Zentralgrönland war (geologisch gesehen) vor kurzem eisfrei und mit Pflanzen bedeckt, als der CO_2-Gehalt unter 300 ppm lag

geschrieben von Chris Frey | 8. Januar 2025

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Heute, wo der CO_2-Gehalt angeblich „gefährlich hoch" ist, türmt sich in Zentralgrönland ein 3 km dicker Eisschild auf.

Seit der GISP2-Bohrung im Jahr 1993 wissen die Wissenschaftler, dass Zentralgrönland im späten Pleistozän mindestens einmal gletscherfrei war (Bierman et al., 2024). Tatsächlich war der Gipfel des modernen grönländischen Eisschildes irgendwann zwischen 250 000 und 1,1 Millionen Jahren eisfrei – was aus geologischer Sicht relativ jung ist.

Am Boden der Bohrung wurden Pflanzen, Holz, Insekten, Pilze und andere Überreste gefunden, die auf eine Vegetation schließen lassen. Das ist ein ziemlicher Kontrast zu der 3000 Meter hohen Eisdecke, die heute an der gleichen Stelle liegt.

„Das Vorhandensein von Mohn, Ährenmoos, Pilzsklerotien, holzigem Gewebe und Insektenteilen am Boden des GISP2-Bohrkerns zeigt, dass die Tundra-Vegetation einst Zentralgrönland bedeckte, was darauf schließen lässt, dass die Insel weitgehend eisfrei war."

Man nimmt an, dass die atmosphärische CO_2-Konzentration während des Spätpleistozäns, also während der Zeit, als Grönland eisfrei war, zwischen 275 und 290 ppm lag. Man geht davon aus, dass diese CO_2-Werte unter 300 ppm denen von 1700 bis 1900 (der Kleinen Eiszeit) entsprechen, als Zentralgrönland wie heute unter Kilometer dickem Eis begraben war.

Die Autoren dieser Studie nutzen das vorhandene Wissen über das grönländische Klima (z. B. beträgt die mittlere Juli-Temperatur in Summit -7 °C), um zu berechnen, wie viel wärmer Zentralgrönland in den letzten 1,1 Millionen Jahren war, „als das Eis weg war". Unter Berücksichtigung der Stornorate lagen die durchschnittlichen Temperaturen in Zentralgrönland im Juli wahrscheinlich bei +3 bis 7 °C, als es noch keinen Eisschild gab.

Die atmosphärische CO_2-Konzentration scheint also weitgehend unabhängig von Grönlands Klima oder dem Zustand der Vergletscherung zu sein.

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Plant, insect, and fungi fossils under the center of Greenland's ice sheet are evidence of ice-free times

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The persistence and size of the Greenland Ice Sheet (GrIS) through the Pleistocene is uncertain. This is important because reconstructing changes in the GrIS determines its contribution to sea level rise during prior warm climate periods and informs future projections. To understand better the history of Greenland's ice, we analyzed glacial till collected in 1993 from below 3 km of ice at Summit, Greenland. The till contains plant fragments, wood, insect parts, fungi, and cosmogenic nuclides showing that the bed of the GrIS at Summit is a long-lived, stable land surface preserving a record of deposition, exposure, and interglacial ecosystems. Knowing that central Greenland was tundra-covered during the Pleistocene informs the understanding of Arctic biosphere response to deglaciation.

(*A*) Map of coring sites.

