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The Ice Age—It Really was Short

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Abstract

The Ice Age and its ending have been dated based on uniformitarian thinking with ^{14}C, dendrochronology, varves and many tens of other dating methods. These dating methods have been correlated to each other, and basically have been fitted to the uniformitarian interpretation of the geological column.

The methods, which are stated to be more important, have been more carefully studied. These methods are sometimes even labeled "absolute," and are the main methods for correlation and especially dating of the last stages of the Ice Age. Fieldwork on Swedish laminated clays called (yearly) varves show climbing ripples and water escape structures, hence showing that the "varves" cannot be yearly but must instead sometimes even have been catastrophically deposited. Also, the "absolute" correlation of ^{14}C dates and dendrochronology has been shown to be faulty, and fits a short biblical chronology very well.

Glacigenic erosional and depositional landforms, for example, extent and stratigraphy of tills, moraine forms, depth of glacial erosion, and glaciofluvial sediments, all indicate one single short Ice Age.

Keywords

Ice Age, Ice Age dating, ^{14}C dating, Varve, De Geer, Dendrochronology, Radiocarbon

Introduction

Many people wonder how the Ice Age fits into a biblical framework. Is it possible that one Ice Age (or maybe many ice ages), with its different stades and the great depth and extent of the glaciers, and also the dates put forward for all this (hundreds of thousands to millions of years), can be harmonized with the Bible?

It is absolutely clear, as shown by a multitude of geological evidences, that there has been a Quaternary (in this case—post-Flood) Ice Age. The meteorological and correlational aspects of ice ages (that is, different stades of one or many Quaternary glaciations) show that the uniformitarian theories will not work, but only a catastrophic model with a fluctuating glacier border (Molén, 2000; Oard, 1990a, 1990b, 1990c). The same holds for pre-Quaternary "glaciations," that is, pre-Quaternary diamictites and accompanied depositional and erosional structures have actually been formed by gravity flows and other geological processes, but *not* by glaciations (Molén, 1990a, 1990b, 1992, 2000; Oard 1990a, 1997a). These geological data perfectly fit in with a biblical short time scale and a single post-Flood Ice Age.

The present paper mainly is concerned with the absolute dating of the end of the Quaternary ice age, and the geological evidence for glaciation. Do they better fit a short, biblical, or a long, uniformitarian, timescale?

Ice Age Dating

There are hundreds of different dating methods, not only those relevant to the Ice Age but to many phenomena in the universe. But most of these dating methods are relative, that is, they are correlated with the timescale that is already present (for example, dating with microfossils, oxygen isotopes or magnetic field changes; Mahaney, 1984). So, if the timescale is changed, the dates resulting from all these dating methods also change (for example, Mahaney, 1984). Originally, the Ice Age was dated in such a way that it would fit in with the theory of evolution and the philosophy of uniformitarianism. The Ice Age "must" have lasted a long time since major changes had occurred both geologically and biologically (Lyell, 1872; Penck, 1908). The dating methods viewed as being most reliable today, and therefore often considered "absolute," (that is, giving a "true" age) are ^{14}C, the amino acid racemisation method, and different kinds of "yearly varves."

Dating with carbon-14

One of the most popular dating methods is carbon-14 dating (^{14}C). The basic problem with this method, for evolutionists, is that ^{14}C is building up quicker than it is disappearing by radioactive decay. Dating with this method is, hence, affected by the increasing amount of ^{14}C, through the millennia. However, during the last few thousand years, this fact does not affect the dates that much. But, as soon as we go further back than a few thousand years, then only a few tens of years of real age difference will show up as thousands or even tens of thousands of ^{14}C years (Brown, 1975, 1986, 1994, 2004; Cook, 1986; Molén, 2000). Also, fossils and other matter which is believed to be up to hundreds of millions of years old, give ages lower than 10,000 years, if the unbalance in the ^{14}C data is taken into account (for example, Molén, 2000; see also Snelling, 2000 and Walker, 2000). (There is also the possibility of changed decay rates, but those theories are not necessary for the present paper.) This paper will not delve further into this subject, but will use the results of the disequilibrium in the ^{14}C method in the interpretation of the dendrochronological record.

Amino acid racemisation

The amino acid racemisation dating method is not an absolute method, even if it is often presented as such. In order to get the method to correspond with the accepted evolutionary timescale, it must be assumed that the rate of structural changes in the amino acids decreases almost exponentially. The racemisation rate for the oldest findings is therefore "corrected" to be up to c. 1,000 times slower than the current rate. If we assume that the rate of change in the amino acids always have occurred at about the present rate, the amino acid method supports a young earth. Ages of millions of years then give values of only between 10,000 and 20,000 years (Brown, 1985; Brown & Webster, 1991). (These dates are, of course, also uncertain, but they give a hint about the real age.)

Yearly "varves"

The varve chronology of De Geer

A method often being viewed as absolute is the varve chronology of Gerhard De Geer (1858–1943). The method is based on counting and correlation of couplets of light and dark sedimentary layers lying superimposed on each other. Thin layers, consisting of small darker particles, are regarded as having been deposited during winter when little erosion occurred and the currents were weak. Thick layers, consisting of lighter and coarser particles, are viewed as having been deposited by greater water discharge during spring/summer/fall (Figure 1).

De Geer counted the number of dark/light couplets in laminated clays from about 1,500 different places. By comparing sequences of such clays from these different places, he tried to show that the uppermost couplets in each place were repeated deeper down at a place lying further north. The number of couplets De Geer arrived at when he had added the data from the 1,500 places was around 5,000. This made him believe that it took 5,000 years for the ice to have melted away from the south to the north in Sweden. When he examined the recessional time for the ice from Leipzig in Germany to the south of Sweden, he did not find any laminated clays at all, but he assumed that it took approximately 4000 years (Schuchhardt, 1943; Velikovsky, 1976). In the age determinations for North America, only 19,000 of around 40,000 years were based on direct counting of clay couplets. The other 21,000 years were theoretically calculated (Flint, 1947). This is the way many researchers have worked (Zeuner, 1958). The existing couplets are first counted, and where couplets are missing, the number of years needed are then added, so that the ages will correspond to the ages already determined by using other uniformitarian dating methods (Velikovsky, 1976). This is an example of circular reasoning, as is also the case with all dating methods that are fitted into the uniformitarian framework.

Figure 1. "Varves" from Nylinge, Ulricehamn, Sweden. The lighter layers containing coarser particles have supposedly been deposited during spring, summer and fall. The darker layers, containing smaller particles, are supposed to have been deposited during winter. These "varve" sequences can be correlated in many different ways, just by moving the sequences up or down, next to each other. A light layer will always correlate with a light layer, and a dark layer with a dark layer. Hence, it is possible to correlate in many different ways to get the result that is needed, if you only have couplets to correlate. (Photo from the Quaternary Institution of Geology at the University of Stockholm. The profile taken by E. Antevs in 1914, Nylinge 3.)

