The Chesapeake Bay Impact and Noah's Flood

Wayne R. Spencer and Michael J. Oard*

Abstract

The largest impact structure in the United States, 85 kilometers (km) in diameter, was discovered under Chesapeake Bay, centered near the small town of Cape Charles on the eastern shore of Virginia. Evidence that the feature is an impact structure includes shocked quartz, concentric normal faults, gravity anomalies, and the presence of tektites. The Chesapeake Bay impact structure cuts through 1 to 2 km of sedimentary rock classified by uniformitarian scientists as Mesozoic to Eocene and is covered by hundreds of meters (m) of other mid- to late-Cenozoic strata, including the Exmore breccia. The impact likely occurred in water on the continental shelf. From an evolutionary perspective, the crater is dated at 35.5 million years, or late Eocene, but there is evidence that the impact was much more recent. We address the relationship of this impact to the Creation-Flood model, and conclude that the impact occurred during the Abative Phase of the Recessional Stage of the Flood, the mid- to late-Flood, according to Walker's biblical geological model.

Introduction

In recent years, some creationists have addressed evidence of impacts on Earth throughout the geologic record (Froede and DeYoung, 1996; Froede and Williams, 1999; Oard, 1994; Spencer, 1998a; b, 1999). Remnants of impact craters, called astroblemes, can be found in all types of rock and all through the geologic column (Spencer, 1998a; 1999). Approximately 160 impact sites on Earth have been documented. The presence of special shocked minerals, gravity anomalies, magnetic anomalies, circular or concentric fault structures, and a variety of indications of catastrophic erosion and deposition phenomena identify these as impact structures. Sedimentary strata, generally understood by creationists to have formed in Noah's Flood, may contain astrobleme structures, meteorites, impact-shocked minerals, tektites and other impact-related features. This implies that impacts occurred during the deposition of Flood sediments. There are also a few impact structures in Precambrian basement rock, suggesting that impacts began at the onset of Noah's Flood. Some impacts occurred in the post-Flood period, as suggested by DeYoung (1994) for the Barringer crater in Arizona.

The timing and character of impacts in the solar system and on Earth have been topics of debate and discussion by creationists (Faulkner, 1999; 2000; Faulkner and Spencer, 2000; Froede, 2002; Hovis, 2000; Spencer, 1994; 2000; 2002). Various possibilities regarding the timing of impacts have been suggested, including during the Creation week of Genesis 1, at or following the time of the Fall (Genesis 3), and within Noah's Flood. Spencer has argued that impacts took place within the Flood and that the same event affected not only the Earth, but other objects in the solar system as well (Spencer, 1994). Faulkner has suggested impacts took place in the solar system during the Creation week and on the Earth and Moon at the time of the Flood. Froede and DeYoung (1996) proposed the breakup of a planet in the asteroid region that generated

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* Wayne Spencer, M.S., Creation Education Materials, P.O. Box 153402, Irving, TX 75015-3402
Michael J. Oard, M.S., 34 West Clara Court, Bozeman, MT 59718

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impacts in the inner solar system.

In this article, we will analyze a newly discovered large impact structure in the United States. This feature is known as the Chesapeake Bay impact and is now considered one of the largest impacts ever discovered. We will place the impact within the Creation-Flood model.

The Chesapeake Bay Astrobleme

In 1991 and 1992, a group of researchers from the U.S. Geological Survey reported evidence of impact-shocked minerals, glassy material, and concentric normal faults in the region of Chesapeake Bay, Virginia (Poag, Powars, Poppe, et. al., 1992; Koeberl, Poag, et. al., 1996). The presence of shocked minerals and glassy material is a strong indication of impact, especially since there is no indication of igneous or volcanic activity in the vicinity. Though evidence in the early 1990s strongly suggested an impact, no crater structure was known in the region at that time except a smaller one that is 10–15 km (6–9 mi) in diameter. This is the Toms Canyon crater (Poag et al., 1992; Poag and Poppe, 1998) northeast of Chesapeake Bay along the edge of the continental slope. Subsequent studies of the region included single channel and multichannel seismic reflection profiles of the bay as well as a number of boreholes that reached depths of 728 m (2,388 ft)(see USGS web site, <http://geology.er.usgs.gov/eespteam/crater>). Boreholes intersect the basement in some areas at a depth of 681 m (2,234 ft)(Poag, Hutchinson, and Colman, 1999, p. 151). Based on seismic reflection profiles, the sedimentary rocks dip seaward. The dip begins gently at 9 m/km below the coast section, but increases to a rate of about 58 m/km along the continental margin (Poag, 1997, p. 46).

