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ARTICLE

Pleistocene Continental Glaciers: A Single Ice Age Following a Genesis Flood or Multiple Ice Ages?

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Introduction

Young-earth creationist Larry Vardiman (1993, 2009) has proposed that the continental glaciation that occurred during the Pleistocene Epoch in North America, Greenland, northern Europe, and northern Asia (Figure 1) was a single ice-age event that occurred following the Genesis worldwide Flood, about 4500 years ago or about 2500 BCE, and postulates that the

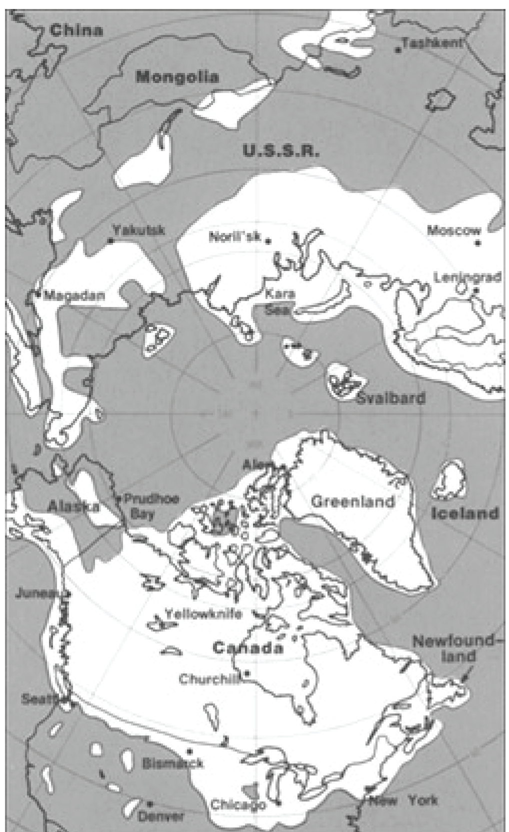

Figure 1. *The maximum extent of glacial ice in the north polar area during Pleistocene time. (Map from the United States Geological Service, http://pubs.usgs.gov/gip/continents/.)*

earth is about 6000 years old based on Bishop Ussher's estimate (Ussher 1786). Another creationist estimate (Osgood 1981) suggests that the Flood occurred in 2304 BCE, but Vardiman's choice of 2500 BCE is more common and will be used here.

In his model, Vardiman, like Snelling (2007, 2009), asserts that the Ice Age was caused by volcanic eruptions along mid-ocean ridges during catastrophic plate tectonics—an idea promoted by Baumgardner (2002, 2003). The model proposes that these eruptions heated the ocean waters so that huge amounts of water vapor were released into the upper atmosphere to provide the source of the water that produced the great thicknesses of continental ice.

Snelling (2009) indicates that water temperatures in the oceans were raised to levels 20°C warmer than today. The heated water is alleged to have formed "hypercanes" (enormous hurricanes) that rapidly precipitated the snow to form the polar ice sheets in just 500–600 years (Vardiman 2009). Oard (1990, 2004, 2005) calculated that the Ice Age lasted about 700 years and ended "within the last several millennia." Because these authors did not indicate a time for melting of the ice, we must conclude that the extension of the ice into the United States from Canada and the subsequent melting occurred soon after this time period and that *the* single Ice Age ended about 2000 BCE. Oard (1997) also dismissed all pre-Pleistocene glacial deposits as resulting from submarine landslides during the Noachian Flood (Heaton 2009).

Vardiman (1993) and Oard (2005) studied the data in published reports describing the annual layers in the Greenland ice cap in a core at Camp Century, Greenland. Uniformitarian models, using oscillations of delta ^{18}O values, indicate that the deposition of snow formed this ice cap during the last 110 000 to 125 000 years (Johnsen and others 1972; Meese and others 1997). Vardiman (1993), however, suggests that these annual layers could actually have been deposited in just 500 years and that the delta ^{18}O values can be better interpreted as giving ages in the last 4500 years. He believes that various factors cause the conventional interpretations of annual layers to be in error because the delta ^{18}O values can be affected by several influences, such as proximity of the ice layers to the ocean, acidification by volcanic ash and gases, temperature changes between storms, plasticity and flowage that thins the ice layers, and melting to produce firnication (converting snowflakes to ice by melting and re-freezing), although he concedes that the interpretation of the existence of recent annual layers is accurate through a limited range.

