# A Preliminary Report on the Precambrian Pikes Peak Iron Formation Yavapai County, Arizona

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## Abstract

The Precambrian Yavapai Series contains the Pikes[1] Peak Iron Formation, dated to the Early Proterozoic, a uniformitarian age of 1.75 billion years old. The origin and development of iron bearing strata remain somewhat enigmatic within the uniformitarian model because no modern analogy of iron-rich deposition occurs on earth today. Various models have been proposed by uniformitarians in their attempt to explain its origin and occurrence. Based on our examination of several outcrops, we propose that the Precambrian Yavapai Series and the Pikes Peak Iron Formation formed during the earliest stages of the Flood (Lower Flood Event Division) in a volcanic setting (possibly including hydrothermal activity) under subaqueous conditions.

## Introduction

Precambrian iron formations represent interesting problems for uniformitarian geologists. Their origin and possible depositional setting have not been conclusively resolved because no modern environment currently exists from which comparisons can be derived. However, several models have been proposed in an attempt to explain their origin and/or diagenetic development (e.g., Dimroth, 1979a, 1979b; Govett, 1966; Gross, 1965; Lepp and Goldich, 1964; Lewis and McConchie, 1994).

Within the continental United States there are only three areas where Precambrian iron formations are found: the Lake Superior region, the northern Rocky Mountains, and the desert southwest (Bayley and James, 1973). Within the southwestern United States, the best exposures of these iron-rich layers are found in the Pikes Peak Iron Formation of Arizona.

The Pikes Peak Iron Formation, within the Precambrian Yavapai Series, outcrops in several areas near the Creation Research Society's Van Andel Creation Research Center (Figure 1). These rocks are exposed within the Transition Zone geomorphic province (Froede, Howe, Reed, Meyer, and Williams, 1997). We conducted a preliminary investigation of several outcrops of the Pikes Peak Iron Formation within this area. We propose that the Precambrian Yavapai Series (which contains the Pikes Peak Iron Formation) represents volcanically-derived sediments which were deposited during the early stages of the Flood. Because of burial, heat, pressure, volcanism (including hydrothermal activity), and tectonic activity associated with the Flood event, the original volcaniclastic sediments have been subsequently altered to form low to medium grade metamorphic rocks (Yavapai Series) containing lenses of iron-rich chert (i.e., Pikes Peak Iron Formation).

A glossary of terms is provided at the end of this article to aid the reader in understanding some of the geological terminology.

### Precambrian Yavapai Series Pikes Peak Iron Formation

The Precambrian Yavapai Series strata are exposed across a broad area of Yavapai County and along northern portions of Maricopa, County, in central Arizona (Figure 1). Within these Precambrian rocks are a series of iron-rich chert layers identified as the Pikes Peak Iron Formation (dated as Early

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[1] At this location, "Pikes" is spelled with no apostrophe.

