Final report. Volcanological & Archaeological Program for Obsidian Research – Afar Ethiopia

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FINAL REPORT

VOLCANOLOGICAL & ARCHAEOLOGICAL PROGRAM for OBSIDIAN RESEARCH-AFAR (ETHIOPIA)

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Illustrations on cover page (from left to right): The Awash river seen from Assaita ; Modern ceramics in the Basha hotel Assaita; L. Bruxelles, C. Tribolo and C. Oppenheimer during excavation of a geomorphological sounding at KUR-05 in the Afar.

HIGHLIGHTS OF THE VAPOR-AFAR 2016 SEASON

Site registry & new documentation

❖ *11 Neolithic and LSA sites in the area: 4 of these were sounded for radiocarbon and OSL dating. 3 Post-Neolithic sites also registered.*

❖ *The topography, site plans and artifacts of two sites (BETBA-01 and KUR-07) were photographed aerially, planned, piece plotted and captured using photogrammetry.*

Lake Abhe & the LSA

❖ *Palaeoenvironmental work in tandem with dating of lake sediments on which the site is found demonstrate that the* ***site of BETBA-01*** *was occupied during a period when Abhe lake levels were much higher and has a terminus post-quem (****site is younger than****) in the first half of* ***the 9th millennium BC and is LSA****.*

❖ *Zooarchaeological study of remains from the site of BETBA-01 show that its inhabitants hunted crocodiles, hippopotami and gazelle and that they fished.*

The Neolithic of the Afar

❖ *Secure* ***radiocarbon dates*** *associated with ceramics and* ***domestic cattle*** *at KUR-07* ***confirm the presence of ceramic Neolithic groups along the banks of Lake Abhe from at least the 2nd millennium BC (4000 years ago)****.*

❖ *The partial excavation of what appears to be a circular burnt earthen structure with impressions of wood and vegetation, is the* ***first Neolithic structure of its kind in the Horn of Africa*** *and promises to provide interesting information about life in Neolithic Ethiopia.*

❖ *Zooarchaeological study confirms that these ceramic pastoralists had cattle and possibly sheep/goats, hunted wild gazelle and fished Tilapia in a landscape that was becoming drier and in which Lake Abhe was receding.*

❖ *Dates and faunal analysis carried out in 2016 confirm that these sites are the* ***first local ceramic Neolithic sites known in the Afar in Ethiopia.***

Regional variability, mobility and exchange in the prehistory of the Ethiopian Afar

❖ *Ceramic Neolithic period stone tool technology comparable to sites in Djibouti and the Red Sea coast of Yemen*

❖ *Abhe Neolithic Pottery traditions are diverse and distinct and include beautiful incised geometric motifs never encountered before in Ethiopia.*

❖ *5 distinctive obsidian composition groups corresponding to 5 different sources identified in the study area*

❖ *One of these obsidian sources matches obsidian tools on sites outside of Ethiopia*

❖ ***First proof that prehistoric societies were engaged in long-distance trade at least as early as the 2nd millennium BC.***

INTRODUCTION TO THE PROJECT

The *Volcanological and Archaeological Program for Obsidian Research* (*VAPOR*)-*Afar* is a Franco-Ethiopian project initiated with the institutional support of the CNRS and the Centre Français des Etudes Ethiopiennes (CFEE). The second field season, financed by the Fyssen Foundation and the CNRS-CEPAM, took place from March 15 to April 2, 2016 in the Lower Awash valley in the Ethiopian Central Afar. The permit issued by the Ethiopian Authority for Research and Conservation of Cultural Heritage (ARCCH) included authorization to excavate in an area equaling 100 km2 in total, divided into two areas: A. north of Assaita and B. south of Dubti. It also included authorization to survey in an area which comprises the northern part of the Lake Abhe basin in which we find several major volcanic complexes: Kurub, Borawli, and Manda Gargori (Fig. 1).

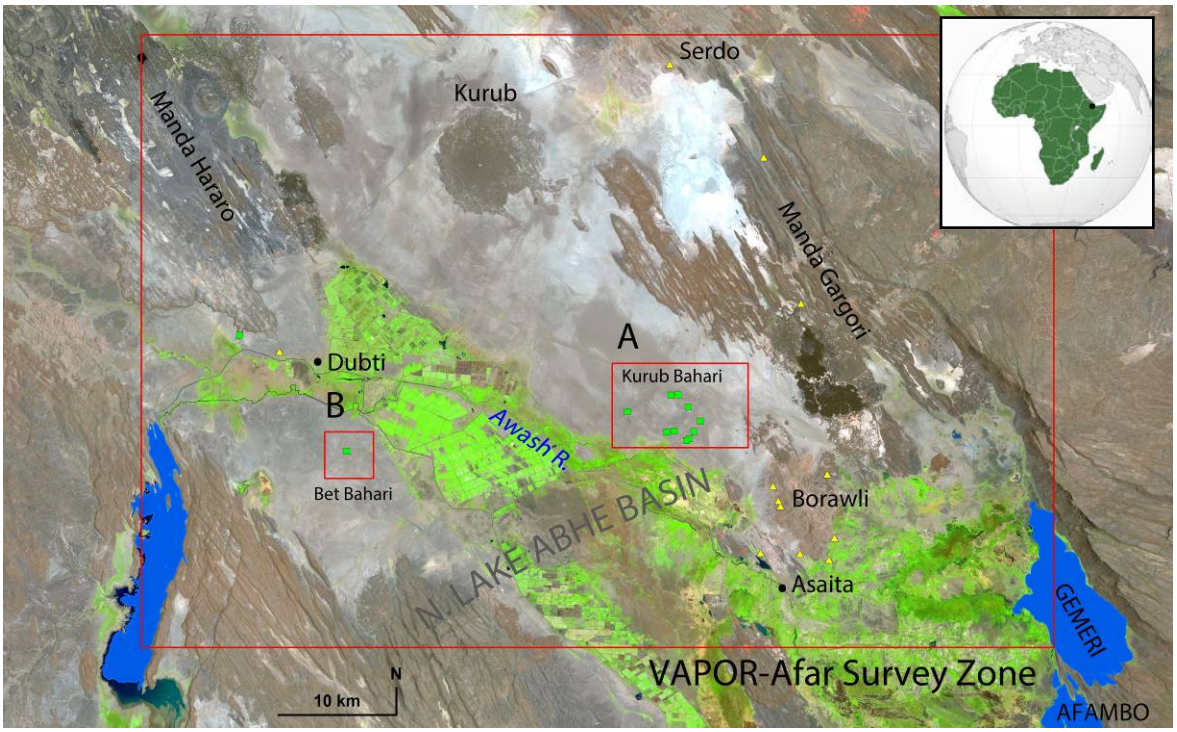


Figure 1: The 2016 VAPOR-Afar Survey and Excavation Zones. Zones A and B are excavation zones and together equal 100 km^2 while the larger survey area was authorized for geomorphological, and geological survey and sampling. The green squares represent sites identified in 2014, while the yellow triangles represent geological obsidian sampled in 2014.

The aim of the VAPOR-Afar program is to highlight the archaeological and geological potential of the region in the following ways: 1) to reconstruct the human-environment milieu (lacustrine and alluvial landscape evolution in tandem with taphonomic, aeolian, volcanological and seismological processes) 2) to excavate and date late prehistoric sites and create a late LSA/ Neolithic chrono-cultural sequence for the Central Afar region and 3) to identify and sample new obsidian sources that were likely to have been exploited by populations in the region as well as in more distant regions (Djibouti (Gutherz 2010), Yemen (Khalidi 2010), Egypt (Tykot 1996; Zarins 1989) and other raw materials such as clay, basalt, shell and silcretes.

REGIONAL BACKGROUND

Lake Abhe which is located in the Central Afar is the final drainage basin of the Awash River. As the lake is currently in a major regression phase, what survives is a smaller Lake Abhe reduced to the southeastern area of the survey region, as well as lakes Gemeri, Afambo and the Awash delta. These lakes belonged to what can be called a Hyper- (29-17,000 BP and 10-8,000 BP), Mega- (7,500-3,500 BP) and Macro- (0-2,500 BP) lake Abhe (surface area ca. 6000 km^2 at its maximum extent) over the course of the 4 phases of transgression that concern this project

(Phases Abhé III, IV, V and VI ; Fig. 2; Gasse 1977). Despite the in-depth geomorphological and geological studies carried out in the 1970s (Varet and Gasse 1978; Gasse 1977), this region has never been studied archaeologically prior to the VAPOR-Afar's work in 2014 save for a site found in the Logiya region in the 70s (Faure et al. 1976). Lake Abhe's major Pleistocene and Holocene transgressions and regressions have produced extremely well-developed lacustrine sequences and present an ideal context for the preservation of stratified late prehistoric sites (Late Stone Age and Neolithic periods) which allow us to reconstruct the evolution of this lake and changes in settlement pattern along its banks over the course of the Holocene.

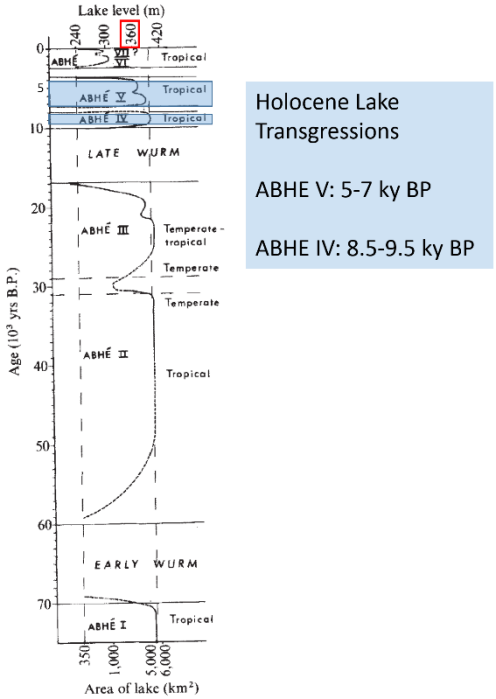


***Figure 2*:** Diagram of the phases of Lake Abhe, after F. Gasse 1977. "Evolution of Lake Abhe (Ethiopia and TFAI), from 70,000 b.p." *Nature*.

In addition to the archaeological potential offered by the geomorphological contexts, this region complements the results provided by the French project in Djibouti 'Premières Sociétés de Production dans la Corne de l'Afrique (PSPCA)' (Joussaume 1995a, b ; Gutherz 1996 ; Gutherz *et al.* 1996). In 30 years of research, this project established the presence of ceramic Neolithic sites in Djibouti. Sites of this period can be found from the south-eastern shore of Lake Abhe in the Dikhil region of Djibouti, continuing to the Red Sea littoral. Sites surveyed and excavated by the PSPCA project have provided evidence of bovid and caprid domestication beginning in the 3rd millennium BC (Lesur 2007) as well as a lithic production that can also be found across the Red Sea in Yemen (technology as well as products), during the same period (Khalidi and Keall 2011; Khalidi 2011). Sites like Asa Koma and Wakrita provide cultural and chronological comparison with the VAPOR-Afar study region in Ethiopia. While this region is a geographical extension of the natural and anthropogenic landscape in which the sites in Djibouti can be found, it also provides elements that are not present in Djibouti and which are fundamental to an understanding of the evolution of the landscape, of the transition between the LSA and the Neolithic and of human interaction networks (sources of raw materials, establishment of contacts towards the Ethiopian Rift and Ethiopian highlands).

RECAP OF THE 2014 SEASON

In 2014 the VAPOR-Afar project surveyed in two regions characterized by large aeolian structures just north of Assaita and south of Dubti. Our surveys identified abundant surface materials such as ceramics, groundstone, lithics and fauna that evidenced a high density of past occupation in this area. While the entire area was littered with artifact scatters, ten geographically distinct sites were documented in the Kurub Bahari area (Fig. 1) and one in the

Bet Bahari area (Fig. 1), for a total of eleven sites identified (Table 1). Three new sites (1 ceramic Neolithic and 2 Post-Neolithic/Contemporary) were identified during the 2016 survey (Table 1).

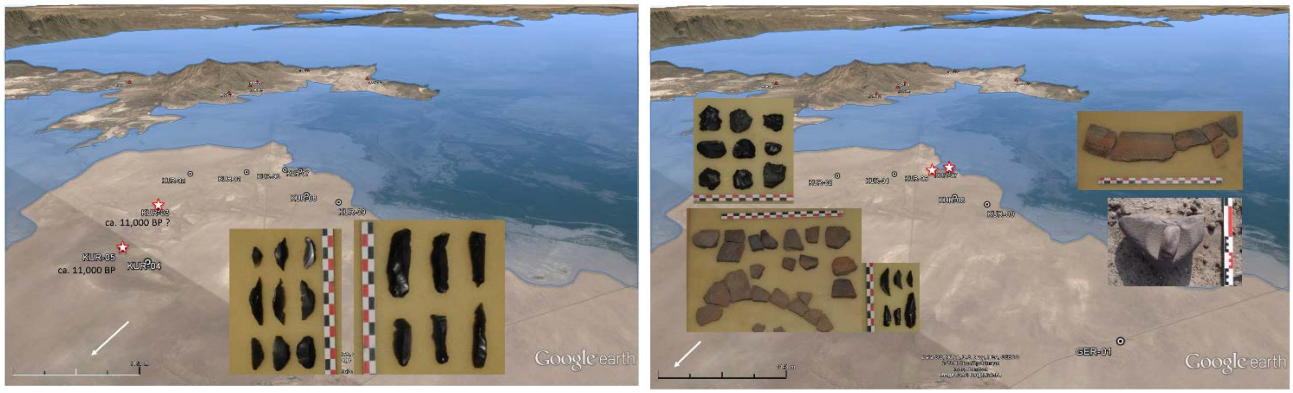
At the time of the survey it was unclear whether the mobile dunes found today concealed older palaeodunes occupied by humans or whether this undulating aeolian landscape was a product of more recent aridification that covered older occupation sequences. What was clear, was that different periods of occupation were represented. These were differentiated by the presence or absence of ceramics that had affinities with ceramic Neolithic sites identified in Djibouti (Cauliez et al. 2008).

