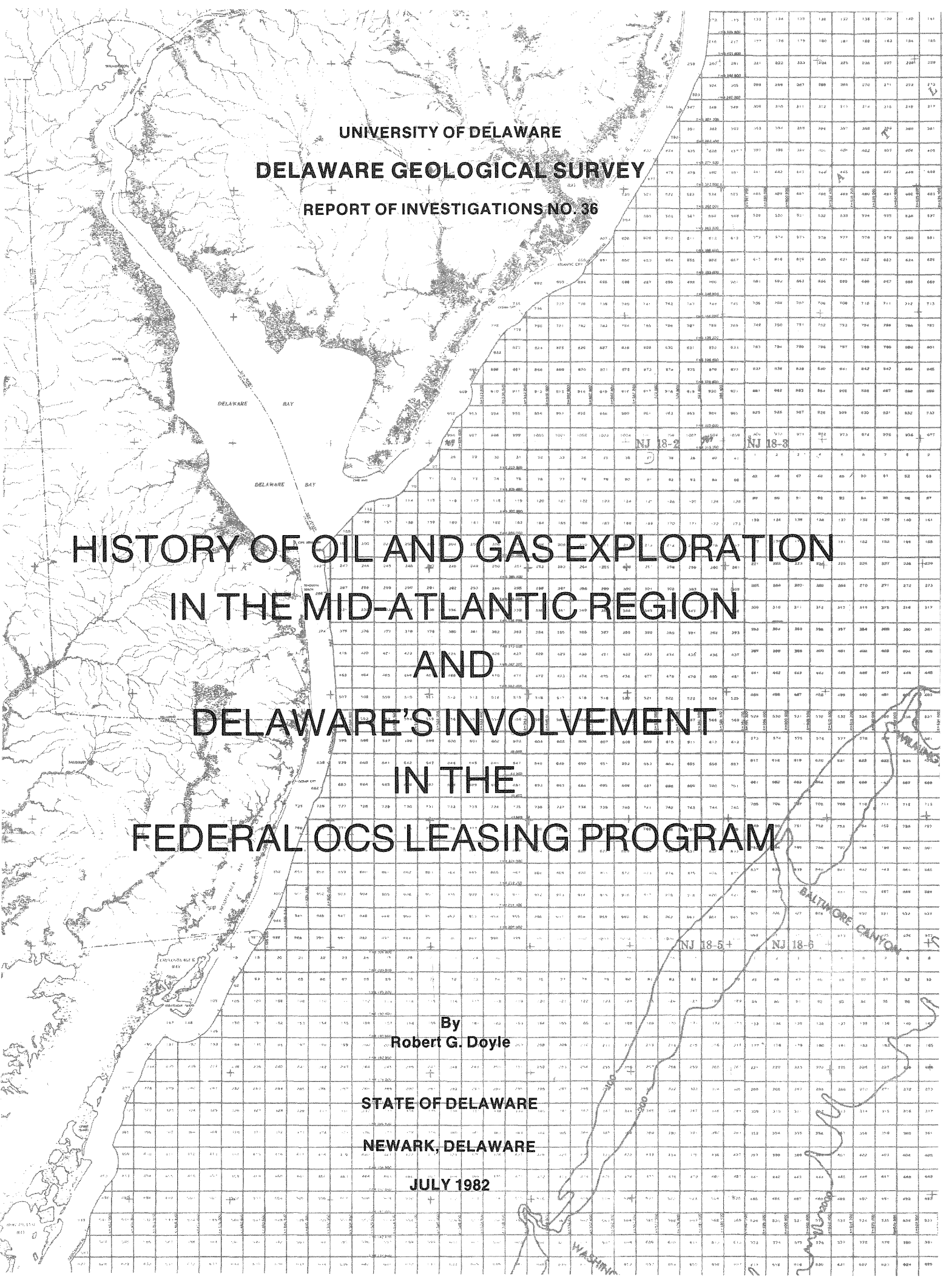


UNIVERSITY OF DELAWARE

DELAWARE GEOLOGICAL SURVEY

REPORT OF INVESTIGATIONS NO. 36

HISTORY OF OIL AND GAS EXPLORATION IN THE MID-ATLANTIC REGION AND DELAWARE'S INVOLVEMENT IN THE FEDERAL OCS LEASING PROGRAM

By
Robert G. Doyle

STATE OF DELAWARE

NEWARK, DELAWARE

JULY 1982

Public Access Copy
DO NOT REMOVE
from room 208.

HISTORY OF OIL AND GAS EXPLORATION IN THE MID-ATLANTIC REGION AND DELAWARE'S INVOLVEMENT IN THE FEDERAL OCS LEASING PROGRAM

By

Robert G. Doyle

Delaware Geological Survey

July 1982

FOREWORD

Exploration for oil and gas off the shores of Delaware and other Atlantic States has involved significant decisions by government, major commitments by industry, and advances in science and technology. There have been many issues, events, and participants. Unless recorded, as in this Report, it will be difficult to reconstruct the causes of current conditions, attitudes, and policies.

Delaware has sought to understand the potential resources offshore in order to make informed decisions about possible positive and negative impacts and appropriate policies. Geology, because it seeks to determine the nature of earth resources, threads through this process. Thus an objective account may be offered by the State's Geological Survey.

Report of Investigations No. 36 deals with events through December 1981. Since its preparation other important events have occurred, for example: a new 5-Year Leasing Plan has been issued, OCS Sale 76 has been announced for April 1983, an exploration well has been planned for a world-record water depth offshore Delaware, federal budgeting has threatened funding that helps States cope with impacts, and Interior's leasing procedures have been "streamlined." It should be noted in particular that functions ascribed in this report to a variety of federal agencies were largely consolidated in a new Minerals Management Service formalized on January 19, 1982.

The search for petroleum offshore will continue, as will the need for informed public decisions. We will attempt to provide current information as this dynamic story continues.

Robert R. Jordan
State Geologist

CONTENTS

	Page
FOREWORD.	ii
ABSTRACT.	1
INTRODUCTION.	3
Purpose and Scope.	3
Acknowledgments.	4
Geologic Environment and Potential of Mid-Atlantic Oil and Gas Resources.	4
ADMINISTRATION OF OIL AND GAS ACTIVITIES.	8
Federal Oil and Gas Leasing Program.	8
Delaware Oil and Gas Administration.	10
PRE-LEASE SALE HYDROCARBON EXPLORATION IN THE MID-ATLANTIC REGION.	11
Onshore Exploration in Delaware and Neighboring States	11
Geological and Geophysical Exploration in the Mid-Atlantic OCS.	14
Seismic Profiling	15
COST Wells.	20
Shallow Depth Core Hole Projects.	21
BACKGROUND FOR STATE-FEDERAL RELATIONSHIPS IN THE MID-ATLANTIC AREA, PRE-1975.	23
Overview	23
Record of Events	23
Comparison of Atlantic and Gulf Coast Leasing Areas.	26

Page

HISTORY OF STATE-FEDERAL RELATIONSHIPS IN REGARD TO THE MID-ATLANTIC OCS, 1975-1981. 29

Initial Actions. 29

Delaware Activities, 1975-1981 32

MAGCRC Activities, The Interstate Program. 37

Federal Activities 40

MID-ATLANTIC OCS LEASING PROGRAM. 48

Introduction 48

Sale 40. 49

Sale 49. 55

Sale 59. 58

RESULTS OF EXPLORATORY DRILLING OF LEASE TRACTS IN THE MID-ATLANTIC OCS 59

Discussion of Hydrocarbon Discoveries. 66

598 Structure. 66

Avalon Structure 66

Summary of Exploratory Drilling Activity 68

CONCLUSIONS 69

REFERENCES. 72

ILLUSTRATIONS

Figure 1. Location of OCS Planning Areas and limits of the continental shelf. 6

Figure 2. Location of the major physical features of the Mid-Atlantic region 7

Page

Figure 3. Location of onshore test wells, Mid-Atlantic region. 13

Figure 4. BGR-USGS multichannel seismic program. . . 18

Figure 5. Diagram showing Gulf Coastal Plain - continental shelf geology. 28

Figure 6. Diagram showing Atlantic Coastal Plain - continental shelf geology. 30

Figure 7. Typical MAGCRC agenda during active period, August 1975. 38

Figure 8. Organization chart of the OCS National Advisory Board. 46

Figure 9. Proposed OCS Planning Schedule of November 1974, showing first Notice of Sale 40. 50

Figure 10. OCS lease sale procedure 52

Figure 11. OCS tracts leased in Sale 40 54

Figure 12. OCS tracts leased in Sale 49 57

Figure 13. OCS tracts leased in Sale 59 60

Figure 14. Early exploratory target areas in the Mid-Atlantic OCS Planning Area (names designated by industry) 62

Figure 15. Location of all Mid-Atlantic OCS Planning Area exploratory wells. 63

Figure 16. Location and results of wells drilled on 598 Structure shown on portion of OCS Protraction Diagram NJ 18-3 . . . 67

TABLES

Page

Table I. Decision Process: OCS Lease Sale Process. . 51

Table II. Mid-Atlantic Area OCS well information as of 12/31/81. 61

Table III. Wells with observed or significant hydrocarbons, Mid-Atlantic OCS. 65

Table IV. Phases of Mid-Atlantic OCS activity 70

HISTORY OF OIL AND GAS EXPLORATION IN THE MID-ATLANTIC REGION AND DELAWARE'S INVOLVEMENT IN THE FEDERAL OCS LEASING PROGRAM

ABSTRACT

There has been sporadic exploration for oil and gas in the Mid-Atlantic region for over 50 years. Non-commercial deposits of oil and gas have recently been discovered in the sedimentary rock section of the Outer Continental Shelf (OCS) 80 miles off the New Jersey-Delaware coast. The oil and gas occurs within entrapment structures in ancient rocks deposited and buried in a deep basin called the Baltimore Canyon trough. This trough forms part of the Coastal Plain and continental shelf geologic provinces on the Atlantic Coast.

The development of oil and gas resources in submerged lands seaward of a line three nautical miles from the coast is administered by the Department of Interior. The submerged lands and onshore lands shoreward of that line are administered by the State of Delaware and the other Coastal States.

A limited amount of onshore exploration took place, beginning in the 1930's, in Delaware and neighboring States. It included geological and geophysical exploration, plus the drilling of 10 to 15 test wells from southern New Jersey to northern Virginia. No oil or gas shows were reported from this drilling. The geologic study of the offshore portion of the Mid-Atlantic region began in 1935 when seismic surveys were conducted by researchers from Lehigh University. The first of these surveys, a few miles off the New Jersey coast, used seismic refraction techniques. In the 1950's continuous seismic reflection profiling became predominant. By the mid-1960's offshore multichannel, common depth point seismic reflection profiling, with non-explosive air gun energy sources, was used exclusively. The U. S. Geological Survey began seismic reflection profiling in 1973 under a Congressional order to evaluate the geologic resources of the continental margins of the United States. In 1976 the Delaware Geological

Survey conducted a high resolution seismic reflection profile off Delaware Bay. Since 1973, 50,000 miles of public agency seismic reflection profiling have been completed.

Additional pre-leasing exploration included two test wells by oil-company consortia in the Department of Interior-authorized Continental Offshore Stratigraphic Test program. Several other industry and non-industry groups drilled shallow (less than 1,000 feet) wells in the Mid-Atlantic region during the 1960's and 1970's.

The introduction in the early 1970's of the Mid-Atlantic OCS leasing program was a difficult and controversial process. This was partly because of a series of events that took place prior to the first lease sale which aroused concern among the general public and Coastal State officials. Those events included the oil spill from a well being drilled in the Santa Barbara Channel, tanker spills in Delaware Bay, the passage of much stricter environmental legislation, a series of challenges by the States on federal sovereignty over the shelf, and a strengthening of coastal zone management programs. The experience gained from previous lease sales in the Gulf Coast was not generally applicable to Atlantic Coast leasing because of significant differences in both the historic background and geologic environment between the two areas. All of these things impelled the Mid-Atlantic Coastal States to develop internal and interstate policies that demanded greater participation in the leasing program. They enacted coastal zone management programs, pressed the Department of Interior to develop an interagency organization allowing more State input into the process, and, in 1975, organized a five-State committee, the Mid-Atlantic Governors Coastal Resources Council (MAGCRC), to coordinate and strengthen their negotiating position with the federal government.

Delaware and MAGCRC were active during the Mid-Atlantic leasing program between 1975 and 1981, participating in OCS-related advisory meetings and conducting coastal impact studies with Office of Coastal Zone Management funding assistance. In Delaware, emphasis was placed on a technical data acquisition and analysis program. Each Mid-Atlantic State presented a rigorous critique of the Sale 40 Environmental Impact Statement. MAGCRC successfully negotiated an Agreement of Confidentiality with the oil industry to receive technical data for the two Mid-Atlantic pre-sale stratigraphic test wells. It encouraged more State participation in the lease sales, promoted improved environmental studies research, and urged the Department of Interior to devise a more rigorous and

inclusive environmental impact statement format. The Department of Interior established a series of formal State-federal advisory organizations to provide forum for active State participation in the leasing program. The Congress passed several OCS-related laws, including a complete revision of the OCS Lands Act. The Office of Coastal Zone Management legislation was improved to provide additional funding for State impact studies. The Bureau of Land Management revised procedures to include State representation on tract selection, environmental studies, and oil pipeline transportation planning. By 1978, the State-federal OCS relationships, though not perfect, had become greatly improved and more orderly.

Three Mid-Atlantic lease sales were held, Sale 40 in 1976, Sale 49 in 1978, and Sale 59 in 1981. A total of 361 tracts were offered and industry paid nearly $1.5 billion in bonus money for 187 of these tracts. From 1978 through 1981, there were 28 wells drilled ranging in total depth from 13,000 to 18,000 feet. Five wells encountered significant oil and gas in a small part of a major target structure. Two others, plus the COST B-3 well, encountered minor gas shows. Results from the five-well group with significant hydrocarbon shows indicate a total of 88.45 million cubic feet of gas per day, some condensate, and 630 barrels per day of oil. Although no drilling is planned for 1982 in the Mid-Atlantic Area, it is expected to resume in mid-1983, concentrating on the Sale 59 leases which cover the trend of a carbonate reef-platform complex along the outer edge of the continental slope.

INTRODUCTION

Purpose and Scope

This report describes the history of Mid-Atlantic oil and gas exploration concentrating on Delaware and the offshore area affecting that State directly. Pertinent activities in other Mid-Atlantic States are also considered. It covers two interrelated subjects: (1) a history of oil and gas exploration on and offshore Delaware and its neighbors during the last 50 years and (2) the role of Delaware State government in evolving relationships between the Coastal States and the federal government in development of the Outer Continental Shelf (OCS) leasing program. As geology is the driving force behind all OCS activity, the second subject details the

activities of the Delaware Geological Survey (DGS) as a leading participant in State oil and gas activities. The report was written to provide information for resource planners, public agencies, environmental groups, and others interested in the history of oil and gas development in the Mid-Atlantic region so that the basis for future constructive activities may be clearly established.

Acknowledgments

The author wishes to acknowledge the assistance of the staff of DGS, and that of Frank Basile, Manager of the New York Office of the Bureau of Land Management (BLM), whose discussions on the history of oil and gas exploration have greatly assisted in the writing of this report.

The preparation of this report was financed through Coastal Energy Impact Program (CEIP) OCS State Participation Grant No. NA-80-AA-D-CZ085 from the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under the provisions of Section 308(C)(2) of the Coastal Zone Management Act of 1972 (Public Law 92-583) as amended. Funds were administered by the Delaware Office of Management, Budget and Planning (OMBP) and later transferred to the Department of Natural Resources and Environmental Control (DNREC) as contract number CEIP 80-2.

Geologic Environment and Potential of Mid-Atlantic Oil and Gas Resources

Oil and gas (hydrocarbon) deposits occur as liquid or gas that occupies the pore spaces of sedimentary rocks. These rocks were originally deposited as layers of sand, mud, or limestone in sedimentary basins that received the products of erosion from adjacent continental masses. Through burial and long geologic time, hydrocarbons are formed by heat-generated chemical transformation of buried organic material that was deposited and preserved along with the original sediment. Once formed, the fluid hydrocarbons migrate from the fine-grained source beds where they were formed through porous and permeable rock layers until they collect against an impermeable barrier.*

---

* For a more complete discussion of oil and gas generation, the reader is referred to DGS Report of Investigations No. 31 (1979) by R. N. Benson.

The North American continent is rimmed by a submerged platform of rocks called the continental shelf (Fig. 1). It is comprised of a seaward-thickening mass of sedimentary layers that began to accumulate over 200 million years ago. This depositional process is still going on today. The Mid-Atlantic portion of the continental shelf extends 150 miles seaward and contains over 46,000 feet of sediment at its thickest section off the New Jersey coast (Schlee, 1981).

The known oil and gas reserves of the North American continental shelf are concentrated in several areas: the Texas-Louisiana Gulf Coast, the Yucatan Peninsula of Mexico, southern California, portions of Alaska, and the Newfoundland Shelf off the Canadian Maritime Provinces (Fig. 1). For the remainder of the continental shelf commercial hydrocarbon deposits are either not present or, as is the case for the Atlantic offshore, exploration has not yet been completed.

The portion of the continental shelf lying off the Delaware coast is within the Mid-Atlantic OCS Planning Area, a geographic designation formally assigned by the Bureau of Land Management (BLM) in 1981. This Area, shown in Figure 2, includes a major sedimentary basin, the Baltimore Canyon trough (BCT), originally named by Maher and Applin (1971), which has been the principal target of offshore exploration. The trough is over 200 miles long, with its deep axis lying 60 to 100 miles off Delaware and southern New Jersey (Fig. 2). Similar rocks onshore form the Atlantic Coastal Plain including the Salisbury Embayment which extends inland for 50 miles. Along the outer margin, in very deep water, there is evidence of a buried carbonate reef-platform complex which is a target for future exploratory drilling (Schlee and Grow, 1981). Other prospective areas in the Mid-Atlantic Area include the shoreward hinge zone of the trough, buried rift basins within reach of the drill bit, and the tops and flanks of buried igneous rock and salt dome intrusions. Part of the hinge zone extends onshore through Delaware waters and inland for several miles.

Geologic evaluation of these prospective areas defines where leasing and drilling are to be concentrated. This in turn controls where onshore impacts will be greatest if hydrocarbons are found and brought ashore.

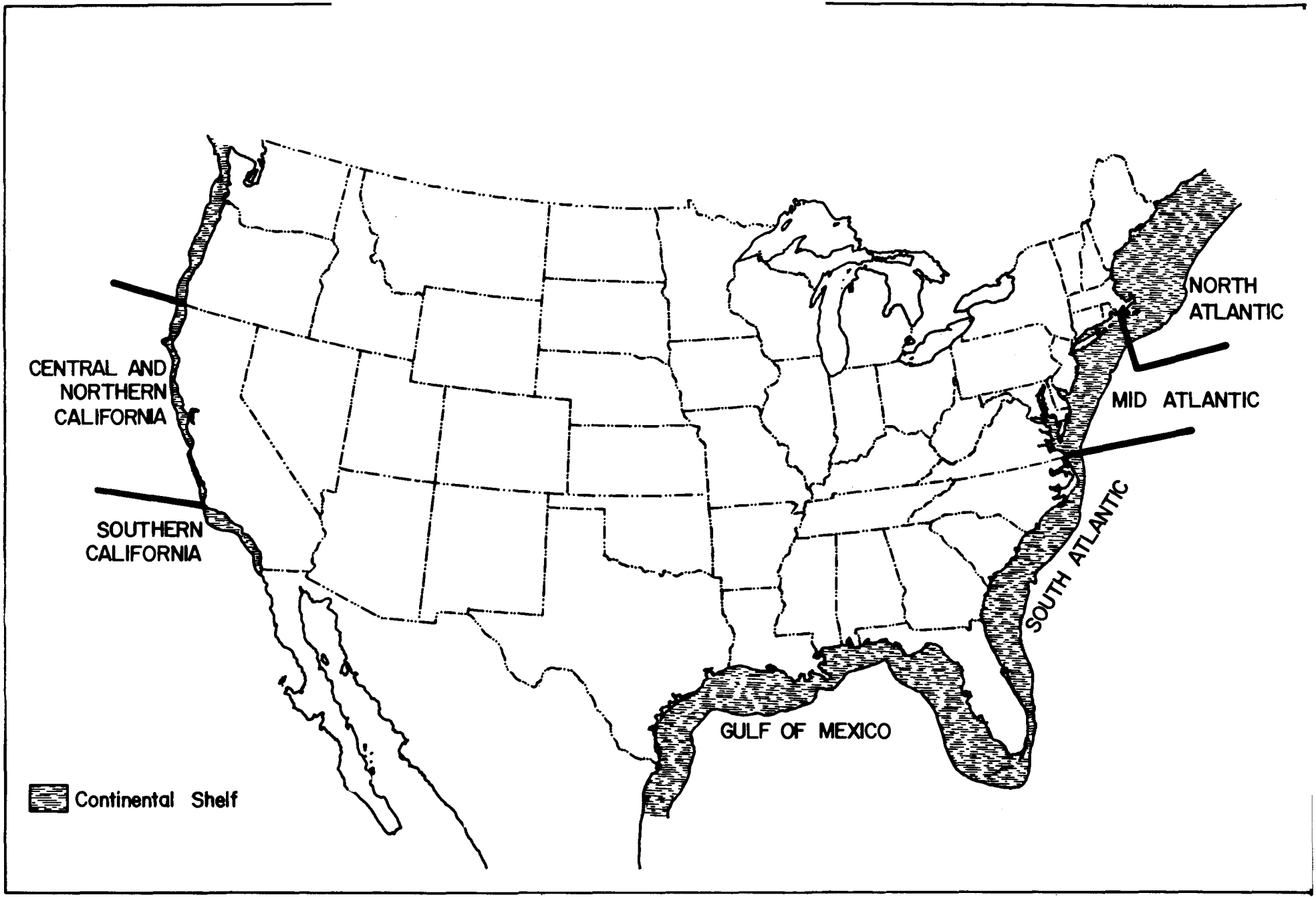


Figure 1. Location of OCS Planning Areas and limits of the Continental Shelf.