Oard (1990, 2004) agrees with Vardiman that the uniformitarian model (accepted by almost all geologists today) for the origin of the Pleistocene continental glaciation is not correct. He suggests, however, that instead of catastrophic plate tectonics that produced volcanic eruptions in mid-oceans to produce the heat that warmed the ocean waters, it was the "fountains of the great deep" that burst open to supply the warm water.

> In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened. And rain fell upon the earth forty days and forty nights. (Genesis 7:11–12, RSV)

Oard (1990:6) points out:

> The earth's crust warms about 10°F per 1000 feet (2°C per 100 m) depth. If the water for the fountains came from 3000 feet (900 m), it would be quite warm. If it came from 10 000 or more feet (3000 m), the water would have been hot.

Therefore, in Oard's model, this hot water was added to the water that came from rain that fell during the 40 days and 40 nights of the Noachian Flood, and the warmed water would supply copious quantities of vapor that would have precipitated as the large volumes of snow that produced the one-time continental Ice Age. He combines this "fountains-of-the-deep" model with abundant volcanism in wide parts of the world during the Pleistocene Epoch to produce huge amounts of ash and gas that were trapped in the stratosphere. This ash and gas would act as an "anti-greenhouse":

> instead of warming the earth, it would reflect sunlight back into space and cool it. At the same time, infrared radiation would continue to escape the earth. (Oard 1990:3).

He suggests that this cooling by both processes is what caused the water vapor to precipitate as snow in the north polar regions to produce the Pleistocene one-time Ice Age.

FIGURE 2. *Generalized geographic map of North America in Pleistocene time. (Map from the United States Geological Service, http://pubs.usgs.gov/gip/continents/.)*

GLACIATION DURING THE PLEISTOCENE EPOCH

Vardiman (1993) points out that the farthest advance of the Pleistocene continental glaciers was nearly to the southern end of Illinois (Figure 2), but claims that this advance represents the maximum extent of the ice mass during a one-time Ice Age event that supposedly lasted only 500–600 years. According to the uniformitarian model, 500–600 years would represent only the last part of the Wisconsinan stage, the youngest stage of the Pleistocene

Epoch, which may have lasted nearly 57 000 years (Table 1). Although Vardiman (1993) and Oard (1990, 2004, 2005) indicate "fluctuation" or "surges" of a single ice mass, Snelling (2009), on the other hand, claims that there was only one ice advance and only one retreating ice sheet, and that there never were interglacial periods.

Table 1. *Holocene and Glacial and Interglacial Stages of the Pleistocene Epoch*

	Dating (thousands of years before present)	Duration (thousands of years)
Holocene	0–10	10
Wisconsinan	10–67	57
Sangamon	67–128	61
Illinoian	128–180	52
Yarmouthian	180–230	50
Kansan	230–300	70
Aftonian	300–330	30
Nebraskan	330–470	140

Adapted from Gleason and Stone (1994:153, table 7.1). Glacial stages are in **boldface***; interglacial stages are italicized.*

Nevertheless, all these authors seem to ignore the evidence for interglacial times and older Kansan and Nebraskan stages (Table 1; Dutch 1997; Stanley 2009; Wicander and Monroe 2010). Note that the older Kansan and Nebraskan stages listed on Table 1 are no longer valid names. Because of more complicated pre-Illinoian glaciation of the central United States, other names are now substituted, such as the Independence stage (Richmond and Fullerton 1986; GAGE 2000). But these name changes and calling such older glacial stages as "pre-Illinoian" give a better understanding of the glacial history.

If all four formerly accepted glacial stages of Table 1 (or so-called "fluctuations" in Vardiman's model) were in a single Ice Age event, then all the various glacial tills deposited in that single event should have approximately the same age and have the same amount of time available for soils to form on top of them by weathering processes.

The amount of time since the end of Vardiman's "one-time Ice Age event" is estimated to be 4011 years. That is, if the Noachian Flood is alleged to have occurred in 2500 BCE and if the Ice Age lasted 500 years, the end of the Ice Age would be 2500 minus 500 or 2000 BCE. From that end-time until the present year of CE 2011 is 4011 years for soil formation to occur.

Soils formed during the Pleistocene Epoch

According to the conventional geologic model, the youngest glacial ice cap is Wisconsinan in age, and its terminal moraine (the moraine that records the farthest advance of the glacier) is about 230 km south of Chicago in the middle part of Illinois. The farthest advance of all the continental glaciers from Canada south into the United States was during the Illinoian stage, and its terminal moraine is near the southern tip of Illinois, near Carbondale, 465 km south of Chicago (Figure 2). Soils that occur on the ground moraines of both Wisconsinan and Illinoian age have formed from the loess that overlies each of these moraines. (The origin of this loess is discussed in the next section.)

