Fourth-millennium-BC 'leopard traps' from the Negev Desert (Israel)

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Stone-built installations known as 'leopard traps' are found throughout the deserts of the Middle East. They have generally been considered to be recent in date, and to have been built by Bedouin or other local communities to trap carnivores that threatened their flocks. But how much older might they be? Survey in the hyper-arid 'Uvda Valley of the southern Negev Desert in Israel discovered 23 'leopard traps', 19 of them clustered in a relatively small area. This study describes the architecture and function of these structures and presents the first optically stimulated luminescence ages for two of them. These results demonstrate that the traps are ancient and were already in use before the late fourth millennium BC, not long after the adoption of herding by the desert dwellers.

Keywords: Israel, Negev Desert, 'Uvda Valley, leopard traps, Arabian leopard, OSL

Supplementary Table S1 is published online at http://antiquity.ac.uk/projgall/porat337/

Introduction

Recent studies attest to the use of net traps and cordage technology from Upper Palaeolithic sites in Eurasia (Soffer *et al.* 2000; Soffer 2004; Kvavadze *et al.* 2009). Since organic remains are rarely preserved, archaeologists have argued that trapping technology may have been used in even earlier periods, aimed at increasing hunting efficiency and lowering risk, and serving as an indication of the cognitive abilities of early hominins (e.g. Campana & Crabtree 1990; Milo 1998; Lupo & Schmitt 2002; Wadley 2010). The most widespread and best preserved archaeological installations for catching prey are probably fish weirs and fish traps,

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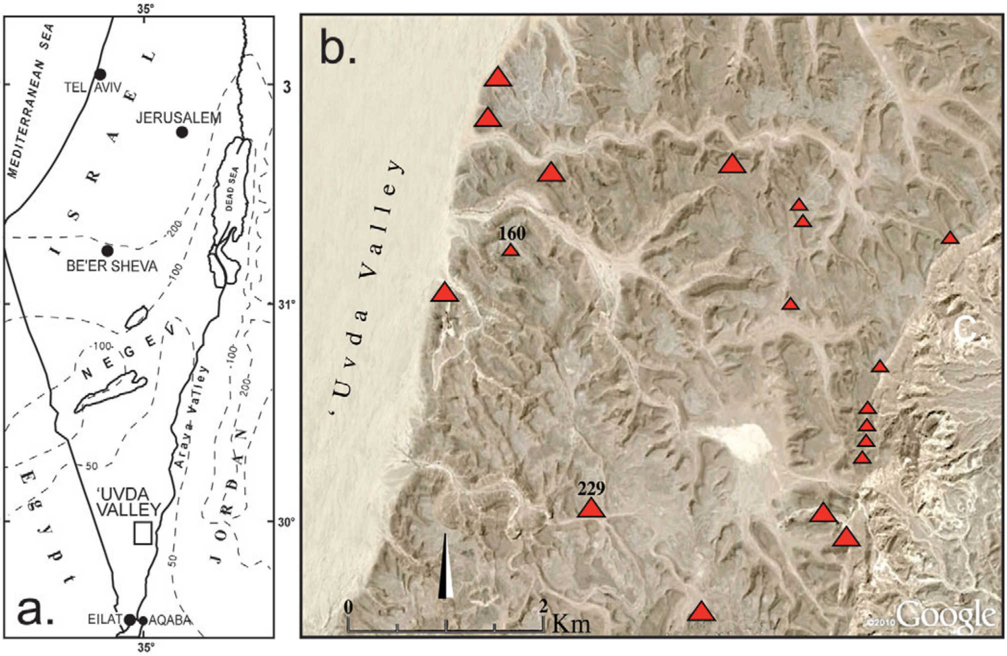

Figure 1. a) Location map of southern Israel, with the 'Uvda Valley shown as a rectangle; b) satellite image of the 'Uvda Valley showing large and small traps (large and small triangles, respectively) and the location of the two dated traps (numbered) (© Google).

ubiquitous in the Late Pleistocene and Holocene records of North America, Europe, Africa and Oceania (Strandberg & Tomlinson 1969; Avery 1975; Johnston & Cassavoy 1978; Brinkhuizen & Clason 1983; Godwin 1988; Christensen 1997; McNiven *et al*. 2012). In contrast, built installations for trapping ungulates are rare in the archaeological record, but include claims for 40 000-year-old pit-traps in Japan (Sato 2012), stone-built installations for trapping reindeer in Holocene Norway (Barth 1982; Jordhøy 2008), and the 'desert kites' of the fourth millennium BC or earlier that were primarily used for trapping gazelle in the deserts of the southern Levant (Holzer *et al*. 2010; Nadel *et al*. 2010). Here we present the first absolute dates for stone-built 'leopard traps' that were in use in the 'Uvda Valley of the Negev Desert, Israel (Figure 1), at least as early as the late fourth millennium BC. First, however, we offer a general description of the geographical distribution, architecture and mechanism of these hunting installations.

