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Early to Middle Holocene human adaptations on the Buri Peninsula and Gulf of Zula, coastal lowlands of Eritrea

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Recent excavations at three sites on the Red Sea coast of Eritrea revealed early-middle Holocene human occupations. Marine shells were found in close association with lithic artefacts at the sites, suggesting a coastal economy. Two broad occupation phases have been recognised: i) eighth millennium BP settlements at Gelalo NW and Misse East; and ii) a sixth millennium BP occupation at Asfet Unit F. Environmental changes and/or autocatalytic niche broadening mechanisms may have stimulated prehistoric human adaptations on the Eritrean coast. Drawing upon the archaeological evidence from the three excavated sites, this paper discusses the chronological and cultural contexts of early-middle Holocene human adaptations on the Red Sea coast of Eritrea.

Keywords: Red Sea coast; Eritrea; Later Stone Age; early-middle Holocene

Des fouilles récentes sur trois stations archéologiques sur la côte érythréenne de la Mer Rouge ont révélé des occupations humains de l'Holocène ancien et moyen. Les coquilles marines trouvées en association avec des outils lithiques suggèrent une économie littorale. Deux phases principales d'occupation sont reconnues: i) les sites de Gelala Nord-Ouest et de Misse Est du huitième millénaire BP; et ii) une occupation du sixième millénaire BP au site de Asfet Unit F. Des changements environnementaux et/ou des mécanismes autocatalytiques d'expansion des niches écologiques ont pu encourager les adaptations humaines préhistoriques sur la côte érythréenne. En employant les témoignages archéologiques des trois sites fouillés, cet article présente les contextes chronologiques et culturels des adaptations humaines pendant l'Holocène ancien et moyen sur la côte érythréenne de la Mer Rouge.

Introduction

The African side of the Red Sea basin has seen little archaeological research. The geographical position of Eritrea adjacent to the Red Sea, with over 1000 km of coastline, makes it an ideal place to look for evidence of prehistoric coastal habitation. Although archaeological discoveries from the historic and protohistoric periods have been made in Eritrea (Salt 1814; Lefebvre 1845–49; Paribeni 1907; Anfray 1961; Fattovich 1977), the Stone Age of the country has remained poorly known due to protracted political instability. The first evidence for early human presence along the Red Sea coast of Eritrea has come from the site of Abdur (on the eastern side of the Gulf of Zula), where handaxes and artefacts with Middle Stone

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Age (MSA) affinity were found within an emerged coral reef terrace dating to ~125 kya (Walter *et al.* 2000).

Subsequent to the Abdur discovery, the first archaeological reconnaissance on the Eritrean coast took place in 2005 (Beyin and Shea 2007), followed by two seasons of survey and excavation in 2006 (Beyin 2009). The project's goal was to gather archaeological data with which to elucidate the ecological, cultural and chronological backgrounds of prehistoric human adaptations on the African side of the Red Sea. The survey covered an approximately 400 km^2 area of the Buri Peninsula and the Gulf of Zula (Buri-Zula). Sites were documented from near coastal and inland landscapes. Three sites, namely Asfet, Gelalo NW and Misse East (Figure 1) were selected for excavation and formed the basis of the author's dissertation work (Beyin 2009). The excavations revealed early-middle Holocene (8000-5000 BP) cultural adaptations featuring typical Later Stone Age (LSA) artefacts found in close association with marine shells. This article synthesises the cultural and chronological contexts of these three sites.

Environmental context of the study region

The research area (Figure 1) has an altitudinal range of -8 to 80 m above sea level (asl). It is the driest part of Eritrea today, with a growing season of less than 75 days and annual precipitation of less than 200 mm (Government of Eritrea 1999). Plant cover consists of mangrove vegetation that grows along the muddy shorelines, sparsely distributed halophytic *Acacia* communities (*A. tortilis, A. mellifera*, *A. nubica)*, low shrubs and grass (Yohannes 2003). Common wild animals include ostrich, Soemmerring's and Dorcas gazelles, hamadryas baboon, dikdik, spotted hyena, and one of the last free-ranging populations of African wild ass (*Equus*

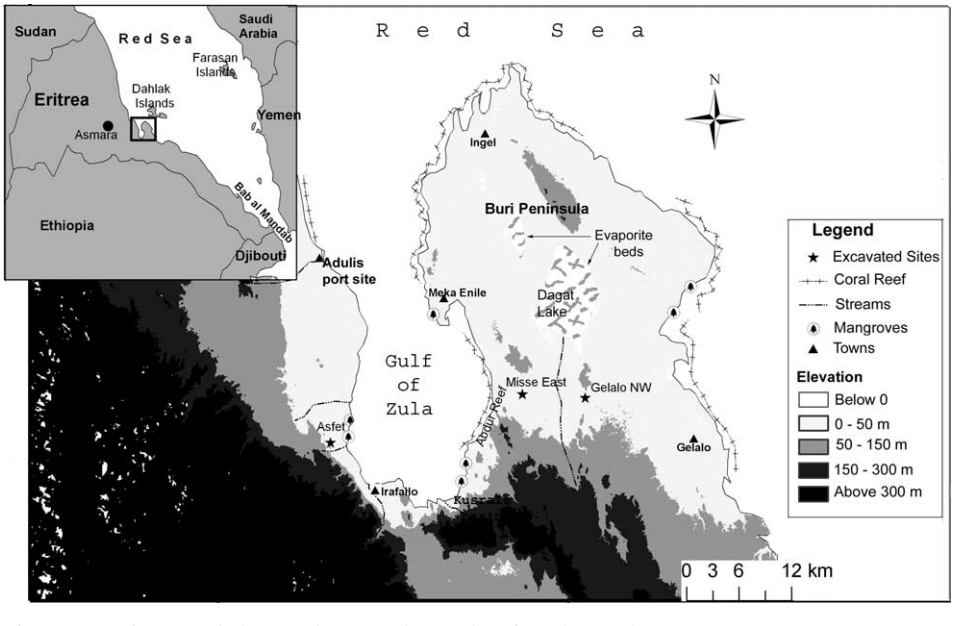

Figure 1. Eritrea and the southern Red Sea showing the study area.

