
Contents

1	Introduction	1
1.1	Why Lecturing?	1
1.2	Why This Textbook?	4
1.3	Why Physical Principles?	5
1.4	Why a Readable Textbook?	8
1.5	Suggested Reading	9
2	Sorting Out and Mixing	11
2.1	Bulk Minerals	11
2.2	Heavy Minerals	15
2.3	Size and Sorting	19
2.4	Exclusion Principle	20
2.5	Suggested Reading	22
3	Grains Settle	25
3.1	Stokes' Law	25
3.2	Why Derivation?	27
3.3	Dimensional Analysis	29
3.4	Fluid Resistance	32
3.5	Reynolds Number	35
3.6	Resistance Coefficient	38
3.7	Lacustrine Varves	41
3.8	Suggested Reading	46
4	Sediments Are Moved	47
4.1	Turbidity Currents	47
4.2	Chezy's Equation	50
4.3	Stream Transport	56
4.4	Shields' Diagram	57
4.5	Hjulström's Curve	60
4.6	Suggested Reading	62

5	Rocks Fall	65
5.1	Sediment-Gravity Flows	65
5.2	Elm Landslide	67
5.3	Grand Banks Slide	73
5.4	Speed of Slides	77
5.5	Debris Flows	80
5.6	Sand Avalanches	82
5.7	Mud Slide	83
5.8	Olistostrome	84
5.9	Volume Dependence of Sturzstrom	85
5.10	Suggested Reading	87
6	Suspensions Flow	89
6.1	Suspension Current	89
6.2	Auto-suspension	90
6.3	Bagnold's Criterion	92
6.4	Chezy-Kuenen Equation	93
6.5	Keulegan's Law	95
6.6	Energy Line	96
6.7	Hyperconcentrated Density Flows	97
6.8	Suggested Reading	100
7	Sand Waves Migrate	103
7.1	Richardson Number	103
7.2	Froude Number	105
7.3	Model Theory	106
7.4	Point-Bar Sequence	111
7.5	Bedform	113
7.6	Facies Models	118
7.7	Suggested Reading	121
8	Oceans Are Ventilated	123
8.1	Ocean Currents	123
8.2	Bernoulli's Theorem	129
8.3	Darcy-Weisbach Equation	131
8.4	Contourites	134
8.5	Suggested Reading	135
9	Groundwater Circulates	137
9.1	Darcy Equation	137
9.2	Poiseuille Law	141
9.3	Hydrodynamic Potential	142

9.4	Permeability	143
9.5	Compaction	146
9.6	Diffusion	148
9.7	Suggested Reading	150
10	Components Equilibrate	151
10.1	Mass-Action Law	151
10.2	Gibbs Criteria of Chemical Equilibrium	152
10.3	First and Second Law of Thermodynamics	154
10.4	Lewis Concept of Chemical Activity	156
10.5	Carbonate Equilibria	157
10.6	Metastable Phases	161
10.7	Calcite Dissolution	163
10.8	Suggested Reading	164
11	Evaporation Pumps	167
11.1	Dolomite	167
11.2	Dolomite Solubility	168
11.3	Material Transfer in Open Systems	170
11.4	Seepage Refluxing	172
11.5	Evaporative Pumping	173
11.6	Flood Recharge	175
11.7	Suggested Reading	176
12	Isotopes Fractionate	179
12.1	Isotopes	179
12.2	Isotope Tracers	180
12.3	Paleotemperature	182
12.4	Paleoproductivity	185
12.5	Strangelove Ocean	187
12.6	Suggested Reading	190
13	Basins Subside	191
13.1	Isostasy	191
13.2	Airy Model	192
13.3	Crustal Thinning	194
13.4	Mantle Heterogeneity	195
13.5	Lithospheric Stresses	196
13.6	Suggested Reading	199
14	Why Creativity in Geology	201
	Suggested Reading	206

XIV Contents

Appendix I	209
Appendix II	213
References	217
Index	223