Kites in the Desert: Placing Ancient Animal Traps in Context

Austin Hill, Bilal Fawwaz Boreni, Quinn Comprosky, Jennifer Feng, Rosemary Hanson, Blair Heidkamp, Morag M. Kersel, Kathleen D. Morrison, Gary Rollefson and Yorke Rowan

Introduction

The Harrat al-Sham, or the Black Desert, extends from southern Syria across Jordan and into northern Saudi Arabia. Across this virtually impassable rocky terrain, a remarkable number of anthropogenic features are identifiable. Although initially spotted by early aviators over 100 years ago, it is only through the more recent increase in accessibility of aerial and satellite imagery that the sheer quantity and widespread distribution has been recognized. The most familiar of these features are the desert 'kites,' extensive networks of animal traps built by prehistoric hunters in the Neolithic. Extensively mapped across a broad region (Crassard *et al.* 2015), over 6000 individual kites are currently mapped, and that number will expand with additional research in nearby regions (*e.g.*, Fradley *et al*. 2022). To date, 1281 kites are noted in Jordan (Crassard *et al.* 2015). The growing recognition of the abundance and distribution of kites across the region has driven significant research focus on the subject (Helms and Betts 1987; van Berg *et al.* 2004; Bar-Oz *et al.* 2011; Kempe and Al-Malabeh 2013; Abu Azizeh and Tarawneh 2015; Chahoud *et al.* 2015; Crassard *et al.* 2015; Hammer and Lauricella 2017; Repper *et al.* 2022), with most researchers working from remotely sensed data, although very recent excavations of kites contributed tantalizing new insights to their dating and function (*e.g.*, Crassard *et al.* 2022).

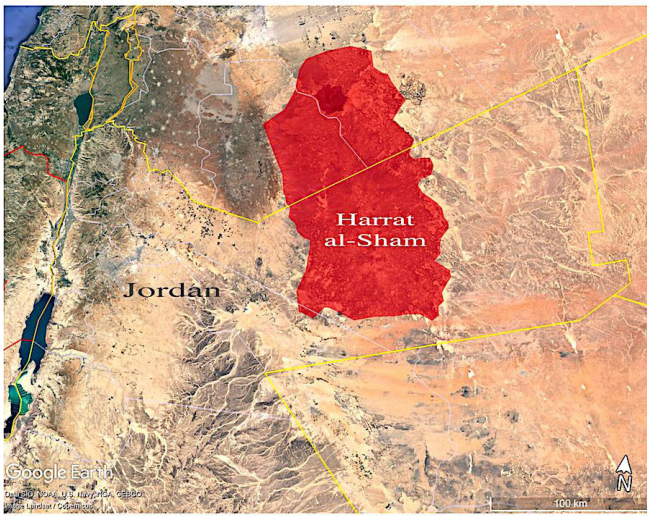

Fig. 1 The Black Desert, or Harrat al-Sham. (Figure: A. Hill; Map data: Google Earth Dada SIo, NOAA, US. Nav, NGA, CEBCO, Image Landsat/ Copernicus)

Fig. 2 *Phantom 4 RTK* taking off (*Emlid RTK* base station not pictured). (Photo: M. Kersel, KiC Project)

In June 2022, we launched a new project, the Kites in Context Project (KiC), which focused on a multi-scalar investigation of "Desert Kites" in the eastern *badia* region of Jordan, one of the core regions of kite distribution (Fig. 1). This long-term project is designed to provide novel insights into the chronology and function of these animal traps through an intensive study incorporating remote sensing with boots-on-the-ground excavation. The project operates at several scales of investigation, using satellite and aerial imagery to investigate the distribution of kites and associated structures throughout the region, drone imagery to map and record the landscape in high resolution around a small subset of kites in the *harra*, and excavation and terrestrial survey to study individual kites and associated structures at an even smaller scale.

In the first season (Summer 2022) of the KiC Project we had two primary goals: drone-based mapping of the landscape, with a focus on recording as many kites in the survey area as possible, and initial excavations of one kite. We decided to focus on the area around a site located along a wadi known locally as Wadi el-Mahdath, located at 32°19'35.64"N, 37°59'52.41"E. Chosen because the site appears to be a concentration point for human and animal use of the landscape, it contains many apparent Neolithic structures, and sits right along one of the core "chains" of kites in the *harra*. We focused our excavation efforts for the season on the kite that sits immediately to the north of Wadi el-Mahdath,

Neo-Lithics 22 DOI: 10.48632/nl.2022.1.105041

which we labelled "KiC 1-4", and the aerial survey on the kites to the immediate north and south.