There are numerous soil types in Illinois, but mollisols and alfisols are the dominant types (USDA nd; Barnhardt 2010). Mollisols occur in 45 percent of the state's land area in northern Illinois on loess lying above Wisconsinan glacial till. Alfisols occur in 45 percent of the state's land area in southern Illinois on loess on top of Illinoian glacial till.

Soil formation is a very slow process. Older soils have deeper and thicker subsoil horizons if other soil producing factors remain constant. The alfisols in southern Illinois have a thick soil profile and support a mixed conifer and deciduous forest. They have been deeply weathered in the following way: (1) the feldspar grains in the loess have been extensively converted to clay in a thick soil profile, (2) iron-bearing minerals have been oxidized to form red hematite (iron oxide) and yellowish brown limonite (hydrated iron oxide), and (3) calcium in calcium carbonate cement and other elements have been leached out for depths of several decimeters. As a result, the alfisols in southern Illinois are light brown.

In contrast, in northern Illinois the mollisols are black and were originally covered by prairie grasses whose roots decomposed to make the soil rich in black organic matter (USDA nd). The mollisols exhibit a less thick soil profile in which (1) the feldspars in the loess are not as extensively converted to clay to the same depth as in the alfisols, (2) the iron-bearing minerals are not as oxidized to form hematite and limonite, and (3) little leaching of calcium and other soluble elements occurs. The alfisols in southern Illinois are not nearly as productive for agriculture as are the mollisols (USDA nd). Farmers living in Illinois north of the Wisconsinan terminal moraine enjoy rich farmland and do not have to add lime to their black mollisols, whereas farmers living south of the Wisconsinan terminal moraine have to add lime and other fertilizers to their brown alfisols to replenish the missing leached elements.

These differences in the color and the characteristics of the mollisols and alfisols show an important relationship that Vardiman (2009), Snelling (2009), and Oard (1990, 2004, 2005) have not considered in their models; nor have they any explanation for them. Various factors determine the soil type, including topography (rolling hills or flat plains), vegetation (forest or grasses), climate (temperature and precipitation), and time (USDA nd). Given that the distance between these two soil types is a kilometer or less and they exist on terrain at essentially the same elevation, separated only by the Wisconsinan terminal moraine, how could these soils have been formed and modified simultaneously after a single Ice Age event at about 2000 BC? Because the black mollisols to the north and the brown alfisols to the south differ across this short distance and the climate is the same for both areas, some other factors must have produced the differences. Vardiman's, Snelling's, and Oard's models do not explain why. Oard (1990) dismisses the evidence for soils forming on loess during interglacial stages because he believes that correlations of horizons in soil profiles and rates of deposition of loess are not dependable. Nevertheless, different soils exist, and rates of deposition and horizon correlations are not the deciding factors as to whether interglacial stages occurred.

Glacial till of the Illinoian stage and its overlying weathered brown alfisols can be traced north under the younger Wisconsinan glacial till and its black mollisols for several hundred kilometers (Table 1; Dubsky and others 2000; Soller and others 1999; Kolata and Nimz 2010; McKay and others 2008; Hansel and others 1999). Because the Illinoian till and its weathered alfisols are buried under the Wisconsinan till and its mollisols, the Wisconsinan terminal moraine cannot be a recessional moraine of the same Illinoian glacier that nearly reached the southern tip of Illinois.

Not only did multiple glaciations cause the distribution of soils of different ages to vary, but they also caused topography to vary. When there has been more time for erosion, streams will have cut down into the soil and underlying rock and created rolling hills, typical of southern Illinois (USDA nd). Northern Illinois, on the other hand, has nearly flat topography, indicating that little time for erosion has been available following the disappearance of the last glacial ice cover. In other words, the difference in topography also supports the supposition that the alfisols in the south and mollisols in the north are not the same age—as would be expected if these soils had formed nearly simultaneously on loess of the same age during a one-time Ice Age as proposed by Vardiman (1993, 2009), Snelling (2009), and Oard (1990, 2004, 2005).