More problems show up when sequences of laminated clays from different places are correlated, in an effort to show that the same sequences of couplets are repeated at different depths in locations near each other. In such correlations there are often just a few sequences containing the "right" number of couplets (Fromm, 1970; Strömberg, 1983). And, since there are only two kinds of layers to pair up (dark and light) it should be easy to pair up different sequences of laminated clays in many ways, thereby getting many different age correlations (Oard, 1992b; Ringberg & Rudmark, 1985; Strömberg, 1985). Also, differences in the sedimentary structures (for example, thickness of individual couplets or laminated clay sequences) are sometimes correlated, before it is believed that the same sequence of laminated clay exists in two places (Fromm, 1970; Strömberg, 1983). But, the fact is that even comparisons between laminated clay sequences from locations only a few meters or less apart from each other sometimes show a poor or non-existent correspondence (Flint, 1947; Strömberg, 1983). Additional "varves" often do exist (Fromm, 1970).

The main problem with varve dating is illustrated by a series of Danish "varves". According to De Geer these "varves" had been laid down in about 2,500 years. A Danish researcher reduced the age to 129 years (Hansen, 1940; see also Flint, 1947, 1957). In the article where this was described, other explanations for the dark/light couplets, other than annual, were provided: (1) sunny days with quick melting of the ice, (2) heavy rainfalls, (3) strong wind and stormy weather when a low pressure system was passing and (4) alternating frost and thaw during spring and fall. As early as 1958 Zeuner (p. 36) wrote that: "It appears that we have in the past been too confident in the belief that all varves are annual."

Even "typical" Swedish clay layers that are believed to have been deposited during the winter may contain several couplets formed during temporary periods of thaw (Schneider, 1945). Also, observations on recent glaciers have shown that several "varves" can form every year (Oard, 1992a; Pickrill & Irwin, 1983; Quigley, 1983), and that will probably happen at many places close to each other during the same "disturbance" (for example, a sunny day with much thaw will influence quite a large area). However, an effort is being made to discern yearly varves from those which have been deposited more rapidly, but the criteria for this distinction does not hold (Oard, 1992a).

The problems mentioned above clearly show why laminated clay sequences can usually never be assumed to be correlated correctly, and there is no reason to dispute that we can measure only hundreds instead of thousands of years, when the time for the melting of the ice sheets is considered.

Further on, different types of climbing ripples are common in so called "varves," which is evidence of extremely rapid deposition of these sediments (Bergström, 1968; Borell & Offerberg, 1955; Eriksson, 1983; Kuenen, 1951a, 1951b; Lindström, 1973; Sugden & John, 1976; see also Macquaker & Bohacs, 2007; and Schieber, Southard, & Thaisen, 2007). This indicates that many sequences of dark/light couplets, particularly the deepest lying ones (Bergström, personal communication), have been formed in seconds, minutes and hours, rather than years (Allen, 1971; Jopling, 1966b; McKee, 1965). Climbing ripples transform into flat sedimentary layers during reduced current velocity and also during lowered water depth (this also applies when the current is increasing) (Allen, 1971; McKee, 1965). This means that many flat layers, on top of the layers with climbing ripples, also ought to have been formed in a very short time, since currents commonly do not slow down almost instantaneously to a velocity where there is no deposition. Sometimes, the deposition of "varves" has been so rapid that water has been trapped beneath them. The water then was forced up through the layers from the weight of the rapidly deposited overlying sedimentary layers, producing so-called water escape structures. This forcing up of water has occurred even through sedimentary layers that are thought to be very slowly deposited winter layers (Lindström, 1973). Several well-preserved fish have also been found in "slowly deposited yearly varves," for example, a 50-centimeter long walleye (Hörner, 1946–1948). This might be hard to imagine, even if there were few bacteria next to the inland ice.

In summary, the dark/light couplets, which are claimed to be yearly varves, show no evidence of having been formed during a very long time. The varve chronology of De Geer is not an absolute dating method. As far as geological evidence is concerned, a total time of a few thousand years is the absolute maximum for the deposits concerned. But because of many unknowns and miscorrelations, the time is more probably only a few hundred years.

Post-glacial laminated lake deposits

It is common to count couplets of lake sediments in order to try to determine how long ago the Ice Age ended. In Sweden, around 9,000 couplets have been counted (Oard, 1992b). It is, however, known that, in recent lakes, several couplets can form per year. At such an insignificant environmental change as an increase of the wind speed from below to above 3 m/s, during more than 6 hours, an additional "varve" may be formed. A laminated clay couplet in a recent lake, was first believed to have been formed in 1941, but it actually was deposited in 1960. This was shown by more thorough examinations of among other things, microorganisms, existing in the layer (Simola & Tolonen, 1981). Up to five "summer/winter varves," with an average of almost three "summer/winter varves," have been deposited every year in a lake in Switzerland (Lambert & Hsü, 1979). Considering the more catastrophic conditions occurring during deglaciation, it is possible that even more "varves" could have been formed every year.

Also, many laboratory experiments and field observations show that several couplets can be formed almost simultaneously when a mixture of particles is deposited in water or air (Berthault, 1990; Fineberg, 1997; Julien, Lan, & Raslan, 1998; Makse, 1997; Roth, 1998).

Many times it has been argued that sunspot and other short-period cycles show up in laminated clays. However, there are many problems with this interpretation. "Cyclical periods" which do not correlate with real, observed, periodic processes have for instance been recorded in many "varves," and "cyclical periods" have been recorded in "varves" which are known not to be periodic (Brack, Mundil, Oberli, Meier, & Rieber, 1996; Drummond & Wilkinson, 1993; Hecht, 1997; Murray, Jones, & Buchholtz ten Brink, 1992; Oard, 1997b; 1999; Peper & Cloetingh, 1995; Stihler, Stone, & Beget, 1992). Some "yearly varves" are now believed to have been formed by daily tidal changes, other "varves" have been formed chemically after sedimentation, and some "varves" have simply formed rapidly in subaqueous gravity flows (Feldman, Archer, Kvale, Cunningham, Maples, & West, 1993; Murray, Jones, & Buchholtz ten Brink, 1992; Sugisaki, 1982).

Hence, there is no evidence for a long period of time in the laminated lake sediments.

"Varves" in glacier ice

Layers of ice are supposed to be deposited as yearly varves, according to a uniformitarian interpretation. On Greenland there are, for instance, a great number of very thin layers of ice supposedly having been formed during a time of more than 250,000 years (Dansgaard et al., 1993). However, several layers of ice could form every year. Every snowfall followed by a day of thaw or a downfall of ash from volcanoes can form its own "varve" of ice (example shown in Lipman & Mullineaux, 1981). However, it is not possible to discern more than around 14,500 supposed annual layers by the naked eye. Supposed varves lying deeper down have only been inferred to be old by using oxygen-isotope and other methods. The results from the age determinations have then been compared to and fit into other climatic data sets and the geological column. The method is certainly not an absolute method (see more info in Oard, 2001, 2005).

Dendrochronology

Observations on tree rings and correlations

It appears that the "final test" of the uniformitarian timescale of the closure of the Ice Age is dendrochronology. And, if dating with tree-rings is correct, then the uniformitarian extrapolation to "millions" of years of geological time, is also supposed to be correct. "If the most recent part is shown to be correctly dated, then the rest ought to be correct too," is how one argument goes.

