THORNTON QUARRY DEPOSITS: A FOSSIL CORAL REEF OR A CATASTROPHIC FLOOD DEPOSIT? A PRELIMINARY STUDY

David B. D'Armond*

Received 14 February, 1980

Thornton Quarry, the world's largest working commercial limestone quarry, is made up of massive deposits of fossil-bearing, dolomitized limestone. Because of the high concentration of fossil corals, brachiopods, crinoids and other shallow marine organisms, it has long been viewed as an ancient coral reef of Silurian age (approximately 410 million years) and is often compared to modern reefs for similarity. However, in a brief review of evolutionist literature, it readily can be discerned that these deposits are **not** *comparable to modern reefs and that the standard uniformitarian view is both misleading and imaginary.*

The actual facts instead readily submit themsielves to a flood -geology intrpretation, making the Thornton deposits of probable mid-Flood origin, influenced by tidal effects during the Flood. It is suggested that these tidal effects have been greatly underestimated by many creationists, but when coupled with tsunami effects, these become powerful agents for massive erosion, deposition and cyclical deposits. Deposits underlying Thornton probably reflect such activity. A Catastrophic Wave-Action Model of deposition is proposed.

Introduction

Over the past several years the Midwest Center of the Institute for Creation Research has conducted fossil-hunting field trips for creation enthusiasts from Chicago and vicinity among the richly fossiliferous limestone deposits of Thornton Quarry. Because each tour was accompanied by an evolution-oriented presentation by the company geologist, it became desirable to research and develop a scientifically sound creationist alternative. This writer conducted a limited literature search on the Thornton deposits; and while this search was not exhaustive, it revealed a number of surprising facts that clearly confirm the error of the standard evolutionary "fossil-reef" view. This report is identified as a preliminary study not only because the literature search was limited, but also since very few field investigations were involved. It is hoped that this report will encourage other researchers into more complete studies, both in the field and in the pertinent literature. It is further hoped that this preliminary study may provide useful guidelines for future investigations.

Geographically, Thornton Quarry is located in the extreme south of the Chicago metropolitan area, in the city limits of Thornton (see Fig. 1), immediately east and south of the intersection of Illinois Highway 1 in Harvey and Interstate 294 (Tri-State Tollway). This quarry, the world's largest working commercial limestone quarry, is operated by Material Services Corporation, a division of General Dynamics Corporation. This facility mines, crushes and processes more than seven million tons of limestone each year (or nearly 22,000 tons per day) and produces approximately 60 different marketable products. Material Services Corporation maintains an open policy toward the public for the purpose of tours and fossil collecting (see Fig. 2). Such tours stress proper personal and group safety procedures. Rock hounds and fossil-hunting groups are accompanied by a company representative into freshly blasted areas that are a collector's paradise. Each person is allowed to take home as many specimens as he or she can carry.

Geological Setting

The Thornton limestone deposits form a body nearly circular in shape and over two square miles in area.[1] Vertically, the commercial-grade stone extends from just below the surface of the ground to a depth of 400 feet.[2] The body consists of highly fossiliferous limestone that has been dolomitized, thus exhibiting some recrystallization. Dated by its fossil content, the deposit is identified by standard evolutionary means as an ancient coral reef of Silurian age, approximately 410 million years old. The surrounding Silurian deposits are both of thick-bedded and thin-bedded massive limestone deposits, formed, for the most part, in a shallow marine environment.[3]

The Thornton deposit is one of dozens of such deposits scattered throughout Illinois, Indiana, northwestern Ohio, eastern Michigan, eastern Wisconsin and eastern Iowa. A few other "reef" deposits of the same age occur in small areas of Ontario, New Brunswick and the Districts of Franklin and Keewatin, Canada. All of these deposits are Silurian in age and are further sub-classified as "Niagaran" age within the Silurian time period (the name being derived from outcrops at Niagara Falls). These "reefs" are further described as forming an evolving (in Niagaran time), wedge-shaped, coral reef archipelago positioned offshore from an ancient shoreline.[4] (See Fig. 3.)

In the Chicago area, the overlying strata is Pleistocene in age, principally glacial deposits directly over the Silurian limestones. The underlying strata, as shown in well-drilling logs (Fig. 17), consists of up to 2500 feet of massive limestone, sandstone and shale deposits of Cambrian and Ordovician age, which in turn overlie a basement of Precambrian granite.[5] The importance of these deposits to a creationist view cannot be overemphasized and will be discussed later.

The main point of interest in the descriptions of the Thornton deposits is that they are likened to modern

*Mr. D'Armond is a co-founder and former Vice-President of the Institute for Creation Research–Midwest Center; holds a BS in Geology; was a former evolutionist; taught evolutionary historical geology at junior high level; was a former field exploration geologist for the U.S. Geological Survey; currently employed by Imperial Oil & Grease Company; holds professional memberships in the Geological Society of America, the American Society of Lubrication Engineers, and the Creation Research Society. His address is 5 S 324 Stewart Drive, Naperville, Illinois 60540.

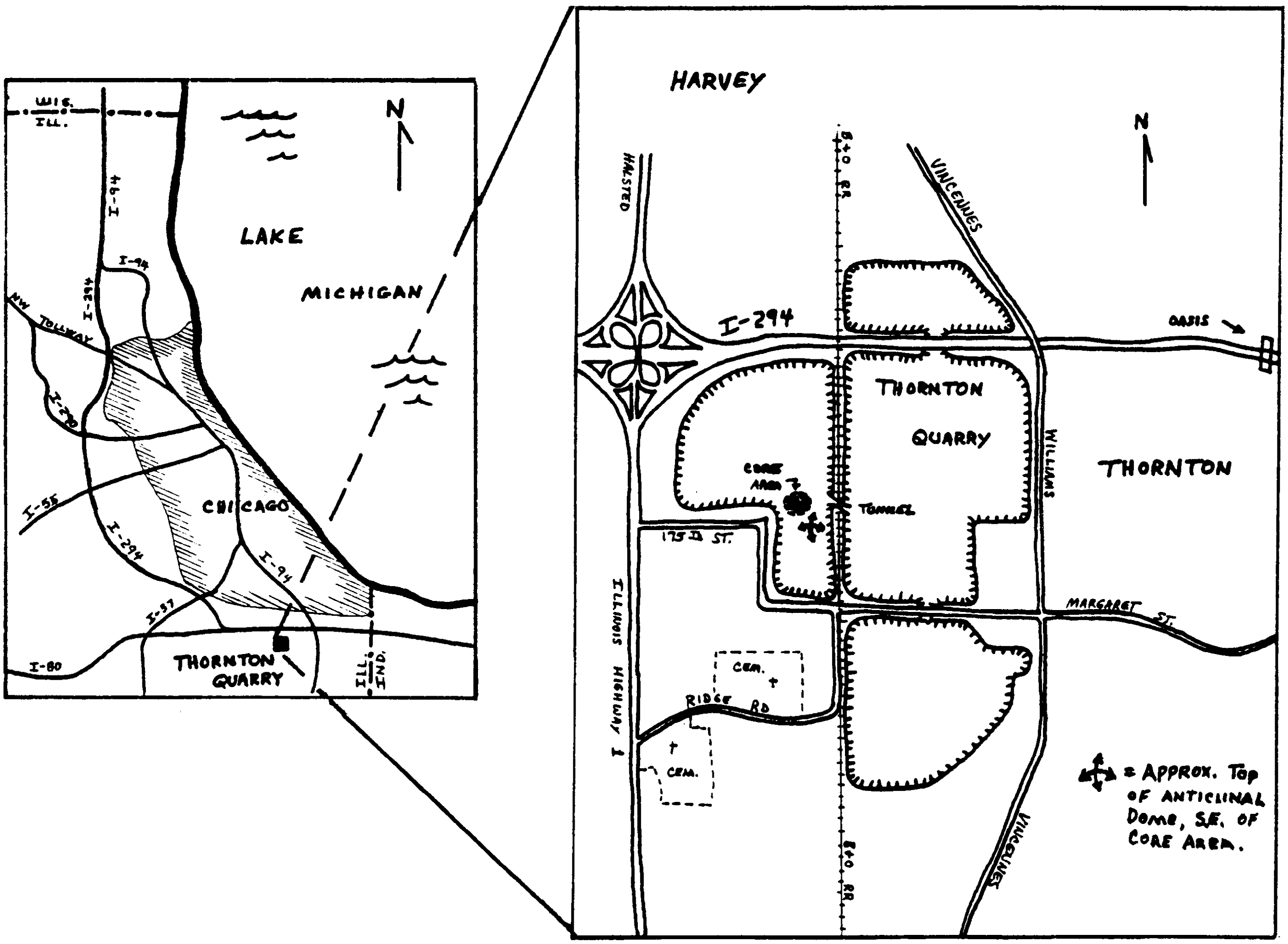

Figure 1. Map view of Thornton Quarry, located south of Chicago. The extent of quarrying operations shown is as of October, 1979.

coral reef formations. A map view of Thornton by one investigator (see Fig. 4) suggests the existence of ecological zonations. (It might be noted at this point that hydrodynamic sorting* could yield a similar fossil distribution.) Since all evolutionary writers consider the Niagaran deposits to be ancient remains of coral reefs, comparable in most ways to modern reefs, we need to review the nature of modern reefs, their growth characteristics and their requirements for formation in order to establish a basis for comparison with the Thornton deposits.

Modern Reef Deposits

Three dominant kinds of coral reefs appear throughout the world: fringing, barrier and atoll.[6] Fringing reefs grow outward from the coastlines of islands, producing shallow waters only a few feet deep extending for several miles out from the island (see Fig. 5). The most active area of coral growth is not on the top of such platforms but on the steep outer edges.

Barrier reefs differ from fringing reefs in that the lagoonal waters are no longer shallow, but may be up to 180 feet in depth, the reefs forming natural barriers to navigation. In both the barrier and atoll reefs, coral and algae grow profusely upward toward the sunlight, surviving only in warm (68° – 93°) and shallow waters. A famous example of a barrier reef is the Great Barrier Reef of Australia, extending over 1200 miles in length.

Atolls are coral reefs that enclose lagoonal waters with no visible evidence of the underlying island. An example of these are the Bikini and Eniwetok Atolls. Charles Darwin in 1837 was the first to propose a theory about possible interrelationships between the types of reefs. He believed that corals started building on hard-rock substrate in shallow areas around undersea mountains whose peaks formed islands. Over long periods of time, he reasoned, the surrounding ocean floor would begin to subside isostatically, coinciding with the accumulation of sheer weight of reef materials from its rapid upward growth. Thus a fringing reef, growing upward as the sea floor subsided, would become a barrier reef and finally a coral atoll, with the underlying island subsiding below sea level, as can be traced in Fig. 5. While Darwin's theory is perhaps the most widely known, modern theory of reef formation combines his theory with those of Sir John Murray (who suggested that extinct underwater volcanoes were the underlying structures) and Professor

*Hydrodynamic sorting is the sorting of particles of similar sizes, shapes, and densities by the force of water, different types or sizes being deposited in relation to different velocities of the water.

Figure 2. One of the ICR-Midwest Center fossil hunts in Thornton Quarry. The company geologist is espousing reef evolution. This photograph is courtesy of Mr. Jim Canon.

Figure 3. Ancient coral reef archipelago, outlined by dashed lines. Niagaran age "reefs" are indicated by dots and black areas. Note the large areas adjacent to Hudson Bay. Modified after Lowenstam, Reference 4.

Reginald Daly (who felt that reef growth and ocean water levels were determined by "glacial control") and others. Darwin's ideas, however, are still regarded as the most significant.

It is important to note the upward and outward growth of the reef (or reef core, as it is often called). A coral animal (polyp) secretes an exoskeleton of limestone (corallite). Inside this skeleton are formed radial partitions called septa. As a' coral polyp grows upward, it continues to expand its secreted exoskeleton upward, closing off its lower chambers by secreting floors over them. As this process continues, more and more empty chambers are closed off as the coral continues its upward growth.[7]

The obvious result of this kind of upward growth in the reef core is the presence of highly organized growth *structures* throughout the depths of the core. This result has been confirmed by core drillings made in coral reef areas such as Eniwetok in the late 1940's which showed an orderly sequence of coral skeletons for over 4,000 feet in depth.[8] Thus the reef core is a highly ordered, growth-oriented, non-bedded structure (see Fig. 6).

