**Supplementary Material – Tables**

**Table S1.** Gravimetric moisture contents of soils in the area of the new CRREL Permafrost Tunnel.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Cryostratigraphic unit** | **Number of samples** | **Gravimetric moisture content, %** | | |
| **Average** | **Median** | **Standard Deviation** |
| 1. Active layer | 12 | 39.7 | 39.2 | 19.3 |
| 2. Modern intermediate layer | 8 | 91.8 | 90.4 | 27.6 |
| 3. Holocene silt | 56 | 61.6 | 49.0 | 29.7 |
| 4. Late Pleistocene yedoma silt | 111 | 94.0 | 85.4 | 34.4 |
| 5. Alluvial gravel and sand | 8 | 19.9 | 17.4 | 8.0 |

**Table S2.** Stable-isotope composition of ground ice sampled in the boreholes located near the new CRREL Permafrost Tunnel (for borehole locations, see **Figures 2, 3**). Isotope analyses were performed at the Alaska Stable Isotope Facility (UAF).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Borehole** | **Depth, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | F2 | 4.75 | 238.8 | -197.21 | 0.72 | -24.49 | 0.38 | -1.29 | W |
| 2 | F2 | 5.2 | 238.4 | -193.59 | 1.70 | -23.97 | 0.20 | -1.83 | W |
| 3 | F2 | 6.1 | 237.5 | -214.53 | 1.13 | -26.83 | 0.35 | 0.11 | W |
| 4 | F2 | 7.0 | 236.6 | -214.95 | 0.82 | -28.01 | 0.23 | 9.13 | W |
| 5 | F2 | 8.55 | 235.0 | -212.21 | 0.93 | -26.75 | 0.34 | 1.79 | W |
| 6 | F2 | 9.75 | 233.8 | -209.29 | 2.03 | -26.37 | 0.07 | 1.67 | W |
| 7 | F2 | 11.15 | 232.4 | -194.75 | 1.75 | -24.72 | 0.25 | 3.01 | W |
| 8 | F2 | 12.2 | 231.4 | -195.10 | 0.77 | -24.34 | 0.39 | -0.38 | W |
| 9 | F2 | 13.1 | 230.5 | -218.24 | 0.97 | -26.69 | 0.35 | -4.72 | W |
| 10 | F2 | 13.6 | 230.0 | -195.29 | 1.57 | -24.45 | 0.47 | 0.31 | W |
| 11 | F2 | 14.3 | 229.3 | -174.75 | 1.60 | -22.47 | 0.44 | 5.01 | W |
| 12 | F4 | 18.3 | 225.3 | -163.79 | 1.24 | -20.11 | 0.60 | -2.91 | U |
| 13 | F12 | 3.7 | 235.4 | -144.57 | 0.42 | -19.13 | 0.34 | 8.47 | T |
| 14 | F12 | 5.75 | 233.4 | -179.08 | 1.03 | -24.01 | 0.51 | 13.00 | W-H |
| 15 | F12 | 6.2 | 232.9 | -204.51 | 0.22 | -26.64 | 0.08 | 8.61 | W |
| 16 | F12 | 6.6 | 232.5 | -207.73 | 0.50 | -27.07 | 0.14 | 8.83 | W |
| 17 | F12 | 6.8 | 232.3 | -195.38 | 0.34 | -25.89 | 0.12 | 11.74 | W |

\* W – wedge ice (W-H – wedge ice of supposedly Holocene age); T – thermokarst-cave ice; U – unknown (supposedly intrusive).

