A VOLUMETRIC METHOD FOR A STUDY OF THE HISTORY OF EPEIROGENIC MOVEMENTS

By ALEXANDER B. RONOV

Institute of Theoretical Geophysics of the Academy of Sciences of the U.S.S.R., Moscow

ANY territory which is sufficiently large may be divided for any geological age into areas of tectonic uplifts and subsidence of the earth's crust, the rate of uplift and subsidence being different for different places[1]. One may speak about an average and a 'volume' rate of subsidence and uplift, meaning the rate of increment of the total volume of all the tectonic depressions and convexities of the earth's crust within a given territory. This total volume rate of movements may be calculated. The volume of subsidences is approximately equal to the total volume of sediments accumulated during the given time. An elevation of the earth's crust causes erosion, and the volume of the uplift may be determined from the volume of the eroded clastic material[3,4]. In this way the problem is confined to a determination of the volumes, on one hand, of all the deposits accumulated; and on the other, to a separate determination of those of clastic deposits. Tracing from one geological age to another the change of these values, it is possible to study in volumes (cu.km.) the kinematics of the vertical movements of different signs. Referring these volumes to a unit of area (sq. km.) gives the average magnitude of subsidence or uplift of the earth's crust (in km.).

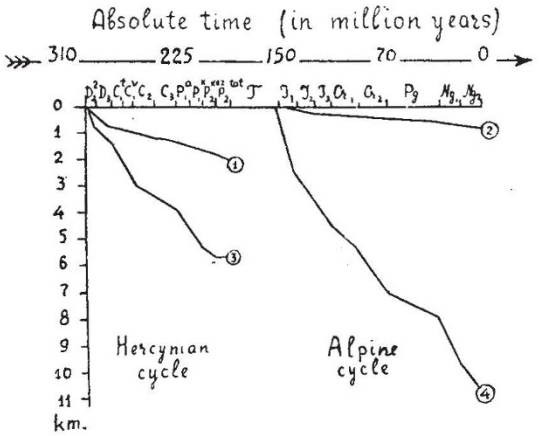

Fig. 1. CURVES SHOWING THE AVERAGE MAGNITUDE OF SUBSIDENCE OF THE HERCYNIAN (1) AND ALPINE (2) RUSSIAN PLATFORM, THE HERCYNIAN GEOSYNCLINE OF THE URALS (3), AND ALPINE GEOSYNCLINE OF THE GREAT CAUCASUS (4)

Fig. 1 shows the curves of the average magnitude of subsidence of the Russian Platform and the surrounding geosynclines during the Hercynian and the Alpine cycles. Here the difference in the scale of movements is of interest[3,4,7]. If the average magnitude of subsidence or uplift be referred to a unit of absolute time (a million years[2]), the average rate of vertical movements will be obtained[3,4]. Fig. 2 presents the curves of the average rate of subsidence of the Russian Platform, Uralian and Caucasian geosynclines; an examination of these will show that there is some parallelism and a similar periodicity in the movements

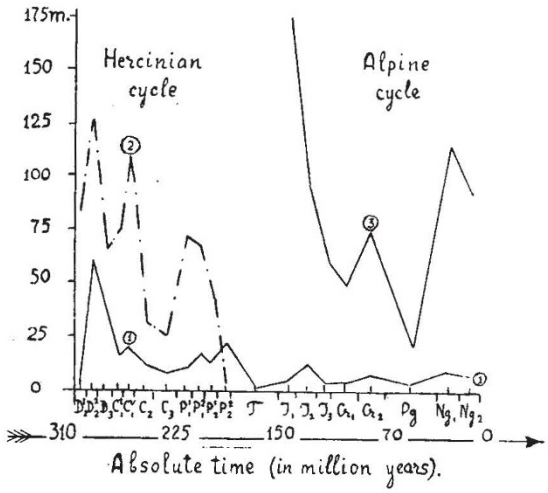

Fig. 2. CURVES SHOWING THE AVERAGE RATE OF SUBSIDENCE OF THE RUSSIAN PLATFORM (1) AND GEOSYNCLINES OF THE URALS (2) AND GREAT CAUCASUS (3), IN METRES PER MILLION YEARS

of these different tectonic zones, the rate of subsidence on the Hercynian and particularly the Alpine platform having been considerably slower. Both the downward and the upward movements on the platform were somewhat retarded as compared to the movements of the adjacent geosynclines of the same age[4,7].

