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Desert kites and aggregated cells of Mount Aragats (Armenia): spatial coincidences?

Olivier Barge[a*], Bérengère Perello[a], Emmanuelle. Régagnon[a]

[a]Lyon Univ, CNRS, UMR 5133 'Archéorient', Maison de l'Orient et de la Méditerranée, 7 rue Raulin, 69007 Lyon, France

[*] Corresponding author. E-mail address: olivier.barge@mom.fr

Abstract : The aggregated cells were discovered during the fieldworks about desert kites conducted on the western slopes of Mount Aragats between 2011 and 2015, which is not surprising after all: the two categories of constructions share some logics of location in the landscape and it turns out that their respective extension areas, in Armenia, are very similar. Moreover, if the questions asked by the functions found only partial explanations, it seems that they imply animals in both cases. Could we advance the hypothesis of a coexistence of these two types of constructions, or even of their functional complementarity? The chronology, tricky to establish in the case of kites and still preliminary in that of the aggregates, could strengthen the idea of a possible contemporaneity. However, some rare cases of superposition make probable the anteriority of the aggregated cells.

Keywords : dating; functions; spatial extension; morphology; survey; GIS;

1. Introduction

Two types of constructions studied in recent years on the south-western slopes of Mount Aragats in Armenia, "desert kites" and aggregated cells, present surprisingly similar geographic distributions. Indeed, a large number of these constructions are confined to the same zone. They are often found in close proximity to each other, which explains why aggregated cells were discovered during field research on kites. Such proximity is intriguing, especially since in Harrat al-Shaam in Jordan, abundant kites are found alongside constructions similar to the aggregated cells of Armenia. This thus raises the question of their coexistence.

Aggregated cells are original constructions, which, as their name suggests, are formed by roughly circular coalescent cells. The study of such structures began with the excavation of the site of Arteni between 2015 and 2017 (Kalantaryan et al., 2017) and continued with prospections in 2016 and 2017. The latter led to a morphological description of the 26 visited sites. This work followed on from the discovery of these constructions in 2012 during fieldwork on desert kites in the same region. Since the discovery of desert kites in the Aragats in 2010 by Arkadi Kharakanian, detailed investigations have been carried out in this region (Brochier et al., 2014; Nadel et al., 2015; Barge et al. 2016a; Malkinson et al. 2017; Barge et al., 2018) whereas these structures are still poorly known in many other regions. Many questions still remain unanswered, but the function of these constructions has now been confirmed (Crassard et al., forthcoming), as well as their age, although the temporal resolution of the latter is still rather slack (Barge et al., 2019).

All these new data tend to show that the spatial distribution of these two types of constructions is too similar to be accidental. Two hypotheses can be advanced:
- both construction types are geographically close together as they are contemporaneous, and functioned at the same time. The unit of space corresponds to a unit of time,
- similar environmental characteristics were sought after in the geographic zone for the installation of aggregate cells and kites, at two separate periods of regional history.

In order to examine these two hypotheses, this paper will first of all present a description of the morphological characteristics of aggregates. New data from Arteni (Kalantaryan et al., 2017) show that the site was occupied before and after the "aggregated cell phase" and this site will thus be reconsidered within the whole corpus of aggregated cells. This will be followed by a detailed analysis

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and a comparison of the geographic distribution of both types of construction on the slopes of Mount Aragats. The coexistence of aggregated cells and kites outside Armenia will also be examined, where relevant. We will then undertake a comparison of the functions of these constructions, as the function of kites has been clearly established and can at least be discussed for aggregates. Finally, although data defining the time frame for kites are still approximate, we will nonetheless examine the absolute and relative chronologies of these constructions.

2. Methodology

Both types of construction can be identified on the high-definition satellite images available on online platforms (Google Earth, Bing Maps). Field trips were conducted to monitor these observations, but also to enhance our interpretation of the images and provide new information. The combined fieldwork/image approach is very advantageous; it was widely used for the study of kites as part of the Globalkites project (Crassard et al., 2015) and led to the implementation of a multi-scalar approach, taking account of construction, the regional scale and the overall distribution area. The Aragats area is one of the regional "windows" studied in this programme. During fieldwork in Armenia between 2011 and 2015, 49 kites were visited, 11 of them were mapped and archaeological test pits were carried out at six of them (Barge et al., 2019). Today, abundant data is available on the Aragats kites, completed if necessary by the work of an Israeli-Armenian team (Nadel et al., 2015; Malkinson et al., 2017). Mostly, the study of kites in other regions using the same methodology (Abu Azize & Tarawneh., 2015; Barge et al., 2016b) led to the detection of common points and underlined regional specificities (Barge et al., 2015; Barge et al., 2016a).

A comparable approach was set up for the aggregated cells of the Aragats, which also enabled us to avail of previously acquired data (topography, hydrography, geology). The first fieldwork observations in 2012 characterized the form, surface and geographic installation of these sites. Their signature on high-resolution satellite images subsequently led to the identification of numerous other aggregated cells and an inventory was drawn up. The largest cells and the layout of each construction were recorded, so that it was possible to delimit their extension. After the 2017 fieldwork mission, 121 aggregated cells had been recorded. The vectorization of the extension of these aggregates led to an estimation of their surface areas and the measurement of slope orientations. The primary aim of fieldwork was to monitor the validity of observations based on satellite images. Out of 26 visited sites, the existence of an aggregated cells was confirmed in each case. Ground observations showed that the somewhat rough estimation of their extension was nonetheless reliable. In addition, the existence of subsequent constructions partly covering the aggregates, recognized on the images, was confirmed in most cases.
The second aim was to enhance the characterization of aggregated cells morphology. To this end, in-depth studies were carried out for 11 sites, based on the observation of the structures and the search for surface material, the identification of frequent subsequent constructions in the same place and detailed mapping.

The following fieldwork was conducted as part of the survey of kites and aggregated cells:
- Mapping of the built structures with a differential GPS, mounted on a backpack, with decimetric accuracy,
- aerial photographs taken with a kite. The photos were then photogrammetrically processed, using reference points recorded with the DGPS, enabling us to obtain Digital Surface Models (DSM) and orthophotographs with spatial resolution ranging between 1 and 10 cm, depending on the sites, and accuracy of less than 5 cm. For the mapping, contour lines were generated based on the DSM; subsequent constructions and contextual elements were vectorized after identification on the orthophotographs.

All of these data were used to provide a general picture of aggregates, bearing in mind the diversity of these constructions. The last aim of fieldwork was to find relative chronological markers for

aggregated cells and other archaeological remains, in particular kites, based on the potential overlaps identified beforehand on satellite images.

3. Morphology of aggregated cells

Aggregated cells consist of irregular and coalescent cells, delimited by dry stone walls, generally with only one facing, or by simple alignments of blocks (Annexes 1 to 7, The letter J for "Jellyfish", nomenclature used at the beginning of the program by analogy with the Jordanian structures. This analogy subsequently appeared to be erroneous to us, but the letter J was kept in the inventories.). On the surface, in some places, we can sometimes observe elevations of two, or exceptionally three rows of stones, but generally, there is only one layer of stones. The stones used were not squared but the most regular edges were frequently used for alignments. The size of the stones varies drastically, from stones about twenty centimetres long to imposing blocks reaching 1.5 or 2 metres.

The overall structure of the aggregated cells is built by the relatively regular juxtaposition of large cells with a roughly constant size ranging from 10 to 20 metres (figure 1.a). These large cells seem to form the framework of the aggregate, and in some cases, only these large cells are present (J18, central part of J38, northern part of J31, …). But we frequently observe that smaller cells, or arrangements that are difficult to identify, are interposed in the layout. The case of the western part of aggregate J31 is totally representative of general aggregated cells morphology (figure 2). The large cells 1, 2, 3, 4, 5 and 6 outline the general framework, but we observe that smaller areas overlap with the latter. The diameter of cells 7 and 8 is 6 to 7 metres, whereas area 9 includes subdivisions that are difficult to read, and which may correspond to circulation areas, small closed constructions of several square metres, or to unidentified structures, in terms of shape. We also note that large cells were sometimes subdivided (cell 1).

As indicated above, aggregated cells are often located on rocky slopes. The upper cells are on even steeper slopes (between 10° and 20°, even 25°), which decrease gradually towards the lower part (between 10° and 0°).
Towards the top, the first cells were frequently built immediately below rocky scarps (which can be almost vertical). In these places, we clearly observe that blocks were extracted from the scarp, and we assume that these extracted blocks were used for the construction of cells. We also observe, at the base of the extraction, the presence of small platforms resting on and delimited by large blocks (figure 3). It is difficult to interpret these small areas due to the size of the materials and the irregularity of the walls from which the blocks were extracted. However, their recurrent presence suggests that they represent rustic but intentional structures. Lower down, we observe the progressive disappearance of the aggregated cells, in such a way that in most of the studied cases, it is impossible to identify a precise limit (J18 and J77 are exceptions). The walls of the cells clearly recorded further up give way to segments, then to alignments of blocks, and finally to isolated blocks at the bottom. The latter suggest that the aggregate continued but that it is no longer possible to formally identify it on the surface.
These progressive disappearances towards the base can be explained by two factors which could have acted in different ways from case to case:
- colluviation, which is clearly recorded by the presence of a sedimentary prism systematically formed further up from walls perpendicular to the slope, undoubtedly covered a lot of the structures at the base of slopes.
- we note that places where aggregated cells are preferentially implanted were also used at much later periods. Very often, we observe that other very characteristic constructions, which have been identified as medieval sheepfold (Brochier et al., 2014), overlap the lower part of aggregated cells, partially destroying them and probably reusing their materials (J9, J26, J31, J38, J56).

Aggregated cells sometimes consist of a single complex (J9, J18, J54, J56, J77), but they can also be subdivided into two or three groups located several dozen metres away from each other (J31, J38, J78). In this case, it is not impossible that these groups may have had distinctive functions, with complexes consisting of large homogenous cells (central part of J38, northern part of J31) and others with less extensive and less regular subdivisions (west of J31, eastern part of J38).

The total surfaces covered by aggregated cells range from several thousand square metres to nearly four hectares (figure 1.b). However, small aggregated cells are more frequent than large ones, with a median surface of 0.72 hectare.