**Table S3.** Stable-isotope composition of ground ice sampled in **the main adit of the new CRREL Permafrost Tunnel (T2), right wall** (for sampling locations, see **Figures 6, 7**). Isotope analyses were performed at the Alaska Stable Isotope Facility, UAF (samples #1 to #36), and the CRREL Alaska geochemistry laboratory (samples #37 to #72).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 17.40 | 228.45 | -192.66 | 1.31 | -25.30 | 0.29 | 9.74 | T |
| 2 | 17.60 | 228.90 | -198.01 | 0.46 | -25.22 | 0.23 | 3.75 | W |
| 3 | 18.20 | 230.30 | -203.79 | 2.01 | -26.45 | 0.37 | 7.81 | W-H |
| 4 | 17.60 | 228.90 | -193.94 | 0.78 | -25.55 | 0.30 | 10.46 | W-H |
| 5 | 18.50 | 229.50 | -196.20 | 0.93 | -24.93 | 0.33 | 3.24 | W-H |
| 6 | 18.70 | 228.80 | -189.49 | 1.03 | -24.66 | 0.13 | 7.79 | W |
| 7 | 19.00 | 230.50 | -185.45 | 1.02 | -24.42 | 0.37 | 9.91 | W-H |
| 8 | 19.20 | 230.10 | -183.04 | 0.89 | -23.86 | 0.16 | 7.84 | W-H |
| 9 | 19.95 | 229.85 | -178.68 | 1.54 | -22.51 | 0.16 | 1.40 | W-H |
| 10 | 22.60 | 230.90 | -187.98 | 1.83 | -24.20 | 0.18 | 5.62 | T |
| 11 | 24.00 | 231.00 | -186.66 | 1.52 | -23.94 | 0.20 | 4.86 | T |
| 12 | 25.40 | 230.80 | -192.90 | 1.78 | -24.46 | 0.15 | 2.78 | W-H |
| 13 | 25.55 | 228.67 | -164.51 | 0.99 | -22.00 | 0.26 | 11.49 | T |
| 14 | 32.40 | 231.00 | -189.71 | 1.20 | -23.53 | 0.20 | -1.47 | W-H |
| 15 | 33.10 | 229.60 | -204.51 | 1.65 | -25.96 | 0.25 | 3.17 | W |
| 16 | 35.14 | 229.00 | -219.07 | 1.97 | -28.47 | 0.43 | 8.69 | W |
| 17 | 35.43 | 229.00 | -221.31 | 1.90 | -28.73 | 0.13 | 8.53 | W |
| 18 | 35.81 | 229.00 | -218.99 | 1.98 | -28.36 | 0.22 | 7.89 | W |
| 19 | 39.50 | 229.35 | -169.94 | 1.03 | -23.30 | 0.29 | 16.46 | T |
| 20 | 39.50 | 229.55 | -179.14 | 0.47 | -23.70 | 0.05 | 10.46 | T |
| 21 | 39.70 | 229.20 | -165.66 | 0.73 | -22.79 | 0.07 | 16.66 | T |
| 22 | 41.80 | 228.00 | -168.11 | 1.20 | -22.51 | 0.09 | 11.97 | T |
| 23 | 44.90 | 230.20 | -161.54 | 0.17 | -21.25 | 0.16 | 8.46 | B |
| 24 | 48.80 | 229.55 | -181.13 | 2.02 | -22.66 | 0.22 | 0.15 | T |
| 25 | 51.37 | 229.00 | -215.69 | 1.32 | -27.34 | 0.40 | 3.03 | W |
| 26 | 51.72 | 229.00 | -218.87 | 1.47 | -27.98 | 0.26 | 4.97 | W |
| 27 | 52.90 | 229.70 | -178.31 | 1.46 | -23.39 | 0.36 | 8.81 | T |
| 28 | 54.50 | 229.45 | -167.64 | 1.59 | -21.43 | 0.32 | 3.80 | B |
| 29 | 56.40 | 229.75 | -165.25 | 0.74 | -19.33 | 0.26 | -10.61 | T |
| 30 | 57.12 | 229.15 | -164.94 | 0.37 | -17.86 | 0.34 | -22.06 | V |
| 31 | 58.10 | 228.90 | -164.92 | 0.29 | -21.28 | 0.11 | 5.32 | B |
| 32 | 61.20 | 229.78 | -167.85 | 1.31 | -21.03 | 0.22 | 0.39 | B |
| 33 | 61.25 | 229.22 | -167.77 | 1.15 | -21.35 | 0.14 | 3.03 | B |
