and since, except in beryls, it is not found in minerals which do not contain radioactive elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radioactive equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radioactive elements, is permanent and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Professor Strutt, may lead to determinations not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneerink work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant, spirit abroad which leads men to make with confidence experiments which would have been thought fantastic twenty years ago. It has quite dispelled the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an approach to finality in science. The sum of knowledge is at present, at any rate, a diverging not a converging series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasized by every advance in science, that "Great are the Works of the Lord."

THE ORIGIN OF THE EARTH'S LAND FORMATIONS

By Dr. C. D. PERRINE

ARGENTINE NATIONAL OBSERVATORY, CORDOBA

THE peculiar and very irregular distribution of the land and water areas of the earth's surface as well as their forms and constitutions have attracted attention since man has known of their existence as such. Explanations to account for some of these conditions have been made from time to time, but none has been wholly satisfactory and for some no explanation has been attempted. The object of this note is to put on record the chief points of a general theory which occurred to me some years ago, and which appears to explain satisfactorily a number of observed facts. It is recognized that the difficulties in the way of substantial proofs are very great. For this and other reasons of scientific caution, the hypothesis is presented tentatively for further study and future confirmation or rejection. It is my belief, however, that, in general and radical as it is, it will be confirmed, because some of the evidence is of considerable weight and I have so far found none which is prohibitory.

Several years ago, the principal points known at that time were placed (on a general invitation) at the disposal of a group interested in the progress of science and its dissemination, but as far as I know nothing has yet been published on the subject. These and other details will be given in a full discussion of the hypothesis which it is planned to publish if my impaired health permits.

The theory rests upon the possibility that the earth was bombarded in some past age by a meteoric swarm or swarms which came from a southerly direction. When the explanation first suggested itself, no facts were known which could throw light on this all-important point, the suggestion coming solely from two well-marked peculiarities of continental and mountain

formation, *viz.*, the accumulation of land in the higher northern latitudes with a complementary deficiency in the southern hemisphere, and the appearance of the Indian Peninsula and the Himalayan mountain ranges which give the impression of having been thrust northward into the Asiatic Continent. These suggested a force acting from the south. Later, the fact occurred to me that far the larger number of craters on the moon were in its southern hemisphere.

It is now generally accepted that such "craters" could have been formed by the impact of meteors. If, therefore, these "craters" or a considerable number of them, were formed in that way, the assumption is permissible that the earth may have been, and almost certainly was, bombarded in a similar manner. These circumstances provide the possibility of such meteoric action as could bring about the observed conditions.

Briefly, aside from the above, the principal observed facts and their bearing are as follows:

(1) The large land excess in the northern hemisphere and a corresponding deficiency in the south.

(2) The broadening out toward the equator of the continental areas from their pointed southern extremities and still more in the far northern regions where they form an almost continuous ring about the polar ocean.

(3) An open polar ocean and surrounding land mass in the north, and a continental land mass surrounded by water about the south pole.

(4) Generally greater elevations of the land above sea-level near the southern extremities of the continents than in their northern portions. This is especially noticeable in South America, Africa, Asia and, to some extent, in North America.

(5) Low-lying and frequently marshy or desert areas of great extent in the northern and wider portions of the continental masses.

(6) Carboniferous deposits in these basins, including forests.

(7) As already mentioned, the peculiar appearance of the Indian Peninsula and the Himalaya Mountains to the north. If we look at a contour map of those regions we find the Himalayas folded around the northern and broad part of the Indian Peninsula in just such a manner as is conceivable if the triangular peninsula had been thrust into the Asiatic Continent from the south where we now find the extensive Indian Ocean.

(8) The distances from the South Pole of South America, Africa, India and Greenland all pointed at the southern end, are roughly in the inverse order of their size.

(9) During the Gondwana period the flora (Glossopteris) of India differed greatly from that of Europe but was strikingly similar to the contemporaneous flora of South America, South Africa and Australia.

(10) The southern portions of the South American and African continents are, in general, less temperate than corresponding latitudes in the north.

(11) No secular change in latitude has been established, at least for the continental areas of the northern hemisphere.

(12) Observed earthquake displacements in California, the Philippines and Japan show a relative movement of the continental areas on both sides southward with respect to the Pacific Basin.

(13) It is fairly well established by direct evidence that the earth's crust underneath the great ocean beds is of considerably greater specific gravity than the crust of the continental areas.

(14) The (average) specific gravity of meteorites composing such a swarm may vary from that of stone—say two and one half, to that of iron—say seven.

(15) If, as is usually assumed, the planetary bodies were originally, like the sun, in a gaseous or liquid state, they should remain more or less homogeneous on solidifying, and the present large differences of specific gravity require explanation.

The above are the observed facts for which an explanation is required.

The following hypothesis outlines the course of events and the results which are conceived to have succeeded an encounter of the earth with a swarm or swarms of meteorites. It is assumed that the meteorites came from a southerly direction—not necessarily exactly in the direction of the pole, that they were numerous and that many of them were of considerable size. A single large meteor is not considered capable of having produced the observed effects.

If any considerable part of these meteors was of the heavy metallic type, we have at once a cause for the greater specific gravity of the earth's crust under the oceans. But such an assumption as to specific gravity is not necessary to the general action of such meteor streams because the ordinary stone meteorites are quite sufficient.

