

THE EVIDENCE FOR ONLY ONE ICE AGE

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ABSTRACT

Evolutionists believe in many Late Cenozoic ice ages, each lasting a long time. Previously, I showed that one ice age can occur very rapidly. Generally accepted evidence from history, climate simulations, paleontology, and the till deposits themselves indicate that one ice age is much more probable than many.

INTRODUCTION

Radiometric dating methods are not the only phenomenon that challenge the short time scale of Scripture. Many geophysical processes appear to need much more time than Scripture allows. One of these processes is the ice age.

Evolutionists believe that one Pleistocene ice age cycle or glacial/interglacial oscillation lasts 100,000 years, and that many such cycles repeated in succession during the Late Cenozoic Era of geological time. Ice ages are also claimed for other periods of geological time. These pre-Pleistocene ice ages are represented by rock layers within a sedimentary sequence that appear similar to lithified glacial till. However these till-like layers could just as well if not better be explained as the product of gigantic submarine mass flow during the Flood (as discussed by Mats Molen in this volume). The focus of this article will be on Late Cenozoic ice ages.

At the First International Conference on Creationism I discussed how one ice age can occur quickly - if different initial conditions are substituted for the uniformitarian principle (1). The initial conditions are extensive Flood and post-Flood volcanism that caused cooler summers, and a universally warm ocean which provided the copious moisture needed for an ice age. These conditions were triggered by the Genesis Flood. The duration of the ice age depends primarily upon the cooling time of the warm ocean. A reasonable estimate for the length of the ice age, based on the heat budgets of the ocean and atmosphere applied to post-Flood climatology, was about 600 years. Even using minimum and maximum estimates for the most important variables in the equations still resulted in a very short time. The amount of snow and ice during a post-Flood rapid ice age was estimated to be a little less than one-half uniformitarian estimates. The article ended with a brief summary of evidence for one Pleistocene ice age. In the present article I will expand this evidence. A detailed model of the ice age has been developed (2) and will be used as a backdrop for explaining several glacial features.

BRIEF HISTORICAL ANALYSIS

Before discussing the evidence for one ice age, I shall present a brief historical analysis of the multiple glaciation hypothesis. I believe the past is the key to the present in regard to this concept.

After the glacial theory as an explanation for the surface "drift" became popular in the mid 1800s, investigators at first believed in only one ice age. But because the glacial debris is complex and because multiple till layers are separated by non-glacial deposits in some areas, glacial geologists postulated multiple ice ages. Debate over the exact number ensued for many years, with those scientists who favored the astronomical theory preferring a large number of glaciations (3).

In the early twentieth century Albrecht Penck and Eduard Bruckner established what they thought was a method for determining the number of glaciations. By connecting gravel terraces along rivers in the northern foothills of the Alps upstream to end moraines, three glaciations were first proposed, but later four ice ages were claimed (4). Their method became known as

the alpine model and was so influential that all data, worldwide was accommodated to it for the next sixty years. The four-ice-age model is now considered false and many reasons can be adduced to show why it is wrong.

The number of Late Cenozoic glaciations is now believed to range from fifteen to thirty, based on oxygen isotopes from foraminifera shells in deep-sea cores. There are a host of assumptions, problems, and unknowns associated with the interpretation of these cores (5-7). The connection to ice ages is inherently indirect and will not be discussed further. This article will focus on continental deposits, which in spite of glacial erosion, possess direct indications of the number of ice ages.

THE REINFORCEMENT SYNDROME

The alpine model teaches us a valuable lesson in self deception. Numerous research studies all "agreed," and the four-ice-age model was "confirmed" as the truth to laymen and scientists alike. This is an example of the reinforcement syndrome. Watkins states (8):

Perhaps, the best known, or at least most significant, result of the "reinforcement syndrome" in the geological sciences is the very firmly established concept of four glacial periods during the last Ice Age. The initially defined system was confirmed by many different studies (quote his).

