The meaning of unconformities

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An important distinction between diluvial and uniformitarian geology is their contrary interpretive approach to unconformities. Uniformitarian geology has long emphasized unconformities as repositories of all the time that cannot reasonably be attributed to the strata. But that interpretive framework would be unworkable if most unconformities formed during the Flood. Diluvial geology must focus on the physical interplay of hydraulics, tectonics, and sedimentology to investigate the formation of erosional surfaces of all scales.

Dramatic events, like Archimedes' bathtub and Newton's apple tree, persist across the landscape of science. For geologists, that moment was the 1788 boating expedition of Hutton, Playfair, and Hall off Siccar Point, Scotland. This was when Playfair saw an angular unconformity, thinking he 'gazed into the abyss of time'. Unconformities of much greater extent and duration, like the Great Unconformity of North America (figure 1), have since been discovered, but Siccar Point remains a Mecca for geology students. Though quite readily explainable in a diluvial framework,[1] its only significance to the uniformitarian faithful is as an icon of uniformitarian deep time:

> "The idea of time as an abyss was borrowed from Buffon, *but it encapsulates what Playfair's generation (and others since) found most striking about Hutton's system* [emphasis added]."[2]

Playfair's interpretation firmly steered the understanding of unconformities away from any mechanical investigation of their formation and towards a role as repositories of deep time. That framework has remained unchanged, despite modern pressures from sequence stratigraphy and neocatastrophism. But biblical history demands that most unconformities formed rapidly.

Unconformities: two approaches

Diluvialists and uniformitarians can agree that unconformities represent erosional or non-depositional processes over time between the emplacement of two adjacent rock units distinct in lithology, geometry, or biota. But how those factors (time and process) are weighted is quite different. Uniformitarian geology uses the 'stratigraphic approach'—focusing primarily on the duration of time represented by an unconformity.[3] The contrary view—the 'dynamic approach'—focuses on the mechanics of deposition and erosion. The stratigraphic approach has become synonymous with uniformitarian geology because that framework for understanding the sedimentary record demands vast amounts of time *not* seen in the actual strata.[4] From Barrell[5] to Ager,[6] geologists have recognized that the actual rocks represent only a small fraction of deep time;[4] thus, unconformities buffer forensic uncertainty by providing the illusion that we can see the missing time.

Stratigraphic approach embedded in definition

The temporal bias of the stratigraphic approach is clear even in the dictionary definition of 'unconformity'. Neuendorf *et al.* define an unconformity as:

> "(a) A substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic succession, such as an interruption in the continuity of a depositional sequence of sedimentary rocks or a break between eroded igneous rocks and younger sedimentary strata. It results from a change that caused deposition to cease for *a considerable span of time*, and it normally implies uplift and erosion with loss of the previously-formed record [emphasis added]."[7]

This 'substantial break' or 'gap' in the passage of time clearly infers deep time, which has been the fundamental assumption of geology since the late 1700s.[2] Geologists 'see' an interruption in the stratigraphic succession in an unconformity, which assumes much time because they assume uniformitarianism and its timescale. This emphasis is obvious in "the considerable span of time" in the second sentence. In a sense, the definition is circular: an unconformity is defined by reference to deep time, and then presented as *evidence* of the lapse of a 'considerable span'. The second definition of 'unconformity' relates it to surrounding strata:

> "(b) The structural relationship between rock strata in contact, characterized by a lack of continuity in deposition, and corresponding to a period of nondeposition, weathering, or esp. erosion (either subaerial or subaqueous) prior to the deposition of the younger beds, and often (but not always) marked by absence of parallelism between the strata; strictly, the relationship where the younger overlying stratum does not 'conform' to the dip and strike of the older underlying rocks, as shown specif. by an angular unconformity."