'Leopard traps'

'Leopard traps', known locally (in Arabic) as *nusrat al-nimr* (literally meaning 'leopard trap'), are rectangular installations constructed from unworked field stones. They are found throughout the deserts of the Middle East, from Yemen to the Sinai Peninsula, and are described as having been used specifically to trap the Arabian leopard (*Panthera pardus nimr*; Levi 1976; Al Jumaily *et al.* 2006; Judas *et al.* 2006; Qarqaz & Abu Baker 2006;

Mallon 2007; Mallon *et al.* 2008; Avner *et al.* 2011; Hadas 2011; *Leopard Traps* n.d.) This is supported by comments made by early travellers in the region such as Palmer (1871: 225) who noted: "on the watershed, where we stood, were some old stone ruins, a hermit's deserted cell, and a leopard-trap, in front of which were recent traces of a huge beast of that species". It cannot, however, be discounted that these traps were used to capture other carnivore species, as suggested by their name in the Yemen, where they are known as 'wolf-traps' (Brass & Britton 2004: 155; see also discussions in Avner *et al.* 2011 and below). There are also remarkably similar constructions dating to the nineteenth century in South Africa called 'wolwehokke' that are said to have been used to trap jackals and hyenas in addition to leopards (Walton 1989). The introduction of these traps into South Africa may pre-date the European colonists, since Thomas Pringle (1835: 133–37) attributed this technology to the 'Hottentots' (Khoi).

The Middle Eastern traps consist of two parallel walls built of upright stones or several courses of stones, roofed by large cover slabs, with an opening at one end of the cell. A vertical stone slab was set through a narrow gap in the roof and suspended by a rope to form the door of the trap. At the other end of the trap the rope looped around a wooden stave, to which bait was attached (Figure 2). When the carnivore grabbed the bait it dislodged the rope, dropping the stone slab and closing the trap door. The chamber itself was reinforced with field stones piled on top and against both sides. Commonly, the traps were built on bedrock to prevent the trapped animal from digging its way out; in other cases the chamber floor was paved with flagstones for that reason. The trapped animal was left to starve (Judas *et al.* 2006: 13) or was speared through an opening in the roof (Figure 2; Levi 1976: 11–12). Traps vary in size geographically. Those from Yemen are reported to be 2.75–3m long and 1.5m high (Mallon *et al.* 2008), while in the Negev Desert two sizes of traps are found. The larger (Figure 3c & d) are 2–4m long and 1.5–2.5m wide while the internal dimensions of the chamber are *c.* 0.4m wide and 0.5m high. The smaller traps (Figure 3a & b) are around 1.5 × 1.0m, the chamber only 0.15–0.2m wide and 0.2–0.25m high. Irrespective of their size, both types of traps are identical in design and function. Logically, the larger traps suited large carnivores such as desert wolves, striped hyenas, leopards and possibly even cheetahs, animals with mean body weights for males of ⩾20kg and body lengths of ⩾0.95m (Mendelssohn & Yom-Tov 1999). The smaller traps were built for small-sized carnivores, such as caracals and foxes, with mean body weights of ⩽17kg and body lengths of ⩽0.95m (Mendelssohn & Yom-Tov 1999). In the Negev traps, the chambers are too narrow for the trapped carnivore to turn around; in Yemen, on the other hand, the chambers of the more recently built traps are wide enough for the animal to turn around, facilitating their transfer to a cage. This modern adaptation has enabled the sale of live leopards to zoos or private buyers (Mallon *et al.* 2008).

Throughout the Middle East, 'leopard traps' are considered to be recent in age, and to have been built by Bedouin or other local communities (Levi 1976; Qarqaz & Abu Baker 2006; Mallon 2007). Indeed, eye-witness accounts from the 1960s, 1990s and even up until 2007 note that local communities in Yemen, Jordan and the Sinai Peninsula used these traps to capture the Arabian leopard, in order either to rid the area of predators that attacked their herds or to capture the animals for sale (Levi 1976; Al Jumaily *et al.* 2006; Qarqaz & Abu Baker 2006; Mallon *et al.* 2008; Stanton 2010).

