

Interpretations: Reading the Book of Earth



Case Study 5.2
Unit 5  *Climate of Change* InTeGrate Module

Credit: Jean-Pierre Normand, artist

Source: GISP2 Drill Site, Greenland Summit Illustration. <http://chandra.harvard.edu/edu/formal/icec>

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Credit: Pete Bucktrout, British Antarctic Survey

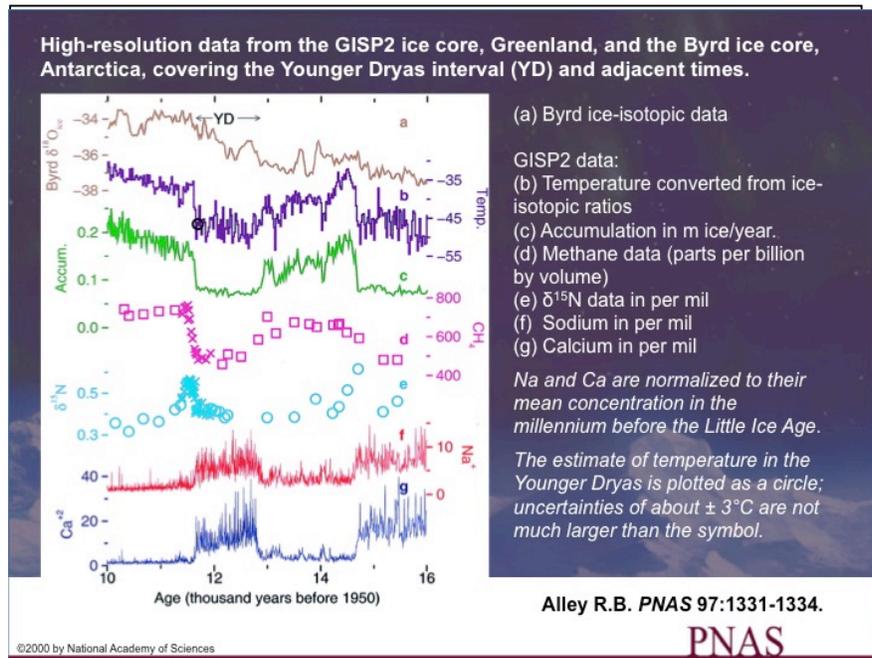
Source: http://www.discoveringantarctica.org.uk/alevel_img/10002019.jpg, last accessed June 24, 2014.

Credit: Kendrick Taylor, University of Nevada-Reno/National Oceanic and Atmospheric Administration Paleoclimatology Program/Department of Commerce

Source: Core processing line: The temperature of the ice cores is never allowed to rise above -15 degrees C, partly to prevent microcracks from forming and allowing present-day air to contaminate the fossil air trapped in the ice fabric, and partly to inhibit recrystallization of the ice structure. Since summer temperatures in central Greenland are often higher than this, the core is moved immediately from the drill dome to a network of trenches beneath the snow surface known as the core processing line (CPL). The first step in the CPL are these wooden trays where cores are stored before measurements are performed. This ice is from 1500 m and is clear with the exception of a few subtle seasonal dust bands. <http://science.psu.edu/news-and-events/2008-news/Loveland-Curtze5-2008.htm>, last accessed 7 Aug 12.

Credit: Mark Twickler, University of New Hampshire/National Oceanic and Atmospheric Administration Paleoclimatology Program/Department of Commerce

Source: The GISP2 (Greenland Ice Sheet Project 2) drill dome, located in Greenland, obtained an ice core 3053 meters in depth. The GISP2 drill dome measures 32.5 m across, housing the drill and the lower part of its 37 m tower. The drill dome is connected via trenches and shafts to the subterranean core processing line. <http://science.psu.edu/news-and-events/2008-news/Loveland-Curtze5-2008.htm>, last accessed 7 Aug 12.



High-resolution data from the GISP2 ice core, Greenland, and the Byrd ice core, Antarctica, covering the Younger Dryas interval (YD) and adjacent times, modified slightly from ref. 37. (a) Byrd ice-isotopic data (6, 38, 39). (b–e) GISP2 data mostly from ref. 8, with the accumulation and temperature originally from ref. 40. (b) Temperature converted from ice-isotopic ratios (41) using the glacial-interglacial calibration of ref. 12, shown in $^\circ\text{C}$. (c) Accumulation in m ice/year. The estimate of temperature in the Younger Dryas from (8) is plotted as a circle; uncertainties of about $\pm 3^\circ\text{C}$ are not much larger than the symbol. (d) Methane data (parts per billion by volume) from ref. 23 (\square) and ref. 8 (\times). (e) $\delta^{15}\text{N}$ data in per mil from ref. 8, with \circ from their figure 2 and \times from their figure 4. (f and g) GISP2 sodium (f) and calcium (g) data from ref. 17, normalized to their mean concentration in the millennium before the Little Ice Age following ref. 36 by using the accumulation-rate estimates of ref. 9. Most of the ice-core data, and many related data sets, are available on The Greenland Summit Ice Cores CD-ROM, 1997, National Snow and Ice Data Center, University of Colorado at Boulder, and the World Data Center-A for Paleoclimatology, National Geophysical Data Center, Boulder, CO, www.ngdc.noaa.gov/paleo/icecore/greenland/summit/index.html.

