DISCUSSION AND COMMUNICATIONS.

*THE "OSCILLATION THEORY" OF DIASTROPHISM.**

The idea of a contracting earth, once so nearly a universal creed among students of tectonics that it was considered a fundamental postulate of geology, continues to lose prestige as new competing hypotheses are put forward. Dr. Haarmann, in his attractive new book, devotes several pages to the shortcomings of the contraction hypothesis before he presents his own explanation of diastrophism. Not only has the old hypothesis failed to explain the facts, he says, but it has become a dangerous stumbling block for geology, because its wide influence, as a sort of tradition, prevents progress in thought. Whether or not we agree with this pessimistic note, students of tectonics welcome Haarmann's new and independent ideas on this greatest of geological puzzles—the cause of diastrophism. At best the time-honored assumption of a contracting earth can be considered only as one of several hypotheses in a highly speculative field, all of them to be tried and tested by the slowly accumulating facts of geology.

Haarmann maintains that folds, thrusts, and other evidences of horizontal crustal movement are secondary effects of large-scale vertical movements, which constitute *primary* diastrophism. He sees evidence that great uplifts and depressions have come and gone repeatedly in the course of geologic history. The *oscillatory* character of such movements gives the name to his theory. To the major uplifts he applies the term *geotumors;* the areas of subsidence are *geodepressions.* Sediments eroded from the elevated continental regions accumulate in adjoining depressions, and in favored belts these sedimentary deposits eventually attain very great thicknesses. Such deposits are plastic and easily deformed, and under their own weight they are crowded from the margins of the sedimentary trough toward the middle. Such movements, called by Haarmann "full-trough gliding," are likely to occur repeatedly during the long time of accumulation. This type of deformation gives rise to rather regular, upright folds and steep thrusts; it cannot cause recumbent folds and low-angle thrusts such as are found in the Alps and many other mountain zones. The Carboniferous of the Ruhr Basin, which is thrown into quite regular folds that become more pronounced downward, furnishes an excellent example of full-trough deformation unmodified by any important later movements (Fig. 1).

* A review and discussion of *Die Oszillations-Theorie, eine Erklärung der Krustenbewegungen von Erde und Mond;* by Dr. Erich Haarmann. Published by Ferdinand Enke, Stuttgart, 1930. xii and 260 pp., 78 figs., 1 map. RM 17 (in linen, RM 19).

The one-sided structure found in most great mountain zones, where overturned folds and flat thrusts are the major structural

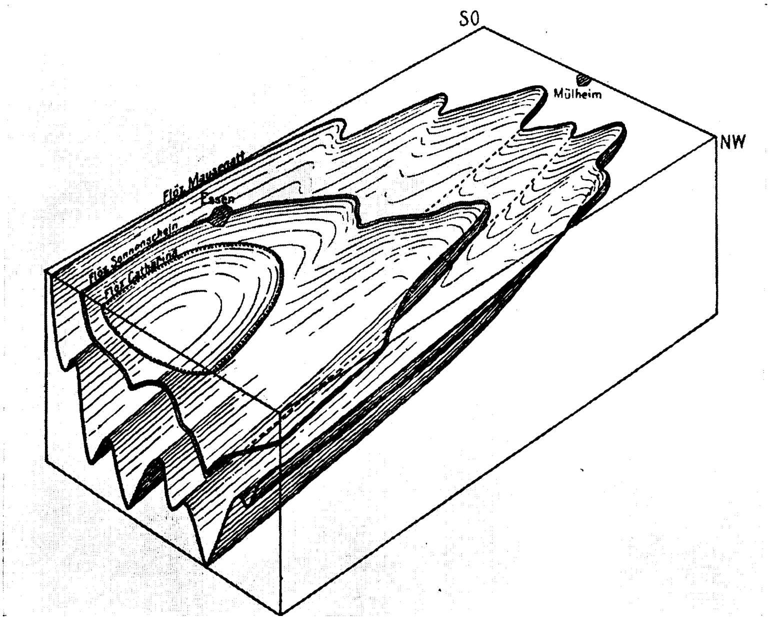

Fig. 1 (Haarmann's Fig. 62).—Full-trough gliding of the Ruhr Carboniferous. After Bärtling.

features, is the result of "free gliding" (Fig. 2). Secondary movements of this kind result during the growth and migration

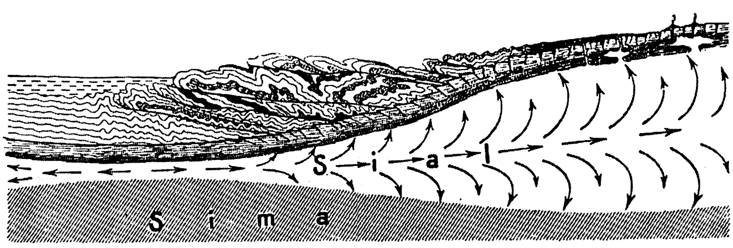

Fig. 2 (Haarmann's Fig. 34).—Representation of *tumor* formation and free gliding.

