

Editors:

S. Bhattacharji, Brooklyn

G. M. Friedman, Brooklyn and Troy

H. J. Neugebauer, Bonn

A. Seilacher, Tuebingen



Norbert Clauer Sambhu Chaudhuri (Eds.)

# Isotopic Signatures and Sedimentary Records

With 151 Figures and 20 Tables

**Springer-Verlag**

Berlin Heidelberg New York

London Paris Tokyo

Hong Kong Barcelona

Budapest

## Editors

Norbert Clauer  
Centre de Géochimie de la Surface  
1, rue Blessig, 67084 Strasbourg, France

Sambhu Chaudhuri  
Kansas State University  
Manhattan, KS 66506, USA

"For all Lecture Notes in Earth Sciences published till now please see final page of the book"

ISBN 3-540-55828-4 Springer-Verlag Berlin Heidelberg New York  
ISBN 0-387-55828-4 Springer-Verlag New York Berlin Heidelberg

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

© Springer-Verlag Berlin Heidelberg 1992  
Printed in Germany

Typesetting: Camera ready by author  
Printing and binding: Druckhaus Beltz, Hemsbach/Bergstr.  
32/3140-543210 - Printed on acid-free paper

## PREFACE

The emergence of new information from drilling in deep-sea and coastal areas and the surfacing of the plate tectonics theory probably had the greatest impacts in recent decades on the highly accelerated growth of knowledge regarding the evolution of sediments and sedimentary rocks. Studies in recent years have also provided new insights on global sedimentary processes, and isotopic tools in many ways have enhanced our knowledge and have provided even an unexpected added dimension to the mechanisms of some specific processes. Many different uses of isotopic tools in studies of sedimentary processes can be found in the literature, but the information is highly scattered in the vast field of sedimentology. The disseminated state of existing isotopic knowledge on sedimentary systems has undoubtedly deprived many practitioners in the field to fully appreciate the benefits and limitations, and even the apparent confusion, concerning the use of isotopic tools. We have endeavored here to bring together discussions on some major sedimentary systems in the sedimentary cycle and to analyze them according to isotopic evidence. To accomplish such a task required contributions from many individuals. We were fortunate to have friends who accepted to share our goals. We most sincerely thank all the contributors to this book and deeply appreciate their patience and fortitude despite our undue demands on them to reach our objectives.

A collective effort like this one could not be accomplished within any predetermined date, because the contributors had many other professional goals and objectives which they also had to

meet. Consequently, some contributors submitted their articles earlier than others. This may be reflected in the omissions of some very recent works, but this should not be viewed as either the lack of awareness or the negligence on the part of the authors.

The news of the untimely death of our colleague and friend Douglas G. Brookins, Jr., an early explorer in the field of sedimentary isotope geochemistry, reached us in the midst of our work on this volume. Besides his unflagging enthusiasm in the works of others, he helped many to overcome the barriers of prejudice in their attempts to create a solid foundation for a professional career. Doug, consider this book a token of our appreciation for leaving us a legacy to build a truly multicultural professional world.

Sambhu Chaudhuri

Norbert Clauer

Strasbourg, January 1992

## CONTENTS

Introduction	1
Depositional and diagenetic history of limestones: Stable and radiogenic isotopes J. VEIZER	13
The dolomite problem: Stable and radiogenic isotope clues L.S. LAND	49
Isotope signatures in phosphate deposits: Formation and diagenetic history Y. KOLODNY and B. LUZ	69
Origin and diagenesis of cherts: An isotopic perspective L.P. KNAUTH	123
Stable isotope geochemistry of sulfate and chloride rocks W.T. HOLSER	153
History of marine evaporites: Constraints from radiogenic isotopes S. CHAUDHURI and N. CLAUSER	177
The stable isotope composition of sedimentary iron oxides with special reference to banded iron formations J. HOEFS	199
Isotopic records in detrital and authigenic feldspars in sedimentary rocks G. FAURE	215
Isotopic compositions of clay minerals as indicators of the timing and conditions of sedimentation and burial diagenesis N. CLAUSER, S.M. SAVIN and S. CHAUDHURI	239
Sm-Nd isotopes in fine-grained clastic sedimentary materials: clues to sedimentary processes and recycling growth of the continental crust S. CHAUDHURI, P. STILLE and N. CLAUSER	287

Depositional history of uranium ores: Isotopic constraints M. PAGEL	321
Indirect dating of sediment-hosted ore deposits: Promises and problems N. CLAUSER and S. CHAUDHURI	361
Neodymium, strontium, oxygen and hydrogen isotope compositions of waters in present and past oceans: A review P. STILLE, S. CHAUDHURI, Y.K. KHARAKA and N. CLAUSER	389
Stable isotope geochemistry and origin of waters in sedimentary basins Y.K. KHARAKA and J.J. THORSEN	411
Isotopic compositions of dissolved strontium and neodymium in continental surface and shallow subsurface waters S. CHAUDHURI and N. CLAUSER	467
Signatures of radiogenic isotopes in deep subsurface waters in continents S. CHAUDHURI and N. CLAUSER	497