

Are global megasequences real?

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Numerous questions about megasequences are presented. There does not appear to be any published literature addressing some of these questions, such as how the various columns that make up the megasequences were determined. I hope Dr Tim Clarey can provide satisfactory answers. I applaud the work of Tim Clarey and Davis Werner in roughing out megasequences on five continents. I have some questions and look forward to their answers; especially, more detail on their data and methods.

What are sequence stratigraphy and megasequences?

Until the mid-20th century, the dominant paradigm in stratigraphy was the correlation of strata to time. While this paradigm has not been abandoned, another, more practical paradigm has soared in popularity and use—sequence stratigraphy. It is commonly applied using seismic and well data at all sorts of scales, from as fine and local as an individual sedimentary event in a lake to continental-scale sedimentary packages that can span several stratigraphic systems (which are the chronostratigraphic equivalent of geologic periods, e.g., the Jurassic period), based on the work of Larry Sloss (see below). At its root, it attempts to subdivide and link unconformity-bounded strata of various scales to marine transgression–regression cycles, with major regional unconformities defining megasequences. Klevberg concluded that sequence stratigraphy might be useful to Flood geologists, but he also advised caution, recognizing its many uniformitarian assumptions.^{1–3} The late Dr John Morris was an early advocate of using megasequences.⁴

Six, possibly seven, megasequences

Megasequences are the large-scale sequence stratigraphy packages defined as:

“... discrete groups of sedimentary rock layers bounded on top and bottom by erosional surfaces, often with coarse sandstone layers at the bottom (deposited first), followed by shale, and then limestone at the top (deposited last).”⁵

In 1950, Sloss defined four Paleozoic megasequences in Montana.⁶ He later extended those sequences and added two more to cover the entire Phanerozoic for North America.⁷ After Sloss, petroleum geologists extended the megasequences to offshore regions and adjacent continents using well logs and seismic data.⁸

Clarey and Werner have defined six Flood megasequences, following Sloss’s nomenclature. These are, from bottom to

top: Sauk, Tippecanoe, Kaskaskia, Absaroka, Zuni, and Tejas (figure 1). Clarey has proposed a seventh megasequence, the pre-Sauk, which encompasses the upper Precambrian. This megasequence would include features such as the 2,200-km-long Midcontinent Rift, with thicknesses reaching over 30 km.^{9,10} It would also include the 20-km-thick Mesoproterozoic Belt-Purcell Supergroup in the Pacific Northwest and Canada.¹¹ Clarey first defined megasequences for North America and then extended them to Africa, Europe, South America, and Asia.^{12,13} After examining the megasequences, Clarey estimated their extent and thickness, mapped across North America and the other countries. He attributes Flood megasequences to major pulses of sedimentation during the Flood.

Baumgardner’s mechanism

Baumgardner proposed that tens of thousands of continent-scale tsunamis, generated by episodic plate motions, produced the strata and explain how thick sediments accumulated on the continents rather than in ocean basins.¹⁴ The episodic sea floor cooling and abrupt subsidence of 700 m caused the bounding erosional unconformities that distinguish the individual megasequences. The Recessional Stage of the Flood¹⁵ represented a 1,200 m fall in the sea bottom.

There are several challenges for Baumgardner’s model. First, the six megasequences start at the Precambrian/Cambrian boundary, while CPT modelling starts with the breakup of Pangea. How does CPT account for the pre-Pangea megasequences? Second, were the bounding unconformities created during transgression or regression? How would we know? Third, we would expect tsunamis large and powerful enough to span continents to leave a blatant directional signature and relative uniformity of lithology as they eroded and deposited sediment. Do local records, which vary widely in lithology, depositional style, and paleocurrent indicators, really reflect such a mechanism? I would like to see detailed diluvialist field studies that show such phenomena. Finally, during regression of such volumes

