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THE HARTFORD BASIN OF CENTRAL CONNECTICUT: MULTIPLE EVIDENCES OF CATASTROPHISM

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ABSTRACT

The Hartford basin consists of a long band of clastic sediments and basalts outcropping in Central Connecticut and Massachusetts. Geologists have long considered these sediments to be deposited by uniformitarian processes. Evidence will be presented in support of catastrophic deposition of these sediments over a short period of time. A possible Flood model for the formation of the basin shall be proposed.

INTRODUCTION

The Hartford Basin is a classic area geologically. It has been visited by many prominent geologists including Sir Charles Lyell, Edward Hitchcock, William Morris Davis, and Paul D. Krynine. These and others have used the outcrops in the basin to support their uniformitarian models. Hubert et al. (1) proposed the basin took up to 24 million years to form. During this time, caliche horizons, multiple layers of mudcracks, dinosaur footprints, and black shales allegedly formed. All of these features indicate long periods of time from a uniformitarian viewpoint. Therefore this area is important for those who hold to a Creation/Flood model for earth history.

The Hartford basin is about 140 km long and 30 km at its widest point. It is part of the Newark Supergroup, a group of about 20 sedimentary basins which range in age from Triassic to Jurassic, along the east coast of the United States. In Connecticut, the area of this study, the basin consists of four sedimentary and three basalt formations. In general, the units dip about 10 to 15 degrees to the east. The basin is bordered on the east by a large border fault.

There are features of the basin which some would look at and immediately assume the basin took millions of years to be deposited. Some of these features include black shales, mudcracks, dolomite nodules, caliche horizons, skeletal halites, multiple layers of dinosaur footprints, and redbeds. The scope and length of this paper prevent a discussion of these problems in detail. Alternate explanations and interpretations have been given in the author's masters thesis that do not require millions of years for formation (2). For example, it was shown "mudcracks" did not form by exposure and drying to the sun, but were formed substratally, after burial. It was shown the paleosol caliche zones present in the New Haven Arkose did not have the necessary features to be interpreted as such.

The purpose of this paper is to show that the long held uniformitarian interpretations are not valid for the Hartford basin. Evidence will be presented in support of catastrophic sedimentation. A brief discussion of how the Flood may have played a part in the development of the basin will conclude this paper.

STRATIGRAPHY AND PALEONTOLOGY

The important features of the stratigraphy of the Hartford basin have been summarized in Figure 1. Where sandstones and siltstones are found they are generally poorly sorted and red in color. Sand grains tend to be angular and subangular. In places where sedimentary units outcrop near the eastern border fault, a large breccia facies is found. Clasts of over one meter in diameter have been seen in this area. Conglomerate lenses occur throughout the rocks of the basin, but are most notable in the New Haven Arkose. Plant fragments and fish remains are well known from the black shales of the upper three clastic units of the basin. Partial dinosaur skeletons and abundant footprints have also been found in these formations. Very few fossils of any kind have been found in the New Haven beds.

STRATIGRAPHY OF THE HARTFORD BASIN

Formation	Thickness	Description
Portland	1250m	coarse siltstones and fine grained sandstones sediments are poorly sorted and angular conglomerates and breccias near border fault black shales contain fish dinosaur tracks and rare skeletons
Hampden Basalt	15-50m	consists of eight different flows
East Berlin	150-300m	red mudstones, siltstones, and sandstones all sediments are angular and poorly sorted shrinkage cracks and dinosaur footprints common fish preservation excellent in black shales
Holyoke Basalt	100-200m	forms prominent ridges throughout Connecticut consists of two different flows
Shuttle Meadow	100-300m	red mudstones, siltstones and sandstones climbing ripples and mudchip breccias common black shales with fish dinosaur footprints in red siltstones
Talcott Basalt	30-75m	no single flows are extensive complex stratigraphy, extensive pillows
New Haven Arkose	2500-3000m	mostly sandstones, very few siltstones, shale poorly sorted, subangular to angular sediments no fossils, calcite rich zones, lenses of gravel quartz boulders up to 1 meter at base

Figure 1. Stratigraphy of the Hartford Basin.

