Impala and Ngabaa Rockshelters. The isotope data reflect whether the environment was cool and/or wet, favoring $C_3$ woodlands, or warm and/or dry, favoring $C_4$ grasslands. It is recognized that this sort of reconstruction would benefit from direct dating of each sample rather than relying on their buried context, given that small artifacts may move through the profile. In addition, given the anthropogenic nature of the rockshelter fill, their proposed times of abandonment, presumably during harsh environmental conditions, are not represented in the depositional record, and other proxy data must be found to fill in these gaps.
Chapter 4 compared the geomorphic sequences and periods of soil development from six different areas, to examine large scale geomorphic processes. The geology, sediment types, and soil development within each area were inspected and documented for their potential to support early farming activity. The results show that the broad basin of Kapula Vlei may have been the best place for early farmers because of the mixture of sediments derived from both fine and coarse-grained bedrock, the clay loam terraces, deep soils, and local topographic relief. This combination of factors would allow shifting placement of cultivated crops to follow the changing moisture conditions of sediments at different elevations and/or parent material, from the seasonal wet period to the early dry period of the year, as well as during differing climatic conditions. However, overall mesic conditions would have been required in this now relatively dry area. The Deteema locality also shows promise to provide future evidence of the earliest farmers given its reliable spring waters, varied topography, and sediments of the appropriate age. The Bumbusi River drainage has clay loams within the lower river terraces that may have had appeal for early farmers, but the basin was scoured just before their arrival, and had just begun to accumulate sediments within catchments ca. 1350 cal yrs BP. In contrast, due to poor substrate or topographic conditions, the other tested localities, Josivanini, Shumba, and Sinamatella, were shown to have little to offer early farmers.

All three chapters contain data and information important for general paleoenvironmental reconstructions, and help balance the record given their different inputs and scale. Chapter 2 provides temporal control of human occupation and adaptations to the environment, while Chapter 3 provides detailed information of vegetational communities during the ostrich egg-laying season, just after the onset of the
Fig. 5.1. Paleoclimatic reconstruction data and summary
Chapters 4 provides a broad-scale geomorphic and soil landscape model that shows both periods of stability and drought. By combining all of these data, development of a paleoclimatic model was possible, as shown in Fig. 5-1.

This paleoclimatic model was then compared with the archaeological record once more to analyze how environmental factors affected the spread of agropastoralism, or food production, within Hwange National Park. Fig. 5-2 shows the paleoclimatic model split by cultural units determined from the archaeological excavations, and illuminates how environmental conditions interacted with cultural developments and adaptations to either encourage or discourage occupation of the study area, or influence which tasks were emphasized.

Although paleoclimatic information is limited for the Middle Holocene Wilton cultural complex, the information available shows that mesic conditions prevailed when Impala Rockshelter was first occupied; however, the sparse climatic indicators also show at least one drought during the period (Fig. 5-2). The Late Holocene Wilton began more mesic than today, but with a dramatic drought evident before a sustained, relatively cool and/or wet period led to woodland expansion before ca. 3500 cal yrs BP. This time period supported greater hunter-gatherer populations than any other; however, this was short lived, as drought and climatic volatility becomes the norm by ca. 3000 cal yrs BP (Fig. 5-2). Between ca. 3000 and 2300 cal yrs BP, a sustained drought led to human abandonment of the area, dune reactivation along the margin of the Kalahari, woodlands burnt by wildfires, and basins scoured to bedrock (Fig. 5-2).
Small task or family groups still occasionally occupied Impala Rockshelter during the Post-Wilton phase ca. 2400 cal yrs BP to hunt medium-sized game and trap and collect small game, in addition to manufacturing ostrich eggshell beads, and painting, or possibly engraving, more rock art. Environments improved over this period, with relatively mesic conditions by ca. 2000 cal yrs BP (Fig. 5-2). Sediments slowly began accumulating in catchments again and woodlands began to recover. This is the environment which the earliest farmers entered.

Woodlands, and presumably tsetse fly habitat, were in recovery from the previous long drought, and surface water was more readily available than today. Importantly, climatic fluctuations become more subdued than in the past. Droughts or extended dry periods occurred, but were relatively short-lived and of lower amplitude (Fig. 5-2). Hunter-gatherers and the earliest farmers lived 30 km from each other, but apparently with little sustained contact. Hunter-gatherers began using smaller rockshelters probably due to their smaller group size, and previous aggregation sites were virtually abandoned, suggesting changes in the trade (hxaro) network or practice. However, favored trade items, such as microlithic crescents (segments) and ostrich eggshell beads were still manufactured, and leather work tools, such as scrapers, were deposited in greater numbers.

