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

2

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

19

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

21

22

23 1. Introduction

24

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

32

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

44

45 All these new data tend to show that the spatial distribution of these two types of constructions is too
46 similar to be accidental. Two hypotheses can be advanced:

- 47 - both construction types are geographically close together as they are contemporaneous, and
- 48 functioned at the same time. The unit of space corresponds to a unit of time,
- 49 - similar environmental characteristics were sought after in the geographic zone for the installation of
- 50 aggregate cells and kites, at two separate periods of regional history.

51

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

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

62 63 64 **2. Methodology** 65

66 Both types of construction can be identified on the high-definition satellite images available on online
67 platforms (Google Earth, Bing Maps). Field trips were conducted to monitor these observations, but
68 also to enhance our interpretation of the images and provide new information. The combined
69 fieldwork/image approach is very advantageous; it was widely used for the study of kites as part of the
70 Globalkites project (Crassard et al., 2015) and led to the implementation of a multi-scalar approach,
71 taking account of construction, the regional scale and the overall distribution area. The Aragats area is
72 one of the regional “windows” studied in this programme. During fieldwork in Armenia between 2011
73 and 2015, 49 kites were visited, 11 of them were mapped and archaeological test pits were carried out
74 at six of them (Barge et al., 2019). Today, abundant data is available on the Aragats kites, completed if
75 necessary by the work of an Israeli-Armenian team (Nadel et al., 2015; Malkinson et al., 2017).
76 Mostly, the study of kites in other regions using the same methodology (Abu Azize & Tarawneh,
77 2015; Barge et al., 2016b) led to the detection of common points and underlined regional specificities
78 (Barge et al., 2015; Barge et al., 2016a).

79
80 A comparable approach was set up for the aggregated cells of the Aragats, which also enabled us to
81 avail of previously acquired data (topography, hydrography, geology). The first fieldwork
82 observations in 2012 characterized the form, surface and geographic installation of these sites. Their
83 signature on high-resolution satellite images subsequently led to the identification of numerous other
84 aggregated cells and an inventory was drawn up. The largest cells and the layout of each construction
85 were recorded, so that it was possible to delimit their extension. After the 2017 fieldwork mission, 121
86 aggregated cells had been recorded. The vectorization of the extension of these aggregates led to an
87 estimation of their surface areas and the measurement of slope orientations. The primary aim of
88 fieldwork was to monitor the validity of observations based on satellite images. Out of 26 visited sites,
89 the existence of an aggregated cells was confirmed in each case. Ground observations showed that the
90 somewhat rough estimation of their extension was nonetheless reliable. In addition, the existence of
91 subsequent constructions partly covering the aggregates, recognized on the images, was confirmed in
92 most cases.

93 The second aim was to enhance the characterization of aggregated cells morphology. To this end, in-
94 depth studies were carried out for 11 sites, based on the observation of the structures and the search for
95 surface material, the identification of frequent subsequent constructions in the same place and detailed
96 mapping.

97
98 The following fieldwork was conducted as part of the survey of kites and aggregated cells:

- 99 - Mapping of the built structures with a differential GPS, mounted on a backpack, with decimetric
100 accuracy,
- 101 - aerial photographs taken with a kite. The photos were then photogrammetrically processed, using
102 reference points recorded with the DGPS, enabling us to obtain Digital Surface Models (DSM) and
103 orthophotographs with spatial resolution ranging between 1 and 10 cm, depending on the sites, and
104 accuracy of less than 5 cm. For the mapping, contour lines were generated based on the DSM;
105 subsequent constructions and contextual elements were vectorized after identification on the
106 orthophotographs.

107
108 All of these data were used to provide a general picture of aggregates, bearing in mind the diversity of
109 these constructions. The last aim of fieldwork was to find relative chronological markers for

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

112

113 3. Morphology of aggregated cells

114

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

123

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

135

136 As indicated above, aggregated cells are often located on rocky slopes. The upper cells are on even
137 steeper slopes (between 10° and 20°, even 25°), which decrease gradually towards the lower part
138 (between 10° and 0°).

139 Towards the top, the first cells were frequently built immediately below rocky scarps (which can be
140 almost vertical). In these places, we clearly observe that blocks were extracted from the scarp, and we
141 assume that these extracted blocks were used for the construction of cells. We also observe, at the base
142 of the extraction, the presence of small platforms resting on and delimited by large blocks (figure 3). It
143 is difficult to interpret these small areas due to the size of the materials and the irregularity of the walls
144 from which the blocks were extracted. However, their recurrent presence suggests that they represent
145 rustic but intentional structures. Lower down, we observe the progressive disappearance of the
146 aggregated cells, in such a way that in most of the studied cases, it is impossible to identify a precise
147 limit (J18 and J77 are exceptions). The walls of the cells clearly recorded further up give way to
148 segments, then to alignments of blocks, and finally to isolated blocks at the bottom. The latter suggest
149 that the aggregate continued but that it is no longer possible to formally identify it on the surface.

150 These progressive disappearances towards the base can be explained by two factors which could have
151 acted in different ways from case to case:

152 - colluviation, which is clearly recorded by the presence of a sedimentary prism systematically formed
153 further up from walls perpendicular to the slope, undoubtedly covered a lot of the structures at the base
154 of slopes.

155 - we note that places where aggregated cells are preferentially implanted were also used at much later
156 periods. Very often, we observe that other very characteristic constructions, which have been
157 identified as medieval sheepfold (Brochier et al., 2014), overlap the lower part of aggregated cells,
158 partially destroying them and probably reusing their materials (J9, J26, J31, J38, J56).

159

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

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

168

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

172

173 4. Installation rationales

174

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

184

185 Aggregated cells are almost systematically backed by steep slopes (often between 30° and 40°, or even
186 more), formed by rocky outcrops (J9, J28, J31, J38, J56, J77). The presence of these rocky outcrops is
187 characteristic of the western slopes of Mount Aragats and seems to have played a preponderant role in
188 the choice of aggregated cells installation. As mentioned above, they may have been used as a
189 convenient procurement source for the stones and blocks used for construction. They also acted as
190 shelters, as the south-facing bases of flow fronts were clearly preferentially selected. Indeed, when we
191 measure the orientation of all the slopes within the aggregated cell surface, we observe that more than
192 60% of the values are clustered in the southeast-southwest quadrant (figure 5). Only 13% are in the
193 northern half and the circular average is close to 183° (a difference of less than 3° from the south).
194 Thus, the building of aggregated cells backed by steep slopes combined with a southern orientation
195 suggests that warm and sheltered conditions were a prerequisite.

