Supplementary Material

Supplementary Table 1: General statistics from bulk sediment, pore water and *n*-alkane parameters: minimum, median, maximum, mean, standard deviation.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Min** | **Median** | **Max** | **Mean** | **Standard deviation** |
| **Biogeochemical parameters** |  |  |  |  |  |
| Total organic carbon [wt%] | <0.1 | 1.1 | 17.8 | 2.6 | 4.3 |
| Stable carbon isotopes [‰ vs. VPDB] | -28.6 | -24.9 | -23.8 | -25.2 | 1.1 |
| **Hydrochemical parameters** |  |  |  |  |  |
| Water content [wt%] | 10.5 | 17.1 | 65.4 | 21.0 | 12.9 |
| pH | 6.3 | 8.2 | 8.7 | 8.0 | 0.5 |
| EC [µS cm-1] | 202 | 778 | 1301 | 729 | 261 |
| ***n*-Alkane parameters** |  |  |  |  |  |
| *n*-Alkane Concentration [µg g-1 sed.] | 0.57 | 1.80 | 20.82 | 4.76 | 6.18 |
| *n*-Alkane Concentration [µg g-1 TOC] | 50.1 | 367.5 | 581.4 | 347.7 | 153.1 |
| *n*-Alkane Average chain length [number of carbon atoms] | 26.5 | 27.5 | 28.4 | 27.5 | 0.5 |
| *n*-Alkane Carbon preference index | 2.3 | 4.8 | 8.9 | 5.4 | 2.0 |
| *n*-Alkane Odd-over-even predominance | 2.2 | 5.7 | 11.0 | 6.2 | 2.6 |

Supplementary Table 2: Radiocarbon ages of Goltsovoye Lake sediment core PG2412. The calibrations were carried out using the CALIB 7.1 software and the IntCal13 calibration curve (Stuiver et al., 2017). F14C: fraction modern carbon, +/-: uncertainty, dated material: plant or wood remains, or bulk sediment.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **AWI no.** | **Depth [cm]** | **Material** | **F14C** | **+/-** | **Age**  **[a]** | **+/-** | **2σ range**  **(95.4 %)**  **[cal a BP]** | **Rounded cal. ages**  **[cal ka BP]** | **Uncert. cal. ages**  **[cal ka BP]** |
| 4210.1.1 | 555-560 | Plant/wood | 0.6620 | 0.0106 | 3,314 | 128 | 3,318-3,875 | 3.60 | 0.28 |
| 4210.2.1 | 555-560 | Bulk | 0.3522 | 0.0044 | 8,382 | 101 | 9,123-9,542 | 9.34 | 0.21 |
| 4211.1.1 | 666-672 | Plant/wood | 0.3145 | 0.0020 | 9,291 | 50 | 10,629-10,648 | 10.64 | 0.01 |
| 4212.1.1 | 910-930 | Plant/wood | 0.6680 | 0.0039 | 3,241 | 46 | 3,379-3,569 | 3.48 | 0.10 |
| 4213.1.1 | 1065-1074 | Plant/wood | 0.1107 | 0.0008 | 17,678 | 60 | 21,114-21,648 | 21.39 | 0.27 |
| 4214.1.1 | 1400-1430 | Plant/wood | 0.4057 | 0.0026 | 7,246 | 52 | 7,973-8,171 | 8.08 | 0.10 |
| 4215.1.1 | 1556-1562 | Plant/wood | <0.0018 | NA | >50,800 | NA | NA | NA | NA |
| 4216.1.1 | 1808-1816 | Plant/wood | 0.2606 | 0.0017 | 10,802 | 54 | 12,646-12,779 | 12.72 | 0.07 |
| 4218.1.1 | 2037-2043 | Plant/wood | <0.0014 | NA | >52,900 | NA | NA | NA | NA |
| 4219.1.1 | 2306-2310 | Plant/wood | <0.0031 | NA | >46,400 | NA | NA | NA | NA |
| 4220.1.1 | 2422-2426 | Plant/wood | <0.0051 | NA | >42,400 | NA | NA | NA | NA |
| 4221.1.1 | 2667-2677 | Plant/wood | 0.0025 | 0.0003 | 48,114 | 849 | NA | NA | NA |
| 4222.1.1 | 2920-2924 | Plant/wood | 0.0249 | 0.0012 | 29,677 | 392 | 32,981-34,537 | 22.76 | 0.78 |
| 4223.1.1 | 3170-3178 | Plant/wood | 0.0081 | 0.0012 | 38,719 | 1,159 | 40,920-44,713 | 42.82 | 1.90 |
| 4225.1.1 | 3298-3301 | Bulk | 0.0041 | 0.0002 | 44,247 | 331 | 46,556-48,424 | 47.49 | 0.93 |
| 2431.1.1 | 3425-3437 | Plant/wood | 0.0083 | 0.0012 | 38,484 | 1,136 | 40,698-44,479 | 42.59 | 1.90 |
| 4224.1.1 | 3550-3555 | Plant/wood | 0.0009 | 0.0001 | 56,064 | 714 | NA | NA | NA |
| 2430.1.1 | 3660-3660 | Plant/wood | <0.0012 | NA | >53,800 | NA | NA | NA | NA |