Aerial Survey

Previous Work

This new project builds on the aerial survey work previously conducted (Hill *et al.* 2014; Hill and Rowan 2017, 2022) as part of the Eastern Badia Archaeological Project at the sites of Wisad Pools and Wadi al-Qattafi (Rowan *et al.* 2015, 2017; Rollefson *et al.* 2018; Hill *et al.* 2020). Earlier work demonstrated that high-resolution photogrammetry using drones can provide significantly more detailed recording of landscape data than satellite imagery alone, and at relatively low cost. By using drones to survey landscapes in the *badia*, we can record human-made features at a notably higher resolution than is possible with satellite imagery, allowing for the production of more detailed Digital Elevation Models/ DEMs. The increased resolution from drone mapping permits us to record smaller and more imperceptible prehistoric features than possible from the much coarser imagery of satellite data. We have greater information on the construction of anthropogenic structures and the utilization of landscape features like topography. The drone survey at Wadi al-Qattafi enabled us to produce a database of thousands of ancient and modern structures and to identify a previously unrecognized kite (Hill and Rowan 2022). With this proven methodology, we turn to mapping another area of the *badia* to understand better the complex association of different structures and the ancient use of this landscape.

2022 Aerial Survey Campaign

New aerial surveys are, in part, a continuation of aerial surveys we conducted between 2012 and 2016 as part of the Eastern Badia Archaeological Project (Hill *et al.* 2014; Hill and Rowan 2017). Between 2016-2019 it was impossible to get permission to operate drones for archaeological surveys, and then no fieldwork was conducted due to Covid in 2020-2021. In 2018, we experimented with using Kite Aerial Photography (KAP) for aerial surveys at the Eastern Badia Archaeological Project, but for large-scale surveys, this proved impractical. With the new project, we were delighted to receive permission to operate drones with the assistance of the Royal Film Commission and the Department of Antiquities, and through oversight by the military.

For this new project, we brought an advanced drone as our primary mapping equipment, a *DJI Phantom 4 RTK*, and a smaller, much less powerful drone, a *DJI Mini 2*, as a backup. The *Phantom 4 RTK* is based on an older drone model (the *Phantom 4*) but incorporates a Real Time Kinematic (RTK) GPS/GNSS receiver, making it an ideal archaeological mapping platform. RTK positioning onboard the drone collects centimeter-accurate positioning data as precision "geo-tags" attached to every recorded image. These high-precision geotags can be utilized when post-processing sets of overlapping images with photogrammetry software to produce exceptionally accurate, high-resolution, undistorted composite orthoimages of the landscape (Hill *et al.* 2019).

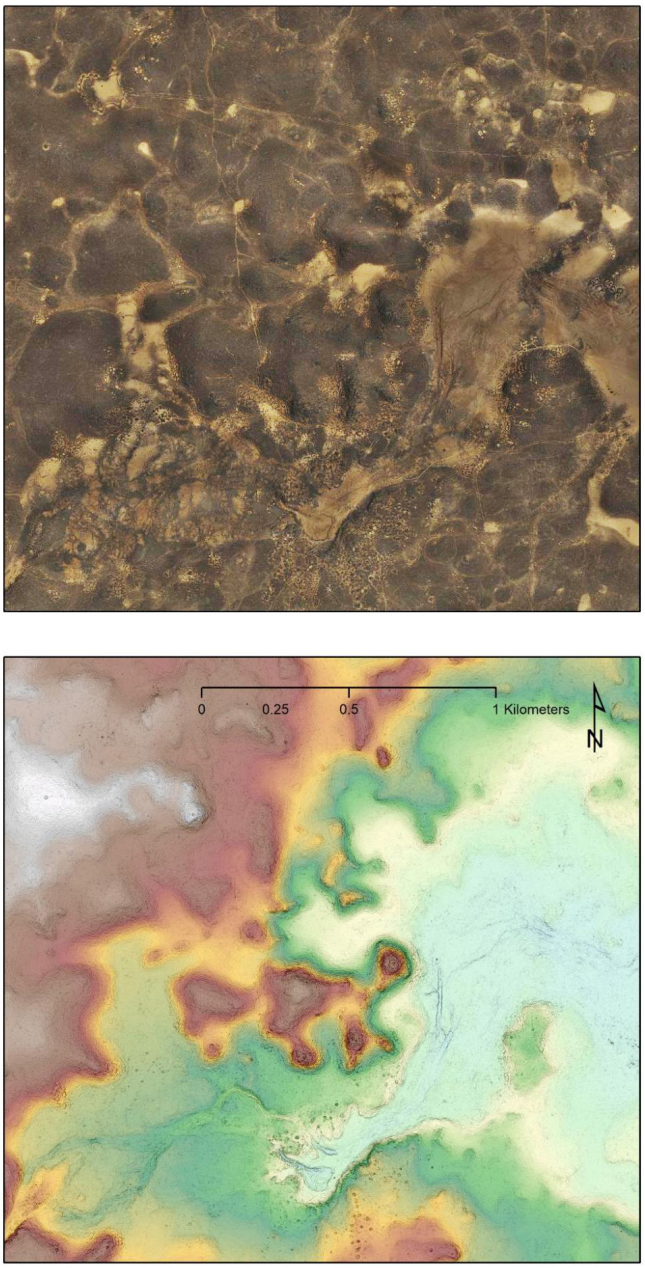

Fig. 3 An orthophoto (upper) and hillshaded DEM (lower) of a large area surrounding the site and excavation. (Figure and Imagery: A. Hill, KiC Project)

