

CONTENTS

PREFACE	VII
Further reading	XII
PREFACE to the second edition	XII
CHAPTER 1. PETROGRAPHY OF CARBONATE GRAINS 1: SKELETAL	
STRUCTURES	1
Introduction	1
Mollusca	2
Molluscan structures	3
Tubules	14
The organic matrix	14
Amphineura	16
Gastropoda	16
Bivalvia	17
Scaphopoda	18
Cephalopoda	19
Brachiopoda	20
Zoantharia	25
Scleractinia (calcareous Hexacorallia)	25
Rugosa	26
Tabulata	28
Heterocorallia	28
Octocorallia (Alcyonaria)	28
Spiculate orders	29
Hydrozoa	30
Stromatoporoidea	31
The skeletal walls	33
Skeletal microstructure	33
Palaeozoic stromatoporoids	35
Mesozoic stromatoporoids	38
Foraminiferida	39
Textulariina	41
Fusulinina	41
Miliolina	45
Rotaliina	45
Identification of Recent foraminiferal debris	48
Echinodermata	50
Echinoidea, Crinoidea, Asteroidea, Ophiuroidea, Blastoidea	50
Holothuroidea	55
Families of disjunct holothurian sclerites	57
Benthonic calcareous algae	58
Corallinaceae	58
Solenoporaceae	61
Gymnocodiaceae	61

Codiaceae	62
Dasycladaceae	64
Charophyta	64
Uncertain affinity	64
Phylloid algae	66
Planktonic calcareous algae	67
Coccolithaceae	67
Calcispheres	69
Bryozoa	70
Trilobita	73
Further reading	75
Additional references not given in the preceding chapter	76

CHAPTER 2. PETROGRAPHY OF CARBONATE GRAINS 2: OÖIDS, PISOLITES, PELOIDS AND OTHER MICRITIC FABRICS

Recent oöids and pisolites	77
Marine and lacustrine oöids	77
Cave oöids and pisolites (cave pearls)	81
Ancient oöids and pisolites	82
Primary and secondary fabrics	82
Vadose pisolites in caliche	84
Peloids	84
Faecal pellets	84
Other peloids	86
Grapestone and lumps	87
Calclutites	87
Muds (clay-grade): precipitated or algal	87
Muds: clastic	87
Mudstone (clay-grade)	88
Coarser calclutites	89
Micrite envelopes	90
Ancient stromatolites	90
Further reading	91

CHAPTER 3. RECENT CARBONATE ENVIRONMENTS 1: GENERAL INTRODUCTION AND THE GREAT BAHAMA BANK

General introduction: Research on Recent carbonate sediments	93
Stimulus of marine geology and stratigraphy	93
Summary of principal past researches	94
The complex environment	95
The Great Bahama Bank	96
Dimensions	96
Topography	98
Water movement	100
Temperature and salinity	100
Lithofacies, habitats, communities	102
The corallgal lithofacies and its environment	108
The oölitic and grapestone lithofacies and their environment	121
The oölite lithofacies and its environment	134
The pellet-mud and mud lithofacies and their environment	136
Retrospect: the significance of lithofacies	138
Further reading	141
Additional references not given in the preceding chapter	142
Papers on Recent reef complexes	143
Other papers of interest	144

CHAPTER 4. RECENT CARBONATE ENVIRONMENTS 2: FLORIDA, GULF OF BATABANO, PERSIAN GULF, BRITISH HONDURAS	147
Southern Florida	147
Topography	147
Water movement	148
Temperature and salinity	149
The reefs.	150
Back-reef lagoon	154
Florida Bay	161
A note on carbonate mud banks	164
Gulf of Batabano, Cuba	165
Topography, water movement, salinity.	165
Organisms. substrates	170
Environments	173
Discussion	176
The Trucial Coast Embayment, Persian Gulf	178
Topography	178
Water movement, temperature, salinity	180
The open sea floor off Qatar	181
The Abu Dhabi complex.	189
Sabkha of the Qatar Peninsula	209
British Honduras	212
Skeletal calcilutites	212
Further reading	216
Additional references not given in the preceding chapter	216
CHAPTER 5. RECENT CARBONATE ALGAL STROMATOLITES	217
Introduction	217
The work of Black	218
Morphology and growth	219
Classification	219
Finer depositional fabrics	222
Morphology and distribution of stromatolites	227
Summary	230
Further reading	230
CHAPTER 6. SOME CHEMICAL CONSIDERATIONS	231
The simple system $\text{CO}_2\text{--H}_2\text{O--CaCO}_3$	231
Equilibria	231
pH and buffering	233
Alkalinity	234
The commoner carbonate minerals	234
Polymorphs of CaCO_3	234
Magnesian calcites	235
Dolomites and protodolomites	238
Mineral transformations	239
Dry transformation (inversion) of aragonite to calcite	239
Wet transformation of aragonite to calcite	239
Factors affecting carbonate equilibria	242
Surface layer reactions.	242
Inhibiting effect of Mg^{2+} on calcite precipitation	243
Inhibiting effect of Mg^{2+} adsorption on dolomite growth	250
Effect of history of crystal surfaces on dolomite-calcite equilibria	252
Influence of organic films on particle-water reactions	252
Enhanced solubility of very small grains	254
Complexing in sea water	254

