Radiocarbon, Vol 66, Nr 6, 2024, p 1630–1642 DOI:10.1017/RDC.2023.82
Selected Papers from the 24th Radiocarbon and 10th Radiocarbon & Archaeology International Conferences, Zurich, Switzerland, 11–16 Sept. 2022

CHRONOLOGY OF THE VOLCHIA GRIVA MEGAFAUNAL LOCALITY AND PALEOLITHIC SITE (WESTERN SIBERIA) AND THE ISSUE OF HUMAN OCCUPATION OF SIBERIA AT THE LAST GLACIAL MAXIMUM

Yaroslav V Kuzmin[1]* • Sergey V Leshchinskiy[2] • Vasily N Zenin[3] • Elena M Burkanova[2] • Elya P Zazovskaya[4] • Aleksandra S Samandrosova[2]

[1]Sobolev Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences, 630090 Novosibirsk, Russia
[2]Tomsk State University, 634050 Tomsk, Russia
[3]Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences, 630090 Novosibirsk, Russia
[4]Center for Applied Isotope Studies, University of Georgia, Athens, GA 30602, USA

ABSTRACT. A summary of the chronology for the key paleontological and archaeological site of Volchia Griva in the southern part of the West Siberian Plain is presented. Currently, 42 reliable ^{14}C values have been generated on animal bones (37 ^{14}C dates) and charcoal (5 ^{14}C dates). Three stratigraphic levels of animal bones are established. The ^{14}C ages of the fossils are as follows: the upper level—ca. 10,620–12,520 BP; the middle level—ca. 13,700–17,800 BP; and the lower level—ca. 18,230–19,790 BP. The majority of animal fossils and artifacts are associated with the lower level. Based on the results obtained, we suggest that Upper Paleolithic people occupied the Volchia Griva site during the second part of the Last Glacial Maximum (LGM), ca. 18,200–19,800 BP, and perhaps occasionally afterwards. It is obvious that these humans were well adapted to the cold and dry climate of the LGM, as well as numerous other populations in Siberia south of 58°N. It is noteworthy that the youngest ^{14}C values on woolly mammoth are of ca. 10,620–11,815 BP, and this makes the Volchia Griva one of the latest mammoth refugia in northern Eurasia outside of the Arctic.

KEYWORDS: chronology, Last Glacial Maximum, megafauna, Upper Paleolithic, Volchia Griva, Western Siberia.

INTRODUCTION

Upper Paleolithic localities in Western Siberia are not numerous (Zenin 2002), and the Volchia Griva (*Wolf's Ridge*) is today one of the best-studied sites in this vast region. It is also one of the largest accumulations of megafaunal remains in Asia, with *in situ* bones (Leshchinskiy and Burkanova 2022). While the Volchia Griva (hereafter—VG) site was discovered in the late 1950s, and excavated mainly in the 1960s–1970s (Derev'anko and Markin 1998:82–83) and in 1991 (Zenin 2002), its chronological aspect was unclear until the mid-2000s when more data were obtained (Leshchinskiy et al. 2008). Recently, numerous ^{14}C dates were generated for VG, and this allowed us to better understand the main temporal patterns of megafaunal presence in the southern part of the West Siberian Plain, and for the first time to firmly establish the timing and nature of the site's occupation by humans in the Upper Paleolithic. In this paper, we present the progress with ^{14}C dating of VG, and discuss more general issue of human presence in Siberia at the Last Glacial Maximum (LGM) that is still a subject of active debates (e.g., Kuzmin and Keates 2018 *versus* Buvit et al. 2022).

MATERIALS AND METHODS

The VG site is located within the modern Mamontovoe Village (Kargat County, Novosibirsk Province, Russia), with coordinates 54°39′55″N, 80°20′02″E (Figure 1). The site occupies the top and slopes of the *griva* (ridge; also the term "mound" was used, see Leshchinskiy and Burkanova 2022), the elongated landform ca. 11 km long and ca. 0.5–1 km wide, with an elevation of ca. 10–15 m above the surrounding flat surface of the Baraba Lowland (Figures 1–2). Two areas (a.k.a. sectors) in the spatial structure of VG can be determined:

*Corresponding author. Emails: kuzmin@fulbrightmail.org; kuzmin_yv@igm.nsc.ru

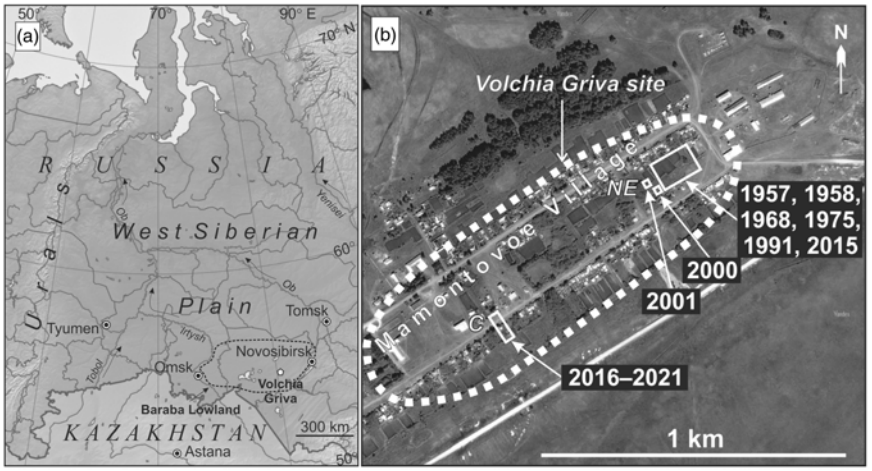

Figure 1 Position of the Volchia Griva site: (a) in the West Siberian Plain; (b) on the Volchia Griva ridge (NE—northeastern sector; C—central sector), with excavation localities and years of work; background is based on satellite image (free access).

