

Contents

1	Introduction	1
1.1	General	1
1.2	Earth Sciences Phenomena	2
1.3	Variability	8
1.4	Determinism Versus Uncertainty	12
1.5	Earth, Environment, and Atmospheric Researches	16
1.6	Random Field (RF)	17
1.7	Regionalized Variable (ReV)	18
	References	19
2	Data Types and Logical Processing Methods	21
2.1	General	21
2.2	Observations	22
2.3	Numerical Data Types	25
2.4	Sampling	27
2.5	Number of Data	31
	2.5.1 Small Sample Length of Independent Models	33
	2.5.2 Small Sample Length of Dependent Models	35
2.6	Regional Representation	41
	2.6.1 Variability Range	42
	2.6.2 Inverse Distance Models	45
2.7	Sub-areal Partition	46
	2.7.1 Triangularization	47
2.8	Polygonizations	52
	2.8.1 Delaney, Varoni, and Thiessen Polygons	52
	2.8.2 Percentage-Weighted Polygon (PWP) Method	55
2.9	Areal Coverage Probability	67
	2.9.1 Theoretical Treatment	69
	2.9.2 Extreme Value Probabilities	72
2.10	Spatio-Temporal Drought Theory and Analysis	73
	2.10.1 Drought Parameters	76
	References	81

3	Classical Spatial Variation Models	83
3.1	General	83
3.2	Spatio-Temporal Characteristics	84
3.3	Spatial Pattern Search	85
3.4	Spatial Data Analysis Needs	87
3.5	Simple Uniformity Test	93
3.6	Random Field	95
3.7	Cluster Sampling	98
3.8	Nearest Neighbor Analysis	100
3.9	Search Algorithms	102
3.9.1	Geometric Weighting Functions	103
3.10	Trend Surface Analysis	106
3.10.1	Trend Model Parameter Estimations	108
3.11	Multisite Kalman Filter Methodology	110
3.11.1	One-Dimensional Kalman Filter	112
3.11.2	Kalman Filter Application	115
	References	126
4	Spatial Dependence Measures	127
4.1	General	127
4.2	Isotropy, Anisotropy, and Homogeneity	129
4.3	Spatial Dependence Function	132
4.4	Spatial Correlation Function	135
4.4.1	Correlation Coefficient Drawback	136
4.5	Semivariogram Regional Dependence Measure	140
4.5.1	SV Philosophy	140
4.5.2	SV Definition	144
4.5.3	SV Limitations	149
4.6	Sample SV	151
4.7	Theoretical SV	153
4.7.1	Simple Nugget SV	156
4.7.2	Linear SV	157
4.7.3	Exponential SV	159
4.7.4	Gaussian SV	159
4.7.5	Quadratic SV	160
4.7.6	Rational Quadratic SV	160
4.7.7	Power SV	161
4.7.8	Wave (Hole Effect) SV	162
4.7.9	Spherical SV	162
4.7.10	Logarithmic SV	163
4.8	Cumulative Semivariogram	164
4.8.1	Sample CSV	167
4.8.2	Theoretical CSV Models	169
4.9	Point Cumulative Semivariogram	175
4.10	Spatial Dependence Function	183
	References	199

5	Spatial Modeling	203
5.1	General	204
5.2	Spatial Estimation of ReV	205
5.3	Optimum Interpolation Model	207
5.3.1	Data and Application	211
5.4	Geostatistical Analysis	224
5.4.1	Kriging Technique	225
5.5	Geostatistical Estimator (Kriging)	228
5.5.1	Kriging Methodologies and Advantages	230
5.6	Simple Kriging	232
5.7	Ordinary Kriging	239
5.8	Universal Kriging	245
5.9	Block Kriging	249
5.10	Triple Diagram Model	250
5.11	Regional Rainfall Pattern Description	256
	References	266
6	Spatial Simulation	271
6.1	General	272
6.2	3D Autoregressive Model	273
6.2.1	Parameters Estimation	274
6.2.2	2D Uniform Model Parameters	276
6.2.3	Extension to 3D	279
6.3	Rock Quality Designation Simulation	281
6.3.1	Independent Intact Lengths	281
6.3.2	Dependent Intact Lengths	290
6.4	RQD and Correlated Intact Length Simulation	300
6.4.1	Proposed Models of Persistence	303
6.4.2	Simulation of Intact Lengths	305
6.5	Autorun Simulation of Porous Material	310
6.5.1	Line Characteristic Function of Porous Medium	312
6.5.2	Autorun Analysis of Sandstone	312
6.5.3	Autorun Modeling of Porous Media	316
6.6	CSV Technique for Identification of Intact Length Correlation Structure	321
6.6.1	Intact Length CSV	323
6.6.2	Theoretical CSV Model	324
6.7	Multidirectional RQD Simulation	333
6.7.1	Fracture Network Model	334
6.7.2	RQD Analysis	335
6.7.3	RQD Simulation Results	338
	References	340
	Index	343