

Yaroslav V. Kuzmin ¹, Lyobov A. Orlova ² & Ivan D. Zolnikov ²

¹ Pacific Institute of Geography, Vladivostok

² Institute of Geology, Novosibirsk

Dynamics of the mammoth (*Mammuthus primigenius*) population in Northern Asia: radiocarbon evidence

Kuzmin, Y.V., Orlova, L.A. & Zolnikov, I.D., 2003 - Dynamics of the mammoth (*Mammuthus primigenius*) population in Northern Asia: radiocarbon evidence - in: J.W.F. Reumer, J. de Vos & D. Mol (eds.) - ADVANCES IN MAMMOTH RESEARCH (Proceedings of the Second International Mammoth Conference, Rotterdam, May 16-20 1999) - DEINSEA 9: 221-237 [ISSN 0923-9308] Published 24 May 2003

On the basis of 309 radiocarbon dates on woolly mammoth remains, and Geographic Information System technology data processing, we have reconstructed mammoth population dynamics in Northern Asia for the second part of the Upper Pleistocene, c. 53,000-10,000 yBP, and the Holocene c. 8,000-3,700 yBP. For most of the Upper Pleistocene, c. 53,000-12,000 yBP, mammoths existed throughout Northern Asia. They occupied northern, central and southern parts of Siberia and adjacent areas during both cold and warm phases. The sharp decrease of mammoth natural habitat started at c. 12,000 yBP. The last mammoths went extinct in the northern continental Siberia c. 9,600 yBP. A population of small-sized mammoths survived on Wrangel Island during the period c. 7,700-3,700 yBP.

Correspondence: Yaroslav V. Kuzmin, Pacific Institute of Geography, Far Eastern Branch of the Russian Academy of Sciences, Radio St. 7, Vladivostok 690041, Russia, e-mail: ykuzmin@tig.dvo.ru; Lyobov A. Orlova & Ivan D. Zolnikov, Institute of Geology, Siberian Branch of the Russian Academy of Sciences, Koptyug Ave. 3, Novosibirsk 630090, Russia.

Keywords: Woolly mammoth, *Mammuthus primigenius*, Siberia, Northern Asia, Radiocarbon dating, Geographic Information System

INTRODUCTION

The history of woolly mammoth (*Mammuthus primigenius*) has been studied for about 200 years and in Siberia for more than 100 years (Chersky 1891). Nowadays, such studies form part of wider research on global environmental and climatic changes in the Pleistocene, since both climate and vegetation were fundamental to the existence of large herbivores such as mammoth. Since the 1950s, radiocarbon (¹⁴C) dating has become very important in the investigation of mammoth history. Numerous ¹⁴C dates on mammoth bones, tusks, teeth, and soft tissues have been obtained since the 1960s for

Northern Asia, including Siberia, northern Kazakhstan, the Russian Far East, and north-eastern China. Using the data collected, we have been able to reconstruct the general features of mammoth population dynamics in Northern Asia for the last 40,000 - 50,000 ¹⁴C years with the help of Geographic Information System (GIS) technology.

MATERIAL AND METHODS

As a basis of this research, we used the ¹⁴C mammoth date lists for Northern Eurasia, published in 1995-1997 (Sulerzhitsky 1997; Sulerzhitsky & Romanenko 1997; Vasil'chuk *et al.* 1997). We also added ¹⁴C dates for the

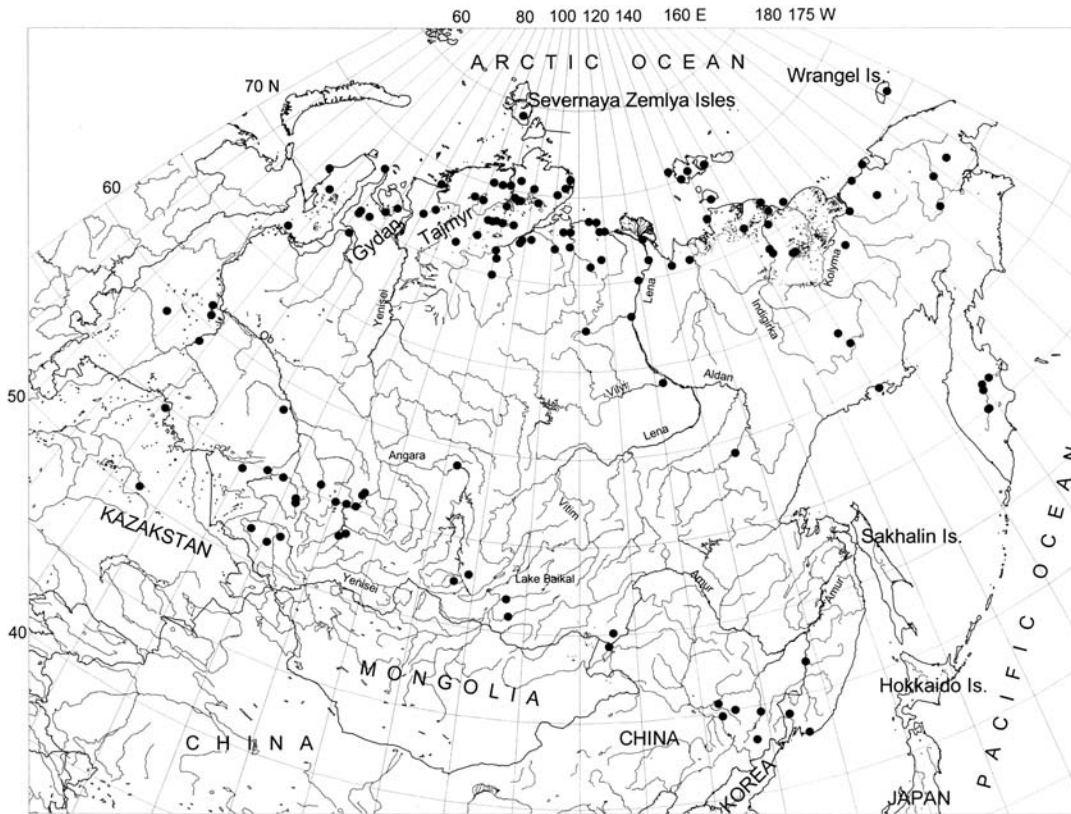


Figure 1 The distribution of radiocarbon-dated mammoth remains in Northern Asia.

territories of Kazakstan, the Russian Far East, and northeastern China (Korotky *et al.* 1989; Liu & Li 1984; Ho & Jiang 1993; Ives *et al.* 1994), and some unpublished data from the archives of the Radiocarbon Laboratory at the Institute of Geology, Siberian Branch of the Russian Academy of Sciences, Novosibirsk (Firsov *et al.* 1985). When using Chinese data, we re-calculated them for ^{14}C half-life equal to 5568 years. In total, the Database includes 309 ^{14}C determinations from more than 140 locations (Appendix; Fig. 1).

For computer processing and map generation, we used Arc View 3.0a software (ESRI Co., USA). To estimate their geographic coordinates as decimal values, both 'Atlas of the USSR' (Baranov 1969) and PALEO FAUNA Database (Markova *et al.* 1995) were used. The infinite ^{14}C dates were considered

as minimal values during the map processing (i.e., date of greater than 40,000 ^{14}C years ago [yBP] was loaded into Database as 40,000 yBP).

Taking account of the main climatostratigraphic sub-divisions of the second part of the Late Pleistocene in Siberia (Kind 1974; Velichko 1984; Arkhipov *et al.* 1986), we generated maps of spatial distribution of ^{14}C -dated mammoth remains for several time intervals: (1) the Karginian Interglacial; with subdivision into (1a) Early Karginian warmings and coolings, c. 55,000 - 33,000 yBP, (1b) Konoschelye cooling, c. 33,000 - 30,000 yBP, and (1c) Lipovka-Novoselovo warming, c. 30,000 - 24,000 yBP; (2) Sartan Glaciation; with subdivision into (2a) Early Sartan time, c. 24,000 - 20,000 yBP, (2b) Sartan Glacial maximum, c. 20,000 - 18,000 yBP, and (2c)



Figure 2 The distribution of radiocarbon-dated mammoth remains in Northern Asia in Karginian Interglacial period: **a** 55,000 - 33,000 yBP; **b** 33,000 - 30,000 yBP; **c** 30,000 - 24,000 yBP.

