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Non-Radiometric Data Relevant to the Question of Age

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Within the past twenty years several useful types of age-indicating data have become available. An abundance of objective research reports on these subjects can now be easily found in scientific journals and other publications. It is time for creationists to begin to make far more use of such reports than we have in the past. We have often failed to realize that these are very helpful in making estimates of the earth's age. The record of God's work in nature is far more complete, informative, and worthy of consideration than we have usually thought.

It is our purpose here to list some of the specific types of data available, giving a few selected bibliographic references for each type. These sources have been carefully chosen with a view to their being sufficient to serve as at least a "starter" for anyone wishing to pursue a given subject. Most of the sources themselves also have good bibliographies, which will readily enable any interested person to locate numerous additional articles on the subject. An effort has been made to choose those articles and monographs which consist primarily of the objective results of research rather than of theory. However, in the references in which evolutionary theory may appear, the presence of some theoretical material need not obscure the facts which were obtained in the research. The reader should keep in mind that long periods of time do not necessarily imply evolutionary development, and that all of the types of data which are listed below appear to be in keeping with the historical account of

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creation that we find in Genesis 1 and 2.

Most of the bibliographic entries are available at the geology library of practically any large university. Other materials can be obtained from the geological societies of major oil producing states, and by means of interlibrary loan. The addresses of most of the geological societies are found in a special Directory section near the back of each issue of the *American Association of Petroleum Geologists Bulletin.* Many of the sources can be used and understood without an extensive background in geology. This paper is basically a *listing* of types of data, rather than a composite monograph. There is a separate bibliography for each section. The reader will thus be able to consider any one subject separately, and locate the bibliographic references for that subject easily.

Carbonate Deposits

Drilling records from the sedimentary carbonate deposits of the Great Bahama Bank, off the coast of Florida. This is a multilayered deposit of various forms of limestone and dolomite somewhat in excess of 14,500 feet in thickness. In the deeper parts, dolomites alternate with limestones, with evidence of erosion between four major cycles of deposition. Identifiable fossils were found to a depth of at least 10,600 ft. Alternations between limestone and dolomites in this and similar formations indicate at least a corresponding number of changes of environment during deposition and during the process of dolomite formation. (See below on dolomite formation and on limestone formation.) Also, the unconformities, at the levels where erosion is revealed, must represent significant amounts of time.[1]

Ooids

The distribution and rates of formation of the small, spheroidal bodies known as ooids, oolites, or ooliths. (The term oolite is more properly used of rocks containing the individual ooids.) Most ooids are concentrically laminated, around a core of extraneous material such as a grain of sand, a small shell fragment, or a recrystallized fecal pellet. This process of adding concrete layers (which can be readily observed with a microscope) is accomplished by a slow accretion of mineral which is extracted from the sea water on the beach where the ooids are being formed. The present-day formation of carbonate ooids is observable on numerous shores where shallow water carbonate deposition is taking place. Oolitic limestone, with ooids of various types, appears at numerous levels in the Great Bahama Bank and in many other carbonate deposits.[2]

Sediments

The similarities between the order of deposition of present-day marine sediments, and the order found in deep subsurface sedimentary deposits in oil fields. These similiarities are now being used by oil research geologists for understanding and predicting the arrangement of older deposits deep in the earth. This research also deals with paleoecological topics, such as the faunal associations and ecological succession found in ancient strata, and compares them to modern faunal associations observed in shallow-water depositional environments. Even though we cannot accept all the tenets of uniformitarianism, the close similarities between modern marine carbonate deposition and these ancient deposits demand that we recognize slow, natural deposition as accounting for many thick carbonate deposits in the oil fields.[3]

Oceanic Sedimentation

The thickness and arrangement of the layers of carbonate and siliceous skeletal remains found on the ocean floor, formed by the accumulation of the shells of Foraminifera, Radiolaria, and other planktonic organisms. A comparision of the thicknesses of such deposits with current rates of deposition of these skeletons in parts of the ocean floor where there is no evidence of rapid deposition or recent disturbance is meaningful. Of special significance are the pelagic sediments found in isolated parts of the ocean, such as on the tops of certain seamounts and abyssal hills, which are far enough from land masses that the rate of deposition is not appreciably affected by currents bringing sediments from those land masses.[4]