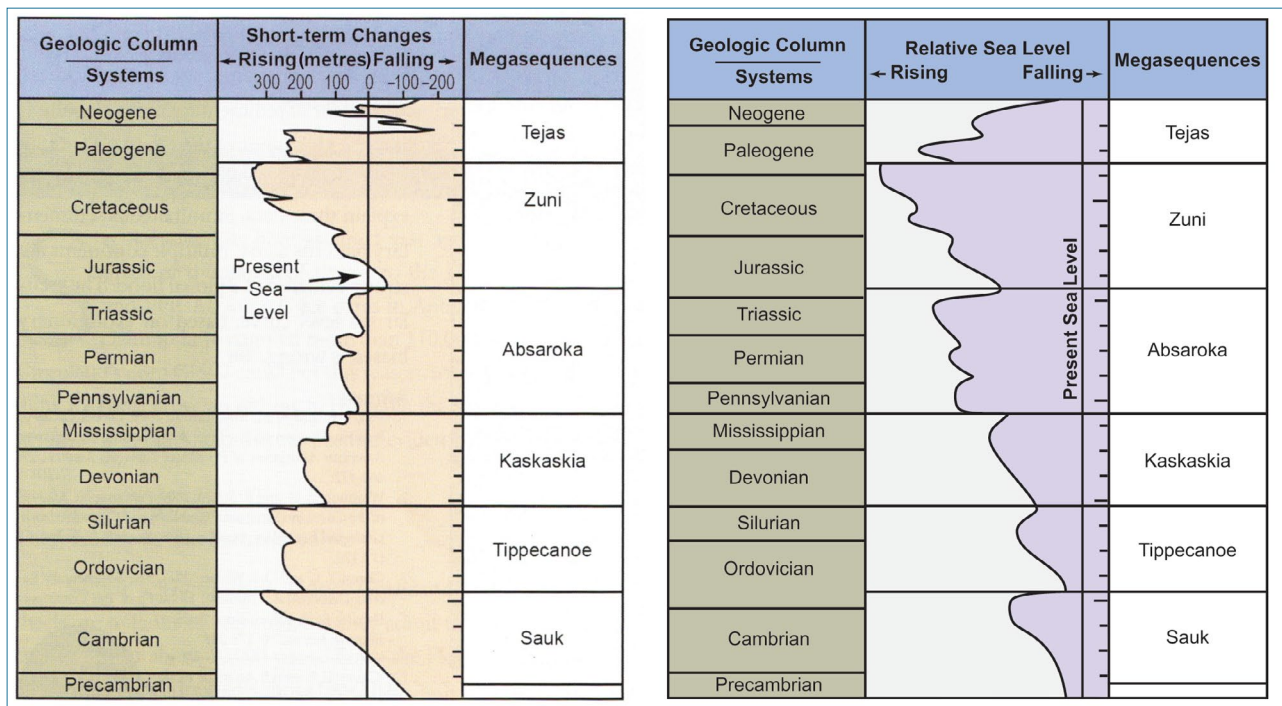


Figure 1. The six megasequences with respect to the geological column with the conventional sea level fluctuations (left) and Clarey's reinterpretation of the 'sea level' during the Genesis Flood (right).³⁷ Note that Clarey does not give absolute values of sea level but rising or falling trends within a general rise to the top of the Zuni, with a rapid fall during the Tejas megasequences.

of water, we would expect numerous channels to be eroded into these newly deposited sequences. However, they seem to be rarely observed in the rock record.

Megasequence boundaries

Sloss recognized numerous unconformities in strata. Bailey and Smith extended the conclusions of his structure of inference and concluded that hiatuses are fractal, and thus ubiquitous at all scales.^{16,17} Many recognize that most of the physical rock record in any given location is missing.¹⁸⁻²¹ Many of these hiatuses are 'missing time' or paraconformities that show little, if any, evidence of erosion or non-deposition. Morris agrees that missing time defines an unconformity, regardless of physical evidence.²² All these unconformities raise a serious question about how the 'regional unconformities' that define megasequences are identified. Are they clearly seen in the field and regionally correlative? Or are they artefacts of the geologic timescale (paraconformities)? I don't know how Clarey and Werner address this issue, since it is not addressed in their publications.

In a related issue, Sloss claimed that the megasequences were diachronous with respect to the geological timescale. However, Clarey seems to regard megasequence boundaries as globally synchronous markers. What aspect of the Flood

led to this conclusion? Or is this a reflection of his mapping uncertainty, relative to that of Sloss? He does say that he used regional unconformities and not fossil dates.²³ Clarification of these points would help.

Data for the Clarey megasequences

Likewise, a more detailed description of his data and methods would be helpful. Starting in North America, Clarey used 500 stratigraphic columns, based largely on the 50-year-old COSUNA (Correlation of Stratigraphic Units in North America) columns to define the megasequences.^{24,25} These columns are compilations of regional well data into a single point. They are not true point definitions as a single well is, and they do not show local variability within the defined area. They are a good first approximation. Clarey and Werner indicated that in these 'points' hiatuses are 'collapsed'.²⁶ If so, how were the hiatuses determined, and how were they collapsed? Were they determined by the geological column and relative uniformitarian dating? Based on my understanding of the COSUNA method, the geological timescale is the template for the COSUNA sections. How, then, do the uniformitarian temporal gaps relate to Flood hydraulics? There does not seem to be an intuitive correlation. It seems interesting that large temporal gaps would correlate

so perfectly with Flood hydraulics, especially if those were generated by unidirectional tsunamis.

