MINING AND MINERALS POLICY

1976

BICENTENNIAL EDITION

MASTER

ANNUAL REPORT of the SECRETARY of the INTERIOR
UNDER THE MINING AND MINERALS POLICY ACT of 1970

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

MINING AND MINERALS POLICY

1976 Bicentennial Edition

ANNUAL REPORT of the SECRETARY of the INTERIOR
UNDER THE MINING AND MINERALS POLICY ACT OF 1970
(P.L. 91-631)

July 1976

MASTER

Public Law 91-631
91st Congress, S. 719
December 31, 1970

An Act

84 STAT. 1876

To establish a national mining and minerals policy.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Mining and Minerals Policy Act of 1970".

Mining and
Minerals Policy
Act of 1970.

SEC. 2. The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs, (3) mining, mineral, and metallurgical research, including the use and recycling of scrap to promote the wise and efficient use of our natural and reclaimable mineral resources, and (4) the study and development of methods for the disposal, control, and reclamation of mineral waste products, and the reclamation of mined land, so as to lessen any adverse impact of mineral extraction and processing upon the physical environment that may result from mining or mineral activities.

For the purpose of this Act "minerals" shall include all minerals and mineral fuels including oil, gas, coal, oil shale and uranium.

"Minerals."

It shall be the responsibility of the Secretary of the Interior to carry out this policy when exercising his authority under such programs as may be authorized by law other than this Act. For this purpose the Secretary of the Interior shall include in his annual report to the Congress a report on the state of the domestic mining, minerals, and mineral reclamation industries, including a statement of the trend in utilization and depletion of these resources, together with such recommendations for legislative programs as may be necessary to implement the policy of this Act.

Report to
Congress.

Approved December 31, 1970.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 91-1442 (Comm. on Interior and Insular Affairs).

SENATE REPORT No. 91-390 (Comm. on Interior and Insular Affairs).

CONGRESSIONAL RECORD:

Vol. 115 (1969): Sept. 5, considered and passed Senate.

Vol. 116 (1970): Sept. 21, considered and passed House, amended.

Oct. 14, Dec. 18, Senate concurred in House amendments.

FOREWORD

In accordance with the mandate of Public Law 91-631, it is my pleasure to submit to the Congress this Annual Report on Mining and Minerals Policy.

Of recent developments affecting energy and minerals policy decision-making, changes in the international markets since 1973 are perhaps the most significant. Not only has the Organization of Petroleum Exporting Countries continued to control the world price of oil, but rapid changes continue to occur in the political and economic institutions which form the structure of international minerals markets. Such developments, while heightening concerns over the availability of energy and minerals supplies, have perhaps, more importantly, lent a sense of urgency to the need to reconcile public policy decisions affecting the many conflicting, yet interdependent, goals of our Nation.

As the principal agency of the U.S. Government responsible for the management of federally owned energy and minerals resources, the Department of the Interior (DOI) has a major role in the formulation of energy and minerals policy on which recent market events continue to have a direct bearing. The objective of the 1976 Annual Report is to address those actions which have been taken by the Department to deal with changing market conditions, to raise those issues requiring resolution if we are to assure an optimum domestic supply of energy and minerals in the years to come, and finally, to recommend those initiatives which must be undertaken, either legislatively or administratively or both, to enable the Department to effectively execute the policy embodied in the Mining and Minerals Policy Act of 1970.

Within DOI, geologic, mining, and mineral research and development activities, and mine health and safety matters are the responsibility of the Geological Survey, the Bureau of Mines, and the Mining Enforcement and Safety Administration. Another major agency within DOI, the Bureau of Land Management, is responsible for assuring adequate minerals availability from public lands. These agencies have a combined estimated budget authorization of \$966 million for fiscal year 1977.

Major energy and mineral programs conducted by these agencies include energy and mineral resource appraisals, supervision of mineral lease operations on Federal and Indian land and the Outer Continental Shelf (OCS), geologic and topographic mapping by the Geological Survey, energy and mineral supply-demand data collection and analysis, mining and metallurgy research by the Bureau of Mines, coal, metal, and nonmetal mine health and safety enforcement activities by the Mining Enforcement and Safety Administration; and the management and leasing of resources on

Federal lands, including the OCS, by the Bureau of Land Management. These programs are referenced in such reports as *Geologic Research 1975*, *Bureau of Mines Research 75*, *1974 Annual Report of the Secretary of the Interior Under the Federal Coal Mine Health and Safety Act, Part I and Part II, Moving Ahead in Metal and Nonmetal Mine Health and Safety—Report of the Secretary of the Interior on Administration of P.L. 89-577*, *1974, Public Land Statistics*, and other reports.

A handwritten signature in black ink, reading "Thomas A. Klapp". The signature is fluid and cursive, with a long horizontal stroke at the end.

Secretary of the Interior.

PREFACE

The 1976 Annual Report is organized into three basic parts in an attempt to accommodate the wide range of information needs and requirements of the reading public.

The "Executive Summary," the first part of this report, provides a very brief description of the major topics discussed within the report and gives a complete listing of all of the issues and recommendations.

The main body of the Annual Report is divided into two major sections. Section I, entitled "Summary," is comprised of chapters 1, 2, and 3. This section summarizes and briefly evaluates the state of the energy and minerals industries (chs. 1 and 2, respectively) as of the end of 1975. The situation in these areas is described, and consideration is given to the changing conditions that have led to problems or are likely to lead to problems in the future. All of the issues and recommendations are presented in these two chapters along with a brief discussion of why each issue is raised and why each recommendation is made. Chapter 3 provides a synopsis of the major trends and events through 1975 for 15 major energy and mineral commodities.

Section II, entitled "Issues in Energy and Minerals Policy," provides a thorough description and analysis of the major issues and problems identified in section I. Programs and policies of the Department of the Interior and the Administration to deal with these problems are discussed and recommended. This section of the Annual Report is designed to serve the needs of those readers who are interested in the specific details and reasons behind the recommendations and the programs to alleviate the problems and issues addressed in each of the chapters.

In general, the closing date for subject matter for this Annual Report was the end of 1975. Two slight exceptions to this general rule occur in the discussions of coal leasing and ocean mining issues which contain information about early 1976.

TABLE OF CONTENTS

	<i>Page</i>
Foreword	iii
Preface	v
List of Figures	viii
List of Tables	ix
Executive Summary	1
Issues and Recommendations	5

SECTION I. SUMMARY

CHAPTER 1. INCREASED ENERGY SECURITY	9
Background	9
Increasing Domestic Energy Production	12
CHAPTER 2. METALS AND NONMETALLIC MINERALS	19
Background	19
International Developments and U.S. Responses	20
Domestic Developments	23
CHAPTER 3. TRENDS AND EVENTS	31
Energy	31
Major Nonferrous Metals	39
Ferrous Metals and Major Ferroalloys	47
Fertilizer Materials	55
Nonmetallic Construction Materials	60

SECTION II. ISSUES IN ENERGY AND MINERALS POLICY

CHAPTER 4. FEDERAL LEASING	63
Petroleum and Natural Gas Leasing	63
Coal Leasing	67
Oil Shale Leasing	71
Geothermal Leasing	73
Federal Leasing of Nonfuel Minerals	75
Issues and Recommendations	75
CHAPTER 5. THE FEDERAL ROLE IN REDUCING THE FISCAL IMPACTS OF ENERGY DEVELOPMENT	77
Introduction and Overview	77
Energy Development Impacts by Geographic Area	78
The Need for Legislation	79
CHAPTER 6. AVAILABILITY OF FEDERAL LANDS FOR MINERAL EXPLORATION AND DEVELOPMENT	81
Introduction	81
The Mining and Mineral Leasing Laws	82
Limitations and Restrictions on Mineral Exploration and Development	84
Policy Problems	91
Issues and Recommendations	92

	<i>Page</i>
CHAPTER 7. ENVIRONMENTAL ISSUES AND THE MINERAL INDUSTRY	95
Background	95
Environmental Legislation	95
Costs of Compliance	97
Industrial Progress Toward Compliance	98
Departmental Progress at the Environment-Development Interface	99
CHAPTER 8. DEVELOPMENTS IN INTERNATIONAL MINERALS TRADE AND INVESTMENT	107
New Elements in International Minerals	107
Strategic Assessment	108
Interior Department Activities	110
Unresolved Issues	110
Conclusion	113
CHAPTER 9. OCEAN MINING	115
General	115
U.S. Mineral Requirements and Ocean Mining	115
Development of a Domestic Ocean Mining Capability	116
Factors Affecting Development	117
Issues and Recommendation	118
CHAPTER 10. THE DEVELOPMENT OF NEW TOOLS FOR ENERGY AND MINERALS POLICY ANALYSIS	119
The Use of Supply Functions in Minerals Policy Analysis	119
Information in Supply Functions	120
Development of Minerals Supply Functions in the Minerals Availability System	121
Aluminum as an Example of a Minerals Availability System Evaluation	121
Geological Survey's Oil and Gas Resource Price Elasticity Studies	125

LIST OF FIGURES

<i>Number</i>		<i>Page</i>
3-1	U.S. Users of Major Energy Sources, 1950-75	32
3-2	Consumption of Energy by Sources, 1975	33
3-3	U.S. Sources of Petroleum, 1950-75	34
3-4	Price of Crude Petroleum, 1950-75	34
3-5	U.S. Sources of Natural Gas, 1950-75	35
3-6	Price of Natural Gas, 1950-75	36
3-7	U.S. Production of Coal, 1950-75	37
3-8	Price of Bituminous Coal and Lignite, 1950-75	37
3-9	U.S. Sources of Uranium (U_3O_8), 1950-75	38
3-10	Price of Uranium Concentrate, 1950-75	39
3-11	U.S. Sources of Aluminum, 1950-75	40
3-12	Price of Aluminum, 1950-75	40
3-13	U.S. Sources of Copper, 1950-75	41
3-14	Price of Copper, 1950-75	42
3-15	U.S. Sources of Lead, 1950-75	43
3-16	Price of Lead, 1950-75	43
3-17	U.S. Sources of Zinc, 1950-75	44
3-18	Price of Zinc, 1950-75	45
3-19	U.S. Sources of Tin, 1950-75	46
3-20	Price of Tin, 1950-75	46
3-21	U.S. Sources of Iron, 1950-75	48
3-22	U.S. Production of Raw Steel by Furnace Type, 1950-75	48
3-23	Price of Iron in Ore, 1950-75	49
3-24	U.S. Sources of Chromium, 1950-75	50

3-25	Price of Chromium, 1950-75	50
3-26	U.S. Sources of Manganese, 1950-75	51
3-27	Price of Manganese, 1950-75	52
3-28	U.S. Sources of Tungsten, 1950-75	53
3-29	Price of Tungsten, 1950-75	53
3-30	U.S. Sources of Nickel, 1950-75	54
3-31	Price of Nickel, 1950-75	55
3-32	U.S. Sources of Fixed Nitrogen, 1950-75	56
3-33	Price of Fixed Nitrogen (Ammonia), 1950-75	56
3-34	U.S. Sources of Phosphate Rock, 1950-75	57
3-35	Price of Phosphate Rock, 1950-75	58
3-36	U.S. Sources of Potash, 1950-75	59
3-37	Price of Potash, 1950-75	59
3-38	U.S. Sources of Major Nonmetallic Construction Raw Materials, 1950-75	60
6-1	Federal Lands	82
8-1	Imports Supplied Significant Percentage of Mineral and Metals Con- sumption in 1975	109
10-1	Theoretical Price-Quantity Availability Relationships	120
10-2	Potential Availability of Alumina from Domestic Resources	123
10-3	Potential Annual Production Capacity from Domestic Alumina Resources	124

LIST OF TABLES

1-1	Oil Reserves and Undiscovered Recoverable Resources for the United States	10
1-2	Natural Gas Reserves and Undiscovered Recoverable Resources for the United States	11
2-1	Percentage by Type of Host Country Control of World Total Production and Estimated Reserves of Selected Minerals, 1974	21
2-2	Producer Associations	22
2-3	Percent of U.S. Annual Total Demand for Selected Metal and Nonmetallic Minerals Supplied From Domestic Sources During the Period 1971 through 1975 Compared With Estimated Domestic Resources	24
2-4	Principal Sources of Selected Imports to the U.S. by Country	25
5-1	Additional Population and Infrastructure Costs Resulting from Coal Develop- ment in the West, 1976-90	78
5-2	Additional Population and Infrastructure Costs Resulting from OCS Exploration and Development, 1976-90	79
6-1	Classification of Federal Lands According to Limitations and Restrictions that Prohibit or Discourage Mineral Exploration and Development Under the Mining Law, 1974 data	85
6-2	Classification of Federal Lands According to Limitations and Restrictions that Prohibit or Discourage Mineral Exploration and Development Under the Mineral Leasing Laws, 1974 data	86
7-1	Selected Environmental Statutes, Purposes, and Impacts	96
7-2	Selected Fiscal Impacts of Environmental Legislation on the Minerals Industry	98
7-3	Outer Continental Shelf Baseline and Monitoring Studies, 1975	99
7-4	Energy- and Minerals-Related Department of the Interior Environmental Statements, 1975	101

EXECUTIVE SUMMARY

ENERGY

Domestic supplies of energy showed mixed trends.

- Domestic production and reserves of oil and gas continued to decline as did imports. However, the share of foreign sources in total oil and gas supply actually rose.
- Coal production increased 37 million tons, and coal consumption increased 10 million tons. Exports increased 6 million tons, and the remaining increment in coal production was reflected in inventory changes.
- Uranium concentrate production remained about what it had been in 1974 despite a doubling in price.
- Private company research on shale oil production by both surface retorting and in situ methods proceeded though no major progress was made toward realizing the potential of the Nation's oil shale resources.
- Programs for converting coal to liquid and gaseous fuels continued toward their commercialization goals set for the mid-1980's.

The supply problems are in part technological, in part institutional, and in part natural. It is generally accepted that most of the lower cost oil and gas supplies of our own country have been found and developed. Although geologic evidence supports the view that additional supplies can be obtained through new discoveries and increased recovery from known fields, the cost will be higher than what prevailed before 1973. Yet oil and gas are subject to Federal price control. While the Energy Policy and Conservation Act of 1975 provides for the de-

regulation of oil prices over a 40-month period, there is no similar provision for sales of gas moving in interstate commerce. The predictable result is a diversion of new gas reserves to markets in the State of origin where the gas is valued at three to four times the price permitted for interstate purchases.

Coal is plentiful, but in its solid form has fewer uses than liquid or gaseous hydrocarbons. Electric utilities continue to be the major direct consumers of coal. During 1975, steam electric-generating plants directly consumed slightly more than 70 percent of the total bituminous coal and lignite used by domestic coal consumers. As compared with a 1.9-percent increase from 1974 to 1975 in total electric generation, the quantity of coal burned by electric utilities increased by 2.8 percent. As a means of conserving relatively scarce supplies of oil and natural gas, the Administration continues to encourage the direct combustion of coal through such initiatives as the Federal Energy Administration's (FEA) Coal Conversion Program and the Environmental Protection Agency's (EPA) Clean Fuels Program. Since the Arab oil embargo, FEA has been directing those oil-fired utilities with the capacity to do so to convert from oil combustion to coal. By issuing variances and extensions, EPA has suspended application of the sulfur oxide emission standards under the Clean Air Act Amendments of 1970, which, otherwise, would have shut down nearly half the Nation's electric-generating capacity in July 1975.

Besides the direct combustion of coal by electric utilities and certain other industries, the hope for the future lies in the conversion of coal into the more flexible liquid and gaseous fuels. Such conversions will require immense amounts of capital committed to high-cost, un-

tested technologies with the prospect that at the outset, at least, the resulting prices for these products will be barely competitive with the cartelized prices of imported oil. Cartelized prices can be manipulated by the cartel to destroy high-cost producers of competing products.

The same point can be made about oil shale development, which, in addition, is faced with problems of land titles clouded by unpatented mining claims and checkerboard ownership of shale lands. While these limitations can be troublesome now, they would become a major barrier to development should breakthroughs in shale oil production technology result in large-scale demand for leasing. If synthetic fuels such as oil from shale or gas from coal are to make a significant contribution to the energy supply of the country, the high degree of uncertainty about the profitability of investments in first generation technologies will have to be reduced. Accordingly, the Administration has proposed a Synthetic Fuels Commercialization Program.

The Nation's efforts to expand the supply of domestic energy resources are at present most visible in four major endeavors, the latter three of which are programs of the Department of the Interior: the construction of the Alyeska pipeline, the sharply accelerated oil- and gas-leasing activity on the Outer Continental Shelf (OCS), the recently announced coal-leasing program, and the prototype oil-shale-leasing program. Concomitant with actions aimed at expanding the domestic energy supply, the Administration has grown increasingly concerned over possible socioeconomic impacts on the political jurisdictions and on neighboring regions, particularly of the West and in the frontier OCS areas where rapid energy resource development is expected. Despite fiscal innovations at the State and local levels of Government, some States and localities may experience difficulty in financing energy-related capital costs that must be incurred before the energy production is actually underway and additional tax receipts accrue to the political jurisdiction. Federal financial assistance to impacted communities and regions to meet front-end fiscal needs will help resolve one attendant problem regarding Federal energy resource development.

The potential contribution of coal, oil, and gas as major domestic energy sources is dependent to a large degree upon the continued availability of adequate transportation facilities. Unit trains have come into widespread use for movement of coal to consumers who are able to take deliveries of large quantities on a regular schedule. Coal slurry pipelines could provide capacity in the transport of western coal to midwestern markets. One major constraint to the growth of slurry pipelines is the lack of authority by the private companies in obtaining rights-of-way. Although legislation to amend the Mineral Leasing Act of 1920 to grant rights-of-way for coal pipelines on private lands is pending, the entire issue is complicated by water requirements in arid areas and by economic and environmental factors.

The construction of pipelines to carry Alaskan oil and gas to the lower 48 States will enlarge the domestic fuel supply. Construction of the Alyeska oil pipeline from Prudhoe Bay to Valdez, Alaska, is continuing on schedule. The pipeline is expected to begin transporting North Slope oil at a rate of 1.2 million barrels per day by the end of 1977. The Administration has proposed legislation to expedite the route selection for a natural gas pipeline from Alaska's North Slope to assure that a choice between the alternative routes will be made before August 1977.

During the 1973-75 period, only a slight decline in domestic consumption of petroleum occurred. As real income increases in the United States with the continuing upswing in economic activity, a substantial increase in domestic consumption of foreign petroleum supplies is likely to occur unless conservation practices radically improve or until domestic supplies increase.

METALS AND NONMETALLIC MINERALS

As with energy, a slackening in demand for metals and nonmetallic minerals obscured the supply situation both at home and abroad in 1975. The shortages and price runups of the 2 preceding years had disappeared, and, on the face of it, 1975 resembled any number of previous years when adequate supply conditions prevailed.

Abroad, the governments of minerals-exporting countries sought to emulate the success of the Organization of Petroleum Exporting Countries through the formation of producer associations and the expansion of their control over the production and processing of minerals. Bauxite, copper, and iron ore producing properties were among those nationalized by some countries in 1975, and host-country participation in management and ownership of foreign enterprises was enlarged by others. Increasingly, marketing decisions were made or significantly influenced by governments of countries where the mineral resources are found. What this means for future investment and production levels in these countries or for the terms of trade for the commodities they export is uncertain. What is certain is that the conditions of access to the mineral resources of other nations are changing at a time when our own mineral resources are becoming increasingly difficult and costly to find and to produce.

The United States may always be dependent upon other nations for some of its mineral supplies. Geologic conditions and natural mineral distributions dictate this. The United States chooses to be dependent upon other nations for some mineral supplies. Economic conditions influence this. The challenge is to strike an intelligent balance between imports and domestic production by utilizing the options that are available to us. These include trade agreements, economic incentives, research and development on new discovery and recovery techniques, development and use of substitutes, and stockpiling of critical and strategic materials. The problems attending our supply of nonfuel minerals require a readiness on the part of the United States to meet emergent conditions that may displace the operation of normal market forces.

Along with the changing international conditions affecting the future availability of metals and nonmetallic minerals there is a growing concern that further development of the domestic resource base is not receiving sufficient encouragement. Even though U.S. self-sufficiency increased at least temporarily in 1975 for many minerals, due, for the most part, to curtailed demand, our domestic identified-resource position appears inadequate for several commodi-

ties when compared to recent estimates of cumulative demand for these minerals through the year 2000.

A prominent opportunity for expanding some mineral supplies is emerging from ocean mining. The advances in the technical ability to recover minerals from the ocean floor suggest that commercial ocean-mining operations can soon become a reality. However, a stable investment climate will likely be required before a viable ocean-mining industry will develop. Since international legal and political developments bear directly on the investment climate for ocean mining, a successful conclusion to the United Nations Conference on the Law of the Sea would strongly encourage the future development of these mineral resources.

The grace period of 1975 gave the Nation some comfort from the afflictions of supply that had been so evident the year before. However, in view of the institutional and economic changes since 1970, the United States must maintain a close watch over the developments within each of the individual mineral markets and prepare alternative measures for meeting any undesirable set of circumstances.

THE ISSUE OF ACCESS

Development of both energy and mineral resources is profoundly affected by public attitudes and policies regarding access to federally owned lands. About one-third of the Nation's total area is publicly held, and this portion is believed to be among the most promising of all remaining areas in the United States for the discovery and development of energy and mineral resources. It includes approximately 80 percent of the Nation's oil shale deposits, most of its low-sulfur coal and geothermal resources, and most of the remaining undeveloped mineralized areas.

However, numerous factors hinder and often exclude mineral entry to these lands. In the 104 years since the passage of the Mining Law and the 56 years since passage of the Leasing Act, numerous congressional acts and executive policies have placed restrictions on the availability of Federal lands for mineral exploration and development. Government decisionmakers have adopted policies and procedures that restrict

mineral exploration and development on various relatively small tracts of land without adequately assessing the cumulative effect of all such restrictions on meeting the Nation's mineral needs. The restrictions can range from moderate to prohibitive and from temporary to permanent. The magnitude of the problem is causing concern about the future accessibility of energy and minerals within the country.

In response to the preliminary evidence that mineral exploration and development are being severely restricted on over 50 percent of the lands owned by the Federal Government, although some of this is temporary, the Secretary of the Interior has ordered a study to review present administrative policies and procedures, with the purpose of making recommendations for modifying these practices to help assure continued access to the Nation's energy and mineral resources.

ENVIRONMENTAL ISSUES

As it has done in so many years gone by, the Nation continues to grapple with balancing the necessities for developing its mineral and energy resources with the necessities for environmental protection. The historical uses of land, water, and air have been challenged through the recognition by most people that protection of environmental quality is a necessity. As a result, the amount of environmental legislation, rules, and regulations has increased dramatically in recent years.

Legislation, rules, and regulations applicable to environmental concerns present the developer of a potential mineral deposit with multiple requirements. Complying with these requirements produces unparalleled challenges for the development of workable solutions.

The variety of solutions to environmental concerns is only hinted at when it is realized that due regard for the environment takes into account the types of materials, the stages of

use, the environmental media (air, water, land), the sources, and the effects. Although many reactions have occurred ranging from outright opposition to willing acceptance of the new situation, explicit attention is being given to environmental management at every stage of the mineral cycle, from preexploration through reuse of materials.

Nevertheless, progress has been made in protecting the environment; but costs are being incurred that impact on energy and mineral resource development. The remedies taken by the minerals industry for preventing or repairing environmental damage take one of several forms: reduction of emissions, improved protection of the landscape and ecosystem, repair of the landscape and ecosystem that have been damaged, optimum siting of unavoidable damage, and concentration and safe disposal of wastes.

The problem of achieving a balance between the need for environmental protection and the need for mineral resource development remains.

NEW TOOLS FOR ENERGY AND MINERALS POLICY ANALYSIS

The development of energy and minerals policy relies heavily upon the use of estimates as to the amount of resources that are recoverable in the future. What the estimates suggest about the future availability of each resource influences the choice among policy options. Since availability is subject to a variety of influences—geologic, technical, economic, and legal-political—some means are necessary to measure the impact of these influences on the availability of each resource. To provide better measurements of the impacts of these geologic, technical, economic, and legal-political influences upon energy and mineral availability, the Bureau of Mines and the U.S. Geological Survey are taking significant steps to develop supply functions and associated supply curves useful for policy analysis.

ISSUES AND RECOMMENDATIONS

- Enact legislation that would decontrol the price of new natural gas shipped to interstate markets (ch. 1).
- Enact legislation to provide for Government incentive programs, e.g., the Administration's proposed Synthetic Fuels Commercialization Program, to encourage investments in the currently available, but commercially untested, technologies for producing synthetic fuels (chs. 1 and 4).
- Continue Government-sponsored research in new technologies at the level of the past few years to reduce the costs of exploration, extraction, recovery, and processing of energy (ch. 1).
- Enact legislation authorizing the Secretary of the Interior to grant lessees additional land for offsite disposal of spent shale (chs. 1 and 4).
- Enact legislation to amend the Minerals Leasing Act of 1920 to grant rights-of-way for coal pipelines across Federal lands and to authorize the use of eminent domain for coal pipelines on private lands (ch. 1).
- Enact the Administration's legislative proposal to expedite delivery of natural gas from Alaska's North Slope (ch. 1).
- Make a Governmentwide compilation or inventory of those Federal lands where mineral exploration and development is formally prohibited or severely restricted. This inventory should be updated and results published on a periodic basis (chs. 2 and 6).
- Adopt new mining regulations that permit mineral exploration and development on appropriate public lands but which, at the same time, allow the land-administering agencies to prevent or minimize possible harmful impacts caused by mineral development (chs. 2 and 6).
- Study Federal lands where Government policies prohibit or severely restrict mineral exploration and development to determine the desirability of eliminating or altering these policies. It should be noted that the Administration has recommended that all units of the national park system except Glacier Bay National Monument, Alaska, be closed to operation of the mining laws. In addition, the Administration's wilderness proposals for units of the national wildlife refuge system have consistently recommended that the refuge wilderness areas be closed to operation of the mining and mineral leasing laws. It is not intended that the study call into question these recommendations (chs. 2 and 6).
- Develop policies and practices that will insure that future restrictions on mineral exploration and development will be made only after a balanced and informed consideration of the benefits and costs of such restrictions is conducted, including a mineral appraisal of affected lands (chs. 2 and 6).

- Review the current efforts to determine the final land use and ownership of lands in Alaska pursuant to the Alaska Native Claims Settlement Act (native ownership, State settlements, national parks, forests, wildlife refuges, etc.) to see whether these efforts should be expedited to speed up the time when development can occur in Alaska (chs. 2 and 6).
- The Federal Government has recognized the desirability of establishing a stable investment climate for the ocean-mining industry, in order to promote the timely development of deep seabed mineral resources. Long-term, stable development of these resources would be achieved preferably by the adoption of a satisfactory international regulatory regime under a new law-of-the-sea-treaty. However, we cannot delay indefinitely the creation of secure investment conditions for ocean-mining activities. If the law-of-the-sea negotiations are not meeting U.S. mineral resource objectives at the conclusion of the 1976 summer session of the conference, we should consider alternative action to protect these interests (chs. 2 and 9).

Section I

SUMMARY

Chapter 1

INCREASED ENERGY SECURITY

Summary.—This chapter reviews the progress, as of the end of 1975, of the United States in moving toward its goal of increased energy security. At best, progress is found to be slow. A number of significant issues must be dealt with effectively before further progress can be made.

BACKGROUND

The Arab oil embargo of 1973 was preceded by a decade and a half of declining real prices of petroleum, which contributed to a 4.3-percent annual rate of growth in domestic demand. Similarly, domestic consumption of natural gas increased at a 4.1-percent annual rate during the 1960–74 period, assisted by a relatively constant real price for natural gas during the decade and a half preceding the 1973 oil embargo. During the latter part of this period, the regulated wellhead price of gas shipped to interstate markets was held below market clearing levels as indicated by the inability of new home buyers in many parts of the country to purchase natural gas for home-heating purposes.

While demand for these fuels has been growing by greater than 4 percent annually, domestic production of petroleum and natural gas has been declining since petroleum production peaked in 1970 and natural gas production in 1973. Moreover, except for the discovery of the Prudhoe Bay field in Alaska, domestic petroleum and natural gas production has exceeded additions to reserves each year since the late 1960's. The protracted decline in domestic exploration from 1957 through 1971, which can be attributed, at least in part, to the availability of foreign oil at relatively low prices, can be seen as the primary causative factor for diminishing reserves.

Since the energy crisis created by the Arab

oil embargo and the subsequent quadrupling of world oil prices, the Federal Power Commission (FPC) has allowed the interstate price of natural gas to rise somewhat. The higher price in conjunction with the unregulated, free-market intrastate price of natural gas has increased the incentive for producers to explore and drill for additional natural gas supplies during the past 2 years.

In 1974, net imports of petroleum represented 37 percent of U.S. petroleum consumption, while net imports of natural gas represented 4.5 percent of U.S. natural gas consumption. (Certain regions of the country are heavily dependent upon natural gas imports, even though these imports satisfy only a small proportion of total domestic demand.) Despite the establishment in 1974 of a national policy of "energy independence," imports of petroleum and natural gas declined only slightly during 1975, while crude oil imports increased by about 18 percent.

During the 1973–75 period, a time both of considerable petroleum price increases and of a fall in domestic real income because of the recession, only a slight decline in domestic consumption of petroleum occurred. As real income increases in the United States with the continuing upswing in economic activity, a substantial increase in domestic consumption of foreign petroleum supplies is likely to occur unless con-

servation practices radically improve or until domestic supplies increase.

U.S. Domestic Energy Reserves and Resources

Tables 1-1 and 1-2 present the latest U.S. Geological Survey (USGS) estimates for petroleum and natural gas reserves and resources of the United States. Inspection of these tables indicates that approximately 90 percent of total U.S. petroleum reserves and 76 percent of total natural gas reserves¹ are located onshore. Alaskan onshore petroleum and natural gas reserves are significant and constitute about 25 percent of total U.S. petroleum reserves and 11 percent of natural gas reserves.

Most of the oil and gas hydrocarbons occur in and are produced from the largest fields. Since most authorities believe that the most promising major onshore prospects for petroleum and natural gas development have already been drilled, the probability of finding additional giant fields onshore is not very high. The unleased frontier areas of Alaska, both onshore

and offshore, and the unleased frontier Outer Continental Shelf (OCS) areas probably contain the most promising exploratory prospects for giant petroleum and natural gas fields. Nonetheless, a high proportion of shortrun U.S. petroleum production will be derived from onshore sites, chiefly from additional discoveries and improved recovery in known fields. After a thorough analysis during 1974 and 1975 of petroleum and natural gas leasing policies on Federal lands, the Department of the Interior (DOI) determined appropriate initiatives and policy changes to overcome constraints to development, both onshore and offshore, and thereby to increase domestic production of these resources. In addition to the petroleum and natural-gas-leasing policy review, DOI also studied leasing constraints to the development of U.S. coal, oil shale, and geothermal energy resources. The findings and subsequent actions are briefly described in chapters 4 through 7 of this report.

The demonstrated coal reserve base—inplace coal that is technically and economically minable at this time—is estimated at 437 billion tons. Recoverability varies in a range from 40

¹ Total of measured, indicated, and inferred reserves.

TABLE 1-1. *Oil reserves and undiscovered recoverable resources for the United States*

[Billion barrels]

Region	Reserves				Undiscovered recoverable resources	
	Measured ¹	Indicated ²	Inferred	Total	Statistical mean	Estimated range ³
Onshore:						
Alaska	9.9	(⁴)	6.1	16.0	12	6-19
Lower 48	21.1	4.3	14.3	39.7	44	29-64
Total onshore	31.0	4.3	20.4	55.7	56	37-81
Offshore:						
Alaska	0.2	(⁴)	0.1	0.3	15	3-31
Lower 48	3.1	.3	2.6	6.0	11	5-18
Total offshore	3.3	.3	2.7	6.3	26	10-49
Total United States	⁵ 34.3	⁵ 4.6	23.1	62.0	82	50-127
Total natural gas liquids	6.4		6	12.4		11-22

¹ Equivalent to "proved reserves" as defined by the American Petroleum Institute (API).

² Equivalent to "indicated additional reserves" as defined by API.

³ The low value of the range is the quantity associated with a 95-percent probability that there is at least this amount. The high value is the quantity with a 5-percent probability that there is at least this amount. Totals for the low and high values must be derived by statistical methods—they are not obtained by arithmetic summation.

⁴ Negligible.

⁵ According to API, total U.S. measured reserves declined during 1975 from 34.3 to 32.7 billion barrels, while total U.S. indicated reserves increased from 4.6 to 5.0 billion barrels.

Source: Miller, Betty M., et al. *Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States*, U.S. Geological Survey Circular 725, National Center, Reston, Va., 1975.

TABLE 1-2. *Natural gas reserves and undiscovered recoverable resources for the United States*

[Trillion cubic feet]

Region	Reserves			Undiscovered recoverable resources	
	Measured ¹	Inferred	Total	Statistical mean	Estimated range ²
Onshore:					
Alaska	31.7	14.7	46.4	32	16-57
Lower 48	169.5	119.4	288.9	345	246-453
Total onshore	201.2	134.1	335.3	377	264-506
Offshore:					
Alaska	0.1	0.1	0.2	44	8-80
Lower 48	35.8	67.4	103.2	63	26-111
Total offshore	35.9	67.5	103.4	107	42-181
Total United States	³ 237.1	201.6	438.7	484	322-655

¹ Equivalent to "proved reserves" as defined by the American Gas Association (AGA).

² The low value of the range is the quantity associated with a 95-percent probability that there is at least this amount. The high value is the quantity with a 5-percent probability that there is at least this amount. Totals for the low and high values must be derived by statistical methods—they are *not* obtained by arithmetic summation.