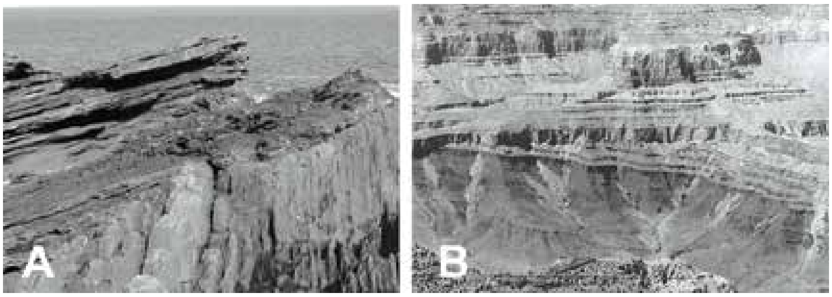

Figure 1. Hutton's unconformity at Siccar Point (A), though much smaller than the Great Unconformity in North America (B), has an unmatched emotive value in promoting deep time.

This definition focuses on tangible causes, but only with causal mechanisms consistent with deep time. A period of nondeposition or erosion brings to mind a stately sea-level change and its erosion. Weathering, uplift, and erosion are thought to be slow processes. Thus, the physical causes for strata failing to maintain consistent strike and dip are put in the context of deep time. The third definition notes specific types of unconformities (figure 2):

> "(c) *surface of unconformity*. Common types of unconformities recognized in U.S.: *nonconformity; angular unconformity; disconformity; paraconformity*. Since the essential feature of an unconformity, as understood in Great Britain, is structural discordance rather than a time gap, the British do not recognize disconformity and paraconformity as unconformities."[7]

Stratigraphic approach built into geology

Miall[8] recounts the work of Blackwelder,[9] Grabau,[10] and Barrell[5] in the early 20th century, who refined the stratigraphic approach, discussing theoretical reasons for the uniformitarian distribution of accommodation space, preservation, and unconformity-bounded sequences. Levorson[11] described the stratigraphy of central North America as natural groupings of strata between unconformities. Wheeler[12] developed a chronostratigraphic depiction of strata that made the stratigraphic approach normative in geological cross-sections. This all anticipated the work of Larry Sloss[13] in defining continent-scale megasequences.[14]

It is worth noting the influence of Wheeler charts, which use *time* as the Y axis, masking the physical geometry of strata and erosion. A wide gap on a Wheeler plot means a *long span* of time, even if physical evidence does not show it. Such a stratigraphic presentation carries a subliminal bias towards deep time:

> "Wheeler (1958) developed the concept of the chronostratigraphic cross-section, in which the vertical dimension in a stratigraphic cross-section is drawn with a time scale instead of a thickness scale. … In this way, *time gaps (unconformities) become readily apparent*, and the nature of time correlation may be accurately indicated. Such diagrams have come to be termed 'Wheeler plots' [emphasis added]."[15]

Wheeler charts replace a primary field property—thickness—with an imaginary 'thickness' of time. In other words, on a Wheeler chart, a 5-m-thick unit may appear identical to a 5,000-m-thick unit, because they are interpreted as occupying the same amount of time. This accustoms people to think they *see* deep time in addition to strata. The COSUNA charts, published by the American Association of Petroleum Geologists,[16] use the Wheeler method, illustrating the visual distortion when compared to a plot using physical geometry (figure 3).

In the latter half of the 20th century, two developments affected our understanding of unconformities. First, sequence stratigraphy[18] opened the door to a dynamic approach, but uniformitarianism was so ingrained that little came of it. But unconformities *per se* were re-emphasized on a variety of scales, up to global eustatic curves. Creationist views were

