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Arabian archaeology and epigraphy

New insights into desert kites in Armenia: the fringes of the Ararat Depression

The Armenian kites are the northernmost known kites in south-west Asia. In contrast to those in the deserts further south, their research has only recently begun. The Armenian kites are situated at high elevations, mostly between 900 and 1500 m above mean sea level, in steppic conditions where *Artemisia* is at present the dominant shrub on the landscape. In our ongoing project we excavated three V-shaped kites and one enclosure kite. The two kinds are similar in construction details, but they differ in size and location: the former run down into gullies, while the latter were placed on the plateau. Six OSL ages suggest terminal Late Bronze Age and Early Iron Age construction dates, while geomorphological considerations and surface artefacts suggest earlier dates. A preliminary palynological study suggests a gradual increase in grazing-resistant vegetation since the mid-Holocene, probably reflecting human impact on the natural vegetation through the herding of grazing animals.

Keywords: desert kites, Armenia, architecture, OSL dates, vegetation change

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I. Introduction

Desert kites have been a well-known archaeological phenomenon for about ninety years. The first studied kites were in eastern Jordan, Syria, Israel and Sinai. Later, additional investigations were carried out in these regions, as well as in new ones such as Saudi Arabia and Yemen (Avner 1987; Bar-Oz *et al*. 2011; Barge *et al*. 2013; Betts & Helms 1986; Betts *et al*. 1998; Betts & Yagodin 2000; Brunner 2009; Échallier & Braemer 1995; Holzer *et al*. 2010; Fowden 1999; Kempe & al-Malabeh 2010, 2013; Kennedy 2011, 2012; Kennedy & Bewley 2009; Kennedy & Bishop 2011; Kobusiewicz 1999; Maitland 1927; Meshel 1974, 2000; Bonacossi & Iamoni 2012; Nadel *et al*. 2010, 2013; Rees 1929; Van Berg *et al.* 2004; Zeder *et al.* 2013; and see also this volume). Further into Asia, the first studied area was the Ustiurt plateau in Uzbekistan (Yagodin 1998). In this respect, a vast area in between has barely been studied. In recent years, two research groups turned to these expanses of west-central Asia, focusing on Kazakhstan (Crassard *et al*. 2014) and Armenia (Brochier *et al*. 2014; Gasparyan *et al*. 2013). The results of our ongoing work in Armenia are the subject of the current paper (Fig. 1).

In this paper we aim to present our research results focusing, as case studies, on three small kites and one enclosure kite. We address their cultural, topographic and geographic settings, past environments and the architecture of each kite with particular attention to the location and construction details of the head. Importantly, there are too few detailed reports addressing the architecture of kites, and it is our contention that such reports should be the best platform for local and regional studies and syntheses. Thus, our paper provides construction data in text, photographs, plans and sections. Dating the kites—a major issue—is addressed here by using a variety of methods that include OSL (optically stimulated luminescence), geomorphological considerations and artefact identification. We will also use this opportunity to draw some very preliminary comparisons of the studied Armenian kites with other kites in south-west Asia, in particular those in the Negev with which we are well acquainted.

II. Methodology

In order to study a sample of kites in Armenia, we designed a framework that included several steps. The first was a reconnaissance survey of a variety of sites in the region. At this stage we used the thorough knowledge of Boris Gasparyan, who has surveyed and excavated in the region for several years. We also used Google Earth images and walked the landscape for several days.

The second step was to define a study area. Thus, a 10 x 8 km rectangle on the northern fringes of the Ararat Depression was chosen (Fig. 1). It includes a variety of kites, a huge area with dense dwellings, graveyards and ceremonial sites, several round 'towers', cairns and a wealth of petroglyph sites, all well preserved on the landscape.

The third step was to choose sites for excavation. These included three small V-shaped kites, one enclosure kite, a ceremonial complex and a grave. This paper does not address the latter two.

In each of the studied kites we conducted excavations in the kite's head, in order to create a full section through the fill, expose construction details and establish the geomorphological setting of the head. The same approach was followed along the arms, and in each kite several trenches were excavated across them. Furthermore, samples for micromorphology, pollen and OSL studies were collected. A survey of each kite was conducted on foot, documenting annexed features and collecting material remains. A general survey of the vicinity of each studied kite was also performed.

Importantly, we specifically wanted to study examples of the two major kite types, namely the V-shaped kite and the enclosure kite (Bar-Oz & Nadel 2013). The first is the funnel-like structure, with two arms leading diagonally to an enclosure below a cliff or small vertical drop. According to common knowledge, these were used for killing the target game. The second type is much larger, with an enclosure that has several cells or heads. These appear to have been used as corrals and not as immediate killing devices (ibid. and references therein). Both types are present in the selected study area.

III. The studied kites

A. General

As stated above, the Armenian kites were not studied until very recently. According to the work of the first research project here, there are at least 173 kites in Armenia (Brochier *et al*. 2014). These are found mostly in western Armenia, in an area measuring *c.*2000 km^2 and in relatively high altitudes—between 900 and 1500 m above mean sea level.

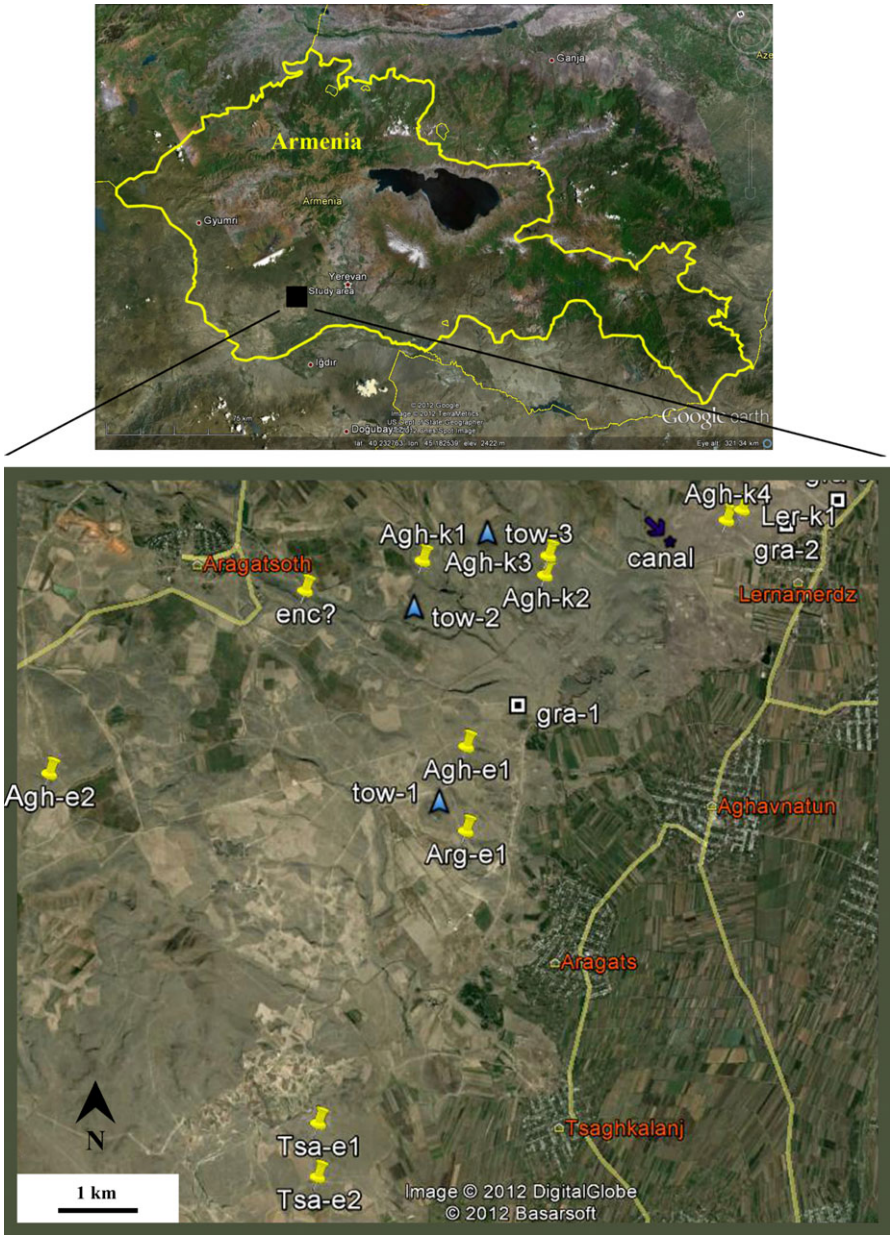

Fig. 1.
Google Earth images of Armenia and the study area with major sites (kites are marked by yellow pins; the canal is long, partly hewn in the bedrock; names in red denote modern villages). Key: gra – grave; k – killing kite; e – enclosure kite; tow – tower (Google Earth 2014, Avghanatun Region, Armenia).

Our study area includes a wide range of archaeological sites, characterized by distinct spatial patterns. The valley floor (Ararat Depression) has arable land and thus is currently cultivated, with villages located exclusively here. The surrounding hills and slopes, actually the piedmont of Mount Aragats, accommodate the kites and many other sites. The slopes are almost barren, covered by basalt outcrops and boulders, with *Artemisia* covering the landscape but trees totally absent. The lowest part of the slopes, immediately above the valley floor, is the richest in terms of site density. In the study area, a stretch several kilometres long encompasses a continuous complex, with dwellings, graveyards and ceremonial sites (Fig. 2). This complex has only been partially studied; it may be a palimpsest representing a long history of occupation, with some sites contemporaneous with the adjacent kites.

Fig. 2.
A typical landscape of the ecotone between the arable land and current villages on the valley floor; the archaeological sites are concentrated on the adjacent barren slopes. The people seen in the photograph are part of our research group, excavating the Lernamerdz complex 1 site (a ceremonial site) in July 2013.

