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CONTENTS

RADIOCARBON DATES OF THE "GRAVETTIAN ENTITY" IN HUNGARY

György LENGYEL*

Abstract

The re-evaluation of the "Gravettian Entity" (29–12 k years uncal. BP) radiocarbon database in Hungary reveals sever problems in using ^{14}C dates for chronological considerations. A great percent of the available radiocarbon dates lack clearly demonstrable relationships with archaeological finds and past human activities. Others are false because of sample contamination issues and a few of them cannot be properly reviewed because of the deficient date reporting.

1. Introduction

The first mention of the Gravettian in Hungary dates back to the 1950s, when Magdalenian lithic assemblages were reclassified under the term "Eastern Gravettian" (Gábori 1954a, 1954b). The chronological position of this new archaeological culture was assigned to Würm 2 and 3 of the Alpine Pleistocene division on the basis of faunal and botanical remains, and geological features of the archaeological sites (Gábori & Gábori 1957; Kretzoi & Vértes 1965; Vértes 1960). Compared to this relative chronological sequence, pioneer radiocarbon dating results marked the lower and the upper boundaries of the Gravettian to ca. 29 and 12 k years BP, respectively (Gábori-Csánk 1970; Vértes 1965a).[1]

Synthesis published in the 1960s subdivided the Gravettian in Hungary into two geographic groups, northern and southern (Gábori 1969: 161). Later, this was reviewed and the Gravettian sites were reorganized into Northeastern, Danube bend, and inner Pannonian basin groups (Gábori 1989: 135, 1990: 105). In addition, the groups were chronologically divided into three immigration waves based on radiocarbon dates: ca. 30 to 27, ca. 18 to 16 and ca. 13 to 12 k years BP (Gábori 1989: 139, 1990: 105–106).

In the past decade a new cultural and chronological schema emerged, which is the regnant classification model for the Gravettian (Dobosi 2004, 2005, 2009). This schema classifies the lithic assemblages within the "Gravettian Entity" into three distinct archaeological units as follows (Dobosi 2004, 2005, 2009) (Fig. 1).

The earliest unit of the Gravettian Entity is dated to between 29 and 26 k years BP. This is called Pavlovian, referring to its age and cultural identity. The lithic industries are characterized by blade technology, burins, end scrapers, and retouched blades, and a moderate frequency of Gravettian fossil markers such as backed blades, backed bladelets, Gravette points, and shouldered blade points.

The next unit is a special archaeological phenomenon, the Ságvárian, which is dated to between 20 and 17 k years BP. Lithic assemblages are characterized by a special technology that obtained short blades and flakes and tiny bladelets from radiolarite pebble raw materials. Stone tool types are similar to those in Hungarian Pavlovian context, including burins, end scrapers, backed bladelets, and Gravette points. The eponymous site Ságvár is located some 10 km south of Lake Balaton, in the loess hill area of the southern Western Hungary.

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1 All dates in present paper show uncalibrated years.

BP	Period	SITES /having C14 dates/	Soil/loess sequences in Hungary	July mean tempera-ture °C		Climatofaunal phases named after main sites	CULTURES		
				V	M54				
11		Szekszárd							
12		Lovas							
		Istállóskő VI, Jankovich 5	L						
			O			B		E	
		Dunaföldvár	E	15,7		A	**G**	P	
13		Arka/upper, Peskő upper layer	S	14,3		J		I	
			S	13,6	16,5	Ó		G	
15		Pilisszántó II upper 5/a		12,1		T	**R**	R	
								A	
16	**S**	Pilismarót, Budapest-Csillaghegy		15,6	18	P		V	
17	**Á**					I	**A**	E	
	G	Esztergom, Szeged				L		T	
	V	**SÁGVÁR** upper cultural layer	h1 soil	16	19	I		T	
	Á		Tápiósüly			S	**V**	I	
18	**R**	Jászfelsőszentgyörgy I–II	L			S		A	S
		Arka/lower cultural layer	O			Z		N	Á
			E			Á	**E**		G
	S		S	14,3		N			V
	T	Madaras	S	15,7		T			Á
19	**A**					Ó	**T**		R
	G	Mogyorósbánya							I
	E	**SÁGVÁR** lower cultural layer	h2 soil						A
			Dunaújváros	16,2			**T**		N
							I		
20									
21		Remete Lower, Pilisszántó	L						
		I middle layers	O				**A**		
22		Peskő middle layers	E	15,6	15				
			S					P	
23		Pilisszántó I lower layers	S	17			**N**	A	
.								V	
.					18			L	
.		Hidasnémeti				I		O	
		Istállóskő IV–V, Nadap		16,3		S		V	
						T		I	
						Á		A	
28		Bodrogkeresztúr, Megyaszó	(Mende	17,4		L		N	
		Püspökhatvan, Hont/Parassa	Upper soil?)			L			
		Sajószentpéter				Ó			
						S			
						K			
						Ő			

Fig. 1. The Gravettian Entity schema (after Dobosi & Szántó 2003).

Unit three is called Epigravettian. Radiocarbon dates assign ages for this unit between 18 and 12 k years BP. The Epigravettian lithic technology and tool types do not differ from those of the Hungarian Pavlovian. Consequently, the Epigravettian is viewed as a descendant of the Pavlovian.

The radiocarbon ages of the Gravettian Entity derive from twenty-four dates of sixteen sites (Fig. 2, Table 1). An unfortunate character of this database is the scanty number of dates and that most sites have single dates, which is a vital problem in building radiocarbon based chronology (Pettitt *et al.* 2003). Especially great inaccuracy arises in interpreting radiocarbon

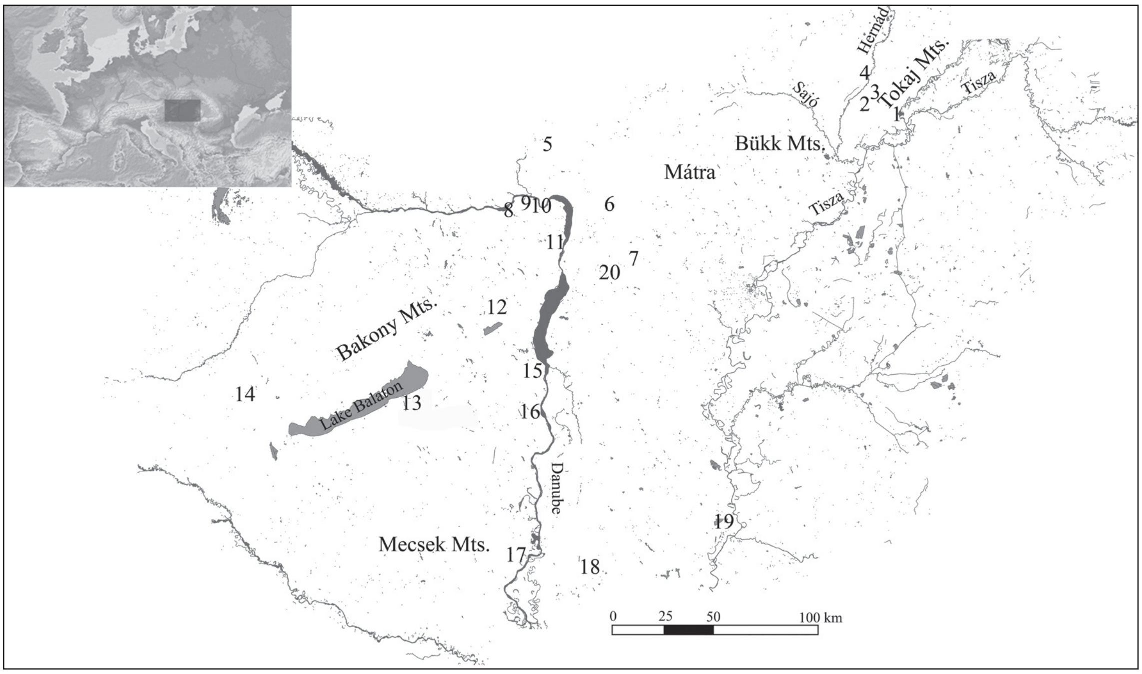

Fig. 2. Map of Hungary with sites and localities mentioned in the text. 1: Bodrogkeresztúr; 2: Megyaszó; 3: Arka; 4: Hidasnémeti; 5: Hont-Parassa III; 6: Püspökhatvan; 7: Jászfelsőszentgyörgy; 8: Mogyorósbánya; 9: Esztergom; 10: Pilismarót Pálrét; 11: Budapest-Csillaghegy; 12: Nadap; 13: Ságvár; 14: Zalaegerszeg; 15: Dunaújváros; 16: Dunaföldvár; 17: Dunaszekcső; 18: Madaras; 19: Szeged-Öthalom; 20: Mende.

Table 1. List of ^{14}C dates of the Gravettian Entity.

