

Contents

Preface.....	III
1. Introduction and Overview	1
<i>Georg Kleinschmidt</i>	
1.1. Introduction	1
1.1.1. Antarctica: definitions, topographic and geographic outline	1
1.1.2. Previous appropriate books.....	3
1.1.3. The book's main concept	3
1.2. Geological Overview	4
1.2.1. The Antarctic cratons	6
1.2.1.1. The Grunehogna Craton.....	6
1.2.1.2. The Napier Craton	7
1.2.1.3. The Mawson Craton.....	7
1.2.1.4. The Crohn Craton ($\approx$ Ruker Craton).....	7
1.2.1.5. Other Cratons of East Antarctica	7
1.2.2. Grenvillian Orogens	8
1.2.3. Pan-African Orogens	9
1.2.3.1. The Ross Orogen	9
1.2.3.2. Other Pan-African Orogens	10
1.2.4. The lifetime of Gondwana	11
1.2.5. The disintegration of Gondwana	11
1.2.6. The Ellsworth Orogen = Weddell Orogen	12
1.2.7. The Antarctic Andean Orogen	13
1.2.7.1. The active part of the Antarctic Andean Orogen	14
1.2.8. Large fault systems	15
1.2.9. The present plate-tectonic situation of Antarctica	16
1.2.10. Appended paragraph on Antarctic meteorites	17
2. Antarctic Peninsula – Geology and Dynamic Development.....	18
<i>John L. Smellie</i>	
2.1. Introduction	18
2.2. The Antarctic Peninsula: Physiography, Climate and Ice Cover	18
2.3. Tectonic Setting	20
2.4. Pre-Middle Jurassic: Gondwana Margin “Basement”	22
2.4.1. Palaeozoic gneissic basement	25
2.4.2. Devonian(?) craton and passive margin sedimentation [Fitzgerald quartzite beds]	28
2.4.3. Permian sedimentation and transition to a subduction plate margin [Erehwon beds]	30
2.4.4. Permian–Triassic deep-sea fan sedimentation at a passive margin evolving to subducting margin [Trinity Peninsula Group and correlatives]	30

2.4.5.	Pre-Jurassic deposition and accretion [Scotia Metamorphic Complex (Terrane B)]	35
2.5.	Jurassic–Early Cretaceous: Gondwana Break-up Sequences	36
2.5.1.	Jurassic terrestrial sedimentation in grabens [Botany Bay Group]	36
2.5.2.	Jurassic large-volume plume-related bimodal volcanism [Palmer Land Volcanic Group and Graham Land Volcanic Group]	38
2.5.3.	Jurassic–Early Cretaceous basin sedimentation linked to Weddell Sea formation [Latady Basin]	40
2.6.	Cretaceous–Palaeogene “Andean” Arc–Trench System and Early Glacial Stages	42
2.6.1.	Jurassic–Cenozoic accretion [LeMay Group and Scotia Metamorphic Complex (Terrane A)]	42
2.6.2.	Jurassic–Cretaceous fore-arc basin sedimentation [Fossil Bluff Group and correlatives]	45
2.6.3.	Subduction-related Cretaceous–Cenozoic magmatism [Antarctic Peninsula Volcanic Group, Alexander Island Volcanic Group, Antarctic Peninsula batholith]	51
2.6.4.	Cretaceous–Cenozoic intra-arc sedimentation and earliest glaciation	60
2.6.5.	Cretaceous–Palaeogene back-arc deposition and basin inversion [Larsen Basin]	63
2.7.	Late Neogene–Present: Post-subduction Magmatism and Main Glacial Stage	73
2.7.1.	Neogene–Quaternary marine record	73
2.7.2.	Neogene–Quaternary terrestrial volcanism and sedimentation [James Ross Island Volcanic Group; Hobbs Glacier, Cockburn Island and Mendel formations]	76
2.7.3.	A Quaternary marginal basin [Bransfield Strait volcanism]	79
2.8.	Summary: Antarctic Peninsula – Dynamic Development of a Long-lived Continental Margin	80
3.	The Geology of West Antarctica	87