PROBLEMS WITH DATING THE BASIN

Geologists have relied upon paleontological means to determine the age of the rocks in the basin. Because there are so few fossils in the basin, this has proven difficult. Even modern radiometric dating methods have not been able to resolve the problem. After doing a paleomagnetic study of the three basalts in the basin, deBoer (3) came to the conclusion that absolute dating methods cannot provide enough resolution to differentiate between their ages. Since this is the case, how can one tell what period of time these rocks were deposited without using paleontological methods? These methods may be inaccurate not only because of the scarcity of fossils in the basin, but also because of circular reasoning and the assumption of the evolutionary theory to arrive at a date. (For an explanation of this circular reasoning process see Morris (4)).

No one has satisfactorily demonstrated that the Hartford basin was deposited over millions of years. It has yet to be shown that the basin was deposited in a short amount of time. Austin and Morris (5) have argued that a large thickness of strata in California was folded plastically not long after deposition. Tight folds occur throughout the section which supposedly took millions of years to deposit. In a uniformitarian model the oldest beds should have been lithified by the time of deformation and should have behaved in a brittle manner, not a plastic one. Their arguments show it is unreasonable to believe rocks in this area remained unlithified for millions of years until deformation took place (which the uniformitarian model demands) and therefore deposition and deformation must have occurred within a short time of each other. Unfortunately, large sedimentary outcrops are few and far apart in the Hartford basin, and those which do occur do not contain structures appropriate for applying the studies Austin and Morris. However, there is no evidence which prevents a short depositional time span for the basin. Evidence of catastrophism will now be examined.

EVIDENCES OF CATASTROPHISM

Black Shales and Fossil Fish

The black shales of the Hartford basin have been interpreted as forming from organic rich sediments deposited in oxygen-poor waters at the bottom of a relatively large lake. The lake bottom was supposedly free of scavengers and bacteria which could have decomposed the numerous fish that are now found as well preserved fossils in the black shales (6). It has been common for most authors to attribute black shale formation to oxygen-poor, deep sea environments. The shales were thought to accumulate by simple settling processes over long periods of time.

Black shales are contained within the Shuttle Meadow, East Berlin, and Portland Formations. The shales range in thickness from about 0.1 to 4 meters. The shales are often very dark and rich in kerogenous organic material. Often fish scales, whole fish, fish coprolites, and plant material can be found within the finely laminated shales. The fine lamination of the shales is an indication to many sedimentologists that these shales were deposited below wave base in an oxygen-poor environment where bioturbating organisms could not survive. The black shales are sometimes interbedded with coarser gray siltstones rich in micaceous material.

Even though a shale is black, that does not automatically indicate it was deposited in deep, quiet, toxic bottom water. Ruedemann (7) discussed some conclusions made by Richter regarding the black Hunsruchschiefer shale. This shale was generally inferred to have been deposited under "standard black shale conditions" but Richter found evidence that this was not the case. He found "small ripples, cross-bedding, sandstone lenses, and the drifted positions of starfish arms that [proved] the water was in motion." Also the presence of branching worm burrows showed life was able to exist in this black shale environment. Another study by Zangerl and Richardson (8) suggests movement of bottom water from the evidence of oriented plant and fish remains in the black shales they studied. No studies are known on the orientation of fossils in black shales of the Hartford basin. A study of this nature for the Hartford basin would be beneficial.

Fissile shales have been interpreted (and rightly so) as shales which were deposited in environments with no bioturbation and therefore no (or very few) animals were present in the environment at the time of deposition (9). Azoic environments are those which are also anoxic or extremely deep. Therefore, most sedimentologists would conclude any fissile shale with no bioturbation (especially a black shale) would accumulate either in deep or anoxic environments. However, another possibility exists.

Piper (10) reported how a variety of different laminated mudstone beds were formed by turbidites. Whittington (11) also reported that the well preserved invertebrate organisms from the famous Burgess Shale were quickly buried. Could lack of bioturbation in the finely laminated black shales of the Hartford basin be due to the rapid deposition of these sediments? From the papers by Piper and Whittington it is apparent that fine-grained sediments can accumulate rather quickly. J. H. Bretz (12) described how thick sequences of silt beds were formed quickly due to backflooding during the Lake Missoula floods. Lambert and Hsu (13) described how silt and clay layers formed rapidly by catastrophic, turbid water underflows. These are just a few of the papers which describe how fine grained sediments can accumulate quickly. This is contrary to the commonly held view that shales accumulate slowly due to simple settling processes.

