

TRANSACTIONS
OF
THE ROYAL SOCIETY
OF
EDINBURGH



EARTH SCIENCES

Volume 81 Part 1

PUBLISHED BY THE ROYAL SOCIETY OF EDINBURGH

22 GEORGE STREET · EDINBURGH · EH2 2PQ

1990

Editorial Board

E. N. K. CLARKSON
University of Edinburgh
(Chairman)

S. CRAMPIN
British Geological Survey

C. H. DONALDSON
University of St Andrews

A. L. HARRIS
University of Liverpool

B. HARTE
University of Edinburgh
(Executive Editor)

J. MCMANUS
University of St Andrews

C. D. WATERSTON
General Secretary
Royal Society of Edinburgh

R. MCQUILLIN
Britoil plc.

D. M. RAMSAY
University of Dundee

W. RITCHIE
University of Aberdeen
(Executive Editor)

E. K. WALTON
University of St Andrews

W. DUNCAN
Executive Secretary

Consulting Editors

SHOHEI BANNO
Kyoto University

W. L. BROWN
Centre de Recherches Pétrographiques et Géochimiques,
Vandoeuvre-les-Nancy

B. W. CHAPPELL
Australian National University, Canberra

J. M. COLEMAN
Louisiana State University, Baton Rouge

J. F. DEWEY
University of Oxford

D. G. GEE
Lunds Universitet

R. W. HUTCHINSON
Colorado School of Mines

E. JÄGER
Universität Bern

J. KONTA
Charles University, Prague

R. MACDONALD
University of Lancaster

D. B. MCINTYRE
Pomona College, Claremont

K. J. MÜLLER
Rhein. Friedrich-Wilhelms-Universität Bonn

D. F. STRONG
Memorial University, St Johns

V. C. THAKUR
Wadia Institute of Himalayan Geology

S. UYEDA
University of Tokyo

O. VAN BREEMEN
Geological Survey of Canada, Ottawa

R. WOODALL
Western Mining Co., Adelaide

Publications Manager, Royal Society of Edinburgh: T. Dart

COPYRIGHT: It is the policy of the Royal Society of Edinburgh not to charge any royalty for the production of a single copy of any one article made for private study or research. Specific permission will not be required for photocopying multiple copies of copyright material, to be used for *bona fide* educational purposes, provided this is done by a member of the staff of the university, school or other comparable institution, for distribution without profit to student members of that institution and provided the copies are made from the original journal. Requests for the copying or reprinting of any article for any other purpose should be sent to the Royal Society of Edinburgh.

Transactions of the Royal Society of Edinburgh: Earth Sciences is published quarterly by the Royal Society of Edinburgh. Subscription price is \$125 for four issues (1 volume), second class postage pending at Rahway, N.J., Postmaster send corrections to Transactions of the Royal Society of Edinburgh: Earth Sciences, c/o Mercury Airfreight International Ltd. Inc., 2323 Randolph Avenue, Avenel, New Jersey 07001, U.S.A.

© 1990 The Royal Society of Edinburgh and the authors of individual papers.