FOSSILS AND THE FLOOD

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Introduction

The Bible describes a worldwide catastrophe that destroyed nearly all humans and land animals in a flood. The story of the flood is now ridiculed by many educated people, with claims that science has shown that the biblical flood never happened. Since the flood story is an integral part of the biblical record of history, the claim of scientific disproof is a serious challenge to Christian faith. But does the scientific evidence truly disprove the flood, or is there evidence that such an event could have happened? The purpose of this paper is to explore some of the physical evidence that seems consistent with a worldwide flood and challenges the evolutionary paradigm. The author is not an expert in geology, but suitable references are supplied to permit interested persons to explore the subject in greater depth than presented here.

Problems with the geologic time scale

Standard geological interpretations propose a very old age for the existence of life on the planet Earth. But some geological features suggest otherwise. We will examine some of these to illustrate that the geologic time scale seems to be wrong. Discussion of these points was largely taken from Roth (1977, 1986, 1988), as well as other sources.

Mountains and erosion. *Rates of erosion.* Erosion rates provide one difficulty for the geologic time scale. Roth (1986) has done some calculations on the length of time needed to erode the continents. The average rate of erosion at present is estimated at 61 meters per million years (Ma; Judson and Ritter 1964). According to Roth (1986), this rate is sufficient to erode the continents down to sea level in only 10-30 Ma. Yet the continents are believed to be hundreds of millions of years old. Erosion takes place more rapidly in mountainous regions than on plains, and one would expect that the mountains would be gone long before the continents would be eroded away. Yet mountains remain, some of them, such as the Appalachians of North America, believed to be hundreds of millions of years old.

Rates of uplift. One possible explanation for the continued existence of mountains is the fact they seem to be continually uplifted. Present measured rates of uplift range from about 1-1.5 km/Ma for the Alps (Mueller 1983) to about 10 km per Ma for portions of the Rocky Mountains and the Appalachians (see Roth 1986 for additional references). If this rate were to continue for millions of years, it is clear that mountains would tend to rise to unimaginable heights, resulting in greatly increased rates of erosion. The conventional time scale does not seem to fit the observations on the rate of mountain uplift.

Fossils on mountaintops. One might wonder whether uplift and erosion might be in some kind of near-equilibrium, so that the height of the mountains is maintained at some relatively stable level. If this were so, one would expect the sediments on top of the mountains to be eroded away in a few million years, with only the basement rock (granite) remaining. But this is often not the case. Mountains commonly are covered with fossiliferous sedimentary layers. The Appalachian Mountains can serve as an example.

The Appalachian Mountains of the eastern United States are composed of folded and faulted beds of Cambrian and Ordovician sediments. Uplift of the Appalachians is believed to have occurred near the end of Paleozoic deposition, at least 250 million years ago by conventional geological estimates. At the present average rate of erosion of the North American continent, over 15 km of material would have been eroded from the Appalachian Mountains in 250 Ma. Erosion would have been faster if the mountains were higher. Taking a conservative figure of 1 km of uplift per million years, the Appalachians would have been uplifted 250 km in 250 Ma. Since about 2 km of sediments remain above sea level, this means that present erosion rates would have removed about 248 km from the top of the Appalachians, rather than only 15 km. Even 15 km of erosion off the top of the Appalachians should have long ago removed any trace of Paleozoic sediments, yet they remain. The existence of fossils on "old" mountains seems inconsistent with the effects of millions of years of uplift and erosion. The presence of marine fossils on "old" mountaintops seems more consistent with the effects of a worldwide flood.

Ocean sedimentation. Another difficulty with the long ages model is ocean sedimentation. The present rate of sedimentation into the oceans is estimated at from 4-25 km^3 per year (see Roth 1986). At a rate of 10 km^3 per year, all the ocean basins could be filled in about 150 Ma. Some have tried to explain the lack of sediment by subduction, but the rate of subduction is too low, and ocean floor basalts have a different chemical composition from granites, so they have not been recycled into granites. The erosion needed to supply the amount of sediment expected would have removed the geologic column from the continents. Since the fossil layers remain on the continents, it seems the earth may be much younger than commonly thought.