The black shales of the Hartford basin contain evidence for rapid deposition. The shales contain numerous fish fossils. Cornet _et al_. (14) reported over 450 fish in a 2 cubic meter excavation of shale. It is apparent, in order for a fish to be preserved, it must be rapidly buried. When fish die, some float on the surface of the water. Here they most likely would be eaten by scavengers or by bacterial decay. If a dead fish sinks to the bottom of a body of water for burial, it seems reasonable that the fish would decay to the point of disarticulation before it could be buried by the slow processes of sediment accumulation envisioned for shales (tens or hundreds of years depending on the size of the fish). Brett and Baird (15) claimed disarticulation of fish occurred in short periods of time (days to a few weeks) in anaerobic experimental conditions. They went on to argue anaerobic conditions alone are insufficient to preserve intact skeletons and deposits which contained these skeletons were formed by rapid burial.

Of the thousands of sediment cores recorded from various lakes, Vallentyne (16) reported only one known case on record of fish remains being found. He goes on to describe fish remains (mostly scales) which he found in some deep water lake sediments. His study shows whole fish were not found, only parts and pieces such as scales, vertebrae, neural and hemal arches, ribs, skulls, and opercular bones. This report is significant because we find whole, perfectly preserved fishes in the black shales of Connecticut. Vallentyne's study shows that present lake processes are dissimilar to the processes which deposited the black shales of the Hartford basin. Since perfectly preserved fish have been found, one must come to the conclusion that they were buried catastrophically. Therefore, the black shales of the basin must have been deposited in a different way than black sediments forming today.

The shales did not necessarily have to be deposited laminae by laminae. A slurry of organic material, similar to a turbidite flow, could have taken place as a hyperpycnal flow. This slurry conceivably would have buried many organisms, including fish. Shale fissility could have developed post-depositionally. White (17) has shown experimentally how fissility can develop post-depositionally in certain types of clays. Lambert and Hsu (18) have seen up to five graded laminae deposited in a single year in Lake Walensee in Switzerland. Previously geologists thought the laminae in this lake and others like it were deposited as varves--two layers each year. The "varves" in this lake were formed rapidly by turbidity underflows. A French geologist (19) has shown how lamination can develop rapidly in slurries of fine-grained suspensions.

There are many ways, besides simple settling, in which fine grained sediments with laminations can develop. These possibilities should be considered when examining the black shales of the Hartford basin, especially when the catastrophic evidence of the fish is present. Any other conclusion besides catastrophic burial is hardly reasonable.

Dinosaur Tracks

Coombs (20) reported what he called swimming dinosaur tracks which were found at Dinosaur State Park in Rocky Hill, Connecticut. Coombs was not the first to recognize such features. Bird (21) reported swimming Brontosaurus tracks found near Glen Rose, Texas. The tracks from Connecticut show there was a moderate amount of water in which an animal had to swim. Also significant, is the fact that in order to eventually be preserved, these tracks had to be buried soon after formation. These dinosaur tracks show swimming animals, in relatively deep water, in which burial of the tracks occurred soon after formation. If burial did not happen quickly, it is reasonable they would have eroded soon after formation.

Bioturbation

The general absence of widespread bioturbation throughout the rocks of the Hartford basin and other rocks throughout the world, is an indication these sediments were deposited quickly enough that bioturbation did not have time to take place. Another possibility is that the sediments were deposited slowly and there was no animal or plant life to cause bioturbation. The former interpretation is favored because animals and plants were present during deposition of the basin sediments, demonstrated by their fossil remains. Hitchcock (22) and Lull (23) recognized up to 27 different track, trail and burrow genera made by invertebrates throughout the basin. These fossil remains were supposedly made by larval and adult insects, crustaceans, myriapods, annelids, mollusks, and other forms. Tracks, trails, and burrows are present throughout the basin, but they are only found in abundance locally.

In recent marine environments, bedded sediments are destroyed by burrowing organisms. Dott (24) reported bedded sediments deposited by Hurricane Carla in 1961 were completely homogenized when they were investigated in 1981. Rhoads (25) studied rates of sediment reworking in Buzzard Bay, Massachusetts and Long Island Sound. He determined that bottom fauna is capable of reworking the annual sediment accumulation several times over. If marine organisms are capable of reworking sediment so quickly, and sediments were deposited at uniformitarian rates in the past, why are bedded marine sediments preserved in the fossil record? Any marine sediments which are bedded, and contained organisms which were capable of bioturbation, must have been deposited in thick sequences (catastrophically), or else the organisms would have had time to destroy bedding through bioturbation.