| 34 | 61.70 | 229.45 | -198.54 | 0.79 | -24.04 | 0.38 | -6.22 | W |
| 35 | 62.10 | 228.50 | -214.08 | 0.42 | -26.92 | 0.35 | 1.28 | W |
| 36 | 62.60 | 229.15 | -175.61 | 0.97 | -22.89 | 0.32 | 7.51 | T |
| 37 | 66.50 | 230.10 | -198.69 | 0.05 | -25.34 | 0.04 | 4.03 | W |
| 38 | 67.50 | 229.50 | -215.55 | 0.12 | -27.67 | 0.12 | 5.81 | W |
| 39 | 67.80 | 228.10 | -200.59 | 0.02 | -25.69 | 0.03 | 4.93 | W |
| 40 | 68.10 | 231.20 | -217.12 | 0.05 | -27.59 | 0.02 | 3.60 | W |
| 41 | 68.50 | 227.90 | -179.16 | 0.30 | -22.69 | 0.08 | 2.36 | W |
| 42 | 69.50 | 230.30 | -203.64 | 0.34 | -25.94 | 0.04 | 3.88 | T |
| 43 | 70.50 | 231.40 | -193.18 | 0.21 | -24.31 | 0.04 | 1.30 | W |
| 44 | 70.90 | 229.80 | -185.40 | 0.24 | -23.31 | 0.05 | 1.08 | W |
| 45 | 71.40 | 230.10 | -203.65 | 0.27 | -25.87 | 0.03 | 3.31 | T |
| 46 | 72.60 | 229.40 | -200.98 | 0.24 | -25.79 | 0.07 | 5.34 | W |
| 47 | 74.30 | 229.30 | -211.53 | 0.20 | -27.07 | 0.01 | 5.03 | W |
| 48 | 75.20 | 228.00 | -197.53 | 0.06 | -25.27 | 0.01 | 4.63 | W |
| 49 | 78.30 | 229.40 | -180.26 | 0.08 | -22.90 | 0.04 | 2.94 | W |
| 50 | 83.60 | 231.20 | -194.11 | 0.11 | -24.32 | 0.05 | 0.45 | W |
| 51 | 84.10 | 230.40 | -210.88 | 0.16 | -26.68 | 0.04 | 2.56 | W |
| 52 | 86.00 | 228.60 | -192.49 | 0.21 | -24.44 | 0.02 | 3.03 | W |
| 53 | 88.00 | 231.50 | -217.20 | 0.19 | -27.63 | 0.01 | 3.84 | W |
| 54 | 90.80 | 231.30 | -217.72 | 0.15 | -27.37 | 0.03 | 1.24 | W |
| 55 | 91.40 | 231.40 | -218.73 | 0.05 | -27.98 | 0.01 | 5.11 | W |
| 56 | 91.50 | 229.40 | -196.85 | 0.16 | -24.62 | 0.02 | 0.11 | W |
| 57 | 91.50 | 230.60 | -209.00 | 0.18 | -26.22 | 0.07 | 0.76 | W |
| 58 | 91.80 | 228.00 | -196.78 | 0.16 | -24.86 | 0.04 | 2.10 | W |
| 59 | 93.60 | 231.30 | -181.22 | 0.13 | -22.77 | 0.03 | 0.94 | W |
| 60 | 97.50 | 231.20 | -183.29 | 0.05 | -22.80 | 0.06 | -0.89 | T |
| 61 | 97.50 | 231.40 | -190.52 | 0.16 | -23.74 | 0.03 | -0.60 | W |
| 62 | 97.70 | 229.80 | -172.78 | 0.34 | -21.82 | 0.05 | 1.78 | W |
| 63 | 104.90 | 231.40 | -195.12 | 0.11 | -24.92 | 0.01 | 4.24 | W |
| 64 | 105.50 | 230.60 | -210.19 | 0.04 | -26.98 | 0.10 | 5.65 | W |
| 65 | 105.60 | 228.70 | -187.16 | 0.18 | -23.69 | 0.05 | 2.36 | W |
| 66 | 106.50 | 229.10 | -194.43 | 0.12 | -24.47 | 0.05 | 1.33 | T |
| 67 | 112.50 | 229.20 | -192.43 | 0.30 | -24.33 | 0.02 | 2.21 | W |
| 68 | 112.70 | 228.10 | -193.42 | 0.11 | -24.62 | 0.03 | 3.54 | W |
| 69 | 114.20 | 229.80 | -212.41 | 0.05 | -26.93 | 0.02 | 3.03 | W |
| 70 | 115.90 | 229.90 | -203.33 | 0.20 | -25.51 | 0.04 | 0.75 | W |
| 71 | 116.30 | 228.40 | -172.79 | 0.22 | -22.16 | 0.07 | 4.49 | W |
| 72 | 119.90 | 229.70 | -179.73 | 0.23 | -22.58 | 0.04 | 0.91 | W |

