GLOBAL, CONTINENTAL AND REGIONAL SEDIMENTATION SYSTEMS AND THEIR IMPLICATIONS

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The geologic record displays a trend in which certain lithologies are more prominently deposited during certain geologic periods. The trend is a worldwide phenomenon which seems to better fit within creationist views of earth history.

Introduction

Under the basic assumptions of modern geology, global and continental catastrophes are excluded as possible explanations of the deposition of the geologic strata. The Principle of Uniformitarianism, as proposed by Hutton and Lyell, would predict that lithologies similar to those deposited today are all that is found in the stratigraphic column. Modern work relaxes this constraint somewhat but still would not encourage the view of continental or global sedimentation.

The prevailing creationist view with its extremely short flood (e.g. *The Genesis Flood*) would appear to require a global sedimentation system having few exceptions. The geological column is something in between both expectations. A given lithology, found to be the dominant rock type in a certain stratigraphical position, implies some type of global system at work. There are many exceptions to the rule, but one can find nearly any rock type in any geological period. The purpose of this paper is to outline the predominant lithology.

Three assumptions are made in this paper. The first is that Nicholas Steno, who was a creationist, was correct when he set forth in 1660 the Principle of Superposition. This principle is that the oldest strata are on the bottom and the youngest strata are on top. In Figure 1 the layers 1 and 1a were deposited before bed 2 which in turn was deposited earlier than layer 3. One cannot determine by this rule whether 1 or 1a was laid down first.

Secondly, it is assumed that when terms such as "Cambrian," etc. are used, we are referring to a stratigraphic position, not an absolute age of millions of years.

The third assumption is that there is generally a difference between the usually fossiliferous Lower Cambrian and the usually unfossiliferous Precambrian. Most creationists seem to accept this idea since much effort has been expended discussing the sudden appearance of fossils at the base of the Cambrian.[1]

Beginning with these assumptions a column, similar to the existing one, can be built *without* using the much abused method of fossil correlation. In this paper, lithology alone will be the prime means of correlation. Fossils will be mentioned only when they are unique lithologic components of a rock much like the widespread occurrence of a conglomerate containing an odd purple pebble. This paper will delineate the general trend of the lithology of a given strata system.

Precambrian

Among the stratigraphically lowest rocks occurs a unique type of basalt, an igneous rock, with a chemical composition which has a much higher melting temperature than subsequent basalts.[2] Siever postulates that these occurred because the earth's temperature gradient was different on the early earth. Any number of other conditions could explain these rocks. They indicate that the conditions of the present do not apply to the earliest Precambrian.

In the Middle and Early Precambrian there occurs a rock type which is unique to the Precambrian. These are the Banded Iron Formations or Jaspillites and consist of iron ore interlaminated with a silica-rich rock such as chert or jasper. Preston Cloud notes:

> This rock has long been a major geochemical puzzle. . . . It taxes the imagination, however, to visualize what kind of chemical system might explain the observed continuity of individual iron-rich laminae, often only a fraction of a millimeter thick, for distances of hundreds of kilometers within certain prominant sedimentary basins that were being filled about 2 to 2.2 billion years ago (and less prominently, in older ones). No convincing modern counterpart is known.[3]

Banded iron formations occur in Australia,[4] India,[5] central Asia, the Urals, Siberia,[6] southern Rhodesia,[7] the Great Lakes region of North America and many other places. These are found below the fossiliferous strata. Banded iron formations do not occur ever again after the end of the Precambrian. Once again this implies that current physical conditions are not equivalent to those that existed in the past.

Above these deposits and just below the Cambrian lie a suite of lithologies that have often been interpreted as glacial deposits. Dott and Batten remark:

> The most remarkable trademark of Eocambrian rocks is the presence of peculiar unsorted boulder-bearing deposits slightly below the fossiliferous Cambrian strata. Since they were first described in northern Norway in 1891, they have been found on practically all continents. In North America they are best known in East Greenland, Utah, Nevada, western Canada and Alaska. Peculiar textures, wide distribution and local scratched surfaces beneath the conglomerates led most geologists to regard them as tills representing a major

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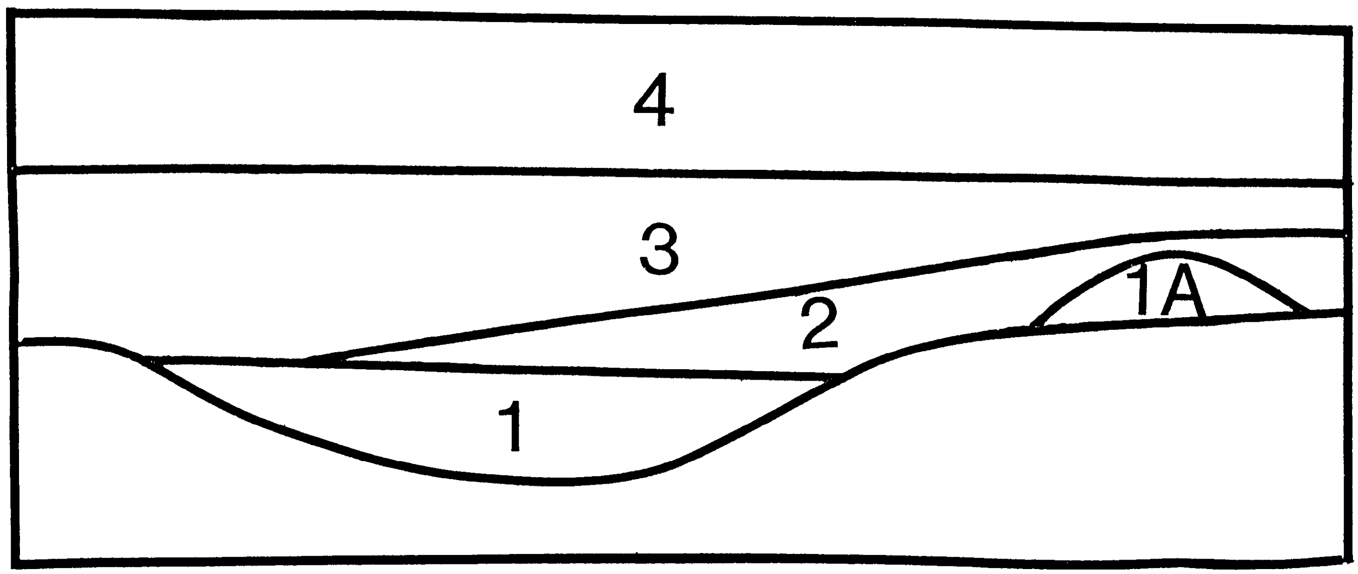

Figure 1. This illustrates the Principle of Superposition which was first outlined by Steno. Since sedimentary material is only deposited from above, the beds must have been laid down in the order shown since new material cannot be laid down below the contemporaneous water bottom.

episode of continental glaciation about 700 million years ago.[8]

Besides the above localities, these types of deposits are known from Brazil, western Australia and Africa.[9] The worldwide distribution of these "glacial deposits" argues strongly that they were caused by other agencies since it is difficult to see how life could survive a worldwide deep freeze, even in the oceans. The importance of this to the creationist is that, due to our limited time frame, several periods of glaciation might be difficult to explain.

