OCS Report
MMS 98-0028

# The Resource Evaluation Program

## Structure and Mission on the Outer Continental Shelf

U.S. Department of the Interior
Minerals Management Service
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**U.S. Department of the Interior**
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# Preface

The oil and gas resources on the Outer Continental Shelf belong to the people of the United States, who, through their Government, lease the right to explore and develop those resources. The Federal Government, through the Minerals Management Service, issues permits for prelease exploration activities, evaluates resources, leases acreage, and regulates drilling and production activities. This publication provides information about how these oil and gas resources are effectively evaluated.

The Outer Continental Shelf Lands Act, passed by Congress in 1953 and amended in 1978, is the basis for the procedures and activities to be discussed here.

This publication describes the procedures followed in evaluating offshore resources, beginning with the permitting and collecting of geological and geophysical data and ending with the resource economic and engineering evaluations and analyses for a lease sale. It is a summary of the Minerals Management Service oil and gas Resource Evaluation Program on the Outer Continental Shelf, the results of which are intended to assure the Government receipt of fair market value for these lands.

We hope this publication will provide you with a better understanding of the evaluation of oil and gas resources on the Outer Continental Shelf.

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# Acronyms

| | |
|---|---|
| **BEG** | Bureau of Economic Geology |
| **BLM** | Bureau of Land Management |
| **CDP** | Common Depth Point |
| **CFR** | Code of Federal Regulations |
| **DOI** | Department of the Interior |
| **EEZ** | Exclusive Economic Zone |
| **EIS** | Environmental Impact Statement |
| **FMV** | Fair Market Value |
| **G&G** | Geological and Geophysical (data) |
| **GOM** | Gulf of Mexico |
| **MMS** | Minerals Management Service |
| **MONTCAR** | Monte Carlo Range of Values (methodology) |
| **NEPA** | National Environmental Policy Act |
| **OCS** | Outer Continental Shelf |
| **OCSLA** | Outer Continental Shelf Lands Act and its Amendments |
| **PRESTO** | Probabilistic Resource Estimates--Offshore (methodology) |
| **RE** | Resource Evaluation |
| **USGS** | U.S. Geological Survey |

# Introduction

## Legislative Background

### *Statutory Authority for the Resource Evaluation Program*

Jurisdiction over the offshore lands is divided between the Federal Government and the coastal States. In response to public concerns about the ownership and development of offshore resources, Congress, in 1953, enacted two laws that granted certain offshore lands to coastal States and provided a framework for regulating and managing exploration, development, and production of resources under the seabed beyond the area managed by the coastal States. The two acts are as follows:

**The Submerged Lands Act.** The Submerged Lands Act of May 22, 1953, granted the coastal States a belt of submerged lands seaward of their coastlines to a distance of 3 geographical miles. A greater distance from shore (about 3 marine leagues) was granted to Texas and Florida (west coast only), because these States had established jurisdiction over the larger area before achieving statehood. As a result of this Act, natural resources of the seabed beyond those granted to coastal States would be under the jurisdiction of the Federal Government.

**The Outer Continental Shelf (OCS) Lands Act and its Amendments.** The OCS Lands Act of August 7, 1953 (1) reaffirmed that those lands beyond the 3 geographical mile limit, or more, are subject to the jurisdiction of the Federal Government and (2) authorized the Secretary of the Interior to grant mineral leases on OCS lands and to provide regulations to carry out the provisions of the Act.

The Act was amended on September 18, 1978. The amendments established a policy for managing oil and gas on the OCS and required revision of bidding systems and lease administration, coordination, and consultation with affected State and local governments, development of environmental studies for lease sale areas, and development of a 5-year leasing program. In addition, with regard to resource evaluation, the Secretary is required to assure the receipt of fair market value (FMV) for OCS lands in oil and gas leasing.

**Other Laws that Govern the OCS.** Resource evaluation of the OCS is also subject to the requirements of other Federal laws administered by numerous Federal Departments and Agencies. Among them is the National Environmental Policy Act (NEPA) of 1969, which establishes requirements for preparation of environmental assessments and environmental impact statements for major Federal actions that could affect significantly the quality of the human environment. Included in the environmental impact statements are resource estimates and exploration, development, and production scenarios for oil and gas resources.

### *Regulatory Authority for the Resource Evaluation Program*

**Regulations.** The Minerals Management Service (MMS) administers the provisions of the OCS Lands Act, as amended, through regulations found in Title 30 of the Code of

Federal Regulations (CFR). The regulations govern leasing, permitting, collecting of data, and operations on the OCS. With regard to the Resource Evaluation Program, authority has been vested in the Secretary of the Interior under 30 CFR Part 251 to regulate the conduct of prelease geological and geophysical (G&G) exploration for mineral resources on the OCS. Part 251 applies not only to G&G exploration but to scientific research as well. The purpose of these regulations is (1) to prescribe when a permit or the filing of a statement of intent to conduct G&G exploration on the OCS is required and (2) to prescribe operating procedures for conducting exploration, requirements for disclosing data and information, conditions for reimbursing permittees for certain costs, and other conditions under which exploration shall be conducted. Similar regulations addressing prelease prospecting activities can be found in 30 CFR Part 280.