Around ca. 800 cal yrs BP, the archaeological record reflects the growing impact of agropastoralists on hunter-gatherers living in the uplands. For the first time, there was continuous contact between the two groups as agropastoralists moved in the Bumbusi River basin, possibly due to growing populations and the increasing frequency of short-term droughts (Fig. 5-2).
Fig. 5-2. Paleoclimatic summary and cultural units
Regionally, environmental conditions reflected by the Hwange proxy records are part of a complex system that reflects strengthening of anti-cyclonic circulation that began as recently as 5000 years ago—when modern synoptic patterns began to emerge (Deacon 1995; Deacon and Lancaster 1988) and modern plant and animal communities were established (also see Marchant and Hooghiemstra 2004).

Differences between regions of southern Africa should be expected as local environments respond to changes in global circulation patterns and climatic conditions. To the west of Hwange, in Namibia and Botswana, much of the proxy data suggest dry conditions between 7875 and 4500 years ago. However, after 4500 years ago, cores from Okavango Panhandle reflect progressively moister conditions with wettest between 2300-1000 years ago (Nash et al. 2006). Stalagmites from Drotsky’s Cave (Cooke 1984; Cooke and Verhagen 1977; Shaw and Cooke 1986; Thomas and Shaw 1991) suggest wet periods just west of the Okavango delta at 6900 to 5800 years ago, 4500 years ago, 2000 years ago, and 750 years ago. Robbins, et al.’s (1998) work at Toteng shows that Lake Ngami (southeastern margin of the Okavango Delta) rose 4600-3700 years ago, but the best evidence of shoreline occupation was an LSA assemblage dated to between 4275 and 2460 years ago. In the Makgadikgadi Depression, located south of Hwange, lake levels were elevated between 1700 and 1500 years ago (Deacon 1984b). In the central Namib, Chase (2009a; Chase et al. 2010) has used fossilized hyrax middens to derive high-resolution stable carbon and nitrogen isotope records spanning the Holocene. Results indicate relatively humid conditions from 5600 to 4900 years ago and 4200 to 3500 years ago, with a rapid transition to marked aridity lasting from 3500 to ca. 300 years ago (Chase et al. 2009).
In South Africa, the most recent interpretations (Scott et al. 2003) of pollen and dated peat sequences at Wonderwerk suggest warmer temperatures 9500-6000 years ago followed by cooling, with temperatures reaching their lowest by c. 3000 years ago (Scott et al. 2003). Low temperatures and dry conditions at 3250 years ago are also represented at Tswaing (Finch and Hill 2008; Scott 1999; Scott et al. 2003). Although Jubilee Shelter in the Transvaal had only minor fluctuations in vegetation and macrofauna (Turner 1986; Wadley 1986), the abundance of deposits dating to between 7400 and 3375 years ago, suggest some sort of unexplained geomorphic control change, possibly due to increasing hunter-gatherer use and accumulation of anthropogenic sediments. Stalagmite isotopic records from the Canga Valley ca. 3000-2000 years ago reflect an increase in valley grasses due to high summer temperatures (Talma and Vogel 1992). Deacon (1995) takes this further, as representing a shift in the season of precipitation, with increased summer precipitation allowing C4 grasses to compete with C3 grasses. Deacon (1984) recognized that the southern Cape is a patchwork of paleoenvironmental evidence that is often contradictory in nature.

Northward in Zambia, Stager (1988) shows that Lake Cheshi levels exhibit an abrupt dry episode at c. 3250 years ago. Similar findings are shown in cores from Lake Rukwa, Tanzania (Talbot and Livingstone 1989). O’Connor and Thomas (1999) retrieved OSL dates from linear dunes in southern Zambia, and found that dune construction episodes (and presumably persistently drier conditions) 10-8000 and 5000-4000 years ago due to decreased effective precipitation.

Within Zimbabwe little paleoenvironmental work has been completed, much to the lament of Walker (1995) as he was studying archaeological evidence from the
Matapos. Here he found that between 6900 and 5150 years ago, few sites were occupied relative to previous time periods and only by small groups that were trapping small game. After ca. 5150 years ago, larger caves were occupied by larger bands. Further east, at Malilangwe, Thorp (2004) found that hunter-gatherers were present in the lowveld by 8900-7025 years ago. Numerous Early Farming Communities were also documented in the lowveld that are assumed to date to around 1500 years ago, suggesting environmental conditions conducive to agropastoralism. However, hunting-and-gathering sites persist until at least 800 years ago, indicating a long period of overlap (Thorp 2004).

