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KONSO-GARDULA RESEARCH PROJECT

Volume 2

Archaeological Collections:

Background and the Early Acheulean Assemblages

Edited by

Yonas Beyene, Berhane Asfaw, Katsuhiko Sano, and Gen Suwa



2015 TOKYO

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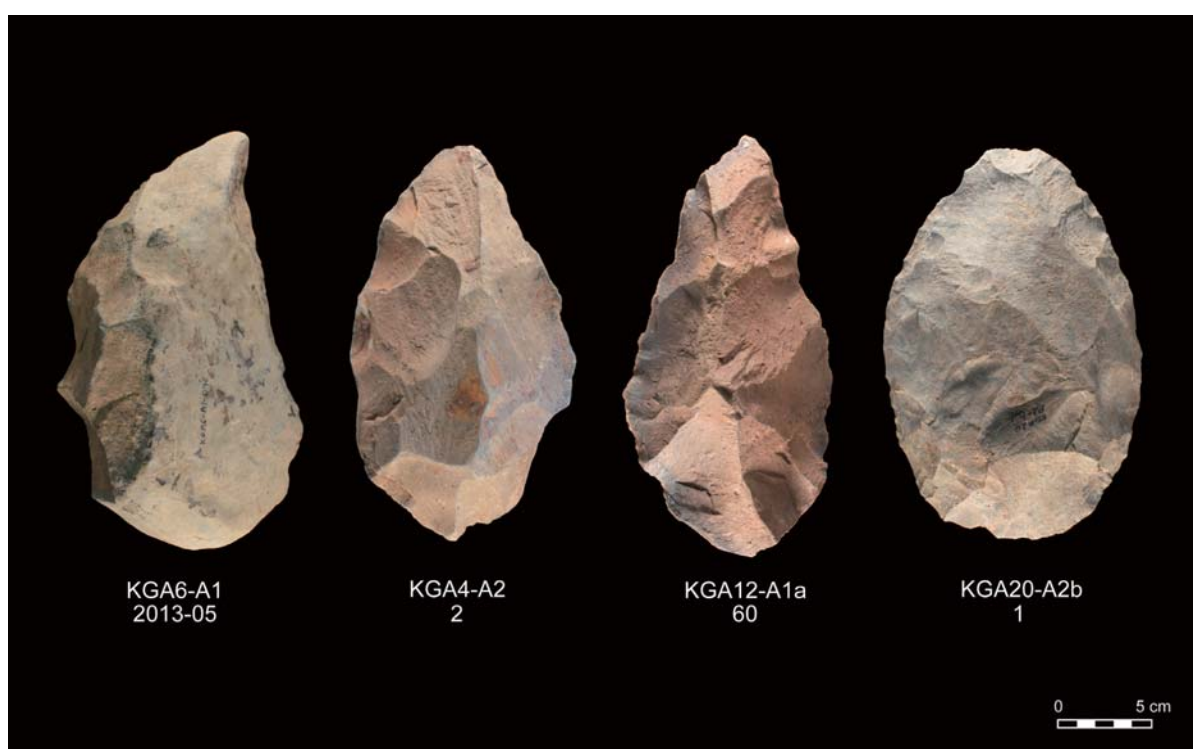
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Archaeological Collections:

Background and the Early Acheulean Assemblages



Edited by

Yonas Beyene,* Berhane Asfaw, Katsuhiko Sano,*** and Gen Suwa*****

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We thank the Ethiopian government and its many individuals involved in supporting and promoting paleoanthropological research in Ethiopia, and in particular enabling the field and laboratory research of the KGA project. We thank the Southern Nations, Nationalities, and People's Regional State (S.N.N.P.R.S.), the Culture and Tourism Bureau of the S.N.N.P.R.S., and the Konso administrative district for their support and facilitation to the research.

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CHAPTER 1

Introduction

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1.1 OVERVIEW

The Konso-Gardula (KGA) paleoanthropological research area was first discovered in fall 1991 by the field project led by one of us (B.A.), the Paleoanthropological Inventory of Ethiopia (Asfaw et al., 1992). The Inventory project led to the unexpected realization that sediments exposed in the Karat (or Konso) town area were rich in Early Pleistocene artifacts and vertebrate fossils. A brief summary of the events at Konso-Gardula that led to its discovery is presented below. The research area was named after the two administrative zones Konso and Gardula (now the Dirashie administrative district) where the sediments crop out. Thereafter, administrative boundaries changed so that the entire research area lies within the Konso district. Therefore, for brevity, we alternatively call the research area and the project the Konso paleoanthropological research area or project.

The KGA research area is located at the southern extremity of the Ganjuli Graben, south of Lake Chamo, approximately 180 km northeast of the fossiliferous Plio-Pleistocene deposits of the northern Turkana Basin (see Chapter 2 Fig. 2.1). The Ganjuli Graben occupies the southwestern extremity of the Main Ethiopian Rift and is offset to the east from the Stephanie Rift, the latter a northern extension of the Kenyan Gregory Rift. The Early Pleistocene sediments of the Konso Formation occur between 1,100 and 1,500 meters altitude in the headwaters of the Gato/Iyanda drainage system, a tributary of the Segen River. This region is separated from the Stephanie Rift and the Turkana Basin by the Konso mountainous terrain of approximately 1,600 to 2,100 m altitude.

The Paleoanthropological Inventory of Ethiopia established the occurrence of ~1.4 Ma *Homo erectus* fossils and early Acheulean artifacts at Konso (Asfaw et al., 1992). Field research and laboratory analysis thereafter established that the formation spans the time period ~1.95 to ~0.8 Ma (Katoh et al., 2000; Nagaoka et al., 2005; WoldeGabriel et al., 2005; Beyene et al., 2013). Abundant lithic assemblages and vertebrate fossils have been recovered (Beyene et al., 1996, 1997, 2013; Suwa et al., 1997, 2003), including fossil remains of *Australopithecus boisei* (1.43~1.44 Ma) and *Homo erectus* (~1.45 to ~1.25 Ma) (Suwa et al., 2007). However, only brief descriptions of the Konso archaeology have so far been reported (Beyene et al., 1996, 1997, 2013; Echassoux, 2012).

In this volume we systematically present the archaeological materials that formed the basis of the Beyene et al. (2013) comparative analysis of the ~1.75 to ~0.85 Ma Acheulean lithic assemblages. These time-successive assemblages were collected at locations where concentrations of lithic artifacts were found, many of them characterized by large cutting tools (LCTs) and picks. The stratigraphic horizons of origins of these assemblages were determined by excavations and/or examination of local sections. The LCT and related assemblages thus available are crucial in understanding the characteristics and range of lithic technologies that occurred in the ~1.75 to ~0.85 Ma time interval.

In Chapter 2, we overview the archaeological field research undertaken from 1993 through 2010. We then summarize the collection and documentation methodologies and present the chronostratigraphic background.

In Chapter 3, we present a site by site analysis of the LCT and pick assemblages that we collected. We do this by a combination of 1) a systematic presentation based on a comprehensive attribute logging system, and 2) individual descriptions of selected tools that show lithic technology representative of the assemblage and/or are particularly worthy of mention.

In Chapter 4, we provide more comprehensive inter-assemblage comparisons and discuss some of the insights that we gained from the early Acheulean at Konso.

1.2 A BRIEF HISTORY OF DISCOVERY

The field survey project the Paleoanthropological Inventory of Ethiopia was conceived and initiated by Berhane Asfaw in 1988 and continued through 1991. The project background and aims are outlined in Asfaw et al. (1990) and WoldeGabriel et al. (1992). Briefly, it aimed to document paleoanthropological resources outside established research areas.



Fig1.1. The KGA1 locality, where limited surface scatters that included well-made handaxes were found (September 29, 1991, soldier Kalayu holding a handaxe).

The methods used were to identify target areas by satellite and air photographic imagery in little known and/or paleoanthropologically unexplored areas, and to undertake foot transect surveys to sample the area for initial understandings. From its initiation in December 1988 to November 1991, 127 days of Inventory survey field work were undertaken. Aside from Berhane Asfaw, leader of the project, Gen Suwa and Yonas Beyene, two senior authors of this volume, were invited to participate. Others that participated in the Inventory project include Tim White, Giday WoldeGabriel, Sileshi Semaw, Yohannes Haile-Selassie, and other Ethiopian professionals who later developed into established scientists.

In 1991, a three week Inventory field work was planned for a part of the southern Ethiopian Main Rift, an area extending from around Lake Chamo south to the Konso area. This field work was conducted from September 25 to October 15, 1991, by B. Asfaw, Y. Beyene, T. White, G. Suwa, and Y. Haile-Selassie, joined by Tesfaye Yemane of the Geological Survey of Ethiopia. Four government soldiers (EPRDF) from Arba Minch accompanied us for this field work. In this survey, we first focused on volcanoclastic sedimentary target areas at the northern and southern parts of the planned survey areas near Lake Chamo and around Konso town. Although some, perhaps Miocene, wood fossils were recorded southeast of Konso town, the fossil-rich Konso Formation deposits were not encountered until about a week into the survey.