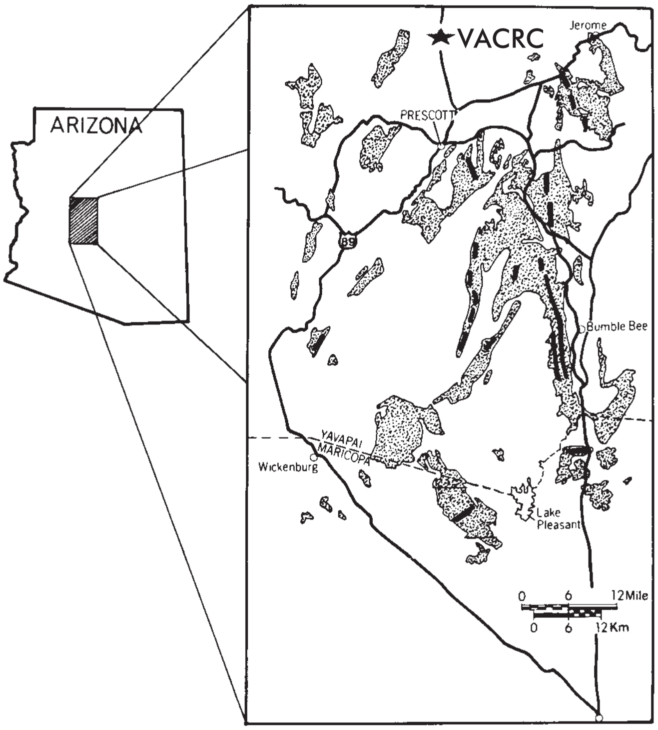


**Figure 1. Generalized map showing the extent of the Precambrian Yavapai Series rocks as they are exposed across Yavapai and Maricopa, Counties.The Yavapai Series (Precambrian) are shown stippled and the Pikes Peak BIF outcrops are shown as solid black lines.The Creation Research Society's Van Andel Creation Research Center is located to the north of Prescott, within close access to several locations from which the Pikes Peak BIF can be examined.Modified from Figure 1 in Slatt, Heintz, Lowry, and O'Hara, 1978.**

Proterozoic—1.75 Ga (billion years old). Because the Pikes Peak Iron Formation exhibits distinct stratigraphic layering, it has the characteristics of a banded iron formation (BIF) [Figure 2], referred to hereafter as the Pikes Peak BIF.

According to Bayley and James (1973, pp. 955-956), the Yavapai Series of central Arizona is described as:

> …a complex sequence of rocks, dominantly of volcanic origin, more than 20,000 feet thick. Flows and volcanic breccias range in composition from basaltic to rhyolitic, and interbedded sediments consist mainly of volcanic materials.

Presently no fossils have been identified within the Yavapai Series which would allow for biostratigraphic dating or paleoecological reconstruction. However, using its lateral position to fossil-bearing strata, combined with radiometric dating, the Yavapai Series has been estimated as forming 1.6 to 1.82 Ga before present (Anderson, Blacet, Silver, and Stern, 1971, p. C1; Lanphere, 1967, p. 757).

According to Slatt, Heintz, Lowry, and O'Hara (1978, p. 73) the Pikes Peak BIF:

> …consists of a series of lenticular bodies of interlaminated chert and iron oxide which form an outcrop belt about 6 km (4 miles) long by 700 m (2300 feet) wide within more areally extensive phyllites and associated meta-volcanic rocks. (parenthesis ours)

The Pikes Peak BIF has steeply dipping beds that strike N. 60 E. (Lindberg, 1989, p. 207). The tectonic event which resulted in the deformation of not only the Pikes Peak BIF, but the entire Yavapai Supergroup is called the Yavapai Orogeny (Nations and Stump, 1996, p. 116).

In our field work within this area we noticed a variability in the thickness and composition of the iron-rich layers, and in the adjacent phyllites and schists (Figure 3). The Pikes Peak BIF varied from brown to red jasper cherts which were interbedded with magnetite and hematite-rich layers and bounded by phyllites and schists (Figure 4). In many places the upturned iron-rich rocks formed ridges, because they are harder and erode at a slower rate than the surrounding strata (Figure 5).

It is noteworthy that the Pikes Peak BIF is physically similar to many of the other BIFs found across the globe (e.g., Blatt, Middleton, and Murray, 1972, p. 577).

