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1 **Archaeobotanical and isotopic evidence of Early Bronze Age farming activities and diet**
2 **in the mountainous environment of the South Caucasus: A pilot study of Chobareti site**
3 **(Samtskhe-Javakheti region)**

4
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20 Keywords (3 to 7): South Caucasus, Early Bronze Age, plant macroremains, pollens and
21 phytoliths, human and animal skeletons, stable isotope analysis, farming activities

22
23 Abstract

24 Recent excavation at the site of Chobareti (1615 m a.s.l., South Caucasus Mountains) reveals
25 an important Kura-Araxes settlement and eleven burials so far, for which a first multi-proxies
26 approach was conducted to understand both exploitation of plants and human dietary practices
27 in this mountainous area. Thanks to the excavation of several pits, in 2011, a well-reasoned
28 sampling for archaeobotanical analysis, including phytoliths, pollen and non-pollen
29 palynomorphs, charcoal, seeds and other plant macroremains was undertaken. In parallel,
30 human, animal bones and wheat seeds were recovered in order to perform stable isotope
31 analysis ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$). Results show the strong presence of cereals (especially naked wheat, as
32 a hexaploid form, and emmer), highlighting the role played by cereal growing in the Kura-
33 Araxes farming activities. Plant macroremains, but also phytoliths recovered in pits, reflect
34 processing activities on the site. While animal dung seems to have been used to enhance

35 cereal yields, different herding practices can be suggested by $\delta^{15}\text{N}$ values. Whereas $\delta^{13}\text{C}$
36 values and archaeobotanical data agree for a consumption of C_3 plants, with no significant
37 input in wheat for both animals and humans, a homogeneous mixed diet, with a great
38 contribution of animal protein source (meat, secondary products) has been observed.

39

40 Highlights:

41 - Chobareti site is an Early Bronze Age settlement (3300-2900 cal. B.C.) located at 1615 m
42 a.s.l. in the South Caucasus

43 - Archaeobotanical and stable isotope analysis have been performed on several pits and
44 burials

45 - Phytoliths, pollen and macroremains highlight the importance of cereals cultivation in these
46 highlands

47 - Isotope data suggest the use of manuring, differential herding practices, as well as C_3 plants
48 consumption for both animals and humans

49 - Human dietary practices express a unique pattern with a preferential input of meat and dairy
50 products

51

52 1. Introduction

53 Around 3500/3400 cal. B.C., the southern Caucasus played a pivotal role in the development
54 of one of the most widely known archaeological cultures in the ancient Near East. Various
55 termed Kura-Araxes or Early Trans-Caucasian, the tradition represents the remains of village
56 communities of stock-breeders and farmers (Sagona, 1993; Connor and Sagona, 2007). Many
57 Kura-Araxes (K-A) sites have been discovered in the South Caucasus Mountains. While the
58 hypothesis of their farming activities is often proposed based on archaeobotanical and
59 archaeozoological data, it remains difficult to decipher their farming strategies in the high
60 mountains. Despite the considerable archaeological research conducted in the Caucasus
61 during the Soviet period, few archaeobotanical investigations have been carried out on K-A
62 sites, except in Armenia where recent studies have been undertaken (Hovsepian, 2009, 2010,
63 2011). These previous investigations provide some information about the cereal choices, but
64 the diet strategies of K-A populations living in high mountain environment is still little
65 known. In Chobareti (Javakheti, Georgia), despite the lack of archaeozoological data, the
66 issue is to evaluate how significant crops were in the diet, alongside other resources. In order
67 to tackle this issue, the combination of a multi-archaeobotanical analysis (phytoliths, pollen,
68 non-pollen palynomorphs, plant macroremains) with stable isotope analysis ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) have

69 been conducted to assess crop choices, diets, as well as subsistence strategies of K-A
70 populations, in such a mountain environment.

71

72 2. The site of Chobareti

73 The site of Chobareti (1615 m a.s.l., 41°35' N, 43°07' E) was discovered in 2008 during the
74 construction of the 32 km Aspindza-Akhalsikhe gas pipeline. Situated in the Samtskhe-
75 Javakheti region of Georgia (Fig. 1), an area that has received little archaeological attention,
76 excavations have so far revealed a K-A settlement and several burials, an Iron Age and
77 Medieval stronghold, and a kurgan of a date as yet unknown. It is significant for the late
78 prehistory of the Southern Caucasus for several reasons, but primarily because it is revealing
79 a detailed picture of life in high altitudes at the elusive interface between the K-A tradition
80 and its antecedents. Thirteen radiocarbon (AMS) dates (including two new dates on human
81 bones), each falling comfortably within 3300–2900 cal. B.C. (Table 1), but clustering within
82 the 3300–3100 bracket, enable us to better understand the nuances of cultural change and
83 economic subsistence patterns during the earliest phase of the K-A (Kakhiani et al., 2013).

84 Chobareti was established on the slope of a mountain (Fig. 2). That it is a terrace site is
85 unusual enough, but its topography is also distinctive, a saddle bookended by two rocky
86 knolls. In choosing the site, the ancient community no doubt had considered its strategic
87 position, overlooking the Kura River valley not far from where it meets the Uraveli River.
88 Excavations have exposed an unusually large, curvilinear building (Structure 4), a substantial
89 number of pits, and a growing number of burials. A distinctive feature of Chobareti is the
90 presence of fifteen pits probably used for storage purposes and later for the disposal of waste
91 (Kakhiani et al., 2013). One may consider that some pits have been also used for ritual
92 purposes indicated by their structured deposition. That is, objects of value deposited in an
93 intentional and meaningful manner (Chapman 2000).

94

95 3. Characterization of Chobareti population

96 Amongst the nine of the burials excavated, seven correspond to rectangular structures
97 delimited by small basalt stones walls. One burial (Burial 5) is a circular pit and corresponds
98 to a reuse of the pit 12 while the last one is a jar burial of a child (Burial 9). Removing the
99 two burials (3 and 6) for which no bones allowed an anthropological study, biological
100 analysis enabled the identification of 12 individuals of which three were subadults. The
101 absence or bad preservation of coxal bone, which wears the most reliable indicator for sex and
102 age at death assignation, restricts the evaluation of demographic parameters of Chobareti

103 population (Bruzek and Murail, 2006). Nevertheless, based on skull morphology, sex
104 assessment yielded three males, four females and one indeterminate, while age assessment
105 yielded five young adults below 40 years old and three adults above 40 years old.

106 The archaeoethanatology study reveals strict anatomical connections for most of the skeletons
107 with two types of body deposit: primary burials and reductions or secondary deposits (see
108 Supplementary Material SD1). All individuals in primary burial were deposited in a crouched
109 position on one side, however a difference in side was observed between adults and subadults.
110 The deposit of the infant body in a jar (Burial 9) is surprising in a K-A context and could
111 evoke a link with Chalcolithic tradition (Poulmarc'h, 2014).

112

113 3. Materials and methods

114 3.1. Phytoliths

115 For phytolith analysis, five samples from the lower part of pit 17 and five samples from the
116 lower part of the pit 18 (Fig. 4) were collected at regular intervals of 10 cm along the deposits
117 to investigate the evolution of the phytolith assemblages in each pit. Phytoliths were extracted
118 from sediment samples using HCl and H₂O₂ baths, sieving, clay removal and densimetric
119 separation (Lentfer and Boyd, 1998). After cleaning, the residue was suspended in glycerine,
120 mounted on slides and observed under a Microscope at 600x magnification. Each phytolith
121 was classified according to its morphology, following several systems (Twiss et al., 1969;
122 Fredlund and Tieszen, 1994; Mulholland, 1989) and the International Code for Phytolith
123 Nomenclature (ICPN Working Group et al., 2005). Based on the previous literature, the
124 observed phytoliths were classified into 13 different categories (Table 2, see Messenger et al.,
125 2010). Silica skeletons, corresponding to fragments of silicified Poaceae epidermis, were also
126 identified and counted, but not included in the phytolith sum.

127

128 3.2. Pollen and non-pollen palynomorphs (NPP)

129 For pollen analysis, five samples from the lower part of pit 17 and six samples from the lower
130 part of pit 18 located in the trench 1 (Fig. 3) were collected. The samples were taken at
131 regular intervals of 10 cm in each pit section to evaluate the potential evolution of the
132 assemblages during the deposits. Pollen samples were prepared using a 10 per cent solution of
133 potassium hydroxide (KOH), followed by heavy liquid separation and standard acetolysis
134 (Faegri and Iversen, 1989). Pollen and non-pollen palynomorphs (NPP) identifications were
135 made with reference to atlases (Beug, 2004; Reille, 1992, 1995, 1998; van Geel, 1998; van
136 Geel and Aptroot, 2006) and the modern reference collection of the Institute of Palaeobiology

137 (Tbilisi). The criteria used for NPP identification recovered in Georgian archaeological sites
138 have already been described in Kvavadze and Kakhiani (2010) and Chichinadze and
139 Kvavadze (2013).

140

141 3.3. Plant macroremains

142 For plant macroremains analysis, including seeds, fruits and charcoal, sediment was collected
143 from the three pits which represent a total of 48.6 litres (Fig. 3). 34.2 litres of sediment have
144 been wet-sieved in the laboratory of the University of Geneva (Switzerland) with mesh sizes
145 4, 2 and 0.5 mm. Additional samples recovered from pit 18 (14.4 litres) were sieved in the
146 field using a flotation machine (see Longford in Kakhiani et al., 2013). All residues were
147 dried and plant remains were extracted and sorted, either with the naked eye (4 mm mesh), or
148 with a stereoscopic microscope with magnifications x6.5–x40 (2 and 0.5 mm meshes).

149

150 Seeds, fruits and other plant macroremains were identified using the modern reference
151 collection of plant material of the Institute for Prehistory and Archaeological Sciences (Basel
152 University), as well as specialised literature (Cappers et al., 2006). Nomenclature follows
153 Zohary et al. (2012). The 0.5 mm organic fraction of pit 16 was sub-sampled because of its
154 richness in plant macrofossils. Due to its abundance, chaff was sorted in 10% of the volume
155 of each sample; other macro-remains in 25% of the sample; remarkable elements were sorted
156 in the whole sample. The numerical values for each group were extrapolated to the total
157 volume of the sample applying a correction factor of x10 and x4 according to the used
158 division.

