William D. Ehmann, radioanalytical chemist and radiochemistry educator

D. E. Vance,* S. W. Yates**

*Lockheed Martin Energy Systems, Analytical Services Organization, Building 9769, MS 8081, Oak Ridge, TN 37831, USA
**Department of Chemistry, University of Kentucky, Lexington, KY 40506-0055, USA

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The contributions of William D. Ehmann to radioanalytical chemistry and education in radiochemistry are summarized, and a selected bibliography of his publications is presented.

Introduction

In his research, William ("Bill") D. EHANN has developed many innovative approaches to trace element analytical chemistry using nuclear methods. He is a leader in the application of activation analysis to a wide variety of analytical problems and was the 1996 recipient of the American Chemical Society (ACS) Award for Nuclear Chemistry for his contributions in radioanalytical chemistry.

In addition to this Award, Bill has received many other honors including the 1994 Harty Medal, awarded by the Georgia Section of the ACS and the 1982 Distinguished Kentucky Scientist Award from the Kentucky Academy of Sciences. Most recently, he was named as the first recipient of the Ehmann Award, named in his honor, by the American Nuclear Society in recognition of excellence in the field of radioanalytical chemistry and related nuclear methods of analysis.

At the University of Kentucky, Bill was elected in 1968 as the Distinguished Professor of the College of Arts and Sciences, received a University Research Professorship in 1977, and was the 1987 recipient of the Sturgill Award for Contributions to Graduate Education. In addition, he is a Fellow of the American Association for the Advancement of Science and a Fellow of the Meteoritical Society. He was awarded a Fulbright scholarship to work at the Australian National University in 1964-65.

A native of Madison, Wisconsin, Bill received his B. S. (1952) and M. S. (1954) degrees from the University of Wisconsin at Madison and his doctoral degree (1957) in chemistry under the direction of Truman P. KOHMAN from Carnegie Institute of Technology (now Carnegie Mellon University) where he sought to detect cosmic-ray induced radioactivities in meteorites. In his dissertation research, he demonstrated the presence of the long-lived cosmic-ray induced radionuclides 26Al and 10Be in meteorites, a finding that led in later work by others to the development of important radioactive dating methods for determining exposure ages of meteorites in space.

Following the completion of his Ph. D. degree, Bill accepted a postdoctoral fellowship with John HUIZENGA at Argonne National Laboratory where he began to use the technique of neutron activation analysis. He was one of a small number of investigators at that time to apply the technique to estimate cosmic elemental abundances (for example, of Bi and Hg) by analysis of stony meteorites. Following this postdoctoral work, he joined the faculty at the University of Kentucky in 1958 as an assistant professor. He was promoted rapidly through the ranks to Professor of Chemistry in 1966 and, since January 1995, has been an Emeritus Professor. Bill served the University as Chairman of the Department of Chemistry, Associate Dean for Research of the Graduate School, Councilor for Oak Ridge Associated Universities, and is an Associate of the Sanders-Brown Center on Aging.

Following his move to Kentucky, Bill immediately began to build on his previous work. Among his important early papers was a study of the distribution of noble metals in meteorites and natural materials. That work, which was later reprinted as a "Benchmark Paper in Geology: Tektites," reported concentrations of Au, Ir, and Pt in meteorites, tektites, terrestrial rocks, and deep-sea sediments. Concentrations of these elements and their elemental ratios (Pt : Ir : Au) in tektites were found to be most similar to terrestrial sediments. This finding supported the now widely held view that tektites are fused terrestrial material formed by meteorite impact, not unique meteorites or ejecta from the moon as many at the time had proposed. This work was among the early papers to link the presence of iridium in rocks and sediments to meteoritic infall and contains the statement that "...the depletion of iridium in the Earth's crust suggests that this element might serve as a sensitive indicator of an extraterrestrial origin for materials..." Later, the presence of iridium in geological strata that date to the time of the extinction of the dinosaurs was used by others to suggest that the extinction was linked to the collision of an asteroid with the Earth.

As a result of his experience with the analysis of geological materials, Bill was one of a select number of researchers chosen by NASA to perform trace element analyses of the first lunar samples. One set of publications that resulted in considerable interest dealt with the...
detection of a fractionation of zirconium and hafnium in the crustal rocks from the moon. By using laborious radiochemical NAA procedures, he was able to demonstrate that Zr and Hf are appreciably fractionated in chemically defined lunar rock groups, while significant fractionation of these elements through basic igneous differentiation and metamorphism in terrestrial rock systems does not exist. The chemical and physical properties of Zr and Hf are virtually identical and separation even under extreme laboratory conditions is difficult. This fractionation was not accommodated by then current lunar evolution models and the Zr and Hf data from Bill’s laboratory were viewed with skepticism by many investigators at the time. Later, however, other researchers confirmed the fractionation.

Bill’s research group has made many contributions to the field of 14-MeV INAA, both in development of the technique and in its application to lunar materials, fossil fuels, semiconductors, and biological tissue. A unique single sample transfer system coupled with multichannel scaling of relative neutron output and the oxygen indicator radionuclide \(^{16}\text{N}\) was first developed in his laboratories in 1965. His group was the first to perform direct determination of the oxygen content of lunar rocks and developed several 14-MeV INAA methods for the determination of the organic oxygen content of fossil fuels. His work on the determination of the stoichiometric compositions of some of the starting materials used by different laboratories to synthesize superconductors showed that some disputes concerning the superconductor properties could be traced to differences in oxygen content of the starting materials. Bill has used the technique of derivative activation analysis together with 14-MeV INAA to speciate oxygen in coal, to determine O, F, and B in materials with corrections for multiple interferences, and has presented major invited reviews of the field of 14-MeV INAA.

Some of Bill’s other early contributions of special interest involve the use of coincidence counting in INAA and the development of a new approach to calculating advantage factors in epithermal NAA.

Bill’s recent research has focused on biological trace element analyses aimed at elucidating the potential role of trace elements as causative agents in neurological diseases such as Alzheimer’s disease (AD), amyotrophic lateral sclerosis (ALS), and Pick’s disease. This work initially began with investigations of aluminum levels in the brains of AD patients and lead to the refutation of the notion that Al was definitively involved in causing AD. From there, the work was extended to include some thirty to forty other elements in a variety of tissues, including the brain, blood, internal organs, subcellular brain fractions, and external tissues. This work also led Bill into the use of other analytical techniques such as graphite furnace atomic absorption and laser microprobe mass spectrometry. Some of the more significant results of this work include the Al work mentioned above, the discovery that there were some elemental imbalances in the brains of AD subjects, especially large elevations of mercury in specific regions and in certain subcellular fractions, the discovery of elemental imbalances in ALS tissues, and trends in brain trace element levels with age in normal subjects.

Bill’s educational efforts form another important contribution to radiochemistry. In addition to providing outstanding, enthusiastic classroom instruction to hundreds of radiochemistry students, he is the senior author of the well-received basic textbook *Radiochemistry and Nuclear Methods of Analysis*. First published in 1991, this monograph has been adopted nationally and internationally by universities, colleges, and nuclear training centers for their basic radiochemistry courses, and reviews of this work have been highly complementary. In addition, Bill has served as the leading author of the *Analytical Chemistry* biennial reviews on “Nuclear and Radiochemical Analysis.” He has directed 28 Ph. D. dissertations and 11 M. S. Theses, worked with numerous undergraduates, postdoctoral fellows, and visiting scholars, and published well over two hundred research articles. References of some of these and other publications follow.

**Representative publications of William D. Ehmann**

*Selected research papers*