STREAMLINING STRATIGRAPHY

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Many problems of stratigraphy could more easily be resolved if we returned to concepts of catastrophism. Until about 1800 geologists believed that all the stratified or water deposited rocks of the earth's surface were deposited in just one year's time during the Noachian Flood. This extreme form of catastrophism is not here championed, since obviously the earth has suffered other catastrophes since the Flood such as widespread droughts and vulcanism. However, many of the vexing problems of stratigraphy would be solved if we simply took the evidence we see at face value instead of attempting to fit it into the concept of uniformitarianism made popular by Sir Charles Lyell. Lack of space forbids a discussion of all the simplifications resulting from a return to catastrophism. The following are illustrative.

The phenomenon of *graded bedding,* i.e. coarse conglomerate on the bottom, with finer material graded upward is pertinent. Rodgers and Dunbar have this to say: "A reasonable explanation of graded bedding in terms of the standard processes of stream or shallow-water deposition has proved difficult. The facts seem to demand that material be dumped suddenly yet fairly evenly over a large area and then allowed to settle quietly in accordance with size, coarser before finer . . . and that the dumping be endlessly repeated though separated by intervals of complete quiet." [1] This does not sound much like uniformity where a river continues its ceaseless flow, gradually building its delta farther and farther out into the sea; nor does it sound like the constant pounding of the breakers against the shore, building littoral zone deposits. We are reminded, however, of the statement in Genesis 8:1-3 how the Creator dried up the flood-waters by strong winds that drove the waters by a "going and returning," a tidal wave in one direction, then a reversal and a wave in the other direction. Thus we get the sudden dumping, followed by a period of quiet to account for the graded bedding.

Keeping this tectonic "modus operandi" in mind, let us consider briefly another common phenomenon of stratigraphy, interbedding, otherwise known as cyclic or repetitive stratification. Sometimes a rock exposure will show a white limestone band followed by a darker band of sandstone or shale, then another band of limestone until the entire exposure will resemble the American Flag. Such exposures occur in Topanga Canyon, near Santa Monica, California, where layers of red conglomerate alternate with layers of white limestone. Geologists who have made observations along the new Alcan Highway from Canada to Alaska have noted as many as 150 such alternations or repetitions of similar strata. In fact, these types of formations are so common the world-over as to elicit no special wonderment. especially for those versed in Flood geology.

It would be difficult indeed to explain these features on the basis of uniformitarian geology, by river delta action, flood plain, or wave action at the seashore. But Genesis 8:1-3 mentioned above would seem to offer a far more logical explanation of the mechanics involved.

Two of the most notable examples of repetition of similar strata occur in the Highlands of Scotland and in the Alps. At least these regions have attracted more publicity on account of long drawn out geological controversy centering in these two regions. Not only have there been repetitions of the strata, judged from a lithological standpoint, but the fossils have also been repeated; and this violates a cardinal principle of paleontology. Five repetitions have been recorded in Scotland and six in the Alps. This presented a real challenge to orthodox geology.

Murchison and Lyell wrestled with this problem of interbedding in Scotland where gneisses and schists were interbedded with Paleozoic sandstones and limestones. They were convinced that they were dealing with a conformable series because they failed to discover any physical evidence to the contrary. But because the fossils were repeated, it was finally decided on fossil evidence alone that some earth movement had taken place to cause the repetition of the strata.

Field [2] summed up the lesson to be learned from this experience: "Geologists all over the world began to realize that correlation by lithology alone was a dangerous procedure . . . fossils were the best and safest criteria." Field further expressed a view often held by scientists concerning Genesis: "While the Protestant Reformation helped to encourage interest in geologic research, Christianity had unfortunately included in its 'Sacred Writings' the Mosaic account of the origin of the earth as well as the Deluge." [3]

Some blame for the controversy seems to have been placed on Moses' shoulders, broad enough incidentally to carry the load.

