Vertical Tectonics and the Drainage of Floodwater A Model for the Middle and Late Diluvian Period — Part I

Michael J. Oard*

Abstract

A model is presented for the erosional effects in the mid and late Flood that are due to large- and small-scale vertical tectonics of the crust coupled with Flood water movement. Other Flood models are briefly discussed without commenting on their merits or problems. Instead of a problem, all these models indicate a healthy state of Flood geology, according to the principle of multiple working hypotheses. The model is a further development of the Whitcomb-Morris concept using the terminology of Tas Walker. Evidence for great upward vertical tectonics of continents and subsidence of the ocean basins is presented. During this great event, massive evidence of sheet erosion of the continents is ubiquitous in the form of erosional remnants, erosion surfaces, and the long distance transport of resistant clasts.

The model is able to explain a number of mysterious phenomena in geomorphology, such as high-elevation erosional remnants, large-scale erosion surfaces, distally-deposited coarse gravel, continental margins, water gaps, pediments, and submarine canyons. The model has significant implications for other models and concepts concerning the Flood.

Introduction

A model can be considered a representation of a real event, object, or idea. Models of the past are necessary because we cannot observe what occurred then. Models of historical events are based on assumptions that are always tempered by what one believes about the past (Klevberg, 1999). Models of the past often need to be revised, falsified, or "verified" by data from the present. For example, geologic models constantly need refining by observation of existing fossils and rocks. A successful model can be considered one that has a reasonable explanation for a variety of observed data.

A model is presented for the mid and late Flood period based on surface features of the continents and ocean bottoms. The surface features of the earth come under the umbrella of the geological subdiscipline of geomorphology or physiography. The model presented here is preliminary; many details need to be fine tuned. Development of the model is more on the global scale. Complications may arise on the regional or local scales, but these can be dealt with later. The model must at least be able to explain the macroscale features of the Earth.

Creationist Models

There are a number of models or ideas about the Flood in various stages of development. These models are not necessarily exclusive. There are common threads in most of them. I shall briefly describe the main models or ideas on the Flood that seem to be in vogue.

One of the first models developed is the "Whitcomb-Morris model," based on the classic book *The Genesis Flood* (Whitcomb and Morris, 1961). The book is primarily a Biblical and geological defense or apologetic for a global Flood, but it still represents a "model" in the sense that it describes details of the Flood and the expected geological consequences. The model includes two stages of the Flood: 21 weeks of "prevailing," representing the first 150 days of the Flood, and 31 weeks of "assuaging," in which the waters drain from the rising continents for 221 days. The Flood generates tectonic and volcanic upheavals, tremendous sedimentation that provides ideal conditions for forming fossils rapidly, and produces a post-Flood ice age. The book contains such concepts as ecological zonation, hydrodynamic sorting and the higher mobility of the vertebrates attempting to escape the encroaching Flood waters. It tries to explain seemingly anomalous features for a one-year global Flood, such as formations implying slow deposition, ancient "varve" sequences, and the

*Michael J. Oard, M.S., 3600 7th Avenue South, Great Falls, MT 59405-3409
Received 1 February 2000; Revised 6 June 2000

origin of coal and oil. Creationists have further developed many aspects of the Whitcomb-Morris model since 1961.

There are at least two vertical tectonics models that have been published. John Woodmorappe has introduced a concept called Tectonically-Associated Biological Provinces, called TABS (Woodmorappe, 1999, pp. 44–61). This concept or model postulates that tectonics and biogeography are generally linked resulting in a general ordering of fossils. He divides the uniformitarian Phanerozoic era into 4 divisions—I, II, III, and IV, which is their relative order of subsidence during the vertical tectonics of the Flood. Whatever these TABs represent in the antediluvian biosphere, each TAB is downfaulted in a certain order relative to the other TABs. This produces a general vertical order of the fossils. David Tyler (1990) has proposed a model in which crystalline blocks rapidly rise, resulting in catastrophic erosion, deposition, basin faulting, metamorphism, and gravity sliding of nappes.

A very elaborate geophysical model, called catastrophic plate tectonics, has been developed by John Baumgardner (1986; 1990; 1994a,b) and integrated into many other aspects of the Flood (Austin et al., 1994). This model is similar to plate tectonics but with a catastrophic separation of a single pre-Flood continent, resulting in the geography we see today. Besides catastrophic plate tectonics, the expanded model of Austin et al. (1994) includes pre-Flood geology and sedimentation; the rise of the ocean water onto the continents due to the addition of an all-new, hot ocean crust; the slow regression of the Flood waters off the continents in the late Flood and after the Flood; and isostatic uplift of the continents accompanied by intense mountain uplift, earthquakes, and high volcanism for hundreds of years following the Deluge.

Walter Brown (1995) has developed a model of the Flood that also asserts rapid continental drift. In his model, one supercontinent possessed interconnected chambers of water averaging 1 km in thickness at 16 km below the Earth's surface. Increasing water pressure caused the water to erupt along linear cracks that later became the mid-ocean ridges. The water, in the form of steam, rose at supersonic speeds into and above the atmosphere. Due to the release of the water and bulging upward of the lower crust and mantle at the mid-ocean ridges, the plates gravitationally slid away from the rupture zone for several thousand kilometers, ending with the present geography of the earth. The water from the chambers flowed out and covered the splitting continents. Water injected into the atmosphere fell as torrential rain, while the water above the atmosphere dumped as dirty ice, which in Siberia and Alaska resulted in the quick freezing of the woolly mammoths. Brown considers his model a working hypothesis that explains many mysterious features of the earth. He is constantly improving and revising his model.

Subdivisions of Geologic Time and Symbols

ERA	PERIOD AND SUBPERIOD		EPOCH	AGE (Ma)
CENOZOIC	QUATERNARY		Holocene	0.01
			Pleistocene	←
	TERTIARY	NEOGENE SUBPERIOD	Pliocene	5.3
			Miocene	23.7
		PALEOGENE SUBPERIOD	Oligocene	36.6
			Eocene	57.8
			Paleocene	←
MESOZOIC	CRETACEOUS		Late	
			Early	144
	JURASSIC		Late	
			Middle	
			Early	208
	TRIASSIC		Late	
			Middle	
			Early	245
PALEOZOIC	PERMIAN		Late	
			Early	←
	PENNSYLVANIAN		Late	
			Middle	
			Early	320
	MISSISSIPPIAN		Late	
			Early	360
	DEVONIAN		Late	
			Middle	
			Early	408
	SILURIAN		Late	
			Middle	
			Early	438
	ORDOVICIAN		Late	
			Middle	
			Early	505
	CAMBRIAN		Late	
			Middle	
			Early	570
PROTEROZOIC				2500
ARCHEAN				3800

Figure 1. The uniformitarian geological column and time scale. The three main locations that creationists have postulated for the Flood/post-Flood are in the late Paleozoic, the Mesozoic/Cenozoic boundary, and in the late Cenozoic (shown in age column by a horizontal arrow).

Mats Molén (1994) has developed a model in which an underground network of chambers filled with water burst forth as the "fountains of the great deep." As the roof of the chambers collapsed, the hollows were filled with sediment, which being denser than water, caused the crust to sink, forming the "geosynclines." The deepest parts of the lithosphere were forced downward, were melted, and formed magma that ascended. The ascending magma resulted in plutonism and volcanism, all mixed with the thick geosynclinal sediments. The rising magma would compress the surrounding sediments and cause gravity sliding and nappes. This magmatism would take perhaps a few hundred years. He further adds a post-Flood continental drift scheme during the time of Peleg.

There are a number of models or ideas about the Flood based on where creationists place the Flood/pre-Flood boundary and the Flood/post-Flood boundary within the geological column (Figure 1). This assumes the geological column is a compressed chronology of the Flood (Austin, 1994, pp. 57–82; Brand, 1997; Coffin, 1983, pp. 69–81; Roth, 1998, pp. 153,163). The relationship of the geological column to Flood geology is a controversial matter (Reed, 1996; Woodmorappe, 1996, 1999; Froede and Reed, 1999; Klevberg, 2000), but it is generally assumed to be viable by many model builders. The question of how the geological column relates to the Flood is partly a problem of how *absolute* a modeler follows the geological column. The Flood/pre-Flood boundary is often placed at the end of the Precambrian by many creationists, mainly because of the almost total absence of fossils in Precambrian sedimentary rocks (Austin, 1994; Roth, 1998, p. 209). But there are creationists who would include most if not all the Precambrian sedimentary rocks, including Archean rocks, within the Flood (Snelling, 1991; Hunter, 1996).

