The measured concentrations of dissolved material in Greenland Ice Sheet borehole (Table DR1) and outlet (Table DR2) waters appear below. The sample naming scheme is as follows: The number after GL indicates the year the sample was collected. Borehole samples are labeled with numbers and letters. The numbers identify a site, the letters identify boreholes within that site. Boreholes within a single site are located ~20 m apart. Samples with -T were collected from the terminal outlet. Samples with -L were collected from a lateral outlet. Samples with -S were collected from surface streams (Table DR3). The final number represents a sequence of samples taken from a single borehole or outlet site. Several of the borehole samples required corrections for drill water dilution and other issues (discussed below). Table DR1 represents the measurements prior to these corrections. The data from outlet samples were plotted directly from Table DR2.

Table S1. Location, timing, and raw (uncorrected) measurements for borehole samples

Sample	Latitude	Longitude	Depth (m)	Date and Time	SiO_2	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4	pH	Charge Balance
								micro-moles per liter							
GL10-1C-1	67.163	-50.063	91	6/14/2010 12:00	54.1	42.2	27.8	32.6	38.3	NA	NA	NA	NA	7.50	NA
GL10-1C-2	67.163	-50.063	91	6/15/2010 13:45	259	131	88.6	62.9	75.6	375	14.1	17.7	7.29	7.75	0.16
GL10-1D-1	67.162	-50.063	98.5	6/14/2010 17:30	12.5	17.5	7.10	24.7	17.2	59.7	25.4	1.29	2.08	6.75	0.00
GL10-1D-2	67.162	-50.063	98.5	6/15/2010 10:20	33.9	21.9	11.9	27.1	18.0	93.1	14.1	1.61	2.08	NA	0.00
GL10-1E-1	67.163	-50.063	91.9	6/16/2010 17:40	7.58	10.1	4.27	7.71	7.93	34.8	5.64	<0.81	<0.52	6.64	0.05
GL10-2D-1	67.167	-50.066	145.6	6/25/2010 10:36	17.5	10.2	6.57	10.2	15.7	39.7	19.7	6.77	2.08	5.80	-0.08
GL11-1A-1	67.195	-49.720	457.5	7/2/2011 20:46	2.72	6.13	0.82	2.34	3.23	26.5	<2.82	<0.32	1.25	6.50	-0.20
GL11-1B-1	67.195	-49.719	466	7/4/2011 17:37	14.8	37.8	8.45	31.9	14.9	92.5	3.48	1.05	11.9	7.00	-0.01
GL11-1B-2	67.195	-49.719	466	7/4/2011 18:15	2.44	5.29	0.99	5.40	2.91	19.0	<2.82	<0.32	2.24	6.25	-0.06
GL11-1C-1	67.195	-49.719	459.5	7/6/2011 18:30	0.79	1.10	0.39	2.40	1.00	3.56	<2.82	<0.32	1.60	5.50	-0.03
GL11-1C-2	67.195	-49.719	459.5	7/7/2011 15:18	13.2	20.7	4.69	17.1	10.8	44.1	9.88	2.99	6.80	6.50	0.05
GL11-1C-3	67.195	-49.719	459.5	7/7/2011 17:48	12.8	20.3	4.48	14.8	9.09	44.4	7.37	3.07	7.78	6.50	0.02
GL11-2C-1	67.201	-49.289	816	7/17/2011 20:24	425	77.6	101	118	69.5	178	4.25	0.35	21.0	7.50	0.42
GL12-2A-1	67.204	-49.718	707	6/13/2012 18:00	33.2	87.8	9.05	77.4	60.5	301	5.92	<3.23	18.1	7.60	-0.02
GL12-2B-1	67.204	-49.718	720	6/15/2012 19:00	2.50	14.5	<4.12	70.0	100	92.2	79.0	<3.23	6.56	7.10	0.04
GL12-2C-1	67.204	-49.718	695	6/17/2012 17:00	4.29	11.5	<4.12	56.1	231	102	179	<3.23	5.00	7.15	0.03
GL12-2D-2	67.204	-49.718	696	6/20/2012 17:30	77.1	92.8	7.00	60.0	242	312	127	<3.23	37.2	7.50	-0.01

The GL10 boreholes are located in a near-marginal environment (< 1 km from the ice margin) and in relatively shallow ice. Both the GL11-1 boreholes and the GL12 boreholes are located approximately 15 km from the ice margin. These sites contrast deep and shallow ice, with the GL11-1 boreholes located on a local basal topographic high and the GL12-2 boreholes located in a basal trough. The GL11-2 borehole is located ~30 km from the ice margin. All of the boreholes are in ice that feeds the Isunnguata Sermia outlet. This outlet is of relatively simple geometry, feeding into straight valley walls that parallel the east-west ice flow direction.

