OUTER CONTINENTAL SHELF OIL AND GAS INFORMATION PROGRAM

Outer Continental Shelf Oil and Gas Activities in the South Atlantic (U.S.) and their Onshore Impacts: A Summary Report, July 1980

Prepared for the U.S. Department of the Interior, Geological Survey, in cooperation with the Bureau of Land Management and the Council on Environmental Quality

U.S. Geological Survey Open-File Report 80-626

For answers to specific questions regarding the Summary Report, contact:

Mr. David A. Nystrom
Manager, OCS Oil and Gas Information Program
U.S. Geological Survey
750 National Center
Reston, VA 22092
(703) 860-7166

To receive South Atlantic Summary Report updates, see the post card attached to the back cover, or write to Mr. David A. Nystrom.

COVER.—Drilling rig **Offshore Mercury** operating on the Georgia OCS, fall 1979, as seen from a work boat. Photograph by Dave L. Karp, Transco Companies, Inc.

OUTER CONTINENTAL SHELF OIL AND GAS INFORMATION PROGRAM

Outer Continental Shelf Oil and Gas Activities in the South Atlantic (U.S.) and their Onshore Impacts: A Summary Report, July 1980

By Joanne Barnes Jackson

Prepared for the U.S. Department of the Interior, Geological Survey,
in cooperation with the Bureau of Land Management
and the Council on Environmental Quality
under Contract No. EQ9AC006, by

ROGERS, GOLDEN & HALPERN, INC.
1920 Association Drive, Reston, Virginia 22091
1427 Vine Street, Philadelphia, Pennsylvania 19102

U.S. Geological Survey Open-File Report 80-626

CONVERSION TABLE

English	Metric
3.28 feet	1 meter
0.62 mile	1 kilometer
2.47 acres	1 hectare

ABBREVIATIONS

APCD	-	Air Pollution Control District
bbl	-	barrel(s)
BLM	-	Bureau of Land Management, U.S. Department of the Interior
bpd	-	barrels per day
CEIP	-	Coastal Energy Impact Program, administered by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Cfd	-	cubic feet per day
COST	-	Continental Offshore Stratigraphic Test
CZM	-	Coastal Zone Management
DEIS	-	Draft Environmental Impact statement
DES	-	Draft Environmental Statement
EA	-	Environmental Assessment
EIR	-	Environmental Impact Report
EIS	-	Environmental Impact Statement
FO	-	Field office(s), BLM
GS	-	Geological Survey
IPP	-	Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities, BLM
NEPA	-	National Environmental Policy Act
OCS	-	Outer Continental Shelf
OCSIP	-	Outer Continental Shelf Oil and Gas Information Program, USGS
OSRAM	-	Oil Spill Risk Analysis Model
PNS	-	Proposed Notice of Sale
RTWG	-	Regional Technical Working Group, BLM
SID	-	Secretarial Issue Document, U.S. Department of the Interior
2974	-	Order from the Secretary of the Interior on Inter-Bureau Coordination in the OCS Minerals Program
USGS	-	U.S. Geological Survey, Department of the Interior
WO	-	Washington Office, BLM

Acknowledgments

A large number of people have provided information and insights to the author. All of them deserve special thanks. Paul Martin, Supervisor of the USGS office in St. Simon's, Georgia; Ed Hulse, city manager of Brunswick, Georgia; Bill Bartlett, vice president of Golden Isle Aviation in St. Simon's; Trish Jerman of the Division of Natural Resources in North Carolina; and Jack Saylor of Saylor Marine Corporation in Savannah, Georgia, were especially generous.

The Field Draft Review Committee improved the report in a number of ways. Its members were: David Nystrom, Jim Hendrix, Sara Jacobson, Lucille C. Tamm, and Mary Davis from the U.S. Geological Survey; and Yvonne Morehouse from the Bureau of Land Management. David Nystrom provided guidance and directed the project for the USGS. Sara Jacobson and Lucille Tamm made major contributions to the discussions of geology in chapter 1 and appendix A. Sara Jacobson also provided invaluable assistance in the preparation of several figures. Jim Frederick, also of the USGS, made useful contributions to the final draft. Mary Davis served as editorial coordinator for the USGS.

At Rogers, Golden & Halpern, Fritts Golden provided overall project direction. George Macpherson offered many valuable insights. Sandy Dechert designed and edited the report and supervised its production. Mark Yankoski directed graphics production and executed the graphics with Kim Tomlinson. Valerie Smith, Deborah Gould, and Sue McGuire provided editorial, graphics, and technical support.

Abstract

Activity in the search for oil and gas on the outer continental shelf (OCS) in the South Atlantic Region began in 1960 when geophysical surveys of the area were initiated. In 1977, a Continental Offshore Stratigraphic Test (COST) well was drilled in the Southeast Georgia Embayment. In March 1978, the first lease sale, Sale 43, was held, resulting in the lease of 43 tracts. Approximately a year later, in May 1979, the first exploratory vessel began drilling, and by February 1980, six exploratory wells had been drilled by four companies. However, hydrocarbons were not found in any of these wells. As of mid-February 1980, exploratory drilling activity had ceased, and none was planned for the near future. The next lease sale, Sale 56, is scheduled for August 1981.

The most recent risked estimates (January 1980) by the U.S. Geological Survey of undiscovered, economically recoverable oil and gas resources for the 43 tracts currently under lease in the South Atlantic Region are 7.9 million barrels of oil and 48 billion cubic feet of natural gas. On the basis of geologic information from wells completed to date, current prices of oil and gas, and the expense of constructing a pipeline to bring the hydrocarbons ashore, these resource estimates for currently leased tracts in the Region appear to be short of commercially producible amounts.

Onshore impacts resulting from OCS exploration have been minimal. Tenneco, using existing facilities, has established a support base in Savannah, Georgia; Getty, Transco, and Exxon have used a support base established for them by the city of Brunswick, Georgia. All the companies have used a helicopter service operating from St. Simon's Island, Georgia.

Contents

Illustrations

Tables

Introduction

The United States is currently engaged in an effort to develop the oil and gas resources of the outer continental shelf (OCS). The offshore activities must be supplied and supported from land, and the onshore activities required may have significant effects on the communities in which they occur. For example, oil and gas production might require expansion of existing transportation facilities and construction of new ones, and it might trigger an influx of workers and change employment patterns. These effects, in turn, could influence regional income, demand on public services, tax revenues, and air and water quality.

The need for planning to accommodate the onshore impacts of offshore oil and gas development has long been recognized. State and local governments need current information about offshore resources and related onshore activity to make these plans. In response to needs expressed by State and local governments for current information about offshore resources and related onshore activity, the Outer Continental Shelf Lands Act Amendments of 1978 (Public Law 95-372) created an Outer Continental Shelf Oil and Gas Information Program (OCSIP). Authorities and operating procedures for the OCSIP are detailed in the Code of Federal Regulations (30 CFR 252), published in the Federal Register of August 7, 1979. Under this program, the Director of the U.S. Geological Survey (USGS), in conjunction with the Director of the Bureau of Land Management (BLM) (43 CFR 3300), has prepared indexes of information used by the Federal Government in its OCS decisionmaking process. The Atlantic, Gulf of Mexico, Pacific, and Alaska Indexes have already been made available to the public. Revisions, which are made annually, are currently under way. The Director of the USGS is also required to make available to affected States a Regional Summary Report of data and information designed to assist them in planning for the onshore impacts of potential OCS oil and gas development and production.

The OCS comprises the submerged lands of the continental shelf seaward of State boundaries. In the South Atlantic, State jurisdiction extends 3 miles from the coastline. The OCS is under Federal jurisdiction.

This Summary Report describes offshore activity in the South Atlantic Region, the area extending from Cape Hatteras, North Carolina, to Cape Canaveral, Florida. The South Atlantic Summary Report is the third in a series of regional Summary Reports. It was preceded by reports on the Mid-Atlantic and Pacific (Southern California). Summary Reports are also being prepared for the Gulf of Mexico and the Gulf of Alaska (including Lower Cook Inlet).

The South Atlantic Summary Report is designed to assist the States and local communities in the Region in their planning efforts. The Report contains descriptions of the OCS-related activity that has occurred to date and projections of activity for the next 6 months. Approximately every 6 months a memorandum describing current levels of activity in the Region will be distributed. When events warrant, a revised Summary Report will be issued. To receive updates and revisions, return the postcard attached to the back cover or write to Mr. David A. Nystrom, OCS Oil and Gas Information Program, U.S. Geological Survey, 750 National Center, Reston, VA 22092. The OCSIP staff is available to consult with State agencies if additional information or clarification is requested (Telephone: (703)860-7166).

Each Summary Report begins with a chapter presenting the most recent OCS oil and gas resource and reserve estimates. The magnitude and timing of OCS activity are discussed in chapter 2 of the Report. The third chapter presents information on oil and gas transportation strategies, including those that are developed as part of the BLM's ongoing Intergovernmental Planning Program. Chapter 4 describes the nearshore and onshore activities that are occurring and/or probably will occur as a result of current and projected offshore activity. Appendixes provide further details, and a glossary presents definitions of geologic, industry-specific, and other special terms used in the report.

At a meeting of the South Atlantic Regional Technical Working Group Committee held in Atlanta on February 27-29, 1980, State representatives expressed an interest in having an extensive bibliography as a part of the South Atlantic Summary Report. Two lists of useful reports have therefore been included: appendix D, which is a short annotated list of studies useful for transportation planning, and appendix E, which contains studies of a more diverse nature.

Resource and reserve estimates presented in the Summary Report reflect the most recent Federal Government information. The Report is based on data collected by Federal agencies in the course of leasing and managing the South Atlantic OCS and on studies and reports of OCS activities that have been prepared outside the Federal Government. Representatives of the OCSIP have also discussed oil and gas activities directly with Federal officials, oil industry representatives, State and local officials, and others. In order to identify OCS-related issues and to explain the Summary Report process, the OCSIP convened a public meeting in Charleston, South Carolina, on March 6 and 7, 1978. The meeting was attended by 29 people, 11 representing State and local governments. Concerns voiced at this meeting and in subsequent conversations resulted in the identification of issues to be treated in this Summary Report.

A continuing concern of State and local officials in the South Atlantic Region is the nature and magnitude of onshore facilities that may locate in or otherwise affect their communities as a result of offshore development. Central to this concern is whether or not the South Atlantic OCS has oil and gas in commercially attractive quantities. The Summary Report presents a background for discussion of this issue by explaining what resource estimates mean, how they are derived, what they can be used for, and how the process of exploring for oil and gas relates to the process of estimating resources. This explanation of the nature of resource estimates provides a basis for understanding the uncertainties of the situation in the South Atlantic.

One lease sale, Sale 43, has been held in the area. It occurred on March 28, 1978, and resulted in the leasing of 43 tracts, comprising 99,072 hectares (244,810 acres). Exploratory drilling has been in progress in the South Atlantic Region for almost a year, but no discoveries have yet been made.

As exploration in the South Atlantic continues, our knowledge of the Region's resource potential will improve. In the event of a discovery of oil or gas in commercially attractive amounts, future editions of the Summary Report will include the most recent resource and reserve estimates, anticipated production curves, transportation strategies, and descriptions of nearshore and onshore support activity and production facilities.

1. Offshore Oil and Gas Resources of the South Atlantic Region

This chapter summarizes the geology of the outer continental shelf in the South Atlantic Region of the United States, an area defined for this Report as extending from Cape Hatteras, North Carolina, to Cape Canaveral, Florida. Figure 1 shows the extent of the Region. Because the Federal Government must prepare resource estimates for a variety of purposes and the estimation procedures used may differ, the various estimation processes and their applicability to onshore planning are also discussed here. The most recent information available on the oil and gas resources of the South Atlantic OCS is summarized at the end of the chapter.

GEOLOGIC ASPECTS OF THE SOUTH ATLANTIC REGION

The South Atlantic offshore lands have long been considered a likely petroleum province and are currently being explored. The areas of most interest to petroleum geologists are the continental shelf, the Blake Plateau, and the continental slope. The locations of these areas of the continental margin are shown in figure 2.

The South Atlantic outer continental margin is not a simple margin consisting of shelf, slope, and rise, as is found to the north. Instead, the continental shelf is separated from the abyssal depths by the Florida-Hatteras Slope, the Blake Plateau, and the Blake Escarpment. Figure 3 shows these geologic features in cross section.

Exploration associated with Lease Sale 43 has been concentrated on the continental shelf within the Southeast Georgia Embayment, an east-plunging depression that extends beneath the Atlantic Coastal Plain of South Carolina, Georgia, and Florida. The Southeast Georgia Embayment is filled with sandstones, shales, and carbonates. It lies in a zone of transition between a predominantly sandstone and shale depositional province north of Cape Hatteras and a carbonate province that includes Florida and the Bahamas (BLM, 1977, vol. 1, p. II-9). The continental shelf here is a broad, gently sloping, shallow feature with a width of approximately 135 km. Most surficial features on the shelf are of low relief.

The U. S. Geological Survey, which is responsible for estimating oil and gas resources on Federal OCS lands, has found that the Southeast Georgia Embayment contains many of the specific conditions necessary for hydrocarbon accumulation. The USGS has conducted various geological and geophysical investigations and has information that oil companies have gathered under prelease permits or as a result of exploration activity on leases obtained from the Federal Government. These data include geophysical surveys and the results of a Continental Offshore Stratigraphic Test (COST) well and of exploratory wells on leased tracts. Analysis of this public and proprietary information has enabled the USGS to develop a better understanding of the petroleum geology of the Embayment. A summary of the geologic setting is presented in appendix A.

Some geologic features and conditions may jeopardize offshore oil and gas exploration and development activities. High-risk conditions are classified as **geologic hazards;** lower-risk conditions that can be mitigated more easily, as **geologic constraints.** Failure

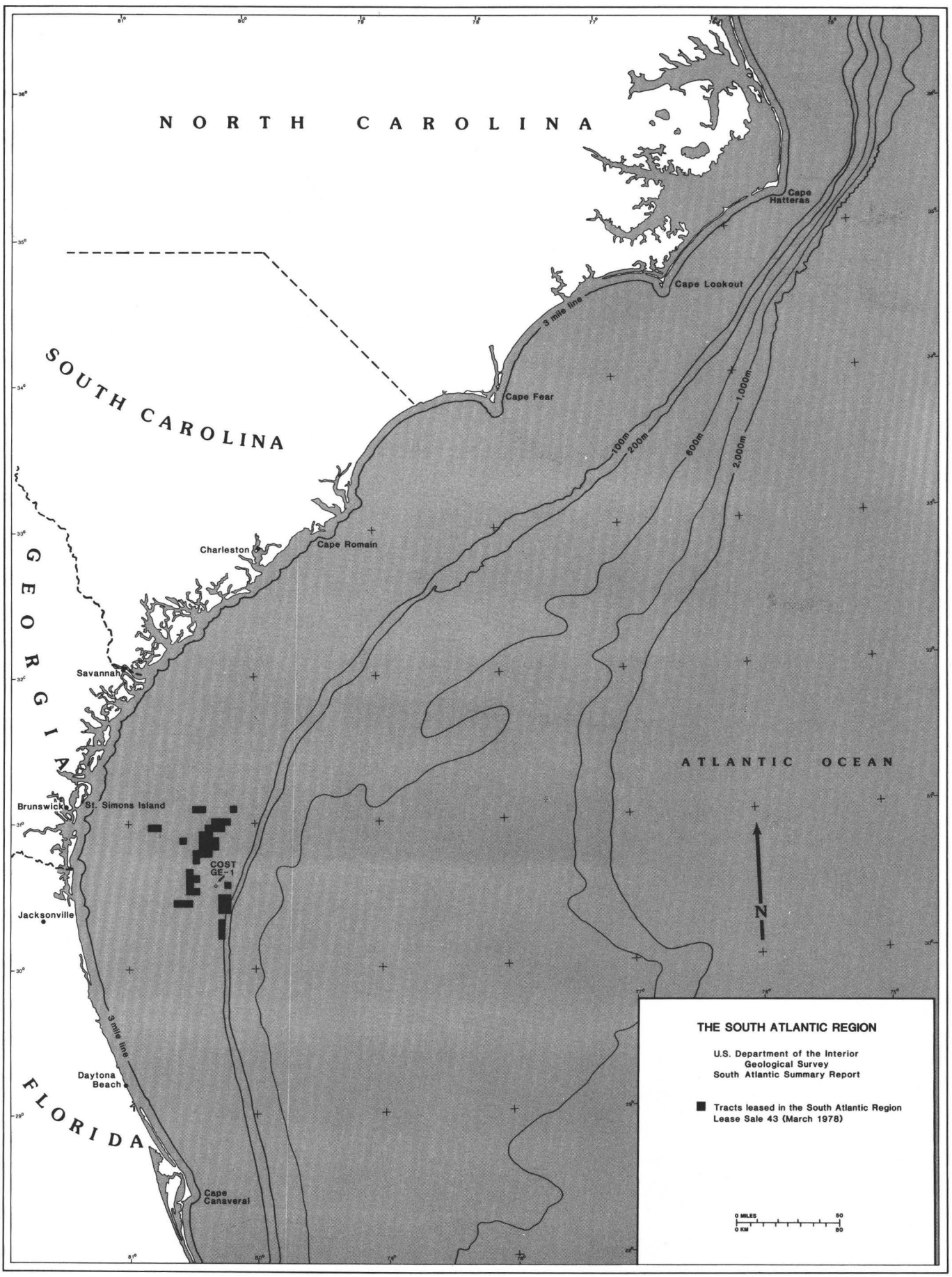


FIGURE 1.—The South Atlantic Region (Adapted from USGS, n.d., by Rogers, Golden & Halpern, 1980).

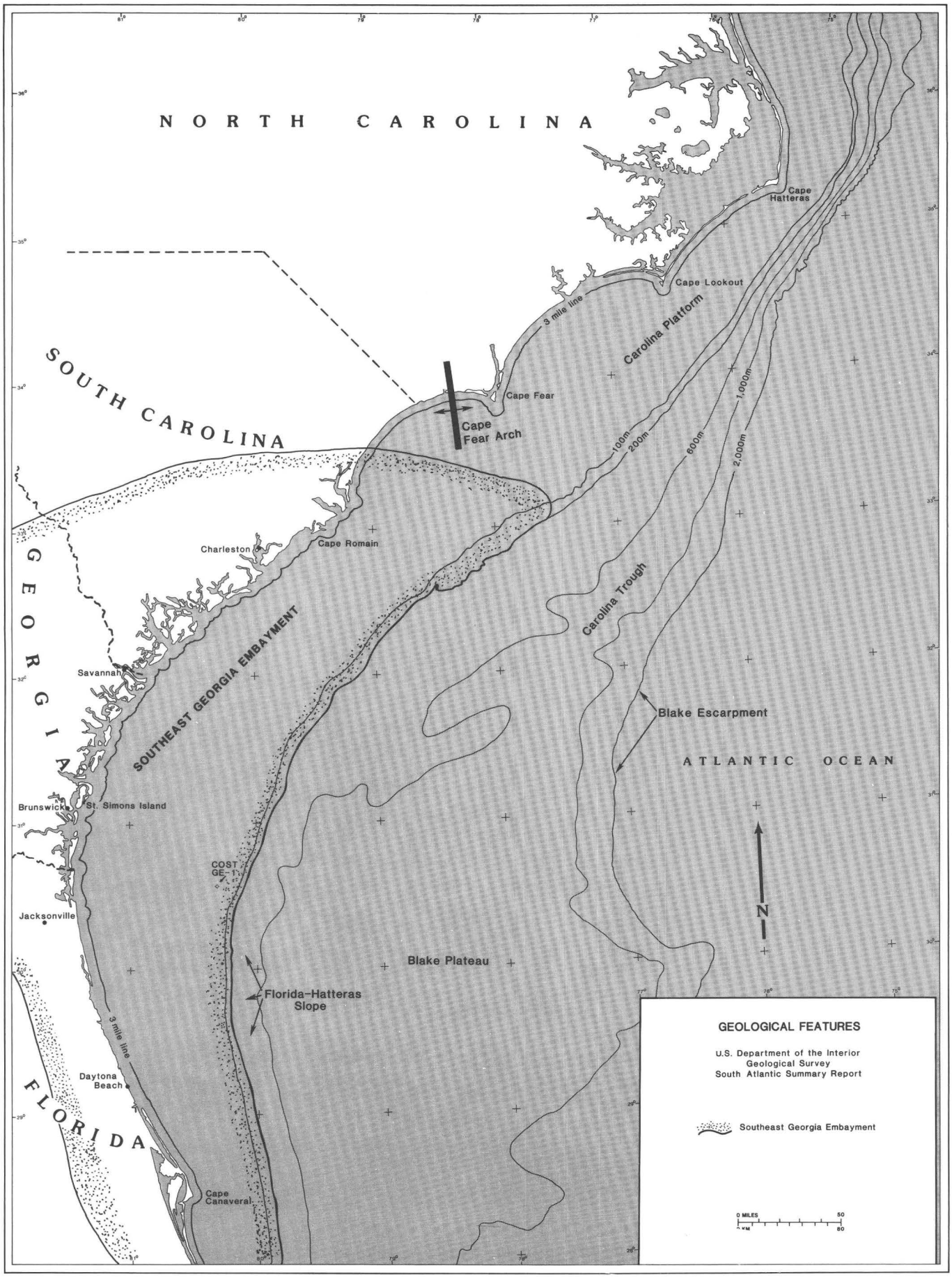


FIGURE 2.—Geologic features of the South Atlantic Region (Adapted from Jacobson, 1980, by Rogers, Golden & Halpern, 1980).

