The GISP2 Ice Core: Ultimate Proof that Noah's Flood Was Not Global

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Recently an ice core nearly two miles long has been extracted from the Greenland ice sheet. The first 110,000 annual layers of snow in that ice core (GISP2) have been visually counted and corroborated by two to three different and independent methods as well as by correlation with volcanic eruptions and other datable events. Since the ice sheet would have floated away in the event of a global flood, the ice core is strong evidence that there was no global flood any time in the last 110,000 years.

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There is an ice sheet nearly two miles deep covering most of Greenland. Each year snow accumulates on it and presses the layers of snow below into thinner layers and into ice. Drilling rigs can cut down through the ice and bring up a continuous record of the ice as cores in segments three to eighteen feet long and three to five inches in diameter (5" for GISP2).[1]

There are a dozen or so important Greenland ice cores, but the latest and greatest are GRIP (Greenland Ice Project) and GISP2 (Greenland Ice Sheet Project 2), which were extracted at the Summit where the ice rarely melts. GRIP was dated by counting back annual layers from the surface to c. 14,500 BP (before the present, dated 1950) using electrical conductivity method (ECM, see below) and the rest of the ice core was dated on the basis of flow modeling and chemical techniques.[2] GISP2 was dated by visually counting annual hoar frost layers back to c. 12,000 BP and from 12,000 to 110,000 BP by visually counting annual dust layers.

Back to 12,000 BP, this counting was validated by a *very* close agreement of three independent methods of counting the annual layers. From 12,000 BP back to 40,000 BP, the counting was validated by a *very* close agreement of two independent methods of counting the annual layers, and from 40,000 BP back to 110,000 BP by a close agreement of two independent methods. Also, despite the different methods used for dating GRIP and GISP2, there is "excellent agreement" between them (and with deep sea cores as well); so the cores corroborate each other.[3]

Mainstream creation science writers are in agreement that the Greenland ice sheet could not have been deposited before a global flood because the supposed climate of the pre-Flood world was too warm to allow the build-up of an ice sheet. They also believe that even if an ice sheet had built up, the water of a global flood would have caused the ice sheet to rise, break up, float away, and melt.[4] So the annual layers in the GISP2 ice core reflect the years *since* the Flood according to creationist theory. This means that if the dating of the GISP2 ice core is valid and there was a global flood, it must have occurred at least 40,000 years ago and probably more than 110,000 years ago. Yet even 40,000 years ago does not at all fit the biblical indications for the date of Noah's Flood, which cannot be dated earlier than around 6000 BC (8000 BP).[5] If the dating of the GISP2 ice core is valid, it falsifies the theory that Noah's flood was a global flood.

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It should also be noted that if there was an ice sheet before the Flood and it did not float away, Gen 7:19–8:4 virtually demands that it was covered by the ocean. If this had happened, the core would show an extra-large melt layer sometime in the past with saline marine residues, but there is no such layer. And if the ocean contained all the earth materials which creation science theorists attribute to it at the time of the Flood, there would also be a silt deposit of some kind in the core, but there is none.

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If one supposes the rather unbiblical scenario that the ice sheet existed before the Flood but neither floated away nor was covered by the ocean, the extraordinary amounts of precipitation at the time of the Flood (Gen 7:4, 12) would cause the ice core to have either an extra-large melt layer from rain as well as ice pipes, lenses, glands, and such in the snow above or an extra-large annual layer of snow sometime in the past, probably in the last 8,000 years, but it does not. If the Flood lifted such an ice sheet, it probably would have floated away, but if by some chance the Flood set it back down, ocean currents would have kept it from coming back down exactly in its former place with the shape of the bottom of the ice sheet exactly matching the complex topographic shape of the Greenland bedrock—as it now does. In addition, the sloping parts of the ice sheet would have produced a unique "marine" ice that is found under ice shelves but has never been found under a grounded ice sheet and is not under the Greenland ice sheet.[6]

We can see then that on any possible scenario, without any need to appeal to radiometric dating, the 110,000 regular annual layers of fresh-water ice in the GISP2 ice core falsify the theory of a global Flood in the time of Noah. The only critical question is: How do we know the layers being counted are really annual? The answer to this question is three-fold and more.

Ice Crystals Vary from Summer to Winter

The first way we know the top 12,000 layers are annual is because the snow that falls in the summer in Greenland is affected by the sun (which only shines in the summer) in such a way that its crystals become much more coarse-grained than winter snow. At the GISP2 site, on the summit of the ice cap, the temperature only warms up enough to melt the ice about once in a couple of centuries.[7] But, the annual summer sun regularly heats the first inch of snow during the day with the result that much of it evaporates, leaving it light and airy. Then during the summer nights the snow surface and the air just above it cool and form fog. The fog in turn condenses as frost on the surface of the snow. The result of this daily warming, cooling, and frost-forming is that an inch of fine-grained high density snow becomes two inches of coarse-grained low density snow called *hoar*.[8]