One other interesting item concerning the Precambrian concerns the paucity of limestone. Cloud reports:

> Considered on a global scale, however, older sedimentary rocks, up to as recently as about 2.6 billion years ago, include relatively little limestone but are rich in chemically precipitated silica.[10]

In between the Cambrian and Precambrian is usually an unconformity representing a period of erosion. Archibald Geikie notes:

> In those regions of the world where the relations of the pre-Cambrian to the oldest unmetamorphosed Paleozoic rocks are most clearly exposed and have been most carefully studied, it is seldom that any conformable passage can be traced between these two great rock groups . . .[11]

Whitcomb and Morris,[12] as well as Woodmorappe,[13] have pointed out that there are several areas in the world that the Cambrian-Precambrian boundary shows no evidence of erosion. Figure 2 shows fossiliferous Cambrian lying conformably over unfossiliferous Precambrian. In these cases, if one goes lower, eventually an unconformity is reached. One then has the problem of deciding whether layers 6 and 7 are unfossiliferous Cambrian, as is layer 9, or whether it is Precambrian. Not every strata above the Cambrian contains fossils so why must every Lower Cambrian strata contain fossils? Thus it is possible that the conformable areas are really due to misidentified rock strata. In that case the unconformity could be worldwide. Rock strata are not found with labels identifying their age; human beings must decide their age.

Cambrian

Above the unconformity, one quite commonly discovers an unfossiliferous sandstone or quartzite conformably below the fossiliferous Lower Cambrian. This is the case in Kentucky where a basal sandstone (the Erwin) unconformably rests on a crystalline basement and is overlain by limestones and shales. It is true in Scotland (the Eriboll sandstone), in eastern Greenland (the Kloftelv sandstone), and Newfoundland (the Bradore Formation).[14] This is also found in Upper Volta,[15] Arctic Russia[16] and many, many other locations. However, as Ager observes:

> In fact it is even more remarkable than this, in that it is not only the quartzite, but the whole deepening succession that tends to turn up almost everywhere; i.e. a basal conglomerate, followed by the orthoquartzite, followed by glauconitic sandstones, followed by marine shales and thin limestones.[17]

With the exception of the glauconitic sandstone, I have been able to verify the widespread occurrence of that sequence in the regions mentioned above, as well as in the San Francisco Mountains, Utah,[18] Nevada,[19] England,[20] Australia,[21] Bolivia[22] and Ghana.[23] As long ago as 1903, Geikie recognized:

> The rocks of the Cambrian system present considerable uniformity of lithological character over the globe.[24]

Another aspect of the Lower Paleozoic is the widespread distribution of lithologically similar sheet sandstones. Each sheet can be traced for hundreds of miles. They are cross-stratified, nearly pure quartz sandstones which also show ripple marks and often contain scolithus, a vertical burrow. When the sands are less pure they often show desiccation features such as

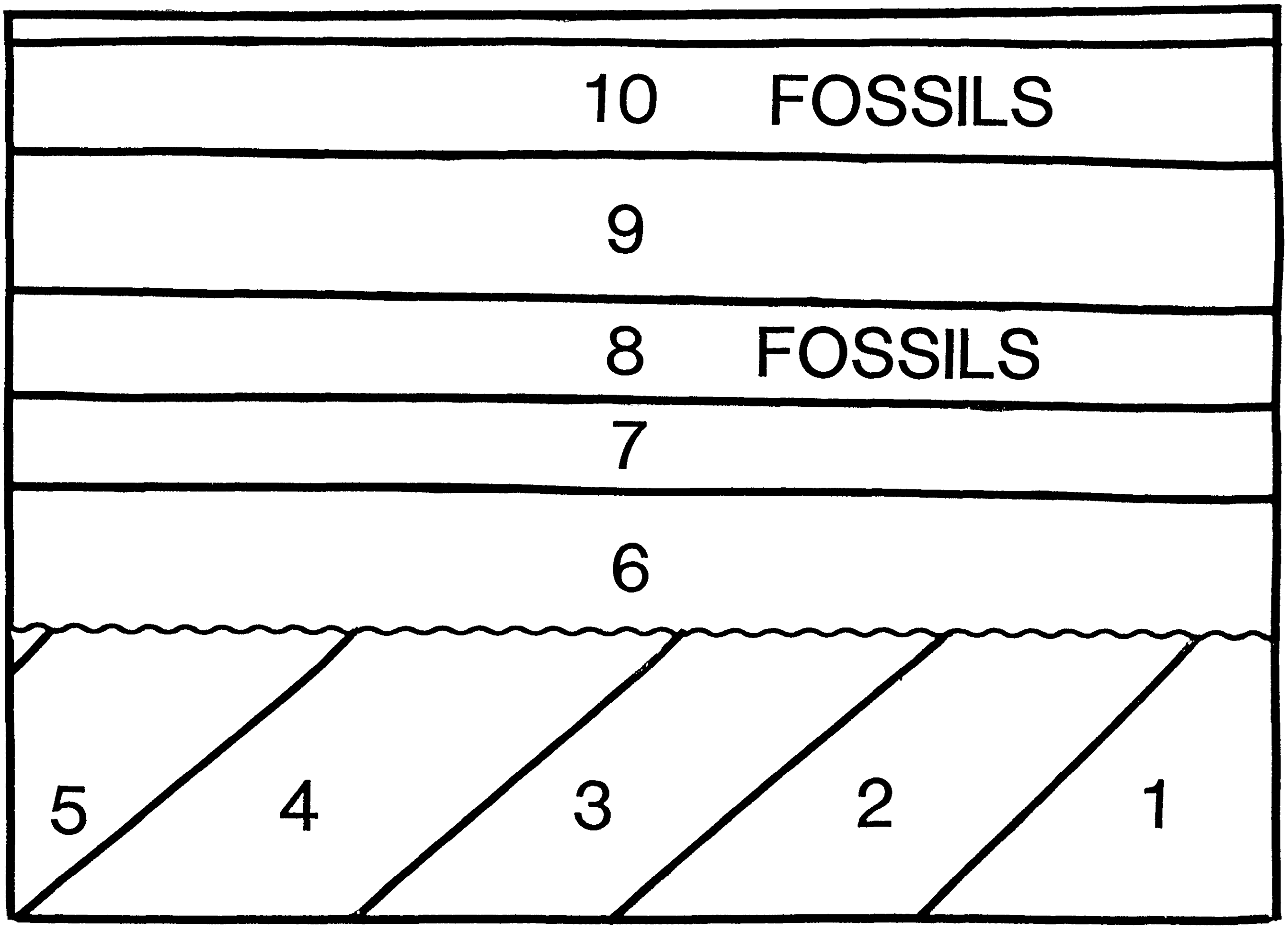

Figure 2. This illustrates the problem of trying to determine the age of beds near the Cambrian-Precambrian boundary. Beds 8 and 10 contain Cambrian fossils which requires that bed 9, which contains no fossils, be Cambrian. The question which the investigator must answer is whether beds 6 and 7 are unfossiliferous Cambrian or Precambrian as are beds 1-5.

cracks, or casts of salt or anhydrite crystals. When they are nearly pure quartz, the associated bedding shows these features. Of one of these Dott and Batten state:

> Cross stratification is one of the most prominent features of the Upper Cambrian sandstones of the craton. Cross stratified Cambrian quartz sandstones occur from Ausable Chasm in northeastern New York to the bottom of the Grand Canyon. Ripple marks are also prevalent.[25]

The Bradore Formation of Newfoundland, the Kloftelv of Greenland, the Eribol of Scotland,[26] the Larapinta of Australia[27] and the 90 percent pure quartz sand of the Precambrian Gronnes Formation of Norway[28] are lithologically similar. The St. Peter sandstone is a huge deposit of sand of Ordovician age.[29] This cross-bedded body of sand extends from the northeastern U.S. down to Oklahoma where these sands are included in the Simpson group. These sands are also found in New Mexico and then can be traced north to Canada. Similar cross-bedded Lower Paleozoic sandstones found in the Transantarctic Mountains of Antarctica contain ripple-marks, mudcracks and vertical burrows.[30] The widespread distribution of these sands with identical features points to processes operating on a global scale.

