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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh. — Exodus 20:11

Notes from the Panorama of Science

Morphogenetic Genes, Symmetric Variation, and the Production of Form in *Drosophila*

Many of the main areas of development of form in the vinegar fly, *Drosophila*, are now known. The main aspects of the production of form are controlled by very special genes. One part of the egg chamber, in its early stage, is divided into many nurse cells and the oocyte, or the unfertilized egg, is in the other part of the chamber. There is a cytoplasmic bridge by which the mRNA molecules cross over from the nurse cells into the area of the oocyte. Cellular organelles and proteins also make this journey from the nurse cell region to the oocyte. The mRNA molecules help to restrict the expression and spatial distribution of proteins (Gehring, 1998, p. 138). The head versus tail polarity of the egg and beginnings of the embryo are dependent on this distribution of mRNA in an asymmetrical fashion.

The distribution of mRNA is caused by signals in the mRNA and on the RNA-binding proteins that recognize such signals (Cost and Schedi, 2001, pp. 593–595). After about two or three days the Hox gene called Hedgehog plays an early role by stimulating the change of ovarian somatic cells into stem cells. Without hedgehog this cannot happen (Zhang and Kalderson, 2001, pp. 599–604).

The polarity of the oocyte is established as soon as some of the mRNA molecules are translated into proteins. Bicoid is one such protein which helps establish the head end. In fact, if you put this protein at both ends, two heads result. RNA bicoid together with RNA's of two genes called oskar and torso-like produce three pathways which give rise to four protein gradients that start subdividing the embryo (Nusslein-Volhard, 1996, pp. 38–43). A gradient of another protein called dpp actively subdivides the dorsal ectoderm of the *Drosophila* embryo into two areas: amnioserosa and dorsal epidermis. The two proteins called short gastrulation and tolloid help to shape this gradient (Ashe and Levine, 1999, pp. 427–430).

The Hox gene Hedgehog helps to initiate the formation of eyes and limbs (Brown, 2001, pp. 48–49). Dpp also is seen as crucial for *Drosophila* wing development (de Celis, Barrion and Kafatos, 1996, pp. 421–424).

The main aspects of development are clearly caused by proteins and these proteins remain stable because of the principle of symmetric variation (Brown, 1999, p. 200). Some changes in DNA chemical bases that ultimately code for amino acids resulting in the proteins will produce the

same outcome, hence the term 'symmetric.' Other DNA changes will field amino acids within the same chemical group to which the original amino acid belonged. If these remain, they can produce broader changes. The enzyme repair system, however, will repair most of the changes including many that would be adverse. For a review of how all this works, see Brown, 1989, pp. 18–19. Changes therefore, in these proteins, can bring about changes in form but such change is moderated by symmetric variation and is thus always kept within the kind. We will have far to go before we can express the same detailed understanding of most life forms that is possible now with *Drosophila*, but what we do know supports the belief that the Creator produces an animal's form by means of a series of marvelous developmental genes. In one such example of a recent work, the face of a bird was shown to be produced by the working together of the morphogenetic protein Noggin and a vitamin A derivative called retinoic acid (Lee, Fu, Hui and Richman, 2001, pp. 909–912). Retinoic acid is a nuclear receptor. Surely each creature is "fearfully and wonderfully made."

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Paleontology, Palynology and Archaeology—Saltville Valley, Virginia

Introduction

Recently I completed a paper on the evaporite deposits near Saltville, Virginia (Williams, 2003). While examining the literature on Saltville Valley, I found some interesting reports on paleontological investigations conducted in the region. Many of these studies will be discussed in this note. To place the various fossil finds in the proper regional geological setting, refer to Williams (2003).

Paleontology

Saltville Valley has been known to yield vertebrate fossils for over 200 years (McDonald and Bartlett, 1983; Ray, Cooper and Benninghoff, 1967). Bones, skulls, teeth, tusks and antlers were routinely uncovered during excavations for ditches, road and railway cuts, etc. (Craig, 1973, p. 11). The first systematic study appears to have been done by Ray, et al., 1967. They examined fragmentary fossil material from private collections, museums and universities. Most of the terrestrial vertebrate fossils were recovered from a dark gray unstratified muck layer or mud having a thickness up to 25 ft. which also contained "...spores, pollen, abundant ostracodes and fresh-water clams..." (Ray, et al., p. 610). The gray muck overlies the Maccrady Formation "...which contains most of the salt and gypsum in the Saltville area" (p. 611).

In their examination, Ray, et al. classified the late Pleistocene vertebrate fossil finds as follows:

Jefferson's ground sloth—*Megalonyx jeffersonii* (Desmarest)
 American mastodon—*Mammot americanum* (Kerr)
 Woolly mammoth—*Mammuthus primigenius*
 Horse—*Equus*, sp. indet.
 Caribou—*Rangifer tarandus* (Linnaeus)
 (?)Extinct moose—(?) *Cervalces*, sp. indet.
 Bison—*Bison*, sp. indet.
 Extinct woodland musk ox—*Symbos cavifrons* (Leidy)
 Extinct musk ox—*Bootherium*, sp. indet.

Undetermined extinct musk ox—*Ovibovini*, gen. et sp. indet.

At the time of the publication of their article, the Saltville locality represented the most southeasterly occurrence for *Symbos*, *Rangifer* and *Bootherium*. No complete specimens were found. Ray, et al. (p. 612) state:

Many of the bones show abraded, rounded broken ends that indicate some transportation. Isolated bones, teeth and tusks also suggest transportation that lead to dismemberment of skeletons after death and prior to burial.

At the bottom of the muck layers, from which the fossils were removed, rounded pebbles and cobbles as well as thin delicate clam shells were found (p. 613). Yet even with this available evidence, the authors suggested a La Brea tar pit type entrapment before death and fossilization (cf. Weston, 2002a; 2002b), only in these instances the large mammals were assumed to have been mired in soft, swampy muck. Craig (1973, p. 12) did not accept the entrapment concept and claimed:

The presence of rounded river boulders and cobbles, the water worn fossils, and the virtual total disaggregation of the skeletal remains clearly indicate that many of the animals died elsewhere and were washed downstream (being disaggregated before or during river transport) to the site where they were found. The sharpness of the contact between the gravel and muck beds and the underlying Maccrady formation also indicated that the gravels are river channel deposits.

Palynology

The *Bootherium* skull contained sediment which was removed and examined for pollen and spore content (Ray, et al., pp. 613–615). Pine and spruce were the major tree pollens identified with trace amounts of balsam fir, oak and birch pollen present. Pollen from grasses, sedges and

members of Compositae also was found. Ray et al. felt that some of the pollen and spores had been present in a previous deposit. They assumed redeposition of the suspected grains and eliminated them from the analysis. They then concluded that the environment from which the pollen assemblage was derived was:

...one of spruce parkland. Marshes, ponds, and prairies probably dotted the landscape between knolls or ridges with spruce in park-like or locally dense stands (p. 615).

More Paleontology

McDonald and Bartlett (1983) reported finding additional fossil vertebrate bones in Saltville; American mastodon, woolly mammoth, stag-moose (?) *Cervalces scotti*, extinct musk ox, and bones of a fish (either a sucker or minnow). Forty-nine different bones of an extinct musk ox specimen were found in "... a lacustrine or marsh clay overlying fluvial gravel and sand deposits..." (McDonald, 1985, p. 291), making it the third most complete skeleton known in North America at that time. In discussing the taphonomy of this particular ovibovine, the authors stated that the cause of death could not be determined (pp. 462–463) but they speculated on carnivore activity after death and suggested the possibility of the ox being mired in surface mud and likely experiencing in situ burial. The authors note that:

The fact that this skeleton is, for the most part, very well preserved suggests that it was buried soon after death (p. 465).

McDonald and Bartlett (p. 454) noted that a woolly mammoth tooth they uncovered was abraded and they concluded that:

well abraded gravels and faunal remains, the tightly fitting pavement, the differential abrasion on the mammoth tooth and the presence of boulders all suggest a stream system of moderate dimensions was present in Saltville Valley.

They named the stream the Saltville River and postulated that it was a Wisconsin tributary of the North Fork of the Holston River. The authors surmised that unstratified clay deposits rich in organic matter from which the musk ox bones were retrieved suggested "...prolonged hydroturbid conditions and the absence of well-defined wet-dry cycles" (p. 455). Using historical references, they noted that a lake and adjacent marsh existed in the lower valley in recent times. For instance, Watson (1909) claimed that "the first borings for salt were in the old swampy lake-covered area near the present town of Saltville" (p. 119). McDonald named this body of water Lake Totten, probably after Charles W. Totten of Saltville.

Both McDonald (1985, p. 295) and Bird (1985, p. 177) speculated that large carnivores may have been responsible for "tooth compression markings" and breakage patterns on certain herbivore bones. Bird suggested that the predators could have been "sabretoothed cats", wolves and bears. However no large carnivore fossils have been found in Saltville Valley. Bird also suggested the possibility of scavengers chewing on the bones which may be more likely. McDonald (1985, p. 295) noted that artiodactyls, hoofed animals with an even number of toes on each foot, are the group of mammals most frequently represented by fossils in Saltville. It is known that the chewing of bones by artiodactyls is widespread (Sutcliffe, 1973, pp. 428–430; Williams, 1990, pp. 136–137). The herbivores simply could have drowned or died by means other than predation. Later, artiodactyls may have chewed on the herbivore bones, breaking some and leaving imprints on others. With many of the herbivores being washed into place, bone breakage and chipping could have occurred by collisions with rocks and other objects during transport.

Possible evidence of late Pleistocene carnivores large enough to prey on large herbivores was found in Clark's Cave in Bath County, Virginia about 150 aerial miles northeast of Saltville. A single carpal (right unciform) was thought to be from a dire wolf (*Canis*, cf. *C. dirus* Leidy). Guilday, Parmalee and Hamilton (1977, p. 69) stated:

The dire wolf is the only specimen of wolf present in Appalachian deposits of Wisconsinian age. It was replaced by the timber wolf following its extinction at the close of the Pleistocene.

An isolated tooth and phalanx of black bear (*Ursus americanus* Pallas) were found in Clark's cave also. The cave was located such that likely its numerous entrances were used as roosts for birds of prey (Guilday et al., 1977, p. 73). They did not speculate on how the large carnivore fossil parts were deposited in the cave except that possibly rodents carried the items into their nests within the cave (p. 69).

One could speculate that dire wolves or black bears, the latter becoming a carnivore opportunely, could have preyed on the large herbivores or scavenged their remains after death. Teeth marks on herbivore fossil bones thus could have come from these predators. Possibly smaller carnivores also could have scavenged a carcass leaving teeth marks on the bones of a herbivore.

Plant fossils uncovered by McDonald and Bartlett (1983) "...were almost entirely herbaceous and normally stem-like in appearance..." (p. 456). An acorn, possibly a spruce branch and what may have been abraded spruce cones were found. The authors concluded that the fossil vegetation they examined appears to be similar to that pro-

posed by Ray, et al. (1967).

Holman and McDonald (1986, pp. 85–100) reported finding fossils of two salamanders, two anurans, two turtles and four snakes which they assumed were from a late Quaternary herpetofauna. All of the forms can be found living in the Saltville region today. Holman (1986, p. 36) stated that “the late Pleistocene herpetofauna [in Virginia] appears almost identical to what it is today.” [Brackets added.] The late Pleistocene mammalian fauna from Virginia contain forms that suggest boreal climatic conditions. Boreal temperatures as presently known, however, would not provide enough warm days for the eggs of some species of the herpetofauna found as fossils in Saltville to hatch (Holman and McDonald, 1986, p. 85).

Radenbaugh and McKinney (1998) reported that pen shells (Pelecypoda: Pinnidae) in the Mississippian Little Valley Formation “...appear to have more structural similarities than differences, [when compared with pen shells in a Holocene environment] despite their separation by over 300 million years (p. 52). [Brackets added.]

Archaeology

McCary (1986, p. 77) conjectured that a Clovis culture existed in the Saltville Valley since Clovis points have been found in the region. Recently, McDonald (2000) discussed the possibility of a pre-Clovis human presence in the vicinity of Saltville as a result of finding possible human tools in the area. Radiocarbon dates for late Wisconsinan to earliest Holocene sediments in which the possible artifacts were found ranged from 9930–14,510 yrs BP. Mud, a paleosol, peat, wood, tusk and bone were the materials dated. Using Robert Brown’s method (1992) of correlating radiocarbon age with real time, the ages vary between approximately 5000 and 5200 yrs BP, likely placing them into a post-Flood ice age interval (cf. Froede, 1998, p. 3).

Conclusions

The fossils found in Saltville Valley thus far have led to some interesting interpretations. The late Pleistocene mammal fossils indicate boreal conditions whereas the late Pleistocene herpetofauna fossils indicate climatic conditions similar to what is experienced in Virginia today. Anyone postulating paleoenvironmental conditions for the Saltville, Virginia region must face this dilemma. Froede (1996, p. 121) has been critical of paleoenvironmental predictions based on paleontology. This example in Saltville Valley reinforces such criticism. Would a warm post-Flood ice age as suggested by Oard (1990) possibly solve the problem? If the mammals were migrating through the region after the

Flood on their way to other locations, died en route and were rapidly buried in sediment during river flooding, paleoclimatic speculations based on their fossils would be useless. If some herbivores were entrapped in the muck, why were no carnivores trapped and fossilized in the same way? Possibly the uncovering of more fossilized remains will answer these questions.

The observations concerning the pen shells suggest that the proposed 300 million years between the deposition of the Mississippian shells and the present do not exist or that no significant evolutionary changes occurred on the pen shells during the imagined time period. Was there no 300 million year time interval and no evolution? A young earth creationist would probably answer yes to that question. Saltville, Virginia appears to be a splendid location for fossil finds. As more artifacts and fossils are found, possibly interpretations about past environments may undergo considerable revision.

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Book Review

The Sacred Cosmos by Terence Nichols
Brazos Press, Grand Rapids, 2003, 240 pages, \$18.

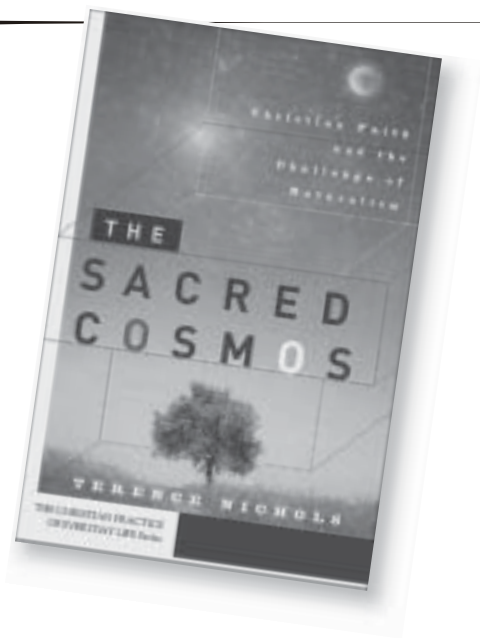
Author Nichols is a theology professor at the Catholic University of St. Thomas, St. Paul, MN. This scholarly book is about Christian faith and the challenge of naturalism. It should be noted at the start that Nichols is a theistic evolutionist, strongly influenced by John Polkinghorne. The book nevertheless is valuable in its thorough discussion of the theistic heritage of science, the rise of naturalism, and the occurrence of miracles. Also, the human soul is discussed in 50 thoughtful pages.

Several weaknesses occur in the book. Nichols assumes it is a surprise for readers to learn that today's prevalent scientific naturalism undermines Christian faith. The idea will be news only to someone who has totally avoided all television, radio, newspapers, magazines, movies, books, and classrooms! Nichols also reveals the shallowness of his biblical theology by writing that the miracle of changing water to wine is "weakly attested" since it is found in only one gospel (p. 190). The author is enamored with the word *complementary* in comparing science and faith, using the word ten times on page 51 alone. He cannot find a clear statement of *ex nihilo* creation in Scripture (p. 232), ne-

glecting such references as Gen. 1:3; Ps. 33:6,9; Col. 1:16–17; Heb. 11:3.

Beyond the points just raised this book provides excellent mental exercise. Nichols writes with passion and clarity. There is a gospel invitation in the final pages. I hope that Terence Nichols soon discovers the excitement of the literal creation worldview. Alas, the book has no index.

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Friesenhahn Cave: Window on the Past

Introduction

Concordia University at Austin, Texas, recently acquired Friesenhahn Cave near San Antonio, Texas. No other site except perhaps the La Brea Tar Pits in California yielded a greater variety of Pleistocene vertebrate fossils. The site offers exciting possibilities for further research.

Background History

The name “Friesenhahn” was adopted for the fossil-rich cave in northern Bexar County, Texas (near San Antonio), from the name of the owner of the ranch on which the cave was discovered. The earliest discoverer of the cave is unknown, but the first published material in a scientific

journal appeared in 1919 (Sellards, pp. 73–74). Early discoveries of fossils by local residents had brought the cave to the attention of the scientific community. O.P. Hay (1920) published more material about the cave, originally named “Bulverde Cave,” and the known fossils from it.

It was nearly 30 years later before earnest scientific work at the site would commence. A field team from the Memorial Museum at the University of Texas excavated the site during the summers of 1949 and 1951 at the invitation of the owner of the cave, Alfred Friesenhahn. More recently published material about excavations at the cave date from the 1970s and 1980s by R. W. Graham (1976;1987).

Interview with Dr. Larry Meissner

Question: What background information can you give us regarding the acquisition of the cave by Concordia University at Austin [The Lutheran Church—Missouri Synod (LCMS)]?

Dr. Meissner: The cave was given to us by a member of The LCMS whose daughter was a student at Concordia. We got access to the cave for study purposes in 1996 and acquired legal ownership in 1998. The total property is about 3.5 acres.

Question: What types of activities have been happening at the cave recently?

Dr. Meissner: Right now we are still doing removal of disturbed sediments from the cave that were moved during previous excavations in the 1950's through 1970's. I have a grant from the 3M Corporation to take several hundred students and teachers from local schools to the cave for training and paleontological work.

Question: Any comments on the history of the cave before Concordia University acquired it?

Dr. Meissner: None other than what are in the bulletins you have from the UT Memorial Museum. Thankfully, between the late 1970s and the mid-1990s the cave was virtually “lost” and unentered. I know this because when we first entered the cave there were valuable fos-

sils laying undisturbed on the cave floor—fossils that surely would have been taken had people been going in and out.

Question: How can anyone who wishes to visit or help at the cave contact you?

Dr. Meissner: They can contact me at my office at Concordia using my e-mail address: meissnerl@concordia.edu.

Question: Do you have any other comments you think would be helpful?

Dr. Meissner: We hope to apply for major funding for an excavation in virgin sediments in a couple of years when disturbed sediments have all been removed and analyzed. I have reason to believe that the cave extends much farther than what we currently see and that there are additional passageways or chambers where there may be more important fossils.

In conclusion: We thank Dr. Meissner for his help. Many photos of fossils found in the cave and photos taken during cave excavations are found at Dr. Meissner's website of the cave at www.concordia.edu/html/faculty/meissner/fries_home.htm.

—Edward C. Lain and Robert E. Gentet

Cave Characteristics

Present-day entrance to the cave is gained by descending a ladder some 45 feet below the surrounding land surface. The original cave opening has long since been closed due to collapsed limestone blocks and rock debris that washed

Figure 1. The cave deposits lie in four zones. The oldest and bottom, zone one, is separated from the zones above it by a highly irregular disconformity. Zone one consists of fallen limestone blocks, gravels and red clay. Only a few vertebrate bones have been found in zone one, mainly of small mammals and turtle shells. Zone two is the result of clay, vegetable matter and limestone grit. It records the history of ponded water that once existed in the cave. Important peccary and saber-toothed cat fossils have been found in its upper portion. The most abundant fossil remains are found in the banded clay layer of Zone 3. However, the bones found in zone 3 are not as articulated as in the previous zone. Zone 4 represents deposits of a channel cut into the previous layers. The present vertical cave entrance allows water to flow into the cave that appears to have formed the channel during wet periods. Much of its heterogeneous mixture of rocks is from older rock zones from within the cave. Remains of smaller vertebrates such as rodents are especially plentiful in this uppermost zone 4, along with disarticulated fossil bones from previous zones that have been redeposited. (Profile of Friesenhahn Cave is courtesy of Dr. Laurence Meissner's website at: www.concordia.edu/html/faculty/meissner/fries_home.htm.)



in from the surface. At sometime later the new vertical shaft (sinkhole) opening was formed, once again providing a natural, but straight vertical decent into the cave.

The present dimensions of the cave are approximately 60 feet long and 30 feet wide. The rather modest dimensions of the Friesenhahn Cave belie its paleontological importance. It was the first cave in Texas studied by the scientific community for fossils. It is now acknowledged one of the richest and most important Pleistocene fossil sites in all America.

The diggings of archeologists since the late 1940s have changed the characteristics of the cavern. Originally the surface of the cave fill extended to within 2 to 6 feet of its roof. Much cave fill has since been removed. Now due to the excavations, most of the room is about 7 to 8 feet high. As the cave was excavated in a series of trenches, the location of each new fossil was carefully noted. The cave fill was found to have had four distinct zones or units (see Figure 1 and caption for further explanation).

Fossil Contents

The original entrance passage to the cave was at the northwest end of the cavern slanted upward at an angle of twenty to thirty degrees. Through this passage various animals made their way into the cave and alluvial fill washed into the interior. A pond of water occupied the lower part of the cave when the angular, original entrance was still open. The cave provided a natural and convenient home to various animals. It also provided a burial ground for bones in the cavern when heavy rainfall periodically washed soil and rock debris into the cave. Through this process, a stratified series of bone deposits was created that almost filled the cave before the original entrance was sealed.

Excavations in the cave fill have yielded an exceptional number of bones and teeth of more than 30 genera of mammals, reptiles, amphibians, and birds. One of the most important finds was a nearly complete set of remains of an adult *Homotherium serum* (saber-toothed cat). Other *Homotherium* remains were also recovered from the cave, including a nearly complete infant skeleton. Up until their discovery in the Friesenhahn Cave, *Homotherium* (formerly noted as *Dinobastis*) was previously only known by a few fossil fragments (Meade, 1961, p.27).

Large herbivorous animal remains have also been identified in the cave deposits, including the mammoth, mastodon, bear, camel, horse, bison, tapir, and deer. These probably would not have entered the cave of their own accord but may have been carried there by carnivores.

An exceptional number of immature Mammoth (*Mammuthus columbi*) remains have been found (Toomey,

1994, p.59). Several hundred young mammoth remains accumulated in Friesenhahn Cave. The bones are disarticulated and scattered. Some appear to have pits or sheared surfaces possibly made by the sharp teeth of a large carnivore. This strongly suggests that *Homotherium serum* selectively chose young mammoths for food and brought them into the cave.

The American Mastodon (*Mammuth americanum*) is also represented, but its remains are not as abundant as is the mammoth. This is an intriguing bit of evidence. The mastodon is a warm climate animal whereas the mammoth has been predominantly linked to colder, northern climates. This possibly suggests a cooler climate in this area of Texas at that time more suitable for the mammoth.

Fragmentary remains of the ground sloth have also been found in the cavern deposits, but other edentates (glyptodonts and armadillos) commonly present in late Pleistocene deposits of the Coastal Plain and river deposits of Central Texas are absent from the collection.

Three time settings are available for the fossils, less than 300 years, 8,000–9,000 years, and 17,000–19,000 years old (Toomey, 1994, p.59). There is probably some validity to the first date, but the latter dates are of little value, given the notorious unreliability of C-14 dates.

Evidence for Man

Evidence of the presence of man in Friesenhahn Cave is scant and only suggestive. However, the existence of Paleo-Indian life in the Lower Pecos River region of Texas (some 200 miles to the west of Friesenhahn Cave) is known from two sites (Bonfire Shelter and Cueva Quebrada) ranging in dubious C-14 dates as old as 14,500 years ago (Turpin, 1994, p.69). There clear evidence of man (flint flakes and tools, burned animal bones) and remains of “extinct species” (Turpin, p. 69) of horse, camel, bison, bear, and mammoth are found mixed together, evidence that Paleo-Indians used these sites for big game hunts. Sutcliffe (1973, pp. 428–30) reported that gnawed bones and antlers by Norwegian reindeer and Scottish reindeer were sometimes mistaken for human artifacts. However, this does not seem to be the case with the remains found along the Pecos River.

When reading the literature regarding the Pleistocene, one is left with the impression that eight or ten thousand years ago a large number of Ice Age animals took one last step, one last breath, and then fell dead and vanished from the face of the Earth. There is evidence, however, for a quite different story.

For example, in Notes on Virginia, Thomas Jefferson (Peterson, 1977, pp.73–74) relates that Delaware Indians visiting the Governor of Virginia during the American Revolu-

tion informed their listeners that the mammoth was still alive in the northwestern part of the country. He further relates the account of a Mr. Stanley, captured by the Indians at the mouth of the Tennessee and transferred through several tribes. Eventually he was taken over the mountains west of the Missouri River to a westward flowing river. There, Mr. Stanley observed an abundance of bones, which he attributed to the elephant. His captors assured him that the animal was still alive in the northern part of their territory.

A recent book by Vine Deloria, Jr. (1997) details the oral traditions of many American Indian tribes and their intimate encounters with now extinct animals. Various geologic events commonly dated many thousands and even millions of years ago by scientific community are also recorded. Such memories are still vivid within the Indian tribes indicating a much shorter time frame since these events occurred.

Conclusion

Friesenhahn Cave, though small, records a wealth of information about the paleontological history of South Central Texas. The fossils found in the cave note post-Flood changes in the environment and ecosystem of the region. Much can be learned from the cave deposits that would be applicable to fossil deposits in other areas. A complete survey of the regional geology of Friesenhahn Cave using the Creation/Curse/Catastrophe (CCC) young-Earth geologic model is planned by the authors for future submission to the Quarterly. The accompanying interview with Dr. Larry Meissner, Concordia University biology professor, provides more information about the cave and associated excavation activities.

Acknowledgments

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Methylation, Histones, and Symmetric Variation

Histones are proteins that are made up of unusually large proportions of the amino acids arginine and lysine. These proteins are DNA-binding proteins present in chromosomes, and form the core of the nucleosomes (Hodson, 1992, p. 140).

Because the protein-coding genes in man are only twice the number of those in the fruit fly, it is thought by some that there must be more codes and that a code carried by histone proteins offers a way to extend the genetic information (Jenuwein and Allis, 2001). Individual genes can be turned off by adding methyl groups to DNA; this process is called imprinting. Methylation occurs when an enzyme replaces the hydrogen atom with a methyl group on the chemical base cytosine, which is part of the nucleic acid base coding (Holiday, 1989, p. 42)

This is just one of the many forms of methylation. To add to this, it has been shown that changes in the histone proteins can regulate gene expression. The addition of methyl groups to specific parts of the histone called H3 can affect single genes, and can also turn large stretches of our genome on or off (Young, 2001, p. 16).

If histones do extend the information carrying capability in the production of form this extends the domain in which the Creator can work to preserve the limits of the created kinds and to bring about whatever genetic variation He purposes within a kind. That work involves both the enzymes connected with methylation of DNA and the

protein makeup of the histones in a manner disclosed in Brown (1999 and 2001). All of this extra basis for coding is welcome news to creation scientists because they believe that life forms are maintained within their respective kinds by mechanisms like these.

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Letters to the Editor

Helioseismology—A Reply to Jonathan Henry

We appreciate Jonathan Henry's helioseismology article published in the June 2003 issue of *CRSQ* (Henry, 2003). He deserves credit for commenting on a field of astrophysics that has been little studied by creationists. However, we would like to examine some difficulties that occurred to us about the paper. Many of the important references cited in support of his thesis that the 160-minute solar oscillation is devastating to the standard solar model (SSM) are from the 1970's and early 1980's, from the infancy of helioseismology. There are many other references from this early time period and more recently that offer other possibilities. This issue needs to be addressed and updated in the recent creation literature, something that we intend to do in a forthcoming article. Therefore, in this letter we will discuss other problems with Henry's paper.

In his introductory paragraph and again in his conclusion Henry suggested that the sun has a core temperature of 1 million K or less. This contradicts another statement Henry gleaned from two references that the "central temperature of the sun would be less than half the conventional value." The SSM core temperature is 15.8 million K, so half this value would be 7.9 million K. Henry could argue that 1 million is less than 7.9 million, but from the original source that Henry cited it is obvious that the intended meaning is well above 1 million and close to 7.9 million. Such a low temperature is not physically realistic, which we will demonstrate three ways. Assuming hydrostatic equilibrium and the ideal gas law, one can easily show that the average temperature within the sun is about 10 million K (Schwarzschild, 1958, pp. 31–32). One would expect that the core temperature would be higher than this average, which is consistent with the 15–16 million K of the standard solar model, but grossly inconsistent with Henry's proposal. Lest Henry claim that this average temperature depends upon evolutionary assumptions, let us re-iterate: the derivation is solely based on the assumption of hydrostatic equilibrium and the ideal gas law with no concern with energy generation, age, or composition. This average temperature is higher than the temperature that is half the SSM value.

Henry prefers a homogeneous model for the sun. In astrophysical parlance, a homogeneous star is one that has constant (or near constant) density throughout. What is the core temperature of a homogeneous sun? We will give

the derivation here. Let us assume, as Henry does, that the sun has a uniform composition. Hydrostatic equilibrium takes the form:

$$dP = -GM_r \rho \, dr/r^2,$$

where P is the pressure, G is the gravitational constant, M_r is the mass contained in a radius r , and $\rho = 1.41 \times 10^3 \text{ kg/m}^3$ is the constant density of the sun, M_r can be written as

$$M_r = \rho(4/3)\pi r^3.$$

Combining these two and integrating over the radius of the sun ($6.96 \times 10^8 \text{ m}$), we find that the central pressure is $1.34 \times 10^{14} \text{ Pa}$. The number density of a gas can be written

$$N = \rho/\mu m_a,$$

where μ is the mean molecular weight and m_a is the mass of one atomic mass unit, $1.66 \times 10^{-27} \text{ kg}$. Assuming the observed solar surface composition and that most of the solar interior is completely ionized, we find a number density of $1.416 \times 10^{30} \text{ m}^{-3}$. The ideal gas law can be written as

$$T = P/Nk,$$

where k is the Boltzmann constant. Inserting the central pressure into the ideal gas law we find that the central temperature of homogenous sun is $6.89 \times 10^6 \text{ K}$. This is significantly higher than Henry's value of 1 million K and very close to "less than half the conventional value." This calculation is undoubtedly the basis for the statement referenced by Henry.

Further, Rose (1973) derived an expression,

$$T_c = 0.538 GM\mu m_a/Rk,$$

for the core temperature for a fully convective polytropic ($n = 3/2$) model of the sun where M is the total mass and R the radius of the sun. This results in a core temperature of $6 \times 10^6 \text{ K}$. Henry did not offer any physical justification for his 1 million K suggestion, while numerous methods of estimating the sun's core temperature consistently produce higher core values than Henry.