\* W – wedge ice (W-H – wedge ice of supposedly Holocene age); T – thermokarst-cave ice; B – ice belts (segregated ice); V – ice veins.

**Table S4.** Stable-isotope composition of ground ice sampled **in the main adit of the new CRREL Permafrost Tunnel (T2), left wall** (for sampling locations, see **Figure 6**). Isotope analyses were performed at the Alaska Stable Isotope Facility, UAF (samples #1 to #32), and the CRREL Alaska geochemistry laboratory (samples #33 to #75).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 16.10 | 228.40 | -185.88 | 0.76 | -23.99 | 0.10 | 6.04 | T |
| 2 | 17.10 | 228.90 | -181.82 | 1.90 | -23.35 | 0.14 | 4.98 | B |
| 3 | 18.00 | 228.10 | -188.11 | 1.61 | -23.71 | 0.12 | 1.57 | W |
| 4 | 19.30 | 230.80 | -181.78 | 1.17 | -23.73 | 0.15 | 8.06 | W-H |
| 5 | 19.50 | 231.00 | -178.69 | 1.40 | -23.38 | 0.05 | 8.35 | W-H |
| 6 | 20.00 | 230.90 | -187.72 | 1.36 | -23.97 | 0.28 | 4.04 | W-H |
| 7 | 20.70 | 229.10 | -172.93 | 0.81 | -21.95 | 0.25 | 2.67 | W-H |
| 8 | 23.20 | 227.90 | -166.29 | 1.69 | -21.19 | 0.06 | 3.23 | T |
| 9 | 25.30 | 231.40 | -201.40 | 1.23 | -25.45 | 0.27 | 2.20 | W-H |
| 10 | 25.75 | 230.30 | -171.69 | 2.18 | -21.86 | 0.44 | 3.19 | W-H |
| 11 | 26.30 | 230.95 | -173.26 | 0.88 | -21.96 | 0.10 | 2.42 | B |
| 12 | 27.80 | 228.00 | -182.78 | 2.80 | -23.17 | 0.29 | 2.58 | T |
| 13 | 27.80 | 228.15 | -173.83 | 1.01 | -22.55 | 0.16 | 6.57 | T |
| 14 | 30.10 | 231.20 | -189.90 | 2.67 | -23.39 | 0.14 | -2.78 | W-H |
| 15 | 34.00 | 229.20 | -219.38 | 2.34 | -27.53 | 0.23 | 0.86 | W |
| 16 | 34.60 | 229.10 | -217.81 | 0.89 | -27.67 | 0.15 | 3.55 | W |
| 17 | 35.30 | 229.45 | -185.69 | 1.81 | -23.28 | 0.33 | 0.55 | T |
| 18 | 35.50 | 229.00 | -200.76 | 1.15 | -25.53 | 0.42 | 3.48 | W |
| 19 | 36.85 | 228.80 | -203.91 | 1.24 | -25.65 | 0.12 | 1.29 | W |
| 20 | 47.00 | 228.45 | -166.95 | 1.38 | -21.92 | 0.24 | 8.41 | B |
| 21 | 47.90 | 229.10 | -216.53 | 1.99 | -27.35 | 0.35 | 2.27 | W |
| 22 | 48.10 | 231.00 | -195.13 | 0.81 | -25.54 | 0.31 | 9.19 | T |
| 23 | 55.20 | 228.60 | -164.18 | 1.28 | -21.27 | 0.19 | 5.98 | B |
| 24 | 56.30 | 229.70 | -162.04 | 0.36 | -21.49 | 0.11 | 9.88 | T |
| 25 | 57.20 | 228.30 | -218.94 | 1.85 | -27.83 | 0.34 | 3.70 | W |
| 26 | 58.60 | 230.10 | -186.59 | 0.67 | -24.27 | 0.33 | 7.57 | T |
| 27 | 59.00 | 230.30 | -208.60 | 1.76 | -26.39 | 0.37 | 2.52 | W |
| 28 | 60.00 | 229.45 | -177.06 | 1.80 | -23.40 | 0.28 | 10.14 | T |
| 29 | 60.70 | 228.85 | -164.97 | 1.84 | -21.94 | 0.38 | 10.55 | V |
| 30 | 61.80 | 229.80 | -175.85 | 1.80 | -22.48 | 0.41 | 3.99 | T |
| 31 | 62.90 | 229.70 | -168.73 | 0.69 | -22.18 | 0.26 | 8.71 | T |
| 32 | 63.15 | 230.30 | -199.89 | 1.71 | -25.36 | 0.27 | 2.99 | W |
| 33 | 65.00 | 229.90 | -172.92 | 0.21 | -22.00 | 0.05 | 3.08 | T |
| 34 | 67.20 | 229.90 | -172.60 | 0.13 | -21.96 | 0.09 | 3.08 | T |