Plant and Invertebrate Skeletons

Present-day burial and fossilization of calcareous plant and invertebrate animal skeletons in marine coastal environments, on the sea floor, and in the subsurface of modern reefs. It has sometimes been said that processes of fossilization are not occurring today, but recent studies of marine coastal environments have revealed numerous cases of the current formation of fossils.[5]

Dolomite Formation

The rate of dolomite formation in modern marine environments, combined with a study of ancient formations which exhibit alternating dolomite (dolostone) and calcium carbonate (limestone) strata. In recent years the process of natural dolomite production has been observed and studied in several marine environments which have the proper conditions for the necessary magnesium ions to be extracted from the sea water and deposited. There are many lines of very strong evidence indicating that practically all dolomites—both ancient and modern—are formed by a process of replacement of calcium carbonate particles in lime sediment or limerock. In order for dolomitization of such sediment or rock to occur there must be a ratio of Mg and Ca ions in the water which will favor the formation of dolomite, and there must be an extensive circulation of the water over the sediment or through pores in the rock. Because dolomization proceeds by ion exchange it is of necessity a slow process, and can not occur to any appreciable degree without extensive circulation of water.[6]

Deposits of Evaporites

Multilayered deposits of the (water soluble) evaporites anhydrite and salt, which often not only alternate with each other, but also alternate with (relatively insoluble) calcium carbonate layers. The Castile Formation of west Texas and southeastern New Mexico is one such deposit, the thickness being in excess of 2,000 feet in some places, including approximately

200,000 calcium carbonate-anhydrite "couplet" layers. The nature of these thin layers of anhydrite and of calcium carbonate definitely shows that they were deposited by precipitation. It should be remembered that these two substances do not precipitate at the same degree of concentration of the sea water. Calcium carbonate begins to precipitate when the sea water has been evaporated to about half the original volume, but the precipitation of anhydrite does not begin until a volume of about 19% has been reached.

Thus it is evident that a major change in the concentration of the sea water took place 200,000 times, with the concentration coming back each time to at least very near the same value. Furthermore, each of the precipitation events had to be accompanied by quiet water, for allowing the mineral to settle to the bottom to form the thin, uniform layer that it did. (The areal extent of these layers is many miles, with almost uniform thickness of any given layer maintained over at least a distance of 18 miles.) These are processes which required very considerable amounts of time.

Another very significant evaporite formation which shows conclusive evidence that it was formed slowly is that found in the Mediterranean Sea. Beneath the Sea floor in several areas core drillings have revealed repeating layers of fossil-bearing oceanic sediments interbedded with evaporite layers, showing that the Mediterranean dried up numerous times. Also, in the Balearic abyssal plain, west of Corsica and Sardinia, a "bulls-eye pattern" of evaporite deposition was found. In this deposit, layers of $CaCo_3$, $CaSO_4$, and NaCl were found *in the normal order* of precipitation when evaporation of sea water occurs. There is good evidence that this evaporite deposit is a few thousand feet in thickness.[7]

Deposits of Sandstone and Shale

Multilayered deposits of sandstone and shale. An example is found in the Haymond Formation in the Marathon region of Texas. There are approximately 15,000 thin sandstone layers alternating with approximately the same number of contrasting shale layers in this formation. The study of such a deposit requires that we carefully consider the length of time required for the clay particles, which formed each layer of shale, to settle out of suspension. The clay particles which form uniform layers such as this are extremely small, thus settling slowly, and only when a minimum of turbulence exists.[8]

Modern Coral Reefs

The thicknesses of modern coral reefs, as related to the growth rates of reef-forming organisms. The thickest deposit of this kind measured to date is that of the Eniwetok atoll, where the test drill penetrated 4,610 ft. of coral deposit in order to reach the volcanic seamount on which the reef was built. A study of such deposits in the light of present-day coral growth rates cannot produce an exact chronology of the past, but will nevertheless be very meaningful. This is because of our recognition of the stability of God's natural laws, including the laws of nutrition, respiration, and secretion in living organisms. According to detailed and extensive studies by A. G. Mayor (1924) on the growth rates of various genera of corals in the Samoan Islands (in a tropical area where conditions are most favorable for rapid growth), the fastest rate of upward growth of the reef surfaces was only about 8 mm per year.[9]

