

INVESTIGATING THE SPATIAL ORGANIZATION OF FORTRESS COMPLEXES IN THE SOUTH CAUCASUS  
USING MULTIPLE SURVEY TECHNIQUES

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**Abstract**

The South Caucasus has been largely absent in broader discussions of population aggregation in greater Eurasia. This paper uses remote sensing, surface collection, and magnetometry to explore two hilltop fortress-settlements at the margins of the Kura River Basin, with a particular emphasis on the exploration of settlement off the main hill. The results support a model of settlement growth in which previously-mobile groups settled around the fortress, while maintaining some spatial and perhaps social separation. Multi-technique survey provided a complex picture of settlement organization with implications for comparative analysis of population aggregation models.

## Introduction

Studying the processes of population aggregation is an enduring focus in the archaeology of complex societies. Recent work has documented a remarkable diversity in the spatial and social organization of large settlements, challenging scholars to re-think models of population aggregation, settlement growth, and urbanism (Collis 2014, Chapman & Gaydarska 2016, Szentmiklosi *et al.* 2011). These processes are often the result of complex, non-monotonic trajectories, with both centripetal and centrifugal forces affecting the expansion and decline of large sites (Ur 2010, Fernández-Götz 2017). The Caucasus is an appealing region to explore the interplay of these forces, as the tension between mobility and sedentism resulted in variable levels of population aggregation during the Bronze and Iron Age. Moreover, the lack of correlation between increasing sedentism and increasing markers of extreme social hierarchy provide an intriguing contrast to the neighbouring regions of the Fertile Crescent. While population aggregation and settlement growth were important topics in the Soviet-period scholarship on the South Caucasus (e.g. Berdzenishvili 1975), it was not until recently that these processes began to attract wider international attention. This lag can be attributed to modern linguistic and political barriers, and perhaps also to the rather late appearance of sites that would be considered urban in the traditional Near Eastern sense.

The appearance of fortified hilltop sites in the Late Bronze Age (c. 1500-1100 BC) corresponds to a period of significant social change (Figure 1). While the preceding Middle Bronze Age (c. 2400-1500 BC) is characterized by large, sumptuously outfitted kurgan burials, some reaching 100 m in diameter and 12 m high (Makharadze & Murvanidze 2014), settlement sites are largely lacking. This period has been interpreted as an interval of more mobile lifeways between the Early and Late Bronze Age, both of which feature large numbers of settlement sites (Smith 2005:261-264, Smith *et al.* 2009:27-29).

Late Bronze Age and Early Iron Age hilltop sites, often fortified, are found across much of eastern Georgia, Armenia, northeastern Turkey, and parts of Azerbaijan (Yardimicel *et al.* 2018, Smith *et al.* 2009, Narimanishvili 2012, Hammer 2014). They vary in size and construction; some have massive walls constructed of unworked “cyclopean” dry stone masonry, while others have more modest defensive constructions of smaller stones. While there has been some notable work on these types of sites in both the Soviet and post-Soviet period (e.g. Esayan

1976, Badalyan *et al.* 2010, Narimanishvili 2012), much remains unclear about their social dynamics, spatial organization, and the circumstances of their emergence. Further work on these sites is necessary to assess the variability and coherence of this fortress-building phenomenon.

Many archaeologists view the emergence of fortresses as a result of changing modes of expressing social hierarchy, with the rich grave assemblages of massive kurgan burials of the Middle Bronze Age giving way to more muted mortuary expression of hierarchy in Late Bronze Age (Lindsay *et al.* 2010:16-17, Smith 2005:266-268). Despite the rise of fortress-settlements, research suggests that significant segments of the Late Bronze Age population remained mobile (Lindsay & Greene 2013, Lindsay *et al.* 2010). Archaeologists have proposed a range of centripetal social forces that would have drawn or compelled people to gather at these landscape anchors (Smith & Leon 2014). Yet, many questions remain about the social dynamics that drove the growth of fortresses.

Settlement of areas below these hilltop fortresses is a key issue in these discussions. The fortress complex at Oğlanqala-Qizqala 1 has walls extending off the main hills, which may date as far back as the Iron Age. These walls enclose very large areas, though it is unclear how much of this lower area was filled by structures (Hammer 2014). At Tsaghkahovit, the extensive lower town dates primarily to the Iron III (Achaemenid) period (Badalyan *et al.* 2010, Khatchadourian 2013). Late Bronze Age occupation in the lower town has been documented, but the structures appear less substantial, and perhaps less permanent than those in the later Iron Age settlement (Lindsay *et al.* 2010, Lindsay *et al.* 2014).

The emergence and growth of Late Bronze Age fortress settlements has long been a subject of interest, though systematic investigation of these issues through archaeological survey and excavation has been limited. In the mid-twentieth century, Berdzenishvili identified hilltop sites as a significant stage of cultural development in his Marxist model of social development (Berdzenishvili 1975:19). He linked the rise of larger settlements to the expansion of settlement around Late Bronze-Early Iron Age (LBA-EIA) hilltop fortresses. Berdzenishvili's model relied partially on linguistic observations. The Georgian word for 'town' is 'daba,' which also means 'low' or 'lower' (daba, dabali). Berdzenishvili took this as an indication that early towns emerged as lower settlements of fortresses (Berdzenishvili 1975:23-61). The antiquity of this term is far from clear, however, so linguistic support for an evolutionary linkage between

fortresses and towns is speculative at best. After all, this pairing may simply reflect spatial relations between fortresses and towns in later periods.

Later archaeological excavations at Khovle Gora supported some of Berdzenishvili's initial hypotheses (Muskhelishvili 1978). Evidence for LBA-EIA settlement expansion and occupation of smaller satellite hills was identified at other sites, such as Narekvavi and Samtavro. Interestingly, at Narekvavi, the previously unoccupied central hill was fortified and acted as the main defensive structure for the surrounding settlements (Sadradze 2002:173-203, 222-241). This latter case, then, suggests an alternative settlement aggregation process, whereby the central fortified node postdates the expansion of the surrounding settlement. Lordkipanidze (1989:181-182) espouses a slightly different perspective, at least with respect to the relationship between LBA-EIA fortress settlements and the urban sites of the late 1st millennium BC. He points to a period of widespread settlement destruction and abandonment in the late sixth-early fourth centuries BC, during which the continued settlement at Khovle Gora is an exception. In his view, therefore, the "urban explosion" of the late-fourth and third centuries BC, while often reoccupying sites occupied in the LBA-EIA, represented a distinctly different development (Lordkipanidze 1989:312-314).

Recent investigations in Armenia, Azerbaijan, and the North Caucasus have provided valuable information about Late Bronze and Iron Age settlement patterns (Smith *et al.* 2009, Lindsay *et al.* 2014, Lindsay *et al.* 2010, Badalyan *et al.* 2010, Hammer 2014, Reinhold *et al.* 2016). However, with the occasional exception (Giese *et al.* 2007), systematic spatial approaches have not been applied to questions of LBA-EIA settlement structure in the middle Kura Valley. By applying a suite of complementary techniques including unmanned aerial vehicle (UAV) imaging, magnetic gradiometry survey, and systematic surface collection, we developed a more robust understanding of settlement structure and explored its implications for models of settlement growth.

## **Survey Methodologies**

The Project "Archaeological Research in Kvemo Kartli" (ARKK) was founded to explore social and technological transformations in the South Caucasus in the Late Bronze and Early Iron Age. Initial surveys of the region mapped a number of hilltop sites with Late Bronze and Early

Iron Age pottery (Erb-Satullo 2018). In the Debeda River valley (Figure 2), hilltop sites are situated at various points along the valley as it narrows and rises into the highlands. Two sites, Mtsvane Gora and Kavakh Tepe, were chosen for comprehensive survey using multiple techniques in 2016. Kavakh Tepe was chosen for its substantial surface architecture and possible lower settlement, while Mtsvane Gora was chosen due to the presence of metallurgical debris on its surface. Both hilltop sites had a series of shallow depressions on the slopes and surrounding lower areas that were originally hypothesized to be possible extramural houses. Three complementary classes of techniques were employed: UAV imaging and photogrammetry, surface mapping and systematic collection, and magnetic gradiometry.