The rocks contained in the Hartford basin are not of marine origin, but the same principle can be applied. Organisms and plants were obviously present in the basin. In fact, abundant plant life must have been present to support the dinosaur population. Although only scarce remains of the invertebrates have been found, there are scattered tracks and trails which prove their presence. If the basin was deposited over 24 million years, would this not be sufficient time for small burrowing organisms to destroy bedding in the finer grained red sediments of, for example, the East Berlin Formation? This was supposed to be deposited in shallow, quiet lakes. Plants on supposed floodplains of the basin would have destroyed any finely laminated floodplain sediment.

In conclusion, the general absence of abundant bioturbation in the basin supports catastrophic sedimentation and does not support the uniformitarian model for basin deposition. Bioturbation takes place only if organisms or plants are present to do work. They apparently were present during basin deposition, for we have evidence of their presence, but deposition occurred so quickly they did not have time to re-root and cause any significant bioturbation.

Basalts

One of the most impressive evidences of catastrophism in the basin are the basalts: The Talcott, the Holyoke, and the Hampden. Almost everyone would agree that each flow of these basalts was laid down within a short period of time. It is very impressive that these basalts contain pillows, vesicles, amygdules, and other features at their contacts, which indicate the basalt flows occurred shortly after clastic deposition, while the sediments were still wet.

Only the lower most basalt, the Talcott, is extensively pillowed. In Meriden, the pillows range from 0.5 to 1.0 meters in diameter. Gray (26) reported pillows up to 2.0 meters in diameter. It is generally agreed that lava must be spewed out in a subaqueous environment for pillows to be formed. Snyder and Fraser (27) who have done extensive review on the literature of pillow formation have come to the conclusion that the only way for pillows to form is the contact of hot magma with water or mud. Authors such as Krynine (28), Hubert et al. (29), and Gray (30) also support the idea that the pillows were formed in a wet environment.

Due to the extensive pillowed nature of the Talcott Basalt at most localities, it seems reasonable the Talcott was deposited under water, on muddy, water saturated sediments, or both. This is very obvious at the New Haven Arkose/Talcott Basalt contact in the Farmington River Gorge at Tariffville, Connecticut. Gray (31) described the pillows at the base of the contact as "intimately intermixed with the underlying sediment." At this contact pillows of basalt can be seen one meter below the main contact completely surrounded by the New Haven sediments. Either the characteristics of this outcrop indicate the deposition of the sediments and the basalt was contemporaneous; or, when the basalt was deposited, the underlying sediments were so soft and muddy they actually "swallowed up" some of the pillows. Whatever the case, it is obvious water was present when this particular flow took place. Since these sediments were soft and unconsolidated when the flow occurred, not much time passed by between clastic sedimentation and the basalt flow. The universality of pillows in the Talcott indicates that the New Haven Arkose was totally covered with water at the time of the Talcott flows or at least was extremely water saturated. The shales of the New Haven remain fissile right up to the contact with the Talcott Basalt. This is remarkable considering the uniformitarian viewpoint. Why haven't the shales been bioturbated by plant or animal life? Why isn't there a soil here? This is evidence that the Talcott flow occurred soon after clastic deposition.

The lowest of the three basalts in Connecticut is extensively pillowed. The Holyoke and the Hampden contain rare pillows. A few pillows about a meter in diameter were observed in the Hampden Basalt by the author near Branford. It seems these basalts were deposited under different conditions, because pillows are scarcely found in the upper basalts. However, it seems water was present because of the wide occurrence of vesicles and amygdules in these basalts. These features occur widely at the base of the first Hampden flow and at the base of some of the other Hampden flows (32). Large pipe amygdules occur near Trinity College in Hartford. Chapman argued these formed by steam rising from the moist sediments below.

If in fact the Hartford basin was deposited over millions of years, there should be a paleosol below the basalt contact. Bedding should have been obliterated by plants and trees that grew in this soil. Why aren't plant roots preserved here? Would not this be the ideal place? The contacts were carefully observed and the literature was searched for such features at the basalt/clastic boundaries. As far as the literature shows, no evidence of paleosols exist at these contacts. It appears as though the East Berlin sediments were deposited before any kind of plant life could be established. The Hampden flows occurred while the sediments were still water saturated from depositional processes.