Source: U.S. Dept. of the Interior

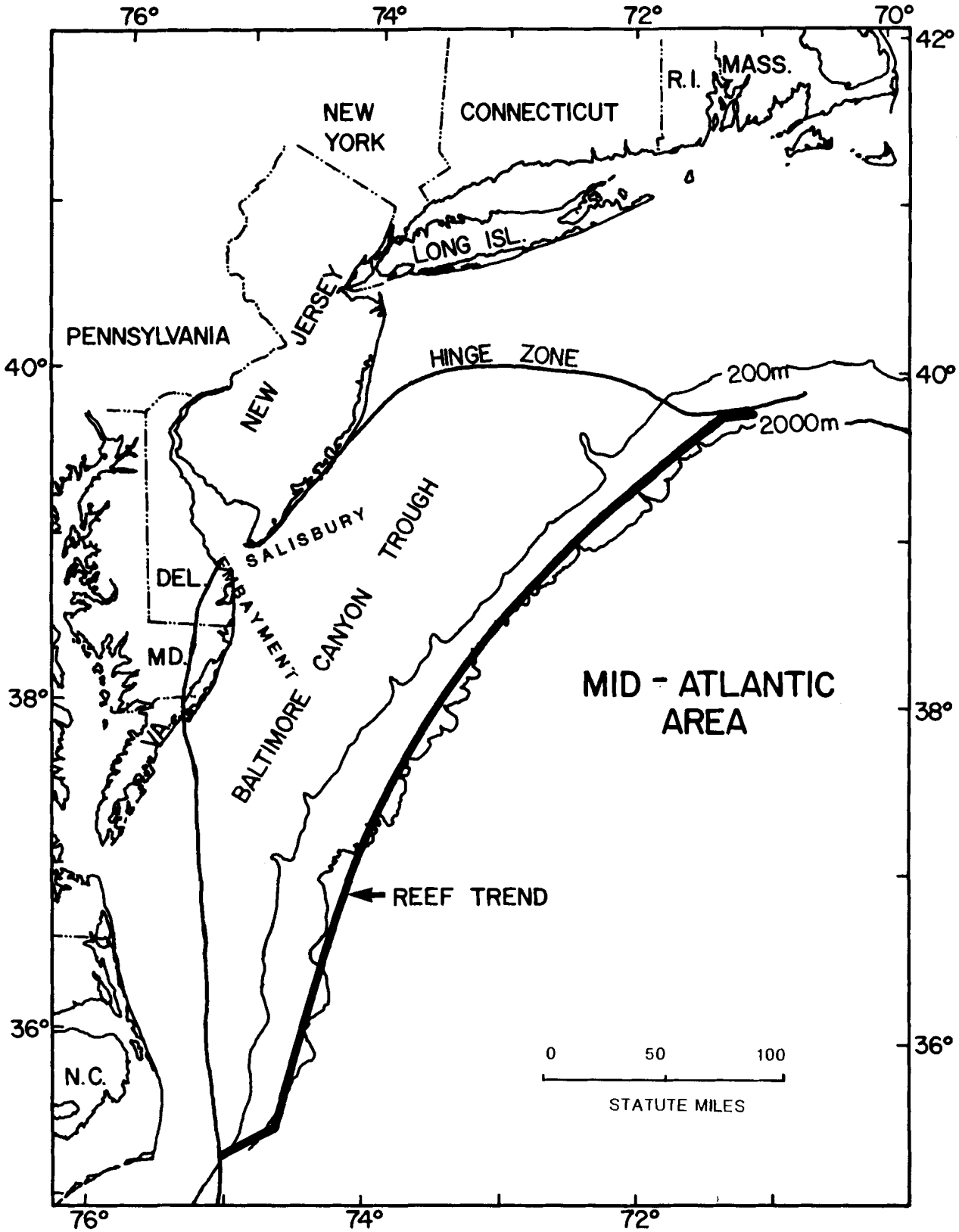


Figure 2. Location of the major physical features of the Mid-Atlantic region.

Source: Bureau of Land Management

ADMINISTRATION OF OIL AND GAS ACTIVITIES

Exploration, development and production of oil and gas in the area is under the jurisdiction of either federal or State laws. These laws, some of which have been in effect for almost 30 years, define how oil and gas resources will be explored. Recent changes in the federal oil and gas laws have emphasized the need for maximum environmental protection and cooperation with Coastal States.

For federal waters, management of OCS oil and gas activities is under the U. S. Department of Interior (DOI). Delaware oil and gas activities are included in Chapter 61 of the Delaware Code. This chapter, "Underwater Lands," is administered by the Division of Environmental Control of the Department of Natural Resources and Environmental Control (DNREC). Chapter 61 covers oil and gas activities on all the uplands of the State of Delaware and submerged lands seaward from the coast for three nautical miles. Federal administration extends from that three-mile line seaward for an unspecified distance, at least 150 miles.

Federal Oil and Gas Leasing Program

Federal and State offshore leasing began in the Gulf Coast region, first onshore in the Coastal Plain and later offshore into the Gulf of Mexico. The Gulf Coast has accounted for most of the nation's oil and gas production from 1895 to the present. Beginning in 1938 when the Creole Field was discovered in the shallow Gulf waters off the Louisiana coast, the oil industry moved offshore. Since then an ever-increasing percentage of Gulf Coast production has come from beneath the waters of the Gulf in both State and federal jurisdiction. Today, all offshore areas of the United States produce 12 percent of the total domestic oil consumed in this country (West, 1981). Technological advances during the last two decades have enabled the industry to move farther offshore into deeper water. More than 23,000 offshore wells have been drilled in the State and federal continental shelf area of North America (DOI OCS Statistics, 1981).

Many of the early Gulf Coast wells were drilled offshore in unclaimed waters or as extensions of various State and county jurisdictions. This resulted in confusing, complicated, and costly arguments about the ownership of lease areas, the oil therein, and payment of royalties. The U. S. Congress responded to this complicated problem in 1953 by enacting two

very important land management laws. The Outer Continental Shelf Lands Act (OCSLA) of August 7, 1953 (67 Stat 462; 43 USC 1331-1343) and The Submerged Lands Act of May 22, 1953 (67 Stat 29; 43 USC 1303-1315). The OCSLA was complemented by regulations promulgated by DOI and contained in the Code of Federal Regulations (CFR). In addition, a series of detailed Orders, Rules, and Notices provided many of the implementation and enforcement procedures designed by the U. S. Geological Survey (USGS) and BLM to administer the Act. The responsibility for administration of the oil and gas leasing program was assumed in 1982 by the newly created Minerals Management Service (MMS).

The Submerged Lands Act had the effect of placing jurisdiction with the federal government over the seabed and submerged lands of the entire offshore of the United States, excepting a narrow strip of submerged land within three nautical miles of the coast of each State.* The act authorized the President to cause the division of this strip by seaward extension of each Coastal State boundary, giving each of those States jurisdiction over the submerged land within its individual segment. This authority has yet to be exercised in the Atlantic and many extended Coastal State boundaries have not been established. The Submerged Lands Act was challenged unsuccessfully in the U. S. Supreme Court in several separate cases.

The OCSLA reaffirmed the jurisdiction of the federal government over the submerged lands of the Outer Continental Shelf and directed the DOI to administer the Act for exploration, leasing, drilling, production, transportation, and collection of royalties for oil, gas, and sulphur operations within the entire OCS (USGS, OCS Statistics, 1981).

Beginning in 1954 hundreds of Regulations, Orders, Notices, and Stipulations have been written, amended, and reaffirmed by DOI in its administration of the OCSLA. The Act itself was drastically amended in 1978. The amendments were in part a result of intense pressure from the Coastal States and an environmentally aware general public, which requested the Congress to institute more environmental controls and increase drilling rig safety measures on OCS operations. The 1978

---

*For Texas and western Florida, by virtue of their unique entry into the United States, this strip is 12 miles wide.

Amendments also assured an increased role for the Coastal States in decision-making processes for all phases of OCS activities.

The first leases under OCSLA were granted in 1954 in the Gulf Coast area. West Coast lease sales were added in 1962, and in 1976 the first Alaskan and Mid-Atlantic sales were conducted. These regional sales were conducted in specific geographic areas of the OCS. These areas were given formal designations as OCS Planning Areas in 1981 by BLM. From 1954 to 1980, over 15 million acres of OCS submerged lands were leased in 65 lease sales and, by the end of 1980, 18,625 wells had been drilled in federal waters. Total OCS production has been more than 5.4 billion barrels of oil and gas condensate, plus 48.6 trillion cubic feet of gas (DOI OCS Statistics, 1981). In 1980, 277 million barrels of oil and condensate were extracted from OCS areas. This amount, when included with the 1980 production of 4.6 trillion cubic feet of natural gas, demonstrates the significant contribution of OCS activity to our national energy needs (West, 1981).

Delaware Oil and Gas Administration

Chapter 61, "Underwater Lands," in Title 7 of the Delaware Code was designed primarily to regulate the use of Delaware submerged lands for oil and gas exploration and development. It was passed by the Delaware General Assembly in 1966 in response to the growing interest in the Atlantic OCS and onshore Coastal Plain as a potential oil and gas province. This Act was originally part of the environmental package that created the Water and Air Resources Commission (WARC). In 1974, as part of the Executive Department reorganization, it became an administrative responsibility of the newly created DNREC. Chapter 61 contains four subchapters: Minerals and Submerged Lands, Subaqueous Lands, Riparian Rights, and Enforcement. The 1966 Act had been submitted as a draft proposal to the General Assembly prior to 1966, but failed passage. The DGS, as the State geologic agency, assisted in the preparation and presentation of both the draft and enacted bills. Oil and gas regulations, passed in 1971, were the product of study by a combined effort by several groups including a committee from the American Petroleum Institute (API), that provided legal and technical advice.

The Delaware oil and gas statute and regulations were reviewed by DGS in 1980 at the request of OMBP. The statutes

were becoming out-dated and did not take into account new State and federal laws, nor the rapidly evolving oil industry technology. The DGS reviewed the law and regulations and prepared for OMBP a draft revision of the entire Chapter 61 (Doyle, 1981). This revision was submitted to the General Assembly for consideration in 1982.

DNREC has not received many requests for information on oil and gas possibilities, few private land leases were acquired, and no in-State exploration permits were issued during the last decade (personal communication, 1982, W. A. Moyers, DNREC staff). However, this level of interest could change when the inner margin or hinge zone of the Baltimore Canyon trough is explored for hydrocarbons (Fig. 2).

PRE-LEASE SALE HYDROCARBON EXPLORATION IN THE MID-ATLANTIC REGION

Pre-lease sale hydrocarbon exploration and geologic activity in the Mid-Atlantic region is separated into two phases in this section: (1) onshore exploration in Delaware and neighboring States, (2) offshore geologic and geophysical exploration, Mid-Atlantic OCS Area. The history of exploration in the region covers a period of almost 50 years, from 1930, when oil companies began onshore geological studies in Delaware, to 1978 when the offshore well drilling program began.

Onshore Exploration in Delaware and Neighboring States

There has been a limited amount of oil exploration and drilling activity in Delaware and neighboring States. The earliest work, as indicated by undocumented reports in the DGS files, was some geological mapping and geophysical surveying by oil companies beginning about 1930. In 1946, the USGS published a map showing the results of an aeromagnetic survey conducted in southeastern Maryland during the 1940's (Balsley *et al.*, 1946). The map shows two large magnetic closures in southern Worcester County, Maryland. The U. S. Bureau of Mines (USBM) analyzed the magnetic data from the USGS survey, comparing its results to a similar ground magnetic survey conducted by USBM in 1945 (Kuehn and Dent, 1947). These surveys present the earliest known published geophysical information in the area.

The first documented test drilling in the area (Fig. 3) was in 1934 on an apple orchard farm four miles southeast of Bridgeville, Sussex County, Delaware. The Cleveland Oil Company, locally owned, drilled a well to a total depth of 3,012 feet. Reports of hydrocarbon shows have not been substantiated, although the driller stated in an interview with DGS geologists in 1968 (DGS office files) that oil and gas shows were present at various intervals in the well. A second well was drilled by Cleveland Oil Company in 1935. It was located one mile from the first well and bottomed at 2,555 feet. No substantiated oil or gas shows have been reported from this well.

According to the driller, the Cleveland Oil Company leases at Bridgeville were transferred to another local group that formed the Milford Oil Company. This company interested Sun Oil Company in more drilling on their leases. In 1938 and 1939, Sun Oil drilled as many as five test wells near the original Cleveland tests. The range of depths for these wells was from 500 to 2,674 feet. Two Sun Oil tests reached more than 2,500 feet. The Russell-D-5 well reached 2,674 feet, and the Apple Orchard-D-6 to 2,600 feet. This was the last oil well drilled in Delaware. Oil and gas shows were not reported from any of the Sun Oil Company drilling. The Russell-D-5 wellhead was still open in the mid-1970's and samples of fluid from the well were analyzed in 1975 by the U. S. Department of Energy (DOE) with negative results. A gamma ray geophysical log was run by the DGS to a depth of 626 feet during the same year (all information from DGS office files). There is no available information on why the Bridgeville site was originally chosen for oil and gas testing, nor any explanation, except limited funding, why these wells penetrated only the upper one-half of the Coastal Plain section.

Since the 1930's there has been little activity in Delaware. Several companies have discussed the possibility of exploration for oil and gas. One company, Lenape Oil Company of Tampa, Florida, applied in 1967 to the State for a permit to explore the nearshore waters of Delaware Bay. A permit was not issued. In 1970 a local group formed the REM Corporation to acquire mineral leases in the Bridgeville-Greenwood area. None of these company activities have resulted in a drilling program.

In Maryland, seismic and magnetic surveys were conducted by the Ohio Oil Company, starting in 1942. On the basis of these surveys and other studies, oil companies drilled several

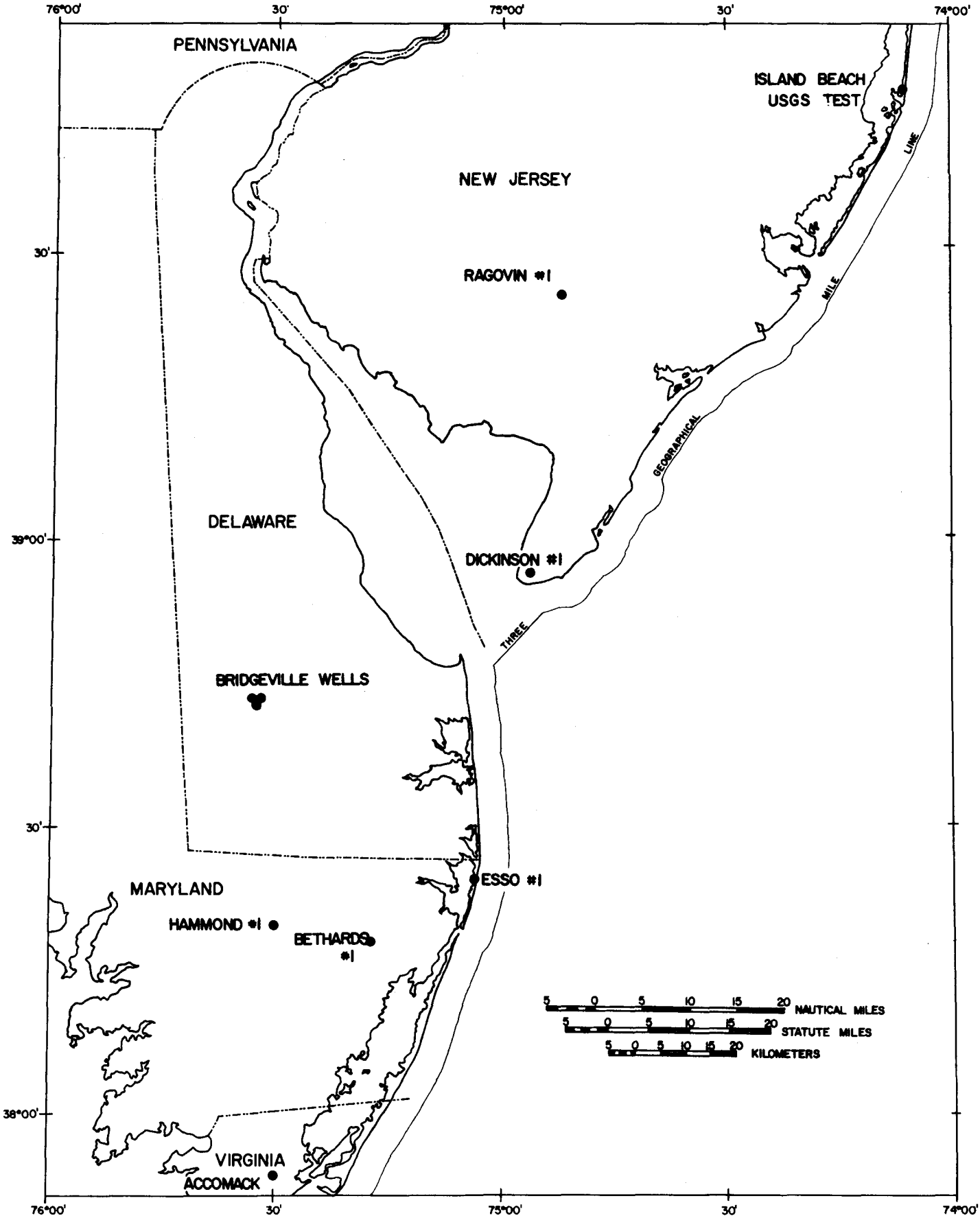


Figure 3. Location of onshore test wells, Mid-Atlantic region.

test wells in the Maryland Coastal Plain just south of the Delaware line. Three of these, on a line west from Ocean City, Maryland, were drilled in the 1940's, reached depths of 5,400 to 7,700 feet without encountering oil or gas shows (Anderson, 1948). The test well drilled near Ocean City by the Standard Oil Company of New Jersey (Esso No. 1 well) reached a total depth of 7,710 feet while still in sediments of Early Cretaceous age (Anderson, 1948). The Bethards No. 1 well was drilled to a depth of 7,178 feet, penetrating a few feet of crystalline basement. This well was drilled by Socony-Vacuum Oil Company (Balsley, 1946; Anderson, 1948). The Ohio Oil Company Hammond No. 1 well was drilled to 5,428 feet, cutting Triassic sediments and bottoming in Paleozoic(?) basement (Richards, 1945). Farther to the south along the Delmarva Peninsula, J and J Enterprises drilled a deep well in Accomack County, Virginia with negative results (Onuschak, 1972). This well, completed in October 1972, was significant as an example of industry, federal and State participation in providing bottom hole money to complete a water test well to basement. Anchor Gas Company drilled two oil test wells in New Jersey. One, the Dickenson No. 1, was drilled at Cape May, New Jersey in 1963 across the Delaware Bay from Lewes, Delaware penetrating 6,357 feet of Coastal Plain sedimentary rocks and bottoming in crystalline basement. The other Anchor Gas well, Ragovin 1, was drilled in 1964 in Cumberland County, New Jersey, to a total depth of 3,623 feet, bottoming also in crystalline basement (DGS file information). No oil or gas was reported from these two New Jersey tests. Figure 3 shows the locations of the onshore test wells discussed in this report. For the last decade, interest in oil and gas exploration has been centered offshore in the Mid-Atlantic OCS. There is a possibility however, that during the next few years interest may shift nearer shore, because this area cannot be ruled out as non-prospective for hydrocarbons (Benson, 1979a, b).

Geological and Geophysical Exploration in the Mid-Atlantic OCS

Geological and geophysical exploration in the Mid-Atlantic OCS Area consisted primarily of seismic profiling using a variety of seismic methods, off-structure deep stratigraphic test wells, and a series of shallow drill holes into various parts of the continental margin. Regional aeromagnetic and gravity surveys were also conducted in the Mid-Atlantic region in 1975.

Seismic Profiling

Beginning in the 1930's and continuing sporadically for the next 25 years, several academic institutions performed seismic surveying (or profiling) to determine the configuration of the basement, the thickness of the sedimentary rocks in the Baltimore Canyon trough, and the character of the internal structure of those rocks. Seismic profiling was accelerated by academic institutions and the USGS following World War II. These surveys continue today. In 1960, following the academic lead, private industry began seismic surveying in the Atlantic offshore. The combination of both academic and industry surveys totals approximately 135,000 line miles of seismic profiling in the Mid-Atlantic Area (Donald Clark, Minerals Management Service, DOI, personal communication, 1982).

Seismic profiling is a geophysical method that sends acoustical energy waves through a subsurface rock section and very precisely measures the time (travel-time) it takes for those waves to reflect and refract at certain interfaces between contrasting layers of rock (called seismic horizons) and return to the surface. These return waves are detected by a series of hydrophones and recorded on shipboard by various means. There are two basic seismic profiling methods, reflection and refraction. In the reflection method the acoustic waves reflect from a seismic horizon and return to the surface. This provides information on the time-depth and configuration of the reflector surfaces. The refraction method measures the travel time of a part of the wave that is refracted or bent, along a seismic horizon for some horizontal distance before being refracted back to the surface. In addition to the depth information, it provides information on the acoustic velocity, and, by inference, the physical properties and composition of the rock layers penetrated by sonic waves.

Until the 1960's refraction seismic profiling was the most commonly used method in the Atlantic offshore. Since that time, however, the reflection seismic method has been perfected and used more commonly. For modern petroleum exploration the reflection method is used. Continuous seismic reflection (CSR) profiling, that continuously records the reflected wave returns on a shipboard plotter, was initially employed in reflection methods. By the mid-1960's (Dobrin, 1977) multichannel, common depth point (CDP) seismic reflection profiling became the accepted technique that is still in use today. The application of computer technology for

digitizing and processing data, and the use of micro-circuitry to build more efficient and sensitive equipment were responsible for the success of CDP multichannel seismic reflection profiling.

The first seismic surveys in the Mid-Atlantic offshore were conducted by Maurice Ewing (then at Lehigh University), principally with support from the Geological Society of America (GSA). These were refraction seismic surveys, conducted from 1935 to 1939, as part of an Atlantic Coastal Plain project. One segment (Part III of that project) was a series of three refraction seismic profiles across the New Jersey Coastal Plain and, using a Wood's Hole Oceanographic Institution (WHOI) vessel, out to sea for approximately 30 miles (M. Ewing, 1939). The objective was to discern the Coastal Plain stratigraphy and correlate it with onshore well data. In addition, Ewing attempted to define the basement configuration. East Coast offshore seismic surveying was interrupted by World War II, but started again in 1948, when Maurice Ewing began a program of seismic refraction profiling off New York and New Jersey. This program was sponsored by the newly created Lamont Geophysical Observatory with Ewing as its first director. Jack Oliver and Charles Drake, early Lamont graduate students, published, in 1951, the results of seismic refraction profiles near the west end of Long Island, New York. Drake et al. (1959) summarized these studies in a classic paper that noted the huge thicknesses of sediments offshore and correctly compared these deposits to ancient geosynclines. John Ewing ran some early CSR profiles off the north-central New Jersey coast in 1960 and 1961 (J. Ewing et al., 1966).

In 1960, WHOI, with Elazar Uchupi and K. O. Emery as managers, began a serious study of the eastern Continental Margin sponsored by the U. S. Geological Survey. From 1962 to 1968, with funding from many federal agencies, WHOI ran several thousands of miles of CSR profiles along the Atlantic continental margin. Sparker and air gun acoustic energy sources were employed for these profiles (Emery et al., 1970). The profiles and those from the earlier Lamont Geophysical Observatory program produced detailed and reliable information of the shallow continental shelf stratigraphy and subsurface structure but the basement reflector was only well-defined far offshore in oceanic areas. Basement was too deeply buried under the shelf and slope to be detected in early CSR work. In 1967, two major CSR surveys, Chain 70 and 73, were conducted from Nova Scotia to Cape Hatteras and included several hundred profile miles in the Mid-Atlantic Area.

