IS THE EARTH'S SHAPE CHANGING?

BY J. F. SPRINGER.

We have been so accustomed to regard the earth as globular, or at most as a sphere symmetrically flattened, that it is somewhat startling to be told that there is perhaps something of a polyhedral form to it. Back in the seventies, Mr. Lowthian Green discussed at length the proposition that the contraction of the earth subsequent to its condensation into a spheroidal form has been in the direction of a regular tetrahedron. We must not understand from this, however, that if we could station ourselves off somewhere in space, and view the earth as a whole, we should see, in accordance with this hypothesis, a geometrical tetrahedron having four perfectly flat surfaces, each an equilateral triangle. Nor are we to expect a geometrically exact tetrahedron, even if we imagine the water drawn off and nothing left but the solid earth, that is, the lithosphere. No; the hypothesis means a deformation tending in this direction. But Mr. Green's conception attracted but little solid scientific attention, being regarded perhaps as too grotesque for serious consideration. More recently, however, Mr. J. W. Gregory has recalled attention to this view in a paper read before the Royal Geographical Society. The present article will, in the main, and without being exhaustive, set forth arguments there brought forward.

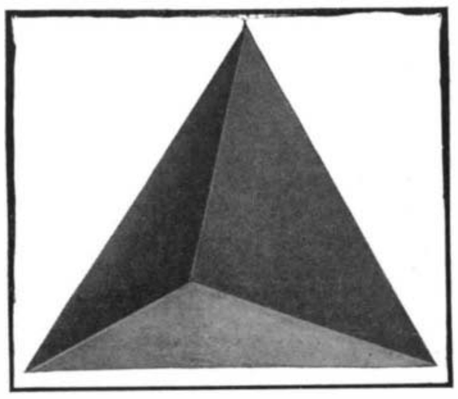

Fig. 1.—Top view of a regular tetrahedron.

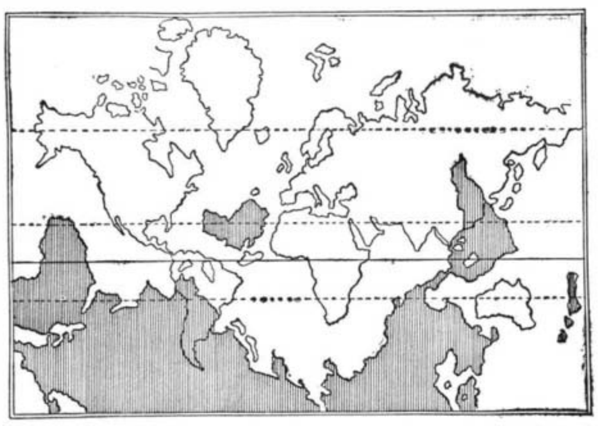

Fig. 2.—Mercator's projection showing antipodal "shadows" which would be drawn upon the globe by the opposite ends of lines passing through the center of the earth from points on the coasts of land surfaces.

First, consider the regular tetrahedron of geometry. There are four equal faces, each of which is an equilateral triangle, Fig. 1. It is the regular geometrical solid which has the least number of faces, that is, four. The cube, which is the next simplest—being formed of squares—has six faces. Now, the sphere is the solid which has the smallest surface with a given volume. The regular tetrahedron, on the contrary, is that regular solid which has the greatest surface with a given volume. By referring to the figure, it will be observed, too, that every vertex is opposite a face and *vice versa*. Further, the nearer one goes to the center of a face, the nearer he will approach the center of the entire solid.

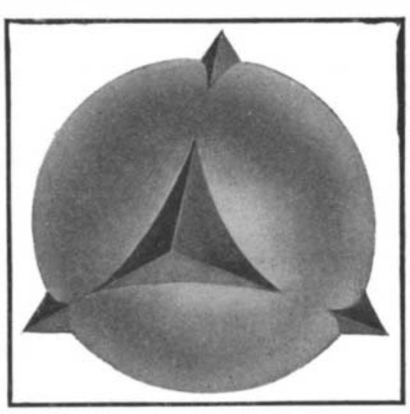

Fig. 3.—Tetrahedron projecting through sphere.