196

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

209

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

216

217

218

219

5. Geographic distribution of aggregated cells and kites

220
221 The installation strategies of both types of construction rely on the same topographic elements, which
222 explains why aggregated cells and kites are found near each other (figure 4). The median distance
223 from aggregated cells to the nearest kite is 600 metres, whereas only one out of four is more than a
224 kilometre away (figure 4b). Therefore, it is not surprising that both types of construction display very
225 similar geographic distributions (figure 7a). From an overall quantitative viewpoint, the convex hull of
226 all the aggregated cells on the map measures 1,188 km², that of kites 1,321 km² and shared areas 1,110
227 km². The shared part of the distribution area thus represents 93% for aggregated cells and 84% for
228 kites. Inside these hulls, we observe that the areas where kites are absent correspond to those where
229 aggregates are also absent. An increasing gradient from the east towards the west also exists for kites
230 and aggregated cells, which is very similar to the gradient of the presence of rocky outcrops, which are
231 much more abundant in the west than in the east.
232 These two distributions are thus surprisingly similar, but we can nonetheless perceive several
233 variations. Aggregated cells are very abundant in the northwest, and as a result, kites are relatively
234 under-represented in this zone, whereas in the south, aggregated cells are comparatively less present in
235 the area of two kite alignments (figure 7b).
236 These very similar geographic distributions are also surprising considering the observed isolation of
237 the structures in both cases. This has already been highlighted for kites (Brochier et al., 2014),
238 although no explanation could be advanced. In the case of aggregated cells, it is also impossible to
239 explain this isolation. In spite of meticulous and systematic examinations of the satellite images
240 beyond the area represented on the map (figure 7), none of these constructions could be identified in
241 peripheral areas.

242 243 **6. Kites and aggregated cells outside the Aragats area**

244
245 These very singular geographic distributions incited us to move out of a regional scale to a much
246 wider scale. This investigation had already been carried out based on the literature (Kalantaryan et al.,
247 2017), but was limited to the Harrat-al-Shaam in Jordan and did not explicitly examine the possible
248 relationship between kites and aggregated cells. It thus seemed necessary to provide additional
249 elements.

250
251 In Armenia, several sites from the region of Vardenis have been compared to aggregated cells on
252 account of the fact that they present similar overall structures. The comparison of results from
253 archaeological work carried out at Geghaqar and Aghbradzor (Harutyunyan and Badalyan 2008, cited
254 by Kalantaryan et al., 2017) with data from Arteni should enable us to identify possible parallels.
255 However, after surface field observations at the Aghbradzor site, we concluded that these two types of
256 sites were very different. Indeed, at the latter, the cells are larger in size and are not layered, there is
257 often a depression inside each cell, we distinguish clear circulation areas between groups of cells and
258 their construction reveals double-faced walls. None of these features have ever been observed in the
259 aggregated cells of the Aragats area.

260
261 The distribution area of kites is now better known (Barge et al, forthcoming). The systematic search
262 for aggregated cells on satellite images from this area shows that outside Armenia, the latter are not at
263 all omnipresent, and in fact are practically only present in Harrat-al-Shaam, a basaltic region along the
264 Syrian-Jordanian border (figure 8a). Several studies have been carried out on these structures, or
265 related structures (Akkermans et al., 2014; Athanassas et al., 2015; Rollefson et al., 2016), yet few
266 conclusions have been reached regarding the type and function of these sites. The most widely studied
267 of these constructions are “wheel houses” or “jellyfish”, dating from the end of the Neolithic or
268 Chalcolithic, which present a very different morphology to the aggregated cells of Mount Aragats. In
269 spite of widespread diversity, they are circular in shape and the cells inside the circle are organized
270 around the centre, in such a way that they embody rays (figure 8b and c). On the other hand, we often
271 observe other constructions on the images, which are much more morphologically similar to the
272 aggregated cells of Armenia (figure 8d and e). They are more frequent than “wheel houses” with a
273 much wider spatial extension. We have very little information on these structures. However,
274 considering the preserved elevations observed in the field during the study of kites in the east of

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

278

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

285

286 7. Functions

287

288 Up until now, most authors have suggested that the function of kites was for hunting (among others,
289 Helms and Betts, 1987; Van Berg et al., 2004; Holzer et al., 2010; Morandi Bonacossi and Iamoni,
290 2012). However, the possibility of a pastoral use has also often been mentioned, or even asserted
291 (Svizzero and Tisdell, 2018), particularly for the kites of Armenia (Malkinson et al., 2017; Hovsepian,
292 2018), in spite of strong criticism (Rosen & Perevolotsky, 1998). Both of these hypotheses were
293 explored together during the course of work on the Globalkites programme; leading to the rejection of
294 the pastoral hypothesis, in particular in Armenia (Barge et al., 2018) and to the conclusion that kites
295 were used for hunting (Crassard et al, forthcoming). The main argument for this is based on the
296 systematic existence of cells in the plan of kites, an element that has not generally been taken into
297 account up until now and which was often considered to be a surveillance position or a lookout post.
298 In reality, these cells are the key element of the kite and acted as a killing stratagem. Indeed, wherever
299 they were excavated (8 in Armenia, 14 in Kazakhstan, 6 in South Jordan, 31 in Harat-al-Shaam, and 7
300 in Saudi Arabia), these cells turned out to be deep pits (figure 9) into which animals were thrown. The
301 identification of the final trapping process enabled us to coherently interpret other recurring
302 morphological details of kites, and provided elements for understanding the overall functioning of the
303 structures. In this way, all the projections built into the enclosure, whether they are inflections, angles
304 or points (particularly frequent in Armenia), systematically end in a cell. These enclosure shapes made
305 it easier to drive the animals towards the pits. The latter were often hidden from the interior of the
306 enclosure behind slope discontinuities, which were also used to conceal the entrance of the enclosure
307 when approached from between the antennae. This clever use of slope discontinuities explains the fact
308 that complex topographies were chosen in most cases for constructing the enclosure and in particular
309 in Armenia, where rocky outcrops seemed to play an important role in masking obstacles or marking
310 out circulation paths. Finally, the orientation of kites (the direction in which the antennae point) on a
311 regional scale is partly determined by the topography of sites, but also presents a highly dominant
312 direction which, in cases where it could be studied, such as in Armenia (Chahoud et al., 2015), is in
313 keeping with migratory movements of animals. All of these elements thus validate the hunting
314 hypothesis. Furthermore, the considerable surface of kite enclosures (on average, about a hectare, with
315 higher values in Armenia) refutes the pastoral hypothesis: it is more than ten times superior to that of
316 the pastoral enclosures studied up until now (Crassard et al., forthcoming).