Apparently Henry refuses to believe that the sun derives at least most of its energy from thermonuclear reactions, and he has re-assigned the sun's core temperature in a vain attempt to circumvent these reactions. Henry mistakenly believes that high core temperature is demanded by thermonuclear reactions, when in reality it is the other way around: the sun's high core temperature requires that thermonuclear reactions take place. If the sun's core were as cool as Henry suggests, then the sun would be dramatically out of equilibrium and its core would rapidly con-

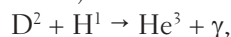
tract and heat in an attempt to reach equilibrium. This would cause tremendous instability in the structure and output of the sun with disastrous consequences for the earth.

The comment that the Saha equation establishing “a quantitative relationship between stellar spectra and temperature” and “thus somewhat divorcing stellar spectra from intimations of composition” is misleading in at least two ways. First, in his book Henry (1999) incorrectly states that the recognized stellar spectral types result from compositional differences, when temperature is by far the prime factor. In a backhanded way Henry appears to repeat that error in his article. Second, the Saha equation has absolutely nothing to do with Henry’s complaint in the paragraph where this is mentioned. That complaint is that astronomers generally assume that there is no convective transport of processed material from the core to the surface of a star and thus the surface composition of a star does not reflect core composition. Incidentally, we think that this complaint has some merit.

Henry suggests that the sun was created with no deuterium and that half the sun’s luminosity is provided by the first step of the proton-proton (pp) cycle,



He further supposes with no physical justification that the deuterium produced is not consumed. The reaction that consumes the deuterium,



is the second step of the pp cycle. There are several things wrong with this. As was discussed above, Henry suggested a physically impossible core temperature that is also far too low to permit the first reaction to occur. Second, the aforementioned first step of the pp cycle is the bottleneck of the reaction – the first step does not happen often, but when it does the subsequent steps occur rapidly. For instance, assuming a core temperature of 13 million K, Schwarzschild (1958, pp. 75–79) lists mean reaction times for the first step as 14 billion years and the mean reaction time of the second step as six seconds. Both reactions are extremely temperature sensitive, so while a lower temperature as Henry suggests would reduce the second reaction, the first reaction is reduced so drastically as to cause the reaction to cease. Thus his assumptions here are physically unwarranted.

In his calculation to determine how much deuterium the sun would have produced in 6,000 years, Henry neglected to subtract the 0.26 Mev carried away by the neutrino, so his estimate is off by 18%. Henry apparently assumed that any deuterium created in the sun (presumably in the core) is manifest in the surface right away. The transport of the deuterium by convection or any other realistic mechanism would take longer than 6,000 years so we ought

not see much evidence of deuterium production within the sun in the past few thousand years. Henry mentions rapid convection at several points, but where are the calculations to support this assertion?

Henry’s discussion of interstellar matter (ISM) and his suggestion that it has been generated post-fall from stellar winds has many problems. First, most of the universe does not suffer from extreme extinction, so dimming of even a few tenths of a magnitude does not seriously impede the visibility of stars and galaxies (except in the Milky Way’s plane and in particular toward the direction of its center). Most stars and galaxies are too faint to see without a telescope, absent any extinction. Second, extinction is caused by dust, not gas, and dust generally contains little H. This article seems to imply that gas is a major contributor to extinction. Third, the numbers do not support this suggestion. Typical solar wind particles are protons (H nuclei) moving at about 0.1% c. There are some solar wind particles moving faster than this, but they represent very little of the mass of the solar wind. In 6,000 years at this speed the solar wind would fill a volume with a radius of about six light years (6×10^{16} m), provided that the solar wind is not turned back at about 100 astronomical units from the sun, as most astronomers think. This distance is comparable to the average distance between stars, so if we assume that other stars are producing similar stellar winds, then after 6,000 years we would expect the contributions of the various stars to overlap and merge. However, stellar winds diminish in density with increasing distance from stars, so we would expect the ISM to be most dense around stars and least dense between the stars. The estimated outflow of the solar wind is about 10^9 kg/s. In 6,000 years this would accumulate to 2×10^{20} kg. This results in an average density of $2 \times 10^{20} \text{ kg} / (4/3 \pi (6 \times 10^{18} \text{ cm})^3) = 2.6 \times 10^{-37} \text{ kg/cc} = 1.6 \times 10^{-10} \text{ protons/cc}$. The average density of the ISM is about one proton per cc, so this mechanism falls short by ten orders of magnitude. Henry further suggests that the diffuse intergalactic medium (IGM) was similarly populated, but given the great distances between galaxies, it would require many of millions of years for stellar winds to do this with the observed speeds of stellar winds.

Henry is incorrect when he states that the idea that dust grains form in stars and not being primordial is a recent development. We are not aware that astronomers ever believed that dust is primordial. Interstellar dust was first deduced in 1930. It may have remained a mystery how and where dust came from for some time, but certainly by the 1960’s we knew enough about grain formation that astronomers realized that grains form in the atmospheres of red giants. Recent studies have suggested supernova explosions as sites of significant dust creation. Henry quotes Slusher

on the origin of dust, but Slusher may have been wrong about this as well, or he did not understand where astronomers thought dust originated.

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Reply to Questions on Helioseismology

The conventional view of how the sun works is called the standard solar model (SSM). There are actually many such models, and they have in common the claims (1) that the sun is composed of a dense core, a radiative zone, and a convective zone, and (2) that these zones are structured in such a way so as to render fusion virtually the only possible source of the sun's energy. In my recent article, I have questioned these claims (Henry 2003).

At first glance these claims would appear to be compatible with creationist science. Furthermore, though the SSM also claims that the sun's main sequence lifetime is some 10 billion years, is it not possible for the biblical creationist to reject the long solar chronology, yet accept the other claims of the SSM?

Unfortunately, the answer to this question is not as simple as Faulkner and Samec appear to believe. Parameter values employed in the SSM are selected so as to model the evolutionary development of the sun over its presumed lifetime of billions of years (Harwit, 1982, p. 329; Liebacher, 1985, p. 48; Bahcall et al., 1995, p. 784). Most such parameters are not observed, but modeled (Wallerstein et al., 1997, p. 1001; Bahcall, 1989, p. 60). Thus the evaluation of parameters is age dependent. In assessing the validity of the SSM from the perspective of biblical creation, the biblical creationist should begin by critically examining the rationale for parameter choices in the SSM. Faulkner and Samec have not done this. Instead within their communication there is an implicit and uncritical acceptance of conventional parameter values. This is a basic problem. For example, the p - p fusion of hydrogen into deuterium begins solar nucleosynthesis. Yet the p - p reaction rate cannot be measured directly and is therefore theoretical (Brun et al., 1998, p. 921). It is sized to fit chronological preconceptions.

In addition, the Biblical record indicates that the SSM may be flawed. Biblical prophecy describes future solar events involving extreme darkening (Joel 2:31; Revelation 8:12) and luminosity changes (Isaiah 30:26; Zechariah 14:6–7; Revelation 16:8) in the sun on a scale unexpected by any SSM until billions of years in the future, yet most serious Bible students agree that biblical prophecy has a chronology of thousands of years, not billions. If biblical statements are indeed predicting solar instabilities only thousands of years into the future as concluded by Morris (1983, p. 150), then the SSM must be questioned. Faulkner and Samec object to departure from the SSM on grounds that, "... the sun would be dramatically out of equilibrium.... This would cause tremendous instability in the structure and output of the sun...." But this would appear to be the future of the sun implied in Biblical prophecy. A sun with billions of years of future stability may be as mythical as the long ages of radiometric dating.

Arguably, astronomy of all disciplines is most permeated by evolutionary thought. A surprising amount of what many believe to be true in astronomy is really a mixture of inference and conclusion based on evolutionary reasoning. Historically, evolutionary astronomy began in the 1600s, well before Lyell and Darwin made geological and biological evolution popular. Even today, accommodationists such as Hugh Ross accept virtually all the claims of evolutionary astronomy, yet refuse to accept the occurrence of full-blown biological evolution, at least to the extent of asserting the historicity of Adam and Eve (Ross, 1994, p. 10). Yet the claims of astronomical evolution are no better founded than those of biological or geological evolution.

As an example, Faulkner and Samec question the possibility of a degree of homogeneity in the sun as proposed

by Henry (2003, pp. 34–35, 38–39), by invoking the assumption of hydrostatic equilibrium, an assumption in turn based on evolutionary premises as discussed below. From the assumption of hydrostatic equilibrium, Faulkner and Samec compute a core temperature about half that modeled in the SSM, a result which they claim is inconsistent with the proposition of my article (Henry 2003, pp. 34, 39) that the core temperature may be in the neighborhood of 10^6 K.

Faulkner and Samec apparently hope to show (1) that a homogeneous sun must be in hydrostatic equilibrium, thus contradicting my overall claim that the SSM is questionable (Henry 2003, p. 34); and (2) that the hydrostatic equilibrium supposedly demanded by the possibility of homogeneity leads to a core temperature higher than that (10^6 K) as I have proposed. Thus Faulkner and Samec have neatly disposed of two of my claims. Or have they?

No where did I make the statement that the sun really is totally homogeneous, rather, the conclusion being that it is “somewhat” homogeneous (Henry, 2003, p. 39). Further, there is no contradiction in my article regarding cited core temperatures as Faulkner and Samec claim. Rather, I cite a core temperature of half the usual value in the context of questioning the SSM, not for purposes of saying this is the actual condition (Henry 2003, p. 35). A core in the neighborhood of 10^6 K is proposed as the actual condition (Henry, 2003, pp. 34, 39).

A more serious misstep by Faulkner and Samec is the apparent lack of awareness of the chronological premises driving the assumption of hydrostatic equilibrium. This assumption was promoted by Arthur S. Eddington in the early 1900s. Eddington asserted that he believed the sun is old because the earth is old (Eddington, 1926, p. 290; Eddington, 1929, pp. 96–97). Thus, Eddington’s solar chronology was founded on the belief in an old earth. Eddington explicitly stated that he imposed a condition of hydrostatic equilibrium on the sun to escape the possibility that the sun might be younger than the earth (Eddington, 1926, pp. 289, 290; Eddington, 1929, pp. 94–95). The assumption of hydrostatic equilibrium continues to be the starting point for the SSM (Bahcall, 1989, p. 46), and Eddington has been repeatedly acknowledged as the theorist with the most influence on modern solar modeling (Eddington, 1926, p. vi; Hartmann, 1991, p. 372; Abell et al., 1987, p. 492). But if the sun is not in hydrostatic equilibrium, there is the possibility of non-cyclic solar contraction, further discussed below.

Faulkner and Samec claim that “Henry mistakenly believes that high core temperature is demanded by thermonuclear reactions.” This is not true. Eddington’s rationale for assuming high core temperature predated the advent of

solar modeling by fusion, first proposed by Bethe (1939, p. 434). It is true, as Faulkner and Samec claim, that high core temperature requires thermonuclear reactions, but it is also true that low core temperature could imply a lack of the complete reaction suite assumed in the SSM. This is the claim I made (Henry 2003, p. 39). This claim does not follow from *a priori* doubts about the SSM reaction suite, but from the helioseismic implication of low core temperature. Doubts about the SSM reaction suite are a consequence of possible low core temperature. The occurrence of *p-p* fusion, inferred from electron neutrino capture rates, with a model temperature of 10^6 K (Harwit, 1982, p. 335), gives rise to the 10^6 K temperature proposal for the core.

Faulkner and Samec claim that with a core temperature of 10^6 K the *p-p* reaction would “cease.” This claim is not known from observation. As mentioned previously, *p-p* reaction rate data have not been observed and must be modeled.

Faulkner and Samec point out that I used supporting references from the 1970s and 1980s, evidently intending to imply that such references have been superseded by newer claims. Such an inference is unwarranted. Recently, Davies (1996, p. 1) has made claims similar to mine. Lack of helioseismic g-modes is a major circumstance supporting the absence of a dense core and a degree of solar homogeneity (Henry, 2003, p. 39). The lack of g-mode detection has persisted into recent years (Phoebus Collaboration, 2001, p. 467).

This lack of g-modes strikes at the heart of the SSM. Toulmonde (1997, p. 1177) has argued that long-term solar contraction does not exist. But if the sun does not have the dense core and the highly segregated structure inherent in the SSM, having instead the relatively undifferentiated structure of a young star, then non-cyclic solar contraction remains a viable possibility. Yet there is conflict between the claims of the SSM and the possibility of such contraction: “Since stellar evolution theory predicts a positive secular solar radius change with increasing age ($+ 3.3 \times 10^{-6}$ arc s per century), any negative secular change (or detectably large positive change) is significant” (Gilliland, 1981, pp. 1149–1150). One cannot therefore expect a neutral reception of secular contraction claims. Nevertheless even Toulmonde (1997, pp. 1174, 1178) did not close the case for secular contraction, implicitly acknowledging the possible validity of earlier claims of its occurrence. The PICARD solar mission will sense solar diameter changes to a precision of milli-arcseconds in search of g-modes (Dame et al., 2001, p. 321). It will be most interesting if g-modes are absent, yet a small but definite secular contraction is confirmed to exist.

In addition, current claims that helioseismology sup-

ports the SSM are ill-founded, for the sound speeds allegedly confirming the SSM must be modelled from oscillation data using a “reference solar model,” really another SSM (Basu et al., 2000, pp. 1084, 1086). Thus one evolutionary model “confirms” another, reflecting the analogous situation in geology in which sedimentary rocks “date” fossils and in turn fossils “date” the rocks. Finally, despite common claims, even neutrino oscillation theory does not confirm the SSM. Neutrino oscillation theory has so broadened the possibilities of parameter selection for assessing neutrino detection rates that virtually any possible suite of alleged solar fusion reactions can be inferred, even a sun producing over 99% of its energy by a CNO reaction series (Bahcall et al., 2002, p. 1). Bahcall points out that as surprising as it might be that CNO reactions could power the sun, “experiments that measure the energy of low energy neutrino events, such as BOREXINO or HELLASZ/HERON, are necessary to rule out this model via neutrino observations” (Bahcall, 2001, p. 5; Adams et al., 2000, p. 112).

Since so much remains to be learned of how the sun really works, and since neither Faulkner nor Samec defends the long chronology underlying the SSM, it is puzzling why they manifest a strong commitment to the SSM, complaining that “apparently Henry refuses to believe that the sun derives at least most of its energy from thermonuclear reactions.” Though there is doubtless fusion in the sun as indicated by electron neutrino capture rates, how can anyone be sure—apart from the SSM with its evolutionary premises—what fraction of energy is due to fusion? I used a fraction of one-half for the purpose of discussion (Henry 2003, p. 36). Even if the fraction were essentially unity, still the only current basis for making this assertion is the series of ad hoc parameter selections made one after the other over the decades to uphold a long solar chronology. Parameter selection first focused on physical conditions in the sun à la Eddington, then proceeded to fusion reaction parameters, next to helioseismic parameters, and finally to neutrino oscillation parameters.

Faulkner and Samec have raised several other non-helioseismic issues. They claim that Henry (2003, p. 37) asserts that H or D in the solar wind causes extinction of starlight. I did not make this assertion but Faulkner and Samec erroneously infer that I did. Nevertheless, Faulkner and Samec agree that solar convection might explain the presence of D in the ISM as I proposed (Henry 2003, pp. 36–37), but then they (1) question the possibility of solar convection occurring rapidly enough to supply the observed H abundance over 6000 years, and (2) they assert that the ISM proton density is of the order of 10^{10} times greater than convection transport can explain. The conclusion that

solar convection transport would be too slow is drawn from expectations of the SSM (Fix, 1999, p. 390), in which the sun is modeled with a convection zone segregated from the radiative zone. Modern theorists follow Eddington, who modeled a sun in hydrostatic equilibrium, which required a high-temperature core, which in turn required a radiative zone segregated from the convection zone. Thus the assumption of low (or essentially no) convection transport is ultimately based on the premise that the sun has a long chronology.

Further, there is uniformitarianism in their implicit assumption that solar wind production has been always the same. There is good evidence that the past was non-uniformitarian and involved higher process rates than at present. It is probable that radioactive decay rates were higher in the past (Vardiman, 2000, p. 19). The processes of the Biblical Flood are a key example of other higher past process rates. Of course, Henry’s estimation of the D/H ratio in the ISM is also a uniformitarian result. Rather than invalidating my estimate, the discrepancy (10^{10}) emphasized by Faulkner and Samec could be taken to imply that the uniformitarian assumption for ISM formation is not valid. However, data for correcting that assumption are not available. If it is allowable because of the paucity of data for Faulkner and Samec to invoke uniformitarianism, surely the same leniency can be extended to Henry’s results.

Faulkner and Samec also claim that I say all the ISM is made of H (Henry 2003, pp. 36–37). This is not true. They also assert that I am wrong to speak of primordial dust formation in the ISM as if theorists ever thought it possible (Henry, 2003, p. 39). But this idea was once indeed considered a possibility (Zirin, 1952, p. 20). When the Big Bang theory was proposed in the 1940s, it was assumed that all elements first formed as Big Bang products, not in stars (Burbidge, Hoyle, and Narlikar, 1999, p. 38). A contemporary concept was the possible formation of ISM as a primordial product: “To explain the origin of the cosmic grains, we suggest that they were formed in the early stages of the expansion of the universe...” (Cernuschi, 1947, p. 241). It was soon obvious that the Big Bang could not account for most isotopes, so stars were invoked as the source (Burbidge et al., 1957, p. 550; Burbidge and Hoyle, 1998, p. L1). Now even the ISM is viewed as a stellar product.

Finally, Faulkner and Samec do not care for my comments about the Saha equation (Henry 2003, p. 36). To buttress their complaint, they inaccurately allude to another source (Henry 2002, p. 51), claiming that this source wrongly relates stellar spectra to composition. Nowhere does this source claim that stellar spectra arise primarily from composition, but that spectra *reveal* composition, a point made elsewhere: “Identification of spectral lines tells us

what elements are present in a star” (Hartmann, 1991, p. 347). Spectra at a given temperature cannot reveal the presence of atomic states excited at other temperatures, but apparently Faulkner and Samec would prefer that if the Saha equation is mentioned at all, it be affirmed that stellar spectra have nothing to do with composition. If this were true, we would still not know of the elements in stars.

Thanks are due Faulkner and Samec for opening this opportunity for discussion. However, a number of the alleged “problems” they perceive arise from their allegiance to the SSM. Yet they appear to be unaware of the chronological premises underlying the assumptions of the SSM. Ironically these chronological premises are at total odds with their “recent creation” position.

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Descending into the Pit to Avoid the Fall (Response to Reed and Froede)

Let me begin with down to earth philosophical issues: to me the basic fact is the existence of a very large amount of sedimentary rocks with an obvious 4-dimensional characteristic. These rocks have been studied for centuries and a huge number of names have been attached to them, breaking them down into units and subunits based on lithologic and biostratigraphic approaches. Reed and Froede's (2003) objections (which I understand to pertain to stratigraphy as a whole, not just to the diluvial one) leave open the following questions:

- 1) Are sedimentary environments reflected in sediments?
- 2) If so, can one ignore local and even regional environments in order to always and only see "the big picture"?

In other words, even if the Flood was the "megaenvironment," one has to accept that there were also regional environments that could have resulted in similar types of sediments. By studying those sediments, one would eventually attempt to correlate them, thereby producing lithostratigraphic information. To Reed and Froede the attempt is futile:

However, lithostratigraphy depends on the assumption of superposition (i.e., one layer stacked over another) and continuity to define age relations between strata... Lithostratigraphy cannot provide accurate or widespread age relations between rocks. (Reed & Froede, 2003, p.92)

Accepting this statement requires a clear definition of "accurate" first, and I believe that here lies one of the major sources of problems between creationists and evolutionists: ours is an archaeological degree of accuracy (on the scale of days) while theirs is a geological one (with highest resolutions on the order of thousands of years). There is a big difference between building a lithostratigraphy based on an average depositional rate of meters per year (evolutionary geology) and one based on meters per minute (Young Earth creationary geology). And the main difference (in ways of results) is the number of lithostratigraphic units separated. If my understanding of Reed and Froede's approach is correct, there seems to be a bit of a paradox here: accuracy is impossible where the number of lithostratigraphic units is greatest (covering millions of years) and unnecessary where the number of units is the smallest (covering thousands of years, with the main source of sedimentation a short, global cataclysmic event). Nevertheless, I believe a lithostratigraphy can be built regardless the sedimentation rate and that it can provide an accu-

rate and/or widespread age relationship between rocks. The accuracy in identifying relations between strata depends on the amount and spatial distribution of available sediments which at its turn depends on the duration and intensity of sedimentation as well as the type of sedimentation. Now if the time component involved is very short (years) or very long (millions of years) represents only a change in the quantitative input but the "equation" remains basically the same, regardless the vertical or lateral deposition of sediments.

For example, cave sediments do not fit Reed and Froede's rejection of lithostratigraphy above. Caves are small, confined sedimentary environments and thus there is no physical continuity between the sediments inside two separate caves, yet one can quite accurately correlate sediments in caves worldwide. For example all cave sediments containing *Ursus spelaeus* are confidently assigned to the later phase of the Ice Age, facts confirmed by speleothem and pollen date. Tephrochronology of speleothems have yielded clear connections to known volcanic eruptions with global signatures whilst cave artefacts are all indicators of synchronous sediments. All of these are postdiluvian features, so this applies to all postdiluvian sediments, does it not?

Finally, the statement above raises the question of whether or not Reed and Froede are ruling out any stratigraphic investigation whatsoever (even from a diluvialist prospective) since it's not able to "provide accurate or widespread relations between rocks." If I understand them correctly, they appear to be saying: *"Forget all those layers, formations, systems, cycles etc. They have all been deposited during the Flood and if they seem to correlate, it's merely a coincidence. In principle there should be no correlation because the Flood is a catastrophic event and so random that no orderly structure could emerge of it."*

Yet, creationists have an advantage over evolutionists in this regard. While they must develop a history of billions of years, we only have to deal with a few thousand years of history, do we not? Therefore, we should be able to develop a very accurate lithostratigraphy. Furthermore, there is clearly a vertical succession of layers and its continuity or discontinuity does not make it any less of a succession. The issue of vertical vs. lateral deposition is secondary; a succession is merely a sequence of events in time and that is what one finds in sedimentary rocks. Whether they were formed in 1 day, 400 days or 5,000 years, it is still a succession in time.

By accepting that most of time lacked sedimentation

which occurred in episodes of hundreds or thousands of years (Reading, 2002, p. 18), modern sedimentology acknowledges (even if indirectly) that the column is an artificial construct. Nevertheless, by use of it one can still find ores and fossil fuels. So the relative relationships between strata are confirmed (abundantly I would say). This being said, the existence of a real column seems compelling to me. Its interpretation is another story. I lean towards the belief that the evolutionary paradigm emerged from the attempt to interpret the geologic column, rather than the other way around.

I am afraid that wasting the work of generations by simply erasing it is not useful at all. We will never have the financial and human resources or time to rewrite all sedimentology. If we discard the evolutionary column altogether we will just make our work more difficult, since it is ultimately the evolutionists that we have to convince, not creationists. Building with new materials in this particular case,

is, in my opinion, more difficult than rebuilding with the existing bricks. In order to do that we have to constantly use the geologic column as frame of reference (the absolute relative frame of reference) until we can completely rewrite it.

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Response by Reed and Froede

We appreciate the letter by Dr. Silvestru (2004) because we believe that a better understanding of stratigraphy within a creationist framework is badly needed. He raises many interesting questions and we appreciate the opportunity to explain our position more completely.

Dr. Silvestru suggests that we are rejecting the rock record and the disciplines of stratigraphy, sedimentology, and palaeontology in our call to reject the uniformitarian stratigraphic column. We recognize that centuries of stratigraphic research has resulted in the classification, correlation, and naming of rock units within the rock record. We agree with him that creationists must offer some explanation of the features of the earth's crust if we wish to participate in the stratigraphic venture. However, the modern enterprise has been based upon faulty assumptions. We reject evolution; thus, we must logically reject biostratigraphic dating of rock units. We understand that there are diagnostic fossil fauna and flora in rock units, but what are they diagnosing? We believe that they may be useful in determining depositional conditions, just as are sedimentary composition and geometry.

In our paper, we described a distinction between the physical rock record and the conceptual geologic column. It is the latter that we reject. It cannot be any other way if we reject evolution, because evolution provides the means

of dating rock units and of their large-scale correlation. Likewise, we must reject uniformitarianism and its associated emphasis on modern depositional environments as templates for the ancient record because we agree that the accumulation of the bulk of the rock record occurred within one year. The rejection of these two premises forces us, as it should force any creationist, to a radically different approach to stratigraphy and environmental interpretation. Has that approach been adequately defined? We believe not, but we also believe that we must let go of things that are undoubtedly false and begin the task of developing a new stratigraphic method.

So in answer to Dr. Silvestru's first question, sedimentary environments are reflected in the rock record, but they are not those of modern settings, but instead the sedimentary environments of an unobserved and almost unimaginable global Flood. In answer to his second question, we do not propose to ignore environmental indicators on any scale; we encourage creationists to reinterpret uniformitarian stratigraphy on all scales. Because the Bible does not provide detailed local information about geological activities during the Flood, we have no choice but to discover that information empirically.

We also perceive a misunderstanding of our position in Dr. Silvestru's two questions and apologize for any lack of

clarity on our part. We would first point out that the facies approach to rock units, or the attempt to find depositional environments in ancient rocks, is not synonymous with the uniformitarian stratigraphic column. We believe that lithostratigraphic correlation can be a viable tool in stratigraphy, an assertion that is in reality contrary to uniformitarian stratigraphy, which should theoretically rely on fossil content. We did not say that lithostratigraphic correlation was not viable; we stated that it was not always a reliable age indicator. In creationist stratigraphy, it is possible that correlation is not necessarily of one specific age to another. That is because: (1) synchronous facies changes would occur rapidly during the Flood, and (2) diachronous deposition would result in age correlations being much more questionable within the short timeframe of the Flood. The latter reason is why the lateral vs. vertical succession of units does not appear to be a secondary issue. Also, we believe that the work of Guy Berthault, in questioning the foundational assumptions of stratigraphy: (1) original horizontality, (2) original extent, and (3) superposition demands the careful consideration of all creationists and although it has not yet been determined to what extent that work applies to the rock record, we suspect that this, like so many other things, will end up as a matter of scale.

Dr. Silvestru is in agreement with us when he describes the need to consider a scale of minutes instead of millions of years. We suspect that the scale difference between uniformitarians and creationists demands what Mortimer Adler (1967) called a “difference in kind” rather than a “difference in degree.” In other words, we cannot compress uniformitarian stratigraphy and expect to be able to perform creationist stratigraphy because the approaches are fundamentally different. That is why we diverge from uniformitarians at the point of accepting time as the key parameter of stratigraphy, and have advocated energy instead (Reed et al., 1996). Another alternative is that of Walker (1994), who proposed classifying by Flood stage. Our one concern with his work is that it still applies time as the key discriminator of stratigraphy.

We confess a lack of expertise in the subject of cave stratigraphy (especially in comparison with that of Dr. Silvestru), but we would point out that: (1) caves are not representative of the rock record as a whole and (2) post-diluvial stratigraphy must be performed under different assumptions and rules from diluvial stratigraphy.

Dr. Silvestru states:

If I understand them correctly, they appear to be saying: “Forget all those layers, formations, systems, cycles etc. They have all been deposited during the Flood and if they seem to correlate, it’s merely a coincidence. In principle there should be no correlation

because the Flood is a catastrophic event and so random that no orderly structure could emerge of it.”

He seems to think that we seek the death of stratigraphy when all we really want is to resurrect it from its uniformitarian coma. This may require radical surgery—but even then we will still be doing stratigraphy. A review of our publications is the best argument that we can make for this assertion, and we would urge Dr. Silvestru especially to read Reed and Froede (1997). The Flood would certainly impose order upon its sedimentary products, but that order is not that of modern stratigraphy. We do not deny the order, we believe that a change in focus is required to fully perceive and understand it.

Dr. Silvestru makes the practical argument: modern geology has resulted in the discovery of economic minerals and hydrocarbons, therefore the column must be true. While neither of us are experts in the area of economic geology, both are experienced in the oil and gas industry. In that case we assert that this is a *non sequitur* argument because hydrocarbons are found in all “ages” of rocks by discovering the proper conjunction of source, seal, and reservoir. In our years of work, we found the column to be irrelevant to hydrocarbon discovery.

Finally, Dr. Silvestru raises a very troubling point; one that was the heart of our paper. If we are to reject the work of millions of man-hours, and if we are severely limited in our current manpower and resources, then how can we junk so much of modern stratigraphy and start over? At the end of our paper, we asserted that there were two choices: to accept the column in a compressed form and enjoy the shortcut that it represents to fruitful research, or to reject it and rebuild stratigraphy from a new foundation. Like Dr. Silvestru, we would prefer the former, because of its inherent efficiency. However, we are convinced that the false premises of evolution and uniformitarianism force the latter. Since uniformitarian stratigraphy explicitly rejects God’s word, then its wasted efforts are a matter for sorrow, not for emulation. Can a few creationists really revise the vast stratigraphic enterprise? We do not know; we only know that with God, all things are possible.

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Challenge from Chard Berndt

In the September, 2003, *Creation Research Society Quarterly*, Chard Berndt provided a strong challenge to some very long-held creationist beliefs about death before the Fall. While I have previously presented objections to a simplistic approach to plant death (Klevberg, 1998), Berndt's paper has challenged us to a more thorough understanding of the whole topic. One salient aspect of Berndt's thesis of consumption of *nephesh* organisms in the primordial state struck me: these organisms appear, by and large, to be unicellular. Is the demise of such a creature death? I would claim so if it meant the extinction of that *baramin*, but asexual reproduction results in identical individuals. Would, therefore, consumption of any such individual be death as long as the created kind continued? Might it not be analogous to the "death" of cells in our bodies which are sloughed off and replaced? This is similar to my arguments regarding stump sprouts in trees and vegetative (i.e. asexual) reproduction of sexually reproducing plants. Sexual reproduction, of course, leads to unique individuals, as we see among *ruwach* organisms. Death of such an individual would still appear to be death in the biblical use of the term.

Berndt stresses the uniqueness of man and states, "...one must acknowledge that the death introduced at the Fall of man is spoken of explicitly regarding only mankind. One can infer that the 'groaning' and 'decay' of creation is a result of man's death" (Berndt, p. 87). Actually, it is a result of man's *sin*. This is far more than a reasonable inference; that the result of the Fall was a general curse on creation is

very clear (Genesis 3:17,18), as many creationists have observed. In this, the "traditional" view of post-Fall death is accurate. "Spiritualizing" death, as with all other attempts at resolution that compromise Scripture, does not work.