Late Sartan time, c. 18,000 - 13,000 yBP; and (3) Late Glacial time and the Holocene; with subdivision into (3a) Late Glacial time, c. 13,000 - 12,000 yBP, (3b) Pleistocene-Holocene transition, c. 12,000 - 9,000 yBP, and (3c) Atlantic and Subboreal periods of the Holocene, c. 8,000 - 3,700 yBP (Figs. 2 - 4).

RESULTS AND DISCUSSION

The distribution of ¹⁴C-dated mammoth remains in Northern Asia is presented in Figure 1. There are two latitudinal ‘belts’ with the highest concentration of ¹⁴C dates: (a) in the Arctic; and (b) in the southern part of both Western and Central Siberia. However, this does not mean that the mammoth habitat was divided into northern and southern parts. In our opinion, mammoth

existed in the Late Pleistocene in the whole of Northern Asia. The mammoth remains were found throughout Siberia, in northern Kazakhstan and Mongolia, in northeastern China and North Korea, and on the Sakhalin and Hokkaido Islands (cf. Baryshnikov & Markova 1992; Markova *et al.* 1995). During Karginian and Early Sartan times, c. 55,000 - 20,000 yBP, mammoth inhabited all Northern Asia (Figs. 2 and 3). There is no observed difference in the size of mammoth habitat between warm and cold stages; for example compare Lipovka-Novoselovo (Fig. 2: b) and Konoschelye (Fig. 2: c). For the Last Glacial Maximum, we have so far only 15 ¹⁴C dates (4.9% of the total) from 13 localities. They concentrate in two regions, the High Arctic and the middle section of the Yenisey River (Fig. 3: b). Most probably, because of insuffi-

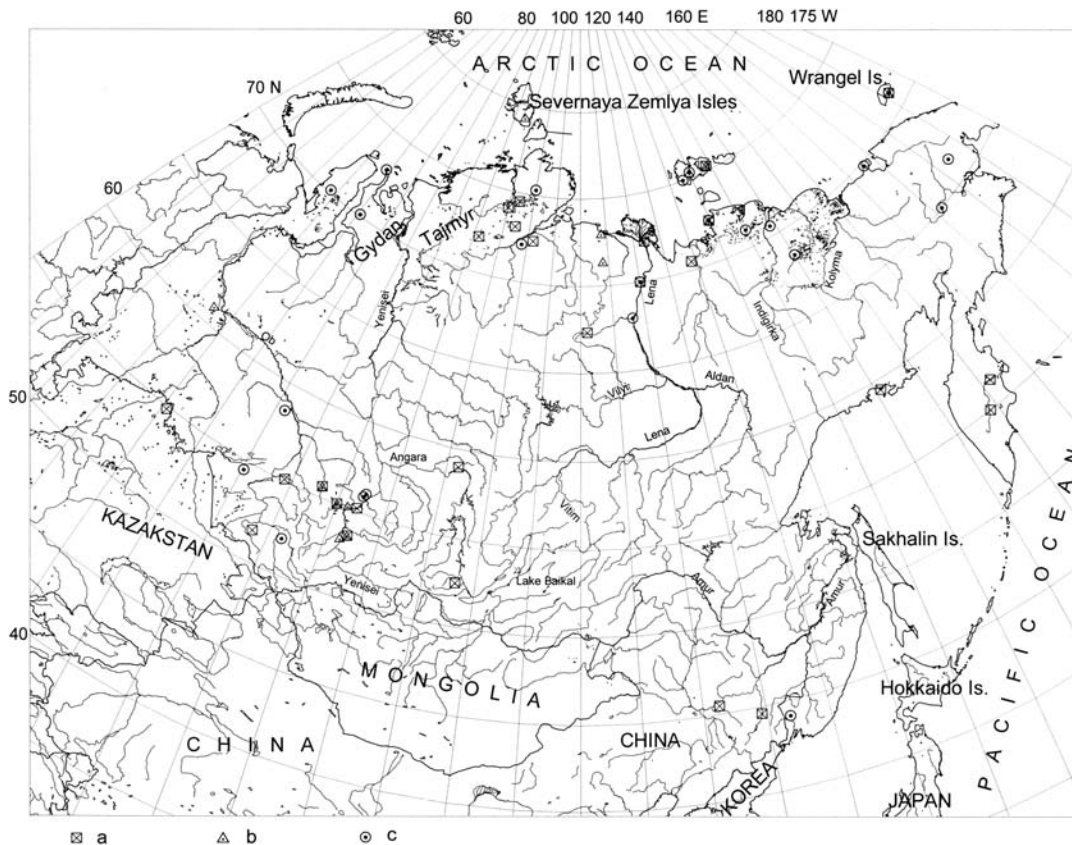


Figure 3 The distribution of radiocarbon-dated mammoth remains in Northern Asia in Sartan Glacial period: **a** 24,000 - 20,000 yBP; **b** 20,000 - 18,000 yBP; **c** 18,000 - 13,000 yBP.

cient ^{14}C data, this picture does not reflect the real distribution of mammoth at c. 20,000 - 18,000 yBP. Mammoth bones were identified on several Upper Paleolithic sites corresponding with the Last Glacial Maximum, e.g. Malta and Buret in the headwaters of the Angara River, Kunalei in the Transbaikal, and Ikhine 2 and Verkhne-Troitskaya in Yakutia (Ravsky 1972; Mochanov 1977; Tseitlin 1979; Kuzmin & Orlova 1998). This shows that mammoth habitat during the Sartan Glacial Maximum covered the whole of Siberia, from the Severnaya Zemlya Islands to the Transbaikal (Fig 3: b).

As in Karginian and Early Sartan times, mammoths occupied all Northern Asia during Late Sartan and Late Glacial times, c. 18,000 - 12,000 yBP (Fig. 3: c and 4: a). There are finds of mammoth bones from two Upper Paleolithic

sites in the Yenisey River basin which correspond to Late Glacial time, c. 13,300 - 12,900 yBP, Bolshaya Slizneva and Kokorevo 2 (Tseitlin 1979; Kuzmin & Orlova 1998). Thus, until c. 12,000 yBP most of Siberia was still suitable for mammoths (Fig. 4: a).

However, at c. 12,000 yBP there was a major change in mammoth distribution in Northern Asia (Fig. 4: b). The mammoth habitat shrunk significantly, and only the lower part of the Indigirka River, the Taymyr Peninsula, and the Severnaya Zemlya Islands have yielded ^{14}C -dated mammoth remains for the period c. 12,000 - 10,000 yBP. About 10,000 yBP, mammoth became extinct in the Indigirka River basin, and survived only on the Taymyr and Gydan Peninsulas in the High Arctic, north of 69°N latitude (Fig. 4). This is consistent with previous conclusions by



Figure 4 The distribution of radiocarbon-dated mammoth remains in Northern Asia in Late Glacial and Holocene periods: **a** 13,000 - 12,000 yBP; **b** 12,000 - 9,000 yBP; **c** 8,000 - 3,700 yBP.

Sulerzhitsky (1997) and Sher (1997) that there was a sharp decrease in environments suitable for mammoth at c. 12,500 - 12,000 yBP. The youngest ¹⁴C dates for the Taymyr mammoths are c. 9,780 - 9,670 yBP, and for Gydan c. 9,730 - 9,600 yBP (Sulerzhitsky 1997, Vasil'chuk *et al.* 1997). In the mid-Holocene, c. 7,700 - 3,700 yBP, a small mammoth (*M. primigenius vrangeliensis*) survived on Wrangel Island (Vartanyan *et al.* 1993) (Fig. 4: c).

It is evident that mammoth population in Siberia successfully survived up to c. 12,000 yBP, in spite of repeated environmental changes from cold to warm phases and vice versa. At c. 12,000 yBP the irreversible contraction of mammoth environments began, and most probably this was connected with very specific process of final disappearance of particular

landscapes where mammoth could exist. However, it is not possible to explain the extinction of mammoth in continental Siberia at c. 9,700 - 9,600 yBP as the result of general global warming and consequent vegetation changes only, as was previously mentioned by Sher (1997).