Fortunately, I have some experience at Grand Canyon.²⁷ The most significant hiatus inferred in the Grand Canyon is between the Cambrian Muav Limestone and the Mississippian Redwall Limestone (figure 2). It is said to represent a gap of about 160 Myr, but the contact is generally conformable (i.e., a paraconformity or disconformity). The Muav Limestone is the top of the Sauk Megasequence. Since both formations are limestone, was this gap collapsed by combining the Muav and Redwall Limestones into the top of the Sauk Megasequence? Or was it determined that the Muav delineates the top of the Sauk Megasequence and the Redwall the Kaskaskia Megasequence, with the Tippecanoe missing, based on the geological column? I believe it was the latter, since the Tippecanoe is missing in the Grand Canyon.²⁸ The basal Kaskaskia is limestone over most of the United States.²⁹ This suggests that Clarey simply followed the relative uniformitarian dates of the geological column.

Other questions concern the integration of other data with the COSUNA points. How were oil wells, cross sections, seismic data, and outcrops integrated into the representative COSUNA points? How many geological observations were integrated with the COSUNA points? How representative were the COSUNA points in the 1970s? How representative are they today? Each COSUNA area shown covers around 260 km².²⁴ In areas with simple stratigraphy the COSUNA columns might be very representative, but, in complex areas, the geological relationships can change dramatically within a few kilometres. It would be helpful to know how confident we can be in each COSUNA interpretation. With geology, as with so many other things, details are crucial. It would be helpful if Clarey and Werner could provide an assessment of their base data, especially given their crucial place in defining Flood megasequences.

Another issue is that there are no COSUNA columns on the other four continents. Clarey clearly had other data from which to construct the sequences he used in his work. For example, 404 columns were developed for South America.³⁰ But how then were those columns constructed?

The ideal Sauk Megasequence—strong evidence against uniformitarianism

In the ideal, megasequences are globally correlative packages of a fining-upward sequence, typically from sandstone to fine clastics, such as shale to chemical sediments (e.g., carbonates) (figure 3). The Sauk is thickest in western and eastern North America, but thin in the midcontinent. In Grand Canyon, the basal Tapeats Sandstone is overlain by the Bright Angel Shale and then the Muav Limestone. It is called the ‘Tonto Group’.



Figure 2. The contact between the Cambrian Muav Limestone and the Mississippian Redwall Limestone along the North Kaibab Trail.

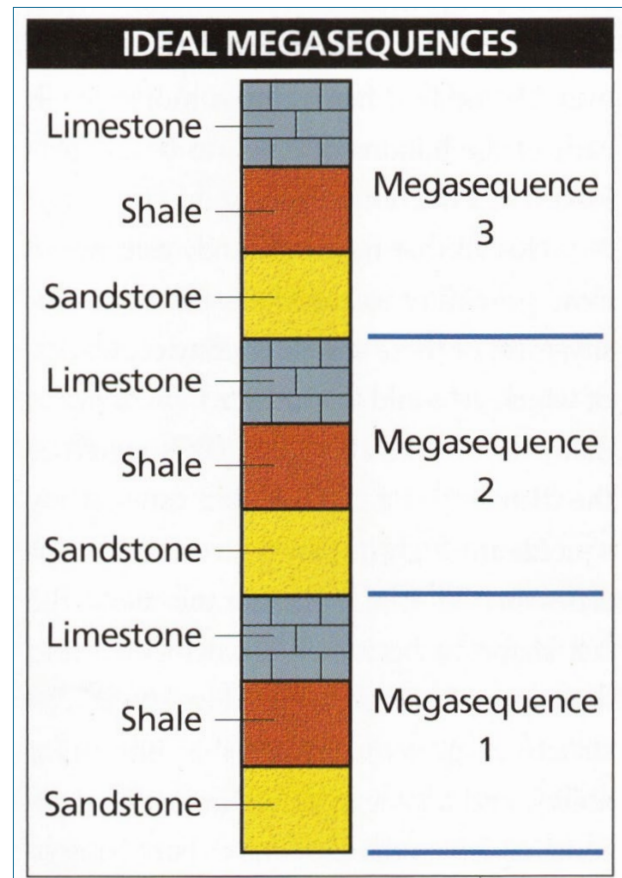


Figure 3. Three ideal megasequences (from Clarey, ref. 31, p. 19)