159

160 The wood charcoal fragments were sorted from the 4 and 2 mm meshes only. Each fragment
161 was hand-broken along the three characteristic directions (transverse, longitudinal-radial,
162 longitudinal-tangential) in order to get fresh sections, and observed with a reflecting light
163 microscope fitted with a bright field/dark field device (magnifications x100–x1000). The
164 identification is done by comparing the anatomic structures with those of the modern charred
165 wood from the laboratory's collection (UMR 7264, Nice) and with the published descriptions
166 (Greguss, 1959; Schweingruber, 1990). Most of the time, the identification reaches the genus
167 or group of species level, rarely the species level, and sometimes only the family level or a
168 group of several genera. According to previous methodological investigations (Chabal, 1997,
169 p. 27-29), the study of scattered charcoal fragments recovered from living surfaces is needed
170 to display a reliable and complete image of the past vegetation. Thus, considering the small

171 size of charcoal samples from Chobareti (29 to 183 fragments) and the fact that they are
172 coming from pits, the interpretation of the floristic list will be mainly qualitative.
173 Nevertheless, the relative proportions of the various taxa have been figured to better visualize
174 the results, but they must be interpreted cautiously.

175

176 3.4. Stable isotope analysis

177 In order to reconstitute the nature of the consumed proteins, carbon and nitrogen stable
178 isotopes were measured on bone collagen (Katzenberg and Saunders, 2008). Since carbon
179 stable isotope ratios ($\delta^{13}\text{C}$) are in relation with the photosynthetic pathway of plants, they can
180 discriminate plants from temperate environment using the C_3 photosynthesis and those using
181 C_4 photosynthesis, like millet (Smith and Epstein, 1971). Nitrogen stable isotope ratios ($\delta^{15}\text{N}$)
182 permit to assess the trophic level of an individual within its food web because the more
183 animal proteins are consumed the higher the isotopic values are (DeNiro and Epstein, 1981).
184 In terrestrial ecosystems, there is a small step-wise in $\delta^{13}\text{C}$ values of about 0-2‰ while the
185 step-wise is higher in $\delta^{15}\text{N}$ values of 3-5‰ between trophic levels (Bocherens and Drucker,
186 2003). Isotopic measurements on bone collagen authorize a food behaviour restitution
187 corresponding to the consumption of proteins of the 10-15 last years of life (Hedges *et al.*,
188 2007). The interpretation of human isotope values is dependant of those of the consumed
189 potential food items which make indispensable the characterisation of the local environment
190 of Chobareti population. It is well admitted that animal bones need to be considered to avoid
191 any misinterpretation of human data (Herrscher and Le Bras-Goude, 2010). Recently, studies
192 have also shown that anthropic factors, like manuring can significantly raise nitrogen stable
193 isotope values in cereal grains and chaffs, affecting the isotope values in consumer tissues. It
194 demonstrates the interest of considering the isotope values of archaeological plant remains,
195 for reconstructing human past diets (Bogaard *et al.*, 2007). Only two individuals, among the
196 twelve identified, weren't sampled because of a bad macroscopic preservation and a low
197 skeletal representation (see Supplementary Material SD1). Thus, the subsample of Chobareti
198 population is composed of eight adults and two sub-adults (Table 3). Animal sample includes
199 21 herbivores attributed to nine specimens of *Bos* sp., one *Bison* sp. specimen and 11
200 specimens of *Ovis/Capra* (Table 4). In addition, analyses were also carried out on six charred
201 seeds of *Triticum* sp., sampled from the pit 16 (Table 4).

202

203 Bone collagen extraction was based on Longin's method (1971), modified by Bocherens and
204 collaborators (Bocherens et al., 1991) and charred seeds were prepared following the ABA
205 method (Brock *et al.*, 2010) at Aix Marseille University (UMR 7269). Samples were analyzed
206 by elemental analysis-isotope ratio mass spectrometry (EA-IRMS) using an elemental
207 analyzer (Europa Scientific) coupled to a continuous-flow isotope ratio mass spectrometer
208 (Europa Scientific 20-20). International standards are V-PDB for carbon and AIR for
209 nitrogen. Precision of isotope measurements, calculated on internal standard replicates (IA-
210 R042, IA-R045, IA-R046 and IA-R05, IA-R06), is inferior to 0.2‰ for nitrogen and inferior
211 to 0.1‰ for carbon. To ensure the good quality of collagens, four criteria: yield of extraction
212 (above 10 mg/g), percentages in carbon and nitrogen (respectively above 30 per cent and 11
213 per cent), carbon to nitrogen atomic ratios (between 2.9 and 3.6) were checked (DeNiro,
214 1985; Ambrose, 1990; van Klinken, 1999).

215

216 4. Results

217 4.1. Phytoliths

218 Chobareti sediments yielded large amount of phytoliths (200 000 – 500 000 phytoliths per
219 gram of sediment). The sediments sampled in both pits (17 and 18) have relatively
220 homogenous phytolith assemblages (Fig. 4). Grasses (Poaceae family) are the dominant taxon
221 in all phytolith samples (Fig. 4). In this group, long cells such as elongate and acicular
222 morphotypes are preponderant while short acicular forms and bulliform cells are rare (Fig. 4).
223 Rondels and sinuate short cells are well represented. They correspond to Pooideae sub-family
224 (Twiss et al., 1969; Fredlund and Tieszen, 1994), the main group of Poaceae in temperate
225 areas. In Chobareti archaeological deposits, bilobate phytoliths are recorded, attesting of the
226 occurrence of the Panicoideae subfamily in the past grasses (Fredlund and Tieszen, 1994; Lu
227 and Liu, 2003; Messenger et al., 2010).

228 Owing to the significant values in "elongate dendritic" phytolith class, the assemblages are
229 rather different from natural phytolith assemblages. This class of phytolith is produced in
230 chaff (glumes, lemma, palea) of Poaceae (Ball et al., 2001). Since domesticated cereals
231 Poaceae are selected for their abundant grains (and chaff as a consequence), they produce
232 many dendritic phytoliths. Moreover, they also correspond to the nutritive part of the plant
233 which is the most subject to harvesting and storage. These are the reasons why this class of
234 phytolith is especially abundant in archaeological sites in which cereals have been processed
235 (Berlin et al., 2003; Portillo and Albert, 2011). The other main feature of these assemblages is
236 the frequent occurrence of silica skeletons (Fig. 4) corresponding to fragments of epidermis

237 (linked phytoliths) (Rosen, 1992). They represent the remains of fragmented pieces of stems,
238 leaves and chaff of Poaceae.

239

240 4.2. Pollen and non-pollen palynomorphs

241 The pollen grains and non-pollen palynomorphs (NPP) were well preserved in the four lowest
242 samples coming from pit 18 (Fig. 5). In the top of pit 18 as well as in every sample from pit
243 17, pollen grains were not found in sufficient quantities (<100) to be sure of the reliability of
244 pollen spectra (Kakhiani et al., 2013). In the pit 18 spectra, pollen grains of Cerealia type are
245 predominant (Fig. 5). Crop weeds were also identified (*Polygonum*, *Convolvulus*, *Carduus*,
246 *Centaurea*, *Dipsacus*). The group of arboreal pollen is essentially represented by coniferous
247 trees such as *Pinus* (pine), *Picea* (spruce) and *Abies* (fir). Pine is predominant, although there
248 are also large quantities of fir (*Abies nordmanniana*) in the lower part of the pit 18 (Fig. 5). In
249 the group of NPP, spores of *Glomus*, a fungus which settles only either on tilled or erosion
250 soils (van Geel, 1998; van Geel and Aptroot, 2006) are well represented in the Chobareti
251 spectra. Spores of dung fungi, such as *Sordaria* or *Arniium* are well-recorded. Another
252 interesting feature of the NPP spectrum is that in all samples, remains of mites and other
253 insects were found.

254

255 4.3. Seeds and fruits

256 The preservation of plant macroremains is exclusively due to carbonisation. Almost 50 litres
257 of sediment provided more than 11,000 plant remains (Fig. 6, Table 5). It represents an
258 average of 231.6 items/litre but concentration varies from 6.2 item/litre in pit 18 to almost
259 2000 items/litre in pit 16. We attested 43 different taxa, of which 16 identified as species.

260 The assemblage is composed of cereal grains and chaff and of wild plants seeds (Table 5).
261 Domestic plants are represented only by wheat and barley. This group includes einkorn
262 (*Triticum monococcum*), emmer (*Triticum turgidum* ssp. *dicoccon* often referred to as the
263 short term *Triticum dicoccon*), naked wheat (*Triticum aestivum/durum/turgidum*) and barley
264 (*Hordeum vulgare*) sometimes hulled; the presence of connected rachis fragments, with
265 typical curved sides and striations, and no thickenings under the glumes (Jacomet et al., 2006,
266 p.36-37) allows us identifying naked wheat as a hexaploid form, belonging to the *aestivum*
267 type (see Supplementary Material SD2). Cereals are badly preserved: more than 70% are
268 identified as Cerealia type or *Triticum* sp. and as groups of species i.e. *Triticum*
269 *monococcum/dicoccon*. Representing more than 90% of the assemblage, cereals grains and
270 chaff are dominating in the three pits. More than 85% of cereals remains are chaff – glume

271 base, spikelet fork and rachis fragment – and could not be assigned to a species. Few seeds
272 attested trees and shrubs: *Rosa* sp. (one seed), *Rubus* sp. (one seed) and yew, *Taxus baccata*
273 (several fragments of seeds). Ruderal and arable-weeds are dominated by various
274 *Chenopodium* (*C. album* and *C. hybridum*), *Fallopia convolvulus* and *Galium* (*G. aparine*
275 and/or *spurium*); we also determined *Avena* sp., *Buglossoides arvensis*, *Euphorbia* sp. and
276 *Euphorbia helioscopia*, *Hyosyamus niger*, *Papaver* sp., *Polygonum* sp., *Polygonum aviculare*,
277 *Rumex* sp. and *Urtica dioica*. Finally, various taxa mostly only assigned to a plant family are
278 grouped in the “Miscellaneous” section which includes *Bromus* sp., Brassicaceae, *Carex* sp.,
279 Caryophyllaceae, Fabaceae type *Trifolium* and *Vicia*, Lamiaceae, Paniceae, *Poa* sp., Poaceae,
280 Polygonaceae, Rosaceae type *Potentilla*, *Teucrium* sp. and maybe *Teucrium botrys*.

