Examining the floating forest hypothesis: a geological perspective

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The hypothesis of a pre-Flood floating forest biome has been in the creation literature for several decades. The idea was developed as an explanation for the massive coal beds found in Carboniferous rocks globally and was based primarily on paleontological analysis. Surprisingly, this hypothesis was never adequately tested against other geological data. This paper presents three challenges, from a geological perspective, that draw into question the validity of the floating forest hypothesis. First, floating forests are found incapable of maintaining a sizable freshwater lens to supply the plant life, pools, and springs as suggested. Second, tsunami-like waves associated with plate movements would have likely broken up the floating biome earlier in the Flood than suggested, depositing coal beds throughout much of the stratigraphic column, contradicting the rock record. Third, relatively few coal beds are found as a result of the closure of the Iapetus Ocean ('proto-Atlantic') early in the Flood as Rodinia began to fragment. It is not until after this pre-Flood ocean was completely consumed that we find extensive coal beds deposited on the adjacent continents. When examined against available geological data, the floating forest hypothesis is found to lack explanatory ability. Instead, a return to studies of pre-Flood paleogeography and plant zonation to explain the coal beds is suggested.

One of the problems many creationists struggle with is the fossil record, and in particular, explaining the order of the fossils in Flood sediments. Secular paleontologists have used the order of fossils, generally from older marine organisms to younger terrestrial organisms, to advocate their theory of evolution, concluding that life evolved from marine organisms. In fact, land plants do appear in Flood rocks stratigraphically above the first appearance of marine organisms, but this does not demonstrate that evolution has occurred.

One rather novel approach to explain this pattern has been the hypothesis of a floating forest, advocated by Wise.[1,2] The beginning of this concept goes back even further to the work of Scheven.[3,4] Many other authors have subsequently written in support of the floating forest hypothesis, primarily focusing on the lycopod hollow root system[5–8] (figure 1). These authors conclude that huge, subcontinent- to continent-sized, floating forest biomes existed in the pre-Flood world along the continental margins and across the open ocean[1] (figure 2). The proposed massive mats of diverse plant life are envisioned to have later broken up during the Flood event, becoming deposited as globally extensive Carboniferous coal beds.[1] Wise has also suggested that these mats contained their own unique fish and animal fauna, and may have even trapped fresh water atop the mat in a perched freshwater lens with pools and even freshwater springs above the ocean surface.[1]

While the floating forest is a unique concept, and is a creative attempt to explain the order of the plants and animals in the fossil record, it has not been adequately scrutinized against the observed geological record. This paper examines the floating forest hypothesis using three geological criteria in an attempt to assess its validity.

Trapping a freshwater lens

Water flow through a 'floating forest island' is likely similar to flow through an unconfined aquifer in a modern island setting. In marine islands, groundwater flowlines travel away from the centre, the highest point, where water pressure is highest, and toward discharge points along the island edge at the freshwater / ocean water interface.[9]

The water table (the boundary between the unsaturated and saturated zones), and any freshwater lens is recharged by precipitation that infiltrates downward, under the influence of gravity, through pores in the unsaturated zone, causing the water table to rise.[9] Water in the saturated zone can actually flow upward due to differences in hydraulic head pressure. Recurring precipitation is the primary method for the creation and the maintenance of an 'island' style freshwater lens atop salt water. Without sufficient rainfall, the water table flattens and the freshwater lens thins to zero.