2022 Aerial Survey Results

The aerial survey was exceptionally successful. We visited 15 individual kites and flew approximately 24 different "missions" comprising between one and six batteries worth of flights per mission. We recorded approximately 14,000 drone images of the kites, other attached and nearby structures, and the surrounding

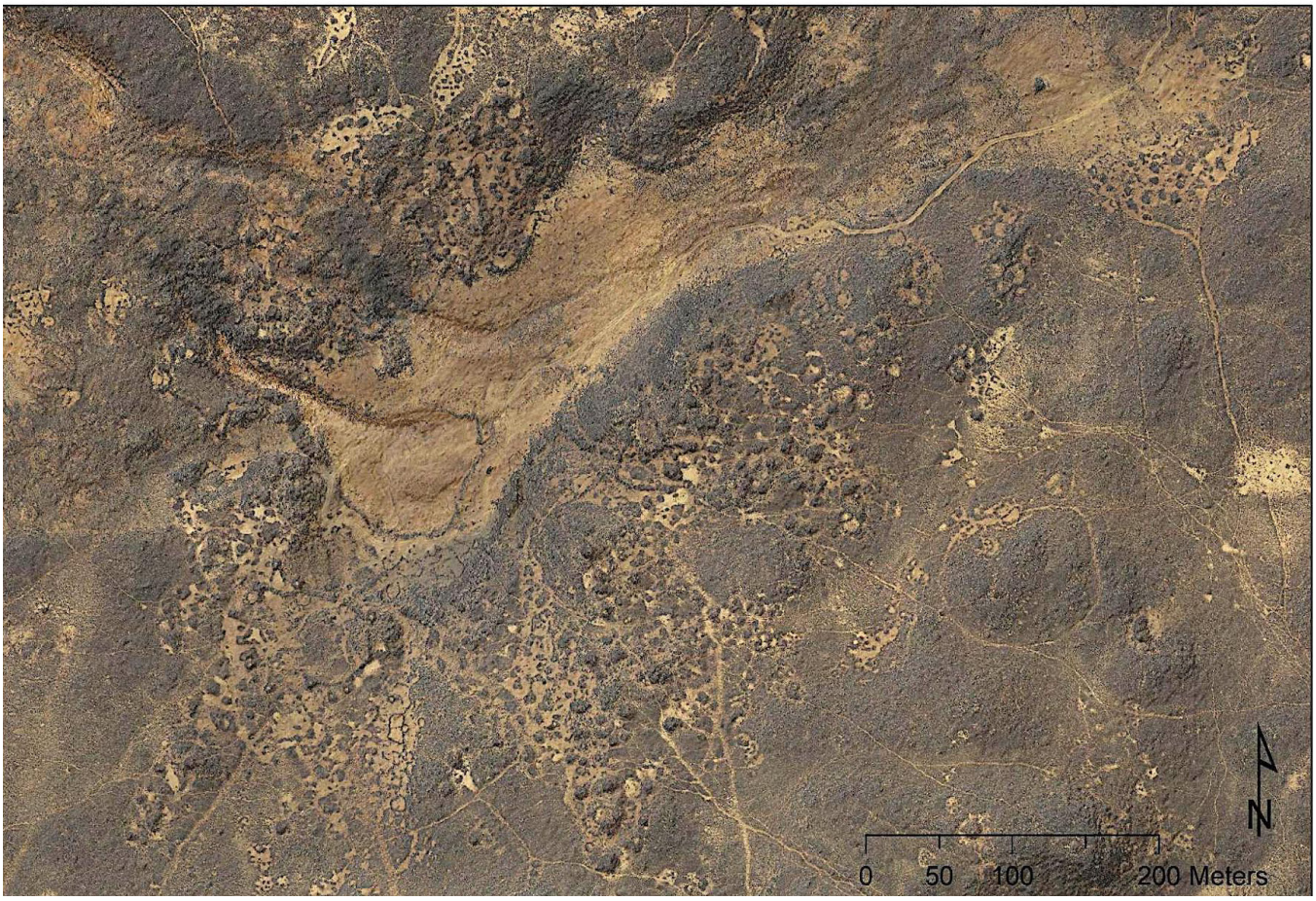

Fig. 4 A close-up ortho/ DEM composite showing the “Roman Pool” area. Note the kite on the southwest side of the pool and multiple structures around the pools. (Figure and Imagery: A. Hill, KiC Project)

Fig. 5 Oblique aerial view of two kites in the survey area. (Image: A. Hill, KiC Project)

landscape. The vast majority of these are sets of mapping images that will be post-processed to produce the primary output of the survey: Orthophotos and Digital Elevation Models (Figs. 3-4). That processing is ongoing. We can only do rough processing in the field to ensure the data is acceptable.