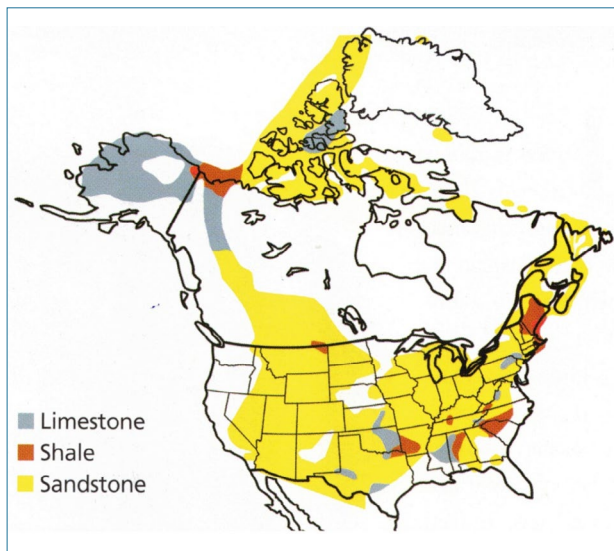


Figure 4. The basal Sauk Megasequence across North America coloured by lithology: yellow is sandstone, brown is shale, and blue is limestone (from Clarey, ref. 31, p. 19).

The basal Sauk is the most iconic megasequence, characterized by basal sandstone that covers about half of North America (figure 4).³¹ This conflicts with uniformitarian principles, since most depositional processes observed today occur on local, rather than continental, scales. Moreover, we currently observe abrupt facies changes between sand, mud, and conglomerate, both laterally and vertically. The extensive, even deposition of 100 m of sand that serves as the base of the Sauk, overlying eroded igneous and metamorphic crust reflects Flood-related processes. The absence of significant erosion between the strata indicates overlying strata were deposited in quick succession. However, erosion on a million-year timescale is rapid, and all the continents can be levelled to sea level within about 50 Myr. Nevertheless, uniformitarians claim that the basal Sauk was laid down at a transgressing beach. Would such a beach transgress most of North America? Modern beach environments are narrow, and show rapid facies changes, vertically and horizontally, totally unlike the Tapeats and its equivalents.

Post-Sauk megasequences far from ideal

Above the Sauk, ideal megasequences rarely exist:

“Rarely do we see complete ‘idealized’ megasequences, starting with sandstone and progressing through to shale and limestone. And if this pattern is observed, it is only found across a limited region.”³²

Clarey points out that some megasequences start with limestone at the bottom and end with sandstone at the top;

the opposite of an ideal megasequence. Some start with shale or salt, and some have very little sandstone at all:

“However, many subsequent megasequences greatly differ from the layer pattern we observed in the Sauk. Some megasequences start with limestone at the bottom and sandstone at the top—a complete reversal of the secular story! Others start with shale or even salt at the base, and some have very little sandstone in the sequence at all.”³²

In the eastern U.S., the basal Tippecanoe sequence places limestone on top of the limestone of the upper Sauk Megasequence.³² This raises the question: why not place all the limestone within the Sauk? This also suggests that Clarey is defaulting to the geological timescale to define sequences. If so, then what is the value of megasequences? If there are questions about the bounding unconformities, do further problems ensue? Clear bounding unconformities should be the essence of megasequences.

The base of the Kaskaskia sequence is mostly limestone in the eastern U.S. and lacks sandstone.³² Clarey says that this much limestone suggests that the water stayed deep enough for just limestone deposition. How then are the two megasequences determined? In the western U.S., there is very little limestone in the later megasequences; they are composed of clastics.³² This might explain why Clarey states that some megasequences do not exhibit erosional boundaries.³²

Clarey and Werner acknowledge that erosion would occur both during transgressions and regression. This might make us expect the megasequences to be quite chaotic. In places, erosion might be expected to remove an entire megasequence almost completely. They also say erosion is more likely to strip the top of a megasequence, which is reasonable.³³ Is this why the widespread (Paleozoic) sandstones in North Africa and Saudi Arabia are claimed to be from the lower three megasequences? If megasequences are global and can be defined, it stands to reason that the defining criteria would be clear, consistent, and explicit in the field. All this raises questions as to how the later megasequences were defined.