	SITE #	Date SUR/EXC	UTM	N	E	Alt.	Region	Area	Date	Cult dating (PO; LI; FAU)	LI	Obs	PO	GS	FAU	Fish	Sh	Oes	Fos
1	GER 01	2014	37P	752898	1293925	370	Kurub	Gerjele		Post Neolithic	X	X	X				X	X	
2	KUR 01	2014/2016	37P	758500	1292237	362	Kurub		OSL?	Ceramic Neolithic/ aceramic	X	X	X		X	X			X
3	KUR 02	2014	37P	759045	1293116	359	Kurub	Galfagi Kebele		Ceramic Neolithic	X	X	X	X	X		X	X	
4	KUR 03	2014	37P	758018	1294329	376	Kurub			Aceramic	X	X		X					X
5	KUR 04	2014	37P	756578	1295315	371	Kurub			Aceramic	X	X							X
6	KUR 05	2014/2016	37P	757172	1295342	375	Kurub	Galfagi Kebele	OSL?	Aceramic	X	X		X	X	X	X		X
7	KUR 06	2014	37P	758101	1291652	370	Kurub	Galfagi Kebele		Ceramic Neolithic	X	X	X	X	X	X		X	
8	KUR 07	2014/2016	37P	757867	1291478	366	Kurub	Galfagi Kebele	1620 cal BC	Ceramic Neolithic	X	X	X	X	X	X	X	X	
9	KUR 08	2014	37P	756848	1292309	372	Kurub	Galfagi Kebele		Ceramic Neolithic/aceramic	X	X	X	X	X		X	X	
10	KUR 09	2014	37P	756231	1292203	373	Kurub	Kurub Bahari		Ceramic /aceramic	X	X	X				X		X
11	BETBA 01	2014/2016	37P	729234	1290599	386	Dubti	Bet Bahari	<8245 cal BC	Aceramic LSA	X	X			X	X	X		
12	DUB 01	2016	37P	720186	1300360	423	Dubti	Dubti		Ceramic Neolithic/aceramic	X	X	X	X	X			X	
13	Gada'ale	2016	37P	766361	1292844	370	Borawli			Post Neolithic PO	X	X	X	X					
14	Lakora	2016	37P	767831	1291785	373	Borawli			Post Neolithic PO	X	X	X		X				

Table 1: List of prehistoric sites documented in 2014 and 2016 and excavated in 2016 and archaeological materials present on site surfaces

A large number of these sites have a dominantly ceramic component made up of large sherds that could be refitted and that presented forms, tempers and elaborate decorative motifs that had never been attested before in Ethiopia and that cannot be found in regional ceramic traditions today. In addition, these sites presented abundant groundstone, and obsidian tools and production debris such as pièces esquillées flakes and cores, batonnets and bipolar flake and bladelet cores. These lithic bi-products and tools are typical elements of a bipolar technology on anvil using direct hard and soft hammer percussion. They were found associated with a large number of obsidian backed geometric circle segments and lunates made on flake and bladelet supports (Fig. 3B). Other remains such as bivalve shell concentrations, ostrich eggshell fragments, and fragmented faunal specimens including fish, littered the majority of these ceramic sites. Polishing stones, basalt grindstones, pestles, hard hammers, and anvils are some of the groundstone elements that could be found in large concentrations on the surface of sites. An abundance of groundstone equipment and this same lithic production have also been attested on ceramic Neolithic sites in Djibouti and on contemporary ceramic sites on the coast of Yemen. An association of these different elements (grinding and pounding equipment, indigenous and exogenous raw material use, ceramics and a variety of subsistence strategies) is often attributed to early food producing societies (Neolithic or otherwise).

A number of other sites were distinguished on the basis of a total absence of ceramics, and more structured methods of obsidian laminar lithic production that had more affinities with known LSA traditions in Ethiopia (Ménard et al. 2014) than with Neolithic ones. The lithic industries found on these sites also included a large number of obsidian backed circle segments but on exclusively lamellar supports and a basalt industry (Fig. 3A). The rare faunal remains identified on these sites were generally heavily fossilized and pertained mainly to aquatic mammals and larger fish providing us with a window into what would have been a different landscape at the time of these older occupations.



A ***B***

***Figure 3*:** Google Earth satellite 3D image with lake transgression scenario added and the location of sites in the Kurub Bahari area. **A:** Sites with lithic traditions that have some affinities with known LSA traditions in Ethiopia. **B:** Ceramic sites with the same final obsidian tool products but using different technologies, groundstone elements and decorated ceramics with a great number of refits, all elements that can be compared to ceramic Neolithic traditions in Djibouti.

The discovery of a great number of sites that were marked by an abundance of traditions that had never before been attested in Ethiopia and which appeared to correspond to pre-Neolithic (LSA) and Neolithic traditions known elsewhere, was unprecedented and required confirmation through excavation and dating as well as further exploration of the landscape and its evolution with a larger team of specialists. The presence of these sites across a dunescape within the dried-out Abhe lake basin and in proximity to obsidian sources also identified the same season, necessitated an in-depth paleoenvironmental study of the region to determine precise lake levels and environmental factors (temperature, vegetation, fauna) during different occupation phases, site formation and taphonomy in relation to different lake levels and to dune formation, and identification and accessibility of obsidian, clay and other raw material sources. The 2016 season set out to begin answering these questions through test excavations and precise geomorphological and geological survey and sampling.

2016 FIELD METHODS AND PRELIMINARY RESULTS

GEOLOGICAL AND GEOMORPHOLOGICAL SURVEY

Geomorphological, geochronological and geological survey and sampling was conducted over a one week period within the authorized survey zone and consisted of sampling for radiocarbon and OSL dating (shell, sediment, etc.), and for geological analyses (obsidian, basalts, trachytes). Zones where evidence of relict Pleistocene and Holocene margins of Lake Abhe (corresponding to lake levels during lacustrine transgressions and regressions), as well as the Borawli volcano and the Manda Gargori rift system dominating the surrounding lake basin within our concession, were visited (Fig. 4).

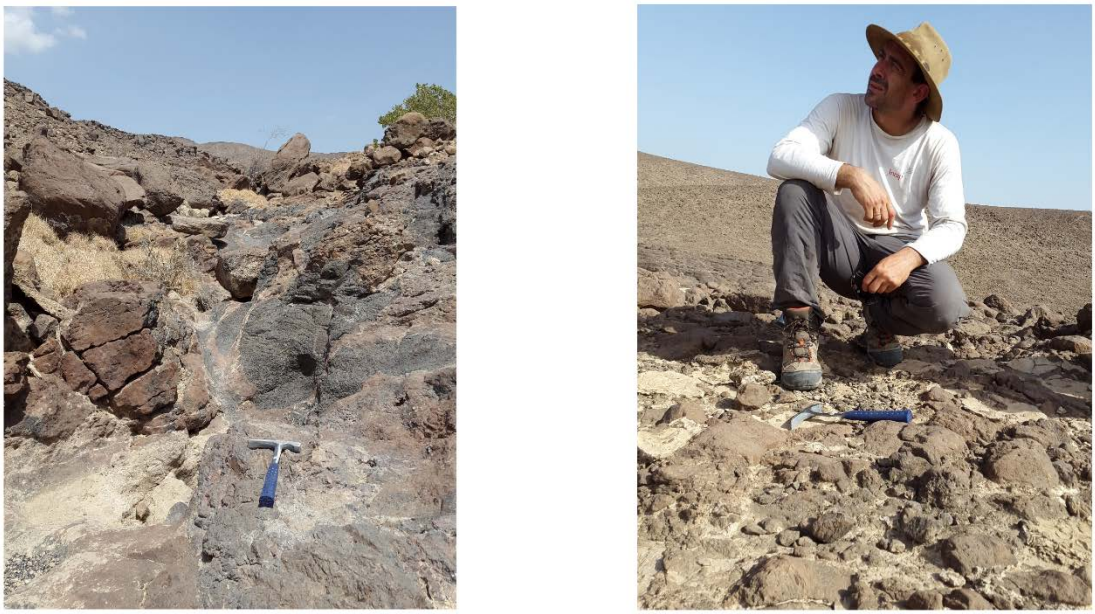


***Figure 4*: Obsidian source on Borawli volcano and a vestige of calcareous lake deposit from Pleistocene period transgressions of Lake Abhe at 420m in altitude on Borawli volcano.**

A new obsidian flow was identified and sampled in the Manda Gargori Rift area and several samples were collected from the Borawli volcano (Fig. 5). All of these samples were exported to France and have been analyzed by B. Gratuze by LA-HR-ICP-MS at the CNRS - IRAMAT laboratory in Orléans.

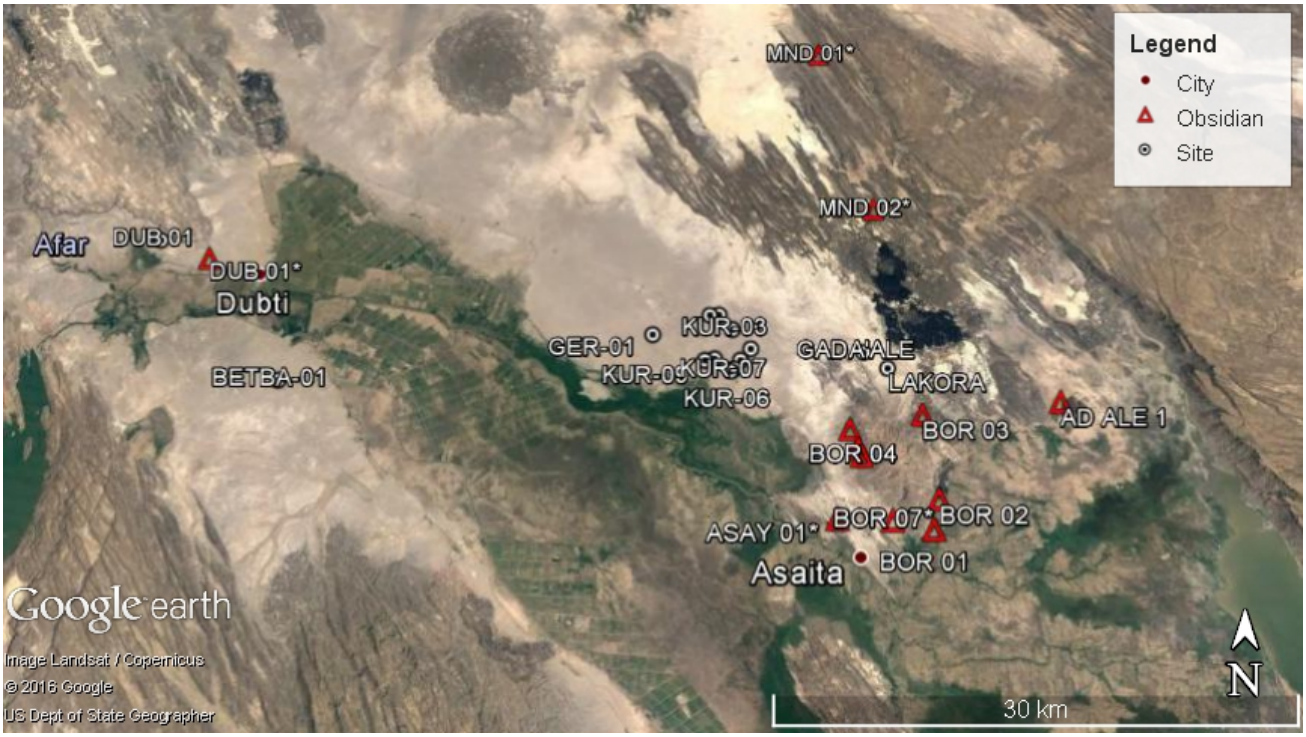


***Figure 5*: Google Earth image with sites and obsidian sample spots (red triangles) from the 2014 and 2016 seasons. DUB = Dubti, SR = Serdo, MND = Manda Gargori, BOR = Borawli, * represent geological secondary positions.**

ARCHAEOLOGICAL EXCAVATION: 2016 TEST PITS

During the 2016 field season 10 small test pits were conducted on four sites (KUR-01, KUR-05, KUR-07, BETBA-01; Fig. 6) in our authorized excavation areas. Six of these were geomorphological test pits that allowed us to understand the formation of sites in relation to underlying lake and marsh sediment and to conduct OSL dates on site sequences and environmental sequences. The four remaining test pits were carried out on two reference sites

with the most archaeological potential (1 sounding of 1m^2 at BETBA-01 and 3 soundings of 1m^2 at KUR-07) aimed to establish whether these sites were in fact stratified or whether nothing but a residual surface remained.

