A taxonomically harmonized and temporally standardized fossil pollen dataset from Siberia covering the last 40 ka

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Abstract

Pollen records from Siberia are mostly absent in global or Northern Hemisphere synthesis works. Here we present a taxonomically harmonized and temporally standardized pollen dataset that was synthesized using 173 palynological records from Siberia and adjacent areas (northeast Asia, 50°–180°E and 42°–75°N). Pollen data were taxonomically harmonized, that is the original 437 taxa were assigned to 106 combined pollen taxa. Age-depth models for all records were revised by applying a constant Bayesian age-depth modelling routine. The pollen dataset is available as count data and percentage data in a table format (taxa vs. samples) with age information for each sample. The dataset has relatively few sites covering the last glacial period between 40 and 11.5 cal ka BP (calibrated thousand years before present 1950 CE) particularly from the central and western part of the study area. In the Holocene period, the dataset has many sites from most of the area except the central part of Siberia. Of the 173 pollen records, 81% of pollen counts were downloaded from open databases (GPD, EPD, Pangaea) and 10% were contributions by the original data gatherers, while a few were digitized from publications. Most of the pollen records originate from peatlands (48%) and lake sediments (33%). Most of the records (83%) have ≥3 dates allowing the establishment of reliable chronologies. The dataset can be used for various purposes including pollen data mapping (example maps for *Larix* at selected time-slices are shown) as well as quantitative climate and vegetation reconstructions. The datasets for pollen counts and pollen percentages are available at https://doi.pangaea.de/10.1594/PANGAEA.898616 (Cao et al., 2019); including also the site information, data source, original publication, dating data, and the plant funcational type for each pollen taxa.

1 Introduction

Continental or sub-continental pollen databases are essential for spatial reconstructions of former climates and past vegetation patterns of the terrestrial biosphere, and in interpreting their driving forces (Cao et al., 2013); they also provide data for use in palaeodata-model comparisons at a continental scale (Gaillard et al., 2010; Trondman et al., 2015). Continental pollen databases from North America, Europe, Africa, and Latin America have been successfully established (Gajewski, 2008) and a fossil pollen dataset has been established for the eastern part of continental Asia (including China, Mongolia, south Siberia and parts of central Asia; Cao et al., 2013). These datasets have been used to infer the locations of glacial refugia and migrational pathways by pollen mapping (e.g. Magri, 2008; Cao et al., 2015) and to reconstruct biome or land-cover (e.g. Ni et al., 2014; Trondman et al., 2015; Tian et al., 2016) and climates at broad spatial scales (e.g. Mauri et al., 2015; Marsicek et al., 2018).

Pollen records from Siberia have rather seldomly been included in global, Northern Hemisphere, or synthesis works (Sanchez Goñi et al., 2017; Marsicek et al., 2018), probably because (1) few records are available in open databases or (2) available data are not taxonomically harmonized and lack reliable chronologies. Binney et al. (2017) establish a pollen dataset together with a plant macrofossil dataset for northern Eurasia (excluding east Asia; and the dataset has not been made accessible yet), but the chronologies were not standardized and the pollen data restricted to 1000-year time-slices. In addition, a few works that make use of Siberian fossil pollen data either present biome reconstructions (Binney et al. 2017; Tian et al., 2018) which do not require taxonomic harmonization of the data, or restrict the analyses to selected times slices such as 18 ka, 6 ka and 0 ka (Tarasov et al., 1998, 2000; Bigelow et al., 2003).

Here we provide a new taxonomically harmonized and temporally standardized fossil pollen dataset for Siberia and adjacent areas.

2 Dataset description

2.1 Data sources

We obtained 173 late Quaternary fossil pollen records (generally since 40 cal ka BP) from Siberia and surrounding areas (50°–180°E and 42°–75°N), from database sources and/or contributers, or by digitizing published pollen diagrams (Appendix 1; this table is available in PANGAEA). One hundred and two raw pollen count records were downloaded from the Global Pollen Database (GPD; http://www.ncdc.noaa.gov/paleo/gpd.html); 18 pollen count records were downloaded from the European Pollen Database (EPD; http://www.europeanpollendatabase.net); 20 pollen records (16 sites have pollen count data, others with pollen percentages) were collected from the Pangaea website (Data Publisher for Earth & Environmental Science, which also includes most pollen records found in GPD and EPD; https://www.pangaea.de); raw pollen count data of 17 sites were contributed directly by the data gatherers; and pollen percentages for the remaining 16 sites were digitized from the published pollen diagrams.

2.2 Data processing

Pollen standardization follows Cao et al. (2013), including homogenization of taxonomy at family or genus level generally (437 pollen names were combined into 106 taxa; Appendix 2; this table is available in PANGAEA) and re-calculation of pollen percentages on the basis of the total number of terrestrial pollen grains. To obtain comparable chronologies, age-depth models for these pollen records were re-established using Bayesian age-depth modeling with the IntCal09 radiocarbon calibration curve ("Bacon" software; Blaauw and Christen, 2011). We set up a gamma distribution accumulation rate with a shape parameter equal to 2, and for the accumulation variability a beta distribution with a "strength" of 20 for all records, while we set up a mean "memory" of 0.1 for lake sediments and a high "memory" of 0.7 for peat and other sediment types (following Blaauw and Christen, 2011). For the

20 pollen records without raw pollen counts, we set the terrestrial pollen sum based on the descriptions given in the original publications (approximate values or ranges for 16 records; e.g. it is more than 600 for the pollen record from Chernaya Gorka Palsa (peat permafrost mound), and between 452 and 494 grains for Two-Yurts Lake – pollen sums of 600 and 470, respectively, are assigned in these two cases; and a pollen sum of 400 for the other 4 records because no information was provided in the publications). The "pollen counts" were then back-calculated using the pollen percentages and pollen sum. Finally, the pollen datasets are available with both count data and percentage data in table format in EXCEL software (taxa vs. samples) with age and location information for each sample.

2.3 Data quality

The Siberia pollen dataset includes pollen count data and percentages from 173 pollen sampling sites (Figure 1). Sites are distributed reasonably evenly in east and west Siberia, but geographic gaps still exist in the central part (90°–120°E and 55°–70°N), where no published pollen records exist.

The dataset includes 83 pollen records from peat sediments, 57 records from lake sediments, 23 from fluvial sediments, 6 from coastal or marine sediments, 3 from palaeosol profiles, and one from palsa sediment (Appendix 1). The peat and lake sediments generally have reliable chronologies and high sampling resolutions of the pollen records. About 83% of the pollen records have ≥3 dates (~57% have ≥5 dates); 73% of the pollen records have sampling resolutions of <500 years/sample and only 14% sites with >1000 years/sample (Appendix 1).

