An American Geologist

Grove Karl Gilbert. A Great Engine of Research. STEPHEN J. PYNE. University of Texas Press, Austin, 1980. xiv, 306 pp., illus. $20.

Stephen J. Pyne has filled a gap in the history of American geology by writing the first modern biography of Grove Karl Gilbert. The career of this pioneering American geologist spanned the period during which American geology entered what Pyne terms its "heroic age . . . during which the science was intellectually and institutionally defined." Not a figure the like of John Wesley Powell, Gilbert was, in the words of his long-time friend C. Hart Merriam, "an authority in many fields, and yet one who never assumed authority; a leader in science, and yet one who never assumed leadership."

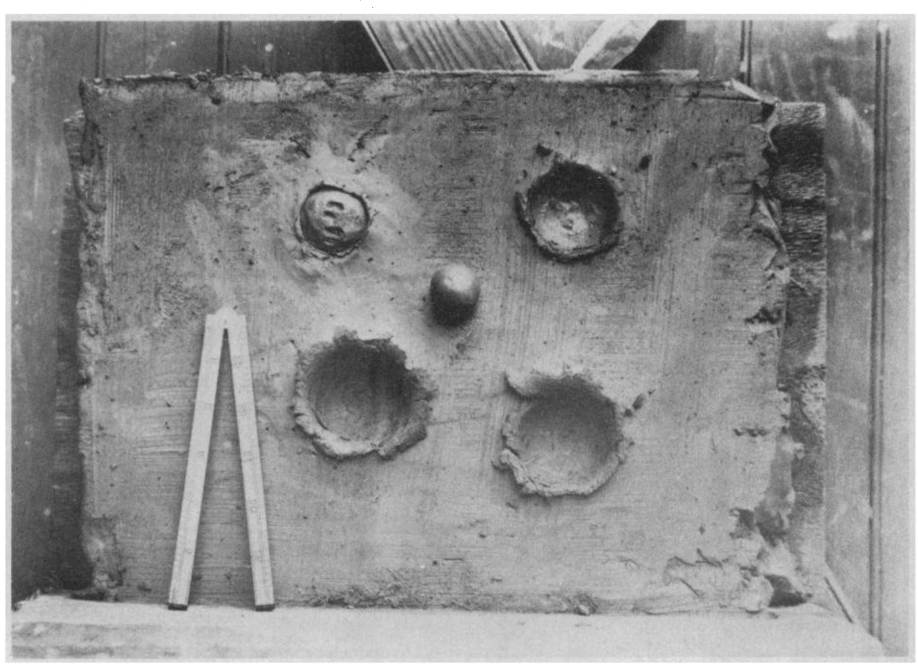
Born in Rochester, New York, in 1843, Gilbert completed his studies at the University of Rochester at age 19. Temperamentally disinclined to get involved in the Civil War, which the uncertain state of his health would doubtless have precluded anyway, Gilbert briefly turned to schoolteaching in Michigan. He resigned in embarrassment when it became apparent that he could not control his obstreperous pupils. Five years with Henry Ward's Scientific Establishment in Rochester followed, during which an assignment to excavate mastodon bones near Albany triggered an interest in the surrounding rock formations. At 25, Gilbert was launched on his life's work.

Following a brief stint as a volunteer assistant with the Geological Survey of Ohio, Gilbert joined the U.S. Army's Geographical Survey West of the 100th Meridian, led by Lt. George M. Wheeler. After four sometimes frustrating years as a civilian geologist with the Wheeler Survey, during which he mastered his craft, Gilbert left in 1875 to begin work with John Wesley Powell's Geological and Geographical Survey of the Rocky Mountain Region. He had met Powell in 1872, thus beginning a close personal and professional association that ended only with Powell's death in 1902. It proved to be a fortunate connection for Gilbert. He met his future wife at a party held in Powell's home and in 1879 was carried over from Powell's Corps to the ranks of the newly formed U.S. Geological Survey, an agency largely of Powell's making. Gilbert was made head of several of the Survey's field divisions before being named chief geologist in 1888.

