SUPPLEMENTAL

FIELD

LOCALITIES

WESTERN UNITED STATES

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SUPPLEMENTAL FIELD LOCALITIES

INTRODUCTION

Over the years, the author has conducted many geological field conferences on several continents. Several individuals have requested that information about the location, reference material, and discussions, for the various localities be made available. The main stops of field conferences are described in field conference printed field guides, which give specific location data:

A GUIDE TO SOME LOCALITIES OF GEOLOGICAL AND PALEONTOLOGICAL SIGNIFICANCE IN NEW SOUTH WALES AND NEW ZEALAND. 1992.

A GUIDE TO SOME GEOLOGICALLY SIGNIFICANT AREAS OF THE ALPS. 1998.

AN INTRODUCTION TO SOME GEOLOGICALLY SIGNIFICANT LOCALITIES OF THE COLORADO PLATEAU. 1999.

AN INTRODUCTION TO SOME GEOLOGICALLY SIGNIFICANT LOCALITIES OF THE COLORADO PLATEAU. 2003.

GENESIS AND GEOLOGY ON THE COLORADO PLATEAU. 2007.

In addition to these field guides, there are a number of localities that were not included but were visited under special circumstances as time and interest allowed. Sixteen supplemental localities are described in this set, giving the specific locations (sometimes GPS), descriptions, references, and comments from a creation-Flood perspective. They are all in the western United States, and vary from simple fossil localities to extended discussion and references for further study. High resolution figures are provided for quality reproduction. All are copyright free. To facilitate travel plans, a map indicating the general location of each site follows on the next page, the numbers correspond to the listing below. Item 16 has three localities on the map.

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LOCALITIES

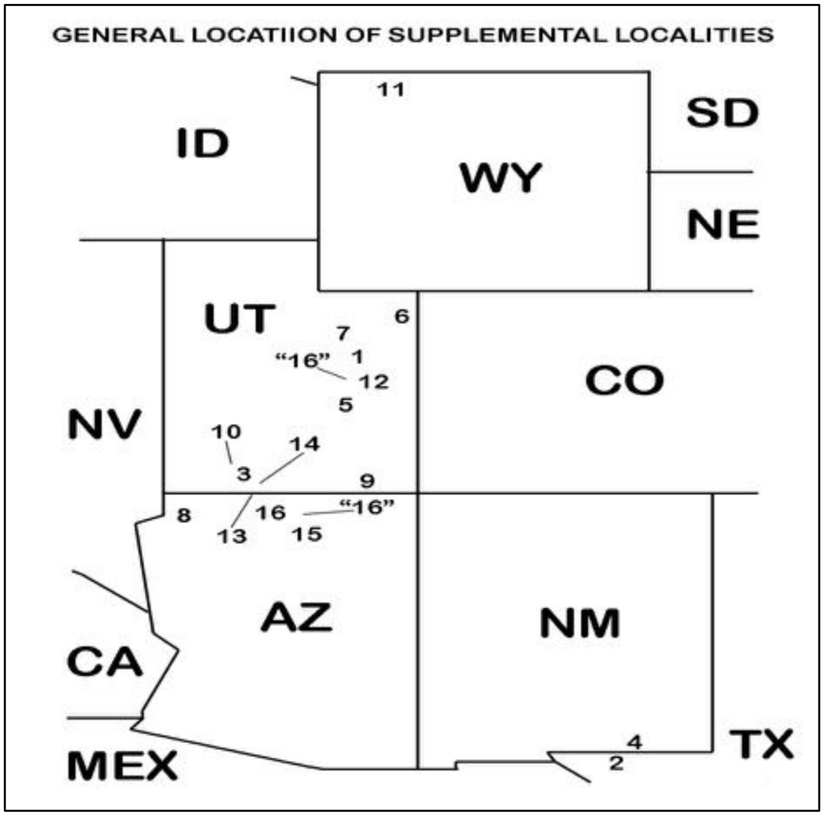

Figure 1. Western United States. Numbers refer to the supplemental field localities listed above..

1. THE BOOK CLIFFS

LOCATION

You can see the Book Cliffs most anywhere along US highways 6 and 191, between Price and Green River, in central-eastern Utah, and further east along Interstate highway 70 from Green River to the Colorado State line and beyond. A good place to view it is 1.5 miles just north of the inconspicuous bridge over the Price River along US 6 and 191 by the little town of Woodside (GPS 39.28643 – 110.35132). Furthermore, you can conveniently examine good exposures of coal from these cliffs (Blackhawk Formation) north of the town of Helper. Go to the deep roadside cuts (GPS 39.72836 – 110.86763), on US 6 just north of the "Castlegate" junction of US 6 and 191. Just a little further north on US 6, you will find ample parking on the east side of the road, and smaller coal seams in the scarp on the west side. Here, looking to the north, note also the thick, massive Castlegate Sandstone that forms the vertical steep cliffs of the region. Still further north, where the road reaches the level of the Castlegate Sandstone there is a narrow "gate" passage, hence the name "Castlegate."

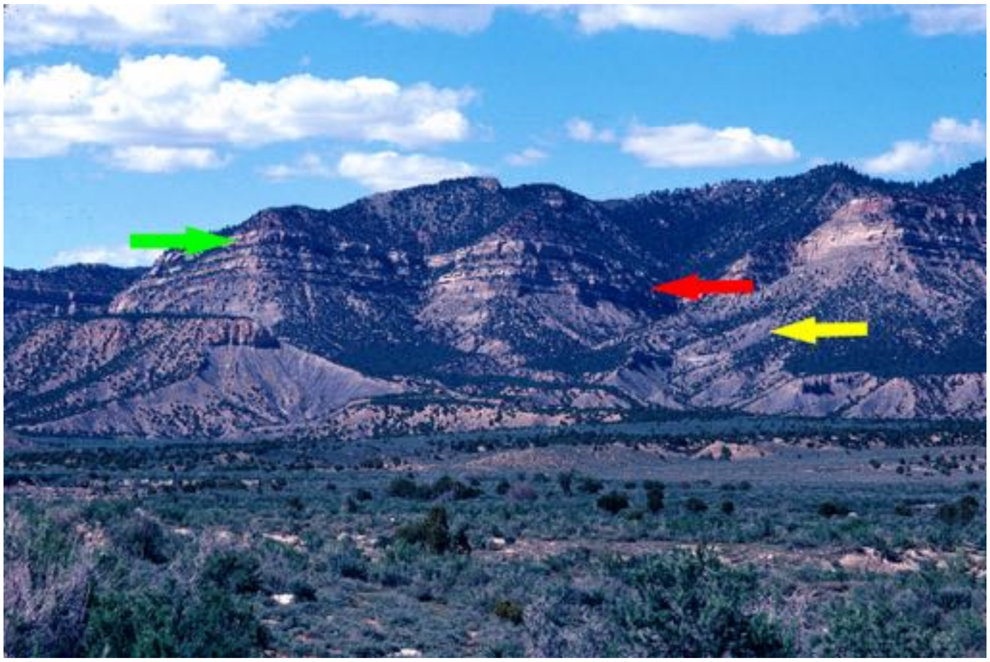

Figure 1. View of the Book Cliffs between Sunnyside and Woodside, Utah. The green arrow points to the single widespread Castlegate Sandstone layer, the red arrow to the many sandstone layers of the Blackhawk Formation below the Castlegate, and the yellow arrow to the thick Mancos Shale that forms the lower part of the cliff.

DESCRIPTION

The Book Cliffs are widespread, mostly Cretaceous deposits of considerable commercial value because of their coal and natural gas. The name "Book Cliffs" is likely because the cliffs can be viewed as the edge of a bound book lying on its side with the Castlegate Sandstone and other similar resistant layers representing the hard top cover, and the sometimes undercut softer dark sediments representing the pages lying below.[1] Others suggest that the pages of a book are represented by the fine lamina of the distant Eocene Green River Formation that lies further above, while still others attribute the name to the many deep narrowing valleys in the region representing the open regions between the pages of a partially open vertically oriented upright book.

Figure 1, from the region west of Woodside gives you a view of the main divisions of the Book Cliffs. The green arrow points to the dominant layer of this region, the Castlegate Sandstone. Just below this layer are several thinner sandstone layers, intercalated with dark grey shales, forming the Blackhawk Formation (red arrow). The thick, dark grey lower slope below is the widespread Mancos Shale (yellow arrow) found in Utah, Colorado, New Mexico, and Wyoming.

The Castlegate Sandstone is one of many major units of the region extending to the east, from west of Price, UT for well over 160 kilometers (100 miles) clear into Colorado. Its thickness and particle size decrease, as you follow it from west to east. It is 150 meters (500 feet) thick west of Price, decreasing to10 meters at the Utah-Colorado state line, and gradually thins to insignificance further east.[2] The unit, which is recognized as a formation, also extends more than 80 kilometers (50 miles) southwest from Price, Utah; it may have originally covered more than 10,000 square kilometers (4,000 square miles). In the long geologic ages development model[3] it is proposed that deposition took some 5 million years. Braided streams and floodplains added sediments coming from uplifts in the west, and distributed in a mixed environment of rivers and shorelines as an inland seashore migrated to the east. Both tectonic variations in the land and/or sea level changes are sometimes invoked in the assumed depositional process. There is an abundance of literature about this formation that in recent years tries to incorporate sequence stratigraphic interpretations, that assume slow cyclic patterns of changes in environmental conditions, as sediments are deposited. These interpretations have generated an abundance of disagreement,[4] and likely reflect the speculative nature of sequence stratigraphic interpretations.

The Blackhawk Formation lies below the Castlegate Sandstone and is more restricted to the western region of the Book Cliffs. It has yielded abundant coal deposits (Figure 2). The formation is interpreted as a group of four or more cycles of deposition involving repeated sequential changes from open marine, to shoreline, to intertidal (foreshore), to coal-forming swamp and lagoon environments.[5]

The main unit below the Blackhawk is the Mancos Shale. This huge dark deposit, sometimes reaching a thickness of 1.5 kilometers (5000 feet), is attributed to the accumulation of fine sediments in an ancient sea that was retreating to the east. In the western region, such as around Price, there is considerable intertonguing with sandy units that thin out towards the east, thus implying a western source. Just a little below the Blackhawk Formation, there is a sandy unit called the Panther Tongue that gives some evidence of rapid action because of the interflowing of separate sedimentary units that had to be soft.[6] Further down into the Mancos, large units of dominantly sandstone units also thin out to the east indicating a western source. These are not as widespread as the Castlegate Sandstone, but the Emery Sandstone has also been reported in the Henry Mountains to the southeast 90 kilometers (60 miles) from its type locality, although this is disputed. The Ferron Sandstone is found in the Moab region that lies 130 kilometers (80 miles) to the east of where it is found as a thicker unit in the eastern cliffs of the Wasatch Plateau.

Figure 1. Coal seams (arrows) in the Castlegate road cut. Note their flat structure and also the sandstone parting across the lower part of the lower coal seam.

A CREATION-FLOOD PERSPECTIVE

As one examines the exposure of the Book Cliffs for well over a hundred miles from west to east, one becomes aware of the striking flatness and lateral continuity of the many sedimentary units for scores of kilometers or miles. The Book Cliffs illustrate the contrast between our present continental topography, that is dominantly irregular, and the dominantly flat topography of the widespread sedimentary layers of the geologic record. This is not what we would expect from slowly changing local deposition regimes over the assumed eons of time. It is more what we would expect from widespread catastrophic activity from the Genesis Flood. We do find a few widespread deposits being laid down at present on our continents, such as the delta of the Niger River in Nigeria that is likely even larger than the Castlegate Sandstone ever was. However, the issue is more one of the dominance of one flat layer above another. These relatively thin widespread layers had to have flat surfaces on which to be deposited, and such flat surfaces are very rare on our continents. Renowned paleontologist Norman Newell reflects on this as he comments about some paraconformities (flat gaps) in the geological record and lists five references to back up his view:

> Search for present-day analogues of paraconformities in limestone sequences is complicated by the fact that most present configurations (topography, chemistry, circulation, climate) are strikingly unlike those that must have prevailed when the Paleozoic and Mesozoic limestone seas spread over immense and incredibly flat areas of the world (Shaw, 1964; Curray, 1964; Irwin, 1965; McGugan, 1965a, 1965b). Closely comparable epeiric seas probably do not exist today.[7]

The "immense and incredibly flat areas of the world" are more in accord with what would be expected from a worldwide Flood.

The same can be said for the lagoon and swamp interpretation for the coal layers in the Blackhawk Formation (Figure 2). These are so flat that they reflect transported deposits as expected from catastrophic activity, instead of representing irregular local plant growth interpretations for swamps and lagoons. This has been recognized in the geologic literature.[8] The thin even sandstone parting seen throughout the lower part of the lower coal seam in Figure 2 adds further evidence for rapid lateral transport instead of local swamp formation.

The Book Cliffs are found in the Cretaceous part of the geologic column, and this is towards the top region of the geologic column. In the context of the Genesis Flood, this permits the suggestion that some of these layers might represent the redeposition of sediments towards the end of the Flood as the waters gradually receded from the continents. In the biblical account of this (Genesis 8:3) some translators (e.g. the marginal option of the King James Version, or Young's Analytical Concordance to the Bible) describe the usual "continual[9]ly" translation instead as "in going forth and returning" or "going and returning." These latter translations of that verse allows one to conceive of back and forth cycles of activity as the waters of the Flood gradually abated. This kind of activity may be responsible for the four or more cycles of the Blackhawk mentioned above. The repeated layers of the Eocene flysch, common to the European Alps, may have been deposited by the same kind of "going and returning" activity. This is only a suggestion.

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[1] Fisher DJ, Erdmann CE, Reeside, Jr. JB. 1960. Cretaceous and Tertiary Formations of the Book Cliffs, Carbon, Emery, and Grand Counties, Utah, and Garfield and Mesa Counties, Colorado. US Geological Survey Professional Paper 332,

[2] For detailed mapping of the Book Cliffs, see Young RG. 1955. Sedimentary facies and intertonguing in the Upper Cretaceous of the Book Cliffs, Utah-Colorado. Bulletin of the Geological Society of America 66:177-202.

[3] Miall AD, Arush M. 2001. The Castle Gate Sandstone of the Book Cliffs, Utah: Sequence stratigraphy, paleogeography, and tectonic controls. Journal of Sedimentary Research 71(4):537-548.

[4] Yoshida S, Miall AD, Willis A. 1998. Sequence stratigraphy and marine to nonmarine facies architecture of foreland basin strata, Book Cliffs, Utah, U.S.A.: Discussion. American Association of Petroleum Geologists Bulletin 82(8):1596-1606; Van Wagoner JC. 1998. Sequence stratigraphy and marine to nonmarine facies architecture of foreland basin strata, Book Cliffs, Utah, U.S.A.: Reply. American Association of Petroleum

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Geologists Bulletin 82(8):1607-1618; Yoshida S, Willis A, Miall AD. 2001. Fourth-order nonmarine to marine sequences, middle Castlegate Formation, Book Cliffs, Utah—comment and reply—discussion. Geology 29:187-188; see also Miall AD, Arush M. 2001. listed above.

[5] Rigby KJ, Russon MP, Carroll RE. 1987. The Book Cliffs Cretaceous section: Western edge of the Interior Seaway. Geological Society of America Centennial Field Guide—Rocky Mountain Section, p 251-256.

[6] Howard JD, Lohrengel CF. 1969. Large non-tectonic deformation structures from Upper Cretaceous Rocks of Utah. Journal of Sedimentary Petrology 39:1032-1039.

[7] Newell ND. 1984. Paraconformities. In: Teichert C, Yochelson EL, editors. Essays in paleontology and stratigraphy. Department of Geology, University of Kansas Special Publication 2, p 349-367..

[8] Marley WE. 1978. Lithogenic variations of the Upper Cretaceous Blackhawk Formation and Star Point Sandstone in the Wasatch Plateau, Utah. Geological Society of America Abstracts with Programs 10:233.

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2. THE CAPITAN "REEF"

An expanded version is located in the section on CORAL REEFS

LOCATION

Located in both Texas and New Mexico, the best exposed parts of the Capitan Reef can be seen in the Guadalupe Mountains. The reef can be followed for some 40 miles, on the northwest side of US 62 and 180 between White's City (near Carlsbad, New Mexico) and the dramatic El Capitan Peak of the Guadalupe Mountains National Park of west Texas. One of the best exposures is at McKittrick Canyon (Figure 1) whose entrance is just west of the NM-TX state line. There you can gain access to the Permian Reef (Capitan Reef) geology trail that climbs up 2000 feet through the reef in 3.5 miles.

Also of interest at this locality is the famed Carlsbad Caverns, endowed with stunning speleothems (stalactites and stalagmites). Speleothems can grow inches per year when provided with the right minerals and moisture. The very dominantly dry speleothems of Carlsbad Caverns indicate that there was much more moisture in the region in the past. The caverns were dissolved out of the massive upper part of the reef called the reef core, probably by sulfuric acid coming from hydrogen sulfide gas. During the warmer seasons you can see hundreds of thousands of bats flying out of the caverns at sundown time. To get to the caverns turn northwest from US 62 and 180 at White's City.

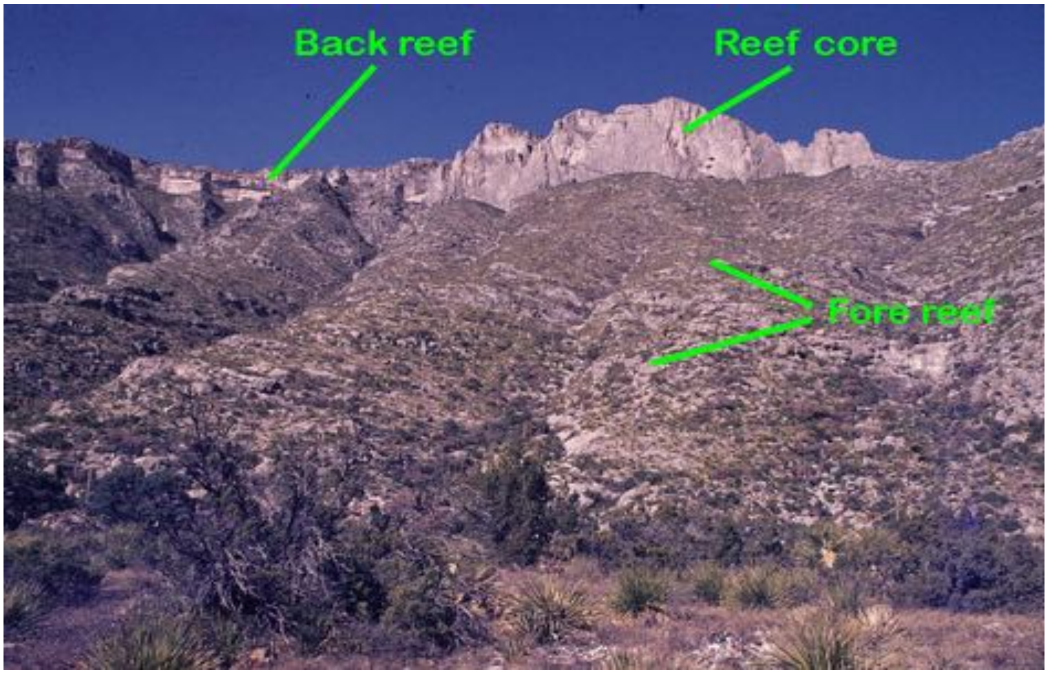


Figure 1. View to the east of the Capitan Reef from McKittrick Canyon. For the proposed relationship of the parts designated above to a modern reef, see Figure 2. Note the many extended layers sloping down to the right in the fore reef. In a normal reef interpretation these are assumed to have originated mainly from the reef core.