317

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

330 used for specific activities, which cannot be accurately identified solely on the basis of surface
331 observation.

332 The south-facing orientation suggests that warm slopes sheltered from cold winds were sought after,
333 perhaps for seasonal use. This would exclude the warm period, from June to September, and also the
334 winter period, when snow cover is continuous. They may thus have been used during the mid-season.

335
336 For the moment, the excavation of aggregated cells is limited to the site of Arteni and unfortunately,
337 the levels corresponding to the aggregated cells yielded little information. However, several interesting
338 elements provide clues regarding the function of the site. Archaeobotanical data point towards a
339 pastoral use (Hovsepyan, 2018). Although data from the level of the aggregated cells are sparse, they
340 reveal large quantities of coprolites (mineralized animal excrements), demonstrating the use of manure
341 as fuel. Although they are scarce, these data point in the same direction as those from animal bone
342 remains (Creuzieux, in: Perello et al. 2019). Indeed, data from the archaeozoological analysis show
343 that more than 80% of the bones belong to domestic caprines (sheep/goat). In addition, the kill-off
344 ages of young animals also point to seasonal use, and corroborate the analysis of construction
345 orientation, suggesting occupations during intermediary periods, in spring and autumn (Perello et al.
346 2019, data on seasonality are only based on levels preceding aggregated cells).

347
348 We could also advance the hypothesis of an agricultural function for these aggregated cells which
349 could be considered as terraces. This is supported by the south-facing orientation and the
350 archaeobotanical data from Arteni showing the presence of coprolites, which could be interpreted as
351 fertiliser. These terraces may have been planted with specific seasonal cultures (tinctorial, medicinal?).
352 The fact that they are so localized could be explained by the specific characteristics of the cultivated
353 plant, the type of soil or cultivation method.

354
355 Data pointing to the function of aggregated cells are thus tenuous and we cannot reach any firm
356 conclusions. However, we can cautiously postulate that the pastoral function seems to be the most
357 likely in so far as the data from three different approaches (surface morphology, archaeobotany,
358 archaeozoology) all point towards this interpretation.

359
360

361 8. Chronology

362
363 A radiocarbon date from the site of Arteni places the aggregated cells level at the beginning of the
364 Late Bronze Age (1431 – 1283 Cal BC). This date is in keeping with the objects found in this level.
365 The pottery is characterized by comb treatment on the interior and exterior surfaces and decoration
366 consisting of layers of marks made by fingernails (Perello et al. forthcoming). This type of pottery is
367 known in the central part of the South Caucasus in Armenia and Georgia, where it is characteristic of
368 the transition phase between the Middle Bronze Age and the Late Bronze Age (Trialeti-Vanadzor
369 culture), that is to say, the middle of the second millennium BC (Avetisyan & Bobokhyan, 2008).
370 Data for the absolute dating of kites are sparse (Brochier et al., 2014; Barge et al., 2019). As a result,
371 here, we will simply place their construction in a wide chronological timeframe extending from the
372 Late Bronze Age to the first centuries of our era, although their dating is more likely to be constricted
373 to the Iron Age. In this way, the absolute dates would probably position the existence of kites after
374 aggregated cells, but the temporal resolution of kite dating does not formally exclude the fact that
375 these two types of construction could have been used at the same time over a short period.

376
377 We saw above that aggregated cells are often located near kites: there are even two cases where we
378 observe an overlap, thereby providing information on the relative chronology of the structures. The
379 case of kite AM94, where the construction partially destroyed aggregated cell J2 has already been
380 presented (Brochier et al., 2014). It is clear that the aggregated cell came before the kite: the wall of
381 the kite enclosure is continuous whereas those of the aggregated cells are interrupted near the kite
382 wall. In the southern part of the overlap, we even perceive the former layering of the aggregated cells
383 on the high resolution DSM, while the probably dismantled walls have disappeared (figure 10). A
384 second case of overlap provides the same information, i.e., a kite post-dating an aggregated cell.

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

393

394 9. Conclusion

395

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

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

414

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

424

425 (Annexes 1 to 7)

426

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431 colleagues from the Institute of Archaeology and Ethnography for extremely helpful assistance in
432 Armenia.

