# O. E. MEINZER AWARD
**presented to**
# MARY P. ANDERSON

## Citation by CHUNMIAO ZHENG

I am privileged to introduce Mary Anderson. I first met Mary in January 1985, just a few days after I arrived at the University of Wisconsin—Madison from China to study hydrogeology with her. Not long after my arrival, Mary gave me one of those big computer tapes and said "Chunmiao, this is a modular flow model recently released by the USGS. It looks pretty good; why don't you install it on our departmental mainframe and try it?" At that time, I knew next to nothing about computers or modeling. After several sleepless nights, I finally got the program working, and along the way learned a few Unix and FORTRAN commands. Mary rewarded my hard work by taking me to see a Shakespeare play, the true passion of Mary and her wonderful husband Charles. Naturally, I was thrilled to see a Shakespeare play for the first time in my life. But I had no idea at that time that I would be stuck with what would later be known as MODFLOW for the rest of my life!

Mary has had a distinguished career at the University of Wisconsin—Madison since 1975, after receiving her Ph.D. from Stanford in 1973 and serving a short stint as an adjunct professor at Southampton College of Long Island University. At UW—Madison, Mary has taught hydrogeology and groundwater modeling to a generation of students, many of whom have become industry leaders and productive researchers. On many occasions, I have discussed the UW hydrogeology program with other alumni; the consensus is always the same—the program's success and prominence are a direct result of Mary's vision and leadership in many research areas, and a unique style of working with graduate students that encourages independent thinking and develops in students a deep-rooted passion for solving real-world problems. Not only have her own students benefited tremendously from her guidance and mentoring, our entire hydrogeology community is indebted to Mary for her numerous professional service activities, including serving as president of the Hydrology Section of the American Geophysical Union and service on the editorial boards of *Geology, Ground Water, Journal of Contaminant Hydrology, Hydrological Processes,* and *Water Resources Research.*

Few people have been more influential than Mary in the transformation of groundwater modeling from an esoteric plaything into a fundamental tool of practicing hydrogeologists. As an original member of Professor Remson's "Stanford

mafia", which now threatens to take over the hydrogeologic universe, Mary developed an interest in numerical modeling of groundwater flow systems that led her to publish a pioneering paper on the coupling of the one-dimensional Richards equation with saturated flow equations. Since receiving her Ph.D., Mary has continued to work on all aspects of computer modeling of groundwater systems, and she has made significant contributions to the science of hydrogeology in many areas. Among these are the interaction between groundwater and lakes, the characterization of geologic heterogeneity for purposes of groundwater investigations, the quantification of groundwater recharge, and philosophical issues of model application. While it would take a very long time to describe everything Mary has done, let me briefly touch on the areas cited in the Meinzer Award.

Soon after arriving at UW—Madison, Mary and her students began studying groundwater-surface water interaction at several lakes in northern Wisconsin, as part of the NSF's Long Term Ecological Research (LTER) program. At a time when quantitative analysis was the exception rather than the rule, Mary realized the power of groundwater modeling and used it as a primary tool in her research. The continuing work in this area has led to numerous publications, including the three most recent ones cited for the Meinzer Award: Long- and short-term transience in a groundwater-lake system in Wisconsin (*Journal of Hydrology,* 1993, v. 145); simulating the influence of lake position on groundwater fluxes (*Water Resources Research,* 1994, v. 30, no. 7), both with Xiangxue Cheng; and groundwater inflow measurements in wetland systems (*Water Resources Research,* 1996, v. 32, no. 3), with Randy Hunt and Dave Krabbenhoft. This research by Mary and her students has provided invaluable insights into the role of groundwater in the hydrological, geochemical, and ecological evolution of lakes and wetland systems. Equally important, their work has established a quantitative and multidisciplinary framework for studying groundwater-surface water interactions which combines computer modeling with field measurements of hydrological and geochemical data.

Mary became interested in the influence of aquifer heterogeneity on groundwater flow and contaminant transport early in her career. Her landmark paper "Using Models to Simulate the Movement of Contaminants through Groundwater Systems," published in 1979, pointed out many of the conceptual and numerical pitfalls associated with modeling contaminant transport in heterogeneous aquifers. This paper continues to be cited in journal articles as a framework for the study of contaminant transport. Many of the points discussed in the paper are as applicable today as they were 20 years ago. In 1989, Mary published a paper in the *GSA Bulletin,* "Hydrogeologic Facies Models to Delineate Large-scale Spatial Trends in Glacial and Glaciofluvial Sediments," that represents one of the finest examples of ingenious thinking on how to deal with aquifer heterogeneity; it has had an enormous impact on subsequent research in this area. Later, Mary and her student Erik Webb adapted geologic depositional models to generate internally consistent hydraulic conductivity fields for use in groundwater models. This work led to several publications including the fourth paper cited for the Meinzer Award: "Simulations of Preferential Flow in Three Dimensional Heterogeneous Conductivity Fields with Realistic Internal Architecture (*Water Resources Research,* 1996, v. 32, no. 3). This pioneering work has paved the way for much ongoing research in this exciting area.