There are three general locations within the geological column where the Flood/post-Flood boundary is commonly placed (Tyler, 1997): 1) in or below the upper Paleozoic (Garner, 1996a,b; Garton, 1996; Robinson, 1995,1996; Scheven, 1990,1996; Tyler, 1994,1996), 2) the Cretaceous/Tertiary boundary (Brand, 1997; Austin et al., 1994, p. 614), and 3) the late Cenozoic (Coffin, 1983; Holt, 1996; Morris, 1996; Oard, 1996, 1998; Roth, 1998, p. 209). The Cenozoic includes the Tertiary and the Quaternary periods, the later of which includes the Pleistocene and Recent stages. A Flood/post-Flood boundary in the late Cenozoic is deliberately vague because it depends upon the fine-scale accuracy of the various stages of the Cenozoic: the Paleocene, Eocene, Oligocene, Miocene, and Pliocene, and what exactly is meant by the Pleistocene stage. Just because a layer of strata is labeled "Pleistocene" does not mean it is automatically post-Flood (Holt, 1996; Froede and Reed, 1999). These stages are dated by fossils and radiometric methods, and sometimes have no relationship to surficial processes that are obviously post-Flood, such as the ice age. Creationists should be skeptical of these systems for building a chronology of earth history.

In contrast to using the geological column as a guide to Flood chronology, Tasman Walker (1994) and Carl Froede (1995) advocate that we should examine the rocks and fossils and classify them according to the *mechanism of deposition*. This mechanism is the Flood as described in Scripture and not the uniformitarian system of slow processes over millions of years. The pre-Flood, Flood, and post-Flood stages are divided into a number of phases that we should see in the rock record. Classification criteria for determining this sequence have been developed but need further application.

The Principle of Multiple Working Hypotheses

It disturbs many creationists and Christians that there are so many models and ideas on the Flood. Many Christians have believed or leaned towards a certain creationist model only to discover later that the model has problems. I once leaned 80% in favor of the vapor canopy model for the pre-Flood environment, until the experiments of atmospheric scientist, Dr. Larry Vardiman of ICR. (I use probabilities, i.e. weather jargon, to describe my current leaning towards a particular model or idea that is equivocal. The percents change with time as more data are revealed.) Now I lean in favor of the vapor canopy hypothesis only 30% and 70% against it, because of the technical problems with the model. The model still has merit and investigation should continue. Further research may solve some or all of these problems, in which case my percentage confidence in the model would increase.

Creationists should not become disturbed about the "chaotic" state of Flood geology. They should continue reading and investigating, as this state is really a *healthy trend* under the circumstances. The reason this is a healthy trend is because there are really few technical data provided by the Bible by which to construct a model of the Flood. Furthermore, we do not understand the dynamics of such a global inundation very well. There is a tremendous scale problem in extrapolating from modern flash floods to the global Flood. Another problem is accurately interpreting the rocks and fossils. There are too many unknowns in geology and paleontology, especially about the mantle of the earth and the three-dimensional fossil distribution. These are crucial for developing a geological and geophysical model of the Flood. A third major problem is that many of the geological data creationists employ in their models come from uniformitarian sources, who have vastly different assumptions and philosophies from creationists. These "data" may be tainted by assumptions and theory (LeGrand, 1988). So, we need to first perform a data check, i.e. "separate the wheat from the chaff," which is difficult in geology because it means doing field work and skeptically reading the existing literature on a subject. Given these circumstances, it is reasonable and healthy to have a number of models and ideas in trying to reconstruct real Earth history. I believe it is an exciting time for Christians with an interest in science, because the Creation/Flood model has made great progress and promises to continue that trend in the future.

The idea of using competing hypotheses simultaneously to advance science was recommended by T.C. Chamberlin just before the turn of the century. He wrote a paper advocating the principle of multiple working hypotheses (Chamberlin, 1995—reprinted as an historical essay with an introduction by David Raup in the *Journal of Geology*). He claimed that it is good to consider several working hypotheses instead of just one. It is too much of a human tendency to fall in love with one hypothesis, which blinds us to either its weaknesses or defects and makes us unwilling to investigate the merits of other hypotheses. A ruling hypothesis usually allows no competitors and stifles scientific advance. Chamberlin (1995, p. 351) writes:

> The theory then rapidly rises to a position of control in the processes of the mind and observation, induction and interpretation are guided by it. From an unduly favored child it readily grows to be a master and leads its author whithersoever it will.

Chamberlin's essay is still controversial. Johnson (1990) believes Chamberlin's method of multiple working hypotheses is a chimera. It is believed to be unrealistic and excessively time consuming to examine all hypotheses to explain a certain phenomenon. Besides, *few* scientists (if any) have actually used the method (Johnson, 1990; Locke, 1990). However Railsback (1990) counters that Chamberlin's method is even more valuable today than ever because of some of the central problems of current science and the dominance of certain favored hypotheses. Blewett (1993) claims the method, similar to Popper's falsification criterion, is difficult to apply:

> On all these bases, Chamberlin's method of Multiple Working Hypotheses cannot be supported on purely logical grounds, but neither can any other "method" when viewed from the perspective of the logic of science. Most scientific investigations ignore such difficulties, and rarely, if ever, is a method of inquiry followed as spelled out in formal terms (Blewett, 1993, p. 257).

This controversy clearly signifies that methods of investigation in geology are rather ill defined.

Patrick Spencer (1997) emphasizes that the spirit of Chamberlin's method should be preserved where its application is of great value, especially in undergraduate education for emerging scientists. He provides examples from the past where personalities and ruling hypotheses perpetrated bad science, for instance in Marsh's evolutionary horse series and the Salmon Creek "coprolites." He also provides a modern example—the ruling hypothesis of plate tectonics:

> Students come out of their first geology course spouting plate tectonics as if it is the gospel rather than the most current acceptable explanation of an observed phenomenon (Spencer, 1997, p. 128).

I believe that in Flood geology we need multiple working hypotheses. It is in this spirit that I present the following model as one among many to be tested with further data. It only applies to the Flood after Day 150. However, the model does have implications for a model of the Flood during the first 150 days, as well as the post-Flood period. These implications will be discussed at the end of Part II of this series. It seems to me that a large amount of puzzling (to the uniformitarian scientist) geomorphological data support the model. But again, maybe I am in love with the model and am overlooking weaknesses. I hope readers will call these to my attention.

Tasman Walker's Recessional Stage of the Flood

The model that I will be unfolding is really not a new model in the strict sense. It is a derivative of the Whitcomb-Morris model using Tasman Walker's terminology and defining criterion with a Flood/post-Flood boundary in the late Cenozoic (Oard, 1996). At one time I could have accepted another model, but I have come to my present views by examining field data, especially in the northwest states of the U.S.A. and adjacent Canada, and by reading much geologic literature related to the subject. What I especially like about Walker's model is that it basically mirrors the straightforward meaning of the Bible without regard to speculations of "historical science." The Bible says that there was a global Flood about 5000 years ago that lasted 370 or 371 days. It was not a local flood because there would have been no need for an ark. A 370-day Flood would not have been local. The ark settled in the mountains and was not floated to the ocean or a flood plain. The covenant of the rainbow would make no sense because there have been thousands of local floods since the Flood of Noah's day.

About the same time that Walker's model was published, several other creationists, including myself, felt that we needed a model that groups the rocks by the mechanism whereby the rocks were deposited and not the uniformitarian system. One such effort was published by Carl Froede in the 1995 *Creation Research Society Quarterly*. Of the various geochronologic schemes, Walker's model is the most developed, including defining criteria for classifying rocks, for instance footprints.

Footprints were left by a living animal at the time the print was made. So footprints from air-breathing terrestrial animals could only come from 1) uneroded pre-Flood sediments, 2) Flood sediments from the first 150 days, or 3) post-Flood sediments. It is unlikely that much, if any, pre-Flood sediment or sedimentary rock survived the tremendous earth upheavals during the Flood. This only leaves options 2 or 3. If the sediments are likely from the Flood, the footprints mean that the animal was alive during the first 150 days of the Flood while the water was rising and/or prevailing (Oard, 1998, p. 70).