Locality KGA1 was established as an artifact-bearing site based on rare surface occurrences of well-made handaxes (Fig. 1.1). At that time, because of their seemingly advanced lithic technology, these were thought to belong to the middle or late Middle Pleistocene. Today, we consider these to probably derive from the uppermost Konso Formation, possibly ~0.8 Ma, broadly coeval in time to the KGA18 and KGA20 sediments and artifacts. Locality KGA2 where few fossils were found was established close to KGA1.



Fig.1.2. Locality KGA4 as encountered in October 1991. Fossils scattered along villager trail (left), Berhane Asfaw with villagers aside large mammal limb bone fossils (October 2, 1991).

The fossil and artifact rich exposures of the Konso Formation were encountered in the first week of October. On October 2, 1991, we conducted several foot survey transects that targeted low lying soft sediments hidden ~5 km away from the main highway road. We walked from the main road or navigated our field vehicles into small river sand beds and approached the target exposures. We first encountered the low-lying sediments of KGA3 where a cluster of fossils and artifacts were found. We then targeted what appeared to be a sizeable sediment exposure on the air photograph. As we walked onto the slopes of this low hill, what we now call the KGA4 locality, the unexpected sight of mammalian fossils literally scattered along the villager foot trails awaited us (Fig. 1.2). Fossil and artifact bearing exposure patches in between KGA3 and KGA4 was named KGA5. KGA6 was established one drainage south of KGA4.

On the air photo imagery other apparently similar sedimentary patches were seen, distributed 10 to 20 km northwest of Karat (Konso) town in an area over 10 km in extent. In the coming week we would transect a part of this area, leading to the discovery of the fossil and artifact rich localities of KGA7 through KGA12. These fossiliferous exposures are patchy, low-lying, and partially covered by more recent deposits. They inter-finger the more noticeable but sterile weathered volcanic or basement exposures. Because of this, they had gone unnoticed and unknown to science until our survey of October 1991.



Fig.1.3. Southwestern part of Locality KGA10 on October 8, 1991, the first day of survey at KGA10. The right lower photograph shows a partial cranium of a bovid.

On October 5, we planned to transect the southwestern part of the targeted exposures. We parked at the western margin of the Boleshe river basin that overlooks what we now call KGA7. We descended down the exposed Precambrian margin and walked into the Boleshe valley. There, as we walked downstream towards the east, thin sedimentary layers overlying the Precambrian were seen to gradually thicken. After walking ~1 km, a whitish sand layer gradually but noticeably thickened. This layer is a useful stratigraphic marker lying in between the overlying dark gray clays and the underlying orange to brown silt/sands/gravels. To our delight, fossils and artifacts were found exposed on the surface down slope of the whitish sands. Fossils were found to increase in density towards the eastern end of the exposure. One location exhibited an impressive concentration of crude handaxes and picks, later designated the archaeological site KGA7-A1.

The next day, on October 6, we planned a south to north transect from KGA7, and encountered fossil and artifact bearing sediments to the north that we named KGA8. Towards the end of this day's survey, Yonas Beyene and Tim White walked north of KGA8 to the ridge top overlooking farther north. The exposures that they viewed were later named KGA9, and also included the western part of KGA10. They verbally reported observing steep-sloped "layer cake-like sediments reminiscent of Olduvai Gorge", and that fossils were seen literally "raining" down slope.



Fig.1.4. Berhane Asfaw examining the surface scatter of fossils at Locality KGA10 southern face on October 8, 1991.

On October 8, we planned a transect through the “mesa-like” outcrop, visible on the air photo, that we would name KGA10. We walked along the eastern margin of the KGA7 and KGA8 exposures. Walking past these, the KGA10 “mesa” comes into full frontal view (Fig. 1.3). Overlooking the KGA10 exposure, unknown to science until then, we took a deep breath and then set into its southwestern part. When we reached the foot slopes of the mesa hill, our expectations were more than realized. All along the mesa slope, an impressive surface scatter of fossil and artifacts were observed (Fig. 1.4). Teeth, postcranial articular ends, horn cores, occasional partial crania, handaxes and picks were all awaiting discovery. Since the objective of the Inventory project was to document but not necessarily collect, the survey team did minimal fossil and artifact collecting.

On October 9, we surveyed exposures north of KGA10, one of which we named KGA12. From the car park, this was a foot survey 5 km in a straight line on the imagery. KGA12 was another locality incredibly rich in both fossils and artifacts. In particular, we discovered a small depression with an impressive surface concentration of handaxes prompting the nickname “handaxe valley” (Fig. 1.5).

As we were heading back to the car park close to the main highway, unexpected strong rains came. This was followed by flash flooding that almost washed away our vehicles. With the sky clear and the sun bright in the morning, we had parked our field vehicles in the dry sand river bed close



Fig.1.5. Concentration of handaxes discovered at KGA12, photograph taken on August 24, 1994.

to the highway. As we rushed back after the downpour, the waters had risen to the floorboard level. One of our field vehicles was stuck in loose sand, which we had to dig and pull out with the other vehicle. We returned to camp drenched and soaked with water, mud, and silt.

The results of this Inventory project fieldwork at Konso was in part published in Asfaw et al. (1992) in the journal *Nature*. In summer 1993, Yonas Beyene and Gen Suwa initiated the Konso-Gardula paleoanthropological field research. Systematic field research initially focused on the core areas of KGA4, KGA6 and KGA 7 through KGA12, and subsequently expanded to the more peripheral areas of KGA18 through KGA21.

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CHAPTER 2

Overview of the Archaeological Research at Konso

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2.1 OVERVIEW

Archaeological assemblages occur throughout the ~1.9 Ma to ~0.85 Ma time period of the Konso Formation. The Konso paleoanthropological research area is divided into 21 collecting localities (Figs. 2.1 and 2.2). These were designated and defined to broadly coincide with accessible sedimentary outcrop patches of circa one or more kilometers in diameter. Locality boundaries are defined predominantly by ridge tops, valley floors, or uplifted basement, and occasionally by visible faults that bring into contact non-overlapping stratigraphic intervals.

Systematic surface collecting and excavations were undertaken in the field seasons of 1993 through 2000, 2002 and 2003. Follow up work were done in 2010 and 2013. Each archaeological “site” was designated by a combination of collecting locality number (in common with the paleontological work, see Suwa et al., 2014) and a site designation nomenclature comprising the alphabet “A” followed by a numerical number. This results in site designations such as KGA7-A1 and so on. These “sites” represent locations of archaeological occurrences, where we initially observed concentrations of artifacts exposed on sediment surfaces and thereafter conducted excavations and/or made systematic collections. In the latter case, we confirmed stratigraphic provenience by excavation and/or stratigraphic observation of nearby sections. In a few cases, we encountered and collected artifacts in trench excavations that were conducted for soil carbonate sampling.

The archaeological sites established as per above and their geographical locations within the KGA research area are summarized in Table 2.1 and Figs. 2.3 and 2.4.

Assemblages that apparently lack large cutting tools (LCTs) and/or picks, and possibly attributable to the Oldowan technological complex, were observed at ~1.9 Ma (KGA4 and KGA11), ~1.75 Ma (circum KYT1 and KYT2 levels at KGA6), ~1.6 Ma (KGA21), and ~1.45 Ma (KGA4-A3 site). However, the younger examples may be better considered facies of the early Acheulean, depending on the large core and flake technology representations seen in the assemblages with few or no LCTs (see also, Semaw et al., 2009 for a discussion on developed Oldowan versus Acheulean).