PARACONFORMITIES

To many, *Disconformities* may be a more familiar term, but the meaning is the same. Some have it "Deceptive Conformities." Geike [4] perhaps gave the best definition: "Fossil evidence may be made to prove the existence of gaps which are not otherwise apparent." With *Unconformities* there is an evident hiatus or gap in time between episodes of deposition, inasmuch as the earlier beds have been

tilted or folded, then eroded or truncated by a new deposition, exhibiting an angular discordance between the two formations. In a *Non-conformity* the sedimentary beds rest upon the igneous or basement complex. In a *Paraconformity* the physical evidence points to a continuous deposition, the only suggestion of a time gap being a sudden change in fossil types.

In the Grand Canyon, for example, no Pennsylvania fossils are to be found, the Permian fossils resting upon the Mississippian, and yet there is no evidence of erosion during that assumed hiatus of perhaps some 30,000,000 years. Even in our brief time since measurements have been recorded, coastlines are rising and sinking, in Scandinavia for instance. It is then inconceivable that the crust of the earth would remain so stable and at just the right elevation that it would be unaffected by either erosion or sedimentation for millions of years. Edward Suess [5] says such things "may well be cause for astonishment." Field has this to say concerning this paraconformity in the Grand Canyon: "Without the aid of fossils, disconformities are usually very difficult to determine—the physical evidence of an hiatus between the Mississippian and the Permian periods is therefore not represented by a well defined plane of erosion." [6] But this is not the most acute stratigraphical problem in the Grand Canyon which, incidentally, is one of the best places in the world to study stratigraphy. Below the Mississippian in most places the Devonian is not present and nowhere does the Silurian or the Ordovician appear which means that the Redwall formation which is Lower Mississippian actually rests upon the Cambrian Muav limestone, a time gap of over 50,000,000 years. Surely in this immense space of time we would expect to find effects of very extensive erosion, perhaps warping and folding with angular discordance, but what do we actually find? The appearance of a perfectly conformable series of beds, laid down in fairly quick succession. Surely there is "cause for astonishment !"

A few miles northwest of Windowrock, Arizona, in the Defiance Uplift, the Permian Supai formation rests upon the Precambrian quartzite in Bonita Canyon, near Fort Defiance. Most of the Paleozoic is missing; although in this case there is some evidence of truncation of the quartzite.

The region about Heart Mountain, Wyoming, shows the same perplexing problem of disconformities as in the Grand Canyon, where the Silurian and Davonian fossils are missing, representing a time hiatus of many millions of years, with no physical evidence to correspond. Concerning this assumed hiatus, Field has this to say: "We realize that what at first appears to be a perfectly gradational contact between the Big Horn and Madison represents a considerable stratigraphical hiatus, measured by the total absence of the Silurian and probably the Devonian sediments and fossils. This experience serves to remind us of the value of fossils in helping to determine the age of the formations, for it is extremely difficult to discover any physical evidence of even a disconformity between the sediments which were deposited in the Ordovician and those which were deposited in the Mississippian periods." [7]

The root of the difficulty here appears to be "a priori" reasoning; even reasoning in a circle. Rastall was frank enough to admit as much when he said: "It cannot be denied from a strictly philosophical standpoint that geologists are here arguing in a circle. The succession of organisms has been determined by a study of their remains embedded in the rocks, and the relative age of the rocks are determined by the remains of the organisms that they contain." [8]

THRUST FAULTING

An overthrust is conceived of as a plate or block of strata in a more or less level position that is believed to have been displaced from its original position where deposited. Normal faults involve high angle dips where one block has fallen in relation to the other, involving tension or stretching of the crust at that point. Wrench faults are concerned with fractures, along which there has been differential horizontal movement. Overthrusting presupposes a previous folding of the strata due to compression in the crust of the earth at that point. If folding continues past a certain point, the top of the fold will break over like a wave or breaker on the ocean, and the continued compression will continue to move the broken and detached upper plate over the lower section until the stress is relieved. This may require considerable horizontal movement of the upper block if the rock is competent enough, or the stress may-be relieved by numerous fractures in the moving block. If the block is soft enough or incompetent, we may find a series of small wrinkles. A very important factor governing the possible distance of movement is the coefficient of friction along the surface of movement.