What is refreshing about Berndt's approach is his exegetical effort at understanding the Hebrew terms in the Genesis account. The primordial biosphere is clearly a field of speculation, with only the limited information of the Genesis record to provide a sure basis for analysis. Modern data are of only subordinate utility in historic studies and must be subordinate to the sacred text in this case. While I am not sure I understand all of the implications of his views, I am challenged to consider the potential subtleties of the death issue. I believe the same will prove true for the creation community at large, and perhaps especially for taxonomists.

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Stormy Arrival for African Cattle Egret in the New World

After reading Carl Froede's recent article, "Dust Storms From the Sub-Saharan African Continent: Implications For Plant and Insect Dispersion in The Post-Flood World," (Froede, 2003), I could not help but be reminded of other life-forms which have taken a similar route across the Atlantic Ocean—for instance, the common African cattle egret (*Bubulcus ibis*). Originally an Old World animal, several cattle egrets (or cowbirds) first appeared in Suriname, South America, in the late 1870s, apparently blown off course across the Atlantic by a hurricane or other storm. They then migrated to the Caribbean and were in Florida by the 1930s and 1940s. Today they are widespread across the United States. Though cattle egrets represent a recent arrival via Africa, it might be advantageous for creation biologists to pursue research on the first arrivals of many "New World" species of birds (and other animals). The wildlife dispersal from the mountains of Ararat after the Flood took many shapes and forms, and some of the clues to the original migration routes could still be out there by

investigating the animal populations in various continents.

Along similar lines, the plant and animal repopulation of the Indonesian island of Krakatoa after its catastrophic volcanic explosion in 1883 is another wonderful laboratory for seeing how plants, insects, and other animals found their way to a new home in a formerly inhospitable environment. This definitely has relevance to creation biologists seeking to understand the methods of dispersal of animal (and plant) life after the Flood.

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Interested in a useful scientific analogy for the Trinity and hypostatic union? See the intriguing article by Michael Bozack entitled "Physics In The Theological Seminary" in *Journal of the Evangelical Theological Society* 36/1 (March 1993), Pgs. 65–76. Although these short excerpts cannot hope to do justice to his treatment of the issue, they are offered in the hope you will be motivated to read the full article.

"The Trinity and the hypostatic union are among the most difficult doctrines in systematic theology. The difficulties originate from several sources: The doctrines are distinctive of theology, they are a mystery beyond human comprehension, adequate methodology to study them is lacking, and no effective analogies have existed for comparison.

"A renewed study combining physics and theology shows that it is possible to identify effective and thought-provoking analogies to the Trinity and the hypostatic union. In this paper I explore the relationship between (1) the triple point and the Trinity, and (2) complementarity and the hypostatic union. Awareness of such similarities has value for both physicists and theologians. For the physicist, the existence of analogy with theology is intellectually satisfying and shows that physics can be useful in a wholly diverse area of inquiry. For the theologian, the use of analogy stimulates new perspectives and provides an epistemic counterpart from which to view complicated points of theology."

Is There a Genesis Flood Heat Dissipation Problem?

Honeyman (2002) and Reed and Froede (2002) discussed the “heat problem” of Catastrophic Plate Tectonics (CPT) and Honeyman suggested that rapid subduction of the pre-Flood ocean floor and exposure of the ocean to the new hot basaltic ocean floor, would boil the water and destroy life in the oceans.

The proposed gravitational de-compression/re-compression Genesis Flood tectonic (GDT) model (Hunter, 2000b, 2003a) allows a significant resurfacing of the Earth, and exposure of the floodwaters to mantle differentiates to occur during the Flood, without the heat dissipation problem discussed by several creationists (Baumgardner, 1990; Froede, 1998; 1999; Herrmann, 1998; 1999; Woodmorappe, 2001; Hunter, 2001; Honeyman, 2002).

The revised¹ [The gravitational decompression Genesis Flood tectonic (GDT) model as originally presented (Hunter, 2000b), advocated a reduction of gravitational force due to a reduction of the magnitude of the Universal Gravitational Constant (G). Reduction of G is now discarded in favor of a revised model in which an increase in the magnitude of the exponent of the distance parameter (d) in Newton’s Inverse Square Law (Newton, 1687) is advocated as the cause of the gravitational de-compression.] gravitational decompression model (Hunter, in prep.) posits that God initiated the Genesis Flood by temporarily reducing the compressive force holding the Earth together, by increasing the magnitude of the exponent of the distance parameter (d) in Newton’s *Inverse Square Law* ($F = G m_1 m_2 / d^2$). This de-compression caused much of the mantle to melt, possibly to a depth of 1,000 km, resulting in the sub-crustal mantle “magnasphere” (or “magma ocean”)² [Mantle petrologists have long recognized that circumstantial evidence, such as chemical and petrological considerations, indicates that significant melting of the mantles of the Earth, the other planets, and the Moon may have occurred early in their geological histories. On Earth, the occurrence of high-temperature komatiitic lavas in the Archean is the main evidence cited for widespread mantle melting. On the Moon, Warren (1985) suggests that the global distribution and purity of the anorthositic crust suggest either a near-surface fully molten mantle “magma ocean” or a partially molten mantle “magnasphere.” Warren (1984, p. 201) notes that; “... ‘ocean’ implies the system is virtually 100% liquid, with a mainly gas/liquid upper surface and a waterlike viscosity...” and suggests that the term “magnasphere,” implying only partial mantle melting, is preferable. Mantle researchers interpret the Earth’s hot, at least partially molten, “magnasphere” as

having occurred during the Hadean Era (ca. 4.5 Ga) before the Precambrian, during the accretionary origin of the Earth. Depth estimates of the “magnasphere” vary from 200 km to 1,000 km. The “magnasphere” concept, if real, must be incorporated into the young Earth creationist Genesis Flood paradigm, and gravitational decompression should be considered as the only force of sufficient magnitude to initiate development of a global mantle “magnasphere” and differentiation of the (partially) molten mantle, during the early stages of the Flood.], postulated by several researchers (e.g., Warren, 1984; 1985; Stevenson, 1992). Melting provided the reduced mantle viscosity that Baumgardner considered necessary to facilitate rapid large-scale tectonic movements during the Flood (Baumgardner, 1990).

Differentiation of the molten mantle during Stage I of the Flood (Days 1 to 40) resulted in the build-up of the continental crust by granitic magmatic and ultramafic volcanic activity, and the extraction from the mantle of the components of the sedimentary record, and vast quantities of mantle water (‘...the fountains of the great deep...’ Genesis 7:11 KJV), initially in the areas of the globe now known as the Precambrian Archean provinces, over approximately 15% of the Earth’s total preserved Precambrian crustal area (Hunter, 1992; Goodwin, 1991; Condie, 1981).

Recompression of the Earth occurred upon God’s restoration of the d exponent, and thereby the gravitational force, to its original created magnitude. I suggest that this may have occurred partially on Day 40, stopping “the fountains,” and causing the mantle and associated crustal magmas and lavas to resolidify, and completely on Day 150, perhaps initiating the development of the ocean basins.

The “heat problem” has been raised before for both the gravitational decompression model and for CPT. Woodmorappe asked of the gravitational decompression model:

...how could the ‘new crust,’ then consisting of molten plutonic crustal material...to an average depth of 30 km, have cooled in thousands of years, let alone in one year?...where would all the heat from so much plutonic material cooling have gone to ...? (Woodmorappe, 2001, p. 61).

Baumgardner noted the “heat-problem” in CPT as one of the major challenges to large-scale tectonic change in a time frame of only a few thousand years, stating:

If one wants to postulate a mantle *several hundred degrees warmer during the Flood* than at present...he is faced with the problem of *how to cool the volume*

of the mantle by that much in the brief period of time since the Flood. (Baumgardner, 1990, p. 99, emphasis added.)

Froede (1998) also discussed the problem with CPT.

CPT proposes that the present ocean floor formed quite rapidly and the extruded basalt might actually have attained temperatures up to 3600°C (6512°F)...This freshly extruded basalt ocean floor covering slightly more than 75 percent of the earth's surface, would generate intense heat, perhaps sufficient to vaporize the overlying Floodwater. (Froede, 1998, p. 46)

Honeyman echoed the problem of heating of the ocean water and asked:

... how much could the ocean water be heated before marine life would be destroyed? (Honeyman, 2002, p. 208).

He also stated:

...water at the ocean floor would remain at the boiling point for an unknown length of time. Obviously *most marine life would be killed* if subjected for only a short time to a temperature somewhat less than boiling. (Honeyman, 2002, p. 208, emphasis added.)

I suggest that, in consideration of the following three aspects of the proposed GDT model, significant exposure of the mantle to the Earth's surface, and to the Flood waters could have occurred without the significant "heat dissipation problem" discussed by these writers:

1. Decompression-induced sub-crustal mantle melting and subsequent recompression induced mantle resolidification did not add or remove heat (Figure 1).
2. Magmatic and volcanic activity resulting from mantle decompression was initially restricted to the Archean provinces, which comprise only 15% of the Precambrian continental crust, during the first 40 days of the Flood (Figure 2). Also, previously molten magmas and intrusives of all "ages" outcrop over only 20% of the Earth's land surface.
3. The uppermost, outer layers of the oceanic crust acted to insulate the Flood waters from the hot mantle during Stages I and II of the Flood (Days 1–150), as did sediments deposited on the newly forming oceanic crust during Stage III (Days 150–371) of the Flood.

Decompression induced sub-crustal mantle melting.

Baumgardner notes as follows regarding the extreme sensitivity of the deformation properties of mantle rock to temperature:

... viscosity depends exponentially on the local temperature...The strong temperature dependence suggests one conceivable way to have the mantle deform more readily—namely to *make its temperature closer to its melting temperature*" (Baumgardner, 1990, p. 99, emphasis added)

The GDT model postulates that the Earth's sub-crustal mantle temperature was made closer to its melting temperature (probably at approximately 1,000°C–2,000°C), by gravitational decompression, and was thereby melted, resulting in reduced mantle viscosity, without the addition of any heat. Melting reduced mantle viscosity sufficiently to allow rapid mantle differentiation during the first 40 days of the Flood, and gravitational decompression provided the energy required to lift sialic continental crustal material rapidly to the Earth's surface.

Figure 1 (Jeanloz and Morris, 1986) shows that just 100 km below the Earth's surface the mantle is still very hot (in excess of 1,000°C) indicating that it has solidified, probably due to recompression, but probably not cooled significantly since the Flood. Thus, contrary to Baumgardner's assumption, the mantle may not have had to cool in the brief period of time since the Flood.

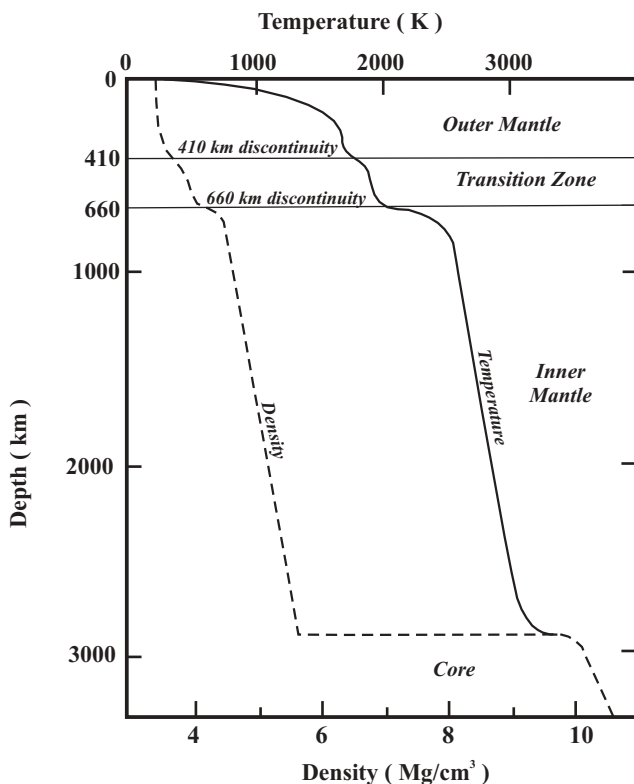


Figure 1. Temperature profile through the Earth's mantle and crust (after Jeanloz and Morris, 1986)

Restricted spatial extent of Precambrian Archean provinces and previously molten outcrops.

Goodwin (1991) notes that 71% of the continental crust is Precambrian, and mantle researchers seem to agree that most continental crust building activity occurred as a result of mantle plume activity in the Precambrian, by differentiation from mafic mantle material. (Albarede, 1998; Baer, 1977; Christiansen and Mooney, 1995; Goodwin, 1991; O'Nions and McKenzie, 1988; Patchett, 1996). Goodwin also notes that 15% of the Precambrian continental crust is composed of the Archean greenstone belts. These belts are characterized by mafic and ultramafic volcanics requiring hot ($1,650^{\circ}\text{C}$) temperatures, and granitic intrusives. I believe that these rocks are the initial surface expression of the sub-crustal "magnasphere," and represent areas where most of the heat transfer from mantle material to the hydrosphere and atmosphere took place.

Figure 2 shows the distribution of the nine main areas containing the Precambrian Archean provinces around the globe. Several localities, including central Eurasia (Tigris-Euphrates/Mount Ararat region), Central Asia, and the

central Atlantic, Indian, Pacific, Arctic and Antarctic oceans are between 1,100 and 1,600 km from the Precambrian Archean provinces. Therefore, small pockets of relatively quiescent and cool waters may have been preserved in these localities during Stages I and II (Day 1 to 150) of the Flood.

The scriptural record states that the present population of air-breathing creatures on Earth arose from just one pair of each kind preserved on the Ark (Gen. 6:19). Is it not possible then, that the present population of fish and marine/fresh-water creatures could have resulted from as few as one pair of each kind preserved in the combined pre Flood seas and mantle-derived Flood waters? In that case it would not matter if most marine life were killed in the Flood, and indeed, the abundance of marine fossils in the sedimentary record may attest to the death of most marine life. Honeyman's speculation that fish and marine creatures would be killed by boiling water is probably partly confirmed by the discovery of evidence of boiling water in Archean strata. (Costa et al., 1980).

The outcrop on the Earth's land surface of the molten magmas and lavas of all "ages" which would require even-

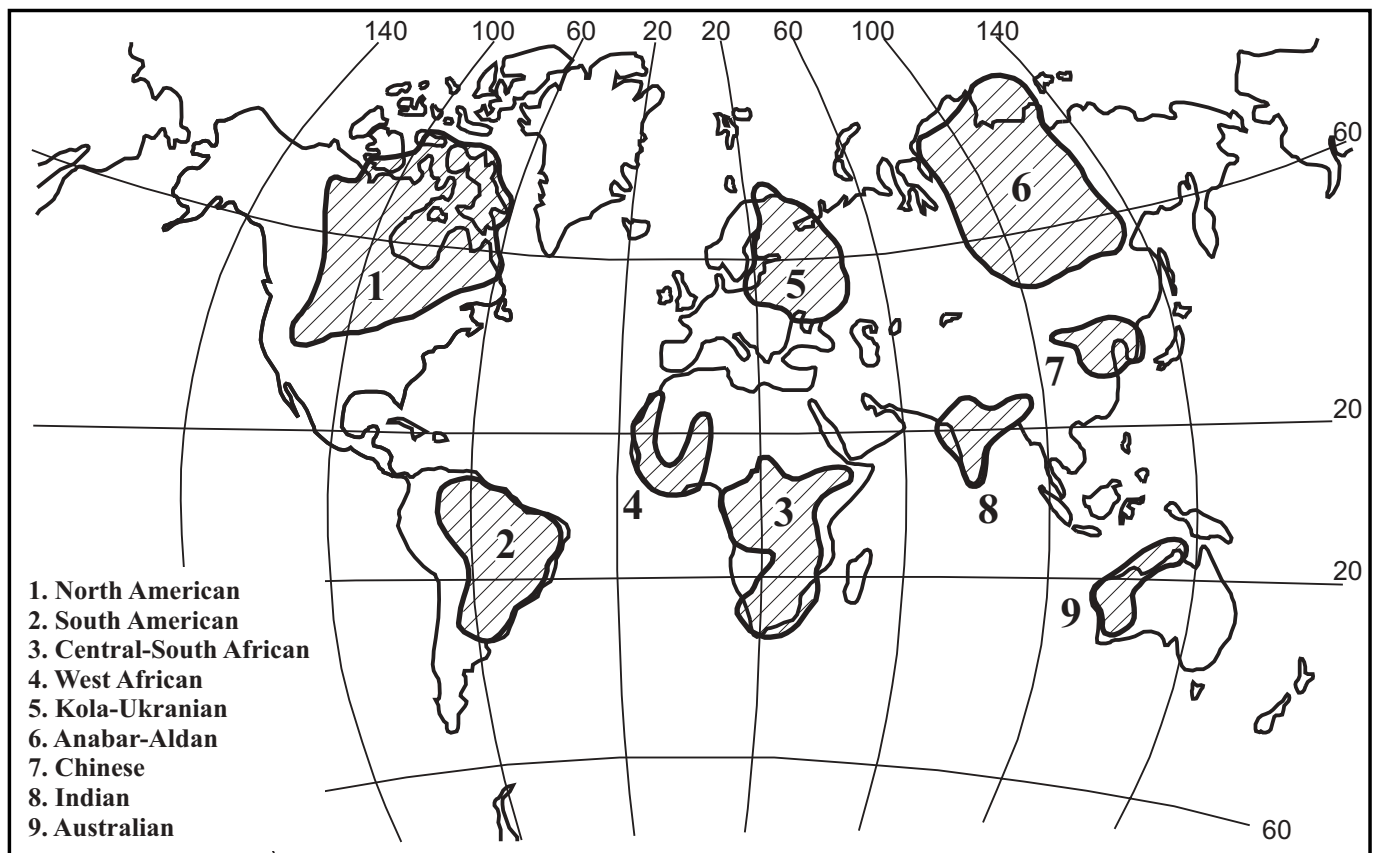


Figure 2. Areas containing main Precambrian (Archean) provinces. (Modified after Condie, 1981)

tual cooling covers only about 20% of the land area (6% of the total Earth surface; Ronov, 1978; Blatt and Jones, 1975; Wedepohl, 1995). It is likely then that only this 20% of the new continental crust had to cool after the Flood.

The cooling history of Mount Ararat may be typical of such previously molten volcanic and intrusive rocks. Mount Ararat is probably a submarine stratovolcano, comprising dominantly basalts, extruded during the first forty days of the Flood (Hunter, 2003b). As such it would have been very hot (in excess of 1,000° C) when formed, yet Noah and his family, and all the air breathing creatures which came off the Ark, traveled safely down its slopes, at most only 331 days after its formation. This attests to it having solidified and cooled considerably during that time. This rapid solidification and cooling might be considered miraculous only insofar as it may have been related to gravitational re-compression.

The only requirement for post-Flood crustal cooling was that most of the land surface and the oceans were cool enough to allow biological processes immediately after the Flood. This would include rapid revegetation of the barren land surface. This requirement may have been facilitated by a greenhouse effect due to warm oceans and land with increased evaporation giving rise to greater rainfall, which would taper off as the oceans and land cooled.

Insulating nature of the oceanic crust

Reed and Froede note:

...CPT proponents equate the onset of the Genesis Flood with the initiation of a “runaway subduction event” that led to the destruction of the antediluvian ocean floors and the recrystallization of the present floors. (Reed and Froede, 2002, p. 149).

They also note that CPT theory is unclear as to when the “runaway subduction event” and therefore the development of the new basaltic ocean floor occurred in the Flood timetable.

The hot basaltic oceanic crust, I believe, formed beneath the rising floodwaters during Days 1–40. Gravitational decompression caused mantle plume activity which resulted in buildup of continental crust on the continents. Simultaneously, in the oceanic areas, the decompression caused the oceanic mantle to melt and differentiate into a layered outer mantle “stratigraphy” including the uppermost basaltic pillow lava of typical oceanic crust, and other layers. During this time a radial expansion of the Earth of about 95–100 km caused horizontal stretching of the oceanic crust, resulting in the characteristic thinning.

The uppermost layers of the oceanic crust, perhaps especially the pillow lava layer, and perhaps some sediment

from the continents, acted as an insulating layer during the period until Day 40, when partial gravitational recompression may have instantly solidified the newly formed hot basaltic oceanic crust, thereby severely inhibiting heat flow to the overlying Flood waters during the subsequent 110 day period of stability until Day 150.

On Day 150 the ocean basins were formed, probably as a result of vertical subsidence along ocean margin faults, probably due to complete restoration of the gravitational force to its original magnitude. This further re-compression may have further restricted heat flow. At this time, the Flood waters began to subside into these basins, which were formed as repositories for the Flood waters and wet sediment draining from the land masses during the “Recessive” stage (Walker, 1994) of the Flood (Stage III/Days 150 to 371 of Hunter, 2000c).

Soft wet sediment was washed off the land masses, forming first the thick, protective, continental shelves close to the land masses, and later the thinner (approximately 300 m) sediment blanket found as the uppermost layer of much of the oceanic crust (Cann, 1974). The ocean waters would have thereby been further insulated from the underlying hot basalt exposed on the ocean floors.

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Book Review

Petrified Wood in the U.S.A. by Arthur Manning
Self published, Lancaster, PA. 2002, 111 pages, \$20.

Author Manning traveled more than 28,000 miles collecting and verifying data for this field guide. It is an attractive book with color photos, notes, and petrified wood sites for most of the states. In some cases the locations for specimens are quite general.

Manning gives a creationist view of petrified wood origin. He prefers the model of Emmett Williams: Waterlogged trees from the Flood were stranded by receding water, then covered by volcanic ash. Abundant rains leached minerals from the ash and petrified the underlying wood on a rapid scale (p. 3). A creationist analysis is given of the famous Specimen Ridge in Yellowstone Na-

tional Park (p. 95).

The top states for finding petrified wood appear to be Wyoming (14 pp.), Arizona (8 pp.), and Nevada (5 pp.). Manning is sensitive to local rules about collecting fossils. He writes, "Stealing is morally wrong, and there are steep fines for those who have no morals" (p. 18). This concise book will be helpful to any serious or recreational hunter of petrified wood.

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King Crab Research

In the June, 1998, *Creation Research Society Quarterly* (Klevberg), I relayed news of the spread of the Kamchatka or Alaska King Crab, *Paralithodes camtschaticus*, west along the coast of the Arctic Ocean to northern Norway. I pointed out the following important issues:

- *Paralithodes camtschaticus* is known for returning to the same spawning grounds year after year and for frequenting the same feeding grounds. Three or four phenotypes are identified in the Bering Sea and are quite distinct geographically. What might the rapid spread of the King Crab along the Arctic coast tell us of postdiluvial dispersion of other organisms and establishment of migration patterns?
- When an organism known for its inflexible geographic distribution spreads as rapidly as has been observed, what does that imply for the utility of fossils in recording paleoecology, geographic distribution of organisms, or even the completeness of the record?
- Evolutionists often posit that relatively small, isolated populations result in accelerated evolution. The spread of *Paralithodes camtschaticus* indicates that the idea of isolation is suspect, and the lack of evolution in the King Crab also fails to support this evolutionist notion.
- *Paralithodes camtschaticus* is a marine organism that would have survived the global Flood cataclysm in adequate numbers to reestablish sustainable populations. It may thus represent a polytypic baramin, since more than one reproducing pair would likely have constituted the initial postdiluvial population.
- To what extent does this rapid expansion of the range of the King Crab elucidate establishment of migratory patterns in other organisms since the Deluge?

Research on the King Crab in Varangerfjord and the Barents Sea continues. The initial spread of the crab into waters near the Kola Peninsula of northwestern Russia was the result of activities by Russian fisheries in the 1960's (Sundet, 2002). However, its spread westward and northward into Norwegian waters since 1990 has occurred under the watchful eye of the Norwegian fisheries ministry, and is clearly not the result of human activity. The average increase has been 45 km (30 miles) per year along the north coast of Norway, though more recently the annual rate has approached 150 km (90 miles). Many are concerned that its spread westward along the coast of Finnmark as well as northward toward Svalbard will devastate the marine ecosystem (Havforskningsinstituttet, 2003; NRK, 2002). Oth-

ers see it as an economic opportunity and part of the dynamics of marine biology (Sundet, 2002). Research is now becoming more diverse, including marine ecology, parasitology, potential inadvertent spread by ships, bioenergetics, and genetic studies, and not just population dynamics (Havforskningsinstituttet, 2003).

Some of the data generated by current research projects may be helpful in addressing the points I raised above, and I continue to encourage creationist biologists to consider pursuing this research. Migration patterns of salmon, terns, butterflies, and other migratory fish, birds, and insects must have become established after the Deluge. The enlarged range of *Paralithodes camtschaticus* may provide information useful in gaining a better understanding of migration in general. Genetic and other data generated by Norwegian and Russian researchers may also be useful to baraminology (taxonomy) studies and in addressing the notion of accelerated evolution in isolated populations. I encourage creationist taxonomists to pursue marine baraminology following the excellent examples in mammalian taxonomy of Garcia-Pozuelo-Ramos (1997), Robinson (1997), and Robinson and Cavanaugh (1998a, 1998b).

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Saltville Virginia Evaporites: Hydrothermal Model

Recently a hydrothermal young earth, Flood model was proposed as the method of formation of the evaporites in the Saltville, Virginia region (Williams, 2003). One would expect that evidence should exist that the strata in which the evaporites were found experienced a past thermal excursion event if such a hypothesis is possible. Lewis and Hower (1990, pp. 927–942), employing vitrinite reflectance and conodont alteration index (CAI) data, concluded that the Saltville thrust sheet reached maximum temperatures of approximately 200°C (p. 927). The vitrinite reflectance values were obtained from coals in the Price Formation which underlies the Maccrady Formation that contains the evaporites. The Price and Maccrady are considered Mississippian according to the standard geological timetable.

On the Saltville thrust sheet, geothermometry indicators (CAI and vitrinite reflectance) imply relatively high temperatures well up into the Mississippian section... (Lewis and Hower, 1990, p. 937).

Refer to Williams (2003, p. 76) for the location of the Saltville fault in relation to the evaporite deposits in Saltville Valley.

Interestingly about 50 miles southeast of Saltville in the Austinville-Ivanhoe District of Virginia are zinc and lead deposits which are thought to be formed by the ascension of hydrothermal waters into an early Paleozoic carbonate sediment (Brown and Weinberg, 1968, p. 185). Also see McQueen, 1986. Considering the abbreviated time scale of the young earth, Flood model of earth history, hydrothermal activity in a depositional syncline (Williams, 2003) at the present location of Saltville Valley could have led to the accumulation of evaporites.

Appendix I: Vitrinite Reflectance

There are three main groups of materials that constitute coals that are used to define coal type. These material groups identified under an optical microscope in reflected white light are referred to as vitrinite, liptinite and inertinite.... (Mitchell, 2000, p. 5).

The vitrinite group forms from woody plant material such as branches, roots and trunks. It may have a remnant cell structure or can have no structure at all (Gammidge, 2003, p. 5; Mitchell, 2000, p. 5). Vitrinite reflectance testing can be performed on polished coal samples, usually mounted in an epoxy matrix, by an oil immersion technique under a microscope using white light according to ASTM Test Method D 2798. Also see USGS, 1999, p. 1–7.

Appendix II: Conodont Alteration Index

Conodonts are a group of microfossils consisting of calcium phosphate. They are thought to be "...jaw elements of an extinct wormlike marine animal, which is considered to have been a chordate" (Eriksson, 2002, p. 2). Conodonts change color with temperature and are used as paleothermometers (Eriksson, p.3). Using an optical microscope the color of the microfossils can be compared with CAI standard colors on a glass slide to determine the maximum temperature which the conodonts experienced (Eriksson, p. 3; USGS, pp. 3–7).

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Earthquakes and the End Times

In speaking of the of the “end of the age,” the Lord Jesus Christ said, “For nation will rise against nation, and kingdom against kingdom, and in various places there will be famines and earthquakes. But all these things are merely the beginning of birth pangs” (Matthew 24:7,8 NAS). This passage is popular with some evangelists, who marshall evidence for increasing intensity and frequency of earthquakes as we approach the second coming of Christ. Simply looking at the passage, at least the following are possible: 1) seismicity will increase noticeably as Christ’s return approaches, as it is claimed by some to do, 2) seismicity will increase suddenly prior to the coming of Christ but has not yet done so, and 3) while no statement is made regarding an increase or decrease in seismicity, seismic events themselves remind us of the finitude of time and the certainty of Christ’s return. While earthquakes seem to get the most attention (in my experience) from preachers, wars and famines are included in these verses as signs of the times along with the earthquakes.

The popular interpretation of this passage that we are observing a prophesied increase in seismicity does not appear to jibe with the scientific evidence, however, as was noted by Austin (1989; 1998) in a review of world literature. While the historiography of earthquakes is sometimes faulty (Rucker, 1996), the perceived increase in seismicity probably results from better monitoring and reporting in recent times. Growing populations, especially urban populations, also put more people at risk. At the 2003 Montana Joint Engineers Conference, Michael Stickney, the geologist in charge of the Montana Bureau of Mines and Geology Earthquake Studies Office, presented data indicating that seismicity in Montana has actually decreased in recent decades. These data, clearly, are only regional and only cover the past 125 years.

While Austin (1989) asserted the divine purpose exhibited in biblical earthquakes, he also pointed out (1998) that the “birth pangs” analogy used by our Lord in referring to end times earthquakes need not imply that they increase in intensity or frequency. Being personally ignorant of the Messiah’s analogy, I spoke with some women with considerable firsthand experience. They agreed that birth pangs often begin subtly and infrequently. They do not necessar-

ily escalate immediately and rapidly in the way that some believe earthquakes have. This observation is consonant with Austin’s (1989, p. iv) conclusion:

Earthquakes have been used of God at special times, with special people, for special purposes. Like other miracles, Biblical earthquakes were employed infrequently when no other human or physical agency could inflict judgment on the wicked, redeem His righteous people from difficult situations, or gain man’s attention so God’s Word could be considered. In fact, these three purposes—judgment, deliverance, and communication—should form our basis for understanding earthquakes. In our fast paced, man-centered, technology-based society of the late 20th century, God would have us pause and consider His sovereign nature and His coming program for the world.

The scientific data and divine statement are in agreement. As we have witnessed so often relative to other phenomena, there is no real conflict here between the scientific data and Scripture. The popular misinterpretation of Scripture that seismicity will increase during the course of the “last days” needs to be laid to rest; it is supported by neither Scripture nor science. Earthquakes should not form the basis for speculation as to the timing of the return of Christ Jesus, but instead remind us of the certainty of His return, the coming day of judgment, and the work He has called us to do now.