The Atlantic Ocean. The formation of the Atlantic Ocean provides a specific example of the problem (Coffin unpublished). The Atlantic Ocean is believed to be presently expanding at a rate of 2 cm/yr. One can consider that the Atlantic expands each year by the equivalent of a "crack" 2 cm wide, 4 km deep, and 15,000 km long. The volume of this "crack" is about 1.2 km^3. The Atlantic Ocean contains about 24% of the earth's water. Estimating that 20% of world ocean sedimentation goes into the Atlantic, and using a figure of 10 km^3 per year, means that 2 km^3 of sediment are deposited in the Atlantic each year. This is much more than required to keep filling the expanding ocean basin. Yet the Atlantic Ocean does exist. This may also be interpreted as suggesting the Atlantic ocean basin is younger than is commonly thought.

Stratigraphic contacts. The boundaries between different strata also give evidence that the geologic time scale may not be correct. Two types of evidence will be described here: clastic dikes and paraconformities.

Clastic dikes. In many rock layers, cracks are found that are filled with sediment from another layer either above or below. These infillings are called clastic dikes. The process of formation of clastic dikes can be compared with mud oozing up between one's toes as one steps down onto a layer of soft mud. In order for a clastic dike to be formed, the lower sediment must be uncemented and soft enough to flow upward under pressure into the crack. This implies that a relatively short time elapsed between the deposition of the soft layer and the layer containing the filled cracks.

Roth (1977) describes an example of intrusion of a clastic dike composed of material supposedly 400 million years old at the time of its intrusion. This particular dike is found in the Front Range of Colorado, north of Pikes Peak. The Cambrian Sawatch sandstone intruded the underlying Precambrian granite. The intrusion is associated with the uplift of the Rocky Mountains, which occurred during the deposition of Cretaceous sediments. If the geologic timescale is correct, the Cambrian sandstone should have been lithified for hundreds of millions of years before the intrusion. Lithified rock should have been too brittle to flow into the Precambrian granite as a dike. Clastic dikes composed of material supposedly millions of years old when the dike was formed present a problem for the long geologic timescale. Either the dike material was plastic and uncemented for those millions of years, or the layers were deposited in a short time. The latter case is more consistent with the structural relationships, and with the biblical record of a world-wide flood.

Paraconformities. Paraconformities (see Roth 1988) are found where two superposed sedimentary layers representing great differences in standard geologic time are found lying flat one above the other. In the present world, virtually all surface areas are undergoing either deposition or erosion. Deposition tends to fill in an uneven surface while erosion tends to produce an uneven surface. Any surface left exposed, without deposition occurring, would tend to become increasingly uneven as erosion proceeded.

It is generally held that no locality on earth contains a complete depositional sequence of the entire history of the earth. Certain layers are missing from any local geological sequence. The missing layers often represent supposed millions of years according to the geologic timescale. If deposition were to stop for millions of years, one would expect to see the effects of erosion. Yet in many such cases, the layers lie flat one upon another, with no evidence of the extensive erosion one would expect to see in a surface exposed for millions of years. This observation suggests that the layers may have been deposited rapidly, one after the other, rather than being separated by long ages. An example from the Grand Canyon is described below.

The walls of the Grand Canyon show many parallel layers piled on top of each other. One of these layers, the Redwall limestone, forms prominent cliffs. Below the Redwall limestone is the Temple Butte limestone, with Devonian fossils. Below this is the Muav Limestone, which contains Cambrian fossils. These Cambrian and Devonian sediments are supposedly separated by over 100 Ma, yet the layers are remarkable parallel. One would expect either continued deposition or considerable erosion, or both, during a period of 100 million years. Their absence seems difficult to reconcile with the long periods of time postulated, but is consistent with the actions of a worldwide flood.

