ground water

Historical Note/ David Deming, History Editor

William "Bill" Back: An Incisive Geochemist and a Great Mentor

by Mary Jo Baedecker[1] and Warren W. Wood[2,3]

Introduction

William ''Bill'' Back (Figure 1) was one of the great ''idea people'' in low-temperature geochemistry during the blossoming of ground water hydrology in the latter half of the twentieth century. Prior to the1950s, most of the research in ground water chemistry was related to water quality and was carried out by chemists who rarely ventured into the field. Bill, Ivan Barnes, Bruce Hanshaw, Blair Jones, and Don White of the USGS were among the first to change that by using aquifer systems to test models of natural solute evolution and thus changed the way people thought about water chemistry.

Bill Back was an early leader in recognizing the importance of thermodynamics in ground water systems. He related ground water chemistry to flow in aquifers, and in what is now a benchmark paper (Back 1960), he introduced the concept of hydrochemical facies by drawing on the concept of geological facies (units of similar lithology and depositional history). Bill defined hydrochemcial facies as ''*the diagnostic chemical aspect of water solutions occurring in hydrologic systems*,'' which ''*reflect the response of chemical processes in the lithologic framework and the pattern of water flow in it.*'' In later work, he used geochemical mass balance and stable isotope data to constrain possible reactions and recognized the value of dating water and solutes in aquifer systems. He was among the first to investigate redox processes in iron-reducing aquifers and later turned to extreme geochemical environments such as landfills and investigation of the role of organics in solute evolution in ground water. Later in his career, he investigated the importance of ground water in the development of ancient cultures. Although his numerous publications reflect his many scientific accomplishments, he is perhaps most endearingly remembered as a mentor to young students and professionals, for encouraging and supporting women in hydrogeology, and for his contributions to professional societies and international hydrogeological activities.

Early Career

Bill was born on August 9, 1925, in East St. Louis, Illinois, and he died on January 31, 2008, in Honolulu, Hawaii, where he had lived for the past 2 years. Bill graduated in geology from the University of Illinois in 1948, and he attended the University of Colorado and University of California, Berkeley, where he received an MS degree in geology in 1955. He received a Masters in Public Administration from Harvard in 1956, and PhD from the University of Nevada in 1969 under George Burke Maxey. Bill retired from the USGS in 1996 after 47 years of service. Bill met and married, Connie, his lifelong partner for 57 years, while he was in California, and together they raised a family of three sons and one daughter. Bill was proud of his children and was pleased that two of his sons received degrees in geology, one of whom (David) works as a hydrogeologist in Virginia.

Bill started his career with the USGS in the summer of 1946 in the Alaskan Section of the USGS in Seattle, Washington, as a data recorder and then in Sacramento, California, as a hydrologic field assistant, including work in Yakataga, Alaska. He developed and honed his professional skills, publishing a series of USGS reports on local investigations in California. In 1954, he transferred to the USGS Regional office in Arlington, Virginia, to join a new program in ground water geochemistry for the Eastern Region. (This was 10 years before the organization of the Surface-Water, Ground-Water, and Water-Quality Branches in the current Water Resources Discipline.) His

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Figure 1. Photograph of William Back around 1990.

interest in karst hydrology and geomorphology of aquifer systems began at this time while working with Vic Stringfield on the Floridan Aquifer. He initially published little on these investigations with Vic but over his career kept returning to the Floridan Aquifer system to test new ideas. In what was to become his ''signature'' of providing conceptual models and data to young scientists within and outside of the USGS, he encouraged others to use this aquifer system to study the solute mass balance approach to field geochemistry.

In the late 1950s and early1960s, Bill applied the concept of hydrochemical facies to ground water solutes and illustrated for the first time how solutes evolved along a flowpath in the North Atlantic Coastal Plain Aquifers (Back 1960, 1966). Bill, along with Ivan Barnes, was among the first to apply thermodynamic principles to the study of chemical reactions in aquifer systems and to explain the occurrence of dissolved iron in ground water of the Atlantic Coastal Plain (Barnes and Back 1964; Back and Barnes 1965). In addition to detailed investigations, Bill wrote reviews of the discipline at various times in his career. One of his first reviews, written with Bruce Hanshaw, was an extensive article on chemical geohydrology that included examples from the Atlantic Coastal Plain and other parts of the country (Back and Hanshaw 1965).