Figure 2 presents Walker's Biblical geological model (modified by Peter Klevberg). The time scale is shown on the left, and the rock scale on the right, divided into events and eras. I will focus only on the Deluge, which occupies only 370 days, but as far as the rock scale is concerned, is responsible for deposition or emplacement of the vast majority of the sedimentary rocks.

Peter Klevberg modified Walker's Flood timescale slightly to make the Inundatory Stage 150 days instead of Walker's 60 days (Genesis 7:24; Whitcomb and Morris, 1961, pp. 4–7). This made the Recessive Stage of the Flood 220 days, instead of about 310 days. The reason for this is that Klevberg and I lean towards the Flood reaching maximum depth at 150 days (based on Scripture). An alternative reading could have the Flood peaking at 40 days and then prevailing for 110 more days. Regardless, Scripture indicates all air-breathing animals died by Day 150 and the Ark grounded on the mountains of Ararat at the same time. Day 150 seems like the time of the maximum depth of the Flood water with regression thereafter. Our understanding is the same as the 21 weeks of "prevailing" and the 31 weeks of "assuaging" in the Whitcomb-Morris model. For my purposes, this is not a significant change, and even Walker (1994, p. 585) acknowledges that the Inundatory Stage could have lasted 150 days:

> Figure 5 (and Figure 7) is drawn assuming an Inundatory Stage a little longer than 40 days—arbitrarily shown as 60 days to allow time for the Flood to peak. Although these figures would need to be modified if the Inundatory Stage were 150 days long, the validity of the model would not be affected.

Since I will only be providing more details for the Recessive Stage, the time difference is 220 days vs. 310 days, which is insignificant for model considerations.

The model I will be developing begins at Day 150 of the Flood, when the earth was totally covered by water, and goes to Day 370 as the waters drain from the surface of the earth forming the general topography of today. This is called the *Recessional Stage* of the Flood by Walker. There is a question of whether the Flood was raging at other locations far from the mountains of Ararat at the end of Day 370. In other words, does Noah's description of falling sea level represent what occurred for the whole earth? I have addressed this subject elsewhere (Oard, 1999b), and will have more to add on the topic in the section on continental margins in Part II. I lean towards the Flood being finished everywhere at Day 370 with sea level about 40 meters higher than today since the Greenland and Antarctic Ice Sheets had not yet developed, as well as several other smaller factors. Thus, the earth changed from being totally covered by water at Day 150 to the general geography we see today at Day 370.

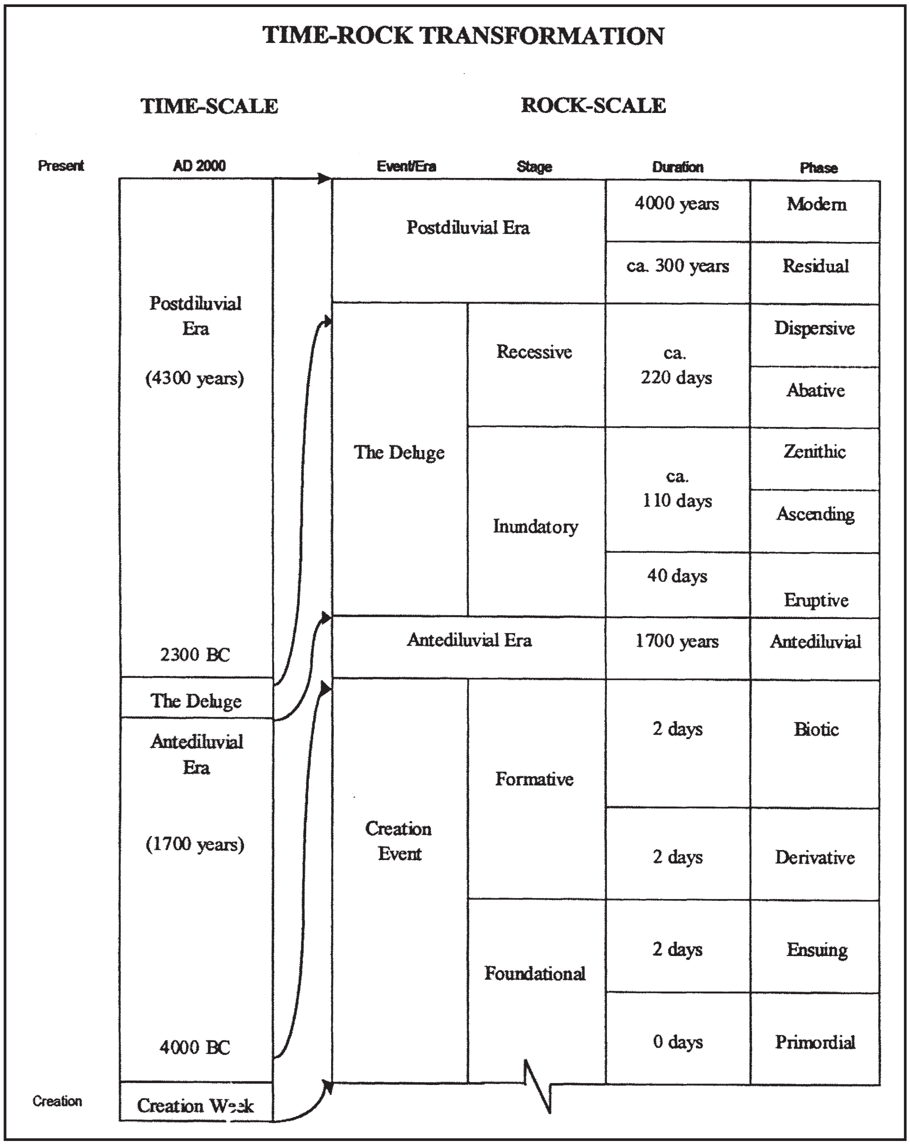

Figure 2. Tasman Walker's Biblical geological Flood model (permission from Tasman Walker with modifications by Peter Klevberg, especially in the durations of the Flood stages and phases).

Viewing Figure 2 in more detail, note that the Recessional Stage has two phases: 1) The Abative or Sheet Flow Phase, and 2) the Dispersive or Channelized Flow Phase. The Abative Phase applies to the Flood waters soon after 150 days when huge currents were flowing around the earth as wide sheets with few obstacles to disturb the flow. This situation would have been similar to the jet stream in the atmosphere today. During the middle and end of the Recessive Stage, mountains and plateaus would be protruding out of the Flood water, diverting the flow and forcing the water to become quite channelized. The Recessive Stage was very likely a gradual progression from the Sheet Flow Phase to the Channelized Flow Phase as the waters flowed over and drained from the continents.

The Recessional Stage and Vertical Tectonics

The Recessional Stage of the Flood requires huge vertical tectonics for the Flood waters to drain from a totally flooded Earth and end with essentially the geography we observe today. This implies vertical tectonics on a number of scales, from the small scale of individual mountain ranges and adjacent basins or valleys to the large scale of continents and the ocean basins. This *differential* vertical tectonics is likely what is meant by Psalm 104:8,9:

> The mountains rose: the valleys sank down to the place which Thou didst establish for them. Thou didst set a boundary that they may not pass over; that they may not return to cover the earth (NASV).

Verse 9 indicates that verse 8, as well as verses 6 and 7, refer to the last time the earth was covered by water, i.e. Noah's Flood. Charles Taylor (1998, 1999) examined the meaning of Psalm 104:8 and concluded that the NASV as quoted above is the correct meaning. I believe that differential vertical tectonics is required to drain the Flood waters.

Is there geological evidence for such great vertical tectonics occurring recently? Yes, the evidence is ubiquitous. Most of the mountains of the Earth have a sharp, fresh appearance, whether glaciated or not in the post-Flood rapid ice age (Oard, 1990). Marine fossils are found in most of these mountains. For example marine crinoid fossils are found in limestone on the top of Mount Everest (Gansser, 1964, p. 164), indicating that Mount Everest has been vertically raised at least 9 km from below the sea to its present height. The fresh appearance of the Himalaya Mountains, Zagros Mountains, and many other mountains over the earth has caused uniformitarian geologists to postulate that these mountains are "youthful," mostly rising in the Miocene, Pliocene, or even the Pleistocene. This postulated time is the late Cenozoic in the uniformitarian time scale.