Archaeological classification	Radiocarbon date	Laboratory code	Sample	Site (reference)
Pavlovian	28,700 ± 3,000	GXO–195	Charcoal	Bodrogkeresztúr (Vértes 1966)
Pavlovian	26,318 ± 365	Deb–2555	Charcoal	Bodrogkeresztúr (Sümegi *et al.* 2000)
Pavlovian	18,575 ± 208	Deb–3381	Bone	Bodrogkeresztúr (Dobosi 2000)
Pavlovian	10,630 ± 270	Hv–12986	Bone	Bodrogkeresztúr (Dobosi 2000)
Pavlovian	27,700 ± 300	Deb–1901	Charcoal	Püspökhatvan (Csongrádi-Balogh & Dobosi 1995)
Pavlovian	27,350 ± 610	Deb–5027	Charcoal	Hont-Parassa (Dobosi &Simán 2003)
Pavlovian	27,070 ± 300	Deb–5372	Charcoal	Megyaszó (Dobosi 2000)
Pavlovian	13,050 ± 70	GrA–16563	Bone	Nadap (Verpoorte 2004)
Ságvárian	17,760 ± 150	GrN–1959	Charcoal	Ságvár upper layer (Vogel & Waterbolk 1964)
Ságvárian	18,900 ± 100	GrN–1783	Charcoal	Ságvár lower layer (Vogel & Waterbolk 1964)
Ságvárian	18,510 ± 160	Deb–8822	Mollusk	Ságvár (Krolopp & Sümegi 2002)
Ságvárian	19,770 ± 150	Deb–8821	Charcoal	Ságvár (Krolopp & Sümegi 2002)
Ságvárian	19,930 ± 300	Deb–1169	Charcoal	Mogyorósbánya (Hertelendi 1992)
Ságvárian	19,000 ± 250	Deb–9673	Charcoal	Mogyorósbánya (Dobosi & Szántó 2003)
Ságvárian	18,080 ± 405	Hv–1619	Charcoal	Madaras (Dobosi 1989)
Epigravettian	17,050 ± 350	GrN–4038	Charcoal	Arka lower layer (Vogel & Waterbolk 1964)
Epigravettian	13,230 ± 85	GrN–4218	Charcoal	Arka upper layer (Vogel & Waterbolk 1967)
Epigravettian	18,600 ± 1900	A–518	Charcoal	Arka (Haynes *et al.* 1966)
Epigravettian	18,500 ± 400	Deb–1674	Bone	Jászfelsőszentgyörgy (Hertelendi 1993)
Epigravettian	16,160 ± 200	Deb–1160	Charcoal	Esztergom-Gyurgyalag (Hertelendi 1991)
Epigravettian	15,940 ± 150	Deb–3160	Mollusk	Budapest-Csillaghegy (Sümegi *et al.* 1998)
Epigravettian	15,916 ± 168	Deb–3344	Bone	Szeged-Öthalom (Sümegi *et al.* 1998)
Epigravettian	13,130 ± 100	Hv–12988	Mollusk	Pilismarót Pálrét (Dobosi 2006)
Epigravettian	12,125 ± 360	Hv–1616	Charcoal	Zalaegerszeg (Geyh *et al.* 1969)
Epigravettian	12,110 ± 315	Hv–1657	Charcoal	Dunaföldvár (Geyh *et al.* 1969)

chronology when the relation between samples and archaeological features remain unclear (Bayliss 2009; Boaretto 2009; Pettitt *et al.* 2003; Waterbolk 1971; Zilhão & d'Errico 1999), which is exactly the case in the Gravettian Entity. Emerging from this situation, the aim of this paper is to review the radiocarbon dates of the Gravettian Entity in order to realize their chronological value.

2. Method of review

In the beginning of the 1970s Waterbolk (1971) proposed nine issues to be taken into account in working with radiocarbon dates. Decades later, Pettitt *et al.* (2003) refined the issues of Waterbolk according to recent standards in the interpretation of radiocarbon dates. Both papers pay attention to the same basic issues of using radiocarbon dates for chronological considerations. Cardinal point is the association between samples and archaeological phenomena. If the association cannot be firmly demonstrable, the date produced from the sample cannot be accepted as an age for the archaeological site, feature, or find assemblage. Thus, those dates are valuable chronologically whose samples are surely residues of the human activity performed at the site as well as the finds intended to be dated. Further important issues which make fundamental effect upon the accuracy of radiocarbon date evaluation in both papers are the preservation of the original carbon in the sample, the effect of sample contamination on the date, and the details of reporting of radiocarbon dates. The importance of the latter is based on the fact that if no information is available on the sampling, sample environment, the sample's archaeological and stratigraphic context, and sample pretreatment, the radiocarbon date cannot be evaluated in its chronological and archaeological context. Taking into account these fundamental criteria, Pettitt *et al.* (2003) proposed a test that serves to evaluate the chronological value of any set of radiocarbon dates. This test as demonstrated in their paper can be accomplished in ideal cases when all details of the radiocarbon dating process and the sample's archaeological context are fully available. In the case of the Hungarian Gravettian Entity radiocarbon database, if all points of Pettitt *et al.* (2003) are to be investigated almost ninety percent of the dates could be proclaimed chronologically untrustworthy. This situation forces the present paper to exclude several points of the original test, due to that: 1) single dates are available from most of the Hungarian sites, 2) for the most part there is no information on sample pretreatment, 3) all charcoal dates were obtained by decay counting method using bulked samples, and, except a single case, 4) the size of the dated sample is unknown. Thus, only two issues after Pettitt *et al.* (2003) are applied herein for the evaluation of the Gravettian Entity radiocarbon database.

The first issue is the sample's association with past human activities. For discussing this issue it has to be demonstrated that the radiocarbon samples and artifacts or archaeological features are involved in the same find assemblage and that the samples are residues of human activity such as animal bones from hunting-butchering and charcoals form burning wood. Although mollusk shells are often radiocarbon samples in Quaternary studies of Hungary (Sümegi 2005), they are not part of past human activity taken place at the archaeological site. For that reason the dates obtained from them are automatically excluded from the archaeological chronology. In the case of bone samples the human impact can easily be verified when cut marks incise the bone surface. Unfortunately, taphonomy studies have not yet been carried out on the dated faunal assemblages of the Gravettian Entity in Hungary. Therefore a simplification is made here: large mammal bones recovered along with artifacts in open-air sites are regarded as hunted animals and eventually traits of human activity. In the case of charcoals, individual grains often occur in paleosoils without being connected to human occupation (Pécsi 1982, 1987; Rudner & Sümegi 2001). Charcoals therefore can be regarded as residues of human activity if they were found in hearths. Also, due to the lack of studies on site formation processes, the identification of hearths in the cases of this paper relies only on the archaeologist's naked eye. If the samples derive from within non-archaeological but natural geological context of the site, they have no archaeologically chronological value. Furthermore, ambiguous association can be declared when a post-depositionally disturbed matrix questions the direct relation between archaeological finds and sampled materials for radiocarbon dating.

The second issue is the sample contamination and organic preservation which basically affect the reliability of the radiocarbon date. If irremovable contamination or low organic material preservation is revealed and the measurement then was accomplished, the date can be regarded as a minimum age of the sample or anomalous (Brock *et al.* 2007; Hassan & Hare 1978; Vogel & Waterbolk 1964; Weber *et al.* 2005).

3. Radiocarbon dates of the Gravettian Entity

In this section the radiocarbon dates are presented by sites. The order of sites follows the Gravettian Entity division. Accordingly, the earliest group of sites is Pavlovian, which is followed by Ságvárian sites. The Epigravettian dates are presented at the end of the section.

3.1. The Pavlovian

3.1.1. Bodrogkeresztúr (Henye)

The site, hill Henye, is situated in the vineyards of village Bodrogkeresztúr, in Northeastern Hungary, in the southern extremity of Tokaj Mountains, a little north-west of Nagy-Kopasz Hill of Tokaj where rivers Bodrog and Tisza have a confluence today (Vértes 1966; Dobosi 2000) (Fig. 3).

Two excavations were carried out at the site, in 1963 (Vértes 1966) and in 1982 (Dobosi 2000). Both excavations recorded that most of the artifacts lay in agriculturally disturbed situation and on the top soil surface. A small portion of finds were retrieved from within a layer that was situated in undisturbed matrix, on the border of typical loess and an underlying limy, whitish

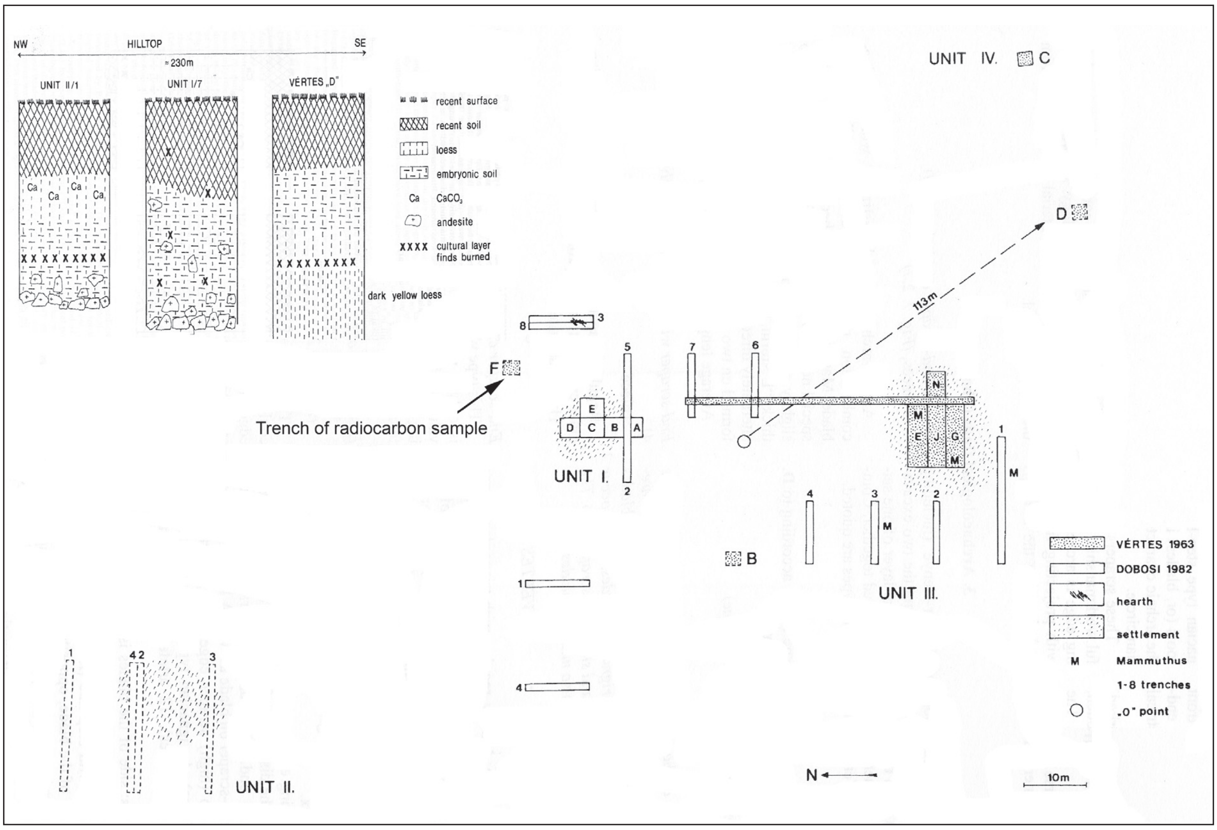

Fig. 3. Trenches and sections of Bodrogkeresztúr (modified after Dobosi 2000).

loess like sediment (Dobosi 2000). A paleosoil also was noticed at the site, which according to Vértes, lay under the cultural layer (Vértes 1966). Contrary to this, Dobosi made a clear association between the human occupation and the paleosoil (Dobosi 2000).

