

# Early and Middle Holocene Human Occupation of the Egyptian Eastern Desert: Sodmein Cave

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Published online: 10 September 2015

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**Abstract** In this paper, we discuss human occupation during the Early and Middle Holocene in the Eastern Desert of Egypt, based mainly on the data provided by excavated deposits from the Sodmein Cave, which produced an important Holocene stratigraphic sequence. This sequence is dated by a large number of conventional and AMS <sup>14</sup>C dates. It appears that the area was empty of human occupation during the Late Glacial Maximum (LGM) and the earliest Holocene. With improved climatic conditions, humans arrived in the area, as hunter-gatherers using no ceramics, from around 7.1 to 6.4 Ka cal BC. Humans were absent from the cave during the Holocene 8.2 Ka event (*ca.* 6.3 Ka cal BC). From 6.2 to 5.0 Ka cal BC, herders visited the site on a regular basis importing caprines. The bone evidence for domesticated small stock is very limited at Sodmein but is nevertheless extremely important, as it contains the oldest known specimens for Africa to date. After 5.0 Ka cal BC, the area was almost entirely deserted.

**Résumé** La présente contribution discute de l'occupation humaine au cours de l'Holocène ancien et moyen dans le désert oriental d'Égypte. L'analyse des données fournies par les dépôts de la grotte Sodmein fournit une séquence stratigraphique holocène importante. Cette séquence est datée par un grand nombre de dates

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**Electronic supplementary material** The online version of this article (doi:10.1007/s10437-015-9195-6) contains supplementary material, which is available to authorized users.

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conventionnelles et AMS  $^{14}\text{C}$ . Il semble que la région n'ait pas été occupée au cours de la fin du maximum glaciaire (LGM) et au début de l'Holocène. L'arrivée des humains, chasseurs-cueilleurs sans céramique, dans la région, se situe aux environs de 7.1 à 6.4 Ka calBC au moment de l'amélioration des conditions climatiques. Durant le '*Holocene 8.2 Ka event*' ( 6.3 Ka calBC) l'homme semble absent du site. Plus tard, de 6,2 à 5,0 Ka calBC, des éleveurs, qui ont introduit des caprins, ont visité le site régulièrement. À Sodmein l'évidence osseuse de caprins domestiques, quoique limitée, est néanmoins extrêmement importante, car elle représente à ce jour les plus anciens spécimens connus pour l'Afrique. Après 5.0 Ka calBC la région a été presque entièrement désertée.

**Keywords** Egypt · Neolithic · Holocene · Herding ·  $^{14}\text{C}$  dating · Prehistory

## Introduction

The Egyptian Western Desert has been surveyed by many research groups, and the data collected provide extensive information for the understanding of the different population groups that visited the area, mainly during the Early and Middle Holocene (Bubbenzer *et al.* 2007). However, understanding of what happened in the Nile Valley during this same time period remains very restricted (Midant-Reynes 2003). Moreover, very little research has been initiated that considers human occupation in the Egyptian Eastern Desert.

The Belgian Middle Egypt Prehistoric Project of Leuven University carried out surveys and excavations in the Egyptian Eastern Desert, mainly along the Red Sea during the winters of 1989, 1993, 1995 and 1999. The project aimed to understand the prehistoric occupation of this area. Surveys resulted in the identification of several sites. These include Middle Stone Age (MSA) sites, such as Sodmein Cave (Prickett 1979, Vermeersch *et al.* 1996) and Wadi Bili (Vermeersch *et al.* 2007), Epipalaeolithic sites such as Tree Shelter (Vermeersch 2008) and Sodmein Cave, and also Neolithic sites such as Wadi Bili, El Gouna (Vermeersch *et al.* 2005b), Tree Shelter, and Sodmein Cave. The present paper discusses data from Sodmein Cave that are relevant to the human occupation of the Egyptian Eastern Desert during the Early and Middle Holocene (Vermeersch 2012). A variety of integrated data from both archaeology and natural sciences (stratigraphy, fauna, plant remains) were collected. They provide us with evidence for a better understanding of the human occupation during the environmental changes of the area. These data will be integrated in an overview of the North African human population dynamics during the Early and Middle Holocene.

The cave (Figs. 1, 2 and 3) is located in the Red Sea Mountains of the Egyptian Eastern Desert, at  $26^{\circ} 14' 27''$  N and  $33^{\circ} 58' 12''$  E, about 35 km to the NNW of Quseir in an area where limestone of the Thebes Formation is outcropping. The geology and geomorphology of the Sodmein Cave were studied by Moeyersons *et al.* (1996, 1999, 2002). The slightly sloping cave floor is 41 m wide, 10 to 20 m deep and 18 m high at the entrance. At the confluence of the Wadi Nakheil and the Wadi El Ambagi, there is a perennial spring. Other springs, now dry, are found at Bir Nakheil and in the Bir el-Anz.

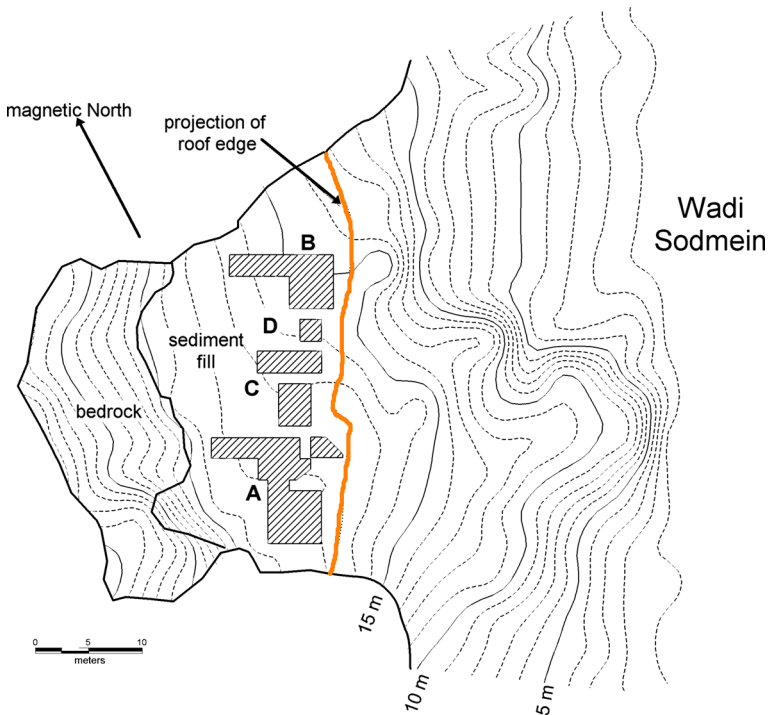




**Fig. 3** View from the Sodmein Cave (sector B) over the Wadi Sodmein. (photo: P. Vermeersch)

in different sectors of the site in order to disclose the stratigraphy (additional data are given in Online Resource 1). Screening of deposits on 5-mm mesh was a standard procedure throughout the excavation.

The backwall of the cave and the depositional area in front (Figs. 5 and 6) are covered by a thin veneer of loose loamy sand, containing some angular, 1- to 15-cm



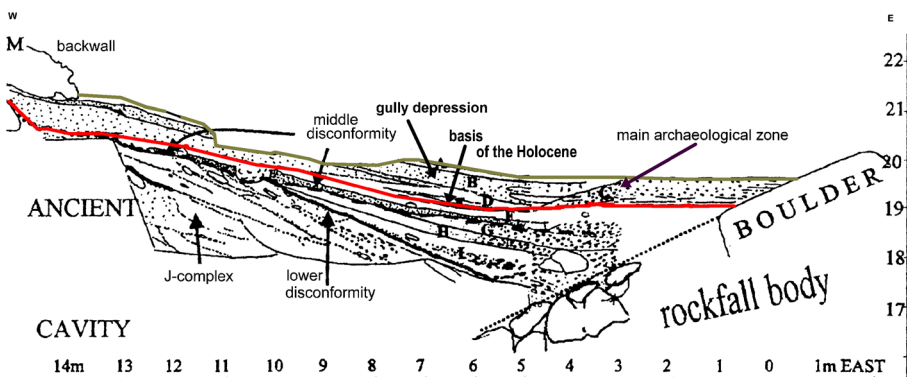
**Fig. 4** Topographical map of Sodmein Cave showing the excavation sectors (A–D) and trenches



**Fig. 5** The surface of the cave interior at the start of the excavations (photo: P. Vermeersch)

sized limestone fragments. The rockfall, at the cave entrance, contains essentially clast-supported angular limestone and relatively abundant chert fragments. The edge of the rockfall wall does not form a single, continuous, steep scree slope. Instead, there is a subhorizontal interfingering of rock debris lobes with the layers coming from inside the cave, thus indicating the episodic nature of the rockfall. In sector A, the backfill is at least 2 m thick and contains mineralogical as well as organic material. The majority of the organic material consists of intact or mechanically fragmented animal droppings. Successive fills (layers A to D) rest discomformably upon older backfill (Fig. 6) with MSA artefacts and are attributed to the Holocene. The upper layer represents the “gully depression,” while the lower one represents the “main archaeological zone.” The latter can be easily distinguished on the basis of numerous hearths. The fill of the “gully depression” was rather poor in archaeological material, whereas the “main archaeological zone” was quite rich.

Working from top (most recent) to base, the following stratigraphic sequence has been identified:



**Fig. 6** Stratigraphic section west-east along 23 N (adapted from Moeyersons *et al.* 2002)

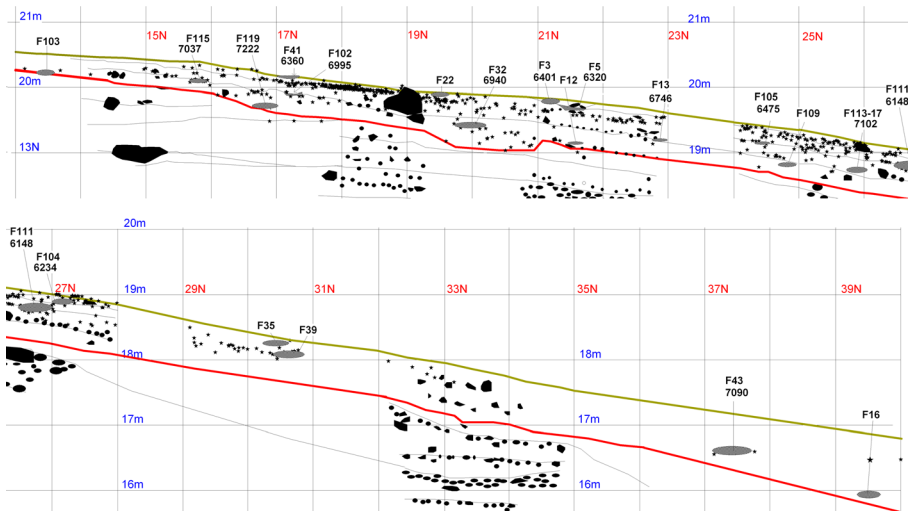
- Layers A and B: deposits and the archaeological material that fill the gully depression
- Layer C: deposits and the archaeological material of the main archaeological zone, of which the upper part is the C1-horizon (*ca.* 6.15–6.48 Ka BP) and the lower part is the C2-horizon (*ca.* 6.68–7.35 Ka BP).

A number of profiles with plotted artefacts and features are presented here in order to illustrate this sequence (Figs. 7 and 8).

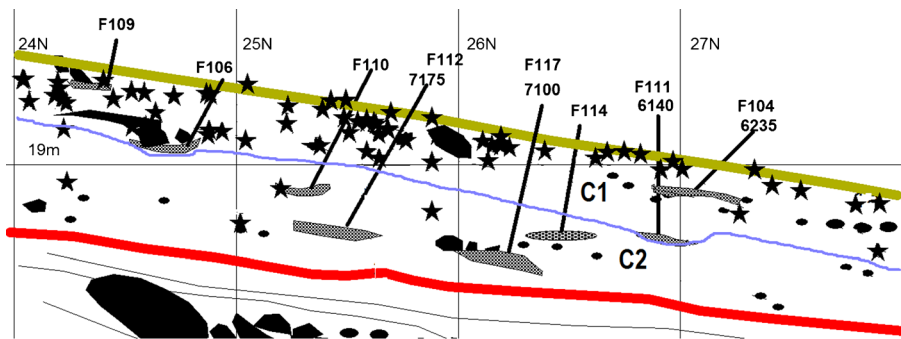
## Results

### Holocene Features

In the main archaeological horizon, numerous archaeological features were registered during the excavation. These features are described in chronological order of their excavation (additional data are given in Online Resource 2). Figure 9 gives an overview of the position of each feature within the cave. Table 2 identifies their stratigraphic position. Most features functioned as hearths. They consist very often of white ash covering an accumulation of small or large charcoal fragments, resting upon reddish burnt sediment. They are usually circular or somewhat oval with an average diameter of about 42 cm. The preserved white ash accumulation is often rather restricted in surface and thickness. In some instances, numerous hearthstones are present, such as is the case for features F103, F104, F107 and F203. However, hearths without hearthstone(s) also occur. The principal species represented in the charcoal from the hearths (Table 1) vary. There seems to be no correlation between the feature structure and the main charcoal species present.



**Fig. 7** A composite south-north profile, partially from 4 W (14–18 N, 24–28 N) with artefacts (stars) plotted from 3.00 W up to 3.49 W. The hearths from 3 to 4 W have been positioned on the profile with their feature number and  $^{14}\text{C}$  age in BP. The area between the olive and red line corresponds to the Holocene deposits (image in full colour online)



**Fig. 8** South-north profile (24–28 N), from 2 W with artefacts (stars) plotted from 2.00 W up to 2.49 W

At Tree Shelter, archaeological horizon 3, several hearths (*e.g.*, F12 and F23) were quite similar to some of the hearths (*e.g.*, Feature 104) at Sodmein Cave but in a better state of preservation. Little information is available regarding the activities performed at these hearths.