DESCRIPTION

The Capitan Reef, also known as the Permian Reef, is one of the most controversial and most studied fossil reefs. It is a huge structure, over 100 miles in diameter, and geologists propose that it surrounded a restricted ocean inside. Most of it is underground, but due to a later uplift creating the Guadalupe Mountains, part of it can be viewed and studied more carefully above ground. The reef does not follow the same pattern as seen in the Guadalupe Mountains when followed around its entire perimeter. What you see in the hills, extending from El Capitan peak to almost Carlsbad, is part of the northwestern segment of the reef. The rest is mainly to the south in Texas. As you travel along US 62 and 180 including the beginning of McKittrick Canyon, or at similar canyons along the reef, you are on the ocean side, which is inside the perimeter of this huge reef. The back reef and lagoon would be on the outside of that perimeter.

The structure of a modern living reef is illustrated below (Figure 2) to facilitate comparison with the Capitan Reef. Note the location of the back reef (also called shelf or backreef), reef core (also called reef massif), and fore reef (also called forereef or reef slope) on both figures 1 and 2. The massive pale cliff at the top in Figure 1 is the reef core that is the postulated main source of the backreef and forereef deposits. El Capitan peak to the southwest, is considered to be part of the forereef, the reef core lying to the north of that famous peak.

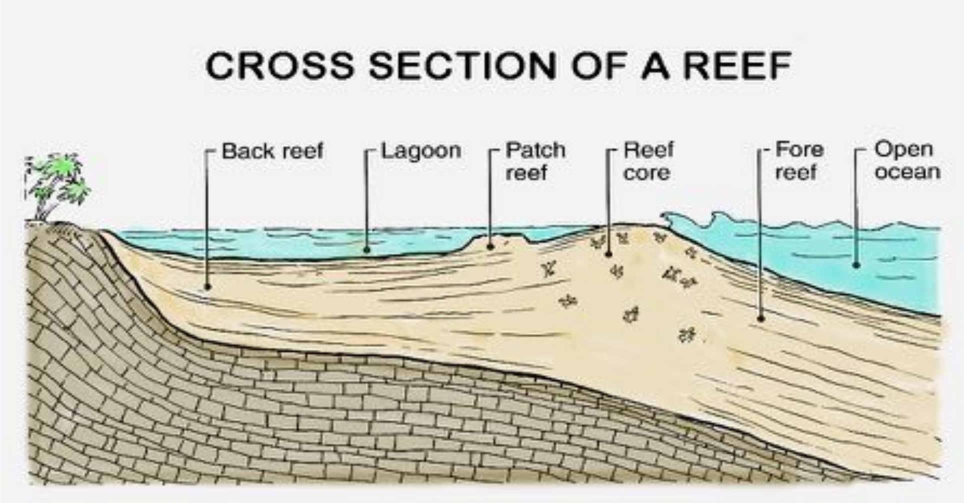


Figure 2. Cross section of a modern living reef. The reef is the light tan deposits which are produced mainly by living corals and algae growing at the surface of the reef core.

"The magnificent El Capitan is as controversial as it is classical."[10] There are many important disputations about this reef.[11] At least four basic models about how the reef is assumed to have grown have been proposed, some favoring an uninterrupted slope from backreef through the reef core to the forereef, others favoring an arresting reef core structure but with different relationships to sea level. Some argue that the reef never was above sea level while others favor different localities for sea level barriers.

How the reef core was produced is an enigma. That core is essentially mostly massive, unlayered fine lime mud but with a significant minor component of fossil sponges, bryozoans (moss animals), possible algal lamina and tubes, both of problematic biological affinities, and a few other organisms. More recently, the present trend of suggesting that all kinds of fine sedimentary layers, called microbialites, produced by microscopic microbes, has been added to the Capitan discussion.[12] The most abundant macrofossils (large fossils you can see) are sponges (Figure 3). Some think they are mostly upright in position of growth,[13] while others under the rubric "Turning the Capitan Reef upside down" favor an upside down position as they grew down from the roof of cavities[14] (Figure 4).

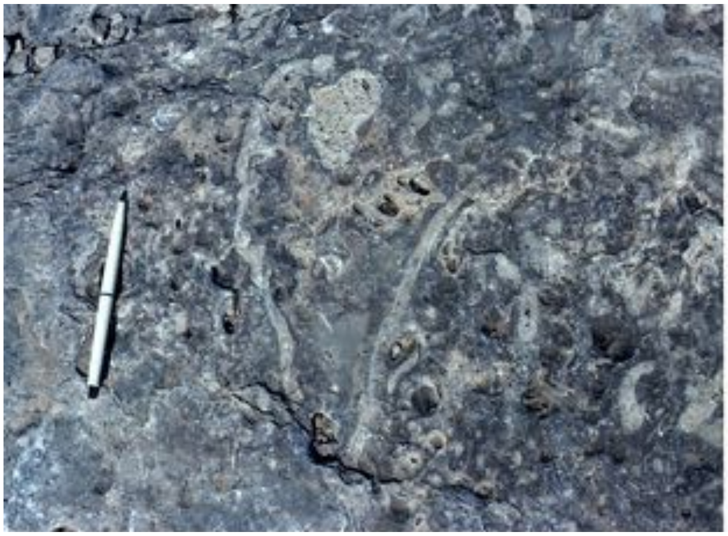


Figure 3

The pale V shaped object in the middle of the picture is a sponge from the Capitan Reef. It is lying on its side and is filled with reef sediments.

Sequence stratigraphic concepts, that are based on interpretations of slow cyclic changes, were applied to the Capitan Reef long before such studies became popular in sedimentology. Both general and detailed cyclic sequence studies have been controversial. Part of the problem is the absence of strata in the reef core that hinders correlation, but on a larger scale another problem is the incongruity of abundant sandstone deposits, especially in some of the forereef deposits (Figure 5). Reef cores produce limestone, so the sandstone is assumed to have come from the backreef or beyond. Some suggest that when the sea level was high, limestone was produced for the forereef, while at lower sea levels sandstone type sediments were carried across the reef core to the forereef. Since there is very little sand in the reef core, one can wonder how so much of it traveled over a widespread area of the reef without being trapped by the backreef and the growing reef. Channels through which it might have traveled are notoriously scarce in the reef core.

Also of interest is the evidence for rapid deposition of the forereef. When you look at the forereef (Figure 1), you note a strong bedding pattern of layers downslope toward the right. This is not so much what you would expect from slow gradual accumulation of sediments produced by the reef core over millions of years. The extended beds suggest rapid lateral (downslope) transport. In fact lots of turbidites, that are produced essentially instantly, as well as rapid debris flows and megabreccias

(Figure 5) are reported for the forereef.[15] Related to this are the breccias you can note in forereef deposits in McKittrick and Slaughter canyons (Figure 6). These sharp angular brecciated (broken) particles are more of what is expected from catastrophic deposits than from rock particles rounded by wave activity around a reef, but not all of the forereef is brecciated.

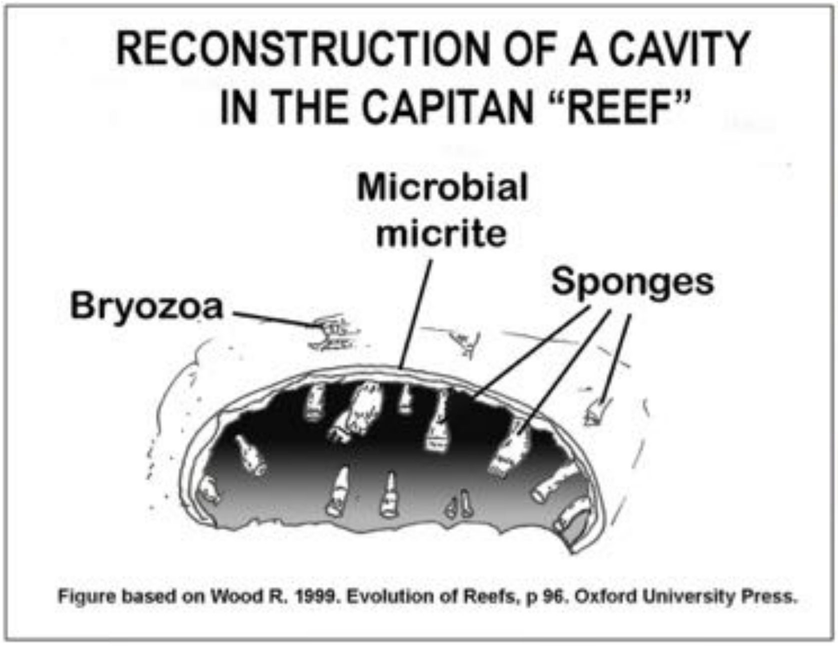


Figure based on Wood R. 1999. Evolution of Reefs, p 96. Oxford University Press.

Figure 4

Proposed arrangement of sponges growing down in a cavity in the Capitan Reef.

A CREATION-FLOOD PERSPECTIVE

Having a reef that would take several million years to grow in the middle of the geologic layers (Permian) does not fit at all with the creation model of a Genesis Flood. The most reef-like feature is the relation of the massive reef core that lies on top of slanting layers representing the forereef layers that the core would have produced (Figures 1) In modern living reefs, the forereef is produced by the organisms in the core (Figure 2). However, there are major problems in trying to interpret the Capitan Reef as a real reef..

Foremost is the absence of reef frame builders like the coral and algae of our present reefs that provide wave resistant structures. Some suggest the reef grew below wave level, but you still need organisms that build reefs, and sponges and bryozoans are very unlikely candidates because at present they are not known to build any significant reef structures. Yet the Capitan Reef is sometimes called a sponge reef, because there is little else that might qualify as frame builders. Furthermore, coral fossils are very rare and sponges are sparsely distributed in the Capitan Reef. One study reports that about 76% of the reef consists of various kinds of fine lime mud, while sponges, bryozoans, and other large organisms form only 5.4%, and this is likely generous for the whole reef.[16] This anomaly also applies to many other assumed fossil reefs. A book by three leading sedimentologists states:

> Closer inspection of many of these ancient carbonate "reefs" reveals that they are composed largely of carbonate mud with the larger skeletal particles "floating" within the mud matrix. Conclusive evidence for a rigid organic framework does not exist in most of the ancient carbonate mounds. In this sense, they are remarkably different from modern coral-algal reefs.[17]

In attempting to show that the "reef" grew where it is located, an article in what is arguably the leading geologic journal of the world, states that 74% of the sponges in the Capitan Reef are upright.[18] With that many upright, it looks like the sponges and the reef grew there, the sponges having been preserved in position of growth. However, the parameters the authors used to determine an upright position were so generous that you would likely obtain the same figure if the sponges were randomly distributed in all directions, as expected if they had been transported there by some catastrophe. To determine position of growth, horizontal slabs of the reef were examined (Figure 7), and if the round cylindrical sponges appeared up to twice as long as wide, they were considered upright. This means that the sponges could deviate up to 60° from the vertical and they would still be considered upright. This is generous, but not totally unreasonable.

Figure 5. A megabreccia in the Capitan forereef. The large grey limestone blocks are "floating" in sandstone layers of the Bell Canyon Formation at the foot of the Capitan Reef. This is the northwest face of a road cut along US Highway 180 and 62, located about 1.2 miles southwest of the road that leads into McKittrick Canyon. GPS is about 31.93149 – 104.73107.

The more serious problem is that if a round sponge was bottom side up, it would still appear near round on the surface of a slab and be considered upright, thus raising the proportion of upright sponges for a random sample from 33% to 67%. In Figure 8, all the sponges that happen to be oriented in the yellow region would be considered upright.

In the study, some irregular sponges, such as Figure 18B in their article, exceeded twice their width but were considered upright and contributed to raising the reported upright proportion to 74%. It appears that the sponges of the Capitan Reef are actually randomly oriented, as expected for catastrophic deposition. Personal communication to this writer from one of the authors of the article indicates that they considered the report of sponges growing upside down in cavities to be “anecdotal.” One needs to be probing when reading geological literature, especially when dealing with long ages interpretations. In performing orientation studies of organisms, it would be much better to study vertical surfaces[19] instead of horizontal slabs where up and down can be easily confused.

Figure 6

Breccia in the forereef seen at the foot of Slaughter Canyon. Note the angular fragments of rock, and the coin at the left for scale.

The suggestion that microbialites (microbial micrite) played an important role in Capitan Reef growth[20] is subject to reevaluation. The problem is not only with the Capitan Reef, but with microbialite interpretations as a whole. This is one of those areas where speculation and fact-free science have taken inordinate control of geological interpretations. Microbialites are supposed to be sediments slowly built up by mats of microorganisms living on surfaces. The microscopic organisms trap sedimentary particles or create conditions that favor precipitation of minerals. At present, there are very few living microbialites on our globe, but all kinds of fossil microbialites are being described in the fossil record. A number that were thought to be microbialites have turned out to not be that. Reported stromatolites (a kind of microbialite) in various parts of Scandinavia have been reinterpreted as of non-biological origin.[21] A microbialite in China turned out to have abundant sponge parts, thus removing it from the microscopic organism concept,[22] In Australia, filaments thought to represent earth’s earliest fossils have been reidentified as phyllosylicate minerals,[23] etc.[24] while present genuine microbialites are usually characterized by rich mats of microorganisms, and these mats are seldom found in supposedly fossil ones. It is postulated that they existed but were not preserved. However, if they are not preserved, how can you be sure that the microbial mats ever existed? Rare microbe fossils are sometimes described in microbialites, hence it appears that microbes can be preserved as fossils. Why are the mats absent? Furthermore, billions of microorganisms now live in sedimentary rocks, so just finding a few fossil ones can mean little because you don't know if they are originals or just later infiltrated microscopic intruders that happen to get preserved. Also, because of lack of data, there is lots of speculation, but little authentication that the preserved organisms had the biochemical pathways that would help precipitate sediments. Rigorous reevaluation, reformation and caution are needed to restore confidence to the microbialite concept.

Samples of the Capitan Reef core have been examined for microbialites, and a few elongated structures that look like filaments that could trap sediments have been found. Many spherical bodies interpreted as microbes have been reported.[25] These are 1/10 the diameter of our ordinary spherical coccus type of bacteria and half the size of the smallest known organisms. Similar spheres have been reported in other limestones,[26] but a sphere shape, like a balloon or soap bubble, is a common shape, and seems unlikely to contribute much to trapping sediments. On the basis of present evidence, it seems very unlikely that the Capitan Reef was built by microorganisms, or any other organisms.

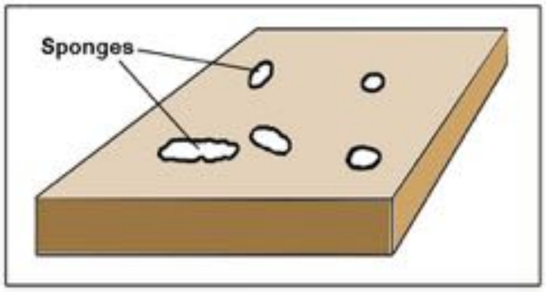


Figure 7. Representation of a horizontal slab from the Capitan Reef core with fossil sponges in cross-section.

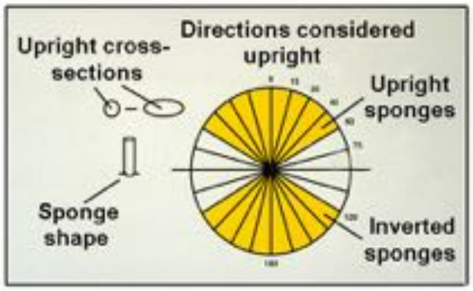
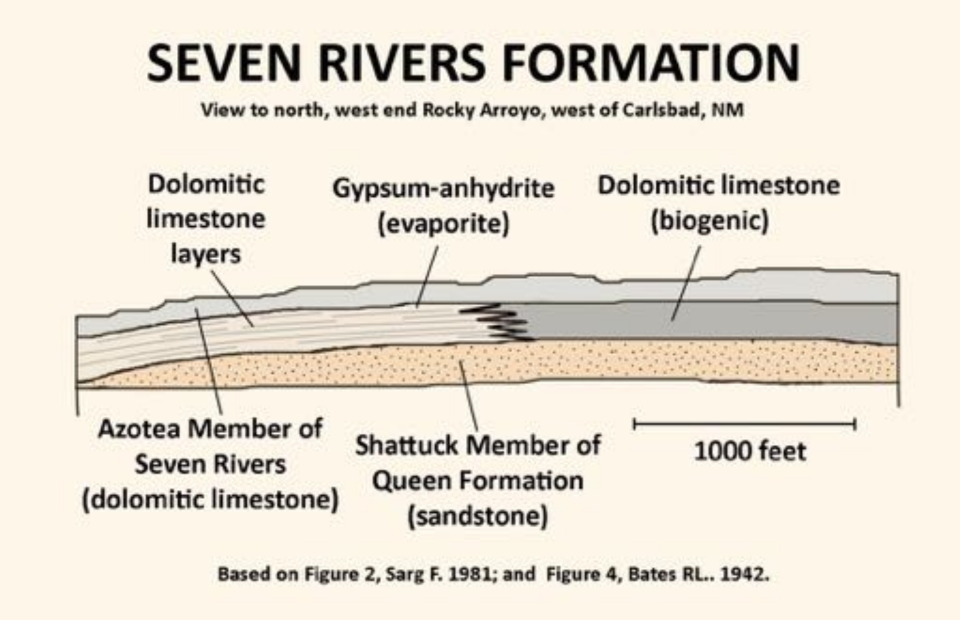


Figure 8. Vertical orientation of sponges using only cross-sections. All sponges oriented in the yellow region would be considered upright.

Compared to modern reefs, the Capitan Reef seems ecologically simplistic. Japtan Reef at Enewetak Atoll, a living reef in the western Pacific Ocean, has six distinct zones of organisms as you go from open sea to the lagoon. This lack of organization for the Capitan Reef can be attributed in part to a paucity of organisms, but that lack underlines the problem of considering Capitan a biological product. Beyond that, on our present reefs, we often find tidal surge channels and spur-and-groove structures at the surface, but these are notoriously rare or absent in the Capitan Reef. While a few suggestions of detailed reef structure have been proposed for the Capitan Reef, it does not look like it ever was a shoreline structure.