# Technical and Historical Background

## Outer Continental Shelf

The term "continental shelf" is distinct from the term "Outer Continental Shelf", which is a legal term created by Federal statute. There is no scientific definition for the OCS. Legally, the OCS comprises that part of the continental margin adjacent to the United States that remained subject to Federal jurisdiction and control after enactment of the Submerged Lands Act. Under the 1958 Geneva Convention on the Continental Shelf, the seaward limit of the shelf is defined as ". . . a depth of 200 meters (656 feet) or, beyond that limit to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas."

The submerged seaward extension of a continent is called the continental margin. In most areas, this submerged extension is composed of the gently sloping continental shelf and the steeper gradients of the continental slope. In some areas, an apron of material derived from the continent—the continental rise—extends from the base of the continental slope to the abyssal ocean floor. Figure 1 shows a generalized profile of the continental margin.

The contour and extent of the continental shelf vary from one coastal area to another. The shelf is relatively narrow along the Pacific coast, moderately wide along much of the Atlantic coast and the Gulf of Alaska, and broad in the Gulf of Mexico and around western and northwestern Alaska. It is generally defined as a gently sloping submerged marginal zone of the continents extending from the shore outward through shallow waters to a dropoff at the continental slope in deeper waters.

Evaluation of oil and gas resources on the Federal OCS currently involves the submerged lands generally 3 geographic miles seaward from a State's coast line to about 200 to 300 nautical miles offshore.

## Exclusive Economic Zone

On March 10, 1983, a Presidential Proclamation established an Exclusive Economic Zone (EEZ) of the United States of America. The EEZ extends seaward 200 nautical miles from the "baseline" (the legal coastline) of the territorial sea of the United States, the Commonwealths of Puerto Rico and Northern Mariana Islands, and other U.S. overseas territories and possessions. The EEZ covers over 3 billion acres subject to U.S. jurisdiction.

Within the EEZ, the United States has sovereign rights, to the extent permitted by international law, to explore, exploit, conserve, and manage natural resources, both living and nonliving, of the seabed and subsoil. The Federal Government is authorized by the OCS Lands Act to manage the leasing of all minerals including oil and gas within the EEZ off the 50 States. Figure 2 shows the location of the EEZ.

