GROUND WATER

DISCUSSION OF PAPERS

DISCUSSION OF "Ground-Water Tracers – A Short Review," by Stanley N. Davis, Glenn M. Thompson, Harold W. Bentley and Gary Stiles, January-February 1980 issue, v. 18, no. 1, pp. 14-23

by Gordon V. Evans, Hydrological Tracers and Coastal Sediment Project, Applied Nuclear Geophysics Group, Nuclear Physics Division, Atomic Energy Research Establishment, Harwell OX11 ORA, England

While this paper provides a general review of tracers used in ground-water studies, it does less than service to the important role played by radioactive tracers, mainly, I believe, because of the administrative problems of using these tracers in the United States. It is important to differentiate between scientific facts and any ideas promulgated by emotion or restrictive legislation.

The paper states that, "the ideal tracer is nontoxic (but I would add 'at the required levels'), inexpensive, moves with the water, is easy to detect in trace amounts, does not alter the natural direction of the flow of the water, is chemically stable for a desired length of time, is not present in large amounts in the water being studied, and, for most purposes, is neither filtered nor sorbed by the solid medium through which the water moves." I may add that it would also be convenient to be able to measure the tracer concentrations at the site of the investigation.

Apart from this last preference, these requirements are best met by the use of tritium which is generally accepted to follow the water movement completely as it forms part of the water molecule (HTO). It is quite wrong for the authors to state that, "if it were not hazardous and if it were easier to detect in trace amounts it would be an ideal tracer." Natural background levels of tritium in ground water of less than 9,000 Bq/m^3 240 pci/ℓ or 75 tritium units) can be measured directly by liquid scintillation counting. A more laborious measurement technique of sample enrichment allows measurements of some fifty times less. Allowing for the measurement by liquid scintillation counting, a ground-water dilution of 10^4 can be accommodated by injecting less than one-third of the allowed concentration even assuming that three litres of the injected solution is consumed daily by the general population (ICRP, 1977 and 1979). Occasional tracer tests will, therefore, present possible intakes of tritium considerably less than the recommended annual limit and therefore, allow much greater (several orders of magnitude) dilution factors. Also as tracer is usually injected into a volume or flow of water, then the concentration of tracer solution may be increased further.

The main disadvantage of tritium is that on-site measurements are not convenient. For relatively short transit times (~several days), a gamma emitting tracer such as Bromine 82 can be safely used in many hydrological areas either by injecting tracer concentrations below drinking water levels or, where access to the flow is restricted (e.g. subsurface flow with long residence times to any natural discharge areas) by injecting higher levels consistent with acceptable concentrations at the sample positions.

The use of fluorocarbons as ground-water tracers have a number of attractions as the authors state, such as equally high sensitivity of detection as radioactivity. No doubt the authors would agree that it would be quite wrong to describe their use as hazardous because high concentrations are poisonous or that accumulation of these compounds in the atmosphere may encourage skin cancers (Sugden and West, 1980).

I hope, therefore, that hydrological studies are not impeded by choice of tools dictated by irrational arguments or emotional statements. If restrictive legislation exists on reasonable uses of certain compounds or radioactive materials, we should seek to educate those in authority, through the media of scientific journals, so that objectivity prevails.

References

ICRP Publication No. 26. 1977. Recommendations of the International Commission on Radiological Protection. Pergamon Press.

ICRP Publication No. 30. 1979. Limits of intakes of radionuclides by workers. Annals of the ICRP. v. 2, no. 3/4.

Sugden, T. M. and T. F. West. 1980. Chlorofluorocarbons in the environment: The aerosol controversy. Ellis Horwood Ltd., Chichester, England.

REPLY TO the preceding Discussion by Gordon V. Evans of "Ground-Water Tracers – A Short Review"

by Stanley N. Davis

I am pleased with the comments by Gordon V. Evans and agree fully with his scientific evaluation of the usefulness of radionuclides as ground-water tracers. The differences in our perception of the socio-political constraints, however, are significant and deserve some attention. My viewpoint is influenced by my direct contact with the situation in the United States but only indirectly through conversations with hydrogeologists from other countries.