Huge bodies of sand such as these are not generally found higher in the geologic column. To this author's knowledge only one Mesozoic sandstone, the Nubian, rivals the lower Paleozoic sands in size.

Ordovician

In studying the dolomite deposits of Greenland, Scotland and Newfoundland, Swett and Smit describe the dolomites as containing flake conglomerates (the shingled fragments of mud-cracks), mottled textures, stromatolites, oolites and mudcracked surfaces. The similarities of these features led them to remark:

> The problem of the remarkable continuity of facies is not simplified by tracing these units southwestward (present coordinates). The lithologic correlations of equivalent strata in the areas of Montreal, Quebec, Shoreham, Vermont and western Maryland are not as precise as between Newfoundland and Scotland or as between Scotland and Greenland. Nonetheless, similar environments of carbonate sedimentation prevailed to the southwest during Lower Ordovician time. The

> algal and mottled structures described by Sando (1957) from the Beekmantown rocks of Maryland are similar to those of western Newfoundland, Northwest Scotland, and central East Greenland. If one also regards these as contiguous and contemporaneous deposits, he is confronted by a marine shelf environment roughly 1,500 mi in length that was within the ecological/environmental limits of cryptalgal and oolitic sedimentation. Precise modern analogues are lacking . . .[31]

In addition to a 1,500 mile shelf, similar rocks of similar age outcrop further south in the Appalachians and are found in Texas, Oklahoma and New Mexico. This makes a total length of 3,000 miles, one-eighth of the circumference of the earth.[32] Across the Arctic Ocean from Greenland, Ordovician dolomites are found on the Siberian Platform. I have not found an exact lithological description but the Siberian dolomites represent an interesting possible extension of these amazing Lower Ordovician carbonates.

Ager[33] tells of a purple and white quartzite of Lower Ordovician age which extends from England across France and Spain and then is found in Africa, a distance of at least 1,200 miles. He points out that similar rocks of similar age also occur in Bulgaria and the Canadian Rockies.

The Upper Ordovician dolomites of Western North America are wide spread. Schuchert and Dunbar report:

> As a result the Upper Ordovician is represented throughout the Rocky Mountain region and the Arctic regions of Canada by a remarkably widespread and homogenous formation of massive cliff-forming dolomite. In the northern Rockies of the United States, it is known as the Bighorn dolomite. It is recognized under local names from Mexico to Alaska and northwestern Greenland, and strangely, over this vast area seldom exceeds a thickness of 300 feet. It is everywhere characterized by a single fauna of corals, cephalopods. and large gastropods.[34]

The variation of limestone to dolomite deposition over geologic time should be noted. This ratio is shown in Table I from Chilinger.[35] Presently dolomite is deposited only in very minute quantities demonstrating a difference from the geologic past.

Table I. Calcium to Magnesium Ratio over Geologic Time.

Pre-Cambrian	4.0:1
Cambrian	4.2:1
Ordovician	3.5:1
Silurian	3.0:1
Devonian	7.0:1
Permo-Carboniferous	16:1
Cretaceous	56:1
Tertiary	53:1
Quarternary	40:1

Silurian

In the Middle Silurian the Niagaran limestone was widely distributed across North America. Pirrson and Schuchert note that the limestone occurs from Kentucky to northern Greenland and that over this distance ". . . The species are everywhere identical or much alike, whether it be in Kentucky, New York, the Hudson Bay region, or within the Arctic Circle at Polaris Bay, northern Greenland."[36]

The Upper Silurian and Lower Devonian are represented by redbeds and evaporites such as salt, gypsum and anhydrite. In New York salt-bearing shales cover the Niagaran limestone. The lower part of the Salina formation consists of bright red shale (the Vernon), while the higher part consists of shales interbedded with salt.[37] Similar deposits are found in Michigan, the eastern Baltic,[38] Japan,[39] Siberia,[40] and Australia.[41] Lower Devonian salt and anhydrite are also found in the Williston Basin of North Dakota.[42]

Devonian

The Lower Devonian was dominated by the redbed-evaporite period and one of the most interesting deposits of this period is the Old Red Sandstone of England. Raynor describes it as follows:

> Fossils are only occasionally plentiful in the Old Red Sandstone and there are great thicknesses of rock which have so far yielded none. The most common and the most useful stratigraphically are the vertebrates. Although these are sometimes referred to indiscriminantly as 'fishes,' representatives of modern groups . . . did not appear until Middle Devonian times.[43]

The 'fish' referred to is a unique type of extinct armoured fish. Identical rocks containing armoured fish are found in the Polish-Podola Depression of western Russia,[44] on the Russian Platform,[45] in Greenland, Ireland, Kashmir,[46] and Siberia.[47] Of the Kashmir occurrence, Ager states:

> There not only does the fish fauna closely resemble that of the Middle Old Red Sandstone in Scotland, but the sediments themselves are said to be exactly like the Thurso Flagstone Group of Caithness. [England][48]

The Middle Devonian Onondaga group is widely distributed over the North American continent and is uniform in character.[49] This rock extends from Oklahoma to Tennessee and Kentucky then northeastward across the Ohio Valley and into Ontario and the Hudson Valley. Outliers of this rock are found as far north as Hudson Bay. Over this distance, not only is the lithologic character the same, the same fossils are contained in the rock. Schuchert and Dunbar note:

> Furthermore, the same genera and species existed in Kentucky, Ohio, New York and the Hudson Bay region, showing no regard for latitude.[50]

Lower Mississippian

Above all of the deposits mentioned heretofore, are the Lower Mississippian limestones. These limestones contain innumerable crinoids, marine animals known as lilies. This author calculated that just one of these crinoidal limestones (the Mission Canyon of Wyoming) contained enough dead crinoids to cover the entire surface of the earth to a depth of eight centimeters (see Appendix). The Mission Canyon limestone, part of the Madison Formation, covers parts of Idaho, most of Wyoming and Montana and parts of North and South Dakota.

However, similar limestones containing primarily crinoids of Lower Mississippian age, are found in Arizona, California, New Mexico, Texas, Oklahoma, Kansas, Iowa, Missouri, Illinois, Indiana, Tennessee, Alabama and Kentucky.[51]

Similar crinoidal limestones are also found in Britain,[52] Belgium,[53] and the Urals,[54] European Russia,[55] Central Asia,[56] Egypt,[57] Australia,[58] and Libya.[59] They are found in Canada,[60] and Alaska.[61] Thus we see a major, almost worldwide, deposit of limestone which has zones of nothing more than smashed and broken crinoids.

The most amazing fact about these limestones which go under different names in all these localities has yet to be mentioned. Many of these limestones show evidence of erosion at the top, form cliffs due to their low erodibility, are overlain by redbeds and are stained red at the top of the formation. This is true in Alaska, Canada, Wyoming, Montana, Arizona (where the limestone is named the Redwall because of the stain), and Britain. In Belgium and Russia no mention was made of staining but the Belgium case shows the erosion and both are overlain by redbeds.[62, 63] In Belgium 24 Iguanodon skeletons were found in an erosional sinkhole in the limestone. Similar Lower Mississippian rocks are found in Kashmir.[64]

In addition to all these similarities one finds much chert associated with these rocks. Without even mentioning index fossils can anyone reasonably doubt that these rocks are one huge system of contemporaneous limestones? And yet this rock does contain similar fossils worldwide.