Based on these field observations, completed by the observation of numerous cases on satellite images, aggregated cells reveal quite marked morphological homogeneity. In spite of specificities and adaptation to local topographic conditions, they have many points in common.

4. Installation rationales

The lower part of the successive basalt flows from Mount Aragats generally presents moderate slopes, but these slopes are much sharper around the front. They are concave at the foot of flow fronts, where they shift considerably, and then become sub-horizontal, and some of them are in contact with the plain. These slopes were frequently chosen for constructing aggregated cells, which are quite regularly spaced out around slope edges (figure 4). Thus, this locally rugged topography beside flatter areas was clearly sought after. This is undoubtedly one of the elements explaining the absence of aggregated cells on the right bank of the Akhurian. The slopes of the latter are generally similar to those of the other bank, but they are relatively even, and do not present the local topographical accidents that characterize the slopes and basalt flows of Mount Aragats.

Aggregated cells are almost systematically backed by steep slopes (often between 30° and 40°, or even more), formed by rocky outcrops (J9, J28, J31, J38, J56, J77). The presence of these rocky outcrops is characteristic of the western slopes of Mount Aragats and seems to have played a preponderant role in the choice of aggregated cells installation. As mentioned above, they may have been used as a convenient procurement source for the stones and blocks used for construction. They also acted as shelters, as the south-facing bases of flow fronts were clearly preferentially selected. Indeed, when we measure the orientation of all the slopes within the aggregated cell surface, we observe that more than 60% of the values are clustered in the southeast-southwest quadrant (figure 5). Only 13% are in the northern half and the circular average is close to 183° (a difference of less than 3° from the south). Thus, the building of aggregated cells backed by steep slopes combined with a southern orientation suggests that warm and sheltered conditions were a prerequisite.

The topographic installation of kites has already been described in detail (Brochier et al., 2014, Barge et al., 2016a). In Armenia and elsewhere, the entrance of the enclosure at the extremity of the antennae was often built on a slope discontinuity (81% of cases). On the slopes of Mount Aragats, kite antennae are spread over the slightly sloped and relatively even surface of basalt flows; they converge at the convex slope discontinuity marking the upper part of flow fronts and the enclosure is built lower down the slope. The plan of each kite was clearly adapted to local topographic features, but the example of kite AM7 is representative of most situations (figure 6). In addition, front flows are nearly always dotted with rocky outcrops. As is the case for kite AM7, these rocky outcrops were clearly deliberately integrated into the interior of enclosures, and sometimes, as a result, walls had to be built on steep slopes whereas it would have been easier to build them on scarps. The construction of the walls outlines corridors between them and the rocky outcrops, suggesting that it was important to define preferential circulation directions in the topography of the interior of the enclosure.

Therefore, the recurrence of rocky outcrops shows that they were clearly sought after for the installation of both types of construction: they acted as shelters in the case of aggregated cells, and this increased topographic complexity was propitious for the construction of kites. These rocky outcrops are particularly abundant in basalt front flows, which seem to present suitable conditions for aggregated cells and kites. The former were built on the lower part of front flows, whereas the latter were built on the upper part (figure 4).

5. Geographic distribution of aggregated cells and kites

The installation strategies of both types of construction rely on the same topographic elements, which explains why aggregated cells and kites are found near each other (figure 4). The median distance from aggregated cells to the nearest kite is 600 metres, whereas only one out of four is more than a kilometre away (figure 4b). Therefore, it is not surprising that both types of construction display very similar geographic distributions (figure 7a). From an overall quantitative viewpoint, the convex hull of all the aggregated cells on the map measures 1,188 km^2, that of kites 1,321 km^2 and shared areas 1,110 km^2. The shared part of the distribution area thus represents 93% for aggregated cells and 84% for kites. Inside these hulls, we observe that the areas where kites are absent correspond to those where aggregates are also absent. An increasing gradient from the east towards the west also exists for kites and aggregated cells, which is vey similar to the gradient of the presence of rocky outcrops, which are much more abundant in the west than in the east.

These two distributions are thus surprisingly similar, but we can nonetheless perceive several variations. Aggregated cells are very abundant in the northwest, and as a result, kites are relatively under-represented in this zone, whereas in the south, aggregated cells are comparatively less present in the area of two kite alignments (figure 7b).

These very similar geographic distributions are also surprising considering the observed isolation of the structures in both cases. This has already been highlighted for kites (Brochier et al., 2014), although no explanation could be advanced. In the case of aggregated cells, it is also impossible to explain this isolation. In spite of meticulous and systematic examinations of the satellite images beyond the area represented on the map (figure 7), none of these constructions could be identified in peripheral areas.

6. Kites and aggregated cells outside the Aragats area

These very singular geographic distributions incited us to move out of a regional scale to a much wider scale. This investigation had already carried out based on the literature (Kalantaryan et al., 2017), but was limited to the Harrat-al-Shaam in Jordan and did not explicitly examine the possible relationship between kites and aggregated cells. It thus seemed necessary to provide additional elements.

In Armenia, several sites from the region of Vardenis have been compared to aggregated cells on account of the fact that they present similar overall structures. The comparison of results from archaeological work carried out at Geghaqar and Aghbradzor (Harutyunyan and Badalyan 2008, cited by Kalantaryan et al., 2017) with data from Arteni should enable us to identify possible parallels. However, after surface field observations at the Aghbradzor site, we concluded that these two types of sites were very different. Indeed, at the latter, the cells are larger in size and are not layered, there is often a depression inside each cell, we distinguish clear circulation areas between groups of cells and their construction reveals double-faced walls. None of these features have ever been observed in the aggregated cells of the Aragats area.

The distribution area of kites is now better known (Barge et al, forthcoming). The systematic search for aggregated cells on satellite images from this area shows that outside Armenia, the latter are not at all omnipresent, and in fact are practically only present in Harrat-al-Shaam, a basaltic region along the Syrian-Jordanian border (figure 8a). Several studies have been carried out on these structures, or related structures (Akkermans et al., 2014; Athanassas et al., 2015; Rollefson et al., 2016), yet few conclusions have been reached regarding the type and function of these sites. The most widely studied of these constructions are “wheel houses” or “jellyfish”, dating from the end of the Neolithic or Chalcolithic, which present a very different morphology to the aggregated cells of Mount Aragats. In spite of widespread diversity, they are circular in shape and the cells inside the circle are organized around the centre, in such a way that they embody rays (figure 8b and c). On the other hand, we often observe other constructions on the images, which are much more morphologically similar to the aggregated cells of Armenia (figure 8d and e). They are more frequent than “wheel houses” with a much wider spatial extension. We have very little information on these structures. However, considering the preserved elevations observed in the field during the study of kites in the east of

Jordan and the apparent "freshness" of the constructions on satellite images, some of them could be recent. In any event, cases where kites overlap with aggregated cells and "wheel houses" all show that kites are earlier than the other structures (figure 8f and g).

This overview shows that the spatial association of aggregated cells and kites is far from systematic as the presence of kites is not associated with aggregated cells in many regions. In Harrat-al-Shaam, where this co-existence was mentioned at a very early stage, and led at times to considering these two types of constructions together (Kalantaryan et al., 2017), elements indicating their relative chronology seem to rule out their contemporaneity. What about any possible functional link between these structures?

7. Functions

Up until now, most authors have suggested that the function of kites was for hunting (among others, Helms and Betts, 1987; Van Berg *et al*., 2004; Holzer *et al*., 2010; Morandi Bonacossi and Iamoni, 2012). However, the possibility of a pastoral use has also often been mentioned, or even asserted (Svizzero and Tisdell, 2018), particularly for the kites of Armenia (Malkinson et al., 2017; Hovsepyan, 2018), in spite of strong criticism (Rosen & Perevolotsky, 1998). Both of these hypotheses were explored together during the course of work on the Globalkites programme; leading to the rejection of the pastoral hypothesis, in particular in Armenia (Barge et al., 2018) and to the conclusion that kites were used for hunting (Crassard et al, forthcoming). The main argument for this is based on the systematic existence of cells in the plan of kites, an element that has not generally been taken into account up until now and which was often considered to be a surveillance position or a lookout post. In reality, these cells are the key element of the kite and acted as a killing stratagem. Indeed, wherever they were excavated (8 in Armenia, 14 in Kazakhstan, 6 in South Jordan, 31 in Harat-al-Shaam, and 7 in Saudi Arabia), these cells turned out to be deep pits (figure 9) into which animals were thrown. The identification of the final trapping process enabled us to coherently interpret other recurring morphological details of kites, and provided elements for understanding the overall functioning of the structures. In this way, all the projections built into the enclosure, whether they are inflections, angles or points (particularly frequent in Armenia), systematically end in a cell. These enclosure shapes made it easier to drive the animals towards the pits. The latter were often hidden from the interior of the enclosure behind slope discontinuities, which were also used to conceal the entrance of the enclosure when approached from between the antennae. This clever use of slope discontinuities explains the fact that complex topographies were chosen in most cases for constructing the enclosure and in particular in Armenia, where rocky outcrops seemed to play an important role in masking obstacles or marking out circulation paths. Finally, the orientation of kites (the direction in which the antennae point) on a regional scale is partly determined by the topography of sites, but also presents a highly dominant direction which, in cases where it could be studied, such as in Armenia (Chahoud et al., 2015), is in keeping with migratory movements of animals. All of these elements thus validate the hunting hypothesis. Furthermore, the considerable surface of kite enclosures (on average, about a hectare, with higher values in Armenia) refutes the pastoral hypothesis: it is more than ten times superior to that of the pastoral enclosures studied up until now (Crassard et al., forthcoming).

Data for determining the function of aggregated cells are more limited. Based on the observation of numerous surface cases, the constant topographic features and the morphological uniformity of the constructions imply that they were functional structures. Initially, we thought of a pastoral use, where each of the large cells looks like an enclosure. The fact that aggregated cells are systematically built on steep slopes supports this hypothesis as slopes facilitate the cleaning of pastoral mountain enclosures (Rendu et al., 2016). Large herds may thus have been gathered in the same place and the different cells may have been used to separate the animals by species, sex, or affiliation to different (family?) groups, in order to take advantage of grazing resources. We also observed the presence of areas with reduced dimensions between the large cells forming the outline of aggregated cells or immediately below rocky scarps. Some of them may have been elementary dwellings, perhaps especially those built on the upper slopes, as they would have been more sheltered and would have leaned against the wall, making it easier to install roof cover. Others, for which the structure is less visible, could have been

used for specific activities, which cannot be accurately identified solely on the basis of surface observation.
The south-facing orientation suggests that warm slopes sheltered from cold winds were sought after, perhaps for seasonal use. This would exclude the warm period, from June to September, and also the winter period, when snow cover is continuous. They may thus have been used during the mid-season.