Now, if the solid rocky mass of the earth—the lithosphere—were of such a form, gravitation would increase as one approached the center of each face, as such a course would bring him nearer the center of gravity. Consequently, water lying on such a surface would tend to collect at the center. However, the form of the exterior surface would be approximately spherical. And the deepest points of such oceans would be at the centers of the triangular faces. Now, our earth does not present precisely the aspect suggested. But, on the other hand, let us consider some of the facts.

If we refer to a geographical globe, or even to a plane map of the world, we shall see that the hemisphere north of the equator contains nearly all the land, and the hemisphere south nearly all the water. This is a tremendous fact in geography, and has probably arisen from, at most, a few causes. If we follow the northern boundaries of Asia, Europe, and North America, we shall find that there is an almost unbroken zone of land extending around the earth. Thus, North America and Asia are separated by an insignificant distance. Continuing eastward, we find land without a break until we pass from Europe to Greenland *via* Iceland. Here a moderate stretch of sea intervenes between Scotland or Norway and Iceland. But this break is only apparent. There is in reality a ridge—now submerged—connecting Iceland and Scotland. There is thus a ridge circling, almost if not entirely without breaks, the lithosphere along moderately high parallels of latitude. From this the continental land masses depend in three groups—North and South America, Europe and Africa, Asia and Australia—thus accounting for almost the entire land surface of the globe.

Consider now another great fact in geography. The continental masses are, roughly, triangular masses or combinations of triangles, the bases being toward the north. North America and South America are evidently triangles thus arranged. Europe—including Iceland and the British Isles—may be regarded as a triangle, or better perhaps as a series, with the vertices in the Mediterranean Sea. Africa needs no comment. Asia tapers off in the peninsula of India and in the Malaysian peninsula and islands, etc. Australia has its triangular vertex in the island of Tasmania. The Arabian peninsula is to be included with Europe, as will now be explained. From the Arctic Ocean to the Caspian Sea Europe is depressed. Then from the Persian Gulf there is a depression which almost enables a connection to be made with the Caspian Sea. By dividing the land mass Eurasia along the neighborhood of the meridian, 50 deg. E., the Arabian peninsula will fall to Europe, forming the vertex of a triangle having for its base Iceland and the Arctic shore of Europe. To view Asia as a single great triangle, the vertex is to be placed in the neighborhood of Java and Celebes. The Philippines would be included in this Asiatic triangle. The base of the Australian triangle is north of the continent itself, as certain of the islands in that direction belong to the continental platform, of which Australia itself is merely the largest portion extending above the sea level. Greenland is to be included with North America.

With the exception of the land lying in the Antarctic Ocean, we have thus accounted for nearly all the prominent protuberances of the lithosphere. That is to say, almost the whole of the prominences may be regarded as separable into three groups of two triangles each. Each group consists of a northern and a southern section; and all six triangles have their bases to the north and their vertices to the south.

Further, between the two triangles of each group is a marked separating depression. In the New World this depression is the basin of the Caribbean Sea. It might be thought that a consideration of the Rocky Mountain highland with that of the Andes would prohibit the idea of a severance. But it is held that these two mountain systems do not constitute in effect a single chain—what might be looked on as connecting links being short ranges running from east to west, instead of north to south. The Euro-African combination is separated by the Mediterranean and Red Seas. The remaining combination of triangles is divided by a deep channel known as Wallace's Line, which cuts in between Asia and Australia, throwing Java and Celebes and the Philippines to Asia and New Guinea to Australia.

Now, these are marked features of the lithosphere, and stand out conspicuously upon even a superficial examination. They are to be explained by some great fact of the earth's history.

But let us turn now to consider the depressions on the surface of the lithosphere. These are prominently marked out by the three great oceans. These are also triangular, but with their bases to the south and their vertices to the north. Thus, the great basin of the Pacific constitutes one immense triangle, its two sides sloping to the vertex at Bering Strait. The Atlantic forms two triangles. One has its base in the region of the Antarctic Circle, and tending to a vertex between the eastern projection of South America and the western projection of Africa; the other triangle has its vertex between Greenland and Iceland, for we must remember the ridge sloping to the northwest from Scotland to Iceland. The Indian Ocean with its base, or bases, along the Antarctic Circle tapers northward to the Arabian Sea and Bay of Bengal. All of these triangles have their bases to the south and running east and west, with their vertices to the north.