Upper Carboniferous

Above the Lower Carboniferous (Mississippian) limestones lies the majority of the Carboniferous coal. Beginning in the Lower Carboniferous and extending to the Lower Permian massive coal deposits were laid down. Apart from the coal itself one of the most fascinating features of the Upper Carboniferous is the cyclicity of the sediments during this period. Dott and Batten state:

> Beginning in Late Mississippian and continuing through early Permian times, the strata deposited over the craton and inner parts of the mobile belts displayed a *striking repetitive pattern, which is present in varying degrees in late Paleozoic strata on other continents.* Upper Mississippian deposits in the southeastern craton show clear repetitions of a sandstone-shale-limestone triplet set repeated several times vertically. . . . Practically all Pennsylvanian strata on the continent show some kind of repetitive pattern, but the most striking occurs in coal-bearing sequences. At least 50 late Paleozoic cycles are known, many of which can be traced widely over the southern craton.[65] (my emphasis)

Cyclic deposition during this period seems to be linked to coal. In the Tamworth Trough in Australia, Brown, Campbell and Crook observed:

> Probably by the end of Namurian times [Upper Mississippian-GRM] the whole trough was above sealevel and coarse clastics were everywhere being deposited. Cyclic deposition has been described, and thin coal seams recorded.[66]

Cyclic Permian deposits containing coal are found in another part of Australia, the Sydney Basin.[67] Carboniferous sedimentary cycles containing coal were laid down in Britain as well as the rest of Europe. Dorothy H. Raynor relates:

> Sedimentary cycles have been described in detail from the Middle Coal Measures of Nottinghamshire and Darbyshire, and are especially well developed in the upper part of those measures, where nine cyclothems are found in some 700 feet of strata.[68]

Even coal outside of the Permo-Carboniferous range sometimes displays cycles. Kambe and Tokuyama, in describing Triassic coals in Japan relate:

> Strata like those of the Momonaki formation formed during elevation of the hinterland and characterized by deltaic conglomerate and rhythmic coal beds, including coarse, pure sandstones alternating with muddy and coaly sediments.[69]

Coals are found contained within nearly identical facies from Texas all the way to the Donetz Basin north of the Caspian Sea in Russia and they generally lie above the crinoidal limestones. Permo-Carboniferous coals are found in Scotland, Spitzbergen, Pennsylvania, Nova Scotia, New Brunswick, Great Britain, Germany, Silesia, Moravia, France, Belgium, Russia, Spain, Brazil, Bohemia, Illinois, Michigan, Indiana, Iowa, Missouri, Kansas, Oklahoma, Arkansas, Virginia, New South Wales Australia, The Urals, China, India, Africa, Argentina, Tasmania[70] and Antarctica.[71] Obviously some world wide system was operating since coals are more widespread at this time than any other.

Even as widespread as coal is, the microstructure of coal which extends over far smaller areas is even more amazing. W. S. Gresley describes the Pittsburgh coal seam as follows:

> Given a 'bench' or layer of good bituminous coal, of very uniform quality, varying in thickness from say 22 to 27 inches, with one or two more or less irregular slaty partings or binders here and there in it; and imagine such a deposit spread out over at least 15,000 square miles. The edges or outcroppings of this layer of coal reveal no signs of a beginning or of an end; in other words, there is nothing to indicate that this coal did not originally extend hundreds of miles beyond any of its existing limits. We will not now discuss the question, 'How did this layer of coal get where it is? but we proceed at once to observe that it has a practically dead level and even surface or top. Suppose this vast expanse of dead-level coal vegetation to be completely covered or sealed over by a thin layer or band of shale, or 'slate' as miners call it. We will suppose the thickness of this film of shale to be from ¼ to ½ of an inch only. Imagine a practically unbroken 15,000+ square mile sheet of shale only ⅜ of an inch thick! On top of this shale-band let a second and equally uniform layer of the same coal as the thicker one below, be de-

posited, whose thickness is about 4 inches—a layer of coal practically free from impurities, and, in every respect, similar to the rest of the seam, regarded as a whole. Again, on top of this 4 inch band of coal conceive a second layer of shale to exist, in the thickness and kind just about the same as the shale-layer 4 inches below it. Then above this suppose we have a uniform bench of coal 3 to 5 feet high.[72]

That is the structure of the Pittsburg coal seam and it does not fit the picture of a swamp deposit. Shale cannot be deposited that uniformly over a swamp since it would be stopped by the numerous trees and channeled by the drainage pattern. A uniformitarian colleague of mine, after reading this, said, "That sounds like a precipitate, as ridiculous as that would be." He is correct—it does look like a precipitate—even though there is no known mechanism for such an occurrence. In any event something was different from current conditions in the deposition of this seam.

The final Pennsylvanian example of the persistence of a rock formation is the Altamont Limestone. Paul E. Schenk notes:

> The Altamont Limestone of the Marmaton Group, Desmoinsian Series consists of three members—in ascending order, the Amoret Limestone, the Lake Neosho shale and the Worland Limestone. The Amoret Limestone is characterized by rapid lateral changes, the Lake Neosho Shale by a medium, black phosphorite, and the Worland Limestone by very slow lateral change. Although the formation is only 1 to 13 m thick, it crops out in a narrow band over 740 km long from Iowa to Oklahoma.[73]

It is fascinating that such a thin layer could be deposited over such a distance and yet retain its lithological character.

Permian

Nearly worldwide, above the dark coal measures, lie red shales and red sandstones. Redbed deposition began locally in the Late Pennsylvanian (as is evidenced by the red rocks of this age in The Garden of the Gods in Colorado Springs) and continued primarily through the end of the Triassic with local areas of redbed deposition in the Lower Jurassic. The Permian and Triassic strata contain 50 percent of all the world's redbeds.[74]

Lithologically, one major difference between Permian and Triassic rocks is that the Permian redbeds are more often associated with salt, gypsum and anhydrite than the Triassic. The Permian also contain different fossils than does the Triassic.

The Rotliegendes formation of the Early Permian consists of extensive coarse red clastic sediments which lie on top of the coal bearing strata. Glennie describes the extent of part of this deposit.

> It has long been known that [the Rotliegendes] were deposited in a post-Variscan basin that extended from Germany to the Russo-Polish border. Following the discovery in 1959 of the Groningen gas field in the Netherlands, and the spread of exploration activity to the southern North Sea, it was confirmed that this basin also extended westwards to eastern England.[75]

He concludes by understating:

> This Rotliegendes basin was fairly large.[76]

Upon the Rotliegendes lies the Zechstein beds which contain salt interbedded with carbonates and clastics. In Germany, the Zechstein contains nearly 1,000 meters or 3000 feet of salt.[77] Amazingly, similar strata occur in Texas. Raynor notes:

> A good example is the considerable resemblance between the Permian evaporite sequences of the Zechstein basin and Texas.[78]

Permian strata containing redbeds are found also in New Mexico, Colorado, Wyoming, Utah and Idaho.[79] Also they are found in Peru,[80] South Africa,[81] southern Russia,[82] central Asia,[83] Argentina,[84] Brazil,[85] and Arabia.[86]

Salt and potash were deposited in great abundance in the Permian. Brinkmann states:

> Owing to its thick rocksalt and potash-salt deposits the Permian was the most important time for salt-formation in the geologic past.[87]

The Permian salt deposits that extend from New Mexico to Kansas are estimated to include 30,000 billion tons of salt which would require, according to uniformitarian calculations, the evaporation of an unbelievable 22,000 cubic miles of seawater.[88]

Triassic

Triassic redbeds are as equally widespread as are the Permian redbeds. They are found in central Asia (the Karduanian),[89] England (New Red Sandstone),[90] Greenland,[91] Australia,[92] North Africa,[93] India,[94] and the eastern United States. The Triassic is recorded primarily as redbeds on nearly all continents.