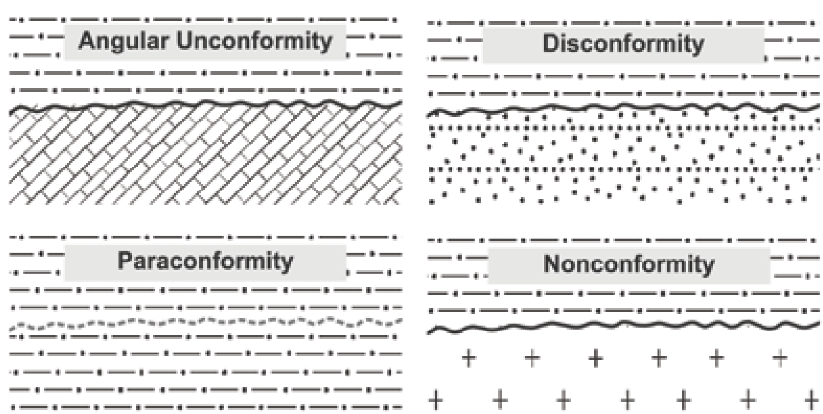

Figure 2. Types of unconformities: (A) *Angular unconformities* are erosional surfaces between strata which exhibit different strikes and dips above and below the unconformity; (B) *disconformities* are erosional surfaces between distinct yet parallel sedimentary strata; (C) *paraconformities* represent the assumed absence of time, but without any physically significant surface or angle between the strata; (D) nonconformities are surfaces separating sedimentary layers above from igneous or metamorphic rocks below.

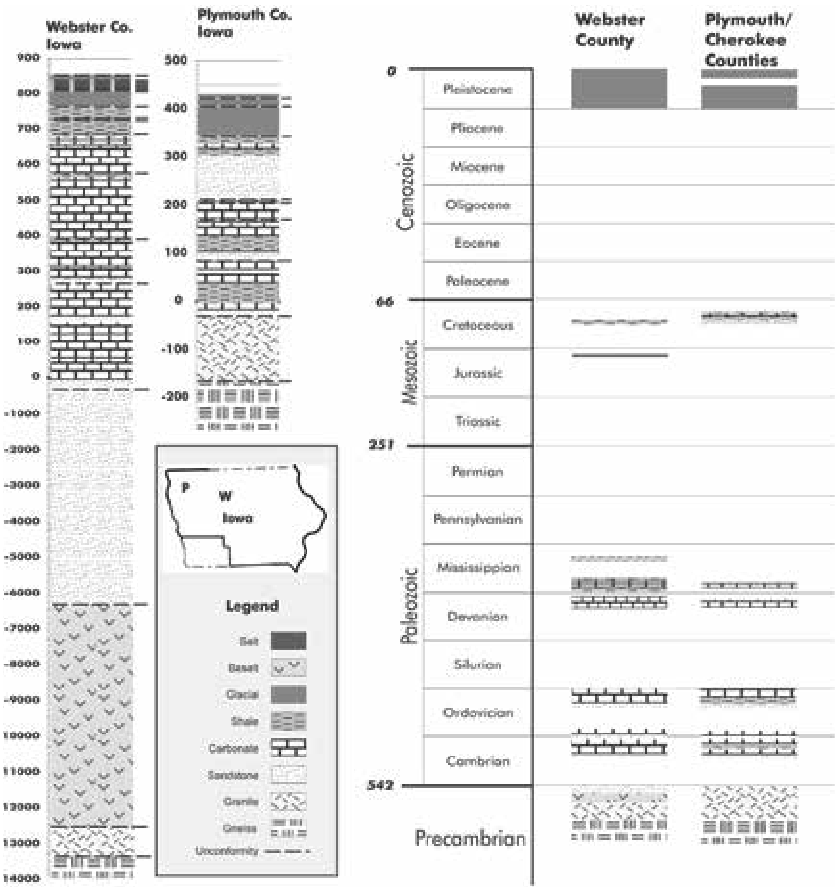

Figure 3. Two stratigraphic sections in Iowa, based on COSUNA charts. Contrast the visual impact of the presentation by thickness and lithology (left) and the stratigraphic interpretation (right). Note the vast amount of time pigeonholed into major unconformities. Note the 10x vertical scale change in the left Webster County column.[17] Thicknesses are averages of ranges provided by COSUNA charts, and thus are approximations for any given location.

