Table S1 Proxies used in palaeoecological peatland studies in Western Siberia Lowland (WSL) included in the Western Siberian Peat Cores Database (WSPC)

Proxy type	Proxy	Information provided / interpretation	Examples of studies in the WSPC database
Biological*	Pollen	Pollen and spores provide information on past vegetation composition, allowing reconstruction of historical vegetation dynamics and the climatic conditions (Mander and Punyasena, 2018)	Blyakharchuk, 2003; Novenko et al., 2023; Peteet et al., 1998
	Non-pollen palynomorphs (NPPs)	NPP assemblages reflect local ecological conditions, including hydrology, fire, erosion, and grazing activities, providing complementary information to pollen for reconstructing past environments (Shumilovskikh et al., 2021; Van Geel, 2001)	Feurdean et al., 2022; Halaś et al., 2025
	Plant macrofossils	Provide information on local vegetation and flora with high taxonomic precision, allowing reconstruction of site-scale vegetation dynamics, paleoclimatic conditions (Birks and Birks, 2000)	Preis, 2015; Tarasov et al., 1998; Tikhonravova et al., 2023
	Testate amoebae (TA)	Mainly used for reconstruction of past changes in peatland hydrology and as a proxy for hydroclimate (Charman, 2001; Mitchell and Payne, 2018)	Halaś et al., 2025; Kurina et al., 2020; Willis et al., 2015
	Oribatid mites	Good bioindicators of microhabitat and moisture conditions in peatlands (Seniczak et al., 2022)	Kurina et al., 2017, 2023
	Molluscs	Useful for reconstruction of water chemistry, hydrology and paleoclimate, like precipitation and temperature (Horsák, 2011)	Kurina et al., 2017, 2023
	Arthropods	Arthropods serve as bioindicators, used to assess biodiversity, restoration success, habitat alteration, and potential impacts of climate change (Batzer et al., 2016)	Panova et al., 2010
	Diatoms	Diatoms are mostly used in minerotrophic peatlands, indicate past water level, chemical conditions or human disturbances (Carballeira and Pontevedra-Pombal, 2020)	Paradossky et al., 2019
	Microcharcoal	Provide information on past fire history, based on the size of charcoal particles the distance to the source can be determined. Microcharcoal is used to recontract regional fire history, while macrocharcoal is used for local-scale fire reconstructions (Conedera et al., 2009).	Halaś et al., 2025; Lamentowicz et al., 2015; Shefer et al., 2024
	Macrocharcoal		Feurdean et al., 2019; Novenko et al., 2023; Ryabogina et al., 2024
Physical	Bulk density	Provide information on peat compaction, peat accumulation, decomposition and carbon content (Chambers and Charman, 2004)	(Preis et al., 2024; Smith et al., 2012)
	Moisture content	Moisture controls decomposition, microbial activity and nutrient mobility (Rydin et al., 2006)	Preis, 2024; Tikhonravova et al., 2023
	Degree of decomposition / Peat humification	Is a measure of peat decomposition, useful as proxy to reconstruct past hydrological and climatic conditions (Biester et al., 2014)	Syso and Peregon, 2009; Tsyganov et al., 2021; Turunen et al., 2001
	Peat accumulation	Gives information about past climate variability, peatland development and productivity (Swindles et al., 2025)	Borren et al., 2004; Malyasova et al., 1991; Swindles et al., 2025
	Basal depth	Basal depth provides information on peatland initiation, development and functioning, it is also essential for carbon accumulation calculation and in climate change models (Parry et al., 2014)	Kremenetski et al., 2003; MacDonald et al., 2006; Smith et al., 2004
Chemical	Ash content	Informs about mineral input, dust or pollution deposition, erosion, or fire signal (Tolonen, 1984)	Kurina et al., 2023; Veretennikova et al., 2021
	pH	Paleo pH provides information about trophic status, carbon/methane cycling and can be used as an indirect proxy for paleoclimate (Schaaff et al., 2024)	Stepanova and Volkova, 2017; Syso and Peregon, 2009
	Organic matter (LOI)	It helps to identify non-organic input and reconstruct land-use history (Chambers and Charman, 2004)	Lapshina and Zarov, 2023; Minayeva et al., 2006; Peteet et al., 1998