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The Geology of the Kansas Basement: Part II

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Abstract

The identification of deficiencies and errors in the presuppositions and methods of uniformitarian natural history should be accompanied by an empirical reinterpretation of geological data within the Biblical worldview. The wealth of geological and geophysical data demands a systematic replacement of the ruling paradigm by creationist explanations of the rock record. Such a reinterpretation is underway for the geology of Kansas, and the first step in that project addresses the basement. The erosional contact be-

tween the crystalline basement and overlying sediments can be interpreted as the erosional basal Flood boundary. The exception to this interpretation is found at the Midcontinent Rift System, a complex of basalt flows and adjoining sedimentary basins. This feature is interpreted as the tectonic basal Flood boundary, marking tectonic disruption associated with the Flood onset, with both basalt flows and sedimentation occurring between the onset of the Flood and its marine inundation of the region.

The Kansas Midcontinent Rift Segment

The MRS is a regional basement feature extending in an arc from southeastern Michigan under Lake Superior and southwest into Kansas (Reed, 2000). The southernmost segment of the MRS disrupts the basement in eastern Kansas from Nebraska to Oklahoma, between the Central Kansas Uplift and the Nemaha Tectonic Zone (Figure 1). Its lithologic expression ranges up to 40 km (25 miles) wide and up to 8–9 km (~5 miles) in depth, although some geophysical data suggest a widening towards Oklahoma. Analysis of the seismic velocity and reflection data also suggested that the crust extends down to 45 km (28 miles) under the MRS.

The MRS is clearly seen on a Bouguer gravity anomaly map (Figure 2) with a strong positive (up to 6 mgals) that trends south, southwest from Marshall County at the Nebraska border to Ottawa County, and then in decreased strength south to Kingman County near the Oklahoma border. A very strong negative (down to –88 mgals) anomaly flanks the strong positive feature to the east and southeast; from Marshall County in the north to Marion County in the central part of the state (Lam, 1986). However, much of the gravity anomaly has been determined to be derived from deep-seated crustal intrusives rather than rift basalt flows.

The northern boundary of the Kansas Segment is separated in a left-lateral offset from the Iowa Segment by 80

km (50 miles) of granitic craton. Well data (Lidiak, 1972) and seismic data (Serpa et al., 1984) demonstrate a clear crustal separation between the mafic fill of the Kansas Segment and the Iowa Segment in Nebraska. The offset is a continuation of the geophysically-defined Missouri Gravity Low, a gravity anomaly trending northwest through Missouri into Nebraska (Van Schmus et al., 1993).

Early structural interpretation of COCORP seismic lines (Figure 3) suggested a basin formed by listric normal faults and rotating fault blocks, and filled with a lower group of basalt flows and an upper group of rift sediments (Serpa et al., 1984). However Woelk and Hinze (1991) reprocessed the upper portions of the COCORP lines and constrained their interpretation with data from the Texaco Noel Poersch well to derive a different rift model; one with reverse faults bounding the central rift fill of basalt and gabbro, displacing it over rift clastics of the Rice Series. This model is similar to the style of the MRS segments to the north. Woelk and Hinze (1991) also noted the presence of mafic intrusives beneath the rift in the lower crust. They interpreted the maximum rift depth as 9 km (29,528 ft), and the throw on the reverse faults as 3 km (9,843 ft).

Lam (1986) noted that gravity data show a clear extension of the MRS to the Oklahoma border, although direct data suggest that rift basalt terminates in central Kansas. He predicted a minimum of 1500 km³ each of basalt and sandstone in southern Kansas. However, the 60 mgal gravity high (second order residual gravity) in north central Kansas abruptly decreases to a 20 mgal gravity high in Saline County. Lam (1986) explained this as the effects of the boundary between the more rigid northern granite terrane

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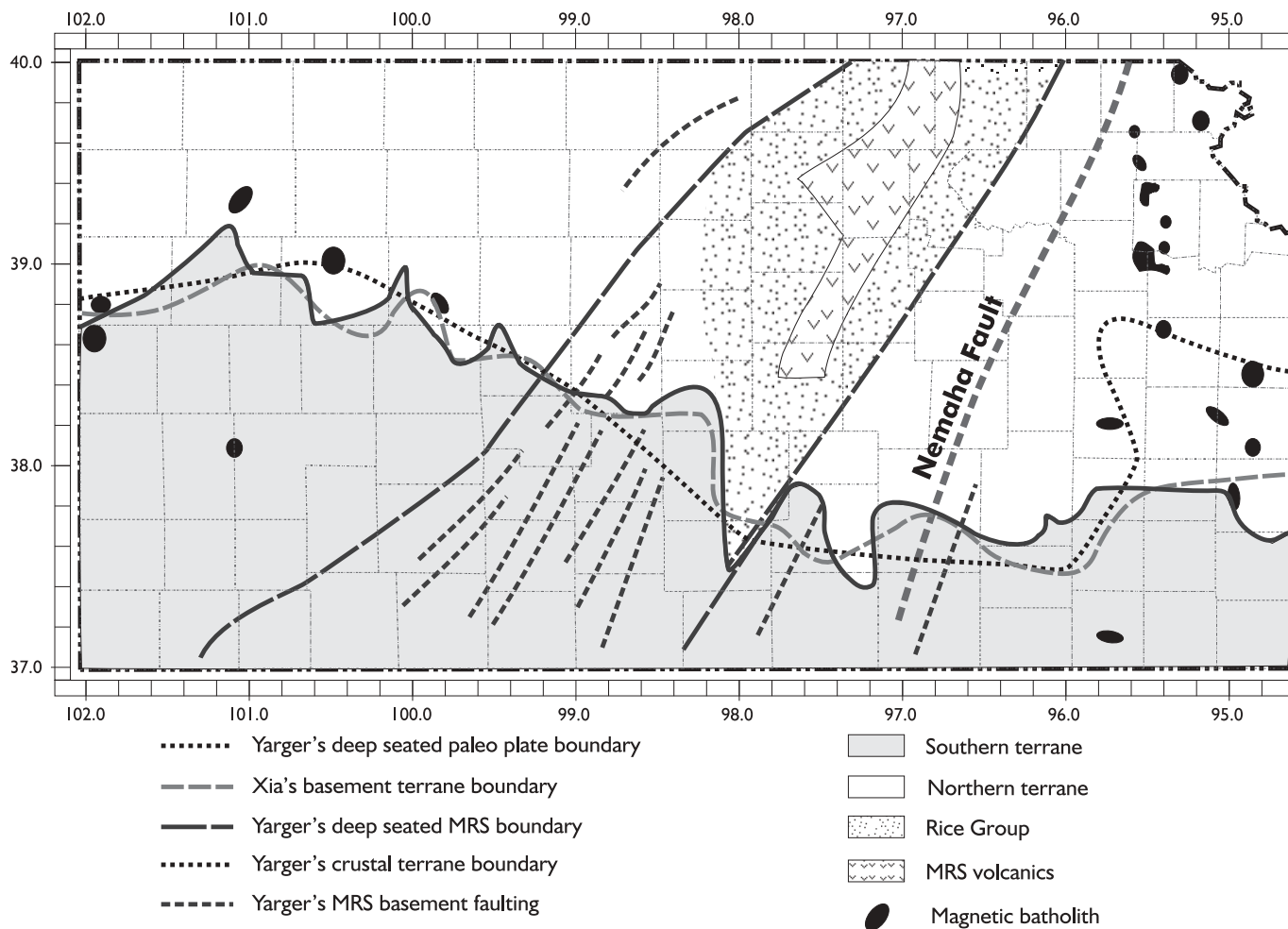


Figure 1. Basement terrane boundaries in Kansas. Modified from Yarger (1983) and Xia (1995).

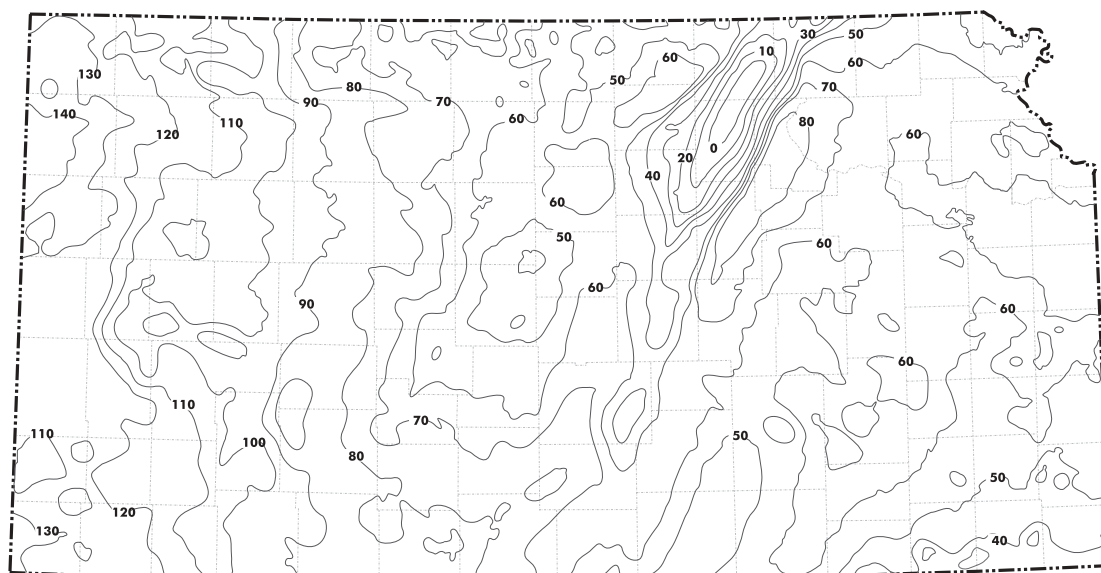


Figure 2. Bouguer Anomaly Map. After Xia et al. (1993).

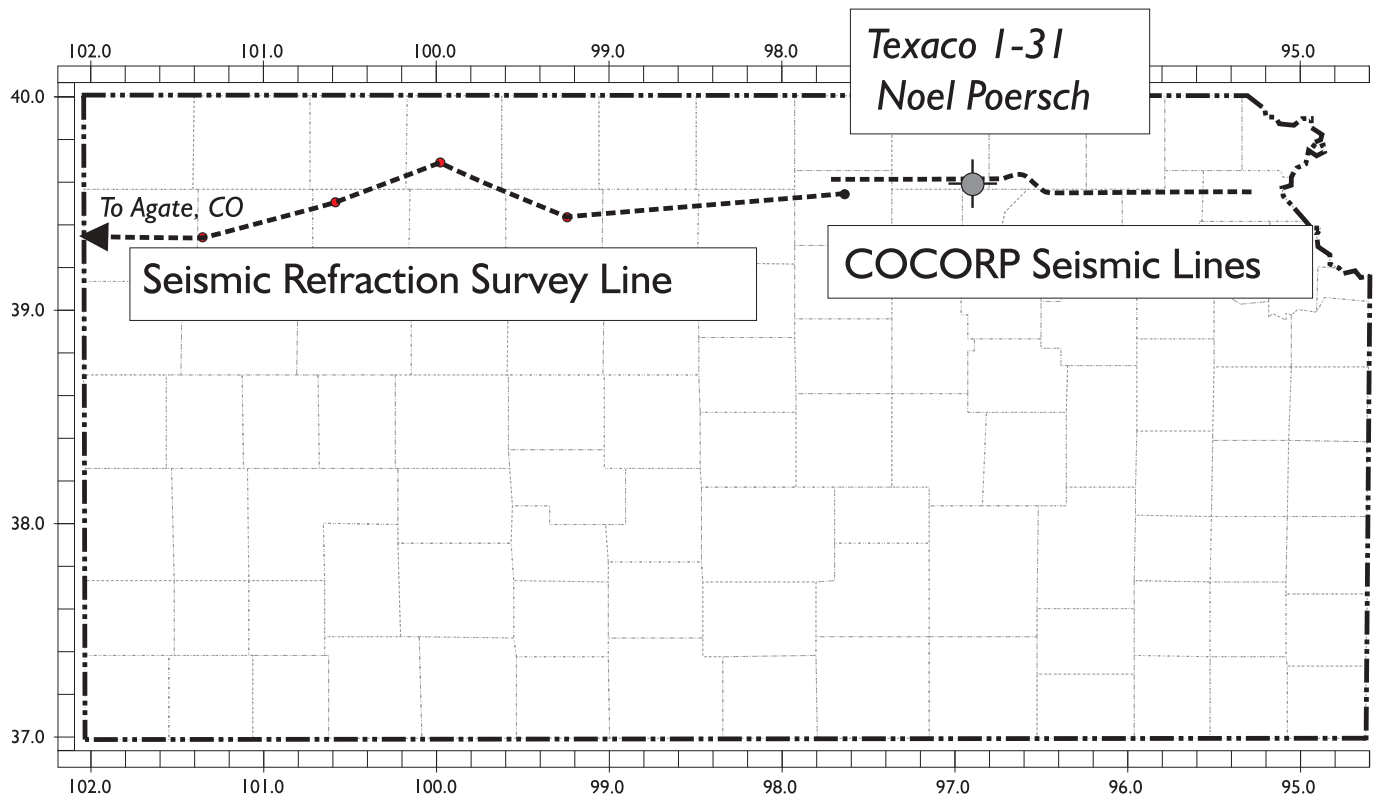


Figure 3. Location of COCORP seismic reflection and Kansas Geological Survey seismic refraction lines. After Berendsen et al. (1988) and Steeples and Miller (1989).

and the more ductile southern granite terrane cause by elevated geothermal gradient from the 1.4 Ga granite-rhyolite igneous event. He estimated a total volume of rift basalt and sandstone at a minimum of 36,000 km³ and 16,000 km³, respectively.

Yarger (1983) agreed that the MRS extends to the southern boundary of Kansas based on his interpretation of magnetic anomaly data. Magnetic data also support thick clastic fill associated with the rift. However, he concluded that the MRS in southern Kansas included only block faulting and igneous intrusions, the large-scale extrusive and sedimentary features of the northern Kansas rift being absent. Magnetic anomaly data also suggest fault boundaries of the MRS on both east and west sides and a relationship between the MRS and the Humboldt Fault.

The structure of MRS basins in Kansas appears more complex than other parts of the rift. Structural complexity results from the intersection of the Nemaha Tectonic Zone, the Abilene and Vorshell anticlines, and cross-cutting northwest-trending basement structural zones (Berendsen, 1997; Berendsen and Blair, 1992). The role of new data and interpretation is illustrated in a comparison between the relatively simple understanding conveyed in Bickford et al. (1979) map and a recent interpretation (Figure 4).

Berendsen (1997) shows Rice Series clastics occurring in flanking and horst top basins only in the northern area of the Kansas zone, but apparently covering volcanics at the Precambrian subcrop in the southern part of the Kansas Segment. In the northern area, the clastic basin is more extensive on the west side of the volcanic horst and was named the Rice Basin by Scott (1966). Atop the volcanics in the area of the Abilene Anticline, Rice Series clastics occur in a mosaic of small fault blocks and in a narrow strip to the east of the volcanics and west of the Nemaha Tectonic Zone (Figure 4B). No clastics occur in the Nemaha Tectonic Zone, although such sediments are found in fault-bounded basins in the granitic basement to the east of the Humboldt Fault (Berendsen, 1997), suggesting that the fault was possibly active during Rice Series deposition.

Rift Fill and Stratigraphy

The clastic fill associated with the MRS in Kansas has been informally termed "arkose" and "red clastics" (Koester, 1935) and "granite wash" (Mettner, 1936). Scott (1966) posited a distinct unit, which he termed the Rice Formation, based on 5,200 km² (2,007 mile²) area in east-central Kansas. Although the base of the Rice Formation had not

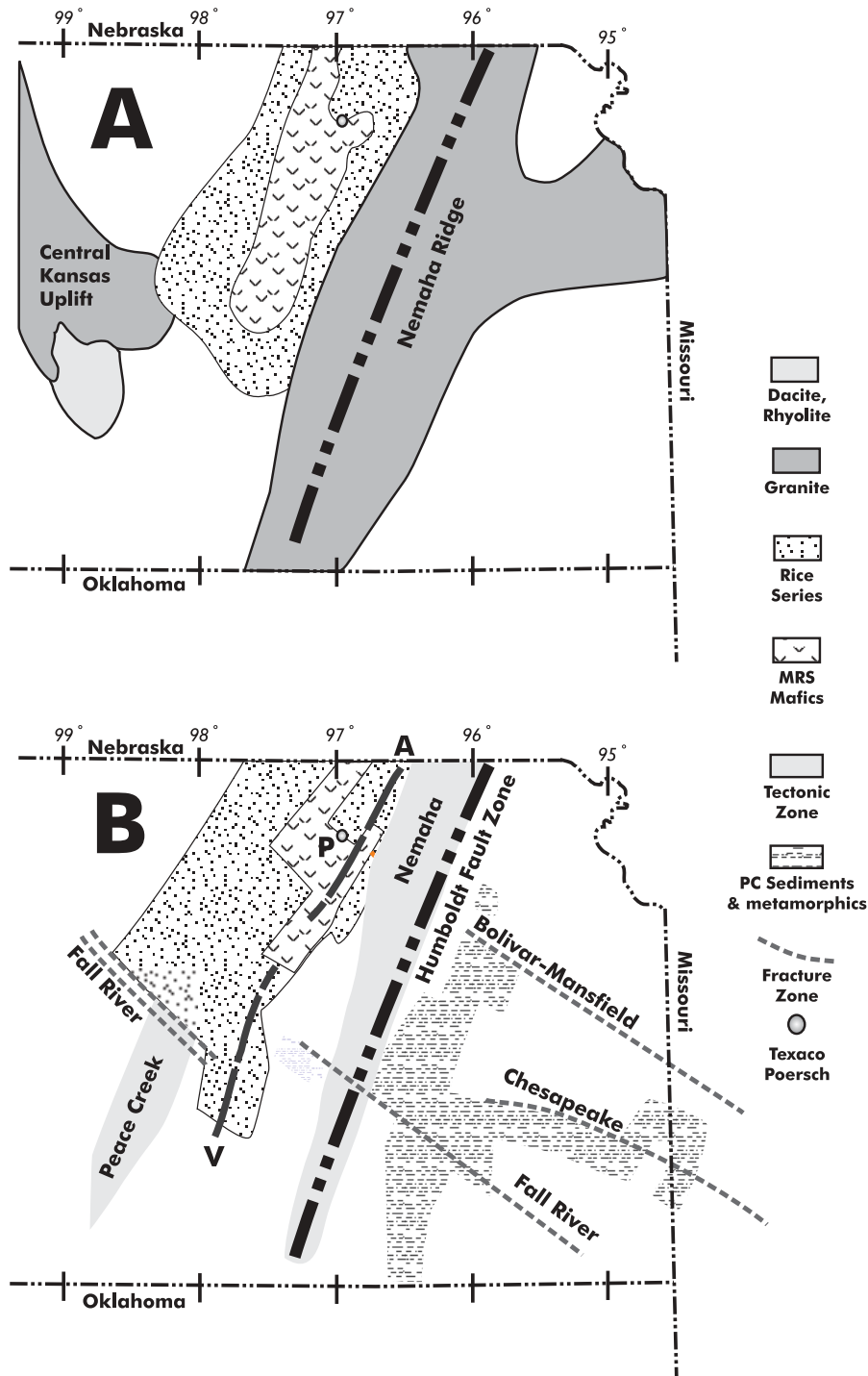


Figure 4. (A) Bickford (1979) basement interpretation at the Midcontinent Rift System as compared to that of (B) Berendsen and Blair (1992). A is Abilene Anticline, V is Vorshell Anticline, and P is Texaco Poersch well.

then been penetrated, Scott used cores from four different wells as a type section.

The Rice Formation was described by Scott (1966) as arkose to feldspathic sandstone with interbedded brown and

green micaceous shale and dolomite cement. Occasional dolomite and limestone beds are present in the section. The Rice Formation was described in an area of eastern Kansas coincident with the MRS. Although there are numerous Precambrian penetrations by wells in Kansas (Cole and Watney, 1985), the depth of penetration in most wells is severely limited relative to the posited thickness of the unit, and there had been no real synthesis of the data until the drilling of the Poersch well in 1985.

Berendsen et al. (1990) compared MRS sediments with overlying Cambrian clastics. These included formations found outside Kansas, the Low Rock Formation in Iowa, the Ironton Formation in Wisconsin, the Eu Clair Formation in Wisconsin, and the Mt. Simon Sandstone in Wisconsin. They concluded that it would be easy to distinguish MRS and Cambrian sandstones because of the pronounced angular unconformity commonly found between the two, the addition of glauconite and phosphorite faunal material, different types of sedimentary rock fragments, and mineralogy suggesting marine deposition.

Other workers disagree that the contact between the Proterozoic and Paleozoic sediments was clearly defined (Dickas, 1986). Also, it should be noted that angular unconformities are present between “conformable” units, such as the Oronto and Bayfield Groups at the margins of the Lake Superior Basin (Reed, 2000), and that considerable lithologic variation is encountered between sediments of similar age along the MRS. The relationship between lithologic variation and age appears uncertain.

The Rice Series is associated with the MRS. Delineation of the limits of that structural basin and the edge of the clastic fill is difficult, and done primarily by gravity and magnetic data, supported by well penetrations. However, wells penetrating the Rice Formation prior to 1966 may have used a variety of names to mark the

Unit		Top (ft) (m)		Base (ft) (m)		Thickness (ft) (m)		Composition
Upper Volcanic-Dominated Succession		2,846	867	7,429	2,264	4,583	1,397	90% igneous; 10% sediments
2e	Gabbro	2,846	867	3,150	960	304	93	intrusive mafic
2d	Basalt Sequence	3,150	960	4,140	1,262	990	302	layered basalt flows
2c	Upper Mixed Volcanic-Sedimentary Sequence	4,140	1,262	5,719	1,743	1,579	481	alternating basalt flows and arkosic clastics
2b	Basalt-Dominated Sequence	5,719	1,743	7,039	2,145	1,320	402	thicker, more altered basalt flows
2a	Lower Mixed Volcanic-Sedimentary Sequence	7,039	2,145	7,429	2,264	390	119	alternating thin basalt flows and arkosic clastics
Lower Sedimentary-Dominated Succession		7,429	2,264	11,300	3,444	3,871	1,180	90% sediments; 10% igneous
1e	Upper Sedimentary Sequence	7,429	2,264	8,806	2,684	1,377	420	fining up cycles of cong. - coarse arkose to siltstone
1d	Upper Mafic Unit	8,678	2,645	8,806	2,684	128	39	altered gabbro sill
1c	Middle Sedimentary Sequence	8,806	2,684	10,840	3,304	2,034	620	same as 1e, coarser, more variable grain size
1b	Lower Mafic Unit	10,622	3,238	10,840	3,304	218	66	altered thin basalt flows
1a	Lower Sedimentary Sequence	10,840	3,304	11,300	3,444	460	140	similar to 1c and 1e, coarser, more volcanic lithics

Table I. Sedimentary sequence of the Texaco Noel Poersch 1-31 Well in Kansas.

sediments, and if the contact between Paleozoic and Proterozoic sediments is difficult to pick, no differentiation may have been made between immature Paleozoic arkosic sandstones, relatively *in situ* granite detritus, and the Rice Formation.

Berendsen et al. (1990) discussed categories of Precambrian clastic rocks in Kansas. They classified them as Rice Formation, Hinckley Sandstone equivalents, Fond du Lac equivalents, and granite wash clastics. Granite wash is residual material resulting from the weathering and erosion of granitic basement. Accumulations vary from a few feet to several hundred feet (Cole and Watney, 1985). No age is assigned since the rocks are unfossiliferous and exposure of basement rocks is not limited to a particular time. They correlate the Rice Series sediments to the Keweenaw Chequamegon Sandstone in Wisconsin, the lower Mt. Simon Sandstone in Minnesota and Iowa, and the Red Clastic Series in Nebraska, based on lithology and relative stratigraphic position (Reed, 2000).

Sediments at the Poersch Well

A detailed description of Precambrian sediments in Kansas was developed from cores, cuttings, and logs from the Texaco 1-31 Noel Poersch well. It was drilled in southwestern Washington County, Kansas in 1985 on the east side of the MRS near the Kansas COCORP seismic lines. The well was drilled to a total depth of 3,445 m (11,302 ft), penetrating 868 m (2,848 ft) of Phanerozoic sediments before encountering a 1,397 m (4,583 ft) section of Proterozoic mafic volcanics and intrusives with minor sedi-

ments. Below this unit the well penetrated 1,180 m (3,871 ft) of predominantly arkosic clastic sediments with minor mafic units. Berendsen et al. (1988) described two major successions in the Precambrian section (Table I), each with five sequences, ranging from 39 m (128 ft) to 620 m (2,034 ft).

Sequences 1a–1e belong to the Lower Sedimentary-Dominated Succession, and sequences 2a–2e belong to their Upper Volcanic-Dominated Succession. The Lower Sedimentary-Dominated Succession consists of three sedimentary sequences divided by two thin mafic units. All three of these sequences consist of series of fining-upwards cycles of arkosic conglomerate and coarse-grained sandstone to finer sandstone and siltstone. Dolomite cement is locally present, and more common in sequence 1c. The coarser-grained clastics are generally subarkoses, while the quartz fraction decreases in the finer-grained sandstones and siltstones. Sandstones vary widely in sorting (poor to medium) and grain roundness. Rounded and frosted quartz grains are common in the coarser-grained rocks. Feldspars in the coarser-grained fraction are relatively fresh, light pink to salmon potassium feldspar. Feldspar alteration and hematite staining increase in the finer-grained rocks. Lithic grains are usually fresh volcanics. Coarser grain sizes are more common in the lower sequences, and volcanic lithic fragments are common in the lowest sequence. The increase of volcanic lithics downward through the lowest sequence suggests a lower volcanic source. Indications of fractures are present in the clastics. The lower mafic unit is composed of a series of thin alkali basalt flows, heavily altered to epidote and chlorite. The upper mafic unit is a dark

green/gray fine to very fine grained gabbro, with common epidote and sulfide alteration.

The Upper Volcanic-Dominated Succession is described by Berendsen et al. (1988) from the base up (2a to 2e in Table I) as a mixed volcanic/sedimentary sequence, overlain by a basalt flow sequence, overlain by another mixed volcanic/sedimentary sequence, overlain by a basalt flow sequence, overlain by gabbro. The top of the gabbro is the erosional Ordovician unconformity, overlain by sediments of the Simpson Group. The mixed volcanic/sedimentary sequences consist of thin flows of alkali basalt, with oxidized and altered tops, interlayered with coarse-grained arkose to siltstone. The sandstone resembles “granite wash,” an immature relict of granitic basement erosion, common in many locations across the cratonic interior. Berendsen et al. (1988) noted more extensive alteration of the basalt in the upper volcanic/sedimentary sections. Overlying each mixed sequence are basalt flows that do not contain any sedimentary interlayering. Although individual flows were difficult to discern, they appear thicker in the basalt sequences, up to 113 m (371 ft) in thickness. The basalt is microcrystalline, light to dark green/gray, with red staining at presumed flow tops, and mafic content increases downward through individual flows. Extensive hydrothermal alteration is common. The final sequence in the upper succession is a thick, green to black, fine to medium grained gabbro. The contact between the intrusive gabbro and the overlying Ordovician sediments is sharp, and the gabbro is relatively unweathered near the contact. The low density measured in this gabbro by well logs suggests that open fractures occur deep within the rock. Several thin pegmatites, composed mostly of quartz and potassium feldspar are also present in the upper succession.

Discussion

Background: Uniformitarian versus Biblical Natural History

Creationists must question the legitimacy of the entire natural history enterprise within the worldview of naturalism. An evaluation of natural history in the naturalist worldview demonstrates contradictions between its assumptions, methods, and conclusions (Reed, 2001). Ironically, these contradictions arise from a cloaked dependence on Biblical theology. Another significant weakness of naturalism is the conflict between its positivist epistemology and its assumption of the validity of uniformitarianism.

The nature of this conflict rests upon the recognition

that “deep time” consists mostly of “dead time”—time with no evidence of its existence. The rock record does not contain billions of years of strata. Instead, the rocks represent mere dribs and drabs of time, strung together on the skeleton of uniformitarianism. Although naturalists purport to present a continuous record of earth history in the geologic column, the real rock record (physical evidence) is scanty relative to the inferred history. This lack of physical evidence clashes with naturalism’s epistemological assertion of positivism, and within that framework the lack of physical evidence strongly suggests that an empirical natural history cannot be trusted.

Uniformitarianism presents another problem for naturalists. Being an attempt to force positivism on the unobservable past via extrapolation, natural history and natural science are merged. But extrapolation can only be done confidently if the template of the present can be precisely fitted to the data of the past. Uniformitarians must answer two questions:

- (1) does the variety found in the “present” preclude the construction of a precise template? and
- (2) does the evidence of the past fit whatever template can be fashioned?

In the 19th century, Charles Lyell was fighting an entrenched Biblical history. He required a minimum level of certainty for his approach that would overcome the cultural confidence in the Bible. Lyell solved that problem by means of a rigid uniformitarianism. But empirical evidence collected since then is clearly at odds with that approach. However, he won, and the evidence that undermines his position remains inconsequential to his disciples because they have ignored the true challenge of catastrophism. Unfortunately, the challenge has not always been presented in its full logical force because of an emphasis on developing a corpus of empirical data supporting the young-earth interpretation, rather than attacking the faulty assumptions of uniformitarian natural history. Given the logical flaws in naturalism, the data cannot provide a credible history based upon discrete particles of strata floating in a sea of unobserved and unrecorded time.

Correlative problems do not exist for creationists because history is ultimately controlled and recorded outside of nature and man. A precise and accurate accounting of time is provided by an infinite, eternal, unchanging God. His omniscience makes Him the ideal historian. And when this God chooses to reveal history to man, those gaps that He allows in our knowledge are not absolute, since He retains the “missing” knowledge. These historiographic facets of the Biblical worldview save the possibility of natural history, but only within a Christian framework.

Another, largely unrecognized problem with uniformi-

tarianism is the implication of temporal invariability (Reed, 1998). If “the present is the key to the past” at any given point in time, then there must be a corresponding relationship between any two given points in the past via the Principle of Identity (i.e., if Present = Past1 and Present = Past2, then Past1 = Past2). If the present is the key to all points in the past, then all points in the past must bear a resemblance to each other as well as the present.

Aspects of the geology of the Kansas basement illustrate these challenges to uniformitarian natural history. There are discontinuities between inferred historical processes across time. There are processes that are not observed in the present. Finally, there are vast amounts of missing time, undocumented by physical evidence. When the evidence is examined carefully, an interpretation within the Biblical worldview is seen to be more fruitful than that of uniformitarianism.