This process of warming, cooling, and frost-forming does not occur in the winter because the sun does not shine at all in Greenland during the winter. Hence the fine-grained high density snow which falls in the winter remains fine-grained high density snow.[9] The difference between the summer and winter snow is easily seen by leaving marked poles in the snow at the end of the summer, coming back the next summer, and digging pits in the snow deep enough to see how the new winter snow varies from the older summer snow (not only over the last year but over several earlier years as well). The summer snow appears as light bands, while the winter snow shows up as homogeneous darker-appearing snow, and this same alternation of light and dark snow is seen in the ice core.[10]

In the ice core, at about 200 feet down, compression results in the large crystals of the summer snow being less prominent than the large air bubbles which have been trapped inside them. When one shines a light through the ice core, the coarse crystals of the summer snow or their large air bubbles show up as light bands which alternate with the darker finer crystals of the winter snow. These bands can be counted by eye and dated throughout the Holocene period and into the interglacial, that is, back to c. 12,000 BP albeit the large air bubbles from c. 8000 BP slowly become too compressed to be seen when the core is first removed, and researchers must wait for them to become depressurized (this takes about a year) before they can be seen and counted.

About the same time as the air bubbles begin to disappear (c. 8000 BP) due to being under such great pressure from the ice above, the dust in the summer layers slowly begins to become more prominent. So, for a while both dust layers and hoar layers are counted. Then, as the large air bubbles disappear altogether, the dust layers alone are counted. After the large air bubbles in the summer layer reappear, they are counted as well, giving a double visual read on the annual layers back to c. 12,000 BP. In the Holocene (back to c. 11,500 BP) the count of the re-emerged large air bubbles agrees very closely (better than 98%) with the dust layer count, and the dust layers are independent of the hoar frost and its bubbles; so they corroborate the hoar frost/air bubble count. From c. 12,000 BP to 110,000 BP, it is the dust layers rather than the hoar frost layers that are visually counted. These dust layers eventually become so

The three main methods of [dating are the] visual counting of hoar frost (back to 12,000 BP) and dust (back to 110,000 BP), laser light scattering, and the electrical conductivity method.

prominent they can be counted by eye from across the room.[11]

Dust Concentrations Vary Seasonally

Another way to distinguish the annual layers is to note the dust concentrations. In the late winter/early spring when the wind is stronger than usual, significantly more dust (insoluble matter of various kinds) is carried in the air—even from the Southern hemisphere and Asia—and is deposited in the layers of snow in Greenland. Although large influxes of dust can occur at other times than during the late winter/early spring, a number of studies have shown that there is usually a clear and decided difference in the amount of dust in the late winter/early spring layers compared to the rest of the year.[12]

Although there are several ways to measure the amount of dust in the layers of an ice core, 90° laser light scattering (LLS) is the most rapid and effective way to measure it.[13] Ram and Koenig found that using this method on ice meltwater from the top 1800 meters of the GISP2 ice core down (I estimate around 16,500 annual layers down) showed "clear, sharp, seasonal dust peaks."[14] In the lower half of GISP2 (1,678 meters to the bottom) where the dust is more concentrated, Ram and Koenig could scatter the laser light directly off the ice without having to melt it—and could do this mechanically one mm at a time—and feed the data directly into a computer. The readout showed the seasonal variations as a series of peaks and valleys. In this way, they were able to date the ice down to 2,849 meters at around 127,600 BP.

At c. 2,464 meters down, their dating of the volcanic ash found there (57,300 ± 1700 BP) agrees very closely with the Z2 layer of volcanic ash found in Atlantic sea cores which is dated 57,500 ± 1300 BP. At 2,808 meters down, their dating was c. 115,000 BP which was in essential agreement with the independent gas-age dating of c. 111,000 BP for that level.[15] Although the ice below 2,850 meters may be disturbed, Ram and Koenig continued measuring via LLS both with 1 mm and some 0.5 mm steps; and, this yielded an estimated age for the ice at the silty ice boundary of "at least 250,000 BP."

Electrical Conductivity Varies from Summer to Winter

The third way annual layers can be distinguished is via the electrical conductivity of the layers.[16] In the spring and summer when the sun is shining, nitric acid is produced in the stratosphere and enters the snow, but this does not happen in the winter.[17] The acid in the spring/summer layer enables an electrical current to easily flow through that layer, but the relative lack of acid in the winter layer allows much less electricity to flow through that layer. So, as two electrodes mechanically run down the ice core the readout (mm by mm) of the resultant flows of electricity shows the successive years as a series of peaks (summer) and valleys (winter).

Thus the electrical conductivity method (ECM) is an excellent indicator of annual layers, though there can be occasional peaks of acidity from other sources, primarily volcanoes. Peaks from volcanoes, however, are relatively rare and are easily distinguished from the regular summer peaks because they are much higher and because, in the Greenland ice cores, the acid is sulfuric rather than nitric from the spring/summer stratosphere.