Relation between saturation of sea water for CaCO_3 and mineralogy of the sediment	256
Stability of CaCO_3 polymorphs in sea water in the light of partition coefficients for Sr^{2+} and Mg^{2+}	258
Control of calcite–aragonite precipitation in pure water solutions in contact with air	259
Strontium in aragonite and calcite	260
Solubility and pressure.	265
Preservation of skeletal aragonite in ancient limestones.	274
Origin of Bahamian aragonite mud; inorganic or physiological precipitate?	276
The sediment	277
Skeletal contribution to the sediment	278
Recognition of algal needles by $^{18}\text{O}/^{16}\text{O}$ ratios	279
Inorganic precipitation.	284
Further reading.	292
Additional references not given in the preceding chapter	293
A selection of references on the relation of trace-elements and isotopes to salinity and temperature	294
CHAPTER 7. GROWTH OF OÖIDS, PISOLITES AND GRAPESTONE	295
The history of oölite theory.	295
The role of algae	295
The role of bacteria	298
Inorganic precipitation	300
Growth in caves and mines	305
Further development of oölite theory	307
The building of oölitic aragonite in the sea	307
Tangential growth of aragonite	308
Origin of radial-fibrous calcite in certain Jurassic limestones	311
Grain size limits	313
The origin of grapestone	316
Needle, oöid or grapestone	318
Further reading.	319
Additional references not given in the preceding chapter	319
CHAPTER 8. DIAGENESIS IN THE SUBAERIAL, FRESH WATER ENVIRONMENT	321
Introduction	321
Evidence for diagenesis during subaerial exposure	322
Fabric and mineralogical evolution of Recent and Pleistocene limestones:	
Bermuda and Florida	325
Fabric evolution of Bermudan limestones	325
Mineralogical evolution of some Bermudan and Floridan limestones.	330
The role of the micrite envelope in diagenesis	333
Experiments on dissolution of magnesian calcites	335
Isotopic evolution of Bermudan limestones	339
Summary of Bermudan limestone diagenesis	344
Comparison with Recent–Pleistocene carbonate sediments of Israeli Mediterranean coast	345
Fabric and mineralogical evolution of Cainozoic limestones: Guam, Eniwetok and Lau	345
Passive dissolution and precipitation	345
Calcitization of aragonite skeletons and carbonate mud at Guam, Eniwetok and Lau	347
Growth of neomorphic spar at Guam and Eniwetok.	350
Fabric and mineralogical evolution of Recent limestones: Funafuti	350
Cementation at Funafuti	351
Calcitization of calcilutite at Funafuti	353
Calcitization of primary and secondary aragonite at Funafuti	353
Growth of neomorphic spar at Funafuti	355

Dissolution of aragonite at Funafuti	355
Summary of diagenesis at Funafuti	355
Early vadose geopetal silt	356
Internal calcite silts in a Permian wackestone mud	356
Summary of subaerial, fresh water diagenesis	357
Further reading	360
CHAPTER 9. DIAGENESIS ON THE SEA FLOOR	361
Introduction	361
The pore water in Recent marine carbonate sediments	361
Dissolution on the Recent sea floor	362
Dissolution in shallow tropical seas	362
Dissolution in deep sea water	363
Cementation on the Recent sea floor	363
Subtidal cementation in unconsolidated lime sediments	363
Subtidal cementation in reef porosity	365
Beach rock	367
Submarine hardgrounds (hard layers) in the Persian Gulf	371
Submarine hardgrounds on the New Providence platform	374
Cementation in deeper waters	375
Boring algae and micritization on the Recent sea floor	381
Micritization in Bimini Lagoon	384
Micritization and the production of peloids	389
Emplacement of micritic aragonite	391
Diagenesis on ancient sea floors	392
Submarine cementation	392
Micritization	394
The problem of hardgrounds	394
Some Ordovician hardgrounds in Sweden	397
The Chalk hardgrounds of northwest Europe	399
Porosity of the Chalk hardgrounds	400
The scant cementation of the soft chalk	401
The role of skeletal aragonite	404
Chalk hardgrounds emergent?	404
Rate of deposition of the Chalk	405
Chalk hardgrounds and non-deposition	405
Cementation of Chalk hardgrounds	406
Shoaling and Chalk hardgrounds	408
The Chalk hardground established	409
Further reading	412
Additional references not given in the preceding chapter	413
CHAPTER 10. CEMENTATION	415
Introduction	415
Recognition of cement in thin section	416
The philosophy	416
Fabric criteria for cement	417
Discussion of fabric criteria	420
The precipitation of cement in the subaerial fresh water and deep crustal environments	428
Influence of substrate	428
Discontinuities in growth of cement	431
Nucleation of cement crystals	435
Influence of water chemistry on mineralogy and fabric of cement	439
The supply and delivery of CaCO_3 for cementation in the subaerial fresh water and deep crustal environments	439
The problem of the supply of CaCO_3	439

