CONTENTS

Foreword by W. A. Berggren Introduction by John A. Van Couvering	xi 3
Part I THE CONCEPT OF CATASTROPHE AS A NATURAL AGENT	7
Chapter 1 TOWARD THE VINDICATION OF PUNCTUATIONAL CHANGE by Stephen Jay Gould	9
 Part 1 Lyell's Vision and Rhetoric The Multiple Meanings of Uniformity Modern Geology as a Blend of Lyell and the Catastrophists Part 2 The Validity of Punctuational Change The Channeled Scablands of Eastern Washington Punctuated Equilibria and the Tempo of Evolutionary Change Part 3 The Cultural Context of Gradualism The Growing Popularity of Punctuational Change Literature Cited 	9 10 13 16 17 21 27 29 31
Chapter 2 PERFECTION, CONTINUITY, AND COMMON SENSE IN HISTORICAL GEOLOGY by Richard H. Benson	35
Introduction The Origins of Catastrophism British Catastrophism and Uniformitarianism Charles Lyell History and Continuity by Analogy Models and Disruption Evolution and Sudden Events Conclusion Acknowledgments Literature Cited	35 40 45 50 56 60 66 70 71 72
Chapter 3 REFLECTIONS ON THE "RARE EVENT" AND RELATED CONCEPTS IN GEOLOGY by Peter E. Gretener	77
Introduction The Concept of the "Rare Event"	77 78
	v

_

vi CONTENTS

The Concept of Punctuation The Concept of the "Haze of the Past" and the Relativity of Gradualism An Attempt to Define the Term "Event" in Geology "Uniformitarianism" and "Catastrophism": Equally Misleading Terms The Relevance of the Previous Considerations to "Modern Man's Predicament" Conclusions Acknowledgments Literature Cited	81 82 83 85 86 87 88 88 88
Chapter 4 THE STRATIGRAPHIC CODE AND WHAT IT IMPLIES by Derek V. Ager	91
Literature Cited	99
Chapter 5 STATISTICAL SEDIMENTATION AND MAGNETIC POLARITY STRATIGRAPHY by Charles R. Denham	101
Introduction Poisson Processes Poisson Magnetostratigraphy Application to the Oligocene Epoch Discussion Acknowledgments Literature Cited	101 101 102 105 107 111 111
Part II THE CRETACEOUS/TERTIARY BOUNDARY: A CASE IN POINT	113
Chapter 6 MASS EXTINCTION: UNIQUE OR RECURRENT CAUSES?	
by Norman D. Newell	115
Literature Cited	126
Chapter 7 THE TWO PHANEROZOIC SUPERCYCLES by Alfred G. Fischer	129
Introduction	129
The Perception of Long-Term Change The Eustatic Curve and Its Implications	130
Volcanism	131 135
Carbon Dioxide in the Atmosphere	136
Climates and Carbon Dioxide Regimes	139
Climatic Oscillations and Biotic Crises Summary and Conclusions	144
Acknowledgments	146 147
Literature Cited	148

247

305

Chapter 8 THE FABRIC OF CRETACEOUS MARINE EXTINCTIONS	
by Erle G. Kauffman	151
Introduction	151
The Cretaceous-Tertiary Boundary Event: An Historical Perspective	155
The Pattern of Late Cretaceous Marine Extinction: An Overview	164
The Preserved Record of Marine Macrofaunal Extinction at the End	
of the Cretaceous	177
Tethyan Pelagic Sequences	178
The Macrofaunal Record of the Extinction Event on Carbonate Platform	
Facies in Tethys	185
The North Temperate Sequences	190
Intra-Cretaceous Extinction Events	200
A Model of Intra-Cretaceous Extinction Events	216
An Environmental Interpretation of the Cretaceous-Tertiary Extinction Event	224
Acknowledgments	237
Literature Cited	237

Chapter 9

CAMPANIAN THROUGH PALEOCENE PALEOTEMPERATURE AND CARBON ISOTOPE SEQUENCE AND THE CRETACEOUS-TERTIARY BOUNDARY IN THE ATLANTIC OCEAN by Anne Boersma