Some kites are only a few hundred metres from the valley floor. Thus, a rich and varied cultural landscape is present by the valley and beyond, and the dating and association of particular site types with past cultural entities are yet to be established.

B. Aghavnatun 2 kite

General

The kite is situated on a moderate slope descending to the north (easting: 44.2290°; northing: 40.2356°). The head was built below a natural topographic step. The bedrock is volcanic tuff; it is present as almost flat outcrops in the middle of the kite, and to the east as detached boulders on the slopes and as flat cracked exposures and blocks along the wadi bed.

The kite includes two converging walls and a round head (Figs. 3 & 4). The walls have been disturbed by modern works and only their lower parts, near the head, are preserved. An exceptionally large isolated boulder, now broken into several pieces, is located at the upper part, closer to the left arm. The upper half of this arm is damaged due to modern works. Excavations focused on the head; additionally, two trenches were dug in the 'bottleneck' where the arms converge before reaching the head, and three outside the kite.

A thorough survey was undertaken of the entire kite area and the immediate surroundings, up to 50 m from the arms. Three pottery sherds (medieval in age) were found near the large boulder by the upper left arm, and several very crude stone implements made of dacite, which are probably not contemporaneous with the kite, were found within the kite area.

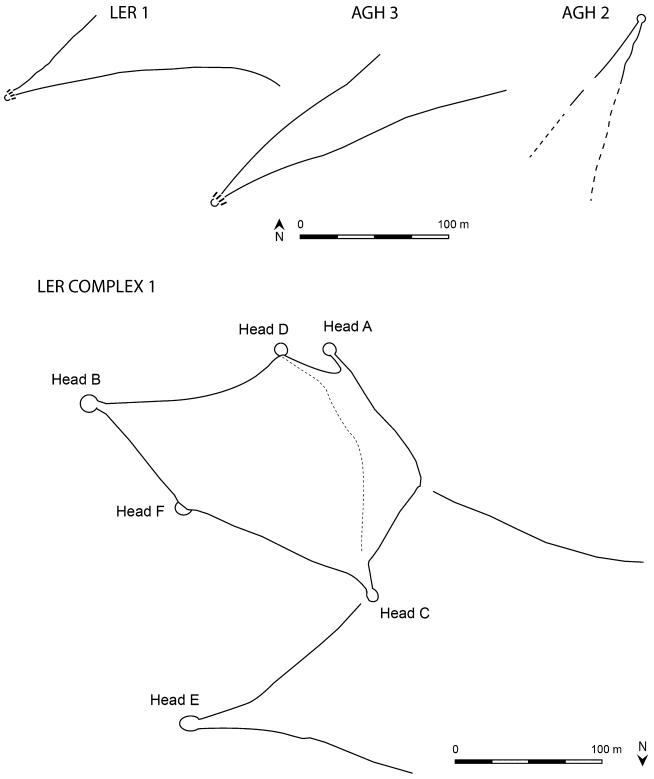

Fig. 3.
Plans of the three killing kites (top) and the enclosure kite (bottom) studied in this project. Head E is considered part of the complex, although it was probably an independent killing kite.

Fig. 4.
A view of Aghavnatun 2 kite from the north; archaeologists can be seen excavating at the head.

THE HEAD

The head is situated immediately above a dry watercourse that runs to the east; its measurements inside are 6.1 x 4.6 m and it is built of round and angular boulders. A few stones and some sedge were scattered on the surface; no material remains were visible. The western half was chosen for excavation as the wall here looked better preserved. The excavation created a north–south section within the head (Locus 1, Fig. 5).

The sediment was routinely sieved. Out of more than 3 m^2 excavated, *c.*75% was sieved. Finds were very scarce, with isolated pieces of obsidian being the most common.

The head was constructed as a round feature, mostly of a double wall of boulders. The southern upper side—the jump—took advantage of a natural line of large boulders. They were either used as found on the landscape or, more probably, several were shifted to create a tight row and thus form a steep drop. A trench was also dug into the steep slope to accommodate a solid wall. This is most apparent in the south-west part of the head, where one foundation boulder was set *c.*0.4–0.5 m below the surface. The evidence is present both in the section showing the bottom of the boulder (Fig. 6), and in the heights of the natural layer in the head and all the trenches excavated outside the kite (see below).

The construction stones took the form of either oval boulders found on the slopes or angular blocks found in the adjacent wadi bed. Both types were found in the wall of the head. The round ones are much more common, however, while the angular ones were usually placed only in chosen locales. This may represent either the distance from the nearest source of angular blocks or construction desires. The head was built of at least two courses, usually more. Many of the stones have collapsed inwards; they formed a dense fill adjacent to the walls and a more defused density towards the middle (Fig. 7). Some of the stones that collapsed outwards probably rolled down-slope and are no longer close to the walls.

Within the west wall a unique set of stones was excellently preserved. It includes three courses, with two blocks at the bottom and an oval boulder at the top (Fig. 8). The top element is the largest in the head, and small stones were set between the large ones to consolidate the three courses. Setting the largest component at the top, and its long-lasting preservation there, reflects a special desire for a massive wall component.

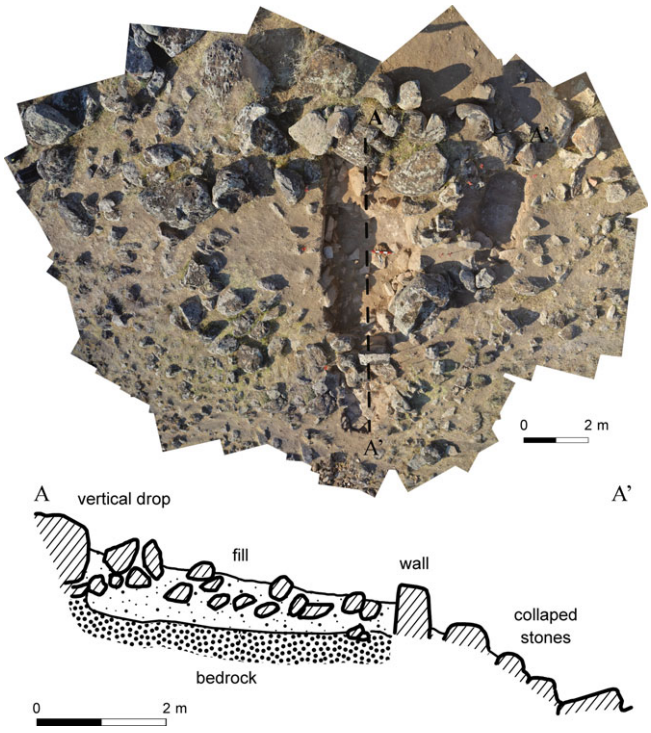

Fig. 5.
An overhead view and a section of the head of Aghavnatun 2. The animals would have been driven into the head from the top (overhead view) or the left (section).

Fig. 6.
The foundation trench of the head wall seen from inside looking south-west (Aghavnatun 2). (Scale bar 20 cm).

Fig. 7.
The trench through the head of Aghavnatun 2, looking north. Note the inner side of the head wall with a huge boulder on top (left), the collapsed stones and a circle (around the scale bar). (Scale bar 0.5 m).

Interestingly, a circle of stones was constructed inside the head, adjacent to this unique portion of the wall (Fig. 9). One stele was also preserved within this circle, and two potentially additional specimens found immediately above. The round feature and the stele(s) are definitely later than the original head wall, if it was used as a hunting device. Thus the circle, stele and probably also the largest top boulder represent a secondary utilisation phase of the head, most probably symbolic and not directly functional.

The bottleneck

An east–west trench was excavated between the two arms where the neck is narrow (3 m wide, Locus 2). The trench

Fig. 8.
The western wall of the Aghavnatun 2 head seen from inside. Note the two courses of angular blocks, upon which was placed a huge boulder supported by several pebbles. (Scale bar 20 cm).

Fig. 9.
An overhead view of the head of Aghavnatun 2 during excavation. The large boulder on the left is the one seen in Figure 8. Note the stone circle around the scale bar and the stele (triangular stone, left of scale bar).

was located to include large boulders set on edge in the two arms (Fig. 10). The section shows that the wall was constructed on a hard natural yellow surface composed of a dense layer of pebbles and cobbles, with boulders set on edge. A deeper pit was excavated and a crude dacite tool was found *c.*0.6 m below the surface. The post-construction fill is 25–35 cm thick.

Trenches outside the kite

The aim of opening trenches outside the kite was to correlate observations inside the head (Locus 1) to the natural characteristics of the slope. The locations were chosen partly randomly, 21 m to the east and 30 m to the west of the head. In both pits (2 x 1 m) stones larger than 15 cm were scarce. The yellow stony surface was reached in all, enabling reconstruction of the past surface and its inclination; no finds were observed in these trenches.

The arms

The walls were constructed of one row of boulders, some set on edge; very few collapsed stones were found nearby (Fig. 11/a), indicating that the walls were mostly one boulder wide and one boulder high. The left arm is badly disturbed by modern work and its upper part is missing. A

Fig. 10.
A section by the right arm of Aghavnatun 2. The wall was constructed on a hard stony layer, and the post-construction fill is 25–35 cm thick. (Scale bar 0.5 m).