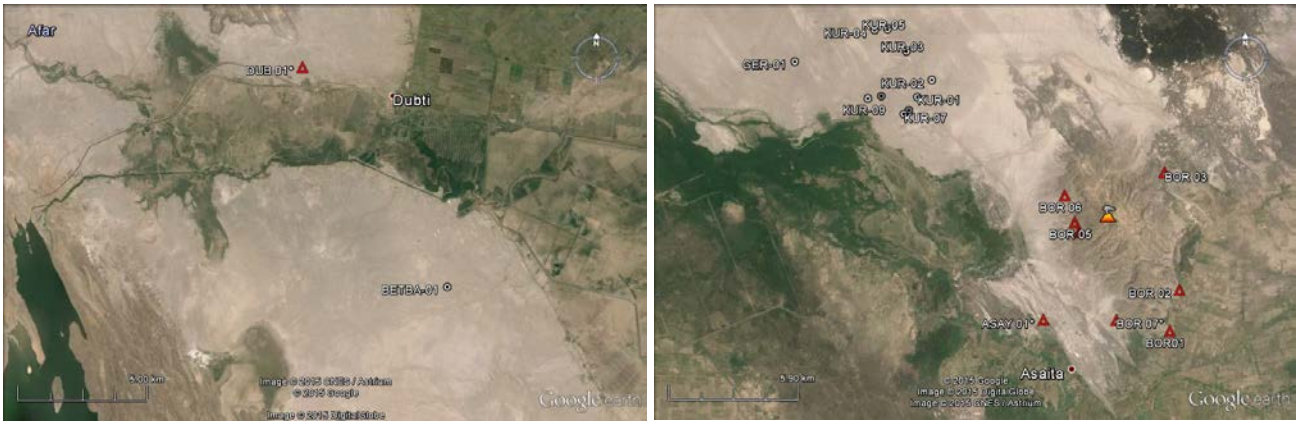


***Figure 6*: Sites (white dots) and geological collection points (red triangles). **Left map:** The Bet Bahari area south of the town of Dubti. A test pit was carried out at the site of BETBA-01. **Right map:** The Kurub Bahari/Gerjele area near the town of Assaita. Test pits were carried out at the sites of KUR-01, KUR-05 and KUR-07. Base Maps Google earth.**

Save the faunal and ceramic analyses conducted, the results presented below are preliminary and section plans are approximate as final altitude calculations, analyses of the remaining materials and samples, and the fusion of datasets and their interpretation are still in progress.

BET BAHARI 01 (BETBA-01)

BETBA-01 is a small site, very slightly elevated above the Bet Bahari plain (Fig. 7). The surface of the site was abundant with lithics and fauna and our preliminary objective was to determine whether the occupation level was preserved below the surface.

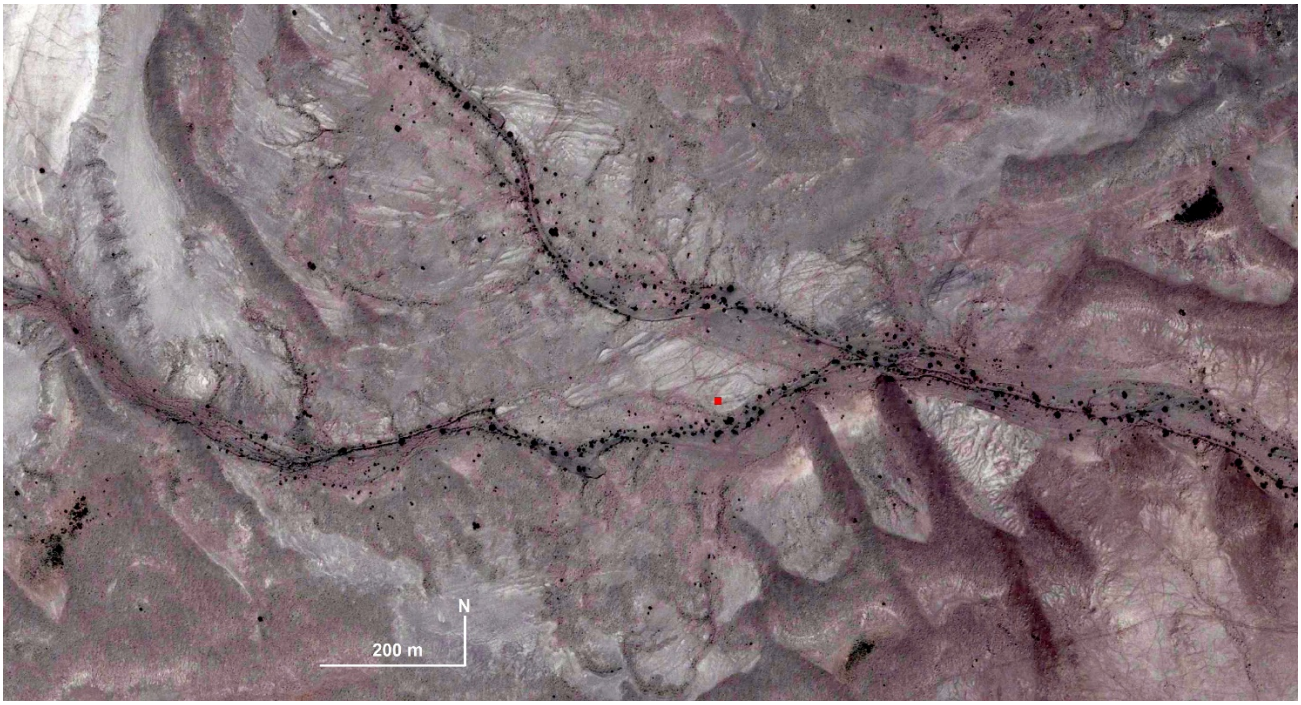


***Figure 7*: Quickbird satellite image of the Bet Bahari region. The red square marks the location of the site.**

Our first operation at the site consisted of a 1m^2 test pit which we placed at the highest and flattest point of the site (Fig. 8, see *Sondage* in Fig. 11). This test pit was excavated in 5 cm spits to a depth of 10 cm. We first scraped the site surface which was characterized by a powdery brownish gray silt, and immediately came upon a very hard dark brown hardened clay surface abundant with bivalve and *Melania* shell and large gypsum formations which made

excavation difficult. The matrix remained the same to a depth of 10 cm and was absent of any archaeological materials. The test pit confirmed that the site was simply a residual occupation surface that had been eroded by gully formations in later periods. The hard gypsum rich deposits underlying the site pertained to rich lake deposits from a period of lake transgression prior to the occupation of the site. This was confirmed by L. Bruxelles's geomorphological study of the natural western section of the site (formed by gullying) and in which the relationship of these lake sediments rich in shell and gypsum to the occupation surface, were clearer (Fig. 8, Right). Two shells from these lake sequences were dated by AMS and provided a terminus post quem of 8245 cal. BC for the occupation of the site and for a period of lake transgression in the area.

***Figure 8*: Left:** First 5 cm spit showing dark gypsum and bivalve-rich lake sediments immediately below the occupation surface in the 1m^2 test pit. **Right:** L. Bruxelles and C. Tribolo describing the western section of BETBA-01 which provided a window into the lake sequences underlying the site. Two dated shell were sampled from this section.

Given that our test pit had demonstrated that 1. the site was not preserved below the surface, 2. much of what was on the surface had not moved far from its origin and 3. erosion was now taking its toll on what remained in place, we developed a strategy to comprehensively document the site and salvage what information was available. G. Davtian took kite aerial photographs and carried out a digital terrain model of the site using a differential GPS (Fig. 9). We proceeded to piece plot (x, y and z) and collect all of the archaeological materials distributed across the site (total of >1398 artifacts with a unique number) for in depth study of the total site assemblage preserved.

***Figure 9*:** Left: G. Davtian preparing to fly his kite and to photograph the site aerially. Right: G. Davtian and E. Gauvrit-Roux preparing to piece plot and register the nearly 1400 surface artifacts from BETBA-01 using a differential GPS.

This allowed us to map artifact type (fauna, shell, basalt, obsidian, etc.) and distribution in relation to the topography and morphology of the site. For example, high concentrations of artifacts were recovered near the natural western section and localized in small erosion gullies at the edges of the site (Fig. 10, 11). However,

abundant material was also recovered in less disturbed areas of the site mound. The presence of several elements that could be refitted demonstrated that most of the materials had not moved considerably since their abandonment and justified the provenancing and collection of every artifact.

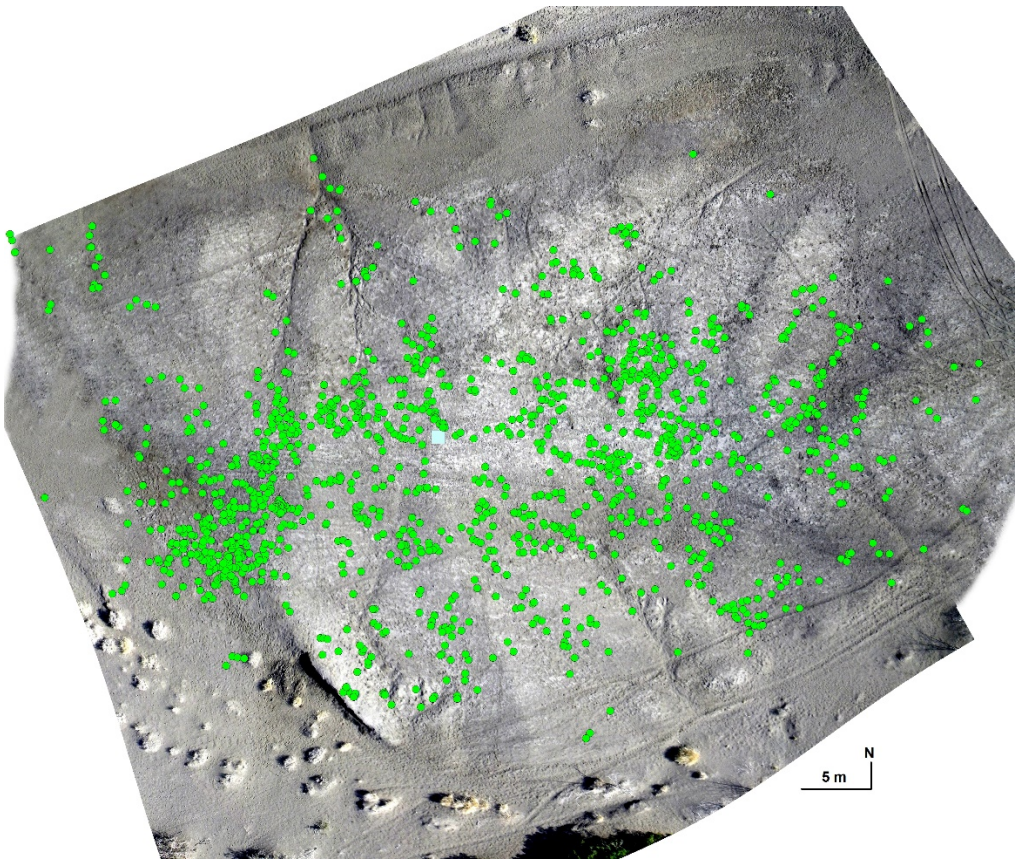


Figure 10: Nearly 1400 artifacts were piece-plotted and draped onto the georeferenced aerial kite photograph mosaic of BETBA-01. Each green dot represents the location of an artifact collected on the site and registered in our database. The $1m^2$ sounding that was carried out in 2016 is represented by the light blue square.

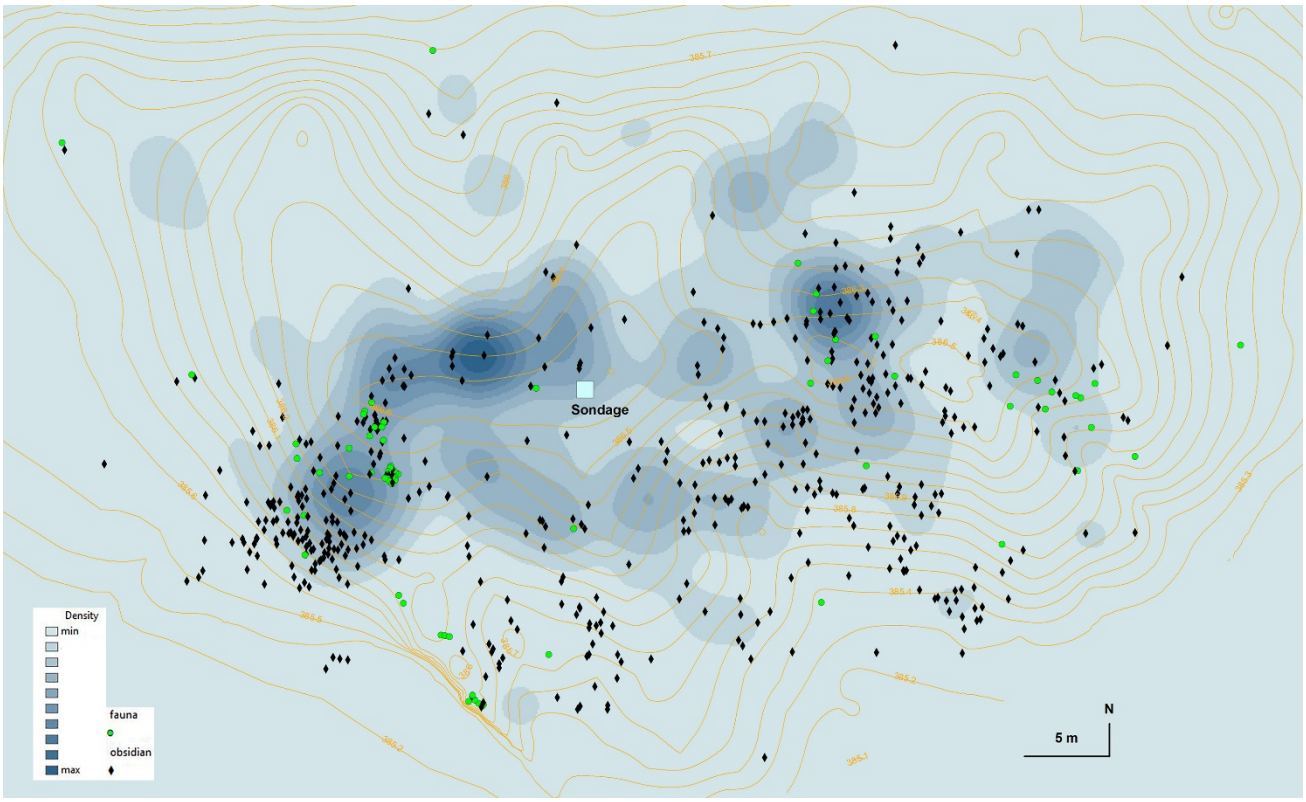


Figure 11: Digital terrain model of the site of BETBA-01 with piece-plotted fauna and obsidian artefacts against a density distribution model of worked basalt tools and debitage. Density distribution models draped on a DTM allow us to analyze areas of highest preservation and erosion based on the formation of gullies, the type of artifact (for example, basalt fragments were generally larger and heavier than the other materials and less likely to move than faunal remains or obsidian, and modelling basalt density can help us identify areas of least disturbance). The $1m^2$ sounding that was carried out in 2016 is represented by the light blue square. DTM and mapping by G. Davtian

Study of the materials recovered from the site are ongoing. The basalt industry is quite unique and proved to be the most dominant on this site comprising 735 artifacts. The obsidian industry which has affinities to LSA production known elsewhere in Ethiopia comprised 499 artifacts. 76 faunal remains and 12 shell remains were piece plotted and collected from the site and their study by J. Lesur highlights a large number of large fish and aquatic animals (Table 2) providing further evidence that this site is likely pre-Neolithic and was a lake margin site occupied during a period of lake transgression. In addition, the site contained 54 chalcedony, 5 sandstone and 16 unidentified artifacts. 1 ceramic was found on the site and was described by J. Cauliez as having affinities to Neolithic pottery in the region. This single ceramic is certainly a later addition to the site assemblage which judging by all of the materials recovered and the dates provided by lake deposits immediately underlying the site, is otherwise coherently pre-Neolithic.