One evidence that the ocean basins have sunk is the widespread presence of guyots (Oard, 1999a). Guyots are flat-topped seamounts or possibly the remnants of broken-apart carbonate plateaus. It is likely that the flattened seamounts, most of which are capped by carbonate, were sheared off at sea level, possibly by rapid currents. (One of the evidences for sea level erosion of guyots is shallow water benthic organisms on them, but within a Flood model, their paleodepth significance is equivocal, since in a global Flood shallow water benthic organisms can be eroded and transported to deep water.) There are thousands of guyots on the ocean floor, especially in the western Pacific Ocean. The tops of the guyots are generally about 1,500 meters below sea level, although depths vary considerably. Distinguished geomorphologist, Lester King (1983, pp. 168,171), states:

> Marine volcanic islands which have been truncated by the waves and since subsided below sea level are called guyots. Most of them seem to have sunk by 600 to 2000 m and it is evident that they afford a measure of the amount by which the ocean floor has sunk in later geologic time. The Pacific floor especially has subsided...All the ocean basins afford evidence of subsidence (amounting to hundreds and even thousands of meters) in areas far from land.

In fact, thick carbonates on Eniwetok and other islands—perceived as a persistent creationist problem— could simply be sea level remnants associated with drowned guyots or a fractured carbonate platform (Oard, 1999a). So, the evidence from the sea floor indicates that great areas of the floor have subsided around 1,500 meters.

The tremendous evidence from land and sea demonstrates that great vertical movements of the crust have occurred recently. Continents and mountains have risen out of the water, and the ocean basins have sunk. King (1983, pp. 16, 71) states that this large-scale crustal vertical motion is *fundamental and clearly seen*:

> So the fundamental tectonic mechanisms of global geology are *vertical, up or down*: and the normal and most general tectonic structures in the crust are also vertically disposed...But one must bear in mind that every part of the globe—on the continents or in the ocean basins—provides direct geological evidence that formerly it stood at different levels, up or down, and that it is subject *in situ* to vertical displacements (italics his).

What is the powerful geophysical mechanism causing such stupendous vertical displacement occurring at the middle and end of the Flood? I really do not know, but I am pondering several hypotheses. I do not believe any creationist model has provided an adequate mechanism. However, our knowledge of geology, especially of the lower crust and mantle, is increasing, so possibly in the future new information will point to a likely mechanism.

It is interesting that many critics of the Flood, Christian and non-Christian, have presented the "problem" that Flood water supposedly had to cover the high mountains of today. Bernard Ramm (1954, p. 166), who wrote the very influential book, *The Christian View of Science and Scripture*, states the problem as follows:

> If the earth were a perfect sphere so that all the waters of the ocean covered it, the depth of the ocean would be two and one-half to three miles. To cover the highest mountains would require eight times more water than we now have.

Besides his poor mathematics, the problem with this criticism is that the mountains *rose out of* the Flood waters—the ocean did not have to rise to cover Mount Everest. The Himalaya Mountains rose out of the Flood waters. Theologians and other critics of Genesis, like Ramm, have especially one problem: *They believe men's speculations about the unobservable past ahead of God's infallible word*. Ramm (1954, p. 8) even acknowledges his unrecognized problem right in his *preface*: "With reference to technical details of the sciences I must depend on what other men say, and I am thereby at their mercy." Is it any wonder that the Christian church has so many confused theologians, scientists, and laymen, who seem to accept every speculative hypothesis about the unobservable past by scientists who did not observe the past and who do not regard the Bible as God's holy word?

Large-Scale Evidence for the Abative or Sheet Flow Phase

During the great vertical change when the continents rose and the ocean basins sank, large-scale currents likely were sweeping over the Earth. The velocity of the currents would likely be swift, due to several mechanisms. One mechanism is water acceleration due to earthquakes. Large tsunamis would be likely (Whitcomb and Morris, 1961). Another mechanism would be tidal effects, especially in shallow water, and possibly amplified by resonance (Clark and Voss, 1990; 1994).

A third mechanism that would cause high velocity currents is the spin of the earth. Barnette and Baumgardner (1994) modeled a completely flooded earth using the shallow water equations on a rotating sphere. On shallow continents, the currents started from rest and quickly accelerated to 40–80 m/sec, depending upon the boundary conditions. The currents mimicked the jet stream in the atmosphere with large-scale waves on the shallow water continent. The currents generally flowed west to east in large curves. The continent had to be at least 2500 km long and the water depth shallower than 1000 m. The spin of the earth represents a powerful force to accelerate and maintain high velocity currents over large, relatively shallow, areas during the Flood.

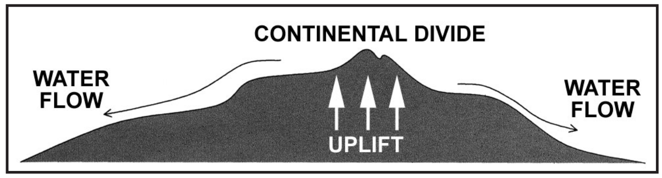

Figure 3. Currents induced by continental uplift during the Recessive Stage of the Flood (drawn by Peter Klevberg).

A fourth mechanism for water accelerations would be the large-scale uplift of the continents while the ocean basins were sinking. In addition to the other forces, this force would tend to cause the water to flow off the continents into the ocean basins (Figure 3). It would be slow in developing because the other forces discussed above likely would be overwhelming. Eventually, however, it would predominate. An analogy for this force would be raising a plate in dishwater. The water is forced to accelerate off the dish. The analogy is even more realistic if you stir the dishwater with a spoon to simulate the large currents before the Recessive Stage and then drain the dishwater to simulate the regressing Flood waters. During the Recessive Stage, the currents likely would gradually change from a rapid global flow, mainly on shallow continents, to more regionalized flow from high areas of continents towards the ocean basins. These regional currents likely would vary in velocity due to the momentary accelerations of crustal uplift. Various degrees of uplift would result in various current speeds rushing from the rising land. Considering all four mechanisms, powerful, vast currents would flow over and off the continents as the land rose out of the water during the 220 days of the Recessional Stage of the Flood.

The erosional potential of flowing water varies significantly, based on such factors as rock lithology, depth of flow, material being transported along the bottom, and current velocity. The size of the clast that can be transported is conservatively proportional to the square of the current velocity (Blatt, Middleton and Murray, 1972, p. 93). Doubling the velocity would increase the clast size that can be transported about four times. Increase the current velocity four times, the transported clast size would increase around sixteen fold. If the clast size (competence) can be linearly related to the capacity of the current, and the other variables are small compared to the velocity, then the erosion rate would generally be proportional to the square of the velocity. The clasts dragged along in the lower part of the flow would act as abrasive cutting tools. The faster the current, the larger the clasts and the more abrasive the transported debris likely becomes. Thus, such powerful currents during the Abative or Sheet Flow Phase of the Flood would cause massive sheet erosion of the con-

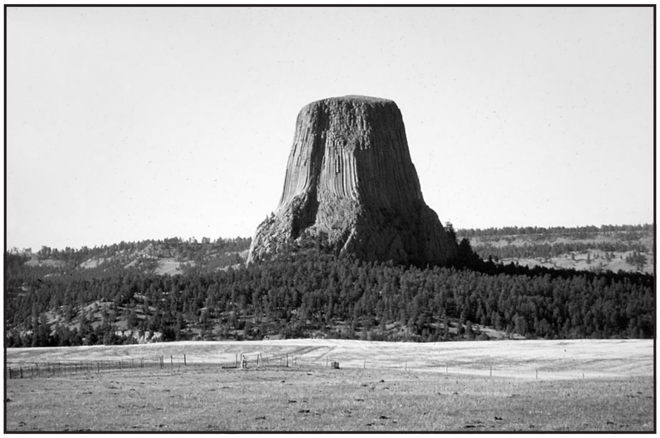

Figure 4. Devil's Tower in northeast Wyoming is evidence for sheet flow erosion.

Figure 5. Square Butte (right butte in background) in central Montana. Round butte is another erosional remnant to the left of Square Butte. In the foreground is a remnant of a flat-topped, gravel capped erosion surface.

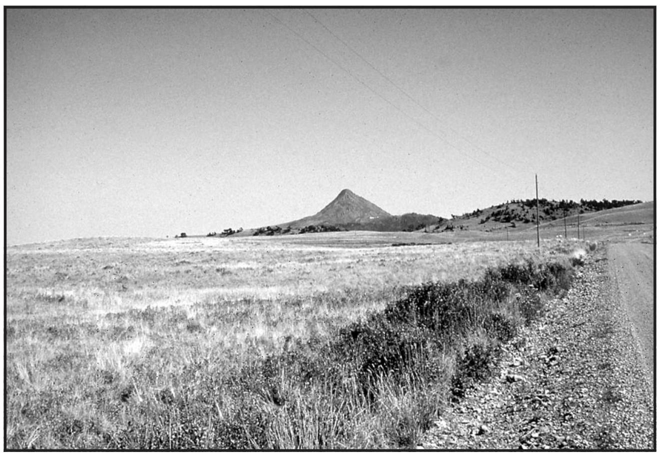

Figure 6. Haystack Butte just east of the Rocky Mountains in Montana is believed to be an intrusive igneous remnant of sheet flow erosion.