Bill extended the concept of chemical thermodynamics developed by Robert Garrels and his students at Harvard to aquifer systems in examining the ''dolomite problem'' first articulated in 1957 by Fairbridge (Back 1961, 1963; Hanshaw et al. 1971). Bill knew Garrels from his studies at Harvard in the 1950s. He later extended this interest in quantitative geochemistry, using a mass balance approach to explain geochemical changes in aquifers of Florida and Yucatan, Mexico (Back et al. 1979; Plummer and Back 1980). Advising young professionals to ''compare and contrast'' information from several field sites, much of his career was spent in comparing and contrasting the hydrogeology and geochemistry of carbonate aquifers using the Floridan and Yucatan aquifers as his laboratory. Much of his work on carbonate systems from the mid-1960s to mid-1980s was done with Bruce Hanshaw, and they received the 1973 Geological Society of America (GSA) O.E. Meinzer Award (Back 1974), which recognizes authors of a publication that has significantly advanced the science of hydrogeology, for their work on the carbonate peninsulas of Florida and the Yucatan (Back and Hanshaw 1970). Putting their work in a broader context, they wrote several reviews on the development of carbonate aquifers (Back and Hanshaw 1971; Hanshaw and Back 1979).

In some of the earliest work on the application of stable isotopes in ground water systems, Bill and his colleagues used water and carbon isotopes to constrain the possible reactions (Back and Zoetl 1975; Rye et al. 1981). Bill recognized that kinetics of some carbonate reactions were significant and believed that the aquifer system could be used to test hypotheses using different rates of solute and water movement. Thus came some of the earliest carbon-14 dating of ground water systems to be used for geochemical studies (Hanshaw et al. 1965a, 1965b; Back et al. 1970, 1983).

Later Work, Honors, and Personal Legacy

In 1975, Bill's office moved from Arlington, Virginia, to the new Headquarters of the USGS in Reston, Virginia, where he worked in the National Research Program in Hydrologic Sciences until he retired. Recognizing that humans were changing the nature of shallow aquifers with the disposal of wastes, he wrote a paper with John Cherry of the University of Waterloo about the chemical aspects of future hydrogeologic problems (Back and Cherry 1976). Also, in the late 1970s, Bill began working with Mary Jo Baedecker on contaminated aquifers, first at a landfill in Delaware. They recognized the importance of organic material and microbial processes that break down organics as factors in the geochemical evolution of ground water, especially in contaminated environments where such reactions are dominant (Baedecker and Back 1979a, 1979b). This work was an important early analysis of chemical reactions in a contaminated aquifer; it was done under sponsorship of the USGS Toxics Substances Hydrology Program started in 1982 to understand how contaminants interact with aquifers and streambeds and are transported along flowpaths.

Bill had an intuitive feeling for aquifer systems and could conceptualize the hydrogeologic framework and geomorphic features relevant to chemical evolution of solutes. Bill had taught English briefly early in his career, and he was indeed a prolific writer and editor with a publication list of journal articles and books spanning the water science spectrum. His real thrill, however, was the conception and the testing of a hypothesis in the field. He was generous with his ideas and time and was a natural mentor to a large number of young professionals and students. Bill also gave time to the development of professional societies where he placed special emphasis on engaging students and early career researchers. He was a long-term Fellow of the GSA and provided leadership for growth of the Hydrogeology Division, where he served for 4 years on the Executive Board and was Chairman of the Division in 1986. Bill was a driving force in the preparation of the GSA's publication Hydrogeology: The Geology of North America coedited with Joe Rosenshein and Paul Seaber. This volume, covering a review of the hydrogeologic regions of North America and comparative hydrogeology of major rock types, focuses on the relation of ground water to geology (Back et al. 1988).

Always willing to assist and advise in foreign countries throughout his career, he had assignments in Israel, Pakistan, Costa Rica, Poland, Bolivia, China (Figure 2), Brazil, and Turkey. Many of these trips were facilitated through the United Nations. As a senior scientist for the USGS, Bill was the principal investigator of a National Science Foundation (NSF) project with the University of New Orleans and the government of Mexico in the 1970s and a coprincipal investigator with Ramon Llamas on a project in Spain under a U.S./Spain Cooperative agreement in the 1980s. He facilitated much of the work under these agreements and continued to expand his knowledge of carbonate aquifers and the surface/ground water mixing problem. Bill was pleased to be able to aid and assist others in developing countries and learn more about their water resources (Back and Lesser 1981). He loved to travel and to view and understand hydrogeology under different conditions—that was his reward for the time spent on these projects. With Janet Herman of the University of Virginia, he continued work on karst systems into the 1990s (Herman et al. 1986, Back et al. 1992). Throughout his career, he examined systems in different parts of the world, and he encouraged others to view research problems holistically as he did.

