KITES IN CONTEXT

YORKE M. ROWAN AND AUSTIN "CHAD" HILL

The inaugural season of the Kites in Context project ran from June 17 to July 7, 2022. This new project, funded by a grant from the National Science Foundation to Austin "Chad" Hill, Kathleen Morrison, and Yorke Rowan, is designed to explore the phenomenon known as "kites" in the Black Desert of eastern Jordan. Termed *kites* by early pilots flying over the region in the 1920s because of their resemblance to a small boy's kite when viewed from the air, these structures are animal traps for hunting gazelle. Often joined by additional wall networks, they form chains of traps extending across the rocky terrain from Syria to Saudi Arabia. Although well known from satellite imagery, little archaeological research has been conducted on kites until very recently due to the difficulty of field work in the region. This multiyear project is designed to learn more about the chronological development and function of these traps through multiple scales of investigation, including satellite imagery to examine the distribution of kites and associated structures, drone imagery to map and record the landscape in high resolution, and excavation and terrestrial survey to study individual kites at a much smaller scale.

For this first year of the Kites in Context project, our primary goals were to begin drone-based mapping of the landscape, with a focus on recording as many kites in the local area as possible, and initial excavations of selected features of one kite. We concentrated on the area around a site located along a wadi roughly 25 km southwest of er-Ruweished, Jordan. This site appears to be a focal point for human and animal use of the landscape, represented by many possible Neolithic structures, and sits right along one of the core "chains" of kites in the eastern desert. Excavation during the 2022 season focused on the kite immediately to the north of this wadi, which we have labeled "Kite 1-4." The aerial survey concentrated on kites and associated features to the immediate north and south.

Our small team included Morag Kersel (DePaul University); students Blair Heidkamp (University of Texas at Austin), Rosemary Hanson, Quinn Comprosky (DePaul University), and Jen Feng (University of Illinois Urbana-Champaign); and Department of Antiquities representative Bilal Boreni. Additional assistance was provided by local visitors who provided information, suggestions, guidance, and sometimes cold drinks or fresh coffee and tea.

EXCAVATIONS

For the initial season of the Kites in Context project, the primary goal of the excavation was to start to understand the construction and function of the kite cells. Kite 1-4 was selected because it was intact and largely untouched by modern changes (e.g., road cuts, limestone mining). Nevertheless, accessibility was challenging because vehicles could come within only 2 km of the kite, so all equipment had to be carried in on foot, requiring a daily hike across the rocky terrain (fig. 1).

We selected three cells around the main enclosure of Kite 1-4 for excavation. Each was sectioned and half the cell was excavated, with the sediment sieved. Cells 1, 9, and 10 (fig. 2) were selected because they were intact. The interior configuration of each was not homogenous. Cell 9, for instance, is circular in shape, with walls that are 1.25–2.0 m thick, though the thickness is created in

part by the tumble (fig. 3). The walls were apparently two to three courses high and constructed by loose stacking of smaller cobbles with larger stones placed on top. The interior of the cell measures 4 m across. Flat bedrock was exposed at 80 cm below the surface, covering more than half the exposure, and could have been used as a surface or floor for the cell. Few artifacts were recovered from the sieving.

Cell 10 had a similar sediment sequence to that of Cell 9, but many smaller cobbles were discovered toward the bottom (fig. 4). Removal of those cobbles exposed an interesting alignment of larger basalt cobbles, perhaps outlining the edge of a pit (figs. 5 and 6). No basaltic bedrock was discovered. Within this sediment at least one small drill was found, as well as fragments of Dabba marble (or possibly turquoise).

Figure 1. Landscape view from Kite 1-4 down to camp.