There are questions about the back reef that also challenge traditional geologic interpretations. One of the more intriguing ones is the relatively abrupt change in minerals from calcite-dolomite (carbonates) sediments to gypsum-anhydrite (sulfates) in the Seven Rivers Formation. The change can be seen as you proceed northwest from the reef core across the lagoon of the back reef. This change is along at least a nine mile front, and is abrupt but not very easy to see through surface debris. The gypsum-anhydrite is more whitish. The classic exposure is along the north flank of the western end of Rocky Arroyo, about 12 miles west of Carlsbad, NM[27] (Figure 9). There, the lower part of the Seven Rivers Formation is several hundred feet thick. If you look in the erosion channels that expose the original rocks between abundant debris, you can note an abrupt change from sulfates to carbonates as you go from west to east. The broad region of changes extends laterally over some 500 feet, but locally it is much closer. The traditional interpretation is that the calcite-dolomite was formed mainly by calcifying organisms and precipitation of lime in a marine lagoon, while the gypsum-anhydrite were formed by shoreline evaporation of water in moist sediments as for the sebkhas (also sabkha) of the Persian Gulf. It has recently been suggested that dissolution (dissolving) of the sulfates may have contributed to the abrupt change,[28] but in another context the absence of unrelated masses of either type would invalidate this kind of interpretation.[29] The classic sebkha interpretation has also been severely challenged.[30]



Based on Figure 2, Sarg F. 1981; and Figure 4, Bates RL.. 1942.

Figure 9. Abrupt change in the lower part of the Seven Rivers Formation from gypsum-anhydrite to calcite-dolomite in Rocky Orroyo, near Carlsbad, New Mexico.

Besides the major change from calcite-dolomite to gypsum-anhydrite, there are equally abrupt changes in small layers several feet thick that suddenly change from dolomite to gypsum.[31] Furthermore, between the 3-20’ major layers of gypsum-anhydrite one finds thin layers of calcite-dolomite in the thin to 2 foot thickness range. There is frequent interfingering of the two kinds of rock types in the transition zone. To have such contrasting causes (evaporation versus organisms and precipitation) for sediment formation so sharply delineated and mixed up in the middle of the backreef region seems very unlikely, and furthermore to have that contrast in causes remain sharply delineated within a few hundred feet over many hundreds of thousands of years is even more unlikely. The abrupt changes in rock type within a layer and the many interfingerings of the two are difficult to reconcile with sebkhas and without invoking sediment transport. These changes are likely better explained by catastrophic transport of both of these contrasting kinds of sediments from different sources. One needs to also keep in perspective that there is lots of sand in the backreef deposits (Yates Formation), and this would have to be also transported there. An alternative consideration is that is less challenging to the transport model is that after deposition of carbonate layers, sulfuric acid contributed to the formation of the gypsum in limited areas. That model seems unlikely because of the widespread horizontal layers.

No one knows for sure how the Capitan Reef was formed. In the context of a worldwide Flood model, it can be suggested that the massive Capitan Reef core was deposited after and on top of the deposition of the assumed forereef. The reef core is almost free of any major sedimentary structures, and is obviously different (Figure 1), and has little sand when compared to the forereef and backreef. It may have been transported from a different but somewhat similar source as the forereef and backreef. The evidence for the catastrophic deposition of the forereef by turbidity currents, debris flows, and megabreccias, is impressive. The sloping down angle of the beds is as expected for foreset beds, as is seen in the formation of present river deltas. The abrupt changes in the layers in the backreef formations could represent rapid deposition from different sedimentary sources including evaporite, dolomite-calcite, and sand sources.

Significant data favors a catastrophic interpretation for the Capitan Reef. While it does not appear that the Capitan Reef grew there, we also need to keep in mind that only a minute part of this apparently 300 mile long encircling reef has been studied carefully, and there is likely much more to be learned from the rest of this intriguing structure.

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3. CARMEL FORMATION FOSSILS

LOCATION

This good exposure of fossil bearing limestone is easily accessible, but may be a bit difficult to locate because there are few characteristic features around the locality. It is found in southern Utah along US 89, between Kanab and Mount Carmel Junction. If you are going north on US 89, go 1.0 miles beyond the second entrance to Coral Pink Sand Dunes State Park, Note that the second entrance may not be signed for northbound traffic, but it is 0.4 miles north of the first entrance that is well signed. Figure 1 is a vintage image of the locality. You will find better parking on the left (west) at a wider section of the road shoulder just beyond the end of a metal road guard rail on the west side of the highway. GPS at this wider parking place is 37.19880 and 112.66829. If you are coming from the north, go 2.5 miles from Mount Carmel Junction and you will find the wider parking space on the right (west)of the highway, at the designated GPS, as an opening between long sections of guard rail.

Figure 1. Fossil locality in the Carmel Formation. This is along US 89, 2.5 miles south of Mount Carmel Junction, in southern Utah. Note that this view is looking north. There is better parking on a wider left (west) shoulder a few meters ahead of this locality. Fossils are in the low part of the road cut to the right (east) and further north of the parked vehicles.

DESCRIPTION

You can find some fossils here by looking in the ditch and slope on the east side of the highway. However, you can locate the source of many of these, from a coquina layer with lots of fossils that lies some two meters above the ditch level. It is well exposed in a region around 30 meters (100 feet) down the road (north) beyond the open parking space in the guard rail on the west side of the road as designated above.

The fossils at this locality are in the Jurassic Carmel Formation, a formation spread over five western states (Colorado, Wyoming, Utah, New Mexico, and Arizona). It is named after the town of Mount Carmel just a few miles north of here. This formation is interpreted as a marine deposit, in part, because its fossils are of marine organisms. Some shoreline interpretations are also suggested. The fossils you will find here are well preserved, and consist of a variety of marine mollusks, including ribbed "Shell" clams. Also present are crinoid stems, and bryozoans.

We see all kinds of beautiful fossils in textbooks and museums, but when we go out to look for them in the rocks, they can be hard to find. One main reason for the incongruity is that fossils are often concentrated in limited localities where they are abundant. Some sedimentary formations may not have any fossils, others, especially those of marine origin, show rare concentrations in local areas. The best way to find many fossils is to go where abundant fossils are known to exist, and there are some good general references and localities identified in the geologic literature, although some authors are reluctant to be too specific, in order to minimize pilfering.

Is it legal to collect fossils? That depends on the locality and the kind of fossils involved. You may not collect in national parks or monuments. On private lands, you should obtain permission from the owner. On public lands, limited collecting of invertebrate and plant fossils including petrified wood is usually allowed, but regulations vary by state and locality and they can change over time.

A CREATION-FLOOD PERSPECTIVE

The extended horizontal depositional pattern of the Carmel Formation, like many widespread formations, is more easily explained by catastrophic (Flood) activity than by local deposition over long ages. That the fossils are concentrated in one layer and that they represent a variety of organisms not in position of growth suggests transport. This also underlines the irregular distribution of fossils and their scarcity in many sedimentary deposits.

In a number of formations, including the Carmel, there are rare deposits called "hardgrounds" that are alleged to have formed by the slow growth of organisms on top of each other and sometimes borings onto hardened layers. The long time proposed for these events is interpreted as challenging fast deposition during the year of the Genesis Flood. Speculation is involved in deciphering such past events and some data does not fit some of the long ages interpretations. See the references by Woodmorappe[32] for a review of the literature and suggested interpretations from a Flood perspective. This area of geologic interpretations is in need of further study.

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4. CASTILE FORMATION

LOCATION

An excellent exposure of the Castile Formation is along highway US 62 and 180 that runs between El Paso, TX and Carlsbad, NM. Just two miles northeast of the Texas and New Mexico state line, you come to a low widespread gray cliff of Castile. A road cut, (Figure 1) is through the beginning of that cliff and the rocks expose an amazing array of fine laminae (Figure 2). GPS for the locality is about 30.00980 – 104. 49804. If you are traveling southwest from Carlsbad along US 62 and 180, this exposure is almost 14 miles southwest of the junction to White's City and Carlsbad Caverns (NM 7). Castile is also exposed in several smaller road cuts for nearly a mile northeast of the major exposure mentioned above.

Figure 1. Road cut in the gray Castile Formation, along US highway 62 and 180, two miles northwest of the Texas and New Mexico state line. The road has been widened, likely on the other side, since this photograph was taken.

DESCRIPTION

The Permian Castile Formation is a fascinating deposit that has generated considerable discussion because it challenges all reasonable explanations for its existence. It covers about 10,000 square miles in the Delaware Basin, with an average thickness around 1600 feet and displays some 200,000 laminae (complex layers). Most of the laminae that are at lower depths are much thinner than those in the exposed road cuts designated above. There are exceptions to the regularity of the laminae (Figures 3 and 4, arrows). The main minerals in the formation are *calcite* (lime), *gypsum-anhydrite* (calcium sulfate), and *halite* (salt). The calcite portions are mixed with organic material to form the dark part of the laminae, while the gray-white parts are mainly gypsum-anhydrite; anhydrite is gypsum with water removed. Halite is occasionally present with irregular distribution, being more abundant in the northeast region of the formation. Since these minerals are all precipitated out of seawater when it is evaporated, it is very dominantly concluded that the Castile is an “evaporite” produced by prolonged evaporation of sea water. It is generally assumed that each lamina took one year to form through processes involving seasonal variation, hence the laminae are often called “varves,” a term reserved for *annual* laminae. Longer cycles and periodicities involving trends of small changes in thickness through many laminae are often suggested for the Castile.[33] However, the details of seawater evaporation and the nature of the laminae pose challenging complications.

Figure 2. Laminae in the Castile Formation. Note the penny coin at the left for scale.

If you evaporate a thousand feet of sea water, you would end up with approximately 1/2 inch of calcite, 1/2 foot of gypsum, and 12 feet of halite (salt). The minerals would be precipitated out in that order, with calcite starting when the seawater had evaporated down to around 1/2 its original volume, gypsum when down to around 1/5, and halite when down to 1/10. It is estimated that in order to precipitate the volume of the gypsum-anhydrite of the Castile, which are the dominant minerals of the laminae, would require the evaporation of 420,000 cubic miles of sea water,[34] which represents a volume of sea water 4,200 miles high over the area of the formation.

Geologists have provided a variety of models, to try to resolve such huge evaporation and especially the incongruity of so little halite (salt) in the Castile.[35] In evaporating seawater, you would expect some 20 times as much halite compared to all the rest of the minerals that would be precipitated. So why is there so little halite in the Castile? The models usually involve evaporating down only part of a fresh seawater supply, to provide some calcite and gypsum-anhydrite, that are precipitated out first, and also getting rid of concentrated halite brine, to make room for more fresh seawater. Repeat that process every year 200,000 times and you can have the mostly calcite and gypsum-anhydrite laminae (varves) of the Castile with little halite. Proposed environments usually suggest a Castile Sea in a restricted embayment, or in a completely isolated (like a salty lake) marine-like environment, enclosed in a usually deep basin, with a concentrated brine layer resting at the middle to lower depths in that basin. That brine layer contains the halite, and is removed as new fresh seawater comes into the basin, thus explaining the paucity of the huge amount of expected halite in the Castile if it was formed by the evaporation of sea water.

Some suggest that the Castile was formed in an embayment basin in the 100 mile diameter range. That embayment was lying next to an ocean and had a small shallow inlet-outlet (Figure 5) at just the right level to allow some fresh sea water into the embayment. That fresh sea water is needed to provide new calcite and gypsum-anhydrite by evaporation. The inlet-outlet also allowed some deeper concentrated brine in the basin to escape, thus getting rid of excess halite and providing room for fresh seawater. This all worked out through a seasonal yearly reflux flowing system through the inlet-outlet for 200,000 years as the basin filled up with 1600 feet of Castile. Others suggest that the halite brine simply seeped out through the walls of the Castile Sea. Another model is a basin completely isolated from the ocean, and the source of the Castile minerals was from seepage of fluids from mineral sources in the surrounding sediments, thus not produced especially by evaporation. Still others suggest that fluids came from and returned to a neighboring ocean by seeping through a permeable sedimentary barrier connecting the ocean to the Castile Sea where seawater was partially evaporated, while the remaining concentrated halite brine seeped out through the permeable barrier. Chemical changes after deposition (diagenesis) and changes induced by microorganisms have occasionally been suggested as explanations for Castile minerals. Seasonal factors are often invoked to explain an assumed varved periodicity. There are many suggestions, each with serious problems, and no consensus.

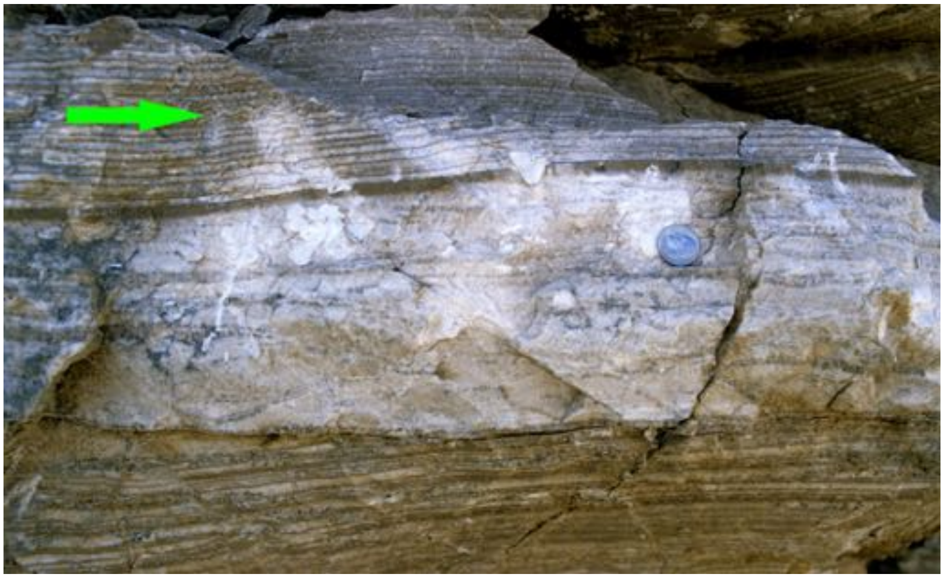

Figure 3. Laminae in the Castile Formation showing major irregularities in thickness. The arrow points to some wavy microfolding of some of the laminae, a fairly common occurrence in the Castile. Coin at right for scale is a quarter.

The laminae vary in thickness and similar laminae thickness sequence patterns can be found great distances from each other, suggesting continuity of specific laminae over incredibly wide areas. Several comparisons have been made, and high degrees of statistical correlation have been reported. Photographs of groups of laminae from different locations over the surface of the Castile, but from the same depth region in the formation, sometimes show impressive pattern similarities. This is akin to the process of matching tree rings which is problematic and about which there is extensive discussion in the scientific literature. Correlation of specific laminae thickness patterns in the Castile has been reported for samples 71 miles apart, however without statistical evaluation.[36]

A CREATION-FLOOD PERSPECTIVE

There is reason to be cautious about how widespread specific Castile laminae can be. Processes that would deposit layers in the millimeter scale over 10,000 square miles are difficult to envision by any model. While some of the comparisons of pictures of layers from distant locations show outstanding similarity of laminae thickness patterns, it also needs to be kept in perspective that any major storm over the Castile Sea would very likely dramatically modify the distribution pattern of the precipitating minerals. Ocean waves are often reflected down to great depths.

Very high degrees of statistical correlation can be obtained when there is no valid relationship between samples because of coincidental repetitive patterns. This has been very well illustrated many times when comparing tree ring sequences.[37] Furthermore, a statistical evaluation of the Castile laminae at the University of Kansas Department of Geology, using Fourier analysis and autocorrelation, failed to authenticate solar and longer planetary motion cycles often attributed to the Castile laminae. That study concludes that "The visually apparent cyclicity in the Castile cannot be quantified statistically. … Solar, climatic, and geologic cycles could not be identified. … Comparison and correlation of the components place the interpretation of the couplets as varves in serious doubt."[38] It is also generally agreed that different factors were involved in controlling the formation of the calcite and the gypsum-anhydrite components of each lamina, because their relative thicknesses are too inconsistent (Figure 4, middle layers).

There are significant irregularities in the Castile laminae as seen in Figures 3 and 4. Note at the tip of the arrow in Figure 3 that the laminae are wavy, due to what is called microfolding. Such features suggest that the laminae were not indurated when microfolding occurred and that the layers could slide past each other. Microfolding has been attributed to volumetric changes when anhydrite is changed to gypsum as water is taken up, or to much larger folding events in the Castile Formation.

It appears that some of the layers did not originate by evaporation. The thick layers in Figure 4 (arrows) are about half a foot thick, and it would require the evaporation of 1000 feet of sea water to provide the gypsum-anhydrite and carbonate for each of these. The surrounding landscape at the time of the Castile is assumed to have been nearly flat; the Guadalupe Mountains, that lie to the north, are a much later uplift. Hence, the topography of the region could not provide for a restricted sea deep enough to provide the minerals of that lamina, and similar thicker ones "several feet thick" are reported.[39] Furthermore, as you look at Figure 4, note that the thick laminae have a darker region at the top; that region tests for calcite while the thicker lower region of that same thick lamina does not. Also, recall that when you evaporate sea water, the calcite precipitates first, and the gypsum-anhydrite follows later. How come the gypsum-anhydrite was deposited first, and the calcite came to be on top, if this was from a single event of evaporation of sea water? One study proposes that such thick laminae are the result of deposition by turbidity currents.[40] Turbidity currents are rapid underwater sediment flows, sometimes traveling faster than 50 miles per hour as they deposit sediments. However, keep in perspective that the usual thin Castile laminae are usually described as a thin darker calcite layer below a thicker light grey gypsum-anhydrite layer, and that is in the order expected from the evaporation of seawater.

Figure 4. Extra thick layers in the Castile (arrows). The thicker darker layers at the top of the thick light layers are calcite. Note the pen for scale.

Could the Castile be deposited rapidly as suggested by the Creation-Flood account, either during or after the Flood, or a combination of both times. One can speculate about this. Two hundred thousand laminae is a high number, but some sedimentary processes such as deposition by turbidity currents can be very fast. Furthermore, a single turbidity current can deposit many laminae layers as it slows down. However, the layers in Figure 2 do not reflect a typical Bauma sequence of turbidite current pattern when comparing many laminae, but deposition by turbidity currents can be very complex. However, some things can happen rapidly especially during catastrophes. A 12-hour flood in Colorado is reported to have deposited more than 100 laminae.[41] It is also of interest, that in describing the receding waters of the great Flood in Genesis 8:3, some translations suggest the expression "in going and returning" as an alternate to the usual translation of the word "continually." "Going and returning" might represent rapid cyclic activity as waves of water repeatedly eroded a source of gypsum-anhydrite and calcite that was already present before the Genesis Flood. This is only a suggestion.