For the moment, the excavation of aggregated cells is limited to the site of Arteni and unfortunately, the levels corresponding to the aggregated cells yielded little information. However, several interesting elements provide clues regarding the function of the site. Archaeobotanical data point towards a pastoral use (Hovsepyan, 2018). Although data from the level of the aggregated cells are sparse, they reveal large quantities of coprolites (mineralized animal excrements), demonstrating the use of manure as fuel. Although they are scarce, these data point in the same direction as those from animal bone remains (Creuzieux, in: Perello et al. 2019). Indeed, data from the archaeozoological analysis show that more than 80% of the bones belong to domestic caprines (sheep/goat). In addition, the kill-off ages of young animals also point to seasonal use, and corroborate the analysis of construction orientation, suggesting occupations during intermediary periods, in spring and autumn (Perello et al. 2019, data on seasonality are only based on levels preceding aggregated cells).

We could also advance the hypothesis of an agricultural function for these aggregated cells which could be considered as terraces. This is supported by the south-facing orientation and the archaeobotanical data from Arteni showing the presence of coprolites, which could be interpreted as fertiliser. These terraces may have been planted with specific seasonal cultures (tinctorial, medicinal?). The fact that they are so localized could be explained by the specific characteristics of the cultivated plant, the type of soil or cultivation method.

Data pointing to the function of aggregated cells are thus tenuous and we cannot reach any firm conclusions. However, we can cautiously postulate that the pastoral function seems to be the most likely in so far as the data from three different approaches (surface morphology, archaeobotany, archaeozoology) all point towards this interpretation.

8. Chronology

A radiocarbon date from the site of Arteni places the aggregated cells level at the beginning of the Late Bronze Age (1431 – 1283 Cal BC). This date is in keeping with the objects found in this level. The pottery is characterized by comb treatment on the interior and exterior surfaces and decoration consisting of layers of marks made by fingernails (Perello et al. forthcoming). This type of pottery is known in the central part of the South Caucasus in Armenia and Georgia, where it is characteristic of the transition phase between the Middle Bronze Age and the Late Bronze Age (Trialeti-Vanadzor culture), that is to say, the middle of the second millennium BC (Avetisyan & Bobokhyan, 2008). Data for the absolute dating of kites are sparse (Brochier et al., 2014; Barge et al., 2019). As a result, here, we will simply place their construction in a wide chronological timeframe extending from the Late Bronze Age to the first centuries of our era, although their dating is more likely to be constricted to the Iron Age. In this way, the absolute dates would probably position the existence of kites after aggregated cells, but the temporal resolution of kite dating does not formally exclude the fact that these two types of construction could have been used at the same time over a short period.

We saw above that aggregated cells are often located near kites: there are even two cases where we observe an overlap, thereby providing information on the relative chronology of the structures. The case of kite AM94, where the construction partially destroyed aggregated cell J2 has already been presented (Brochier et al., 2014). It is clear that the aggregated cell came before the kite: the wall of the kite enclosure is continuous whereas those of the aggregated cells are interrupted near the kite wall. In the southern part of the overlap, we even perceive the former layering of the aggregated cells on the high resolution DSM, while the probably dismantled walls have disappeared (figure 10). A second case of overlap provides the same information, i.e., a kite post-dating an aggregated cell.

Aggregated cells J28, which must originally have consisted of about twenty cells, was classically constructed at the base of the southern face of a rocky outcrop. A proximal pointed cell of kite AM78 was positioned on the west part of the aggregated cells, and the enclosure wall crosses, then goes around the rocky outcrop (figure 11a). This kite cell appears very clearly on the DSM while the aggregated cells is more blurred (figure 11b). The cells have totally disappeared from this place and the blocks and stones were probably reused for the construction of the kite cell. It is possible that the terrace effect that we distinguished immediately to the west of the pointed kite cell is the trace of a former cell on which the kite was built.

9. Conclusion

We have demonstrated that aggregated cells and kites display astonishing spatial unity. The spatial distribution of these constructions is very similar, although not totally identical. It seems as though this unit of space does not correspond to a unit of time. Relative chronology shows that kites were built after aggregated cells, and absolute chronological elements also tend to point in the same direction, placing kites after aggregated cells. However, this conclusion is still somewhat tenuous as there are only two cases where both types of structures overlap and it is still difficult to establish an absolute chronology. Therefore, we cannot totally rule out the fact that aggregated cells and kites may be contemporaneous in other places.

If both types of construction turned out to be contemporaneous, we would have to assess their functional compatibility. We can now affirm that kites are hunting traps, in Armenia and elsewhere. There is no longer any doubt as to the role played by pit cells as a killing device and as an element for identifying kites in relation to other structures with convergent antennae. Furthermore, numerous other elements support this assertion. The pastoral interpretation of aggregated cells is less firmly established as the corresponding levels at the site of Arteni have yielded little archaeological material. However, markers pointing to a pastoral use are independent. In view of this, it is difficult to see how traps intended to kill animals could be functionally associated with structures designed to enclose them, without even taking the types of animal species into consideration. The coexistence of two types of independent constructions, with different functions, is thus very unlikely.

In spite of the inaccuracy of temporal data and some functional data that prevent us from reaching a firm conclusion, it would be very risky to associate, in one way or another, aggregated cells and kites. In addition, outside Armenia, the coexistence of these constructions is far from systematic, and when it occurs, kites and aggregated cells do not seem to be contemporaneous. On the slopes of Mount Aragats, the observed spatial proximity between these types of construction can be explained by the fact that they rely on the same geomorphological features. The motives for their localization are closely linked to topography. For distinct reasons, the fronts of basalt flows, and in particular the rocky outcrops in these flows, were sought after in both cases. For the time being, with currently available data, the most probable explanation is thus spatial coincidence.

(Annexes 1 to 7)

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References

Abu-Azizeh W., Tarawneh M. 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.

Akkermans P.M.M.G., Huigens H.O., Bruning M.L. 2014. A landscape of preservation: Late prehistoric settlement and sequence in the Jebel Qurma region, north-eastern Jordan. Levant 46(2): 186-205.

Athanassas C.D., Rollefson G.O., Kadereit A., Kennedy D., Theodorakopoulou K., Rowan Y.M., Wasse A. 2015. Optically stimulated luminescence (OSL) dating and spatial analysis of geometric lines in the Northern Arabian Desert. Journal of Archaeological Science 64: 1-11.

Avetisyan P., Bobokhyan A. 2008.The pottery traditions of the Armenian Middle to Late Bronze Age 'Transition' in the context of the Bronze and Iron Age Periodization. In: K.S. Rubinson and A. Sagona, Ceramics in Transitions: Chalcolithic Through Iron Age in the Highlands of the Southern Caucasus and Anatolia. Ancient Near Eastern Studies, Supp. 27, 123-183

Barge O., Brochier J.É., Régagnon E., Chambrade M.-L., Crassard R. 2015. Unity and diversity of the kite phenomenon: a comparative study between Jordan, Armenia and Kazakhstan. Arabian Archaeology and Epigraphy 26(2): 144-161.

Barge O. Brochier J.É., Karakhanyan A. 2016a. Northernmost kites? Quaternary International 395: 104-112.

Barge O., Brochier J.É., Deom J.-M., Sala R., Karakhanyan A., Avagyan A., Plakhov K. 2016b. The "desert kites" of the Ustyurt plateau. Quaternary International 395: 113-132.

Barge O., Brochier J.É., Crassard R., Régagnon E., 2018. Hunting or pastoralism ? Comments on 'seasonal use of corrals and game traps (desert kites) in Arménia" by Malkinson et al., Quaternary International 493: 19-21,

Barge O., Brochier J.É., Chahoud J., Chataigner C., Régagnon E. and Crassard R. 2019, Hunting with kites in Armenia, In: Betts A. and van Pelt P., (Eds.), The Gazelle's Dream. Game Drives of the Old and New Worlds, University of Sydney Press; Sydney.

Barge O., Abu-Azizeh W., Brochier J.É., Crassard R., Régagnon E. forthcoming, Desert-kites et constructions apparentées : découvertes récentes et aire d'extension géographique, Paléorient

Brochier J.É., Barge O., Karakhanyan A., Kalantarian I., Chambrade M.-L., Magnin F. 2014. Kites on the margins: the Aragats kites in Armenia. Paléorient 40(1): 25-53.

Chahoud J., Vila E., Crassard R. 2015. Zooarchaeological approach in understanding the desert kites. Arabian Archaeology and Epigraphy 26(2): 235-244.

Crassard R., Barge O., Bichot C.-E., Brochier J.É, Chahoud J., Chambrade M.-L., Chataigner C., Madi K., Régagnon E., Seba H., Vila E. 2015. Addressing the Desert Kites Phenomenon and Its Global Range Through a Multi-proxy Approach. Journal of Archaeological Method and Theory 22(4): 1093-1121.

Crassard R., Abu-Azizeh W., Barge O., Brochier J.É., Chahoud J., Régagnon E. forthcoming, Desert kites were hunting mega-traps, Journal of Archaeological Science

Helms S., Betts A. 1987. The desert 'kites' of the Badiyatesh-Sham and north Arabia. Paléorient 13: 41-67.

Holzer A., Avner U., Porat N., Horwitz L.K. 2010. Desert kites in the Negev desert and northeast Sinai: their function, chronology and ecology. Journal of Arid Environments 74: 806-817.

Hovsepyan R. 2018. Archaeobotanical data from an 'agglomerated cells' type site: Plant macro-remains from Arteni-1 (Armenia), Journal of Archaeological Science: Reports 21: 619-628.

Kalantaryan, I., Perello, B., Chataigner Ch. New insight into the Agglomerated Cells in Armenia: Arteni, Aragats massif, 2017, In P. S. Avetisyan, Y.H. Greykyan, Bridging Times and Spaces,

Festschrift in Honour of Gregory E. ARESHIAN on the Occasion of his Sixty-Fifth Birthday, Archeopress, Londres, 183-201.

