

Aerial survey of the cemetery and surrounding fields at Metsamor

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Abstract: The first aerial survey conducted within the vicinity of the ancient city of Metsamor and its cemetery detected several promising anomalies in the aerial photos and processed images within and beyond the known limits of the burial ground. The survey results are discussed in this article along with a brief outline of the burial types found in this cemetery.

Keywords: aerial photography, survey, photogrammetry, Metsamor, necropolis, kurgan, cromlech, Karmir-Berd culture, Lchashen-Metsamor culture

The ancient city of Metsamor lies within the boundaries of the Metsamor Historical-Archaeological Museum-Reserve near the modern village of Taronik about 35 km west from the capital, Yerevan [Fig. 1]. The area was settled as early as the end of 5th – beginning of the 4th millennium BC and remained as such, with intervals, until the 17th century AD. The nucleus of the settlement is located on and around the main citadel, while the necropolis is situated outside the limits of the protected area about 500 m directly to the east.

The site, including the cemetery, was intensively excavated from the 1960s to the 1990s by Armenian archaeologists Emma Khanzadyan and Koryun Mkrtchyan, while further works, carried out by Ashot Piliposyan in 2011–2013, focused solely on the

burial ground. More than 100 burials have been unearthed in the area since the 1960s. The earliest assemblage of excavated tombs, mainly rectangular cist graves, can be dated to the Middle Bronze Age III¹ and represents for the most part the Karmir-Berd horizon (Khanzadyan 1995: 5–37). However, the most numerous burial types are small cist and box graves belonging to the Lchashen-Metsamor culture, dated now anywhere from the Late Bronze Age until Iron II (Khanzadyan, Mkrtchyan, and Parsamyan 1973: 178). The latest burials come from the first half of the 7th century BC.

The best-known funerary structure of the period between the Middle Bronze Age and Iron II in this region is a kurgan (tumulus burial or barrow). These structures are typically circular in shape with an earth

¹ Periodisation after Smith, Badalyan, and Avetisyan 2009: 34, Fig. 2.

or stone mound (in some cases both) covering single or multiple earthen burial pits or stone-built chambers. The tumulus is sometimes surrounded by a ditch or a ring of stones, the so-called cromlech (Badalyan et al. 2008: 59). A new type of circular superstructure, confusingly referred to also as a cromlech, appeared in the region in the Late Bronze–Iron I Age. This is a layer of stones on a flat surface, arranged in circular fashion atop the burial cham-

ber (Marshall 2012: 162–163). It co-exists with the kurgan tradition sharing many of its attributes to such an extent that without a superstructure it is often difficult to determine the typology of the burial. Despite the popularity of burial structures of this kind, only a dozen or so have been excavated at Metsamor. Typically, they are dated to the Late Bronze–Iron I Age and contain single burials within well-built rectangular stone chambers.

THE SURVEY

Excavations in the cemetery area were resumed in 2016 by a joint Armenian–Polish archaeological mission. The arable land surrounding the main necropolis and a field situated about 400 m north of the citadel were investigated with aerial photography and with photogrammetric documentation methods. The size of the areas in question are 22 and 4 ha respectively. The larger field was understandably known

to contain burials but the full extent of the burial ground had never been determined. The second, smaller field had not been investigated by archaeologists to date. Moreover, no aerial survey had ever been conducted in any of these areas before.

The survey of the necropolis took place on 16 September while the second field was photographed the following day, 17 September. On both days the weather