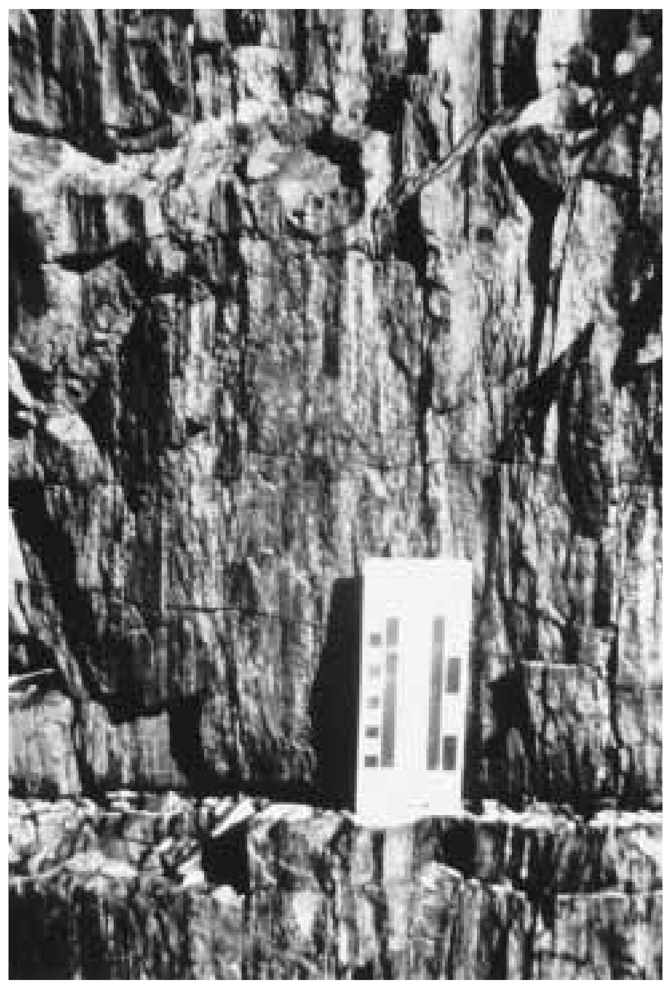

**Figure 2. Banded iron layers are exposed in a near vertical orientation due to the tectonic forces experienced following original deposition. The layering is alternating brown to red jasper cherts interbedded with magnetite and hematite-rich layers. Scale is in inches and centimeters.**