Contrary to what has been suggested,[10] the capillary fringe plays a minimal role in the creation of a freshwater lens. Capillary action is not technically part of the saturated zone but instead occurs on top of the water table, 'wicking' up some water into the vadose zone (unsaturated zone).[9] While it is true that the thickness of a capillary fringe is greatest in fine sediments, the pressure head is still negative, indicating that the fringe is still unsaturated and not part of the water table (freshwater lens) beneath.[9]

My first goal was to determine whether a floating lycopod forest could create and sustain an adequate freshwater lens to supply the plants, and presumably the animals. I assumed that the floating mat of tangled lycopod forest roots and plants described by Woolley[6] and Scheven[4] approximated a porous medium. The governing equation that defines flow through a porous medium is Darcy's Law.[9] Average linear velocity of flow can also be approximated using a derivation of Darcy's Law:[9]

$$V = -KG/n_e$$

V = Average Linear Velocity (cm/sec)
K = Hydraulic Conductivity or Permeability (cm/sec)
G = Hydraulic Gradient
n_e = Effective Porosity.

I then had to assume a hydraulic conductivity (or permeability) for tangled roots and a plant raft, with a rhizome-based anatomy and lycopod root system (figure 2). As this environment does not exist today, I used the hydraulic conductivity for woody peat, which ranges from $K = 10^{-1}$ to 10^{-4} cm/sec,[11] which is similar to the hydraulic conductivity in the upper range of silty sands ($K = 10^{-3}$ to 10^{-5} cm/sec).[9] Peats that are derived from reed and sedge plants have a slightly lower hydraulic conductivity range,[11] with values down to 10^{-6} cm/sec. However, Holden[12] found values for hydraulic conductivity in the vadose zone peat layer between $K = 10^{0}$ and 10^{-4} cm/sec, and Pitcher and Hession[13] conducted slug tests on the upper peat beds of a kettle bog, finding values between $K = 10^{-3}$ and 10^{-4} cm/sec. For my calculations, I chose a hydraulic conductivity value within the range of these values, settling on $K = 1 \times 10^{-3}$ cm/sec, which seemed a very reasonable approximation of the floating forest permeability. Finally, I assumed an effective porosity between silt and sand and gravel of 35% and a modest gradient or hydraulic pressure head of 0.5 cm/100 cm, or 0.005.[9]

The resulting linear velocity was determined as $V = 1.4 \times 10^{-5}$ cm/sec. Knowing that 1 cm/sec = 864 m/day,[9] this velocity was converted to V = 0.012 m/day, or over 1 cm/day. This is likely a minimum velocity. A realistic value could be 5–10 times greater in the lycopod root system described by Woolley,[5–7] assuming a slightly higher permeability. Higher gradients would also only increase the velocity. These seepage velocities are far too large to sustain freshwater ponds, springs and even much of a perched freshwater lens as proposed,[1] without continual precipitation. Water would merely flow through the root system and discharge into the ocean, making a sizable freshwater lens problematic.

Finally, what is the source of this freshwater influx? Many creationists assume there was little rainfall before the Flood (Gen. 2:5), or at most only slight rainfall events (mists?), or infrequent, non-violent rainfall events. It seems likely that the pre-Flood world did not provide sufficient rainfall to sustain a floating forest biome. Without being attached directly to land, which could provide a source of hydrologic groundwater flow, a floating mat fails to hold water.

But, let's assume there was sufficient rainfall in the pre-Flood world to sustain a significant freshwater lens within the proposed floating forest biome. This also assumes any storms bringing precipitation were not very severe or they would have produced strong winds and waves to break up the floating mat from the outside edges inward. Also, we must assume ocean currents were in operation before the Flood to prevent stagnant ocean water at depth. Without ocean currents, there would be only limited upwelling and downwelling occurring in the open ocean. Vertical transport of ocean water is necessary to bring nutrients upward to the surface for plant growth and to transport oxygen downward for animal sustainability at depth.[14]

Pre-Flood currents circulating around the margins of the oceans would likely create gyres. Ocean gyres move surface water to the centres of the oceans, as is observed today, due to geostrophic flow caused by the Ekman spiral.[14] Surface convergence in the centre of the ocean gyres produces a broad mound of water about 2 m high, which is relatively high in salinity and supports little life.[15] Likewise, these conditions produce downwelling beneath the area of surface convergence, and, presumably, would have done likewise beneath the continent-sized floating forests, contrary to earlier claims.[10] Downwelling produces surface waters with low productivity,[15] presumably inhibiting the postulated floating forest biome.

