

Geology

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By H. E. McKINSTRY

TWENTY years ago a German meteorologist, pondering over a map of the Atlantic Ocean, observed something that no less a worthy than Sir Francis Bacon had noticed four centuries before him—how neatly the projecting cape of Brazil would fit into the African Gulf of Guinea if only those seven maids with seven mops could clear away the intervening sea. In fact, the whole eastern coast of the Americas fits the western side of Europe and Africa like the two pieces of a jig-saw puzzle, if only one allows here and there the appropriate amount of stretching and fudging. Is this a coincidence, or have the continents, by any chance, ever been joined and torn apart?

Alfred Wegener¹ believed that they had and proceeded to marshal a host of reasons in support of his belief, some of them good and many of them pretty bad. In his fertile imagination he pictured the Americas, North as well as South, as a wayward portion of a great original, all-embracing continent of Pangea, which in true pioneering spirit cast loose its moorings and barged some three thousand miles westward, in which direction it is, for all anyone knows, still moving. Fantastic as the idea seemed, it was not completely novel, for something very like it had been proposed by a gentleman from Indiana, Frank Bursley Taylor of Fort Wayne, although it was not until Wegener's "Entstehung der Kontinente

und Ozeane" presented pictures of the continents in the act of fission that Taylor's dust-covered paper was unearthed and the Taylor-Wegener Hypothesis became the butt of ridicule or a great forward step in geology, depending on how one liked it.

At first blush, the thought of a continent drifting across the ocean is amusingly bizarre, yet it is not at all out of harmony with what is known of the earth's crust. That our continent actually is a floating block is pretty generally believed. Put a weight on it, say a great ice-sheet, and it sinks hundreds of feet. Remove the weight and it bobs up again. Such an experiment was tried by nature fifty thousand years ago, and the records of it are still to be read in the shorelines and gorges of New England and Canada. The continents are relatively light rock-masses composed of what the great Suess termed "sial" (the chemist will recognize the symbols Si and Al), floating like a titanic iceberg in a substratum, the "sima," which may be molten or solid (authorities differ on this), but in any case behaves like a stiff liquid toward slowly applied stresses.

All this is understood not only by the scientists but by the great Henry Ford himself, who a year ago was perturbed about the weight of sky-scrapers. "Everyone," he said, "knows that the interior of the earth is plastic. It's possible to get too much weight upon the surface. It's bound to make a dent." While Mr. Ford's alarm was rather excessive, his cosmogony was quite impeccable. The doctrine of floating blocks, technically termed "isostasy," is a minor or major article of the credo of every orthodox geologist. Not only do the continents float, but they pretty certainly move from time to time, for the folded rocks of the Alps have been squeezed be-

¹ Attention has recently been focussed on the theory of continental drift by reports of the circumstances of Prof. Wegener's death on the Greenland Ice-Cap, where his body was found by a search-party last May. He had started out, accompanied only by an Esquimo, to replenish the failing food supplies of the climatological expedition that he was leading, and never returned.

tween Africa and North Europe as between the jaws of a vise, and this goes for most mountains. *Eppur si muove.*

But the theory of continental drift was not received with hosannas. Geologists were quick to detect certain absurdities in Wegener's presentation which obscured whatever nucleus of truth it contained. Overcome with enthusiasm for the child of his brain, he saw the skin of the earth slipping about in such an irresponsible manner that at one period the North Pole was somewhere in the Pacific and at another in the coast of Alaska. This *Pol-flucht* he judiciously arranged to explain why palms once flourished in Greenland and glaciers covered the tropics in times past. No one now believes the story quite as Wegener told it, but eminent geologists have bolstered up his fundamental theory with sound evidence.

One bit of corroboration may be found in the rocks themselves. Long before any continental drift was dreamed of, geologists had felt the need for some sort of land-mass east of the present New Jersey coast from which to derive the sand and pebbles that have since been hoisted high into the Appalachian ridges; some continent which has since softly and suddenly vanished away. If Wegener was right, no lost Atlantis is necessary—Europe will do instead. The biologists, too, need a land-connection with Europe to get their animals across. Moreover, the rocks on the two sides of the Atlantic match up tolerably well—the coal beds of Wales with those of Nova Scotia and the granites of Brazil with those of West Africa.