³ According to AGA, total U.S. measured reserves declined during 1975 from 237.1 trillion to 228.2 trillion cubic feet.

Source: Miller, Betty M., et al. *Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States*, U.S. Geological Survey Circular 725, National Center, Reston, Va., 1975.

to 90 percent of the reserve base, and mining experience has indicated that, nationally, at least half of the in-place coals can be recovered. In terms of Btu, coal represents a preponderance of the Nation's proved reserves of all fuels. Thus, it is coal that will play a major role in meeting our growing energy requirements through the remainder of this century.

The total in-place shale oil resource in medium- and high-grade oil shales is estimated to be approximately 2 trillion barrels, of which 1.8 trillion may be found in the Green River oil shales of Colorado, Utah, and Wyoming. With the technology currently under development, about 80 billion barrels of oil have been estimated to be recoverable from the near-surface, high-grade oil shale beds of the Green River Formation.

In 1975, the USGS prepared the first comprehensive assessment of the geothermal resources of the Nation. Geological Survey Circular 726 provides estimates of total heat in the ground to a depth of 10 kilometers as well as estimates of the part of this heat that is recoverable with present technology, regardless of price considerations. Economic assessments are greatly complicated by the various kinds of potentially available geothermal energy as well as by possible environmental problems.

Policy initiatives and new programs have been proposed and are being implemented to facilitate the exploration and development of these energy sources in a manner consistent with economic, environmental, and other social values.

U.S. Domestic Emergency Oil Reserves

The Energy Policy and Conservation Act of 1975 provides for the establishment of a domestic emergency oil reserve for possible use during any future disruption of imported supplies. It is projected that the oil stockpile will contain at least 150 million barrels of petroleum initially, expanding ultimately to about 500 million barrels.

A stockpile is a major element in the mix of policy actions aimed at securing an adequate domestic supply of fuels. Past studies have shown that stockpiles in general² and an oil stockpile in particular³ can be the most cost-

² Office of Minerals Policy Development, U.S. Department of the Interior, *Critical Materials: Commodity Action Analyses—Aluminum, Chromium, Platinum and Palladium*, Washington, D.C., U.S. Government Printing Office, Mar. 1975.

³ Cabinet Task Force on Oil Imports Control, *The Oil Import Question*, Washington, D.C., U.S. Government Printing Office, 1970.

effective means of providing some measure of national protection against a potential disruption of imported supplies as well as reducing the likelihood that a disruption will occur. Because an oil stockpile provides time to adjust to a loss of imported supplies, the United States will be able to import some portion of its oil requirements with lessened concern over the adverse consequences of a potential embargo. The stockpiling strategy will give the United States flexibility to take advantage of lower world oil prices should they occur in the future.

INCREASING DOMESTIC ENERGY PRODUCTION

The Administration has proposed and/or undertaken major policy initiatives designed to increase domestic energy production. The following paragraphs provide a discussion of those initiatives as well as of certain issues needing resolution before significant gains in domestic energy development can be made.

Energy Pricing Policies

Since many of the potential, new sources of domestic energy production, with the exception of coal, will be higher cost sources, any policy designed to reverse the trend of rising crude oil imports must include energy prices which are substantially higher than those prevailing before 1973.

As long as the Organization of Petroleum Exporting Countries (OPEC) exists, world oil prices are likely to remain at levels substantially higher than preembargo levels. The domestic supply of oil and gas responds to the usual economic incentives; that is, the higher the prices, the greater the levels of exploration, development, and production. The Administration has proposed and strongly backed an energy-pricing policy that would deregulate the domestic price of oil and the price of new natural gas sold in the interstate market.

The Energy Policy and Conservation Act of 1975 provides for the deregulation of oil prices over a 40-month period. However, a great deal of uncertainty still exists as to whether interstate natural gas prices will continue to be regulated. The regulated low price of interstate natural gas discourages investments in and production of natural gas sources that would not

be profitable unless sold at the deregulated higher prices.

ISSUE AND RECOMMENDATION

- Enact legislation that would decontrol the price of new natural gas shipped to interstate markets.

New or Commercially Untested Technologies

Large-scale development of the nonconventional domestic energy sources will require the implementation of higher cost, high-risk, new, or commercially untested technologies. Such technologies include cleaner methods of burning coal, coal gasification and liquefaction, and oil shale, geothermal, and solar energy development.

The amount of capital available to achieve an efficient scale of production from any of these new or untested technologies is severely limited not only by the high risks associated with first generation technologies, but also by the potential for significantly lower oil prices.

There are few reliable cost estimates of producing energy from possible, new domestic sources. The scarcity of cost information that is crucial to energy and minerals policy decision-making indicates the urgency of developing reliable supply curve estimates discussed in chapter 10 of this report.

Some preliminary estimates of the production costs for shale oil, coal liquefaction, and coal gasification are available. For example, the Bureau of Mines estimated the cost of producing shale oil, including a 15-percent discounted cash flow rate of return on investment, to range between \$10 and \$11 per barrel of oil, or from \$1.72 to \$1.90 per million Btu, as of June 1975. The Bureau estimated the cost of producing oil from coal to range from \$18 to \$27 per barrel (\$3.10 to \$4.65 per million Btu) depending upon the production process and source of coal used. The estimated costs of producing high-Btu gas ranges from \$2.47 per thousand cubic feet (million Btu) from Montana coal to \$4.19 per thousand cubic feet (million Btu) using New Mexico coal. The current price of imported oil is approximately \$12 to \$13 per barrel or \$2.07 to \$2.24 per million Btu.

Since June 1975, the range of production costs for shale oil has been revised to between \$10 and \$14 per barrel of crude oil plus \$2 to \$4 in refining costs because of a lower recovery factor than had earlier been used and because of increasing capital and operating costs. It should be noted that some industry cost figures for producing shale oil have been as high as \$22.50 per barrel. If the revised lower cost estimates are at all accurate, both gas from coal and shale oil could be marginally competitive with OPEC oil, particularly if real world oil prices should rise. Moreover, the cost of coal gasification and shale oil development probably could be reduced considerably in the future, since common experience reveals that the costs of production usually decrease as operating experience is gained, and as second and third generation technologies are developed and utilized.

If synthetic fuels such as oil from shale or gas from coal are to make a significant contribution to the energy supply of the United States, the high degree of uncertainty about the profitability of investments in first-generation technologies will have to be reduced considerably. In 1975, an Interagency Task Force on Synthetic Fuels concluded that initial investments in these high-risk, first-generation technologies will be inadequate during the next decade unless the Federal Government plays an active role in reducing the risk of large capital losses and assists communities in meeting the front-end fiscal impacts associated with such development.

If the United States is to make headway during the next 10 to 15 years in attaining the objective of an adequate long-term supply of domestic fuels, the Federal Government must actively pursue a program of encouraging the development of the most promising synthetic fuels. The Administration has proposed a Synthetic Fuels Commercialization Program (Synfuels) to reduce the high risks of investment in first-generation technologies. The Administrator of the Energy Research and Development Administration (ERDA) would be authorized to provide loan guarantees for the construction of commercial demonstration plants capable of converting coal, oil shale, and other domestic resources into fuel.

In early 1975, the Federal Government awarded a \$237 million contract to build the Nation's first large plant to convert coal to gas and oil. Although this project is much smaller in scope than the Administration's Energy Independence Authority or Synfuels program, it does represent a first step in enabling the United States to use its vast coal reserves to satisfy a much wider variety of end-use demands for energy than is possible under conventional coal-consuming technologies. Responsibility for this project was transferred by statute from DOI to ERDA.

ISSUES AND RECOMMENDATIONS

- Enact legislation to provide for Government incentive programs, e.g., the Administration's proposed Synthetic Fuels Commercialization Program, to encourage investments in the currently available but commercially untested technologies for producing synthetic fuels.
- Continue Government-sponsored research in new technologies at the levels of the past few years to reduce the costs of exploration, extraction, recovering, and processing of energy.

Federal Leasing Policies

Federal leasing policy significantly affects the long-run domestic energy supply. To meet national goals, Federal leasing activities have been thoroughly reviewed since the Arab oil embargo, and new policy initiatives are being implemented. For example, plans to accelerate the rate of leasing of the OCS lands for oil and gas development are apparent in the revised OCS schedule, which includes four lease sales in 1975 and a proposed rate of six lease sales per year for the 1976-78 period, including some or all frontier areas by the end of 1978. In addition, to increase competition in the bidding for OCS oil and gas lease tracts, the Department has banned joint bidding by the largest oil companies. It has also conducted a royalty-bidding experiment in the OCS to determine the competitive effects of royalty versus bonus bidding.

In January 1976, the Secretary of the Interior announced a new Federal Coal Leasing

Program, which resumes coal leasing under competitive bidding in amounts appropriate to actual production plans. Production will be insured through the implementation of continuous operation, and diligence requirements and advance royalty payments. Coal leasing will not take place where the value of the coal does not exceed cost, including environmental cost, or where the coal development activity would result in irreversible environmental degradation.

Under the Prototype Oil Shale Leasing Program, the Department issued four oil shale leases in 1974: Colorado A and B, and Utah A and B. Submission by the lessees of final Detailed Development Plans for all four lease tracts is expected during 1976. Despite the early progress of the Prototype Oil Shale Leasing Program, commercial development of oil shale on Federal lands remains clouded by a number of unresolved issues, including: the future of Synfuels legislation, resolution of the spent shale disposal problem, determination of ownership for those public lands (approximately 85 percent) covered by mining claims that have never been brought to patent, and adverse economics for producing oil from shale as illustrated by the relinquishments by two companies of their interests in the Colorado B lease and the request by the remaining companies for a suspension of their lease.

To date, the Department has held 28 lease sales for Known Geothermal Resource Areas (KGRA's) and has tentatively scheduled an additional 10 sales in fiscal year 1976. The Geysers geothermal field in California is the only producing geothermal power facility in the United States. Because of economic, technical, and environmental problems, geothermal power development did not proceed on federally leased lands in 1975, despite the increased leasing that occurred. Moreover, leasing of certain lands within KGRA's will be constrained until the definitional question relating to classification of geothermal resources as a mineral, gas, or superheated water and the issue of control or ownership of these resources are resolved by the courts. In the meantime, the Department is considering developing special procedures for the leasing of lands where ownership of geothermal resources is in dis-

pute through issuance of leases with the understanding that all rents, royalties, and bonuses would be held in escrow pending resolution of these questions.

The Department has several key programs designed to support the increased activity involved in its energy-leasing responsibilities.

The tract selection workload for OCS lease sales will increase substantially to select tracts with high resource potential and to assure that the Government receives a fair return for use of its resources. In conjunction with accelerated leasing, 15 major environmental baseline and monitoring studies will be underway in frontier areas.

In addition, a large data bank will be developed to contain more than 13,000 well logs, information on more than 250,000 miles of geophysical survey data purchased over the past decade, and an extensive collection of data internally generated and purchased on OCS areas containing oil and gas mineral deposits. An inventory of oil and gas reserves on Federal OCS land also will be developed to provide information to plan future energy policy and to improve OCS lease regulation operations.

Increases in onshore leasing activities are proposed to keep pace with the increasing workload, as well as to improve the quality of lease management in every facet of lease operations, including exploration, development, production, storage, receipt of fair market value, and diligent development of Federal oil and gas reserves.

For USGS oil and gas activities, environmental analysis studies are estimated to increase from 2,000 to 2,500, inspection of wells from 26,000 to 34,000, reservoir studies from 15 to 300, and prelease engineering evaluations from 750 to 800.

A significant workload increase is projected for existing coal and uranium leases, and permits are expected to bring increased industry exploration and development in fiscal year 1977. Coal production from Federal lands increased 38 percent in 1975 over 1974, and the trend is expected to continue in 1976 and 1977. Projected increases include rises in lease inspections from 500 in 1976 to more than 2,100 in 1977, environmental analysis studies from

200 to 550, and mining plan appraisals from 200 to 440.

ISSUE AND RECOMMENDATION

- Enact legislation authorizing the Secretary of the Interior to grant lessees additional land for offsite disposal of spent shale.

Financing the Fiscal Impacts of Energy Development

Development of western coal and oil shale and the petroleum and natural gas resources of the frontier OCS areas may result in socioeconomic impacts upon the political jurisdictions and population in neighboring regions. Despite fiscal innovations at the State and local levels of government, some States and localities may experience difficulty in financing energy-related capital costs that must be incurred before the energy production is actually underway and additional tax receipts accrue to the political jurisdiction. Federal financial assistance in the form of a loan program to impacted communities and regions to meet front-end fiscal needs will help remove impediments to Federal energy resource development. In early February 1976, the Secretary of the Interior submitted to the Congress and the Administration a legislative proposal that would provide planning grants, loans, and loan guarantees to States, localities, and Indian reservations to help finance front-end infrastructure needs. Such a program would provide needed assistance in a timely fashion yet would encourage States and localities to implement fiscal systems whereby the beneficiaries of the energy development would ultimately pay the costs.

Environmental Policies and Programs

Protection of the environment continues to be an important factor in actions to increase the domestic supply of energy resources by both the private and public sectors. Although environmental activities of the Department are interrelated, they can be relegated by function to three basic categories: environmental data collection, regulation, and research and demonstration. The following are a few highlights of the total departmental effort.

A major initiative to preserve the environment of the OCS areas is the Department's baseline environmental data-gathering and -monitoring activities. Identification of toxicity levels in the water, sediment, and organisms provides baseline data against which future changes due to oil and gas operations can be compared. During 1975, OCS benchmark data collection activities in the Mississippi-Alabama-Florida, northwestern Gulf of Alaska, southern California, south Texas, and mid-Atlantic areas were completed. Drawing upon the benchmark data, the Bureau of Land Management has already begun a monitoring program in each of these areas. Data collection activities continue underway in 10 other OCS areas.

The new Coal Leasing Program, recently announced by the Secretary of the Interior, will achieve a proper balance between the national interest in the production of coal and the national interest in the protection of the environment. Under this Coal Leasing Program, the scope of Federal environmental regulations is expanded to include performance standards for surface mining of Federal coal, and Federal responsibility is expanded to include the private surface overlying Federal coal. The new regulations set forth environmental standards that will be used in conducting prelease, permitting, and licensing examinations which will develop the terms and conditions of the lease, permit, or license. Performance and reclamation requirements will be consistent throughout the preleasing, exploration, mining, and abandonment phases of coal operations and will further require that exploration and/or mining plans be submitted in advance of the operation.

To assure maximum near-term coal production with minimal impact on the environment, new or modified equipment and techniques are being developed by the Bureau of Mines. Demonstration of mining systems (extraction and reclamation) is in process to permit environmentally acceptable mining in areas with delicate ecosystems, such as the arid Western States, and of methods and equipment to allow elimination of such environmental problems as highwalls and stream siltation in the Eastern States.

The air pollution effects of expanding coal use have been the subject of continuing re-

search by the Bureau of Mines and other Federal agencies concerned with the effects of sulfur dioxide pollution. Research must be continued on processes to remove sulfur from coal prior to combustion or to remove sulfur oxides during or after combustion. Hardware used at present for stack gas cleanup is bulky, expensive, and difficult to keep operational.

Transportation

The potential contribution of coal, oil, and gas as major domestic energy sources is dependent to a large degree upon the continued availability of adequate transportation facilities.

Unit trains have come into widespread use for movement of coal to consumers who are able to take deliveries of large quantities (8,500 to 10,000 tons) on a regular schedule. However, the fact that 23.5 percent of the coal hauled during 1975 was hauled over railroads already in bankruptcy indicates that the Government must be alert to the possibility that the lack of capacity of the railroads could place a limitation on the expanded use of coal during the next decade.

Coal slurry pipelines could provide substantial capacity in the transport of western coal to midwestern markets. Slurry pipelines currently under consideration are nearly four times the length and have up to five times the capacity of the 275-mile, 5-million-ton-per-year pipeline now in use for movement of coal from the Black Mesa mine in northeastern Arizona to an electric-generating station at the southern tip of Nevada. However, there are several issues relating to the installation and operation of such pipelines.

One major constraint to the growth of slurry pipelines is the lack of authority by the private companies in obtaining rights-of-way. Legislation to amend the Minerals Leasing Act of 1920 to grant rights-of-way for coal pipelines across Federal lands and to authorize the use of eminent domain for coal pipelines on private lands is pending before both the House and Senate Committees on Interior and Insular Affairs. Unless such legislation is enacted, slurry pipelines will continue to be limited to short distances. The rights-of-way issue is complicated

by economic and environmental issues. For instance, one obstacle to the development of a full-scale slurry pipeline delivery system, particularly in the arid West, is the amount of water required by current commercially available slurry processes.

The construction of pipelines to carry Alaskan oil and gas to the lower 48 States will provide substantial additions to the domestic fuel supply. Construction of the Alyeska oil pipeline from Prudhoe Bay to Valdez, Alaska, is continuing on schedule. The pipeline is expected to begin transporting North Slope oil at a rate of 1.2 million barrels per day by the end of 1977.

Currently two groups are vying for the right to construct a natural gas pipeline to transport natural gas from Prudhoe Bay to market. One group proposes to build a pipeline across Alaska to Point Gravina, Alaska, where the gas would be liquefied and shipped in cryogenic tankers to regasification facilities in California. The second group, a consortium of Canadian and American companies, proposes a pipeline to carry North Slope Alaskan and Canadian gas from Alaska and the Canadian Arctic across Canada to be delivered to Canadian and U.S. markets.

The results of a study conducted by DOI during 1975 indicate that both proposed delivery systems are technologically and economically feasible. However, in transmitting the report on the two transportation systems to Congress, the Secretary of the Interior emphasized that his conclusions were subject to consideration of the environmental impacts disclosed by the final Environmental Impact Statement (EIS). The Federal Power Commission is proceeding with a draft EIS on the trans-Alaska system, and DOI filed the final EIS on the trans-Canada system on March 29, 1976. The selection of a route is further complicated by varying economic factors, international relations, and effects on consumers. The Administration has proposed legislation to expedite route selection and to assure that a choice between the alternatives will be made before August 1977.

ISSUES AND RECOMMENDATIONS

- Enact legislation to amend the Minerals Leasing Act of 1920 to grant rights-of-way

for coal pipelines across Federal lands and to authorize the use of eminent domain for coal pipelines on private lands.

- Enact the Administration's legislative proposal to expedite delivery of natural gas from Alaska's North Slope.

Improving the Safety and Economics of Energy Production

The DOI has several program areas administered by the Bureau of Mines that will affect the safety and economics of energy production. Three such program areas, administered by the Bureau of Mines, involve coal mine health and safety research, advancing coal-mining technology, and advancing oil-shale-mining technology. A brief description of these efforts follows.

Coal Mine Health and Safety

Research, development, and transfer of technology is carried on in all facets of coal mining involving health and safety hazards. As an example, the Bureau's fire and explosion program undertakes broadly based research into the spread of fires in coal mines to develop optimal means for their prevention, suppression, and extinguishment, including improved personnel safety procedures, which will result in a meaningful reduction of explosion hazards in coal mines.

A methane control program is directed to determining and assessing geologic and other factors related to the occurrence and movement of methane in coal and adjacent strata, development and testing of techniques for degasification ahead of mining, and development and testing of techniques to control methane in active workings and abandoned areas during mining. In addition to these two coal mine health and safety programs, the Bureau focuses its efforts on such other coal mine health and safety problems as ground control, industrial-type hazards, respirable dust, noise levels, and post-disaster rescue technology.

Advancing Coal-Mining Technology

The overall goal of this activity is to develop and demonstrate coal-mining technology that will lower the cost of coal, assure greater protection to the miner and more efficient use of

our coal resources, and reduce the environmental costs of mining. To these ends, the Bureau of Mines continues to:

(1) Develop longwall mining technology to a higher degree of production capability and utilization than that now available.

(2) Automate room and pillar mining technology to allow for safer and more efficient coal extraction.

(3) Develop methods to permit the mining of thin, thick, and multiple coal seams efficiently and in a manner that insures full resource utilization.

(4) Improve equipment and techniques for surface coal mining that assure minimum environmental impact and overall cost by proving the efficacy of integrated extraction and reclamation equipment and systems in all the major surface coal-mining regions.

(5) Advance coal preparation and cleaning technology to assure a continuing supply of clean coal for direct combustion or for conversion.

Advancing Oil Shale Mining Technologies

The vast oil shale deposits contain great quantities of potentially usable energy which could make a significant contribution to this Nation's goal of reducing its dependence upon imported energy. To assist the Nation in solving some of the major problems encountered in mining the shale, the Bureau of Mines conducts programs:

(1) To evaluate oil shale mining concepts in order to assist government and industry decisionmakers in the determination of the economic and other consequences of oil shale mining.

(2) To develop waste stabilization techniques for processed shale in order to assure that the surrounding environment is not degraded by mining or waste disposal operations.

(3) To evaluate the nature and extent of hazards associated with the working and living environment in the oil shale industry and which affect the design of mining/processing/disposal systems.

(4) To develop, test, and demonstrate improved, low-cost mining methods and equipment that will be needed to mine large tonnages of oil shale.

Chapter 2

METALS AND NONMETALLIC MINERALS

Summary.—This chapter reviews the conditions facing the United States at the end of 1975 regarding our minerals position. Uncertainties abound, resulting mainly from the movement toward more host country control of production and reserves. These changes may affect our ability to maintain adequate supplies of metals and nonmetallic minerals for domestic consumption. New terms for world trade are being debated that could alter continued access to worldwide resources as the United States has known it in the past. The development of domestic resources faces significant concerns about land-use policy and environmental quality.

BACKGROUND

In 1975, the reduced demand for many metal and nonmetallic minerals relieved the high price surges of 1973 and shortages of 1974. This relief also gave U.S. policy analysts the opportunity to review the situation and options. They concluded that the temptation to adopt mineral policy actions similar to those presented for energy should be resisted for two basic reasons: (1) the 1973-74 situation reflected an extraordinary combination of events, and (2) the basic circumstances in most mineral markets differ from those produced by the relationship of the Organization of Petroleum Exporting Countries (OPEC) to the oil markets.

The 1973-74 problems resulted from an extraordinary combination of the four following circumstances:

- (1) Mineral demand in many industrial countries increased sharply thus straining the productive capacity for many materials and causing temporary shortages.
- (2) Considerable speculative buying occurred as a hedge against inflation and currency fluctuations thus reinforcing the demand surge.

- (3) Serious supply disruptions from pollution control measures on some smelters, the delayed effects of price controls in the United States, labor problems, political instability in some producing areas, and other production problems at least temporarily stopped or curtailed expansion of capacity.
- (4) Dollar devaluation amplified price increases in real terms.

The structures of most mineral markets differ from that of the oil market in at least four ways:

- (1) Mineral producer groups generally have significantly less control of export markets than OPEC in the case of oil. This results from both the substitution possibilities available for many nonfuel minerals and the different distribution patterns of world oil resources as compared to the nonfuel minerals.
- (2) Nearly all the major metal and non-metallic mineral producing countries in the developing world urgently need foreign exchange income.
- (3) The value of most mineral raw materials is generally a much smaller portion of the final product value than the corre-

sponding values of petroleum and its products.

- (4) The absolute magnitude of the potential impact of supply curtailment or drastic price increases for mineral raw materials is considerably less than that for petroleum.

INTERNATIONAL DEVELOPMENTS AND U.S. RESPONSES

Developments

The movement by producers of raw materials toward more control of markets faltered in 1975 as problems arose about financing proposed changes. This pause is permitting industrialized countries, the major consumers of metals and nonmetallic minerals, to evaluate and digest the concerns of developing countries. At the same time, developing countries are elaborating on their ideas and proposals for a changed world economic order. There now appears to be a favorable atmosphere for constructive dialogue. The United States is participating in discussions to try to resolve our differences with the raw material producing countries while taking account of all interests.

Differences between producer and consumer countries sharpened when international developments of the past 2 years alerted consumers to the possibility of OPEC-like producer groups for several mineral commodities. In addition, many producer countries asserted more sovereignty over private, foreign investors operating within their political jurisdictions. Major points in the move to change raw material supply conditions were symbolically expressed through a "Charter of Economic Rights and Duties," passed in the fall of 1974 by the 29th Session of the United Nations General Assembly. This charter, among other features, asserted the right of raw-material-producing countries to prices at remunerative levels, and to the expropriation of foreign-owned assets without regard for compensation. The United States made it clear at the time that it did not consider the charter a unanimous position on world economic problems, but the forces supporting such a producer country declaration are of concern to this country.

Although the aspirations and understanding of the suggested "New International Economic Order" vary from one producing country to another, a convenient formulation comes from the objectives of the Integrated Commodity Program of the United Nations Conference on Trade and Development. These objectives include:

- (1) Simultaneous solutions of all commodity problems as opposed to commodity-by-commodity agreements
- (2) Commodity action to take account of interests of both consumers and producers
- (3) Approval of cooperative actions by producer organizations
- (4) Price stabilization, i.e., reducing price fluctuations without raising the general level of prices
- (5) Raising and maintaining commodity prices at "remunerative levels," adjusted for inflation
- (6) Encouragement of diversification and downstream processing of commodities in producer countries
- (7) Improved marketing arrangements and access to markets for primary commodity producers

The United Nations declaration and the policies of many mineral-rich countries that no longer permit control of their natural resources by private foreign investors emphasize part of the future mineral availability problem: Namely, how to promote investment to expand worldwide capacity in minerals and other critical raw materials. Host country control over investment opportunities based on the latest year of comparable world data, 1974, is summarized in table 2-1. Events in 1975 will show even more host country control or less opportunity for controlling interest by nonhost country (foreign) private investment.

Foreign private investment could gain controlling interest in mineral properties containing just over half of the world's manganese reserves, less than half of the copper and tin reserves, about one-third of the bauxite and iron ore reserves, less than one-fourth of the tungsten reserves, and less than one-sixth of the mercury and phosphate rock reserves. These conditions essentially increase the burden on

TABLE 2-1. *Percentage by type of host country control of world total production and estimated reserves of selected minerals, 1974*

Commodity	Market economies ¹ in foreign countries										U.S. domestic	
	Centrally controlled economies		Complete state ownership		Controlling interest							
					By state		By country nationals		By private investor ²			
	Produc- tion	Re- serves	Produc- tion	Re- serves	Produc- tion	Re- serves	Produc- tion	Re- serves	Produc- tion	Re- serves	Produc- tion	Re- serves
Bauxite	13	4	4	1	20	6	30	58	29	32	3	(³)
Copper	17	12	11	8	23	31	5	4	26	25	19	20
Iron ore	35	45	11	6	1	1	13	13	31	28	9	7
Manganese	39	39	2	(³)	1	(³)	17	4	40	56	none	none
Mercury	39	31	41	59	none	none	8	5	11	5	1	9
Phosphate rock	25	5	32	71	5	3	neg.	6	(³)	1	38	14
Tin	22	20	none	none	20	34	(³)	(³)	53	45	(³)	(³)
Tungsten	49	68	2	(³)	13	7	4	1	22	18	10	6
Petroleum	19	16	26	30	28	36	(³)	(³)	10	13	16	5

¹ The exact list of countries grouped by type of controlling interest within a market economy varies from commodity to commodity.

² This category represents those circumstances in foreign countries where citizenship of the investor does not restrict investment in the host country. This is in contrast to those countries where private investment is encouraged, but country nationals must have controlling interest of the investment.

³ Negligible.

⁴ Withheld to maintain confidentiality of company data.

Note.—Totals may not add to 100% because of rounding procedures. Latest year for which comparable world data are available is 1974.

Source: U.S. Bureau of Mines.

the host country or its nationals to raise the necessary capital for future mineral industry expansions.

Although significant portions of the world's production and reserves remain under the control of non-host-country private investments, nationalization of mineral properties has reduced these amounts. Most nationalization has occurred in three commodities: bauxite, copper, and iron ore. In 1975, Peru and Mauritania nationalized copper and iron ore properties, as did Venezuela with iron ore. Guyana nationalized some bauxite properties during 1975. Other commodities impacted by nationalization in the 1970's include graphite (Sri Lanka and Malagasy), phosphate rock (Togo), tin (Bolivia), and zinc (Bolivia).

Uncertainties have arisen from the organization of producer associations by foreign suppliers of bauxite, copper, iron ore, mercury, tin, and tungsten. Although these producer groups have not yet been successful in cartelizing their respective supplies, their presence has increased the degree of uncertainty associated with foreign supplies. The tin producer-consumer group

controls 70 percent of world production and 60 percent of world reserves (table 2-2). The tungsten producer group controls 55 percent of world production and 70 percent of world reserves. For bauxite, the percentages are 75 and 65; for mercury, 43 and 60; for iron ore, 26 and 20; and for copper, 32 and 35. In comparison, OPEC controls over half of world production of crude petroleum and over two-thirds of world reserves.

The reliance of the exporting countries within the producer groups on the foreign exchange earned by their exports of these commodities varies greatly by commodity and country. Aluminum raw materials account for over 70 percent of the value of exports from Guinea, Jamaica, and Surinam. Copper export earnings are essential to three association members: Zambia (93 percent), Chile (75 percent), and Zaïre (54 percent). Tin exports earn significant foreign exchange for Bolivia (45 percent of export earnings). For the other commodities and countries, export earnings from iron ore, mercury, or tungsten are not as dominant in the total export earning picture.

TABLE 2-2. *Producer associations*

Commodity	Countries in the association	Top three producers in association (1974)	Groups' percentage of production by top 3 (1974)	Groups' percentage of world production (1974)	Groups' percentage of world reserves (1974)
Bauxite	Australia, Guinea, Guyana, Jamaica, Sierra Leone, Surinam, Yugoslavia, Dominican Republic, Ghana, Haiti, Indonesia ¹	Australia Jamaica Surinam	54	75	65
Copper	Chile, Indonesia, ¹ Peru, Zaïre, Zambia; Australia, ¹ Papua-New Guinea ¹ as associated members	Chile Zaïre Zambia	90	32	35
Iron ore	Algeria, Australia, Chile, India, Mauritania, Peru, Tunisia, Sierra Leone, Venezuela, Sweden	Australia India Sweden	72	26 ² (28)	20 ² (21)
Mercury	Italy, Yugoslavia, Turkey, Peru, Spain	Spain Italy Yugoslavia	89	43	60
Tin (producers only)	Australia, Bolivia, Indonesia, Malaysia, Nigeria, Thailand, Zaïre	Malaysia Bolivia Indonesia	75	70	60
Tungsten	Australia, Bolivia, Brazil, Portugal, Peru, Thailand, Mexico, ³ South Korea, ³ France, People's Republic of China, ³ Canada, ³ Rwanda, Spain, Zaïre	People's Republic of China South Korea Bolivia	64	55	70

¹ Became associated with group in 1975.² Numbers in parentheses are based on percent iron in ore.³ As an observer.

Source: U.S. Bureau of Mines.

U.S. Responses and Opportunities

A review of U.S. commodity policy, under the auspices of the National Security Council and the Economic Policy Board, was conducted during 1975 to consider all the proposals for change of the international economic order. That review produced a reaffirmation of our belief in a free and competitive market as the best mechanism for allocating scarce investment resources. It also confirmed U.S. skepticism of international commodity agreements as effective commodity price stabilization measures, since such agreements must be administered to strike a balance between the opposing interests of producers and consumers.

The problems of instability of export earnings to mineral producing countries have been recognized as a significant factor affecting the outlook for trade and investment and the uninterrupted flows of raw materials. The United States has proposed the creation in the International Monetary Fund of a new development

security fund to stabilize overall export earnings. A second U.S. proposal is for an expanded role for the World Bank as an intermediary between private investors and host governments in developing raw materials. This proposal attempts to preserve the market-orientation allocation of investment capital resources. In addition, the United States has called for a consensus on the proper role of multinational enterprises in world commodity trade and investment.

Opportunities for expanding mineral supplies are emerging from ocean mining and are discussed further in chapter 9. The advances in the technical ability to recover minerals from the ocean floor suggest that commercial ocean mining operations will soon become a reality. However, a stable investment climate will likely be required before a viable ocean mining industry will develop. The United States is heavily dependent on the international market for supplies of three of the potentially recoverable

Minerals, cobalt, manganese, and nickel (98, 99, and 71 percent, respectively).

Several U.S. companies have been active in ocean mining activities both individually and in consortia. A major hurdle that must be overcome is the resolution of international legal and political issues concerning the management of seabed resources beyond the limits of national jurisdiction. The preferred approach to long-term, stable development of these resources would be the adoption of a satisfactory international regulatory regime under a new law-of-the-sea treaty. During the recent session of the Law of the Sea Conference, there were indications that some developing countries are willing to work with the United States to achieve a reasonable treaty. Yet, a number of issues will require intensive negotiation before a treaty becomes a reality, so that the uncertainty about the timing and contents of any international legal regime for ocean mining continues.

ISSUE AND RECOMMENDATION

- The Federal Government should continue to pursue a satisfactory international regulatory regime for ocean mining under a new law-of-the-sea treaty. However, we cannot delay indefinitely the creation of secure investment conditions for ocean-mining activities. If the law-of-the-sea negotiations are not meeting U.S. mineral resource objectives at the conclusion of the 1976 summer session of the conference, we should consider alternative action to protect these interests.

Future Outlook

To an ever-increasing degree, marketing decisions are being made or significantly influenced by the host governments in the countries where the mineral reserves and resources are found. This growing role of government participation in the decisionmaking processes of world minerals markets increases the likelihood that political as well as economic factors will determine the allocation, distribution, and consumption of minerals in the future. Just exactly what the impact of this role will be is unknown at this time.

The increased control by resource-rich countries of the developments within their borders

will change the historical, institutional, and economic framework of the minerals industry. International companies that are vertically integrated from raw material production through the manufacturing of consumer products stand to lose control of the raw material production end of the flow of materials. The exact cutoff point will vary from situation to situation, but more interest by the developing countries to process raw materials to higher valued products is definitely apparent.