Transgressions, regressions, and erosion

Megasequence boundaries supposedly represent global episodes of synchronous erosion via major transgressions and regressions. However, why would these sequences provide clear evidence of erosional boundaries, yet retain deposits from between erosional cycles so well? Does this suggest that there were originally more megasequences, and that what we see today reflects preservation bias? Bailey and Smith concluded that traditional stratigraphy was invalidated by the fractal scales of unconformities randomly occurring in the rock record.¹⁶

Regressions could have erased most of the transgressive cycle, which could be used to explain why several megasequences are stacked on each other in certain regions.³⁴ Erosion is an open-ended variable, and it often functions as an *ad hoc* hypothesis to explain anomalies.^{21,22} It appears that erosion did remove much of the evidence for the five sequences above the well-defined Sauk Megasequence. Thus, the described megasequences are really erosional remnants, which brings up the major question of whether they represent global megasequences. Another possibility is that we see Flood sequences, but that they are not globally correlative. This is perfectly consistent with the Flood paradigm *per se*, though probably less so with the Baumgardner tsunami hypothesis.

Reed, Klevberg, and I have determined that about 1,900 m of erosion occurred during the Recessional Stage of the Flood.³⁵ Since this represents more than a third of the rock record at the peak of the Flood, we would expect large sediment sequences along shorelines of the new oceans to be correlated with unconformities inland. This, by definition, precludes a global sedimentary sequence being formed after this time.

What about 'sea level' and the depth of the floodwater?

Megasequences are “interpreted as representing the depth of the sea at the particular time each one was laid.”³⁶ Clarey and Werner do not believe the ocean water completely drained off the continents, as the uniformitarian scientists sometimes believe. Their model is similar to the general short-amplitude oscillations in the uniformitarian sea level curve, but they are superimposed on a gradual rise until the Zuni Megasequence, then a rapid fall during the Tejas Megasequence (figure 1).³⁷ They do not give absolute values, unlike the uniformitarian scientists, which is good. The floodwaters could have been very deep, and, instead of transgressions and regressions, waxing and waning currents could have produced similar features. It is unclear whether waxing currents are caused by sea level rise, and vice versa for waning currents, since other processes are involved that influence current speed.

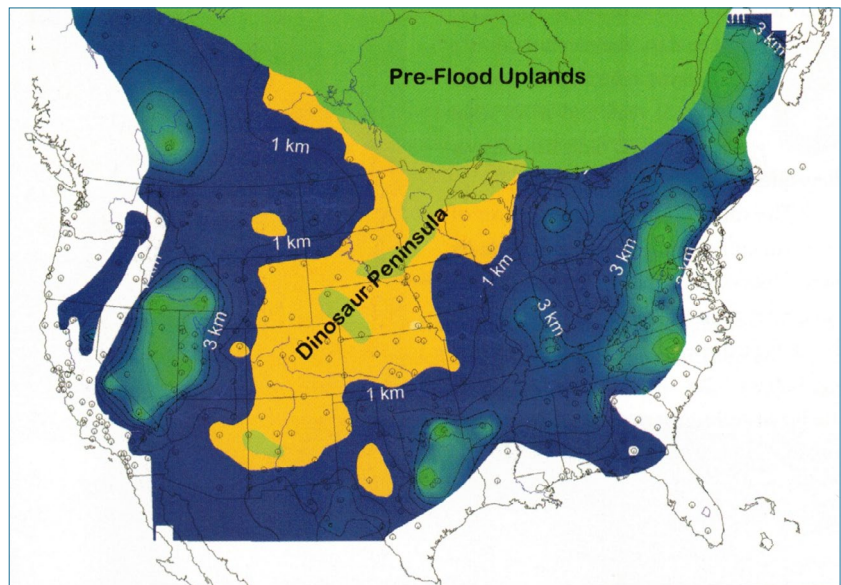


Figure 5. Possible extent of pre-Flood Dinosaur Peninsula and Uplands where the first three megasequences are thin or non-existent (from Clarey, ref. 39, p. 16)

Evidence for an Upper Cenozoic Flood/post-Flood boundary

Clarey places the Flood/post-Flood boundary near the Pliocene/Quaternary boundary, especially since uninterrupted carbonate rocks extend from the Cretaceous through the Miocene in much of North Africa and the Middle East.^{12,38} Since carbonates form in water, these carbonates indicate formation in floodwaters in the area where the Ark landed until the late Cenozoic.

Where were the dinosaurs early in the Flood?

Creation scientists rightly wonder about the absence of dinosaurs and mammals in the lower rock record. These animals must have been on higher ground, and Clarey has suggested that the high ground over North America was the Canadian Shield, with a ‘dinosaur peninsula’ extending from Minnesota southwest into New Mexico (figure 5).³⁹

However, the Dinosaur Peninsula Hypothesis has one major problem: it is based on the *rarity* of the lower three megasequences from Minnesota southwest to Utah. Erosion during the transgression and regression of the megasequences could explain the ‘Dinosaur Peninsula’ rather than needing to appeal to a strip of high ground early in the Flood.

