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Carbon and nitrogen pools in thermokarst-affected permafrost landscapes in Arctic Siberia

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Table S1: Sample locations on Sobo-Sise Island and Bykovsky Peninsula

Transect site Sobo-Sise Island	Latitude [°]	Longitude [°]	Sampling date	Mean organic layer depth [cm]	Mean active layer depth [cm]	Sample depth [cm]	Landscape unit
SOB14-T1-1	72.5044	128.0392	13.08.2014	14	26.5	101	Yedoma upland
SOB14-T1-2	72.5057	128.0373	13.08.2014	3	28.5	111	Yedoma upland
SOB14-T1-3	72.5070	128.0362	14.08.2014	10	35	189	Yedoma slope
SOB14-T1-4	72.5083	128.0355	14.08.2014	10	29.6	186	Thermokarst
SOB14-T1-5	72.5096	128.0344	14.08.2014	11	16.5	200	Thermokarst
SOB14-T2-1	72.5285	127.9698	15.08.2014	4	47.5	128	Yedoma upland
SOB14-T2-1B	72.5283	127.9705	15.08.2014	7.5	62.5	259	Baydzherakh
SOB14-T2-2	72.5285	127.9728	15.08.2014	4.5	39	238	Yedoma upland
SOB14-T2-3	72.5285	127.9758	16.08.2014	3.5	48	249	Yedoma slope
SOB14-T2-4	72.5285	127.9789	15.08.2014	6	34	223	Thermokarst
SOB14-T2-5	72.5285	127.9818	16.08.2014	5	41	318	Thermokarst
SOB14-T2-6	72.5285	127.9848	16.08.2014	2	83.5	123	Deltaic deposits
SOB14-T2-7	72.5285	127.9878	16.08.2014	0	na	45	Deltaic deposits
SOB14-P-01	72.5327	128.0390	17.08.2014	0	na	45	Deltaic deposit
SOB14-P-02	72.5246	128.0231	18.08.2014	14	21.5	187	Thermokarst
SOB14-04-A	71.8518	129.3509	12.08.2014	5	na	165	Thermokarst

Transect site Bykovsky Peninsula	Latitude [°]	Longitude [°]	Sampling date	Mean organic layer depth [cm]	Mean active layer depth [cm]	Sample depth [cm]	Landscape unit
BYK14-T2-1	71.8584	129.2869	29.08.2014	8.5	55	18	Thermokarst
BYK14-T2-1B	71.8588	129.2882	29.08.2014	4	57	35	Thermokarst
BYK14-T2-2	71.8595	129.2897	29.08.2014	3	58.5	111	Thermokarst
BYK14-T2-3	71.8605	129.2928	29.08.2014	17	45	211	Baydzherakh
BYK14-T2-4	71.8614	129.2953	29.08.2014	7.5	23.5	125	Thermokarst
BYK14-T2-5	71.8625	129.2981	01.09.2014	12	28	100	Thermokarst
BYK14-T3-1	71.8193	129.3255	26.08.2014	na	na	12	Thermokarst
BYK14-T3-2B	71.8197	129.3232	26.08.2014	8	18	101	Thermokarst
BYK14-T3-3	71.8206	129.3213	26.08.2014	14.5	28	208	Thermokarst
BYK14-T3-4	71.8212	129.3194	25.08.2014	4	64	189	Baydzherakh
BYK14-T3-5	71.8218	129.3172	25.08.2014	4.5	36.5	112	Yedoma upland
BYK14-T3-6	71.8224	129.3152	25.08.2014	5	45.5	121	Yedoma upland
BYK14-T3-6B	71.8224	129.3154	25.08.2014	7	33.5	191	Yedoma upland

Table S2: Laboratory results of soil carbon, nitrogen, and ground ice characteristics for the different geomorphological landscape units on Sobo-Sise Island and Bykovsky Peninsula. All values are median values. +/- values indicate the 75 and 25 percentile.

