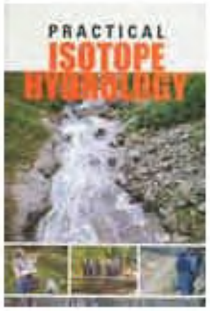

Practical Isotope Hydrology. S. M. Rao. New India Publishing Agency, New Delhi 110 088. 2006. 201 pp. Price: Rs 695.

There is an urgent need to develop India's water resources fully, given the increasing shortfall between the requirement of water and its current availability. Taken along with other well-established techniques, isotope hydrology is a valuable and sensitive tool with great potential to help in solving our hydrological problems.

This book on isotope hydrology is one of the few available in this field, and is, to my knowledge, the only book dealing with practical aspects of using the isotope techniques and giving examples of case studies in India. The author, S. M. Rao, is himself a recognized specialist in this field and has been primarily responsible for establishing the isotope hydrology programme at the Bhabha Atomic Research Centre, Mumbai. Other institutions with similar programmes include the National Institute of Hydrology, Roorkee; National Geophysical Research Institute (NGRI), Hyderabad; Physical Research Laboratory, Ahmedabad and the Centre for Water Resources Development and Management, Kozhikode. Regrettably, the Central Ground Water Board (CGWB), the main body responsible for the development of groundwater resources in the country, has no infrastructure in the field, considering the inputs obtainable from isotope techniques to our knowledge of India's groundwater resources. In this book, the author tries to make out a case for enhanced scientific inputs in water resources development and management practices.

Isotope hydrology involves the use of isotopes as tracers and is essentially an extension of geochemistry. The tracer concept and the basics to understand the use of isotope tracers, both intrinsic and injected, are dealt with in the early chapters of the book, as the expected readership is largely practising hydrologists and hydrogeologists with no formal training in isotope science. The reader is introduced to the techniques for detection of radioisotopes with special reference to those of hydrological interest. The assay of tritium and carbon-14, two important radioisotopes naturally present in water, is described in detail. Stable (non-radioactive) isotopes in the water molecule (^{2}H, ^{18}O) as well as those in the dissolved salts (^{13}C, ^{34}S) have a major role as intrinsic tracers in the hydrological cycle. Details of sampling and treatment of these isotopes and mass spectrometric measurement of stable isotope ratios ($^{2}H/^{1}H$, $^{18}O/^{16}O$, $^{13}C/^{12}C$, $^{34}S/^{32}S$) are given.

Where injected tracers have to be used, the advantages of radioisotope tracers over chemical and organic dye tracers, the factors leading to the selection of a radioactive tracer for a specific application and finally, the optimum areas of application of injected tracers are well brought out. The presently limited use of injected tracers for stream flow measurements in *special* cases, to estimate rainfall recharge to unconfined aquifers and in the measurement of groundwater velocities is discussed.

The book lays greater emphasis on the use of environmental isotopes, both stable and radioactive, in studies on surface water and groundwater regimes; how the levels of stable isotope ratios of hydrogen and oxygen in natural waters and their variations can help in determining the origin of water from a particular source or sources, and how young and old groundwaters can be distinguished based on their tritium and carbon-14 levels. It is rightly stressed that isotope techniques provide additional information for a fuller description of a hydrological system when integrated with other established methodologies.

Many areas of field applications of isotope techniques in surface and groundwater hydrology are covered with adequate number of case studies, mostly from India. Application of environmental isotopes in surface water hydrology appears to be mainly in stream component separation (base flow, run-off, snow melt) and in studies on lake dynamics. The information obtained on the groundwater contribution to the Ganga river in the Hardwar–Narora sector using stable oxygen-18 is a good example. So also is the example of the isotope study on the hydrodynamics of Naini lake in which the residence time of lake water and the age of groundwater feeding the lake could be determined. Examination of seepage situations in canals and tunnels is yet another application of environmental isotopes leading to large economic benefits. Examples of Salal tunnel near Jammu and the case of Chilla hydel channel in Uttaranchal have been aptly chosen.

The main thrust of the book is naturally reserved for applications in groundwater hydrology where the hydrogeologist faces severe challenges, particularly in arid zones, coastal aquifers and hard rock areas. Use of injected tritium to estimate rainfall recharge is well established in India, particularly by NGRI, as there is a real need for such an approach.

Identification of groundwater recharge and recharge processes, with special reference to arid western Rajasthan, is dealt with in great detail; how the isotope techniques led to the development of very old freshwater aquifers in parts of the Thar Desert. One such area in Jaisalmer district is the suspected palaeo channel of ancient Sarasvati river. This study, which is a combination of remote sensing and isotope techniques, concluded that the freshwater aquifer in the area was recharged when the river was flowing and that the river could not have been of glacial origin. It is a good example of the potential of isotope methods. So also is the work by NGRI on the estimation of recharge to Neyveli-confined aquifer in South India, including delineation of the recharge zone.

Studies on sea water intrusion on the east coast of India (north of Chennai, Orissa coast and Midnapore coast) come out as yet another success story. The isotope approach not only established that intrusion in the Orissa coast was due to Flandrian transgression some thousands of years ago, but also identified one exploitable freshwater zone free from sea water contamination.

The book goes on to mention the efforts by various groups to characterize arsenic-infested groundwaters in West Bengal and Bangladesh. Though much further work needs to be done, isotope generated information on the interconnection between arsenic-carrying shallow waters and arsenic-free deeper waters should help in planning the exploitation of deep waters. An interesting case of nitrate pollution of deep groundwater in Tanzania is also mentioned. Isotope study showed nitrate ingress from the top shallow aquifer due to short-term increase in pumping rates and consequent reversal of the pressure gradient. This helped solve the problem.

Such examples will be of great value to the hydrologist.

The author finally makes a fervent appeal for enhanced use of isotope geochemical methods in water resources development. India's increasing reliance on groundwater, its climatic and hydrological diversity, its experience in isotope methods and academic leadership are, according to the author, the positive points in favour of such enhanced use. Such large projects as interlinking of river basins would be immensely benefited by isotope and chemical data. One major constraint is trained manpower at the field level. There is no alternative to university education to overcome this. Isotope geochemistry should be part of the postgraduate hydrology curriculum. The book gives some suggestions on the course content. This suggestion merits further discussion at appropriate levels.

Finally, the book is well written in a simple and clear style, though a lot of material appears somewhat cramped in its small size of about 200 pages. Providing a bibliography at the end of each chapter does, to some extent, overcome this problem. The examples are, to a large extent, relevant and reasonably well explained with about 175 figures. More such examples from Africa and South America could have made the book wholesome.

The book will be useful to field hydrologists and hydrogeologists as well research scientists, students and teachers.

V. K. IYA

21, Saras Baug,
V. N. Purav Marg,
Deonar,
Mumbai 400 088, India
e-mail: vkiya@yahoo.com