Summary. Several features of the geologic record suggest problems with the geologic time scale. Erosion rates are not consistent with the presence of fossil layers on mountaintops. Stratigraphic contacts often have features that suggest relatively rapid deposition of successive layers. Another feature is that present rates of deposition would fill in the Atlantic Ocean, and should have prevented its formation (Coffin unpublished). These considerations taken together show that either the present is much different from the past or that the conventional geologic timescale is incorrect or both. The following section will outline some geological evidences that suggest that both may be true. The concept of a worldwide catastrophic flood should be considered as a superior explanation for these features.

Evidences for catastrophes in the geologic record

Geology has traditionally been interpreted according to the maxim, "the present is the key to the past." The classical position of geologists has been that sediments accumulate slowly, in ways similar to those observed today. But much evidence in the geological column indicates a past that was very different from the present. More recently, geologists have recognized catastrophes as playing an important role in the formation of the sedimentary layers. This thinking has promoted increased exploration of questions concerning rates of geological processes. Examples are given below that indicate catastrophic activity on a scale unparalleled today.

Paleontological evidence of catastrophe. *Mass burials.* Fossils are rarely formed at present except in special, highly localized conditions. Organic remains are normally recycled back through the ecosystem. Yet mass concentrations of fossils are often found in the geologic record. The Burgess Shale of Alberta, Canada, is one such example (Conway Morris and Whittington 1979). The existence of large quantities of fossils is a phenomenon requiring an explanation.

Mass mortality occasionally occurs in today's oceans. One such event occurred in 1983 among sea urchins in the Caribbean. A later search failed to detect evidence of this mass mortality in the sediments of the reefs inhabited by the sea urchins (Greenstein 1989). It seems that this mass mortality is not the kind of event recorded in the fossil layers. Mollusk shells may also illustrate the unusual nature of fossiliferous deposits. Mollusk shells are exceptionally abundant in the fossil record. Local subtidal accumulations of shells may be found at present (Russell 1991), but it seems doubtful that these localized conditions can explain the extensive shellbeds sometimes found in the fossil record. Large concentrations of fossils can probably best be explained as evidence of large-scale catastrophic activity, and not as the gradual accumulation of organic remains. The excellent condition of many preserved fossils also points to rapid, catastrophic burial.

Mass extinctions. Different species and higher taxa are present at different levels in the stratigraphic column. Such taxa generally appear and disappear abruptly in the fossil record. The well-known missing-link problem deals with abrupt appearances of species. Abrupt disappearance is also a significant feature of the fossil record. The last appearance of a species in the fossil record is usually interpreted to indicate the extinction of that species. Simultaneous extinctions of many species are often used to identify the boundaries between subdivisions of the geologic column. Certain points in the stratigraphic column are marked by the abrupt disappearances of large numbers of species. These points are identified as mass extinction events. Such world-wide extinctions require a world-wide process as an explanation.

The greatest mass extinction of all is the end-Permian extinction. At this point in the geologic column, about 57% of the marine families, 78-84% of genera, and 90-95% of species disappear from the fossil record (Sepkoski 1984, 1989). This compares with about 10-33% generic extinction for Mesozoic and Cenozoic stratigraphic intervals (Sepkoski 1989). Major mass extinctions are also found at the top of the Triassic and the top of the Cretaceous.

The Cretaceous-Tertiary (KT) mass extinction has generated the most interest and the most controversy. Heightened interest in this question comes partly because it involves the dinosaurs, which are popular with the public. Much of the controversy surrounds the proposal that the extinction was caused by an extraterrestrial impact. Dinosaurs are relatively common in Jurassic and Cretaceous sediments, but are (arguably) not found in strata higher in the geologic column. Many other groups also disappeared from the fossil record at the end of the Cretaceous. One such group was the ammonites, which were swimming, shelled mollusks. About 60-76% of all Cretaceous marine species (Crutzen 1987), including 90% of coccolithophorid (a family of unicellular algae) genera and planktonic foraminifera (McLean 1985) are not found in strata above the Cretaceous. Thus there is considerable extinction across the KT boundary.