	Carbon accumulation	Provides information about carbon sequestration over time, indicates past changes in peatland productivity, decomposition and indirectly climate conditions (Charman et al., 2015)	Sheng et al., 2004; Turunen et al., 2001; Yu et al., 2009
	Stable isotopes ($\delta^{13}C$, $\delta^{15}N$, δD, $\delta^{18}O$)	Stable isotopes combined with other analysis are valuable tools to reconstruct past temperature, humidity, and water table conditions (McClymont et al., 2010)	Feurdean et al., 2019; Startsev et al., 2022, Novenko et al. 2024
	Geochemistry*	To determine chemical composition of peat, natural and anthropogenic fluxes of metals, secondary sources of mineral matter e.g. sea spray, fires or industrial emissions (Shotyk, 1988)	Fiałkiewicz-Kozieł et al., 2016; Veretennikova et al., 2021
	X-ray fluorescence (XRF) / X-ray diffraction (XRD)	XRF determines elemental composition of the sediment, interpretation depends on the elements/element ratios used, e.g. used to infer anthropogenic impact, hydrological shifts or dust input. Measurements can be of uncertain reliability (Longman et al., 2019). XRD identifies crystalline minerals in a sample, allowing direct, non-destructive mineral characterization, though amorphous or poorly crystalline materials may not be detected (Sjöström et al., 2019).	Feurdean et al., 2022; Leonova et al. 2022; Shvartseva et al., 2024
	FTIR (Fourier transform infrared spectroscopy)	FTIR spectra can indicate peat decomposition, organic matter quality, peat mineral matter and assessment of peatland restoration success (Artz et al., 2008; Martínez Cortizas et al., 2021)	Kurina et al., 2023
Chronological	Dating (e.g., ^{14}C, ^{210}Pb, ^{137}Cs)	Used to determine peat components age, for age–depth model calculations, accumulation rate and sedimentation chronology (Chambers and Charman, 2004)	Borisova et al., 2011; Glebov et al., 2002; Kremenetski et al., 2003

**Among the biological proxies, a category termed "zoogenic remains" was also distinguished, which was used in the context of the study by Paradossky et al. (2019). In that study, the authors identified general groups of zoogenic remains rather than specific taxa.*
** General group of analysis applied on peat core excluding stable isotopes, XRF and FTIR.*

Table S2 Results of calibration of uncalibrated radiocarbon ages (yr BP) for peat cores in Western Siberian Peat Cores Database (WSPC) with reference to the source of original (uncalibrated) ages.

No.	Core ID	^{14}C age (yr BP)	± 1σ (yr)	Calibrated age range (cal. yr BP)	Median calibrated age (cal. yr BP)	Reference
1	WS_6	8710	105	9539-10127	9676	MacDonald et al., 2006
2	WS_8	4578	72	4992-5465	5310	Leonova et al., 2021; Preis et al., 2024
3	WS_15	5611	54	6304-6519	6398	Leonova et al., 2021; Preis et al., 2024
4	WS_67	5260	60	5921-6207	5997	Lapshina and Zarov, 2023
5	WS_68	1780	70	1534-1846	1644	Lapshina and Zarov, 2023
6	WS_71	5260	160	5666-6355	5997	Blyakharchuk, 2003
7	WS_134	8450	60	9308-9532	9479	Blyakharchuk, 2003
8	WS_158	4310	90	4601-5253	4856	Preis, 2024
9	WS_171	9780	210	10588-11912	11207	Khotinsky, 1984
10	WS_221	9000	100	9753-10395	10196	MacDonald et al., 2006
11	WS_228	8400	80	9149-9525	9454	Liss and Berezina, 1981
12	WS_251	10600	80	12236-12723	12627	Khotinsky, 1984
13	WS_549	4840	110	5329-5860	5587	Vasil'chuk et al., 2001
14	WS_567	7420	110	8019-8406	8280	Vasil'chuk et al., 2001
16	WS_584	8670	100	9504-10100	9553	Punning et al., 1974
15	WS_585	7960	100	8559-9083	8930	Punning et al., 1974
17	WS_589	6550	170	7054-7729	7429	MacDonald et al., 2006
18	WS_590	7640	220	8028-9008	8414	MacDonald et al., 2006
19	WS_591	7730	220	8089-9151	8524	MacDonald et al., 2006
20	WS_592	7800	170	8269-9083	8591	MacDonald et al., 2006
21	WS_593	7820	200	8233-9224	8595	MacDonald et al., 2006
22	WS_594	8000	50	8656-9000	8820	MacDonald et al., 2006
23	WS_595	8000	200	8436-9399	8820	MacDonald et al., 2006
24	WS_596	8180	40	9022-9274	9106	MacDonald et al., 2006
25	WS_597	8180	230	8538-9584	9106	MacDonald et al., 2006