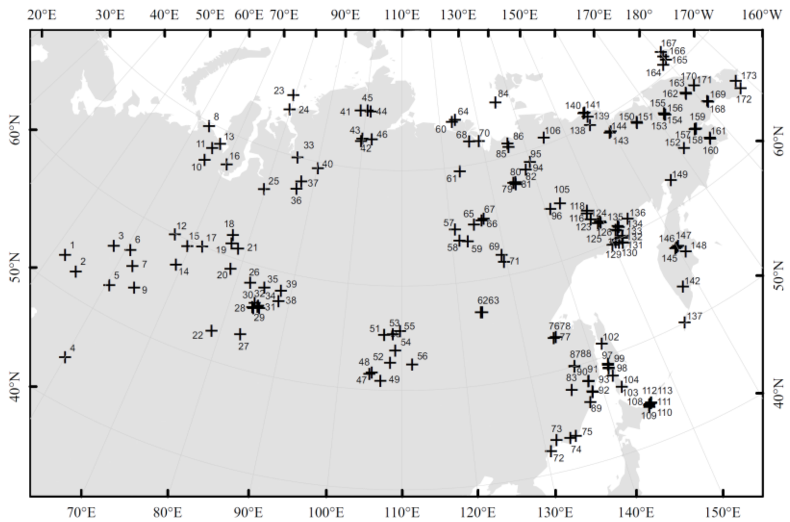
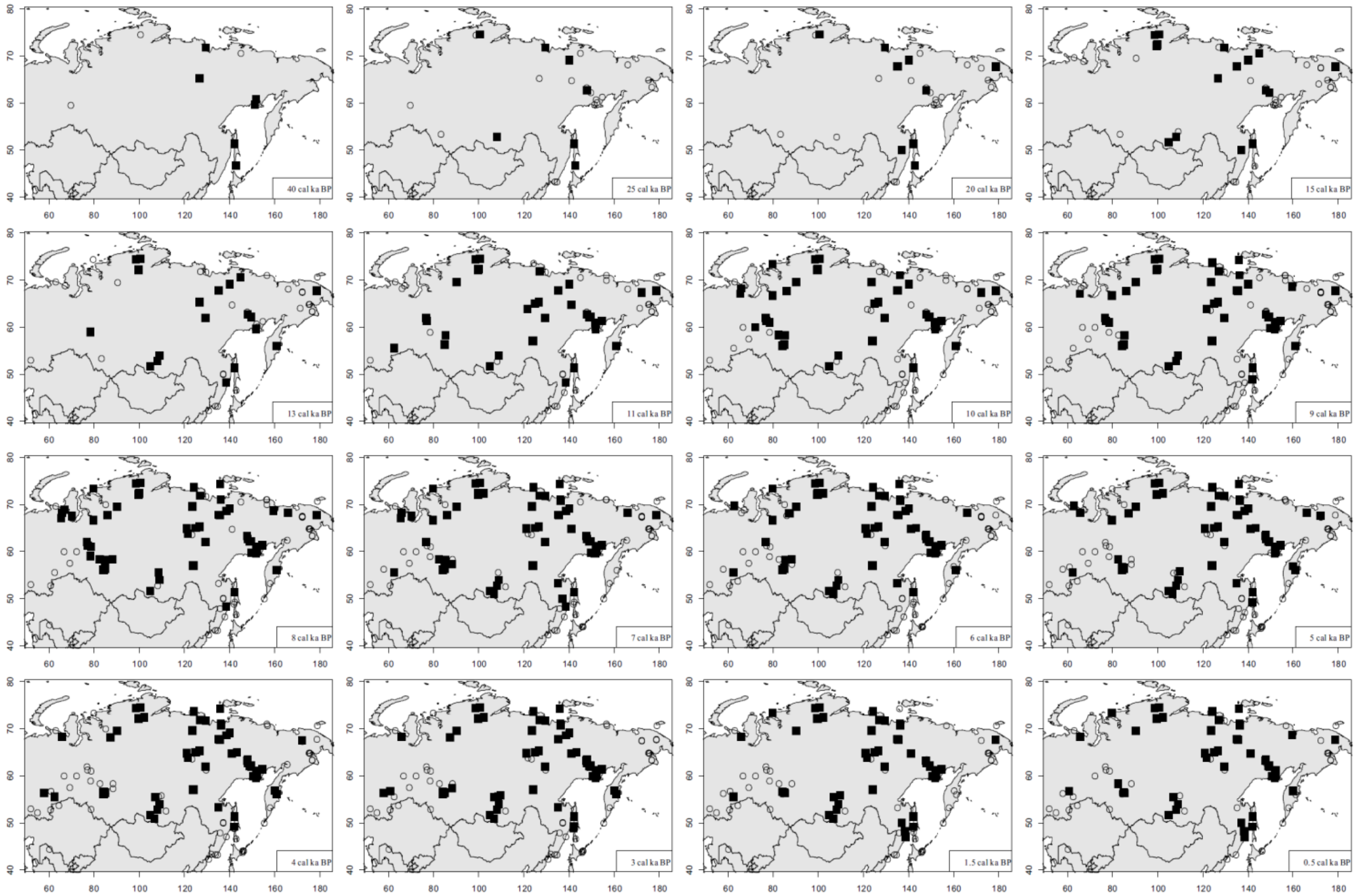


Figure 1 Spatial distribution of fossil pollen records (+) in the study area. The number of each site is used as its ID in Table 1.

Within this dataset, 91% of the pollen records (157 sites) have raw pollen count data or percentages with complete pollen assemblages (Appendix 1). Although there might be some rare pollen taxa excluded from the published pollen diagrams (16 sites) that were digitized, these pollen taxa are likely of minor importance within the pollen assemblages. In addition, during digitizing we ensured that the sum of pollen percentages for each pollen assemblage was within 100±10%, to minimize artificially introduced errors.

The pollen records were counted by different scientists that gave different pollen names to the same pollen types requiring taxonomic homogenization (from 437 original taxa to 106 combined taxa). However, this reduces the taxonomic resolution of the dataset. In cases where homogenization would have resulted in grouping pollen taxa with different growth forms (herb/shrub, tree) together, did we keep the taxa separately even though not all analysts separated them (for instance, *Betula* pollen is separated into *Betula*_shrub, *Betula*_tree and *Betula*_undiff). We also append the original pollen names to the dataset, to ensure feasibility of future studies on various topics using these data.

The chronologies of most pollen records are based on a reasonable number of dates (mostly ^{14}C; at least 3 dates per record). However, we also included pollen records from under-represented areas or periods that do not meet this criterion. Furthermore, most of the pollen records cover only part of the last 40 cal ka and comparatively few pollen records cover (parts of) the last glacial (i.e. >11 ka BP). We interpolated pollen abundances at 16 key time slices (40 ka, 25 ka, 15 ka, 13 ka, 11 ka, 10 ka, 9 ka, 8 ka, 7 ka, 6 ka, 5 ka, 4 ka, 3 ka, 1.5 ka and 0.5 ka) using the *interp.dataset* function in the R package rioja (Juggins, 2012) to produce pollen presence/absence maps for *Larix* as an example of the distribution of available sites at these 16 key time slices (Figure 2). We also present boxplots for 14 major pollen taxa from all available sites at the 16 key time-slices (Figure 3), which illustrates the general temporal patterns.


40 cal ka BP
25 cal ka BP
20 cal ka BP
15 cal ka BP
13 cal ka BP
11 cal ka BP
10 cal ka BP
9 cal ka BP
8 cal ka BP
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6 cal ka BP
5 cal ka BP
4 cal ka BP
3 cal ka BP
1.5 cal ka BP
0.5 cal ka BP
40
50
60
70
80
60
80
100
120
140
160
180

Figure 2 Pollen-infered presence/absence maps for *Larix* at key time slices. Black squares indicate presence while empty circles indicate absence.