	TOC [%]	TIC [%]	TN [%]	C/N [-]	Vol. ice content [%]	SOC [kg/m^3]	Nitrogen [kg/m^3]	n
Sobo-Sise	2.7 +1.3/-1.0	0.08 +0.11/-0.08	0.28 +0.07/-0.10	10.1 +2.5/-1.6	62.0 +9.6/-8.2	16.4 +7.8/-5.9	1.6 +0.4/-0.5	279
Sobo-Sise Yedoma upland	3.5 +1.5/-0.8	0.13 +0.17/-0.09	0.34 +0.05/-0.05	10.8 +2.2/-1.6	60.0 +11.8/-5.7	19.4 +15.7/-4.0	1.8 +0.9/-0.3	85
Sobo-Sise Yedoma slope	2.6 +0.7/-0.4	0.14 +0.05/-0.06	0.28 +0.04/-0.06	9.9 +1.2/-0.7	61.1 +9.3/-6.8	17.5 +9.1/-4.1	1.8 +0.4/-0.5	33
Sobo-Sise Thermokarst	2.5 +1.4/-0.8	0.04 +0.12/-0.04	0.25 +0.09/-0.07	10.5 +3.0/-2.1	64.6 +8.3/-10.1	15.7 +7.2/-5.5	1.5 +0.4/-0.3	135
Sobo-Sise Fluvial Deposits	0.7 +0.3/-0.4	0.00 +0.04/-0.00	0.05 +0.01/-0.00	12.2 +2.6/-5.9	44.9 +7.6/-10.6	9.5 +2.7/-4.5	0.7 +0.1/-0.1	26
Bykovsky	3.7 +5.2/-1.8	0.39 +0.55/-0.23	0.34 +0.27/-0.10	10.5 +3.5/-2.4	61.7 +11.3/-6.7	22.0 +17.2/-8.8	2.1 +0.9/-0.6	176
Bykovsky Yedoma upland	3.6 +3.4/-1.7	0.42 +0.29/-0.16	0.34 +0.13/-0.10	9.9 +3.3/-1.9	61.4 +9.3/-6.7	22.7 +14.9/-9.6	2.1 +1.1/-0.5	80
Bykovsky Thermokarst	3.9 +7.3/-2.1	0.36 +1.10/-0.30	0.34 +0.41/-0.14	11.4 +4.8/-3.0	64.9 +11.2/-7.4	20.9 +20.2/-7.5	2.0 +0.9/-0.7	96

Table S3: Total landscape soil organic carbon (SOC) and soil nitrogen (SN) stocks for selected depth intervals based on mean sampling site carbon contents.

Study site	SOC active layer	SOC 0-30 cm	SOC 0-100 cm	SOC 0-200 cm	SN active layer	SN 0-30 cm	SN 0-100 cm	SN 0-200 cm
Sobo-Sise Yedoma	2.16 Tg	1.56 Tg	3.19 Tg	4.62 Tg	0.22 Tg	0.13 Tg	0.34 Tg	0.47 Tg
Sobo-Sise Thermokarst	1.16 Tg	1.03 Tg	2.60 Tg	4.39 Tg	0.07 Tg	0.07 Tg	0.19 Tg	0.38 Tg
Sobo-Sise Fluvial	0.01 Tg	< 0.01 Tg	0.02 Tg	> 0.02 Tg	< 0.01 Tg	< 0.01 Tg	< 0.01 Tg	> 0.01 Tg
Sobo-Sise Total	**3.34 Tg**	**2.59 Tg**	**5.81 Tg**	**9.00 Tg**	**0.29 Tg**	**0.20 Tg**	**0.53 Tg**	**0.86 Tg**
Bykovsky Yedoma	1.62 Tg	1.06 Tg	2.48 Tg	3.29 Tg	0.15 Tg	0.09 Tg	0.22 Tg	0.31 Tg
Bykovsky Thermokarst	0.69 Tg	0.61 Tg	1.50 Tg	4.17[a] Tg	0.05 Tg	0.05 Tg	0.12 Tg	0.32 Tg
Bykovsky Total	**2.31 Tg**	**1.67 Tg**	**3.98 Tg**	**7.45 Tg**	**0.20 Tg**	**0.14 Tg**	**0.34 Tg**	**0.62 Tg**
Total (SOB + BYK)	5.66 Tg	4.26 Tg	9.80 Tg	16.46 Tg	0.49 Tg	0.34 Tg	0.87 Tg	1.48 Tg

[a]Only one core collected in a DTLB on Bykovsky Peninsula reached two meter.