281

282 4.4 Charcoal

283 Charcoal from the three pits was analysed (Fig. 7, Table 6). Nine different taxa were
284 identified, among 295 identifiable fragments. The pit 16 yielded an assemblage composed of
285 only two taxa: *Acer t. campestre* (maple) and *Quercus* (deciduous oak). They could be made
286 of a few original fragments, broken into smaller pieces, as it is sometimes the case when
287 dealing with localized, concentrated charcoal sample (Chabal, 1997). Pits 17 and 18 show
288 more diverse spectra, even if *Acer* and *Quercus* are still present but in low amounts. *Pinus* sp.
289 (Pine) is dominating the assemblages from the pits, but broadleaved trees are also present:
290 *Carpinus* sp. (hornbeam), *Fraxinus* sp. (ash), *Corylus avellana* (hazel) and Ulmaceae (wood
291 anatomy does not allow discriminating between *Ulmus* sp., *Celtis* sp. and *Zelkova* sp.) and
292 *Ilex aquifolium* (holly). All these broadleaved taxa refer to mixed forests in contexts of high
293 edaphic humidity (humid mixed forests or riparian formations), some of the deciduous ones
294 being light-demanding species (in particular hazel and ash) while the evergreen one (holly) is
295 more shadow-loving. Charcoal assemblages show that wood was in part collected in humid
296 mixed forest areas and on their edges, but also in dryer places, as evidenced by the important
297 amount of pine.

298

299 4.5. Stable isotopes

300 Isotope values of *Triticum* sp. charred seeds range from -22.3 to -20.5‰ and from 3.9 to
301 11.1‰, respectively for carbon and nitrogen (Table 4). The typical $\delta^{13}\text{C}$ values of modern C_3
302 plants present a modal value of -27‰ (O’Leary, 1988), while archaeological crop species can
303 range between -26.7 to -21.1‰ (Riehl et al., 2008). A variety of environmental factors can
304 affect their ratios and explain the more positive $\delta^{13}\text{C}$ values measured on Chobareti seeds

305 (Tieszen, 1991). Compared to modern values, one could be the depletion of atmospheric CO₂
306 in modern time due to anthropogenic addition of CO₂ (Tieszen and Fagre, 1993), as well as
307 the fact that seed proteins isotope values are enriched relative to leaf tissue because of their
308 low cellulose content (Tieszen, 1991; Heaton, 1999). Among the factors which could affect
309 $\delta^{13}\text{C}$ values, the altitude could be a reliable one to explain the high *Triticum* sp. $\delta^{13}\text{C}$ values.
310 As altitude increases the partial pressure of CO₂, an increase of 1‰ per 1000m of $\delta^{13}\text{C}$ values
311 can be expected in plant (Heaton, 1999). Similarly, a water stress as well as a high nutrient
312 level in soil can be correlated with an enrichment in ¹³C of plant tissues (Tieszen, 1991). In
313 addition, concerning the wide dispersion of $\delta^{13}\text{C}$ values, the inter-individual seed variability
314 could be related to the short-term seasonal/annual indicating the presence of seeds from
315 different harvests (Heaton, 1999). $\delta^{15}\text{N}$ values of modern C₃ and C₄ plants of a wide variety of
316 environments range from -1 to 6‰ (Heaton, 1987). Among factors which could increase the
317 nitrogen isotope ratios, the modification of the environment by human might be one of the
318 more relevant (Bogaard et al., 2007; Fraser et al., 2011).

319 Human and animal bones present yields of collagen extraction above 15.6mg/g
320 (m=94.3±47.0mg/g, n=31). The percentages of carbon and nitrogen are above the required
321 limits (%C: 39.4±1.8%; %N: 14.4±0.7%) and the C/N ratios have a mean of 3.2 indicating a
322 well preservation for all collagen samples (Table 4). For herbivores (Fig. 8), $\delta^{13}\text{C}$ values
323 range from -20.5 to -18.4‰ (-19.5±0.5‰, n=21) and from 3.3 to 8.1‰ (5.7±1.3‰, n=21) for
324 $\delta^{15}\text{N}$ values (Fig 8). A sole wild animal, the bison, is included in the isotope variability of *Bos*
325 sp. indicating a similar environment occupancy. Its carbon and nitrogen isotope values are
326 amongst the highest (-18.5‰; 7.1‰) within *Bos* sp. group. Bovid group express significant
327 higher nitrogen isotope values in comparison to *Ovis/Capra* group (p($\delta^{15}\text{N}$)=0.02, Mann
328 Whitney test), for which no biological explanation, as the age at death, can be evoked. On the
329 other hand, both groups exhibit no difference for $\delta^{13}\text{C}$ values, indicating a similar
330 environment occupancy constituted mainly by C₃ plants.

331 Human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values range respectively from -19.3 to -18.1 ‰ and from 9.8 to 13.9‰
332 (Table 3, Fig 8). The wide dispersion of $\delta^{15}\text{N}$ values (4.1‰) can be explained by the value of
333 a young child (under one year-old), who was probably breastfed at his/her death (Katzenberg
334 et al., 1996). Removing this specific individual, the dispersion of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values
335 becomes very low (respectively about 0.3‰ and 1.4‰), highlighting a homogeneous dietary
336 practice within the group (O'Connell and Hedges 1999; O'Connell et al., 2001). In addition,
337 despite an apparent diversified funeral practices identified, any significant relation has been

338 observed between isotopic values, funerary and biological criteria, confirming the strong
339 homogeneity of dietary practices at Chobareti.

340

341 5. Discussion

342 5.1. Surrounding vegetation

343 Despite the clear anthropogenic origin of botanical remains accumulations in the pits, they
344 can provide some information about the surrounding vegetation. In the pollen and charcoal
345 spectra from Chobareti site, coniferous, as well as deciduous broadleaved trees, are attested
346 (Fig. 5). Pine is predominant according to both proxies. In pollen assemblages, fir (*Abies*) is
347 better represented than spruce (*Picea*), which is a trend also recorded for the same period
348 (4500-4000 cal BP) in continuous pollen sequences from lakes such as Aligol or Paravani
349 (Connor, 2011; Messenger et al., 2013). The presence of *Pinus* in the form of charcoal
350 indicates its occurrence in the Chobareti vicinity. Deciduous trees such as oak, maple or
351 hornbeam have been identified in charcoals assemblages (Table 6), whereas they are slightly
352 recorded in pollen spectra. Charcoal reflects local environment, which is the one exploited for
353 fuel gathering according the “principle of least effort” defined by Shackleton and Prins
354 (1992). The occurrence of few fragments of yew seeds (*Taxus baccata*), and holly (*Ilex*
355 *aquifolium*) charcoal confirms the local presence of dense forests, as both taxa are shade-
356 loving species. All archaeobotanical data deliver a partial picture of the vegetation due to the
357 anthropogenic origin of the assemblages but the palaeoenvironmental information they
358 provide fits well with pollen records from regional natural sequences (Margalidze, 1995;
359 Connor, 2011; Messenger et al., 2013). It's important to note that the landscape depicted by
360 palaeoenvironmental records on the Javakheti Plateau is completely different from the
361 present-day landscape, mainly dominated by steppic grassland (Nakhutsrishvili, 1999;
362 Matcharashvili et al., 2004).

363

364 5.2. Agricultural practices

365 5.2.1. Cultivated cereals

366 In Chobareti, phytoliths and pollen as well as plant macroremains show a predominance of
367 cereals in the studied pits. Pollen assemblages are not so well-preserved than in the lakes, but
368 deliver information concerning human practices, which are badly recorded in pollen
369 sequences from lakes (Messenger et al., 2013; Joannin et al., 2014). According to seed
370 analysis, *Triticum* (wheat) is the most important cereal in Chobareti, while *Hordeum* (barley)
371 is found in very low quantity. Within *Triticum*, it seems that naked wheat, and probably the

372 hexaploid form (*T. aestivum*), is the most cultivated cereal, even if *T. dicoccum* (emmer)
373 predominates in pits 17 and 18. Indeed, cereals in pit 16 are much more abundant than in pits
374 17 and 18 (Table 5). In the latter, few grains and chaff of emmer (n=136) were identified
375 whereas naked wheat widely predominates in pit 16 with more than 2,000 pieces of chaff
376 (Fig. 6).

377 The studied pits only draw a partial picture of the relative proportions of cultivated cereals.
378 The archaeobotanical analysis of other sectors of the site is currently under process (C.
379 Longford, University of Sheffield) and will give further information. Nevertheless, these first
380 data at Chobareti confirm that, as previously observed on other K-A sites in the region,
381 *Triticum aestivum* is one of the most important cultivated cereals, with *Hordeum*. For
382 instance, in Armenia, on the sites of Tsaghkasar and Arapan III, located between 1860 and
383 2080m a.s.l, *T. aestivum* and *Hordeum*, mainly hulled, predominate while *T. dicoccum* is very
384 discrete (Hovsepyan, 2010; 2011). In Gegharot, around 2000m a.s.l, hulled barley represents
385 96.1% of the assemblage, together with few bread wheat grains and weeds (Hovsepyan,
386 2009). In northeast Turkey, at Sos Höyük, bread wheat and hulled barley also predominate
387 (Longford et al., 2009). In Azerbaijan, the site of Ovçular Tepesi (912m a.s.l) also delivered
388 naked hexaploid wheat, and barley, including hulled form (Decaix, 2011).

389 In Chobareti, the presence of *T. dicoccum* is interesting, considering that hulled wheats
390 (*Triticum monococcum*, *T. dicoccum*, *T. spelta*) are rare, or even missing, on other K-A sites.
391 At the contrary, we found very few grains of *Hordeum* (n = 18, including six hulled forms),
392 whereas this cereal is predominant elsewhere. In this way, further analyses on the site should
393 precise the status of emmer and barley. The abundance of cereal remains in Chobareti, as well
394 as in other sites we have mentioned above, shows that K-A populations successfully managed
395 mountainous environments for cereals cultivation. Indeed, Chobareti is located on the western
396 part of the Javakheti Plateau (1500-2000m a.s.l), which is still today, a fertile land where
397 barley and wheat are widely cultivated.

398

399 5.2.2. Seed isotopic values: evidence of manuring?