Malkinson, D., Bar-Oz, G., Gasparyan, B., Nachmias, A., Crater Gershtein, E., Nadel, D., 2017. Seasonal use of corrals and game traps (desert kites) in Armenia. Quaternary International 464 (A): 285-304.

Morandi Bonacossi D., Iamoni M. 2012. The early history of the western Palmyra desert region. The change in the settlement patterns and the adaptation of subsistence strategies to encroaching aridity: a first assessment of the desert-kite and tumulus cultural horizons. Syria 89: 31-58.

Nadel, D., Bar-Oz, G., Malkinson, D., Spivak, P., Langgut, D., Porat, N., Khechoyan, A., Nachmias, A., Crater-Gershtein, E., Katinaa, A., Bermatov-Paz, G., 2015, New insights into desert kites in Armenia: the fringes of the Ararat Depression. Arabian Archaeology and Epigraphy 26: 120-143.

Perello, B., Kalantaryan, I., Azatyan, K., Barge, O., Creuzieux, A., Hovspeyan, R., forthcoming, The "agglomerated cells" of the Aragats region: new perspectives from the Arteni excavations.

Rollefson G. O., Constantin D. Athanassas C. D., Rowan Y. M., Wasse A.M.R. 2016. First chronometric results for 'works of the old men': late prehistoric 'wheels' near Wisad Pools, Black Desert, Jordan, Antiquity 90 352: 939–952

Rendu C., Calastrenc C., Le Couédic M., Berdoy A. 2016. Estives d'Ossau, 7000 ans de pastoralisme dans les Pyrénées. Le Pas d'Oiseau éditions.

Rosen B., Perevolotsky A. 1998. The function of 'desert kites' – hunting or livestock husbandry? Paléorient 24(1): 107-111.

Svizzero S.,Tisdell C. 2018. Desert kites: were they used for hunting or for herding? A review of the recent academic literature, Journal of Zoological Research 2 – 4: 7-28.

Van Berg P.-L., Vander Linden M., Lemaître S., Cauwe N., Picalause V. 2004. Desert-kites of the Hemma Plateau (Hassake, Syria). Paléorient 30(1): 89-99.

Captions:

Figure 1: a) histogram of the diameter of cells forming the framework of aggregated cells, b) histogram of the surfaces of aggregated cells.

Figure 2: Detailed plan of the west part of aggregated cell J31.

Figure 3: DSM hillshade: upper part and contact with the rocky outcrop of aggregated cells J9.

Figure 4: a) Topographic context of the installation of kites and aggregated cells: example of the basalt flow front in the northeast of Aragatsavan. b) Distance from aggregated cells to the nearest kite (box plot).

Figure 5: Orientation of slopes with aggregated cells: distribution of the orientation of each pixel of the SRTM DEM included in the area of an aggregated cells.

Figure 6: Topographic installation of kites: the example of kite AM7. a) oblique aerial photograph, b) interpretative approach.

Figure 7: a) Geographic distribution of the aggregated cells and kites of Armenia; b) difference in the densities of kites and aggregated cells: the density of both types of construction was calculated independently based on point features of both feature class (radius of research = 1,500 m), then subtracted from each other. In spite of the fact that kites are more numerous than aggregated cells, the discretization of the values using the Jenks algorithm spatially underlines the relative over-representation of one or the other construction.

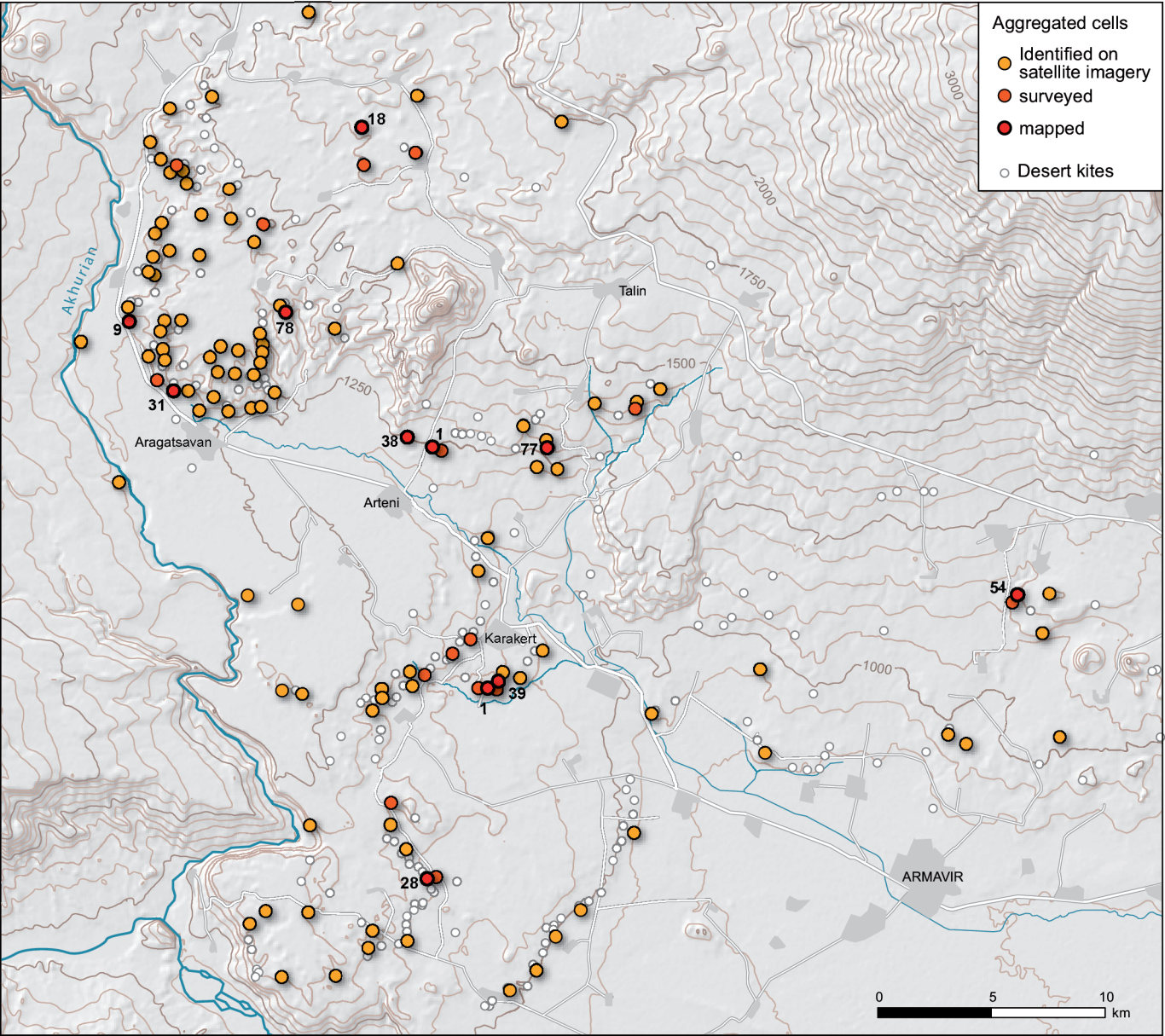
Figure 8: a) Presence and absence of aggregated cells in the distribution area of kites; examples of "wheel houses" (b and c), aggregated cells (d and e) and overlapping with kites (f and g) observed on high resolution satellite imagery in Harrat-al-Shaam.

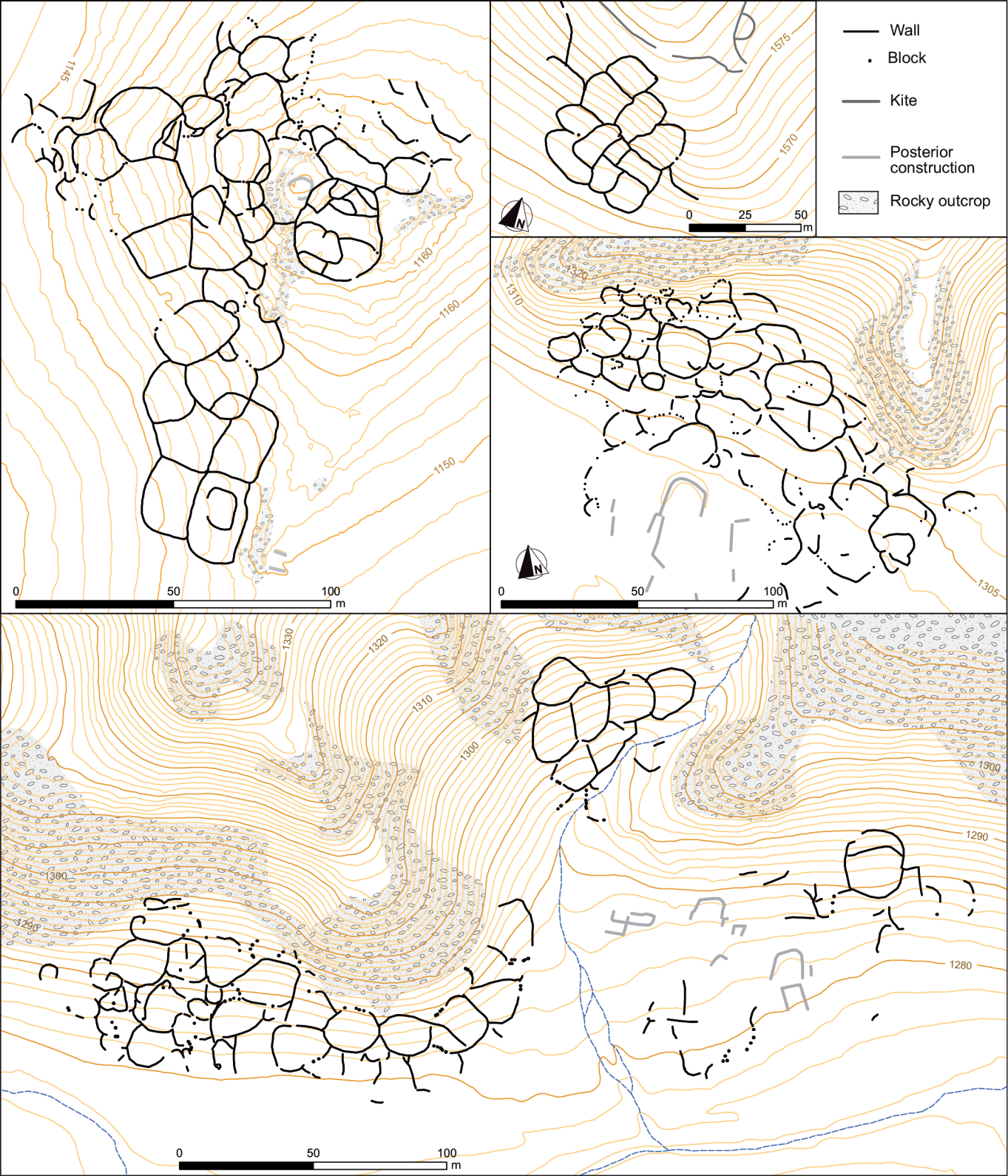
Figure 9: Examples of cells during excavation work filled with an accumulation of run-off sediments after being abandoned, with dry-stone lining reaching various depths, but which is often deep, a) cross section of AM14-cell1 in Armenia b) on the Ustyurt Plateau in Kazakhstan, c) in Harrat-al-Shaam in Jordan,