Figure 7. Red Mountain just southeast of Grand Canyon. The top is capped by basalt, which was obviously horizontally continuous before erosion.

tinents. This erosion would be greatly aided if some of the sediments deposited during the Inundatory Stage were still unconsolidated or partly consolidated.

Since the Flood ended about 5000 years ago, erosion in the present climate would have been slight, except in highly erosive environments such as badlands, landslide areas, glaciated areas, etc. Summerfield (1991, p. 396) summarizes the present rate of erosion over many areas of the Earth based on climate, precipitation, and relief. Although the rates vary considerably, they generally range from about 40 cm/1000 years for mountainous areas to about 0.5 cm/1000 years for low relief, tropical areas. Undoubtedly, erosion would have been higher during the post-Flood ice age because of more precipitation (Oard, 1990; Holt, 1996). Therefore, erosion generally has been slight since the time of the Flood. What one observes on the surface of the Earth is predominantly what remains after the Recessional Stage of the Flood. Thus, one should observe copious evidence for the Sheet Flow Phase of the Flood on the surface of the Earth. (I will discuss possible post-Flood catastrophism in Part II of this series.)

There is evidence for the sheet flow erosion of the continents in the form of igneous and sedimentary erosional remnants. I previously presented a case that 500 to 1000 m of sediment and sedimentary rock likely has been eroded from the high plains of Montana, adjacent southern Canada, and northern Wyoming (Oard, 1996, pp. 261, 262). Igneous remnants include Devil's Tower of northeast Wyoming, 400 meters above the surrounding area (Figure 4); Round and Square Butte of central Montana, 600 meters above the plains (Figure 5); and Haystack Butte, just east of the Rocky Mountains and about 600 meters above the plains (Figure 6). Devil's Tower is very likely the throat of an eroded volcano or lava dike, while Square Butte, Round Butte, and Haystack Butte are believed to be intrusive igneous rocks. These igneous rocks had to *intrude* into other rock, which no longer exists. For some reason, these igneous and sedimentary remnants were more resistant while the surrounding sedimentary rocks were being rapidly eroded during the Recessive Stage of the Flood. These ero-

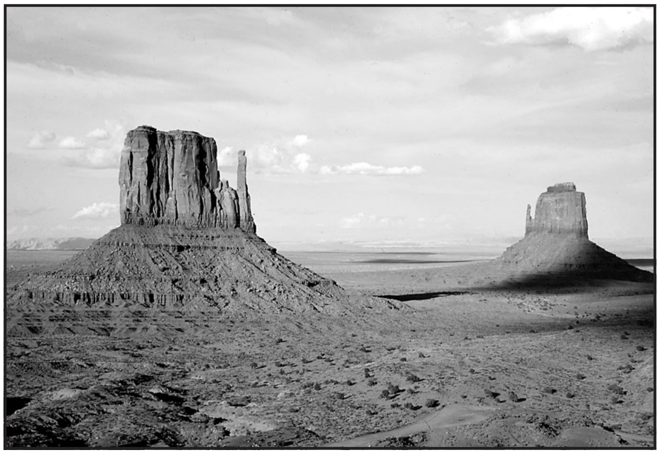

Figure 8. Remnants of rapid erosion can be seen in Monument valley on the border of Utah and Arizona.

sional remnants provide evidence for very rapid erosion of the surrounding sedimentary rock, because these remnants could not have been left standing today if the surrounding rocks were eroded slowly over millions of years, as believed by uniformitarian scientists. Erosion at the present rate would have destroyed all of them probably within a million years. This is because at the present rate of erosion, continents will be reduced to sea level in anywhere from 10 million to 33 million years (Roth, 1998, pp. 263–266; Schumm, 1963). Sedimentary erosional remnants include Pumpkin Buttes in the Powder River Basin of northeast Wyoming, Tatman Mountain in the Bighorn Basin of north central Wyoming, and the Cypress Hills of southeast Alberta and southwest Saskatchewan (discussed below) (Oard, 1996; Oard and Klevberg, 1998).

Igneous and sedimentary remnants exist at other locations of the intermountain west, such as Red Mountain, south of the Grand Canyon (Figure 7); Ship Rock in northwest New Mexico; and Monument Valley, along the Arizona-Utah border (Figure 8). Ship Rock is considered an eroded remnant of a former volcano, indicating a former land surface around 750 to 1000 m higher than the valley floor (Plummer and McGeary, 1996. pp. 77,78). All these remnants indicate that great erosion of the Rocky Mountains, Basin and Range, and the high plains has occurred recently, or else the remnants would not be present.

Further evidence of the great sheet scouring of the continents is provided by remnants of large erosion surfaces. An erosion surface is defined in the *Dictionary of Geological Terms* (Bates and Jackson, 1984, p. 170) as: "A land surface shaped and subdued by the action of erosion, especially by running water. The term is generally applied to a level or nearly level surface." Erosion surfaces are not plains of deposition, such as a flood plain, alluvial fan, or river terrace. Erosion surfaces are *smoothly planed rock*. The rocks can be either hard, soft or a combination of both. It does not matter; hard and soft rocks commonly are

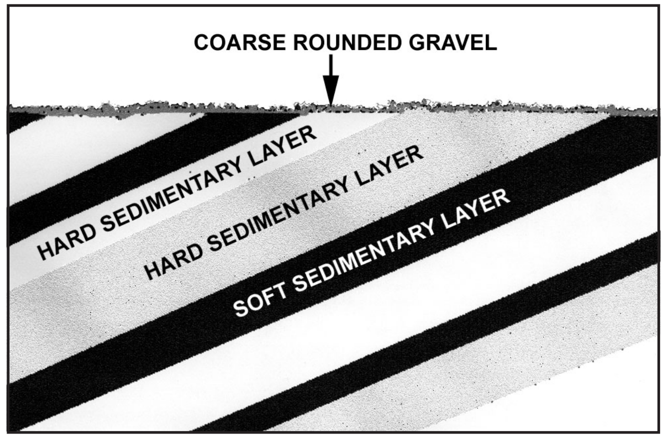

Figure 9. Schematic diagram of a gravel capped erosion surface on tilted sedimentary rocks that has truncated all lithologies the same amount whether hard or soft (Drawn by Peter Klevberg).

truncated the same by the eroding mechanism. An erosion surface can be eroded in horizontal sedimentary rocks, but the most significant and easily identified erosion surfaces are cut on tilted sediment rocks. Figure 9 illustrates an erosion surface cut across interbedded, tilted hard and soft sedimentary rocks and covered with a veneer of rounded, course gravel, as commonly seen in the field.

While erosion surfaces were being formed, other Flood processes continued, modifying these surfaces. For instance, continued Flood erosion would carve the edge or dissect a newly formed erosion surface, leaving behind only remnants of the original surface. The erosion surface could have been completely obliterated. Continued vertical tectonics could cause an erosion surface to fault with parts eventually being at different elevations. In other situations, volcanic products sometimes would cover an erosion surface.

Assuming the uniformitarian paradigm, normal erosion over long periods of time tends to carve softer rocks faster than harder rocks. Thus, if a generally flat surface could form, somehow, it would soon be roughed with increasing relief with time. Thus, the flat surface would form a configuration as depicted in Figure 10. Erosion surfaces are not being formed today, except possibly on a very small scale. Natural processes do not favor their formation or preservation. Erosion surfaces, hence, are relics of a past process. In the present world, we observe them being eroded and dissected (Figure 11).

