

Contents

Color Plates	xvii
1 Introduction	1
2 The Fractal Dimension	6
2.1 The Coast of Norway	6
2.2 The Schwarz Area Paradox	9
2.3 The Fractal Dimension	11
2.4 The Triadic Koch Curve	15
2.5 Similarity and Scaling	18
2.6 Mandelbrot-Given and Sierpinski Curves	22
2.7 More on Scaling	26
2.8 The Weierstrass-Mandelbrot Function	27
3 The Cluster Fractal Dimension	31
3.1 Measurements of Cluster Fractal Dimensions	36
4 Viscous Fingering in Porous Media	41
4.1 Fluid Flow in the Hele-Shaw Cell	41
4.2 Viscous Fingers in Hele-Shaw Cells	45
4.3 Viscous Fingers in Two-Dimensional Porous Media	49
4.4 Viscous Fingering and DLA	53
4.5 Viscous Fingers in Three-Dimensional Porous Media	56

5 Cantor Sets	62
5.1 The Triadic Cantor Set	62
5.2 Scaling with Unequal Ratios	64
6 Multifractal Measures	66
6.1 Curdling and the Devil's Staircase	67
6.2 The Binomial Multiplicative Process	70
6.3 Fractal Subsets	73
6.4 The Lipschitz-Hölder Exponent α	75
6.5 The $f(\alpha)$ Curve	76
6.6 The Measure's Concentrate	78
6.7 The Sequence of Mass Exponents $\tau(q)$	80
6.8 The Relation between $\tau(q)$ and $f(\alpha)$	83
6.9 Curdling with Several Length Scales	85
6.10 Multifractal Rayleigh-Benard Convection	89
6.11 DLA and the Harmonic Measure	92
6.12 Multifractal Growth of Viscous Fingers	96
7 Percolation	104
7.1 Site Percolation on a Quadratic Lattice	105
7.2 The Infinite Cluster at p_c	109
7.3 Self-Similarity of Percolation Clusters	112
7.4 Finite Clusters at Percolation	117
7.5 The Cluster Size Distribution at p_c	120
7.6 The Correlation Length ξ	122
7.7 The Percolation Cluster Backbone	126
7.8 Invasion Percolation	131
7.9 The Fractal Diffusion Front	139
8 Fractal Records in Time	149
8.1 Hurst's Empirical Law and Rescaled Range Analysis	149
8.2 Simulations of Random Records	154
8.3 Simulations of Long-Term Dependence	157

9 Random Walks and Fractals	163
9.1 Brownian Motion	163
9.2 Random Walk in One Dimension	164
9.3 Scaling Properties of One-Dimensional Random Walks	166
9.4 Fractional Brownian Motion	170
9.5 Definition of Fractional Brownian Motion	172
9.6 Simulation of Fractional Brownian Motion	173
9.7 <i>R/S</i> Analysis of Fractional Brownian Motion	178
9.8 Successive Random Addition	180
10 Self-Similarity and Self-Affinity	184
10.1 The Strategy of Bold Play	189
11 Wave-Height Statistics	193
11.1 <i>R/S</i> Analysis of the Observed h_s	194
11.2 <i>R/S</i> for Seasonally Adjusted Data	195
12 The Perimeter-Area Relation	200
12.1 The Fractal Dimension of Clouds	202
12.2 The Fractal Dimension of Rivers	208
13 Fractal Surfaces	212
13.1 The Fractal Koch Surface	212
13.2 Random Translation Surfaces	214
13.3 Generating Fractal Surfaces	216
13.4 Random Addition Surfaces	221
13.5 Comments on Fractal Landscapes	228
14 Observations of Fractal Surfaces	229
14.1 Observed Surface Topography	229
14.2 D for Landscapes and Environmental Data	234
14.3 Molecular Fractal Surfaces	236
References	244
Author Index	258
Subject Index	265