Independent producing countries will have economic incentives to act in a manner similar to the actions that could be expected from independent companies. To the extent that this happens, the degree of security or insecurity of imported mineral supplies to the United States will depend upon the particular mineral and the market forces. Studies indicate that in most cases the market forces will assure the security and the availability of mineral supplies to the United States in the future. In view of the institutional and economic changes since 1970, however, the United States must maintain a close watch over the developments within each of the individual mineral markets and prepare alternative measures for meeting any undesirable set of circumstances.

DOMESTIC DEVELOPMENTS¹

Minerals Position

Along with the changing international conditions affecting the future availability of metals and nonmetallic minerals is a growing concern that further development of the domestic resource base is not receiving sufficient encouragement. Table 2-3 presents data for 1971 through 1975 on the percentage of U.S. annual total demand for selected commodities supplied from domestic sources. These sources include recycled materials. Table 2-4 presents data showing the principal sources of selected U.S. imports of metal and nonmetallic minerals by country. The major suppliers of the 33 commodities ranked by number of commodities are

¹ More details are presented in *Commodity Data Summaries 1976*, published by the Bureau of Mines. These tables represent summations of the data presented in that report.

TABLE 2-3. Percent of U.S. annual total demand for selected metal and nonmetallic minerals supplied from domestic sources during the period 1971 through 1975 compared with estimated domestic resources¹

Commodity	Percent of U.S. annual demand supplied from domestic sources by year					Estimated domestic resources ²	
	1971	1972	1973	1974	1975	Identified resources ³	Hypothetical resources ⁴
Aluminum (ores and metal)	15	13	11	12	15	Very large	KDI
Antimony	64	50	50	56	44	SMALL	SMALL
Asbestos	17	16	18	12	14	SMALL	INSIGNIFICANT
Barium	64	61	63	62	65	Very large	Very large
Bismuth	73	36	27	36	20	SMALL	KDI
Cadmium	69	62	59	54	50	Moderate	Large
Chromium	16	9	9	10	9	INSIGNIFICANT	INSIGNIFICANT
Cobalt	4	2	2	1	2	Very large	Huge
Columbium	0	0	0	0	0	Very large	KDI
Copper	91	89	92	80	99	Large	Large
Fluorine	21	23	21	19	18	SMALL	Moderate
Gold	34	29	52	37	55	Large	KDI
Iron	68	74	77	76	71	Very large	Huge
Lead	76	76	71	81	96	Large	Moderate
Magnesium (nonmetallic)	95	95	94	94	97	Huge	Huge
Manganese	3	2	2	2	1	Large	KDI
Mercury	52	39	22	14	27	SMALL	KDI
Mica (sheet)	0	0	0	1	0	INSIGNIFICANT	SMALL
Molybdenum	100	100	100	100	100	Huge	Huge
Nickel	40	35	31	28	29	Large	KDI
Platinum group metals	25	18	12	12	20	Moderate	Large
Phosphate	100	100	100	100	100	Very large	Huge
Potassium	54	55	47	42	51	Very large	Huge
Selenium	73	76	43	41	42	Huge	Huge
Silver	55	50	34	45	70	Moderate	Large
Strontium	0	0	0	0	0	Huge	Huge
Tantalum	4	4	13	13	5	INSIGNIFICANT	KDI
Tellurium	80	62	67	59	41	Large	Very large
Tin	19	17	16	16	25	INSIGNIFICANT	INSIGNIFICANT
Titanium (ilmenite)	67	82	72	67	72	Very large	Very large
Titanium (rutile)	1	20	4	2	22	Moderate	Very large
Tungsten	54	57	37	37	46	Moderate	Moderate
Vanadium	79	73	57	64	64	Very large	KDI
Zinc	41	89	36	41	36	Very large	Very large

¹ The concepts of this table are under continual review and represent current state of the art procedures.

² Resource appraisal terms:

Huge—domestic resources (of the category shown) are greater than 10 times the minimum anticipated cumulative demand (MACD) between the years 1975 and 2000.

Very large—domestic resources are 2 to 10 times the MACD.

Large—domestic resources are approximately 75 percent to twice the MACD.

Moderate—domestic resources are approximately 35 percent to 75 percent of the MACD.

SMALL—domestic resources are approximately 10 percent to 35 percent of the MACD.

INSIGNIFICANT—domestic resources are less than 10 percent of the MACD.

KDI (known data insufficient)—resources not esti-

mated because of insufficient geologic knowledge of surface or subsurface areas.

³ Identified resources are defined as including reserves and materials other than reserves that are reasonably well known as to location, extent, and grade and that may be exploitable in the future under more favorable economic conditions or with improvements in technology. Reserves are those portions of the identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination.

⁴ Hypothetical resources are undiscovered, but geologically are predictable deposits of materials similar to identified resources.

Source: Based on information from U.S. Geological Survey and U.S. Bureau of Mines.

Canada (20), Mexico (12), Australia (8), Peru (8), and South Africa (7).

Inspection of table 2-3 shows that U.S. self-sufficiency increased at least temporarily in 1975 in the case of about half of the commodities listed, due for the most part to curtailed demand. Table 2-3 also presents the latest estimates for selected metal and nonmetallic mineral resources in the United States. The table shows that for chromium, sheet mica, tantalum, and tin, the domestic U.S.-identified-resource position is substantially inadequate when compared to a recent estimate of cumulative demand for these minerals through the year 2000. For five other commodities, antimony, asbestos, bismuth, fluorine, and mercury, the U.S.-identified-resource position, in relation to the minimum anticipated cumulative demand from now to the year 2000, may be considered nearly as inadequate. Hypothetical resources² do not give much encouragement for improvement from this situation either. It should be emphasized that the table shows the relationship between potential domestic sources for these minerals and an estimate of the cumulative minimum anticipated demand to the year 2000. Thus, changes in the estimates for demand, additional recycling, and additional scope for materials substitutions will alter the comparison and the data presented in the table.

Inspection of table 2-3 further shows that for those commodities with insignificant or small quantities of identified domestic resources (antimony, asbestos, bismuth, chromium, fluorine, mercury, sheet mica, tantalum, and tin), the domestic supply base appears to have been developed to the extent supportable by the apparent potential through the year 2000. There are also several mineral commodities where the domestic resource base appears more than adequate to supply significantly more of the domestic demand than recent experience shows is being supplied.³

² Hypothetical resources have not yet been discovered, but are geologically predictable in known mineral districts. Exploration activity and new earth science theory methods can move these hypothetical resources into reserve and identified subeconomic categories.

³ A problem with this conclusion is not enough attention has been paid to relating prices to the potential quantities available from domestic sources. Some steps

Constraints

Two prominent factors illustrate constraints on developing domestic resources: the availability of Federal lands for mineral exploration and development and the effects of environmental legislation on the minerals industry.⁴

Availability of Federal Land

The availability of land for exploration and development of energy sources and minerals controls the opportunities available to the domestic industry for meeting the future needs of the country. The Federal Government, as a major landowner in many important mineral-producing States, can significantly influence the future course of mineral exploration and development by its land policy.

Laws governing development and control of onshore mineral resources on Federal lands can be divided into two basic categories. The first category consists of the Mining Law of 1872. The second category, referred to in this report under the collective term "Mineral Leasing Laws," includes three separate laws. The first and most important Mineral Leasing Law is the Mineral Leasing Act of 1920. A second leasing law is the Acquired Lands Act of 1947, which regulates mineral disposal on all lands acquired by the Federal Government, and which incorporates most features of the 1920 act. The third leasing law is the Geothermal Steam Act of 1970, which regulates the disposition of geothermal steam. The Mining Law applies to only 19 States, whereas the Mineral Leasing Laws apply to all 50.⁵ Frequently, the surface estates of public lands are managed separately from the mineral estates under circumstances that

are being taken within the Department of the Interior to correct this deficiency. See ch. 10 on "The Development of New Tools for Energy and Minerals Policy Analysis."

⁴ See chs. 6 and 7, respectively, for a more detailed discussion of these issues.

⁵ The Mineral Leasing Act of 1920 is applicable only to the public domain and, therefore, is inapplicable to the States with no public domain, i.e., the 13 original States, Vermont, Kentucky, Tennessee, Texas, and Hawaii. The Mineral Leasing Act for Acquired Lands of 1947 is applicable to all 50 States, but certain acquired lands, e.g., lands set apart for military purposes, are outside its scope.

can inhibit access to a mineral site by control of surface activities.

Since the passage of the Mining Law and the Leasing Act, numerous congressional acts and executive policies have placed restrictions on the availability of Federal lands for mineral exploration and development. On about 40 percent of the Federal lands, mineral activities have been formally prohibited. Another 20 percent of the Federal lands are severely restricted so that mineral exploration and development is very unlikely. About 10 percent of the Federal lands have moderate restrictions that would likely delay developments of the best prospects but could prevent any development of marginal deposits. The remaining 32 percent of the lands are considered available for mineral exploration case by case. Since 1968, formally prohibited or severely restricted lands have increased from less than 20 percent to over 50 percent of Federal lands, mainly due to the establishment of wilderness areas and to temporary withdrawals pursuant to the Alaska Native Claims Settlement Act.

Since some of these land withdrawals should be considered temporary, once specific decisions are made regarding the exact boundaries for the areas that will be permanently changed in status, the remaining areas will likely, once again, become available for mineral entry under the Federal mining or leasing authorities. In addition, mineral entry on Alaskan native and State lands may be open to mineral exploration and development under the control of those authorities. However, the conclusion is obvious: There is now less land available to the domestic minerals industry for the exploration and development of domestic resources.

ISSUES AND RECOMMENDATIONS

- Make a Governmentwide compilation or inventory of those Federal lands where mineral exploration and development is formally prohibited or severely restricted. This inventory should be updated, and results published periodically. The Department has made a beginning by establishing a task force to classify and categorize all lands under the supervision of the Department of the Interior (DOI).

- Adopt new mining regulations that permit mineral exploration and development on appropriate public lands but that, at the same time, allow the land-administering agencies to prevent or minimize possible harmful impacts caused by mineral development.
- Study Federal lands where Government policies prohibit or severely restrict mineral exploration and development to determine the desirability of eliminating or altering these policies. It should be noted that the Administration has recommended that all units of the national park system except Glacier Bay National Monument, Alaska, be closed to operation of the mining laws. In addition, the Administration's wilderness proposals for units of the national wildlife refuge system have consistently recommended that the refuge wilderness areas be closed to operation of the mining and mineral laws. It is not intended that the study call into question these recommendations.
- Develop policies and practices which will insure that future restrictions on mineral exploration and development will be made only after a balanced and informed consideration of the benefits and costs of such restrictions, including a mineral appraisal of affected lands.
- Review the current efforts to determine the final land use and ownership of lands in Alaska pursuant to the Alaska Native Claims Settlement Act (native ownership, State settlements, national parks, forests, wildlife refuges, etc.) to see whether these efforts should be expedited so as to hasten mineral development in Alaska.

Environmental Regulations

The second major factor that is complicating the development of the domestic resource base concerns the efforts for the protection of the environment. During the past 10 years, numerous laws and regulations have come into effect to support legitimate concerns about the quality of the environment and the need for remedial action. Progress in cleaning up the environment has been substantial and so has the impact on the energy and minerals industries.

Recent efforts by the industry to meet environmental standards and to comply with rules and regulations have altered many plans for industry expansion. It is possible that the longer term implication of such nonproductive investments will constrain future capacity expansion as investment costs per unit of output rise to include the necessary protective equipment.

Decisionmaking on future investments has become more complex and time consuming as the interrelated objectives of mineral production and environmental protection are pursued. In addition, uncertainties abound as a result of the possibility that court decisions may place novel and unforeseen interpretations on compliance requirements under the growing number of Federal, State, and local laws, ordinances, rules, and regulations.

Concerted efforts are necessary to find a balance between the need for environmental protection and the need for a strong domestic minerals industry. As environmental standards for purity are increased, each additional increment of improvement in environmental quality becomes more expensive as compared to earlier improvements. This is simply the operation of the usual economic phenomenon of increasing marginal costs. Hard decisions will have to be made about balancing benefits and costs and reducing the uncertainties about enforcement of existing rules and regulations.

Department of the Interior Programs to Increase Minerals Availability

In its Bureau of Mines and Geological Survey (USGS), DOI has numerous programs in mining research, metallurgical research, and minerals exploration that are designed to increase the availability and/or reduce the costs of finding and utilizing minerals that are currently unprofitable or undiscovered. The following paragraphs provide a brief discussion of some of these program areas.

Exploration Research

The USGS has numerous programs designed to improve the efficiency and effectiveness of exploration activities. One program develops and extends new scientific theory and concepts as the basis for improved and more rapid appraisal and discovery of mineral resources.

Present efforts depend upon well-recognized concepts and data developed by past research on the geology of mineral occurrences. Future appraisal and discovery would be accelerated by continuing these research efforts. The goals of this program provide the basic tools for meeting the needs of the mission-oriented programs of mineral resource appraisal and, thereby, developing new sources of needed minerals. The program focus is on understanding the environment and location controls of mineral deposits through field and laboratory investigations of known mining districts, studies of metallogenic provinces, and the examination of potential new environments for mineral deposits.

Another program develops and tests new methods of geochemical and geophysical appraisal and exploration technology in order to provide new capabilities for the evaluation as well as the discovery of ore deposits; emphasis is on subsurface deposits and new types of low-grade deposits that so far have escaped detection. This program provides essential analytical support to programs of wilderness and Alaskan mineral resource appraisal. Investigators of the geochemical cycle and its influence on the distribution of elements in various geologic environments and sampling media are developing and testing new methods of geochemical analysis and detection. New geophysical systems being developed include a new cryogenic electromagnetic survey detector, a pulse radar system, and improved in-hole sensors for use in detecting mineralized zones of rock. Computer methods for interpreting geophysical data are also being developed.

Mining Research

In addition to the energy-related mining research programs discussed in chapter 1, the Bureau of Mines has significant programs to increase minerals availability through metal and nonmetal mining research. Two such important program areas include: (1) metal and nonmetal mine health and safety research and (2) advancing metal and nonmetal mining technology and explosives.

Health and Safety

Metal and nonmetal mining rank among the most hazardous occupations in the United

States when considering both frequency and severity of injuries. Unquestioned technologic inadequacies exist that are the root cause of these injuries and fatalities. Statistics show that the major causes of accidents are falls of material from the roof, rib, and face; hazards associated with the use of electricity, haulage systems, and mechanical equipment; and fires and explosions. Major causes of health problems are respirable dust, radiation, toxic gases, and noise.

Mine disasters caused by fire and explosions have taken a heavy toll of lives over the years and are one of the major causes of miner apprehension. A multifaceted research program, applying recent advances in fire detection and protection, includes fundamental studies of the combustion behavior of mine materials and the structure of mine fires as they relate to factors such as ventilation pattern, shaft inclination, and rescue methodology.

The thrust of the ground control research program is to develop a rational methodology for safe mine planning. The program is primarily concerned with underground mining because falls of roof, rib, and face continue to be a major cause of accidents. Another program is aimed at designing hazards out of the mining system by solving problems such as those connected with human factors; engineering, electrical, and equipment hazards; illumination; materials handling; and haulage.

Additional mining research programs are designed to increase miner efficiency by attacking such problems as respirable dust, radiation hazards, excessive noise levels, and poor ventilation.

Advancing Technology and Explosives

Present-day underground mining methods are basically the same methods that have been used for decades. Equipment has improved, but the mining cycle is virtually unchanged because the risks of mining inhibit industrial experimentation with untried methods. It is difficult to keep pace in a cost-effective manner with the increasing demand for domestic minerals and the increased difficulty in mining deeper and lower grade ores. Surface mining has been able to maintain high productivity and efficiency at reasonable cost by the introduction of large-

scale, more cost-effective equipment, but problems still remain with environmental considerations such as airblast/ground vibration effects, slope stability, waste disposal, and reclamation. In situ mining offers a potential alternative for the extraction of certain types of minerals. Much of the technology exists (e.g., leaching on the surface has been done for years), but it has not been widely adopted as a viable mining method because of uncertainties in the ability to control leaching solutions and to fragment the ore sufficiently.

Mine planning and design decisions rely heavily on premining investigations. Core drilling and testing are the major investigative techniques for collecting data in advance of mining. Coring is expensive, time consuming, and often only partially successful. Better methods are needed to determine orebody characteristics so that long-term decisions can be made with better information. Safe, effective handling and use of explosives in all types of mining is a continuing problem.

Metallurgy Research

Four major Bureau of Mines program areas in metallurgy research include: (1) advancing minerals technology, (2) effecting pollution abatement, (3) recovering secondary resources, and (4) minimizing mineral and metal needs.

One goal of the programs to advance mineral technology involves expanding minerals availability through augmenting the Nation's reserves by developing processes to extract valuable materials from refractory or low-grade ores and by utilizing abundant resources as substitutes for scarce commodities. Primary concern is not with adequacy of resources but rather with developing the technology to convert more abundant domestic resources into economic reserves for a number of key or critical commodities. Major efforts are directed at aluminum and iron ore.

To the extent that the costs of pollution abatement can be reduced, the Nation will benefit through the lower costs of goods and services. In some instances, such as for methods to control sulfur dioxide pollution, a degree of technology exists, but vast improvements are necessary to lower costs, to improve efficiency, and to avoid creating new land or water pol-

lution problems. Hydrometallurgical processing of sulfide ores to recover metals without smelting is another alternative under investigation. These technologies will not be available for large-scale application for many years.

Unlike sulfur dioxide, very fine particulate matter, including aerosols, presents extremely difficult collection problems and will require imaginative approaches to be controlled at reasonable cost. Many dusts, if collected, could be recycled to help offset some of the cost of control systems. Where applicable, this approach promises the greatest benefit. Agglomeration is one of the most promising technical approaches because the fine particulates could then be collected with conventional control systems.

A third method of increasing the availability of minerals is to recover and recycle them after use. Increased recycling of the valuable materials currently discarded as wastes should be an essential part of any national effort to overcome materials shortages. Thus, the Secondary

Resource Recovery subactivity seeks to develop the technology necessary for this increase to occur. Processes applicable to many types of wastes are being developed and evaluated. For example, minerals beneficiation techniques are being applied to junk cars and urban refuse; and leaching and smelting techniques are being applied to dusts, slags, and other residues. In addition to developing new techniques, improvements in existing processes are being investigated.

Finally, metallurgy research can serve to minimize mineral and metal needs. Specific programs are underway or are planned to develop ways of substituting abundant for scarce materials. Alloys can be modified to utilize more abundant alloying elements. In addition to working on materials substitution, Bureau research is addressing the problems of improving the performance of materials. For example, significant efforts will be made to make certain construction materials last longer.

Chapter 3

TRENDS AND EVENTS

Summary.—This chapter presents a synopsis of the important events affecting the major fuel and nonfuel minerals industries during 1975. To assist the reader in putting these events into perspective, historical trends are shown for production, imports, exports, and prices for each mineral. The Bureau of Labor Statistics GNP implicit price index was used to calculate the constant price series. More details are included for these and other commodities in *Commodity Data Summaries—1976*, published by the Bureau of Mines.

ENERGY

- Gross energy consumed in the United States for heat, light, and power in all forms increased from 33.0 quadrillion Btu in 1947 to 74.7 quadrillion Btu in 1973, then declined by 2.4 percent to 72.9 quadrillion Btu in 1974 and declined again in 1975 by 2.5 percent to a level of 71.1 quadrillion Btu. Higher prices, conservation efforts, slow economic recovery, and a relatively mild winter contributed to the second consecutive annual decline in U.S. total energy use.
- Per capita gross energy use averaged 345 million Btu in 1974 and declined 2 percent to an average of 338 million Btu per capita in 1975. The energy/GNP ratio in 1975 at an average of 59.9 thousand Btu per dollar was down from 60.2 thousand Btu per dollar in 1974 (both 1972 dollars), continuing the downward trend that began in 1971.
- Bituminous coal and lignite consumption in 1975 increased 1.7 percent over 1974, attributed mainly to an increased use of coal for generating electric power. With fuel oil at higher prices and natural gas in short supply, electric utilities increased coal's share of fossil fuels used in generating electric power from 54.9 percent in 1974 to 57.6 percent in 1975. Total utility power generation increased 1.6 percent in 1975, but the total use of fossil fuels was reduced 1.3 percent as nuclear power generation rose by 37.5 percent. Natural gas used to generate electricity declined 9.6 percent from 1974, and fuel oils used for this purpose dropped 4.8 percent to 533 million barrels in 1975.
- Although tapping the Nation's shale oil resources to supplement petroleum supplies has been a longtime goal, little progress was made toward that end in 1975. If costs escalate further, shale oil production may be unlikely unless additional incentives are provided by the Government.
- Significant legislative actions in 1975 included passage of the Energy Policy and Conservation Act (Public Law 94-163), signed on December 22, 1975.
- Total U.S. production of all forms of energy in 1975 was the equivalent of 60,103 trillion Btu, or 84.6 percent of total energy consumed. The balance of total energy demand was met through imports and withdrawals from crude petroleum stocks.
- Net imports of all fuels in 1975 declined 4.4 percent from 1974, but supplied about

16 percent of the estimated total gross consumption of energy in 1975. Crude oil imports totaled 1,498.2 million barrels in 1975, an increase of 18 percent from 1974. However, imports of petroleum products declined from 962 million barrels in 1974 to 715 million barrels in 1975, a decline of 27.1 percent. Imports of natural gas

totaled an estimated 950 billion cubic feet in 1975, down 10 percent from the previous year.

- Historic trends in U.S. energy consumption and uses of major energy sources are charted in figures 3-1 and 3-2. Summaries of 1975 developments affecting major individual energy sources follow.

Figure 3-1. U.S. users of major energy sources, 1950-75.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(BASED IN PART ON DATA FROM U.S. BUREAU OF THE
CENSUS, FEDERAL POWER COMMISSION, AND EDISON
ELECTRIC INSTITUTE)

Figure 3-2. Consumption of energy by sources, 1975.

Petroleum

- Production of crude oil continued the decline that began after 1970. U.S. crude oil and natural gas liquids production was about 3.6 billion barrels in 1975, or 4.4 percent below 1974.
- The price of crude oil in 1975 was 18.6 percent above 1974; natural gas liquids prices were 13.3 percent above 1974 levels.
- Consumption of petroleum products was 5.9 billion barrels. 1.498 billion barrels of crude oil and 0.701 billion barrels of products were imported. Imports supplied 37 percent of petroleum requirements in 1975 and are expected to increase, particularly in crude oil.
- Nigeria in 1975 became the principal supplier of crude oil to the United States, replacing Canada, the leader since 1967. Canada is trimming oil exports to the

United States—from 700,000 barrels per day in 1975 to a recently announced 460,000 barrels per day in 1976.

- The trans-Alaska pipeline is more than half completed and is expected to become operational by mid-1977.
- Significant Government actions in 1975 follow: the U.S. Geological Survey (USGS) estimates that the probability is 90 percent that remaining recoverable resources of crude oil range between 112 billion and 189 billion barrels. The 1975 Tax Reduction Act eliminated percentage depletion on oil production in excess of 2,000 barrels per day. The Energy Policy and Conservation Act became law (Public Law 94-163) late in 1975 and placed ceilings on prices for domestic crude oil.
- Employment in oil and gas production and petroleum refining totaled 320,000.

See figures 3-3 and 3-4.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(BASED IN PART ON DATA FROM U.S. BUREAU OF THE
CENSUS, FEDERAL ENERGY ADMINISTRATION, AND
FEDERAL POWER COMMISSION)

Figure 3-3. U.S. sources of petroleum, 1950-75.

Figure 3-4. Price of crude petroleum, 1950-75. (Average value per barrel of domestic production of crude petroleum at the wellhead.)

Natural Gas

- Domestic production in 1975 declined about 7 percent from 1974. Imports from Canada remained at approximately the same level in 1975 as the previous year.
- Domestic-marketed production of 20.1 trillion cubic feet accounted for 95 percent of consumption. Wellhead price averaged 43.5 cents per thousand cubic feet, a 43-percent increase over 1974.
- As of late 1975, the Federal Power Commission's single, uniform national base rate for interstate natural gas sales by producers was 52 cents per thousand cubic feet.
- Early in 1975, Congress abolished the depletion allowance for major intrastate gas producers, effective January 1, 1975, and

for major interstate producers, effective July 1, 1976.

- The Department of the Interior formally proposed emergency procedures for granting priorities and allocating natural gas under the Defense Production Act of 1950 to assure adequate natural gas for vital defense activities.
- As of January 1, 1975, natural gas resources consisted of 237 trillion cubic feet of measured reserves, 202 trillion cubic feet of inferred reserves, and 322 to 655 trillion cubic feet of undiscovered recoverable resources.
- The USGS estimates that the probability is 90 percent that remaining recoverable resources of natural gas range between 761 trillion cubic feet and 1,094 trillion cubic feet.

See figures 3-5 and 3-6.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(BASED IN PART ON DATA FROM U.S. BUREAU OF THE
CENSUS, FEDERAL ENERGY ADMINISTRATION, AND
FEDERAL POWER COMMISSION)

Figure 3-5. U.S. sources of natural gas, 1950-75.

Figure 3-6. Price of natural gas, 1950-75. (Average wellhead price in cents per thousand cubic feet. Annual data compiled from Bureau of Mines survey of approximately 1,100 producers and pipeline companies and from State agency reports.)

Coal (Bituminous, Anthracite, Lignite)

- Estimated domestic production of coal in 1975 totaled 646 million tons, 6 percent more than in 1974. The bulk of the increased production was used to rebuild consumer inventories and to meet growing foreign demands.
- Following the trends of other energy prices, coal prices approached \$20 per ton in 1975, up from around \$10 per ton in 1973.
- Domestic consumption rose less than 1 percent, from 558 to 560 million tons.
- Productivity declined to an average of 15.2 tons per man-day for bituminous coal and lignite mines in 1975, compared with 17.6 tons per man-day in 1974.
- Low-sulfur, low-heating-value coals from western mines continued to move eastward in greater quantities in 1975.
- Nearly half of eastern low-sulfur bituminous coals are used for metallurgical purposes at home and abroad, while the balance is used for the generation of electricity and other purposes.
- Anthracite production declined further in 1975, down to 6.2 million tons, due to high mining costs associated with unresolved technological and environmental problems of the anthracite region.
- Coal and coke exports in 1975 totaled 68 million tons, 9 percent greater than in 1974.
- Coal and coke imports decreased from 5.7 million tons in 1974, to 2.8 million tons in 1975.
- Mine employment totaled 198,000.

See figures 3-7 and 3-8.

Figure 3-7. U.S. production of coal, 1950-75.

Figure 3-8. Price of bituminous coal and lignite, 1950-75. (Average f.o.b. mine value of coal.)

Uranium U_3O_8

- Uranium mill production in 1975 is estimated at 11,600 tons. The production level is basically unchanged from the previous year, although the price more than doubled to an average price of \$22 per

pound. One hundred twenty mining operations produced over 7 million tons of ore averaging 0.18 percent U_3O_8 .

- Fourteen mills produced the concentrate (yellowcake). Enrichment remained strictly with the purview of the Energy Research and Development Administra-

tion (ERDA). However, there were proposals by four groups to develop private enrichment capacity.

- According to ERDA, numerous reactor construction plans were delayed or can-

celed. At yearend, 55 units were operable, 76 under construction, and 112 planned. Total megawatts were 243,326.

- Mine and mill employment totaled 5,800. See figures 3-9 and 3-10.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE
CENSUS; URANIUM PRODUCTION DATA FROM U.S.
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRA-
TION

Figure 3-9. U.S. sources of uranium U_3O_8 , 1950-75.

Imports for Government stockpiles until 1970. Imports for enrichment services and private stockpiles not for domestic consumption from 1970 to 1975.

Figure 3-10. Price of uranium concentrate, 1950-75. (August spot price 1974-75; 1950-73 based on long-term contract price or ERDA price.)

MAJOR NONFERROUS METALS

Aluminum

- Domestic production included 3.9 million tons of primary aluminum metal (mainly from imported raw materials from Jamaica, Australia, Guinea, and Surinam) and the recovery from old scrap of 0.3 million tons of aluminum metal. Metal imported from Canada also comprised a significant component of U.S. aluminum supply.
- Aluminum consumption of 4.6 million tons was 30 percent below the 1974 level. The growth trend of U.S. aluminum consumption, which was 7.7 percent per year during the past 25 years, is expected to decrease to about 6 percent per year from 1975 to 1985, and to slow further to about 4.5 percent per year from 1985 to 2000.
- Despite the decline in aluminum consumption and production, the price of

aluminum continued to rise during 1975, indicating, in part, the continued impact of the pricing and taxing policies of the member countries of the International Bauxite Association. Higher energy costs have also contributed to the increase in the aluminum prices.

- The Bureau of Mines, in a cost-sharing cooperative program with 10 companies, continued research on a miniplant scale to recover alumina from nonbauxitic domestic resources. Other Bureau research to increase domestic aluminum supply included development of methods to recover aluminum and other metals from waste and scrap and assistance to public works officials in the planning and installation of facilities to recover aluminum and other materials from municipal refuse.
- Total employment in the aluminum industry was 190,000.

See figures 3-11 and 3-12.

Figure 3-11. U.S. sources of aluminum, 1950-75. (Sources: Bureau of Mines, U.S. Department of the Interior. Import-export data from U.S. Bureau of the Census.)

Figure 3-12. Price of aluminum, 1950-75. (Price of primary aluminum ingot as reported in *American Metal Market*, daily, Fairchild Publications, Inc.)

Copper

- Domestic mine output was 1.4 million tons, and recovery of copper from old scrap was about 0.5 million tons. The assigned value of this processed copper, in terms of the producer price of refined copper, was \$2.9 billion.
- A buildup of copper stocks occurred with a resultant price drop to an average 64.2 cents per pound compared with 77.3 cents in 1974. The range of domestic producer copper price quotations for 1950-75 was

a low of 21.5 cents in 1950 and a high of 77.3 cents in 1974.

- Consumption of refined copper was about 1.54 million tons, a 30-percent drop and the smallest quantity consumed since 1961. This decline was a reflection of general economic conditions, particularly in the large copper-consuming sectors of automobiles, home construction, and utility construction.
- Total employment in the copper industry was 150,000.

See figures 3-13 and 3-14.

Figure 3-13. U.S. sources of copper, 1950-75. (Source: Bureau of Mines, U.S. Department of the Interior. Import-export data from U.S. Bureau of the Census.)

Figure 3-14. Price of copper, 1950-75. (U.S. producer price of electrolytic wirebar copper as reported in *Metals Week*, McGraw-Hill, Inc.)

Lead

- Domestic mine production of 0.63 million tons of lead supplied approximately one-half of the total of 1.23 million tons of lead consumed during 1975.
- Old lead scrap, mostly from batteries, accounted for most of the remaining supply of lead consumed in 1975.
- Government stockpile sales were minimal in 1975; about 72,000 tons were available for disposal at yearend.
- The falloff in consumption and the maintenance of a high level of production substantially reduced U.S. import reliance during 1975.
- The average price of lead in 1975 was 21.5 cents per pound, and at yearend 19.0 cents per pound versus 24.5 cents per pound at yearend 1974.
- Domestic prices exceeded foreign prices during most of the year. During the period 1950 through 1975, the low average annual price of 9.6 cents per pound was recorded in 1962 and the high of 22.5 cents in 1974.
- Employment in mining, milling, smelting, and the first stage of processing (rolled, cast, chemicals) totaled 16,000.

See figures 3-15 and 3-16.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-15. U.S. sources of lead, 1950-75.

Figure 3-16. Price of lead, 1950-75.

Average yearly quoted price at New York, 1960-71, as reported in *Metal Statistics*; and average monthly and yearly U.S. producer quoted price, delivered nationwide, 1972 to present, as reported in *Metals Week*, McGraw-Hill, Inc.)

Zinc

- Mine production of zinc in 1975 was 472,000 tons, and primary smelter production of slab zinc was 445,000 tons.
- Tariffs were suspended for zinc ores concentrate imports. Imports of slab zinc supplied about 40 percent of slab zinc consumption, while sales of Government stockpile excesses were suspended because of high producer inventory.
- Domestic smelter capacity was reduced to

680,000 tons per year with the closure of a horizontal retort smelter.

- The average price of prime western zinc in 1975 was 39 cents per pound, up from 35.9 cents in 1974. The low average of 10 cents was recorded in 1958 and the high in 1975.
- Employment in mining, milling, smelting, and the first stage of processing (alloys, roll, brass, and chemicals) totaled 30,000.

See figures 3-17 and 3-18.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-17. U.S. sources of zinc, 1950-75.

Figure 3-18. Price of zinc, 1950-75. (U.S. producer price of prime western as reported in *Metals Week*, McGraw-Hill, Inc.)

Tin

- Domestic mine production was less than 100 tons in 1975. Most of the Nation's supply came from foreign sources such as Malaysia, Thailand, Bolivia, and the People's Republic of China.
- The 1975 prices declined from the record levels of 1974 because of low world industrial demand. The 1975 average price was 340 cents per pound compared to 396 cents per pound in 1974. The lowest annual price for tin over the 1950-75 period occurred in 1954 at 92 cents per pound. The highest annual price was 396 cents per pound in 1974.
- Only 575 long tons of tin were sold from the Government stockpile because of decreased domestic demand and increased availability of low-price imported tin.
- Tin consumption was 54,000 long tons during 1975.
- The International Tin Council, a producer-consumer organization establishing tin prices, increased the floor and ceiling prices for tin early in 1975, but export controls on member producing nations were necessary to keep the price above the floor. Over 12,000 long tons of buffer stock purchases, in addition to the export controls, have been required to support the floor price.
- The President announced the United States will join the Fifth International Tin Agreement subject to congressional approval.

See figures 3-19 and 3-20.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-19. U.S. sources of tin, 1950-75.