But the most potent testimony in favor of continental drift is the existence of mountains. Most of us were taught at a tender age that the ranges which pucker the relief map are like ridges in the skin of a shriveled apple. "As the earth cooled,"

our geography teacher explained, "the inside shrank and the skin, which was now too large, made itself fit by wrinkling." That was the accepted geology of a generation ago, but investigation has proved that it doesn't work very well. As a matter of fact there is now widespread doubt that the earth ever cooled at all, or at least that it was still cooling when our most respected mountains were being formed. Even if it did cool there is reason to believe that the molten rock under such pressures as must exist in the interior of the earth would not have contracted; and even if it did contract the contraction would not have been enough to account for the amount of squeezing that obviously happened when the Alps were born, unless the appleskin was as rigid as a cocoanut shell, which it wasn't. So we have thrown away the shrunken apple, yet we have puzzled ever since as to how the mountains really got folded. Well, if a continent slides majestically along over the face of the globe it may crumple rocks before it as a moving toboggan crumples up snow. May not the great ranges of the Sierra Nevada, the Andes, and the half-drowned ridges whose peaks are Japan all be the result of the continents sliding toward the Pacific?

So far, so good. But what makes the continents move? Ah, there's the rub! Try to find a force sufficient to do the work! One of the earliest theories was this: If, as George Darwin suggested, the moon, when thrown off from the earth, left a hole which the Pacific Ocean now fills, the continents may have slumped toward the cavity. But as it is hardly likely that the earth had a crust when the moon was born, no one now takes this suggestion very seriously.

The moon was made use of in a different way by a school of enthusiasts who

believed that its pull upon the land masses tugged the Americas westward as the earth revolved—or according to some, it was the sun. In either case it would operate in the proper direction. But Harold Jeffreys, that rare young Englishman who, despite his startling custom of prefacing learned chapters with quotations from “Alice in Wonderland” and Mark Twain, is accorded the most serious consideration among his confrères, has shown that to produce the effects accredited to it tidal friction would have to be some ten thousand million times as powerful as it is—and if it were it would produce the unpleasant result of stopping the rotation of the earth within a year.

One of the soundest suggestions, based upon John Joly’s calculations, calls upon radioactivity. It is known that rocks, particularly the relatively light ones that form the continents, are radioactive, and are constantly generating heat. Once you have the heat you can use it any way that seems expedient to you. Through expansion it may cause a bulge in the middle of the continent, a hill down which the land masses may slide; or it may set up convection currents—a mighty welling up of molten rock like the column of rising liquid in a coffee percolator, which, spreading out under a continent, rends it in twain and scatters the pieces widely asunder.

All such explanations and suggestions have many doubters, but some of the objections made to them are quite as dubious. It has even been suggested that the similarity of coast line between Africa and Brazil must have been made by Satan to vex scientists. More seriously, a leading structural geologist argues as follows: “If the continental blocks had been torn apart, some pieces would have been lost in the shuffle and the coast lines modified by

subsequent erosion. Therefore, granting that they fit together now, this is a mere coincidence. But as a matter of fact, they do not fit particularly well, hence they were never torn apart.” There is no pleasing such a fellow!

The biologists, to whom the idea was offered as an aid to the migration of prehistoric animals, almost universally reject it; they don’t need any continental Noah’s Ark, thank you—the old land-bridge was much better. One paleontologist, whose taste for sarcasm has definitely escaped petrification, likes to reduce the theory to absurdity by telling how he found in New Jersey a low cliff of red sandstone in which were the heads of several fossil fishes. A few months later he found in Scotland an exactly similar cliff with the tails of the same fish. Thus he not only had proof that the continents had been torn apart, but since the Scottish fish were headed east and the Jersey fish were headed west he could advance confidently the further theory that North America had encountered a since lost turn-table in mid-Atlantic!