A smaller fraction, approximately 3,000 of the 14,000 images, are oblique shots that are primarily meant as illustrations and basic records of the kites and landscape. Like the APAAME project, these oblique shots provide an important record of the structures in the region as they existed in 2022 (Fig. 5).

Excavations

For the initial season of the KiC Project, the primary goal of the excavation was to examine the construction and function of the kite cells. In Kite 1-4, Cells 1, 9, and 10 were selected due to their intact form and locations within the kite (Fig. 6). Each cell was sectioned, and half of the cell was excavated. Multiple samples for OSL dating were taken from each excavated cell and one below the sondage of the enclosure wall.

Kite KiC 1-4, Cell 9: Cell 9 (Fig. 7) was bisected along a north-south axis, cutting the cell in half from the apparent entrance to the cell from the kite interior to the exterior cell wall. The cell is circular in shape with walls that are 1.25-2m thick, though we suspect the thickness may have resulted from the tumble of the previously higher walls and superstructure. At present, the walls are 2-3 courses high and constructed by loose stacking of smaller cobbles with larger stones placed on top. The interior of the cell measures 4m across. The eastern half of the cell was excavated. The top 70cm of fill was a homogeneous reddish beige loose sediment. At 70cm below the surface, the sediment became much more compact and a lighter beige color. This continued to the top of the bedrock, which was exposed at 80cm below the surface. Within the entire fill matrix, there were a number of small to medium-sized cobbles, which were located primarily around the exterior wall, indicating they likely were tumble. The bedrock at the bottom of Cell 9 covered over half of the base of the section. It was flat and could have been used as a surface or floor for the cell.

Kite KiC 1-4, Cell 10: Sectioned on the north-south axis, Cell 10 (Fig. 7) had a similar sediment sequence to that of Cell 9, with light loose sand sediment at the top, becoming slightly more compact. At least one small drill was found within this sediment and fragments of Dabba marble or turquoise. Cell 10 was distinguished by the collection of smaller cobbles near the bottom of the cell (cobbles, *c.* 130 x 83cm). Removing those cobbles exposed an interesting alignment of larger basalt cobbles that seemed to line one side of an additional pit feature. This was apparently the sterile sediment that was excavated to create greater depth at the bottom of the cell.

Kite KiC 1-4, Cell 1: Cell 1 was bisected across the southwest to northeast axis to accurately section the

