

Presentation of the Roebling Medal of the Mineralogical Society of America for 1981 to

Robert M. Garrels

HAROLD C. HELGESON

*Department of Geology and Geophysics
University of California
Berkeley, California 94720*

Mr. President, Ladies, and Gentlemen:

Robert M. Garrels is truly a man for all scientific seasons! He is not only widely regarded as the father of aqueous geochemistry, but he has also been acclaimed for outstanding achievements in geology and oceanography. Robert Garrels was awarded the Arthur L. Day Medal by the Geological Society of America in 1966, the V. M. Goldschmidt Medal by the Geochemical Society in 1973, the Penrose Medal by the Geological Society of America in 1978, the Wollaston Medal by the Geological Society of London in 1981, and now as the 1981 recipient of the Roebling medal he is being honored by the Mineralogical Society of America for scientific eminence in the field of mineralogy. I can think of no one more deserving or better qualified for such universal recognition of superb achievement in science.

The first paper to appear in the *American Mineralogist* bearing Robert Garrels' name was published in 1949 on the subject of fluid inclusions and geologic thermometry, a topic that has expanded dramatically from a position of relative obscurity to prominence over the past thirty years. This observation underscores both the insight and farsight that characterize his research. His pioneering work on uranium deposits and the oxidation of sulfides sparked myriad experimental and theoretical studies of ore-forming processes, and his early research in solution chemistry set the stage for modern theories of ore transport and deposition. The experimental and theoretical studies he carried out in the 1940's and 50's were directed toward application of chemical thermodynamics to mineral systems and investigation of the kinetics of reactions among minerals and aqueous solutions. The results of these studies are still fundamental to current theories of silicate hydrolysis, weathering processes, and diagenesis.

Robert M. Garrels, more than anyone else, is

responsible for the current proliferation of activity diagrams in the geologic literature. Working independently, he and Marcel Pourbaix in Belgium pioneered the application of oxidation/reduction–pH diagrams to mineral systems. His research on cation-sensitive electrodes led to development of equations describing the behavior of glass electrodes in aqueous systems. Working with Roland Wollast, he was the first person to measure diffusion coefficients in sea water. The studies of clay mineral chemistry that he has carried out are still widely cited throughout the profession, both from a geochemical and mineralogic point of view. His outstanding work on the chemical evolution of the oceans, continents, and atmosphere is not only internationally known and admired in the geological sciences, but it is now becoming recognized by biochemists for its importance in developing theories of the origin of life and its environment.

Robert M. Garrels is without question one of the most outstanding, respected, and influential scientists in the world. He has no peers at what he does, and his research and teaching accomplishments have accelerated and altered demonstrably our understanding of the Earth and the world around us. He has won international respect for his dedication to, and staunch respect for geologic reality. His prime concern has always been with what actually happens in nature, rather than what thermodynamics or theoretical concepts indicate *should* be happening! This concern is perhaps best manifested by his paper entitled "Some free energy values from geological relations," which appeared nearly twenty-five years ago in the *American Mineralogist*. This paper typifies the "Garrelsonian" approach to science.

Robert Garrels has never been concerned with the details of crystallography, nor has he ever engaged in the search for a new mineral species (although one such species bears his name). In-

stead, he has devoted his efforts to discovery of why minerals occur where they do, and how they came to be where they are. He is widely acclaimed for the elegant simplicity of both the experiments and arguments he employs to attack complex problems. In addition, he has gained an international reputation as a master of the "intuitive leap" with an enviable and uncanny ability to perceive the solution to problems and remain on the forefront of research progress. It is of some interest to note in this regard that in 1950, when he arrived at the Annual GSA meeting to present his paper (coauthored by R. M. Dreyer) on the solubility and rate of solution of calcium carbonate, he found only one person in the audience. Thirty years later, the thermodynamic and kinetic behavior of calcium carbonate dominates the interests of a great many Earth scientists.

Robert M. Garrels was born August 24, 1916 in Detroit, Michigan, but he spent his formative years in the mountains of southwest Virginia. He received his B.Sc. from the University of Michigan in 1936, and his M.Sc. and Ph.D. degrees from Northwestern University in 1939 and 1941, respectively. Throughout his long and distinguished career he has developed many friendships in the scientific profession and has collaborated closely through the years with both his colleagues and students. Many of his former students now occupy positions of promi-

nence in shaping the course of current and future research in the Earth Sciences, much of which is developing along lines first suggested by him. His mentor was Charles H. Behre, who suggested to him over 40 years ago that he study chloride complexes as possible transport agents for the ore-forming metals. He has authored or co-authored nearly 100 scientific contributions, including six books on topics ranging from physical geology and solution chemistry to the history of the Earth's environment. In addition, he has played a prominent role in many professional societies and has contributed enormously to their growth and effectiveness. He has been awarded four honorary degrees, and in 1962 he was elected to the National Academy of Sciences and the American Academy of Arts and Sciences.

In addition to his scientific brilliance, Robert Garrels demonstrates a rare and generous capacity for patience, courtesy, and human kindness. His erudite instruction, inspiration and enthusiasm, wise counsel, and dedication to the highest ideals of scholarship have touched the lives of many. His influence on my own career has been more than profound!

Mr. President, it gives me great pleasure to present to you and the members, fellows, and guests of the Mineralogical Society of America, the 1981 Roebling medalist, Robert Minard Garrels.