400 Chobareti charred seeds display more positive $\delta^{15}\text{N}$ values than expected variability for plants
401 (Heaton, 1987). The aridity is usually evoked to explain this kind of shift (Ambrose, 1991).
402 But, in this region, the different palaeoecological records do not reveal a drought phase at that
403 time (Connor 2011; Messenger et al., 2013). Recently, agricultural long-term and short-term
404 experiments have been done to understand the impact of animal manure application on the
405 $\delta^{15}\text{N}$ values of a broad range of crops and pulses (Bogaard et al., 2007; Fraser et al., 2011). It

406 has been demonstrated a gradual increase of $\delta^{15}\text{N}$ values in modern wheat and barley samples
407 related to low, medium and high manuring rates, with the respective ranges: inferior to 3‰,
408 from 3 to 6‰ and up to 6‰ (Bogaard et al., 2013). The wide variability of Chobareti wheat
409 $\delta^{15}\text{N}$ values (from 3.9 to 11.1‰; Fig. 8) could be explained by different strategies of
410 manuring. Wheat may have not grown in the same location, and/or in the meantime,
411 indicating specific practices of using animal dung, to restore nutrients and enhance crop
412 yields. Even if, only wheat seeds have been considered here, their specific isotopic pattern
413 constitute a great constraint to interpret animal and human isotope values and assess the
414 potential contribution of domesticated cereals in their diets.

415

416 5.2.3. Animal husbandry practices

417 The animal $\delta^{13}\text{C}$ values display a range from -20.5 to -18.4‰, in agreement with a
418 consumption of C_3 plants which fits well with the archaeobotanical assemblages. Considering
419 wheat seed $\delta^{13}\text{C}$ values, whatever animal species, the diet-tissue spacing ($\Delta^{13}\text{C}_{\text{seed-bos}} = 1.7\text{‰}$;
420 $\Delta^{13}\text{C}_{\text{seed-ovis/capra}} = 1.9\text{‰}$) is significantly less important than the average of +5‰ observed
421 between $\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{13}\text{C}_{\text{diet}}$ in numerous experimental animal studies (Froehle et al.,
422 2010). Our data can't be explained by a regular consumption of wheat, whatever seeds, or
423 chaff, even if these last have lower $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values than seeds (Tieszen, 1991; Bogaard
424 et al., 2007). The high $\delta^{15}\text{N}$ values of *Bos* sp. in comparison with those of *Ovis/Capra* sp.
425 suggest various strategies to feed those animals. In addition, our results could indicate herding
426 practices based on the use of animal dung for agriculture and the probable use of different
427 pastures rather than a feeding strategy based on wheat chaff.

428

429 5.3. Function of the pits

430 In the pits, among cereals remains, chaff is very abundant, especially in pit 16, where only
431 6.8% of wheat remains are grains. The assemblage is composed of rachis and awn (not
432 counted) fragments, spikelet forks and glume basis, probably waste products of threshing.
433 This hypothesis is strengthened by the presence of common arable weeds in the macroremains
434 assemblages (e.g. *Fallopia convolvulus*, *Euphorbia helioscopia*, *Polygonum aviculare*) as well
435 as in the pollen assemblage (*Polygonum* sp., *Convolvulus* sp.). The phytolith spectra from pits
436 17 and 18, displaying a lot of dendritic phytolith and fragmented silicified epidermis, support
437 the interpretation of cereals threshing.

438 All these botanical remains evidence cereals processing, however their presence in these pits

439 can have several origins. Threshing by-products can be stored and used for fuel or forage. It is
440 also plausible that the pits were silos re-used as rubbish dumps. It is difficult to determine
441 whether there was *in situ* burning in the pits or if the material has been deposited after being
442 charred elsewhere. Plant remains could also come from burnt dung. It has been demonstrated
443 that the burning of dung cakes is a plausible pathway for the presence of charred cereals
444 remains, especially threshing by-products like chaff, which was used as fodder (Miller, 1984).
445 In Chobareti, this interpretation could be supported by the record of spores of coprophilous
446 fungi (e.g. *Sordaria*), but no spherulites have been observed in the sediment. In this case, it is
447 challenging to assign a function to those pits.

448

449 5.4. Human dietary breadth

450 Animal and human $\delta^{13}\text{C}$ values (average respectively -19.5‰ and -18.8‰), as well as $\Delta^{13}\text{C}$
451 offset between the Chobareti domesticated animals and human isotopic values of 0.7‰ ,
452 suggest a dietary pattern focusing on either the direct consumption of C_3 plants and cereals, as
453 recorded by archaeobotanical data, or the exploitation of livestock products (meat, secondary
454 products) of animals fed on C_3 plants. In the same vein, the $\Delta^{15}\text{N}$ of 4.9‰ between local
455 animals and adult humans indicate a significant contribution of animal proteins in human diet.
456 It highlights an exploitation of livestock products as much as, or more than plant products.
457 Alternatively, based on the theoretical enrichment in heavy isotopes between two consecutive
458 trophic levels (on average $+0.8\text{‰}$ in ^{13}C and $+4\text{‰}$ in ^{15}N ; Bocherens and Drucker, 2003), the
459 expected mean isotopic values of the consumed food items by the adult group would be
460 around $-19.7\pm 0.2\text{‰}$ and $6.6\pm 0.5\text{‰}$, for respectively carbon and nitrogen. These isotope values
461 would refer to a preferential consumption of bovid meat, since these animals present
462 significantly higher $\delta^{15}\text{N}$ values in comparison with those of *Ovis/Capra* group.

463 Furthermore, recent isotopic data on modern freshwater fishes from the Northern Caucasus
464 can be used as proxy to question their consumption by humans (Higham et al., 2010, Svyatko
465 et al., 2013). Even if freshwater fish did contribute to the diet, it was not significant enough to
466 be recorded in the isotopic composition of Chobareti human tissues (Fig. 8). In addition, as
467 previously mentioned, concerning management practices of arable land, the consumption of
468 animal proteins could be overestimated instead of the consumption of vegetal ones (Bogaard
469 et al., 2013). Indeed, wheat seeds of Chobareti show $\delta^{15}\text{N}$ values, similar to those of
470 herbivores, making difficult the estimation of proportion of animal *versus* vegetal proteins in
471 human diet (Fig. 8). Another limit comes from the magnitude of $\Delta^{13}\text{C}_{\text{diet-collagen}}$ that can greatly

472 vary depending on the $\delta^{13}\text{C}$ values of dietary macronutrients (Froehle et al. 2010). While
473 archaeological seeds were analysed to evaluate the crop contribution to human and/or
474 herbivore diet, their isotopic values reveal a problem of equifinality for past dietary
475 reconstruction. To gain insight about the real contribution of C_3 cereals to Chobareti diet,
476 carbon isotope analyses of human bone apatite could be undertaken, as prescribed elsewhere
477 (Kellner and Schoeninger, 2007).

478 In any case, our results support the view of a mixed diet for the Chobareti group involving a
479 direct consumption of cereals as well as a consumption of meat or dairy products from the
480 livestock. While funerary practices are diversified, the low dispersion of carbon and nitrogen
481 isotope values supports the hypothesis of a community life, without any social, age or sex
482 distinction in the food item choices. Such a pattern could be in relation with either the
483 stability of the environment through time (Connor, 2011; Messenger et al., 2013), a
484 homogenous range of food items at this altitude, or the equality of the Kura-Araxes people, as
485 already proposed, based on socio-cultural features (Sagona, 1994).

486

487 6. Conclusion

488 This pilot study, involving archaeobotanical and isotopic investigations, performed at
489 Chobareti site, has started to draw a picture of the subsistence activities in mountainous
490 environment of the South Caucasus during the Kura-Araxes culture.

491 All botanical data indicate that inhabitant of Chobareti cultivated cereals. Cultivated crops
492 were essentially naked wheat, including *Triticum aestivum* and *Triticum dicoccum* (emmer).
493 The threshing process is attested by phytoliths as well as macroremains assemblages, both
494 dominated by cereal chaff remains. Chobareti community appears to be an efficient farming
495 group, able to grow wheat and barley up to 1600m a.s.l.. High $\delta^{15}\text{N}$ values of wheat seeds
496 suggest that animal dung were used to restore nutrients and enhance crop yields. Animal
497 nitrogen stable isotope data indicate different herding practices based on differential
498 occupancy of environments. In the meantime, both animal and human carbon stable isotope
499 data support C_3 plants and cereals consumption. Whereas biological and funerary records
500 support diversified cultural traits, a mixed diet, with a great contribution of animal protein
501 source (meat, secondary products) seems homogenous within the entire Chobareti population.

502

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514

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760 **Captions**

761 Figure 1. Map showing the location of Chobareti.

762 Figure 2. Bottom: location of the pipeline corridor and the Kura-Araxes site of Chobareti,
763 Top: Chobareti structures. A. Burials, B. Structure 4.

764 Figure 3. Chobareti: trench 1 (2011) in which archaeobotanical sampling was undertaken.

765 Figure 4. Phytolith assemblages (%) of pits 17 and 18 from Chobareti.

766 Figure 5. Pollen and non-pollen palynomorphs (NPP) assemblages (%) of pit 18 from
767 Chobareti.

768 Figure 6. Different proportions of cereals identified in pits 16, 17 and 18 from Chobareti,
769 according to the number of caryopsis and chaff. For chaff, we took into account only spikelet
770 fork and glume basis, estimating that one spikelet fork = two glume basis, and only rachis
771 segments for naked wheat.

772 Figure 7. Charcoal assemblages from pits 16, 17 and 18. N=number of identified charcoals for
773 each pit of Chobareti.

774 Figure 8. Carbon and nitrogen isotope ratios for animals, seeds and humans from Chobareti.
775 (Freshwater fish data from Higham et al., 2010 and Svyatko et al., 2013)

776

777 Table 1. List of AMS ^{14}C dates from Chobareti. All data are from Kakhiani et al., 2013,
778 except samples Poz-56370 (Burial 5) and Poz-56370 (Burial 9). ^{14}C ages were calibrated
779 using INTCAL09 (Stuiver and Reimer, 1993, Reimer et al., 2009).

780 Table 2. Phytolith morphotypes (following ICPN Working Group et al., 2005) identified in
781 Chobareti with their taxonomic attributions and the corresponding literature.

