edited by

Judith T. Kildow

DEEPSEA MINING

DEEPSEA MINING

Selected Papers from a Series of Seminars Held at the Massachusetts Institute of Technology in December 1978 and January 1979

Edited by Judith T. Kildow

The MIT Press
Cambridge, Massachusetts, and London, England

This volume was prepared with the support of a National Science Foundation Grant, number OCE-7815700. The opinions, findings, conclusions, and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Printed and bound in the United States of America.

Library of Congress Cataloging in Publication Data
Main entry under title:

Deepsea mining.

Includes bibliographies.
1. Ocean mining--Congresses. I. Kildow, Judith Tegger.
TN291.5.D43 333.8'09162 79-23633
ISBN 0-262-11-075-X

PREFACE

The papers in this volume were among those presented at a series of four seminars held at the Massachusetts Institute of Technology during December 1978 and January 1979. The seminars--jointly sponsored by the departments of ocean engineering, materials science and engineering, and the Center for Policy Alternatives, and supported by a grant from the National Science Foundation--were designed to examine several policy issues related specifically to deepsea mining but also more broadly to international resource management. It is commonly agreed that the availability of a valuable mineral resource in a seabed territory delimited as belonging to the heritage of mankind exacerbates a set of older, unresolved national and international policy problems by adding a group of newer, even more poorly understood problems. The newer problems reflect fundamental changes in the international political and resource supply systems; and the concurrence of these interlinked dynamic forces has created an awesome challenge for policy makers throughout the world.

Before discussing the individual papers, I should remark on the absence of concentrated discussion of one crucial topic: environmental impacts. Both the harvesting and the processing of the resource present potential problems. Unfortunately, despite the attempt by the Department of Commerce to do a small-scale on-site assessment for harvesting in its DOMES project, the data base for the study of these problems remains shaky at best. Given this lack, which will be remedied only when we have a better idea of the shape of a full-scale production process, we felt it best to exclude the topic rather than discuss it incompletely and prematurely. This should not, of course, be taken as an indication of lack of interest in these problems; inevitably, environmental considerations will have a major effect on the shape of policy.

The first paper, by Judith T. Kildow and Vinod K. Dar, provides an overview of the deepsea mining con-

troversy in both national and international frameworks. The paper stresses the unusual nature of the resource and the problems it presents to industries and governments; but it also shows that many of the problems are general and must be considered in the broader context of global resource utilization and management and the inevitable changes that are coming in the international system.

The second section opens with a paper by Jane Z. Frazer of the Scripps Institution of Oceanography, who maintains the central data bank in the public sector on the abundance and grade of the deepsea resource. She describes the current data base and some of the controversies that have come up in its collection and interpretation.

The paper by Lance Antrim contrasts the availability of the metals found in the manganese nodules with land-based supplies. He thereby demonstrates the relative importance of deepsea mining over time in supplementing the worlds supply of the four principal metals found in these deposits: nickel, cobalt, copper, and manganese.

The next two papers provide estimates of the net effects of deepsea mining on the markets for the four metals and on the costs to the United States, taking into consideration forecasts of supply and demand and possible technological changes. The paper by Bernard J. Reddy and Joel P. Clark assesses the potential market impacts, trying to determine where the benefits and disbenefits of deepsea mining will fall. James C. Burrows then examines some of the positive results of seabed mining for the United States, including reduced probability and severity of cartelization, reduced rate of depletion of land-based reserves, and increased military and political security. Through this analysis, Burrows derives an approximate net value of the resource to the United States over time.

The final paper in the second section discusses a potentially significant technological breakthrough

that could affect the global market for manganese and thus change the configuration of policy issues considerably. Nicholas J. Grant, who has been working on this project for some time, indicates the extent to which technological changes can influence the entire market system for many of these metals and as a consequence affect the politics of the resources as well.

The third section opens with two differing assessments of U.S. policy on deepsea mining. Arthur Kobler, a staff member of the Department of State Office of Commodities who has worked with the Common Fund in the UNCTAD discussions, outlines the government's rationale for its positions and discusses some of the problems therein. Richard G. Darman, a former member of the U.S. delegation to the Law of the Sea Conference, presents a more critical analysis, giving the reader a broader time perspective and illuminating some interesting and controversial patterns that have emerged.

A Third World perspective is offered next by A. O. Adede of Kenya, a staff member of the U.N. Legal Office. Adede describes a broad range of issues that he feels to be important in negotiating the Seabed Authority that would regulate the development of the resource; he emphasizes the points of controversy that remain.

