geologic specialties and to other disciplines.

My career and the book, which is a reflection of it, have been markedly influenced by several people who represent the best in geomorphology, hydrology, and engineering. These people are all in the "give-away idea" class. That is, they have so many ideas that it is easy for them to share with the less fortunate. This, of course, is the essence of a good scientist. First, there was Art Strahler, who put me on the right track, or rather diverted me from a promising career in structural geology. Then there were Walter Langbein and Luna Leopold. Luna, in particular made life difficult by stressing that one ask oneself important questions. Certainly that is easier said than done, but it is exactly what must be done. Finally, there is Daryl Simons of Colorado State University who insists that a geomorphologist should say what the landscape was, what it is, and what it will be. He is the worst of the lot, because he is committing us to prediction with all the opportunities for embarrassment that it entails.

Considering the present need to anticipate landform change, prediction is required if geomorphology is to survive in the rigorous and competitive world of basic and applied science. Obviously, if we don't do it, others will, and probably not as well.

The temporal and spatial perspective of the geomorphologist is desperately needed in many fields. Not the least of these are engineering and law. I hope that we will continue to provide this perspective, to explain its significance and to support it with quantitative information. Obviously, an understanding of the landscape and its variability through time and in space is essential to intelligent utilization and management of it.

PRESENTATION OF THE

O.E. MEINZER AWARD FOR 1979 TO

JOHN M. SHARP, JR. AND PATRICK A. DOMENICO

PRESENTATION BY GEORGE W. WHITE

Those who have received a Meinzer Award

have been honored for carrying forward the work in ground-water hydrology of Oscar Edward Meinzer, long-time head of the Division of Ground-water Geology of the United States Geological Survey. To most of those here, O. E. Meinzer is only a legendary figure. As a setting for recognizing the 1979 awardees, let me include some introductory remarks on the man in whose honor and memory this award was established.

Oscar Edward Meinzer was born in 1876 near Davis, Illinois, a small village near the Wisconsin border, about midway between Freeport and Rockford, and about 25 miles west-southwest of Beloit, Wisconsin, where Meinzer attended Beloit College from which he was graduated in 1901. After a variety of teaching positions in South Dakota and Iowa, he began graduate study in geology in Chicago in 1906 and also began work with the Geological Survey. In 1922 he received the Ph.D. at Chicago. From the beginning he stressed quantitative methods and developed these. His well-known monograph *Groundwater in the United States with Principles* was published in 1939 and his famous *Outline of Groundwater Hydrology* in 1923, W.S.P. 494. Of course, there were scores of bulletins and articles from 1910 to 1947. Meinzer continued work on the artesian Dakota Sandstone, from which he developed ideas on compressibility of aquifers and other parameters. He encouraged young staff members to carry the quantitative work further, and it is to his leadership that we owe the important work of Wenzel Theis, Jacob, and others. In summary of the work of the man in whose memory this award is established, we can do no better than quote the concluding remarks of Nelson Sayre's Memorial in *Proceedings for 1948 of Geological Society of America*, 1949, page 197-206:

> Thus, Meinzer not only developed and recorded a science, but also organized and trained a competent group of scientists and engineers who, working with him, were able to give it practicable value, and who would insure its continuing development and use after he had finished his work. This is a monument of achievement which will

endure and of which any man might well be proud.

John M. Sharp, Jr., was born in 1944 in St. Paul, Minnesota. He attended the University of Minnesota, where he received the degree of B. Geol. Eng. in 1967 and was elected to Tau Beta Pi. He then spent 3 1/2 years in the U.S. Air Force, in engineering activities, reaching the grade of captain. He then began graduate study in hydrogeology and mathematical geology at the University of Illinois. He received the degree of M.S. in 1974, and later the same year, the Ph.D. He began work under Professor Domenico, especially on modeling of heat and pressure in sediments and on core analysis of rock structural properties.

Dr. Sharp accepted appointment in 1974 at the University of Missouri-Columbia, where he now is Associate Professor, with responsibility for the work in hydrogeology. Dr. Sharp has continued his work in transport and related processes in ground-water geology and in engineering aspects of these processes. His work after 1976, the date of the paper for which the Meinzer Award is presented, has continued its high quality and provided innovative approaches in problems. These further achievements attest to the excellent judgment of the Awards Committee in this selection.