Aerial imagery was collected using a GoPro Hero4 Black mounted on a 3D Robotics Solo Quadcopter, which was used to create orthoimages, a DEM, and various DEM-derived products, including hillshades, slope models, and local relief models (LRMs).

Extensive surface collection was carried out at Kavakh Tepe to map the extent of settlement and date features mapped by other techniques. Ceramics were collected in contiguous 15 m units in the areas selected for magnetometry survey, as well as in 30 m grids scattered over the site. Surface collection at Mtsvane Gora, undertaken during preliminary survey in 2014, focused on the top and the slopes of the hill, with the goal of obtaining a broad sample of ceramics and collecting metallurgical debris (Erb-Satullo 2018).

Magnetic prospection was carried out with a Bartington 601 Magnetic Gadiometer. At Kavakh Tepe, magnetic prospection focused on areas where surface walls or concentrations of LBA-EIA ceramics were visible. At Mtsvane Gora, because of the metallurgical remains at the surface, magnetometry focused on areas where metallurgical slag was recovered, in the hope of locating metallurgical features such as furnaces, hearths, or concentrated slag dumps. Further details about the survey methodologies can be found in the online supplementary information.

## **Results**

### *Kavakh Tepe*

#### Surface mapping and UAV imaging

Surface mapping and UAV imaging identified a wide range of archaeological features comprising the fortress-settlement complex (Figure 3). The main hill is dominated by a series of large terraces. These features are most clearly visible on the northern and western slopes (Figures 3 & 4), but evidence of walls and terraces extends around virtually the entire hill. Up to five terraces are visible in places, though the lower ones are partial and do not extend around the whole hill.

Linear stone features, the remnants of the fortress walls, were visible at the surface across the site (Figure 5). The stones used in these constructions vary in size, in some places approaching 1 m in diameter. Although most walls were rarely preserved above ground height, in one place, multiple courses were visible (Figure 5D). The top of the fortress is demarcated by a circular wall surrounding two topographic prominences with a shallow saddle between them. Bedrock is exposed at the two high points, suggesting that either no structures were present, or that no traces remain. However, walls visible at the surface within the citadel, particularly in the saddle, reveal a casemate structure to the arrangement of rooms, with buildings constructed against the exterior fortress walls.

A DEM-derived slope model reveals a series of depressions to the south and southwest of the main hill at Kavakh Tepe (Figure 3). The larger rectangular depressions are clearly modern: remains of collective farm buildings dating to the Soviet period. Other clusters of shallow depressions, less sharp than the oblong collective farm ruins, are also present in these areas. From topography alone, it was difficult to say whether these depressions were ancient semi-subterranean houses or the result of modern activity associated with the collective farm. In one instance (Figure 5B), linear stone walls were noted near the edge of these depressions, but it may be that modern digging disturbed ancient structures in this area. The pits tend to cluster closer to the collective farm buildings, and there is little correlation between the pits and the distribution of LBA-EIA ceramics (see below), suggesting a recent date.

Linear stone features visible at the surface are likely a better indicator of ancient activity off the main hilltop. These surface features are concentrated on a series of low rises to south of the main hill, though indistinct stone structures were noted in one or two places to the west near the collective farm ruins. Sections of walls, corners of structures, and a semi-circular feature were mapped on the surface. Scatters of stones and indistinct structures were also noted in certain areas (Figure 6).

## Surface Collection

Systematic surface collection provided key information about the spatial organization and chronology of the fortress settlement (Figure 6). On both the upper hill and in the lower areas, diagnostic ceramics overwhelmingly dated to the Late Bronze-Early Iron Age. Ceramics with diagnostic LBA-EIA shapes or decoration include: comb-stamping, incised wavy or parallel lines, pattern-burnishing, and one instance of a “zoomorphic” handle (Figure S1 in Supplementary Information). Because of the large number of body sherds with no diagnostic surface decorations or morphological features, sherds collected in systematic survey (n=1478) were classified by fabric type. Nevertheless, the majority of certain key fabric types, such as black/grey burnished wares (15% of total assemblage; n=221) and un-burnished black/grey wares (49%; n=725), likely belong to the LBA-EIA. Ceramic assemblages from later Hellenistic and Medieval sites have a significant proportion of higher-fired reddish orange ceramics. Only a few sherds of this type were found at Kavakh Tepe (1%; n=18), and 10 of these were found in the nine northwestern-most 30m collection grids near the ruined collective farm buildings, where evidence for LBA-EIA occupation is minimal.

A distinctive ware with abundant inclusions of mica and a white mineral (quartz or feldspar) comprised a significant portion of the assemblage (21%; n=306) at Kavakh Tepe. Occasional diagnostic features such as comb stamping and pattern burnishing on mica-tempered sherds suggest that these ceramics also date to the LBA-EIA. Other ware types, such as red/brown burnished wares (2%, n=28) and generic buff/brown (7%; n=99) are found in small enough quantities that they probably reflect colour variation within in LBA-EIA pottery. Red-painted wares typical of the late first millennium BC in the Kura Valley (Narimanishvili & Shatberashvili 2004) are completely absent. No clearly diagnostic sherds of earlier periods were identified, but a few unusual obsidian-tempered coarse body sherds may be earlier.

Because virtually all diagnostic ceramics from the site date to the LBA-EIA (c. 1500-500 BC), the spatial distribution of ceramics (particularly black/grey burnished wares) should approximate the spatial extent of the settlement during this period. The distribution off the main hill shows some particularly interesting patterns (Figure 6). Instead of forming a continuous zone of activity, the ceramic distribution forms a series of discontinuous hot-spots. Colluvial

redeposition from the main hill is an insufficient explanation for the ceramics in the lower area, since a low valley separates this area from the main hill. Moreover, these areas of high ceramic densities roughly correspond to areas where stone walls and/or stone scatters were mapped on the surface, strongly suggesting that these structures date to the LBA-EIA. On the other hand, there is little correlation between the shallow depressions and high densities of ceramics, suggesting that these are later and probably connected with the collective farm.

### Geophysical survey

Magnetometry was successful in mapping buried structures on both the upper fortress and the lower areas to the south (Figures 7 & 8). In several areas of the upper hill, tentatively mapped surface features, such as the “casemate” structures of rooms in the saddle and the possible terrace house to the north, were identified and expanded upon in the magnetometry data. Surface walls were used to identify the characteristic magnetic signature for exposed anthropogenic structures and guide the interpretation of sub-surface features.

In the lower area, the gradiometry survey revealed a compound of structures, only small parts of which were visible at the surface. Thin linear anomalies are interpreted as walls or otherwise intentionally-arranged stones. These structures are situated on a low rise, which is partially demarcated by a wall to the northwest. This wall, which has one obtuse angle, parallels a broad linear area of high magnetism. This parallel arrangement may indicate that this latter feature is also anthropogenic. A series of compact circular strongly positive magnetic readings, some with negative halos that indicate the likely presence of buried round structures, are distributed within and around the compound of structures. The western half of the lower survey area lacks obvious curvilinear stone features, but includes several broad (~10m diameter) magnetic highs appearing at somewhat regular intervals.

Because cemeteries are often located in the areas surrounding hilltop fortresses, it is essential to consider whether these features are burials or residential structures. On one hand, cromlechs burials of the period often consist of stone circles with a burial in the middle (Narimanishvili 2006:10, Smith *et al.* 2009:107, Pls. 77C. 81B). On the other hand, the shape of a central walled structure with smaller, rounded oblong structures coming off is somewhat similar to residential compounds seen elsewhere (Lindsay *et al.* 2014, Lindsay *et al.* 2010),

though these are not usually perfect circles. One possibility is that the structures mapped in the magnetometry survey are several superimposed cromlechs.