The artefact distribution (Fig. 10) in the excavated trenches reflects the paucity of artefacts in the gully depression deposits. There seems to be no clear correlation between areas of high artefact density and specific features. The eastern edge of the artefact distribution coincides with the westward expansion of the rockfall wall. The absence of artefacts in 14–17 N 4 W is not a reality but the result of a registration error in the field.

### Radiocarbon Chronology of the Site

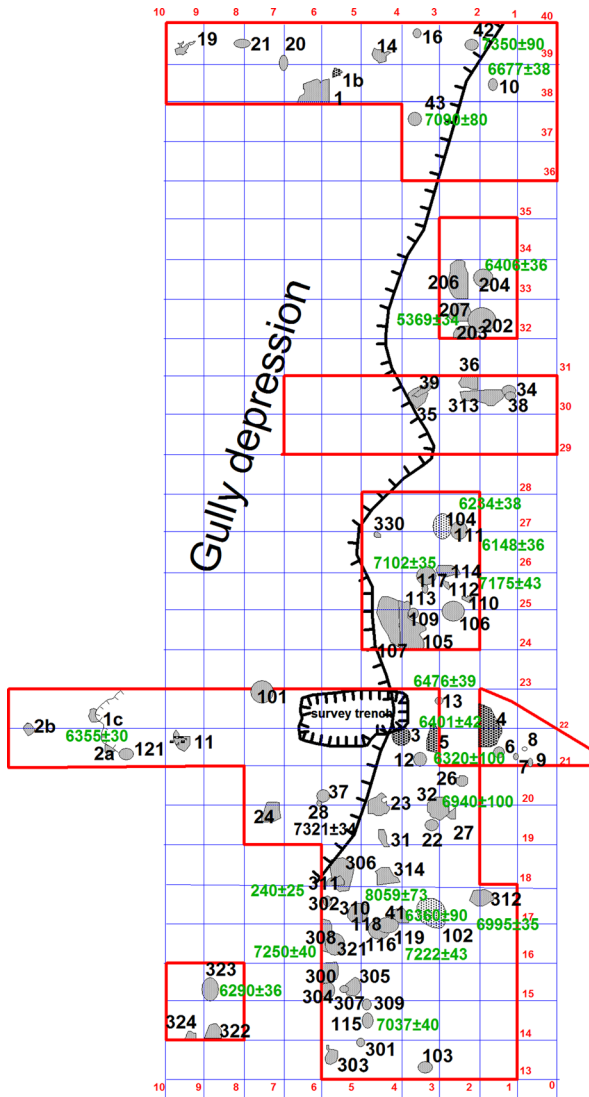
Charcoal was plentiful in all deposits. Several handpicked charcoal samples were submitted for conventional and AMS dating. The resulting dates are listed in uncalibrated form in Table 2. All Sodmein dates were calibrated using the OxCal v4.2.2 software (Bronk Ramsey 2009) (Fig. 11). Feature 311, from near the surface, is clearly of a recent date.

### The Holocene Artefacts

The artefacts collected in the main archaeological horizon are considered to belong to a time period younger than 7.0 Ka cal BC, frequently younger even than 6.25 Ka cal BC and older than 5.15 Ka cal BC. This artefact collection will be treated as a single assemblage, considered the “Holocene” assemblage, even when it is certain that a high number of occupations have been present. It is noteworthy that more than 70 features, most of them hearths or hearth remains, have been registered within the “Holocene” deposits. The few tool types, which are considered as typologically characteristic, will be described individually and related to their stratigraphic and chronological position and, where possible, to a specific feature.

### Chert Occurrences

Good chert is abundantly present in the area of Wadi Sodmein. Most exploited chert nodules have an ovaloid shape and typically consist of a grey-whitish, fine structured chert with good knapping qualities. Sometimes this chert is dotted with white spots, sometimes



**Fig. 9** Plan of features attributed to the Holocene occupation and their  $^{14}\text{C}$  age in years BP

it is darker in the centre of the nodule. Less frequently, the chert colour is brownish or even bluish. Flint with a rolled abraded cortex is most common, suggesting they were collected from the wadi deposits. The cortex surface is most often rather smooth with a whitish colour. Artefacts with a fresh cortex are rare. Quartz pebbles were also used for a limited number of products. Such pebbles can also be found in the nearby wadi deposits.

### *Debitage*

The artefacts are most often preserved in a fresh state with cutting edges intact and are either unpatinated or only slightly patinated. The lithic material (Table 3) is composed



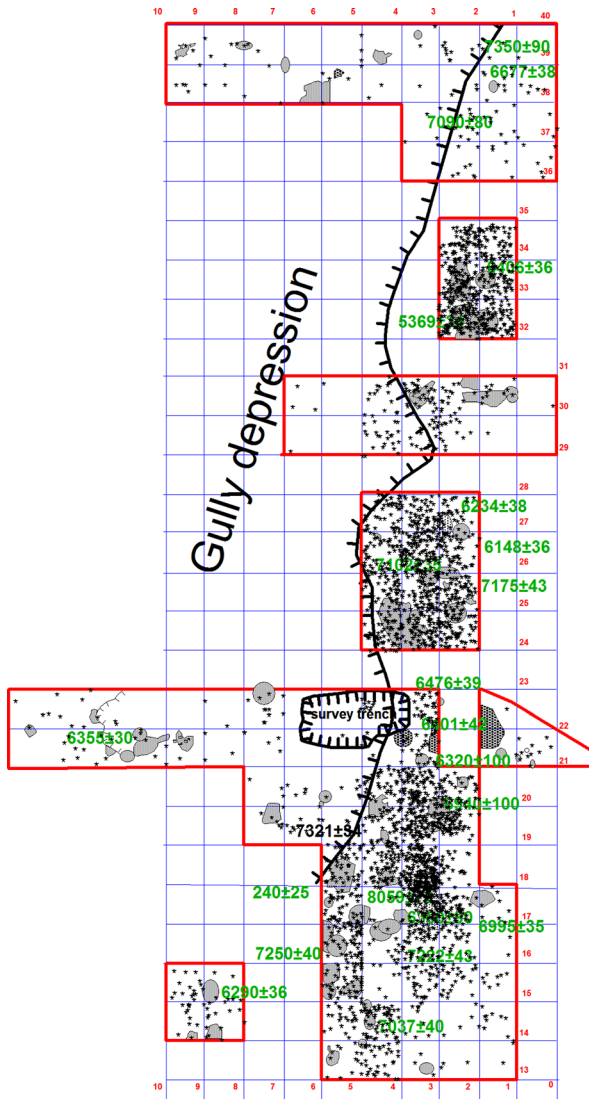
**Table 1** Charcoal determinations from some of the features (number of fragments)

Layer	Layer A-B	Layer C1					Layer C2					
		F1	F3	F5	F31	F41	F10	F112	F119	F6	F28	Scattered
<i>Acacia</i> sp.			5	23	97				25	53	57	35
<i>Salvadora persica</i>			55	52	48		23			38	35	5
<i>Tamarix</i> sp.			30	11	70					14	86	21
<i>Capparis decidua</i>			2	4	25							
<i>Maerua crassifolia</i>					17						3	
<i>Fagonia/Zygophyllum</i>					1				4			
<i>cf. Suaeda</i>			1	2								
Chenopodiaceae				7	13					3	18	
Fabaceae											2	
Dicotyledons indet			1	4	2							
Indet. (partly “melted”)	150	150	4	5	18	150				8	6	4
Indet.				14	8					9		
Total studied charcoal fragments	150	150	98	122	299	150	23	25	120	207	65	

mainly of flakes, some cortical flakes and smaller debitage remains. Cores for blade production (Fig. 12) are rare. This situation might suggest an import of blades into the cave. Levallois products are present (Fig. 13: 6, 8(?), 11–12), albeit in small quantities. All of them were located in the central or southern parts of the cave and are probably in a secondary position, having being eroded from lower deposits of the Middle Stone Age.

Cores (Table 3) are not well represented, comprising only 1.22 % of the assemblage. Most cores have been formed out of a rolled nodule, although sometimes a large, thick cortical flake was used. Flakes are produced without their removal being preceded by special core preparation. Cortex is often still present. Most cores are exhausted. Direct hard-hammer percussion is the only technique used for the debitage. The cores are mostly of irregular type (Fig. 12: 2). When a more systematic knapping approach was used, a single platform procedure was preferred (Fig. 12: 3–8). In addition to these irregular or single platform cores for flakes, some single platform cores for bladelets (Fig. 12: 6 and 8) are present. Other core types, such as multiplatform cores (Fig. 12: 1) and opposed platform cores (Fig. 12: 9), are rare. One of the multiplatform cores can be interpreted as a thick scraper.

Flakes are numerous, displaying very few traces of preparation. The percussion bulb is usually quite prominent. Flakes have mainly been obtained without preparation of the platform and often have a flat butt (66 %). Sometimes they have a dihedral butt (22 %) (Table 4). Facetted butts are rare. Average flake length was estimated (no measurements were taken) at about 4 cm. Large flakes are rare. In addition to chert, quartz (1 %) was also used, mainly for the production of small flakes (Fig. 17: 11). No quartz cores were found, suggesting that the flakes were introduced into the cave. Cortical flakes and blades are not numerous (about 2 % of the assemblage). Apparently, decortication took place outside the cave and mainly blanks were introduced. Blades (Figs. 13: 1–3, 17: 1)



**Fig. 10** Plan of artefacts and features

and bladelets are not numerous (about 4.4 % of the assemblage) and certainly not characteristic for the assemblage. They are rather short and thick, not really elongated and probably the incidental result of flake production, and not of a specific blade debitage technique. Thick blades have a triangular section. The butt (Table 4) is mostly flat, usually with a pronounced percussion bulb, suggesting a very restricted core preparation. Blades and bladelets of Epipalaeolithic type (Fig. 15: 3) are rare. Some of the Epipalaeolithic bladelets were used as blanks for microlithic points (Fig. 15: 4–5). Their presence and the age of Feature 310 (7.1 Ka cal BC) give rise to the hypothesis that groups of Elkabian (Vermeersch 1978, 2012) hunter-gatherers visited the site. However, a specific horizon with Elkabian debitage or tools is not present. It

**Table 2** Features from the Holocene deposits. Sample pre-treatment methods for radiocarbon dating: A—acid extraction, AAA—acid-alkali-acid extraction, H<sub>2</sub>SO<sub>4</sub>—acid treatment of carbonate samples (see Supporting Information 2) for detailed method descriptions

FeatureF	Position	Elevation	Layer	Dated material	Sample ID	Age BP	Method	Pretreat.
311	18.2 N 5.5 W	20.27	Surf.	Ch	ME99/45/96	240±25 (KIA-28777)	AMS	AAA
303	13.6 N 5.7 W	20.77	A-B					
301	13.9 N 4.9 W	20.65	A-B					
302	17.6 N 5.9 W	20.67	A-B					
312	17.6 N 1.9 W	19.97	A-B					
24	19.3 N 7.3 W	19.90	A-B					
26	20.6 N 2.4 W	20.10	A-B					
121	21.4 N 11.0 W	21.70	A-B					
2b	22.0 N 13.5 W	21.10						
11	2136 N 9.5 W	20.10	A-B					
101	22.9 N 7.5 W	19.29	A-B					
35	30.5 N 3.6 W	18.20	A-B					
202	32.4 N 1.9 W	17.99	A-B					
207	32.6 N 2.6 W	17.64	A-B	Ch	ME95/123	5369±34 (COL1337.1.2)	AMS	AAA
1b	38.6 N 5.4 W	17.30	A-B					
1	38.7 N 5.9 W	17.44	A-B					
20	38.9 N 7.0 W	18.00	A-B					
19	39.3 N 9.4 W	18.57	A-B					
21	39.5 N 8.0 W	18.00	A-B					
322	14.2 N 8.6 W	21.10	C1					
324	14.0 N 9.4 W	21.34	C1					
323	15.3 N 8.8 W	21.09	C1	Ch	ME99/49/44	6290±36 (COL1339.1.2)	AMS	AAA
116	16.0 N 4.7 W	20.06	C1					
41	17.2 N 4.0 W	20.18	C1	Ch	ME93/508	6360±90 (Lv-2085)	Conv.	A
22	19.5 N 3.2 W	19.94	C1					
27	19.8 N 2.7 W	19.84	C1					
23	20.0 N 4.6 W	19.83	C1					
31	19.2 N 4.4 W	19.45	C1					
3	21.8 N 4.0 W	19.62	C1	Ch	ME93/05	6401±40 (COL1325.1.1)	AMS	AAA
2a	21.4 N 11.4 W	20.70	C1	OES	ME93/69	6354±31 (COL1326.1.2)	AMS	H <sub>2</sub> SO <sub>4</sub>
1c	22.4 N 11.9 W	20.65	C1					
5	21.7 N 3.0 W	19.60	C1	Ch	ME93/31	6320±100 (Lv-2082)	Conv.	A
105	24.5 N 3.7 W	19.15	C1	Ch	ME95/15/406	6475±36 (COL1330.1.2)	AMS	AAA
111	27.1 N 2.5 W	18.63	C1	Ch	ME95/17/598	6148±36 (COL1331.1.1)	AMS	AAA
330	26.9 N 4.6 W	18.98	C1					
104	27.3 N 2.9 W	18.90	C1	Ch	ME95/15/299	6234±38 (COL1329.1.2)	AMS	AAA
36	30.9 N 2.2 W	18.10	C1					
39	30.4 N 3.5 W	18.10	C1					
203	32.4 N 2.2 W	17.94	C1					
204	33.5 N 1.9 W	17.70	C1	Ch	ME95/97	6406±36 (COL1336.1.2)	AMS	AAA
103	13.1 N 3.2 W	20.36	C2					
115	14.4 N 4.8 W	20.19	C2	Ch	ME95/11/84	7037±40 (COL1333.1.1)	AMS	AAA
305	15.4 N 5.1 W	20.40	C2					