In these studies, a large crater was discovered below southern Chesapeake Bay, centered at approximately 37° N latitude and 76° W longitude, on the Delmarva Peninsula near Cape Charles, Virginia (Figure 1). The crater averages 85 km (53 mi) in diameter, but the outer rim has slumped

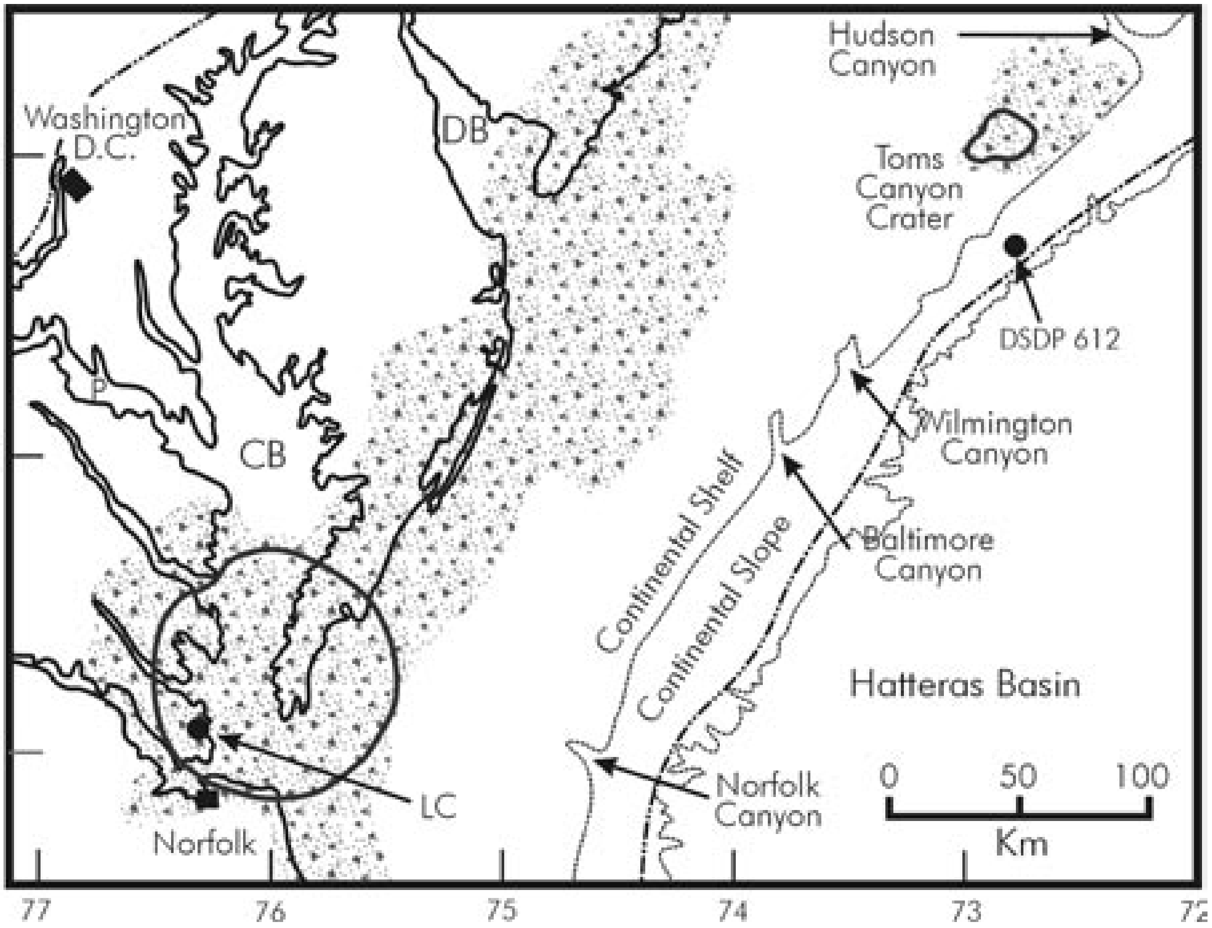

Figure 1. Plan view of Chesapeake Bay crater along the Atlantic coast. Dashed lines represent boundary of Baltimore Canyon Trough. Shaded areas represent approximate extent of breccia from Chesapeake Bay impact and from Toms Canyon impact. LC = Langley corehole (see Table I), CB = Chesapeake Bay, DB = Delaware Bay, P = Potomac River. Modified from Poag (1997).

heavily into the impact basin forming a scalloped margin (Poag, 1997; Poag, Hutchinson, and Colman, 1999). The structure encompasses an area from Virginia Beach to Newport News to the mouth of the Rappahannock River on the west (USGS web site; Poag, 1997). The geographic area encompassed by the structure is roughly 6,400 km^2 (2,471 mi^2), about double the area of Rhode Island. The buried crater structure lies at a depth of approximately 400–500 m (1,312–1,641 ft) under the ground surface (near sea level). The depth of the structure itself is roughly 1.3 km (4,265 ft), based on the probable depth of the inner basin. Southeast from the center of the crater, the edge of the continental shelf is about 130 km (81 mi) away from the outer rim). Seismic profiles reveal that numerous high-angle normal faults and a few low-angle reverse faults disrupt the basement inside the crater. Outside the crater, the surface of the basement is generally smooth. The North American tektite strewn field is now attributed to the Chesapeake Bay impact (Poag et al., 1994).