The ^{18}Oxygen/^{16}Oxygen Ratio Varies from Summer to Winter

One of the older methods for dating ice cores is to use a mass spectrometer to identify the summer vs. the winter layers in the ice. The mass spectrometer can measure the ratio of the heavier oxygen isotopes (^{18}O) to the lighter oxygen isotopes (^{16}O). Because water containing the lighter isotope evaporates preferentially from the ocean (it is even more efficiently separated from the ocean water when temperatures are low), winter snow contains more of the lighter isotope than does summer snow. As each pair of summer and winter snow layers are identified they equal one year, so they can be used to date the ice core.[18] This neat difference can be disturbed somewhat if summer and winter snow layers are mixed by wind, but Greenland ice cores seem to be relatively immune to this problem.

More importantly, because in most of Greenland the annual seasonal variations of the ratio are obliterated by diffusion of the oxygen in ice older than 10,000 years, this method is usually only good for dating the most recent ten thousand years or so of the Greenland ice cores.[19] It was a major dating method for dating the Dye 3 core back to c. 10,000 BP[20] but was only used back c. 1100 years (300 meters) in the GISP2 core and only as a secondary method corroborating the three main methods of visual counting of hoar frost (back to 12,000 BP) and dust (back to 110,000 BP), laser light scattering, and the electrical conductivity method.[21]

In addition to the agreement of the three main methods of dating, the years are correlated as far as possible with volcanic events which can be dated.

It is to a large extent the correlation and corroborating testimony of these three main methods of counting the annual layers in the GISP2 core which guarantees the validity of the ice core dating.[22] The three methods have excellent correlation with each other down to 2500 m, that is, back to c. 57,000 BP.[23] In the upper 2300 m (down to c. 40,000 BP) the correspondence of the three methods has been called "remarkable."[24] As Ram and Illing said of the LLS method:

> When combined with visual stratigraphy and ECM, the distinct annual spring/summer dust peaks we observe can be used to date the core with tree-ring-like precision.[25]

In addition to the agreement of the three main methods of dating, the years are correlated as far as possible with volcanic events which can be dated. The Icelandic volcano Laki had an enormous eruption in 1783/1784. On the GISP2 ice core, a large acid peak via ECM was found at the level visually counted to be 1785; and, volcanic glass found at that level in the ice core matched the volcanic glass from Laki. A high reading of sulfuric acid was also found in the GISP2 core at 1623 BC (3573 BP) which correlates very well with the tree-ring dates of 1625 and 1628 BC for the Santorini eruption.[26]

Reaching back even further, in addition to sulfuric acid peaks, tephra has been found in both the GRIP and GISP2 ice cores which matches the composition of tephra from particular volcanic eruptions around 10,300 BP and 52,700 BP. Zielinski, et al. comment:

> Tephra has been found in both cores with a composition similar to that originating from the Vatnaöldur Icelandic eruption that produced the Settlement layer in Iceland (mid-AD 870s), from the Icelandic eruption that produced the Saksunarvatn ash (~10,300 years ago), and from the Icelandic eruption(s) that produced the Z2 ash zone in North Atlantic marine cores (~52,700 years ago). The presence of these layers provides absolute time lines for correlation between the two cores and for correlation with proxy records from marine sediment cores and terrestrial deposits containing these same tephras.[27]

The cross correlations of the varied independent methods of counting annual layers plus the correlations with known volcanic events show that for the first 11,500 BP, the layer counting is correct to within 1% over century length times and from 11,500 BP down to c. 50,000 BP within 5% over millennial or longer intervals.[28] From 50,000 BP down to 110,000 BP, the accuracy is within about 10% to 20%.[29] As one goes deeper down the ice core, the layers become more narrow and harder and harder to separate; and the movement of the ice distorts the layers. Nevertheless, even though accuracy beyond the 110,000 year level is uncertain, there is reason to believe the ice cores from Summit, Greenland are c. 250,000 years old at the bottom.

Creation Science and Ice Cores

Larry Vardiman, who teaches at the Institute for Creation Research, has written three papers on ice cores primarily with reference to the age of the earth. In his 1992 paper, he considered the ice core at Camp Century near the northern tip of Greenland.[30] He admitted that "it is relatively easy to count annual layers downward from the surface through considerable depths in the Greenland ice sheet" but said an age of 6,000 years which he had roughly calculated for the age of the ice sheet is "in relatively good agreement with the number of annual oscillations currently observed in Greenland cores." This was an optimistic stretch of the dating of the ice sheet even at that time, and now the 110,000 annual oscillations counted in the GISP2 core completely invalidate an age of just 6,000 years for the ice sheet.

In his 1992 paper, Vardiman also considered the Vostok ice core of Antarctica which could not be dated by counting the annual layers because they are too thin, so it was dated partly by an ice flow model and partly by measuring the $^{18}O/^{16}O$ ratio at intervals down the core. Since this method of dating is less exact and dependent upon a model as opposed to the direct methods used on the GISP2 core, Vardiman had room to speculate that it might not be accurate.

Vardiman's second paper in 1994 presented a young-earth ice flow model to take the place of the model that was being used at that time to help date the ice sheets.[31] He had heard about the counting of 14,500 annual layers in

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the GRIP ice core, awaited publication of the raw data, and in his conclusion accepted the possibility that Aardsma might be right about dating the Flood 14,000 years ago.[32] It is to Vardiman's credit that he took the counting of the annual layers in the GRIP core seriously and never attempted to deny their validity on the basis of a mere hypothesis. Now that the annual layers counted in the GISP2 core by methods not dependent on ice flow modeling indisputably push the date of the Flood back at least 40,000 years and probably more than 110,000 years, even a date of 12,000 BC for the Flood is falsified.