Table S4: Soil organic carbon (SOC) stocks for the reference depths in kg C m^{-2} for all sampled sites. SOC stocks were extrapolated to the next reference depth but not further than 50 cm below the last sample. IW = Ice Wedge, AL = Active layer

Transect site Sobo-Sise Island	SOC 0-30 cm	SOC 0- 100 cm	SOC 0-150 cm	SOC 0-200 cm	SOC 0-250 cm	SOC 0-300 cm	Core depth [cm]	Comment
SOB14-T1-1	14.91	18.19					101	IW below 83 cm
SOB14-T1-2	14.37	21.68					111	
SOB14-T1-3	9.44	15.24	15.24				189	IW below 99 cm
SOB14-T1-4	10.61	18.27	27.57	30.44			186	IW below 171 cm
SOB14-T1-5	4.31	8.82	13.38	21.31			200	
SOB14-T2-1	12.48	18.64					128	IW below 59 cm
SOB14-T2-1B	13.59	39.59	48.96	56.02	63.01	71.79	259	
SOB14-T2-2	10.64	28.38	38.41	47.61	55.01		238	
SOB14-T2-3	8.61	21.65	29.29	37.26	49.86		249	
SOB14-T2-4	6.64	19.94	24.16	29.47	35.83		223	
SOB14-T2-5	4.62	16.83	23.12	28.74	34.78	40.29	318	
SOB14-T2-6	4.37	11.20	15.23				123	
SOB14-T2-7	1.50						45	Only AL samples
SOB14-P-01	1.77						45	Only AL samples
SOB14-P-02	11.99	28.14	37.50	46.07			187	
SOB14-04-A	5.27	23.30	33.32	41.60			165	Only AL samples

Transect site Bykovsky Peninsula	SOC 0-30 cm	SOC 0- 100 cm	SOC 0-150 cm	SOC 0-200 cm	SOC 0-250 cm	SOC 0-300 cm	Core depth [cm]	Comment
BYK14-T2-1	4.92						18	Only AL samples
BYK14-T2-1B	5.47						35	Only AL samples
BYK14-T2-2	4.41	13.71	22.92				111	
BYK14-T2-3	18.72	53.78	63.41	73.86	82.52		211	
BYK14-T2-4	13.19	32.56	37.11				125	
BYK14-T2-5	12.92	20.72					100	
BYK14-T3-1	11.54						12	Only AL samples
BYK14-T3-2B	7.10	14.45	21.26				101	
BYK14-T3-3	14.22	37.97	57.04	68.21	81.48		208	
BYK14-T3-4	7.30	21.88	33.08	38.76			189	
BYK14-T3-5	10.33	18.52					112	IW below 53 cm
BYK14-T3-6	10.42	21.89					121	IW below 53 cm
BYK14-T3-6B	13.44	32.20	39.48	44.14			191	

Table S5: Soil nitrogen (SN) stocks for the reference depths in kg C m^{-2} for all sampled sites. SN stocks were extrapolated to the next reference depth but not further than 50 cm below the last sample. IW = Ice Wedge, AL = Active layer

Transect site Sobo-Sise Island	SN 0-30 cm	SN 0- 100 cm	SN 0-150 cm	SN 0-200 cm	SN 0-250 cm	SN 0-300 cm	Core depth [cm]	Comment
SOB14-T1-1	0.79	0.98					101	IW below 83 cm
SOB14-T1-2	0.98	1.46					111	
SOB14-T1-3	0.75	1.33	1.33				189	IW below 99 cm
SOB14-T1-4	0.76	1.83	2.85	3.25			186	IW below 171 cm
SOB14-T1-5	0.39	0.84	1.22	2.18			200	
SOB14-T2-1	1.04	2.71					128	IW below 59 cm
SOB14-T2-1B	1.40	3.94	4.96	5.80	6.54	7.38	259	
SOB14-T2-2	1.35	3.88	4.63	5.44	6.21		238	
SOB14-T2-3	0.78	2.08	2.76	3.59	4.75		249	
SOB14-T2-4	0.28	1.20	1.52	2.17	2.80		223	
SOB14-T2-5	0.20	1.16	1.97	2.70	3.45	4.28	318	
SOB14-T2-6	0.15	0.41	0.49				123	
SOB14-T2-7	0.00						45	Only AL samples
SOB14-P-01	0.00						45	Only AL samples
SOB14-P-02	0.66	1.71	2.58	3.53			187	
SOB14-04-A	0.48	1.87	2.66	3.50			165	Only AL samples