This proved to be the high point of Gilbert's administrative career with the Survey. His position was cut away four years later, when Powell's ambitious plans caused him to overreach himself with cost-conscious congressional watchdogs. His budget slashed and his effectiveness largely ended, Powell stepped down in 1894, and appropriations for the Survey were restored to something approximating their old level. Gilbert was assigned to do fieldwork to help propitiate congressmen still sensitive to Powell's ways of doing things. He made little objection, since this decision suited his own proclivities. Besides, internal wrangling, both philosophical and personal, had temporarily reduced the Survey's effectiveness. The Survey's dominance in American geology was also slipping at this time. Leadership in the field was passing to private institutions, such as the Carnegie Institution of Washington, and to universities such as Chicago, Harvard, and Yale. In addition, as Pyne points out, the explosion of knowledge in the field was such that the Survey "was too small to contain it all."

Once Powell left, Gilbert's career continued on something of a plateau. He was not recommended as Powell's successor because the latter realized that Gilbert was simply not suited for the annual round of negotiations with Congress for appropriations, the Survey's life blood. Gilbert could have accepted various university posts at this point, but he was no more interested in teaching in the '90's than he had been 30 years earlier. He therefore elected to remain with the Survey, though almost semiretired, and passed up the opportunity to create his own school of geological thought, as several of his more prominent contemporaries were doing.

In the last two decades of his life, Gilbert gradually "withdrew from bureaucratic chores as rapidly as he could" and "receded visibly from positions of administrative significance" in the Survey. He lived by himself in a Washington hotel for some time following his wife's death in 1899. Gilbert had lost his only daughter when she was 7, a tragedy from which he had never completely recovered, and relations with his two sons were not close. After several years, Gilbert accepted Hart Merriam's invitation to stay for a while in the latter's Washington home. This turned into a perma-



One of Gilbert's experiments (around 1891) on the formation of craters by impact. "Varying angles, materials, and velocities, Gilbert dropped, threw, and shot pellets of mud, clay, and lead into . . . similar substances in an effort to replicate the impact craters he believed he saw on the moon's face," in Stephen J. Pyne's account. "He performed a number of these experiments in a hotel room when he gave a lecture series at Columbia University, referring to them as his knitting." [G. K. Gilbert photo 842; reproduced in *Grove Karl Gilbert*, courtesy of the USGS Photographic Library, and in *The Scientific Ideas of G. K. Gilbert*] nent arrangement; Gilbert became another member of the Merriam household six months of the year until the end of his life. Plans to marry a California botanist he had known for more than a decade were on the verge of being completed when he died of heart failure at his sister's home in Michigan.

Pyne deals with these and many of Gilbert's other very human experiences and feelings only as afterthoughts, so that Gilbert the man comes alive for the reader only through considerable effort of imagination. His personal life and interests outside of geology come through only intermittently. What is apparent is that Gilbert was in all of his dealings a self-effacing person, quietly unconventional, but a man of dignity. Except with very close friends or in settings resembling those of his sheltered childhood and youth he was "a little stiff . . . self-conscious, vaguely preposterous with his meticulously self-repaired clothes, occasionally brusque manner, and dogged sense of responsibility."

Pyne is best when describing and assessing Gilbert's research, his scientific concerns and philosophy, his professional associations and frustrations, and the significance of his published work. Gilbert took a Newtonian view of his subject. His training had been in the classics, mathematics, engineering, and mechanics. He was out of step with the majority of his fellow geologists, who approached the field from either a paleontological or a geophysical standpoint. He was also fascinated with astronomy, instituted modern thinking about the origins of the moon, and strove to demonstrate the affinities between planetary cycles and geological processes.

Gilbert's *Report on the Geology of the Henry Mountains* (1877) and *Lake Bonneville* (1890) were his most notable publications, the former because of its discussion of the processes of erosion and the dynamics of the graded stream and its description of laccoliths, a type of mountain structure then new to geology. This study proved to be the making of Gilbert's reputation and of that of the Powell Survey. In the report on Lake Bonneville, which Gilbert considered his magnum opus, he stressed lake topography and shoreline processes and analyzed postglacial drift. He was more interested in the concept of equilibrium than in the essentially historical processes represented by paleontology or geophysics. *Lake Bonneville* was thus the first major synthesis of isostasy in American geology.