The oil industry and several geophysical service companies began seismic reflection work in 1960 in the Mid-Atlantic region. The first federal Geological and Geophysical Permit for seismic surveying in the Mid-Atlantic was issued in 1960 by the USGS to Kerr-McGee Oil Industries, Inc. (USGS, 1960 to date), for a seismic reflection profile between Cape Charles, Virginia and Long Island, New York. Since that time industry by itself has conducted 85,000 miles of CDP seismic reflection profiles in the Mid-Atlantic OCS Area (Donald Clark, MMS, personal communication, 1982). The first of these industry seismic surveys used chemical explosives as the acoustical energy source. This was later replaced by a variety of non-explosive energy sources, including sparker, gas gun, and air gun. Since 1971 the air gun energy source has been used almost exclusively.

The USGS became active in seismic reflection profiling in the 1970's when it was authorized by the Congress to evaluate the geology and resources of the continental margins of the United States. In 1973 the USGS Branch of Atlantic-Gulf of Mexico Geology (now based at Wood's Hole, Massachusetts) began contracting of multichannel CDP seismic reflection profiles covering the entire Atlantic margin. A series of 38 Atlantic offshore profiles were conducted from 1973 to 1978, with 21 full or partial lines located between Cape Cod and Cape Hatteras (Schlee et al., 1976; Schlee, 1981). Locations of these USGS lines are shown on Figure 4. The Branch has recently (1980-1982) been studying nearshore rift basin structures off New Jersey and Long Island. The USGS group is still analyzing the data from these profiles to develop a more detailed seismic stratigraphy of the Atlantic margin. In addition, they are assisting in data analysis from a series of multichannel seismic reflection profiles run in 1979 by the Federal Geological Survey of West Germany, the Bundersanstalt fur Geowissenschaften und Rohstoffe (designated as the BGR Lines on Fig. 4). The major objective of the 1973-1978 profiles, and most of the other USGS profiles, was to gather subsurface information for a better understanding of the geology of the continental margin and to provide an independent appraisal of potential hydrocarbon-bearing structures in making estimates of hydrocarbon resources on the Atlantic Coast.

In 1972, the Naval Oceanographic Office (NOO), USGS, and WHOI undertook a cooperative seismic survey and collected data from two single-channel reflection profiles across the Mid- and North Atlantic margins (Schlee et al., 1976).

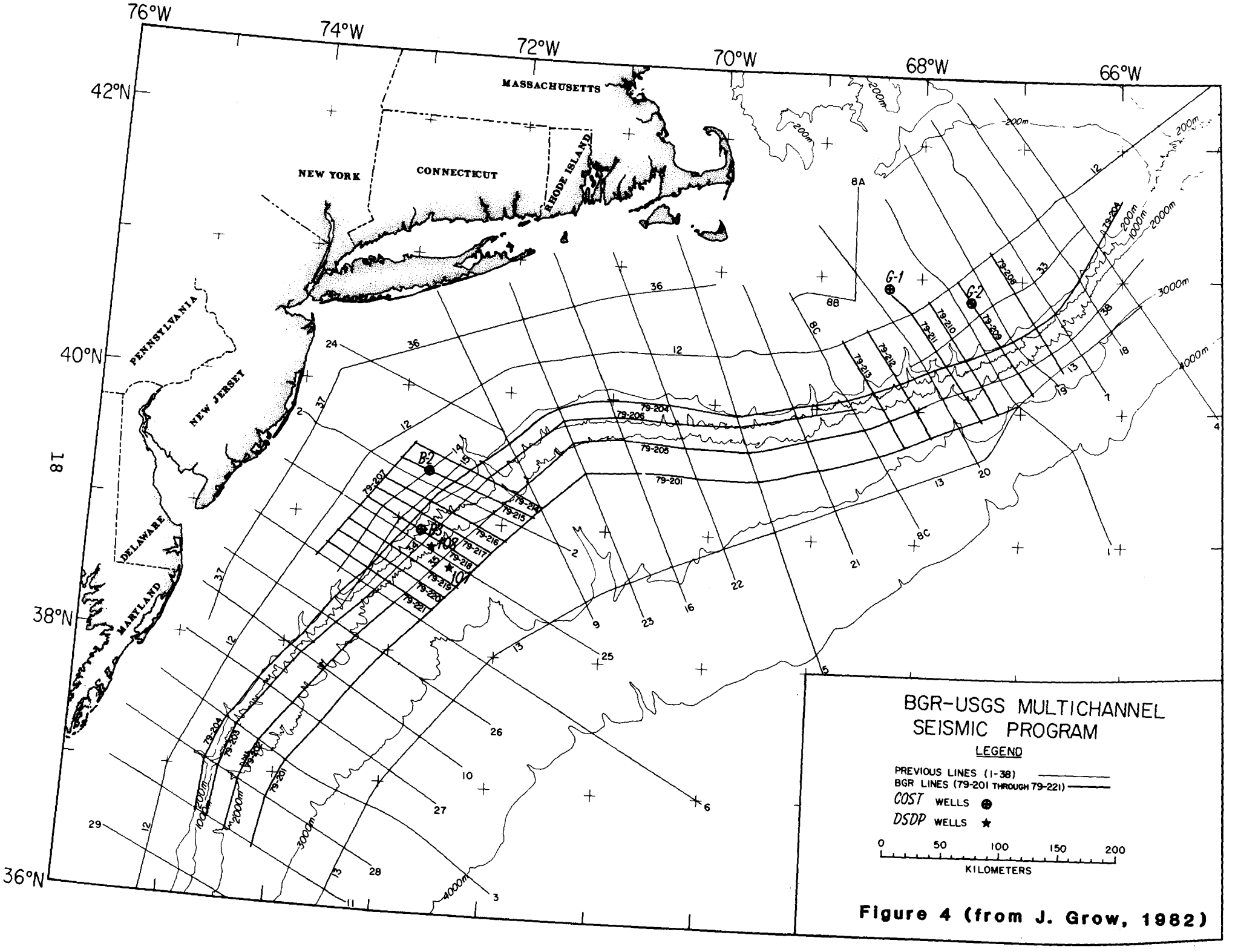


Figure 4 (from J. Grow, 1982)

Data from the several references cited above totals approximately 50,000 miles of public agency (non-proprietary) CDP single and multichannel seismic reflection profile lines conducted in the Mid-Atlantic Area from 1962 to the present day. Included in that total was another cooperative project between USGS and the National Science Foundation (NSF) which contracted for a series of long-line CDP multichannel profiles from Cape Hatteras southeast across the entire continental margin. This series of lines, over 2,100 miles long, was part of the International Phase of Ocean Drilling (IPOD) project (Grow and Markl, 1977).

The most recent seismic reflection profiling done by a non-industry group was a Lamont-Doherty Geophysical Observatory seismic reflection program in the Mid-Atlantic Area (Watts, 1981). This program, which ran from 1978 to 1981, was directed toward filling in some of the wide spacing between the USGS lines.

In 1974, a 300,000-square mile aeromagnetic survey was contracted by USGS to complement the CDP seismic reflection profiles being conducted in the Mid-Atlantic Area. Aerial coverage extended from Maine to Florida (DOI News Release, 9/14/74).

The DGS became involved with Atlantic margin geophysical studies in 1976 when it contracted with Digicon, Incorporated for a 41-mile, high resolution seismic reflection profile along the Delaware coast. This survey was funded by a grant from OCZM and sponsored by OMBP. Additional funds were provided by USGS to connect with the western end of USGS Line 10 (Fig. 4). The purpose, as noted by Woodruff of the DGS, "...was to map the top of the basement surface beneath the rocks of the Coastal Plain sediments in southern Delaware" (Woodruff, 1977, p. 1). This survey and other geologic work conducted by the DGS were parts of a major project by the DGS to assist the Delaware Coastal Zone Management Program in a preliminary evaluation of the hydrocarbon potential of the nearshore coastal region, and help in the interpretation of seismic and well data from the Mid-Atlantic OCS Area that would be acquired from various sources. An adjunct study to the DGS seismic profiling project was a DGS-sponsored analysis and interpretation of unpublished USGS aeromagnetic surveying data covering the same nearshore area as the seismic reflection lines. The interpretation of these aeromagnetic data complemented the results obtained from the seismic profiling and indicated that depth to basement (either crystalline or acoustical) 15 miles off the coast was over 16,000 feet

(Woodruff, 1977). This depth is well in excess of previous estimates both in Delaware and other parts of the Atlantic shore.

The DGS has since undertaken an extensive program to interpret the seismic stratigraphy of the offshore area, in the Mid-Atlantic region using proprietary and non-proprietary multichannel CDP seismic reflection profile information, plus offshore well data from several sources.

COST Wells

OCSLA and the Regulations [30 CFR 251.9(b)] provide for test drilling both shallow (< 1,000 feet) and deep. The regulations require that the deep penetration wells be located off-structure to be sure that no hydrocarbons are encountered.* Deep test wells have been completed in the Mid-Atlantic Area by two consortia of oil companies that are called Continental Offshore Stratigraphic Test (COST) groups.

The first COST well, designated B-2, was drilled by Ocean Production Company, as operator for 31 oil companies. The B-2 well was located 78 miles east of Atlantic City, New Jersey in 298 feet of water on OCS Block 594, Protraction Diagram NJ 18-3. Drilling commenced on December 14, 1975 and was completed at 16,043 feet on March 18, 1976. A complete suite of well cuttings, samples, electric logs, physical information logs, and a variety of other scientific reports were produced. In addition, 822 sidewall and 4 conventional cores were recovered. The well penetrated sediments of Jurassic to Pleistocene age but did not reach crystalline basement. No oil or gas shows were encountered (well data from USGS Open File Report 76-744, 1976). The Maryland Geological Survey, by agreement with the B-2 well operator, received the well data as it was generated. Under the agreement, the State Geological Surveys of Delaware, Maryland, New York, and Virginia were able to examine the data on a confidential basis at its repository at the Maryland Survey office. This same agreement also held for the B-3 COST well data (DGS office files).

---

*This Regulation was changed in January 1980 to allow on-structure location ((DOI News Release, January 25, 1980).

The second COST hole, B-3, with Chevron, USA Inc. as operator for 11 oil company participants, commenced on October 9, 1978 and was completed on January 25, 1979. It was located 93 miles southeast of Atlantic City, New Jersey on OCS Block 66 of OCS Protraction Diagram NJ 18-6 in 2,686 feet of water. It penetrated sediments of Tertiary, Cretaceous, and Jurassic age and was completed at a depth of 15,820 feet without encountering crystalline basement. The well had an unexpected gas show within the interval 15,744 to 15,752 feet which was judged significant by USGS (Scholle, 1980). Sampling, logging, and other measurements similar to those for the B-2 well were conducted (well data from USGS Open File Report 79-1159, 1979). The location of the two COST wells is included in Figure 15.

The purpose of the COST wells was to analyze the well cuttings and core samples for a wide variety of geological and chemical characteristics in order to evaluate the potential hydrocarbon resources before leasing. It also allowed for calibration of seismic reflection profiles by comparing both down-hole geophysical logs and lithologic descriptions of the sedimentary layers with the reflectors on seismic record sections.

Shallow Depth Core Hole Projects

Several shallow depth core hole projects were included in the Mid-Atlantic Area: the Atlantic Stratigraphic Project (ASP) in 1967; the Atlantic Margin Coring Project (AMCOR) in 1976; and the Deep Sea Drilling Project (DSDP) in 1970.

The ASP was sponsored by a consortium of oil companies to drill a series of holes at various locations along the Atlantic offshore. Most of these holes were located on the eroded continental slope in order to obtain the maximum geologic data from continuous coring of outcropping stratigraphic units that normally would not have been penetrated in a 1,000 foot well on the flat shelf. These data were used to calibrate seismic reflection profiles and obtain geochemical and thermal information on the character of the sediments encountered. The R/V Caldrill II was used as the drill ship in the ASP work (Beard, Sangree, and Smith (1982).

The AMCOR Project, conducted in 1976 by the USGS, was designed ".... to obtain information on the stratigraphy, hydrology, and underwater chemistry, mineral resources other than petroleum hydrocarbons and geotechnical engineering

properties at sites widely distributed along the continental shelf and slope of the eastern United States" (Hathaway et al., 1979, p. 515). Nineteen sites were drilled, with eight located in the Mid-Atlantic Area. As with the ASP program, continuous coring was conducted with reasonably good core recovery. All core material was analyzed at both shipboard and shoreside laboratories for a complete spectrum of physical, chemical and hydrologic properties. Post-completion bore-hole geophysical surveys using a variety of sensors were also conducted whenever possible.

DSDP Leg 11 in 1970 completed four holes off New Jersey. Mid- and deep water continental margin sediments and oceanic crust were encountered in the four holes. Sites 105-108 were located in an approximate south-southeast line extending from the base of the continental slope seaward for over 400 miles. A variety of regional stratigraphic and seismo-stratigraphic objectives were achieved that contributed to the geologic knowledge of the region. CSR profiling was conducted for short distances over each drill site by R/V Chain (Hollister et al., 1972).

The geological information derived from interpretation of three decades of exploratory work formed the basis for a number of actions and decisions by industry, the federal government, various Coastal States, and the general public in anticipation of the test well drilling program which began in 1978 on Mid-Atlantic leases. Geology was truly "calling the shots in the OCS program" because it alone was able to give some idea where potential oil and gas resources were located.

It should be noted that even with what seems to be a large amount of data available, much more is needed to solve the important problems of the Mid-Atlantic region. Compared to the amount and detailed quality of data from the Gulf Coast offshore, the Mid-Atlantic is still an unknown frontier province. From 1963 to 1980, 5,478 permits were issued to conduct geophysical surveys off Texas and Louisiana. During that same time the entire Mid-Atlantic Area has received only 147 permits. The Louisiana federal OCS region alone reports 15,858 wells drilled through 1980. The Mid-Atlantic has had 30 wells drilled. Much more geologic data must be acquired before the potential of the region can be adequately assessed.

BACKGROUND FOR STATE-FEDERAL RELATIONSHIPS IN THE MID-ATLANTIC AREA, PRE-1975

Overview

The OCS Mid-Atlantic leasing program began in 1975 with the DOI process for a Mid-Atlantic Sale. From 1975 to 1981 three lease sales (40, 49, and 59) were held, and 28 exploratory wells drilled without discovering a proven commercial oil or gas field. This period was also a time of continual and sometimes difficult negotiation between the Coastal States and the federal government to find policy directions which would accomodate the objectives of both sides and still provide an opportunity for the industry to explore the resources of the region. These negotiations were difficult, in part for reasons that can be traced back for many years, even to the early Gulf Coast lease sales.

Prior to the Atlantic OCS leasing program, the administration of OCS oil and gas operations was designed for the Gulf Coast, where there was an orderly and mutually supportive relationship between DOI and industry. Oil was inexpensive, and offshore lease sales were held in areas with a long history of oil production. The principal concern of DOI at that time was to protect the resources from over-production and wasteful extractive practices. The entire leasing process changed dramatically when it was extended to include the Atlantic OCS frontier. This change was in part predictable: when shifting from a known producing area to an unknown area there are always basic management problems which have to be overcome. However, there were more serious difficulties than just moving to the Atlantic frontier. These resulted from a series of events which took place outside the leasing program itself both prior to and shortly after the first Atlantic lease sale. These events, some of which still affect the process, brought about major changes in the conduct of the OCS leasing operations.

Record of Events

(1) The first of these events occurred in January 1969 during the drilling of a production well by Union Oil Company on the West Coast 15 miles off Santa Barbara, California. Oil and gas from a shallow, 500-foot deep reservoir began to escape from the well bore and up through the seabed trace of a fault which had been penetrated by the drilling operation.

Oil and gas poured into the ocean for several days at the rate of approximately 500 barrels a day. Only after vast quantities of drilling mud were pumped into the well was the company able to contain the flow. The drilling plan had not anticipated oil or gas zones higher than 1,200 foot depth. During the outflow period an 800-square mile oil slick developed, reaching shore in several places. Beaches, harbor facilities, and hundreds of boats were affected by the oil slick. Some birds and fish were lost. Cleanup operations, begun immediately after the oil leak was discovered, were completed in three months. Opinions differ on whether any large amount of permanent damage occurred from this spill. In any event, public response was very strong. It triggered a temporary suspension of all California OCS activities and caused the USGS to implement stricter drilling rules. In addition, new federal laws and regulations established that oil companies would be liable for damages and for clean up of oil spills resulting from OCS operations (details from Oil and Gas Journal, 2/10/69, p. 50 and 2/17/69, p. 43).

(2) In 1969 the National Environment Policy Act (NEPA) was enacted (42 USC 4321, et seq.). It was implemented in 1970 by Executive Reorganization Order No. 3 which established the cabinet-level Environmental Protection Agency (EPA). Section 102 of NEPA contains a requirement that all federal agencies include a detailed statement regarding the environmental impact of every major federal action that would significantly affect the quality of the human environment [Sec. 102(2)(C), 42 V.S.C. 4332 (2)(C)]. This became the commonly required Environmental Impact Statement (EIS) for any major project involved with federal money or federal lands, including the OCS.

(3) President Nixon, in mid-1973, declared an energy war called "Operation Independence." The following January he directed the Secretary of DOI to accelerate its entire OCS leasing program by tripling the annual acreage leased on the OCS by 1979 (Project Independence Report, 1974). This acceleration resulted in a new 5-Year OCS Planning Schedule that called for the beginning of Atlantic Coast lease sales in 1976. The accelerated OCS leasing program was viewed by many Coastal States as a potentially dangerous decision. They felt that there was insufficient time to conduct the essential baseline environmental studies and other impact evaluations within the time schedule outlined by DOI.

(4) Several years prior to their confrontation with DOI over the accelerated leasing program, several Coastal States

were challenging the federal government over another matter: the three-mile limitation imposed by the Submerged Lands Act of 1953. These challenges were all decided in the U. S. Supreme Court where the judicial decisions supported the federal government.

There were two periods of challenge, an early one from 1957-1960, related to the controversy over passage of the Submerged Lands Act. The States of Florida, Louisiana, Texas, and California brought suit against the federal government to be excluded from the three-mile limitation under the Act. Another legal challenge to the three-mile limitation, more closely related to the Mid-Atlantic region, was initiated in 1968 when the State of Maine, through its Mining Bureau, issued prospecting permit rights and a conditional License to Mine to King Resources Company of Denver, Colorado, to explore for oil and gas on a 3.3-million acre tract extending seaward from the Maine coast 80 to 100 miles. In 1969, using Maine Mining Bureau submerged lands mining leases as a precedent, the Maine State Attorney General approved a conditional license for King Resources Company. He cited as justification British Colonial treaties which granted extensive seaward jurisdiction to the Massachusetts Bay Colony (and thus to Maine). The other Atlantic Coastal States, including Delaware, joined Maine in asserting jurisdiction beyond the three-mile limit based on similar crown grants. The U. S. Attorney General filed a complaint with the Supreme Court to overturn this claim of the thirteen States. The Court accepted the complaint and appointed a Special Master to examine the facts of the case and make recommendations to the Court. The case, U. S. vs. Maine et al., drew considerable national attention and delayed leasing in the Atlantic OCS for several years. During that time, King Resources Company conducted extensive seismic surveys over portions of its offshore licensed area, but in agreement with the State of Maine did not drill a well. The recommendation of the Special Master and a subsequent decision of the Supreme Court reaffirmed the federal definition of the Submerged Lands Act and rejected this last State challenge (Maris, 1974).

(5) Another federal action proved to have very strong impact on federal-State relationships in the OCS leasing program. In 1972, the Congress passed the Coastal Zone Management Act (CZMA) (16 USC 1451, et seq.). This Act established an Office of Coastal Zone Management (OCZM) to support and assist in the development of State management plans for more effective protection of the sensitive coastlands of the nation. This support, which provided funds and allowed increased

jurisdiction over the coastal zone to the various States, enabled those States to begin developing individual coastal management plans to control coastal activities and to protect the environment. All during the 1970's State coastal zone management plans were designed, approved (by OCZM), and implemented (Sec. 306, 16 USC 1455). Amendments to the Act in 1976 also required (Sec. 307, 16 USC 1456) that USGS not approve exploration plans, including drilling, until Coastal States concur with a consistency certification accompanying such exploration plans when presented by a prospective industry operator (30 CFR 250.34.1). Consistency means that these exploration and drilling plans must be consistent with the terms of each coastal management plan adopted by a State affected by such operations. This consistency requirement, adopted by USGS in the Federal Regulations in 1978 and 1979, became one of the most important guarantees to Coastal States that their environments and public interests would be considered in all OCS operations.

The 1976 CZMA amendments also established the Coastal Energy Impact Program (CEIP). This program provided funds to the Coastal States to study OCS oil exploration and plan projects to ameliorate their impacts. The CEIP has become the principal source of revenue for the States to carry on this important task of evaluating energy development impacts.

(6) Two other environmental laws affecting OCS activities were passed in 1972. These were the Federal Water Pollution Control Act Amendments and the Marine Protection, Research and Sanctuaries Act.

Comparison of Atlantic and Gulf Coast Leasing Areas

Not only were there new public attitudes and more stringent laws constraining Mid-Atlantic OCS oil and gas activities and the leasing program, there were also problems created by differences in the history, geography, and geology of the Atlantic and Gulf coasts.

When offshore leasing began in 1954, the Gulf Coast had been an oil-producing region for almost 50 years. Much of the economy was oil-industry based, and initial offshore leasing was reasonably well received. Given the very large number of wells drilled in the Gulf Coast, oil spills have been negligible and no major environmental disaster has occurred. The Gulf Coast fishing and oil industries had grown up together

and had learned to accomodate each other. Some controversy existed during the early days of offshore drilling, but this did not seriously hamper the program. On the Atlantic Coast however, where the richest fishing area in the world covered one-fourth to one-fifth of the offshore area, oil well drilling was almost foreign to public perception. By the 1970's concern over the environment became a major public issue. Reaction to offshore exploration on the East Coast was often negative, and a lack of information from a traditionally reticent industry and from federal agencies did not encourage confidence in the already environmentally aware public. This problem was compounded when, four months after the first Atlantic OCS lease sale, in December 1976, the Liberian tanker ARGO MERCHANT grounded on Nantucket Shoals, spilling over 166,800 barrels of No. 6 fuel oil into Nantucket Sound (Oil and Gas Journal, 12/27/76, p. 88 and 1/3/77, p. 36). There were also two major tanker spills in the Delaware River estuary in 1975 and 1976, and grounding of an oil barge at Rehoboth, Delaware in 1968 (DGS files).

These tanker accidents and the increased interest by industry and developers in supertanker ports with their requirement for more oil refineries on the East Coast caused the public to view any oil-related activity as a major environmental threat. They equated hydrocarbon exploration with tankers, refineries, and oil spills, and began to resist the proposed OCS leasing program. Oil in whatever form was becoming a dirty word to the people of the eastern Coastal States.