| 35 | 68.20 | 229.30 | -167.63 | 0.20 | -21.49 | 0.02 | 4.29 | W |
| 36 | 68.40 | 231.50 | -201.76 | 0.19 | -25.74 | 0.05 | 4.16 | W |
| 37 | 69.30 | 228.30 | -207.52 | 0.12 | -26.49 | 0.02 | 4.40 | W |
| 38 | 70.20 | 228.40 | -178.81 | 0.28 | -22.84 | 0.05 | 3.91 | W |
| 39 | 70.60 | 230.70 | -166.38 | 0.23 | -21.32 | 0.04 | 4.18 | T |
| 40 | 77.10 | 231.60 | -210.10 | 0.12 | -26.79 | 0.06 | 4.22 | W |
| 41 | 79.00 | 230.90 | -178.24 | 0.24 | -22.35 | 0.02 | 0.56 | T |
| 42 | 79.70 | 230.70 | -210.78 | 0.38 | -26.89 | 0.05 | 4.34 | W |
| 43 | 79.90 | 230.50 | -199.62 | 0.09 | -25.13 | 0.05 | 1.42 | T |
| 44 | 80.00 | 230.00 | -195.42 | 0.29 | -24.76 | 0.02 | 2.66 | T |
| 45 | 80.00 | 231.60 | -216.58 | 0.16 | -27.58 | 0.03 | 4.06 | W |
| 46 | 80.80 | 231.60 | -213.23 | 0.14 | -26.94 | 0.02 | 2.29 | W |
| 47 | 80.90 | 229.60 | -196.53 | 0.06 | -24.76 | 0.04 | 1.55 | W |
| 48 | 81.00 | 230.50 | -219.34 | 0.16 | -27.86 | 0.03 | 3.54 | W |
| 49 | 91.10 | 231.40 | -214.75 | 0.13 | -27.23 | 0.06 | 3.09 | W |
| 50 | 91.40 | 230.50 | -210.89 | 0.10 | -26.91 | 0.07 | 4.39 | W |
| 51 | 92.10 | 230.90 | -206.18 | 0.14 | -26.17 | 0.05 | 3.18 | W |
| 52 | 92.30 | 228.40 | -187.21 | 0.17 | -23.68 | 0.04 | 2.23 | W |
| 53 | 93.10 | 230.80 | -188.49 | 0.24 | -23.71 | 0.09 | 1.19 | T |
| 54 | 93.10 | 231.20 | -210.26 | 0.44 | -26.71 | 0.10 | 3.42 | W |
| 55 | 96.50 | 230.00 | -178.39 | 0.25 | -22.48 | 0.02 | 1.45 | W |
| 56 | 97.40 | 230.00 | -181.83 | 0.33 | -22.61 | 0.04 | -0.95 | W |
| 57 | 98.70 | 229.90 | -185.24 | 0.07 | -23.09 | 0.06 | -0.52 | W |
| 58 | 99.70 | 231.40 | -181.59 | 0.05 | -22.50 | 0.08 | -1.59 | W |
| 59 | 100.40 | 229.20 | -183.07 | 0.09 | -23.37 | 0.07 | 3.89 | W |
| 60 | 102.90 | 230.40 | -196.08 | 0.35 | -24.21 | 0.03 | -2.40 | W |
| 61 | 103.10 | 230.60 | -189.88 | 0.10 | -23.89 | 0.01 | 1.24 | T |
| 62 | 103.30 | 229.50 | -185.94 | 0.07 | -23.29 | 0.01 | 0.38 | W |
| 63 | 103.35 | 228.30 | -170.81 | 0.07 | -21.56 | 0.07 | 1.67 | W |
| 64 | 103.70 | 230.10 | -187.76 | 0.13 | -23.06 | 0.05 | -3.28 | W |
| 65 | 106.00 | 230.10 | -190.61 | 0.08 | -23.90 | 0.04 | 0.59 | W |
| 66 | 106.30 | 231.50 | -208.52 | 0.06 | -26.44 | 0.01 | 3.00 | W |
| 67 | 106.80 | 229.90 | -191.44 | 0.02 | -23.79 | 0.03 | -1.12 | W |
| 68 | 107.30 | 228.30 | -175.70 | 0.13 | -22.07 | 0.06 | 0.86 | W |
| 69 | 112.10 | 231.00 | -178.56 | 0.15 | -22.40 | 0.04 | 0.64 | T |
| 70 | 112.30 | 229.10 | -203.43 | 0.29 | -25.51 | 0.05 | 0.65 | W |
| 71 | 112.40 | 230.20 | -212.33 | 0.13 | -26.78 | 0.03 | 1.91 | W |
| 72 | 112.70 | 228.00 | -181.41 | 0.20 | -23.13 | 0.01 | 3.63 | W |
| 73 | 120.00 | 231.80 | -198.55 | 0.11 | -24.87 | 0.05 | 0.41 | W |
| 74 | 121.95 | 229.10 | -173.40 | 0.18 | -21.91 | 0.02 | 1.88 | W |
| 75 | 122.00 | 230.70 | -207.40 | 0.11 | -25.97 | 0.03 | 0.36 | W |