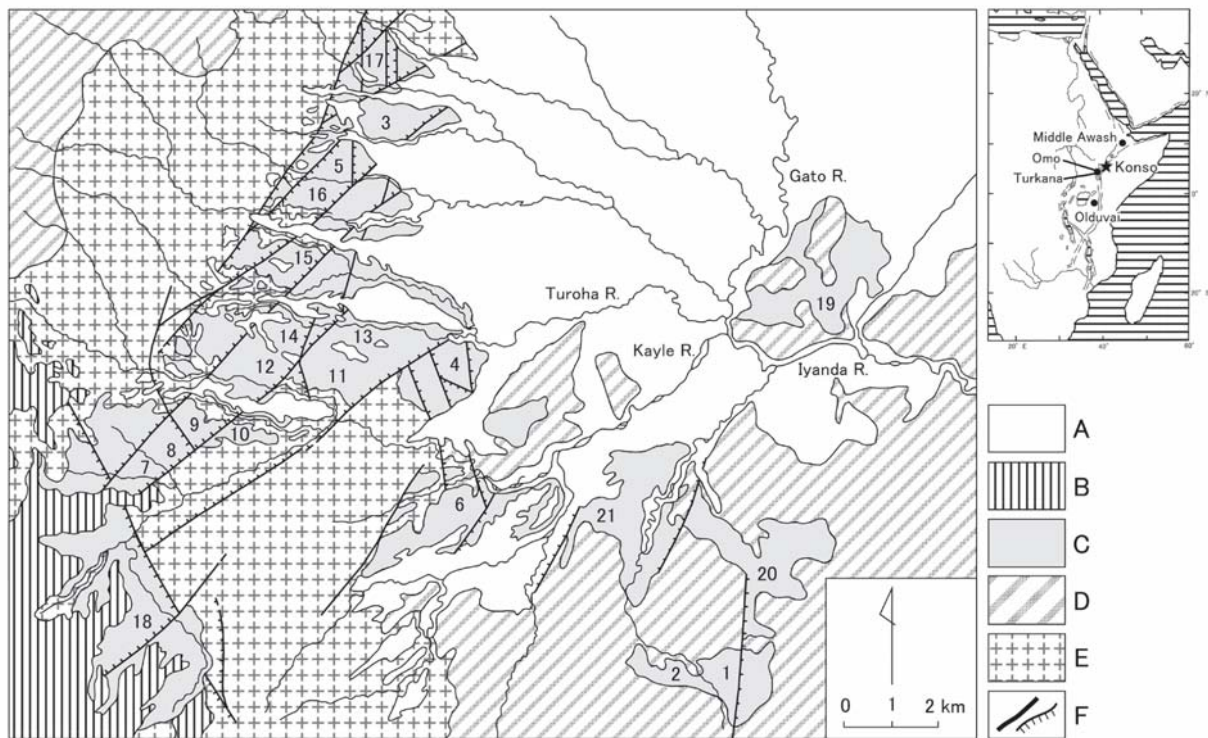


Fig. 2.1. Geologic map and localities of the Konso Formation. Numbers in the map refer to collecting localities named in sequence from KGA1 to KGA21. A, Middle Pleistocene to Holocene fluvial deposits; B, Early to Middle Pleistocene erosional surface deposits; C, Early Pleistocene Konso Formation; D, Tertiary mafic lavas; E, Precambrian crystalline basement rocks; F, faults with downthrown side shown by ticks.

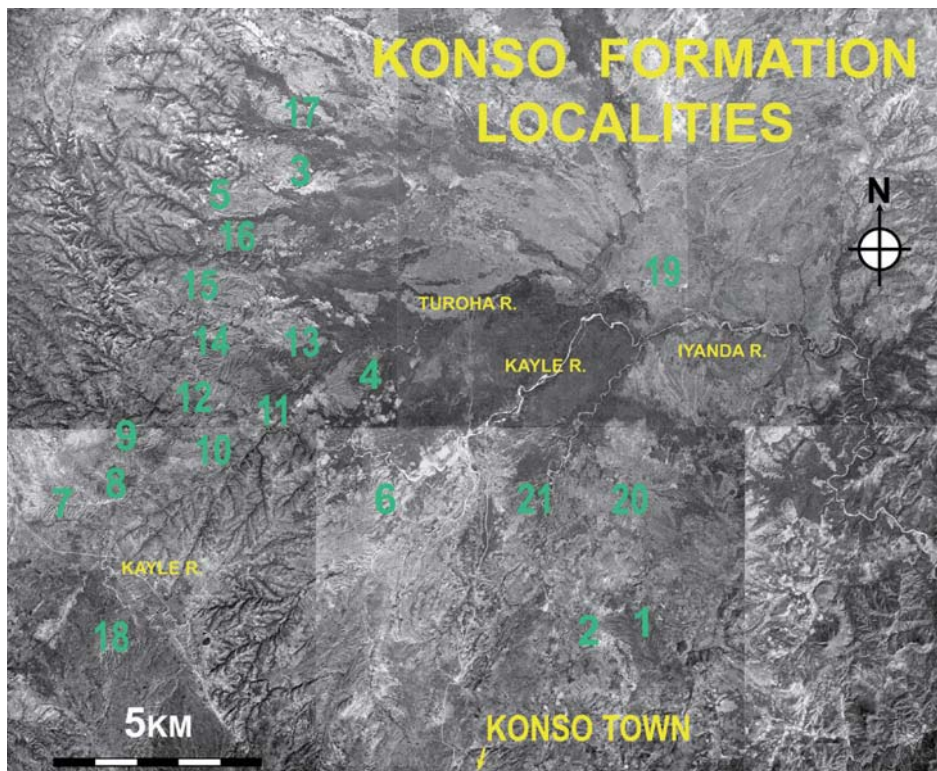


Fig. 2.2. The Konso Formation localities designated for survey and collecting. The air photograph composite is based on 1/50000-scale prints of runs taken in 1984, available at the Mapping Authority, Addis Ababa.

Table 2.1. KGA archaeological sites

Locality	Year	Investigation type	Age	Level	Characteristics (dominant tools)
KGA1-A1	1991/93/98	surface data (Inventory preproject survey area)	~0.8 Ma ?	not known	Acheulean (handaxes)
KGA4-A1	1993/95	surface data (KGA4-14 <i>H. erectus</i> site)	~1.45 Ma	TBT-	Acheulean (picks, cores)
KGA4-A2	1994/95	surface collection/excavation	~1.6 Ma	HAT+	Acheulean (LCT, picks)
KGA4-A3	1997	excavation	~1.45 Ma	A3T+ TBT-	Acheulean/Oldowan?
KGA4-A4	1998	surface data	~1.45 Ma	TBT-	Acheulean (picks, handaxes)
KGA4-TRTct	2002	carbonate isotope trench	~1.9 Ma	TRT-	Oldowan
KGA4-EE	2010	survey/selective collection	~1.45 Ma	TBT+	Acheulean (picks, cores)
KGA6-A1	1996/2002/03/13	surface collection	~1.75 Ma	~KYT2	earliest Acheulean (picks)
	1997	excavation: Locus A	~1.75 Ma	~KYT2	earliest Acheulean/Oldowan
	2003	excavation: Locus B, C	~1.75 Ma	KYT2+	earliest Acheulean/Oldowan
	2003	excavation: Locus D	1.76 Ma	KYT1-	Oldowan
KGA7-A1	1993	surface collection	~1.4 Ma	~BWT	Acheulean (picks)
KGA7-A2	1993	surface collection	1.3~1.4 Ma	BWT+	Acheulean (knives, cleavers)
KGA7-A3a, b, c	1998	surface collection	~1.4 Ma	~BWT	Acheulean (picks)
KGA8-A1	1995/2013	surface collection	1.3~1.4 Ma	8HGT+	Acheulean (handaxes, cleavers)
KGA8-A2	2013	surface collection	1.3~1.4 Ma	BWT+	Acheulean (handaxes)
KGA10-A1	1993/94	geological trench (KGA10-1 <i>H. erectus</i> site)	1.43~1.44 Ma	LHT- to LHT+	not diagnostic (flakes, cores)
KGA10-A2	1993/94	excavation	1.43~1.44 Ma	LHT-	not diagnostic (flakes, cores)
KGA10-A3	1993	excavation	1.43~1.44 Ma	LHT+	not diagnostic (flakes, cores)
KGA10-A4	1993	excavation (sands in upper dark clay)	~1.43 Ma	LHT++	not diagnostic (flakes, cores)
KGA10-A5	1993	excavation (sands in upper dark clay)	~1.43 Ma	LHT++	not diagnostic (flakes, cores)
KGA10-A6	1993	surface collection	1.43~1.44 Ma	LHT+	Acheulean (cores, handaxes, picks)
KGA10-A7	1994/96	excavation	1.43~1.44 Ma	LHT+	not diagnostic (flakes, cores)
KGA10-A8	1994	surface collection	1.43~1.44 Ma	LHT+	Acheulean (cores)
KGA10-A9	1994	excavation (KGA10-656 <i>H. erectus</i> site)	1.43~1.44 Ma	LHT+	not diagnostic (flakes, cores)
KGA10-A10	1994/96	excavation	1.43~1.44 Ma	LHT-	Acheulean (picks, cores)
KGA10-A11	1994	surface collection	~1.45 Ma	IVT-	Acheulean (handaxes, picks)
KGA10-A12	1995	excavation (landscape approach trench)	1.43~1.44 Ma	LHT-	few artifacts
KGA10-A13	1996	excavation (landscape approach trench)	1.43~1.44 Ma	LHT-	few artifacts
KGA10-A14	1996	excavation (landscape approach trench)	1.43~1.44 Ma	LHT-	few artifacts
KGA10-A15	1996	excavation (landscape approach trench)	1.43~1.44 Ma	LHT-	few artifacts
KGA12-A1a,b	1994	surface collection	~1.25 Ma	PST2+ HGT-	Acheulean (handaxes)
KGA12-A1c	1996	surface collection	~1.25 Ma	PST2+ HGT-	Acheulean (handaxes)
KGA18-A1a	1999/2000	surface collection	~0.85 Ma	BAT1+	Acheulean (handaxes)
KGA18-A1b	2013	surface collection	~0.85 Ma	BAT1+	Acheulean (handaxes)
KGA19 west NBT block	2000	surface data	~1.6 Ma	NBT+	Acheulean (handaxes, picks)
KGA20-A1	1998/2000	surface collection	~0.85 Ma	BAT1-	Acheulean (handaxes)
KGA20-A2	1998/2000	surface collection	~0.85 Ma	BAT1+	Acheulean (handaxes)
KGA21-BRTct	2002	carbonate isotope trench	~1.6 Ma	BRT-	Acheulean/Oldowan?