The Castile is a fascinating formation and is an enigma for both short time and long time interpretations. For the long ages model, one has to wonder about how it would ever be possible for the delicate yearly volumetric balance between input of sea water and the removal of concentrated brine -- in order to get rid of the halite component from the Castile Sea -- ever continued for 200,000 years. With respect to that problem, the Creation-Flood model has an advantage in that a delicate balance does not have to be maintained over such an inordinately long period.

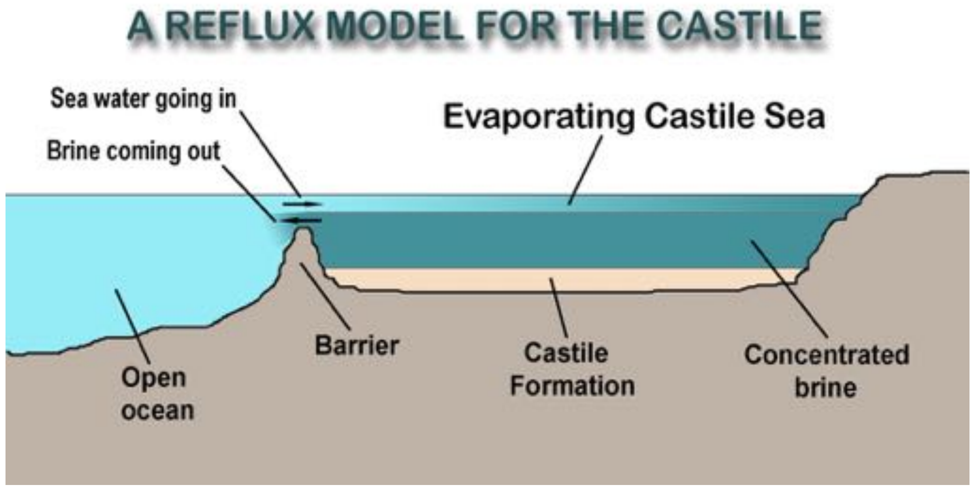

Figure 5. Proposed model for the Castile where a shallow inlet to a deeper basin allows both the inlet of fresh sea water and the exit of heavy brine. Based on Figure 1 in King RH, 1947.[42]

The Castile Formation is unique. Limited deposition of sea water minerals from splashing seawater, such as that of the sabkhas in the Persian gulf, has been proposed as an analogue, but the Castile consists of mainly calcite and gypsum-anhydrite with little halite. Furthermore, there is no place on earth where at present huge bodies of "evaporites" are being deposited, on a scale approaching anything remotely close to that of the Castile and other huge evaporite deposits found embedded in the sedimentary layers of the earth. We all need to recognize that there is much more that we do not know, than what we do know, about the past history of the Castile, and that should engender further thorough inquiry.

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[34] For details and references see: Kirkland DW. 2003. An explanation for the varves of the Castile evaporites (Upper Permian), Texas and New Mexico, USA. Sedimentology 50:899-920.

[35] The literature covering these models is extensive. For some leading articles see: King RH. 1947. Sedimentation in Permian Castile sea. Bulletin of the American Association of

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Petroleum Geologist 31:470-477; Anderson RY, et al. 1972. Permian Castile varved evaporite sequence, West Texas and New Mexico. Geological Society of America Bulletin 83:59-86; Leslie AB, et al. 1996. Conflicting indicators of paleodepth during deposition of the Upper Permian Castile Formation, Texas and New Mexico. Geological Society, London, Special Publications 116:79-92, DOI: 10.1144/GSL.SP.1996.116.01.09; Kirkland DW, Denison RE, Dean WE. 2000. Parent brine of the Castile evaporites (Upper Permian), Texas and New Mexico. Journal of Sedimentary Research 70(3):749-761.

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5. DAKOTA FORMATION FOSSILS

LOCATION

This fossil locality is in eastern Utah along Utah State highway 24, between Hanksville and Capitol Reef National Park. Coming from the east on State Highway 24, go 5.2 miles beyond the bridge over the Freemont River that is on the west side of Hanksville, to an unpaved turnout on the left (south) of the road, GPS for the turnout is about 38.36757 - 110.81748, and in 2007, this was right at mile maker 110. The fossils are found in the small butte across the road to the north. If coming from the west along SH 24, go 11.7 miles east of the east end of Caineville (start mileage at the large motel north of highway), to the unpaved turnout on the right at mile marker 110 and the GPS designated above.

DESCRIPTION

The Cretaceous Dakota Formation (sometimes Dakota Group) lies here above the Cedar Mountain Formation. It presents a steeper scarp than the Cedar Mountain, forming more resistant layer higher up in the butte. It has abundant oysters (*Graphaea newberryi*) especially in its top portion. *Graphaea* fossils are noted especially for their extremely thick upper shells and much thinner lower ones. *Graphaea* are so abundant here that they have been excavated for road metal. Good samples can be found on some slopes, of the butte, especially on the west side. You can climb up to the Dakota to examine the fossil distribution, noting that they “float” in the Dakota sediments (Figure 1). This is not where the oysters grew. Oysters commonly grow in compact patterns on surfaces.

Figure 1. Fossil oysters in the Dakota Formation. Note the white shells “floating” in the matrix, reflecting massive transport. The largest shells are around five centimeters in length.

A CREATION-FLOOD PERSPECTIVE

Obviously the oysters did not grow where they are presently located. It appears as though they were massively transported with the Dakota sediments, and this is what would be expected for the Genesis Flood. However, this evidence can also be accommodated within a long ages evolutionary model that allows for catastrophic events; and geologists in general have no problem with that. They postulate many catastrophes, with lots of time between them. However, when one sees a lot of evidence for rapid deposition in so many sedimentary deposits, the evidence for the Flood, such as seen here can become significant.

More convincing for the Flood is the incredibly widespread distribution of the Dakota Formation (Dakota Group). While it has several subunits, as a whole it is relatively thin, averaging 30 meters (100 feet), found over some 815 thousand square kilometers, (315 square miles) in 12 western states. An association with the Flood is not only based on its wide distribution, which is hard to attribute to slow local deposition, but also to the incredibly flat surface on which it had to be deposited. Such flat surfaces of low relief are more in agreement with the expectations of rapid catastrophic activity of the Flood in contrast to the usual pronounced irregular topography of our continents configured by the local erosion and deposition that go on there at present.

6. DINOSAUR NATIONAL MONUMENT AND THE MORRISON FORMATION

LOCATION

The Monument is located some 20 miles east of Vernal in northeastern Utah and well into Colorado. To view the wall of bones (Figure 1), go to the Dinosaur Quarry near the town of Jensen, Utah and not the Monument Headquarters in Dinosaur, Colorado. At the Quarry visitor center you will be directed to the phenomenal Quarry display. You can also walk from the visitor center to the east along the ¾ mile Fossil Discovery Trail (See the Park Pamphlet). The Fossil Discovery Trail is also accessible from another trail originating near the Quarry itself. The best fossils along the fossil discovery trail (Figure 2), are in the last part of the trail, which is a part running directly east high up in the Morrison Formation. Along the way up to that part, you may find a few fish scales in the silver grey Mowry Shale. The Stump Formation to the north of the Fossil Discovery Trail has a variety of marine fossils.

Figure 1. Part of the “Wall of Bones” of the Quarry at Dinosaur National Monument. The long thin bone in the center is in the two meter range.

DESCRIPTION

Over the surface of our earth, there are not many locations that can give you a better display of vertebrate fossils in their original location than the wall of bones at this quarry. These are found in the Jurassic Morrison Formation, a unit that spreads from Texas to Canada in the western part of North America. Over the widespread area of this formation, the dinosaur bones are located mainly in a few concentrated areas such as here. This paleontological icon was discovered by Earl Douglas, a former Seventh-day Adventist.[43] A dozen species of dinosaurs as well as a few species of crocodiles and turtles have been found here. Since only a few articulated bones (bones attached to other bones) have been found, it does not at all appear that the animals died here. They have been transported along with other debris by some kind of flood activity. A tree trunk was also found here. The original climate of the region has been interpreted as semi-tropical.

Figure 2. The green arrow points to part of a dinosaur bone seen along the Fossil Discovery Trail. Note the pen to the right of the bone for scale.

A CREATION AND FLOOD PERSPECTIVE

The Morrison Formation displays several features that fit better with the biblical Flood model than with the standard model of local deposition over 7 million years. One can first note the extremely widespread distribution of the Morrison. It averages only about 100 meters in thickness, yet it covers a million square kilometers (Figure 3). This is an extremely flat depositional environment and it had to have a very flat region to be deposited on, suggesting little time for formation of normal irregular continental topography. The Morrison is interpreted to represent river and lake deposits, but no major river has been found that would spread the deposit over such a wide area. Some geologists studying the Morrison comment: "The enormous area covered by Morrison sediments and the general thinness of the sedimentary sheet (being in most areas less than 100 m in thickness) indicate that the sediments were distributed by widespread flowing water."[44]

Figure 3. Distribution of the Morrison Formation in western North America.

Animals require food that comes from plants. Yet what is puzzling is that this formation, that has been one of the richest sources for dinosaur fossils, appears to be a vast incomplete ecosystem,[45] with a paucity of necessary plants. In the Morrison sediments, plant fossils are rare, especially in the regions of dinosaur remains. So what did the behemoths eat over the millions of years? There seems to be an incomplete food chain here. Paleontologist Theodore White comments that "although the Morison plain was an area of reasonably rapid accumulation of sediment, identifiable plant fossils are practically nonexistent."[46] He further muses that by comparison to an elephant, a large sauropod, such as an *Apatosaurus* "would consume 3 ½ tons of green fodder daily." Another investigator states that the Morrison in Montana "is practically barren of plant fossils throughout most of its sequence"[47]

A more recent study[48] suggests that "large and varied flora and fauna have been recovered from the Morrison over the years" and even proposes that the Morrison was somewhat like an African savannah that would typically have lots of grass and a few trees. However, the same paper refers to the rarity of plant fossils. Furthermore, no fossils of grasses have been found in the Morrison, hence, the comparison to a savanna is difficult. Significant data suggests dry conditions,[49] and there is further difficulty in reconciling the hydrological activity necessary to distribute Morrison sediments over such an enormous area with so few plant fossils from plants that would be abundant in a moist environment. The scarcity of plant fossils has been a persistent theme in the paleontological Morrison literature.[50]

So what did the largest herbivores to have ever roamed our earth eat during the millions of years while the Morrison Formation is assumed to have been deposited? Adding to the dilemma is the "general absence of fish remains and diverse molluscan assemblages,"[51] in places assumed to have been ancient lakes. Perhaps the Morrison was not a place where dinosaurs lived, instead it may have been a vast dinosaur burial ground created by the waters of the Flood, with plants sorted and transported elsewhere, likely forming some of our huge widespread coal deposits.

Organisms found over the surface of the earth are sometimes classified into characteristic groups called provinces. For instance, a desert environment can have several different provinces reflecting different kinds of environments such as dunes or oases. On the other hand, it has been found that the dinosaurs in the widespread Morrison are not distributed in several local provinces as is seen for present biological patterns, but as some researchers report, "The single most striking observation about the Morrison dinosaur fauna as a whole is the breadth and equitability of distribution … The same genera are found in the same recurring associations over a very wide geographical area."[52] Could this represent widespread distribution by the action of the catastrophic Genesis Flood? What we see for the dinosaurs agrees with the incredibly extensive Morrison sediments – a lot of extremely widespread distribution.

It is not only the Morrison that reflects unusually widespread distribution (low provinciality) of fossils. The same is seen in dinosaurs found in sedimentary layers lying above the Morrison.[53] Furthermore, as expected from widespread distribution by Flood waters, this is a general pattern observed by several researchers. Speaking of plants, one paleontologist refers to "the extraordinary cosmopolitan distribution of many ancient groups."[54] Speaking of marine organisms, three other paleontologists state "The Paleozoic and Mesozoic were characterized by low provinciality."[55]

In an evolutionary context, the dinosaurs found in the Morrison reflect the "age of dinosaurs" that existed some 200 million years ago and later. This is in the middle of the dominant Phanerozoic fossil record. What explanations can those who believe in creation present to explain such a unique sequence pattern in the fossil record. A proposed answer is that this reflects the altitudinal level where the dinosaurs dominated before the Flood. They were buried around this level when the rising flood waters reached their region. There are many kinds of organisms that lived before the flood that do not live now on the earth, and their ecological distribution had to accommodate them as well as present organisms. The suggestion is that the dinosaurs lived at this intermediate level and their fossils are now found there in the fossil sequence. For further discussion of this important question see the references on this topic.[56]

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7. FIRE AND TRACKS IN COAL

LOCATION

A convenient view of clinker, that is caused by the burning of coal, is north of the town of Helper, UT. Go northwest a couple of miles along US 6 and turn northeast on US 191. The reddish clinker (Figure 1) will be at the right at a road scarp 1.3 miles from the junction, above the cemetery and the now closed entrances to the Castle Gate Mines. GPS is 39.73297 – 110.84988; good parking across the road.

Figure 1. Reddish clinker in a road cut along US 191, above the old entrances to the Castle Gate Mines. This is 1.3 miles north of the junction with US 6.

DESCRIPTION-DISCUSSION

This locality is in the Cretaceous Blackhawk Formation. The clinker near Castle Gate, Utah and other similar outcrops relate to geologic discussions about fire in the earth. To Seventh-day Adventist they are of special interest because of statements by Ellen G. White regarding fire and volcanoes. Speaking about the Flood she states:

> At this time immense forests were buried. These have since been changed to coal, forming the extensive coal beds that now exist, and also yielding large quantities of oil. The coal and oil frequently ignite and burn beneath the surface of the earth. Thus rock are heated, limestone is burned and iron ore melted. The action of the water upon the lime adds fury to the intense heat, and causes earthquakes, volcanoes, and fiery issues. As the fire and water come in contact with ledges of rock and ore, there are heavy explosions underground, which sound like muffled thunder. The air is hot and suffocating. Volcanic eruptions follow; and these often failing to give vent to the heated elements, the earth itself

> is convulsed, the ground heaves and swells like waves of the sea, great fissures appear, and sometimes cities, villages, and burning mountains are swallowed up. (*Patriarchs and Prophets* p 108-109).

Related statements by EGW are found in *Spiritual Gifts*, Vol. 3, p 79-80; MS 29, 1885; and MS 21, 1902.

Some have argued that White's statements reflect the thinking of her contemporaries. Although the idea of fire in the earth was temporarily accepted (e.g., Werner) before her time, she did not accept other contemporary geological concepts. She took a firm stand against uniformitarianism and in favor of the Genesis Flood. Her statement about fires, coal, lime, and iron is considered to be "unique" (Johns 1977a).

That there have been many fires in the earth is well attested. Fires from burning coal seams, as evidenced by a characteristic red imprint of the adjacent rocks, are common in the cliffs of this region (Stracher et al. 2005). Sometimes glassy slag-type clinker attests to temperatures causing the melting of the rock (Figure 2). In Germany, fires burning for 150 years are reported; one was used as a source of heat for a greenhouse for 31 years (see Johns 1977b for references). Cisowski and Fuller (1987) refer to layers of burned rocks from depths of several hundred meters. In Australia, Burning Mountain (Rattigan 1967a) has been burning since prehistoric times (England 1982, p 43) and is currently burning at a depth of about 50 m, reaching temperatures of 1700° C (Rattigan 1967b).

Figure 2. Close-up view of the clinker near Castle Gate, UT. Note the gas vesicles in the glassy grey scoria, indicating melting.

The question of a source of oxygen for burning is important. White refers to the hot air associated with these activities. Coal is known to be quite permeable to air (Johns 1977b,. Rattigan 1967b) reports a “blast furnace effect” by air intake through fissures at Burning Mountain. Some oxygen could come from iron oxide.

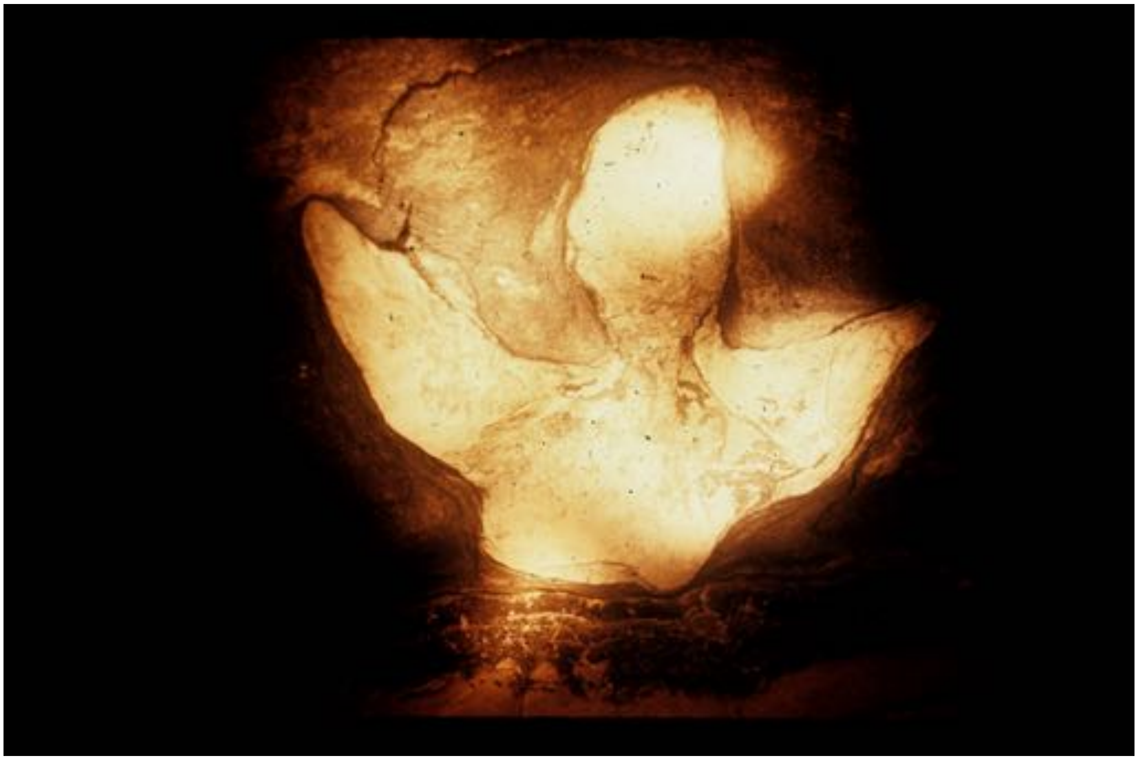

Figure 3. Dinosaur footprint as seen in the top of a coal mine shaft of a Castle Gate Mine. The coal was mined out and footprints are seen in the sandstone on top of the coal, a very anomalous pattern. The footprint is in the one foot or more range in size. Photo by Mollerus Couperus.