Deposition of three megasequences beneath the forests

Second, I examined the level in the Flood record where we see the 'floating forest' coals. The rocks that contain the bulk of the proposed biome fossils are within the Carboniferous system, specifically the Pennsylvanian system or the Upper Carboniferous. This places the burial of the vast majority of the floating forest biome near the base of the fourth megasequence, or Absaroka Megasequence,[16] as defined for the North American craton.[17] Therefore, this requires the deposition of three complete megasequence cycles in North America beneath the floating forests, and all prior to their sudden and rapid burial in the Pennsylvanian system rocks of the Absaroka Megasequence. The amount of sediment

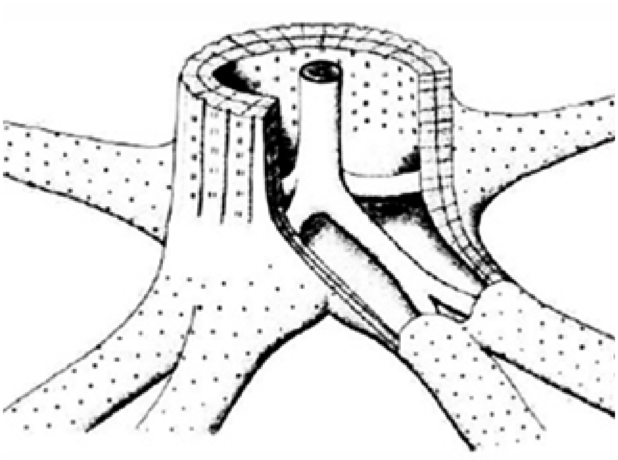

Figure 1. Reconstruction of a lycopod tree stump. Used with permission of *Journal of Creation*.[4]

deposited as part of these three earlier megasequences is tremendous. Upwards of 3 km of virtually coal-free sediment (and in some places over 6 km) was deposited along the entire US Eastern seaboard prior to deposition of the Upper Carboniferous (Pennsylvanian system) coal-rich beds (figure 3).[18] How did the forests remain intact atop the sea while all this deposition was occurring beneath? It seems highly unlikely that they floated as an essentially intact log mat for three megasequence cycles, and were then suddenly buried completely in the fourth (Absaroka) megasequence. Why not as part of an earlier continent-wide megasequence?

If, as some creationists have proposed,[19,20] the various megasequences were caused by plate movements during the Flood, then there would likely have been huge tsunami-like waves tearing apart the floating forests from the very onset. Tsunami waves observed today surge toward land and sometimes rise tens of metres upward nearest the shore as the water in front slows from friction against the sea floor, while continuing to build and accumulate from faster water waves behind. They do not create a simple breaking wave, but a massive mound of water, more like a fast-moving tide than a wind-driven wave.[14] Tsunamis approaching shore produce waves that are much larger on the landward side. The resulting surge of water can easily race across low-lying terrain, shearing trees and plants off in its path.[14]

During the Flood, it can be assumed these waves were even greater than what has been observed in the recent past, transporting sediment and water (which would include the floating forests) 100s of kilometres inward. Evidence for mass transport of water and sediment during the Flood is illustrated by the basal Sauk Megasequence map, showing the Tapeats and equivalent sandstone, covering a major part of the North American continent.[21]

It seems likely that the very first North American megasequence cycle, the Sauk,[17] would have broken up the floating lycopod forest right from the start. This would have deposited coals in Cambrian system rocks, contradicting the fossil record. It is not until the second North American megasequence, or the Tippecanoe,[17] that the rocks show the first appearance of any terrestrial plants, and only a very limited amount.[22] During the deposition of the third megasequence, the Kaskaskia,[17] we find larger numbers of terrestrial plants and limited thin coal beds.[22] But it is not until the start of the fourth megasequence, in the Upper Carboniferous, that we find extensive coal beds filled with the bulk of the proposed floating forest plants.[1,22]

