

Memorial to Robert M. Garrels

1916-1988

L. L. SLOSS

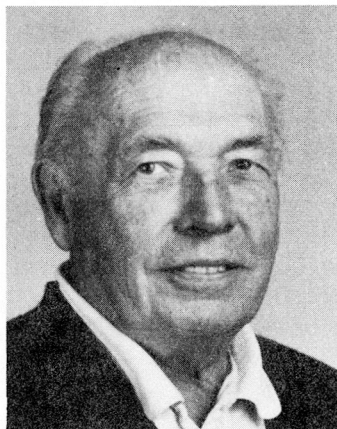
Evanston, Illinois

ROBERT A. BERNER

New Haven, Connecticut

Bob Garrels went his way in early March 1988, despite the same kind of valiant effort he put into climbing a mountain, swimming a lagoon, or going downfield for that long pass. Bob had lots of colleagues, ex-students, associates, and just plain friends, globally distributed, and he was beloved and admired by all. In turn, the worst complaint about others we can remember him voicing was that his more mature friends "are getting so bald and pot-bellied that they don't recognize me anymore."

Bob Garrels was a man for all seasons (except for winter), for almost all places (especially warm places), and for all people (give or take a dean or two). A natural athlete, he was a sports historian and an addicted exercise nut long before jogging was socially acceptable; swimming was his favorite sport, but there were room and talent for other outlets. Indeed, it is difficult to know how he would prefer to be remembered: as the winner of GSA's Penrose and Day medals, the Mineralogical Society's Roebling Medal, the Geochemical Society's Goldschmidt Award, the Geological Society of London's Wollaston Medal; as the recipient of honorary degrees here and abroad; as a member of the National Academy; or as the one-time holder of the world's high-jump record for senior athletes.



Bob was born in Detroit, but the family soon moved to the mountains of Virginia where the great out-of-doors became (and remained) an all-important source of interest and education. After a return to the Detroit area for high school, it was natural for Bob to go to the University of Michigan, where, influenced by his mountain childhood, it was equally natural to pursue geology (B.S. *cum laude*, 1937). Graduate studies were made attractive by the small differential between a teaching assistant's stipend and the going wage for newly hatched B.S. geologists; on to Northwestern and a career-dominating association with Arthur L. Howland and John T. Stark.

Howland, a Princeton-bred mineralogist/petrologist, had a program going on the geology of sedimentary iron ores in Newfoundland; Bob was taken on as field assistant, initiating a never-ending romance with banded iron formations. The young Garrels had been turned off by chemistry as it was encountered in his undergraduate experience; nevertheless, a sense of value and purpose emerged from his M.S.-thesis study of the complex interrelations of mineral species revealed in his samples. The reactions of iron and silica with near-surface waters and atmospheric gases became a happy obsession that continued to his last important paper (1987).

There were, of course, departures from concentration on near-surface conditions. Charles Behre suggested that Bob take on the enigmatic sulfides of the Mississippi Valley lead-zinc deposits as a doctoral dissertation. Frank Gucker of the chemistry department was called upon as a co-director of the study, and through his efforts, Garrels was brought up to speed on the essential lore and literature of chemical thermodynamics. "To Gucker I give the credit for any ability I may have in chemistry. . . . He led me into problems that required more chemical training than I possessed, and somehow made me

understand that it was unthinkable for me not to solve them. So, of course, I did" (from Garrels' autobiographical writings). The resulting thesis, based largely on what were then advanced electrochemical techniques, led to a 1941 Ph.D. and a widely ignored paper before the Boston meeting of the Society (the geochemical community was too deeply entranced by trigonal phase diagrams to have a concern for complexing in aqueous solutions).

Throughout the formative graduate-student years and for decades thereafter, Jack Stark was a powerful influence on Bob Garrels as a scientist and as a participant in the culture of the western world. A lot of Garrels' splendid step-by-logical-step approach to the exposition and solution of a problem and his ability and eagerness to communicate ideas to all comers, from seemingly retarded students to Nobel laureates, are traits (among others) attributable to his association with John T. Stark of Jackson, Tennessee.

With admirable timing, Charles Behre departed for Columbia, and Garrels was appointed to fill the slot, although the Northwestern geology department had never before (or since) hired one of its own Ph.D.s. University Hall, an 1867 Silurian dolomite structure with windows suitable for the protection of defending archers, housed the geology department. Here a laboratory, originally built for V. N. Ipatieff, renowned ultra-high-pressure experimentalist, became the site of a succession of investigations at a P/T range that made lab glassware out of baby food jars and peanut butter jars. Wartime service, mostly in Washington, soon interrupted academic life but served to introduce Bob to the Federal scene while expanding his acquaintance among the movers and shakers in earth science.

Returning to Evanston, Bob began a period of preparing forefront papers (see publications list) concerned with diffusion in water-saturated rocks, fluid inclusions as thermometers, activity coefficients of lead and chloride ions, the origin of the Clinton iron ores, and more. It was also the epoch of cultural exchange with the super-organized mind of Bill Krumbein. The fusion of Bob's concern for hydrogen-ion concentrations and redox potentials with Bill's need to place everything in its proper place resulted in a classic paper built around an Eh-pH diagram featuring fences that define the fields of origin and occurrence of chemical sediments. No one studying sedimentary rocks in the 1950s could escape that diagram nor consider pH or oxidation-reduction states without taking Garrels' precepts into account.