africanus). The region exhibits a modest topographic diversity with low-lying coastal plains, coral reefs and some elevated volcanic ridges. The geological history of the region has been greatly affected by the Tertiary and Quaternary tectonics associated with the formation of the East African Rift System (Barberi and Varet 1977; Ghebretensae 2002). Its two prominent landscape features are the Buri Peninsula, a thumb-shaped landmass that protrudes northwards into the Red Sea, and the Gulf of Zula, a narrow bay ($\sim$40 km north-south) where the Danakil Depression merges into the Red Sea. The Buri-Zula plains occupy an important location at the nexus of three broad ecological zones: the highland escarpments to the west, the Danakil Depression to the south and the coastal plains adjacent to the seashore. For this reasons, the Eritrean coastal region may shed some light on prehistoric coastal adaptations on the African side of the Red Sea basin.

Methods and dating

The reconnaissance survey employed involved walking around judgmentally selected areas, such as the summits of flat ridges and near coastal terraces. Site locations and artefact scatters were mapped using Global Positioning System (GPS) and Total Station points (in the case of Asfet) georeferenced to Universal Transverse Mercator, Datum WGS 1984. Distances from the sites to the current coast were estimated using GPS and existing satellite imagery. However, a detailed reconstruction of past sea level changes could not be achieved due to lack of funding for employing a geomorphologist.

Excavation units were placed in areas of high artefact density and stable surfaces. Standard procedures were followed during excavation and sediments were dry sieved using a 2.5 mm mesh. Arbitrary units of 10 cm thickness if artefact concentrations were high, but of 15 cm in areas of low concentration were used to designate excavation levels. The main archaeological traces at the sites were lithic artefacts and shells. The results of the lithic analysis are discussed in this paper, while samples of the shell assemblages have recently been reported elsewhere (Bar-Yosef and Beyin 2009).

Mollusc shell was the only material suitable for dating the archaeological sites. Shell samples were dated using both AMS and conventional radiocarbon methods. A marine calibration dataset (Hughen *et al.* 2004) compatible with the Calib5.0 program (Stuiver *et al.* 2005) was employed for calibrating the ^{14}C ages. In this study, a reservoir age correction value of 127 ± 1 years for Port Sudan ($\sim 4^{\circ}$ of latitude north of the study area) was used to calibrate the radiocarbon ages (Stuiver and Braziunas 1993; Reimer *et al.* 2004). The dating results are presented in Table 1.

Overall, the sites found range from the early to the middle Holocene in age. The two older sites (Gelalo and Misse) are located further inland than the younger site (Asfet), which also produced a higher concentration of shell remains, something that may imply that the area's middle Holocene inhabitants relied more heavily on aquatic resources than did earlier groups. The climate was relatively humid in the middle Holocene as attested by high lake levels in the Ethiopian rift lakes, such as Lakes Abhe and Shala-Ziway (Gasse 1977; Street 1979; Umer *et al.* 2004).

Table 1. Radiocarbon and calibrated dates for the three excavated sites.

Site (sample name)	Laboratory number	Level	Dating method	^{14}C dates (BP)	Calibrated age (BC)
Asfet (Asfet01)	ISGS-A0794	1 (-6 cm)	AMS	5385 ± 15	3682-3637 (1 sigma) 3713-3622 (2 sigma)
Asfet (Asfet07)	GX -32978	2 (-21 cm)	AMS	5350 ± 40	3688-3604 (1 sigma) 3723-3526 (2 sigma)
Gelalo (GNW 05)	GX-32910	A (-10 cm)	Conventional	7890 ± 130	6415-6150 (1 sigma) 6529-6004 (2 sigma)
Gelalo (GNW 06)	GX-32911	B (-8 cm)	Conventional	6970 ± 170	5565-5246 (1 sigma) 5709-5033 (2 sigma)
Gelalo (GNW 07)	GX-32913	C (-9)	Conventional	7900 ± 190	6458-6069 (1 sigma) 6702-5877 (2 sigma)
Misse East (Misse01)	ISGS-A0796	(-6 cm)	AMS	7145 ± 20	5596-5536 (1 sigma) 5615-5503 (2 sigma)
Misse East (Misse02)	GX-32911	(-5 cm)	Conventional	7330 ± 190	5908-5555 (1 sigma) 6090-5374 (2 sigma)

Site descriptions and lithic characterisation

Asfet

Asfet is located on the southwestern edge of the Gulf of Zula, approximately 1000 m from the present shoreline. Its landscape encompasses a sandy basin between two north-south running basalt ridges ranging from 10 to 30 m in elevation (Figure 2). No marine deposits are visible within the site's immediate proximity. Such deposits may have either eroded away or else it is possible that the sea did not reach this area in the recent past. Mangrove vegetation grows along the nearby coast where we observed abundant *Terebralia palustris* shells. The fact that one of the excavated units (Unit F) produced dense *Terebralia* remains indicates that prehistoric humans harvested shellfish from the nearby beach. The site produced two assemblages, a surface MSA industry and an LSA one excavated from Unit F (discussed below). The surface assemblage is outside the scope of this paper, but some of the diagnostic