\* W – wedge ice (W-H – wedge ice of supposedly Holocene age); T – thermokarst-cave ice; B – ice belts (segregated ice); V – ice veins.

**Table S5.** Stable-isotope composition of ground ice sampled in **Crosscut #1 of the new CRREL Permafrost Tunnel (C1), right wall** (for sampling locations, see **Figure 8**). Isotope analyses were performed at the CRREL Alaska geochemistry laboratory.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 0.10 | 227.80 | -170.71 | 0.20 | -21.28 | 0.02 | -0.47 | W |
| 2 | 2.90 | 231.40 | -210.31 | 0.18 | -26.33 | 0.08 | 0.33 | W |
| 3 | 3.80 | 228.10 | -181.25 | 0.13 | -22.36 | 0.04 | -2.37 | W |
| 4 | 4.60 | 229.40 | -189.69 | 0.17 | -23.88 | 0.03 | 1.35 | W |
| 5 | 8.80 | 229.30 | -177.77 | 0.17 | -22.89 | 0.07 | 5.35 | RC |
| 6 | 10.30 | 231.50 | -202.79 | 0.17 | -25.60 | 0.06 | 2.01 | W |
| 7 | 11.30 | 228.60 | -210.41 | 0.07 | -26.86 | 0.04 | 4.47 | W |
| 8 | 11.30 | 231.50 | -180.64 | 0.34 | -22.41 | 0.03 | -1.36 | W |
| 9 | 11.40 | 230.40 | -196.79 | 0.07 | -24.65 | 0.05 | 0.41 | W |
| 10 | 11.90 | 231.00 | -176.96 | 0.22 | -22.02 | 0.06 | -0.80 | W |
| 11 | 12.00 | 230.50 | -204.14 | 0.12 | -25.81 | 0.02 | 2.34 | W |
| 12 | 15.70 | 229.50 | -172.99 | 0.05 | -21.54 | 0.03 | -0.67 | W |
| 13 | 16.90 | 229.30 | -198.26 | 0.06 | -25.11 | 0.04 | 2.62 | W |
| 14 | 17.20 | 229.00 | -174.61 | 0.25 | -22.11 | 0.03 | 2.27 | W |
| 15 | 17.90 | 228.20 | -184.53 | 0.25 | -23.19 | 0.00 | 0.99 | W |
| 16 | 18.40 | 229.35 | -166.88 | 0.23 | -21.33 | 0.03 | 3.76 | B |
| 17 | 18.50 | 229.00 | -184.77 | 0.22 | -23.54 | 0.04 | 3.55 | W |
| 18 | 23.50 | 228.90 | -173.80 | 0.11 | -21.94 | 0.10 | 1.72 | B |
| 19 | 23.60 | 227.85 | -170.54 | 0.08 | -21.64 | 0.06 | 2.58 | T |
| 20 | 23.60 | 228.05 | -184.38 | 0.15 | -22.83 | 0.02 | -1.74 | W |
| 21 | 23.90 | 229.80 | -208.12 | 0.10 | -26.21 | 0.09 | 1.56 | W |
| 22 | 24.20 | 230.50 | -210.96 | 0.14 | -26.44 | 0.06 | 0.56 | W |
| 23 | 24.30 | 228.30 | -198.38 | 0.16 | -24.67 | 0.03 | -1.02 | W |
| 24 | 24.80 | 228.30 | -200.48 | 0.20 | -25.08 | 0.05 | 0.16 | W |
| 25 | 24.80 | 229.30 | -180.76 | 0.02 | -22.65 | 0.05 | 0.44 | B |
| 26 | 25.00 | 228.10 | -194.33 | 0.16 | -24.59 | 0.04 | 2.39 | W |
| 27 | 29.40 | 229.30 | -189.74 | 0.25 | -23.42 | 0.02 | -2.38 | W |
| 28 | 29.40 | 230.55 | -171.08 | 0.26 | -20.73 | 0.01 | -5.24 | T |
| 29 | 29.60 | 230.40 | -182.22 | 0.10 | -22.42 | 0.07 | -2.86 | T |
| 30 | 30.30 | 227.90 | -196.17 | 0.15 | -24.15 | 0.11 | -2.97 | W |
| 31 | 30.60 | 228.40 | -180.16 | 0.13 | -21.53 | 0.04 | -7.92 | T |
| 32 | 30.80 | 228.20 | -184.16 | 0.10 | -22.09 | 0.10 | -7.44 | RC |
| 33 | 31.00 | 228.60 | -181.90 | 0.12 | -22.18 | 0.04 | -4.46 | W |
| 34 | 31.25 | 228.65 | -179.36 | 0.13 | -22.72 | 0.04 | 2.40 | W |
| 35 | 31.80 | 227.85 | -163.74 | 0.24 | -20.41 | 0.08 | -0.46 | T |
| 36 | 32.00 | 228.45 | -175.32 | 0.17 | -21.11 | 0.02 | -6.44 | T |
| 37 | 32.30 | 228.30 | -174.83 | 0.03 | -21.31 | 0.06 | -4.35 | RC |
| 38 | 33.85 | 229.40 | -198.88 | 0.16 | -24.19 | 0.07 | -5.36 | W |
| 39 | 34.40 | 230.60 | -208.28 | 0.26 | -25.73 | 0.06 | -2.44 | W |
| 40 | 34.50 | 227.80 | -186.75 | 0.15 | -22.16 | 0.03 | -9.47 | W |
| 41 | 34.60 | 228.40 | -179.43 | 0.31 | -21.86 | 0.04 | -4.55 | RC |
| 42 | 34.60 | 230.70 | -220.91 | 0.17 | -27.30 | 0.02 | -2.51 | W |
| 43 | 34.70 | 228.60 | -178.05 | 0.15 | -21.84 | 0.02 | -3.33 | T |
| 44 | 34.70 | 229.50 | -211.16 | 0.21 | -26.16 | 0.00 | -1.88 | W |
| 45 | 41.20 | 228.25 | -175.87 | 0.20 | -21.87 | 0.04 | -0.91 | T |
| 46 | 42.70 | 227.45 | -185.20 | 0.05 | -22.68 | 0.05 | -3.76 | T |
| 47 | 42.70 | 227.55 | -179.93 | 0.06 | -22.30 | 0.05 | -1.53 | T |
| 48 | 43.60 | 228.10 | -173.76 | 0.16 | -21.13 | 0.06 | -4.72 | RC |
| 49 | 45.70 | 227.45 | -176.38 | 0.17 | -21.75 | 0.01 | -2.38 | T |
| 50 | 47.60 | 226.85 | -191.86 | 0.17 | -23.60 | 0.06 | -3.06 | W |
| 51 | 48.00 | 227.40 | -208.08 | 0.08 | -26.48 | 0.01 | 3.76 | W |

