

Notes on the History and Philosophy of Science

1. *A Conference on the Scope and Philosophy of Geology*

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I

In October of 1960 a small group of geologists and philosophers met in Dallas to discuss problems related to the scope and philosophy of geology. Among the subjects considered were homotaxis and geochronometry, the classification of faults, explanation in historical geology, the principle of simplicity, the principle of uniformity, the methodology of geologic mapping, the contribution of geology to general thought, and the scope of the earth sciences. Messrs. William E. Benson of the National Science Foundation, Frederick Betz, Jr. of The Geological Society of America, James Gilluly of the U. S. Geological Survey, J. M. Harrison of the Geological Survey of Canada, Harry H. Hess of Princeton University, Mason L. Hill of the Richfield Oil Company, M. King Hubbert of the Shell Development Company, Luna Leopold of the U. S. Geological Survey, Eugene Herrin of Southern Methodist University, and Claude C. Albritton, Jr. represented the geological sciences. The philosophers, outnumbered but not outgunned, were professors Nelson Goodman of the University of Pennsylvania, Carl G. Hempel of Princeton and John H. Kultgen of Southern Methodist University.

II

Historically, the conference was a belated outgrowth of recommendations offered in 1949 by the Committee of Geological Education of The Geological Society of America. In the report of this committee, M. King Hubbert, T. A. Hendricks, and G. A. Thiel had urged that

... at all instructional levels from the most elementary to the most advanced, only those inferences be presented to students for which the essential observational data and the logical steps leading to the inference have also been presented. The satisfaction of this criteria will compel a badly needed critical re-examination from the ground up of the logical structure of geological science . . .”

The sentiment was not new: G. K. Gilbert said much the same thing three-quarters of a century ago. If, however, the exhortations of Gilbert and the Hubbert Committee have prompted geologists to

explain their explanations, the fact has gone unnoticed by the anthologists of scientific philosophy. The index of Feigl and Brodbeck's *Readings in the Philosophy of Science*, a book of 811 pages, does not contain the word geology. This is partly the fault of the index, for Ernst Nagel's essay on historical analysis incidentally relates geophysics and animal ecology as sciences "concerned with the spatiotemporal distribution and development of individual systems." But no essay in this volume—nor, to my knowledge, in any other college textbook on philosophy of science—was chosen from the vast literature of the earth sciences.

To what is the neglect of geology by the philosophers of science due? If Hutton's *Theory of the Earth* is to be taken as the beginning of modern geology, the science certainly got off to a sufficiently theoretical and philosophical start. After a tempest of controversy between the Neptunists and Vulcanists, however, the Geological Society of London, beginning in 1807, turned to the less hazardous occupation of gathering facts. Lyell, writing in 1830, thought that the Society had at least made geology safe for British consumption.

. . . A new school at last arose who professed the strictest neutrality, and the utmost indifference to the systems of Werner and Hutton, and who were resolved diligently to devote their labours to observation . . . But although the reluctance to theorize was carried somewhat to excess, no measure could have been more salutary at such a moment than a suspension of all attempts to form what were termed 'theories of the earth'. A great body of new data were required, and the Geological Society of London, founded in 1807, conduced greatly to the attainment of this desirable end. To multiply and record observations, and patiently to await the result at some future period, was the object proposed by them, and it was their favourite maxim that the time was not yet come for a general system of geology, but that all must be content for many years to be exclusively engaged in furnishing materials for future generalizations. By acting up to these principles with consistency, they in a few years disarmed all prejudice, and rescued the science from the imputation of being a dangerous, or at best but a visionary pursuit." (p. 72)

This disposition to describe rather than explain has persisted among geologists to the present day. Accordingly, most of the philosophical essays in the geologic literature are given to the explication of terms and categories, to the methods of classifying the objects of nature, and to the relationships between two or more of the hundred-odd specialties into which the earth sciences are now split. Little of this

writing would be suitable for a general anthology of the philosophy of science.

Meanwhile, scholars in other disciplines have been forming their own opinions of geology. H. E. Bliss categorizes geology as a descriptive and historical science that derives its theory from chemistry and physics. Charles Frankel states that geology, like history, is "predominantly concerned with discovering individual occurrences that have taken place at some particular place and time." Professor Hooykaas is of the opinion that the principle of uniformity, generally considered a foundation block of geology, actually says more about the investigator of nature than about nature herself. V. F. Lazen relates historical geology and paleontology with political history, as having common aims in the arrangements of events chronologically.