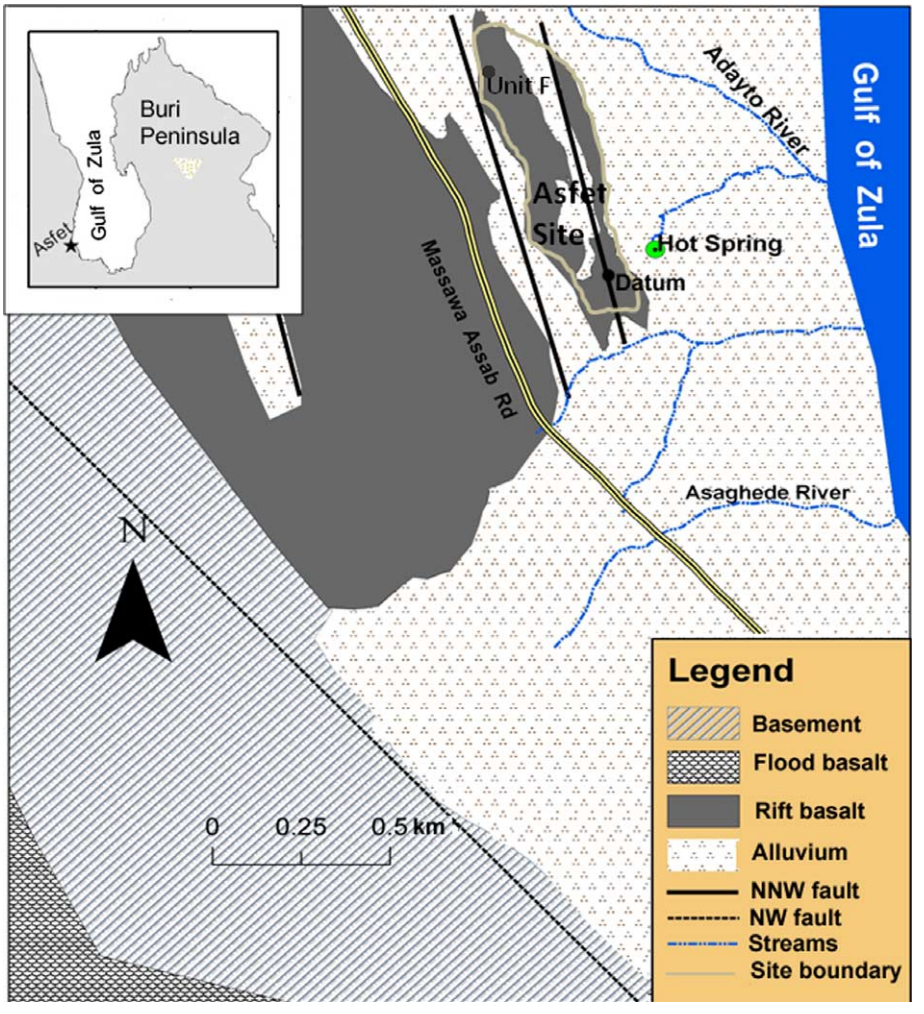

Figure 2. Geological setting of the Asfet site.

MSA elements include prepared core products, points and small bifaces made on diverse raw materials. Unit F was placed on a flat area on the northern summit of the western ridge. The unit started with a 1x1 m pit and was expanded to 2.6 m^2. It was excavated to a depth of 30 cm below surface, and to 50 cm in a 20 cm x 100 cm sounding pit on the southern wall. The unit features poorly sorted loamy matrix that graded downward to a sandy-gravelly matrix. Shell remains and stone artefacts were recovered from the upper 25 cm of the excavated deposit. Although lithic and shell densities decreased steadily downward, their positive association remained consistent. Asfet has produced the first evidence for middle Holocene (sixth millennium BP) human habitation along the Red Sea coast of Eritrea.

Asfet yielded 411 lithic artefacts, comprising a few cores, shaped tools and débitage. Summaries of the lithic data from Asfet Unit F and the other two sites are presented in Tables 2–4. Obsidian, quartz and basalt account for 63%, 19% and 15% respectively of the Asfet assemblage. Generally, non-diagnostic complete flakes and fragmentary débitage dominate the lithic sample. A few fully cortical flakes recovered from the upper layer of the unit indicate some level of initial core reduction activity. While the Unit F lithic assemblage is dominated by non-diagnostic débitage, the presence of a few backed elements hints at an LSA tradition.

Gelalo NW

The Gelalo NW site is situated on top of a cone-shaped basalt ridge on the Buri Peninsula, approximately 15 km inland from the present coastline. The site covers about 400 m^2 confined to the top of the ridge, which is covered by Neogene lava with a shallow loose substrate on the western edge. Circular stone structures were observed around the hill that, according to oral accounts of the local Afar inhabitants, mark places where humans were killed by violence, although the bodies were buried elsewhere. Two collection grids (2 x 4 m each) were placed on the northern and western margins of the main site where over 1000 lithic artefacts and a small quantity of shell fragments were mapped and collected. Three 1 m^2 units were excavated to a depth of 50, 40, and 50 cm respectively (Figure 3). In all the units, the cultural traces were limited to the upper 25 cm of the deposit with artefact densities decreasing rapidly with depth. A poorly sorted loamy matrix characterises the

Table 2. Raw material variability in the lithic assemblages.

		Raw material count				
Site	Tool type	Obsidian	Quartz	Basalt	Other	Totals
Asfet	Cores	4	3	0	1	8
	Shaped tools	12	0	1	0	13
	Débitage	245	77	61	7	390
Gelalo NW	Cores	58	0	0	0	58
	Shaped tools	242	0	0	0	242
	Débitage	4583	0	0	0	4583
Misse East	Cores	8	0	0	0	8
	Shaped tools	54	0	0	0	54
	Débitage	677	0	0	0	677

Table 3. Raw material and mass variability in the core class.

	Sites				
	Asfet			Gelalo	Misse East
Mass range	Obsidian	Quartz	Other	Obsidian	Obsidian
<10 g	1	3	0	32	4
11-20 g	3	0	0	18	2
$>$ 20 g	0	0	1	8	2
Total	3	3	1	58	8

deposit. The site has been dated to between the early eighth and mid-seventh millennia BP.