782 Table 3. Archaeological, funerary, biological data and isotope values for humans from
783 Chobareti

784 Table 4. Archaeological data and isotope values for animals and seeds from Chobareti

785 Table 5. Plant macroremains identified in pits 16, 17 and 18 from Chobareti.

786 Table 6. Results of charcoal analysis from pits 16, 17 and 18 from Chobareti.

787 Supplementary data SD1. Archaeothanatological study

788 Supplementary data SD2. Archaeobotanical material from pits 16, 17 and 18

Lab. Code	material	Radiocarbon Age BP			Age cal BC
Wk-34451	charcoal	4490	±	33	3349-3089
Wk-34452	charcoal	4470	±	36	3341-3024
Wk-34453	charcoal	4528	±	33	3244-3101
Wk-34454	charcoal	4517	±	35	3359-3262
Wk-34455	charcoal	4501	±	39	3356-3090
Wk-34456	charcoal	4501	±	33	3351-3094
Wk-34457	charred grain	4451	±	34	3338-3208
Wk-34458	charred grain	4451	±	34	3195-3007
Wk-34459	charred grain	4434	±	35	3125-2926
SacA 27471	charcoal	4500	±	30	3348-3096
SacA 27472	charcoal	4535	±	30	3241-3104
Poz-56370	human bone	4460	±	40	3346-2944
Poz-56371	human bone	4380	±	40	3264-2902

Samples	median depth	Age BP	Age cal BP	remarks
PAR09-P1-0-2	1	0 ± 0	0	
PAR09-P1-12-13	12.5	525 ± 30	509-628	
PAR09-P3-25-27	26	490 ± 45	474-632	rejected
PAR09-P1-35.5-36.5	36	2430 ± 40	2351-2702	
PAR09-P1-45.5-46.5	46	5345 ± 35	6000-6269	rejected
PAR09-P6-54-56	55	5355 ± 40	6001-6275	
PAR09-P1-61.5.5-62.5	62	6325 ± 30	7171-7313	
PAR09-P8-68-70	69	7400 ± 50	8050-8355	
PAR09-P1-81.5.5-82.5	82	10740 ± 40	12563-12739	rejected
PAR09-P10-94-96	95	10690 ± 50	12548-12710	

		top depth	base depth	median depth		Age BP		Age cal BP	remarks
PAR09-P1-0-2	PAR09-P1	0	2	1	0	±	0	0	
PAR09-P1-12-1	PAR09-P2	12	13	12.5	525	±	30	509-628	
PAR09-P3-25-2	PAR09-P3	25	27	26	490	±	45	474-632	rejected
PAR09-P1-35.5-3	PAR09-P4	35.5	36.5	36	2430	±	40	2351-2702	
PAR09-P1-45.5-4	PAR09-P5	45.5	46.5	46	5345	±	35	6000-6269	rejected
PAR09-P6-54-5	PAR09-P6	54	56	55	5355	±	40	6001-6275	
PAR09-P1-61.5-5-6	PAR09-P7	61.5	62.5	62	6325	±	30	7171-7313	
PAR09-P8-68-7	PAR09-P8	68	70	69	7400	±	50	8050-8355	
PAR09-P1-81.5-5-8	PAR09-P9	81.5	82.5	82	10740	±	40	12563-12739	rejected
PAR09-P10-94-9	PAR09-P10	94	96	95	10690	±	50	12548-12710	

Morphotypes	Main taxonomic attribution	Bibliography
Elongate	Poaceae	Twiss et al., 1969 (elongate)
Elongate dendritic	Poaceae	Ball et al., 1996 (dendriform)
Acicular	Poaceae	Twiss et al., 1969 (point-shaped)
Short acicular	Poaceae	Kaplan et al., 1992 (short point)
Bulliform (cuneiform & parallepipetal)	Poaceae	Twiss et al., 1969 (fan-shaped)
Papillae	Poaceae	Rosen, 1992 (papillae)
Rondel & trapeziform short cells	Poaceae, Pooideae	Fredlund et Tieszen, 1994 (keeled, conical, pyramidal)
Sinuate trapeziform	Poaceae, Pooideae	Mulholland, 1989 (sinuate)
Bilobate	Poaceae, Panicoideae/Arundinoideae	Brown, 1984 (bilobate)
Cylindric sulcate	cf. Dicotyledonous	Strömberg, 2002 (tracheid)
Globular	cf. Dicotyledonous	Runge, 1999 (spherical)
Jigsaw	cf. Dicotyledonous	Bozarth, 1992 (jigsaw)
Point-hair	No taxonomic value	Pearsall, 2000 (hair cell)

Burial	#Catalog	Individual	Funerary practices	Decomposition	Stage	Skull ¹		Coxal		Skeletal Element	Yield (mg/g)	%C	%N	C/N	$\delta^{13}\text{C}_{\text{V-PDB}}$	$\delta^{15}\text{N}_{\text{Air}}$
						Age	Sex	Age ²	Sex ³							
Burial 1	2838		Primary burial	Filled space	adult	30-35	M	25-30 ^a		Phalanx	104.3	42.1	15.7	3.1	-19.0	9.8
Burial 2	2846	1	Several inhumation	?	adult	40-45	F			Skull	58.7	38.9	14.1	3.2	-18.7	10.8
Burial 2	2840	3	Several inhumation	?	adult	50-55	M			Skull	30.6	35.2	12.7	3.2	-18.8	11.2
Burial 2	2839	4	Several inhumation	?	adult	20-25	F	20-29 ^b	F ^b	Skull	106.9	37.9	13.8	3.2	-19.3	10.5
Burial 4	-		Primary burial	Filled space	adult	25-30	F			Skull	78.4	41.0	15.1	3.2	-18.9	10.8
Burial 5	2845		Primary burial	Filled space	adult	30-35	M	25-30 ^a		Phalanx	57.3	40.1	14.8	3.1	-18.8	11.0
Burial 7	2842		Primary burial	Filled space	subadult	5y		2y-3y6m ^c		Skull	114.9	41.3	15.0	3.2	-18.9	9.9
Burial 8	2843	1	Primary burial	Filled space	adult	40-45	F	>40 ²	F	Phalanx	33.6	40.9	14.9	3.2	-18.7	10.1
Burial 8	-	2	?	?	adult	25-30				Skull	40.8	37.9	13.7	3.2	-19.0	11.0
Burial 9	2944		Primary burial	Filled space	subadult	1y		1y ^d		Skull	46.6	38.6	14.1	3.2	-18.1	13.9
										<i>Mean</i>	<i>67.2</i>	<i>39.4</i>	<i>14.4</i>	<i>3.2</i>	<i>-18.8</i>	<i>10.9</i>
										<i>N</i>	<i>10</i>	<i>10</i>	<i>10</i>	<i>10</i>	<i>10</i>	<i>10</i>
										<i>SD</i>	<i>31.8</i>	<i>2.1</i>	<i>0.9</i>	<i>0.03</i>	<i>0.3</i>	<i>1.2</i>
										<i>minimum</i>	<i>30.6</i>	<i>35.2</i>	<i>12.7</i>	<i>3.1</i>	<i>-19.3</i>	<i>9.8</i>
										<i>maximum</i>	<i>114.9</i>	<i>42.1</i>	<i>15.7</i>	<i>3.2</i>	<i>-18.1</i>	<i>13.9</i>

Several inhumation: no possibility to reconstruct the chronology/reorganization of the skeleton deposits and to cut off between reductions and secondary deposits

¹Buikstra and Ubelaker 1994; ²Schmitt 2005; ³Bruzek 2002; Murail et al. 2005

^abased on fusion of sternal extremity of clavícula; ^bcoxal bone could be associated with this skull but nothing is sure; ^cdental age expressed in years/months after Moorrees et al. 1963a, 1963b; ^dAge expressed in years based on long bone measurements after Scheuer and Black 2000

#Lab	Excavation	Archaeological Information	Species	Skeletal Element	Yield (mg/g)	%C	%N	C/N	$\delta^{13}\text{C}_{\text{V-PDB}}$	$\delta^{15}\text{N}_{\text{Air}}$
CHOF01	2011	Trench I	<i>Bos</i> sp.	Femur	44.0	40.1	14.6	3.2	-19.9	6.0
CHOF02	2011	Trench I	<i>Bos</i> sp.	Radius	67.4	41.0	14.8	3.2	-18.9	5.5
CHOF04	2011	Trench I	<i>Bos</i> sp.	Talus	58.2	39.4	14.3	3.2	-20.2	8.1
CHOF05	2011	Trench I	<i>Bos</i> sp.	Calcaneum	75.6	39.9	14.4	3.2	-20.0	6.1
CHOF06	2011	Trench I	<i>Bos</i> sp.	Phalanx	15.6	39.4	14.1	3.2	-19.2	5.1
CHOF09	2009	Building 4	<i>Bos</i> sp.	Talus	81.5	40.4	14.6	3.2	-19.2	7.9
CHOF10	2009	Building 4	<i>Bos</i> sp.	Radius	40.2	37.4	13.7	3.2	-19.6	4.6
CHOF11	2009	Building 4	<i>Ovis</i> sp.	Humerus	73.6	39.8	14.6	3.2	-18.4	3.3
CHOF12	2009	Building 4	<i>Bos</i> sp.	Radius	101.7	42.6	15.3	3.2	-20.5	5.3
CHOF30	2009	Pit 4	<i>Bison</i> sp.	Calcaneum	149.9	38.6	14.4	3.1	-18.5	7.1
CHOF31	2009	Pit 4	<i>Bos taurus</i>	Mandibula	128.3	35.8	13.1	3.2	-19.4	7.9
CHOF32	2009	Pit 4	<i>Ovis/Capra</i>	Femur	156.9	41.6	15.3	3.2	-19.6	5.0
CHOF33	2009	Pit 4	<i>Ovis/Capra</i>	Mandibula	130.1	38.0	13.9	3.2	-19.4	4.9
CHOF34	2009	Pit 4	<i>Ovis/Capra</i>	Radius	164.7	39.9	14.7	3.1	-19.0	4.5
CHOF35	2009	Pit 4	<i>Ovis/Capra</i>	Humerus	120.3	40.4	14.7	3.2	-19.5	5.9
CHOF36	2009	Pit 4	<i>Ovis/Capra</i>	Femur	116.4	41.4	15.1	3.2	-19.5	4.3
CHOF37	2009	Pit 5	<i>Ovis/Capra</i>	Metapode	94.4	36.1	13.2	3.2	-19.9	6.3
CHOF38	2009	Pit 4	<i>Ovis/Capra</i> ^a	Mandibula	126.3	38.7	14.1	3.2	-19.1	5.7
CHOF39	2009	Pit 4	<i>Ovis/Capra</i>	Tibia	155.6	38.9	14.2	3.2	-19.5	4.1
CHOF40	2009	Pit 6	<i>Ovis/Capra</i>	Rib	146.5	39.0	14.2	3.2	-19.3	5.2
CHOF41	2009	Pit 13	<i>Ovis aries</i>	Phalanx	204.4	38.4	14.1	3.2	-20.0	5.9
CHO.BL01	2012	Pit 16	<i>Triticum a/d/t</i>	Charred seed		66.1	4.8	-	-21.4	6.0
CHO.BL02	2012	Pit 16	<i>Triticum a/d/t</i>	Charred seed		61.6	4.2	-	-20.5	6.6
CHO.BL04	2012	Pit 16	<i>Triticum a/d/t</i>	Charred seed		58.6	5.0	-	-20.8	6.0
CHO.BL05	2012	Pit 16	<i>Triticum a/d/t</i>	Charred seed		61.3	4.5	-	-21.2	3.9
CHO.BL06	2012	Pit 16	<i>Triticum a/d/t.</i>	Charred seed		59.1	3.8	-	-21.7	11.1
CHO.BL07	2012	Pit 16	<i>Triticum a/d/t</i>	Charred seed		59.5	3.5	-	-22.3	4.8