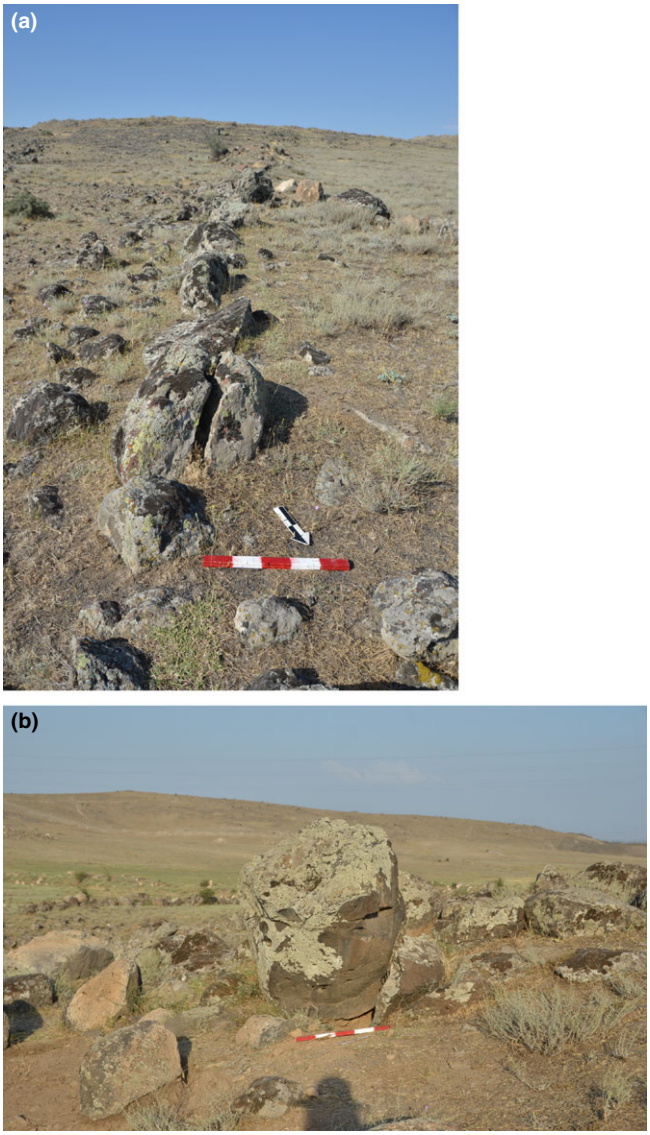

Fig. 11.
The left arm of Aghavnatun 2. **a.** looking upwards; **b.** a close-up of the large isolated boulder by the top part of the arm. (Scale bar 0.5 m).

large boulder, almost 1 m high, was found by the left arm, inside the kite and near the head (Fig. 11/b); it may have been set there by the hunters, although the purpose remains unknown.

C. Aghavnatun 3 kite

The kite is located *c.*400 m from kite Aghavnatun 2, leading south-west to a cliff (Fig. 12). The arms are 260 m and 240 m long. Both kites are set in the same wadi, although in opposite directions. Below the head, and only several metres away, there is a complex of structures in the wide wadi. On the channel itself there appear to be several dams and a long canal leads from here downstream.

The head was constructed below a cliff, using huge boulders set on a steep slope. A small test pit revealed no finds. A huge boulder was set on edge, at the proximal end of the left arm, just above the cliff.

D. Lernamerdz 1 kite

General

In terms of density and variety of archaeological sites, the Lernamerdz 1 kite is situated in the richest location within our study area. Along the arms there are several tombs and stone circles of various types. At the top of the hill (east) there are petroglyphs associated with ceremonial sites; on the slopes to the south and south-east there are many stone circles, tombs and rock-art locations; and in the foothills, just above the valley floor, along a stretch of more than 2 km there is a high density of structures, enclosures, tombs and ceremonial sites. We excavated one ceremonial site and one tomb here. A wall more than 1 km long (almost continuous) begins by the distal end of the left arm and runs to the east with many sites annexed to it. These

Fig. 12.
Aghavnatun 3, leading to a cliff. Note the boulder set on edge at the end of the left arm, just above the cliff (marked by an arrow).

include—beyond the hill on which the kite is built—a series of square enclosures.

The kite is located less than 1 km from the nearest village. It has a general east–west orientation, with the arms descending into a natural basalt cliff (Figs. 3, 13). The head is built in a steep narrow gorge. The arms are built on a slope, with various features annexed or adjacent to them; the left arm is 82 m long, the right arm 91 m long. There are two hides (?) along the right arm. The lower is set several metres outside the kite providing a view into the lower part of the kite; the higher one is set on the arm providing a view into the upper part of the kite. Further up there is a structure on a natural knoll near the left arm. A cairn immediately below the head may represent a tomb.

We excavated a trench through the head (Loci 1, 2), and opened three trenches along the walls (Loci 3–5), a pit in what may have been a hide (Locus 6) and a pit in a robbed tomb (Locus 7).

Fig. 13.
A Google Earth image of Lernamerdz 1. A wall annexed to the left arm continues for more than 1 km (beyond the image). (Google Earth 2014, Lernamerdz Region, Armenia).

The head

The head was set under a cliff of natural basalt boulders, some of them more than 1.5 m long. The head is almost round, with inner dimensions of *c.*4.5 x 4 m. A round dark stone feature was visible within the head, at its lowest western side. It had a diameter of *c.*1.5 m. The dark appearance was due to the large proportion of stones covered with lichen.

The southern half of the head (Locus 1) was excavated from the cliff to the opposite wall and down to bedrock (Fig. 14). During the clearance of the collapsed stones, it became apparent that the dark circular feature had no clear construction boundaries around or below it. It may have been a natural phenomenon or a late infilling by humans. Below the collapsed stones and embedded in the fill sediment we found several bones that appear to be fresh. They include those of a fox and a large bird (the size of a stork), and probably represent a medium-carnivore lair. The verti-

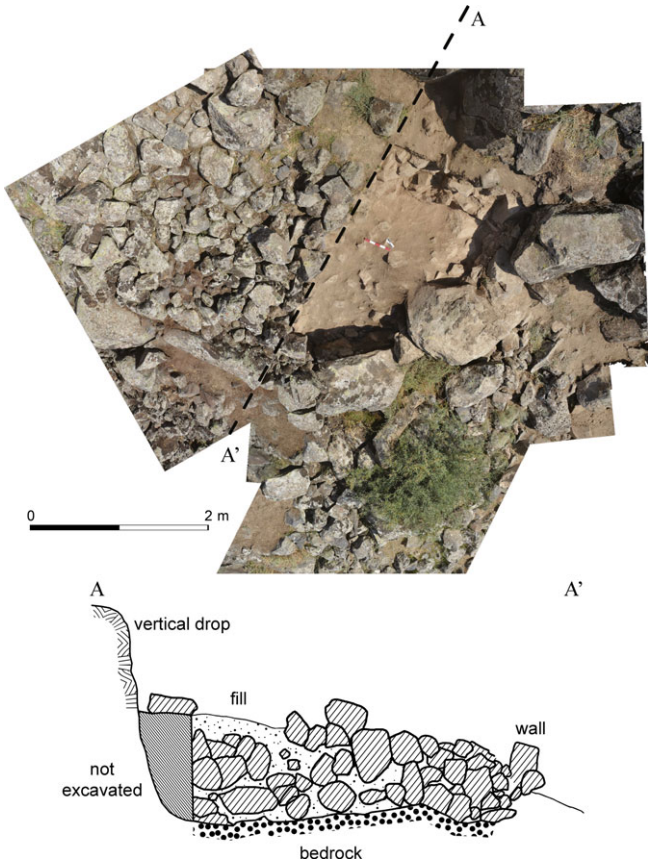

Fig. 14.
An overhead view and a section through the head of Lernamerdz 1. The animals would have been driven into the head from the top (overhead view) or the left (section).

Fig. 15.
The head of Lernamerdz 1 during excavation, looking north-east towards the cliff. (Scale bar 0.5 m).

cal drop from the surface between the arms into the head was about 2.5 m (Fig. 15).

Trenches by the arms

Three trenches were excavated along the arms. They all show that the walls were constructed on a slope different in inclination from today, with a hard compact surface. The walls were mostly 1–4 courses high and 1–2 courses wide (Fig. 16). According to the adjacent collapsed stones they were not much larger at the time of use. Soil accumulation by the walls varies, in some cases reaching 20–30 cm.

A hide (?)

A stone feature built on a basalt outcrop is located *c.*10 m outside and to the north of the right arm, about 45 m from the head; it could have served as a hide for one person (Fig. 17). The inner dimensions are irregular, *c.*1.2 x 1.5 m, and the wall was up to *c.*1 m in height when found. We excavated inside and found isolated modern artefacts and an obsidian flake. According to lichen and patina colour, at least some of the stones were only recently incorporated into the wall. Originally, it may have served as a hide for the hunters, when driving game into the trap.

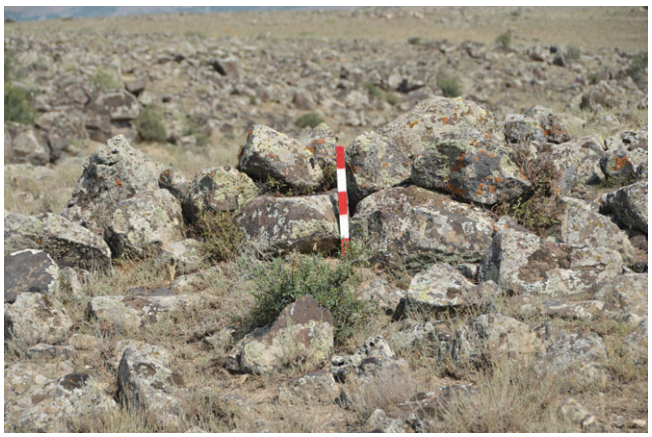

Fig. 16.
Lernamerdz 1: construction details of the right arm. (Scale bar 0.5 m).

Fig. 17.
A hide (?) adjacent to the right arm of Lernamerdz 1. The narrow excavation pit (bright colour) yielded an obsidian flake and modern artefacts. (Scale bar 0.5 m).