Coming from any direction within, say, 30° or 40° of the South Pole, such streams of meteorites could be expected to exert a pressure upon the earth's crust which would depress it where the pressure was normal to the surface, that is, in the regions more or less adjacent to the pole, and elsewhere to "sweep" the surface layers along toward the equator. The known fact that the earth is not perfectly rigid but slightly elastic, and the observed folding of the rock strata are sufficient evidence that such changes can take place. The indications are that these changes have taken place slowly rather than suddenly.

As a further result of such "sweeping" action we can conceive of the land accumulations in the northern hemisphere as formed in a way similar to the snow or sand drifts in the lee of an obstruction, the equatorial bulge acting as such an obstruction.

An alternative, slightly different conception, but one which is simpler and perhaps more probable, is that instead of heavy meteors being responsible for the greater specific gravity of the crust under the oceans, the "sweeping" process has affected only the lighter

layers near the surface, pushing these northward and elevating them above the sea-level, thus exposing heavier layers deeper down. A fact favoring this conception is that the average specific gravity of the entire earth is approximately twice that of the continental masses. It may be that both conceptions are involved.

In a preliminary note it is neither necessary nor feasible to discuss in detail the bearing of the proposed hypothesis on all the different observed peculiarities which have been noted above. In most cases a possible bearing is obvious at a glance, which is enough for the present. That some of these relations are apparent rather than real and that not all will be confirmed, is to be expected. The hypothesis is too radical and too many factors are involved to permit of more than tentative acceptance for careful examination. There appears, however, to be no reason known at present for concluding that some such origin is impossible.

SCIENTIFIC EVENTS

THE BIOLOGICAL RESEARCH INSTITUTE OF THE ZOOLOGICAL SOCIETY OF SAN DIEGO

HOUSED in the hospital and laboratory building of the Zoological Society of San Diego is the Biological Research Institute, whose facilities, research opportunities and two research fellowships have been discussed in a recent number of this journal.[1]

Two out of some thirty applicants have been advised of their election to the two fellowships. Jackson S. Kiser, graduate student at the University of Washington, will pursue at the Biological Research Institute studies of food infection in animals, for work toward the doctor's degree from the University of California at Los Angeles. Lawrence R. Penner, Ph.D., 1940, University of Minnesota, will conduct comparative parasitological investigations. Both these men began their work on September 1.

In addition to the conducting of careful and complete *post-mortem* examinations of all animals which die in the zoo and of many wild animals which are brought in from the outside, dead from natural causes, special hospitalization is given to a great variety of animals maintained in the zoo. Investigations concerning nutritional requirements and especially the parasitic diseases of various animals, are in progress, and an early extension of such studies is planned.

Dr. Charles R. Schroeder, veterinary pathologist in charge of the hospital and laboratory; Dr. Carlton M. Herman, a visiting investigator; and Willis Doetschman, a graduate student in the University of Southern California, are conducting research in various phases of animal parasitology. Dr. Herman's present investigations are concerned with life-cycles of certain worm parasites of seals and other animals. Mr. Doetschman is conducting a survey of internal parasites of captive animals, in partial fulfillment of the requirements for a master's degree. Several voluntary workers and a number of students from San Diego State College on a special National Youth Administration project are carrying out technical and statistical investigations under the direct supervision of Dr. Schroeder.

[1] SCIENCE, 92: 55, 1940.

The Research Committee of the institute, who give their counsel and other assistance without compensation to students and research workers are the following: *Protozoology:* Dr. Rawson J. Pickard, San Diego (chairman); *Pathology:* Dr. Howard A. Ball, San Diego; *Biochemistry:* Dr. Denis L. Fox, assistant professor of marine biochemistry, Scripps Institution of Oceanography of the University of California, La Jolla; *Surgery:* Dr. Hall G. Holder, San Diego; *Ophthalmology:* Dr. George L. Kilgore, San Diego; *Physiology:* Dr. Eaton M. MacKay, director of research, Scripps Metabolic Clinic, La Jolla; *Cardiology:* Dr. Francis M. Smith, Scripps Metabolic Clinic, La Jolla; *Dental Pathology:* Dr. Quintin M. Stephen-Hassard, La Jolla; *Microbiology:* Dr. Claude E. ZoBell, assistant professor of marine microbiology, Scripps Institution of Oceanography of the University of California, La Jolla.

The committee appointed to supervise the research conducted under the fellowships consists of the following members of the Research Committee: Drs. Pickard (chairman), Ball, Fox and ZoBell.

DENIS L. FOX

THE GREAT SMOKY MOUNTAINS NATIONAL PARK

THE Great Smoky Mountains National Park was dedicated at Newfound Gap by President Roosevelt on September 2.

The park is almost equally in the states of North Carolina and Tennessee, on the crest of the Great Smokies. Newfound Gap is on the boundary line, where the park's one trans-mountain road crosses.

Harold L. Ickes, Secretary of the Interior, presided at the dedication exercises, and Governor Clyde R. Hoey, of North Carolina, and Governor Prentice Cooper, of Tennessee, made brief addresses. These were followed by the dedicatory address of the President.

The Great Smoky Mountains National Park is one of the units of the Federal Park System administered by the National Park Service "for the benefit and enjoyment of the people." It may be visited any day