Samples were filtered using 0.45 µm nylon filters. With most samples, filtration was performed in the field. Cation concentrations were measured using filtered samples and anion concentrations measured from unfiltered samples. Cation samples were acidified in the laboratory using 12 M HNO$_3$. In 2010 and 2011, samples were analyzed at the USGS hydrochemistry analytic laboratory in Boulder, Colorado, USA, using a Perkin-Elmer/Sciex Elan 6000 inductively coupled plasma mass spectrometer for cations and a Perkin-Elmer Optime 3300 DV inductively coupled plasma atomic emissions spectrometer for Si. Anions were measured using an ion chromatograph. In 2012, samples were analyzed by the Geological Survey of Finland using similar instruments and methods.

Table S2. Location, timing, and measurements for outlet samples

Sample	Latitude	Longitude	Date and Time	SiO$_2$	Ca	Mg	Na	K	HCO$_3$	Cl	NO$_3$	SO$_4$	TDS	pH	Charge Balance
							micro-moles per liter								
GL10-L-1	67.177	-50.312	6/17/2010 18:18	2.47	2.93	1.13	3.17	9.01	13.1	5.64	<0.81	1.04	38.5	5.50	-0.01
GL10-L-3	67.177	-50.312	6/17/2010 19:12	5.87	2.88	1.18	2.28	5.87	12.2	2.82	<0.81	<1.04	33.1	5.80	0.04
GL10-T-1	67.181	-50.336	6/17/2010 20:00	37.3	18.2	7.42	6.66	9.31	62.1	<2.82	<0.81	6.18	147	7.75	-0.05
GL11-T-13	67.181	-50.336	6/17/2011 8:30	31.5	73.5	11.0	57.6	37.4	161	9.73	2.50	42.0	426	7.00	0.01
GL11-T-14	67.181	-50.336	6/17/2011 10:24	32.2	71.7	11.9	56.4	37.2	156	7.46	2.03	42.2	417	7.00	0.02
GL11-T-16	67.181	-50.336	6/17/2011 16:28	28.9	72.3	11.2	54.7	39.2	161	13.0	2.13	41.4	424	7.00	0.00
GL11-T-18	67.181	-50.336	6/18/2011 5:34	26.4	65.7	10.2	45.7	31.9	144	5.79	1.49	37.4	369	7.00	0.01
GL11-T-20	67.181	-50.336	6/18/2011 11:25	33.7	69.1	12.2	48.0	33.8	138	7.67	1.87	39.6	384	7.50	0.04
GL11-T-21	67.181	-50.336	6/18/2011 17:27	31.8	72.4	11.4	49.5	33.8	150	6.07	1.85	41.5	398	7.00	0.02
GL11-T-22	67.181	-50.336	6/18/2011 23:20	30.2	63.0	11.1	44.4	30.3	139	7.61	1.52	34.6	362	7.00	0.01
GL12-L-1	67.157	-50.057	6/24/2012 11:45	4.64	10.8	<4.12	23.0	10.8	92.1	<5.64	<3.23	1.98	143	6.60	-0.27
GL12-L-2	67.157	-50.059	6/24/2012 16:30	7.50	9.75	<4.12	37.0	23.6	87.0	<5.64	<3.23	1.77	167	6.60	-0.06
GL12-T-1	67.179	-50.345	6/26/2012 11:15	41.4	86.8	14.4	170	130	428	7.90	<3.23	61.5	940	7.75	-0.05

pH was measured in the field using a Beckman-Coulter meter. In some cases, pH indicator strips were alternatively used. An alkalinity titration was employed to estimate bicarbonate content. Because the alkalinity titration was performed in the laboratory, the samples almost certainly equilibrated with atmospheric carbon. The data were therefore corrected:

$$[HCO_3^-] = Alk_{Meas}(\frac{[H^+]}{K_2} + 1)^{-1} \, , \qquad\qquad (1)$$

where Alk_{Meas} is the measured alkalinity, and K_2 is a partition coefficient between carbonic acid and bicarbonate (e.g. Langmuir, 1997). At 0°C, K_2 equals $10^{-6.58}$ (Plummer and Busenburg, 1982). The values for HCO_3^- that appear in Tables S1-S3 employ this correction. The charge balance is provided as a check on the validity of this correction and on data quality.

In order to assess the effects of drill water mixing, the composition of the surface streams used as drilling water were measured in several instances (Table S3). GL11-T-15 is a surface stream near the terminus, and is also included for reference. These data show the surface waters to be highly dilute, and therefore unlikely to add substantial chemical constituents to the basal water.