published in the 1990s,[19] though research today is focused on large-scale sequences.[20] Second, the rise of neocatastrophism forced geologists to confront the amount of time actually residing in unconformities. Ager[6] was famous for his comments that the record was comprised mostly of gaps. Saddler[21] noted that accumulation rates diminish with time. Bailey and Smith[22] noted the ubiquity of unconformities at all scales, and the corollary that most stratigraphic charts vastly overstate the actual time in the rocks. Miall responded with a defense of uniformitarianism,[23] and proposed that the wide variation in the scale of sedimentary events provides a representative record.

Dynamic approach of Flood geology

Uniformitarian geology favours the stratigraphic approach, but diluvial geology is restricted to one approach—the dynamic. How do these fundamentally distinct approaches to unconformities affect stratigraphic and historical interpretation?

Quantity of time minimal. Uniformitarians grant that a single waveform can form in a matter of seconds, but assert that increasing physical scale demands an increasing temporal scale—up to 10^7–10^8 years for continental scale sequence boundaries.[23] We reject that link between temporal and physical scale; the Flood was an event of great energy, in both extent and intensity. Even large sequence boundaries may have formed in hours; the major constraint being the upper boundaries of the motion of large volumes of water.

Unconformities reflect changes in flow. If most of the rock record was produced in a year, then unconformities mark rapid tectonic and hydrodynamic changes. Changes in current direction, velocity, and depth can produce rapid changes in erosion and sedimentation, as seen on a small scale in modern floods. Extrapolation to larger scales is consistent with both actualism and the Flood.

Global signatures. Large unconformities are not necessarily time boundaries correlated to a global time-scale, but are more likely signatures of hydraulic and tectonic events that cannot be synchronized to any fine scale during the Flood. Thus, the criteria for correlating unconformities must be reassessed. Modern correlation methods—fossils, astronomical cycles, etc.—are largely irrelevant to diluvialism.

Unconformities keyed to events. Inundation was rapid, but was complete within 150 days. During that time, interactions between flowing water and topography produced distinct local to regional signatures, sometimes in minutes to hours. The hydraulic environment is therefore more significant than time.

Completeness of record. If the Flood was a global one-year event, and if unconformities represent hydrodynamic and tectonic shifts of hours to days, then the Flood record (including unconformities) is much more complete in the domain of time than the uniformitarian stratigraphic record. Thus, quantifiable sedimentological analysis would also carry more historical certainty.

Fossil record result of transport, burial, and preservation. In marked contrast to uniformitarian stratigraphy, fossils rarely represent *in situ* snapshots of ancient environments.

Thus, while there is likely a recognizable pattern to fossil burial during the Flood in any given location, using biostratigraphy to control the timing of unconformities is based on faulty assumptions.

Exciting research opportunity. Uniformitarian geologists have been blinded to rapid, large-scale sedimentation by their obsession with the time-stratigraphic importance of unconformities. This is an opportunity for diluvial research today, which a few have begun to seize.[24–30] Research into hydrodynamic causes of large currents and waves also has the inherent advantage of a closer link to the physics of fluid flow and sedimentation.

Discussion

The stratigraphic approach interprets unconformities primarily by the duration of time represented by the absence of and/or erosional truncation of strata. While stratigraphers also address the geographic scale and environmental setting, uniformitarianism and deep time still control interpretation. Otherwise, it would not have taken decades for the overwhelming sedimentological and geomorphic evidence to convince geologists of the historicity of the Lake Missoula Flood.[31,32] A dynamic approach would make hydrodynamic and tectonic setting the primary focus, considering water moving at scales not seen today as the most likely cause of unconformities.