Much new scientific data has accumulated recently and it has been found that there is a definite limit to the possible size of thrust blocks or distance that they can be moved before the crushing strength of the rock is exceeded. When that is exceeded the result will be a mass or rubble rather than apparently conformable strata. It is generally assumed that there would need to be a contact layer like shale or some material of low coefficient of friction plus an adequate gradient to permit the movement. I can still hear Professor Leith, structural geologist at the University of Wisconsin, remark: "One wonders what giant lubricator enabled the great mass to be translated forward many miles with no unconformity or brecciation?" Small overthrusts

are commonplace. Thus one I examined in the southern part of the Santa Rita mountains, south of Tucson, Arizona, involved Permian blocks of limestone thrust northward for a distance of about one half mile. At the contact line a three foot thick gouge layer of finely powdered rock, or mylonite, ground fine by the differential movement of the two rock plates, was exposed. Where there has been movement of many miles as is postulated for the 40-mile Lewis thrust in Glacier National Park, Montana, one would expect a gouge layer of great thickness. Where is the evidence of such a layer?

In fact, Field was greatly puzzled over the plausibility of giant overthrusts: "If this be true, it represents one of the most astonishing and impressive features in the structures of the Alps. But what caused such a tremendous translocation as to move a portion of North Africa (Hinterland) toward and finally over Switzerland (Foreland)? The question still remains unanswered. Like any other outstanding hypothesis, even when built on careful and critical research, it must be open to discussion. What caused the western jaw to move is not known. Some geologists are skeptical of the whole interpretation of the structure of the Alps because they are unable to visualize the cause." [9]

Mention has been made of the problem of interbedding and repetition of fossils in the Highlands with which Murchison and Geike wrestled until they sent Peach and Home to work out the geology. They finally suggested the Moine overthrust concept involving an imbricate series of slices or thrusts. The Harmony formation is widely found in thrust sheets of various mountain ranges of Nevada. Slivers of Harmony presumably were stripped off underlying units and forced through and overrode the eugeosynclinal rocks.[10] Hundreds of such "wrong order" formations are found.

We previously mentioned Heart Mountain in Wyoming as showing disconformities. It also has strata in the wrong order, according to fossil ages. It is capped with Paleozoic limestone and lower down is supposedly younger Jurassic and Tertiary sediments. The same is true of nearby Sheep Mountain, and last but by no means least is the aforementioned Lewis thrust extending from Glacier Park in Montana at least 500 miles along the Rockies wherein an area covering several thousand square miles is assumed to have been pushed from the west toward the east from thirty to sixty miles. The capping of the Rocky Mountain range in this section is composed of Cambrian, Precambrian, or Paleozoic strata. This mighty Rocky Mountain Cordillera rests upon a base of Cretaceus rocks, in some places showing dinosaur remains. The fossil flora of the mountain capping is mostly an algae.

Glacier Park, in the U.S.A. and Banff and Jasper National Parks in Canada are along the most scenic sections to study thrusting.

There have been many phases of geology over which controversy has raged over the years, and the subject of thrusting has been an outstanding example. This appears to have been due to three factors: 1. The concept of large-scale overthrusts never has made sense from the engineering or logical viewpoint. 2. The causes and mechanics of thrusting have never been well understood. 3. It is the only explanation of the many exceptions to the fundamental assumptions of historical geology, i.e., a more or less orderly evolution of life.[11]

Small-scale thrusts have long been observed; it was therefore reasoned, why would not the same principle apply to larger ones? This type of logic may apply to many things, but in other applications there are limiting factors. For instance in fissionable elements there is a critical size, beyond which there is danger or even certainty of an explosion. This principle applies also to thrust blocks, the larger and longer, the greater the stress of compression required to move it. Soon this stress exceeds the crushing strength of the rock, and instead of movement we get shearing or crushing. This relieves the pent up crustal stresses and no forward translation of the block would take place.