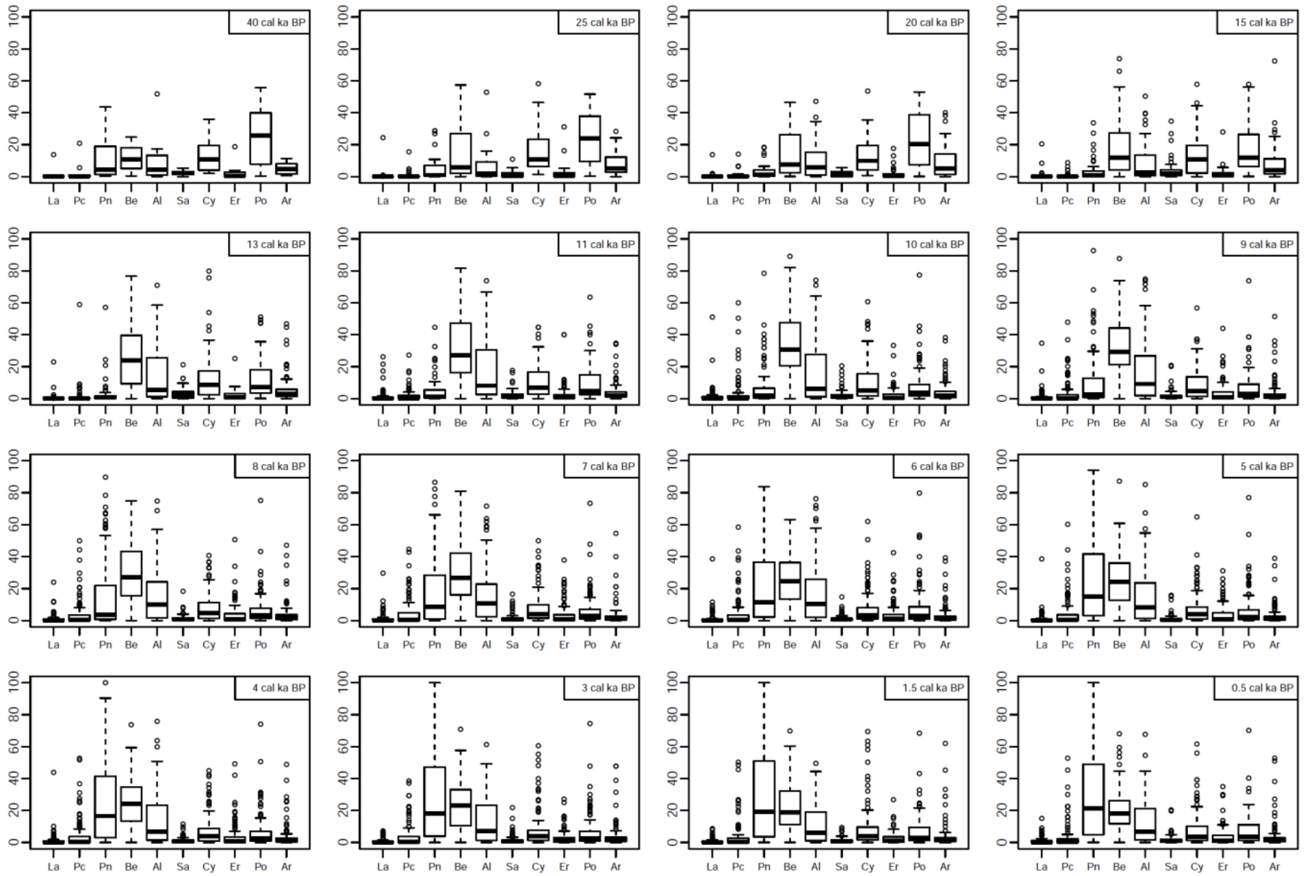

Figure 3 Boxplots of percentages of 10 major pollen taxa at all available sites at key time slices. La: *Larix*; Pc: *Picea*; Pn: *Pinus*; Be: *Betula*; Al: *Alnus*; Sa: *Salix*; Cy: Cyperaceae; Er: Ericaceae; Po: Poaceae; Ar: *Artemisia*.

3 Potential use of the Siberian fossil pollen data set

Fossil pollen data mapping can be used to reveal broad-scale spatial distributions over time, as Cao et al. (2015) demonstrate. In this paper, we present presence/absence maps for *Larix* as an example (Figure 2). *Larix* has extremely low pollen productivity (e.g. Niemeyer et al., 2015) that causes the under-representation of *Larix* pollen compared to its cover in the pollen source vegetation (Lisitsyna et al., 2011). Accordingly, *Larix* pollen is accepted as an indicator of the presence of *Larix* locally (e.g. Lisitsyna et al., 2011). The pollen presence/absence maps for *Larix* (Figure 2) show a wide geographical range over the last 40,000 years, even during the Last Glacial Maximum, when there was very likely a relatively low density of larch. Our results generally confirm the distribution revealed by *Larix* macrofossil analysis (Binney et al., 2009). The *Larix* distribution changes revealed by our pollen dataset exemplify the usability of the dataset for vegetation reconstruction.

The Siberian fossil pollen dataset has already been used for biome reconstruction (Tian et al., 2018), although an integration of this dataset into global or Northern Hemisphere-wide biomization research is still pending.

Pollen percentages in pollen assemblages do not directly reflect species abundance in the vegetation community because of different pollen productivity. Therefore, quantitative vegetation composition is modelled using pollen productivity estimates (e.g. Sugita et al., 2010; Trondman et al., 2015). Our pollen dataset was recently used to reconstruct plant cover quantitatively using the REVEALS model to describe the compositional changes in space and time, which is more reliable than using pollen percentages directly (Cao et al., 2018).

Modern pollen data have been published from many sites in Siberia (e.g. Tarasov et al., 2007, 2011; Müller et al., 2010; Klemm et al., 2015). These modern pollen datasets can be used to investigate modern pollen-climate relationships, and these modern relationships can be used to make quantitative climate reconstructions as has been done previously (e.g. Marsicek et al., 2018).

4 Summary

We present a taxonomically harmonized and temporally standardized fossil pollen dataset of 173 palynological records with counts and percentages from Siberia and adjacent areas (northeast Asia, 50 °–180 °E and 42 °–75 °N).

Our open-access dataset is a key component that can help provide quantitative estimates of vegetation or climate which can be used to validate palaeosimulation results of general circulation models for the Northern Hemisphere.

5 data availability

Five datasets including overview and reference (site information), dating data, plant functional type for each pollen taxa, pollen count and pollen percentage for each sample are available at https://doi.pangaea.de/10.1594/PANGAEA.898616 (Cao et al., 2019).

Author contributions. UH and XC designed the pollen dataset. XC and FT compiled the standardization for the dataset and wrote the draft. Other authors provided pollen data and all authors discussed the results and contributed to the final paper.

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Appendix 1 Details of the fossil pollen records in the Siberian pollen dataset.

ID	Site	Lat. (°)	Long. (°)	Elev. (m)	Archive type	Data type	Source	Dating method	No. of dates & material code	Time span (ka BP)	Res. (yr)	Reference
1	Pobochnoye	53.03	51.84	58	Peat sediment	digitized	-	^{14}C	10C+6E	14.4-0	540	Kremenetski et al., 1999
2	Novienky Peat	52.24	54.75	197	Peat sediment	counts	EPD, Pan	^{14}C	1U	4.5-0	270	López-García et al., 2003
3	Ust'Mashevskoe	56.32	57.88	220	Peat sediment	counts	EPD, Pan	^{14}C	5C	7.8-0	150	Panova et al., 1996
4	Aral Lake	44.42	59.98	53	Lake sediment	counts	EPD, Pan	^{14}C	4U	8.7-0	260	Aleshinskaya, unpublished.
5	Fernsehsee Lake	52.83	60.50	290	Lake sediment	counts	From author	^{14}C	10A	9.1-0.4	220	Stobbe et al., 2015
6	Karasieozerskoe	56.77	60.75	230	Peat sediment	counts	EPD, Pan	^{14}C	3A	5.9-0.1	190	Panova, 1997
7	Zaboinoe Lake	55.53	62.37	275	Lake sediment	counts	GPD, EPD, Pan	^{14}C	1U	12.3-0.1	220	Khomutova & Pushenko, 1995
8	Shpindler Cape	69.72	62.80	20	Fluvial sediment	counts	Pan	^{14}C	12A	15.8-0	420	Andreev et al., 2001

9	Mokhovoye	53.77	64.25	178	Peat sediment	counts	GPD, EPD, Pan	^{14}C	4C+1E	6.0-0	180	Kremenetskii et al., 1994
10	Chernaya Gorka	67.08	65.35	170	Palsa sediment	digitized	-	^{14}C	1A+3C	10.1-6.9	70	Jankovská et al., 2006
11	Lyadhej-To Lake	68.25	65.75	150	Lake sediment	counts	Pan	^{14}C	14A+6E	12.5-0.3	170	Andreev et al., 2005
12	Chesnok Peat	60.00	66.50	42	Peat sediment	counts	GPD, EPD, Pan	^{14}C	7C	10.6-0.5	280	Volkova, 1966
13	Baidara Gulf	68.85	66.90	30	Coast sediment	counts	EPD, Pan	^{14}C	10C	15.8-4.6	170	Andreev et al., 1998
14	Komaritsa Peat	57.50	69.00	42	Peat sediment	counts	GPD, EPD, Pan	^{14}C	10C	10.5-0.5	350	Volkova, 1966
15	Demyanskoye	59.50	69.50	65	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A	50.3-22.3	2000	Bakhareva, 1983
16	Nulsaveito	67.53	70.17	57	Peat sediment	counts	EPD, Pan	^{14}C	4A+1C	8.4-6.4	70	Panova, 1990
17	Salym-Yugan	60.02	72.08	56	Peat sediment	digitized	-	^{14}C	5C	10.1-0.2	200	Pitkänen et al., 2002
18	Nizhnevartovsk	62.00	76.67	54	Peat sedimen	counts	GPD, EPD,	^{14}C	3A+7C	11.1-0	300	Neustadt and Zelikson, 1985

