Several of the above principles have been more or less fully known by anatomists, some of them reaching back of the time of Aristotle as treated in his "Physics" and in his "History of Animals." But the following three principles (10–12) are those which are first demonstrated in the Titanothere monograph although previously adumbrated in the author's earlier researches on the teeth of the Eocene primates and of the horses and rhinoceroses: (10) principle of allometrons, or adaptive changes of proportion in all the hard parts of mammals; (11) principle of rectigradations, or adaptive origins *versus* fortuitous or random origins of new characters; (12) principle of potential heredity, predetermination or emergence of rectigradations.

Whatever may be true as to fortuitous mutation and as to chance or random variation in chemical and physical adaptations, the mechanical evolution of the Titanotheres, a unique record of ten million years in the development of the Titanothere germ-plasm, shows absolute continuity in every single organ examined. There is not the slightest trace of discontinuity or of random origin.

Thus it may be claimed that the Titanothere monograph solves the chief principles involved in the origin of "ascending mutations," species, genera, subfamilies, etc., as displayed in the hard parts of mammals. There is a firm undeviating orthogenetic order in the entire animal mechanism. There is a phylogenetic continuity of germinal adaptation and reaction in response to secular changes of habit and of environment.

DUAL NATURE OF PHYSIOGRAPHY[1]

By Dr. WALDO S. GLOCK

OHIO STATE UNIVERSITY

IT may be held axiomatic that we live in a world which is active, dynamic and changing, in a world where energy is by nature more important, more universal, than matter. Causes arising from the flow of energy are elusive and difficult to formulate into natural laws; they seem to border too much upon the abstract. Effects impressed on matter are as a rule clearly visible and lend themselves to description, measurement and comparison. They are above all concrete. Therefore it is not wholly strange that physiography has developed to a great extent in the matter of description and interpretation of land forms.

However, physiography possesses a dual nature in causes and effects, in active forces and passive results. Geodynamics (even if necessarily modified by the word surficial) appears to be a good name for the study of those processes—active, dynamic, progressive—which are constantly at work molding the surface of the lithosphere. In contrast, geomorphology studies the physiographic products wrought by those same processes. Formal treatment of the subject, physiography, actually resolves the dual nature into two view-points, the one looking at the science in the light of activity, the other, of passivity. There remains the task of bringing out the contrasts between them.

GEODYNAMICS—THE ACTIVE PHASE

The so-called processes represent the forces at work, while the detailed surface features appear as the direct results; this is rather common knowledge. It is the attitude of approach and the method of treatment that may be radically new and different. In this case we refer to the dynamic view-point, which considers a stream to be the dominant factor in a fluvial environment, which accentuates the forces at work and represses the resultant products to mere incidents in the constant flow of energy. The stream, in fact, is the permanent, concrete reality of a situation. Geodynamics adopts the active view-point and seeks to analyze and understand intimately the physiographic processes, all the while cognizant of the fact that they are now and have been in the past at work on the land surfaces. This active phase of physiography contrasts vividly with the ordinary and purely passive study of earth form. The one is dominantly analytical and causative, the other descriptive and interpretative.

At first sight process and result depend vitally upon each other, since they are related as cause is to effect. They seem, indeed, to be inextricably interwoven—a slight variation in one either causes an equivalent change in the second or else is followed by a consistent response. These intimate relations may suggest of necessity a lack of reality in the dynamic view-point.

The absolute interdependence of process and product should not be assumed too strongly until another idea is considered. Let us imagine a comparatively resistant rock stratum forming a shoulder where it crops out on a valley wall. That stratum when first uncovered at the bottom of the valley no doubt influenced the rate of erosion and perhaps the exact position of the stream, but it did not alter or influence

[1] The work for this paper was carried on with funds made available by the research committee of the Graduate School of the Ohio State University

the fundamental nature of the agent or the characteristic activities whereby it pursued its habitual tasks. Corrasion and transportation, as processes, were not changed. Running water works on all rocks, hard and soft alike, and it is not the fault of the water if the hard rock is etched into relief.