The name Mary Anderson has become synonymous with groundwater modeling because of her two popular textbooks *Introduction to Groundwater Modeling: Finite Difference and Finite Element,* first published in 1982 with Herb Wang, and *Applied Groundwater Modeling: Simulation of Flow and Advective Transport,* published in 1990 with Bill Woessner. The exemplary clarity and the clever mixture of concepts and short computer codes in the first book have helped thousands learn the fundamentals of groundwater modeling, and the lucid presentation and careful synthesis of a vast amount of information have turned the second book into the standard reference work for conducting groundwater modeling studies.

I congratulate the Hydrogeology Division Award panel for selecting Mary Anderson as the recipient of the 1998 O. E. Meinzer Award, for few are as richly deserving of this recognition as Mary. Please join me in congratulating Mary for her remarkable achievements both as a researcher and as an educator.

## Response by MARY P. ANDERSON

Thank you, Chunmiao, for your generous citation and introduction. I also thank Steve Gorelick and the award committee for selecting me for this honor. I have been tracking the Meinzer Award papers for a long time. In fact, I keep a running list handy for quick reference. To be able to add my own set of four papers to this prestigious list is indeed a tremendous honor.

The collection of papers cited in the award is, I believe, representative of the major themes in research over much of my career. I have been involved in groundwater-lake studies ever since arriving at the University of Wisconsin—Madison in 1975. At that time, Dave Stephenson, my predecessor in the department there, had been engaged in lake studies and generously helped me by sending offers of funding my way and making sure that I was introduced to people with compatible interests and expertise.

Recent contributions to groundwater-lake studies are represented in the two papers with Xiangxue Cheng, which are cited in the award, giving me an opportunity to say a few words about Xiangxue and also about Chunmiao. Chunmiao Zheng was the first student I accepted into the Ph.D. program from China and Xiangxue was the second. Chunmiao is a professor at the University of Alabama and Xiangxue works for Mobil Oil in Dallas. Both are accomplished modelers and in them you see examples of the major theme in my career—groundwater modeling. Chunmiao has developed very popular groundwater modeling software including MT3D. He has co-authored a textbook on transport modeling and is now a well-known modeler in his own right. Xiangxue's Lake Package for MODFLOW, which is the subject of one of the Meinzer papers, has been very well received; a modified version is now marketed by HSI GeoTrans.

Groundwater modeling has been the predominant theme in my career. I suspect that my two textbooks on modeling, published in 1982 and 1992, may also have played some role in the selection for the Meinzer Award. I would like to acknowledge my two co-authors, because I believe that they should share in this recognition. My colleague at UW—Madison, Herb Wang, had the idea for the 1982 book and proposed that we work together on it almost as soon as I arrived in Madison. My other co-author, Bill Woessner at the University of Montana, had the idea for the second book. Over chicken soup in the back room of a bar in Denver, Bill laid out his ideas for a book on groundwater modeling and told me that I should write it.

My foray into the problem of geological heterogeneity is represented by the paper with former student Erik Webb, who is now at Sandia National Laboratories. I had an idea that the arrangement of sedimentary facies was critical in the transport of contaminants but wasn't quite sure how to demonstrate this. Erik found a way after studying the sedimentological literature. He constructed a model that generated facies in braided-stream sediment and demonstrated that the resulting patterns formed preferential flow paths for contaminant movement.

Finally, the fourth paper named in the award is co-authored with Randy Hunt and Dave Krabbenhoft, who are both with the USGS in Middleton, Wisconsin. This paper returns to the subject of wetlands, which I had explored with my first Ph.D. student, Charlie Andrews, who is now president of Papadopulous and Associates. Randy took the lead on the wetlands work cited in the award, and I have had a lot of fun recently as he leads me into analytic element modeling.

I've mentioned the contributions of five of my former Ph.D. students above. But all eleven of my former Ph.D. students, as well as my five current Ph.D. students, deserve some share in this award. Both ideas and people are key to a career in science. In my own career, several people whom I've already mentioned played critical roles. Earlier, my undergraduate advisor at SUNY—Buffalo, Parker Calkin, helped and encouraged me in many ways. For instance, he urged me to "go West" to pursue graduate work. I took his advice and went to Stanford University, where I was fortunate to find an advisor and a friend in Irwin Remson, who coached me through the Ph.D. and who helped me in many ways then and since. At Stanford, I was also fortunate to meet my husband, Charles. At the University of Wisconsin—Madison, I found a series of mentors who guided me through tenure and later through a tangled labyrinth of university politics and administration.

Professional collaborations are important in most careers in science and they certainly have been in mine. What makes a professional collaboration work is rather intangible; it has something to do with finding complementary strengths that forge a whole from disparate parts. Receiving the Meinzer Award is an honor that I feel I share with those colleagues with whom I have had the pleasure of special professional relationships. Thank you again for this recognition.