26	WS_598	8400	240	8706-10069	9454	MacDonald et al., 2006
27	WS_645	8790	170	9512-10235	9774	Vasil'chuk et al., 2001

Table S3 Proxy groups and individual proxy weights used in the scoring framework

Proxy group	Proxy	Weight
Biological	Pollen	2.0
	Non-pollen palynomorphs (NPPs)	1.2
	Plant macrofossils	1.5
	Testate amoebae	2.5
	Microcharcoal	1.5
	Macrocharcoal	1.5
	Oribatid mites	0.5
	Molluscs	0.5
	Diatoms	1.0
	Arthropods	0.2
	Zoogenic remains	0.2
Physical	Bulk density	2.0
	Moisture content	0.5
	Degree of decomposition	1.0
	Peat humification	1.0
	Peat accumulation	2.0
	Basal depth	1.0
Chemical	Ash content	1.5
	pH	1.0
	Organic matter (LOI)	2.0
	Carbon accumulation	2.5
	Stable isotopes	2.5
	Geochemistry	2.0
	XRF/XRD	2.0
	FTIR	2.0

Table S4 Components of scoring framework for peat cores in WSPC database

Component	Description	Scaling	Weight
Chronology (chron)	Presence of an independent age model	Binary: 1 = present, 0 = absent	1
Record length (record)	Total temporal coverage of the core	Scaled 0.05–1.0: <200 yr = 0.05 200-500 yr = 0.2 500-2,000 yr = 0.4 2,000-5,000 yr = 0.6 5,000-10,000 yr = 0.8 >10,000 yr = 1.0	1
Proxy count (count)	Number of proxy available	Linearly rescaled 0–1 (1–12 proxies)	1
Proxy group scores (proxies)	Weighted sum of proxies within each group	According to Table S3	4
All proxies combined (proxies)	Weighted sum of all proxies across groups	According to Table S3	5

$$\text{Combined Score} = S_{chron} \times W_{chron} + S_{record} \times W_{record} + S_{count} \times W_{count} + \sum_{S\ proxies} \times W_{proxies}$$