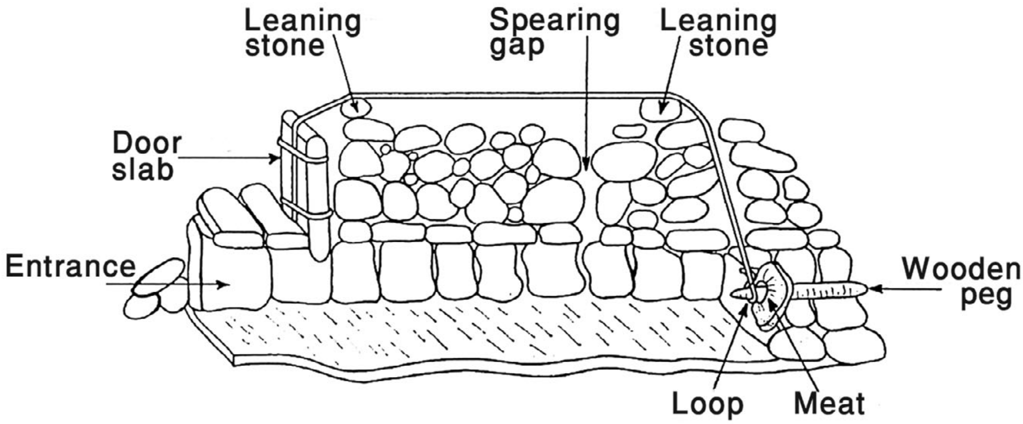

Figure 2. A schematic cross-section of a functioning 'leopard trap' with the different parts as described in the text (modified after Levi 1976).

'Leopard traps' in the 'Uvda Valley, southern Negev Desert (Israel)

Research in the 'Uvda Valley began in 1978 as a part of the Negev Emergency Archaeological Survey undertaken by the Israel Antiquities Department, before the redeployment of the Israel Defense Forces from Sinai into the Negev following the peace agreement between Israel and Egypt. A survey team headed by Uzi Avner concentrated on the eastern side of the valley where most of the archaeological sites are clustered. An area of 60km^2 was surveyed in which 400 sites were recorded. The survey operated under pressure from development (a new airbase, infrastructures, army training zones, etc.), and areas not under immediate threat were surveyed only briefly. The survey was followed in 1980 by excavations at 22 sites, with subsequent excavations contributing still more information to the knowledge of early settlement patterns. Resumption of survey work in 2008–11 led to the discovery of 330 new sites, and ongoing research into the palaeoenvironment during the last 10 000 years is attempting to understand better the unusual settlement pattern.

The 'Uvda Valley is a hyper-arid area, with 15mm average annual precipitation against 4000mm annual potential evaporation. Despite this, the area east of the valley contains the highest density of ancient sites yet documented in the Negev Desert and Sinai Peninsula. Currently over 700 archaeological sites and installations have been recorded in a surveyed area of only around 80km^2, most of them dated to the sixth–third millennia BC (Late Neolithic, Chalcolithic and Early Bronze Age). The subsistence base of this settlement system was cereal cultivation and pastoralism, the latter almost exclusively comprising herds of domestic sheep and goats. Scant remains of equids or wild or domestic ass have also been found, while wild taxa (hares, birds, reptiles) comprise on average only 3 per cent or less of faunal remains. Both animal husbandry and plant cultivation began in this region *c.* 6000 BC (Avner 1990, 1998, 2006; Horwitz *et al.* 2001; Avner *et al.* 2003; Rosen *et al.* 2005). The recorded sites include 186 stone-built settlements containing corrals, each site suited to one extended family (around 20–80 persons); hundreds of tent encampments; 86 animal pens of two types; a cultivated area of 1200ha organised in 'limans' to harness flood water;

Figure 3. Photographs of the 'Uvda Valley 'leopard traps' studied here; ***a)*** *the small 'leopard trap' BU160 before opening for sampling, looking towards the entrance;* ***b)*** *Trap BU160, after sediment sampling. Note flagstones forming the the floor of the trap;* ***c)*** *the large 'leopard trap' BU229 before sampling. Clearly visible are the large slabs covering the central cell and entrance;* ***d)*** *sampling Trap BU229 for dating—photographed towards the entrance. Note large cover slabs.*

32 threshing floors; other farming installations; and many cult sites of various types (Avner 1990, 1998, 2002: chs. 2, 4 and 5, 2006; Avner *et al*. 2003). Within the surveyed area 23 carnivore traps were recorded, 13 large and 10 small. Nineteen traps are clustered in an area of 20km^2 (Figure 1b) and form the highest density of such traps known to date in the Near East.