Verosub writes how the reinforcement syndrome works with the example of paleomagnetic excursions (9):

The importance of the "reinforcement syndrome"...should not be underestimated. The initial report of a paleomagnetic excursion will encourage other workers to reexamine previously unexplained or disregarded "curious" results and to reinterpret sedimentation rates so that the anomalous behavior seen by them is contemporaneous with the paleomagnetic excursion. Subsequent work will also focus on sediments of the same age. Reported excursions will then tend to cluster around a single date, whereas negative results showing no anomalous behavior will tend to remain unpublished because they are "not interesting." Thus the initial reports exert considerable leverage on the direction of future research (quotes his).

Paleomagnetic excursions and the four-ice-age model are not the only concepts established by the reinforcement syndrome. It is "...an inherent weakness involved in experimental approaches and publication" (10). The reinforcement syndrome is a cancer in historical sciences. I believe the reinforcement syndrome is the reason why the geological column is "supported" by radioactive dating, and why many geological processes "agree" with each other.

The current belief in fifteen to thirty ice ages is basically a product of a reinforcement syndrome assuming the truth of the astronomical theory of the ice age. Continental deposits do not show anywhere near the number of ice ages deduced from the ocean sediments. In view of the reinforcement syndrome and the historical debate over the number of ice ages, I conclude that the number of glaciations is still an open question.

THE EVIDENCE FOR ONE ICE AGE

The evidence presented in this section will mostly be large-scale or general. Most glacial geologists would agree with the observational data. Small-scale data will be used sparingly because local data is usually complex and difficult to interpret within any framework. For example, a classical area for studying multiple glacial advances is the Scarborough Bluffs on the north shore of Lake Ontario near Toronto, Canada. Previous interpretation had divided three vertical lithologic units on the face of the cliff into three separate glacial advances. A more recent investigation placed the boundaries of lithological units at different heights on the bluffs because the lithological breaks pinched out or merged in the subsurface north of the cliffs (11). Moreover the sediments likely were not brought directly into place by an ice sheet at all but were deposited in a large lake by a floating ice shelf. If experts cannot agree whether a local succession was deposited directly below a glacier or dropped from an ice shelf in a large lake, glacial geology is in real trouble. I will avoid disputes of this nature by sticking mainly with large-scale data.

Perhaps the strongest evidence against ice ages repeating every 100,000 years is the uniformitarian principle itself. Williams showed, based on a reasonable climate simulation of the energy balance over a snow cover, that a summer temperature drop of at least 10 to 12 deg. C. with double the winter snowfall was required just to develop a perennial snow cover in northeast Canada (12). Presumably an ice age in northeast Canada could develop from this snow cover, although the atmosphere would tend to become drier than at present due to the colder air. If one ice age is this difficult to account for, what are the odds against two, three, or thirty ice ages in regular succession? Williams' experiment indicates a catastrophic mechanism is more likely for starting any ice age.

Ice age sediments, generally called till, also pose strong evidence against multiple ice ages. In the standard explanation for glaciation, each ice sheet developed in the far north and moved southward to the mid latitudes. During each advance the ice sheet picks up debris at its base and transports this debris farther and farther south. Thus we would expect to find a large amount of glacial till that has been transported long distances from the north. Is this what we observe? Other than a small number of "far-traveled" erratics, practically all the till is derived locally. Many investigators have commented on this observation. Feininger states (13):

Earlier in this report, the nearness of most glacial boulders to their source was cited as evidence that glacial transport is generally short. Even stronger evidence to support this view can be read from the tills themselves. Where the direction of movement carried a continental ice sheet from one terrain to another of markedly different rock type, the tills derived from each terrain are predominantly restricted to the area of their corresponding source rocks.

The local nature of most till is not what one expects even for one uniformitarian glacial/interglacial cycle. The claimed far-traveled erratics are rather enigmatic in view of the local nature of the remainder of the till and their occasional large size and angularity. The source for many erratics is unknown and may be buried nearby underneath till. Many erratics could have been transported long distances by icebergs. These icebergs could have traveled across large marine bays or extensive proglacial lakes, or been carried down large rivers swollen by meltwater. Regardless, the preponderance of the till favors one relatively thin ice sheet that did not move far. The ice sheet probably grew in situ and melted after a relatively short time.