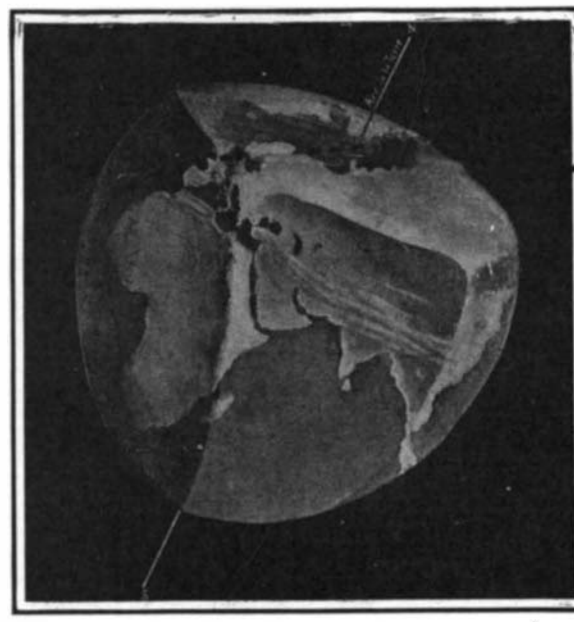

Fig. 4.—How the earth would appear as a tetrahedron.

Thus is accounted for nearly the whole of the sea. We have to add that the three oceans are connected at the south. The triangular depressions correspond then to the triangular elevations. There are three main divisions of each. The one set has its bases practically connected at the north with its extremities to the south. The other reverses these conditions.

A further fact in geography, and which is a notable one, consists in the antipodal relation of land and water. If we imagine a diameter running through the earth, one extremity being, say, at Cape Hatteras, the other extremity will of course be the antipodal point of this cape. Suppose now that the American end of this diameter moves along, tracing out the continent of North America. The other extremity will, of course, trace out a reversed North America on the opposite side of the globe. If this process be carried out for all the land surfaces, we shall find that, with the exception of the southern part of South America (perhaps one-third of the entire area), these antipodal shadows lie in the oceans, Fig. 2. There is no other considerable exception, unless the Arctic and Antarctic regions shall be found to furnish them. This would seem to be a remarkable fact. The correspondence is such as must be expected to arise if the causes of depression of an ocean bed on one side of the earth should react through to the opposite side and cause there an elevation—not so great, perhaps, as the de-

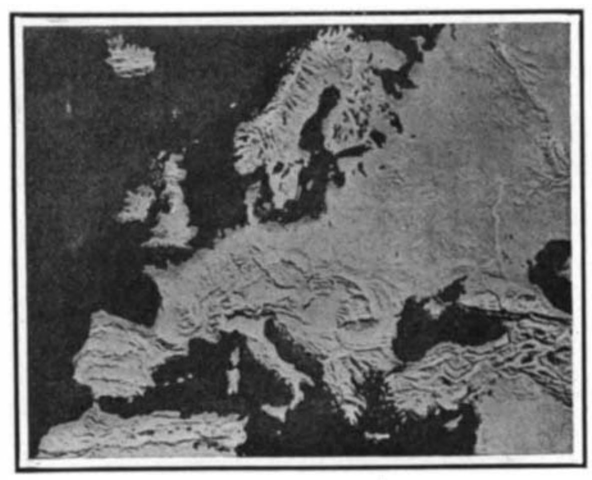

Fig. 5.—Europe as it is.

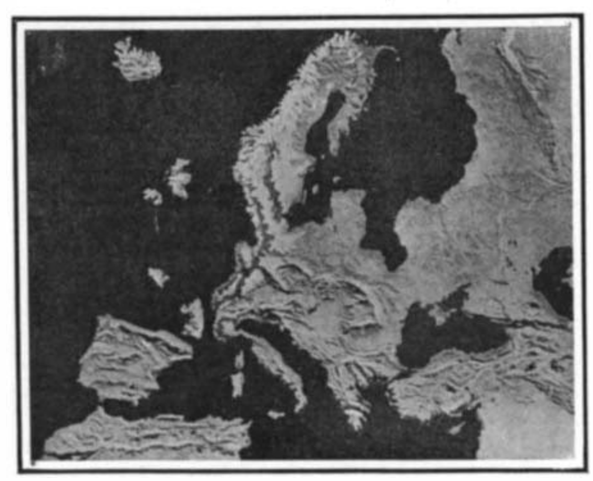

Fig. 6.—Europe as it will be.

pression, as some of the pressure would radiate off in other directions, and thus lack conspicuous expression.

