

Antarctic Palaeoenvironments and Earth-Surface Processes

Edited by

**M. J. Hambrey, P. F. Barker, P. J. Barrett, V. Bowman,
B. Davies, J. L. Smellie and M. Tranter**



Geological Society
Special Publication 381



Antarctic Palaeoenvironments and Earth-Surface Processes

The Geological Society of London
Books Editorial Committee

Chief Editor

RICK LAW (USA)

Society Books Editors

JIM GRIFFITHS (UK)

DAVE HODGSON (UK)

HOWARD JOHNSON (UK)

PHIL LEAT (UK)

DANIELA SCHMIDT (UK)

RANDELL STEPHENSON (UK)

ROB STRACHAN (UK)

MARK WHITEMAN (UK)

Society Books Advisors

GHULAM BHAT (India)

MARIE-FRANÇOISE BRUNET (France)

JAMES GOFF (Australia)

MARIO PARISE (Italy)

SATISH-KUMAR (Japan)

MARCO VECOLI (Saudi Arabia)

GONZALO VEIGA (Argentina)

MAARTEN DE WIT (South Africa)

SCAR/GSL publishing agreement

This volume is published under an agreement between the Scientific Committee on Antarctic Research and the Geological Society of London and arises from the 11th International Symposium on Antarctic Earth Sciences (ISAES) held in Edinburgh, Scotland, 10–16 July 2011.

GSL is the publisher of choice for books related to SCAR's geoscience activities, and SCAR receives a fee for all books published under this agreement.

Books published under this agreement are subject to the Society's standard rigorous proposal and manuscript review procedures.

It is recommended that reference to all or part of this book should be made in one of the following ways:

HAMBREY, M. J., BARKER, P. F., BARRETT, P. J., BOWMAN, V., DAVIES, B., SMELLIE, J. L. & TRANTER, M. (eds) 2013. *Antarctic Palaeoenvironments and Earth-Surface Processes*. Geological Society, London, Special Publications, **381**.

FOLEY, D. J., STUMP, E., VAN SOEST, M., WHIPPLE, K. X. & HODGES, K. V. 2013. Differential Movement across Byrd Glacier, Antarctica, as indicated by Apatite (U–Th)/He thermochronology and geomorphological analysis. In: HAMBREY, M. J., BARKER, P. F., BARRETT, P. J., BOWMAN, V., DAVIES, B., SMELLIE, J. L. & TRANTER, M. (eds) *Antarctic Palaeoenvironments and Earth-Surface Processes*. Geological Society, London, Special Publications, **381**, 39–46. First published online August 6, 2013, <http://dx.doi.org/10.1144/SP381.25>

GEOLOGICAL SOCIETY SPECIAL PUBLICATION NO. 381

Antarctic Palaeoenvironments and Earth-Surface Processes

EDITED BY

M. J. HAMBREY

Aberystwyth University, Wales

P. F. BARKER

British Antarctic Survey, UK

P. J. BARRETT

Victoria University of Wellington, New Zealand

V. BOWMAN

University of Leeds, UK

B. DAVIES

Aberystwyth University, Wales

J. L. SMELLIE

University of Leicester, UK

and

M. TRANTER

University of Bristol, UK

2013

Published by
The Geological Society
London

THE GEOLOGICAL SOCIETY

The Geological Society of London (GSL) was founded in 1807. It is the oldest national geological society in the world and the largest in Europe. It was incorporated under Royal Charter in 1825 and is Registered Charity 210161.

The Society is the UK national learned and professional society for geology with a worldwide Fellowship (FGS) of over 10 000. The Society has the power to confer Chartered status on suitably qualified Fellows, and about 2000 of the Fellowship carry the title (CGeol). Chartered Geologists may also obtain the equivalent European title, European Geologist (EurGeol). One fifth of the Society's fellowship resides outside the UK. To find out more about the Society, log on to www.geolsoc.org.uk.

The Geological Society Publishing House (Bath, UK) produces the Society's international journals and books, and acts as European distributor for selected publications of the American Association of Petroleum Geologists (AAPG), the Indonesian Petroleum Association (IPA), the Geological Society of America (GSA), the Society for Sedimentary Geology (SEPM) and the Geologists' Association (GA). Joint marketing agreements ensure that GSL Fellows may purchase these societies' publications at a discount. The Society's online bookshop (accessible from www.geolsoc.org.uk) offers secure book purchasing with your credit or debit card.

To find out about joining the Society and benefiting from substantial discounts on publications of GSL and other societies worldwide, consult www.geolsoc.org.uk, or contact the Fellowship Department at: The Geological Society, Burlington House, Piccadilly, London W1J 0BG: Tel. +44 (0)20 7434 9944; Fax +44 (0)20 7439 8975; E-mail: enquiries@geolsoc.org.uk.

For information about the Society's meetings, consult *Events* on www.geolsoc.org.uk. To find out more about the Society's Corporate Affiliates Scheme, write to enquiries@geolsoc.org.uk.