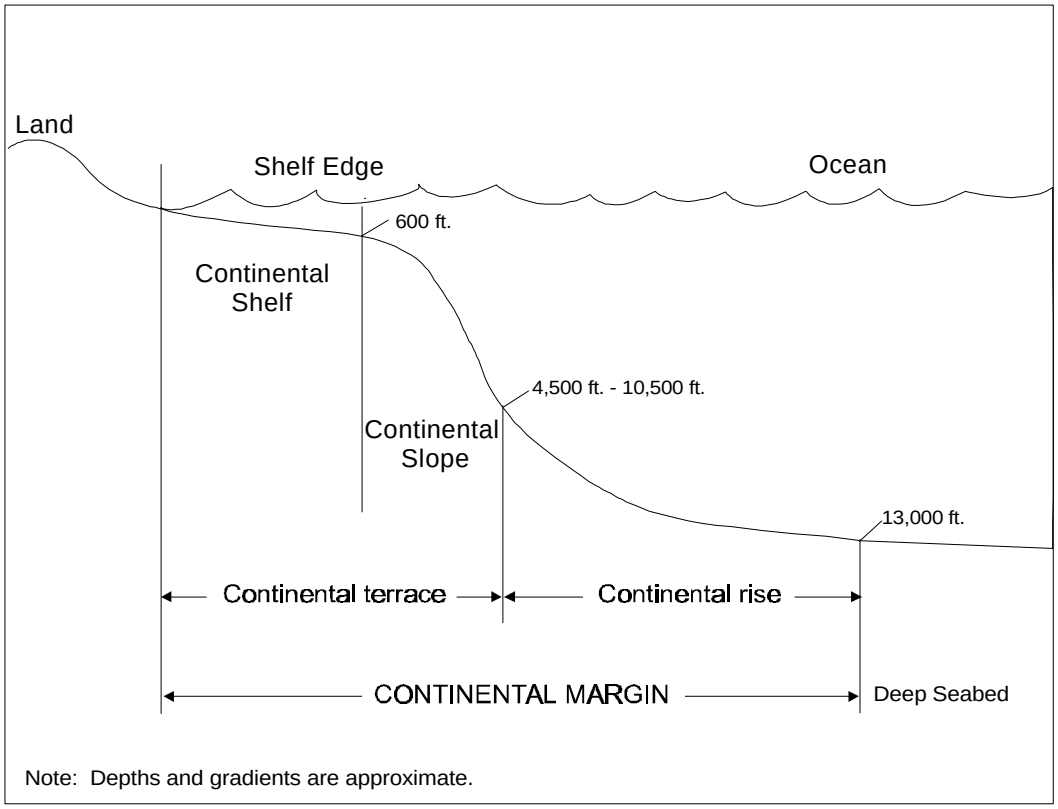



**Figure 1.** Profile of the continental margin

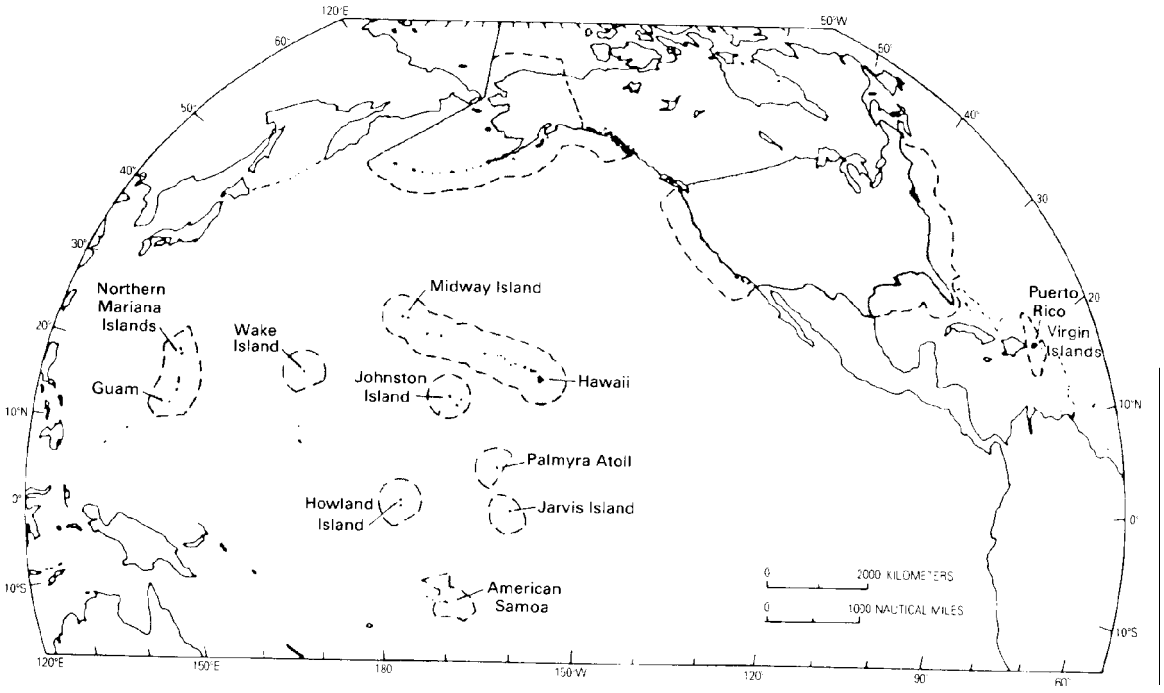



**Figure 2.** Exclusive Economic Zone

## Petroleum Geology

The Resource Evaluation Program addresses the mineral potential of the OCS, predominantly oil and gas, i.e., petroleum. Petroleum is found beneath the surface of the Earth both onshore and on the continental shelf and slope. The key geologic requirements are (1) source rocks — organic-rich sediments that serve as a source of hydrocarbons, (2) reservoir rocks — porous and permeable rocks where the hydrocarbons can accumulate, (3) an impermeable capping rock or porosity barrier that serves as a trapping mechanism and prevents the hydrocarbons from escaping, and (4) a favorable thermal history to transform the organics into hydrocarbons.

Most scientists believe that the majority of hydrocarbons are associated with rocks that were formed or deposited in a marine environment millions of years ago. Great volumes of organic and inorganic matter accumulated in these marine environments, and, as this material continued to accumulate, pressure was applied from the weight of the overlying sedimentary pile. This pressure, together with the heat of the Earth, probably produced oil and gas from the organic matter. Scientists have proven that organic matter may be transformed into oil and gas by long periods of continuous heat and pressure aided by bacterial action. Gradually, over millions of years, some of the oil and gas migrated into porous and permeable rocks.

Oil is not a homogeneous compound. Two primary elements — hydrogen and carbon — are combined in complex and various proportions. In crude oils, the amount of hydrogen varies from 10 to 15 percent and carbon from 80 to 89 percent by weight. Oil usually occurs with natural gas and saltwater within porous rocks. Gas is lighter than oil or water and tends to accumulate at the top of any reservoir. Most oil is lighter than water and also accumulates in the upper part of a reservoir, below the gas. Oil also contains minor amounts of other chemicals, such as sulfur and nitrogen, in its natural state or condition.