Dendrochronology is often believed to be the "ultimate" absolute method, more than any other method and more detailed than any other method (for example, see how the method is described in Pearson, Pilcher, Baillie, Corbett, & Qua, 1986), and ^{14}C dates are actually corrected by dendrochronology. Therefore, dendrochronology has to be tested, not only to find "small problems" inherent in the method, but to find a basic problem in the logic of the method, in order to find out if it is an absolute method or not.

It is already well known that there are many problems with dendrochronology. As is the case for all correlations with couplets, there are basically only two different data, in this case dark and light tree-rings. Therefore it is easy to correlate tree-rings in many different ways. It has also been documented that extra rings can grow each year, for different reasons (for example, drought) and rings can be missing. Sometimes huge problems with the correlation between different trees have been described in the scientific literature, for example, a sequence of 290 tree-rings could be correlated with 99.9% accuracy, in 113 different ways, with a time span of 830 years between the lowest and highest age (Brown, 1995; Yamaguchi, 1986). These problems are especially evident in the "world's oldest trees," the Bristlecone Pines of the White Mountains in California (Matthews, 2006; Woodmorappe, 2003). It appears that multiple rings are more common than annual rings. The "tree-ring-age" of trees that are living in harsh conditions is commonly about ten times higher than those living under good conditions (Matthews, 2006). This observation may be an indication that multiple tree-rings are very common for trees living in harsh conditions. But this ten-fold difference in the number of tree-rings may mainly show that trees live longer if they grow slower and, therefore, actually are older. There has been no directed research concerning this last observation, even though it is observed that multiple rings often originate during harsh growing conditions.

The problems mentioned above are not foundational, but they make us suspicious that there may be something wrong with dendrochronology. The "final mistake" in the logic of dendrochronology has to be found in the way the "master tree-ring sequence" is set up and correlated. Fortunately, in 1986 a full set of detailed papers concerning correlation of ^{14}C dates and dendrochronology was published in the journal *Radiocarbon* (Vol. 28/2B). The latest revision of these correlations was published in 2004 (Vol. 46/3). It is of highest importance to study the early correlations, because later correlations commonly only try to fill in holes in the first correlations or to make small revisions. The original first long tree-ring sequence, made from 700 samples from Bristlecone pines, is a foundation for how all later correlations are made, as Suess (1986, p. 263) stated: "Never have indications been observed of an error in this tree-ring sequence". This pattern of how to build a timescale is similar to when the timescale for the Phanerozoic geological column was constructed (Molén, 2000): Start with an assumption or philosophy (uniformitarianism), find a method which fits the dates you need based on this assumption (that is, radioactive dating), "fix" the timescale with only one single date (that single date is from the famous Swedish Ordovician kolm in Gullhögen, Skövde)—and then throw away the date you have used to "fix" the time scale (and even much of the philosophy of uniformitarianism), but keep the timescale!

In both the 1986 and the 2004 *Radiocarbon* publications there are many correlations of the timescale done with different relative dating methods, such as coral growth patterns. But a timescale will not be improved with many correlations, if all the methods that are used are dependent on each other (Mahaney, 1984). This paper is mainly concerned with the correlations of the two "absolute" methods used in the above reports, ^{14}C dating and dendrochronology.

The trees used for the correlations in the *Radiocarbon* reports were commonly dated with ^{14}C every tenth or every twentieth year, but sometimes it was about 100 "tree-ring years" between the dates. Originally, tree-rings from one to eight trees commonly were correlated with each other. But in especially the younger part of the 2004 revision more than 100 individual trees were commonly correlated with each other, and many new trees were incorporated in the correlations.

What is most remarkable in the *Radiocarbon* papers, is that the graphs of correlation between ^{14}C years and tree-ring years (A) goes up and down most of the time (hereafter these "ups and downs" are called "bumps"), and sometimes is (B) almost a straight (horizontal) line, and sometimes (C) jumps (almost vertically) many years, sometimes even a few hundred years. These variations are so prominent that even the researchers themselves are calling them wiggles, and use the word "wiggle-matching" as the term for the correlations (Pearson, 1986). There is, of course, always some variation in most kinds of measurements, but if the wiggles are too large and too common, one could suspect that there is some systematic mistake in the data (even if many trees are compared, that is, the reinforcement syndrome will help fit all trees into the same pattern).

However, there are a few real wiggles in the correlations of the most recent ^{14}C ages and tree-rings. It is difficult to know what the reason is for these wiggles. They may partly be a result of the large scale burning of fossil fuel and other anthropogenic contamination during the last c. 200 years, and there could be some influence from the conditions that gave us the "Little Ice Age" since the 15th century (the $^{14}C/^{12}C$ ratio is periodically increasing a lot during this time). If there only were one or a few "bumps," here and there in the correlations, one would suspect that these were natural. But the "bumps" are systematic, all the way through the whole sequence.

It would be very peculiar if tree-rings always were growing one a year (when it is demonstrated that they at least sometimes are not), while the correlations commonly showed up as "bumps" (as described in A, above), which would mean that ^{14}C often gave ages on older material that actually became younger. And, if the correlation shows up as almost a horizontal line (as described in B, above) the ^{14}C age did not change, which would imply that many tree-rings originated during one or many ^{14}C years. The "record" for this kind of wiggle is 380 tree-ring years at the same time as the age difference is zero ^{14}C years (*Radiocarbon* 1986, Vol. 28/2B, pp. 974–975, Figures 3–4). And, when the correlations suddenly jump upwards (as is described in C, above), which commonly makes the ^{14}C age fit better with the tree-ring dates, this would imply that very few tree-rings were growing during many ^{14}C-years. Something is wrong, somewhere, with ^{14}C dates, tree-ring dates, or both.

Uniformitarians try to interpret the wiggles (A to C, above) in the curve of correlation as if they are caused by periodic changes in the ^{14}C production in the atmosphere, which they believe can be connected to for example, the solar sunspot cycle (Suess, 1986). But, in such a case you should see some systematic regularity in the variations, while there are none. The only systematic variation that can be observed is that the wiggles are more common and "bumps" are steeper/quicker (that is, larger differences in ^{14}C-age between different tree-rings) in the older part of the curve compared to the younger part.

Measurements of wiggles and theory of mismatches

I conducted a simple calculation of how many ^{14}C years were "lost," in the "bumps" in the 1986 correlations, and tried to understand if there is another explanation than ^{14}C variation in the atmosphere to all these "bumps" (that is, as defined in A, above; horizontal lines and the jumps, B and C respectively, are not included in this calculation). So, every time the ^{14}C date on older material became younger in the published diagrams, I counted how many years that were "lost." I ignored smaller variations, less than 20 year "bumps," and small trends which are stretched over a long time, just because there may be some real variations in the ^{14}C-data that are small. (For example, see Keenan, 2002, where he describes age differences which he interpret may have been caused by continual outgassing during a long time from old sea water. Another interpretation is that these age differences are caused by disequilibrium in the ^{14}C method. But, in any case, outgassing from old sea water would not affect areas far away from the sea, were most of the current dendrochronological readings have been made.) But, in so doing I may have missed some unjustified uniformitarian correlations, which have been smeared out over a long time.