A robbed tomb

A robbed tomb was found above and to the north of the right arm. We cleaned the pit and sections; originally it was only 0.4 m deep. The tomb was elongated although it was not possible to obtain an exact plan and sections. Some Middle Bronze Age pottery sherds were scattered in the rubble.

Stone circles

Two stone circles were observed adjacent and outside the right arm between the hide and the head, each 1.5–2.5 m across. Similar circles were observed on the nearby slopes. In most cases, soil accumulation was very shallow, indicating that the circles are much later than the kite. There is no doubt that a comprehensive survey and the use of high-resolution aerial photos will reveal additional features.

E. Aghavnatun enclosure 1 kite

General

This site is the largest complex studied by us so far. It is situated about 2 km south of the Aghavnatun 2 and 3 kites (easting: 44.2177°; northing: 40.2358°). It includes a major

Fig. 18.
A Google Earth image of Aghavnatun enclosure 1. (Google Earth 2014, Aghavnatun Region, Armenia).

enclosure with at least five heads and several long walls that total 527 m in length, and an annexed northern part which is an independent V-shaped kite (Figs. 18, 19). The site is in a high setting, mostly on a small plateau surrounded by gentle slopes. None of the heads is built in a wadi course or on a steep slope, and none of the arms runs into a wadi course.

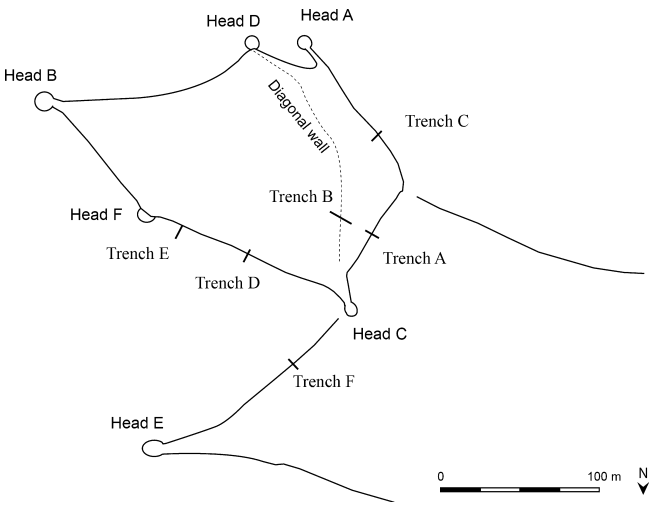

Fig. 19.
A plan of Aghavnatun enclosure 1. Heads A, C and E were excavated and six trenches (A–F) were cut through the walls. Samples for OSL dating were collected from Trench B and Head E, samples for palynological investigation were also collected from Trench B.

There are several natural basalt outcrops in the area, in the form of small knolls protruding above the surroundings and composed of boulders. Some of the walls run between these outcrops, and some of the heads are incorporated in or annexed to them. There are no water sources within the site, although water may have been available in the nearby north gorge and further below towards the valley. The area of the enclosure is 16,700 m^2.

Head A

This is the southernmost head in the complex. The head was built above a small cliff, at the end of an elongated basalt outcrop. Below the cliff the slope descends steeply to the south. Inside the head there was a large pile of stones. Some boulders, more than 1 m long, were conspicuous on the top of this pile. Several were leaning one on the other, forming a loose line from the cliff into the head. They may represent an event of collapse such as an earthquake, although it is possible that in this case the head was filled with stones and boulders taken from the walls and surroundings in order to 'block' it.

Locus 1 is the north-eastern half of Head A, cleared and excavated to bedrock and below (Figs. 20, 21). The fill contained large boulders at the top, and boulders and stones embedded in aeolian yellow sediment below. Under these was a hard white layer with compact stones. The other half was cleared of boulders and the top stones, while the stones within the aeolian layer were left intact.

The head measures 4.1 x 3.9 m inside, and is built of a double massive wall, well preserved in most parts. The original width was about 2 m, with the largest boulders forming the inner face. The wall was constructed as an annexe to a basalt outcrop composed of *in situ* boulders forming a small natural cliff. The largest boulder in the lower course of the wall is about 1.5 m wide and set directly opposite the vertical drop. In front of it, set on edge, was a slab (45 x 23 cm; Fig. 22). It was the only one of its kind found in the head and it has been termed a stele.

The bottleneck leading to the head is narrow, with the two almost parallel walls running 3–5 m from each other. In the neck, just before the left arm curves away to the north-east and towards Head D, there are two sets of stone circles adjacent to the right arm. They are 1–2 m in diameter and both have a stone set on edge in their centre (Fig. 23).

The right arm, at the entrance to the neck, represents two construction methods. Outside, as part of the enclosure wall and away from the head, it is simple and low with 20–40 cm-long stones as the common construction

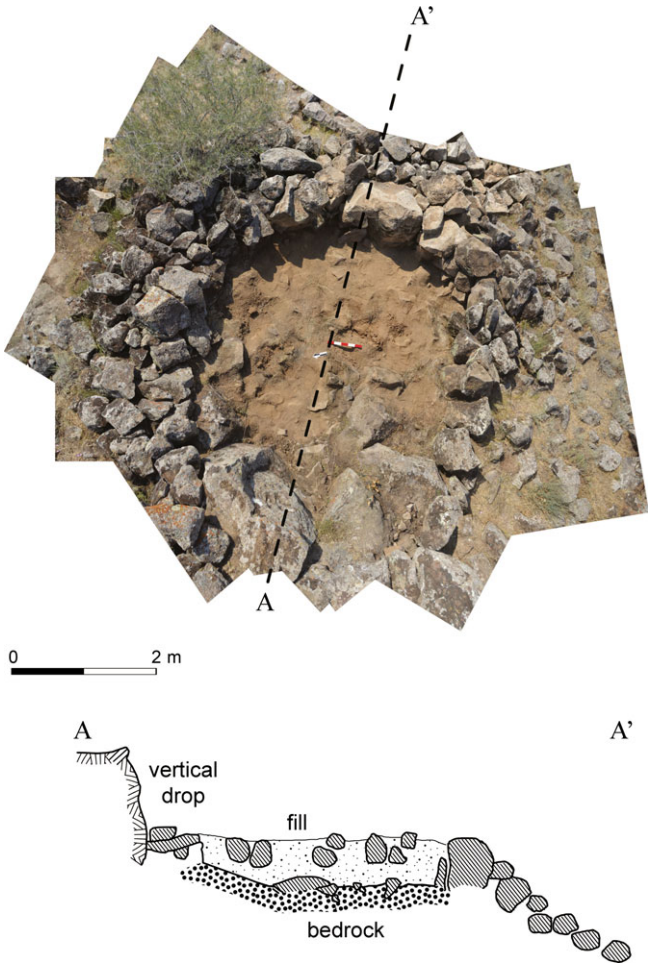

Fig. 20.
An overhead view and a section of Aghavnatun enclosure 1, Head A. The animals would have been driven into the head from the bottom (overhead view) or the left (section).

Fig. 21.
A view of Aghavnatun enclosure 1, Head A, looking north.

Fig. 22.
A view of Aghavnatun enclosure 1, Head A, looking south-east. In front of the largest boulder in the wall there is a thin slab set on edge (left of scale).

components, preserved one course high and several stones across and relatively diffused. Along the neck itself the wall is more massive in terms of boulder size, and it is mostly two-course high with a very clear line.

North-east of the head, a cairn was found on the wall between Heads A and D and the only one observed directly on a wall in any of the studied sites. The feature was almost round, with a 1.3–1.5 m outer diameter (Fig. 24). The two courses were removed and the natural basalt outcrop was reached. Between the lower stones there were patches of aeolian yellow sediment. The wall on which the cairn was built was lower here, with some stones missing. Here there seems to have been a late con-

Fig. 23.
A disturbed stone circle in the bottleneck of Aghavnatun enclosure 1, Head A. A large central stone is visible in the middle with several smaller collapsed stones. (Scale bar and arrow both 20 cm).

Fig. 24.
Aghavnatun enclosure 1: the cairn on the wall between Heads A and D during excavation. (Scale bar 0.5 m).

struction of a round stone feature on the wall, using the stones of the wall. No finds were encountered.

Head C

Head C is located on a natural basalt outcrop. It has a narrow neck, *c.*1 m wide, opening down into the enclosure, as well as a wall leading down to Head E. For animals driven from the enclosure into the neck the head was not visible, as they had to pass a very shallow ridge first. The head is actually an elongated feature (2.2 x 1.6 m) with one side being the natural basalt outcrop, to which a massive wall was annexed (Fig. 25). It is the smallest at the site in terms of area and not as deep as the other heads.

Most of the fill in the structure was excavated and sieved (Fig. 26). The feature had a later wall built inside. The loose construction method and the presence of various types of lichen all over the stones indicate that this is a very late wall. It is possible that many of the original wall stones were used for the later inner wall, with the result that the top and middle of the original massive wall are missing.

We reached the uneven basalt bedrock in most of the structure. It would appear that for people or animals entering from the enclosure (e.g. from the south-east), the bottom was only two stone courses below the surface, with no steep vertical drop (Fig. 27). This is the only such feature at the site.

Finds include the isolated bones of a bird, a rodent and a young (?) sheep. Sheep coprolites were retrieved from depths of 15–40 cm; one was dated to the twentieth century (^{14}C; E. Boaretto, personal communication, July 2014). Some obsidian specimens were also recovered.