In addition to the core itself, bedded deposits of talus develop on both the steep seaward side and on the shallow landward lagoonal side. This debris is wave-eroded material from the reef in the areas where the reef actually reaches the surface of the water. Seaward side deposits are of coarse material and lie at a steeper bedding angle than the finer lagoonal deposits. Nevins has

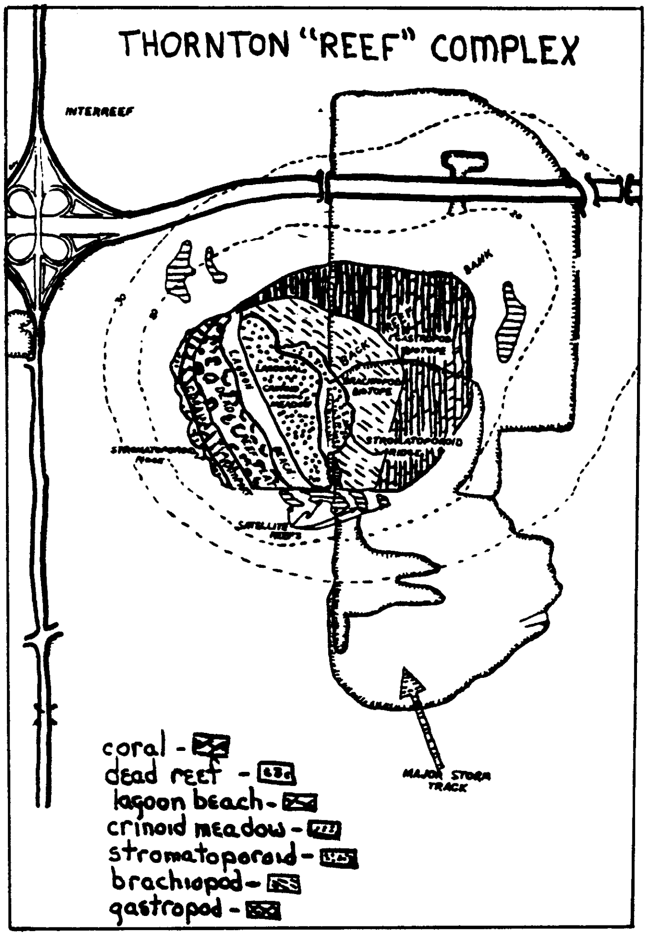

Figure 4. Thornton "reef" complex, modified after Ingels, Reference 1. Statistical sampling suggested this pattern to Ingels. The "reef core" is on the left, represented by the Dead Reef Flat, the Coral Rampart, and by the Stromatoporoid crescent. It forms an elongated crescent.

pointed out that there exists a maximum limit to the angle of dip of these bedding planes which probably may not exceed much over 20° due to the buoyancy of the material in water, thus creating a low angle of repose.[9]

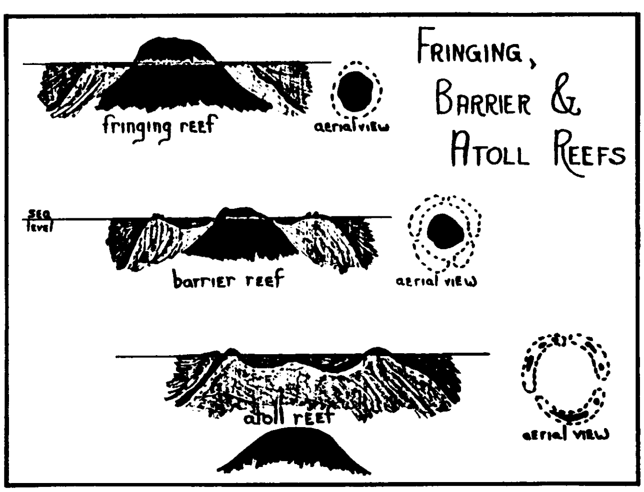

Figure 5. Modern types of coral reef. Drawn after Cowen, Reference 6.

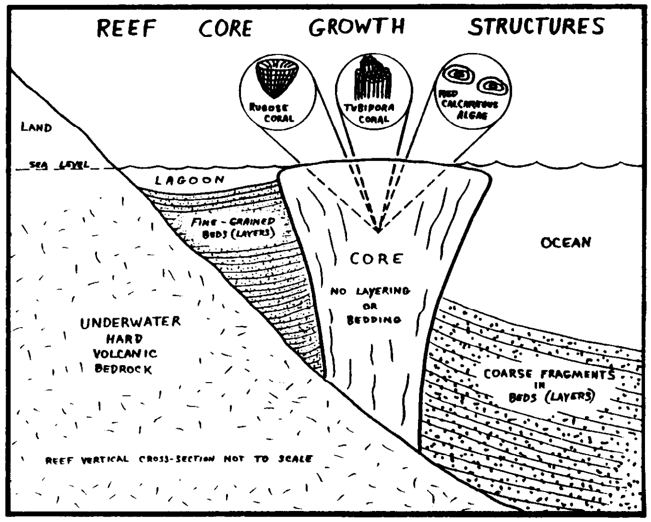

Figure 6. Typical structures found in a reef core. The flanks develop bedded deposits. In many cases the core may be actually V-shaped, as a result of upward and outward growth.

It is also important that corals, by themselves, cannot successfully withstand the continuous pounding action of surf. Only when growing in conjunction with surf-resistant algae (such as red calcareous algae) can a reef continue to grow in the face of continuous erosion. Modern reefs commonly contain between 50 to 80 percent red calcareous algae.[10]

It is also essential that pioneer populations of reefs get started on *hard* bedrock, for without this kind of footing a colony could never develop.[11] One final notable characteristic of modern reefs is that they grow upward and outward primarily along the periphery of the reef.[12] This suggests that the cross-section of a reef should look similar to a molar tooth: a nearly vertical wedge with a narrow root and a broad top.

In summary, a modern reef exhibits the following characteristics:

1) distinct and highly ordered growth structure in the core: no bedding present;
2) shallow dipping, bedded talus slopes on flanks of core;
3) a high percentage of reef-forming algae (50-80%);
4) solid, anchored, hard bedrock as initial foothold and growth points;
5) a V-shaped growth profile of the reef as a whole.

Conflicts in the Thornton "Reef" Deposits

It is now possible for us to compare directly, point by point, the characteristics of the Thornton deposits with those of modern reefs as described above.

1. REEF CORE STRUCTURE. Ingels, in his study of Thornton, points out that the non-bedded core area is "characterized by massive, structureless to highly coralliferous, finely crystalline dolomite . . ."[13] It is notable that no growth structures are mentioned in the core area. Others have commented that the core growth structures have been destroyed by the recrystallization of the limestone into dolomite, and Ingels shows a

similar line of thought when he tries to explain the absence of algae fossils in the core:

> "Inability to recognize algae, because of dolomitization, allows their role in the reef development to go undiscovered."[14]

He thus assigns to stromatoporoids the role of binding agents commonly associated with reef-forming algae. (For a discussion of the problems of stromatoporoids as reef-formers, see Nevins.[9]) It is interesting to note that some algae fossils are found in Thornton, though infrequently, and that details are well preserved. In further contradiction, Ingels himself makes the observation:

> "However, examination of the dolomitized fossils shows that in many cases the preservation of morphologic detail is excellent . . . "[15]

It becomes apparent, then, that even with excellent morphological detail preserved in the dolomitized rock, the "structureless" core area means that no growth structures are found in the core. It is therefore probably not a "core" at all.

2. TALUS SLOPE ANGLE OF DIP. Flank deposits have been reported by Ingels as variable between 34 to 45 degrees. In some places, bedding planes show dips as great as 50 degrees. It can be readily seen that these dips are very steep and beyond the normal angle of repose in a marine environment. Figure 7 is a photograph looking to the west, of the wall supporting the B&O Railroad tracks that run north-south through the center of the quarry (see Fig. 1). The black lines on the photograph trace bedding planes. Figure 7.1 gives a more extensive view of the same wail, showing more clearly the dips of the strata on each side of the top of the dome, or "core" area. The "core" lies just west of the tunnel. (Tunnel height is approximately 105 feet while the height of the wall is about 150 feet.)

A more serious problem arises from the fact that the size of the "core" is far smaller than Ingels predicted. Part of the "core" or top of the dome has been mined away leaving a remarkable east-west cross-sectional view of the actual rock structures (see Fig. 7.2) near the center of the "core." Combining the north-south cross-section in Fig. 7.1 with the east-west cross-section shown in the photograph of Fig. 7.2, it is obvious that the so-called "core" is indeed very small, especially

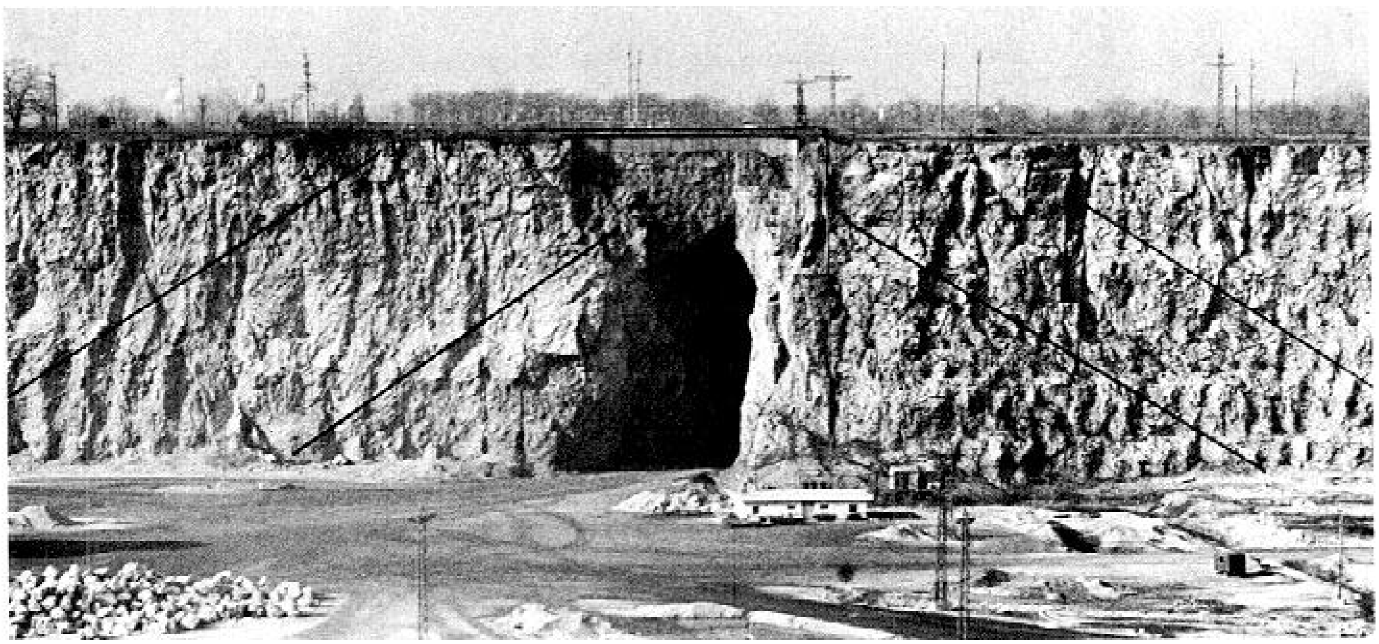

Figure 7. Photograph showing the opposing steep dips on each side of the crest of the anticline, which the location of the tunnel approximates. Drill and blast marks, along with weathering, have obscured the bedding planes in the photograph to the point that they are not very visible, but at close range they can be seen clearly. This anticline is actually a dome, bedded deposits dipping away from the crest in all directions. Photograph courtesy of Mr. Carl Mueller.