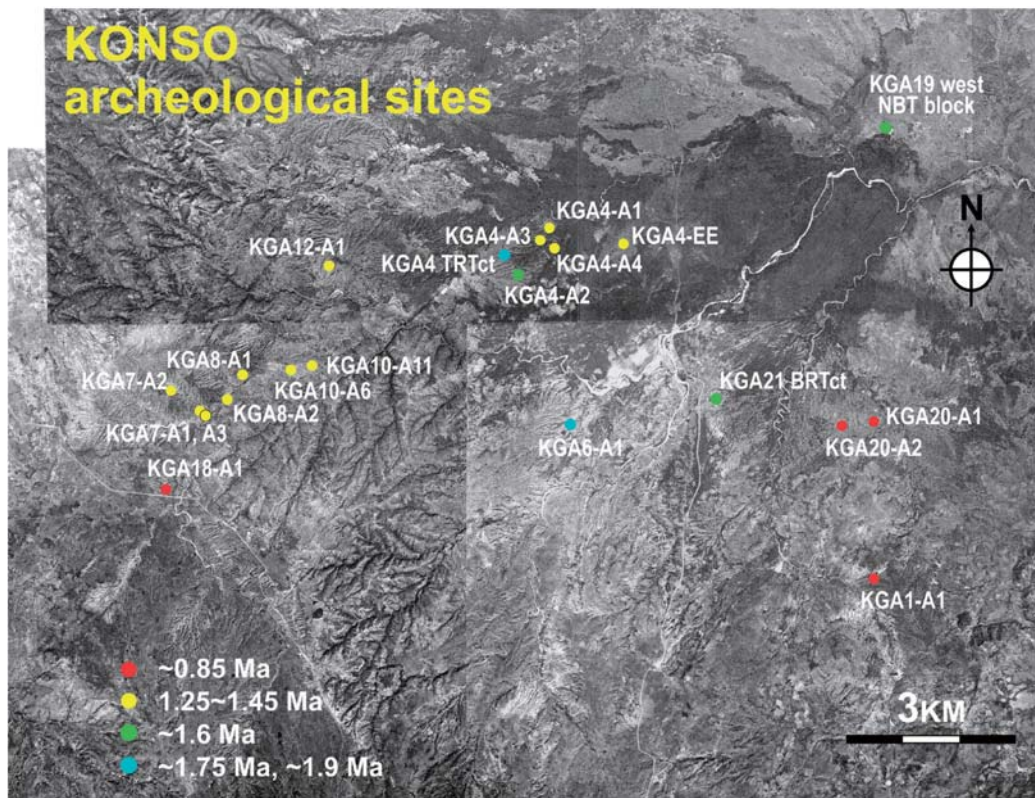


Fig. 2.3. Location of archaeological sites documented at Konso (air photographs as in Fig. 2.2).

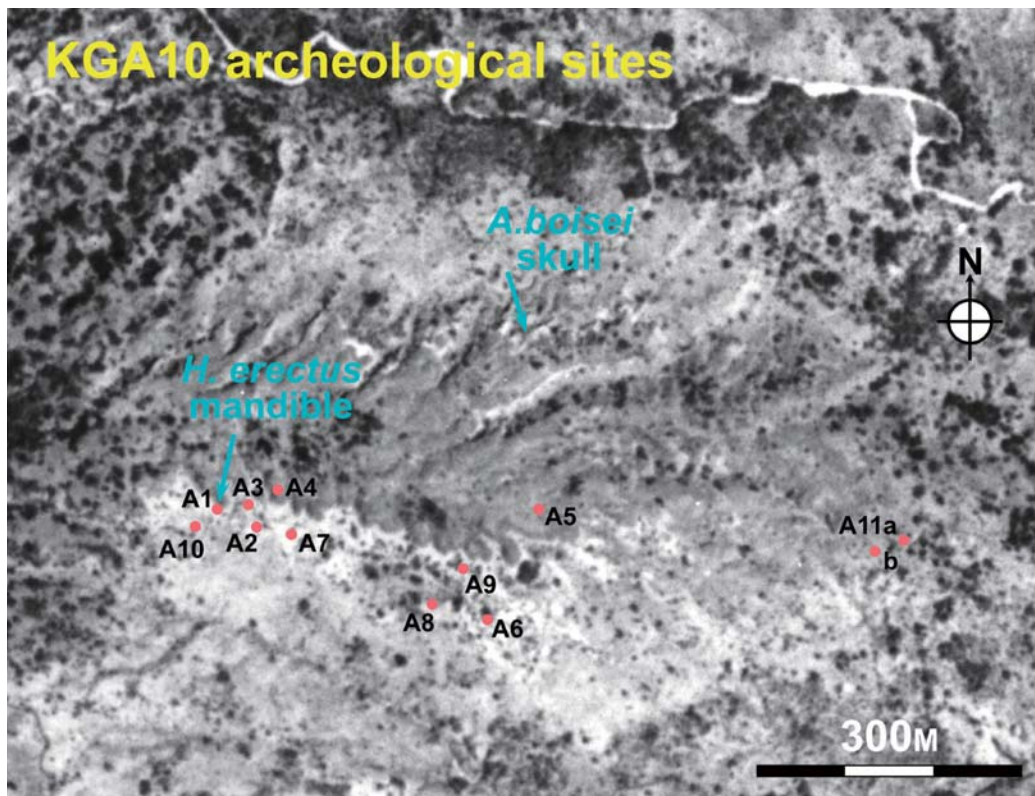


Fig. 2.4. Location details of archaeological sites at the KGA10 locality, plotted on enlarged ($\times 10$) print of 1/50000 scale air photograph.

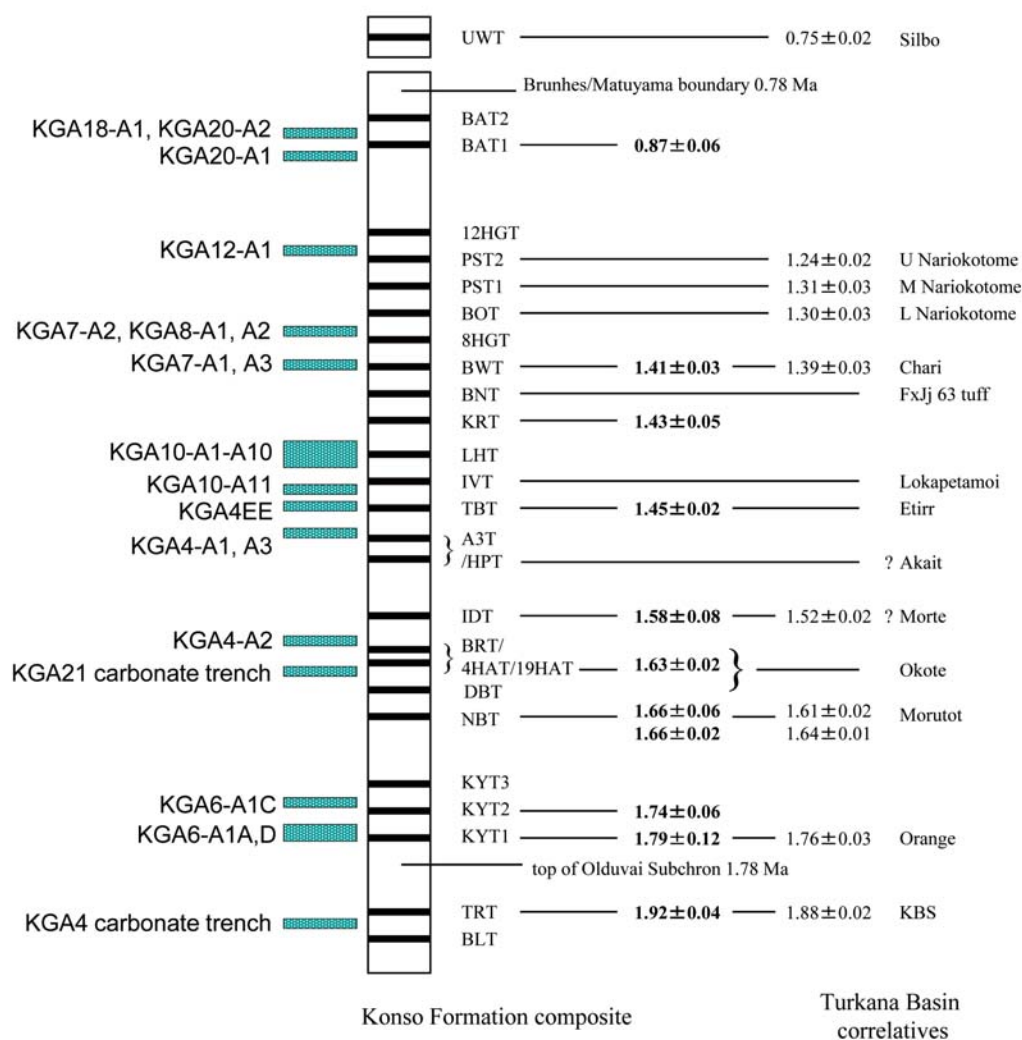


Fig. 2.5. Schematic stratigraphic column of the Konso Formation and archaeological site placements. $^{40}\text{Ar}/^{39}\text{Ar}$ dates of the Konso tuffs are indicated in million years (Ma); error margins are in SD of dated grains (Beyene et al., 2013). Green horizontal bars indicate approximate stratigraphic positions of archaeological sites.