Snelling has used the floating forest model to explain coal cyclothem deposits in the Paleozoic.[23] He suggested that the main cores of the floating forest biome were destroyed early in the Flood, but did not give a specific timeframe, resulting in toppled lycopod trees that floated temporarily on the surface. He proposed that as the floating debris and logs became progressively water-logged, sinking a few at a time,

Figure 2. Diagrammatic representation of a floating forest. Used with permission of *Answers Magazine*[2]

they became thin coal beds within the sedimentary deposits beneath. This gradual process, he suggested, explained the repetitive nature of later Paleozoic coal and marine sediments called cyclothems.

However, no explanation was given to justify why the bulk of the 'floating' debris mats became water-logged and buried nearly simultaneously in just one system (Pennsylvanian) and within only the fourth North American megasequence (Absaroka).[23] Again, the floating forest hypothesis fails to address the lack of significant coal deposits in the first three, continent-encompassing, megasequence cycles. The rapid plate movements responsible for the first megasequences (Sauk and Tippecanoe) would likely have produced tsunami-like waves right from the onset, destroying the core of the floating forests early in the Flood, as mentioned above. This would have resulted in deposition of water-logged debris and 'cyclothems' throughout a greater span of the rock record, starting with the earliest megasequences and possibly even into later Flood rocks, contrary to the observable fossil record. At the very least, it is unlikely that this process would have deposited most of the lycopod logs within one narrow mid-Flood episode as the rock record clearly indicates.[22]

Alternatively, Paleozoic coals and cyclothems may be simply a consequence of multiple tsunami waves washing across progressively higher levels of land as sea level rose during the Flood. During the deposition of the Absaroka Megasequence, the water levels may have reached the bulk of the pre-Flood lycopod forests and its associated animals. This would have torn free massive amounts of plant debris and nearly simultaneously deposited the forests with sediments in rapid succession as tsunami-like waves 'broke' onto the continental interior—a process more similar to the allochthonous origin of coal described by Austin.[24]

Missing forests of the proto-Atlantic

Third, I tested the hypothesis in a plate tectonic scenario using a segment of the pre-Flood ocean that was presumably destroyed early in the Flood. Catastrophic Plate Tectonics (CPT) has been proposed as playing a major role in Flood initiation.[20,23] Plate movement is envisioned to have begun with the break-up of Rodinia and the formation of the supercontinent Pangaea early in the Flood.[20]

According to secular geologists, and many creation geologists who advocate CPT, there was a pre-Flood ocean along the East Coast of the US called the Iapetus Ocean, separating North America from Baltica (another continental mass).[22] Early in the Flood, ocean lithosphere began to be consumed by runaway subduction along the US East coast, marked by the Taconic orogeny, while Ordovician system rocks (Tippecanoe Megasequence) were being deposited (table 1). The destruction of the Iapetus Ocean presumably continued through the Caledonian and Acadian orogenies as Laurentia (North America) collided with Baltica and Avalonia, finally placing continental crust against continental crust from Newfoundland to Pennsylvania. This three-part process completely consumed the Iapetus Ocean lithosphere by the time Upper Devonian system rocks