An estimation of the total volume of the rocks is made with the aid of isopachous maps. The volumes of terrigenous, carbonate, continental and volcanogenous rocks are measured by means of specially prepared isopachyte (equal thickness) maps separately for each of the rock types listed[4,6].

It is often impossible to measure the area from which the clastic rocks have been removed, since the region of the ancient erosion is overburden under younger deposits. In these cases we study the ratio of the volumes of terrigenous rocks (V_1), removed from the region of uplift, to the total volume of rocks (including effusives) (V_2), accumulated in the surrounding regions of subsidence during the same time interval.

This ratio, named the 'uplift coefficient' (δ), in the first approximation is equal to the relation between the volume of uplifts to the volume of subsidences of the earth's crust:

$$\delta = \frac{V_1}{V_2} = \frac{\text{uplift}}{\text{subsidence}}. \qquad (1)$$

Studying in this way one division after the other, we find the changes of δ in the course of time. In many cases this is sufficient to make it possible to draw important conclusions regarding the development of epeirogenic movements[4].

Since we refer the volume of terrigenous rocks to the total volume of all rocks, the ratio can never exceed unity. Hence it is not possible in this way to determine the cases when the volume of uplifts exceeds that of subsidences. However, such cases do exist, and it is necessary to have some means of determining them. With this object in view, a correction to a change of facies is introduced. If the total of uplifts exceeds that of subsidences, the amount of material removed is greater than the corresponding space in the areas of subsidence, and the surface of sediments in the zones of accumulation is raised. The additional

© 1947 Nature Publishing Group

volume of rocks obtained as a result of rise of the level of sediments (v) is subtracted from the total volume of rocks. The correction (v) but with the opposite sign is used when a lowering of the surface of sediments (a deepening of the basin) has occurred during this time interval:

$$\delta = \frac{V_1}{V_2 \pm v} = \frac{\text{uplift}}{\text{subsidence}}. \qquad (2)$$

Fig. 3 shows the changes of the uplift coefficient (δ) in the Uralian geosyncline from the Cambrian to the Permian. We see that the curve records two large cycles of epeirogenic movements (Caledonian and Hercynian), upon which second order cycles are superimposed. The beginning of each large and small cycle is characterized by a predominance of uplifts; at the middle, subsidences become prevalent; and at the close of a cycle, the significance of uplifts of the earth's crust again increases. An analogous curve has been obtained for the Caucasian geosyncline[4].

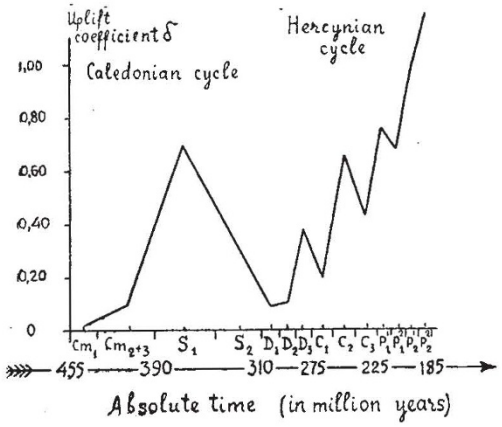

Fig. 3. Curve showing the ratio of uplifts to subsidences in the Ural geosyncline

An important part in quantitative estimations is played by the determination of the boundaries of the territory actually studied. Since the volumes of clastic rocks are taken into consideration, all the areas which have supplied terrigenous material in this particular case are automatically included in the territory studied.