In addition to public perceptions and attitudes about Atlantic Coast oil drilling, the very nature of the geography and geology of the Atlantic and Gulf coasts are very different. These differences also make the move from Gulf Coast to East Coast more difficult. Compared to the shallow offshore waters, low-lying coastal topography and smooth, unindented coastline on the Gulf Coast, the geography of the Atlantic coast is quite different. The waters directly off the Atlantic shore are much deeper, coastal relief is greater, and the irregular coastline is cut by deep, long estuaries extending far inland. The geologic settings of the Gulf and Atlantic coasts are also markedly different. Much of the thick sedimentary wedge forming the Gulf Coast continental margin is emergent and forms the Gulf Coastal Plain (Fig. 5). Both on- and offshore it is hydrocarbon-bearing. The structures containing oil onshore are continuous offshore, so that the first move offshore in Louisiana was an easy step, following oil-bearing structures seaward. The emergent portion of the

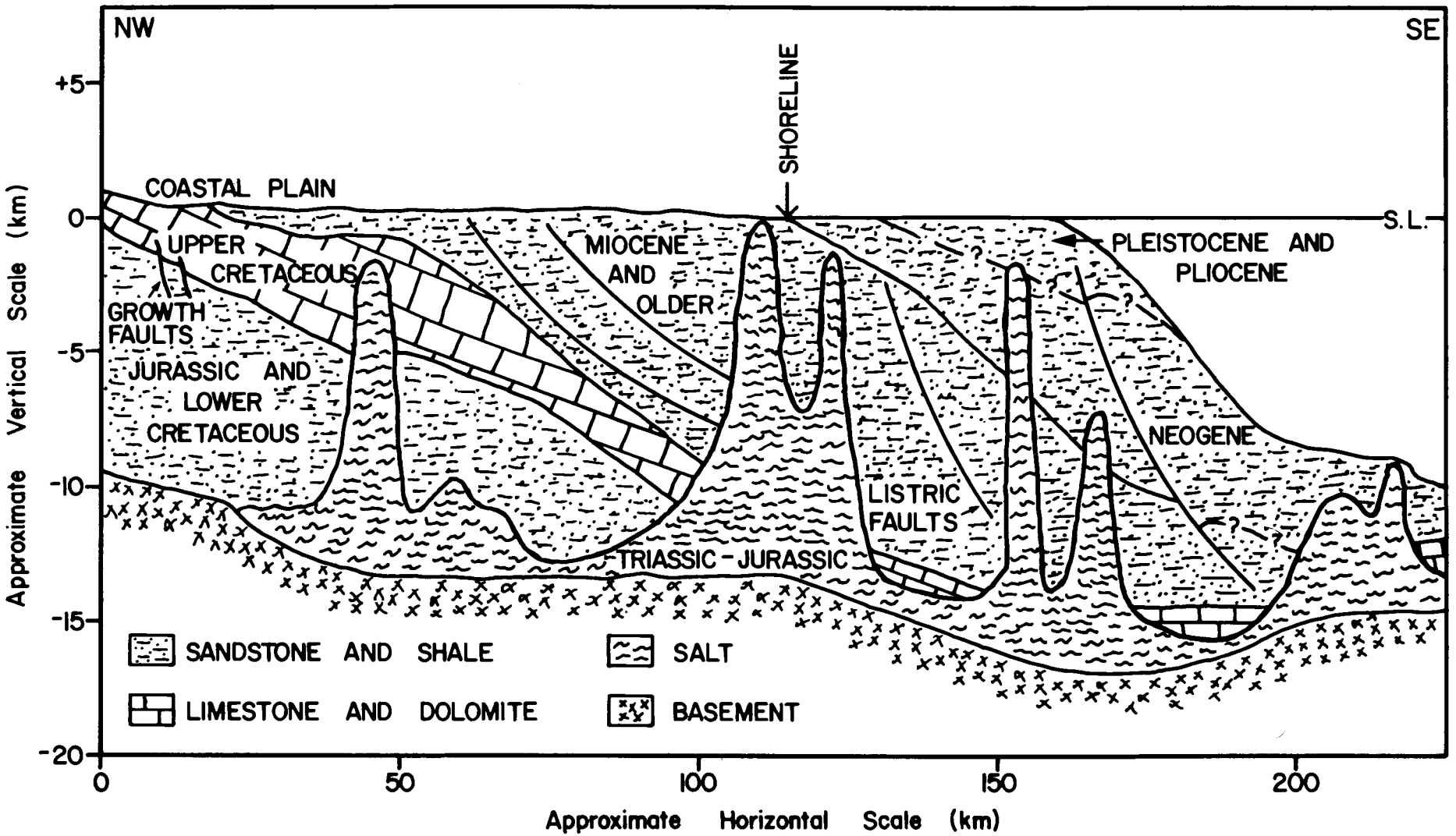


Figure 5. Diagram showing Gulf Coastal Plain - continental shelf geology. (Modified after Burk and Drake, p. 689, 1974.)

Atlantic continental shelf - the Atlantic Coastal Plain - however, narrows and becomes submerged under the ocean in northern New Jersey. Sediments are thinner beneath the Atlantic Coastal Plain compared to the Gulf Coast, and therefore have less hydrocarbon potential than the thicker offshore portion (Fig. 6). The initially prospective part of the East Coast continental shelf lies at least 60 miles offshore. There is no easy stepping out from onshore to offshore following a single oil-bearing structure as there was on the Gulf Coast.

These physical and attitudinal differences, plus the new environmental laws and increased public sensitivity to environmental problems combined, by 1975, to make the Mid-Atlantic OCS Leasing Program very complicated and often controversial.

HISTORY OF STATE-FEDERAL RELATIONSHIPS IN REGARD TO THE MID-ATLANTIC OCS, 1975-1981

By the mid-1970's the combined effects of both more stringent environmental and coastal management legislation, plus the strong public reaction to the major marine oil spill incidents alerted Coastal State officials to the practical and political necessity of increased involvement in the Atlantic OCS leasing program. This involvement became the focus of State-federal relationships during the six-year period. This section describes those OCS-related activities which took place in three arenas: in Delaware, within a Mid-Atlantic interstate council, and in the federal agencies.

Initial Actions

Interagency activity prior to 1975 was informal, with State officials using professional contacts with their federal counterparts to stay in touch with the developing OCS leasing program on the Atlantic Coast. These contacts, plus some knowledge of the Gulf Coast leasing program, provided the few guidelines used to build organizations that were the precursors of the more formal federal-State organizations which would develop from 1975-1978. In 1973 and 1974 Atlantic Coastal State officials held several informal meetings with BLM and USGS representatives to discuss the details of the proposed Mid- and North Atlantic lease sales. At this same time,

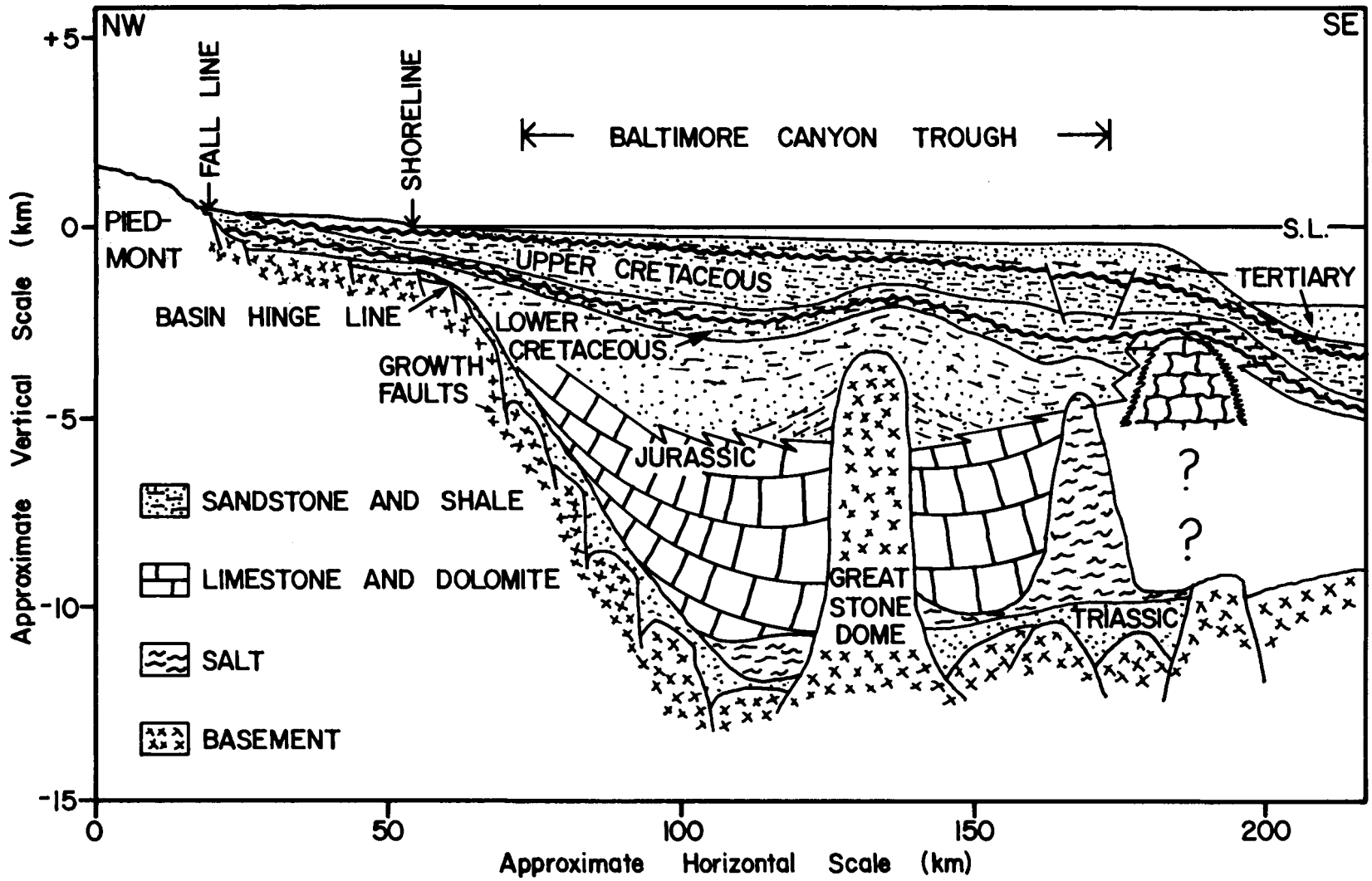


Figure 6. Diagram showing Atlantic Coastal Plain - continental shelf geology. (Modified after Grow *et al.*, 1979, p. 78-80.)

the U. S. Fish and Wildlife Service and the U. S. Park Service, together with State environmental officials, began to press the DOI to expand and accelerate its environmental baseline studies of the OCS. The marine life monitoring program of the Louisiana Department of Wildlife and Fisheries became a model for the original East Coast environmental studies.

Delaware recognized the need to begin preparing for East Coast oil and gas exploration in the early 1970's. Governor Peterson, in 1970, appointed a Task Force on Marine and Coastal Affairs "... to develop a master plan for our coastal and bay areas" ("The Coastal Zone of Delaware," p. XXV, 1972). In June 1972, the Task Force published its final report, a 464-page review of Delaware's coastal zone.

State boundary issues, which were to become so important and controversial in later years, were discussed in 1971, and a formal Delaware State Boundary Commission was established in November of that year. A Board of Registration of Geologists was established by the General Assembly in September 1972.

In 1971, a select committee appointed by the Delaware General Assembly submitted a comprehensive report on oil transport. This report, "Energy, Oil, and the State of Delaware" formed the basis both for future oil transport legislation and for dealing with BLM on transportation planning (Delaware Bay Oil Transport Committee Report, January 15, 1973).

The Mid-Atlantic States collectively recognized the need for a more effective method of interacting with the proposed OCS leasing program. The Mid-Atlantic State Geologists in 1972 and 1973 began discussions of the common interests in the OCS program. Out of these discussions a more formal meeting was held in Annapolis, Maryland in July 1974, when policy planning and technical representatives from several Mid-Atlantic Coastal States met to discuss the prospects for more effective interrelationships with the DOI. This was the first of several State technical and policy meetings which, by mid-1975, resulted in the formation of the Mid-Atlantic Governors' Coastal Resources Council (MAGCRC). This organization was to become the major point of contact between the Mid-Atlantic Coastal States and federal government agencies. The representatives from Delaware that participated in pre-MAGCRC discussions had been brought together by Governor Tribbitt of Delaware as an informal OCS committee following recommendations at a Governor's Seminar on OCS Oil

and Gas Activities at the University of Delaware in September 1973. The Delaware State Planning Office, DNREC, and the DGS staffed this informal OCS committee. Its initial task was to study all DOI activities concerned with the OCS and advise the Governor on policy matters (DGS files). To implement this task, the committee established the following guidelines (from DGS files):

1. It was important to explore the area in order to prove the presence and size of hydrocarbon resource deposits, if only for future national self-sufficiency.

2. As a legitimate concern of State government, Delaware must be involved in all phases of planning and policy decision-making in the OCS leasing program.

3. Timely acquisition and analysis of technical data operations is a primary requisite for deciding State OCS policy questions. This item has been a serious concern of DGS because only by study and evaluation of these data can the agency effectively advise the Governor on the nature of the resource as well as responses to the DOI leasing program. It should be noted that there has been an apparent reluctance by DOI, continuing to the present day, in sharing the proprietary well and seismic data with the Coastal States, even though the OCSLA Amendments and ensuing regulations clearly authorize this on confidential bases.

The action of the Mid-Atlantic States forming MAGCRC, and a similar move by the New England River Basin Commission to coordinate a common response to the OCS program, made it clear to DOI that a more formal interagency mechanism was necessary. The Department had previous experience in the Southeast when BLM treated Mississippi, Alabama, and Florida (MAFLA) as a single entity in an earlier sale. MAFLA was in part a model for developing the first State-federal OCS advisory group, the OCS Research Management Advisory Board (OCSRMAB). Established in 1974, its original role was to advise the BLM on scientific research programs that were related to OCS environmental studies. The OCSRMAB has been succeeded by a series of interagency groups culminating in the present OCS Advisory Board and its satellite committees.

Delaware Activities, 1975-1981

Delaware was deeply involved with the OCS program from the time of the announcement of the first Mid-Atlantic sale in 1974. It maintained, through DNREC representation, an

active membership, until 1977, in the Coastal States Organization (CSO). State agency representatives involved with planning, environmental affairs, and geology have participated in all of the federal organizational groups and advisory meetings with BLM, the USGS, and other DOI agencies. Delaware was among the first of the Mid-Atlantic Coastal States to make use of the OCZM and CEIP funding. This funding was used for both coastal impact planning studies and a geological and geophysical data acquisition and interpretation program by DGS since 1975.

Three Delaware State agencies shared the effort in Delaware's OCS program. DNREC has served as the focus of an environmental impact analysis program. OMBP has had the responsibility of not only writing the coastal zone planning and management program for Delaware, but has also administered the OCZM funding program, including CEIP fund distribution. The DGS has, from the early 1970's, continued an active program of evaluation of all the technical matters relating to OCS operations. DGS has also been the point of contact between the State's internal agencies and the USGS, BLM, and other federal agencies and the oil industry. The DGS has been particularly close in its relationships with the BLM and various OCS advisory groups sponsored by the DOI.

From 1975 through 1978 the various State agencies in Delaware were very active in OCS matters. Since 1978 however, the relationship has become more formalized, routine, and to a large extent, supportive. After the Congress passed the OCZM and OCSLA amendments, and after DOI came to recognize more clearly the interest of the States in the OCS leasing program, the federal government tended to accept the role of the Coastal States in the process. The States had, at least in part, achieved their objective to obtain a more prominent role in the planning and execution of the program. The first few years of the Mid-Atlantic leasing program were, however, very active for the State. A very extensive and careful critique of the Sale 40 Draft Environmental Impact Statement (DEIS) in the cooperative effort between DNREC and the DGS resulted in the submission of a 30-page commentary on the State to BLM. The State also made an oral presentation at the DEIS hearings. Delaware had a major role in establishing MAGCRC. Governor Tribbitt chaired the MAGCRC organizational meeting in March 1975. OMBP and several State agencies were very active during 1975 in an extensive lobbying effort to insure that amendment of the OCZM Act would include funding for energy impact studies when it was finally passed by the Congress. Representatives from OMBP and DNREC also

participated in meetings of the CSO concerned with an interstate safeguard system to protect the coastal beaches and the nearshore marine fisheries.

One of the most important programs in Delaware State government, and one which is still active, was the DGS technical data acquisition program. In late 1975, anticipating the Mid-Atlantic OCS exploratory drilling program, the DGS added a petroleum geologist to its staff. It had already been acquiring geologic data in the Mid-Atlantic Area, but with this new position it was able to initiate a major program of acquisition and interpretation of newly available public and proprietary CDP seismic reflection profile lines covering much of the Mid-Atlantic Area. The objective of this data acquisition and interpretation program is to provide timely knowledge of the hydrocarbon resource potential of the Mid-Atlantic OCS. DGS has found that the most effective way of accomplishing this is to study the geology of the Baltimore Canyon trough and identify those areas which have promising hydrocarbon potential. The geologic study was also important to provide accurate information and make an accurate interpretation of data provided by DOI on potential geologic hazards. These hazards include submarine slumping of the sea bottom, the presence and potential for leakage of shallow hydrocarbon accumulations, and other geologic features which make both the sea bottom and the drilled sedimentary layers unstable.

The DGS had two principal sources of seismic reflection and other geophysical data. One was low cost seismic records generated by the Branch of Atlantic-Gulf of Mexico Geology in the Office of Marine Geology, Geological Division, USGS. The other source was purchased seismic data from private geophysical contracting companies; speculative seismic surveys which have been run and offered for sale to industry or any other interested buyer. Seismic data acquired by this method must be held confidential by agreement between the DGS and the seismic contracting company. These data have provided the DGS with an opportunity to map the subsurface geology of the Baltimore Canyon trough and the areas near and onshore in Delaware.

The DGS data acquisition program and federal agency liaison activities were at first supported entirely through the DGS' budget which could only allow limited participation. Beginning in 1976 however, and continuing to the present, the DGS has been able to expand its activities and develop the program through contract funds provided by OMBP and later DNREC, the agencies responsible for administering NOAA's OCZM grants to the State.

An additional source of funds for the State was a share of a MAGCRC grant of $115,000 obtained in 1975 from the Federal Energy Administration (FEA). This grant was divided between MAGCRC and its member States. It was provided by FEA for a study on the problems of developing the Atlantic OCS leasing program. The grant to MAGCRC itself allocated $35,000 for an analysis of the current studies which were concerned with OCS activities, including the DOI EIS and other technology assessment programs relating to the Baltimore Canyon trough. The balance of $16,000 per State was to enable each of them to prepare an analysis of existing State laws and regulations (Federal Energy News, FEA, June 16, 1975). The product of the Delaware portion of the study was published in June 1976. It was entitled, "Delaware and Outer Continental Shelf Development Roles and Systems at Various Levels of Government." The Delaware State Planning Office prepared the report, with the DGS assisting in the review and editing process.

During 1976 and 1977 the DGS and other State agencies continued their active participation in MAGCRC. By 1976 this Council was the focus of federal-State relationships concerned with the Atlantic OCS. Representatives from State agencies attended meetings of the various OCS advisory groups that were being organized, sponsored, and frequently revised by the DOI. DGS staff geologists participated in the COST well confidential data distribution program initiated by MAGCRC and on March 18, 1976 several State geologists visited the COST B-2 semi-submersible drilling ship SEDCO-J. Representatives of various State agencies testified at several federal hearings and participated in meetings of importance to the State. These included the amendments to the OCZM law, the introduction of the OCS Order No. 15 (granting the Coastal States an opportunity to review proposed oil company drilling and development plans), and the first hearings concerned with amendment of the OCS Lands Act. Activity in the State in 1976 was dominated by preparations for OCS Sale 40. The DGS was also involved with BLM in an attempt, late in 1976, to develop a new and more effective way of managing the Call for Nominations and the Tentative Tract Selection processes. These new methods would be tested for Sale 49.

The Delaware General Assembly had begun hearings on a State Energy Act which would eventually be passed in mid-1978. In anticipation of this legislative action, the several State agencies involved with energy matters, including the OCS program, organized an informal energy facilities committee that first met in 1977.

One of the most important OCS-related items in 1977 was a Mid-Atlantic Governors Policy Position Statement. The gist of this statement, prepared and presented in June 1977, was to tell the federal government that the States, although generally supportive of the OCS leasing program, would no longer accept a secondary role in the OCS planning and leasing program. The Governors asked for a more effective and extensive environmental evaluation study of the Mid-Atlantic. The statement also contained recommendations for a reorganization of the federal-State advisory structure, which until that time had been an out-of-focus discussion group between the two sides. It also did much to provide a better perspective on the entire picture of federal-State relationships.

During 1976 and early 1977 the oil companies also began to have discussions with the Coastal States in regard to the proposed Sale 40 drilling program. The American Petroleum Institute (API) requested a meeting of several Coastal States to discuss the upcoming drilling program and the potential impact on those States. This meeting was held in October 1977 in Wilmington, Delaware and served as a springboard for continued and lengthly discussions between Delaware State officials and representatives of the oil industry.

With the passage of the Delaware Energy Act in 1978, more recognition was given to the informal energy facilities siting committee. In late 1978 the new State Energy Office formally established an Energy Facilities Siting Committee (EFSC). An OCS Subcommittee was included in EFSC to advise the State on OCS activities, advise the Governor on policy formulation, and represent the State at OCS-related meetings. The subcommittee included staff members from DNREC, the original State Planning Office (later OMBP), the DGS, and the Governor's office. It was the action committee on all OCS activities until late 1981 when the State Energy Office was reorganized by Governor du Pont.

By the end of 1978 the policy side of OCS activities within the State had become more stable and scheduled. An effective federal-State OCS policy liaison had been developed and was functioning smoothly. There were periodic bursts of activity and more frequent meetings as both Sale 49 and Sale 59 dates approached.

The discovery of oil and gas by Texaco, Inc. off the New Jersey coast in 1979 sparked considerable discussion of the possibility of future oil and gas landings along the coast.

The DGS continued its data acquisition program, and began to provide a preliminary geologic analysis of the drilling targets. The Survey published several reports on the geologic framework, offshore leasing and drilling methods, and the potential of the Texaco and Tenneco hydrocarbon shows. Various other studies concentrated on Delaware waters or the geologic environment of the inner margin.

MAGCRC Activities, The Interstate Program

Following its organizational meeting in mid-1975, MAGCRC began monthly sessions on all phases of the OCS leasing program. At the December 1976 meeting, MAGCRC outlined a set of program objectives for the following two years. The objectives included: the development of more comprehensive environmental impact studies; energy facilities siting and hydrocarbon transportation studies; the potential use of Mid-Atlantic deep water ports in oil-related activities; onshore oil and gas transmission lines; and a coordinated Mid-Atlantic coastal land use policy. MAGCRC also supported continued State participation in COST well activities, and worked to improve opportunities to obtain access to proprietary data from USGS. Figure 7 is a copy of a typical agenda for a MAGCRC meeting during 1975, in its early and active period (DGS office files).