During the erosional process by Flood waters, soft lithologies are expected to be pulverized quickly. More resistant lithologies, such as quartzite and chert, are expected to break apart as blocks and become smaller and rounded while being transported large distances by the Flood water. These clasts eventually would disintegrate also. Therefore, during this rapid sheet erosion event, resistant rocks would

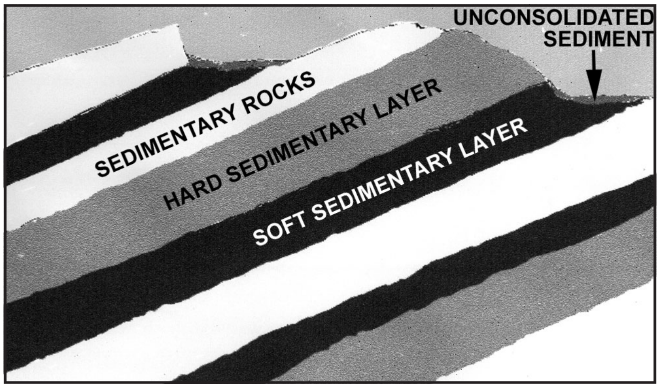

Figure 10. Schematic diagram of normal erosional processes forming ridges and valleys. (Drawn by Peter Klevberg).

Figure 11. Gravel-capped pediment east of the Little Rocky Mountains of north central Montana which is currently being dissected.

Figure 12. A boulder with percussion marks 10 cm in diameter found in the western Cypress Hills, southeast Alberta (head of rock pick for scale).

be transported far from their sources. These rounded, resistant clasts should sometimes be found on top of the erosion surfaces.

Peter Klevberg and I are studying the Cypress Hills of southeastern Alberta and southwest Saskatchewan, and the Flaxville plateaus of northeast Montana (Klevberg and Oard, 1998; Oard and Klevberg, 1998). The Cypress Hills form a high, flat plateau about 300 meters above the next highest erosion surface and about 600 meters above the rivers to the north and south. Therefore, at least 600 meters of sedimentary rock has been eroded from the region around the Cypress Hills, since the substrate is generally horizontal. Over eastern Montana and adjacent Canada, the erosion has left behind generally four erosion surfaces at different altitudes. The Cypress Hills erosion surface had an area of about 2000 km^2, before being dissected into channels, probably by glaciofluvial activity. The gravel on both the Cypress Hills and Flaxville plateaus is mostly well-rounded, iron-stained quartzite pebbles, cobbles and boulders with abundant percussion marks. The gravel cap is approximately 25 m thick and is massive with few sand interbeds in the western and central blocks of the Cypress Hills (Vonhof, 1965). The largest clast we observed was in the western Cypress Hills and has a length of 39 cm and a width of 24 cm with a mass of 26 kg. Based on inferred paleocurrent directions from imbricate clasts and interbedded sand, the nearest source for the clasts is the Rocky Mountains of northwest Montana (Vonhof, 1965). Thus, the quartzite clasts have been transported over a slope ranging from less than 0.1 degree to a maximum of 0.4 degree (Klevberg and Oard, 1998, p. 372) for a distance of 300 km to the western Cypress Hills and 700 km to the eastern Flaxville plain. Some researchers suggest that the coarse gravel may have originated from central Idaho (Leckie and Cheel, 1989). If this is the case, one has to add another 200 km to the above distances, making a total transport of up to *900 km*.

Intuitively, modern rivers cannot transport abundant cobbles and boulders this long distance on such low slopes. To quantitatively estimate current velocities, current depths and other paleohydrological variables, Peter employed standard coarse-sediment hydrologic equations. He calculated that to transport the clasts as bedload, minimum current velocities of 4 to 6 m/sec with minimum water depths of 3 to 40 meters are required over a broad area. Unless very narrow channels are postulated, for which there is contrary evidence, resulting discharges would have been orders of magnitude greater than historic regional floods. Furthermore, the abundant percussion marks, a few 10 cm in diameter (Figure 12), imply that much of the pebble- and cobble-size fractions were transported as intermittent suspension. Based on the size and shape of these clasts, and the relationship between the horizontal velocity and the fall velocity (Blatt, Middleton, and Murray, 1972), Peter calculated a *minimum current velocity of* 30 *m/sec* with a flow depth of at least 55 *m* (Klevberg and Oard,

Figure 13. Gypsum Mountain, northwest Wind River Mountains of central Wyoming. The mountain is composed of limestone with beds dipping about 30° to the right. The flat top is a remnant of an erosion surface.

Figure 14. Round Top Mountain (center), northwest Wind River Mountains of central Wyoming. The mountain is composed of granite. Another flat-topped mountain on the right is tilted, probably caused by faulting. These erosion surface remnants and the one in Figure 13 are parts of a larger erosion surface beveled in granite and limestone in the area that are now seen only at the mountain tops.

1998). The geomorphology of the flat-topped Cypress Hills alone indicates a sheet flow at least 20 km in width. The current necessary to produce a sheet of gravel such as that observed capping the Cypress Hills and Flaxville Plateaus in both lateral and run-out distance exceeds any conceivable flash flood or jökulhlaup (burst glacial lake) by many orders of magnitude. We believe the Cypress Hills and Flaxville Plateaus erosion surface and coarse-gravel cap defy uniformitarian processes and are more consistent with a diluvial mechanism (Oard and Klevberg, 1998; Oard,2000).

The Cypress Hills Formation, based on paleontology, is now dated as 45 to 15 millions years old. The Flaxville Formation is dated possibly as young as 1 million years old, depending upon whether an "early Pleistocene" camel tooth is accepted or not. An important characteristic we discovered is that no matter what the putative age of these gravels, the clasts are little weathered and identical—no matter where they are found (within the Cypress Hills, on the Flaxville Plateaus, or between on other gravel-capped plateaus or reworked by glaciation). This data suggest to us: 1) that the gravel is not very old, and 2) the Tertiary fossil dating scheme is subjective. The edge of the Cypress Hills is actively eroding (Crickmay, 1974; Sauchyn, 1990), so it could not have lasted 45 million years.

Erosion surfaces, occasionally with a capping of well-rounded cobbles and boulders, are observed regionally in the northwest states. Erosion surfaces are most impressive when they are at the tops of mountains, for instance at about 3,500 meters ASL in the northwest Wind River Mountains, Wyoming (Figures 13 and 14), and 4000 meters ASL in the Beartooth Mountains of south central Montana (Figures 15 and 16). Quartzite gravel from the Rocky Mountains of western Montana and northern and central Idaho is found not only on the Cypress Hills and Flaxville Plateaus, but also can be traced, sometimes as very thick deposits, in southwest Montana, southeast Idaho, western Wyoming, northern Oregon as far as Astoria, and southern Washington.

One of the most interesting locations for quartzite boulders is on the tops of ridges in the Wallowa Mountains of northeast Oregon. Figure 17 shows a 10 meter thick outcrop of well-rounded quartzite boulders up to 1 meter in diameter on a ridge just southeast of Lookout Mountain at 2,500 m ASL. The largest boulder we found was 0.7 m in diameter with an estimated weight of 200 kg (Figure 18). The nearest outcrop of quartzite is 100 km east in central Idaho. Especially interesting is that gold is mixed in with the gravel deposits and was even placer mined at one location. John Eliot Allen, late professor of geology at Portland State University, discovered these quartzite boulders on eight ridges in 1938, and related that the boulders have haunted him ever since (Allen, 1991, p. 104). He believed that the boulders had to be deposited by torrential paleocurrents.

All of these many outcrops of quartzite cobbles and boulders indicate large-scale erosion and long distance transport east and west of the Rocky Mountains during a period of massive regional erosion. Since the boulders are often found one to several mountain ranges away from their source, their transport implies that the uplift of the mountains had not yet occurred or was just beginning while the boulders were transported many hundreds of kilometers. The mountain top erosion surfaces, therefore, were formed while the northwest states were generally a flat, planed surface during the Flood. The rugged relief of

Figure 15. View of the flat-topped crest of the granitic Beartooth Mountains, south central Montana. These flat-topped peaks likely are remnants of an erosion surface that had been broken up and uplifted to the lofty elevation seen today.

Figure 16. Another view of the flat-topped mountains of Figure 15 (right of center). The lower altitude of some of the peaks is probably due to faulting.

Figure 17. Ten meter thick outcrop in foreground of well-rounded mostly quartzite boulders just southeast of Lookout Mountain, Wallowa Mountains of northeast Oregon.