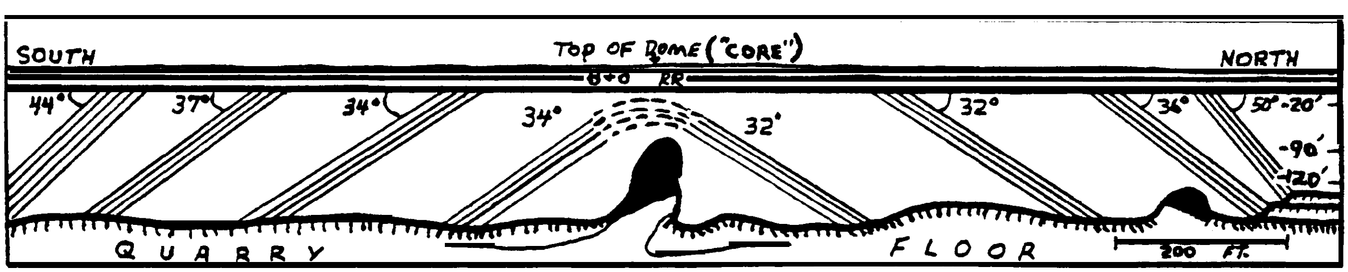

Figure 7.1 Cross-section view of the west wall in the main pit (same view as in the photograph in Fig. 7) showing more of the wall and the varying angles of dip of bedding planes on each side of the tunnel. The "core" or the "top of the dome" is located immediately west of the tunnel (refer to Fig. 1). To appreciate the vast size of the quarrying operation, note that the height of the wall is approximately 150 feet, and the height of the tunnel is about 105 feet.

Figure 7.2. Photograph showing the center of the "core" or "top of the dome" and the steeply dipping bedding planes dipping in opposite directions. (The black has been added here to emphasize them, but they are readily visible in the rock.) The reef block is roughly outlined by the dotted black line. The boulders at the base of the wall, on the right side of the picture, are as large as full-sized automobiles. Photograph by Mr. Jim Canon.

compared to that described by Ingels (see Fig. 4). A close look at the photograph in Fig. 7.2 clearly shows that the steeply dipping strata converge to points over the "core." Thus, the "core" can in no way be the source of the sediments which formed the layered deposits that are stratigraphically *above* the "core." But the basic fact of true coral reefs is that the flank deposits *are* derived from the reef core and that these deposits are stratigraphically *beside* the reef core as in Fig. 6. Therefore, all of the deposits exposed by quarrying thus far are not flank deposits at all, since nearly all layers of sediment are stratigraphically above the "core." Extrapolating the lines representing bedding planes in Fig. 7.1 to their points of convergence above the tunnel suggests that these sediments at one time overlaid the core area by several hundred feet, before they were eroded to their present-day level. This is powerful evidence that the so-called "core" is not a true reef core at all, but is an allochthonous reef block, having no roots. This block became the focal point for subsequent deposits, which buried it layer after layer in a catastrophic environment. Simply stated, the dips of the bedding planes provide abundant and powerful evidence against the evolutionary "fossil reef" hypothesis.

3. REEF-FORMING ALGAE. As has already been noted, except for some isolated, non-reef-forming algal fossils, the reef-forming red calcareous algae are not found in the Thornton deposits, nor are they found in any of the Niagaran "reefs." Over half of the core area in each "reef" should be algae. Lowenstam clearly points out that this is a major problem:

> "It is perhaps worth stressing that the enourmous biomass of the Niagaran reefs was, as that of modern reefs, basically dependent upon a plant (algae) foundation. Yet so far, we have no definite records of this vital element of the Niagaran reefs."[16]

A further problem appears in the fact that pieces of crinoid stems are found throughout the Thornton deposit and are heavily concentrated near the "surf zone" (refer to Fig. 4). First of all, crinoids are fragile animals (sea lilies) and cannot be one of the reef-formers. Secondly, only stem fragments are found with other crinoid parts such as calyces and cirri nearly always totally missing. In a true crinoid meadow all parts of crinoids would be easily found, including nearly complete specimens of the entire animal. But this is not the case in these deposits. This absence of parts suggests that these fragments are not *in situ* deposits, as has

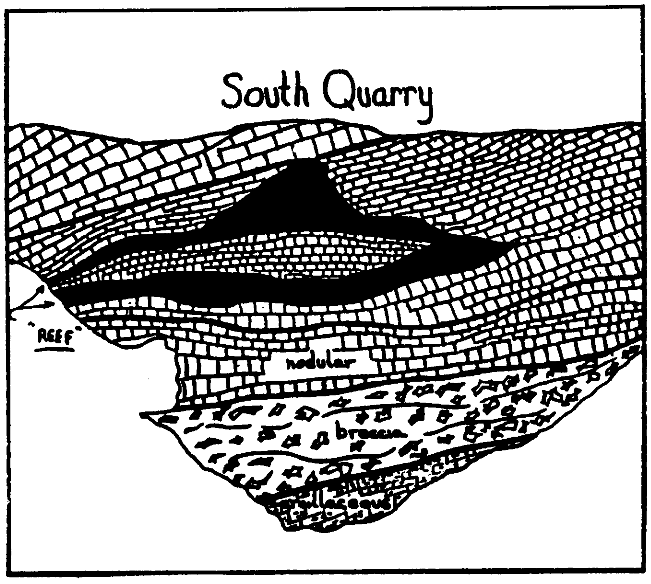

Figure 8. Cross-section view of the South Quarry according to Ingels' interpretation. (Reference 1.) The dark area depicts "reef core".

been proposed, but that they exhibit both transport and sorting, creating a deposit of uniformly sized and uniformly dense crinoid stems. Therefore, since algae are missing in the "reef," and since abundant crinoid stems are found in the "surf zone," the fossil reef interpretation once again appears to be in error.

4. SOLID REEF FOUNDATION ROCK. There is no solid footing upon which the pioneer coral colonies started, not only at Thornton, but at any of the Niagaran reefs. Lowenstam reveals:

> "Reef bases wherever observed are 'rooted' in sedimentary rocks . . .
> Nowhere in the region is there evidence of a hard substrate. Hence, reef building throughout the archipelago occurred on unconsolidated bottoms. The unconsolidated nature of the substrated is further corroborated by evidence that a number of reefs in northeastern Illinois and northern Indiana have settled into the argillaceous bottom deposits."[17]

Lowenstam, obviously believing that the evolution of coral reefs is true, says, in effect, that since it is there, and since evolution is true, reefs grew where it is impossible for reefs to grow. He evidently feels that more explanation is needed, since reefs really need a hard substrate:

> "Solid objects were doubtlessly required before the pioneer population could gain a foothold on the muddy or sandy bottoms. At first skeletal remains and, after the formation of wave-resistant reefs, dislodged reef pebbles and blocks, *must have* served this function *for no other attachment sites suitable for reef organisms have been located in the sediments.*"[18] (emphases added)

Obviously then, lacking footholds, a reef could not have formed until a reef had formed to supply footholds!! Suffice it to say that the entire deposit at Thornton, as well as those of the archipelago, are not *in situ*, but are allochthonous.

5. REEF CORE SHAPE. Following the excavation of the "core" area during quarrying operations, the observed "core" area was found to be neither the size nor the shape described by Ingels. Indeed, the South Quarry core is depicted by Ingels as an inverted V—which is opposite to the usual and normal expectations (see Fig. 8). Of course, *any* shape of a reef core can be accounted for theoretically if an appropriate set of evolutionary assumptions is made. But once again the evidence from modern reefs does not appear to fit with the Niagaran "reef" deposits.

6. FOSSIL TAR DEPOSITS. Fossil tar deposits, known as Albertite and locally called Asphaltum, are riddled throughout the Thornton deposits, including the "core" area.[19] Since such fossilization requires rapid burial at some depth, these fossil remains of animals should not be found in any part of the "reef," particularly because of the long periods of time involved in forming debris to any significant depth. Animal remains would be entirely scavenged or decayed long before they could be buried. Thus, in order for the Albertite to be formed, there must first be quick burial of animal parts. Therefore, the entire "core" and flank areas give strong evidence that the formation of the Thornton deposits was rapid and catastrophic, not at all a slow, time-consuming process.

CONCLUSION. None of the criteria listed for a modern coral reef is met in the actual physical facts of the Thornton deposits. How then might these deposits be better interpreted according to the facts discussed above?

A Creationist Alternative—the Catastrophic Wave-Action Model

Each of the points in which the physical facts of the Thornton deposit do not match the corresponding properties of modern reefs is, in fact, a direct evidence for an allochthonous flood-deposit interpretation. It is clear from the foregoing evidence that the Thornton deposits are not reef deposits. There are no *in situ* growth structures or reef-forming algae because the deposit is not *in situ*. Further evidence of transport and sorting can be seen in the so-called ecological zonations that are described by Ingels. Abundance of crinoid stems in "high-surf areas" is better explained by sorting. The ubiquitous fossil tar deposits speak of *rapid* burial at a fair depth. The total lack of a foundation of hard-rock substrate for initial reef footholds indicates that the deposit, again, is allochthonous. The remainder of this paper is devoted to setting forth broad outlines of depositional forces and events. Finely detailed descriptions of how this deposition may have taken place is properly relegated to future in-depth investigations.

However, the very significant *underlying* deposits provide important clues to this overall nature of deposition, especially those deposits preceding the actual emplacement of the Thornton "reef" materials. Before discussing the forces and the mechanisms of this massive deposition, it might be well to review certain Biblical data related to geologic activity prior to the Flood of Noah.

1. *No rain erosion or deposition prior to the Flood.* Genesis 2:5 and Hebrews 11:7 indicate that prior to the Flood rain had not occurred, so as Noah built the ark, he was exercising faith concerning things not seen as yet. Therefore, prior to the Flood there could be no erosion and redeposition caused by rainfall.

2. *Only minor depositions by rivers prior to the Flood.* Psalm 104:6-9 tells us of mountains rising and valleys deepening to receive the Flood waters. The clear implication is that topographic relief was at a minimum before the Flood, certainly far less than at present. Flowing water derives its energy from its elevation above sea level: the higher the elevation, the greater the imparted erosive energy in those waters. Therefore, much more stream erosion and redeposition is occurring at present than in antediluvian days. In view of the relative insignificance of present-day world-wide deposition, it is clear that pre-Flood deposition would have to be of even less significance. Once the Flood began, these small antediluvian deposits would probably have quickly eroded away for the most part.

3. *No major wave (or wind) erosion prior to the Flood.* Because of the effects of a water-vapor canopy and its accompanying greenhouse effect,[20] there would be only minor movements of air to create wind storms or stormy seas, so that, once again, wave erosion, possibly the most significant form of erosion in the antediluvian world, would still be relatively unimportant. Clearly, forces required to achieve fossilization were not in operation, except possibly in the minutest dimensions.

In summarizing these antediluvian conditions, one realizes that only the smallest deposits would be found from this period, if at all, and would essentially be non-fossiliferous deposits over Precambrian basement rocks. Also, since the earth's Pleistocene deposits are possibly the only post-Flood erosion and redeposition, then the rest of the earth's sedimentary structures would have to be attributed to forces related to the Flood. Most of these forces are given to us directly, i.e., the breaking up of the fountains of the great deep (volcanism and earthquakes), heavy and prolonged rainfall (Genesis 7:11), a mighty wind over the surface of the earth (Genesis 8:1), great tectonic earth movements creating more earthquakes and volcanism (Psalm 104:6-9), and heavy and prolonged water runoff erosion (Genesis 8:5, 13). Our discussion will center on the various types of wave forces generated by such catastrophic events, and their role in forming and shaping the sedimentary structures of the earth.

Tsunamis

It is of particular interest to note the oceanic effects of deposition and erosion due to forces operating uniquely during the Flood. The breaking up of the "fountains of the great deep" is recognized as having been the starting point for unparalleled volcanism and earth movements (earthquakes and landslides). When such phenomena occur under water, destructive seismic sea-wave trains are generated that are commonly called tsunamis. These waves are often erroneously called "tidal waves" but the term "tsunami" is equally a misnomer, as the world-renowned oceanographer Willard Bascom humorously points out:

> "The general public has long referred to these waves as tidal waves, much to the annoyance of American oceanographers who are acutely aware that there is no connection with the tides. In an effort to straighten out the matter they adopted the Japanese word tsunami, which now is in general use. Later they discovered that tsunami merely means tidal wave in Japanese, but at least the annoyance has been shifted overseas."[21]

Seismic sea waves, or tsunamis, are long period waves (on the order of 1,000 seconds) and possess wavelengths as long as 150 miles. In the deep ocean, these waves may be only a foot or two in height, but travel with speeds approaching 500 miles per hour. Bascom points out that such waves have little effect until they approach shallow waters where they become transformed into "rampaging monsters," reaching up to *135 feet in height.* Another oceanographer, Bernstein, shows that tsunami devastation is further increased by the fact that tsunamis travel in wave "trains" or series of up to 15 destructive waves, the third and eighth waves usually the most destructive. In some extreme cases these wave trains may have wavelengths as long as 600 miles.[22] These repeating waves would pass by a particular point from between every 15 minutes to over an hour, depending upon the wavelength (measured from wave crest to wave crest).