CONCLUSION

The results presented are among the first attempts to analyse the history of woolly mammoth in Northern Eurasia using GIS technology. It is clear that mammoth existed throughout Northern Asia until c. 12,000 yBP, when the rapid decrease of mammoth habitat began. Most probably this process was due to the disappearance of its ecological niche as a result of climatic and vegetation changes driven by global warming.

ACKNOWLEDGEMENTS

We are grateful to colleagues who helped us to complete this paper; including dr Leopold D. Sulerzhitsky, dr Anastasia K. Markova, dr Anthony J. Stuart, dr Sergei L. Vartanyan, dr Natalia E. Zaretskaia, dr Sergei V. Alkin, dr Aleksander E. Igolnikov, and ms Ekaterina N. Kulik. We are also grateful to dr Anthony J. Stuart for correcting the English. Technical assistance in GIS processing was provided by the Novosibirsk Regional GIS Center, Siberian Branch of the Russian Academy of Sciences. This research was partially funded by the Russian Foundation for Fundamental Investigations (RFFI), Grants # 96-05-64837, 99-06-80348 and 00-06-80410; and by the Russian Foundation for Humanities Research (RGNF), Grant # 99-01-12010.

REFERENCES

- Arkhipov, S.A., Isayeva, L.L., Bespaly, V.G. & Glushkova, O.Y., 1986 - Glaciation of Siberia and Northeast USSR - *Quaternary Science Reviews* 5: 463-474
- Baranov, A.N. (ed.), 1969 - *Atlas of the USSR* - Ministry of Geodesy and Cartography, Moscow (in Russian)
- Baryshnikov, G.F. & Markova, A.K., 1992 - Main mammoth assemblages between 24,000 -12,000 yBP - in: Frenzel, B., Pecsli, M. & Velichko, A.A. (eds.) - *Atlas of Paleoclimates and Paleoenvironments of the Northern Hemisphere (Late Pleistocene-Holocene)* - Institute of Geography, Hungarian Academy of Sciences & Gustav Fisher Verlag, Budapest & Stuttgart, pp. 61, 127-129
- Chersky, I.D., 1891 - The description of post-Tertiary fossil animals, collected by New Siberian Expedition, 1885-1886 - *Memoirs of the Imperial Russian Academy of Sciences* 64 (Supplement 1): 1-706 (in Russian)
- Firsov, L.V., Panychev, V.A. & Orlova, L.A., 1985 - *The Catalogue of radiocarbon dates* - Institute of Geology and Geophysics Press, Siberian Branch of the USSR Academy of Sciences, Novosibirsk (in Russian)
- Ho, C.K. & Jiang, P., 1993 - Adaptations au Pléistocène Moyen et au Pléistocène Supérieur dans le Nord-Est de la Chine - *L'Anthropologie* 97 (2/3): 355-398
- Ives, J.W., Zhijun, Y., Beaudoin, A.B. & Qixiao, Y., 1994 - Human presence in Heilongjiang, China, along the Late Pleistocene periphery of Beringia - *Current Research in the Pleistocene* 11: 136-138
- Kind, N.V., 1974 - Geochronology of the Late Anthropogene according to isotopic data - *Nauka, Moscow* (in Russian)
- Korotky, A.M., Kovalukh, N.N. & Volkov, V.G., 1989 - Radiocarbon dating of Quaternary deposits (southern Russian Far East) - *Far Eastern Branch of the USSR Academy of Sciences, Vladivostok* (in Russian)
- Kuzmin, Y.V. & Orlova, L.A., 1998 - Radiocarbon chronology of the Siberian Paleolithic - *Journal of World Prehistory* 12 (1): 1-53
- Liu, T., & Li, X. - Mammoths in China - in: Martin, P.S. & Klein, R.G. (eds.) - *Quaternary Extinctions: A Prehistoric Revolution* - University of Arizona Press, Tucson, pp. 517-527
- Markova, A.K., Smirnov, N.G., Kozharinov, A.V., Kazantseva, N.E., Simakova, A.N. & Kitaev, L.M., 1995 - Late Pleistocene Distribution and Diversity of Mammals in Northern Eurasia (PALEOFAUNA Database) - *Paleontologia i Evolucio* 28/29: 5-143
- Mochanov, Y.A., 1977 - The most ancient stages of human settling of Northeast Asia - *Nauka, Novosibirsk* (in Russian)
- Orlova, L.A., 1979 - Radiocarbon age of the fossil mammoth remains on the USSR territory - *Bulletin of Siberian Branch of the USSR Academy of Sciences* 9 (6): 89-97 (in Russian)
- Ravsky, E.I., 1972 - Sedimentation in the Inner Asia in Anthropogene - *Nauka, Moscow* (in Russian)
- Sher, A.V., 1997 - Late-Quaternary extinction of large mammals in northern Eurasia: a new look at the Siberian contribution - in: Huntley, B., Cramer, W., Morgan, A.V., Prentice, H.C. & Allen, J.R.M. (eds.) - *Past and future rapid environmental changes: the spatial and evolutionary responses of terrestrial biota* - Springer-Verlag, Berlin, Heidelberg, New York, pp. 319-339
- Sulerzhitsky, L.D., 1997 - The features of radiocarbon chronology of mammoths in Siberia and northern Eastern Europe (as substratum for human colonization) - in: Velichko, A.A. & Soffer, O. (eds.) - *Humans settle the planet Earth: Global dispersal of hominids* - Institute of Geography, Russian Academy of Sciences, Moscow, pp. 184-202 (in Russian)
- Sulerzhitsky, L.D. & Romanenko, F.A., 1997 - The age and dispersal of 'mammoth' fauna of asiatic Transpolar regions (by radiocarbon data) -

Cryosphere of the Earth 1 (4): 12-19 (in Russian)
Tseitlin, S.M., 1979 - The geology of Paleolithic of the
Northern Asia - Nauka, Moscow (in Russian)
Vartanyan, S.L., Garutt, W.E. & Sher, A.V., 1993 -
Holocene dwarf mammoths from Wrangel Island in
Siberian Arctic - Nature 362: 337-340
Vasil'chuk, Y., Punning, J.-M. & Vasil'chuk, A., 1997 -
Radiocarbon ages of mammoths in Northern Eurasia:

implications for population development and Late
Quaternary environment - Radiocarbon 39 (1): 1-18
Velichko, A.A. (ed.), 1984 - Late Quaternary
Environments of the Soviet Union - University of
Minnesota Press, Minneapolis

Received 27 April 1999

APPENDIX Radiocarbon dates of the woolly mammoth remains in Northern Asia.

