

Cambridge University Press

0521675561 - Reversals of the Earth's Magnetic Field, Second Edition

J. A. Jacobs

Frontmatter

[More information](#)

By measuring the direction and intensity of magnetism in rocks of different ages, a record of the Earth's magnetic field in the past can be obtained. This book deals with the particular case of reversals of the Earth's magnetic field. These have played a major role in the development of plate tectonics and in establishing a geological timescale. The magnetism of rocks is discussed in some detail, with a warning of possible misinterpretations of the record. The latest observational results and theories are reviewed, with special attention to the structure and geometry of the transition field.

Changing conditions at the core–mantle boundary, their effect on reversals, the generation of plumes and the possible correlation of reversals with tectonic changes, ice ages or mass extinctions are thoroughly discussed, including suggested periodicities in the reversal record and in other geophysical data.

Cambridge University Press

0521675561 - Reversals of the Earth's Magnetic Field, Second Edition

J. A. Jacobs

Frontmatter

[More information](#)

Reversals of the Earth's Magnetic Field

Cambridge University Press

0521675561 - Reversals of the Earth's Magnetic Field, Second Edition

J. A. Jacobs

Frontmatter

[More information](#)

Reversals of the Earth's Magnetic Field

Second Edition

J. A. Jacobs

*Institute of Earth Studies,
University of Wales, Aberystwyth*



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press
0521675561 - Reversals of the Earth's Magnetic Field, Second Edition
J. A. Jacobs
Frontmatter
[More information](#)

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

Cambridge University Press
The Edinburgh Building, Cambridge CB2 2RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521450720

First edition © Adam Hilger Ltd 1984
Second edition © Cambridge University Press 1994

This book is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without
the written permission of Cambridge University Press.

First published by Adam Hilger Ltd 1984
Second edition published by Cambridge University Press 1994
This digitally printed first paperback version 2005

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data

Jacobs, J. A. (John Arthur), 1916–
Reversals of earth's magnetic field / J. A. Jacobs – 2nd ed.
p. cm.
Includes bibliographical references and index.
ISBN 0 521 45072 1
1. Geomagnetism. I. Title.
QC815.2.J33 1994
538'.72 – dc20 93-50683 CIP

ISBN-13 978-0-521-45072-0 hardback
ISBN-10 0-521-45072-1 hardback

ISBN-13 978-0-521-67556-7 paperback
ISBN-10 0-521-67556-1 paperback

Contents

<i>Preface</i>	ix
1 The Earth's magnetic field	1
1.1 Introduction	1
1.2 Spherical harmonic analysis of the Earth's magnetic field	11
1.3 Origin of the Earth's magnetic field	28
1.4 Mean-field electrodynamics	33
2 The magnetization of rocks	35
2.1 Introduction	35
2.2 Processes of magnetization in rocks	38
2.3 Self-reversal	46
2.4 Field reversal or self-reversal?	54
3 The morphology of geomagnetic reversals	59
3.1 Introduction	59
3.2 Field intensity during a polarity transition	66
3.3 Field direction during a polarity transition	73
3.4 Changes in the mean frequency of reversals	79
4 Geomagnetic excursions	87
4.1 Introduction	87
4.2 The Laschamp excursion	90
4.3 The Lake Mungo excursion	94
4.4 The Mono Lake excursion	96
4.5 The Gothenburg 'flip'	103
4.6 The Blake event	107
4.7 Lake Biwa events	110
4.8 Other excursions and short period events	112
4.9 Further comments	120

viii	<i>Contents</i>	
5	Models for reversals	124
5.1	Introduction	124
5.2	The models of Cox and Parker	126
5.3	The disc dynamo	131
5.4	The flooding model of Hoffman	145
5.5	Olson's model	149
5.6	Williams and Fuller's model	154
5.7	Dynamo families	158
5.8	McFadden's and Merrill's models	160
5.9	Gubbins' model	164
5.10	Statistical analyses	165
6	Transition fields	179
6.1	Introduction	179
6.2	The Matuyama–Brunhes transition	187
6.3	The Olduvai transition	192
6.4	The Cobb Mountain transition	198
6.5	Longitudinal confinement of transitional VGPs	202
6.6	Clustering of VGPs	211
6.7	The Steens Mountain reversal	216
6.8	Other rapid reversals	222
7	Magnetostratigraphy	226
7.1	Introduction	226
7.2	Magnetostratigraphic polarity units	228
7.3	The polarity time scale	235
7.4	Isotopic dating of magnetic anomalies	236
7.5	The Cenozoic–late Cretaceous timescale (0–83 Ma)	245
7.6	The late Jurassic and early Cretaceous timescale (83 ~ 160 Ma)	252
7.7	Magnetostratigraphy in the Jurassic and earlier	254
8	The Earth's magnetic field and other geophysical phenomena	258
8.1	Introduction	258
8.2	The orbital climatic theory of Milankovitch	258
8.3	The Earth's magnetic field, reversals and climate	266
8.4	Reversals, impacts and mass extinctions	271
8.5	Reversals, plumes and tectonics	278
8.6	Magnetic reversals and faunal extinctions	289
	<i>References</i>	294
	<i>Index</i>	341

Cambridge University Press

0521675561 - Reversals of the Earth's Magnetic Field, Second Edition

J. A. Jacobs

Frontmatter

[More information](#)

Preface

This book was finished in June 1993, almost 11 years since the first edition of *Reversals of the Earth's Magnetic Field* was finished (published by Adam Hilger Ltd 1984). It has often been said that the typical doubling period for the accumulation of scientific knowledge during the last two centuries is about 15 years. This is certainly true for reversals of the Earth's magnetic field if we substitute data and theoretical modelling for scientific knowledge. We have accumulated a vastly increased amount of data, most of it with much greater precision. Our knowledge of the physics of the geodynamo has also been greatly expanded, but we still do not know the detailed mechanism of the generation of the field, and even less about the reversal process.

This book is an attempt to summarize the most important advances that have been made in the last decade. The general layout of the first edition has been preserved. The first chapter is a brief overview of the Earth's magnetic field and the second chapter discusses the magnetization of rocks. This chapter has been expanded and discusses some of the problems that have now been highlighted in the acquisition of natural remanent magnetization. Chapter 3 discusses in general terms the morphology of geomagnetic reversals and gives some of the early development of the subject. These three chapters lay the background for the next three chapters, which form the heart of the book. Chapter 4 deals with excursions of the magnetic field and chapter 5 with models and possible reversal mechanisms. Chapter 6 is a new chapter on transition fields, a topic that has attracted much attention in recent years and is still highly controversial. Chapter 7 (the old Chapter 6) deals with magnetostratigraphy and gives a much more detailed account of how a magnetic polarity timescale is constructed. Chapter 8 (the old Chapter 7) discusses the controversial question of possible correlations of the Earth's magnetic field with near-surface phenomena – climate, mass extinctions, tectonics, mantle plumes. As noted before, this is a highly speculative area, but nevertheless one of increasing popular appeal.

J. A. Jacobs