433

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506

507 **Captions:**

508

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

511

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

513

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

515

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

519

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

522

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

525

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

532

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

536

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

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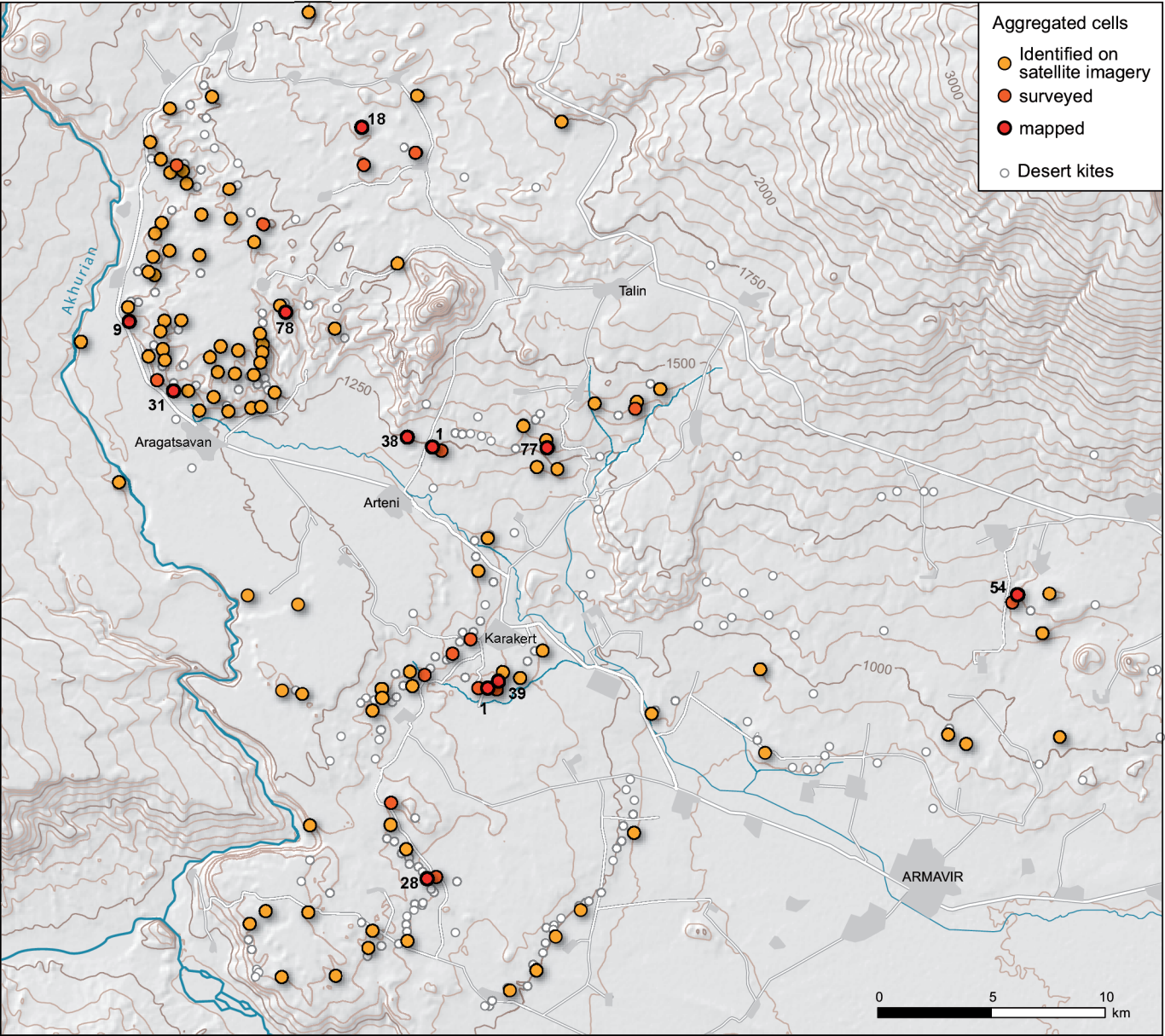
542 Figure 10: Overlap of kite AM94 and the aggregated cells J2; a) DSM hillshade, b) Plan of the kite,
543 plan of the aggregated cells and reconstruction proposal for the aggregated cells.