No.	Site name	Latitude, °N	Longitude, °E-W	Age, yr YBP	±1σ	Lab Code and No.	Reference
1	Wrangel Island	71.00	179.00 W	3,730	40	LU-2741	Vasil'chuk et al. 1997
2	Wrangel Island	71.00	179.00 W	3,920	30	GIN-6980	Sulerzhitsky 1997
3	Wrangel Island	71.00	179.00 W	4,010	50	LU-2798	Vasil'chuk et al. 1997
4	Wrangel Island	71.00	179.00 W	4,040	30	LU-2808	Vasil'chuk et al. 1997
5	Wrangel Island	71.00	179.00 W	4,370	70	GIN-8249	Vasil'chuk et al. 1997
6	Wrangel Island	71.00	179.00 W	4,400	40	LU-2756	Vasil'chuk et al. 1997
7	Wrangel Island	71.00	179.00 W	4,410	50	LU-2768	Vasil'chuk et al. 1997
8	Wrangel Island	71.00	179.00 W	4,740	40	LU-2556	Vasil'chuk et al. 1997
9	Wrangel Island	71.00	179.00 W	4,900	40	LU-2740	Vasil'chuk et al. 1997
10	Wrangel Island	71.00	179.00 W	5,110	40	LU-2794	Vasil'chuk et al. 1997
11	Wrangel Island	71.00	179.00 W	5,200	30	LU-2745	Vasil'chuk et al. 1997
12	Wrangel Island	71.00	179.00 W	5,250	40	LU-2744	Vasil'chuk et al. 1997
13	Wrangel Island	71.00	179.00 W	5,310	90	LU-2742	Vasil'chuk et al. 1997
14	Wrangel Island	71.00	179.00 W	5,480	50	LU-2535	Vasil'chuk et al. 1997
15	Wrangel Island	71.00	179.00 W	6,260	50	LU-2799	Vasil'chuk et al. 1997
16	Wrangel Island	71.00	179.00 W	6,360	60	AA-11529	Vasil'chuk et al. 1997
17	Wrangel Island	71.00	179.00 W	6,610	50	LU-2558	Vasil'chuk et al. 1997
18	Wrangel Island	71.00	179.00 W	6,760	50	LU-2736	Vasil'chuk et al. 1997
19	Wrangel Island	71.00	179.00 W	6,890	50	LU-2810	Vasil'chuk et al. 1997
20	Wrangel Island	71.00	179.00 W	7,040	60	LU-2746	Vasil'chuk et al. 1997
21	Wrangel Island	71.00	179.00 W	7,250	60	LU-2809	Vasil'chuk et al. 1997
22	Wrangel Island	71.00	179.00 W	7,295	95	AA-11530	Vasil'chuk et al. 1997
23	Wrangel Island	71.00	179.00 W	7,360	50	LU-2559	Vasil'chuk et al. 1997
24	Wrangel Island	71.00	179.00 W	7,710	40	GIN-6995	Sulerzhitsky 1997
25	Yuribey River, Gydan Peninsula	68.92	76.00 E	9,600	300	VSEGINGEO	Vasil'chuk et al. 1997
26	Nizhnaya Taymyra River	75.25	99.73 E	9,670	60	GIN-1828	Sulerzhitsky 1997
27	Yuribey River, Gydan Peninsula	68.92	76.00 E	9,730	100	MGU-763	Vasil'chuk et al. 1997
28	Taymyr Peninsula	76.00	113.00 E	9,780	40	GIN-8256	Sulerzhitsky & Romanenko 1997
29	Nizhnaya Taymyra River	75.25	99.73 E	9,860	50	GIN-1495	Sulerzhitsky 1997
30	Yuribey River, Gydan Peninsula	68.92	76.00 E	10,000	70	LU-1153	Sulerzhitsky 1997
31	Engelgardt Lake	75.10	110.30 E	10,100	100	GIN-1489	Sulerzhitsky 1997
32	Nizhnaya Taymyra River	75.25	99.73 E	10,300	100	GIN-1828k	Sulerzhitsky 1997
33	Mutnaya Seyakha River	70.15	69.00 E	10,350	50	GIN-6386	Sulerzhitsky 1997
34	Berelekh River	70.55	149.05 E	10,370	70	SOAN-327	Vasil'chuk et al. 1997
35	Nganasanskaya River	71.26	92.72 E	10,680	70	GIN-3768	Sulerzhitsky 1997
36	Taymyr Lake, Baykura-Neru	74.05	93.10 E	11,140	180	GIN-3067	Sulerzhitsky 1997
37	Mamont River	75.15	96.00 E	11,450	250	T-297	Sulerzhitsky 1997
38	Severnaya Zemiya Islands	79.30	98.00 E	11,500	60	LU-610	Sulerzhitsky 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	±σ	Lab Code and No.	Reference
39	Berelekh River	70.55	149.05 E	12,000	130	LU-149	Sulerzhitsky 1997
40	Wrangel Island	71.00	179.00 W	12,010	110	LU-2823	Vasil'chuk <i>et al.</i> 1997
41	Taymyr Lake, Baskura	74.03	100.00 E	12,100	80	GIN-1783	Sulerzhitsky 1997
42	Berelekh River	70.55	149.05 E	12,240	160	LU-149	Sulerzhitsky 1997
43	Severnaya River	75.50	112.00 E	12,260	120	GIN-2943g	Sulerzhitsky 1997
44	Severnaya River	75.50	112.00 E	12,450	120	GIN-3242	Sulerzhitsky 1997
45	Dyuktai Cave, layer 7a	59.25	132.67 E	12,520	250	IM-462	Mochanov 1977
46	Atchagyi-Allaikha River	69.00	147.30 E	12,530	60	SOAN-2203	Vasil'chuk <i>et al.</i> 1997
47	Batpak	50.50	72.75 E	12,570	400	KIGN-199	Sulerzhitsky 1997
48	Atchagyi-Allaikha River	69.00	147.30 E	12,570	80	MAG-826	Sulerzhitsky 1997
49	Kamchatka River, Urz	55.00	159.00 E	12,630	50	GIN-3420	Sulerzhitsky 1997
50	Wrangel Island	71.00	179.00 W	12,750	50	GIN-6987	Vasil'chuk <i>et al.</i> 1997
51	Bikada River	74.53	106.30 E	12,780	80	GIN-2677	Sulerzhitsky 1997
52	Berelekh River	70.55	149.05 E	12,850	110	LU-1055	Sulerzhitsky 1997
53	Beryozovsky	59.00	69.00 E	12,860	90	SOAN-1283	Sulerzhitsky 1997
54	Xiaonanshan	46.78	134.03 E	12,900	410	PV-0179	Liu & Li 1984
55	Ayon Island	69.78	168.00 E	12,950	130	GIN-8241	Sulerzhitsky & Romanenko 1997
56	Wrangel Island	71.00	179.00 W	12,980	80	LU-2792	Vasil'chuk <i>et al.</i> 1997
57	Berelekh River	70.55	149.05 E	13,205	150	LE-2335	Mochanov 1977
58	Bolshaya Balachnya River	75.30	105.00 E	13,340	240	GIN-2758a	Sulerzhitsky 1997
59	Afontova Gora 2, layer 3a	56.10	92.50 E	13,350	60	GIN-7539	Sulerzhitsky 1997
60	Volchya Griva	54.50	80.20 E	13,600	230	SOAN-111	Orlova 1979
61	Shokals'kogo Island	73.00	74.40 E	13,650	170	GIN-8427	Sulerzhitsky & Romanenko 1997
62	Kotel'nyy Island	75.00	138.00 E	13,700	100	GIN-8230	Sulerzhitsky & Romanenko 1997
63	Berelekh River	71.00	145.00 E	13,700	800	MAG-114	Vasil'chuk <i>et al.</i> 1997
64	Khorol	44.15	131.78 E	13,750	780	TIG-51	Korotky <i>et al.</i> 1989
65	Afontova Gora 2, layer 4	56.10	92.50 E	13,930	80	GIN-7541	Sulerzhitsky 1997
66	Ayon Island	69.78	168.00 E	14,000	120	GIN-8242	Sulerzhitsky & Romanenko 1997
67	Ayon Island	69.78	168.00 E	14,120	170	GIN-8241a	Sulerzhitsky & Romanenko 1997
68	Volchya Griva	54.50	80.20 E	14,200	150	SOAN-78	Orlova 1979
69	Lena River	68.00	123.00 E	14,340	50	GIN-4115	Sulerzhitsky 1997
70	Chukotka Peninsula	66.30	177.00 E	14,380	70	GIN-7289	Sulerzhitsky 1997
71	Zelyonaya Seyakha River	70.15	69.00 E	14,400	80	GIN-7292	Sulerzhitsky 1997
72	Ulakhan-Yuryakh River	72.12	104.00 E	14,800	50	GIN-3518	Sulerzhitsky 1997

APPENDIX (continued)