The excavation by Vértes in 1963 yielded samples for ^{14}C dating which gave an age of 28,700 ± 3,000 (GXO–195) (Vértes 1966). Although the date appears in the first paper on the site without details, Vértes recorded in the excavation diary (Archives of the Hungarian National Museum, No. X. 244/1963) that the sample was charcoal from trench F. Trench F situated about 57 m westward from the main excavation area of 1963 and 10 m from the trenches of the 1982 excavation (Fig. 3). The charcoals were retrieved from 10–15 cm thick amorphous patches situating in two levels (100–110 cm and 140–150 cm beneath the top soil) within in which artifacts were not found. It is unspecified in the excavation diary which one of the charcoal patches yielded the samples for dating.

The second radiocarbon date of the site was obtained from samples taken during the geological investigation of the area between 1988 and 1994 (Sümegi *et al.* 2000). This field work involved a 2 x 1 m trench, but its location and association with the excavation trenches remained unpublished. The stratigraphy in this trench from bottom to top consisted of a rhyolite bedrock, a regolith layer 10 cm thick, silt 20 cm thick, and a paleosoil completely woven by roots of recent vegetation with scattered minor bone fragments and charcoals of pine tree. This soil was correlated to that recovered during the archaeological excavations. A portion of 5 kg of this soil was sampled for malacology and the charcoals found within this bulked soil sample were dated to 26,318 ± 365 (Deb–2555).

Two further dates were obtained on bone samples of unmentioned origin. One of them is 18,575 ± 208 (Deb–3381), published without further information (Dobosi 2000). The second bone date is 10,630 ± 270 (Hv–12986). According to the laboratory, the collagen fraction was extremely low and the unsuitable storage of the fresh-sample in a paper bag renders a possible contamination. However, the laboratory did not rule out the possibility that this young age was correct for the bone (Dobosi 2000; Dobosi & Szántó 2003).

3.1.2. Püspökhatvan (Diós)

Village Püspökhatvan is situated in the Galga valley of North Hungary, in Cserhát Mountains (Csongrádi-Balogh & Dobosi 1995). Diós is a locality, one of the sites in the outer territory of the village (Fig. 4).

Archaeological remains from Diós are solely lithic artifacts which were recovered from within a yellow, clayey layer between 40 and 50 cm depth from the top soil surface. Artifacts were sporadically found above and beneath this level as well. The number of artifacts is more numerous from the surface than from within the layer in ground. Sporadically charcoals were observed in poor physical preservation. Use-wear analysis revealed post depositional gloss on the surface of the lithic implements.

A ^{14}C date, 27,700 ± 300 (Deb–1901), was obtained on charcoals. All other information about the sample and dating process is withheld.

3.1.3. Hont-Parassa III

The site is located on the edge of an ancient terrace of river Ipoly in North Hungary, near the border with Slovakia (Dobosi & Simán 2003) (Fig. 5). Most of the artifacts were collected from the surface and the humus covering the surface of the area. The smaller portion of finds was retrieved from within five "habitation levels". The first levels was in clayey loess, the second one in typical loess, the third one in limy or calcareous loess, and the fourth and fifth ones in brown limy or calcareous soil. The five habitation levels lay in four excavation trenches. Trench 1 included habitation level 2, 3, and 4, trench 2 included levels 3, 4, and 5,

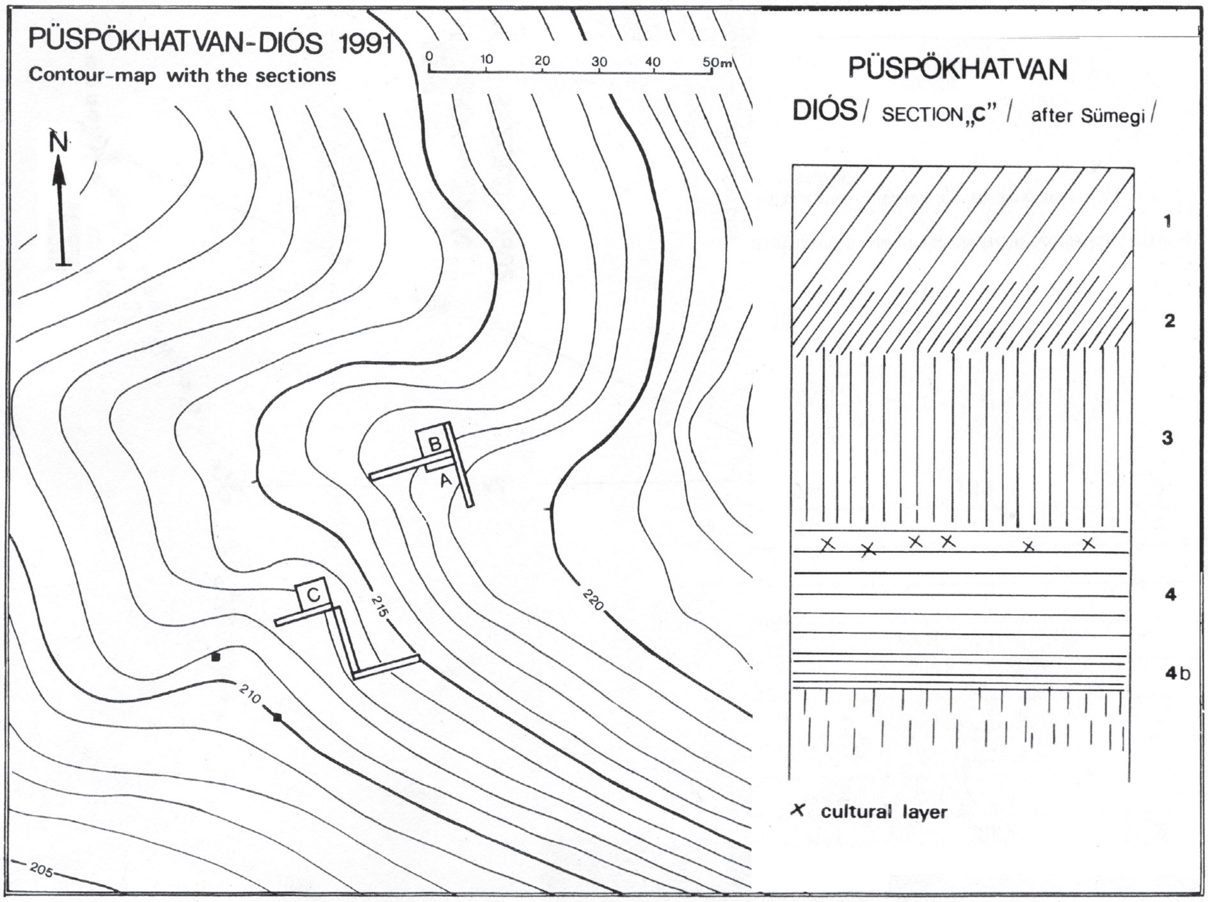

Fig. 4. Trenches and sections of Püspökhatvan (modified after Csongrádiné-Balogh & Dobosi 1995).

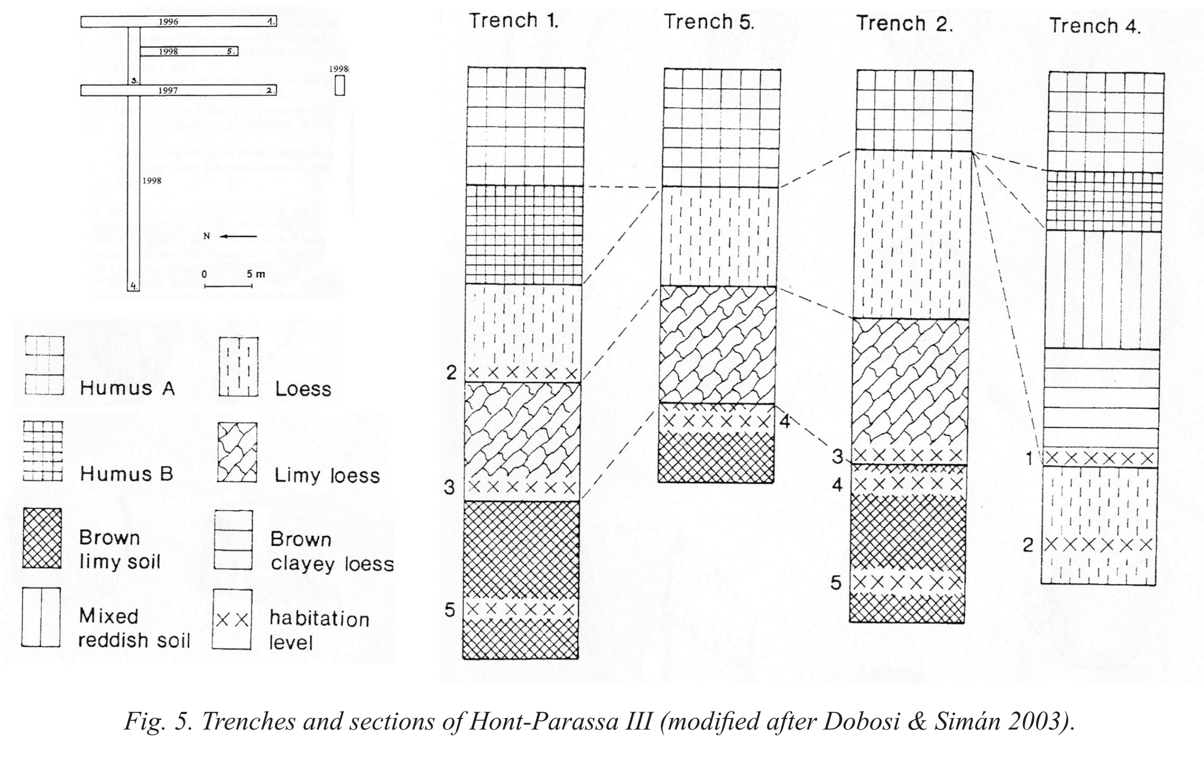

Fig. 5. Trenches and sections of Hont-Parassa III (modified after Dobosi & Simán 2003).

trench 4 presented levels 1 and 2, and trench 5 included only level 4. The stratigraphy presented on figure 3 in Dobosi & Simán 2003 does not correspond exactly with the description in the text. Habitation level 4 is indicated in the brown limy/calcareous soil together with level 5 while the text describes level 4 as being part of calcareous humic loess with calcareous precipitations, which does not occur in the stratigraphic sequence of figure 3. Although the excavators present habitation levels, they emphasize there was no concentration of finds and classic settlement features were represented only by two small ashy spots containing a few bones and stone flakes 130–140 cm below actual surface in trench 2 lowermost level. This level in the series of habitations is level 5, which according to the tables presenting the knapped artifacts contained no lithic finds.