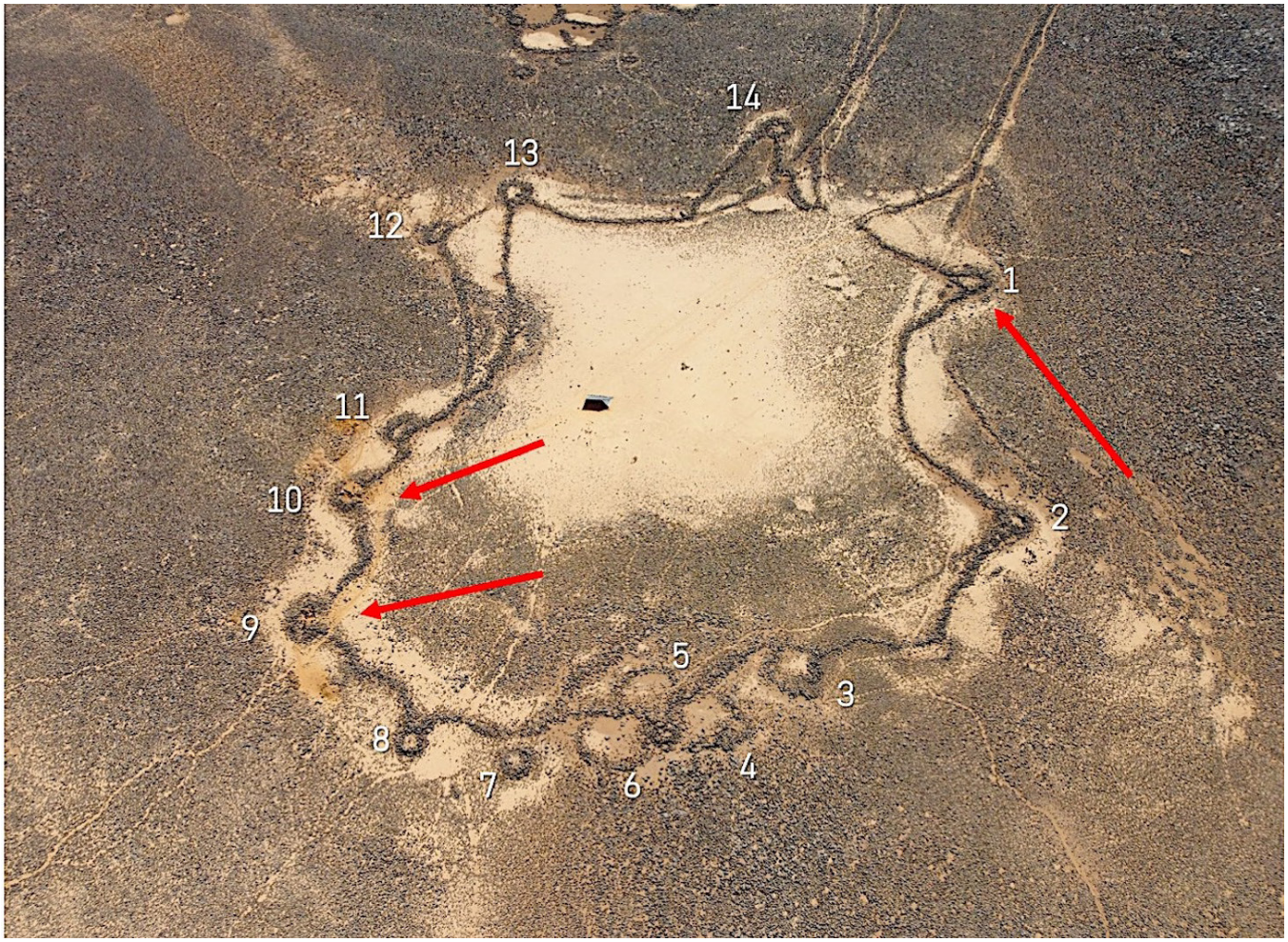

Fig. 6 Oblique view of a pair of kites (1-15 and 1-16) in the survey area, shot with the *DJI Mini* 2 drone. (Image: A. Hill, KiC Project)

Fig. 7 Views of excavated Cells 9 and 10. (Photo: Y. Rowan, KiC Project)

cell in half. The circular cell was larger than Cells 9 and 10. The interior fill was homogeneous reddish beige. In the upper 35cm, small to medium cobbles were found primarily around the edges of the exterior wall. At 35cm below the surface, we started to find larger slabs, particularly in the northern section towards the wall with the interior of the kite. These slabs were all slanted with the eastern edges pointed down. Some of these slabs looked as if they were stacked on another flat slab located on the center section line, cutting the cell in half. These slabs were not found in the southern section of the cell. At 40-50cm down, a series of large flat stones appeared in the bottom of the cell, apparently bedrock. The slanted slabs appear to have been stacked on this bedrock, possibly creating a short wall sectioning the cell into smaller compartments. Also of note is a large stone standing up, which appears to be wedged between bedrock slabs and secured with small and medium cobbles. This upright stone could be another edge of an interior section with the slabs in the center line. The fill continues down to a gritty pebble-filled layer, which appears to be sterile, eroded basalt bedrock. The northeast quadrant of Cell 1, between the slabs and upright, reaches 70-80cm of depth.

The excavation of these three structures demonstrates a diversity of construction styles for the kite cells. The shape of the cells, depth, and bases are all varied. All three cells have walls facing the interior of the kite. If the function of the kite cells was to capture gazelle where they would then be captured or killed (Crassard *et al.* 2022), it makes little sense for the cells to have walls facing the interior of the kite, closing off the cells. If the walls facing the interior of the kite are original, this would hinder the entrance of a gazelle, which could easily jump back out if it jumped into the cell. Given the presence of the wall facing the interior kite and the shallow depth of the cells, our current hypothesis is that these cells served as "hunter's blinds", where the hunters would be hidden until the gazelle entered the large enclosure. This suggests that the cells at this kite are more likely to be hunting blinds than gazelle pit traps, unlike those discovered at other recently excavated kites in Jordan with much deeper cells (Crassard *et al.* 2022: Figs. 5-7). Additional cells must be excavated to understand if there are two different forms of cells with different functions.

Petroglyph Survey

At the main part of the site, around Wadi el-Mahdath, we noticed a high concentration of petroglyphs clustered around the potential water source of the area the local Bedouin refer to as the "Roman Pool". Like the clustering of petroglyphs at Wisad Pools, the rock art depicts a range of animals (Hill *et al.* 2020). We undertook a small survey of the petroglyphs to see if we could see any patterning that might delineate any association with the many hundreds of anthropogenic structures in this area. Many of the structures appear to be later tower tombs, presumably dating between the Iron Age to Safaitic period, like those found at most higher elevation spots across the *badia*, but given the presence of the kite chain, water resources and flint scatters, we assume many must be earlier as well. We hoped that surveying the petroglyphs might give some glimpse into past distributions of human occupation on the landscape.