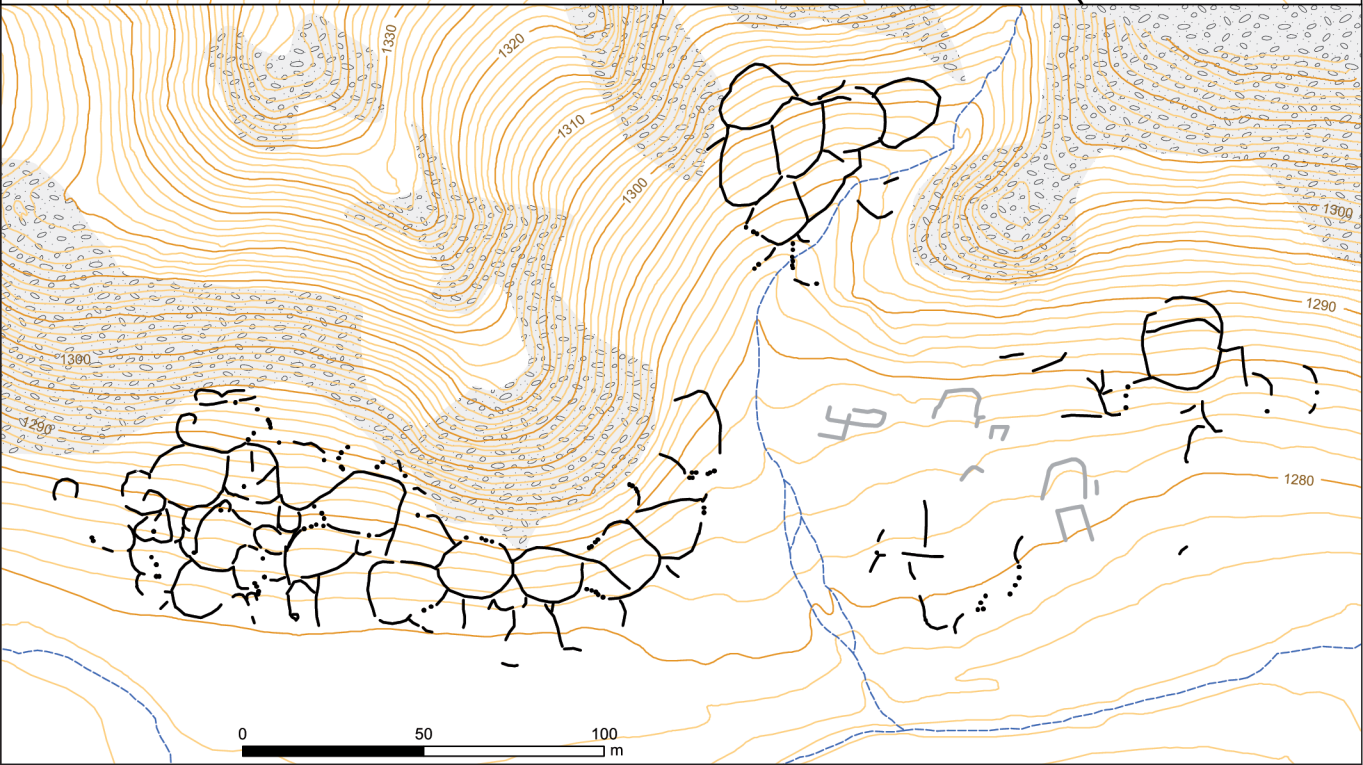
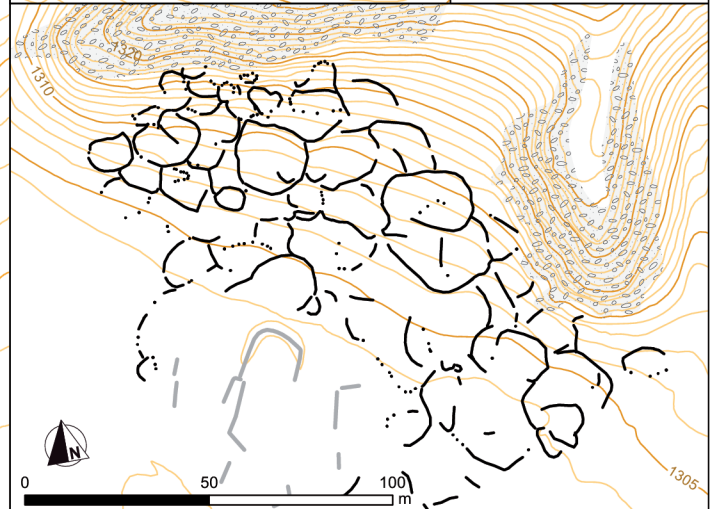
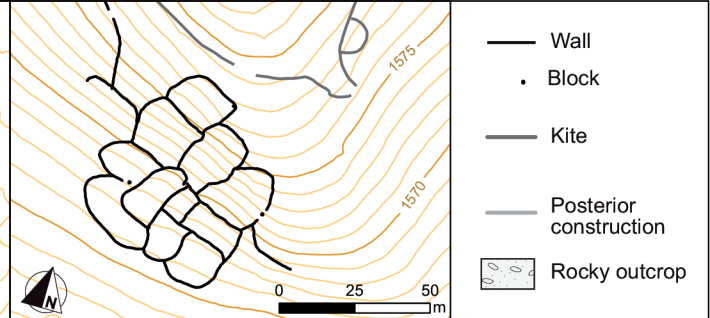
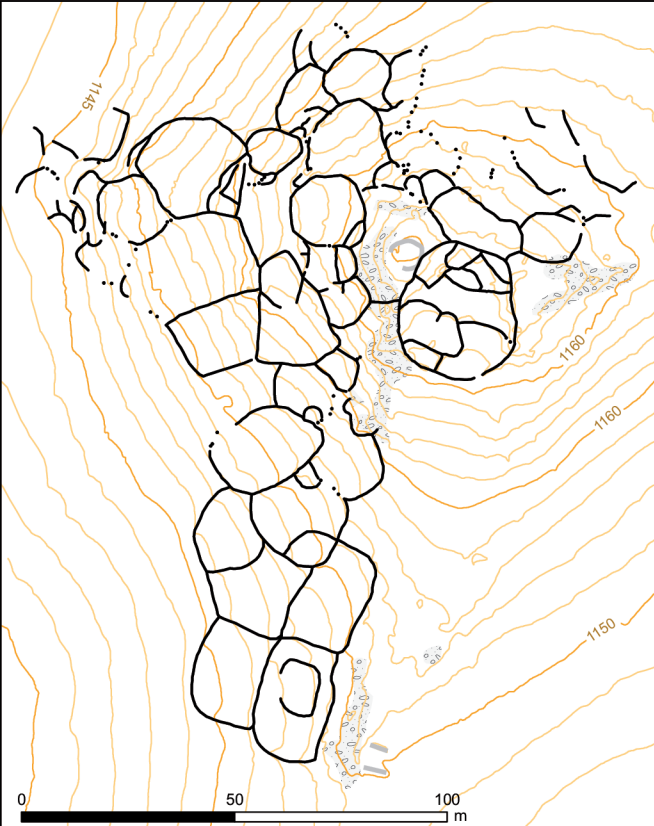
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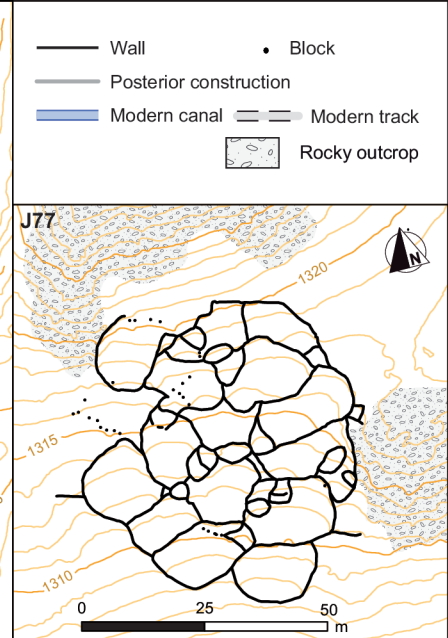
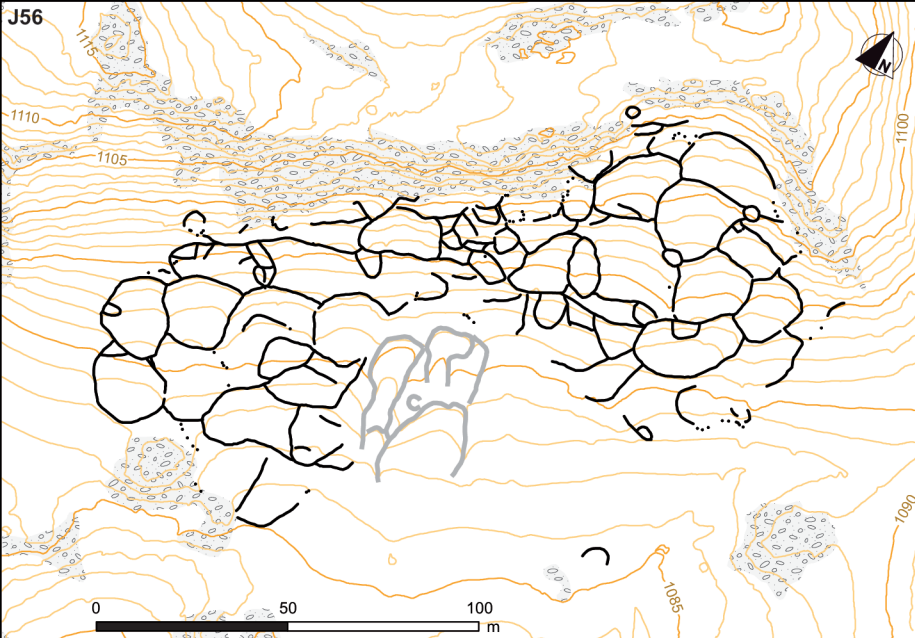
545 Figure 11: a) Plan of the aggregated cells J28 and overlapping of kite AM78, b) DSM hillshade
546 centred on the overlap.