**Table 2** (continued)

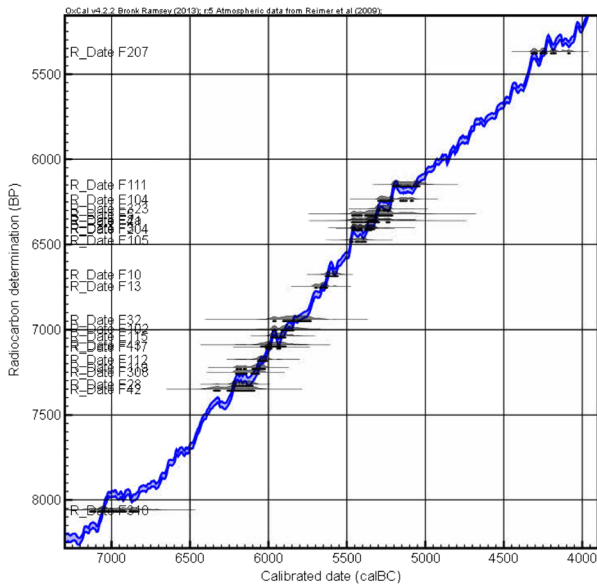
FeatureF	Position	Elevation	Layer	Dated material	Sample ID	Age BP	Method	Pretreat.
300	15.0 N 5.5 W	20.56	C2					
304	15.4 N 5.8 W	20.44	C2					
307	15.4 N 5.5 W	20.35	C2					
119	16.9 N 4.3 W	19.66	C2	Ch	ME95/18/1	7222±43 (COL1335.1.1)	AMS	AAA
308	16.9 N 5.9 W	20.10	C2	Ch	ME99/46/15	7250±40 (IRPA-1372)	AMS	AAA
118	17.1 N 4.8 W	19.78	C2					
102	17.3 N 3.2 W	20.00	C2	Ch	ME95/10/149	6995±35 (KIA-28778)	AMS	AAA
306	18.3 N 5.5 W	20.05	C2					
314	18.2 N 4.3 W	19.81	C2					
32	19.9 N 3.1 W	19.43	C2	Ch	ME93/366	6940±100 (Lv-2083)	Conv.	A
28	20.0 N 6.1 W	19.70	C2	Ch	ME93/315	7321±36 (COL1328.1.2)	AMS	AAA
12	21.0 N 3.8 W	19.15	C2					
9	21.1 N 0.7 W	19.40	C2					
6	21.2 N 1.0 W	19.58	C2					
7	21.4 N 1.1 W	19.41	C2					
8	21.4 N 0.7 W	19.39	C2					
4	21.9 N 2.0 W	19.65	C2					
13	22.7 N 3.0 W	19.14	C2	Ch	ME93/545	6746±39 (COL1341.1.2)	AMS	AAA
109	24.7 N 3.7 W	18.82	C2					
106	24.9 N 2.6 W	19.16	C2					
107	24.9 N 2.6 W	19.11	C2					
110	25.2 N 2.4 W	18.91	C2					
114	25.5 N 3.0 W	18.72	C2					
113	25.5 N 3.5 W	18.71	C2					
112	25.7 N 2.8 W	18.73	C2	Ch	ME95/17/646	7175±42 (COL1332.1.1)	AMS	AAA
117	25.7 N 3.4 W	18.61	C2	Ch	ME95/17/655	7102±35 (COL1334.1.2)	AMS	AAA
34	30.7 N 1.3 W	18.17	C2					
38	30.4 N 1.1 W	18.05	C2					
206	32.5 N 2.5 W	17.52	C2					
43	37.5 N 3.5 W	16.42	C2	Ch	ME93/428	7090±80 (Lv-2086)	Conv.	A
10	38.4 N 1.6 W	16.83	C2	Ch	ME93/61	6677±38 (COL1327.1.2)	AMS	AAA
42	39.5 N 2.1 W	16.10	C2	Ch	ME93/333	7350±80 (UIC-3312)	AMS	AAA
310	17.3 N 5.2 W	19.63	C2 base	Ch	ME99/46/15	8059±73 (COL1338.1.2)	AMS	AAA

*Ch* charcoal, *OES* ostrich egg shell

seems that remains of the Epipalaeolithic Elkabian were eroded before the arrival of later groups.

### *Retouched Blanks*

Tools (Table 5), defined as retouched blanks, are well represented (6 % of the artefacts). Simple tools, such as retouched flakes (34 %), denticulates (18 %) and notched flakes (6 %), are by far the most dominant categories. However, typologically more specified



**Fig. 11** Calibration of the radiocarbon dates of the Sodmein Cave using OxCal v4.2.2

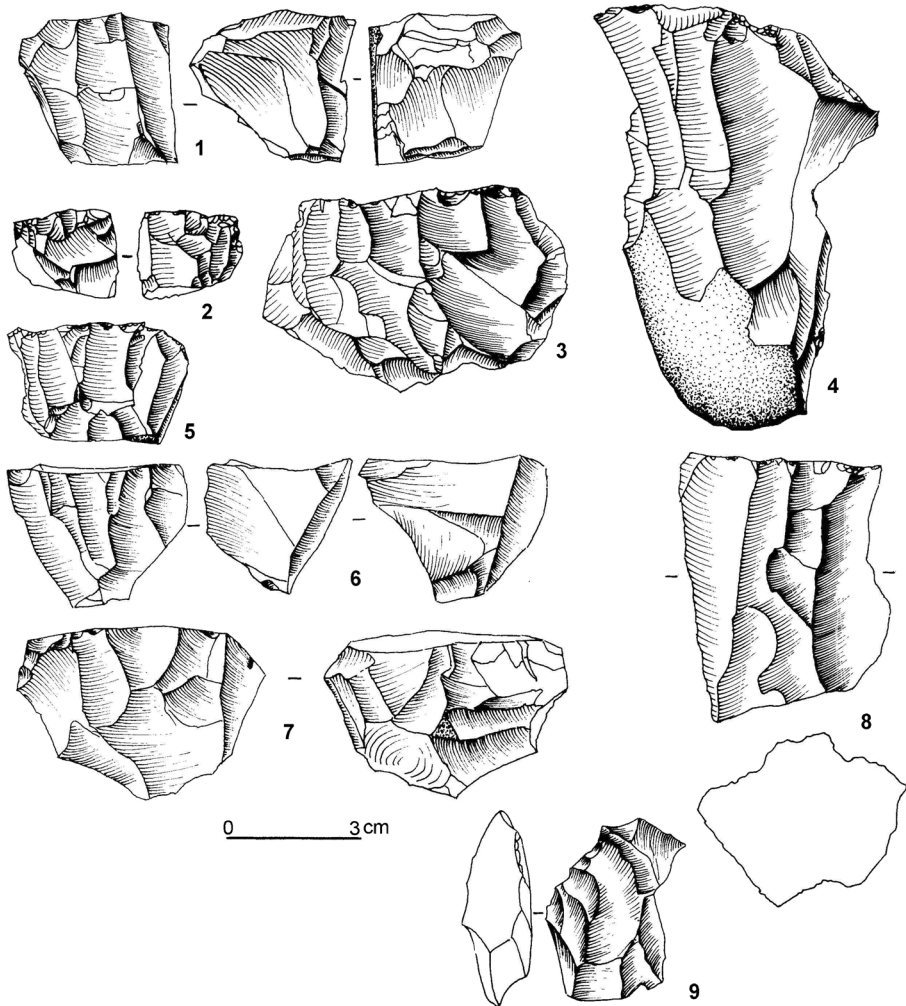
tools such as different types of arrowheads (together about 11 %) are also well represented.

End-scrapers are present but they do not represent particularly specific types. Some are thumbnail-scrapers (Fig. 15: 26–27); others are end-scrapers on an elongated flake (Fig. 15: 25, 28) or on a thick flake. Some of the end-scrapers have a denticulated scraper front (Fig. 17: 8), display a bifacial retouch (Fig. 15: 24) or are only end-scraper fragments (Fig. 14: 16). There is a large cortical scraper (Fig. 14: 5) which resembles scrapers that occur often in predynastic and Neolithic contexts, such as Djara A (Gehlen *et al.* 2002). Some side-scrapers (Fig. 13: 4) display an MSA morphology and could be intrusive from the lower levels. Borers are present but not numerous. Some are obtained by two distal notches (Fig. 13: 7) or by a more significant distal retouch (Fig. 16: 1–3). One of them (Fig. 16: 1), with an intensively used tip, is produced on a flake by semi-abrupt to abrupt retouch. A large borer (Fig. 16: 5) resembles those found in the Badarian (Hendrickx *et al.* 2001). Only two burins (Fig. 14: 1, 6), originating from the northern sector C1-deposits, have been discovered. Bifacial flaking is clearly present, but most bifacial pieces are fragments (Fig. 16: 6) or seem to be preforms (Fig. 16: 9, 10). They can be interpreted as fragments of bifacial knives. Their form is not the result of careful specialised production. A small, more carefully prepared, bifacial foliate (Fig. 15: 29) was found in the A-deposits. Most bifacial artefacts are less characteristic and often display a restricted bifacial retouch.

Several arrowhead types are present. Some of them are similar to Epipalaeolithic or early Neolithic types such as Ounan points. Two Ounan points (Fig. 15: 4, 5) are similar to those recovered at Abu Tartur 1072 (Riemer *et al.* 2004). They have been manufactured on pointed (Epipalaeolithic) bladelets which have obtained a central stem by a steep retouch. A pointed backed bladelet (Fig. 15: 6) can also be attributed to Epipalaeolithic activity. Most arrowheads are characterised by a rather flat, invasive

**Table 3** Debitage products from the Holocene assemblages

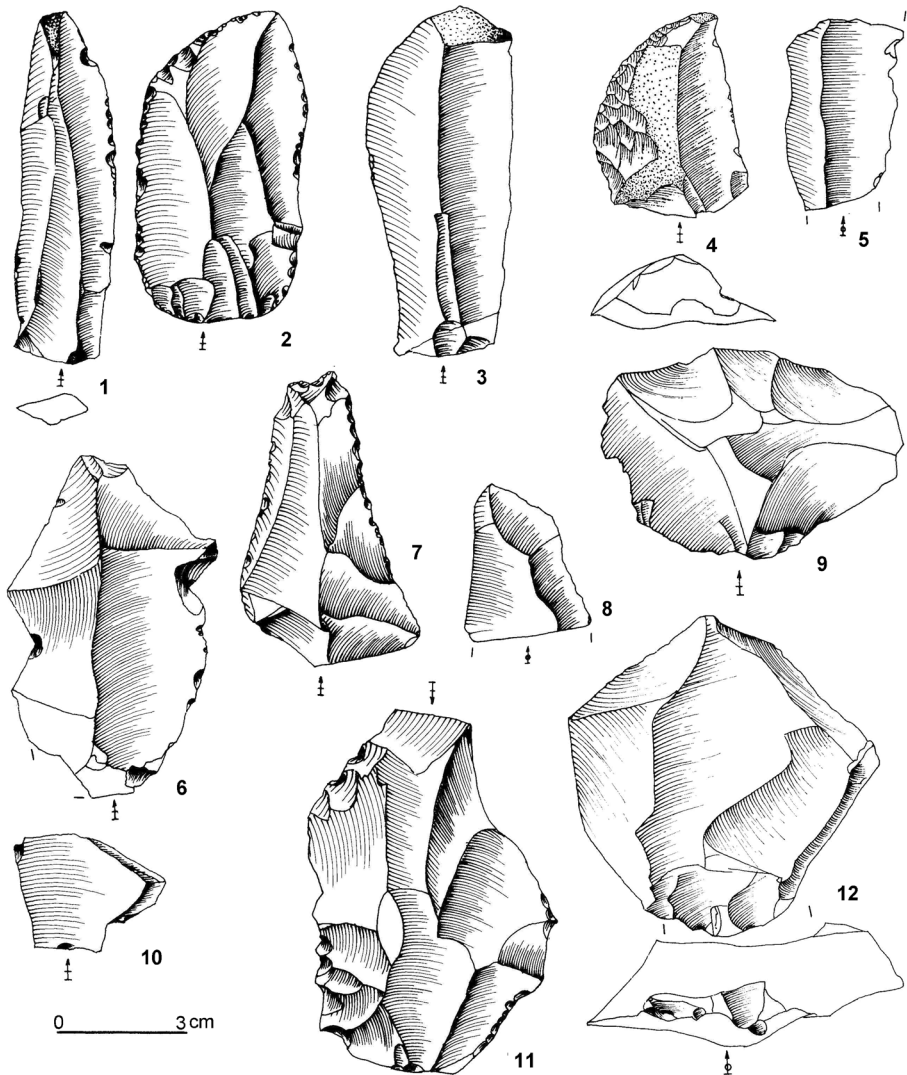
ID	A-B	C 1		C 2		Total	
	<i>N</i>	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Single platform core for flakes	1	8	0.23	6	0.27	15	0.26
Single platform core for blade(let)s	0	3	0.09	0	0	3	0.05
Opposed platform core	1	1	0.03	4	0.18	6	0.11
Multiplatform core	1	0	0	3	0.14	4	0.07
Discoid core	0	1	0.03	1	0.05	2	0.04
Irregular core	0	18	0.52	10	0.46	28	0.49
Core preform	0	3	0.09	6	0.27	9	0.16
Core fragment	0	1	0.03	0	0	1	0.02
Core rejuvenation	0	0	0	1	0.05	1	0.02
Core tablet	0	0	0	2	0.09	2	0.04
Crested flake	0	0	0	1	0.05	1	0.02
Cortical flake	0	81	2.33	25	1.14	106	1.86
Cortical flake fragment	0	3	0.09	15	0.69	18	0.32
Cortical blade	0	2	0.06	0	0	2	0.04
Cortical blade fragment	0	0	0	2	0.09	2	0.04
Flake	12	1343	38.58	1200	54.87	2555	44.89
Flake fragment	4	684	19.65	209	9.56	897	15.76
Chip	2	1015	29.16	317	14.49	1334	23.44
Quartz flake	0	57	1.64	17	0.78	74	1.30
Quartz chip	0	5	0.14	1	0.05	6	0.11
Chunk	1	20	0.57	9	0.41	30	0.53
Levallois preparation flake	0	1	0.03	0	0	1	0.02
Levallois flake	0	0	0	2	0.09	2	0.04
(Levallois) retouched flake	0	2	0.06	8	0.37	10	0.18
(Levallois) point fragment	0	1	0.03	1	0.05	2	0.04
Blade	0	31	0.89	72	3.29	103	1.81
Blade irregular	0	4	0.11	0	0	4	0.07
Blade fragment	0	3	0.09	2	0.09	5	0.09
Blade fragment distal	0	6	0.17	0	0	6	0.11
Blade fragment proximal	0	11	0.32	28	1.28	39	0.69
Blade fragment medial	0	9	0.26	44	2.01	53	0.93
Blade fragment distal	0	5	0.14	3	0.14	8	0.14
Bladelet	0	2	0.06	21	0.96	23	0.40
Bladelet fragment proximal	0	0	0	1	0.05	1	0.02
Bladelet fragment medial	0	0	0	1	0.05	1	0.02
Bladelet fragment distal	0	0	0	1	0.05	1	0.02
Epipalaeo bladelet	0	1	0.03	0	0	1	0.02
Tool	2	160	4.6	174	7.96	336	5.90
Total	24	3481	100	2187	100	5692	100.00



**Fig. 12** Cores. 1: multiplatform core; 2: irregular core; 3–8: single platform core; 9: opposed platform core

retouch. They often display a lenticular form, generally with a bifacial retouch (Fig. 15: 11, 13–15, 18) on a flake. Occasionally, the surfaces display a covering retouch (Fig. 15: 18). An irregular trapeze (Fig. 15: 23), which might have been a transverse arrowhead, was present.