Patrick A. Domenico was born in 1932 in Rome, New York. After four years in the U.S. Navy, he entered Syracuse University and received the B.S. in geology in 1959. He received the degree of M.S. in engineering geology from Syracuse in 1963 with specialization in soil mechanics and hydrology. He then became a Research Associate in Hydrology at the Desert Research Institute and also pursued graduate study at the University of Nevada, receiving the Ph.D. degree in 1967. He was appointed Professor of Geology at the University of Illinois in 1968 where he has maintained an important program of teaching and research in ground-water hydrology, with emphasis on simulation and optimization techniques for ground-water systems. He and his students are especially concerned with mass (chemical) and energy (heat) transport

phenomena in regional ground-water flow.

Professor Domenico is a registered engineer and has been Visiting Lecturer or Visiting Professor at Indiana and Penn State. His professional work has taken him to Alberta, California, Nevada, Mexico, and elsewhere.

Professor Domenico has important publications in geological, hydrogeological, mathematical geological, and engineering journals. His book, *Concepts and models in groundwater hydrology*, published in 1972, is widely used in the profession.

Students of Professor Domenico now have important position in government, industry, and universities. All of his students are distinguished by their ability — secured through his encouragement, example, and training in mathematical and engineering methods — for solving complex hydrogeological problems. It should be noted that they also have a firm foundation in physical and stratigraphic geology.

The paper for which Dr. Sharp and Professor Domenico are honored today is "Energy transport in thick sequences of compacting sediment," *Geological Society of America Bulletin*, v. 87, p. 390-400, 1976. I can do no better in summarizing the paper than to quote from the paper itself:

> It is our intention to (1) determine the importance of pore-fluid expulsion induced by sediment compaction as a mechanism for the forced convection of energy; (2) examine the magnitude and importance of various thermophysical and geologic parameters involed in these processes, including hydraulic conductivity and diffusivity and sedimentation rates; and (3) to apply the model to a field area where excess pressures are known to exist. The area chosen is the northern Gulf of Mexico.

In this paper, the theory of energy transport is developed by rigorous mathematical analysis and then applied to character and history of the sediments of the northern Gulf of Mexico. The occurrence of geopressurized zones is thus explained. The great importance of this theory for geopressurized fluids, especially gas in these sedimentary rocks,

as well as elsewhere, is immediately obvious. The application will, of course, be the subject of other publications.

Mr. Meinzer would have heartily approved of this award to Dr. Sharp and Professor Domenico. The development of mathematical analysis of fluids in the Earth was greatly advanced by Meinzer and his associates. This paper not only carries on the tradition, but advances it further.

I am pleased indeed to present to you John M. Sharp and Patrick A. Domenico for the Meinzer Award for 1979.

RESPONSE BY JOHN M. SHARP, Jr.

I am deeply honored to be named, along with Pat Domenico, a recipient of the O. E. Meinzer Award. Surely, this must rank as one of the most gratifying awards one in my profession can attain.

When I found that I had to make this acceptance speech, one of my thoughts was inevitably a reflection on those who helped guide me over the past years. Of course, there were many such individuals, but some stand out as particularly influential. These include my parents who led me to appreciate education and books in an atmosphere of trust and affection; my collegiate advisors both at Minnesota and Illinois, especially Pat whose advice and common sense is most appreciated; the staff and graduate students of the University of Illinois, who provided a stimulating academic climate in the early 1970's; my present colleagues at the University of Missouri; and most importantly my wife, Carol, whose faith in me and wise counsel have been a vital cornerstone in my life.

I think hydrogeology as a field has been fortunate, because the processes we deal with are often not observable. Consequently, earlier workers in our field were forced to use non-descriptive, quantitative methods — methods often borrowed from engineering, applied mathematics, physics, and chemistry. These methods include potential and consolidation theory, as well as the eager adaptation of analog and digital computers to ground-water problems. Hydrogeology, therefore, became one of the most quantitative and advanced on the earth sciences, and the hydrogeologist has been able to make predictive models of Earth systems.

Because of the heritage of deterministic, quantitative study, hydrogeology has important contributions to make toward solving both fundamental geologic problems and practical matters of water resources and environmental protection. Our earlier and older sister fields traditionally have been more concerned with systems of classification, description, and collection of more readily observable processes and data. Much of this impressive array of information is ripe for interpretation, using fundamental hydrogeologic concepts and tools. I would further suggest that continued and expanded application of quantitative deterministic models will serve to point out areas of fruitful field and experimental research for future scientists in many geological disciplines. Finally, the combination of practical geological observations and knowledge of basic mathematical, physical, and chemical principles, the basis for hydrogeologic education, should insure a vital niche in Society for our students of tomorrow.