THE SITES OF KURUB BAHARI

KURUB 01 (KUR-01)

Four geomorphological test soundings (Soundings 1-4) were carried out at the site of KUR-01 to evaluate the stratigraphic potential and preservation of this very large site situated to the east and north of a large mobile dune and to better understand how this site related to the area's aeolian and lacustrine deposits (Fig. 12, dune corresponds to the elevated area in brown on the DTM). We chose these locations as the surface cover in the area of Sounding 1 and to its east was heavy in artifact concentration, including a large number of ceramics, basalt groundstone and obsidian, whereas the area of Soundings 2-4 was more deflated with no evidence of ceramics but with occasional remnants of an obsidian industry that has more affinities with LSA traditions. We hoped to understand whether this difference was a function of the topography and deflation in the area (The DTM shows

that the area of Soundings 2-4 is a depression whereas Sounding 1 is slightly more elevated), whether we were dealing with two separate sites of different dates, or both.

These soundings were initiated by burrowing a long trough through a cross-section of the visible topography in 4 different areas (Fig. 12). These long burrows served to provide a shallow window through the variable surfaces visible (sand dune, artifact scatter, lake-bed fossil rich sediment) to see whether they were superficial (deflated or residual surfaces) or whether they continued. This allowed us to better choose areas for soundings, of which Sounding 3 was never excavated beyond the burrow. Only Soundings 1, 2 and 4 were excavated in 1m^2 test pits until we reached sterile sediment.

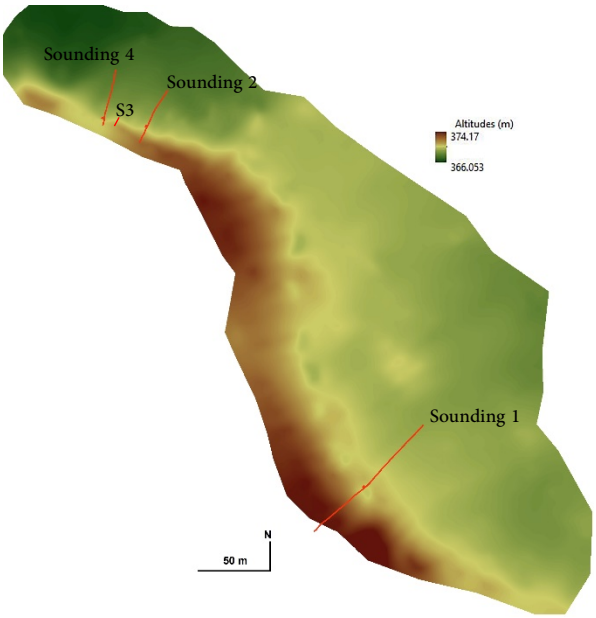


Figure 12: Digital terrain model of the site of KUR-01. The red lines represent the location and orientation of the geomorphological Soundings 1-4 carried out on the site. DTM and mapping by G. Davtian

KUR-01, SOUNDING 1

Sounding 1 was excavated to a depth of 1.4 meters by C. Menard, B. Engda, E. Gauvrit-Roux, and T. Senay and was the only sounding on the KUR-01 site to provide successive 'strata' with a good deal of archaeological material from between 30 and 80 cm below the surface and a few isolated artifacts at 90 and 100 cm below the surface, after which sterile soil was reached. As this was a rapid diagnostic test pit meant to create section profiles for geomorphological study and for OSL dating, collections were made in 10 cm spits (calculated in relation to surface level). Artifact collections and changes in sediment were recorded. One part (ca. ¼) of the sediment was sieved and all archaeological materials were retrieved from each 10 cm spit, when present.

The first archaeological material was retrieved at ca. -40 cm, in a spit underlying the modern dune. 6 faunal remains were recovered of which one tooth of an indeterminate bovid was the only diagnostic bone. One indeterminate ceramic body sherd as well as obsidian and basalt lithics were also among the artifacts recovered (Fig. 13).

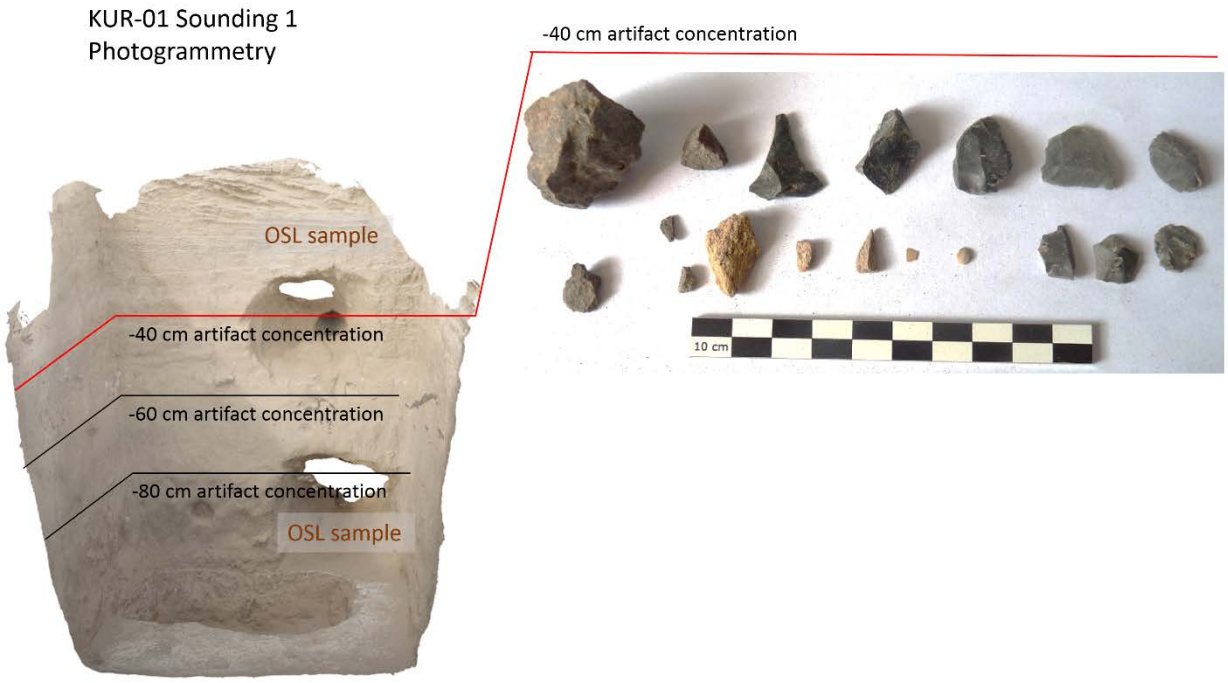


Figure 13: Photogrammetry of the S section of KUR-01, Sounding 1 with a selection of the artifacts recovered at -40 cm.

The ca. -50 cm spit provided 4 indeterminate faunal specimens, 11 lithics (9 obsidian and 2 basalt) and 2 small ceramic body sherds of which one has red paint and is typologically consistent with Neolithic ceramics in the region and with those found on the surface of KUR-02 in 2014 (Fig. 14).

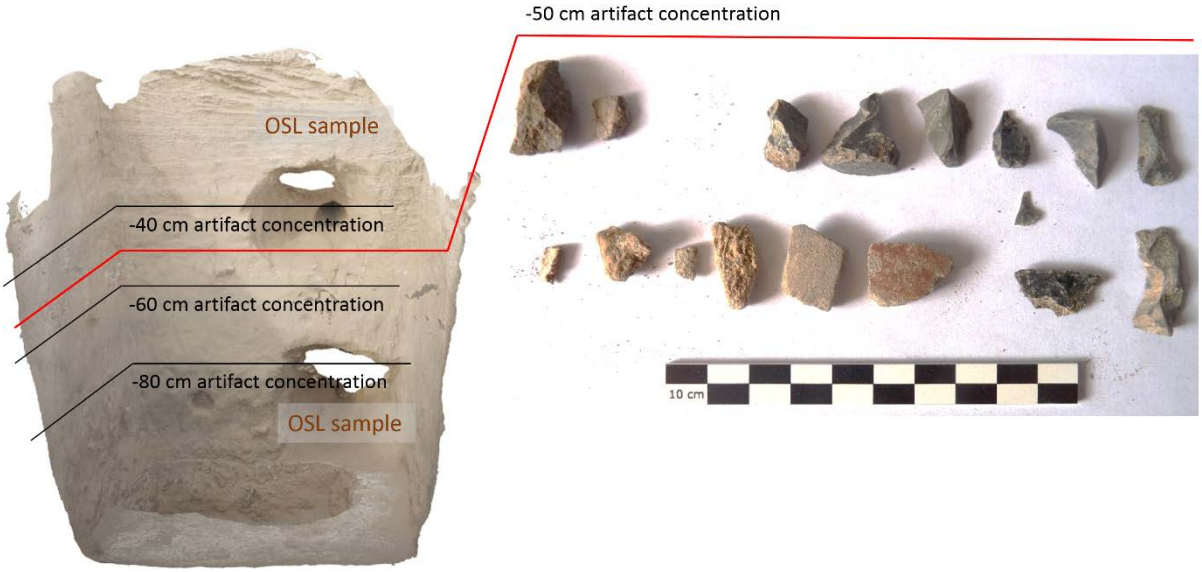


Figure 14: Photogrammetry of the S section of KUR-01, Sounding 1 with all of the artifacts recovered at -50 cm.

The ca. -60 cm spit was the richest, providing 12 indeterminate faunal specimens, 36 lithics (30 obsidian and 6 basalt including a small fragmented grinding stone) and 9 small ceramic sherds of which 3 were decorated. The decorated ceramics included a sherd with an external rim impressed with a vertical chevron decoration and roulette decoration on the body, a sherd with an impressed or incised lozenge pattern, all of which are typologically consistent with Neolithic ceramics in the region and with decorated ceramics found at KUR-02 (Fig. 15).

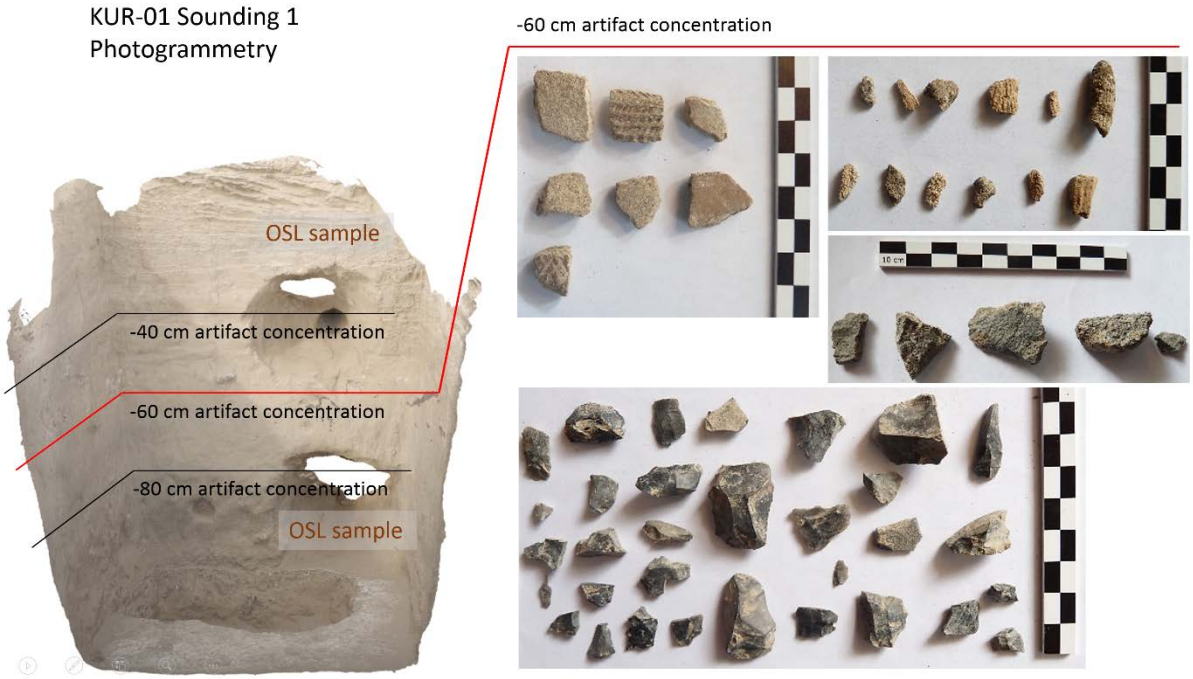


Figure 15: Photogrammetry of the S section of KUR-01, Sounding 1 with a selection of the artifacts recovered at -60 cm.