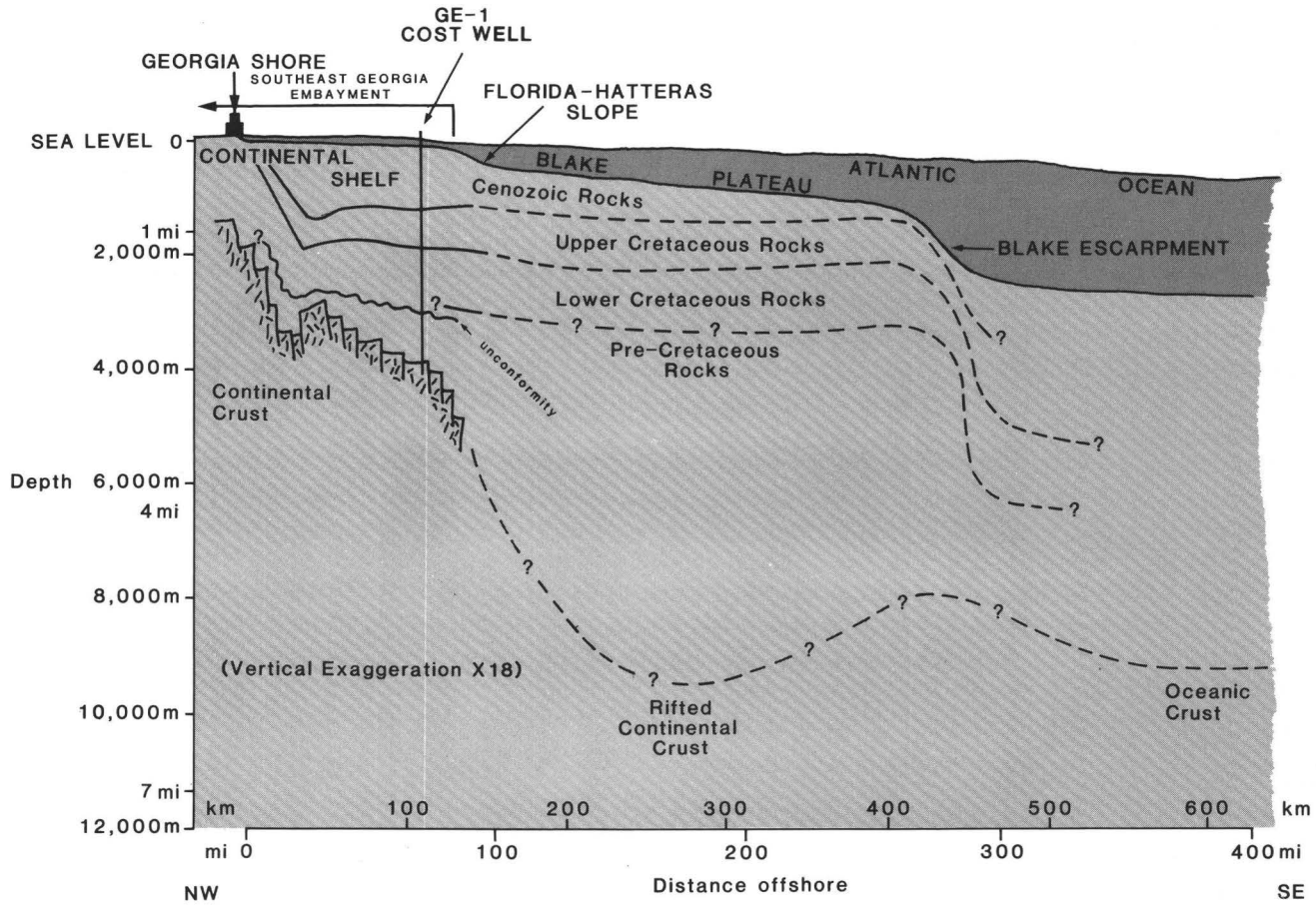


FIGURE 3.—Interpretive cross section of the South Atlantic continental margin (Adapted from Jacobson, 1980, by Rogers, Golden & Halpern, 1980).

to identify, avoid, or take proper engineering precautions against potential geologic hazards could result in the failure of a platform or pipeline. Constraints are usually considered merely developmental conditions: once they have been identified, existing standard design and engineering technology can be used to minimize their adverse effects. These second-order problems include such features and conditions as sand waves and erosion/scour, filled channels, potentially unstable slopes, and bottom objects or debris.

In preparation for OCS lease sales, the USGS conducts detailed geophysical studies to delineate potential hazards and constraints on tracts to be leased. As a result of the USGS evaluation, the Secretary of the Interior may delete tracts from a sale or may impose stipulations on the development that can take place on a leased tract.

Very few geologic hazards or constraints to OCS operations have been found in the South Atlantic. No hazards were delineated by the USGS in the Sale 43 area. However, one block (NI-17-12-380) was deleted prior to the sale because it is in a "live bottom" area that produces an abundance of marine life. Examination of the block also presented some evidence of possible mass movement of sediments.

In the near future, a USGS research program will be undertaken to further describe geologic hazards on the Atlantic upper continental slope. Specifically, side-scan sonar data and seismic reflection profiles will be

obtained to provide information on the distribution and geometry of sediment slumping.

ESTIMATING HYDROCARBON POTENTIAL

To appreciate the complexities of estimating hydrocarbon potential, one must understand the process by which hydrocarbons are discovered and developed. Until a well has been drilled, investigators derive all knowledge of subsurface geology indirectly from geological and geophysical data collected at the surface.

The existence of hydrocarbons can be confirmed only by physical evidence produced by drilling. At this early stage of exploration in the South Atlantic, there are no proven fields of oil or gas, and it is possible to estimate the Region's resources only in terms of **undiscovered resources:** quantities of oil and gas that have been estimated to exist outside known fields. Estimates of undiscovered resources are made by identifying areas of resource potential on the basis of available information and geologic knowledge and theory. Using available data as a basis for further investigations, petroleum geologists then conduct a variety of geological assessments of the region. The geologists' data base may or may not include physical confirmation of the presence of hydrocarbons by exploratory drilling, which can provide valuable information for appraising resource potential. The porosity and permeability of rock samples extracted from the well can be analyzed in the laboratory, and any oil and/or gas found can be sampled and examined.

Although these additions to the geological and geophysical data base enable estimates to be refined, estimates of undiscovered resources are always matters of subjective, albeit expert, interpretation. To delineate the hydrocarbon reservoirs, if, in fact, they exist, and to determine if the accumulations are commercially attractive, the area must be extensively explored by further drilling.

In estimating resources, certain assumptions are often made. For example, a resource estimate conditioned by the word **recoverable** takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface. An estimate of **economically** recoverable resources takes into account the cost of exploration and development and the market price of oil and gas. A third uncertainty stems from the probability that resources are, or are not, present in a given area. A **risked** resource estimate is one that has been modified according to the es-timator's confidence in his or her estimate (i.e., "risked" to account for the probability that economically recoverable resources will actually be encountered within the area of interest).

After the commercial potential of an area has been established, it is possible to calculate reserves. **Reserve estimates** are estimates of the portion of the identified resource that can be economically extracted. A preliminary estimate of reserves might be based on information obtained from several wells, or conceivably from a single well, and a map of the subsurface geology.

Estimates of reserves allow us to more closely approximate the level of resource development activity that can be expected in an area than do risked estimates of economically recoverable resources. Site-specific planning for OCS development and production that a State or local government undertakes should be based on reserve estimates, if they are available. In the absence of a reserve estimate, the most appropriate figure to use is the risked estimate of economically recoverable resources. This is a much less firm number, but it is the most useful resource estimate for generalized--as opposed to site-specific--planning, because it has been modified by the likelihood of finding hydrocarbons in an area, as well as by the likelihood of any discovery being commercially attractive.

For additional information on the process of resource estimation, see appendix B, which explains in greater detail how resource estimates are derived, what they mean, what they should be used for, and how the process of estimating resources relates to the process of exploring for oil and gas.

TABLE 1.—South Atlantic OCS oil and gas resource and reserve estimates, January 1980

	Oil (million barrels)	Gas (trillion cu ft)
Undiscovered recoverable resources		
South Atlantic Region (including leased lands):		
0 - 200 m water depth	300	.7
Greater than 200 m water depth (exclusive of Blake Plateau)	300	.3
Blake Plateau (200-2,500 m water depth)	600	1.2
South Atlantic leased lands:		
Risked, economically recoverable resources	7.9	.048
Reserves	0	0

SOURCES: USGS, Geologic Division (Regional undiscovered recoverable resource estimates), January 1980; USGS, Conservation Division (Risked, economically recoverable resource estimates and reserve estimates), January 1980.

RESOURCE AND RESERVE ESTIMATES

The USGS's most recent (January 1980) resource and reserve estimates for the South Atlantic Region and for the offshore area currently under lease are presented in table 1.

The undiscovered recoverable resource estimates for the South Atlantic Region are given in the first three lines of the table. These estimates are included in order to provide a measure of the petroleum potential of the entire South Atlantic Region. It is important to understand that the regionwide estimates are based on interpretation of broad-scale geological data and therefore provide only a first approximation of the total hydrocarbon potential of the Region.

The risked estimates of economically recoverable resources are given next. They cover all leased tracts in which no discovery of oil and/or gas fields has been announced (i.e., all tracts currently leased in the South Atlantic). These estimates are based on the following information:

- the results of drilling seven wells (six exploratory wells and one COST well), plus seismic data; and
- an assumption that the potential geologic traps that have been identified contain risked, economically recoverable quantities of hydrocarbons.

These risked, economically recoverable resource estimates provide a basis for studies

and preliminary planning for onshore impacts.

Reserve estimates approximate the cumulative production that can be expected from a discovery. For this reason, they provide a foundation for site-specific onshore planning. The entry for reserves is zero at this time because no discovery of oil or gas has yet been made in the South Atlantic. However, not all prospective areas in the South Atlantic have been explored.

2. Magnitude and Timing of Offshore Development

The history of OCS activity in the South Atlantic is brief. Geophysical surveys were begun in 1960. In 1977 a deep stratigraphic test well was drilled under a USGS permit issued to a group of 25 oil companies for purposes of developing preliminary estimates of the area's petroleum potential before submitting bids for Lease Sale 43. This well, COST well GE-1, was drilled in 41.5 m (136 ft) of water in the Southeast Georgia Embayment area east of Jacksonville, Florida, by the Ocean Star rig, owned by Ocean Drilling and Exploration Company (ODECO). Drilling began February 22 and ended May 31, 1977.

Since the lease sale, held on March 28, 1978, six exploratory wells have been drilled in the South Atlantic. Figure 4 shows the wells (identified by block numbers), the companies responsible for drilling them, the rigs, and the periods during which drilling took place.

The first exploratory well on a leased tract was drilled by Offshore Company's rig, Offshore Mercury, for Tenneco on block 208. Drilling began on May 29, 1979. After that hole was plugged and abandoned, the Offshore Mercury was moved, in rapid order, to three other sites (blocks 427, 913, and 1005) and drilled for Tenneco, Getty, and Transco. The cover photo shows this rig, and figures 5 through 7 depict day-to-day operations during the drilling. During October 1979, a second rig, Glomar Semi 1 (owned by Global Marine, Inc.), joined the Offshore Mercury over the Embayment. Glomar Semi 1, drilling for Exxon, was in the area for over 4 months, until mid-February 1980.

The lack of current drilling activity suggests that the initial optimism of the oil companies has been somewhat dampened. But the exploration results to date neither prove

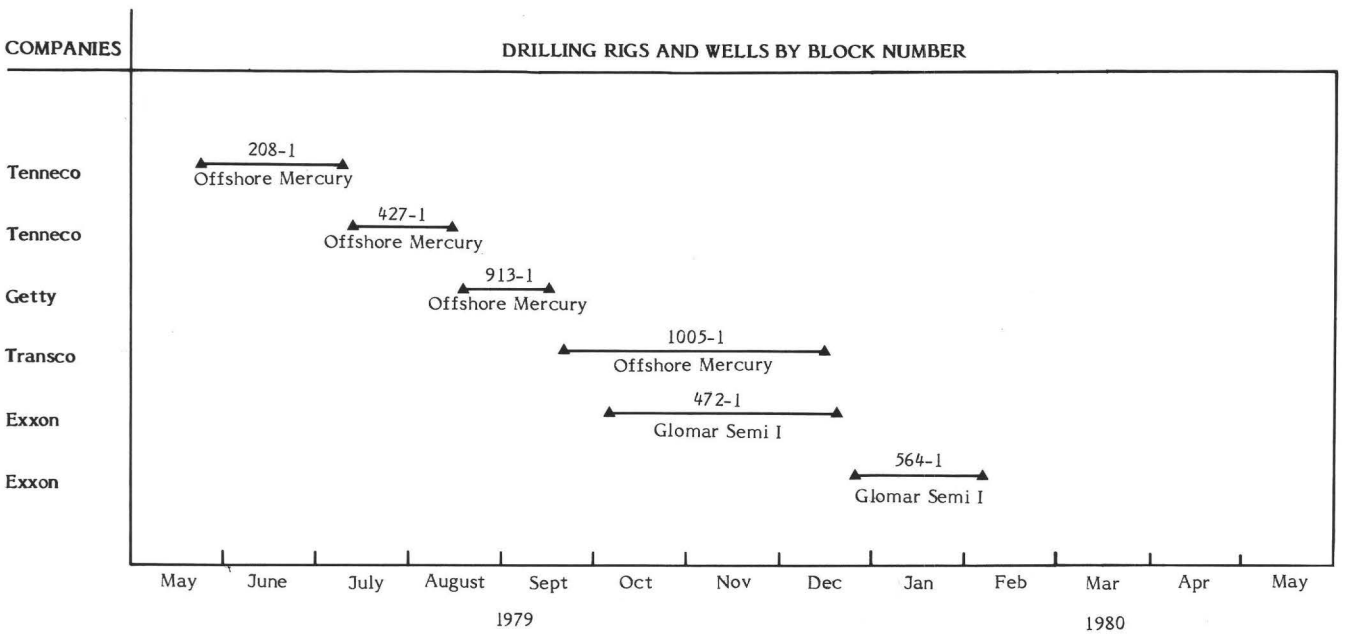


FIGURE 4.—Exploratory drilling in South Atlantic to date (Martin, 1980, oral commun.).

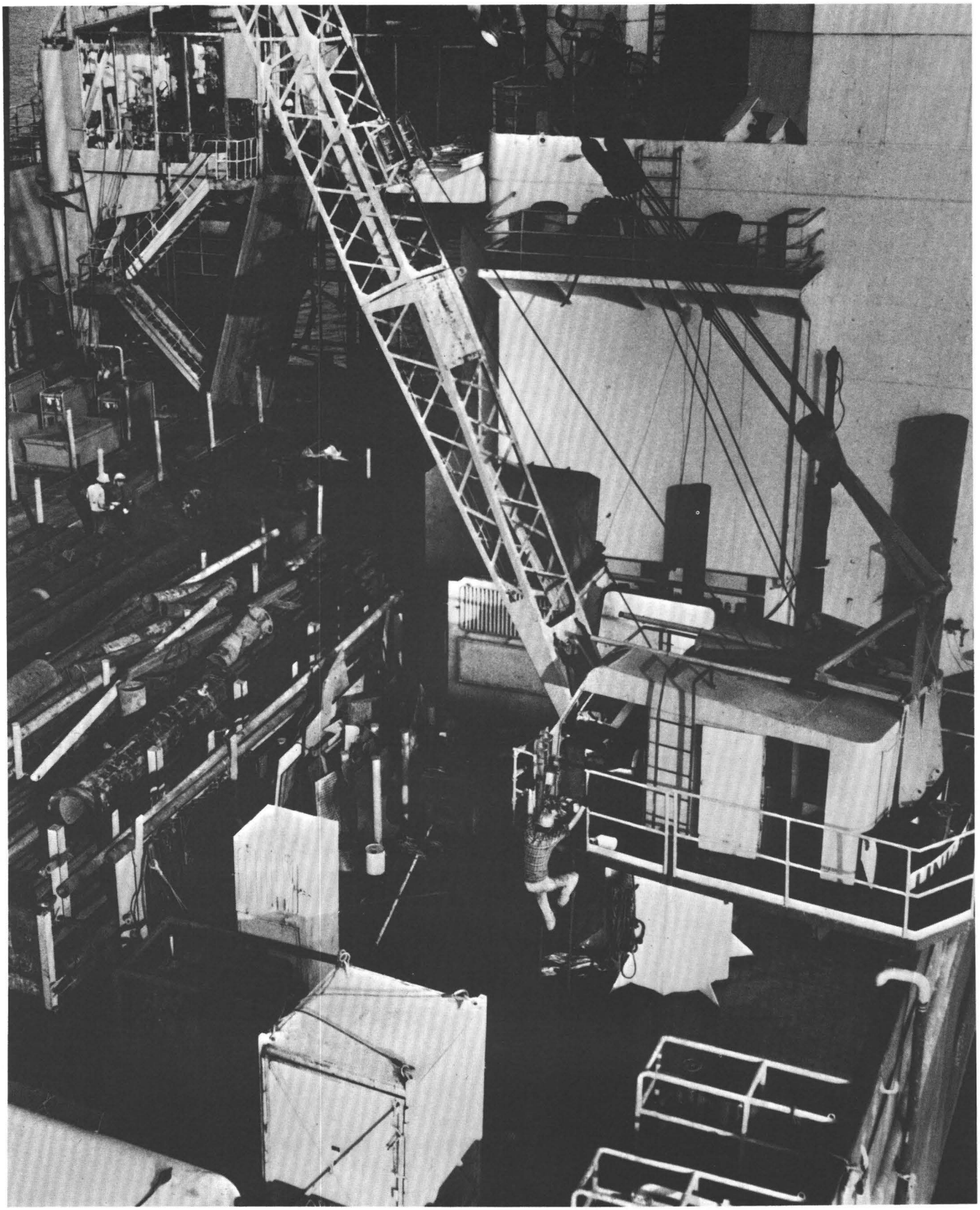


FIGURE 5.—View of central work area on the Offshore Mercury during drilling on block 1005 off Georgia, September 1979. Photograph by Dave L. Karp, Transco Companies, Inc.