The Kansas Basement versus Uniformitarian Natural History

Does the basement beneath Kansas support the corollary or temporal invariability? The uniformitarian interpretation of the upper Midcontinent region includes 700,000,000

years of crustal accretion between 1.8 Ga and 1.1 Ga (Van Schmus et al., 1993) represented by various geochemical differences in sparse samples of basement rock. This period culminated in a spurt of intense deformation, volcanism, and sedimentation that formed the MRS. These processes occurred over regional areas (cf. Figure 5). There are no widespread regions of continental crustal accretion occurring today. Following these events was a span of 550,000,000 years of no discernible activity, which in turn was followed by another 500,000,000 years of active sedimentation, erosion, and structuring. Although one could argue that the evidence warrants a different interpretation, let us grant the uniformitarian scenario for the sake of evaluating its internal coherence.

At face value, the historical sequence of the midcontinent basement violates predictions of uniformitarianism with respect to temporal invariability based on the regional, major discontinuities between various parts of the rock record. It is incumbent upon uniformitarians to explain how this region underwent such singular events, then (based on the physical evidence) remained quiescent for 550,000,000 years, then was deformed and inundated by another 500,000,000 years of Phanerozoic activity. Which aspect of this history does the “present” unlock?

One of the more interesting features of the midcontinent basement is the 550,000,000-year unconformity between the eroded basement surface and Phanerozoic sedimentary rock (Reed, in press-a). This interval is defined in Kansas by its end points; the youngest sediments and volcanics of the MRS, circa 1050 Ma, and the earliest Cambrian sediments, circa 500 Ma. There is no rock record for the time interval, only an erosional surface. Thus, there is no empirical method of discovering or recounting that interval of history.

To place this problem in perspective, the hiatus is longer than the entire record of the Phanerozoic, which represents the vast majority of the regional sedimentary record between this hiatus and the ground surface. The problem is compounded in the uniformitarian

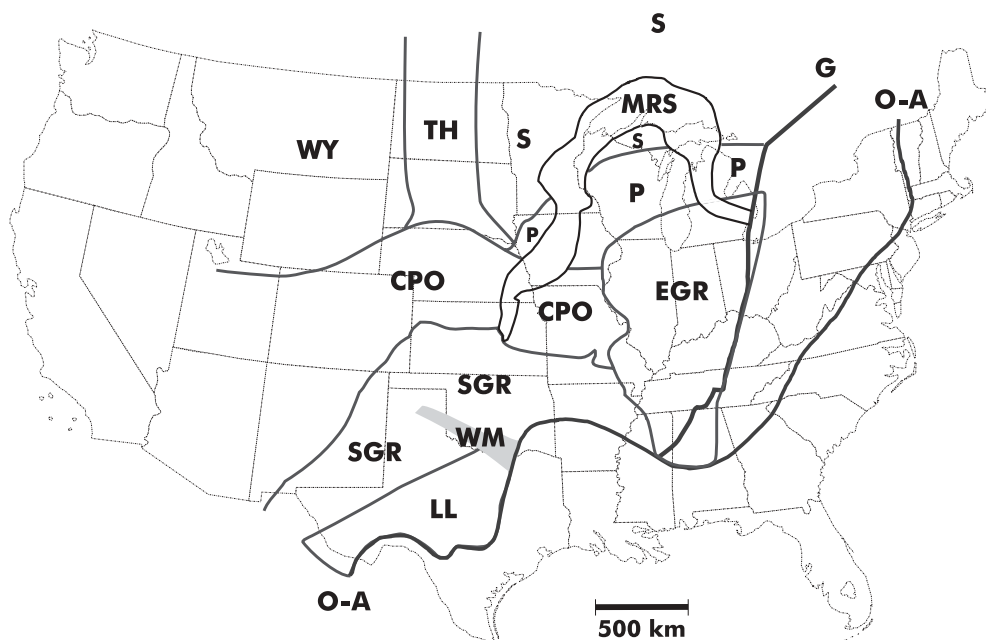


Figure 5. Basement provinces of the North American Midcontinent. S is the Superior province, W is the Wyoming province, TH is the Trans-Hudson orogen, CPO is the Central Plains Orogen, P is the Penokean orogen, EGR is the Eastern Granite-Rhyolite province, SGR is the Southern Granite-Rhyolite province, G is the Grenville front, MRS is the Midcontinent Rift System, LL is the Llanero province, WM is the Wichita Magmatic province, and OA is the Ouchita-Appalachian front. Modified from Van Schmus et al. (1993) and Hinze (1996).

framework; in addition to the missing evidence for this period, pre-Paleozoic sediments in Kansas are classified as non-marine (Van Schmus and Hinze, 1985) because of their mineralogical makeup, the lack of fossils, and the absence of associated marine beds. Thus, there is no evidence of a marine transgression during the hiatus. However, the same time interval in the Phanerozoic records at least six major transgressive-regressive cycles in the Midcontinent (Sloss, 1963). Similarly, evidence for plate tectonic cycles predicted by Hoffman (1989), and referenced by Anderson (1990) and Van Schmus et al. (1993) is missing. Hoffman (1989) predicted 200–300 million-year cycles. If the MRS is the result of one of these cycles, then why are there not two others observed in the 550,000,000-year hiatus?

Furthermore, dead time predominates even in those sections of the rock record that appear complete. Consider the presentation of stratigraphic charts in geologic publications. Comparing the scale of “deep time” against the page size of most publications, it is clear that hundreds of thousands or even millions of years can be compressed into the width of a line on the chart. On most stratigraphic charts, there is not even an effort to accurately portray the actual amount of time represented by strata. Why? Because the actual time of deposition is unknown, and also because if known, it is embarrassingly short relative to the stratigraphic interval. So history is blurred by two factors: (1) the inability or unwillingness to note that a purported “history” of several million years may depend on a thin layer of strata deposited in a very short time, and (2) the “scale masking” that takes place when the width of a line on the page is the equivalent of millions of years.

Reed (2000; in press-b) describes this problem with MRS volcanic flows. In Kansas, the MRS basalt flows observed in the Texaco 1-31 Poersch well occurred over a period of 23,000,000 years (Cannon (1994). The Poersch well logged 38 individual flows averaging 41 m (135 ft) thick over a 2361 m (7,746 ft) interval. Extrapolation over a suggested 8,000 m (26,247 ft) total thickness implies a total of 194 flows in the Kansas MRS. Evidence strongly suggests that individual flows could have formed in hours or days rather than over many tens of thousands of years. If the 194 flows formed over 23,000,000 years, and each flow occurred in less than one year, then each flow would commence on average following 119,000 years of inactivity. This simple illustration reveals that almost all of the history supposedly documented by the basalt flows is actually 99.99% “dead time” not documented by physical evidence.

If historical evidence must be tangible (as opposed to revelatory) then missing sections of the physical rock record are missing history. Since breaks in the historical record render it discontinuous, and the actual record is comprised

predominantly of “dead time,” the validity of the uniformitarian approach is severely compromised. Only the unsupported assumption of identity across time saves that version of natural history, and as mentioned before, that assumption is severely undercut by empirical data.

The Kansas Basement in Biblical Natural History

If uniformitarian natural history cannot survive its own weight, then how can the geological data pertaining to the Kansas basement be reinterpreted in the biblical framework of a young earth and global flood?

The most obvious features of the basement are the (1) lithologic discontinuity between the predominantly igneous and metamorphic basement and overlying sediments, (2) the widespread erosional contact between them, and (3) the tectonic disruption evidenced by the MRS. A rapid change from a continental to marine environment, deep erosion, and structural deformation are congruent with a Flood interpretation. With the exception of the MRS, the basement of Kansas can be interpreted as an erosional contact representing the basal Flood boundary. The occurrence of granite wash deposits in certain areas of the basement suggests local reworking of the newly-eroded granite and limited transport prior to preservation beneath regional marine beds.

Reed (2000) interpreted the MRS as a feature recording the very onset of the Flood. Its nonmarine sediments and volcanics represent the time between the tectonic initiation of the Flood and the arrival in Kansas of the marine transgressive front. Other igneous activity in the form of granite intrusions could have been associated with the same event, since it appears that some of the batholiths are genetically related to the downwarping of sedimentary basins, such as the Forest City Basin. Contrary to historical scenarios driven by isotopic dating, the physical evidence of a single igneous event, with both intrusive and extrusive components ties together the MRS, the granite batholiths, and basement structuring at the Nemaha Tectonic Zone. It is likely then, that large volumes of MRS volcanics and sediments were eroded, with the Rice Series, granite wash, and other pre-marine sediments representing the remnants of those pre-marine sedimentary deposits and the remaining basalt representing the remnants of more extensive flows.

Given such a Flood scenario, it is also possible that the granite wash, non-marine sediments of the Rice Series, and the basal Cambrian sandstones all are derived from the same source and represent different depositional situations occurring simultaneously. They would thus be distinguished by their depositional parameters and not by uni-

formitarian history. Thus, these sediments could have been deposited within a short timeframe. Rather than indicators of time, they represent a continuum of sedimentary maturity (and the marine overprint on the Cambrian sands) with granite wash at one end and the basal Cambrian sandstones at the other. If so, then the links between these sedimentary deposits would span the basement unconformity and provide another indication that the 550,000,000 missing years never existed.

Sparse data from the basement are supplemented by the uniformitarian assumptions of isotopically dated terranes and provinces and their historical emplacement by plate tectonic processes. For creationists, the resulting elaborately constructed basement history would be largely irrelevant to a diluvial interpretation. The variations in basement lithology, chemistry, and isotopic ages may be a relict of creation, the result of antediluvian processes, or the tectonic processes operating at the onset of the Flood. The presence of rhyolite fields across stretches of the Kansas basement and the granitic intrusions would probably fall into the latter category.

In a diluvial model, the regionally scoured surface of the basement would serve to illustrate the erosional power of the Flood. The underlying rocks might be of interest to those creationists who might wish to reconstruct or earliest Flood events (e.g., Reed, 2000). In this model, the irrelevance of isotopic dating as currently applied would support the conclusions of Woodmorappe (1999). Given the

estimated depth and extent of erosion of the basement, it is unlikely that any antediluvian strata were preserved.

Thus, all strata atop the eroded basement (along with the MRS) can be classified as either Flood or post-Flood deposits. This would mean that any antediluvian faunal communities would have been eroded, displaced, and re-deposited. Fossiliferous strata between the basement and the ground surface represent processes of chemical precipitation, transport, and deposition. It is not possible in this paper to determine the scale limitations of such transport (e.g., of fossil reef blocks).

It seems likely from the erosion of the granite surface itself and the estimates of eroded basalts of the MRS, that significant erosion occurred between the onset of the Flood and the deposition of initial marine sediments. Based on the location of feeder dikes near the Lake Superior Basin, it is estimated that up to one half of the original basalt flows associated with the MRS were eroded. As noted by Reed (2000), such widespread and intense erosion during some part of the first 40 days of the Flood would certainly qualify as "catastrophic."

Examination of the Kansas basement offers the opportunity of an alternate interpretation within the framework of the Biblical worldview. One method of interpretation within this worldview is by reference to the relative levels of geologic energy that can be inferred from various features (Reed et al., 1996). A regional interpretation of the MRS within this context (Reed, 2000) attributed the MRS

to the abrupt energy increase that marks the onset of the Genesis Flood (Figure 6). Does this interpretation appear sound in Kansas?

If the basement in Kansas represents the results of an igneous and tectonic event of short duration, then the associated energy must have been quite intense. It would include the additive energy of structural uplift (e.g., Nemaha Tectonic Zone), igneous intrusions of granite batholiths and mafic bodies, igneous extrusion of MRS volcanic flows and rhyolite fields, and the subsequent development of cratonic basins (Anadarko, Salina, and Forest City). Intense rainfall prior to marine transgression could have resulted in severe erosion of the granitic base-

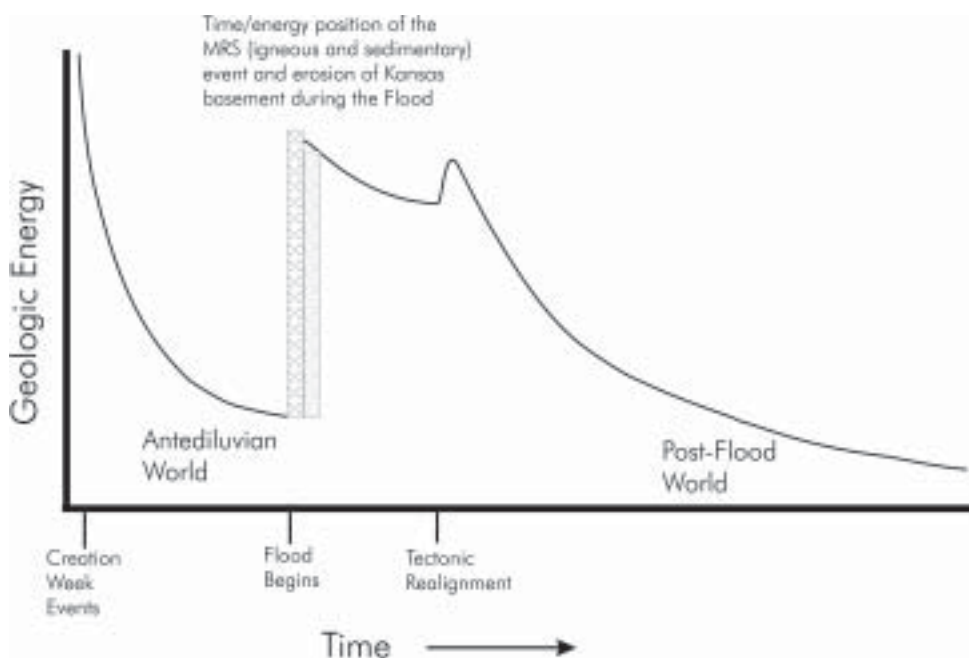


Figure 6. A graph of geologic energy versus times showing the location of the Midcontinent Rift System relative to the Genesis Flood. From Reed (2000).

ment and MRS rocks prior to the erosive power of the marine front. Structural deformation would also have weakened areas of rock, making them more susceptible to erosion. This would be particularly true as large areas of granite were uplifted, resulting in exfoliation. Finally, the Flood marine front would have resulted in additional erosion via large scale waves prior to the redeposition of basement-derived clastic sediments.

Origin of Phanerozoic Basins

The relationship between Precambrian basement features and Phanerozoic basins assumes a radically different nature in a catastrophic framework. Rather than a complex system of repeating cycles of structuring, quiescence, and reactivation, a Flood model would recognize that structuring would be a logical outcome of tectonic activity at the onset of the Flood. Thus, events that uniformitarians place hundreds of millions of years apart would actually be relatively simultaneous and possibly be related. Thus the formation of the MRS, the Central Kansas Uplift, the Nemaha Tectonic Zone, the Forest City Basin, the Salina Basin, and other similar features would all be tied together at the Flood onset. This would alleviate some of the genetic problems that baffle uniformitarians.

It is commonly difficult to interpret these features. Most are known from structures in the overlying Phanerozoic rocks, and it is seldom clear whether these reflect Phanerozoic deformational structures, structures resulting from topographic features on the basement surface, or reactivation of Precambrian structures.

In general, because of poor detail in subsurface control, we have not found good correlation between the known geology of the Precambrian basement and location of younger structures. For example, the Nemaha uplift of eastern Kansas, Oklahoma, and Nebraska, a major basement feature, does not correspond to any identifiable lithologic or age-province boundary defined by petrography or geochronology. Moreover, it has virtually no geophysical expression on either gravity or magnetic maps of the region. (Van Schmus et al., 1993, p. 241).

Marshak et al. (2000) note that the late Proterozoic to Eocambrian in North America was a time of intense structural and magmatic activity. If the uniformitarian timescale is ignored and the timing of this activity is reconsidered to be prior to widespread Phanerozoic sedimentation, then a Flood model would take the same evidence and conclude that there was a burst of tectonic and magmatic activity prior to Flood sedimentation. Such an interpretation would agree with the implications of the biblical description of the Flood onset and would provide a basis for linking these

features across North America. The search for genetic links between basement tectonic and magmatic features such as the Wichita Magmatic province in Oklahoma and Texas, the MRS, the Nemaha Tectonic Zone, and cratonic basins opens a new area of potentially fruitful research for creationist geologists.

Conclusion

The basement of Kansas has been determined, by a variety of indirect techniques, to consist of predominantly crystalline rocks, divisible into two terranes. Interrupting the primarily granitic basement is the Kansas segment of the Midcontinent Rift System, noted for its mafic intrusive and extrusive rocks and continental clastics. Interpretation of these features within uniformitarianism emphasizes isotopic dates and plate tectonic processes. A more satisfactory interpretation is found within the context of the Genesis Flood.

In summary:

- crystalline basement and terranes in Kansas are eroded pre-Flood continental rocks
- the earliest marine sedimentary deposits (Cambrian) in Kansas represent the initial marine transgression of the Flood
- the earliest non-marine sediments (i.e., Rice Series, granite wash, undifferentiated sediments east of the Nemaha Tectonic Zone) are probably non-marine relicts of pre-marine Flood activity
- a contemporaneous origin and causal links for events considered widely separate in time by uniformitarians can be explored by creationists
- the short time frame for the Flood demands interpretation of geologic features in light of tectonic and depositional processes rather than time

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“Everything about the origin of life on earth is a mystery, and it seems the more that is known, the more acute the puzzles get. ...The chemistry of the first life is a nightmare to explain. No one yet has devised a plausible explanation to show how the earliest chemicals of life ... might have constructed themselves from the inorganic chemicals likely to have been around on the early earth. The spontaneous assembly of small RNA molecules on the primitive earth ‘would have been a near miracle....’”

—Nicholas Wade. Life's Origins Get Murkier and Messier. “Science Times” in the *New York Times*, June 13, 2000

Why Mammal Body Hair Is an Evolutionary Enigma

Jerry Bergman*

Abstract

Mammal body hair is a complex structure that involves several basic parts, including a shaft, a root, and a follicle. The most common theory currently in vogue is that hair evolved from reptile scales. Although both scales and hair preserve well in the fossil record, especially in amber, no

evidence of hair evolution has been found after more than a century of searching. Another problem is that all primates have thick, coarse hair called fur, and explanations as to how this fur was lost in human evolution are deficient and contradictory.

Introduction

Hair is a defining characteristic of mammals. It is found on all mammals and on no other animal (Denton, 1986). Even the “hairless” mammals, including pigs, elephants, hippopotamuses, rhinoceroses, whales, dolphins, and other cetaceans (all of which are mammals) are partly covered with very fine short hair, especially in the young. The many functions of hair include the retention of heat, sexual dimorphism, attraction of mates, protection of skin, reflection (or absorption) of sunlight and, in the case of pets, the elicitation of a protective response from humans.

The Structure of Hair

Hair is a complex structure that is epidermal in origin. Animal hair is constructed out of proteins “composed of thousands of amino acids linked together in a highly organized arrangement and sequence” (Saferstein, 2002, p. 205). Hair is held in place below the epidermis by a root situated in a shaft surrounded by a hair follicle. The hair follicle consists of an epidermal and a dermal root sheath. One or more sebaceous glands also exist in the hair follicle and serve to secrete oil into the space between the shaft and the surrounding tissues. This oil lubricates the area and traps moisture, a function that benefits both the hair and the skin.

A small, smooth muscle called the *Arrector pili* runs from the epidermis to the base of the hair shaft. Cold temperature causes this muscle to “stand the hair on its end” to help insulate the body. Also, muscle activity is a means

the body can use to produce heat. The muscle contraction produces the familiar “goose bumps” that result from cold temperatures, embarrassment, or fear (and is an important means of communication both to one’s self and to others).

Located in the hair root, the external root sheath contains all the epidermal strata existing in normal skin. If the epidermis and superficial part of the dermis are damaged, the undamaged part of the hair follicle (which is protected because it lies deep within the dermis) is a source of new epithelium to repair surface skin damage (Seeley *et al.*, 2003).

Each hair shaft has an inner layer of cells called the *medulla* or pith, containing soft keratin and shrunken cells of dried epithelial structures. The next layer is called the *cortex*, which is a semi-transparent, thick layer that contains “hard type keratin” filled cells (Seeley *et al.*, 2003). It occupies the bulk of the hair. The cortex contains scattered pigment cells that produce melanin, giving hair its color. Color is an important tool used to differentiate hair for both biological research studies and forensic work (Saferstein, 2002).

The outer layer of the hair shaft, the **cuticle**, consists of a single layer of colorless keratinized cells that cover the hair somewhat like skin. These hardened, flat cells overlap like house shingles and are arranged “in an imbricate fashion and often beautifully sculptured” (Hamilton, 1939, p. 69). The ends of the flat cells always point toward the *tip* of the hair, not the hair root (Saferstein, 2002).

Types of Hair

Hair comes in many types, from very fine, short hair called “vellus hair” to the stiff quills of the porcupine, but the

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most common type is the soft, woolly hair commonly covering most mammals—from dogs to bears (Cooper, 1971). The thick coat of body hair found on mammals is commonly called **fur**. The length and color of fur is a genetically determined, species-specific trait. Nonetheless, the “basic design of mammalian hair is invariant” (Denton, 1986, p. 106). Almost the entire human body is covered with very fine **vellus hair**; only the lips, parts of the genital organs, the nipples, soles of the feet, and palms of the hands are totally free of hair.

Another variance in mammal hair is that it can be straight, curly, or kinky. Straight hair has a round circular shaft, curly hair a flatter, more elliptical shaft, and kinky hair, an even flatter shaft. The flatter the shaft, the more kinky the hair.

Theories of Why Hair Evolved

It commonly is believed that hair evolved to help retain body heat, because hair is an excellent heat insulator (Wong and Simmons, 2001). This conclusion, however, is pure speculation. As one researcher admits, researchers do not even agree on the question whether hair or warm-bloodedness (endothermy) evolved first. Wong and Simmons (2001, p. 1) also admit that the theory that hair evolved as a means of insulation is only:

one of the ideas about why we have hair. Of course, there is no way for us to tell whether hair evolved first and then endothermy evolved, or whether endothermy evolved and then somehow hair evolved. We really don't know anything about these things.

Most Darwinists believe that humans evolved in Africa along with other primates, all of which were almost totally covered with thick fur. As such, a common view is that now the “body hair of men and women is purely vestigial,” a useless evolutionary leftover from when we were ape-like animals (Wells *et. al.*, 1931, p. 415).

The Evidence for the Evolution of Hair

Hair is widely believed by Darwinists to have evolved from scales, yet “no structures are known which can be considered in any sense transitional between hair and any other vertebrate dermal structure” (Denton, 1986, p. 106). Some mammals, such as the Order Pholidota, have both horny scales and fully developed hair (which grows between their scales), but no animal has less than fully developed hair; none has structures that are morphologically in-between hair and scales or even hair that is not fully developed.

Scientists have not been able to determine when hair evolved. We only know that it existed very early in the fossil record as fully developed, completely modern hair. Studies of mammal hair have found no evidence of hair evolution; ancient hair is found to be identical to modern hair in all respects.

Hair is one of the better-preserved parts of the body and, in some situations, is even better preserved than bones. Its resistance to chemical composition is due partly to the keratinized cuticle covering the hair, and is one reason why hair is of such importance in forensics (Saferstein, 2001). The structural features of hair can remain intact for thousands of years, and for this reason, hair is a critically important tool in the study of early humans and human evolution. Mammalian hair has even been found perfectly preserved in amber, with some of the best examples coming from Baltic and Dominican amber (Lewis and Grimaldi, 1997; Poinar and Columbus, 1992; Poinar, 1988). The preservation is so good that the order, family, or even genus can be identified (Poinar and Poinar, 1999). Often, only a few strands are found in amber, but complete tufts or clusters have been preserved. Hair is also well preserved in tar pits and ice, as well as fossil impressions.

Also, the hair of different mammals is often distinctly different, and no evidence exists that the hair from “more advanced” mammals is more evolved than that of “less advanced” mammals (such as rodents). They are just simply different. Furthermore, insects also have hair-like structures that are very different from mammal hair, yet are also somewhat similar. Since no one claims that humans evolved from insects, the only current neo-Darwinian explanation is convergent evolution—hair evolved separately several times in history.

One problem with this explanation is that even more evidence is required to demonstrate the evolution of these different types of hair-like structures. In contrast to many structures (such as the eye, which Darwinists teach evolved independently as many as 34 times), scientists believe that mammal hair evolved only *once* and never reversed, i.e. is not the product of devolution from feathers or another structure. Researchers do not even have evidence for the phylogenetic origin of hair. Kardong (2002, p. 221) concluded that:

The phylogenetic origin of hair remains speculative. One view holds that hair arose initially as surface insulation, retaining body heat in primitive mammalian endotherms. An alternative view is that hair evolved first as tiny projecting rods in the hinges between scales and served as tactile devices. The “protohairs” could help monitor surface sensory data when an animal was hiding from an enemy or re-

treating from the weather. If such a role increased in importance, it would have favored longer shafts and perhaps the evolution of structures resembling vibrissae. This sensory protohair might then have evolved secondarily into an insulative pelage as mammals become endothermic. Although insulative in modern mammals, hair still retains a sensory function.

Kardong (2002) adds that the fossil record does not even give a hint of hair evolution. The evidence claimed by some, such as the tiny pits on the ancestors of mammals, does not provide support for hair evolution:

Some therapsids, ancestors to mammals, have tiny pits in the facial region of their skulls. These pits resemble pits on skulls associated with sensory vibrissae in modern mammals. Some have interpreted these pits as indirect evidence of hair in therapsids. ...But the skulls of some modern lizards with scales have similar pits and, of course, lizards have no hair. Thus, such pits are not conclusive evidence of the presence of hair. Further, one especially well-preserved skin impression of *Estemmenosuchus*, a therapsid from the Upper Permian, shows no evidence of hair. The epidermis was smooth, without scales, and undifferentiated, although it was supplied with glands ... Thus, we still do not know when hair first arose in primitive mammals or in their therapsid ancestors (Kardong, 2002, p. 221).

Loss of Hair in Human Evolution

Darwinists claim that mammals evolved hair primarily as a result of sexual selection and also for protection and heat insulation (Darwin, 1871). Of the approximately 3,000 living mammals, only a few lack fur, such as pigs, whales, elephants, humans, mole rats and walruses. With the exception of humans, the absence of fur is consistent with the animal's natural environment—walruses and whales are aquatic, wild pigs are fairly hairy, and mole rats are ground burrowers. Darwin was very emphatic about the importance of sexual selection in primate evolution, and tried to explain human nakedness by selection (Darwin, 1871). Others have attempted to continue this line of reasoning, suggesting that as prehumans continued to evolve into humans, the species lost most of their hair due to sexual selection (Schwartz and Rosenblum, 1981).

Cooper (1971) notes the somewhat contradictory argument where Darwin taught that at one time sexual selection selected *for hair* in prehumans, and later, sexual selection selected *for hairlessness*. It would seem more logical

that selection would select for human brains that found hairiness sexually attractive—after all, allegedly, *all* prehumans were once hairy. Those prehumans that saw hair in potential mates as erotic would be more likely to mate, and as a result, they would be more likely to have offspring to pass this trait on. Consequently, humans would continue to maintain a positive affinity for hairiness in mates.

Actually, prehumans must have had a positive affinity for *hairiness* in mates. Otherwise, how did they successfully mate for thousands of generations as primates? Remember, all primates except humans are almost totally covered with thick, furry hair, and those with less hair would be regarded as freaks. They would also be less socially connected due to the importance of mutual grooming (removing ticks and other insects). Wong and Simmons (2001) admit the reason why humans today have lost most of their fur-type body hair is not known. They add:

There's a lot of variation in how much of the body is covered with fur in various primate groups. Some are incredibly hairy, and some have considerably less fur on the face and the chest and so on. Primates tend to rely on facial expressions for social communication, and of course the better you can see the face, perhaps the better that social communication works. That doesn't mean you have to get rid of the hair to see the face. That just happens to be what happened in apes. But that could be one of the reasons why we don't have hair on our faces (Wong and Simmons, 2001, p. 1).

Morris (1986) considers reasons for human hair loss in evolution at length, but was unable to produce a plausible explanation. The latest theory is that humans lost their hair to reduce their vulnerability to fur-loving parasites (Bhattacharya, 2003). Actually, hair protects against many types of insects, such as mosquitoes and biting flies. It also protects against sunburn and skin cancer. In addition, humans have enough hair on their heads and pubic areas that lice and ticks can still pose a problem.

Darwinists also admit they have no idea why humans did not lose *all* their body hair, including that on the head, pubic, and auxiliary hair (Cooper, 1971). If humans selected for hairlessness, why do humans today still have considerable body hair? Why would males or females select certain traits in a male when they had been successfully mating with hair-covered mates for eons, and no non-human primate preferred these "human" traits. If sexual selection caused the development of the male beard (and its lack in females), why do women often prefer clean shaven males? Obviously, cultural norms are critical in determining what is considered sexually attractive, and these stan-

dards change, precluding the long term sexual selection required to biologically evolve them. Desmond Morris addressed this question in his best selling book, *The Naked Ape* (Morris, 1986). Morris points out that all primates (including all 192 species of monkeys) are covered with hair, the only exception being humans. Actually, humans have more hair than a chimpanzee; the difference is that most human hair consists of the almost invisible, fine hair.

The fact that the animal morphology most like that of humans, the great apes, are all covered with thick hair and most aquatic mammals are hairless is important evidence for the aquatic ape theory supported by Sir Alister Hardy, Daniel Dennett, and Elaine Morgan, among others (Ingram, 2000; Morgan 1997; 1982). This theory argues that so many aspects of human anatomy resemble, not the great apes, but aquatic mammals, thus the idea that we once lived in the water, like dolphins, is considered a reasonable interpretation (Morgan, 1982; 1997). Needless to say, this theory does not fit much of the data and has never been widely accepted among paleontologists. Also, this theory illustrates the difficulty evolutionists face in explaining the loss of fur if the human evolutionary ancestor resembled the great apes.

For most people, especially young adults, their head hair is one of their most important physical features—so much so that both males and females in all cultures carefully style it, trim it, dye it, and spend billions of dollars and numerous hours caring for it. Its importance is so great that hair color alone is synonymous with attractiveness, as evident in the expression “gentlemen prefer blonds.” Humans have, on average, 100,000 scalp hairs, the loss of which can cause significant social and psychological problems. Hair can also lose its volume as one ages; it can, for example, thin from 100 micrometers to 50 or fewer micrometers. Treatment of hair loss, a common problem in males, or loss of hair pigment (which results in gray and eventually white hair) are multi-billion-dollar industries.

Conclusions

Hair appears in the fossil record as a complex, fully functional structure, without antecedent evolutionary stages. The reason for the putative problem of human hair loss in evolution is unknown, and the reasons proposed are contradictory. Studies of 23 anthropoid primate taxa have found that the larger (and usually more human-like) the primates, the fewer hairs per equal unit of body surface (Schwartz and Rosenblum, 1981).