Methane (ppb)	Age (ka)																		
1871.000	0.002	627.378	6.328	526.188	11.776	674.937	14.343	397.677	26.256	491.783	38.552	593.985	45.265	596.009	58.212	459.403	74.118	493.807	93.012
747.794	0.133	610.176	6.659	514.045	11.792	629.402	14.364	366.308	26.672	543.390	38.585	576.783	45.298	457.379	58.425	448.272	74.820	531.248	93.529
745.770	0.135	661.783	6.816	540.355	11.805	633.449	14.411	393.629	27.653	471.545	38.619	570.712	45.313	406.784	58.664	583.866	75.482	435.117	94.051
761.961	0.138	651.664	6.995	494.819	11.822	655.711	14.437	464.462	27.844	465.474	38.913	581.843	45.327	466.486	58.921	480.653	75.778	469.522	94.582
762.973	0.140	642.557	7.181	490.772	11.901	661.783	14.437	495.831	28.886	468.510	39.090	534.283	45.340	440.177	59.141	466.486	76.097	481.664	95.101
738.687	0.273	641.545	7.510	527.200	11.932	665.830	14.458	416.903	29.549	407.796	39.291	486.724	45.397	471.545	59.370	579.819	76.739	534.283	96.140
709.342	0.284	628.390	7.688	486.724	11.972	629.402	14.486	400.712	29.987	466.486	39.521	550.474	45.418	494.819	59.777	516.069	77.069	519.105	96.687
702.259	0.294	620.295	7.867	500.891	11.999	612.200	14.501	471.545	30.460	438.153	39.621	564.640	45.512	455.355	60.327	512.021	77.372	541.367	97.215
712.378	0.306	572.735	8.233	546.426	11.999	645.592	14.516	432.081	31.326	457.379	39.832	527.200	45.550	465.474	60.778	528.212	77.686	594.997	97.745
718.449	0.478	664.818	8.431	531.248	12.054	619.283	14.531	531.248	32.062	476.605	40.043	521.129	45.623	459.403	61.218	520.117	78.032	590.950	98.697
708.330	0.565	669.878	8.631	489.760	12.110	620.295	14.551	467.498	33.244	447.260	40.415	512.021	45.665	481.664	61.422	580.831	78.708	578.807	99.145
708.330	0.653	735.651	8.828	463.450	12.146	631.426	14.603	548.450	33.452	494.819	40.800	477.617	45.703	527.200	61.696	565.652	79.040	554.521	99.610
723.509	0.830	660.771	9.026	497.855	12.196	628.390	14.666	435.117	33.692	505.950	40.910	496.843	45.741	544.402	61.817	597.021	79.406	572.735	99.969
760.890	1.007	666.842	9.243	516.069	12.255	600.057	14.718	448.272	34.213	438.153	41.094	465.474	45.799	474.581	61.940	586.902	79.779	567.676	100.315
690.116	1.145	690.116	9.451	493.807	12.396	589.938	14.820	597.021	34.737	412.850	41.590	459.403	46.195	469.522	62.092	583.866	80.156	642.557	100.614
672.914	1.369	718.449	9.664	502.914	12.500	495.831	14.930	589.938	35.072	463.450	41.873	455.355	46.685	530.236	62.300	598.033	80.543	647.616	100.958
666.842	1.481	757.913	9.914	496.843	12.500	495.831	15.032	449.284	35.334	491.783	42.162	491.783	47.634	457.379	62.584	598.033	81.924	601.069	101.369
658.747	1.584	757.913	10.153	481.664	12.647	463.450	15.138	466.486	36.112	520.117	42.305	467.498	48.047	509.998	62.874	656.723	81.326	507.974	101.794
661.783	1.679	711.366	10.236	604.104	12.799	487.736	15.177	539.343	36.538	479.641	42.406	487.736	48.308	437.141	63.146	646.604	81.890	584.878	102.158
644.580	1.779	750.830	10.311	591.962	12.822	544.402	15.245	505.950	36.679	418.927	42.880	521.129	48.748	518.093	63.373	734.639	82.083	650.652	102.507
662.795	1.902	716.425	10.399	633.449	12.912	471.545	15.367	583.866	37.041	439.165	43.207	506.962	49.132	495.831	63.564	718.449	82.868	548.450	102.939
633.449	2.088	709.342	10.493	711.366	12.991	481.664	15.367	577.795	37.221	479.641	43.331	533.271	49.386	462.438	63.817	673.925	83.283	452.319	103.333