Table S3. Location, timing, and measurements for surface water samples

Sample	Latitude	Longitude	Date and Time	SiO_2	Ca	Mg	Na	K	HCO_3	Cl	NO_3	SO_4
							micro-moles per liter					
GL11-1-S1	67.195	-49.719	7/2/2011 17:27	1.02	0.56	0.34	1.29	0.48	3.25	<2.82	0.72	<1.14
GL11-2-S1	67.201	-49.289	7/17/2011 14:45	0.50	0.28	0.17	0.95	0.48	3.16	<2.82	0.87	1.14
GL11-2-S2	67.201	-49.289	7/17/2011 14:45	1.63	0.53	0.26	2.01	1.34	3.49	<2.82	1.46	<1.14
GL11-T-S1	67.181	-50.337	6/17/2011 15:36	3.54	1.88	0.79	0.91	0.88	5.40	<2.82	<0.32	<1.14

In 2011 and 2012, drill water was pumped out of a tank where a constant level of fluorescein was maintained. The dilution of basal water by the drill water was calculated by dividing the concentration of fluorescein in the sample by the concentration of fluorescein in the returning drill water prior to connection with the bed. Where returning fluorescein was not measured, it was estimated from the fluorescein concentration in the pump tank. Pump tank fluorescein concentrations were found to be $16 \pm 1\%$ higher than returning drill water fluorescein concentrations during the 2012 season. Ion concentrations in the basal water can then be calculated:

$$m_{basal} = \frac{m - Rm_{sur}}{1 - R},\qquad(2)$$

where m is the measured molar concentration, m_{sur} is the molar concentration in average surface waters, and R is the ratio of drill water to total water. Due to carbonic acid buffering, the pH of basal waters is largely controlled by the ratio of carbonic acid to bicarbonate. The corrected pH is therefore calculated:

$$pH_{basal} = -\log_{10}\left(\frac{[HCO_3^-]10^{-pH} - R[HCO_3^-]_{sur}10^{-pH_{sur}}}{[HCO_3^-] - R[HCO_3^-]_{sur}}\right)\ (3)$$

where pH_{sur} is the pH of the surface waters (assumed to be 5.6) and $[HCO_3^-]_{sur}$ is the average bicarbonate concentration in surface waters.

Fluorescein measurements were not performed in 2010. In the GL10 boreholes, -1 samples were collected immediately after drilling, while -2 samples were collected approximately one day later. The -1 samples likely contain a mixture of drill water and basal water. The -2 samples are likely mostly basal water, as they were collected while water levels were rising in the boreholes. Because it is not clear how diluted the by drill water the -1 samples are, only the -2 samples are included on Figure 4 (for the GL10 boreholes).

Samples GL12-2B, 2C, and 2D all contain substantial quantities of Cl⁻. We believe that this is likely due to an error in sampling procedure by which small quantities of 3.5 M KCl electrode storage solution were allowed to enter the samples. We correct this by subtracting equal quantities of K and Cl from the sample, assuming the Cl concentrations are the same as the value measured for GL12-2A-1. GL12-2A-1 has a Cl concentration comparable to that found in other borehole sampling sites.

The borehole values used for plotting Figures 2-4 appear in Table DR4. Drill water dilution corrections for the 2011 and 2012 are effected, as well as the corrections for the KCl contamination in samples GL12-2B, 2C, and 2D. As sample G11-1A is highly dilute and a high percentage drill water, it is excluded from the analysis.

