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Acceptance of the Roebling Medal of the Mineralogical Society of America for 1998

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Mr. President, members of the society, and guests:

I am greatly honored to be rewarded the Roebling Medal by the Mineralogical Society of America and to be cited for this honor by an esteemed former Ph.D. student and longtime friend John R. Holloway. In as much as the fifty years of research leading up to this award was based in part on a previous history of approximately 25 years, it is appropriate here to provide some of this earlier history.

In 1922 I was born, as the youngest of five brothers, into a farmer's family that was living in the Elsinore Valley of southern California. I lived on the farm until I graduated from high school in 1940; then I moved to Santa Monica, California, where I worked as a machinist before entering U.S. Naval Flight Training in 1942. I received my "wings" in Corpus Christi, Texas, in June 1943 and on the same day married Estelle M. Covington, who unfortunately passed away in 1982.

The next, highly significant tour of duty was in combat aboard the aircraft carrier USS Bismarck Sea (CVE95) until she was sunk off Iwo Jima in February 1945 as the result of a kamikaze attack. While in a naval hospital in 1945 for wounds I received, I was awarded the Purple Heart and in 1946, when I was released from the hospital and into the Naval Reserve, my eldest brother George talked me into joining him in the establishment of the now well-known mineral business Burminco. This company then dealt primarily with the acquisition and sales of museum-type mineral specimens; today it handles the above and rock and mineral collections for schools and students.

After joining my brother I soon learned that I needed to know more about the origins of these amazing specimens. I therefore returned to school at Ponoma College where I wrote a thesis on the "Geology of the Crestmore Quarries," which was then published in the California Division of Mines Bulletin, v. 170, ch. VII, p. 61–70 (1954) as "Contact metamorphism at Crestmore, California," where more than 110 individual mineral species were produced. I graduated magna cum laude from Ponoma College in 1951. From there I went to Cal Tech where, in 1955, I completed a Ph.D. thesis under the supervision of James A. Noble that was entitled "Metallogenic Provinces of the Southwestern United States and Northern Mexico"—receiving the second Ph.D. degree in Geochemistry to be awarded there. I then published a paper under the same title in the New Mexico Bureau of Mines Bulletin, v. 65, 76 p. (1959).

With degree in hand, I received a faculty position at Penn State in 1955 where I set up a laboratory with large volume, internally heated pressure vessels designed to determine the thermodynamic properties of fluids and melts at high temperature and pressures. During the more than 30 years I served at

Pictured left to right: Bruce Watson, 1999 president, John R. Holloway, presenter, and C. Wayne Burham.

Penn State, I held positions such as Australian-American Education Foundation Lectureship in 1970; a Distinguished Lecturer in Scientific Research for the Society of Economic Geologists in 1971; a Special Guest of the U.S.S.R. Academy of Sciences in 1973 and 1978; President of the Geochemical Society in 1974; an Invited Participant in the Nobel Symposium on Chemistry and Geochemistry of Solutions at High Temperatures and Pressures at Karlskoga, Sweden in 1979; a member of the Roebling Medal Committee, Mineralogical Society of American in 1980; and a Thayer Lindsley Distinguished Lecturer of the Society of Economic Geologists in 1982–1983. During my last twelve years at Penn State, I served as Head of the Department of Geosciences.

Through all of this time at Penn State, I had the good fortune of working with graduate students such as John Holloway, R.J. Bodnar, N.F. Davis, Rosalind T. Helz, Atilla Kilinc, Hanna Nekvasil, and post-doctorates such as G.M. Anderson, J.G. Blencoe, D.L. Hamilton, M.P. Ryan, and V.J. Wall. Thus, I have many geoscientists to thank for the decades of scientific work that have continued to pay off. Among the discoveries we have made during all of this time, one of the more important ones was that if the moles of non-volatile melt components are chosen on the basis of equal numbers of oxygen atoms (eight in the present case), a close approach to ideal mixing thermodynamically occurs amongst these eight oxygen atoms per mole species of melt components. As a consequence, it has become a relatively simple matter to develop a thermodynamically based model to calculate phase equilibrium relationships in

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magmas ranging in composition from peridotites and basalts to granites and rhyolites.

In accomplishing this thermodynamic task, I had the good fortune of gaining research support mainly from the National Science Foundation for the above-mentioned graduate students and post-doctoral research associates at Penn State for more than 30 years, as well as for the long-time assistance of machinist Merle Wilson. A great deal of research support also came from discussions with professional scientific colleagues such as H.L. Barnes, A.C. Lasaga, L.S. Darken, H. Ohmoto, A.J.R. White, and, especially the late "Mr. Pegmatite," R.H. Jahns. Interactions with Dick Jahns were especially helpful because of his long time convictions regarding the role of aqueous fluids in the origin of pegmatites. These convictions, along with other needs to better understand hydrothermal fluids at high temperatures and pressures and the availability of large volume internally heated pressure vessels prompted me to undertake many years and thousands of measurements on the *PVT* properties of H_2O. These measurements resulted in one of my most useful publications, "Thermodynamic Properties of Water to 1,000°C and 10,000 Bars" (1969; C.W. Burnham, J.R. Holloway, and N.F. Davis, GSA SP132).

Retiring from Penn State in 1986 and remaining Professor Emeritus, I accepted a position of Adjunct Professor of Geology at Arizona State where I am at present with John R. Holloway and Stanley N. Williams. Stan is currently providing the chemical data and oxidation states needed to evaluate, through the latest thermodynamic model, the sulfur-dioxide producing potential of volcanoes around the world.

I thank you all for this honor that you have bestowed upon me!