Ager relates some interesting features found in the Triassic.

> The basal conglomerate in England is full of boulders of a distinctive purple 'liver-coloured' and white quartzites that have been matched with the Gres de May and the Gres Armoricain right across the other side of the English Channel in Brittany (though I regard with some skepticism the notion that the boulders here traveled so far.) Along the Rio Cabriel in Spain, it is the same, but there the source quartzite outcrops immediately below. Near Belgradchik, in northwest Bulgaria, again the basal conglomerate is largely composed of exactly similar purple quartzite pebbles (resting on Permian breccias also like those of Middle England). Even if one postulates continent-wide uplift to produce the conglomerate in such widely separated places, it is very difficult to explain why the source rock is also so remarkably similar from one end of Europe to the other.[95]

The "Building Stones" of the English Keuper are amazingly similar to the "brownstone" which was used to build so many of New York's tenements. Both stones are Triassic. In Morocco, the similarities with the Triassic of eastern North America are such to make one wonder on which continent he is.[96]

The Triassic also contains the Muschelkalk, a Middle Triassic limestone of Europe that extends across Europe into the Middle East,[97, 98] and into India.[99] The pelagic Triassic is equally extensive. Geikie reports:

> Continued study of the pelagic facies of the Triassic as first encountered in the eastern Alps has shown that this type extends throughout the Mediterranean basin, extending into Asia Minor and sweeping across central and southern Asia even as far as Japan and the East Indian Archipelago.[100]

At each end of this vast extent the uppermost Triassic is the same. In Japan, Geikie describes the Rhaetic as consisting ". . . of a thick series of shales and sandstones with seams of anthracite."[101] The Triassic of Europe is described as:

> Grey sandy clays and fine-grained sandstones containing Equisetum, Asplenites, and cycads (Zamites, Pterophylum), sometimes forming thin seams of coal . . ."[102]

This is precisely what is contained in the Upper Triassic of eastern North America!

Jurassic

The Lower Jurassic was a time in which a peculiar type of deposits were laid down in widely separated localities. These are the oolitic iron ores which are not being deposited anywhere on earth today. Thus we do not know what conditions were necessary for the deposition of these ironstones. Economically they are important in Europe but are found in Canada, Scotland, Western Europe, Southern Europe, Western Russia, Siberia, northeast Africa and Australia.[103] These ironstones were more widespread at this time than any other period in earth history. They were also widespread in the early Paleozoic but at other times were quite scarce.

Ager mentions that high-quality, fine-grained lithographic limestones, such as the Solnhofen only occur in the Jurassic in limited deposits. They are found in Cerin, France; Ager, Spain; Nusplingen, Swabia; New South Wales and in the central Congo.[104] Ager failed to mention an occurrence in Dalmatia. Arkell says:

> The overlying Plattenkalke strongly resemble those at Solnhofen in Bavaria and contain some of the same species of fossils, including ammonites, and are probably of about the same age.[105]

All of these deposits are not only just Jurassic but occur only in the Kimmeridgian series of the Jurassic. Brinkman gives one final characteristic of the Jurassic.

> The petrographic subdivision into Black, Brown and White Jurassic, which originated in southern Germany, is on the whole valid for almost the entire world. In many localities dark shales predominate in the lower subdivision; brown sandstones and oolitic ironstones in the middle; and pale limestones, in the upper.[106]

Cretaceous

Above the Jurassic beds lie the Cretaceous strata. They are named for the chalk deposits which occur in this period, *creta* being the Latin word for chalk. Chalk is not the dominant lithology of this period but most of the world's chalk deposits do occur in the Upper Cretaceous and Lower Tertiary. In general the Lower Cretaceous consists of clastic sediments (sands and shales) while the Upper Cretaceous is predominantly carbonate.

Within the clastics of the Cretaceous, the sandstones are more glauconitic than are the sands of any other period. Glauconite, known only to form in marine environments, is a silicate mineral containing potassium. Thus the presence of glauconite is considered to be proof of a marine environment. When it becomes very abundant, the sandstone is known as a greensand due to the color imparted to the deposit by the green glauconite grains.

Greensands are found in Cretaceous deposits of New Jersey (Merchantville member of the Bass River Formation),[107] the Crimea,[108] central Asia,[109] Argentina,[110] northwestern Australia,[111] the Gault in England,[112] and in oil wells 100 miles east of New Jersey.[113] Greensands are also in Mali, Niger and Chad,[114] southwestern Australia,[115] New Zealand,[116] Japan,[117] Madagascar,[118] and northeastern Australia.[119]

Over the past 14 years the Deep Sea Drilling Project has drilled into the sediments in the ocean basins all over the world. They have discovered the existence of mid-Cretaceous organic rich, black shales in every ocean basin.[120] Cool observes:

> Black clays from these various locales are remarkably similar in appearance and character.[121]

These mid-Cretaceous black shales are also found onshore in the Yezo Group on Hokkaido (northern Japan), the Kennicott Formation in Alaska, the Haida in British Columbia, the Horsetown Group in California,[122] as well as in Nigeria,[123] the Alps, the Caribbean Islands, and the southern Andes.[124]

Even though other lithologies outweigh the Upper Cretaceous Chalk, the chalk is very widespread. Chalk is a very special kind of limestone composed of the shells of microscopic animals, the coccoliths. In North America the Upper Cretaceous of the continental interior includes the Greenhorn Limestone, a chalky limestone, and the Niobrara Chalk. Jenkyns notes:

> The depositional setting of both the *Greenhorn Limestone* and the *Niobrara Chalk* was clearly a large epeiric sea of low relief stretching north-south across the continent of North America. At times of maximum transgression, when pelagic oozes were being laid down, the seaway was some 5,000 km long and some 1,400 km wide.[125]

To the south of this huge chalk deposit lies the Austin Chalk which is in the same position as the Niobrara. The Austin Chalk extends from northern Texas to northern Mexico where it is known as the San Felipe Formation. In England are the white cliffs of Dover which are in the identical stratigraphical position as the Austin Chalk. The Dover Chalk is found in Ireland, England, France, Germany, Poland, Scandinavia, Bulgaria, Egypt, Israel and Georgia in the Soviet Union.[126] The Gingin Chalk in the Perth Basin Australia is in the same position.[127] as is the Issek-djal area of Russia.[128]

One of the most interesting deposits of the Cretaceous is the Hippurite limestones. This limestone is composed of billions of dead pelecypods (Hippurites). Geikie says of these:

> These Hippurite limestones sweep across the center of Europe and along both sides of the Mediterranean basin into Asia, forming one of the most distinctive landmarks for the Cretaceous system.[129]

and further:

> The Hippurite limestone of southeastern Europe is prolonged into Asia Minor, and occupies vast areas of Persia. It has been detected here and there among the Himalaya Mountains in fragmentary outliers.[130]

Tertiary

Overlying the Cretaceous are the Tertiary strata. Only in the Tertiary rocks do we see the end of the worldwide systems of deposition. Geikie relates:

> The tendency towards local and variable development, which is increasingly observable as we ascend through the series of Tertiary deposits, reaches its culmination in those to which the name of Pliocene has been given.[131]

Nevertheless, there are two rather widespread deposits, one in the Eocene and the other in the Miocene. In the Eocene unique limestones occur which are called nummulitic limestones. Much like the Lower Mississippian crinoidal limestones or the Hippurite limestone of the Cretaceous, the nummulitic limestones are the shells of billions and trillions of quarter-sized nummulites. Geikie describes these beds:

> In Europe and Asia the most distributed deposit of this epoch is the nummulitic limestone which extends from the Pyranees through the Alps, Carpathians, Caucasus, Asia Minor, Northern Africa, Persia, Beloochistan, and the Suleiman Mountains, and is found in China and Japan. It attains a thickness of several thousand feet.[132]

Eocene nummulitic limestones are also found in Australia,[133] and Crimea,[134] India and the Himalayas.[135] The pyramids of Egypt are made from nummulitic limestone.