The earliest recognized Acheulean assemblage occurs at KGA6 just above the KYT2 tuff. The KYT2 is ~6 m above the top of the Olduvai Subchron and has been radioisotopically dated to 1.74 ± 0.06 Ma (Beyene et al., 2013). This is indistinguishable in age from the earliest Acheulean of the Turkana Basin (Roche et al., 2004; Texier et al., 2006), recently considered the world's oldest with an interpolated age of 1.72 or 1.76 Ma (Lepre et al., 2011).

At Konso, a more typical early Acheulean with abundant large bifacial tools occurs at the ~1.6 Ma HAT levels of KGA4 and KGA19. Thereafter, Acheulean assemblages are commonly seen at many of the fossil- and artifact-bearing Konso localities. Well-preserved artifacts were observed at the ~1.45 Ma (KGA4, KGA10), ~1.4 Ma (KGA5, KGA7), ~1.3 to ~1.25 Ma (KGA8, KGA12), and ~0.85 Ma (KGA18, KGA20) levels.

2.2 STRATIGRAPHIC AND CHRONOLOGIC CONTEXT

The chronostratigraphic framework of the Konso Formation was first presented in Katoh et al. (2000) and Nagaoka et al. (2005), focusing on localities KGA4 and KGA6 to KGA14. Tephrostratigraphic summaries of KGA18 through KGA21 were added by Beyene et al. (2013). In the latter publication, we presented an overview of the Konso Formation stratigraphy, and a schematic summary of the chronological placements of the archaeological assemblages. In this chapter, we present in more detail the chronostratigraphic placements of the Konso Formation archaeological assemblages.

The Konso Formation represents unconsolidated sediments of predominantly lacustrine and lake-margin fluvial lithofacies that accumulated at the southern extremity of a small subsiding sedimentary basin. A lacustrine depositional environment is thought to have intermittently prevailed in the area, with the maximum paleolake expansion of up to 2 km east-west and 8 km north-south at about ~ 1.3 Ma to ~ 1.4 Ma (Nagaoka et al., 2005). The uppermost sediments of the Konso Formation at ~ 0.85 Ma age are exposed several kilometers farther south, suggesting that there was either additional lake expansion or a shift of the paleolake location after 1.0 Ma.

The northeastern extent of this paleolake cannot be determined from available surface exposures. However, the topography of the Ganjuli Graben and the lack of known contemporary sediments in the Lake Chamo Basin suggest that the Konso paleolake was confined to the southern extremity of the graben, rather than being part of a greater paleolake Chamo. The relative rarity of fossil fish remains in much of the Konso Formation supports this interpretation. Fossils and lithic artifacts occur mainly in the fluvial sediments of small river systems, mostly representing lake-margin floodplain and alluvial fan settings. These river systems were perhaps equivalent in development to the present day tributaries of the Gato/Iyanda Rivers.

The chronostratigraphic placements of the Konso archaeological assemblages range from ~ 1.9 to ~ 0.8 Ma and are schematically shown in Fig. 2.5. In Katoh et al. (2014), we presented selected stratigraphic columns of the Konso Formation for the purpose of placing the paleontological collection in chronostratigraphic context. These stratigraphic columns are also applicable to the archaeological assemblages that occur within the same area.

2.3 SITE CONTEXT OF THE COLLECTED ASSEMBLAGES

We present below (in chronological order) the contextual information of the sites and respective assemblages that we describe in Chapters 3 and 4. Artifact assemblages from the other sites listed in Table 2.1 will be reported elsewhere.

- KGA6-A1 (~ 1.75 Ma)
- KGA4-A2 (~ 1.6 Ma)
- KGA10-A11 (~ 1.45 Ma)
- KGA10-A6 (~ 1.43 to ~ 1.44 Ma)
- KGA7-A1 and A3 (~ 1.40 Ma)
- KGA7-A2 (~ 1.40 to ~ 1.30 Ma)
- KGA8-A1 (~ 1.40 to ~ 1.30 Ma)
- KGA12-A1 (~ 1.25 Ma)
- KGA18-A1 (~ 0.85 Ma)
- KGA20-A1 and A2 (~ 0.85 Ma)

KGA6-A1

Differential GPS reading: N5° 23'55.4", E37° 25' 29.6" (Locus A)

Estimated age: ~1.75 Ma

The Acheulean assemblage at the KGA6-A1 site was first recognized in 1996 during survey when initial surface collections were done. Because of the crude Acheulean-looking artifacts and their inferred old age (considered ~1.7 Ma at that time), the location was first excavated in 1997 and additionally in 2003. The 1997 excavation (at Locus A) revealed multiple archaeological horizons but the LCT/pick-bearing horizon was not conclusively established. The 2003 excavations were undertaken in grids designated Locus B, Locus C and Locus D, immediately adjacent to the Locus A excavation.

The four excavation loci span an area of ~16 m × 6 m. Five *in situ* archaeological horizons were recognized from just below the Kayle Tuff-1 (KYT1) to about 2 m above the Kayle Tuff-2 (KYT2). Three of these horizons exhibited tool assemblage characteristics compatible with an Oldowan technological attribution. Both Locus C and a stratigraphically higher more limited occurrence at Locus A exhibited large flake-based blanks. At Locus C, a 4 m × 5 m excavation yielded *in situ* tools attributable to the Acheulean technology (n = 4), whereas another 24 were concentrated within ~1 m adjacent to the *in situ* excavation margin. The latter suggested a recently washed out lag accumulation. The remaining specimens were found farther down slope of the Locus C northern margin. The excavation plan and local stratigraphic section taken at Locus C are shown in Fig. 2.6.

A composite stratigraphic section (K6-1), taken in the general area that includes the KGA6-A1 site, is shown in Katoh et al. (2014) page 19.

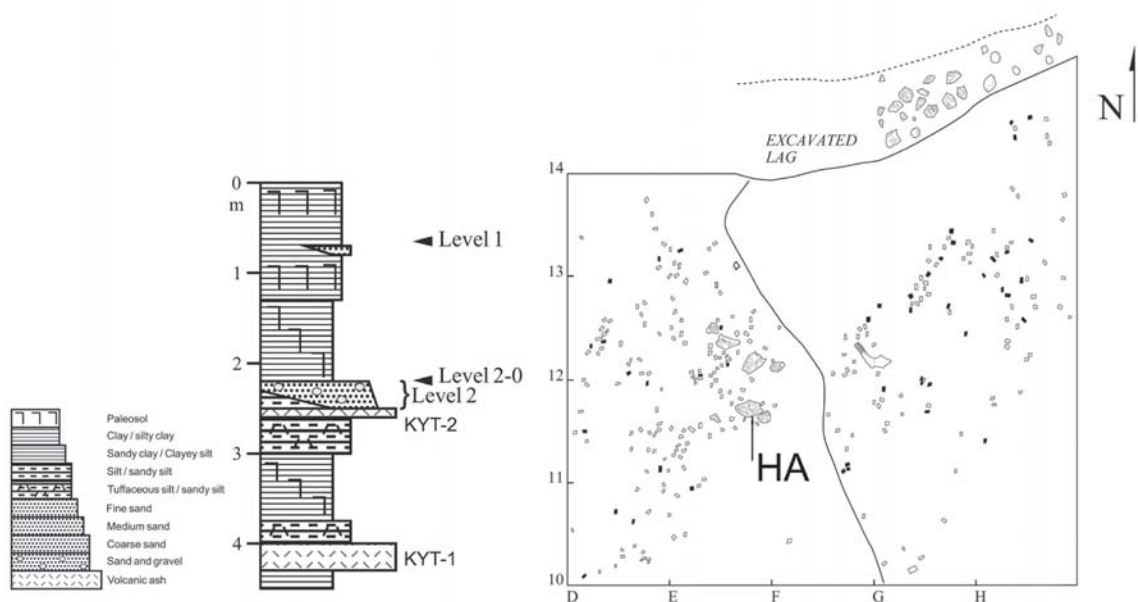


Fig. 2.6. Local stratigraphic section and excavation plan and at KGA6-A1 Locus C. Grids were designated in 1 meter intervals. Hatched symbols represent large flakes and tools; open smaller symbols represent flakes, cores, and fragments; filled symbols are osteodontal fragments. The irregular line traversing the excavation represents a fault line with the western side downthrown by about 50 cm. Artifacts recovered at levels 2-0 and 2 are shown. Artifact labeled HA is the handaxe E11-13 described in Chapter 3.