Where: S – score, W – weight

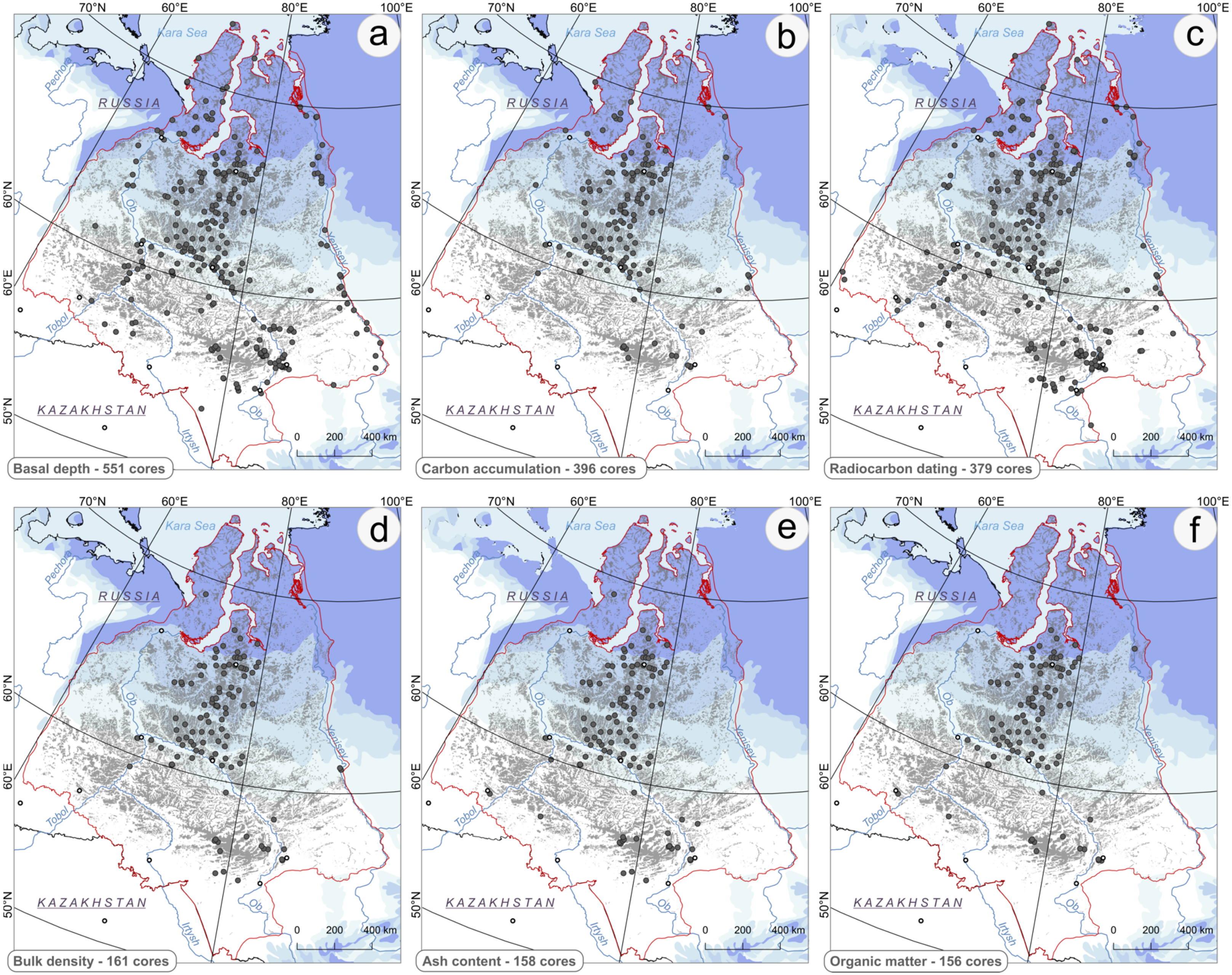

Figure S1. Spatial distribution of peat cores included in the Western Siberian Peat Core Database with records of proxies: (a) basal depth, (b) carbon accumulation, (c) radiocarbon dating, (d) bulk density, (e) ash content, (f) organic matter, (g) plant macrofossils, (h) degree of decomposition, (i) moisture content, (j) pollen, (k) peat accumulation, (l) macrocharcoal, (m) testate amoebae, (n) geochemistry, (o) microcharcoal, (p) peat humification, (q) non-pollen palynomorphs, (r) pH, (s) stable isotopes, (t) XRF/XRD, (u) diatoms, (v) FTIR, (w) arthropod, (x) mollusc, (y) zoogenic remains, (z) oribatid.