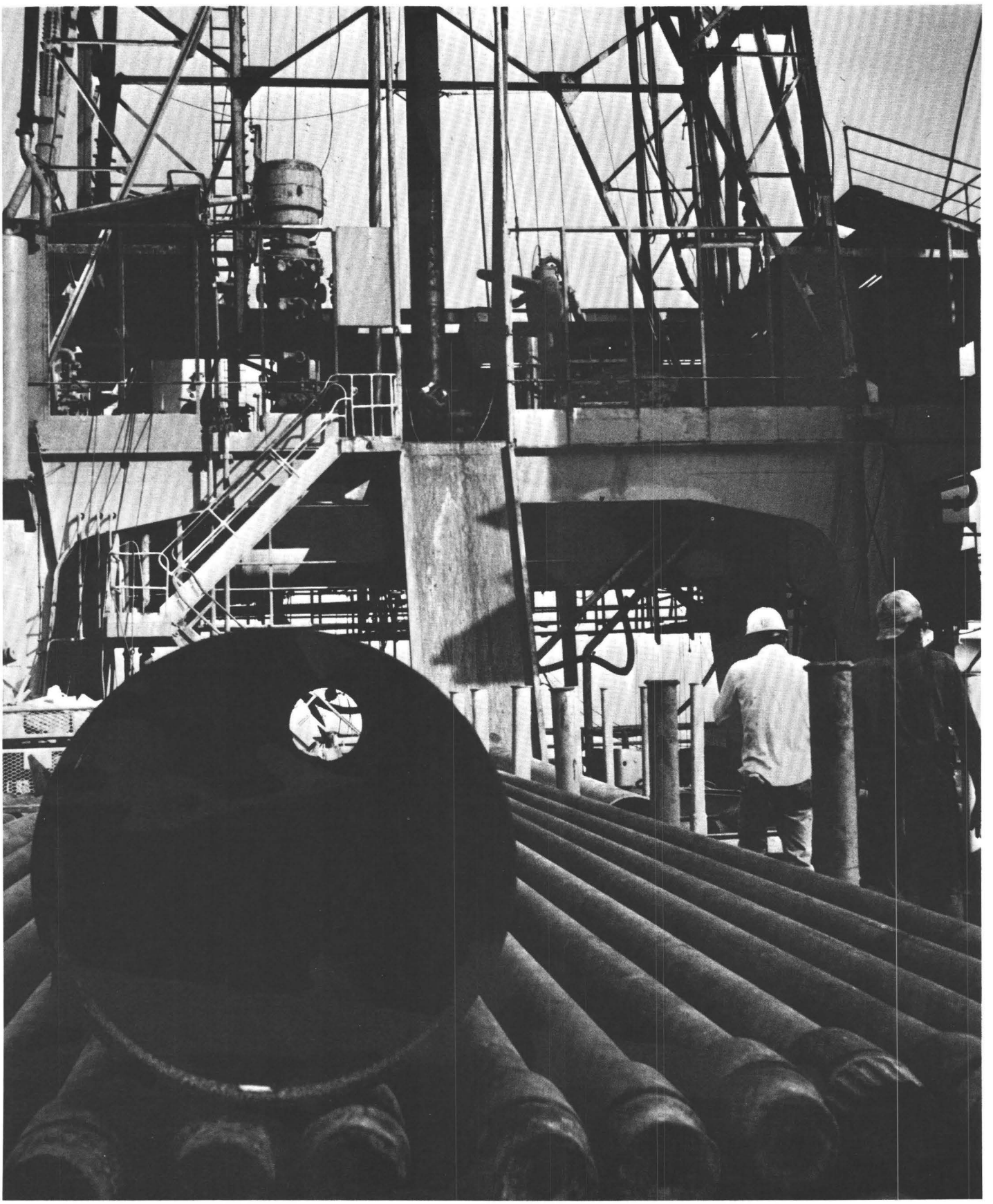
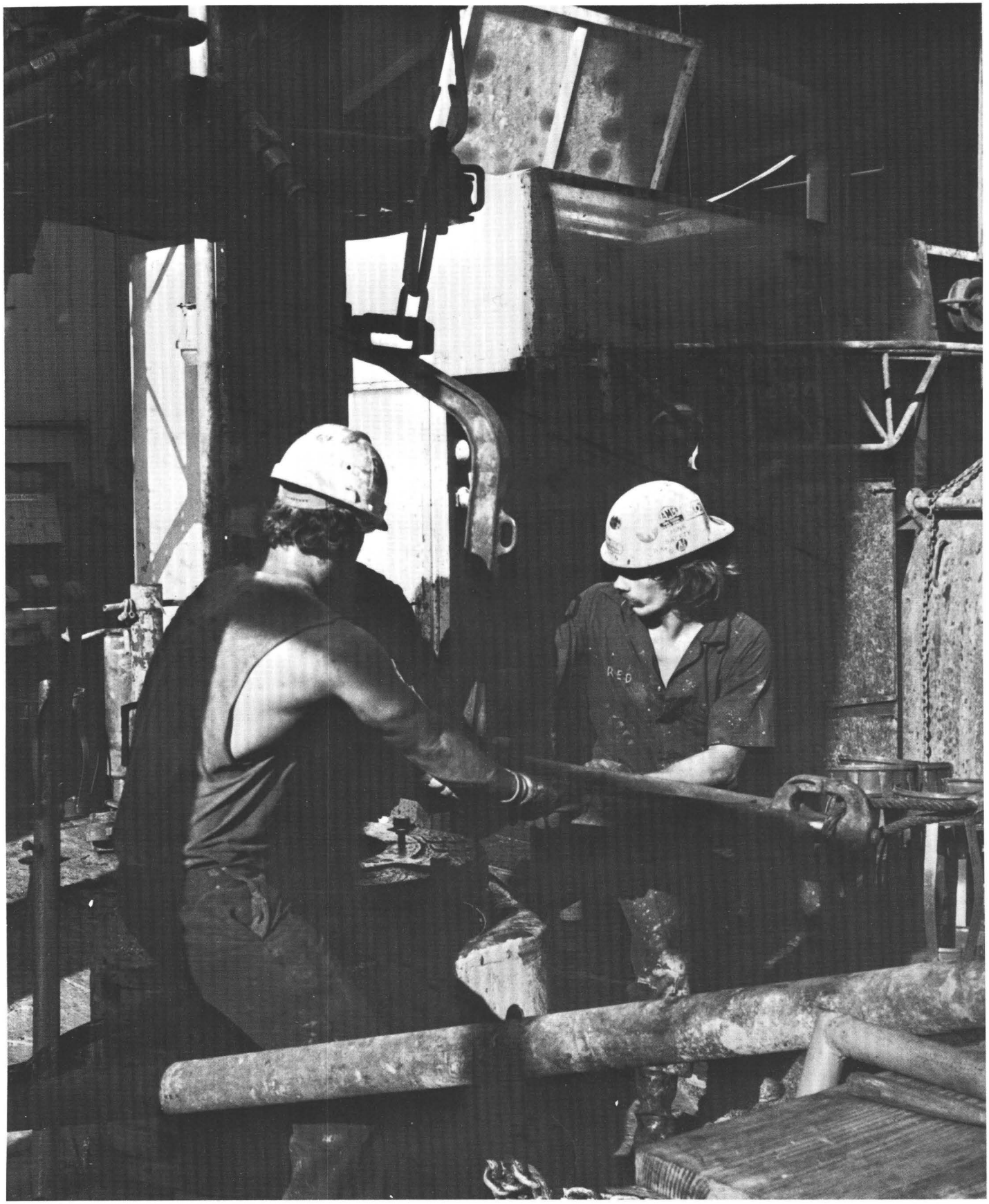


FIGURE 6.—Drill pipe on the Offshore Mercury, September 1979. Photograph by Dave L. Karp, Transco Companies, Inc.


RED

nor disprove the existence of hydrocarbons in the South Atlantic. Many wells will have to be drilled before the resource potential of the area is established: in the North Sea, for example, 51 exploratory wells were drilled before a commercial discovery was made. Nevertheless, drilling results to date have caused the initial estimates for the South Atlantic to be lowered.

Figure 8 shows the locations of the COST well and the exploratory wells. As indicated on the map, all of the holes were dry. If and when any company announces a commercial discovery and a Development and Production Plan is filed, a revision of the reserve estimate would be appropriate. But until such a time, it must be considered that there are no reserves of either oil or gas in the South Atlantic Region.

The Environmental Impact Statement (EIS) prepared by BLM for Lease Sale 43 (published October 1977) projected a possible course of development for the South Atlantic offshore. The EIS estimated that if hydrocarbons were found, the tracts offered in the lease sale would range from a low of 0.282 to a high of 1.009 billion barrels of oil and a low of 1.890 to a high of 6.810 trillion cubic feet of gas. Based on these estimates, the environmental statement projected that oil and gas production would begin in 1982 and would continue until 2010, with peak production being reached in 1991. Peak production rates were assumed to be between 56 and 170 thousand barrels per day of oil and between 470 and 1,400 million cubic feet per day of gas. It was further assumed that development would involve 10 to 25 platforms, 255 to 720 wells, and 80 to 320 miles of pipeline, as well as one or two onshore terminals.

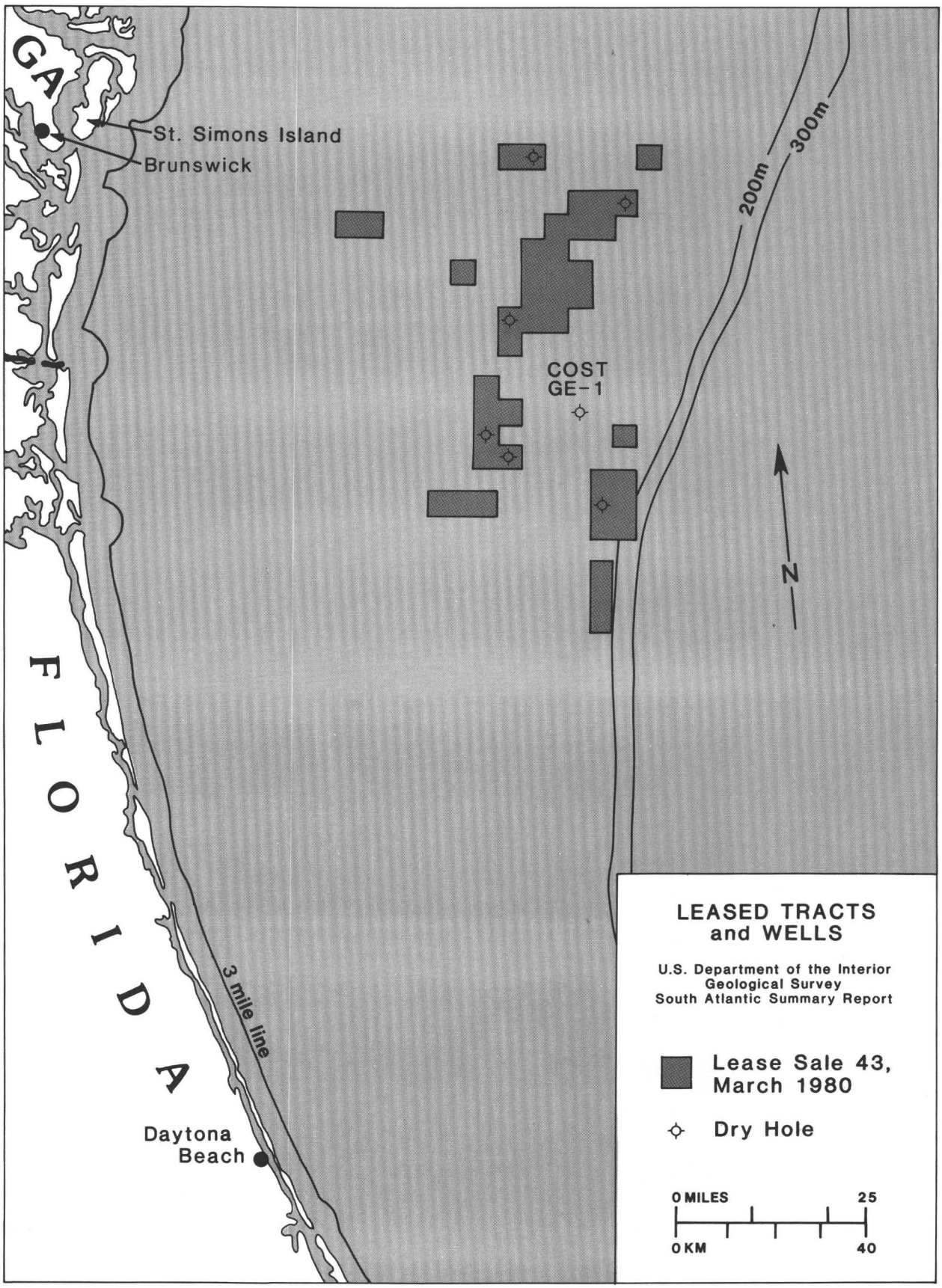
The resource estimates on which the EIS scenario for development was based are not directly comparable to the resource estimates presented in this Summary Report. First, the estimates used in the Summary Report were made more recently. They are based on much more data than was available at the time the EIS was published and include the results of the six exploratory wells drilled on the South Atlantic OCS. Second, the geographic areas covered by the EIS and this report differ. The EIS estimate covered all lands **proposed for lease** in Sale 43; the estimates presented in the Summary Report cover the offshore lands **actually leased** in the sale. Third, the method used for the EIS tends to produce larger estimates of resources than the method used for obtaining the Summary Report estimates. One significant difference is that the EIS resource estimate does not take into account the possibility that the entire Region may not contain any oil or gas.

Given the more recent resource estimates used here, production of oil from the tracts currently under lease is unlikely. Revenues from the estimated 7.9 million barrels of oil, if these resources were found at the water depth and distance offshore where present leases are located, might not cover the costs of recovery and transportation and thus would not be commercially attractive.

As for natural gas, the present risked, economically recoverable resource estimate of 480 billion cubic feet appears at the present time to be short of commercially producible, if the resources were discovered. It is difficult to say whether this much natural gas would justify the cost of a pipeline, and thus be commercially attractive, because the estimate applies to all the leased tracts from Sale 43. These tracts are scattered over a broad area. If large and relatively concentrated accumulations of gas were found, they might be commercially producible. If the resources were scattered over all the tracts, they would not be.

At present, there are currently five leased tracts for which Exploration Plans have been approved, but no Applications for Permit to Drill have yet been filed for them. Exploration is expected to continue at a slow pace until the next South Atlantic lease sale, Sale 56. It is expected that there will probably be

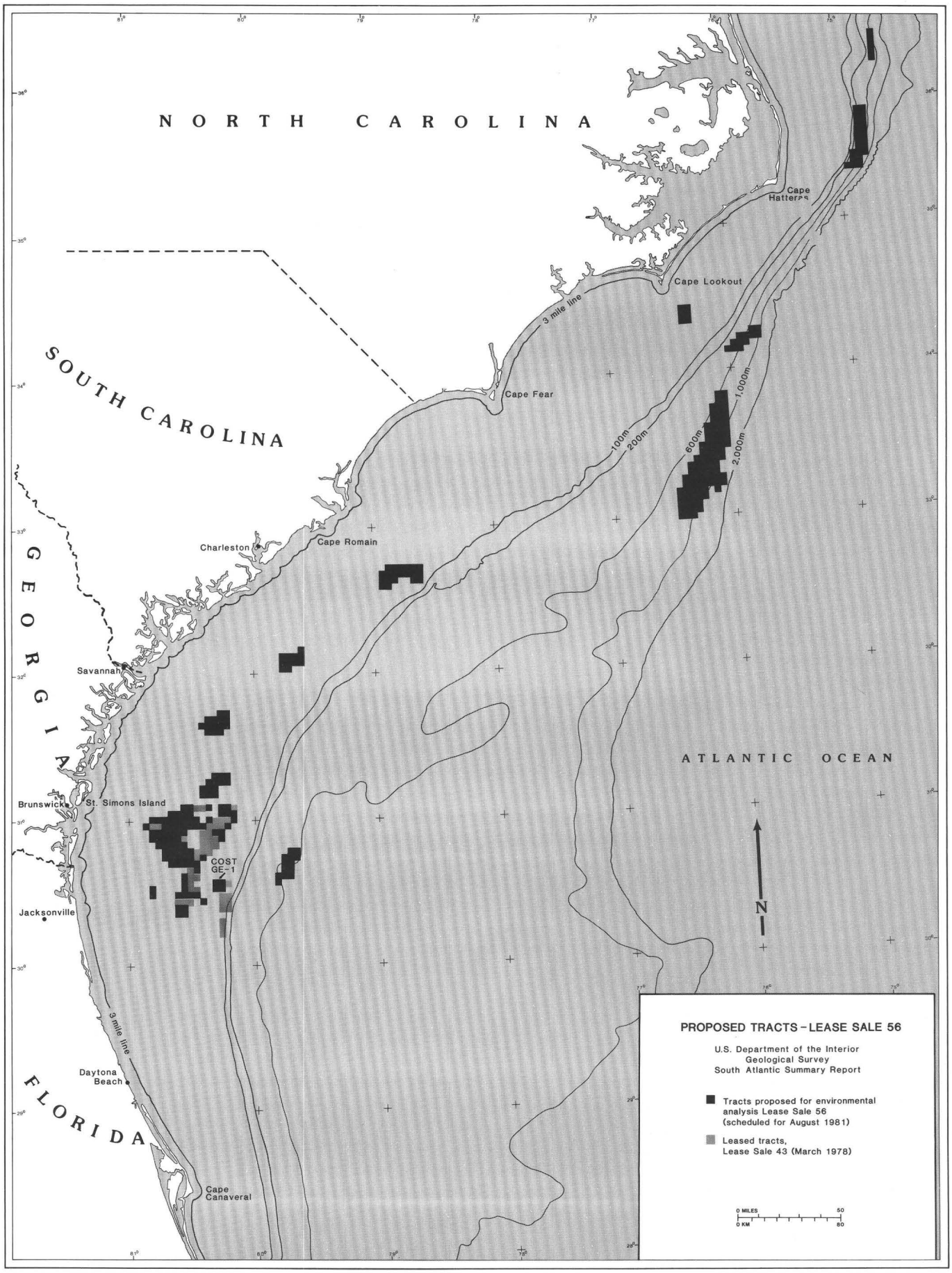
FIGURE 7.—Drilling operations on the Offshore Mercury, October 1, 1979. Photograph by Dave L. Karp, Transco Companies, Inc.


GA
St. Simons Island
Brunswick
200m
300m
COST
GE-1
N
FLORIDA
3 mile line
Daytona
Beach
LEASED TRACTS
and WELLS
U.S. Department of the Interior
Geological Survey
South Atlantic Summary Report
Lease Sale 43,
March 1980
Dry Hole
0 MILES
25
0 KM
40

no more than one rig drilling in the South Atlantic at any one time before the next sale. However, if a discovery were made, greater levels of exploratory activity would be likely.

Lease Sale 56 is currently scheduled to take place in August 1981. In preparation for that sale the Bureau of Land Management has selected for environmental analysis 286 tracts totaling approximately 659,190 hectares (1,628,198 acres) (see fig. 9). The area covered by the proposed sale includes the same general area covered by Lease Sale 43. The tracts selected range from 25 to 183 km (15 to 114 mi) from shore and lie in waters from 20 to 2,012 m (66 to 6,600 ft) deep.

<FIGURE 8.—Leased tracts and wells in South Atlantic Region, 1980 (Adapted from Boudreaux, 1979).


NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
FLORIDA
ATLANTIC OCEAN
Cape Hatteras
Cape Lookout
Cape Fear
Cape Romain
Charleston
Savannah
Brunswick
St. Simons Island
Jacksonville
Daytona Beach
Cape Canaveral
COST GE-1
3 mile line
3 mile line
100m
200m
600m
1,000m
2,000m
N
PROPOSED TRACTS - LEASE SALE 56
U.S. Department of the Interior
Geological Survey
South Atlantic Summary Report
Tracts proposed for environmental analysis Lease Sale 56 (scheduled for August 1981)
Leased tracts, Lease Sale 43 (March 1978)
0 MILES 50
0 KM 80

3. OCS Oil and Gas Transportation Strategies

If commercially producible quantities of oil and gas are discovered in the South Atlantic, they will have to be transported ashore for processing, refining, and distribution. The process of planning for and constructing the necessary transportation facilities is multifaceted and expensive. Because of the complexity of this process, it is desirable to begin planning as early as possible, before oil and gas lease sales take place. The Bureau of Land Management takes a lead role in transportation planning through its Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities (IPP).

The IPP was officially activated on September 20, 1979, when the private-sector appointments were made for the Regional Technical Working Group (RTWG) Committees. These working group committees are composed of Federal and State officials and representatives of industry and other special and private interests. The members of the South Atlantic RTWG Committee are listed in table 2.

The movement of oil and/or gas from the outer continental shelf to processing points or or to users is an important part of the overall RTWG planning function. The principal end product of this planning effort is a Regional Transportation Management Plan (RTMP). If commercially producible quantities of oil or natural gas are discovered in the South Atlantic leasing region, an RTMP will be developed.

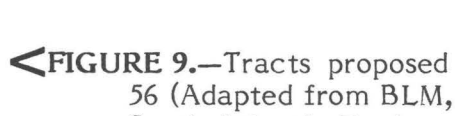


FIGURE 9.—Tracts proposed for lease in Sale 56 (Adapted from BLM, OCS Office, U.S. South Atlantic Region, n.d.).

Transportation Planning is only one element of the IPP. Two other activities, the Oil and Gas Leasing Process and the Environmental Studies Program, are combined with Transportation Planning to form a coordinated planning system for OCS activity. For an overview of the Oil and Gas Leasing Process and the Environmental Studies Program, see appendix C, Intergovernmental Planning Program of the Bureau of Land Management.

At a minimum, the RTMP will include the following information and recommendations:

- analysis and recommendations for definite transportation corridors and alternatives, including all routes to onshore facilities or to offshore terminals serving as collection points for more than one production area;
- identification of environmentally sound alternative areas for the location of onshore facilities;
- alternatives regarding surface vessel transportation, in accordance with appropriate regulatory agencies;
- plans for monitoring of construction and operations and any required follow-up studies; and
- any stipulations and use restrictions identified as applicable to transportation rights-of-way.

Each RTMP will result from the efforts of a State Technical Working Group composed of all members of the South Atlantic Regional Technical Working Group Committee except the representatives from States not potentially affected by OCS production activities. Other Federal agencies and individuals whose

TABLE 2.—South Atlantic Regional Technical Working Group Committee

Member	Affiliation
Dr. Murice Rinkel	State of Florida (Co-chairperson)
Mr. John Rankin	U.S. Bureau of Land Management (Co-chairperson)
Mr. Reginald Rogers	U.S. Environmental Protection Agency
Mr. Randy Cheek	U.S. National Oceanic and Atmospheric Administration
Capt. Henry Helgesen	U.S. Coast Guard
Dr. James Kirkwood	U.S. Fish and Wildlife Service
Mr. Paul Martin	U.S. Geological Survey
Mr. James Barber	State of Georgia
Mr. James Smith	State of North Carolina
Ms. Patricia L. Jerman	State of South Carolina
Mrs. Susan R. Graber	Legal Assistant
Mr. John M. Seymour	Southern Natural Gas Company
Mr. Hans Neuhauser	The Georgia Conservancy
Mr. Vernon Bolleter	Tenneco

expertise may be needed by the State Technical Working Group during RTMP development activities may participate in Working Group deliberations on an ad hoc basis.

No RTMP's have been finalized for the South Atlantic leasing region. Preliminary planning for criteria for corridor siting is underway. A detailed methodology to be used in planning pipeline corridors is being prepared by the Washington office of the BLM and will be released during the summer of 1980.

A number of studies have been conducted in the South Atlantic Region that may aid in transportation planning. More information on these Federal, State, and local OCS-related studies may be found in appendix D.

4. Nature and Location of Nearshore and Onshore Facilities

The onshore effects of OCS activity in the South Atlantic Region to date have been associated with support bases for exploratory drilling in the Southeast Georgia Embayment. This onshore support activity has been concentrated in three areas of Georgia: Savannah, Brunswick, and St. Simon's Island.

Exploratory drilling is an expensive activity that requires specialized equipment and skilled personnel. To keep costs down, much of the equipment needed for the exploration effort is leased. The oil companies involved in exploratory drilling on Sale 43 leases do not own the rigs that performed the drilling. Tenneco, Getty, and Transco all leased the same rig, Offshore Mercury, from Offshore Company, and Exxon leased Glomar Semi 1 from Global Marine, Inc. The rig owners provided the personnel needed to operate their rigs. Because Offshore Mercury is registered in the United Kingdom and was used to drill in the North Sea, many members of her crew are English and were flown to Georgia from England. Entry-level personnel were hired locally, a standard procedure in a frontier area followed partly as a local goodwill effort and partly to reduce costs. Hiring local people eliminated the need to transport workers to and from another part of the country (or from another country) and the concomitant costs. The positions that the rig companies filled locally were cooks, stewards, galley personnel, roustabouts, roughnecks, and utility people (Liddell, 1980, oral commun.).

The crews on rigs in the South Atlantic have worked on/off shifts of 14 days. These shifts are on a staggered rotating basis, i.e., the entire crew is not changed at one time. Rather, some changes are made each day, so that half the crew of each rig is replaced every 7 days. A full complement on a rig is approximately 40 people, so the rotating shift arrangement necessitates a total crew of about 80. The oil companies, responsible for providing transportation for the rig crews, arranged for and leased helicopters to ferry these personnel to and from the rigs.

Although neither rig company has statistical information concerning the number of people hired locally, the number was estimated as being between 30 and 40 at any one time per rig. Because of the demanding nature of the work, the turnover rate has been fairly high (Liddell, 1980, oral commun.).

The work boats used to transport supplies from support bases to the rigs have been leased by the drilling rig companies. At least two boats are needed to service each rig. The supplies transported by the work boats include drill pipe, drilling mud, cement, food, fuel, water, casing, hardware, and other equipment. Federal safety regulations require that one boat must be at the rig, or in sight of it, at all times. The work boats used in the South Atlantic are 48 to 60 m (160 to 200 ft) long and approximately 12.5 m (42 ft) wide. They draw 3.5 to 5 m (12 to 17 ft) when loaded. Figure 10 shows a work boat moored to a drilling rig in the South Atlantic.

Work boat crews number between 10 and 12 per boat, working 14-day on/off shifts like the rig workers. Some local people were hired to work on the boats.


OFFSHORE
MERCURY
GULF FLEET NO 33

SAVANNAH, GEORGIA

Tenneco, the first oil company to drill in the Southeast Georgia Embayment, chose Savannah as its support base for Sale 43 operations. In May 1979, when Tenneco began operations, the pier and support facilities that were being built in Brunswick were not complete, and Tenneco personnel were impressed with existing facilities in Savannah. Saylor Marine Corporation had sufficient dock space, rail siding, and warehousing on 2.8 hectares (7 acres) of land, with a 152.5-m (500-ft) frontage on the Savannah River (Nichols, 1980, oral commun.).

All equipment and supplies needed by the Offshore Mercury, the rig that drilled two wells for Tenneco between May and August, were delivered to the Saylor Marina, half by rail and half by truck, and then loaded onto work boats. Jack Saylor, the owner of the Saylor Marine Corporation, employed six people in addition to his usual staff to help load and unload the work boats (Saylor, 1980, oral commun.).

As part of the support base operation, Tenneco sent one warehouseman and one drilling engineer to Savannah from Houston for the approximately 80 days that Tenneco drilled. Another drilling engineer was stationed in Savannah for about 40 days during this time. Two additional drilling engineers and two geologists spelled each other on the rig in rotating 7-day shifts and returned to Houston during their off-rig weeks. Locally, Tenneco hired a secretary and a warehouse guard for the duration of its operations (Nichols, 1980, oral commun.).

Tenneco's well was located about 145 km (90 mi) from Savannah. It took the work boats about 13 hours to make the trip. Each boat stayed with the rig for 3 to 4 days.

<FIGURE 10.—Work boat **Gulf Fleet No. 33** moored to the Offshore Mercury off Georgia, October 1, 1979. Photograph by Dave L. Karp, Transco Companies, Inc.

Offshore Company, which owns the rig used for Tenneco's operations, also leased office space and hired a secretary in Savannah.

The support base in Savannah appears to have presented no serious environmental problems: the impacts associated with OCS-related activity were easily handled by the facility and the city. Water was loaded aboard the work boats and then pumped onto the rig. Waste brought back by the boats from the rig was packed in garbage containers, collected by a Savannah waste operation, and disposed of locally (Saylor, 1980, oral commun.).

BRUNSWICK, GEORGIA

By August 1979, when Getty began to drill on its Sale 43 leases in the Southeast Georgia Embayment, the city of Brunswick had completed building its support base. This 1.2-million-dollar facility, built on 5.6 hectares (14 acres) of urban renewal land, consists of warehousing for dry storage, loading cranes, a trailer to serve as an operations office, open storage for pipe and casing, drilling mud containers, fuel storage tanks, and dock space for loading and unloading, as well as berthage for work boats. The financing of the construction was guaranteed by 1979 Coastal Energy Impact Program (CEIP) funds. The Brunswick Chamber of Commerce and local officials actively recruited the oil companies and promoted the construction of the support base (Hulse, Mellor, 1980, oral communs.).

Both Getty and Transco leased the Offshore Mercury to drill for them; their operations in Brunswick were similar. The Offshore Mercury drilled one well for Getty from August 17 to September 16, 1979, and then drilled a hole for Transco between September 19 and December 15, 1979.

Getty sent five people from Houston to Brunswick: one supervisor, two onshore dispatchers and two foremen. The supervisor and his wife lived in an apartment in Brunswick for the duration of the operation. The dispatchers and foremen worked 7-day rotating shifts and were housed in a local motel. Getty hired a

local secretary for 45 days. Two cars were leased locally for the duration of the operation (Lilley, 1980, oral commun.).

Brunswick also served as the support base for Exxon's Sale 43 operations. However, Exxon's operation differed slightly from Getty's and Transco's. A different rig, the Glomar Semi 1, was used. Exxon also drilled for the longest period of time, from early October 1979 to February 1980. The company took a 2-year lease on 350 square meters (15,000 square feet) of office space in a Brunswick bank on May 1, 1978 (Fuge, 1980, personal commun.). The Glomar Semi 1 was serviced by three work boats.

Global Marine, Inc., the company that provided the rig used to drill on Exxon's leases, set up a field office in Brunswick to serve as its onshore base. The office employed three staff people and a secretary.

Brunswick is slightly closer than Savannah to the drilling activity that has taken place in the South Atlantic. Work boats generally took between 11 and 12 hours to make the 120-km (75-mi) trip.

The environmental impacts associated with the support base in Brunswick appear to have been minimal. The base was connected to Brunswick's water and sewage systems. The work boats carried empty solid waste containers to the rigs, which were filled and reloaded on the work boats. The municipal trash service picked up the containers from the dock and disposed of the wastes locally (Hulse, 1980, oral commun.).

ST. SIMON'S ISLAND, GEORGIA

St. Simon's Island, the third area to support South Atlantic OCS activity resulting from Lease Sale 43, served as a helicopter base and has continued to be the location of a district USGS office.

The airport at St. Simon's, Malcolm McKinnon Airport, was chosen as the base for helicopters because of its proximity to the offshore drilling area and because the required facilities were already there. The requirements of a helicopter support base are few: hangar space, warehousing, a helicopter pad (which requires less than half a hectare, or less than one acre, of land), and perhaps some office space. St. Simon's airport met all the requirements.

Petroleum Helicopters, Inc. (PHI) serviced both drilling rigs that worked in the Southeast Georgia Embayment. Generally, there were two trips per day to each rig. PHI used three types of helicopters: the Puma, which carries 18 passengers and a crew of 2; the Bell 212, which carries 9 passengers and a crew of 2; and the Boeing Boekal 105, which carries 4 passengers and 1 crew member (Johnson, 1980, oral commun.). Figure 11 shows the view of a rig from a helicopter.

When both rigs were operating in the Embayment, PHI had 10 pilots and 4 mechanics operating out of St. Simon's on a 14-day on/off shift. Two radio operators worked each shift on the rig. Each helicopter used approximtely 1,365 liters (360 gal) of jet fuel, purchased locally, per day. PHI rented a total of about 110 square meters (1,200 square ft) of space at the airport (Bartlett, 1980, oral commun.).

The USGS established a district office on St. Simon's Island to monitor exploratory activity on the OCS. During the peak period of drilling activity, the office had nine staff members, of whom one was hired locally. Currently, there are seven people working in the USGS office; however, there are plans to transfer two of these people in the near future. In addition to the office space, the USGS leased a helicopter from Chesapeake and Potomac (CP) Airlines for daily inspection trips of the rigs. The helicopter operated out of St. Simon's airport (Martin, 1980, oral commun.).

FIGURE 11.—Helicopter view of drilling rig in the South Atlantic, fall 1979. Photograph by Dave L. Karp, Transco Companies, Inc. >

The number of persons working at the helicopter base and the onshore support bases did not present a significant demand for either permanent or transient housing in any of the local communities. The great majority of workers simply passed through the area, and those employed locally already had homes there. PHI rented two apartments and CP Airlines rented a trailer on St. Simon's. The most significant demand for housing may have been generated by the USGS, with its transfer of eight people to St. Simon's Island.

SUMMARY

Because of the diverse nature of spending for South Atlantic OCS operations, it is difficult to estimate how much money was spent locally as a result of exploratory drilling in the Southeast Georgia Embayment to date. The Oil and Gas Journal reported that the oil companies spent about $25.5 million to drill the six wells (Sumpter, 1980). Direct contact with the oil companies indicates that this figure is correct. However, not all of this amount was spent locally. A report commissioned by the Brunswick-Glynn County Joint Planning Commission to analyze the potential impacts of onshore support activities on the community estimated that an onshore support base in Brunswick might result in an influx of about $1.5 million annually per drilling rig in operation (Roberts & Eichler Associates, 1979). On a monthly basis, this indicates expenditures of $125,000 per rig.

As has been the case in other frontier areas (Macpherson and Bookman, 1980), it seems that the most negative impact of OCS-related activity in the South Atlantic to date has been the decline in exploratory activity from its peak, in the fall of 1979, rather than its arrival in the first place.

References

Amato, R. V., and Bebout, J. W., eds., 1978, Geological and Operational Summary, COST No. GE-1 Well, Southeast Georgia Embayment Area, South Atlantic OCS: U.S. Geological Survey. Open-File Report 78-688, 122 p.

Bartlett, Bill, 1980, Vice-President, Golden Isle Aviation, St. Simon's Island, Ga., oral communication.

Bird, Cyril, 1979, Estimated oil and gas reserves, Southern California Outer Continental Shelf, January 1, 1978: U.S. Geological Survey Open-File Report 79-345.

Bolleter, Vern, 1980, Tenneco, Houston, Tex., oral communication.

Boudreaux, Clay, 1979, Record of operators, areas, blocks, leases and States (South Atlantic Area--Southeast Georgia Embayment): U.S. Department of the Interior, Geological Survey, South Atlantic District, memorandum, April 17, 1979.

Dillon, W.P., Graw, J.A., and Paull, C.K., 1980, Unconventional gas hydrate seals may trap gas off Southeast U.S.: Oil and Gas Journal, January 7, p. 124-130.

Fuge, W. R., Jr., 1980, Exxon Company, U.S.A., Houston, Tex., personal communication.

Hulse, Ed, 1980, City Manager, Brunswick, Ga., oral communication.

Jacobson, Sara S., 1980, U.S. Geological Survey, Washington, D.C., unpublished documents and oral communications.

Johnson, Dale, 1980, Petroleum Helicopters, Inc., Lafayette, La., oral communication.

Liddell, Bill, 1980, Offshore Company, Houston, Tex., oral communication.

Lilley, Ed, 1980, Getty Oil Company, Houston, Tex., oral communication.

Macpherson, George, and Bookman, Charles, 1980, Outer Continental Shelf oil and gas activities in the Mid-Atlantic and their onshore impacts: a summary report, November 1979: U.S. Geological Survey Open-File Report 80-17, 63 p.

Martin, Paul, 1980, District Supervisor, U.S. Geological Survey, St. Simon's Island, Ga., oral communication.

Mellor, Phil, 1980, Chamber of Commerce, Brunswick, Ga., oral communication.

Miller, B.M., and others, 1975, Geological estimates of undiscovered recoverable oil and gas resources in the U.S.: U.S. Geological Survey Circular 725, 78 p.

Nichols, Harold, 1980, Tenneco, Houston, Tex., oral communication.

Roberts & Eichler Associates, 1979, An analysis of the community impacts on Brunswick, Georgia, resulting from the development of onshore support facilities for offshore energy exploration: Decatur, Ga., Brunswick-Glynn County Joint Planning Commission, 89 p.

Saylor, Jack, 1980, Saylor Marine Construction Co., Savannah, Ga., oral communication.

Shipley, T. H., Buffler, R. T., and Watkins, J. S., 1978: Seismic stratigraphy and geologic history of Blake Plateau and adjacent Western Atlantic Continental Margin: American Association of Petroleum Geologists Bulletin, v. 62, p. 792-812.

Sumpter, Randy, 1980, Embayment prospects due further look: Oil and Gas Journal, v. 78, no. 11, March 17, p. 76-77.

Tissot, B.P., and Welte, D.H., 1978, Petroleum formation and occurrence: New York, Springer-Verlag, 538 p.

U.S. Department of the Interior, Bureau of Land Management, 1977, Final environmental impact statement: proposed 1978 OCS oil and gas lease sale, South Atlantic OCS Sale No. 43: October 31, 3 vols., 488 p.

U.S. Department of the Interior, Bureau of Land Management, New Orleans OCS Office, 1980, Intergovernmental Planning Program for Gulf of Mexico and South Atlantic Regional Technical Working Group Committees: New Orleans, La., unpublished document, February 1980.

U.S. Department of the Interior, Bureau of Land Management, Outer Continental Shelf Office, United States South Atlantic Region, n.d., Proposed tracts OCS Sale #56.

U.S. Department of the Interior, Geological Survey, n.d., Outer Continental Shelf of the Atlantic Ocean from 24° to 43° north latitude, scale 1:1,000,000, 2 maps.

Appendix A. The Geologic Setting

PETROLEUM GEOLOGY

Hydrocarbons are formed within the upper part of the earth's crust. Through the action of heat and pressure, depositions of organic matter are transformed into various mixtures of crude oil and natural gas. The time between deposition of organic material and the formation of hydrocarbons is on the order of millions of years (Tissot and Welte, 1978, p. 198).

The occurrence of hydrocarbon accumulations depends on many factors (Miller and others, 1975, p. 17):

- an adequate thickness of sedimentary rocks;
- the presence of source beds (rocks containing large amounts of organic matter);
- a suitable environment for maturation of the organic matter into oil and/or gas;
- the presence of porous and permeable reservoir rocks;
- hydrodynamic conditions permitting the migration of hydrocarbons and their ultimate entrapment in reservoir rocks;
- the area's having a thermal history that favors production and preservation of hydrocarbons;
- formation of adequate geologic traps for accumulation of the hydrocarbons; and
- suitable timing of petroleum generation and migration to ensure the entrapment and preservation of the hydrocarbons.

In a prospective hydrocarbon province, geologists look for structural or stratigraphic traps in which oil and gas can accumulate. Structural traps include anticlines, sediments draped over salt diapirs and other dome-like intrusions, and fault traps. Examples of stratigraphic traps are reefs and the truncated edges of porous strata. Traps may also be formed by a combination of structural and stratigraphic elements.