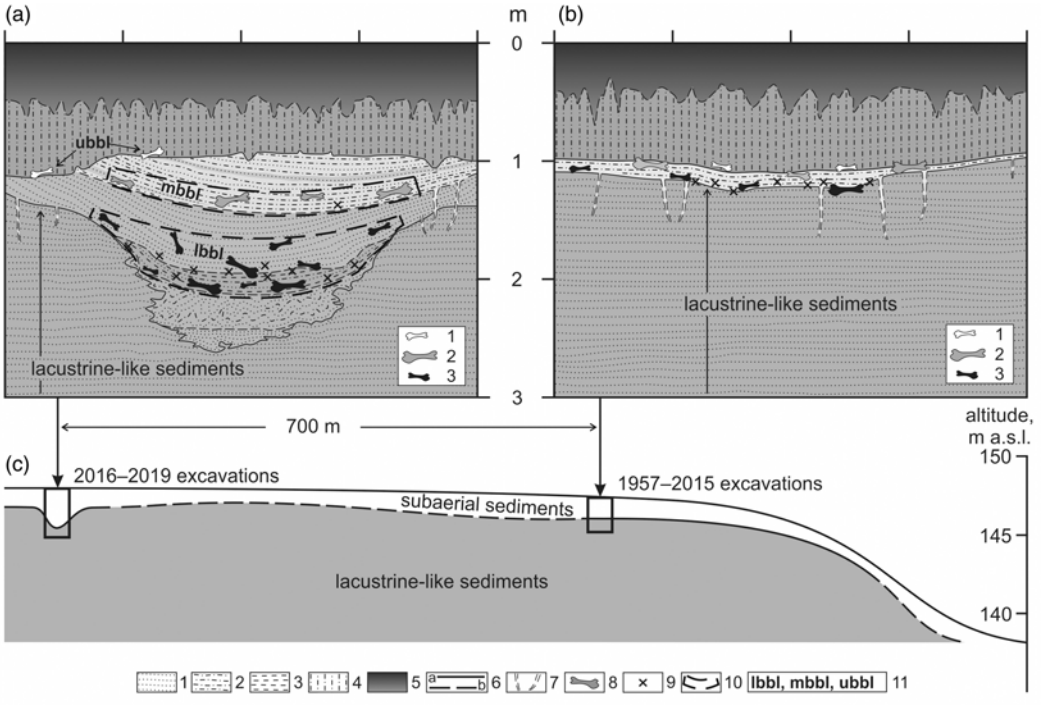

Figure 2 General stratigraphy of the Volchia Griva site (after Leshchinskiy et al. 2021, modified): (a) 2016–2019 excavations, central sector; (b) 1957–2015 excavations, northeastern sector (1—bones from the upper level; 2—from the middle level; and 3—from the lower level); (c) schematic latitudinal cross-section. 1—sand; 2—silt; 3—clay; 4—loess-like loam; 5—soil; 6—layer boundaries: a—certain, b—assumed; 7—desiccation cracks; 8—faunal remains; 9—lithic artifacts; 10—boundaries of bone-bearing levels; 11—abbreviations: lbbl—lower bone-bearing level, mbbl—middle bone-bearing level, and ubbl—upper bone-bearing level.

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(1) northeastern, and (2) central (Figure 1, b). Up to 2015, the excavations were carried out in the former area, and since 2016—in the latter one. Overall, more than ca. 550 m^2 of bone-bearing deposits were unearthed. Several thousand mammoth bones and teeth, and ca. 80 lithic tools and flakes were obtained before 2020 (Leshchinskiy et al. 2021); unfortunately, most of the faunal material collected before 2015 was lost (Leshchinskiy and Burkanova 2022). Excavations using the three-dimensional plotting of bones and lithic artifacts were carried out in the northeastern sector in 1991 (main pit) and in 2015 (4 × 3 m pit next to it). In addition, two small test pits were examined in this part of the site in 2000–2001; the 2000 test pit was dug next to the 1991 main area of work (Orlova et al. 2003) (Figure 1, b). In 2016–2022, investigations were shifted toward the center of the village (Figure 1, b) where by preliminary sounding the high concentrations of bones were detected. Until recently, all studies were conducted on the flat top surface of the ridge. In 2020–2021, a pit was dug on the gentle slope (2–3°), ca. 38 m distant from the 2016–2017 excavation.

Besides numerous bones of large mammals (mainly woolly mammoth, *Mammuthus primigenius* Blum.), until 2020 a few dozens of lithic artifacts were found at VG (Zenin 2002; Leshchinskiy et al. 2021). This raised the issue of the relationship between prehistoric humans and the megafauna; it was not clear—did people kill mammoths or exploit the natural accumulation of bones ("mammoth cemetery"), or did the animals die naturally? Some observations in 1991 and 2015–2018, when excavations were carried out with strict stratigraphic and planigraphic controls, allowed us to suggest that the human impact on the VG megafauna was very small, almost negligible (see details: Leshchinskiy and Burkanova 2022). Prehistoric people could have hunted animals like bison, horse, wolf, and fox, but the amount of these species at VG is small, up to a few percent. The breakthrough in understanding the nature of VG took place in 2020–2021 when clear traces of human occupation, including ca. 10,500 lithic artifacts, slightly re-deposited hearths with small pieces of charcoal and abundant ash, and numerous fox bones (mainly of polar fox), were excavated.

The general stratigraphy of the VG site can be presented as follows (Figures 2–3). Below the modern soil (up to 0.5 m thick), there are subaerial deposits—loess-like loams (ca. 0.3–0.75 m thick) and underlying clayey sands and silts (up to 1–2 m thick; these are present mainly in the central sector), and they contain three levels (upper, middle, and lower) of bones and artifacts. Bone-bearing sediments are represented by lenses ca. 0.15–1 m thick, which are distributed throughout the VG site but are not continuous. It is sometimes difficult (especially in the northeastern sector; see Figure 2, b) to determine to which level the bones belong because of post-sedimentation disturbance caused by trampling of subfossil bones in antiquity by animals who were attracted to VG as a mineral lick. Beneath loess-like deposits, clayey sands, and silts, there are finely laminated sands, most probably of aquatic (lacustrine) origin, without any bones and artifacts.