^aNo age information ; (*Triticum a/d/t* = *Triticum aestivum/durum/turgidum*)

Samples	Pit 16	Pit 17	Pit 18	Total (MNI)
Samples volumes (litres)	4,9	20,7	23	48,6
Domesticated plants				
cf. Cerealia, grain	41	26	20	87
Cerealia, grain	296	189	66	551
<i>Triticum</i> sp., grain	14	31	12	57
<i>Triticum</i> sp., spikelet fork	136	-	-	136
<i>Triticum</i> sp., glume base	5519	281	100	5900
<i>Triticum</i> sp., rachis fragment	218	44	14	276
<i>Triticum monococcum</i> , grain	1	-	-	1
<i>Triticum monococcum</i> , spikelet fork	8	-	-	8
<i>Triticum monococcum/dicoccum</i> , spikelet fork	40	5	6	51
<i>Triticum monococcum/dicoccum</i> , rachis fragment	112	-	-	112
<i>Triticum</i> cf. <i>dicoccum</i> , grain	13	-	-	13
<i>Triticum</i> cf. <i>dicoccum</i> , glume base	25	-	-	25
<i>Triticum dicoccum</i> , grain	36	10	9	55
<i>Triticum dicoccum</i> , spikelet fork	50	1	1	52
<i>Triticum dicoccum</i> , glume base	89	94	21	204
<i>Triticum</i> cf. <i>aestivum/turgidum</i> , grain	18	-	-	18
<i>Triticum aestivum/turgidum</i> , grain	80	13	12	105
<i>Triticum aestivum/turgidum</i> , rachis fragment	2059	18	12	2089
<i>Triticum aestivum</i> , rachis fragment	423	12	3	438
cf. <i>Hordeum vulgare</i> , grain	8	1	2	11
<i>Hordeum vulgare</i> , grain	-	-	1	1
<i>Hordeum vulgare</i> hulled, grain	6	-	-	6
TOTAL CEREALS	9192	725	279	10,196
Trees and shrubs				
<i>Rosa</i> sp., seed	-	1	-	1
<i>Rubus</i> sp., seed	-	1	-	1
<i>Taxus baccata</i> , seed	-	2	1	3
Ruderal and arable-weeds				
cf. <i>Avena</i> sp., grain	-	1	1	2
<i>Avena</i> sp., grain	-	-	2	2
<i>Buglossoides arvensis</i> , seed	-	1	-	1
<i>Chenopodium</i> sp., seed	20	28	10	58
<i>Chenopodium album</i> , seed	6	17	8	31
<i>Chenopodium hybridum</i> , seed	-	5	4	9
<i>Euphorbia</i> sp., seed	-	1	1	2
<i>Euphorbia helioscopia</i> , seed	-	2	-	2
<i>Fallopia convolvulus</i> , seed	10	17	5	32
<i>Galium</i> sp., seed	49	62	15	126
<i>Galium aparine</i> , seed	-	-	3	3
<i>Galium aparine/spurium</i> , seed	-	161	35	196
<i>Hyoscyamus niger</i> , seed	-	2	-	2
<i>Papaver</i> sp., seed	4	-	-	4
<i>Polygonum</i> sp., seed	-	16	2	18
<i>Polygonum aviculare</i> , seed	-	1	-	1
<i>Rumex</i> sp., seed	25	-	-	25
cf. <i>Urtica dioica</i> , seed	-	1	-	1
<i>Urtica dioica</i> , seed	-	3	-	3
Miscellaneous				
cf. <i>Bromus</i> sp., grain	135	1	-	136
<i>Bromus</i> sp., grain	161	25	8	194
Brassicaceae, seed	3	-	-	3
<i>Carex</i> sp., seed	1	-	-	1
Caryophyllaceae, seed	-	1	-	1
Fabaceae type <i>Trifolium</i> , seed	15	29	10	54
Fabaceae type <i>Vicia</i> , seed	-	1	-	1
Lamiaceae, seed	-	3	-	3
Paniceae, grain	-	3	-	3
<i>Poa</i> sp., grain	4	-	-	4
Poaceae, grain	45	21	26	92
Poaceae type <i>Poa</i> , grain	-	8	3	11
Polygonaceae, seed	11	7	3	21
Rosaceae type <i>Potentilla</i> , seed	-	4	-	4
<i>Teucrium</i> sp., seed	-	1	-	1
<i>Teucrium</i> cf. <i>botrys</i> , seed	-	3	-	3
Foliar scar	-	3	-	3
Total	9681	1157	416	11,254
Concentration/litres	1975,7	55,9	18,1	231,6

	Pit 16	Pit 17	Pit 18
<i>Acer campestre</i> type	33	8	-
<i>Carpinus</i> sp.	-	11	-
cf. <i>Carpinus</i> sp.	-	1	-
<i>Corylus avellana</i>	-	1	1
<i>Fraxinus</i> sp.	-	8	6
Maloideae	-	1	-
<i>Ilex aquifolium</i>	-	-	2
<i>Pinus sylvestris</i> type	-	126	18
<i>Quercus</i> deciduous	50	26	1
cf. <i>Quercus</i> sp.	-	1	-
<i>Ulmus/Zelkova</i> sp.	-	-	1
TOTAL (identified)	83	183	29
Unidentified	-	5	2
TOTAL	83	188	31

	Treligorebi I Square C4 building 4 locus 15 floor level	Treligorebi I Square E3 building 4 locus 3 (-4,00)	Treligorebi I Square E3 locus 12	
	4		2	
<i>Fagus</i> sp.			24	
<i>Quercus caducifolié</i>	1	1		
TOTAL	1	1	24	26

	Godachrili Gora 2012	Godachrili Gora 2012	Godachrili Gora 2012
	CB 13	CB9	
	US 123	US 142	Fosse 148
		Ashy layer	
<i>Fraxinus</i> sp.			5
<i>Populus</i> sp./ <i>Salix</i> sp.			7
Angiosperme dicotylédone	1		

Rhamnaceae??

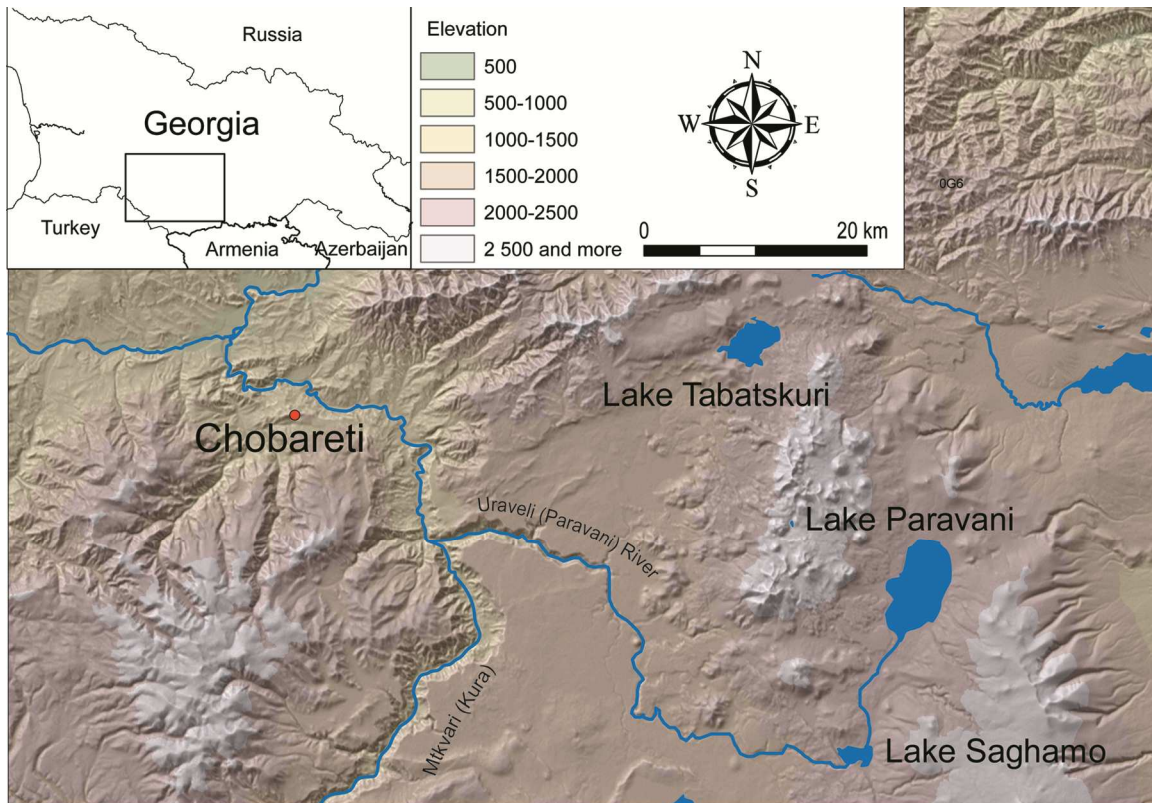
Racine probable...