The arrival of the first wave of a tsunami is often so deceptive that it can easily cost the lives of unsuspecting people. The first wave is often no more than a sharp swell, hardly noticeable, but is followed by a great and tremendous "suck" of water away from the shore, as the first wave trough arrives. Reefs are left high and dry, and people, amazed at the spectacle of a denuded beach, unsuspectingly run out to inspect flopping stranded fish and other bottom features, only to find themselves looking up at a huge and fatal wall of water. Once again, people may be trapped by the successive waves if they believe that after the first big wave it is all over, when in reality, the biggest waves are yet to come. Entire cities and hundreds of thousands of lives have been totally destroyed by a single tsunami wave train. A recent tsunami in Indonesia in July, 1979, wiped out four villages and scooped up tons of mud and sand *off the sea floor* and buried the villages, killing all inhabitants. These waves were small—only 30 feet high and traveling at 90 miles per hour.[23] In Hilo, Hawaii, where tsunamis hit on the average of once every 25 years, huge masses of coral reef were reported to have been torn loose from the sea floor and piled up on beaches.[22] In the 1923 Sagami Bay tsunami, Japanese fishermen hauled in thousands of fish scooped ashore *from a depth of 3,000 feet!*[22]

The mechanism of waves and wave train travel are shown in figures 9 and 10.[24] As a wave passes a point occupied by a water particle, a rotational motion is set up, and the water particle never travels laterally more than the diameter of its circle of rotation (orbit) describ-

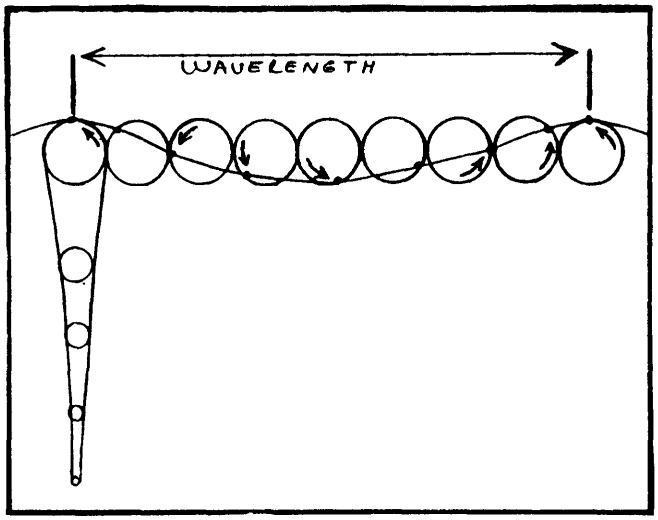

Figure 9. Water particles move in orbits as a wave passes by. As discussed by Bascom, Reference 24. For a discussion of the movements of water particles in other types of wave, see Clark and Voss, Reference 38.

ed by one wavelength (see Fig. 9). Furthermore, in some cases, the wave travels as a train of waves, the energy stored in the first wave being used up in setting water particles in motion in advance of the traveling wave train. Since the energy in a wave train is conserved, a wave appears at the end of the train at the same time as the frontal wave is disappearing (see Fig. 10). This, by analogy, explains why a first wave of a tsunami may move through shallow water relatively unnoticed, having been partially dissipated during the advance of the wave train.

When waves enter increasingly shallow waters, friction slows the wave front down and "piling up" of water occurs, heightening and steepening the wave until it becomes unstable and the wave breaks, changing from a wave of rotation to a wave of translation where water particle orbits are broken. Also a downhill flow of water along the bottom occurs in front of and into the breaking wave crest[25] (see Fig. 11). This process sheds light on the tremendous "suck" of water, with its

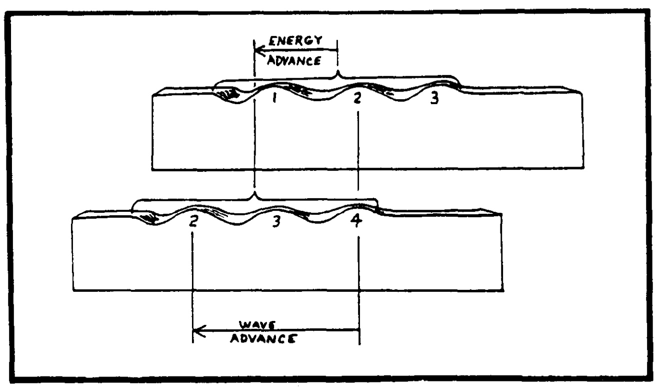

Figure 10. Moving train of waves advances at only half the speed of its individual waves. At the top is the wave train in its first position. At the bottom the train, and its energy, have moved only half as far as wave 2 has. Meanwhile wave 1 has died, but wave 4 has formed at the rear of the train to replace it. As explained by Bascom, Reference 24.

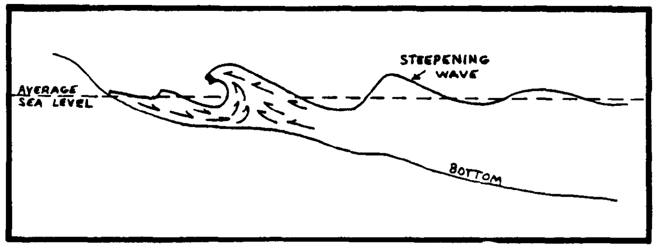

Figure 11. The flow of water in a breaking wave. Modified after Bascom, Reference 21.

powerful erosive force, that precedes the arrival of a mountainous tsunami crest.

It should be obvious that the events of the Flood, i.e., submarine volcanism, earthquakes and landslides, would be inestimably more frequent and of much greater magnitude than those of the present times, possibly producing tsunami trains by the thousands all over the world, with magnitudes greater than 135 feet, dwarfing present-day tsunamis. Since the destructive (erosional and depositional) aspects of tsunamis occur in shallow water, it follows that no part of a continental mass would be exempt from tsunamis, since shallow-water stages would at some time exist for all land areas, both for the *submerging and emerging* stages of continents during the Flood (see Fig. 12). This is the first and most significant implication of the effects of tsunamis during the year of the Flood.

Secondly, deposits would occur from a variety of directions with different source material areas for each seismic wave train. A seismic wave train would radiate out in all directions from the epicenter, or point-source of the submarine earth shock. Thirdly, with simultaneous or nearly simultaneous earth movements, resulting tsunami deposits may occur in conjunction with other deposits to form what is commonly referred to in geologic terms as *facies deposits* (see Fig. 13). Facies are areas where two (or more) rock types blend in, or interfinger with one another. These rock units are usually geologically time-equivalent, but represent different source areas for their sediments. Simultaneous tsunamis easily explain such facies. Earth upheavals and movements of nearly simultaneous occurrence would have been commonplace during the year of the

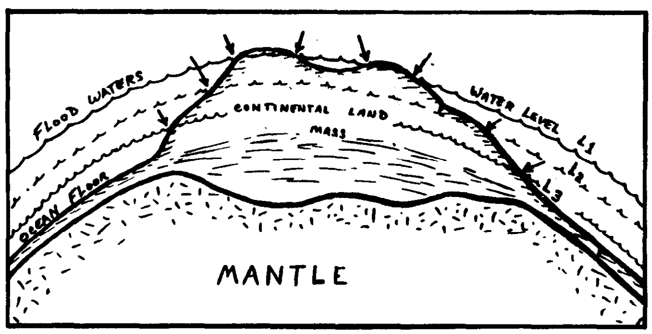

Figure 12. Cross-section (not to scale) of continental land masses at different stages (indicated by L_1, L_2, and L_3) of submergence by Flood waters. Arrows point to areas devastated by giant tsunamis generated by the great earth movements of the Flood. As the water level changed, no area of any continent would have been exempt from erosion and deposition by the tsunamis.

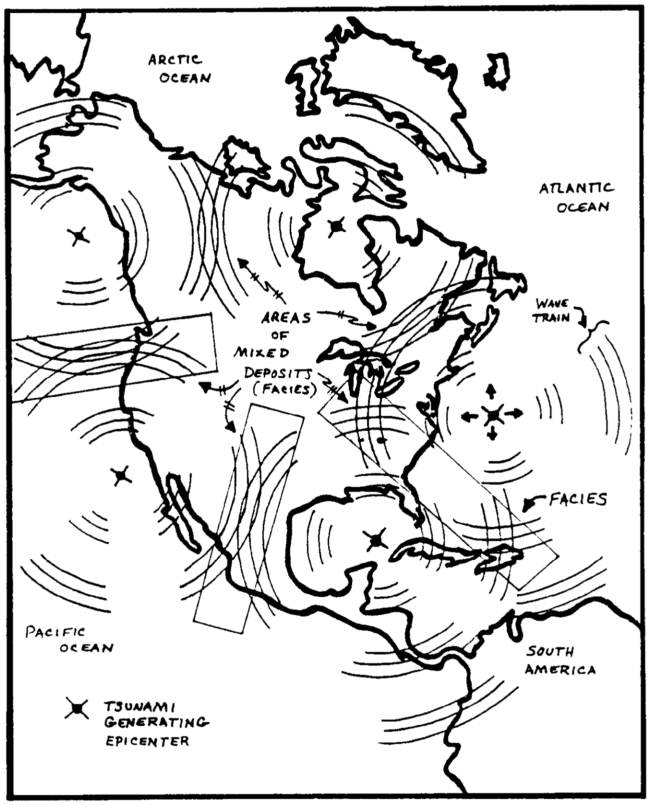

Figure 13. Facies deposits could have resulted from simultaneous, or nearly so, tsunamis originating from widely diverse areas. Sudden underwater crustal movements, occurring by the thousands during the Flood year, generated tsunami waves which picked up sediments and redeposited them as the energies of the waves were dissipated. As the waves traversed differing areas, e.g. continental or marine, and collided with one another, an intermixing of lithologic types would have occurred. Six such areas of mixing are shown here, four of them being outlined in the three rectangles. The wave trains would have radiated outward in all directions from the respective epicenters.

Flood, with a final burst of activity at the close with the raising of the mountains and deepening of the valleys to receive the Flood waters as described in Psalm 104. This deepening can be interpreted to mean that ocean basins, once small, were enlarged and downfaulted to their present size and depth. Such processes would have generated a whole new series of tsunami deposits. The continental upthrusting at this time would have created great runoff erosion on the emerging, draining land masses. The resulting scouring action and redeposition of already once-deposited materials would create the effect of "older" deposits being placed on top of younger deposits, as in the cases of so-called inverted strata.