Even if some of these structures are burials, other evidence suggests that occupation in this lower area was not exclusively mortuary. The density of ceramics here equals that seen on the main hill, suggesting a level of activity consistent with habitation and its associated household discard. Indeed, some of the highest densities of ceramics in the lower town were recorded adjacent to the compound of structures. A cemetery is an odd location for a household waste dump unless residential areas are quite close by. Finally, a denticulate chipped stone sickle-insert was also found in western part of the lower settlement magnetometry survey, further suggesting the non-mortuary character of at least some of the activities in these areas.

At the same time, the area of high ceramic density in the western part of the lower town magnetometry survey is not matched by structures visible in the magnetometry data. Could these ceramics derive from the area immediately to the south, where a series of shallow depressions and sections of linear stone walls were noted? Or could these high ceramic densities indicate that settlement in these areas was constructed with different (perhaps more ephemeral) materials that lack a strong magnetic signature? The broad 10m diameter highs in this area, noted above, might be evidence for this, but without excavation, it is not possible to argue with certainty that these features are anthropogenic rather than natural. Tentatively, one might explain the combination of high ceramic densities without clear structures in the magnetometry as the product of regular, but non-permanent occupation.

Thus, the overall structure of the LBA-EIA fortress settlement is one in which a series of smaller satellite areas, possibly encompassing both residential and mortuary areas, were constructed on low rises off the main hill. There seems to have been a clear spatial separation between the main fortress and the lower settlement, with the low valley between them. Within the lower settlement itself, there are hints that habitation in the lower town was discontinuous and potentially less permanent than on the main hilltop.

*Mtsvane Gora*

Surface Mapping and Remote Sensing

In comparison with Kavakh Tepe, Mtsvane Gora is more modestly sized. Only one major encircling wall is visible at Mtsvane Gora (Figure 9), though other slight terraces are visible in a few locations. As at Kavakh Tepe, a number of depressions are visible outside the main walls of the fortress, some of which are clearly modern. Others are less attributable. The shallow depressions on the northern slopes of the hill, arranged in roughly four lines, are difficult to interpret. The slope model shows that these depressions continue into the modern cemetery, suggesting they predate its construction. However, a test pit excavated at the edge of one of these depressions in hopes of finding the wall of the structure yielded only colluvial deposits and much smaller quantities of ceramics than excavations within the encircling wall. On balance, therefore, it seems unlikely that these depressions represent extra-mural LBA-EIA settlement. A well-preserved circular cromlech, clearly identifiable as such, was located to the NW of the site in an area that contained other indistinct scatters of stones—perhaps indicating the presence of other structures.

### Surface Collection

Systematic surface collection, carried out in 2014, is reported in detail elsewhere (Erb-Satullo 2018). Surface collection revealed significant quantities of diagnostic LBA-EIA ceramics. Surprisingly, given the prominence of the hill and its proximity to the main route of travel up the Debeda Valley, there is little evidence of significant later occupation at the site. Only one fragment of glazed ceramic was found on survey (outside of the systematic surface collection squares), and one additional glazed sherd was found in topsoil of the 2015 test trench. Excavations in 2015 and 2017 have confirmed a substantial LBA-EIA occupation on the hill-top. Unfortunately, systematic surface collection was not carried out around the cromlech to the NW, though it was clear from casual observations that there were far fewer ceramics there than on the hill itself. Given the lack of systematic survey in areas farther removed from the hill, and the closer proximity of modern settlement, it is not possible to rule out the existence of lower settlement in these more distant outlying areas.

### Geophysical Survey

Relative to Kavakh Tepe, magnetometry (Figure 10) was less successful at identifying buried architecture and metallurgical features at Mtsvane Gora, perhaps because of the differing geology. The fortification wall is visible on the northern edge of the hill, but it is significantly less clear on the southeastern side, despite other indications that it clearly extends around the whole hill. Despite finds of metallurgical slag on the surface, there appear to be no clear concentrations of metallurgical debris buried beneath the surface. Several circular high anomalies (2-3 m in diameter) were noted, but as these do not correlate with slag finds of the surface, it is difficult to identify them as metallurgical. These results probably indicate that metal production activities were restricted to processes that did not produce large amounts of slag and/or that metallurgical activities took place in areas covered by the modern communications tower. No clear extra-mural structures are visible in the magnetometry data on the slopes of the hill, including around the shallow surface depressions.

## **Discussion**

The combination of aerial drone mapping, magnetometry survey, and surface collection provides important data on the socio-spatial organization of fortress settlements c. 1500-500 BC. At Kavakh Tepe, the data show that the area of low rises to the south, somewhat removed from main hill, was occupied during this period. At the smaller site of Mtsvane Gora extramural settlement was not identified, though survey was restricted to areas on the immediate hillslope, and more distant zones were not systematically examined.

The development of ancillary settlement somewhat removed from the main fortress suggests that people living in these satellite areas maintained a degree of social distance from the fortress, even as they were drawn into its social orbit. Perhaps mobile groups preferred this approach as a way of avoiding complete and irreversible incorporation into the social fabric of the fortress community. Other lines of evidence, such as the mismatch between the amount of visible architecture and the high ceramic densities, are consistent with regular, though impermanent habitation. Positioned along major routes of travel between lowland and highland areas, sites like Kavakh Tepe and Mtsvane Gora probably experienced seasonal fluctuations in populations.

While living in a fortress-settlement might have offered an added measure of security, access to economic networks, or participation in ritual activities (e.g. Smith & Leon 2014, Lindsay *et al.* 2008), it would have also presented a new set of social demands. It is difficult to assess how much this spatial separation reflected social boundaries, but it is certainly conceivable that there was a correlation. If fortresses like Kavakh Tepe are indeed the product of political centralization, the abandonment of mobile lifeways would have subjected previously mobile groups to the growing authority of fortress elites (Lindsay & Greene 2013). Even if fortresses communities lacked a single centralized authority, residence in such a community would have imposed new social obligations.

Placed into a wider regional framework, the data from Kavakh Tepe support a model of settlement aggregation in which previously-mobile (and perhaps still partially-mobile) segments of the population progressively settled around Late Bronze Age fortresses. Two caveats must be mentioned, however. First, the time resolution of ceramic chronologies (see Supplementary Information) means that we cannot distinguish between the initial construction of the fortress and the later settlement of the lower areas. Though settlement in earlier periods on the hilltop cannot be ruled out, the current evidence for it is weak. Second, the process of settlement growth was not necessarily a unidirectional, monotonic trajectory, as earlier Marxist models imply. There are some suggestions that the first millennium BC was punctuated by a period of significant settlement destruction and/or abandonment around the 6th-4th centuries BC (Narimanishvili *et al.* 2007:19, Lordkipanidze 1989:181-182). The reasons for this decline in settlement are not entirely clear, but it is consistent with what we see at Kavakh Tepe, which has little evidence of occupation from the second half of the first millennium BC. Farther south, at Tsaghkahovit, excavations have shown that the Iron III (Achaemenid) settlement was re-founded after a break in occupation, and followed a significantly different set of spatial logics (Khatchadourian 2016:155-158).

Given this gap, to what extent can the model of settlement growth around hilltop fortresses be linked to the nucleation of larger settlements and towns in the late first millennium BC? The existing data make it difficult to address this question. Kavakh Tepe itself lacks any significant late-first millennium BC occupation, but there are numerous sites in the Kura Valley with settlement during both the Late Bronze Age-Early Iron Age and Achaemenid/Hellenistic period (Khakhutaishvili 1964:101, 1970:110, Licheli 2011, Sadradze 2002, Gagoshidze 1979). In

many of those cases, however, later occupation obscures a full exploration of earlier settlement patterns, and there has been no systematic surface collection at these sites to clarify the chronology of their spatial growth. Kavakh Tepe, on the other hand, provides a snapshot of this early configuration unobscured by later settlement.