Figure 3-20. Price of tin, 1950-75. (Average annual or monthly price for New York prompt delivery Straits tin as published in *Metals Week*, McGraw-Hill, Inc.)

FERROUS METALS AND MAJOR FERROALLOYS

Iron Ore

- U.S. production of iron ore in 1975 declined 8 percent from the 84 million long tons produced in 1974; consumption was down 18 percent.
- Imports remained high despite strikes in Canada and nationalization of U.S. mines in Venezuela and Peru.
- Average prices for domestic ore were up 25-30 percent; inland freight rates rose 12-15 percent; but ocean freight rates dropped sharply during the year.
- The Association of Iron Ore Exporting Countries was formed in 1975; the 10 member countries account for about 25 percent of world output of iron ore and 50 percent of world exports.
- U.S. producers decided to build 23 million tons of new domestic production capacity for iron ore processing plants by 1979 at a total cost of about \$1 billion. Owing to limited availability of natural gas, some of these plants will be forced to use coal as substitute fuel. The technical problems involved are being researched by Bureau of Mines and others.

Iron and Steel

- Raw steel production in 1975 was down 19 percent from the 145 million tons produced in 1974.

- Receipts of iron and steel scrap were down 10 percent, but 22 percent less scrap was used as there was some adjustment of the scrap to iron ore ratio following lifting of the embargo on scrap exports.
- Steel mill shipments were 17 percent less than in 1974. The consuming industry used about 10 million tons from its inventory.
- The high rate of steel imports of the last few years leveled off in the first half of 1975, and declined sharply in the last half. For the year, imports were 25 percent less than in 1974. However, high-cost alloy and stainless steels comprised a larger share of the total. In view of these high-cost imports, the Tool and Stainless Steel Industry Committee for Import Relief and the United Steel Workers of America (AFL-CIO) petitioned the Government for relief in accordance with Section 201(b)(1) of the Trade Act of 1974.
- On January 16, 1976, the U.S. International Trade Commission notified the President that increased imports of stainless and alloy tool steel were substantial causes of the serious injury to certain U.S. industries.

See figures 3-21, 3-22, and 3-23.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(BASED IN PART ON DATA FROM THE U.S. DEPARTMENT
OF COMMERCE AND THE AMERICAN IRON AND STEEL
INSTITUTE)

Figure 3-21. U.S. sources of iron, 1950-75.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
BASED IN PART ON DATA FROM THE U.S. DEPARTMENT
OF COMMERCE AND THE AMERICAN IRON AND STEEL
INSTITUTE)

Figure 3-22.—U.S. production of raw steel by furnace type, 1950-75.

Figure 3-23. Price of iron in ore, 1950-75. (Average f.o.b. mine price of iron contained in ore, calculated from producers' statements.)

Chromium

- There has been no domestic chromite mine production since 1961.
- The U.S. demand for primary chromium in 1975 was met by imports of both chromite and chromium alloys, supplemented by deliveries of 411,000 tons of chromite sold from Government stockpile excesses.
- Consumption of chromium in 1975 decreased to about the same level as that of 1971. Imports of chromite exceeded consumption, allowing stocks to increase.
- Imports of chromium alloys in recent years have increased substantially as countries with chromite resources expand their furnace capacities.
- Published prices for high-grade chromite for metallurgical use were more than doubled.
- World resources of chromite are more than adequate for the foreseeable future, but supply disruptions caused by cartel actions or political situations are possible because of the limited number of countries with large resources.
- The outlook for significantly larger domestic resources is not favorable. However, Bureau of Mines researchers are working on recovery of chromium from laterites which, if successful, would extend world resources by up to 50 million tons and spread the geographical supply base.

See figures 3-24 and 3-25.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE
CENSUS)

Figure 3-24. U.S. sources of chromium, 1950-75.

Figure 3-25. Price of chromium, 1950-75.

Calculated on a weighted basis from consumption patterns in consuming industries. Quoted prices as published in *Metals Week*, McGraw-Hill, for Turkish and South African chromite, and personal communication from industry for Philippine chromite.)

Manganese

- There was no domestic production of manganese ore containing 35 percent or more manganese in 1975.
- Consumption was down to 1,194,000 short tons of manganese. Ferromanganese imports continued to be high at 407,000 tons, while ore imports were 1,574,000 tons.
- France, the Republic of South Africa, and Japan were the principal suppliers of ferromanganese, whereas Brazil and Gabon supplied almost three-fourths of the imported ore, with the Republic of South

Africa and Australia providing most of the remainder.

- Prices for metallurgical manganese ore were quoted in a price range of \$1.38 to \$1.45 per long-ton unit, c.i.f. U.S. ports, for most of the year.
- The General Services Administration continued to sell excess, stockpiled manganese ore.
- The industry continued efforts leading toward manganese recovery from deep sea-floor deposits.

See figures 3-26 and 3-27.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-26. U.S. sources of manganese, 1950-75.

Figure 3-27. Price of manganese, 1950-75.

Average price for metallurgical ore containing 46-48 percent manganese, in dollars per long-ton unit. One long-ton unit is 22.4 pounds contained manganese. Price per long ton: multiply percent manganese content by long-ton-unit price; e.g., an ore with 48-percent manganese content at \$1 per long-ton unit would be \$48 per long ton.

Tungsten

- Although domestic production decreased 21 percent and reported tungsten concentrate consumption fell 13 percent in 1975 from that of 1974, the average price remained relatively stable and ranged from \$76 to \$92 per short-ton unit tungsten trioxide (WO_3). The average price of tungsten concentrate during the year was \$83 per short-ton unit WO_3 .
- A new tungsten mine planned for Nevada will increase domestic production by about 25 percent.
- Approximately 45 percent of the 1975 reported tungsten consumption was supplied by domestic production, 35 percent

by imports, and 20 percent by sales of Government stockpile excesses.

- During 1975, the Primary Tungsten Association (PTA) was formed by foreign tungsten producers in an attempt to stabilize the tungsten market. The major producers in PTA are from Bolivia, Portugal, Peru, Australia, the Republic of Korea, and Thailand.
- Reported industrial consumption of tungsten concentrate during 1975 was 15.2 million pounds.
- Estimated mine and mill employment totaled 510.

See figures 3-28 and 3-29.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE
CENSUS)

Figure 3-28. U.S. sources of tungsten, 1950-75.

Figure 3-29. Price of tungsten, 1950-75. (Average quoted price per short-ton unit WO₃, as reported in *Metals Week*, McGraw-Hill, Inc., converted to dollars per pound W.)

Nickel

- Consumption of 145 thousand tons of processed primary nickel materials in 1975 included 13.9 thousand tons of nickel produced in the United States.
- Imports of nickel in 1975 were 28 percent below imports in 1974, with Canada supplying 62 percent of the total, followed by New Caledonia, Norway, the Dominican Republic, and Australia.
- Nickel prices remained stabilized at \$2.01 per pound through 8 months of 1975, when they were raised to \$2.20. Nevertheless, major consumers of nickel were able to purchase nickel at the old price of \$2.01 for the remainder of the year.

- Record high consumer inventories of nickel were being worked off near year-end.
- Expansion and rehabilitation of the Port Nickel, La., refinery was completed by yearend 1974, and the plant was operating at about 30 percent of capacity at yearend 1975.
- Considerable interest was expressed in developing the nickel-copper-sulfide deposits of northeastern Minnesota. However, many environmental concerns must be resolved before mining can proceed.
- Development of nickel laterite deposits in Oregon and California will have to await detailed exploration of the area and improvements in extraction technology.

See figures 3-30 and 3-31.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE
CENSUS)

Figure 3-30. U.S. sources of nickel, 1950-75.

Figure 3-31. Price of nickel, 1950-75. (Based on producer quotes for cathode nickel as reported in *Engineering and Mining Journal*, monthly, McGraw-Hill, Inc.)

FERTILIZER MATERIALS

Nitrogen

- Production of fixed nitrogen, i.e., nitrogen in compounds, was steady at 13 million tons in 1975. Production of elemental (gaseous and liquid) nitrogen declined slightly to about 8.4 million tons.
- Imports of fixed nitrogen, at 1.3 million tons, exceeded exports (1.1 million) for the second year in a row. This situation is a reversal of traditional U.S. self-sufficiency in years past, and will bear watching in view of the importance of fixed nitrogen to U.S. agriculture. Consumption of fixed and elemental nitrogen declined a total of 1 percent in 1975.

- Consumption of fixed nitrogen has grown from less than 2 million tons in 1950 to over 12.6 million in 1975.

- The average price per short ton of fixed nitrogen was \$190 in 1975.

See figures 3-32 and 3-33.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-32. U.S. sources of fixed nitrogen, 1950-75.

Figure 3-33. Price of fixed nitrogen (ammonia), 1950-75. (Average quoted price in *Chemical Marketing Reporter*, weekly, Schnell Publishing Co., Inc.)

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-34. U.S. sources of phosphate rock, 1950-75.

Phosphate Rock

- Production of phosphate rock in the United States increased 7 percent to 49 million short tons; domestic consumption was stable at 34 million tons; imports were not significant at 30,000 tons; and exports declined slightly to 13 million tons.
- An increasing tonnage of phosphate rock was converted to phosphatic intermediates for export markets. Total exports of equivalent phosphate rock was 20 million tons.

- World consumption of phosphate rock declined 4 percent, a direct effect of exceptionally high prices.
- Development of new mines in Florida, North Carolina, and Idaho on Federal and private land has been inhibited by opponents of strip mining.
- The 1975 average price was \$23 per ton, the highest price of the 1950-75 era. The lowest price was \$5.10 per ton in 1972.
- Employment was 5,500.

See figures 3-34 and 3-35.

Figure 3-35. Price of phosphate rock, 1950-75.

Average price of marketable phosphate rock, dry basis, f.o.b. plant, in dollars per short ton. Average calculated from production in Florida, North Carolina, Arkansas, Tennessee, and the Western States, and averaged 30.8 percent P_2O_5 in 1975.

Potash

- U.S. production of potash remained stable in 1975 at 2.5 million tons of K_2O . Consumption declined from a record high of 6.0 million tons in 1974 to 5.0 million in 1975, because of a general decline in consumption of fertilizers, the market for 95 percent of the potash produced.
- Consumption of potash steadily increased from 1950, when it amounted to 1.4 million tons, to the record high in 1974. U.S.

self-sufficiency was maintained until 1962, but in 1975 domestic production supplied only 50 percent of consumption.

- U.S. industry was actively considering development of alternative sources of potash to supplement imports from Canada.
- The potash mining industry employs about 4,000 persons.

See figures 3-36 and 3-37.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(IMPORT-EXPORT DATA FROM U.S. BUREAU OF THE CENSUS)

Figure 3-36. U.S. sources of potash, 1950-75.

Figure 3-37. Price of potash, 1950-75. (Derived from producer tonnage and value of production reports to the U.S. Bureau of Mines (f.o.b. mine).)

NONMETALLIC CONSTRUCTION MATERIALS

- Consumption of nonmetallic construction materials decreased significantly in 1975, conforming with the continued decline of the construction industry.
- Of the two most widely used construction materials, output of sand and gravel was off 12 percent to about 861 million tons, and output of all types of stone declined 18 percent to 857 million tons.
- Reserves and production of the basic raw materials were adequate to meet domestic requirements; however, local shortages may occur as a result of zoning or environmental regulations.
- Foreign trade was a minor factor for the raw materials; most trade was across conterminous international borders. Total imports and exports were essentially in balance except for gypsum. Imports of gypsum supplied 39 percent of U.S. requirements.
- Since 1950, use of sand and gravel has

grown at an average annual rate of 3.5 percent, and use of stone has increased at an average rate of 5 percent.

- The development of standards for emission of dust and wastewater effluents to protect the environment has had a minor, but growing, impact on the producers of nonmetallic construction raw materials. Many operations are being updated and modernized to reduce energy requirements or to provide for alternative fuels and for installation of emission control devices.
- The average producers' price per ton for cement rose from \$26.54 in 1974 to \$27.10 in 1975. Corresponding changes in producers' price per ton of crude gypsum were from \$4.41 to \$4.66, of sand and gravel from \$1.48 to \$1.50, and of stone from \$2 to \$2.23.
- Total employment in production of non-metallic construction materials was 140,000 in 1975.

See figure 3-38.

BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(SLAG DATA FROM NATIONAL SLAG ASSOCIATION)

Figure 3-38. U.S. sources of major nonmetallic construction raw materials, 1950-75.

Section II

ISSUES IN ENERGY AND MINERALS POLICY

Chapter 4

FEDERAL LEASING

Summary.—The energy needs of our Nation justify a program of accelerated development of the petroleum and natural gas resources in frontier areas of the Outer Continental Shelf when done with protection of environmental and other values. A new coal-leasing program has been announced to achieve a proper balance between the national interest in increased production of coal and in the protection of the environment.

Chapter 1 of this report presented a brief sketch of the present and likely future dependency of our Nation upon imported petroleum and natural gas supplies and the promising areas of future development of these and other energy resources in this country. Chapter 2 has presented the major problems occurring in specific nonfuel minerals markets. To deal effectively with such problems and to meet his mandate under the Mining and Minerals Policy Act, the Secretary of the Interior has undertaken major initiatives in 1975 such as development of the accelerated Outer Continental Shelf (OCS) leasing program and of a new coal-leasing program. These initiatives and others will be described in the following section in addition to those problems requiring further administrative or congressional action.

PETROLEUM AND NATURAL GAS LEASING

Conventional Petroleum Sources

Because onshore areas have been thoroughly explored for petroleum and natural gas development, the chief sources of increased conventional onshore petroleum production will be new discoveries in Alaska and added recovery of oil in known fields through secondary and tertiary recovery from existing wells. Secondary recovery is expected to make a considerable contribution to enhanced production, one esti-

mate being as high as 2 million barrels a day by 1985.

Assuming that present consumption and production trends continue, large amounts of foreign petroleum supplies will be imported through 1985 and thereafter, unless major program efforts are undertaken to accelerate the development of the oil and gas resources of OCS and the Alaskan Arctic region. The Department of the Interior (DOI), therefore, placed great emphasis in 1975 upon the initiation of policies to accelerate the leasing and development of petroleum and natural gas resources from the undeveloped regions.

The Outer Continental Shelf

Of 350 million OCS acres considered as promising for petroleum and natural gas development, only 29 million acres have been offered for leasing, most of these located in the Gulf of Mexico. Thus, a great deal of promising acreage remains to be offered, especially in the undeveloped OCS areas under Federal jurisdiction and control.

To meet national objectives during 1975, DOI developed an accelerated OCS leasing plan that takes into account the legitimate concerns of affected individuals, States, and organizations. It is being implemented in close cooperation with coastal States to enable them to properly plan for increased local development,

adequate protection of the environment, and other problems that could arise. A revised OCS planning schedule was developed which included four lease sales in 1975 and six proposed lease sales per year for the 1976-78 period, including some or all frontier areas by the end of 1978. Lease sales in 1975 were held in south Texas, the central gulf areas, and in southern California. In 1976, lease sales are projected for the Gulf of Mexico (general and drainage), the Mid-Atlantic, North Atlantic, and South Atlantic, and the Gulf of Alaska (including Kodiak).

Development of the proposed OCS leasing plan has been accompanied by both economic and environmental analyses that found that if OCS resources are not developed the most likely result will be the importation of increased amounts of foreign oil via foreign tankers with the potential for environmental impacts far more serious than those which may result from OCS drilling and production.

A thorough and continuing environmental analysis of each of the OCS lease sales has been initiated by DOI. Subsequent analyses could conclude that some or all sales should not take place, or that they should only take place under certain specified conditions. Already, decisions have been made to eliminate some areas from leasing because of environmental conditions.

Department of the Interior Initiatives

Major departmental initiatives undertaken during 1975, which are directed at conducting the exploration and development of the OCS in both an economically efficient and environmentally acceptable manner, are highlighted below.

Southern California OCS Sale

The Secretary of the Interior approved a number of modifications of the oil and gas lease sale on the southern California OCS which took place on December 11, 1975, in order to meet environmental and other concerns raised by State officials and others commenting on the proposal. These modifications included the following: (1) elimination from the sale of all tracts in the Santa Monica Bay area, as well as tracts south of San Miguel Island; (2) lease stipulations providing specifically for protec-

tion for seabird rookeries and habitats for seals and sea lions offshore of San Miguel, Santa Rosa, and Santa Barbara Islands; and (3) protection by special restrictions on lease holders of coral species believed to be unique and found in portions of the Tanner and Cortes Bank.

During the 2-year interval following DOI's call for nominations and the closing date for comments on the California lease sale proposal, California officials and organizations were thoroughly and continually consulted about the sale proposal.

The draft Environmental Impact Statement (EIS) on the California sale was issued on February 21, 1975, and the final report in August 1975. It was the most extensive site-specific study to be published on an OCS proposal and was written by an environmental assessment team of physical, biological, and social scientists, who benefited from the review and comments of a number of local and State government officials and environmental advocates.

Ban on Joint Bidding

To obviate any concentration in production, final regulations banning joint bidding among the largest petroleum companies were published in the *Federal Register* on October 1, 1975. All companies, including their subsidiaries, producing more than 1.6 million barrels of oil and natural gas equivalent a day were to be banned from bidding jointly with each other, although they could bid jointly with one or more of the smaller companies. A list of bidders excluded from joint bidding during the above period was published in the *Federal Register* on October 31, 1975. Since the proposed California OCS sale was the first sale under this new regulation, the Department extended the filing deadline to February 9, 1976. The Energy Policy and Conservation Act of 1975 also imposed a statutory ban on joint bidding similar to that already imposed by DOI's regulations, and also provided that the statutory ban could be waived by DOI in frontier and other high cost areas.

Royalty-Bidding Experiment

During 1975, DOI conducted a royalty-bidding experiment in OCS sale No. 36 to assess

the impact of a royalty- versus a bonus-bidding system for OCS leasing. Mandatory unitization was stipulated. Study results indicated that royalty bidding may bring more bidders into OCS auctions, including more new bidders, and may also result in more competition among independents.

To the extent that it would bring about a broader distribution of OCS reserves among companies, royalty bidding could have a positive impact in effecting a more competitive structure of the oil industry. In addition, an increase in the number of companies involved in OCS auctions may decrease the chances that potentially valuable tracts will be ignored in the bidding—although one would expect this phenomenon to involve only marginal tracts. It is also evident from the royalty-bidding study results that competitive bidding may drive royalty rates to high levels. One bid was as high as 82 percent.

Final OCS Environmental Impact Statement

The *Final Environmental Impact Statement on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf* was completed in July 1975. The EIS concluded that leasing in frontier areas could proceed provided very high priority was given to environmental protection. The most cost-effective technology available should be used to minimize environmental risks, and States and local communities should have an opportunity to participate in those aspects of the management and regulation of the OCS which affect their socioeconomic systems.

Shut-in Wells

A major concern related to DOI's leasing program in fiscal year 1975 was the question of shut-in wells. As of June 30, 1975, 172 leases were shut-in and not producing. In January 1975, the U.S. Geological Survey (USGS) asked 10 companies that appeared to have the most questionable cases of shut-in wells or leases to initiate production immediately, or to submit reasons and data explaining why the shut-in status should be permitted. Subsequently, in March 1975, 3 of these 10 lessees were required

to submit additional data supporting the shut-in status of their wells.

As a result of these actions, two lessees chose to terminate one lease each. In general, analysis indicated that the wells and leases were shut-in because of transportation difficulties, production equipment delivery problems, or gas reserves depletion to the point where further production was not economic. While investigations continued into fiscal year 1976, the findings so far have not supported the position that a substantial number of wells had been shut-in for price speculation.

The OCS operating regulations were reviewed by a DOI task force to determine if the regulations assured proper diligence in the exploration, development, and production of oil and gas reserves on the OCS. One outcome of this review was the development of an OCS order and associated guidelines for area oil and gas supervisors. This order and the associated guidelines are intended to assure that positive action to develop a lease is a firm prerequisite to allowing a leaseholder to retain his lease beyond its primary 5-year lease term. The task force also developed modifications to the regulations to clarify the Secretary's authority to suspend production on the OCS in accordance with the requirements of the National Environmental Policy Act.

The order, guidelines, and regulation modifications were published for comment in the *Federal Register* on December 19, 1975.

Geologic and Geophysical Data

In November 1974, USGS required that processed geophysical data be submitted by geophysical surveying companies as a condition for obtaining OCS surveying permits. A number of steps were taken in fiscal year 1975 to develop regulations pertaining to the collection of OCS geological and geophysical data. On April 22, 1975, the regulations were published in the *Federal Register* as proposed rulemaking. A Geological Survey Notice was issued on September 3, 1975, specifying that new permits and agreements for geophysical exploration shall continue to be subject to the requirements for submitting data, and that the new permits and agreements will provide appropriate pro-

tection for confidential geophysical data submitted by permittees.

Tract Evaluation

To assure that the lease auction of OCS resources yielded a fair market price, DOI has developed a Monte Carlo simulation model to estimate the value of tracts offered for lease. This simulation approach is believed to provide an accurate representation of the uncertainties inherent in hydrocarbon estimation. Through its use and an improved bid evaluation system, DOI can accurately assess bids in relation to fair market value.

Resources values, together with recommendations on bid acceptance or rejection and supporting data, are provided to the Bureau of Land Management (BLM) by USGS. The final decision to accept or reject bids is made by the Secretary of the Interior. During fiscal year 1975, tract evaluations were completed for 6.94 million acres offered; 1.8 million acres were leased; and bonuses and rentals totaling \$1.936 billion and royalties of \$491.8 million were paid by lessees.

Tract evaluations were begun in fiscal year 1975 for OCS sales 38A and 41 in the Gulf of Mexico, sale 35 off southern California, and sale 39 in the Gulf of Alaska. Preliminary work was also in progress at the year's end for sale 40 in the Mid-Atlantic area, sale 42 in the North Atlantic, sale 43 in the South Atlantic, sale 45 in the Bering Sea, and sale 46 in the western Gulf of Alaska.

Safety Requirements

Improved safety standards and enforcement procedures for the OCS have been or are in the process of being implemented. The DOI is committed to standards at least as high (assuming reasonable standards) as those of adjacent States that have proved to be reasonable and practicable. Studies have been conducted in cooperation with the National Academy of Engineering, the American Technical Standards Institute, and the National Aeronautics and Space Administration; and steps have been taken to implement resulting recommendations for improving safety of OCS operations. Proposed OCS orders have been published for the Gulf

of Alaska and are soon to be published for the Mid-Atlantic. The USGS is currently working with appropriate States to draft orders.

Environmental Data Collection

A major initiative of DOI has been the environmental data collection activities relating to the leasing and development of the OCS. During 1975, OCS benchmark data collection activities in the Mississippi-Alabama-Florida (MAFLA), northeastern Gulf of Alaska, and south Texas areas were completed, and BLM initiated its first OCS-monitoring program in the MAFLA area. Such studies will be conducted in the other areas to determine the environmental effects attributable to OCS operations. These reports are expected to be available in final form during the first quarter of 1976.

New benchmark data collection activities were initiated during 1975 in the Mid-Atlantic, southern California, and greater Alaska areas of the OCS frontier. Planning for these activities was initiated through regional conferences and took into account existing information disclosed by the conferences, as well as data inventories conducted by BLM and cooperating groups and need of special research projects (e.g., toxicity studies). The OCS Research Management Advisory Board, now the OCS Environmental Studies Advisory Committee, reviewed and made recommendations concerning each plan.

The BLM has initiated a systematic revision of its tract selection procedures (BLM Manual Article No. 3301) to insure that pertinent information concerning OCS resources and reserves is assembled and shared with the States and public in advance of tract sales.

State and Public Consultation

During 1975, the OCS Research Management Advisory Board designated a committee to assist BLM in (1) designing a monitoring system for the MAFLA area, and (2) studying the need for future MAFLA programs in light of first-year benchmark results. Emphasis was placed on need for more attention to nearshore coastal data.

In addition, a new OCS Advisory Board to deal with OCS policy has been established to provide a formal mechanism for policy discussions between the Federal Government, the States, and private groups. Regional advisory committees are being established to assess OCS regional data collection plans, to examine the results of regional baseline studies, and to assess the need for new environmental studies. A committee on nearshore and coastal data needs also has been established.

Representatives from all coastal States serve in the OCS advisory system which reviews both BLM's environmental study program and the Department's OCS policy formulation. During 1975, DOI issued regulations that established new procedures for State participation in the development stage of OCS leasing. At a minimum, affected Coastal States will be provided by the lessee with information on proposed operations, both onshore and offshore, and the States will be given a 60-day period to review and comment on the lease development plan. The specific components of the information package to be provided to the States are being worked out by DOI in consultation with industry and a committee of the newly formed OCS Advisory Board which includes Coastal State representatives. These new regulations appeared in the *Federal Register* on November 4, 1975. The States also participate in all phases of the leasing process.

Future OCS and Onshore Leasing Plans

The study and evaluation workload for OCS lease sales will increase substantially during the next year. In conjunction with the accelerated leasing program, 15 major environmental baseline and monitoring studies will be underway in frontier areas by the end of next year.

A large data bank is being developed that will contain more than 13,000 well logs and information on more than 250,000 miles of geophysical survey data purchased over the past decade—an extensive collection including both those generated inhouse and those purchased from operators on OCS lands. An inventory of oil and gas reserves on Federal OCS lands also will be developed to provide information for future planning.

OCS Leasing Problems and New Legislation

Existing legislation provides a satisfactory framework for carrying out the objectives of the accelerated OCS leasing program. The OCS Lands Act of 1953 permits substantial latitude for adjustment to changing circumstances. Significant changes in that law could seriously delay achievement of OCS program objectives.

In contrast to the changes contained in the pending bills, existing law provides sufficient flexibility for an appropriate balancing of energy, environmental, and other social needs. For example, under its present authority DOI has adopted regulations which set forth new procedures for State participation at the development stage. As indicated, affected Coastal States will be provided by the lessee with information on proposed operations, both onshore and offshore, and the States will be given a 60-day period to review and comment on the lease development plan. The specific components of the information package to be provided to the States are being worked out by DOI in consultation with industry and a committee of the newly formed OCS Advisory Board including State representatives. The Department believes that these procedures will greatly assist the States in getting the necessary data to carry out their own planning and land management duties and will provide the opportunity for increased dialog between the States and the lessees. These new regulations appeared in the *Federal Register* on November 4, 1975, and became effective immediately.

COAL LEASING

Early in 1971, further coal leasing on Federal lands was halted because large amounts of coal were already under lease, little coal was being produced, and there was widespread concern that DOI's leasing processes were not based on an adequate environmental assessment. In February 1973, this moratorium was modified to permit leasing when coal was needed to maintain existing mining operations, or to act as a reserve against production in the near future. This limited leasing was allowed only when the environment could be protected and when the provisions of the National Environmental Policy Act had been complied with.

Only 10 leases have been issued under these criteria, and all were for extensions of existing operations.

Since the near moratorium on coal leasing, demand for western coal has grown. At the same time, challenges to the desirability and need for vast coal development in the West have surfaced. At issue are the concerns over the environmental and socioeconomic impacts of large-scale western coal development versus the significant contribution western coal resources might make toward reducing U.S. dependency on imported petroleum and natural gas from unreliable sources.

On January 26, 1976, the Secretary announced a new coal-leasing policy to permit resumption of Federal coal leasing as the need arises. Important steps in the development of the new coal policy were the issuance of the Northern Great Plains Report in August 1975, which analyzed the socioeconomic impacts of coal development on the northern Great Plains region, and the *Coal Programmatic Environmental Impact Statement*, which was released in September 1975. The EIS provides a general analysis of the environmental impacts of major leasing alternatives.

The Coal-Leasing Program

The new coal-leasing program was accompanied by a lifting of the moratorium imposed 5 years earlier. At the same time, the Secretary reaffirmed support for Indian self-determination in the leasing of tribal coal resources that encompass a significant portion of western coal reserves.

In the development of the coal-leasing program, the Western States were consulted, and there was also consultation and close coordination with the Western Governors' Regional Energy Policy Office.

Under the coal-leasing program, the rate of Federal leasing that is in the public interest is determined by the following criteria: Federal coal will be competitively leased only under environmental and diligence restrictions, where the value of coal would exceed its costs of production (including allowance for unavoidable environmental damages); and only if the winning bid is equal to or exceeds the fair market

value of the deposit. Under the new coal-leasing program, the provisions of Federal environmental regulations related to surface mining have been expanded; and Federal responsibility for the private surface has been clarified.

Elements of the Proposed Federal Coal-Leasing Program

The Federal coal-leasing program features competitive coal leasing based on the principles of multiple or sequential land use and nominations for or against the leasing, as well as identification by industry and the public at large of areas where leasing should or should not be allowed.

The coal-leasing program will include the following elements, among others:

- (1) Timely development of new and existing Federal coal leases through the application of diligence and advance royalty requirements
- (2) A definition of the term "commercial quantities" to evaluate more properly the merits of pending preference right lease applications
- (3) The offering of new leases for competitive sale through the Energy Minerals Activity Recommendation System
- (4) Data gathering for coal resources and rehabilitation potential
- (5) The establishment of effective surface-mined land reclamation standards
- (6) The establishment of Federal coal-leasing policy with respect to Indian lands held in trust

Diligence and Advance Royalty Requirements

There are 536 Federal coal leases currently in existence, covering approximately 16.4 billion tons of recoverable coal reserves under 782,000 acres of land. The DOI intends to stimulate early production on these existing leases, or, if the lessees have no desire to develop the leases, to encourage early relinquishment of the leases. These objectives will be pursued through two approaches: (1) promulgation of diligent development and continuous operations regulations, and (2) incorporation of advance royalty requirements at the time of lease renewal.

Diligent development regulations were first published in draft form as proposed rulemaking in the *Federal Register* on December 31, 1974, and refined in subsequent draft regulations published in December 1975. These proposed regulations define the terms "logical mining unit" (LMU), "LMU reserves," "diligent development," and "continuous operations." The lessee is required to file a development plan with the USGS mining supervisor and to conduct operations on the LMU in accordance with the plan (that is, to operate under diligence requirements including necessary work to prepare for production), and, as required by the terms of the lease, to engage in the continuous operation of the mine or mines in the LMU. The lease can be terminated if the lessee does not diligently develop his LMU. The Department is reviewing comments on the proposed diligent development rulemaking and intends to publish final regulations in 1976.

In lieu of continuous production, advance royalty requirements—a financial incentive to encourage diligent development and continuous production—will be imposed on new leases and on existing leases at the time of their 20-year readjustment. These requirements will include required annual production schedules and a royalty rate of approximately 8 percent, but not less than 5 percent of the gross value of the coal at the mine. Advance royalties are payments made by a lessee based upon an annual production rate that would exhaust the deposit in 40 years. Advance royalty minimum production schedules would begin in the sixth year of the lease. Minimum production rates would be computed on the basis of a 40-year period to exhaust reserves on the lease. Advance royalty payments may be credited against royalty due for actual production at a later time.

No mining will be permitted on an existing lease until a mining and reclamation plan has been approved by the mining supervisor. Prior to approval of the mining and reclamation plan, the mining supervisor, in consultation with appropriate governmental agencies and affected parties, will conduct an environmental analysis of the proposed mining operation to determine whether an EIS would be required and to determine the stipulation that would be required in the mining and reclamation plan. If the min-

ing supervisor determines that the operation could result in environmental impacts that would significantly affect the quality of the human environment, an EIS would be prepared before the mining and reclamation plan is approved, unless a previous EIS has sufficiently analyzed the impacts.

Definition of "Commercial Quantities"

There are at present 28 prospecting permits in force covering 70,528 acres and possibly 2.7 billion tons of reserves that were obtained under the old leasing policy. There are also 190 applications currently on hand for preference right leases on 490,000 acres. These lease applications include conservatively about 9.3 billion tons of recoverable coal reserves. Processing of these preference right lease applications would require a determination by USGS that the permittee has demonstrated that coal exists on the proposed lease area in commercial quantities. A realistic definition of the term "commercial quantities" must be made under the Mineral Leasing Act of 1920. Heretofore, the standard generally applied was simply whether the mineral existed in the proposed lease area and whether it was minable under present technology without regard to cost. That standard has been changed. A standard based on the statutory requirements has been included in the final regulations published in the *Federal Register* on May 7, 1976.

Under the new policy, a prudent person in undertaking development of a coal mine would have to consider the costs of actual mining, the cost of transporting his coal to market, the cost of meeting environmental protection requirements, and the cost of complying with all the provisions of his lease. The applicant would have to demonstrate that a reasonably prudent person would be justified in the expenditure of his labor and means in the development of the mine; this would entail a comparison of estimated revenues and estimated costs.

The definition of the term "commercial quantities" that has been adopted sets out those factors which a prudent person must take into account. With the final promulgation of this definition, DOI is now able to determine which preference right lease applications have met the requirements of the Mineral Leasing Act

and, thus, can begin to process the preference right lease applications now pending.

EMARS

The system used to select areas to be offered for competitive coal lease sale is termed "Energy Minerals Activity Recommendation System" (EMARS). Under EMARS, coal leasing would be determined through a three-phase process, consisting of nominations, tract selection, and competitive leasing. In the initial nomination phase, industry and the interested public indicate areas of leasing interest, areas that should not be offered for lease, or areas that should be offered only under special conditions.

Nominations would be included with other information to supplement the data base of BLM's multiple-use planning system. Other Federal agency, State and local government, and public participation is obtained through several stages of BLM's planning system and at the time of tentative selection of tracts for possible competitive lease sale. Proposed lease sales selected by the field levels of BLM and USGS would then be aggregated into an annual Federal coal-leasing schedule.

Prior to the decision to offer an area for coal lease sale, an environmental analysis will be prepared for the area. If the analysis indicates that a major Federal action is involved, i.e., the development of the lease would result in impacts that would significantly affect the quality of the human environment, an EIS would be prepared before any decision to offer the lease is made unless a previous EIS has already sufficiently analyzed the impacts. Similarly, before a mining and reclamation plan for the lease would be approved, an environmental analysis and an EIS, if found necessary, would be prepared.