Transect site Bykovsky Peninsula	SN 0-30 cm	SN 0- 100 cm	SN 0-150 cm	SN 0-200 cm	SN 0-250 cm	SN 0-300 cm	Core depth [cm]	Comment
BYK14-T2-1	0.48						18	Only AL samples
BYK14-T2-1B	0.77						35	Only AL samples
BYK14-T2-2	0.63	2.06	3.30				111	
BYK14-T2-3	1.44	4.03	4.85	5.68	6.75		211	
BYK14-T2-4	0.88	2.19	2.76				125	
BYK14-T2-5	0.67	1.48					100	
BYK14-T3-1	0.92						12	Only AL samples
BYK14-T3-2B	0.59	1.14	1.88				101	
BYK14-T3-3	0.99	2.69	4.11	5.16	6.32		208	
BYK14-T3-4	0.80	2.73	4.00	4.73			189	
BYK14-T3-5	0.95	1.66					112	IW below 53 cm
BYK14-T3-6	0.85	1.64					121	IW below 53 cm
BYK14-T3-6B	1.24	2.71	3.54	4.30			191	

Table S6: Sediment (sedim. rate) accumulation rate corrected for core ice content. Sediment accumulation rate is based on the depth of the sample and the calibrated radiocarbon date. Mean sediment accumulation rate is calculated always referring to the soil surface (depth = 0 cm and Cum SOC = 0 kg C m^{-2}). Relative sediment accumulation rate is calculated always referring to the sample above a particular sample.

Sample	Age[a] [calib yr BP]	Depth [cm]	Mean sedim. rate [mm yr^{-1}]	Relative sedim. rate [mm yr^{-1}]
SOB14-T1-1-3	842	19.5-23.5	0.26	0.26
SOB14-T1-5-2	modern	10-11	na	na
SOB14-T1-5-15	5058	148-150	0.12	0.12
SOB14-T1-5-19	7481	187-200	0.12	0.07
SOB14-T2-2-7	1329	55-65	0.29	0.29
SOB14-T2-2-16	3272	119-122	0.17	0.11
SOB14-T2-2-24	7113.5	173-179	0.11	0.05
SOB14-T2-2-30	9807	218-223	0.09	0.05
SOB14-T2-5-2	modern	5-6	na	na
SOB14-T2-5-10	168	67-74	2.31	2.31
SOB14-T2-5-19	364	145-156	2.15	1.76
SOB14-T2-5-31	5517	273-278	0.24	0.10
SOB14-T2-5-34	842	298.5-302.5	1.61	0.97
BYK14-T2-3-2b	615	14-16	0.24	0.24
BYK14-T2-3-4	1109	40-45	0.38	0.56
BYK14-T2-3-8	1576	68-75	0.26	0.35
BYK14-T2-3-19	2812	159-167	0.26	0.27
BYK14-T2-3-20	45203	178-179	0.02	0.001
BYK14-T2-4-4	615	23-24	0.38	0.38
BYK14-T2-4-10	1222	45-48	0.26	0.18
BYK14-T2-4-16	1449	76-79	0.29	0.44
BYK14-T2-4-22	9368	117-125	0.06	0.02
BYK14-T3-6B-14	15533	110-116	0.04	0.04
BYK14-T3-6B-18	16048	142-148	0.04	0.24
BYK14-T3-6B-23	17970	185-191	0.04	0.09

[a]radiocarbon dates were calibrated with the Calib 7.1 software (Stuiver et al., 2017)

