GEOPHYSICS

The Earth Is a Soup-Kettle

Currents of Rock Boil From the Earth's Depths To Move Mountains, New Hypothesis Holds

By DR. FRANK THONE

EARTH'S INTERIOR is "boiling" like a soup-kettle, with the continents floating on the surface like flakes of scum. Only, the "soup" does its boiling in terms of millenia instead of minutes, and is thousands of times as stiff as glass instead of being fluid as water, so that its movements are naturally slow.

This is, in rough outline, the picture sketched by Prof. Arthur Holmes of the University of Durham, England, to account for the rate at which the earth is losing its heat, for the way mountains are built, and for many other things that have happened during the old planet's long geological history—and are still happening.

Scientists have known for a long time that the earth is losing heat. Not only does all the warmth poured upon its surface by the sun eventually go off into space again; a good deal more goes besides. The earth is no glowing star like the sun, and its heat radiation is of a great deal lower order, but it is there just the same, and in really measurable quantities.

Heat as Afterglow

The first theories put forward by geologists to account for this stock of buried heat which the earth is constantly spending began with the notion that at the outset the earth was hot like the sun and simply assumed that the heat now being lost was only the faint afterglow of its pristine fires—just as a stove keeps radiating for a while after its fire has gone out. The great English physicist, Lord Kelvin, based his calculation of the earth's age on this simple assumption, and arrived at a maximum figure of forty million years. This estimated age of Mother Earth might have been very flattering to her; but some of her boys, the geologists and evolutionists, protested that she couldn't possibly be that young: they had been looking into her diary, and had found a lot of things recorded that must have happened much longer ago than a mere forty million years.

The physicist had to stand pat: he could estimate how much heat the earth had had in its infancy, and here was a known rapidity of loss. Unless there was some other source he didn't know about, to add heat to the earth's original birth-gift brought from the sun, he could not change his figures.

Radium Broke Impasse

This impasse between geophysicists and geologists was broken when radium and its related elements were discovered and their activities understood. Radioactive elements break down, automatically transmuting themselves into other less active elements, and in so doing give off energy that can express itself as heat. Radium and its relatives thorium and uranium were found in at least minute amounts in practically all the rocks of the earth's crust. The old familiar element potassium was also found to be radioactive. Its radioactivity is only feeble, but there is such a lot of potassium that even this little adds up like pennies in a Scotch kid's savings bank.

Here, then, was the supplementary source of heat, that would allow for a slower spending of the original solar dowry and thereby permit Earth to claim her proper age—which is, however, not yet known with anything like final definiteness. The ancients seem to have been right when they personified Earth as a female!

The first rocks examined for radioactive contents yielded an embarrassment of riches in energy. There was too much of it to account for the earth's radiation, if all the rocks clear down to the center were as richly endowed as the surface granites and their kinstones.

But it was soon learned that this is not the case. Granitic rocks from near the surface contain far more radium and allied elements than the basalts from deeper in the crust; and the basalts in turn are very much more radioactive than are the still deeper rocks, called peridotites, that are assumed to make up the bulk of the stony material of the globe, filling all the space between the surface crust and the rigid central core, which is believed to be a solid lump of metal.

The differences in radioactive elements contained in surface and "deep" rocks is most striking. Prof. Holmes states that in average "crustal" rocks that make up the earth's surface to an estimated average depth of 35 miles there is the equivalent of one ounce of radium to ten million tons. Samples of the deeper peridotitic rock that crop out on the surface in places indicate an equivalent of an ounce of radium to a billion tons. The crustal rocks therefore are a hundred times as rich in radioactive elements as are the deep rocks that make up the mass of the earth.

Yet even with their small radium content, these deep rocks generate a terrific amount of heat. Neither must the radioactivity of the earth's metallic core be overlooked in the calculations, even though it is probably less than that of the deep rock. Prof. Holmes has likened this iron-nickel core to the cook-stove of his 'soup-kettle" earth—with the difference that it is in the kettle instead of under it.

Geophysicists as a whole are pretty thoroughly convinced that there is a solid lump of metal occupying the center of the earth for about a half of its diameter. They believe this largely because earthquake waves that travel straight through the earth, to register on a seismograph on the opposite side, behave as though they travelled through solid iron for about one-half of the earth's diameter. The metal is more than hot enough to melt, but the terrific pressure of the overlying rock depths keeps it in a solid state.

Vast Total Heat Production

But to return to the radium. Little though there is of it per ton, in the earth's core and the deep rock hundreds of miles "down in," there are dizzying numbers of tons to reckon with, and the total heat production is vast. Unless there is some mechanism for getting it to the surface and letting it radiate off into space, along with the residual heat from the earth's natal supply, part of the earth's interior would certainly be too fluid for our ultimate comfort, and the rest too stiff.

Prof. Holmes' hypothesis boldly visions the solid deep rock, the apparently rigid peridotite, as being fluid enough to "boil" with a rising motion, just like the convection currents that rise in a kettle of soup that is getting good and hot.

This sounds like a paradox, but there are plenty of familiar examples to show how it might be. Any number of familiar substances are solid enough to drive nails with, yet fluid enough to flow very slowly. One needs only to name asphalt, rosin, and the proverbial "molasses in January." This convectional "boiling" of the glassy, rigid yet fluid rock in the earth's interior can be a great deal slower than that same molasses: it has thousands, even millions, of Januaries in which to do its flowing.