Other tools or tool fragments are rare. An axe preparation flake (Fig. 14: 8) was found in the upper part of the Holocene levels. A cortical flake fragment with very flat retouch (Fig. 14: 13) is similar to some of the predynastic retouched flakes. Most other tools are uncharacteristic and comprise a number of diverse retouched blades and blade fragments (Fig. 13: 1, 2–3, 5), some of which attest a fine retouch (Fig. 13: 3). Retouched flakes and their fragments are among the most frequent tool types. They are diversified in their appearance (Figs. 13: 2, 10; 14: 7, 11, 15; 15: 30; 16: 4, 11, 16; 17: 9, 13; 18: 4). Some of the retouched flakes (Fig. 14: 11, 13 and 15) have flat retouches, which often occur on predynastic tools. Notched flakes (Figs. 13: 9; 17: 5;



**Fig. 13** Debitage products. 1–2: retouched blade; 3: blade with fine retouch; 4: side-scraper; 5: retouched blade fragment; 6: retouched (Levallois) flake; 7: retouched flake or borer; 8: (Levallois) point fragment; 9: notched flake; 10: retouched flake; 11: retouched (Levallois?) flake; 12: Levallois flake

**Table 4** Butt-type distribution of blades/bladelets

	Flat	Dihedral	Pointed	Facetted	Diverse
Blades/bladelets	16	2	1	1	1
Flakes	644	214	22	0	89
% flakes	66.46	22.08	2.27	0	9.18



**Table 5** Tools from the Holocene assemblages

ID	A-B	C 1		C 2		Total	
	<i>N</i>	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
End-scraper	0	3	1.9	7	3.9	10	2.9
End-scraper fragment	0	1	0.6	1	0.6	2	0.6
Denticulated end-scraper	0	1	0.6	5	2.8	6	1.8
Thumbnail-scraper	1	1	0.6	2	1.1	4	1.2
Bifacial end-scraper	0	0	0.0	1	0.6	1	0.3
Side-scraper	0	2	1.3	2	1.1	4	1.2
Predynastic cortical scraper	0	1	0.6	1	0.6	2	0.6
Borer	0	3	1.9	2	1.1	5	1.5
Badarian large borer	0	1	0.6	1	0.6	2	0.6
Burin on break	0	1	0.6	0	0.0	1	0.3
Burin on natural surface	0	1	0.6	0	0.0	1	0.3
Backed blade	0	1	0.6	1	0.6	2	0.6
Backed bladelet	0	1	0.6	0	0.0	1	0.3
Denticulate	0	23	14.6	32	17.7	55	16.1
Denticulate fragment	0	5	3.2	0	0.0	5	1.5
Denticulated blade	0	2	1.3	4	2.2	6	1.8
Denticulated blade frag. ventral retouch	0	1	0.6	1	0.6	2	0.6
Denticulated chip flake	0	1	0.6	0	0.0	1	0.3
Fine denticulate	0	0	0.0	3	1.7	3	0.9
Arrowhead	0	0	0.0	6	3.3	6	1.8
Arrowhead fragment	0	0	0.0	1	0.6	1	0.3
Arrowhead preform	0	2	1.3	7	3.9	9	2.6
Point tang fragment	0	1	0.6	0	0.0	1	0.3
Pointed flake	0	1	0.6	0	0.0	1	0.3
Irregular trapeze	0	1	0.6	0	0.0	1	0.3
Ounan point	0	1	0.6	2	1.1	3	0.9
Stemmed arrowhead or borer	0	1	0.6	0	0.0	1	0.3
Tanged point	0	2	1.3	0	0.0	2	0.6
Tayac point	0	0	0.0	3	1.7	3	0.9
Bifacial arrowhead	0	1	0.6	8	4.4	9	2.6
Bifacial preform	0	0	0.0	4	2.2	4	1.2
Bifacial fragment	0	1	0.6	1	0.6	2	0.6
Axe (tranchet) preparation flake	0	0	0.0	1	0.6	1	0.3
Small flake axe	0	0	0.0	2	1.1	2	0.6
Retouched blade	0	2	1.3	2	1.1	4	1.2
Blade with fine retouch	0	0	0.0	1	0.6	1	0.3
Inverse denticulated blade	0	1	0.6	1	0.6	2	0.6
Notched bladelet	0	0	0.0	1	0.6	1	0.3
Predynastic retouched flake	0	2	1.3	1	0.6	3	0.9
Retouched flake	0	63	39.9	64	35.4	127	37.2

**Table 5** (continued)

ID	A-B	C 1		C 2		Total	
	<i>N</i>	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Retouched flake overpassed	0	1	0.6	0	0.0	1	0.3
Retouched flake fragment	1	13	8.2	1	0.6	15	4.4
Flake with inverse retouch	0	1	0.6	1	0.6	2	0.6
Notched flake	0	12	7.6	6	3.3	18	5.3
Notched quartz flake	0	1	0.6	0	0.0	1	0.3
Inversely notched flake	0	0	0.0	1	0.6	1	0.3
Inversely retouched flake fragment	0	0	0.0	1	0.6	1	0.3
Flake with blunted edge	0	2	1.3	2	1.1	4	1.2
<i>Pièce esquillée</i>	0	0	0.0	1	0.6	1	0.3
Sum tools	2	158	100.0	181	100.0	341	100.0

18: 3) and denticulated flakes (Figs. 14: 3–4, 9, 12; 16: 8, 12–14; 17: 3, 6, 12, 15) are numerous. Sometimes, retouch is inversely applied (Fig. 16: 7, 17). Some rare denticulated blade and blade fragments (Fig. 17: 2, 4, 10) were found.

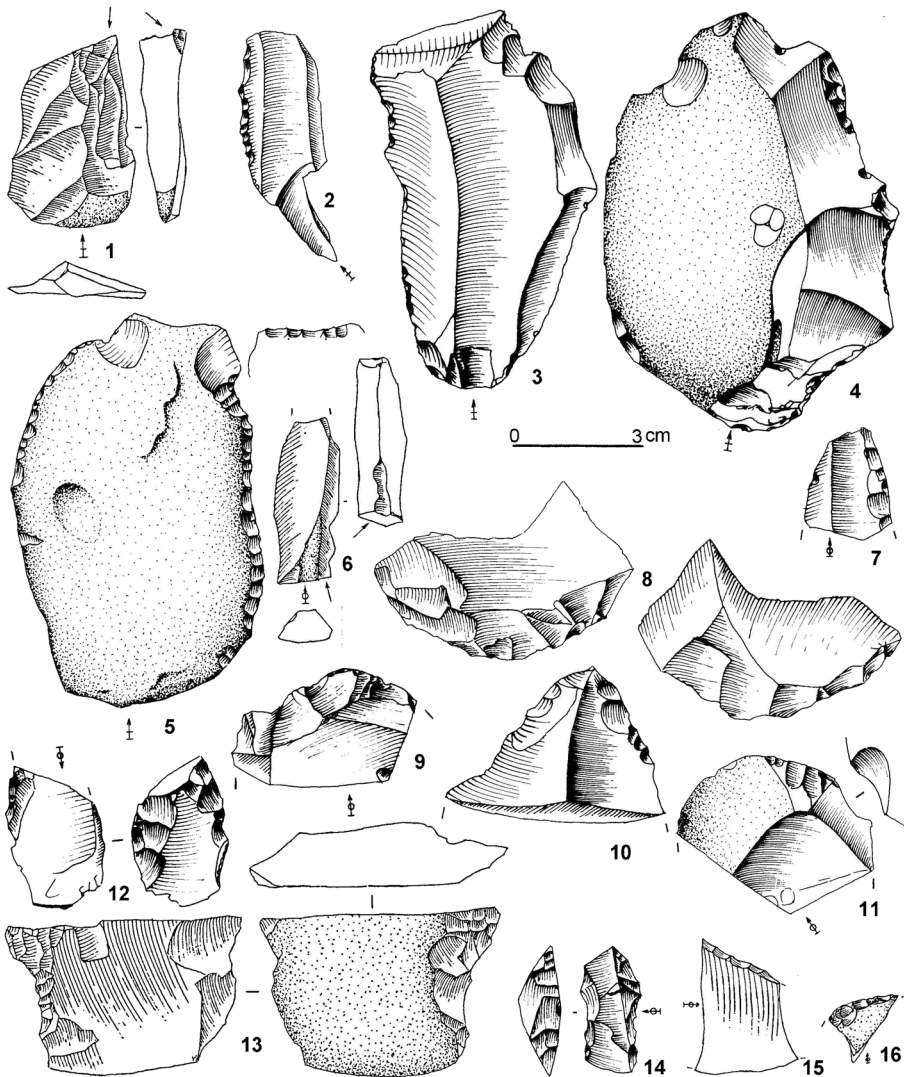
The numerous  $^{14}\text{C}$  dates suggest that artefacts from the C2 horizon can be dated to a period from about 6.2 to 5.6 Ka cal BC, whereas those from the C1 horizon may be assigned to the period from 5.4 to 5.0 Ka cal BC. The age of the artefacts from the youngest deposits is rather uncertain but a general terminus to the occupation may be placed around 4.3 Ka cal BC.

All the arrowheads were collected in the upper part of the Holocene levels with the exception of four items (Fig. 15: 1, 15, 19–20) that appear to be rather short triangular rough-outs. They are leaf-shaped and only partially bifacial. As they occur from archaeological horizon C2 onwards, it may be concluded that they were in use from at least 6.2 Ka cal BC.

### Ceramic Fabrics (Additional Data are Provided in Online Resource 3)

In the material collected from within the cave, different types of ceramic fabric can be distinguished. Nearly all of this material is in the form of very small sherds. Few rims and no base fragments were recorded.

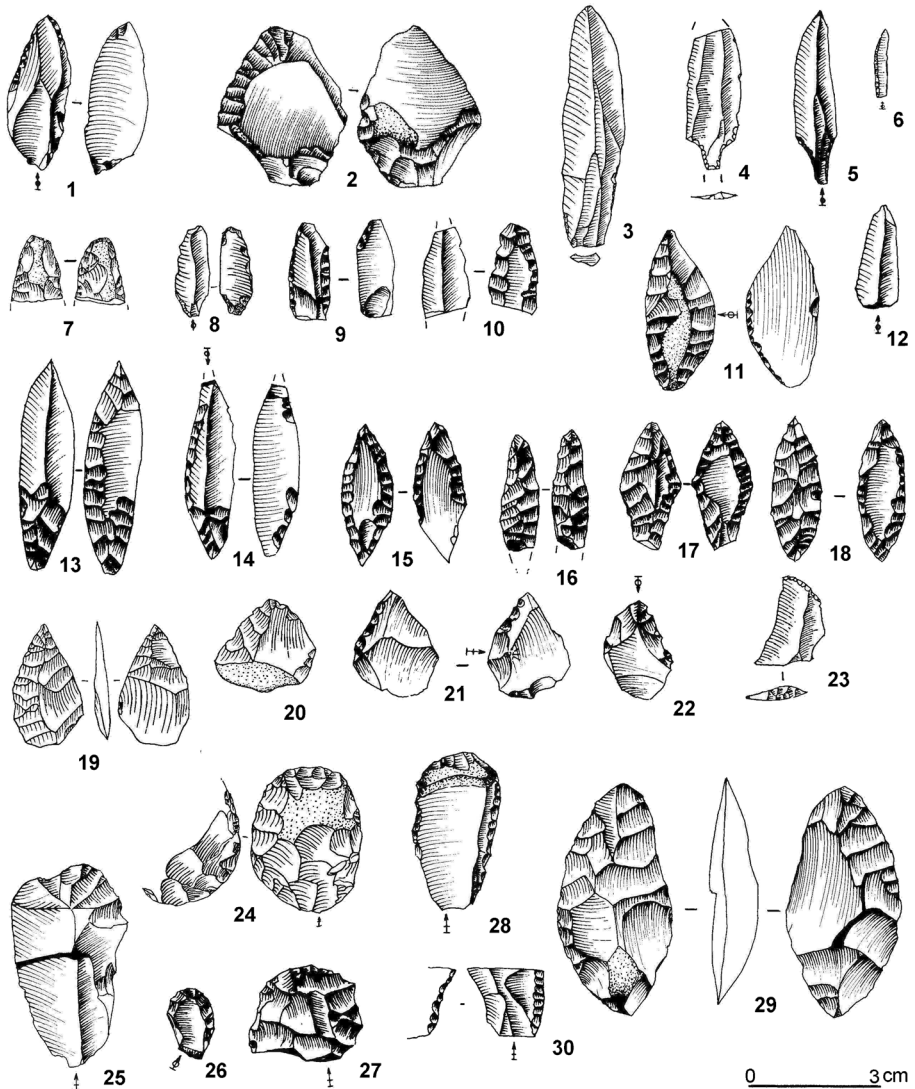
Most sherds were collected in the northern part of the cave and mostly in the A and the C1-deposits, where they can be associated with feature 111, which has an age of  $6148 \pm 38$  BP. The concentration of ceramic sherds in squares 25–27 N 2–4 W is mainly composed of a grey and a light red fabric (Fig. 19). It is almost impossible, because of the significant vertical scattering of the artefacts, to associate other sherds with specific features or tools. Many ceramic fragments are associated with the A-deposits, suggesting that they belong to a period posterior to 4.2 Ka cal BC date obtained from feature 207 situated at the basis of the A-deposits. As there are no absolute age indications for the end of the deposition of the A-deposits; a *terminus ante quem* is not available.