In sum, the data gathered in the current project reveal more about the organization and growth of LBA-EIA fortress communities than they do the emergence of larger towns and cities in the late-first millennium. Indeed, there is a growing body of work that suggests that settlement aggregation and the growth of fortress-settlements resulted in communities that were distinctly different from the traditional Near Eastern urban model (Lindsay & Greene 2013, Smith 2005:230, for a perspective that differs in some respects, see Hammer 2014). Certainly, LBA-EIA population aggregation differs in key ways from Chalcolithic and Early Bronze Age Mesopotamian urbanism. Whereas Late Bronze Age fortress communities emerged from a social landscape characterized by high levels of mobility, a dearth of settlement, and clear indicators of social inequality, northern Mesopotamian urbanism grew from a more settled landscape with comparatively less evidence of extreme social inequality (Ur 2010). It should also be noted that the size of Kavakh Tepe at about 10 ha is an order of magnitude smaller than many Mesopotamian Bronze Age urban sites. At the same time, these different models of population aggregation all share similar themes, including the challenges of incorporating disparate groups into a durable social unit, as well as the tension between centripetal and centrifugal forces at work in the growth of settlements. In the comparative study of population aggregation in greater Eurasia, there are numerous other instances of population aggregation at fortified settlement complexes (e.g. Sharples 2014, Anthony 2009), some of which also arise in highly mobile societies. The continued study of South Caucasian fortress complexes has an important role to play in building a comparative understanding of these processes.

## **Conclusions**

The combination of the UAV photogrammetry, magnetometry, surface mapping, and field collection provide a far more complete picture of the spatial organization of the fortress settlement of Kavakh Tepe than any one of these methods alone. At Mtsvane Gora, remote sensing and magnetometry proved less successful in identifying buried structures and metal

production workshops. Integration of these three methods at Kavakh Tepe suggests that the clusters of shallow depression were likely modern, yet also reveal significant areas of ancient activity spread across the low rises to the south of the main hill. It is ironic that the features that originally drew our attention to the possibility of a lower settlement are probably modern, yet other evidence clearly demonstrates the presence of off-hill occupation. Combined analysis of topography, magnetometry and surface collection suggested these lower areas may have included both residential and mortuary zones. High concentrations of ceramics in areas without clear structures in the magnetometry may indicate that settlement in these lower areas differed in character from those of the main hill, perhaps suggesting ephemeral or seasonal habitation. These lines of evidence support a model of settlement aggregation in which previously mobile groups settled around these fortresses while maintaining a degree of spatial, and perhaps social separation. Whether analogous processes drove the emergence of large towns and cities in the late first millennium BC remains an open question. More broadly, the spatial investigations of fortress-settlements like Kavakh Tepe and Mtsvane Gora contribute to a comparative understanding of how large settlements can emerge from highly mobile societies.

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## SUPPLEMENTARY INFORMATION ON SURVEY METHODOLOGIES

### **Aerial Drone Survey**

Ground control targets were laid out and mapped using a Leica TS-02 Total Station. Images were captured at regular intervals (80% overlap) and then used to generate a georeferenced photogrammetric model with Agisoft Photoscan. The resulting 5 cm resolution orthoimage and digital elevation model (DEM) were used to create a number of DEM-derived products in ESRI's ArcGIS. These products were correlated with additional georeferenced survey data (such as walls visible at the surface) in order to determine which were most useful in identifying archaeological features.

### **Surface Mapping and Collection**

Unlike some areas of the South Caucasus (e.g. the rain-drenched Black Sea coast and the highland plateaus of southern Georgia and northern Armenia), the landscape of lowland Kvemo Kartli is reasonably well-suited to systematic surface collection. The warmer, drier climate of the Middle Kura valley means that surface collections can provide a significant sampling of ceramics with which to assess the chronology and spatial extent of sites.

In 2013 and 2014, we tested a variety of systematic surface collection methodologies in order to determine the collections strategy that best matched the local landscape and our research goals (Erb-Satullo 2018). Surface collection within gridded squares proved a useful and flexible strategy for obtaining a significant yet manageable sample of surface materials. The size and distribution of these squares were adjusted based on the specific research questions and the quantities of materials exposed at the surface of each site.

With regard to hilltop sites, it is worth considering the effect that erosion may have had on the distribution of materials. Indeed, differential colluvial erosion has been documented on hilltop sites in this region (Erb-Satullo 2018). The specific environs of Kavakh Tepe and Mtsvane Gora were broadly similar but there were some differences that affected the surface exposure of ceramics. At Kavakh Tepe, vegetation cover and erosion patterns varied slightly, but did not affect the overall pattern; some of the highest densities of ceramics were found in areas

with heavier vegetation. Importantly, the higher densities of ceramics seen in the lower settlement are situated on rising terrain separated from the main hill by a low valley. Thus, it is physically impossible for ceramics in this area to have derived from erosion off the main hill. Some colluvial erosion undoubtedly did take place in other areas of the site, but the key element of the distribution—a lower settlement somewhat removed from the main hill, cannot be accounted for by colluvial erosion.

At Mtsvane Gora, the south slope of the hill was noticeably warmer and drier, so colluvial erosion and exposure of ceramics and other materials were much more pronounced than on the north slope. In these circumstances, the extra-mural distribution of ceramics on the southeastern slope of the hill is more likely the result of erosion and/or discard of materials down the slope.

In terms of ceramic terminology, the category of Late Bronze-Early Iron Age (LBA-EIA) ceramics included those dating from roughly the second half of the second and the first half of the first millennium BC, preceding the Achaemenid, Hellenistic and Roman periods (sometimes referred to collectively as the “Antique” period in local terminology). This differs slightly from other chronologies, where metal artefacts, whole vessels, and/or the presence of intrusive Urartian materials allows finer distinctions (see Smith *et al.* 2009:68-93, Abramishvili 1957). For surface collections, we prefer this coarser set of chronological distinctions.

Generally speaking, the LBA-EIA material culture groupings in modern day Eastern Georgia are far from settled (Sagona 2018:380-382). While ceramics from this period (Figure S1) are distinguishable from earlier Middle Bronze Age and later Achaemenid-period ceramics, finer divisions are difficult to make. Much discussion surrounds the geographical and chronological differentiation of assemblages such as the Samtavro and Lchashen-Tsitolgori Cultures (e.g. Akhvlediani 2005), the latter a Georgian variant of the Lchashen-Metsamor sequence discussed by Smith *et al.* (2009:68-93). The source of this challenging chronological problem is rooted in a) the lack of major ceramic transformations within this period and b) the likelihood of significant geographical variation within this mountainous region (for additional explanations, see Sagona 2018:382). Resolution of these issues must await the accumulation of a significant number of radiocarbon-dated ceramic assemblages (e.g. Bertram 2008).



Figure S1. Selected Sherds from Kavakh Tepe showing typical LBA-EIA forms.

## Magnetometry

Archaeological magnetic prospection maps surface and subsurface variations in the magnetic properties of deposits with the aim of distinguishing between natural and anthropogenic features. A magnetic gradiometer measures the local magnetic field at a given location. This measurement is of the sum of both induced and remanent magnetizations (Dalan 2005).