\* W – wedge ice; T – thermokarst-cave ice; RC – silt with reticulate-chaotic cryostructure; B – ice belts (segregated ice).

**Table S6.** Stable-isotope composition of ground ice sampled in **Crosscut #1 of the new CRREL Permafrost Tunnel (C1)**, left wall (for sampling locations, see **Figure 8**). Isotope analyses were performed at the CRREL Alaska geochemistry laboratory.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 2.70 | 229.50 | -195.58 | 0.13 | -24.52 | 0.02 | 0.58 | W |
| 2 | 3.00 | 230.50 | -211.46 | 0.30 | -26.73 | 0.05 | 2.38 | W |
| 3 | 3.60 | 231.40 | -209.65 | 0.28 | -26.89 | 0.05 | 5.47 | W |
| 4 | 4.65 | 230.00 | -195.30 | 0.17 | -24.65 | 0.07 | 1.90 | W |
| 5 | 4.70 | 231.40 | -211.61 | 0.21 | -26.32 | 0.04 | -1.05 | W |
| 6 | 5.50 | 230.60 | -211.74 | 0.13 | -26.60 | 0.07 | 1.06 | W |
| 7 | 10.50 | 231.10 | -207.97 | 0.18 | -26.50 | 0.06 | 4.03 | W |
| 8 | 10.80 | 229.20 | -197.47 | 0.04 | -24.52 | 0.04 | -1.31 | W |
| 9 | 15.30 | 229.90 | -177.54 | 0.19 | -22.16 | 0.03 | -0.26 | T |
| 10 | 16.00 | 229.50 | -169.47 | 0.14 | -21.09 | 0.03 | -0.75 | T |
| 11 | 16.10 | 228.80 | -210.21 | 0.35 | -25.85 | 0.07 | -3.41 | W |
| 12 | 16.70 | 229.60 | -175.41 | 0.17 | -21.84 | 0.06 | -0.69 | W |
| 13 | 16.80 | 228.90 | -204.77 | 0.18 | -25.98 | 0.05 | 3.07 | W |
| 14 | 26.25 | 230.40 | -194.41 | 0.10 | -24.73 | 0.05 | 3.43 | W |
| 15 | 26.50 | 230.40 | -213.47 | 0.08 | -27.25 | 0.04 | 4.53 | W |
| 16 | 27.20 | 228.45 | -179.71 | 0.17 | -21.79 | 0.02 | -5.39 | T |
| 17 | 27.30 | 228.30 | -180.57 | 0.12 | -22.36 | 0.01 | -1.69 | RC |
| 18 | 27.70 | 229.20 | -205.71 | 0.35 | -25.41 | 0.07 | -2.43 | W |
| 19 | 28.40 | 228.30 | -181.73 | 0.15 | -22.26 | 0.08 | -3.65 | RC |
| 20 | 28.70 | 228.40 | -190.82 | 0.06 | -23.18 | 0.06 | -5.38 | T |
| 21 | 29.00 | 228.80 | -185.06 | 0.13 | -22.93 | 0.04 | -1.62 | T |
| 22 | 32.10 | 228.10 | -194.13 | 0.21 | -24.31 | 0.08 | 0.35 | RC |
| 23 | 33.50 | 228.15 | -197.65 | 0.51 | -24.82 | 0.03 | 0.91 | RC |
| 24 | 34.00 | 229.30 | -205.28 | 0.15 | -26.10 | 0.06 | 3.52 | T |
| 25 | 35.50 | 228.90 | -213.57 | 0.20 | -26.58 | 0.04 | -0.93 | W |
| 26 | 37.10 | 227.80 | -209.22 | 0.10 | -25.83 | 0.01 | -2.58 | W |
| 27 | 38.70 | 227.60 | -189.03 | 0.08 | -23.72 | 0.05 | 0.73 | W |

\* W – wedge ice; T – thermokarst-cave ice; RC – silt with reticulate-chaotic cryostructure.