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The Evolutionary Basis of Eddington's Solar Modelling

Jonathan F. Henry*

Abstract

In the early 1900s Arthur S. Eddington established the current theoretical basis for the operation of the sun and other stars. Generally, Eddington asserted that main sequence stars generate energy under a condition of hydrostatic equilibrium without contraction. Eddington is one of the more significant solar theorists of the last hundred years. His assumptions are firmly fixed in modern models such that they are often believed to be beyond reasonable doubt, virtually on a par with basic laws of physics. Further, his Quaker background is sometimes emphasized in a man-

ner which obscures the evolutionary presuppositions which he acknowledged as the basis of his theorizing. Scientifically, Eddington is better described not in terms of his Quaker background but as a convinced evolutionist. Evolutionary bias rather than scientific objectivity has been the driving force in stellar modelling since Eddington. Whether conventional solar fusion has been disproved or alternative solar energy sources have been confirmed is not addressed.

Introduction

The concept of nuclear reactions in the sun was developed long before the discovery of fusion, due to the evolutionary need to power the sun for an extremely long time. Even before the proposal of nuclear reactions in the sun, there was a conflict between the long evolutionary age of the earth and the relatively short age for the sun implied by previous solar models. Solar models based on nuclear reactions were seen as a way of resolving this conflict. This historical reality does not in itself invalidate the concept of solar fusion. Further, the common belief that solar fusion has powered the sun for billions of years does not mean that it could not have been doing so for a shorter period.

The conventional solar fusion model (the "standard solar model," or SSM) supposes that, "Nuclear fusion at the centers of stars [like the sun] produces all the energy that emerges from the stars' surfaces" (Goldsmith, 1985, p. 243). Actually there are many SSM's, but they all share the same basic assumptions: (1) that a main sequence star such as the sun is in hydrostatic equilibrium; (2) that the star derives its energy from nuclear fusion reactions; (3) that the star is in thermal equilibrium; (4) that the stellar material is described by an equation of state for gases (Abell et al., 1987, pp. 506–509; Bahcall, 1989, pp. 6–7; Bahcall, 1997, p. 1; Davis, 1994, p. 24; Harwit, 1982, pp. 306–343).

Regarding point (1), Bahcall (1989, p. 46) calls hydrostatic equilibrium the "first condition" for stellar evolution models. Each of these assumptions is due directly or indirectly to Eddington.

Eddington's Theorizing Is a Foundation of Modern Astronomy

Eddington provided the basis for much of the conventional theorizing about solar and stellar operation (Eddington, 1926, p. vi; Hartmann, 1991, p. 372; Abell et al., 1987, p. 492). Eddington's theorizing led to Bethe's prediction of fusion in the sun (Bahcall et al., 2002, p. 1), followed by Fowler's modelling of solar/stellar nucleosynthesis (Salpeter, 1999, p. S220), culminating in the famous "B²FH" paper authored by Burbidge, Burbidge, Fowler, and Hoyle (Burbidge and Hoyle, 1998, p. L1). This paper remains the reference point for nucleosynthesis theory (Wallerstein, 1997, pp. 997–998). Eddington was therefore only one contributor in a lineage of developments in modern solar/stellar evolution theory, though, as history reveals, he was quite an important contributor.

It is possible that if Eddington had never lived, eventually someone else or several others would have devised the same general approach toward solar energy as did Eddington. At any rate, as will be shown below, by Eddington's lifetime Western culture had been "evolutionized" and therefore was ready to receive further evolutionary theorizing by Eddington or others. It will also be shown that notable Christian personalities of Eddington's time had ac-

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cepted evolution, thus illustrating the high level of acceptance of evolution a century ago. Nevertheless, none of what might have been diminishes the significance of what Eddington actually accomplished.

A wide consensus, ultimately based on Eddington's work, has established an evolutionary lifetime for the sun of some 10 billion years, with the sun described as a "middle aged" star having some 5 billion years remaining. There are many parameters in any SSM which can be adjusted to make the sun appear to have a 10 billion year lifetime, while simultaneously attempting to account for observed properties such as luminosity and surface temperature. These parameters include core temperature, the reactions assumed to occur and their dominance, and reaction rates. The difference among SSM's lies largely in the choice of parameters, a situation so flexible that neutrino researcher Raymond Davis (1994, p. 30) has observed "there are many ad hoc elements in the standard model calculations."

Not all of the reactions supposed to be happening in the sun have been observed in the laboratory, nor have their rates and effects been actually measured under solar conditions. Instead, these data are the result of "model calculations" (Wallerstein et al., 1997, p. 1001). At best, conditions for solar reactions are extrapolations from laboratory data (Bahcall, 1989, p. 60; Bahcall et al., 1995, p. 783; Guenther and Demarque, 1996, p. 5). Indeed, one of the most basic reaction rates, that for the p - p reaction, "is not measurable in the laboratory" (Brun et al., 1998, p. 921). This means that if one cites solar reaction data as virtually certain, there is a misplaced confidence, for the truth is that the reaction parameters have been adjusted so as to make the imaginary 10 billion year life for the sun appear real (Harwit, 1982, pp. 329–332). Any claims that the sun could "evolve" if given enough time are questionable at best, since the possibility of such evolution is derived from reaction parameters adjusted to correspond to the solar core conditions deemed necessary to give a long lifetime. This is circular reasoning. The probability of solar evolution given enough time would appear to be as elusive as the long time scale itself.

Further, there are no generally accepted data (i.e., observations) for internal solar composition, such as core abundance of He. Such figures are model-based. Bahcall writes of "the unknown composition of the deep [solar] interior, where neutrinos are generated" (Bahcall, 1990, p. 56). Christensen-Dalsgaard and Gough (1980, p. 544) write of modelling element abundances in the sun by a "theoretical study" of solar oscillations.

Despite these uncertainties, the SSM is routinely extrapolated to describe how other stars work. Neutrino scientist John Bahcall (1990, p. 56) states,

The greatest achievement of the solar model is so overwhelming that it is usually overlooked: astronomers use the theory routinely in interpreting observations of the physical and chemical compositions of stars in all sorts of environments, from the solar neighborhood to distant galaxies, without obvious inconsistencies. Any modifications of the solar model, therefore, would have profound implications for astronomy.

Van der Raay (1980, p. 536) concludes: "Clearly if we do not understand our own closest star, the implications on the whole field of cosmology are enormous."

While it is not the purpose of this paper to critique conventional solar/stellar models as such, it is obvious that with modern cosmology riding on solar modelling, which in turn is parametrically adjusted to buttress the evolutionary chronology, there is the definite possibility that defense of the SSM is done for reasons that are chronological as well as data-based. As we will see, the concerns motivating Eddington long ago continue to be reflected in the modern defense of the SSM.

Solar Models Are Built around the Evolutionary Age of the Earth

Ultimately, the only evolutionary reason for believing the sun is old is that the earth is supposed to be old. Thus, the evolutionary belief in an old sun is an extension of the "old earth" doctrine of nineteenth century geological evolution popularized by Charles Lyell. It is a commonplace to claim that the first and only reason for thinking the sun is old is that,

Geologists have found rocks 3.5 billion years old that contain fossils of marine organisms. These discoveries clearly demonstrate that the Sun has warmed the Earth for at least 3.5 billion years and probably for as long as the Earth has existed (Fix, 1999, p. 387).

In the same vein, astrophysicist Martin Harwit (1982, p. 307) claims,

The sun must be older than the earth which, as judged from the abundance of the radioactive uranium isotope U^{238} and its decay products, is more than four aeons [billions of years] old. The sun is thought to be of the order of 4.5 ae old.

Similar statements abound (Abell et al., 1987, p. 516; Pasachoff, 1985, p. 154; Snow, 1984, pp. 196–197). John Bahcall (1989, p. 56) repeats this same argument:

The Sun has been shining for several billion years. Evidence to support this proposition comes from different fields of science [but Bahcall presents only

one such ‘evidence,’ as follows]. For example, fossils of primitive organisms have been found on Earth that are more than a billion years old. In addition, the oldest rocks ... are of order 3.8 billion years old.

Bahcall (1989, p. 56) concludes that the solar system must be older than this, so “the Sun began to shine ... several billion years ago.” The sun’s age is sometimes said to be based on the presumed age of the oldest meteorites. Bahcall et al. (1995, p. 784) claim that, “The solar age is relatively well determined from meteoritic measurements.” However, since conventional meteorite ages are correlated with the alleged age of the oldest ocean sediments on earth (Patterson, 1956, p. 230; Allegre et al., 1995, p. 1445), meteorite ages are actually proxies for the earth’s age. Indeed, Brun et al. (1998, p. 918) note that, “The present age [of the sun] is deduced from a study of the age of the earth and solar system formation,” with the time of solar system formation being fixed by the presumed age of the oldest meteorites (Bahcall et al., 1995, p. 805), which in turn is based on the supposed age of the earth. Thus the age of the sun, and the resulting commitment to the SSM, are based ultimately on evolutionary beliefs concerning the age of the earth.

This fact was recognized a number of years ago by solar astronomer John Eddy, himself an evolutionist, who observed (Kazmann, 1978, p. 18),

There is no evidence based solely on solar observations that the sun is $4.5\text{--}5 \times 10^9$ years old. ... I suspect that we could live with Bishop Ussher’s value for the age of the earth and the sun. I don’t think we have much in the way of observational evidence in astronomy to conflict with that.

Rather than the SSM providing an indication that the sun could function for billions of years, the SSM, and all cosmology by extension, derive their chronology from the evolutionary age of the earth.

Eddington Was Born in a Time of Origins Paradigm Shift

By the mid 1800s, some 300 years had passed since the Reformation, and the physical sciences had developed sufficiently to devise a scientific model of the sun’s energy generation. This was the gravitational contraction model, the idea that the potential energy of the sun’s in-falling gases is converted into heat and light as the sun slowly shrinks. Also known as gravitational collapse or the “shrinking sun” theory, this process would occur at a rate too small to be detectable over intervals less than many decades. This theory was first announced during a public lecture by Hermann von Helmholtz in 1854 and published in 1856

(Moulton, 1902, p. 62; Birchfield, 1990, p. 54).

Helmholtz was not a creationist. Neither was he seeking to show that the sun is young. He assumed an evolutionary model for solar formation that is still in vogue today, that the sun began forming by the gravitational contraction of a nebula. Helmholtz concluded that about 20 million years would be needed for the sun to form this way. Almost from the beginning, there was tension between the evolutionary age of the sun implied by gravitational collapse, and the time claimed for terrestrial evolution. Even in the mid to late 1800s, the earth and its life were thought to be hundreds of millions of years old. Accordingly, investigators sought to make increasingly accurate computations of the sun’s age assuming it evolved by gravitational contraction.

George Howard Darwin, son of Charles Darwin, published a study on this topic in 1888 (Moulton, 1902, p. 62). It became increasingly clear that gravitational contraction alone could not provide the age for the sun demanded by geological and biological evolution. This dilemma was part of a larger process in which evolutionists were completing the paradigm shift away from creation toward evolution that had begun with Charles Lyell and Charles Darwin. By the late 1800s, evolutionists were trying to bring chronologies from all scientific disciplines into agreement with the terrestrial chronology devised from Lyell’s uniformitarian principles. It was into this context that Eddington was born in 1882.

Defying the evolutionary chronology for the earth, William Thompson, Lord Kelvin, championed the concept of gravitational contraction, believing it provided a more accurate evolutionary age for the solar system than the geologists and biologists were willing to admit. Kelvin was a Christian, but not a biblical creationist. Today he would probably be described as a theistic evolutionist, and he did not have any particular difficulty with an old age for the creation. However, the physical sciences indicated that the earth and the sun could not be as old as was typically demanded, and these were the sciences he trusted (Birchfield, 1990, pp. 29–32). Kelvin’s first major paper about solar energy generation was published in 1862 (Birchfield, 1990, pp. 54, 241). Since Helmholtz’ original estimate of the sun’s evolutionary lifetime was about 20 million yr, any time for stellar change on the order of 10^7 yr became known as Kelvin-Helmholtz (or Helmholtz-Kelvin) time.

A consensus eventually arose that gravitational collapse *on chronological grounds* could not explain all the sun’s luminosity. Astronomer Charles Young (1890, p. 154) stated,

If the sun’s heat has been and is still *wholly* due to the contraction of its mass, it cannot have been ra-

diating heat at the present rate, on the shrinkage hypothesis, for more than 18,000,000 years; and on that hypothesis the solar system in anything like its present condition cannot be much more than as old as that [emphasis in original].

However, Young recognized the evolutionary need for more time, and appended a footnote: “But notice the ‘if.’ It is quite conceivable that the solar system may have received in the past other supplies of heat than that due to the contraction of mass. If so, it may be much older.”

It eventually became unfashionable to discuss the age of the sun implied by the Helmholtz theory. Moulton’s classic text (1902, pp. 57–61) presents gravitational contraction as the mode of the sun’s energy generation, but makes no mention of the possible age of the sun. The age constraint implied by contraction was carefully avoided as theorists cast about for ways to make the sun older. Helmholtz contraction therefore acquired a stigma which has remained to this day. Eddington (1926, p. 295) noted that “the contraction hypothesis was already becoming obsolete” at this time, that “Lord Kelvin’s date of the creation of the sun [was] treated with no more respect than Archbishop Ussher’s” (Eddington, 1920), and that the sun’s 20 million yr life time disagreed with “geological, physical, and biological evidence” (Eddington, 1959, p. 162).

Contradicting these statements, neutrino scientist and anti-creationist Sverker Johansson, writing of the attitude which existed toward gravitational contraction in the early 1900s, has claimed that solar fusion was *not* proposed to give the sun a longer lifetime compatible with terrestrial evolution: “The quest for a new energy source for the sun did *not*, as is commonly believed, stem primarily from a desire to provide sufficient time for biological evolution [emphasis in original]” (Johansson, 1999, p. 3). Johansson then claims that all arguments against gravitational contraction were based on science alone: “The gravitational contraction theory ... was abandoned in the early part of the 20th century, for good scientific reasons that had nothing to do with creationism” (Johansson, 1999, p. 18).

On the other hand, Johansson admits that the Helmholtz contraction time scale “was troublesome to many; it was ... too short for geologists and biologists, who could see that the earth and its fauna had a far longer history. ... Fusion is the only known source of energy that can keep the sun going for billions of years” (Johansson, 1999, p. 3). Thus the claim that solar contraction was rejected for scientific reasons is not true. Even before fusion was accepted as a solar energy source, Eddington emphasized that because of the “demand for an extended time-scale” for the sun, “allowance had to be made for the source [of the sun’s energy] being probably subatomic” (Eddington,

1926, p. 295).

The first person to propose a nuclear source of the sun’s heat was George Darwin (Darwin, 1903, p. 496). He “suggested that radioactivity, such as produced by radium, might be the source of the sun’s heat, and within a week the idea was supported by others who could see this as an explanation for the greater age required by Darwinism” (Taylor, 1987, p. 496). Thus the first proposal of nuclear reactions in the sun was made for reasons of extending the solar chronology, not scientific ones. While the concept of solar nuclear reactions is not inherently evolutionary, the advocacy of this concept has a consistent history of evolutionary activism. But Darwin’s idea of fission reactions (as opposed to fusion) powering the sun was soon given up, since it was apparent that even fission could not maintain the sun’s luminosity for the required time. Nonetheless, contraction was now firmly rejected despite the absence of any known subatomic solar energy source. This rejection occurred long before fusion reactions were proposed, demonstrating that contraction was not abandoned because of compelling evidence that modern solar theory is accurate, but because of the evolutionary need for a longer chronology.

Eddington Reflected the Evolutionary and Religious Views of His Time

Eddington has been described as “a deeply religious man” (Clausen, 1997) with “strongly held Quaker beliefs” (Encyclopedia Britannica, 2000), a characterization which could lead one to conclude that Eddington’s solar theorizing arose from a backdrop of Christian thought, and therefore should be acceptable to biblical creationists. Such a characterization is simplistic, and overlooks the fact that Eddington was first and foremost a thoroughgoing evolutionist whose beliefs on biblical doctrine were not always orthodox. Significantly, Eddington is not listed as a Bible-believing scientist by either Morris (1982) or Barnes (1993).

By Eddington’s lifetime, evolutionary ideas had swamped Western culture as if there had never been a widespread belief in creation only a few decades before. In 1894 when Eddington was eleven, it was possible to state accurately that,

We cannot escape from [evolution]. Its technical phrases have become parts of current common speech. ... It does not matter to what sphere of human work we turn, for in all alike we meet with the same mental atmosphere. Are we students of physics or chemistry, we have no sooner mastered the elements of the science than we are plunged into questions which deal with the ‘evolution’ of the

‘atom’ or ‘molecule’ from simpler forms of matter (Iverach, 1894, p. 1).

Since Eddington was schooled in this atmosphere, it is hardly a wonder that he became a convinced evolutionist.

Well known evangelists were also espousing evolutionary beliefs at this time, so completely had evolutionism captured the mind of the Church. Evangelist R.A. Torrey rejected Genesis chapter 1 as a literal creation account, denied that the creation occurred over six ordinary days, and insisted that the evolutionary chronology must be accurate (Torrey, 1907, pp. 19, 29–31, 33–34). Numerous fundamentalists of the time also pressed evolutionary thinking upon the Church. R.A. Torrey in fact led the committee which edited the famous series of twelve volumes setting forth the beliefs which came to be known as fundamentalism (Feinberg, 1990, p. 9). With Torrey in charge, perhaps it is not surprising that though all the contributors to *The Fundamentals* gave lip service to biblical inerrancy, some mildly and others aggressively espoused evolutionary thought and chronology (Feinberg, 1990, pp. 81, 107, 133–134).

Not only the Church but imminent scientists were aggressively urging public acceptance of evolution. Nobel Laureate Robert A. Millikan, who is known today for his “oil drop” method of determining electron charge, sought to integrate his science with Christian faith. However, he supported the secular evolutionary community in questions touching on origins. Millikan claimed that “science” (i.e., evolution) and “religion” were mutually exclusive concepts, that John Wesley had supported evolution before it was fashionable, that Christianity and the Bible were products of the evolution of religion, and that “one of the greatest contributions of science” was the discovery of the “evolutionary process” (Millikan, 1924, pp. 40–41, 48–49, 54–55, 70). He also described those who resisted the entrance of evolutionism into education as “a menace to democracy and civilization” (Millikan, 1924, p. 76), referred to William Jennings Bryan of Scopes trial fame as a “pure dogmatist,” opined that a clear victory for creationists at the Scopes trial would have been “the worst set-back to civilization in all history,” and ridiculed fundamentalists as having minds that are “closed” and “irrational” (Millikan, 1927, pp. 60, 63, 87). Not surprisingly, he asserted that all the universe was “progressing” through evolution, and that the earth was at least a billion years old (Millikan, 1927, pp. 41, 80).

The ideas of Millikan and Eddington had much in common, not only generally but specifically. Millikan rejoiced with evolutionary astronomers that, because of Eddington’s solar modelling, they had been able “to escape their otherwise insuperable [chronological] difficulties encountered

because of the sun” (Millikan, 1927, p. 17). Eddington stated that “time” and “nature” were responsible for the upward development of the universe, concluding that “I cannot profess to say whether anything more than this prolific structure-building power of carbon” caused the “beginning” of life (Eddington, 1930, pp. 11, 17, 20). To him, invoking God as Creator is an “attitude [which] is liable to grate a little on the scientific mind,” and claimed that most astronomers, “when they are reminded of the psalm ‘The heavens declare the glory of God,’” might “confess to some chafing” because “it is so often rubbed into us” (Eddington, 1930, pp. 23–25).

Interestingly, Eddington justified his “free spirit of inquiry” by an appeal to an inner “voice” or “light” as a rationale for departing from biblical teaching on origins (Eddington, 1930, pp. 24, 26, 41). Such an emphasis on “experience,” an “inward Light [sic]” or an “inward way” has been a hallmark of Quakerism in reaction to dead orthodoxy starting with its founder George Fox (Jones, 1924, pp. 11, 13, 22). Unlike George Fox, however, Eddington had a low view of biblical revelation, saying, “I confine myself to the revelation implied in the indwelling of the divine spirit in the mind of man,” identifying this spirit as “the self-knowledge of mind” rather than the Holy Spirit (Eddington, 1930, pp. 72, 74). Eddington realized that this position made it possible for him to accept evolutionary doctrine, for he wrote, “Quakerism in dispensing with all creeds holds out a hand to the scientist [i.e., evolutionist]” (Eddington, 1930, p. 89). Thus for Eddington his Quaker background was a vehicle for moving away from orthodoxy.

Indeed, he considered the existence of God “irrelevant to the assurance for which we hunger,” claimed that the spiritual world arises “from our own personality,” and emphasized “seeking” over religious certainty (Eddington, 1930, pp. 68–70, 82, 88). One hopes that Eddington eventually found “the kind of security we should seek in our relationship with God” (Eddington, 1930, p. 70). On the other hand, his Quakerism produced a certain humility rare among eminent scientists, and Eddington, though driven by his evolutionary beliefs, readily admitted which of his theories he considered to be “speculation” (Eddington, 1920). The combination of his lack of arrogance with his skillful articulation of complex concepts makes Eddington’s writings quite accessible, a factor which no doubt aided the acceptance of his stellar theories.

Eddington Defended Evolutionary Chronology by Opposing Contraction

Probably no one was more influential than Eddington in stigmatizing the gravitational contraction theory. As astrono-

mer Lloyd Motz said in an introduction to Eddington's influential *The Internal Constitution of the Stars* (Eddington, 1926, p. vi): "It is to Eddington more than to any other one man that we owe the very rapid development of astrophysics" in modern times. Hartmann (1991, p. 372) opines, "Eddington showed why stars are the way they are," and Hartmann cites Eddington frequently as the starting point for understanding stellar evolution (Hartmann, 1991, pp. 371–378). Abell et al. (1987, p. 492) have similarly summarized Eddington's significance: "Eddington is best known among astronomers for his development of theoretical methods for investigating the internal structure of the sun and stars." Yet as we will see, Eddington never disproved the existence of solar contraction in the sun. He simply rejected it because of the conflict with evolutionary chronology. Eddington (1929, p. 94) was explicit about the long-standing evolutionary animus towards solar contraction:

In the last century it was shown by Helmholtz and Kelvin that the sun could maintain its heat for a very long time by continually shrinking. ... It was assumed that this was the sole resource since no other supply capable of yielding anything like so large an amount was known. But the supply is not unlimited, and on this hypothesis the birth of the sun must be dated not more than 20,000,000 years ago. Even at the time [around 1900] of which I am speaking the time-limit was found to be cramping; but Kelvin assured the geologists and biologists that they must confine their outlines of terrestrial history within this period.

Eddington (1929, p. 94) continues:

About the beginning of the present century the contraction theory was in the curious position of being generally accepted and generally ignored. Whilst few ventured to dispute the hypothesis, no one seems to have had any hesitation, if it suited him, in carrying back the history of the earth or moon to a time long before the supposed era of the formation of the solar system. Lord Kelvin's date of the creation was treated with no more respect than Archbishop Ussher's.

As previously mentioned, anti-creationist Johansson (1999, p. 18) claims that Eddington disproved gravitational contraction on scientific grounds alone:

Eddington ... showed that the only reasonable conclusion is that stars start out contracting (and shining from gravitational energy), but that they then reach equilibrium along what is now known as the 'main sequence.' Gravitational energy cannot account for that equilibrium; a new energy source is needed. ... But even if we didn't know anything about

nuclear fusion (or if fusion for some reason didn't work in the sun), Eddington's (1920; 1924) refutation of the gravitational-contraction theory would still remain solid.

This is not true. In fact, Eddington's "scientific proof" that main sequence stars are not contracting was based on the same criterion we have already examined—the belief that the earth must be billions of years old, and that therefore the sun cannot be younger than this. Eddington was quite explicit on this point. In the next several paragraphs, Johansson's claims are interwoven with Eddington's statements, first quoting Eddington to show his true motive for rejecting the possibility of gravitational collapse in main sequence stars:

The serious consequences of the [contraction] hypothesis become particularly prominent when we consider the diffuse stars of high luminosity; these are prodigal of their energy and squander it a hundred or a thousand times faster than the sun. The economical sun could have subsisted on its contraction energy for 20,000,000 years, but for the high luminosity stars the limit is cut down to 100,000 years. This includes most of the naked-eye stars (Eddington, 1929, pp. 94–95).

Of course, Eddington has here summarized an excellent argument for a young cosmos, assuming that stars generally derive energy by contraction. But he goes on to say, "Dare we believe that [stars] were formed within the last 100,000 years?" (Eddington, 1929, p. 95). Thus he negates the possibility of a young cosmos—and hence contraction—due to a contrary belief about chronology.

Johansson also claims that Eddington made a successful "argument against gravitational contraction, from the frequency stability of variable stars. . ." (Johansson, 1999, p. 19). But Eddington himself reveals his actual motivation for the variable star argument against contraction, and the argument is ultimately not scientific but chronological. Eddington begins by noting that Cepheid variables, if contracting, should show a change in period:

Does the period show any change? It is doubtful; there is perhaps sufficient evidence for a slight change, but it is not more than 1/200th of the change demanded by the contraction hypothesis. Accepting the pulsation theory, the period should diminish 17 seconds every year—a quantity easily detectable. The actual change is not more than one-tenth of a second per year (Eddington, 1929, pp. 95–96).

At first glance this would appear to be a successful argument against stellar contraction, at least in variable stars. However, there is the possibility of fusion and contraction simultaneously occurring, as Eddington acknowledged: "At

least during the Cepheid phase the stars are drawing on some source of energy other than that provided by contraction” (Eddington, 1929, p. 96). Thus, Eddington admitted that the evidence from Cepheids is not conclusive against contraction, contrary to Johansson’s claim. But then Eddington made what can only be considered a staggering statement (though it should not truly surprise us at this point). After marshalling the supposed evidence from the Cepheids against contraction, he concluded with what he believed to be the strongest evidence against contraction:

On such an important question we should not like to put implicit trust in one argument alone, and we turn to the sister sciences for other and perhaps more conclusive evidence. Physical and geological investigations seem to decide definitely that the age of the earth—reckoned from an epoch which by no means goes back to its beginnings as a planet—is far greater than the Kelvin-Helmholtz age of the solar system. It is usual to lay most stress on a determination of the age of the rocks from the uranium-lead ratio of their contents. ...By measuring how much lead occurs with the uranium we can determine how long ago the uranium was deposited. The age of the older rocks is found to be about 1,200 million years; lower estimates have been urged by some authorities, but none low enough to save the contraction hypothesis. The sun, of course, must be very much older than the earth and its rocks (Eddington, 1929, p. 96).

One might think that in his technical opus, *The Internal Constitution of the Stars*, Eddington might have adduced more persuasive theoretical reasons for disallowing contraction, but not so. There we read:

The energy obtainable from contraction is quite inadequate in view of the great age now attributed to the sun. ...Biological, geological, physical and astronomical arguments all lead to the conclusion ... that the time-scale given by the contraction hypothesis must somehow be extended (Eddington, 1926, pp. 289, 290).

In short, the earth is old, so the sun must be old. Eddington here at least alludes to a multiplicity of supposed “biological, geological, physical and astronomical” evidences of great evolutionary age. But in the end, the “best” evidence for great age is only geological. Immediately following the last sentence quoted above, he says, “The most direct evidence [for great age] is given by the date of formation of terrestrial rocks...” (Eddington, 1926, p. 290). Thus we see that there really never has been a scientific argument against contraction, even from Eddington, but only the same argument used today, that the sun cannot be

younger than the evolutionary age of the earth.

Eddington’s Solar Modeling Came from Denying a Young Earth

Contradicting Eddington’s statements about upholding a long chronology in solar modelling, Johansson (1999, p. 4) writes as if chronological questions were not a factor in Eddington’s theorizing:

In the early 20th century it was found that a new energy source was needed on astronomical grounds alone. The internal structure of stars had been worked out by Eddington and others (Eddington 1920), well before the discovery of nuclear fusion, and found to be consistent with astronomical observations only if a new energy source was postulated. ...And the conditions prevailing inside the sun and other stars (calculated by Eddington (1916; 1917) and others long before Bethe’s work) were precisely those in which fusion reactions proceeded at an appropriate rate. Quite coincidentally, it also turned out that the lifetime of a fusion-driven sun is of the same order of magnitude as the age of the earth, solving the geologists’ problem.

This statement has several inaccuracies. As has already been shown, it was no coincidence that the sun’s age worked out by evolutionists was of the same order as the evolutionary age of the earth. Eddington (1929, pp. 96–97) made this point clearly:

The sun, of course, must be very much older than the earth and its rocks. We seem to require a time-scale which will allow at least 10,000,000,000 years for the age of the sun; certainly we cannot abate our demands below 1,000,000,000 years. It is necessary to look for a more prolific source of energy [than contraction] to maintain the heat of the sun and stars through this extended period.

Because of this evolutionary requirement, reaction characteristics and other parameters in the SSM are chosen so as to make the sun appear to be as old as the common wisdom says it is.

Another inaccuracy in Johansson’s statement above is that “the conditions prevailing inside the sun and other stars ... were precisely those in which fusion reactions proceeded at an appropriate rate.” In fact Eddington’s calculation of the sun’s central temperature was 40 million degrees (Eddington, 1929, p. 14), a value so high that even fusion models would predict a far different sun from the real one. Far from predicting conditions suitable for solar fusion, Eddington did not believe that solar fusion was occurring at all. Though aware of the possibility of fusion, he

believed that another process supplied the sun's energy: "On the whole the hypothesis of annihilation of matter seems the more promising [instead of fusion]; and I shall prefer it in the brief discussion of stellar evolution which I propose to give" (Eddington, 1929, p. 94). He was referring to the "annihilation of electrons and protons" (Eddington, 1959, p. 181), and considered the "transmutation" [fusion] of hydrogen to be an "unsatisfactory" hypothesis (Eddington, 1929, p. 102), though later he came to doubt his annihilation scenario.

Finally, it is not true that "the internal structure of stars had been worked out by Eddington and others ... and found to be consistent with astronomical observations only if a new energy source was postulated." The internal structure of stars cannot be observed but only modelled: "Descriptions of what lies beneath the sun's fiery surface have been essentially conjecture..." (Bartusiak, 1990, p. 25). Further, solar scientist John Bahcall reportedly looks forward to "knowing the conditions under which [solar] neutrinos were created" (Normille, 1999, p. 1910). In other words, conditions in the solar core are not yet known, despite expressions of confidence to the contrary, as Eddington himself acknowledged: "In any case the composition of the layers bubbling on the outside of the stellar furnaces cannot be taken as a safe guide to the composition within" (Eddington, 1959, p. 137).

It is not true that Eddington had a scientific foundation for his concepts of stellar structure. Eddington's starting point for deriving new concepts of stellar structure was a denial of contraction. As Eddington (1929, pp. 96–97) wrote:

It is necessary to look for a more prolific source of energy to maintain the heat of the sun and stars through this extended period. We can at once narrow down the field of search. No source of energy is of any avail unless it liberates heat deep in the interior of a star. The crux of the problem is not merely the provision for radiation but the maintenance of the internal heat which keeps the gravitating mass from collapsing. ... But the internal heat is continually running away towards the cooler outside and then escaping into space as the sun's radiation. This, or its equivalent, must be put back if the star is to be kept steady—that it is not to contract and evolve at the rate of the Kelvin time-scale.