The sample of the ^{14}C date 27,350 ± 610 (Deb–5027) was charcoal collected in 1996 from the "lower habitation layer". "Lower habitation layer" remained unspecified in the series of habitation levels and trenches of the site in the publication.

3.1.4. Megyaszó (Szelestető)

The site is situated in Northeast Hungary in the southeastern Tokaj Mountains (Dobosi & Simán 1996) (Fig. 6). Most of the finds, only lithic artifacts, were retrieved from the surface and from within the ploughed humus. Several disarticulated excavation trenches yielded a very few artifacts in different stratigraphic positions: on the bedrock, in loess, and in a buried soil. However, the archaeological material is claimed to have been derived from a lower and an upper cultural layer. Animal bones and charcoals, both of poor physical preservation came along with the lithic artifacts. According to the excavators, the quantity of charcoals in the layers was low and insufficient for radiocarbon dating.

In spite of the low quality sampling circumstances, a radiocarbon date was obtained on charcoals, 27,070 ± 300 (Deb–5372). The date was published without the localization of the sample (Dobosi 2000).

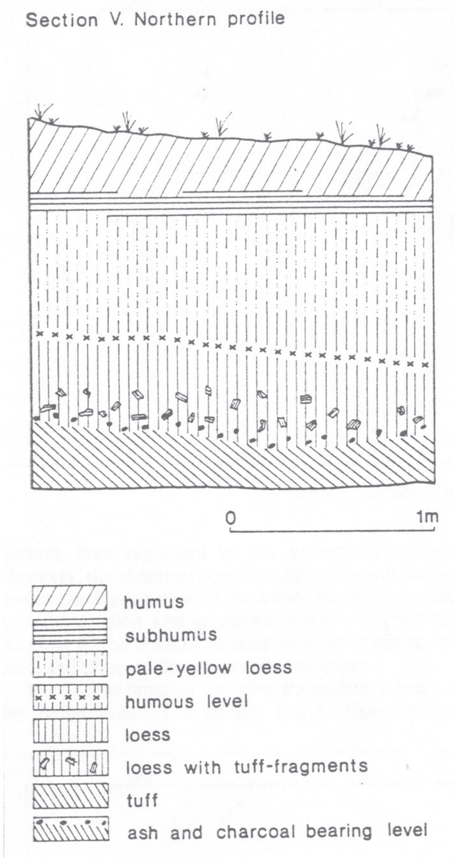

Fig. 6. Sections of Megyaszó (after Dobosi & Simán 1996).

3.1.5. Nadap

The site of Nadap is situated near Lake Velencei in West Hungary in a stone quarry (Dobosi *et al.* 1988). The archaeological collection consists of bones of horse and knapped lithics. The archaeological level was embedded in sandy slope loess (Fig. 7). The first finds appeared 30 cm under the surface and the lowest finds lay at the depth of 40 cm. No regularity was observable in the distribution of the finds. Bones and knapped stones lay randomly. Two burnt spots interpreted as hearths were found in block E and in block H, respectively. These had vague outlines and their area contained some very badly preserved charcoal grains. Animal bones in the area of the hearths bore signs of burning. Near the spot in block E a plastered surface of hand palm size was recovered.

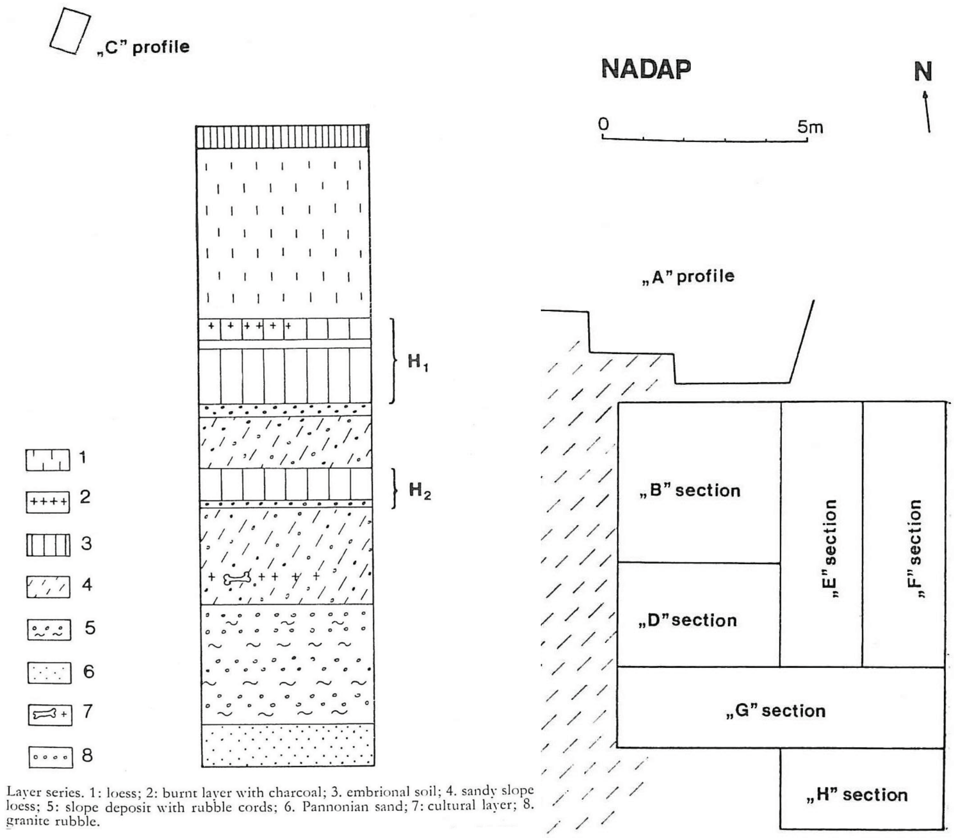

Fig. 7. Trenches and sections of Nadap (modified after Dobosi et al. *1988).*

The radiocarbon dating at Nadap involved a horse phalange of the 16 fragments of bones of the archaeological level from block D (Dobosi *et al.* 1988; A. Verpoorte personal communication 2009). The dating result was 13,050 ± 70 (GrA–16563). A short review on the lithic assemblage that claims it is uncharacteristic to the early stage of the Gravettian in this region (Verpoorte 2004, 261).

3.2. The Ságvárian

3.2.1. Ságvár

The site is situated in western Hungary, 10 km south to Lake Balaton, embedded in loess. The traces of the human settlement were reported to have been found in two layers. The best documented excavation was carried out in 1957–1959. According to this fieldwork, the upper layer was found 1.2 m beneath actual soil surface, while the lower layer lay at 3.3 m (Gábori 1959, 1964, 1965).

The upper layer was 14 cm thick at maximum and yielded the majority of the artifacts and archaeological features. Abundant lithic remains, basements of two huts, several hearths, and bone and antler tools of reindeer were found. The filling of the huts contained the significant part of the knapped lithics (Fig. 8).

The lower layer was only a few cm thick and contrary to the upper layer it appeared as a small patch. The archaeological material in it was scanty, but seven hearth remains were recovered. The largest hearth, 1.5 m in diameter, contained a noteworthy amount of charcoals.

Both layers were detected by geochemical analyses. Their high organic material residue content led to the conclusion that these were ancient soil formations. Their correlation to the Western European chronology resulted in the creation of Lascaux-Ságvár Interstadial in Hungary (Gábori-Csánk 1978).

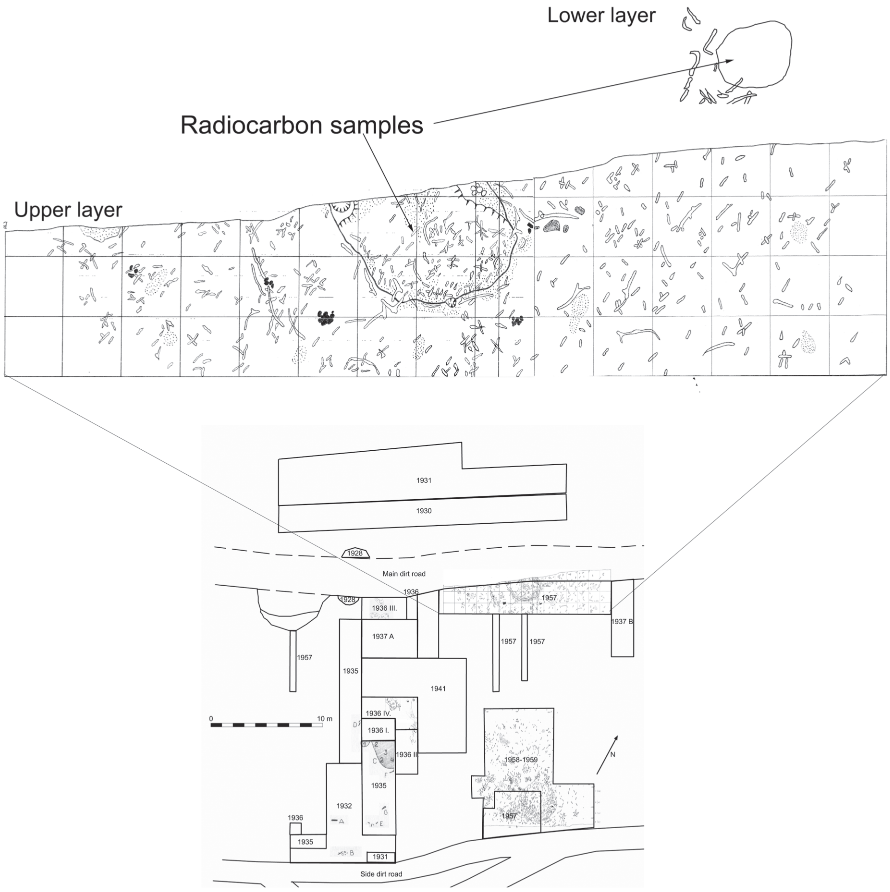

Fig. 8. Trenches of Ságvár (after Lengyel 2010).