The ca. -80 cm spit provided only 4 lithics (3 obsidian and 1 chalcedony) and no faunal or ceramic remains. (Fig. 16). At -90 cm and -100 cm, 1 basalt and 1 obsidian were recovered.

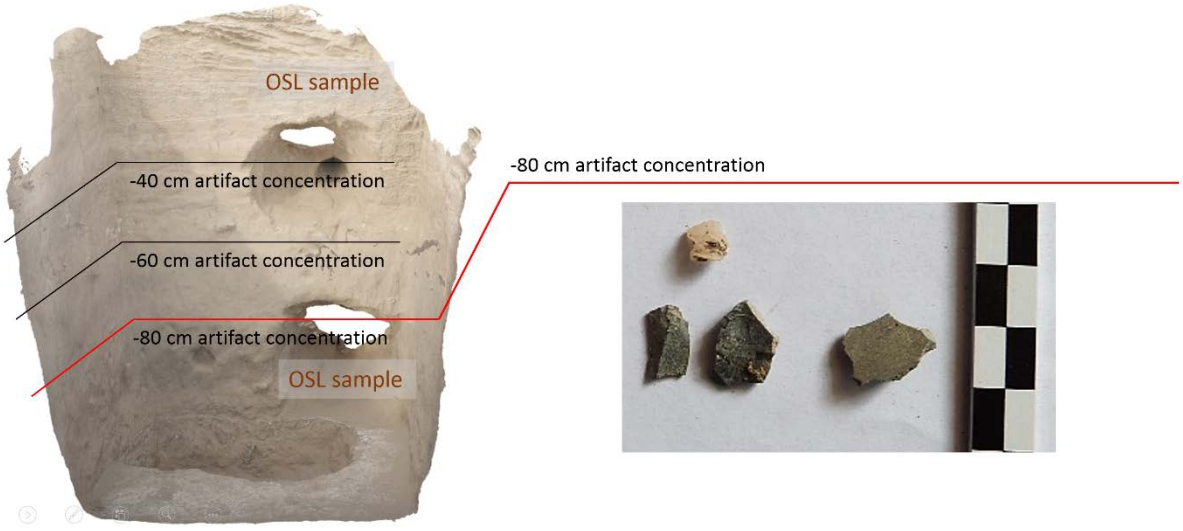


Figure 16: Photogrammetry of the S section of KUR-01, Sounding 1 with a selection of the artifacts recovered at -80 cm.

While below -60 cm, the artifact concentrations are so low that their incidence could, in theory, be attributed to taphonomic factors, it is worth noting that from this point on there are no ceramics present. More extensive excavations are required to determine whether these are older in situ occupational levels and whether the younger ceramic levels are in fact in place or on deflated surfaces covered by more recent dunes. What is certain is that this sounding provided poorly preserved remains of all types (small fragmented artifacts) with respect to KUR-07 and even BETBA-01.

After the completion of the sounding, two OSL samples were recovered from selected areas in the S section of Sounding 1, as is visible in the series of section illustrations above, and their treatment and processing is currently underway in France.

KUR-01, SOUNDING 2

Sounding 2 was excavated in larger spits than Sounding 1 and all sediment was sieved.

- Between ca. 0-25 cm below the surface the sediment was made up of fine-layered loose sand with a total absence of artifacts.
- Between 25 and 55 cm below the surface, the sediment was made up of a dark clay sediment with desiccation cracks interspersed with layers of small shell and sandy layers, all presenting an absence of artifacts. At -45 cm within this large spit was a layer of sand with flat slabs of calcium carbonate *poupées* covered in accumulating layers of sand and iron oxide inclusions.
- At -55 cm there appeared an additional but more massive layer of clay sediment with desiccation cracks and within which at least one paleosol emerged (Fig. 17).

The entire test pit was sterile of archaeological material and was therefore not chosen for OSL dates. However, the detailed section logs (L. Bruxelles) across the landscape of the Kurub Bahari area and on an intra-site level, such is the case with KUR-01, will enable us to link the different sediment levels with each other to reconstruct the landscape in the area.

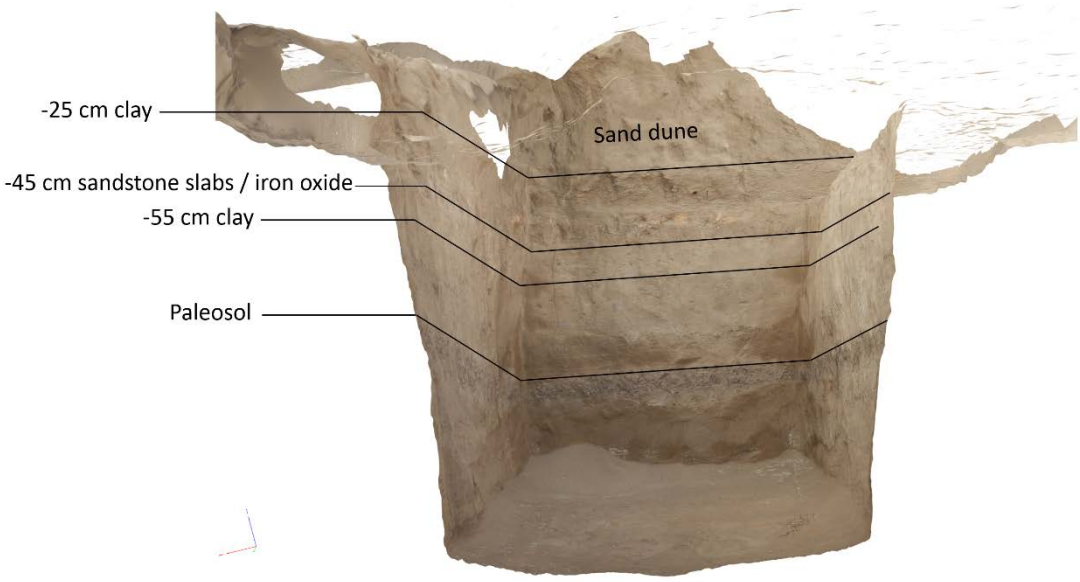


Figure 17: Photogrammetry of the SW section of KUR-01, Sounding 2.

KUR-01, SOUNDING 4

Sounding 4 was less deep than the other 2 soundings in KUR-01. Below the fine layers of sand dune, clay sediment appeared like in Sounding 2. Between these two sedimentary formations was a surface of deflation/occupation on which one obsidian flake was recovered (Fig. 18).

Figure 18: Photogrammetry of the SW section of KUR-01, Sounding 4 with the single obsidian artifact recovered from this test pit.

KURUB 05 (KUR-05)

KUR 05 is a site located on the southern side of a long NE-SW oriented mobile dune between 3 and 4 km to the NNW of KUR-01 and KUR-07. The site is composed of deflated relict lake deposits with large numbers of fossilized faunal specimens including hippopotamus, crocodile and fish remains. During surveys in 2014, we recovered an abundant aceramic obsidian industry with affinities to LSA traditions elsewhere in Ethiopia on the surface of the site. We chose this area for geomorphological soundings because of the problematic intermixing of fossilized aquatic faunal remains with large numbers of obsidian tools and debitage. Our objective was to recover occupational and lake deposits in situ and to date them to establish a firm chronology of pre-Neolithic occupation in relation to the last major period of lake transgression in the area. Soundings 5 and 6 were conducted as long burrow trenches oriented approximately N-S in order to create a section from the current sand dune and across the deflated artifact and lake rich surfaces we encountered south of the dune (Fig. 19). This allowed us to study the relationship between the dune, preserved archaeological and sedimentary levels and the creation of these deflation surfaces. The section logs are in preparation.

Figure 19: Photographs of L. Bruxelles studying the sections in Soundings 5 and 6 at the site of KUR-05. These soundings produced one obsidian fragment each. Sounding 5 produced 6 fish remains from relict lake sediments reached, including the skull of an African sharptooth catfish *Clarias gariepinus* (left).

Sounding 5 produced 6 fish remains including 1 neurocranium (Fig. 19, left), 1 neurocranial fragment and 1 vertebra of catfish as well as 3 undetermined fish remains. In addition, 1 obsidian fragment was recovered from this test pit. Sounding 6 which was sampled for OSL dating (Fig. 20), produced 1 obsidian fragment.

Figure 20: L. Bruxelles and C. Tribolo preparing samples in plaster blocks for OSL dating in Sounding 6 at the site of KUR-05.

KURUB 07 (KUR-07)

KUR-07 was first identified during surveys of the area in 2014. However, it was only in 2016 that we recognized a burnt clay structure partially visible on the surface of the site. The presence of ceramics within the partially exposed structure, its proximity to a concentration of basalt groundstone elements, and abundant faunal remains fragmented

by erosion in its proximity were determining factors for choosing this location to conduct a series of test pits.

On the 24th of March, 2016 we laid out a grid of 12 m^2 (6x2m) over the area. The grid covered the area of the structure (SE corner) and the densest concentration of basalts (NW corner) and was oriented more or less N-S.

K15	L15
K14	L14
K13	L13
K12	L12
K11	L11
K10	L10

A digital terrain model and aerial kite photography was carried out by G. Davtian (Fig. 21) in the immediate area of the location chosen for excavation (but did not cover the entire area of dense artifact cover that constitutes the much larger site of KUR-07).

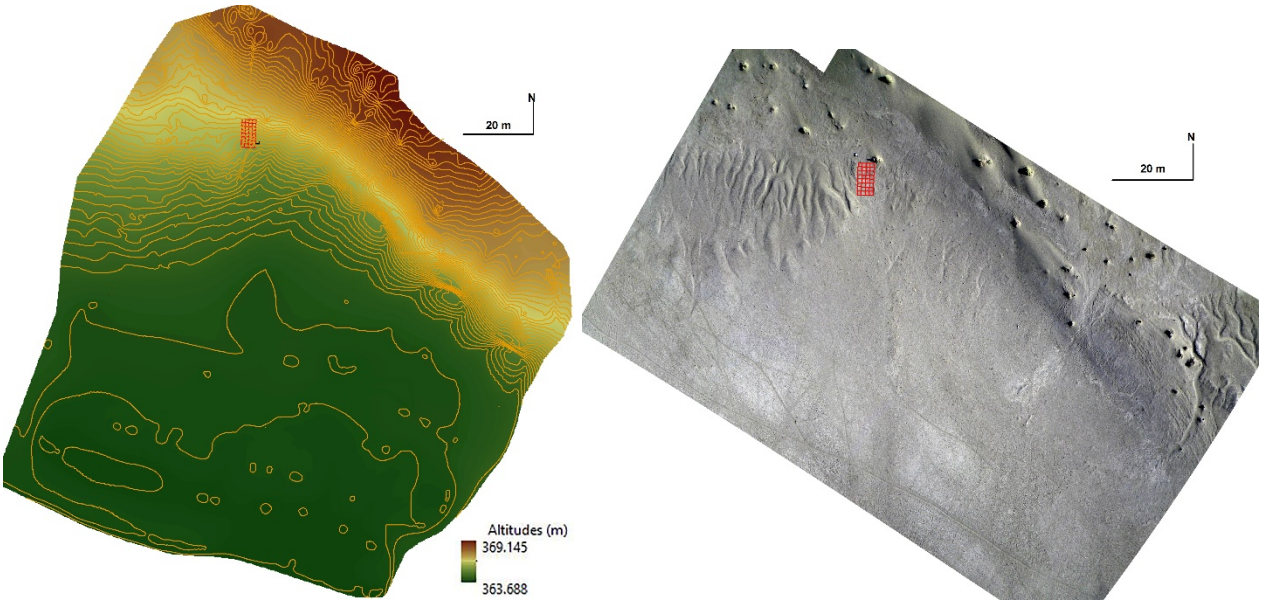


Figure 21: The red rectangle in both images represents the site grid used in 2016 divided into 1m squares. **Left:** Digital terrain model of the site of KUR-07. **Right:** aerial kite photography of the site of KUR-07 overlain with the same site grid. DTM, Aerial kite photography and mapping by G. Davtian.

We proceeded to systematically register and piece plot (ceramics piece plotted from surface, Fig. 22, 23) all of the visible surface artifacts in the grid (regardless of size), with the addition of about 50 cm along the perimeter of the grid periphery to avoid dislodging or moving artifacts during excavation and section cleaning. The total area of the zone documented measured about 20 m^2, corresponding to a continuous concentration of surface artifacts.

***Figure 22*:** Decorated ceramic sherds #79 (Square K11), #13 (Square L13) piece plotted from the surface of KUR-07 and a sherd found on the surface of KUR-07 during surveys in 2014. A large variety of decorations are found on the ceramics of this site alone.