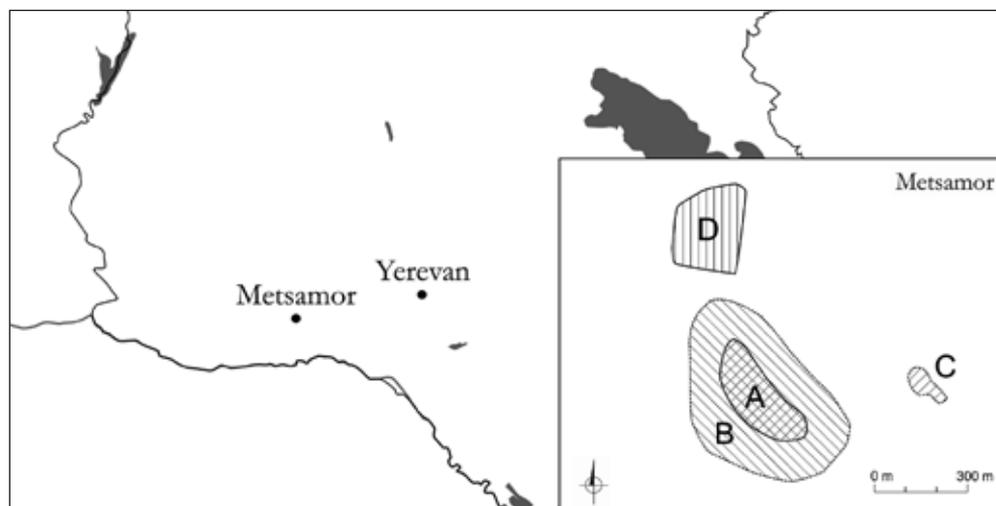


Fig. 1. Metsamor on the map and the location of the citadel (A), "lower town" (B), cemetery (C) and "northern field" (D) within the archaeological site (Drawing O. Bagi)

conditions were favorable for aerial photography, the wind was below 1 m/s and the sky was cloudy, however there were a few short sunny intervals during the survey, which resulted in some shadow and color differences between pictures. A DJI Phantom 3 Advanced Quadcopter was used for aerial photography. It was equipped with a built-in Sony EXMOR 1/2.3" 12.4 Mpix camera fitted with a 20 mm (35 mm format equivalent) f/2.8 lens producing 4000×3000 pixel resolution images. A 2.4 GHz DJI (in-built) radio controller in conjunction with a NVIDIA Shield K1 tablet running the DJI Go application to display flight parameters and live video transmission were used to control the aircraft, which helped to frame the pictures while photographing.

In total, 291 pictures were taken over the cemetery field from an average height of 61.50 m. The images were captured in DNG format with ISO set to 100 to minimize noise and increase accuracy during the photogrammetric processing. Six ground control points were placed in the field for referencing using high visibility red paint spray. High accuracy measurements of the said points in a locally established coordinate system were taken with a Leica TCR 407 Total Station. The second, smaller field was surveyed provisionally without taking reference points and measurements. Altogether 20 vertical and oblique pictures for visual reconnaissance purposes were taken from a height of 200 m.

The images showing the cemetery field were converted to lossless TIFF format and



Fig. 2. Orthophoto of the cemetery
(Photo M. Truszkowski, O. Bagi)

fed into the Agisoft Photoscan software for further processing. Once the camera was aligned, a dense cloud was generated using medium settings producing 47.4 million points. The mesh was also created in medium details resulting in 750573 faces. The resolution of the texture was set to 8192×8192 pixels. After camera optimization, the obtained model accuracy was outstandingly high: 2.2 cm on the X, 1.2 cm on the Y and 0.7 cm on the Z (elevation) axis. The next step, after generating a 3D model, was the creation of an orthophoto [Fig. 2] and a Digital Elevation Model (DEM) with resolutions of 11952×12288 and 8426×9654 pixels

respectively. Therefore, the attained ground resolution for the orthophoto was as high as 2.4 cm/pixel while that for the DEM was 9.61 cm/pixel. The project was saved in Photoscan's native psx file format, as well as in OBJ, for increased compatibility with other 3D software. The orthophoto and the DEM were exported as geoTIFF and further processed in XnView and QGIS. In XnView, a relief filter was applied to the orthophoto, while in QGIS the DEM was further enhanced by applying different colors to elevation thresholds. Also, a new layer was created utilizing the hill shade terrain analysis algorithm to make surface details more visible.

INTERPRETATION

Examination of the results from the necropolis, once the evidence of modern activity covering most of the field was disregarded, allowed five anomalies to be marked as possible traces of past human activity. All were located in the northwestern corner of the photographed area, in the vicinity of the known burials; they have been numbered continuously from 1 to 5 [Fig. 3]. Some of them likely date to the same period as the settlement excavated by the Armenian–Polish team on the slope of the citadel.

Some of the already unearthed larger burial structures are visible in the aerial pictures, hence they will be used as reference points in this article for convenience. However, due to imprecise documentation techniques typical of the early excavations in the region and the general lack of relevant data, neither the correct numbering nor the typology of the tombs excavated earlier could be established to this date. Therefore, to avoid confusing the reader, the three

circular burial structures visible in the photos and the one unearthed by the joint Armenian–Polish team (for a preliminary report from this excavation, see Jakubiak et al. 2017, in this volume) have been marked with capital letters (A to D) and will be referred to accordingly [see Fig. 3].

Anomalies 1 and 2 [see Fig. 3] are situated respectively about 67 m and 79 m southeast of kurgan D. They appear similar in shape, size (8 × 4 m and 11 × 5 m) and alignment to the burial chambers of the nearby Late Bronze III–Iron I kurgans (A, B, C) excavated by Emma Khanzadyan. The yellow discoloration of vegetation indicates less moisture in the ground, suggestive of a concentration of underlying stones (Riley 1996: 25–31). These anomalies are persistent since they appear in satellite images taken in previous years. Therefore, it is highly plausible that they are traces of burial chambers built in a fashion and period similar to that of kurgans A, B, and C.