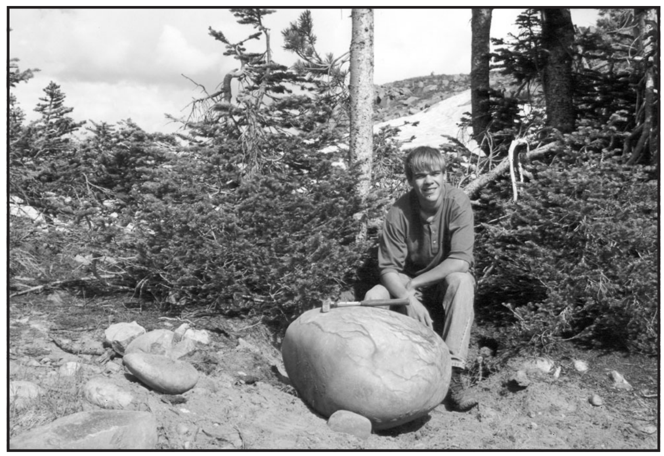

Figure 18. Two hundred kilogram quartzite boulder from outcrop shown in Figure 17. Sharp angled rocks in foreground likely due to frost cracking (photograph by Paul Kollas).

the area, therefore, was produced during the Recessive Stage of the Flood due to vertical tectonics and the more channelized phase of the Flood, which will be discussed in Part II.

Especially interesting is that generally flat erosion surfaces are a worldwide observation. Lester King (1967) documented this in his book: *The Morphology of the Earth*. He reiterated this theme throughout his writings, and in his last book he wrote:

> A planation of extraordinary smoothness developed over enormous areas in *all* the continents... Outside the rare areas in which the older Gondwana and Kretacic planations (I and II) can be identified, this 'Moorland' planation is sought upon the highest, and often bleak, plateaux. It has been given many local names...With emphasis upon its extreme planation, it appears particularly flat when viewed in cross-section as across the intervening valleys of succeeding cycles which commonly intersect it. From it, most of the world's present scenery has subsequently been carved by renewed erosions (King, 1983, pp. 188, 189).

Sixty percent of Africa is a planed erosion surface at one or more levels (King, 1967, pp. 241–309). Well-known Australian geomorphologist, C.R. Twidale (1998, p. 660) in a provocative article on supposed *very old* erosion surfaces that have been only slightly eroded over many tens of millions of years, admits that King's grand scheme of multiple worldwide erosion surfaces is generally correct.

There are many hypotheses to account for these large-scale erosion surfaces, but all have problems. Crickmay (1974, pp. 192, 201) summarized the deplorable state of geomorphic research in 1974, including hypotheses for the formation of erosion surfaces:

> The difficulty that now confronts the student is that, though there are plenty of hypotheses of geomorphic evolution, there is not one that would not be rejected by any majority vote for all competent minds. This situation is in itself remarkable in a respectable department of science in the latter half of the 20th Century...A century and a half of literature bearing on scenery and its meaning shows primarily the inspired innovations that carried understanding forward; followed in every case by diversion from sound thinking into inaccuracy and error.

I suggest that the situation is little different today.

Therefore, erosion surfaces are a powerful witness to the reality of a global Flood and against slow processes over millions of years. Erosion surfaces are a testimony to the sheet erosion during the Abative Phase of the Recessional Stage of the global Flood that produced a scoured surface on *all the continents*.

Summary

Several Flood models were briefly reviewed without comment. All these models indicate a healthy state of Flood geology, according to the principle of multiple working hypotheses. Based on the model of Whitcomb and Morris (1961) with the terminology of Tas Walker (1994), a general sequence of events for the Flood between Day 150 to Day 370 was introduced. During this period, uplift of the continents and the sinking of the ocean basins (to drain the Flood waters) resulted in great vertical changes of the Earth's crust. There is copious evidence for this vertical tectonism during the Flood in the form of massive sheet erosion of the continents, the formation of erosion surfaces, and the long-distance transport of resistant rocks.

Acknowledgments

I am appreciative of all those model builders and other creationists who have contributed ideas for the above described model. Many of these ideas are not original to me. I thank Peter Klevberg for drawing most of the figures and for reviewing the manuscript and as usual offering valuable criticism. The manuscript was improved by the suggestions of anonymous reviewers. I thank the Design Science Association of Portland, Oregon, for the opportunity to first present this model in their June, 1999, meeting and for discussion on various aspects of the model. Tim Skertich of Allison Park, Pennsylvania, showed me the famous Susquehanna water gaps, for which I am appreciative. I thank my son, Nathan, and son-in-law, Mark Wolfe, for scanning slides, improving them when necessary, and for redrawing several figures.

References

CRSQ: Creation Research Society Quarterly
CENTJ: Creation Ex Nihilo Technical Journal

Allen, J. E. 1991. The case of the inverted auriferous paleotorrent—Exotic quartzite gravels on the Wallowa Mountain Peaks. *Oregon Geology* 43:104–107.

Austin, S. A. 1994. A creationist view of Grand Canyon strata. In Austin, S.A. (editor), *Grand Canyon—Monument to catastrophe*, pp. 57–82. Institute for Creation Research, Santee, CA.

Austin, S. A., J. R. Baumgardner, D. R. Humphreys, A. A. Snelling, L. Vardiman, and K. P. Wise. 1994. Catastrophic plate tectonics: A global flood model of earth history. In Walsh R. E. (editor), *Proceedings of the Third International Conference on Creationism, Technical Symposium Sessions*, pp. 609–621. Creation Science Fellowship, Pittsburgh, PA.

Bates, R. L. and J. A. Jackson (editors). 1984. *Dictionary of geological terms*, third edition. Anchor Press/ Doubleday, Garden City, NY.

Barnette, D. W. and J. R. Baumgardner. 1994. Patterns of ocean circulation over the continents during Noah's Flood. In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism, technical symposium sessions*, pp. 77–86. Creation Science Fellowship, Pittsburgh, PA.

Baumgardner, J. R. 1986. Numerical simulation of the large-scale tectonic changes accompanying the Flood. In Walsh, R. E., C. L. Brooks, and R. S. Crowell (editors), *Proceedings of the First International Conference on Creationism, Volume II: Technical symposium sessions and additional topics*, pp. 17–30. Creation Science Fellowship, Pittsburgh, PA.

———. 1990. 3-D finite element simulation of the global tectonic changes accompanying Noah's Flood. In Walsh, R. E. and C. L. Brooks (editors), *Proceedings of the Second International Conference on Creationism, Volume II*, pp. 35–45. Creation Science Fellowship, Pittsburgh, PA.

———. 1994a. Computer modeling of the large-scale tectonics associated with the Genesis Flood. In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism, technical symposium sessions*, pp. 49–62. Creation Science Fellowship, Pittsburgh, PA.

———. 1994b. Runaway subduction as the driving mechanism for the Genesis Flood. In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism, technical symposium sessions*, pp. 63–75. Creation Science Fellowship, Pittsburgh, PA.

Blatt H., G. Middleton, and R. Murray. 1972. *Origin of sedimentary rocks*. Prentice-Hall. Englewood Cliffs, NJ.

Blewett, W. L. 1993. Description, analysis, and critique of the method of multiple working hypotheses. *Journal of Geological Education* 41:254–259.

Brand, L. 1997. *Faith, reason, and earth history*. Andrews University Press, Berrien Springs, MI.

Brown, Jr., W. T. 1995. *In the beginning*, sixth edition. Center for Scientific Creation, Phoenix, AZ.

Chamberlin, T. C. 1995. Historical essay—The method of multiple working hypotheses, by T. C. Chamberlin with an introduction by D. C. Raup. *Journal of Geology* 103:349–354.

Clark, M. E. and H. D. Voss. 1990. Resonance and sedimentary layering in the context of a global Flood. In Walsh, R. E. and C. L. Brooks (editors), *Proceedings of the Second International Conference on Creationism, Volume II*, pp. 53–63. Creation Science Fellowship, Pittsburgh, PA.

———. 1994. Towards an understanding of the tidal fluid mechanics associated with the Genesis Flood. In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism, technical symposium sessions*, pp. 151–167. Creation Science Fellowship, Pittsburgh, PA.

Coffin, H. G with R. H. Brown. 1983. *Origin by design*. Review and Herald Publishing Association, Washington, D.C.

Crickmay C. H. 1974. *Work of the river*. Macmillan, London.

Froede, C. R., Jr. 1995. A proposal for a creationist geological timescale. *CRSQ* 32:90–94.

Froede, C. R., Jr., and J. K. Reed. 1999. Assessing creationist stratigraphy with evidence from the Gulf of Mexico. *CRSQ* 36:51–60.

Gansser, A. 1964. *Geology of the Himalayas*. Interscience Publishers, New York.