The next three papers provide an array of industrial perspective. In the first, Burton H. Klein, an economist from the California Institute of Technology, describes some of the structural problems of the large industries that must provide the innovative pioneering for the deepsea mining effort. The paper by J. A. Agarwal, who has played a central role in the development of the processing technologies proposed by the Kennecott Copper Company for its deepsea mining effort, then offers a pragmatic technical viewpoint. The final paper in the section was written by John E. Flipse, now a professor at Texas A&M and formerly president of Deepsea Ventures,

one of the first consortia formed for the purpose of developing the manganese nodules. Flipse takes a sharp look into the future of the industry and identifies some of the obstacles ahead.

The final paper in the book summarizes the key points raised in the seminars, outlining both areas of consensus and outstanding issues where conflicting perspectives and values hinder consensus.

The seminars were conducted principally by myself and my colleague Joel Clark. I would also like to express gratitude for the valuable assistance provided by our steering committee, which included Richard Baxter, Michael Bever, James Burrows, Gordon Christenson, Marne Dubs, Ira Dyer, Herbert Holloman, Alan Kaufman, Amor Lane, Walter Owen, Robert Seamans, and Maxwell Morton, and by those who participated in the seminars and contributed to the discussions that followed the papers. I am also grateful for the administrative and editorial assistance of Heinz Stubblefield and Holly Altman.

A final acknowledgment of appreciation goes to the Office of Marine Affairs of the IDOE in the National Science Foundation for its financial support, which made this volume and the seminar discussions possible.

Judith T. Kildow
Cambridge, Massachusetts

LIST OF CONTRIBUTORS

A. O. Adede
Office of Legal Affairs
U.N. Secretariat
New York, NY

J. A. Agarwal
Kennecott Copper
Corporation
Lexington, MA

Lance Antrim
Office of Ocean,
Resource, and
Scientific Policy
Coordination
U.S. Department of
Commerce
Washington, D.C.

James C. Burrows
Charles River Associates
Boston, MA

Joel P. Clark
Department of Materials
Science and Engineering
MIT
Cambridge, MA

Vinod K. Dar
Resource Planning
Associates
Washington, D.C.

Richard G. Darman
Kennedy School of
Government
Harvard University
Cambridge, MA

John E. Flipse
Department of Ocean
Engineering
Texas A&M University
College Station, TX

Jane Z. Frazer
Scripps Institution of
Oceanography
University of California
at San Diego
La Jolla, CA

Nicholas J. Grant
Department of Materials
Science and Engineering
MIT
Cambridge, MA

Judith T. Kildow
Department of Ocean
Engineering
MIT
Cambridge, MA

Burton H. Klein
Department of Humanities
and Social Sciences
California Institute
of Technology
Pasadena, CA

Arthur Kobler
Commodities Office
Department of State
Washington, D.C.

Bernard J. Reddy
Charles River Associates
Boston, MA

CONTENTS

Contents

PART I

CHANGING INSTITUTIONS AND RESOURCE CONDITIONS

INTRODUCTION TO AN UNUSUAL RESOURCE MANAGEMENT PROBLEM

Judith T. Kildow and Vinod K. Dar

INTRODUCTION

Concern over the availability of stable resource supplies to fuel the U.S. economy is by no means a new phenomenon. What is new, however, are the political concerns that have been added to the traditional problem of the gradual depletion of supplies. The United States has become increasingly dependent on imports and is now quite vulnerable to foreign political and economic actions. Within the past few years, for example, we have seen:

1. an exertion of market power by foreign bauxite producers;

2. political manipulation of the oil market in the 1973 embargo;

3. a violent conflict disrupting cobalt and copper mining in Kolwezi, Zaire, causing a rapid escalation of the free market price of cobalt from $12.50/kg to over $60/kg.

4. labor strife in Canada causing serious shortages of nickel and a sharp rise in price;

5. manipulation of the international chromium market by the Soviet Union, leading to a tripling in the price of its ore and sharp increases in the prices charged by other producers (Turkey, Sourth Africa);

6. market pressure by foreign copper producers who increased their share of the U.S. market from 5% in 1976 to 20% in 1978 while keeping the world price below the level necessary for a financially healthy domestic industry.

A number of changes in world conditions have increased the likelihood that such disruptive actions will occur even more frequently in the future. These changes can be classified as strategic, structural and attitudinal. Strategic changes include the emergence of resource powers such as Australia, Brazil, Canada, South Africa (for chromium in particular), and Zaire and Zambia (for cobalt); the Soviet push to dominate major African and Middle Eastern Resource-producing areas; and attempts by some developing countries to expand their market shares at the expense of U.S., Canadian, and Western European mining firms by pursuing policies of revenue and employment maximization rather than profit maximazation.

The structural changes result mainly from the process of decolonization, which has removed a number of major resource reserves from the control of Western economies. This has often been accomplished through the nationalization of Western mining investments. Another structural change has been the consolidation of efforts on the part of resource producers pursuing a common interest--the extraction of economic rent from consumers--which has resulted in new alignments and new coalitions in international bargaining forums. (On the other hand, a decaying of traditional coalitions seems to be taking place among developed countries as they find themselves increasingly in competition for the same shrinking pool of resources.)