					t		Pan					
1	Nizhnevarto	61.	77.	55	Peat	cou	GPD,	^{14}C	1A+13C	12.6-0	38	Neishtadt, 1976
9	vskoye	25	00		sedimen	nts	EPD,		+1E		0	
					t		Pan					
2	Entarnoye	59.	78.	65	Peat	cou	GPD,	^{14}C	5C	14.9-0.9	46	Neishtadt, 1976
0	Peat	00	33		sedimen	nts	EPD,				0	
					t		Pan					
2	Lukaschin	61.	78.	65	Peat	cou	GPD,	^{14}C	13C	10.9-0.3	43	Neishtadt, 1976
1	Yar	00	50		sedimen	nts	EPD,				0	
					t		Pan					
2	Big Yarovoe	52.	78.	79	Lake	cou	From	Biwa*	-	4.3-0	19	Rudaya et al.,
2	Lake	85	63		sedimen	nts	author				0	2012
					t							
2	Sverdrup	74.	79.	7	Peat	cou	GPD,	^{14}C	3C	13.4-11.	29	Tarasov et al.,
3		50	50		sedimen	nts	EPD,			1	0	1995
					t		Pan					
2	BP99-04/06	73.	79.	-32	Marine	cou	Pan	^{14}C	12U	10.0-0.3	19	Kraus et al.,
4		41	67		sedimen	nts					0	2003
					t							
2	Pur-Taz	66.	79.	50	Peat	cou	GPD,	^{14}C	5A	10.3-4.7	80	Peteet et al.,
5	Peatland	70	73		sedimen	nts	EPD,					1998
					t		Pan					
2	Petropavlov	58.	82.	10	Peat	cou	EPD,	^{14}C	4C+1E	10.5-0.1	16	Blyakharchuk,
6	ka	33	50	0	sedimen	nts	Pan				0	1989
					t							
2	Kalistratikha	53.	83.	19	Peat	cou	GPD,	^{14}C	4A	39.0-12.	18	Zudin and
7		33	25	0	sedimen	nts	EPD,			7	70	Votakh, 1977
					t		Pan					
2	Tom' River	56.	84.	10	Peat	cou	GPD	^{14}C	6C	10.1-0.2	39	Arkhipov and

8	Peat	17	00	0	sediment	nts					0	Votakh, 1980
29	Novouuspenka	56.62	84.17	150	Fluvial sediment	counts	EPD, Pan	^{14}C	5C	5.3-0	130	Blyakharchuk, 1989
30	Kirek Lake	56.10	84.22	90	Lake sediment	digitized	-	^{14}C	3G	10.5-1.5	190	Blyakharchuk, 2003
31	Zhukovskoye Mire	56.33	84.83	106	Peat sediment	counts	From author	^{14}C	9C+6H	11.2-0	130	Borisova et al., 2011
32	Chaginskoe	56.45	84.88	80	Peat sediment	digitized	-	^{14}C	2C	8.8-0	320	Blyakharchuk, 2003.
33	Karginskii Cape	70.00	85.00	60	Peat sediment	counts	GPD, EPD, Pan	^{14}C	13C	8.9-3.5	290	Firsov et al., 1972
34	Ovrazhnoe	56.25	85.17	110	Peat sediment	counts	EPD, Pan	^{14}C	1C	5.8-0.1	230	Blyakharchuk, 1989
35	Bugristoye Bog	58.25	85.17	100	Peat sediment	counts	EPD, Pan	^{14}C	4C+1E	11.5-5.0	100	Blyakharchuk, 1989
36	Igarka Peat	67.48	86.50	2	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+2C	10.9-5.9	230	Kats, 1953
37	Yenisei	68.17	87.15	68	Peat sediment	digitized	-	^{14}C	7C	6.5-1.6	110	Andreev and Klimanov 2000

38	Teguldet	57.33	88.17	150	Peat sediment	counts	Pan	^{14}C	3C	7.3-2.4	90	Blyakharchuk, 1989
39	Maksimkin Yar	58.33	88.17	150	Peat sediment	counts	EPD, Pan	^{14}C	4C	8.3-0.2	170	Blyakharchuk, 1989
40	Lama Lake	69.53	90.20	77	Lake sediment	counts	From author	^{14}C	26A+4D+4E	19.5-0	170	Andreev et al., 2004
41	Levinson-Lessing Lake	74.47	98.64	NA	Lake sediment	counts	Pan	^{14}C	30A+19E	35.3-0	390	Andreev et al., 2003
42	LAO13-94	72.19	99.58	65	Peat sediment	counts	Pan	^{14}C	2C+1U	16.1-0	1240	Andreev et al., 2002
43	LAB2-95	72.38	99.86	65	Peat sediment	counts	Pan	^{14}C	1A+1C	17.4-5.6	980	Andreev et al., 2002
44	Taymyr Lake_SAO4	74.53	100.53	47	Lake sediment	counts	Pan	^{14}C	1C	8.7-0.4	600	Andreev et al., 2003
45	Taymyr Lake_SAO1	74.55	100.53	47	Lake sediment	counts	Pan	^{14}C	6A+5C	57.9-0	1320	Andreev et al., 2003
46	11-CH-12A Lake	72.40	102.29	60	Lake sediment	counts	Pan	^{14}C	8A+7E	7.0-0.1	110	Klemm et al., 2015
47	Baikal -CON01-605	51.58	104.8	480	Lake sedimen	digitize	-	^{14}C	12D	11.5-0	130	Demske et al., 2005

	-5		5		t	d						
48	Baikal-CON01-605-3	51.59	104.85	480	Lake sediment	digitized	-	^{14}C	5D	17.7-0	200	Demske et al., 2005
49	Chernoe Lake	50.95	106.63	500	Lake sediment	counts	EPD, Pan	^{14}C	4E	7-0.7	620	Vipper, 2010
50	Khanda-1	55.44	107.00	840	Peat sediment	counts	From author	^{14}C	3C	3.1-0.3	50	Bezrukova et al., 2011
51	Khanda	55.44	107.00	840	Peat sediment	counts	From author	^{14}C	6C	5.8-0	140	Bezrukova et al., 2011
52	Cheremushka Bog	52.75	108.08	1500	Peat sediment	digitized	-	^{14}C	6C	33.5-0	460	Shichi et al., 2009
53	Okunaika	55.52	108.47	802	Peat sediment	counts	From author	^{14}C	6C	8.3-2.0	120	Bezrukova et al., 2011
54	Baikal-CON01-603-5	53.95	108.91	480	Lake sediment	digitized	-	^{14}C	10D	15.8-0	270	Demske et al., 2005
55	Ukta Creek mouth	55.80	109.70	906	Peat sediment	counts	From author	^{14}C	3U	5.1-0	160	Bezrukova et al., 2006
56	Bolshoe Eravnoe Lake	52.58	111.67	947	Lake sediment	counts	EPD, Pan	^{14}C	3E	7.3-0.2	710	Vipper, 2010
5	Madjagara	64.	12	16	Lake	cou	GPD,	^{14}C	7E	8.2-0.2	12	Andreev and

7	Lake	83	0.9	0	sedimen	nts	EPD,				0	Klimanov, 1989
			7		t		Pan					
5	Khomustakh	63.	12	12	Lake	cou	GPD,	^{14}C	9E	12.3-0.1	17	Andreev et al.,
8	Lake	82	1.6	0	sedimen	nts	EPD,				0	1989
			2		t		Pan					
5	Boguda Lake	63.	12	12	Lake	cou	GPD,	^{14}C	7E	10.9-0.4	18	Andreev et al.,
9		67	3.2	0	sedimen	nts	EPD,				0	1989
			5		t		Pan					
6	Barbarina	73.	12	10	Peat	cou	Pan	^{14}C	4C	4.9-0.3	24	Andreev et al.,
0	Tumsa	57	3.3		sedimen	nts					0	2004
			5		t							
6	Lake	69.	12	66	Lake	cou	Pan	^{14}C	10E	10.8-0.3	36	Biskaborn et al.,
1	Kyutyunda	63	3.6		sedimen	nts					0	2015
			5		t							
6	Suollakh	57.	12	81	Peat	cou	GPD,	^{14}C	8C	12.8-3.7	18	Andreev et al.,
2		05	3.8	6	sedimen	nts	EPD,				0	1991
			5		t		Pan					
6	Derput Bog	57.	12	70	Peat	cou	GPD,	^{14}C	1A+4C	11.7-0.8	21	Andreev and
3		03	4.1	0	sedimen	nts	EPD,				0	Klimanov, 1991
			2		t		Pan					
6	Nikolay Lake	73.	12	35	Lake	cou	EPD,	^{14}C	6A	12.5-0	60	Andreev et al.,
4		67	4.2		sedimen	nts	Pan				0	2004
			5		t							
6	Dyanushka	65.	12	12	Fluvial	cou	Pan	^{14}C	13A	12.6-0	17	Werner et al.,
5	River	04	5.0	3	sedimen	nts					0	2010
			4		t							
6	Billyakh	65.	12	34	Lake	cou	Pan	^{14}C	1A+10E	50.6-0.2	47	Müller et al.,
6	Lake	27	6.7	0	sedimen	nts					0	2010
			5		t							