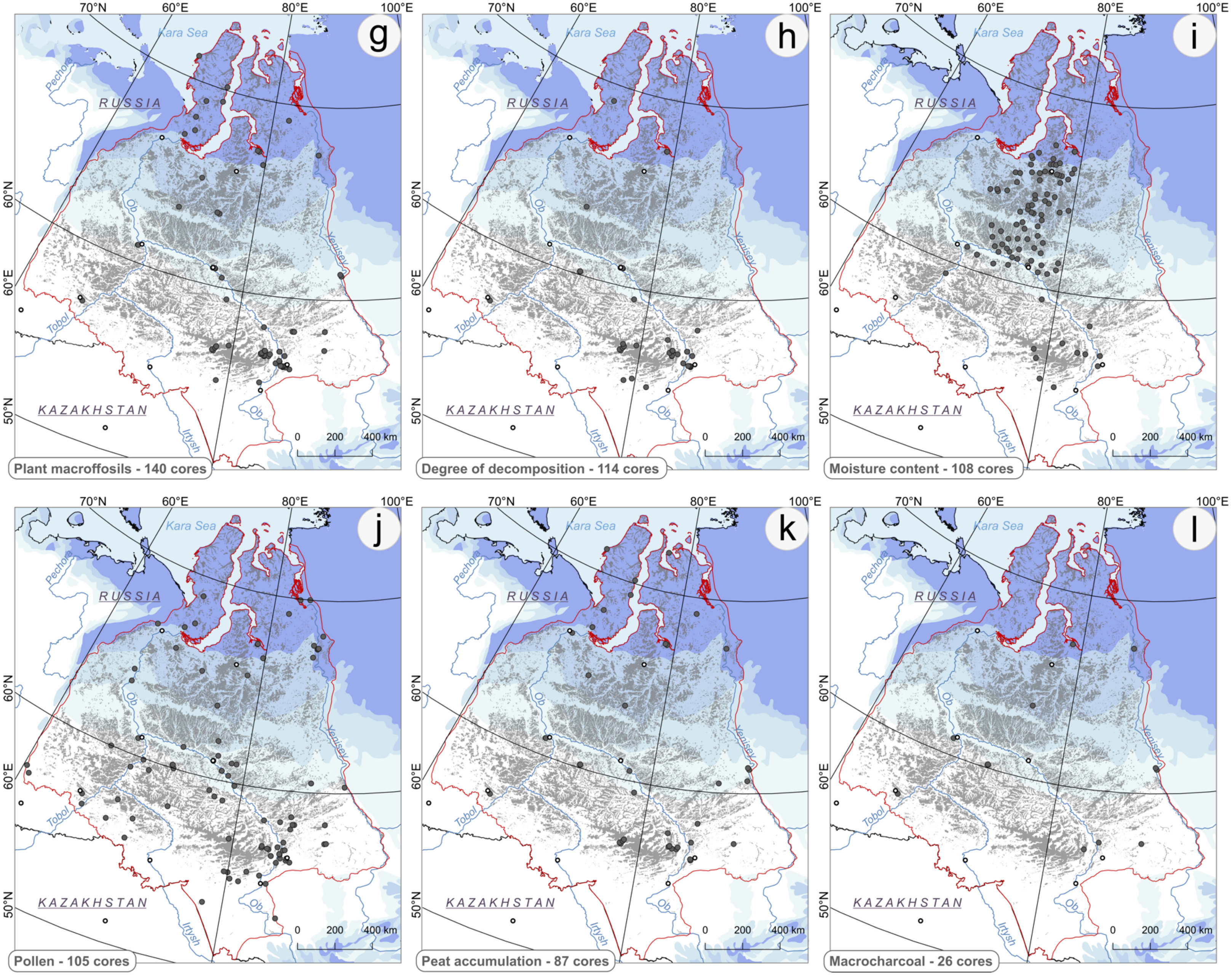

Figure S1. continued

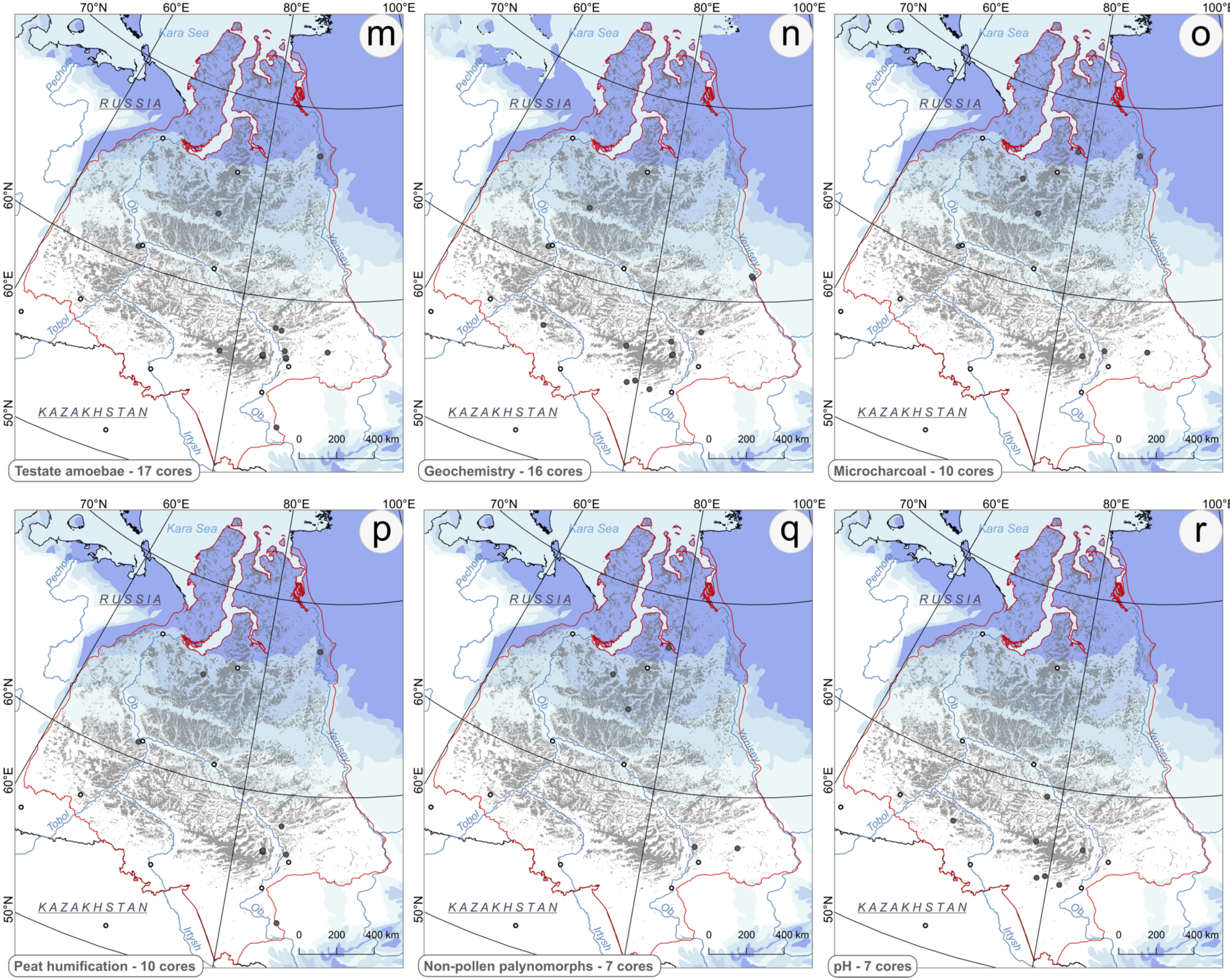

Figure S1. Continued