One ice age is favored by the observation that practically all the till was deposited during the last advance of the last ice age (14). Glacial geologists commonly appeal to massive erosion and reworking by each successive ice sheet to explain this observation. Eroded and reworked till should at least be deposited at the periphery of the ice sheet. A great volume of till showing evidence of long distance transport should have accumulated at the periphery. However, there is little evidence of long distance transport or a huge thickness of till. A straightforward reading of the observed deposits, without resorting to additional hypotheses, better indicates the main volume of till is the result of just one ice age.

The character of glacial till observed in interior regions, like Canada and Scandinavia, points towards one ice age. Each successive ice sheet is believed to have built up to three thousand meters high in these areas. Thick deposits of till should be left over from the motion and melting of just the last thick ice sheet. The opposite is observed. The till is only two to ten meters thick on the average, and is found mainly in depressions and consists partly of stream and lake deposits (15). The till deposits seem too thin for all the postulated glacial activity. Furthermore the till is coarse grained, suggesting little transport and reworking.

A possible explanation for the above observation is that each successive ice sheet transported glacial debris from the Canadian shield to the periphery. If this was the case fifteen to thirty ice sheets should have deeply eroded the Canadian shield. However, the crystalline bedrock of Canada is still of moderate relief, and the relief is the same even under a cover of sedimentary rocks. Flint adds further (16):

Local evidence of slight depth of glacial erosion has been reported from many different districts...Indeed, the detailed adjustment of drainage to lithology, long antedating the glaciation and yet not destroyed by that event, is a feature that characterizes wide areas of the Canadian Shield.

Little erosion is also observed over Scandinavia. Eyles tries to explain this observation (17): The absence of a thick drift cover on shield areas is not the result of enhanced glacial erosion as has been previously thought but rather is due to ineffective glacial deposition and the predominance of areal scouring rather than selective linear erosion...

In other words the thin till cover is due to both ineffective erosion and deposition. However ice sheet motion during development and melting throughout several million years should have considerably planed down the relief by now. Ineffective erosion and deposition and a thin till cover more directly support one thin short-lived ice sheet that probably was frozen to its bed and moved little.

Next we turn to the periphery where most of the till from the many postulated ice ages is supposed to collect. Even here the evidence better supports only one ice age. The average thickness of till at the periphery is not over thirty meters (18), and a significant proportion of this till is glaciofluvial and glaciolacustrine. Given the likelihood that the ice sheets incorporated unconsolidated pre-glacial surface deposits (19), the actual thickness of eroded bedrock is rather thin for all the purported ice ages.

How much time is required to deposit thirty meters of till? Under the right circumstances till can be eroded and deposited rapidly. Glacial erosion is enhanced if the glacier is warm-based, moves rapidly, is subject to surges, and the bedrock is soft. A wet-based glacier in the Alps moving at 250 meters/year has been observed to erode at a rate of about 36 millimeters/year (20). Assuming this constant erosion rate the glacier would erode thirty meters of rock in only 833 years. A glacier in Spitsbergen deposited a pile of till thirty meters high in only ten years (21). The ancient ice sheets over North America and Europe are now believed to have been relatively thin, moved rapidly over soft bedrock, and surged at the periphery (22,23). Thus thirty meters of till at the periphery is more in accord with one ice age and not multiple ice ages.

The direct evidence supporting multiple glaciation separated by interglacials comes from the periphery. This evidence consists mainly of soils and organic remains sandwiched between layers of till. Actually this evidence is rare: "Within the glaciated territory, interglacial horizons are rarely more than fragmentary" (24). The four-ice-age framework from the north central United States was based on soils overlying till. Since two soils are rarely found in a vertical sequence, the model was pieced together from different regions or type sites. It is now considered erroneous by most glacial geologists. Many problems are inherent in the interpretation of ice age soils, such as the recognition of a buried soil from a sediment layer that has undergone diagenesis, the general lack of the diagnostic A-horizon, and the likely formation of the typical clay soil of the ice age due to poor drainage or a high water table (25,26). So the physical evidence for interglacials from the glaciated territory that supports the multiple glaciation hypothesis is equivocal. The rare evidence for "interglacials" within glaciated terrain can be explained by one mild ice age that retreated, advanced, and surged at the periphery, similar to modern glaciers but on a larger scale.

