statistical calculations may not be enough in coming years to deal effectively with evolutionist arguments. Many evolutionists and others turn to General System Theory to show that there are many paths that a system, living or non-living, may take to reach a particular outcome. Biologist L. von Bertalanffy[9] calls this process "equifinality". Even when controlling for a few of the many posible variables, the number of paths a system may take gets quite large through a multiplicative process not unlike that used in calculating probabilities. I hope that the readers of this journal will pick up where this admittedly brief discussion leaves off so that together we may further Creation research.

The ultimate resolution of this situation through Creation research will add to our partial understanding of what day by day becomes more incomprehensible to human beings. I can offer no special insights here. Rather, I present the details of a common argument to the readers in order to encourage the combination of elaborate calculation of statistics with more complete interpretation.

In closing, it is tempting to repeat an often quoted and more often misunderstood observation made by Albert Einstein concerning his struggle with chance versus order.

"God does not play dice with the world."[10]

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PROLEGOMENA TO THE STUDY OF THE SEDIMENTS

Robert Morton*

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An analysis of the distribution of the sediments seems to indicate that the earth at the time of the flood was considerably smaller. Assuming that the flood occurred on an earth of the present radius, the sediment distribution can not be explained and appears to violate the second law of thermodynamics.

This paper intends to raise an issue about the distribution of the sediments which form sedimentary rocks which at first glance is rather disturbing to the creationist position. An analysis of the distribution of the sediments reveals that a world-wide flood, at least as it is presently envisioned, would not be able to account for that distribution. In order to properly introduce this problem we must first examine how the sediments were formed, where the source of the sediments was, and in what manner the depositional mechanism operated. Following the philosophical analysis, a mathematical analysis of the distribution of the sediments will be presented.

Basically there seem to be two methods which could account for the depositing of the huge layers of sedimentary material observed on the earth. Uniform forces acting over millions of years would seem to account for the sediments (but not the fossils) every bit as effectively as non-uniform forces acting over a short time span. Therefore the first question to be answered is this one: fast or slow sedimentation?

This author does not intend to repeat the massive evidence collected from the fossils which indicate that the sediments were the result of non-uniform forces acting over a short time since most readers will already be familiar with it. However, even if the above conclusion is true it does not necessarily follow that the sediments were deposited during Noah's flood. Obviously either the majority of the sediments were deposited by Noah's flood or they were deposited by some other mechanism. There appear to be only three choices: a previous flood, Noah's flood or uniformitarian processes. Belief in a merely local Noah's flood forces one to accept one of the other two ideas to explain the sediments. To believe that the sediments were the result of a previous deluge for which there is only the shakiest Biblical evidence seems to be a repeat of Cuvier's theory. To accept the uniformitarian formation of the sediments clearly raises the fundamental question, "Why should we believe in a worldwide flood which left no evidence of itself?" For if the sediments were formed by uniformitarian methods then there is no geological evidence for the flood and we should all accept uniformitarianism. Therefore, it must be concluded that the sediments with their fossils were deposited by Noah's flood. At least this must be concluded if we are to be logically consistent.

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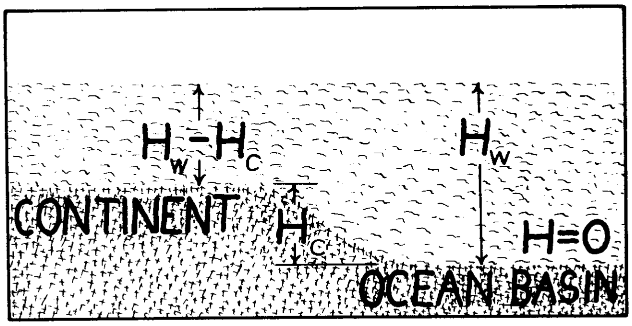

Figure 1. Structure of the continents. The meanings of the symbols are explained in the text.

The Source of the Sediments

Figure 1 shows an idealized view of the continents and the ocean basins. With this structure there are only two possible sources for the sediments which were deposited during the flood: the top of the continental platform and the ocean bottom. Primeval material had to be eroded from either the platform, the ocean bottom or from both and redeposited elsewhere as the sedimentary rocks.