The three excavated units at the Gelalo site produced a total of 4883 lithic artefacts, comprising cores, shaped tools and débitage, all on obsidian (Table 2). Unit A yielded the highest number of cores (n = 30) and more shaped tools (n = 107). The core class contains some prismatic/tabular blade cores, exhibiting parallel flake scars and flat striking platforms. Generally, the Gelalo lithic assemblage represents an LSA industry featuring microlithic and blade technologies (Tables 2–4).

Misse East

This site is located on top of a limestone ridge on the western margin of the Buri Peninsula about 4 km from the coast. It overlooks the Misse River, an ephemeral channel that flows into the Gulf of Zula. The landscape around the site is generally rugged and features undulating flat ridges covered by heavily weathered limestone bedrock and isolated Neogene lava flows. Only one 1 m^2 unit was excavated at Misse East. The site preserves a shallow deposit, but one rich in archaeological remains, especially mollusc shells. The mollusc sample from Misse is different from those of the other two sites. The assemblage from Misse is dominated by *Atactodea striata*, a small bivalve that burrows into intertidal sands, whereas *Terebralia palustris,* a large gastropod living in mangrove swamps, characterises the Gelalo and Asfet Unit F assemblages (Bar-Yosef and Beyin 2009). The substrate of the excavated unit comprised clay-loam and is loose in texture and dark brown in colour (Figure 4). Stone artefacts and mollusc shells were found at high density on the surface and in the upper 10 cm of the excavated deposit. The site has been dated to about the eighth millennium BP.

Despite the limited excavation (a 1 m^2 test unit, dug only 25 cm deep), Misse produced 739 lithic artefacts (Table 2). Obsidian was the sole raw material used. Cores, shaped tools, whole flakes and fragments make up 1%, 7%, 16% and 76% of the assemblage respectively. The majority of the Misse artefacts were collected from

Table 4. Microlithic (backed tools) size variability.

Site	N	Mean length (mm)	Mean width (mm)	Mean thickness (mm)
Gelalo NW	40	24.6	7.8	1.6
Misse East	17	33.1	8.3	2.9

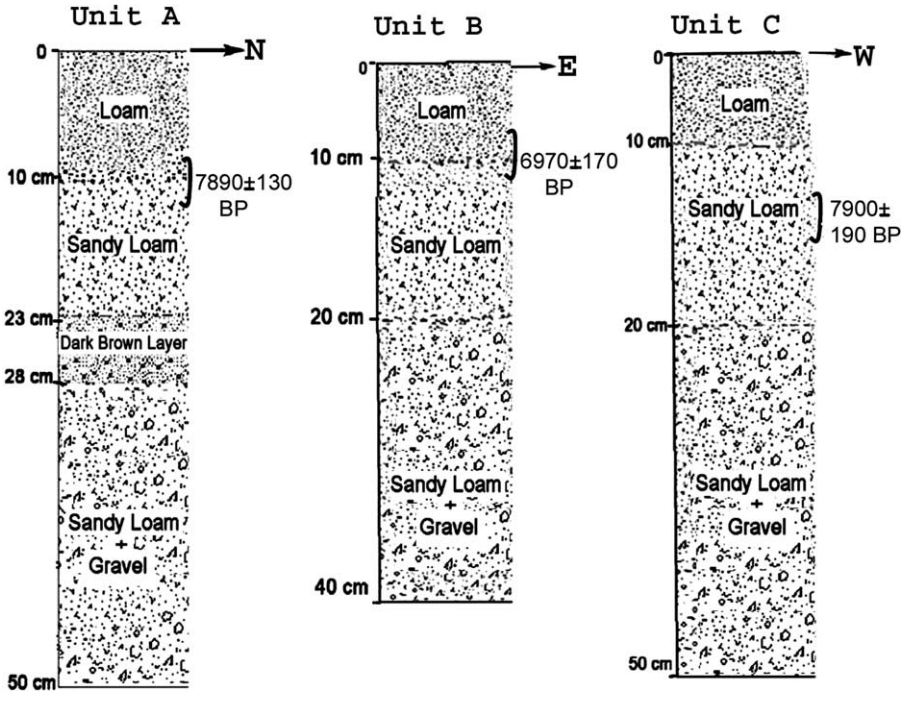

Figure 3. Gelalo NW stratigraphy.

the upper 10 cm deposit of the excavated unit. Overall, the Misse lithic assemblage represents an LSA industry featuring blades and microliths (Figures 5 and 6).

Chaîne opératoire perspectives on the lithic assemblages

In recent years there has been an increasing emphasis on the *chaîne opératoire* or *operational sequence* approach to lithic analysis, which essentially follows the life-histories of artefacts from raw material procurement to tool production, maintenance, use and discard (e.g. Sellet 1993).

Obsidian was the sole raw material used at Gelalo and Misse East, while the Asfet assemblage contains a modest quantity of quartz and basalt in addition to obsidian. Basalt was locally available at all sites, but the inhabitants of Gelalo and Misse East did not use it, possibly because they had better access to obsidian. A few quartz outcrops were noted near Asfet (within 4 km of the site), but not around the other two sites. One potential obsidian source area was located during our survey along the Kusrale basin, on the southeastern margin of the Gulf of Zula (Figure 1). XRF analysis revealed that the Gelalo and Misse artefacts, but not those of Asfet, were very similar to the reference sample from Kusrale (Glascock *et al.* 2008). However, neutron activation analysis of artefacts from the three sites revealed three clusters indicative of at least three potential source areas. Indeed, the region has numerous volcanic flows, so obsidian may have been procured from a variety of sources. If the Kusrale basin was the main source for the Gelalo and Misse East lithic raw materials, the inhabitants must have transported obsidian more than 10 km to these sites.

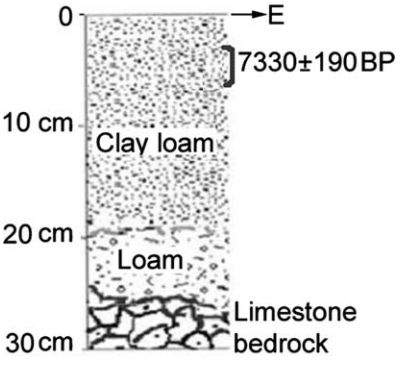

Figure 4. Misse East stratigraphy.