Christine Siddoway

3.1.	Overview	87
3.2.	Ellsworth–Whitmore Mountains Terrane	90
3.3.	Marie Byrd Land	94
3.3.1.	Ross Province	97
3.3.2.	Amundsen Province	102
3.3.3.	Fosdick Mountains migmatite-granite complex and gneiss dome	104
3.4.	Thurston Island/Eights Coast	107
3.5.	West Antarctic Rift Province	108
3.5.1.	Character of crust and lithosphere	109
3.5.2.	Bedrock structures’ influence upon ice–ocean dynamics	112
3.6.	Tectonic Evolution and Timing of the WARS	112
3.6.1.	Relationship between the Transantarctic Mountains and West Antarctic rift system	112
3.6.2.	Mesozoic development	115

3.6.3.	The Cenozoic: tectonic sedimentation, structural reactivation, seismicity	118
3.6.4.	Characteristics and origin of the Marie Byrd Land volcanic province	122
3.6.5.	Paleotopography and landscape rejuvenation	128
3.7.	Conclusion	131
4.	The Geology of the Transantarctic Mountains	132

John W. Goodge

4.1.	Overview	132
4.1.1.	Physiography	134
4.1.2.	History of geologic exploration	137
4.2.	Stratigraphy and Geological Evolution	138
4.2.1.	Precambrian basement	141
4.2.2.	Neoproterozoic rift-margin successions	149
4.2.3.	Early Paleozoic successions	156
4.2.4.	Cambro-Ordovician granite batholith	165
4.2.5.	Devonian magmatism	168
4.2.6.	Paleozoic-Mesozoic Beacon Supergroup	168
4.2.7.	Jurassic Ferrar magmas (Ferrar Group and Kirkpatrick Basalt) ...	176
4.2.8.	Neogene Volcanic province	180
4.2.9.	Neogene Glacial deposits and landscape	183
4.3.	Geological Architecture/Structure	186
4.3.1.	Crustal structure of Precambrian basement	186
4.3.2.	Neoproterozoic rift margin	187
4.3.3.	Active Ross margin of Gondwana	189
4.3.3.1.	Northern Victoria Land	190
4.3.3.2.	Southern Victoria Land	191
4.3.3.3.	Central TAM	191
4.3.3.4.	Southern TAM	193
4.3.3.5.	Ross deformation	193
4.3.3.6.	Ross magmatism	199
4.3.3.7.	Ross metamorphism	201
4.3.3.8.	Tectonic models for the Ross Orogen	206
4.3.4.	Cenozoic uplift of the Transantarctic Mountains front and West Antarctic rift system	211
4.4.	Summery and Future of Geologic Research	216
5.	The Shackleton Range and Surroundings	218

Georg Kleinschmidt

5.1.	General Introduction	218
5.1.1.	Topography	218
5.1.2.	History	221
5.2.	Shackleton Range	222
5.2.1.	Geological overview	222
5.2.2.	Unit I "Autochthon"	225
5.2.3.	Unit II "Mount Wegener Nappe"	227
5.2.4.	Unit III "Fuchs Dome Nappe"	229