As we will see, the greatest thicknesses of sediment presently reside on top of the continental platform. The source of the sediment on top of the platform could not be solely from the ocean basin for basically two reasons. First and foremost, the initial state of any natural process always contains more useful energy than the final state. This is the second law of thermodynamics in action. Consider a tank of water in which the bottom of the tank varies in depth. (See Fig. 2) No matter how the water is stirred up there is just no way for all of the sediment on the bottom to be deposited on top of the elevated portion of the tank bottom. When very little energy is expended stirring up the water, very little of the sediment on the tank bottom will be deposited on the upper level. As more energy is input to this system, more will be deposited there—up to a point. When a certain amount of energy is input in stirring up the sediment, the sediment will be uniformly mixed in the water. As we shall see later under these conditions the maximum sediment thickness on the upraised portion of the tank will always be less than the thickness on the bottom of the tank. In fact, this condition will represent the maximum amount of energy which can be saved out of the energy which was input to the system to stir up the water. Inputting more energy into stirring up the water will not result in storing any more of the input energy.

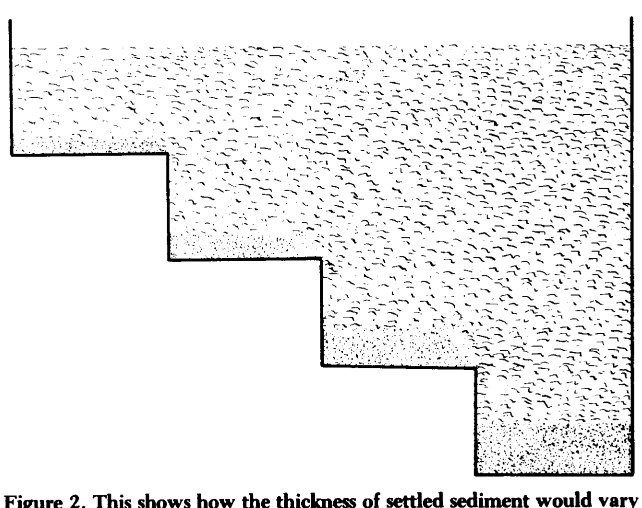

Figure 2. This shows how the thickness of settled sediment would vary with depth in a water-filled tank, in the experiment discussed in the text.

Secondly, the erosion due to water can only occur down to the base of the waves. Sedimentation occurs below this level. In order for the ocean bottom to be the source of the sediments, the base of the waves must be at the ocean bottom. If this were the case then the top of the platform would also be subject to erosion and thus the source of the sediments could not be *solely* from the ocean basins; it would be from both. In fact, under these conditions the top of the platform would be subjected to more severe erosion than the ocean bottom.

When the effects of gravity are included it is realized that the source of the net sediments on top of the platform cannot be both from the top of the platform and the ocean bottom. It is easier for a particle to drift from the higher level to the lower than for the reverse to occur. Because of this it is to be expected that more of the sediment from the top of the platform will end up on the ocean bottom than the sediment which started on the ocean bottom and ended up on top. Thus the net effect is that the primary source of the sediments on top of the platforms *must* be from the top.

If the top of the platform was the source of the sediments then obviously for any given area the basement had to be eroded to its final depth before any permanent deposition could occur. Thus the sediments had to be eroded and temporarily stored somewhere else before permanent deposition commenced.

There are only three possible places that the sediments could be stored: on the ocean bottom, the top of the platform, or in the water itself. If the sediments were stored temporarily on the ocean floor, then there would be no way to pick up the sediments and retransport them to the platform top for the same reason outlined earlier. Thus either the sediments were stored on top of the platforms or in the water at or above the level of the platform.

Figure 3 shows the gross relationship of the Cambrian deposits as they were laid down.[1] Very little of the continent remains exposed for erosion, and even that small area was permanently covered by the Pennsylvanian, halfway through the geologic column. By the time these sediments were laid down the vast majority of erosion on the platform had ceased. Bearing this fact in mind, one realizes that the sediments could not have been temporarily deposited all over the platform or no permanent sedimentation could have occurred. It is also unlikely that the sediments could have been piled up on one place on the platforms. A mound of unconsolidated sedimentary material would easily be attacked by the waves and could not exist long. Furthermore it is inconceivable how water action could produce such a feature in the first place. The erosive action of water tends to level higher points of elevation, not build them.