In his 1997 paper, Vardiman presented a young-earth scenario to explain why $^{18}O/^{16}O$ decreases from the beginning of the ice age to its end and then increases and remains fairly constant for the last thousand years.[33] This paper has strictly to do with climate and did not make any attempt to disprove the summer/winter $^{18}O/^{16}O$ differences which are used to count annual layers.

In conclusion, it must be emphasized that Vardiman's three papers do not provide any scientific data which would falsify the fact that some 110,000 annual layers have been counted in the GISP2 core, the first 40,000 of which are strongly validated by the consistent agreement of two different and independent methods of determining annual layers (LLS and ECM). Even his scientifically unsupported suggestion that the annual layers may be just due to storms was only made with reference to the layers "deep in the Greenland ice sheet," not at the top where the annual layers were counted by ECM. Vardiman did not address the GISP2 ice core or make any attempt to refute the three major methods which were used to count the top 110,000 annual layers. The fact that Vardiman took the counting of the top 14,500 layers in the GRIP core seriously suggests that, if anything, his papers support the validity of the counting of the 110,000 layers as annual. There is *nothing* in his papers which even addresses, much less refutes, that counting.

Oard's Proofs that the Layers Are Less than Annual

Michael Oard published a paper in 2001 attempting to show that the annual layers in the GISP2 and GRIP ice cores are subannual.[34] This paper went beyond Vardiman by claiming that even the main methods used for dating the ice cores (hoar frost, LLS, ECM) could not be trusted to be annual except over the last 2,000 years or so. He offered five reasons why the layers being counted could be less than annual layers.

His first argument is that the interpretation of annual layers from all of the dating methods "has been determined by the thickness of the annual layers that they expect, based on their model."[35]

The estimated annual thickness of the layers is relevant to the way some ice cores like the Devon Island core have been dated, but it is *not* an assumption underlying the visual counting of hoar frost/dust, LLS, or ECM methods of counting annual layers; and these are the methods that were used to count the first 110,000 layers of the GISP2 ice core. Contrary to Oard, the expected annual thickness of the layers down the core does *not* determine what uniformitarian scientists conclude with these latter methods. The truth is exactly the opposite: LLS counting is used to correct the initial estimated thickness of the annual layers.[36] Oard's statement that the hoar frost, LLS, and ECM methods of dating the annual layers are dependent upon an assumption as to the thickness of the annual layers, is false and should be retracted.

Oard's second argument is based on his hypothesis that there was only one Ice Age and that the ice sheet during that time (c. 2700 to 2000 BC) would have been lower and temperatures warmer, and this would have produced "more melt or hoar frost layers (cloudy bands) … Therefore, what uniformitarian scientists are claiming as annual variations are simply oscillations that occur *within* a single year."[37]

If the weather was sufficiently warmer in the past to frequently raise the temperature above freezing, then more melt layers would be produced. But, Oard has confused melt layers with hoar frost layers. Any experienced glaciologist will tell you that melt layers are quite different in nature and appearance from hoar frost layers; and thus are easy to spot and discount.[38] Melt layers were not counted as annual layers in the GISP2 core. Furthermore, the annual alternation of hoar frost layers—being abundantly present in the summer snow but not in the winter snow—is due to the fact that the sun

shines in the summer in Greenland but not in the winter. Warmer weather would not change this seasonal alternation and hence would not change hoar frost from being an annual indicator. Oard's confusion of melt-layers with hoar frost layers and his failure to understand that the latter are due to seasonal differences invalidates his second argument.

Oard's third argument is that storms have warm and cold sectors that could produce oscillations on the order of just several days; and he cites glaciologists Grootes and Stuiver to document this fact.

This third reason is false, however, because the warm and cold oscillations of storms are too weak to either cause or disrupt the sharp differences in the ice that the radical differences between the seasons cause. The peaks and valleys of hoar frost, dust, and acidity take months to develop. Individual storms cannot produce them. If individual storms could have produced these differences, they would have shown up throughout the GISP2 ice core over the last 2,000 years and been mistakenly counted as annual. But as Oard admits, the last 2,000 layers are annual and have been accurately counted; so, storms that have obviously occurred many times in the last 2,000 years do not cause or disrupt the annual signals which are being counted. Nor incidentally would more snow each year disrupt the annual signals. In fact, increased yearly snowfall would make the counting even easier.

As for the citation from Grootes and Stuiver, they do say that the $^{18}O/^{16}O$ ratio varies on a timescale of days, but they go on to say that this variability "is not preserved in accumulating snow but is smoothed to yield a distinct seasonal cycle."[39] So Oard's citation is out of context. The variation of $^{18}O/^{16}O$ that occurs in summer storms is consistently within a summer range of values, whereas the variation of the ratio in winter storms is within a contrastingly different range of winter values. The daily variations of $^{18}O/^{16}O$, therefore, do not obscure the clear difference between the summer and winter ratios. And since the $^{18}O/^{16}O$ ratios were only used to date the GISP2 core in the very upper part which Oard admits was accurately counted, Oard's argument from the daily variations of the $^{18}O/^{16}O$ ratio is not only invalid (because the seasonal variation is not obscured by the daily variations), it is irrelevant to the dating of GISP2.