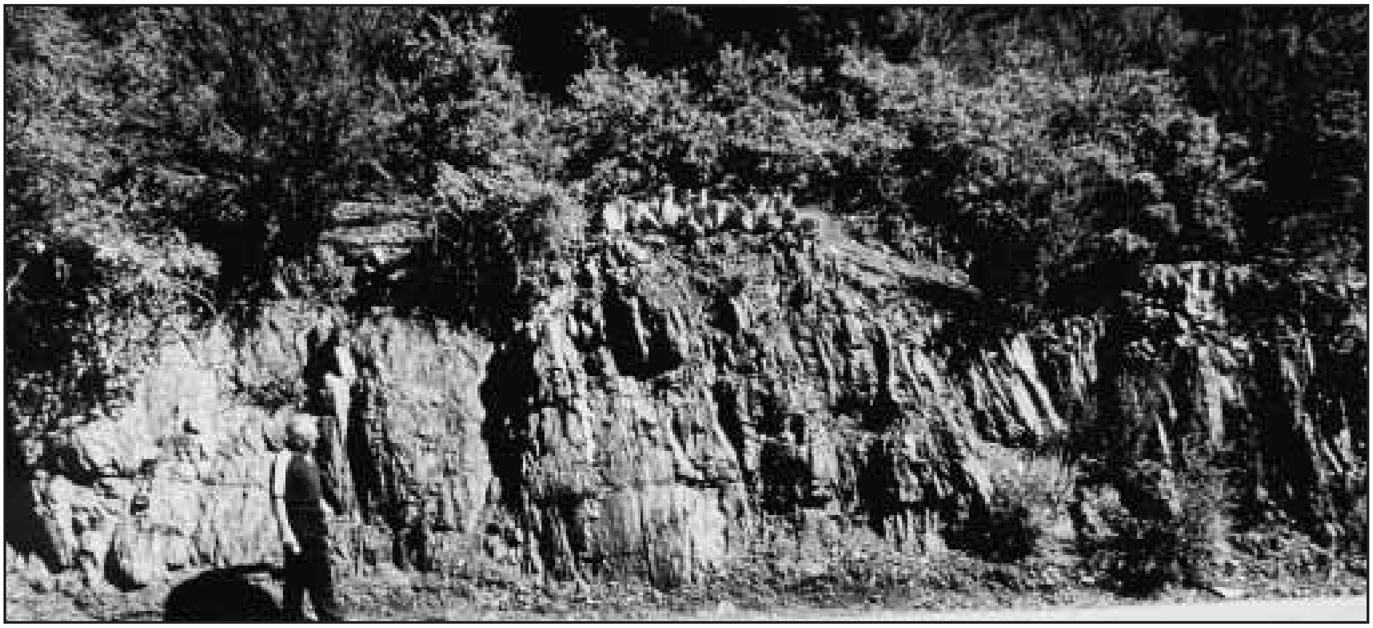

**Figure 3. An outcrop of Pikes Peak BIF bounded by phyllites and schists. Note person at left for scale.**

## Economic Significance

The Pikes Peak BIF is recognized as a possible economical source for iron. As part of an United States Bureau of Mines investigation, Farnham and Havens (1957, pp. 1–2) examined the potential reserves within a limited outcrop area of the Pikes Peak Iron Formation. They determined that the iron could be open-pit strip mined to a depth of 400 feet below grade with approximately 30 percent of the minable material providing iron ore. Although this report only addressed the Pikes Peak BIF for a limited area, it does provide an understanding of how and where the concentrated iron deposits lie both in outcrop as well as in the subsurface. Likely the iron lenses were at one time concentrated areas of iron-rich sediment, which reinforces our understanding of the original sediments probably being formed within a volcanic (possibly hydrothermal) environment.

## Depositional Environment

Several depositional environments have been proposed within the uniformitarian model in an attempt to explain the occurrence of banded iron formations (e.g., Gross, 1980, 1983; Isley, 1995; James, 1954, 1992; Trendall, 1968). Gross (1965, p. 89) originally classified the world's iron formations into six different types. Bayley and James (1973, p. 936) have stated that the Pikes Peak BIF is most closely characterized by the "Algoma Type" of iron-rich strata.

Gross (1965, pp. 90-91) described the "Algoma Type" of Precambrian iron formation as:

> …characteristically thin banded or laminated with interbands of ferruginous grey or jasper chert and hematite and magnetite. They are intimately associated with various volcanic rocks including pillowed andesites, tuffs, pyroclastic rocks, or rhyolitic flows and with greywacke, grey-green slate, or black carbonaceous slate. Tuff and fine-grained clastic beds or ferruginous cherts are interbedded in the iron-formation and detailed stratigraphic successions show heterogeneous lithological assemblages. *The associated rocks indicate a eugeosynclinal environment for their formation and a close relationship in time and space to volcanic activity.* (emphasis ours)

Slatt et al. (1978, p. 81) have postulated the origin of the Pikes Peak BIF as:

> …at least three cycles of deltaic sedimentation led to the development of the Pikes Peak deposit. Each cycle of sedimentation is represented by prodelta and delta front phyllites overlain by tidal flat cherty iron oxide. Chemical sedimentation in very shallow water might

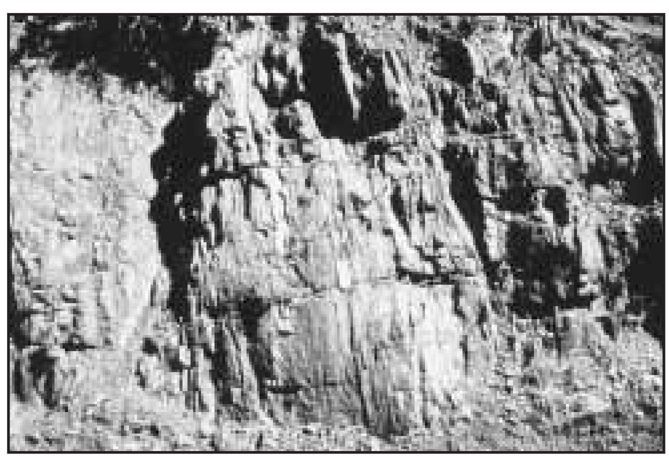

**Figure 4. The Pikes Peak BIF is a massive series of iron-rich chert layers which exhibit the typical physical features of BIF found in many other places across the globe.**

**Figure 5. As a hardened chert layer, the Pikes Peak BIF resists erosion better than the surrounding phyllites and schists. Hence, in many places the BIF is typically exposed as a ridge or as in this case a wall.**

indicate the iron was derived from terrestrial chemical weathering.