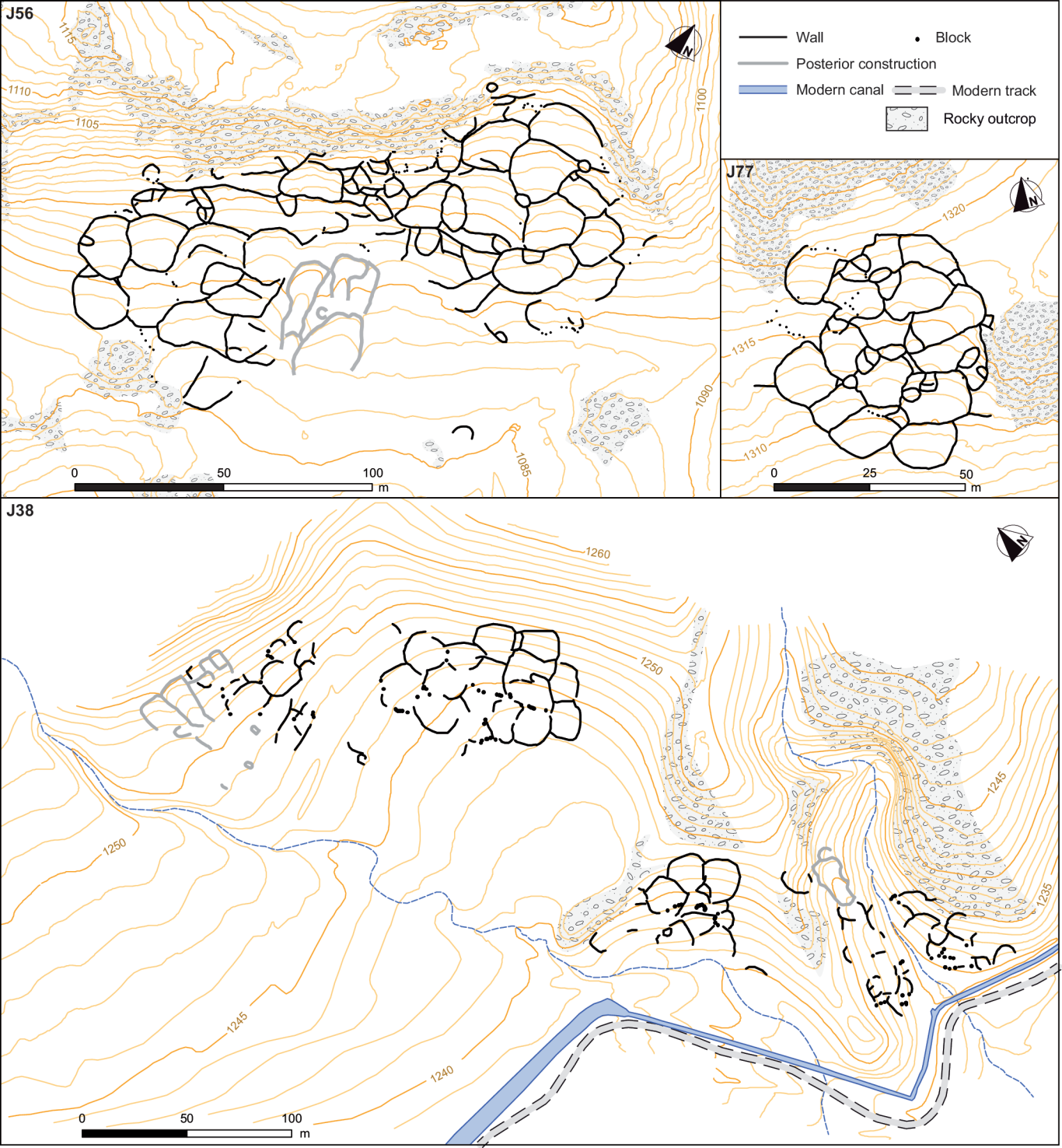
Figure 10: Overlap of kite AM94 and the aggregated cells J2; a) DSM hillshade, b) Plan of the kite, plan of the aggregated cells and reconstruction proposal for the aggregated cells.

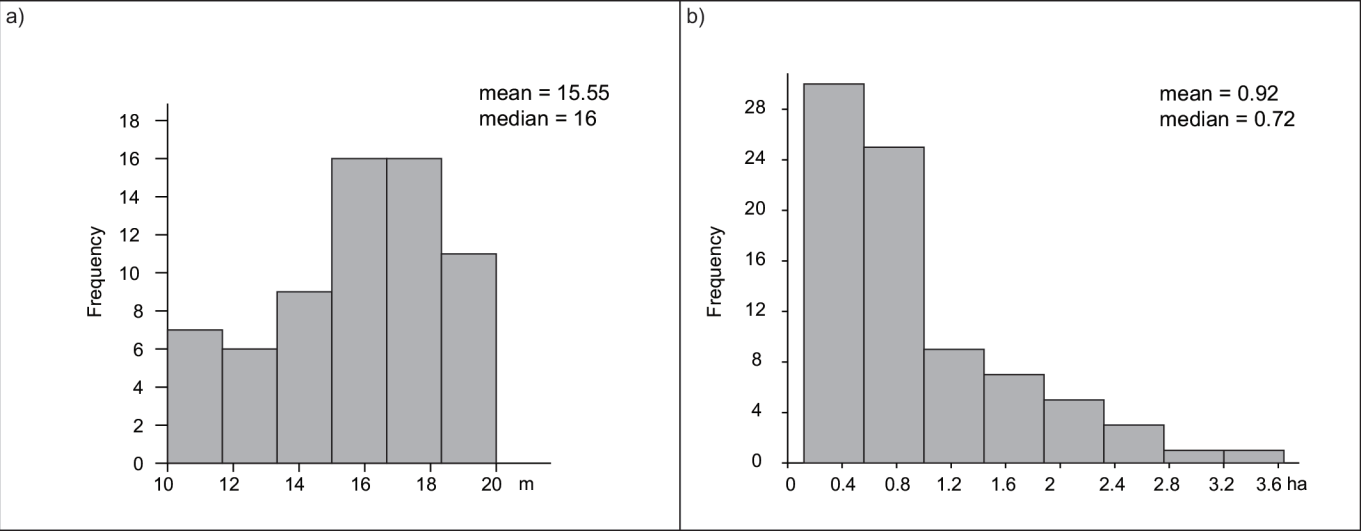
Figure 11: a) Plan of the aggregated cells J28 and overlapping of kite AM78, b) DSM hillshade centred on the overlap.

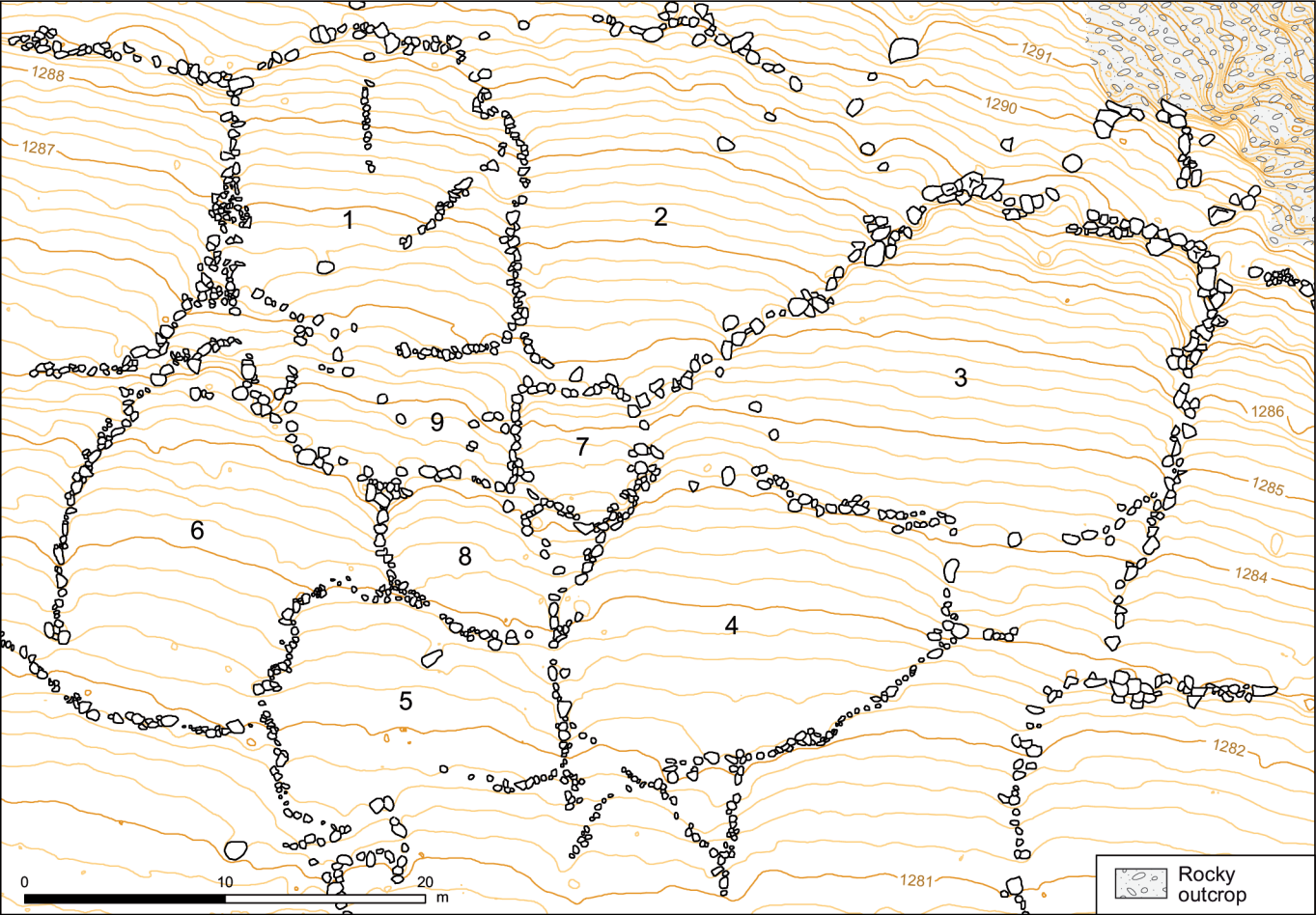
Annexes 1 to 7 (to be placed at the end of the article): Plan of the aggregated cells J9, J18, J31, J38, J54, J56 and J77 (