The ^{14}C dating of materials from VG was conducted mainly using the AMS technique (AA, UGAMS, $IGAN_{AMS}$, and RICH laboratories), and also by LSC counting (GIN and SOAN labs). Details of the pretreatment for bones can be found in the relevant publications (Ovodov et al. 2011; Kuzmin et al. 2020, 2022; Leshchinskiy and Burkanova 2022). In general, bone collagen was extracted by usual protocols (see Kuzmin and Orlova 2004:144–145; Ovodov et al. 2011; Leshchinskiy and Burkanova 2022: 160; Leshchinskiy et al. 2023:7); charcoal was treated by standard acid-base-acid protocol (see Taylor and Bar-Yosef 2014:93).

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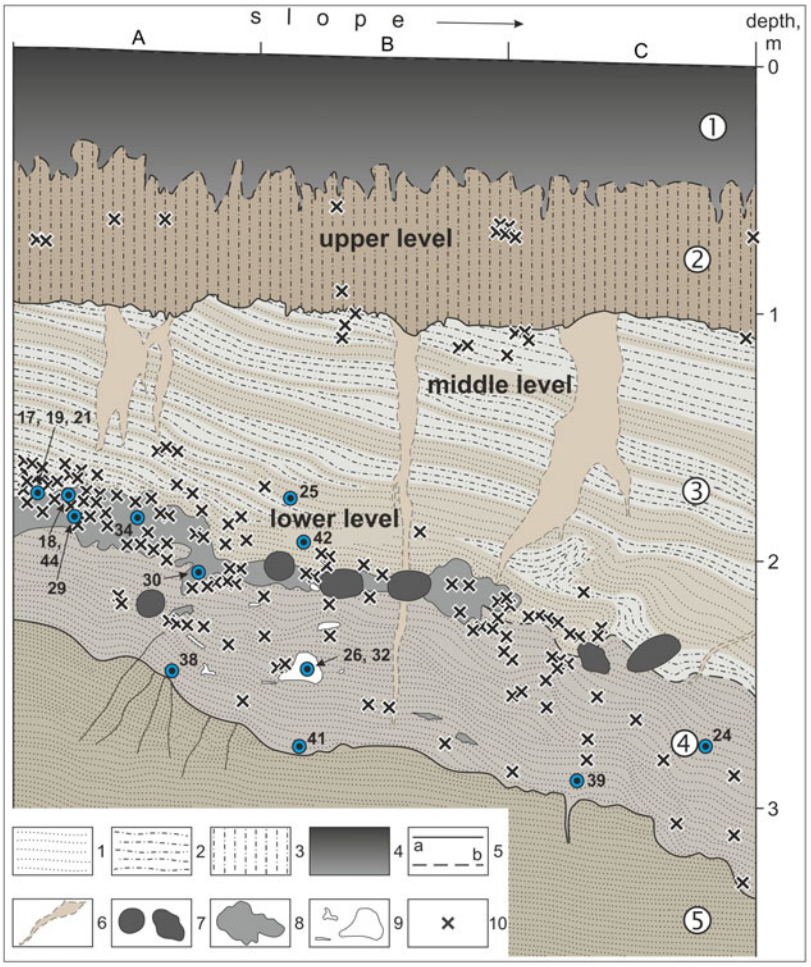

Figure 3 The stratigraphy of the Volchia Griva site, 2020–2021 excavations (central sector) (numbers in circles are sediment layers: 1—Layer 1, modern soil; 2—Layer 2, loess-like loam; 3 and 4—Layers 3–4, thinly laminated clayey sand and silts; 5—Layer 5, thinly laminated sand). 1—sand; 2—silt; 3—loess-like loam; 4—soil; 5—boundaries: a—certain, b—assumed; 6—desiccation cracks; 7—krotovinas; 8—concentrations of ash and small charcoal pieces; 9—animal bones; 10—artifacts. Blue circles with black centers and their numbers correspond to samples in Table 1. (Please see online version for color figures.)

RESULTS AND DISCUSSION

The ^{14}C values, available up to early 2023 for the VG site, are summarized in Tables 1–2. The first ^{14}C dates were obtained in the late 1960s at the SOAN laboratory by the LSC method (Table 2). Unfortunately, the documentation about the sample locations is poor, and this is why we decided to label them as "unclear". On the other hand, these three ^{14}C values do not contradict the general chronological range of the site.

The next stage in ^{14}C dating the VG site came in the 2000s when the northeastern sector was additionally excavated (see Leshchinskiy et al. 2008, 2021). This allowed us to better understand the overall age range, including the middle and upper bone-bearing stratigraphic

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Table 1 Reliable ^{14}C dates of the Volchia Griva site (the youngest mammoth values are in bold).