The contact between the East Berlin and the Hampden Basalt is very sharp and regular. As just mentioned, there is no organic debris or soil horizon present at or below the contact. Between the eight Hampden flows, no clastic sediment has been reported. This contact is also sharp and usually defined by a layer of amygdules or vesicles. This is evidence that the flows were deposited immediately after the previous one occurred. If these flows occurred hundreds or thousands of years apart one would expect to find a hummocky, erosional surface between the flows and some type of sedimentary material. Instead, one finds sharp contacts, indicating rapid succession of each flow.

The upper contact of the Hampden with the Portland Formation is interesting because there are small pockets of red sediment in the basalt just below the upper contact. This shows that red sediment was being deposited contemporaneously with the basalt. How else could the sediment have gotten into the small pockets? The contacts with the red sediment are sharp. At its upper surface the basalt is very sharp and angular. There was no erosion of the basalt before the Portland was deposited.

The Holyoke consists of two flows. Gray (33) noted that the upper surface of the lower flow suffered little erosional relief and sediment accumulation before the second flow was deposited. This evidence indicates that the second flow occurred soon after the first. Again, this is evidence for rapid succession of events for deposition of rocks in the Hartford basin.

Sedimentology

The sediments of the Hartford basin support the idea that the basin was deposited in a short period of time. The sedimentary features which indicate rapid deposition include conglomerates, breccias, the Great Unconformity found in Southington, soft-sediment deformation, cross-bedding, flaser bedding, mud-chip breccias and angular sediments. Paul D. Krynine (34) is credited for the most thoroughly documented study of the sediments of the Hartford basin. He recognized the angularity of the basin sediments throughout many parts of his classic work. He emphasizes the idea that erosion was rapid and violent without much weathering.

Krynine believed the basin was deposited over millions of years. A current estimate by Hubert et al. (35) is that deposition took 24 million years. Because the basin is about 5 km thick, the average rate of sediment deposition would be .0002 m/yr or 2 cm per 100 years. Would not this rate be slow enough to allow rounding of sediments and weathering of minerals? No references could be found concerning how fast rounding and weathering could take place (on an absolute time scale). It is expected at these sedimentary rates much more evidence of rounding and weathering should be present. Therefore, it is concluded from the evidence of angularity of the sediments, the basin must have been deposited in a shorter time span than authors such as Hubert would suggest. Angularity does not show exactly how fast the basin was deposited (nor will any known method), but it does indicate it was deposited quickly and not over millions of years.

Only one place in the Hartford basin shows sediments found in contact with the underlying crystalline bedrock. On the western edge of Southington, Connecticut, 1/2 km upstream from where Roaring Brook crosses Mt. Vernon Rd., this contact is exposed. It has been described and observed by William M. Davis (36), Rice and Gregory (37), Krynine (38) and other authors. This has been named the "Great Unconformity" (39) because 200 million years of time is unaccounted for, and unrepresented by rock. The erosional contact occurs between the Devonian Southington Mountain Member of the Straits Schist and the Upper Triassic New Haven Arkose. Of course, the present author does not agree with the geological ages of millions of years placed on these rocks, nor does he agree there are 200 million years of missing time. However, he does concur that there is an unconformity at this locality which is extremely significant.

The contact occurs about 100 meters along the north side of Roaring Brook. The most significant part of the outcrop is found furthest upstream where the topography begins to steepen. This is the area where one can go from the easily erodible New Haven Arkose to the more resistant metamorphic rocks of the Western Highlands. Although difficult to find the contact downstream, it can be found by close inspection. The New Haven Arkose fills deep channels in the schist below. It is difficult to determine how deep the largest channels are. The channels' upper contacts are lost in vegetation as they are traced up the ravine wall. The channels within the larger channels are from 1 to 3 meters deep. All channels are carved along strike of the foliation of the schist (approximately N-S).

The New Haven Arkose which fills the channels is brown to tan in color. It mostly consists of a very coarse to granular sandstone, which is poorly sorted and subangular. Many metamorphic clasts are contained within the arkose. They originated from the metamorphic rocks surrounding the Hartford basin. Clasts found in the immediate vicinity of the unconformity range from granules to cobbles about 150 mm in diameter. Bedding is indistinguishable near the contact but becomes more apparent higher in the ravine wall. If observed from a distance, a hint of trough cross-bedding can be observed in the outcrop. The contact between the New Haven and the Straits Schist is very sharp.