The main question would seem to be about the large amount of heat required for the production of volcanoes as implied in *Patriarchs and Prophets*, p 108. White’s statements that coal and oil come from the flood (*Patriarchs and Prophets*, p 108) and that there were volcanoes during the flood (MS 62, 1886) would suggest that she did not think all volcanoes came from the burning of coal. At present, we do not know of good evidence for the burning of coal as the primary force for volcanoes. Several plausible alternatives have been proposed:

1. This process of volcanism is not occurring now, although it did in a limited way in the past.

2. Burning of coal can serve as a triggering mechanism that initiates release of pent-up volcanic forces latent in an unstable crust.

3. White was reflecting a commonly understood interpretations of volcanic activity. Unless you believe in verbal inspiration, which White did not, she may have been reflecting contemporary expressions.

4. God in His own time causes these special phenomena. The pertinent account by White in Spiritual Gifts, Vol. 3, p 79 states, “God causes large quantities of coal and oil to ignite and burn.” The suggestion that God may be active in some geologic phenomena has biblical support as evidenced by the flood (Genesis 6-9) and the earthquake at Christ’s death (Matthew 27:51), etc.

Also of interest here is the fact that thousands of dinosaur footprints (Figure 3, see Carpenter 1992) and roots of trees in upright orientation have been found in the top of the coal seams of this region. Samples of the footprints can be seen in the USU Eastern Prehistoric Museum in Price, UT and at the Geoscience Research Institute in Loma Linda, CA. In a Flood context, they would have been formed during the year of the Genesis Flood. In order for the footprints to form, the sediments must have been soft, and rapid burial is implied for their preservation before they are destroyed, as is usually the case for footprints now . The preservation of both the footprints and tree roots reflects unusually rapid activity. Trees can sometimes float upright during flood conditions (Coffin 1997).

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8. FLAT GAP AT GRAND CANYON WEST

LOCATION

Grand Canyon West is located on the Hualapai Indian reservation in northwestern Arizona. There you will find the “Skywalk,” where you can look down through a glass sidewalk that extends over part of the Grand Canyon. This is in a region of limited accommodations, but only a couple of hours drive either to the east of Las Vegas, NV or to the north from Kingman, AZ. Our purpose is to view a major time gap in the sedimentary layers of the Grand Canyon. A good place to begin is just north of Meadview, AZ. Location details will be provided with the specific descriptions.

GRAND WASH CLIFFS

A good view of the gap is in the Grand Wash Cliffs strata along State Highway 25 (GPS around 36.03858-114.07426), a couple of miles beyond the junction with the main road into downtown Meadview. The Grand Wash Cliffs are the steep scarp to the east, formed by tremendous uplift along the Grand Wash Fault. This scarp is the western edge of the Grand Canyon Plateau. About eight miles further north, the highway takes you to Pearce Ferry where you can see the Colorado River coming out of the Grand Canyon into Lake Mead.

Figure 1. View to the east, from north of Meadview, AZ, of the Grand Wash Cliffs at the western edge of the Grand Canyon Plateau. The Arrow points to a major gap in layers. You can follow the gap across the picture between the light gray layer (Muav) below and the darker gray layer (Temple Butte) right above it. Note the flatness of the top of the light grey layer that is assumed to be over 100 million years older than the dark grey layer just above it. If the time gap is that long, why isn’t the Muav and more sediments, all eroded away?

The arrow in Figure 1 points to a “flat gap” in the sedimentary layers of the Grand Canyon. An assumed 100 million years of the sedimentary record are missing at the tip of the arrow. You can note the very light grey (whitish) layer that runs across the landscape just below the tip of the arrow; that layer is the Grand Wash Dolomite that is part of the Muav Limestone and is Cambrian in age.[57] Just above the tip of the arrow is the darker many-layered Temple Butte Formation that you can also follow across the landscape. That formation is Devonian in age; hence, the Ordovician and Silurian periods and more of the geologic column is missing between these two units. This is a gap of over 100 million years in the geologic column, and the contact line appears to be flat, hence this qualifies as a "flat gap" in the geologic layers. Geologists call these kinds of gaps *paraconformities*, or *disconformities*; the two terms are not precisely differentiated. Above the darker Temple Butte you can see a lighter cream-buff colored irregular layer that extends to the skyline. This is the famous Mississippian Redwall Limestone of the Grand Canyon region. Below the tip of the arrow in Figure 1, the light grey Grand Wash Dolomite member of the Muav blends into darker Muav Limestone. Below the resistant castellated Muav is the softer more gently sloped Bright Angel Shale that is grey-green in color but includes dark red sandstone layers. All these units below the tip of the arrow are Cambrian in age.

Figure 2. Grand Wash Cliffs south of Meadview, AZ. The lower arrow points to the widespread dark Tapeats Sandstone that lies below the softer grayish Bright Angel Shale intercalated with widespread reddish brown sandstone layers. In the closer hill to the right, the thick irregularly eroded light tan Muav Limestone lies above, reaching to the skyline. To the left, the upper arrow points to the gap line with the whitish Grand Wash Dolomite member of the Muav below, and the darker Temple Butte Formation above.

A CREATION FLOOD PERSPECTIVE

The significance of flat gaps is that they challenge the long geologic ages assigned to the geologic column.[58] As weathering of the rocks takes place over the assumed long geologic ages, you either have erosion or deposition. No part of our restless planet can escape the ravages of time as elevated areas are eroded away and are transported and deposited in lower regions. However, erosion leaves an irregular topography as streams and rivers cut deep into the surface being eroded. The irregular surface of our hills and mountains demonstrates the usual uneven surfaces resulting from erosion; the Grand Canyon itself is an extreme example. In the long geologic ages interpretation, these missing layers also represent "time gaps" because both the layers and the amount of time assumed for their deposition appear missing. You can tell that you have a gap, because the layers with the kind of fossils usually found at that level in the geologic column are not there. They are found elsewhere over the earth and the long time assumed for their slow deposition is assigned to the gaps where they are missing.

The challenge to the long geological ages is the lack of erosion where major parts of the geologic column (gaps) are missing between the layers at the flat disconformities or paraconformities. In other words, if you are going to claim that there is a 100 million year gap at the top of the Muav Limestone (Grand Wash Dolomite) you should expect a lot of irregular erosion of the Grand Wash Dolomite, and much more, over that time; yet you can see that the surface (arrow in Figure 1) is flat. According to average rates of erosion of our continents,[59] in 100 million years you should expect at least 3 kilometers of downward erosion, yet hardly any can be detected in much of the Grand Canyon region at this gap. It looks like the 100 million years never occurred. The problem for the proposed long ages at these flat gaps, is that if you have deposition of sediments, you have no gap, if you have erosion you should have an irregular surface. Since you have neither, it looks like the proposed long ages for the geologic column never occurred. Paraconformities (flat gaps) are found among sediments over the world.

Figure 3. View of the two formations at the gap. This is a few dozen meters northwest of mile marker "12" on highway AZ 261. The Devonian Temple Butte Formation is the darker layers in the upper half of the picture. The Grand Wash Dolomite of the Cambrian Muav is the lighter gray layers in the lower half.

CLOSE UP VIEW OF THE GAP

You can put your hands on this "100 million years" gap at a locality close to the Hualapai Indian Reservation along the highway to the Skywalk. From the previous stop north of Meadview, go south about 12 miles on SH 25. Along the way, at the foot of the cliff to the east (left) you can occasionally see the resistant Cambrian Tapeats Sandstone that forms a thin, dark gray cliff (Figure 2). This thin formation is spread over almost all of the Grand Canyon and well beyond, indicating extreme lateral continuity of relatively thin unique sediments as expected by the Genesis Flood. The thicker pale greenish Cambrian Bright Angel Shale, here also intercalated by several resistant thin reddish brown sandstone layers, overlies the Tapeats. Proceed to the junction with SH 261, also known as the Diamond Bar Road, that goes up the Grand Wash Cliffs to the Skywalk. Note your mileage at the junction. As you go up, you can again see the softer (gentle slope) grayish Bright Angel Shale and its conspicuous reddish sandstone partings. The steeper irregularly eroded Muav Limestone follows this. Go just a little over 11.9 miles, and stop just a little before a little mile marker for "12" miles located on the right (south) side of the highway. Locate a culvert for an ephemeral stream that crosses under the highway west of the 12 mile marker. The GPS for the culvert is: 39.921390 – 113.915680. To access the Muav-Temple Butte contact line, which is in the hill to the north (left), crawl through the streambed under the fence. Follow up the streambed for several dozen meters, and then go a little ways up the hill to the west (left) till you come to where the lighter colored, more massive and irregular Cambrian Muav (Grand Wash Dolomite) is overlain by the slightly darker, usually more bedded, Devonian Temple Butte (Figure 3). The weathering of the Temple Butte sometimes results in a sugary (sandy) texture that helps in identification.

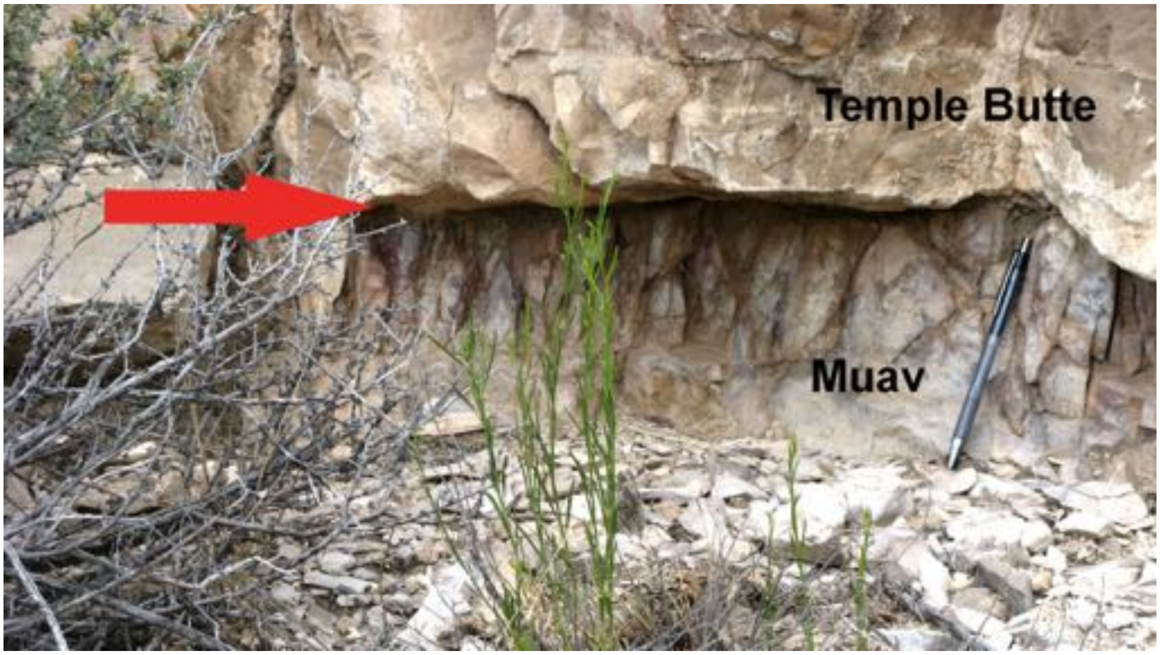

Figure 4. Close up view of the gap. The darker Devonian Temple Butte overlies the lighter Cambrian Muav. The arrow points to the sharp line of demarcation of an assumed 100 million year gap. The Ordovician and Silurian and more are missing here. Note pen to the right for scale.

At this locality,[60] you can note a rather sharp demarcation between the Temple Butte and the Muav that is postulated to be 100 million years older (Figure 4). You can note some small irregularities but, at least from a visual perspective, the top of the Muav does not appear to have suffered greatly from the expected ravages of eons of weathering postulated for the duration of this gap. This gap is found over the entire Grand Canyon, but it can be inconspicuous. Sometimes, in other parts, you don't see much. Two geologists comment "In parts of the Grand Canyon, including the type section on Temple Butte (where the channels are absent), the Cambrian-Devonian strata appear in local exposures to be without angular discordance, and the contact is planar, with gray dolomite beds below and above. Here, the unconformity [disconformity, paraconformity], even though representing more than 100 million years, may be difficult to locate."[61]

The Temple Butte Formation gets thinner towards the eastern side of the Grand Canyon where it is sometimes represented only by what is interpreted as channel fill in the top of the Muav. Further east it gets thicker again. Because of the channels, the top of the Muav is not as flat there as usually seen here and elsewhere, and these channels can reach down 30 meters. It needs to be kept in perspective that during a major flood such as the Genesis Flood one could expect lots of rapid channeling. Furthermore, in the context that in 100 million years of erosion, you would expect at least three kilometers of erosion, these channels are only "scratches" on the topography whose depth represents only 1% of the expected erosion. The flat gaps over the earth tend to confirm the Biblical account of beginnings.

Figure 5. View to the north from Eagle Point at Grand Canyon West. The arrow points to the 100 million year (Ma) gap that is at the top of the light gray layer (Muav), that you can follow across the view below the darker and steeper Temple Butte.

EAGLE POINT

To get to Eagle Point where the Skywalk is located, continue up the Diamond Bar Road for several miles and follow the signs to the Skywalk reception center. You will need entrance tickets and you will likely have to take a shuttle bus to Eagle Point. A ticket to walk on the Skywalk is not necessary since the geology can be seen just as well from localities next to it. Figure 5 is a view to the north of the Grand Canyon. Keep in mind that in contrast to the usual high level of viewpoints at Grand Canyon National Park, at this level, you are about half way down into the typical Grand Canyon itself, and major limestone formation dominate the local geology. Note the high edge of the Grand Canyon, as you look to the north skyline and the red formations that typically are near the top.

Figure 6. Looking down from Eagle Point at Grand Canyon. Note the muddy Colorado River to the left. Arrow points to the 100 million year (Ma) gap. The darkest , almost vertical cliff in the middle right is the Mississippian Redwall, and the many little steps in the layer below is the Temple Butte that lies just above the gap.

The arrow in Figure 6 points to the 100 million year gap in sediments with strongly bedded Temple Butte above the tip of the arrow, and the light grey Muav (Grand Wash Dolomite) just below as also seen at the Grand wash cliffs. The flat contact line can be viewed at a number of places all across the landscape. Figure 6 is looking down from Eagle Point with the arrow pointing at the likely locality of the same contact line. Closer examination of the rocks would help confirm this, but accessibility is very difficult here.

GUANO POINT

You likely will be required to take a shuttle bus from Eagle point to Guano Point which lies further to the north and where you get a better view of typical Grand Canyon stratigraphy. When there, proceed about 300 meters north past the concessions along a path to the east (right) of the buttes until you come to Guano Point, north of the ruins of a tall steel framework (GPS is 36.03292 – 113.82492) that was part of a cable transport system for guano (fertilizer) across the Colorado River. Part way down are the ruins of a supporting tower for the cable system The Guano came from bat droppings in small caves that you can see across the river. That region is now part of Grand Canyon National Park.

Figure 7, labels the main stratigraphic units which are similar to what you see almost 200 kilometers to the east at the main Grand Canyon National Park viewpoints.[62] The Supai label in the figure is a group of four formations, but at this end of the Grand Canyon there is some disagreement as to where some suggested new units (Callville and Pakoon limestones of the Supai) may belong.[63] As mentioned earlier, the Grand Wash Dolomite is grouped within the Muav Limestone.

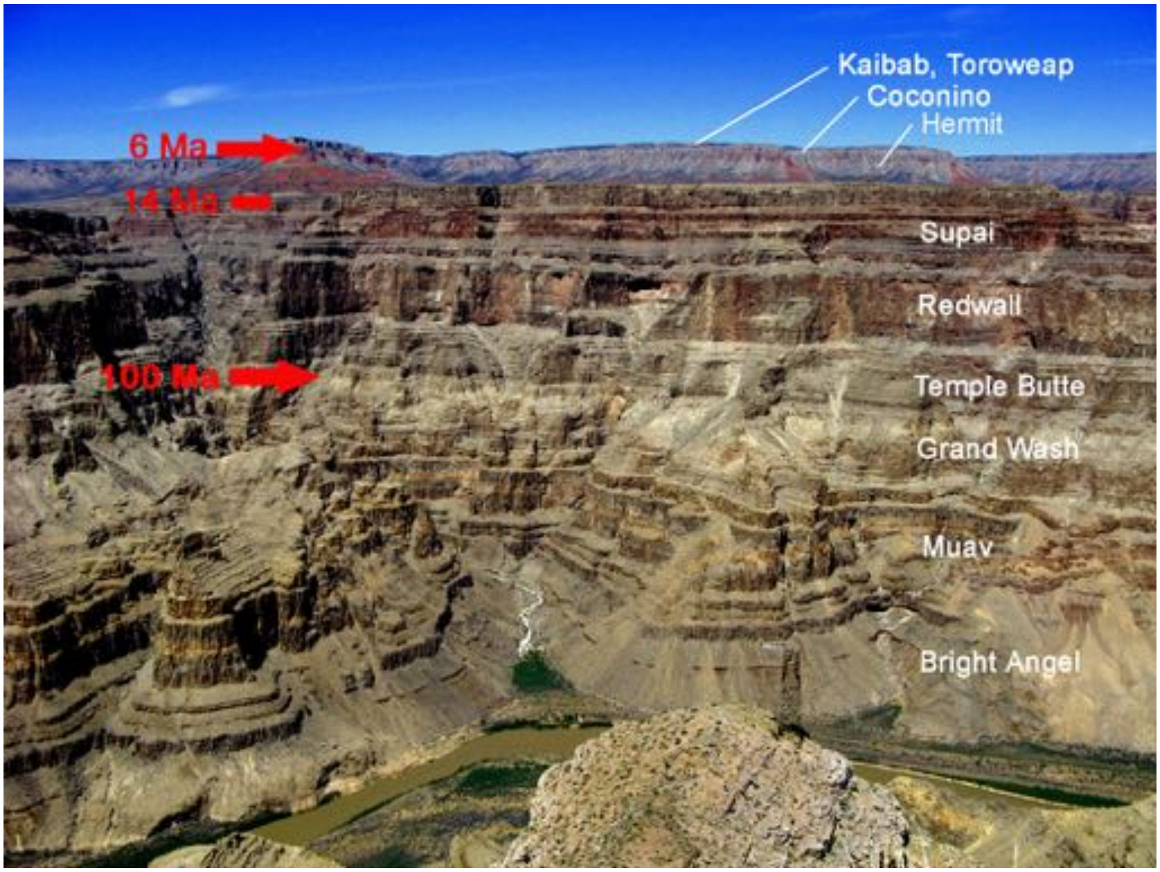

Figure 7. View to the north of Guano Point at Grand Canyon West. The arrows point to some flat paraconformities you can follow across the view. The assumed duration of the gaps is indicated in millions of years (Ma). See text for details.