In the Miocene a deposit, similar in origin to the chalk, formed. Like chalk, diatomite or diatomaceous earth consists of the remains of microscopic animals called Radiolarian. In beds overlying the Oligocene strata, dead radiolarians, whose shells were siliceous instead of calcareous, became so numerous that some beds are little more than dead radiolarians. Jenkyns tells us:

> The best documented example of these is the Miocene *Monterey Formation* of California. The rocks are light coloured and vary from quartzose chert, through porcelanite to soft opaline diatomites. . . . The total thickness of the formation varies considerably from place to place but locally extends to around 3 kilometres.[136]

Identical deposits of identical age are found in Japan.[137] Other Miocene diatomites are found in Kamchatka,[138] Sakhalin Island,[139] the Bering Sea,[140] Romania, Spain, Sicily, Algeria, Italy,[141] the Black Sea region, the Caucasus,[142] and Chesapeake Bay.[143]

The Southern Continents

The southern continents from Carboniferous to the Lower Jurassic have their unique sequence of sediments known as the Gondwana series. They were named for the ancient kingdom of Gond in India.

In all the southern continents the Gondwana series begins with a tillite, which is an unsorted boulder-bearing bed, lying on a scratched and grooved substrate with striated boulders. In India it is the Talchir boulder beds;[144] in Africa, the Dwyka;[145] in South America the Palmeira Formation;[146] in Antarctica the Buckeye[147] or Metschel Tillite[148] and in Australia these glacial beds have a variety of names such as the Nangetty Glacials[149] or the Zeehan Tillite.[150] The similarity of these beds is emphasized when it is discovered that even the colors of the Talchir beds in India are identical to those of the Dwyka beds in Africa.

Lying over these beds are sands and shales which contain coal and the leaves of Glossopteris and Gangamopteris. These beds are called the Damuda series in India,[151] the Ecca series in Africa,[152] Rio Bonito in South America,[153] the Coal Measures in the Artesian Basin of Australia,[154] and the Mount Glossopteris Formation in Antarctica.[155]

Overlying these are the sandstones and shales without coal, Glossopteris, or Gangamopteris leaves but containing Dicroidium (Thinfeldia) leaves. Quite often these beds contain vertebrate bones. The Beaufort beds of Africa, the most famous of these bone beds, contain vertebrate bones by the thousands.[156] In India the Panchet and Mahadev series fulfills these criteria.[157] In South America these beds have a variety of names,[158] and in Antarctica these are the Fremouw beds.[159] Many of the sands of these beds show cross-bedding such as the Cave Sandstone of South Africa.

Overlying all these beds like icing on a cake are basalt flows. These volcanics are known as the Stromberg volcanics in Africa, the Serra Geral in South America, the Kirkpatrick Basalts in Antarctica, and the Rajmahal in India.

The wide distribution of these beds is awe inspiring and one wonders what could produce such similarity of strata over such a vast area. One also wonders whether these beds might not formerly have been of greater extent. In Afghanistan a series of coal-bearing sandstones lies on top of a boulder bed remarkably similar to the Talchir beds of India. In England a Permian boulder bed, identical to the Permian Gondwana boulder beds, is found contrary to all expectations of continental drift. Geikie explains:

> The breccias just referred to have much interest in the history of geological investigation, inasmuch as they were claimed by Ramsay in 1855 as proofs of glacial action in Permian time. He pointed out their resemblance to moraine-stuff and boulder-clay, showing that the shapes of stones recall those of ice-worn boulders and pebbles, and that in many cases they are distinctly striated. . . . But the character of the striation on the stones is strongly suggestive of ice-action, as is admitted even by those who do not wholly accept Ramsay's explanation. Since his day observations have multiplied in India, Australia and South Africa, which considerably strengthen his inferences, and make it probable that in late Carboniferous or Permo-Carboniferous times a rigorous climate did really extend for a time over a large part of the southern hemisphere.[160]

The "Continental Intercalaire" or Nubian Sandstone

The final rock layer we will follow is the "Continental Intercalaire" which is part of the Nubian Sandstone. Since this section is not referenced, consult the cited books on African Geology.

The "Continental Intercalaire" consists of continental sandstones containing silicified wood of *Dadoxylon* and a fossil fish, *Ceratodus*. These beds are found in Madagascar, Tanganyika, Kenya, Sudan, Egypt, Libya, Algeria, Chad, Niger, Zaire, South Africa, and Arabia, Iraq and Jordan. In short it is found all over the African continent. In the south, these beds cover the Gondwana sediments. However, once again contrary to the predictions of continental drift, similar strata are found covering the Gondwana sequence in India.[161] In India these beds, known as the Kota sandstone and shales, contain the same fossil fish *Ceratodus* as does the "Continental Intercalaire." Thus once again similar sequences of lithology are seen on widely separated areas.

Implications

There are several implications of this systematic deposition of lithologies that we have studied. First, the present is not the key to the past. As Geikie pointed out the present depositional framework is only local and variable. Nowhere today do we see the widespread deposition of a single lithology on such a vast scale. An actualist (uniformitarianist) would claim that, given enough time, these local depositional systems would eventually cover similar vast areas. This would be wishful thinking since nothing we see being deposited today even remotely resembles what must have been taking place in the past. Dolomite, oolitic ironstones, and phosphate are but three of the many depositional systems that have either little known or no counterpart in today's world. Why is salt less abundant in Precambrian rocks than in Phanerozoic ones? We can only speculate how some of these beds came into being.

The second implication of this work is that the geologic periods used were generally determined by fossils, yet the lithology follows the fossils. Those creationists who feel that the geologic column does not exist and those who feel that index fossils do not work need to explain why the fossils *and* the lithology tend to parallel each other. Of course time will be needed to develop a satisfactory explanation for these phenomena.

The third implication is that since global systems of rock deposition exist, the deposition of the geologic column must be globally controlled. This fits our concept of global catastrophism better than it does the current actualist viewpoint even though we may not completely understand how the deposition occurred.

The number of dead organisms found in ancient rocks presents a problem to the creationist position. The trillions of dead and smashed crinoids found in Mississippian strata, the billions of hippurites and nummulites found strewn from Europe to Asia and the mass of dead microscopic animals found in Chalk and diatomaceous earth require some explanation in order to fit within our preferred chronology. These dead animals represent several times the living organic matter contained on the present earth. Once again, though, we are free to appeal to non-uniformitarian agencies to explain these items. Along with this problem is the question as to why species living today are not found in these rocks. Evolution is not the answer but a creationist answer needs to be found. In a future paper this author hopes to deal with that problem.

Appendix

Clark and Stearn estimate that the Mission Canyon formation contains an estimated 10,000 cubic miles of broken crinoids.[162] Dividing this by the surface area of the earth, 1.9695×10^8 square miles will yield the average thickness of a layer of broken crinoids if they were to be spread around evenly over the surface of the earth. This yields 5.07×10^{-5} miles thick. Converting to inches one finds that the layer is 3.2 inches thick or 8.17 centimeters thick.