Published by The Geological Society from:

The Geological Society Publishing House, Unit 7, Brassmill Enterprise Centre, Brassmill Lane, Bath BA1 3JN, UK

The Lyell Collection: www.lyellcollection.org

Online bookshop: www.geolsoc.org.uk/bookshop

Orders: Tel. +44 (0)1225 445046, Fax +44 (0)1225 442836

The publishers make no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility for any errors or omissions that may be made.

© The Geological Society of London 2013. No reproduction, copy or transmission of all or part of this publication may be made without the prior written permission of the publisher. In the UK, users may clear copying permissions and make payment to The Copyright Licensing Agency Ltd, Saffron House, 6–10 Kirby Street, London EC1N 8TS UK, and in the USA to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, USA. Other countries may have a local reproduction rights agency for such payments. Full information on the Society's permissions policy can be found at: www.geolsoc.org.uk/permissions

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

ISBN 978-1-86239-363-9

ISSN 0305-8719

Distributors

For details of international agents and distributors see:

www.geolsoc.org.uk/agentsdistributors

Typeset by Techset Composition India (P) Ltd., Bangalore and Chennai, India.

Printed by Berforts Information Press Ltd, Oxford, UK

Contents

Introduction

HAMBREY, M. J. & DAVIES, B. J. Antarctic Palaeoenvironments and Earth-Surface Processes in context 1

A. Palaeozoic and Mesozoic evolution of the Antarctic Continent

ELLIOT, D. H. The geological and tectonic evolution of the Transantarctic Mountains: a review 7

FOLEY, D. J., STUMP, E., VAN SOEST, M., WHIPPLE, K. X. & HODGES, K. V. Differential Movement across Byrd Glacier, Antarctica, as indicated by Apatite (U–Th)/He thermochronology and geomorphological analysis 37

MAESTRO, A., LÓPEZ-MARTÍNEZ, J. & BOHOYO, F. Mesozoic to recent evolution of intraplate stress fields under multiple remote stresses: The case of Signy Island (South Orkney Microcontinent, Antarctica) 45

BRADSHAW, M. A. The Taylor Group (Beacon Supergroup): the Devonian sediments of Antarctica 67

REGUERO, M. A., TAMBUSI, C. P., CORIA, R. A. & MARENSSI, S. A. Late Cretaceous dinosaurs from the James Ross Basin, West Antarctica 99

SAUCEDE, T., PIERRAT, B., BRAYARD, A. & DAVID, B. Palaeobiogeography of Austral echinoid faunas: a first quantitative approach 117

B. Cenozoic glaciation and impacts

JADWISZCZAK, P. Taxonomic diversity of Eocene Antarctic penguins: a changing picture 129

BARKER, P. F., LAWVER, L. A. & LARTER, R. D. Heat-flow determinations of basement age in small oceanic basins of the southern central Scotia Sea 139

WHITE, D. A. Cenozoic landscape and ice drainage evolution in the Lambert Glacier–Amery Ice Shelf system 151

HALL, B. L., DENTON, G. H., STONE, J. O. & CONWAY, H. History of the grounded ice sheet in the Ross Sea sector of Antarctica during the Last Glacial Maximum and the last termination 167

STRAND, K., KÖYKKÄ, J. & LAMMINEN, J. Late Eocene Glaciofluvial to Glaciomarine transition in the Lambert Graben: constraints from lithofacies and mineralogy of ODP Site 1166 sediments, Prydz Bay, Antarctica 183

PEKAR, S. F., SPEECE, M. A., WILSON, G. S., SUNWALL, D. S. & TINTO, K. J. The Offshore New Harbour Project: deciphering the Middle Miocene through Late Eocene seismic stratigraphy of Offshore New Harbour, western Ross Sea, Antarctica 199

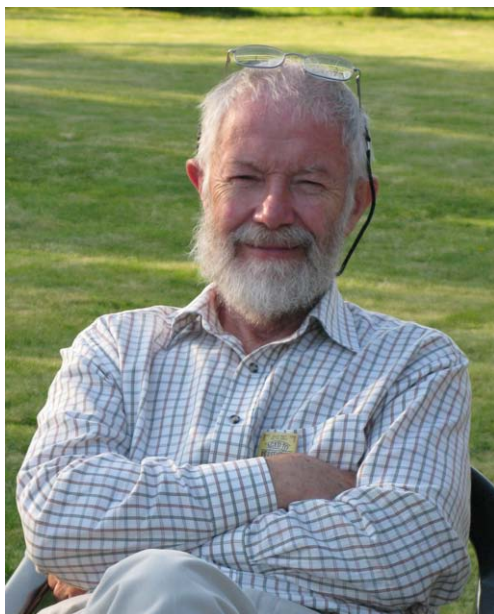
ANDERSON, J. B., KIRSHNER, A. E. & SIMMS, A. R. Constraints on Antarctic Ice Sheet configuration during and following the Last Glacial Maximum and its episodic contribution to sea-level rise 215