No.	Sector[a], pit	Year	Depth (m)	Level[b]	^{14}C date (BP)	Lab code	Material	Calendar age, cal BP[c]
1	C	2020	—	Krotovina in L	1590 ± 20	$IGAN_{AMS}$-8206	Rodent	1410–1530
2	NE, test pit	2000	0.75	U	**11,090 ± 120**	SOAN-4291	Mammoth	12,760–13,180
3	NE, 1991 pit	2000	0.86	U	**11,815 ± 90**	AA-60771	Mammoth	13,480–14,000
4	C	2016	0.86–0.90	U ?	16,750 ± 45	UGAMS-32286	Bison	20,100–20,420
5	NE	2015	0.74–0.99	U/M	17,840 ± 60	UGAMS-26111	Mammoth	21,420–21,920
6	NE, test pit	2001	0.95	U/M ?	16,090 ± 110	AA-60832	Mammoth	19,100–19,780
7	NE, test pit[d]	2001	0.8	U/M ?	17,650 ± 140	AA-60831	Mammoth	20,940–21,840
8	NE, test pit[d]	2001	0.8	U/M ?	17,800 ± 100	GIN-11463	Mammoth	21,280–21,990
9	C	2018	0.73–0.93	M	**10,620 ± 30**	UGAMS-40948	Mammoth	12,510–12,720
10	NE, 1991 pit	2000	0.8	M	12,520 ± 150	SOAN-4293	Mammoth	14,150–15,250
11	C	2016	1.04–1.38	M	13,700 ± 35	UGAMS-32275	Mammoth	16,390–16,740
12	NE, 1991 pit	2000	1.0	M	14,280 ± 285	SOAN-4292	Mammoth	16,640–18,190
13	C	2017	0.97–1.03	M	15,870 ± 40	UGAMS-32281	Mammoth	18,990–19,310
14	C	2017	1.11–1.15	M	16,550 ± 40	UGAMS-32282	Mammoth	19,870–20,150
15	C	2016	1.24–1.42	M	18,460 ± 45	UGAMS-32277	Mammoth	22,300–22,480
16	C	2018	0.74–0.94	M	18,640 ± 40	UGAMS-40949	Mammoth	22,380–22,770
17	C	2020	1.68–1.70	L	16,940 ± 40	$IGAN_{AMS}$-8472	Mammoth[e]	20,350–20,560
18	C[f]	2020	1.65–1.75	L	17,375 ± 50	$IGAN_{AMS}$-8486	Charcoal	20,830–21,100
19	C	2020	1.60–1.70	L	18,230 ± 70	$IGAN_{AMS}$-8485	Charcoal	22,030–22,350
20	C	2016	1.58–1.79	L	18,420 ± 45	UGAMS-32278	Mammoth	22,260–22,460
21	C	2021	1.63–1.70	L	18,715 ± 50	$IGAN_{AMS}$-10103	Wolf	22,450–22,890
22	NE	2015	1.07–1.10	L	18,840 ± 50	UGAMS-26107	Horse	22,550–22,950
23	NE	2015	1.10–1.16	L	18,840 ± 50	UGAMS-26110	Mammoth[e]	22,550–22,950
24	C	2020	2.72–2.73	L	18,960 ± 40	$IGAN_{AMS}$-8476	Mammoth[e]	22,630–23,020
25	C	2020	1.70–1.75	L	18,980 ± 60	$IGAN_{AMS}$-8487	Charcoal	22,630–23,040
26	C[g]	2020	2.33–2.50	L	19,125 ± 40	$IGAN_{AMS}$-8477	Mammoth	22,930–23,120
27	NE	2015	1.14–1.20	L	19,130 ± 50	UGAMS-26104	Horse	22,930–23,140
28	C	2016	1.69–1.76	L	19,160 ± 50	UGAMS-32289	Mammoth	22,940–23,180
29	C	2020	1.78–1.80	L	19,225 ± 60	$IGAN_{AMS}$-8488	Charcoal	22,960–23,660
30	C	2021	2.02–2.07	L	19,230 ± 50	$IGAN_{AMS}$-10104	Fox	22,960–23,650

Table 1 (*Continued*)

No.	Sector[a], pit	Year	Depth (m)	Level[b]	^{14}C date (BP)	Lab code	Material	Calendar age, cal BP[c]
31	C	2016	1.97–2.05	L	19,240 ± 50	UGAMS-32283	Mammoth	22,970–23,660
32	C[g]	2020	2.33–2.50	L	19,245 ± 45	IGAN$_{AMS}$-8478	Fox	22,980–23,660
33	C	2016	1.87–1.88	L	19,250 ± 50	UGAMS-32273	Wolf	22,980–23,670
34	C	2020	1.82–1.83	L	19,260 ± 50	IGAN$_{AMS}$-8474	Bird	22,990–23,680
35	C	2016	1.77–1.83	L	19,320 ± 50	UGAMS-32288	Mammoth	23,030–23,710
36	C	2016	1.90–1.91	L	19,360 ± 50	UGAMS-32272	Fox	23,070–23,720
37	C	2016	1.62–1.65	L	19,450 ± 50	UGAMS-32284	Wolf	23,210–23,750
38	C	2021	2.30–2.47	L	19,485 ± 60	IGAN$_{AMS}$-10106	Mammoth	23,250–23,760
39	C	2021	2.87–2.90	L	19,485 ± 50	IGAN$_{AMS}$-10107	Fox	23,260–23,760
40	C	2016	1.91–1.95	L	19,540 ± 50	UGAMS-32287	Horse	23,340–23,780
41	C	2021	2.81	L	19,540 ± 50	IGAN$_{AMS}$-9802	Charcoal	23,340–23,780
42	C	2020	1.79–1.90	L	19,590 ± 50	IGAN$_{AMS}$-8473	Mammoth	23,360–23,800
43	C	2021	2.70–2.73	L	19,620 ± 55	IGAN$_{AMS}$-10105	Mammoth	23,370–23,810
44	C[f]	2020	1.65–1.75	L	19,790 ± 70	RICH-29414.1.1	Charcoal	23,440–24,000

[a]NE—northeastern; C—central.
[b]U—upper; M—middle; L—lower.
[c]Expressed with ± 2 σ, combined and rounded to the next 10 yrs, using Calib 8.1.0 software (http://calib.org/calib/).
[d]The same specimen was ^{14}C-dated.
[e]Mammoth tusks.
[f]The same specimen was ^{14}C-dated (the IGAN$_{AMS}$-8486 value is not plotted in Figure 4).
[g]These samples constitute an artificial bone assemblage (fox bones were placed in a cavity made in a mammoth's femur; see Leshchinskiy et al. 2023).

Table 2 Unclear ^{14}C dates and outliers of the Volchia Griva site.

Sector[a]	Year	Depth (m)	Level[b]	^{14}C date (BP)	Lab code	Material	Calendar age, cal BP[c]
Unclear ^{14}C dates							
NE	1968	0.7–2.0	Uncertain	14,200 ± 520	SOAN-78	Mammoth	15,820–18,630
NE	1968	0.7–1.5	Uncertain	13,600 ± 230	SOAN-111	Mammoth	15,770–17,060
NE	1968	0.7–1.5	Uncertain	14,450 ± 110	SOAN-111A	Mammoth	17,320–18,010
Outliers							
NE, 1991 pit	2001	0.98	U/M ?	34,000 ± 1200	AA-60770	Mammoth	36,200–41,200
C	2020	2.08–2.09	L	29,550 ± 85	$IGAN_{AMS}$-8475	Mollusk	33,890–34,380
C	2021	1.61–1.62	L	15,000 ± 50	$IGAN_{AMS}$-9800	Burnt bone	18,200–18,610

[a]NE—northeast; C—central.
[b]U—upper; M—middle; L—lower.
[c]Expressed with ± 2 σ, combined and rounded to the next 10 yrs, using Calib 8.1.0 software (http://calib.org/calib/).