No.	Site name	Latitude, ° N	Longitude, ° E/W	Age, yr YBP	±1σ	Lab Code and No.	Reference
73	Volchya Griva	54.50	80.20 E	14,800	150	SOAN-111A	Orlova 1979
74	Shirokostas Peninsula	72.36	139.73 E	15,000	70	GIN-8255	Sulerzhitsky & Romanenko 1997
75	Mayn River	65.00	171.00 E	15,100	70	GIN-5370	Sulerzhitsky 1997
76	Kolyma River	68.45	150.00 E	15,130	50	GIN-6023	Sulerzhitsky 1997
77	Kolyma River	68.45	150.00 E	15,130	90	GIN-6024	Sulerzhitsky 1997
78	Kolyma River	68.45	150.00 E	15,200	80	GIN-6024bis	Sulerzhitsky 1997
79	Khorol	44.15	131.78 E	15,300	140	Ki-1130	Korotky et al. 1989
80	Wrangel Island	71.00	179.00 W	15,400	100	GIN-8258	Sulerzhitsky & Romanenko 1997
81	Kotel'nyy Island	75.30	140.00 E	15,420	100	LU-1671	Vasil'chuk et al. 1997
82	Bolshoi Istok	58.50	81.05 E	16,000	385	SOAN-3835	This paper
83	Listvenka, layer 19	55.92	92.33 E	16,300	600	GIN-6093	Kuzmin & Orlova 1998
84	Bolshaya Balachnya River	75.30	105.00 E	16,330	100	GIN-3130	Sulerzhitsky 1997
85	Isha River	52.01	86.32 E	17,220	245	SOAN-3504	This paper
86	Khorol	44.15	131.78 E	17,400	150	Ki-1301	Korotky et al. 1989
87	Parisento River	70.11	75.46 E	17,500	300	GIN-7576	Sulerzhitsky 1997
88	Isha River	52.01	86.32 E	17,600	500	SOAN-3503	This paper
89	Lower Lena River	70.00	125.00 E	17,780	80	GIN-5042	Sulerzhitsky 1997
90	Shestakovo	55.64	88.00 E	18,040	175	SOAN-3610	Kuzmin & Orlova 1998
91	Khanty Mansiysk	61.00	67.51 E	18,250	1,100	SOAN-3838	This paper
92	Faddeyevskiy Island	75.26	144.00 E	18,500	120	GIN-8229	Sulerzhitsky & Romanenko 1997
93	Shlenka	53.55	92.00 E	18,600	2,000	GIN-2862	Sulerzhitsky 1997
94	Bur	71.40	119.00 E	18,680	120	GIN-5046	Sulerzhitsky 1997
95	Amydai	73.00	119.00 E	18,700	100	GIN-6099	Sulerzhitsky 1997
96	Tarachikha	55.15	91.10 E	18,930	320	LE-3834	Kuzmin & Orlova 1998
97	Shestakovo	55.64	88.00 E	19,190	310	SOAN-3609	Kuzmin & Orlova 1998
98	Severnaya Zemlya Islands	79.30	98.00 E	19,270	300	LU-654B	Sulerzhitsky 1997
99	Middle Yenisey River	53.55	92.00 E	19,500	200	GIN-2859	Sulerzhitsky 1997
100	Minusinsk Depression	53.30	91.40 E	19,700	200	GIN-2861	Sulerzhitsky 1997
101	Chulym River	55.05	90.00 E	19,960	80	GIN-3016	Sulerzhitsky 1997
102	Severnaya Zemlya Islands	79.30	98.00 E	19,970	110	LU-688	Sulerzhitsky 1997
103	Kotel'nyy Island	75.30	140.00 E	19,990	110	LU-1970	Sulerzhitsky 1997
104	Wrangel Island	71.00	179.00 W	20,000	110	LU-2807	Vasil'chuk et al. 1997
105	Shlenka	55.20	92.05 E	20,100	100	GIN-2863	Sulerzhitsky 1997
106	Shirokostas Peninsula	72.36	139.73 E	20,100	150	GIN-8263	Sulerzhitsky & Romanenko 1997
107	Middle Yenisey River	53.55	92.00 E	20,100	300	GIN-3017	Sulerzhitsky 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr.YBP ±1σ	Lab Code and No.	Reference
108	Mogochino	51.75	83.52 E	20,140	SOAN-1513	Kuzmin & Orlova 1998
109	Chulym River	55.05	90.00 E	20,200	GIN-2860	Sulerzhitsky 1997
110	Dudypa River	72.00	96.00 E	20,400	GIN-3952	Sulerzhitsky 1997
111	Shestakovo	55.64	88.00 E	20,480	SOAN-3607	Kuzmin & Orlova 1998
112	San Zhan	45.50	126.33 E	20,580	ZK-425-0	Liu & Li 1984
113	Belaya River	52.50	103.10 E	20,700	GIN-7709	Kuzmin & Orlova 1998
114	Shestakovo	55.64	88.00 E	20,770	SOAN-3218	Kuzmin & Orlova 1998
115	Faddeyskiy Island	75.25	144.00 E	20,900	GIN-5760	Sulerzhitsky 1997
116	Mudanjiang	44.63	129.58 E	20,910	ZK-118-0	Liu & Li 1984
117	Lower Lena River	70.00	125.00 E	21,260	LU-786	Sulerzhitsky 1997
118	Pakhcha River	56.35	161.00 E	21,300	GIN-2224	Sulerzhitsky 1997
119	Shestakovo	55.64	88.00 E	21,300	SOAN-3611	Kuzmin & Orlova 1998
120	Tanon River	59.45	150.55 E	21,600	GIN-6309	Sulerzhitsky 1997
121	Belaya River	52.50	103.10 E	21,600	GIN-7708	Kuzmin & Orlova 1998
122	Bykovskiy Peninsula	72.25	127.00 E	21,630	LU-1328	Sulerzhitsky 1997
123	Kamchatka River, Generalka	55.00	159.15 E	21,750	GIN-5299B	Sulerzhitsky 1997
124	Popigay River	72.40	106.00 E	22,000	GIN-5574	Sulerzhitsky 1997
125	Shestakovo	55.64	88.00 E	22,240	SOAN-3612	Kuzmin & Orlova 1998
126	Shestakovo	55.64	88.00 E	22,290	SOAN-1380	Kuzmin & Orlova 1998
127	Wrangel Island	71.00	179.00 W	22,400	GIN-8257	Sulerzhitsky & Romanenko 1997
128	Wrangel Island	71.00	179.00 W	22,400	GIN-8259	Sulerzhitsky & Romanenko 1997
129	Shestakovo	55.64	88.00 E	22,410	LU-104	Kuzmin & Orlova 1998
130	Kiya River	55.64	88.00 E	22,450	SOAN-1467	Firsov <i>et al.</i> 1985
131	Taymyr Lake, Baskura	74.03	100.00 E	22,750	GIN-3089	Sulerzhitsky 1997
132	Shestakovo	55.64	88.00 E	22,990	SOAN-1386	Firsov <i>et al.</i> , 1985
133	Tyung	67.35	116.00 E	23,100	GIN-3232	Sulerzhitsky 1997
134	Boderbo-Tarida River	73.06	102.16 E	23,500	GIN-2763a	Sulerzhitsky 1997
135	Middle-Angara River	59.00	101.30 E	23,600	GIN-5886	Sulerzhitsky 1997
136	Uspenka	54.87	70.50 E	23,670	KIGN-397f	Sulerzhitsky 1997
137	Kudelin Kluch	55.12	84.24 E	23,760	SOAN-3634	This paper
138	Taymyr Lake, Sablera	74.50	102.00 E	23,800	GIN-1296B	Sulerzhitsky 1997
139	Faddeyskiy Island	75.26	144.00 E	23,940	GIN-8244	Sulerzhitsky & Romanenko 1997
140	Kular	70.50	134.23 E	24,000	GIN-7166	Vasil'chuk <i>et al.</i> 1997
141	Batpak-7	50.50	72.75 E	24,650	SOAN-2712	This paper
142	Taymyr Lake, Baskura	73.04	100.00 E	24,900	GIN-2160	Sulerzhitsky 1997
143	Severnaya Zemiya Islands	79.30	98.00 E	25,030	LU-749B	Vasil'chuk <i>et al.</i> 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	±1σ	Lab Code and No.	Reference
144	Pyasina River	72.50	87.00 E	25,100	500	LE-612	Vasil'chuk et al. 1997
145	Faddeyevskiy Island	75.26	144.00 E	25,180	150	GIN-8227	Sulerzhitsky & Romanenko 1997
146	Faddeyevskiy Island	75.26	144.00 E	25,200	180	GIN-8246	Sulerzhitsky & Romanenko 1997
147	Laptev Sea Coast	70.45	131.00 E	25,300	600	GIN-3502	Sulerzhitsky 1997
148	Yuribey River, Gydan	70.30	75.50 E	25,400	300	GIN-2210	Vasil'chuk et al. 1997
149	Faddeyevskiy Island	75.26	144.00 E	25,540	170	GIN-8532	Sulerzhitsky & Romanenko 1997
150	Mingyuegou	43.11	128.91 E	25,790	550	WB-78-41	Liu & Li 1984
151	Faddeyevskiy Island	75.25	144.00 E	25,800	200	GIN-4710B	Sulerzhitsky 1997
152	Zhalainuoer	49.35	117.58 E	25,920	1,300	PV-0175	Liu & Li 1984
153	Chekurovka	71.05	127.30 E	26,000	1,600	Mo-215	Sulerzhitsky 1997
154	Lopatka Peninsula	71.83	150.00 E	26,680	200	GIN-8237	Sulerzhitsky & Romanenko 1997
155	Gulya River	70.05	100.30 E	26,700	700	GIN-1216	Sulerzhitsky 1997
156	Faddeyevskiy Island	75.26	144.00 E	27,100	300	GIN-8224	Sulerzhitsky & Romanenko 1997
157	Yambuto Lake	71.02	79.20 E	27,200	500	GIN-2021b	Vasil'chuk et al. 1997
158	Logata River	73.00	98.00 E	27,300	200	GIN-3836	Sulerzhitsky 1997
159	Kubalakh River	73.00	97.12 E	27,500	300	GIN-3929	Sulerzhitsky 1997
160	Laptev Sea Coast	70.45	131.00 E	27,500	300	GIN-3505	Sulerzhitsky 1997
161	Irkutsk	53.00	104.40 E	27,615	2,015	SOAN-2222	Firsov et al. 1985
162	Faddeyevskiy Island	75.25	144.00 E	28,000	200	GIN-4710	Sulerzhitsky 1997
163	Yamal Peninsula	71.00	66.50 E	28,300	350	GIN-8545	Sulerzhitsky & Romanenko 1997
164	Srednekan River	62.45	150.30 E	28,400	300	GIN-5696	Romanenko 1997
165	Terpyi-Tumus Peninsula	73.55	118.50 E	28,400	340	GIN-8220	Sulerzhitsky & Romanenko 1997
166	Urtuiskoe	50.11	118.00 E	28,525	200	SOAN-3440	This paper
167	Duvanny Yar	68.45	150.45 E	28,600	300	GIN-3867	Sulerzhitsky 1997
168	Faddeyevskiy Island	75.26	144.00 E	28,650	350	GIN-8225	Sulerzhitsky & Romanenko 1997
169	Lopatka Peninsula	71.83	150.00 E	28,680	200	GIN-8237	Sulerzhitsky & Romanenko 1997
170	Katun River	51.43	85.35 E	28,730	995	SOAN-2301	Romanenko 1997
171	Shrenk River	75.15	98.00 E	28,800	600	GIN-952	Firsov et al. 1985
172	Kuznetsky Basin	54.35	86.21 E	28,870	600	SOAN-2026	Sulerzhitsky 1997
173	Zhoujiayoufang	44.76	126.53 E	28,880	1,220	WB-78-45	Firsov et al., 1985 Liu & Li 1984