References

AG— Adie, Raymond J., editor. 1964. Antarctic geology, John Wiley & Sons, New York.
AGG— Adie, Raymond J., editor. 1972. Antarctic geology and geophysics, Universitetsforlaget, Oslo.
CEM— Cloud, Preston. 1978. Cosmos, earth and man, Yale University Press, New Haven.
COAL— Francis, Wilfred. 1961. Coal: its formation and composition, Edward Arnold Ltd., London.
EE— Dott, Jr., Robert H. and Roger L. Batten. 1971. Evolution of the earth, McGraw-Hill Book Co., St. Louis.
GA— Furon, Raymond. 1963. Geology of Africa, trans. by A. Hallam and L. A. Stevens: Oliver S. Boyd, London.
GEANZ—Brown, D. A., K. S. W. Campbell and K. A. W. Crook. 1968. The geological evolution of Australia & New Zealand, Pergamon Press, New York.
GEE— Brinkmann, Roland. 1960. Geologic evolution of Europe, trans. by John E. Sanders, Hafner Publishing Co., New York.
GF— Whitcomb, John C. and Henry M. Morris. 1961. The Genesis Flood, Baker Book House, Grand Rapids.
GIPB— Mehdiratta, R. C. 1967. Geology of India, Pakistan and Burma, Atma Ram & Sons, New Delhi.
GJ— Takai, F., T. Matsumoto, R. Toriyama, editors. 1963. Geology of Japan, University of California Press, Los Angeles.
GQ— Hill, D. and A. K. Denmead. 1960. The geology of Queensland, Melbourne University Press, Melbourne.
GTB— Geikie, Archibald. 1903. Textbook of geology, vol. II, MacMillan & Co., London.
HSAG— Jenks, William F., editor. 1956. Handbook of South American geology, Geological Society of America, Memoir 65, New York.
JGW— Arkell, W. J. 1956. Jurassic geology of the world, Hafner Publishing Co., New York.
NSR— Ager, Derek V. 1981. The nature of the stratigraphical record, John Wiley and Sons, Inc., New York.
SBI— Raynor, Dorothy. 1967. The stratigraphy of the British Isles, Cambridge University Press, Cambridge.
SDTB— Schuchert, Charles and Carl O. Dunbar. 1933. Textbook of geology, pt. 2, John Wiley and Sons, New York.
SEF— Reading, H. G., editor. 1978. Sedimentary environments and facies, Elsevier, New York.
SHASS— Haughton, S. H. 1963. The stratigraphic history of Africa south of the Sahara, Hafner Publishing Co., New York.
SP— Dunstan, A. E., et al., editors. 1938. The science of petroleum, vol. I, Oxford University Press, New York.
USSR— Nalivkin, D. V. 1973. Geology of the U.S.S.R., trans. by N. Rast, University of Toronto Press, Toronto.

1. GF, p. 230-231.
2. Siever, Raymond. 1983. The dynamic earth. *Scientific American* 249(3):46-55.
3. CEM, p. 129.
4. EE, p. 508.
5. GIPB, p. 55.
6. USSR, pp. 270, 370, 557.
7. SHASS, p. 105.

8. EE, p. 198.
9. Edwards, M. B., Glacial environments, SEF, p. 433.
10. CEM, p. 114.
11. GTB, p. 908.
12. GF, p. 231.
13. Woodmorappe, John. 1983. Concerning several matters, *Creation Research Society Quarterly*, 20:53-56.
14. Swett, Keene and David E. Smit. 1972. Paleogeography and depositional environments of the Cambro-Ordovician shallow-marine facies of the North Atlantic. *Bulletin of the Geological Society of America*, 83:3223-3248.
15. GA, p. 225.
16. USSR, p. 384.
17. NSR, p. 11.
18. East, Edwin H. 1966. Structure and stratigraphy of the San Francisco mountains, western Utah, *Bulletin of the American Association of Petroleum Geologists*, 50(5):904.
19. Drewes, Harold and A. R. Palmer. 1957. Cambrian rocks of southern Snake Range, Nevada. *Bulletin of the American Association of Petroleum Geologists*, 41(1):104-120.
20. SBI, p. 55.
21. Sprigg, Reg C. 1958. Petroleum prospects of western parts of great Australian artesian basin, *Bulletin of the American Association of Petroleum Geologists*, 42(10): 2470.
22. Ahlfeld, Frederice, Bolivia, HSAG, p. 172.
23. GA, p. 229-231.
24. GTB, p. 909.
25. EE, p. 211.
26. Swett and Smit, *Op. cit.*
27. GEANZ, p. 84-85.
28. Johnson, Howard D. 1977. Sedimentation and water escape structures in some late Precambrian shallow-marine sandstones from Finmar, North Norway. *Sedimentology*, 24:389-411.
29. EE, p. 236.
30. Mckelvey, B. C., et al. Stratigraphy of the Beacon supergroup between the Olympus and Boomerang ranges, Victoria Land, AGG, p. 345-352.
31. Swett and Smit, *Op. cit.*, pp. 3243-3244.
32. SDTB, p. 157.
33. NSR, p. 10-11.
34. SDTB, p. 161.
35. Chillinger, George V. 1956. Relationship between Ca/Mg ratio and geologic age, *Bulletin of the American Association of Petroleum Geologists*, 40(9):2257.
36. SDTB, p. 187.
37. *Ibid.*, p. 186-187.
38. GEE, p. 31.
39. GJ, p. 20.
40. USSR, p. 226.
41. Powell, D. E. 1982. The northwest Australian continental margin. *Transactions, Royal Society London*, A 305: 45-62.
42. Baillie, Andrew. 1955. Devonian system of Williston basin, *Bulletin of the American Association of Petroleum Geologists*, 39(5):575-629.
43. SBI, p. 136.
44. USSR, p. 84.
45. *Ibid.*, p. 77.
46. NSR, p. 9.
47. USSR, p. 228.
48. NSR, p. 9.
49. SDTB, p. 200.
50. *Ibid.*, p. 210-211.
51. See The Mississippian and Pennsylvanian (Carboniferous) systems in the United States, 1979. Geological Survey Professional Paper 1110, chaps. A-DD, U. S. Government Printing Office, Washington, D.C.
52. SBI, p. 170.
53. GEE, p. 46.
54. USSR, p. 334.
55. *Ibid.*, p. 160.
56. *Ibid.*, p. 508.
57. GA, p. 153.
58. GEANZ, p. 158.
59. GA, p. 146.
60. Martin, L. J. 1959. Stratigraphy and depositional tectonics of north Yukon-lower Mackenzie area, Canada, *Bulletin of the American Association of Petroleum Geologists*, 43(10):2424.
61. GEE, p. 104.
62. *Ibid.*
63. USSR, Table 12, p. 100.
64. NSR, p. 8.
65. EE, p. 311.
66. GEANZ, p. 159.
67. *Ibid.*, p. 188.
68. SBI, p. 219.
69. Kanbe, Nobukazu and Akiro Tokuyama, Triassic, GJ, p. 74.
70. COAL, p. 38.
71. Barrett, Peter J., Stratigraphy and petrology of the mainly fluviatile Permian and Triassic part of the Beacon supergroup, beardmore glacier area, AGG, p. 366.
72. Gresley, W. S., 1894. The slate binders of the Pittsburgh coal-bed. *American Scientist*, 14:356-365.
73. Schenk, Paul E. 1967. Facies and phases of the Altamont limestone and megacyclothem (Pennsylvanian), Iowa to Oklahoma, *Bulletin of the Geologic Society of America*, 78:1370.
74. EE, p. 335.
75. Glennie, K. W. 1982. Early Permian (Rotliegendes) palaeowinds of the North Sea, *Sedimentary Geology*, 34:246.
76. *Ibid.*
77. GEE, p. 65.
78. SBI, p. 401.
79. SDTB, p. 276.
80. Szekely, Thomas S. 1967. Geology near Huallacocha lakes, Central High Andes, Peru, *Bulletin of the American Association of Petroleum Geologists*, 51(7):1348.
81. SDTB, p. 282.
82. Ulmishek, G. and W. Harrison. 1981. Petroleum geology and resource assessment of the middle Caspian basin, USSR, with special emphasis on the Uzen field, Argonne National Laboratory ANL/ES-116:38.
83. USSR, p. 511.
84. Harrington, H. J. Argentina, HSAG, p. 139.
85. de Oliveira, A. I. Brazil, HSAG, p. 37.
86. GA, p. 171.
87. GEE, p. 67-69.
88. SDTB, p. 281-282.
90. SDTB, p. 294.
91. Waugh, B. 1973. The distribution and formation of Permian-Triassic red beds. Canadian Society of Petroleum Geologists, Memoir 2, pp. 678-693.
92. GEANZ, p. 225.
93. Assad, Fakhry A. 1981. A further geologic study on the Triassic formations of north central Algeria with special emphasis on halokinesis, *Journal of Petroleum Geology*, 4(2):163-176.
94. GIPB, p. 83.
95. NSR, p. 6.
96. *Ibid.*
97. *Ibid.*
98. GA, p. 171.
99. Basha, S. H. S. 1983. Microfouna from the Triassic rocks of Jordan, *Revue de Micropaleontologie*, 25(1):3-11.
100. GTB., p. 1104.
101. GTB, pp. 1107-1108.
102. GTB, p. 1096.
103. Van Houten, F. B. and D. P. Battacharyya. 1982. Phanerozoic oolitic ironstones. *Annual Review Earth and Planetary Science*, 10:441-457.
104. NSR, p. 12-13.
105. JGW, p. 193.
106. GEE, p. 96.
107. Petters, Sunday W. 1976. Upper Cretaceous subsurface stratigraphy of atlantic coastal plain of New Jersey, *Bulletin of the American Association of Petroleum Geologists*, 60(1):87-107.
108. USSR. p. 115, 292.
109. USSR, p. 521.
110. GTB, p. 1218.
111. Powell, *Op. cit.*
112. GEE, p. 106.
113. Pollack, Barry M. 1980. Lithology. geological studies of the cost no. B-3 well, United States mid-Atlantic continental slope area, United States Geologic Survey Circular 833, U. S. Government Printing Office, Washington, pp. 20-23.
114. GA, p. 201.
115. GEANZ, p. 273.