Direct percussion with a hard hammer appears to have been the main flaking technique employed at the sites. Several of the microliths preserve dense abrasion and opposite step scars along the backed margins, suggesting the use of a bipolar on anvil technique. The few prismatic cores discovered at Gelalo and Misse East preserve a single discrete platform and parallel running scars that traverse the longest axis of the core. The fact that most of the scars were aligned along the longest axis of the cores suggests that flaking occurred in the direction of the maximum core-dimension. The majority of cores contain less than 33% cortical surface, implying they were extensively reduced prior to discard. Only small quantities of cortical flakes were identified in the assemblages, indicating that most cores were decorticated elsewhere.

The question of the size of the cores when first brought to the sites is vital to understanding the mode of raw material transportation and curation behaviour. In this study, the longest artefact in the relevant débitage or tool class was used to predict the size of the original cores brought to the sites (Figures 7 and 8). Assuming that at least one flake from the entire assemblage would have traversed the longest axis of one of the largest cores, the maximum size score in the débitage/tool samples may roughly correspond to the length of the largest core reduced at the site. This is particularly feasible in an assemblage where the débitage sample is well preserved and a high quality raw material, such as obsidian, was used. The longest débitage specimen in the Gelalo sample was 55 mm in length. Hence, one can roughly estimate the size of the largest nodule reduced at Gelalo at 55–65 mm. Likewise, the longest artefact in the Misse East débitage sample was 60 mm in length, suggesting that the largest nodule reduced at the site was roughly 60–70 mm long. The overall picture at Asfet is similar, with small pieces dominating the débitage sample (maximum length = 48 mm). One potential caveat with this approach is that the knappers could have split the cores into smaller pieces before removing potential flakes. In general, however, the toolmakers do not seem to have removed flakes from large cores. This could be due to either their use of distant raw material sources from which smaller nodules were transported in bulk or to potential nodules being broken into smaller pieces before usable flakes were removed.

With the exception of backed microliths, relatively few diagnostic shaped tools were identified. Backing retouch was selectively applied to long, thin and symmetrical

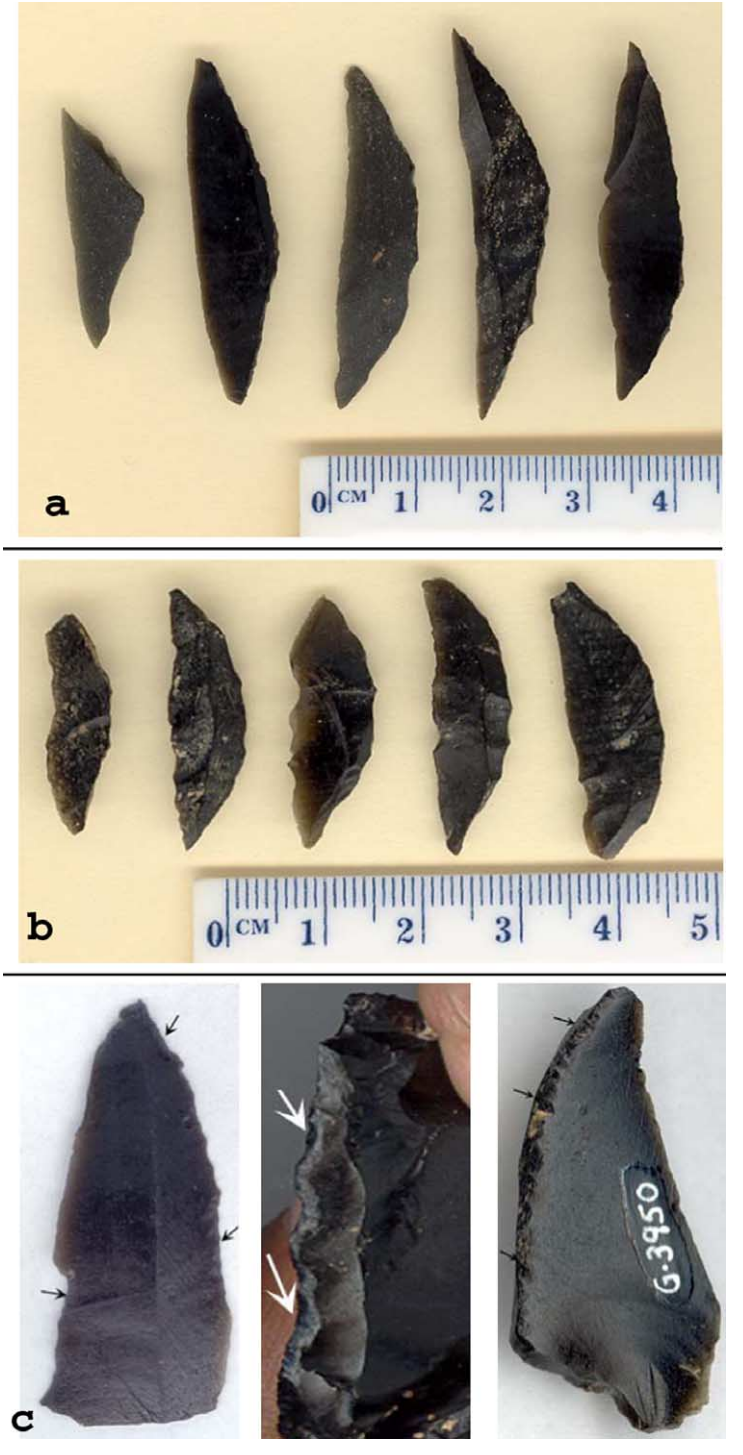

Figure 5. Diagnostic artefacts; a and b: backed tools from Misse East and Gelalo respectively, c: obsidian tools with use-wear evidence (all from Gelalo).