In 1993, the Greenland Ice Sheet Project 2 (GISP2) recovered the only basal material from central Greenland: 40 cm of erratic boulders, 8 cm of till, and 105 cm of rock (Fig. 1*B*) 6–8. Analysis of sediment in the lowest basal ice revealed substantial organic carbon and nitrogen and meteoric ^{10}Be—consistent with limited erosion, long subaerial exposure, and the presence of soil (9). A depth profile of cosmogenic nuclides from the GISP2 subglacial rock core indicated that central Greenland deglaciated at least once in the last 1.1 My (6). Here, we re-examine the till to learn about past conditions at Summit. The presence of poppy, spike-moss, fungal sclerotia, woody tissue, and insect parts in the GISP2 till shows that tundra vegetation once covered central Greenland, mandating that the island was largely ice-free. The fossil assemblage suggests that ice was replaced by a cold, dry, open environment where snow lingered into summer. We make this interpretation because we found *S. rupestris*, which forms creeping mats on sandy gravel or rocky places (11) and is today found only in southern Greenland (12). *S. rupestris* forms spores, such as those identified in the till, during late July (13). *Papaver* sect. *Scapiflora* is a dominant member of the most depauperate vegetation assemblage that borders the Arctic Ocean. In the High Arctic, they grow in areas with long-lasting snow cover (14). *Papaver* blooms in June–July and is pollinated by bees in early summer but by flies later (15).

The very dry exposed vegetation assemblage with abundant *S. rupestris* megaspores, fragile *Cenococcum* fungal sclerotia, and lack of other taxa including bryophytes suggests minimal fossil transport and a mean July temperature in central Greenland somewhere between 1 and 10 °C (16) reflecting the wide distribution of *Papaver* sect. *Scapiflora* today in Greenland (17). The botanically determined temperature range is consistent with the 3 to 7 °C range derived using lapse rates (*SI Appendix*). The abundance of macrofossils in the till explains the organic carbon and nitrogen found in sediment from GISP2 basal ice. High concentrations of meteoric ^{10}Be (9) on basal ice sediment reflect stability and exposure of the soil developed on the till in which the plants grew.

The timing of the most recent exposure of Summit remains uncertain although rock core ^{26}Al/^{10}Be data indicate that it occurred within the last 1.1 My (6). Argon measurements in the overlying clear ice suggest that it persisted for at least the past 250 ky (18).

Paleotemperature estimate

We have two ways of estimating the temperature at GISP2 when the ice was gone, the first based on physical principals and contemporary empirical measurements, and the second based on inferences related to the ecology of plant fossils found in the till.

Understanding the temperature at the GISP2 site when the ice was gone requires considering both the elevation of the site when it was deglaciated and the environmental lapse rate in the summer when the plants grew. The GISP2 site on the present ice surface is at an elevation of 3216 m asl, and the ice core length is 3053 meters to the bed. Thus, the current bed elevation is about 160 m asl. The contemporary environmental lapse rate (determined empirically by ref 14) is lowest in July when the plants would have been growing (0.46 °C per 100 m).

Using the July mean temperature for Summit (-7 °C) and the 0.46 °C per 100 m lapse rate suggests that if there were no isostatic rebound, the surface temperature during an interglacial comparable to the present would be about 7 °C. However, this is an upper bound as some rebound must have occurred while the ice was thinning and then absent. A recent calculation suggests that if rebound went to completion, a process that would take many thousands to a few tens of thousands of years without ice, then the elevation at GISP2 would be at most 900 m (15). In this case, the July mean surface temperature would have been about 3 °C.

Thus, if we accept modern interglacial July environmental lapse rate (0.46/100 m) we can bracket the expected July mean temperature (peak of growing season) with ice gone between 7 °C (no rebound) and 3 °C (full rebound) – fully consistent with the estimate based on the plant assemblage. However, our simple calculation ignores feedbacks such as albedo changes from substantial reduction in ice extent as well as changes in humidity and cloud cover that likely changed the environmental lapse rate. Such considerations are outside the scope of this simple, first-order analysis but suggest that our estimate of paleo-temperature when the plants grew at GISP2 are probably minima.

Quelle: Bierman et al., 2024

Link: https://notrickszone.com/2025/01/03/central-greenland-was-recently-ice-free-and-covered-with-plants-when-CO₂-was-under-300-ppm/

Übersetzt von Christian Freuer für das EIKE