Now, the tetrahedral hypothesis proposes to explain some, if not all, of these large facts. It is assumed that a more or less solid crust was formed, the earth being still, perhaps, in an approximately spheroidal form. If the interior goes on contracting, the external shell will be too large. But it is possible that it be maintained at the same size and with a smaller content if arranged in a form different from the spheroidal. One of the best of the forms permitting the same shell with a diminished interior is the regular tetrahedron. Perhaps this was not assumed at once, as at first the contraction would not be sufficient to demand a form having a fixed surface with a minimum interior. And perhaps the facts do not demand a consummation as yet.

Assuming that there is existent a well-advanced tendency of the lithosphere—not including the water—to take this form, we shall be able to explain some of the facts.

For the oceans would lie one on each face, with their depths in the center. They would be four in number. This would seem to agree with the requirements, if we postulate the Arctic Ocean as covering the region of the North Pole. If these did not fill their basins, the portions of the tetrahedron protruding would form the continents, each continent consisting of a corner with portions running off along the three edges meeting there. If the amount of water forming the hydrosphere were sufficient to cause each ocean to overflow the three sides of its containing triangle, but not enough to cover the corners, then we should have them all connected with each other, and each somewhat triangular in shape. The continents would be four in number and triangular in shape, Fig. 3. These would correspond to (1) North and South America, (2) Euro-Africa, (3) Asia-Australia, (4) Antarctica. To this it may be objected that North and South America constitute, not one triangle, but two. Likewise with Nos. 2 and 3. In reply to this, it may be suggested that we are not to assume that the tetrahedral tendency has reached completion. There may be at present more than four faces.

It will be observed that, since in a regular tetrahedron a corner lies opposite to a face, the continents are antipodal to the oceans, Fig. 2.

It is, perhaps, time for us to state distinctly just where on our present earth we may conceive the various corners to lie. First, we place one corner in coincidence with the South Pole. We thus account for Antarctica and the Arctic Ocean opposite. The three remaining corners we arrange thus: one on the Labrador peninsula, another in Scandinavia, and the third in Manchuria. They are thus not far from 120 deg. separated from each other. There are geologic reasons for this disposition. The rocks of these regions are of the most primitive character and of great extent, seemingly fitted to become the foundations of great land areas.

Now, it might be thought that if this hypothesis of a tetrahedral earth be true, we should find some evidence of a ridge running from corner to corner. By examining a map of North America, it will be found that there is such a ridge extending from east to west in the neighborhood of 50 deg. N. latitude, the rivers on each side flowing in different directions. In Asia extending across from east to west is a divide sending the rivers to the north of it to the Arctic Ocean. It may be that the Telegraphic Plateau in the North Atlantic is to be regarded as evidence of such a ridge connecting Scandinavia and Labrador.

As to the ridges extending from the northern corners toward the South Pole, the three double continents themselves supply evidence. Now, it might reasonably be thought that the divergence of the three ridges from each of the northern corners would give rise to a confusion of river flow. And the facts are in fair agreement with this. Also, it might just as reasonably be supposed that farther south—since the ridges are separate and extend north and south—there would be water flow to east and west. In South America this is the case. Likewise, Africa corresponds well to this requirement. Australia exhibits, perhaps, no very clear evidence.

Consider now the triangle formed by the three northern corners and their connecting ridges. With certain exceptions to be mentioned later, the principal mountain ranges in the north are parallel to these ridges. Thus, in Asia we have the Himalayas extending roughly from east to west. In Europe the same may be said of the Carpathians, the Alps, and the Pyrenees. The Ural Mountains, the Rockies, and the Appalachians are apparent exceptions. But these are said to belong to a different era of mountain formation.