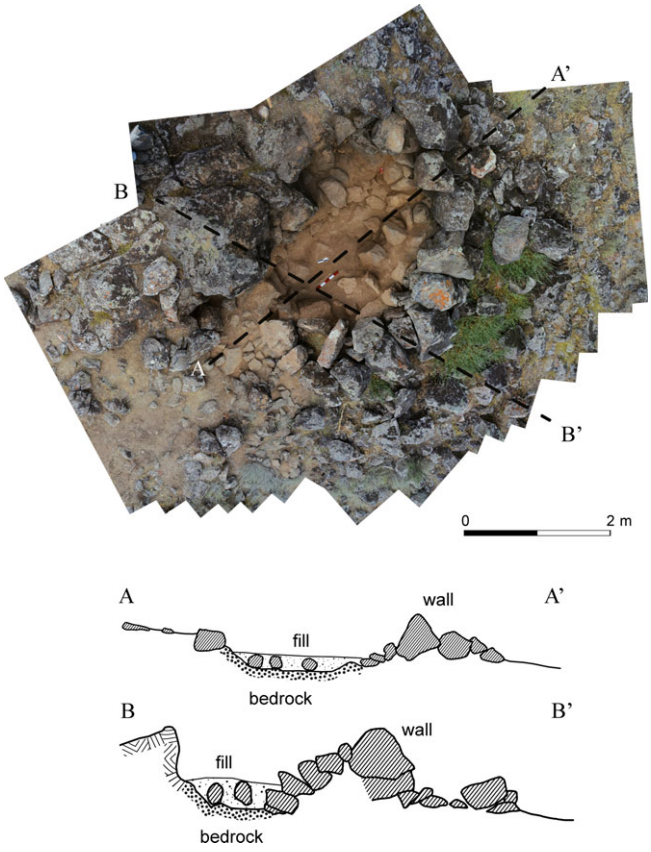

Fig. 25.
An overhead view and a section of the Aghavnatun enclosure 1, Head C.

Fig. 26.
The entrance to Head C, Aghavnatun enclosure 1, before excavation but after clearing away the late wall and the collapsed stones. (Scale bar 0.5 m).

The bottleneck leading to Head C is narrow, with two walls converging and running almost parallel near the head. Some unclear stone circles were visible on the surface.

Fig. 27.
Aghavnatun enclosure 1: looking south-south-east towards the inner 'step' of the Head C structure. The step is two-course high and built directly on the uneven basalt bedrock.

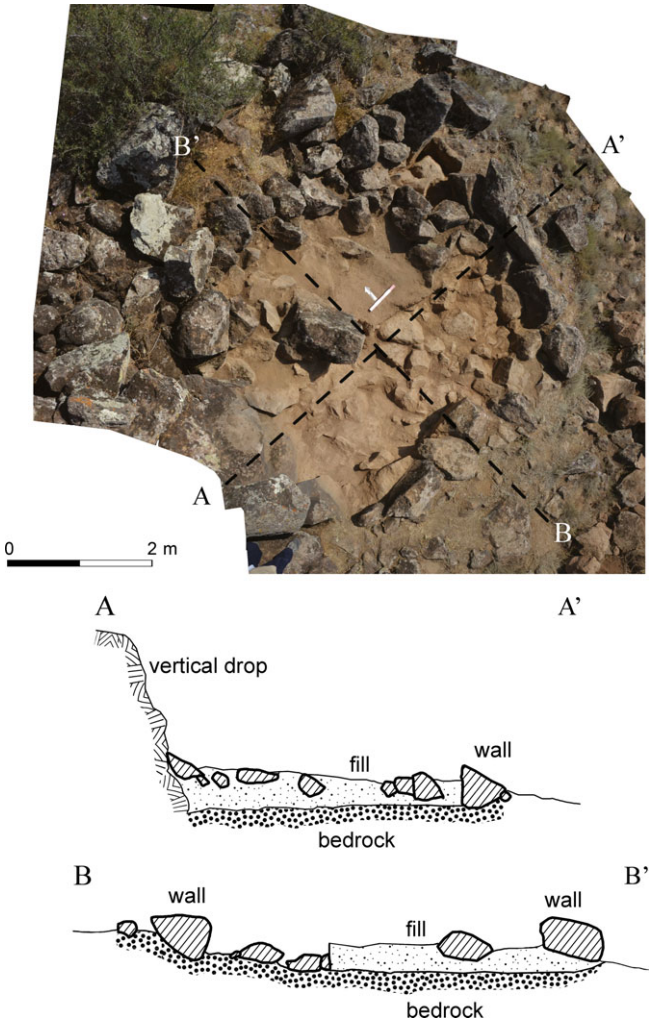

Fig. 28.
An overhead view and a section of Aghavnatun enclosure 1, Head E. The animals would have been driven into the head from the bottom left (overhead view) or the left (section).

Head E

This is a V-shaped kite, seemingly architecturally independent from the rest of the complex, and located to the north of the enclosure component. It has a right arm that begins near Head C (147 m long). It may have been connected to the latter but if so, stones have been reused elsewhere. The left arm runs parallel to a gorge and is poorly preserved along most of its length (*c.*154 m long). There are large cairns, tombs and other features between the left arm and the gorge, and there is at least one stone feature—perhaps a tomb—south of the head. There may have been another kite running into the steep gorge, head towards the north, although preservation conditions do not permit a clear statement. The two arms of Head E lead downwards, to the east. They are the most inclined among all arms in the site.

The head was built below a natural basalt outcrop. The boulders here form a flat area covering several square metres with a cliff to the east. There are deep cracks between some of the boulders, now filled with stones. Possibly, the builders filled the cracks to enable a clear passage towards the cliff.

The head is almost round with an inner diameter of 3–4 m (Fig. 28). We removed large collapsed boulders found on the topsoil. A trapezoidal flat stone was incorporated into the wall as part of the bottom course and set on edge, opposite the vertical drop.

Two outstanding boulders were set on edge and incorporated into the wall on the northern side. The one on the north-east, 1.3 m high, was examined for construction details. It appears that a shallow pit was dug into the natural layer to accommodate the boulder and some small supportive stones (Fig. 29).

A round feature full of stones was adjacent to the head, on the south-west. It had a diameter of 0.6–0.7 m and a depth of 0.3–0.4 m, and two to three courses of small to medium stones were preserved. Most of it was excavated but no finds were retrieved. A section shows that the fea-

Fig. 29.
Aghavnatun enclosure 1, Head E: the largest boulder within the head wall, set on edge at the north-east corner, seen from inside.

ture was built immediately above the white natural stony layer, thus roughly contemporaneous with the head and other kites.

A stone circle around a central high boulder was found annexed to the right arm, *c.*10 m from the head (Fig. 30). Most of the stones are 30–40 cm long; those near the kite's wall are bigger. Behind the wall, outside and to the south, there is a pile of disturbed stones. The central stone, which we have termed a stele, is 0.9 m high and 0.7 x 0.7 m in other dimensions. The latter was set on a flat basalt exposure, while most of the surrounding stones were set on a thin layer of soil. At least one stone was supported by a smaller stone set on the basalt bedrock. It seems that this circle was constructed with the kite or roughly at the same time.

Fig. 30.
Aghavnatun enclosure 1, Head E: a stone circle around a vertical boulder incorporated in the right arm. (Scale bar 0.5 m).

The two arms are badly preserved with many stones missing. The left arm runs down towards the head, parallel to a gorge only *c.*20 m to the north. There are isolated stones higher than the rest, some set on edge. The right arm descends from Head C. It has several sections with no stones and was apparently recently robbed.

Heads B and D

Head B appears to be the largest at the site, according to the outer diameter and the amount of stones present; it was not excavated (see Fig. 19).

Head D is located to the east of Head A, topographically almost at the same height; it was not excavated. The head contains a pile of stones inside, as all other heads. The enclosure wall leading between Heads A and B blocks the entrance to Head D, thus representing a later phase. The arms leading to Head D are similar to those of Head A. The right is adjacent to an elongated basalt outcrop and its construction boulders are large. The left arm, parallel for tens of metres, is not as well-built or preserved, with somewhat smaller boulders. Further away from the heads, in both cases (A and D) the arms are built of substantially smaller stones. The left arm of Head D is actually the diagonal wall crossing the enclosure towards Head C (see below).

The walls

The longest wall joins the enclosure by a basalt outcrop on the west; it is partially disturbed and preserved along 527 m, usually wide and shallow (Fig. 19). Most stones are less than 40 cm across. The wall creates a small geomorphological step on the landscape, similar to the one created by the inner diagonal wall. The rest of the walls are constructed of stones of various dimensions, including large boulders, some set on edge. The western and diagonal walls (see below) differ from the arms of kite E and the enclosure, as they have no large stones and no stones set on edge.

In several locations animal trails cross the ancient walls. In some cases, at least, it appears that gaps were intentionally left in the walls.

The diagonal wall

The wall has a general north–south orientation and it follows the topography, in that it remains on the same level, somewhat curving around the centre of the enclosure (Fig. 19). It created a step on the gently sloping topography and is wide and very low. In some places the stones create a feature 3–5 m wide, and more stones are scattered

below to the east. This looks like a loose double wall, although two walls are not clearly visible, but the stones along the supposed lines (*c.*1.5 m apart) are somewhat larger and more homogeneous than the rest of the stones. Furthermore, there are no clear two-course examples along it, which is very different from all other long walls at the site. Although not measured, the average size of the stones is significantly smaller than those in the walls near the heads.

Following these observations we suggest that the diagonal wall is older than most of the walls; it may have been the left arm of Head D before the enclosure was constructed. There are several stone circles along the diagonal wall. Some are obvious, others are questionable and may be random arrangements or circles too disturbed to be satisfactorily identified. We counted at least eight circles 1–1.5 m across. Importantly, all circles are on the surface with hardly any sediment accumulation around the stones.