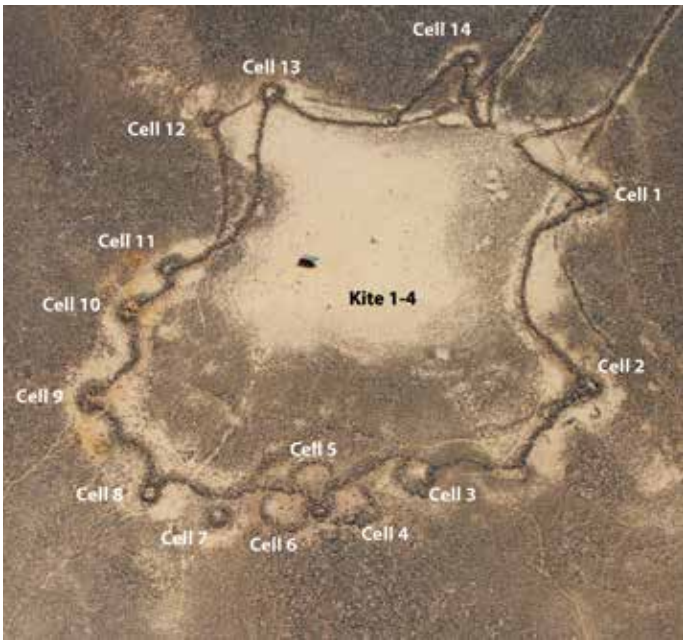

Figure 2. Kite 1-4, aerial view, with cell numbers marked (object in center is a shade).

Figure 3. Cell 9, basalt bedrock at bottom of excavation.

Figure 4. Cell 10, cobbles found near bottom of excavation.

Figure 5. Cell 10, bottom of cell.

Figure 6. Cell 10, stack of large basalt slabs.

Cell 1, larger than Cells 9 and 10, was bisected across the southwest–northeast axis to section the cell in half accurately. Although its loose, sandy fill was like that of the other cells, larger slabs 35 cm below the surface suggested a stack that had possibly fallen over. At 40–50 cm below the cell's surface, a series of large, flat stones appeared to be bedrock.

These three cells demonstrate a diversity of construction styles for the kite cells, with varying shapes, depths, and floors. All three have walls facing the interior of the kite, suggesting that these cells probably represented blinds for hunters waiting for animals to enter the larger enclosure. An optically stimulated luminescence sample was collected from each of the cells in hopes of dating their construction.

AERIAL SURVEY

Previous Work

This new project builds on the aerial survey work that we conducted as part of the Eastern Badia Archaeological Project at Wisad Pools and Wadi Qattafi (Hill et al. 2020; Hill and Rowan 2017, 2022; Hill, Rowan, and Kersel 2014; Rowan et al. 2015, 2017). We previously demonstrated that high-resolution photogrammetry using drones can provide significantly greater recording of landscape data than satellite imagery alone. By surveying landscapes in the *badia* (desert areas) with drones, we can record human-made features at significantly higher resolution than is possible with satellite imagery, and we are able to produce elevation data (digital elevation models, or DEMs) that provide more information about how human-made structures were built to utilize landscape topography. Drone mapping allows us to record smaller and more difficult-to-see prehistoric features that may be challenging or impossible to document from satellite data. For instance, our drone survey at Wadi Qattafi allowed us to produce a database of thousands of ancient and modern structures (Hill and Rowan 2022).

2022 Aerial Survey Campaign

Our last drone-based survey with the Eastern Badia Archaeological Project was in 2016, when flying drones in Jordan was still permitted. We were happy to receive permission for the new project, with the help of the Royal Film Commission of Jordan and the Department of Antiquities, and with oversight by the military, to operate drones as part of the 2022 field season.

Our primary mapping equipment is an advanced drone—a DJI Phantom 4 RTK—and a smaller, much less powerful drone—a DJI Mini 2—as a backup. Based on an older drone model (the Phantom 4), the Phantom 4 RTK incorporates a real-time kinematic (RTK) GPS/GNSS receiver that makes it an ideal platform for archaeological

Figure 7. The Phantom 4 RTK taking off. Photo by Morag M. Kersel.

mapping (fig. 7). RTK positioning on board the drone is used to collect centimeter-accurate positioning data as "geotags" attached to every recorded image. These high-precision geotags can be used when post-processing sets of overlapping images with photogrammetry software to produce exceptionally accurate, high-resolution, and undistorted composite orthoimages of the landscape.

Figure 8. The Mini 2. Photo by Morag M. Kersel.

The Phantom 4 RTK is expensive, requires large batteries that take time to charge, and is slow and difficult to move around the landscape. The Mini 2 (fig. 8) makes an excellent backup in the event there are problems with the bigger drone, and it can also take quick, oblique photographs of the landscape. This drone worked perfectly for getting quick snapshots of the landscape showing the kites, related structures, and excavations. These images are not crucial for the analysis or mapping, but they are incredibly useful for illustrating the project.