Indirect evidence for multiple glaciation is postulated from the strongly eroded till south of the "last" glacial boundary in the north central United States, and alternating loess/soil layers south of the glaciated area in eastern Europe and China. However this indirect evidence can be explained with a post-Flood model if the ice sheet developed in situ in the north central United States at the beginning of the ice age. After a little climatic amelioration due to less volcanism, the ice sheet would melt back to a more stable position in the northern United States. Heavy precipitation on fresh glacial sediments would cause rapid erosion and an "old" appearance in a short time. The loess/soil alternations in eastern Europe and China could occur quickly at the end of a post-Flood ice age due to "dry" windy storms that would characterize this period. A classic area for a loess/soil stratigraphy is presented by Kukla along the west bank of the Svratka River in Czechoslovakia (27). About nine loess/soil cycles within various abandoned river terrace depressions putatively represent about one million years. The main basis for this length of time is simple curve matching to the oxygen isotope record in deep-sea cores. The depth of the sequence varies from ten to thirty meters. As discussed below, loess can be deposited rapidly in depressions. Ten to thirty meters can be deposited in a short time. The deposits along the west bank of the Svratka River show evidence of deposition by periodic strong winds, as indicated by frequent sandy interlayers and wind-moved rock fragments along the slopes. During periods of nondeposition, a soil (if they really are soils) could develop rapidly, especially in view of the fact modern soil formation rates are not known (28).

One final indication from the till for just one ice age can be garnered. At the periphery of the ancient glaciated area two relatively flat areas were not glaciated at all. These are the driftless areas in southwest Wisconsin (including small portions of southeast Minnesota and northeast Iowa) and a portion of the plains in northeast Montana (including a small section of south central Saskatchewan). These driftless areas should have been covered at least once by a thick ice sheet descending out of Canada. Driftless areas offer strong evidence for one thin ice sheet that missed a few areas along the periphery. How could many thick ice sheets all miss these areas, if indeed there were many thick ice sheets?

In addition to the till most loess (wind blown dust) was deposited during the later part of the last glaciation, at least in North America (29). Loess especially accumulated close to its source, in depressions, and against or in the lee side of wind breaks. Thus the thickness of loess is variable. In the central United States loess thickness occasionally exceeds sixty meters in favorable locations, but in general twenty to thirty meters is more typical (30). This much loess can be deposited quickly. During the dust bowl years in the midwestern United States, sand and dust storms rapidly covered fences and partially buried farms (31). During one storm that lasted two weeks, two meters of dust accumulated in places in southeast Colorado. The fact that cross bedding and fossils of large animals are sometimes found in loess is a strong indication of its rapid deposition at times (32). The missing loess from previous ice ages is usually explained by erosion. However, this does not make much sense since investigators cannot appeal to erosion and reworking by an ice sheet, and a soil cover would protect loess from erosion. Most of the loess from the last glaciation still remains, right before the next ice age is suppose to begin according to the astronomical theory of the ice age (unless of course the greenhouse effect takes over). Therefore, the observation that most of the loess,

especially from the central United States, was deposited at the end of the last glaciation and that loess can be deposited rapidly better supports one ice age.

Next we turn from the character of the till and loess to the paleontology of the ice age. Lack of evolutionary change in the plants and animals during each supposed glacial/interglacial oscillation better supports one ice age. Although the radical climatic changes should have provided abundant opportunities for evolutionary change, Flint states (33):

Nevertheless, in Quaternary strata correlation by means of fossils encounters special difficulties. Rates of change of Quaternary environments were generally more rapid than rates of evolution in Quaternary organisms. The same faunas may appear repeatedly in successive strata, and their transgression of time is commonly evident.

Bowen adds with respect to the ice age flora: "The fact is that similar constellations of species were repeated several times in the Pleistocene, though not perhaps in the same relative abundance" (34). In other words, few fossil criteria are available to distinguish between each particular putative interglacial.

Another characteristic of the ice age plants and animals is that they are nearly all found in nonglaciated areas. Animals and plants would have repopulated glaciated areas after each ice sheet melted. The musk ox and reindeer would surely migrate back to the northland after the ice melted. We would expect to find some of their remains fossilized in protective hollows. However their near absence even along the periphery as well as from the interior is indeed mysterious within the multiple glaciation framework. The claim that the plants and animals simply did not become fossilized during each interglacial is hollow since the numerous fossils found in Alaska are attributed to an interglacial period (35).