très petits et nbx cernes

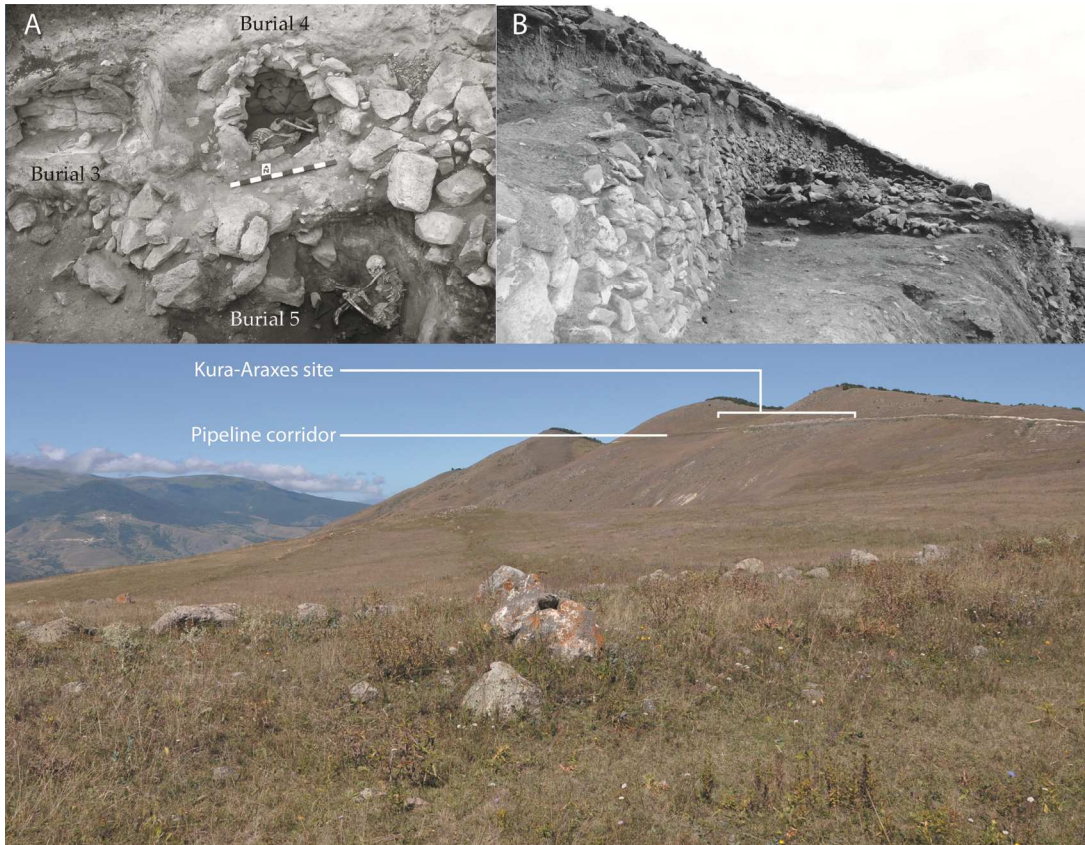
monospé: 1 seul fgmt

P. Nigra possible

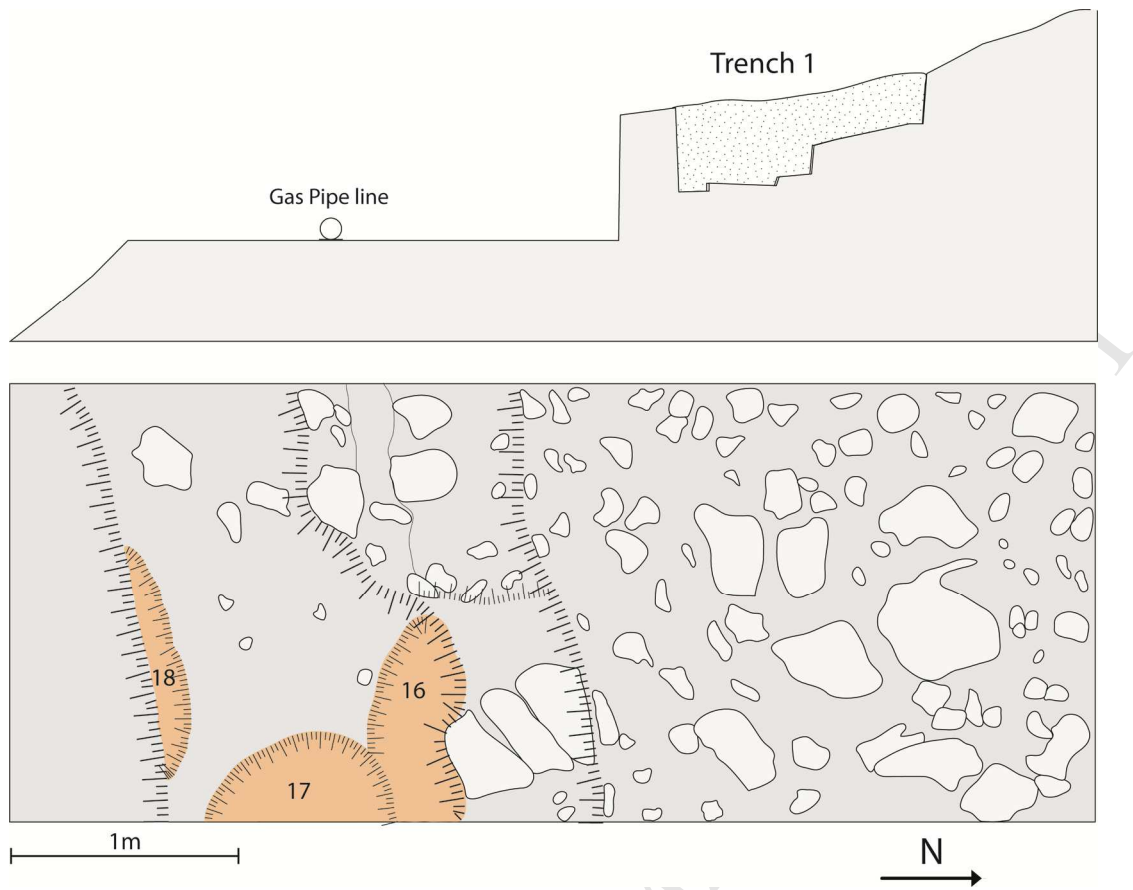
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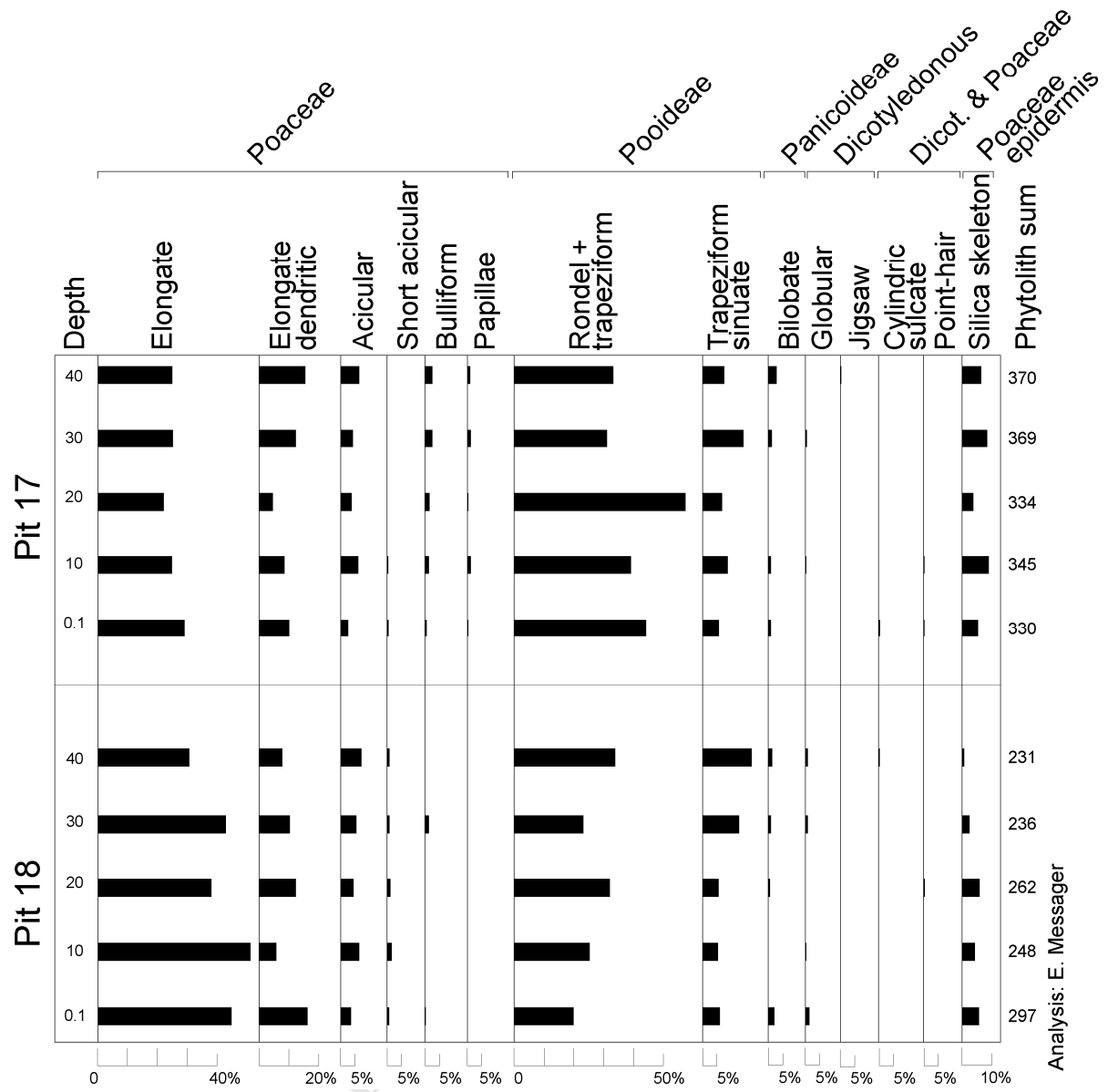