646.604	2.193	728.568	10.579	688.092	13.083	486.724	15.440	561.605	37.346	444.224	43.470	542.378	49.925	495.831	64.241	744.758	83.624	520.117	103.757
644.580	2.320	724.520	10.672	625.354	13.151	463.450	15.684	584.878	37.470	475.593	43.607	554.521	50.461	469.522	64.873	718.449	83.956	506.962	104.184
603.092	2.510	740.711	10.857	682.021	13.263	491.783	15.951	560.593	37.595	436.129	43.725	554.521	50.777	518.093	65.263	511.010	84.347	476.605	104.541
622.319	2.615	740.711	10.957	693.152	13.344	467.498	16.225	567.676	37.728	478.629	43.836	552.497	51.778	472.557	65.438	469.522	84.725	518.093	104.933
672.914	2.730	732.616	11.061	692.140	13.421	445.236	16.507	577.795	37.868	502.914	43.958	539.343	51.778	515.057	65.691	467.498	85.495	491.783	105.264
654.699	3.198	749.818	11.157	683.033	13.497	455.355	16.767	566.664	37.951	483.688	44.087	561.605	52.012	453.331	66.233	446.248	85.495	492.795	105.572
597.021	3.310	746.782	11.261	682.021	13.651	408.808	17.263	590.950	38.049	483.688	44.196	521.129	52.434	451.307	66.741	532.259	85.889	486.724	106.268
624.342	3.315	688.092	11.369	673.925	13.783	374.403	17.477	581.843	38.091	487.736	44.296	443.212	53.080	479.641	67.037	467.498	86.293	480.653	106.624
614.223	3.428	689.104	11.407	655.711	13.783	364.284	17.806	566.664	38.142	492.795	44.382	498.867	53.568	493.807	67.582	454.343	86.876	457.379	106.957
613.211	3.804	701.247	11.458	712.378	13.861	410.831	18.190	630.414	38.166	520.117	44.477	567.676	53.743	512.021	68.125	490.772	86.876	542.378	107.322
616.247	4.035	717.437	11.505	658.747	13.921	384.522	18.587	577.795	38.192	496.843	44.580	555.533	53.988	493.807	68.413	518.093	87.439	508.986	107.708
605.116	4.328	745.770	11.510	647.616	14.006	360.296	18.864	592.973	38.219	494.819	44.684	544.402	55.114	458.391	68.471	499.879	87.939	563.628	108.116
617.259	4.484	759.937	11.557	631.449	14.054	400.712	19.163	588.936	38.269	540.335	44.776	553.509	55.615	459.403	69.736	511.010	88.382	518.093	108.531
605.116	4.690	763.985	11.589	709.342	14.069	407.796	19.751	612.200	38.298	536.307	44.876	587.914	56.305	468.510	70.519	492.795	88.861	576.783	108.655
594.997	4.802	778.151	11.626	612.438	14.161	398.649	20.069	601.069	38.321	517.081	44.967	579.819	56.456	472.557	70.852	540.335	89.122	501.902	108.847
587.914	4.965	694.163	11.641	637.497	14.161	414.879	20.423	602.081	38.321	526.188	45.047	636.485	56.840	445.236	71.186	500.891	89.730	567.676	109.007
596.099	5.134	746.782	11.652	668.866	14.228	375.415	20.751	617.259	38.349	514.045	45.110	588.688	57.147	518.093	71.824	452.319	90.134	505.950	109.175
605.116	5.280	745.770	11.652	639.521	14.246	417.915	21.123	583.866	38.386	543.390	45.164	486.724	57.396	462.438	72.146	449.284	90.580		
599.045	5.387	701.247	11.675	622.319	14.265	430.058	21.123	590.950	38.419	556.545	45.188	599.045	57.591	477.617	72.441	454.343	91.026		
593.985	5.698	632.438	11.703	625.354	14.284	399.701	21.298	606.128	38.452	539.343	45.206	604.104	57.794	502.914	72.747	448.272	91.487		
585.890	5.855	598.033	11.729	643.568	14.303	418.927	21.288	556.545	38.486	560.593	45.231	609.164	57.954	453.331	72.988	435.117	91.983		
600.057	6.260	542.378	11.761	668.866	14.324	388.570	25.786	513.033	38.510	554.521	45.248	513.033	58.077	420.950	73.664	475.593	92.477		