We surveyed a 100 x 200m area and recorded all observed petroglyphs (Fig. 8). In total, there were more than 400 individual petroglyphs. Somewhat surprisingly, there is distinct patterning to the distribution. Most petroglyphs occur at the highest elevations in the survey area. Density drops significantly, almost to zero,

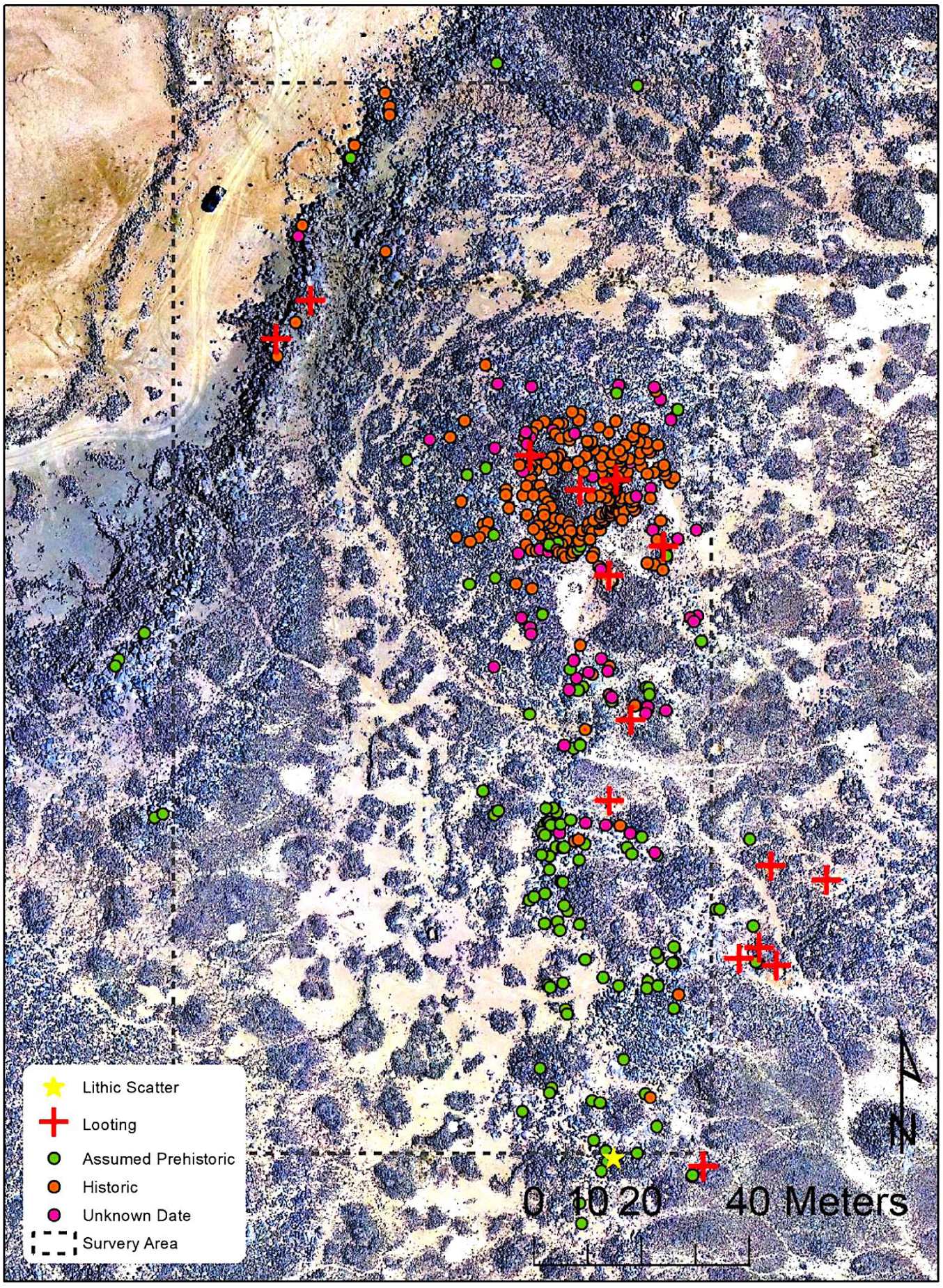

Fig. 8 The distribution of petroglyphs, looting, and lithic scatters near the “Roman Pool.” (Fig. and imagery: A. Hill, KiC Project)

everywhere else, except where vertical stones with faces pointing toward the "pool" area. Around the largest and highest tomb, which we assume to be a later-period burial, there are dense clusters of camel depictions and Safaitic inscriptions. But only a few dozen meters to the south of this cluster, the camels and Safaitic inscriptions disappear and are replaced by petroglyphs that we associate with earlier periods and depictions of wild animals like ibex, like the pattern documented at Wisad Pools (Hill *et al.* 2020).

As part of this survey, we collected surface samples of lithics from a few areas that had been disturbed by looting (Fig. 9). This small sample was analyzed to give some context for the area around the peak petroglyph density and close to the pool. Lithics collected include PPNB naviform blades and cores, a mix of Late Neolithic blades, some of which have likely been reworked in the Chalcolithic/Early Bronze age into denticulates, and a Late Acheulian/Early Middle Paleolithic Levallois point.

Looting

In the past, we have identified evidence of looting at our previous sites in the *badia*, at Wisad Pools and Wadi al-Qattafi. Those sites are significantly more difficult to get to than the current survey area. Unsurprisingly, we noticed significant evidence for looting at and around the main site of Wadi el-Mahdath (see Fig. 6) and at many of the kites and structures we visited. Recording looting and more recent disturbances to the area is an ongoing and elemental part of understanding the use of this landscape in the past and in the present, and a core part of our work documenting the current context of the desert kites.