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	$\pm 1\sigma$	Lab Code and No.	Reference
174	Anabarka River	72.40	106.00 E	28,900	300	GIN-5073	Sulerzhitsky 1997
175	Kotel'nyy Island	75.30	140.00 E	29,020	190	LU-1791	Sulerzhitsky 1997
176	Faddeyskiy Island	75.25	144.00 E	29,100	400	GIN-4330	Sulerzhitsky 1997
177	Faddeyskiy Island	75.25	144.00 E	29,100	1,000	GIN-4711	Sulerzhitsky 1997
178	Yamal Peninsula	67.10	68.00 E	29,300	300	GIN-6386A	Vasil'chuk <i>et al.</i> 1997
179	Anabar River	72.15	113.30 E	29,400	400	GIN-3310	Sulerzhitsky 1997
180	Taymyr Lake, Matuda	74.50	102.63 E	29,500	300	GIN-2155	Sulerzhitsky 1997
181	Sanga-Yuryakh	64.00	126.00 E	29,500	3,000	T-170	Vasil'chuk <i>et al.</i> 1997
182	Tyung	67.35	116.00 E	29,600	500	GIN-3234	Sulerzhitsky 1997
183	Faddeyskiy Island	75.26	144.00 E	29,700	250	GIN-8260	Sulerzhitsky & Romanenko 1997
184	Lopatka Peninsula	71.83	150.00 E	29,900	300	GIN-8236	Sulerzhitsky & Romanenko 1997
185	Terpyi-Tumus Peninsula	73.55	118.50 E	30,000	300	GIN-8218	Sulerzhitsky & Romanenko 1997
186	Kamchatka River, Bolshoy Yar	56.00	159.75 E	30,000	300	GIN-3415	Sulerzhitsky 1997
187	Gyda River	70.30	77.30 E	30,250	1,800	T-298	Vasil'chuk <i>et al.</i> 1997
188	Bol'shoi Khomus-Yuryakh River	71.16	153.45 E	30,400	300	GIN-6023a	Vasil'chuk <i>et al.</i> 1997
189	Borgo-Tokur River	71.00	117.01 E	30,600	1,240	SOAN-3030	This paper
190	Kamenka-I, unit A	51.87	108.15 E	31,060	530	SOAN-3133	Kuzmin & Orlova 1998
191	Enmynveem River	66.30	173.70 E	31,100	900	MAG-1000B	Vasil'chuk <i>et al.</i> 1997
192	Enmynveem River	66.30	173.70 E	31,370	900	MAG-1000A	Vasil'chuk <i>et al.</i> 1997
193	Faddeyskiy Island	75.26	144.00 E	31,400	300	GIN-8226	Sulerzhitsky & Romanenko 1997
194	Yekaryayukha River	71.55	80.66 E	31,500	1,000	T-298	Vasil'chuk <i>et al.</i> 1997
195	Lower Lena River	70.00	125.00 E	31,500	2,000	T-170(3)	Sulerzhitsky 1997
196	Lower Keinguveem River	69.60	164.80 E	31,530	420	GIN-8240	Sulerzhitsky & Romanenko 1997
197	Beryozovka River	67.15	157.30 E	31,750	2,500	T-299	Vasil'chuk <i>et al.</i> 1997
198	Severnaya River	75.50	112.00 E	31,800	500	GIN-3240a	Sulerzhitsky 1997
199	Sualerna River	73.00	112.00 E	31,900	300	GIN-5726	Sulerzhitsky 1997
200	Bolshaya Balachnya River	75.30	105.00 E	32,000	200	GIN-3117	Sulerzhitsky 1997
201	Taymyr Lake, Matuda	74.50	102.63 E	32,000	500	GIN-2151	Sulerzhitsky 1997
202	Enmynveem River	66.30	173.70 E	32,000	3,000	MAG-1124	Vasil'chuk <i>et al.</i> 1997
203	Bol'shoi Lyakhovskiy Island	73.30	142.00 E	32,100	900	MAG-316	Vasil'chuk <i>et al.</i> 1997
204	Popigay River	72.40	106.00 E	32,300	400	GIN-5074	Sulerzhitsky 1997
205	Zhalanuoer	49.35	117.58 E	32,430	1,700	PV-0170	Liu & Li 1984
206	Geographical Society Cave	42.87	133.00 E	32,570	1,510	IGAN-341	Kuzmin & Orlova 1998
207	Pyasina River	73.95	85.75 E	32,600	700	GIN-8261	Sulerzhitsky &