In order to assess whether some stone clearing took place within the compound, stone densities (SD) were estimated within the perimeter of the enclosure and in an exterior area bordering it. The method was based on a random sample of sixty units measuring 1 x 1 m. In each unit all stones longer than 10 cm were counted. The mean stone number was 5.95 (n = 30, SD = 2.44) inside the enclosure, and 10.78 (n = 30, SD = 3.28) outside. The areas are significantly different (p = 0.0002). We interpret this as direct evidence for area cleaning by stone removal inside the enclosure, although we do not know when—after construction—this took place.

Trenches across the long walls

Six trenches were cut across three enclosure walls, the diagonal wall and the right arm of kite E (see Fig. 19). They are all perpendicular to the walls, 0.5 m wide and range in length between 2 and 7 m (total = 22 m). They were all excavated to a depth of 0.3–0.5 m.

Trench A cuts through the north-western wall of the enclosure, near the middle of it. The location was chosen randomly and Trenches A and B were set on the same line. The wall at this location is 1 m wide and up to two courses high.

Trench B, the longest at the site (7 m), cuts through the diagonal wall. Due to the inclination of the slope the trench was dug in several steps. The sections clearly show the presence of a double wall, with two parallel construction units *c.*0.5 m apart (Fig. 31). At least one wall was constructed in a foundation trench. It is noteworthy that the surface stone scatter is wider than the two walls, which are well defined in the sections. Samples for OSL dating and palynological investigation were collected from this trench (see below).

Trench C was cut through the southern wall of the enclosure. This wall may have been constructed of two parallel components.

Trench D was cut through the north-east wall. It was constructed of boulders and stones preserved to a height of

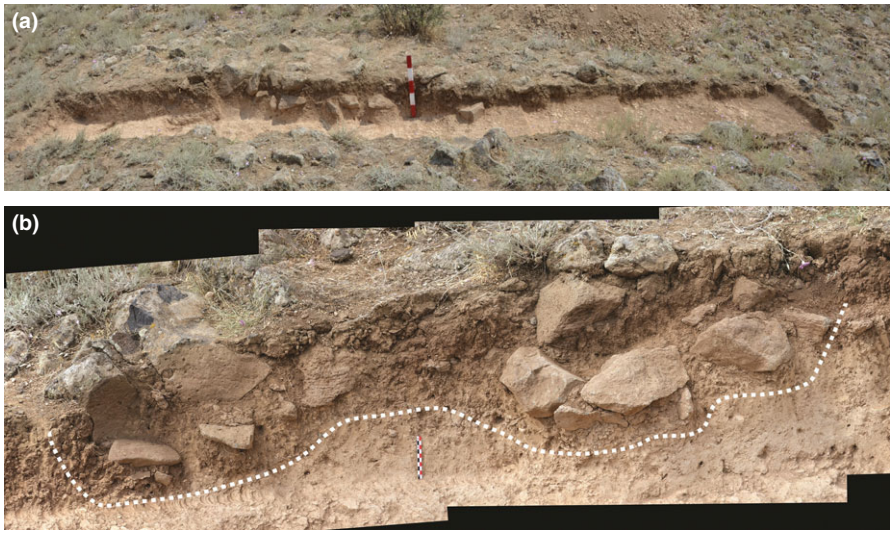

Fig. 31.
Aghavnatun enclosure 1, Trench B. **a.** a general view of the north-east section; **b.** a close-up view of the south-west section, with the two components of the double wall. A foundation trench (partially disturbed) is marked by the dotted line.

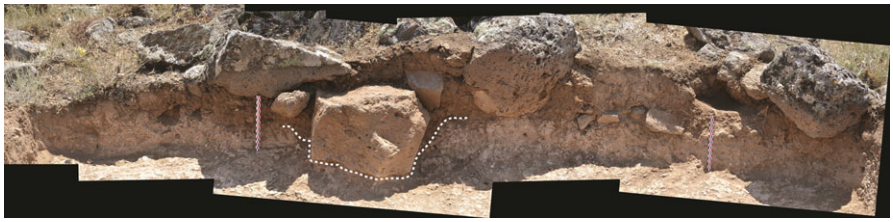

Fig. 32.
Aghavnatun enclosure 1: Trench D cutting the enclosure wall—a compiled profile of the south-east section. Note the foundation trench marked by a dotted line. (Scale bars 20 cm).

three courses. A foundation trench is visible in the section (Fig. 32). Trench E is 35 m south of Trench D, on the same wall.

Trench F is on the right arm of kite E, 40 m downhill from Head C. The wall was built of two adjacent parallel lines of boulders. No fill between them is visible in the trench, and no collapsed stones are present in the section.

IV. Dating

OSL dating

The OSL method dates the last event of exposure to sunlight of buried quartz grains (Aitken 1998). Our first set of samples was taken from Trench B in Aghavnatun enclosure 1 (Fig. 33). Samples for OSL were collected from sediment underlying the construction stones (ARM-7 and -8) and filling the spaces between the stones (ARM-9) (Table 1). The former is pale and indurated whereas the latter is dark and powdery. The pollen samples were retrieved from one vertical sequence near the wall stones.

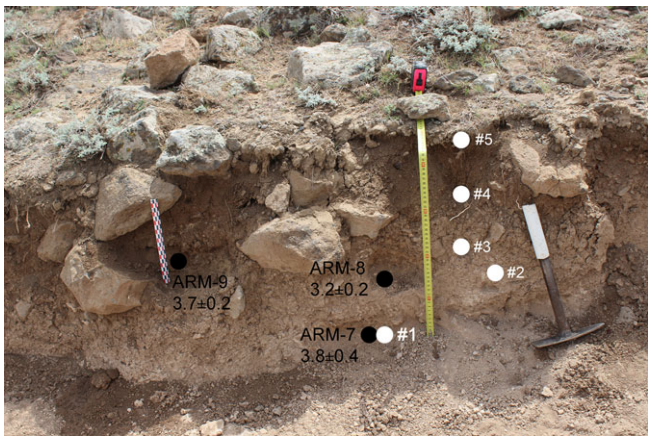

Fig. 33.
Aghavnatun enclosure 1, Trench B: the location of OSL (ARM-7–9) and pollen samples (nos. #1–#5).

The second set was taken from Head E in the same site (Fig. 34). The samples were collected from the south-western wall, between and below the boulders used for construction. Samples ARM-10 and ARM-12 were adjacent to each other, while ARM-11 was taken from under another boulder.

Samples were collected while preventing any exposure to sunlight, as the OSL signal is light sensitive. Sample preparation and quartz extraction followed conventional laboratory procedures (Davidovich *et al*. 2012). The equivalent dose (De) of the purified quartz was measured using the single aliquot regenerative dose (SAR) protocol on thirty to forty-five 2-mm aliquots. Prior tests showed that a given dose can be fully recovered when using a preheat of 260°C and a cut-heat of 200°C.

Dose rates were calculated from the concentrations of the radioactive elements U, Th and K, measured on complementary sediment samples by ICP (Inductively Coupled Plasma spectroscopy). The cosmic dose rate was estimated from burial depth and moisture content estimated at $5 \pm 3\%$ for all samples, taking into account the aridity of the region and the shallow burial depths.

All samples showed a substantial scatter in De values (O–D in Table 1). Ages were first calculated using all the measurements, and models were then used to isolate different De components. The pale sediment predating construction was reworked when the stones were placed in their position, and some of the grains were exposed to sunlight and bleached. Thus the youngest De population represents the best-bleached grains, and this population was used to calculate construction ages from samples ARM-7, ARM-8 and ARM-10. On the other hand, the sediment filling the interstices between stones began to accumulate soon after construction and continued so until the space filled up. In this case, therefore, the oldest De population represents an age closest to construction as possible (e.g. samples ARM-9 and ARM-12; Table 1).

Table 1. OSL results for the Aghavnatun enclosure 1 kite. Model ages used in the text are in bold.

Lab code	Provenance	O–D[1](%)	N[2]	Average age[3] (ka before present)	Model age[4] (ka before present)	Comments
Trench B, SW section:						
ARM-7	Top white pre-construction layer	50	30	7.8 ± 0.8	**3.8 ± 0.4**	MAM[5]
ARM-8	White layer disturbed during construction	99	42	8.3 ± 1.3	**3.2 ± 0.2**	FMM[6], youngest significant component (22%)
ARM-9	Dust under stone, post construction	53	45	1.9 ± 0.2	**3.7 ± 0.2**	FMM[6], oldest component (23%)
Head E, SW wall:						
ARM-10	Space between and below construction stones	69	33	2.7 ± 0.3	**3.2 ± 0.2**	FMM[6], major component (94%)
ARM-11	Dust, base of a construction stone	57	34	1.3 ± 0.1	**1.5 ± 0.1**	FMM[6], oldest significant component (67%)
ARM-12	Dust between construction stones	48	34	1.4 ± 0.1	**3.1 ± 0.3**	FMM[6], oldest component (55%)

[1]Over-dispersion, a measure of scatter beyond instrumental noise.[2]Number of aliquots measured for the sample.[3]Calculated using all measurements and the Central Age Model.[4]Model age is based on the relations between sediment sample and construction.[5]Minimum age model, assumes that the youngest grains are closest to construction age.[6]Finite mixture model, divides measurements into components and the one chosen for age calculation depends on the event one is interested in.

Fig. 34.
Aghavnatun enclosure 1, Head E: the location of OSL samples (ARM-10–12).

The construction age of the diagonal wall of Aghavnatun enclosure 1, Trench B, samples ARM-7–9, can be constrained by the minimum age of the underlying sediment and the maximum age of the overlying sediment to the first half of the second millennium BC. The age of Head E may be bracketed between 3.2 and 1.5 ka. Samples ARM-10 and ARM-12 (3.2 ± 0.2 ka and 3.1 ± 0.3 ka, identical dates) were collected from under the construction stones. ARM-11, however, gave a much younger date of 1.5 ± 0.1 ka. Thus, it appears to have been built later than 3.2 ± 0.2 ka and may have been in use until the middle of the first millennium AD.