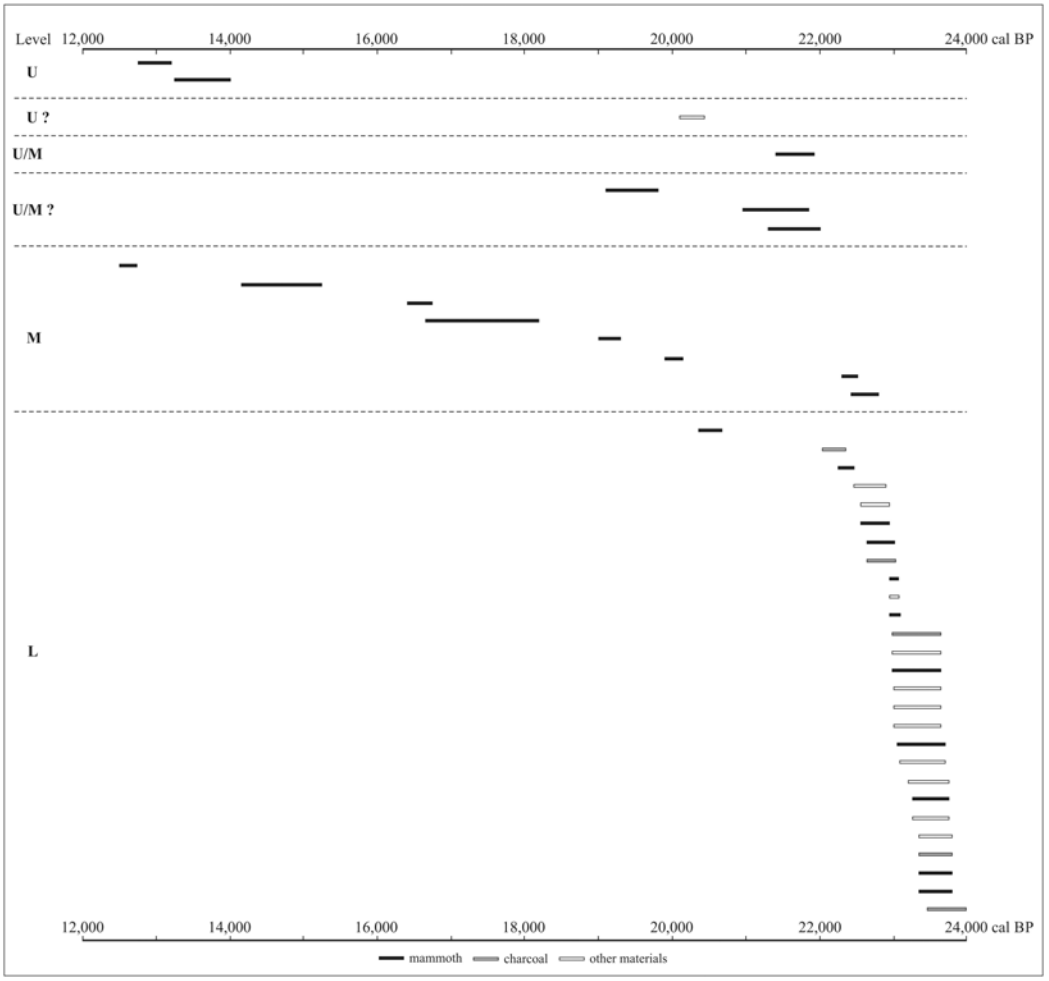

Figure 4 Distribution of calibrated ^{14}C dates for the Volchia Griva site according to bone-bearing levels (see Table 1).

levels. One ^{14}C value, ca. 34,000 BP (AA-60770), was much older than the rest of dates, and we determined it as an "outlier" (Table 2). The reason for such a large deviation from the other ages is still unclear. The upper level of the northeastern sector was ^{14}C-dated to ca. 11,090–11,815 BP; the combined upper and middle level—to ca. 12,520–17,840 BP, and the lower level—to ca. 18,840–19,130 BP (Table 1; Figure 4). On the other hand, the age of the upper/middle level is to some extent tentative due to the possibility of re-deposition (see below).

Since 2015, the amount of ^{14}C dates for VG increased sharply, and the AMS method was employed; bones of woolly mammoth, Pleistocene horse and bison, wolf, and fox were selected for analysis (Leshchinskiy et al. 2021; Leshchinskiy and Burkanova 2022). The excavations in 2020–2021 of the part of the central sector with clear traces of human habitation (i.e., presence of artifacts and hearths) and increased funding allowed us to generate even more ^{14}C values on different material, including bones of woolly mammoth, Pleistocene horse, wolf, fox, and a bird (unidentified to species), and wood charcoal (Table 1). The overall ages for the middle level are determined as ca. 10,620–18,640 BP; and for the lower level—ca. 16,940–19,790 BP (Table 1;

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Figure 4). Once again, these ranges are tentative because of possible re-deposition occurred in the middle level. One ^{14}C value on freshwater mollusk shell, ca. 29,550 BP ($IGAN_{AMS}$-8475), turned out to be much older than the rest of dates from the lower level. Probably, Upper Paleolithic people collected this unusual looking sample from the older deposits and brought it to the site as a kind of 'souvenir'; we determined it as an "outlier" (Table 2). Another ^{14}C date of ca. 15,000 BP ($IGAN_{AMS}$-9800), run on burnt bone, does not fit the overall sequence, and we also placed it into the "outliers" (Table 2).

There are several cases when particular ^{14}C values do not correspond well to the rest of dates from the bone-bearing levels. For example, in the northeastern sector two ^{14}C dates associated with the middle level—ca. 12,520–14,280 BP (SOAN-4292 and SOAN-4293)—are younger than the dates from the upper/middle (?) level, ca. 16,090–17,800 BP. Because in this sector of the VG the levels are located closely to each other (Figure 2, b), trampling of subfossil bones by mammoths and other large animals (and possibly even prehistoric humans) may have caused the re-deposition of these bones from the upper level to the middle one. Therefore, overlaps in the ^{14}C dates for the upper and middle levels (Figure 4) can be related to trampling by animals and re-deposition by erosion.