There is another line of evidence which may be thought to have some bearing. This is in reference to polar flattening of the earth. This flattening was suspected because in 1672 a clock which was known to be a correct time-keeper in Paris was observed to lag two minutes per day in French Guiana. If a terrestrial radius in the latter locality were longer than one at Paris, this loss might be accounted for, since in the one case the strength of gravity would be feebler than in the other, thus causing the clock to run more slowly. By actually measuring a degree of latitude in a far northern country and again near the equator, certain French astronomers were able to show, from the fact that the former was longer, that the earth was flattened at the North Pole. By carrying out the same process at the Cape of Good Hope, it was shown that there was flattening at the South Pole also. Now, these facts can be explained—and adequately, perhaps—by the oblateness induced by rotation when the earth was in liquid and plastic stages. But it has been shown that the southern flattening is not so great as the northern. Here is where the tetrahedral hypothesis enters with its Arctic depression and Antarctic elevation.

Now, it is quite possible, perhaps, that this hypothesis can not be made—in its present form—to explain everything, and can even be made to appear inconsistent with facts. But that would not necessarily mean that it is not a step in the right direction, containing a germ of real truth. Perhaps it may need modification. However, until the logic of inescapable facts intervenes, this may be looked on as a tenable and possible, though perhaps not complete, explanation.

BELIN'S IMPROVED APPARATUS FOR THE ELECTRICAL TRANSMISSION OF PICTURES.

(Concluded from page 440.)

are made n times larger or smaller than the corresponding parts of the transmitter, the copy will be correspondingly enlarged or reduced, but it will always remain as sharp as the original because the aperture is in contact with the film.

It was necessary to make some other additions to the primitive apparatus in order to allow the operators to exchange signals. For this purpose a system of bell signals is employed, operated by the synchronizing relay and a switch which connects the line either with a call or with the photographic apparatus, like the switch moved by the hook of the telephone.

In the recent experiments between Paris and Lyons the sender called up the receiving station by a prolonged ringing and the receiving operator replied with three short rings, and then waited until the sending operator had started his apparatus. The movement of the apparatus was indicated at the receiving station by a series of rings, the frequency of which increased with the speed of the motor, and gave to the operator an idea of the speed to be employed, while his commutator enabled him to obtain perfect synchronism. Then the photograph was transmitted in the manner above described.

M. Belin sent a portrait from Lyons to Paris in 5 minutes and 20 seconds, and a landscape photograph was then sent from Paris to Lyons in 9 minutes and 15 seconds. At the end of each transmission the circuit was broken and both operators were informed of this fact by the return to zero of the needles of their amperemeters.

It is not, however, necessary for the operator to observe the needle, as the motor simply goes on and when the cylinders have arrived at the end of their course they continue to rotate without advancing.

Lightning arresters and fusible plugs are added to each station.

M. Belin expects soon to repeat his experiment between Paris and London, Vienna and Rome. The object of the tele-stereograph is to reproduce not only photographs and half-tone pictures, but also all designs in black and white, including writing, printing, engraving, and process engraving. For this purpose the apparatus can be simplified.

At the transmitting station the lever, the wheel, the rheostat, and the resistance coils are omitted. Their place is taken by a simple and quick acting interrupter. The apparatus becomes, in fact, a Morse key worked automatically. At the receiver the graded screen is replaced by a narrow slit in a diaphragm placed before the lens. The transmitter is so arranged as to close the circuit when the tracing point enters the depressions, and to break it when the point passes over the raised lines. In this method, which is necessary for line drawings, the result is independent of the height of the relief. At the receiving station the luminous pencil may be arranged to fall upon the slit when the current is closed and to move away from it when the circuit is broken, or by a simple adjustment of the oscillograph, the rays may be thrown upon the slit when the circuit is broken and away from it when the circuit is closed. In the former case the lines of the original picture are represented in the copy by white lines on a black background; in the latter case they appear as black lines on a white ground. Either method may be used according to the object in view and also according to the direction of rotation of the cylinder, by which the direction of the lines may be reversed.

It is evident that when the apparatus is thus used for transmitting writing and line drawings by simply opening and closing the circuit, its operation is entirely analogous to that of an ordinary telegraph. It may, if desired, be operated by a relay and even by wireless impulses.