Finally, the areas covered by such deposits from giant Flood-related tsunamis would vary in size from small deposits of a few square miles to an upward limit of tens and perhaps hundreds, of square miles. As described above, such waves would yield the ideal conditions needed for fossilization—rapid and complete burial—and would easily match the conditions cited by Whitcomb and Morris of instances of rapid burial and fossilization. An excellent example of this is the estimated one billion red herring buried in a four-square-mile area in Miocene deposits in California.[26]

The application of tsunamis to the Thornton deposit and to the whole of the Niagaran "reef" archipelago of Lowenstam can be explained as follows. Using the ancient shorelines suggested by modern geologists, the reef archipelago is seen to present an ancient shoreline that could have received tsunami deposits from offshore shoal and reef areas (see Figs. 14 and 14.1). The archipelago deposits could actually represent a series of seismic sea waves occurring within a short period of time. Interestingly enough, reference to modern shoal areas provides us with some striking similarities to the inferred ancient landform (see Fig. 15). For instance, a tsunami-generating epicenter in or near Hudson Bay would be easily analogous to a hypothetical epicenter near the Great Bahama Bank shoal and reef areas. The shorelines of Florida, Cuba, and Mexico would be

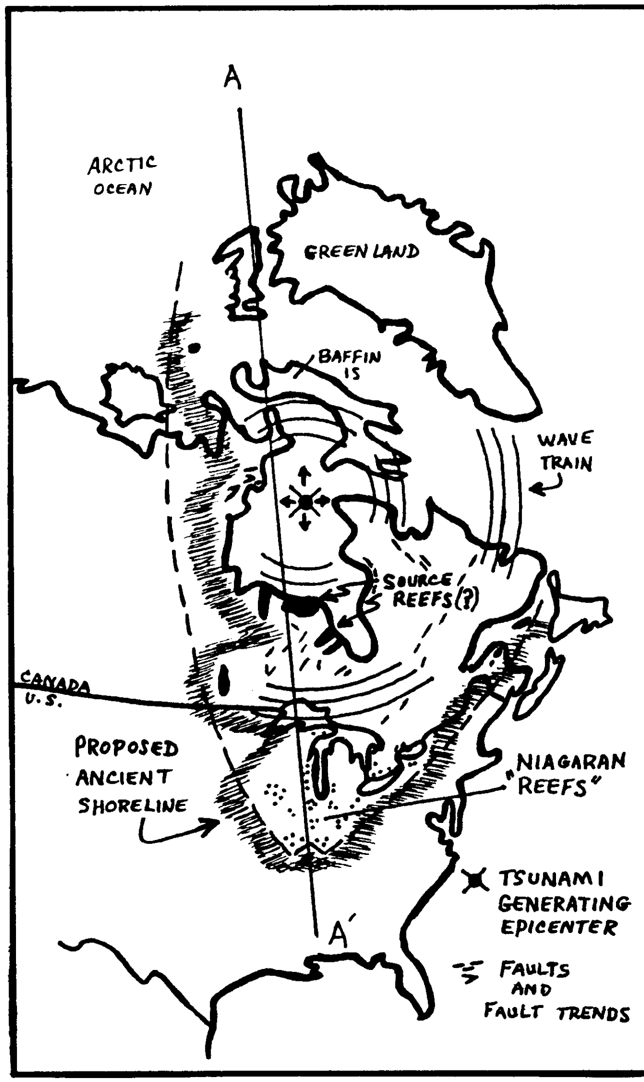

Figure 14. Possible source of archipelago "reef" deposits. Tsunamis generated in the general area of Hudson Bay could have torn loose ancient coral reefs (growing on "Precambrian" bedrock) and transported the material to final resting-places along the ancient shoreline. The location of the suggested ancient shoreline and its relationship to the coral deposits is intended to show the possibilities, and is not claimed to be accurate in detail. The tectonics are after Badgley, Reference 35.

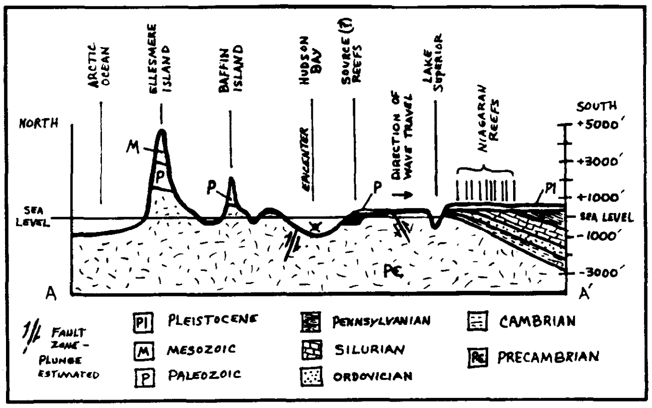

Figure 14.1. A vertical cross-section along the north-south line A-A' in Figure 14. Geological formations are depicted, including a "basin" containing sedimentary deposits south of the Great Lakes, reaching to a depth of 3,000 feet. Topography and geology according to References 36 and 37, respectively. Note that the vertical scale is greatly exaggerated.

analogous to the ancient shoreline represented by the archipelago arc, acting as receiving areas for sediments dislodged by giant tsunamis.

Storm Surges or Storm waves

Another type of destructive sea wave of astonishing power is the storm surge or storm wave, which is associated with high winds of long duration, such as found in gales, hurricanes and typhoons. The great wind of Genesis 8:1 that evidently helped to abate the water from the land must have intensified the magnitude of normal storm surge destructive power. While areas thus affected would be considerably smaller and more localized than those affected by tsunamis, the erosive effects on exposed shorelines would have been disastrous. Waves of nearly 125 feet in height have been seen in modern storm surges which have thrown rock masses about as if they were pebbles. Bascom cites various events where rock and concrete breakwater fragments weighing over *2600 tons* were tossed about, with a calculated wave pressure of 6340 pounds per square foot. In another case the instantaneous wave pressure was computed at 2500 psf. The highest wave pressure measurement on record occurred at Dieppe, France, in 1938 with calculated instantaneous pressures of 12,700 psf.[27]

Although storm surges are smaller in scope than tsunamis, an understanding of them can play an important role in deciphering localized Flood deposits in the geologic record. Storm surge deposits (and erosion) would have affected the earth the most during the last half of the Flood. It is particularly interesting to note that wind-driven wave energies increase exponentially with wind velocity (see Fig. 16). It follows that the violent, high-velocity winds caused by sharp temperature differentials produced by the collapse of the water-vapor canopy[32] would have produced spectacular storm surges.

Tidal Waves

We now come to the phenomenon which may prove to be the most significant of the Flood-related agents of erosion and deposition. At the outset, let us recognize that present-day tides are mild and relatively unspectacular as an erosional and depositional agent. However, today's tides are trapped between continental masses, producing unusual and restrictive influences on

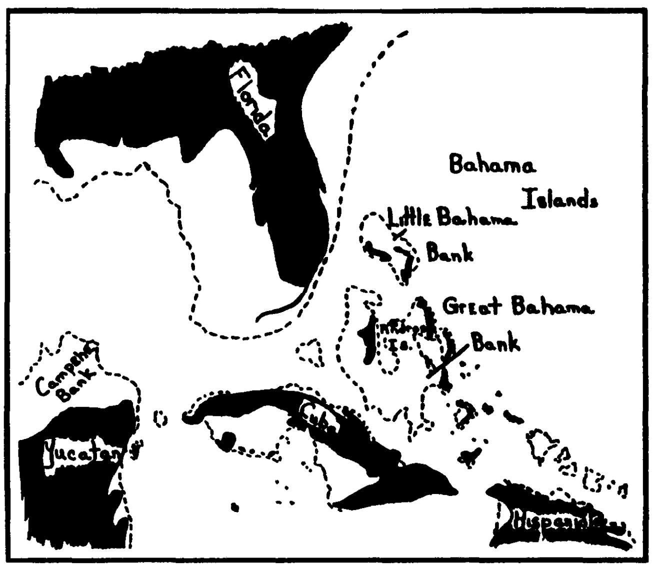

Figure 15. Modern shoal areas in the Caribbean Sea and vicinity may be analogous to certain pre-Flood landforms. Those pre-Flood landforms served as sources of material which, transported by Flood-sized giant tsunamis, was deposited in the Great Lakes region as the allochthonous deposits which are called Niagaran "reefs".

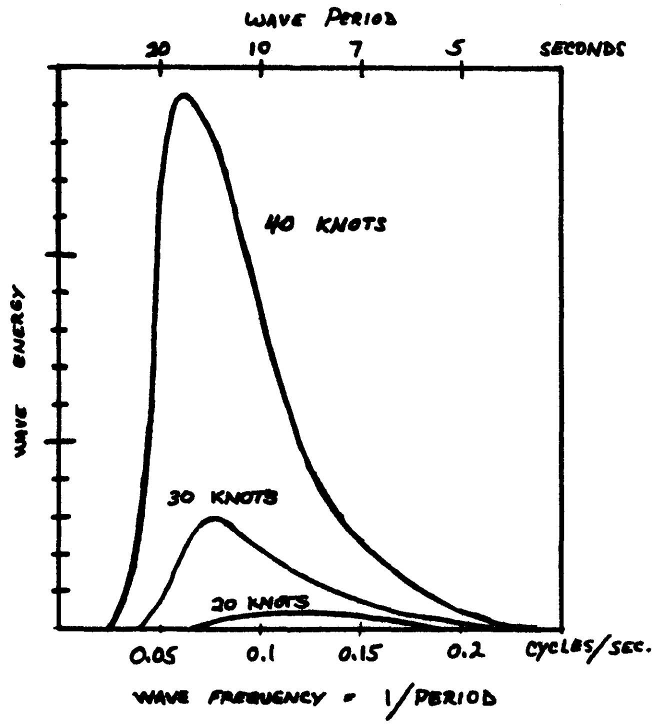

Figure 16. How the wave energy depends on the frequency or period, and on the wind speed. As the wind speed increases from 20 to 40 knots, the wave energies increase exponentially. As shown by Bascom, Reference 21, p. 51.

tidal movements, whereas during the Flood, tidal movements would have been unhindered, for the most part, by continental masses. Conceivably, the same astronomical forces acting on today's oceans would have produced results very different during the Noahic Flood.

There are many depositional features in the sedimentary rocks of the earth that simply cannot yield themselves to a tsunami, storm surge, or any other conventional explanation. The deposits directly underlying the Thornton Quarry deposits are just such deposits and are of particular interest to this discussion. We cannot attempt to explain the origin of the Thornton deposits without also dealing with the rest of the geological formations underneath, and therefore it is of utmost importance to address their origins as well.

Underlying the Thornton deposits are massive formations of Cambrian and Ordovician strata. As previously mentioned, well-log data show these formations to consist of limestones, sandstones, and shales, some of which are highly fossiliferous, and extending to a depth estimated at nearly 2500 feet in the Chicago area. These deposits continue to deepen to the south as the Precambrian basement rocks form a basin, an ancient landform, in which the sediments accumulated. These deposits occured prior to the emplacement of the Niagaran "reefs." One of the smaller of these formations is the St. Peter Sandstone, which will be briefly discussed (see Fig. 17).

The St. Peter Sandstone has long been an object of interest to geologists because of its purely-sorted, well-rounded quartz sand covering a vast area (see Fig. 18). The St. Peter formation covers over 225,000 square miles and portions of eleven states, averaging 75 feet in thickness.[28] The St. Peter Sandstone is famous commercially for a variety of industrial uses including glass manufacturing because of its exceptional purity and uniformity. But of primary interest to us is the sheer size of this highly sorted, single deposit. Remembering that this is a *smaller* member of the formations underlying

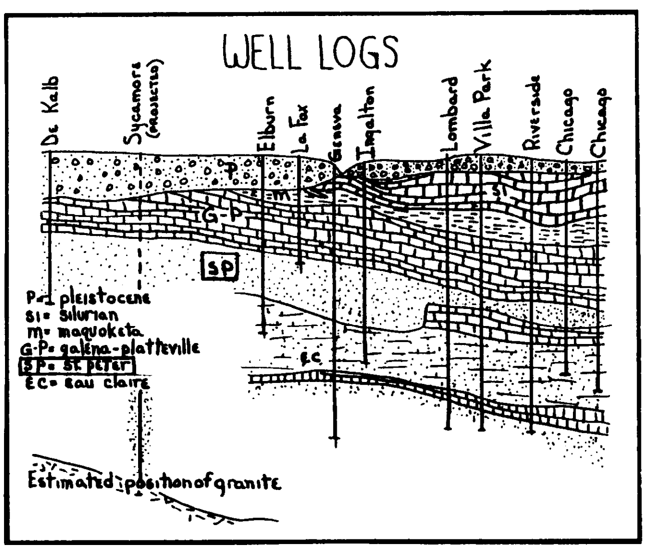

Figure 17. Well-log data on sediments underlying the Silurian "reef" deposits. Modified after Bretz, Reference 3.

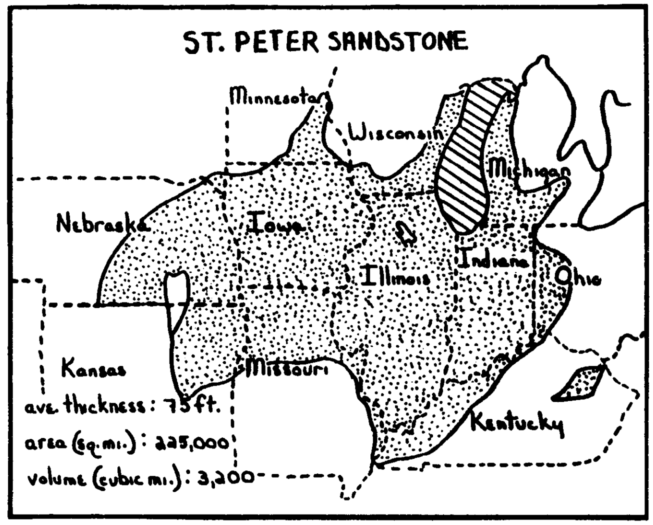

Figure 18. Extent of the St. Peter Sandstone, Reference 28.