**Fig. 14** Retouched blanks. 1: burin on natural surface; 2: retouched blade; 3, 4, 9, 12: denticulated flake; 5: predynastic (?) cortical scraper; 6: burin on a break; 7, 11, 15: retouched flake fragment; 8: axe (tranchet) preparation flake; 10: pointed flake; 13: predynastic (?) retouched flake; 14: small flake axe; 16: end-scraper fragment

### Faunal Remains

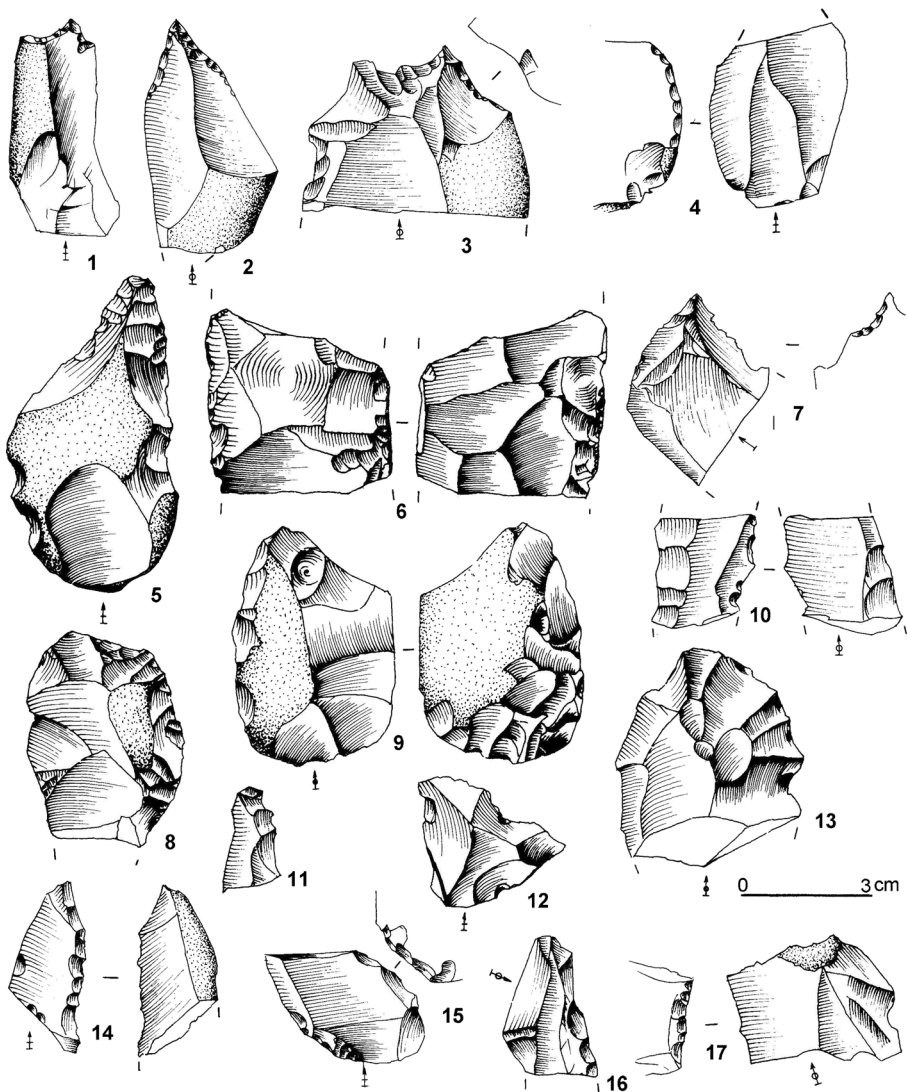
Since the publication of the initial results from the Holocene deposits at Sodmein, which mention the presence of caprine remains (Vermeersch *et al.* 1994), the site has often been cited in the context of the early spread of domesticated caprines in northeastern Africa and the African continent in general. While a report analysing the large amounts of animal dung found in the Sodmein Cave has in the meantime also become available (Linseele *et al.* 2010), a full description of the bone remains has never been published (Table 6). In view of their importance, the present report on Holocene



**Fig. 15** Retouched blanks. 1: arrowhead; 2, 20–22: arrowhead preform; 3: epipalaeolithic bladelet; 4–5: Ounan point; 6: backed bladelet; 7: bifacial arrowhead fragment; 8: stemmed arrowhead; 9–10: arrowhead preform; 11–12: arrowhead; 13–16, 18–19: bifacial arrowhead; 17: arrowhead (stemmed); 23: irregular trapeze; 24: bifacial end-scraper; 25, 28: end-scraper on a flake; 26–27: thumbnail-scraper; 29: bifacial foliate; 30: retouched flake

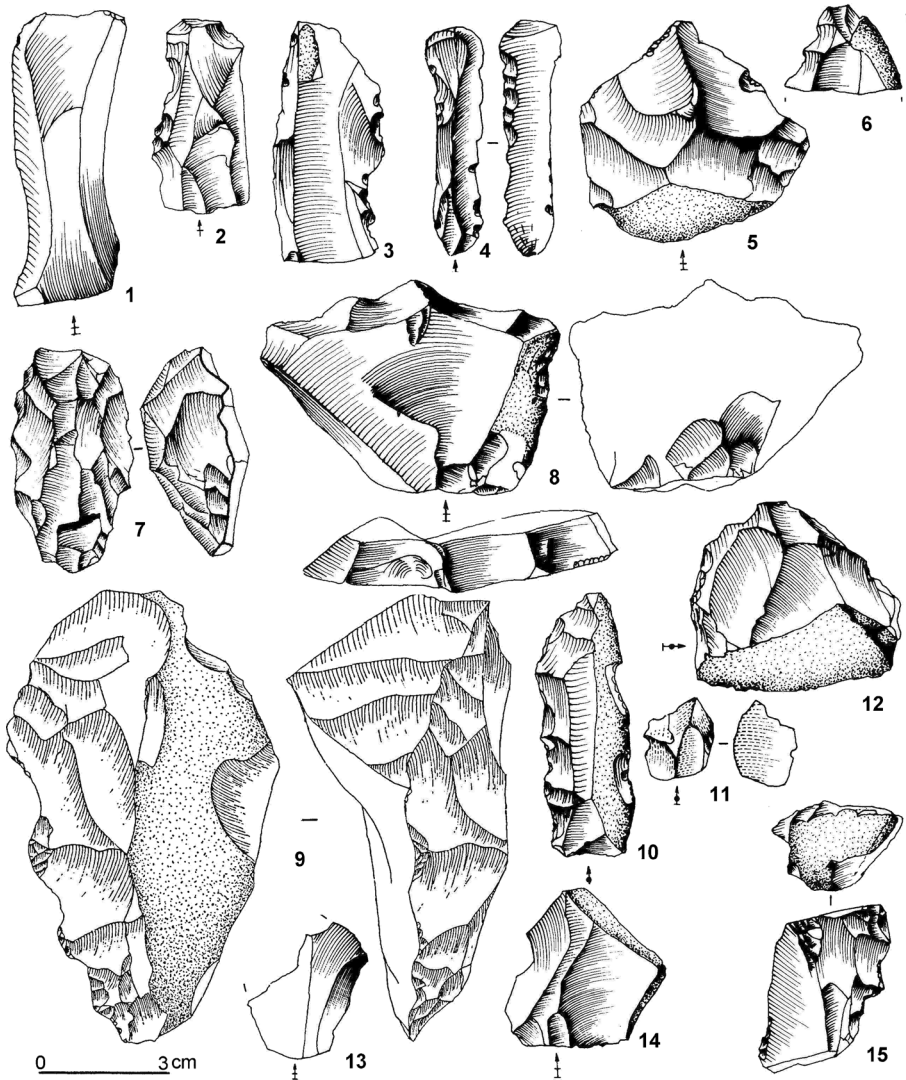
Sodmein will therefore provide the necessary details on the actual osteological evidence for domesticates (additional data are given in Online Resource 4).

Most of the faunal remains are presumably non-anthropogenic introductions to the cave, representing animals that may have lived and died there independently of its human occupation. These include various small taxa, the landsnails, amphibians, small lizards and snakes, birds, microbats and rodents. As shown by the find of a pellet with the remains of a minimum of three rodent individuals, small animals may also have



**Fig. 16** Retouched blanks. 1–2: borer; 3: notched flake or borer; 4, 11, 16: retouched flake; 5: large borer (Badarian?); 6: bifacial fragment; 7: inversely notched flake; 8, 12–14: denticulated flake; 9–10: bifacial preform; 15: retouched flake fragment or arrowhead preform; 17: inversely retouched flake fragment

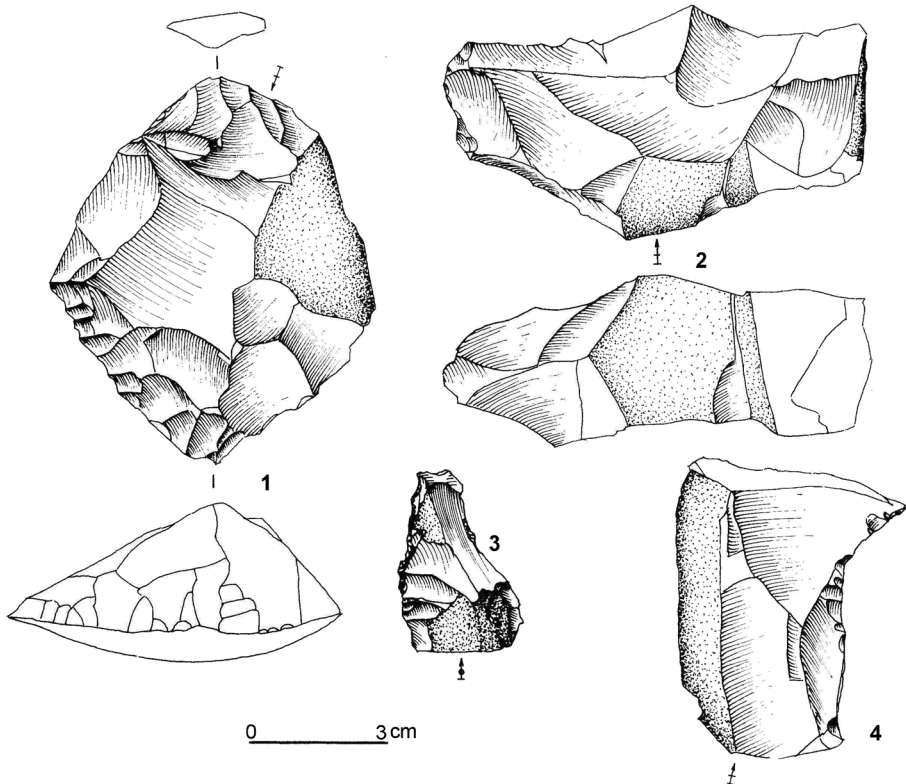
ended up in the cave through the activities of birds of prey. Animals that may have been partly hunted by humans include hare, rock dassie, cat, Rüppell’s fox, dorcas gazelle and possibly other small wild bovids, for example ibex (*Capra ibex*) or Barbary sheep (*Ammotragus lervia*). The find of 30 bones of presumably a single fox, suggests we are dealing with an individual that used the cave and died there without human interference, rather than with a hunted animal. The only fauna with a more probable anthropic origin are the Red Sea shells (*Dentalium* and cowry), the ostrich eggshell fragments and the domesticated caprines.



**Fig. 17** Retouched blanks. 1: blade; 2: denticulated blade; 3: denticulated flake; 4, 10: denticulated blade; 5: notched flake; 6: denticulated flake fragment; 7: multiplatform core or thick scraper; 8: denticulated end-scraper; 9: retouched plunging flake; 11: quartz flake; 12, 15: denticulated flake; 13: retouched flake; 14: notched flake

Osteomorphological and osteometric criteria for the differentiation of sheep, goat, ibex and Barbary sheep, described in Gabler (1985), were used as much as possible but frequently could not be applied on the more small and fragmentary remains. Attributions were generally done on the basis of morphology corresponding to sheep, goat, Barbary sheep or ibex, combined with small size, which allowed a wild species to be excluded. The domesticated caprines total only 10 bones for the entire Holocene sequence.