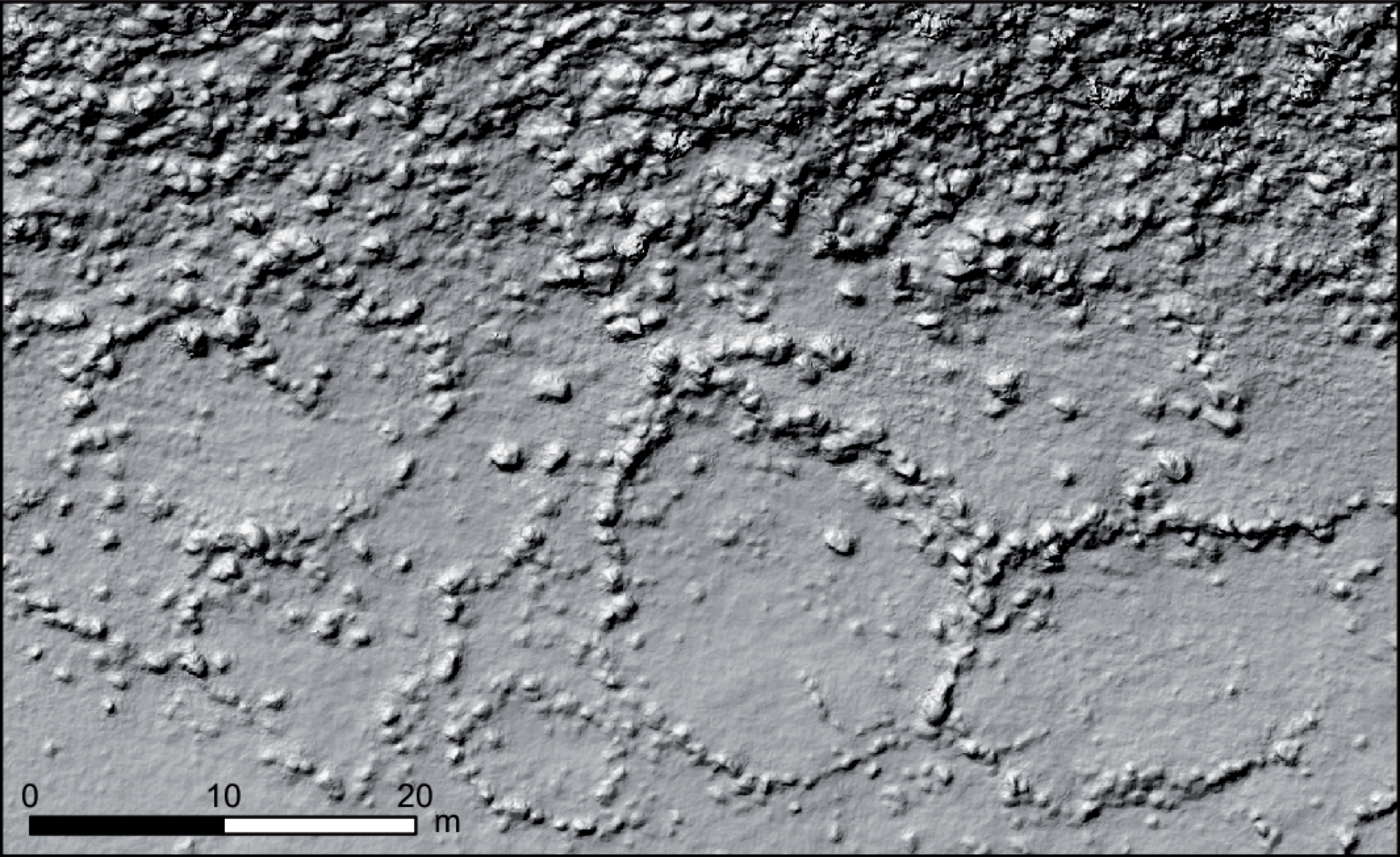

Aggregated cells
Identified on satellite imagery
surveyed
mapped
Desert kites
Akhurian
Aragatsavan
Arteni
Talin
Karakert
ARMAVIR
18
9
78
31
38
1
77
54
39
1
28
3000
2000
1750
1500
1250
1000
0
5
10
km

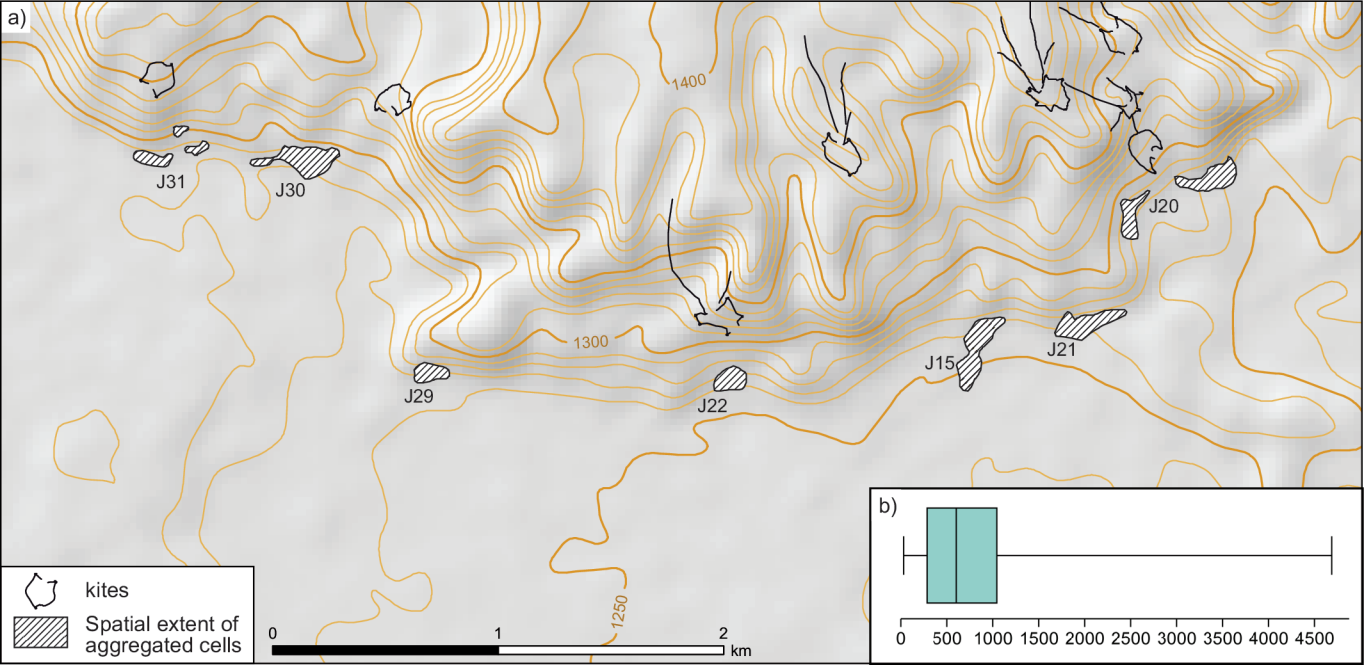

Wall
Block
Kite
Posterior construction
Rocky outcrop
1145
1160
1160
1150
0
50
100
m
1575
1570
0
25
50
m
1320
1310
1305
0
50
100
m
1330
1320
1310
1300
1300
1290
1290
1280
0
50
100
m