Thornton, it becomes obvious that we must deal with geological forces of much greater significance, affecting much larger geographical areas, than agents such as rivers and streams, tsunamis, turbidity currents, underwater landslides, etc.

This brings us to the wave form called (correctly, this time!) tidal waves—especially as related to the shallow-water effects generated by global tides. A brief description of the forces operating in gravity waves (tides) follows. As previously stated, the purpose of this paper is not to explore exhaustively any phenomena, but as a preliminary study it is designed to stimulate further research by able investigators. Those desiring a more complete description of tidal forces and related phenomena will find a wealth of information in the references cited. The following discussion will be appropriately abbreviated.

Without a doubt, the amount of energy involved in tidal movements dwarfs anything discussed thus far. Tides are incredibly complex phenomena, but the major driving forces are astronomical gravitational attractions, primarily from the moon and secondarily from the sun. It may seem strange that the sun's influence on tides is only about forty-six percent as strong as the moon's, especially when the gravitational force of the sun is so much larger than the moon's gravitational force. The answer lies in two facts: 1) the moon is much closer to the earth than is the sun; and 2) tide-raising forces are horizontal forces, known as "tractive" forces, which are exerted on waters *not* directly under the moon, pulling them toward a point that is under the moon. The tractive tide-raising forces are inversely proportional to the *cube* of the astronomical distances, whereas the strength of simple gravitational attraction varies inversely with the square of the distance. Even though the sun is 27,000,000 times as massive as the moon, the effect of the cube of the distance to the sun (93,000,000 miles) greatly outweighs its gravitational force when compared to the cube of the distance to the moon (239,000 miles average) and the moon's gravitational force. Thus the moon, being much closer, has the dominating effect on the tides.[29] (The inverse cube relationship also explains, incidentally, why planets, even when in "super-conjunction" with one another and the sun, would have little effect upon either ocean tides or land tides on the earth.)

It is easy to see why a tidal bulge forms on the side of the earth facing the moon, but it is not so obvious why a similar tidal bulge forms on the opposite side of the earth. The answer becomes apparent when we realize that since the earth and the moon attract one another, they revolve about a common center of gravity as an earth-moon system. Thus the moon does not revolve around the center of the earth. Rather, both the earth and the moon revolve around this common center of gravity which is located under the surface of the earth, about 3,000 miles from its center (see Fig. 19). Simplistically speaking, the movement about the common center of gravity, or center of mass, produces a centrifugal force that tends to hurl the oceans into space on the side of the earth opposite the moon. Of course, the earth's gravitation prevents such a catastrophic occurrence, but a second tidal bulge is thus produced. Because of the complexity of the forces involved in producing the second tidal bulge, different writers will use different illustrations to explain how the second bulge is formed, in an effort to simplify concepts. For further study, a good analysis of these complex forces is given by Dr. Edward Clancy, chairman of the Mount Holyoke College physics department, on pages 12-23 in his book *The Tides: Pulse of the Earth*, published in 1968 by Doubleday & Co., New York.

Since the moon's orbit is actually inclined from the axis of the earth, the moon will move alternately from the Tropic of Cancer to the Tropic of Capricorn (see Fig. 20). The result of this alternate movement is that the area of the earth affected by the highest water will alternate between the limits of the declination of the moon, or approximately between the limits of the two Tropics. Polar tides are minimal.

As is apparent from Fig. 19, if the earth were totally inundated, water would exist as two huge bulges on the earth, and as the earth rotated once completely in 24 hours, a point on the earth would pass through these two bulges of water. Actually, since the moon's orbit is in the same direction as the earth's rotation, but at a much slower rate, the given point on earth would travel slightly farther, and so take longer, to pass through both bulges completely—a total time of 24 hours 50 minutes. (The relative direction of travel of tides on the surface of the earth would be from east to west.) Since the circumference of the earth is appoximately 24,900 miles and the full rotation time for a given particle to intersect the same high water bulge twice is 24.833 hours, then the velocity of the crest of the tidal bulge over a

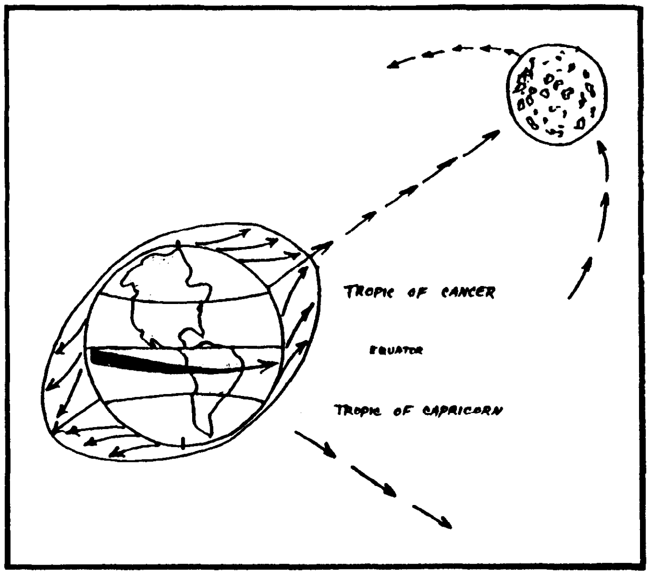

Figure 20. The highest tides—the greatest bulges—would move north and south, approximately between the tropics of Cancer and Capricorn, about once a month, because of the inclination of the moon's orbit to the plane of the equator. (The plane of the moon's orbit shifts, moreover; but probably not much in the one year of the Flood.) Modified after Bascom, Reference 21, p. 89.

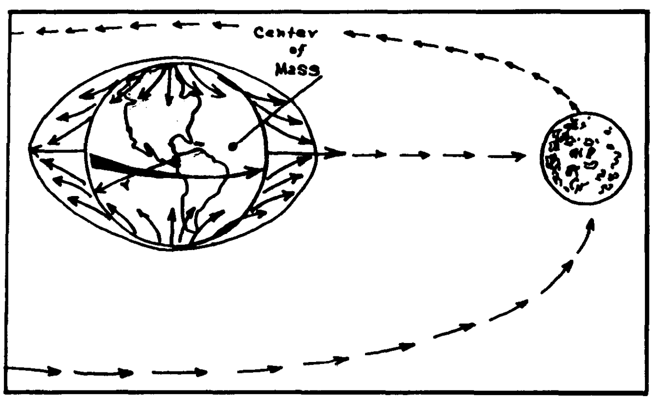

Figure 19. How the water, as a result of the attraction of the moon, bulges to produce the tides. Here the moon is shown in the earth's equatorial plane; under those circumstances the highest tides would be expected at or near the equator. The effect of the sun, being less, modifies that of the moon, either helping it to cause spring tides, or counteracting it to cause neaps. This drawing is not to scale; in particular, the bulges are greatly exaggerated. The arrows toward the moon indicate its gravitational pull; those the other way the forces causing the other bulge.

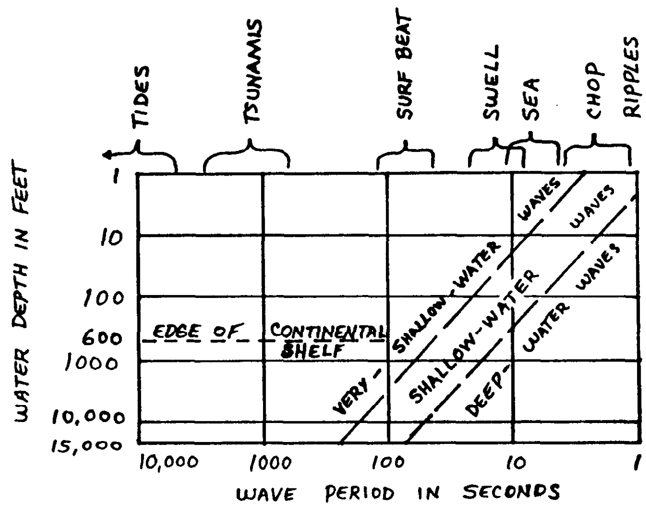

Figure 21. Chart identifying waves by types. Tides and tsunamis are both very-shallow-water (in the sense that the water is shallow compared with the great wavelengths) waves of very high velocity and long wave period. After Bascom, Reference 21, p. 66.

given point on the earth is nearly 1003 miles per hour. In terms of wave period and wavelength, the wave period, from crest to crest, would be 12 hours 25 minutes (44,700 seconds) and the wavelength would be approximately 12,450 miles (see Fig. 21). In theory, this would be true if the oceans averaged 14 miles in depth. However, with an average depth of only two miles, the speed of the tidal crests in an inundated world would be between 800 to 1,000 miles per hour, with shorter wavelengths and periods.

These long-period waves of high velocity on an inundated earth clearly resemble the tsunamis (which also are long-period, high-velocity waves), but on a much larger scale. The shallow-water effects of these tidal waves, as with tsunamis, cause a steepening and heightening of the waves as bottom friction slows them. *Like* tsunamis, the effects of tidal bulges are negligible in deep water but increase rapidly in shallow areas. *Unlike* tsunamis, which gain their energy by single impulses, storing that energy in the wave train until it is dissipated, the tidal wave has energy continuously being imparted to it by the gravitational tractive forces of the moon and sun, so that in conditions that cause dissipation of energy, the tidal wave's energy will be operating much longer. Again, unlike tsunamis, which have a point source (epicenter) and travel in a radiating circular pattern, the tidal wave front travels more linearly, even though it may be altered gyroscopically by the earth's spin (the Coriolis effect).

The normal question at this point is, "Why don't we see such great effects in our present day world due to tidal movements?" The answer appears to lie in at least two areas. First, continental land masses effectively contain tides within each ocean basin and completely prevent the formation of a single wavelength, while on an innundated earth not only could complete wavelengths form, but they would be free to resonate, increasing their effects. Secondly, the frustrated tidal movements of today's oceans are dominated by the Coriolis effect, or gyroscopic effect, of the rotating earth. A look at cotidal charts of the Atlantic Ocean reveals that since the tides cannot circle the earth, the Coriolis effect causes a circling of the high tide fronts within the ocean basin that looks like the system of cyclonic movements so common in our atmosphere[30] (see Fig. 22). Cotidal charts in the Pacific and Indian Oceans show similar circulations.

Because of the difficulties in actually measuring tidal depths in the deep oceans, cotidal charts are somewhat hypothetical, but the rotational effects are well established. As in Fig. 22, the point of intersecting lines is a hypothetical point of no tidal elevation change, called an amphidromic point, while each radiating line represents sequentially the position of highest tide with the passing hours. It is interesting to note that while the Coriolis effect produces clockwise *ocean currents* in the Northern Hemisphere, the direction of high tide movement is just the opposite.

It should be noted at this point that with a vertical rise or fall in tidal elevations there are generated powerful underwater lateral currents called tidal currents. It is these strong currents, covering perhaps hundreds of miles in breadth on an inundated world (responding also to the Coriolis tidal movements as well as the primary vertical tidal movements), that may be responsible for vast areas of sorting and deposition during the Flood. It is these currents, enhanced by the greatly magnified and resonating tidal wavelengths, that could sort and uniformily deposit such large-scale formations such as the St. Peter Sandstone. Tsunamis, volcanic activity, underwater landslides, etc., would be the primary agents for scooping up or stirring up vast amounts of heavy sediments, so that the highly energized tidal environment could hold this material in partial suspension as it transported it over large areas. With the nearly continuous occurrences of catastrophic phenomena—earthquakes, tsunamis, storm surges, volcanism—a great abundance of sediments, rock fragments, soil, chemical precipitates, volcanic ash, and plant and animal remains would have been freshly injected into the Flood waters on nearly a continuous basis. Temporary lulls in such activity would probably coincide with the deposition of the larger formations, while periods of renewed and increased activity would coincide with periods of erosion of freshly deposited materials.

It is particularly noteworthy that by far the thickest deposits occur *only on the continental land masses*, while deposits in ocean basins are quite minor by comparison. This situation confirms the fact that the shallow-water effects of the forces of the Flood are enormounsly more energetic and potent than anything occuring in deep water. It may at first seem quite odd that the greatest depths of deposition would occur on the already-elevated continental mass, but, in fact, this situation is clearly dictated by the physics of the forces acting in water, as they are brought to points of focus in shallowing waters, finally impinging in multiplied fury at the land/water interfaces.