During the first survey in the 'Uvda Valley, several observations indicated that the 'leopard traps' were older than commonly believed, based on their proximity to ancient corrals and habitation sites that span the Late Neolithic to Early Bronze Age; the substantial dust fill in the trap chambers; the presence of uniform patination on the rocks from which the traps were constructed; and scatters of flint tools and debitage around most of the traps. Only two of the traps lacking these indications were attributed to the Bedouin population of recent centuries. Accordingly it was suggested that the 'leopard traps' were specifically built to protect early caprine herds from predators, possibly from as early as the Chalcolithic period (Avner 1989: 127, 1998, 2002: 20; Avner *et al.* 2011). This hypothesis needed, however, to be tested by radiometric dating. The carnivores for which these traps were intended and that would have endangered herds may have included leopards, wolves, caracals, foxes, hyenas and possibly also cheetahs. Most of these species still inhabit the region today (Mendelssohn & Yom-Tov 1999), a leopard last being seen in the 'Uvda Valley in 1979 (Avner *et al.* 2011).

OSL dating

To verify the age of the 'Uvda Valley traps, two were selected for dating. In the absence of preserved organic remains (bone, charcoal), we dated quartz grains from the sedimentary infill of the traps using optically stimulated luminescence (OSL) dating (Aitken 1998). This method dates the most recent exposure of a mineral grain to sunlight, effectively fixing the time of burial. It is increasingly used to date sediments associated with archaeological structures such as stone rows and other installations where organic matter or artefacts are lacking (Porat *et al.* 2006; Outram *et al.* 2010; Feathers 2012). In the limestone terrain of the 'Uvda Valley, the only source of quartz is dust brought by seasonal strong winds. This dust settles directly on the landscape, accumulating within man-made structures, and it thus post-dates their construction, or their abandonment. In the traps considered here it covered the paving stones and filled the interstices between the stones of the chamber walls after the traps were abandoned.

Methods

The two 'Uvda Valley traps chosen for dating are of different sizes: a large trap (BU229) built on bedrock, on the side of a small wadi (ephemeral water channel; Figure 3c); and a small trap (BU160), situated on a hilltop. Although both had long been out of use, they were only slightly disturbed. Most of the roofing slabs were still in place but some field stones covering the slabs had been dislodged, as were the trap doors. Very fine accumulated sediment, 50–150mm thick, was visible within the main chambers. The first trap (BU229) could have received some waterborne sediment owing to its position in the wadi, but no sediment of other than Aeolian origin could have reached the hilltop trap (BU160), and its sediment infill comprises fine, uniform dust. Taking precautions to prevent exposure to sunlight by covering the trap's opening with a dark cloth, sediment samples were taken from each trap at a location within the main chamber. To gain access to the interior, a cover slab was removed after the trap had been documented (measured, photographed and drawn), which was later replaced.

After removing the surface 2–3mm that were exposed to light, four sediment samples were taken at each trap, from the top to the base of the sediment infill, in horizontal layers (spits) 15–25mm thick (Table 1; Figure 4). Each spit represents a time interval of sediment accumulation, whereby the lowermost sample is the oldest and closest in age to the time of abandonment. A modern analogue sample was taken from the surface of the wadi sediments near Trap BU229 (sample BU-15), to provide an indication of the extent of bleaching of sediments in the open in the vicinity of the trap.

Table 1. OSL results.

Sample	Location	Depth (m)	K (%)	U (ppm)	Th (ppm)	Ext. α (μGy/a)	Ext. β (μGy/a)	Ext. γ (μGy/a)	Cosmic (μGy/a)	Total dose (μGy/a)	No. aliquots/grains	OD (%)	D_e (Gy)	Age (years b. 2010)	Calendar years
Trap BU160 on a hill top (IAU 254/65/3; Israel Grid 196930/427780)															
BU-11	Top 15mm	2.0	0.32	1.6	2.5	6	480	367	243	1096±29	19/23	100	0.27±0.07	**270±60**	**AD 1680–1800**
BU-12	Above floor	2.5	0.32	1.6	2.5	6	480	367	236	1089±29	21/25	79	0.8±0.1	770±120	
SG											36/87	91	4.3±0.2	**3950±190**	**2130–1750 BC**
BU-13	Between floor	4.0	0.32	1.6	2.5	6	480	367	219	1072±29	25/25	35	3.7±0.3	3450±270	
SG	slabs										41/72	79	5.1±0.2	**4720±200**	**2910–2510 BC**
BU-14	Between wall	5.0	0.32	1.6	2.5	6	480	367	210	1063±29	33/33	36	6.9±0.4	6500±420	
SG	stone and floor slabs										33/71	70	5.6±0.2	**5260±240**	**3490–3010 BC**
BU-15	Surface sediment near trap 229	0									10/12	98	0.10±0.02	**100±20**	**AD 1890–1930**
Trap BU229 in a stream bed (IAU 254/75/11; Israel Grid 197590/425420)															
BU-16	10–40mm	2.0	0.32	1.9	2.4	7	523	398	243	1171±29	24/25	58	0.25±0.02	**210±30**	**AD 1770–1930**
BU-17	60–100mm	2.5	0.32	1.9	2.4	7	523	398	236	1163±29	23/24	61	0.62±0.07	**540±70**	**AD 1400–1540**
BU-18	110–140mm	3.0	0.32	1.9	2.4	7	523	398	229	1157±29	24/24	28	0.92±0.06	**920±60**	**AD 1030–1150**
BU-19	150–200mm	4.0	0.32	1.9	2.4	7	523	398	219	1146±29	24/24	31	1.4±0.1	1250±90	
SG											21/42	48	1.9±0.1	**1620±110**	**AD 208–500**