I have also used the volumetric method for a quantitative study of the Hercynian volcanism in the Urals[5] and of the history of sedimentation within the European part of the U.S.S.R.[6]. As a result, a number of regularities have been established which so far have escaped detection by the usual methods of geological investigation.

[1] Belousov, I. V. V., *Trans. Inst. Geol. Sci., Acad. Sci. U.S.S.R.*, No. 76 (1944), in Russian.
[2] Holmes, A., "The Age of the Earth" (1937).
[3] Ronov, A. B., *C.R. (Doklady) Acad. Sci. U.R.S.S.*, **44**, No. 4 (1944), in English.
[4] Ronov, A. B., *Bull. Acad. Sci. U.R.S.S.*, sér. géogr. et géophys., **8**, No. 6 (1944), and **9**, No. 4 (1946), in Russian with English summary.
[5] Ronov, A. B., *Bull. Acad. Sci. U.R.S.S.*, sér. géogr. et géophys., 10, No. 4 (1946), in Russian, with English summary.
[6] Ronov, A. B., *C.R. (Doklady) Acad. Sci. U.R.S.S.*, **50** (1945), in English.
[7] Ronov, A. B., *C.R. (Doklady) Acad. Sci. U.R.S.S.*, **50**, No. 2 (1946), in English.

PSYCHOLOGISTS IN THE ASSOCIATION OF SCIENTIFIC WORKERS

THE Section of Psychology, lately formed inside the Association of Scientific Workers, met for the first time at Bedford College, London, on January 18; in the chair was Mrs. Winifred Raphael, of the National Institute of Industrial Psychology. The speakers were Miss I. M. Dunsdon, Dr. H. J. Eysenck, Miss Pearl King, Prof. T. H. Pear, Mrs. Raphael, Dr. J. D. Sutherland and Dr. Stephen Taylor, M.P. All the papers were followed by discussion. Until this meeting, psychologists had met within the Association of Scientific Workers as part of its Medical Section. The establishment of a Psychological Section has resulted in a considerable increase in the number of psychologists joining the Association (117 up to the time of writing).

The chief subjects emphasized were the relations between psychologists and other professional workers, and the ways in which psychologists may make practical contacts with others and contribute usefully from their sphere of knowledge. There is an obvious division between fields in which psychologists can make an immediate contribution, and those in which they might help after research into specific problems has been conducted. It was felt that a subject of international importance is "channels of communication", for example, the Press, radio, films, etc. An investigation into this subject is in progress.

It was urged that the Association of Scientific Workers might consider putting forward a more definite policy with regard to the results of recent scientific research, such as the atomic bomb and other revolutionary weapons of war. Certain psychologists specially interested in the subject could help by advising upon ways of 'getting ideas across' to the public.

The primary responsibility of psychologists as such is to work whole-heartedly for the advancement of their science. To-day in most sciences comparatively little can be done by individual workers, and the importance of co-ordinated research here as elsewhere was stressed. The time may even have come for university departments of psychology to establish a co-ordinating body so that (1) research workers can know what others are doing at present in their field and thus avoid duplication, and (2) plans for research into fundamental problems can be developed.

An urgent need is to let the public—at present badly instructed—know what psychology can and cannot do. More use could be made of the ordinary media of communication by psychologists who can express complicated ideas simply and clearly; but this might require a changed attitude upon the part of some editors.

Dr. Stephen Taylor discussed the possibilities and conditions of employment of social psychologists in the public services.

Dr. J. D. Sutherland considered "Relations between Psychologists and Other Professional Workers". Such relations, where they exist, are on the whole good. Probably the oldest and closest is in the educational field, because of its more obvious psychological implications. He deplored the fact that as yet there seems to be almost no co-operation between psychology departments and university authorities in the problems of selecting and training university students.

In the industrial field, relations are good, partly because only progressive industrialists ask for

© 1947 Nature Publishing Group