KGA4-A2

Differential GPS reading: N5° 25' 19.3", E37° 24' 59.1"

Estimated age: ~1.6 Ma

The KGA4-A2 site is situated adjacent to the KGA4 paleontological “collecting area 3” which widely exposes the ~1.9 Ma strata and abundant fossils. In 1994, joint paleontological and archaeological survey at mid-southeastern part of KGA4 led to the recognition of a concentrated surface and *in-situ* occurrences of early Acheulean handaxes and picks. Close examination of the deposits revealed that these occurred close to a fault that separated the handaxe-bearing sediments from the more extensive ~1.9 Ma fossiliferous sequence. A tuff, the KGA4 Handaxe Tuff (4HAT), occurs at the fault margin in the form of a small localized lens, at a stratigraphic level ~2 m below the handaxe and fossil-bearing indurated sands. A composite stratigraphic section (K4-3) of the KGA4 area close to the KGA4-A2 site is shown in Katoh et al. (2014) page 18. The local section at the KGA4-A2 site is shown in Fig. 2.7.

Multiple attempts of radioisotopically dating this tuff failed to clarify its age, although two crystals were reported as roughly ~1.5 Ma in age (Katoh et al., 2000). With this geochronological ambiguity, we proceeded to undertake tephro- and magnetostratigraphic assessments within the Konso Formation. Tuff correlations were complicated, but through a combination of geochemical, petrographic and magnetostratigraphic analyses, our current interpretation is that the 4HAT is probably very close in depositional age to the KGA19 Handaxe Tuff (19HAT) dated to 1.63 ± 0.02 Ma (Beyene et al., 2013; Katoh et al. in preparation). The tuffs 4HAT and 19HAT have very similar geochemical composition, and probably come from closely separated eruptions of the same volcanic source or even from the same eruptive sequence. Combining the petrographic, tephrostratigraphic, geochronologic, and magnetostratigraphic results, we consider both 4HAT and 19HAT to be broadly ~1.6 Ma in age, as outlined in more detail in Beyene et al. (2013).

In 1995, we excavated the northeastern end of the low-lying ridge at the KGA4-A2 site, where erosion exposes the fossil and artifact-bearing horizon in a tongue-like fashion. The artifact and fossil bearing horizon is a sandy layer containing small (<~5 mm) oxidized nodules, and forms a small resistant ledge (~5 meters) at the northeastern end of the low-lying predominantly silty clay ridge. *In situ* artifacts and fossils were observed partially exposed on this erosional ledge and

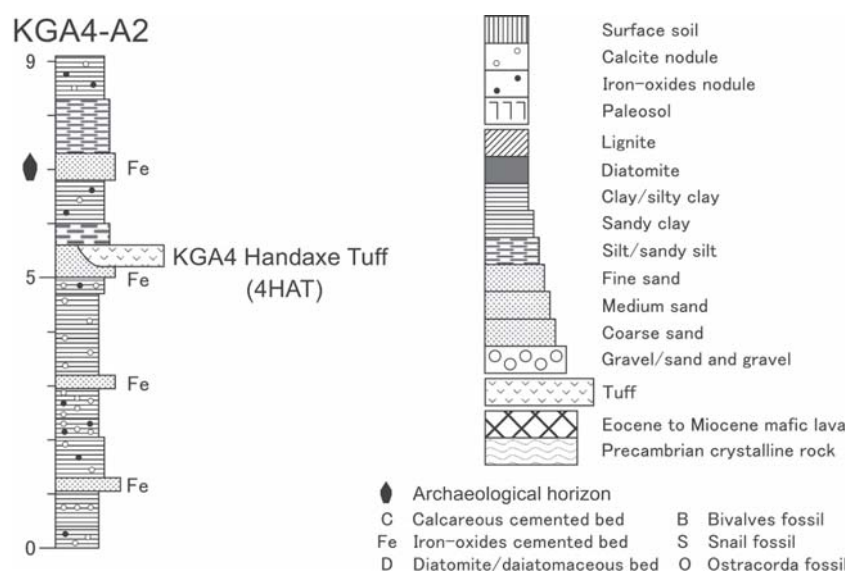


Fig. 2.7 Local stratigraphic section at KGA4-A2.

its slope, which enabled both controlled surface collection of the exposed materials and *in situ* excavation. A 100% surface collection (all tools, cores, and flakes on the lag surface) was conducted in an area totaling 5 m × 8 m, initially in 1994 and in preparing for the 1995 excavation. In 1995, an area of 2 m × 2 m was excavated. These materials were briefly reported in Beyene et al. (1997) and further details of the excavated materials will be presented elsewhere. In Chapter 3, we describe the surface collection assemblage.

KGA10-A11

Differential GPS reading: N5° 24' 27.5", E37° 23' 06.5" (A11a)

Differential GPS reading: N5° 24' 27.1", E37° 23' 05.7" (A11b)

Estimated age: ~1.45 Ma

KGA10 is paleontologically the richest locality so far recognized and has yielded the greatest number (n=14) of hominid specimens. Systematic paleontological and archaeological surveys were conducted from 1993 to 1996.

The KGA10-A11 surface collection site is located at the eastern end of the fossil-rich KGA10 exposures. A stratigraphic section (K10-1) shown in Katoh et al. (2014) page 20 depicts the general stratigraphy of the area spanning the KGA10-A11 site and the isolated and small Ivory Tuff (IVT) exposure patch.

The stratigraphically higher *Australopithecus boisei* fossil-bearing whitish-colored sands pinch out west of the KGA10-A11 location. The local section at the KGA10-A11 site exposes the lower sedimentary units dominated by dark gray/brown silty clays that unconformably overlie the Precambrian basement rock. A gravelly sand horizon is intermittently exposed showing *in situ* bone and artifacts. This horizon occurs stratigraphically ~2m below the IVT which is considered ~1.44 Ma. The widely distributed Trail Bottom Tuff (TBT) does not crop out at KGA10, and the stratigraphic relationship between the artifact bearing KGA10-A11 level and the TBT is therefore unclear.

Several locations of relatively dense cluster of surface accumulation of handaxes and picks were found in the KGA10-A11 area. In 1994, two collection areas were designated KGA10-A11a and -A11b, each in 50 m² (5 m × 10 m) grids, and 100% collecting was undertaken.

KGA10-A6

Differential GPS reading: N5° 24' 24.0", E37° 22' 51.1"

Estimated age: ~1.43 to ~1.44 Ma

The KGA10-A6 surface collection site is located on the southern side of the KGA10 mesa-like hill, ~300 meters east of the KGA10-A1 *Homo erectus* site and ~50 meters south of the hill margin. The KGA10 southern face area exhibits in descending stratigraphic order a predominantly dark gray upper clay sequence, a whitish partially calcified sand bed, a yellowish brown series of alternating tuffaceous silts and sands, and a lower sequence of predominantly dark gray/brown silty clays.

KGA10-A6 is located at the western margin of a small valley exposing the lower dark clays, and stands out in the form of a small (~15 m diameter) resistant sediment block. General stratigraphic sections at southern KGA10 are shown in Katoh et al. (2014) page 20 (sections K10-2 and K10-3). An impressive concentration of stone tools, mostly picks and large cores in quartz and basalt, were observed *in situ* and eroding out of the tuffaceous silty sands at a stratigraphic level less than 3 m above the Lehayte Tuff (LHT). Selective surface collecting of the LCTs/picks was undertaken in 1993 in a 22.5 m² area.

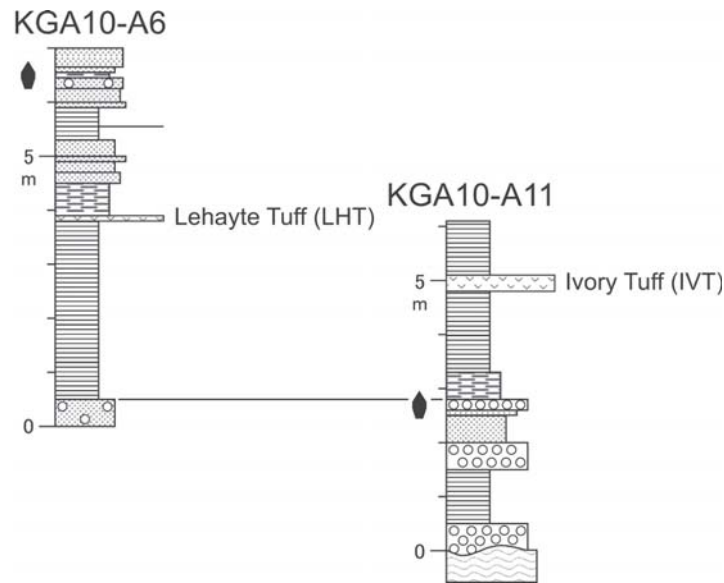


Fig. 2.8. Local stratigraphic sections at KGA10-A6 (left) and the KGA10-A11 and adjacent area (right) (symbols and legends as in Fig. 2.7).

KGA7-A1 and A3

Differential GPS reading: N5° 24' 02.0", E37° 22' 00.5" (KGA7-A1)

Differential GPS reading: N5° 23' 59.0", E37° 22' 03.7" (KGA7-A3)

Estimated age: ~1.40 Ma

Locality KGA7 includes the Boleshe River valley and the smaller drainage to the north. Sites KGA7-A1 and A3 are located close by (~100 meters), at the eastern end of the sediments exposed along the small drainage north of the Boleshe.