Notes: SG—single grain measurements; OD—over-dispersion; SE—standard errors

No. aliquots/grains: for multi-grain—the number of aliquots used for age calculations from all those accepted. For single grains—the two numbers are the number of grains in the major component (see Supplementary Material) over the number of accepted grains with positive D_e values.

When two ages are listed for a sample, the upper one is from multi-grain measurements and the lower one from single grains measurements. Ages used in the text are in **bold**. Uncertainties on the ages include statistical and systematic sources, including a 1% uncertainty on source calibration. Errors on the radioactive elements are ±5% of the concentrations for K and U, and ±10% of the concentrations for Th. The multi-grain D_e values were calculated using the Central Age Model (Galbraith *et al.* 1999) and are presented with their standard errors, whereas the single grain D_e values were calculated using the Finite Mixture Model (Galbraith *et al.* 1999) and are presented with their statistical uncertainty.

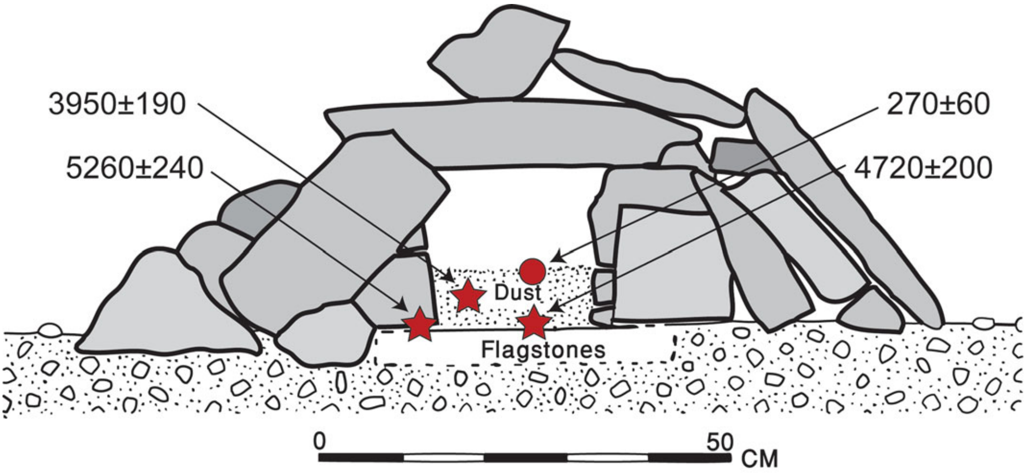

Figure 4. A cross-section through Trap BU160, showing the structure of the floor slabs, walls and roof. The trap was filled with around 70mm of sediments that were collected in c. *15mm spits for OSL dating. Single grain model ages are shown as stars and the multi-grain age as a circle, with the relative location of each sample (samples BU-11 to BU-14 from top to bottom) and its age (in years before 2010).*

Only very fine sand quartz was present, attesting to long-distance dust transport and the concurrent solar bleaching experienced by this mineral. Using routine procedures (Porat 2007), the 88–125μm quartz grains were selected by sieving. Carbonates were dissolved with 10% hydrochloric acid (HCl) and heavy minerals and most feldspars were removed by magnetic separation. The remaining feldspars were dissolved and the quartz etched with 42% hydrofluoric acid (HF), followed by soaking in 16% HCl to dissolve any fluorides which may have precipitated. Dose recovery tests over a range of preheats showed that a recovery of 100% can be achieved using a preheat of 10s at 260°C, a test dose of *c.* 3.5Gy and a test dose preheat of 5s at 220°C (Figure 5e). Equivalent doses (D_e) were measured on 2mm aliquots using a modified single aliquot regenerative protocol (SAR; Murray & Wintle 2000) and 23–25 aliquots were measured for each sample (except for the modern analogue). The central age model (CAM; Galbraith *et al.* 1999) was used to obtain a representative D_e value, with standard errors (SE), propagated to the errors on the ages (Table 1).