The structure possesses a circular basin around the edge, called an annular trough, with a central peak ring, approximately 35–40 km (22–25 mi) in diameter, and possibly another central peak inside the major peak ring (Poag, Hutchinson, and Colman, 1999) (Figure 2). Gravity measurements show a notable negative anomaly, circular in shape, that corresponds to the inner peak ring structure (Poag, 1997, p. 58). The underlying basement rock in the annular trough region includes a number of concentric normal faults that indicate large-scale slumping from what would be the outer rim area inward and downward.

There are certain unique characteristics of the Chesapeake astrobleme that distinguish it from some other impact sites on Earth. First, since the impact likely occurred in water, a large amount of water would have been vaporized, generating a very significant aerosol plume. Vaporized and fragmented rock and sediment would be entrained with the steam explosion to produce the plume. The efficiency of an impact in forming the crater structure in the target rock depends on the depth of the water compared to the size of the impactor. Greater water depths tend to make the crater structure smaller and with lesser relief, as more of the energy of impact is transferred into the water. The Chesapeake Bay crater is of nearly the same size as the Acraman impact crater in Australia and the Popigai crater in Siberia. For the Acraman structure, the impactor has been estimated to be about 4.7 km in diameter, assuming it was a chondritic asteroid (Williams, 1994). Because the sediments under the Chesapeake site were likely of a weaker material than those at the Acraman crater, it may be reasonable to estimate the size of the Chesapeake impactor in the range of 3–5 km (~2–3 mi) in diameter, depending on its velocity. Since the size of the impactor was perhaps significantly more than the water depth, most of the energy would go into forming the crater structure and producing a powerful tsunami. The tsunami and the backwash gen-

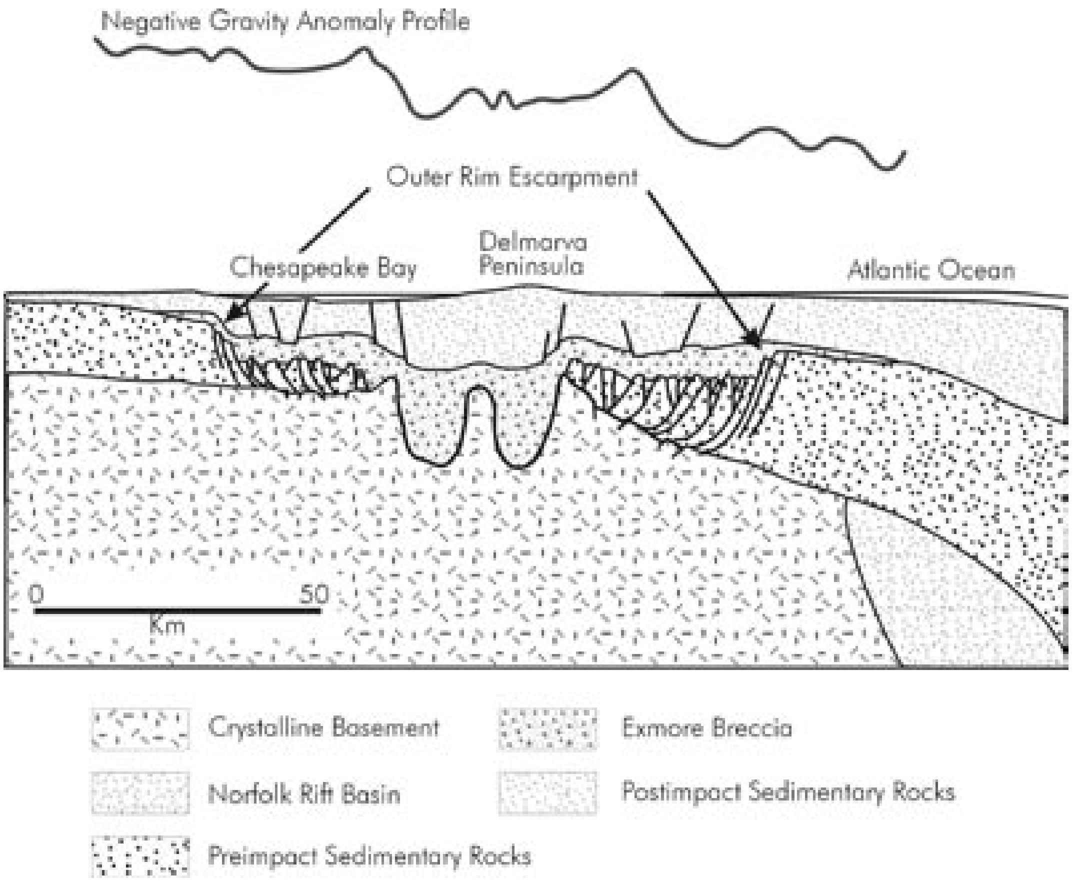

Figure 2. Cross section of Chesapeake impact structure. Modified from Poag et al. (1999).