Site KGA7-A1 occurs along a narrow subsidiary incision that intersects the KGA7 ridge (the ridge in between the Boleshe and smaller northern drainage), ~200 meters from the eastern contact of the Konso Formation sediments with the Precambrian basement rock. During the inventory survey, striking examples of large elongated picks were found. Selective surface collecting of the picks and LCTs was undertaken in 1993.

Site KGA7-A3 was established close to the eastern end of the Konso Formation exposures at KGA7, where *in situ* and deflated artifacts and fossils were observed near the sediment/basement contact area. Three surface collection areas, KGA7-A3a to A3c, were designated within a distance of ~50 meters. Each was approximately 120 m² in area and 100% collecting was undertaken.

Representative stratigraphic sections (K7-1 and K7-2) of locality KGA7 are shown in Katoh et al. (2014) page 21. The KGA7-A1 and A3 sites are located northeast of geologic section K7-1. The local sections at the KGA7-A1/A3 sites and vicinity are shown in Fig. 2.9. The KGA7-A1 and A3 artifacts and fossils were observed eroding out of the whitish sandy unit, locally ~2 m thick, at the lower contact of the dark gray silty clays that dominate the upper horizons. This unit can be traced widely across much of KGA7 and KGA8, and at places contains small patches of the Bright White Tuff (BWT). In the stratigraphic sections immediate at and near KGA7-A1 and A3, the BWT is not exposed. The relationship between the main artifact-bearing unit(s) and the BWT is therefore unknown, but the collected assemblages and the BWT can be considered broadly coeval. The Karat Tuff (KRT) is exposed locally and occurs 3 to 4 m below the main artifact and fossil-bearing sandy unit.

KGA7-A2

Differential GPS reading: N5° 24'13.2", E37° 21' 44.8"

Estimated age: ~1.40 to ~1.30 Ma

The KGA7-A2 site is located ~0.7 km upstream (west) of KGA7-A1 and A3. A small number of fresh quartzite artifacts were found clustered on the slopes of the ridge, at and below a thin sandy horizon within the dark gray silt/clay sediments. Because of the otherwise sterile nature of the sediments, this sand layer is considered the source of the artifacts. This inference was confirmed by a geological trench dug in 2002. The sand lens occurs ~10 m above a thick sand unit correlative to

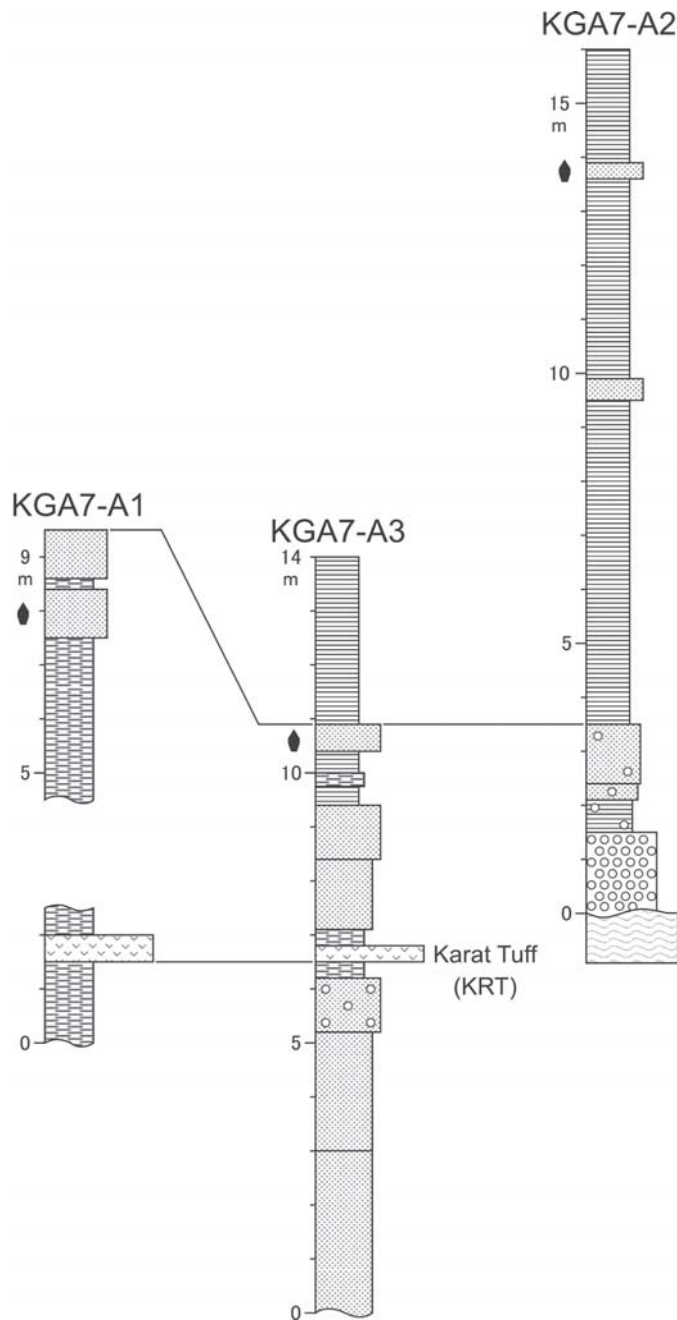


Fig. 2.9. Local stratigraphic sections at KGA7-A1 (left), A2 (right) and A3 (middle) (symbols and legends as in previous figures).

the KGA7-A1 and A3 artifact containing sands. The local stratigraphic section at the KGA7-A2 site is shown in Fig. 2.9.

At KGA7, the Boleshe Tuff (BOT) and PisoTuff-1 (PST1) overlie the BWT. West of KGA7-A2, several altered tuffs are recognized above the KGA7-A2 sand level. It is possible that these include correlatives of BOT and/or PST1, although geochemical analyses were not possible. Thus, we consider the KGA7-A2 artifact bearing sands to underlie the BOT. Controlled surface collecting was done in 1993, and all observable artifacts were collected within a small area of approximately 20 m².

KGA8-A1

Differential GPS reading: N5° 24' 21.8", E37° 22' 24.8"

Estimated age: ~1.40 to ~1.30 Ma

The KGA8-A1 site occurs on the northern side of the KGA8 valley, towards the eastern end of the KGA8 sediment exposures. At or close to KGA8-A1, both upper and lower KGA8 sedimentary sections are exposed (sections K8-3 and K8-4 in Katoh et al., 2014, page 21). The local section at the KGA8-A1 site is shown in Fig. 2.10, together with geologic composite section K8-4 of this area. As is the case at KGA7, the upper horizons are dominated by dark gray silty clays. This sequence is underlain by a whitish calcified sandy unit that laterally contains small lenses of the BWT. The KRT is exposed further below. Another tuff, the KGA8 Hard Gray Tuff (8HGT), occurs ~2 m above the BWT containing calcified sands, locally just west of KGA8-A1.

KGA8-A1 lies close to a small fault that juxtaposes the upper dark silty clays with the main KGA8 sedimentary sequence. The upper sequence contains the KGA8 Hard Gray Tuff (8HGT) and a superjacent buff tuffaceous sandy silt unit. The artifact bearing horizon at KGA8-A1 was confirmed by a geological trench as the first gravelly sand unit ~1 m above the buff tuffaceous sandy silt, and thus stratigraphically overlies both 8HGT and BWT. Although, no capping tuff unit occurs locally, the KGA8-A1 artifact bearing horizon is inferred to lie below the BOT level.

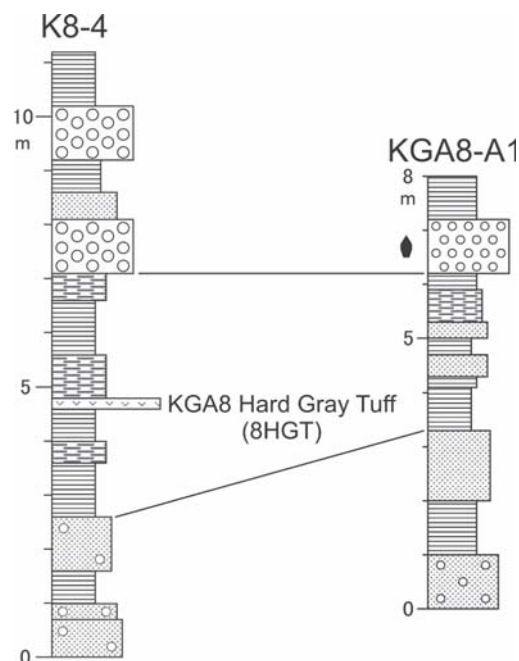


Fig. 2.10. Local stratigraphic section at KGA8-A1 (right) (symbols and legends as in previous figures).

The relative stratigraphic positions of KGA8-A1 and KGA7-A2 are identical in that the artifact-bearing horizons are considered to lie above BWT and below BOT. It is possible that the artifact assemblages of the two sites, both characterized by fresh quartzites, in fact represent (pene) contemporaneous assemblages although they are located >1 km apart.