Remanent magnetism is the permanent magnetization of a material that occurs during its compositional, thermal or depositional history (Heimmer & De Vore 1995). These materials remain magnetic in the absence of a magnetic field. Magnetometry surveys can be particularly successful in detecting anthropogenic activities that utilize or create materials with remanent magnetism. The success is partially due to the robust anomalies in magnetic data caused by thermoremanence. Thermoremanence occurs when soils, clays or rocks containing iron oxides

are heated—most naturally contain 1 to 10 percent. The particles at first have no net magnetic properties, but when heated to the Curie point (about 600° C) the magnetization is completely removed only to remagnetize at the time of cooling to the current geomagnetic field (Clark 2001). Many processes of heating were common in prehistoric and historic settlements including pottery production, cooking and perhaps the destruction of structures through burning (Kvamme 2006).

The earth's magnetic field produces a second type of magnetism known as induced magnetism. This type of magnetism only exists in the presence of a magnetic field. The potential of a material to become magnetized is known as its magnetic susceptibility, which is a function of the minerals in its composition that can become magnetized. Most soils and rocks contain such minerals and, in general, topsoils tend to be more magnetically susceptible than subsoil layers as well as the rocks they were produced from. This is the case for several reasons, including anthropogenic and naturally occurring fires as well as human refuse of organic and thermally altered materials during occupation. There is also a natural tendency for iron minerals to accumulate in topsoil due to their relative insolubility in comparison to less magnetic soil contents. Additionally, pedogenic enhancements such as low-heat chemical reactions as well as organic processes such as magnetotactic bacteria and other bacteria cause magnetic compounds to accumulate in topsoils (Dalan 2005, Kvamme 2006).

Slight anthropogenic alterations to topsoils are therefore detectable using sensitive instruments like magnetometers and magnetic susceptibility meters. The magnetic gradiometer has two sensors aligned vertically. The difference between the two measurements is called the “magnetic field gradient” (Kvamme 2001) and the unit of measurement for magnetic surveys is the nanotesla (nT). The use of the two sensors makes for a quick yet sensitive survey instrument. The distance of sensor separation determines the sensitivity of the instrument. The farther the sensors are apart, the closer it approaches the sensitivity of a total field measurement. However, there is a limit to how far apart the sensors can be with confidence that the operator can maintain vertical alignment while walking a straight line; a standard distance is .5 to 1 m (Clark 2001).

A Bartington 601 Magnetic Gradiometer, consisting of a single axis magnetic field gradiometer system with two gradiometers mounted 1 m apart on a horizontal bar, was employed in the survey. This instrument's configuration provides sensitivity of archaeological anomalies to an average depth of one meter. Surveys were conducted in parallel transects which were guided

by fibreglass tapes laid precisely along the transect direction at 50 cm intervals with a 0.125 m sampling separation along the walking direction.

The magnetic gradiometry data were downloaded and processed in ArchaeoFusion, a program developed by CAST. Magnetic data was processed using various processes depending on potential data issues. A zero median traverse (ZMT) was applied to the data of zig-zag survey grids to reduce striping effects caused by the directional changes of the survey direction and differences between sensors, although a majority of the survey was conducted in a unilateral transect pattern. A mean profile filter was applied which further assists in reducing striping effects, but is often better at reducing stripes that are not the entire length of a profile. In some cases, destaggering was applied to reduce or remove data offsets caused by zig-zag survey. Grid matching was applied to reduce edge effects between survey grid blocks where necessary. A low pass spatial filter was applied to smooth data and reduce noise. The data were clipped to one or two standard deviations to enhance specific archaeological features. Additionally, data were resampled to 0.125 x 0.125 m cells for visual appeal.

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Figure 1. Map of selected hilltop sites with Late Bronze and/or Iron Age occupation.

65x99mm (300 x 300 DPI)

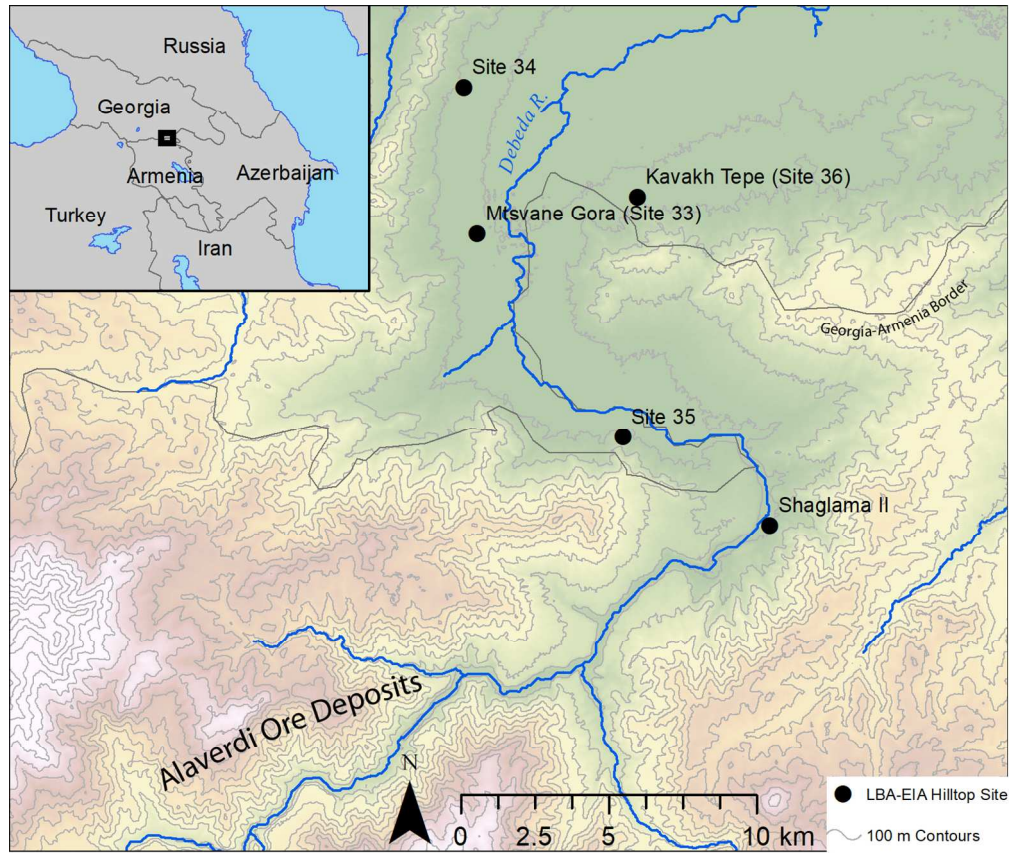


Figure 2. Map of Debeda River Valley.

135x114mm (300 x 300 DPI)