In many cases, the significance of any proposed coal leasing goes beyond the issuance of an individual lease or the approval of a mining plan. Leasing will frequently set the course of development for geographic areas encompassing both Federal and non-Federal lands. For this reason, as determined by the Secretary, several coal leases, or mining plans, may be covered in a single regional EIS, rather than by multiple EIS's. In such cases, the region covered will be determined by basin boundaries,

drainage areas, areas of economic interdependence, and other relevant factors.

Competitive coal leases would include diligent development requirements and advance royalty payments as previously described. Similarly, environmental and rehabilitation requirements would be incorporated in the leases. The level of lease offerings would be determined by bidding results in competitive lease sales. Lease sales would be offered so long as bidding competition remains sufficiently high to indicate the desirability of further leasing.

Data Gathering

Data-gathering efforts to support the proposed coal-leasing program include:

- Surface and mineral ownership (BLM)
- Coal development potential mapping (USGS)
- Coal resource classification (USGS)
- Geologic, engineering, and economic evaluation data (USGS)
- Overburden and hydrologic data to determine the potential for and requirements of rehabilitation (BLM/USGS)
- Reserve data on areas under consideration for leasing (USGS)

Surface and mineral ownership maps and coal development potential maps are being prepared by DOI for all areas of known Federal coal resources. These maps will be of use to the Department in planning for effective coal resource management and of aid to the public in recommending areas for lease or for special considerations.

The USGS is classifying lands as Known Coal Leasing Areas where coal exists in quality and quantity to warrant competitive leasing.

The BLM and USGS are conducting drilling programs to analyze the overburden and hydrological characteristics of areas considered to have a high potential for coal leasing. Data from this program will be used for determining rehabilitation measures to be applied to mining operations on these areas. Mining operations under subsequent leases in the areas will be monitored to determine the success of rehabilitation measures. Correlation between presale information and postsale rehabilitation results will be made prior to prescribing rehabilitation measures on future sales.

Surface Mined Land Reclamation Standards

A major element of the coal-leasing program would expand the scope of Federal environmental regulations for surface coal mining. More explicitly, Federal responsibility now includes the private surface where the minerals are in Federal ownership. Specific language will be provided to clarify responsibilities of lessees, permittees, and licensees for all phases of coal-mining operations on public and acquired lands of the United States administered by DOI. The scope of the new regulations addresses not only the "orderly and efficient development" phase of the operation, but also the total spectrum of events beginning with the prelease land-use planning and environmental analyses, continuing into prospecting, exploration, and testing activities and extending through the development, mining, production, and coal-processing practices, as well as the abandonment and reclamation measures. The new regulations set forth environmental standards that will be used in conducting prelease, permitting, and licensing examinations, which, in turn, will develop the terms and conditions of the lease, permit, or license. These standards are correlated between the two sets of regulations (BLM and USGS), and reclamation requirements will be consistent throughout the preleasing, exploration, mining, reclamation, and abandonment phases of coal operations. The new regulations further require that exploration and/or mining plans, describing in detail the operations to be undertaken, be prepared and submitted in advance of those operations.

The Secretary of the Interior can adopt and apply State regulations relating to reclamation of lands disturbed by surface mining, if the Secretary determines that such State laws and regulations afford general protection of environmental quality and values at least as stringent as would occur under exclusive application of Federal regulations. The Secretary may, however, decline to apply State laws or regulations if he determines such application would unreasonably and substantially prevent the mining of Federal coal and if it is in the overriding national interest to produce such coal without the application of State laws and regu-

lations. In addition, the Secretary and the Governor of a State can enter into an agreement to provide for a joint Federal-State program with respect to surface coal-mining reclamation operations for administrative and enforcement purposes. Such agreements will provide for State administration and enforcement of such programs, provided that Federal interests are protected.

Coal-Leasing Policy on Indian Lands

Coal resources on Indian lands represent a significant portion of western coal deposits. Development of these resources will not take place without the full concurrence of the Indian tribe having jurisdiction of the area concerned. As trustee for the various tribes, the Department's responsibility is to see that the desires of the Indian tribes with respect to coal development are met. Should a tribe decide to lease coal, it will be the Department's responsibility to support that decision. The Department will therefore approve coal leasing on Indian lands when: (1) the tribal or individual Indian landowner desires to dispose of the coal, (2) appropriate environmental protection and reclamation safeguards are imposed on the lessee, and (3) the terms and conditions of the lease are in the best interest of the Indian landowner.

Need for New Legislation

At this time the Department does not believe that changes in the Mineral Leasing Laws are needed to further coal-leasing objectives. Sufficient flexibility is afforded the Secretary under current legislation to meet program objectives.

OIL SHALE LEASING

Four oil shale leases were issued in 1974 under the prototype oil shale leasing program: Colorado A and B, and Utah A and B. The lease terms require the submission of a Detailed Development Plan (DDP) and, prior to that, completion of an environmental baseline study. The DDP must include a schedule of operations, a detailed description of the procedures designed to meet the environmental criteria and controls incorporated in the lease, and provisions for diligent and orderly development of the oil shale deposits.

The Oil Shale Environmental Advisory Panel (OSEAP), which was instituted in February 1974, advises the Department on the supervision and development of the oil shale program, and on the identification and mitigation of environmental hazards. The advisory panel includes Federal, State, and local government, environmental, and public representatives. The area oil shale supervisor of the Department submits development plans to OSEAP for comment on environmental aspects.

1975 Developments

A draft DDP of the Colorado A lease, which will involve both open pit and underground mining, was received by the Department in 1975. The final DDP is nearly completed, and submission is expected shortly. The final DDP of the Colorado B lease was received by the Department in February 1976. Notice of the availability of the DDP appeared in the *Federal Register* on February 19, 1976. Public hearings on the lease will be held in 1976. After a 6-month review, approval for development can occur. During 1975, draft DDP's were also received for the Utah A and B leases. The final DDP's are expected in 1976. Based on DDP submission dates, the earliest possible date for commencing of development operations is the first quarter of 1977. A 6-month minimum time period would be required for approval of a DDP. All companies involved in the four oil shale leases paid the second annual bonus installment in 1975.

On April 23, 1975, the Department published in the *Federal Register* a call for nominations of oil shale tracts to be developed by in situ or modified in situ technologies. Industry responded by nominating six tracts in Colorado, and three tracts in Utah. Subsequent to the July 31 closing date for the nominations, a Federal-State tract selection committee, which included a representative of the Governors of Utah and Colorado, was formed to review the tracts and to make preliminary recommendations as to which tracts should be selected. On September 12, the Assistant Secretary—Land and Water Resources—submitted the selection committee's report to OSEAP and requested its review and recommendations.

At present, DOI is developing an EIS for the lease areas, which should be completed at the end of 1976, to supplement the 1973 EIS on the prototype program. Lease sales could be held shortly after this time if a decision is made to hold such sales.

Problems

Previously, analysts had estimated the costs of production of shale oil as low as \$10 to \$11 per barrel. Some revision of these cost estimates has taken place recently because of a lower recovery factor; i.e., the shale oil content of the oil shale rock proved less than originally estimated. The best present Government estimate is that production of a barrel of crude shale oil would range between \$10 to \$14 a barrel, and refining costs would add an additional \$2 to \$4 a barrel. This estimate assumes a 3-to-1 debt/equity ratio. A 50,000-barrel-a-day shale oil plant is estimated at present to cost approximately \$1 billion.

The revised cost estimates of shale oil, including refining costs (ranging from \$12 to \$18 a barrel), would indicate that shale oil could be competitive with oil of the Organization of Petroleum Exporting Countries, especially if real world oil prices should rise. However, some industry cost estimates range higher than these estimates.

A major uncertainty, affecting the development of shale oil in the United States and discussed in chapter 1 of this report, relates to the level of future international oil prices. Any major decline in such prices would jeopardize the development of the American shale oil industry, barring major improvements in the efficiency of shale oil production or a Government subsidy or guarantee program.

Two major developments affecting the shale oil industry in 1975 were the defeat in November 1975 of the synthetic fuels commercialization provisions of H.R. 3474 (secs. 103 and 104), and the relinquishment in December 1975 by two companies of their interests in the Colorado B lease through sale to the remaining two companies. The remaining companies, in turn, have asked DOI for suspension of their lease, which, if approved, would enable these firms to forgo bonus installment payments during the

suspension period. The DOI is currently reviewing this request.

Whether a synthetic fuel commercialization bill will be enacted by Congress in 1976 continues to be another factor affecting the development of current and future oil shale tracts. Passage of such legislation would encourage the development of the industry and provide an incentive for accelerated leasing and production of shale oil.

On February 20, 1975, the Solicitor's Office of the Department ruled that, under existing law, it is not possible to grant offsite disposal areas to lessees. Without offsite disposal, there could be only a limited open-pit mine on Colorado A with corresponding higher costs and a much lower resource recovery. To assist the Colorado A lessees with their spent shale disposal problem, the Department supports enactment of legislation that would give DOI authority to grant lessees additional land for specified purposes, such as offsite disposal of spent shale and expanded plant sites; but no more than 6,400 acres could be leased for these combined purposes.

Prior to the Mineral Leasing Act of 1920, oil shale was a locatable mineral under the Mining Law of 1872. Oil shale mining claims were filed on a large share of the public-domain oil shale lands, but most of these have never been brought to patent. The validity of such claims is being contested by the Government. The time that may be required for determining ownership of these lands with clouded titles may be another impediment to commercial development on some public lands.

In addition, mining claims based on metaliferous minerals or other locatable minerals in public-domain lands that also contain oil shale were filed in the 1950's and 1960's. The Multiple Mineral Development Act, which was enacted in 1954, permitted the location of mining claims for separate deposits of locatable minerals in lands known to be valuable for leasable minerals. In 1966, there was a claims rush for oil shale lands containing dawsonite deposits. In 1967, the oil shale lands were closed to all mining location. A review of the claims records made in 1968 of total Federal oil shale lands indicated that 85 percent of these lands were covered by mining claims. Titles to such lands

will remain clouded until their validity is established by adjudication.

GEOHERMAL LEASING

Competitive Leasing of Geothermal Resources

The BLM has held 28 sales to date, and has issued 119 competitive leases on about 229,000 acres of Known Geothermal Resource Areas (KGRA's). The BLM has tentatively scheduled an additional 10 sales for fiscal year 1976. Each sale will range from 10,000 to 30,000 acres. By the end of fiscal year 1976, it is anticipated that an additional 50 competitive leases and approximately 400-500 additional noncompetitive leases will have been issued.

All Federal geothermal leases have a primary term of 10 years. In general, if the lessee produces geothermal steam in commercial quantities during the primary term, his lease will continue for the life of production, but not for more than 40 years after the primary term. Thereafter, the lessee will have a preferential right to renew his lease for a second 40-year term. Diligence is further encouraged during the primary term of the lease by provisions for escalating rental rates and minimum expenditures for exploration, beginning in the sixth year of the lease and continuing until there is commercial production.

Noncompetitive Leasing of Lands

Federal lands authorized for geothermal exploration and not designated as KGRA's must be leased noncompetitively. To date, BLM has received approximately 5,300 noncompetitive geothermal lease applications covering about 11 million acres. About 450 of these applications, encompassing 788,000 acres, have resulted in corresponding leases. Issuance of the remaining leases awaits land status determinations, the formulation of special stipulations, and required environmental studies. Approximately 50 percent of these applications received will not mature into leases because of rejections, withdrawals, lease refusals by the applicants, and competitive interest designations (where two or more applications filed during the same filing period overlap one another by 50 percent or more).

Geothermal Production

The Geysers geothermal field in California, a dry steam field, produces the only geothermal power in the United States. At present, planned installation will bring capacity at the Geysers up to 1,000 megawatts, which could eventually reach 4,000 megawatts. Because of economic, technical, geologic, and environmental factors, geothermal power development has not proceeded on federally leased lands in 1975, despite the increased leasing that has taken place recently.

Recent Legislation

The Geothermal Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-410) established a geothermal program under the general management of the ERDA. Functions of this program include the following: the determination and evaluation of the resource base; research and development with respect to exploration, extraction, and utilization technologies; the demonstration of appropriate technologies; and a loan guaranty program.

Under the act, USGS and others are responsible for the implementation of innovative geological, geophysical, geochemical, and stratigraphic drilling techniques, which will lead to a national inventory of geothermal resources in the United States. Currently, the most complete and up-to-date assessment of U.S. geothermal resources is Geological Survey Circular 726, published in 1975, which includes resource estimates for the various types of geothermal systems and subsystems with data broken down by individual site. Estimates are given for total volumes and electric-generating potential, where applicable. The parameters assumed in calculating volumes, heat contents, and recoverabilities are listed. As stated in the circular, these data should not be taken as final appraisals, but will be revised as improved methods of evaluation become available, and as technology and economic conditions change.

Problems Affecting Geothermal Leasing

A major problem constraining geothermal resource development concerns conflicts and ambiguities over the ownership and control of

the use of geothermal resources, which, on certain lands, is in question because of the lack of a definite classification of geothermal resources as minerals, gas, or superheated water. Differing laws pertain to the ownership and control over the use of minerals, gas, and water. Thus, leases on certain lands within known geothermal resource areas will not be issued before adjudication of legal issues takes place. Section 21 of the Geothermal Steam Act of 1970 provides for judicial action in resolving whether mineral reservations include geothermal resources. Thus, the Secretary of the Interior must obtain a judicial interpretation as to whether mineral reservations include geothermal resources.

In November 1973, a U.S. district court concluded that geothermal resources are not minerals within the meaning of the act, and determined that the Government had no right to, or interest in, geothermal resources discovered on land granted by the Government under the act, because such resources did not come within the definition of "minerals" in use when the Stock-raising Homestead Act was passed in 1916.¹ This case has now been appealed to the Court of Appeals for the Ninth Circuit.

However, there is some indication that certain surface owners, as well as grandfather preference right holders,² would be willing to have the geothermal resources leased with the understanding that all rents, royalties, and bonuses be held in escrow, pending final resolution of the title question.

Another problem relates to the control over use of geothermal resources—to what extent may States maintain control over the use of geothermal resources on Federal lands. For example, if geothermal resources are classified as water, depending on the extent to which State water laws apply to geothermal resources lo-

¹ *United States v. Union Oil Co. of Calif.*, 369 F. Supp. 1289 (N.D. Calif. 1973).

² The grandfather clause provision of the Geothermal Steam Act gave preference to persons who could convert their leases, permits, or claims to geothermal leases under the Mineral Leasing Act of 1920, as amended (30 U.S.C. 181-287), or the Minerals Leasing Act of Acquired Lands, as amended (30 U.S.C. 351, 358).

cated on Federal lands, development of the geothermal resources could be hampered.

FEDERAL LEASING OF NONFUEL MINERALS

Under Section 30 of the Mineral Leasing Act (30 U.S.C. 187), the Secretary of the Interior has considerable discretionary authority in determining the conditions affecting the exploration and leasing of minerals. The following policy initiatives were undertaken in 1975 to meet national objectives in the development of our nonfuel mineral resources:

(1) The DOI has initiated analyses to determine how royalty rates should be properly computed for selected nonfuel minerals.

(2) As in the case of the new coal-leasing program, a definition of valuable deposit would be adopted by regulation to govern the processing of preference right lease applications for phosphates, sodium, sulfur, and potassium. The statute requires the applicant to show a discovery of a "valuable deposit" in order to earn a preference right lease. The proposed regulation would define "valuable deposit" as equivalent to commercial quantities in respect to coal, taking into consideration the costs of actual

mining, of transporting the minerals to market, of meeting environmental protection requirements, and of complying with lease provisions. For sodium, sulfur, and potassium, the applicant must show not only that he has discovered valuable deposits of these minerals, but also that the land would not have a higher value in some alternative use.

(3) In 1975, DOI initiated analyses to determine whether advance royalties should be required in the leasing of minerals other than coal, and is awaiting comments from its field offices on this issue.

ISSUES AND RECOMMENDATIONS

- Enact legislation authorizing the Secretary of the Interior to grant lessees additional land for offsite disposal of spent shale.
- Enact legislation to provide for Government incentive programs, i.e., the Administration's proposed synthetic fuels commercialization program, to encourage investments in the currently available but commercially untested technologies for producing synthetic fuels.

Chapter 5

THE FEDERAL ROLE IN REDUCING THE FISCAL IMPACTS OF ENERGY DEVELOPMENT

Summary.—The development of Federal energy resources during the next 10 to 15 years may present difficulties for some State and local governments concerning their ability to support the front-end infrastructure and other costs that may accompany energy development. Under these circumstances, the Federal Government should provide some assistance. To this end the Administration has transmitted to Congress legislation to create a Federal Energy Development Impact Assistance fund to provide \$1 billion for planning grants, loans, and loan guarantees to States, localities, and Indian reservations impacted by development of Federal energy resources.

INTRODUCTION AND OVERVIEW

Because of developments in the world energy situation during the last few years, accelerated production of domestic energy resources has become a high priority national goal. The Department of the Interior (DOI) has a major responsibility in the achievement of this goal through the leasing of oil, gas, coal, oil shale, and geothermal resources on Federal and federally administered lands. The front-end fiscal impacts on State and local governments that may result from Federal energy resource development are a major concern.

The construction and operation of new energy facilities usually result in local economic growth and relatively large increases in population, accompanied by the need for increases in public facilities and services. The outlays for additional capital investments and operating cost increases often precede the increases in tax revenues, thus causing a front-end financing problem even though new developments, in the long run, should result in a creation of sufficient economic benefits to pay their own way. Because of the revenues lag in communities impacted by development of Federal energy resources, because of the risk that selected energy

projects may fail to be productive for their expected lives, and because of the natural benefits that will be derived from such energy developments, the Federal Government has a responsibility to assist State and local governments by sharing in those risks, and to assist State and local communities in meeting front end costs that cannot be effectively handled in a timely fashion.

During the past year, DOI has been examining alternative approaches by which the Federal Government can help to minimize the front-end fiscal impacts associated with the development of Federal energy projects that are of concern to States and localities. In designing an impact assistance program, care must be taken to insure that the program will provide front-end financing assistance where it is needed and in a timely fashion, that it will maximize State and local decisionmaking and discretion, that it will avoid creation of a large new Federal bureaucracy, and that it will encourage State and local governments to implement a fiscal system whereby the consumers, in the long run, pay for the needed, new public facilities.

ENERGY DEVELOPMENT IMPACTS BY GEOGRAPHIC AREA

The programs of the DOI include the leasing of oil and gas in such dissimilar environments as Alaska and California and the leasing of coal near towns with populations numbering in the hundreds. The addition of an energy facility staffed by 500 or 1,000 people would cause substantial impact in a sparsely populated rural area in Alaska or in the Mountain States, while a similar facility in California or the urbanized areas of the Atlantic coast would result in impacts that would not rise above the threshold of measurable effects.

Inland Development

The development and expansion of energy extraction, processing, and transportation facilities in inland States will frequently impact regions characterized by limited population and economic bases, such as the Southwest, the Rocky Mountains, the Northern Great Plains, and Appalachia. Communities in these regions are typically rural with minimal public service levels and limited capability to manage or finance the infrastructure required by an expanding population. Often there are statutory, cultural, and political limitations on the capacity of States and localities in these regions to respond to growth, such as prohibitions against State bonding, lack of bonding authority for certain types of institutions, and limited tax options.

Limited information, a high aversion to risk, and uncertainty regarding the permanence of a boom tied to a single economic activity, all combine to limit private and public investment in many areas. Even in communities with adequate fiscal systems, infrastructure expenditures may significantly precede revenues, creating a serious front-end financing problem. This problem is exacerbated when the energy facilities are located outside the community limits, and the communities do not share in the county tax base.

The probable one-time capital costs for public facilities and infrastructure to serve the increasing population accompanying energy development have been estimated to be between \$4,000 and \$4,800 per capita in constant 1974 dollars. When public capital costs are increased

by 25 percent to account for higher costs under boom conditions, one-time capital costs of public facilities and infrastructure range between \$5,000 and \$6,000 per capita in constant 1974 dollars.

Focusing solely on the Western States, in which accelerated energy development on Federal lands is expected during the next 15 years, the Office of Management and Budget has estimated that population will increase by 200,000 persons and public expenditures for planning and public infrastructure, by \$1 billion (table 5-1). This estimated expenditure of \$1 billion, in common with estimates of the infrastructure needs of areas impacted by development of Outer Continental Shelf (OCS) resources, is only a rough approximation and does not take into account tax revenues generated by energy development and transfers or aids and bonding revenues that would reduce the impacts on States and localities. Presumably, the communities, counties, States, and industries involved in energy development should be able to finance a high proportion of the infrastructure costs.

OCS Development

The impacts of OCS activities arise from the exploration, development, and production

TABLE 5-1. *Additional population and infrastructure costs resulting from coal development in the West, 1976-90*

State	Additional population ¹ from increased Federal coal production (persons)	Cost of additional infrastructure ² (millions of dollars)
Colorado	97,477	502.0
Kentucky	2,719	14.0
Montana	1,776	9.1
North Dakota	80	.4
New Mexico	2,243	11.6
Oklahoma	1,277	6.6
Utah	30,437	156.8
Washington	195	1.0
Wyoming	65,476	337.2
Total	201,680	1,039.0

¹ Based on estimated production levels, labor input factors, and estimated total employment.

² Assumes cost of infrastructure at \$5,000 per capita, and that 1 out of 10 developments will require a new town allowance of an additional \$1,500 per capita.

Source: Office of Management and Budget.

phases of oil and gas operations and vary substantially, depending upon the existing population and infrastructure. During the exploration phase, when drilling rigs and crews are brought in, the level of onshore activity is usually only a modest addition to the existing activities, causing little impact on the coastal communities except in sparsely populated areas, such as Alaska.

Once exploration has located oil reserves of commercial size, development begins with its associated construction activities. Construction and support crews can mean a substantial influx of population to remote areas lacking adequate public facilities. Because of the time required to plan and construct new facilities, State and local governments may find they have to increase their expenditures before their tax revenues are increased by the new developments.

Projected OCS exploration and development in the Atlantic, Gulf, and Pacific States and Alaska during the next 15 years is expected to result in an increased population of 148,000 and to necessitate additional infrastructure and other related public expenditures of \$950 million (table 5-2). Again, this expenditure estimate has not been offset by potential revenues nor does it take into account the capacity utilization of existing infrastructure.

TABLE 5-2. *Additional population and infrastructure costs resulting from OCS exploration and development, 1976-90*

Area	Additional population ¹ from increased OCS exploration and production (persons)	Cost of additional infrastructure ² (millions of dollars)
Atlantic	21,317	107
Gulf	17,991	90
Pacific	14,175	71
Alaska	94,185	683
Total	147,668	951

¹ Based on estimated production and population levels.

² Assumes cost of infrastructure at \$7,250 per capita in Alaska and \$5,000 per capita in all other areas.

Source: Office of Management and Budget.

Indian Reservations

Severe front-end financing problems may exist on Indian reservations because of an inaccessibility by Indian tribes to traditional sources of revenue and credit stemming from the inability to issue bonds and to mortgage trust property. Since capital market funding for public infrastructure on Indian reservations is burdened by existing laws and Federal-Indian relationships, significant private sector or governmental participation in facilitating the development of public infrastructure may be necessary to assure development.

THE NEED FOR LEGISLATION

To improve understanding of fiscal impacts associated with energy development during 1975, the Office of Minerals Policy Development of DOI commissioned several studies for selected sites in the West most likely to experience major energy development within the next 10 to 15 years.¹

Analysis of completed studies indicates that the States have a great deal of potential in dealing with fiscal impact problems through use of their own resources. Thus, in designing a Federal impact assistance program, care should be taken to assure that Federal actions will not serve as a disincentive for fiscal innovation at the State and local levels of government or lead to the substitution of Federal for State and local area expenditures.

¹ See, for example: Resource Management Systems, *A Description of Potential Socioeconomic Impacts from Energy-Related Development on Campbell County, Wyoming*, prepared for Office of Minerals Policy Development, U.S. Department of the Interior, Washington, D.C., Sept. 1975. Real Estate Research Corporation, *Excess Cost Burden, Problems and Future Development in Three Energy Impacted Communities of the West*, prepared for Office of Minerals Policy Development, U.S. Department of the Interior, Washington, D.C., Sept. 1975. Maxine C. Johnson and Randle V. White, *Colstrip, Montana: The Fiscal Effects of Recent Coal Development and an Evaluation of the Community's Ability to Handle Further Expansion*, prepared for Office of Minerals Policy Development, U.S. Department of the Interior, Washington, D.C., Oct., 1975. Linda W. Hickok and Douglas A. Samuelson, *Economic Impact of Projected Energy Development: Craig and Moffat County, Colorado*, Office of Minerals Policy Development, U.S. Department of the Interior, Washington, D.C., Dec., 1975.

In February 1976, the Secretary of the Interior submitted to Congress the Administration's Federal Energy Development Impact Assistance Act, which would provide \$1 billion in

planning grants, loans, and loan guarantees to States, units of local Government, and Indian reservations impacted by Federal energy resource development.

Chapter 6

AVAILABILITY OF FEDERAL LANDS FOR MINERAL EXPLORATION AND DEVELOPMENT

Summary.—Approximately one-third of the Nation's land mass is owned by the Federal Government. How mineral exploration and development is encouraged or restricted on these lands is an important element in our national minerals policy. Preliminary evidence indicates that mineral exploration and development is prohibited or severely restricted on over 50 percent of these lands. However, a large portion of these restrictions are due to the Alaska Native Claims Settlement Act, and some of these restrictions are likely to be temporary. A thorough assessment of the availability of Federal lands for mineral development and an analysis of Government policy toward mineral development on Federal lands are needed. A departmental task force has been formed to study the problem and to make specific recommendations.

INTRODUCTION

Vast areas of the United States, totaling about one-third of the Nation's land mass, are owned by the Federal Government. Most of these Federal lands are in the 11 States of the Far West and in Alaska, where rugged topography and varied geology have concentrated a great natural storehouse of mineral wealth. The map in figure 6-1 shows the location of those lands owned by the Federal Government.

More than 90 percent of the country's copper production and 80 percent of the silver production come from just five Western States. Twenty of the 25 largest metal mines in the country are in the Far West. Montana, Wyoming, and other Western States have vast reserves of coal. These Western States plus Alaska are likely to continue to be the major domestic source of many metals and minerals. The State of Alaska, in particular, because of its immense size, varied geology, and vast unexplored areas could prove to be this country's major hope for increasing the domestic production of various important metals and minerals.

The tremendous amount of land in these important mineral-producing States that has not passed into private ownership gives the Federal Government a great deal of impact upon the future of mineral production in this country. How the Federal Government allows or restricts mineral exploration and development on these lands will be a major determinant of the future level of domestic mineral production.

U.S. demand for minerals can be satisfied from two sources, domestic production (including recycling) and imports. There are two major benefits to the Nation from producing minerals from domestic resources rather than importing them. First, if domestic production is cheaper, there is a net benefit to the country equal to the difference between the cost of producing the mineral domestically and the world price for the mineral if it is imported. The second benefit from domestic production is that our reliance on supplies from possibly unreliable foreign sources is reduced. If the foreign supply of a critical mineral is suddenly reduced or eliminated and that mineral is not quickly available through domestic

Figure 6-1. Federal lands.

production and domestic stockpiles, or if substitution of other materials is not possible in a short period of time, then the cost to this Nation can be extremely large. The recent oil embargo is an obvious example. While failure to develop the mineral resources that are available on Federal lands and that would otherwise have to be imported will deprive the Nation of the benefits of a lower cost and more secure source of supply, domestic mineral production can also create a cost to the Nation in the form of adverse environmental impacts.

THE MINING AND MINERAL LEASING LAWS

Laws that govern development and control of onshore mineral resources on Federal lands can be divided into two basic categories. The first category consists of the Mining Law of 1872. The second category, which is referred to in this report under the collective term "Mineral

Leasing Laws," includes three separate laws. The first and most important Mineral Leasing Law is the Mineral Leasing Act of 1920. Two other leasing laws of lesser importance are the Acquired Lands Act of 1947, which regulates mineral disposal on all lands that have been acquired by the Federal Government and which incorporates most features of the 1920 act, and the Geothermal Steam Act of 1970, which regulates the disposition of geothermal steam. Laws that govern mineral resources on the Outer Continental Shelf and common variety minerals used mostly for construction purposes are not discussed here.

Mining Law

The 1872 Mining Law was a product of the social and economic conditions in the middle of the 19th century. The Federal Government's policy in this era was to transfer lands from

the public domain to private ownership as quickly as possible to satisfy a variety of needs. For example, the Homestead Act of 1862 made public lands easily available to farmers who could show a serious intention to engage in agriculture and thus settle the empty lands of the west. Similarly, the Mining Law of 1872 makes public lands easily available to miners who can show that the land contained a valuable mineral deposit and who can demonstrate a serious intent to develop these minerals. If an individual makes a discovery of a valuable mineral on some portion of the open Federal lands and undertakes at least \$100 worth of labor or improvements per year at the site of the discovery, he can establish a possessory right to the area (called a mining claim) for the purpose of developing and extracting minerals. After fulfilling additional requirements, a mining claimant can obtain a patent, a legal process that ordinarily conveys the whole of the Government's title to the land covered by the claim. Such a conveyance passes the land into private ownership.

The Mining Law applies in only 19 States. In these States, public domain lands and those lands where the mineral estate (but not the surface rights) has been reserved for the Federal Government totaled 734 million acres in 1974. This is approximately 33 percent of the total land area of the United States. Since 1872, various acts of Congress and Executive actions have withdrawn a large portion of these lands from the jurisdiction of the Mining Law. The Mining Law never applied to public lands in the other 31 States (approximately 1.8 million acres) or to those lands which were once in private ownership but subsequently were acquired by the Federal Government. These acquired lands total approximately 56.3 million acres, or about 2½ percent of the total land area of the United States. The Mining Law applies to all minerals with the exception of oil, gas, coal, phosphate, sodium, oil shale, sulfur, potash, and certain other hydrocarbons—all of which are subject to the Mineral Leasing Act of 1920—and common varieties of sand, stone, pumice, and cinders, which are subject to the Material Act.

In general, the Mining Law of 1872 has served the Nation well over the more than

100 years of its existence. The legal framework of the Mining Law has provided a sound basis for protecting the rights of those who would explore for the minerals under its coverage. In so doing, the 1872 Mining Law has contributed greatly to the legal and economic atmosphere required to support the domestic development of the metals and minerals so important to the economy throughout the years.

On the other hand, the Mining Law of 1872 does not reflect some of the goals of the Nation that have developed during the past 100 years. For example, it makes no specific provisions to protect the environment or to preserve the land for other uses that may be of greater value than the minerals. Moreover, the United States does not receive compensation for the minerals disposed of under the Mining Law.

Mineral Leasing Laws

In 1920, in response to concerns that the Mining Law was inadequate, a number of important and widely occurring minerals were removed from the jurisdiction of the Mining Law and were placed under the Mineral Leasing Act. In all of the 50 States, the three Mineral Leasing Laws, described previously, apply to public domain lands, acquired lands (lands once in private ownership), and lands where the mineral estate has been reserved for the Federal Government. These lands total 809 million acres, or 36 percent of the total land area of the United States. The Leasing Laws themselves, other subsequent statutes, and Executive actions have excluded various portions of these lands from the Mineral Leasing Laws.

The Mineral Leasing Laws introduced two changes in the management of mineral resources on Federal lands that were not found in the Mining Law. First, they provided for mineral leases. In those areas where valuable minerals are known to exist, the right to develop these minerals is given to the high bidder under a competitive bidding process. The lessee is required to reimburse the Government for the right to develop the minerals in the form of bonus bids, rents, royalties, or other payments. Note that only the right to develop the minerals is given to the lessees. The ownership of the land remains with the Government.

In other areas, the Mineral Leasing Act pro-

vides for the issuance of prospecting permits for a 2-year period with a preference right to a lease if a valuable mineral deposit is discovered. In comparable situations for oil and gas, noncompetitive leases were authorized. These represent the noncompetitive leasing provision of the Mineral Leasing Laws. It is important to note that the agencies that administer the surface have a great deal more discretionary authority to allow or prohibit mineral development under the Leasing Laws than under the Mining Law. Also, the United States receives rentals and royalties under these leases.

The second change is that the Secretary of the Interior was given authority to issue regulations and impose restrictions on mining activities on Federal lands for those minerals covered by the Mineral Leasing Act in order to protect the general interest of the United States.

Administrative Responsibility

The Federal agency with primary responsibility for administering the Mining and Leasing Laws is the Bureau of Land Management (BLM) in the Department of the Interior (DOI). The BLM grants patents to mining claims, leases all lands under the Mineral Leasing Laws, and prepares public land orders (for the signature of the Secretary) that officially withdraw land from the Mining and Mineral Leasing Laws. Many of these activities, including record keeping, are carried out by the local and State BLM offices. For example, to find out if a particular area is open to location of a mining claim under the Mining Law, one must consult the records in BLM's State or district office and the local county recorder's office and, in many cases, undertake a ground search for mining claim monuments and markers. Within DOI, the Geological Survey (USGS) also has important responsibilities for the administration of the Mineral Leasing Laws. The USGS classifies public lands as to their mineral character and as to their value for water power and storage purposes and evaluates mineral tracts subject to competitive lease. The USGS also supervises operations incident to the prospecting, development, and production of minerals on Federal lands that are under lease or covered by prospecting permits.