THE SOUTH ATLANTIC OUTER CONTINENTAL SHELF

As stated in chapter 1, the South Atlantic outer continental margin is a geologically complex area. Lease and drilling activity has been confined to the Southeast Georgia Embayment, an eastward-plunging depression underlying the continental shelf and extending beneath the Atlantic Coastal Plain of South Carolina, Georgia, and Florida. The Embayment is bounded on the northeast by the Cape Fear Arch, on the southwest by the Florida Peninsular Arch, and on the west by the Georgia-Carolina Piedmont. The basin opens seaward, where its offshore extent has not been well defined.

Extensive seismic studies of the Embayment have been conducted. Prior to Lease Sale 43, the USGS obtained and evaluated 27,358 km (17,000 line miles) of seismic data.

One Continental Offshore Stratigraphic Test well (COST well GE-1) was drilled in the basin prior to Sale 43. (See figure 8, p. 16).

The oldest rocks penetrated by COST well GE-1 are approximately 370 million years old and are composed of altered terrestrial sediments and volcanic rocks. This section is organically barren and does not contain reservoir-quality rocks; it is not considered prospective for hydrocarbon accumulations. These oldest rocks are considered to be basement rocks formed before the basin began to subside and accumulate younger sediments.

Directly above these oldest rocks are much younger sedimentary rocks, dated at 110 million years. During the time period 110 to 370 million years ago, there was considerable movement and deformation of the earth's crust in this area as mountains were uplifted and eroded and the continents of North America, Europe, and Africa rifted apart. Rocks formed during this time were eroded or destroyed in the rifting activity, creating a gap in the rock record. The surface or boundary between the older and younger rocks where the rock record is discontinuous is called an unconformity.

The younger rocks, which range from 110 to 2 million years old, thicken and dip eastward in the Embayment. In the vicinity of the COST well, they are found to a depth of 11,000 feet. These rocks were deposited in environments ranging from nonmarine to deep marine. Sandstone, shales, and carbonates predominate in the upper portions of this section. The Southeast Georgia Embayment is located in a lithologic transition zone: to the north of the area, rocks such as sandstones, siltstones, and shales predominate, whereas to the south of the area, carbonates predominate in the stratigraphic section. Evaporites are found in minor amounts in the rock column.

The sandstones and some of the carbonates could provide adequate reservoirs for hydrocarbons, and the shales and evaporites could act as seals to trap hydrocarbons there. Some of the shales that contain large amounts of organic material could also provide a source of hydrocarbons; however, the section as a whole appears to be organically lean. Another problem is that although thermal maturation of the sediments increases with depth, most of the rocks are thermally immature. Given the terrestrial nature of the deeper, more thermally mature sediments, the leased tracts on the shelf would be gas-prone. The oil-prone material in the upper parts of the section is not thermally mature. Good sources of hydrocarbons are postulated to exist east of the area, where the deeper and thicker rock column may contain larger amounts of marine sediments. Migration of these hydrocarbons into traps in the Embayment may have occurred.

Within the Southeast Georgia Embayment both structural and stratigraphic traps have been identified. Structural traps appear to have been formed by sediments draping over and abutting deep-seated uplifted areas: few fault-related structures are found. Stratigraphic traps caused by pinch-outs of rock layers have been identified but have proved difficult to delineate.

Gas traps with unusual gas-hydrate seals may be well developed at relatively shallow sub-bottom depths in the continental slope off the Carolinas (Dillion, Graw, and Paull, 1980). Further research is needed to learn more about these gas-hydrates, which are also known as clathrates. If they do exist in the South Atlantic, they may require engineering techniques to provide a seal around well casings. Such techniques have been used in Alaska (Bolleter, 1980, oral commun.).

OCS Lease Sale 56, scheduled to be held in 1981, would offer more tracts in the Southeast Georgia Embayment. In addition, tracts may be offered at that time in areas north and east of existing leases. Figure 9, p. 18, shows the tracts being considered for Sale 56.

SUMMARY OF GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS TO DATE

In reviewing the petroleum geology of the South Atlantic in light of the specific requirements for hydrocarbon accumulation,

several comments can be made. The Southeast Georgia Embayment contains thick layers of sedimentary rocks, including potential hydrocarbon reservoirs. Source beds capable of generating hydrocarbons are found, but most are thermally immature. Mature source beds may exist to the east, downdip of the area. Structural and stratigraphic traps are present. Other prospective hydrocarbon basins may be found to the north and east of the Southeast Georgia Embayment.

It appears that the Southeast Georgia Embayment has many of the characteristics that allow oil and gas to accumulate. However, the only way to verify that these events occurred in a sequence that would ensure the entrapment and preservation of hydrocarbons is to drill and confirm the presence of oil and gas. Chapter 2 presents the results of the drilling conducted to date.

ADDITIONAL GEOLOGIC AND GEOPHYSICAL STUDIES ON THE SOUTH ATLANTIC AREA

Subsequent to Sale 43, about 2,100 additional km (1,300 line miles) of seismic data have been obtained in the Sale 56 call area under permits E1-78, E16-78, E6-79, and E8-79. Recently, permits have been granted to Geosource (E1-80) and Digicon (E2-80) for the collection of about 12,900 km (8,000 line miles) of seismic data in the Sale 56 call area to the north and east of the Sale 43 leased tracts.

High-resolution geophysical surveys for hazards studies are now under way. The data are being collected by Fairfield Industries, under contract to the USGS, and will be analyzed by the USGS. Data acquisition should be completed in April 1980, and the hazards data will be available to the public in May 1980. The Survey will issue a report on its hazards studies prior to Sale 56.

Appendix B. Estimating Oil and Gas Resources

Before exploratory drilling, both the government and industry undertake analyses of geological basins to determine their oil and gas potential. The government uses methods of analysis that differ depending on the purpose of the estimate and the availability and level of detail of data. The data base for resource estimation is regularly updated with new geologic and geophysical data, and as more data are gathered, processed, analyzed, and interpreted, the resource estimate for a given area is updated to reflect the added data.

Prior to a lease sale, the process of estimating the amount of oil and gas in a potential reservoir or a lease sale area involves a high degree of uncertainty. The USGS makes these pre-sale estimates for a variety of purposes. Regionwide estimates are used to aid in the preparation of proposed lease sale schedules. More specific resource estimates are made for the purpose of tract selection. Later estimates are made on a tract-by-tract basis to establish an economic value for each tract offered. However, it should be reemphasized that estimates of undiscovered resources are extremely uncertain. The existence of resources cannot be confirmed until an area has been thoroughly explored by drilling.

REGIONWIDE RESOURCE ESTIMATES

In the early stages of exploration, when only broad interpretations of regional geology are possible, it is necessary to use expert judgment based on these minimal amounts of data to make resource estimates. As more data become available, the resource estimates and the methods used become more refined. When data are abundant and detailed, the choice of method used depends on the purpose of the resource estimate. The quality of the estimate, however, depends on the quality of the geological and geophysical data and studies upon which it is based.

A number of estimation techniques are available for making regionwide or basin resource estimates. For an area that has not been extensively drilled, the most useful group of techniques may be classified as **volumetric-yield methods.** In these methods, the volume of potentially hydrocarbon-producing rocks is calculated, and a yield of oil and/or gas based on known yields from geologically analogous basins or regions is derived. Other methods, more useful in regions that have experienced extensive exploratory drilling, are **performance** or **behavioristic extrapolation methods.** In these, various indexes of past performance such as discovery rates, cumulative production, and productive capacity are fitted by various mathematical derivations into logistic or growth curves that are then projected into the future. In addition to these, more sophisticated methods involving geological, engineering, and statistical models may be used (Miller and others, 1975, p.18).

TRACT-SPECIFIC RESOURCE ESTIMATES

Each tract selected for leasing for exploration and development of oil and gas resources must be evaluated prior to the lease sale. After a lease sale, resource estimates are periodically updated.

Resource evaluations of tracts consist of three parts: a geophysical and geological evaluation of potentially recoverable resources of possible hydrocarbon-bearing structures and stratigraphic traps underlying the tract; an assessment of the risk that, for whatever reason, hydrocarbons are not, in fact, present in the quantities estimated in the geologic evaluation; and an engineering and economic evaluation of those resources, taking the assessed risk into account.

Data used for resource estimation are seismic records, well data, other geologic data, and production histories from wells and fields in or near the sale area. In the case of frontier areas, drilling and production histories of geologically analogous petroleum-producing basins and fields are substituted. Once an area has been leased and exploratory drilling has commenced, the results of drilling may allow updating of resource estimates. Changes in drilling and production technologies and costs may also necessitate the revision of the resource estimates.

The tract-specific resource estimates are derived by using a **Monte Carlo discounted cash flow computer program.** In this program, geologic, engineering, and economic information is used to calculate recoverable resources and an economic value of the resources for each tract. Some parameters, such as tract size, are entered as fixed values. Others, such as pay thickness and production rates, are given a range of values. The program then randomly selects values for each variable and combines them with the fixed parameters to calculate a resource estimate and economic value. The process is run many times, and eventually a mean resource estimate and economic value are determined.

A **risk factor** is used to discount the mean resource estimate. The risk factor represents the probability that a particular trap will not contain hydrocarbons in the quantities predicted by the geologic evaluation. The risk factor is a subjective appraisal by a geologist, geophysicist, and engineer based on the data available to them. It is determined through a knowledge of an area's (or an analogous area's) exploration history, together with an assessment of how strongly the data indicate the presence of a trap, of source rocks, and of other elements that make a good prospect.

RESERVE ESTIMATES

Reserves are the portion of identified resources that can be economically extracted (Miller and others, 1975, p. 8). The techniques available for estimating reserves are similar to those used in making resource estimates, only they are more refined and are based on more information. In **volumetric estimation,** the volume of a reservoir can be calculated from seismic data and information gained by drilling. Porosity and permeability of the rock and the relative amounts of oil, gas, and water in its pore spaces can be interpreted from borehole logs and analyses of cores.

The **decline-curve method** may also be used in estimating reserves of reservoirs where production has taken place. In this method, future production is estimated by extrapolating plots of actual production rates and fluid percents into the future. By adding past production to predicted future production, an estimate of original reserves can be obtained (Bird, 1979, p. 4).

Appendix C. Intergovernmental Planning Program of the Bureau of Land Management

The Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities (IPP) was implemented to provide a formal coordination and planning mechanism for three major OCS program elements administered by the Bureau of Land Management (BLM). These elements are the Leasing Process, the Environmental Studies Program, and Transportation Planning. The latter element, Transportation Planning, was discussed in chapter 3. The other two elements will be presented in this appendix.

In each of the six OCS leasing regions, IPP establishes a Regional Technical Working Group (RTWG) Committee and, if a marketable discovery of oil or gas is made, a State Technical Working Group. The RTWG Committees are one of three types of committees comprising the National OCS Advisory Board.

The OCS Advisory Board provides advice to the Secretary of the Interior and to other offices in the Department of the Interior in the performance of discretionary functions of the OCS Lands Act as amended (43 U.S.C. 1331 et. seq.), including all aspects of leasing, exploration, development, and production of the resources of the outer continental shelf. The organization of the National OCS Advisory Board and its reporting structure are presented in figure 12.

Through the accumulation and evaluation of information, the Regional Technical Working Group provides guidance to the BLM and information to other bureaus within the Department of the Interior. Each RTWG is composed of representatives of the participating States, the BLM, the Fish and Wildlife Service, the Coast Guard, the Geological Survey, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the petroleum industry, and other special and private interests that exist in a leasing region. Every RTWG is co-chaired by a State representative, who is elected by all the State representatives on the group, and by a BLM employee. The State representative's term of service is determined by all the State representatives on the group.

The South Atlantic Regional Technical Working Group first met on October 30, 1979, in New Orleans, Louisiana. The meeting was chaired by Harry P. Sieverding, Assistant Manager of the New Orleans OCS Office. It was an introductory meeting and was held in conjunction with the Gulf of Mexico RTWG.

The second meeting of the South Atlantic RTWG took place on December 6 and 7, 1979, in Norfolk, Virginia, when the entire OCS Advisory Board met in full session. Again, the meeting was held in conjunction with the Gulf of Mexico RTWG and was chaired by Harry P. Sieverding. Dr. Murice Rinkel of Florida was selected as the State co-chair.

At the third meeting, held on February 26, 27, and 28, 1980, in Atlanta, Georgia, the major agenda items discussed were Environmental Studies Program, the status of South Atlantic leasing, the OCS Oil and Gas Information Program (RALI), oil spill planning, and the Regional Transportation Management Plan. Murice Rinkel and Harry P. Sieverding presided.

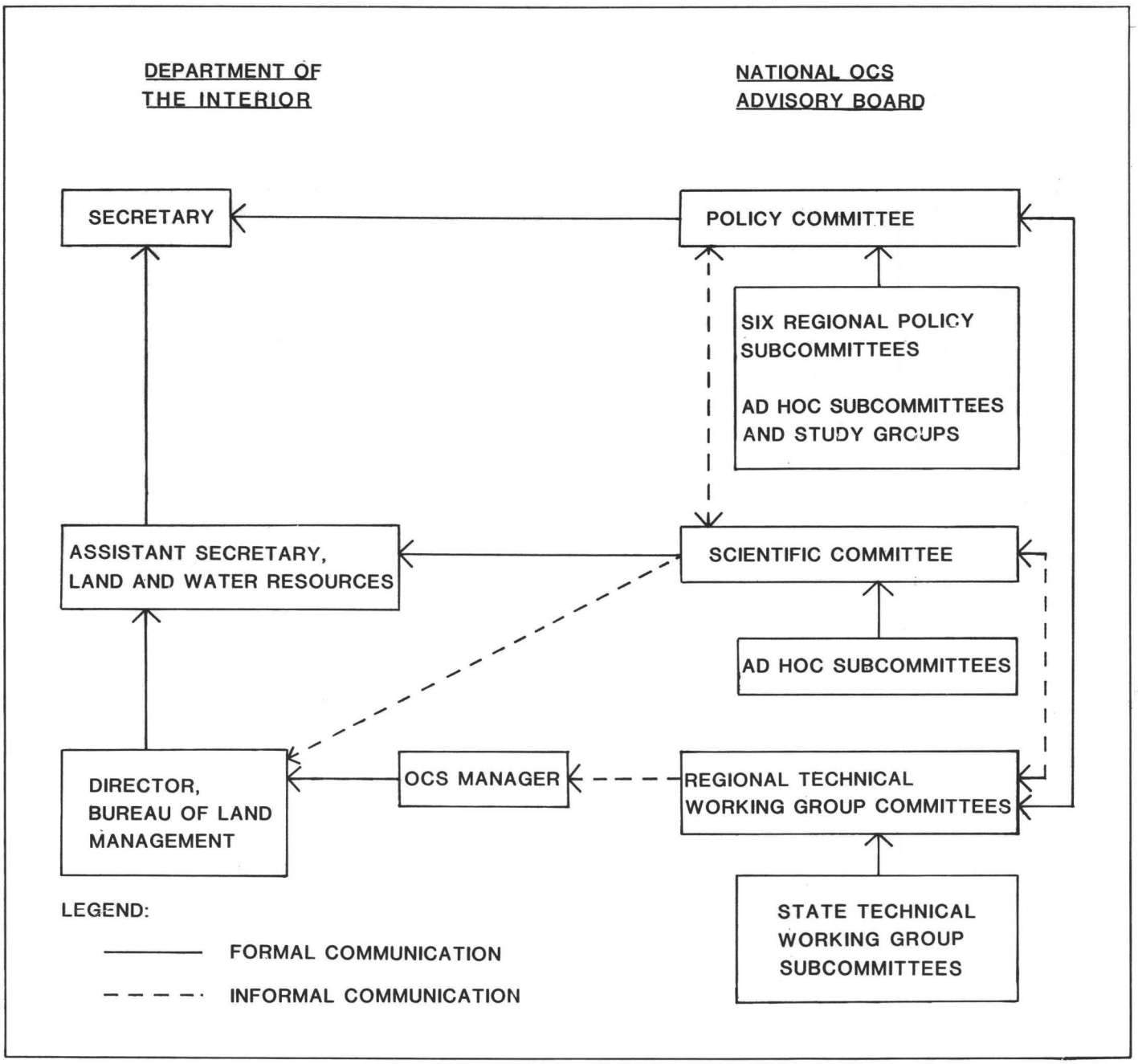


FIGURE 12.—Organization of National OCS. Advisory Board and reporting structure (Modified by Rogers, Golden & Halpern from Aronson, 1979).

The fourth meeting was held in conjunction with the Gulf of Mexico RTWG on May 14, 15, and 16, 1980 in New Orleans. The purpose of the meeting was to examine the New Orleans OCS office's FY 1982 Preliminary Draft Regional Studies Plan. The current membership of the South Atlantic RTWG was given in table 2, p. 20.

The three IPP activities identified above--leasing, environmental studies, and transportation planning--are interdependent. For ease of description, each is treated here as a separate component of the planning process, and they are discussed in greater detail in the following sections.

THE LEASING PROCESS

The leasing of OCS lands sets in motion a process that can affect interests at local, State, regional, and national levels. Many decisions are made in that process that determine the manner in which development will take place. The Leasing Process has been divided into four phases, discussed below and shown in figure 13.

Phase I

The objective of the IPP Leasing Process efforts during Phase I is to assist in coordinating all activities leading up to a lease sale decision. This phase begins prior to the Call for Nominations and terminates with the Sale Decision. Most activities in Phase I concern the exchange and assessment of information for tract selection. Information needs related to the later preparation of Regional Study Plans and Transportation Management Plans are also a part of this Phase.

Phase I can last about 2 years. It is completed by the time of a sale decision. Lease Sale 56, tentatively scheduled for August 1981, is in the early stages of Phase I.

Phase II

Phase II of the IPP Leasing Process is formally implemented with the publication of the Proposed Notice of Sale in the Federal Register. During this Phase, each RTWG recommends site-specific and generic studies that should be included in a Regional Study Plan to be drawn up during Phase III. Other Federal, State, or local agencies may also identify and fund OCS-related studies independently of the IPP Leasing Process.

Phase II should be completed by the time a discovery of commercial quantities of oil and/or gas is made. Lease Sale 42 is currently in Phase II of IPP planning.