Interestingly, Gilbert's views on conservation were of a piece with his scientific philosophy. Here again, he strove for equilibrium when drafting his *Hydraulic Mining Debris in the Sierra Nevada*, published in 1917, the year before his death. Rather than take sides between industry and agricultural interests in California, he urged that they cooperate to ensure the integrity of the navigable waters flowing into San Francisco Bay, thus contributing to the common good. He refused to adapt his analysis to any program of political reform, believing that "the natural world was at its base orderly, balanced, and susceptible to mathematical-mechanical reasoning."

A modern assessment of Gilbert's work is that his significance "was not revolutionary," but rather lay "in the general excellence of his works. In his example rather than in the novelty of his philosophy is the reason for the tremendous impact of G. K. Gilbert upon American and world geology."

Pyne's account is a most helpful study of a figure whose work was critical to the development of modern geology. He has ranged widely and capably through the available manuscript and published sources. Though he scants much in Gilbert's personal life that was probably essential in forming the man's character and traits, his account places Gilbert's professional attainments squarely in the context of other developments in the coming of age of American geology.

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Left, Gilbert photographing a fault surface south of Klamath Falls, Oregon, in 1916. This photograph, from the collection of Mrs. J. P. Buwalda, was taken by J. P. Buwalda. "While the photographers were engrossed in examining the scarp," Mrs. Buwalda recalled, "the brakes of the car in the background released and the car rolled over the road embankment into the bushes." *Right*, The photograph obtained. In Gilbert's account, "The scratches upon the fault surface show a slight variation in direction, and some of them intersect at small angles, but collectively they indicate that the relative motion of the rock masses had no horizontal component within the fault plane." [From *The Scientific Ideas of G. K. Gilbert*]

The Scientific Ideas of G. K. Gilbert. An Assessment on the Occasion of the Centennial of the United States Geological Survey (1879–1979). ELLIS L. YOCHELSON, Ed. Geological Society of America, Boulder, Colo., 1980. viii, 148 pp., illus. Paper, $17. GSA Special Paper 183.

Grove Karl Gilbert is probably the best-known geologist to have served on the staff of the U.S. Geological Survey and is the only person to have been twice elected president of the Geological Society of America, so it seems natural for the USGS to choose to celebrate its centennial (1879–1979) with a symposium on his scientific works and for the GSA to publish the symposium proceedings.

The title of the proceedings emphasizes Gilbert's ideas, whereas the 14 papers (by 15 authors) reflect on various aspects of his scientific contributions, from his description of observations to his formulation of ideas concerning those observations to his methods of checking those ideas through subsequent field observations and measurements. Some of the papers review his commentaries on scientific methods in geology. This diversity of emphasis is fortunate, because scientific ideas in a complicated science such as geology are necessarily of transient value. As the papers describing Gilbert's research efforts indicate, marks of his greatness are that he helped geology to take several long steps forward but that he did not establish final boundaries of the science. His scientific ideas have been outdistanced by the progress of successive generations of geologists precisely because of his influence on the science. In the words of Claude Bernard (in *An Introduction to the Study of Experimental Method*), "Great men have been compared to giants upon whose shoulders pygmies have climbed, who nevertheless see further than they."

His emphasis on scientific method is an almost unique feature of Gilbert's geological writings. One of the papers touching on the subject is by Stephen Pyne. According to Pyne, writing in reference to three of Gilbert's papers devoted to explaining scientific method in geology, Gilbert emphasized that creative scientific thought is guided by analogies. David Kitts, however, takes issue with Pyne about the role of analogies in Gilbert's scientific methodology and argues convincingly that analogies play a minor role in the methodology of most present-day geologists. Kitts distinguishes between historical science (which includes most of geology), which is concerned with singular events that are located, described, and named, and theoretical science (which includes physics), which is concerned with collections of things or kinds of things that have common essential properties. Kitts argues that geology is essentially a historical science and that geologists formulate general principles in order to make historical inferences. In contrast, theoretical scientists derive general principles or theories and test the theories by observing or measuring singular events. Thus, geological scientists and theoretical scientists have different goals: for geological scientists, "singular descriptive statements are ends, and theories are means to those ends. For theoretical scientists, theories are ends, and singular descriptive statements are means to those ends."