The other Federal agencies that administer the surface activities on Federal lands also have a great deal of influence over the operation of the Mining and Mineral Leasing Laws on these lands. Some of the more important surface administration agencies, in addition to BLM, include (1) the Forest Service, (2) the Department of Defense, (3) the Fish and Wildlife Service, (4) the National Park Service, (5) the Bureau of Reclamation, (6) the Nuclear Regulatory Commission (formerly the Atomic Energy Commission), (7) the Federal Power Commission, and (8) the Bureau of Indian Affairs. Land is not normally leased under the Mineral Leasing Laws without the approval of the surface managing agency. Mineral exploration and development under either the Mining Law or the Leasing Laws can be severely restricted by an agency's control over access to the site or over the surface activities necessary to the exploration and development of a mineral resource.

LIMITATIONS AND RESTRICTIONS ON MINERAL EXPLORATION AND DEVELOPMENT

Summary of Findings

In the 104 years since the passage of the Mining Law and the 56 years since the Leasing Act, numerous congressional acts and executive policies have placed restrictions on the availability of Federal lands for mineral exploration and development. For this report, an attempt has been made to classify all Federal lands according to their degree of availability for mineral exploration and development. The sources of data and methodology used are described below. This classification is a difficult task because of the large number of statutes, executive policies, and Government agencies involved and because of the lack of any previous data or studies on the subject. The results of this effort must be considered tentative and preliminary, but they do give an overall view of the restrictions that have been placed on mineral exploration and development on Federal lands.

Because of the different nature of the two categories of mineral laws, the results of the study are shown separately for those minerals covered by the Mining Law (table 6-1) and

TABLE 6-1. *Classification of Federal lands according to limitations and restrictions that prohibit or discourage mineral exploration and development under the Mining Law, 1974 data*

Degree of availability	Number	Category Description	Acres (millions)	Percent of total
Formally prohibited	A1	National parks and monuments	14.6	2.0
	A2	Naval petroleum and oil shale reserves	23.9	3.3
	A3	Military (other than naval reserves)	17.4	2.4
	A4	Indian purpose lands (not reservations)	4.2	.6
	A5	Wild and scenic rivers (wild category only)	.5	.1
	A6	Reclamation and national recreation areas	5.7	.8
	A7	Atomic Energy Commission	1.4	.2
	A8	Small tracts and recreation and public purposes	.5	.1
	A9	Administration and recreation areas (Forest Service and Bureau of Land Management)	1.9	.3
	A10	Utility corridor (Alaska)	2.9	.4
	A11	Oil shale	3.7	.5
	A12	Wildlife refuges	18.6	2.5
	A13	Alaska Native Claims Settlement Act (ANCSA)—native selections	120.0	16.3
	A14	ANCSA—D2/four systems	80.0	10.9
	A15	Bureau of Land Management primitive and natural areas	.4	.1
	A16	Proposed withdrawals	2.6	.4
	A17	Miscellaneous	6.5	.9
	A18	Classification and Multiple Use Act	.7	.1
	Subtotal		305.5	41.9
Severely restricted	A19	Application for Alaskan State selections	55.5	7.6
	A20	Wilderness areas	10.7	1.5
	A21	ANCSA—D1 lands (open for metalliferous only)	46.0	6.3
	A22	Utility corridor (open for metalliferous only)	2.5	.3
	A23	Proposed wilderness (primitive areas—Forest Service)	3.8	.5
		Subtotal		118.5
Moderately restricted	A24	National trails	.1	—
	A25	National parks and monuments	5.1	.7
	A26	Power site withdrawals	15.2	2.1
	A27	Forest Service roadless areas (wilderness review)	55.9	7.6
		Subtotal		76.3
Slight or no restrictions	A28	Leased areas (some overlap)	73.8	10.0
	A29	Bureau of Land Management wilderness review areas	24.7	3.4
	A30	Stock driveways	2.5	.3
	A31	Tentatively approved Alaskan State selections	13.0	1.8
	A32	Other	119.6	16.3
		Subtotal		233.6
	Grand total		733.9	100.0

those covered by the Leasing Laws (table 6-2). As can be seen from the tables, all Federal lands have been divided into approximately

30 to 40 categories. These categories are based either on the surface managing agency (for example, national parks and monuments,

TABLE 6-2. *Classification of Federal lands according to limitations and restrictions that prohibit or discourage mineral exploration and development under the Mineral Leasing Laws, 1974*

Degree of availability	Category		Acres (millions)	Percent of total
	Number	Description		
Formally prohibited	B1	National parks and monuments	24.6	3.0
	B2	Naval petroleum and oil shale reserves	23.9	2.9
	B3	Military (other than naval reserves)	10.6	1.3
	B4	Atomic Energy Commission acquired lands	.7	.1
	B5	Wild and scenic rivers (wild category only)	.5	.1
	B6	Utility corridor	5.4	.7
	B7	ANCSA—native selections	120.0	14.8
	B8	ANCSA—D2/four systems	80.0	9.9
	B9	ANCSA—D1 lands	46.0	5.7
	B10	Petroleum reserve buffer zone (lower 48 only)	.1	—
	B11	Wildlife refuges (acquired lands and special reserve)	.7	.1
Severely restricted	Subtotal		312.5	38.6
	B12	Wildlife refuges (prohibited for oil and gas except drainage)	23.4	2.9
	B13	Application for Alaskan State selections	55.5	6.9
	B14	Wilderness areas	11.6	1.4
	B15	Oil shale (prohibited for sodium)	3.7	.5
	B16	Proposed wilderness (primitive areas—Forest Service)	3.8	.5
	B17	National trails	.1	—
	B18	Miscellaneous	5.5	.7
	B19	Military (other than naval reserves)	6.8	.8
	B20	Indian purpose lands (not reservations)	4.2	.5
	B21	Atomic Energy Commission lands	.7	.1
	B22	Administration and recreation	1.9	.2
	B23	Reclamation and national recreation areas	5.7	.7
	B24	Small tract and recreation and public purposes	.5	.1
	B25	Bureau of Land Management primitive and natural areas	.4	.1
	B26	Classification and Multiple Use Act	.7	.1
	B27	Proposed withdrawals	2.6	.3
	B28	Forest Service roadless areas (wilderness review)	55.9	6.9
Moderately restricted	Subtotal		183.0	22.7
	B29	Tennessee Valley Authority (acquired lands)	0.9	0.1
	B30	Power site withdrawals	15.2	1.9
	B31	Bureau of Land Management wilderness review areas	24.7	3.0
	B32	Tentatively approved Alaskan State selections	13.0	1.6
Slight or no restrictions	Subtotal		53.8	6.6
	B33	Leased areas (some overlap)	73.8	9.1
	B34	Indian purposes (acquired lands, not reservations)	.8	.1
	B35	Remainder subject to agency planning	185.1	22.9
Subtotal			259.7	32.1
Grand total			809.0	100.0

Atomic Energy Commission lands, and military reserves) or the congressional statute or executive policy that set aside these lands for special uses (for example, wilderness areas, wild and scenic Rivers, and "D1" and "D2" lands in Alaska). These land categories are in turn placed in four classifications according to their degree of availability for mineral exploration and development. These classifications are entitled "formally prohibited," "severely restricted," "moderately restricted," and "slight or no restrictions."

The first classification includes those lands where mineral exploration and development has been formally prohibited. These lands are those for which an act of Congress, an Executive order, a public land order, or some other published notice has been made that excludes all forms of mineral exploration and development under the Mining and Mineral Leasing Laws. If a published notice or act does not exclude all forms of mineral exploration and development or if the exclusion does not take effect until some time in the future, these lands are not included in this classification of availability. As of 1974, mineral exploration and development was formally prohibited under the Mining Law on 305 million acres, or 42 percent of all Federal lands subject to that statute, and under the Leasing Laws on 312 million acres, or 39 percent of the Federal lands subject to that statute.

The severely restricted classification includes those lands where mineral exploration and development is very unlikely. This may result because some, but not all, forms of mining have been formally prohibited; because of agency leasing policy; because of policies which restrict surface activities necessary for mineral exploration and development; or because of policies which increase the risk for mining investment. Under the Mining Law, 16 percent of the applicable Federal lands are in this category. Under the Leasing Laws, 23 percent of the applicable lands are in this category.

In the moderately restricted classification, similar discouragements to mineral exploration and development exist, though to a lesser extent, as in the severely restricted classification. If the mineral potential of an area is high enough to offset the time and money involved in

overcoming these restrictions, a mineral company may be able to proceed with exploration and development on these lands. Under the Mining Law, mineral exploration and development is moderately restricted on about 10 percent of the applicable lands, and under the Leasing Laws on about 7 percent.

On the remaining lands, there are either slight or no restrictions on mineral exploration and development. This classification includes about 32 percent of applicable lands under the Mining Law and 32 percent under the Leasing Laws. Particularly for the Leasing Laws, the amount of lands in this category is difficult to measure precisely because of the discretionary authority that agencies have in permitting leasing. Though official agency policies occasionally prohibit leasing on these lands, each lease is usually treated case by case. If an agency feels that mineral development would interfere with other uses of the land, then a lease or exploration permit application may simply be rejected.

The overall conclusion from this study is that mineral exploration and development under the two basic mineral laws is very unlikely to occur on over 50 percent of Federal lands (the formally prohibited and severely restricted classifications). On a large part of the other Federal lands, slight to moderate restrictions exist on mineral exploration and development. A large part of these restrictions on mineral exploration and development are due to the Alaska Native Claims Settlement Act. As land use and ownership questions are resolved for the State of Alaska, a large part of the lands in this State, where mineral exploration is now prohibited or severely discouraged, is again likely to be open for mineral development.

Methodology of Analysis

The methods or techniques used to arrive at this classification of Federal lands need some explanation. Because a comprehensive accounting system of restrictions on mineral exploration and development does not exist and because the acreage of lands administered by various agencies or of lands affected by various statutes or executive policies is not readily available, an ad hoc approach was used in each case to gather the data summarized in tables 6-1 and 6-2.

First, the acreage of the 30 to 40 categories was estimated from a number of sources. Acreage for lands administered by some agencies is recorded in the *Public Land Statistics*. Acreage affected by some congressional acts was found in records in the various bureaus in DOI and the Department of Agriculture. Additional information was found in a section of the Public Land Law Review Commission Report (1968), titled *Withdrawals and Reservations on Public Lands*. Over 1,500 public land orders between 1964 and 1974 were examined to determine the acreage of lands where restrictions had been placed on mineral exploration and development. In some cases, agencies upon request provided the information (wilderness, wild and scenic rivers, Forest Service lands, and BLM lands).

Second, the degree of availability of each land category for mineral development was analyzed. For those land categories where development is formally prohibited by published statutes or executive policies, this was a relatively easy process. However, for those categories where some development is possible, though restricted in one form or another, the classification is more difficult. Each congressional act that restricts development was examined to assess its impact. Discussions were held with agency officials to determine each agency's policy with regard to leasing or restrictions on surface activities necessary for mining. In some cases, past experience by mining companies who have tried to make a discovery, develop a mining claim, obtain a prospecting permit, or obtain a lease was used to judge the degree of availability of certain land categories for mineral exploration and development.

Errors in the classification system presented in tables 6-1 and 6-2 may exist. One potential source of error is a failure to eliminate all overlaps between various categories. Some land is covered by two (or more) of the categories, and all overlaps must be subtracted from one of the categories to avoid double counting. For example, the wilderness area categories do not include lands in wilderness areas located in national parks and monuments, since this acreage is already included in the latter category. Some overlaps may not have been removed. In

some cases, acreages for certain categories of land where mineral development is restricted were simply not available without conducting a title survey of all land records in Federal, State, and local government offices; for example, Federal lands occupied by small incorporated villages and towns. The largest potential source of error, however, is the classification of lands into the severely, moderately, or slightly restricted categories. The degree of restrictiveness of some agency policies may have been overestimated. On the other hand, it may have been underestimated, due to the discretionary authority of surface managing agencies under the Leasing Laws.

Examples of Limitations and Restrictions

In order to better understand the classification system presented in tables 6-1 and 6-2 and the nature of the various acts or policies that restrict mineral exploration and development on Federal lands, some of the more important categories presented in the tables will be discussed in detail. For ease of reference, a discussion of a particular category will be followed by the identification numbers used for that category in tables 6-1 and 6-2. For example, a discussion of the restrictions placed on mineral development in wilderness areas under the Mining Law will be followed by the symbols (A20). A discussion of restrictions on wildlife refuges under the Leasing Laws will be followed by (B11).

The restrictions being placed on mineral development have greatly increased in recent years. In 1968, mineral development was formally prohibited or severely restricted on less than 20 percent of Federal lands. Today the figure is over 50 percent. The large increase has come about for two primary reasons. The first reason is the enactment of the Alaska Native Claims Settlement Act of 1971 (ANCSA), and the second is an increased interest in preserving large tracts of land as wilderness.

Though practically all categories of land withdrawals have increased in recent years, the largest land withdrawal in history is attributable to a single act of Congress, ANCSA. When Alaska entered the Union in 1959, less than two-tenths of 1 percent of Alaska was in private ownership. The Statehood Act declared

that the State was entitled to 105 million acres. The ANCSA is a complicated act whose first goal is to provide "a fair and just settlement of all claims by natives and native groups of Alaska based on Aboriginal land claims," and whose second goal is to incorporate large areas of the State into new parks, scenic rivers, refuges, and forests, and in other ways to plan the future land use of the State. Until the land use decisions for the State are finally determined, actions taken pursuant to the act severely restrict mineral exploration and development on 60 to 70 percent of the acreage in the State, in addition to large areas where mineral development was previously restricted. Some of this land will eventually be made available for mineral exploration and development, for example, lands owned by the Indians or the State government, or some Federal lands not set aside for other uses, such as parks, refuges, and wilderness areas. The fact remains, however, that for the present and for an undetermined number of years to come, most of our largest State (also the State with the greatest untapped mineral potential) is not open to mineral exploration and development.

The current situation in Alaska with respect to mineral exploration and development can be summarized as follows. Large areas of the Federal lands in the State have been segregated from the Federal mineral laws because of applications by the State of Alaska for these lands as part of its entitlement under the Statehood Act (A19 and B13). This land remains inaccessible for mineral development until the title to the land passes from the United States to Alaska and consequently becomes available for development under the relevant State laws or until it is clear that the lands will remain in the public domain. A mineral development company, which attempts to explore or develop a deposit on these lands, takes the risk of uncertain title to the land or rights to minerals on the land until a decision is made on the State entry. Another portion of the State has been tentatively approved as a State selection (A31 and B32), though the title to the land still rests with the Federal Government. The State has allowed some conditional leases to be granted on the lands resulting in these lands being classified as slightly or moderately restricted.

Approximately 120 million acres of land in Alaska were formally withdrawn from the Mining and Mineral Leasing Laws by ANCSA in order to provide a pool of land from which the Alaskan natives could select approximately 48 million acres (A13 and B7). The process of selection and the transfer of title is a complicated process that will take a number of years to carry out. In the future, when this land has been transferred to native villages and corporations, it is then possible for the lands to be open for mineral exploration and development depending upon the wishes of the native groups. Land that has not been transferred to the natives will remain in the public domain, and may become available for mineral exploration and development after other pending claims are settled.

Another large block of land in Alaska (A14 and B8) has been withdrawn from the Mining and Mineral Leasing Laws as a pool of land from which the Congress can select areas to be included in national parks and monuments, refuges, wild and scenic rivers, and forests. That portion of these lands which is not included in these selections may eventually be made available for mineral development. In response to section 17(d)(1) of ANCSA, approximately 46 million acres have been withdrawn from the Leasing Laws and withdrawn from the Mining Laws for nonmetalliferous mining in order to insure "that the public interest in these lands is properly protected" (A21 and B9). In order to facilitate the construction of the trans-Alaska oil pipeline and other possible utility systems in Alaska, another portion of the State has been withdrawn from some of the Mining and Mineral Leasing Laws for use as utility corridors (A10, A22, and B6).

Another act of Congress that will eventually close millions of acres of Federal land to mineral exploration and development is the 1964 Wilderness Act, which established a national wilderness preservation system. On January 1, 1984, Forest Service lands designated as wilderness areas by the Wilderness Act (A20 and B14) will be withdrawn from the Mining and Leasing Laws, although they are theoretically available for exploration and development until that date. Although mineral activity is not

formally prohibited in these areas for the next 8 years, the restrictions on surface activities necessary for exploration are so severe and the risk of not perfecting a discovery before 1984 are so high that these lands are not attractive for the investment of exploratory risk capital. It is also very likely that any lease applications would be rejected by the agencies administering these lands, even though these lands have not been formally withdrawn from the Leasing Laws. Consequently, these lands have been classified in tables 6-1 and 6-2 as being severely restricted.

Similarly, proposed wilderness areas managed by the Forest Service (primitive areas) are also subject to many of the same restrictions as those areas established as wilderness areas by the Wilderness Act and consequently have been placed in the severely restricted category (A23 and B16). Other large areas of lands administered by the Forest Service (roadless areas) and BLM (wilderness review) have been identified for possible inclusion in the wilderness system, and, in the meantime, some of these areas are being managed in ways that will help to preserve their wilderness characteristics. Consequently, these areas have been classified as areas where mineral exploration and development is severely or moderately restricted under the Leasing Laws (B28, B31) and moderately or slightly restricted under the Mining Law (A27, A29).

To give some examples of the wide variety of Government actions that restrict mineral exploration and development, consider the category in the two tables called proposed power site withdrawals (A26 and B30). These are areas that are theoretically available for mineral exploration and development under both the Mining Law and the Leasing Laws. However, these areas have been designated as possible hydroelectric power sites. It is the Government's policy that a dam may be built at any time at these sites that would flood a large portion of the area. Any damage to mining activities underway in these areas would not be compensated for by the Federal Government. Because of this discouragement to mineral exploration and development, these power site withdrawals have been placed in the moderately restricted category.

Though all national parks and monuments are closed to exploration and development for those minerals covered by the Leasing Laws, approximately 5 million acres of national parks and monuments are theoretically open for development of those minerals covered by the Mining Law. However, these lands have been placed in the moderately restricted category (A25) because of surface administering agency policies that discourage attempts to discover a commercial or valuable mineral deposit or to establish a valid claim under the Mining Law. Mining activities are restricted in order to protect the environment and other uses of these areas. Special use permits are required for many activities necessary to establish a mining claim such as taking rock samples or traveling in vehicles off established roads. In one case, a miner was fined for removing rock samples from his mining claim in a national monument because he did not first obtain a special use permit. Also, legislation has been proposed toward eliminating these lands from mining entirely.

To give two examples of land categories where slight restrictions on mineral exploration and development exist, approximately 74 million acres of land (in 1974) have already been leased under the Leasing Laws for single mineral commodities (B33). Attempts to explore and develop other minerals on these lands under either the Mining Law or Leasing Laws may be hindered by legal, physical, or regulatory restrictions resulting from the preexisting lease. Consequently, a prospector may be discouraged from attempting to establish a valid mining claim or from obtaining a lease on land that has already been leased to someone else, even though this lease covers a different mineral.

In table 6-2, approximately 23 percent of Federal lands are placed in the classification of slight or no restrictions (B35), but are, however, subject to agency planning. Because of the discretionary authority given to the various agencies that administer Federal lands, an application for a lease or a prospecting permit can be rejected if that agency feels that mineral exploration and development would conflict with other uses of the land. Without a detailed survey of all agency policies for all por-

tions of Federal lands, it is difficult to state precisely the extent of the availability of the remaining 23 percent of lands under the Leasing Laws for mineral exploration and development.

POLICY PROBLEMS

Congressional acts and executive policies that prohibit or severely restrict mineral exploration and development on large areas of Federal land raise difficult policy problems and issues. In deciding to adopt such laws or policies, a decisionmaker in Government must weigh the advantages or benefits to the Nation against the disadvantages or costs of that policy or action. However, it is almost impossible to determine accurately the advantages of allowing mineral development in any specific area. Over the whole history of man's use of minerals, minerals that were once thought to be useless have now become valuable. (Uranium is a recent example.) Deposits of minerals that were once completely uneconomical to mine have now become economical because of new mining technology or changing economic conditions (for example, low-grade copper deposits). Similarly, areas that were thought to have little or no mineral potential have in subsequent years proven to have a great deal of mineral potential (for example, the revival of interest in mineral deposits in southeast Missouri). Though our ability to evaluate the mineral potential of a specific area has increased greatly, it is still very difficult to say with any degree of certainty that a particular area does or does not have significant mineral potential.

Congress did attempt to solve this problem through the Wilderness Act by requiring the Bureau of Mines and USGS to evaluate the mineral values present in those areas to be included in the National Forest Service Wilderness System, but not in those wilderness areas within national parks and monuments. Resource appraisals of areas proposed for inclusion in the National Wilderness Preservation System are made through a program of geologic mapping and geochemical and geophysical surveys. This information constitutes a data base that is interpreted and evaluated by an interdisciplinary scientific team to determine the resource potential of metals, non-

metals, coal, oil and gas, and geothermal energy. Mineral surveys of national forest lands will continue to be the principal program activity. In fiscal year 1976, mineral surveys were begun on 7.8 million acres of Interior Department game ranges.

Since 1965 about 17 million acres have been evaluated, leaving about 22 million acres to be studied by 1983 when, as specified by the Wilderness Act, the wilderness areas will be closed to mineral entry. Reports have been published on 51 areas; by the end of fiscal year 1976, reports on approximately 60 areas will have been published; and 38 will be in preparation. However, it is generally recognized that these surveys can give no more than an indication of the present potential of an area. Notwithstanding these limitations, areas with mineral potential have been identified by USGS and the Bureau of Mines, and a few exploration holes have been drilled by the mining industry. If mineral exploration and development were less restricted in these areas, it is likely that more private exploration would take place. The only certain way to maximize information about the mineral potential of an area is to leave the area open for mineral exploration and to avoid policies which discourage those activities necessary for mineral exploration.

Three factors may lead decisionmakers in the Congress or the Executive to prefer devoting large areas of the public domain to a single use or to a limited range of uses rather than allowing a wide range of compatible uses including mineral exploration and development. The first is that, in the past, mining laws and regulations gave very little discretionary authority to those who manage the public lands. Land was either open to entry under the Mining Law with almost no restrictions, or closed to all types of entry under all conditions. Government policy has often taken one or the other extreme position with no compromise possible. Administering agencies should have sufficient flexibility to assure that mining proceeds in an environmentally acceptable manner. Forest Service regulations which limit and control certain types of activities on Forest Service lands are a good example of this needed flexibility.

The second factor is that there seems to be a widespread belief that mining is or must be

destructive to the environment and, consequently, is incompatible with most other uses of the Federal lands. The term "mining," however, is broad and covers a wide range of techniques and methods. Some mining techniques have had significant environmental impacts, but others have not. To consider mining as a single type of land use that is either totally allowed with no restrictions or totally prohibited is a serious error.

The third factor is that much of the information necessary for Congress or the Executive to make sound decisions on land use is not available. The most obvious gap in the Federal Government's information-gathering system is the lack of a comprehensive accounting of those policies and actions which prohibit or severely discourage mineral exploration and development on Federal lands. Because this information is not available and because responsibility for administering the Federal lands is spread over so many different agencies, Government decisionmakers adopt policies that restrict mineral exploration and development on various, relatively small tracts of land without having an appreciation of the cumulative extent of all the restrictions on mineral exploration and development that exist on Federal lands.

In response to the growing evidence that mineral exploration and development was being severely restricted on large portions of the lands owned by the Federal Government and while some of this is temporary, the DOI has established a task force on the availability of federally owned mineral lands. The objectives of this task force are broad and comprehensive and include the following tasks:

(1) Determine which lands—of all public lands and lands where the Government owns the mineral estate—have been withdrawn, segregated, or otherwise restricted from mineral exploration and development.

(2) Review present administrative policies and procedures governing withdrawal of public lands and other restrictions, and review modification and termination of withdrawals and restrictions.

(3) Review alternatives to the present withdrawal system and other restrictive actions.

From this, the task force will make recommendations concerning but not limited to the following:

(1) Establish a system of accounting for cumulative effects of all actions that remove federally owned lands from mineral exploration and development.

(2) Increase the level of mineral resource information available to decisionmakers.

(3) Improve the decision process for all actions that propose to withdraw lands or otherwise restrict mineral exploration and development so as to assure balanced consideration of the benefits and costs of such actions.

(4) Establish a system of periodic review of existing withdrawals and determine the continued need for such.

Over the coming year, this task force will make specific recommendations for policies to improve the availability of Federal lands for mineral exploration and development. However, based on the preliminary evidence now available, it is possible to make at least five general recommendations.

ISSUES AND RECOMMENDATIONS

- Make a Governmentwide compilation or inventory of those Federal lands where mineral exploration and development is formally prohibited or severely restricted. This inventory should be updated and results published periodically.
- Adopt new mining regulations that permit mineral exploration and development on appropriate public lands but that, at the same time, allow the land-administering agencies to prevent or to minimize possible harmful impacts caused by mineral development.
- Study Federal lands where Government policies prohibit or severely restrict mineral exploration and development to determine the desirability of eliminating or altering these policies. It should be noted that the Administration has recommended that all units of the national park system except Glacier Bay National Monument, Alaska, be closed to operation of the Mining Laws. In addition, the Administration's wilderness proposals for

units of the national wildlife refuge system have consistently recommended that the refuge wilderness areas be closed to operation of the Mining and Mineral Leasing Laws. It is not intended that the study call into question these recommendations.

- Develop policies and practices which will insure that future restrictions on mineral exploration and development will be made only after a balanced and informed consideration of the benefits and costs of

such restrictions including a mineral appraisal of affected lands.

- Review the current efforts to determine the final land use and ownership of lands in Alaska pursuant to the Alaska Native Claims Settlement Act (native ownership, State settlements, national parks, forests, and wildlife refuges) to see whether they should be expedited to hasten the time when mineral development can occur in Alaska.

Chapter 7

ENVIRONMENTAL ISSUES AND THE MINERAL INDUSTRY

Summary.—The burden of pollution encountered by an industrialized economy such as the United States challenges the historical uses of land, water, and air since pollution may have profound effects on health, genetics, and the earth's life-support system. Most people recognize that protection of environmental quality has become a necessity. As a result, the amount of environmental legislation, rules, and regulations has increased dramatically in recent years. Progress has been made in protecting the environment. Costs, however, are being incurred that impact on mineral resource development. The problem of achieving a balance between the need for environmental protection and the need for mineral resource development continues and is becoming increasingly acute as more and more resources are needed to maintain our standard of living and, in turn, more and more environmental regulations are implemented. This chapter briefly discusses some of the environmental issues as they relate to the mineral industries.

BACKGROUND

Through our history, industrial man has proved himself capable of using a wide variety of materials recovered from Nature so that a high-income society has developed, particularly in the United States, based on the availability of moderately priced raw materials. The desire to continue to improve these standards of living appears certain to continue for some time.

At the same time, man has proved himself to be an important force in causing environmental disruptions significantly different from the natural changes which evolve over time in the ecosystem. This ability has raised general concerns about man's use of the environment even though much of the environmental change can be considered as temporary, correctable, or non-degradable. Three factors operate to support these concerns: the long timelag that often intervenes between an environmental impact and the appearance of harm, the irreversibility of some kinds of damage, and the apparent existence of environmental thresholds in some processes where a small increment of some input to the environment triggers a disproportionate response in the natural process.

Industrial man's desire to use a wide variety of materials recovered from Nature, but causing environmental disruptions significantly different from natural changes in the ecosystem and his heightened concerns about man's use of the environment taken together with the added difficulty of finding increasingly scarce resources and lower grade ores point out the problem of simultaneously pursuing commonly recognized and desired goals that are sometimes incompatible with one another. Obviously, the historical uses of land, water, and air are being challenged by environmental concerns.

ENVIRONMENTAL LEGISLATION

The growth of public concern for the environment during the past 10 years has resulted in an increase in the amount of environmental legislation and in the number of applications of existing statutes to environmental purposes. The passage of the National Environmental Policy Act (NEPA), the Federal Water Pollution Control Act, the Clean Air Act, the Endangered Species Act, the Solid Waste Disposal Act, the Safe Drinking Water Act, and the Federal Noise Pollution Control Act covered most

of the specific aspects of the interaction of society's activities with its environment. A legislative framework for setting environmental standards is now in place.

The statutes listed in table 7-1 represent frequently cited Federal environmental legislation. Perhaps the most widely applied statute from the list is NEPA, which requires the preparation of an Environmental Impact Statement (EIS) on every major Federal action significantly affecting the quality of the human environment. This covers matters subject to the Clean Air Act, the Water Pollution Control Act, the Endangered Species Act, or one of

many other environmentally or socially protective statutes. For northern Great Plains coal development, for example, satisfaction of NEPA would include consideration of: assessment of air pollution potentials, possible withdrawn Federal lands, endangered or threatened species, population distribution, traffic problems, historical and archeological land marks and monuments, agriculture, reclamation, and economics. The list of Federal statutes in table 7-1 is not exhaustive, but the compilation of legislative purposes demonstrates the multiplicity of environmental values generally held by the public.

TABLE 7-1. *Selected environmental statutes, purposes, and impacts*

Title	Statement of purpose	Environmental impact
National Environmental Policy Act, 42 U.S.C. 4321 et seq., Public Law 91-190.	To create and maintain conditions under which man and nature can exist in productive harmony and fulfill the social, economic, and other requirements of present and future generations.	Introduction of environmental consideration into development plans requirement for comprehensive planning.
Clean Air Act, 42 U.S.C. 1867 et seq., as amended by the Air Quality Act of 1907, Public Law 90-148; by the Clean Air Amendments of 1970, Public Law 91-604; by technical amendments to the Clean Air Act, Public Law 92-157, by Public Law 93-15, H.R. 5445, April 1973, and by Public Law 93-39, June 24, 1974.	To protect and enhance the quality of the Nation's air resources so as to promote public health and welfare and the productive capacity of its population.	Abatement of emission, ambient air quality standards. Health, productivity, and agriculture benefits.
Federal Water Pollution Control Act, 33 U.S.C. 1251 et seq., Public Law 92-308, as amended by Public Law 93-207, 93-243, and 93-392.	To restore and maintain the chemical, physical, and biological intensity of the Nation's water.	Abatement of all water pollution by 1983. Health, recreation, agriculture, esthetic, and economic benefits.
National Wilderness System Preservation Act of 1964, 16 U.S.C. 1131.	To secure for the American people of present and future generations the benefits of an enduring resource wilderness.	Preservation of wilderness areas for continued use.
Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et seq., Public Law 92-583	To preserve, protect, develop, and, where possible, to restore or enhance the resources of the Nation's coastal zone for this and succeeding generations.	Protection of coastal zone from profiteering development, coordination of coastal zone activities and impacts.
Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.	To provide the means whereby the ecosystems, upon which endangered species and threatened species depend, may be conserved.	Preserves endangered species and maintains a diversified ecosystem.
Solid Waste Disposal Act, 42 U.S.C. 3251 et seq., Public Law 89-272 as amended by Public Law 91-512	To promote the demonstration, construction, and application of solid waste management and resource recovery systems that preserve and enhance the quality of the air, water, and land resources.	Systematic treatment of solid wastes and energy conservation.

The impact on industry of these laws covers the total cycle of activity from project planning through operations and restoration of mining and milling sites. For example, project planning is modified to include specific requirements of the laws. Costs of compliance may increase in terms of productivity, unit costs, and production. Capital costs may increase as pollution control devices are required on mills and smelters. Some operations may close. Others may modify processing procedures. Penalties may be assessed for violation of various regulations. Lands may be withdrawn from mining exploration and development. Although the impacts differ from operation to operation, they generally lead to higher costs to the company.

In addition to the Federal legislation, individual States have their own mining and environmental statutes. Some State laws pose absolute restrictions upon types of mining activity, or severely limit activities; other State laws parallel Federal environmental legislation. State mining and environmental laws are complex and numerous and are sometimes more restrictive than Federal acts. The noise pollution regulations of Illinois, for example, have been applied to restrict coal-mining operations in that State,¹ while the Pennsylvania Clean Streams Law has similarly required extensive pollution control from coal mine operations within that State.²

State rules and regulations also carry out Federal legislation. For example, one company (8th Cir., 1975) is alleged in a court action to have committed violations of the Clean Air Act through discharge of airborne asbestiform fibers, and violations of the Federal Water Pollution Control Act by discharge of waste products into an interstate waterway. Standards for the effluent were those set up by the State authority to satisfy the Federal legislation.

Regions and local governments also have additional restrictions and ordinances, while numerous applications of common law affect mining operations. Regional groups acting in response to such Federal legislation as the Coastal Zone Management Act, groups created

to study and control specific problems such as the Appalachian Regional Commission; and those developed as local autonomous governmental units, for example, the American Indian Tribal Governments, have developed rules and regulations of their own for mining or land use within their territorial boundaries. Such regional regulation may run the gamut from planning, study, and data base coordination, as done by the Appalachian Commission, to the drafting of the specific site-oriented legislation, as is being considered by the Navajo Tribal Council.

It becomes readily apparent that legislation, rules, and regulations applicable to environmental concerns present the developer of a potential mineral deposit with multiple requirements. Complying with these requirements presents unparalleled challenges for the development of workable solutions.

The variety of solutions to environmental concerns is only hinted at when it is realized that due regard for the environment takes into account types of materials, stages of use, environmental media (air, water, land), sources, and effects.³ Although many reactions have occurred that range from outright opposition to willing acceptance of the new situation, explicit attention is being given to environmental management at every stage of the mineral cycle, from preexploration through reuse.

COSTS OF COMPLIANCE

Some estimated costs of compliance with environmental legislation are listed in table 7-2. The Council on Environmental Quality estimates that the overall cost to industry, spread out over the next decade, will be less than 5 percent of total investment.⁴ Recently, a United Nations committee estimated that the cost of abating all the world's pollution due to mining industry sources by the year 2000 would be high in actual dollars (\$200 billion plus or minus), but low as a percentage of the wealth recovered

¹ *Illinois Coal Operators Assn. v. Illinois Pollution Control Bd.* (Ill. Sup. Ct. 1974), 7 ERC 1315.