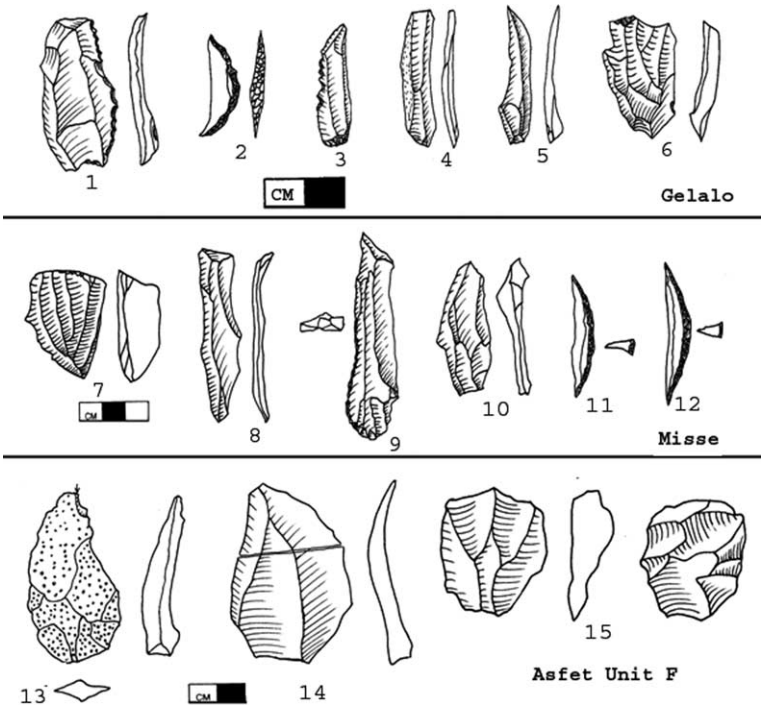

Figure 6. Representative lithic artefacts from Gelalo, Misse East and Asfet (all obsidian except no. 15, basalt); cores: 6,7,15; backed tools: 2,11-12; denticulates: 1,3; blades and flakes: 4-5,8-10,13-14.

blanks. The Misse East microliths are longer than those of Gelalo (Table 4). Misse East also contains a higher proportion of long débitage pieces (Figure 8).

A use-wear study of selected artefacts from Gelalo and Misse East (Beyin 2010) found patterned microfracture scars on several specimens in the form of: (i) dense step, crushing and hinge fractures typically confined to the lateral edges; and (ii) feather scars organised in a scalar manner (Figure 5). The observed damage patterns suggest

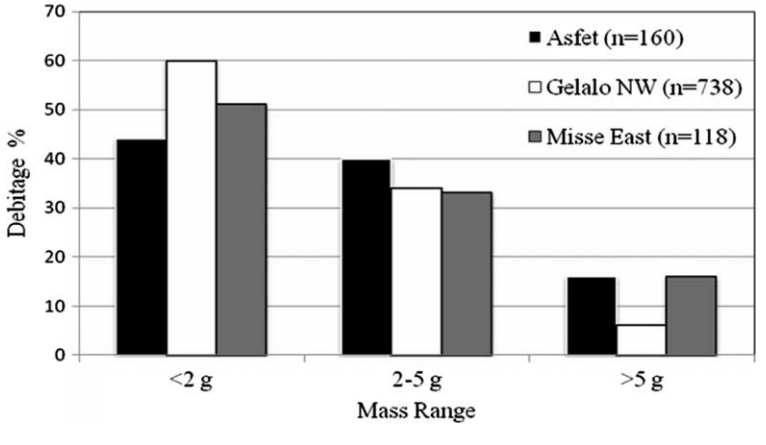

Figure 7. Mass variability among the Asfet, Gelalo and Misse East débitage samples.

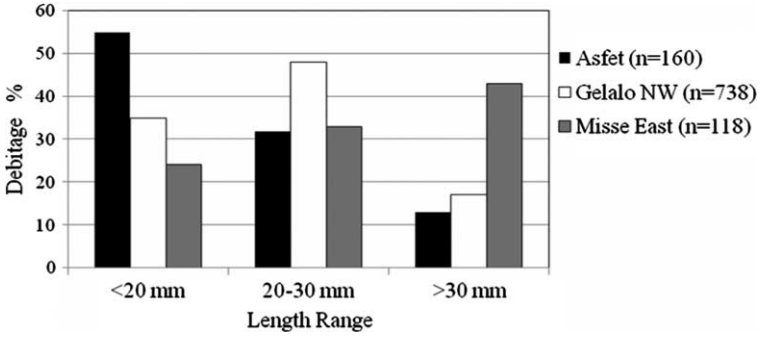

Figure 8. Length variability among the Asfet, Gelalo and Misse East débitage samples.

cutting and engraving medium to hard materials. Microliths showed lower frequency of use-wear, but their geometric design implies that they may have been intended for use as composite tools. However, the microliths hafted and used in hunting are unlikely to have been brought back to camp. Thus, the majority of the microliths found at the sites could be either those freshly made or discarded before use.

In summary, obsidian was preferred over volcanic lava, despite the latter's local availability, and it appears to have been procured from sources located at least 10 km away. The inhabitants of the sites do not seem to have reduced large nodules; the Misse East artefacts appear larger compared with that of Gelalo and Asfet Unit F (Figure 8). The presence of dense débitage but fewer cores may indicate that the inhabitants transported blanks to the site, leaving most of the exhausted cores at the source/manufacturing places.