Uniformitarian geology uses stratigraphic analysis to posit nebulous low-energy processes acting over long periods of time. Sedimentological analysis offers a more robust look in its ability to quantify current velocity, depth, and channel size. For example, the transport of boulders demands large, fast currents. Oard[33] used erosional remnants, coal rank, and the volume of coastal plain sediments to estimate the volume of erosion in the Appalachians.

Unconformities and stratigraphic completeness

Unconformities as erosional surfaces do not directly yield information about the duration of time they represent. That must be inferred stratigraphically. But such an inference assumes a valid record. If there is not one, then confidence decreases. The extent to which unconformities or 'gaps' permeate the strata correlates to uncertainty in that record. Miall noted:

> "'Only one-sixth of time is recorded' by sediments (Barrell, 1917, p. 797). This demonstration of the significance of missing time in the geological record has largely been ignored until recently. Modern stratigraphic charts show the major, recognized breaks, based on paleontological or structural data, although commonly these charts are drawn using an arbitrary and variable scale for the time axis, which under-represents the significance of missing time. The pervasive nature of minor breaks, and the generally fragmentary nature of the sedimentary record is typically not part of the description or interpretation of stratigraphic sections."[15]

Bailey and Smith introduced a quantitative method of evaluating completeness using gamma ray logs.[34] They showed a statistically significant correlation between the thickness of layers and the frequency of occurrence and that unconformities occur at every scale. Reed noted:

> "Bailey and Smith demonstrate that the application of statistical methods to measurements made from natural gamma ray logs yield information about the rocks undreamed of by Lyell, Cuvier, or any of the 19th century 'fathers' of the science. One way of seeing the meaning of their work is to see it as the liberation of sedimentology from stratigraphy. This is pertinent for Flood geology because today's methods allow a more rigorous examination of the Flood from a sedimentological/hydrodynamic point of view. If the movement of water occurred in similar ways across a wide range of scales, then the self-similarity of sedimentary layering and hiatuses may have been a natural outgrowth of the Flood and a way to help us understand it."[35]

Unconformities, then, also offer a means to critique uniformitarianism on its home field, showing that most of the 'record' is missing and it is thus far less credible and confidence-promoting than geologists believe.

Diachronous vs synchronous boundaries

Uniformitarians pay lip service to diachronous erosional surfaces (a surface where some deposits above the surface are older than some deposits below), because the time during which the erosion took place is typically less than field stratigraphic discrimination or is constrained within large stratigraphic intervals. Diluvialists, however, are constrained by the relative ages of boundaries; one day in the Flood might represent significant deposition or erosion (figure 4). Modern events demonstrate rapid erosion and deposition. Storms, tsunamis, eruptions, turbidity flows, and river flooding all indicate that significant sedimentation and erosion can occur in very short time periods. During a global Flood, this effect would be magnified, and the geographic scale would be global, not local:

> "The Flood shatters the illusion that time is the key to stratigraphy, focusing attention instead on the effects of widely varying tectonic and hydraulic energy levels on depositional environments, and on widespread diagenetic effects on those rapidly-deposited rocks."[36]