² *Pennsylvania v. Harmon Coal* (Sup. Ct. Penn.), 5 ERC 1190.

³ See *Man, Materials, and Environment*, National Academy of Sciences, National Academy of Engineering, MIT Press, Cambridge, Mass., pp. 10-11.

⁴ *Sixth Annual Report of the Council on Environmental Quality*, 1975, p. 538.

TABLE 7-2. *Selected fiscal impacts of environmental legislation on the minerals industry*¹

Title	Impact of compliance with regulations (1973 dollars)	
Federal Water Pollution Control Act (FWPCA)	Industrywide Best Practicable Tech- nology	\$27.6 billion ² capital investment or +1.5% price effect \$5 billion ² operating cost per year or +7.3% price effect \$16.7 billion ² capital investment or +0.9% price effect \$4.4 billion ² operating cost per year or +6.3% price effect
	Best Available Tech- nology	
Clean Air Act (CAA):		
Cost to Cu industry	\$940 million ³ investment over several years.	
Cost to Al	\$616 million ³ (21.7 cents per lb) over unstated period.	
Cost to Fe	\$12 billion to \$14 billion ⁴ over 9 years for both CAA and FWPCA.	
Surface Mining Regulations (43 C.F.R. 3040)	Rehabilitation (shaping, topsoil management, seeding, refertilization, surface manipulation, drainage control, and mulching) \$925-\$2,750 per acre. ⁵	
National Environmental Policy Act; Coastal Zone Management Act		
Wilderness Act; Endangered Species Act; Solid Waste Act	Opportunity losses, withdrawal of critical areas. Cost of preliminary planning not clearly evaluated.	

¹ Does not include estimated economic benefits to other segments of society.

² Estimated by the National Council on Water Quality.

³ Secretary of Commerce. Third Annual Report to Congress.

⁴ *Mining Engineer*, vol. 27, No. 7, p. 40.

⁵ Established by Study Committee on the Potential for Rehabilitating Lands Surface Mined for Coal in the Western U.S., NAS Rehabilitation of Western Coal Lands, Ballinger Publication Co., Cambridge, Mass., 1974.

(1 to 2 percent).⁵ At times, however, specific industries have had to expend a significant percentage of their capital investment in pollution control equipment. In 1971-74, for example, the nonferrous mining industry spent over 20 percent of its capital investment in compliance with environmental regulations. Accurate estimates are difficult to make because steps taken to reduce pollution frequently result in plant modernization, including nonpolluting processes and increased production capacity.

The complexities and difficulties of measuring some benefits and costs are recognized, but the principles of benefit-cost studies offer a systematic analysis useful to many levels of decisionmaking. These problems need not delay adoption of the approach, but they do suggest

that research to improve the benefit-cost analysis techniques will pay off in better knowledge of the consequences of proposed governmental legislation and regulation before enactment or implementation.⁶

INDUSTRIAL PROGRESS TOWARD COMPLIANCE⁷

As a direct result of environmental legislation and concern, progress has been made in recent years toward cleaning up the environment. The remedies for preventing or repairing environmental damage take one of several

⁶ For example, see the soon-to-be-released study contracted by the Office of Minerals Policy Development entitled, *A Benefit Cost Analysis of Regulatory Requirements on Coal Production and Consumption*.

⁷ For more details on the progress being made toward compliance, refer to the *Sixth Annual Report of the Council on Environmental Quality*, 1975.

⁵ United Nations, *Environmental Impacts on the Growth and Structure of the World Economy*. United Nations Document E/AC.54/L.76, 1975.

forms: (1) reduction of emissions, (2) improved protection of the landscape and ecosystem, (3) repair of the landscape and ecosystem that has been damaged, (4) optimum site selection of unavoidable damage, and (5) concentration and safe disposal or storage.

In reducing emissions, for example, 15,600 of the 20,000 stationary sources (factories, utilities, and incinerators) of air pollution in the United States were in compliance with emission regulations or were meeting compliance schedules by mid-1975. The level of smoke, soot, and dust in the air has dropped over 10 percent since these cleanup schedules began. In many other areas, accomplishments of the past 5 years have also been impressive.

In the mining industry specifically, pollution control devices have been installed on mills and smelters, water pollution has been reduced, solid waste has been treated, and land has been reclaimed. In some existing plants, particularly copper smelters, new metallurgical processes that will meet pollution standards are replacing the older methods of smelting and refining. Industry is also designing and constructing new plants that will have built-in pollution control features.

DEPARTMENTAL PROGRESS AT THE ENVIRONMENT-DEVELOPMENT INTERFACE *

Because of the dual goals facing the Department of the Interior (DOI) regarding protection of the environment and development of our domestic resource base, special attention has been directed toward resolving potential conflicts. Several key approaches are used in the Department to accomplish these goals, namely: expansion of the data base through baseline, monitoring, and environmental impact studies; establishment of appropriate regulations for and conduct of effective inspections of activity on Federal and Indian mineral leases; development of new technologies that have the poten-

* More details about the Department of the Interior's program efforts and results are presented in budget justification documents submitted to Congress. The latest appear as *Part I, Justification Material, Department of the Interior and Related Agencies Appropriations for 1977, Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives, 94th Congress, 2d sess.*, GPO, Washington, D.C., 1976.

tial to reduce environmental problems; demonstrations on correcting damages from past mineral operations; and guidance to planners responsible for various mineral and environmental activities.

Baseline, Monitoring, and Environmental Impact Studies

In this area, key biological, chemical, geological, hydrological, and physical data are gathered before development and are measured again during the monitoring phase, at stations both within and outside of the area of interest, to distinguish changes which result from mineral-related operations and to evaluate the magnitude and impact of these changes. The primary benefits resulting from this program are both a rapid assessment of ecological conditions leading to early recognition and documentation of environmental changes, especially those related to pollution, and the evaluation of long-term trends of environmental contaminants. Regulatory agencies are provided data in support of actions to mitigate adverse effects of contaminants so that further degradation of unique habitats can be prevented and species that may become endangered can be protected. In the Outer Continental Shelf (OCS) areas, several studies are being proposed or are underway (table 7-3). Baseline studies apply to most of the areas, whereas monitoring activities apply to two areas at this time.

TABLE 7-3. *Outer Continental Shelf baseline and monitoring studies, 1975*

Area	Type study
Mississippi, Alabama, Florida	M ¹
South Texas	M
Southern California	B ²
Gulf of Alaska	B
Mid-Atlantic	B
Bering Sea	B
Beaufort Sea	B
Kodiak	B
Aleutian Shelf	B
Chukchi	B
Norton Sound	B
North Atlantic	B
South Atlantic	B
Cook Inlet	B

¹ M=monitoring.

² Baseline.

Other special investigations are designed to provide data required in assessing impacts of OCS development. Examples of these studies include preparation of bathymetric maps, trace metal quality control for baseline programs, toxicity studies, and a study on resource use conflict between fishing industry and Atlantic OCS development. Of particular concern are oil spill hazards resulting from ocean transportation, and from offshore drilling and the associated pipelines. Spills commonly impact wetlands, and the ecological functions of wetlands can be affected when oil, moved by wind and waves, reaches shoreline areas. Alternative drilling sites may be selected, and/or appropriate actions stipulated to minimize these problems once the locations of coastal wetlands are established by the National Wetlands Inventory.

The arctic environmental studies are developing background geologic, hydrologic, and engineering data necessary to assess the potential, probable environmental problems related to development of major oil and gas transportation corridors that will be required by accelerated energy resource development in Alaska. These studies are designed to interpret and disseminate data in forms useful for planning and for EIS preparation and review. Special attention is being directed to monitoring pipeline construction activities to assure compliance with stipulations developed to prevent degradation of fish and wildlife habitat in and adjacent to pipeline rights-of-way. Investigations also include geologic, hydrologic, and seismic studies needed to monitor safety procedures during the construction and initial operational phases. Information collected is used to make decisions on what engineering designs are acceptable and conform to environmental safety requirements.

Ecological studies are carried out in areas of high priority coal resources in the Western States and in the eastern Appalachian region. Program objectives include developing a better understanding of the basic ecosystems affected by extraction and conversion of coal and in rapid assessment approaches using aircraft remote sensing, biotelemetry, and computer-based information systems to insure environmentally sound coal development decisions. Efforts like this can include offsite mitigation, site

reclamation and rehabilitation, and identification of critical habitats for endangered and threatened species. Products of this work will be maps, methodological handbooks, and data bases which will contribute directly to the leasing process, energy site selection, preparation of EIS's, operating plan stipulations, and mitigation programs relating to coal development. Regional investigation of the distribution and variation of metals and other elements in rocks, surficial materials, vegetation, and waters also are part of this program. These data will form part of a baseline understanding against which local changes in the geochemical environment can be accurately measured to permit future monitoring of the processes by which potentially dangerous elements are dispersed in the environment.

Special attention is being directed toward the Madison Aquifer in the northern Great Plains area to obtain definitive information of the hydraulic and hydrologic properties of the aquifer as a guide to its water potential for its industrial development. Similar investigations on the Chattahoochee River in Georgia, and the Yampa River in Colorado and Wyoming, are producing data on basinwide water quality needed for regional environmental controls. The oil shale region of Colorado, Utah, and Wyoming is also receiving attention in the hydrologic baseline monitoring activity. Data of the surface and ground water hydrology will disclose the amount and quality of water present in the oil shale and how it will affect and be affected by underground mining, open pit mining, and in situ oil extraction processes. The basic purpose will be to provide baseline data so the Department can evaluate the long-term impacts of oil shale development on water quantity and quality both in the oil shale region and on the Colorado River Basin.

During 1975, DOI filed 11 final and 11 draft energy and minerals related environmental statements (table 7-4). In addition, 18 other statements were in various stages of preparation at the start of 1976.

Leasing Activities

A new set of coal-leasing regulations for the public lands was released in early 1976. The new regulations will cover the total spectrum of

TABLE 7-4. Energy- and minerals-related Department of the Interior environmental statements, 1975

Final statements filed in 1975:

Belle Ayr South Coal Mine, Wyoming
Federal Coal-Leasing Program
Huntington Canyon Generating Station, Utah
Increase in OCS Acreage for Oil and Gas Development
OCS Sale #35, Offshore Southern California
OCS Sale #38, Central Gulf of Mexico
OCS Sale #39, Gulf of Alaska
OCS Sale #41, Gulf of Mexico
Phoenix to Tucson Transmission Line, Arizona
Sigurd to Cedar City Transmission Line, Utah
Ute Mountain Tribal Lands for Uranium, Colorado

Draft statements filed in 1975:

Alaska Natural Gas Transportation System¹
Coal Development, Crow Indian Reservation, Montana
Colony Oil Shale Development, Colorado
Cordero Coal Mine, Wyoming
Four Corners Powerplant Modifications, New Mexico
Geological and Geophysical Exploration of the OCS Regulations
Kaiparowits Plateau Powerplant, Utah¹
Oil and Gas Development, Santa Barbara Channel OCS¹
OCS Sale #40, Offshore Mid-Atlantic States
Sherwood Uranium Project, Spokane Reservation, Washington
Surface Management of Federally Owned Coal Resources and Coal Mining Operating Regulations¹

Pending final statements:

El Paso Coal Gasification Complex
OCS Hard Mineral Mining Operating and Leasing Regulations

Pending draft statements:

Allen-Warner Valley Power Project
Colstrip Powerplant
Coronado Generating Station
Decker Coal Mine, Montana
Energy Generating Station
Idaho Powerplant
Intermountain Power Project
Lucerne Valley Generating Station
Regional Coal Statements
Rochelle Coal Mine, Wyoming
San Juan Generating Station
SOHIO Pipeline Conversion
Upland Oil and Gas Leasing
Valmy Generating Station
Westmoreland Coal Mine, Montana
Wyoming to Arkansas Coal Slurry Pipeline

¹ Final already filed in 1976.

events, beginning with the prelease land-use planning and environmental analyses and continuing through the prospecting, exploration, development, production, processing, abandon-

ment, and reclamation. The regulations set forth environmental standards that will be used in conducting prelease, permit issuance, and licensing examinations, which will develop the terms and conditions of the lease, permit, or license. The provisions of Federal environmental regulations related to surface mining of coal have been expanded, and Federal responsibility for private surfaces has been clarified.⁹

A new approval process for initial oil shale exploration and monitoring plans has been completed. The scope of the process includes water resources, air resources, biological resources, geology and soils, archeology and history, visibility and noise, and fish and wildlife management plans.

The DOI is responsible for the regulation and supervision of leasing and development activities on Federal and Indian lands for onshore oil, gas, coal, oil shale, and OCS minerals. Intensified inspections of lease operations are underway to provide proper protection of the environment. For example, the environmental impact of each oil and gas well drilled is determined. In addition, because petroleum operations in most frontier areas will be subject to severe weather conditions, possible seismic events, high tides, and tsunamis; proposals for exploration and development will be reviewed in a thorough and systematic manner to insure their technical competency; and the operations themselves will be kept under close surveillance.

Leasing for phosphate and potash has halted in New Mexico and Idaho pending completion of an environmental analysis record on potash leasing in New Mexico and a joint agency EIS on phosphate in Idaho. The potash study in New Mexico identified certain environmental problems associated with tailing and brine disposal from the existing potash refineries. Brine was found to be leaking from the brine ponds and causing brine lakes in certain areas. A followup monitoring system for refinery effluents, evaporation, and ground water levels and qualities is being established.

Research and Development

It is not practical or realistic to try to solve each individual pollution problem in the min-

⁹ For more details on the new coal-leasing regulations, refer to ch. 4 of this report.

erals industry through a fragmented program of research. Instead, DOI, principally through the U.S. Geological Survey and the Bureau of Mines, addresses major problems that are common to large segments of the industry. In some instances, such as for methods to control sulfur dioxide pollution, a degree of technology exists; but vast improvements are necessary to lower costs, improve efficiency, and avoid creating new land or water pollution problems. However, several control processes, thought viable only a few years ago, have proven far more costly than estimated and unreliable for long-term continuous operations. New scrubbing systems, such as the Bureau of Mines-developed citrate process, have potential to emerge as superior technologies; but they must be tested to prove their economic and technical feasibility. Another approach is to remove nonorganic sulfur from fossil fuels before they are burned. Coal cleaning (i.e., coal preparation) is, therefore, also being investigated.

Hydrometallurgical processing of sulfide ores to recover metals without burning is another alternative under investigation within the Department. These technologies may not be available for large-scale application for many years.

Very fine particulate matter, including aerosols, presents extremely difficult collection problems and requires imaginative approaches for control at reasonable cost. Many dusts, if collected, could be recycled to help offset some of the cost of control systems. Where applicable, this approach promises great benefit. Agglomeration is one of the most promising technical approaches because the fine particulate materials could then be collected with conventional control systems.

Processing water in the minerals industry frequently has been treated to neutralize gross contamination before discharging, but stringent regulations for pollutants such as cyanide, toxic heavy metals, and organic compounds demand entirely new approaches to purify the waters. Modified hydrometallurgical processes may prove adaptable to clean up many of these contaminated waters and to permit recycling to lessen the demand on scarce water supply. This technical approach will provide early solutions to many wastewater problems. Ponding and evaporation can be used in some instances, but

the water is wasted and seepage and spills are constant hazards.

Much has been accomplished in research to stabilize mineral waste piles and ponds. Through more laboratory research and field testing, it is likely that waste stabilization will become a common, desirable practice within the next decade. Currently, active mill tailings are controlled by keeping the pond wet. On inactive ponds, more lasting stabilization is required; physical, chemical, vegetative, and combination methods have been developed and are in use. Vegetative processes have been found to have the greatest potential for long-term endurance.

Increased recycling of the valuable materials currently discarded as wastes should be an essential part of any national effort to clean up the environment as well as to overcome materials shortages. Processes are being developed that would be applicable to many types of wastes. For example, minerals beneficiation techniques are being applied to junk cars and urban refuse, and leaching and smelting techniques are being applied to dusts, slags, and other residues. New techniques and improvements in existing processes are both being investigated.

The Department is developing improved technology for extraction of minerals and disposition of related waste products at acceptable social and material costs with a minimum of environmental degradation and with maximum protection of the health and safety of the miners and the public. The program is directed to help meet the technologic needs in light of foreseeable marked increases in demand for coal, metals, and minerals; current and future environmental constraints; the outlook for more adverse natural conditions to be overcome in future mining; and the related health and safety problems and constraints.

New or modified equipment and techniques are being developed to assure maximum near-term coal production. Demonstrations of mining systems (extraction and reclamation) are in process to permit environmentally acceptable mining in areas with delicate ecologies such as the arid Western States and on methods and equipment to allow elimination of environmentally unacceptable problems such as highwalls and stream siltation in the Eastern

States. Three techniques have been demonstrated for contour mining and reclamation whereby spoil is returned to the original contour, and environmental impact substantially lessened. Another demonstration was held to determine the effectiveness of several earth-moving systems to speed strip-mining reclamation through the use of a 40-foot angle blade used with two dozers; a 24-foot dozer-mounted vee-blade, and a 30-foot dozer-mounted grading bar.

In situ mining is a promising alternative for the extraction of valuable minerals from low-grade and small orebodies. It promises reduced capital costs, less development time, and reduced environmental effects. To a large degree, the technology necessary for successful in situ mining is already available, but extensions and refinements can more successfully demonstrate the feasibility of the method in comparison to conventional mining.

Safety and antipollution devices for oil and gas operations on the OCS are being developed through research already underway. The devices will prove beneficial in the development of standards and regulatory control. Studies on offshore unstable sediments, which have the potential possibility for rig failures, are also underway. Data gathered from these studies are also used to exclude potentially dangerous areas from leasing.

In the area of nuclear energy development and environmental protection, DOI is currently investigating the integrity of various rock materials, such as salt, shale, and basalt, so as to judge their long-term suitability as repositories for high-level radioactive wastes (hundreds of thousands of years of toxicity). The Department is also developing improved geologic and hydrologic criteria and guidelines for landfill systems of disposal of low-level solid radioactive wastes (hundreds of years of toxicity). Current methods of disposal are not considered entirely satisfactory.

The disposal of nonradioactive pollutants into deep wells may prove to be a viable alternative to current disposal practices. The Department is investigating the fundamental principles of waste movement into and through the subsurface, including the chemical and physical reactions with aquifer materials and

ground water, and the dilution and dispersion of pollutants in the subsurface. Other efforts are directed toward developing techniques to relate deep-well injection to seismic risk, to evaluate the role of microbes in the leaching of contaminants from mine wastes, to predict the rate of waste movement in aquifers, and to map and describe potential disposal aquifers.

The nature and magnitude of problems associated with the disposal of oil shale wastes are dependent on the physical properties of the waste, the mining method, the quantity of material, the handling or rehandling sequence, the type of disposal site available, the transportation method, the placement method, and the hydrology of the disposal site. There will be 15 to 25 percent more waste volume to be disposed of than is mined. Thus, even if acceptable techniques for underground disposal are developed, there will always be a requirement for permanent surface disposal. Appropriate methods of permanent surface disposal are under investigation.

Correcting Damages from Past Mining

Early mining and mine-processing practices have created present-day problems in some areas. One such area, the anthracite region of northeastern Pennsylvania, represents a microcosm of the diversity of potential environmental problems facing many of the Nation's coal-producing areas: underground, outcrop, and coal mine refuse fires; mine subsidence; acid mine water; land degradation from strip and surface mining and mine spoils. It thus has become a logical place for the Department to develop mined land control and protection technology so as to minimize these same problems within present and future mining/processing activities.

Demonstrations of new ways to improve environmental quality have already shown benefits. Land quality has been improved through the prevention of mine subsidence, the control of fires, the extinguishment and removal of coal mine refuse, and the restoration of strip-mined lands; air quality has been improved through the extinguishment of underground, outcrop, and coal mine refuse bank fires; water quality has been improved through the removal of coal

mine refuse banks, the drainage and sealing of abandoned underground mines, and the reclamation of strip- and surface-mined areas.

A simple and quick method for detecting surface subsidence over mined areas was developed. This approach will provide an early warning of drastic subsidence so that corrective action may be taken.

A mined land demonstration project on an abandoned 126-acre surface and underground mined area in Lackawanna County, Pa., was completed. The reclamation method, used successfully, demonstrated the feasibility of reclaiming the severely damaged public-owned land to a useful condition—in this instance, a public park. The steeply sloping land was completely reclaimed; vegetation was established; a natural stream was restored; paths, trails, and drainage courses established; and parking and playground areas were constructed.

Another successful demonstration of reclamation techniques was completed on barren land created by a burned coal mine refuse pile. The area was revegetated following various treatments using sewage sludge and effluent.

The control of mine fires in inactive coal deposits is a continuing responsibility of DOI in accord with Public Law 83-738, the Mine Fire Control Act of 1954. A pressure flushing system for backfilling abandoned underground mines for subsidence control, developed by the Bureau of Mines, has been demonstrated as a successful approach to control underground mine fires also. The process can be effective for the placement of underground barriers that can contain and effectively control fires in abandoned and inaccessible mine void areas.

Under Public Law 89-4 as amended, Section 205 (Mining Area Restoration) of the Appalachian Regional Development Act, the Bureau of Mines continues to engineer, manage, and administer work-action projects for resolving environmental problems associated with past mining of anthracite, bituminous coal, minerals, and their related mine waste products. Since passage of the act in 1965, the Bureau has acted in cooperation with the Appalachian Regional Commission and several of the 13 States in the region to complete 65 major mined land restoration project contracts and grants. Included in the total are 44 mine fire contracts, 8

subsidence control grants, 8 surface mine reclamation grants, 4 oil- and gas-well-sealing grants, and 1 mine refuse bank reclamation grant.

Under authority granted by the Anthracite Mine Drainage Act of 1955 (Public Law 162) and the subsequent 1962 amendment (Public Law 87-818), the Bureau of Mines cooperates with the State of Pennsylvania to control acid mine water in the anthracite-producing region. The process involves the sealing of abandoned coal mines or the filling of voids in abandoned coal mines. Although the congressional intent of this legislation is to conserve anthracite resources and protect public health and safety, a byproduct of that effort is the control of acid water by preventing its discharge into undamaged water systems. The Bureau has cooperated in 39 water control projects since the inception of the program.

Guidance

The heightened national awareness of and concern about land use, resource depletion, and environmental pollution issues prompted the Department to develop methodological guidebooks, technical manuals, and supporting studies which facilitate the application of existing scientific and technical knowledge by the land and resource planning community for the solution of problems of national priority. Problems include siting onshore facilities in related OCS development, planning for the reclamation of mined areas, siting powerplants, assessing environmental impact processes, identifying critical environmental areas, and evaluating utility corridor proposals.

An important aspect of guidance data being developed by DOI is the orientation toward both an increased awareness of ecological values, particularly for fish and wildlife, and an increased awareness of potentially unfavorable geological settings for energy or mineral developments. By providing guidance of this scope, environmental damages can be avoided or mitigated through well-planned development projects.

The scope of increased ecological awareness is directed principally toward energy and re-

lated resource development efforts. For coal developments, attention is focused on fish and wildlife habitats in surface mining areas of the Great Plains, the Southwest, and Appalachia. Research is underway on methodologies for surveying and characterizing ecosystems by key variables, including the presence of rare and endangered species, so that important habitat areas can be quickly identified and protected under Federal leases. For oil shale development, emphasis is being placed on evaluating the environmental costs of oil shale development based on the present prototype operation, and on ways of dealing effectively with the residues including contouring, compacting, and revegetating to rehabilitate fish and wildlife habitats. For OCS developments, approaches for evaluating the full range of offshore oil and gas development impacts upon coastal ecosystems are being developed. In addition, updating of the National Wetlands Inventory is progressing and will include coastal areas particularly adjacent to potential OCS development sites.

The closely related subject of water allocation in the West has important implications for energy developments. Increased ecological awareness will be achieved through development of scientific information on streamflow requirements for maintaining fish and wildlife resources. In addition, data are being developed for guidance to minimize losses of aquatic life in streams, lakes, and other waters affected by transmission corridors or used for cooling in large, new steam electric plants.

The DOI is assisting in planning safe, orderly, and efficient development of the Nation's energy resources, with minimum impact on the environment, by providing a national overview of geologic hazards and geologic materials that influence or constrain development of energy resource or energy-related facilities. The Department also identifies and evaluates geologic processes and events that pose hazards to nuclear power reactors and determines the general distribution, frequency, and severity of such hazards over broad regions.

Another major approach of the Department is to investigate the environmental geologic aspects of accelerated development and production of solid fossil fuels in order to evaluate and minimize hazards and adverse impacts of extraction, processing, conversion, transportation of energy resources, and urbanization related to energy resource development. National overview maps are being developed to show factors that must be considered in planning for large-scale energy extraction, production, and distribution facilities such as nuclear and fossil-fuel energy-generating plants, coal and oil shale mines, pipelines and power transmission corridors, tanker ports, and high- and low-level radioactive waste disposal sites. Maps on surficial deposits, active faults, landslide hazards, volcano hazards, streamflows sufficient for reactor cooling, and geologic settings of existing and planned nuclear reactors also are in preparation.

Special attention to the environmental effects of accelerated development of solid fossil-fuel resources is concentrated in the Western United States because of the extensive tracts underlain by thick surface-minable oil shale and coal deposits, the imminence of rapid development on a very large scale, the delicate environmental setting, and the complexity of surface and subsurface ownership. Areas being investigated include the Powder River Basin (Wyoming), the Piceance Basin (Colorado and Utah), the Black Mesa Coal Field (Arizona), and the Kaiparowits Plateau (Utah).

Although efforts are concentrated in the West, extensive investigations also are underway in the Appalachian bituminous coal fields on slope stability, soil strength and depth, engineering characteristics of soils, vegetation, and hydrology with special reference to suitability of land for safe and efficient coal waste bank deposition and strip mine reclamation. Maps and illustrated texts are being prepared as guides for planners and decisionmakers concerned with safety of mining and related activities.

Chapter 8

DEVELOPMENTS IN INTERNATIONAL MINERALS TRADE AND INVESTMENT

Summary.—This chapter presents some of the changes that have occurred in the structure of world minerals trade in 1975, the responses of the U.S. Government to such changes, and international trade issues.

NEW ELEMENTS IN INTERNATIONAL MINERALS TRADE

Through international trade and monetary flows, the U.S. economy is closely interrelated with the economies of the industrialized and developing countries. The Secretary of State has outlined this interdependence as follows:

The world economy is a single global system of trade and monetary relations on which hinges the development of all our economies. The advanced nations have an interest in the growth of markets and production in the developing world; . . . the developing countries have a stake in the markets, technological innovation, and capital investment of the industrial countries.¹

Recognizing this interdependence, there have been recent trends of great importance to mineral-consuming countries. Following the successful pattern of the Organization of Petroleum Exporting Countries (OPEC) cartel, producers of other commodities have sought greater market control through international producer associations. Most recently, the bauxite and iron ore producers have formed international organizations. While the newly formed producer associations currently do not present the cartel threat initially feared, they have

actively promoted increased government control over minerals production and activities within their countries, such as the processing and marketing of mineral raw materials.

Between 1960 and 1974, there was a decided shift in foreign countries from private to public ownership of raw materials production. For three major metals—copper, lead, and zinc—the non-Communist world production of ore controlled by public corporations increased from less than 1 percent to approximately 25 percent for two of these metals and to more than 40 percent for the third. Minerals production operations in developing nations are especially vulnerable to nationalization because these industries, which produce a major share of income of these nations, are often owned and controlled by foreign companies.

The governments of some industrially advanced nations have also recently involved themselves in actions formerly left to the private sector. In 1975, for example, Canada imposed a set of formal criteria on foreign-controlled companies, including a requirement that a majority of a board of directors be Canadians. In September 1975, the Australian Prime Minister issued a policy statement that his government will expect proposals for all new mineral development in Australia to provide for a preponderance of Australian participation. However, the implementation of these policies

¹Kissinger, The Honorable Henry A., "Global Consensus and Economic Department, an address before the Seventh Special Session of the United Nations General Assembly," U.S. Department of State Press Release No. 450, Sept. 1, 1975.

in Australia may be constrained because of a recent change in government and because of limits to the availability of Australian capital for exploration and development of mineral resources.

Nationalization and expropriation of private direct investment in selected developing countries has resulted in a decline in capital flows to countries in which the political and economic climate are considered unfavorable. Although the book value of U.S. foreign investment in mining and smelting rose from approximately \$4 billion in 1966 to over \$6.1 billion in 1974, this increase was proportionately less than the increase in total U.S. direct foreign investment over the same period. Perhaps more significant is the fact that 79 percent of this increase in foreign mining and smelting investment by the United States was in developed countries, with Canada receiving about 48 percent of the total.

A significant point of recent efforts to move away from traditional free trade relationships was the passage, in the fall of 1974, by the Twenty-ninth Session of the United Nations General Assembly of a "Charter of Economic Rights and Duties." This charter, among other things, asserted the rights of producing countries to raw materials prices at remunerative levels and to expropriation of foreign-owned assets without compensation.

The U.S. representatives did not vote in favor of the General Assembly resolution. In fact, representatives of the U.S. Government have stated in every available forum that we regard international debates over "morality" issues underlying action on commodities as sterile, and that we cannot accept the income-transfer rationale espoused by many less developed countries (LDC's). The United States is prepared to discuss general principles and concepts underlying U.S. international commodity policy. However, the final formulation of these principles and concepts will have to be consistent with our underlying market-oriented philosophy.

Nevertheless, during a period when the diminishing supply of high-grade domestic reserves of selected minerals would normally lead U.S. companies to increased investments in raw materials production facilities abroad, it must be recognized that foreign supplies of minerals

to the United States will be increasingly affected by nationalistic and political considerations. According to one view, the conditions surrounding direct foreign investment are such that there is little the United States can or should do about the changing policies of minerals-producing countries, but others assert that the United States should play a more aggressive role in effecting international free trade.

Recent trade trends have prompted an assessment of the U.S. position with respect to critical materials, and have raised a set of issues concerning the relationship of the American economy to that of the rest of the world. As the Federal department with principal responsibilities for the management of the Nation's natural resources, and with a statutory obligation to promote a sound and stable domestic mining industry, the Department of the Interior (DOI) welcomes public debate and analyses of the issues involved in insuring adequate supplies of mineral commodities essential to the security of our economy.

STRATEGIC ASSESSMENT

In March 1974, the President directed that a special Administration task force identify and assess potential threats to our supplies of mineral commodities as a basis for effective policy decisions. The study,² completed in December 1974, found that U.S. import dependence for the industrial materials studied was on the average modest: about 15 percent of total consumption, as contrasted with Europe's 75 percent and Japan's 90 percent. However, the situation with respect to particular critical materials varied significantly. For example, while we have exportable surpluses of phosphate, we are totally dependent on imports of columbium (fig. 8-1).

The critical materials study, as well as more recent studies, affirm that other industrialized countries, our principal trading partners, are far more dependent on raw materials imports than the United States; and that their vulnerability to economic disruption by international commodity actions results in an indirect U.S. exposure by virtue of our interdependency. A

² Council on International Economic Policy, *Special Report: Critical Imported Materials*, Dec. 1974.

* APPARENT CONSUMPTION = U.S. PRIMARY
+ SECONDARY PRODUCTION + NET IMPORT
RELIANCE

** NET IMPORT RELIANCE = IMPORTS - EXPORTS
± GOV'T STOCKPILE AND INDUSTRY
STOCK CHANGES

BUREAU OF MINES, U.S. DEPARTMENT OF THE
INTERIOR (import-export data from Bureau of the
Census)

Figure 8-1. Imports supplied significant percentage of minerals and metals consumption¹ in 1975.

second finding of the critical materials study is that the growth prospects of the LDC's soared with the prices of their primary commodity exports during the worldwide economic boom of 1973, only to fall off again as a result of the worldwide recession that followed. This has been the historical pattern of commodity prices for less-developed nations.

Recently an interagency review of U.S. commodity policy was conducted under the auspices

of the National Security Council and the Economic Policy Board. That review reaffirmed the historical U.S. belief in the efficacy of free and competitive markets as the most efficient allocators of investment capital among the nations of the world, and also confirmed U.S. skepticism of international commodity agreements as effective commodity price stabilization mechanisms. The review did recognize, however, certain concerns of the primary commod-

ity producers regarding raw materials prices and the need for more stability in international trade and investment to assure uninterrupted flows of raw materials. The task force also reviewed and approved a series of U.S. proposals developed by the State Department, which were introduced at the Seventh Special Session of the United Nations General Assembly in the fall of 1975.

The United States has proposed a number of major measures in the commodity field:

(1) The World Bank group, especially the International Finance Corporation, should take the lead in bringing together private and public capital as well as technical, managerial, and financial expertise to finance new minerals development.

(2) The United States is seeking supply access commitments in multilateral trade negotiations.

(3) Because no one formula will apply to all commodities, new arrangements for individual commodities should be assured case by case.

(4) The United States intends to participate actively in negotiations for new commodity agreements in tin, cocoa, coffee, and sugar, and, with the consent of Congress, would sign the new tin agreement.

(5) A substantial improvement in the International Monetary Fund's (IMF's) compensatory finance facility has been proposed. At the recent IMF meeting in Jamaica, a substantial improvement was agreed upon to help stabilize the earnings from commodity trade.

(6) The United States is supporting an improvement in the IMF's arrangements for financing buffer stocks.

(7) The United States is willing to consider arrangements, case by case, to reduce excessive price volatility for specific commodities, where feasible and appropriate, and to help establish producer/consumer forums for key commodities.

