issue for January, 1941 (there are ten issues each year) devotes 11½ of its 30 pages to the monthly list of "Entomological Literature," comprising 200 titles under 9 headings, both taxonomic and non-taxonomic. Under each heading the authors' names are arranged alphabetically.

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SCIENTIFIC BOOKS

STRENGTH AND STRUCTURE OF THE EARTH

Strength and Structure of the Earth. By REGINALD ALDSWORTH DALY. New York: Prentice-Hall. 1940. Pp. ix + 434; 83 figs., 69 tables, biblgr., index. $3.50.

ISOSTATIC equilibrium and the strength of the earth's crust are subjects that loom ever larger in connection with problems of geotectonics. Geologists appreciate readily enough the great importance of these subjects, but are somewhat appalled by their magnitude, difficulty and apparent elusiveness. One serious handicap for students in this field has been the scattered and undigested character of the large literature containing the pertinent data. There has been a crying need for summation and evaluation of these data, by an informed geologist, for the use of geologists. The new volume by Professor Daly is an answer to this need. Four fifths of the book is devoted to the growth of the concept of isostasy, the geodetic data on which the concept is based and geologic evidence bearing on the problem. With the factual materials are presented interpretations made by leading investigators. In a final chapter the author makes his own analysis, and suggests a model of the earth that will harmonize with the facts of geodesy and geology.

Hayford's laborious study based on deflections of the vertical, the first quantitative test of an old theory, is explained in some detail. Advantages of the gravimetric method are made clear; a major advantage is the practicability of determining gravity anywhere at sea, where triangulation on which the deflection method depends is impossible. It will be news to some readers that there are as many as five methods of reducing gravity values, all assuming isostatic compensation of topography. The chief advantage of the Hayford-Bowie method, based on the Pratt concept of compensation at uniform depth, lies in the relatively simple calculations involved. Heiskanen has used two forms of the Airy hypothesis, which assumes variable thickness of a light crust. The G. R. Putnam and Venig-Meinesz reductions are based on assumption of regional compensation, which from the geologic viewpoint is more reasonable than strictly local compensation. Anomalies derived by the several methods differ among themselves; and anomalies obtained by any one of the methods can be varied by changing from one spheroid of reference to another. In 1938 Heiskanen proposed a triaxial spheroid, of which the major equatorial axis is 704 meters longer than the minor axis. Daly favors this triaxial figure of reference, and uses it in his speculative model earth.

In 1932 Glennie, of the Survey of India, challenged the entire concept of isostasy as it applies to India. He showed that the crests and troughs of the Indian geoid do not correspond to topography in accordance with Hayford's concept; and that the Hayford anomalies, based on the international spheroid, have a large average negative value for the entire peninsula, with negative values of more than 100 milligals in the Gangetic plain. Using a new spheroid of reference, and assuming that the anomalies reflect strong warping of a heavy crustal layer at depth, Glennie calculated anomalies of a new type—"warp anomalies"—which are positive in a broad east-west belt, negative in flanking belts to the north and south. The average of "warp anomalies" for the entire peninsula is not far from zero. It appears, therefore, that Glennie has demonstrated for India not a lack of isostasy, but broadly regional isostasy. Indeed, his very attempt to explain the anomalies as caused by crustal warping seems to suggest an unconscious assumption that before warping occurred the region was in perfect isostatic balance. Hunter, commenting on gravity conditions in India, suggests that the term isostasy should be dropped, because it has become synonymous with "Hayford isostasy," which is disproved for the Indian peninsula. Daly correctly remarks that Hunter's suggestion is based on a misconception. Isostasy, meaning either the tendency for disappearance of stresses caused by shift of load, or actual equilibrium in the crust, is not confused, in the minds of thoughtful students, with Hayford's artificial assumption of local compensation at a uniform depth.

Daly finds that the average of negative anomalies in India is much reduced if reference is made to Heiskanen's 1938 triaxial spheroid. Anomalies for India given by this reduction are comparable, as a regional group, to those in Fennoscandia, a region of comparable size. There is striking contrast, however, in the behavior of these two regions: Fennoscandia is rising, as if to restore equilibrium, whereas there is no indication that uplift is occurring in India. The distribution of the Indian anomalies suggests strongly that the crust has been warped in front of the Himalayan arc. Possibly orogenic pressure has increased the capacity of the crust to bear vertical stresses, distributed in alternating belts of positive and negative load. Daly selects peninsular India as the continental region of greatest demonstrated departure from isostasy and therefore the region best adapted to give a measure of strength in the continental crust. He estimates from the anomalies a maximum stress-difference in India of 400 kilograms per square centimeter. Similar estimates for Hawaii and the Mindanao Deep indicate considerably larger stress-differences in the Pacific floor, and lead to agreement with Barrell that the sub-Pacific part of the lithosphere is much stronger than the continental part.