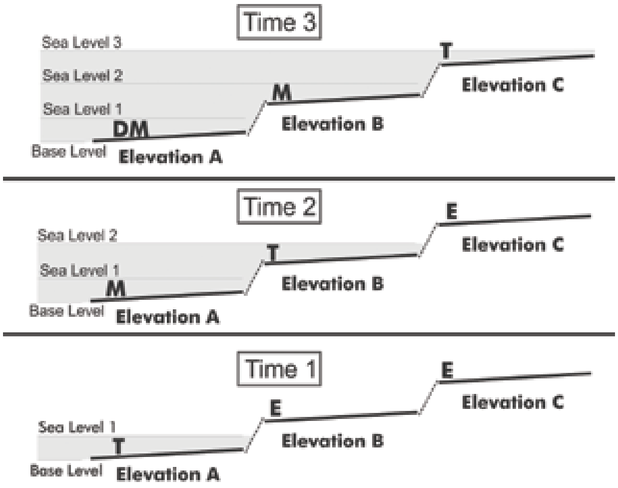

Figure 4. Cross-section of large region during Flood transgression from left to right showing how topography would cause different processes at the same time in a transgressing marine front (breaks inserted to shorten geographic scale). Time 1 = erosion (E) at higher elevations (B and C), while transgressive deposits (T) cover Elevation A. Time 2 = erosion at Elevation C, while transgressive deposits move to (B) and deeper marine deposits (M) cover the transgressive deposits at Elevation A. Time 3 = transgressive deposits cover Elevation C, *at the same time* as deep marine facies (DM) are deposited at A. The resulting record would show a large erosion surface covered by sedimentary units, T, M, and DM, but none are synchronous.[37]

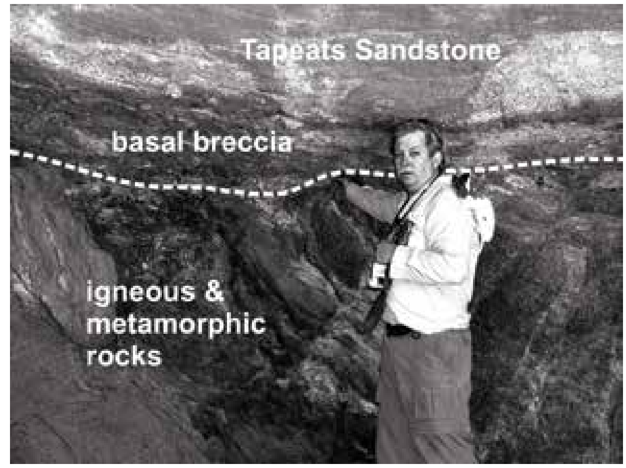

Figure 5. The contact between the igneous and metamorphic rocks of the upper crust and the flat lying Tapeats Sandstone at the bottom of the Grand Canyon (dashed line). Note breccia at the base of Tapeats.

Figure 6. Great Unconformity at the top of the Wind River Mountains of Wyoming. View is to the east.

Towards a more actualistic understanding

Actualism proposes that observed processes form the only valid analogies for historical explanations. But actualism is impossible in the dimension of time because the length of human observation is infinitesimal with respect to deep time. Furthermore, geologic processes are scale-dependent; the result of the flow of 100 gallons of water across a location is much different from the flow of 100 million gallons. Geologists cannot deny evidence of large-scale processes in the rock record, but act in cognitive dissonance as if these 'rare events' are the exception rather than the rule. Flood geology offers a different kind of 'actualism'. Although its processes were physically of greater geographic scale and intensity, underlying hydraulic principles allow quantitative assessment.[38]

Likely explanations for unconformities during the Flood

Diluvialists see *nonconformities* as nothing more than the deposition of sedimentary rocks on igneous and/or metamorphic rocks. For example, the Great Unconformity occurs at the base of the horizontal sequence in Grand Canyon, and rests mostly on igneous and metamorphic rocks (figure 5). It likely represents an early-Flood planation surface,[39] and its regional nature is seen in its occurrence in Wyoming and south-central Montana (figure 6). *Paraconformities*, if real, would represent short breaks in continuous sedimentation, or possibly short time intervals between successive tsunami-like wave sets. *Disconformities* and *angular unconformities* would have been caused by rapid erosion, often accompanied by rapid tectonic changes.