Gilbert indicated that scientific research is focused on determination of antecedent and consequent relationships among singular events that make up the history of the earth and that the role of analogies is in the generation, not in the testing, of hypotheses. He suggested that hypotheses about the antecedents of phenomena are generated out of analogies. For example, Gilbert was clearly using analogy when he was studying the forms of badlands topography in the Henry Mountains, in which he imagined the processes responsible for the tendency for summits to be rounded to be analogous to the process of diffusion of heat into a solid with sharp corners (Gilbert, field notebook No. 9, Friday 27 October 1876, p. 40). He imagined that weathering is analogous to diffusion of heat. But Kitts argues that "it is a striking feature of contemporary geology that geologists never encounter phenomena which they regard as so unfamiliar as to be in need of explanation in terms of as yet unformulated theory," so that there is no need to discover antecedents of a phenomenon by means of analogies. Rather, accepted geological principles and physical theories are the sources of hypotheses for geologists, and the antecedents geologists recognize to a phenomenon will invariably conform to these principles and theories. Kitts indicates that geologists, including Gilbert, suppose that no event they encounter is new, that all events are explained by extant theory. In Kitts's view, the only significant role of analogies in geology is in experimentation, involving two phenomena that are known to have some properties in common and that are hypothesized to have some others. The two phenomena, however, are no longer considered to be merely analogous when they are believed to have many properties in common; they are then considered to be of the same kind. I feel that we owe deep gratitude to Kitts for clarifying the scientific method commonly followed by geologists and for clarifying the role of analogies in geological research.

Several papers in the symposium touch on the priority of Gilbert's scientific ideas and on their impact on subsequent research on a variety of subjects, including the craters of the moon, gravity measurements and the internal structure of the earth, geochronology, groundwater hydrology, and glacial geology. Gilbert himself had little patience with discussions of priority. As quoted in Stephen Pyne's paper, Gilbert stated, "In my opinion it makes little difference to the scientific world by whom discoveries are made, and I regard public discussion of questions of authorship and priority as a burden to the literature of science, occupying space and costing energy that could be better devoted." Several authors point out that many of Gilbert's published results had little or no impact on subsequent investigations. Some suggest that this is because Gilbert did not hold a professorship in a major university and so did not develop a school of devoted students. Robert Wallace, however, has another explanation, that the very different reception different parts of Gilbert's work received might be understood in terms of the mental climate and timing of the work: "A scientific audience must exist and be suitably attuned to the subject at hand in order to perceive and be influenced by a scientific contribution, and the particular science must be dynamic and capable of reflecting changing ideas." Thus, Gilbert's paper "Earthquake Forecasts," which contained "issues and concepts . . . ranging from earthquake prediction, earthquake engineering, and land use considerations to the evaluation of risk and insurance [that] anticipated most of the 1977 law" embodied in the national earthquake hazard reduction program, "fell on deaf ears." In contrast, Gilbert's ideas on fault-block mountains in the basin ranges captured the attention of the geological community because of contemporary interest in mountain building processes.

I essentially agree with a comment by Robert Wallace, that "geologists could profit from repeated study of Gilbert's writings." One reason is indicated by Charles Hunt, who writes with respect to the report on the Henry Mountains that it "sets an example of reporting technique that could be a model for present-day geologists" and that "present-day PhD candidates and many of their faculty would do well to adopt Gilbert's technique." Another reason was indicated by Gilbert himself, that creative scientific thought can be guided by imitating examples of great scientific works. In geology, certainly, Gilbert's reports on laccolithic intrusions, on geomorphology, on the origin of craters of the moon, on the origin of Coons Butte, on the transportation of debris by running water, and on the origin of sheet structure in the Sierra Nevadas are worthy of imitation. If the papers in the symposium on the scientific ideas of Grove Karl Gilbert induce readers to study the original scientific works by this great geologist, I would judge the symposium to be a success.

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