An important feature of the KT boundary extinction is its selectivity (Jablonski 1986, McKinney 1987, Officer et al. 1987). Marine families suffered the highest rates of extinction, with less effect on terrestrial groups. Fossils of insects and freshwater organisms are found through the KT boundary with little change (Crutzen 1987, Hutchinson and Archibald 1986, Whalley 1987). Among plants, there is more change in the kinds of evergreen trees than in deciduous trees (Wolfe and Upchurch 1987), and an abrupt change from angiosperm pollen to fern pollen has been recorded at the boundary (Saito, Yamanoi and Kaiho 1986).

It is important to note here that creationist interpretations of fossil patterns may differ widely from evolutionist interpretations. More specifically, the presence of fossils of freshwater organisms both below and above the KT boundary does not necessarily indicate these organisms survived the mass extinction believed to have occurred at the boundary. It merely means that their remains were deposited both before and after the boundary event. Presence of a fossil in a particular layer does not necessarily indicate the organism was living at the time it was buried. Neither does the highest occurrence of a fossil indicate the time of its extinction. The fossil may have been reworked from some previous deposit, or it may have been floating or suspended in the water for some time previous to burial. Alternatively, it may not be truly extinct, since many species have gaps in their fossil records.

A large amount of research is presently being conducted in an effort to identify the nature and causes of mass extinctions in the fossil record. At one time, the rate of sedimentation was assumed to be more or less constant throughout geologic time. Abrupt appearances and disappearances were explained as the result of interruptions in deposition. More recently it has been recognized that uniform sedimentation rates cannot explain the features of the fossil record, and the role of catastrophes in earth history is increasingly recognized. A catastrophe can rapidly deposit significant amounts of sediment in a short time, and it is more likely that the record of such events will be preserved over time than would be the case for ordinary, gradual processes. Thus, the stratigraphic column seems to be largely a record of catastrophic activity.

Extraterrestrial impacts. *Evidence of impacts.* Meteorites are rocks that fall to the earth from space. Meteorites have a mineral composition that is different from minerals in the earth's crust. Their composition is believed to be more similar to that of the moon and the earth's mantle. Fortunately, most meteorites are quite small. The largest known meteorite is the Hoba meteorite in southwest Africa (McCall 1973). The Hoba meteorite is about 3 meters in length and one-half meter in diameter, and now weighs an estimated 60 tons, although its weight may have been 100 tons before its impact. It did not produce a crater in the limestone where it landed.

Scientists have recently discovered that small asteroids occasionally pass near our earth more often than thought. One such object of about 300 m in diameter missed the earth by about 750,000 km, twice the distance to the moon, in 1989 (Chapman and Morrison 1991). If the asteroid had struck the earth, it probably would have released the equivalent energy of 50,000 Hiroshima bombs, and left a crater about 3 km in diameter. The 1908 explosion over Tunguska, Siberia is now thought to have been caused by a stony meteorite striking the earth's atmosphere (Chyba, Thomas and Zahnle 1993).

An impact of a large meteorite or comet would be expected to produce a crater on the earth's surface. Many such craters are known. Nearly 100 meteorite craters have been identified in the fossil layers (Grieve 1987). Two of these craters have a diameter of at least 100 km, indicating a major catastrophic impact. One of these large craters is in Russia, the other is in Canada. Since the ocean surface is about three times as great as the land surface, it is reasonable to suppose that nearly 400 large meteors may have fallen while the geologic column was being deposited. If the geologic column was mostly deposited in a short time during a worldwide flood, the flood must have involved a series of catastrophic events.

Geologic features of the KT (Cretaceous-Tertiary) boundary present interesting evidence relating to a possible extraterrestrial impact. A clay layer with unusually high levels of iridium has been discovered at the KT boundary in several widely spaced localities (Alvarez et al. 1980). The widespread existence of the boundary clay has been interpreted as evidence for a worldwide event at the boundary. Iridium is found in higher concentrations in meteorites than in rocks of the earth's crust, and its high concentration in the boundary clay has been interpreted to be the result of a collision between the earth and either an asteroid or a comet. Shocked quartz grains are also found at the boundary (Bohor et al. 1984), and high levels of carbon, mainly soot (Wolbach et al. 1988). The production of shocked quartz grains requires an event of considerable force, such as a nuclear explosion or meteoric impact. The soot has been explained as possibly the result of a global fire triggered by heat from a meteoric or asteroidal impact. Together, these features have led to the development of the impact hypothesis as a cause of mass extinctions.