Phase III

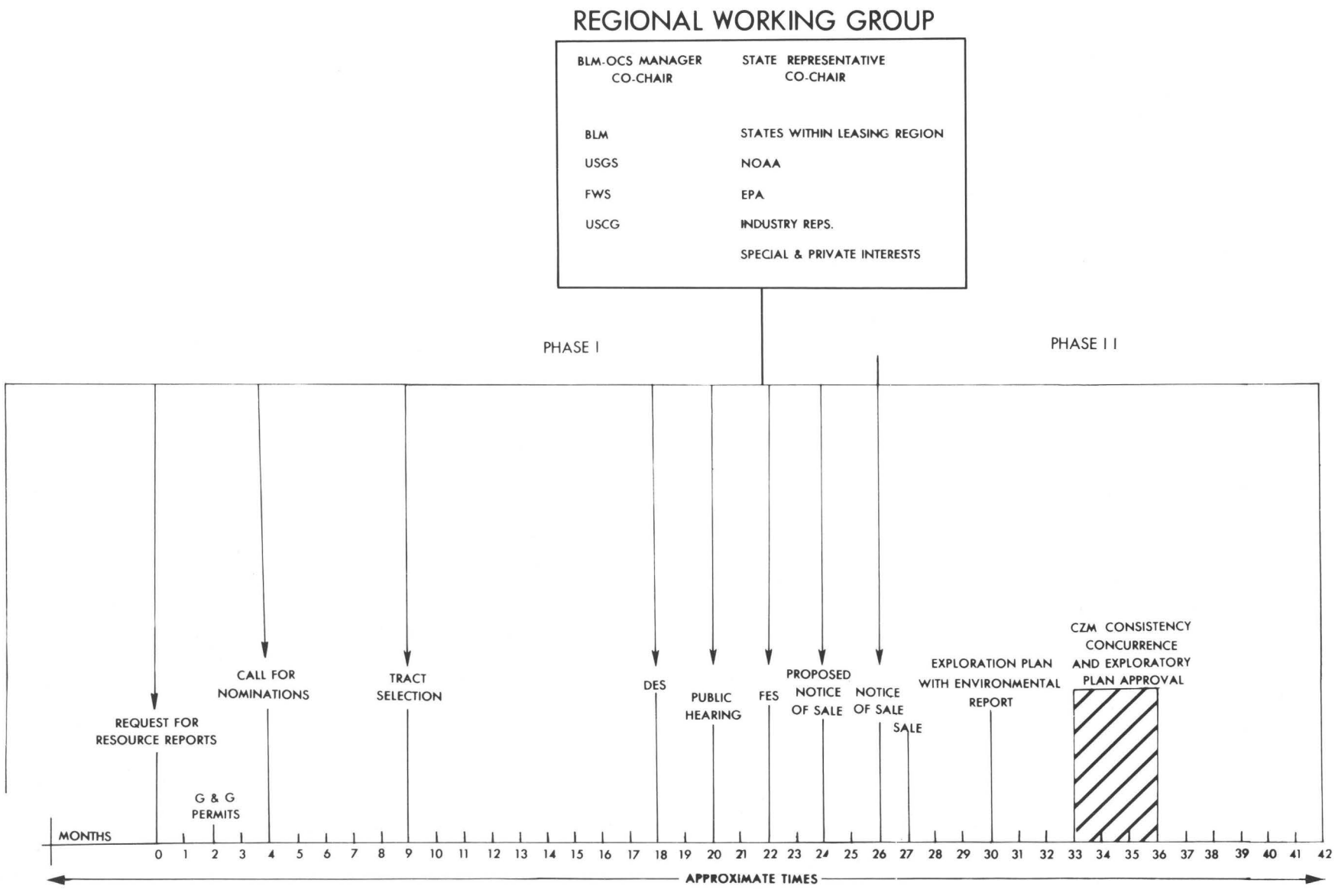
Phase III of the IPP Leasing Process begins with the announcement of a discovery of hydrocarbons in marketable quantities in the region. At this time, a State Technical Working Group is formed to refine potential transportation corridors. The State Technical Working Group includes all Federal and private members of the RTWG as well as the State representatives of the affected States.

The State Working Group also disseminates information to the States during development. Because there has not yet been a marketable discovery of oil in the South Atlantic, no State Technical Working Groups have yet been formed.

Phase IV

During Phase IV, a Regional Transportation Management Plan is developed. Phase IV begins as soon as transportation studies are complete and should either precede or coincide with the first Development Plan.

The Leasing Process is a long-range planning effort. While its actual timing varies from region to region, the estimated minimum time for completion of the four phases of the process is approximately 4½ to 5 years. However, the process could conceivably take as long as 9 years (BLM, 1979). Figure 13 shows the relationship between the Leasing Process, a Regional Technical Working Group, and a State Working Group. A summary of the OCS Leasing Process and its relations to the OCS Field Office and OCS Field Office IPP action is presented in table 3.


REGIONAL WORKING GROUP
BLM-OCS MANAGER
CO-CHAIR
STATE REPRESENTATIVE
CO-CHAIR
BLM
USGS
FWS
USCG
STATES WITHIN LEASING REGION
NOAA
EPA
INDUSTRY REPS.
SPECIAL & PRIVATE INTERESTS
PHASE I
PHASE II
REQUEST FOR RESOURCE REPORTS
G & G PERMITS
CALL FOR NOMINATIONS
TRACT SELECTION
DES
PUBLIC HEARING
FES
PROPOSED NOTICE OF SALE
NOTICE OF SALE
SALE
EXPLORATION PLAN WITH ENVIRONMENTAL REPORT
CZM CONSISTENCY CONCURRENCE AND EXPLORATORY PLAN APPROVAL
MONTHS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
APPROXIMATE TIMES

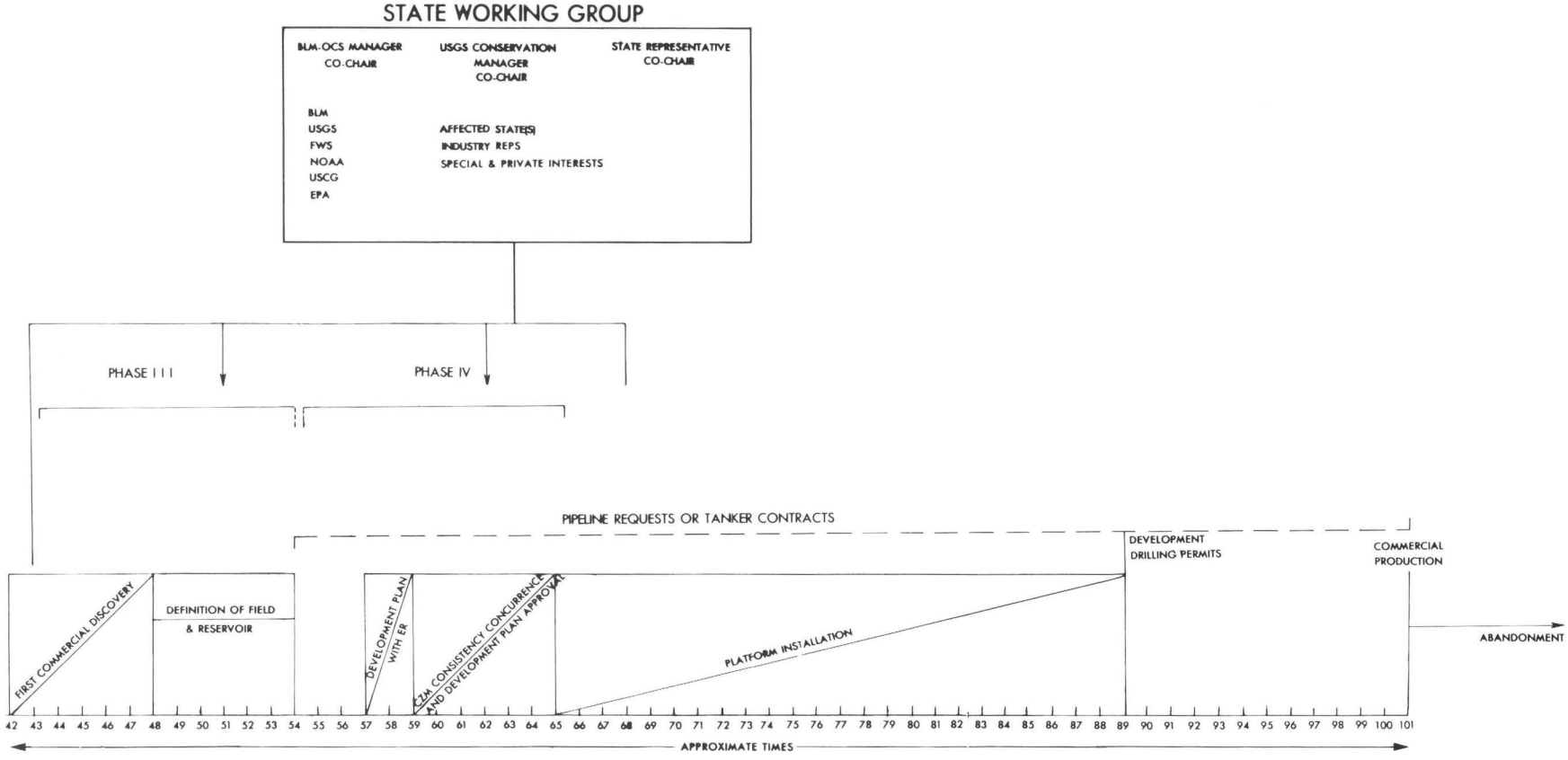


FIGURE 13.—Relationship of the OCS oil and gas leasing process to the IPP (Euler, 1979).

TABLE 3.--The OCS Leasing Process

OCS Lease Program activity	OCS Field Office action	OCS Field Office IPP action
Area of Call outlined	Letter to Federal and State Agencies.	
Resource Reports requested, received, and analyzed	2974 meeting with GS.	
Call for Nominations and Comments issued	Notice of Call sent to the Federal Register. Nominations comments sent to BLM WO, GS, and OCS office.	IPP working group has an opportunity to review the Area of Call and to provide comments on any aspect of the area to BLM.
Resource Portrayals for Tentative Tract Selection	EA and Operations staff prepare resource portrayals as one of four inputs to tract selection. Other inputs are: (1) resource estimates from GS, (2) nominations from industry, and (3) comments from concerned individuals, organizations, and governmental agencies.	IPP working group has an opportunity to listen to and view the resource portrayals and to make its own recommendations on blocks to be deleted and those to be included for further consideration.
Joint Tract Selection Meeting	2974 meeting to develop joint recommendations for tentative tract selection.	
Tentative Tract Selection	Joint tract selection memo prepared for transmittal to WO.	
Scoping	Meetings held and responses solicited from various publics, including communities adjacent to or affected by the proposed sale to solicit a listing of critical issues to be discussed in the EIS process, and to develop alternatives to the proposal.	IPP working group has an opportunity to act as a "technical public" in identifying issues that need addressing in the EIS process, and to develop alternatives to the proposal.
Development of Petroleum Development Scenarios for use in the EIS	BLM letter to GS asking for information on resources, the timing of resource development, methods and modes of OCS exploration and production, possible facility sites and facility types, pipelines if necessary, support activities, and locations and oil spill cleanup capability. BLM develops tentative scenarios for the EIS on which subsequent impacts are based. This includes the proposal as well as alternatives.	IPP working group has an opportunity to be involved in early planning stages by assisting in developing the scenarios. Important time to utilize local ad hoc members. Recommendations based on local CZM plans, land use and land status, and the most current information available. In addition, a look at what information is not available and what additional information will be needed. Recommendations could be in the form of potential facility sites needing further study as well as possible corridor routes.
Oil Spill Risk Analysis Model (OSRAM)	Letter from BLM to GS requesting that the OSRAM be run.	
Draft Environmental Impact Statement (DEIS)	Preparations of DEIS by EA with input from operations and studies.	IPP may be contacted as a group or as individuals to support/assist in EIS preparation and review throughout.

TABLE 3.—The OCS Leasing Process (Continued)

OCS Lease Program activity	OCS Field Office action	OCS Field Office IPP action
Review of DEIS	Public hearings held.	IPP working group has an opportunity to comment on the proposed mitigation measures designed to reduce or eliminate problems that may occur when a lease area is developed, and on other aspects of the DEIS.
Final Environmental Impact Statement	Rewrite based on comments.	
Secretarial Issue Document (SID)	WO and FO staff prepare the SID, which summarizes and analyzes the major issues and options available to the Secretary.	
Proposed Notice of Sale (PNS)	Federal Register notice describing proposed terms and conditions of the proposed sale.	IPP working group has an opportunity to review and comment on the PNS.
Receipt of Comments on PNS's	Comments received, in particular those from the State, are evaluated and changes in notice are made as appropriate.	
Notice of Sale	Copies of Federal Register notice sent to interested OCS publics describing terms and conditions of the proposed sale.	
Sale	Opening and reading of bids by the office manager at time and place specified in the Notice of Sale.	

SOURCE: Euler, 1979.

ENVIRONMENTAL STUDIES PROGRAM

The BLM's Environmental Studies Program was initiated in 1973 by the Secretary of the Interior through a commitment to perform investigations of certain environmental features of the Gulf of Mexico. From its original budget of $0.5 million for studies in the Gulf, the program has expanded to include the outer continental shelf of the entire United States. The program's budget during the past few years has averaged $35 million annually. The program was formalized in Section 20 of the Outer Continental Shelf Lands Act Amendments of 1978 (P.L. 95-372), which requires the Secretary to conduct a study of any area or region included in any oil and gas lease sale in order to establish information needed for assessment of the human, marine, and coastal environments of the outer continental shelf and the coastal areas that may be affected by oil and gas development there.

The Environmental Studies Program is currently included under the direction of the Bureau's Assistant Director, Energy and Mineral Resources. As of June 2, 1980, this position will be held by Dr. Irwin White. The program consists of an environmental studies group in each of the Bureau's OCS offices (New York, New Orleans, Los Angeles, and Anchorage) and the Branch of Offshore Studies in Washington, D.C. The OCS offices and the

Washington office have different functions in the program. The OCS offices have the responsibility for developing statements of regional study needs (Regional Study Plans), preparing statements of work, and monitoring contractor performance on all approved regional studies. The Branch of Offshore Studies in Washington has the overall management, planning, and budgeting responsibility for the studies program. The Chief of the Branch of Offshore Studies is responsible for the technical adequacy of the program and its component studies. The Branch of Offshore Studies prepares program guidance for the OCS offices to use in the preparation of Regional Study Plans, establishes national priorities, compiles the National Study Plan, and manages studies that are applicable to more than one leasing region.

The normal process of defining the National Study Plan usually begins with the Branch of Offshore Studies, through the Assistant Director, establishing the schedule for the OCS offices to prepare Regional Study Plans. These plans include statements of regional study needs, the regional perspective on the priorities of these needs, and a brief description of each proposed study. The Branch of Offshore Studies reviews draft Regional Study Plans from all four OCS offices for programmatic consistency, cost, use of ranking criteria, and relevance to issues of national interest, and the OCS offices revise their respective study plans accordingly. Following the submission of final study plans, the Branch of Offshore Studies compiles a preliminary National Study List.

The total cost of all studies nominated for funding during any fiscal year has historically exceeded available funds. As a result of this, the BLM devised a set of ranking criteria to establish the priority of studies on the National Study List. The current ranking criteria, developed jointly by the Bureau and the Office of Management and Budget, are as follows:

- importance of the information to the decision-maker;
- date of the decision for which the study is designed;
- generic applicability of results or techniques from the study;
- status of the information; and
- applicability of the study to issues of regional or programmatic concern.

Each proposed study is ranked by the nominating OCS office using these five criteria. The Branch of Offshore Studies then reviews each OCS office's use of the criteria and prepares a preliminary National Study List from the Regional Study Plans. The Branch may revise the regional priorities when the criteria are not properly applied. The resulting list of studies is reviewed and approved by all four OCS managers, and then submitted to the Assistant Director for formal approval. Upon the Assistant Director's approval, each OCS office is formally notified of its list of approved studies and its studies allocation. Each OCS office then provides Washington with a schedule for procurement of the approved studies.

The OCS offices are required to procure the studies on the approved studies list unless a proposed change is approved by the BLM's Assistant Director, Energy and Mineral Resources. This permits the OCS offices to respond to unanticipated study needs that arise between compilation of study plans, and it also ensures the continuity of program initiatives.

The RTWG Committees are also involved in the development of regional study programs. These groups are involved in the determination of issues that require study and their importance to regional decisionmakers. They may become involved in ranking the candidate studies using the BLM's criteria. The Working Groups review the draft Regional Study Plan. They are briefed on the status of regional studies on the national list and may be involved in preparing the final draft of the Regional Study Plans. The Working Groups are advised of studies that are approved for funding, and they compile the plans for the following year's Regional Study Plan based upon this information. The Working Groups may also be involved in the design of approved studies. This involvement may include suggesting study

techniques, defining critical products and the schedule of their delivery, establishing the study scope, and suggesting an appropriate level of funding.

The environmental studies of the IPP are reviewed by the Scientific Committee of the OCS Advisory Board. This committee has the responsibility to review the appropriateness, feasibility, and scientific merit of the program's component studies. The committee may comment on any study in the program, including those nominated by the RTWG's. The Scientific Committee may institute a change in any study's scope, techniques, or cost and has access to any technical and management information critical to its function.

The current structure of the Environmental Studies Program is complex. It contains checks and balances designed to support both regional and national needs. Although the system is still in an evolutionary phase, the results to date are encouraging.

SUMMARY

The IPP's third element, Transportation Planning, was discussed in chapter 3. Together the three elements--the Leasing Process, Environmental Studies, and Transportation Planning--make up the entire Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities. Members of the South Atlantic RTWG will be actively involved in each element, providing input and participation at specified steps in the process.

Appendix D. Annotated Bibliography of Studies Relating to Transportation and Onshore Impacts of OCS Activities

FEDERAL STUDIES

U.S. Department of the Interior:

Bureau of Land Management

The Bureau of Land Management of the U.S. Department of the Interior conducts an Environmental Studies Program. The New Orleans OCS Office of the BLM administers studies approved by the Washington Office for the South Atlantic Region. Appendix C describes this program. A number of studies have already been completed for the South Atlantic, and additional studies are planned for fiscal years 1980 and 1981. These are listed below. Some of the studies were conducted by other agencies within the DOI as a part of the BLM's Environmental Studies Program. Completed studies may be reviewed at the New Orleans OCS Office of the Bureau of Land Management, Hale Boggs Federal Building, 500 Camp Street, Suite 841, New Orleans, LA 70130, or at the Washington OCS Office of the Bureau of Land Management, 18th and C Streets, NW, Washington, DC 20240.

Jacobson, John P., 1974, Physical oceanography: v. I of a socio-economic environmental baseline summary for the South Atlantic Region between Cape Hatteras, North Carolina, and Cape Canaveral, Florida, Virginia Institute of Marine Science, Gloucester Point, Virginia, for Bureau of Land Management, Department of the Interior, 247 p. Limited number of copies available from the New Orleans OCS Office of the BLM.

Rezecki, Evon P., 1974, Climatology: v. II of a socio-economic environmental baseline summary for the South Atlantic Region between Cape Hatteras, North Carolina, and Cape Canaveral, Florida, Virginia Institute of Marine Science, Gloucester Point, Virginia, for Bureau of Land Management, Department of the Interior, 210 p. Limited number of copies available from the New Orleans OCS Office of the BLM.

Roberts, Morris H., Jr., 1974, Chemical and biological oceanography: v. III of a socio-economic environmental baseline summary for the South Atlantic Region between Cape Hatteras, North Carolina, and Cape Canaveral, Florida, Virginia Institute of Marine Science, Gloucester Point, Virginia, for Bureau of Land Management, Department of the Interior, 210 p. Limited number of copies available from the New Orleans OCS Office of the BLM.

Zeigler, J.M., and M.A. Patton, 1974, Geologic oceanography: v. IV of a socio-economic environmental baseline summary for the South Atlantic Region between Cape Hatteras, North Carolina, and Cape Canaveral, Florida, Virginia Institute of Marine Science, Gloucester Point, Virginia, for Bureau of Land Management, Department of the Interior, 200 p. Limited number of copies available from the New Orleans OCS Office of the BLM.

Planners Inc., 1974, Socio-economic inventory: v. V of a socio-economic environmental

baseline summary for the South Atlantic Region between Cape Hatteras, North Carolina, and Cape Canaveral, Florida, Virginia Institute of Marine Science, Gloucester Point, Virginia, for Bureau of Land Management, Department of the Interior, 199 p., visuals. Limited number of copies available from the New Orleans OCS Office of the BLM.

This five-volume report, known as VIMS, inventories and analyzes coastal portions of Counties in the Region. Existing information was synthesized and the bibliographies are excellent. The following study updates these reports.

RTI, 1976, Proceedings from South Atlantic OCS conference workshop: Research Triangle Park, N.C., 327 p., appendices. Based on a meeting held at Skidaway Institute of Oceanography, Savannah, Georgia, October 14-17, 1975. Available for review at BLM offices.

The conference proceedings describe the marine environmental assessment needs related to petroleum exploration and development within the potential outer continental shelf lease sale area. The document includes the following: summary of available data, prediction of possible effects of drilling on the environment, identification of areas where more information is needed, and suggestions for baseline and monitoring programs. The possibility of accidents resulting from geological hazards, the permanent destruction of unique environments, and the effects of metals and hydrocarbons on aquatic organisms were the major issues identified during the conference.

Continental Shelf Associates, 1978, South Atlantic hard bottom study: Tequesta, Fla. Available from the National Technical Information Service (NTIS), 2585 Royal Road, Springfield, VA 22161, $19.00 (PB-300-821/AS). Loaner copies available for 60 days (by mail or in person) at the New Orleans OCS Office of the Bureau of Land Management, 500 Camp Street, Suite 841, New Orleans, LA 70130.