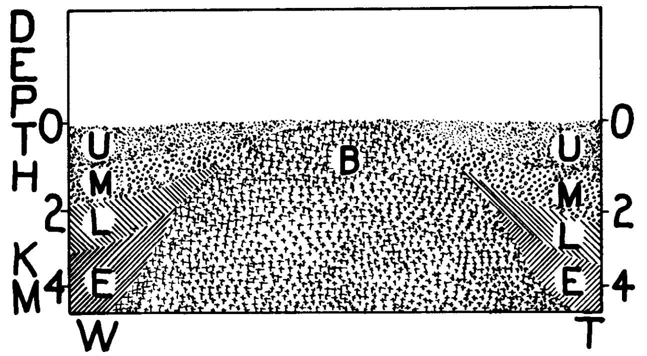

Figure 3. A cross-section showing the relationship of the Cambrian deposits to the continental basement at the time of deposition. (After Dott and Batten, Reference 1.) The meaning of the letters is as follows: W: Washington State; T: Tennessee; U: Upper Cambrian; M: Middle Cambrian; L: Lower Cambrian; E: Eocambrian; B: continental basement.

Even sedimentation, temporary or permanent, also fills up the lower elevations more quickly than the higher ones, producing a level surface, not one with a huge mound of temporary deposits. Neither is it possible for the sediments to have been washed from place to place solely on top of the platform. Since it takes longer for the clay particles to come out of suspension than the sand, most likely the clay would not be deposited until the current carrying it was over the ocean basin. Thus we would expect to find more sand on the platforms and more shale on the ocean bottom. Therefore the sediments must have been temporarily stored in suspension. This is especially true of all sediments deposited after Pennsylvanian time.

Thus there had to be sufficient water to support the sediment load in suspension as well as enough turbidity.

Thus we have reached five conclusions. First the sediments are the result of Noah's flood. Secondly, the sediment's source was the top of the platform. Third, the continents were eroded to their permanent basement depths before permanent deposition occurred. Fourth, the sediments were stored in suspension in the water. Finally, there was enough water in the flood to accomplish this.

It is realized that many will not relish the idea that the majority of the sediments were in suspension at one time before permanent deposition occurred. However there is one important fact which must be considered. There is a tremendous lack of clay in Cambrian deposits. Dott and Batten remark of the Cambrian deposits,

> "Upper Cambrian sandstones, the dominant cratonic sediment, rank among the most mature in the world. They are unrivaled for perfection of rounding and sorting of grains, and contain 90 to 99 per cent quartz . . . "[2]

The problem is that the source rocks for these huge deposits contain less than 40 per cent quartz. They further state,

> "Where is all of the clay that must have formed by decay of the immense volumes of igneous and metamorphic rocks indicated by the pure quartz sand concentrate? Possible ultimate source rocks contain less than 40 per cent quartz, whereas most of the remaining minerals tend to weather to clays. Certainly there is too little shale found in Cambrian deposits of the craton to correspond with the phenomenal amount of quartz."[3]

Assuming that the Cambrian deposits are the earliest deposits of the deluge, the lack of clay is not surprising at all. As the Flood waters began to still, there would be a time when the turbulence would keep the clay particles suspended while allowing the sand to be deposited. However for a uniformitarianist this lack of clay presents a nearly insoluble problem. The worldwide turbulence must have been maintained at this precise level for millions of years if the problem is to be explained. Obviously the flood model is better at this point.

The Problem of Distribution

There is a problem in the distribution of the sediments which has generally been overlooked by creationists. That is that there is too much sediment on top of the continental platforms. Poldervaart has estimated the sedimentary thicknesses over several geologic regions of the earth's surface.[4] He divided the earth into four regions: the deep-sea region, the suboceanic region, the continental shield region and the young folded belt region. Table 1 gives Poldervaart's estimates for the thickness of the sediments, the average elevation of the surface and the area each of these regions covers. Table 1 also shows what would be the average basement for each region.

As noted earlier, since many would not like the idea of all of the sediments being stirred up in the flood waters at one time, the following analysis of the sediment distribution will not make that assumption. We will assume that only a small per cent of the total sediments seen on the earth were stirred up at any given time. Mathematically these two views led to the same conclusion.

Consider a small amount of sediment stirrd up in the flood waters. The average sediment load density will be simply this amount of mass divided by the volume of the ocean. The volume of the sediments themselves may be considered small compared to the oceanic volume. In mathematical terms $\varrho_w = m_i/V$ where m_i is the increment of mass of the sediments and V is the volume of the oceans.