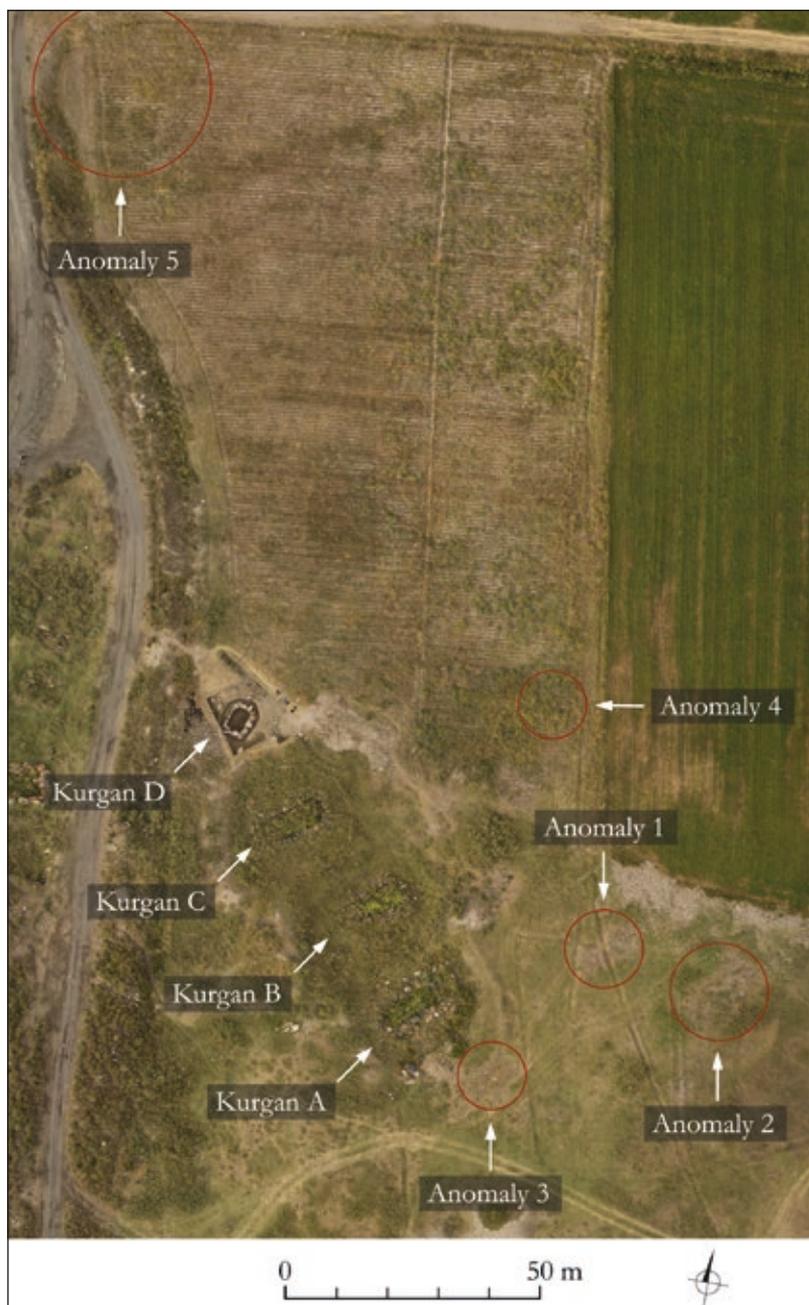


Fig. 3. Anomalies (1 to 5) and previously excavated burials (kurgans A to D) marked on an orthophoto of the cemetery (Photo M. Truskowski, O. Bagi)