Effects of impacts. According to the end-Cretaceous impact hypothesis (Alvarez et al. 1980), an extraterrestrial object about 10 km in diameter struck the earth at the close of the Cretaceous. The resulting dust cloud obscured the sun for several months, causing prolonged darkness, cooling, and acid rain (Crutzen 1987, Diamond 1983). Many species could not cope with such alterations of the environment and became extinct. Species resistant to the environmental disturbance would be more likely to survive, explaining the selective nature of the extinctions. Few hypotheses in recent years have stimulated as much research and provoked as much controversy in science as has the impact hypothesis.

Calculations by scientists indicate that the impact of a 10-km diameter extraterrestrial object would be a catastrophe almost beyond our ability to envision. The energy of the impact would have been about 10^{23}-10^{24} J (Crutzen 1987) (1 J = 10^7 ergs). The results of such an impact (Clube and Napier 1982) might include a blast wave that would kill off any life over half the world, with an air temperature of 500 °C and windspeed of about 2500 km/hr. Nitric oxides produced in the fireball would destroy the earth's ozone level, exposing survivors to life-threatening UV light. Global earthquakes with ground waves 10 m high would result. If the object hit the ocean, it could generate waves as high as 500-1000 m at a distance of 2000 km from the impact target. The earth's core would be disrupted, possibly producing magnetic reversals. Plate movement would be accelerated, opening cracks

10-100 km wide in the earth's crust, and causing rapid mountain-building and worldwide vulcanism. If the calculations are correct, it is difficult to understand how any significant number of species could survive such an event.

The impact hypothesis as a cause for mass extinction has been challenged by many paleontologists on several grounds (Officer and Drake 1983). There is more than one iridium peak, iridium has been detected in volcanic emissions (Zoller et al. 1983), and fossil extinctions appear stepwise rather than simultaneous. No obvious impact crater of sufficient size (200 km diameter) has been discovered, and some scientists have proposed that a group of extraterrestrial objects struck the earth (Hut 1987). This would better explain the multiple iridium peaks, smaller size of craters, and stepwise fossil extinctions. Several impact craters are known at approximately the KT boundary. More recently, a large subterranean circular feature in Yucatan, Mexico, has been proposed as a possible site for a large end-Cretaceous extraterrestrial impact (Hildebrand et al. 1991). Named the Chicxulub Crater, the diameter is about 180 km, which is close to that expected for a impactor of about 10 km in diameter. If this tentative interpretation is upheld, the impact hypothesis will probably be considered to have been verified, and opposition to it will become more subdued.

Summary. Catastrophic activity is now recognized throughout the geologic column. The existence of large numbers of fossils is best explained as due to one or more catastrophes. Evidence of probable extraterrestrial impacts suggests catastrophes of far greater magnitude than any event in our experience. Additional evidence of catastrophism, not discussed here, includes rapid, large-scale movements of sediment such as turbidites and megabreccias (see Roth 1986, Chadwick 1978). Such evidence is consistent with what one might expect from a worldwide flood, and may aid our understanding of this event.

Evidence for a worldwide flood

Some critics have suggested that the biblical flood was actually a localized catastrophe that has been exaggerated in the form of a legend. But there is evidence that catastrophic activity has affected the entire world.

Marine fossils on the continents. The present ocean basins are composed of basalt, while the continents are composed largely of granitic materials. Granite is less dense than basalt, and it is believed that this is why the continents rise higher than the ocean basins. The crust is believed to "float" on the semi-liquid mantle. The greater density of basalt causes it to sink lower than granite, forming the ocean floors.