Another illustration would be a freight train. In spite of the number of engines, there would be a theoretical limit to the number of loaded cars that could be pulled because the weakest coupling would break.

This is a vital point that should always be kept in mind when we read about how a certain thrust block was propelled a certain distance: are they talking about some small thrust where physical evidences of movement can be observed such as a gouge layer or slickensides, or are they talking about an assumed thrust block where the only evidence of a thrust is not physical but theoretical, based on fossil evidence alone? By frank admission on the part of leading stratigraphers, physical evidence for thrusting is often lacking. The thrusts are assumed because "older" fossils are embedded in the upper strata and "younger" ones in the lower beds.

This point can be amply verified by statements from famous stratigraphers such as Dana, who said: "The thrust planes look like planes of bedding and were long so considered." [12] Geike came to the same conclusion: "Had these sections been planned for the purpose of deception they could not have been more skillfully devised," and in his textbook we read, "The strata could scarcely be supposed to have been really inverted save for the evidence as to their true order of succession supplied by their included fossils." [13]

In the Alps, as well as the Scottish Highlands there is an interlacing of relatively thin thrust slices, far too thin to have the internal stiffness to withstand such pressures as needed to push these.

slices so far. The same anomaly was observed in Heart Mountain, Wyoming.

Lawson sums up the subject thusly: "It seems, therefore, mechanically impossible (a priori) that a single intact prism of the earth's crust could move more than a small fraction of a mile by real overthrusting as a mobile block past a passive underlying block, owing to the fact that strain is relieved by a succession of limited ruptures and the development of an imbricated structure." [14]

William Bowie, of the U. S. Coast and Geodetic Survey, is a specialist in isostasy and the mechanics of earth movements. He has this to say: "The theory that a mountain system has been caused by lateral thrusts originating from a distance presupposes a very anomalous condition. The theory implies that the earth's crust is competent to carry thrusts that would squeeze up mountains and plateaus, and that at the same time it is so weak that it can undergo the distortion incident to the movement causing the uplift — this, it seems is an inconceivable situation because no structure that is so weak as to be distorted to this extent (folded mountains of the Appalachians) could possibly transmit the stresses necessary to hoist the mountains. From an engineering standpoint, we cannot conceive of horizontal movements originating outside of the area occupied by the mountains as the cause of a mountain uplift." [15]

The foregoing pronouncements, although sound, still do not reflect the latest information available. Such laborers as Terzaghi, Hubbert, Rubey, Moore, Birch and others have investigated the problem of large overthrusts from laboratory investigation, as well as applied mathematics. Although Hubbert and Rubey have certainly contributed much of value to the science, it appears that their conclusions have by no means been universally accepted, as evidenced by the running debates from time to time appearing in recent issues of the bulletins of the Geological Society of America.

Their computations are far too technical and mathematical to outline here, but their conclusions may be summarized. Smoluchowski discussed the problem of sliding a rectangular block along a horizontal surface. The pressure needed would equal to $\frac{F}{ac} = Wbc$. If (b) equals 100 miles, the length of the block, the strength of the block must be capable of supporting a column 15 miles high; but the crushing strength of granite will be reached in supporting a rock column only two miles high.*

One alternative proposed was gravitational gliding when a bentonite or shaly layer acts as a lubricator between the top and bottom blocks. However, Chester Longell showed that gravitational gliding down a geologically acceptable slope incompatible with known values of the coefficient of friction.

Hubbert and Rubey [16] argued from the analogy of high fluid pressures in an oil well whether the fluid be oil or water. This pore water pressure in porous rocks is assumed to cause the rocks to partially float over the lower block, and thus reduce the shearing force needed to overcome the coefficient of friction.

Terzaghi showed that low angle landslides occur in loose soils when the water pressures in the clays became great enough to reduce the frictional force pulling the block down the given slope. However, let it be pointed out that landslides in loose soils are not analogous to solid blocks. In the landslides, the discrete particles, sand grains, or larger pebbles and rocks in a semi-viscous state are free to rotate or give way in relation to the other particles when obstructions are met. In the case of the thrust in solid blocks, if a rock knob or obstruction meets an obstruction in the other blocks, nothing gives. but the coefficient of friction rises sharply and greater force is required to grind off the salient, for it would be almost impossible to find two blocks in contact that were perfectly smooth.