All this while, Bob was also a teacher, and a good one. Part of the first course in geology—presented to majors, sorority girls, and the intellectually unwashed as an exercise in the scientific method—was shared by Sloss. Bob wouldn't label the development of Tertiary horses as an example of evolution; the facts had to be exposed such that, as to Darwin on the *Beagle*, the concept of evolution appeared as a natural product. From these efforts came a truly fine Garrels book, titled simply *A Textbook of Geology*, so far ahead of its generation and so ineptly promoted as to stand no chance in competition with the dominant texts of the time.

A still more significant contribution to general education came out of collaboration with Irving Klotz (world class physical chemist born again as a biochemist) in a course called "Basic Science." Bob and Irv set up a fabulous straw man, Dr. Unohu, who bumbled about in theory and experiment, producing clouds of ideas and observations from which the first principles of science could be derived. That a finished text never emerged is a great pity—the course was a beacon for those trying to stem the rising tide of scientific illiteracy.

Bob Garrels was never one to sound off in public with reference to the obvious culpability of institutionally desensitized university administrators in their official contacts with high-minded faculty members. Instead, when irritation reached an unacceptable level, he would quietly transfer to a different locale. Thus, it came to pass in 1952 that the Geochemistry and Petrology Branch of the U.S. Geological Survey in Washington became the beneficiary of Northwestern's failure in the field of interpersonal relationships.

The change from semi-isolation in a small department to daily association with multiple geochemical peers was a stimulating experience, as was the opportunity to study the effects of Eh and

pH on the precipitation of uranium (and its fellow traveler vanadium) from aqueous solution at modest T and P . The Survey connection was exciting and productive, but it also entailed administrative responsibilities; Bob was not eager to be in charge of anything more than himself and a student or two. (Hewing unflinchingly to this line, Bob twice declined nomination as president of GSA.) Another penalty assessed by the USGS post was the deprivation of close contact with students. So, after three fruitful years in Washington, when Harvard beckoned, Garrels returned enthusiastically to the academic scene, entering what many consider his most productive phase in terms of writing and of students introduced to their careers. The appended partial list of papers for the years from 1956 to 1965 speaks for itself among geochemists; note that Bob's continuing concern for sediment-bound minerals was reinforced at Harvard by collaboration with Mary Thompson and Ray Siever. From the same epoch came "Mineral equilibria at low temperatures and pressures" and its revision (with Charles Christ) as "Solutions, minerals and equilibria," which stand as influential landmarks in the field.

When Francis Birch left the chairmanship at Harvard, Garrels, always the good soldier, took on the job in spite of his aversion to administrative posts. Soon the demands of the chair, exacerbated by unrelated nonacademic pressures, made a change of scene imperative and a return to Evanston attractive, thus closing the longest unbroken tour of duty in Bob's career.

Although the Second (or Penultimate) Northwestern Period covered only four years, it was a time of productive in-house collaboration with Fred Mackenzie (aided and abetted by former student Hal Helgeson) and of the initiation of close interchanges with Roland Wollast. This was the time of scrutiny of the chemical mass balance between rivers and oceans and of sedimentary recycling, both major topics to be treated in a pioneering and still-influential Garrels-Mackenzie text, *Evolution of Sedimentary Rocks*.

With the inevitability of Greek drama, it again became appropriate to move on; this time a span of five academic years was divided between the Scripps Institution of Oceanography and the University of Hawaii before the Third Return to Northwestern. In spite of a certain amount of wasted motion during the La Jolla–Manoa hegira, a lot of good things happened. Paramount among these was the marriage of Cynthia A. Hunt and Robert M. Garrels, a union not quickly contrived and true to the "till death do us part" vow. Cynthia not only made a house a home, whether in La Jolla, Hawaii, Bermuda, Evanston, or St. Pete, but also operated with great efficiency as unpaid research assistant and effective collaborator (two books on the record and much more).

Hawaii was great, but "frequent flier" programs were not yet in vogue as rewards for excessive flight time; meanwhile, Bob was being called to meetings and conferences all over the western world. So, come 1974, it was back to a central location at (where else?) Evanston and the beginning of yet another five-year cycle, the Third (or Terminal) Northwestern Period. Fred Mackenzie was just down the hall, as was Abe Lerman; Yves Tardy added to the Francophone connection provided by Roland Wollast, and all of these men interacted vigorously on the exploration of geochemical cycling (see publications list for 1975–1982).

Ultimately, the kind of offer that should have been placed before Bob and Cynthia much earlier was made by the Marine Science Department of the University of South Florida. They moved to St. Petersburg in 1980 to enjoy broad fiscal support and slender responsibilities while being soothed by a gentle climate. When it got hot in St. Pete the Garrels ménage often shifted to New Haven (ancestral Hunt terrain) where Berner and his Yale students and colleagues were available for continuing discussions and action on geochemical cycles.

What would have been Bob's seventy-second birthday passed while these remarks were being assembled. We like to remember previous birthdays at the Bermuda bio station—days ornamented by a late-afternoon swim in Ferry Reach (Bob off on one of his endurance trials, Cynthia near shore trying to keep an eye on him), a few drinks before dinner (perhaps a gourmet dinner prepared by Roland), an evening stretched out on the concrete cover of the cistern, scanning the sky for tardy Perseids. Those

were great days; there were many such with Bob Garrels in office, lab, and field; it was a privilege to have shared an aliquot of space and time with him.

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