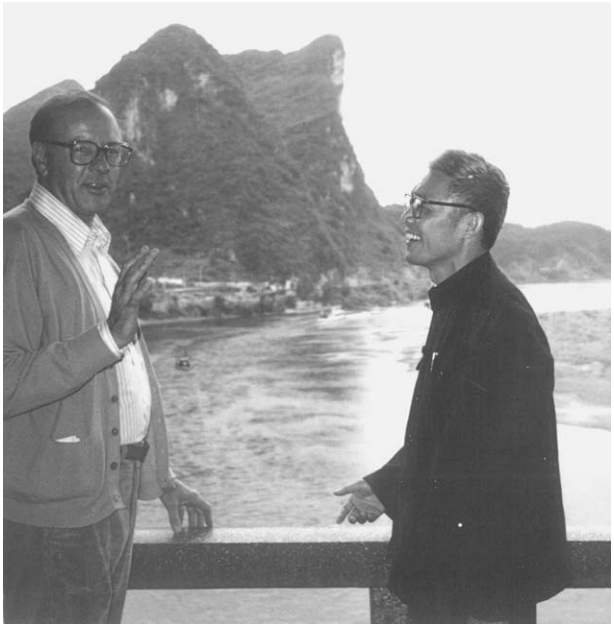

Figure 2. William Back talking with his friend and colleague, Yuan Daoxian, at the Institute of Karst Geology, overlooking the Lijiang River in Guilin, China, in 1981.

Bill had a great interest in history as well as scientific investigations. One of his papers concerns how the indigenous people in North and South America used and managed their water resources, their knowledge and beliefs about water, and the effects these ideas and practices had on their cultural evolution (Back 1981, 1995). He wrote about early spas and the chemistry of water and the recent trend of using bottled water (Back et al. 1995). In 1983, Bill and Allan Freeze compiled a two-volume set of papers for the Benchmark Papers in Geology Series on *Physical Hydrogeology* and *Chemical Hydrogeology*, bringing together much of the classic literature on ground water hydrology (Back and Freeze 1983; Freeze and Back 1983). He later coauthored an annotated chronology of the 100 most influential papers in the development of hydrogeology in America (Back and Herman 1997). One of his most interesting titles for a presentation given at the 1993 American Water Resources Association meeting was entitled "Dynamite, barbed wire, air conditioning, and water-resources management." When some of his colleagues questioned him about the title, he said that these three things have had the most influence on how we develop land and allocate and use water resources. His last publication was a contribution to a chapter about water management in the Yucatan (LaMoreaux 1999).

In addition to receiving the GSA O.E. Meinzer Award, Bill was the second GSA Birdsall (now the Birdsall/Dreiss) Distinguished Lecturer in 1979 and received the Hydrogeology Division Distinguished Service Award in 1988. Bill was also active in the American Geophysical Union and the International Association of Hydrogeologists. He received the M. King Hubbert Award from the National Ground Water Association in 1995 and the C.V. Theis Award from the American Institute of Hydrology in 1997. In recognition of his outstanding contributions, the Department of Interior awarded him the Meritorious Service Award in 1982 and the Distinguished Service Award in 1987. In addition to professional societies, Bill was active in the administration of the USGS, serving as a supervisor for a few years. This was short lived as he did not like management, and despite his graduate degree in public administration, being a manager was not consistent with one of his sayings: "If you follow all the rules, you are not working very hard."

Bill was an adjunct professor at George Washington University for more than 10 years and helped the Geology Department establish a program in hydrogeology. Some of Bill's most important contributions were as a mentor to many young scientists in the USGS and universities where he provided a huge amount of time and insight into scientific questions yet never took any credit for his input. He helped many young professionals by asking the right questions to attack a problem, introducing them to established scientists, advising them on career development, and helping them with international connections.

Bill was elected to the exclusive Cosmos Club of Washington, DC in 1969 and, as such, met with ''movers and shakers'' of Washington society. His generous holiday party with Connie's antique dolls and accessories displayed was attended by many of his scientific friends and colleagues as well as leaders in Arlington County and the Washington, DC area.

Bill's colleagues found him to be a bright, warm, outgoing person who was quick to make friends and who was a superb mentor. His quick wit and dry sense of humor were always refreshing, and he always made time to talk about technical, policy, or personal problems. Although Bill sometimes disagreed with the policy of his administrators, he was always civil and constructive in criticism. Each year as the fall GSA meeting appears on the calendar, many of us visualize a slightly unkempt Bill with blue blazer wildly rushing around from session to session with great enthusiasm. Those whom he mentored, colleagues, and associates miss him.

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