Arrows on the left of Figure 7 indicate three paraconformities. They are found over the whole Grand Canyon. The top one represents six million years (Ma), and some 200 meters of erosion of the Hermit Shale would be expected during that time. The middle arrow points to the Supai Group, but precise location would depend on disputed stratigraphic interpretations referred to above. While there is this major gap in the layers, it is not always easy to find. A specialist of this area comments, "that the location of the boundary … can be difficult to determine, both from a distance and from close range."[64] Its precise location is not indicated in Figure 7. Here you would expect some 500 meters of erosion during 14 million years of exposure, and there is no indication of that among the layers. The whole Grand Canyon is about 1500 meters deep, so the gap should be a dominant feature. You can see that the 100 million year gap (arrow) at the top of the Muav is flat, but we would expect at least 3,000 meters of normal erosion during that time. That figure is based on present average rates of erosion of 61 mm per 1000 years reduced ½ as a generous correction for the effects of modern agricultural erosion that would not be expected in the past.[65] On the basis of this data, it does not appear that the long geological ages ever occurred.

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[58] **See the author's webpage: www.sciencesandscriptures.com, look at section 2c of DISCUSSION 16 of the Bible and Science series (viewed on October 21, 2015); some other references are: Roth AA. 2009. "Flat gaps" in the sedimentary rock layers challenge long geologic ages. Journal of Creation 23(2): 76-81; Roth AA. 1998. ORIGINS: Linking Science and Scripture. Hagerstown, MD: Review and Herald Publishing Association, p 222-229.**

[59] **Roth AA. 1998. ORIGINS: Linking Science and Scriptures. Hagerstown, MD: Review and Herald Publishing Association, p 263-267.**

[60] **For a geologic map see Billiingsley GH, Block DL, Dyer HC. 2006. Geologic map of the Peach Springs 30' x 60' Quadrangle, Mohave and Coconino Counties, Northwest Arizona. U.S. Geological Survey, U.S. Department of the Interior.**

[61] **Middleton LT, Elliot DK. 2003. Tonto Group. In Beus SS, Morales M. Grand Canyon Geology, 2nd edition. New York: Oxford University Press, p 110.**

[62] **For more discussion about the deposition of the layers and carving of the Grand Canyon, see the two DISCUSSIONS about the Grand Canyon on the author's webpage; www.sciencesandscriptures.com, Look for these following the 17 discussions about the Bible and Science, (viewed on October 17, 2015).**

[63] **Blakey RC. 2003. Supai Group and Hermit Formation. In Beus SS, Morales M. Grand Canyon Geology, 2nd edition. New York: Oxford University Press, p 136-137.**

[64] **Blakey RC. 2003. Supai Group and Hermit Formation. In Beus SS, Morales M. Grand Canyon Geology, 2nd edition. New York: Oxford University Press, p 145.**

[65] **For data and calculations see Roth AA. 1998. ORIGINS: Linking Science and Scripture. Hagerstown, MD: Review and Herald Publishing Association, p 263-266.**

9. GOOSENECKS OF THE SAN JUAN

LOCATION

Go to the Goosenecks State Park in southeast Utah by way of US 163 and SH 261 and 316 to the overlook. This is northwest of the town of Mexican Hat, Utah.

Figure 1. The Gooseneck carved by the San Juan River in a meandering pattern.

DESCRIPTION

The striking incised meandering erosion seen here is by the San Juan River, flowing generally towards the right of the picture, on its way to Lake Powell and the Grand Canyon. This is just a small sample of many meandering turns by this river in this region. Erosion is down through over a thousand feet of upper Paleozoic layers and is postulated to have occurred as the meandering antecedent river kept at the same level as the sedimentary layers of the region were slowly uplifted. Millions and even hundreds of millions of years have been proposed for this erosion.

Another feature of this gorge, which you cannot see from the top, is that some of the sedimentary layers at the bottom of the gorge become gradually thicker (Figure 2) and then thinner. Dozens of such thickenings have been noted for several miles above river level in this region. The thickened portions have been interpreted as “bioherms” and “barrier-reefs.”[66] Bioherms and reefs, like coral reefs, are produced by the slow growth of mineral-depositing organisms such as coral, clams, algae and bryozoan, and would require many years to grow. As reefs, they should represent solid wave resistant structures. If you want to see some of these thickened layers you will have to hike down the famous poorly developed Honaker Trail which starts a couple of miles (longer by the road) to the northwest of the Goosenecks lookout. When you reach the river level, look for layers that gradually thicken and thin out again (Figure 2).

Dozens of feet down from the gooseneck viewpoint, on the slope south of the edge of the low outlook wall, you will find some marine fossils; some of them are red because they have been jasperized (replaced with jasper). You can photograph them, but do not take any of them; leave them there for others to also enjoy.

Figure 2. An assumed bioherm or reef. This is the thickened part of the layer (red arrow) which thins out to the left. This one is just above river level in San Juan Canyon, near the base of the Honaker Trail.

A CREATION-FLOOD PERSPECTIVE

The interpretations of a long time required for erosion and for reef growth are subject to reevaluation. A report in what is arguably the leading science journal, "*Science,*" suggests that "vertically incised meanders of the San Juan may have resulted from downcutting during low-frequency discharges of large magnitude which entrained all of the alluvium in the channel."[67] The "low frequency" mentioned is not at all required for downcutting and the "large magnitude" is what would be expected from Genesis Flood activity. The report is based on laboratory tests in a 60 foot flume testing the erosion of sediments. During slow erosion, as a river goes around a curve, you expect gradual erosion of the outside (concave side) and accumulation of sediments on the inside (convex side). During rapid erosion incision around bends would be vertically symmetrical as all sediment would be entrained, as you can see for the curves of the canyon at the Gooseneck.

The suggested "bioherms" (Figure 2) do not appear to be real reefs. What one sees are continuous sedimentary layers that thicken up, likely due to altered depositional regimes, not abrupt edges as is common to our present living wave resistant reefs (bioherms). A close examination of some of these revealed a paucity of fossils, and they were not from well-known reef forming organisms. Furthermore, they were not in growth position as expected for real reefs. These appear to be thickened sedimentary layers. For further discussion of reefs, see DISCUSSION 8 on the authors webpage: www.sciencesandscriptures.

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[66] **Wengerd SA. 1955, (2011). Biohermal trends in Pennsylvanian strata of San Juan Canyon, Utah. In Geology of Parts of Paradox, Black Mesa, and San Juan Basins. Four Corners Field Conference, 1955, p 70-77.**

[67] **Shepherd RG. 1972. Incised river meanders: Evolution in simulated bedrock. Science 178:409-411.**

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10. GYPSUM EVAPORITE

LOCATION

An excellent and easily accessible exposure of an evaporite is found along US 89 between Mt. Carmel Junction and the town of Mt. Carmel in Utah. The whitish rock (Figure1), on the west side of the road, is about 1.3 miles north of Mt. Carmel Junction, which is a junction with UT 9, and (at least in the 1980s) was 0.3 miles south of the town of Mt. Carmel. GPS is 37.23993 – 112.67244. This is the Jurassic Curtis Formation and is likely related to the Todilto Formation of New Mexico and Colorado.

Figure 1. The Jurassic Curtis Formation just south of Mt. Carmel UT. It consists mostly of the mineral gypsum ($CaSO_42H_20$) . It is interpreted to have formed by evaporation of seawater.

DESCRIPTION

Evaporites are rocks that are considered to have been formed by the evaporation of sea water. When sea water is evaporated, chemicals such as lime, gypsum, salt, and potash, etc., are precipitated generally in that order, and deposits of these minerals found in the sedimentary layers of the earth are usually called evaporites.

The process of evaporite formation is not well understood and is the basis of abundant conjecture in the geologic literature. One of the main problems is that at present on the surface of the earth, we do not see forming the pure and massive evaporites that we find in the earth. Simple evaporation of sea water does not provide an easy explanation, because it would require inordinate depths of sea water to supply the thickness of evaporite mineral layers commonly found in many ancient evaporites. For instance, the 40 feet thick layer of gypsum exposed at this locality would require the evaporation of 15 miles of seawater over this locality to produce it, but the deepest part of the world oceans is less than 7 miles!

A variety of models has been suggested for the formation of evaporites, including:

1. Ordinary evaporation of sea water.
2. Reflux model where sea water in a restricted basin is repeatedly replaced, thus providing a source for more minerals.
3. Shallow semi-restricted broad and flat saturation shelf providing evaporation and precipitation especially at a closed end, and a fresh supply of seawater from the open ocean at an open end.
4. Deep water accumulation of evaporites from evaporation at the surface in semi-closed basins.
5. Origin by diagenesis, which involves chemical changes to form evaporite minerals after deposition of other minerals .
6. Transport of evaporite-mineral clasts (particles) to form a layer
7. Conversion to evaporite minerals by microbial activity.
8. Due to volcanic activity in the oceans.

Many geologists refer to the present sabkhas forming along the coasts of the Persian Gulf as examples of how evaporites form. These are widespread shallow supratidal basins where evaporites slowly accumulate. However these are not good examples for the thick evaporites of the sedimentary record such as the Zechstein of Europe, the Delaware Basin of West Texas and New Mexico, or the Paradox basin in Utah and Colorado, because sabkhas are so shallow and often mixed with detrital sand. The purity of the evaporites in the deeper rock layers is notorious.

Quite often evaporites show cyclic (i.e. repeated) patterns of different layers of minerals. Both large patterns like the four cycles of the Zechstein evaporites, and smaller patterns like the 200,000 couplets of the Castile Formation of the Delaware Basin are considered cyclic. The latter look almost like tree rings and, like tree rings, these finer cycles are often interpreted as annual cycles, and even longer sunspot cycle patterns with statistical authentication are claimed for some sequences. But not all agree[68] and statistical confirmation, like in tree ring matching, is much more difficult than many researchers realize.[69]

A CREATION-FLOOD PERSPECTIVE

The presence of evaporites, formed by the slow evaporation of seawater, is not at all what one would expect for sediments laid down during the year of the great catastrophic Genesis Flood. However, it needs to be kept in mind that the formation of evaporites is a much disputed and unauthenticated topic of the geologic literature. Transport of evaporite clasts from an original evaporite particle source would be rapid and rapidly deposited evaporite turbidites have been described in the geologic literature,[70] but these seem rare. Some models involving volcanic activity could especially speed up the process, and would thus fit in a Flood model, especially if deposits of evaporite type minerals were already present before the Genesis Flood. This might explain the unusual purity of many of our deep evaporite deposits. Two references suggesting volcanic activity associated with evaporite formation are listed below.[71]

A very important point to keep in mind is the striking difference between the huge evaporite deposits we find buried in the sedimentary layers of the earth, and the usually restricted area and especially thin examples of evaporites we now see forming on the present surface of the earth. Two leading specialists in evaporites state that "there are no thick evaporites forming anywhere on earth, and it will be appreciated why speculation on a geologic model to explain thick monomineralic deposits takes up much space in the literature on evaporites."[72] The Genesis Flood was an astonishingly unusual event, and unusual deposits like evaporites may find explanation in that event.

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[68] For brief discussion and references see: Kirkland DW, Evans R. 1973. MARINE EVAPORITES: Origin, Diagenesis, and Geochemistry. Benchmark Papers in Geology. Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., p 219.

[69] Brown RH. 1995. Can tree rings be used to calibrate radiocarbon dates? Origins 22(1):47-52.

[70] Schreiber BC, et al. 1976. Depositional environments of Upper Miocene (Messinian) evaporite deposit of the Sicilian Basin. Sedimentology 23:729-760.

[71] (a) Rode KP. 1944. On the submarine volcanic origin of rock-salt deposits. Proceedings of the Indiana Academy of Science XX Sec. B: 130-142; (b) Sozansky VI. 1973. Origin of salt deposits in deep-water basins of Atlantic Ocean. American Association of Petroleum Geologists Bulletin 57(3):589-595.

[72] Kirkland DW, Evans R. 1973. MARINE EVAPORITES: Origin, Diagenesis, and Geochemistry. Benchmark Papers in Geology. Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., p 104.

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11. HEART MOUNTAIN LANDSLIDE

LOCATIONS

Various parts of the Heart Mountain Landslide can be viewed from many localities between Cody, Wyoming and Cooke City, Montana. The region is just east of Yellowstone National Park. A trek pattern is to go north from Cody along State Highway 120 for 17 miles and turn left on SH 296 up through Dead Indian Pass (8048 feet), and down to the junction of SH 296 and US 212 that goes west to Cooke City and Yellowstone NP; or follow the reverse. This is fascinating country.

Of special interest is Heart Mountain which is an isolated peak seen some ten miles north of Cody. You will also see it east of SH 120, as you proceed north. You can see it occasionally, also to the east, as you go up to Dead Indian Pass along SH 296 (Figure 1).

Figure 1. Looking east at Heart Mountain. The part that slid is the steeper peak in the center of the distant hill. It consists of Paleozoic carbonate formations (Bighorn Dolomite, Jefferson and Three Forks formations, and Madison Limestone) layers that lie on top of softer Mesozoic and Tertiary formations that form the gentler side slopes of the mountain. Mesozoic red Chugwater and whitish Gypsum Springs formations in the foreground.

The Cathedral Cliffs scarp which exposes the general landslide stratigraphy is worthy of a stop. It can be viewed from a distance along SH 296, southeast of Cooke City and the northeast entrance to Yellowstone NP. Coming from the east, a good view is about 15 miles west of the Sunlight Bridge over Sunlight Creek along US 296. Suggested GPS is 44.8458 – 109.6008. Coming from Yellowstone NP, a view is around 8.7 miles southeast along SH 296, starting from the junction with US 212. The E-W trending cliff is a little over a mile directly to the south along this E-W trending part of the highway. Further details will be considered below.

DESCRIPTION

The Heart Mountain Landslide (detachment)[73] is one of the largest and most enigmatic landslides found on the surface of our continents. A puzzling icon is Heart Mountain which is formed of the same Paleozoic layers found to the west, but lays over younger layers of Mesozoic and Tertiary (i.e. Eocene Willwood Formation) sediments. It is isolated , being at least 10 miles away from any possible source. How did Paleozoic Heart Mountain, composed of Ordovician, Devonian, and Mississippian carbonates, move over to a higher part of the geological column while at best, sliding down on an almost flat surface. Figure 2 illustrates the relationships. Note in that figure, that in the east (right side) the deeper layers dip down to the right, resulting in younger (higher) layers at the surface as you proceed east. One of the big question is: How did Heart Mountain get pushed out there with nothing between? And then there are the McCulloch Peaks, composed of the same kind of Paleozoic layers as Heart mountain, about 10 more miles further east (Figure 2, right side). How did they get out there?

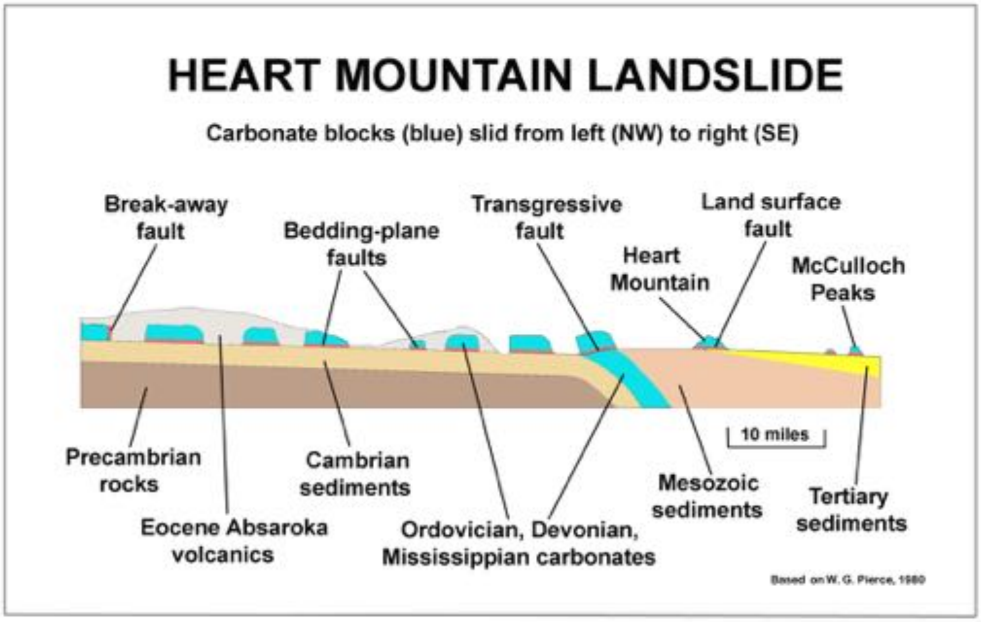

Figure 2. Heart Mountain Landslide. The parts that slid to the southeast are the blue Paleozoic carbonate blocks that lie above red fault lines. The blue layers to the left of the break-away fault and those below the transgressive fault did not slide and are essentially in their original position before the slide.

That is just the beginning of the story. To the southwest of Heart Mountain are much larger blocks than Heart Mountain, also resting on younger rocks, and to the west and northwest there are many more large and small blocks that have slid but still rest on the same Cambrian formations they originated on. It appears that some 50 to 100 large and small blocks, consisting of Ordovician, Devonian and Mississippian carbonates

(Figure 3), started separating from the Break-away fault (Figure 2), that lies very close to the eastern edge of Yellowstone NP.[74] The blocks moved in a south-easterly direction as they separated further from each other, forming a huge elongated triangle of blocks, widening to the southeast. An area of about 500 square miles of the original blocks, spread out over some 1300 square miles. The sliding was accompanied by, and followed by, volcanic activity depositing a complex of Eocene Absaroka volcanics (Cathedral Cliffs and Wapiti formations) over the eastern part of the landslide (Figure 2).