Discussion

Early-middle Holocene human adaptation on the Red Coast of Eritrea: a synthesis

The results of this study represent the first systematically analysed traces of prehistoric human adaptation on the Eritrean coast. Two phases of early-middle Holocene occupation have been recognised: i) eighth millennium BP settlements at Gelalo and Misse; and ii) a sixth millennium BP occupation at Asfet. Modest quantities of blade cores and microlithic products have been recovered from both Gelalo and Misse East, whereas the Asfet sample is mainly characterised by non-diagnostic lithic artefacts. Variability in tool and core design is thought to have important implications for understanding prehistoric settlement systems. According to Parry and Kelly (1987), highly mobile foragers often rely on formal cores and designed tools because such implements provide higher efficiency (potential benefit) during foraging movements far from raw material sources. Thus, the higher frequencies of formal cores and designed tools, albeit very few in number, at Misse East and Gelalo suggest that the early Holocene sites on the Buri plains may have been occupied by more mobile human groups. Furthermore, the shallow nature of the archaeological deposits and the absence of less portable cultural remains, such as ceramics and grindstones, indicate a non-sedentary settlement system.

The presence of marine shells at the sites clearly demonstrates that the inhabitants of the Buri-Zula plains consumed coastal resources, although the degree

to which molluscs may have constituted an important component of the human diet remains less well understood. Shell densities vary from site to site, with the low densities from Gelalo implying only intermittent use of molluscs as food at this site, the one located farthest away from the coast. Despite their similar ages, the Misse East and Gelalo shell assemblages are characterised by different shell species, Misse East being dominated by *Atactodea striata,* a small bivalve found buried in intertidal sandy substrate, and Gelalo by *Terebralia palustris*, a large gastropod. The fragmentary nature of the shells suggests that the majority of them were collected for food. However, human use of molluscs as ornaments has been identified at Gelalo, where perforated *Nerita*, *Engina* and *Persicula* were discovered, along with ostrich eggshell beads (Figure 9).

One limiting factor in assessing the subsistence behaviour of early-middle Holocene foragers on the Buri-Zula plains is the absence of terrestrial faunal remains. According to an ethnographic study of coastal foragers in Australia (Meehan 1982), mollusc species similar to those found at the Eritrean sites were usually boiled before being consumed and the flesh sucked from a hole created around the posterior end of the whorl. Thus, if used at all, the stone tools at the Eritrean sites may have only been needed for drilling a hole on the whorl or for breaking the shells. The fact that the focal sites produced abundant lithic artefacts on high quality raw materials implies that humans made use of them to extract a variety of food sources, including terrestrial fauna (Beyin 2010).

Several other sites with LSA and MSA artefacts were recorded in a wide range of landscape contexts in the Buri Peninsula and around the southern periphery of the Gulf of Zula (Beyin and Shea 2007). The inland location of some sites indicates that diverse faunal and floral resources were available in the interior plains of the Buri

Figure 9. Symbolic objects and intentionally broken mollusc shells: a) ostrich eggshell beads from Gelalo, b) perforated shells for symbolic use, recovered at Gelalo: *Engina mendicaria* (three left specimens), and *Persicula terveriana* (identification by Daniella E. Bar-Yosef), c) intentionally broken shells from Misse East: *Anadara antiquate* (left) and *Chicoreus* (right), d) intentionally broken *Terebralia palustris* shells from Asfet.

Peninsula for human consumption. When conditions were not hospitable in the hinterlands, foragers would have had to increase their diet breadth and incorporate molluscs to offset the decline of high-ranked terrestrial resources (Kelly 1995). Hence, shell gathering may have been scheduled in relation to the availability of terrestrial resources in the inland habitats. The Buri-Zula plains also feature ecotonal habitats with shallow beaches and ephemeral estuaries where assorted resources may have been available.

Intermittent dry and humid climatic episodes characterised the early Holocene in Northeast Africa (Hassan 1997; Umer *et al.* 2004). The Gelalo and Misse settlements fall largely in a wet episode in relation to the climatic record of Lake Abhe in the Afar Rift (Umer *et al.* 2004), whereas the earlier phase of the Gelalo settlement seems to coincide with an arid episode in relation to the Ziway-Shala hydrological record (Gasse 2000) (Figure 10). Sea level reconstruction of the Red Sea Basin using oxygen isotope ($\partial^{18}O$) records shows that there were repeated sea level fluctuations between the terminal Pleistocene and early Holocene leaving the Red Sea as low as 20 m below its present level at 8, 7, and 6.5 kya (Siddall *et al.* 2003, 845). Human occupations of the Gelalo and Misse East sites seem to coincide with these low sea level events. However, the evidence from the Afar Rift and the isotopic data from the Red Sea demonstrate contrasting patterns, making it difficult to confidently ascertain the exact climatic contexts of the excavated sites. Asfet Unit F broadly coincides with a wet period indicated by the hydrological record of Lake Abhe (Gasse 1977).

Environmental changes associated with the onset of a dry climate may have stimulated prehistoric human adaptations on the Eritrean coast. Freshwater is a critical resource along the Buri-Zula plains today. In a region where the daily

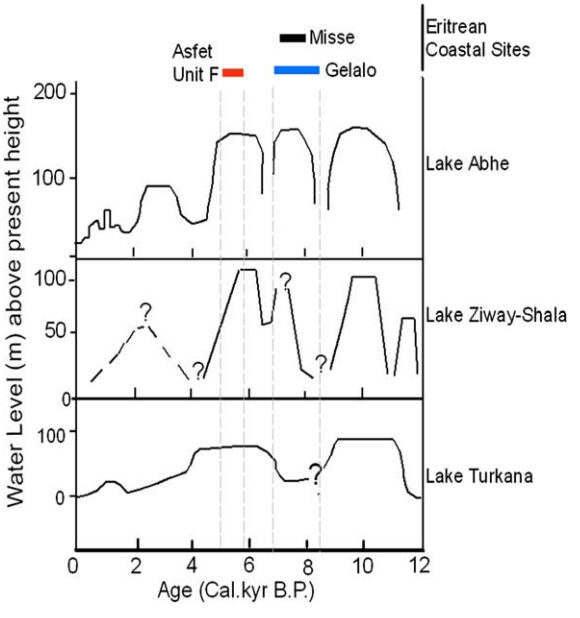

Figure 10. Climatic context of the focal sites with respect to the early Holocene lacustrine records of the Ethiopian/Afar Rift and Lake Turkana. Sources: Lake Abhe (Gasse 1977), Lake Ziway–Shala (Street 1979; Umer *et al.* 2004), Lake Turkana (Gasse 2000; Johnson 1996).