In 1976 MAGCRC activities concentrated on preparations for Sale 40, discussions with DOI on the establishment of an OCS advisory group, and continued support for effective amendment of OCS-related laws. Both MAGCRC and the individual States pushed for changes in the pre-lease Tentative Tract Selection (TTS) process, which for Sale 40 had not included State participation. Without State participation where the sensitivities of the general public and local community groups could be considered, tract selection was heavily criticized and the overall leasing program delayed while BLM defended its choices. MAGCRC members also debated for several meetings whether or not to join with the two New York counties in the federal law suit to prevent Sale 40. New York State, in November 1976, separated itself from the suit, and shortly afterward the other State members decided not to join.

MAGCRC paid particular attention to the reports coming from the research of the Mid-Atlantic Environmental Studies Program. These reports began to reach the public by 1975 and 1976. The Environmental Studies Program was a program of research and data gathering for an OCS area to provide environmental information on baseline, environmental monitoring,

State of Delaware
DELAWARE GEOLOGICAL SURVEY
UNIVERSITY OF DELAWARE
Newark, Delaware
19711

ROBERT R. JORDAN, STATE GEOLOGIST
101 PENNY HALL
PHONE: 302-738-2833

MEETING OF AUGUST 7, 1975

SUGGESTED ITEMS FOR INFORMATION OR DECISION

A. 1. Comments on S. 521 and H. R. 6218.

2. Reaction to Final Environmental Impact Statement on Accelerated OCS Leasing Program.

3. Reaction to preliminary draft sections of BLM Draft Environmental Impact Statement on Mid-Atlantic.

B. 1. Report on tract selection meetings, including cut-off of southern high-interest tracts.

2. Report on meeting with Deputy Assistant Secretary for Energy.

C. 1. Acquisition of "proprietary" data - from USGS - from industry.

2. Maintenance of confidentiality of any proprietary data obtained.

3. Affiliation with other State Geological Surveys in

Data acquisition
Repository for data
Processing of data

D. 1. Status of marine geophysical survey permits.

2. Revision of Delaware Oil and Gas Regulations in light of changes in federal regulations.

3. Input by States of OCS Orders and leases stipulations.

4. COST wells.

5. California model for geologic reports on OCS activities.

Figure 7. Typical MAGCRC agenda, during active period, August 1975.

and other scientific activities. This information was used, mostly by BLM, to make decisions on various parts of the OCS program. Working with the newly chartered (1975) OCS Environmental Studies Advisory Committee (OCSESAC), MAGCRC assisted in the Studies Program development and also recommended that it become a multi-year, ongoing program because of its value in providing the necessary biological, geological, and oceanographic data for OCS decision-making.

In 1977 MAGCRC continued its discussions with Congress urging acceptance of State-oriented OCSLA amendments. The discussions and the completion of the FEA contract were the major activities of the Council. MAGCRC tried to help the individual States solve the problems created by CEIP-required negotiations between the Coastal States to determine seaward extensions of interstate boundaries. These boundary negotiations were complicated by a lack of accurate historical records, relevant precedent legal cases, and a disinclination of some States to negotiate. Although MAGCRC was helpful, in the end it was a State-by-State problem, which in some cases is not yet resolved. Establishment of extended seaward boundaries was necessary because some elements in the formula adopted by Congress for OCZM to arrive at the level of funding in CEIP are calculated from the level and type of activity that, each year, occurred in the OCS portion that was "adjacent" to each State. As adjacency is defined by extended seaward boundaries, the more adjacent area a State receives, the larger will be its share of CEIP revenue. There is, in the CEIP regulations (15 CFR 931), a rule which provides minimum and maximum limits on the annual funding level a State may receive.

Review of the Sale 49 pre-lease process and a more effective revision of the OCS State advisory mechanism were also on the 1977 MAGCRC agenda.

The major activities in 1978 and 1979 were concentrated in a few areas: MAGCRC contributed its ideas for the new regulations in CFR Title 30 (Mineral Resources) to implement boundary decisions; and reviewed BLM tract selection and the EIS for Sale 49. The EPA-proposed Oil Spill Containment Law and "Superfund" legislation, passed in 1977, were strongly supported by MAGCRC. These laws required an industry-contributed fund for rapid oil spill containment.

With these and other accomplishments, MAGCRC had "got the job done," as noted by the record of the December 1978 meeting. By that time and into 1979 the Council was meeting

only a few times a year. Its most recent meeting was held on January 30, 1980 in Baltimore, Maryland. The effective groundwork established by MAGCRC from 1975 to 1978 enabled each State, in later years, to maintain a direct relationship with DOI. The need for MAGCRC lessened as federal-State relationships improved. In addition, the active role of the Technical Working Group began to transfer the responsibility from the Council.

The Continental Margins Committee of the Association of American State Geologists, begun in 1976, was another important liaison with the federal government. It dealt with more technical aspects of the geology of prospective areas and with the DOI policies derived therefrom. The Committee remains active today.

Federal Activities

The first federal actions, save U. S. v. Maine et al., involving the Atlantic Coastal States began in 1970-1971. The USGS and other DOI representatives met informally in Washington several times with State officials to discuss the OCS program that was being considered for the Atlantic offshore. The 1971 Proposed Leasing Schedule first noted an Atlantic sale to take place prior to 1976. The USGS began OCS resource estimation in 1972. Immediately following the formal inclusion of an Atlantic sale in the 1974 Proposed Leasing Schedule there were more frequent and formal federal-State meetings, culminating in a DOI Advisory Board established in late 1974. These meetings, the organizations that grew out of them, and the events that occurred from 1974 to 1981 are presented below in chronological order. The information in this chronology comes from a variety of sources, primarily DGS office files, DOI and BLM news releases, and the writer's own background.

1974

November - Inclusion of an Atlantic sale in 1974 Proposed Leasing Schedule.

December - OCS Research Management Advisory Board (OCSRMAB) established by DOI to accomodate State's interest in the OCS Leasing Program.

- Publication of Council on Environmental Quality Report, "OCS Oil and Gas - An Environmental Assessment."

1975

March - The Sale 40 Draft Environmental Impact Statement (DEIS) was in preparation, and BLM announced the award of first contracts to begin research on Atlantic Environmental Studies Program.

- Call for Nominations in Sale 40.

May - DOI established an OCS Environmental Studies Advisory Committee (OCSESAC) to review the environmental impact of oil exploration for the entire OCS.

- First draft of OCSLA Amendments under study in Congress.

- OCS production pipeline discussions initiated by BLM with States; BLM also began compilation of existing studies and reports relating to environmental impacts from OCS activities.

June - Congress declared that the OCSLA Amendments should consider States' position.

- OCZM Amendments, with CEIP concept, being discussed in Congress.

July - Sale 40 DEIS begun.

- Mid-Atlantic States' representatives met BLM for briefing on response to Call for Nominations for Sale 40.

August - Tentative Tract Selection (TTS), for Sale 40 published by BLM; comment by States requested.

October - Establishment of OCS Advisory Board (OCSAM) as liaison with the States. OCSRMAB integrated with OCSAB.

December - The federal General Accounting Office (GAO) report on BLM tract selection procedures is critical of DOI and recommends federal-sponsored and funded well test program modeled after the COST well program to determine selection and value.

1975

December - DEIS for Sale 40 issued.

1976

January - OCSESAC reviewed the first results of the Mid-Atlantic Environmental Studies Program for Mid-Atlantic Sale 40.

- Public hearing on Sale 40 DEIS held in Atlantic City, New Jersey.

March - Among several other OCS Orders designed by USGS to improve management of OCS drilling operations, Order 15 was approved. It required State review of OCS drilling plans.

April - BLM initiated DEIS State review process, participating in several regional meetings.

May - Final tract selection for Sale 40; Sale 40 FEIS issued by BLM.

June - The OCZM Amendments, with CEIP concept, enacted.

July - Notice of Sale 40.

August - Sale 40, the first Atlantic sale, was conducted in New York City where industry bid on 101 tracts and offered $1.135 billion. the sale was delayed 8 hours by court action, and drilling of its leases was blocked for 18 months by federal court action.

October - CEIP regulations and guidelines published by OCZM.

November - Call for Nominations, Sale 49.

- First Applications for a Permit to Drill (APD) test wells received by USGS for Sale 40 tracts.

1976

November - The Atlantic City Regional Office of the USGS Conservation Division is opened to manage exploration on the Sale 40 leases.

- The general concept of the intergovernmental planning program (IPP) was started, informally by BLM in late 1976.

1977

February - The BLM invites State and public interest participation to its Managers Meeting to make tract selection for Sale 49.

March - Urged on by the President, DOI pressures the courts to end the suit that had suspended activities for the Sale 40 leases.

- TTS completed for Sale 49.

- DEIS on Sale 49 made available for public and State review.

August - DOI Secretary Andrus announces a slowdown of all OCS sales and leasing schedules until more environmental studies are completed and the OCSLA amendments are enacted.

September- Funding to the States through CEIP grants begins.

- TTS for Sale 49 completed.

November - USGS, Conservation Division, begins approval of drilling permits for Sale 40 leases.

December - Mid-Atlantic IPP/TWG meetings are begun.

- First issue of weekly well status report sent to Mid-Atlantic State Geologists from the Atlantic OCS Office of USGS.

1978

January - Initial, informal discussion with OCZM and Coastal States on CEIP offshore boundaries.

1978

February - DOI officials begin discussions with the Corps of Engineers (COE) on the issue of controlled seaways (fairways) into East Coast ports relating to Sale 49.

- Exxon spuds first well on Sale 40 leases.

April - DOI extends the term of Sale 40 leases for 8 months because of delay caused by the federal court case.

June - Revised, non-matching CEIP grants begun.

July - Public hearings in Atlantic City, New Jersey on Sale 49.

September- Final EIS on Sale 49 completed.

- 30 CFR 252, a public information section is added to Mineral Resources Title 30.

October - The existing OCS Environmental Studies Advisory Committee (OCSESAC) was combined with a newly established OCS Advisory Committee (OCSAC). The functions of OCSESAC were retained as a scientific advisory committee to review scientific and environmental documents and advise the Interior Secretary's Office on science matters.

- OCSLA Amendments enacted.

December - Texaco reports a significant gas show from its 598-1 well in the Sale 40 lease area. This is the first Atlantic OCS hydrocarbon show of significance.

1979

February - Sale 49 conducted, using new cash bonus/ sliding scale royalty method. Lowest bonus total of any recent sale.

- Discussions continue between DOI officials, USCG, and NOAA regarding navigation fairways.

1979

April - Continued revision of OCSAC. The rarely used OCSESAC is removed and the BLM given responsibility for oil and gas leasing and transportation discussions with States (BLM News Release, 4/12/79).

June - Oil spill containment law and superfund passed by Congress.

- DOI established a new organization, the OCS Advisory Board (OCSAB) to replace the existing OCSAC. The Board will have a much-needed regional "sub-committee" separation between technical and policy representation on the Advisory Board. The OCSAB was to meet twice a year and the regional "sub-committee" three times a year. There are six regional "sub-committees" for both policy and technical activities. The Regional Policy Boards will handle policy recommendations and the Regional Technical Working Groups the technical discussions. (NOTE: The Regional Policy Boards were never implemented) (Fig. 8).

July - Sale 59 Call for Nominations issued.

- Changes in BLM leasing process implemented (43 CFR 2880 and 3300).

October - First meeting of Mid-Atlantic States did not resolve interstate agreement on seaward boundaries for CEIP purposes, NOAA had proposed "equitable" boundaries for New York, New Jersey, Delaware, and Maryland.

- A revised, but not accelerated, Proposed 5-Year OCS Lease Schedule was published early in 1979, revised twice and changed again in 1980. All schedules include Sale 59 as scheduled.

- OCS Oil and Gas Operations, Rules, and Regulations (30 CFR 250) revised, updating environmental and safety practices.

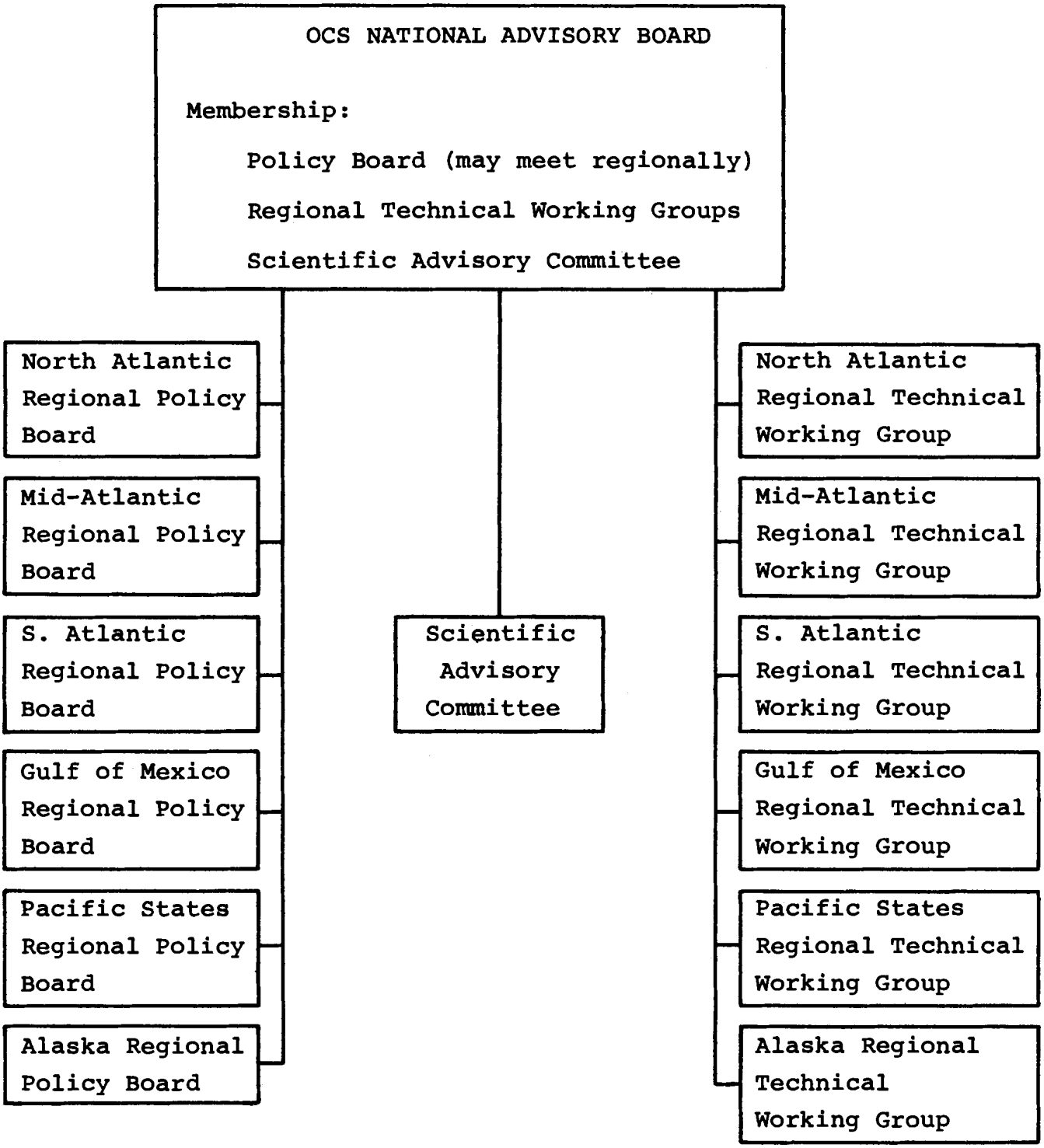


Figure 8. Organization chart of the OCS National Advisory Board.

1979

October - First meeting of the Mid-Atlantic Regional Technical Working Group, in New York City.

- Issuance of new section, 30 CFR 252, by USGS: OCS Oil and Gas Information Program. This rule authorized the Secretary, DOI, to make OCS information available to the Governors of Coastal States.

1980

March - USGS revises regulations dealing with geological and geophysical exploration of the OCS (30 CFR 251).

April - DOI published its Proposed 5-Year OCS Lease Schedule, changing much of the slowdown process begun by Secretary Andrus.

June - USGS introduced new OCS Regulations and Orders aimed at reducing air and water pollution coming from drilling rigs (30 CFR 250).

- The first annual OCSAB meeting took place in New York City.

August - Discussions within DOI to develop an accelerated OCS leasing program.

- Revision of parts of 30 CFR 250 to clarify roles of USGS and BLM in OCS pipeline activities.

- TTS for Sale 59 completed by BLM New York Office.

October - Charter of new advisory group, the OCS Advisory Board, with policy, technical working groups, and scientific committees, now formalized by Secretarial action (see Fig. 8).

November - The DEIS for Sale 59 completed and distributed for State review. The first regular meetings of the new OCSAB and the Regional Technical Working Group completed.

1981

- During the first several months of 1981, the DOI prepared a revised 5-Year OCS Leasing Program which would greatly accelerate the schedule.

January - Public hearing held on DEIS for Sale 59.

March - Secretarial Issue Document (SID) and Secretary's Decision Memorandum on the streamlining of the OCS leasing program submitted to Secretary Watt.

April - Tentative Proposed Final 5-Year OCS Oil and Gas Leasing Program presented to Coastal State Governors for review.

May - Final EIS completed for Sale 59.

June - Partial implementation of revision of 5-Year OCS Leasing Program.

- Proposed Notice of Sale 59.

- SID on Sale 59 submitted to Secretary Watt, DOI.

July - Secretary's Decision Memorandum prepared for Secretary Watt on Sale 59.

November - Notice of Sale 59.

December - Sale 59 held in New York City.

MID-ATLANTIC OCS LEASING PROGRAM

Introduction

The Mid-Atlantic leasing program became active in 1974 when DOI Secretary Morton, in response to President Nixon's 1973 message on the nation's energy needs, announced that an Atlantic Coast lease sale was to be conducted prior to 1976 (DOI News Release, 6/15/73). During the following decade administrative activity on the OCS included three Mid-Atlantic

sales, a complete revision of the OCS Lands Act and supplementing regulations, plus the establishment of a variety of organizational structures that defined the course of State and federal relationships on the OCS.

Three OCS lease sales have been conducted in the Mid-Atlantic area. Sale 40, on August 17, 1976 leased tracts in the northern part of the Mid-Atlantic area off New Jersey and Delaware, with industry bids on 93 tracts accepted. Sale 49, on February 28, 1979 leased tracts north, south, and farther seaward of the Sale 40 area off the New Jersey to Maryland coast, with industry bids on 44 tracts accepted. Sale 59, on December 14, 1981, sold leases in the area of a postulated deep-water carbonate reef-platform complex beneath the deep-water continental slope off the New Jersey to Virginia coast, with industry bids on 50 tracts accepted by BLM (statistics in part from Oil and Gas Journal, 8/30/76; 3/5/77; and DGS files).

Sale 40

For several years following the initial announcement in the 1971 5-Year OCS Leasing Schedule, preparations were being made for an Atlantic sale. The New York OCS Office of the BLM has managed the sale process for all North and Mid-Atlantic sales. Figure 9 shows the proposed OCS planning schedule of November 1974 that included Mid-Atlantic Sale 40. Under the OCSLA and 1978 Amendments, a leasing schedule must be reviewed and revised by the Secretary of DOI, and presented to the Congress for approval at least every five years. The lease process for each individual sale requires 18 months to 3 years. The details of the pre-sale process are shown in Table I. This outline has been in use for all sales covered by the period of this report. The process is currently being revised as part of the OCS streamlined leasing program initiated by DOI in mid-1981 (Fig. 10).

The first step in the Sale 40 leasing process was a Call for Nominations in March 1975 for industry to indicate where they wished lease areas to be offered. The area offered to industry for nomination included almost all of what is now the Mid-Atlantic Planning Area from the Long Island Platform to Virginia, and from a line approximately 30 miles seaward of the coast to the edge of the continental shelf. Twenty companies responded and nominated 557 tracts totaling 3,161,249 acres (DOI News Release, 6/24/75). Baseline environmental studies for a complete EIS, as required by

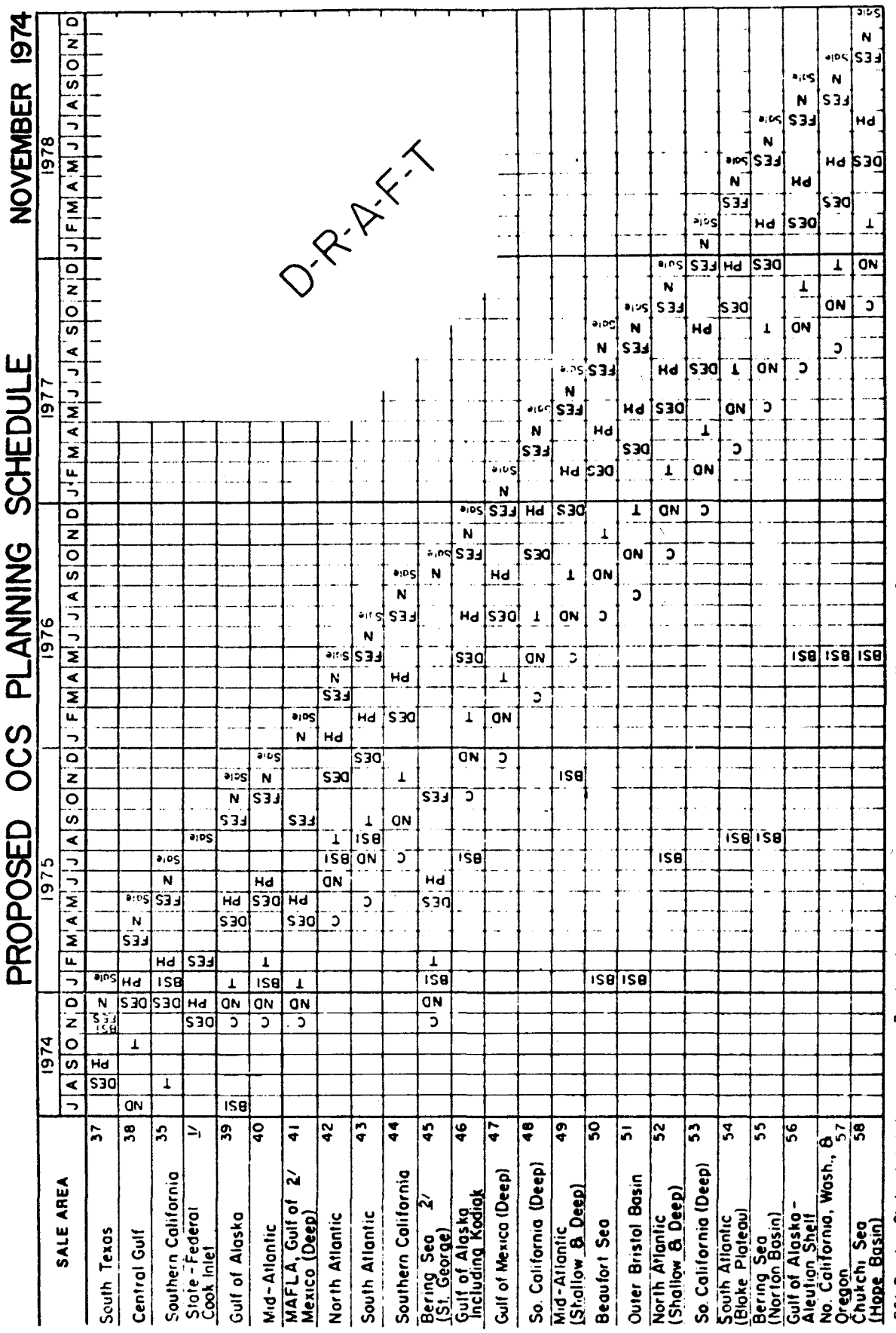


Figure 9. Proposed OCS Planning Schedule of November 1974, showing first Notice of Sale 40.