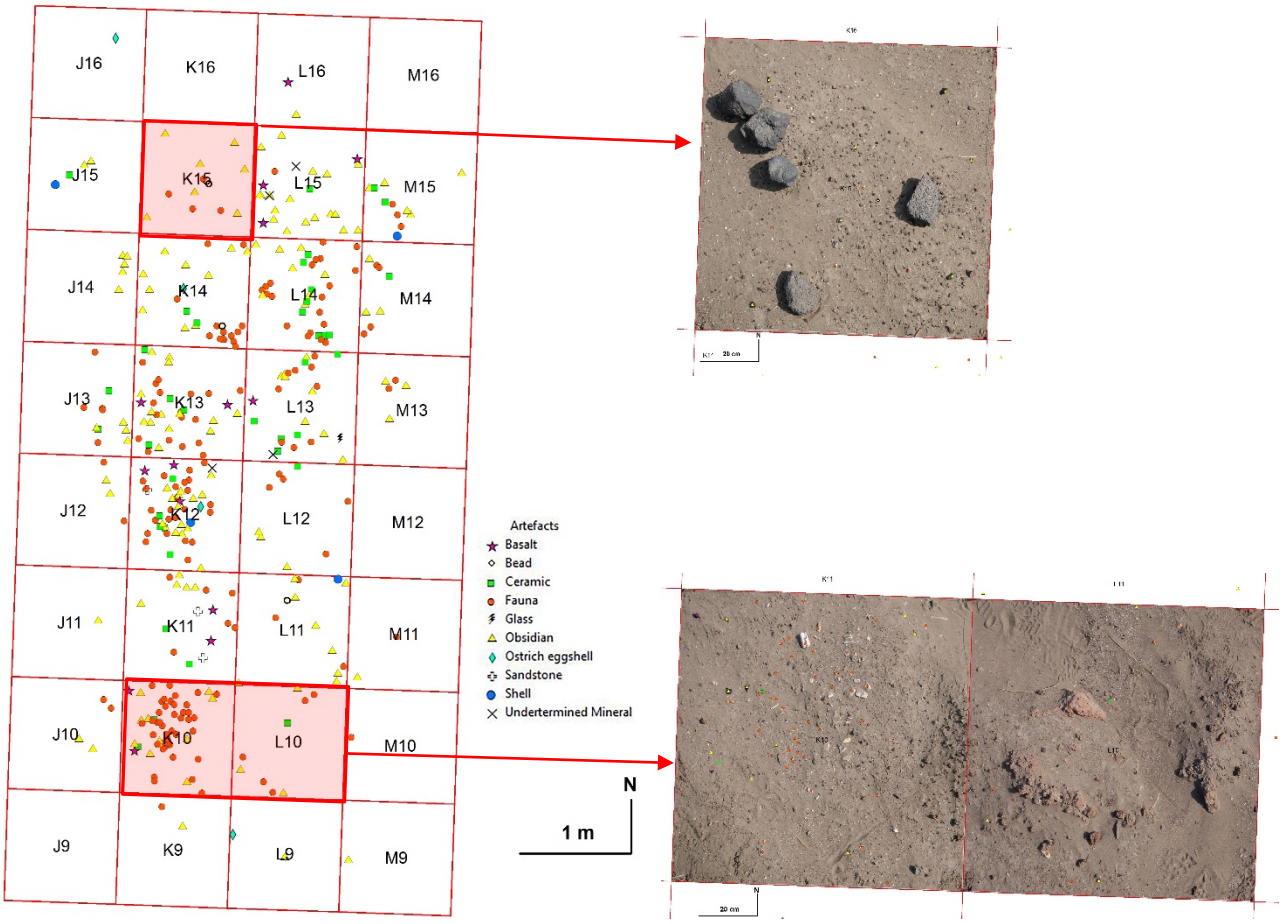


***Figure 23*:** Grid of the site of KUR-07 with surface artefacts piece-plotted by type prior to excavation. Zoom of aerial kite photograph of the three 1m^2 areas (K15, K10 and L10) before their excavation. Photography and mapping by G. Davtian.

Between the 24th and 30th of March, the excavation of KUR-07 concentrated on two different zones within the grid (K10-L10 (S) and K15 (NW), Fig. 23) that were excavated simultaneously by C. Ménard, E. Gauvrit-Roux, B. Engda, T. Senay and L. Khalidi. To avoid confusion, the excavation of these two zones will be described separately. The excavation was divided by square (K10, L10…) and carried out in spits (Arabic numerals with a number sequence unique to each square: Spit or Décapage 1, 2, 3,…). A new spit number was assigned when there were evident changes in stratigraphy (archaeological: features, appearance of surfaces, or sedimentological: soil color, soil texture, etc.). When structures were identified, they were assigned structure numbers (ST1, 2, 3,…) independent of the spit numbers. In one case (ST1 in square L10), the excavation was made up of 3 Spits. All archaeological artifacts larger

than 20 mm were piece plotted by differential GPS or by traditional means off of the corner nails. Exceptions were made for certain tools, objects and charcoal smaller than 20 mm, which were provenanced when possible, despite their size. The rest of the sediment was dry sieved and all of the remains were bagged according to the square, spit and structure number from which they were recovered.

SQUARE K15

The excavation of K15 was subdivided into 8 Spits (of which Spit 3 proved to be sterile). It is worth noting that excavators separated artifacts collected from Spit 4 and Spit 4 (bottom) to take account of material that was laying directly on the archaeological surface that constituted the bottom of Spit 4. In addition, 2 structures (ST2 and ST6) were excavated separately within K15.

The highlight of this test pit was the excavation of Spit 4 which was a compacted flat dark clay surface with calcium carbonate inclusions and an unidentified whitish crust in certain areas (on a slight decline between 10-12 cm NW) on which a single decorated ceramic hole-mouth pot was fractured in 47 sherds (Fig. 24). Some of these sherds were still interconnected (most with internal face up) and lying flat along this surface at the time of excavation which facilitated a partial refitting of the pot (Fig. 25). There were concentrations of charcoal (12 charcoal samples piece plotted) in their proximity and underneath them. On the same surface there were 2 obsidian flakes and 2 cores as well as 23 piece plotted faunal remains including 2 remains of domestic cattle (an entire mandible of *Bos taurus*) as well as 1 possible domestic caprine, though this remains to be confirmed. The remaining taxa were wild, including 4 large wild mammals, and a large number of wild bovids. An additional 59 faunal remains were recovered from sieving including two fish fragments (Tilapia otolith and unidentified).

***Figure 24*:** Screenshot of photogrammetry of test pit carried out on the site of KUR-07 (G. Davtian): Square K15, Spit 4 (Bottom), excavated in an area equaling 1m^2. Spit 4 produced ceramics fractured in situ and partially interconnected on an occupation surface with remains of *Bos taurus*.

The remaining Spits had archaeological materials but no clear in situ levels were identified except for Spit 7 which

produced few archaeological materials (2 obsidian and 2 fauna including wild bovid and reptile piece plotted) in conjunction with a few charcoal fragments (Fig. 25). It is worth noting that there was an absence of ceramics in Spits 7 and 8. Spit 8 was the last level to produce archaeological material, and the remaining sediment excavated was sterile.

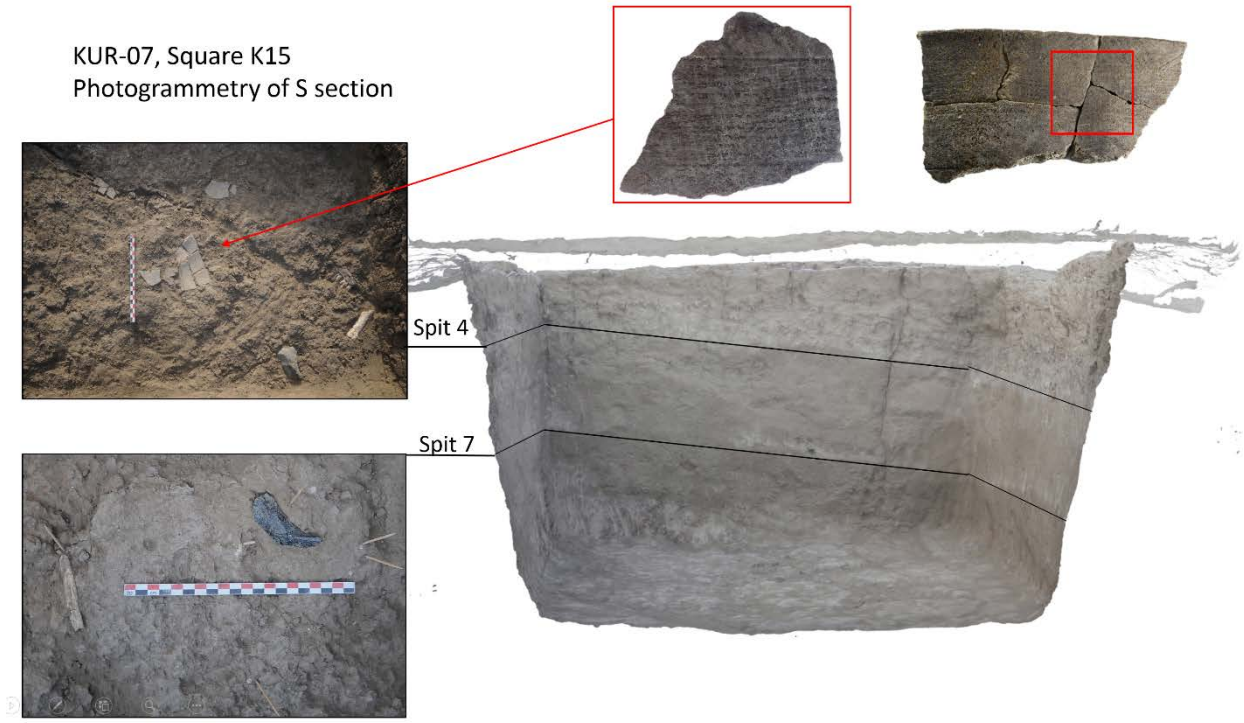


***Figure 25*:** Screenshot of photogrammetry of S section of 1m^2 test pit carried out in Square K15 on the site of KUR-07 with the main archaeological levels including Spit 4 (Bottom) which yielded broken decorated ceramics on a flat compact surface which could be refitted into a single vessel and Spit 7 which yielded occasional fauna and one obsidian blade.

The following sedimentary succession was observed in Square K15 (Roman numerals (I, II, III…) present in the stratigraphic profile illustrated below but which do not appear in the inventory or on the collection bags, Fig. 26):

I: alternating layers of sand (dune)
II: clay with calcium carbonate inclusions. At the top of layer II in K15/K16, there was a darker level that suggested the presence of an occupation surface.
III-IV: Sandy-silt level. More sandy in interstratified layer IV. ST6, distinction between layers III-IV not seen during excavation. Note that sand fills a depression in the clay in the eastern sector of squares K15/K16.
V: Massive clays with significant desiccation cracks.

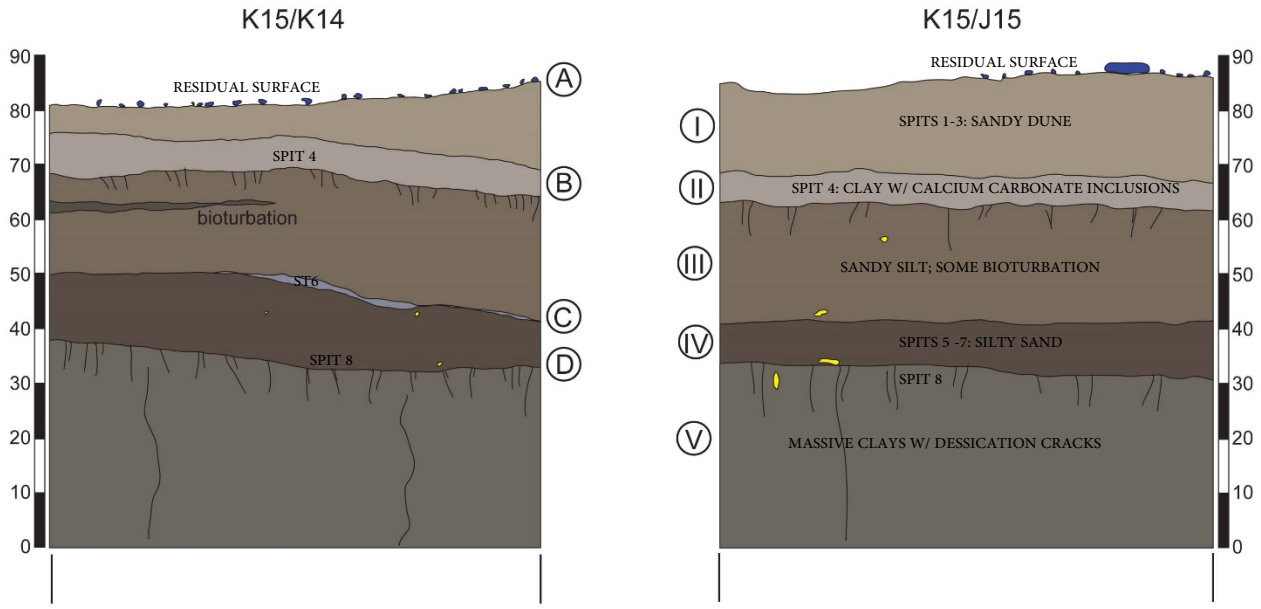


***Figure 26*:** KUR-07, Square K15 South and West stratigraphic profiles (left to right respectively).

From an archaeological point of view, we observed at least 4 distinct archaeological levels (see levels A-B in the stratigraphic profiles; again no mention of these letters in the inventory or on the collection bags).

A: Abundant material deflated on the surface (mainly ceramics, lithics and faunal bone), and basalt groundstone.
B: The main archaeological level excavated. Large number of ceramic sherds broken in situ and interconnected (registered by lots).
C (ST6): Structure ST6 was only present in the southern part of square K15. This structure, considered anthropogenic despite a total absence of archaeological material, was visible in the section and corresponded to a shallow pit or lens with compacted white ash.
D: Many very small relatively dispersed micro-fauna in top part of clay mass (between 3 and 5 cm of depth).