An estimate of the order of strength in the asthenosphere is furnished by Fennoscandia. In the area of maximum uplift there is a defect of mass equal to a plate of granite about 200 meters thick; this value is deduced from the anomalies, and also from the measured rates of uplift since the ice disappeared. Using a stress diagram prepared by Timoshenko, Daly estimates that at a depth of 100 kilometers under the center of the Fennoscandian tract the stress-difference can not exceed 4 kilograms per square centimeter. Thus the degree of strength indicated for the asthenosphere is at least two orders of magnitude smaller than the estimates of Barrell and Jeffreys.

The hypothesis of a thin, strong lithosphere resting on a subcrust devoid of strength accords with evidence that orogeny is accompanied by horizontal shearing of a superficial shell over its foundation. Daly finds that the concept serves also to clarify some of the larger facts of igneous geology. However, an asthenosphere of unlimited depth is not compatible with Heiskanen's triaxial spheroid as the preferred figure of reference in gravity reductions. The major axis of this assumed figure emerges at 25° west longitude and 155° east longitude; the minor axis, at 115° west longitude and 65° east longitude. In Daly's view, the chief groups of regional one-sign anomaly are explained most logically in reference to the triaxial figure. In an attempt to harmonize the two concepts—a strengthless asthenosphere and a triaxial earth—Daly suggests that the asthenospheric shell is thin, and that it rests on a thick *mesospheric* shell which is strong enough to bear the stresses implied by the triaxial form. The suggested shells are, therefore, from the surface downward: (1) the lithosphere, 60 to 80 kilometers thick; (2) the asthenosphere, with a maximum thickness of about 400 kilometers and possibly much less; (3) the mesosphere, nearly 2,500 kilometers thick and resting on the central core. Daly recognizes that this hypothesis excludes the concept of deep-seated convection as a mechanism to explain crustal deformation. The two hypotheses must compete with each other.

To the reviewer the concept of a thin shell devoid of strength between shells of high strength seems artificial and open to grave doubt. Could such an arrangement be stable, even if it could be brought about? The question of stability arises also in connection with triaxiality supposed to be maintained in the mesosphere. If the assumed small asymmetry produces a figure of disequilibrium in the mesosphere, would not the lack of strength in the surrounding asthenosphere permit compensating adjustments, thus erasing the asymmetry for the earth as a whole? The problem is very difficult, but in a "naturalistic" analysis this criticism seems warranted. Readers will appreciate, of course, that Professor Daly is "going all out" in an attempt to grapple with a stupendous problem. As he says, "To make any progress with the present question, we can not avoid pyramiding speculative ideas."

In this discussion of major issues, one critical comment on terminology may be permitted. Daly adopts Gutenberg's suggested term *mantle* for the entire composite shell of the earth outside the central core. Introduction of this usage into the literature seems unfortunate, because the term *mantle rock,* commonly shortened to *mantle,* has long been in use with another meaning. Even without this objection the appropriateness of the term as Gutenberg uses it may be challenged, since a mantle suggests a superficial covering, whereas the feature in question comprises five sixths of the volume of the earth. The reviewer realizes the need of a short term to designate the entire unit surrounding the central core, but protests the adoption of "mantle" for the purpose.

We are indebted to Professor Daly for a highly useful study, involving much labor on his part and designed to make the way easier and more profitable for future students. In spite of the difficult character of the subject-matter, the book has the pleasing literary quality that characterizes Daly's writings generally. Whatever may be the reactions to interpretations and hypotheses proposed by the author, the book has no rival as a comprehensive guide to a subject of increasing importance in geology.

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SOCIETIES AND MEETINGS

THE ANNUAL MEETING OF THE SOUTHWESTERN DIVISION

THE twenty-first annual meeting of the Southwestern Division of the American Association for the Advancement of Science will be held at Lubbock, Texas, on April 28, 29, 30 and May 1, 1941. This