Table 1. Physical Data for the Four Geologic Regions (meters)

Region	*Thickness of Sediment*	*Average Surface Elevation*	*Average Basement Elevation*	*Area*
Deep Sea	300	−4500	−4800	268×10^{12}
Sub-oceanic	4000	−1750	−5750	93×10^{12}
Continental Shield	500	750	250	105×10^{12}
Young Folded Belt	3000	1250	−3750	42×10^{12}

Table 2. Potential Energy of Sediments Datum − 4800 m (i.e., below sea level.)

Region	*Elev. of Base*	*Elev. of Surface*	*Density*	*Potential Energy (Joules)*
Deep Sea	0	300	2.7	3.19×10^{23}
Suboceanic	−950	3050	2.7	1.033×10^{25}
Continental Shield	5050	5550	2.7	7.36×10^{24}
Young Folded Belt	1050	6050	1.62	1.18×10^{25}
	Total			2.985×10^{25}

Table 3. Potential Energy of Sediments From a Flood of Infinite Depth.

Region	*Potential Energy (Joules)*
Deep Sea	5.42×10^{24}
Suboceanic	-1.01×10^{24}
Continental Shelf	1.948×10^{25}
Young Folded Belt	2.86×10^{24}
Total	2.675×10^{25}

The amount of sediment suspended in the water above any given point is $SL_i = m_i(H_w - H_c)/V$, where H_w is the height of the flood, and H_c is the height of the platform.

Dividing SL_i by the average density of the deposited sediments (ϱ_s) we have the average thickness of the sediment deposited by the small increment of mass stirred up at any given time: $\Theta_i = m_i(H_w - H_c)/V\varrho_s$. Summing on i yields the average total thickness of the sediments after all increments have been stirred up. It is the same as if all of the sediments were stirred up at one time. Therefore, $\Theta = m(H_w - H_c)/V\varrho_s$ where ϱ_s is the density of the solid sediment. This will be assumed to be 2.7 gm/cc.

Using the basement of the deepsea region as the zero potential energy line (all elevations will henceforth be measured from this level), we find that the potential energy of an element of mass is $dU = dm\ gh$ where dm is the element of mass, g is the acceleration due to gravity, and h is the height above the datum (the deep-sea basement).

Now, since $dm = \varrho_s dh\ A$ where A is the area, then $dU = \varrho_s Agh\ dh$. Integrating gives $U = \frac{1}{2}\ \varrho_s Agh^2$.

Table 2 shows the potential energy of sediments as they exist on the earth. The total potential energy for all of the sediments is also given in Table 2.

The sediment thicknesses cited in Tables 1 and 2 are the solid sediment thicknesses. This means that the sediments will be treated as if there were no porosity. It will be noticed that the density of the sediments in the young folded region is less than that of the others. The reason for this is that it is estimated that about 40% of their thickness is made up of volcanics. Since we are only interested in the sedimentary thickness and not in the volcanics, the total thickness of 5 km in these regions must be reduced by 40% to 3 km. However, this lesser thickness of sediment is spread out over the 5 km distance. Therefore, the effective density of the sediments in this region is also reduced by 40%.

Table 3 gives the expected distribution (thickness and potential energy) of sediments for a flood of an infinite depth. In a flood of an infinite depth, the structures of the earth would have no effect on the sediment thickness. It would be the same everywhere. One can see that even in this situation the potential energy predicted is considerably smaller than what is actualy observed. This indicates that the flood, at least on the earth of the present radius could not possibly account for the distribution of the sediments.

Table 4 shows the potential energy and thicknesses of the sediments for floods of various depths (measured from the oceanic basement). Current sea level would be 4800 m in this system of elevations. Thus a flood in which the depth of the water was 5500 m actually covered all elevations below 700 m above sea level. Thus, the flood in table 4 with a listed depth of 15,000 m would be deep enough to have covered the current elevation of Mount Everest (29,000 feet) by nearly 1400 m.

As can be seen, none of these cases can explain the current distribution of the sediments. Figure 4 shows graphically how the potential energy of the sediments

Table 4. Potential Energy and Sediment Thicknesses for Floods of Various Depths.