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	±1σ	Lab Code and No.	Reference
174	Anabarka River	72.40	106.00 E	28,900	300	GIN-5073	Sulerzhitsky 1997
175	Kotel'nyy Island	75.30	140.00 E	29,020	190	LU-1791	Sulerzhitsky 1997
176	Faddeyskiy Island	75.25	144.00 E	29,100	400	GIN-4330	Sulerzhitsky 1997
177	Faddeyskiy Island	75.25	144.00 E	29,100	1,000	GIN-4711	Sulerzhitsky 1997
178	Yamal Peninsula	67.10	68.00 E	29,300	300	GIN-6386A	Vasil'chuk et al. 1997
179	Anabar River	72.15	113.30 E	29,400	400	GIN-3310	Sulerzhitsky 1997
180	Taymyr Lake, Matuda	74.50	102.63 E	29,500	300	GIN-2155	Sulerzhitsky 1997
181	Sanga-Yuryakh	64.00	126.00 E	29,500	3,000	T-170	Vasil'chuk et al. 1997
182	Tyung	67.35	116.00 E	29,600	500	GIN-3234	Sulerzhitsky 1997
183	Faddeyskiy Island	75.26	144.00 E	29,700	250	GIN-8260	Sulerzhitsky & Romanenko 1997
184	Lopatka Peninsula	71.83	150.00 E	29,900	300	GIN-8236	Sulerzhitsky & Romanenko 1997
185	Terpyi-Tumus Peninsula	73.55	118.50 E	30,000	300	GIN-8218	Sulerzhitsky & Romanenko 1997
186	Kamchatka River, Bolshoy Yar	56.00	159.75 E	30,000	300	GIN-3415	Sulerzhitsky 1997
187	Gyda River	70.30	77.30 E	30,250	1,800	T-298	Vasil'chuk et al. 1997
188	Bolshoi Khomus-Yuryakh River	71.16	153.45 E	30,400	300	GIN-6023a	Vasil'chuk et al. 1997
189	Borgo-Tokur River	71.00	117.01 E	30,600	1,240	SOAN-3030	This paper
190	Kamenka-I, unit A	51.87	108.15 E	31,060	530	SOAN-3133	Kuzmin & Orlova 1998
191	Enmynveem River	66.30	173.70 E	31,100	900	MAG-1000B	Vasil'chuk et al. 1997
192	Enmynveem River	66.30	173.70 E	31,370	900	MAG-1000A	Vasil'chuk et al. 1997
193	Faddeyskiy Island	75.26	144.00 E	31,400	300	GIN-8226	Sulerzhitsky & Romanenko 1997
194	Yekaryauakha River	71.55	80.66 E	31,500	1,000	T-298	Vasil'chuk et al. 1997
195	Lower Lena River	70.00	125.00 E	31,500	2,000	T-170(3)	Sulerzhitsky 1997
196	Lower Keinguveem River	69.60	164.80 E	31,530	420	GIN-8240	Sulerzhitsky & Romanenko 1997
197	Beryozovka River	67.15	157.30 E	31,750	2,500	T-299	Vasil'chuk et al. 1997
198	Severnaya River	75.50	112.00 E	31,800	500	GIN-3240a	Sulerzhitsky 1997
199	Sualema River	73.00	112.00 E	31,900	300	GIN-5726	Sulerzhitsky 1997
200	Bolshaya Balachnya River	75.30	105.00 E	32,000	200	GIN-3117	Sulerzhitsky 1997
201	Taymyr Lake, Matuda	74.50	102.63 E	32,000	500	GIN-2151	Sulerzhitsky 1997
202	Enmynveem River	66.30	173.70 E	32,000	3,000	MAG-1124	Vasil'chuk et al. 1997
203	Bolshoy Lyakhovskiy Island	73.30	142.00 E	32,100	900	MAG-316	Vasil'chuk et al. 1997
204	Popigay River	72.40	106.00 E	32,300	400	GIN-5074	Sulerzhitsky 1997
205	Zhalainuoer	49.35	117.58 E	32,430	1,700	PV-0170	Liu & Li 1984
206	Geographical Society Cave	42.87	133.00 E	32,570	1,510	IGAN-341	Kuzmin & Orlova 1998
207	Pyasina River	73.95	85.75 E	32,600	700	GIN-8261	Sulerzhitsky & Romanenko 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	±σ	Lab Code and No.	Reference
208	Sanga-Yuryakh	64.00	126.00	32,650	2,500	T-170	Vasil'chuk <i>et al.</i> 1997
209	Enmynveem River	66.30	173.70 E	32,810	720	MAG-1001A	Vasil'chuk <i>et al.</i> 1997
210	Enmynveem River	66.30	173.70 E	32,850	900	MAG-1000A	Vasil'chuk <i>et al.</i> 1997
211	Pirkanaivayam River	68.03	166.00 E	32,850	900	MAG-1000	Vasil'chuk <i>et al.</i> 1997
212	Enmynveem River	66.30	173.70 E	32,890	1,200	MAG-1001B	Vasil'chuk <i>et al.</i> 1997
213	Gyda River	70.30	77.30 E	33,500	1,000	T-298(g)	Sulerzhitsky 1997
214	Lopatka Peninsula	71.83	150.00 E	33,600	500	GIN-8233	Sulerzhitsky & Romanenko 1997
215	Duvanny Yar	68.45	150.45 E	33,800	500	GIN-3861	Sulerzhitsky 1997
216	Mingyuegou	43.11	128.91 E	34,310	1,850	WB-78-42	Liu & Li 1984
217	Kotel'nyy Island	75.00	138.00 E	34,400	400	GIN-8254	Sulerzhitsky & Romanenko 1997
218	Bykovskiy Channel	72.25	127.00 E	34,450	2,500	T-171	Sulerzhitsky 1997
219	Schuchya River	67.10	68.00 E	34,500	300	GIN-6475A	Vasil'chuk <i>et al.</i> 1997
220	Faddeyevskiy Island	75.26	144.00 E	34,500	500	GIN-8247	Sulerzhitsky & Romanenko 1997
221	Duvanny Yar	68.45	150.45 E	34,700	400	GIN-4434	Vasil'chuk <i>et al.</i> 1997
222	Logata River	73.00	98.00 E	35,000	500	GIN-3821	Sulerzhitsky 1997
223	Laptev Sea Coast	70.45	131.00 E	35,000	300	GIN-3503	Sulerzhitsky 1997
224	Faddeyevskiy Island	75.26	144.00 E	35,210	500	GIN-8243	Sulerzhitsky & Romanenko 1997
225	Gyda River	70.30	77.30 E	35,500	1,100	T-298	Sulerzhitsky 1997
226	Bykovskiy Channel	72.25	127.00 E	35,800	1,200	T-171 (2)	Sulerzhitsky 1997
227	Bell'kovskiy Island	75.63	135.83 E	35,800	700	GIN-8223	Sulerzhitsky & Romanenko 1997
228	Mokhovaya River	72.00	85.30 E	35,800	2,700	T-169(3)	Sulerzhitsky 1997
229	Tirekhtyakh River	69.30	147.15 E	35,830	630	LU-504	Vasil'chuk <i>et al.</i> 1997
230	Anabar-Olenek Interfluve	73.60	117.00 E	35,900	500	GIN-8262	Sulerzhitsky & Romanenko 1997
231	Kamchatka River, Nikolka Yar	55.00	159.00 E	36,000	500	GIN-3425	Sulerzhitsky 1997
232	Faddeyevskiy Island	75.26	144.00 E	36,000	500	GIN-8238	Sulerzhitsky & Romanenko 1997
233	Logata River	73.00	98.00 E	36,200	500	GIN-3822	Sulerzhitsky 1997
234	Shandrin River	71.20	150.30 E	36,450	420	SOAN-1005	Firsov <i>et al.</i> 1985
235	Anabarka River	72.40	106.00 E	36,600	500	GIN-5751	Sulerzhitsky 1997
236	Faddeyevskiy Island	75.26	144.00 E	36,700	500	GIN-8243a	Sulerzhitsky & Romanenko 1997
237	Bolshaya Balachnya River	75.30	105.00 E	36,800	500	GIN-3122	Romanenko 1997
238	Mokhovaya River	72.00	85.30 E	36,950	4,300	T-169	Sulerzhitsky 1997 Vasil'chuk <i>et al.</i> 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, yr YBP	±1σ	Lab Code and No.	Reference
239	Semiriskay River	72.00	110.55 E	37,000	500	GIN-5750	Sulerzhitsky 1997
240	Khatanga River	72.30	104.30 E	38,000	1,500	GIN-942	Sulerzhitsky 1997
241	Logata River	73.00	98.00 E	38,300	600	GIN-3817	Sulerzhitsky 1997
242	Bolshaya Balachnya River	75.30	105.00 E	38,400	700	GIN-3118	Sulerzhitsky 1997
243	Kandabaevo	50.90	108.48 E	38,460	1,100	SOAN-1625	Kuzmin & Orlova 1998
244	Boderbo-Tarida River	73.06	102.16 E	38,500	500	GIN-2763B	Sulerzhitsky 1997
245	Boderbo-Tarida River	73.06	102.16 E	38,500	600	GIN-3136	Sulerzhitsky 1997
245	Bolshaya Balachnya River	75.30	105.00 E	38,500	600	GIN-3073	Sulerzhitsky 1997
247	Lower Keinguveem River	69.60	164.80 E	38,500	900	GIN-8250	Sulerzhitsky & Romanenko 1997
248	Nemu-Dika-Tarida River	73.08	98.75 E	38,800	400	GIN-3476	Sulerzhitsky 1997
249	Trautfetter River	75.63	101.80 E	38,800	1,300	GIN-1491	Sulerzhitsky 1997
250	Xietian	45.00	127.60 E	38,800	3,500	AECV-1405c	Ives et al. 1994
251	Logata River	73.00	98.00 E	38,900	600	GIN-3831	Sulerzhitsky 1997
252	Kuznetskiy Basin	54.12	86.38 E	39,090	2,440	SOAN-2027	Firsov et al. 1985
253	Bolshaya Balachnya River	75.30	105.00 E	39,100	1,000	GIN-3120/P	Sulerzhitsky 1997
254	Bolshaya Balachnya River	75.30	105.00 E	39,200	700	GIN-3121/P	Sulerzhitsky 1997
255	Taymyr Lake, Baykura-Nenu	74.05	93.10 E	39,300	500	GIN-3071	Sulerzhitsky 1997
256	Laptev Sea Coast	70.45	131.00 E	39,400	1,000	GIN-3517	Sulerzhitsky 1997
257	Kirgilyakh River	63.27	149.60 E	39,570	870	LU-718A	Sulerzhitsky 1997
258	Kirgilyakh River	63.27	149.60 E	39,590	770	LU-718B	Sulerzhitsky 1997
259	Kimitina River	56.30	160.00 E	39,600	1,600	GIN-3411	Sulerzhitsky 1997
260	Xietian	45.00	127.60 E	39,600	3,000	AECV-1407c	Ives et al. 1994
261	Boderbo-Tarida River	73.06	102.16 E	39,800	600	GIN-3135	Sulerzhitsky 1997
262	Anabarskiy Gulf Coast	73.00	113.35 E	40,100	500	GIN-5726A	Sulerzhitsky 1997
263	Logata River	73.00	98.00 E	40,200	600	GIN-3804	Sulerzhitsky 1997
264	Xietian	45.00	127.60 E	40,200	3,500	AECV-1406c	Ives et al. 1994
265	Anabarka River	72.40	106.00 E	40,300	400	GIN-5025	Sulerzhitsky 1997
266	Shandrin River	71.20	150.30 E	40,350	880	LU-595	Vasil'chuk et al. 1997
267	Engelgardt Lake	75.10	110.30	40,500	800	GIN-1818/P	Sulerzhitsky 1997
268	Kamchatka River, Polovinka	55.00	159.00 E	40,600	600	GIN-3407	Sulerzhitsky 1997
269	Kirgilyakh River	63.27	149.60 E	40,600	700	MAG-366A	Sulerzhitsky 1997
270	Taymyr Lake, Gofman	74.60	101.20 E	40,800	2,000	GIN-1835	Sulerzhitsky 1997
271	Kirgilyakh River	63.27	149.60 E	41,000	900	MAG-576	Sulerzhitsky 1997
272	Kirgilyakh River	63.27	149.60 E	41,000	1,100	MAG-366B	Sulerzhitsky 1997
273	Belaya River	52.50	103.10 E	41,100	1,500	GIN-7707	Kuzmin & Orlova 1998
274	Boderbo-Tarida River	73.06	102.16 E	41,200	1,000	GIN-2744B	Sulerzhitsky 1997
275	Shaytan Lake	74.00	95.00 E	41,400	2,000	GIN-3941	Sulerzhitsky 1997
276	Shandrin River	71.20	150.30 E	41,750	1,290	LU-505	Sulerzhitsky 1997