A final paleontological argument in support of a single ice age is that nearly all of the regional and worldwide extinctions of large animals occurred after the last glaciation (36). Each ice age would have highly stressed the animals. How could they survive intact for fifteen to thirty ice ages over several million years, and then go extinct only after the last? Although scientists have been working on this puzzle for a long time, the evidence is more consistent with just one "mild" ice age which turned colder at the end.

A thick flow of ice would reduce irregularities in the landscape. But on Flowerpot Island in northern Lake Huron two rock pillars thirty and fifty feet high stand above the terrain along the eastern shore of the island (37). These pillars and other pinnacles in the area would have been planed down by even one thick ice sheet. This evidence suggests the ice sheet in this area was thin and moved very slow. One short ice age better fits this feature.

Ireland has an amazing record of ice age mammals - amazing from the point of view of the multiple glaciation hypothesis. The only record of ice age mammals comes from the very end of the last ice age (38,39). The giant deer or so-called Irish elk outnumbers all the other mammals, which includes only a few other species such as the mammoth, reindeer, and brown bear. Where is the record of previous glacials and interglacials in Ireland? Sutcliffe states the problem well (40):

If Ireland was indeed previously uninhabited by mammals, then we are faced with the incredible prospect of a vast tract of land with ample rainfall and a luxuriant vegetation flourishing during the Last Interglacial (the Ipswichian of the British mainland, 120000 years ago) yet without any mammalian fauna to consume it; whilst a short distance away great herds of hippopotamus and other mammals competed for food.

Erosion of fossiliferous deposits from previous glacial or interglacial periods cannot be invoked since some of the fossils are found in caves. The Irish Sea would not have been a barrier for mammal migration to Ireland because the Irish Sea is shallow and England and Scotland are in close proximity. A passageway to Ireland would have been opened during each successive ice age if sea level lowered only forty-five meters below present sea level (41). The fact that animals arrived late in the last ice age indicates that they should have been able to make the crossing during other ice ages - if indeed there were any other ice ages.

SUMMARY

Table I summarizes the evidence for one ice age. Most of this evidence is directly from the glacial deposits themselves, so no further assumptions relating them to the ice age are required. The record from deep-sea cores needs many assumptions in order to connect the ocean sediments to glaciation. A straightforward reading of the evidence in Table I from the actual glacial deposits themselves better supports only one ice age.

TABLE I
Summary of evidence supporting a single post-Flood ice age

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- 1) One ice age meteorologically difficult
 - 2) Most till local
 - 3) Most till from the "last" ice age
 - 4) Interior till thin and coarse grained
 - 5) Bedrock eroded little interior areas
 - 6) Periphery till not that thick
 - 7) Driftless areas within the periphery
 - 8) Most loess U.S. from the "last" ice age
 - 9) Little change in ice age plants and animals
 - 10) Fossils rare in glaciated regions
 - 11) Most extinction after the "last" ice age
 - 12) Local survival of delicate landforms
 - 13) Irish mammals only from end of "last" ice age
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DISCUSSION

Mr. Oard continues to excel in research on late Cenozoic glaciation. This paper provides detail not addressed in previous papers. It is an excellent summary of evidences supporting a single post-Flood ice age. Because of the abundance of Pleistocene strata and importance to creationist theory, further research is in order.

Steven Austin, Ph.D.
El Cajon, California

Mr. Oard has presented a commendable brief review of the physical evidence that calls for explanation as a consequence of continental glaciation. The twelve categories of evidence he cites from till, loess, erosion, and fossils within glaciated areas strongly call for explanation on the basis of only one glaciation. Combined with consideration of the severe unlikelihood of the meteorological conditions necessary for continental glaciation, this evidence forcibly constrains to a postulation of only one ice age, only one glaciation. The prevailing presumption of three ice ages over phanerozoic time is accordingly seen to be held because it meets the requirements of a speculative view concerning Earth history, and not as a logical consequence of the available directly-related evidence.

The data in the book of Genesis specifies an event (the Flood and its aftermath) which can be expected to provide meteorological conditions necessary for continental glaciation. In other publications which he cites Oard has shown that adequate time for one, but only one, continental glaciation cycle is provided by the chronological data in the Old Testament.