In the published diagrams with correlations between tree-rings and ^{14}C dates, between 10–20% (mainly data from trees younger than 2,500 years) and 40–100% (mainly data from trees between 2,500 and 12,500 tree-ring years old) of the time the ^{14}C ages become younger while the tree-ring dates increase (as described in A, above), that is, the ring counts give older ages, but ^{14}C dating gives younger ages on the older samples. With increasing age the ^{14}C age deviates more and more from the tree-ring age, eventually reaching more than 1,000 years. As is documented above, the "bumps" are more common in older samples, but they are also steeper (that is, the age difference between different nearby tree-rings gets larger). The "bump record" is about 700 years, that is, the tree-ring dates go up about 500 years while the "^{14}C age" repeatedly goes down a total of about 700 "lost" years (that is, 700 years down, and 500+700=1,200 years up) (*Radiocarbon* 1986, Vol. 28/2B, p. 949, Figure 4A reproduced as Figure 2 in this paper).

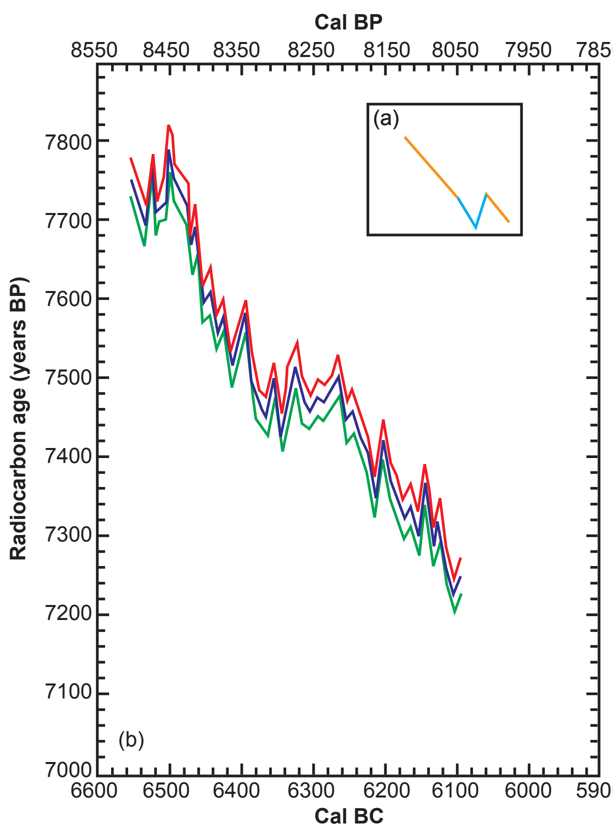

Figure 2. Mistake A. (a) This simple drawing shows how a correlation of two tree-rings, of the same age, will appear in a diagram, if the tree rings are mismatched. The ^{14}C date will be the same for both trees, but the "ring-date" will not. There will be a "bump" in the diagram. (b) A published diagram showing many "bumps." This diagram actually shows the part of the correlations where the "bump record" is, as described in the text. (From: Linick, Long, Damon, & Ferguson,, 1986, p. 949, Figure 4A. ^{14}C-years are on the vertical axis and dendro-years, BP and BC, are on the horizontal axes).

Uniformitarians, of course, need to keep the correlations more or less in the way they have been published, otherwise, their timescale is ruined. But, if we build our interpretation on observations, instead of the philosophy of uniformitarianism, the result will be very different. For instance, the real observations show, as is documented in this paper, that (1) multiple tree-rings are not uncommon, (2) there are problems in the correlation of different trees, (3) ^{14}C is not in balance, and (4) even fossils and other findings which are believed to be "hundreds of millions" of years give young ^{14}C ages. Observation number one is the least important of these four observations. We must leave the philosophical speculations, and stop to interpret all data from a long time/uniformitarian perspective and the authority of Ferguson (a long-time expert in the field of dendrochronology), and instead, base our understanding of the world on a knowledge of how mistakes have been done to reinforce the long ages needed by evolutionists. Then, we can make some new interpretations of the wiggles, as in A–C below.

A: "Bumps". *The up and down "bumps" shown in the wiggles are readily explained if two trees of the same age are miscorrelated. It is not possible to find out exactly which trees have been dated, from the published diagrams or raw data, and if any one tree have been dated twice. But, if tree-rings of the same age on two different trees, are displaced in the correlations by 50 tree-rings (for example, a tree-ring which is 8,000 years old is correlated/assumed to be the same age as a tree-ring on a second tree which is 7,950 years old), then suddenly the ^{14}C age will differ by about 50 years when you compare the two trees. (Figure 2a.) But, if different dates have been measured on the same tree, we are lead to believe that five tree-ring years can show up as 75 ^{14}C years in that single tree (see many similar age "jumps" in* Radiocarbon *2004, IntCal04 supplemental data). That is a lot of atmospheric variation in the ^{14}C ratio, especially if it is* *believed that something similar has taken place over and over again simultaneously and worldwide. Also, initially, all workers could not recognize wiggles from the measurements. However, with the advent of the ¹⁴C/dendrochronology correlations, the wiggles became recognized as real (Suess, 1986). But, if the timescale is stretched out, with a mismatch of tree-rings, then automatically, some "bumps" will show up in the ¹⁴C data. There are also commonly some small differences in the dates given by different laboratories, which the researchers are aware of. But, as stated before, if there were just a few "bumps," and not a systematic trend, we would not suspect that there was any significant problem in the correlations.*

B: Horizontal lines. *More or less straight (horizontal) lines will show up in the correlations if you believe that the tree-rings are yearly, even though multiple rings grew during one or a few years. If many trees with multiple rings from the same (or nearly the same) growing season are correlated incorrectly, then the straight line will be longer (Figure 3.) A horizontal line will also show up if there are many minor "bumps." A straight line may also, as all other measurements/correlations, be assumed to have originated by contamination.*

C: Jumps. *If there is a gap in the recording of the tree-rings, that is, tree-rings have not been recorded for a long period, and trees with different ages which are believed to be of the same age have been correlated, then you will have a jump in the ¹⁴C age. This commonly makes the fit better between the ¹⁴C age and the tree-ring age. It corrects mistakes done if the timescale has been stretched out too much (as in A and B above), even for the evolutionists (Figure 4.) But, some of the jumps, especially in the older parts of the records where the "bumps" in general are more pointed, may be more readily explained by just ¹⁴C disequilibrium and a lower ¹⁴C ratio which has been enhanced in the correlations.*

The most important point, of the three situations above, is the miscorrelation in A ("bumps"). Of course, there may be other smaller mistakes in the data, for example, a lot of smearing originating from many small correlational mistakes that do not show up readily in the diagrams. And some of the "bumps" are probably real (there always has to be some noise in the data). But, if we leave these (there is no possibility to get full access to the data and redo all the correlations), the diagrams display many large "bumps" all the time, which should not exist in a uniformitarian framework, at least not if the trees are from the same environment/place (which the individual tree-ring sequences often are). One can understand that a different environment (for example, at a place close to were there is outgassing from old sea water), could shift the ¹⁴C-dates, but all the