Table 1. Sequence of events along eastern North America during the early Flood

Strata/Megasequence	Location	Interpreted Tectonism	Flood Interpretation
Neoproterozoic to Cambrian	East coast of USA	Open Iapetus Ocean	Pre-Flood Iapetus Ocean
Cambrian to Middle Ordovician Sauk Megasequence	Eastern USA	Initial subduction of Iapetus Ocean	Early Flood runaway subduction consuming ocean lithosphere of Iapetus Ocean
Upper Ordovician Tippecanoe Megasequence	NE USA and Canada	Taconic phase/collision with Baltica	Early Flood runaway subduction consuming ocean lithosphere of Iapetus Ocean
Silurian and Lower Devonian Tippecanoe and Kaskaskia Megasequences	Eastern USA	Acadian and Caledonian phase; N. America collided with Baltica and Avalonia; Iapetus Ocean consumed	
Devonian Kaskaskia Megasequence	SE USA	Continued closing of southern Iapetus Ocean	Complete closing of Iapetus Ocean
Mississippian (Lower Carboniferous) Kaskaskia Megasequence	NE USA	Initial collision of Laurasia with Galatian Superterrane and Gondwana	Closing of Rheic Ocean
Pennsylvanian (Upper Carboniferous) through Permian, extensive coal Absaroka Megasequence	Eastern USA	Hercynian–Alleghenian phase; Appalachian Mountains resulting from a collision between North America and Africa. Formation of Pangaea	Floating logs get buried, and later turn to coal

were deposited (Kaskaskia).[22] Later, during deposition of the Mississippian system rocks (Lower Carboniferous), Laurasia (including North America) again collided with the Galatian Superterrane and Gondwana as part of the Hercynian–Alleghenian orogeny, completing the destruction of another segment of ocean (Rheic Ocean) lithosphere, and the formation of Pangaea.[22,25]

This scenario suggests that at least two significant segments of the pre-Flood ocean were completely destroyed through subduction, to the point of placing continent against continent, and all prior to the deposition of the most significant coal deposits (table 1). What happened to the presumed floating forests in these oceans? How did they escape deposition during runaway subduction and consumption of these pre-Flood oceans? There should be massive coal seams as evidence of their demise in eastern North America within the Tippecanoe and Kaskaskia Megasequences. However, it is not until later in the Flood, during the deposition of the next system (Pennsylvanian), part of the next megasequence (Absaroka), that we see the bulk of the coal deposited in eastern North America.[22] The floating forest hypothesis fails to adequately explain the lack of any massive coal beds at the time the oceans were destroyed, and cannot explain why the bulk of the lycopod forests were deposited en masse as part of the Pennsylvanian system. The proposed floating forests seem to have become phantom forests.

Instead, the lycopod coal beds were possibly deposited in a scenario more like the floating log mat model put forth by Austin,[24] where the plant material was ripped free from the land as the floodwaters rose, transporting and depositing the logs as part of the Absaroka Megasequence (Pennsylvanian system).[16,19] In this scenario, the closing of pre-Flood ocean segments would have had little influence on the timing of deposition of lycopod coal beds.

Other issues

In addition to these geological issues, I examined the plants involved in the presumed floating forests. Wise[1,2] and Scheven[3] have explained that the unique, hollow lycopod trees found in Carboniferous coal deposits would make perfect candidates for floating forests. Wise also interpreted the mixed terrestrial plants and animals encased within marine sediments as further evidence of the floating forest's existence in a pre-Flood marine realm.[1] But the mixing of terrestrial and marine organisms is insufficient evidence to conclude the existence of a floating forest biome because the mixing of these two environments is rather common in Flood sediments. Terrestrial coal fragments are found mixed with marine fossils in offshore sediments near Labrador (CAN), and dinosaurs in the Hell Creek Formation in Montana are encased with many marine fossils, including sharks and marine invertebrates.[26]

Advocates for this hypothesis also assert that many Carboniferous fossil plants became extinct because the pre-Flood floating forest biome no longer exists in the modern world. They have suggested that the 'choppy waters' of today's oceans would have prevented their re-formation after the Flood destroyed the original systems, causing the post-Flood extinction of the lycopod trees.[2,23] However, there are many extinct marine and terrestrial organisms, including brachiopods, trilobites, and dinosaurs, that are found only in Flood rocks. Post-Flood extinction cannot be used to argue for the existence of a floating forest biome any more than any other unique biome that might have existed in the pre-Flood world.