One would expect the ocean floors to be covered with marine fossils. This is pretty much the case, as a constant "rain" of planktonic skeletons sinks to the ocean floor. However, the amount of sediment on the ocean floor is insignificant compared to the amount of sediment on the continents. Surprisingly, marine sediments comprise a large proportion of the sediment on the continents. There is much more marine sediment on the continents than in the ocean. This indicates that the continents were once covered with water. This is true for all the continents, and indicates that conditions were similar over the entire world. The presence of vast quantities of marine sediments on all the continents is the type of evidence one would expect from a worldwide flood.

Turbidites. On November 18, 1929, an earthquake shook the Atlantic Coast region of North America just south of Newfoundland. There were twelve underwater transatlantic telegraph cables along the coast at the time (Heezen and Ewing 1952). Half of these broke at the time of the earthquake. A few minutes later, another cable broke, then another, in a sequence from north to south. The last cable broke about 13.3 hours after the earthquake.

An investigation revealed the reason for the pattern in the breaking of the cables. The earthquake had shaken loose a large amount of sediment, causing it to flow like an underwater avalanche of mud. The water buoyed the particles of loose sediment, reducing friction and permitting the sediment to flow rapidly. This type of underwater sediment flow is known as a turbidity current, and the deposit formed is called a turbidite. This particular turbidity current flowed down the continental slope into the deep ocean, breaking cables as it went. The turbidite covered more than 100,000 square miles with an average thickness of 2-3 feet of sediment. The speed of the turbidity current could be calculated from the time and location of the cable breaks. On the continental slope the turbidity current traveled about 90 km/hr, slowing to about 20 km/hr on the ocean floor. This experience opened up a new understanding in geology.

Turbidites have certain characteristics that aid in their identification. Typically, the lowest part of a turbidite is made of very fine particles in thin flat-lying layers. Above this is a swirled layer, also of fine particles. The larger particles are often at the top. This peculiar type of sedimentary structure is unique to turbidites, and has aided in the identification of turbidites in the geologic record. Tens of thousands of turbidite layers have been identified. Many of these were originally interpreted as laid down slowly in quiet water. Now it is known that they were laid down rapidly. Turbidites are evidence of rapid deposition under water, the very kind of evidence one would expect from a worldwide flood (see Roth 1975).

Abrupt lithological changes from one type of sedimentation to another are often seen in the strata. For example, marine sediments may alternate with terrestrial sediments, with little or no evidence of gradation from one type to the other. If long ages were involved in deposition of these sediments, one would expect to find more evidence of gradation or mixing. The abruptness of lithological changes seems difficult to explain in a long-age model. Such abrupt changes are generally interpreted as due to erosional unconformities, but one wonders why there is so little erosional mixing at the surface. A rapid change in the source of the sediments seems indicated. This might be due to pulsing currents or to rapid changes in currents during a worldwide flood.

Summary. The presence of greater quantities of marine deposits on the continents than on the ocean floor seems anomalous. Extensive marine sediments on all the continents suggest a worldwide flood. The existence of thousands of layers of turbidites suggests that much of the world was covered by water, with rapid deposition of sediments. These observations, with other evidence (see Roth 1986), can be interpreted as evidence of a worldwide flood.

Evidence for a stepwise catastrophe

The biblical account of the flood is exceedingly brief. Most of what is revealed can be summarized by stating that the waters rose and then retreated. Speculations of how this was accomplished have varied widely. Some have seen the flood as quickly destroying all the land animals. Others have suggested the flood waters rose and fell in stages. Some evidence seems to suggest that the flood may have occurred in a stepwise manner.

Fossil sequence. Whenever fossils are found in superposed layers, they occur in a rather consistent sequence. Different layers contain different kinds of fossils. The consistency of the sequence has made possible the correlation of strata, leading to development of the geologic column. Certain trends are discernable in the fossil sequence. Marine fossils are found throughout the geologic column, especially in Paleozoic and Mesozoic sediments. In Cenozoic sediments, marine fossils are mostly restricted to the margins of the continents. Terrestrial fossils are not found in the lowest part of the Paleozoic. Amphibians and reptiles are present from the upper Paleozoic to the top of the column. Terrestrial birds and mammals are essentially restricted to the Cenozoic layers. The segregation of different types of fossils might indicate a stepwise character for the flood.