Radiocarbon dates were obtained from both layers. The sample of the upper layer, charcoals, was taken from within one of the hut's filling. The charcoals were situated along the round wall of the hut's pit in very soft condition and near the center of the pit. Although it remained unspecified, the location of the charcoal sample in the lower layer may have been collected from the largest hearth mentioned above (Gáboriné Csánk 1960).

Originally, the upper layer date was 17,400 ± 100 (GrO–1959) and the lower layer date was 18,600 ± 150 (GrO–1783) (Gáboriné Csánk 1960). In 1963, Vogel and Waterbolk (1963) published a list of ^{14}C dates with GrO numbers of Groningen laboratory which had to be corrected. Thus, Ságvár dates became a bit older with a few hundred years. Vogel and Waterbolk (1964) published these dates already under GrN code as 17,760 ± 150 BP (GrN–1959) for the upper layer and 18,900 ± 100 (GrN–1783) for the lower layer. Vogel and Waterbolk (1964) reported that both samples contained rootlets, which were easily sorted out and the remaining amount of charcoal was measured.

Two other dates were published in 2002 in the study of land snail fauna of the loess sequence of the site (Krolopp & Sümegi 2002). The samples derived from within a reddish level approximately 5 cm thick situated 60 cm beneath the actual surface. This level corresponds more or less with the lower level of the 1957–1959 excavations. The older date, 19,770 ± 150 (Deb–8821), was obtained on charcoals, while the younger date, 18,510 ± 160 (Deb–8822), was measured from mollusk shells (Krolopp & Sümegi 2002).

Recently, the lithic technology study of the knapped stone assemblages revealed interlayer refitting of the 1957–1959 excavations. The ratio of interlayer refits makes up about forty percent of all refittings and consequently proves that the archaeological remains belong to a single human occupation event. This taphonomic issue thus affects the interpretation of the human occupation history of the site (Lengyel 2010).

3.2.2. Mogyorósbánya

The site is situated in the Danube bend on a plateau of loess. The archaeological layer was rich in finds, especially knapped stones and poorly preserved animal bones. It was 10 cm thick, stretching over almost 200 square meters, embedded in loess between 60 and 100 cm depth under actual surface. This layer was made up of slightly humousy embrional soil with lime mycelia (Dobosi 1992, 2002) (Fig. 9). Archaeological features were hearths of 10 cm thick with ash and scattered charcoal fragments (Dobosi 1992).

Charcoals from the archaeological layer were dated to 19,930 ± 300 (Deb–1169) (Hertelendi 1992). Another date, 19,000 ± 250 (Deb–9673), is also available (Dobosi & Szántó 2003). Both samples' were taken from the hearth features (Dobosi personal communication 2009).

3.2.3. Madaras

The site is situated in southern Hungary, near the border with Serbia (Dobosi 1967, 1989). The archaeological layer was found 6–7 meters below actual surface in loess. It was reddish, interpreted as burnt, 5–6 cm thick, and contained charcoal pieces. Animal bones were fragmentary and some of them were burnt. Four concentrations of artifacts and animal bones and five hearths were recovered (Fig. 10). Ash covered the hearths under which the loess was burnt in 10–15 cm thickness. Charcoals, mostly pine tree, were well preserved in hearths. Charcoals from one of the hearths were dated to 18,080 ± 405 (Hv–1619) BP.

3.3. The Epigravettian

3.3.1. Arka (Herzsarét)

The site is located in Northeastern Hungary in the western zone of Tokaj Mountains, in the outer periphery of village Arka, near ancient streams on a slightly sloping northward plateau (Vértes 1962). Excavations were carried out between 1960 and 1963 (Vértes 1965b) (Fig. 11).

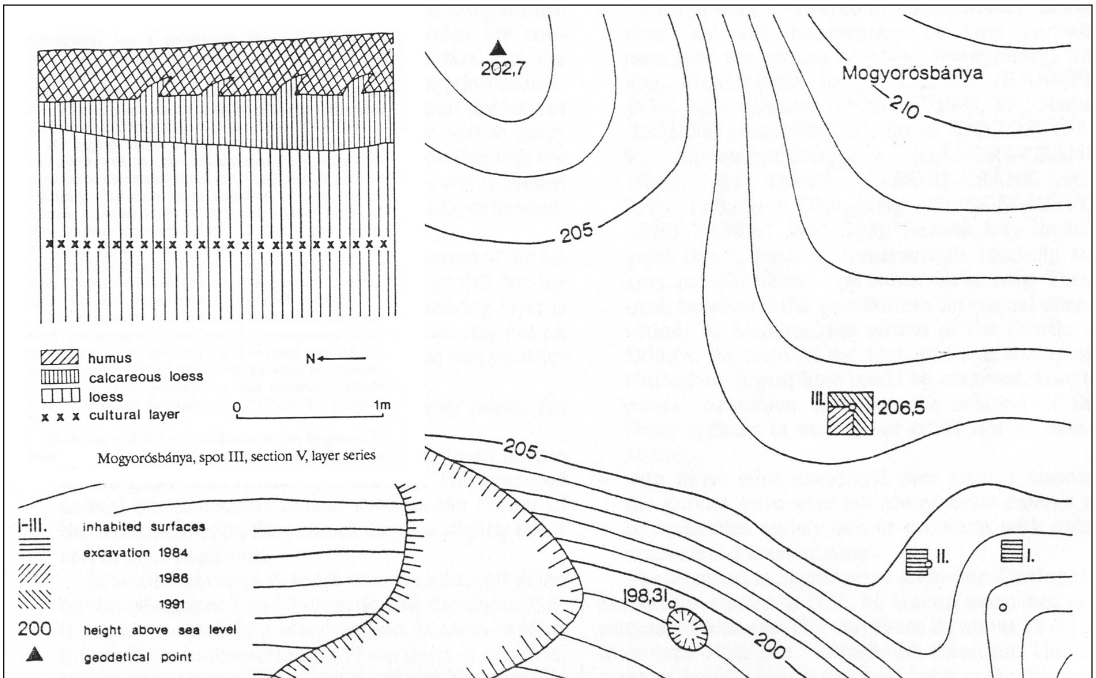

Fig. 9. Trenches and sections of Mogyorósbánya (modified after Dobosi 1991).

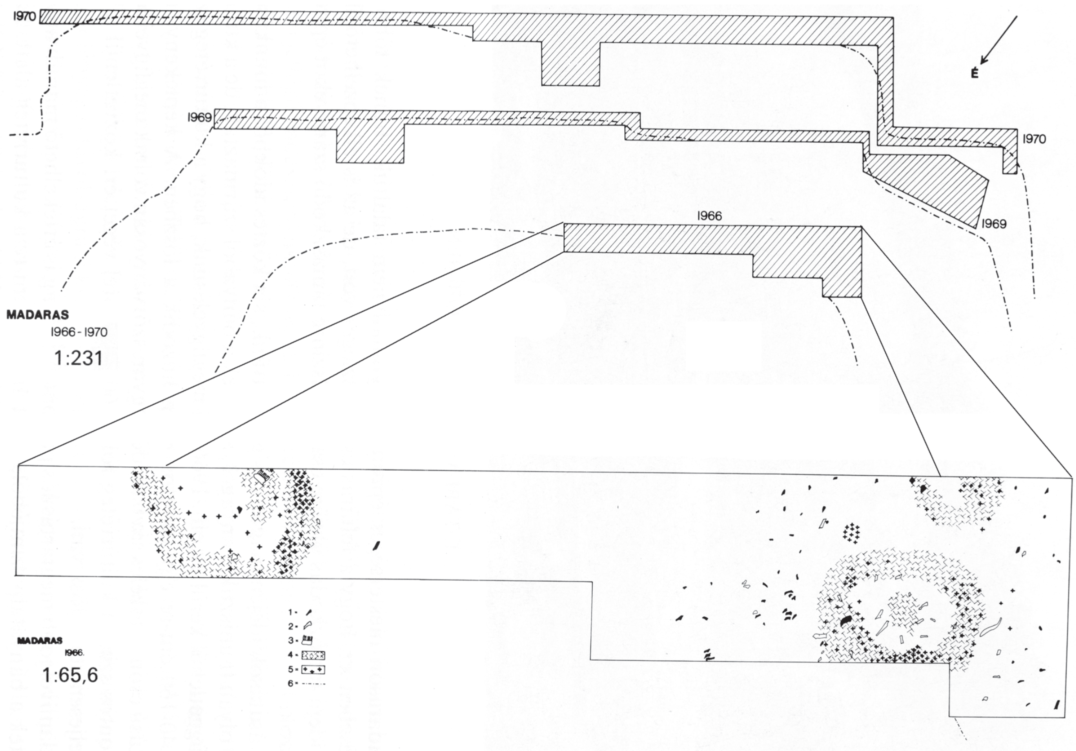

Fig. 10. Trenches and sections of Madaras (modified after Dobosi 1989).