	Depth of the Flood (meters)								
Region	*5500*	*6000*	*7000*	*8000*	*9000*	*10000*	*15000*	*20000*	
Deep Sea	1503	1477	1438	1410	1389	1373	1326	1304	Thickness
Suboceanic	1736	1711	1633	1578	1536	1503	1410	1366	Thickness
Continental Shelf	123	233	400	520	609	679	880	974	Thickness
Young Folded Belt	2027	2031	2037	2042	2045	2048	2056	2059	Thickness
Total Potential Energy of Sediments $\times 10^{25}$	1.22	1.34	1.54	1.69	1.80	1.89	2.16	2.29	Joules

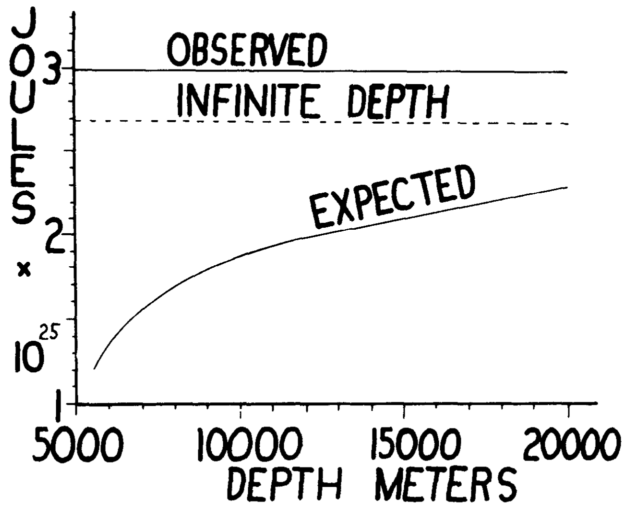

Figure 4. Potential energy of the Flood sediments vs. depth of the Flood.

varies with the depth of the flood waters. It can be seen that the curve becomes asymptotic to the value for a flood of an infinite depth. Since the actual value of the potential energy is higher than the infinite-depth value, it must be concluded that the flood on an earth of the present radius can not account for the sediment distribution.

We are therefore presented with a dilemma. We are fond of accusing evolutionists of violating the second law while we ourselves seem to violate it with a flood. We chide the uniformitarianist position because they can not explain why more sedimentary material is not in the ocean basin, assuming that the earth is as old as they say, while we can not explain it either![5] If there were a flood, there should be more sediments on the ocean basin. This situation must be resolved if the idea of a world wide-flood is to retain any credibility in terms of science as well as faith.

One explanation which has been suggested to the author is that somehow during the flood the continental platforms were lower than the ocean basins. Even though the sediment distribution could be explained in this manner, it should be rejected. Since the sialic continental platforms are floating in the underlying sima one would need to explain how the continents were pushed down against the natural forces of bouyancy. In order for this to have occurred, some rather uniform force must have been operative, pushing *only* the continents down. Thinking of a cause for this force is very difficult. The problems associated with sinking the continents are similar to those of submerging a balloon in a swimming pool. It is very difficult.

The sediment distribution becomes explainable if one assumes that the earth at the time of the flood were considerably smaller. Creer[6] showed that if the earth were shrunk to approximately 55% of its present radius the continental platforms would fit together very nicely. This would imply that the deep-ocean region was formed after the continental platforms. If the ocean basins were formed by an expansion of the earth both during and immediately after the flood, and if the sediments

Table 5. Physical Data for Sub-Oceanic Subregions

Region	*Surface Area*	*Average Thickness*
Shelf Region	30×10^6 KM	4 KM
Hemipelagic Region	63×10^6 KM	4 KM

currently residing on the ocean bottoms are assumed to have come from the other three regions by stripping off a layer of sediment from each of them, then the sediment distribution can be explained.

In shrinking the earth, one must consider which regions will be left. Obviously the deep sea region would be eliminated. Part of the sub-oceanic region would also be eliminated. Poldervaart divides the suboceanic region into two subregions: the shelf region and the hemipelagic regin. With the shrinking of the earth, the hemipelagic region would also be eliminated. Table 5 gives the pertinent data concerning these two subregions.

It can easily be verified that the total surface area which is left after the shrinking is that equal to a sphere with a radius of 58% of the present radius. This is very close to Creer's radius.

Table 6 shows the comparison between Poldervaart's estimates and values calculated assuming that H_w is 6000 m and that the basement in the shelf subregion is 500 m. It can be seen that there is fair agreement. The discrepancies can most likely be explained by the inappropriateness of the assumption that no erosion took place during the draining of the flood waters.