Supplementary Table 3: *n*-Alkane concentrations in µg g-1 sediment (sed.) of Goltsovoye Lake sediment core PG2412.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GFZ no.** | **Depth** | ***n*-C23** | ***n*-C24** | ***n*-C25** | ***n*-C26** | ***n*-C27** | ***n*-C28** | ***n*-C29** | ***n*-C30** | ***n*-C31** | ***n*-C32** | ***n*-C33** |
|  | **[cm]** | **[µg g-1 sed.]** | | | | | | | | | | |
| G018122-1 | 555-560 | 1.31 | 0.41 | 1.51 | 0.37 | 3.07 | 0.34 | 2.61 | 0.20 | 2.06 | 0.09 | 0.65 |
| G018123-1 | 666-672 | 1.49 | 0.42 | 1.81 | 0.44 | 4.36 | 0.49 | 4.01 | 0.31 | 3.24 | 0.13 | 0.94 |
| G018124-1 | 910-930 | 1.84 | 0.55 | 2.07 | 0.51 | 4.46 | 0.51 | 3.73 | 0.29 | 3.24 | 0.18 | 1.03 |
| G018125-1 | 1065-1074 | 0.40 | 0.16 | 0.61 | 0.15 | 1.32 | 0.23 | 1.35 | 0.09 | 1.46 | 0.06 | 0.47 |
| G018126-1 | 1155-1160 | 0.23 | 0.09 | 0.31 | 0.08 | 0.69 | 0.09 | 0.74 | 0.06 | 0.78 | 0.02 | 0.28 |
| G018127-1 | 1400-1430 | 0.21 | 0.07 | 0.28 | 0.06 | 0.52 | 0.05 | 0.50 | 0.03 | 0.44 | 0.00 | 0.14 |
| G018128-1 | 1556-1562 | 0.46 | 0.17 | 0.63 | 0.14 | 1.17 | 0.14 | 1.08 | 0.08 | 1.01 | 0.04 | 0.35 |
| G018129-1 | 1682-1687 | 0.43 | 0.16 | 0.54 | 0.13 | 1.02 | 0.13 | 1.08 | 0.07 | 0.97 | 0.03 | 0.32 |
| G018131-1 | 1920-1928 | 0.07 | 0.03 | 0.07 | 0.02 | 0.11 | 0.02 | 0.11 | 0.01 | 0.10 | 0.00 | 0.03 |
| G018132-1 | 2037-2043 | 0.11 | 0.04 | 0.12 | 0.04 | 0.16 | 0.03 | 0.17 | 0.03 | 0.14 | 0.00 | 0.05 |
| G018133-1 | 2169-2176 | 0.21 | 0.09 | 0.21 | 0.07 | 0.27 | 0.06 | 0.25 | 0.05 | 0.18 | 0.01 | 0.07 |
| G018134-1 | 2306-2310 | 0.27 | 0.11 | 0.32 | 0.10 | 0.51 | 0.08 | 0.50 | 0.06 | 0.38 | 0.02 | 0.12 |
| G018135-1 | 2422-2426 | 0.08 | 0.03 | 0.08 | 0.03 | 0.09 | 0.02 | 0.09 | 0.03 | 0.07 | 0.00 | 0.02 |
| G018136-1 | 2513-2520 | 0.08 | 0.03 | 0.07 | 0.02 | 0.08 | 0.02 | 0.08 | 0.02 | 0.05 | 0.00 | 0.02 |
| G018137-1 | 2667-2677 | 0.18 | 0.07 | 0.21 | 0.06 | 0.35 | 0.04 | 0.32 | 0.03 | 0.27 | 0.00 | 0.08 |
| G018138-1 | 2800-2804 | 0.14 | 0.06 | 0.14 | 0.05 | 0.18 | 0.04 | 0.18 | 0.03 | 0.15 | 0.00 | 0.05 |
| G018139-1 | 2920-2924 | 0.08 | 0.04 | 0.08 | 0.03 | 0.11 | 0.02 | 0.12 | 0.02 | 0.10 | 0.00 | 0.03 |
| G018140-1 | 3042-3048 | 0.10 | 0.04 | 0.10 | 0.03 | 0.15 | 0.03 | 0.15 | 0.02 | 0.13 | 0.00 | 0.04 |
| G018141-1 | 3170-3178 | 0.13 | 0.06 | 0.14 | 0.05 | 0.18 | 0.04 | 0.18 | 0.04 | 0.14 | 0.00 | 0.05 |
| G018142-1 | 3298-3301 | 0.08 | 0.04 | 0.11 | 0.03 | 0.16 | 0.03 | 0.13 | 0.02 | 0.08 | 0.00 | 0.03 |
| G018144-1 | 3455-3467 | 0.13 | 0.07 | 0.15 | 0.04 | 0.12 | 0.03 | 0.08 | 0.04 | 0.05 | 0.00 | 0.03 |
| G018146-1 | 3550-3555 | 0.25 | 0.11 | 0.26 | 0.10 | 0.26 | 0.08 | 0.20 | 0.11 | 0.11 | 0.00 | 0.08 |
| G018147-1 | 3660-3665 | 1.57 | 0.83 | 1.70 | 0.69 | 1.47 | 0.50 | 1.19 | 0.43 | 0.59 | 0.11 | 0.46 |