The Canadian Shield must have been a pre-Flood upland as Clarey suggests. The Sudbury impact structure of the southern Canadian Shield is an erosional remnant, which shows about 5 km of erosion! If this amount of erosion is representative of the whole Canadian Shield, then the

Canadian Shield could easily have been the location of the dinosaurs, as well as the mammals, before and early in the Flood.

Implication of Flood erosion of the Canadian Shield

The Canadian Shield provides significant insights for researchers developing a comprehensive Flood model. First, this extensive erosion observed could be the *source* for the volume of sedimentary rocks on North America resulting from the Flood, including the c. 1,900 m eroded during the Recessional Stage of the Flood.³⁵ The North American sediment likely was not eroded from the continental margins during tens of thousands of tsunamis in the CPT model.¹⁴

This erosion must have occurred very early during the Flood, possibly coinciding with the Great Unconformity. Phanerozoic sediment patches, such as those found in Hudson Bay, remain challenging to correlate with fossil distribution issues.

Over 95% of the strata is fine-grained sandstone, mudrock, and limestone. This indicates that whatever eroded the Canadian Shield strata was powerful enough not only to rapidly erode 5 km of rock, but also to grind the particles to fine grains and form the Great Unconformity. The only conceivable mechanism for this seems to be large impacts very early in the Flood.⁴⁰

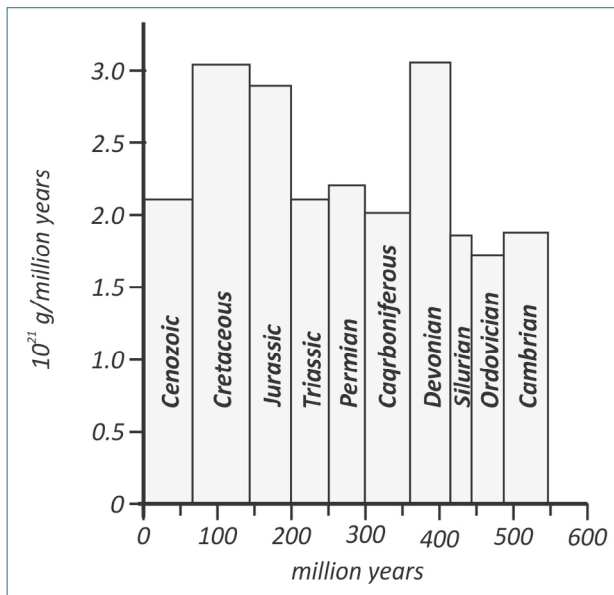


Figure 6. Ronov (1983) compared total sediment mass by stratigraphic periods, showing that there was not a smooth exponential decline in sedimentation, as predicted by many, over time. Instead, mass varied indiscriminately. Modified from figure 7 in Ronov, A.B., *The Earth's sedimentary shell: quantitative patterns of its structure, compositions, and evolution*, *International Geology Review* 24(11):1313–1363, 1983.

Was sedimentation low early in the Flood and high later in the Flood?

Clarey and Werner claim that sedimentation rates were low early in the Flood, based on the low sedimentary rock volume of the Sauk, Tippecanoe, and Kaskaskia, relative to the Absaroka, Zuni, and Tejas.^{8,41,42} This conflicts with the global estimate of Ronov (figure 6),⁴³ though both Ronov's and Clarey's models rely on existing strata and not on what presumably was eroded. However, a closer look at the Zuni and Tejas reveals that they are found along the continental margin, which has sediments up to about 20 km thick. These two megasequences likely represent the depositional end of the 1,900 m of strata eroded from North America in the Recessional Stage. This erosion would have concentrated in the bottom four megasequences. Thus, the lower four megasequences likely were much thicker and more widespread than what is seen today.

Snelling believes that erosion caused the low amount of sediment within the bottom three megasequences, which could have been substantial during transgressions and regressions.⁴⁴ Clarey and Werner do provide several reasons why they believe such erosion was minimal.³⁴ I found it difficult to follow some of Clarey and Werner's answers.

One argument for little erosion is the consistency of the surface pattern of the three lowest megasequences on five continents. Second, Clarey and Werner claim that there should be evidence of this erosion:

“But, if there were lots of earlier erosion that reduced the volume of all pre-Absaroka strata significantly, there should still be evidence to observe. Each continent shows a dramatic increase in volume and areal extent in the Absaroka megasequence (Fig. 10) and even more in the Zuni and Tejas megasequences (Figs. 11–12).”⁴⁵

They elaborate in the next paragraph by stating that the consistent internal stratigraphy indicates little erosion. The Sauk megasequence is fairly consistent, with a fining upward pattern, but the Tippecanoe and Kaskaskia do not seem internally consistent (see above) and are missing over large areas. Moreover, the Canadian Shield has Paleozoic erosional remnants, indicating that the megasequences once covered the Canadian Shield and have been mostly eroded.