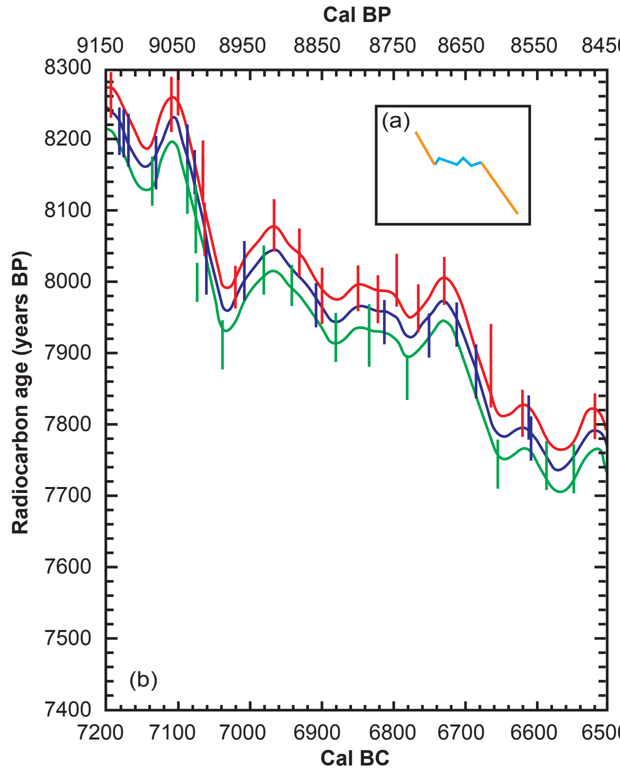

Figure 3. Mistake B. (a) This is how tree-rings of the same or nearly the same age will correlate, if there are multiple rings in one or many trees that have been correlated. There will be a more or less straight (horizontal) line in the diagram. (b) In this diagram, from about 8680 BP to 8980 BP, that is, during approximately 300 years, the ¹⁴C age has not changed, even if there are some "bumps" present. Note that the curve in the diagram has been planed off (compare to Figure 2, above, and Figure 4, below), for example, the low ¹⁴C date in the "bump" at approximately 8,985 BP is 7,913 ¹⁴C years, situated at the middle of the error bar. But, the curve in the diagram show 7,960 ¹⁴C years, that is, 47 years too much. (From: Kromer. et al., 1986, p. 959, Figure 4. ¹⁴C-years are on the vertical axis and dendro-years, BP and BC, are on the horizontal axes).

"bumps" systematically through all the data, would not be expected in any normal case. The diagrams of correlation need systematic recurrent outgassing of old sea water covering large parts of the world, including the high mountains, followed by recurrent flares of cosmic proton radiation that quickly raises the ¹⁴C-ratio. This would be a highly incredible situation.

Also, many of the trees in central Europe that have been dated with tree-rings are young (for example, a mean age of 176 years of oaks) and have been sampled in open gravel pits of former riverbanks (Friedrich et al., 2004). It is known that open pits are easily contaminated with recent ¹⁴C and commonly give about 10% lower age on soils and sediments after just a few years in the open (Haas, Holliday, & Stuckenrath, 1986). Even if these lower dates from open pits were not made on wood samples,

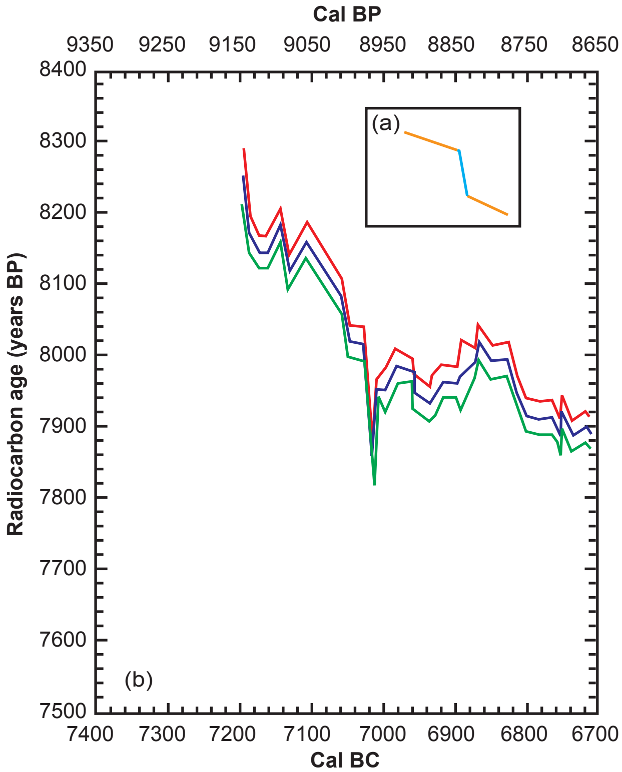

Figure 4. Mistake C. (a) This is how a correlation of tree-rings from trees which are of different age, but are interpreted to be the same age, will show up in a diagram. The line will be more or less vertical, that is, a jump. (b) In the middle of this diagram there is a jump, where 175 ^{14}C years are covered by only 15 "yearly" tree-rings. This jump could also be labeled as a very steep "bump," because the age first went down (actually even "jumped" down), before it went up again. But it was not measured as a "bump" in the calculations because I was suspicious of its origin. (From: Stuvier, Kromer, Becker, & Ferguson, 1986, p. 974, Figure 3. ^{14}C-years are on the vertical axis and dendro-years, BP and BC, are on the horizontal axes)

contamination may be another reason why there are wiggles in the correlations.

Result which is shown from removing mismatches

If we take away all the extra years of all the larger "bumps" and plane out the correlation curve of ^{14}C and dendrochronlogy, the resulting graph correlates well to the curve of a ^{14}C ratio not in balance. During the last 2,500 years there are about 500 years of "extra time" ("bumps") in the data, and during the previous 6,500 years about 50% of this time is represented by "bumps." So, if we take away the "extra" time in the "bumps," the total time is lowered from about 9,000 years to about 5,250 years.

In the 2004 revision of the timescale (Friedrich et al., 2004) c. 3,000 more dendrochronology years were added, totaling 12,400 years BP. The ^{14}C age in this correlation is about 2,000 years lower than the dendrochronology age. The "extra time" in the last 1,000 years is more than 100%, that is, there are so many "bumps" that the "extra time" covers a longer period than the "real age."