erated from it seem to have eroded off the crater rim itself and caused the deposition of breccia that fills the crater.

The Uniformitarian Date of the Astrobleme

Evolutionary scientists have arrived at the generally accepted date of the impact from studies of nearby core samples and seismic data. They argue that the crater is of the same age as the Toms Canyon impact crater northeast of Chesapeake Bay and the same age as core samples from Site 612 of the Deep Sea Drilling Project (DSDP) from the New Jersey continental shelf (Koeberl, Poag, Reimold, et. al., 1996). The Chesapeake Bay crater is thus dated as 35.5 million years based on radiometric dating of tektites from the DSDP Site 612 core samples and from correlation of microfossils such as foraminifera from the crater with those in nearby deposits.

In relation to the standard evolutionary geologic column, the crater structure cuts through strata ranging from middle or upper Eocene down to early Mesozoic and older igneous basement rock. Much of the stratigraphic information of the pre- and post-impact sedimentary rocks comes from the Virginia coastal plain. These formations seem to be relatively widespread sheets (Koeberl, Poag, and Reimold, 1996) and probably are generally representative of the sediments around and above the crater, except for three formations found mainly within the crater. Table 1 presents a stratigraphic section based primarily on the Langley corehole near Hampton, Virginia. This core was drilled to 635.1 m (2,083 ft) in the annular trough, approximately midway between the outer rim and the inner basin. The coastal plain and continental margin deposits around the impact crater are underlain by igneous and metamorphic basement rocks broken up in places by rift basins filled with sedimentary rocks (Powars, 2000). The long axes of the rift basins are parallel to the coast and the Appalachian Mountains. This basement rock consists of granite or greenstone, a metamorphosed basic igneous rock similar to basalt but extruded at significantly higher temperatures. Uniformitarian geologists date the rift sediments as Triassic or Jurassic. The pre-impact sedimentary rocks thicken seaward into the Baltimore Canyon trough. This trough is located below the continental shelf and slope and extends from Cape Hatteras to Long Island with an area of 200,000 km^2 (77,220 mi^2), all covered with sediments that obtain a maximum thickness of 18 km (11 mi) in the northern part of the trough (Pickering, Hiscott, and Hein, 1989, p. 264). These sedimentary rocks are siliciclastic rocks with minor limestone, dated by uniformitarian scientists as Middle Jurassic to late Eocene (Poag, 1997).

The lower portion of the crater is filled with what is called the Exmore breccia. Such a feature is not characteristic of continental craters but seems to be common in craters along continental margins. If the eastern part of North America were significantly covered with water at the time of the impact, then a strong tsunami would have been generated and spread outward from the crater traveling a long distance inland over what is now the continent before depositing sedimentary materials. Thus, extensive impact deposits would not be found surrounding Chesapeake Bay. However, there would be a backwash as the water flowed back into the excavated crater. This backwash appears to be responsible for many features of the strata in and around the crater, such as the Exmore breccia. The shape of the inner peak ring structure and its dimensions suggest that it was filled extremely rapidly with the breccia, probably in just a few minutes. This is indicated by the physics of central peak and peak ring formation (Melosh, 1989) as well as from the very high sedimentation rates that were involved (Poag, 1997).

Further evidence that the backwash deposited the Exmore breccia is that it contains clasts of a wide variety of materials in a gray, silty, sandy and clayey matrix, sometimes not completely consolidated (Powars, 2000). Poag (2000, pp. 16–17) provides an interesting description of the breccia:

> Suddenly, the drillers were pulling out bright, multicolored core segments, which resembled psychedelic barber poles. The dominant constituent of this garish deposit was grayish green sand, whose color came from an abundance of iron-rich glauconite. Imbedded within the glauconitic sand was a kaleidoscopic array of larger clasts, ranging from dime-sized pebbles to six-foot boulders. The clasts changed rapidly and randomly downcore through nearly every color and hue of the rainbow.