The ideal pore system calcite-CO ₂ -H ₂ O	442
Pore systems with more than one solid phase: diffusion and fluid flow	446
Karst evolution and the supply of dissolved CaCO ₃	450
Donor and receptor limestones	451
Submarine cementation	452
The importance of submarine cementation in the past	453
Evidence for near-surface versus deep crustal cementation: a pragmatic approach	454
An experiment: data from micrite envelopes and grain contacts	455
Summary: the state of thinking on cementation	456
Further reading	457
CHAPTER 11. PRESSURE-SOLUTION	459
The general theory of pressure-solution	459
The theories of Thomson and Riecke	459
Grains under load and the Boussinesq equation	460
Grain-to-grain pressure-solution in sediments	462
Grain contacts, diffusion, precipitation	462
The effect of cement on pressure-solution	465
The maintenance of pressure-solution	466
Stylolites	468
Form and growth	468
Development of secondary clay seams (insoluble residues)	471
Critical stress for pressure-solution	472
Further reading	473
CHAPTER 12. NEOMORPHIC PROCESSES IN DIAGENESIS	475
Neomorphic processes	475
Recrystallization	476
Primary recrystallization	477
Grain growth	480
Wet recrystallization	481
Aggrading neomorphism: the growth of neomorphic spar	481
The problem	483
The fabrics of neomorphic spar	484
Fabrics of the sparry calcite	484
Fabrics of the syntaxial calcite rim	491
Interpretation of the fabrics of neomorphic spar	493
The processes of aggrading neomorphism	499
Fabric criteria for neomorphic spar	503
Lithification of micrite	504
The problem	504
Some processes	508
Structure grumeleuse	511
Growth of microspar	513
Further reading	515
Studies of calcilutites with the electron microscope	515
Additional references not given in the preceding chapter	516
CHAPTER 13. RECENT DOLOMITES	517
Introduction	517
Calcium-magnesium carbonate sediments of the Coorong district, South Australia	517
The environment	519
Minerals and chemical parameters	520
Hypotheses	523
Dolomites of the Persian Gulf	525
Chemical parameters	525

Dolomite	526
Hypothesis	527
Dolomite of Bonaire Island, southern Caribbean	530
The environment	530
Textural and chemical parameters	531
Dolomite	531
Hypothesis	531
Seepage reflux	532
Dolomites of the Bahamas	534
The crust	534
Dolomite	535
Hypothesis	535
The growth of dolomite in the Recent environment	536
Search for a mechanism	536
Significance of the surface layer of a crystal	538
Summary	541
Further reading	543
Additional references not given in the preceding chapter	543
Papers on calcitization of dolomites	543

APPENDIX. RECENT DEVELOPMENTS IN CARBONATE SEDIMENTOLOGY	545
Petrography of carbonate grains	545
Recent carbonate environments	546
Recent carbonate algal stromatolites	547
Chemical considerations	548
Growth of ooids	551
Fresh water diagenesis, cementation and neomorphic processes	552
Diagenesis on the sea floor	557
Pressure-solution	559
Recent dolomites	560
Diagenesis under the deep sea floor	561
Lake sediments	562
Calcrete	562
Hydrogeology and karst	563

GLOSSARY OF SEDIMENTOLOGICAL TERMS NOT DEFINED IN THE TEXT	565
--	-----

REFERENCES	569
----------------------	-----

REFERENCES IN THE APPENDIX	615
--------------------------------------	-----

INDEX	633
-----------------	-----