

Contents

<i>Foreword</i>	ix
<i>Preface</i>	xiii
<i>Table of Notation</i>	xv
Chapter 1 The Water Cycle	
1.1. Wetting and Infiltration	1
1.2. Surface Runoff	3
1.3. Evaporation	3
1.4. Snow	8
1.5. Schematization of the Hydrologic Cycle	9
1.6. Different Branches of Hydrology	9
1.7. Other Possible Origins of Groundwater	12
Chapter 2 Rock Porosity and Fluid–Solid Relations in Porous Media	
2.1. Total Porosity	14
2.2. Fluid–Solid Relations in Porous Media	22
2.3. Porosity Measurements	33
2.4. Measurements of the Water Pressure in the Ground	37
Chapter 3 Basic Concepts in Hydraulics	
3.1. General Equations of Fluid Mechanics	39
3.2. Continuity Equation in Porous Media	41
3.3. Hydraulic and Piezometric Head	50
3.4. Simplification and Integration of the Navier–Stokes Equations for Schematic Porous Media	52
Chapter 4 Darcy’s Law	
4.1. Darcy’s Experiment, Hydraulic Conductivity, Permeability, and Transmissivity	58
4.2. Limitations on the Validity of Darcy’s Law	73
4.3. Permeability Measurements on Samples	75
4.4. Probabilistic Approach to Permeability and Spatial Variability	80
4.5. Movement of Water due to the Influence of Other Forces	82

**Chapter 5 Integration of the Elementary Equations,
the Diffusion Equation, and Consolidation**

5.1. Diffusion Equation in Unconfined Aquifers	86
5.2. Terzaghi's Theory of Consolidation.	
Effect of Interstitial Water on Porous Media.	90
5.3. General Diffusion Equation: Confined Aquifers	100
5.4. Highly Compressible Soils	112
5.5. Other Diffusion Equations	114

Chapter 6 Aquifer Systems

6.1. Aquifer Types	116
6.2. Aquifer Reserves	132
6.3. Usual Boundary Conditions and Initial Conditions	135

Chapter 7 Steady State Solutions of the Diffusion Equation

7.1. General Properties of the Diffusion Equation	143
7.2. Parallel Flow: First Solution in a Steady State	147
7.3. Two-Dimensional Solutions in Radial Flow	147
7.4. Elementary Solution in Spherical Coordinates	157
7.5. Complex Potential in Two Dimensions	157

**Chapter 8 Transient Solutions of the Diffusion Equation,
Pumping Tests, and Measurements of Aquifer Properties**

8.1. Elementary Solutions in Radial Coordinates	162
8.2. Interpretation of a Pumping Test	168
8.3. Leakage in Radial Coordinate Systems	179
8.4. Additional Analytical Solutions for the Flow toward a Well	190
8.5. Other (One-Dimensional) Solutions to the Diffusion Equation	198
8.6. <i>In Situ</i> Point Measurements of Permeability	201

Chapter 9 Multiphase Flow of Immiscible Fluids

9.1. Theory	207
9.2. Special Case: Flow in Unsaturated Media	213
9.3. Movement of Separating Interfaces	220
9.4. Multiphase Pollution Problems	225

**Chapter 10 Flow of Miscible Fluids:
Dispersion, Retention, and Heat Transfer**

10.1. Solute Transport of Nonreactive Substances	229
10.2. Laws of Interactions between the Immobile Phase and the Transported Substances and Physicochemical Changes in the Substances	251
10.3. Heat Transfer in Porous Media	277

**Chapter 11 Geostatistic and Stochastic Approach
in Hydrogeology**

11.1. The Problem of Estimation: Definition of Kriging	286
11.2. Kriging in the Stationary Case, Use of the Covariance	288
11.3. Kriging in the Intrinsic Case: Definition of the Variogram	291
11.4. A Few Remarks about Kriging	296
11.5. Statistical Inference	300
11.6. A Few Additional Remarks about Kriging	306
11.7. Nonstationary Problems	309
11.8. Examples of Kriging	318
11.9. Co-Kriging	323
11.10. Stochastic Partial Differential Equations	329

**Chapter 12 Numerical Solutions of the Flow
and Transport Equations**

12.1. Selection of a Numerical Technique and a Code	339
12.2. Finite Differences	342
12.3. Finite Elements	368
12.4. Solving Large Linear Systems	380
12.5. Solving the Transport Equation	387
12.6. Use of a Model	396

Appendix 1 Formulas for Estimating the Potential Evapotranspiration	403
--	-----

Appendix 2 Commonly Used Physical Quantities	407
---	-----

Bibliography	418
---------------------	-----

Index	435
--------------	-----