To understand better the scatter found within the samples, single grain measurements were carried out on the lower (older) samples from each trap. This was expected to provide more information about when sedimentation in the traps began and at what rate it accumulated. Four hundred grain holes were measured for each sample and were screened for further data processing using criteria defined in Porat *et al.* (2006; see also Supplementary Material). It was observed that several grains filled each hole of the single grain sample holder (300μm in diameter), owing to the small grain size of the quartz (88–125μm). In essence, therefore, these are micro-aliquot measurements; this also increased the yield of suitable grains from the usual 3–5% to 15–25%. The finite mixture model (FMM; Galbraith *et al.* 1999) was used to identify the most significant age population. This model assumes that the sample comprises grain populations with differing D_e values, and it attempts to identify these different components. It also provided information on the degree of mixing of the sediment.

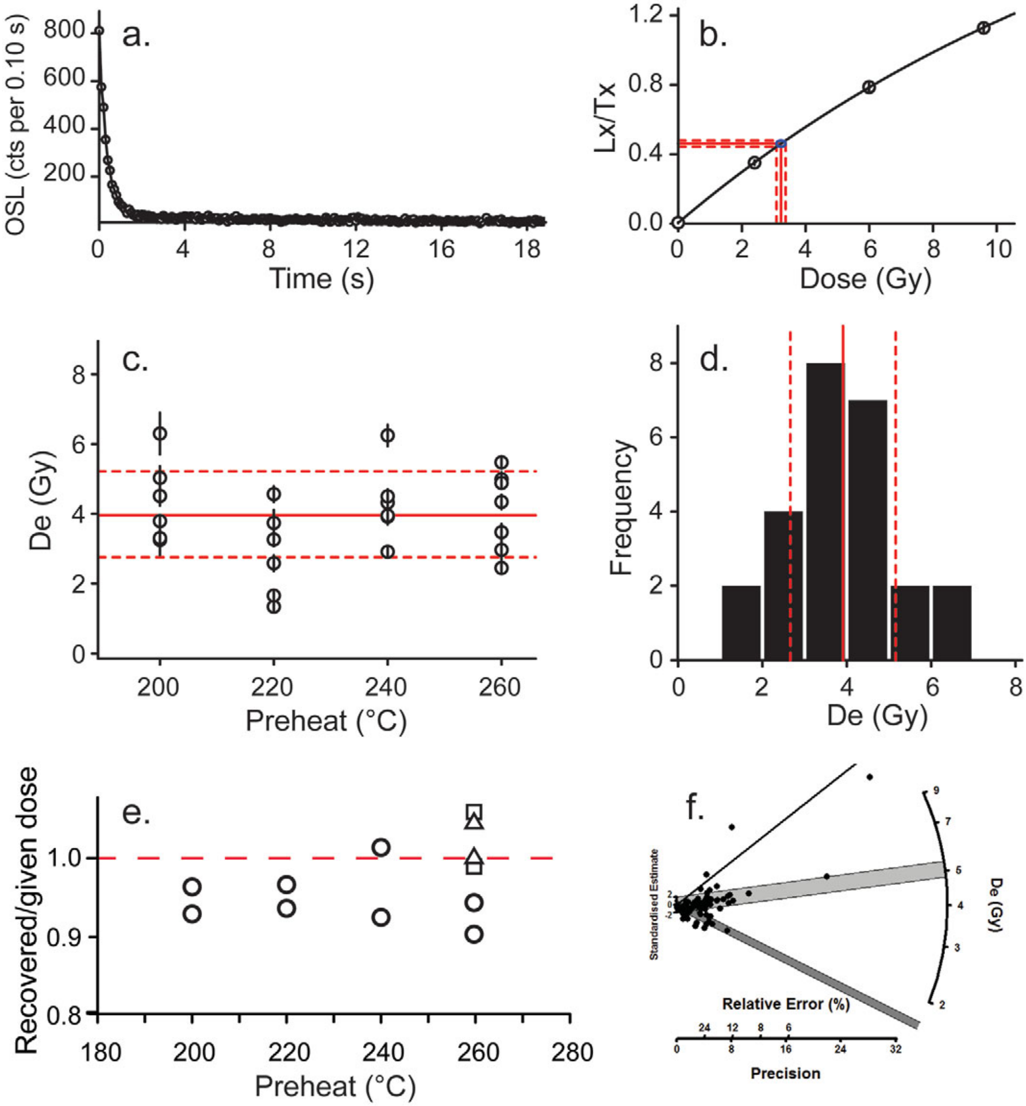

Figure 5. OSL analyses and results for sample BU-13 (for details see the Technical Appendix at the end of the article): ***a)*** *the natural OSL signal of an aliquot;* ***b)*** *dose response curve for one aliquot;* ***c)*** *preheat plateau;* ***d)*** *histogram showing all 25 D_e measurements;* ***e)*** *dose recovery tests over a range of preheat temperatures;* ***f)*** *radial plot of single grain results.*