Unconformities at Grand Canyon

Old-earth proponents identified 19 unconformities at Grand Canyon,[40] and claim such unconformities cannot be explained by Noah's Flood:

> "Multiple unconformities in a sequence of rocks, such as in the Grand Canyon, are impossible to reconcile with a single catastrophic event, which is why flood geologists work so hard at discounting the presence of all but the most obvious ones."[41]

Their assertion ignores modern hydraulics and sedimentation, and assumes the stratigraphic approach and its associated biostratigraphic and radiometric dating methods: "In the case of sedimentary rock in places like the Grand Canyon, estimates are based largely on a comparison of the local fossil record with the global record."[42] This circularity flows not from empirical observation, but from assuming deep time, uniformitarianism, and evolution. They admit that 75% of deep time is missing in the Grand Canyon record (including the Precambrian), as compared to the geologic timescale. The Great Unconformity supposedly represents a billion-year gap. This angular unconformity, as well as others like Siccar Point (figure 1), can be explained by rapid uplift and erosion during the Flood (figure 7). The base of the Tapeats Sandstone above the Great Unconformity is a thin layer of breccia, indicating energetic flow. Since the Tapeats Sandstone can be traced hundreds of kilometres, it seems likely it was formed by widespread energetic events. Furthermore, Flood geologists welcome investigation of these unconformities; if so much of the record is missing, how can we trust the interpretation of uniformitarian geologists?

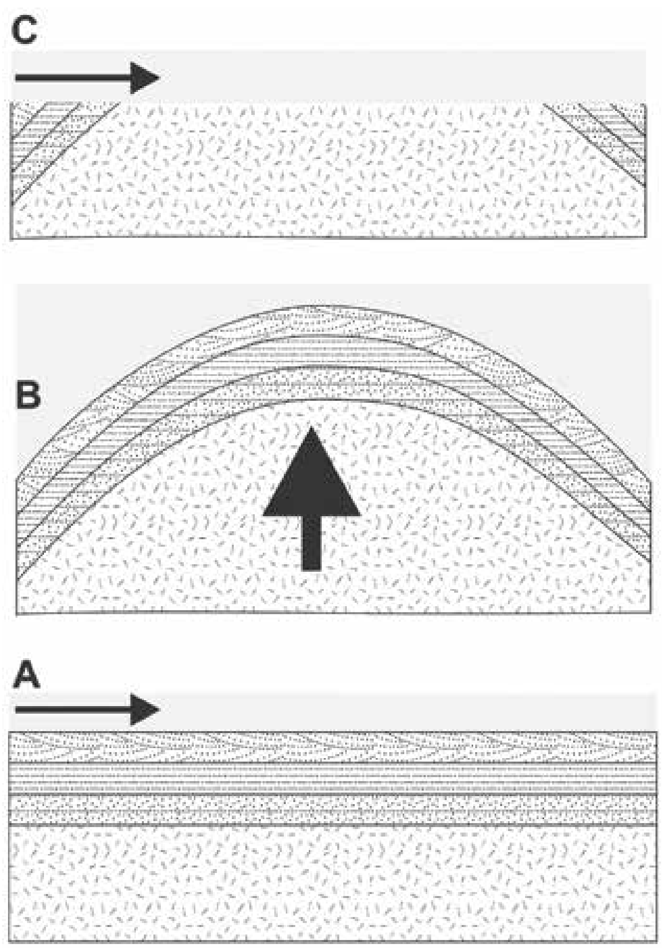

Figure 7. After deposition of strata by Flood (A), uplift would fold those strata (B), and subsequent erosion would create angled beds (C). If covered by later layers, an angular unconformity would be created.

Figure 8. Contact between the Redwall and Muav Limestones supposedly represents about 160 Ma, but it shows little erosion (from the North Kaibab Trail).

Of those 19 unconformities at Grand Canyon, 10 are disconformities (figure 2b) showing gaps of up to many millions of years, like that of 160 Ma between parallel beds of the Cambrian Muav Limestone and the Mississippian Redwall Limestone (figure 8). In addition to fossil changes, the Grand Canyon disconformities are physically identified by weathering of the overlying layer, channels in the lower layer, and karst features on the top of the lower layer when it is carbonate. However, the 'weathered rock in overlying sediments' example of Hill *et al*. is the basal Surprise Canyon Formation within channels on the top of the Redwall Formation.[43] But the Surprise Canyon Formation is equally well explained as a depositional lag within a channel carved by a linear increase in flow velocity. The time required for its deposition is a factor of current size, depth, velocity, and sediment source. To call it 'weathering' is another example of uniformitarian circular reasoning. A similar example is found at the base of the Surprise Canyon Formation.