Clarey and Werner go on to state that if there was significant erosion of the bottom three megasequences (for instance, caused by Cenozoic mountain building), the fossil record of the top three megasequences would show reworked Paleozoic fossils. This is a good point, but one would expect that much of this Paleozoic fossil record would be destroyed and could not be found in the isolated outcrops and boreholes used in the study.

Clarey and Werner also point out that North Africa presumably had no mountain building to affect the bottom three megasequences and that these megasequences stack

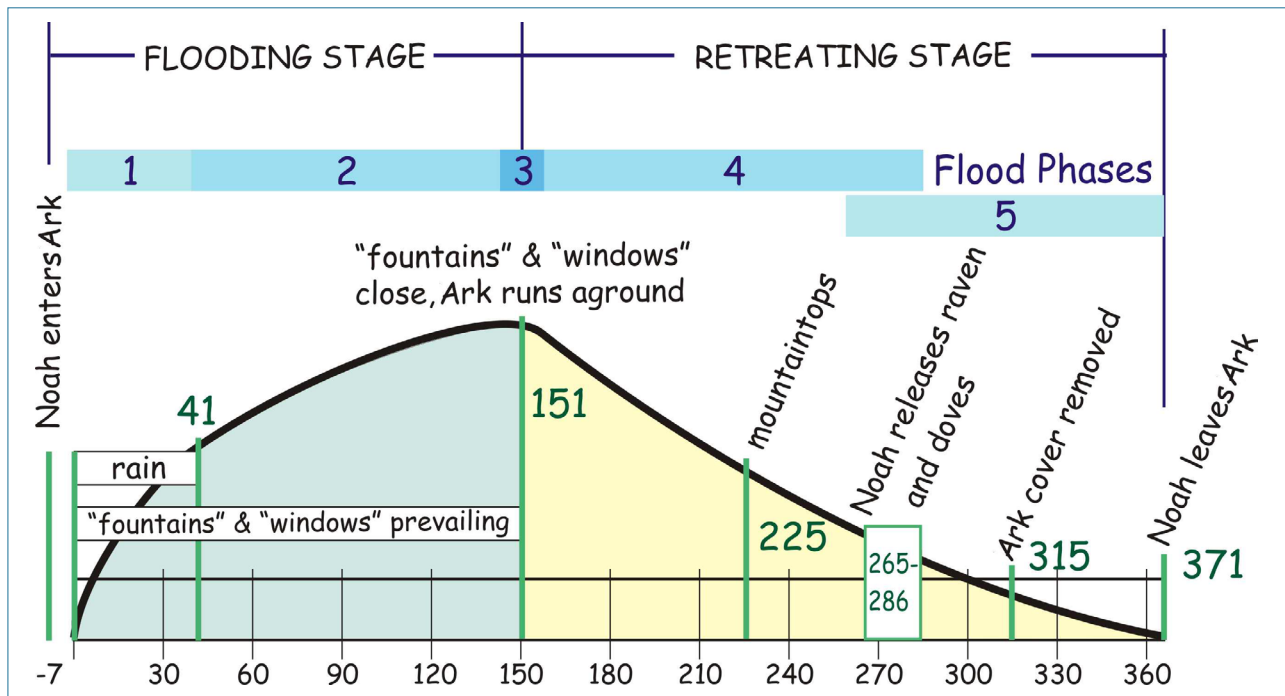


Figure 7. Graph of relative sea level for the two stages and five phases in Walker's model (drawn by John Reed)

on each other, like they do on other continents. Erosion would produce more of a random pattern with erosional remnants. This is another good point. They also state that all megasequences thin toward the shields, which is interesting in itself and would indicate that erosion would have left erosional remnants, but it hasn't.

Still, the bottom three megasequences have been eroded from large areas, and there needs to be a source for the Zuni and Tejas continental margin sediments. Regardless, both Clarey and Ronov show opposite patterns of sedimentation, based on what is still there, and this still remains a conundrum.

Flood timing issues

The timing of the Flood is difficult to correlate to megasequence geology. Clarey's proposals for when the Flood began and when it peaked need attention.