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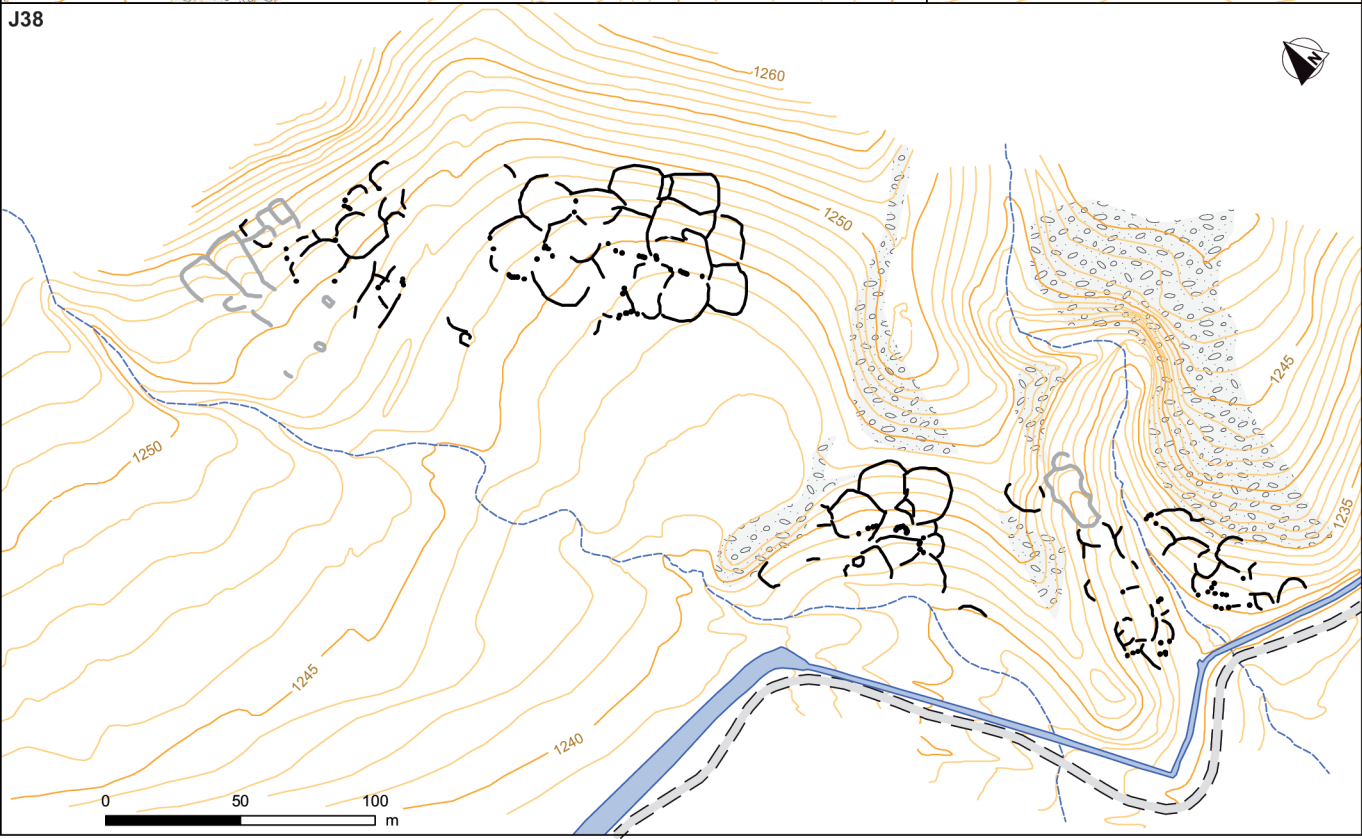
548 Annexes 1 to 7 (to be placed at the end of the article): Plan of the aggregated cells J9, J18, J31, J38,
549 J54, J56 and J77 (