In sum, according to the OSL ages at least two construction phases appear to be present at the site. The earlier is the diagonal wall, the later is Head E. As noted above, however, the A–B wall blocks Head D and thus two construction phases are evident here, not necessarily the same ones indicated by the OSL ages.

Artefacts

No artefacts were found in secure contexts within the kites, thus limiting the assignment of a particular feature such as walls and cairns to a specific culture, but obsidian and flint artefacts found on the surface include ten arrowheads. According to their techno-typological characteristics, they date to the end of the fifth to the late third millennium BC (Fig. 35). Pottery sherds were retrieved from all sites, found both on the surface and in the fills of kite heads and other features. They belong to the Early Bronze Age Kura-Araxes culture, the Trialetian culture of the Middle Bronze Age; there is also presence of Late Bronze and Early Iron Age specimens. These cultures span the mid-fourth to the last quarter of the second millennium BC. Classical period and medieval ceramic fragments are also present.

Architecture

The construction of double walls is common in the kites; there are several examples of long arms and heads. This construction method was common from the Early Bronze Age onwards (Adelyan & Ghafadaryan 1996).

Geomorphology

As described below, the landscape has changed since the construction of the sites. Furthermore, the time elapsed since construction was long enough for soil development. All kites and contemporaneous sites studied by us were constructed on the same bedrock, and in most cases had thick sediment accumulation around the construction

Fig. 35.
Obsidian and flint arrowheads collected on the surface of kites.

stones. The setting of walls on the Upper Pleistocene gravel or on a very thin silty layer above it, estimated to be Early to the mid-Holocene in age, indicates a similar environment during construction and thus general contemporaneity.

Summary

As radiometric dates are rare, a variety of direct and indirect methods have been incorporated in kite-oriented projects. Particularly innovative is the Globalkites project, with which several Armenian kites were dated (Brochier *et al*. 2014). The results include four ^{14}C dates, three of which are later than AD 1000 and one is 340–345 cal BC (2014: table 1). The variety of dating methods used in that research provided a wide range of results, with possible construction dates ranging between the Chalcolithic and the modern era. Even the more restricted range—taking all data into account—is wide, beginning in the Early Bronze Age and ending 3000 years later. Indeed, all possible dating methods should be tested and applied. Nevertheless, at this point the exact construction dates for about 170 Armenian kites remains only vaguely understood.

The data gathered by us for four kites enable us to propose that they are roughly contemporaneous. The similar

geomorphological settings and the presence of similar material remains, such as Kura-Araxes pottery, obsidian and flint arrowheads in most sites, even if not *in situ*, suggest at least some general contemporaneity, although not necessarily identical construction dates and utilisation sequences.

It is noteworthy that our OSL dates are interpreted as minimum construction dates. From a geomorphological point of view, however, the walls were constructed in the mid-Holocene, and the lowest sediments accumulated between the construction stones were also deposited during the mid-Holocene, *c.*7 or 6 ka. We should also point out that ARM-11 (1.5 ± 0.1 ka) has to be the same or at least close to ARM-10 and ARM 12, and not 1.5 ka younger. Put simply, there may be some contradiction between the OSL dates and geomorphological observations. More OSL and ^{14}C dates are needed before conclusive statements regarding the construction period can be advanced.

Among the interpretation possibilities, the first would advocate that the OSL dates reflect the construction phase also indicated by the later group of artefacts. The second would suggest that the OSL dates do not represent the first construction phase, which may have been somewhere between the Chalcolithic and Middle Bronze Age.

The lack of reliable dates is typical for the vast majority of kites across south-west Asia. One of the areas with the largest sets of ^{14}C and OSL dates is the Negev, where both methods yielded reliable results (Holzer *et al*. 2010; Nadel *et al*. 2010, 2013).

V. Past environments

A. Pollen

Palaeoenvironmental reconstruction

The studied region is characterised today by steppic open environment. The flora is mainly composed of semi-desert plants, with a dominance of *Artemisia* (Figs. 4 & 12). In order to reconstruct the type and composition of past vegetation communities in the region, a palynological investigation was carried out. Five sediment samples were taken from the section in Trench B (Aghavnatun enclosure 1) (Figs. 19, 33; Table 1). The same section was also OSL dated.

Pollen extraction followed a chemical preparation procedure: one *Lycopodium* spore tablet was added to each sample in order to calculate pollen concentrations (Bryant & Holloway 1983; Krzywinski *et al*. 1992). Next, samples were immersed in 10% HCl to remove the calcium carbonates, and then a density separation was carried out by using a $ZnBr_2$ solution (with a specific gravity of 1.95) in order to float the organic material together with sieving (150 μm mesh screen). After acetolysis, unstained residues were homogenised and mounted onto microscopic slides using glycerine. In each sample, all the extracted palynomorphs (pollen, spores and fungi) were counted and identified. The palynomorphs were identified under a light microscope at magnifications of 200x, 400x and 1000x (immersion oil). For pollen identification, the comparative reference collection of Tel Aviv University (Steinhardt Museum of Natural History) was used, in addition to regional pollen atlases (e.g. Beug 2004; Reille 1995, 1998, 1999). Pollen identification results are presented in absolute numbers and percentages in Table 2.

The results indicate that during the second half of the Holocene, the flora was mainly composed of desert elements (Table 2). The changes in the frequencies of the dominant taxa within the different palynological assemblages, however, indicate that the composition of the desert vegetation changed with time: the palynological spectrum at the lower part of the section points to the occurrence of Asteraceae-Cheno/Ams steppe vegetation (Sample no. 1). It seems that during the following period (Sample no. 3) the Cheno/Ams plants were replaced by *Artemisia*. Sample no. 4 indicates that later on the vegetation became dominated by *Artemisia*-Cheno/Ams steppic plants. The region today, as represented by Sample no. 5, is controlled by *Artemisia* steppe open environment. The changes in the vegetation cover are summarised in Table 3. The malacofauna assemblages identified nearby by Brochier *et al*. (2014) (which cover the same period) are also indicative of open environments, that is, steppic or semi-desert with poor vegetation cover.

Pollen markers for increasing grazing activity

Artemisia, the most common plant in the region today, is palynologically indistinguishable into the species level, but the most common species in the vegetation cover today is *Artemisia herba-alba.* This desert species is more resistant to grazing than other plants (e.g. Nemati 1977). Therefore, the gradually increasing values of this taxon in the sampled section most probably reflect a gradual increase of human impact on the natural vegetation through the herding of grazing animals. This is also evident by the total absence of *Xanthium* from the bottom of the section and its presence only in the upper samples (nos. 3–5), since this spiny member of the Asteraceae is also known as a grazing-resistant plant and its fruits are dispersed by sticking to mammalian furs (e.g. Sorensen 1986). A similar phenomenon of a

Table 2. The palynological assemblages of a sediment section extracted from Trench B, Aghavnatun enclosure.

Field ID	Agh Enclosure 1 Trench B unit I no. 1		Agh Enclosure 1 Trench B unit I no. 2		Agh Enclosure 1 Trench B unit II no. 3		Agh Enclosure 1 Trench B unit III no. 4		Agh Enclosure 1 Trench B unit IV no. 5	
Depth	5–7 cm		10–12 cm		19–21 cm		32–34 cm		44–45 cm (control sample)	
Weight (g)	2.1		2		2.1		2.1		2.1	
Absolute no./Percentages		%		%		%		%		%
Pinus		0.0	NP*			0.0		0.0	4	1.3
Olea europaea		0.0	NP			0.0		0.0	2	0.6
Asteraceae Asteroideae	17	16.5	NP		41	32.3	43	20.3	4	1.3
Asteraceae Cichorioideae	24	23.3	NP		5	3.9	7	3.3		0.0
Artemisia	16	15.5	NP		61	48.0	45	21.2	291	92.1
Xanthium		0.0	NP		5	3.9	6	2.8	4	1.3
Cheno/Ams (Chenopodiaceae/ Amarantaceae)	9	8.7	NP		4	3.1	3	1.4	8	2.5
Noea type	21	20.4	NP		1	0.8	108	50.9		0.0
Caryophyllaceae		0.0	NP			0.0		0.0	3	0.9
Brassicaceae	13	12.6	NP		10	7.9		0.0		0.0
Polygonaceae	3	2.9	NP			0.0		0.0		0.0
Sum-total counted	103	100	0		127	100	212	100	316	100
Spores	89		108		222		246		15	
Unidentified	4		5		7		15		4	
Fungus	13		44		45		89		11	
Clumps	4				1		78			
Lycopodium	361				1112		511		111	
Palynomorphs concentrations	14070.2				12048.1		19932.0		36432.6	
Total palynomorphs	574		157		1514		1151		457	
OSL dates	~3.8 KA		~3.7 KA		~3.2 KA				recent	

NP* = No Pollen

gradual increase in grazing-resistant plants, most probably due to intensification in herding of grazing animals, was identified in the Near East (e.g. Langgut *et al.* 2014; Zohary 1983).

Table 3. Summary of the vegetation changes since the mid-Holocene in the Ararat Depression area, according to the studied pollen samples.

Field ID	Agh Enclosure 1 Trench B unit I no. 1	Agh Enclosure 1 Trench B unit II no. 3	Agh Enclosure 1 Trench B unit III no. 4	Agh Enclosure 1 Trench B unit IV no. 5
Depth	5–7 cm	19–21 cm	32–34 cm	44–45 cm (control sample)
Date (OSL)	3.8 ka	3.2 ka		
Vegetation cover	Asteraceae-Cheno/Ams steppe	Vegetation is dominated by *Artemisia* and other Asteraceae steppe plants	*Artemisia*-Cheno/Ams steppe	*Artemisia* steppe
Human impact	There has been a gradual transition to a more degraded semi-desert environment mainly due to intensification of pastureland during the last *c.*3500 years. The result, today, is a very degraded open steppic environment dominated by *Artemisia* (a grazing-resistant plant).			