As is true in solar modelling today, the first principle in Eddington's concept of stellar structure was the assumption of hydrostatic equilibrium. Not only is hydrostatic equilibrium the first principle to which he appealed in his theoretical development, but he invoked the principle repeatedly (Eddington, 1926, pp. 5, 15, 27, 35, 97). Edding-

ton stated that he invoked hydrostatic equilibrium to avoid the possibility that the sun is evolving "at the rate of the Kelvin time-scale" (Eddington, 1929, p. 97). And the reason to avoid the Kelvin time-scale is the one already given by Eddington himself, to insure that the sun is "very much older than the earth and its rocks" (Eddington, 1929, p. 96).

Following from the assumption of hydrostatic equilibrium is the assumption of extremely high core temperature to insure that the resulting inner pressure will prevent the outer layers from collapsing inward. Eddington (1929, pp. 12–13) explained the connection:

At each point the elasticity of the gas must be just enough to balance the weight of the layers above [i.e., there must be hydrostatic equilibrium]; and since it is the heat which furnishes the elasticity, this requirement settles how much heat the gas must have. And so we must find the degree of heat or temperature at each point. ... Evidently we have to assign a temperature such that the sum total of the blows [of atoms of gas in collision] is neither too great nor too small to keep the upper material steadily supported. That in principle is our method of calculating the temperature.

Following from the assumption of high core temperature is the assumption of high opacity, which is necessary to generate an extremely high thermal gradient which will in turn maintain the assumed core temperature. Again, Eddington (1929, p. 28) explained the connection:

We soon realize that the material of the star must be decidedly opaque. The quantity of radiation in the interior is so great [due to the assumption of extremely high core temperature] that unless it were very severely confined the leakage would be much greater than the amount which we observe coming out of the stars.

Eddington elsewhere makes the same linkage between high core temperature and high opacity (Eddington, 1926, pp. 21, 217). Based on the assumption of high opacity, the description of the staggeringly long time required for electromagnetic radiation to travel from the core to the surface has been told and retold. For example, Fix (1999, p. 390) claims:

Even though photons travel at the speed of light, the diffusion of radiation from the center of the Sun out to the convection zone is very slow. So many absorptions and reemissions occur that about 170,000 years pass before the energy produced at the Sun's center reaches the surface.

Summarizing the situation, Eddington assumed hydrostatic equilibrium as a denial of gravitational collapse, and

the major features of the SSM follow from it. The evolutionary age of the earth is the basis for the presumed age of the sun, and a long chronology for the sun requires that no significant gravitational collapse be occurring over the sun's main sequence lifetime. Preventing gravitational collapse requires hydrostatic equilibrium, which requires high core temperature, which requires high opacity.

Eddington's concept of stellar structure was no more consistent with astronomical observations than Helmholtz contraction, but was devised primarily for reasons of maintaining an evolutionary chronology. Yet Johansson claims: "That the sun cannot still be in the contraction phase was established already in the 1920's, well before the discovery of fusion" (Johansson, 1999, p. 20). It is indeed true that this conclusion was established before the discovery of fusion, but only because the requirements of evolutionary chronology had trumped the possibility of solar contraction.

Johansson's statements are typical of modern claims, and one must go back to Eddington's writings to understand the chronological assumptions which formed the foundation for his theories of stellar operation. Without doing this, it is easy to accept that there must have been a scientific basis for the establishment of stellar evolution theory. As with Eddington's modelling, modern solar modelling begins with the assumption of great age for the sun (Liebacher et al., 1985, p. 48; Brun et al., 1998, p. 922; Bahcall et al., 2001, pp. 992–993). There is circular reasoning here, however, since Eddington first assumed a process which would give the sun a long lifetime, a consequence of which was high internal temperature and pressure, which in turn would give the sun a long lifetime. This assessment holds despite the "elegant" theoretical system devised for fusion reactions in the sun and other stars (Wallerstein et al., 1997, pp. 995–1084), for Eddington's theoretical framework continues to be the basis of modern solar theory: "[Eddington was responsible for enunciating] the principles that control the structure and evolution of stars ... Eddington showed why stars are the way they are" (Harwit, 1991, pp. 71, 72). Thus the biases in Eddington's work influence solar/stellar modelling today.

An overconfidence in the laws of physics as applied in conventional stellar modelling has led to an intellectual arrogance manifested in comments like the following due to Goldsmith (1985, p. 253):

The power of the human mind, seen both in its analytic ability and in its development of superfast calculating machines, has enabled us to penetrate the interiors of stars and to discover the liberation of kinetic energy [by fusion] within them. We have achieved this success despite the fact that we can

see only the *surfaces* of stars [emphasis in original]. This attitude, tantamount to worship of the human mind, is actually a type of religious position, and is the antithesis of the open minded approach required to do productive science.

Eddington's rejection of gravitational contraction caused the contraction concept to be neglected for many decades. The possibility of fusion reactions for the sun was established by Hans Bethe in 1939. It is ironic that, despite the subsequent scientific confirmation of solar fusion, the basic justification for fusion typically continues to be the chronological one, demonstrating that the chronological question remains uppermost in the minds of theorists:

The problem with explaining the Sun's energy output by gravitational contraction isn't that the Sun couldn't shrink fast enough [an interesting admission], but that it couldn't have been doing so for long enough. ... The total amount of energy released would only be enough to keep the sun shining at its present brightness for about 20 million years. ... [This] is about 200 times [too short] ... (Fix, 1999, p. 387).

In other words, the presumed evolutionary chronology for the sun continues to negate the possibility of gravitational collapse:

The sun is very luminous and has been shining for billions of years. The enormous amount of energy that the sun has produced since its formation makes it possible to rule out many energy sources, such as ... gravitational contraction (Fix, 1999, p. 387).

The core argument against contraction, and ultimately the basic argument for the SSM, has consistently been evolution's need for more time.

Is the SSM Confirmed by "Model Convergence"?

The claim has been made that the conventional solar model must be correct because various SSMs converge on a uniform set of predictions for solar properties (Bahcall and Bethe, 1993, p. 1300; Bahcall and Pinsonneault, 1997, p. 4; Bahcall et al., 1997, pp. 173–174; Bahcall et al., 2001, p. 999). To put such a claim into perspective, astronomers have acknowledged that, apart from chronological considerations, contraction could explain the sun's energy output (Fix, 1999, p. 387), and that there are no data disproving a young age for the sun (Kazmann, 1978, p. 18). Further, we have seen that in conventional solar modelling, the primary solar characteristic consulted (other than directly observable properties such as luminosity, surface temperature, and diameter) is the presumed age of the sun

(Liebacher, 1985, p. 48; Brun et al., 1998, p. 922; Bahcall et al., 2001, p. 991). Apparently the sun could be modelled over a wide range of parameters (e.g., all contraction or all fusion; young or old), but conventional modelling is constrained to a narrow range of parameters (Bahcall et al., 1997, p. 173; Bahcall et al., 2001, p. 991) based on similar assumptions consistent with the assumed evolutionary age (Bahcall et al., 1995, p. 786; Bahcall and Ulmer, 1996, pp. 4202–4203; Basu et al., 2000, pp. 1084, 1099; Bahcall et al., 2001, 998). Indeed, models using parameters within the acceptable range are termed “variant models,” but models with parameters outside this range are said to be “deviant” (Bahcall et al., 2001, pp. 999–1000).

It is not generally recognized how flexible the parameters in solar models really are. One of the dominant reactions thought to occur in the sun is the fusion of hydrogen atoms to produce deuterium, a reaction believed to produce many of the sun’s neutrinos. This process is thought to be followed by additional reactions to produce helium and additional neutrinos. A reaction sequence called the CNO bi-cycle is thought to be a minor contributor to this process in the sun, producing some 1.5% of the sun’s luminosity. However, Bahcall et al. (2002, p. 1) have shown that with appropriate selection of parameters, the CNO bicycle could explain 99.95% of the sun’s luminosity. Further, the sun’s neutrino flux is also explained by this approach. Indeed, this result was generated to illustrate the difficulty of parameter selection given the possibility of neutrino oscillations en route from the sun to earth (Bahcall, 1997, p. 11). The reason that such a solar model is not considered acceptable is that the reactions of the CNO bi-cycle are thought to have significant rates only at temperatures hotter than those assumed for the sun’s core (Groombridge et al., 2002, p. 055802-1), and with a higher temperature, the sun’s lifetime would be shorter than that required by the conventional chronology, i.e., the conventional age of the earth.

The CNO bi-cycle itself has an interesting history in the development of the modern SSM. Eddington had no concept of fusion occurring in the sun, and therefore no scenario for solar nucleosynthesis. His model concepts were developed apart from preconceptions about solar nucleosynthesis. It is well known that Hans Bethe in 1939 made a proposal of nucleosynthesis by solar fusion as mentioned earlier. Less well known is the fact that Bethe believed the CNO bi-cycle was the main source of the sun’s energy (Bahcall et al., 2002, p. 1). On the other hand, in the 1940s George Gamow and others began developing what has become the modern Big Bang theory. The early belief of Gamow and colleagues was that the primordial fireball was responsible for nucleosynthesis of most elements. The du-

bious nature of this claim became rapidly apparent to Fred Hoyle and others (Burbidge and Hoyle, 1998, p. L1). Interestingly, Hoyle, as well as Geoffrey Burbidge, maintained a lifelong aversion to Big Bang theory.

Hoyle, together with Geoffrey Burbidge, Margaret Burbidge, and William Fowler, continued efforts through the 1950s to show that stars could account for nucleosynthesis. In the early 1950s they believed that solar-type stars accounted for a significant occurrence of reactions involving heavy elements (i.e., elements beyond He). However, stellar nucleosynthesis theory was encountering problems until 1953 when Hoyle, working with Fowler, successfully predicted a resonance for ^{12}C in the CNO bi-cycle which would allow this sequence to occur under solar conditions (Wallerstein et al., 1997, p. 999; Salpeter, 1999, p. S220). Later, the CNO bi-cycle was recognized as less and less likely to occur in the interior of the sun or in any normal star (Hoyle, 1954, p. 146). Fowler then proposed that C, N, and O reactions happen on the surfaces of stars due to local heating by magnetic fields (Fowler et al., 1955, pp. 167, 180). Subsequent to this, the CNO bi-cycle was ruled out as insignificant in solar-type stars (Caughlin and Fowler, 1962, p. 453). Reactions involving C, N, and O have been postulated for very hot, massive stars (Wagoner et al., 1967, p. 3; Hoffman et al., 2002), or supernovas (Hoyle and Fowler, 1960, p. 565; Arendt, 1999, p. 234). Data for certain resonances and reaction rates of processes involving C, N, and O remain some of the most uncertain quantities in stellar nucleosynthesis theory (Wallerstein et al., 1997, p. 999; Salpeter, 1999, p. S220). Yet reactions involving C, N, and O, and in particular the CNO cycle, are believed to be a key requirement for the stellar nucleosynthesis of other heavier elements (Groombridge et al., 2002, p. 055802-1). Despite Hoyle’s successful prediction of the ^{12}C resonance, it is clear that solar/stellar nucleosynthesis theory has not answered basic questions about how the elements came to be. Further, since the sun can be modelled with the CNO bi-cycle accounting for virtually all the luminosity, it is difficult to view Hoyle’s successful prediction of ^{12}C resonance as a robust confirmation of the SSM.

As with the reaction parameters for the CNO bi-cycle, many other quantities are treated as parameters in solar modelling, the usual reason being that the actual values are unknown. Previously mentioned is the fact that nuclear reaction rates are generally theoretical and uncertain (Bahcall et al., 1995, p. 783; Guenther and Demarque, 1996, p. 5; Bahcall et al., 2001, p. 1002; Hoffman et al., 2002, p. 1). The following quantities are also treated as adjustable parameters: (1) cross section factors (Bahcall et al., 1995, p. 783; Bahcall and Ulmer, 1996, p. 4203; Hoffman et al., 2002, p. 1), including the cross section fac-

tor for the *hep* reaction (Bahcall et al., 2001, p. 1002) as well as the *p-p* reaction cross section which cannot be measured directly and is therefore theoretical (Brun et al., 1998, p. 921); (2) core temperature (Bahcall and Bethe, 1993, p. 1298); (3) primordial element abundances (Bahcall and Ulmer, 1996, p. 4203), with relative primordial abundances for elements other than He, C, N, O, and Ne being estimated from meteoritic composition (Bahcall, 1997, p. 11), and with primordial He abundance being treated as an unknown which must be modelled (Bahcall et al., 1995, p. 804); (4) Ne abundance, which “cannot be measured directly in the sun” (Bahcall et al., 1995, p. 785); (5) opacities (Guenther and Demarque, 1996, p. 6); (6) adiabatic indices (Basu et al., 2000, p. 1086); (7) density profiles (Basu et al., 2000, p. 1089); (8) equations of state (Basu et al., 2000, p. 1092); and (9) diffusion rates (Bahcall et al., 1995, p. 786). With so many adjustable parameters available, it is little wonder that various models can be made to converge toward virtually any desired set of solar characteristics.

Item 3 in the list above is especially problematic for the biblical creationist, since in the biblical creation account the sun and the other bodies of the solar system were spoken into existence separately rather evolving from a common nebula. Thus there is no Scriptural basis for assuming that the sun has ever had “primordial” elemental abundances supposedly matching those of the meteorites or any other part of the solar system.

In addition, the uncertainty of model predictions is often computed by comparing models with models rather than models with data (Bahcall and Bethe, 1993, p. 1299; Bahcall et al., 1995, pp. 782, 790; Bahcall et al., 2001, pp. 993–994). This has the effect of making model uncertainties appear quite small, given that most researchers will choose model parameters so as to show convergence with existing models rather than “deviance.” Investigators working outside the bounds of acceptable parameters may find themselves the object of criticism (Bahcall and Pinsonneault, 1997, p. 10).

It has been noted that the phenomena causing the greatest difficulties for solar models, namely, neutrino fluxes, helioseismic data, and angular momentum data, are generally not considered in framing SSMs (Guenther and Demarque, 1996, p. 2; Brun et al., 1998, p. 913; Bahcall et al., 2001, p. 991). The success of a model in predicting neutrino flux is computed by adjusting parameters such as (1) reaction cross sections in the neutrino detector (Bahcall and Bethe, 1993, p. 1298; Bahcall and Pinsonneault, 1997, p. 10; Bahcall, 2002, p. 6); (2) dependence of neutrino flux on solar core temperature (Bahcall and Pinsonneault, 1997, p. 172); (3) the occurrence of neutrino oscillations

(Bahcall et al., 2002, p. 1); and (4) the mixing angle for neutrino interaction in the detector (Bahcall, 2002, p. 10). With such a wide selection of parameters, the agreement between the SNO (Sudbury Neutrino Observatory) results and predictions for neutrino detection have been excellent (Seife, 2001, pp. 2227–2228). Indeed, the resulting agreement has been described as “embarrassingly small” (Bahcall, 2002, p. 5), since normally a deviation too small between predictions and results is taken to indicate some sort of misstep in the method used to obtain it.

The success of a model in matching helioseismic data is computed by comparing model sound speeds in the sun with solar sound speeds inferred from helioseismic oscillations. However, the inversion of sound speeds from helioseismic oscillations requires the use of a “reference solar model,” which means that model sound speeds are compared with model sound speeds (Basu et al., 2000, p. 1084), resulting in good agreement between predicted sound speeds (obtained from a SSM) and “observed” sound speeds (obtained via a reference model, also a SSM). This is the basis of claims, for example, that “standard solar models are in remarkable agreement with helioseismological measurements of the Sun” (Basu et al., 1998, p. 1098; Bahcall et al., 1995, p. 782).

In short, model convergence is a result of (1) restricting parameter selection, and (2) restricting model uncertainty computations to comparisons between models. Ironically, among astrophysicists, if not particle physicists, model convergence has been employed as one of the main rationales for accepting neutrino oscillations as real (Bahcall and Bethe, 1993, p. 1299; Bahcall and Pinsonneault, 1997, p. 3–4; Bahcall et al., 2001, p. 999, 1010). Likewise, model convergence in helioseismic sound speeds has also been a basis for accepting neutrino oscillations (Bahcall et al., 2001, p. 991). Among the various considerations taken to imply neutrino oscillations, this type of reasoning would appear to be less than satisfactory.

Conclusions

Since the rise of modern evolution in the 1800s, few if any majority views have escaped its influence. History shows that the present majority view of solar/stellar theory has been shaped by evolutionary bias from the start, particularly by the desire to buttress a long chronology. The theorizing of influential solar astronomer Arthur S. Eddington is an example of this bias.

Rather than being compelled by the laws of physics to reach his conclusions, Eddington selected the laws he wished to invoke so as to sidestep any possibility that the sun and other stars, and therefore the earth, might be young.

He claimed for chronological reasons that the sun must be in hydrostatic equilibrium, and he also insisted that nuclear reactions were the only significant energy source for the sun, again for chronological reasons: "The energy obtainable from contraction is quite inadequate in view of the great age now attributed to the sun" (Eddington, 1926, p. 289); "Unless we choose annihilation of matter [as the energy source], we cut the life of a star so short that there is no time for any significant evolution at all" (Eddington, 1929, p. 112).

Rather than uncritically accepting conventional claims about the operation of the sun and stars, an informed historical perspective would suggest that the biblical creationist ought to tread carefully among such claims, accepting those backed by actual data, while being wary of the evolutionary bias which continues to inform solar/stellar theorizing.

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“...much unnecessary strain is caused by the hasty judgments of the Bible’s friends and foes alike. We cannot examine at all thoroughly all the problems growing out of the creation narrative (Gen. 1–3) for example; but, this general statement is true, we believe: If every Bible scholar were careful not to read anything out of the Scripture teachings except what it indubitably teaches and natural scientists were equally careful to claim nothing as scientifically established but what is indubitably true, the tensions between science and Scripture would be reduced to a negligible minimum.”

—John H. Gerstner, *A Bible Inerrancy Primer* (Grand Rapids, MI.: Baker, 1965), Pg. 50.

The late Dr. Gerstner taught church history and theology at numerous schools including Pittsburgh Seminary, Reformed Seminary, and Knox Seminary. He held a Ph.D. in the philosophy of religion from Harvard University.

An Examination of the Odessa Meteor Craters (Ector County, Texas, U.S.A.) Within the Context of the Young-Earth Flood Framework

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Abstract

The Odessa Meteor Craters are located in West Texas (U.S.A.). The site is approximately five miles southwest of the town of Odessa, Texas in Ector County. The locale consists of five impact craters with the largest being approximately 550 feet in diameter and 103 feet deep. The impact event is viewed by uniformitarian scientists as having occurred between 10 to 50 thousand years ago. At the largest crater, the meteor penetrated Cretaceous-age limestone and underlying clastics creating a raised rim of considerable relief. In the intervening time erosion has removed much of the elevated rim and nearly filled the cra-

ter with sediments. The eroded nature of each of the impact craters suggests that they formed near the end of the Flood Event Timeframe while Floodwater was still slowly withdrawing from the North American continent. Fossils of Ice Age megafauna found within some of the craters suggests that they may have provided a source of drinking water. However, once the creatures entered the depressions some could not escape and they perished. Today, only the largest crater retains any visible expression of its catastrophic origin as the smaller craters have been filled with sediments.

Introduction

It should not surprise young-Earth creationists to realize that the Bible was not written to describe geologic processes. We are told in Proverbs 25:2, that:

It is the glory of God to conceal a thing: but the honour of kings is to search out a matter.

So, mankind is provided the opportunity to investigate the Earth and in return bring God all the glory due Him. Extraterrestrial impact studies allow us to discover the greatness of our God. We tend to think that everything related to planet Earth originates as a function of God's use of Earth's geological processes, but impact craters on Earth as well as across the Solar System reveal that God has command of the entire universe. Much has been written by young-Earth creationists regarding the role that meteorites and comets have played in Earth's brief history and this subject will not be reviewed here. Rather, we will examine a specific location and seek to understand it within the context of a biblical framework.

There are no historical meteor or comet impact events

recorded in the Bible. However, there are approximately 150 known impact sites across the Earth (Hodge, 1994). This number will increase as new sites are identified and added to this list (e.g., Wetumpka crater, Alabama—see Froede and Williams, 1999a; Froede, 1999b; King, Neathery, Petruny, Koeberl, and Hames, 2002).

Impact craters are recognized in two areas of West Texas, those being the Sierra Madera and Odessa Meteor Craters (Hodge, 1994). The Odessa Meteor Craters site consists of five depressions that have been interpreted as having formed as a result of the impact of a small-scale meteor shower. The craters are located in south central Ector County, Texas (U.S.A.), approximately five miles southwest of Odessa (Figure 1).

History of the Impact Craters

The town of Odessa, Texas, was founded as a stop along the Texas and Pacific Railroad, and passenger service began in 1881 (Pollard, 1998). The original discovery of the impact crater is credited to Odessan Julius D. Henderson who came across the site while retrieving a lost cow during the winter of 1892 (Sherburn, 1998). In 1921, Arthur Bibbins was provided samples of what was reported as iron ore by a local rancher who found them adjacent to a blow-out feature (Bibbins, 1926). Bibbins submitted a sample to

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Figure 1. Aerial photograph showing the location of the largest impact crater. Foot trails wind through and around the site. Modified from U.S. Geological Survey aerial photograph. Smaller inset shows the location of the site in relation to Odessa and Penwell, TX.

Smithsonian research scientist George Merrill (1922), who analyzed the iron material (Table I) and determined it was of extraterrestrial origin. A careful examination of the site, however, did not occur until 1926, when D. M. Barringer (son of the famous discoverer of the Arizona Meteor Crater) identified it as an meteor impact crater (Anonymous, n.d.; 2001; Barringer, 1929). In 1927, University of Texas geologist Dr. E. H. Sellards reported on the unusual crater-like feature found southwest of Odessa, Texas. He stated that resolving its origin could occur only if excavation or drilling were conducted (Sellards, 1927). Meteorite expert H. H. Nininger visited the area in 1933, and in seven hours collected 1500 pieces of iron meteorite by using an electromagnet (Anonymous, 2001).

From 1939 to 1941, extensive excavations were conducted at the largest crater by Sellards and Glen Evans (Sellards, 1940; Sellards and Evans, 1941; Sherburn, 1998). A total of 35 wells were drilled to varying depths both in and around this feature (Sellards and Evans, 1941). Several trenches were constructed through portions of the crater walls (Figure 2) and a 165-foot shaft (Figure 3) was excavated in its center (Dearen, 1995). Two other meteor



Figure 2. Photograph of a still-remaining trench constructed during the 1939 to 1941 period that Sellards and Evans investigated the largest crater at the site. Their investigation was to determine the cause of the largest crater. They determined it to be the result of an extraterrestrial impact.

Chemical Analysis of Odessa Meteorite Sample	
Element	Weight Percent
Iron	90.69
Nickel	7.25
Cobalt	.74
Copper	.02
Platinum	None
Chromium	Trace
Manganese	None
Carbon	.35
Phosphorus	.23
Sulphur	.03
TOTAL	99.31

Table 1. Merrill's (1922) analysis of the Odessa iron meteorite sample. He suggested that the cause of the apparent absence of platinum was likely the result of the small sample size provided to him.

craters were also found during the investigation using a magnetometer (Sellards and Evans, 1941). Meteorite material weighing as much as 100 pounds became commonplace during the course of these investigations (Stowers, 1998). The shaft completely penetrated the impact crater (approximately 103 feet deep) and continued down through Cretaceous-age clastics to the top of a carbonate layer. With all of this extensive field work, the shape and stratigraphic composition of both the crater fill and surrounding area have been more clearly defined (Figure 4). In 1958, Glen Evans returned to the site and conducted additional investigations resulting in the discovery of two additional craters and hundreds of ground surface indentations caused by the smaller falling fragments (Sherburn, 1998). Several paleontological finds have also occurred as a result of these investigations. Mammoth remains were found in one of the smaller craters and in sinking the 165-foot shaft in the largest crater, Evans reported finding fossils of Pleistocene horses and elephants (Dearen, 1995).

Today, the craters still show scars from the extensive excavations. However, there remain a few areas around the largest crater that likely reflect its original physical state (Figure 5). Unfortunately, the lack of any significant



Figure 3. Photograph of the metal cover over the 165 foot-deep shaft also constructed by Sellards and Evans to understand the depth of meteor penetration. Scale in inches and centimeters.

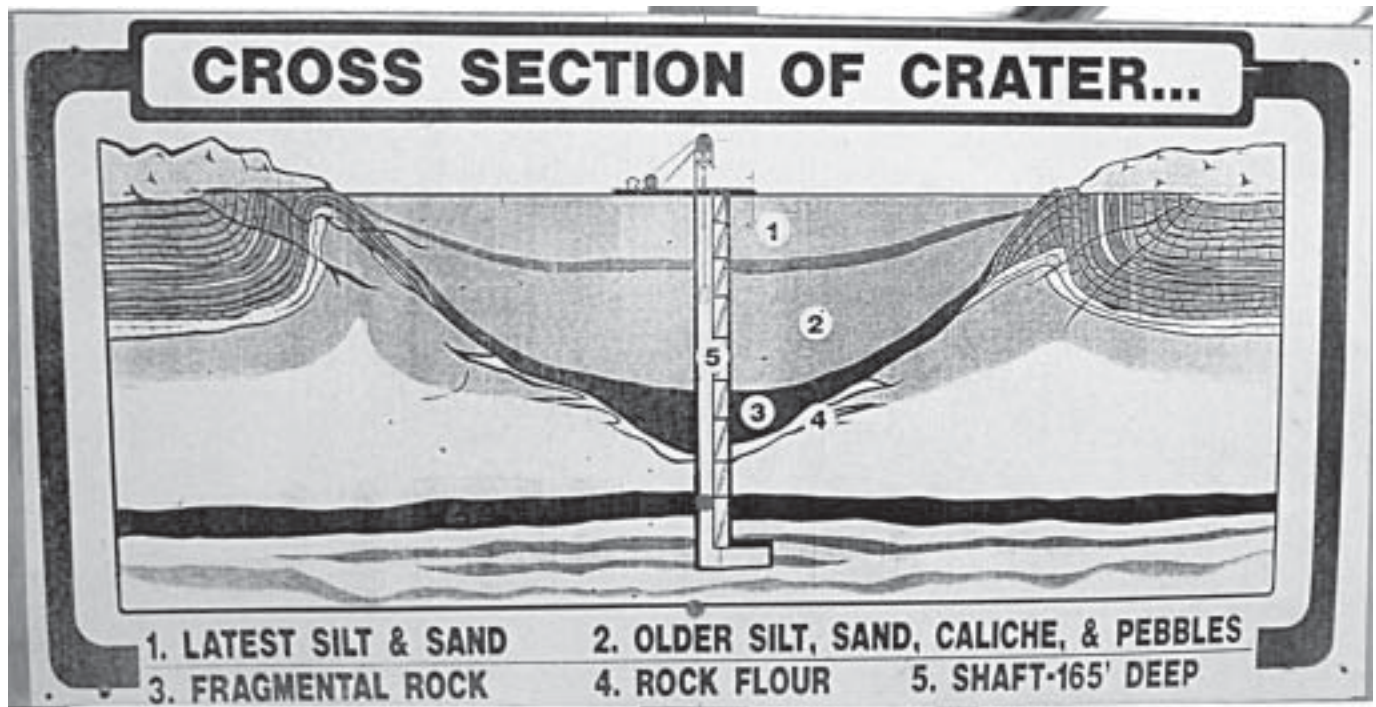


Figure 4. Photograph of the general stratigraphy of the crater from a sign located at the largest crater. This geological information was obtained during the course of the extensive investigation conducted by Sellards and Evans from 1939 to 1941.



Figure 5. Upturned strata along sections of the crater rim still exist today. The rim around the largest crater is highly eroded and suggests either extended periods of time have passed or more properly that it was created and eroded during the closing stages of the Flood. Scale in inches and centimeters.



Figure 6. The crater as it exists today. This view is looking down into the crater from along the northeastern rim. Its highly eroded condition reflects extensive erosion which we interpret as corresponding to the Upper Flood Event Timeframe (Froede, 1995; 1998).

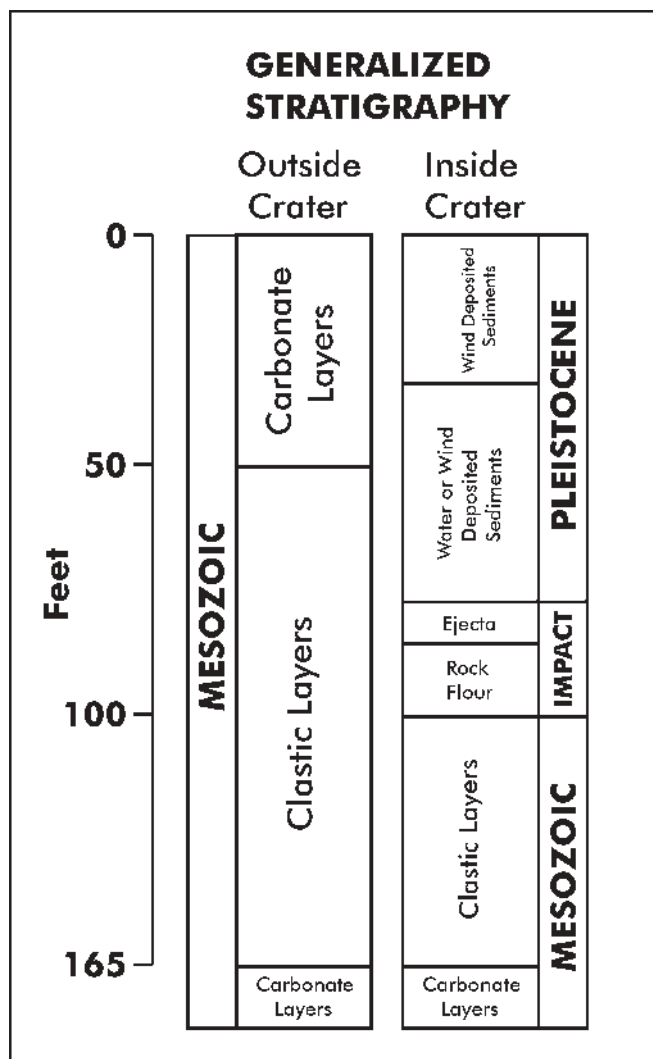


Figure 7. Generalized stratigraphic columns for both inside and outside of the impact crater. The information is adapted from several sources (Anonymous, No date; Anonymous, 2001; Dearen, 1995; Spearing, 1991).

elevational relief reduces the impressive nature of these impact craters (Figure 6).