TABLE I.

DECISION PROCESS: OCS LEASE SALE PROCESS

The Interior Department follows a sequential procedure that includes the following steps in an OCS lease sale.

I. CALL FOR NOMINATIONS AND COMMENTS

--Requested from industry, the affected coastal States and units of local government, and the general public.
--Designed to provide a basis for determining the actual area to be investigated for a proposed future lease sale.

II. TRACT SELECTION

--Defines the actual area to be studied and upon which a draft Environmental Impact Statement (EIS) will be prepared.

III. DRAFT ENVIRONMENTAL IMPACT STATEMENT

--Impacts are examined and alternative actions are evaluated.
--Basic data are collected and examined, including those related to geology, climate, oceanography, biological environment, and natural phenomena unique to the specific area proposed for the sale.
--Specific data collected include information on currents, tides, air and water quality, seasonal temperatures and winds, marine communities of plants and animals, wildlife of any land mass in the area, socio-economics of coastal land areas, commercial and sport fishing, shipping, navigation, military, and beach uses.
--The risks of oil spills are also weighed on a computerized projection of worst-case analyses.
--Is submitted to the President's Council on Environmental Quality (CEQ) and is available to the public.

IV. PUBLIC HEARING

--Gives all interested parties an opportunity to air and record their views concerning the draft EIS and the proposed sale.

V. FINAL ENVIRONMENTAL IMPACT STATEMENT

--Reflects the information, views, and testimony provided at the public hearing and/or submitted to DOI during the review period for the draft EIS.
--Provides any additional data that may have come to light. This is where major State input occurs.
--Is submitted to the President's Council on Environmental Quality (CEQ) for review and is available to the public.

VI. DECISION WHETHER TO HOLD A SALE

--May result in holding the sale, cancellation of the sale, delay of the sale or modification of the sale by deleting any number of tracts, or by including specific environmental and economic conditions on any or all tracts.

VII. SALE

--If sale decision is affirmative, an official notice is published in the Federal Register at least 30 days prior to sale date.

In most leased areas, it may take more than two years from the date of the sale until production commences; in other areas the time lapse will be five years or even longer. Each lease is monitored throughout its producing life to help assure environmental safety.

(Source: DOI Information Office, 1980)

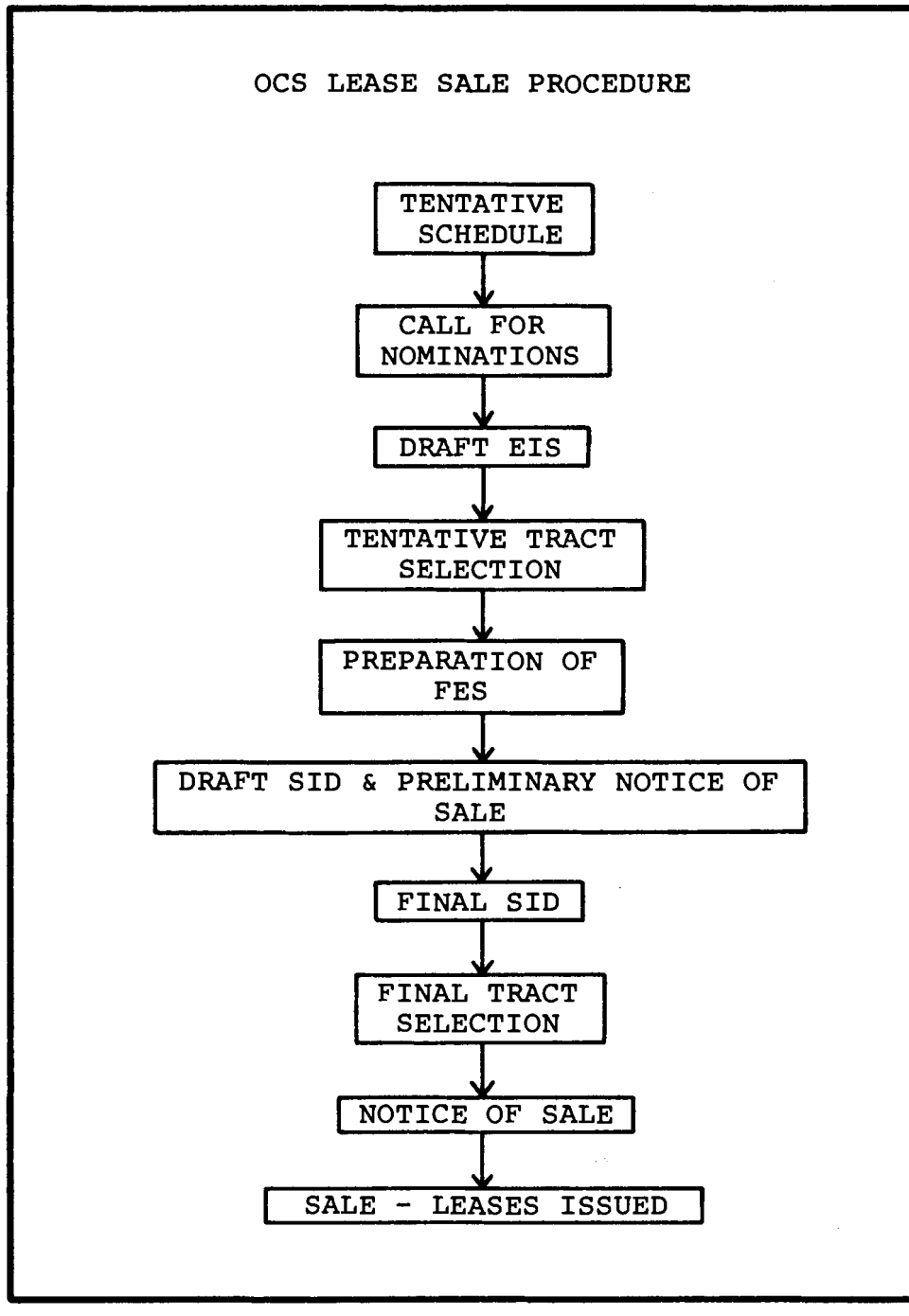


Figure 10. OCS lease sale procedure.

EPA under the NEPA rules, were initiated at the same time. A Tentative Tract Selection (TTS) was published in August 1975. It listed 154 tracts which would be offered for sale. The tracts nominated and accepted by BLM in its TTS were grouped in several large areas on the eastern side of the Baltimore Canyon trough, 50-80 miles off the coast between Ocean City, Maryland and Atlantic City, New Jersey.

During late 1975 and into January 1976 the Coastal States, federal agencies, industry, and the public reviewed the TTS and an outline of the Draft EIS (DEIS). A public hearing on the DEIS was held in Atlantic City, New Jersey in late January 1976 where a broad spectrum of interested parties submitted comments on the statement and the possible sale. Approximately 150 witnesses presented testimony at the hearing (DGS file documents). The DEIS and the comments from the hearing were reviewed by BLM, and on the basis of that review, plus additional scientific studies, a Final EIS (FEIS) was issued in May 1976 which covered the 154 tracts accepted for the Sale by BLM (BLM News Release, 5/26/76).

The results of the FEIS, public and industry comments and other pertinent information were summarized in a Secretarial Issue Document (SID) and presented to the Secretary of DOI. Using this document as his reference, the Secretary made determinations: (1) when or whether to hold the sale, (2) how many tracts to offer, and (3) on the kinds of restrictions (as Lease Stipulations) to be placed on both individual tracts and the entire sale area. The conditions of sale were revised to conform with the Secretary's determinations and a final tract selection and date of sale was set.

A formal Notice of Sale was issued in the Federal Register on July 16, 1976 for Mid-Atlantic Sale 40 to be held in New York City on August 17, 1976. This sale took place only three months after the proposed 1974 Leasing Schedule sale date. Thrity-nine companies bid on 101 of the 154 available tracts and offered $1.135 billion in tract bonuses. DOI accepted high bids for 93 tracts (eight high bids were below the floor set by the USGS tract evaluation process and were rejected). The total accepted bonus value in the Sale was $1.127 billion. Figure 11 shows the location of Sale 40 tracts that were finally accepted. The five highest accepted tract bids ranged from $107.8 million to $65.2 million.

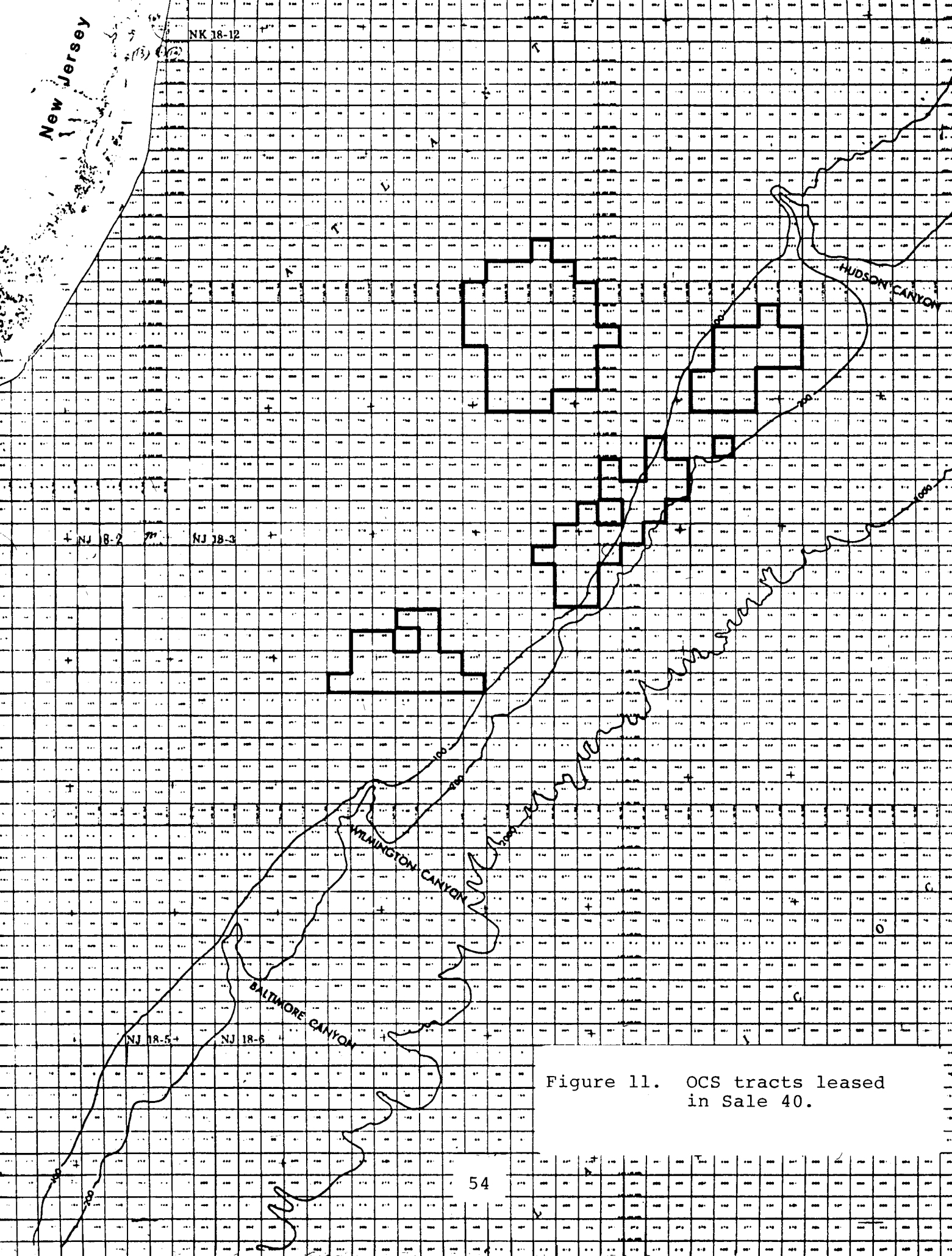


Figure 11. OCS tracts leased in Sale 40.

Sale 40 was notable as the first OCS sale where the opening of bids was delayed for hours while the Supreme Court reviewed whether the Sale should take place. It was also a sale that saw the start of exploratory drilling blocked for 18 months by court action. During the last months before the August 17 sale, the State of New York prepared a complaint against Secretary of Interior Kleppe declaring that he had violated the NEPA law. The complaint, entered into U. S. District Court in New York in June 1976, was decided by the Court on August 13, 1976. The judge granted New York a temporary injunction preventing the upcoming Sale. On August 16, 1976 the U. S. Circuit Court of Appeals stayed the District Court injunction. New York State, two New York counties, and the Natural Resources Defense Council appealed this stay before the U. S. Supreme Court on the morning of the Sale. After an eight-hour delay Supreme Court Justice Marshall vacated the stay of the Sale and bid openings began at 6 p.m. The original complaint against the Sale came to trial in late 1976. In February 1977, the U. S. District Court of Appeals in New York ruled Sale 40 invalid by deciding that Secretary of Interior Kleppe violated various sections of NEPA and other federal laws by not giving sufficient consideration to certain environmental impacts and local government needs. This ruling was overturned in August 1977 and shortly thereafter several companies, including Exxon, Gulf, and Houston Oil and Minerals, began to submit drilling applications for USGS processing. By December 1977 the USGS had approved six applications for a permit to drill (Oil and Gas Journal, 12/5/77) and drilling on Sale 40 tracts was allowed to proceed. The Mid-Atlantic exploratory drilling program got underway in early 1978. The first well was spudded by Exxon Company, USA on OCS Lease Block 684 on March 14, 1978, 80 miles off the southern New Jersey coast. In an effort to relieve some of the time constraints caused by the legal delays on the oil companies holding leases from the sale, Secretary Andrus, in April 1978, extended the lease term for an additional eight-month period (DOI News Release, 6/15/78).

Sale 49

The Call for Nominations of Sale 49 in November 1976 identified an area for nomination of slightly more than a third of the total 16 million acres that now compose the Mid-Atlantic Planning Area. Seventeen companies nominated 1,885 tracts (covering 10.6 million acres) by the January 1977 deadline. BLM, at its regular Manager's Meeting for the TTS process, invited, for the first time, representatives of Coastal States, public interest groups, and other federal

agencies to review and comment on the tract nominations. This broader participation improved the TTS process because it provided timely advice, information, and direction from outside interests which made the post-selection process less complicated and controversial than in Sale 40 (BLM News Release, 9/23/77). The Sale 49 TTS included 190 tracts, which were further reduced to 146. In the final tract selection in September 1977 BLM offered 136 tracts. This reduction in the number of tracts was in part a result of urgent requests from federal agencies and environmental groups. The Department of Defense requested that several areas be excluded because of military operations; the Corps of Engineers asked that certain areas be set aside as fairway shipping lanes: and the fishery-environmental groups urged that certain high value fishing grounds be excluded. A DEIS was scheduled for review in October 1977, but was delayed until May 1978. The required public hearing on the Draft statement was held in Atlantic City, New Jersey in June 1978. BLM reduced the time for this hearing from four to two days as a result of smaller participation by the public and State agencies, which perhaps were becoming more accustomed to OCS activities on the East Coast. In addition, the States had initial input at the time of TTS. The FEIS was published in September 1978 and a tentative sale date of February 28, 1979 was chosen (BLM News Release, 9/29/78).

The SID review by Secretary Andrus in late 1978 resulted in his decision "... to withdraw 27 tracts from the sale because of substantial evidence of geologic hazard" (DOI News Release, 1/29/79). As a result, BLM offered 109 tracts covering 649,987 acres in a sale to be held on February 28, 1979.

Sixteen companies participated in the Sale, offering $41,720,618 in high bids for 44 of the 109 tracts. This was the second lowest total amount of high bids in any sale in the history of an OCS frontier (non-producing area) sale (personal communication, F. Basile, BLM, 1982). Figure 12 shows the distribution of tracts accepted by BLM in Lease Sale 49. The five highest tract bids ranged from $6.3 million to $3.7 million. High value tracts were concentrated along the eastern edge of the continental shelf near the Northeast Slope structure and southwest toward the Wilmington Canyon area (see Fig. 14). Only one well has been drilled on a Sale 49 lease at this writing.

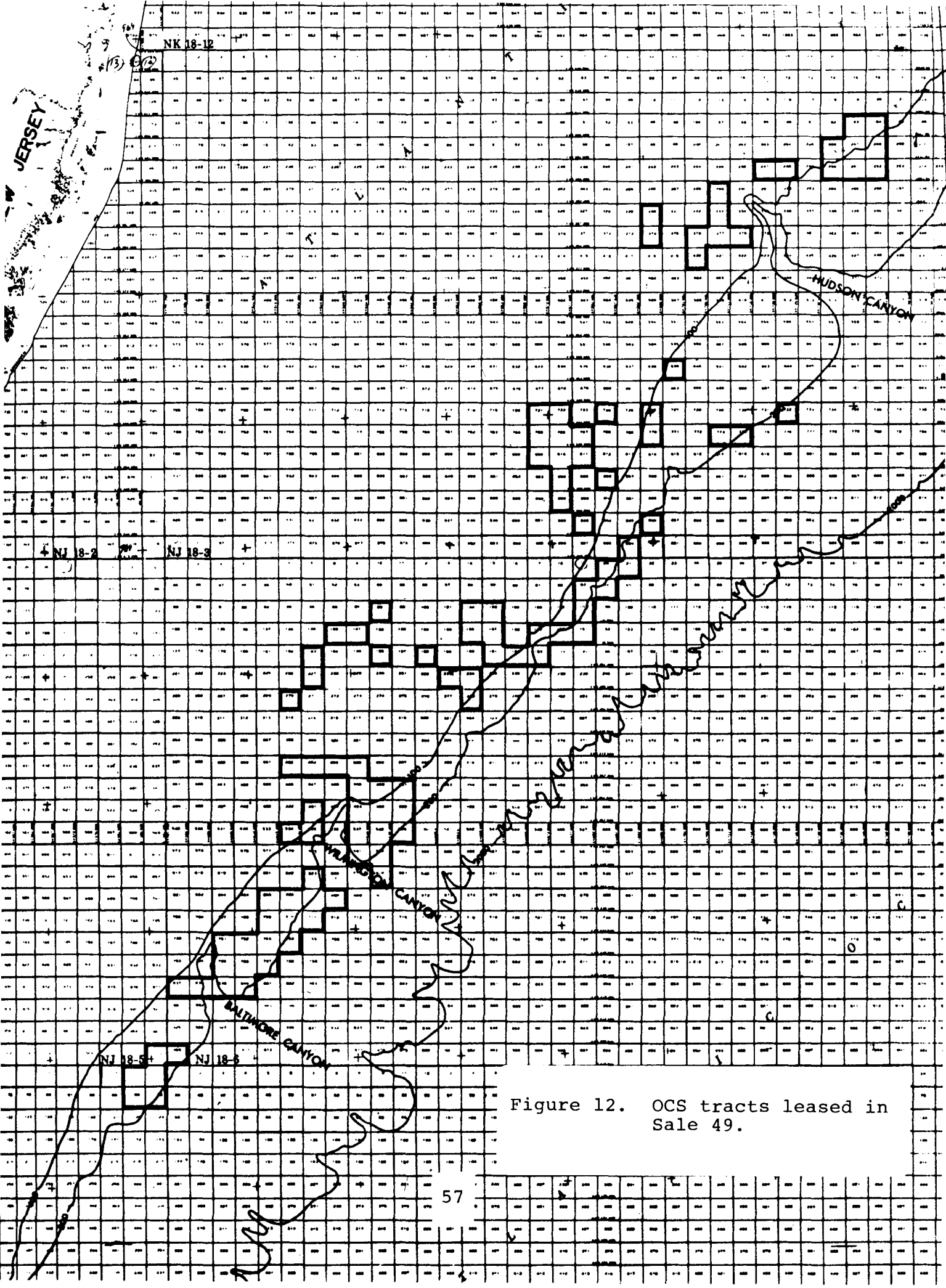


Figure 12. OCS tracts leased in Sale 49.

Sale 59

BLM offered almost the entire 16.5 million acres of the Mid-Atlantic Planning Area for this sale. This was the largest offering of any of the three sales and included 3,421 tracts. The Call for Nominations was made in July 1979, as scheduled in the 1975 OCS Planning Schedule. The Call Area was enlarged in September 1979, and the time for tract nominations extended. These changes were made to encourage industry evaluation of additional lease tracts located on the outer edge of the continental shelf and the upper continental slope where the presumed buried carbonate reef-platform complex had been located. This reef-platform was described by then-USGS Director Menard, who commented that, "... it appears that a great petroliferous reef complex of the Reforma and Campeche Shelf provinces of Mexico can be traced intermittently through the northern Gulf of Mexico and along the Atlantic Continental Margin of the United States" (Oil and Gas Journal, 2/25/80, p. 148). This geologic feature, shown on Figure 2, became the foremost bidding target in the Sale. The TTS for this sale was made on December 31, 1979 when BLM selected 250 tracts containing 1,440,376 acres. As in the Sale 49 process, the BLM tract evaluation analysis included participation by State officials, public interest groups, and other federal agencies.

A group of environmental specialists from the BLM New York OCS office started work on the DEIS for Sale 59 in early 1980. The study area for the DEIS was concentrated over the carbonate reef-platform. The DEIS was published in November 1980 and BLM conducted public hearings on the Document in Newark, New Jersey on January 19, 1981 and in Norfolk, Virginia on January 22, 1981. Public comment was brief and was concentrated on the subject of ocean pollution by platform operations, disposal of drilling mud, and sea bed stability as related to geohazards. The FEIS was issued on May 29, 1981, and following the final review by EPA and other agencies, a SID was prepared and submitted to Secretary Watt for a leasing decision.

The BLM announced the sale date for December 8, 1981 in New York City. The sale was held on schedule, with 19 companies participating in the bidding. They bid on 98 of the 250 tracts offered, offering $424,927,000 in high bonus bids for those tracts. Almost all of the tract bids were over the reef complex in deep water averaging 5,377 feet along the eastern edge of the Shelf. The five highest tract bids ranged from $41.4 million to $15.8 million (Oil and Gas

Journal, 12/14/81). The BLM post-sale analysis of tract bids, however, rejected 48 high bids as too far below the USGS tract evaluation bid floor (Oil and Gas Journal, 1/4/82, p. 75). This reduction in the number of tracts lowered the value of the high bonus bid total to $321,981,000 for the remaining 50 tracts. Figure 13 shows the location of the 50 tracts accepted by BLM.