Introduction	247
Surface Dwelling Planktonic Foraminifera	249
Surface Temperatures	249
Bottom Temperatures	262
Surface Carbon Isotope Values	264
Surface to Bottom Carbon Isotope Differences	266
Thermal Gradients	268
Summary	269
Speculations	270
Acknowledgments	275
Literature Čited	275

Chapter 10

Literature Cited

CHANGES IN THE ANGIOSPERM FLORA ACROSS THE CRETACEOUS-	
TERTIARY BOUNDARY by Leo J. Hickey	279
Introduction	279
Difficulties in Working With the Fossil Plant Record	280
Materials and Methods	283
Cretaceous Angiosperm History	285
Patterns of Change Across the Cretaceous-Tertiary Boundary	295
The Significance of the Observed Changes	301

.

viii CONTENTS

Chapter 11 PALYNOLOGICAL EVIDENCE FOR CHANGE IN CONTINENTAL FLORAS AT THE CRETACEOUS-TERTIARY BOUNDARY by Robert H. Tschudy 315

Introduction	315
The Pollen and Spore Evidence	319
The Physical World During the Cretaceous-Tertiary Transition	331
Conclusions	332
Literature Cited	333

Chapter 12

MAMMAL EVOLUTION NEAR THE CRETACEOUS-TERTIARY BOUNDARY by J. David Archibald and William A. Clemens 339

Introduction	339
Lithographic and Time-Stratigraphic Boundaries in Eastern Montana	341
Geologic Setting	345
Fossil Localities and Their Stratigraphic Context	349
Mammalian Biostratigraphic and Paleoecologic Comparisons	352
Mammalian Evolution Near the Cretaceous-Tertiary Boundary	365
Acknowledgments	367
Literature Cited	367

Chapter 13 TERMINAL CRETACEOUS EXTINCTIONS OF LARGE REPTILES by Dale A. Russell

Introduction	373
Diversity Trends	375
The Maastrichtian-Danian Transition	377
Acknowledgments	380
Literature Cited	380

373

396

Part III

CATASTROPHIC PROCESSES IN THE GEOLOGICAL RECORD

Chapter 14 LOW SEA LEVELS, DROUGHTS, AND MAMMALIAN EXTINCTIONS by Nils-Axel Mörner 387 Introduction 387 The Eocene-Oligocene Event 388 The Late Miocene (Messinian) Event 388 Summary 392 Literature Cited 392 Chapter 15 EUSTASY, GEOID CHANGES, AND MULTIPLE GEOPHYSICAL **INTERACTION by Nils-Axel Mörner** 395 Introduction and Metaphors 395 Eustasy and Its New Definition

The Geoid and Its Instability	399
Some Examples of Geoidal-Eustasy	402
Multiple Eustatic Effects	410
Paleoclimatic Implications	411
Literature Cited	412
Chapter 16 ON TWO KINDS OF RAPID FAUNAL TURNOVER by S. David Webb	417
· · ·	
Introduction	417
The MacArthur-Wilson Equilibrium Hypothesis	418
O-Type and E-Type Rapid Turnover Episodes	420
The Fall of the Clarendonian Chronofauna	420
Recognition of E-Type and O-Type Episodes	429
E-O Compound Episodes: The Ultimate Cataclysms	432
Summary	433
Acknowledgments	434
Literature Cited	434
Chapter 17	
THE PHANEROZOIC "CRISIS" AS VIEWED FROM THE MIOCENE	
by Richard H. Benson	437
Introduction	437
The Permian and Salinity	438
The Messinian Salinity Crisis	439
Permotriassic Faunas and the Ostracodes	440
Miocene Extinctions	441
Comparing the Ostracodes	442
Conclusions	443
Acknowledgments	443
Literature Cited	444

Part IV

CATASTROPHES AND THE REAL WORLD

Chapter 18 MARINE MINERAL RESOURCES AND UNIFORMITARIANISM	
by Kenneth O. Emery	449
Introduction	449
Mineral Deposition	450
Mineral Use	451
Ocean-Floor Minerals	452
Ocean Energy Sources	454
Economic, Social, and Political Impact of Mineral Catastrophe	457
Postscript	460
Acknowledgments	461
Literature Cited and Recommended Reading	461