Loess formation during the Pleistocene Epoch

Another feature of continental glaciation that has been totally ignored by Vardiman (1993, 2009), Snelling (2009), and Oard (1990, 2004, 2005) is the occurrence of loess (wind-blown ground-up rock called "glacial flour") on which the mollisols and alfisols were formed. Each of the four continental ice caps in Canada (or the one-time ice cap of Snelling 2009) was probably 2400–3000 meters thick (Anonymous 2011) in order for them to flow by gravity as far south as the middle and southern tip of Illinois (Figure 2). When these ice caps began to melt back, becoming less thick and decreasing their widths, huge amounts of flood waters drained off the surface area of the ice, eroded through the bordering moraines, and transported large quantities of glacial flour downstream. Much of this powdered rock would have been deposited as silt in river flood plains, in some places as much as 100–300 kilometers wide, and these flood plains would have extended across western United States south of the Canadian border. (This width is logical but has not been documented in the literature. However, it is commonly accepted knowledge.)

During winters when little to no meltwater was coming from the ice cap, these flood plains would dry out, allowing the silts (finely powdered quartz and feldspar crystals) to be converted into dust. Then, cold winter winds coming from the northwest and blowing across the flood plains would pick up this dust and transport it eastward in huge dust storms. In this way, the exposed glacial tills in Iowa, Illinois, Indiana, and Ohio became covered with this dust, known as loess. Loess layers, as much as 70 meters thick, were deposited in the Loess Hills of Iowa and Missouri along the eastern side of the Missouri River valley (USGS 1999; Prior and Quade nd). East of the Illinois River valley in Illinois the loess is 7–10 meters thick (personal observation), and then progressively farther east, the loess deposits diminish in thickness to less than a decimeter in Ohio.

Because each glacial stage allowed thick loess to be deposited on top of the older Illinoian and pre-Illinoian (Kansan and Nebraskan) glacial tills, each of these loess deposits becomes evidence for younger interglacial stages. This means that former ice caps covering

Canada had to melt back at least three previous times to expose these glacial tills so that the loess could be deposited on top of each of them. This cyclic, repeated, extensive melting in the midst of a supposed one-time Ice Age alternating with vast volumes of snow precipitated in very cold climates cannot logically happen in 500–700 years. That is, the models proposed by Vardiman (1993, 2009), Snelling (2009), and Oard (1990, 2004, 2005) do not provide a climatic mechanism to cause such rapid melting or ablation of large volumes of ice in a cold Ice Age in such a short time during the Sangamonian, Yarmouthian, and Aftonian interglacial stages (Table 1). Moreover, the statement by Snelling (2009) that there "never were interglacial periods" is completely negated by the occurrence of loess deposits on tops of the glacial tills. Although Oard (2005) argues that a succession of atmospheric carbon dioxide and methane contents of the ice in the Vostok ice core in Antarctica give evidence for a single Ice Age, Petit and others (1999) argue that these data indicate four glacial-interglacial cycles during 420 000 years.

Qualifying statements

Actually, Vardiman (2009), Snelling (2009), and Oard (1990, 2004, 2005) do not specify when the end of the one-time Ice Age occurred although they suggest that it lasted 500–700 years. Since these authors consider that the ice caps on Greenland and Antarctica were rapidly deposited, they presumably would concur that these ice caps are remnants of their one-time Ice Age. According to these young-earth proponents, these ice caps would remain because both are surrounded by polar oceans that supply moisture that falls as annual snow during winters and because less snow melts during the summers than has fallen during the winters. Nevertheless, because Snelling argues that the average thickness of the ice sheet on the North American continent was only 700 meters (and presumably did not have a maximum thickness of 2400–3000 meters as estimated by glaciologists (Anonymous 2011), most of the ice in his explanation must have been gone in recent history because of rapid melting. However, if the end of the ice coverage in North America is not 500–700 years following the Flood at 2500 BCE or 4011 years ago but at some younger time, this would leave even less time in Vardiman's, Snelling's, and Oard's models for the deposition of loess on the tops of the glacial tills. And this would further limit the development of soils on this loess and the erosion of the glacial-till-covered landscapes to produce rolling hills in southern Illinois.

^{14}C-isotopic dating

According to Vardiman (2009), the Ice Age followed on the heels of the worldwide Noachian Flood dated at approximately 2500 BCE. One must then question the actual timing and validity of the global Flood envisioned by young-earth proponents (Senter 2011). ^{14}C-isotopic dating, although questioned by young-earth creationists, has produced results that verify the accuracy of the ^{14}C-dating method. For example, the ^{14}C-date of plant fragments found in plaster in King Hezekiah's Siloam tunnel is the same as that recorded in biblical records to be 2711 years ago or 700 BCE (2 Kings 20:20; Rogerson and Davies 1996; Bower 2003; Frumkin and others 2003; Deem 2006). This date is consistent with the reign of King Hezekiah from 727 BCE to 698 BCE.