67	Billyakh Lake	65.30	126.78	340	Lake sediment	counts	Pan	^{14}C	7A	14.1-0	180	Müller et al., 2009
68	Dolgoe Ozero	71.87	127.07	40	Lake sediment	counts	From author	^{14}C	1A+9B	15.3-0	210	Pisaric et al., 2001
69	Chabada Lake	61.98	129.37	290	Lake sediment	counts	GPD, EPD, Pan	^{14}C	15U	13-0	110	Andreev and Klimanov, 1989
70	Mamontovy Khayata	71.77	129.45	0	Coast sediment	counts	Pan	^{14}C	40A+24C	58.4-0	970	Andreev et al., 2002
71	Nuochaga Lake	61.30	129.55	260	Lake sediment	counts	GPD, EPD, Pan	^{14}C	4E	6.5-0	140	Andreev and Klimanov, 1989
72	Tumannaya River	42.32	130.73	4	Fluvial sediment	counts	GPD	^{14}C	1F	14.4-0.1	380	Anderson et al., 2002
73	Amba River	43.32	131.82	5	Peat sediment	counts	GPD	^{14}C	1A+1C	4.2-2.0	260	Korotky et al., 1980
74	Paramonovskii Stream	43.20	133.75	120	Fluvial sediment	counts	GPD	^{14}C	2A+1E	32.2-0.6	4530	Korotky et al., 1993
75	Ovrazhnyi Stream-2	43.25	134.57	10	Peat sediment	counts	GPD	^{14}C	3A+1C	36.0-0.4	2250	Korotky and Karaulova, 1975
76	Selitkan-2	53.22	135.0	1300	Peat sedimen	counts	GPD	^{14}C	4C	6.4-1.9	260	Volkov and Arkhipov, 1978

			3		t							
77	Selitkan-1	53.22	135.05	1320	Peat sediment	counts	GPD	^{14}C	6C	7.9-0	140	Korotky et al., 1985
78	Selitkan-3	53.22	135.07	1310	Peat sediment	counts	GPD	^{14}C	2E	10.2-2.3	790	Korotky and Kovalyukh, 1987
79	Bugutakh	67.83	135.12	128	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A	20.4-0	1860	Anderson et al., 2002
80	Betenkyos	67.67	135.58	135	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A+1E	2.2-0	230	Anderson et al., 2002
81	Adycha River	67.75	135.58	130	Fluvial sediment	counts	GPD	^{14}C	5A	9.2-3.7	420	Anderson et al., 2002
82	Ulakhan	67.83	135.58	130	Fluvial sediment	counts	GPD	^{14}C	3C	8.6-5.7	330	Anderson et al., 2002
83	Kiya	47.83	135.67	100	Peat sediment	digitized	-	^{14}C	4C	10.0-0.9	210	Bazarova et al., 2008
84	Laptev PM9462	74.30	136.00	0	Marine sediment	digitized	-	^{14}C	12U	9.3-0.2	100	Naidina and Bauch, 2001
85	Khocho	71.05	136.23	6	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C	10.4-0.4	300	Velichko et al., 1994
8	Samandon	70.	13	10	Peat	cou	GPD,	^{14}C	3A+8C+	7.9-0.2	28	Velichko et al.,

6		77	6.25		sediment	nts	EPD, Pan		4E		0	1994
87	Gur	50.00	137.05	35	Peat sediment	digitized	-	^{14}C	13C	22.1-0	340	Mokhova et al., 2009
88	Gurskii Peat	50.07	137.08	15	Peat sediment	counts	GPD	^{14}C	7C	13.1-1.5	380	Korotky, 1982
89	Siluyanov Yar	46.13	137.83	20	Fluvial sediment	counts	GPD	^{14}C	6A	12.8-4.9	1130	Korotky et al., 1988
90	Oumi	48.22	138.40	990	Peat sediment	counts	GPD	^{14}C	5C	2.6-0.4	80	Anderson et al., 2002
91	Opasnaya River	48.23	138.48	1320	Peat sediment	counts	GPD	14C	7C	13.3-6.7	360	Korotky et al., 1988
92	Venyukovka-2	47.03	138.58	6	Peat sediment	counts	GPD	^{14}C	1A+1C	3.6-0.4	140	Korotky et al., 1980
93	Venyukovka-3	47.12	138.58	5	Peat sediment	counts	GPD	^{14}C	1A+2C	5.8-3.2	140	Korotky et al., 1980
94	Kyurbe-Yuryakh-2	68.60	138.62	650	Peat sediment	counts	GPD	^{14}C	4C	8.8-2.6	1530	Anderson et al., 2002
95	Byllatskoye	69.17	140.06	316	Fluvial sediment	digitized	-	^{14}C	2A	28.6-2.8	4300	Anderson et al., 2002

96	Smorodinovoye Lake	64.77	141.12	800	Lake sediment	counts	GPD, EPD, Pan	^{14}C	6A+5F	27.1-0	360	Anderson et al., 1998b
97	Izylmet'evskaya	48.82	141.97	4	Fluvial sediment	counts	GPD	^{14}C	2A+2E+1F	4.3-2.8	100	Korotky et al., 1997a
98	Orokess River	48.85	142.00	6	Coast sediment	counts	GPD	^{14}C	4A+2C+3F	9.2-0.8	320	Korotky et al., 1997a
99	Nizmennyii Cape	49.17	142.02	5	Coast sediment	counts	GPD	^{14}C	2A	5.9-0.3	630	Korotky et al., 1997a
100	Sergeevka River	49.23	142.08	2	Fluvial sediment	counts	GPD	^{14}C	2C+1F	2.3-0	230	Korotky et al., 1997b
101	Sergeevskii	49.23	142.08	6	Peat sediment	counts	GPD	^{14}C	8A+1C	8.4-2.2	110	Korotky et al., 1997b
102	Khoe, Sakhalin Island	51.34	142.14	15	Palaeosol	digitized	-	^{14}C	5A+3E	40.9-0	360	Leipe et al., 2015
103	Il'inka Terrace	47.97	142.17	3	Peat sediment	counts	GPD	^{14}C	2C+1F	2.6-1.1	360	Korotky et al., 1997a
104	Mereya River	46.62	142.92	4	Peat sediment	counts	GPD	^{14}C	2C+2F	42.0-0.8	1530	Anderson et al., 2002
105	Kuobakh-Baga River	64.98	143.3	500	Fluvial sedimen	counts	GPD, EPD,	^{14}C	5A	6.5-2.6	350	Anderson et al., 2002

5			8		t		Pan					
1	Indigirka	70.	14	20	Fluvial	cou	GPD	^{14}C	3A+1F	59.1-6.0	14	Lozhkin, 1998
0	Lowland	58	5.0		sedimen	nts					40	
6			0		t							
1	Khlebnikova	43.	14	3	Peat	cou	GPD	^{14}C	4C	5.4-1.3	29	Korotky et al.,
0	Stream	75	5.6		sedimen	nts					0	1995
7			2		t							
1	Sernovodskii	43.	14	5	Peat	cou	GPD	^{14}C	1C	3.5-0.7	40	Korotky et al.,
0		92	5.6		sedimen	nts					0	1996
8			7		t							
1	Lesnaya	44.	14	6	Peat	cou	GPD	^{14}C	5C	7.4-3.9	14	Korotky et
0	River	00	5.7		sedimen	nts					0	al.,1995
9			5		t							
1	Seryebryank	44.	14	5	Peat	cou	GPD	^{14}C	4C+2F	5.9-0.1	42	Korotky et al.,
1	a Stream	05	6.0		sedimen	nts					0	1995
0			0		t							
1	Kosmodem'	44.	14	6	Peat	cou	GPD	^{14}C	1A+1C	7.2-0.4	57	Korotky et al.,
1	yanskaya-2	10	6.0		sedimen	nts					0	1995
1			5		t							
1	Kosmodem'	44.	14	6	Peat	cou	GPD	^{14}C	1A+2C	7.0-5.6	10	Korotky et al.,
1	yanskaya-3	10	6.0		sedimen	nts					0	1995
2			5		t							
1	Kosmodem'	44.	14	6	Peat	cou	GPD	^{14}C	1A+1C+	6.6-2.4	42	Korotky et al.,
1	yanskaya-1	10	6.0		sedimen	nts			1E		0	1995
3			7		t							
1	Berelyekh	63.	14	80	Peat	cou	GPD,	^{14}C	3C	34.8-2.5	16	Lozhkin et al.,
1	River	28	7.7	0	sedimen	nts	EPD,				00	1989
4			5		t		Pan					
1	Vechernii	63.	14	80	Peat	cou	GPD	^{14}C	2A+5C	6.1-0.3	21	Anderson et al.,