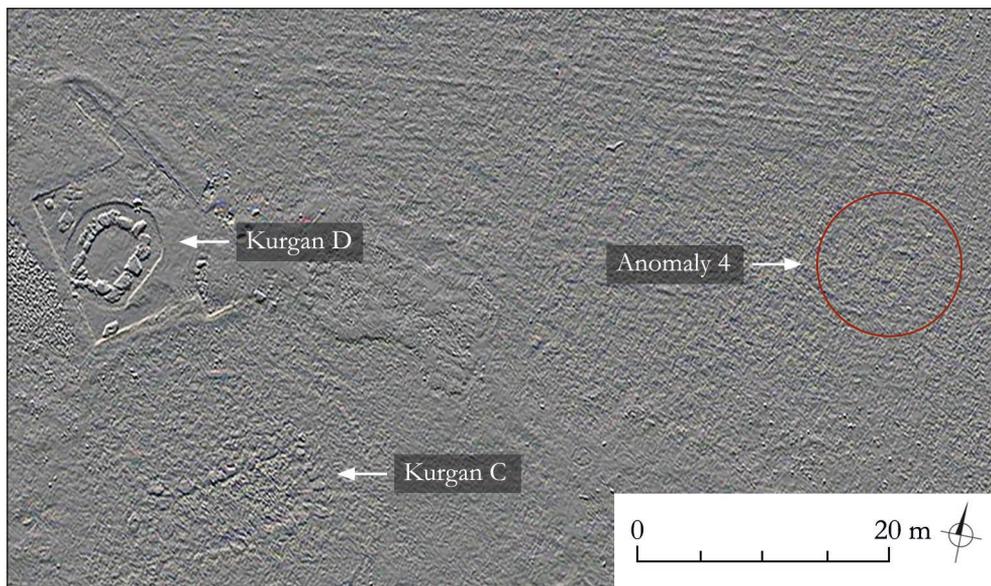


Fig. 4. Anomaly 4 marked on a relief image of the area
(Photo M. Truszkowski)