Between excavation of Spits 2 and 3 in square K15, we isolated structure ST2. This structure corresponded to a loose sediment with shell and likely to the beginning of a ravine that can be seen to the east in square L15. The zone of bioturbation that is visible in section further down (in the same sector) is unrelated. While we await final altitude calculations, we can make preliminary correlations between:

I = Spits 1 – 3
II = Spit 4
III-IV = Spits 5-8

The average altitudes below the datum (= K15 NW) of the different Spits in K15:

Spit	Center	NW	NE	SW	SE
1					
2					
3	11	10	10	14	12
4	16.5	26	19	27.5	15.5
ST6	42.5				
5	43	42	43.5	43.5	45
6	55	56	53	56	51
7	59	58.5	56	57	56
8	85				

SQUARES K10-L10

The excavation strategy was slightly different in squares K10-L10 than in square K15. The objective here was to try to identify the plan of the burnt earthen structure ST1 so as to understand its stratigraphic relation to other levels and to understand its function. The complexity of this structure, the surprising extent of the structure itself (> $1m^2$), the limited area of visibility of the test pits, and the presence of a deep ravine visible from the surface, made it difficult to fulfill these objectives.

The earthen structure ST1 was present in the entirety of square L10 and in the NE corner of square K10. These areas were therefore excavated in such a way as to try to understand the makeup of the structure and to distinguish its exterior from its interior. The majority of square K10 (save for the NE corner), however, was excavated in Spits 1-2.

We first excavated the southern half of L10, followed by the NE corner and then the NW corner while concomitantly excavating K10 in its entirety. It is worth noting that these distinctions (NE, NW etc…) do not necessarily appear on bag labels but that all that was excavated before the 27th of March corresponds to excavation of L10 South (S). The division of this structure and the Spits assigned within the structure ST1 are not meaningful and were simply used in order to have more control over the excavation, especially given the complexity and uniqueness of this structure, the likes of which we had never before encountered. What is meaningful are the coordinates of the materials recovered and registered from within and outside of the structure. These coordinates give us an idea of correlation between interior and exterior, illustrate the abrupt topography of this structure and the manner in which we excavated it as well as illustrating the taphonomy of the structure and its surrounding area.

The principal structure excavated in squares L10 and K10 was ST1. Located in most of Square L10 and the NE corner of Square K10 the interior of the structure is characterized by a mass of heterogeneous burnt reddish clay sediment with whitish-beige nodules often cemented, red clumps of burnt clay, and occasional scoria with areas of loose black and white ash, and burnt archaeological material (bone, charcoal, obsidian, ceramics) contained within modelled/imprinted (by organic material mainly resembling wood) earthen walls in roughly circular calabash form (Fig. 27, 28). The retaining structure itself appears to have several layers: inner and floor of chamber is mainly made up of a very hardened, thick, crackled and often modelled whitish surface with circular empty holes in the floor which resemble postholes (ST3, 4, Fig. 27). Covering this we observe alternating reddish earth and very thin layers of compacted white ash which are mainly visible on the vertical walls of this structure. Within this structure we find ST3, 4, and 5 which are likely features of ST1. ST3-5 pertain to potential postholes. The only exception was ST5 which was located in the NE of square K10 and which was characterized by a localized mass of dark ash abundant with burnt archaeological materials (Fig. 27). Possible interpretations of this lens at the time of excavation were that it was potentially an ash dump, or an overflowing of ash that occurred at the time the structure was burnt.

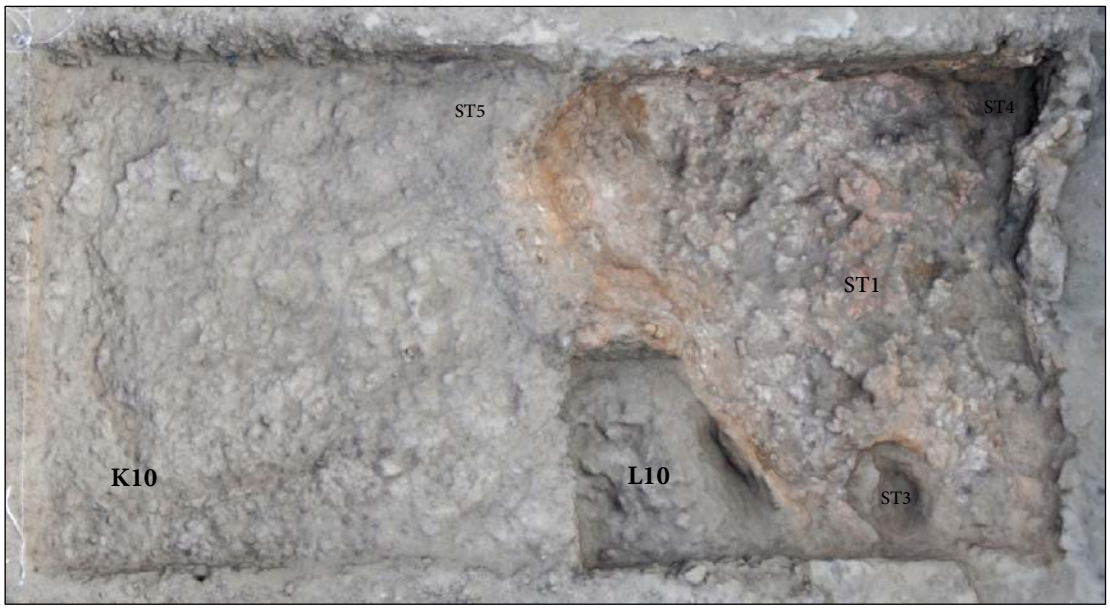


Figure 27: Screenshot of photogrammetry carried out on the test pits excavated on the site of KUR-07. Photograph halfway through the excavation of Squares L10 and K10 (1m^2 each), with sub-circular burnt earthen Structure 1 (ST1) in L10 and what appear to be circular holes/ postholes and imprints of wood and other organic materials.

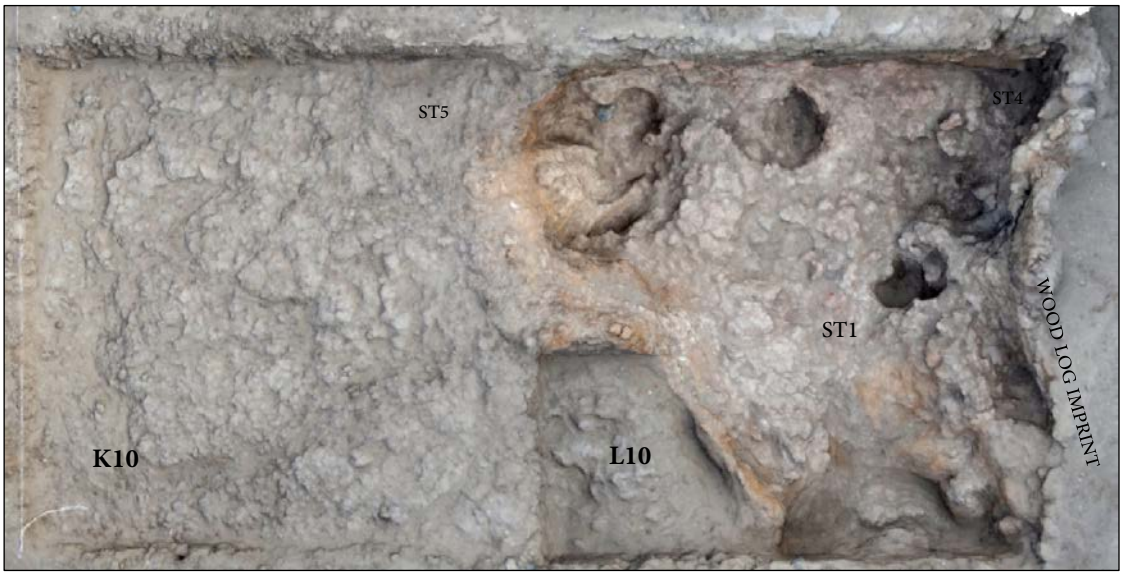


Figure 28: Screenshot of photogrammetry carried out on the test pits excavated on the site of KUR-07. Final photograph of Squares L10 and K10 (1m^2 each), with sub-circular burnt earthen Structure 1 (ST1) and what appear to be circular holes/ postholes and imprints of wood and other organic materials.

While we still do not understand the function of this structure, or structures, several finds and observations allow us to come to several conclusions:

- The structure walls appear to have collapsed into (or outside of) the structure judging by the large number of impressed earth fragments within its fill.
- Impressions in the clay appear to be vegetal and potentially point to a structure that was built of wood and other vegetation and mud.
- The presence of cemented burnt clay, burnt earth, large numbers of charcoal fragments (17 charcoal samples piece plotted in L10, 11 in K10) and ash, and burnt ceramics (Fig. 29) confirm the structure was burnt.
- The presence of scoria within the structure suggests that the structure burned at very high temperatures.
- Charcoal recovered on the bottom of ST1 L10 was dated to 1440 cal BC by AMS confirming this structure was

burnt in the 2nd millennium cal BC.
- Charcoal recovered in K10, Spit 2 was dated to 1620 cal BC by AMS confirming these levels also pertained to the 2nd millennium cal BC.
- 6 faunal remains were piece plotted from the surface of the structure and 14 faunal remains from the interior of ST1 in L10 including 1 possible domestic caprid (to be confirmed by further finds), and 9 wild bovid fragments. 12 faunal remains were piece plotted from Spits 1-2 in K10, and 55 piece plotted on the surface of K10 including 2 fragments of domestic *Bos Taurus*. These numbers do not include fauna recovered from sieving, but demonstrated that the structure belonged to pastoral Neolithic populations.
- Ceramics with variable forms, and styles and techniques of surface decoration were found inside and outside of the structure. # 650 and 653 were found burnt (whitish patina is a result of burning) within ST1.
- Finally it is unclear if the soundings recovered the interior of 1 structure or the exterior of several structures. The structure appears to continue at least into Squares L9, L11 and M10 and may be preserved lower down in Square K10 requiring larger excavations.

***Figure 29*:** Photos of burnt decorated ceramic sherds n°650 and 653 from the interior of ST1 Square L10, and decorated sherd 599 from Square K10.

The progression of the excavation of squares K10 and L10 (by day, area, structure and spit) is laid out in the table below:

Date	**Square**	**Structure**	**Spit**
24-March	K10		Surface
24-March	K10		1
25-March	K10		2
27-March	K10	5	
24-March	L10 S		Surface
24-March	L10 S		1
25-March	L10 S	1	1
25-March	L10 S	1	2
26-March	L10 S	1	3
27-March	L10 NE		1
27-March	L10 NE		2
28-March	L10 NW	1	1

INVENTORY OF SUCCESSIVE STRUCTURES (L10/K10/K15)
- **ST1:** Located in most of Square L10 and the NE corner of Square K10. Retaining structure made of several layers:

inner and floor of chamber is mainly made up of a very hardened, thick, crackled and often modelled whitish surface. Fill made up of mass of heterogeneous burnt reddish clay sediment with whitish-beige nodules often cemented, red clumps of burnt clay, with areas of loose black and white ash, and burnt archaeological material (bone, charcoal, obsidian, ceramics) contained within modelled/imprinted (by organic material mainly resembling wood) earthen walls in roughly circular calabash form. Within this structure we find ST3, 4, and 5 which are likely features of ST1.

- **ST2:** Located in eastern extreme of Square K15 near surface and on the surface of Square L15. Modern gully with powdery sediment and shell.
- **ST3:** Possible posthole in L10 South, ST1.
- **ST4:** Circular feature located along the eastern edge of L10 (L10/M10) within ST1 and containing abundant charcoal and burnt bone.
- **ST5:** At the western edge and beyond western retaining wall of ST. 1 (K10 NE) consisting of a pit or lens over 10 cm in diameter with dark grey and white ashy soft sediment rich in charcoal and burnt archaeological material (sherds of bone, obsidian and basalt). The contours of this feature are not clear and it is likely associated with ST1 (ash dump or overflow of ash after burning).
- **ST6:** Hardened shallow pit or lens of white ashy material with few charcoal in Square K15 between Spits 4 and 5 and equivalent to archaeological level C in section profile (Fig. 26).

PRELIMINARY CONCLUSIONS AND FUTURE PERSPECTIVES

We await final altitude calculations, OSL dates on soundings KUR-01 and KUR-05 and bioapatite dating on faunal remains from KUR-07 for more chrono-stratigraphic and geomorphological precision in reconstructing the evolution of late prehistoric occupation of the Afar. In the meantime, however, we can confidently say that the VAPOR-Afar study area has already provided a great deal of new important data on the late prehistory of Ethiopia.

Geomorphological work on the region in tandem with palaeoenvironmental and archaeological soundings have and will continue to provide secure dates and data that allow us to better understand the evolution of this complex volcanic and lacustrine landscape. Shell from lacustrine sediment underlying the site of BETBA-01 produced two AMS dates of 8245 and 8330 cal BC, or 10195 and 10280 cal BP. As the site's occupation occurred after this period, it, as well as the faunal data (large aquatic mammals and large fish), is coherent with the Abhe IV transgression illustrated by Gasse in 1977 which puts Lake Abhe levels at around 380 m a.s.l. In the simulation of such lake levels (Fig. 30, left) BETBA-01 would be located along the lake margin.