HOCHMUTH, K. & GOHL, K. Glaciomarine sedimentation dynamics of the Abbot glacial trough of the Amundsen Sea Embayment shelf, West Antarctica 233

SPRENK, D., WEBER, M. E., KUHN, G., ROSÉN, P., FRANK, M., MOLINA-KESCHER, M., LIEBETRAU, V. & RÖHLING, H.-G. Southern Ocean bioproductivity during the last glacial cycle – new detection method and decadal-scale insight from the Scotia Sea 245

VAUTRAVERS, M. J., HODELL, D. A., CHANNELL, J. E. T., HILLENBRAND, C.-D., HALL, M., SMITH, J. & LARTER, R. D. Palaeoenvironmental records from the West Antarctic Peninsula drift sediments over the last 75 ka	263
PANT, N. C., BISWAS, P., SHRIVASTAVA, P. K., BHATTACHARYA, S., VERMA, K., PANDEY, M. & IODP EXPEDITION 318 SCIENTIFIC PARTY. Provenance of Pleistocene sediments from Site U1359 of the Wilkes Land IODP Leg 318 – evidence for multiple sourcing from the East Antarctic Craton and Ross Orogen	277
C. Glacial and periglacial processes	
ATKINS, C. B. Geomorphological evidence of cold-based glacier activity in South Victoria Land, Antarctica	299
MARCHANT, D. R., MACKAY, S. L., LAMP, J. L., HAYDEN, A. T. & HEAD, J. W. A review of geomorphic processes and landforms in the Dry Valleys of southern Victoria Land: implications for evaluating climate change and ice-sheet stability	319
DAVIES, B. J., GLASSER, N. F., CARRIVICK, J. L., HAMBREY, M. J., SMELLIE, J. L. & NÝVLT, D. Landscape evolution and ice-sheet behaviour in a semi-arid polar environment: James Ross Island, NE Antarctic Peninsula	353
BALKS, M. R., LÓPEZ-MARTÍNEZ, J., GORYACHKIN, S. V., MERGELOV, N. S., SCHAEFER, C. E. G. R., SIMAS, F. N. B., ALMOND, P. C., CLARIDGE, G. G. C., McLEOD, M. & SCARROW, J. Windows on Antarctic soil–landscape relationships: comparison across selected regions of Antarctica	397
ASTHANA, R., SHRIVASTAVA, P. K., BEG, M. J., SWAIN, A. K., DHARWADKAR, A., ROY, S. K. & SRIVASTAVA, H. B. Sedimentary processes in two different polar periglacial environments: Examples from Schirmacher Oasis and Larsemann Hills, East Antarctica	411
HALL, K. Periglacial processes and landforms of the Antarctic: a review of recent studies and directions	429
KONFAL, S. A., WILSON, T. J. & HALL, B. L. Palaeoshoreline records of glacial isostatic adjustment in the Dry Valleys region, Antarctica	455
KANAO, M., MAGGI, A., ISHIHARA, Y., STUTZMANN, E., YAMAMOTO, M.-Y. & TOYOKUNI, G. Characteristic atmosphere–ocean–solid earth interactions in the Antarctic coastal and marine environment inferred from seismic and infrasound recording at Syowa Station, East Antarctica	469
MORA, C., VIEIRA, G. & RAMOS, M. Evaluation of Envisat ASAR IMP imagery for snow mapping at varying spatial resolution (Deception Island, South Shetlands – Antarctica)	481
Index	495

Peter Frank Barker (1939–2012)



Dr Peter Barker died on 25 June 2012, aged 73, in the midst of editing papers for this volume. During his research career at the University of Birmingham and the British Antarctic Survey he pioneered studies to unravel the tectonic and environmental history of the Southern Ocean. He took over the reins of the Antarctic Marine Group at Birmingham in 1965, when the plate tectonic revolution was still in its infancy, and was quick to recognize the opportunities the new paradigm presented. In addition to leading a series of research cruises on RRS *Shackleton* and RRS *Bransfield* that provided the foundations for understanding of the geological structure and tectonic evolution of the Scotia Sea region, Peter became deeply involved in scientific ocean drilling. During his career he was Co-Chief Scientist on four expeditions of the Deep Sea Drilling Project and Ocean Drilling Program that made fundamental contributions to our knowledge of the tectonic and environmental history of the

South Atlantic region and the Southern Ocean. In 1986, Peter was appointed as Head of the British Antarctic Survey Geophysics Division, and moved to Cambridge. During his first few years in Cambridge, he played an important part in specifying the scientific facilities on a new polar research vessel, RRS *James Clark Ross*, on which he went on to lead several cruises. Peter retired in 1999 and held an E-fellowship with British Antarctic Survey until 2005, when he and his wife Jenny moved to rural Shropshire. He remained active as a sea-going scientist in retirement and his final research cruise was as an invited participant in a cruise to the Scotia Sea on a US research vessel in 2008. An international symposium on Scotia Arc geology was held in Spain in May 2013 in Peter's honour.

Robert D. Larter
British Antarctic Survey