Water content in this hyper-arid region was estimated at 2±1%. Burial depths for cosmic dose calculations included the sediment overburden and the overlying limestone blocks. Owing to the apparent homogeneity of the sediment in the field and the closely spaced samples, a single sediment sample was taken from each trap for chemical analyses. The gamma and cosmic dose rates could not be measured *in situ* with a portable counter on account of the confined spaces from which the samples were collected. Alpha, beta and gamma dose rates were calculated from the concentrations of radioactive elements in the sediment, measured by Inductively Coupled Plasma (ICP) Mass Spectrometry (for U and

Th) or ICP Atomic Emission Spectroscopy (for K), while the cosmic dose rate was calculated for each sample using its current burial depth (overlying sediment and stonework).

Results

Multi-grain measurements: the OSL signals from the quartz within the sediment samples are bright and are dominated by the fast, easy to bleach component (Figure 5a). Recycling ratios are mostly within 5% of unity (Figure 5b), indicating that the SAR protocol corrects for any sensitivity changes that take place in the quartz. No significant feldspar contamination was observed (using the IR depletion ratio) and preheat plateaus over a broad range of temperatures were observed (Figure 5c), implying that a thermally stable signal is measured. The D_e distribution for all samples is broad, with over-dispersion values of up to 100%, and large standard errors (Table 1). This is caused by the slow rate of sediment infill, whereby each sampled spit contains grains that could have been deposited over hundreds or even thousands of years. Nonetheless, the distribution of measured D_e values is roughly normal (Figure 5d), indicating an even mixture of grains with both older and younger ages, as should be expected from samples deposited uniformly over a long time span.

The multi-grain ages for the small trap (BU160) range from 6500±420 years (before 2010, the year of measurement) at the base of the trap to 270±60 years at the top of the sediment infill. The ages for the large trap (BU299) range from 1250±90 to 210±30 years. The modern analogue sample (BU-15; Table 1) gave an age of around 100 years, indicating that overall surface sediments have low residual ages and implying that the sediments that entered the traps were probably well bleached at the time of deposition.

Single grain (micro-aliquot) measurements: all samples contained varying proportions of grains with zero or negative D_e values, or with errors larger than the D_e value ('zero-age grains'). The higher (and younger) the sample in the sediment section, the larger the proportion of these grains, increasing in Trap BU160 from around 15% in the lowermost to 40% in the uppermost sample. These grains were rejected from further data processing, since the current statistical models cannot handle negative D_e values. Since we are interested in the age of the oldest grains, deposited as close as possible to the time of trap construction, removal of these zero-age grains from the calculation has no detrimental effect.

Details of the analyses are found in the Supplementary Material, and the single grain ages are listed in Table 1 and Figure 4. In sample BU-19 from the lowest spit of Trap BU229, the oldest and largest grain population comprises 49% of the grains and has an age of 1620±110 years. The trap was therefore abandoned only *c.* 1600 years ago, i.e. during the Byzantine period.

Sample BU-14, from a crevice between the pavement and one of the standing wall-slabs of Trap BU160, contained five different D_e components that were isolated by FMM. The greatest fraction of grains, 46%, gave an age of 5260±240 years; around 25% of the grains belonged however to populations with ages of *c.* 8000 years or older. Most likely these grains originate from older dust that underlies the paving stones; this dust predates the construction of the site, and introduced an over-estimation of age in the multi-grain measurements. However the major grain population in this sample, with an age of around 5300 years, represents post-construction dust accumulation. The samples immediately overlying the floor pavement are from the centre of the trap (BU-13 and BU-12; Figure 4). This location was most likely dust-free when the trap was constructed, and the chance of contamination by older grains is lower. For sample BU-13, collected from immediately above the pavement, the largest D_e components, comprising 57% of the grains, gave an age of 4720±200 years (Figure 5f). For the overlying sample BU-12, the largest component (41%) gave an age of 3950±190 years.

This sequence of single grain FMM ages for the sediment fill of Trap BU160 ranges from 5260±240 (at the base) to 3950±190 years, and is in stratigraphic order (Table 1; Figure 4). The multi-grain age for the uppermost sample, 270±60 years, accords with this. The age for the lowermost sample, around 5300 years, approximately represents the earliest time when sediment started to accumulate in the trap; the similar age of the overlying sample, around 4700 years, supports this early age. The trap was thus abandoned before *c.* 3300 BC, but we cannot determine how much time had elapsed since it was built. Since the oldest sediment fill dates to Early Bronze Age I, it can be concluded that the trap pre-dates this and most probably was built during the Chalcolithic period.