of "geotumors," with the establishing of inclines on which the plastic sedimentary formations slide and suffer extreme deformation. The decken of the Alps were produced in this way. Such deformation does not result at once in highlands: the folded sediments are elevated later by migration of the "tumor" to the position of the old trough. An important and necessary accompaniment of the compression in free gliding is the tearing apart of the formations on the upper part of the slope. Thus regional tension, with volcanism, develops in the rear of the regional compression. We should expect also that this sliding mechanism would produce the most severe deformation in the forward part of the sliding mass, with a conspicuous decrease in the folding up the slope.

Haarmann's idea of free gliding is strongly suggestive of Daly's sliding hypothesis.[1] However, there are important differences in the two conceptions. According to Daly, the sliding occurs on a glassy substratum and involves the entire crystalline basement with the overlying sediments. Haarmann's hypothesis restricts the important gliding to the sedimentary cover. The fundamental causes of the primary vertical movements also differ in the two schemes. Daly holds three factors responsible for the bodily distortion which produces the sliding slopes: the contraction of the earth, changing of the speed of rotation, and erosion of the lands. Haarmann sees a sufficient cause in polar wandering. In common with many other European scientists he thinks it highly probable that major changes in the position of the Earth's axis, involving a long period, have occurred during geologic time. He discards the suggestion that mass displacements at the Earth's surface have caused shifts in the axis—such displacements are too trivial to produce any noticeable effect. Rather the cause is cosmic, and the polar shifts thus become the primary factor in bringing about mass displacements as the figure of the Earth changes to maintain equilibrium. Wandering of the axis necessitates wandering of "geotumors" and "geodepressions," and in this way the observed up-and-down movement of the Earth's crust is explained.

Surface features of the moon are thought by Haarmann to represent the effects of primary diastrophism unobscured by folds and other secondary features, which cannot develop because the moon has no air or water, and hence no sedimentary formations. The well-known rings and craters have resulted from collapse of the crust on the withdrawal of underlying magma during the migration of "tumors." Since these effects were produced after the moon became nearly rigid from cooling, the action was much more violent than that attending the migration of "tumors" on the earth, which is still relatively mobile.

The author presents his view frankly as hypothesis, and asks that students of tectonics give it unprejudiced consideration. Applying the test of field evidence, American geologists will see

[1]Daly, R. A., *Our Mobile Earth,* Chapter VII.

in the structure of the Appalachians an argument unfavorable to the idea of free gliding. Since the overturning and overthrusting is toward the west-northwest, according to Haarmann's conception the sediments glided westward from a region of uplift near the present Atlantic coast. In this event, however, we should expect to find the most severe deformation toward the west side of the folded tract, with a conspicuous decrease in intensity toward the east. Exactly the opposite is true, throughout the length of the chain. Moreover, it is hard to reconcile with Haarmann's views the occurrence of great thrusts in which the crystalline basement rocks are thrust over the folded sediments. Such thrusts are present in the Appalachians, the Scottish Highlands and other mountain zones.

It is easy to criticise any theory of diastrophism. Dr. Haarmann's book contains many valuable suggestions, and we are indebted to him for the full presentation of his views. The clear style of the author and the excellent work of the publisher have made an attractive volume, easy to read. All geologists interested in tectonics will profit by giving it a careful study.

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APPROXIMATE VALUE OF THE DEPTH OF COMPENSATION FROM JAPANESE GRAVITY DATA.

A very interesting article, entitled "On a relation between the distributions of gravitational anomalies and the origins of earthquakes in Japan," by Dr. Chûji Tsuboi, appears in the Proceedings of the Imperial Academy of Japan, October, 1929, Vol. V, No. 8, pp. 326-329.

In the article Dr. Tsuboi discusses the Bouguer gravity anomalies and shows a definite relation between the areas having large Bouguer anomalies and regions having frequent earthquakes. He seems to have found that, where the anomalies are the greatest, there is the largest number of earthquakes. Unfortunately, up to the present time, no isostatic reduction has been made for the whole group of 122 gravity stations in Japan. The students of the earth will await with great interest the appearance of a report which will show the isostatic anomalies for those stations.

Dr. Tsuboi, in discussing the several areas of Japan where the gravity anomalies are negative, says "The third of them (the middle part of Honsyû) coincides in position with the high mountainous region of Honsyû and the large gravitational anomalies