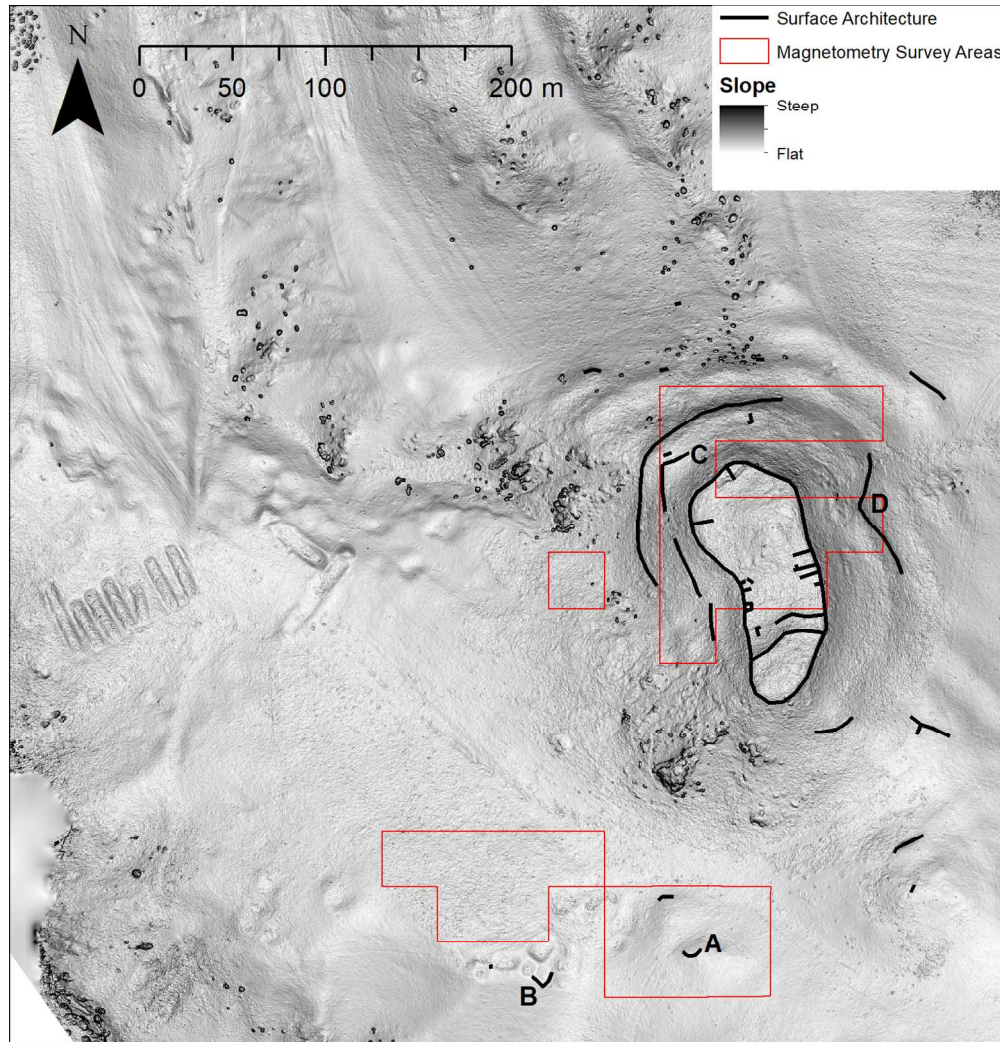


Figure 3. Slope model of topography at Kavakh Tepe, with surface mapped features. Letters show approximate positions of photos in figure 5.

134x139mm (300 x 300 DPI)



Figure 4. Ground-level view of Kavakh Tepe from the north, showing topography of fortress terraces. Areas of lower settlement are obscured from view.

65x44mm (300 x 300 DPI)

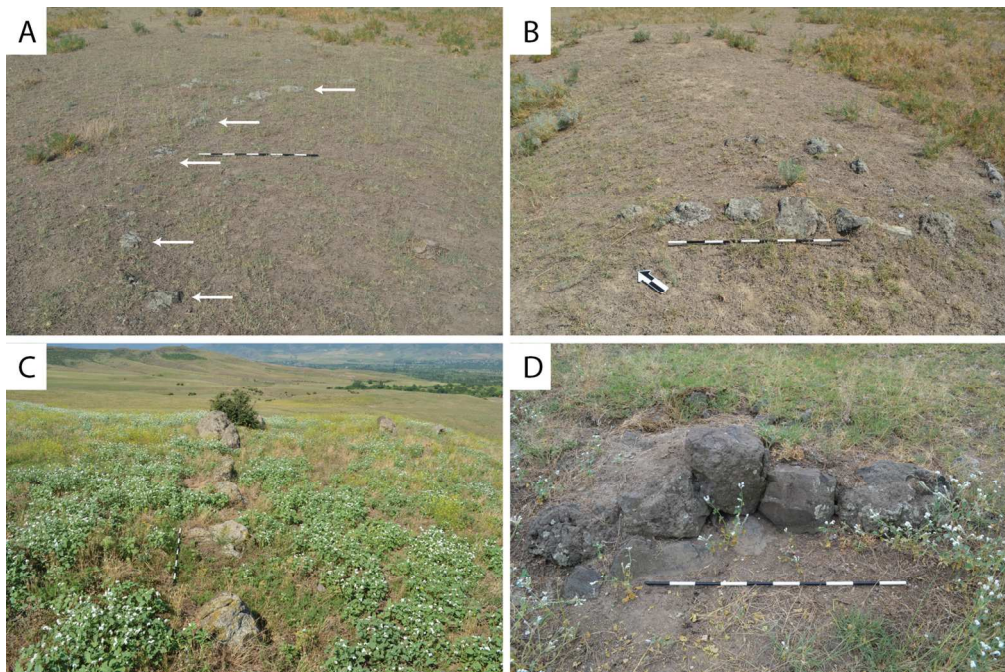


Figure 5. Linear stone features at Kavakh Tepe.

135x89mm (300 x 300 DPI)

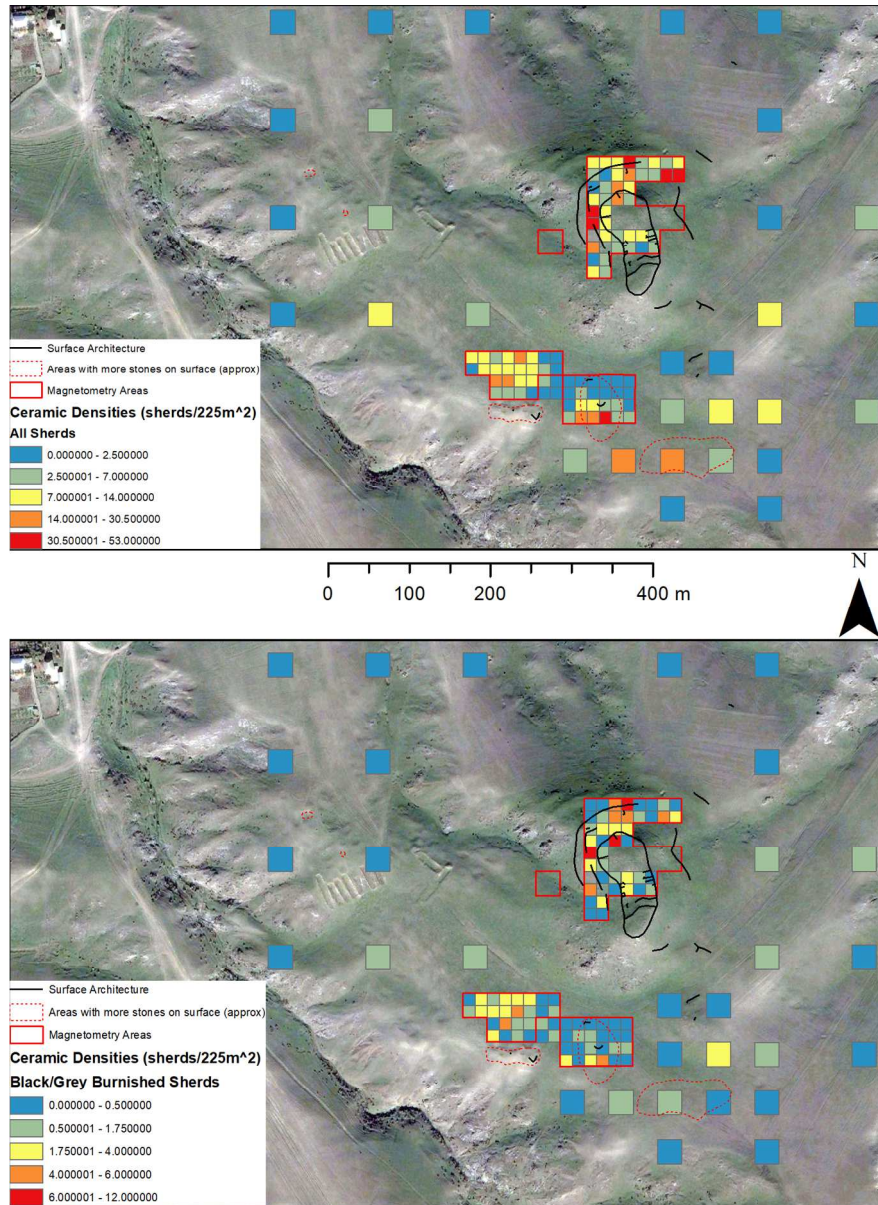


Figure 6. Results of surface collection at Kavakh Tepe, showing density (in sherds per 15m x 15m grid square) for all ceramics (a) and Black/Grey Burnished Wares (b).