2022 Aerial Survey Results

Fifteen individual kites were visited and approximately twenty-four different missions were flown, recording approximately 14,000 drone images of the kites and surrounding landscape. The vast majority are sets of mapping images that will need to be post-processed to produce the primary output of the survey: orthophotos and DEMs. In the field we are able to do only rough processing to check the data, and post-processing will take many weeks. But the result will be data such as the lower-resolution orthophoto and DEM shown in figure 9. A smaller fraction,

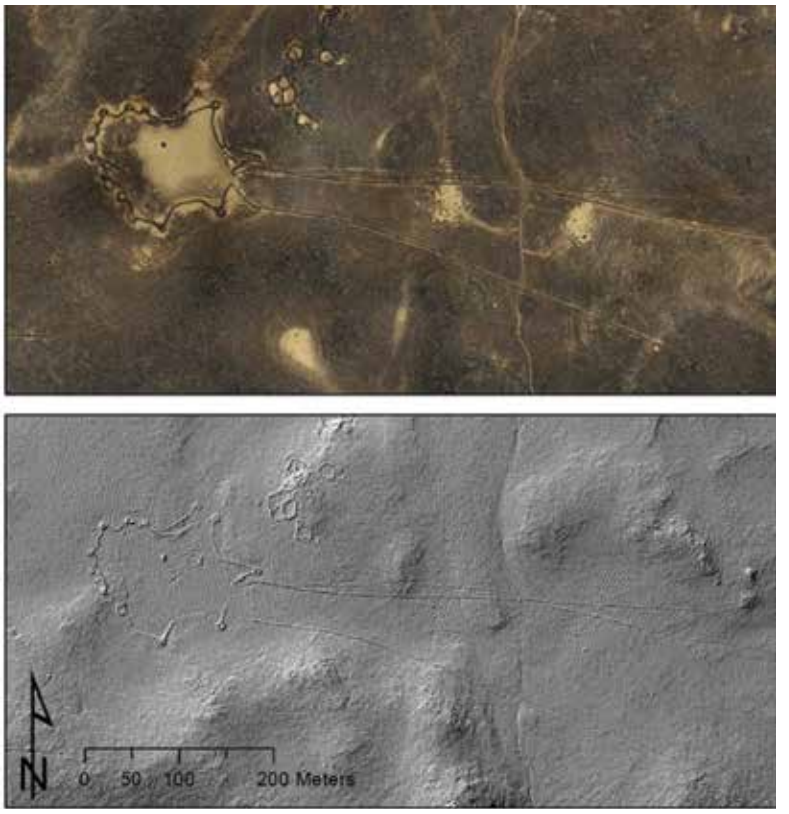

Figure 9. Low-resolution, quickly processed orthophoto (top) and DEM (bottom) of the area around Kite 1-4.

Figure 10. Oblique shot of kite with a "wheel" incorporated into the enclosure of the trap.

approximately 3,000 of the 14,000 images, are oblique shots meant primarily to serve as illustrations and basic recording of the kites and landscapes (fig. 10).

PETROGLYPH SURVEY

A high concentration of petroglyphs clustered around the potential water source of the area, which the local Bedouin refer to as the "Roman pool." This clustering of petroglyphs seemed similar to one that we have previously written about at Wisad Pools, although less diversity of animals is represented (Hill et al. 2020). We undertook a small survey of the petroglyphs to see if we could get a glimpse into the past use of the landscape. We surveyed a 100 × 200 m area, recording more than 400 individual petroglyphs. Surprisingly, distinct patterning to the distribution is apparent. Petroglyphs concentrate at the highest elevations in the survey area, declining in density downslope except for vertical stones facing the pool area of the wadi. Surrounding the largest and highest tomb, presumably a burial from a later period, are dense clusters of camel depictions and Safaitic inscriptions. Immediately to the south, the camels and Safaitic inscriptions are replaced by petroglyphs that we associate with earlier prehistoric periods, as well as depictions of wild animals such as ibex (fig. 11).

Figure 11. Petroglyphs of ibex.

CONCLUSION

From the drone mapping to the excavations of kite cells and recording of rock art, this archaeological season was a successful one for the new Kites in Context project. Processing the 14,000 images into orthophoto maps and DEMs will take many months, but initial testing demonstrates that this data will produce maps of the greatest accuracy. Our excavations of the kite cells leave some questions unanswered—for example, how did they function? Did hunters use them as hunting blinds to wait for gazelle, or were they pits for the gazelle to fall into during their panic? We suspect that the former is the case, but confirmation will require further testing. Future seasons of research will focus on additional mapping of kites and excavation of structures that seem to be associated with the kites.

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