Site Stratigraphy

The most complete knowledge of the site comes from the investigation conducted by Sellards and Evans (1941) at the largest crater. From their work we are able to reconstruct the stratigraphy of the area both before and as a result of the impact event. This information aids us in determining the timing of this event within the young-Earth Flood framework.

Figure 7 provides a general stratigraphic column from both outside and within the impact crater. All of the strata affected by the impact are interpreted by uniformitarian scientists as being deposited during the Cretaceous period. A series of carbonate layers form a significant cap over underlying clastics which in turn rest upon additional carbonates. It is estimated that the top of the Triassic shale occurs approximately 200 feet beneath the ground surface (Anonymous, 2001; Dearen, 1995; Sellards and Evans, 1941).

The pre-impact stratigraphy of the area reflects a former marine environment. The surficial carbonate strata would have been deposited during the Late Cretaceous when a seaway linked the Arctic Ocean with the Gulf of Mexico (Froede, 1995a). The eventual withdrawal of the epeiric seaway resulted in the exposure of the limestone to sub-aerial conditions resulting in its eventual lithification. Post-impact Pleistocene clastic material fills the smaller craters and nearly so the largest crater.

Impact Object and Resulting Craters

The exact size of the object that broke apart and created



Figure 8. During the course of the investigation of the largest crater an adjacent smaller crater was identified based on a magnetometer survey of the surrounding area. This crater was originally filled with sediment and was only partially excavated to verify its extraterrestrial origin.

the Odessa impact craters is unknown. However, it has been speculated to range in size from 300 to 1500 tons (Dearen, 1995; McSpadden, 1998; Sellards and Evans, 1941; Spearling, 1998; Stowers, 1998). There is little doubt that the five craters and surrounding depressions are all the result of one wide-spread fall event.

At the largest crater, the meteor impacted into sedimentary rocks and is said to have raised rim of carbonate strata rising 50 feet in elevation around the crater (Smith, 1997). The resulting crater is 550 feet in diameter and approximately 103 feet deep (Anonymous, 2001; Hodge, 1994; Sellards and Evans, 1941; Sherburn, 1998). Subsequent erosion and infilling of the largest crater has reduced rim relief to five to seven feet above the surrounding area. Four other smaller impact craters are also recognized across the site (Figure 8). They range in size from 15 to 70 feet in diameter and seven to 18 feet in depth (Dearen, 1995). None of the smaller craters fully penetrates the surficial carbonate/clay layers that extend across the site.

Analysis of the octahedral iron meteorite by Merrill (1922) reveals a composition similar to that of other typical iron meteorites (Table I, Figure 9). A recent discovery

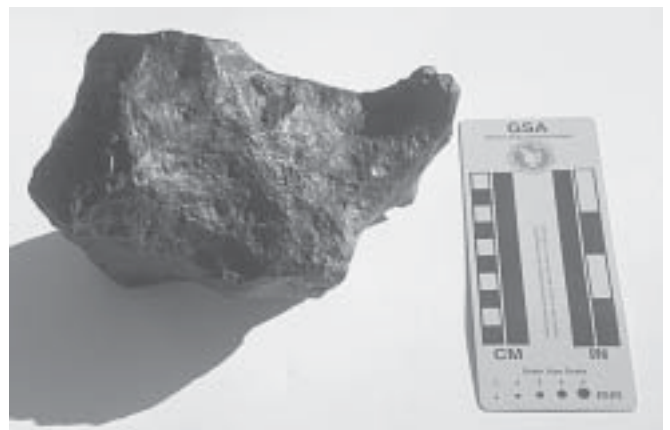


Figure 9. Photograph of an Odessa meteorite on display at the Gallery of Creation, Stone Mountain, Georgia. Scale in inches and centimeters.

northwest of the Odessa craters presents interesting information that possibly explains the original composition of the meteor and why this fall was a meteor shower as opposed to the fall of a single large object. A stony-iron meteorite was found near Penwell, Texas—a locality not far from

the Odessa craters site (Moore, Lewis, and Clark, 1981; 1982; Kempton, 2002). Similar composition between this meteorite and those from the Odessa craters locale lead Moore, Lewis, and Clark (1982) to the following conclusion:

It thus appears that it is possible that the parent meteoroid of the Odessa iron contained various inclusions which may have broken free during entry and scattered over a moderately large area.

Analysis of the Penwell stony-iron meteorite reveals that in addition to iron-nickel (50%), it contains 30% silicates and 20% graphite by weight (Moore, Lewis, and Clark, 1981). According to Norton (1998), the presence of silicates in iron meteorites is common in octahedrites collected from the Odessa crater. We believe that the breakup of the large meteor likely created a shower of materials across a broader area than is presently recognized.

Impact Crater or Volcanic Explosion?

In the past, controversy surrounding the identification of impact craters has largely focused on the belief that catastrophic processes (such as impact events) simply did not occur. Until the 1960's, the general scientific consensus held that the Earth was bombarded early in its history, but nothing like this has occurred since. Thankfully, this view

has changed as many impact craters have been discovered. Some of the earliest evidence used to persuade scientists of an impact origin came from the iron found in association with the depression. The abundant iron-nickel found around the Odessa craters provided important tangible evidence that scientists required to confirm it as an impact crater (Figure 10). More recently, additional evidence has been documented in the form of shatter cones (Figure 11). These features are important in documenting impact crater sites where other evidence (e.g., iron-nickel materials, meteorite debris, impact crater) is missing (Dietz, 1947; 1959; 1963; 1964; 1968; French, 1998). The Odessa Craters not only provide metallic evidence of their extraterrestrial origin, but shatter cones as well.

Age Dating the Impact Event

Presently, the age of the Odessa meteor craters ranges from 10 to 50 thousand years (ka). However, the stratigraphic interpretation more narrowly defines the craters as being from 20 to 25 thousand years old (Dearen, 1995; McSpadden, 1998; Stowers, 1998). Initially, investigators believed that the Odessa craters were linked to the Arizona Meteor Crater based on the similarity of the iron-nickel and age of the individual craters (Anonymous, 2000; Dearen, 1995; Hoyt, 1987). As recently as 1987, late geolo-

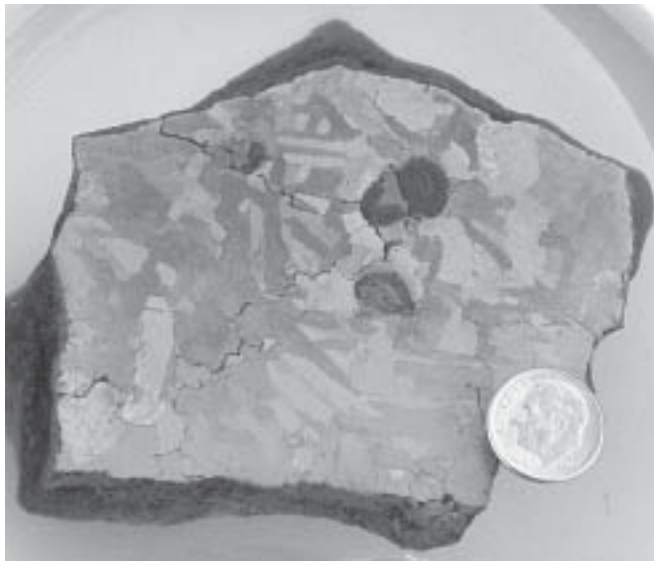


Figure 10. Photograph of a slabbed Odessa meteorite showing the classic Widmanstätten pattern. This regular geometric pattern reflects the intergrowth of kamacite and taenite during slow cooling (McSween, 1999). This fragment is on display at the Gallery of Creation, Stone Mountain, Georgia. Coin is 0.7 inches (1.8 centimeters) in diameter.



Figure 11. A photograph of two shatter cones in limestone collected from the Odessa Meteor Craters on display at the Gallery of Creation, Stone Mountain, Georgia. Scale in inches and centimeters. These features are indicative of impact craters and do not require exceptional impact forces to form them (French, 1998). The impact force propagates in an expanding manner and results in the formation of a cone-shaped feature. Scale in centimeters.

gist Eugene Shoemaker expressed his belief that the Odessa craters and Arizona Meteor Crater were both part of the same southeasterly directed meteorite (Hoyt, 1987). However, some confusion still exists as the Arizona Meteor Crater is presently believed to have formed 50 ka years ago (French, 1998) and the Odessa Craters are believed to be of more recent age. Hence, based on site stratigraphy the age of the Odessa Meteor Craters remains unresolved and open to interpretation.

Fossils are commonly used to age-date strata. Mammalian fossils have been collected from Pleistocene sediments within the Odessa Meteor Craters during the course of several investigations. However, these fossils do not constrain the possible age of the various craters. Rather, they indicate a period of time following crater formation. Based on the age of these fossils, it has recently been proposed that the Odessa craters are 10,000 years old (Mark, 1987).

It is interesting to note that the craters are located in an area with an abundance of windblown sand. Only the largest crater retains a surface expression due to its remaining unfilled within this active eolian setting for at least 10 to 50 ka. One might expect all of the craters to have been completely filled and buried with such an extended period of time available to transport windblown sand across this area.

A Young-Earth Flood Framework Interpretation

The biblical view of Earth history requires less time to form impact craters (Froede and DeYoung, 1996). An analysis of the stratigraphic setting, coupled with the geologic energy of the event and present condition of the site, allow for a reasonable interpretation. Former crater features subsequently removed by erosion can provide us with important clues in attempting to determine their possible age.

Impact events typically create craters with a raised rim and a surrounding ejecta blanket (the ejecta blanket is formed from materials blasted from inside the newly-formed crater). It has been estimated that the impact associated with the largest crater would have produced a rim approximately 50 feet higher than the surrounding ground surface. Past excavations in and around the various craters have not revealed any significant rim-related elevation, either buried or present, across the site. Significant erosion has occurred to reduce the original crater rim to its five- to seven-foot elevation.

An ejecta blanket 10 to 12 feet thick was identified immediately surrounding the crater during the course of the Sellards and Evans (1941) investigation. This material thins with distance from the crater and was postulated to have been "thicker when the crater was first formed" (Sellards

and Evans, 1941). Large weathered blocks of limestone and shale ranging in size from three to four feet immediately surround the largest crater. Some of this ejected material is identified within the adjacent smaller crater as having been water deposited (Sellards and Evans, 1941). It is interesting to note that Sellards and Evans (1941) believed that a "considerable length of time" had passed since the impact event based on the "accumulation of caliche cements." The ejecta blanket is covered by one or more caliche layers.

The fill material within the largest crater aids in defining the time frame in which the impacts occurred. Lining the bottom of the crater is rock flour created as a result of the tremendous meteor impact. Above this layer is sediment believed to be ejecta material that fell back into the crater following impact. Overlying this layer are clastic materials (i.e., sands, silts, and clays) that have washed into the crater and have been partially cemented by caliche which also suggested "an appreciable time interval" to Sellards and Evans (1941). Windblown sediments nearly fill the remaining space.

At least two interpretations addressing the formation and age of the Odessa Meteor Craters are possible within the young-Earth Flood framework:

- 1) The impact event occurred at the closing stages of the Flood when water was slowly retreating from the North American continent (Froede, 1995a). This retreating Floodwater eroded the elevated crater rim and surrounding ejecta blanket. Some of those materials could have been transported and deposited within the submerged craters.
- 2) The craters formed following the retreat of Floodwater. The wetter-than-present conditions associated with the Ice Age (Oard, 1990) eroded the crater rim and transported the majority of the surrounding ejecta blanket away from the site as well as possibly returned a portion of it to the crater.

Discussion

Several interpretations are possible within the context of the biblical framework when considering the impact event along with subsequent erosion and deposition. We favor an interpretation that links the impact to the late stages of the Flood (i.e., Upper Flood Event Timeframe; Froede, 1995b; 1998) while marine water still covered this portion of West Texas. Retreating Floodwater (and tidal forces) created the erosive conditions necessary to remove the elevated crater rim and weather/remove most of the surrounding ejecta blanket. The erosion of the uplifted carbonate strata rim would have been more easily accomplished in a sub-

aqueous setting as the carbonates were still in a soft, semi-lithified state. A subaerial setting for the impact event would have rapidly hardened the upturned crater rim carbonate strata and lithification would have greatly reduced the rate of erosion. The conditions at the site do not appear to support an impact event occurring subaerially during the Ice Age Timeframe.

The presence of caliche cement within and above the ejecta blanket is easily explained within a subaqueous setting. Some of the cement associated with the impact-generated sediments was derived from carbonate-rich water and suspended fine-grained calcareous sediments deposited across this portion of Texas due to the subaqueous Floodwater conditions. Following the impact event the carbonate depositional setting merely continued until the Floodwater retreated from the area. Hence, the presence of one or more caliche cement layers within and above the impact ejecta blanket represents the continuation of carbonate deposition across the site which only concluded with the cessation of marine conditions. We do not believe that a post-Flood impact event would not have provided the conditions necessary to yield one or more caliche layers in association with the weathered ejecta blanket.

The abundance of meteorite material to the northwest (and west) of the site reflects the expansive area covered by the meteorite shower. The heavier iron-nickel meteorite debris likely remains at or near its original position. Less dense meteorite material, such as the Penwell stony-iron meteorite, might have been transported away from the site due to tidal effects or strong water currents and additional investigation is required.

The identification of the fossilized remains of Pleistocene megafauna within some of the larger craters suggests two possible scenarios:

- 1) The fossils are the remains of animals killed during the Flood and washed into the depressions with the retreat of Floodwater, or more likely,
- 2) The largest impact crater would have been rather deep (estimated at 60 feet below the ground surface) following the withdrawal of Floodwater. It could have served as a source for drinking water following the flushing of marine water and the establishment of freshwater conditions within the shallow subsurface. The water-saturated clastics within the crater floor might not have sufficiently consolidated to allow animals to exit once they entered the crater for drinking water. Animals could have become trapped and died. In the case of the smaller craters, the water-saturated carbonates/clays would have created a slick, sticky mud that might have trapped unfortunate animals that happened to

stumble into them. It is also possible that animals were killed in and around the craters by predators. However, no fossils of any kind of Pleistocene predator(s) have been identified or reported from this area in the literature. Much speculation exists and we offer no real final solution. More research into the question of why these fossils were found in some of the craters is clearly warranted.

Our interpretation presently assumes no link to a possible fragmentation event in outer space that also created the Arizona Meteor Crater, although this still remains to be determined within the context of the young-Earth Flood framework. Comet Shoemaker-Levy 9 has demonstrated that a single meteoroid/comet body can break apart and produce a series of related impact events around the globe which might otherwise be interpreted as being non-related. The link to the Penwell stony-iron meteorite suggests that (barring any transport from the original impact site) the fragmentation of the Odessa meteoroid occurred earlier in its Earth-bound course than is presently realized by uniformitarian scientists.

Conclusions

The location of the Odessa Meteor Craters provides an interesting and unique setting in which to study and understand the fragmentation of a parent meteoroid as it enters Earth's atmosphere. The timing of this event and size of the impact object are not resolved within the uniformitarian model of Earth history. While the size of the object likely remains unresolved within the young-Earth Flood framework, the period of time in which this event occurred is resolvable. The present highly-eroded condition of the multiple impact craters suggests they formed when geologic processes were operating on the surface of the planet at a higher energy level than experienced at present. We interpret this period of time to correspond to the end of the Flood (Upper Flood Event Timeframe: Froede, 1995; 1998) when Floodwater still covered this portion of West Texas sufficiently to erode both the elevated carbonate crater rim and surrounding ejecta blanket. We propose that some of the clastics associated with the crater rim and ejecta blanket were eroded and returned into the crater. Following the complete withdrawal of Floodwater, the area was subject to wetter and windier conditions associated with the Ice Age. It was during this time that some Pleistocene megafauna became trapped in the various crater-formed water holes. These animals died and were buried by precipitation-transported and windblown sands. With the drying out of the climate, wind transport of additional clastic materials became the predominant means of depositing

additional sediments into the craters. Insufficient time has passed to fill all of the craters with sedimentary materials which we believe supports the young-Earth Flood framework. Today, we find the craters as weathered shadows of their former existence, providing testimony to the extraterrestrial effects and erosional energy of the global Flood of Genesis.

Acknowledgments

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Book Review

An Agenda for Antiquity: Henry Fairfield Osborn and Vertebrate Paleontology at the American Museum of Natural History, 1890–1935

by Ronald Rainger

University of Alabama Press, Tuscaloosa. 1991, 360 pages, \$44.95

How did we arrive at this point? Why has evolutionary thought so dominated our academic, scientific, mass media and even religious establishments? Several years ago a professor of history at Texas Tech University, H.F. Osborn, wielded great influence. Author Rainger highly has researched Osborn and produced a readable and important summary.

Henry Fairfield Osborn (1857–1935) had a significant impact on the public's perception and acceptance of evolutionary thought. From his work at Princeton and Columbia Universities he developed strategies that bore their greatest fruit when he became curator and president of New York City's American Museum of Natural History (AMNH).

Osborn was a very capable organizer, networker and self-promoter. He took advantage of his high social standing and learned from the mistakes of others. Two prominent paleontologists of the previous generation, Edward Drinker Cope and Othniel Marsh, both exhausted their personal fortunes on the expensive business of fossil excavation and preparation. While Osborn used some of his own money, he had a circle of very wealthy friends who contributed significant financial support for museum projects. Osborn organized his departments and personnel effectively to promote passionate interests in vertebrate paleontology in the realms of ancient mammals, dinosaurs, and ancient man.

What was Osborn's "agenda for antiquity"? At Princeton in the late 1880s Osborn became a neo-Lamarckian (p. 39) as reflected in his writing. He later developed his own

"tetraplastic/tetrakinetic" (p. 128) non-Darwinian view of evolution. Osborn advanced a type of theistic evolution, "Any random, discontinuous change, indeed any change that was not fully predictable, was equivalent to chance or accident, events that occurred without reason, plan, or purpose. Such phenomena could have no place in Osborn's interpretation of evolution or in his conception of nature, where everything operated strictly according to law and under the guidance of God" (p. 139). Rainger also comments on Osborn, "For him the laws of evolution demonstrated the presence and handiwork of the creator every bit as much as the Bible. On those grounds he steadfastly opposed William Jennings Bryan and the fundamentalists who claimed that evolution undermined religion" (p. 131).

Osborn was admonished by his parents and other mentors to use his influence for society's betterment. Through the exhibits at the AMNH Osborn advocated his agenda. He believed the modern educational system produced individuals who "had become domesticated and effeminate, characteristics that Osborn, as a part of the male power structure, considered degenerate" (p. 119). Rainger explains, "But for Osborn the immersion in nature was a personal confrontation that led to self-fulfillment. Osborn, perhaps influenced by the views of his good friend [Theodore] Roosevelt, glorified the outdoor study of nature as a transforming experience that could bring social and spiritual redemption" (p. 120). The museum exhibits especially on the Neanderthal and Cro-Magnon cultures exemplified this "return to nature" ideology.

Rainger emphasizes that Osborn's views presented through the museum exhibits advocated the preservation of the "white Anglo-Saxon Protestant" power elite. Osborn was a part of this elite. To buttress the idea the author also explores Osborn's participation in the eugenic and anti-immigration movements. The 1921 International Eugenics Congress was held at the museum. The Hall of Man especially embodied Osborn's ideas. "[It] was more than an exhibit of paleoanthropological material. It reflected Osborn's belief that only by preserving nature and racial purity, particularly the purity of the English, Scots, and Scandinavians most closely related to the Nordic tribes of Neolithic times, could mankind halt the rapidly accelerating decline toward racial suicide and extinction" (p. 177). Such racist attitudes naturally led Osborn to support the "racial hygiene" policies of Mussolini and Hitler (p. 150). He advocated a program of "positive eugenics" that meant there should be greater reproduction by "the fit," primarily New England Nordic racial stock. He was a powerful supporter of the Immigration Acts of 1921 and 1924 which restricted immigration (p. 149).

Osborn also was involved in developing a theoretical basis for vertebrate paleontology, by mentoring and supporting the work of paleontologists such as William King Gregory and William Diller Matthew. Osborn, through the work of these and other associates, helped lay a biostratigraphy and correlation framework for how the fossil record has been interpreted worldwide (pp. 185-188). It is worth noting that Gregory, Matthew and most other paleontologists disagreed with Osborn's version of evolution, holding a more Darwinian approach (p. 206). That Osborn provided the institutional environment for these men to work is perhaps his most enduring legacy to vertebrate paleontology and evolutionary thought (pp. 242-48).

From the creationist's viewpoint some weaknesses mar Rainger's rich and fascinating research. He gives little information concerning Osborn's early rejection and later acceptance of the Piltdown Man hoax (p. 309). He is silent on Osborn's promotion of Nebraska Man. Perhaps more

important, was there any childhood acceptance of traditional Christian faith and its later rejection by Osborn? Osborn was raised in a very wealthy, Bible-believing Presbyterian home (p. 25). Later in life he maintained membership in St. George's Episcopal Church (p. 46). How did Osborn cope with the person of Jesus Christ as revealed in the New Testament? Rainger implies that very early on Osborn accommodated Christianity with evolutionary thinking (pp. 26-27) through the influence of Princeton president, James McCosh. Any real vestiges of Biblical Christianity quickly fell by the wayside in Osborn's mind. Osborn's new faith revealed a non-personal God who worked through evolution to accomplish his purposes. This was a tame god that was used to serve Osborn's ends of maintaining the status quo for his social and ethnic elite. Osborn dedicated his life to vigorously advocating this new religion.

Osborn's ideas significantly influenced the public knowledge of fossils and acceptance of evolution. Indeed it was Osborn's life mission to influence society's decision makers as well as the masses with his evolutionary gospel. It was through his influence that generations of students were exposed to the familiar orthogenetic chart of horse evolution (p. 165) and the magnificent paintings by Charles R. Knight (p. 89) that cemented the mythical notion that dinosaurs had ruled the earth for 150 million years. Besides the AMNH exhibits Osborn promoted himself and his agenda unceasingly through a multitude of scientific papers, popular press articles, books, and highly publicized journeys to fossil sites in Europe, Mongolia and elsewhere.

One of the primary tasks of creation science is to present a viable alternative to the ideas that Osborn and his ideological descendants have propagated over the last century. This book has numerous illustrations, extensive endnotes, a bibliography, and index.

Don Ensign
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"An honest man, armed with all the knowledge available to us now, could only state that in some sense, the origin of life appears at the moment to be almost a miracle, so many are the conditions which would have had to have been satisfied to get it going."

—Francis Crick,
Nobel Prize-winning co-discoverer of DNA structure, *Life itself*, p. 88, 1981.

Instructions to Authors

Submission

Submit an original plus two copies of each manuscript to the editor of the *Creation Research Society Quarterly* (see the inside front cover for address). Concurrent submission of an electronic version (Word, WordPerfect, or StarOffice/OpenOffice format) of the manuscript text and graphics is also encouraged. The manuscript and graphics will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. Manuscripts containing more than 30 pages are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

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Authors who are unsure of proper English usage should have their manuscripts checked by someone proficient in the English language. Also, authors should endeavor to make certain the manuscript (particularly the references) conforms to the style and format of the *Quarterly*. Manuscripts may be rejected on the basis of poor English or lack of conformity to the proper format.

The *Quarterly* is a journal of original writings, and only under unusual circumstances will previously published material be reprinted. Questions regarding this should be submitted to the Editor (CRSQ_editor@creationresearch.org) prior to submitting any previously published material. In addition, manuscripts submitted to the *Quarterly* should not be concurrently submitted to another journal. Violation of this will result in immediate rejection of the submitted manuscript. Also, if an author uses copyrighted photographs or other material, a release from the copyright holder should be submitted.

Appearance

Manuscripts shall be computer-printed or neatly typed. Lines should be double-spaced, including figure legends, table footnotes, and references. All pages should be sequentially numbered. Upon acceptance of the manuscript for publication, an electronic version is requested (Word, WordPerfect, or StarOffice/OpenOffice format), with the graphics in separate electronic files. However, if submission of an electronic final version is not possible for the author, then a cleanly printed or typed copy is acceptable.

Submitted manuscripts should have the following organizational format:

1. Title page. This page should contain the title of the manuscript, the author's name, and all relevant contact information (including mailing address, telephone number, fax number, and e-mail address). If the manuscript is submitted by multiple authors, one author should serve as the corresponding author, and this should be noted on the title page.

2. Abstract page. This is page 1 of the manuscript, and should contain the article title at the top, followed by the abstract for the article. Abstracts should be between 75 and 200 words in length and present an overview of the material discussed in the article, including all major conclusions. Use of abbreviations and references in the abstract should be avoided. This page should also contain at least five key words appropriate for identifying this article via a computer search.

3. Introduction. The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

4. Body of the text. Two types of headings are typically used by the *CRSQ*. A major heading consists of a large font bold print that is centered in column, and is used for each major change of focus or topic. A minor heading consists of a regular font bold print that is flush to the left margin, and is used following a major heading and helps to organize points within each major topic. Do not split words with hyphens, or use all capital letters for any words. Also, do not use bold type, except for headings (italics can be occasionally used to draw distinction to specific words). Previously published literature should be cited using the author's last name(s) and the year of publication (ex. Smith, 2003; Smith and Jones, 2003). If the citation has more than two authors, only the first author's name should appear (ex. Smith *et al.*, 2003). Contributing authors should ex-

amine this issue of the *CRSQ* or consult the society's web site for specific examples as well as a more detailed explanation of manuscript preparation. Frequently used terms can be abbreviated by placing abbreviations in parentheses following the first usage of the term in the text, for example, polyacrylamide electrophoresis (PAGE) or catastrophic plate tectonics (CPT). Only the abbreviation need be used afterward. If numerous abbreviations are used, authors should consider providing a list of abbreviations. Also, because of the variable usage of the terms "microevolution" and "macroevolution," authors should clearly define how they are specifically using these terms. Use of the term "creationism" should be avoided. All figures and tables should be cited in the body of the text, and be numbered in the sequential order that they appear in the text (figures and tables are numbered separately with Arabic and Roman numerals, respectively).

5. Summary. A summary paragraph(s) is often useful for readers. The summary should provide the reader an overview of the material just presented, and often helps the reader to summarize the salient points and conclusions the author has made throughout the text.

6. References. Authors should take extra measures to be certain that all references cited within the text are documented in the reference section. These references should be formatted in the current *CRSQ* style. (When the *Quarterly* appears in the references multiple times, then an abbreviation to *CRSQ* is acceptable.) The examples below cover the most common types of references:

Robinson, D.A., and D.P. Cavanaugh. 1998. A quantitative approach to baraminology with examples from the catarrhine primates. *CRSQ* 34:196–208.

Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

Margulis, L. 1971a. The origin of plant and animal cells. *American Scientific* 59:230–235.

———. 1971b. *Origin of Eukaryotic Cells*. Yale University Press, New Haven, CT.

Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York.

Walker, T.B. 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.

7. Tables. All tables cited in the text should be individually placed in numerical order following the reference section, and not embedded in the text. Each table should have a header statement that serves as a title for that table (see a current issue of the *Quarterly* for specific examples). Use tabs, rather than multiple spaces, in aligning columns within a table. Tables should be composed with 14-point type to

insure proper appearance in the columns of the *CRSQ*.

8. Figures. All figures cited in the text should be individually placed in numerical order, and placed after the tables. Do not embed figures in the text. Each figure should contain a legend that provides sufficient description to enable the reader to understand the basic concepts of the figure without needing to refer to the text. Legends should be on a separate page from the figure. All figures and drawings should be of high quality (hand-drawn illustrations and lettering should be professionally done). Patterns, not shading, should be used to distinguish areas within graphs or other figures. Unacceptable illustrations will result in rejection of the manuscript. Authors are also strongly encouraged to submit an electronic version (.cdr, .cpt, .gif, .jpg, and .tif formats) of all figures in individual files that are separate from the electronic file containing the text and tables.

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Submission of letters regarding topics relevant to the society or creation science is encouraged. Submission of letters commenting upon articles published in the *Quarterly* will be published two issues after the article's original publication date. Authors will be given an opportunity for a concurrent response. No further letters referring to a specific *Quarterly* article will be published. Following this period, individuals who desire to write additional responses/comments (particularly critical comments) regarding a specific *Quarterly* article are encouraged to submit their own articles to the *Quarterly* for review and publication.

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Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (1000 words), and one response (500 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

Book Reviews:

All book reviews should be submitted to the book review editor, who will determine the acceptability of each submitted review. Book reviews should be limited to 1000 words. Following the style of reviews printed in this issue, all book reviews should contain the following information: book title, author, publisher, publication date, number of pages, and retail cost. Reviews should endeavor to present the salient points of the book that are relevant to the issues of creation/evolution. Typically, such points are accompanied by the reviewer's analysis of the book's content, clarity, and relevance to the creation issue.

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The Creation Research Society Quarterly has been gradually enlarged and improved and now is recognized as the outstanding publication in the field. In 1996 the CRSQ was joined by the newsletter Creation Matters as a source of information of interest to creationists.

Activities—The society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigor-

ous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because

it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.

2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.

3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.

4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

Creation Research Society Resources



CRSQ on CD

George Hunter (editor). Creation Research Society. Members, \$100.00; nonmembers and subscribers, \$115.00. (Prices on this item include postage and handling.)

This two-CD set contains Volumes 1–38 (through March, 2002) of the *Creation Research Society Quarterly* (CRSQ) and

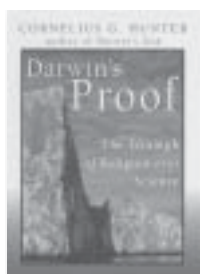
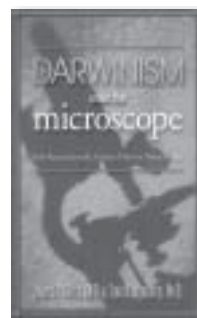
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Darwinism Under the Microscope: How Recent Scientific Evidence Points to Divine Design

James P. Gills, M.D. and Tom Woodward, Ph.D. 2002. Charisma House, 236 pages. \$14.00.

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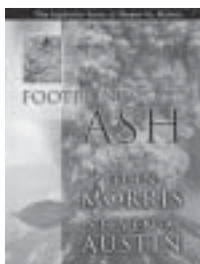


Darwin's Proof: The Triumph of Religion over Science

Cornelius G. Hunter. 2003. Brazos Press, 168 pages. \$18.00 (hard cover).

This book reveals scientific, philosophical, and theological limitations of Darwin's theory. This is an intelligent

response to evolution's overconfidence. It is an important text for those who accept, as well as those who doubt, the validity of evolution.



Footprints in the Ash—The Explosive Story of Mount St. Helens

John Morris and Steven A. Austin. 2003. Master Books, 128 pages. \$17.00 (hard cover).

The eruption of Mount St. Helens helps us to understand many processes that occurred during the Genesis Flood.

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