Downstream from the main contact, large quartz boulders, at least a meter in diameter (possibly up to 2 meters), are found resting on the unconformity. These boulders were probably transported from the Western Metamorphic highlands, not too far from where they are now found. They might have come from the east which would make their transport even more phenomenal. It is interesting to note that large boulders such as this have been observed on the Precambrian/Cambrian contact at many places around the world. It is significant they are also found here. Their significance will be discussed in the next section.

The features of this outcrop (its angularity, sorting, sediment size, and channels) indicated it was deposited under catastrophic conditions. The matrix supported, poorly sorted, angular nature of the sediments near the contact probably indicates these sediments were being transported by suspension processes such as a mud flow. However, the bedded nature of the sediments a meter or so above the contact indicates that transportation may have been occurring by processes closer to traction. Whatever the method of transport and deposition that occurred here, one thing is evident-- it required catastrophic processes to carve the large channels and deposit the sediment at this locality.

Cross-bedding by itself is not an indication of catastrophism. Cross-bedding forms under normal fluvial and marine conditions today. Extraordinarily large cross-beds are not present in the Hartford basin. The largest cross-beds observed are in an outcrop along the North Branch of the Park River at the University of Hartford campus. These large cross-beds were in 1-2 meter sets. Cross-beds elsewhere in the basin were commonly present, often found as trough cross-stratification. Although cross-bedding doesn't necessarily indicate catastrophic deposition, it does indicate moving water, active deposition, and erosional processes. Larger cross-beds (which are occasionally present) do indicate large amounts of moving water. Mud chip breccias and climbing ripples indicate erosional and depositional processes were actively occurring and not stagnant. These two features are very common throughout the basin, especially in the Shuttle Meadow, East Berlin, and western Portland Formations.

FLOOD MODEL

Now that the evidence for catastrophism has been discussed, it is appropriate to apply this evidence and the features of the basin within a possible Flood model. Based upon field work and research the best possible model will be presented and is subject to change upon further research and new data.

Crystalline rocks exist below the sediments of the Hartford basin, as they are assumed to exist under all sediments on the earth. As discussed previously, schist lies below the New Haven Arkose. At this contact, large, angular quartz boulders up to and exceeding one meter in diameter can be found. Similar contacts and boulders exist in the Grand Canyon between the Shinumo Quartzite and the Tapeats Sandstone: the contact between the Cambrian and the Precambrian. The boulders in the Canyon were found up to 40 meters in diameter! Angular quartz boulders can also be observed between the Cambrian and Precambrian in the Black Hills of South Dakota. In fact, this unconformity is worldwide and sometimes referred to as the Great Unconformity. Ager (40) refers to this as the basal Cambrian quartzite and recognizes this as a worldwide contact. It seems reasonable this worldwide basal conglomerate, which represents the beginning of fossilized remains, marks the beginning of the Flood. The author would like to tentatively suggest the unconformity between the basin floor and the New Haven correlates to the world wide basal unconformity.

It is assumed that a great catastrophe such as the Flood would produce deposits which show evidence of rapid erosion and deposition. As previously discussed, there is solid evidence for this in the Hartford basin. After initial erosion and deposition of the basal conglomerate and New Haven Arkose, a fissure developed which allowed the basalt flows of the Talcott to form. The Talcott was deposited in rising Flood waters or on water saturated sediments. The formation of the rift not only allowed basalt flows, but also an influx of sediments to fill the basin. The sediments found in the basin can be traced to surrounding igneous and metamorphic rocks around the basin. Basalt flows are not exclusive to the Hartford basin, but can be found in some of the other basins along the east coast.

As Flood waters rose, dinosaurs left tracks in the newly laid mud while trying to escape to higher ground. Fish and large amounts of plant material were quickly buried to form large organic deposits (coal in some Newark basins), later turning into black shales. Today there is little evidence of marine sediments covering the Hartford basin. However they do cover some other Newark basins along the east coast. Presumably, they also covered the Hartford. These sediments probably eroded away after the Flood due to the action of receding waters, glaciers, and melt wash streams.