INTERIOR DEPARTMENT ACTIVITIES

Upon completion of the critical materials report by the Council on International Economic Policy, the Office of Minerals Policy Development (OMPD) of DOI initiated a study of four critical materials: aluminum, chromium, plat-

inum, and palladium. Phase I of a two-part study involved an economic analysis of several Government policy actions (tariffs, subsidies, stockpiles, and research and development) that might be taken to protect against, or react to, curtailment or monopoly pricing of imported supplies of critical materials. The final segment of phase I, a critical review of the theory and tools of the analysis, as well as the policy alternatives considered, is currently underway. Phase II will consider the problems of implementing the optimum policies identified in phase I.

The DOI also participated in the Administration's commodity policy review through the Bureau of Mines. The Minerals Availability System, under development by the Bureau and described elsewhere in this report, provides an important contribution to a comprehensive assessment of the U.S. domestic reserves of critical mineral commodities. At this time priority is being given to domestic supply evaluations for aluminum and chromium. The computerized Resource Information Bank of the Geological Survey (USGS) provides extensive information on identified resources.

UNRESOLVED ISSUES

Despite the many forums held in 1975 to discuss possible changes in international trading systems, broad areas of agreement have not resulted. However, the working commissions created by the Conference on International Economic Cooperation do provide institutions in which concrete issues can be addressed and perhaps resolved in 1976, and in subsequent years. The remainder of this chapter presents a brief discussion of major issues which have arisen to date.

Role of Private Capital

Sources of investment capital from other than private multinational companies are becoming increasingly available. As indicated, the U.S. proposals to the Seventh Special Session of the United Nations General Assembly called for an expanded role for the World Bank as part of a major new international effort to increase raw materials production in developing countries. The OPEC is a large, potential

new source of capital funds. Libya, Iran, and others have made modest loans to primary commodity producers to expand resource production. The result of such new sources of investment capital available for development may be a reduced requirement for private, direct investments, assuming that the new lenders will indeed play a more active and significant role and that the level of investment needs does not radically increase as compared to previous years.

The existence of alternative investment channels may encourage some countries to increase the rate of nationalization of their mining industries and to limit entry of foreign investors for further development of mineral resources. This possibility is especially strong for those countries able to withstand the interruption of investment which normally follows such restrictive measures. As the evolving relationships between the oil companies and many of the OPEC countries have shown, compensation arrangements may be effected in some cases leaving the companies as vital links to consuming country markets even as their earnings structure shifts toward downstream stages of production. In the metals area, however, nationalization has often been disruptive to both producing countries and the foreign firms whose interests were nationalized.

In the longer term, new participants involved in financing minerals production could promote a continuing role for private companies in minerals development. The international financial agencies would likely insist on management and probably some equity participation by experienced firms as a condition of their own participation. Also, OPEC financiers have shown themselves to be somewhat conservative in their investment policies; i.e., their participation would ordinarily be contingent on the kind of technical and managerial expertise available only through established companies.

Role of Mineral Imports

While the overall U.S. dependence on imports of critical industrial materials is not so significant as compared to that of the other industrialized countries, supplies of certain domestic minerals are limited and must be supplemented by imports. In an effort to become

wholly independent of foreign supplies, the rapid development of some U.S. mineral resources, regardless of cost, could be too high a price to pay and could lead to premature exhaustion of U.S. deposits.

The possibility of increased minerals import dependence by the United States has made the Federal Government focus on the risk of instability in supply and price associated with dependence on sources of raw materials which are not under U.S. control. The U.S. Government has a variety of alternatives at its disposal to reduce the risks of disruption other than by eliminating imports of given commodities. As noted, OMPD, of DOI, has initiated a study to evaluate these alternatives for particular critical materials. One of the major determinants in the degree of protection required for a commodity is the probability of occurrence of a disturbance in supply or price. The main parameters affecting such a probability are the degree of concentration of sources of supply and the elasticities of supply and demand for that particular mineral commodity. The minerals information systems being developed by the Bureau of Mines and the USGS are important sources of that information.

It is believed that adequate information systems to evaluate the risks associated with mineral imports, coupled with a methodology to produce the appropriate combination of Government policies to reduce those risks to acceptable levels, will make a significant contribution to U.S. minerals policymaking. The DOI is making every effort to insure that such systems which are under development are fully responsive to the information and policy analyses needs of the Nation.

Operational Statements Under the Mining and Minerals Policy Act of 1970

The Mining and Minerals Policy Act of 1970 "... declares that it is the continuing policy of the Federal Government . . . to foster and encourage . . . the development of economically sound and stable domestic mining, minerals, metal, and mineral reclamation industries" The Secretary of the Interior views this act as an instruction to strike an intelligent balance among development of domestic mineral resources, research into better utilization of those

resources, and preservation of our national physical environment—all of these objectives to be attained through, and in cooperation with, a viable, competitive minerals industry.

What has been lacking are well understood and broadly acceptable criteria for gauging the economic health and stability of the domestic minerals industry. The specific kinds of questions which need to be answered in the development of such criteria are being addressed as the minerals analysis work of the Department progresses. Thus, if analyses were to recommend increased domestic stocks of a particular mineral, it becomes important to assess the appropriate roles of Government, producers, and consumers in maintaining and disposing of such stocks.

In the area of research and development where some degree of Government involvement is necessary to alleviate potential critical material supply problems, private firms may be inhibited from research on new processes if they believe that the benefits of that research are not likely to accrue to the innovating companies. Thus, increased Government activity, where possible on a cooperative basis with industry, would be indicated.

Government and industry have taken separate and seemingly complementary steps in insuring access to foreign mineral commodity supplies. While the Federal Government has pursued supply access agreements in the context of the Multilateral Trade Negotiations, some integrated companies have tried to sell equity in their distribution systems to foreign suppliers in order to assure themselves of a long-term supply. Such efforts by private companies are not incompatible with Government initiatives, but private long-term supply arrangements should not inhibit competitive forces in obtaining for the U.S. economy adequate minerals supplies at reasonable costs.

Government and industry have a joint responsibility in protecting the domestic economy from potential economic disruption associated with increased mineral imports. The DOI is confident that the ongoing work in the critical materials area will raise the appropriate issues for each mineral commodity studied, as well as provide a framework for resolution of those issues.

The long-term competitive position of U.S. industry with respect to that of other industrialized countries requires competitive access to raw materials supplies. Therefore, the Federal Government has been monitoring changing trade and investment patterns in terms of access to mineral commodity supplies, and is pursuing the possibility of generalized supply access agreements in the Multilateral Trade Negotiations. The U.S. Government has also been negotiating joint positions with other members of the Organization for Economic Cooperation and Development for dealing with cartels or concentrations of market power in petroleum. The kinds of agreements concluded so far have to do with sharing supplies in the event of an embargo and exchanging new technology to reduce dependence on a commodity which is priced above its competitive level. Other areas which present some potential for agreement are common stockpiling policies and perhaps agreements for joint action to deal with anticompetitive practices.

As the industrialized countries have been pressed during the last few years to respond to proposals for altering commercial trade practices, a variety of price stabilization measures have been examined by international bodies. There has been much recent discussion concerning the increasing coincidence of the turning points in the business cycles of the industrialized countries, and the potential benefits of common stabilization measures in dampening the amplitudes of such cycles. However, the political problems in implementing such common policies are considerable.

Another area with potential for agreement among industrialized countries is in governmental responsibilities to domestic producers of a commodity supported by Government incentives, in the event of a drastic decline in the international price of that commodity. For example, what should be the responsibility of the U.S. Government to high-cost domestic petroleum producers given a major decline in international petroleum prices? Efforts to deal with the possibility of dramatic declines in oil prices have revealed the complex nature of such nego-

ations. However, the experience gained in those negotiations should assist in resolving such problems in the future.

CONCLUSION

There is no one single approach in successfully resolving commodity trade problems. The

United States rejects price-fixing arrangements that distort the market, restrict production, and waste resources. However, because of mutual interests, the United States is prepared to consider measures that will directly meet the needs of raw material producers and consumers, as long as they do not result in major damage to international trade and investment.

Chapter 9

OCEAN MINING

Summary.—Manganese nodules may soon become an important source of copper, nickel, cobalt, and manganese. The United States is currently the world leader in deep-sea mining and nodule-processing technology, but an unsettled investment climate has delayed an industry commitment to full-scale operations. A stable legal regime to be established through the United Nations Law of the Sea Conference is currently being sought. However, we cannot delay indefinitely the creation of secure investment conditions for ocean mining activities. If the law-of-the-sea negotiations are not meeting U.S. mineral resource objectives at the conclusion of the 1976 summer session of the conference, we should consider alternative action to protect these interests.

GENERAL

For about 100 years, science and industry have known of the existence of manganese nodules on the ocean bottoms in most parts of the world. These nodules are small, potato-shaped rocks generally found at water depths of greater than 2,000 meters on the seabed surface of the deep ocean basins. They occur in a wide range of sizes and distributions, and with variations in metallic content. Although these nodules contain over 20 metallic elements, the components of principal commercial interest are cobalt, copper, manganese, and nickel.

While only a small fraction of the total ocean floor area has been surveyed in any detail, it appears that the most attractive deposits occur in the North Central Pacific Ocean between Hawaii and southern California and in the South Pacific near Polynesia. The extent of these seabed deposits is so large that planned commercial ventures are likely to mine only a small percentage of potential first-generation mine sites. Some estimates of the size of the total nodule resource range from 90 billion to 1.7 trillion tons.

During the last 10 years, as a result of intensive prospecting, market analyses, and re-

search and development by companies of Canada, Japan, the United Kingdom, the United States, and West Germany, interest has developed in mining these nodules for their nickel and copper content. In some cases, manganese and cobalt will be important revenue earners, and some trace metals may also be recovered. Several U.S. firms are planning to initiate nodule recovery operations in the near term. These companies are generally considered to have a significant technological lead, although some foreign firms are quite active in the field. Within the past 2 years, three U.S. firms have made cooperative agreements with foreign partners. In addition, a number of U.S. companies are members of a 25-company consortium established to develop a Continuous Line Bucket mining system.

U.S. MINERAL REQUIREMENTS AND OCEAN MINING

Aside from international trade considerations and the desire of the Government to foster new economic enterprises by American companies, a national interest exists concerning access to raw materials which could not be threatened by uncertain investment conditions in foreign countries and by the destabilizing ef-

fects of increasing attempts at the formation of cartels. The United States is dependent to a large extent on imports of nickel, cobalt, and manganese. Our net imports of cobalt and manganese are on the order of 98 percent of U.S. consumption. Our net imports of nickel are over 70 percent, while the import picture for copper varies widely and averages around 10 percent dependence on imports for consumption.

When production of deep seabed minerals begins, the United States' dependence on imports of these metals could be radically altered. Based on announced industry plans, some projections suggest that deep ocean mining could, by 1985, reach an annual capacity of 12 million to 15 million tons. A 12-million-ton ocean-mining capacity would produce around 160,000 tons of nickel, 140,000 tons of copper, 15,000 tons of cobalt, and perhaps over a million tons of high-grade manganese ore. The total value of the production could decrease U.S. minerals import expenditures by over \$1 billion in 1985 and could: (1) reduce nickel imports by more than 50 percent, (2) eliminate cobalt imports, (3) nearly eliminate copper imports, and (4) potentially reduce manganese ore imports by more than 50 percent. These projections are necessarily dependent on the timing of investment in the ocean-mining industry.

DEVELOPMENT OF A DOMESTIC OCEAN-MINING CAPABILITY

Status of Research and Development Efforts

The ocean-mining industry has been conducting research and development (R&D) programs for over 10 years. A major element of these programs has been extensive prospecting activity in the North Pacific region. Unpublished proprietary data possessed by industry are estimated to be much more extensive than those now in the public domain. Each principal ocean-mining company has identified nodule deposits that could provide satisfactory mine sites, and one company, Deepsea Ventures, Inc., has made a public claim to a preferred deposit.

All of the companies have designed and, in varying degrees, tested nodule recovery system components. Some have announced at-sea testing, while others have tested their mining ma-

chines in onshore tank facilities simulating seabed conditions. There are some variations in the extent to which metallurgy has been evaluated, although most companies have completed successful tests of their processing techniques on a small pilot-plant scale (around 1 to 2 tons per day).

Expenditures for these R&D programs average \$25 million to \$30 million per company. Industry statements and other sources generally support the conclusion that this initial R&D phase has been completed and that the firms are preparing to enter a more intensive and costly phase of preproduction development. This new level of effort will focus on three interrelated categories of activities. The first category is full-fledged exploration, with detailed assessment of potential sites, including a comprehensive survey of at least one promising deposit's topography and seafloor characteristics, detailed mapping of obstructions, and acquisition of more refined data on nodule composition and chemistry.

The second category is at-sea prototype mining system testing. Current company timetables include some large-scale, at-sea tests during the 1976-77 period. To the maximum extent possible, the prototype mining recovery systems must be tested under conditions identical to those which will prevail for full-scale operation. Thus, testing sites must conform as closely as possible to potential mine sites in terms of general topography, soil mechanics, nodule distribution, and other oceanographic conditions.

The final category of activities in this preproduction phase is the operation of scaleup metallurgical processing facilities and test marketing of seabed production.

While the duration and size of these intended preproduction programs vary among companies, it is clear that annual R&D expenditures will rise significantly during this period. Estimates of program costs range from \$75 million to \$150 million per company over a 3-year period. However, public statements by industry spokesmen indicate a reluctance to commit R&D funds to preproduction programs in the absence of greater investment stability. If present legal and political uncertainties were removed and the preproduction programs completed as scheduled, prospective ocean miners

could be prepared by 1978-79 to commit the sizable investment funds (\$300 million to \$600 million per company) necessary for constructing full-scale mining and metallurgical processing facilities. Given an estimated construction leadtime of 3 or 4 years, commercial-scale operations for most companies could commence between 1981 and 1983. As the technologies currently under development are applied to scaled-up ocean-mining operations, there is, of course, the risk that unforeseen technical difficulties could lead to some delay in this schedule.

Economic Aspects of Ocean-Mining Operations

Present projections indicate that in the early 1980's nickel mine capacity must expand in order to keep pace with projected demand. This expansion will probably take place in higher cost, lateritic nickel deposits. Seabed nickel production must at least be competitive with these mines if it is to gain a position in world markets. Recent studies suggest that, assuming reasonable fiscal and regulatory constraints for ocean-mining development, currently planned deep-sea mines will be competitive with land-based lateritic nickel mine operations.

FACTORS AFFECTING DEVELOPMENT

Third United Nations Law of the Sea Conference

International legal and political developments bear directly on the investment climate for ocean mining. The United Nations Conference on the Law of the Sea is engaged in negotiations designed to achieve a universally acceptable approach to managing the resources of the seabed beyond the limits of national jurisdiction. In 1975, after two substantive sessions of the conference, the chairmen of the three conference committees were requested to draft single negotiating treaty texts. The resulting draft text of treaty provisions concerning ocean mining reflected the full range of the developing nations' economic demands toward the formulation of a new international economic order. This approach would vest, in a one-nation, one-vote international assembly, the discretion to decide whether nations or their nationals would have access to seabed minerals. In addition, the international organization pro-

posed in that text would have the power to limit and to control production levels. The proposed system in its entirety contained no assurance that important U.S. interests in access to these resources would be protected.

During the 1976 spring session of the Law of the Sea Conference, however, there were indications that some developing countries are willing to work with us to achieve a reasonable treaty that would protect this Nation's important interest in ocean mineral resources. As a result, the revised single negotiating text emerging from that session includes a number of improvements. It sets forth a system for exploitation of deep seabed resources that provides for mining by states and their nationals pursuant to contracts with the Authority and that circumscribes the Authority's discretion in granting contracts. At the same time, it provides for exploitation directly by the Authority's operational arm, the Enterprise. Moreover, the text does not grant the Authority the power to impose direct controls over seabed production levels and prices but proposes alternative approaches to protecting developing country, land-based producers against possible economic harm from ocean mining. Finally, the text attempts to balance and to separate the powers and functions of the plenary organ, the Assembly, and the executive Council of the Authority to delineate the differing roles each organ will play.

Based on these improvements, which appear to command widespread support among nations, there is some hope that a subsequent session of the conference in 1976 will bring success. Yet a number of major deep-seabed issues will require intensive negotiation at the next session; and it is not possible to predict whether substantive negotiations will be completed in 1976. Thus, uncertainty as to the timing and contents of any international legal regime which would eventually apply to ocean miners continues. Questions concerning the long-term stability of ocean-mining investments may impede commitments for the large capital outlays required to undertake the preproduction activities previously outlined.

The Department of the Interior (DOI) is concerned by the delay in finding a means of assuring a stable investment climate and does

not believe it would be in the best interests of the United States for the nascent ocean-mining industry to lose hope and to give up plans for this important new technology.

Department of the Interior Activities

In order to prepare for the commencement of deep ocean mining, the Federal Government must expand its information base with respect to ocean minerals resources, technology, and the environmental effects of mining. Such information is a prerequisite to sound resource management policies and should be developed quickly.

The DOI has been engaged in a variety of activities concerned with the promotion of a domestic ocean-mining capability for almost a decade. In February 1975, the Department established the Ocean Mining Administration to serve as the focal point for coordinating these efforts within the Department.

In the near term, DOI would emphasize the following kinds of work with respect to ocean mining:

- (1) Continued efforts to achieve an acceptable and timely international legal regime for ocean mining
- (2) Revision and updating of studies of regulatory approaches for ocean mining, in light of more precise information about ocean mineral recovery operations
- (3) Careful evaluation of measures to stabilize the investment climate for ocean mining, and refinement of economic studies of ocean-mining operations
- (4) Monitoring and investigation by the Government of the state of the art of nodule recovery technologies to under-

stand their efficiency and their safety and to learn techniques for proper conservation of the resource

- (5) Compilation of precise information on the location and magnitude of manganese nodule deposits to determine reserve potentials and to make judgments on appropriate management techniques
- (6) Additional research on metallurgical processing techniques, waste disposal, or utilization of tailings from nodule processing
- (7) Completion of assessments of the environmental impacts of ocean mining utilizing comprehensive baseline data and preparation of a revised draft Environmental Impact Statement.

The Department of Commerce also is carrying out programs concerned with assessing the environmental effects of deep-sea mining.

ISSUE AND RECOMMENDATION

The Federal Government has recognized the desirability of establishing a stable investment climate for the ocean-mining industry, in order to promote the timely development of deep-seabed mineral resources. Long-term, stable development of these resources would be achieved preferably by the adoption of a satisfactory international regulatory regime under a new law-of-the-sea treaty.

However, we cannot delay indefinitely the creation of secure investment conditions for ocean-mining activities. If the law-of-the-sea negotiations are not meeting U.S. mineral resource objectives at the conclusion of the 1976 summer session of the conference, we should consider alternative action to protect these interests.

Chapter 10

THE DEVELOPMENT OF NEW TOOLS FOR ENERGY AND MINERALS POLICY ANALYSIS

Summary.—The Department of the Interior is in the process of developing important new tools for energy and minerals policy analysis. Both the Bureau of Mines and the Geological Survey are taking steps to develop supply functions and associated supply curves which, among other things, present important information about the amount of a particular mineral that is potentially recoverable at alternative expected production costs.

In the 1975 Annual Report of the Secretary of the Interior, the Secretary said, "The Federal Government should continue to improve its data and analysis programs."¹ More specifically, the Secretary said there should be "A thorough evaluation of the domestic resource base to determine the availability of minerals at various prices"

This recommendation to develop minerals supply functions clearly acknowledges the importance of such tools of analysis in furnishing the valuable background information needed to evaluate potential policy options concerning the development of mineral resources. Significant progress in the work on minerals supply functions begun in the last few years by the Bureau of Mines, as well as new initiatives taken during 1975 by the Geological Survey (USGS), represent important steps in the development of these valuable tools of policy analysis.

THE USE OF SUPPLY FUNCTIONS IN MINERALS POLICY ANALYSIS

The development of energy and minerals policy relies heavily on the use of estimates of

the amount of recoverable resources. The accuracy and magnitude of these estimates influence the choice among policy options. In addition, the fact that these resources would be recovered at different prices and production costs adds more complexity and possible error to national strategies and the timing of policy actions. For example, if the estimate of a recoverable resource indicated that only a small quantity is available and only at very great price increases (highly inelastic to price), the national strategy might emphasize international development of supplies with a domestic stockpile as insurance against supply interruptions. Policy actions that could be considered might include: (1) Government purchases of the material for a stockpile, (2) import encouragement, and (3) encouragement of domestic companies to invest in foreign countries possessing resources of this commodity.

If the estimate of a recoverable resource indicated that a large quantity was recoverable at relatively modest price increases, the national strategy might emphasize expansion of domestic production. Policy actions could include: (1) encouragement of domestic production, (2) relaxation of regulatory constraints, (3) some import restrictions, and (4) research and development to reduce production costs.

¹ *Mining and Minerals Policy, 1975, Annual Report of the Secretary of the Interior under the Mining and Minerals Policy Act of 1970*, p. 2.

If the same large quantity was recoverable only after very large price increases, the national strategy might put great emphasis on research and development.

INFORMATION IN SUPPLY FUNCTIONS

Minerals policy decisions are influenced by the degree or type of mineral deposit or resource available. Availability can be defined according to the following four categories: (1) geologic, (2) technical, (3) economic, and (4) legal-political.

A mineral deposit may be geologically in existence (and either known or unknown), but no technology may be available to remove the mineral from the earth. Also, a mineral may be geologically and technically available, but the cost of mining the mineral may exceed its market price. Finally, a mineral may be economically available, but legal-political constraints prevent its production. Besides an outright prohibition of mining, a legal-political constraint may simply increase production costs to a level where a deposit, which is economically recoverable without the constraints, becomes uneconomic. Mineral supply functions can provide the information necessary to analyze the impact of policies that will change the geologic, technical, economic, and legal-political conditions under which minerals are supplied. Just as important, the use of supply functions for policy analysis requires that all input data, assumptions, and parameters be explicitly and systematically specified according to accepted engineering and economic criteria. This requirement assures that analyses of policy alternatives can be completed in a consistent manner and that results of analyzed alternatives will be comparable.

The recent intensification of legal-political measures affecting the mining and processing of minerals suggests a need to separate the impact of those measures on the concept of material availability and to include them in a systematic manner in the estimation process used to develop a supply function. Legal-political constraints can take on many forms, ranging from complete denial of production from a mineral deposit to less restrictive forms of merely delaying production for a short period of time or to imposing regulations that result

in additional direct costs. Examples of complete denial are land withdrawal actions for national parks and monuments. Less restrictive actions include requirements to prepare an Environmental Impact Statement before mining can take place. Actions leading to direct cost increases include requirements for environmental protection equipment and reclamation stipulations, regulatory requirements, and other constraints. These constraints can be translated into economic costs in some cases, but, in others, they operate as constraining factors describing the limits of private actions.

The graph in figure 10-1 demonstrates how a supply curve can be used to evaluate the impact of a policy which might alter the existing legal-political constraints on mineral production. While figure 10-1 represents a hypothetical situation, the concepts are applicable to actual policy analyses. The supply curve in figure 10-1 labeled "E-T-G Availability" (economic, technological, geological) is a schedule showing the quantities of production available at alternative prices without any legal-political constraints. The supply curve labeled "L-P Availability" (legal-political) indicates what quantity of production is available at a given price after the introduction of restrictive legal-

Figure 10-1. Theoretical price-quantity availability relationships.

political constraints. At price P_1 , quantity Q_2 is available in E-T-G terms and Q_1 in E-T-G plus L-P terms. To obtain Q_2 with the additional legal-political constraint implies that the price would have to rise to the level P_2 in order to cover costs and to earn an acceptable profit. The legal-political constraint thus adds the social costs of laws and regulations to the private economic and engineering costs. This assumes that it is possible to express a legal-political constraint in terms of economic costs, an assumption that is not always valid.

DEVELOPMENT OF MINERALS SUPPLY FUNCTIONS IN THE MINERALS AVAILABILITY SYSTEM

The classification² and analysis system being developed by the Bureau of Mines under the label, "Minerals Availability System" (MAS), represents a consistent and systematic method of generating the types of mineral supply functions discussed above. The objectives of the MAS information system are to determine the minerals availability from known domestic and foreign sources of 34 commodities, to construct their supply functions, to evaluate the environmental impacts likely to result from production, and to program this information in computer systems for rapid retrieval and for use in policy analysis requiring supply curves and supply options.

As each mineral deposit is evaluated for inclusion in the MAS system, the evaluator explicitly states (in the form of probabilities) his degree of certainty or uncertainty about the quantity of the mineral in place. Given the estimated quantity of a mineral in place and all available information about the geologic characteristics of the deposit, an optimal mining method and rate of production is selected.³ The selected mining method and rate of production then determines the mining costs and the required inputs to the mining process

(types and numbers of employees, machines, etc.). In addition, the evaluator makes a preliminary estimate of the environmental damage that might result from the mining operation. By adding the potential (or actual) annual production of the lowest cost deposit and the potential (or actual) annual production of the second, third, etc., lowest cost deposits of a particular mineral, a potential supply curve, similar to the one shown in figure 10-1, is developed for each mineral.

All assumptions and data used in evaluating each deposit become a permanent part of the record and are maintained for instant recall on the computer. As a result, the information used in developing the MAS supply functions is readily available for detailed examination, questioning, and updating as conditions change. The importance of the information provided by the MAS supply function is apparent when one considers the value of such information in the consideration of policy options dealing with a potential embargo of imported supplies of a critical mineral.

ALUMINUM AS AN EXAMPLE OF A MINERALS AVAILABILITY SYSTEM EVALUATION

The MAS system is in its early stages of development with highest priority being given to aluminum and chromium, which have been identified in many studies as among the more significant imported materials, followed by others of the identified 18 critical minerals. One of these commodities, aluminum, is briefly discussed below as a representative example of the MAS evaluation in progress.

Information about domestic aluminum resources of 127 known geologically available deposits was reviewed. The review identified 48 deposits as having technical and economic supply potential. Evaluation of these 48 sources shows a 90-percent probability of at least 85 billion tons of alumina (Al_2O_3) available almost wholly from nonbauxitic sources. Unfortunately, at this time no commercially proved process exists for recovering the nonbauxitic resources although numerous technologies are being researched.

The Bureau of Mines is engaged in a cooperative research program with industry to develop the most promising processes for re-

² See IC 8654, *The Bureau of Mines Minerals Availability System and Resource Classification Manual*, for details.

³ If deposits are actually producing, the actual rates of production are used rather than estimated potential rates.

covering alumina from nonbauxitic domestic resources. Ten companies have joined with the Bureau in this cost-sharing project. The processes are being tested at miniplants located at the Bureau's Boulder City, Nev., Metallurgy Research Laboratory. A nitric acid process to recover alumina from clay has been tested, and a hydrochloric acid process for clay is being studied. Miniplants for other processes to treat clay, anorthosite, alunite, and dawsonite are scheduled. Other potential raw materials may also be investigated.

There are a number of uncertainties in basing cost estimates on laboratory and small pilot plant experience. These uncertainties result in a wide range of estimated costs to be used in developing the alumina supply function for the MAS system. These estimates are less reliable than those that could be derived if data from larger scale operations were available. The minerals availability approach, however, permits the estimator to change the input details in a consistent and systematic manner and generate new supply functions as better data become available.

Domestic reserves and resources of bauxite, upon which our present alumina supply technology is based, could provide only a minor fraction of our total annual needs for any length of time. However, evaluation of nonbauxitic potential sources of alumina indicates a resource that would be capable of supplying our domestic alumina needs for many years if the technology can be developed on a commercial scale, and production investments are made.

Based on *estimated* costs of the most promising technologies developed to date, more than 85 billion tons of alumina could be made available for production at prices that could easily become competitive with imported alumina (fig. 10-2).⁴ For comparison, if current demand were to increase at 6 percent per year through the year 2000, only about 0.5 billion tons of alumina would be consumed during that period of time. The potential supply curve for alumina from domestic sources to the year 2000, assuming the process will be made technically available for commercial applications,

is shown in figure 10-3.⁵ The current stage of the research and development on nonbauxitic materials suggests a time in the middle of the 1980's before any significant commercial capacity will be on line if proposed research and development is successful and conditions warrant the investments.

The range of costs (instead of one specific cost) shown for each quantity in figures 10-2 and 10-3 reflects, to a large extent, the degree of uncertainty about the cost estimates based on miniplant data. As a result, there is a potential alumina availability band (fig. 10-2) instead of an availability curve, and a potential supply band (fig. 10-3) instead of a potential supply curve. Cost estimates based on data from larger scale development operations can be expected to yield a narrower band for each of the curves than those shown in figures 10-2 and 10-3. While the current estimates are the best available at this point in time, they must be reviewed and updated periodically. These input details can be changed through the minerals availability system in a systematic, consistent manner as the research progresses.

The potential alumina availability and supply bands shown in figures 10-2 and 10-3 represent the estimated supply situation in the absence of the legal-political constraints discussed earlier in this chapter. The attractiveness of the MAS approach in providing a systematic and consistent framework for policy analysis is more evident when some constraints are introduced. A sample of the variety of possible constraints associated with policy options that can be evaluated with this system follows:

- (1) Proximity to cities and consequent political restrictions
- (2) Requirement of large-scale stripping
- (3) Percentage of minerals on national forest land
- (4) Disruption of substantial amounts of land and vegetation
- (5) Requirement of extensive quarry operations in rolling dairy land
- (6) Location of minerals in State park
- (7) Location of mineral in State forest land

⁴ Because of scaling problems, fig. 10-2 does not include alumina available from domestic bauxite deposits.

⁵ Fig. 10-3 includes production from domestic bauxite sources.

*Excludes alumina available from current commercial operations

4/23/76
Base Price $\pm 25\%$

Figure 10-2. Potential availability of alumina from domestic resources.

Includes estimated production from current commercial operations

4/26/76
Base Price $\pm 25\%$

Figure 10-3. Potential annual productive capacity from domestic alumina resources.

- (8) Proximity to State forest land, military reservation, or town
- (9) Significant water environmental restrictions
- (10) Significant environmental restrictions on land, vegetation, wildlife, water, air, and esthetics.

These sample constraints represent some of the legal and political factors encountered by the minerals industry in the pursuit of developing mineral properties. As with the hypothetical supply curves in figure 10-1, the alumina availability and supply bands in figures 10-2 and 10-3 would shift to the left indicating a smaller quantity of alumina supplied or available at each cost as each of the legal-political constraints shown in the foregoing list is introduced into the supply function. Other types of constraints or changes in input data would be reflected in a similar manner through shifts in the bands.

GEOLOGICAL SURVEY'S OIL AND GAS RESOURCE PRICE ELASTICITY STUDIES

The Bureau of Mines' minerals availability system focuses on that portion of a total supply function which can be estimated from known mineral deposits. However, known deposits make up only a portion of the total potentially available supply of a mineral. A complete supply function must include a consideration of the geological, technical, economic, and legal-political availability of currently unknown or undiscovered deposits. Many of the same variables and parameters which affect and determine the potential supply of minerals from known deposits also affect the level of exploration for, and discovery of, unknown deposits. For example, as the price of a mineral rises relative to expected production costs, the rate of exploration for new, previously undiscovered deposits may increase. With a given distribution of geologically available, but undiscovered, deposits, the number of deposits found is directly related to the increase in exploration activity. As the number of deposits that are discovered increases, some proportion of these new deposits will be economically producible at the new higher prices. Thus, just as the potential production from

known deposits is likely to increase in response to higher prices, production from previously undiscovered deposits will also respond to the same higher prices. Though the response time to higher prices is obviously greater from undiscovered than from known deposits, the relationship is an important component of the total supply function of a mineral. As such, this portion of the total supply function can provide valuable information for use in analyses of alternative minerals policies.

In an attempt to develop the estimating methodologies as well as derive the actual supply function relationships, USGS has initiated a pilot project to predict the effects of higher prices on the supply of petroleum from exploratory drilling in the future. A central input to the effort is an estimate of the number and size distribution of undiscovered petroleum deposits within each major stratigraphic unit in each of the region selected for analysis in the pilot study. The breakdown, according to major stratigraphic units, is important to the effort in order to match each field size distribution with drilling cost estimates to be provided by the Bureau of Mines. Estimates will be prepared on three regions:

- (1) One "mature" onshore region, such as:
 - (a) West Texas, or
 - (b) Onshore Gulf coast, or
 - (c) Northern Rocky Mountains
- (2) One "mature" offshore region such as:
 - (a) Gulf of Mexico, or
 - (b) Pacific coastal States
- (3) One frontier region such as:
 - (a) Offshore east coast, or
 - (b) Offshore Alaska (north), or
 - (c) Offshore Alaska (south)

This diversity of regions is needed to show how the supply of petroleum will be affected by variations in price, expected deposit size, drilling costs, and the construction delays which exist in each region.

With agreement on these three pilot areas, the Bureau of Mines will prepare cost factors for exploration and development for the agreed-upon depth increments. In preparation for work outside the pilot areas, the Bureau will continue with the development of cost factors

in other areas, especially deep water and under-ice conditions of the Arctic.

Given the exploration and discovery function to be prepared by USGS, the Bureau of Mines will develop data and analyses relative

to discovery, recovery, and exploitation. This introduces the concept of time, materials, man, power, equipment, and capital necessary to produce from the undiscovered petroleum resource potential of the Nation.

UNITED STATES
DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C. 20240

THOMAS S. KLEPPE
Secretary

KENT FRIZZELL
Under Secretary

WILLIAM L. FISHER
Assistant Secretary
Energy and Minerals

ROLLAND R. REID
Deputy Assistant Secretary
Minerals

PREPARED BY

Office of Minerals Policy and
Research Analysis
Hermann Enzer, Director

CONTRIBUTIONS BY

U.S. Geological Survey

Vincent E. McKelvey, Director
Richard P. Sheldon, Chief Geologist
and Staff

U.S. Bureau of Mines

Thomas V. Falkie, Director
John D. Morgan, Jr., Associate Director
and Staff

U.S. Bureau of Land Management

Curt Berklund, Director
and Staff

COVER BY

Arthur K. Hiltbrand, U.S. Geological Survey