If we take into account the ^{14}C/^{12}C ratio of the atmosphere in disequilibrium, the mismatches which are observed and inferred in the correlations with the ring data, and the evidence of multiple extra tree-rings, which are all based on observations, then the measured age will be reduced even more, and perfectly fit the biblical record. If all the tree-rings were correctly correlated, then, in a disequilibrium situation, the ^{14}C time between subsequent older rings would increase. But instead, the correlations show the opposite pattern, and we can understand how the timescale has been stretched out more and more by the uniformitarians. This can be seen because the occurrence of "bumps" increases with age, and also that the "bumps" are steeper/more vertical in the older part of the record, and also by the presence of almost horizontal lines in the correlations. The basic, logical mistake in uniformitarian dendrochronology is, hence, found and to a large part resolved, not from a reading of the Bible, but from the field data. But, it is a very difficult and time consuming process, and mistakes may easily be done, if one tries to find the absolute correct correlation from just the data available.

Geological Observations—How did the Ice Age Shape the Landscape?

The geographic extent and thickness of the ice sheets

The theories concerning the maximal geographic extension of the ice sheets during the Ice Age should in certain aspects be questioned. It is for instance not certain that the ice covered the whole North Sea from Norway across to England, at least not as a grounded glacier which slid on the North Sea floor (Nesje & Dahl, 1990; Sissons, 1981, 1982; see also Hoppe, 1981, for mistakes done at Svalbard). (This also holds if there was a great ice dam in the North Sea; that is, Gupta, Collier, Palmer-Felgate, & Potter, 2007.) It is also possible that some far transported rocks have been carried by glacier tongues, sea ice, icebergs or transportation in former gravity flows and not by any inland ice (Jansen, 1992; Oard, 1990a). If single clasts are found, they may even be local, with the former outcrops concealed by sediments (some believe that the Vikings transported some stones, as ballast in their ships, but that is pure speculation). Vast areas in Siberia, Alaska and the northwest part of Canada have never been covered by inland ice (Andrews, 1979; Flint, 1961).

The calculations of the volume of the ice sheets are highly exaggerated. They are to a major part based on the assumption that the ice sheets were similar to those currently existing in Greenland and in Antarctica. If we leave the theoretical models and study the facts, we find something quite different from the uniformitarian explanation that is present in most books and papers. The erosional landmarks and presence of stones on mountain peaks in Norway, Scotland and North America show that the ice sheets did not cover the mountains completely. The ice sheets must therefore have been 500–1,500 meters, and sometimes up to 3,500 meters (see Mörner, 1979; Sjöberg, 1986) thinner than previously believed, in vast areas (Beget, 1986, 1987; Brook, Nesje, Lehman, Raisbeck, & Yiou, 1996; Caldwell & Hanson, 1986; Clark, Hendriks, Timmermans, Struck, & Hilverda, 1994; Clark, Licciardi, MacAyeal, & Jenson, 1997; Nesje, McCarroll, & Dahl, 1994; Nesje & Dahl, 1990; Oard, 1990a; Peltier, 1994; Sollid & Reite, 1983; Stone, Ballantyne, & Fifield, 1998). The ice sheet covering vast areas of the northern USA was probably less than 1/5 as thick as the ice caps currently covering Antarctica and Greenland (Blackwelder, Pilkey, & Howard, 1979; Clayton, Teller, & Attig, 1985; Wagner, 1981), and the total volume of the ice sheets covering both Europe and North America was maybe 35% less than what has previously been suggested (Peltier, 1994).

General appearance of the geological formations formed during the Ice Age

If there have been many ice ages, or just many stadials/interstadials, it seems peculiar that almost all glacigenic material is believed to have been transported short distances and have been deposited during the last Weichselian/Wisconsian glaciation (Flint, 1971; Lundqvist, 1981, 1986a; Oard, 1990a). If there have been many glaciations, there ought to have been many different deposits and much of the glacigenic material should have been transported long distances. The underlying bedrock has not been eroded as much as would be expected either (Eyles, 1983b; Flint, 1971).

In Canada the thickness of the till is 2–10 meters, and is usually only deposited in depressions. In Norway the mean till layer is 5 meters, in Finland 2–3 meters and in Sweden 5–15 meters (Flint, 1971; Oard, 1990a). At the fringes of the inland ice sheets, the till layers are thicker, for example, from 10 to 52 meters in a 300 kilometer wide band at the southern limit of the North American ice sheet. But, it is difficult to believe that the ice age debris is so thin, if there have been as many as 20–30 ice ages (as some scientists have suggested), or even only 3–4 ice ages with many different stades as believed up until the 1970s (Ford et al., 1984; Oard, 1990a).

If we study recent glaciers and ice caps we see many instances of rapid geological erosional and depositional work, but the rates are quite variable. Recent small glaciers usually erode the underlying bedrock between a few millimeters per year up to a few centimeters per year (Drewry, 1986; Hallet, Hunter, & Bogen, 1996). In Alaska tills have been deposited at a rate of 0.5–2.5 centimeters per year and 0.5–2.5-meter high till ridges were deposited in 1–5 years (Goldthwait, 1974). A glacier in the Alps eroded its way down into bedrock at a pace of 3.6 centimeters per year, while a glacier on Spitsbergen deposited a 30-meter thick till layer in 10 years (Flint, 1971; Oard, 1990b). Rates of 1–2 meters of deposition of till per year in the frontal part of Alaskan glaciers are not uncommon (Nolan, Motkya, Echelmeyer, & Trabant, 1995). Sediments have been eroded at a speed of 3 meters per year (Nolan et al., 1995). The "record" for fast erosion in bedrock is almost 20 centimeters in c.2 months, for a surging glacier in Alaska (Hallet, Hunter, & Bogen, 1996). In Antarctica a 10-meter high and 100-meter long drumlin was formed in just a few years, and about 1 meter of sediment is eroded away each year, all below a 2-km thick glacier (Smith et al., 2007).

If the recent real observed values of erosion and deposition are extrapolated just a few hundred years, most of them will yield the total amount of till and glacial erosion which has been formed during the complete Ice Age. Hence, there is no evidence for a long Ice Age. The lowest values for glacial erosion of bedrock are for cold-based glaciers in Antarctica, where movement is slow (Hallet, Hunter, & Bogen, 1996). Only these very low rates are accepted in the uniformitarian model. But, there is no evidence that the ice sheets in the more temperate areas of Europe and North America behaved like recent polar ice sheets. It appears that the Ice Age was not characterized by slow-moving, cold-based glaciers, but by more quickly-moving, warm-based glaciers (Boulton & Clark, 1990). In all instances, it is more likely that the ice sheets during the Ice Age in general were more similar to the recent glaciers in Alaska than to the polar ice sheets.

If there had been many different stades during the Ice Age, and maybe also many ice ages, during a very long time, we would suspect a much more complex stratigraphy then what is present. At least in the marginal areas we should find thick layers of reworked material of all kinds—till, glaciofluvial material, wind-transported material, soils etc. Commonly there are only one or a few till layers on top of each other. These tills are seldom mixed with each other, as would easily have happened if there were recurrent advances and retreats of the glaciers. On top of (or eroded into) these tills is the glaciofluvial material, but not mixed in many layers, as would have occurred during a more complex history. Eskers and kames are commonly quite undisturbed, and most of them seem to have been deposited during a single short deglaciation. The major observation shown by the study of the geological work done by the ice sheets during the Ice Age is of one main growth period and one main retreat period, which in total did not take a long time. There is no evidence of a long complex history, except the "evidence" which is based on uniformitarian interpretations.