1	River	28	7.7	0	sedimen	nts					0	2002
5			5		t							
1	Gek Lake	63.	14	96	Lake	cou	GPD,	^{14}C	8A+1B	9.6-0	44	Stetsenko, 1998
1		52	7.9	9	sedimen	nts	EPD,				0	
6			3		t		Pan					
1	Kirgirlakh	62.	14	70	Fluvial	cou	GPD,	^{14}C	4A	34.5-0.2	21	Shilo et al., 1983
1	Stream_2	67	7.9	0	sedimen	nts	EPD,				40	
7			8		t		Pan					
1	Kirgirlakh	62.	14	70	Fluvial	cou	GPD,	^{14}C	4A	7.1-1.0	61	Shilo et al., 1983
1	Stream_4	67	7.9	0	sedimen	nts	EPD,				0	
8			8		t		Pan					
1	Elgennya	62.	14	10	Lake	cou	GPD,	^{14}C	6A	16.0-0	31	Lozhkin et al.,
1	Lake	08	9.0	40	sedimen	nts	EPD,				0	1996
9			0		t		Pan					
1	Figurnoye	62.	14	10	Lake	cou	GPD	^{14}C	4A	1.3-0	30	Lozhkin et al.,
2	Lake	10	9.0	53	sedimen	nts						1996
0			0		t							
1	Jack London	62.	14	82	Lake	cou	GPD	^{14}C	7F	19.5-0.2	32	Lozhkin et al.,
2	Lake	17	9.5	0	sedimen	nts					0	1993
1			0		t							
1	Rock Island	62.	14	87	Lake	cou	GPD	^{14}C	2E	6.6-0	47	Lozhkin et al.,
2	Lake	17	9.5	0	sedimen	nts					0	1993
2			0		t							
1	Sosednee	62.	14	82	Lake	cou	GPD	^{14}C	4E+1F	26.3-0	64	Lozhkin et al.,
2	Lake	17	9.5	2	sedimen	nts					0	1993
3			0		t							
1	Oldcamp	62.	14	85	Lake	cou	GPD,	^{14}C	2E	3.7-0	37	Anderson,
2	Lake	04	9.5	3	sedimen	nts	EPD,				0	unpublished
4			9		t		Pan					

1	Glukhoye	59.	14	10	Peat	cou	GPD,	^{14}C	5C	9.4-3.4	10	Lozhkin et al.,
2	Lake	75	9.9		sedimen	nts	EPD,				00	1990
5			2		t		Pan					
1	Pepelnoye	59.	15	11	Lake	cou	GPD,	^{14}C	2A	4.3-0	18	Lozhkin et al.,
2	Lake	85	0.6	5	sedimen	nts	EPD,				0	2000b
6			2		t		Pan					
1	Tanon River	59.	15	40	Fluvial	cou	GPD,	^{14}C	6A+4C+	42.4-6.6	12	Lozhkin and
2		67	1.2		sedimen	nts	EPD,		1F		40	Glushkova,
7			0		t		Pan					1997a
1	Maltan River	60.	15	73	Peat	cou	GPD,	^{14}C	4A+7C	12.0-9.4	12	Lozhkin and
2		88	1.6	5	sedimen	nts	EPD,				0	Glushkova,
8			2		t		Pan					1997b
1	Chistoye	59.	15	91	Peat	cou	EPD,	^{14}C	5C	7.0-0	54	Anderson et al.,
2	Lake	55	1.8		sedimen	nts	Pan				0	1997
9			3		t							
1	Lesnoye	59.	15	95	Lake	cou	GPD	^{14}C	8A	15.5-0	40	Anderson et al.,
3	Lake	58	1.8		sedimen	nts					0	1997
0			7		t							
1	Elikchan 4	60.	15	81	Lake	cou	GPD,	^{14}C	16U	55.5-0	44	Lozhkin and
3	Lake	75	1.8	0	sedimen	nts	EPD,				0	Anderson, 1995
1			8		t		Pan					
1	Podkova	59.	15	66	Lake	cou	GPD,	^{14}C	5A	6.0-0	22	Anderson et al.,
3	Lake	96	2.1	0	sedimen	nts	EPD,				0	1997
2			0		t		Pan					
1	Goluboye	61.	15	81	Lake	cou	EPD,	^{14}C	11A+2B	9.7-0	24	Lozhkin et al.,
3	Lake	12	2.2	0	sedimen	nts	Pan				0	2000a
3			7		t							
1	Alut Lake	60.	15	48	Lake	cou	GPD	^{14}C	16A+9B	50.4-0	43	Anderson et al.,
3		14	2.3	0	sedimen	nts					0	1998a

4			1		t							
1	Taloye Lake	61.	15	75	Lake	cou	GPD,	^{14}C	7A	10.3-0	29	Lozhkin et al.,
3		02	2.3	0	sedimen	nts	EPD,				0	2000a
5			3		t		Pan					
1	Julietta Lake	61.	15	88	Lake	cou	From	^{14}C	2A+4E+	36.1-1.4	27	Anderson et al.,
3		34	4.5	0	sedimen	nts	author		1I		0	2010
6			6		t							
1	Pernatoye	50.	15	6	Lake	cou	From	^{14}C	6A+1E	10.1-0.1	16	Anderson et al.,
3	Lake	04	5.4		sedimen	nts	author				0	2015
7			0		t							
1	East	71.	15	8	Peat	cou	GPD,	^{14}C	2A+2C	9.5-4.5	55	Lozhkin et al.,
3	Siberian Sea	07	6.2		sedimen	nts	Pan				0	1975
8	11		5		t							
1	Kur Peat	69.	15	47	Peat	cou	GPD,	^{14}C	1A+4C	11.7-7.5	43	Lozhkin and
3		97	6.3		sedimen	nts	EPD,				0	Vazhenina, 1987
9			7		t		Pan					
1	East	71.	15	9	Peat	cou	GPD	^{14}C	1C	13.0-1.7	16	Anderson et al.,
4	Siberian Sea	07	6.5		sedimen	nts					00	2002
0	Coast		0		t							
1	Kurop7	70.	15	7	Peat	cou	GPD,	^{14}C	3C	5.7-0.4	76	Anderson et al.,
4		67	6.7		sedimen	nts	EPD,				0	2002
1			5		t		Pan					
1	Sokoch Lake	53.	15	49	Lake	digi	-	^{14}C	8E	9.7-0.3	25	Dirksen et al.,
4		25	7.7	5	sedimen	tize					0	2012.
2			5		t	d						
1	Stadukhinsk	68.	15	12	Fluvial	cou	GPD,	^{14}C	4C	9.5-7.2	21	Lozhkin and
4	aya-1	67	9.5		sedimen	nts	EPD,				0	Prokhorova,
3			0		t		Pan					1982
1	Stadukhinsk	68.	15	5	Fluvial	cou	GPD,	^{14}C	2C	1.0-0	18	Lozhkin and

4	aya-2	67	9.5		sedimen	nts	EPD,				0	Prokhorova,
4			0		t		Pan					1982
1	Two-Yurts	56.	16	27	Lake	per	Pan	^{14}C	5A	6.0-2.8	14	Hoff et al., 2015
4	Lake-3	82	0.0	5	sedimen	cen					0	
5			4		t	t						
1	Two-Yurts	56.	16	27	Lake	per	Pan	^{14}C	5A	2.5-0.1	13	Hoff et al., 2015
4	Lake-2	82	0.0	5	sedimen	cen					0	
6			7		t	t						
1	Two-Yurts	56.	16	27	Lake	per	Pan	^{14}C	5A	4.4-2.5	12	Hoff et al., 2015
4	Lake-5	82	0.0	5	sedimen	cen					0	
7			7		t	t						
1	Cherny Yar	56.	16	14	Peat	cou	GPD,	^{14}C	1C+1E	13.0-0.5	83	Osipova.
4		07	1.0	8	sedimen	nts	EPD,				0	unpublished
8			0		t		Pan					
1	Penzhinskay	62.	16	32	Peat	cou	GPD,	^{14}C	2C	8.9-3.4	50	Ivanov et al.,
4	a Gulf	42	5.4		sedimen	nts	EPD,				0	1984
9			2		t		Pan					
1	Enmynveem	68.	16	40	Peat	cou	GPD,	^{14}C	2C+2F	36.4-9.3	24	Lozhkin et al.,
5	River1	17	5.9	0	sedimen	nts	EPD,				70	1988
0			3		t		Pan					
1	Enmynveem	68.	16	50	Peat	cou	GPD,	^{14}C	4C	10.7-4.0	42	Anderson et al.,
5	River2	25	6.0	0	sedimen	nts	EPD,				0	2002
1			0		t		Pan					
1	Ledovyi	64.	17	44	Lake	cou	GPD,	^{14}C	3A+3C+	19.9-9.7	11	Lozhkin et al.,
5	Obryu	10	1.1		sedimen	nts	EPD,		1F		40	2000c
2			8		t		Pan					
1	Enmyvaam	67.	17	49	Peat	cou	GPD,	^{14}C	1A+4C	10.6-4.3	63	Lozhkin and
5	River	42	2.0	0	sedimen	nts	EPD,				0	Vazhenina, 1987
3			8		t		Pan					