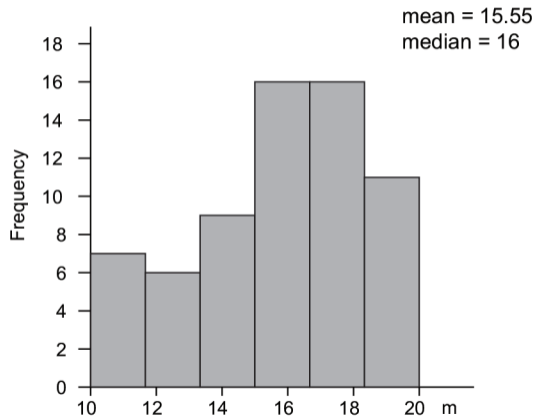




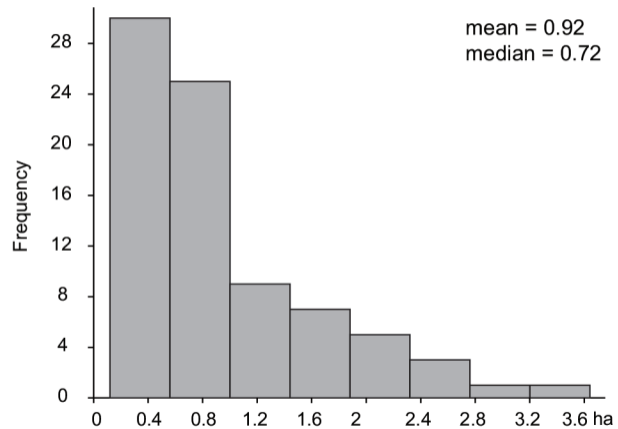
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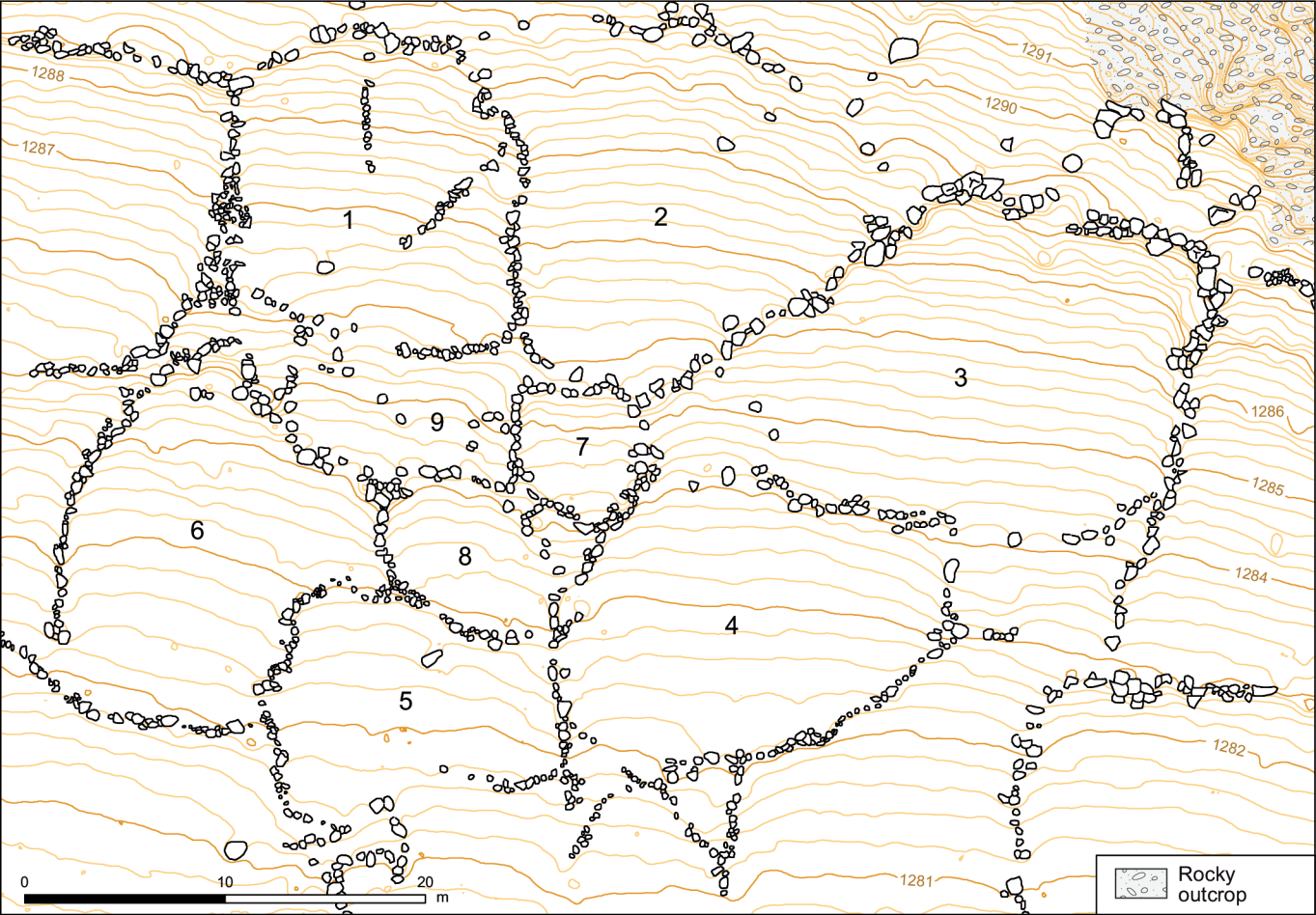