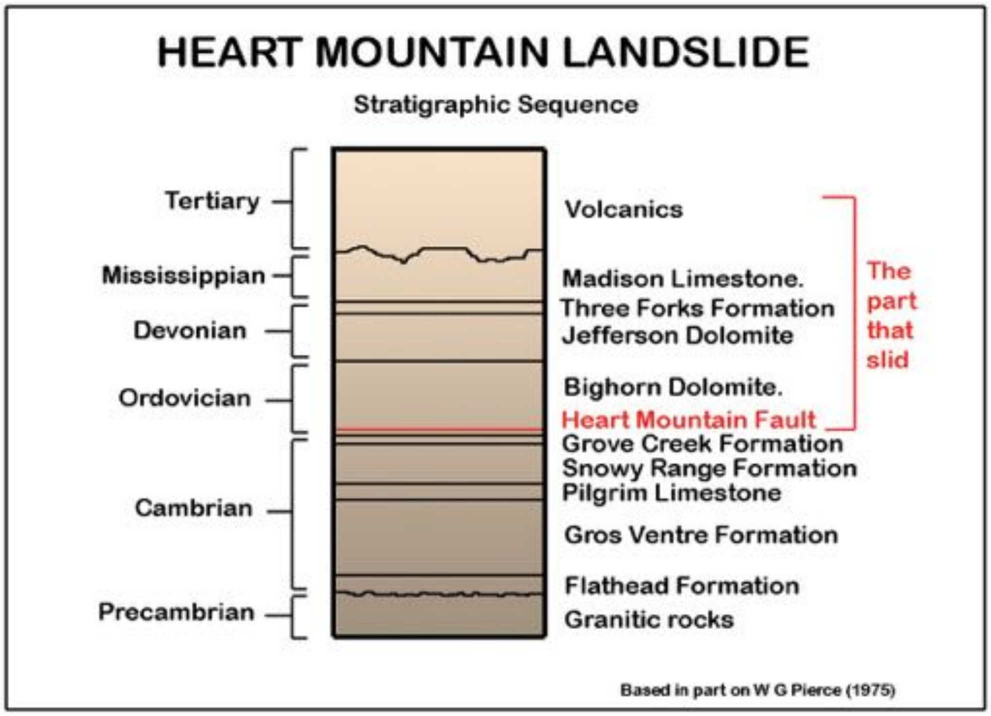

Figure 3. Stratigraphic sequence of formations of the Heart Mountain Landslide. All the designated layers are Paleozoic except for the top one that is Cenozoic (Tertiary), and the bottom Precambrian granitic rocks.

The Paleozoic (Ordovician, Devonian, Mississippian) (Silurian is missing here) carbonate blocks often reach some 1500 feet (450 meters) in thickness, some blocks are as much as 5 miles across. The fault plane on which sliding took place is in the lower part of the Ordovician Bighorn Dolomite Formation (Figure 3), and the surface (fault plane) generally lies about 8 feet (2.5 meters) above the base of that formation, and is not brecciated (broken up into small or fine rocks) below the fault surface. Above the fault surface, there is brecciation, i.e. breaking up or cracking of the dolomite, sometimes extending as high as 50 feet above the fault plane, but usually forming a layer only one inch to two feet thick. The broken up fault breccia is usually of fine particles and is sometimes squeezed up forming vertical tending dikes into the transported carbonate blocks and even into the covering volcanics.[75] Size of the dikes ranges from one inch to two feet wide and reaches as high as 100 feet above the fault plane. It appears that significant volcanic activity accompanied the slide, and significant volcanic activity followed later on, after the sliding was over.

Adding to the Heart Mountain enigma is the fact that the fault plane, that lies near the base of the Bighorn Dolomite, is within one of the more resistant rock formations of the region. The Cambrian Grove Creek and Snowy Range formations which lie just below the Bighorn Dolomite (Figure 3) have a number of shale layers[76] where sliding would seem more likely.

The near horizontal fault plane is estimated to have had a slope of only 2 degrees down towards the southeast, while the portion of the fault plane designated as "Transgressive fault" in Figure 2, " had a slope of 10 degrees down to the northwest, which would indicate that some of the blocks had to actually go uphill through this region as they slid to the southeast.

Most researchers favor a catastrophic emplacement model, some suggesting that the blocks collided with each other as they moved to the southwest. Rates of 20 to 200 miles per hour are suggested, and often it is proposed that the whole event took about 30 minutes. To get Heart Mountain to travel 10 miles on a nearly flat plane can engender innovative thinking.

There is significant speculation and discussion about a mechanism that would facilitate sliding.[77] These include:

1. Earthquake
2. High fluid pressure like hot water[78]
3. Gravity landslide
4. Volcanic gas under pressure
5. Slow continuous non-catastrophic erosion with gravity spreading[79]
6. Sliding on supercritical CO_2 gas from degenerating dolomite at the contact plane[80]

Some of these explanations include abundant sophisticated study, computer modeling, and imagination. We are dealing here with puzzling questions and we can expect more explanations.

The view of Cathedral Cliffs (location given above) provides insight into the enigma. As you look at the cliff, there are three significant series of layers. The lowest is the Cambrian layers that did not slide; above them are the carbonate (Ordovician-Mississippian) that slid, and above are the volcanic deposits (Figure 2, left portion). There is talus covering much of the cliff and that makes identification of formations difficult. See Figure 3 for the expected order. In general, the irregular material that forms the top of the hills and that is not bedded (lacks horizontal layers) is the Absaroka volcanic deposits. The bedded layers in the middle are the part that slid; that includes the striking vertically eroded castellated Madison Limestone that dominates the landscape to the right (west) portion of the cliff, and several layers below that.

From the view from SH 296, it is difficult to locate the exact location of the fault plane, i.e. the bottom of the sliding portion. You can get an idea of where it lies in some

of the well exposed scarps seen on the eastern portion (left) of the Cathedral Cliffs as a whole. Note especially the distinctive Pilgrim Limestone , which is the thin, vegetation free, light grey, vertically faced, very horizontal, limestone scarp exposed especially well near the bottom on the east (left) portion of the Cliffs, but also less distinctly on the west. The Pilgrim Limestone is among the Cambrian formations below the fault plane, and can serve as a guide. It is easy to identify because it appears usually free of vegetation and has a remarkably uniform thickness over much of the broader region and it is exposed in many places. Note the thickness of the Pilgrim Limestone; the Heart Mountain fault plane lies above that formation at a level that is equivalent to about twice the thickness of the Pilgrim Limestone.[81] The layers above that level, except for the top part of the
Absaroka volcanics, that came later, were involved in the sliding (Figure 3, red bracket). Familiarity with formation lithologies might help locate the fault near the base of the more massive Bighorn Dolomite, but inspection from a closer distance would be a more secure procedure.

A CREATION-FLOOD PERSPECTIVE

The Heart Mountain Landslide raises a number of puzzling questions. How did Heart Mountain get pushed out for at least 10 miles over different rock formations? What was the force that engendered the sliding of huge five mile blocks down a 2 degree slope (with likely part going upslope); was it an earthquake, volcanic activity, gravity, etc.? Why did the fault plane form in apparently well consolidated Bighorn Dolomite, when weaker shale levels for sliding were close below? There is no shortage of baffling questions here. The general evidence for major catastrophic activity here, of course, fits better in the context of the worldwide Genesis Flood than the usual more localized activities of slow uniformitarian long ages interpretations. The general uniform thickness of the Pilgrim Limestone also deserves mention as one of those incredibly flat limestone deposits that can be more readily associated with massive catastrophic activity than with the slow irregular local deposition of present marine shelf environments.

In a Genesis Flood interpretation, the Heart Mountain and other extensively traveled blocks that now lie on Mesozoic and Eocene layers would suggest a late Flood or possibly post-Flood event. Fractures in the Bighorn Dolomite and slickensides in the Madison suggest some post-Flood activity, but not necessarily for the main emplacement event. Could the Bighorn Dolomite, where sliding took place, have been less consolidated late in the Flood event than now? In the context of the Genesis Flood, a new dimension of possibilities arise. These ideas deserve further study. We know so little. The Heart Mountain Landslide helps engender healthy humility.

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[73] William G. Pierce has, for half a century, led the research activity about the Heart Mountain detachment thrust. More recently a few others have joined the continuing investigations and speculations. The reader may want to look at all the references listed below and the references contained therein to get a more complete view. An early comprehensive examination is found in: Pierce WG. 1957. Heart Mountain and South Fork detachment thrusts of Wyoming. Bulletin of the American Association of Petroleum Geologists 41:291-626. Pierce's 1975 publication listed below is a useful introduction.

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[74] Pierce WG. 1987. Heart Mountain detachment fault and elastic dikes of fault breccia, and Heart Mountain break-away fault, Wyoming and Montana. Centennial Field Guide, Volume 2, Geological Society of America, sometimes listed under Rocky Mountain Section of the Geological Society of America, available in PDF; Pierce WG. 1980. The Heart Mountain break-away fault, northwestern Wyoming. Geological Society of America Bulletin 91:272-281.

[75] Pierce WG. 1979. Clastic dikes of Heart Mountain Fault Breccia, Northwestern Wyoming, and their significance. US Geological Survey Professional Paper 1133, p 1-25

[76] Dorf E, Lochman C. 1940. Upper Cambrian Formations in Southern Montana. Geological Society of America Bulletin 51:541-556.

[77] Brief discussions of the first four causes and references for these are found in Pierce WG. 1975. Principal features of the Heart Mountain Fault and the mechanism problem. Twenty-Seventh Annual Field Conference, Wyoming Geological Association Guidebook, p 139-148.

[78] Aharonov E, Anders MH. 2006. Hot water: A solution to the Heart Mountain detachment problem. Geology 34:165-168, DOI 10.1130/G22027.1.

[79] Hauge TA. 1990. Kinematic model of a continuous Heart Mountain allochthon. Bulletin Geological Society of America Bulletin 102:1174-1188.

[80] Goren L, Aharonov E, Anders MH. 2010. The long runout of the Heart Mountain landslide: Heating, pressurization, and carbonate decomposition. Journal of Geophysical Research DOI: 10.1029/2009JB007113; Beutner EC, Gerbi GP. 2005. Catastrophic emplacement of the Heart Mountain block slide, Wyoming and Montana, USA. Geological Society of America Bulletin 117:724-735, DOI: 101130/B25451.1.

[81] This estimate is based mainly on Figure 1, in: Pierce WG. 1963. Cathedral Cliffs Formation, the early acid breccia unit of northwestern Wyoming. Geological Society of America Bulletin 74:9-22.

12. HONAKER TRAIL FORMATION FOSSILS

LOCATION

The fossils are located in a small darker gray cliff some 10 meters (30 feet) above road level as you go around a curve in US 191, north of Moab, Utah. It is best if you approach this locality by driving south on US 191. Go 5.5 miles south of the junction of US 191 and UT 213 that goes to Dead Horse Point and Canyonlands National Park. At 5.5 miles you will be going around a curve to the east (left). In the cliff to the right note gray layers between red ones. Park on the side of the road and climb up to the darker gray layers to the south. The fossils are in the vertical cliff face around GPS 38.61320 – 109.62306.

If you come from the south along US 191, the locality is 0.95 miles north of the side road to the east that leads into Arches National Park. The portion of US 191 near the fossil locality is four lane, with double yellow lines in the middle, making it illegal to U-turn, and crossing by foot is hazardous, so it is best to come from the north.

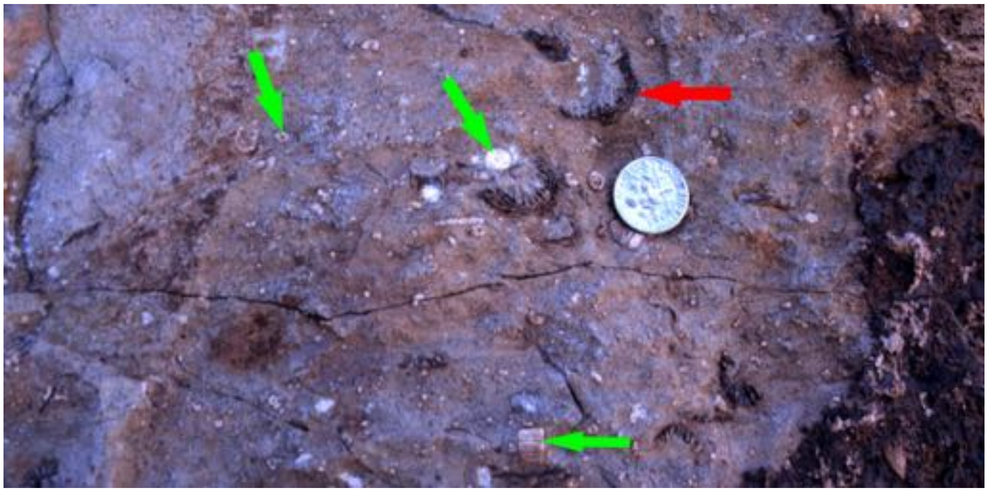

Figure 1. Fossils in the Honaker Trail Formation. The red arrow points to a rugose horn coral, the green arrows point to crinoid stems. Note coin (dime) for scale.

DESCRIPTION

This is simply an easily accessible fossil locality with abundant typical Paleozoic invertebrate fossils (Figure 1). They are located in the Pennsylvanian Honaker Trail Formation that is the grayish layers of the cliff, lying below the reddish Permian Cutler Formation. More fossils can be found by climbing up to the surface above the darker gray cliff. Fossils include an abundance of brachiopods, bryozoa, rugose corals, and crinoids, and rarer fusulinids, and trilobites.[82] While minor invertebrate fossil collecting is legal (circa 2015) on public lands in Utah, these well preserved specimens are imbedded in a tough limestone that makes collecting difficult.

A CREATION-FLOOD PERSPECTIVE

As you examine the outcrop, note that the fossils are in random orientation and appear as “floating” in the enclosing sedimentary layers. They do not appear to be in growth position and this suggests massive movement from another locality as by a debris flow. This type of deposit could occur with either the short time Flood model or as a catastrophic event in the long geological ages model, hence this is not compelling evidence for either model, but is evidence that is more what is expected from the catastrophic Flood model than usual, slow local events expected in the long geologic ages model.

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[82] **Baars DL, Doelling HH. 1987. Moab salt-intruded anticline, east central Utah. In Beus SS, Editor, Geological Society of America Centennial Field Guide Volume 2, p 275-280.**

13. MOENKOPI-SHINARUMP GAP

LOCATION

This easily accessible contact between the widespread Shinarump and Moenkopi formations is along US Alt 89, right at the state line between Utah and Arizona. The state line lies about halfway between the towns of Kanab, UT and Fredonia, AZ. You can park on the east side of US Alt 89, just south of the state line on the AZ side (GPS 37.00066 – 112.52966). Proceed east among the boulders until the upper tan Shinarump layer significantly overrides the reddish-brown Moenkopi along the east-west cliff, thus permitting you to examine the under surface of the Shinarump that shows some large ripple marks that are casts of the ripple marks that were on the top of the Moenkopi when the Shinarump was laid down. (Figure 1, is looking west towards the highway).

You will see more distinct casts of ripple marks on some of the blocks of Shinarump that have tumbled towards the south as you return towards the highway (Figure 2). Further to the east, along this contact you will see evidence of soft sediment disturbance, but check with the owner of the property before adventuring there.

Figure 1. Contact of the Shinarump overlying the Moenkopi formations. The green arrow designates the contact plane while the red arrows point to casts of ripple marks which can be seen by looking up at the lower surface of the Shinarump.

DESCRIPTION

The Shinarump Conglomerate and Moenkopi Formations cover some 100 thousand square miles in parts of six states in the western US. See the discussion about the Shinarump for a map of its distribution. The Shinarump consists of particles ranging in size from coarse sand to pebbles, and rarely larger. It is a resistant layer often forming the caprock of buttes and mesas. It is thought to have been laid down by the action of rivers. The softer Moenkopi consists of shales, mudstones and limestones and is interpreted to have been laid down on floodplains, shallow marine environments, and by rivers. It is famous for well-preserved ripple marks. The Moenkopi is dated as Lower Triassic, the Shinarump as Upper Triassic. The Middle Triassic is missing between these two layers. In other words, according to the standard geologic timescale, there is at least a 10 million year gap between these two layers.

Figure 2. Tumbled block of Shinarump, upside-down, showing parallel ripple marks on its surface. These marks are actually casts of the Moenkopi ripple marks on which it was deposited. Note the small pen on the lower part of the slab surface for scale.

A CREATION FLOOD PERSPECTIVE

The extremely widespread distribution of the Shinarump is more like what you would expect from distribution by a catastrophic flood than by river action as geologists now suggest. That such coarse sediments could be distributed so evenly over 100 thousand square miles is not what you would expect from present local slow river and stream sedimentary processes.

What is especially intriguing at this locality is the preserved ripple marks at the contact between the Moenkopi and the Shinarump. Since there is an assumed 10 million year gap between the two layers, one would expect a lot of erosion of the Moenkopi during that time. According to a conservative average rate of erosion for the continents of the world of 30 meters per million years, you would expect some 300 meters (1000 feet) of downward erosion in 10 million years. So why would depositional ripple marks be preserved over that long a time? These preserved ripple marks favor more a model where the Moenkopi and Shinarump were laid down rapidly during the Genesis Flood.

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14. NAVAJO SANDSTONE

LOCATION AND INTRODUCTION

Drive north of Kanab, UT on US 89 along Kanab Creek. About 3 miles north of town the highway crosses over Kanab Creek that comes from the NW. Follow US 89 to the NE. In the surrounding cliffs, note the light tan strongly crossbedded Navajo Sandstone. Here, the stratigraphy is complicated by a tongue of dark red Kayenta Formation that interfingers with the Navajo and you will see tan Navajo below and above this reddish tongue. The Kayenta normally lies below the Navajo. The Navajo is supposed to represent ancient desert dunes and the Kayenta is interpreted as river deposits. For the next 3 miles along US 89, note the horizontal truncation (cutting across) of the inclined foreset layers in the Navajo (green arrow in Figure 1).

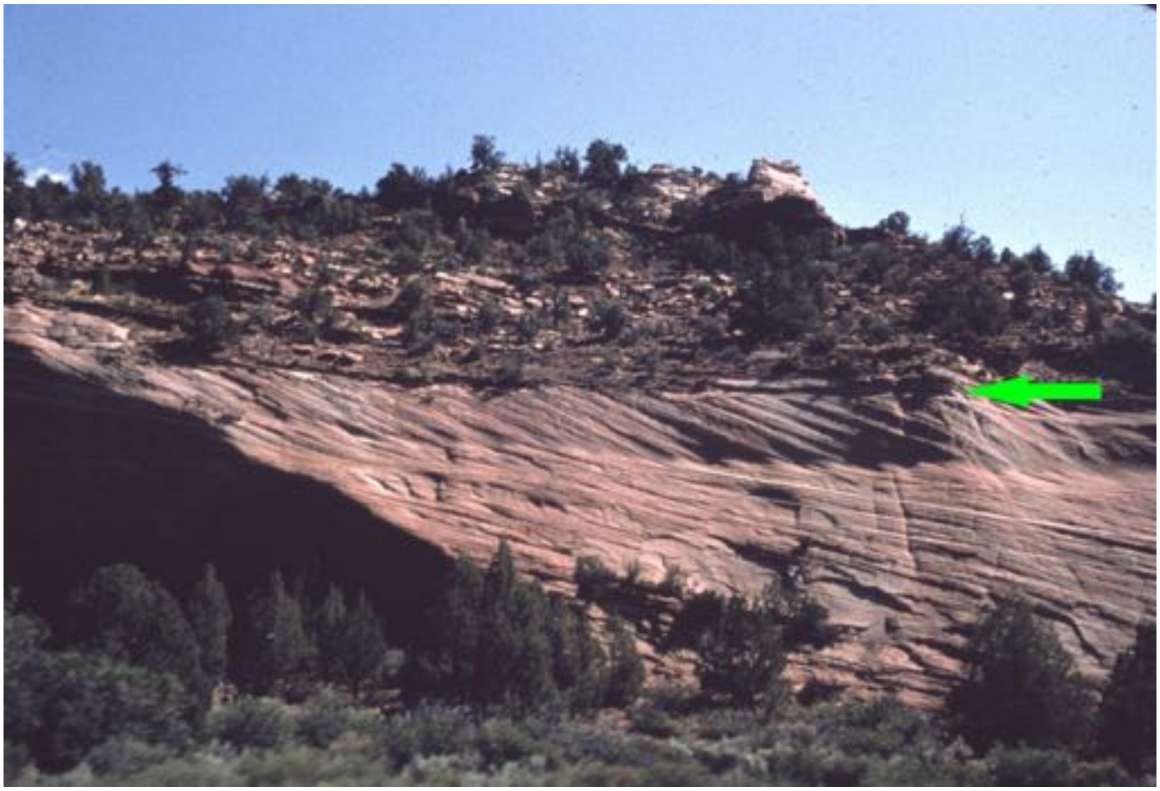

Figure 1. Truncation in the Navajo. The arrow points to a horizontal surface where inclined foreset layers have been planed off, i.e. truncated. This is a fairly common feature of the Navajo Sandstone.