In the central sector, a similar situation can be detected for the presumably upper level; the ^{14}C date of ca. 16,750 BP (UGAMS-32286) is much older than the rest of the ^{14}C values for this level in the northeastern sector. The relatively young ^{14}C dates from the middle level—ca. 10,620 BP (UGAMS-40948) and ca. 13,700 BP (UGAMS-32275)—deviate from the rest of the ^{14}C values, ca. 15,870–18,640 BP. In the lower level, the ^{14}C date of ca. 17,375 BP probably belongs to the middle level. The most likely reason for that could be the re-deposition by trampling and by water transport and erosion in the depression with a large accumulation of bones, and disturbance by prehistoric humans who might have visited VG after the LGM, although this is not certain (Figure 2, a; Leshchinskiy and Burkanova 2022:165–169). It was noticed that some bones were found in almost vertical position (Leshchinskiy and Burkanova 2022:163). Nevertheless, there are several cases of bones in anatomical articulations (Leshchinskiy and Burkanova 2022) in the middle and lower levels, and this testify especially in favor of a minor disturbance of the lower level.

In the excavation pit of 2020–2021, the stratigraphy of VG is the best in terms of separation of the artifact-bearing levels (Figure 3). The majority of animal bones and artifacts (lower level) is associated with Layer 4 and the bottom of Layer 3. Several ^{14}C values from the lower level, ca. 18,230–19,790 BP, were run on wood charcoal associated with slightly re-deposited hearths (Figure 5) and correspond to the timing of human occupation of this area at the VG. Out of two ^{14}C dates of the same sample, 17,375 ± 50 BP ($IGAN_{AMS}$-8486) and 19,790 ± 70 BP (RICH-29414.1.1), we accept the older value because it fits better with the rest of dates from the lower level (Table 1). However, a disturbed stratigraphy even in central sector of VG can be assumed. For example, it is quite possible that two ^{14}C values associated with the middle level—ca. 18,460 BP (UGAMS-32277) and ca. 18,640 BP (UGAMS-40949) (Table 1)—belong to the lower level. In this case, the age of the middle level can be determined as ca. 13,700–16,940 BP, and of the lower level—as ca. 18,230–19,790 BP.

An additional factor of disturbance of the original stratigraphy at VG is the burrowing activity of rodents that is quite common today and in the Holocene of the Baraba Lowland. One sample of rodent bones taken from a krotovina in the lower level was ^{14}C-dated, with a late Holocene age, ca. 1590 BP (Table 1). This is why the areas with traces of numerous burrowing

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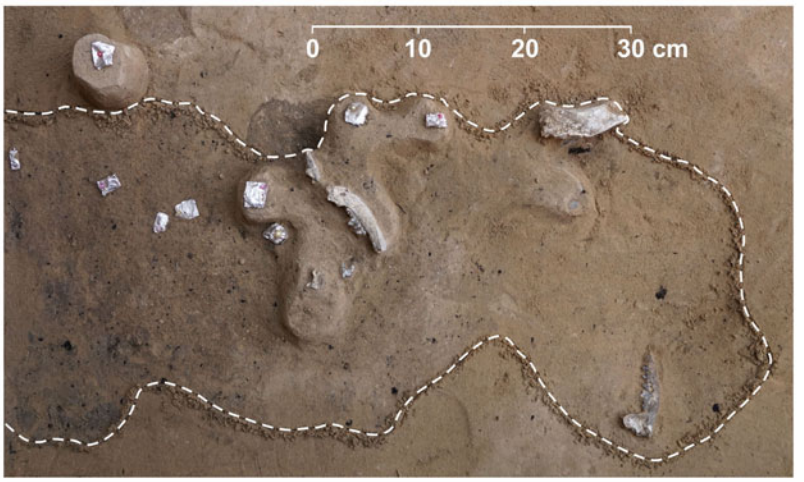

Figure 5 Photo of a lens (view from the top) consists of slightly re-deposited hearth, the bottom of Layer 3, Grid A-6 (2020 pit) (small artifacts and bones and covered by foil). The contour of a lens, enriched with charcoal particles, bones (fragment of the mammoth's rib; two halves of the mandible and small fragments of *Vulpes* sp.), and small artifacts, is highlighted.

holes were treated carefully, in order to avoid the mixing of krotovina fills with materials from undisturbed strata (Leshchinskiy and Burkanova 2022).

By combining all available ^{14}C dates for the VG site into three stratigraphic levels, the general age ranges can be established after critical re-assessment of the ^{14}C values that do not correspond to initially assumed levels. The upper level can be dated to ca. 10,620–12,520 BP; the middle level—to ca. 13,700–17,800 BP; and the lower level—to ca. 18,230–19,790 BP (Figure 4). Due to re-deposition of some animal bones by trampling and erosional and colluvial processes, the ages for the upper and middle levels remain to some extent provisional.

There are two quite "late" ^{14}C dates on woolly mammoth from the VG site, ca. 10,620–11,090 BP (or ca. 12,500–13,200 cal BP) (Table 1). Previously, similar ^{14}C values of ca. 10,200–11,080 BP (or ca. 11,350–13,290 cal BP) were obtained for Western Siberia (Kuzmin 2010; Orlova et al. 2004a). Even though the youngest ^{14}C date, 10,210 ± 135 BP (SOAN-4752) from the Lugovskoe locality in central Western Siberia, could be an outlier (see Orlova et al. 2004b), now the presence of mammoth in the southern part of the West Siberian Plain at ca. 10,620 BP seems to be securely established. According to Puzachenko et al. (2017), the fast fragmentation of mammoth habitat in Siberia occurred at the end of the Bølling–Allerød interstadial, ca. 11,000 BP (ca. 12,900 cal BP), with isolated refugia in northern Eurasia outside of the High Arctic (see also Stuart 2021; Stuart et al. 2002). The Baraba Lowland is one of such areas where mammoths survived until the Younger Dryas, ca. 10,100–11,000 BP (or ca. 11,700–12,900 cal BP).