Geological formations formed during the melting of the ice

If we study the remnant geological landforms from the deglaciation of the ice caps in the Ice Age (erosional forms and glaciofluvial material), the evidence shouts out that the ice sheets melted away rapidly.

There are, for instance, glacial delta formations in many different places. These were formed during the deglaciation, when glacial water flowed out into a lake or into the sea (Figure 5). Calculations have shown that such deltas form rapidly. A normal delta may have been formed at a rate of between about 30 centimeters and 3.7 meters per hour (Jopling, 1966a). That would mean between 216 meters and 2.6 kilometers in a month, or between 860 meters and 10.4 kilometers during a four month long melting season. This shows that almost every single delta from the Ice Age could have been formed during one, or maximally a few melting seasons (Clague, 1986). Similar deltas are not formed in any place in the world today, except where a great amount of loose material (clay, sand and gravel) is transported by fast running water. Rapid delta formation has been observed outside glaciers, where fast flowing creeks end up in a lake, and during flood catastrophes (Austin, 1984; Cowan, Powell, & Smith, 1988).

At many mountain sides there are erosional terraces which have been formed when glacial meltwater flowed between the ice edge and the mountain, so called lateral drainage channels (Figure 6). The mean difference in altitude between adjacent lateral drainage channels in northern Finland is 1.7 meters. In northern Sweden it is between three and six meters. Certain extreme values in Sweden exceed 20 meters, and as great as

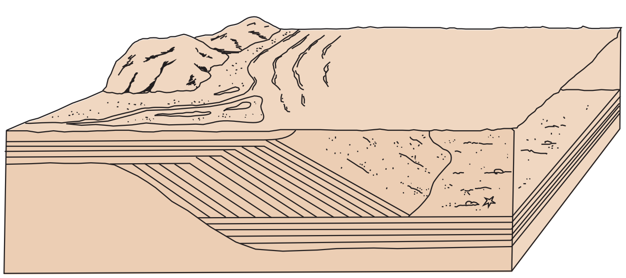

Figure 5. A typical glacial "Gilbert" delta which consists of bottomset, foreset and topset beds. (Ill., Jan Nord.)

Figure 6. Lateral drainage channels filled with snow in Äkäslompolo, Finland. (Photo, K. V. Abrahamsson.)

37 meters (Abrahamsson, 1974). We cannot be sure whether one or many lateral drainage channels have been formed every year, or if the same lateral drainage channel could have been used during several years. But, if we assume that a lateral drainage channel formed every year, the 1.7 meter value recorded for northern Finland (Äkäslompolo) indicates that a 2-kilometer thick ice sheet would melt in about 1,200 years. (It is actually believed that the inland ice retreated from all over Finland in about 1,000 years, as indicated by Lundqvist, 1986b). The mean value of 4.5 meters of melting per year, as recorded in northern Sweden, indicates a time of around 450 years for a 2-kilometer thick ice cap to melt. Of course, if the ice sheet was thinner than 2 kilometers, then the melting time would correspondingly be less.

Figure 7. Gravel pit in esker. Burträskåsen at Kvarnbäcken, Burträsk, Västerbotten, Sweden.

Figure 8. Antamåla Rör southwest of Emmaboda in Småland, Sweden. A kame hill that only consists of big rounded boulders. The current of the water must have been very high in order for these boulders even to move at all.

Eskers and kames have been formed by material being transported by meltwater flowing on top of, in or beneath the ice. There are lots of such eskers and kames spread over Sweden. There are often different kinds of crossbedding in these deposits, which show that the sediments have been deposited very fast (Allen, 1971). The size of many of the stones transported indicates a very strong current (Jones, 1965; Novak, 1981) (Figures 7 and 8). Beneath present glaciers, many kames and eskers up to seven meters high have been formed in 2–6 years (and a small river eroded its way down into the bedrock with a rate of 1–2 meters per year) (Goldthwait, 1974).

Furthermore, many glacial lakes, which have been dammed up by the ice sheets, have catastrophically released very large amounts of stored water, which indicates rapid melting (Baker, Benito, & Rudoy, 1993; Blanchon & Shaw, 1995a; Elfström, 1987; Longva & Thoresen, 1991; O'Connor & Baker, 1992; Rains, Shaw, Skoye, Sjogren, & Kvill, 1993; Shaw & Gilbert, 1992; Smith & Fisher, 1993).

Several researchers are actually of the opinion that major parts of the inland ice sheet melted away in a more catastrophic way, maybe in just a few tens or maximally a few hundred years (Andrews, 1979; Broecker, Ewing, & Heezen, 1960; Maslin, 1993). There are also signs that sea level rose rapidly, possibly by several meters in just days or maximally a few hundred years (Blanchon & Shaw, 1995a; 1995b; Hesse, 1996; Hunt, 1977; Maslin, 1993; Tarling, 1978; Turney & Brown, 2007).

Glaciofluvial processes do not support long ages for melting. Conversely, the geological evidence cries out "short time—short time"! (See more short time data in Table 1.)

Conclusion

There is no observational evidence which successfully justifies the contention that the Ice Age spanned a long part of earth history. There are basic logical mistakes in all uniformitarian dating, so that the millions (or tens of thousands) of years are unsupported. Long ages are only found in uniformitarian interpretations. Correctly interpreted, with no "fudging" to fit the data to a pre-existing long timescale, all methods give a young age.

The Ice Age was not as extensive, nor did it cover such a long time as is described in the secular literature. Reality, as can be studied from observations, shouts out a timescale fully consistent with the short biblical post-Flood timescale.

Acknowledgments

This paper is partly based on a translation by Rudi Arbella (M.S. biology) of the book *Vårt ursprung?* (*Our origin?* in English) which has been published in four editions in Swedish, by the present author. I

Table 1. Some geological observations which show, even under the burden of uniformitarian interpretations of rates of erosion and deposition, that there is no evidence of long time.

Process	Duration	Episode
1. Sediments in Lake Agassiz	Less than 1,000	M. (Upham, 1895.)
2. Erosion and sedimentation in Lake Michigan	A few thousand	T. (Andrews, 1870.)
3. Material formed by the Rhone glacier	2,400	TM. (Schuchhardt, 1943, Velikovsky, 1976.)
4. Deposition of a small chalk layer	100	TI. (Schuchhardt, 1943.)
5. Formation time for the Mississippi River delta	5,000	T. (Allen, 1972.)
6. Concentration time for salt in two lakes with no outlets	4,000	T. (Winkle, 1914.)
7. Concentration time for salt in Owens Lake	2,500	T. (Jones, 1925.)
8. Concentration time for salt in Lake Lahontan	2,500	T. (Jones, 1925.)
9. Erosion in till by a creek	4,000	T. (Oard, 1990a.)
10. Erosion by the Niagara Falls	4,000	T. (Pierce, 2000.)

Note:
M = Melting of half the inland ice.
T = Time since the Ice Age ended.
TI = Time between two "ice ages."
TM = Time for melting of glacier.