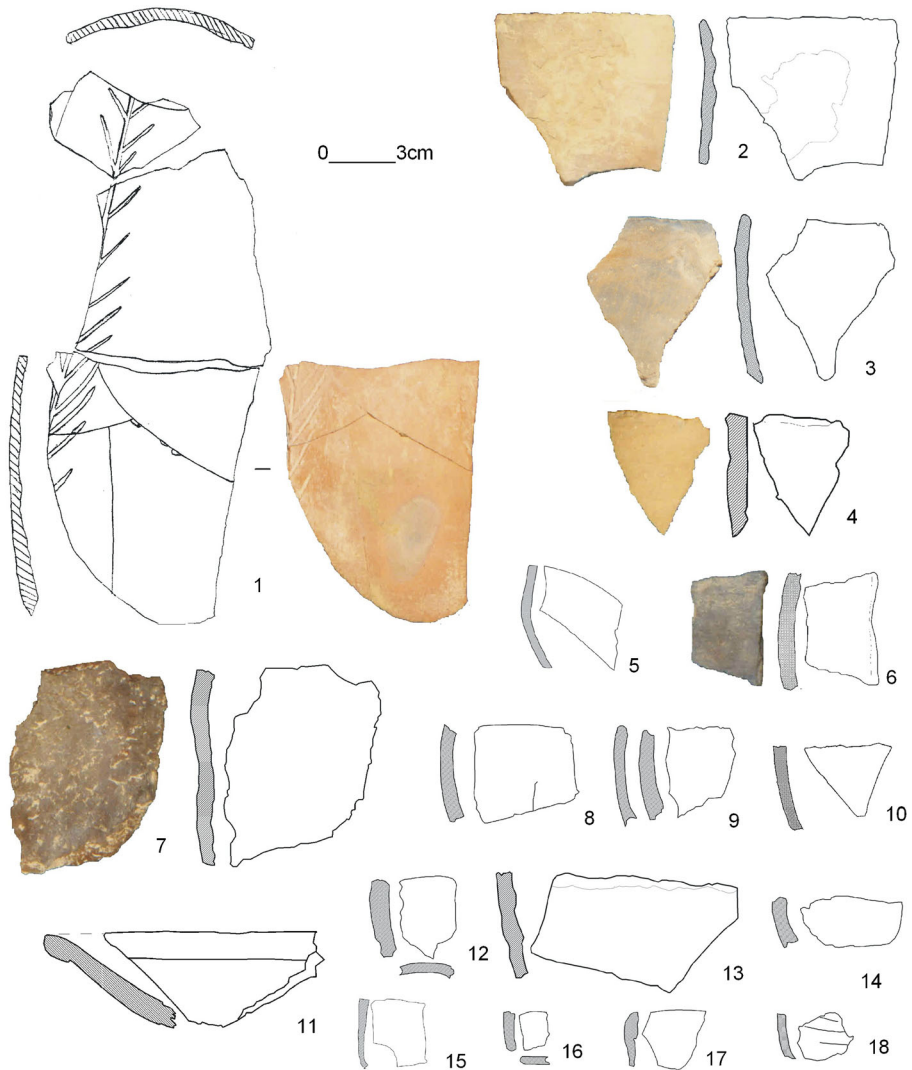
It is important to observe that the sheep/goat phalanx 1 (Fig. 20, k and l, ME99/01/252 and ME99/47/15; see Online Resource 4) is associated (same position) with feature



**Fig. 18** Retouched blanks. 1: thick scraper; 2: irregular core; 3: notched flake; 4: retouched flake

306 (Online Resource 2), which is clearly below feature 308 stratigraphically (Fig. OR2/33 and Fig. OR4/1) with a date of  $7250 \pm 40$  BP (6.2–6.0 Ka Cal BC). The sheep/goat humerus (ME99/12/36) and os femoris (ME/12/54) (Fig. 20e and f) are situated on a higher level (C1) and associated with feature 105 (Fig. 7 and fig. OR4/1), which has a  $^{14}\text{C}$  date of  $6475 \pm 35$  BP. From the stratigraphic position, it is clear that caprines are present from before 7250 BP.

The earliest evidence for caprines in the Western Desert was found at Hidden Valley site in Farafra Oasis, in contexts dated to  $7251 \pm 67$  BP (Gautier 2014). This means that Sodmein yielded the oldest caprines so far known from the African continent, introduced from at least 6.2 Ka cal BC. Gnawing by a medium-sized carnivore, either a wild species or dog, was observed on two caprine bones from Sector B (A/ C-deposits). With the exception of one goat scapula from the A-deposits, none of the caprine bones could be identified to species level (Fig. 20) (*cf.* (Boessneck *et al.* 1964)). Remains identified as small bovid, mainly tooth fragments, were not diagnostic enough to allow a distinction to be made between domestic and wild, small bovid species. In some cases, gazelle, which is the most slender of the small bovid species, could be excluded, resulting in identification as caprine, ibex or Barbary sheep. A category of unidentified large bovids was also distinguished. The few tooth splinters and the humerus proximal epiphysis fragment attributed to this category could represent either a wild species, for



**Fig. 19** Ceramics

example addax (*Addax nasomaculatus*), oryx (*Oryx dammah*) or domesticated cattle (*Bos primigenius* f. *taurus*).

All the animals recorded still survive in the area today (Osborn and Helmy 1980), and no significant environmental changes therefore need to be supposed. Rock dassie has now disappeared from the region as a result of extensive cutting of acacia trees (Osborn and Helmy 1980, p. 465). There are no obvious changes in the faunal composition from the oldest Holocene horizons to the younger ones

Organic deposits, mainly composed of dung, are especially extensive in the A-horizon, with an accumulation in the gully depression up to 50 cm thick, over a surface of at least 50 m<sup>2</sup>. Several combined arguments suggest that the dung deposits were produced by domesticated caprines: the size and weight of the individual pellets, the



**Table 6** Faunal remains recovered from the Holocene deposits at Sodmein, excepting dung pellets

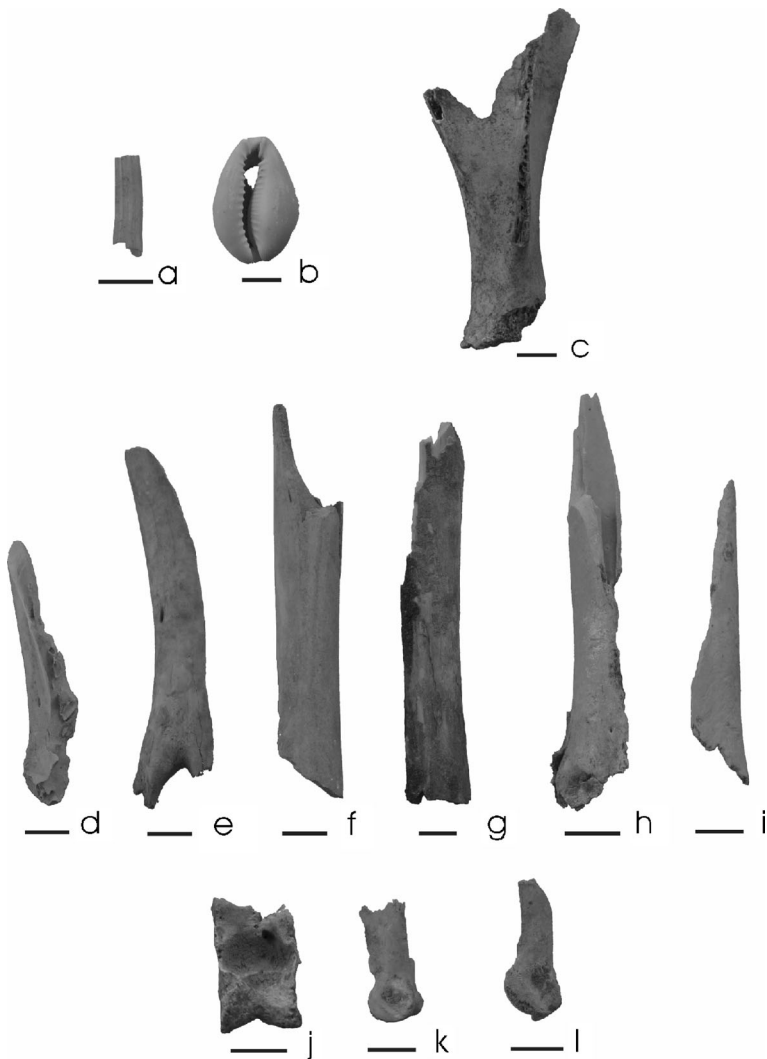
		A-B	C1	C2	Total	
Landsnails	<i>Zootecus insularis</i>	0	32	0	32	
Red Sea shells	<i>Dentalium cf. reevei</i>	0	1	0	1	
	Cowry (Cypraeidae)	0	1	0	1	
Amphibians	Frog or toad	0	2	0	2	
Reptiles	Small lizard (Agamidae?)-MNI	1	11	1	13	
	Small snake	0	2	0	2	
Birds	Dove ( <i>Streptopelia</i> sp.)	0	1	0	1	
	Swift ( <i>Apus apus</i> or <i>Apus pallidus</i> )	0	6	0	6	
	Small Passeriformes	0	1	0	1	
	Unidentified bird	0	11	1	12	
	Ostrich ( <i>Struthio camelus</i> ) eggshell	1	1	0	2	
Mammals	Pellet bird of prey	1	0	1 <sup>a</sup>	2	
	Hare ( <i>Lepus capensis</i> )	0	0	1	1	
	Microbats (Microchiroptera)	1	5	0	6	
	Shrew ( <i>Crocidura</i> sp.)	1	0	0	1	
	Small rodent-MNI	7	30	65	43	
		Of which Jird ( <i>Meriones</i> sp.)	1	0	0	
		Of which Gerbil ( <i>Gerbillus</i> spp.) (min. 3 species)	3	6	3	
		Rock dassie ( <i>Procapra capensis</i> )	6	5	5	16
		Cat ( <i>Felis</i> sp.)	0	1	0	1
		Rüppell's fox ( <i>Vulpes rueppellii</i> )-MNI	0	3	0	3
		Dorcas gazelle ( <i>Gazella dorcas</i> )	0	7	1	8
		Goat ( <i>Capra aegagrus</i> f. <i>hircus</i> )	1	0	0	1
		Sheep ( <i>Ovis ammon</i> f. <i>aries</i> ) or goat	2	3	4	9
		Sheep, goat, Barbary sheep ( <i>Ammotragus lervia</i> ) or ibex ( <i>Capra ibex</i> )	2	7	3	12
		Small bovid	4	102	15	121
		Large bovid	0	7	1	8
		Unidentified	126	586	46	758
	Grand total		157	831	87	1063

Unless otherwise indicated, the figures are numbers of identified specimens (NISP). It should be noted that compared to the preliminary species list (Linseele *et al.* 2010), additional samples have been included

MNI minimum number of individuals

<sup>a</sup> Containing remains of a minimum of two small rodent individuals

large quantities deposited and the presence of hearths and artefacts among the deposits, indicating animals under human management, and the species present among the Holocene bone remains (Linseele *et al.* 2010). Caprines were presumably penned in the cave, a practice that is attested both archaeologically and ethnographically elsewhere (see references in Linseele *et al.* 2010). However, Sodmein Cave is the first archaeological example from the Egyptian Eastern Desert.



**Fig. 20** Red Sea shells and bones identified as caprine from Holocene levels at Sodmein. **a** *Dentalium cf. reevei*; **b** cowrie—ventral view; **c** goat scapula—lateral view; **d** caprine scapula—lateral view; **e** caprine humerus diaphysis—caudal view; **f** caprine femur diaphysis—caudal view; **g** caprine tibia diaphysis—plantar view; **h** caprine metatarsal—dorsal view; **i** caprine metatarsal—dorsal view; **j** caprine talus, dorsal view; **k** caprine phalanx 1—side view; **l** caprine phalanx 1—side view. Scale bar=1 cm

### Plant Remains

Wood identifications were conducted on wood charcoal samples, mainly from hearth features (Table 2). For the analysis, all available wood charcoals bigger than 0.5 cm were selected and studied under a binocular microscope. Subsequently, identifications were made by production of fresh fractures on three surfaces (transversal, radial and tangential) and observing them under a reflected light microscope. In total, 1409 wood charcoal fragments were analysed, of which 892 proved identifiable. Almost 60 % of the wood available for analysis from the C2-deposits was unidentifiable, because of

strong alteration of its morphological structure (resembling “melting”). The study identified the highest diversity of wood charcoal taxa in the C1-deposits (Fig. 21). The wood assemblages from the C2-deposits contain the same dominant taxa (*Acacia*, *Tamarix*, *Salvadora persica*) as those of the C1-deposits. However, the fact that no other taxa are present is most probably due to poor preservation of the charcoals in this horizon.

Further information on the past vegetation is available from archaeobotanical analyses of dung pellets from Sodmein (Table 7). From the Holocene layers A and C, a total of 17 dung pellets have been analysed macrobotanically (Linseele *et al.* 2010). The methodology of Kühn and Hadorn (2004) was followed, with slight modifications. No pollen was found preserved and therefore no further palynological samples were prepared for study.