The breccia also contains marine fossils that would be classified from Cretaceous to Eocene. Indeed, some of these fossils would be classified as Upper Eocene in age, but no strata have been identified as a possible source for these fossils anywhere in Virginia and no Upper Eocene sedimentary clasts have been found in the breccia cores. This could suggest some fossils and fragments in the breccia have been transported long distances. Some clasts are rounded and some are angular with some over 3 m (10 ft) in diameter (Poag, 1997; Powars, 2000). Outside the outer rim of the crater, the Exmore breccia ranges from 10 to 30 m (33–98 ft) in thickness. It may have extended as a once continuous deposit farther outside the outer rim in some areas. Much of it has apparently been eroded. A short distance inside the outer rim it thickens to over 300 m (985 ft) and also seems to fill the inner basin. The Exmore breccia is up to 1,200 m (3,937 ft) thick in the central part

Stratigraphic Unit	Chesapeake Area Strata Names	Depth (feet)	Description of Strata
Pleistocene	Tab Formation (Columbia Group)	0 to 11	Paleochannels cut into older units; oxidized muddy sand, muddy & sandy gravel, cobbles of chert & quartz up to 4 inches in dimension. No fossils in this from the Langley core but shells found in other areas.
Pliocene	Chowan River Formation, Yorktown Formation	11 to 76.3	Calcareous, muddy, very fine to fine quartz sands, clays, silts, common micro- & macrofossils
Miocene	Eastover Formation	76.3 to 223.8	Muddy, very fine to medium sands, fossils include dinoflagellates, ostracodes, & mollusks
	Lower Chesapeake Group, Calvert and St. Marys	223.8 to 470.9	Shelly sands, silts and clays with microfossils
Oligocene	Old Church Formation and Delmarva Beds	470.9 to 601.3	Shells, glauconitic & phosphatic quartz sands in clay-silt matrix, microfossils
Eocene	Chickahominy Formation	601.3 to 774 (up to 227 ft thick in other locations)	Dry, clayey silt, fine sand, iron sulfides, extensive burrows. Fauna include planktonic foraminifera, calcareous nanofossils, coral, shells
	Exmore Breccia (upper Eocene) Lower Pamunkey Group	774 to 1,470	Breccia within crater. Breccia clasts from < 1 inch to 30 feet in dimension. Clay and sandy mixtures, varied clasts (some rounded, some angular). Clasts consist of clay, limestone, & cross-bedded sand. Upper part in a sandy matrix. Shocked quartz present at 820 feet. Pollen and mollusk fossils, wood present.
Cretaceous	Upper Cenomanian Formations Potomac Group	1,470 to 2,054.7	Mega-slump blocks, feldspar and quartz sands, clay-silt clasts, chert and granodiorite pebbles
Paleozoic	Basement metamorphosed granodiorite at Langley core	2,054.7 to 2,083.8	Below crater; granite in some other locations

Table I. Stratigraphic section based on the NASA Langley Corehole, Hampton, Virginia. From Johnson, Kruse, and Vaughn, 1998, pp. 507–510; Powars, 2000; Powars, Bruce, Bybell et al. 2001. This corehole lies approximately midway between the outer rim and the inner basin.

of the crater (Poag, 1997; Powars, 2000). The total volume of the breccia is estimated at 4,300 km^3 (Poag, 1997, p. 62). Because this breccia is so permeable, it is described as a hypersaline aquifer, which has been known from the early 1900s. The groundwater in this aquifer is about 50% saltier than seawater (Poag, 1997). The reason for the existence of this hypersaline aquifer is uncertain (Poag, 1997, p. 69).

The breccia covering the Chesapeake crater structure provides strong evidence of its impact origin. It contains shocked quartz and what is known as "impact glass," which is believed to be melted and metamorphosed basement rock. A number of core samples show indications of shock. Planar shock deformation features tend to occur along certain characteristic crystal orientations, and the particular sets of planes involved allow calculation of the pressures. The highest shock pressures indicated from the Chesapeake samples are in the range of 20 to 60 gigapascals (Koeberl, Poag, Reimold and Brandt, 1996; Poag, Gohn, and Powers, 2001). Some quartz grains from the breccia samples exhibited six different sets of these planar deformations (called lamellae).

Another unique feature within the Chesapeake crater indicating an impact in water is the mega-slump blocks (or megablocks) found in the annular trough region outside the inner peak ring (Poag, 1997; Poag, Hutchinson, and Colman, 1999). These large blocks represent fractured pre-impact (Cretaceous) sedimentary rocks that slumped into the crater. These slumps have created the bulges and embayments in plan view along the outer rim of the crater. They are also believed responsible for removing practically all evidence of a raised lip at the outer rim. Some of these blocks are over a kilometer in length. Many fractures and large faults are found in this rock, some of which reach downward into the basement material. These blocks are over 300 m (985 ft) high over much of the annular trough region. Some of the faults appear to be normal and some have apparently rotated into the crater. The vibrations and initial shock waves from the impact may have caused many of the fractures, making the crater bowl structure and terraces vulnerable to erosion and movement. The liquid water column ejected upward by the steam explosion and waves from the backwash very likely caused most of the crater sides and floor to be broken and eroded into the trough region. This has left the outer rim escarpment a very sharp single-step structure around much of the impact rim, though on the northern rim the structure seems to be terraced (Poag, Hutchinson, and Colman, 1999). Such large megablocks in the annular trough region are not normally found in craters located on the continents. These faults and large blocks seem to be a result of the impact having occurred in water.