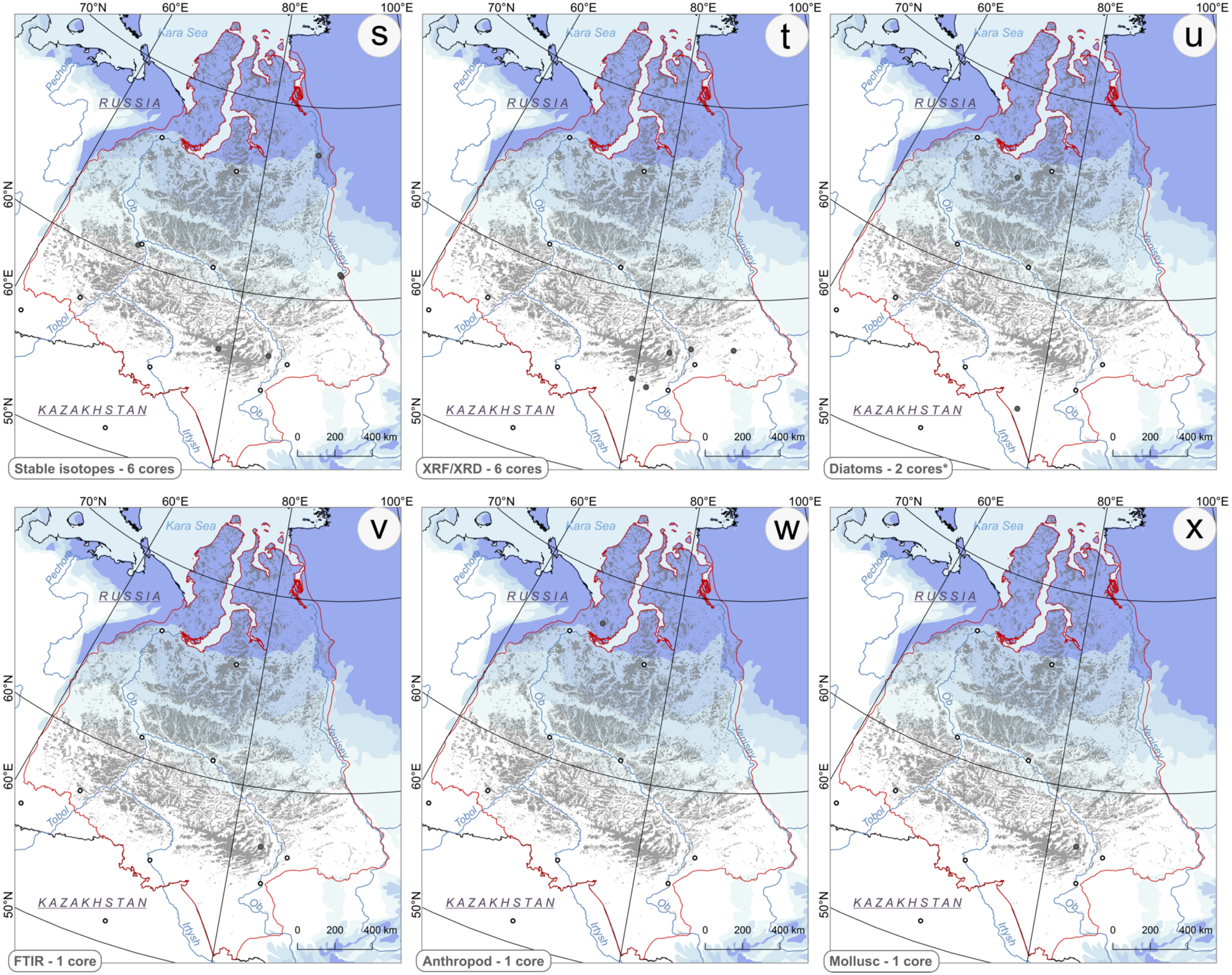

Figure S1. continued
* In one core (located in the north), diatoms were applied only on the lake section of