The proposal of a Precambrian prograding deltaic paleoenvironment implies millions of years of deposition, much volcanic activity, and iron containing volcanic sediments. However, this imagined iron-rich deltaic depositional environment does not exist anywhere on Earth today. Additionally, no deltaic environment (even within a volcanic setting) has ever been suggested as providing substantial iron deposits in any form—this is a first for the prograding delta model.[1]

We propose a high-energy subaqueous volcanic setting from which both volcanic sediments and iron-rich layers were derived. Additionally, possible hydrothermal activity within this paleo-volcanic setting could also explain the formation of the iron-rich and chert layers. Interestingly, a recognized source of iron found within iron-rich sedimentary rocks has been attributed to volcanic sources. Pettijohn (1976, pp. 420-421) has stated:

> The appeal to volcanism as a source of iron (and silica) arises from the presumed inadequacies of ordinary processes to supply and transport iron in sufficient quantities. *The evidence for a volcanic source is the presumed close association in time and space of iron sedimentation and volcanism.* (emphasis ours)

The Precambrian Yavapai Series is clearly derived from volcanic sources, thus it is logical to assume that the Pikes Peak BIF is also derived from volcanic sources. This is the most parsimonious approach to the interpretation of the Precambrian Yavapai Series (and specifically, the Pikes Peak BIF). Note that Gross (1965) and Pettijohn (1976) both agreed that the occurrence of iron-rich rock is best explained within a volcanic environment, and Cloud (1983) has noted problems with the various non-volcanic BIF depositional models.

The close association of the Precambrian Yavapai Series/Pikes Peak BIF with volcanically derived sediments and stratigraphically adjacent massive sulfide deposits suggests a non-uniformitarian (i.e., catastrophic) approach to solving the origin of this strata. All of these strata reflect a former volcanic depositional environment which operated over a very short period of time.

## Young-Earth Flood Model

The young-earth catastrophist must use the physical information and the framework provided by the biblical historical record to evaluate suggested uniformitarian interpretations. The position of strata within a Flood-based stratigraphic column may be established by reference to changing energy levels as inferred from geologic materials (Reed, Froede, and Bennett, 1996). This approach is one possible method of discussing the origin and development of strata within the framework of a creationist geological timescale (e.g., Froede, 1995; 1998; Walker, 1994).

This catastrophic method focusses on the energy conditions under which the sediments were deposited, rather than by the passage of time (the uniformitarian approach). It also eliminates uniformitarian paleo-depositional environments which are believed to have existed for millions of years. In summary, physical evidences (i.e., sedimentary deposits exhibited at various rock outcrops, as well logs, and as cores) are reinterpreted within the context of a biblical-catastrophic framework.

[1]This interpretation clearly falls outside the realm of science, i.e., it is neither demonstrable nor does it correspond to a modern day analogy. This proposal illustrates the great lengths to which uniformitarian scientists will go in order to explain the physical evidences within their model!

There are several creationist proposals which explain how the Precambrian strata might fit within the Young-Earth Flood model. Snelling (1991) and Woodmorappe (1983) have suggested that any fossils/organic matter found within the Precambrian strata should relegate them to Flood deposits. Precambrian strata which do not contain any former evidences of life would then date to the creation week. Counter to this proposal, Wise (1992) and Austin and Wise (1994) have suggested that some types of fossil-containing Precambrian strata were formed before the Flood, and reflect the activities associated with the third day of the creation week (see Appendix A). Hunter (1992) proposed that all of the Precambrian, (based on petrology and lithology) should be considered Flood deposits.