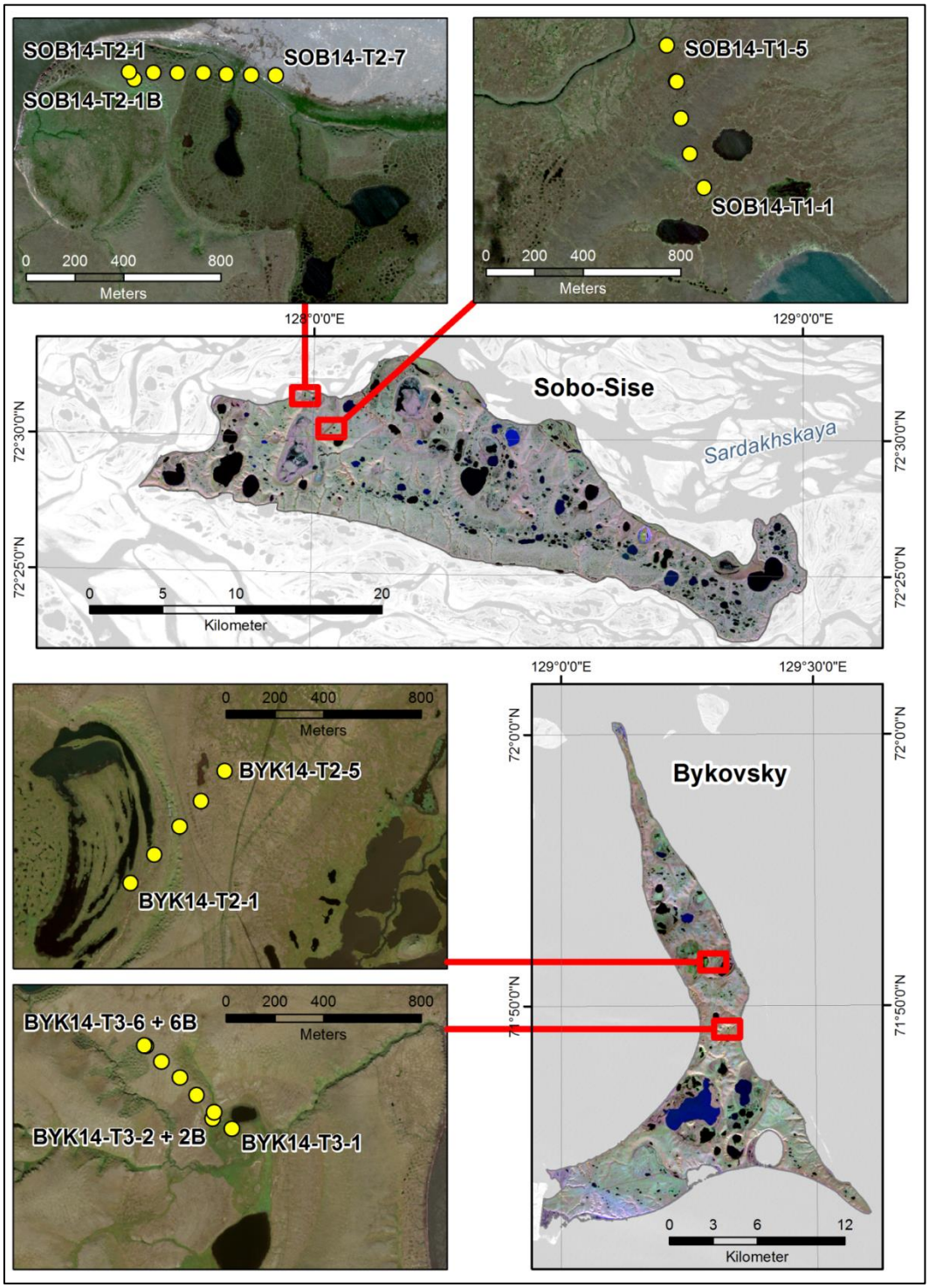
SOB14-T2-1
SOB14-T2-7
SOB14-T2-1B
0 200 400 800
Meters
SOB14-T1-5
SOB14-T1-1
0 200 400 800
Meters
128°0'0"E
129°0'0"E
Sobo-Sise
Sardakhskaya
72°30'0"N
72°25'0"N
0 5 10 20
Kilometer
0 200 400 800
Meters
BYK14-T2-5
BYK14-T2-1
0 200 400 800
Meters
BYK14-T3-6 + 6B
BYK14-T3-2 + 2B
BYK14-T3-1
129°0'0"E
129°30'0"E
72°0'0"N
71°50'0"N
Bykovsky
0 3 6 12
Kilometer

Figure S1: Transects sites on Sobo-Sise Island and Bykovsky Peninsula. The overview maps from Sobo-Sise Island and Bykovsky Peninsula include a Landsat 5 satellite image with a false colour composite (short wave infrared – near infrared – red), (acquisition date: 19th Sept. 2009, path 29, row 009). The detailed maps from the transect sites on Sobo-Sise Island include a GeoEye scene (acquisition date: 27th July 2014, ©DigitalGlobe) and the detailed maps from Bykovsky Peninsula include a WorldView2 image (acquisition date: 29th Aug. 2015, ©DigitalGlobe). All four detailed maps include natural colour images with the bands red-green-blue (bands 3-2-1 for GeoEye images and bands 5-3-2 for WorldView2 images). BYK14-T3-2 was not sampled due to terrain conditions unfavourable to sample. Therefore the alternative site BYK14-T3-2B was chosen.

References

Stuiver, M., Reimer, P.J., and Reimer, R.W., 2017, CALIB 7.1 [WWW program] at http://calib.org, accessed 2017-3-6, 2017.