The proxy data found throughout southern Africa does not always agree, making cohesive, well-supported conclusions about environmental change in southern Africa during the mid-to-late Holocene difficult, and instead points out the necessity of understanding local responses to any atmospheric and global driving forces. This is partly due to the improved preservation and recovery of various types of proxy data from the late Holocene. Because of this, we can reconstruct a much more detailed record, along with all of the messiness that we know occurs in modern times, but making it difficult to reconstruct trends (Burrough et al. 2009; Jones et al. 2009; Thomas 2008). However, understanding the complexity of the system should be the goal. As Shaw and Cooke (1986) point out, conclusions based on large-scale studies are over-simplified. As H.J. Deacon (1984) noted, we need complementary lines of evidence to support inferences drawn from single data points. For instance, geomorphic data tends to provide information on past rainfall and groundwater levels, while biological data better inform about temperatures (Thomas and Shaw 1991). Kiage and Kam-biu (2006) also call for palynological studies that have good temporal resolution and emphasize multi-proxy
methodologies. In this way, we can begin to separate anthropogenic causes from seasonal variation and other cyclical drivers or patterns.

Paleoenvironmental work in South Africa, Botswana, and Namibia has made great strides during the past thirty years. However, Zimbabwe and Zambia remain largely unknown. To echo Deacon and Lancaster’s (1988: 163) sentiment for southern Africa made over twenty years ago, “the details still need resolution”. A relatively abundant number of studies of large-scale geomorphological systems (e.g., lake systems, large dune fields) have been carried out in the Kalahari Desert for instance, but relatively few small-scale (e.g., caves and rockshelters), regionally-specific detailed analyses (Deacon and Lancaster 1988; Lancaster 1989; Shaw and Cooke 1986).

Historic-era inhabitants of Zimbabwe had to have flexible economies and/or strategies due to the dramatic fluctuations in rainfall from year-to-year (cf. Yellen 1977). In general, rainfall amount, duration, and timing is unpredictable (Nyamapfene 1991) in Zimbabwe, and our data show that although this has always been the case, slightly more mesic periods, or periods of sustained drought, may have greatly impacted cultural developments and population movements throughout southern Africa.

**CONCLUSION**

This study has established a local chronological sequence of material culture, analyzed its distribution, and put it within environmental context. The unique animal spoor engravings on the rockshelter walls date to when Impala Rockshelter was used as a large aggregation site ca. 4-3,000 cal yrs BP. In addition, a pioneering method was introduced using strontium isotope analysis to establish which ostrich eggshell artifacts and ecofacts are of local origin and can be used in climatic reconstructions. Field investigations
discovered one of the earliest settled farming village sites in south-central Africa and
geomorphic analysis has outlined where future investigations should focus concerning the
earliest farmers in the region. The data show that the earliest farmers were migrants into
the region rather than native hunter-gatherers who had adopted farming. However, the
hunter-gatherer population was relatively low during a sustained and especially severe
drought between ca. 3000 and 2450 cal yrs BP. Furthermore, as shown in this
dissertation, landscape use by hunter-gatherers and early farmers was distinctly different,
allowing them to live near each other with little contact, until agropastoralists began to
spread into less arable basins and the cultural assemblages begin to intermix after ca. 800
cal yrs BP. However, hunting and gathering persisted alongside agropastoralism until the
colonial-period Wankie Game Reserve was established by government decree in 1928. It
is likely that agropastoralists could not cope with the volatile climatic conditions in the
study area without supplementing diets with hunting and gathering.

This dissertation is only the first step towards comprehending what environmental
and cultural variables led to food production’s spread through south-central Africa, and
can be improved on several fronts. Namely, controlled excavation at Kapula Vlei could
provide additional information about the earliest farmers in the region. Also, expanding
the sample of analyzed artifacts to include other units from the Impala Rockshelter
excavations would test whether or not the initial sample is replicable or the result of an
inadvertent focus on task-specific activity areas that changed through time. Radiocarbon
assay of far more ostrich eggshell fragments used in the paleoenvironmental
reconstructions would solidify the temporal control of this data. And, lastly, revisiting
the Deteema locality to carry out more detailed stratigraphic investigations and
archaeological survey would also determine whether this area has potential for additional information about the first agropastoralists in the study area.

The three studies presented in this dissertation show how multiple lines of evidence are necessary to achieve a good understanding of prehistoric lifeways and the day-to-day decisions and activities that produce the archaeological record. Although much remains to be done, this study is the first to establish local archaeological and environmental sequences, forming a base on which to build an understanding of the complex interplay between hunter-gatherers and the first agropastoralists in south-central Africa, and for predicting how modeled climate changes expected in the future may affect Hwange National Park.
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