CONCLUSION

There are many evidences within the Hartford basin which suggest that it was not deposited in a conventional manner, but catastrophically. When considering depositional models for the basin, its black shales, fossils (especially fish), basalts, and sediments cannot be overlooked. These features point towards catastrophic deposition. Currently, there is no known evidence to suggest the basin has taken millions of years to deposit as those with uniformitarian biases would like to believe. Even radiometric dating techniques have proven unsuccessful in distinguishing the ages between basalt flows in the basin. In considering a possible model for deposition, the catastrophic Flood model agrees with the evidence better than the conventional uniformitarian view does.

This study has bearing on other Newark basins which are found along the east coast of the United States. All of the basins are strikingly similar in structure and sedimentology to each other (41). Even the northwestern Triassic sediments of Europe are similar to the Newark (42). Because of the similarities to the Hartford basin, conclusions reached here may also be applicable to these other areas.

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DISCUSSION

Let me commend Mr. Whitmore on a fine paper. However, there are a few comments or questions I would like to raise.

Under the section "Problems with dating the basin," I was unconvinced by the author's proposed logical flaw, and his citing of Dr. Austin's and my paper. It would be better to attempt to demonstrate that each layer was most likely laid down rapidly, and that there is no evidence of long time passage between the layers. If so, the likelihood of a short time is established.

Regarding black shales, Mr. Whitmore says there are many intact fish fossils. Earlier he had claimed a very few fish had been found. Which is correct? Did he make a study of the fish, bioturbation, etc., and find evidence supporting rapid deposition and short time? It is not enough to list the various mechanisms for rapid deposition of shale, what does *this* shale indicate? If the study has not yet been made, what suggestions can the author offer?

Mr. Whitmore made a good point regarding "swimming dinosaur prints." This was no mud flat. Also, the intermingling of basalts with soft, recently deposited sediments is a good point, rightly arguing for a rapid sequence of events.

Mr. Whitmore mentioned "conglomerate lenses throughout the rocks of the basin, but described them only along the basal unconformity. Are there others, and if so what is their character? Good Job!

John D. Morris, Ph.D.
Santee, California

Mr. Whitmore excels as a field geologist, and this paper show his work well. While others may be content in sitting in their arm chair and citing the literature, the author is at the outcrop examining the strata. His empirical approach to stratigraphy should be an example for both uniformitarian and catastrophist geologists. The evidences for catastrophic depositional processes in Hartford Basin are obvious in black shales, fish fossils, dinosaur tracks, bioturbation, basalt flows and arkosic sandstones. Catastrophism is alive and well in Connecticut Valley!

Mr. Whitmore's paper does not mention very significant observations made concerning shrinkage cracks in shaley sediments of Hartford Basin. Although shrinkages are usually supposed to form by drying in a subaerial environment, field studies in the Hartford Basin indicate that these have formed after burial in a substratal environment. This could be the subject for a future paper.

Steve Austin, Ph.D.
Santee, California

CLOSURE

I would like to thank Dr. Morris for taking the time to review my paper and offering his favorable comments.

It would be tremendous if large folded outcrops of sedimentary rock could be found in Connecticut. There are a few large outcrops (for example, interstate road cuts east of Hartford), but these contain relatively horizontal strata. The point I was trying to make was if there were folds, this might be an additional argument for short time spans as Dr. Morris argued in California and Colorado (5).

I did not claim very few fish fossils had been found. Possibly Dr. Morris is referring to the section when I was discussing modern lake sediments. In modern lake sediments, fish remains are very rare (16). I have not made in depth studies on black shales and their mechanism for deposition. A good study would be to examine modern black shale environments and bioturbation within them. A comparison then could be made to fossil shales with inferences to how or how not they were deposited. I believe black shales have much to offer creationists and catastrophists. Some of the arguments I have used in Connecticut would be good starting points.

Yes, there are many areas conglomerate lenses are found throughout the basin besides the basal unconformity. Notably, they also occur along the eastern margin of the basin, clasts being angular and occasionally exceeding a meter in diameter. Smaller areas of subangular to subrounded conglomerates can be found as lenses throughout the central and western part of the basin.

I would like to thank Dr. Austin, for the time spent with me in the field and the classroom. I appreciate his kind comments.

Unfortunately, the length of this paper was too short to include my studies of shrinkage cracks in Connecticut. Because of their natural likeness to mudcracks, they have been interpreted as such by many authors. I have only begun to look into this subject, but initial studies show, at least at one location, cracks were formed substratally after deposition. See my thesis (2) pages 63-71 for more information. More than likely this will be a forthcoming paper.

John Whitmore, M.S.