I examined an exposure in the Empire Mountains of Southern Arizona where the Paleozoic (Permian) limestone is mapped as having overridden a Creataceous rock formation. However, in places the contact resembled the meshing of gears. There could have been no sliding without grinding off the intermeshing projections without the creation of a thick layer of mylonite or goupe which was not in evidence. It is difficult to envision how pore water pressure could have solved this problem. The top layer fitted the bottom one like a glove or as melted metal fits a mold.

To help clarify the picture of pore water pressure, the authors have used a homely illustration. If a frozen beer can is taken from the refrigerator and set upon a glass inclined plate, it will just sit there. However, if the bottom cap is cut off it will sit there until the heat of the room begins to expand the beer in the can, when the can will start to creep down the inclined glass because the friction between the glass and can has been reduced by the pressure of the beer in the can. In other words, the can of beer starts to float down the glass. This all sounds very plausible, but Francis Birch replied to Hubbert and Rubey in a subsequent issue of the G.S.A. Bulletin contending that the beer can was not analogous to pore water pressure in rocks.

Birch also says that if the pore water pressure so weakens the underlying rock layer that less shearing force is required to start the thrust, then the upper block must also be weakened thus lowering its innate crushing strength, resulting in fracture instead of forward movement.

And so the controversy continues as in so many

***Where F=force needed, a=breadth of block, c=thickness, b=length, w=weight per unit of volume.**

lines of geology. Has there been continental drifting? Has North America drifted westward to its present position from a former junction with Europe? I was once assigned to debate on one side of this subject which still remains unsettled.

However, the possible help of pore water pressure would not eliminate the grinding effect of rock against rock. If there has been thrusting one should observe gouge layers and slickensides. If the formations appear perfectly conformable, with no physical evidences of thrusting, caution would appear to be the watchword in diagnosing a giant thrust as such based on other criteria.

In summation let us return again to the original theme, Catastrophism vs Uniformity. In the Dec. 23, 1963 issue of *Newsweek* the science editor had this to say: "Catastrophism is a fighting word among geologists. It is a theory based on divine intervention, and its adherents held that the history of the earth and life on it were moved by a series of disasters inspired by God, the last one — Noah's Flood. It was the major line of thought for a few decades last century but a vigorous counterattack by naturalists against the supernaturalists eventually pushed it aside.

"But now many geologists believe the counterattack may have been all two vigorous. In their haste to reject the hand of God, they have passed over some solid evidence that could help improve their understanding of both geology and evolution. As a result many geologists at the recent meeting of the American Geological Society were advising the rehabilitation of catastrophism, without recourse to the supernatural agent."

Norman Newell, paleontologist of the American Museum of Natural History in New York admits the past mistake of the orthodox viewpoint by saying, "Geology students are taught that the 'present is the key to the past' and they too often take it to mean that nothing ever happened that isn't happening now. But since the end of World War Two when a new generation moved in, we have gathered more data and we have begun to realize that there were many catastrophic events in the past, some of which happened just once."

How like a breath of Spring to hear paleontologists finally admit that perhaps after all the Creationists and Flood geologists have produced valid evidence that demands recognition.

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[9] Field, Ibid., pp. 224,231,234.

[10] Roberts, Ralph J., Holz, Preston E., Gilluly, James and Ferguson, H. G. ***Paleozoic Rocks of North Central Nevada.*** American Association of Petroleum Geologists. 42:3812-3857.

[11] Hedberg, Hollis D. Stratigraphic Classification and Terminology. Bulletin of the American Association of Petroleum Geologists. 42, 8:1881-1896. Quotes rule 5: "The more or less orderly evolution of life forms throughout geologic time makes fossils particularly valuable in time correlations of strata and in fossil age dating, and in placing of rocks in a worldwide geologic time scale.

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