Finally, a pervasive attitudinal change toward the global distribution of economic rents among developing and developed countries--typified by the debate over the new economic order--has lent legitimacy to attempts by resource producers to cartelize world markets and to seek means of stabilizing their revenues. These attitudinal changes are multifaceted and should not, as is too often done, be reduced to caricature. Some producing nations see their newfound power as a means of attaining equality with their industrialized

customers by raising themselves to a respectable competitive position in the world market. Others see an opportunity to institute fundamental changes in the functioning of the world market system based on a new ideological outlook and a new set of objectives. While the latter states are consciously in conflict with the industrialized states, and so may provide a legitimate basis for concern in those states, the former group finds the general distrust manifested by the developed countries discouraging and frustrating. These more moderate resource producers may hold the key to a middle road, although current debates are still marked by extreme swings of the pendulum. (See, for example, the 1977 and 1978 informal composite negotiating texts of the U.N. Law of the Sea Conference.)

Several recent domestic trends have complicated the problem of U.S. resource security. First, new environmental and safety laws are finally forcing U.S. firms to internalize the social costs of the health and safety risks they pose to their workers and also of the degradation of land, water, and air quality that they cause. One might, of course, argue that this forced convergence between the social and private marginal costs of production is in the national interest; but it does practically reduce the economic rents available to mining corporations and hence inhibits economic growth, adds to unemployment problems, and may contribute to inflation.

Second is the problem of the chaotic state of the national regulatory system for resource management. As resource security has emerged as a policy issue, more and more bureaucratic agencies have become involved in an uncontrolled decision-making structure. For example, the bureaucrats in the Department of the Interior, who have heretofore had domestic mandates only, have now become international resource managers, unofficially--and, indeed, without any recognized structural liaisons--augmenting the operations of the Department of State (see Hopkins,

1976). Given this proliferation of interested parties, the problems of policy coordination and central decision-making are inevitably exacerbated by the classic problems of bureaucratic rivalry.

Finally, there has been a general recognition of the fact that the economics of most resources are inextricably intertwined, and that resource managers must therefore take a broad view of their tasks. (The interdependence of resources was shown most effectively by the major reverberations that accompanied the 1973 oil embargo.) This more enlightened view has dated must of the existing piecemeal legislation and also much of the existing bureaucratic decision-making structure.

RESOURCES AND POLITICAL POLICY

The control of resources is an essential element of political power. The desire for such control has, of course, motivated extraterritorial excursions throughout history; but the current world situation seems to have increased the importance of this aspect of the multidimensional equations of power.

The combination of changing perceptions and evolving geopolitical resource strategies is occurring at a time when a potentially major new resource--the ferromanganese deposits on the seabed--is emerging into importance because of the development of appropriate technologies. This situation demands the formulation of a U.S. government response that transcends conventional organizational structures, since it involves both foreign and domestic policy and requires a blending of the roles of leader and follower.

The ferromanganese deposits contain several minerals in amounts that vary according to location. This special characteristic causes two problems. First, it requires a linkage in the markets of all the minerals that will be mined, which may in turn imply a convergence in the prices of those minerals. Second, it may cause production problems to the

extent that the proportions in which the minerals are found in the deposits differ from the proportionate sizes of their world markets. Clearly there is a need for simultaneous production, pricing, and marketing decisions relating to all the product minerals.

A second fundamental problem is that of legal ownership of the resource. All current international actions seem predicated on the view that the resource is supranational (that is, its ownership is vested in all nations) rather than transnational (in which case its ownership would be vested in no single nation). In the case of a transnational resource, any nation could pursue unilateral actions without violating the rights of other nations. In the case of a supranational resource, unilateral actions automatically impinge on the rights of other states. The very existence of the Law of the Sea negotiations implies the acceptance of some form of supranationality for the resource. Since the United States has no defined policy for either transnational or supranational resources, the implications for precedent-setting in this case are awesome. (The Antarctic is another rich store of resources that seems to be in transition from a somewhat unstable transnational status to one of supranationality.)

Finally, the policy adopted for seabed minerals must reflect the growing recognition of the fallacy of the trichotomous division conventionally made among land, sea, and space resources. What is needed is a coordinated decision-making framework that links not only different resources, but also all possible sources of any given resource.

AN UNUSUAL U.S. NATIONAL PROBLEM

A number of conceptual and structural problems have become evident in the resource policy-making process of the United States. These difficulties emanate in large part from the uncoordinated integration of foreign and domestic policy systems that has occurred in response to the increasingly complicated world