# Contents

Part 3' Changing disclers and their sole in earth surface evolution.

16 Impact of mineral surface area on solute fluxes at Bench Glacier, Alaska

With Glacial chemical weather and strange and from and bland b

Part 2 Gladiers, Oceans, athosphere at

Chris R. Stokes and Chris D. Clark

C. F. Michael Lewis and James T. Teller

John T. Andrews

The subpolar glacter landsystem

List of contributors

# Glacier science and environmental change: introduction Peter G. Knight

#### Glaciers and their coupling with hydraulic and sedimentary processes Part 1

- Keynote introduction: Glaciers and their coupling with hydraulic and sedimentary processes Geoffrey S. Boulton
- Haut Glacier d'Arolla, Switzerland: hydrological controls on basal sediment evacuation and glacial erosion 3 Darrel A. Swift
- A glimpse at meltwater effects associated with continental ice sheets 4 John Shaw
- The erosional origin of hummocky terrain, Alberta, Canada Mandy J. Munro-Stasiuk and Darren Sjogren

25

33

37

39

42

46

50

2

xi

- Tunnel channel character and evolution in central southern Ontario Tracy A. Brennand, Hazen A. J. Russell and David R. Sharpe
- Glacial bedforms and the role of subglacial meltwater: Annandale, southern Scotland Tom Bradwell
- Subglacial megafloods: outrageous hypothesis or just outrageous? Douglas I. Benn and David J. A. Evans
- Reply to Benn and Evans John Shaw and Mandy Munro-Stasiuk
- Groundwater under ice sheets and glaciers 9 Jan A. Piotrowski
- Groundwater flow under the margin of the last Scandinavian ice sheet around the Eckernförde Bay, northwest Germany 60 10 Silke Marczinek and Jan A. Piotrowski
- Simulation of groundwater flow and subglacial hydrology, Late Pleistocene Lake Michigan Lobe, Laurentide Ice Sheet 63 Chris Breemer

## Modelling impact of glacier-permafrost interaction on subglacial water flow Paul M. Cutler

Pleistocene hydrogeology of the Atlantic continental shelf, New England 13 Mark Person



- vi Contents
- 14 Glacial chemical weathering, runoff composition and solute fluxes Martyn Tranter
- 15 Solute enhancement in the proglacial zone J. L. Wadham
- 16 Impact of mineral surface area on solute fluxes at Bench Glacier, Alaska Suzanne Prestrud Anderson
- 17 Phosphorus in glacial meltwaters Andy Hodson
- 18 Glacial landsystems David J. A. Evans
- 19 The subpolar glacier landsystem of the Canadian High Arctic Colm Ó Cofaigh
- 20 Plateau icefield landsystem Brice R. Rea

### Part 2 Glaciers, oceans, atmosphere and climate

- 21 Keynote introduction: Glaciers, oceans, atmosphere and climate John T. Andrews
- 22 A multidisciplined approach to the reconstruction of the Late Weichselian deglaciation of Iceland Alun Hubbard
- 23 The cryosphere and climate change: perspectives on the Arctic's shrinking sea-ice cover Mark C. Serreze and Ignatius Rigor
- 24 The interaction of glaciers and oceans in the context of changing climate *Gerard Bond*
- 25 Northern Hemisphere glaciers responding to climate warming by increasing their sensitivity and their contribution to sea-level rise

135

136

138

71

75

79

81

83

89

91

95

96

114

120

126

- Mark Dyurgerov
- 26 Influence of ice streaming on the ocean-climate system: examining the impact of the M'Clintock Channel Ice Stream, Canadian Arctic Archipelago Chris R. Stokes and Chris D. Clark
- 27 Influence of ocean warming on glaciers and ice streams Eric Rignot
- 28 Glacial runoff from North America and its possible impact on oceans and climate C. F. Michael Lewis and James T. Teller
- 29 Impacts of climatic trends upon groundwater resources, aquifer-stream interactions and aquatic habitat in glacierized watersheds, Yukon Territory, Canada Sean W. Fleming
- 30 Ice sheets and marine sedimentation on high-latitude continental margins Julian A. Dowdeswell
- 31 Seismic geomorphology and Pleistocene ice limits off northwest Britain Martin S. Stoker, David Long, Joseph Bulat and Stephen Davison
- 32 Modelling glacier response to climate change