Based on the results obtained, we can suggest that Paleolithic people occupied the VG site in the southern part of the West Siberian Plain during the second half of the LGM (see Lambeck et al. 2014), ca. 18,200–19,800 BP (or ca. 22,000–24,000 cal BP), in the cold treeless environment sometimes called the 'mammoth steppe' (Leshchinskiy and Burkanova 2022). The latest data for the chronology of VG can shed a new light on the hotly debated issue of human

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Figure 6 LGM-associated sites (dated to ca. 19,000–23,000 BP) in Siberia and the Russian Far East (after Kuzmin 2021; Seuru et al. 2017; modified).

presence in Siberia during the LGM. Some scholars (e.g., Hoffecker 2005:110–111; Graf 2005, 2015; Buvit et al. 2022) are skeptical about the human occupation of northern Eurasia at the LGM, including Siberia. On the contrary, others (e.g., Kuzmin 2008, 2021; Kuzmin and Keates 2018) are positive about the existence of archaeological sites at least in southern Siberia, up to the 58° N latitude (Figure 6).

The progress in studying the LGM paleogeography of the Lake Baikal region in southern Siberia (Müller et al. 2014; Tarasov et al. 2019; Kobe et al. 2022; see also Krivonogov et al. 2004), where several LGM-associated archaeological sites are situated, confirms the survivial of woody plants in the river valleys at that time. This is an additional argument in favor of a suitable environment for the LGM humans in this area, along with the presence of tailored clothes and dwellings among the Upper Paleolithic populations of northern Eurasia. Currently, we have at least 30 sites south of the 58°N, and even six sites north of it (Figure 6). It is obvious that ancient inhabitants of Siberia were able to cope with the LGM climate (e.g., Pitulko et al. 2017; Kuzmin and Keates 2018; Pitulko and Pavlova 2020; Pavlova and Pitulko 2020).

CONCLUSIONS

Based on 20+ years of the ^{14}C dating program at the VG site, today we have 42 values that can be accepted as reliable ones. Currently, in the deposits of VG three stratigraphic levels of mammoth fauna and artifacts can be determined, with preliminary ^{14}C age ranges of the ca. 10,620–12,520 BP (upper level), ca. 13,700–17,800 BP (middle level), and ca. 18,230–19,790 BP

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(lower level). The latter level contains the major part of animal fossils and artifacts. The human presence can now be securely established in the second part of the LGM, ca. 18,200–19,800 BP. It is not clear at the current stage of research for how long people occupied the VG site. However, the rare presence of lithic artifacts in the middle and upper levels may indicate periodical visits of prehistoric people to VG until the end of the Pleistocene. Animals visited the VG site since ca. 19,600 BP until ca. 10,600 BP. Today, VG is one of the latest refugia of woolly mammoth in northern Eurasia beyond the Arctic, and it existed until ca. 10,600 BP. Because only a small part of the site (ca. 5%) has been excavated to date, the potential of VG for Late Quaternary paleontology and Upper Paleolithic archaeology of northern Eurasia is very high.

ACKNOWLEDGMENTS

We are grateful to numerous colleagues, who participated in the excavations of the VG site in 1991–2021, for their assistance. The RICH laboratory (Royal Institute for Cultural Heritage, Brussels, Belgium) generously ^{14}C-dated one of the VG samples, and we are thankful for their help. Work by YV Kuzmin was supported by the State Assignment of the Sobolev Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences, with funding provided by the Ministry of Science and Higher Education of the Russian Federation. We are grateful to SG Keates for final polishing of the text; however, all mistakes are only ours.

REFERENCES

Buvit I, Rasic JT, Izuho M. 2022. Archaeological evidence shows widespread human depopulation of Last Glacial Maximum Northeast Asia. Archaeological and Anthropological Sciences 14:125.

Derev'anko A, Markin S. 1998. The Paleolithic of the Western Siberian Plain. In: Derev'anko AP, Shimkin DB, Powers WR, editors. The Paleolithic of Siberia: new discoveries and interpretations. Urbana, IL & Chicago: University of Illinois Press. p. 79–84.

Graf KE. 2005. Abandonment of the Siberian mammoth-steppe during the LGM: evidence from the calibration of ^{14}C-dated archaeological occupations. Current Research in the Pleistocene 22:2–5.

Graf KE. 2015. Modern human response to the Last Glacial Maximum in Siberia. In: Kaifu Y, Izuho M, Sato H, Ono A, editors. Emergence and diversity of modern human behavior in Paleolithic Asia. College Station, TX: Texas A&M University Press. p. 506–531.

Hoffecker JF. 2005. Prehistory of the North: human settlement of the higher latitudes. New Brunswick (NJ): Rutgers University Press.

Kobe F, Leipe C, Shchetnikov AA, Hoelzmann P, Gliwa J, Olschewski P, Goslar T, Wagner M, Bezrukova EV, Tarasov PE. 2022. Not herbs and forbs alone: pollen-based evidence for the presence of boreal trees and shrubs in Cis-Baikal (Eastern Siberia) derived from the Last Glacial Maximum sediment of Lake Ochaul. Journal of Quaternary Science 37(5):868–883.

Krivonogov SK, Takahara H, Kuzmin YV, Orlova LA, Jull AJT, Nakamura T, Miyoshi N, Kawamuro K., Bezrukova EV. 2004. Radiocarbon chronology of the Late Pleistocene–Holocene paleogeographic events in Lake Baikal region (Siberia). Radiocarbon 46(2):745–754.

Kuzmin YV. 2008. Siberia at the Last Glacial Maximum: environment and archaeology. Journal of Archaeological Research 16(2): 163–221.

Kuzmin YV. 2010. The extinction of woolly mammoth (*Mammuthus primigenius*) and woolly rhinoceros (*Coelodonta antiquitatis*) in Eurasia: review of chronological and environmental issues. Boreas 39(2):247–261.

Kuzmin YV. 2021. Ancient humans in Siberia during the Last Glacial Maximum: development of opinions in the last 40 years. Prehistoric Archaeology. Journal of Interdisciplinary Studies 2:28–36. In Russian with English abstract.