Oard's fourth argument is that snow dunes can occur and add sub-annual layers. This is true, but it is evident from the accuracy of the counting of the first 2,000 years that the sub-annual layers added by snow dunes can normally be distinguished from true annual layers because they have different characteristics.[40] In addition, a weak summer signal can subtract an annual layer. The sum effect of these rare events, therefore, is zero. Consequently, snow dunes do not constitute a logical basis for arguing that radically fewer years have passed than the 110,000 years counted in the GISP2 core. Finally, even if snow dunes had been a hundred times more frequent, they would only confuse the visual counting of the hoar frost layers. The annual layers would still be counted correctly by the LLS and/or the ECM method of counting. In short, sub-annual layers added by snow dunes or storms are rare, usually recognizable, even when not recognized may be offset by weak summer signals, and even if they had been abundant, the other methods of counting annual layers would still uphold the validity of the 110,000 annual layers in the GISP2 core.

Oard's young-earth model is essentially just speculation. It does not have the extensive empirical foundation that underlies the dating of the GISP2 ice core.

Oard's fifth argument is that cold or warm weather patterns can run in cycles as low as a week or as long as a month or even a season; so they could make a problem for estimating the number of annual layers. Perhaps they could, but the *estimation* of the number of annual layers, as noted above, is not relevant to the 110,000 annual layers of the GISP2 core. The estimation was, in fact, corrected by the actual counting of the layers. In addition, the accuracy of the counting of the annual layers in the last 2,000 years of the core shows that this problem is neither insurmountable nor serious enough to serve as a basis for denying the substantial accuracy of the dating of the GISP2 core.

Oard concludes by saying that uniformitarian scientists base their interpretation of the oscillations as annual "on their long-ages model with an ice sheet in equilibrium for several million years" and thus "manage to 'squeak out' 110,000 years of 'annual' cycles by using several parameters." Against this interpretation he sets forth "the creationist young-earth model, including a rapid ice age."[41] Thus Oard would have his readers believe that it is all just a matter of which model one follows. There is a particle of truth in this for some cores other than GISP2 and for the bottom of GISP2 below the 110,000 annual layers; but it is a false and misleading statement with regard to the 110,000 annual layers counted in the upper part of the GISP2 core, which are not dependent upon a model.

In addition, Oard's young-earth model is essentially just speculation. It does not have the extensive empirical foundation that underlies the dating of the GISP2 ice core. As explained and documented above, there is good empirical evidence showing that the light bubbly hoar layers, the heavier dust concentrations, and the greater electrical conductivity of the summer layers are indeed annual, and

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not from storms or sub-annual differences. If they had not been annual, they would not have correlated chronologically with the dates of historically known volcanic eruptions. And there is *no objective evidence* indicating that they changed from being annual to being sub-annual indicators.

The Lost Squadron Argument

In July of 1942, six pursuit planes (P-38's) and two bombers (B-17's) crash-landed on the Greenland ice cap. By 1990 they were found under c. 250 feet of ice and snow, which depth corresponds to c. 250 years of accumulation for the GISP2 ice core. In his 1992 paper, Larry Vardiman mentioned the surprising burial depth of the Lost Squadron planes, but he admitted that their depth of burial could not be simplistically used as evidence that the ice cores are being misdated. Some young-earthers have not been as wise and have argued from the depth of the WWII planes to the rejection of the age of the ice cores.

Carl Wieland wrote a short paper in 1997 arguing on the basis of the depth of the WWII airplanes that the 3,000 meter long GRIP ice core "would only represent some 2000 years of accumulation."[42] Allowing for some compression of lower layers and the greater snowfall for a few centuries after the Flood, he concluded, "There is ample time in the 4,000 or so years since Noah's day for the existing amounts of ice to have built up."

Kent Hovind, who has a four-minute tape on the Internet about ice cores, calculated that the WWII planes were covered at the rate of c. 5½ feet of snow/year. He then said that if you divide that rate into the 10,000 foot ice core, you only get 1,824 years; so "4400 is a really reasonable assumption."[43] Hovind also telephoned Bob Cardin, who was one of the main people who raised one of the planes to the surface and asked him if he had noticed how many layers there were in the ice in the hole made to excavate the plane. Cardin answered off the cuff, "Many hundreds of them." On the basis of this answer, Hovind concluded that the lines in the ice cores are not summer/winter, but warm/cold lines and that thirty of them could be made in a single year.

Two experienced glaciologists informed me that Hovind is largely correct about the "hundreds" of lines in the hole dug to remove the WW2 planes. They both said that the area where the planes landed is a relatively warm area because of its lower, southern elevation, and several melt layers can be formed every year in regions like that which would appear as layers in the hole. Add to these melt layers the actual annual layers, which near the top show up as several lines within the space of a few inches, and you can have an off the cuff estimate of "hundreds of lines." One can understand Hovind's confusion.