The plant macrofossils recognised in the pellets consist mainly of small seeds and wood material (Table 7). It should be noted that all of the identified plant taxa correspond to the natural vegetation and that cultivated crops are completely absent. Some larger fragments of wood could be attributed to Fabaceae, in two cases these most probably belong to acacia (*cf. Acacia*). In addition, seed fragments of *Acacia* were found. Most of the small seeds collected from the dung could be identified as Poaceae (including some Panicoideae) and Asteraceae (including *cf. Pulicaria* sp. and *Artemisia* sp.). A couple of seeds most probably belonging to salt-tolerant *Aizoon canariensis* were also present. In a few cases, small leguminous seeds (like *cf. Lotus* sp.) also appeared in the studied material. Other plant remains that could be recognised are leaf epidermis, leaf fragments, charcoals and fragments of seed testa/fruit coat. The leaves, wood fragments and the seeds of *Acacia* found in the pellets indicate browsing of the tree vegetation by the bovids that produced the dung. As wood charcoal analysis of the Tree Shelter site (Marinova 2008; Marinova *et al.* 2008) and of Sodmein (Fig. 21) has shown, *S. persica* was also used by the prehistoric visitors of the area. The leaves of *Salvadora* also make good fodder, as

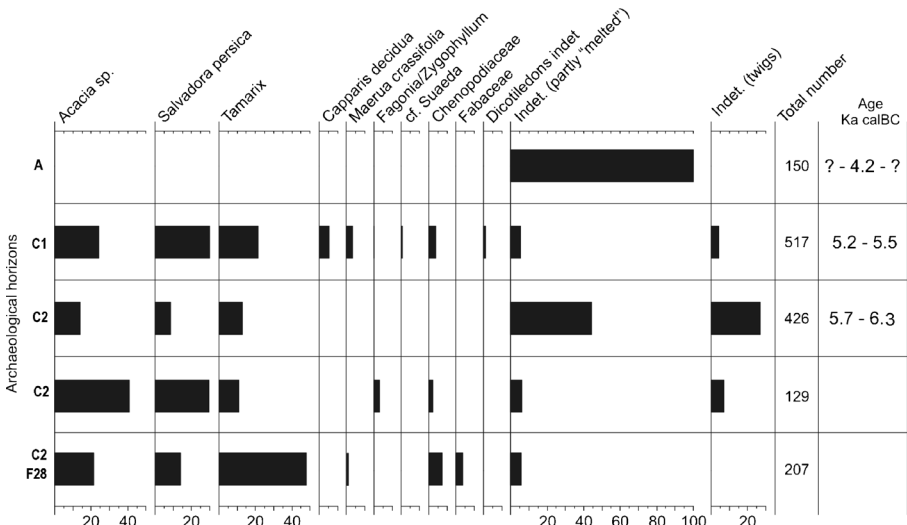


Fig. 21 Wood charcoal identified from the Holocene levels (mainly from hearth contexts—see Table 1) presented as percentage

**Table 7** Results of the macrobotanical analysis of dung pellets from the Sodmein Cave summarised for the Holocene layers (+: fewer than 10 items, ++: between 10 and 30 items, +++: more than 30 items)

Archaeological horizon	A-B	C
Number of studied coprolites	12	5
<i>Acacia</i> (seed)	1	–
<i>Acacia</i> (leaf)	4	2
<i>cf. Acacia</i> (wood)	–	–
Fabaceae (wood)	–	1
<i>Aizoon cf. canariense</i> (seed)	1	1
<i>Artemisia</i> sp. (achene)	1	4
<i>cf. Pulicaria</i> (achene)	10	4
Asteraceae (achene)	2	3
<i>cf. Geraniaceae</i> (fruit)	8	5
Fabaceae (seed)	2	–
<i>cf. Lotus</i> (seed)	–	1
Panicoideae (caryopsis)	3	1
<i>cf. Eragrostis/Sporolobus</i> (caryopsis)	18	10
<i>cf. Pennisetum</i> (caryopsis)	1	2
Poaceae (caryopsis)	15	3
<i>cf. Plantago/Veronica</i> (seed)	2	–
Small seed/fruit indet.	9	5
Fruit/seed fragment indet.	+	–
Leaf nerve	+	+
Wood fragment indet.	++	+++
Poaceae stem fragment	+++	++
Charcoal fragment indet.	+	–

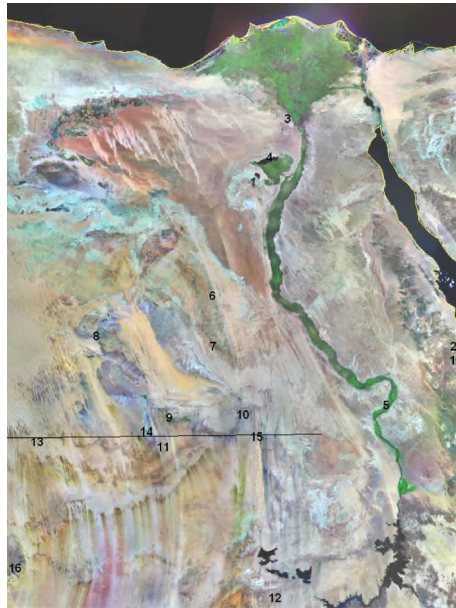
their water content is high (15–36 %) (Von Maydell 1986). Since it was not possible at the time to have a palaeobotanist working at the site during excavation, apart from the charcoals and the macroremains inside the pellets, no plant remains have been collected.

### Sodmein in a Wider Context

Assemblages of a similar date from the Eastern Desert or from the Nile Valley are almost entirely absent. Nevertheless, some groups in and outside the Nile Valley bear some resemblances with the Sodmein material (Fig. 22).

### Eastern Desert

Montenat (1986) observed, after a survey of the Red Sea coast, that Neolithic sites are almost entirely absent. Our knowledge of what happened during the Early and Middle Holocene is thus very restricted.



**Fig. 22** Early and Middle Holocene sites. Satellite picture (NASA Egypt A2004201\_0830\_250m.jpg) of Egypt with sites mentioned in the text: 1: Sodmein Cave, 2: Tree Shelter, 3: Merimde, 4: Fayum, 5: El Tarif, 6: Djara, 7: Abu Gerara, 8: Farafra, 9: Dakhla, 10: Abu Tartur, 11: Eastpans, 12: El Ghanam, 13: Regenfeld, 14: Chufu, 15: Kharga, 16: El Gouna. Horizontal line separates the northern from the southern area of the Western Desert

Several Holocene occupation horizons have been defined at the Tree Shelter site (Vermeersch 2008) within a time period between 7.3 and 3.7 Ka cal BC. The Tree Shelter site is situated some 3 km to the north of Sodmein Cave. The Epipalaeolithic Elkabian at Tree Shelter was well represented in horizon AH5 and had several small hearths dating from 7.1 to 6.5 Ka cal BC. This broadly coincides with the earliest Holocene Sodmein occupation (feature 310), which is nevertheless of an entirely different type from the Tree Shelter site features. The elongated Ounan points (Fig. 15: 4–5) recovered from the Sodmein deposits were apparently not fabricated using the microburin technique, and thus cannot be considered to be Abu Tartur points (Riemer *et al.* 2004). They have been  $^{14}\text{C}$ -dated to about 6.5 cal BC.

The lithics of AH3 at the Tree Shelter site (Vermeersch 2008), with ages from 5.7 to 4.7 Ka cal BC, are similar to those of the Sodmein C-horizon. Save for a side-blow flake, there are no major differences with Sodmein. The fauna from the Tree Shelter site is very comparable to that of the Sodmein Cave. However, microbats, typical cave fauna, are missing and remains of marine fish have been identified, whereas no fish were recorded from Holocene Sodmein (Linseele and Van Neer 2008; Marinova *et al.* 2008).

At Wadi Araba, near Bir Buerat, arrowheads, suggesting a PPNB connection, have been reported (Tristant 2010). They are similar to those from Sodmein. At Gebel Zeit (Dittmann 1990), several elongated leaf-shaped arrowheads and a stemmed arrowhead, both with bifacial retouch, similar to those from Sodmein (Figs. 15, 16–18), were found at site B. Our survey in Wadi Bili (Vermeersch *et al.* 2005a) found a small hunter-gatherer site dated to 4.7 Ka cal BC (GrA-23727) and a shell mound at El Gouna of

similar age. The archaeological material is, however, very limited. The Tasian material from Wadi Atulla (Friedman and Hobbs 2002) is dated to 4.7 Ka cal BC.

## Nile Valley

Merimde Benisalâme I is situated on the western edge of the Nile delta, and the *Urschicht* (Eiwanger 1984) is dated about 4.7–4.5 Ka cal BC, somewhat younger than the main occupation of Holocene Sodmein. The general structure of debitage products and tools is quite similar and simple: cores are mainly single platform cores, of which most are exhausted. Among the retouched artefacts, some bifacial tools are present. Some are borers and arrowheads (Eiwanger 1979), but large bifacial leaf-shaped artefacts, similar to those from Sodmein, are also present. The *Urschicht* ceramics are mostly thin-walled and characterised by an untempered fabric. Typical of this *Urschicht* pottery is a form of herringbone decoration, incised before firing, on some of the polished pottery. This decoration is similar to that of a decorated pot from Sodmein (Fig. 19: 1), although this is probably much older (6.5 Ka cal BC).

With an age around 4.5 Ka cal BC, the Fayumian (Wendrich *et al.* 2010; Shirai 2010) is younger than Sodmein. The Moerian is younger still.

The Tarifian at El Tarif (Ginter *et al.* 1979) in Upper Egypt is not well dated, but is seemingly older than the overlying Predynastic. A single date of 5.3 Ka cal BC (Gd-1756) is available from site MA 2/83 near Armant (Ginter and Kozłowski 1994). The knapping technique is simple, often without any preparation of the core. The main category of tool is the retouched flake. Side-scrapers are the second most characteristic lithic artefact. Twelve retouched bifacial tools can probably be interpreted as axes. It is significant that notches and denticulates are absent from the Tarifian record. The pottery fabric is primarily tempered with plant material. There is very little resemblance between the Tarifian and the Sodmein assemblages.

Although partially contemporaneous, the Shamarkian (Schild *et al.* 1968) is quite different from the Sodmein material. Although the Egyptian Predynastic is later than the Sodmein assemblages, its lithic industry is primarily flake-based with some bifacial tools and, as such, is similar to Sodmein.

## Western Desert

In the Western Desert, numerous Early and Middle Holocene sites have been excavated and dated (Wendorf *et al.* 2001; Gehlen *et al.* 2002; McDonald 2003). Many sites, belonging to the Egyptian Western Desert bifacial technocomplex, *Flächenretuschiertes Komplex*, present similarities with the Sodmein artefacts from the C-deposits. These similarities are best understood in relation to the Djara group. Djara is situated in the Western Desert on the Abu Muhariq Plateau at the latitude of Asyut (Kindermann 2010). The lithic material is characterised by opportunistic flaking, producing mainly flakes from single platform cores and is thus similar to the Sodmein debitage techniques. Tool types are rather similar to those from Sodmein and clearly belong to the bifacial technocomplex of the Western Desert. Kindermann (2010) stresses that it is rather difficult at Djara to attribute a specific arrowhead type to a specific time period since many such pieces are surface finds. The arrowheads from Djara 90/1, cluster 7, corresponding to Djara B with an AMS date of 5.9 Ka cal BC

(KIA-20681), are quite comparable to those from the Sodmein cave. However, facially retouched projectile points appeared for the first time in Djara A. The earliest radiocarbon date of 6.4 Ka cal BC (KN-4602) on the Abu Muhariq Plateau for facially retouched points comes from site Djara 90/1-2. Although bifacially retouched points occur during Djara A, the most characteristic forms are laterally retouched stemmed or lens-shaped points. Points with facial retouch are also known from the Bashendi A unit of Dakhla Oasis (McDonald 1992). However, a Masara C site, Loc 265, dating somewhat later than most Masara C sites, yielded tanged and leaf-shaped points, some with bifacial edge retouch (McDonald 2003). Tranchet axes, represented at Sodmein by a tranchet-preparation flake from C1, seem to occur exclusively as a tool type during Late Djara B (Kindermann 2010). Side-blow flakes, regarded as characteristic of Late Djara B, but already present during Early Djara B, are lacking at Sodmein but were present at the Tree Shelter site in AH3 (5.5–5.3 Ka cal BC) (Vermeersch 2008). No grinding implements were found at Sodmein and the Tree Shelter site, whereas in the Western Desert they are clearly attested from Djara A onwards (Gehlen *et al.* 2002).

Pottery does not occur at Djara A sites, apart from a few thin-walled shards, which might have parallels to fabrics from the Late Bashendi A in Dakhla (Hope 2002; Kindermann 2004; Riemer and Schönfeld 2010). It seems that the Djara B pottery fits best with the majority of the Sodmein pottery. According to Gehlen *et al.* (2002), there is a clear typological similarity between Djara B and the late Bashendi A (6.4–5.7 Ka cal BC) at Dakhla Oasis (McDonald 1991, 1992) and also with the Neolithic assemblages of Kharga (Caton-Thompson 1952) and Farafra (Barich and Hassan 1987). Such sites from the Egyptian Western Desert, belonging to the bifacial technocomplex, also present similarities with Sodmein. Shells of the Nile bivalve *Aspatharia* sp. (also called *Spathopsis* sp. or *Chambardia*) provide evidence for contacts between Djara and the Nile Valley (Kindermann and Bubenzer 2007). The presence of a pair of cowry shells at site 270 (McDonald 2013) suggests contact also with the Red Sea area.

The sites from Regenfeld, Abu Jerar, Mudpans, Gilf, Nabta Playa and the sites occupied by the Ruat el Ghanam mixed pastoralists, which lie south of a line at latitude 25.5° N (Fig. 24), clearly belong to another facies characterised by transverse arrowheads and other geometries.

Domesticated caprines probably appear slightly later in the Western than in the Eastern Desert and have been found at several sites dated to the sixth millennium BC (Gautier 1984, 2014; McDonald 1991; Churcher *et al.* 2008; Pöllath 2010). In contrast to older sites in the Western Desert, large faunal samples have been recorded for KS043 in the Kharga Oasis (4.8–4.4 Ka cal BC) (Lesur *et al.* 2011). These are mainly composed of domesticates, which, in order of decreasing importance, comprise sheep, goat and cattle.

## Palaeoenvironmental Conditions

The cave deposits are thought to have remained under very dry conditions since their sedimentation (Moeyersons *et al.* 2002).

The Early Holocene seems to be a period when a wetter climate is most likely. In the Eastern Sahara, at this latitude, it seems that the wettest period was around 7.0 Ka cal BC (Moeyersons *et al.* 1999; Wendorf *et al.* 2001; Kuper and Kröpelin 2006). At the Tree Shelter site, humans (Elkabian) exploited the desert around 7.0 Ka cal BC (Vermeersch 2008) and yet by 5.7 Ka cal BC the Elkabian deposit (AH5) had been partially eroded by wadi activity. At Sodmein, the anomalous absence of Elkabian may be explained by the likelihood that, posterior to the Pleistocene deposits, an erosive phase created the depression filled with the main archaeological zone deposits. Despite this erosion, an Elkabian human presence is attested by the presence of some bladelets and backed bladelets of a typical Elkabian type (Vermeersch 1978) and by the age of feature 310. The erosional event created the base of the present day Holocene deposits. The erosional event may be dated between 7.0 and 6.2 Ka cal BC.