The post-impact sedimentary strata are 300–500 m (985–1,641 ft) thick above the crater and are dated from late Eocene to Quaternary within the uniformitarian timescale (Poag, 1997, p. 45–46). The stratigraphy is based on seismic reflection profiles and borehole data. The stratigraphy above the crater differs somewhat from the stratigraphy in the Chesapeake Bay area outside the crater rim, especially the lower strata. Seismic reflection profiles indicate that the first three of the overlying formations and the very lowest part of a fourth overlying formation are constrained only within the crater rim. The upper formations are about 140 m (460 ft) thick over the crater and are regionally extensive outside the crater, thickening substantially eastward toward the Baltimore Canyon trough.

Evidence That Contradicts the Uniformitarian Timescale

From a young-Earth viewpoint, the impact would have occurred around 5,000 years ago, while the uniformitarian model assumes an age of 35.5 million years. This is a radical difference in time. Is there any evidence to suggest which timescale is better supported by the data? A possible argument that the Flood timescale is more nearly correct comes from analyzing the fallacies regarding the compacting and subsiding of the Exmore breccia for the supposed 35 million years of uniformitarian time (Poag, 1997, pp. 71–74). In fact, it is still subsiding as indicated by one of the fastest rises in sea level anywhere in the world along the Bay coast (Poag, 2000, p. 112)! Only part of this rise could be due to eustatic sea level rise, so most, if not all of it, is likely due to the continued subsidence of the Exmore breccia. Furthermore, this continuous sagging likely predetermined the location of Chesapeake Bay (Poag, 1997). Moreover, a block along the west rim seems to have slumped down during the late Pliocene of the uniformitarian timescale (Johnson, Kruse, Vaughn, et. al., 1998), well after the impact. It seems paradoxical that such subsidence and slumping could continue for 35 million years. Surely, the breccia and slump blocks should have settled long ago. We believe such evidence is more indicative of a recent impact and rapid sedimentation in the crater and the continental margin.

Dating the Impact within a Flood Framework

How can we place the Chesapeake Bay impact within the Creation-Flood model? First, we must place the impact within the time frame of the Flood. The Exmore breccia appears consistent with the impact having occurred concurrently with erosional processes of Noah's Flood. Such thick breccia would not be expected to be only near the crater and coastline, considering the size of the impact, if the continent were exposed as it exists today at the time of the impact. With the continent not submerged, a monstrous tsunami hundreds or possibly even a few thousand meters high would have been created racing onshore along the Atlantic coast (Poag, 2000, p. 50; Ward and Asphaug, 2000). We would expect copious breccia spread hundreds of kilometers inland. However, breccia has not been observed inland more than about 25–30 km (~15–19 mi) from the crater rim. If the continent were submerged during the impact (even partially), this might significantly change how sediment would have been deposited on the continent by the tsunami and post-impact giant waves. If the Chesapeake impact occurred during a period of great erosion from the continent, such as in the Recessive Stage of the Flood, the eroded material would tend to be found in the crater cavity and along the continental margin, as observed. Thus the distribution of the breccia argues for the event occurring as Floodwater receded, while a significant fraction of the continent was still submerged.