temperature exceeds 40°C for long periods of the year, any sustainable human settlement is likely to have been near freshwater sources, such as ephemeral floodplains and coastal margins. Figure 11 presents a hypothetical model of human settlement dynamics on the Eritrean Red Sea coast. Accordingly, dry episodes would have created optimal conditions for human settlements near shoreline landscapes due to the creation of freshwater springs along the newly exposed coastal gradients when sea level declined (Faure *et al.* 2002). During such scenarios, the interior landscapes would have been hyperarid.

Broader implications of the evidence

The evidence from the Eritrean Red Sea coast parallels early-middle Holocene shoreline adaptations on the Arabian coasts and in the interior landscapes of Northeast Africa and the central Sahara (Holl 2005). Several shell midden sites have been recorded from the Tihamah region of southwestern Yemen dating between the eighth and sixth millennia BP (Tosi 1986). *Terebralia palustris*, the dominant species in the Asfet and Gelalo assemblages, characterises the Tihamah sites. Ongoing research on the Farasan Islands, off the western coast of Saudi Arabia, has recently documented numerous middens dating to the eighth millennium BP (Bailey *et al.* 2007). Several of the middle Holocene sites in the Tihamah region of Yemen produced lithic assemblages made on obsidian, the sources of which were identified as being in coastal areas of Eritrea (Khalidi 2009). Some of the Eritrean sources with which the Yemeni sites showed close association include Irafailo, the Dahlak Islands and Alid volcano. While much remains to be learned about the nature of cultural interaction between the two sides of the Red Sea, the obsidian data hint that the prehistoric inhabitants of the Tihamah and the Buri-Zula sites may have been sharing the same obsidian sources located on the Eritrean side. Other commodities besides obsidian may also have been exchanged between the two regions.

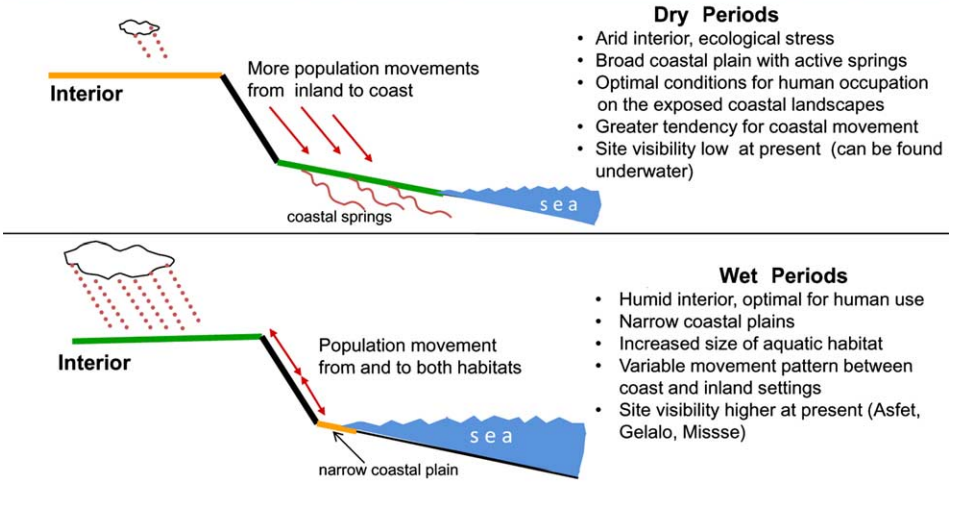

Figure 11. A hypothetical model of human settlement dynamics along the Eritrean coast (after Beyin 2009, 266).

In Africa, sites associated with aquatic adaptations have been widely reported along the Nile Valley, central Sahara and Lake Turkana dating roughly from 9500 to 5000 kya (Arkell 1949; Stewart 1989; Holl 2005). Early-middle Holocene human occupations of the Eritrean coast seem to correspond with these widespread inland shoreline adaptations in Northeast Africa and other regions of the world. A broad comparison of human adaptation along the Red Sea coast and inland shoreline habitats shows some contrasts in technology and subsistence preferences. While mollusc shells were the main aquatic species humans harvested in the coastal settlements of the Red Sea, the interior lacustrine and riverine adaptations (e.g. those around Lake Turkana and the Nile Valley) were focused on fish (Stewart 1989). Likewise, while bone harpoon and ceramic technologies were the hallmark of early Holocene adaptations in the interior shoreline habitats, such artefacts are missing from the coastal sites. This could be due to preservation bias, since no bones are preserved at the Eritrean sites, or to cultural preferences. Alternatively, assuming that harpoons were mainly needed for catching fish and other aquatic mammals, the fact that such tools are missing from the Eritrean coastal sites may suggest that the Buri-Zula coastal topography was not suitable for fishing.

Conclusions

Systematic survey and site excavations should continue on the Buri-Zula plains and elsewhere on the Eritrean coastal margins in order to shed more light on the adaptive variability of Upper Pleistocene and Holocene humans along the African side of the Red Sea basin. Early Holocene settlements were present on the highland plateaux of northern Ethiopia near Aksum (Phillipson 1977; Finneran 2000; Negash 2001) and in the interior Afar Rift (Brandt 1982), but the nature of human contacts between the inland and coastal territories is not well understood at present. A regional survey focusing on the intermediate escarpments, those west and south of the Buri-Zula plains, is desirable in order to elucidate the nature of prehistoric movements between the Red Sea coastal lowlands and the nearby interior.

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