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Ancient Coral Reefs

Ancient coral reefs, such as the atolls found in the oil fields of Canada, together with the extensive deposits of evaporites and other minerals which frequently cover them. This is a geographic area where the process of comparing modern reefs and other modern carbonate deposits with the ancient has yielded spectacular results in predicting the best drilling sites (cf. reference 3). Some of the atoll reefs in the Rainbow Lake area of Alberta, Canada, are 800 ft. in thickness at the rim, and are strikingly similar to the crescent-atolls of the present-day Great Barrier Reef of Australia. The Rainbow Lake reefs contain abundant massive growths of colonial corals *in situ*, as well as crinoids, stromatoporoids, brachiopods, and gastropods. Thus, these were genuine, wave-resistant reefs which grew in ancient times, when most of central North America was covered by relatively shallow ocean waters. The multiple layers of evaporites and other thick mineral deposits which cover these reefs give witness of the long periods of time since that geological period (the Devonian).[10]

Coral Growth Bands

The growth bands exhibited by ancient and modern corals and mollusks, which appear to be an accurate indicator of the daily growth rates of these organisms, as well as of the number of days in the year at the time when the animal was living. It has been known since the beginning of this century that the corallites of some kinds of modern corals possess annual growth bands. Now, within the last decade, it has been learned that these corals possess two lesser orders of growth bands or ridges between the annual rings, the one marking the growth increments of synodical, lunar months, the other the increments of daily growth. When certain fossil corals from the deeper strata, e.g., from Devonian rocks of New York and Ontario, are examined, they are found to show growth bands very similar to those of modern corals, except that the number is approximately 400 instead of 365, apparently indicating that these corals lived at a time far enough back that there were 400 days in the year, and consequently slightly less than 22 hours in the day. (The calculations of astronomers have shown clearly that the rate of rotation of the earth is decreasing, but that the period of the earth's revolution around the sun has been essentially constant. Thus, in earlier times, though the absolute length of the year was the same as now, the earth's rotation was more rapid, making the days shorter, and also affecting the number of lunar—and tidal—months in a year.) The growth rings on the Devonian corals thus show that they lived and grew at a very early date; and the size of the rings shows that the growth rates of these corals were not very different from the growth rates of modern corals. The growth bands which have been observed on certain ancient bivalve mollusk shells are in essential agreement with the findings in corals.[11]

Organic Banks

Various types of ancient carbonate organic banks, and cyclic deposits which include layers of definite, identifiable fossils. The larger of these banks are usually spoken of as reefs in geologic literature. Examples are the famous "Horseshoe atoll" (or Scurry reef) of west Texas, the numerous Silurian reefs of Indiana, and the Capitan reef of west Texas and New Mexico. Organic banks which are moundlike in shape and enclosed in rock of a contrasting type, are usually called bioherms, though the terms reef and bioherm are often applicable to the same structure.

Some of these organic banks are very large, lie at great depths, and are components of extensive, local stratigraphic columns. For example, the Capitan reef is 350 miles long, and 2,000 ft. thick in places; and the eastern half of it lies in a large oil field, at a depth of some thousands of feet. Numerous alternating layers (cyclic deposits) of evaporites make up an extensive part of the formations which cover it. This reef has numerous bryozoan colonies and other fossils still in growth position (*in situ*). Beneath the Capitan reef there are, in some localities, more than 15,000 feet of sedimentary rock. This rock consists of numerous distinct layers of limestone, dolomite, sandstone, shale, etc., alternating with each other. Most of these deep layers underlying the reef possess identifiable fossils.

Often an ancient organic bank will be associated with, or a part of, a group of repeating depositional units called cyclothems. A cyclothem is a series of sedimentary layers which repeats itself in the stratigraphic record in a particular locality. Each cyclothem represents the depositional results of a series of changing environments in the ancient locality involved. The fact that several very similar cyclothems sometimes exist in a local stratigraphic column, and that evaporite layers and other environmental indicators frequently make up a part of each cyclothem, is conclusive evidence that these are naturally formed series representing rather large units of time. It is also significant that cyclothems contain sub-cycles.

Calcareous algal, limestone banks and mounds are often found lying deep in the strata of oil fields. These are of course a type of organic bank, having been produced by calcium-secreting algae which are similar to the many species of calcareous algae which we have today. The fossilized remains of the algae in these banks give every evidence of being *in situ*, and of having accumulated in a manner similar to the formation of algal deposits in modern tropical marine environments.