A selective collection of LCT, picks and other large tools was undertaken in 1995, within a gridded area of 64 m². We revisited the area in 2013, and further undertook surface collection at the same location. In 2013, a 100% collection of not only LCTs and picks, but also flakes and cores were undertaken in a gridded area of approximately 100 m² (9 m × 11 m) (KGA8-A1b). A second selective collection of only the LCTs and picks were made in another gridded area of approximately 60 m² (7.5 m × 8 m) (KGA8-A1c) immediately downslope on the same ridge slope.

KGA12-A1

Differential GPS reading: N5° 25' 25.3", E37° 23' 11.6" (1994 collection area)

Differential GPS reading: N5° 25' 24.7", E37° 23' 11.7" (1996 collection area)

Estimated age: ~1.25 Ma

The KGA12-A1 site occurs towards the western end of the richly fossiliferous sediment exposures of KGA12. A small recess-like valley is formed above the locally resistant Bench Tuff (BNT) horizon. An impressive surface concentration of handaxes was found there during the 1991 Inventory survey. This prompted the nickname "handaxe valley".

A composite stratigraphic section near the KGA12-A1 site (K12-2) is shown in Katoh et al. (2014) page 21, and the section corresponding to the KGA12-A1 site and vicinity is shown in Fig. 2.11. The BWT is exposed at the mid-upper section, and the KGA12 Hard Gray Tuff (12HGT) occurs higher. A yellow gravelly sand unit occurs 2 to 3 m above the BWT and 2.5 m below the 12HGT. This unit is continuous for almost the entire east-west extent of the KGA12 exposures, and locally contains *in situ* fossils and handaxes. Toward the eastern end of KGA12, this sand unit lies immediately above the Piso Tuff-2 (PST2). The KGA12-A1 surface artifacts are considered to have eroded out of this yellow gravelly sand unit. *In situ* artifacts were observed in the sections flanking the KGA12-A1 valley.

The KGA12-A1 assemblage was first collected in the "handaxe valley" in 1994, a collecting area of 50 m² (10 m × 5 m) was designated and this was further divided into two collecting areas each 25 m². A 100% surface collection was done at the southern 25 m² area (KGA12-A1a), and a selective collection of all LCTs was taken at the northern 25 m² area (KGA12-A1b). Another 25 m² 100% collection was made in 1996 in the "handaxe valley" ~20 m south of the 1994 location and designated as KGA12-A1c.

KGA18-A1

Differential GPS reading: N5° 23' 18.3", E37° 21' 42.9" (1999 collection area)

Hand held GPS reading: N5° 23' 18.9", E37° 21' 40.7" (2013 collection area)

Estimated age: ~0.85 Ma

The KGA18-A1 site occurs at outcrops adjacent to the main highway as the road ascends southward from the Kayle River crossing. A gravelly sand unit 1 to 1.5 m thick occurs in shallow local sections that can laterally be shown to lie ~4 m above the Baraisa Tuff-1 (BAT1). Artifacts (and few fossils) can be inferred to erode out of this sand unit, in otherwise sterile sediments. Low density surface scatter is usually seen, but a few locations exhibit concentrations of ~10 or so LCT artifacts. One of such concentrations was collected in 1999 and designated KGA18-A1a. The same area was revisited in 2013. Highway renovation and farming has altered the landscape to the extent

that it was difficult to visually relocate the initially collected KGA18-A1 artifact site. However, in the same general vicinity, probably one small ridge west (~50 m) of KGA18-A1a, another cluster of LCTs were found and collected as KGA18-A1b. The stratigraphic section of the KGA18-A1 area is shown in Fig. 2.12.

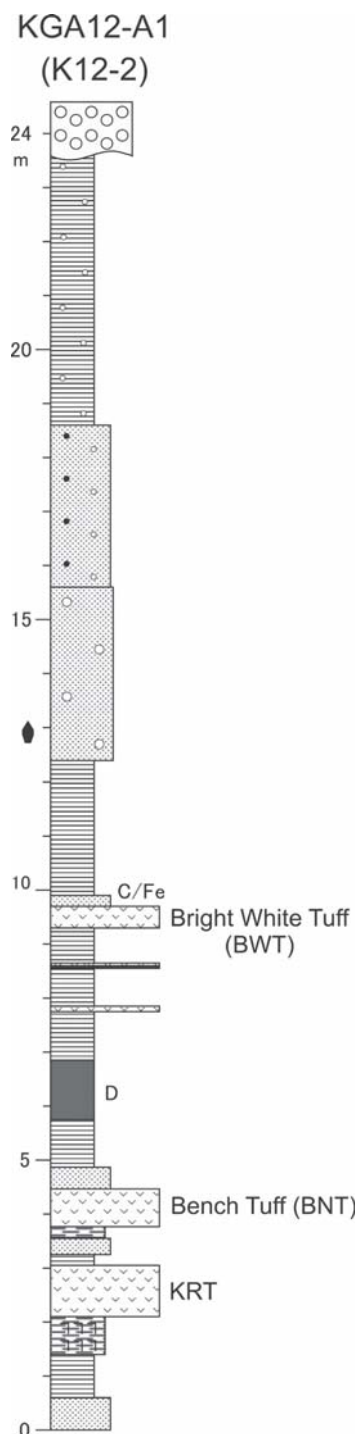


Fig. 2.11. Local stratigraphic section at KGA12-A1 (symbols and legends as in previous figures).

KGA20-A1 and A2

Differential GPS reading: N5° 23' 55.4", E37° 28' 23.5" (KGA20-A1)

Differential GPS reading: N5° 23' 54.7", E37° 28' 03.9" (KGA20-A2)

Estimated age: ~0.85 Ma

KGA20-A1 and A2 occur approximately ~0.5 km apart in the low-lying sediments of the same basin. A tuff horizon correlative of the Baraisa Tuff-1 (BAT1) intervenes between the artifact and fossil-bearing units of the two sites (KGA20-A2 being the stratigraphically higher). Another tuff, the Baraisa Tuff-2 (BAT2), overlies the KGA20-A2 horizon. Tuff BAT2 in turn occurs 2 to 6 m below the Upper White Tuff (UWT), the latter considered a correlative of the Turkana Basin Silbo Tuff (Beyene et al., 2013). Stratigraphic sections near the KGA20-A1 and A2 sites are shown in Katoh et al. (2014) page 32 (sections K20-2 and K20-3), and reproduced here as local sections (Fig. 2.12).

In 1998, selective collecting of the surface LCTs was conducted at KGA20-A1, and controlled collecting was done at KGA20-A2. At KGA20-A2 artifact concentration was not as dense as in some of the other collection sites so that 100% collection was undertaken in an extended area of 28 m × 10 m. Additional selective collecting of LCTs was done outside this area.

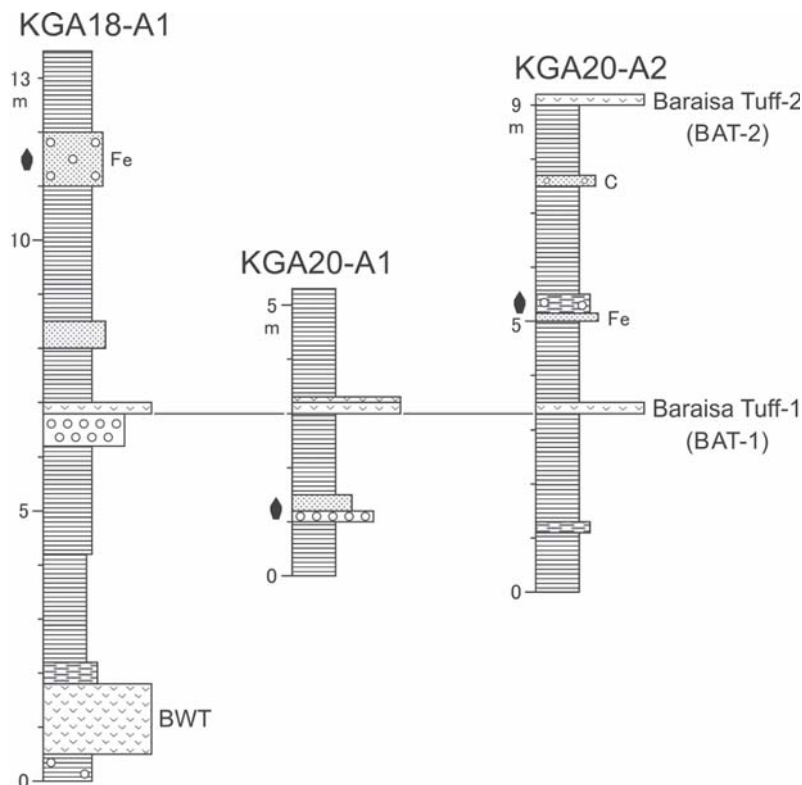


Fig. 2.12 Composite stratigraphic section of the KGA18-A1 area (left) and local sections at KGA20-A1/A2 (middle and right) (symbols and legends as in previous figures).

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