The beginning of the Flood

Clarey and Werner state:

"The sandstone layer, commonly known as the Tapeats Sandstone (and its equivalents), is generally agreed upon by creation geologists to be the first significant deposit of the advancing floodwaters."³²

They also state, "the Sauk megasequence represented only a partial, but violent, start of the global Flood."⁴⁶ They

believe that the first three megasequences were deposited in the first 40 days of the Flood.⁴⁷ This raises an issue: how can these megasequences be the very start of the Flood when there is minimal deformation associated with them, *and* the Great Unconformity had to form below them? It is possible that erosion and formation of the Great Unconformity occurred at the same time. Clarey and Johnson seemed to misinterpret my earlier statements on this issue, claiming, "Surprisingly, Oard argues that there isn't enough *time* to deposit all of the first three megasequences in a mere 40 days or so."⁴⁸ However, my actual point was that it would take *time* to erode up to several kilometres of rock to form the Great Unconformity, and that the Tapeats and subsequent deposition must have occurred later than the beginning of the Flood, perhaps after Day 40. Moreover, many deep basins and rifts occurred below the Sauk Megasequence that were subsequently filled by Precambrian (pre-Sauk?) deposition; 30 km of volcanics and sediment was deposited in the Lake Superior Basin before the Sauk. Clarey and I agree that the Midcontinent rift was early Flood, perhaps part of a pre-Sauk Megasequence.

It is reasonable to place such early rifting very early in the Flood. The tectonism, volcanism, and sedimentation indicate extreme catastrophism from the onset. Widespread currents were sufficiently turbulent to form the Great Unconformity. This would have *taken time* early in the Flood. The Sauk was then deposited atop the Great Unconformity, and the minimal deformation within the Sauk and subsequent strata indicates the early Flood catastrophism became less severe

Table 1. Minimum erosion of Rocky Mountain basins and the High Plains of North America based on erosional remnants, listed from north to south.^{55–57} Total erosion likely was much more, especially on the High Plains, where erosional remnants are limited and/or at low altitude.

Location	Amount of erosion
South-central Saskatchewan	100 m
Northeast Montana (Flaxville Plateaus)	100 m
Northwest Montana, Southeast Alberta	730 m
Near Great Falls, Montana	375 m
Near August, Montana	800 m
East-central Montana	435 m
Southwest North Dakota	300 m
Western North Dakota	160 m
Bighorn Basin, north-central Wyoming	430 m
Powder River Basin, northeast Wyoming	470 m
Wind River Basin, central Wyoming	700 m
Southeast of Wind River Basin	850 m
Southeast Wyoming	270 m
Great Divide Basin, southwest Wyoming	640 m
Fossil Basin, southwest Wyoming	600 m
Western Nebraska	440 m
Northeast Utah	540 m
Northwest Colorado	560 m
North-central Colorado	610 m
Central Colorado	1,520 m
South-central Colorado	1,500 m
Southeast Colorado	180 m
Northwest Kansas	120 m
Northwest New Mexico	760 m
North-central New Mexico	1,000 m
East-central New Mexico	310 m
Northwest Texas	180 m

and chaotic. This shift could have happened on Day 40, when the heavy rain decreased and the waters prevailed until Day 150. I believe that after the floodwaters rose rapidly in the first 40 days, they rose much more slowly between Day 40 and Day 150 (figure 7).^{49,50} This supports the notion that millions of dinosaur tracks were washed away during the 40 days and nights of heavy rain.⁵¹ So, it is likely pre-Flood

land, as well as briefly exposed diluvial sediments, where the dinosaur tracks occur, existed until Day 150, by which time all air-breathing land animals had perished.

The peak of the Flood

Clarey believes that the peak of the Flood (Day 150) corresponds to the top of the Zuni, with the Tejas marking the Recessive Stage.⁸ He also admits that the peak of the Flood could have been in the lower Tejas.⁵² However, the Zuni and Tejas megasequences are mostly found along the continental margins, comprised of sediments eroded from the continental interior.⁴³

Although I agree with Clarey that most of the Tejas is recessional, some of the Tejas is not (for instance, some deposits in the Rocky Mountain valleys and the High Plains of the western United States). These Tejas rocks are likely from the early Flood for two reasons. First, the top of the valley fill is much eroded (table 1). Second, mammal tracks occur in the valley and High Plains sediments.⁵³ These tracks would have to be early Flood or post-Flood. So, the Flood timing of the Tejas and the peak of the Flood is wildly diachronous, depending on the location.⁵⁴

Conclusions

Megasequences bring up major questions for flood geology, the most basic of which is: how were the various columns determined? But there are many more questions. These questions need answers before we can determine whether 7 megasequences explain the strata on the continents during the Flood.

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