APPENDIX (continued)

No.	Site name	Latitude, °N	Longitude, °E/W	Age, Yr YBP	±σ	Lab Code and No.	Reference
277	Anabar'ka River	72.40	106.00 E	41,900	800	GIN-5224	Sulerzhitsky 1997
278	Tavda River	59.00	64.00 E	41,900	800	GIN-5337	Sulerzhitsky 1997
279	Bolshoy Khamus-Yuryakh	71.16	153.45 E	42,400	800	GIN-6310	Sulerzhitsky 1997
280	Massonov	72.30	104.30 E	42,800	800	GIN-3946	Sulerzhitsky 1997
281	Amydai	73.00	119.00 E	43,200	400	GIN-6100	Sulerzhitsky 1997
282	Taymyr Lake, Baykura-Neru	74.05	93.10 E	43,500	1,000	GIN-3072	Sulerzhitsky 1997
283	Chersky	68.45	161.15 E	43,700	800	GIN-3849	Sulerzhitsky 1997
284	Beryozovskaya River	67.15	157.30 E	44,000	3,500	T-299	Sulerzhitsky 1997
285	Sanga-Yuryakh	64.00	126.00 E	44,000	3,500	T-170	Vasil'chuk <i>et al.</i> 1997
286	Tirekhtyakh River	69.30	147.15 E	44,540	1,900	LU-1050	Sulerzhitsky 1997
287	Khanty Mansiysk	60.53	68.15 E	>45,000		SOAN-3839	This paper
288	Urtuiskoe	50.11	118.00 E	>45,000		SOAN-3442	This paper
289	Krasniy Yar	55.08	82.50 E	>45,000		SOAN-3465	This paper
290	Kheta River	71.45	100.00 E	45,000	1,000	GIN-766	Sulerzhitsky 1997
291	Amydai	73.00	119.00 E	45,500	1,200	GIN-6105	Sulerzhitsky 1997
292	Atchagyi-Allaikha River	69.00	147.30 E	46,100	1,000	GIN-3206	Sulerzhitsky 1997
293	Taymyr Lake, Baykura-Neru	74.05	93.10 E	46,100	1,200	GIN-3073	Sulerzhitsky 1997
294	Bolshaya Balachnya River	75.30	105.00 E	47,900	1,600	GIN-3118a	Sulerzhitsky 1997
295	Kuznetskiy Basin	54.35	86.21 E	48,090	2,720	SOAN-2025	Firsov <i>et al.</i> 1985
296	Nekyu River	73.00	120.00 E	>49,500		GIN-6101	Sulerzhitsky 1997
297	Taymyr Lake, Baykura-Neru	74.05	93.10 E	>49,500		GIN-3080	Sulerzhitsky 1997
298	Bolshaya Balachnya River	75.30	105.00 E	>49,500		GIN-3092a	Sulerzhitsky 1997
299	Maimetcha River	71.00	100.45 E	49,700	1,100	GIN-689	Sulerzhitsky 1997
300	Lower Lena River	70.00	125.00 E	>50,000		GIN-359	Sulerzhitsky 1997
301	Tirekhtyakh River	69.30	147.15 E	>50,000		SOAN-813	Firsov <i>et al.</i> 1985
302	Duvanny Yar	68.45	150.45 E	>50,000		GIN-3866	Vasil'chuk <i>et al.</i> 1997
303	Anabar'ka River	72.40	106.00 E	>50,000		GIN-5731	Sulerzhitsky 1997
304	Chersky	68.45	161.15 E	>50,000		GIN-3848	Sulerzhitsky 1997
305	Lena River	68.00	123.00 E	50,400	1,300	GIN-4114	Sulerzhitsky 1997
306	Boderbo-Tarida River	73.06	102.16 E	>52,700		GIN-2764b	Sulerzhitsky 1997
307	Duvanny Yar	68.45	150.45 E	>53,000		GIN-3857	Sulerzhitsky 1997
308	Khatanga River	72.30	104.30 E	>53,170		LU-1057	Sulerzhitsky 1997
309	Tirekhtyakh River	69.30	147.15 E	>53,170		LU-1058	Vasil'chuk <i>et al.</i> 1997

DEINSEA - ANNUAL OF THE NATURAL HISTORY MUSEUM ROTTERDAM
P.O.Box 23452, NL-3001 KL Rotterdam The Netherlands