Isotope hydrology in water resources development

by T.T. Akiti*

The IAEA and UNESCO jointly convened an international symposium on water resources development in September 1983. The meeting, which was held in Vienna, was the sixth on the subject to have been organized by the Agency; previous meetings took place in 1963, 1967, 1970, 1974, and 1978.

The symposium was attended by nearly 200 participants from 55 countries and eight international organizations. A total of 77 papers were presented during eight sessions. Forty-one papers were presented orally and 36 were selected for presentation at two poster sessions. They dealt with the following topics: environmental isotopes in precipitation and surface water studies; studies in the unsaturated zone; field studies of groundwater dynamics using environmental isotopes; groundwater age determination and related problems; groundwater pollution studies; theories and methods used to interpret isotopic data; applications of artificial isotopes; and sediment transport studies.

The large number of participants and papers from most parts of the world evidences the importance that isotope hydrology plays in studies of water resources. The proceedings will be useful in water resources assessment, development, and management.

Some of the papers focused on relationships between groundwater and surface water bodies such as lakes and rivers. Fractions of river discharge contributed by groundwater, depending on geology and climate, have been evaluated. In the Himalayas, for example, studies of fresh snow allow the calculation of flow rates of glacial surface ice during the past century.

Variation of stable isotopes in water in the unsaturated zone has been shown to be useful in estimating yearly recharge, a parameter that is important in water management, especially in arid areas.

Most of the field studies which were reported focused on origin, stratification, circulation patterns, mechanism of recharge, and mixtures of different water bodies. The papers had a wide geographical distribution. Some, for example, discussed studies of the crystalline rocks of Finland, Greece, Niger, and the United Kingdom. Comprehensive studies of the Great Artesian Basin of Australia and of limestone aquifers in central Italy clearly demonstrated the results that can be obtained using environmental isotopes. A paper on the Kalahari desert discussed the influence of river water on groundwaters. A progress report on the use of chlorine-36 at the Stripa crystalline rock site in Sweden was also discussed at the meeting.

Various groundwater dating methods, still at the early stages of development in hydrology, were discussed. It has been shown, for example, that geochemical processes of rock-water interaction play a vital rôle in the evolution of uranium isotope content in groundwater. The presence of carbon-14 in secondary carbonates in sandstone calls for a review of the existing mathematical models for dating waters.

Groundwater pollution from various nitrate sources was the subject of one paper, which discussed the use of natural variations in the isotopic abundance of nitrogen-15 as a tracer.

The relationship between the mass-transfer of water and that of a tracer has been considered theoretically, and it has been shown that analyses of problems involving tracers must be carried out carefully when the systems concerned are not linear.

"Artificial" isotope techniques have been useful in locating leakages in large water reservoirs; and tritium has been used to measure the discharge of the river Rufiji in Tanzania. It has been concluded that the tritium method is feasible for calibrating rating curves at least up to 1000 cubic metres per second.

Finally, there were papers on the use of nuclear density gauges for measuring concentration of silt deposits. The usefulness of radioactive tracers in studies of the transport of fine suspended sediments in rivers, harbours, and estuaries was demonstrated.

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