On that basis, ^{14}C-dating of 11 850 years ago is not unreasonable for logs, branches, needles, and pine cones in a spruce, pine, and hemlock forest buried by a glacial moraine that was deposited during a very late advance of the glacier ice cap of Wisconsin age at Two

Creeks, Wisconsin, near the western shore of Lake Michigan (Black 1974). This date of 11 850 years ago is much older than 2000 BCE that is estimated for the models of Vardiman, Snelling, and Oard for the end of the 500–700-year–long, single Ice Age.

Furthermore, ^{14}C-dating of spruce wood, cones, and needles in a forest buried under loess near Charleston, Illinois, about 58 kilometers north of the Wisconsinan terminal moraine, give dates of about 20 000 years ago (Hansel and others 1999). This forest was growing in and adjacent to a former shallow thermokarst lake (created by thawing of permafrost) on top of Wisconsinan glacial till near Shelbyville, Illinois. This lake is about 600 kilometers south of the above-mentioned buried forest at Two Creeks, Wisconsin, dated at 11 850 years ago. On the basis of the different ages of the two buried forests, there was about 8150 years for the Wisconsinan glacier to retreat (melt back) across this 600 kilometers, and this time, of course, is also longer than the 6000 years favored by Vardiman (1993) for the age of the earth . If the ^{14}C-dating method gives values that are consistent with biblical records, it is logical that the dependable, natural, physical laws, which the Creator made, should also be dependable for ^{14}C-dating applications to older glacial features.

Conclusions

Vardiman (1993, 2009), Snelling (2009), and Oard (1990, 2004, 2005) can omit data to make their models work, but we generally expect that scientific studies include all relevant data in developing a hypothesis. These authors have not done so.

There are no known physical laws that would allow catastrophic movements of 100-km–thick oceanic-basaltic crustal masses across thousands of kilometers, rapid eruptions of great numbers of volcanoes over the entire planet, and subsequent warming of planetary oceans through these processes. The creationists propose that the Ice Age was a single event, lasting 500–700 years with “fluctuations” or “surges” of ice advances during this single event. This model is ingenious but faulty.

The problem with their model is the evidence of three (and possibly more) well-formed (thick) soil profiles on top of each supposed glacial “surge” during the 500–700 years projected in the creationists’ model of the Ice Age. Weathering of loess and glacial till to form a soil by hydration and oxidation of silicate minerals is a very slow process in a cold climate—as is quite apparent by observations made in the last 4000 years in northern United States, Canada, Europe, and Asia. The lack of well-developed soils in these northern regions contrasts with thick, well-developed soils formed in hot tropical climates near the equator in Brazil.

The creationists use an accelerated model for the deposition of great amounts of snow and ice in 500–700 years but seem not to realize that this acceleration also requires (1) simultaneous acceleration of melting and ablation of three ice caps that are 2400–3000 meters thick and (2) subsequent acceleration of weathering and soil formation between “surges” during this same short time. Even the alleged 4011 years (but probably more than 11 850 years and as much as 20 000 years) since the end of the melting of the Wisconsinan glacier are not sufficient time to produce a soil profile on loess as thick and well-developed as occurs on the underlying older Illinoian loess, supposedly formed in less than 700 years. Thus Vardiman, Snelling, and Oard have not produced sound scientific models. There is no valid evidence, claimed by Snelling, that there was only one ice advance and only one retreating ice sheet, and that there never were interglacial periods.

These authors ignore those data that do not support their models: data supporting at least four different ice ages, but perhaps as many as six (Johnson 1986) that occurred within the last 680 000 years. Their models cannot account for (a) the long times necessary to form deeply-weathered, oxidized, brown alfisols in southern Illinois compared to less-weathered and oxidized, black mollisols on younger Wisconsinan glacial till in northern Illinois; (b) the deposition of loess on tops of layers of exposed glacial tills, requiring long periods of melting between continental ice-cap depositions; and (c) age dating by ^{14}C-methods, placing logs, branches, needles, and pine cones in a spruce, pine, and hemlock forest buried in a most recent moraine (Wisconsinan) near Two Creeks, Wisconsin, at 11 850 years ago and for a similar buried forest at Charleston Lake in southern Illinois, dated at 20 000 years ago.

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