Robert H. Brown, Ph.D.
Loma Linda, California

Mr. Oard's model for a quick ice age is very interesting and probably the first and only that can explain an ice age. The evidences given for one ice age are compelling, but I believe that in such a catastrophic model the back and forth movement of large glaciers would give the appearance that there had been many ice ages.

The existence of wind-polished stones and bedrock below the Pleistocene till (Hillefors 1969, Rapp et al 1984) and peat between layers of till means that one would require sufficient time to get the peat growing and the bedrock polished. In northern Sweden, near the center of the glaciated areas, there are post-flood fossils and peat below the first till layer. Also, scientists have found hundreds of places, where the center of glaciation is thought to contain peat overlain with deformation till (Lagerback & Robertsson 1988).

The stone pillars (called "rauks") next to the Great Lakes might have been formed after the ice age by erosion from waves and lake ice. At least that is how similar stone pillars have been formed on the island of Gotland in Sweden.

Therefore, there needs to be some time for formation of peat deposits and other structures after the flood and before the ice age.

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Mats Molén, B.S., B.S.
Holmsund, Sweden

I am thankful that Mr. Oard is again addressing the Glacial Epoch, and that his observations and conclusions are of only one ice age. My observations agree with his. I, too, conclude that one ice age (with surges) adequately explains the data. I am also glad that he proposes that a catastrophic mechanism initiated the Glacial Epoch, i.e., the Flood. It would serve us well if Mr. Oard would elaborate on the causes and dynamics of the peripheral surges. Let me begin by proposing the following outline: As the continental ice sheets grew, the ice-source regions did not remain in the original locations, but the ice-source regions followed the terminal ice. Two factors apply:

- 1) Air beyond the terminal ice would be dry.
- 2) The advance of the glaciers could only be sustained by gravity gradients local to the terminal glaciers.

Therefore the sources and dynamics of the glaciers would reside in the terminal ice. And the atmospheric-ice interplay would produce periodic expansions and contractions of terminal glaciers.

Mr. Oard's comments concerning the peripheral surges would, I believe, also help address the major problem of varves, e.g., Antevs; 4300 varves along the Connecticut River Valley.

David P. Nelson, B.S.
Santa Barbara, California

I believe Mr. Oard has done an admirable job of arguing for a single ice age based on continental deposits. However, I would encourage him to address the same issue relative to deep-sea and ice cores in future work. Regarding this paper I have four questions:

- 1) How much does Mr. Oard believe the surging of the ice sheets contributes to the standard interpretation of multiple ice ages?
- 2) Does he have evidence that "dry" windy storms characterized the end of the post-flood ice age other than loess/soil alterations in eastern Europe and China?
- 3) I do not understand the author's reference to the greenhouse effect at the bottom of page 4. What does the greenhouse effect have to do with the removal of wind blown dust?
- 4) I assume Mr. Oard meant to say in Table I, that multiple ice ages are meteorologically difficult. Would he agree that we are in no immediate danger of entering a new ice age?

Larry Vardiman, Ph.D.
El Cajon, California

CLOSURE

I thank all those who commented on my article, and I hope my work is an encouragement to many.

From Mr. Mats Molén's comments, I may have to delete the stone pillars on Flowerpot Island as evidence for one ice age, since similar structures exist on the island of Gotland in the Baltic Sea. The pillars may have been formed by the vagaries of lake shore erosion, although I do not understand how this could happen. Still, there is the possibility that the pillars on Gotland, in the middle of the southern Baltic Sea, survived one thin ice sheet of short duration. I would like to know if stone pillars exist along shorelines elsewhere within glaciated terrain. Other structures of sharp relief may still be evidence of one ice age, for instance the Niagara escarpment around the Great Lakes.

Further understanding of the details in my model may answer Mr. Molén's other comments. In my article, I stuck to mostly large-scale evidence because I knew that local areas can present complications that are difficult for even uniformitarian scientists to explain. Overall, there is very little fossil flora or fauna in surficial sediments from previously glaciated areas, especially interior areas. Nevertheless, I will attempt to explain the fossils and wind-polished stones (if that is what they are) that are found in Sweden.