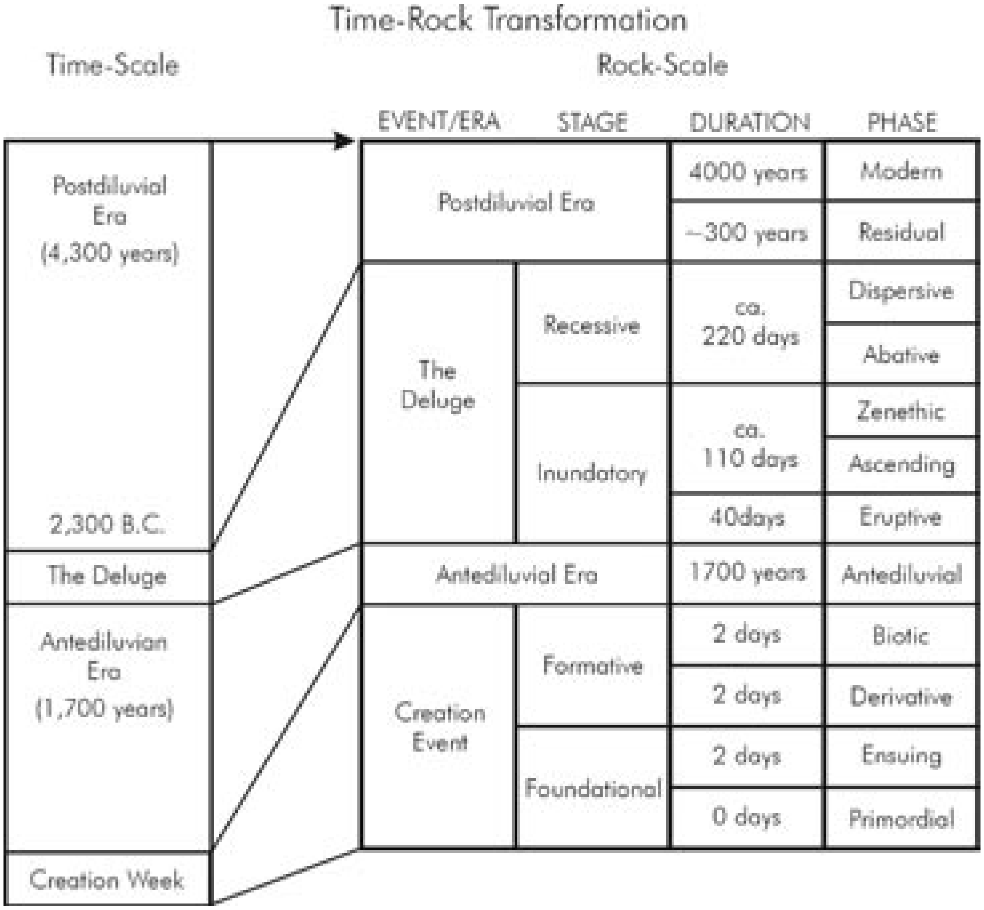

Figure 3. Walker's biblical geological model (permission from Walker with modifications by Peter Klevberg, especially in the timing of Flood stages and phases).

This evidence is further supported considering the energy of the impact. The Chesapeake Bay impact released 100 times the combined energy of all existing nuclear weapons! Such an impact is estimated to have had the kinetic energy equivalent to approximately 10 trillion tons of TNT (Poag, 2000, p. 96), while the total potential energy yield from the world's entire nuclear arsenal is 100 billion tons of TNT. Though the impact occurred in one region of the world, its environmental ramifications would have been worldwide, including a drop in temperature similar to a nuclear winter due to ejected dust and aerosols.

In order to further refine the timing of the impact within the Flood time frame, we applied the particular biblical geological model of Walker (1994) because it is based strictly on the Bible (Figure 3). The model has defining criteria for its various stages and phases that allow it to be related to observations of the rock record. In Walker's model, the time from the onset of the Flood to the point where the water depth reached its peak, the Inundatory Stage, is estimated at 60 days. The draining of the Floodwater off the future continents, the Recessional Stage of the Flood, is about 300 days. Other creationists believe the Inundatory Stage was 150 days and the Recessional Stage was 220 days (Oard, 2001a, p. 7).

In Walker's model, the continental shelf, slope, and rise sediment were formed by sheet flow off the continent during the Abative Phase of the Recessive Stage of the Flood as the continents and mountains were rising and the ocean basins and valleys were sinking down (Oard, 2001a):

> Regional scale sediments would be expected during the Abative Phase [sic] as the flood waters began to move in large sheets from the continents. Local scale sediments would be formed during the Dispersive Stage as the receding waters separated into complexes of lakes and ponds connected by flowing water courses (Walker, 1994, p. 591).

Thus, the continental margins are typical features of the

Abative Phase of the Recessive Stage. The very shallow and wide continental shelf and the steep drop-off of the continental slope are paradoxical features within the uniformitarian scheme, because longshore currents and mass wasting should have produced a gradual descent to the deep sea (King, 1983, pp. 199–200). During the Abative Phase of the Flood, currents perhaps thousands of kilometers wide flowed off the rising continents, likely at high speed at times. These currents would be expected to erode the surface of the rising continents and deposit the sediments in deeper water at the edge of the continents where the currents would decrease in velocity and rapidly deposit the sediments. We argue that these off-continent currents explain the formation of the pre- and post-impact sediments along the east coast of Virginia. Thus, the impact would have probably occurred during the Abative Phase of the Flood.