5.2.5.	Windows	234
5.2.6.	Unit IV (Ophiolite Complex)	235
5.2.7.	Unit V (Högbom Nappe)	238
5.2.8.	Middle Cambrian trilobite shales	239
5.2.9.	Molasse (Blaiklock Glacier Group)	240
5.2.10.	The “Kukri Peneplain”	241
5.2.11.	Permo-Carboniferous (Beacon Supergroup) and hanging beds	242
5.2.12.	Mafic dykes	243
5.2.13.	Major faults	243
5.2.14.	Mesozoic evolution of the Shackleton Range (Vanished Mesozoic basins).....	245
5.2.15.	Meteorite “Mt. Wegener”	246
5.3.	Theron Mountains	246
5.4.	Whichaway Nunataks	248
5.5.	Bertrab, Littlewood, Moltke Nunataks	248
5.6.	Relationship of the Shackleton Range and its further Surroundings	251
6.	Geology and Geodynamic Evolution of Dronning Maud Land, East Antarctica	254
<i>Andreas Läufer</i>		
6.1.	Introduction	254
6.2.	Early Exploration	256
6.3.	Regional Geology	257
6.3.1.	Western Dronning Maud Land	257
6.3.1.1.	The Grunehogna Craton.....	257
6.3.1.2.	The Maud Belt	259
6.3.2.	Central Dronning Maud Land	264
6.3.3.	Eastern Dronning Maud Land	279
6.4.	Geodynamic Evolution: A Synthesis	285
6.4.1.	The Grunehogna Craton	286
6.4.2.	The Grenville Orogen and Rodinia: The Maud Belt	287
6.4.3.	From Rodinia to Gondwana: orogenic quiescence or continued tectonism? The post-Rodinia rift and drift stage	288
6.4.4.	The Pan-African Orogen and the amalgamation of the Gondwana supercontinent: The East African-Antarctic Orogen (or: Lützow Holm Belt) and the Kuunga Orogen	289
6.4.5.	The break-up of Gondwana, formation of the Antarctic passive continental margin and landscape evolution	292
6.4.5.1.	The Karoo Plume and Karoo volcanism.....	292
6.4.5.2.	Rift Structures: The Jutul-Penck-Graben.....	293
6.4.5.3.	Uplift and denudation history of Dronning Maud Land..	293
7.	Lambert Glacier Area (East Antarctica between 45° E and 85° E)	296
<i>A. Läufer, F. Lisker, N.W. Roland, G. Kleinschmidt</i>		
7.1.	General Introduction	296
7.1.1.	Geography	296
7.1.2.	Historic exploration	299
7.1.3.	Stations	300

7.2.	Geological Overview	300
7.3.	Cratonic Regions	303
7.3.1.	The Napier Craton	303
7.3.2.	Cratonic Parts of the Prince Charles Mountains	304
7.3.3.	Small cratons further east (Eastern Prydz Bay with Larseman Hills, Rauer Group, Vestfold Hills)	310
7.4.	Meso-Neoproterozoic (Grenvillian) Belts West of the Lambert Glacier: The Rayner Belt/Complex and the Fisher Complex	311
7.5.	Pan-African of the Prince Charles Mountains and Further East of the Lambert Glacier	313
7.6.	The Lambert Graben	315
7.6.1.	Palaeozoic and Mesozoic sedimentation within the Lambert Graben	315
7.6.2.	Phanerozoic tectonic evolution of the Lambert Graben	318
7.6.3.	Neogene landscape evolution	319
7.7.	The Great Enigma: the Gamburtsev Subglacial Mountains	319
8.	The Geology of East Antarctica (between ~85° E and ~145° E)	322
<i>René-Pierre Menot</i>		
8.1.	Overview	322
8.2.	Geology of the Different Domains	324
8.2.1.	Kaiser-Wilhelm-II.-Land – Queen Mary Land – Princess Elizabeth Land	324
8.2.1.1.	Geology, Lithology, Geochemistry	324
8.2.1.2.	Structures, Deformation and Metamorphism.....	332
8.2.1.3.	Geochronology (Table 8-1).....	332
8.2.1.4.	Geological Evolution and Interpretation.....	333
8.2.2.	Wilkes Land	334
8.2.2.1.	Geology, Lithology, Geochemistry	337
8.2.2.2.	Structures, Deformation and Metamorphism.....	342
8.2.2.3.	Geochronology (Table 8-1).....	345
8.2.2.4.	Geological Evolution	349
8.2.3.	Terre Adélie – Western George V Land, i.e. the Terre Adélie Craton (TAC)	353
8.2.3.1.	Geology, Lithology, Geochemistry	357
8.2.3.2.	Structures, Deformation and Metamorphism.....	370
8.2.3.3.	Geochronology (Tables 8-1 and 8-2)	375
8.2.3.4.	Geological Evolution	382
8.3.	Geological Evolution of the Antarctic Australian Quadrant	387
8.3.1.	Accretion of the “East Antarctic Shield”	387
8.3.2.	Phanerozoic Evolution of the “East Antarctic Shield”, Australian Quadrant – Syn-Gondwana Evolution	390
8.3.2.1.	Palaeozoic – Mesozoic Rifts.....	390
8.3.2.2.	Sedimentary Cover and Basins.....	391
8.3.2.3.	Giant Meteorite Impact.....	391
8.3.3.	Australia – Antarctica Separation	392