Presently, there are no fossils or organic materials reported within the Precambrian Yavapai Series or specifically within the Pikes Peak BIF which might help us determine their time of deposition.[2] However, we believe that several factors help us to establish the timing for the formation of the Precambrian Yavapai Series as being derived during the earliest stages of the Flood (i.e., Lower Flood Event Division). Our interpretation is based on the high-energy levels required to account for the volcanic sediments, their burial under hundreds if not thousands of feet of additional sedimentary materials, followed by tectonic activity, and then tremendous erosion which must have followed to expose these rocks at the Earth's surface.

Within this same general area are Precambrian massive sulfide deposits which were emplaced under subaqueous conditions (Anderson and Creasey, 1958; Anderson and Nash, 1972; Bouley and Hodder, 1976; DeWitt, 1979). These sulfide deposits lie immediately adjacent to and sometimes include portions of the Precambrian Yavapai Series. Hence, these sulfide deposits reinforce our suggestion that the Pikes Peak BIF was emplaced in a subaqueous environment which would clearly fit within a Flood (i.e., Lower Flood Event Division) setting.

## Conclusions

Our preliminary investigation of the Precambrian Pikes Peak BIF reveals a complex association of iron-rich rocks within the surrounding Yavapai Series phyllites and schists. These Precambrian deposits have undergone deformation and alteration via complex tectonic forces which have destroyed any pre-existing fossil information they might have contained. Therefore any interpretation is limited to sediment type, stratigraphic position, and alteration history.

We propose that the Pikes Peak BIF found within the Precambrian Yavapai Series was formed at the onset of the Flood Event. Volcanic and tectonic activity associated with this high-energy event rapidly buried this area under a tremendous volume of rock; volcanic, then carbonate and clastic sediments transported from adjacent areas.[3] Heat, pressure, and pore fluid chemistry could have then altered the Pikes Peak BIF to its present state. Later tectonic activity deformed the strata, and erosion (still associated with the Flood) removed much of the overburden and exposed the now upturned strata. All of this activity resulted in the exposure (within the Transition Zone Province) of tilted and hardened iron-rich chert (e.g., Pikes Peak BIF) with adjoining phyllites, schists, and massive sulfide deposits (i.e., Precambrian Yavapai Series strata).

This is not the only possible interpretation within the Young-Earth Flood model. As creationists conduct additional research into these rocks this interpretation could change. But it serves as a starting point. Only through additional field work will we better understand the variability of the Yavapai Series rocks, and the Pikes Peak Iron Formation.

## Appendix A—Precambrian Strata and the pre-Flood/Flood Boundary

Although the authors have tentatively interpreted the Pikes Peak BIF genetically within the Genesis Flood event, other creationists have discussed the relationship of Precambrian rocks to the boundary separating initial Flood deposits from pre-existing (i.e., Creation Week) strata. Prominent among these are Austin (1994), Wise (1992), and Austin and Wise (1994), who considered several problems surrounding such a classification, and have proposed five criteria for defining a pre-Flood/Flood boundary. Although each of these criteria deserves much discussion, we focus on only one—the "Paleontological Discontinuity."[4] Austin and Wise (1994) define this boundary between strata as separating fossils of simple life forms (i.e., microfossils) from those containing fossils of more complex life forms (i.e., macrofossils).

Historical observation does allow broad classification of sedimentary units by fossil content: (1) those containing both microfossils and macrofossils, (2) those containing microfossils, but no macrofossils, (3) those containing neither (assuming observational knowledge and methods are adequate to justify the claim of a blanket negative), and (4) those containing macrofossils, but no microfossils (again, presuming on observational method). During the development of the uniformitarian geologic column, the existence of these observed classes of sedimentary rocks carried tremendous historical significance for naturalists, because the

[2] In this case we do not propose using fossils in a biostratigraphic sense. Rather, we suggest that fossils could help us determine if the strata in question are Flood deposits in a manner suggested by both Snelling (1991) and Woodmorappe (1983).

[3] This area within the Transition Zone was probably once a part of a much broader Colorado Plateau; this proposal is based on similar strata (Froede, Howe, Reed, Meyer, and Williams, 1997).

