

## Contents

<i>Foreword by Susan S. Hubbard</i>	<i>page ix</i>
<i>Preface</i>	xi
1 Fundamentals of the self-potential method	1
1.1 Measurements	1
1.2 The electrical double layer	11
1.3 Brief history	14
1.4 The Poisson equation	16
1.5 Sources of noise	17
1.6 Conclusions	19
Exercises	19
2 Development of a fundamental theory	23
2.1 Non-equilibrium thermodynamic	23
2.2 Upscaling: from local to macroscopic equations	44
2.3 The geobattery and biogeobattery concepts	68
2.4 Conclusions	75
Exercises	77
3 Laboratory investigations	82
3.1 Analyzing low-frequency electrical properties	82
3.2 Investigating the geobattery concept in the laboratory	99
3.3 Conclusions	104
Exercises	105
4 Forward and inverse modeling	110
4.1 Position of the problem	110
4.2 Gradient-based approaches and their limitations	114
4.3 Fully coupled inversion	131

viii	<i>Contents</i>	
4.4	Conclusions	148
	Exercises	149
5	Applications to geohazards	154
5.1	Landslides and flank stability	154
5.2	Sinkhole detection	160
5.3	Detection of cavities	167
5.4	Leakages in dams and embankments	171
5.5	Conclusion	191
6	Application to water resources	192
6.1	Pumping tests	192
6.2	Flow in the vadose zone	209
6.3	Catchments hydrogeology	219
6.4	Contaminant plumes	232
6.5	Conclusions	243
	Exercises	243
7	Application to hydrothermal systems	245
7.1	Stochastic inversion of temperature and self-potential data	245
7.2	The Cerro Prieto case study	261
7.3	Gradient-based approach applied to hydrothermal fields	268
7.4	Conclusions	282
	Exercises	282
8	Seismoelectric coupling	284
8.1	Position of the problem	284
8.2	Seismoelectric theory in saturated media	286
8.3	Numerical modeling	291
8.4	Application in saturated conditions	293
8.5	Seismoelectric theory in unsaturated media	298
8.6	Application in two-phase flow conditions	319
8.7	Localization of hydromechanical events	326
8.8	Seismic beamforming and the formation of electrical bursts	335
8.9	Conclusions	338
	Exercises	339
	<i>Appendix A A simple model of the Stern layer</i>	342
	<i>Appendix B The <math>\mathbf{u}</math>-<math>p</math> formulation of poroelasticity</i>	345
	<i>References</i>	348
	<i>Index</i>	367
	<i>The color plate section can be found between pages 178 and 179.</i>	