An interesting theoretical adjunct to tidal wave discussions is related to the dampening effect of reflected waves of differing wavelengths. Modern tidal theory treats most wave systems as standing waves of oscillation, operating in an environment enclosed on at least 3 sides. Even large bodies of water are treated as enclosed "channels" with a land barrier at one or both ends. This obviously suits the present-day situation, but in the Flood environment, with no land barriers from which to reflect, many of the standing waves of different periods and wavelengths, tsunamis included, would gradually dissipate one another, transferring their energies into the dominant oscillations travelling around the world. A wave model for a completely inundated world would have to include "channels" of infinite length in order to begin to explain wave behavior during the Flood. The result of waves traveling in infinitely long "channels," in many cases, would be to enhance and further amplify the existing dominant waves (i.e., tides) traveling unopposed around the earth.

In view of the foregoing discussions, the hypothetical results of tides moving on a totally flooded earth, having continents as the shallow-water areas, are as follows.

1) Tidal waves would be able to establish completed wavelengths, able to resonate around the earth producing amplified high crests and low

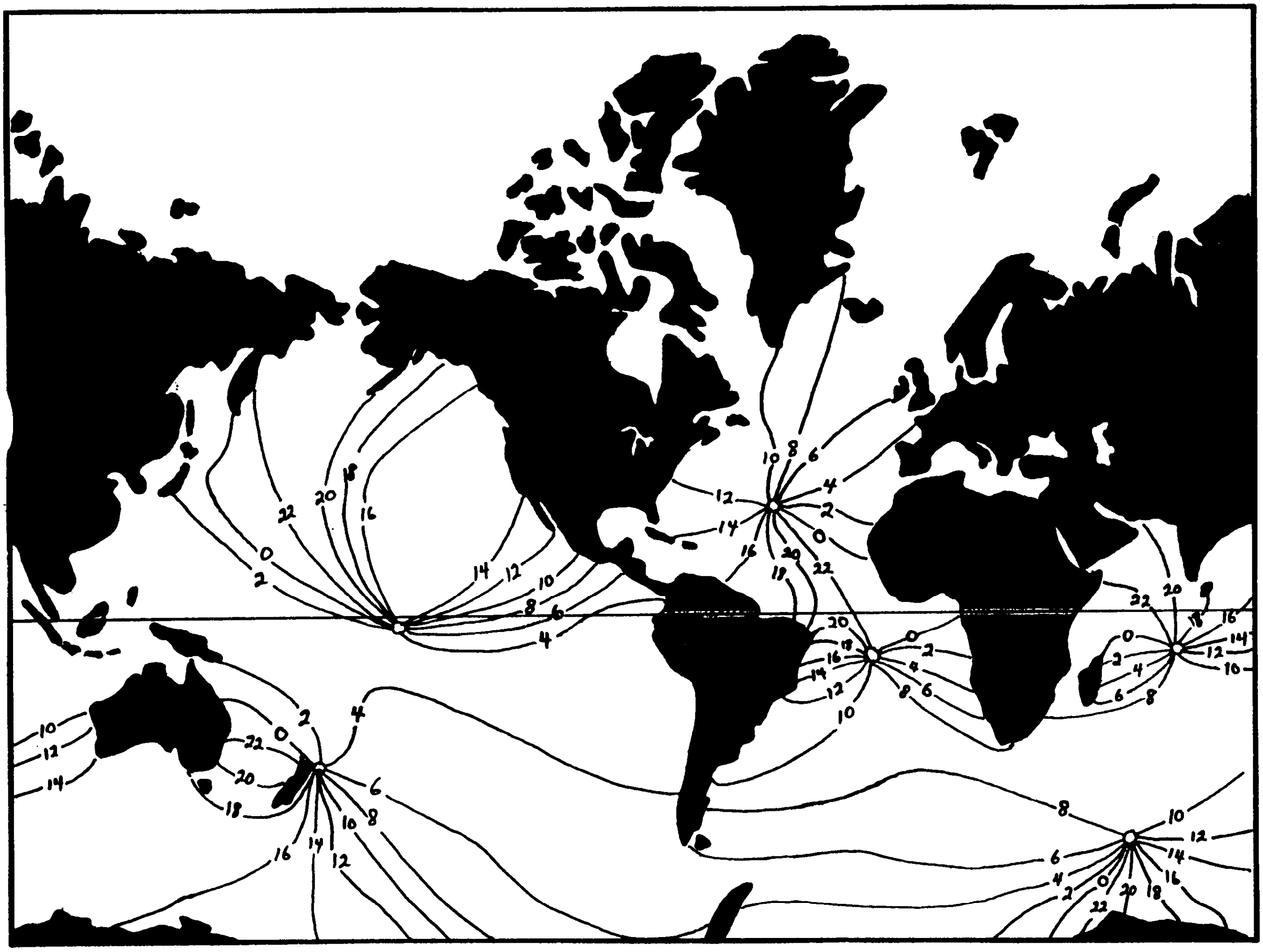

Figure 22. Cotidal chart of the high tides in the oceans. The tides, being trapped in the ocean basins, rotate in each basin, (rather as if the numbered lines were spokes of a somewhat distorted wheel) due to the Coriolis effect, i.e., the effect of the earth's rotation. The amphidromic points, the points to which the numbered lines converge, have no tidal elevation change, while each radiating line represents the passage of high tide at a different hour of the day. On a certain day, for instance, along a line marked "O" the high tide would come at midnight, along the line marked "2" at 2 A.M., etc. It is interesting to notice that, on the whole, the numbers go around clockwise in the Southern Hemisphere, counter-clockwise in the Northern. After Macmillan, Reference 30, p. 70.

troughs, with a crest velocity approaching 1,000 miles per hour.

2) Since tidal waters can represent waves of translation as well as waves of rotation, shallow-water effects similar to but less pronounced than those produced by tsunamis might be expected, transporting and depositing huge amounts of sediments.

3) Tsunami-like shallow-water effects would not lose their energy as fast as actual tsunamis would, due to continuously imparted gravitational energy, so that depositional effects would continue longer and cover much larger geographical areas.

4) The Coriolis effect, causing cyclonic movements in tidal waters, would influence the direction of transport and deposition of sediments. Such giant circulation of waters could conceivably be as large as the continental United States. The Coriolis effect provides an obvious solution to the problem that many of the earth's deposits exhibit differing directions of transport and deposition.

5) Swift and powerful lateral tidal currents, perhaps covering areas of hundreds of miles across, would be generated by the unusual vertical tidal movements and aided by the Coriolis effect. Such currents could scour, sort and evenly redeposit entire regions over short periods of time, being the most important of the depositional agents of tidal forces.

6) Tidal forces probably would not be able to match other forces (tsunamis, storm surges, earthquakes, volcanism) in their destructive and erosional capabilities, but tidal phenomena would be the primary agents for carrying vast amounts of sediments and causing deposits of great uniformity covering hundreds of thousands of square miles. Much of the sediments carried by tidal currents would be derived from tsunami activity. No

other depositional agent can adequately explain large formations.

7) The cyclical effects of the passage of two bulges of water each day, with all of the above phenomena occurring each time, would give rise to cyclical bedding.

8) The changing position of the moon from one Tropic to the other in its inclined and elliptical orbit about the earth, with the accompanying changes in tidal depths and energies, would give rise to rhythmic changes *within* such cyclically bedded structures, as in *cyclothems.*

9) The sheer weight of the bulges of water in the amplified tides of the Flood would cause isostatic adjustments, which in turn would trigger earthquakes, causing additional tsunamis.

10) With such extreme oceanic movements, and with the mixing of changing and totally different underwater zones, chemical precipitation of limestones, dolostones and even many of the so-called evaporites could have occurred due to rapidly changing temperatures, pH and chemical concentrations, particularly in volcanic areas. It is interesting to note that some chemically precipitated limestone has been observed not to differ in crystalline structure from biogenetically produced limestone.[31]

11) All of the above effects would have their most dramatic results in the shallow waters of continental regions, with only small, incidental effects in deeper oceanic regions. Thus sedimentation on continents (and erosion) would occur at several times the order of magnitude as in deeper waters. This fits current observations of continental and oceanic deposits.

12) These effects would be at their height primarily during the deepest part of the Flood. The emergence of land masses would quickly diminish the above listed results, particularly when enough land arose to disrupt the tidal wavelengths.

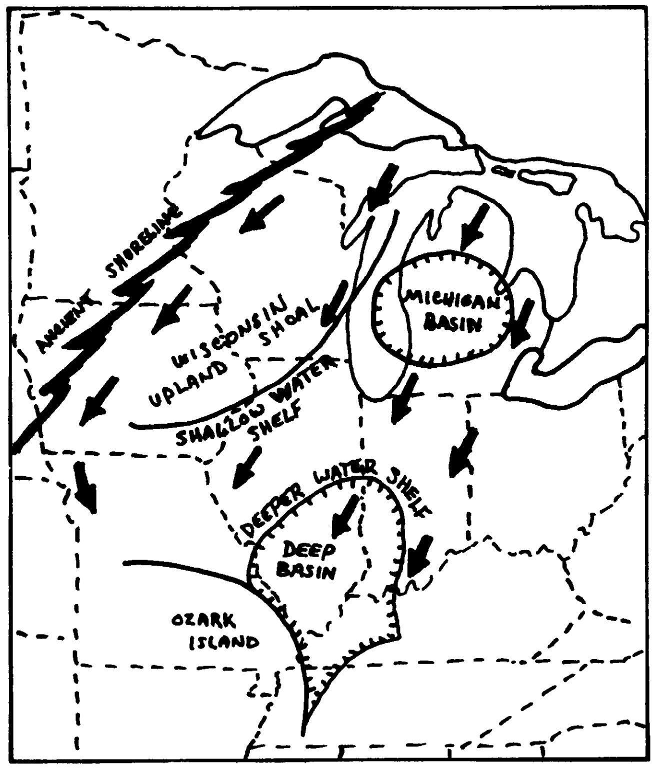

Figure 23. Direction of deposition over basement rocks into the basin areas of Illinois, Indiana, and Michigan. The arrows show the general direction of the transportation of materials to form the St. Peter Sandstone. (The ancient shoreline shown here is as proposed by Dapples to explain the direction of deposition in uniformitarian terms.) As the midwest area basin was filled with Cambrian, Ordovician, and Silurian sediments, and as the continental land mass began to emerge from the Flood, a new shoreline emerged to receive the Niagaran "reef" deposits, which were probably brought by tsunami-type waves. (Refer to Figure 14.) This is a composite drawing, with information from Dapples, Reference 33, and Lowenstam, Reference 34.

Synthesis

It is now possible to synthesize a working hypothesis for the formation of the Thornton "reef" deposits and the underlying strata. By the mechanisms outlined above, it appears that the massive Cambrian and Ordovician strata underlying Thornton, including the St. Peter Sandstone formation, is primarily a mid-Flood deposit. Plant and animal materials, along with sediments broken loose by earthquakes, volcanoes, tsunamis and other forces were deposited in final form by the massive tidal action of the Flood during the months of deepest inundation. Judging from the direction of transport and deposition ascribed by modern geologists to the sediments underlying the Thornton "reef" deposits,[33] it appears that this direction may be interpreted as being the result of tidal wavefronts driven by the Coriolis effect, which created massive tidal currents that swept over shoal areas and Canadian Shield areas into deeper basins (see Fig. 23). Thus, the deep underlying massive sediments may be relegated to the action of tidal waves and currents in the Catastrophic-Wave Action Model. Tidal waves and currents would also be primarily responsible for massive limestone deposits, derived from chemical precipitation occurring with rapidly changing temperature, pH and chemical conditions. The purity of precipitation deposits would be enhanced by a rapid rate of chemical precipitation, while longer periods of deposition would greatly increase the chances of contamination by other materials.

Following the mid-Flood deposition attributed to tidal effects, a rapid emergence of continental land masses started to occur, triggering additional violent crustal movements which, in turn, caused large numbers of tsunamis to sweep over newly emergent shorelines. The newly formed Silurian deposits, being uplifted, became a shoreline area capable of receiving coral reef fragments torn loose and transported by tsunami-type waves. The source area for these reef materials could have been actual antediluvian reefs growing on Precambrian basement rocks in the general area of present-day Hudson Bay. It could also be that the very large area of reef deposits embedded in the Paleozoic sediments on the southern edge of Hudson

Bay (refer to Fig. 14) are actual reefs with footholds on the underlying Precambrian, that were in place before the Flood. At any rate, the allochthonous reef deposits at Thornton and elsewhere along the archipelago are most probably the result of tsunami wave deposition.