But let's make this perfectly clear: The 110,000 layers of the GISP2 ice core are not due to melting. They are *definitely not* melt layers. Even if melting had occurred more often in the past, layers due to melting are readily recognized and would certainly not be counted as annual.[44]

This leaves the question: How could some 250 feet of snow in the area of GISP2 cover a period of c. 250 years while 250 feet of snow in the area of the Lost Squadron planes only covers c. 50 years? In Richard Alley's book, *The Two Mile Time Machine*, he says he is often asked this question. The answer is: "The World War II planes landed in one of the regions of Greenland where snow accumulates fastest."[45] And in answer to the question: Did anyone ever figure out why the Lost Squadron planes were buried so much deeper than expected? Bob Cardin told me that it was because the average snow accumulation in that area is c. 7 feet/year (7 x 50 = 350 feet deep). If you allow for some compression, it is easy to understand how the planes got buried 250 feet deep.

So, the area in which the Lost Squadron landed, which is southern Greenland c. 10 miles from the east coast, with its high rate of snow accumulation (c. 7 feet/year) vs. the area of GISP2 in central Greenland with its comparatively low rate of snow accumulation (1 foot or so/year)[46] is why 250 feet of snow represents just 50 years for the Lost Squadron but around 250 years for the GISP2 ice core.[47] And, of course, as one goes down the core, the snow/ice is compressed more and more so that each foot of ice represents greater and greater lengths of time.

In conclusion we see that creation science has offered little more than speculation as evidence to disprove the validity of the dating of the GISP2 ice core. Opposing this speculation is solid empirical evidence that the layers of hoar frost, dust, and electrical conductivity are seasonal, not from storms, melting, different climate conditions or any other such supposition. Although one of the methods of counting annual layers may fail on rare occasions, the other methods fill in and sustain the accuracy of the counting; and the three methods regularly and repeatedly corroborate each other. In addition, the validity of the dating is established by the fact that there is a dovetailing of the dates of GISP2 with the dates of solar cycles,[48] sea cores, tree rings, volcanic events, and more.[49] The GISP2 ice core thus provides clear, scientific proof that there was no global flood any time in the last 40,000 to 110,000 years. ✯

Acknowledgment

Special thanks to glaciologists Todd Hinkley (at the National Ice Core Laboratory) and Richard Alley for their help in understanding some of the technicalities and to Christopher Sharp for suggesting the topic.

Notes

[1]The quickest overview of GISP2 can be found in Richard B. Alley and Michael Bender, "Greenland Ice Cores: Frozen in Time," *Scientific American* (February 1998): 81–5. A more thorough but still easy to read popular description is found in Richard B. Alley, *The Two Mile Time Machine* (Princeton: Princeton University Press, 2000). Some good photographs of ice cores are in Kendrick Taylor, "Rapid Climate Change," *American Scientist* 87 (July–Aug. 1999): 320–2.

[2]D. A. Meese, et. al., "The Greenland Ice Sheet Project 2 Depth-Age Scale: Methods and Results," *Journal of Geophysical Research* 102 (1997): 26,422; Sigfus J. Johnsen, et. al., "The Eem Stable Isotope Record along the GRIP Ice Core and Its Interpretation," *Quaternary Research* 43 (1995): 119.

[3]Jean Jouzel, "Ice Cores North and South," *Nature* 372 (1994): 612. Down to 103,000 BP they are "almost identical" (Johnsen, et. al., "The Eem Stable Isotope Record," 121).

[4]Cf. below, Vardiman, Oard, Wieland, and Hovind.

[5]Since Adam's Neolithic culture cannot be dated earlier than c. 10,000 BC and Abraham is dated c. 2000 BC, there are 8,000 years at most between the two men. The genealogies of both Gen. 5 and 11 place the Flood in the middle of these 8,000 years, hence roughly c. 6000 BC. Also, the Tower of Babel cannot be dated earlier than c. 3500 BC (Paul H. Seely, "The Date of the Tower of Babel and Some Theological Implications," *Westminster Theological Journal* 63 [2001]: 15–38) and it is probably closer to the Flood than to Abraham (c. 2000 BC), so the Flood is probably not earlier than c. 5000 BC.

[6]Personal communication from Dr. Richard Alley.

[7]Alley, *The Two Mile Time Machine*, 43–4. A layer from melting is easy to spot in the ice core because melted and refrozen ice is nearly bubble free and is glassy looking where the rest of the ice core is bubbly and milky. On the nature of melt layers and the ease with which they are spotted, see R. B. Alley, et. al., "Visual-Stratigraphic Dating of the Greenland Ice Sheet Project 2 Ice Core: Basis, Reproducibility, and Application," *Journal of Geophysics Research* 102 (1997): 26,367–8, Michael M. Herron, Susan L. Herron and Chester C. Langway, Jr., "Climatic Signal of Ice Melt Features in Southern Greenland," *Nature* 293 (1981): 389, and R. B. Alley and S. Anandakrishnan, "Variations in Melt-Layer Frequency in the GISP2 Ice Core: Implications for Holocene Summer Temperatures in Central Greenland," *Annual Glaciology* 21 (1990): 64.