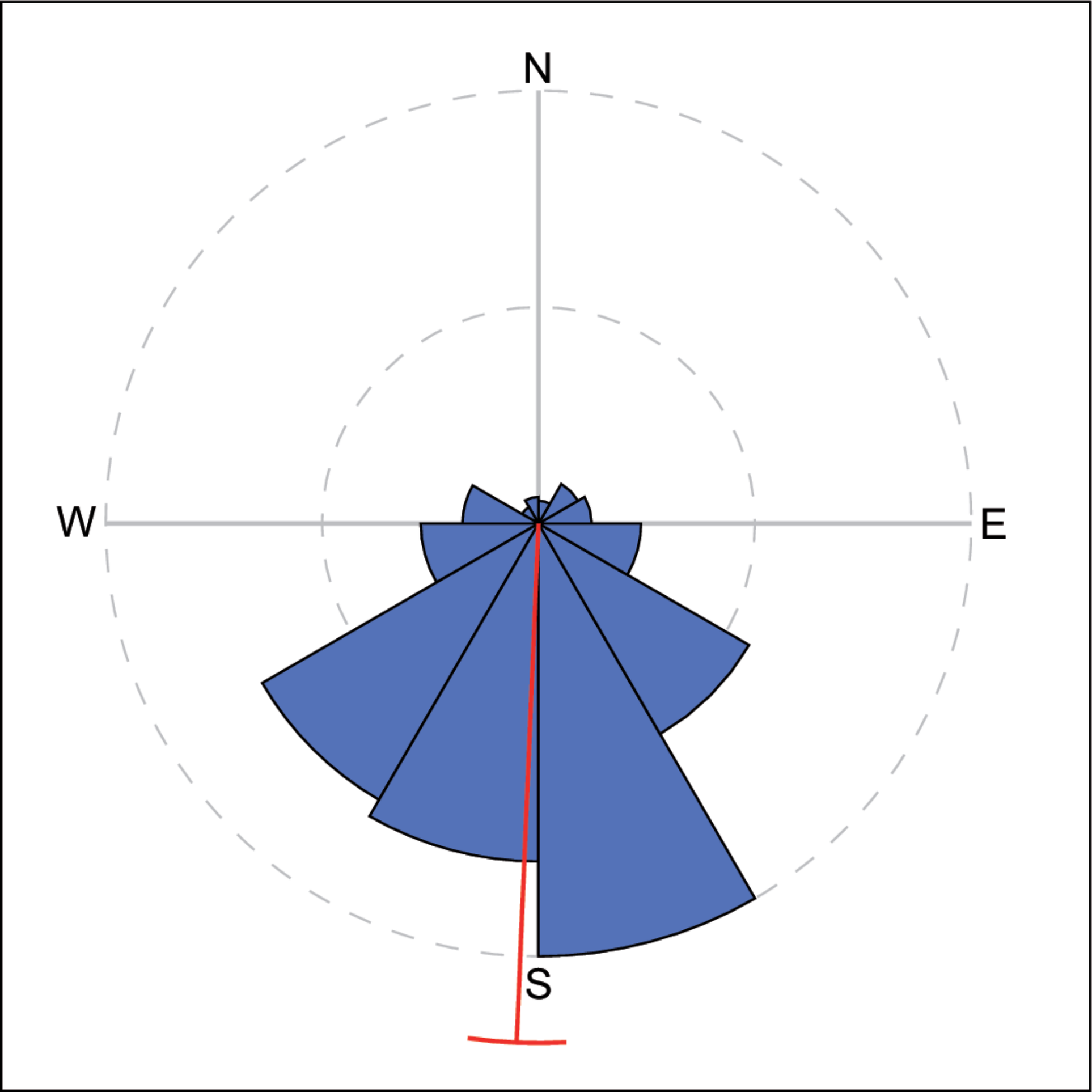

J56
1115
1110
1105
1100
1090
1085
0
50
100
m
Wall
Block
Posterior construction
Modern canal
Modern track
Rocky outcrop
J77
1320
1315
1310
0
25
50
m
J38
1260
1250
1245
1240
1235
0
50
100
m

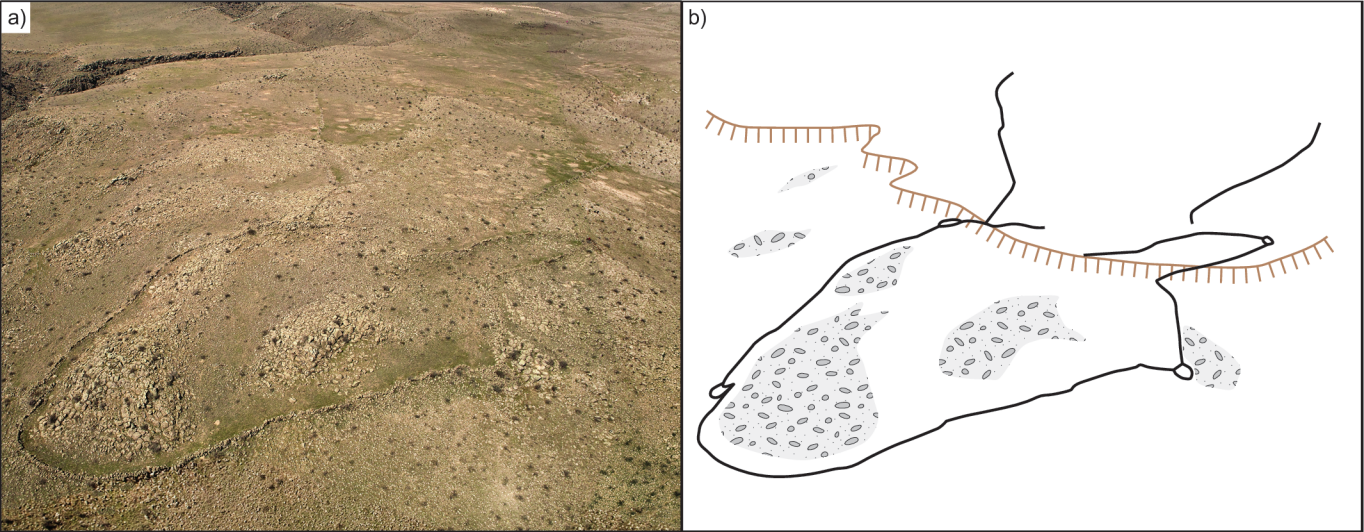

a)
mean = 15.55
median = 16
Frequency
0
2
4
6
8
10
12
14
16
18
10
12
14
16
18
20
m
b)
mean = 0.92
median = 0.72
Frequency
0
4
8
12
16
20
24
28
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
ha

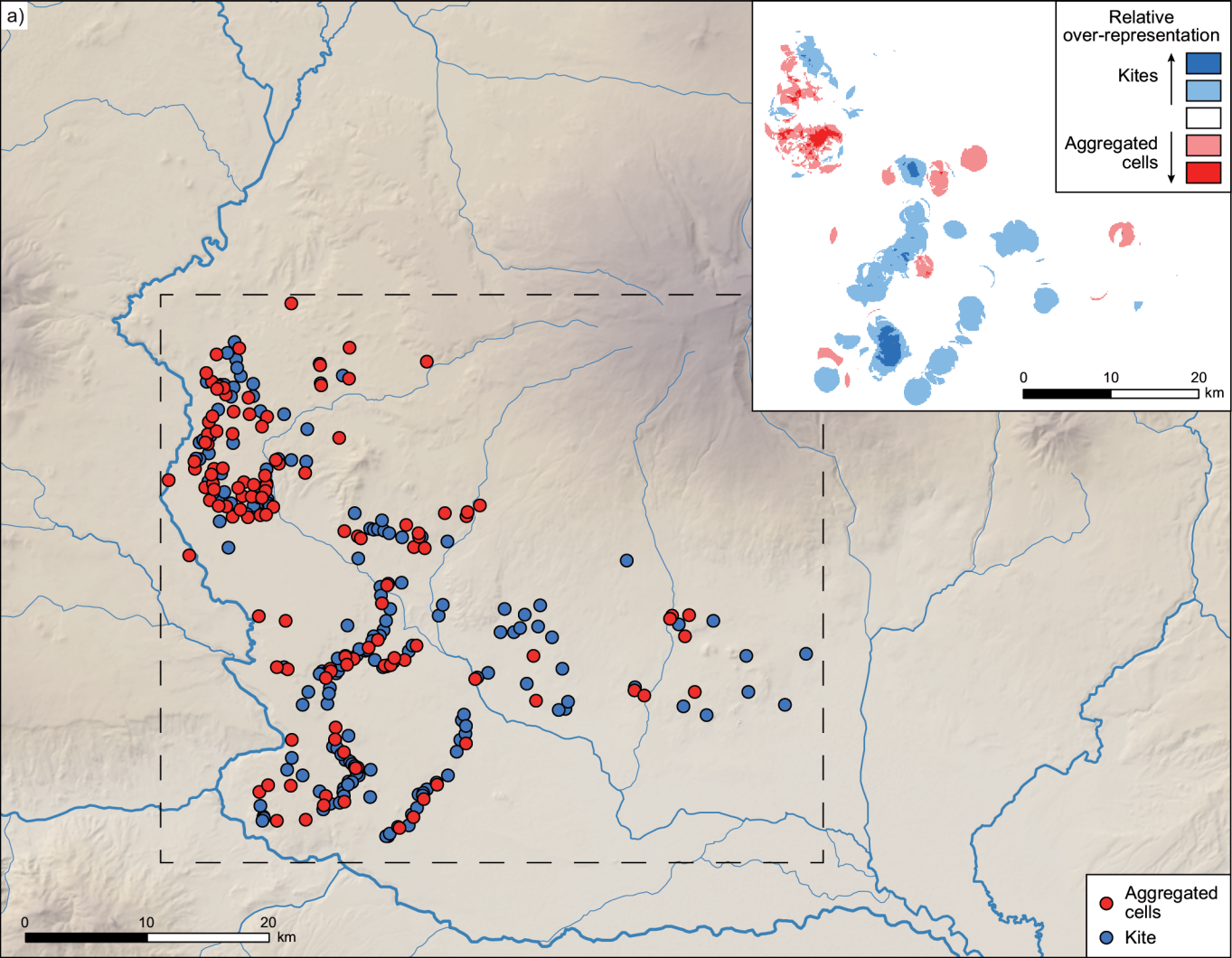

1288
1287
1291
1290
1286
1285
1284
1282
1281
1
2
3
4
5
6
7
8
9
0
10
20
m
Rocky outcrop