134x184mm (300 x 300 DPI)

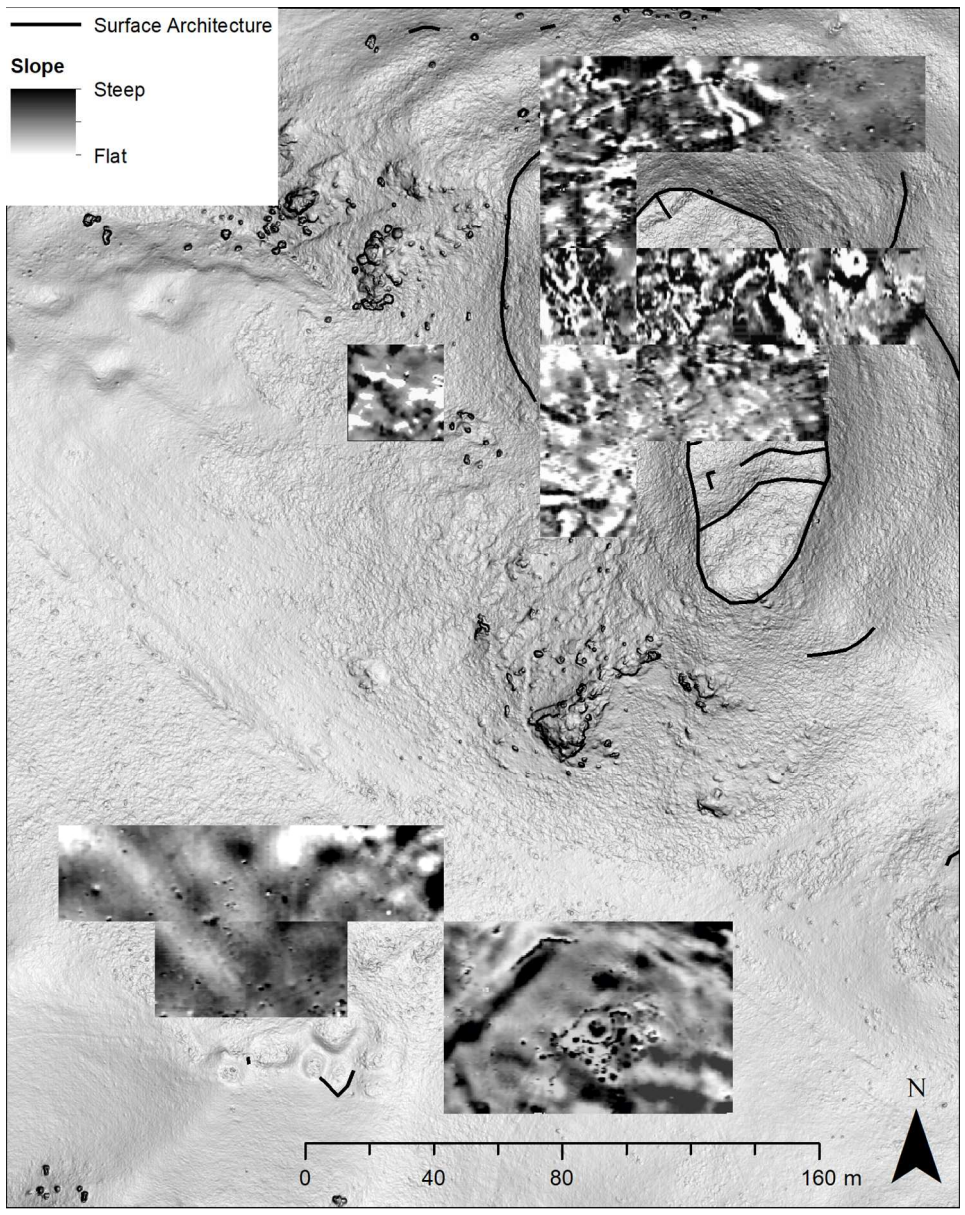


Figure 7. Results of magnetometry survey at Kavakh Tepe overlain onto slope model. Positive anomalies are darker; negative anomalies are lighter.

134x170mm (300 x 300 DPI)

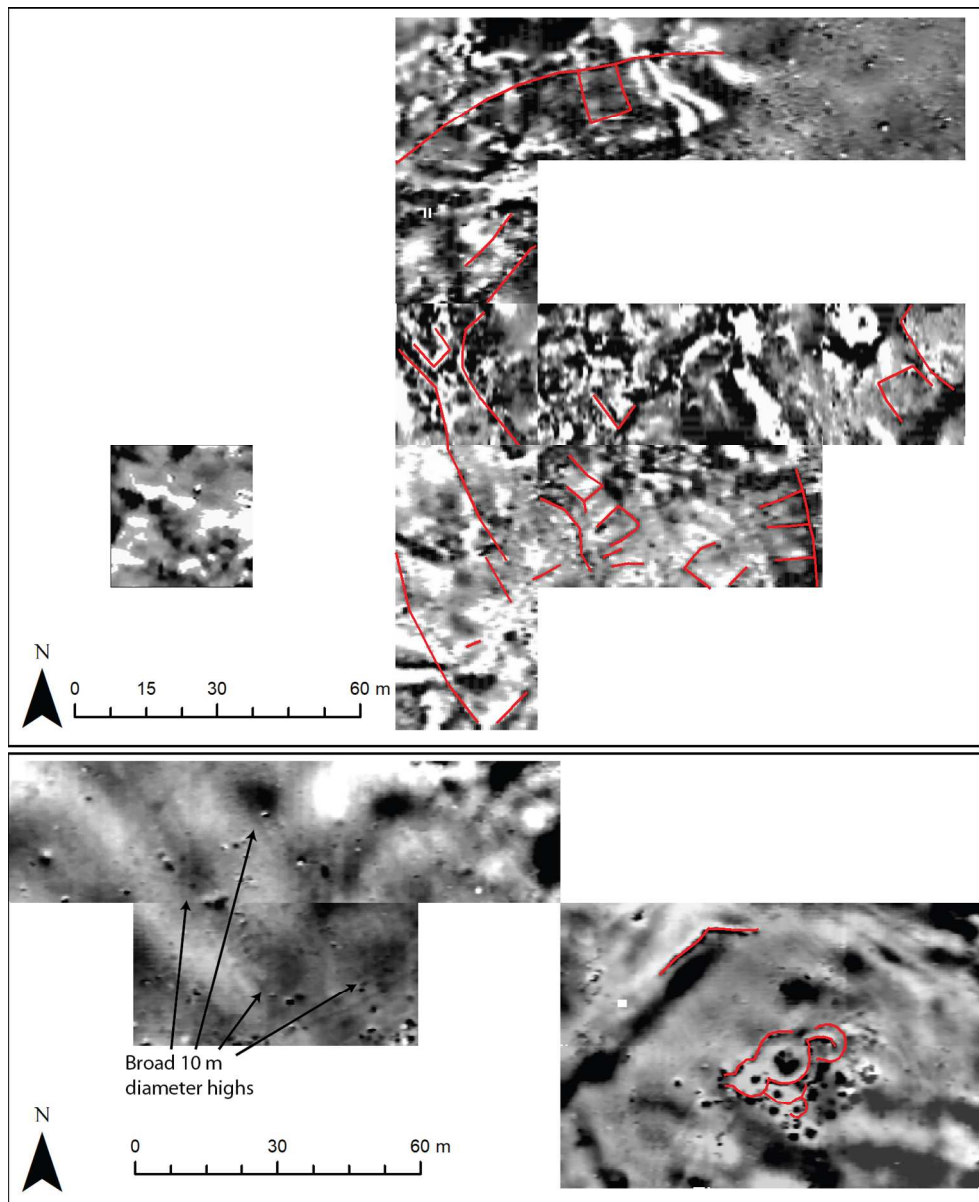


Figure 8. Annotated magnetometry data with possible anthropogenic features marked. Positive anomalies are darker; negative anomalies are lighter.

