

Contents

1. *Introduction*

- A. Self-organization, 3
- B. Nonequilibrium Conditions, 6
- C. Survey Of Self-organization and Other Nonlinear Phenomena, 8
- D. Imposed Templates, 15
- E. Strategy, 19
- References, 20

2. *Feedback, Instability, and Bifurcation*

- A. Feedback, 21
- B. Bifurcation Theory, 23
- C. Symmetry-Breaking Instability and Pattern Formation, 30
- D. Bifurcation of Dissipative Structures, 34
- E. Correlation Analysis, 37
- References, 38

3. *Oscillatory Zoning In Crystals*

- A. Intragranular Self-Organization, 39
- B. Modeling Oscillation Through Coupled Diffusion and Growth Dynamics, 43
- C. Smooth and Multiple Spatial Dimensional Zoning, 54
- D. Surface-Activated Complexes, 58
- E. Oscillatory Replacement, 59
- F. Oscillatory Zoning at Reaction Fronts, 64
- G. Numerical Simulation of Crystal Zoning, 67
- H. Soluble Models, 71
- I. Other Models and Effects, 76
- References, 77

4. *Reaction–Transport Modeling*

- A. Modeling Approach, 79
- B. Descriptive Variables, 79
- C. Processes, 80
- D. Evolution Equations, 81

- E. Boundary and Initial Data, 82
- F. Solid Density Asymptotics, 83
- G. Equilibrium Slow Manifold Projection, 85
- H. Reaction Zones as Free Boundaries, 86
- References, 91

5. *Flow Driven Reaction Fronts*

- A. Moving Fronts: Their Variety and Potential for Self-Organization, 92
- B. A Simple Redox Front, 93
- C. Trapping Fronts, 95
- D. Discrete Front Multiplicity, 96
- E. Reverse Fronts, 99
- F. Front Robustness to Deviations from Monodispersal, 100
- G. Instability and Patterning of Flow Driven Fronts, 102
- References, 102

6. *Dissipative Structures At Reaction Fronts*

- A. Motivation, 103
- B. Simple Reaction Zone Model, 105
- C. Dynamical Behavior of the Uniform Front, 106
- D. Spatio-temporal Structure Along the Reaction Front, 108
- E. Further Developments, 110
- References, 110

7. *Reaction Front Morphology*

- A. Morphological Instabilities and Restabilization, 111
- B. A Simple Illustrative System, 119
- C. Reaction Front Morphological Self-organization in Carbonate Cemented Sandstones, 123
- D. Adaptive Gridding, 131
- E. Further Developments, 134
- References, 134

8. *Liesegang Banding*

- A. The Ostwald Supersaturation-Nucleation-Depletion Cycle, 136
- B. A Quantitative Model of a Flow Driven Ostwald-Liesegang Cycle, 140
- C. Solid Density Asymptotics, 142
- D. Planar Constant Velocity Solutions, 143
- E. Unsteady Deposition—The Transition to Liesegang Banding, 147
- F. Nucleation Theory, 153
- G. Homogeneous Ostwald Cycles in Magmas, 159

- H. Nucleation Banding in a Temperature Gradient, 160
- I. Approximation Techniques for the Particle Size Distribution, 162
- References, 163

9. *Unstable Coarsening Fronts and Precipitate Patterning*

- A. Introduction, 165
- B. Equations of Local Monodisperse Dynamics, 169
- C. Instability of the Uniform Sol, 171
- D. Satellite Induction, 173
- E. CPG in Two Dimensions, 176
- F. Cross-Flux Phenomena, 183
- G. Unstable Growth Fronts, 187
- H. More Complex CPG Phenomena, 189
- I. Observations on Greedy Giants, 196
- J. Self-organization and the Particle Size Distribution, 199
- K. Further Developments, 203
- References, 204

10. *Mechanochemical Coupling*

- A. Origins and Implications of Texture Dependent Grain Solubility, 205
- B. Simple Models of Texture Mediated Pressure Solution, 211
- C. Interfacial Energy, 221
- D. Other Mechanochemical Models, 225
- E. Texture Dynamics, 227
- F. Simple Rock-Flow Phenomenology, 228
- G. Texture Dynamics in the Volume Replacement and Reuss Limits, 230
- H. Texture-Mediated Free Energy Through Texture Dependent Rheology, 233
- References, 233

11. *Metamorphic Differentiation*

- A. The Conceptual Model, 235
- B. Texture Mediated Reaction-Diffusion Model, 241
- C. Linear Stability of the Uniformly Textured, Flow-Free State, 242
- D. Numerical Simulation of Texture Dynamics, 248
- E. Pressure Solution Rate Laws, 260
- F. Further Developments, 265
- References, 266

12. *Diagenetic Differentiated Mechanochemical Structures*

- A. A Variety of Meter and Submeter Scale Patterning Phenomena, 269
- B. Simple Porosity Mediated Feedback, 274

- C. Stylolite and Bedding Orientation, 276
- D. Coupled Truncated Sphere Mechanochemical Model, 277
- E. Kinetics of Coated Free Faces, 283
- F. Simulation of Diagenetic Mechanochemical Differentiation, 287
- G. Further Developments, 307
 - References, 307

13. Geodes, Concretions, Agates and Orbicules

- A. The Phenomena, 310
- B. Origins, 316
- C. Morphological Instability of a Growing Inclusion, 318
- D. Simulation of Metamorphically Differentiated Orbicular Patterns, 321
- E. Spiral Garnets and Noninertial Vorticity, 324
- F. Patterned Agates, 324
 - References, 325

14. Reaction Driven Advection Phenomena

- A. Kilometer-Scale Patterning, 326
- B. Methanogenic Flows, 335
- C. Temperature Dependent Solubility-Driven Advection, 341
- D. Pressure Solution Driven Advection, 351
- E. Further Developments, 358
- F. References, 359

15. Compartmentation Of A Sedimentary Basin

- A. The Powley-Bradley Compartment Concept, 360
- B. A Preliminary Categorization of Compartments, 364
- C. Seals, 367
- D. The Micro-, Meso-, Macro-, and Megascopic Scales: Definitions and Interrelations, 370
- E. Autoisolation, 371
- F. Smart Materials, 375
- G. The Special Sealing Properties of Layered Rock, 376
- H. Sustaining the Hydraulic Connectivity of the Compartment Interior, 377
- I. Seal Puncturing and Episodic Fluid Release, 378
- J. Far-From-Equilibrium Compartmentation, 380
 - References, 382

16. Episodic Fluid Flow and the Fracturing/Healing Cycle

- A. The Qualitative Picture, 384
- B. A Simple Model of Oscillatory Release from Hydrologic Compartments, 386
- C. Analysis and Simple Limiting Cases, 388
- D. Pressurized Porous, Fractured Medium Theory, 392
- E. The Dynamic, Transbasinal Top Seal, 399
- F. Remarks, 402
References, 404

***Index* 407**