

Contents

Preface 9

- 1 *Some basic concepts* 11
 1. Development of the Ice Age concept 11
 2. Stratigraphical terms 15
- 2 *Developments leading to the Ice Age* 17
 1. The Tertiary Period 17
 2. Absolute datings in the Cenozoic, and proposals for a revised classification and nomenclature 21
 3. Absolute datings related to the lower boundary of the Quaternary 24
 4. Climatic evolution in the Cenozoic 25
- 3 *Glacial and periglacial environments* 27
 1. Elementary facts concerning glacial processes and glacial morphology 27
 2. Periglacial features 45
- 4 *Methods of absolute dating within the Quaternary* 52
 1. The MILANKOVITCH CURVE 52
 2. Rhythmic phenomena 52
 3. Radiometric methods 55
 4. Palaeomagnetic correlation 61
 5. Various methods 64
- 5 *The system of glacials and interglacials of the Alpine region* 66
- 6 *Problems concerning the lower boundary of the Quaternary* 80
- 7 *Italy* 83
- 8 *Eustatic sea-level fluctuations in the Mediterranean area* 96
- 9 *The British Isles* 102
 1. "Preglacial" deposits 102
 2. Post-Cromerian deposits 112
- 10 *The Lower Rhine area* 121
 1. Rhine terraces and evidence of glaciation 121
 2. Stratigraphy 129
- 11 *Supplementary notes on the European Early Pleistocene* 146
 1. Deposits of particular interest for the history of vegetation 146
 2. Deposits of particular interest for the history of mammals 154
- 12 *The Middle and early Late Pleistocene evolution in Europe* 161
 1. The basis of the Quaternary in northern Germany 161
 2. The North European system of glacials and interglacials 161
 3. The Middle and early Late Pleistocene glaciations in the North European glaciated area 168
 - The Elster Glaciation (Elster Complex) 172
 - The Saale Glaciation 173

4. Middle and Late Pleistocene temperate stages (true interglacials) in the North European glaciated area and their vegetation development 178
 - “The Cromer Complex” 184
 - The Holstein Interglacial 190
 - The Eem Interglacial 197
 5. Marine interglacial deposits 205
 6. Eolian deposits 212
 7. Fluvial deposits 219
 8. Mammalian faunas 222
 - Early Middle Pleistocene 223
 - Late Middle Pleistocene 229
 - Early Late Pleistocene 230
 9. Human fossils 233
 10. Cultural stages 237
- 13 *The Last Glacial Stage in Europe* 241
1. Extension, deposits, and deglaciation of the last North European ice sheet 241
 2. Stadials and interstadials of Weichsel age in the North European glaciated area 252
 - Studies based on the development of glaciation and vegetation 252
 - a) Early and high-glacial Weichselian 252
 - b) Late-glacial Weichselian 264
 - Studies based on insect faunas 268
 - Problematic interstadials 270
 3. Deposits, vegetation, and climate of the periglacial area 271
 4. Stratigraphy of the loess deposits 274
 5. The mammalian fauna 278
 6. Fossil man 290
 7. Cultural stages 296
 - Mousterian 296
 - Upper Palaeolithic 298
 - The Palaeolithic/Mesolithic boundary 310
- Correlation chart for the European Quaternary 308–309
- 14 *Asia* 311
1. Glaciated areas 311
 2. Loess areas and development of the vegetation in North and East Asia 317
 3. Pluvial and interpluvial stages in arid areas 318
 4. The marine development 320
 5. Mammalian faunas and stratigraphy, human evolution 321
 - North and West Asia 322
 - India 325
 - Java 327
 - China 331
 - Japan 336
- 15 *Africa* 339
1. Climatic fluctuations 339
 2. Marine development 346
 3. Mammalian faunas and faunal stratigraphy 348
 - Early Pleistocene 353
 - Middle Pleistocene 354
 - Late Pleistocene 355
 4. Human fossils, cultural stages 355
 - Australopithecines 355
 - Hominids of *erectus* type 359

Neanderthals and Neanderthaloids	360
Modern <i>sapiens</i> types	362
16 <i>North America</i>	365
1. Glaciated areas	365
2. Loess deposits	367
3. Glacials, interglacials, and interstadials	368
Greenland	369
Local mountain glaciations in the western United States	373
Main glaciated area and adjacent lowland regions	375
a) Nebraskan – Sangamon	378
b) Wisconsin Stage	380
Neoglacial features	391
4. Late Quaternary glacial lakes	393
5. Pluvial lakes	397
6. Fluvial and marine development	402
7. Mammal faunas	407
Blancan Mammal Age	410
Irvingtonian Mammal Age	411
Rancholabrean Mammal Age	411
8. Immigration of the American Indians	415
17 <i>South America</i>	418
1. The geological development	418
2. Mammalian faunas, human fossils	425
18 <i>Australia and Oceania</i>	430
1. Mainland Australia, New Guinea, Tasmania	430
2. New Zealand, South Sea Islands	435
19 <i>Antarctica</i>	441
20 <i>The oceans</i>	444
1. Sampling methods, sediments, processes	444
2. Fossil content, stratigraphy, dating, isotopic composition, palaeotemperatures	447
Tropical and temperate seas	447
Polar and subpolar seas	460
3. The Pliocene-Pleistocene boundary in marine deposits	463
21 <i>Systematic review of Quaternary mammals</i>	469
22 <i>Outline of the cultural development</i>	504
23 <i>Causal problems and ice-age theories</i>	516
1. Theories concerned with variations in the admission of solar energy	516
2. Theories based on physico-geographical changes	521
Appendix 1. <i>The Holocene link to the present</i>	526
Appendix 2. <i>Stratigraphic terminology</i>	530
Appendix 3. <i>The biogeographical subdivision of the earth</i>	533
Appendix 4. <i>Classification of vascular plants</i>	535
<i>References</i>	540
<i>Acknowledgements</i>	621
<i>Index</i>	622