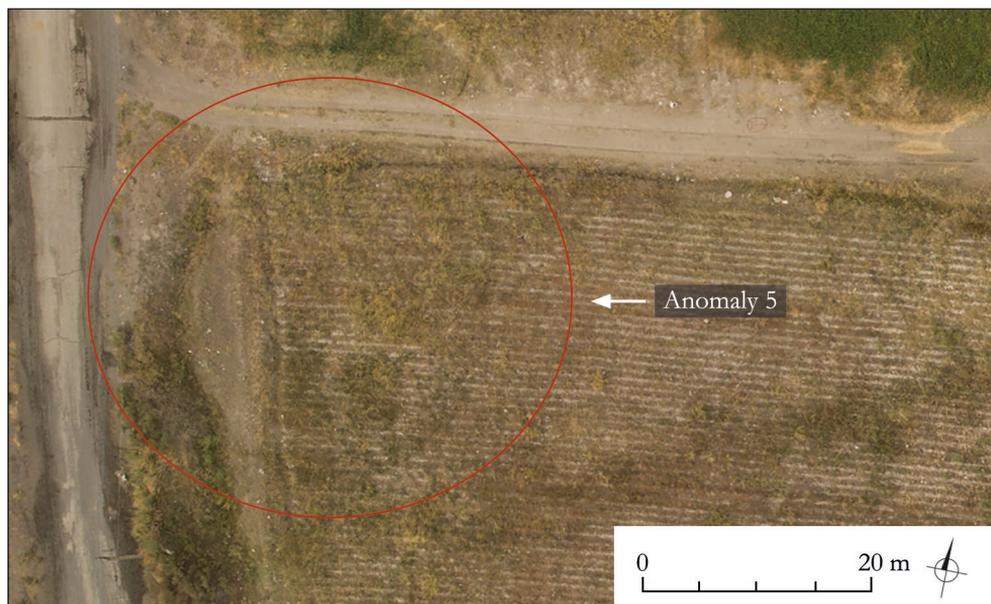


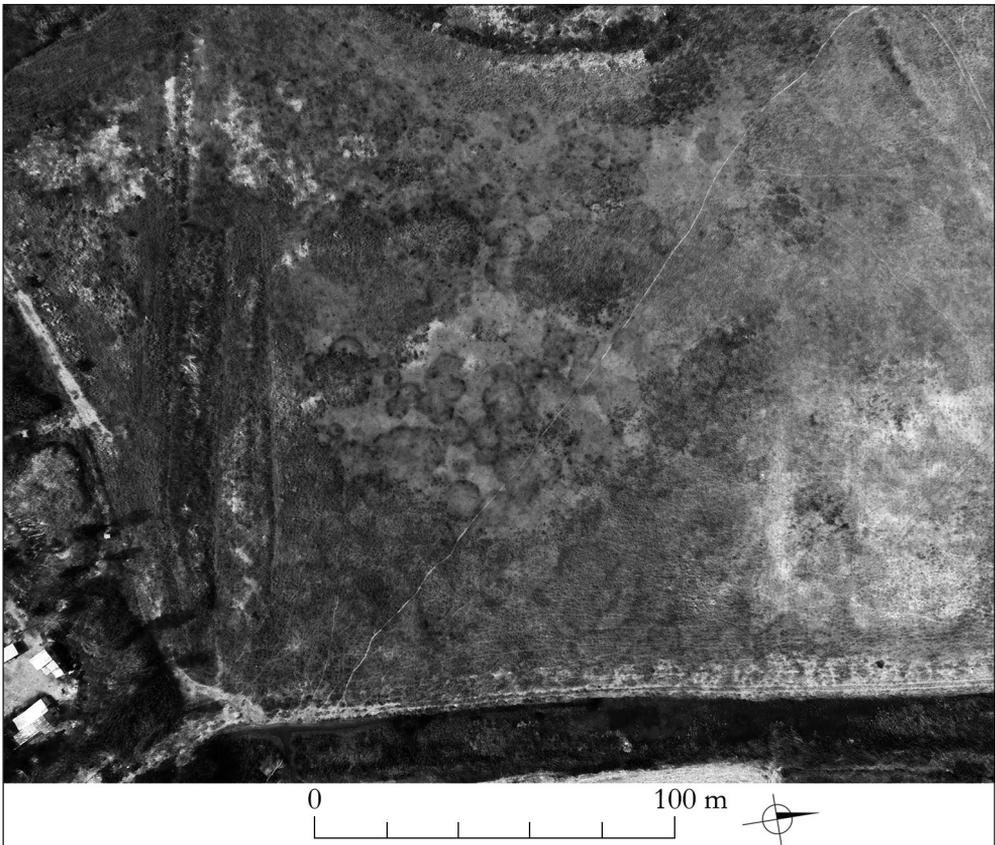
Fig. 5. Anomaly 5 marked on the orthophoto of the cemetery (close-up)
(Photo M. Truszkowski, O. Bagi)

Anomaly 3 [see *Fig. 3*] is located directly southeast of kurgan A and shares some characteristics with anomalies 1 and 2. However, there is a road running across it, thus discoloration caused by traffic rather than an underlying structure cannot be ruled out.

Anomaly 4 is situated about 47 m to the east of kurgan D. In both the orthophoto and the relief image [*Figs 3, 4*], it appears circular in shape with a smaller oval anomaly in its center. The effect seems to be due to a color difference between the

shrubs growing on the top of the anomaly and the bushes surrounding it. The yellow discoloration of the vegetation atop the anomaly suggests, in similarity to anomalies 1 and 2, a lower moisture level in the ground. However, further interpretation of this target without additional examination in the field is not possible at the moment due to its ambiguous nature and the lack of additional supporting data.

Anomaly 5 [see *Figs 3, 5*] is located in the extreme northwestern corner of the field, approximately 95 m northwest



*Fig. 6. Aerial photo of the field to the north of the citadel
(Photo M. Truszkowski)*

of kurgan D. Similarly to anomaly 4, it appears as a circle in the orthophoto, but much larger in size, about 21 m in diameter. Again, its occurrence is caused by a difference in color of the low vegetation growing on and around the area. In opposition to anomaly 4, the circular band of flora appears darker than the vegetation around it. This suggests either a higher concentration of moisture underground caused by disturbed soil or a high level of humus, a reminiscence of long gone organic material (Lasaponara and Masini 2007: 214). It, too, cannot be interpreted as a burial structure at the moment, but its appearance seems to resemble a kurgan surrounded by a ditch. This circular trench may be the source of the soil that had once formed the mound over the burial. Had there been such a superstructure, it must have been ploughed under by now, because there is no significant elevation difference between the anomaly and its surroundings.

The survey of the second, smaller field situated north of the citadel and approximately 800 m northwest of the necropolis yielded similarly interesting and surprising results. No traces of archaeological remains were noted there previously, yet many stand-alone and intersecting circular anomalies are visible in the aerial photos [Fig. 6]. They appear as dark green shapes in the lower vegetation. Like anomaly 5, they are caused possibly either by increased moisture content of the soil or by humus concentration. The lack of data regarding similar structures or features within the region would make any further archaeological interpretation highly speculative. Moreover, certain types of fungi are known to cause circular, deep green discoloration in the low vegetation (also known as “fairy rings”), thus, natural causes cannot be excluded from the list of possible interpretations (Dowson, Rayner, and Boddy 1989: 699).

CONCLUSIONS

The first comprehensive, large scale implementation of aerial photography in combination with photogrammetric methods at Metsamor proved to be a success. The results of the survey of the cemetery and the smaller field to the north of the citadel helped to better understand the extent of past human activity within the landscape surrounding the ancient city. Undoubtedly,

the results, especially with regard to the northern field, will provide ample new targets for the upcoming excavation seasons. While it was not possible to interpret any of these targets, apart from anomalies 1 and 2, with sufficient confidence, it is hoped that future investigations will provide the hard data necessary to determine their exact nature and date.

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