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Nomenclature

Couplet = a pair of something.

Laminated clay = many layers of clay and silt (or sometimes sand). In this paper it is couplets of light layers of mainly silt and dark layers of mainly clay.

Subfossil = a preserved animal or plant which has not turned into fossil yet, like dead material in a peat bog.

Varve = a generic term describing a couplet of a dark and a light layer, which is defined as annually deposited.

Appendix

Many ice ages during the Quaternary?

According to most evolutionists there have been many ice ages during the last million years, and as support for this theory a number of observations are being brought forward. The theory originated from studies conducted in the Alps, where traces from four different glaciations have supposedly been found. There are, for instance, various erosional terraces in many valleys, which are interpreted to have been formed by glaciers during different ice ages. Both these terraces and what evolutionists are regarding as the most complete glacial record of the Late Cenozoic to Quaternary ice ages—the Yakataga formation in the Pacific, south of the coast of Alaska—are more easily understood as caused by tectonic history rather than climatological changes (Eyles, Dearman, & Douglas, 1983).

In certain locations, several till layers and glaciofluvially formed layers lie on top of each other, supposedly originating from different stages between and during the last ice ages. One of the reasons this is believed to be true is that the underlying layers may be chemically altered and that they contain soil profiles (Felix-Henningsen, 1983), a change supposed to have taken place during thousands or tens of thousands of years. Chemical alterations may however form beneath or between already deposited layers, through the impact of rain, seawater or ground water (Eyles & Menzies, 1983; Lougee, 1958; Lozek, 1972; Lundqvist, 1981; Valentine & Dalrymple, 1976; West, 1969). Furthermore, most soil profiles are very weakly formed (Ericsson & Wollin, 1968; Oard, 1990a; Valentine & Dalrymple), and many of them have been used to classify deposits from the Ice Age into different stades, or different ice ages, before it was really known how soil profiles could be formed (Bowen, 1978). Also, soil profiles in the south of Sweden may be formed in a few decades, which show that a long time is not needed (SOU, 1971).

Based on the facts mentioned above, chemically altered layers may be from the same ice age (Lougee, 1958; Oard, 1990b; 1990c). They may have formed when the ice edge temporarily was receding or between already deposited layers. This is supported by the fact that most of the soil profiles are found at the fringes of the ice sheets, for example, in the Netherlands, Denmark and Germany (Felix-Henningsen, 1983). The climate there during the Ice Age has been warmer than further north, and seawater and meltwater from the ice sheets have not been hindered to penetrate into the sediments by mighty ice sheets. Water has therefore been able to penetrate newly deposited sediments, so incipient soil profiles can have formed at a high rate. Layers of peat and glaciofluvial material occurring between till layers are also more common at the edges of the ice.

Many chemically altered layers are found below the lowermost till in many locations, and are probably almost always preglacial.

Deposits from Supposed Early Quaternary Glaciations

There are only a few places in Sweden where there are deposits believed to have originated during two ice ages, or to have been formed between two ice ages (Lundqvist, 1986a; Robertsson & Rodhe, 1988). Also, there are some places on Baffin Island, Canada, which show stratigraphic similarities to those in northern Sweden (Briner. Axford, Forman, Miller, & Wolfe, 2007). These are the best examples of "interglacial" deposits in the world, as far as I know. These may be used as examples for how other deposits, which are supposed to have originated from different ice ages, may have originated by other means.

The sites, which can most easily be interpreted as interglacial deposits, are in Norrbotten (in the north of Sweden) (Lundqvist, 1971; Robertsson & Rodhe, 1988) and on Baffin Island (Briner et al., 2007). A less spectacular site is at Stenberget, Romeleåsen (Berglund & Lagerlund, 1981) in Skåne (in the south of Sweden).

In one site in Norrbotten there are, for instance, subfossils from organisms which currently are living hundreds of kilometers south of the location where they have been found (Lundqvist, 1971). The climate is therefore regarded as having been warmer there than at any time during or after the last Ice Age. That is why the fossils ought to have been buried before the "last" Ice Age. No till layers are present below the fossil-bearing layers, but they lie on weathered Precambrian bedrock (pre-Flood weathering, as there is no possibility for the bedrock to weather so much, over large parts of Sweden, after the Flood but before the Ice Age; Molén, 1992, 1994). The fossils (for example, beetles) lie preserved in peat and clay in a depression. The peat has probably been transported by water. The protected placement in the depression has preserved the deposit throughout the Ice Age. The peat and the fossils found here must therefore have been buried after the Flood but before the Ice Age. After the deposition of the peat, the Ice Age began. The ice then spread out over the depression and the peat was buried beneath till and glaciofluvial material.

At a second site in Norrbotten, there were a few layers of till and a thin layer of peat above weathered bedrock (in the following order: bedrock, "till," peat, sand, till, more till) (Robertsson & Rodhe, 1988). Either the lowermost layer was not a till or, alternatively, it could have been formed by a very small mountain glaciation before the peat was laid down. If the lowermost deposit is not a till, the peat also could have grown in situ before the Ice Age or have been transported into place during the Ice Age.

In Stenberget in Skåne there are only fossils from organisms that indicate a climate colder than today but warmer than during the Ice Age (Berglund & Lagerlund, 1981). The climatic change indicated by the fossils may therefore be interpreted according to the following: When the ice melted temporarily, during one or more seasons, pollen, spores and insects from the warmer continent in the south were blown into Skåne. They were buried by sediments which had been transported by glacial melt water and later on by till during a short advance of the ice sheet.

Explanations similar to these may be provided for other sediments or tills in Europe and North America (including Baffin Island), regarded as originating from different ice ages (Charlesworth, 1957; Cundill & Whittington, 1983). But the deposits in Norrbotten and Baffin Island indicate a prolonged period (maybe tens of years) of warm climate before the Ice Age started, and maybe even a very small glaciation followed by warmer climate and then, after that, the Ice Age.

The Norwegian Fjords

According to generally accepted uniformitarian theories, the Norwegian fjords have been formed through erosion during several successive ice ages. The fjords are cut down into bedrock to a depth of 1.5 kilometers below the surface of the sea, and their bottoms are often covered by sediments several hundred meters thick. The reason for the view that the fjords formed during several ice ages is that they are supposed to be too deep and long in order to have been formed during one single Ice Age.

The theories on the origin of the fjords are however not set in stone. The fjords may have been formed during a more catastrophic event, for instance in connection with the upheaval of the Scandinavian mountain ridge. This may have happened at the end of or some time after the Flood (Molén, 1994). The greatest and deepest fjords ought to have been formed during the actual uplift and folding of the mountain range, for instance through displacements and faults in the bedrock. The overdeepening just before the outlets of the fjords, can only be formed by glacial action, but not by channelized Flood currents. Also, there is no evidence for strong water currents, more than those originating from the deglaciation.

There are also studies showing that the ice sheets have moved along bedrock that had already formed before the Ice Age, and that the ice did not alter the appearance of the bedrock to any major extent (Andrews, 1979; Eyles, 1983a).