[8]R. B. Alley, E. S. Saltzman, K. M. Cuffey, and J. J. Fitzpatrick, "Summertime Formation of Depth Hoar in Central Greenland," *Geophysics Research Letter* 17 (1990): 2393–6; Alley, *The Two Mile Time Machine*, 44.

[9]A depositional hoar layer, as opposed to a true annual diagenetic hoar layer which forms in the summer, does occasionally form in the winter; but, these winter hoar layers are rare and can be distinguished from the regular summer hoar layers by density, thickness, and shape. See Richard B. Alley, "Concerning the Deposition and Diagenesis of Strata in Polar Firn," *Journal of Glaciology* 34 (1988): 283–90.

[10]Alley, *The Two Mile Time Machine*, 45–7. See the photos in Paul Andrew Mayewski and Frank White, *The Ice Chronicles* (Hanover, NH: University Press of New England, 2002), 74, 75.

[11]Alley, *The Two Mile Time Machine*, 50–1.

[12]W. L. Hamilton and C. C. Langway Jr., "A Correlation of Microparticle Concentrations with Oxygen Isotope Ratios in 700 Year Old Greenland Ice," *Earth Planetary Science Letter* 3 (1967): 363–6; C. C. Langway, Jr., "Stratigraphic Analysis of a Deep Ice Core from Greenland," *Geological Society of America, Special Paper 125* (1970); C. U. Hammer, "Dating Greenland Ice Cores by Microparticle Concentrations," 297–301 and "Dust Studies on Greenland Ice Cores," 365–70, both in *Symposium on Isotopes and Impurities in Snow and Ice* (Proceedings of the Grenoble Sumposium, 1975), *IAHS-AISH Publication No. 118* (1977); T. Risbo, H. B. Clausen and K. L. Rasmussen, "Supernovae and Nitrate in the Greenland Ice Sheet," *Nature* 294 (1981): 637–9; Todd K. Hinkley, "Variation of Rock-Forming Metals in Sub-Annual Increments of Modern Greenland Snow," *Atmospheric Environment* 26A, no. 13 (1992): 2283–93.

[13]M. Ram and M. Illing, "Polar Ice Stratigraphy from Laster-Light Scattering: Scattering from Meltwater," *Journal of Glaciology* 40 (1994): 504–8.

[14]Michael Ram and Gershon Koenig, "Continuous Dust Concentration Profile of Pre-Holocene Ice from the Greenland Ice Sheet Project 2 Ice Core: Dust Stadials, Interstadials, and the Eemian," *Journal of Geophysics Research* 102 (1997): 26,641.

[15]Ram and Koenig, "Continuous Dust Concentration Profile," 26,642.

[16]C. U. Hammer, "Acidity of Polar Ice Cores in Relation to Absolute Dating, Past Volcanism, and Radio-Echos," *Journal of Glaciology* 25 (1980): 359–72; K. Taylor, et. al., "Ice-Core Dating and Chemistry by Direct-Current Electrical Conductivity," *Journal of Glaciology* 38 (1992): 325–32.

[17]M. M. Herron, "Impurity Sources of F^-, Cl^-, NO_3^-, and SO_4^{2-} in Greenland and Antarctic Precipitation," *Journal of Geophysics Research* 87 (1982): 3052–4060; A. Neftel, et. al, "Measurements of a Kind of DC-Conductivity on Cores from Dye 3" in *Greenland Ice Core: Geophysics, Geochemistry, and the Environment*, ed. C. C. Langway Jr., H. Oeschger, and W. Dansgaard (Washington, DC: AGU, 1985), 36–7.

[18]Gonfiantini and E. Picciotto, "Oxygen Isotope Variations in Antarctica Snow Samples," *Nature* 184 (1959): 1557–8; E. Picciotto, X. DeMaere, and I. Friedman, "Isotopic Composition and Temperature of Formation of Antarctica Snows," *Nature* 187 (1960): 857–9; W. Dansgaard, "Stable Isotopes in Precipitation," *Tellus* 16:4 (1964): 436–68; S. Epstein and C. Benson, "Oxygen Isotope Studies," *EOS, Transactions American Geophysical Union* 40 (1959): 81–4.

[19]S. J. Johnsen, "Stable Isotope Homogenization of Polar Firn and Ice," *Symposium on Isotope and Impurities in Snow and Ice* (Proceedings of the Grenoble Symposium, 1975), *IAHS–AISH Publication No. 118* (1977): 216.

[20]Claus U. Hammer, Henrik B. Clausen and Henrik Tauber, "Ice-Core Dating of the Pleistocene/Holocene Boundary Applied to a Calibration of the ^{14}C Time Scale," *Radiocarbon* 28:2A (1986): 284–91.