Garner, P. 1996a. Where is the Flood/post-Flood boundary? Implications of dinosaur nests in the Mesozoic. *CENTJ* 10(1):101–106.

Garner, P. 1996b. Continental flood basalts indicate a pre-Mesozoic Flood/post-Flood boundary. *CENTJ* 10(1): 114–127.

Garton, M. 1996. The pattern of fossil tracks in the geological record. *CENTJ* 10(1):82–100.

Holt, R. D. 1996. Evidence for a late Cainozoic Flood/post-Flood boundary. *CENTJ* 10(1):128–167.

Hunter, M. J. 1996. Is the pre-Flood/Flood boundary in the Earth's mantle? *CENTJ* 10(3):344–357.

Johnson, J. G. 1990. Method of multiple working hypotheses: A chimera. *Geology* 18:44–45.

King, L. C. 1967. *The morphology of the Earth—A study and synthesis of world scenery*. Hafner Publishing, New York.

———. 1983. *Wandering continents and spreading sea floors on an expanding earth*. John Wiley and Sons, New York.

Klevberg, P. 1999. The philosophy of sequence stratigraphy: Part I—Philosophic background. *CRSQ* 36: 72–80.

———. 2000. The philosophy of sequence stratigraphy: Part II—Application to stratigraphy. *CRSQ* 37:36–46.

Klevberg, P., and M. J. Oard. 1998. Paleohydrology of the Cypress Hills Formation and Flaxville gravel. In Walsh, R. E. (editor), *Proceedings of the Fourth International Conference on Creationism*, pp. 361–378. Creation Science Fellowship, Pittsburgh, PA.

Leckie D. A. and R. J. Cheel. 1989. The Cypress Hills Formation (Upper Eocene to Miocene): A semiarid braidplain deposit resulting from intrusive uplift. *Canadian Journal of Earth Sciences* 26:1918–1931.

LeGrand, H. E. 1988. *Drifting continents and shifting theories*. Cambridge University Press, New York.

Locke, W. W. 1990. Comments and reply on "Method of multiple working hypotheses: A chimera"—Comment. *Geology* 18:918.

Molén, M. 1994. Mountain building and continental drift. In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism, technical symposium sessions*, pp. 353–367. Creation Science Fellowship, Pittsburgh, PA.

Morris, H. M. 1996. The geological column and the Flood of Genesis. *CRSQ* 33:49–57.

Oard, M. J. 1990. *An Ice Age caused by the Genesis Flood*. Institute for Creation Research, El Cajon, CA.

———. 1996. Where is the Flood/post-Flood boundary in the rock record? *CENTJ* 10(2):258–278.

———. 1998. Dinosaurs in the Flood: A response. *CENTJ*. 12:69–86.

———. 1999a. The paradox of Pacific guyots and a possible solution for the thick 'reefal' limestone on Eniwetok Island. *CENTJ* 13(1):1–2.

———. 1999b. A commentary on coral growth in South Florida. *CRSQ* 36:101–102.

———. 2000. Antiquity of landforms: Objective evidence that dating methods are wrong. CENTJ 14(1):35–39.

Oard M. J. and P. Klevberg. 1998. A diluvial interpretation of the Cypress Hills Formation, Flaxville gravel, and related deposits. In Walsh, R. E. (editor), *Proceedings of the Fourth International Conference on Creationism*, pp. 421–436. Creation Science Fellowship, Pittsburgh, PA.

Plummer, C. C. and D. McGeary. 1996. *Physical geology*, seventh edition. W. C. Brown Publishers, Dubuque, IA.

Ramm, B. 1954. *The Christian view of science and Scripture*. William B. Eerdmans Publishing, Grand Rapids, MI.

Railsback, L. B. 1990. Comments and reply on "Method of multiple working hypotheses: A chimera"—Comment. *Geology* 18:917–918.

Reed, J. K. 1996. A biblical Christian framework for earth history research: Part I—Critique of the naturalist-uniformitarian system. *CRSQ* 33:6–12.
Robinson, S. J. 1995. From the Flood to the Exodus: Egypt's earliest settlers. *CENTJ* 9(1):45–68.
———. 1996. Can Flood geology explain the fossil record? *CENTJ* 10(1):32–69.
Roth, A. A. 1998. *Origins—Linking science and Scripture*. Review and Herald Publishing, Hagerstown, MD.
Sauchyn D. J. 1990. A reconstruction of Holocene geomorphology and climate, western Cypress Hills, Alberta and Saskatchewan. *Canadian Journal of Earth Sciences* 27:1504–1510.
Scheven, J. 1990. The Flood/post-Flood boundary in the fossil record. In Walsh, R. E. and C. L. Brooks (editors), *Proceedings of the Second International Conference on Creationism, Volume II*, pp. 247–256. Creation Science Fellowship, Pittsburgh, PA.
———. 1996. The Carboniferous floating forest—An extinct pre-Flood ecosystem. *CENTJ* 10(1):70–81.
Schumm, S. 1963. Disparity between present rates of denudation and orogeny. *U.S. Geological Survey Professional Paper 454*. Washington, D.C.
Snelling, A. 1991. Creationist geology: Where do the 'Precambrian' strata fit? *CENTJ* 5(2):154–175.
Spencer, P. K. 1997. The method of multiple working hypotheses in undergraduate education with an example of its application and misapplication. *Journal of Geoscience Education* 45:123–128.
Summerfield, M. A. 1991. *Global geomorphology—An introduction to the study of landforms*. Longman Scientific and Technical, New York.
Taylor, C. 1998. Did mountains really rise according to Psalm 104:8? *CENTJ* 12(3):312–313.
———. 1999. More on mountains—Charles Taylor replies. *CENTJ* 13(1):70–71.
Twidale, C. R. 1998. Antiquity of landforms: An 'extremely unlikely' concept vindicated. *Australian Journal of Earth Sciences* 45:657–668.
Tyler, D. J. 1990. A tectonically-controlled rock cycle. In Walsh, R. E. and C. L. Brooks (editors), *Proceedings of the Second International Conference on Creationism, Volume II*, pp. 293–301. Creation Science Fellowship, Pittsburgh, PA.
———. 1994. Tectonic controls on sedimentation in rocks from the Jurassic Series (Yorkshire, England). In Walsh, R. E. (editor), *Proceedings of the Third International Conference on Creationism*, pp. 535–545. Creation Science Fellowship, Pittsburgh, PA.
———. 1996. A post-Flood solution to the chalk problem. *CENTJ* 10(1):107–113.
———. 1997. Flood models and trends in creationist thinking. *Creation Matters* 2(3):1–3.
Vonhof J.A. 1965. The Cypress Hills Formation and its reworked deposits in southwestern Saskatchewan. In Zell, R. L. (editor), *15th annual field conference guidebook, Part I technical papers, Part I Cypress Hills Plateau Alberta and Saskatchewan*, pp 142–161. Alberta Society of Petroleum Geologists, Calgary, Alberta.
Walker, T. 1994. A Biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism, Technical Symposium Sessions*, pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.
Whitcomb, J. C., Jr., and H. M. Morris. 1961. *The Genesis Flood*. Baker Book House, Grand Rapids, MI.
Woodmorappe, J. 1996. Studies in Flood geology: Clarifications related to the 'reality' of the geological column. *CENTJ* 10(2):279–290.
———. 1999. *Studies in Flood geology—A compilation of research studies supporting creation and the Flood*. Institute for Creation Research, El Cajon, CA.

Book Review

The Age of the Universe by Gorman Gray
Morning Star Publications, WA. 1999, 146 pages, $10

The purpose of the book, according to the author is to eliminate the young universe dogma of the Creation movement. The author is concerned that "Multitudes of sincerely interested people have been deflected from creation science by baseless assertions about the speed of light and isotope dating. Dogmatic young-earth contentions lead detractors into skepticism" (p. 59). The author believes that "Because the age-of-the-universe issue is the primary force leading to rejection of biblical literalism, the correction of this error will neutralize that *destructive tool* and may even encourage theistic evolutionists to reconsider their assumptions" (Emphasis mine, p. 11). He attempts to do this with "alternative translations" to Scripture.

Having used such highly charged words as "destructive tool" and "embarrassment," the tone of the book is very critical of young-earth creationists to the point of being hostile. The author makes one conciliatory statement that almost seems obligatory. "A more accurate interpretation of Genesis is claimed by this author, but no aspersions are