It is also during this time that the great wind of Genesis 8 would have been in operation and thus storm surge deposits also could have been expected in the area. Such deposits might be represented by the material piled on top of the Thornton reef blocks, causing moderate anticlinal dips throughout the area. The continuing emergence of the continental land masses would have uplifted these deposits, and probably would have caused steepening of the angles of dip to their present attitudes. And finally, a thin layer of Pleistocene sediments covered the area as a result of a brief glacial period.

Thus, it can be seen that the Catastrophic-Wave Action Model can be effectively used to offer explanations of all the deposits at Thornton, from the allochthonous reef deposits and all of the underlying massive strata down to the Precambrian basement rocks. The incorporation of three catastrophic wave-types comforms well to the forces in action during the Flood, as revealed by Scripture. While no doubt there are weaknesses and deficiencies in the model as presently developed, it nevertheless provides a unified approach for explaining much of the sedimentary structures of the earth, as well as those of the Thornton area. A topic deserving investigation in relation to Flood deposits would be turbidity, or density, currents. Their role could be very significant in localized areas.

With the synthesis completed, an outline of the summary points of this paper follows.

Summary Points

A. Thornton Quarry deposits cannot be true reef deposits for the following reasons:

1) no solid footing available for reef growth;
2) "reef core" does not exhibit growth structures;
3) red calcareous algae, the main reef builder, is totally missing;
4) flank deposits are too steep for underwater angle of repose; and the "core" could not be the source of deposits that are stratigraphically above the core, nor the domelike structure;
5) actual exposed reef shape does not correspond to modern reefs;
6) similar massive shallow-water limestone deposits are not occurring in today's reefs;
7) the ubiquitous fossil "tar" depicts rapid and complete burial of animals before they could decay—not like the slow processes of a reef.

B. The destructive forces given in the Scriptural Flood account are these:

1) torrential rain—great erosion;
2) breaking up of fountains of the great deep—volcanism, earthquakes, landslides creating gigantic and innumerable tsunamis, turbidity currents, etc.;
3) a great wind—produced storm surges; and was probably also the primary source for late-Flood eolian deposits;
4) abating waters—great runoff erosion and redeposition creating canyons and deltas.

C. Mechanisms for massive flood deposits coinciding with and resulting from Biblical Flood events are these:

1) greatly magnified tsunamis, yielding localized catastrophic deposits up to hundreds of square miles;
2) enormous storm surges, yielding localized catastrophic deposits up to tens of square miles;
3) massive tidal undulations unrestricted by continental masses, yielding massive deposits over large areas (hundreds of thousands of square miles) and is the primary source of cyclical bedding.

D. Synthesis of Thornton Quarry deposit formation is as follows:

1) massive underlying deposits are result of tidal effects of Flood;
2) "reef" deposit is result of localized tsunami wave trains and possibly storm surges;
3) final folding of strata was result of final uplift tectonics;
4) Pleistocene deposits resulted from short, vigorous glacial period following the Flood.

Conclusion

This preliminary study on possible origins of Thornton Quarry deposits was done in an attempt to give creationists a reasonable alternative to the usual evolutionary hypothesis. While the conclusions of this study are also hypothetical, it should be noted that a satisfying synthesis of the origin of the Thornton deposits can be made from all of the known facts. These deposits do not fit the evolutionist requirement for a reef, but do fit the Biblical data given on the Flood, and the physical facts of the tremendous power and force available in highly energized and unrestrained waters. Thus, this synthesis is very satisfying from the standpoint that it can incorporate and assimilate such a variety of facts and phenomena. There is a wealth of creationist explanations and understandings available in the use of the Catastrophic Wave-Action Model.

This writer feels that the role of the tides and other wave phenomena have been too long underestimated or ignored by many creationists. Such sources of enormous power as outlined in this model should be investigated in depth. A greater understanding of the mechanisms of the Flood should not only increase our appreciation of the acts of God, but also may lead to the development of practical fields of endeavor such as "exploration Flood geology." A better understanding of the true nature of the world's deposits could lead to unique insights into the science of locating deposits of precious resources. Without a doubt, further research needs to be done on the Thornton deposits, in particular, but also in general topics such as the precipitation of limestones, evaporites, mechanics of ocean waves and turbidity currents, to name a few.

I submit the Catastrophic Wave-Action Model to researchers in creationism to test these ideas, to enlarge upon them, to refute those that are in error and to discover new ideas that can give us a better understanding of the past record of earth's history that is preserved in the rocks. This writer is confident that all future discoveries ultimately will support the truth of the Word of God, and it is toward that purpose that these ideas have been presented.

Acknowledgements

Miss Jan Klopke, an art major at the College of DuPage, Glen Ellyn, Illinois, drew many of the illustrations.

The author wishes to thank also the following people who reviewed the manuscript and offered many valuable suggestions: Mrs. Ralph Boersma, West Chicago, Illinois; Mr. Jim Canon, Wheaton, Illinois; Dr. Phillip Passon, Glen Ellyn, Illinois; and Dr. M.E. Clark, University of Illinois, Urbana, Illinois.

References

[1]Ingels, Jerome J.C., 1963. Geometry, paleontology, and petrography of Thornton Reef Complex, Silurian of Northeastern Illinois. *Bulletin of the American Association of Petroleum Geologists*, Vol. 47, No. 3 (March). p. 405. Ingels is a geologist from Casper, Wyoming.
[2]Material Services Corporation, *Brochure: This is Thornton Quarry*.
[3]Bretz, J. H., 1940. Bedrock of the (Chicago) Region. *Illinois State Geological Survey Bulletin 65*, Vol. 1, p. 65.
[4]Lowenstam, Heinz A., 1957. Niagaran reefs in the Great Lakes area. *Geological Society of America Memoir 67*, Vol. 2, p. 216. Lowenstam is a paleoecologist from California Institute of Technology.
[5]Bretz, *op. cit.*, p. 89.
[6]Cowen, Robert C., 1960. Probing the deep-sea floor. Frontiers of the sea, Doubleday & Co., Inc., New York. Pp. 114-123.
[7]Hannau, Hans W., 1974. In the coral reefs. Doubleday & Co., Inc., New York, in a chapter entitled Corals and coral reefs, by Dennis M. Opresko, Harvard Museum of Comparative Zoology. Pp. 56-57.
[8]Cowen, *op. cit.*, pp. 121-122.
[9]Nevins, Stuart, 1975. Is the Capitan Limestone a fossil reef? Speak to the Earth, edited by George F. Howe, Presbyterian & Reformed Publishing Co., p. 34. This article is also found in the *Creation Research Society Quarterly*, 8(4):231-248.
[10]*Ibid.*, p. 47.
[11]Lowenstam, *op. cit.*, p. 219.
[12]Ingels, *op. cit.*, p. 434.
[13]*Ibid.*, p. 419.
[14]*Ibid.*, pp. 412-414.
[15]*Ibid.*, p. 433.
[16]Lowenstam, *op. cit.*, p. 247.
[17]*Ibid.*, p. 219.
[18]*Ibid.*
[19]Ingels, *op. cit.*, p. 438.
[20]Whitcomb, John C., and Morris, Henry M., 1961. The Genesis Flood. The Presbyterian & Reformed Publishing Co., Philadelphia. Pp. 240-242.
[21]Bascom, Willard, 1964. Waves and Beaches; The dynamics of the ocean surface. Doubleday & Co., Inc., New York. Chapter 6, Pp. 102-121.
[22]Bernstein, Joseph, 1971. Tsunamis. (In) Oceanography: readings from Scientific American. W. H. Freeman & Co., San Francisco. Pp. 56-59.
[23]United Press International (UPI), reporting tsunamis hitting the island of Lomblen, Indonesia, after a volcanic eruption in the Flores Sea, killing the entire populations of four villages on July 21, 1979.
[24]Bascom, Willard, 1971. Ocean Waves. (In) Oceanography: readings from Scientific American. W. H. Freeman & Co., San Francisco. Pp. 45-55.
[25]Bascom, *Waves and Beaches*, Chapters 2 and 8.
[26]Whitcomb and Morris, *op. cit.*, p. 160, note no. 3.
[27]Bascom, *op. cit.*, Chapter 11.
[28]Dapples, E. C., 1955. General lithofacies relationships of St. Peter Sandstone and Simpson Group, *Bulletin of the American Association of Petroleum Geologists*, Vol. 39, No. 4, April. pp. 444-467.
[29]Wylie, Francis E., 1979. Tides and the pull of the Moon. Stephen Greene Press, Brattleboro, Vermont. Pp. 28-31 (also see Ref. 30, p. 32, 185).
[30]Macmillan, Commander D. H., 1966. Tides. American Elsevier Publishing Co., Inc. New York. Pp. 68-72, 80-88.
[31]Voss, Dr. Henry, 1978. *personal communication*. Dr. Voss is an atmospheric physicist from the University of Illinois, who is a cofounder of the Genesis Research Laboratory, Urbana, Illinois.
[32]Morris, Henry M., 1976. The Genesis record. Creation-Life Publishers, San Diego, P. 206.
[33]Dapples, *op. cit.*, p. 465.
[34]Lowenstam, *op. cit.*, p. 218.
[35]Badgley, Peter C., 1965. Structural and tectonic principles. Harper and Row, New York. P. 444.
[36]National Geographic, 1975. Atlas of the World. Fourth Edition, Washington, D.C. P. 19.
[37]Encyclopedia Britannica, 1963. World Atlas. William Benton, Publisher, Chicago, Plate 15.
[38]Clark, M.E., and H.D. Voss, 1980. Computer simulation of large-scale wave motions associated with the Genesis Flood. *Creation Research Society Quarterly* 17(1):28-40. See especially Figure 1 and the related discussion. This paper describes investigations at the Genesis Research Laboratory, Urbana Illinois.

Other Resource Materials

Treatise of Marine Ecology and Paleoecology, 1957. *Geological Society of America Memoir No. 67*, two volumes, edited by Joel W. Hedgepeth and Harry S. Ladd.
Reefs and Related Carbonates—Ecology and Sedimentation, *Studies in Geology No. 4*, 1977, of the American Association of Petroleum Geologists, edited by Frost, Weiss and Saunders. Anthology of papers from an AAPG research symposium. AAPG Bookstore Catalog Number 803.
Reefs and Evaporites: Concepts and Depositional Models, *Studies in Geology No. 5*, 1977, of the American Association of Petroleum Geologists, edited by James H. Fisher. Anthology of papers from another AAPG symposium. AAPG Bookstore Catalog Number 804.
Silurian Reefs of Great Lakes Region of North America, *AAPG Reprint Series 14*, 1975. Compiled by Heckel and O'Brien. Anthology of papers from 1963-1974 Bulletins of the American Association of Petroleum Geologists and others. The Great Lakes area is considered one of the world's classic study areas for ancient reef building. AAPG Bookstore Catalog Number 763.

Panorama of Science

(Continued from page 136)

of one hundred names are given, which overlap in these regions. For instance, the geographical name "Ada" is found in Hungary, in Africa, and in India.[6]

It will be recalled, in this connection, that the vicinity of Hungary has yielded some of the oldest archaeological remains found in Europe.

Is it possible that this community of names is a relic of the dispersal, after the Flood or after the incident at Babel? Creationists might find a worth-while field of investigation here.

References

[1]Kitts, David B., and David J. Kitts, 1979. Biological species as natural kinds. *Philosophy of Science* 46(4):613-622.
[2]Strickling, James E., 1980. After their kind and in His image. *Creation Research Society Quarterly* 17(2):106-109 (This issue.)
[3]Aristotle, *On the Parts of Animals*, Book 1, Chapter 3.
[4]Farmer, Malcolm F., 1980. Milling stones in Africa. *Anthropologiacl Journal of Canada* 18(1):9-13.
[5]Tyler, David J., 1980. Late Paleolithic barley farming. *Ceation Research Society Quarterly* 17(1):3-4.
[6]Kindler, L.M., 1980. Identical geographical names on three continents. *Anthropological Journal of Canada* 18(1):19-25.