

David S. Cronan

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 Springer

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# Preface

From originally being thought of as a good idea to help overcome expected mineral shortages, deep-sea mining has become a subject of considerable controversy. This book describes deep-sea mineral activities during much of the period that this change of heart took place and aims to provide some historical background to the current debate. In writing it, I have drawn extensively on personal experience, conversations with individuals working in the field, the open literature (including the Ph.D. theses of some of my past students), and conferences and meetings attended. Because much of the twentieth-century material on deep-sea mineral-related activities never appeared in library-held peer-reviewed journals, but in trade journals, government and industry reports, and at conferences, I have had to draw extensively on these. Chief amongst the conferences was the Underwater Mining Institute held annually from 1970 until it became the Underwater Mining Conference in the second decade of the twenty-first century. It was founded and chaired by J Robert (Robby) Moore from its inception until Robby's death in 1995. I was a regular attendee from the 1970s onwards. Robby prided himself on being at the forefront of knowledge dissemination on developments in deep-sea mineral-related activities and was able to get speakers at the cutting edge of research. "You heard it first at the UMI" was an often-used catch phrase of his. Much of the material covered in this book was first aired at a UMI, and extensive use has been made of this source. Of course, other conferences were also of importance in this regard, such as the IDOE 1972 Arden House Conference, several conferences at the University of Hawaii and the East-West Centre from 1973 onwards, and the frequent CCOP/SOPAC conferences in the SW Pacific from 1975 onwards. I was fortunate to have attended many of these, and their proceedings (published and unpublished) feature prominently in this book. Almost all the material is pre-Internet.

London, UK

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# Acknowledgements

I would like to express my gratitude to all who have helped me in completing this book, either by providing information via personal communications (acknowledged in the text) or by reading and commenting on chapters or parts of chapters. I would also like to thank those organizations with whom I have had the privilege of working, including the University of Hawaii, the New Zealand Oceanographic Institute, CCOP/SOPAC, and the International Seabed Authority, experiences that strongly influenced my thinking on much of the material in the text.

# General Introduction

The concept of mining minerals underwater dates back to at least the eighteenth century. Lake ferromanganese oxide concretions had been known and mined in the northern Baltic region in the middle ages. Apparently, these grew so fast that the lakes were “cropped” every so many years thereby providing a renewable source of the minerals. More recently, similar activities were carried out in eastern Canada.

Manganese nodules were the first deep-sea minerals to be recognized and were first discovered in the Atlantic Ocean during the Challenger Expedition (1873–1876) around 300 km SW of the Canary Islands on February 18, 1873 [1]. During the Challenger Expedition, large numbers of nodules of varying natures were recovered from the three major oceans. They mainly consisted of concentric bands of ferromanganese oxides around nuclei of various types. Some of the nodules had been fractured and new ferromanganese oxides accreted on the broken surfaces. The morphology of the nodules often reflected the shape of the nucleus, and sometimes multiple nuclei were present.

It was in the Pacific that HMS Challenger found the largest nodule deposits, on red to chocolate-coloured clays. Chemical analysis of them showed that their major constituents were iron (Fe) and manganese (Mn). Minor elements were found to include copper (Cu), nickel (Ni), and cobalt (Co), the main elements of twentieth-century economic interest in the deposits. Many other elements now known to occur in nodules were beneath detection by the analytical methods in use in the late nineteenth century. Glasby [2] has provided more detail of the early history of manganese nodule discovery and pointed out that it was the Challenger Expedition chemist, JY Buchanan, who, in a letter to his father, first drew attention to the commercial possibilities of the nodules.

According to Glasby [2], following the Challenger Expedition, work on manganese nodules was sporadic. Collections were made from the Pacific during the Albatross Expeditions of 1899–1900 and 1904–1905 and the Carnegie Expedition of 1928–1929. Nodules were also recovered from the Indian Ocean during the Valdivia Expedition of 1898 and the John Murray Expedition in 1933–1934. They were also collected on the Swedish Deep-Sea Expedition in the late 1940s.

Ferromanganese oxide crusts were not always distinguished from nodules in the early days. Using dredging for recovery, as was almost always the case, crusts and nodules could get broken and mixed up in the same dredge. As will be outlined later, they were finally recognized as a separate class of deposits in the 1980s.

Phosphorites, being mainly continental margin deposits, are not universally recognized as deep-sea deposits. They were found in the South Atlantic off southern Africa in the early years of the twentieth century and in many other locations since [3].

Deep-sea hydrothermal deposits were first recognized in the Red Sea in the 1960s [4], although anomalous bottom water temperatures had been recorded there in 1948 during the Swedish Deep-Sea Expedition.

Early work on deep-sea minerals was mainly scientific. It was not until the 1950s that significant thought was given to their commercial potential. The possible effects on the marine environment of mining them were rarely considered. This is in marked contrast to the present day when environmental considerations are at the forefront of deep-sea mineral-related activities. Much of the present controversy surrounding deep-sea mining has its roots in the late twentieth century.

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## About the Author

**David S. Cronan** Has been working on and writing about deep-sea minerals since the mid-1960s. He completed a dissertation on them at Oxford University in 1964 and a Ph.D. on them at Imperial College, University of London, in 1967. He was awarded a D.Sc. by Durham University in 1986 for his marine minerals publications, and an Honorary D.Sc. by the University of the Aegean in 2002. From 1973, he was successively Lecturer, Reader, and Professor of Marine Geochemistry at the Royal School of Mines, Imperial College, where he is now an Emeritus Professor, working principally on manganese nodules and hydrothermal deposits. During this period he supervised over 20 Ph.D. projects on deep-sea minerals, published more than 150 papers and 4 books, and attended more than 50 conferences on them. Many of the last of these have provided material for the present book.

Previous books on deep-sea minerals by the author include

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