MEMORIAL OF NORMAN L. BOWEN

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Norman L. Bowen died in Washington, D. C., on September 11, 1956, after an illness of about two years. The passing of this great petrologist and past president of the Mineralogical Society of America will be noted with sadness by his many friends in mineralogy and geology. He leaves his widow, Mary Lamont Bowen of Washington, D. C., and a daughter, Catherine (Mrs. Jerrold Orne) of Montgomery, Alabama.

Like most great men in science, Norman L. Bowen has contributed to both fact and theory. As is the usual case with brilliant scientists, he became recognized as a leader early in his career. By the year 1915, at the age of twenty-eight years, his reputation among petrologists was established when he published a paper on *The later stages of the evolution of igneous rocks*. Besides his many papers reporting the results of phase-equilibrium studies on specific systems of rock-forming minerals, his papers *The problem of the anorthosites* (1917), *Crystallization differentiation in igneous magmas* (1919), *Diffusion in silicate melts* (1921), *Genetic features of alnoitic rocks* (1922), *The reaction principle in petrogenesis* (1922), *The behavior of inclusions in magmas* (1922), and *The origin of ultrabasic and related rocks* (1927) were outstanding contributions to the literature of petrology, which preceded the publication of his monumental book *The evolution of igneous rocks* in 1928. This book has had a profound influence on the younger generation of geologists because it emphasized the importance of the point that sound principles of physical chemistry underlie geological processes. This book has been so much in demand that a new reprint edition has just been issued.

One of the great ideas developed by Bowen is the significance of the reaction principle in petrogenesis. Pentti Eskola of Finland has called it the most important contribution to petrology of the present century. Other great fundamental contributions have been a quantitative discussion of the heat relationships and the quantitative possibilities of incorporation to be expected where magmas intrude and react with country rock, the succession of mineral assemblages to be expected at successively higher temperatures in the metamorphism of impure carbonate rocks, the relations in silicates of ferrous iron, the importance of petrogeny's residua system, and the origin of granites. In addition, the important laboratory contributions of Bowen and his colleagues provide not only a physical-chemical basis for geological processes, but are fundamental contributions to the mineralogy of the rock-forming minerals and have been widely useful as the basic science underlying such important ceramic materials as cements, refractories, and glass, and the chemistry of metallurgical slags.

The desirability of experimental studies in the laboratory as an important adjunct to geological field observations has long been urged by Bowen. Experiment is a necessary check on inference from observations on the natural materials and in turn provides a chemical basis for hypotheses on origins, which may be tested in the field and modified to give a nearer approach to the mechanism of rock genesis. Some have doubted the value of laboratory phase-equilibrium studies in geology because under natural conditions equilibrium is not always attained. The only practical method of studying the physical chemistry of geological processes is to determine equilibrium relations first and then to evaluate the factors that lead to failure of equilibrium under natural conditions, together with the magnitude and direction of their effects.

In the year 1906 the Geophysical Laboratory of the Carnegie Institution of Washington was established for the purpose of studying the problems of rocks and minerals through systematic and sustained experimentation in the laboratory. In the year 1910 Norman L. Bowen came to this laboratory as a young student to use the facilities in making a phase-equilibrium study of a silicate system. He was permitted to use these results for a thesis for the degree of Doctor of Philosophy at the Massachusetts Institute of Technology. For forty-five years he pursued his laboratory studies and carried his results to the field to check them with the rocks themselves.

Norman Levi Bowen was born in Kingston, Ontario, Canada, June 21, 1887. He received his Master of Arts degree from Queen's University in 1907, the Bachelor of Science degree from Queen's University in 1909, the Doctor of Philosophy degree from Massachusetts Institute of Technology in 1912, the Honorary Doctor of Laws degree from Harvard University in 1936, the Honorary Doctor of Science degree from his Alma Mater in 1941, and the Honorary Doctor of Science degree from Yale University in 1951. He was Assistant Petrologist, Geophysical Laboratory of the Carnegie Institution of Washington, 1912 to 1918; Professor of Mineralogy, Queen's University, 1918 to 1920; Petrologist, Geophysical Laboratory, 1920 to 1937; Charles L. Hutchinson distinguished service Professor of Petrology, University of Chicago, 1937 to 1947; Petrologist, Geophysical Laboratory, 1947 until his retirement in 1952. After a year in Clearwater, Florida, following his retirement, he returned to Washington and was still active and had an office at the Geophysical Laboratory until his death.

Bowen's pre-eminence in science is attested by the receipt of many honors both at home and abroad in recognition of his achievements. He was president of the Mineralogical Society of America in 1937 and of the Geological Society of America in 1946. He was elected a member of the American Philosophical Society and the National Academy of Sciences.

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He has been honored abroad by election as a foreign member by the Royal Society (Great Britain), the Finland Academy of Sciences, the Academy Naturwissenshaften (Halle), the Academy Lincei (Rome), the Geological Society of Belgium, and the Indian Academy of Sciences. He has received the Bigsby Medal of the Geological Society of London (1931), the Penrose Medal of the Geological Society of America (1941), the Miller Medal of the Royal Society of Canada (1943), the Roebling Medal of the Mineralogical Society of America (1950), the Wollaston Medal of the Geological Society of London (1950), the Hayden Medal of the Academy of Natural Science of Philadelphia (1953), and the Bakhius Roozeboom Medal of the Royal Netherlands Academy (1954).

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