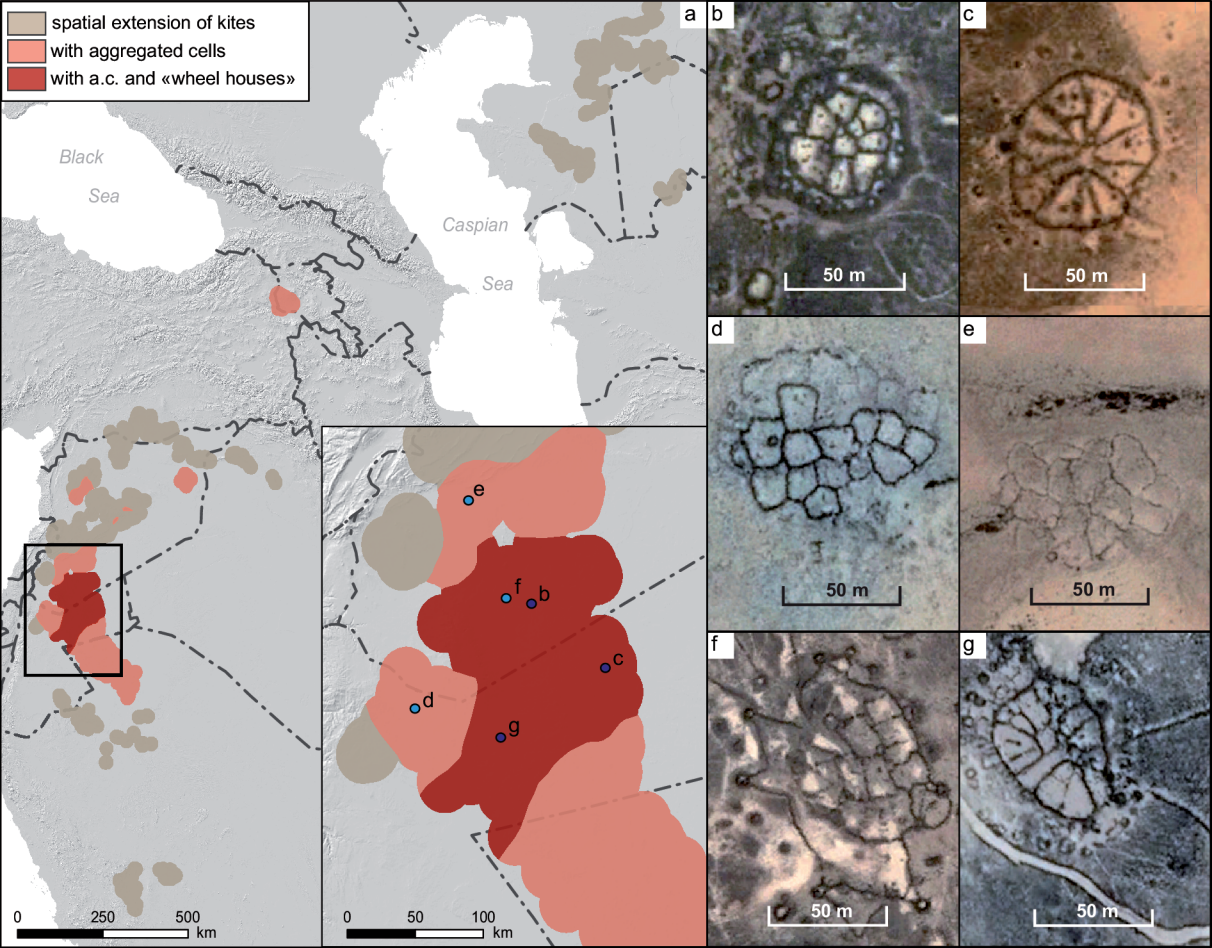

0
10
20
m


a)
1400
1300
1250
J31
J30
J29
J22
J15
J21
J20
kites
Spatial extent of aggregated cells
0
1
2
km
b)
0
500
1000
1500
2000
2500
3000
3500
4000
4500

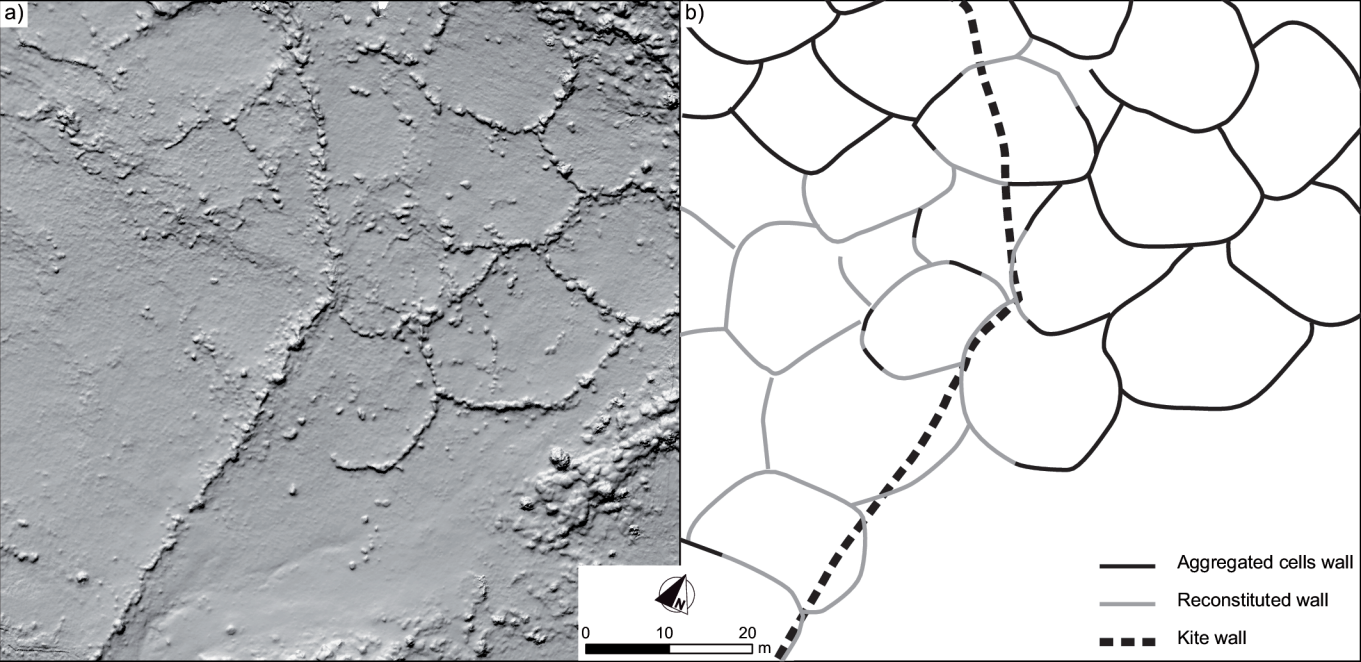

N
W
E
S

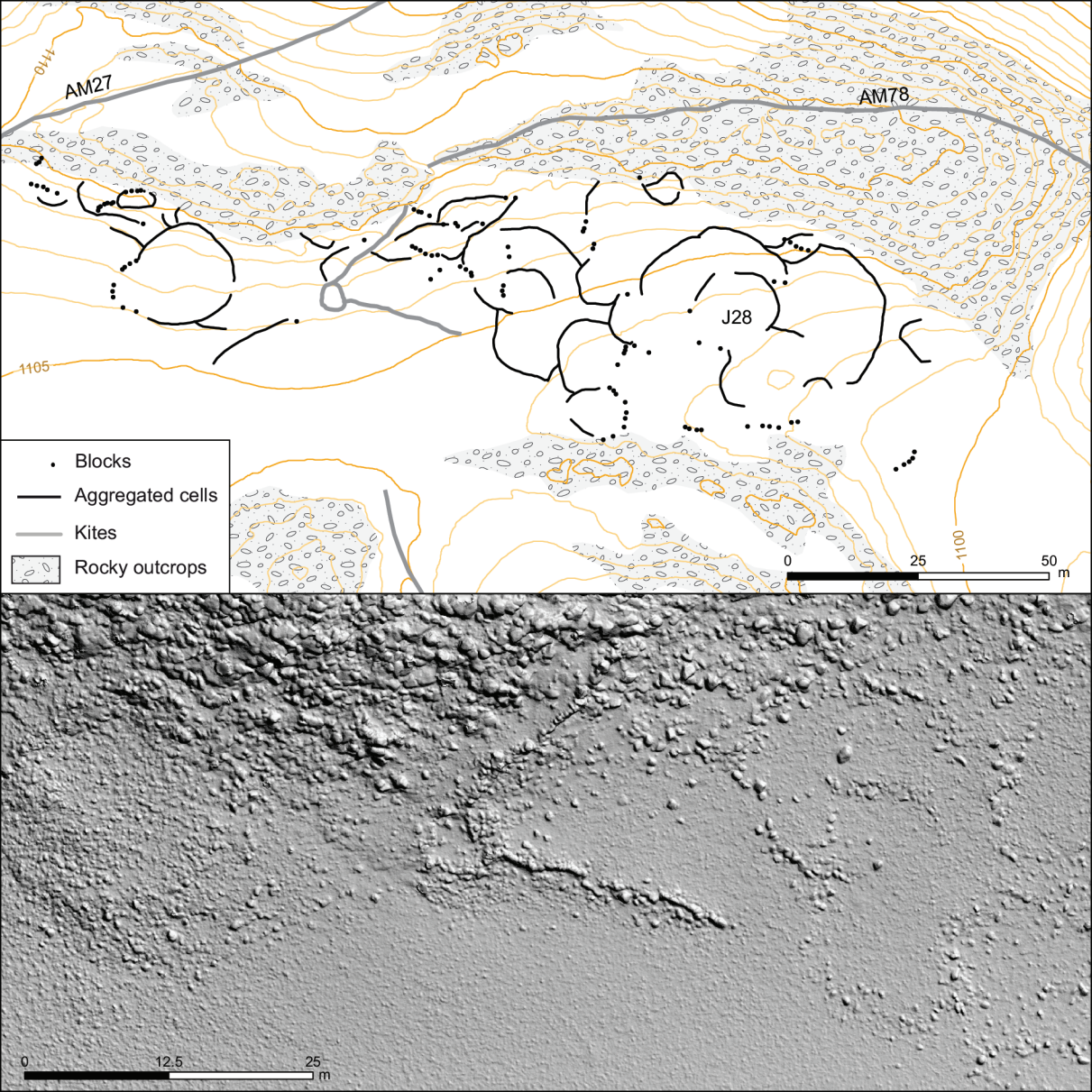

a)
b)


a)
Relative over-representation
Kites
Aggregated cells
0
10
20
km
Aggregated cells
Kite
0
10
20
km


spatial extension of kites
with aggregated cells
with a.c. and «wheel houses»
a
Black
Sea
Caspian
Sea
0
250
500
km
e
f
b
c
d
g
0
50
100
km
b
50 m
c
50 m
d
50 m
e
50 m
f
50 m
g
50 m

a
b
c


a)
b)
N
0
10
20
m
Aggregated cells wall
Reconstituted wall
Kite wall


AM27
AM78
J28
1110
1105
1100
Blocks
Aggregated cells
Kites
Rocky outcrops
0
25
50
m
0
12.5
25
m