151

153

160

163

174

176

# Shawn J. Marshall

- 33 Energy and mass fluxes over dry snow surfaces *Richard Bintanja*
- 34 Energy fluxes over Morteratschgletscher Lisette Klok

- The environmental significance of deuterium excess in meteoric and non-meteoric Antarctic ice 179 35 R. Souchez and R. Lorrain Deuterium excess in Antarctica: a review 184 36 2 G. Hoffmann and F. Vimeux 57 Manifestations of the microphysical processes at the scale of whole icc sheets endar sor directs through himse Changing glaciers and their role in earth surface evolution 187 Part 3 Keynote introduction: Changing glaciers and their role in earth surface evolution 188 37 David Sugden Reconstruction of paleo-ice sheets-inversion of their glacial geomorphological record 192 38 Johan Kleman, Clas Hättestrand, Arjen P. Stroeven, Krister N. Jansson, Hernán De Angelis and Ingmar Borgström
- 39 Reconstructing the pattern and style of deglaciation of Kola Peninsula, northeastern Fennoscandian Ice Sheet Clas Hättestrand and Chris D. Clark
- The Laurentide Ice Sheet: a review of history and processes 40 John T. Andrews
- What can the 'footprint' of a palaeo-ice stream tell us? Interpreting the bed of the Dubawnt Lake Ice Stream, Northern 41 Keewatin, Canada
- Chris R. Stokes and Chris D. Clark
- The Antarctic Ice Sheet 42 David G. Vaughan
- Antarctic Ice Sheet reconstruction using cosmic-ray-produced nuclides 43 Greg Balco, Seth Cowdery, Claire Todd and John O. H. Stone secres of result ministra at an Archic s.
- Current status and recent changes of the Greenland Ice Sheet 44 Niels Reeh
- The impact of ice-sheet fluctuations and isostasy on sea-level change around Greenland 45 Kevin Fleming
- The response of glaciers in South America to environmental change 46

239

242

246

248

264

266

199

201

208

209

221

224

228

() Joseff i Tebre Student Student () Straight i Destal ()

Sorehole-based subglacial instrumentation .

275

# Renji Naruse

- Glacier mass-balance data for southern South America (30°S-56°S) 47 G. Casassa, A. Rivera and M. Schwikowski
- Quantifying the significance of recent glacier recession in the Cordillera Blanca, Perú: a case study of hydrological 48 impact and climatic control Bryan G. Mark
- Glacier variations in central Chile (32°S–41°S) 49 A. Rivera, C. Acuña and G. Casassa
- Palaeoglaciology of the last British-Irish ice sheet: challenges and some recent developments 50 Chris D. Clark, Sarah L. Greenwood and David J. A. Evans
- A regional glacial readvance in Ireland: self-promulgating theory, or science-based reality? 51 Robert T. Meehan
- Average glacial conditions and the landscape of Snowdonia 52 Danny McCarroll
- Mountain glaciers 53 Georg Kaser

268

272

- The Little Ice Age glacial record at Franz Josef Glacier, New Zealand 54 Krista M. McKinzey
- Changing glaciers in High Asia 55 Yao Tandong, Pu Jianchen and Liu Shiying