154	El'gygytgyn Lake	67.50	172.10	(170)	Lake sediment	per cent	Pan	polarity	-	20.2-1.5	650	Melles et al., 2012
155	El'gygytgyn Lake P1	67.37	172.22	561	Palaeosol	counts	From author	^{14}C	11A	12.9-3.1	580	Andreev et al., 2012
156	El'gygytgyn Lake P2	67.55	172.13	542	Palaeosol	counts	From author	^{14}C	9A+1E	16.6-0	470	Andreev et al., 2012
157	Melkoye Lake	64.86	175.23	36	Lake sediment	counts	From author	^{14}C	21E	39.1-0	1260	Lozhkin and Anderson, 2013
158	Sunset Lake	64.84	175.30	36	Lake sediment	counts	From author	^{14}C	7A	14.0-0	260	Lozhkin and Anderson, 2013
159	Malyi Krechet Lake	64.80	175.53	32	Lake sediment	counts	From author	^{14}C	12A	9.6-0	400	Lozhkin and Anderson, 2013
160	Patricia Lake	63.33	176.50	121	Lake sediment	counts	From author	^{14}C	3A+7E	19.1-0	290	Anderson and Lozhkin, 2015
161	Gytgykai Lake	63.42	176.57	102	Lake sediment	counts	GPD, EPD, Pan	^{14}C	1A+8E	32.3-0	470	Lozhkin et al., 1998
162	Amguema River 1	67.75	178.70	175	Fluvial sediment	counts	GPD	^{14}C	2C	23.8-1.6	5550	Lozhkin et al., 1995
16	Amguema River 2	67.67	178.6	87	Fluvial sedimen	counts	GPD	^{14}C	2A	3.2-0.1	390	Lozhkin et al., 1995

3			0		t							
1	Blossom	70.	17	6	Peat	cou	GPD,	^{14}C	1C	13.8-0.2	34	Oganesyan et
6	Cape	68	8.9		sedimen	nts	EPD,				00	al., 1993
4			5		t		Pan					
1	Wrangle	70.	-17	7	Lake	cou	GPD	^{14}C	5A+1E	16.1-0.3	79	Lozhkin et al.,
6	Island_JLL	83	9.8		sedimen	nts					0	2001
5					t							
1	Wrangel	71.	-17	20	Peat	cou	GPD	^{14}C	17A+3C	13.7-10.	11	Lozhkin et al.,
6	Island_wr12	17	9.8	0	sedimen	nts				2	0	2001
6					t							
1	Neizvestnay	71.	-17	3	Peat	cou	EPD,	^{14}C	1C	5.2-1.2	10	Oganesyan et
6	a	55	9.4		sedimen	nts	Pan				00	al., 1993
7					t							
1	Kresta Gulf	66.	-17	5	Peat	cou	GPD,	^{14}C	1A+1C	9.3-3.4	58	Ivanov, 1986
6		00	9.0		sedimen	nts	EPD,				0	
8					t		Pan					
1	Konergino	65.	-17	10	Peat	cou	GPD,	^{14}C	1C	9.8-0	90	Ivanov et al.,
6		90	8.9		sedimen	nts	EPD,				0	1984
9					t		Pan					
1	Dlinnoye	67.	-17	28	Lake	cou	GPD	^{14}C	3A	1.3-0	13	Anderson et al.,
7	Lake	75	8.8	0	sedimen	nts					0	2002
0					t							
1	Dikikh	67.	-17	30	Lake	cou	EPD,	^{14}C	1A+4C	50.3-0	10	Anderson et al.,
7	Olyenyeii	75	8.8	0	sedimen	nts	Pan				50	2002
1	Lake				t							
1	Arakamchec	64.	-17	7	Peat	cou	GPD,	^{14}C	1C	11.5-0	10	Ivanov, 1986
7	hen Island	75	2.1		sedimen	nts	EPD,				50	
2					t		Pan					
1	Lorino	65.	-17	12	Peat	cou	GPD	^{14}C	3C	17.9-5.1	85	Ivanov, 1986

7 3	50	1.7	sedimen t	nts	0

* indicates the inclination of age-depth model with Lake Biwa. Elev. = elevation. Res. (yr) indicates the temporal resolution. GPD: Global Pollen Database; EPD: European Pollen Database; Pan: Pangaea. Material codes for radiocarbon dating: A = terrestrial plant macrofossil; B = non-terrestrial plant macrofossil; C = peat-gyttja bulk; D = pollen; E = total organic matter from silt; F = animal remains and shells; G = charcoal; H = $CaCO_3$; U = unknown.

Appendix 2 Pollen taxa used in the dataset and their corresponding original Latin names.

Standardized pollen name	**Original pollen name**
Abies	*Abies*, *Abies sibirica*
Acer	*Acer*
Alnus (shrub)	*Alnaster*, *Alnaster fruticosa*, *Alnus* cf. *fruticosa*, *Alnus viridis*, *Alnus viridis* ssp. *fruticosa*, *Alnus viridis*-type, *Duschekia fruticosa*
Alnus (tree)	*Alnus* cf. *hirsuta*, *Alnus glutinosa*, *Alnus hirsuta*, *Alnus incana*
Alnus (undiff.)	*Alnus*, *Alnus* undiff.
Apiaceae	Apiaceae, *Bupleurum*, *Heracleum*, Umbelliferae, Umbelliferae undiff.
Araliaceae	*Aralia*, Araliaceae
Artemisia	*Artemisia*, *Artemisia tilesii*, *Artemisia* undiff.
Asteraceae (non-*Artemisia*)	*Achillea*, *Anthemis*, *Aster*, Asteraceae, Asteraceae cichorioideae, Asteraceae liguliflorae, Asteraceae subfam. Asteroideae, Asteraceae subfam. cichorioideae, Asteraceae tubuliflorae, *Centaurea cyanus*, *Cirsium*, Compositae, Compositae subfam. Asteroideae, Compositae subfam. Asteroideae undiff., Compositae subfam. Cichorioideae, *Lactuca*-type, *Matricaria*, *Saussurea*, *Senecio*, *Serratula*, *Taraxacum*
Betula (shrub)	*Betula* (shrub), *Betula* cf. *B. fruticosa*, *Betula* cf. *B. nana*, *Betula* cf.*nana*, *Betula divaricata*, *Betula fruticosa*, *Betula nana*, *Betula nana* ssp. *exilis*, *Betula nana* ssp. *nana*, *Betula ovalifolia*, *Betula* sect. *Fruticosae*, *Betula* sect.

	Nanae, *Betula* sect. *Nanae*/*Fruticosae*
Betula (tree)	*Betula alba*-type, *Betula* cf. *B. pendula*, *Betula* cf. *alba*, *Betula costata*, *Betula dahurica*, *Betula ermanii*, *Betula pendula*, *Betula platyphylla*, *Betula pubescens*, *Betula schmidtii*, *Betula* sect. *Albae*, *Betula* sect. *Betula*, *Betula* sect. *Costatae*
Betula (undiff.)	*Betula*, *Betula* undiff., Betulaceae undiff.
Boraginaceae	Boraginaceae, *Lithospermum*-type
Brassicaceae	Brassicaceae, Brassicaceae undiff., *Cardamine*, Cruciferae, Crucififerae, *Draba*
Campanulaceae	Campanulaceae
Cannabis	Cannabaceae, *Cannabis*
Caprifoliaceae	Caprifoliaceae, Caprifoliaceae undiff., *Diervilla*, *Knautia*, *Linnaea borealis*, *Lonicera*, *Sambucus*, *Viburnum*
Carpinus	*Carpinus*, *Carpinus cordata*, *Carpinus betulus*
Carya	*Carya*
Caryophyllaceae	Caryophyllaceae, Caryophyllaceae Sf. Silenoideae-t, Caryophyllaceae undiff., *Cerastium*, *Gypsophila repens*-type, *Illecebrum verticillatum*, *Lychnis*-type, *Minuartia*, *Silene*, *Stellaria holostea*
Castanea	*Castanea*
Cedrus	*Cedrus*
Celastraceae	Celastraceae, *Euonymus*
Celtis	*Celtis*
Cerealia+large Poaceae	Cerealia, *Hordeum*, *Triticum*-type
Chenopodiaceae	Chenopodiaceae, Chenopodiaceae/Amaranthaceae
Convolvulaceae	Convolvulaceae
Cornus	*Cornus*, *Cornus suecica*
Corylus	*Corylus*
Crassulaceae	Crassulaceae, *Mentanthes trifoliata*, *Sedum*
Cupressaceae (other)	Cupressaceae
Cyperaceae	Cyperaceae
Dacrydium	*Dacrydium*