Various streams do their work under a given (humid) climate in much the same manner almost or quite independent of underlying rock in a dynamic sense. They obey certain laws of their own, perform highly characteristic tasks and create a fluvial environment wherein the land surface responds to the sculpturing activities of the agent. It would seem reasonable to conclude, then, not only that physiography may be approached from a purely dynamic view-point but also that that view-point enjoys a measure and type of independence not shared by the other.

GEOMORPHOLOGY—THE PASSIVE PHASE

Geomorphology is concerned with the details of surface configuration expressed first by the origin of that form and second by the influence of lithology and rock structure. The method of origin has interest only because it explains and rationalizes important lineaments in the composition of the landscape. The form strangely enough is actually a transient, unstable affair connecting in its descriptive aspects with ecology and geography. The study of land form has thrived during the last forty years since the elucidation of the geographic cycle which, without doubt, stands out as the quintessence of geomorphological description.

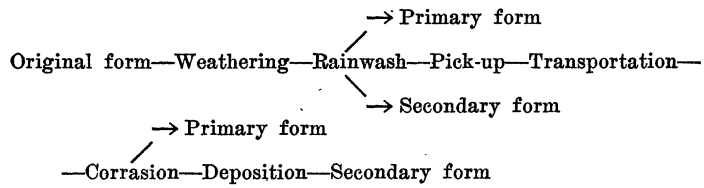
Primary and secondary physiographic features may be recognized as two fundamental types. The primary features originate in processes chiefly destructive and include such forms as valleys, ridges and mesas, whereas the secondary features result from activities chiefly constructive and refer to such forms as fans, deltas and flood plains.

RELATIONS

Geodynamics bears the same relation to geomorphology that cause does to effect. Perhaps it is the apparently abstract nature of processes which has caused the dynamical view-point to be slighted. The wind, the river and the undertow are more difficult to study than the sand dune, the valley and the beach. Streams after all constitute the life of a fluvial situation. They are in fact similar to life—cyclic and eternal ever since the time when they began. They are the immortal soul; sediments and disconformity, simply the "fossil" indications of their presence in the distant past.

The most interesting phase of geomorphology in many ways lies in the study of surface expression as influenced by lithology and rock structure. A full appreciation of surface detail can not be obtained, however, without a knowledge of the process involved, for, without the vitalizing fingers of that process at least mentally visible, the form lies cold and dead. The active forces shape the hills and valleys that blend and flow like clay in the hands of the artist.

A clearer idea of the relative importance, position and relationship of the active phase of physiography may be had if we introduce the idea of the dynamic interlude. Geologically, it includes the series of events changing original rock into resultant sediments; physiographically, it refers to those processes which carve the primary features out of the original, or initial, land form and finally produce the so-called secondary features. A skeletal outline will serve to illustrate the physiographic relations. The outline, not all-inclusive of course, actually represents an expanded form of the familiar erosion-deposition formula.



SUMMARY

Physiography may be viewed from two distinct angles, the one dynamic, the other passive. The processes hold the fascination inherent in energy and force; the products exhibit all the beauty and diversity of form in the composition of landscapes. The tacit adoption of a particular view-point not only will avoid confusion but will also simplify to a great extent both oral and written presentation of physiographic subjects, especially to beginners. We ought, perhaps, to discriminate clearly between process and product.

In a restricted fashion geodynamics studies the process, force or activity, simply acknowledging the form as a passive result. Geomorphology considers that form to be a detailed expression of the influence of rock and structure and acknowledges the process

as a cause chiefly in relation to the gross lineaments of the ensemble.

In a large fashion geodynamics is intimately associated with certain branches of geology, as sedimentation, while geomorphology connects physiography with geography. The dynamic interlude representing the active phase of physiography weaves the basic threads of geologic history.