[4] We focus on this particular discontinuity because it has the greatest bearing on this article. We do not support the uniformitarian age dates assigned to the Precambrian strata, but believe that most, if not all, of these "oldest" strata represent Flood deposits.

transition from microfossils to macrofossils was thought to reflect a historical development (i.e., the rocks are evolutionary clocks). Under the uniformitarian framework, observed sequences of these strata (microfossils only to macrofossils and microfossils, or to macrofossils only) allowed correlation of the strata between widely spaced locations, based on the singularity of the historical evolutionary event.

If Austin and Wise (1994) are proposing a boundary to set the global "clock" (initial Flood event) based upon the same transition from microfossils to macrofossils, then the similarity of their proposed global model to that applied during the historical development of the uniformitarian geologic column is close enough as to require significant discussion to differentiate between an evolutionary and a nonevolutionary cause for the proposed transition. The similarities are twofold: both in the significance attached to the observed differences in the fossil content of various units; and in the use of those differences as an indicator of time presumed to apply globally. The difference would reside in the rejection (as advocated many times by both Austin and Wise) of the causal mechanism of naturalistic evolution as well as its implied context of long ages of uniformitarian history. However, because of the similarity of the method, the possibility exists for misunderstanding and misinterpreting their position. Therefore, the authors encourage Austin and Wise to continue to develop their differences vis a vis uniformitarian Precambrian constructs and the role of fossils as time indicators.

Based partly on the "Paleontological Discontinuity," Austin and Wise (1994) associate the boundary between pre-Flood and Flood strata with the Great Unconformity at the Precambrian/Cambrian boundary in the Grand Canyon (dated at 570 million years). If their definition is valid, and if it can be correlated regionally following strata classified by the uniformitarian framework, then the authors' classification of the Pikes Peak BIF (dated at 1.75 Ga) as Flood strata would obviously be in error. However, the first of these assumptions appears premature based partly upon the published work of Burdick (1974) [repeated by Howe et al. (1988), and discussed by Williams (1997)] that reported the presence of pollens in the Hakatai Shale (dated at 1.25 Ga)—which is well below the Austin/Wise (1994) proposed pre-Flood/Flood boundary. Austin (1994) does not believe that his model is consistent with those observations, and expresses doubt as to the nature of the pollen found in the Hakatai. He does admit the presence of pollen grains within the rock, but relates it to modern pollens infiltrating into pores within the shale (Austin, 1994, p. 137). If the conclusions of Austin (1994) and Burdick (1974) and Howe et al. (1988) exhaust the possibilities, then creationists are faced with a happy dilemma. Either Burdick (1974) and Howe et al. (1988) have demonstrated spectacular contrary evidence to the geologic timescale, or Austin has discovered a mechanism that would not only cast doubt on the work of Burdick (1974) and Howe et al. (1988), but on any work ever done in similar conditions by any palynologist on any sedimentary unit. Within the uniformitarian framework of deposition, emergence, reburial, and re-emergence, could not many palynological discoveries (currently used as time index fossils) be unrelated to the original timing of deposition of a given unit? If the infiltration model can be tested and demonstrated, then Austin's insight will require a significant reevaluation of modern palynology. We hope to see publication of details of this model. Until that time, or until the observations of Burdick and Howe et al. have been rigorously refuted, we accept that work and the uncertainties it adds to the ubiquitous use of a "Paleontological Discontinuity," and look for other means to falsify our tentative interpretation of the Pikes Peak BIF.

In response to the second assumption of the synchronous correlation of the strata from the Grand Canyon to the observed BIF outcrops, the authors encourage the use of interpolation rather than extrapolation in extending catastrophist stratigraphic boundaries from local to regional, or even global scales. The compressed timing of Flood events would imply correlating the rock record by similar events, which though similar in depositional style, could be non-synchronous across a broad area. In other words, the onset of the Flood event may leave similar evidence in the rock record, but the time factor must be reduced in significance from that applied in a uniformitarian context. For example, the deposition of marine carbonates may have been proceeding at a downdip location at the exact moment that underlying "shoreline" transgressive clastics were being laid down updip. We would encourage other creationists to work towards defining key boundaries and units locally at a variety of locations on the basis of depositional events, so as to provide a broader empirical basis in an interpretative framework more congenial to the Biblical record.