Conclusion

From the drone mapping to the excavations of kite cells and recording the rock art and looting, this was a successful archaeological season for the new KiC Project. Processing the 14,000 images into orthophoto maps and Digital Elevation Models will take many more months of work, but initial testing demonstrates that this data will produce maps with superb accuracy and excellent coverage. Our excavations of the kite cells leave unanswered questions – how did they function? Did hunters use them to lie in wait for gazelle, or were they pits for the gazelle to fall into during their panic, as seemed likely elsewhere? We expected to find deep pits like those recently published by Crassard and colleagues (Crassard *et al.* 2022), indicative of the latter. Still, our results suggest there may be more variability, with at least some possibly functioning as blinds. Further testing will be necessary to determine whether this is correct or not. Crucially, we hope that OSL and ^{14}C dating, from this season and future seasons, will also help answer some of the ongoing questions about the timing of the construction and abandonment of these structures. There remain very few good, published dates for the kites and we hope that our work will help build a comprehensive picture of kite development and operation. Future seasons of research will focus on additional mapping of kites and the associated features as well as expanded excavation of kites and associated structures that have been surveyed and mapped via drone.

Acknowledgements: We thank the Department of Antiquities of Jordan for their support and permission to conduct research in the region. This material is based upon work supported by the National Science Foundation under Grant #2122443.

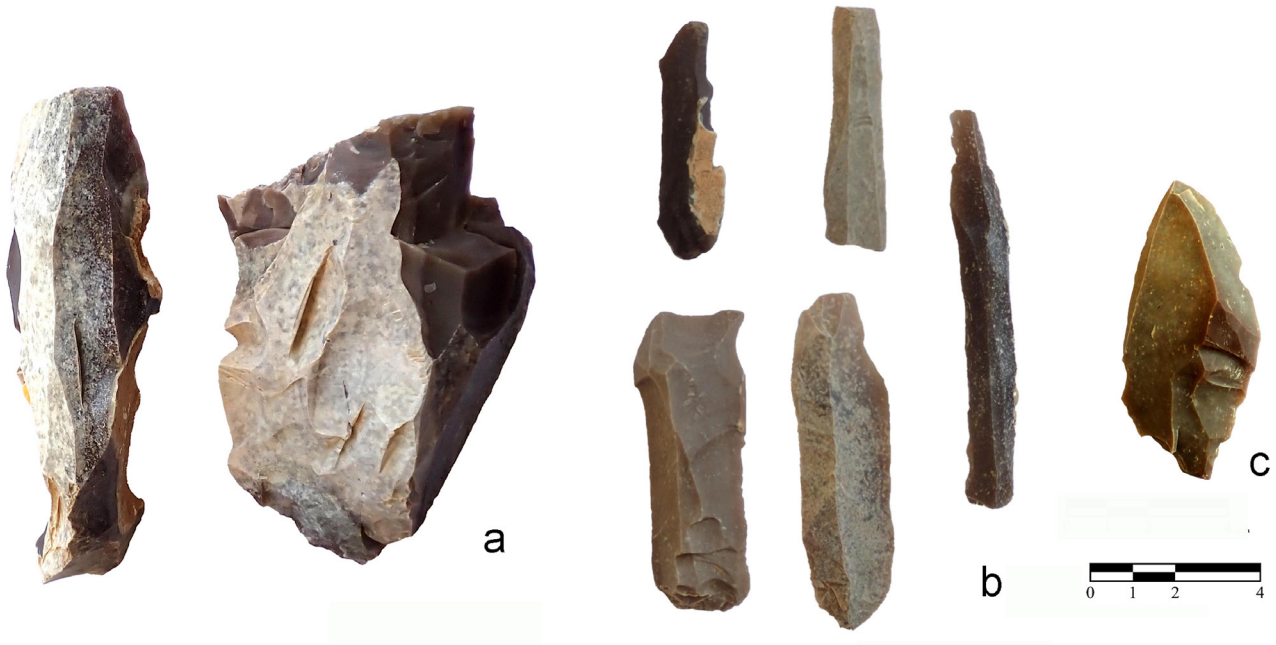

Fig. 9 Lithics collected from the surface near a looter's pit, close to the concentration of petroglyphs. (Photos: G. Rollefson, KiC Project)

Austin Hill
University of Pennsylvania, Philadelphia
Corresponding author: chadhill@sas.upenn.edu

Bilal Fawwaz Boreni
Department of Antiquities of Jordan, Amman

Quinn Comprosky
Indiana University, Boomington

Jennifer Feng
University of Pennsylvania, Philadelphia

Rosemary Hanson
National Historical Museums of Sweden, Stockholm

Blair Heidkamp
University of Texas at Austin

Morag M. Kersel
DePaul University, Chicago

Kathleen D. Morrison
University of Pennsylvania, Philadelphia

Gary Rollefson
Whitman College, Walla Walla

Yorke Rowan
University of Chicago

References

Abu Azizeh W. and Tarawneh M.B.
2015 Out of the *harra*: desert kites in south-eastern Jordan. New results from the South Eastern Badia Archaeological Project. *Arabian Archaeology and Epigraphy* 26: 95-119.