OBITUARY

JESSE WALTER FEWKES

THE death of Jesse Walter Fewkes removes one who was an outstanding influence in the formative period of American archeology, particularly the archeology of our great Southwest. He was born at Newton, Massachusetts, on November 14, 1850, of parents whose ancestral lines in America extended back to the seventeenth century. In 1871 he entered Harvard and he graduated four years later with honors in natural history, besides being elected to membership in Phi Beta Kappa.

In 1874, while he was still an undergraduate, two papers on electrical subjects were published by him, but the year before he had come under the influence of Louis Agassiz in the latter's school at Penikese Island, Buzzards Bay, and this experience probably led him to turn his attention wholly to zoology. At any rate he took up graduate work in natural history and, after receiving the degrees of A.M. and Ph.D. in 1877, he continued zoological studies at Leipzig under Rudolph Lueckart between 1878 and 1880. Later he spent several months in Naples and at Villa Franca on the south coast of France as holder of the Harris fellowship. After his return to America he received an appointment as assistant in the Museum of Comparative Zoology at Harvard where, from 1881 to 1889, he had charge of the collections of the lower invertebrata. In 1881 he accompanied Alexander Agassiz to Key West and the Dry Tortugas for the study of marine life and two years later he visited the Bermudas on a similar quest. Every summer, from 1884 to 1887, he was assistant in charge of the younger Agassiz's marine laboratory at Newport, R. I., but in the spring of 1887 he pursued scientific studies at Santa Barbara, Santa Cruz and Monterey, California, as a guest of Augustus Hemenway, of Boston, and in the summer of 1888 he studied in Paris and engaged in field work in marine zoology at Professor Lacaze Duthier's zoological station at Roscoff, Brittany.

Dr. Fewkes's visit to California proved to be a turning-point in his career, for it was then that he came in contact with the culture of the Pueblo Indians, which excited in him an interest still further stimulated by the enthusiasm of Mrs. Mary Hemenway. In 1889 and 1890 he undertook field work among the Zuñi Indians of New Mexico, and in the latter year he made use of a phonograph—the first time, it is believed, that it was so employed—in the recording of Indian music. In 1891 he became director of the Hemenway Southwestern Archeological Expedition and editor of the *Journal of American Archeology and Ethnology,* established to publish the results of its investigations. During the same year he began those studies of Hopi ceremonials for which he became especially noted and which probably constitute his most enduring contribution to American anthropology. His description of the Hopi Snake Dance, which appeared in 1894, was a pronounced factor in spreading the knowledge of this striking rite and stimulating popular interest in it.

The Hemenway expedition having been invited by the Spanish government to participate in the Historical Exposition held at Madrid in 1892–93 to commemorate the discovery of America by Columbus, Dr. Fewkes was given charge of the exhibit and he was a member of the jury of awards. In recognition of these services he was honored by Maria Cristina, queen regent of Spain, with the decoration "Isabel la Católica," grade of knight. In 1894 King Oscar of Sweden presented him with a gold medal, "Litteris et Artibus," for his work in anthropology.

After returning to America Dr. Fewkes resumed investigations in the Southwest, but they were soon brought to an end by the death of his patroness, Mrs. Hemenway, in 1894. The collections made under his direction during this period are in the Peabody Museum at Cambridge.

In May, 1895, Dr. Fewkes received an appointment as ethnologist in the Bureau of American Ethnology at Washington along with the honorary title of collaborator in the division of ethnology in the United States National Museum, and the connection which he established with the bureau at this time continued unbroken until his resignation and retirement from active service in 1928.

This constituted a turning-point in his career in another direction because, although he continued to publish the results of his work among the living Hopi for many years afterward, his field excursions now became mainly archeological. From 1895 until 1901 the scene of these investigations was in and near the Hopi country in Arizona, but in 1902–04 he made a diversion to the West Indies in continuance of an interest