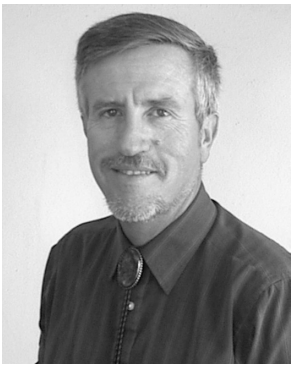

Fred M. Phillips

O.E. MEINZER AWARD

Presented to Fred M. Phillips

Citation by Mark Person

Fred M. Phillips represents a growing number of Meinzer awardees recognized for their pioneering work in the application of isotopic methods in hydrogeology. He is recognized here for five seminal papers focusing on isotope hydrology in general and the development and application of ^{36}Cl isotopic techniques to arid region hydrology, in particular.

In 1995 and 1998, Fred published two outstanding single-authored review articles on the use of isotopic tracers in hydrogeology (Phillips, F.M., 1995, Review of Geophysics, vol. 30, p. 1029–1033; Phillips, F.M., 1998, in National Research Council, Hydrologic Sciences: Taking Stock and Looking Ahead, p. 87–100). These articles have gone a long way toward transforming isotope hydrology from, in his words, "a status akin to alchemy (a field for which the fundamentals are difficult to understand, the terminology peculiar, and the results dubious) to the rank of a method that many might consider applying themselves."

In 1997, one of Fred's doctoral students, Mitch Plummer, along with Fred, June Fabryka-Martin and Jake Turin at Los Alamos National Laboratory, and others published a manuscript in *Science* (Plummer, M.A., Phillips, F.M., et al., 1997, Science, vol. 277, p. 538–541) that presented a chronological record of ^{36}Cl/Cl within rat middens. Assuming that rat bathrooms habits are relatively invariant through time, this record was used to document secular variations in the production rate of ^{36}Cl in the upper atmosphere. This showed, for the first time, that the production rate of ^{36}Cl was at times almost double current levels during the past 70,000 years.

In his book *Roughing It*, Mark Twain described the hydrology of Mono Lake as follows: "Half a dozen little mountain brooks flow into Mono Lake but not a single stream of any kind flows out. What it does with its surplus is a dark and bloody mystery." Fred resolved this mystery using ^{36}Cl/Cl ratios to establish the hydrologic budgets of watersheds in the Great Basin, California. In 1995, Fred, Shirley Dreiss, and others published a manuscript (Phillips et al., 1995, Water Resources Research, vol. 31, p. 3195–3204) that compared salinity and ^{36}Cl/Cl ratios in Mono Lake to those of groundwaters from the contributing watershed. Fred and his coauthors were able to establish that the basin became hydrologically closed about 400 ka when the region's climate is believed to have shifted from humid to arid conditions.

In 1999, two of Fred's graduate students, Michelle Walvoord and Page Pegram, along with Fred and a host of co-investigators used ^{14}C dating methods and thermal data to constrain the transport and fate of deep-dwelling bacteria within the San Juan Basin near a 3.39 million year old basalt dike intrusion (Walvoord, et al., 1999, Water Resources Research, vol. 35, p. 1409–1424). This study helped establish that bacterial transport rates for deep dwelling bacteria are relatively fast, perhaps as high as 0.1 m/yr.

What is truly remarkable is that this represents only a fraction of the work Fred has undertaken in the past two decades in the application of ^{36}Cl and other isotopic methods to the study of earth surface processes. Fred, you richly deserve this honor and we here today heartily congratulate you as the 2001 Meinzer award recipient.

Response by Fred M. Phillips

I am deeply honored and grateful to receive the Meinzer Award. No one enters our profession with wealth or power as the objective. Our only extraordinary reward is public appreciation of our contributions to science by our peers, and that knowledge makes this award very meaningful to me.