116. *Ibid.*, p. 284.
117. Matsumoto, Tatsuro, The Cretaceous, GJ, p. 112.
118. SHASS, p. 264-265.
119. CQ, p. 335-336.
120. Weissert, H. 1981. SEPM Spec. Publication No. 32:547-560 in 1982 *Petroleum Abstracts*, 22(33):1681.
121. Cool, Thomas E. 1982. Sedimentological evidence concerning the paleoceanography of the Cretaceous western north Atlantic ocean, *Paleogeography, Paleoclimatology, Paleoecology*, 39:1-35.
122. Matsumoto, *Op. cit.*, p. 111.
123. Petters, S. W. and C. M. E. Kweozor. 1982. Origin of the mid-Cretaceous black shales in Benue trough, Nigeria, *Paleogeography, Paleoclimatology, Paleoecology*, 40:311-319.
124. Weissert, *Op. cit.*
125. Jenkyns, H. C., Pelagic environments, SEF, p. 369.
126. NSR, p. 2.
127. GEANZ, p. 276.
128. Hobson, G. D., USSR, SP, p. 155-166.
129. GTB, p. 1200.
130. *Ibid.*, p. 1206.
131. *Ibid.*, p. 1275.
132. *Ibid.*, p. 1223.
133. GEANZ, p. 302.
134. USSR, p. 618.
135. GIPB, p. 121-123.
136. Jenkyns, *Op. cit.*, p. 349.
137. *Ibid.*
138. USSR, p. 764.
139. *Ibid.*, p. 769.
140. Jenkyns, *Op. cit.*, p. 336.
141. *Ibid.*, p. 350.
142. Weissert, *Op. cit.*
143. SDTB, p. 416.
144. GIPB, p. 80-81.
145. SHASS, p. 200.
146. Sanford, Robert M. and Frederico W. Lange. 1960. Basin-study an approach to oil evaluation of Parana miogeosyncline, south Brazil. *Bulletin of the American Association of Petroleum Geologists*, 44(8):1330.
147. Barrett, P. J., et al., The Beacon supergroup of east Antarctica, AGG, p. 321.
148. Long, William E., The stratigraphy of the Horlick mountains, AG, p. 355.
149. GEANZ, p. 198.
150. *Ibid.*, p. 68.
151. GIPB, p. 81-82.
152. SHASS, p. 203.
153. Stanford and Lange, *Op. cit.*, p. 1324.
154. Sprigg, *Op. cit.*, pp. 2465-2491.
155. Long, *Op. cit.*
156. SHASS, p. 205-206.
157. GIPB, p. 83.
158. Stanford and Lange, *Op. cit.*
159. Colbert, E. H., Triassic Tetrapods, AGG, p. 396.
160. GTB, p. 1050-1051.
161. JGW, p. 384.
162. Clark, Thomas H. and Colin W. Stearn. 1960. Geological evolution of North America. The Ronald Press. New York, pp. 86-88.

SURVIVAL OF FRESHWATER AND SALTWATER ORGANISMS IN A HETEROGENEOUS FLOOD MODEL EXPERIMENT

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The Noahic flood destroyed all the air breathing animals except those on the ark. No doubt the flood also took a major toll on freshwater and marine organisms due to the turbulance, turbidity, changes in salinity and temperature. Some marine animals probably survived by simply tolerating changes in salinity. Survival of a marine reef fish, Blue Damsel, Abudefduf uniocellatus, was tested at different rates of freshwater dilution. It was found that the salinity where the fish lost the ability to swim was the same when exposed to dilution rates of 15 0/00/hrs (parts per thousand per hour) and 1.5 0/00/hr but was higher with the slow dilution rate of 0.031 0/00/hr. These data suggest that marine organisms could not have survived a homogeneous freshwater deluge.

A heterogeneous flood model was set up in a 55-gallon aquarium. A quantity of saltwater 20 cm deep was overlaid with freshwater and the system was exposed to outdoor summertime weather conditions in western Oklahoma. Marine algae (Phaeophyta and Chlorophyta), brine shrimp (Artemia nauplii), a hermit crab and some marine gastropods were introduced into the saltwater portion. A goldfish (Carassius auratus), two mosquito fish (Gambusia affinis), and freshwater plants were introduced into the surface layer. Although some mixing occurred, all the organisms survived four week exposure to outdoor conditions suggesting that protected pockets of marine organisms may have survived the flood by being overlaid with freshwater.

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Introduction

THE FLOOD AND LIVING ORGANISMS: The flood described in Genesis was a catastrophe of such magnitude that its effects are difficult to grasp. No doubt raging waters during the flood and the receding waters at the end of the flood shaped much of the earth's