There are at least three possible explanations. First, the fossils could have been left on or near the surface after the Genesis Flood. Second, glaciation in northwest Europe would have developed slower than over northeastern North America because of the onshore flow of air heated by the warm water of the sea (1). Snow and ice caps would develop first in the mountains of Scandinavia, coalesce, and gradually spread out into the lowlands. Due to the proximity of the warm ocean water, plants that could not tolerate the present climate likely would grow for awhile in the lowlands. Possibly, woolly mammoths could migrate up into the lowlands of Sweden and the deep mountain valleys of Norway before those areas glaciated. Plants and many animals would eventually be inundated by the growing ice sheet. Wind-polished stones could have formed during this pre-glacial period. Third, the fossils could be post-ice age. Since I have shown the ice sheets would melt rapidly, cold-tolerant plants may gain an early foothold. Woolly mammoths likely still survived awhile during deglaciation and could have migrated into Scandinavia. Any fossils found between till could result from entrapment by an oscillating ice

margin, or by burial in flow till or mudflows after melting.

The third possibility very likely explains the data of Lagerbäck and Robertsson (2), who are bent on fitting data into the astronomical theory of multiple ice ages, which claims three stadials (ice age peaks) during the last ice age. In their article, they claim that organic debris in kettle holes, associated with fresh, sharp-crested eskers, formed during an interstadial after the first stadal. The delicate landforms subsequently survived the second and third stadials! The evidence more directly shows the organic debris followed immediately after total deglaciation of the area.

I believe Mr. David Nelson's idea on the dynamics of the ice sheet is correct, at least for North America. The greatest buildup of ice would occur along the southern and eastern periphery. Variable inputs of volcanic dust would fuel marginal oscillations. These oscillations would be rapid because: 1) volcanic dust in the ice and mild temperature greatly increase ice deformation, 2) basal water causes greater slip, 3) a steep terminal slope of the ice sheet, and 4) a soft moist bedrock (3). Surges should be common and would be partly responsible for multiple till sheets separated by glaciofluvial sand and gravel, interpreted as multiple ice ages by uniformitarian geologists.

I do not believe that peripheral oscillations explain the varves in the Connecticut River Valley, or in Scandinavia for that matter. From my calculations, the periphery of the ice sheet melts within one hundred years. This is, of course, contrary to the varve chronology from the above areas. However, these chronologies are built on a number of assumptions. Two assumptions will be discussed.

The first assumption is that the varves are annual. Varves are complex and variable and can be duplicated by turbidity currents, interflows, and overflows. A large number of rhythmites form each year in brackish estuaries that drain glaciers. (4,5).

The second assumption is that short varve sections can be correlated by curve matching northward up the ancient lake bed. This is why Antevs claims the ice sheet took 4,300 years to melt up the Connecticut Valley. I do not believe this procedure can be justified. One of the main reasons is that Antevs believed the varves were formed from south-flowing currents due to draining of a slowly melting ice sheet. However, most of the sediment input to this thin, 400 km long lake came from the east and west by normal river sedimentation. How can varves then be correlated northward up the river valley? Ashley (6), a recent investigator, states: "In my opinion, the method of visually matching curves drawn from varve tapes, which was so successful in Sweden, is unreliable for the Connecticut Valley." The Swedish varves are another story with special problems and assumptions.

In reference to Dr. Vardiman's comments, there is other evidence, besides loess, of generally dry, windy storms as the ice sheets melted. The mere presence of ice sheets and greater sea ice would meteorologically result in a colder, drier climate at the mid and high latitudes of the Northern Hemisphere. The temperature contrast from the ice sheets to the tropics, which determines strong strength, would be greater than at present. The Nebraska sand hills provides further geological evidence for dry, windy storms.

Any ice age is meteorologically difficult. Special conditions are required that were fulfilled once by the unique climatic consequences of the Genesis Flood. We can rest assured that the next ice age is not due next winter or soon thereafter, according to the astronomical theory of the ice ages. Besides, the greenhouse effect, if real, will halt it (mostly an attempt at humor).

In reference to Dr. Vardiman's comments, I am working on ice cores and deep-sea cores. With respect to Dr. Brown's reference to Phanerozoic ice ages, I am now finishing up a monograph on supposed pre-Pleistocene ice ages.

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