Kuzmin YV, Boudin M, Wojcieszak M, Zazzo A, van der Sluis L, Stulova DI, Gavrilov KN, Veselovskaya EV, Vasilyev SV. 2022. Sungir revisited: new data on chronology and stratigraphy of the key Upper Paleolithic site, central Russian Plain. Radiocarbon 64(5): 949–968.

Kuzmin YV, Keates SG. 2018. Siberia and neighboring regions in the Last Glacial Maximum: did people occupy northern Eurasia at that time? Archaeological and Anthropological Sciences 10(1):111–124.

https://doi.org/10.1017/RDC.2023.82 Published online by Cambridge University Press

Kuzmin YV, Kosintsev PA, Boudin M, Zazovskaya EP. 2020. The freshwater reservoir effect in northern West Siberia: ^{14}C and stable isotope data for fish from the late medieval town of Mangazeya. Quaternary Geochronology 60:101109.

Kuzmin YV, Orlova LA. 2004. Radiocarbon chronology and environment of woolly mammoth (*Mammuthus primigenius* Blum.) in northern Asia: results and perspectives. Earth-Science Reviews 68(1–2):133–169.

Lambeck K, Rouby H, Purcell A, Sun Y, Sambridge M. 2014. Sea level and global ice volumes from the Last Glacial Maximum to the Holocene. Proceedings of the National Academy of Sciences of the USA 111(43):15296–15303.

Leshchinskiy SV, Burkanova EM. 2022. The Volchia Griva mineral oasis as unique locus for research of the mammoth fauna and the Late Pleistocene environment in Northern Eurasia. Quaternary Research 109:157–182.

Leshchinskiy SV, Kuzmin YV, Zenin VN, Jull AJT. 2008. Radiocarbon chronology of the "mammoth cemetery" and Paleolithic site of Volchia Griva (Western Siberia). Current Research in the Pleistocene 25:53–56.

Leshchinskiy SV, Zenin VN, Bukharova OV. 2021. The Volchia Griva mammoth site as a key area for geoarchaeological research of human movements in the Late Paleolithic of the West Siberian Plain. Quaternary International 587–588:368–383.

Leshchinskiy SV, Zenin VN, Burkanova EM, Kuzmin YV. 2023. The unique Late Paleolithic artifactual bone assemblage from the Volchia Griva site, Western Siberia. Quaternary Research 114:93–113.

Müller S, Tarasov PE, Hoelzmann P, Bezrukova EV, Kossler A, Krivonogov SK. 2014. Stable vegetation and environmental conditions during the Last Glacial Maximum: new results from Lake Kotokel (Lake Baikal region, southern Siberia, Russia). Quaternary International 348:14–24.

Orlova LA, Kuzmin YV, Dementiev VN. 2004a. A review of the evidence for extinction chronologies for five species of Upper Pleistocene megafauna in Siberia. Radiocarbon 46(1):301–314.

Orlova LA, Kuzmin YV, Zenin VN, Dement'ev VN. 2003. The mammoth population (*Mammuthus primigenius* Blum.) in Northern Asia: dynamics and habitat conditions in the Late Glacial. Russian Geology and Geophysics 44(8): 774–783.

Orlova LA, Zenin VN, Stuart AJ, Higham TFG, Grootes PM, Leshchinsky SV, Kuzmin YV, Pavlov AF, Maschenko EN. 2004b. Lugovskoe, Western Siberia: a possible extra-Arctic mammoth refugium at the end of the Late Glacial. Radiocarbon 46(1):363–368.

Ovodov ND, Crockford SJ, Kuzmin YV, Higham TFG, Hodgins GWL, van der Plicht J. 2011. A 33,000-year-old incipient dog from the Altai Mountains of Siberia: evidence of the earliest domestication disrupted by the Last Glacial Maximum. PLoS ONE 6(7):e22821.

Pavlova EY, Pitulko VV. 2020. Late Pleistocene and Early Holocene climate changes and human habitation in the arctic Western Beringia based on revision of palaeobotanical data. Quaternary International 549:5–25.

Pitulko VV, Pavlova EY. 2020. Colonization of the Eurasian Arctic. In: Goldstein MI, DellaSala DA, editors. Encyclopedia of the World's Biomes. Volume 2. Amsterdam: Elsevier. p. 374–391.

Pitulko V, Pavlova E, Nikolskiy P. 2017. Revising the archaeological record of the Upper Pleistocene Arctic Siberia: human dispersal and adaptations in MIS 3 and 2. Quaternary Science Reviews 165:127–148.

Puzachenko AY, Markova AK, Kosintsev PA, van Kolfschoten T, van der Plicht J, Kuznetsova TV, Tikhonov AN, Ponomarev DV, Kuitems M, Bachura OP. 2017. The Eurasian mammoth distribution during the second half of the Late Pleistocene and the Holocene: regional aspects. Quaternary International 445:71–88.

Seuru S, Leshchinskiy S, Auguste P, Fedyaev N. 2017. Woolly mammoth and man at Krasnoyarskaya Kurya site, West Siberian plain, Russia (excavation results of 2014). Bulletin de la Societe Geologique de France 188(1–2):1–13.

Stuart AJ. 2021. Vanished giants: the lost world of the Ice Age. Chicago & London: University of Chicago Press.

Stuart AJ, Sulerzhitsky LD, Orlova LA, Kuzmin YV, Lister AM. 2002. The latest woolly mammoths (*Mammuthus primigenius* Blumenbach) in Europe and Asia: a review of the current evidence. Quaternary Science Reviews 21(7):1559–1569.

Tarasov PE, Ilyashuk BP, Leipe C, Müller S, Plessen B, Hoelzmann P, Kostrova SS, Bezrukova EV, Meyer H. 2019. Insight into the Last Glacial Maximum climate and environments of the Baikal region. Boreas 48(2):488–506.

Taylor RE, Bar-Yosef O. 2014. Radiocarbon dating: an archaeological perspective. 2nd edit. Walnut Creek, CA: Left Coast Press.

Zenin VN. 2002. Major stages in the human occupation of the West Siberian Plain during the Paleolithic. Archaeology, Ethnology & Anthropology of Eurasia 3(4):22–44.

https://doi.org/10.1017/RDC.2023.82 Published online by Cambridge University Press