Thus it can be concluded that the sediment distribution can be better explained if the flood occurred when the earth's radius was smaller.

Postscript

Allusion was made to the problem of trying to explain the sediments by just pushing them around from place to place on top of the continental platforms. There is another point. An oceanic current approaching a continent would have to speed up while passing over the continent. The reason for this is that the depth of the waters over the continent is shallower than the oceanic depth and therefore the depth of current would be constricted. According to Resnick and Halliday,[7] "The equation of continuity requires that the speed of the fluid at a con-

Table 6. Sediment Thickness Predicted for a Flood on a Smaller Earth.

Region	*Thickness on Smaller Earth*	*Poldervaart's Estimate*
Suboceanic (shelf only)	3475 M	4000 M
Continental Shield	599 M	500 M
Young Folded Belt	3126 M	3000 M

striction increase . . . " This physical constraint is the basis for the old cliche "Still waters run deep."

It is a known fact in sedimentology that the faster a body of water is moving, the more sediment load it can carry. Verhoogen et al.[8] show a chart which gives a depositional velocity for silt and clay of .4 cm/sec. This is how slow the current must be moving before these tiny particles (.05 mm[9]) will be deposited. Due to the shallowness of waters over the continents and the deepness in the ocean, the depositional velocity for silt and clay will be reached over the ocean far sooner than it will on top of the platforms. What this implies is that the silt and clay will be preferentially deposited in the ocean basins. We don't see this in the sediments as we have observed them. Thus, if the flood occurred on an earth of the present radius, why is there so much shale on the platforms?

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THOUGHTS ON THE STRUCTURE OF THE ARK

P.H. Van Der Werff*

Received 20 May, 1980

Several authors have written on the all-over plan of the Ark, as it is recorded in Genesis.[1-3] They have shown that the Ark was an exceedingly stable vessel, and the shape in accord with good shipbuilding practice. Such findings can strengthen one's belief in the account. For were it fiction, the design given would likely have been wildly impracticable and unseaworthy.

Authors writing on the subject have shown also that the capacity of the Ark was sufficient for the job which it had to do.

Most of these authors seem, however, not to have considered much the finer details of construction. It may be that my background has made me wonder more about such matters. I come from a Dutch family of shipbuilders, and, when young, have seen wooden ships built. While most authors seem to envisage the Ark as just a very large wooden ship, I can see difficulties which would arise. The bending, which, it seems to me, would be inevitable in so long a ship would, I believe, have caused the joints at the ends of planks to open, no matter how well they were protected with pitch.

It occurs to me, then, that it may be that Noah used a completely different construction. What that might have been has been shown to us by Heyerdahl. For he built a raft of balsa logs, and sailed it across the Pacific.[4] In so doing, as he himself reported, he was following the ancient people of the Pacific coast of South America, who built such rafts and made long ocean voyages on them.[5]

*While this item was being edited we received word of Mr. van der Werff's death, at age 82.

The gopher wood, which Noah was told to use, seems to be mentioned nowhere else. I suggest that it may have been balsa, or something similar.

One can visualize, then, how the Ark might have been built with the huge logs which were no doubt available in antediluvian times. There could have been, say, 25 balsa logs side by side to give the width. Ten such groups of logs, one behind the other, could have formed the length. The logs could all have been lashed together with rope. Four such layers of logs, one above the other, would have given the required buoyancy.

This colossal balsa raft, then, was the lower layer: the foundation for the two upper stories. The first floor would be well above the water line. On this floor was the superstructure. Heyerdahl used wickerwork of split bamboo for this purpose, when he built his raft. Ten cubits, about five metres, higher came the second floor. In this way the three sections were built.

The lowest section, the raft proper, would have been mostly under water and inaccessible, once the Ark was afloat. The logs would have been pitched on all sides against the pole-worm, which ruins wood which is under water.

The top of the Ark, I suggest, was a slanted roof with an overhang, against the torrential rain. The door was in the second section, well above the water line.

Heyerdahl's raft was ten by nine metres, about twenty by eighteen cubits. It was built in a few weeks, with one layer of logs. His expedition took three months. Noah's expedition, on the much larger Ark, took only about twice as long—six months—in actual sailing time. But, of course, the passenger list was much greater.