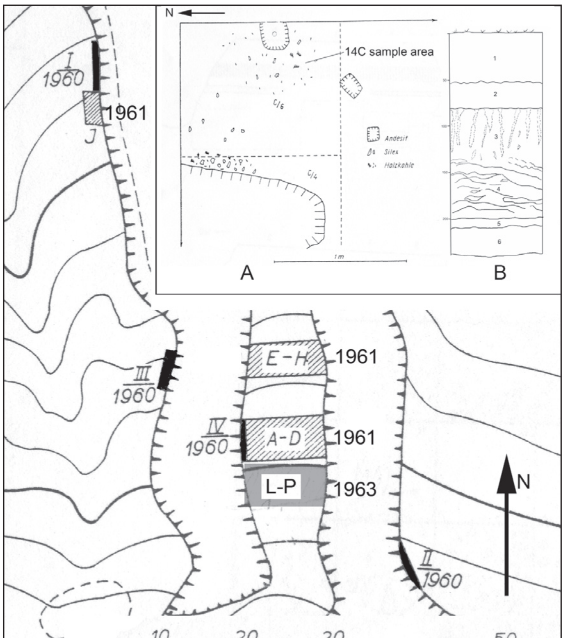

Fig. 11. Trenches and sections of Arka. A: sampling area of date 17,050 ± 350 (GrN–4038); B: The stratigraphy of the site: 1, loess altered by soil formation; 2, paleosoil; 3, cryoturbed loess; 4, andesite debris in loamy loess; 5, transitional layer; 6, loamy layer with andesite debris (modified after Vértes 1962 and 1965b).

According to the final paper on the excavations two archaeological layers were found at Arka (Vértes 1962, 1965b). The upper layer, 10 cm thick, was situated right beneath a sterile buried soil, 90 cm below the top surface. Vértes observed sever cryoturbation under the fossil soil down to the lower archaeological layer in the matrix which also contained artifacts. The lower layer was 30–40 cm thick, situating 50 cm beneath the upper one. Under the lower layer followed the andesite bedrock. The lower archaeological level preserved a hearth with an andesite structure, 2 meters under the actual surface. This feature in the original field notes of Vértes is described as a cluster of charcoals, bones and lithics and an angular flat surfaced andesite rock block and another with a depression in the middle filled with ochre.

The first ^{14}C date, 17,050 ± 350 (GrN–4038), was obtained on charcoals of the 1961 excavation (Vogel & Waterbolk 1964). Its sample derived from the hearth of the lower layer (Fig. 11.A). During the sample cleaning all organic matter dissolved in alkali and this fraction was measured. According to the laboratory, the true age may thus be higher (Vogel & Waterbolk 1964).

The second date is 13,230 ± 85 (GrN–4218). The sample is hearth filling from 2 m depth in Block M excavated in 1963 (Vogel & Waterbolk 1967). In the field notes of Vértes the location of the sample was a small but thick (unspecified thickness) charcoal layer next to which lithic raw material blocks were found (Archives of the Hungarian National Museum, No. XI. 300/1963). The report on this radiocarbon date by Vogel and Waterbolk (1967) mentions that Vértes submitted the sample as taken from the lower layer but later he changed the stratigraphic identity to the upper layer. Henceforth, this date has been associated with the upper archaeological level (Gábori-Csánk 1970; Dobosi & Szántó 2003).

The third date, 18,600 ± 1,900 (A–518) (Haynes *et al.* 1966), was obtained from charcoals of the 1963 excavation season. The sample was taken from within a small patch of charcoal 75 cm beneath the former sample of the same excavation block. The sampled level was situated in the lower third part of an archaeologically sterile portion of the site stratigraphy. The next level of finds was located 25 cm beneath this sampled charcoal patch (Archives of the Hungarian National Museum, No. XI. 300/1963). On the sample submission form the lower archaeological layer is indicated as the sample's relative chronological position (Archives of the University of Arizona, Radiocarbon Laboratory, Geosciences Department). This date appears as 18,700 ± 190 without details in summaries of Hungarian ^{14}C dates (Gábori-Csánk 1970; Dobosi & Szántó 2003).

3.3.2. Jászfelsőszentgyörgy (Szúnyogos)

The site is situated in the northern part of the Great Hungarian Plain, near river Zagyva, on a sand dune plateau covered by loess 7 meters high near the foothills of Mátra Mountains (Dobosi 1993, 2001).

Archaeological finds were recovered at the bottom of the recent ploughed soil and about 80 cm deeper on the interface of a loess layer and the underlying sand (Fig. 12). The level of finds was 10–15 cm thick. In the lower level two ashy spots of 50–60 cm in diameter were recorded, under which the sand was burnt, but charcoals were absent. A few bones of reindeer and horse were also found, nonetheless poorly preserved.

One of the bones, unspecified to species, was sampled for ^{14}C dating. This comes from the border of the loess and the sand. The laboratory reported that all organic material was dissolved during the sample pretreatment and no collagen was found in the bone. The solution after pretreatment was evaporated to dryness and burned to CO_2 for the proportional counter. The counted age is 18,500 ± 400 (Deb–1674) (Hertelendi 1993).

3.3.3. Esztergom (Gyurgyalag)

The site is located in the Danube bend on the right river bank near the town of Esztergom (Dobosi & Kövecses-Varga 1991).

The archaeological layer was 10–20 cm thick, reddish brown, laying 100 cm under the top soil in loess. It contained numerous charcoal grains, a hearth, a pit, decorative shells, bone tools, greasy ochre lumps, and iron oxide concretions. The hearth was 10 cm thick and 150 x 100 cm large, consisting of charcoal

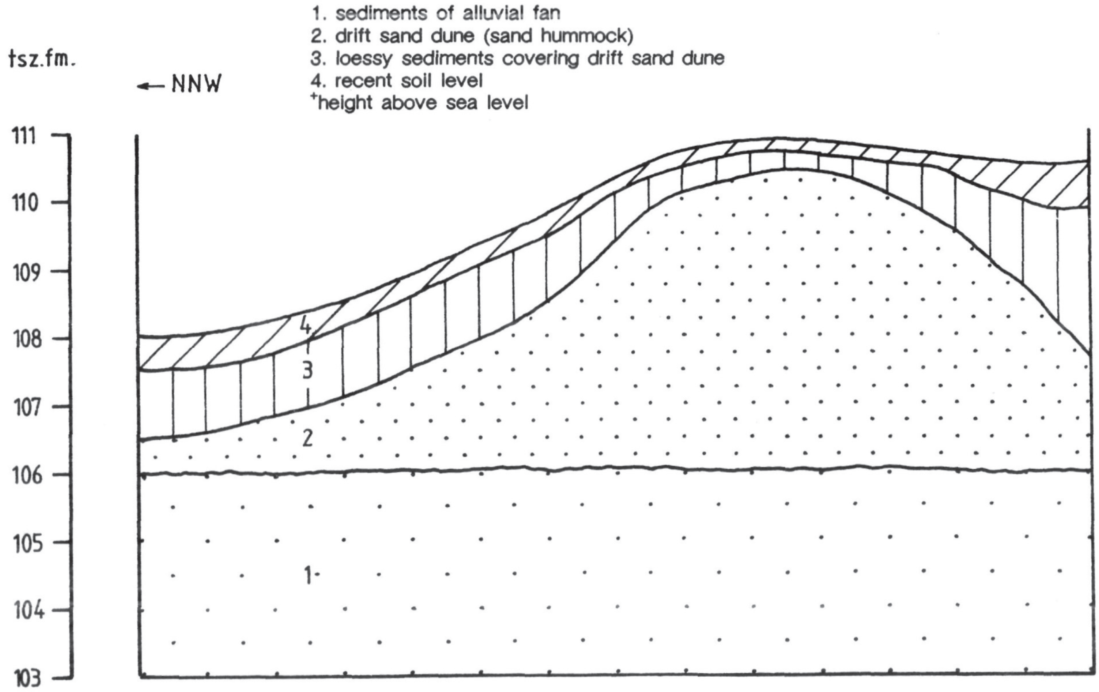

Fig. 12. Section of Jászfelsőszengyörgy (after Dobosi 1993).

grains, burnt bone fragments and the surface of the loess underneath it was burnt (Fig. 13). It is of importance that over 90 percent of the flint raw material originates in the region of river Prut some 600 km away east as the crow flies.

From the site, a charcoal sample of 4.2 g was pretreated with AAA and dated to 16,160 ± 200 BP (Deb–1160) (Hertelendi 1991; Dobosi & Hertelendi 1993). The exact origin of the sample is not reported in the publication, but it comes from the hearth feature (Dobosi personal communication 2009).

3.3.4. Budapest-Csillaghegy

The site was found on the northern periphery of Budapest, on the right bank of river Danube. All together fifty knapped stones and a posthole were recovered from within a layer of 5 cm thick, 1.6 m under the top surface (Gábori-Csánk 1986) (Fig. 14).

A ^{14}C date, 15,940 ± 150 (Deb 3160), was obtained in 1994 on shells of *Arianta arbustorum* collected during the archaeological excavation from within the level between 1.7 and 2.0 m (Sümegi *et al.* 1998), ten centimeters below the archaeological layer (Fig. 14).

3.3.5. Szeged-Öthalom

The site is situated in southern Hungary, near the border with Romania and Serbia (Banner 1936). The excavation was carried out in the 1930s, which recovered scanty archaeological material, including 21 knapped stones altogether, poorly preserved charcoal grains, and a few bones of mammoth and horse. All finds lay 4.3–4.6 meters below actual surface in typical loess. The thickness of the archaeological layer was about 10 cm (Fig. 15). Approximately 50 cm below the archaeological layer an ancient sand dune surface was found. Originally, the excavator claimed that the archaeological finds were collected from two layers. However, except the first paper (Banner 1936), all remains are handled as a single assemblage. There is one radiocarbon date from one of the archaeological layers, 15,916 ± 168 (Deb–3344), which was obtained from a mammoth bone recovered during the excavation in the 1930s (Sümegi *et al.* 1998).