After abandonment, the chamber floor of the trap was gradually filled by environmental dust, which today attains a height of around 70mm, giving an average deposition rate of around 0.01mm/year for the last *c.* 5300 years. Indeed, each sampled spit of around 15mm was deposited on average over a period of 1300 years, an observation that explains the wide scatter in the multi-grain ages.

Discussion and conclusions

Our results represent the first radiometric ages for 'leopard traps' in the Middle East, showing that at least some are older than around 5300 years. The ages support the hypothesis put forward here that most 'leopard traps' in the 'Uvda Valley are ancient and were directly associated with at least some of the adjacent early settlements and corrals. The probable antiquity of 'leopard traps' in other parts of the Negev was previously estimated from archaeological finds recovered inside a trap excavated above the 'Ein Gedi oasis in the Judean desert. Hadas (2011) found a fragment of a Roman oil lamp (30 BC–AD 70) inside the trap, while finds in the sediment immediately outside included lithic artefacts and a Chalcolithic pottery sherd, from a period slightly earlier than the time when the 'Uvda Trap BU160 functioned. Together with the OSL ages presented here, this data attests to the antiquity of the Negev 'leopard traps'.

Leopards are known readily to enter baited cage or box traps, but the capture rate of other carnivores, such as lynx (equivalent to the Middle Eastern caracal), red fox and lion using such installations is much lower (e.g. Mowat *et al.* 1994; Baker *et al.* 2001; Frank *et al.* 2003). Furthermore, throughout the Middle East the 'leopard traps' were constructed in a manner that would encourage the capture of leopards: camouflaged by the use of local field stones and placed in appropriate locations. The traps were built on trails used by ungulates leading to pastures, water sources or to livestock corrals. Alternatively, they were located in wadi beds or on cliff edges which leopards are known to frequent (Mallon 2007: 7; Hadas 2011). Since Trap BU160 went out of use no later than the late fourth millennium BC, it may have been built not long after the adoption of herding by the desert people, around 6000 BC, in an attempt to protect their herds. Additional OSL dating of traps in the Negev may support this argument by clarifying the association of the 'leopard traps' and archaeological sites in the 'Uvda Valley.

The continued use of 'leopard traps' well into the twentieth century echoes that of the Near Eastern 'desert kites', stone-built installations used to capture ungulates. These too functioned over a lengthy period of time, from at least the fourth millennium BC to the early twentieth century AD (Holzer *et al.* 2010; Nadel *et al.* 2010). Both types of hunting installation demonstrate the intimate knowledge of animal ethology possessed by the inhabitants of these deserts, and the longevity of certain human traditions in the region.

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Technical appendix

Notes to Figure 5

OSL analyses results; **a)** the natural OSL signal of an aliquot from sample BU-13. Note that the signal decays rapidly (within 1s, LED power at *c.* 24 mW/cm^2), indicating the dominance of the fast OSL component; **b)** dose response curve for one aliquot of sample BU-13. The signal was measured for 40s, and integrated over the first 0.2s, with background subtraction over the last 4s of measurement. The data points were fitted with an exponential + linear fit. Three repeat points at the dose of 6Gy are all within 0.5% of each other; two are of the same dose (recycling) points and the third point was measured after the IRSL signal (IRSL depletion ratio). The D_e for this aliquot is 3.24±0.14Gy; **c)** preheat plateau for sample BU-13. Aliquots (shown as circles with error bars) were measured using a range of preheat temperatures. Note that while there is a scatter in the D_e among the aliquots, they do not vary as a function of the preheat temperature; **d)** histogram showing all 25 D_e measurements carried out for sample BU-13. Although there is a large scatter (D_e = 3.9Gy, standard deviation = 1.2Gy; shown in red), the distribution is roughly normal; **e)** dose recovery tests over a range of preheat temperatures. Two aliquots were measured at each temperature. Circles = preheat as shown on the x-axis and test dose preheat at 20°C less than preheat; triangle = preheat as shown, test dose preheat at 220°C; squares = preheat as shown, test dose preheat at 200°C. Average recovered to given ratios for all preheat temperatures is 0.97±0.04; **f)** radial plot of sample BU-13, showing single grain results (without negative values) and the finite mixture model D_e components. Wide shaded band is the most frequent component (57% of grains, showing $\pm 2\sigma$ range), that was used for age calculations; narrow band is a second, young component (37% of grains); the solid line is a third, old component (6% of grains).

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