Supplementary Table 4: *n*-Alkane concentrations in µg g-1 total organic carbon (TOC) of Goltsovoye Lake sediment core PG2412.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GFZ no.** | **Depth** | ***n*-C23** | ***n*-C24** | ***n*-C25** | ***n*-C26** | ***n*-C27** | ***n*-C28** | ***n*-C29** | ***n*-C30** | ***n*-C31** | ***n*-C32** | ***n*-C33** |
|  | **[cm]** | **[µg g-1 TOC]** | | | | | | | | | | |
| G018122-1 | 555-560 | 53.73 | 16.70 | 62.18 | 15.16 | 126.52 | 13.87 | 107.50 | 8.37 | 84.65 | 3.84 | 26.79 |
| G018123-1 | 666-672 | 38.78 | 10.83 | 47.12 | 11.58 | 113.50 | 12.70 | 104.34 | 7.98 | 84.38 | 3.39 | 24.61 |
| G018124-1 | 910-930 | 44.81 | 13.39 | 50.47 | 12.29 | 108.59 | 12.38 | 90.86 | 7.13 | 78.83 | 4.36 | 25.11 |
| G018125-1 | 1065-1074 | 21.89 | 8.55 | 32.71 | 7.98 | 71.45 | 12.39 | 73.23 | 5.04 | 79.00 | 3.43 | 25.34 |
| G018126-1 | 1155-1160 | 20.06 | 7.62 | 27.59 | 6.58 | 60.19 | 8.25 | 65.34 | 5.61 | 68.42 | 1.97 | 24.52 |
| G018127-1 | 1400-1430 | 22.03 | 7.33 | 29.42 | 5.94 | 54.45 | 5.66 | 52.68 | 3.51 | 46.29 | 0.13 | 14.44 |
| G018128-1 | 1556-1562 | 32.61 | 11.90 | 44.78 | 9.68 | 83.25 | 10.18 | 77.34 | 5.86 | 72.45 | 2.91 | 24.85 |
| G018129-1 | 1682-1687 | 31.51 | 11.69 | 40.14 | 9.72 | 75.39 | 9.58 | 79.69 | 5.01 | 72.19 | 2.49 | 23.96 |
| G018133-1 | 2169-2176 | 42.18 | 18.46 | 43.29 | 13.38 | 55.36 | 11.56 | 51.36 | 11.17 | 37.54 | 2.42 | 13.95 |
| G018134-1 | 2306-2310 | 45.10 | 18.19 | 53.22 | 15.93 | 84.59 | 13.01 | 82.62 | 10.18 | 64.04 | 2.75 | 20.32 |
| G018137-1 | 2667-2677 | 35.22 | 13.07 | 42.25 | 11.26 | 70.86 | 8.86 | 64.44 | 6.53 | 53.31 | 0.00 | 16.51 |
| G018139-1 | 2920-2924 | 15.54 | 7.09 | 14.72 | 4.89 | 19.75 | 3.91 | 21.56 | 3.63 | 18.97 | 0.00 | 5.26 |
| G018146-1 | 3550-3555 | 6.15 | 2.58 | 6.30 | 2.43 | 6.22 | 2.03 | 4.81 | 2.77 | 2.67 | 0.00 | 1.87 |
| G018147-1 | 3660-3665 | 16.65 | 8.84 | 18.01 | 7.27 | 15.60 | 5.27 | 12.61 | 4.53 | 6.22 | 1.20 | 4.85 |



Supplementary Figure 1: Grain size distribution of PG2412. Mean and standard deviation plotted per unit. Units indicated on the right.



Supplementary Figure 2: Pictures of Goltsovoye Lake sediment core PG2412. (A) Cryoturbation of organic material at 3558-3555 cm deep, (B) inclusion of large organic remains up to 4 cm long at 3570 cm deep.

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Supplementary Figure 3: *n*-Alkane distribution in Goltsovoye Lake sediment core PG2412. Depth below ice surface indicated above graphs. Maximum abundance marked in black. Note: y-axes are scaled differently. Units indicated on the right.

Supplementary Figure 4: Ternary plots of *n*-alkanes of Goltsovoye Lake sediment core PG2412: *n*-C23, *n*-C31 and (*n*-C27 + *n*-C29)/2. Unit I: orange stars, Unit II: green circles, Unit III: blue triangles, Unit IV: purple squares. Note: axes are scaled from 0 to 1, but only shown partly: axes of *n*-C23 and *n*-C31: 0.1-0.6, axis of (*n*-C27 + *n*-C29)/2: 0.3-0.8. The shown ranges are indicated by the small grey triangle in the lower right corner of the ternary diagram.

**References Supplementary Material**

Stuiver, M., Reimer, P. J., and Reimer, R. W. (2017). *CALIB 14C Calibration Program*. Available online at: http://calib.org/calib/ (accessed December 13, 2017).