RESULTS OF EXPLORATORY DRILLING OF LEASE TRACTS IN THE MID-ATLANTIC OCS

There have been 28 exploratory wells drilled on leases bought in Mid-Atlantic OCS Sales 40 and 49. The well information summary of these wells is shown in Table II. Data for this table are derived from the USGS Weekly Director's Report, issued by the Eastern Office of the USGS Conservation Division, now the Minerals Management Service (MMS) within DOI. Also, included in the table are the drilling data for the two COST wells, B-2 and B-3, located on off-structure blocks. Five wells, drilled over a single structural feature, encountered significant natural gas, condensate, and oil. Two other wells located on another structural area reported minor amounts of natural gas. Figure 14 shows the location of the principal geologic target structures for these wells. Future drilling on Sale 49 lease blocks, plus those from Sale 59, is anticipated for 1982 to continue in mid-1983. A request for an exploration unit for four Sale 40 blocks is being reviewed by MMS at this writing. Figure 15 shows the location of all exploratory wells drilled to December 1981.

The target areas for exploratory drilling to date have been large structural closures often called "bullseye" targets that may contain potential hydrocarbon entrapping features in clastic sediments of Cretaceous-Jurassic age that are predominantly of marginal marine origin but range from non-marine to shallow marine. On the basis of indirect calculations, over 8,000 feet of Lower Cretaceous and Upper Jurassic(?) sedimentary rocks are present in exploratory target areas of the Baltimore Canyon trough (Schlee, 1981; Maher and Applin, 1971). There are several large areas, as shown in Figure 14 , with major structural closures that were offered and leased in the first two OCS sales. The best defined of these is the Stone Dome (Baltimore Dome) where the sediments are arched by an igneous(?) intrusion. Another structure, east of the Stone Dome, is the Northeast Slope, where the five wells with significant oil and gas shows were drilled.

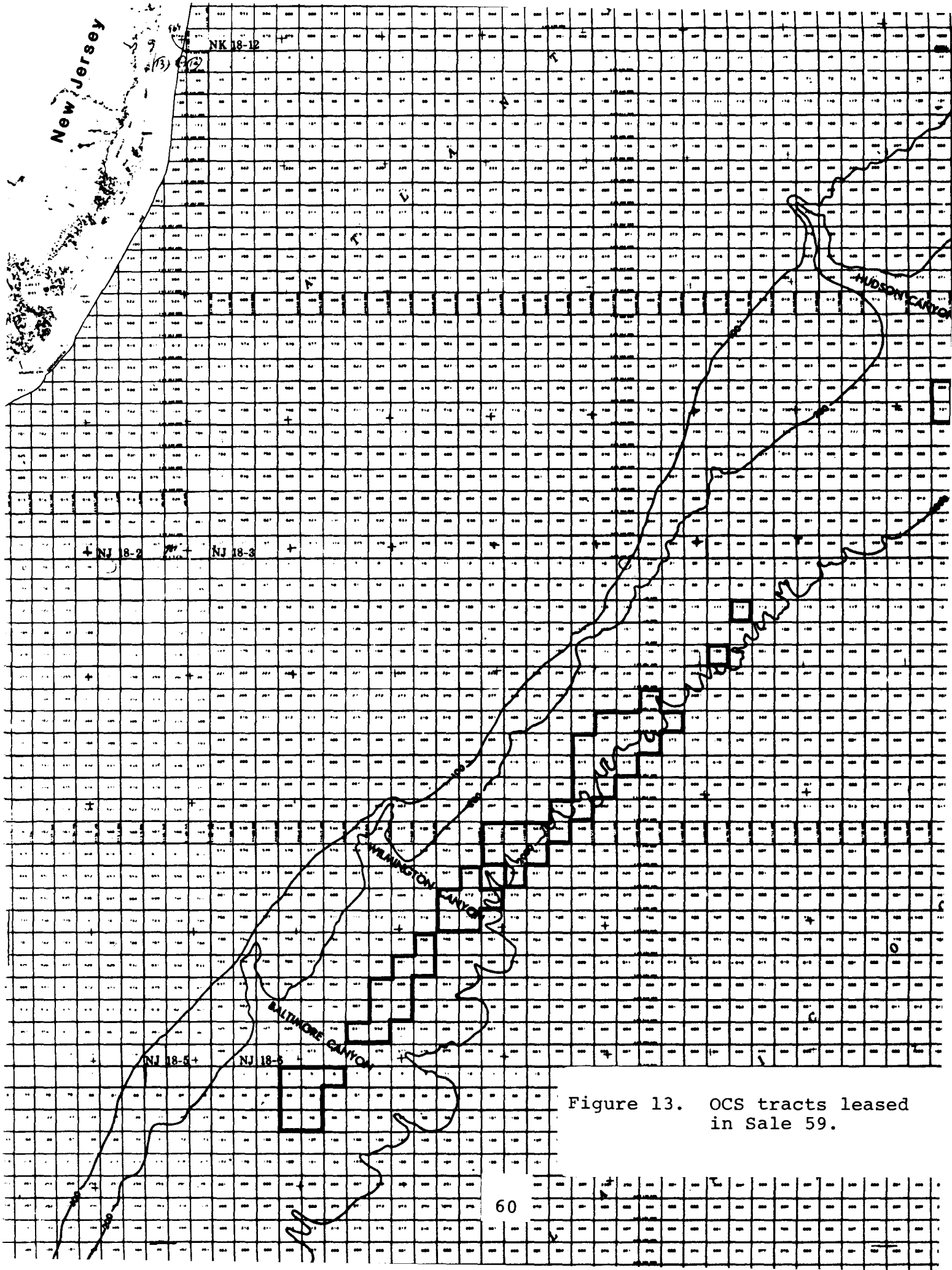


Figure 13. OCS tracts leased in Sale 59.

TABLE II

MID-ATLANTIC AREA OCS WELL INFORMATION AS OF 12/31/81

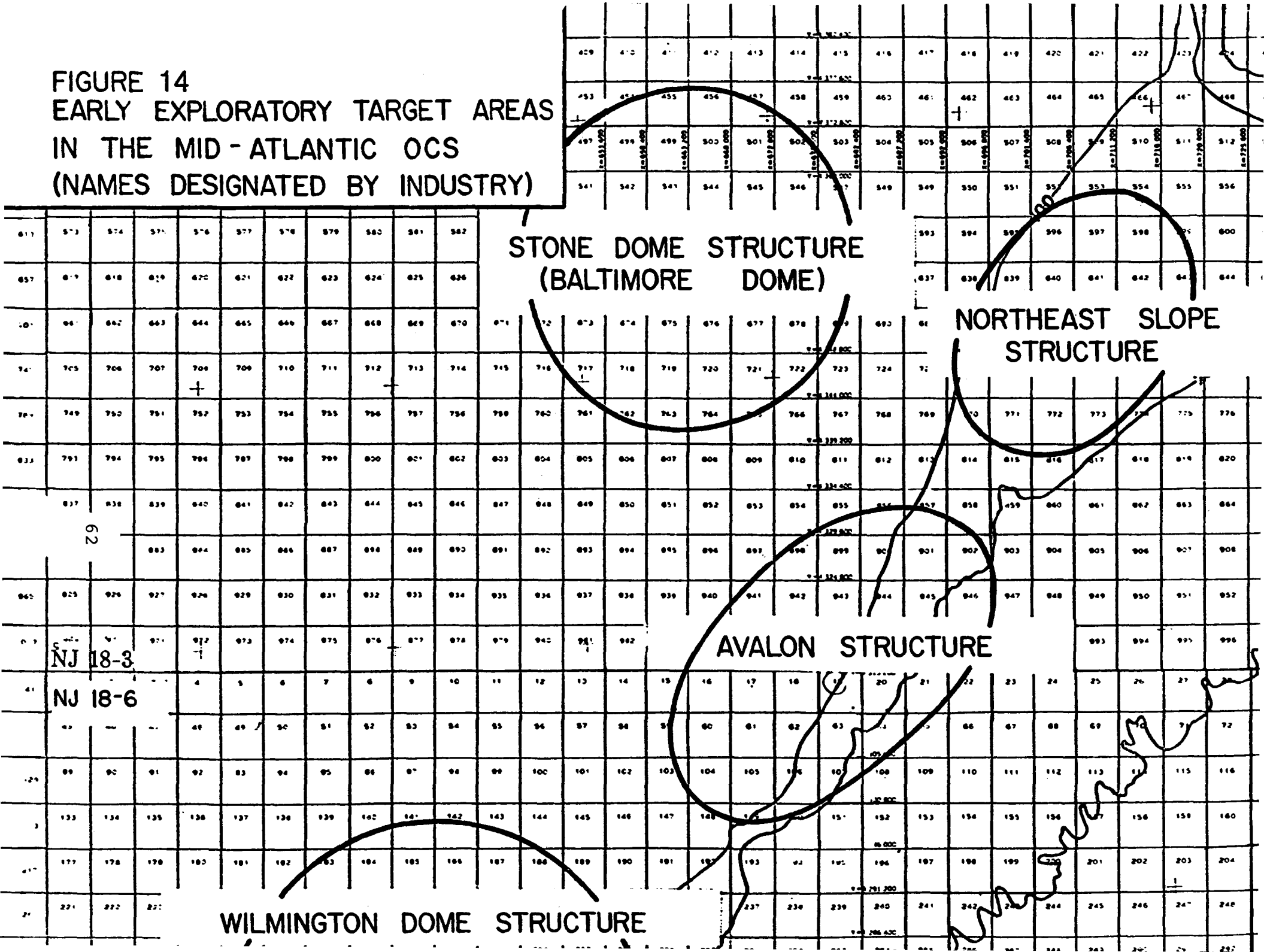
All wells are on Sale 40 tracts except one (Tenneco 495-1)

Operator	Lease/Block	Well No.	Spud Date	Completion Date	Maximum Depth Drilled (ft)
		Mid-Atlantic			
Conoco	0024/590	590-1	04/17/78	06/07/78	12,000
Exxon	0046/684	684-1	03/29/78	03/29/78	17,620
	0046/684	684-2	01/05/79	07/12/79	16,800
	0065/902	902-1	11/01/78	04/05/79	15,968
	0009/500	500-1	07/18/79	09/28/79	12,253
	0029/599	*599-1	04/26/80	11/02/80	17.121
	0055/816	816-1	11/04/80	05/07/81	17,753
	0052/728	728-1	05/09/81	07/04/81	15,205
Gulf	0059/857	857-1	06/10/78	01/17/79	18,554
	0048/718	718-1	01/19/79	03/31/79	12,813
Houston Oil & Minerals	0042/676	676-1	06/02/78	09/19/78	12,500
	0057/855	855-1	09/24/78	01/10/79	17,505
Mobil	0015/544	544-1	06/23/78	12/29/78	17,449
	0075/17	17-1	01/06/79	01/08/79	1,200
	0075/17	17-2	01/26/79	05/14/79	13,992
	0075/544	544-2	08/28/81	10/06/81	9,315
Murphy	0081/106	016-1	12/19/79	05/28/80	18,405
Shell	0032/632	632-1	04/24/78	07/12/78	14,000
	0097/273	273-1	07/15/78	12/19/78	17,500
	0096/272	272-1	12/30/78	02/16/79	13,500
Texaco	0028/598	*598-1	04/16/78	08/30/78	15,025
	0028/598	598-2	09/03/79	03/20/79	17,708
	0038/642	*642-1	03/23/79	11/29/79	15,786
	0028/598	598-3	12/03/79	05/25/80	16,103
	0028/598	598-4	10/21/80	03/24/81	16,050
Tenneco	0038/642	*642-2	01/19/79	06/10/79	18,400
	@ 0131/495	495-1	06/12/79	10/11/79	18,300
	0038/642	*642-3	05/27/80	10/15/80	16,475

* Significant gas and oil and condensate shows.

@ Sale 49

FIGURE 14
EARLY EXPLORATORY TARGET AREAS
IN THE MID-ATLANTIC OCS
(NAMES DESIGNATED BY INDUSTRY)



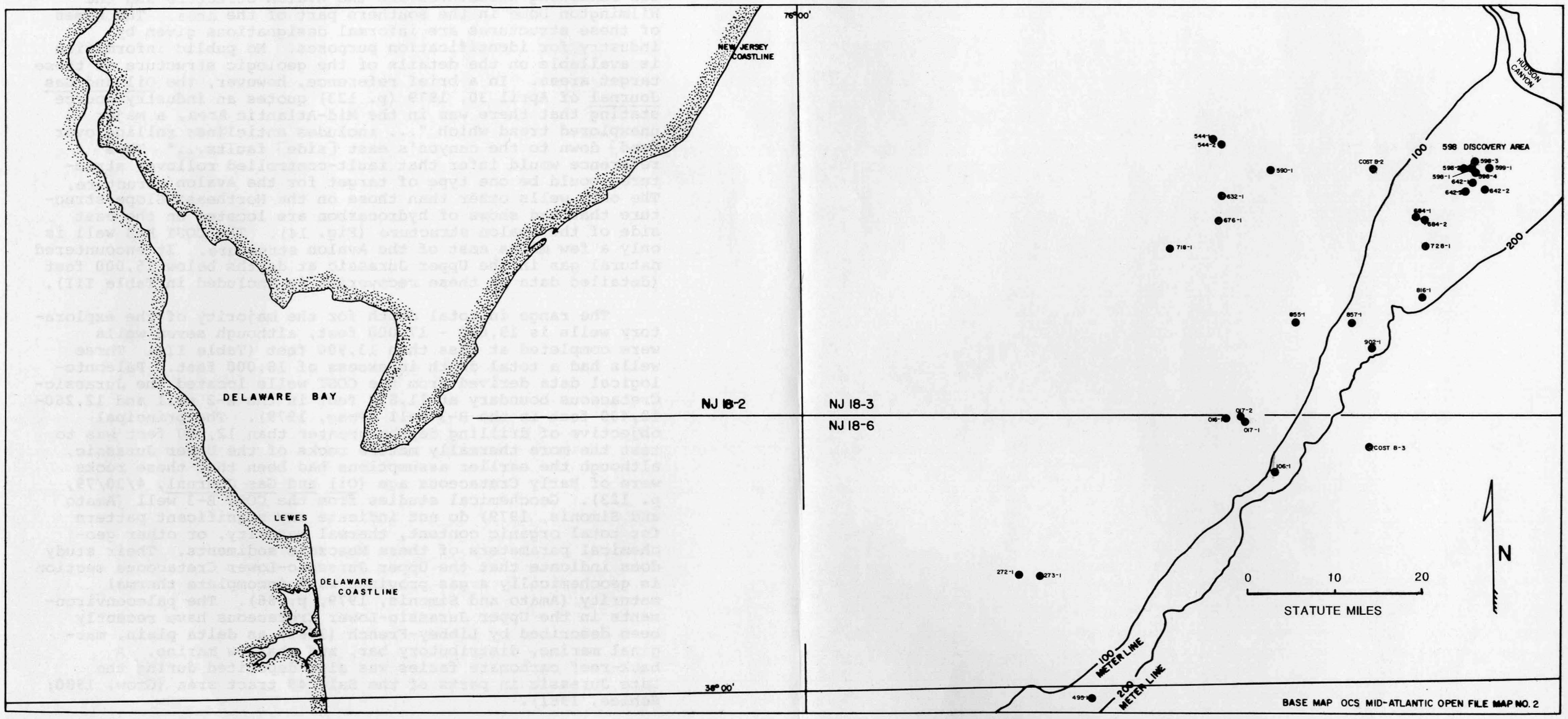


FIGURE 15. Location of all Mid-Atlantic OCS Planning Area exploratory wells.

The hydrocarbon concentration on the Northeast Slope area is associated with an anticlinal closure of Upper Jurassic rocks above a salt(?) structure located on the downthrown block of a large growth fault (Scholle, 1980). The two remaining structures are the Avalon structure and the Wilmington Dome in the southern part of the area. The names of these structures are informal designations given by industry for identification purposes. No public information is available on the details of the geologic structure of these target areas. In a brief reference, however, the Oil and Gas Journal of April 30, 1979 (p. 123) quotes an industry source stating that there was in the Mid-Atlantic Area, a major unexplored trend which "... includes anticlines rolling over [and] down to the canyon's east [side] faults..." This reference would infer that fault-controlled rollover structures would be one type of target for the Avalon structure. The only wells other than those on the Northeast Slope structure that had shows of hydrocarbon are located on the east side of the Avalon structure (Fig. 14). The COST B-3 well is only a few miles east of the Avalon structure. It encountered natural gas in the Upper Jurassic at depths below 15,000 feet (detailed data on these recoveries is included in Table III).

The range in total depth for the majority of the exploratory wells is 15,000 - 17,000 feet, although seven wells were completed at less than 13,900 feet (Table II). Three wells had a total depth in excess of 18,000 feet. Paleontological data derived from the COST wells located the Jurassic-Cretaceous boundary at 11,830 feet in the B-2 well and 12,260-12,400 feet in the B-3 well (Poag, 1979). The principal objective of drilling depths greater than 12,000 feet was to test the more thermally mature rocks of the Upper Jurassic, although the earlier assumptions had been that these rocks were of Early Cretaceous age (Oil and Gas Journal, 4/30/79, p. 123). Geochemical studies from the COST B-3 well (Amato and Simonis, 1979) do not indicate any significant pattern for total organic content, thermal maturity, or other geochemical parameters of these Mesozoic sediments. Their study does indicate that the Upper Jurassic-Lower Cretaceous section is geochemically a gas province with incomplete thermal maturity (Amato and Simonis, 1979, p. 86). The paleoenvironments in the Upper Jurassic-Lower Cretaceous have recently been described by Libbey-French (1981) as delta plain, marginal marine, distributory bar, and shallow marine. A back-reef carbonate facies was also deposited during the Late Jurassic in parts of the Sale 49 tract area (Grow, 1980; Schlee, 1981).

TABLE III

WELLS WITH OBSERVED OR SIGNIFICANT HYDROCARBONS,

MID-ATLANTIC OCS

Operator and Well No.	Total Depth (ft)	Completion Date	Tested Horizon	Reported Gas Flow From All Zones MMcfd*	Reported Condensate Flow From All Zones	Reported Oil Flow bbl/d**	Results of Production Testing	Comments	Data Sources
TEST RESULTS ON 598 STRUCTURE									
TEXACO 598-1	18,025	8/30/78	Upper Jurassic	16.9	2.3 bbl/MMcf gas		2 Intervals a) between 13,000' to 14,000' - a 40' interval with 9.4 MMcfd gas + 2.3 bbl/MMcfd of 39.5° gravity condensate thru a 22/64" choke @ 4,000 psi flowing tube pressure (ftp). b) between 14,000' to 15,000' - a 38' interval with 7.5 MMcfd + trace condensate @ 387 psi.	Several other intervals tested. T.D. was short of expected T.D. due to technical difficulties.	Oil and Gas Journal 8/12/78 8/21/78
TENNECO 642-2	18,400	6/09/79	Upper Jurassic sand	13.0	100 bbl/d	630	4 Intervals a) 8,314' to 8,321' - a 7' interval with 630 bbl/d of 48.4° gravity oil thru a 50/64" choke @ ftp of 900 psi in lower Cretaceous. b) 12,675' to 12,698' - a 23' interval of 1.0 MMcfd gas + 500 bbl/d salt water. c) 12,730' to 12,764' - a 34' interval showed insignificant gas; other intervals above 13,000' showed minor amounts of gas. d) 13,180' to 13,194' - a 14' interval with 12 MMcfd gas + 100 bbl/d condensate thru 24/64" choke @ ftp of 300 psi.	Several fault blocks away from 598-1, and downdip on the general structural complex.	Oil and Gas Journal 5/21/79 5/28/79
TEXACO 642-1	15,786	11/28/79	Jurassic sand	38.6	3.3 bbl/Mmcfd gas		3 Intervals a) below 12,700' - an interval with 18.9 MMcfd gas thru 5/8" choke @ ftp of 2,862 psi. b) below 13,000' - an interval with 14.2 MMcfd gas thru 5/8" choke @ ftp of 2,425 psi. c) below 15,000' - 5.5 MMcfd gas + 3.3 bbl/MMcfd gas of condensate thru 1/4" choke @ ftp of 2,869 psi.	Pay zones in 642-1 are approx. equivalent structurally and stratigraphically to 598-1. Stuck pipe @ 17,807'. Sidetracked @ 15,699'.	Oil and Gas Journal 10/09/79 10/15/79 10/22/79
TENNECO 642-3	16,475	10/15/80	Jurassic	9.65			2 Intervals a) 14,110' to 14,130' - a 20' interval with 3.65 MMcfd gas thru 5/8" choke @ ftp of 550 psi. b) 14,282' to 14,302' - a 20' interval tieh 6.0 MMcfd gas thru 1" choke @ ftp of 528 psi.	Five other zones tested, but not productive.	Oil and Gas Journal 10/09/80 10/15/80 10/22/80
EXXON 599-1	17,128	11/02/80	Jurassic(?)	10.3			3 Intervals a) 11,715' to 11,776' - a 61' interval with 1.3 MMcfd gas. b) 12,370' to 13,420' - a 50' interval with 8.0 MMcfd gas thru 5/8" choke @ ftp of 1,135 psi. c) 14,700' to 14,737' - a 37' interval with 1.0 MMcfd gas.	Between 12,300' and 16,900' several gas intervals reported.	Oil and Gas Journal 8/25/80
Sum of test results 598 STRUCTURE				88.45		630		An additional source document is the BLM, NY OCS Office, Hudson Canyon Transportation Plan, Draft Final, 6/81.	
DRY HOLES ON 598 STRUCTURE									
TEXACO 598-2	17,708	3/20/79	Dry Hole						
TEXACO 598-3	16,103	5/25/80	Dry Hole, tested for 8 weeks						
TEXACO 598-4	16,050	3/24/81	Dry Hole						
TEST RESULTS ON OR NEAR AVALON STRUCTURE									
EXXON 684-1	17,620	10/01/78					below 12,000', several inconclusive gas shows.	* MMcfd = million cubic feet per day **bbl/d = barrels per day	Oil and Gas Journal 10/05/78
MURPHY 106-1	18,405	5/28/80					tested gas shows in thin sands between 15,000' and 18,405' (non-commercial).		Oil and Gas Journal 5/05/79; 5/26/79
CHEVRON COST B-3	15,820	1/25/79	Jurassic	Significant gas show			15,744' to 15,752' - a 8' interval contained a significant gas show in sediments determined to be thermally mature.		USGS Circular 833 1980

Discussion of Hydrocarbon Discoveries

598 Structure

The most important hydrocarbon discovery in the Mid-Atlantic area was found within the Northeast Slope structure, herein called the 598 structure. Eight wells were drilled on the structure, five of which encountered intervals of flowing natural gas, condensate, or oil or sufficient magnitude to be reported as significant shows.* Figure 16 is a large scale map showing the location of these eight wells. A total of 88.45 MMcfd** natural gas flow, 630 barrels per day oil flow and an indeterminate volume of condensate has been reported from the five successful wells. Table III presents detailed information on the available data and reference sources for wells in the 598 structure as well as for those on the Avalon structure and in the COST B-3 well hydrocarbon shows. The range of depths that include all the gas and condensate intervals in the 598 structure extend from 12,370 to 15,786 feet, all presumably from the Upper Jurassic sediments. The oil show interval in Texaco Well 642-2 is at 8,218 feet, presumably within the Lower Cretaceous, according to the stratigraphic column derived from the nearby COST B-2 well (Poag, 1979). The five wells with significant hydrocarbon intervals are within a three lease area forming a pattern that extends in a northeast-southwest direction for 20,000 feet. Although little has been reported on the geology of the 598 structure, a recent presentation by P. Oxley of Tenneco Oil Company describes the structure as an arched sequence of Upper Jurassic to Tertiary sediments, which had been broken by one or more central grabens (Atlantic Margin Energy Conference, October 1981, Atlantic City, New Jersey). The Oil and Gas Journal had previously quoted an industry spokesman (9/29/79) as noting that Tenneco Well 642-2 was 15,000 feet south of and "... several fault blocks removed from the Texaco (598) strike and apparently down-dip on the general complex,...", again indicating the faulted character of the domed structure.