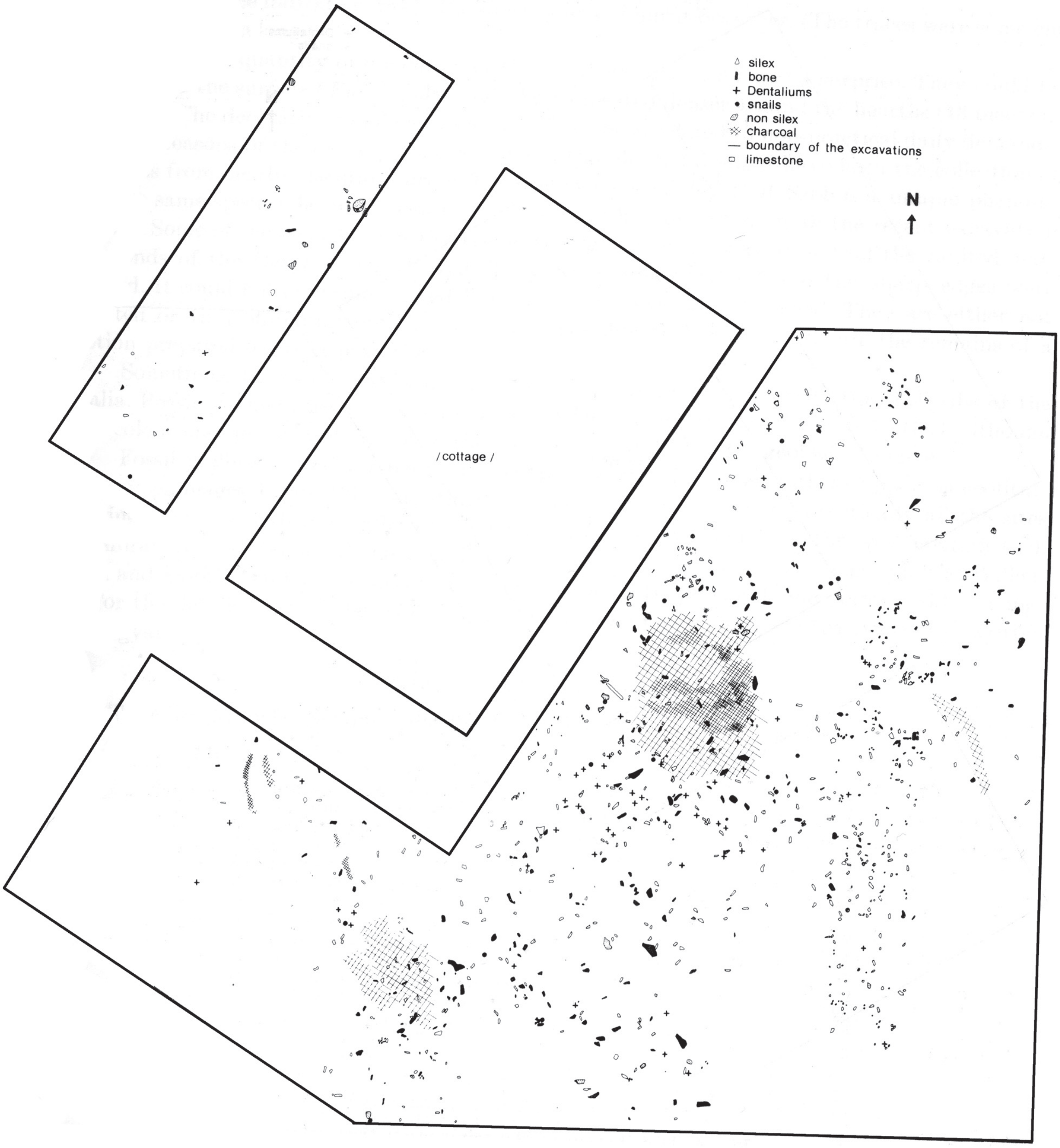

Fig. 13. Trenches of Esztergom (after Dobosi & Kövecses-Varga 1991).

A half century later, a geological investigation took place in the Szeged-Öthalom area (Sümegi 2005). This produced several radiocarbon dates which are often related to the archaeological site (Dobosi & Szántó 2003). In the trenches of the geological sampling, the bottom of the stratigraphic sequence is wind-blown sand of "Middle Würm". On top of the sand there was a paleosoil of 20 cm thick dated to 25,200 ± 300 (Deb–2049) from charcoal of *Pinus sylvestris*. From above the soil up to the top of the Pleistocene sequence 4 m thick loess was dated on mollusk shells to 18,205 ± 200 (Deb–3184), 16,323 ± 145 (Deb–3159), 16,080 ± 150 (Deb–1486), and 16,000 ± 200 (Deb–2056) (Sümegi 2005). The sequence is covered with recent humus layer. Near this section where the hill is sloping the stratigraphy contained an infusion loess layer that replaced the lower two-third part of the aeolian loess. Radiocarbon dates on mollusk shells from the infusion loess and the overlying 1 m thick aeolian loess of this section are almost identical to the series of the full aeolian loess sequence from bottom to top: 18,080 ± 200 (Deb–1600), 16,530 ± 200 (Deb–

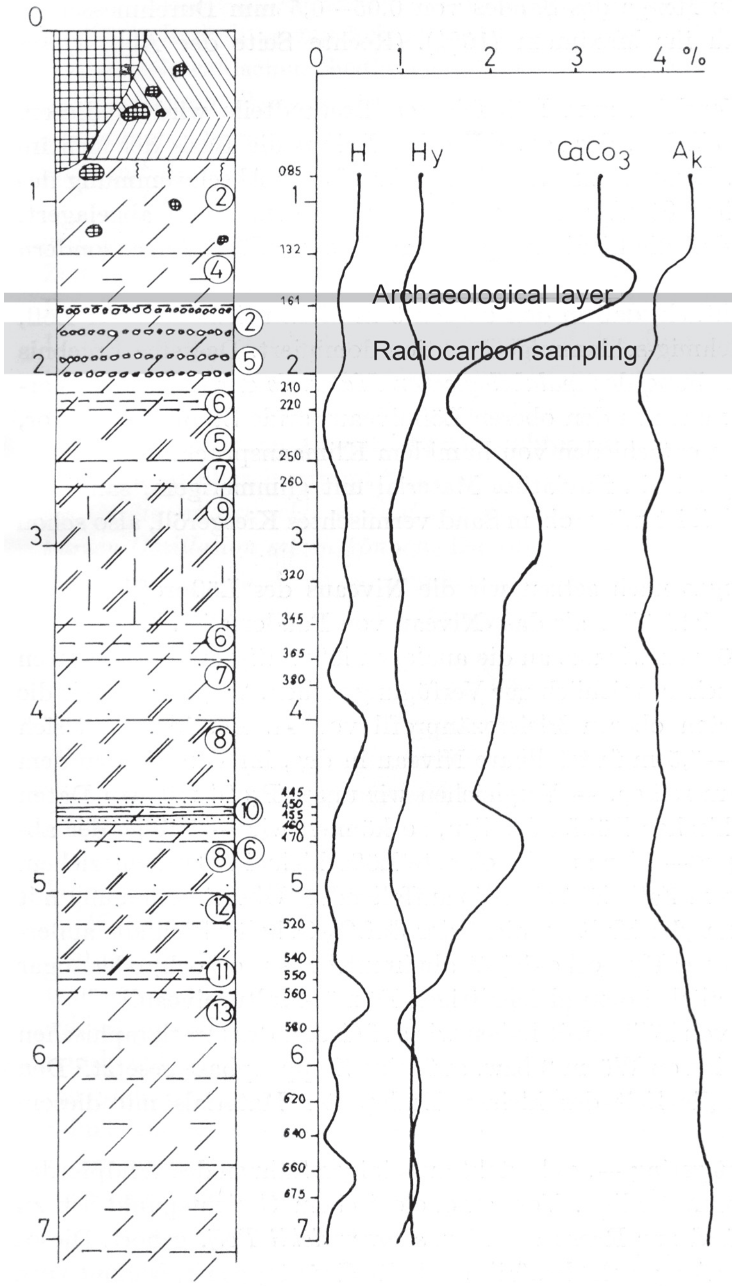

Fig. 14. Section of Budapest-Csillaghegy (modified after Gábori-Csánk 1986).

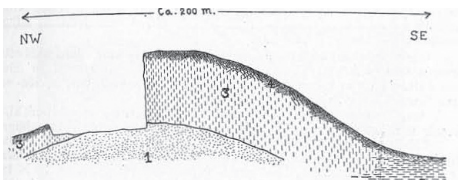

Fig. 15. Section of Szeged-Öthalom (after Banner 1936).

2054), 15,890 ± 200 (Deb–2057), 14,179 ± 140 (Deb–3183) (Sümegi 2005).

A great difference between the stratigraphies of the 1930s excavation and the geological sampling is that the former did not observe the fossil soil described by the latter. In addition, there is a chance that the two field works did not take place at the same locality. Unfortunately, the geological sampling does not mark the excavation area on its plans and does not mark itself on an accurate map. Judging after the topography of the geologically sampled area and the exactly marked location of the 1930s excavation in Banner 1936 there is about 100 meters between the two field works. What may support that the recovered areas mismatch is that the geological sampling did not find any archaeological features or finds through the entire thickness of the loess it recovered.

3.3.6. Pilismarót Pálrét

The site is located in the Danube bend on the right river bank, on a Pleistocene terrace (Dobosi *et al.* 1983). The archaeological level 10 cm thick yielded abundantly stone tools and animal bones. It was situated in a sloping position, 90–140 cm deep under recent surface, embedded in loess (Fig. 16).

On the basis of the stratigraphy and faunal remains the site was dated to 16 k years BP (Dobosi *et al.* 1983). The radiocarbon date, 13,130 ± 100 (Hv–12988), was obtained from a mollusk shell sample of unmentioned species (Dobosi 2006). According to the laboratory, the sample contained 20% contamination and most probably this resulted in this age younger than expected.

3.3.7. Zalaegerszeg

The site was situated in West Hungary, Zalaegerszeg brick yard II. Approximately 14 m under the surface charcoals and sporadically animal bones were collected and a hearth was observed in tilting position. Above and beneath the hearth level charcoals were sporadically distributed over 4 m. One meter above the hearth another but weaker charcoal layer was found (Vértes 1954, 16–17). Charcoals were identified *Larix-Picea* which were dated to 12,125 ± 360 (Hv–1616) (Geyh *et al.* 1969, 7). The only finds are two blade fragments that were provided by the mine workers days after the end of the excavation collected from unknown location.