This report assesses the conditions of hard and live bottom areas. Areas identified as such need protection from the possible deleterious effects of oil and gas drilling operations. Identification of them makes it possible to undertake protection measures.

U.S. Geological Survey, 1978, South Atlantic Geological Studies: Woods Hole, Mass., 562 p. Not yet available.

The objectives of this study were to measure the rate of sediment mobility over the sea bed, to monitor resultant changes in bottom morphology and texture, to study suspended particulate matter in the water column, to determine the vertical distribution of trace metals at selected locations, and to evaluate certain geologic hazards. This study is the first part of a five-year project.

E. R. & T., 1979, A summary and analysis of physical oceanographic and meteorological information on the Continental Shelf and Blake Plateau from Cape Hatteras to Cape Canaveral: Concord, Mass. Report submitted to, but not yet available from, NTIS. Available for review at BLM offices.

The objectives of this study were to identify and to assemble recent oceanographic and meteorological data not available for the South Atlantic Region and to use this information and previously catalogued information to analyze and to interpret oceanographic and meteorological phenomena in the region.

Science Applications, Inc., 1979, South Atlantic OCS physical oceanography field study: Raleigh, N.C., first-year progress report. Final report due late 1981. Available for review at BLM offices.

This three-year-long study has five major components. The first component is concerned with the transport of surface- and near-surface-borne material

across or along the turbid-clear water interface of the Georgia Embayment to determine the ability of this feature to act as a natural barrier to the migration of pollutants toward shore. The second component analyzes temperature time series to monitor the effect of Gulf Stream intrusion. The third component is concerned with the establishment of a long-term current meter stair. The fourth component uses Very High Resolution Radio meter (VHRR) satellite imagery to monitor seasonal characteristics of shelf water masses. The fifth component correlates surface wind and wake field data on the South Atlantic OCS with coastal conditions, National Weather Service predictions, and information derived from satellite imagery.

Texas Instruments, 1979, South Atlantic OCS benchmark study: Dallas, Tex. Report submitted to, but not yet available from, NTIS. Available for review at BLM offices.

This study initiated work concerning the concentration ranges of high molecular weight hydrocarbon and selected trace metals in sediments and selected benthic macrofaunal species preceding oil and gas development in the area. It also initiated (1) quantitative seasonal studies of certain benthic communities and (2) histological studies to determine the tissue condition of selected benthic macrofaunal species preceding oil and gas development.

Center for Natural Areas, 1980, A summary and analysis of environmental information on the Continental Shelf and Blake Plateau from Cape Hatteras to Cape Canaveral: Gardner, Me., three vols., approximately 795 p. Final report submitted to, but not yet available from, NTIS. Available for review at BLM offices. Loaner copies available for 60 days (by mail or in person) at the New Orleans OCS Office of the Bureau of Land Management, 500 Camp Street, Suite 841, New Orleans, LA 70130, v. I, Executive summary (PB-80 159072), v. II, Technical report (PB-80 159080), v. III, Technical appendix (PB-80 159 098).

The objective of this study is to update the environmental survey conducted by VIMS in 1974 (described above) and to provide analysis of all existing biological, chemical and geological data. It also summarizes ongoing biological, chemical, and geological programs in the Region and identifies gaps in the data base.

Jaycor, 1980, South Atlantic OCS physical oceanography model evaluation: Raleigh, N.C., 208 p., appendices. Not yet available.

This report describes and classifies models applicable to the prediction of transport, diffusion, and dispersion of various contaminants. It also assesses the potential for damage or rupture of structures and pipelines on the continental margin under varying atmospheric conditions.

National Aeronautics and Space Administration, 1980, South Atlantic satellite oceanography: Wallops Island, Va., draft report. Final report due fall 1980. Draft report available for review at BLM offices.

The objective of this study is to provide satellite-determined monthly information of the surface current, wave, and low-level wind fields for the South Atlantic OCS and to generate an analytical model and computer program to describe the microscale characteristics of surface transport.

Science Applications, Inc., 1980, South Atlantic cultural resources evaluation study: McLean, Va., final draft report. Available for review at BLM offices.

The geographical area covered in this study extends from Cape Hatteras, North Carolina, to Key West, Florida, and seaward from the mean high-water line to the 200-m isobath. The primary

objective is an assessment of the total cultural resources of the area.

Science Applications, Inc., May, 1980, South Atlantic OCS physical oceanography study: Raleigh, N.C. Final draft report due fall 1980.

This is the second section of the South Atlantic OCS physical oceanography field study described above. This study will provide an understanding of the physical process involved in the transport and dispersal of suspended and dissolved materials in Georgia Embayment waters in order to use these processes in descriptive models. Such models will permit a rational prediction of the intensity of environmental impacts resulting from oil drilling.

U.S. Fish and Wildlife Service, 1980, South Atlantic-South Texas Marine Birds Study: Slidell, La., final draft report. Not yet available.

The objective of this report was to obtain and organize all information from the literature, unpublished reports, oral communications, and other sources that relate to marine birds and the possible effects for OCS oil and gas activity in the South Texas and South Atlantic lease areas.

U.S. Fish and Wildlife Service, Seasonal distribution and abundance of marine birds, mammals, turtles, and endangered manatees of the South Atlantic and Gulf of Mexico: Slidell, La. Final draft due summer 1980.

The objectives of this study are to analyze field data concerning the distribution and abundance of marine birds, mammals, turtles, and manatees, to develop software for analysis and archival of field data, and to identify and describe areas of special biological significance.

U.S. Geological Survey, South Atlantic OCS geological studies: Woods Hole, Mass. Final report due early 1981.

These studies will determine the sedimentation rates and processes on the upper slope and inter-Blake Plateau, as well as the distribution, area extent, and vertical characteristics of geological features supportive of biological communities.

Dynanalysis of Princeton, South Atlantic OCS circulation model application: Princeton, N.J. In progress.

The objective of this study is to apply the circulation models presented in the South Atlantic OCS Physical Oceanography Model evaluation described above. It will also provide recommendations for the type, quantity, and quality of additional data needed to improve the effectiveness of the models and provide quantitative values of the seasonal surface circulation for use in the Department of Interior oil spill risk analysis model.

Science Applications, Inc., South Atlantic OCS physical oceanography field study: Raleigh, N.C. In progress.

The third segment of the South Atlantic OCS physical oceanography field study will present data concerning the currents, circulation, and mixing processes in the South Atlantic OCS Region in sufficient detail to predict the dispersion, dilution, transport, and final distribution of hydrocarbons and other pollutants that may be introduced into the marine environment as a result of OCS oil and gas activities.

South Carolina Marine Resource Research Institute, South Atlantic OCS living marine resources: Charleston, S.C. In progress.

This study will contribute to the understanding of live bottom areas and the relationship between live bottom habitats and adjacent non-live bottom habitats. It will also determine if current lease stipulations are properly directed or if more consideration should be given to benthic habitat types other than live bottoms.

U.S. Geological Survey, South Atlantic OCS geological studies: Woods Hole, Mass. In progress.

This third-year segment of the USGS study of the South Atlantic will determine the distribution, extent, and vertical characteristics of geological features supportive of biological communities. Areas of the shelf near areas of oil and gas interest and possible pipeline corridors will be studied. The geologic units offshore associated with the principal aquifer onshore will be mapped.

U.S. Geologic Survey, South Atlantic OCS geological studies: Woods Hole, Mass. In progress.

The fourth-year program of USGS will, in part, continue the efforts of the first, second, and third years' studies (discussed above) in those areas where earlier study results justify a continuation for the purpose of supporting BLM's mission directly and furnishing information necessary to other BLM investigators.

Fish and Wildlife Service

Osborn, Ronald G., and Custer, Thomas W., 1978, Herons and their allies: atlas of Atlantic Coast colonies, 1975 and 1976: Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, Md., 211 p. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, $6.50 (024-010-00509-2).

The atlas presents data collected in 291 heron colonies along the Atlantic coast from Maine to Florida in 1975 and 1976. It includes regional and individual maps of the colonies, nesting population estimates, and breeding activities by species; and information about the geography, habitats, and human use of each area.

Marine Resources Division, South Carolina Wildlife and Marine Resources Department, 1979, Ecological characterization of the Sea Island Coastal Region of South Carolina and Georgia: directory of information sources: Charleston, S.C., 35 p. Limited number of copies available from U.S. Fish and Wildlife Service, P.O. Box 12559, Charleston, SC 29412.

This document identifies and describes major data sources relevant to the ecological characterization of coastal South Carolina and Georgia. The purpose of the directory is to guide users to known sources of data pertinent to specific subject areas.

Dames and Moore, Atlantic Coast ecological inventory: Washington, D.C. Available September 1980.

The objective of this study is to produce an inventory of important ecological resources along the Atlantic coast that are potentially vulnerable to coastal siting of oil and gas processing and manufacturing facilities and their transportation system. For this study, the coastal zone extends from the Canadian border to the southern-most tip of Florida (excluding the Keys). This zone includes all areas from the shoreline to the Federal-State demarcation (3 miles), from the shoreline inland to the Coastal Zone Boundary for the Atlantic States, and from the shoreline to the head of navigable waters under tidal influence that exceed the Coastal Zone Boundary.

The inventory compiles information concerning endangered species, fish and wildlife species of high commercial, recreational, or aesthetic value, important habitats in coastal areas, and special land use designations (refuges, sanctuaries, Class I air quality areas, etc.).

The inventory consists of a set of 30 color maps at a scale of 1:250,000 and a report. The U.S. Geological Survey National Topographic Map Series is used as a base. Figure 14 is a black and white reproduction of one of the maps in the series and the classification scheme used in the maps to describe aquatic and terrestrial organisms.

ATLANTIC COAST ECOLOGICAL INVENTORY

BRUNSWICK, GEORGIA

SCHEME OF CLASSIFICATION

SPECIES WITH SPECIAL STATUS
(SHOWN IN RED)
THE PRESENCE OF ENDANGERED OR THREATENED SPECIES SUPERCEDES ALL OTHER SPECIES BOUNDARIES OR FEATURES.

AQUATIC ORGANISMS
(SHOWN IN BLUE UNLESS SPECIES HAS SPECIAL STATUS)

- SPECIES FOUND IN AN ESTUARY. OR
- SPECIES FOUND IN A TIDAL FRESH WATER RIVER OR CREEK.
- SPECIES FOUND IN A TIDAL SALT WATER RIVER OR CREEK.
- SPECIES FOUND IN A NONTIDAL FRESH WATER RIVER OR CREEK.

SYMBOL	SPECIES	SYMBOL	SPECIES
	1 TO 50 PLANTS		201 TO 250 HERPTILES
	51 TO 100 INVERTEBRATES		251 TO 300 MAMMALS
	101 TO 200 FISH		

TERRESTRIAL ORGANISMS
(SHOWN IN BROWN UNLESS SPECIES HAS SPECIAL STATUS)

SYMBOL	SPECIES	SYMBOL	SPECIES
	301 TO 350 PLANTS		401 TO 600 (CONTINUED) 501 TO 530 RAPTORS
	351 TO 400 INVERTEBRATES		531 TO 550 SEABIRDS
	401 TO 600 BIRDS 402 TO 430 SHOREBIRDS		551 TO 600 SONGBIRDS AND OTHERS
	431 TO 460 WADING BIRDS		601 TO 700 HERPTILES
	461 TO 500 WATERFOWL		701 TO 800 MAMMALS

HABITAT USE
(SHOWN IN RED FOR SPECIES WITH SPECIAL STATUS; SHOWN IN BLUE FOR AQUATIC ORGANISMS; AND SHOWN IN BROWN FOR TERRESTRIAL ORGANISMS)

A SPAWNING GROUND	D ADULT CONCENTRATION	G MIGRATORY AREA
B NURSERY	E OVERWINTERING AREA	H NESTING AREA
C COMMERCIAL HARVESTING AREA	F SPORT FISHING/HUNTING AREA	I UNUSUAL DISTRIBUTION OR SPECIMEN

NOTE: EACH NUMBER IN A GIVEN COLOR REFERS TO A SINGLE SPECIES THROUGHOUT THE INVENTORY; SEE SPECIES KEY.

U.S. Fish and Wildlife Service, Fish and Wildlife Service coastal endangered species study: Slidell, La., in progress. Final report due summer 1981.

This study will determine and confirm which species of marine mammals, birds, and turtles inhabit or migrate through the OCS areas of the South Atlantic and Gulf of Mexico. It will also formulate specific questions and investigative lines for subsequent research relevant to effects of oil and gas development.

U.S. Department of Commerce:

National Oceanic and Atmospheric Administration

Interagency Committee on Ocean Pollution Research Development and Monitoring, 1979, Federal plan for ocean pollution research development, and monitoring, fiscal years 1979-83: Washington, D. C., 160 p., appendices. Limited number of copies available from National Oceanographic Data Center, Liaison Office, 15 Rickenbacher Causeway, Miami, FL 33149.

This report summarizes a number of Federal agency programs dealing with marine pollution. It also discusses causes and means of evaluating ocean pollution problems. Programmatic, managerial, and technical recommendations are made.

NOAA and Council on Environmental Quality

Office of Ocean Resources Coordination and Assessment (ORCA), Eastern United States coastal and ocean zone resource use mapping project: Washington, D.C. In progress. Final report due fall 1980.

This study will identify and map five categories of data for the Eastern U.S. coastal and ocean zone. These categories are physical environments, living environments, species, economic, and jurisdictions. The study area has been defined as extending (30)from the Canadian border to the Florida Keys, including all coastal counties (as defined by OCZM), and extending seaward to the 200-mile limit of the the U.S. fisheries zone. The data base will contain over 100 maps prepared on a standard base map at a scale of 1:2,000,000. A "data bank" will support each map. Composite maps showing concentrations of economic activities, such as energy-related facilities, concentrations of commercial fisheries or endangered species, and maps showing the total amount of pollution discharged into surface waters from all activities in coastal counties, will be developed from the individual maps.

STATE STUDIES

North Carolina

North Carolina Department of Administration, Office of Marine Affairs, 1976, Planning for North Carolina's OCS: Raleigh, N.C., 124 p. Limited number of copies available from North Carolina Department of Administration, Office of Marine Affairs, P.O. Box 27687, Raleigh, NC 27611.

This document is a bibliography of OCS reference materials with abstracts. A wide variety of topics is covered.

Keer, Steffenie O., 1977, Sediment color and lithofacies of the southeastern United States Atlantic Continental shelf and related land use plan recommendations: Duke University, Durham, N.C. for North Carolina Office of Marine Affairs, 106 p. Limited number of copies available from North Carolina Office of Marine Affairs, 116 W. Jones Street, Raleigh NC 27511, photocopy at 5¢/page.

<FIGURE 14.—Specimen section of the Atlantic Coast Ecological Inventory Map being produced for the U.S. Fish and Wildlife Service by Dames and Moore.

For this report, sediments from the Atlantic continental shelf of the southeastern United States were analyzed. This served as the basis for a land use plan for the shelf.

South Carolina

Trident 2000, 1978, Official transcript of the southeastern conference of Offshore Oil Development, February 24 and 25, 1978: 85 p. Limited number of copies available from Trident 2000, 3370 Rivers Avenue, Room 349, North Charleston SC 29405.

The purpose of the Southeastern Conference on Offshore Oil Development was to exchange information concerning all aspects of OCS development. Federal and State officials as well as industry experts presented papers.

Olson, N.K., and Glowacz, M.E., 1979, Petroleum geology and oil and gas potential of South Carolina: American Association of Petroleum Geologists Bulletin, March 1979: v. 41, no. 3, p. 331-343.

The general geology and geophysics of the central Atlantic Coastal Plain of South Carolina and offshore areas are described in this report. The discussion includes essential elements of geology, geophysics, and bathymetry.

Georgia

Chatham County-Savannah Metropolitan Planning Commission, 1979, Evaluation of local capabilities to contain and recover hazardous liquid spills for the Savannah River: 52 p. Available from Savannah Metropolitan Planning Commission, P.O. Box 1027, Savannah, GA 31402, 10¢/page.

Oil spills resulting from tanker traffic and OCS activity are both presented in this report. A detailed spill cleanup inventory is also included.

Roberts & Eichler Associates, 1979, An analysis of the community impacts on Brunswick, Georgia, resulting from the development of onshore support facilities for offshore energy exploration: Decatur, Ga., for Brunswick-Glynn County Joint Planning Commission, 89 p. Limited number of copies of executive summary available from Brunswick-Glynn County Joint Planning Commission, P.O. Box 1495, Brunswick, GA 31521, photocopy at 10¢/page.

All aspects of OCS activities, from exploratory drilling to production, are examined in this report. Special emphasis is given to economic impacts.

Appendix E. General OCS-Related Studies

This appendix, which contains a listing of studies of a more general nature than those in Appendix D, was requested by members of the South Atlantic Regional Technical Working Group Committee who met in Atlanta on February 26, 27, and 28, 1980. The list is not complete, but it does contain all the publications that committee members recommended.

A number of the articles cited below are published in journals or periodicals available in most large public libraries. State reports, or photocopies thereof, are usually available from the issuing agency at a nominal cost. An excellent source of coastal resources planning and management materials is the Coastal Information Center, NOAA Coastal Zone Management, 3300 Whitehaven Street, NW, Washington, DC 20235. The Coastal Zone Information Center also arranges interlibrary loans; requests for this service should be sent to the above address to the attention of Katherine Johnson.

Bird, S.O., 1970, Shallow marine and estuarine benthic molluscan communities from area near Beaufort, North Carolina: American Association of Petroleum Geologists Bulletin, v. 54, p. 1651-1676.

Buffer, Richard T., Dillon, William P. and Watkins, Joel S., 1979. Geology of offshore Southeast Georgia Embayment U.S. Atlantic Continental Margin, based on multichannel seismic reflection profiles: American Association of Petroleum Geologists Memoir 29, p. 11-25.

Calder, D.R., Eldridge, P.J., and Joseph, E.B., 1974, The shrimp fishery of the southeastern United States: A management planning profile: Charleston, S.C., South Carolina Wildlife & Marine Resource Department Technical Report No. 8, S. Carolina Marine Resources Center.

Caldwell, D.K., Neuhauser, H., Caldwell, M.C., and Coolidge, H.W., 1971, Recent records of marine mammals from the coasts of Georgia and South Carolina: Cetology, v. 5, p. 1-12.

Caldwell, D.K., and Golley, F.B., 1965, Marine mammals from the coast of Georgia to Cape Hatteras: J. Elisha Mitchell Science Society, v. 81, p. 2432.

Coastal Area Planning and Development Commission, 1975, Areawide economic base and population study: Brunswick, Ga.

Commission on the Future of the South, 1975, Future of the south report to the Southern Growth Policies Board: Raleigh, N.C., Research Triangle Institute.

Counts, H.B., and Donsky, E., 1963, Salt-water encroachment, geology and ground-water resources of Savannah area, Georgia and South Carolina: U.S. Geological Survey Water-Supply Paper 1611, 100 p.

Dillon, William, Buffer, Richard T., Paull, Clark K., and Fail, Jean-Pierre, 1979, Structure and development of the Southeast Georgia Embayment and Northern Blake Plateau: preliminary analysis: American Association of Petroleum Geologists, Memoir 29, p. 27-41.

Dillon, W., Folger, D., Ball, M., Powers, R. and Wood, Jr., G., 1978, Sediments, structural framework, petroleum potential, environmental conditions and operational considerations of the U.S. South Atlantic Outer Continental Shelf: U.S. Geological Survey Open-File Report 78-594, 34 p.

EG&G, Environmental Consultants, 1980, Data report, monitoring program for Exxon's

Block 564 Jacksonville OCS Area (lease OCS-6 3705): Houston, Tex., Exxon Company, U.S.A., 29 p.