Scorn and skepticism aside, the most serious blow at the continental drift theory has been struck very recently. We have seen that the whole picture is built on the conception of isostasy—floating blocks in a pseudo-liquid substratum. Remove isostasy and the picture disappears in a slow fade-out. One F. Hopfner has lately been so inconsiderate as to point out a serious flaw in the calculations upon which isostasy itself is founded, and if he is right the continents are not floating blocks after all, Mr. Ford to the contrary notwithstanding.

Entirely aside from the theoretical pros and cons, there is one possible way of demonstrating that continents drift, and that is by catching them in the act. Of

course, if they are not creeping perceptibly today, that is no proof that they have never done so, but if they are still moving one need argue no longer as to their stability. In fact, this test is so obvious that one may well ask why it has not already been applied. There have been some attempts, but if a continent requires a hundred million years to travel the distance that the *Bremen* covers in four days, the ordinary methods of measuring longitude are hardly accurate enough to be convincing. Precise determinations by means of radio time signals may answer the question, though we may have to wait a century until we have travelled a perceptible distance.

Meanwhile, amid all the disagreement of doctors, what are we to think? Is the drift theory "a beautiful dream, the dream of a great poet" or are we really on a voyage from Europe, bound in the general

direction of China? Among thirteen contributors to a recent symposium of the Society of Petroleum Geologists there were three yeas, eight nays, and two men keeping open minds. Adding the favorable opinion of Daly of Harvard and Holmes of Cambridge still fails to muster a majority. Of course, the census is far from complete, but it may give some idea of the weight of opinion among authorities.

Meanwhile, we had better remain on neutral ground, with suspended judgment. The continental drift hypothesis has much the same status that the theory of evolution had early in the last century. Whether it will be found to explain so many mysteries that it will be regarded as a great contribution to world knowledge, or whether another generation will find it in the discard no one can say with finality today. It is a fascinating hypothesis, but still very definitely only a hypothesis.

A KENTUCKY CRUSADER

BY EDWIN ROGERS EMBREE

WHEN I was about six years old my mother took the youngsters of the family to live with her parents in Berea, Kentucky. As my father was dead I grew up under the hand of my grandfather, John G. Fee. He was a bearded patriarch and had fought the battles of the Lord for seventy years. He was a rock-ribbed dogmatist, but as a man he was simple, witty, and very pleasant company for a small boy. Today I don't get purple in the face when reformers are mentioned, for the friend and mentor of my boyhood was one, and I liked him.

My grandfather had been one of the few slaveholders of the South who turned Abolitionist and fought it out on the home grounds. It would have been easy for him to come North, join the society of his fellow Abolitionists and denounce the slave system from afar. But not he. He knew his convictions meant a fight, and he was ready to take his punishment where the blood was going to flow.

One thinks of the old Southern planters as standing in solid phalanx behind the slave system. But there were always a few protesters. Themselves a part of the plantation order, their stand was more disturbing than all the shouting of the Northern Abolitionists. They bored from within. They urged upon their own neighbors the evils of a system in which they had all grown up together. One of the most active and irritating of these reformers was my grandfather.

Of course, when I knew him, he was an old man. The battle was over, and he had won. He used to take me sometimes when he drove about in his one-horse phaëton through the Blue Grass towns of Kentucky. The men who called out greetings and came up to swap stories with him were those who had furiously attacked him. He took a delight in shaking down subscriptions for his church and school from the very men who had persecuted him in the earlier days. As he went about in Richmond, Kentucky, he used to say to me: "Son, that man who just gave me a hundred dollars led a mob against me in '54," or "That man who was telling the race horse story threw me in the Ohio river in '59, and told me if I ever came back to Kentucky he'd kill me with his own hands."

There were few scars, either physical or spiritual, left on the old man when I knew him. He had one big bump on the top of his bald head. An infuriated slaveholder had broken a club there fifty years before. Fortunately, the preacher had just bought a tall stiff hat, and that took most of the blow that had been meant to kill him. Of course, he was dead-set in his convictions. But he wasn't sour; he wasn't pompous; he wasn't even very pious. A good many of the local Baptists thought he was too intellectual. He never joined the sanctifiers or the shouters who were flooding Kentucky at the close of the last century.