When the continental margin is examined by seismic reflection profiles, the post-impact sedimentary rocks, 300 to 500 m (985–1,641 ft) thick, are continuous and generally horizontal above the crater, although dipping gently inward into the crater with short offsets caused by numerous normal faults (Poag, Plescia, and Molzer, 2002). The offsets are attributed to differential compaction of the breccia and slump-block motion near the outer rim (Poag, Hutchinson, and Colman, 1999; Johnson, Kruse, Vaughn, et al., 1998, p. 507). These strata are also continuous with the generally horizontal strata along the coastal plain and continental shelf along much of the Atlantic margin (Poag, 1997; Klitgord, Hutchinson, and Shouten, 1988). Occasional onlapping strata imaged by seismic reflection along the continental shelf indicate the sediments came from the continent (Poulsen, Flemings, et al., 1998). These post-impact sediments thicken and extend significantly seaward by deposition from sheet flow off the continents.

A second reason for believing the impact occurred during the Abative Phase is that very few submarine canyons have been detected in the continental shelf sediments. Submarine canyons, mostly developed after the formation of the continental margin, are typical Dispersive Phase or channelized flow geomorphological features (Oard, 2001b). This indicates that nearly the entire continental margin was deposited before the submarine canyons were cut. For instance, Fulthorpe, Austin and Mountain (2000, p. 817) state:

> High-resolution multichannel seismic reflection profiles confirm that middle-late Miocene continental slope canyons off New Jersey are rare, in contrast to their prevalence on the slope today.

The rarity of submarine canyons within the continental margin sedimentary rocks is a problem for uniformitarian scientists because numerous canyons should be cut over the 125 million-year period the continental margin was supposedly formed. It also indicates that the impact must have occurred before the Dispersive Phase, which would place it in the Abative Phase.

Conclusions

The Chesapeake Bay impact excavated thick Mesozoic and early Cenozoic sediments, penetrated into basement rocks, and was covered by mid- and late-Cenozoic marine sediments. The geologic context of the crater and the unique characteristics of the structure suggest a large impact from space occurred in water. Many impact related features have been discovered, such as shocked quartz. Following the impact, a tsunami eroded the crater area and post-tsunami giant waves and backwash deposited a large volume of breccia and other materials in the crater. The breccia can only be found near and within the crater, likely because of strong erosive currents coming off the continents after the impact. An additional 300–500 m (985–1,641 ft) of generally continuous, horizontal sediment was deposited above the crater structure after the impact. The volume and character of the sediments in and around the Chesapeake structure point to the impact occurring during Noah's Flood.

Erosion from the continents and deposition along the continental margin from receding Floodwater in the Abative Phase of the Flood provides an explanation of the Exmore breccia and the sediments covering the crater. It appears the continent was largely or at least partially covered with water at the time of the impact. The Abative Phase of the mid-to-late-Flood in Walker's model is proposed as the time frame in which the impact occurred.

Impacts were probably most prolific during the early period of the Flood and that much of the evidence was erased by the violence of the Flood. We have presented evidence in this paper proposing that impacts continued into the mid- to late-Flood period based on what we found regarding the Chesapeake Bay Impact Crater. The evidence supports the young-Earth Flood model of Earth history.

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Book Review

The Design Revolution: Answering the Toughest Questions about Intelligent Design
by William A. Dembski
Inter Varsity Press, Downers Grove, IL, 2004, 334 pages, $22.

Author Dembski is the widely recognized leader, tireless writer, and experienced debater for the increasingly popular Intelligent Design (ID) movement. He has assembled 44 chapters in order to answer the main questions about ID. The work was designed as a handbook for replacing the now-outdated Darwinism with another *scientific theory*, namely ID.

ID applies to natural systems which cannot adequately be explained by "undirected natural forces [chance] and that exhibit features which in any other circumstance we would attribute to intelligence" (p. 27). It is important to emphasize that known mechanistic processes cannot explain the systems. Probability considerations are pertinent. "The universal probability bound of 1 in 10^{150} is the most conservative in the literature…any specified event as improbable as this could never be attributed to chance" (p. 85). The origin of life is an excellent example of this.

Many opponents of ID have termed certain intricacies as only "apparent design." These critics (including the late S.J. Gould) have pointed to particular body structures such as the eye, pharynx, the back, wisdom teeth, or pelvis, etc. saying that these organs are suboptimal and not perfectly designed. But Dembski points out that certain tradeoffs often are necessary because of the total pattern of which these organs are a part. So what we find is best for the organism but may be somewhat of a compromise termed constrained optimization. Not only does Dembski deal with a host of challenges such as these, but also he projects future goals including penetration into the educational system with textbooks.

Most chapters of *The Design Revolution* are relatively short and without notes or complete references. There is a six-page "select bibliography" and three-page author index, but no subject index. Some chapters are readily understandable by an ID novice, but others will challenge those with stronger backgrounds in philosophy, sciences and mathematics. In paving the way for the ensuing demise of Darwinism this book will engage all those having an interest in origins.

Wayne Frair
1131 Fellowship Road
Basking Ridge, NJ 07920