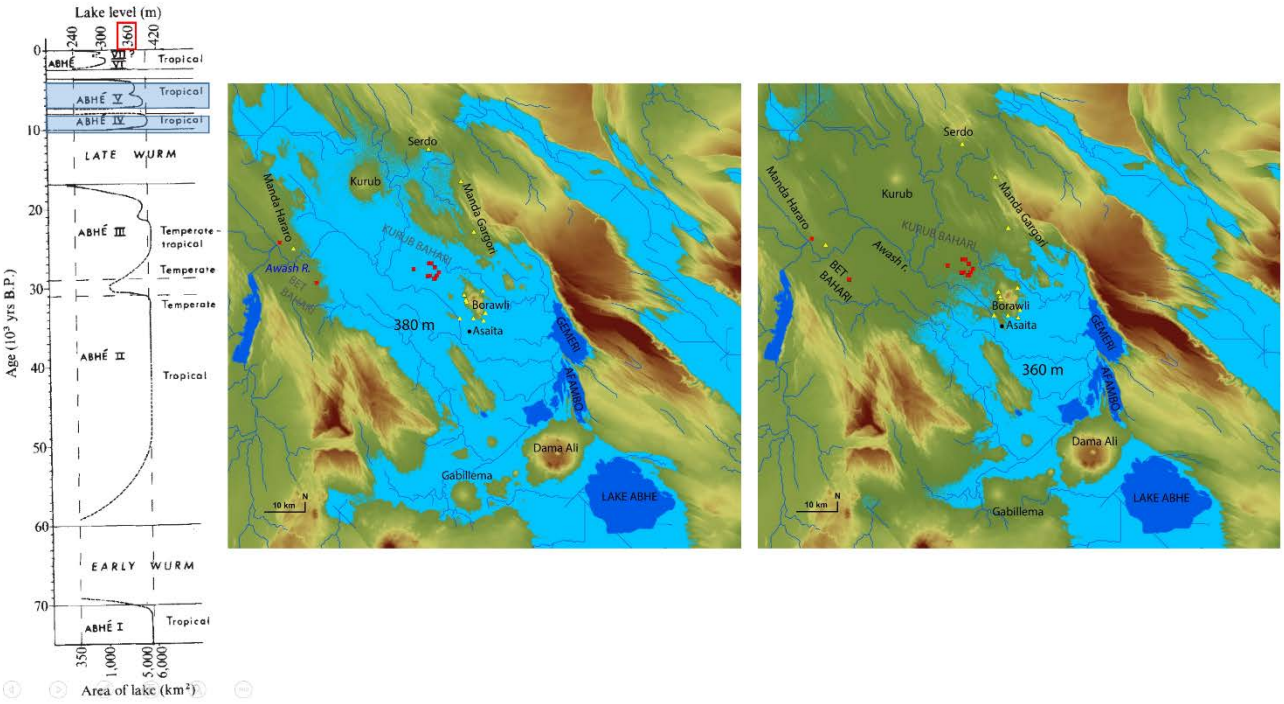


***Figure 30*:** Preliminary simulation of Lake Abhe transgressions (light blue) above the current level of the lake (dark blue) using topographic and hydrological data. Lake levels simulated to 380 m a.s.l. and 360 m a.s.l. in relation to the location of sites in our study area and to the diagram of lake levels by Age ky BP after Gasse 1977.

According to Gasse's diagram, the lake level would have been around 360 m a.s.l. or less and in regression at the period of the occupation of KUR-07, which was dated to 1620 and 1440 cal BC or 3570 and 3390 cal BP (Fig. 30, right). Judging by the preliminary results of the geomorphological study, we can reconstruct a landscape in the process of gradual aridification and where the large Lake Abhe was in regression and Neolithic occupations in Kurub Bahari were on the edges of marshes or slightly inland of the lake. This is coherent with the faunal data we have at KUR-07 in which aquatic mammals are absent, where there are very few fish present, and where the majority of taxa include wild bovids and domesticates, illustrating a less aquatic lifestyle that at BETBA-01 (Table 2).

Taxons	Kurub-01	Kurub-05	Kurub-07	BetBa-01
Grands mammifères			19	4
Hippopotamus amphibius				12
Bos taurus			5	
Bovini			7	
Bovidé T4-5				8
Bovidé T3			36	
Capriné?			2	
Bovidé T2-3			63	
Gazella cf. dorcas			1	
Bovidé indet.	1		16	
Rongeur indét.			38	
Lézard			2	
Crocodylus niloticus				6
Reptile indét.			5	
Siluriforme		1	2	17
Claridae		1		
Clarias gariepinus		1		
Tilapinii			4	2
Poisson indét.		3	5	14

Total vertébrés dét.	**1**	**6**	**205**	**63**
Œuf Autruche			9	
Coquillage			6	
Indéterminés	*20*		*671*	*35*
TOTAL	**21**	**6**	**891**	**98**

***Table 2*:** Spectra of fauna from the Kurub and BetBa-01 sites in relation to the number of remains (analyses by J. Lesur).

The discovery of a Neolithic site with a preserved circular structure and a potentially older preserved occupation surface with an almost entire broken ceramic vessel in association with domestic cattle remains, are a first for Ethiopia and the Horn of Africa. They provide evidence of excellent site preservation relative to what has been excavated previously, and of the existence of complex cultural groups with distinct architectural?, ceramic, lithic and groundstone traditions, all previously unknown in the region.

Finally, our work on obsidian sourcing has provided new geochemical data that will enable us to better understand the mobility and interaction of these pre-Neolithic and Neolithic groups through their exchange of these resources and their acquisition strategies. Analyses of samples of geological obsidian collected during the 2014 and 2016 fieldwork program were analyzed by Bernard Gratuze by Laser-Ablation High-Resolution Inductively Coupled Plasma Mass-Spectrometry (LA-HR-ICP-MS) at the IRAMAT-CNRS laboratory at the University of Orléans.

The results demonstrate the existence of at least four distinct compositional groups that correspond to four different obsidian source complexes (Fig. 31). The sources correspond to the Borawli volcano (samples BOR and ASAY), the Manda Gargori Rift region (samples MND), the Serdo rhyolites (samples SR) and the Dubti alluvial cobbles in secondary position (samples DUB). A new source was sampled in 2016 and is currently under analysis. These results are of utmost importance as they illuminate the great number of distinct sources in this area and clearly delineate volcanic families allowing us to concentrate on sampling each one more systematically in the future.

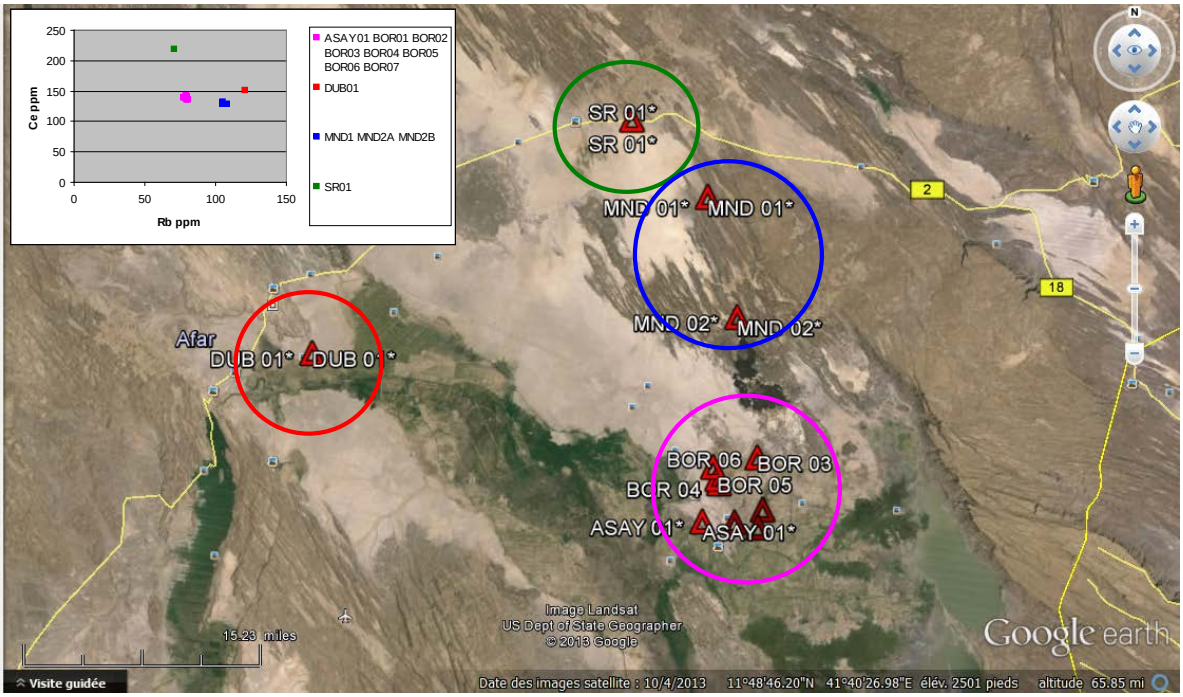


***Figure 31*:** *Map of the obsidian geological sample spots with circles geospatially representing the 4 obsidian compositional families identified as a result of the geochemical analyses carried out. The left hand graph plots the different compositional groups based on two elements Ce and Rb.*

IMPORTANCE OF CONTINUED WORK IN THE REGION

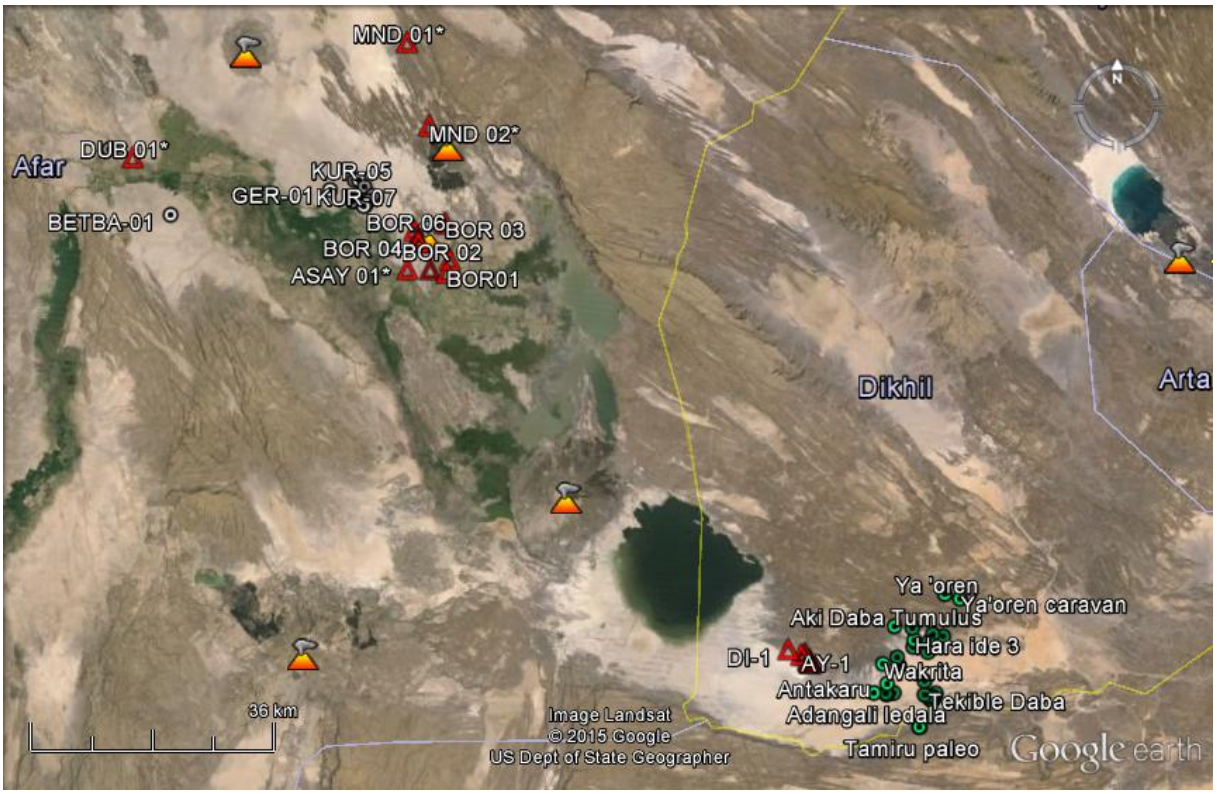


***Figure 32**: The sites and obsidian sources in the VAPOR-Afar project area in relation to the contemporary PSPCA program sites and obsidian sources in Djibouti, on the other side of the massive Lake Abhe.*

The results of the 2014 and 2016 VAPOR-Afar season are of paramount importance to the Ethiopian archaeological record, as they provide a completely new corpus of LSA and Neolithic sites for the region. These sites have proven through test pits and dating strategies to be sufficiently preserved and to pertain to the last hunter-fishing and the first pastoral populations in the Ethiopian Afar.

To date, very few Neolithic sites have been identified in Ethiopia, and even fewer in the Central Afar. Our 2016 season has now confirmed that a Neolithic culture of ceramic pastoralists occupied the margins of Lake Abhe at least by the 2nd millennium cal BC and that they succeeded more ancient LSA populations. In addition, we now have proof that they had developed complex architectural traditions that have never before been witnessed in the greater region and a refined ceramic tradition with complex decorative techniques and patterns that is likely to have older origins.

The chronological variability represented among sites excavated and on sites identified in the northern Lake Abhe basin is an incredibly rare occurrence. This chrono-cultural variability has the potential to cover an even greater range of periods than we have confirmed, and for which we know very little in the region. Further excavation and study of these sites and their surrounding environment is essential to developing our understanding of these important unknown cultures and will enable us to establish a precise chrono-cultural occupation sequence from the LSA to the ceramic Neolithic in this region of Ethiopia. Furthermore it will greatly add to the exploration of the period of transition between the Terminal Pleistocene and the period of Neolithisation in the Horn of Africa.

The continuation of obsidian source sampling is equally important to our understanding of these periods as the matching of objects to specific sources provides profound clues on the nature of mobility practices, the fashioning of territories, interaction and networking and human relationships with the environment. Very few of the hundreds of existing Ethiopian obsidian sources have been sampled and analyzed, and this region is one in which obsidian

sources are virtually undocumented. Our efforts have provided 4 new obsidian source compositions to a growing database for the southern Red Sea zone (Arabia/Africa) which have already provided matches between the Manda Gargori obsidian source in the VAPOR-Afar region and sites located at long distances and outside of Ethiopia. This attests to the importance of the region, its populations and its sources in our global understanding of prehistory.

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