

## **HYDROGEOLOGIC CHALLENGES FOR THE TWENTY FIRST CENTURY: THE SCIENCE AND ITS APPLICATIONS**

S.P. Neuman

*Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona., 85721, U.S.A., e-mail: neuman@hwr.arizona.edu*

It wasn't so long ago that the major role of hydrogeologists was to locate subsurface waters and maximise well yield. The last three decades have seen the rapid emergence of hydrogeology from the relative obscurity of a low-tech profession to the forefront of activities related to humanity's rapidly growing concerns with energy and the environment. We have been faced, and charged, with problems of ever increasing importance and complexity that include the need to improve water management practices; to foretell, and forestall, the consequences of groundwater withdrawal on land subsidence; to store and utilise thermal, fossil, and pneumatic energy underground; to characterise, and remediate, subsurface contamination; and to site, and assess the safety of, geologic waste storage facilities. We have met these charges, and challenges, with enthusiasm and confidence. The latter derived, in large measure, from a belief that subsurface hydrology rests on sufficiently firm scientific principles which, coupled with sound engineering practices, should be adequate for the task. Or so it seemed. It now appears that we might have been overconfident in the powers of hydrologic and environmental sciences to address major issues of public concern; in particular, our perceived ability to help remediate subsurface contamination to regulatory specifications, under reasonable budgetary and time constraints, has been exaggerated and oversold; as has our perceived ability to render believable long-term hydrologic forecasts. How did this happen? In my talk, I will touch briefly on this question and point toward a number of major scientific challenges that we must face, and meet, in the coming decade.