**Table S7.** Stable-isotope composition of ground ice sampled in **Crosscut #2 of the new CRREL Permafrost Tunnel (C2), right wall**. Isotope analyses were performed at the CRREL Alaska geochemistry laboratory.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 4.70 | 229.50 | -200.74 | 0.23 | -25.47 | 0.02 | 3.02 | W |
| 2 | 4.90 | 230.90 | -216.11 | 0.22 | -27.50 | 0.06 | 3.89 | W |
| 3 | 6.60 | 229.20 | -169.17 | 0.21 | -21.52 | 0.03 | 2.99 | W |
| 4 | 6.60 | 230.40 | -181.13 | 0.06 | -22.68 | 0.06 | 0.31 | W |
| 5 | 9.60 | 228.00 | -165.61 | 0.21 | -20.72 | 0.02 | 0.15 | W |
| 6 | 9.70 | 230.20 | -212.46 | 0.13 | -26.99 | 0.03 | 3.46 | W |
| 7 | 12.80 | 226.40 | -205.14 | 0.23 | -25.90 | 0.04 | 2.06 | W |
| 8 | 13.10 | 227.30 | -195.26 | 0.28 | -24.96 | 0.07 | 4.42 | T |
| 9 | 13.40 | 227.60 | -186.86 | 0.17 | -23.73 | 0.03 | 2.98 | T |
| 10 | 13.70 | 227.80 | -207.98 | 0.14 | -26.12 | 0.07 | 0.98 | W |
| 11 | 21.40 | 227.00 | -205.28 | 0.17 | -25.98 | 0.01 | 2.56 | W |
| 12 | 21.90 | 225.30 | -204.00 | 0.27 | -25.26 | 0.04 | -1.92 | W |
| 13 | 22.10 | 227.80 | -206.83 | 0.04 | -26.16 | 0.03 | 2.45 | W |
| 14 | 22.20 | 226.70 | -202.96 | 0.27 | -25.38 | 0.03 | 0.08 | W |

\* W – wedge ice; T – thermokarst-cave ice.

**Table S8.** Stable-isotope composition of ground ice sampled in **Crosscut #2 of the new CRREL** **Permafrost Tunnel (C2), left wall**. Isotope analyses were performed at the CRREL Alaska geochemistry laboratory.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Distance, m** | **Elevation a.s.l., m** | **δ2H**  **VSMOW**  **(‰)** | **δ2H**  **Std Dev**  **(‰)** | **δ18O**  **VSMOW**  **(‰)** | **δ18O**  **Std Dev**  **(‰)** | **d-Excess (‰)** | **Type of ground ice\*** |
| 1 | 4.30 | 229.60 | -164.27 | 0.17 | -20.38 | 0.02 | -1.23 | W |
| 2 | 6.20 | 229.30 | -171.78 | 0.19 | -21.75 | 0.02 | 2.22 | W |
| 3 | 9.50 | 227.10 | -165.54 | 0.20 | -21.20 | 0.04 | 4.06 | T |
| 4 | 12.40 | 228.10 | -168.47 | 0.21 | -20.95 | 0.07 | -0.87 | T |
| 5 | 13.00 | 226.40 | -198.99 | 0.05 | -24.70 | 0.07 | -1.39 | W |
| 6 | 13.70 | 227.30 | -169.70 | 0.03 | -21.24 | 0.07 | 0.22 | W |
| 7 | 14.00 | 229.00 | -183.23 | 0.11 | -22.80 | 0.02 | -0.83 | W |
| 8 | 14.40 | 227.70 | -166.40 | 0.22 | -21.37 | 0.04 | 4.56 | T |
| 9 | 21.60 | 227.00 | -206.48 | 0.22 | -26.12 | 0.09 | 2.48 | W |
| 10 | 21.90 | 225.50 | -205.49 | 0.13 | -26.17 | 0.03 | 3.87 | W |
| 11 | 22.00 | 228.00 | -208.02 | 0.19 | -26.81 | 0.02 | 6.46 | W |

\* W – wedge ice; T – thermokarst-cave ice.