Finally, some of the same types of plants proposed for the floating forest, such as club mosses, horsetails and ferns, have extant versions that are identical to the fossil plants right down to the genus level, and/or are at least likely members of the same biblical kind. *Equisetum* is an extant horsetail that is very similar to *Calamites*, a horsetail that is found prominently in Carboniferous coals. Varieties of *Equisetum* are found primarily on land today, preferring wet, sandy soils with a few living in the semi-aquatic realm. Many of the fossil ferns found in Carboniferous sediments also have living descendants on land today, and many are possibly

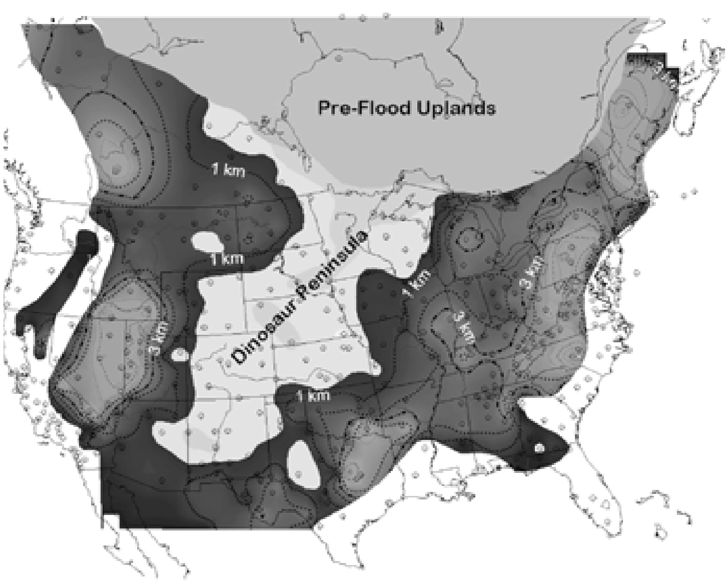

Figure 3. Pre-Flood map of the continental USA showing the proposed dinosaur peninsula trending NE-SW. Numbers shown represent the combined thicknesses of the Sauk, Tippecanoe and Kaskaskia Megasequences, all deposited prior to most major coal layers. Lycopod trees may have lived in shallow coastal areas fringing this low-lying land mass and became buried as the Flood waters advanced across the peninsula during the Absaroka Megasequence. Diagram courtesy of Davis J. Werner.

the same biblical kinds. It seems more likely that these plants have always existed in the terrestrial realm where they are found thriving today. So, to argue that these same kinds of plants primarily existed in the pre-Flood world on a floating forest would seem to contradict the empirical evidence.

Conclusion

A reconsideration of the floating forest hypothesis is in order. When tested against the rock record and the presumed plate movements during the Flood, the hypothesis lacks explanatory power. It seemingly explains the paleontological record, when taken alone, but does not adequately explain other geological issues and the precise timing of coal deposition. There are alternative explanations for the observed fossil record. I suggest we turn our attention to studies of ecological zonation, pre-Flood geography, differential flotation, and hydrodynamic sorting of the pre-Flood plants to explain the coal deposits. Better development of pre-Flood geography will likely lead to a better understanding of pre-Flood biomes and better explain both the fossil and rock records.

Development of an alternative model that increases the height of the floodwater progressively, as indicated in Gen. 7:17–21, may be a place to start. Lycopod forests were possibly similar to cedar swamps and mangrove forests populating lowlands today. These unique flora may have filled the outer edges of the pre-Flood land masses, possibly in lagoons and/or in shallow waters, fringing the coast of areas like the proposed 'dinosaur peninsula' (figure 3).[18] The lycopod trees may have been simply torn loose and deposited *en masse* within the lower sedimentary strata of the Absaroka Megasequence as the floodwaters continued to rise.

This analysis finds no conflict with the flora and fauna found in a lycopod forest, only in the environmental setting. All geologic data support a 'grounded' lycopod forest that was growing attached to the pre-Flood land surface.

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