Recent extensive research has shed much light on the true nature of limestones such as those found in the organic banks. The study of the various types of organic banks, together with a comparison of the carbonate depositional processes in modern marine environments, has shown that a very high percentage of the limestone deposits of the earth was formed by the gradual accumulations of calcareous animals and plants rather than by inorganic processes. Even though diagenetic change obliterates many of the skeletons of these organisms, sufficient parts usually remain (with some of the substrate material on which they were growing) so that we can be sure, in at least many cases, that they were preserved either at or near the place where they grew. Since most limerocks have large amounts of microscopically identifiable particles, it has been observed that the layers of major limestone deposits are usually composed of normal assemblages of grains and other characteristic particles. These are frequently very similar to the assemblages found in modern carbonate rock-forming environments such as those of the Caribbean area and other parts of the world.

Often the fossils found so abundantly in a given bed of limestone make up a typical marine faunal and floral community, and a significant percentage of the delicately articulated skeletons will be intact, showing that they were not transported any long distance. Also, the lack of signs of abrasion of certain carbonate grains, such as fecal pellets, in the rock, and the lack of size sorting of the various types of grains are further evidence that the limestone was formed *in situ* without extensive transport of the materials of which it is composed. One of the most spectacular examples of evidence for the *in situ* formation of limestones, as a result of the growth of organisms, is the rounded, laminated masses of limestone which are called stromatolites. Extensive study of very similar structures being formed today in some carbonate depositional environments has made possible a detailed analysis of the ancient stromatolites. (Each stromatolite is formed by a large mass of algae growing in the water, and collecting layers of carbonate grains on its gelatinous surface as the water sweeps over it.)

The presence of layers of shale between the layers of limestone in many formations has usually aided in the preservation of the skeletal material, and in the identification of the environments in which the limestone layers were accumulated.[12]

Stratigraphic Columns

Well logs and drilling cores from oil fields, which provide us with the structure and composition of entire, *local* stratigraphic columns. In the past we have too often neglected to study the deeper parts of the local stratigraphic columns in areas where we have focused attention upon a single geologic formation. There are now available very complete records of the local columns in many geographic areas in the literature of petroleum geology. For example, Hughes (1954) gives the 16,705 ft. column of the Richardson and Bass No. 1 Harrison-Federal well, in the Delaware Basin of southeast New Mexico, as a 167 inch printed column. By devoting one inch to each 100 feet of well core he was able to show the lithology of the entire well in considerable detail. Also included are the generic names of some of the fossils, to a depth of 16,000 ft. Such records as this help make possible a study of both the chemical and physical nature of the contrasting layers in the column, as well as of some of the types of animals and plants present at the times of deposition. The availability of these well logs and drilling cores makes it possible for interested persons to study the geologic record directly, without having to depend on composite columns or abbreviated summaries.[13]

Distribution of Marine Fossils

The unequal distribution of marine fossils in limestone and other formations. An example of this is the abundance of certain kinds of very dense, thick-shelled mollusks of Class Pelecypoda in the upper strata, but an absence of the same types in lower layers. Conversely, some of the less dense animals, e. g., numerous species of arthropods of Class Trilobita, are abundant in lower strata but are not found in upper layers. Recent electron microscope studies of the chitin of trilobite skeletons give evidence for a low density for these animals. Similarly, many species of the cephalopods, of Phylum Mollusca, though very buoyant due to the air chambers of their shells, are found only in the deeper strata of the earth, indicating that they were buried before the formation of the Mesozoic and Cenozoic strata, and that they became extinct before the Mesozoic and Cenozoic strata were laid down. Thus, the unequal distribution of marine fossils is another indication of the long history which these organisms have, and the theory of some of the proponents of "flood geology" which says that the unequal distribution is largely due to densities is shown to be erroneous.

Even the very fact that many types of fossils are abundant in only a small percent of the stratigraphic column in a given locality, but not found at all in other parts of that column, should be a cause for much serious study. In such columns a great many species which are present at the lower levels are not present in the upper strata at that site, nor in the corresponding strata at other sites. The prevalence of this condition calls for recognition of a long period of time for the formation of the larger (thicker and more extensive) stratigraphic columns.[14]

Forest Deposits

The multiple forest deposits in Yellowstone National Park. The data collected during the study made by Dorf and his associates, concerning the numerous types of fossil vegetation and preserved foliage in the strata of Specimen Ridge and Amethyst Mountain, have apparently not been used to any extent by creationist writers. Whitcomb and Morris have tried to explain these forest deposits by saying the trees were floated into place during the Flood, forming a semblance of successive forests preserved in volcanic ash. The work of Dorf makes this theory completely unacceptable.[15]