The final part of this period coincides with a drought event recorded at Lake Tana and other East African lakes (Marshall *et al.* 2011). The period between 6.5 and 6.2 Ka cal BC seems to coincide with the cold and dry 8.2 Ka event (*ca.* 6.3 Ka cal BC) known from the Greenland ice cores (Thomas *et al.* 2007), which is most probably pancontemporaneous with the dry event of the Post-Al Jerar Arid Phase (Schild and Wendorf 2013). The Holocene 8.2 Ka event in the Egyptian Eastern Desert was apparently too dry and inhospitable for humans.

Starting from 6.2 Ka cal BC, an important accumulation of mass movement (C-deposits) with a high content of organic material was created. Many successive visits by humans are attested by the lithics, ceramics, faunal remains and excavated features.

After 5.3 Ka cal BC, the gully depression was created due to an exceptional erosional event. The fill of the gully (A- and B-deposits) is mainly characterised by an accumulation of caprine dung, suggesting use of the cave for the stabling of domestic animals. Apparently, these people did not introduce any other significant archaeological remains. There seems to be another kind of utilisation of the cave before and after the 5.3 Ka cal BC period. Or, more probably, there were far fewer people visiting the area. In the filling deposits, hearths are clearly less numerous. As soon as it became very dry, after 4.2 Ka cal BC, no humans used the cave; indeed it would seem that very few people ventured into the desert. At the best of times, the valleys of the Eastern Desert were a low, thorn-tree and sparse grass savannah landscape of semi-desert type: much better than the degraded, acacia palimpsests of today, but hardly a habitat for large herds or plentiful pastoralists. Full, contemporary aridity was established in the Eastern Desert by 3.6 Ka cal BC (Wilkinson *et al.* 2004).

Between approximately 7.5 and 6.1 Ka cal BC, the northern Red Sea Mountains registered substantially higher rainfall and freshwater runoff, which thereafter decreased to modern values (Arz *et al.* 2003). In an earlier stage in the study of Holocene climatic phases in the Eastern Sahara, Barich and Hassan (1987) suggested a succession of several wet and dry phases. However, the radiocarbon dates from that area do not indicate any rupture in regional climatic development between 7.0 and 5.3 Ka cal BC (Kuper and Kröpelin 2006). Nevertheless, it is beyond discussion that an important cultural change occurred between the Epipalaeolithic and later occupation of the Eastern Desert, with an absence of visitors during the Holocene cold and dry 8.2 Ka event. The question of whether some cultural changes may have taken place for reasons related to that climatic event cannot yet be resolved.



## Economy

Microwear analysis on stone tools from the Elkabian of the Tree Shelter site indicates mainly hide working and hunting activities (Kweakason 2008). The presence of domestic sheep or goat in the Elkabian levels of Tree Shelter is very unlikely (Linseele and Van Neer 2008; Marinova *et al.* 2008). Sodmein Cave does not provide more information regarding the economic activity of the Elkabian visitors. The economy of such visitors probably consisted solely of hunting and gathering.

The occupants of the C-deposits from Sodmein and of the Tree Shelter AH2 and AH3 horizons might be characterised as mobile livestock keepers. As such, they can be considered as Neolithic (Linseele and Van Neer 2008). These groups engaged in animal husbandry, and no indications of agriculture are present. Admittedly, the collection of archaeobotanical data was not ideal, but considering the archaeobotanical record from contemporary sites (*ca.* 7 to 4 Ka cal BC; see Fahmy 2001; Wasylukowa 2001; Thanheiser 2011), no evidence for agriculture or agricultural products is to be expected. Even grinding stones, present at Bashendi (McDonald 2013) and Djara sites (Kindermann 2010), are absent. Could this be related to an absence of grain collecting?

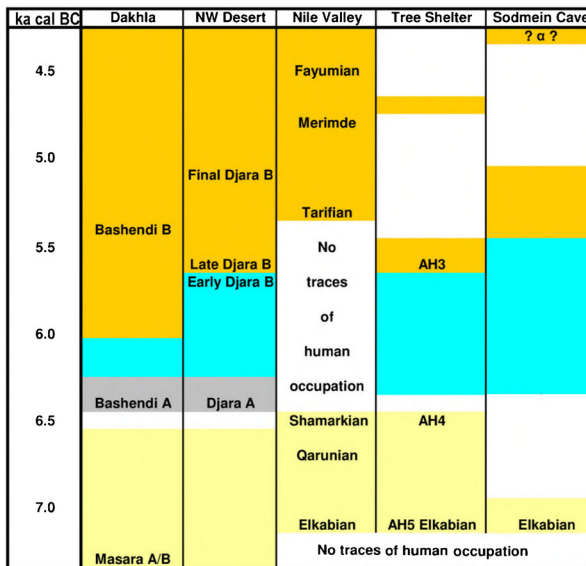
In general, there is very little evidence for meat consumption at the sites, whether of wild or domesticated animals. Only 10 bones could be attributed to domesticated caprines. The large size of the dung accumulations in the A and B-horizon suggests that the size of the herds was larger than would be suspected from the scant bone remains found. Nevertheless, very large herds need not be presumed, as repeated visits after 5.0 Ka cal BC could also have produced the observed accumulations. The use of ephemeral vegetation for the livestock herds was probably the main reason for visiting the Sodmein Cave. Both Sodmein and Tree Shelter were presumably used repeatedly, but for short periods only, as places where livestock was temporarily sheltered. The lack of human food remains may be largely due to the ephemeral nature of the occupation. In addition, the livestock could have been kept for milk, rather than for meat. As has been shown for Eurasia (Vigne and Helmer 2007), milk may have had an important economic role already at the beginning of the Neolithic. Its extensive use has been proven for the fifth millennium BC in Libya (Dunne *et al.* 2012). Does the presence of arrowheads point to the importance of hunting in the Neolithic?

Despite the scarcity of bone remains, the presence of domestic caprines at Sodmein Cave is of great importance for the early history of the dispersal of these animals in the African continent. The remains are present from the oldest Holocene deposits onwards (*i.e.*, the C2-deposits). This indicates that caprines were present from about 6.2 Ka cal BC in the area, from at least 6.2 Ka cal BC, possibly earlier than in the Western Desert. The animals were domesticated in an area encompassing the Northern Levant and the Zagros Mountains (Muigai and Hanotte 2013) and spread from there. Because of the very limited bone evidence for early caprines in northeastern Africa, a reconstruction of their routes of dispersal must remain very tentative, with various possible dispersal routes, from the Western Desert or over the Red Sea Coast, or even *via* the Nile Valley to the Sodmein area (Riemer and Kindermann 2007). It is assumed here that sheep and goat dispersed together, but it should be emphasised that goat is the only one of the two represented by diagnostic remains at both Sodmein and the Tree Shelter site (Linseele and Van Neer 2008, Linseele *et al.* 2010).

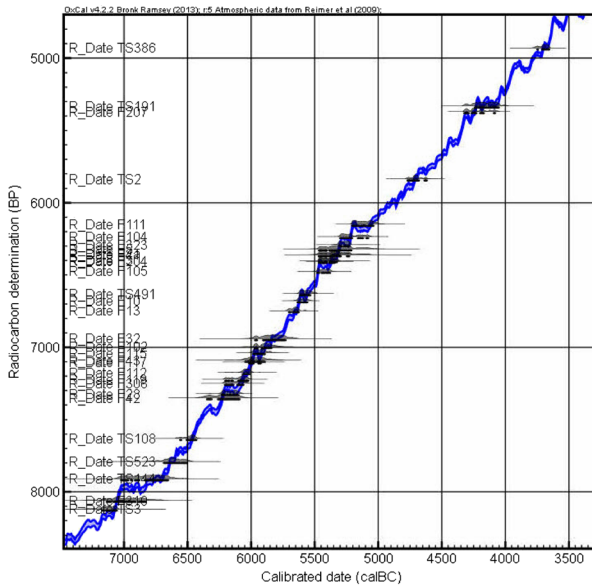
### Conclusions

The Holocene prehistoric remains are attributed to hunter-gatherers of the Elkabian and for the later occupants to groups of herders. The presence of numerous arrowheads could suggest that the herders were also hunters, but this cannot unequivocally be confirmed through the faunal remains. When analysing the series of <sup>14</sup>C dates from Sodmein and the Tree Shelter site, several periods of Holocene geomorphologic events and human occupation phases can be defined (Figs. 23 and 24) from early to late:

1. An Elkabian occupation phase around 7.1 Ka cal BC which left several occupation horizons at the Tree Shelter site (Vermeersch 2008) but from which at Sodmein only a single feature (F310) was preserved together with some scattered artefacts. At the Tree Shelter site, it continues to be present up to 6.6 Ka cal BC. Gehlen *et al.* (2002) have observed that mid-Holocene occupations of the Western Desert evidence a strictly flake-orientated tool production, which replaced the elaborate blade and bladelet technology of the Epipalaeolithic. This replacement, attested at Djara at 6.4 Ka cal BC (Kindermann 2010), is clearly present at the Tree Shelter site and Sodmein Cave only from a somewhat later time period (6.3 Ka cal BC).
2. An erosional event occurred, presumably between 6.5 and 6.2 Ka cal BC. This time period coincides also with a drought event in the upper reaches of the Nile (Marshall *et al.* 2011). The period between 6.5 and 6.2 ka cal BC seems also to coincide with the cold and dry 8.2 Ka event (ca. 6.3 Ka cal BC) known from the Greenland ice cores (Thomas *et al.* 2007). That Holocene 8.2 ka event in the Egyptian Eastern Desert was apparently too dry and inhospitable for humans.



**Fig. 23** Chronological position of Holocene sites in Egypt. Chronological (<sup>14</sup>C) position of different Holocene archaeological units in Egypt. *Yellow*: Epipalaeolithic, *Grey*: start of the Egyptian bifacial technology, *Blue*: start of herding, *Orange*: presence of ceramics (image in full colour online)



**Fig. 24** Calibration of the Sodmein (*F*) and Tree Shelter site (*TS*)  $^{14}\text{C}$  dates using OxCal v4.2.2 (Bronk Ramsey 2009)

3. An occupation by mobile stock-keepers with caprines is mainly centred on a time period of 6.2–5.8 Ka cal BC. They used lithics, which fit within the north-western bifacial technocomplex, and they probably did not use ceramics. Caprine excrement is always present but did not build up thick accumulations.
4. A period of some centuries (5.8–5.4 Ka cal BC) seemingly coincides with reduced visitation of the site, as far as may be supposed from the reduced number of  $^{14}\text{C}$  dates available.
5. A renewed occupation between 5.4 and 5.0 Ka cal BC by herders with caprines, lithics of the same north-western bifacial technocomplex, but this time apparently with some ceramics.
6. An important erosion event posterior to 5.1 Ka cal BC, creating the gully depression (Fig. 9) in Sodmein Cave.
7. New groups of herders visited the cave. They sheltered herds of caprines in the cave, depositing a thick layer of excrement in the gully depression at Sodmein. The exact time period and the duration of this fill is unknown but F207, with an age of about 4.3 Ka cal BC, suggests a time period that could coincide with the  $^{14}\text{C}$  dates at the Tree Shelter site at 4.3 and 3.7 Ka cal BC (Vermeersch 2008).
8. After those later visits, the caves remained deserted for a very long time period.

In many regions of the Western Desert, there is a clear drop-off in the number of  $^{14}\text{C}$  dates just after 5.4/5.3 Ka cal BC. This reflects the beginning of a trend towards hyper-arid conditions, which led to a depopulation of the desert after 5.0 cal BC (Kuper and Kröpelin 2006). In the Eastern Desert, desertification seems to occur somewhat later. This situation is probably related to the presence of the Red Sea Mountains where orographic rainfall might have been frequent.

A fundamental change in technology and blank procurement for tool production, visible in the transition from the Epipalaeolithic to Djara A around 6.5 Ka cal BC, is also observed in the Red Sea area, where the presence of the new technology is attested at all younger sites, such as Sodmein Cave, the Tree Shelter site (Vermeersch 2008), the Wadi Bili Neolithic site (Vermeersch *et al.* 2005a) and the El Gouna shell mound (Vermeersch *et al.* 2005b). Is there a connection between this change in technology and the cold and dry Holocene 8.2 Ka event?

In the Western Desert, cultural traditions are divided by a north-south, rather than a west-east change in material diversity (Fig. 22). The Egyptian North-Western Desert and Eastern Desert share similar cultural traditions. The basic motor behind this cultural spread may have been the climatic gradient between the northern and southern Sahara, primarily differences in the distribution of summer-winter rain.

**Acknowledgments** The Netherlands-Flemish Institute in Cairo took care of all administrative duties in Egypt and provided us with housing while in Cairo.

We have always enjoyed good collaboration with the representatives of the Supreme Council of Antiquities. They truly facilitated the administration in Cairo, permitting us to be in the field within just a few days after our arrival in Egypt. We could rely on the Qena inspectorate for assistance, and the inspectors assigned to our team were very helpful. They co-ordinated our contacts with the local population and solved all kinds of problems that so often occur during excavations. Special thanks go to M. Hussein Ahmed Hussein El Afuni, chief inspector at Qena, who became a good friend during the many years we worked in the area. The motivation and good temper of the local workmen were a relief in the sometimes harsh desert work environment.

We thank many students who were very helpful in the field and in analysing the archaeological materials. The authors are moreover indebted to M. Van Meenen for artefact drawings, and to J. Meersmans for taking care of our equipment. The contribution of Wim Van Neer to this paper presents research results of the Interuniversity Attraction Poles Programme-Belgian Science Policy. Veerle Linseele is a postdoctoral research fellow of the FWO-Flanders. A final word of thanks goes to all our helpful colleagues, especially to Dr. P. Van Peer and Dr. E. Paulissen, for field work and critical discussions, and to the two anonymous reviewers who gave us some very good advice.

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