Avalon Structure

The Avalon structure (Fig. 14) is located 25 miles southwest of the 598 structure. It was explored with five

---

* USGS designation.

** MMcfd = millions of cubic feet per day

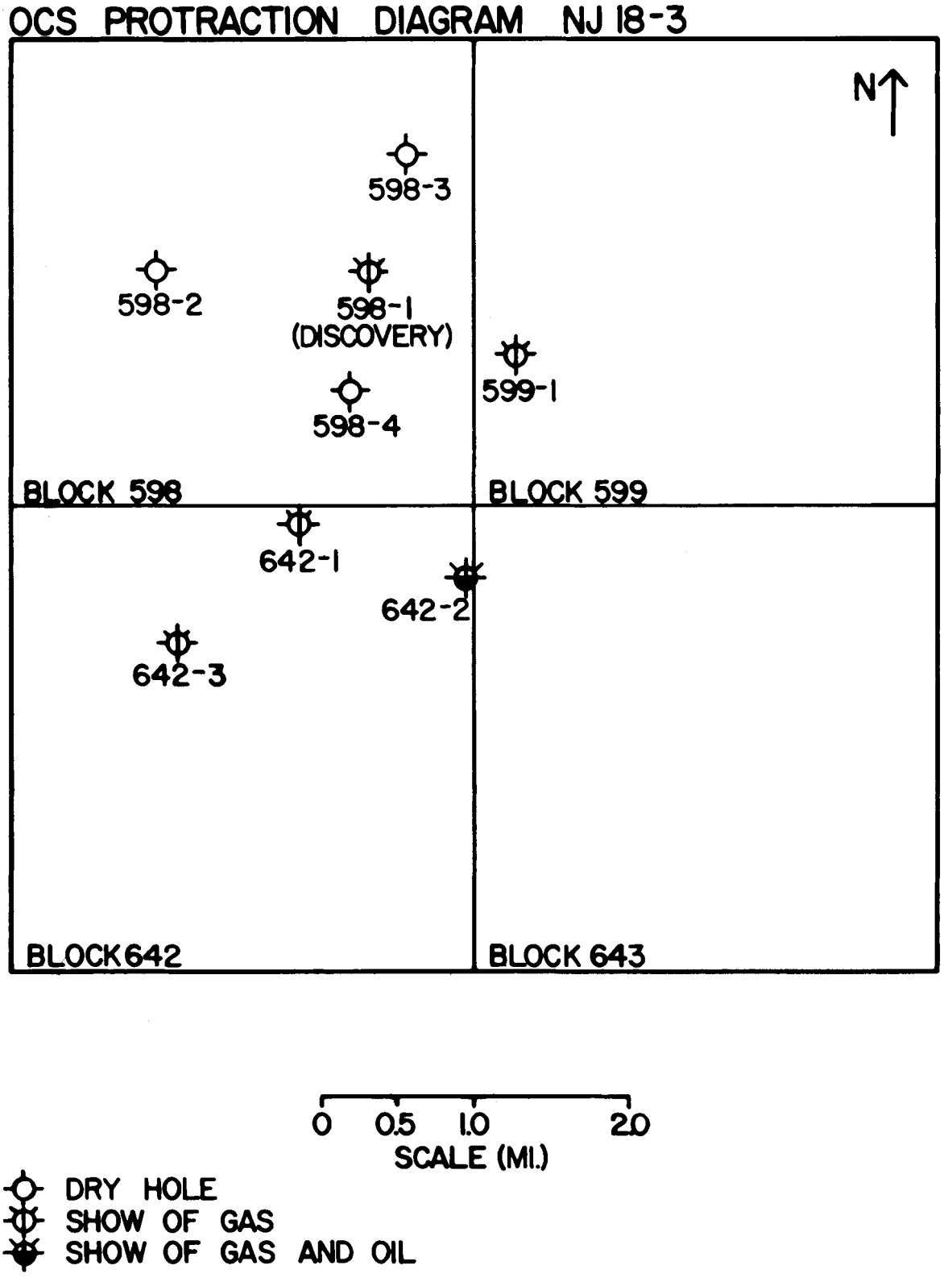


Figure 16. Location and results of wells drilled on 598 structure shown on portion of OCS Protraction Diagram NJ 18-3.

wells, two of which (Gulf 857-1 and Murphy 106-1) intersected gas intervals which were extensively tested. The nature of the structural targets is largely unknown but, as noted above, there is a reference in the Oil and Gas Journal to growth fault rollover structures, possibly within the region of the Avalon structure. Poag (in Scholle, 1980, figure 26, p. 57) shows that the COST B-2 well penetrated a fault-controlled rollover structure. Both the Gulf 857 and Murphy 106 wells were extensively tested but did not recover commercial quantities of gas. The presence of gas in these two wells and in the nearby COST B-3 well does however, demonstrate that there is more than one area with hydrocarbon potential in the Baltimore Canyon trough.

It is interesting to note that the depths of the gas intervals in the two industry wells and the nearby COST B-3 well near the Avalon structure are reported to be between 15,000 and 18,400 feet (Table III). This depth range is significantly deeper than the 12,300 to 15,786 depth range for the hydrocarbon intervals reported from the wells of the 598 structure.

Summary of Exploratory Drilling Activity

From 1978 to 1981, 28 exploratory wells and one COST well were drilled in the Mid-Atlantic Area. Drilling was concentrated in four target areas, two of which (on the seaward side of the continental shelf produced hydrocarbon shows. The Northeast Slope structure contained significant hydrocarbon shows in five wells. To the southwest, on the Avalon structure, two wells, plus the COST B-3 well, contained some hydrocarbon shows. Natural gas is the predominant hydrocarbon recorded, although one well reported flowing oil. The Mid-Atlantic Area has not yet been defined as a commercially producing region, nor has its assessment been completed.

R. N. Benson of the DGS (1979a, p. 28) has speculated that the entire Mid-Atlantic sedimentary basin is a potential target area. Included in this potential are the nearshore hinge zone sediments, which reach 16,000 feet within 15 miles of the Delaware coast, rift basins, the unexplored structural traps in the deep part of the basin, but still within reach of the drill bit, and the carbonate reef complex at the outer edge of the continental shelf. Benson (1979a) further speculates that gas and especially oil may occur at shallow depths within thermally immature rocks, with the hydrocarbons migrating along horizontal or vertical distances from deeper, more mature horizons.

By mid-1980 the petroleum industry had expended over $1,632 billion on exploration in the Mid-Atlantic Area. This included geologic and geophysical work, rent and bonus money, and drilling (Oil and Gas Journal, 5/5/80). During the most active drilling period, in late 1979, there were eight rigs actively drilling in the Mid-Atlantic Area at one time. The cost per well at that time averaged four to seven million dollars; it took an average 85 days to drill a 15,000 foot well, at an average cost of $500 per foot (Oil and Gas Journal, 5/5/80).

CONCLUSIONS

There has been exploration for oil and gas in the Mid-Atlantic region for over 50 years, on land in the 1930's to 1950's, and offshore in the late 1970's and early 1980's. Since 1960 the offshore search for oil and gas had dominated both geologic and public interest in the region. This 20-year interval may be regarded as a series of geologic and technologic advances on the one hand, and, on the other hand, the slow development of attitudinal and institutional accomodation by all parties involved. These two arenas - science and policy - do not have a direct cause and effect relationship, but they do contain common elements of timing and growth. There appear to be five phases of this growth in the Mid-Atlantic region as displayed in Table IV.

With all of the activity described above, not more than 50 test wells, on and offshore, have been drilled in the East Coast region. During a comparable period, from 1938 to 1977, a total of 17,275 wells have been drilled in the Gulf Coast region which was an area of similar size (American Petroleum Institute statistics, 1977). It is obvious, therefore, that the Mid-Atlantic region has not been completely tested. There are indications that more seismic surveying will be done, more wells will be drilled, and presumably a wider variety of prospects will be tested all across the Mid-Atlantic OCS. The DOI/MMS estimate of resource potential for the Mid-Atlantic OCS at the time of Sale 59 in December 1981 was averaged at 3.4 billion barrels of oil and 14.2 trillion cubic feet of gas (Oil and Gas Journal, 6/2/80).

What happens next is dependent on an upcoming drilling phase scheduled for 1983. To date only "bullseye" prospects have been drilled. Other prospect categories, including reef

TABLE IV

PHASES OF MID-ATLANTIC OCS ACTIVITY

	Geological Activities	Public Policy Actions
1960-1964	Evolution of new theories of stratigraphy and structure of the OCS, with improved reflection seismic techniques.	Gradually increasing public awareness that East Coast oil exploration could begin.
1964-1975	Second generation of regional studies, using new data processing methods to analyze seismic records. Increased number of industry seismic surveys.	Initial efforts to define OCS public policy and institutions. Introduction of State response (MAGCRC) and first OCS advisory boards.
1975-1977	Industry tract nomination for First Atlantic lease sale. First COST well drilled, industry seismic studies accelerated. Primary targets are structural closure "bullseyes."	Implementation of environmental legislation and strengthening of OCS regulation, partly in response to State and public pressure. A period of crisis and response to the energy crunch. States given increased role in OCS activities. Congress studies OSCLA amendment. First Atlantic Lease Sale - 40.
1971-1981	Testing of the geological theories by drilling of Sales 40/49 tracts. Significant gas shows found, but general disappointment with known "bullseye" targets. Second COST well completed.	Two more lease sales, with improved Federal management of OCS exploration activities. Stabilization of federal-State relations. Continued improvement of federal OCS policy. Passage of OSCLA amendments.
1981-1995 (?)	Continued drilling of region, testing other prospects (reef, rift basins, nearshore). Pioneering efforts in deep-water drilling initiated.	Lessening of negative public attitudes. Congress considers sharing the OCS revenues with States. More OCS involvement by States.

(Modified after Jordan, 1976.)

structures, rift-basins, and inner margin entrapping structures will be examined. R. R. Jordan (1979) noted that if "bullseye" prospects were to be the primary drilling target for the Sale 40 lease area, the future of the Mid-Atlantic OCS could go one of two ways: (1) oil and gas will be found in the first few holes and the program would go off with a bang; (2) if it didn't, it would be a long drawn-out process, testing all prospects and categories of targets stretching out until the 1990's. As possibility No. 1 was not realized, the future program seems, as predicted by Jordan, to be lengthy and extremely cautious extending probably into the 1990's.

REFERENCES

Adams, M. V., et al., 1975, Mineral resource management of the Outer Continental Shelf: U. S. Geological Survey Circular No. 720, 32 p.

Amato, R. V. and Simonis, E. K., 1979, Geology and operational summary, COST No. B-3 well, Baltimore Canyon trough area, Mid-Atlantic OCS: U. S. Geological Survey Open File Report 79-1159.

Anderson, J. L., 1948, Cretaceous and Tertiary subsurface geology (Maryland) (with appendix, description of well samples): Maryland Department of Geology, Mines, and Water Resources, Bulletin 2, 466 p.

Balsley, J. R., et al., 1946, Magnetic maps of Worcester County and part of Wicomico County, Maryland: U. S. Geological Survey Oil and Gas Investigations, Preliminary Map 46, one map with side text.

Beard, J. H., Sangree, J. B., and Smith, L. A., 1982, Quaternary chronology, paleoclimate, depositional sequences, and eustatic cycles: American Association of Petroleum Geologists Bulletin, v. 66, no. 2, p. 158-169.

Benson, R. N., 1979a, Hydrocarbon resource potential of the Baltimore Canyon trough: Delaware Geological Survey Report of Investigations No. 31, 45 p.

_____, 1979b, Exploration for petroleum in the Baltimore Canyon trough: Delaware Coastal Management Program News, v. 4, no. 6, and v. 6, no. 1, 7 p.

Berg, H. E., 1976, Tabulation of statistics on Atlantic ocean geophysical seismic survey, 1966-1975: in Amoco Public Affairs Office Presentation, Wilmington, Delaware, December 1976.

Bray, E. E. and Evans, E. D., 1969, Organic extracts from Joides cores off northeastern Florida (basic Joides project data): U. S. Geological Survey Professional Paper 581-C, 49 p.

Bureau of Land Management, 1981a, A regional studies plan for the North and Mid-Atlantic regions for FY 1980-FY 1981 (Draft).

_____, 1981b, Compilation of laws related to mineral resource activities on the Outer Continental Shelf, 2 volumes (Special Compilation).

_____, 1981c, New York OCS Office, U. S. Department of Interior Hudson Canyon Transportation Management Plan, Draft Final, June 1981, 167 p.

Burk, C. A. and Drake, C. L. (ed.), 1974, The geology of continental margins: New York, Springer-Verlag New York Inc.

Council of Environmental Quality, 1974, Oil and gas - an environmental assessment, v. 1: U. S. Government Printing Office, Washington, D. C., 136 p.

_____, 1977, Oil and gas in coastal lands and waters: U. S. Government Printing Office, 040-000-00306-0, Washington, D. C., p. 37-39.

Delaware Bay Oil Transport Committee Report, 1973, Energy, Oil, and The State of Delaware: authorized by the 1971 Delaware General Assembly, 316 p.

Delaware Code, Part 7, Chapter 61, Underwater Lands: 7 Del. C. 19, section 6101-6159.

Delaware State Planning Office, 1976, Delaware and Outer Continental Shelf development roles and systems at various levels of government, Dover, Delaware, 246 p.

Dobrin, M. B., 1977, Introduction to geophysical prospecting: Third Edition, McGraw-Hill Book Co., New York, NY, 630 p.

Doyle, R. G., 1981, Review and revision of Delaware mineral laws, including draft legislation: Delaware Geological Survey, 124 p. (Report to DNREC).

Doyle, R. G. and Pickett, T. E., 1981, Delaware's extractive mineral industry: Delaware Geological Survey Open File Report No. 13, 17 p.

Drake, C. L., Ewing, M., and Sutton, G. H., 1959, Continental margins and geosynclines: the east coast of North America north of Cape Hatteras: in Physics and Chemistry of the Earth: London, Pergamon Press, v. 3, p. 110-198.

Emery, K. O., et al., 1970, Continental rise off eastern North America: Geological Society of America Bulletin, v. 54, no. 1 (R. V. Chain traverses), p. 44-108.

Encyclopedia Brittanica, 1977, Book of the year: reference to ARGO MERCHANT sinking, p. 103.

Ewing, J., 1966, Age of horizon A and the oldest Atlantic sediments: Science, v. 154, p. 1125-1132.

Ewing, M., Crary, A. P., and Rutherford, H. M., 1937, Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part I; Geological Society of America Bulletin, v. 48, p. 753-802.

Ewing, M., Wollard, G. P., and Vine, A. C., 1939, Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part II: Geological Society of America Bulletin, v. 50, p. 257-296.

Ewing, M., Wollard, G. P., and Vine, A. C., 1940, Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part III: Geological Society of America Bulletin, v. 51, p. 1821-1839.

Geological and geophysical permits issued by U. S. Geological Survey, Atlantic OCS, 1980-1981; monthly report of activity: U. S. Geological Conservation Division Report.

Grow, J. A., 1980, Deep structure and evolution of the Baltimore Canyon Trough in the vicinity of the COST No. B-3 Well: in Scholle, P. A., (ed.), Geological studies of the COST No. B-3 well, United States Mid-Atlantic continental slope areas: U. S. Geological Survey Circular 833, p. 117-132.

Grow, J. A. and Markl, R. G., 1977, IPOD-USGS multichannel seismic reflection profile from Cape Hatteras to the Mid-Atlantic ridge: Geology, v. 5, p. 625-630.

Grow, J. A., Mattick, R. E., and Schlee, J. S., 1979, Multichannel seismic depth sections and interval velocities over outer continental shelf and upper continental slope between Cape Hatteras and Cape Cod: in Geophysical and geophysical investigations of continental margins: American Association of Petroleum Geologists, Memoir 29, p. 65-85.

Hathaway, J. C., et al., 1979, U. S. Geological Survey core drilling on the Atlantic shelf: Science, v. 208, no. 4418, November 1979, p. 515-527.

Hollister, C. D., et al., 1972, Initial reports of the DSDP, Volume 11: U. S. Government Printing Office, Washington, D. C., 1077 p.

Jordan, R. R., 1979, The last 20 years of East Coast oil exploration (Abs.): in Energy for the Eighties: A Joint Department of Energy, Eastern Gas Shales Project, and American Association of Petroleum Geologists Symposium, Morgantown, West Virginia.

Kuehn, H. E. and Dent, G. E., 1944, Comparative study of magnetic surveys of Worcester County, Maryland made on the ground and from airplane observations: U. S. Bureau of Mines Report of Investigations 4070, 23 p.

Libbey-French, J., 1981, Lithostratigraphy of the Shell 272-1 and 273-1 wells: Implications as to depositional history of the Baltimore Canyon trough, Mid-Atlantic OCS: American Association of Petroleum Geologists Bulletin, v. 65, no. 8, p. 1476-1484.

Maher, J. C. and Applin, E. R., 1971, Stratigraphy: in Maher, J. C. (ed.), Geologic Framework and petroleum potential of the Atlantic Coastal Plain and Continental Shelf: U. S. Geological Survey Professional Paper 659, p. 26-56.

Maris, A. B., 1974, Report of Albert B. Maris, Special Master, for U. S. vs. Maine, et al., to the Supreme Court of the United States: The Legal Intelligencer, Philadelphia, Pennsylvania, 88 p.

Mattick, M. E. and Hennessy, J. L., (eds.), 1980, Structural framework, stratigraphy, and petroleum geology of the area of oil and gas lease Sale No. 49 on the U. S. Atlantic Continental Shelf and Slope: U. S. Geological Survey Circular No. 812, 101 p.

Oil and Gas Journal, various news articles, 1966-1981, Published in Tulsa, Oklahoma.

Oliver, J. E. and Drake, C. L., 1951, Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part VI, The Long Island Sound area: Geological Society of America Bulletin, v. 62, no. 11, p. 1287-1296.

Onuschak, E., Jr., 1972, Deep test in Accomack County, Virginia: Virginia Minerals, v. 18, no. 1, p. 1-4.

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; plus update 3, August 1981: U. S. Geological Survey Open File Report 51-619, 62 p.

Poag, C. W., 1979, Stratigraphy and depositional environments of Baltimore Canyon trough: American Association of Petroleum Geologists Bulletin, v. 53, no. 9, p. 1452-1466.

Project Independence, 1974, Federal Energy Administration Project Independence Report: U. S. Government Printing Office, Washington, D. C., 319 p.

Richards, H. G., 1945, Deep oil test at Salisbury, Wicomico County, Maryland: American Association of Petroleum Geologists Bulletin, v. 29, no. 8, p. 75-126.

Schlee, J. S., et al., 1976, Regional geologic framework off northeastern United States: American Association of Petroleum Geologists Bulletin, v. 60, no. 6, p. 926-951.

Schlee, J. S. and Grow, J. A., 1980, Buried carbonate shelf edge beneath the Atlantic continental shelf: Oil and Gas Journal, February 25, 1980, p. 147-159.

Schlee, J. S. and Markl, R. G., 1977, IPOD-USGS multichannel seismic reflection-seismic refraction profile from Cape Hatteras to Mid-Atlantic ridge: Geology, v. 5, p. 625-630.

Scholle, P. A. (ed.), 1980, Geological studies of the COST No. B-3 well, U. S. Mid-Atlantic Continental Slope area: U. S. Geological Survey Circular 822, 247 p.

Smith, M. A., et al., 1976, Geological and operational summary COST No. B-2 well, Baltimore Canyon trough area, Mid-Atlantic OCS: U. S. Geological Survey Open File Report 76-7441, 185 p.

Spoljaric, N., 1979, Exploring, drilling, and producing petroleum offshore: Delaware Geological Survey Report Of Investigations No. 33, 30 p.

State of Delaware Water and Air Resources Commission, 1969, Regulations governing the use of water resources and public subaqueous lands: State of Delaware Printing Office, Dover, Delaware, 94 p.

U. S. Geological Survey monthly reports of geological and geophysical permits: USGS Conservation Division, Atlantic OCS Office, 1960 to date.

U. S. Geological Survey, 1976, et. seq. to 1980, Regulations pursuant to geological and geophysical explorations of the outer continental shelf: U. S. Geological Survey Publication (available from Mineral Management Service, OCS Eastern Division, Vienna, Virginia).

U. S. Geological Survey, 1977, Policies, practices and responsibilities for safety and environmental protection in oil and gas operations on the outer continental shelf: U. S. Geological Survey Publications Office, Reston, Virginia.

U. S. Geological Survey, et al., 1979, Leasing and management of the energy resources of the outer continental shelf: U. S. Government Printing Office, 1979-281-263/10, 40 p.

U. S. Geological Survey, 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 No. 80-17, 64 p.

U. S. Geological Survey, 1971, Outer continental shelf statistics, 1953 through 1980: U. S. Geological Survey Conservation Division Publication, 92 p.

U. S. Government, Oil and gas and sulphur operations in the outer continental shelf, in Code of Federal Regulations, Title 30, Parts 250, 251, 252, revised as of 1981.

U. S. Government, Outer continental shelf mineral leasing in Code of Federal Regulations Title 43, Part 2800 and 3300, revised as of 1980 and 1981.

Watts, A. B., 1981, in Bally, J. B., et al., (eds.), Geology of passive continental margins: history, structure, and sedimentologic record: American Association of Petroleum Geologists, Education Course Notes Series No. 19, October 1981, 79 p.

Woodruff, K. D., 1977, Preliminary results of seismic and magnetic surveys off Delaware's coast: Delaware Geological Survey Open File Report No. 10, 43 p.