Is it true that geology has no postulates, no theory, no method of its own? Is the aim of geology simply to pigeonhole natural phenomena? Is geology a historical science—whatever that may mean? It was to sift ideas on these and similar questions that the geologists and philosophers held their conference in Dallas.

III

Perhaps the most important result of the conference was our discovery that philosophers and geologists have certain interests in common. The principle of uniformity is a case in point. Most of the geologists present could probably be classified as good dues-paying uniformitarians. And yet two out of three philosophers could not be persuaded that uniformity is essential to our science. These heretics readily agreed that uniformity probably had great heuristic value at the time Lyell was fighting miracle mongers. But now that scientists have by and large agreed to operate from an empirical base, and have moreover accepted the probabilistic nature of natural laws, it may be misleading to postulate that "all former changes of the organic and inorganic creation are referrible to one uninterrupted succession of physical events, governed by the laws now in operation." In any case, "the logical status of uniformity is not clear," as Bondi so mildly put it in his Joule Memorial Lecture.

Another thing that is not clear is the operation of the principle of simplicity (parsimony, Occam's razor) in geology. Take a case in layer-cake stratigraphy: two nearby mesas of three formations conformably arranged in similar sequence from bottom to top. With-

out evidence to the contrary, most stratigraphers would recognize only three formations in all, perhaps on the ground that it is in vain to do with more what can be done with fewer. But if a three-formation column is simpler than a one-formation column, would it not be simpler still to lump the three formations into one group, and then have a single entity? The reasons for not doing so may be compelling, but the example supports Dr. Goodman's contention that the simplicity of a system cannot be gauged simply by counting its parts. How do we rationalize our persistent effort to keep formations, species of minerals and fossils, and feet of fault displacements to minimal numbers?

The philosophers present were unwilling to accept offhand the proposition that the end of historical geology is the establishment of a chronicle for the earth. Dr. Hempel took the view that all sciences, social and natural, should attempt to *explain* the phenomena within their purview. To explain something scientifically is to relate a phenomenon under examination to its antecedent conditions in such a way that it could have been predicted on the basis of the regularities that are the natural laws. In historical geology, the phenomena are usually given, and it is the antecedent conditions that must be reconstructed. But *postdiction*, no less than *prediction*, requires the intermediary of law. What, then, are the laws of historical geology?

Bucher's *The Deformation of the Earth's Crust* stands as one of the few efforts to make geological laws explicit. Many of the 46 laws stated in this book could be cast as statements of universal form, thus satisfying Goodman's requirements for lawlike sentences. Biologists have perhaps been less hesitant than geologists in stating their laws in common language. Thus Rensch includes among his evolutionary laws of interaction with environment the statement that "the offspring of species taking care of their progeny is less in number than in related species not taking care of their progeny"—the Law of Planned Parenthood, no less! This could be recast in the symbols of logic, or in the form of mathematical ratios in the case of cuckoos and robins, but these translations would say no more at bottom than Rensch said in English.

Other topics of discussion were primarily of interest to the geologists. Dr. Woodford's essay and outline of homotaxis and geochronometry, a penetrating critique of stratigraphic fundamentals, applied statistical methods to the art of correlating strata. It would be un-

fair to present Woodford's conclusions here in advance of the supporting data, which all of us hoped he would soon publish.

IV

If the purpose of the conference was to identify problems rather than solve them, it was successful. The ideas that the principle of uniformity may now be a false issue in geology, and that the method of explanation in historical geology may be no wise different from the method of explanation in science generally, will probably haunt the geological members of the conference for some time to come.

Hopefully, this conference is one more step toward the production of a book. In 1959 the Council of The Geological Society of America chose the philosophy of geology as a topic for the seventy-fifth anniversary meeting of the Society in 1963. A committee has been appointed to stage a short program and to produce a small book of essays backed up with a selected bibliography of philosophical writings in the geological literature. Six of the seven members of the Anniversary Committee attended the Dallas conference.

This first conference on the scope and philosophy of geology was sponsored by The Graduate Research Center, Inc. of Texas. To our patrons, the members of the conference again offer their thanks.