As indicated in the article, radionuclides of different types are indeed very useful, and their applications to water tracing will and should continue despite the many restrictive regulations. Also, tritium is, for many purposes, one of the best of all tracers. However, to overcome the modern background concentrations in shallow waters, injected tracer concentrations of at least 2×10^{-9} Ci/ml should be used. This concentration is very close to the maximum permitted in drinking water by several different regulating agencies.

The basic question of strategy for hydrogeologists is whether or not to mount an educational program to try to correct public misconceptions about the hazards of radioactive tracers. To date, similar efforts in various areas have been less than successful. In fact, some have backfired with stricter regulations resulting. Part of the problem lies with scientists and their technical terminology. For example, few members of the general public know the difference between picocuries and megacuries. All they

appear to "know" is that radiation is evil, both morally and medically. A picocurie of tritium in a local water supply may be viewed with much greater alarm than a megacurie of strontium-90 stored at Richland, Washington. Furthermore, few people realize that nature bathes us continuously with radiation having an intensity almost infinitely greater than any possible radiation exposure resulting from the use of hydrologic tracers.

The original review article on tracers was written when Tucson, Arizona, was the focus of national news concerning tritium contamination from a plant manufacturing luminous signs and watch faces. The plant was closed because of numerous alleged violations of State regulations. The publicity surrounding the problem stimulated an amazing amount of public hysteria which provoked serious suggestions to incinerate waste containing tritium in order to completely "destroy" the tritium! Several thousand dollars worth of canned goods were actually buried out of apparent fear that the tritium had penetrated the metal cans. Locally, therefore, no sane hydrogeologist would dare request permission of county health authorities to inject tritium tracers into an aquifer even if the tracer contained tritium concentrations only slightly above ambient values of local surface water. Unfortunately, this irrational fear of tritium is not confined to Tucson.

In conclusion, I agree with Gordon V. Evans that radioactive tracers are potentially very useful and that education on the topic of the true nature of the associated hazards is needed. This education, however, should not be so obvious that it will provoke public debate. In the United States, at least, I have little faith that such debate within the next decade will result in a rational public viewpoint of radioactive tracers.

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PEOPLE IN THE NEWS

Marvin (Nicky) Saines has accepted a position with Woodward-Clyde Consultants in their Chicago office as Project Hydrogeologist. Formerly with Harza Engineering Company in Chicago, where he worked mainly on the application of hydrogeology to damsite engineering, Dr. Saines will be working on land disposal of waste, ground-water supply, ground-water contamination, as well as on engineering projects.

Elmer E. Jones, Jr., Agricultural Engineer, USDA, ARS, Beltsville, Maryland, received the *Journal of Environmental Health's* A. Harry Bliss Editorial Award on July 29 in Milwaukee, Wisconsin, at the National Environmental Health Association's 44th Annual Educational Conference. Jones, a NEHA member of over 10 years, was recognized for his outstanding contributions to the editorial quality of the *Journal* as a reviewer of manuscripts being considered for publication.

Robert F. Kaufmann, Ph.D., has been appointed Senior Geologist with ConverseWardDavisDixon, Geotechnical Consultants, in Las Vegas, Nevada. Dr. Kaufmann is responsible for geological and hydrological studies directed from the Las Vegas office and participates in major geotechnical projects for the firm's six other offices. His expertise includes geology, hydrology, water quality investigations and project management.

James Narkunas, Hydrologist, has joined the Ground-Water Division of Dunn Geoscience, Latham, New York. Narkunas previously worked with the North Carolina Department of Natural Resources and Community Development, where he served as project leader in aquifer studies, with emphasis on waste disposal, hazardous material spills and ground-water development. At Dunn Geoscience, he will continue to work with the same kinds of assignments for both governmental bodies and industries.

Edward L. Griffith, Jr., Fred W. Cope, and R. Lee Dooley have been appointed Associates at Emcon Associates, San Jose, California, consultants in wastes management and environmental control. They each have been with the firm for more than five years, and have made significant contributions to many of the 300 projects completed by EMCON in 35 States and Canada since the firm was founded in 1971.