Table S4. Plotted (corrected) values for borehole samples

Sample	% Drill Water	SiO$_2$	Ca	Mg	Na	K	HCO$_3$	Cl	NO$_3$	SO$_4$	TDS	pH
						micro-moles per liter						
Surface Avg.	NA	1.05	0.46	0.26	1.42	0.77	3.30	NA	1.02	NA	8.26	5.60
GL10-1C-1	NA	54.1	42.2	27.8	32.6	38.3	NA	NA	NA	NA	NA	7.50
GL10-1C-2	NA	259	131	88.6	62.9	75.6	375	14.1	17.7	7.29	1031	7.75
GL10-1D-1	NA	12.5	17.5	7.10	24.7	17.2	59.7	25.4	1.29	2.08	167[1]	6.75
GL10-1D-2	NA	33.9	21.9	11.9	27.1	18.0	93.1	14.1	1.61	2.08	224	NA
GL10-1E-1	NA	7.58	10.1	4.27	7.71	7.93	34.8	5.64	NA	NA	78.1[1]	6.64
GL10-2D-1	NA	17.5	10.2	6.57	10.2	15.7	39.7	19.7	6.77	2.08	128[1]	5.80
GL11-1A-1[2]	88%	15.0	47.7	4.95	9.11	21.3	196	NA	NA	10.4	305	7.34
GL11-1B-1	82%	77.4	208	45.8	171	79.3	499	19.3	1.20	66.1	1275	7.39
GL11-1B-2	70%	5.68	16.6	2.70	14.7	7.91	55.5	NA	NA	7.47	111	6.53
GL11-1C-1	2%	0.78	1.11	0.39	2.42	1.00	3.56	NA	NA	1.63	10.9	5.50
GL11-1C-2	3%	13.6	21.3	4.83	17.6	11.1	45.4	10.2	3.05	7.01	134	6.51
GL11-1C-3	2%	13.0	20.7	4.57	15.1	9.26	45.2	7.52	3.11	7.94	126	6.50
GL11-2C-1	60%	1061	193	252	293	173	440	10.6	NA	52.5	2475	8.43
GL12-2A-1	48%	62.9	168	17.2	147.5	116	576	11.4	3.87	34.8	1138	7.92
GL12-2B-1	18%	2.82	17.6	NA	85.1	36.8[3]	112	11.4[4]	2.25	8.00	276	7.20
GL12-2C-1	40%	6.45	18.9	NA	92.6	97.5[3]	169	11.4[4]	2.87	8.33	407	7.41
GL12-2D-2	45%	139	168	12.5	108	220[3]	565	11.4[4]	1.88	67.6	1294	7.70

[1]: Value excluded from Figure 4 (sampled immediately after drilling without drill water correction)
[2]: Sample is excluded from the analysis (highly dilute and mostly drill water)
[3]: Corrected to account for KCl contamination; Values without correction are 122, 384, and 439
[4]: Corrected to account for KCl contamination; Values without correction are 96.3, 298, and 231

The data from the alpine glaciers and other Greenland Ice Sheet work used in constructing Figures 2 - 4 appear in Table DR5. These values represent averages of several measurements, often designed to represent the integration of an entire annual melt season. For most studies, the averages were calculated by the authors. We calculated averages for Hagedorn and Hasholt, 2004 and for Ryu and Jacobson, 2012.

Table S5. References, locations, and data from alpine glaciers

Reference	Glacier	Source Rock	SiO$_2$	Ca	Mg	Na	K	HCO$_3$	Cl	NO$_3$	SO$_4$	TDS
						micro-moles per liter						
Ryu and Jacobson, 2012	Akuliarusiarsuup Kuua, Greenland	Gneiss	44	55	21	49	30	158	22	NA	5	379
Ryu and Jacobson, 2012	Qinnguata Kuuasua, Greenland	Gneiss	52	55	23	38	28	159	22	NA	7	376
Yde et al. 2005	Kuannersuit, Disko Island	Basalt	150	80	35	120	2	330	25	14	10	766
Hagedorn and Hasholt, 2004	Mittivakkat, SE Greenland	Granite Garnet Gneiss	19	30	21	56	7	29	62	NA	34	257
Hindshaw et al., 2011	Damma, Switzerland	Granite	17	18	4	11	12	32	5	14	7	120
Hosein et al., 2004	Rhone, Switzerland	Gneiss	35	34	5	10	12	30	2	16	14	159
Hosein et al., 2004	Obersraar, Switzerland	Gneiss	56	180	11	9	17	147	2	11	63	495
Hodson et al., 2000	Erdmannbreen, Svalbard	Metasediment	6	59	50	64	6	152	77	3	28	445
Hodson et al., 2000	Lovenbreen, Svalbard	Metasediment	8	107	61	62	15	234	45	1	74	608
Drever and Hurcomb, 1986	South Cascade, USA	Quartz Diorite	25	73	15	18	21	171	13	NA	19	355
Singh et al., 2012	Gangtori, Nepal	Granite / Metasediment	64	103	99	75	83	266	11	2	201	903
Singh and Hasnain, 2002	Satopanth, Nepal	Granite / Metasediment	40	177	43	42	42	221	8	NA	40	613
Tranter et al., 2002	Haut D'Arola, A Boreholes	Gneiss / Greenshist	14	470	46	20	23	620	8	4	220	1425
Tranter et al., 2002	Haut D'Arola, B Boreholes	Gneiss / Greenshist	19	325	41	18	15	480	6	10	135	1049
Tranter et al., 2002	Haut D'Arola, C Boreholes	Gneiss / Greenshist	17	115	11	19	33	260	8	1	18	482
Tranter et al., 2002	Haut D'Arola, Outlet	Gneiss / Greenshist	17	187	18	16	13	310	5	6	68	639

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