3.3.8. Dunaföldvár

The site was situated on the right bank of Danube. Excavations were carried out in 1934 and 1935

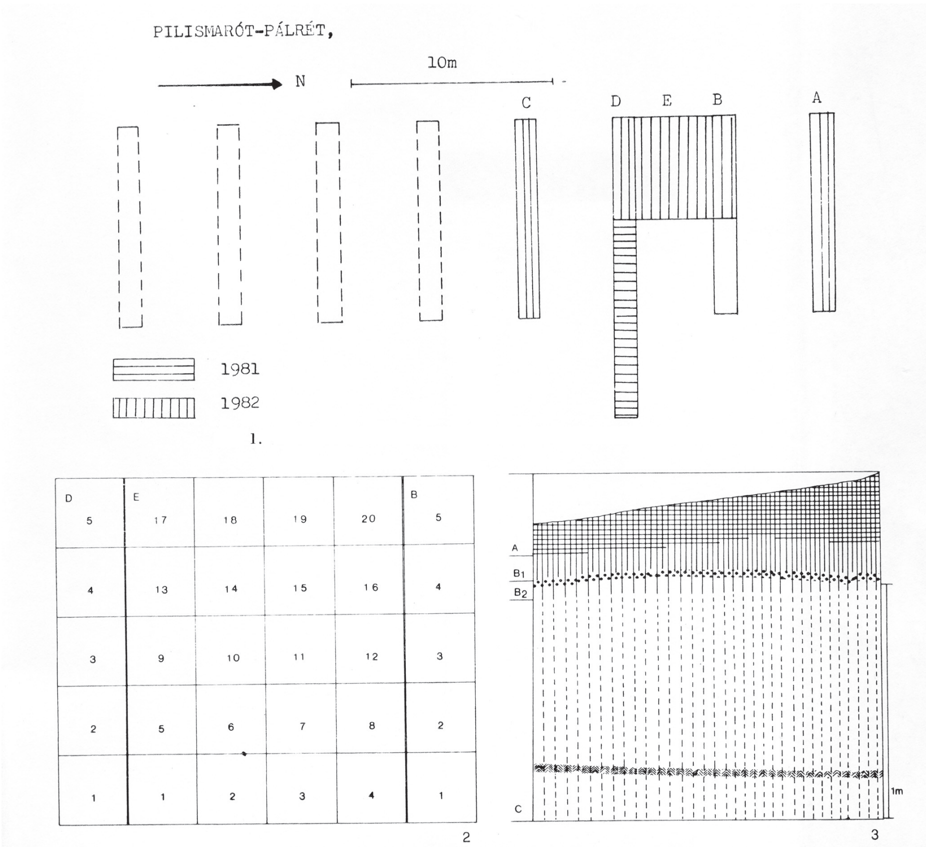

Fig. 16. Trenches and sections of Pilismarót-Pálrét (after Dobosi et al. *1983).*

(Csalogovits 1936). The lithic assemblage is small, contains 35 items. Additionally, hearths, and several mammoth and reindeer remains were found at the site. One of the hearths, recovered in 1934, 1.20 m large and 2–3 cm thick, yielded charcoal samples which were kept in glass tube. Csalogovits mentions that the charcoals were soaked in paraffin in order to achieve the best conservation. Decades later, these charcoals were dated to 12,110 ± 315 (Hv–1657) (Geyh *et al.* 1969).

4. The re-evaluation of the radiocarbon database

The two issues which direct the re-evaluation of the radiocarbon dates in the Gravettian Entity are the sample's association with past human activity and the sample's contamination and organic preservation.

From the description of the radiocarbon samples and their archaeological environments it becomes clear for the first sight that the most common problem with the radiocarbon dates of the Gravettian Entity is the lack of sample's association with past human activities and archaeological finds or features. Bodrogkeresztúr, dates 28,700 ± 3000 and 26,318 ± 365, the 18 k years old date of Arka, Budapest-Csillaghegy date, Ságvár latest two dates, 19,770 ± 150 and 18, 510 ± 160, and the whole dataset of the Szeged-Öthalom geological investigation clearly derive from those parts of the sites where artifacts were not recovered. The papers on Püspökhatvan and Megyaszó provided information simply about the date itself and the sample type. Furthermore, the archaeological features of these sites exclude hearth remains and good preservation of charcoal. Accordingly, the samples cannot convincingly be associated with the human occupation. Hont-Parassa III date is a bit better reported, but the erratic referencing to the habitation levels in the paper does not allow making a clear correlation between the lower habitation layer and the origin of the sample. If this sample was associated with the archaeologically sterile level 5, which is mentioned as the lowest habitation level, then the radiocarbon date has no connection with archaeological finds. In addition to this insecurity, the excavation report mentions no hearths at the site, for this reason the sample cannot be regarded as residue of past human activity.

Besides the lack of association between samples and finds, the date of Budapest-Csillaghegy and the 18 k year old date of the Ságvár were obtained on snail shells which are natural but human occupational remains. The date of Pilismarót also ought to be mentioned here because it was obtained on mollusk shells. In addition, this sample contained additionally recent carbon contamination.

Clear post-depositional disturbance in the matrix of the archaeological site is revealed at Ságvár. At this site although the samples and the archaeological features have clear associations, the interlayer lithic refitting proves that the radiocarbon dates of the two archaeological levels most likely have the same archaeological origin. The cryoturbation at Arka also might have modified the original position of archaeological finds and the organic remains sampled for dating. Therefore it is difficult to make authentic association between the radiocarbon samples and the artifacts. The effect of cryoturbation upon the sediments of Arka site raises the insecurity of the stratigraphic position of the 13 k years old date. Its sample was originally submitted from the lower layer but after receiving the young dating result Vértes revised the archaeological stratigraphic position of the sample and henceforth derived that from within the upper layer. Further admixture in the archaeological layer can be ascertained by the post-depositional gloss on the lithic artifacts at Püspökhatvan site.

The second issue in the re-evaluation, the sample contamination and poor organic material preservation, less frequently occur in the database. This is clearly due to the absence of detailed reporting of the radiocarbon dating procedure. From the few available examples the complete lack of collagen preservation was reported on the bone sample of Jászfelsőszentgyörgy. Hertelendi (1993) does not warn about the possibility that the date of Jászfelsőszentgyörgy might be too young. Arka charcoal sample measured to ca. 17 k years BP was reported to have low content of organic material and the real age of the sample was reconsidered to be greater. Considering the note of Vogel and Waterbolk (1964) on Arka date 17 k years BP about the effect of low organic material content on the true age of the sample and the low yield collagen effect in bone samples (Brock *et al.* 2007; Weber *et al.* 2005), most probably the date of Jászfelsőszentgyörgy shows a younger age than the real. Contamination that makes dates younger was reported along with the 10 k years BP bone date of Bodrogkeresztúr. The charcoal sample of Dunaföldvár site might also have suffered from recent contamination that could have been caused by the paraffin used for conserving the charcoals in the 1930s. This preservative issued most probably in the young age, 12 k years BP, of the sample.

An obtrusive contradiction in the Gravettian Entity dataset is the chronological position of Nadap. Its cultural classification, the Pavlovian, was based upon macroscopic observations of the site's geological features and the faunal remains. According to the excavators the human occupation was sandwiched by an embryonic soil called h_2 from above and the so called Mende Upper soil complex from beneath. H_2 is a poorly developed soil dated on bulk charcoal samples at Dunaújváros to 20,520 ± 290 (Hv–2591) and at Dunaszekcső to 21,740 ± 320 (Hv–4189) (Pécsi 1985). Mende Upper soil complex underlying the archaeological layer was weakly detectable (Dobosi *et al.* 1988, 18). This soil complex in the time of the discoveries at Nadap consisted of two members, MF_1 poorly developed chernozem-like soil dated to 29,800 ± 600 (Mo–422), 27,200 ± 1,400 (I–3130), and 27,000 ± 1589 (Hv–5422) BP at Mende on bulk charcoal samples, and MF_2 forest-steppe soil tentatively dated to 32 k years BP (Pécsi 1985). Based on this geological consideration, the human occupation at Nadap was dated to between 32 and 20 k years BP. Today the Mende Upper soil complex MF_2 is dated to the Last Interglacial (MIS 5) with TL method (Gábris *et al.* 2002; Hahn *et al.* 2002; Horváth 2001). Therefore the upper chronological boundary for the human occupation is unreasonable. Also, contrary to the logic in the geological stratigraphy based chronology, the revised biostratigraphy of the site claimed that the hunted animal remains belonged to the so called Pilisszántó-Bajót fauna stage dated elsewhere to 18–12 k years BP (Vörös 2000), which eventually meets the AMS date 13 k years BP.

Having reviewed the radiocarbon database throughout the issues of association between sample and archaeological material and sample contamination, only a very few dates remain in the circle of chronologically trustful data. These are the bone date of Nadap, the mammoth bone date of Szeged, and the charcoal dates from hearths of Esztergom, Mogyorósbánya, and Madaras. Although these dates are adequate to pass the limits of the issues discussed above positively, it is never to forget that except Mogyorósbánya each site has a single date. This situation, according to the criteria of radiocarbon date evaluation (Pettitt *et al.* 2003; Waterbolk 1971), is deficient to hold a firm chronological body for the Gravettian Entity of Hungary.

5. Conclusion

The re-evaluation of the radiocarbon database of the Gravettian Entity of Hungary, following two main issues of radiocarbon dating, the sample's association with past human activity and the sample's contamination and organic preservation, reveals sever chronological uncertainties.

In the Gravettian Entity the earliest cultural unit, the Pavlovian, sustains a heavy loss of its radiocarbon dates. This is due to that the samples are archaeologically unassociated with finds and past human activities at the sites or the association cannot be convincingly demonstrated. Even though the archaeologically reliable radiocarbon dating fails for these sites, their lithic typological character, which is similar to the Early Gravettian of Willendorf II layer 5 in the Middle Danube course, and Molodova V layers 9–10 in the Middle Dnieper course (Dobosi 2000), allows locating their chronological position to the period between 29 and 27 k years BP.

The earliest reliable radiocarbon dates in the Gravettian Entity model concern the Ságvárian from Mogyorósbánya and Madaras. Consequently, this archaeological culture seems to be dated to between 20 and 18 k years BP.

After the Ságvárian the Epigravettian can provisionally be dated to between 16 and 13 k years BP after the dates of Esztergom, Szeged, and Nadap. After 13 k years BP reliable date is unavailable for the Gravettian Entity radiocarbon chronology.

This analysis shows that most radiocarbon dates are inappropriate for building a chronology upon them. The six dates obtained from definable archaeological context are far insufficient to establish an alternative chronology. However, these show the current model that classifies chronologically and culturally the period between 29 and 12 k years BP is not fully accurate.

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