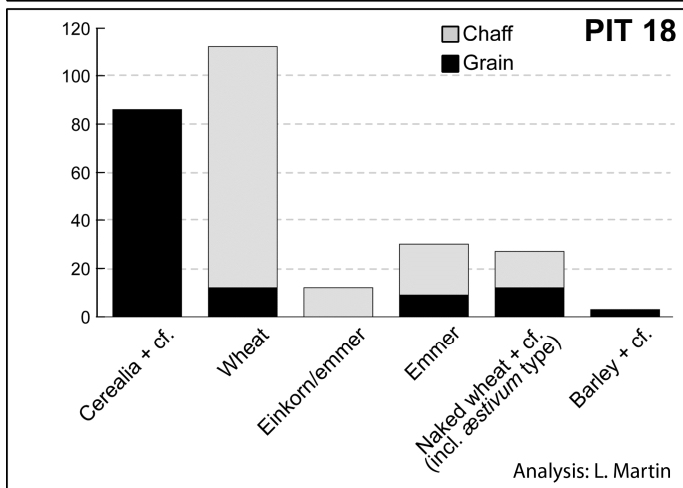
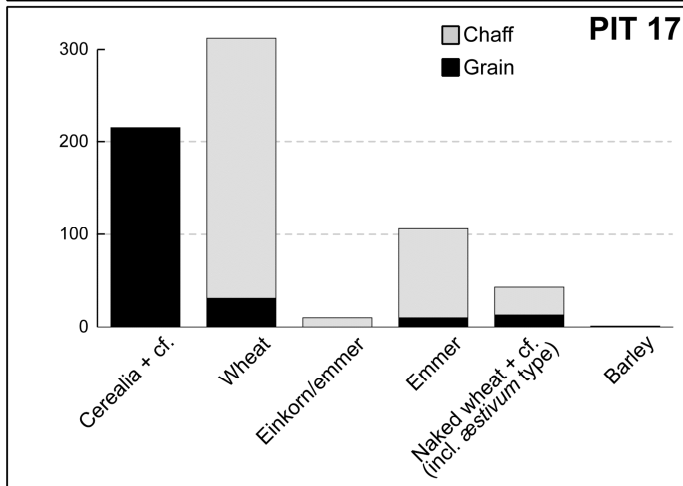
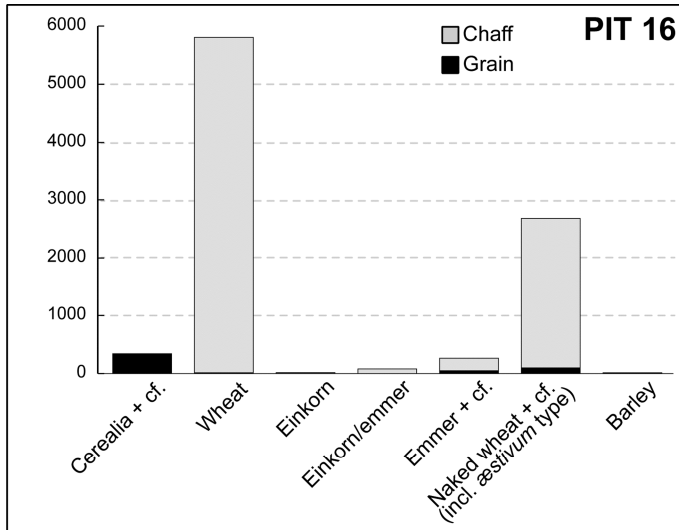
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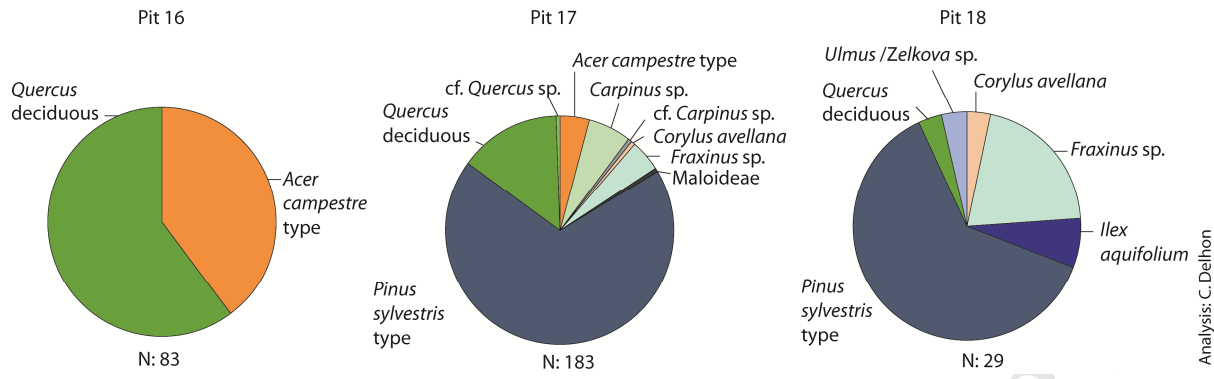


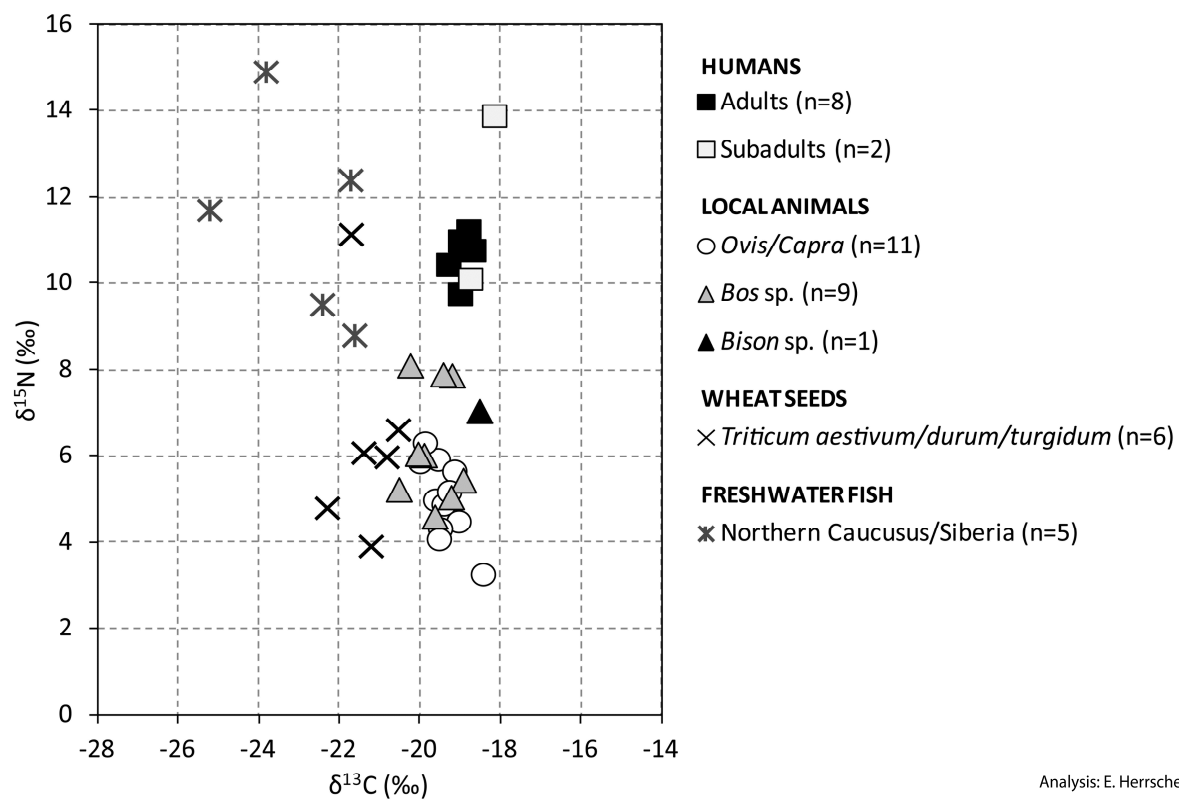
ACCEPTED MANUSCRIPT











Analysis: E. Herrscher

Highlights:

- Chobareti site is an Early Bronze Age settlement (3300-2900 cal. B.C.) located at 1615 m a.s.l. in the South Caucasus
- Archaeobotanical and stable isotope analysis have been performed on several pits and burials
- Phytoliths, pollen and macroremains highlight the importance of cereals cultivation in these highlands
- Isotope data suggest the use of manuring, differential herding practices, as well as C₃ plants consumption for both animals and humans
- Human dietary practices express a unique pattern with a preferential input of meat and dairy products

Archaeobotanical material from pits 16, 17 and 18 of Chobareti (Georgia)



1: Spikelet fork of *Triticum monococcum/dicoccum*; 2-3: Spikelet fork of *Triticum monococcum*
4: Glume base of *Triticum monococcum*; 5: Grains of *Triticum aestivum/durum/turgidum*;
6: Rachis segment in connexion of *Triticum aestivum*;
7-8-9: rachis fragments of *Triticum aestivum/durum/turgidum*.
Photos: L. Martin.

Sd1 Archaeoethanatomical study (M Poulmarc'h)

This archaeoethanatomical analysis is a part of a larger research, focusing on the funerary practices in Southern Caucasus from the 6th to the 3rd millennium B.C. (Poulmarc'h, 2014). In the case of Chobareti, the study revealed strict anatomical connections for most of the skeletons (burials 1, 4, 5, 7, 8 individual 1, and burial 9) indicating body decomposition in a filled space which corresponds to a gradual replacement of soft tissues by soil (Duday, 2009). Concerning the modalities of body deposit, two types were observed: primary burials (burials 1, 4, 5, 7, 8 individual 1, and burial 9) and possible reductions or secondary deposits (burials 2 and 8), both in rectangular structures in shape with stone walls. All individuals in primary burial were deposited in a crouched position on one side, however a difference was observed according to age groups. Adult bodies are right-crouched (burials 1, 4, 5 and 8) while subadults are left-crouched (burials 7 and 9). Reductions are characterized by additional treatments of bones after body decomposition, which could have been motivated by the grave digger to clear the necessary space for depositing a new individual (Duday, 2009). Secondary deposits correspond to the transfer of part of skeleton in a different location, from where the body was decomposed. For instance, in burial 8, one notes a primary burial of a female and bones of two occupants (one adult and one subadult), located to the west wall of the tomb, for which it is not possible to cut off between reductions and secondary deposits. In burial 2, at the northwest corner, commingled bones evoke the displacements (reductions or secondary deposits), at least, of three individuals and a primary deposit of one of them suggested by the presence of anatomical connections of lower limbs and ribs (Poulmarc'h, 2014). In addition, in this burial, a fourth individual is attested by a skull located at the northeast corner of the tomb. Although the infant skeleton (burial 9), aged around one year, was buried in a filled space, the deposit of its body in a jar could evoke a different funerary practice in relation with the container and the age at death of the deceased. This specific practice, unknown during the Kura-Araxes culture, could evoke a link with Chalcolithic tradition.