## Glossary

Banded Iron Formation (BIF)—Iron formation that shows marked banding, generally of iron-rich minerals and chert or fined-grained quartz.

Diagenesis—All the chemical, physical, and biologic changes undergone by a sediment after its initial deposition, and during and after its lithification.

Eugeosyncline—A geosyncline (i.e., a basin on a continental landmass adjacent to an ocean) in which volcanism is associated with clastic sedimentation. From a plate tectonic perspective this would be a basin which develops between a volcanic fore-arc and a subduction zone. Volcanic sediments would mix within this setting with continental derived clastic deposits. Somehow all of these deposits result in the formation of BIF.

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*CENTJ—Creation Ex Nihilo Technical Journal*
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# Call for Papers
# The Second CRS Monograph on Astronomy

Due to the popularity of the first CRS monograph on astronomy, *Design and Origins in Astronomy,* edited by the late George Mulfinger, the CRS has decided to publish a second astronomy monograph. We are interested in original papers, but would consider revisions of papers that have appeared in the *Creation Research Society Quarterly* in the past 15 years. Submissions on all topics of astronomy are encouraged. For submissions or additional information, contact Danny R Faulkner, 1402 University Dr., Lancaster, SC 29720. H: 803-286-9781 O: 803-285-7471 e-mail: Faulkner@gwm.sc.edu

# Errata

CRSQ 34(4), March 1998, page 219. The lowest section was omitted from Table II.

**Table II. Regional Stratigraphy of Western Colorado, adapted from Lohman (1965), Prather (1982), and Young (1984).**

| Uniformitarian term for time periods | Thickness in feet | Rock layers exposed in Grand Mesa-Uncompahgre area |
|---|---|---|
| Miocene | 100 | Basalt cap |
| Eocene | 1000 | Green River Formation |
| Paleocene | 1,700 | Wasatch Formation |
| *Unconformity* | | |
| Late Cretaceous | 1,500 | Mesa Verde Formation |
| Late Cretaceous | 3,800 | Mancos Shale |
| Late Cretaceous | 150 | Dakota Formation |
| Late Cretaceous | 60 | Burro Canyon Formation |
| Early Cretaceous | 600 | Morrison Formation |
| Late Jurassic | 54 | Summerville Formation |
| Late Jurassic | 150 | Entrada Sandstone |
| *Unconformity inferred* | | |
| Late Triassic | 45-80 | Kayenta Formation |
| Triassic | 530 | Wingate Sandstone |
| Triassic | 80-100 | Chinle Formation |
| *Unconformity* | | |
| Precambrian | | crystalline rocks |

*CRSQ* 34(4), March 1998, page 218. In the abstract, "steam" should be "stream."

*CRSQ* 34(4), March 1998, page 248. In "Tasso's Creation" the next to last line in the first paragraph should be "God" instead of "Cod."

CRSQ 34(4), March 1998, page 258. The book review author's address was omitted:

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Creation Education Resources
P.O. Box 1853
Orange Park, FL 32067-1853

*CRSQ* 34(4), March 1998, page 256. Line 8 from the bottom of the first column should read, "Thanh, a family relative from Vietnam who is a practicing civil engineer with..."

*CRSQ* 34(4), March 1998, page 256. Line 17 of the second column should read, "Dr. Imaizumi, now quite aged, is also not known to have changed his views (Kasuya, 1997)." Line 23 has an erroneous repeat of the original line.

*CRSQ* 34(4), March 1998, page 256. Line 21 from the bottom of the second column should read "decomposing sharks, was that what they had caught was indeed very different and unusual."

*CRSQ* 34(4), March 1998, page 257. Line 2 from the end should read "was" instead of "has."