Sea-Floor Spreading

The present and past rates of sea-floor spreading as exhibited in the oceanic ridges, and the thicknesses of pelagic sediments which lie upon the ocean floor at various distances from the present mid-line of the ridges. The present rate of sea-floor spreading along the Mid-Atlantic ridge is estimated to be only a few centimeters per year. The fact that the sediments are thin near the center line of the ridge, and become gradually thicker farther away from the ridge, on each side, is an indication that the spreading has been practically continuous and gradual for a long period of time. Also, the linear strips of igneous rock which lie to the west of the ridge are practically identical to the linear strips extending along the east side. Thus, one side forms a "mirror image" of the other, with respect to the chemical and magnetic nature of the parallel trends of igneous rock. This gives us much reason to believe that each pair of corresponding strips was formed at approximately the same time, from the same mass of magna along the ridge, and that the slow spreading of the floor at the rift has resulted in their now being widely separated. The above mentioned symmetry along the Mid-Atlantic ridge has been carefully mapped, and the two sides correlated for a distance of about 125 miles out from the center of the ridge.[16]

Magnetic Reversals

The geologic records of magnetic reversals in igneous bodies of rock (both on the continents and in the ocean floors), and in sediment cores taken from the ocean floor. A great many extensive rock masses of these types, which exhibit an orderly series of reversals, have been discovered during the past ten years. For example, there is a close agreement between the series of reversals found in ancient lava flows of the Rocky Mountains and those in the Atlantic sea-floor. There are many strong evidences that most of these reversals which are "frozen" into the igneous rocks are separated from one another by at least hundreds of thousands of years.[17]

K-Ar "Clock"

Even though we are presenting here a list of types of non-radiometric data, there is one phase of radiometric dating which should be mentioned, because it has apparently gone unnoticed by a great many creationists.

The discovery that the potassium-argon "clock," in rocks which effectively retain radiogenic Ar^{40}, is restarted whenever the rocks are heated (or reheated) to a temperature of 300° C., or more. Recent writers on this type of dating state that all original argon is lost, when such heating of igneous and metamorphic rocks occurs. Thus when the amount of argon present is measured, only the amount produced in the rocks since they were last heated can be detected. This characteristic is often listed as a disadvantage, because this means that potassium-argon dates can give only the length of time since the rock mass was last cooled to a temperature below 300° C. However, this feature is an advantage for those who are interested in determining how long it has been since igneous or metamorphic rock masses were in a heated condition.

Perhaps we should also mention that Dalrymple, Moore, and others recently discovered that some of the earlier potassium-argon dates obtained for igneous rocks which had been formed in deep water were very incorrect (much too old). Their research showed that whenever lava is erupted into a deep-water environment, the hydrostatic pressure, and the rapid cooling caused by the cold water, causes excess Ar^{40} to be "frozen" into the *outer parts of* the lava mass. Earlier, when this principle was not known, numerous samples of marine volcanic basalt were wrongly dated. However, now that the scientific world has been alerted to this principle, only the potassium-argon dates from continental formations and from samples taken from the interior of submarine masses of rock are considered reliable.[18]

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Biogenesis: Paradigm and Presupposition

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The major experimental approaches and presuppositions employed in current biogenetic investigation are examined from a Christian perspective. Some objections in Christian thought to biogenetic studies are examined. The view is offered that these studies are worthwhile in demonstrating the plausibility of particular models posed for the Creation process. An appeal for freedom of thought in examining the question of origins is made.

Prologue

The module hovered over planet Htrae, then gracefully set down within 300 yards of the designated landing point. The voyage had taken over 9 years, but a technique for slowing life processes allowed the two astronauts to pass the time in a quiescent state with body reactions occurring at only 1/10,000 of the normal rate. As they descended from the space craft they carried with them a number of miniaturized analytical instruments—a gas chromatograph, mass spectrometer, electron and x-ray diffraction apparatus, nuclear magnetic resonance spectrometer and an electron miscoscope. These devices were put quickly to work relaying data to Mission Control in Houston from samples in the vicinity of the landing site and later from many areas on Htrae using the Htrae Rover. Htrae, a relatively young planet 200 million years old, was considered to have an environment at birth and during life very similar to that of Earth. A dozen other teams of astronaut-analysts were on planets of similar origin whose age varied from 1 million to 1 billion years. They pursued a comon task—to gain a