Several factors could contribute to the deposition of a sequence of fossils by a flood. As the waters rose, a succession of habitats would be eroded and deposited. One would expect marine habitats to be destroyed before terrestrial habitats. Flotation of carcasses could also contribute to sequence of deposition. Carcasses of birds and mammals float for much longer periods of time than amphibian and reptile carcasses (Brand unpublished) and this is the sequence of their lowest appearances in the fossil record. Behavior might also influence the order of deposition. Those animals with the greatest intelligence, strength, and ability to swim might be expected to survive the longest, and be deposited later than other species. Sorting by water currents could also segregate different types of organisms into different fossil layers. A more detailed study of fossil sequences and their taphonomic characteristics is needed to develop a better understanding of the flood.

Trace fossils. Certain types of fossils suggest the flood may have occurred in stages. These include stromatolites, nests, burrows and footprints. The most spectacular of these fossils may well be the dinosaur nests with eggs found in Cretaceous deposits in Montana and Mongolia. Dinosaurs are arguably not found in strata above the Cretaceous, so the dinosaur nests represent activity that occurred near the time of their extinction. Any explanation for these dinosaur nests must be regarded as highly speculative, but it should be noted that a dinosaur could probably lay a clutch of eggs in a relatively short time, and this could have happened during pauses in the rising of the flood waters. An interesting point is that the nests are found in areas interpreted to be on high points in an area surrounded with water (Horner 1984). In some cases the eggs are found laid in double lines, as though the female was moving while laying the eggs.

Examples of trace fossils involving aquatic or marine organisms may not be a significant challenge to the flood story, since many of these kinds of organisms survived the flood anyway, and must have been somewhere during the flood. There is no compelling reason to believe that the entire present continental surface was exposed above water within a year of the start of the flood. Regional adjustments could have continued in some areas for scores or perhaps even hundreds of years after Noah left the ark.

Summary. The fact that fossils occur in a definite sequence rather than all mixed up suggests the flood involved a series of events, rather than being a giant mixing bowl. Factors that might have influenced the sequence of fossils include differences in habitat, strength and behavior, and flotation of carcasses. The presence of dinosaur nests and footprints suggests that some animals survived later in the flood than others. A series of extraterrestrial impacts offers one possible mechanism for stepwise activity during the flood.

Summary and conclusion

Most scientists have rejected the accuracy of the biblical story of the flood. But several lines of evidence suggest conditions that seem more consistent with a worldwide flood than with the conventional long-age model of earth history. Present rates of uplift and erosion seem too great to permit survival of "old" mountains. Clastic dikes indicate some sediment remained soft, supposedly for millions of years, until other layers were deposited on top of them. Paraconformities are gaps of supposed millions of years, yet the sediments often appear to have been deposited continuously.

Several other lines of evidence seem to suggest the world was once covered with water. Worldwide mass extinctions, widespread deposits of marine fossils on the continents, and large numbers of turbidites are evidence of widespread catastrophic flood activity.

Other evidence suggests that the flood occurred in stages. Impact craters and impact debris suggest the flood was extremely violent, and probably involved a series of impacts and other events. The segregation of different types of fossils into different strata suggests a sequence of events during the flood. The sequence of vertebrate bodies suggests flotation may have been a factor in their stratigraphic segregation. Trace fossils suggest that some regions may have experienced periods of relative calm during the flood, perhaps lasting days or even weeks. Each of these observations may contribute to our understanding of the flood.

This is not to suggest that the problem of understanding the flood has been solved. There are many unanswered questions regarding the flood. It is not easy to reconstruct any historical event, especially a unique event like a worldwide flood. But there is enough evidence to suggest that the Bible story is plausible. By studying the evidence, we may be able to reach a better understanding of what happened during the flood.

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