Eldridge, P.J., and Goldstein, S.A., 1975, The shrimp fishery of the South Atlantic United States: A regional management plan: Charleston, S.C., South Carolina Marine Resources Center, Technical Report No. 8.

Environmental Law Society, 1977, Environmental law in South Carolina: Columbia, S.C., Environmental Law Society, University of South Carolina.

Florida Department of Commerce, Division of Economic Development, n.d., Economic development of Florida: Tallahassee, Fla.

Florida Department of Natural Resources, Division of Recreation and Parks, 1971, Outdoor recreation in Florida: Tallahassee, Fla.

Georgia Department of Natural Resources, n.d., Historic preservation workbook, Coastal Georgia: Office of Coastal Zone Management, U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Georgia Department of Natural Resources, Division of Planning and Research, 1972, Georgia State comprehensive outdoor recreation plan: Atlanta, Ga.

Georgia Office of Planning and Budget, 1976, Summary of petroleum refinery feasibility study of Coastal Georgia: Atlanta, Ga.

Harris, C.D., 1978, The fisheries resources on selected artificial and live bottom reefs on Georgia's Outer Continental Shelf: Coastal Resources Division, Georgia Department of Natural Resources.

Harris, C.D., 1978, Location and exploration of natural reefs on Georgia's Outer Continental Shelf: Washington, D.C., U.S. Fish and Wildlife Service.

Hayes, Miles O., Moslow, Thomas, and Hubbard, Dennis, 1979, Beach erosion in South Carolina: Charleston, S.C., Coastal Council. South Carolina Coastal Council, 19 Hagood Street, Charleston, S.C.

Hesey, J.B., and others, 1959, Geophysical investigation of the continental margin between Cape Henry, Va., and Jacksonville, Fla.: Geological Society of America Bulletin, v. 70, no. 4, p. 437-466.

Hunt, J.L., Jr., 1974, The geology and origin of Gray's Reef, Georgia Continental Shelf: University of Georgia, Master's thesis.

Hussey, Gay & Bell, Inc., 1979, Planning study: Colonel's Island, Glynn County, Georgia: Savannah, Ga., Georgia Port Authority.

Linton, T.L., 1968, A description of the South Atlantic and Gulf Coast marshes and estuaries, **in** Proceedings of the Marsh and Estuary Management Symposium, J.D. Newsome, editor: Baton Rouge, La., Louisiana State University, p. 1-25.

Miglarese, J.V., et al., 1979, Ecological characterization of the Sea Island coastal region of South Carolina and Georgia: Directory of information sources: U.S. Fish and Wildlife Service, Biological Services program FWS/OBS-79/44, 35 p.

Moore, S.F., et al., 1974, Potential biological effects of hypothetical oil discharges in the Atlantic coast and Gulf of Alaska, **in** Report to the Council on Environmental Quality: Cambridge, Massachusetts Institute of Technology Sea Grant Program MITSG 74-19.

Newsome, J.D., editor, 1968, Proceedings of the Marsh and Estuary Management Symposium: Baton Rouge, La., Louisiana State University.

North Carolina Department of Administration, 1972, The Statewide development policy: Raleigh, N.C.

North Carolina Department of Natural and

Economic Resources, 1972, The North Carolina Statewide Comprehensive Outdoor Recreation Plan: Raleigh, N.C.

Olson, W.S., 1974, Structural history of oil potential of offshore area from Cape Hatteras to Bahamas: American Association of Petroleum Geologists Bulletin, v. 58, no. 6, part II of II.

Olson, N.K., 1973, Petroleum geology and related oil and gas potential of South Carolina: The Interstate Oil Compact Commission Committee Bulletin, v. 15, no. 2, p. 17.

Osborn, R.G., and Custer, T.W., 1978, Herons and their allies: Atlas of Atlantic Coast colonies, 1975 and 1976: Biological Services Program, U.S. Fish and Wildlife Service FWS/OBS-77/08, 211 pp.

Parnell, J.F., and Adams, D.A., 1970, Smith Island, a resource capability study: Wilmington, N.C., 83 p.

Paull, C.K. and Dillon, W.P., 1979, The subsurface geology of the Florida Hatteras Shelf, Slope and Inner Blake Plateau: U.S. Geological Survey Open-File Report 79-488, 94 p.

Research Triangle Institute, 1974, Economic development strategy, North Carolina economic growth management study, Phase I: Research Triangle Park, N.C.

R.R. Nathan Associates and Coastal Zone Resources Commission, 1975, The coastal plains deepwater terminal study: Washington, D.C., 2 vols.

Schlee, J., 1977, Stratigraphy and tertiary development of the Continental Margin east of Florida: U.S. Geological Survey Professional Paper 581-F, 25 p.

Scholle, P.A., ed., 1979, Geological studies of the COST GE-1 well, United States South Atlantic Outer Continental Shelf Area: U.S. Geological Survey Circular 800, 114 p.

Sheridan, Robert and Enos, Paul, 1979, Stratigraphic evaluation of the Blake Plateau after a decade of scientific drilling in AGU, Maurice Ewing Series 3, p. 109.

Slack, J.R. and Smith, R.A., 1976, An oil spill risk analysis for the South Atlantic Outer Continental Shelf Lease Area: U.S. Geological Survey Open-File Report 76-653, 54 p.

South Carolina Department of Parks, Recreation, and Tourism, 1975, The South Carolina overall recreation plan, Titles 1, 2, 3, 4, and 6: Columbia, S.C.

South Carolina Division of Administration, Office of Community Development, 1975, South Carolina development plan, fiscal years 1974 to 1975: Columbia, S.C.

South Carolina Division of Research and Statistical Services, various dates, Annals South Carolina Abstract: Columbia, S.C. Available from S.C. Division of Research and Statistical Services, Room 405, Gressette Building, Columbia, S.C. 29201.

South Carolina Division of Research and Statistical Services, various dates, Annals South Carolina Economic Report: Columbia, S.C. Available from South Carolina Division of Research and Statistical Services, Room 405, Gressette Building, Columbia, S.C. 29201.

South Carolina Office of the Governor, 1976, South Carolina land cover classification manual: Columbia, S.C. Available from South Carolina Division of Economic Development and Transportation, 1205 Pendleton St., Columbia, S.C. 29201.

South Carolina Water Resources Commission, forthcoming, Berkeley Charleston Dorchester Groundwater Report: Columbia, S.C. Available from South Carolina Water Resources Commission, P.O. Box 4515, Columbia, S.C. 29240.

South Carolina Water Resources Commission, 1980, Low Country capacity use report:

Columbia, S.C. Available from South Carolina Water Resources Commission, P.O. Box 4515, Columbia, S.C. 29240.

South Carolina Water Resources Commission, 1978, Waccamaw capacity use report: Columbia, S.C. Available from South Carolina Water Resources Commission, P.O. Box 4515, Columbia, S.C. 29240.

Terrell, T.T., 1979, Physical regionalization of coastal ecosystems of the United States and its territories: U.S. Fish and Wildlife Service, Biological Services Program FWS/OBS-78/80, 30 p.

Thomas, J., 1977, Blacks on the South Carolina Sea Islands: planning for tourist and land development: Ann Arbor, Mich., Ph.D. dissertation. Available from University Microfilms International, Ann Arbor, Mich.

U.S. Department of Agriculture, Forest Service, 1969, A forest atlas of the South: New Orleans, La., Southern Forest Experiment Station, 27 p.

U.S. Department of Agriculture, 1966, Land Resource Map of South Carolina.

U.S. Department of Commerce, 1969, Census of Agriculture: North Carolina, South Carolina, Georgia, and Florida.

Vernberg, F. J., et al., 1978, Conference on Oil Tanker Transportantion: An interdisciplinary analysis of national and international policy and practice, November 8-10, 1978: Hobcaus Barony, Georgetown, S.C. Available from John Vernberg, Baruch Institute, University of South Carolina, Columbia, S.C. 29208.

Waccamaw Regional Planning and Development. Council, 1980, Environmental/economic impacts assessment: Georgetown, SC. Available from ARPDC, P.O. Box 419, Georgetown, S.C. 29440.

Williams, David C., and Horn, Kathleen B., 1979, Onshore impacts of offshore oil: A user's guide to assessment methods: U.S. Department of the Interior Office of Policy Analysis. Available from Regional OCS Offices of the Bureau of Land Management and the OCS Coordination, RALI Program, U.S. Geological Survey, Mail Stop 750, USGS National Center, Reston, Va. 22092.

Zingula, R. P., 1975, Effects of drilling operations on the marine environment, **in** Environmental Aspects of Chemical Use in Well-drilling Operations: U.S Environmental Protection Agency, EPA-S011-75-004.

Glossary

Definitions presented in the Glossary describe terms as they have been used in this Summary Report. The Glossary is intended for general reference only: for detailed descriptions of technical or specialized terms, the reader should seek a reference in the field of particular interest.

Sources used in compiling this glossary were the South Atlantic Summary Report itself; the Atlantic and Pacific Summary Reports, the OCSIP Atlantic, Pacific, Gulf of Mexico, and Alaska Indexes; Webster's Third New International Dictionary; the American Geological Institute's Dictionary of Geological Terms; and Langenkamp's Handbook of Oil Industry Terms and Phrases (2d ed.).

Anticline - An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

Basement rock - Rock in the earth's crust beneath all sedimentary rocks.

Basin - A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of the earth beneath which the strata dip, usually from the sides toward the center.

BLM - Bureau of Land Management, U.S. Department of the Interior.

Block - A geographical area, as portrayed on an official BLM protraction diagram or leasing map, that contains approximately 9 square miles (2,304 hectares or 5,670 acres).

bpd - Barrels per day.

Carbonate - A group of minerals containing compounds of the radical CO_3^{2-}, or a rock composed primarily of such minerals, a limestone or dolomite.

Calcareous - Containing calcium or any calcium compound; consisting of calcium carbonate.

Casing - Steel pipe used in oil wells to seal off fluids in the rocks from the bore hole and to prevent the walls of the hole from sloughing off or caving.

CEIP - Coastal Energy Impact Program, administered by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Clastic - Consisting of fragments of rocks or organic structures that have been moved individually from their places of origin.

Continental margin - A zone separating the emergent continents from the deep sea bottom.

Continental shelf - A broad, gently sloping, shallow feature extending from the shore to the continental slope.

Continental slope - A relatively steep, narrow feature paralleling the continental shelf; the region in which the steepest descent to the ocean bottom occurs.

COST - Continental Offshore Stratigraphic Test.

Development - Activities that take place following discovery of minerals in commercially attractive quantities, including but not limited to geophysical activity, drilling, platform construction, and operation of all directly related onshore support facilities; and that are for the purpose of ultimately producing the minerals discovered.

Development and Production Plan - A plan describing the specific work to be performed, including all development and production activities that the lessee(s) propose(s) to undertake during the time period covered by the plan and all actions to be undertaken up to and including the commencement of sustained production. The plan also includes descriptions of facilities and operations to be used; well locations; current geological and geophysical information; environmental safeguards; safety standards and features; time schedules; and other relevant information. Under 30 CFR 250.34-2, all lease operators are required to formulate and obtain approval of such plans by the Director of the U.S. Geological Survey before development and production activities may commence.

Diapir - A piercing fold; an anticlinal fold in which a mobile core, such as salt, has broken through the more brittle overlying rocks.

Discovery - A find of significant quantities of fluid hydrocarbons on a given lease.

Dome - A roughly symmetrical upfold, the beds dipping in all directions, more or less equally, from a point; any structural deformation characterized by local uplift approximately circular in outline, e.g., the salt domes of Louisiana and Texas.

Downdip - The downward angle at which a stratum or any planar feature is inclined from the horizontal.

Drill pipe - Heavy, thick-walled steel pipe used in rotary drilling to turn the drill bit and to provide a conduit for the drilling mud.

Drilling mud - A special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit; lubri-cates the drill pipe as it turns in the well bore; carries rock cuttings to the surface; serves as a plaster to prevent the wall of the bore hole from crumbling or collapsing; and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered.

Economically recoverable resource estimate - An assessment of the hydrocarbon potential that takes into account (1) physical and technological constraints on production and (2) the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

EIS - Environmental Impact Statement.

Environmental impact statement - A statement required by the National Environmental Policy Act of 1969 (NEPA) or similar State law in relation to any action significantly affecting the environment.

Erosion/scour - A loosening or dissolution of the seabed by high-velocity bottom currents, particularly those due to storms. Erosion and scour can mobilize sand and result in significant horizontal crest and trough displacements. Lateral migration of the crest can "strand" platform supports or wellhead plumbing by eroding the surrounding support materials.

Evaporite - Sediments deposited from an aqueous solution as a result of extensive or total evaporation of the solvent.

Exploration - The process of searching for minerals. Exploration activities include (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the geologic conditions conducive to the accumulation of such minerals and (2) any drilling, whether on or off known geological

structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling of any additional well after such a discovery that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploration Plan - A plan based on all available relevant information about a leased area that identifies, to the maximum extent possible, all the potential hydrocarbon accumulations and wells that the lessee(s) propose(s) to drill to evaluate the accumulations within the entire area of the lease(s) covered by the plan. Under 30 CFR 250.34-1, all lease operators are required to formulate and obtain approval of such plans by the Director of the U.S. Geological Survey before exploration activities may commence.

Fault - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field - An area underlain by one or more geologically related hydrocarbon reservoirs.

Geochemical - Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geologic constraint - A feature or condition posing difficulties for OCS operations that can be mitigated by design and engineering technology.

Geologic hazard - A feature or condition that, if undetected, may seriously jeopardize offshore oil and gas exploration and development activities and, once identified, may necessitate special engineering procedures or relocation of a well.

Geologic trap - An arrangement of rock strata, involving their structural relations or varied lithology and texture, that favors the accumulation of oil and gas.

Geophysical - Of or relating to the physics of the earth, including the fields of hydrology, oceanography, seismology, magnetism, radioactivity, and geology.

Geophysical survey - The exploration of an area in which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

Growth curve - A graphic representation of the relative growth of a population during a sequence of similar-length periods.

Hydrate - A compound formed by the union of water with some other substance.

Hydrocarbon - Any of a large class of organic compounds containing only carbon and hydrogen, comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons, and occurring in many cases in petroleum, natural gas, coal, and bitumens.

Intrusion - A body of igneous rock resulting from solidification of the intruding magma; the plastic injection of masses of salt or shale into overlying rocks; magma, shale, or salt injected into overlying rocks.

IPP - Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities, Bureau of Land Management, U.S. Department of the Interior.

Lease - A contract authorizing exploration for and development and production of minerals; the land covered by such a contract.

Lease sale - The public opening of sealed bids made after competitive auction for leases granting companies or individuals the right to explore for and develop certain minerals within a defined period of time.

Line mile - The linear distance of one mile by which geophysical surveys are measured.

Such surveys are usually conducted in a grid pattern and the total mileage covered in crossing and recrossing the grid is expressed in terms of linear miles.

Lithologic - Of or pertaining to the physical character of a rock.

Logistic curve - A curve representing a function involving an exponential and shaped like the letter S.

Mass movement - Unit movement of a portion of the land surface. Mass movement, or slumping, can occur where unconsolidated sediments are distributed over a steep gradient.

OCS - Outer Continental Shelf.

OCSIP - Outer Continental Shelf Oil and Gas Information Program.

Organic matter - Material derived from living organisms.

Outer Continental Shelf (OCS) - All submerged lands that comprise the continental margin adjacent to the U.S. The OCS remains subject to Federal jurisdiction and control after enactment of the Submerged Lands Act (43 USC 1301 and 1302).

Permeability - The capacity to be penetrated or diffused through; the ability to transmit fluids.

Permeable - Capable of being penetrated or diffused through.

Petroleum - An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoir formations; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

Pinch-out - The disappearance of a porous, permeable formation between two layers of impervious rock; the gradual vertical thinning of a formation, over a horizontal or near-horizontal distance, until it disappears.

Platform - A steel or concrete structure from which offshore wells are drilled.

Plutonic - Igneous rock formed beneath the earth's surface by consolidation from magma.

Porosity - The capability to contain fluids within void spaces; the percent of open space in a rock.

Porous - Capable of containing fluids within void spaces.

Production curve - A curve plotted to show the relation between quantities produced during definite consecutive time intervals.

Proprietary information - Geologic and geophysical data and immediate derivatives thereof that cannot be released to the general public because of Federal law, regulations, or statutes, or because of contractual requirements.

Province - An area throughout which geological history has been essentially the same or that is characterized by particular structural, petrographic, or physiographic features.

Recoverable resource estimate - An assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

Refining - Fractional distillation, usually followed by other processing (as cracking).

Reserve estimate - An assessment of the portion of the identified oil or gas resource that can be economically extracted.

Reserves - Portion of the identified oil or gas resource that can be economically extracted.

Reservoir - An accumulation of hydrocarbons

that is separated from any other such accumulation.

Resource - Concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust.

Rig - Apparatus used for drilling an oil or gas well.

Risked resource estimate - An assessment of oil or gas resources that has been modified to take into account the estimator's confidence in his or her estimate (i.e., "risked" to account for the probability that economically recoverable resources will actually be found within the area of interest).

Risked, economically recoverable resource estimate - An assessment of oil or gas resources that has been modified to take into account (1) physical and technological constraints on production; (2) the influence of the costs of exploration and development and market price on industry investment in OCS exploration and production; and (3) the estimator's confidence in his or her estimate.

Roughneck - Drilling assistant who tends drilling engines and mud pumps and breaks out or unscrews stands of drill pipe.

Roustabout - Manual laborer on or about a drilling rig.

Sandstone - A sedimentary rock made up of sand that usually consists of quartz more or less firmly united by some cement (as silica, iron oxide, or calcium carbonate).

Sediment - Material or a mass of material deposited (as by water, wind, or glaciers).

Sedimentary rocks - Rock formed of mechanical, chemical, or organic sediment.

Seismic - Pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth.

Shale - A fissile rock that is formed by the consolidation of clay, mud, or silt, has a finely stratified or laminated structure parallel to the bedding, and is composed of minerals that have been essentially unaltered since deposition.

Siliceous - Of, pertaining to, or containing silica or quartz.

Siltstone - A very fine-grained, consolidated clastic rock largely composed of particles of silt grade.

Slumping - (See **mass movement**).

Source bed - Rocks containing large amounts of organic matter that is transformed into hydrocarbons.

Stratum (pl., strata) - A tabular mass or thin sheet of sedimentary rock or earth of one kind formed by natural causes and made up usually of a series of layers lying between beds of other kinds.

Stratigraphic trap - A reservoir, capable of holding oil or gas, that is formed from a change in the character of the reservoir rock. Such a trap is harder to locate than a structural trap because it is not readily revealed by geological or geophysical surveys.

Structural trap - A reservoir, capable of holding oil or gas, that is formed from crustal movements in the earth that fold or fracture rock strata in such a manner that oil or gas accumulating in the strata are sealed off and cannot escape. In some cases "structure" may be synonymous with structural trap.

Subsidence - Movement in which there is no free side and surface material is displaced vertically downward with little or no horizontal component; a sinking of a large part of the earth's crust.

Subsurface geology - The study of structure, thickness, facies, correlation, etc. of rock formations beneath land or seafloor surfaces by means of drilling for oil or water, core drilling, and geophysical prospecting.

Summary Report - Document prepared by the Department of the Interior pursuant to 30 CFR 252.4 that is intended to inform affected State and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and onshore facilities.

Supply boat - Vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

Tract - The geographic and legal extent of a single lease area; a convenient way of numbering blocks offered for sale so that they can be sequentially numbered in the process of offering.

Trap - A geologic feature that forms a reservoir enclosing and preventing the escape of accumulated fluids (hydrocarbons or water).

Truncated - Terminated abruptly as if cut or broken off.

Undiscovered resources - Quantities of oil and gas estimated to exist outside known fields.

Uplift - Elevation of any extensive part of the earth's surface relative to other parts.

USGS - Geological Survey, U.S. Department of the Interior.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980 O— 311-344/149