The Temple Butte Formation comprises channel fill deposits at the top of the Muav Limestone, and the Surprise Canyon Formation comprises channel fill atop the Redwall Limestone. These channels are thought to represent ancient fluvial systems. Channels and the channel fill (figure 9) are actually rare in the Grand Canyon,[44] but could have been easily and rapidly formed during the Flood by relative changes in the local base level, creating channels that were subsequently filled in. These channels rarely exceed 120 m in depth. Erosion into the Redwall and Muav Limestones indicates a degree of cementation. This is not surprising, since limestone *is* a cementing agent.

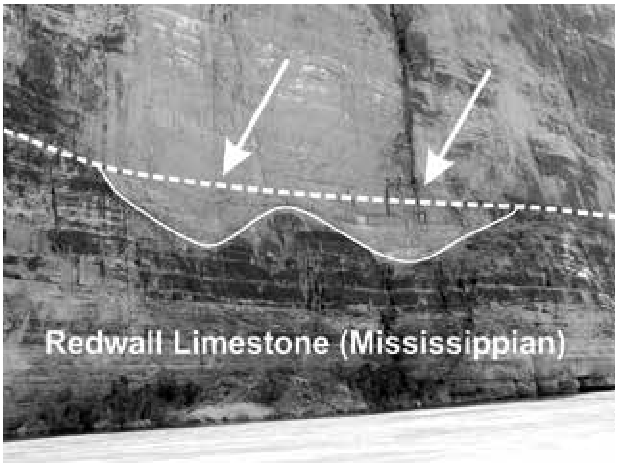

Figure 9. Small double parabolic scour within the Redwall Limestone (courtesy of Tom Vail)

Much ado is made of the channel fill yielding plant fossils at the base and marine fossils at the top: "This is possible only if the Redwall Limestone was above sea level for an extended time and was later submerged."[45] However, time is only in the minds of uniformitarians; plant matter was present in floodwaters. The interpretation of a river system is a uniformitarian interpretation, no more and no less. If the channels and their fills are from an ancient river, why are there not breccia layers at all levels of the fill and not just at the base? That suggests a single event of erosion and deposition.

The 'karst' at the top of the Redwall Limestone consists of collapse features (sinkholes) that are filled with the same sediments as found in the channels. There are also caves found in the formation that might have formed after sedimentation. The features are considered paleokarst, and are believed to have formed over a long time in a subaerial environment. However, such features can be produced by the Flood, by hydrothermal flows or gas seeps.[46,47] The area could also have been briefly exposed above the floodwater in which the so-called paleokarst features formed in a matter of days:

> "It is likely that the rapidly accumulating Flood sediments periodically emerged. The resultant degassing and dewatering of waterlogged sediments, along with the associated chemical changes, would have developed a wide range of negative relief in a matter of days."[48]

So, the observed features of the rock record, including unconformities, can readily be explained by the Flood. Only the Flood explains the lack of physical erosion within large-scale, flat-laying strata—which is typical of the rock record.[49] In either case, unconformities are significant. For uniformitarians, they are convenient places to place the millions of years not actually seen in the rocks. For creationists, they are indicators of the hydraulic and tectonic environments of the Flood.

Conclusion

Unconformities represent erosional events in the rock record. Uniformitarianism emphasizes the supposed time duration of unconformities, and uses unconformities as repositories of the deep time not recorded in strata. Diluvial geology should instead focus on the mechanics of the actual event, recognizing that the larger scale of extent and intensity better defines the surfaces.

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