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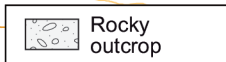
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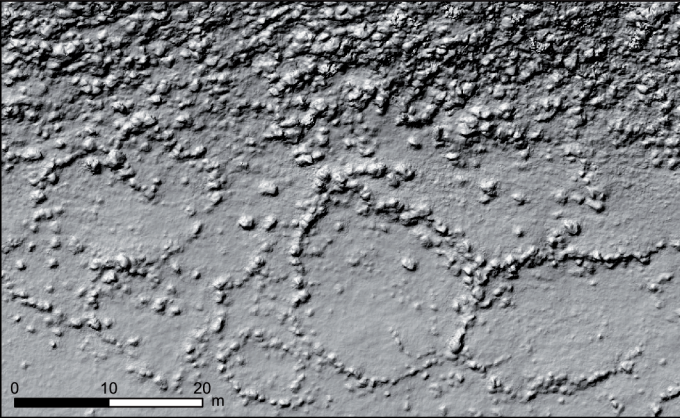
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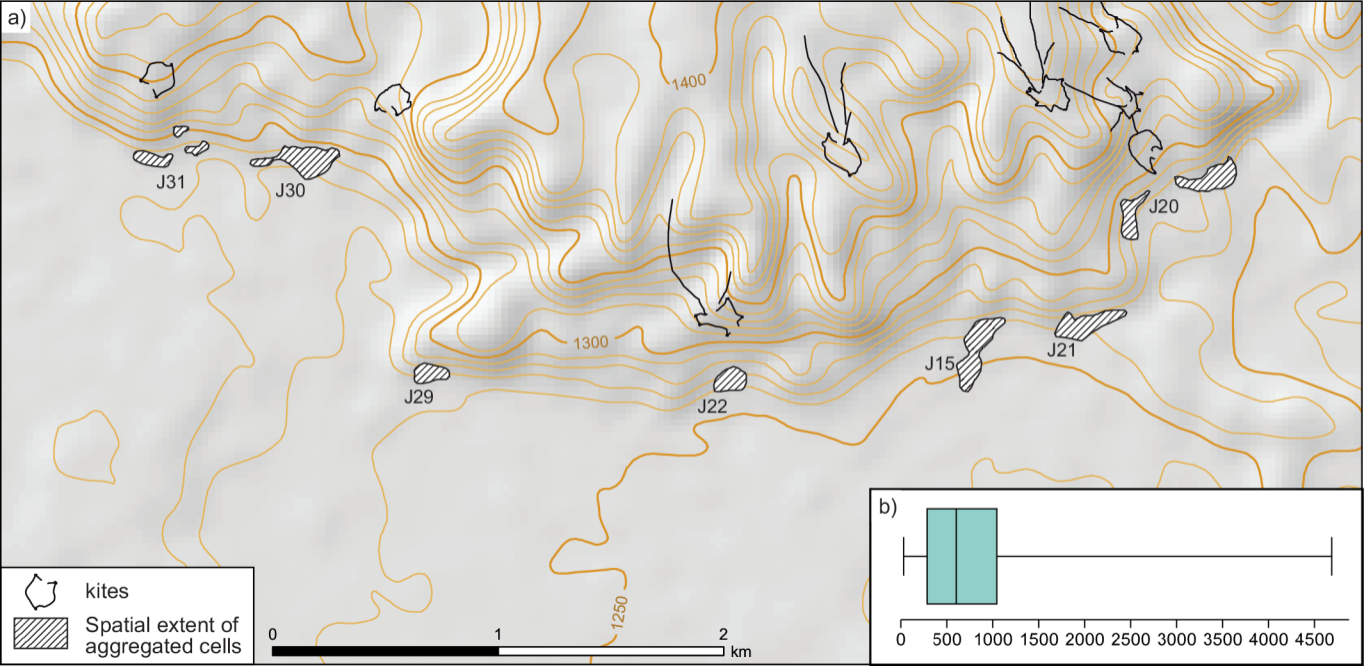
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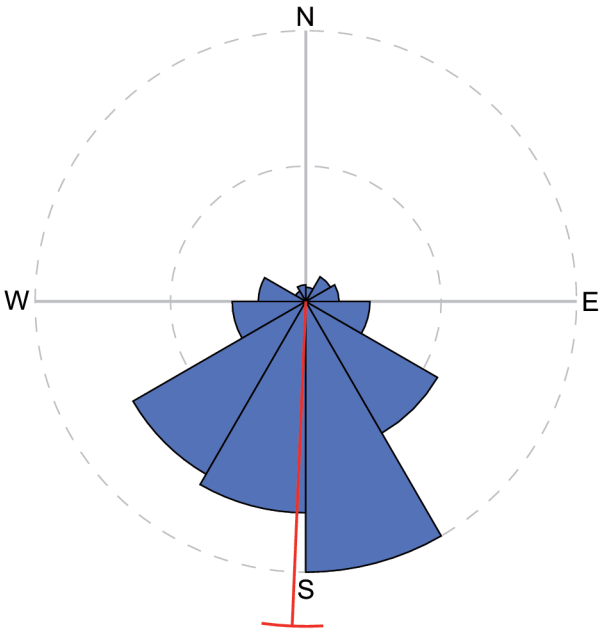
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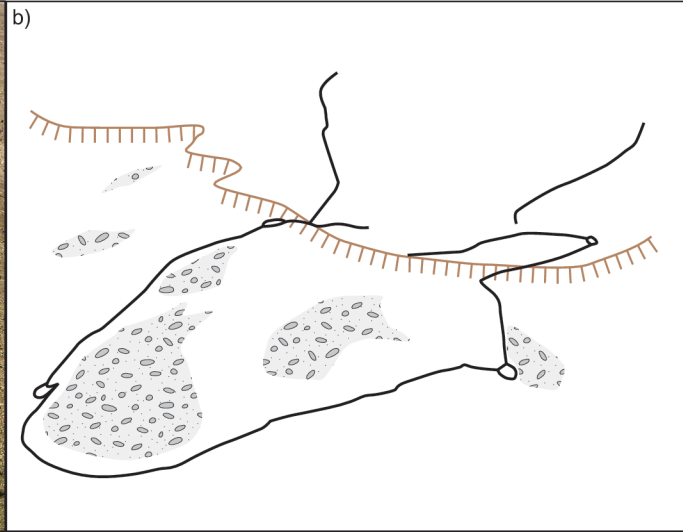
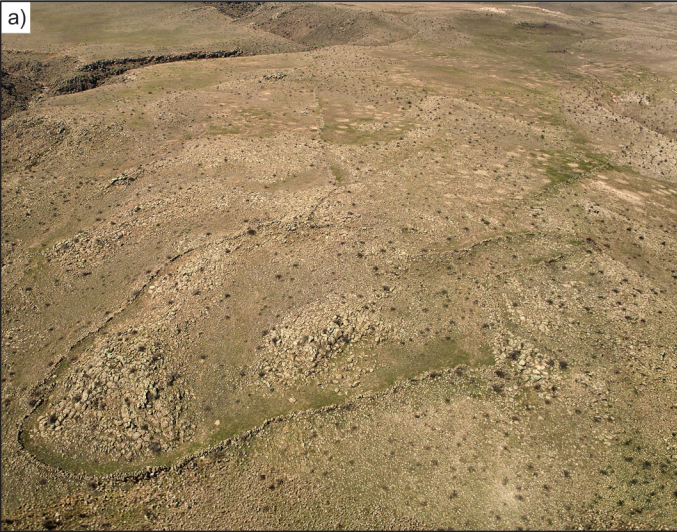
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a)