[21]Neftel mentions the correlation of ECM with $d^{18}O$ (Neftel, et. al., "Measurements of a Kind of DC-Conductivity," 36; Epstein and Sharp, "Oxygen isotope Studies," 8); P. M. Grootes, et. al., "Com-

parison of Oxygen Isotope Records from the GISP2 and GRIP Greenland Ice Cores," *Nature* 366 (1993): 552–4.

[22]Cf. Ram and Koenig, "Continuous Dust Concentration Profile," 26,641 and P. A. Mayewski, et. al., "Record Drilling Depth Struck in Greenland," *EOS, Transactions, American Geophysical Union* 75:10 (1994): 114.

[23]D. A. Meese, et. al., "The Greenland Ice Sheet Project 2," 26,411; cf. R. B. Alley, et. al., "Visual-Stratigraphic Dating of the Greenland Ice Sheet Project 2 Ice Core," 26,367 and Ram and Koenig, "Continuous Dust Concentration Profile," 26,641.

[24]D. A. Meese, et. al., "The Greenland Ice Sheet Project 2," 26,414.

[25]Ram and Illing, "Polar Ice-Stratigraphy," 504.

[26]Although dealing with the earlier Camp Century ice core, the relevant paper is M. G. L. Baillie and M. A. R. Munro, "Irish Tree Rings, Santorini and Volcanic Dust Veils," *Nature* 332 (1988): 344–6.

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[28]Alley, et. al., "Visual Stratigraphic Dating," 26,375 (chart), 26,378.

[29]Alley, *The Two Mile Time Machine*, 57; Meese, et. al., "The Greenland and Ice Sheet Project 2," 26,420, 26,422.

[30]Larry Vardiman, *Ice Cores and the Age of the Earth* (San Diego: Institute for Creation Research, 1993).

[31]Larry Vardiman, "An Analytic Young-Earth Model of Ice Sheet Formation during the Ice Age" in *Proceedings of the Third International Conference on Creationism,* ed. Robert E. Walsh (Pittsburgh, PA: Creation Science Fellowship, 1994), 561–79.

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[33]Larry Vardiman, "Rapid Changes in Oxygen Isotope Content of Ice Cores Caused by Fractionation and Trajectory Dispersion near the Edge of an Ice Shelf," *Creation Ex Nihilo Technical Journal* 11:1 (1997): 52–60; also at www.icr.org/pubs/imp/imp-226.htm

[34]Micael J. Oard, "Do Greenland Ice Cores Show Over One Hundred Thousand Years of Annual Layers?" *Creation Ex Nihilo Technical Journal* 15:3 (2001): 39–42, also at www.answersingenesis.org/docs2001/0704icecores.asp

[35]Oard, "Do Greenland ice cores," 41.

[36]D. A. Meese, et. al., "The Greenland Ice Sheet Project 2," 26,422; Cf. Kendrick Taylor, "Rapid Climate Change," *American Scientist* 87 (1999): 320.

[37]Oard, "Do Greenland ice cores," 42.

[38]See note 7.

[39]P. M. Grootes and M. Stuiver, "Oxygen 18/16 Variability in Greenland Snow and Ice with 10^{-3} to 10^{5}-Year Time Resolution," *Journal of Geophysical Research* 102 (1997): 26,457.

[40]Note 9.

[41]Oard, "Do Greenland ice cores," 42.

[42]Carl Wieland, "The Lost Squadron," *Creation Ex Nihilo* 19:3 (1997): 10–4; also at www.answersingenesis.org/docs/233.asp

[43]*Creation Seminar Online, Part 1, The Age of the Earth*, Seminar 1B O. www.drdino.com/SeminarOnline/Audio/Part1/index.jsp

[44]Note 7.

[45]Alley, *The Two Mile Time Machine*, 33.

[46]Average annual snow accumulation at Summit for the last 100 years is .24 ± 0.05 m; and over the last 75 years just .21 m (D. A. Meese, et. al., "The Accumulation Record from the GISP2 Core as an Indicator of Climate Change throughout the Holocene," *Science* 266 [1994]: 1681–2)

[47]59 meters of ice (c. 195 feet) at Summit = AD 1816, which is 176 years, and 67.6 meters (c. 223 feet) = AD 1783, which is 209 years (S. J. Johnsen, et. al., "Irregular Glacial Interstadials Recorded in a New Greenland Ice Core," *Nature* 359 [24 Sept. 1992]: 312.)

[48]G. Wagner, et. al., "Presence of the Solar de Vries Cycle (~205 years) During the Last Ice Age," *Geophysical Research Letters* 28:2 (2001): 303–6.

[49]Around 11,500 BP in particular, there is a host of indicators from varying disciplines operating from different starting points (glaciology, oceanography, palynology, volcanology, dendrochronology) which all dovetail with the evidence from GISP2 that there was an abrupt radical change in climate at that time.

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1. Publication Title	2. Publication Number	3. Filing Date
Perspectives On Science and Christian Faith	0 8 9 2 - 2 6 7 5	10/14/03
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	$35

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4)
PO Box 668
Ipswich, Essex County, MA 01938-0668
Contact Person: Laurie Grover
Telephone: 978-356-5656

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer)
American Scientific Affiliation
PO Box 668
Ipswich MA 01938-0668

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