135x165mm (300 x 300 DPI)

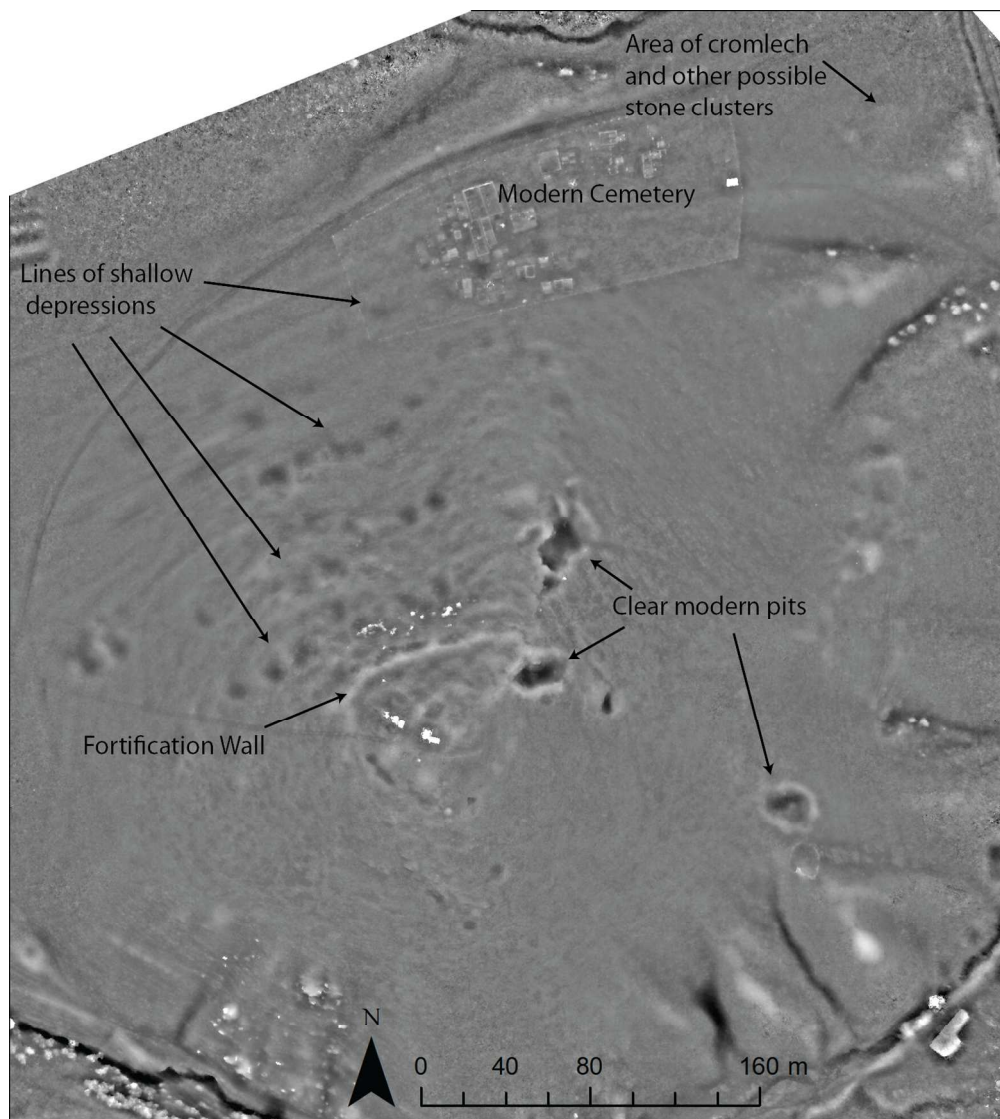


Figure 9. DEM-derived local relief model (LRM) of Mtsvane Gora. Local depressions are darker, local prominences are lighter.

135x150mm (300 x 300 DPI)

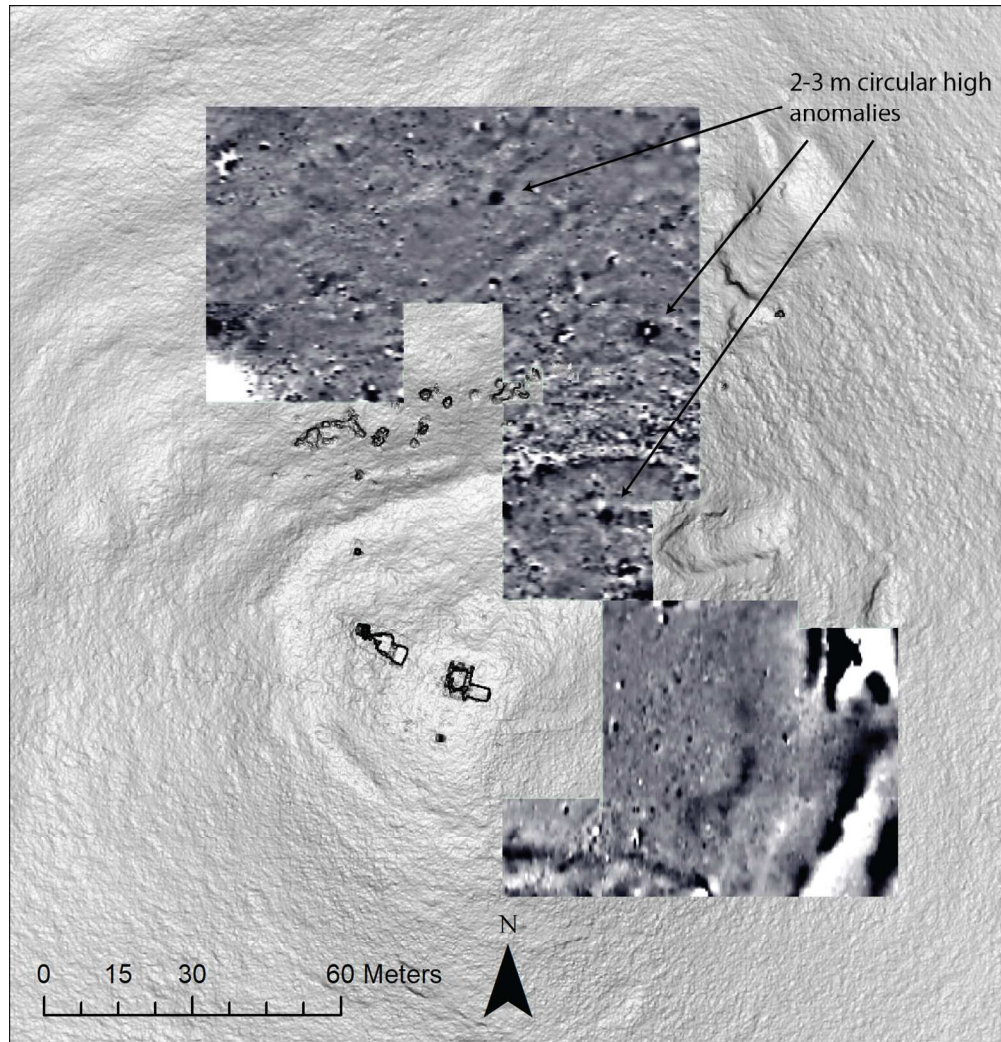


Figure 10. Magnetometry at Mtsvane Gora. Positive anomalies are darker; negative anomalies are lighter.

135x139mm (300 x 300 DPI)