As various systems derived from the inventions of Caselli and Meyer have recently been proposed, it is proper to insist upon the fact that Belin's method is entirely new and original. It is not necessary to execute the drawing or writing with insulating ink or with metal foil. A special, rapidly-drying ink may be used on any paper which can be easily stretched over the transmitting cylinder. Hence the new apparatus is a universal telegraphic instrument, since it transmits equally well writing, drawings, and photographs.

Official Meteorological Summary, New York, N. Y., May, 1909.

Atmospheric pressure: Highest, 30.26; lowest, 29.63; mean, 29.93. Temperature: Highest, 83; date, 14th; lowest, 40; date, 2nd; mean of warmest day, 74; date, 15th; coolest day, 46; date, 2nd; mean of maximum for the month, 68.0; mean of minimum, 52.8; absolute mean, 60.4; normal, 59.8; excess compared with mean of 39 years, 0.6. Warmest mean temperature of May, 65 in 1880; coldest mean, 54 in 1882. Absolute maximum and minimum of May for 39 years, 95, and 34. Average daily excess since January 1, 2.2. Precipitation: 1.72; greatest in 24 hours, 1.22; date, 21st and 22nd; average of May for 39 years, 3.29. Accumulated excess since January 1, 0.23. Greatest precipitation, 9.10, in 1908; least, 0.33, in 1903. Wind: Prevailing direction, northeast; total movement, 9,169 miles; average hourly velocity, 12.3; maximum velocity, 48 miles per hour. Weather: Clear days, 7; partly cloudy, 11; cloudy, 13; on which 0.01 inch or more of precipitation occurred, 11. Thunderstorms: 1st, 6th, 14th, 28th. Dense fog: 1st, 9th. Mean temperature of the spring, 49.40; normal, 48.73. Total precipitation of the spring, 10.84; normal, 10.69.

Ozonizing a City's Water Supply.

The water supplied to Nice (105,000 inhabitants) and several smaller French cities is now purified by ozone, in addition to filtration. The following method has been adopted by the city of Chartres (24,000 inhabitants). The water is pumped from the river Eure into sedimentation basins which are contained in a building of ferro-concrete, with a double roof which keeps the water fairly cool in summer and prevents it from freezing in winter. The building has windows of yellow glass, yellow light being unfavorable to the development of bacteria. In these basins about 1,600,000 gallons of water are clarified in 24 hours. The water flows thence through coarse coke filters and fine sand filters to the ozonizing apparatus. The coke filter beds are cleaned, when they become choked, by exposing them to the air and washing away the oxidized impurities with a current of water. The sand filters are cleaned by powerful jets of compressed air and water, directed upward.

The ozonizing plant is constructed in duplicate, so that one section is always ready for use. The water trickles down through four beds of pebbles which have an aggregate thickness of 14 feet and are supported by perforated floors in a tower, at the bottom of which ozonized air enters under pressure. The ozone generator is a cell of glass 6 feet long, 3 feet wide and 6 feet high. It contains five elements, each composed of three cast iron plates. The middle plate is connected with a transformer which furnishes an alternating current of 20,000 volts; the outside plates are connected to earth. Between the iron plates are glass plates covered with tinfoil. Ozone is produced by the alternating electric discharges between the plates. The outer iron plates are perforated to allow the ozone to escape, and the middle plate is cooled by a current of water from a tank insulated by triple bells of porcelain. Air is forced into the generator under a pressure sufficient to carry it, laden with ozone, through the water tower. One grain of ozone is used for 8½ gallons of water. The primary circuit of the transformer is connected with an alternator which produces a monophase current of 250 volts and 500 cycles. It is of interest to note that the price charged for water, about one cent for 44 gallons, has not been increased since the installation of the ozonizing plant.

British Patent Law Opposed.

The Lord Chief Justice, Baron Alverstone, delivered an address on May 28th before the section of the International Chemistry Congress which is dealing with legislation affecting chemical industry. He spoke strongly against the revoking clause of the new British patent law, saying he considered it a backward step which would result in people keeping their inventions secret. The scientists present were unmistakably hostile to the British patent law, and a resolution was unanimously adopted recommending that committees of the various countries adhering to international conventions agitate in favor of a general understanding providing that manufacture in one country belonging to the union protects the patentee against the revocation of his patent in other countries of the union.