Geomorphology

Currently, stones and boulders are common on the surface of all sites. In all the trenches and sections we opened, however, a bright silty layer or brown-grey soils were encountered below the surface, with stones very rare or absent altogether (Figs. 31, 32). Furthermore, all walls and features were constructed on a dense layer of somewhat rounded pebbles, interpreted as Upper Pleistocene hard carbonated gravel, on exposed basalt and volcanic tuff outcrops or on a thin soil above the pebble layer. This picture repeats itself both on the more precipitous slopes with the V-shaped kites, on the plateau settings with the enclosure kite and even on the valley edge with a ceremonial site (see Fig. 2).

Thus, the kites were constructed in an environment very different from the current one. Viewed from another angle, the lack of stones in the sections indicates that during the construction period, stones were not common on the surface. In other words, the builders had to invest more time and energy than is apparent to collect the stones and construct the walls.

VI. Discussion

The study area presented here includes a wide range and a high density of sites on the fringes of the Ararat Depression, where the barren landscape meets the arable land used by local people for millennia. The proximity of large hunting and corralling devices to past villages, ceremonial sites and graveyards is indeed worthy of a large-scale research project. At this stage, our contribution is focused on the kites.

One of the characteristics of the study area is the presence of the two kite types, the V-shaped kite (killing kite) and the enclosure kite, in the same topographical and ecological niche, sometimes annexed to each other. Thus, in whatever way the two types were used to manipulate animals, they were not geographically exclusive.

Turning to the animals targeted by the kites, one needs to settle for the lack of direct evidence as animal bones are hardly found in the excavated kites. As wild sheep was a dominant species in local Bronze Age sites (N. Manaserian, personal communication, June 2013), and as it is still the main ungulate species in the open landscape of the Ararat Depression, the most plausible candidate for hunting and corralling during the discussed period is indeed the Armenian wild sheep or mouflon (*Ovis orientalis gmelini*).

As a preliminary example of an inter-regional comparison, it is of interest to address two remote and different areas, where the ecology, topography, plant communities and ungulate species are distinct. Thus, a comparison of the fringes of the Ararat Depression (900–1000 m above msl, 400 mm annual rainfall and *Artemisia* dominating a treeless landscape) with the Negev desert in Israel (0–800 m above msl, 10–50 mm annual rainfall and hardly any vegetation away from the wadi courses and valleys) provides some interesting results.

The V-shaped kites are almost identical in both areas. They have the same dimensions and naturally the same principle of having the head constructed below a small cliff, or at least downhill where a man-made vertical drop was built. The details of head construction are the same, including digging foundation trenches and using larger boulders for higher double walls in the heads. Along the arms, isolated larger boulders set on edge are common. In the two Samar West kites in the Negev, for example, the largest boulder along the arms was set adjacent to the head, on the right as the animal entered the trap (Nadel *et al*. 2010). In the Aghavnatun 2 and 3 kites, the largest boulder along the arms is also found by the head but on the left arm. The presence of an isolated and particularly large boulder in the upper distal area of the funnel was documented for several kites in the Negev (e.g. Pitam [Nadel *et al*. 2013] and Achshuv) and is also the case in Armenia (e.g. Aghavnatun 2).

Small structures were incorporated in arms or annexed to them in both areas; these are usually stone circles. A range of sites is frequently found within several hundred metres from the kites in both areas. Furthermore, tombs appear to have been built in the same hunting and corralling areas. Thus, for example, a tumulus with human remains was built on top of the Samar West A kite (Nadel *et al*. 2010), and tombs are common around some of the Ararat Depression kites. As both areas were occupied for generations before and after the use of the kites, however, it is very likely that some of the sites adjacent to the kites are not contemporaneous and are not associated with the kites. Only a rigorous landscape project that includes excavations and dating of the variety of sites in each area will establish the cultural chronology and contemporaneity of sites.

Narrow elongated slabs set on end or fallen were found in the heads of Aghavnatun 2, Lernamerdz 1 and Head C in Aghavnatun enclosure 1 and were tentatively termed stele. This incorporation of what appear to be symbolic objects within the kites should come as no surprise, as in many recent and past societies a variety of rituals were associated with hunting (Gasparyan *et al.* 2013; Zeder *et al.* 2013 with references).

The scarcity of material remains and especially animal bones in the heads of kites is commonplace throughout; common knowledge holds that if animals were killed for consumption, they were taken away and butchered by the dwelling locale (Bar-Oz, Zeder & Hole 2011).

In terms of the animals in question, it appears that in both areas small herds of local non-migratory ungulates were targeted—the gazelle and probably the onager in the Negev and wild sheep in Armenia. In the vast expanses of east Jordan, for example, chains were built to harvest large migratory herds of ungulates. There follows that the differences between the three areas in terms of type, size and setting of kites are likely due to the available game species, the herd size and the scale of migration. Nevertheless, notwithstanding the apparent differences between the Ararat Depression and the Negev desert, the V-shaped kites are amazingly similar, in both concept and details. This is not always the case, as in some areas the smaller kites have very distinct designs; this is best illustrated by the kites in Yemen on the one hand (Brunner 2009, and see

this volume) and those on the Ustiurt plateau on the other (Yagodin 1998).

The excavated enclosure kite does raise the question of head function. There are two kinds of cells or heads here, namely the deep 'killing' features (e.g. Heads A and E) and the shallow cell (e.g. Head C). It should be noted that in many of the large enclosure kites in east Jordan, the cells incorporated in the enclosure are on the same level, with no drop at all between the enclosure surface and the head (e.g. Betts *et al*. 1998; Betts & Yagodin 2000; Helms & Betts 1987; Kempe & al-Malabeh 2010, 2013; see also Échallier & Braemer 1995).

At least a partial answer should be sought in the history of the site. Our contention, at this stage of research, is that there were at least two functional phases at the Aghavnatun enclosure 1 site. The first may have been focusing on killing small herds of animals, operating kites A and/or D; the diagonal wall would have been the left arm of kite D. Later, an enclosure concept was applied, and some of the heads were probably blocked away (e.g. Head D). Once more data and dates are available, such a reconstruction could be either verified or refuted.

VII. Conclusions

Our first point addresses us all: more reliable dates are needed in order to place the kites within their cultural framework. As all researchers in the field know, the lack of dates stems from the scarcity of reliably dateable materials. Nevertheless, we should give this aspect top priority and embrace and apply any possible method or a combination of methods.

A second point about which not enough is done concerns the sites adjacent to the kites. In too many reports and syntheses, including ours, the kites are presented but their nearby sites are hardly mentioned or addressed. The kites were part and parcel of sophisticated societies using the landscape in a variety of ways, and thus there should be close to the kites contemporaneous dwelling sites, ceremonial or gathering sites, graveyards, water systems, etc. Without a landscape archaeology approach to the kites, we will remain limited in our understanding of a unique and admirable phenomenon—the concept, construction and operation of complex and sophisticated devices aimed at hunting and corralling animals. Questions such as the social and economic roles of kites in their respective societies are also yet to be fully addressed.

Relevant here is another point, namely the high-resolution documentation of large sites in harsh environments. Currently, all researchers are using Google Earth images and aerial photography, but using Lidar scanners and photogrammetry for 3D-model building and ensuing analyses will take us some further steps forwards (Arav *et al*., 2014; in press).

Returning to the dates, our geomorphological considerations suggest a mid-Holocene construction; surface artefacts may indicate Chalcolithic to Late Bronze Age construction, while the OSL results tentatively suggest a post-Middle Bronze Age date. The results from other studied Armenian kites provide a wide range of dates and although some methods may indicate earlier dates, four ^{14}C dates are very late (Brochier *et al*. 2014).

As a working hypothesis, we regard the radiometric dates obtained by Brochier *et al*. (2014) and by us as valid and representative for the Armenian kites. On the other hand, we accept the Early Bronze Age dates from some Negev kites as representative for that region. Thus, one may very cautiously suggest that the kite concept as we know it was used in the southern Levant some 1000 years or more before its introduction to the southern Caucasus. This is somewhat surprising, as there is ample evidence for Armenian Highlands—southern Levant connections during the Early Bronze Age, including the migration of people from the Caucasus to the southern Levant and the move of materials and ideas in both ways (Greenberg & Goren 2009; Greenberg *et al*. 2012). Whatever the case, according to this scenario the kites in their two forms were incorporated in the southern Caucasus only long after domesticated ungulates were a prominent component of Early Bronze Age economic systems, whether of sedentary populations based on agriculture or of pastoral nomads. The Armenian radiometric dates, however, may indeed not represent the first construction phase and thus the above scenario is only one of several interpretations.

As a final point, we would stress that in some regions the kites were used for decades and even millennia. We should not focus only on the earliest manifestation of the phenomenon. Rather, kites were still used in east Jordan about 2000 years ago (e.g. Harding 1953) and even in the nineteenth century (e.g. Aharoni 1946; Burckhardt 1831: 220–221; Musil 1928: 26–27). Thus, late radiometric dates obtained from kites across large areas in south-west Asia should not be taken as reflecting contamination of an early site. Instead, we suggest that the late dates should be further studied and that they may reflect the long use of kites, either by utilising the same features for many decades or by adding new features in certain late periods. Fluctuations in the use of the large game traps may have

been correlated to economic shifts driven by climatic or political changes, among other factors.

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