Dipsacaceae	Dipsacaceae, *Succisa*
Droseraceae	*Drosera*, Droseraceae
Elaeagnus	*Elaeagnus*
Ephedra	*Ephedra*, *Ephedra distachya*, *Ephedra distachya+fragilis*, *Ephedra fragilis*, *Ephedra monosperma*
Ericaceae	*Calluna*, *Cassiope*, *Empetrum*, Ericaceae, Ericaceae undiff., *Ericales*, *Ericales* undiff., *Ledum*, *Rhododendron*, *Vaccinium*
Euphorbiaceae	*Euphorbia*, Euphorbiaceae
Fabaceae (herb)	*Trifolium*
Fabaceae (shrub)	*Astragalus*
Fabaceae (undiff.)	Fabaceae, Fabaceae undiff., Leguminosae, Papilionaceae
Fagus	*Fagus*
Gentianaceae	*Gentiana*, Gentianaceae, Gentianaceae undiff.
Geraniaceae	Geraniaceae, *Geranium*
Hippophäe	*Hippophäe rhamnoides*
Humulus	*Humulus*
Ilex	*Ilex*
Impatiens	*Impatiens noli-tangere*
Iridaceae	Iridaceae
Juglans	*Juglans*
Juncaceae	Juncaceae
Juniperus	*Juniperus*
Koenigia	*Koenigia islandica*
Lamiaceae	*Labiatae*, Lamiaceae, Lamiaceae undiff., *Mentha*-type
Larix	*Larix*, *Larix dahurica*, *Larix gmelinii*, *Larix sibirca*
Liliaceae	*Allium*, Liliaceae, *Lloydia*, *Polygonatum*, *Tofieldia*, *Veratrum*, *Zigadenus*
Linaceae	Linaceae
Lythraceae	Lythraceae, *Lythrum*
Malvaceae	Malvaceae
Myrica	*Myrica*

Oenotheraceae	*Chamaenerium*, *Circaea*, *Circaea alpina*, *Epilobium*, *Epilobium angustifolium*, *Epilobium latifolium*, *Epilobium* undiff., Onagraceae, Onagraceae undiff.
Oleaceae (temperate)	*Fraxinus*, *Fraxinus mandschurica*
Oleaceae (undiff.)	Oleaceae, Oleaceae undiff., *Syringa*
Orchidaceae	Orchidaceae
Oxalidaceae	Oxalidaceae
Papaveraceae	*Corydalis*, *Papaver*, Papaveraceae
Phellodendron	*Phellodendron*
Picea	*Picea*, *Picea abies* ssp. *obovata*, *Picea obovata*, *Picea* sect. *Eupicea*, *Picea* sect. *Omorica*, *Picea* undiff., *Picea*/*Pinus* undiff.
Pinguicula	*Pinguicula*
Pinus (Diploxylon)	*Pinus* (Diploxylon), *Pinus* subgen. *Pinus*, *Pinus* subg. *Pinus* undiff., *Pinus sylvestris*
Pinus (Haploxylon)	*Pinus* (Haploxylon), *Pinus cembra*, *Pinus koraiensis*, *Pinus pumila*, *Pinus sibirica*, *Pinus sibirica*-type, *Pinus* subgen. *Strobus*, *Pinus* subgen. *Strobus* undiff., *Pinus* subgen. Haploxylon, *Pinus* subsect. *Cembrae* undiff.
Pinus (undiff.)	Pinaceae, Pinaceae undiff., *Pinus*, *Pinus* undiff.
Plantago	Plantaginaceae, *Plantago*
Plumbaginaceae	*Armeria*, *Armeria maritima*-type, *Goniolimon*, *Limonium*, Plumbaginaceae
Poaceae (wildgrass)	Gramineae, Poaceae, *Stipa*
Podocarpus	*Podocarpus*
Polemoniaceae	*Helianthemum*, *Phlox*, *Phlox sibirica*, Polemoniaceae, Polemoniaceae undiff., *Polemonium*, *Polemonium acutiflorum*, *Polemonium boreale*
Polygala	*Polygala*
Polygonaceae (other)	*Oxyria*, *Oxyria digyna*, Polygonaceae, Polygonaceae undiff.
Polygonum	*Polygonum*, *Polygonum alaskanum*, *Polygonum amphibium*, *Polygonum aviculare*, *Polygonum bistorta*, *Polygonum bistortoides*-type, *Polygonum czukavinae*, *Polygonum ellipticum*, *Polygonum laxmanii*, *Polygonum* sect. *Aconogonon*, *Polygonum* sect. *Bistorta*, *Polygonum* sect. *Persicaria*, *Polygonum tripterocarpum*, *Polygonum* undiff., *Polygonum viviparum*

Populus	*Populus*
Portulacaceae	*Claytonia*, *Claytonia acutifolia*, *Claytonia arctica*, *Claytonia sarmentosa*, *Claytonia sibirica*, *Claytonia* undiff., *Claytoniella vassilievii*, Portulacaceae, Portulacaceae undiff.
Primulaceae	*Androsace*, Androsaceae, *Lysimachia*, *Primula*, Primulaceae, Primulaceae undiff.
Pterocarya	*Pterocarya*
Pyrolaceae	Pyrolaceae
Quercus (deciduous)	*Quercus dentata*, *Quercus mongolica*
Quercus (undiff.)	*Quercus*, *Quercus* undiff.
Ranunculaceae (other)	*Anemone*, *Anemone nemorosa*, *Caltha palustris*, *Delphinium*, *Hepatica*, *Pulsatilla*, Ranunculaceae, Ranunculaceae undiff., *Ranunculus*, *Trollius*
Rhamnus	*Rhamnus*
Ribes	*Ribes*, *Ribes rubrum*-Type
Rosaceae	*Comarum palustre*, *Dryas*, *Dryas octopetala*, *Filipendula*, *Filipendula ulmaria*, *Potentilla*, Rosaceae, Rosaceae subf. Maloideae, Rosaceae undiff., *Rubus*, *Rubus atcticus*, *Rubus chamaemorus*, *Sanguisorba*, *Sanguisorba officinalis*, *Sieversia*-type, *Sorbus aucuparia*, *Spiraea*
Rubiaceae	*Galium*, Rubiaceae
Rumex	*Rumex*, *Rumex aquatilis*, *Rumex* undiff., *Rumex*/*Oxyria*, *Rumex*/*Oxyria digyna*
Salix	*Salix*
Saxifragaceae (herb)	*Parnassia*, *Parnassia palustris*, *Saxifraga*, *Saxifraga cernua*, *Saxifraga gramulata*-type, *Saxifraga hieracifolia*, *Saxifraga nivalis*-type, *Saxifraga oppositifolia*, *Saxifraga* sp., *Saxifraga stellaris*-type, *Saxifraga tricuspidata*, *Saxifraga* undiff.
Saxifragaceae (undiff.)	Saxifragaceae, Saxifragaceae undiff.
Scrophulariaceae	*Castilleja*, *Lagotis*, *Pedicularis*, Scrophulariaceae, Scrophulariaceae undiff.
Thalictrum	*Thalictrum*
Tilia	*Tilia*
Tsuga	*Tsuga*, *Tsuga canadensis*, *Tsuga diversifolia*, *Tsuga* undiff.
Ulmus	*Ulmus*, *Ulmus glabra*, *Ulmus minor*, *Ulmus* sp.

Urtica	*Urtica*
Urticaceae (non-*Urtica*)	Urticaceae
Valerianaceae	*Patrinia*, *Valeriana*, *Valeriana capitata*, *Valeriana officinalis*, *Valeriana* undiff., Valerianaceae, Valerianaceae undiff.
Violaceae	Violaceae