#### viii Contents

#### Glacier composition, mechanics and dynamics Part 4

- Keynote introduction: Glacier composition, mechanics and dynamics 56 T. H. Jacka
- Manifestations of ice microphysical processes at the scale of whole ice sheets 57 K. M. Cuffey
- Ice flow at low deviatoric stress: Siple Dome, West Antarctica 58 Erin C. Pettit
- Physical deformation modes of ice in glaciers and ice sheets 59 Paul Duval and Maurine Montagnat
- Superplastic flow of ice relevant to glacier and ice-sheet mechanics 60 David L. Goldsby
- Anisotropy and flow of ice 315 61 Throstur Thorsteinsson 317 Ductile crevassing 62 The Laurentide Ice Sheet: a review of history and processes Antoine Pralong Environmental conditions, ice facies and glacier behaviour 319 63 Wendy Lawson The behaviour of glaciers on frozen beds: modern and Pleistocene examples 326 64 Richard I. Waller and Julian B. Murton Mechanical behaviour and structure of the debris-rich basal ice layer 329 65 Sean Fitzsimons 43 - Ameandre Inst Sheen High-resolution time series of basal motion at an Arctic glacier margin 335 66 David Chandler On the relationships between field data and numerical models of ice-mass motion 338 67 Bryn Hubbard Measurements and modelling of diurnal flow variations in a temperate valley glacier 345 68

308

283

284

290

300

303

- Shin Sugiyama
- Using field data to constrain ice-flow models: a study of a small alpine glacier 69 Alun Hubbard
- Fast glacier flow and ice streaming 70 Slawek Tulaczyk
- Regional basal-thermal budget: implications for ice streaming along the Siple Coast, West Antarctica 71 Byron R. Parizek

#### The practice of glaciology Part 5

- Keynote introduction: The practice of glaciology 72 Richard B. Alley and Sridhar Anandakrishnan
- Remote sensing in glaciology 73 Jonathan Bamber
- Interferometric synthetic aperture radar (InSAR) study of the northeast Greenland Ice Stream 74 Ian Joughin
- An overview of subglacial bedforms in Ireland, mapped from digital elevation data 75

364

348

353

360

383

384

387

394

Changing Slaciers in Figh Asia

The Little fee Age glacial record at Franz Josef Clacier, New Zenland

Mike J. Smith, Paul Dunlop and Chris D. Clark

Borehole-based subglacial instrumentation 76 Urs H. Fischer and Bryn P. Hubbard

Instrumenting thick, active, clast-rich till 77 W. D. Harrison and M. Truffer

		Contents	1X
78	Ice-core chronology Claus U. Hammer		396
79	The 420,000-yr climate record from the Vostok ice core Jean Robert Petit		403
80	Numerical modelling of polar ice sheets through time Philippe Huybrechts		406
81	Ice-flow models Anthony J. Payne and Andreas Vieli		413
82	Estimating basal properties of glaciers from surface measurements G. Hilmar Gudmundsson		415
83	Measuring and modelling the mass balance of glaciers for global change Roger I. Braithwaite		418

- Integrated perception of glacier changes: a challenge of historical dimensions 84 Wilfried Haeberli
- The Global Land-ice Measurements from Space (GLIMS) project 85 A. Kääb
- Historical glacier fluctuations 86 Frank Paul and Max Maisch
- Interpreting glacial sediments 87 Doug Benn
- Moraine sediment characteristics as indicators of former basal ice layers 88 William George Adam
- Using cosmogenic isotopes to interpret the landscape record of glaciation: nunataks in Newfoundland? 89 J. C. Gosse, T. Bell, J. T. Gray, J. Klein, G. Yang and R. Finkel
- Characteristic cosmogenic nuclide concentrations in relict surfaces of formerly glaciated regions 90 Arjen P. Stroeven, Jon Harbor, Derek Fabel, Johan Kleman, Clas Hättestrand, David Elmore and David Fink

430

432

434

439

442

447

- Laboratory experiments in glaciology 91 Neal R. Iverson
- Laboratory observations of ice formation and debris entrainment by freezing turbid supercooled water 92 Peter G. Knight and Debbie Knight

the second Sprice Sciences. Uningerality of Woolding and All. References

Index entreplucal Sciences University of Bristol, University to

Colour plate section falls between pp. 274 and 275.

456 459 517 K. M. Culley Department of Geography, University of Califor

Cambridge CB2 1ER, U.S. 1.1

Edinburgh EH9 AW, LDC.