9. The Mineral Resources of the Antarctic: Facts and Problems 393

Norbert W. Roland

9.1.	Introduction.....	393
9.2.	Politics Influence on the Development and Economic Exploitation of Antarctica	394
9.3.	Arguments in Favour of the “Treasure House” Antarctica	396
9.4.	Prospective Areas seen in the Gondwana Context	397
9.4.1.	The Antarctic Peninsula and the South American Andes.....	397
9.4.2.	The Weddell Sea Coast and Southeast Africa.....	399
9.4.3.	East Antarctica and the Indian Subcontinent	400
9.4.4.	East Antarctica and South-West Australia	401
9.4.5.	Areas prospective for hydrocarbons	402
9.4.6.	Prospective areas for polymetallic nodules and crusts	404
9.4.7.	Areas prospective for diamonds.....	405
9.5.	The Mineral Deposits of Antarctica.....	406
9.5.1.	Coal.....	406
9.5.2.	Iron ore.....	408
9.5.3.	Platinum, nickel, copper and other metals from the Dufek Intrusion	409
9.5.4.	Base metals and precious metals of the Antarctic Peninsula	412
9.5.5.	Uranium	417
9.5.6.	Icebergs	417
9.6.	Arguments in Favour for the “Frozen Account” Antarctica	420
9.6.1.	Accessibility	420
9.6.2.	Difficulties in exploration	422
9.6.3.	Types of deposits unlikely in Antarctica	422
9.6.4.	Aspects of mining economics	423
9.7.	Summary and Outlook	424

10. The Palaeontological Record of Antarctica 426

Michael R.A. Thomson

10.1.	Introduction	426
10.1.1.	How representative is the fossil record of Antarctica?	427
10.2.	Late Precambrian and Eocambrian.....	429
10.3.	Cambrian.....	431
10.4.	Ordovician and Silurian	434
10.5.	Devonian.....	436
10.5.1.	Invertebrate faunas and trace fossil assemblages.....	436
10.5.2.	Early floras.....	438
10.5.3.	Vertebrates – fish faunas	439
10.6.	Carboniferous	439
10.7.	Permian	441
10.7.1.	Invertebrates – the few.....	442
10.7.2.	<i>Glossopteris</i> floras	442
10.8.	Triassic	444
10.8.1.	Invertebrate faunas and trace fossil assemblages.....	444
10.8.2.	Floras – all change	445
10.8.3.	Gondwana amphibians and reptiles	447

	Contents	XI
10.9. Jurassic.....		448
10.9.1. Invertebrate faunas of land and sea.....		449
10.9.2. Floras		452
10.9.3. Vertebrate faunas – fish and dinosaurs.....		454
10.10. Cretaceous		455
10.10.1. Invertebrates – a rich variety.....		456
10.10.2. Floras – the angiosperms appear		459
10.10.3. Vertebrates –dinosaurs and more		463
10.11. Palaeogene		465
10.11.1. Invertebrates – after the KT event		467
10.11.2. Floras – angiosperms everywhere.....		470
10.11.3. Vertebrates – something of everything		472
10.12. Neogene		474
10.12.1. Invertebrates – scallops abound.....		475
10.12.2. Flora – struggling with the climate		477
10.12.3. Vertebrates – the first whales		479
10.13. Benath the Ice		479
10.13.1. Glacial erratics on land		479
10.13.2. New exposures resulting from ice retreat		480
10.13.3. Reworked clasts and fossils within in situ strata		480
10.13.4. Marine dredge samples and shallow cores.....		481
10.13.5. ‘Deep’ drilling.....		483
10.13.6. Biology in the rear-view mirror		484
References		485
Index		597