the core below the peat

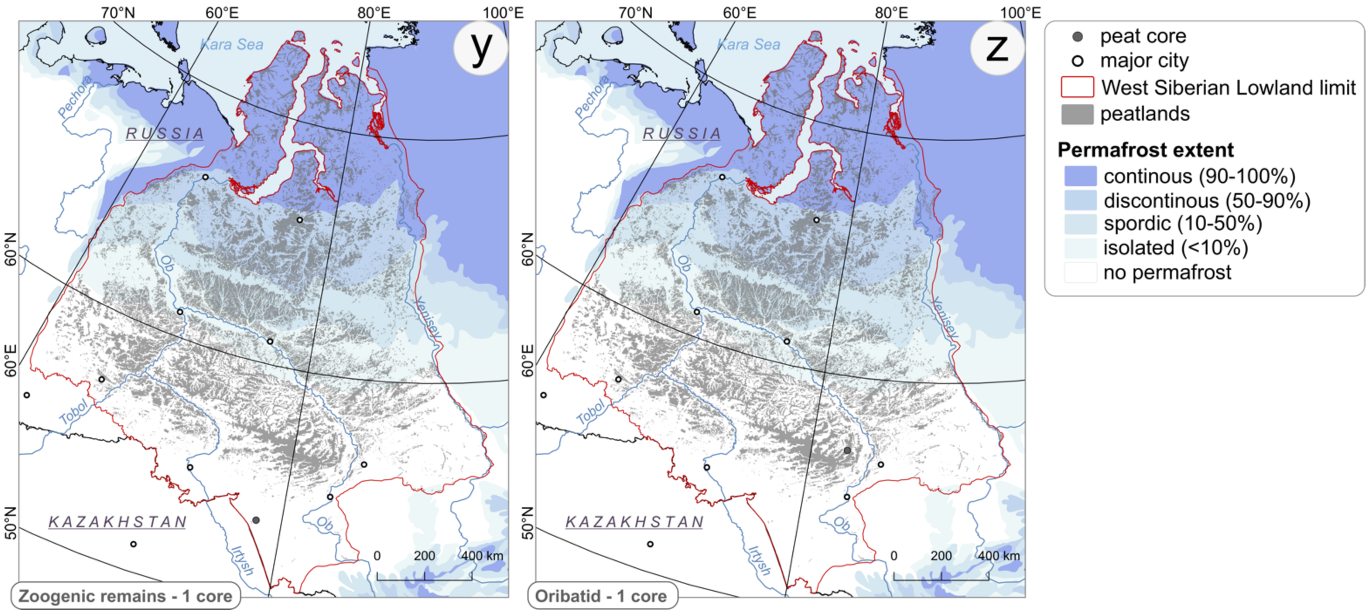

Figure S1. continued

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