Bar-Oz G., Nadel D., Avner U. and Malkinson D.
2011 Mass hunting game traps in the southern Levant: the Negev and Arabah "Desert Kites". *Near Eastern Archaeology* 74: 208-215.

Chahoud J., Vila E. and Crassard R.
2015 A zooarchaeological approach to understanding desert kites. *Arabian Archaeology and Epigraphy* 26: 235-244. https://doi.org/10.1111/aae.12054

Crassard R., Abu Azizeh W., Barge O., Brochier J.É., Chahoud J. and Régagnon E.
2022 The use of desert kites as hunting mega-traps: functional evidence and potential impacts on socioeconomic and ecological spheres. *Journal of World Prehistory* 35: 1-44. https://doi.org/10.1007/s10963-022-09165-z

Crassard R., Barge O., Bichot C.E., Brochier J.É., Chahoud J., Chambrade M.L., Chataigner C., Madi K., Régagnon E. and Seba H.
2015 Addressing the desert kites phenomenon and its global range through a multi-proxy approach. *Journal of Archaeological Method and Theory* 22: 1093-1121.

Fradley M., Simi F. and Guagnin M.
2022 Following the herds? A new distribution of hunting kites in Southwest Asia. *The Holocene* 32: 1160-1172. https://doi.org/10.1177/09596836221114290

Hammer E. and Lauricella A.
2017 Historical imagery of desert kites in Eastern Jordan. *Near Eastern Archaeology* 80: 74-83.

Helms S. and Betts A.
1987 The desert kites of the Badiyat esh-Sham and North Arabia. *Paléorient* 13(1): 41-67.

Hill A.C. and Rowan Y.
2017 Droning on in the Badia: UAVs and site documentation at Wadi al-Qattafi. *Near Eastern Archaeology* 80: 114-123.
2022 The Black Desert Drone Survey: new perspectives on an ancient landscape. *Remote Sensing* 14: 702. https://doi.org/10.3390/rs14030702

Hill A.C., Limp F., Casana J., Laugier E.J. and Williamson M.
2019 A new era in spatial data recording: low-cost GNSS. *Advances in Archaeological Practice* 7: 169-177. https://doi.org/10.1017/aap.2018.50

Hill A., Rowan Y. and Kersel M.M.
2014 Mapping with aerial photographs: recording the past, the present, and the invisible at Marj Rabba, Israel. *Near Eastern Archaeology* 77: 182-186. https://doi.org/10.5615/neareastarch.77.3.0182

Hill A.C., Rowan Y.M., Wasse A. and Rollefson G.O.
2020 Inscribed landscapes in the Black Desert: petroglyphs and kites at Wisad Pools, Jordan. *Arabian Archaeology and Epigraphy* aae.12158. https://doi.org/10.1111/aae.12158

Kempe S. and Al-Malabeh A.
2013 Desert kites in Jordan and Saudi Arabia: structure, statistics and function, a Google Earth study. *Quaternary International*. *Worldwide Large-Scale Trapping and Hunting of Ungulates in Past Societies* 297: 126-146. https://doi.org/10.1016/j.quaint.2013.02.013

Repper R., Kennedy M., McMahon J., Boyer D., Dalton M., Thomas H. and Kennedy D.
2022 Kites of Al-Ula County and the Ḥarrat ʿUwayriḍ, Saudi Arabia. *Arabian Archaeology and Epigraphy* 33: 3-22. https://doi.org/10.1111/aae.12214

Rollefson G., Rowan Y., Wasse A., Kersel M., Hill A., Lorentzen B., Ramsay J. and Jones M.
2018 Excavations of structure W-80, a complex Late Neolithic building at Wisad Pools, Black Desert. *Annual of the Department of Antiquities of Jordan* 59: 531-544.

Rowan Y.M., Rollefson G.O., Wasse A., Abu Azizeh W., Hill A.C. and Kersel M.M.
2015 The "land of conjecture": new late prehistoric discoveries at Maitland's Mesa and Wisad Pools, Jordan. *Journal of Field Archaeology* 40: 176-189.

Rowan Y.M., Rollefson G., Wasse A., Hill A.C. and Kersel M.M.
2017 The Late Neolithic presence in the Black Desert. *Near Eastern Archaeology* 80: 102-113. https://doi.org/10.5615/neareastarch.80.2.0102

van Berg P.L., Vander Linden M., Picalause V., Lemaitre S. and Cauwe N.
2004 Desert-kites of the Hemma Plateau (Hassake, Syria). *Paléorient* 30: 89-99.