In accepting this award, there are two facts which make it most meaningful to me. First, I am aware of the many excellent scientists who are contributing to our increasing knowledge of hydrogeologic principles. Secondly, past awardees constitute a list of many of the most distinguished men in my profession. I am therefore honored to be included in such a group.

RESPONSE BY PATRICK A. DOMENICO

The Hydrogeology Division is the one scientific group that has meant the most to me, both professionally and personally, throughout my career. As we are not only colleagues, but good friends, I feel a bit uneasy standing before you today. So before this exposure becomes overwhelming, let me first thank the Division for establishing such an honorable award in the name of O. E. Meinzer, and second for bestowing this honor on Jack Sharp and myself. Equally important, I should like to personally thank all of the membership who did not write a paper last year, thereby removing the toughest competition.

It is gratifying to know that our colleagues consider our pressure-temperature study useful. We are proud to receive this award for a paper that deals essentially with subsurface flow as a geologic agent, and not within the more usual context of water supply. This sustains one of my long-time beliefs that hydrogeologic research need not be totally committed to problems in water resources, but that hydrogeologists are among the best qualified scientists to examine fundamental geologic problems as well. This is not to say that the outcome of such research has academic value only. The paper for which we are being honored today has found some use in the petroleum industry, where some of the ideas are used to generate plausible arguments concerning the pressure-temperature history of sedimentary basins. Extensions of

these ideas have led Jack Sharp into the field of low temperature economic mineralization in sedimentary basins, and those of us at Illinois into fluid pressures and microfracture development, especially as they pertain to maturation history and primary migration of hydrocarbons. To me, these are fundamental hydrogeologic problems which are subject to attack by our basic transport theories which have been so successful in water-resource problems.

Others apparently share this view — indeed have promulgated such a view long before our modest contribution. Witness the work describing the role of ground water in structural geology, in particular the classic problem of overthrusts and earthquake generation and control; ground water and hydrocarbon migration; ground water and karst development; and ground water and the chemical and thermal evolution of sedimentary basins. The scientific impact of this effort indicates that hydrogeology today is more than just a basic requirement in the training of groundwater geologists, it is a key geologic science for flow processes in the upper crust, and is sufficiently basic so as to cut across specialty areas in geology. It is in this spirit of hydrogeology both for human affairs and for unraveling some of nature's well-guarded secrets that we are proud to accept this award.

It is not possible in this profession of ours to travel very far without incurring many debts, both personal and intellectual. To my mother and father, who somehow instilled in me a healthy sense of hard work and hard play. To my wife, who has given her time generously. To the Alberta Research Council, which provided support for some of my very early graduate work. And then some heavyweight obligation. To the Desert Research Institute, a research environment initiated and fostered by George Burke Maxey that has benefited not only me, but so many of us. And within that debt is a much larger obligation to the memory of Burke Maxey himself — teacher, colleague, and friend. Currently, I am grateful for the unqualified support afforded by the Geology Department at the University of Illinois. To these organizations, to my

colleagues that have made them fruitful learning environments, and to the memory of one man in particular, I acknowledge a large obligation.

An lastly, there are the bright young people who come to study hydrogeology at the University of Illinois. They appear to enter so much better prepared than my own generation of hydrogeologists that I sometimes consider it progress just to keep up with them. In this regard, I have been very fortunate because competent students are a constant reminder to the teacher that he, too, must remain a student. But that's the way its supposed to be, and as long as it continues, I shall be very much satisfied.

PRESENTATION OF THE E. B. BURWELL AWARD TO EVERT HOEK AND JOHN W. BRAY

CITATION BY RICHARD H. JAHNS

Engineering geologists are particularly pleased to find or to develop techniques and solutions for geologic problems facing Mankind. To this end, the Engineering Geology Division, each year, makes the E. B. Burwell Award as evidence of its concern and enthusiasm for developments that apply geologic principles to serve the needs of people throughout the World. It is doubly pleasing to The Division to find among those working in geology for these purposes, engineers who appreciate the primary place of geology in their solutions to these real and recurring problems. In the persons of Drs. Hoek and Bray we have found this ideal combination; a recognition of geological influences and a commitment to apply them as integral parts of reasoned and straightforward engineering-mechanical solutions to rock-support designs.

Rock support is a fascinating area of professional challenge; rock in its infinite varieties of lithologic and petrographic types, its variable degree of alteration and weathering, its often unusual geometry, and its perplexing fracture and planar weaknesses often presents an insurmountable obstacle to the engineering mind. However, our honored guests this evening have seen