About the Book

It has become imperative on the part of water scientists and planners to adopt techniques for quantifying the available groundwater resources for sustainable development and management keeping in mind the scarcity of available water resources versus its demand in the near future. The apparent heterogeneities and complexities present in the hard rock aquifers makes it a challenging research to tackle groundwater problems. The intricacy increases manifold for the management of groundwater when the hard rock aquifers are situated in arid or semi-arid regions. The demand supply gap has led to the over abstraction of the groundwater and water level depletion in many areas beyond economic exploitation.

The Indo-French Centre for Groundwater Research (IFCGR) at Hyderabad, India has taken this challenge and using a suitable pilot site with all the requisites for studying hard rock aquifers present, has surveyed and experimented extensively a typical/representative granitic aquifer present in a semi-arid and monsoon climate agricultural area. The present book contains the results and findings of the advanced research carried out in the pilot area with a thorough investigation of the structure and functioning of the aquifer in such a formation. The various chapters arranged in the book start from a very general scenario of the water resources management in the country then an extremely technical contribution on the hard rock aquifer system, its characterization, theoretical portion of its properties and behaviour that has been necessary to enter into the environment. Then a brief description of various experience of studying the hard rock aquifers globally has been included to provide a much wider experience. The rest of the book has very systematically includes the geophysical, geological and remote sensing applications to conceptualize such an aquifer system. The basics of the hydraulic tests, conducting various types of hydraulic tests for parameter estimation in such an aquifers including their up-scaling with modern interpretation techniques are embedded. Another chapter has been included describing the water budgeting and balance in granitic aquifers using the specific methods for their estimation. A major part covers about the advanced techniques of Geostatistics and Aquifer modeling right from the basics and then demonstrated by suitable case studies. Finally a few examples have been included on the hard rock aquifers from extreme north and also from the south of India with case studies to complete the matter for its readers. The reader of the book will find comprehensive knowledge with suitable examples to investigate a hard rock aquifer for characterization of its flow properties, estimating water balance and finally aquifer modeling for groundwater management including the theory of regionalized variables. Color diagrams wherever necessary have been included for clear understanding.

Contents

Groundwater Dynamics in Hard rock aquifers
including sustainable management and optimal monitoring network design

PREFACE

The areas in arid and semi-arid regions are forced to face a variety of problems regarding ground water as it is the main source of water no matter for any use viz., drinking, domestic, irrigation or industrial particularly for the rural population. The main challenge on water sector in hard rock areas in the semi-arid region is the water conservation, management and planning of the water resources. This is further complicated with several complexities of the geological formation. Therefore, the present research is focused on improving the knowledge on the structure and functioning of the aquifer system in hard rock terrain.

The Indo-French Centre for Groundwater Research (IFCGR: www.ifcgr.net) set-up at the National Geophysical Research Institute (NGRI: www.ngri.org.in) in collaboration with Bureau de Recherche Géologiques et Minières (BRGM: www.brgm.fr), France has realized the need and we set our goal to study the hard rock aquifers for the groundwater flow and management particularly at local to medium scale. The centre has developed specific methods to:

- estimate aquifer parameters and characterize the aquifer system,
- determine the geometry and extent of aquifers,
- estimate recharge and irrigation returns as input/output to the aquifer system,
- estimate various parameters at the unmeasured locations and optimal monitoring network design,
- calculate the groundwater balance and simulate the groundwater flow and
- evolve the strategies for sustainable management of the ground water.

With a considerable amount of research and identifiable output, it was thought to share the findings and transfer the knowledge to other organizations and researchers in this field.

UNESCO has been quite successfully launching and completing a large number of programmes dealing with water resources as it has realized the importance of water for the welfare of the community. The water sector, in addition to its scientific importance, has a much greater societal and cultural relevance. The series of IHP have been very successful and the IHP-VI is going to end soon with the start of IHP-VII. A large number of activities including scientific meetings, projects, workshops and training courses tells the success story of this programme. Within the water sector, there are number of factors to be considered and ground water, particularly in the arid and semi-arid regions, has been of particular attention as the scarcity of water is much severe in these regions. The complexity of the aquifer system in the crystalline and other hard rock terrain adds the problems to tackle in a different way. In spite of a good amount of research in this field, it is still needed to understand the behaviour of such complex system precisely and also apply the result in reasonably larger scales.

A training course under the IHP-VI has been organized at Hyderabad by inviting participants from a number of organizations working in water sector in India and participants from almost all the countries in the region with an objective to discuss and disseminate the knowledge gained in the recent research in the hard rock hydrogeology. The course was sponsored by UNESCO and INCOH (Min. of Water Resources, GOI) with resource persons provided by the IFCGR as well as BRGM, France with infrastructure extended by the NGRI, Hyderabad. The short course of five days also included one day fieldwork and about 24 lectures were enforced to complete the topics. We are grateful to a number of personalities to make the course success. The two authorities viz., Director, NGRI and Director, UNESCO, New Delhi Office have personally extended all support.

The lecture notes supplied were thus edited, a couple of state-of-the-art papers were included and the gaps were filled by adding a few more articles of relevance. Publication of this book will add value to the course and complete a milestone in the hard rock hydrogeology. The book starts with a couple of general articles introducing the IHP and water scenarios in India and then the basic knowledge on the hard rock hydrogeology as well as an overview of the work carried out at the Indo-French Centre for Groundwater Research, Hyderabad. The later articles are all technical depicting mostly the case studies on hydrodynamics of the hard rock aquifers with a brief theory on the applications of geostatistical methods as well as Aquifer Modelling. The editors extend their sincere thanks to all the contributors and UNESCO who could make this possible.

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