What I have been able to accomplish in hydrogeology has only been with the aid and encouragement of many people: my wife, Lois, whose unfailing love and support has been the mainstay of my life; my graduate advisor, Stanley N. Davis, who enabled me to start out on the path I have taken; and numerous colleagues, including John Wilson, Alan Gutjahr, David Elmore at PRIME Lab, Eric Small, Harold Bentley, and June Fabryka-Martin; my students, in particular Nancy Jannik, Matt Davis, Beiling Liu, Mitch Plummer, and Michelle Walvoord; and my hydrogeological heroes, including Stanley Davis, Ike Winograd, Graham Allison, John Cherry, John-Charles Fontes, Charles Slichter, and, last but certainly not least, Oscar Meinzer.

Meinzer was a remarkable man who shaped, guided, and inspired the development of hydrogeology in our nation. I would like to take the occasion of this award to examine a rather somber question: Are we approaching the end of the road that Meinzer started us out upon?

In asking this question, I pick up the gauntlet that Frank Schwartz and Motomu Ibaraki threw down with their paper "Hydrogeological Research: Beginning of the End or End of the Beginning?" published in the July-August, 2001, issue of *Ground Water*. Schwartz and Ibaraki conducted an extensive analysis of citation patterns in the hydrogeology literature, with the goal of assessing the vitality of the field. They conclude: "Research is inefficient with much produced for little gain. On a typical industrial life-cycle curve, groundwater research is likely ranked as mature and close to aging. At this stage, much work will have been completed and the number of truly impactful problems will have dwindled to just a few."

What has brought us from the exciting days of Meinzer and Theis to the present sad picture in the mirror that Schwartz and Ibaraki hold to our faces? These authors describe most hydrogeological research as "commodity-driven," meaning that it is characterized by incremental improvements to issues motivated by practicality, rather than by trying to achieve major advances in understanding. It is a matter of satisfaction to me to be able to contribute to solving problems of societal importance, and also to be able to educate students in a field in which they will be able to find good jobs, but I think that we have become so accustomed to viewing our science as one oriented toward practical problems that we forget that the pioneers embarked on their research simply because exploring how water behaved in the subsurface was so exciting.

I suggest a threefold approach for addressing the exciting issues of the next 20 or 50 years. The first component I call "look back." Most hydrogeologists could

easily recite the geological history of the rocks composing an aquifer they are studying, but what if you asked them the history of the water cycle in that basin over the fairly recent geological past? Just as the rocks have a history, so does the water cycle, but although we often know a lot about the geological history, we generally know almost nothing about the history of the water cycle. When I researched Meinzer's work, I found, rather to my surprise, that he published papers on paleohydrology and clearly considered the issue of the history of the water cycle to be very important. We, as hydrogeologists, have lately tended to define our field in such a way as to exclude questions on the history of the water cycle and we need to reconsider that exclusion.

My second strategy is "stretch out." Eighty years ago, pioneers such as Meinzer defined the region below the land surface as the new frontier of hydrogeology, but in the intervening decades that definition has tended to turn into an intellectual prison. Peter Eagleson has encouraged us to think of hydrology as a global science, rather than one related to local problems. The land surface is the interface that supports plants, and, in fact, most life, but we have tended to ignore that messy zone filled with roots and worms and focus on "cleaner" problems of physics and chemistry at depth. This has ultimately had the effect of distancing us from the more urgent scientific and practical problems of the present day. Ignacio Rodriguez-Iturbe has recently urged us to deal directly with the role of subsurface hydrological processes in plant communities, a new endeavor he calls "ecohydrology." This is only one aspect of integrating subsurface hydrology into the global water cycle, but he is pointing in exactly the right direction.

My third initiative is "push forward." In the past few years, the scientific community has produced very convincing evidence that, due to the effects of human civilization, the globe is beginning to experience environmental changes of an unprecedented magnitude. Shifts in the water cycle will be perhaps the single most significant aspect of these changes and will have enormous impacts on human populations. In order to claim that we can predict the nature and effects of such shifts, we must understand similar changes in the recent geological past, and we must understand how the subsurface hydrology interfaces with ecosystems and with geomorphic systems. Look back, stretch out, and then push forward. We hydrogeologists are in a unique position to meet what will be the most urgent societal needs of the next century and to advance scientific understanding of the earth system, but we will only be able to accomplish this if we stretch our vision beyond the limits we ourselves have defined for our field.