In the soup kettle, the boiling or convectional currents flow upward in the middle, the area of greatest heat, then outward along the top and down the sides to the bottom again as the liquid cools a little and is replaced by fresh supplies of hotter stuff. The bottom of Prof. Holmes' kettle is the middle of the earth. The currents he visions flow toward the surface, discharge their burden of heat, then as they cool sink toward the center again. It may take many thousands of years for the kettle to bubble once; but time is one thing about which geological history is not the least stingy. The Psalmist might have been writing geology instead of religion when he spoke of a thousand years being but as a day, and as a watch in the night when it is past.

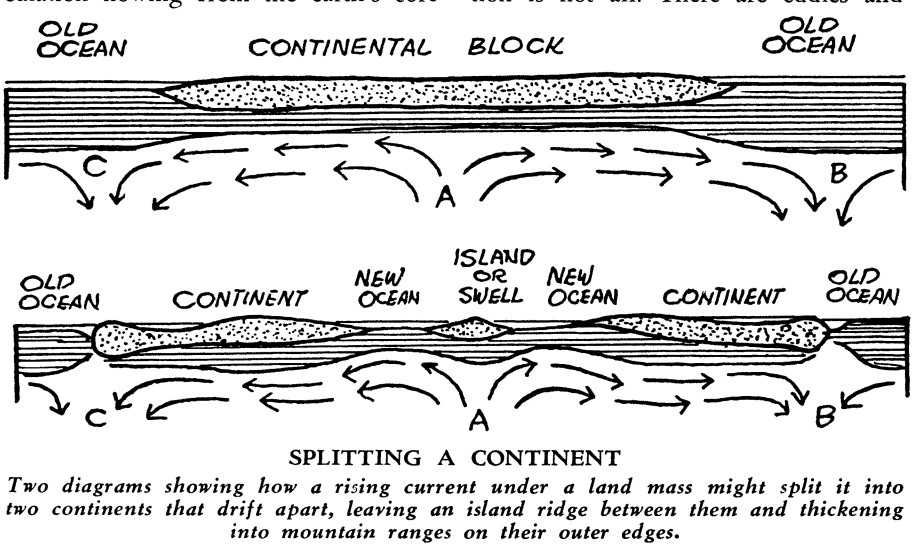
With currents thus flowing up, and along just under the surface, and then down again, they must naturally establish a regular set of circuits, just as the boiling soup in the kettle does. Prof. Holmes thinks in terms of a main circulation flowing from the earth's core toward the surface near the equator, then along the surface (or rather, just under the 35-mile crust) to the polar regions, then down toward the core again.

Scum on the Kettle

That 35-mile-thick crust of basaltic rock, that forms the bottoms of all the oceans and apparently also underlies the lighter, thinner rock masses of the continents, coats the kettle like a tough film. On top of it the granites lie, like lighter masses of scum. When the boiling from underneath heaves the basaltic film, the granitic scum-masses slide about, wrinkling their edges in the direction toward which they are sliding. Thus are mountain folds thrown up on the edge of continents, Prof. Holmes thinks; for he is one of those geologists who believe in the theory of shifting and migrating continents, most notably advocated by the great German scientist, von Wegener.

The movements in the crust due to the "boiling" underneath not only shift the continental masses about; they tear them apart, Prof. Holmes believes. A current from underneath may make two continents where only one was before, and at the same time leave an island chain or a subterranean ridge midway between them. Such an arrangement can be found, for example, in the Atlantic region, with divorced Europe and America on opposite sides of the ocean, and a ridge bearing most of the long series of mid-Atlantic islands, from Iceland to St. Helena, running along the bottom of the ocean between them.

But the main equator-to-pole circulation is not all. There are eddies and counter-currents, both near the surface and below it, that can be called on to account for many of the details of mountain-building and other geological features. One of Prof. Holmes' colleagues performed a very interesting experiment that anybody can repeat. He laid a couple of strips of canvas along the top of a table, with their ends dropping down through a crack in the middle. These represented currents of the deep rock "soup," meeting and sinking toward the earth's core. On top of these he laid several layers of thick woollen cloth, to represent strata of the earth's crust. Then he pulled the ends of his canvas strips: the current in the "soup" was flowing downward. The superimposed cloth layers folded into beautiful "mountains," closely similar to actual geological foldings known in the Swiss Alps!



SPLITTING A CONTINENT

Two diagrams showing how a rising current under a land mass might split it into two continents that drift apart, leaving an island ridge between them and thickening into mountain ranges on their outer edges.

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GENETICS

Few People Have Pure Blue Eyes

BLUE EYES, even the Delft blue eyes of Holland, are seldom all blue. As a rule they contain at least a touch of yellow, and this color combination is a hereditary affair.

At the meeting in Ithaca of the Sixth International Congress of Genetics, Dr. G. P. Frets, of the Maasoord Mental Hospital at Poortugaal, Holland, told of his search for really pure blue eyes and the extreme rarity he discovered to exist, even in a country running as strongly to blonds as does his native land. Almost all the supposedly blue eyes he examined had more or less yellow pigment in them, usually in the central rim of the iris.

The question arose in his mind whether even eyes that have no detectable yellow in them are not simply "the extreme minus variation" of originally yellow-overlaid eyes, just as a yellow tulip is basically a red-and-yellow one with almost all the red eliminated. But he did find some eyes that are "racially blue"—all blue, with no yellow traceable in their ancestry and none discoverable in their descendants. Such really blue eyes, however, are rarer than flawless emeralds.

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