Large scale soft sediment contorted deformation in the Navajo is well exposed in the layers just above three ponds (Figure 2) located about 5 miles north of Kanab. As you follow US 89 going north, you will pass Moqui Cave, a home carved out of the cliff, on the east (right) side of the highway. Between 0.7and 1.1 miles beyond Moqui, you will see the ponds on the west side (left) of the highway. There has usually been good parking just before the first pond. GPS is 37.13179 – 112.56580. Note the distortion at several places in the layers of the Navajo just above the ponds. If you are coming from the north on US 89, the ponds are about half a mile south of the junction with Hancock Road to the west and Angel Canyon Road (north exit) to the east.

Figure 2. Large scale soft sediment deformations in the Navajo. The arrow points to near vertical sedimentary layers distorted by major soft sediment deformation.

DESCRIPTION

The Jurassic Navajo Sandstone is one of the prime formations in the western US.[83] It is usually called the Aztec or Nugget in Nevada and Wyoming respectively, and covers some 135 thousand square miles in parts of 6 states (Figure 3). It is almost devoid of fossils. The steep walls in Zion National Park dramatically expose Navajo to a thickness of 2000 feet. Fossils are very rare in the Navajo

In outcrops over the country, it is seen as a strongly cross-bedded sandstone and is usually interpreted as representing a huge area of desert dunes deposited primarily by wind action. However, not all agree, and discussion of its depositional environment has been contentious. In 1975, two geologists, William Freeman and Glenn Visher presented several lines of evidence indicating a marine environment instead of a desert environment for the Navajo.[84] This unorthodox interpretation generated special attention and two years later, in the same journal, four other geologists presented rebuttals to Freeman and Visher’s interpretations.[85] This was followed by Freman and Visher presenting rebuttals to the rebuttals. All this gives insights into the speculative component of “historical science” as well as the sociology of the scientific community. More recently an article proposes that there were “two long-lived monsoon-dominated pluvial [rain] episodes" during the deposition of part of the Navajo.[86] This complicates the desert-dune model, as an extensive monsoonal climate would be expected to generate a rich flora which is not found. This further illustrates the difficulty and pervasive equivocal nature of paleoenvironmental studies.

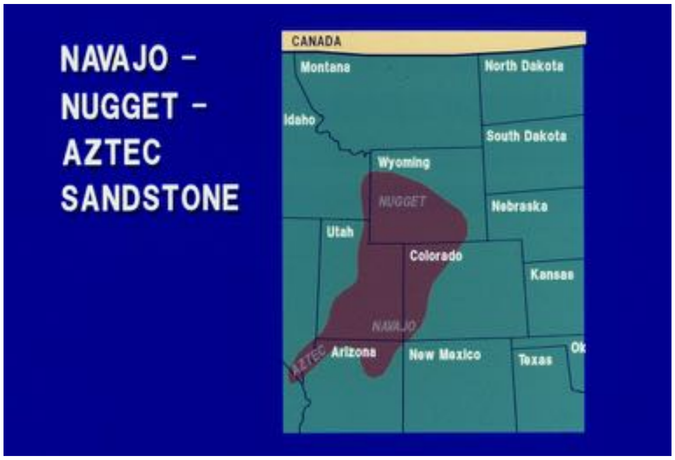

Figure 3. Map showing the distribution of the Navajo Sandstone and its Aztec and Nugget components in the western United States.

A CREATION-FLOOD PERSPECTIVE

The prevailing desert-dune interpretation for the Navajo is not what you would expect in the midst of a worldwide Genesis Flood event, although significant wind activity would be expected then. However, one needs to keep in perspective that at present, dunes are not only the work of wind but are also commonly produced by moving waters in river beds and oceans. Is it possible that the Navajo resulted from Flood activity when fossil-free preflood sands, originally located in deep aquifers, were released when "all the fountains of the great deep [were] broken up"? (Genesis 7:11 and 8:2). This is conjecture, but the extreme scarcity of fossils and some of the data from the Navajo favors a catastrophic interpretation.

The many flat and parallel truncation planes (Figure 1), that are common to the Navajo, sometimes extend for kilometers. Such flat truncation of sloping foreset beds is better explained by widespread catastrophic sheet flood type of activity than by wind activity which commonly tends to build mounded dunes and not flat terrains. Likewise, the large scale soft sediment deformation (Figure 2), is better explained by catastrophic movements, expected from a worldwide Flood, than from slow normal wind-generated dune activity. Large scale contorted deformation can be seen at quite a number of localities in the Navajo.

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[85] See: 1977. Journal of Sedimentary Petrology. 47:475-491.

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[86] Loope DB, Clinton MR. 2003. Long lived pluvial episodes during deposition of the Navajo Sandstone. The Journal of Geology 111:223-232.

15. PETRIFIED TREES IN THE CHINLE

LOCATION

This impressive set of petrified logs is found in the Navajo Nation in northeastern Arizona along US Highway 89 some 70 miles north of Flagstaff. If you are coming from the south go 5.1 miles on US 89 north of the junction with US 160; there as you start slightly downhill, you will find a paved entrance to a dim dirt road going west from US 89. The entrance to the dim road is at about GPS 36.15080 and 111.39746. Turn west (left) and go about 0.1 miles on the dirt road. The largest tree in this locality lies to the northeast. If you are coming from the north, you will find the dirt road 11.9 miles south of the Gap Trading Post, just before the top of a gentle hill. Turn to the west (right) at the GPS locality given above.

Figure 1. Long petrified tree trunk partially buried in the Chinle

DESCRIPTION

Did you note that you drove over several partially buried petrified logs as you came in over the dirt road? You can see them on the way out. There are several large horizontal logs in this region, but the largest is to the NE (Figure 1). It is in the 25 meters (80 feet) range and can even be seen on Google Satellite in a NE-SW direction. These trees which are abundant in this region are in the Triassic Chinle Group (formerly the Chinle Formation). Preservation by petrifaction is exquisite, with the dark fine vessels of the wood easily seen with a hand lens.

A CREATION-FLOOD PERSPECTIVE

It is sometimes claimed that it would take millions of years to petrify a tree, but the process appears to go much faster. In Yellowstone National Park, the process was observed to proceed at the rate of 0.1-4 mm per year,[87] and there are many reports in the popular press about buried wood, such as fence posts, becoming petrified in a few years. It does not appear that the rate of petrifaction is a challenge to the biblical model of origins.

A study of the orientation of 739 petrified trees at eight different localities in the Chinle[88] indicates a dominant local orientation direction. Thirty six trees in this locality showed a pronounced NE-SW orientation, but the direction was not the same at some of the other localities. Orientation in one direction lends support to a catastrophic model, as contrasted to random tree fall, but one must keep in perspective that local catastrophic events could do the same. The fact that so many of the localities showed a preferred orientation is unusual and favors general catastrophism. It also needs to be kept in perspective that some of the geologic literature favors some catastrophic activity for the Chinle.

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16. SHINARUMP FORMATION

LOCATION

The Shinarump Formation – also called Shinarump Conglomerate -- is widespread in the southwestern US (Figure 1), and can be viewed at thousands of localities. Look for a usually light tan, thin, highly resistant conglomerate or coarse sandstone (Figure 2), dozens of feet thick, that tends to form vertical faces or ledges on escarpments. It is usually underlain by the red-brown Moenkopi formation and overlaid by the red-mixed colors of the rest of the Chinle Group (Figure 3). It is best to consult a geologic map of the area to make sure.

FIGURE 1. Map of western USA showing general area of Shinarump Formation.

FIGURE 2. Close up view of typical Shinarump sediments. Note pen for scale.

Examples illustrated below are: (1) in CAPITOL Reef National Park, UT on the east side of the "Scenic Drive," especially between the roads to Grand Wash and Capitol Gorge (Figure 3). (2) You can follow the Shinarump intermittently for nearly a hundred miles along Highway US 89 and ALT 89 as it skirts the base of the Echo Cliffs (GPS 36.76448 – 111.62693), and Vermillion Cliffs, between The Gap and for part of the way west towards Jacob Lake, AZ (Figure 4). You get a little view of how incredibly thin and widespread the Shinarump is when you look at the Grand Staircase from the viewpoint on ALT 89 at a turnout on the NE side of the highway, about 11 miles NW of Jacob Lake or 18 miles SE of Fredonia, AZ (Figure 5); (overlook shelter GPS 36.83058 – 112.25461). For a view of the widespread Buckhorn Conglomerate that lies over the Morrison Formation that is mentioned later below, look at the buttes SE of the junction of Interstate 70 and Utah 24, about 10 miles W of Green River, UT (Figure 6) (GPS 38.91559 – 110.37314).

FIGURE 3. Escarpment on east side of Scenic Drive in Capitol Reef National Park. The red arrow points to the tan Shinarump Formation (or Conglomerate) which is the thin resistant ledge of rock, across the picture, that lies just above the thick orange-brown Moenkopi Formation.

DESCRIPTION

The Shinarump Formation, sometimes called Shinarump Conglomerate, is especially noted for its large areal extent combined with its relatively thin uniform thickness which is usually around 50 to 100'. It is composed mostly of coarse sand and pebbles (Figure 2), although "blocks the size of an automobile also occur."[89] The noted researcher of the Colorado Plateau, Herbert Gregory delineates the paradox of the Shinarump, stating: "the implications are not easy to understand. Generally land-laid gravel is associated with rugged topography or with tectonic movements that provide suitable catchment areas, … Extensive field work shows that the gravel lies on a surface of low relief unaffected by noticeable faults, folds, or regional upwarps, and that it is not restricted to long trains [i.e. rivers] but spreads as an almost continuous sheet nearly 100,000 square miles in area.”[90]

FIGURE 4. Shinarump in the Echo Cliffs escarpment. It is the thin darker ledge designated by the tip of the red arrow.

FIGURE 5. Looking north at the Grand Staircase. The arrow points to the Shinarump which is the very thin light tan layer you can follow across the picture. It lies above the red-brown Moenkopi.

The Shinarump is an Upper Triassic Formation that used to be classified as the basal member part of the Chinle Formation. Many now consider it to be a formation level unit of classification as part of a more inclusive Chinle Group. While there were earlier suggestions that it might be of marine origin, fossils of invertebrates, vertebrates and land plants indicate a “continental” origin. Dinosaur tracks have been found and petrified wood is common. Its mode of deposition has engendered much discussion, but the prevailing interpretation is that it was deposited by stream action, with varied suggestions from meanders, amalgamated streams, to constant reworking of sediments.

Geologist William Lee Stokes of the University of Utah has addressed the Shinarump question and that of other widespread coarse sediments, including the less widespread Buckhorn Conglomerate (Figure 6), that might be associated with the basal conglomerate of the Cloverly Formation that covers much of the state of Wyoming, and that layer may be associated with a similar deposit in Canada, thus representing an even more widespread coarse deposit than the Shinarump. He also mentions the widespread and sometimes coarse Dakota Formation,[91] which is discussed elsewhere in other field guides under widespread formation designations. Stokes proposes that these widespread coarse particle deposits may originate from pediments. Pediments are the gently sloping surfaces one finds at the base of the steep escarpments of many mountains. They are derived from the erosion of the mountain and often represent moderately sloping sediments on their way to forming flatter plains between mountains. This is an ingenious suggestion, but has been strongly challenged in the geologic literature for several reasons, including the facts that pediments are not flat and widespread, and the structure of sediments in the Shinarump look more like stream type of deposits.

FIGURE 6. View near the junction of I70 and UT24. The arrow points to the coarse thin dark Buckhorn Conglomerate that caps a butte of multicolored Morrison sediments.

A CREATION-FLOOD PERSPECTIVE

At present we don’t see relatively thin layers of coarse sediments being deposited over nearly flat surfaces of our continents covering areas of 100,000 square miles. The Shinarump, like many other formations, reflects conditions unnatural to our present slow local geologic processes. The sediments for the Shinarump had to be provided from a unique source because the coarse Shinarump is different from the dark shales of the underlying Moenkopi and from those of the fine lighter-multicolored Chinle formations above (Figure 3). We are dealing with extensive transport of heavy sediment particles, often up to pebble size, over a very wide area. Extreme forces would seem necessary. One gets a further perspective of the depositional incongruity when you realize that if

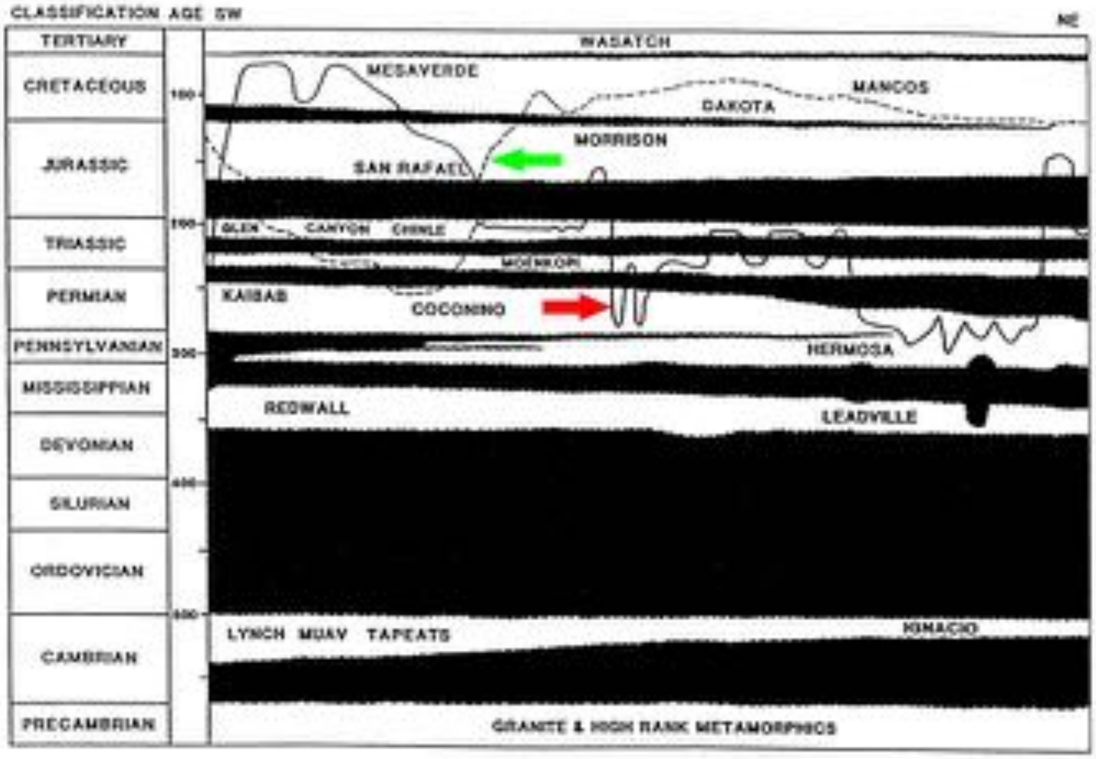

Figure 7. Representation of a vertical section through the sedimentary layers in eastern Utah, assuming the standard geologic time scale. The assumed ages are provided in the second column from the left in million year units. The white labeled layers are the rock layers of the region, that actually lie directly on top of each other. The black regions represent gaps of parts of the geologic column that are missing in this region. The Upper Triassic Shinarup is located at the base of the white layer labeled “Glenn Canyon, Chinle,” Below is a black region that you can follow across the figure that represents a gap of 10-12 million years, because the Middle Triassic is missing here. Just below that is the Lower Triassic white layer labeled Moenkopi. The dashed and solid lines (red and green arrows) are examples of the present irregularly eroded topography of the region. Note the dramatic contrast between those irregular surfaces and the flat surfaces at the top of most of the white layers. The region represented here is 133 kilometers across, and the total thickness of the rock layers (white layers) is 3.5 km. Vertical exaggeration is about 14 times.

the area of the Shinarump were represented by the area of an ordinary sheet of paper, its average thickness would be less than 1/8 the thickness of that sheet (20 lb paper). While we don't have the details we would like about the worldwide Genesis Flood, something like that catastrophic event seems essential to explain the distribution represented by the Shinarump.

A further incongruity is the flatness of the topography on which the Shinarump was deposited. While the Moenkopi on which it lies shows small irregularities, its surface had to be astonishingly flat to accommodate the very thin and nearly continuous Shinarump over 100,000 square miles. Furthermore, from the perspective of geologic time, the Moenkopi is Lower Triassic, the Shinarump is Upper Triassic, and the Middle Triassic is missing between the two (Figure 7). This is an assumed hiatus of at least 10 million years of missing layers.[92] There are some irregularities in the Moenkopi surface, but on an average during that putative 10 million years of no deposition, you would expect at least 1000 feet of erosion, and erosion tends to produce very irregular surfaces. Furthermore, there are suggestions that the Moenkopi Formation "had not been much lithified at the time of Shinarump deposition."[93] Being soft would facilitate rapid erosion. It looks like those 10 million years never occurred. This is an example of a worldwide feature. Geologists The flatness at the hiatuses in the geologic layers challenges the geologic time scale. For further examples, see the section on flat gaps in DISCUSSION 16 on the author's webpage www.sciencesandscriptures.com.

The contrast between the irregular topography of our present continents and the flatness of the widespread older sedimentary deposits is usually striking. Figure 7 illustrates this. The many ancient Mount Everests and Grand Canyons expected to have formed in the past over the eons of time are not there. Rarely this is noted in the secular geologic literature. One geomorphologist notes, "Little of earths topography is older than Tertiary, and most of it is no older than Pleistocene."[94] For those unfamiliar with the standard geologic time scale, the time from the Pleistocene to the present represents less than 1/2000 of the proposed age[95] for the sedimentary record. Our present continental surfaces are usually well carved, while ancient sedimentary surfaces are usually flat and incredibly widespread as expected from Genesis Flood activity.

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