Porous and permeable rocks, such as sandstone or limestone, act as depositories or reservoirs for oil and gas if there is some geologic condition that acts as a seal. If the seal or trap results from the structure of the rock, such as a fold, salt dome intrusion, or fault, it is called a structural trap. If the seal simply resulted from (1) a loss of porosity or permeability of the host rock that prevents further migration of the oil and gas or (2) the halting of the upward movement of hydrocarbons by beds pinching out against impervious cap rock, it is known as a stratigraphic trap.

There are many different shapes, sizes, and types of geologic structures or traps that provide reservoirs in which petroleum is found as depicted in figure 3.

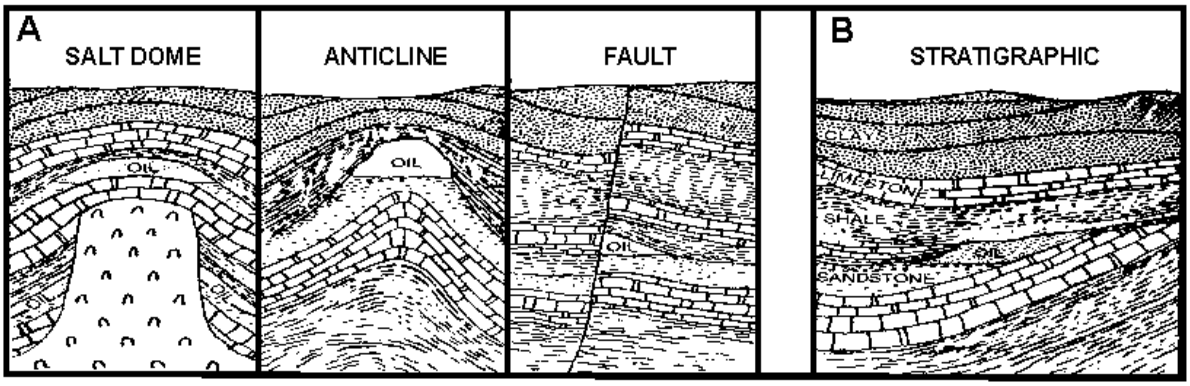



**Figure 3.** Structural and stratigraphic traps. (A.) Structural traps are created when porous rocks are tilted and folded, providing reservoir conditions suitable for the accumulation of petroleum; (B.) A stratigraphic trap is formed by changes in the porosity of a rock formation.

Perhaps the simplest means of classifying reservoirs is to group them according to the conditions causing their occurrence, as in the following:

**Structural Domes and Anticlines** — Reservoirs formed by folding of the rock layers or strata usually have the shape of structural domes or anticlines. These traps were filled by upward migration or movement of oil or gas (or both) through the porous strata or beds to the location of the trap. Here further movement was arrested by a combination of the form of the structure and the seal or cap rock provided by the formation covering the structure. Examples of reservoirs formed by domal structures are located offshore in the Gulf of Mexico and offshore California. Examples of reservoirs formed by anticlinal structure are the Ventura Avenue and Wilmington Oil Fields in California.

**Fault Traps** — Reservoirs are formed when strata are broken or sheared and offset. This is called faulting. The escape of oil from such a trap is prevented by nonporous rocks that have moved into a position opposite the porous petroleum-bearing formation. The oil is confined in traps of this type because of the tilt of the rock layers and the faulting. Examples of fields of this type exist along fault zones in offshore Texas.

**Dome and Plug Traps** — Accumulations of oil are found in porous formations on or surrounding great plugs or masses of salt or intrusive rock that have pierced, deformed, or lifted the overlying rock layers. Some typical accumulations of this type, illustrating a nonporous salt mass that has formed domeshaped traps in overlying and surrounding porous rocks, are located in the central and western offshore Gulf of Mexico.

**Unconformities** — A type of stratigraphic reservoir is formed as a result of an unconformity. Here the upward movement of oil has been halted by the impermeable cap rock laid down across the cutoff (possibly by water or wind erosion) surfaces of the lower beds. An example of this type of reservoir is the giant East Texas Field.

**Pinchouts** — Another type of stratigraphic reservoir is one that is sealed in its upper regions by abrupt changes in the amount of connected pore space. This may be caused in the case of sandstones by irregular depositing of sand pinching out into shale at the time the formation was laid down. In these cases, oil is confined within porous parts of the rock by the nonporous parts of the rock surrounding it. A reservoir of this type is found in the East Breaks Block 945 (Diana) Field.

Often, however, the trapping mechanism results from a combination of structural and stratigraphic factors.

## History of Offshore Petroleum Development

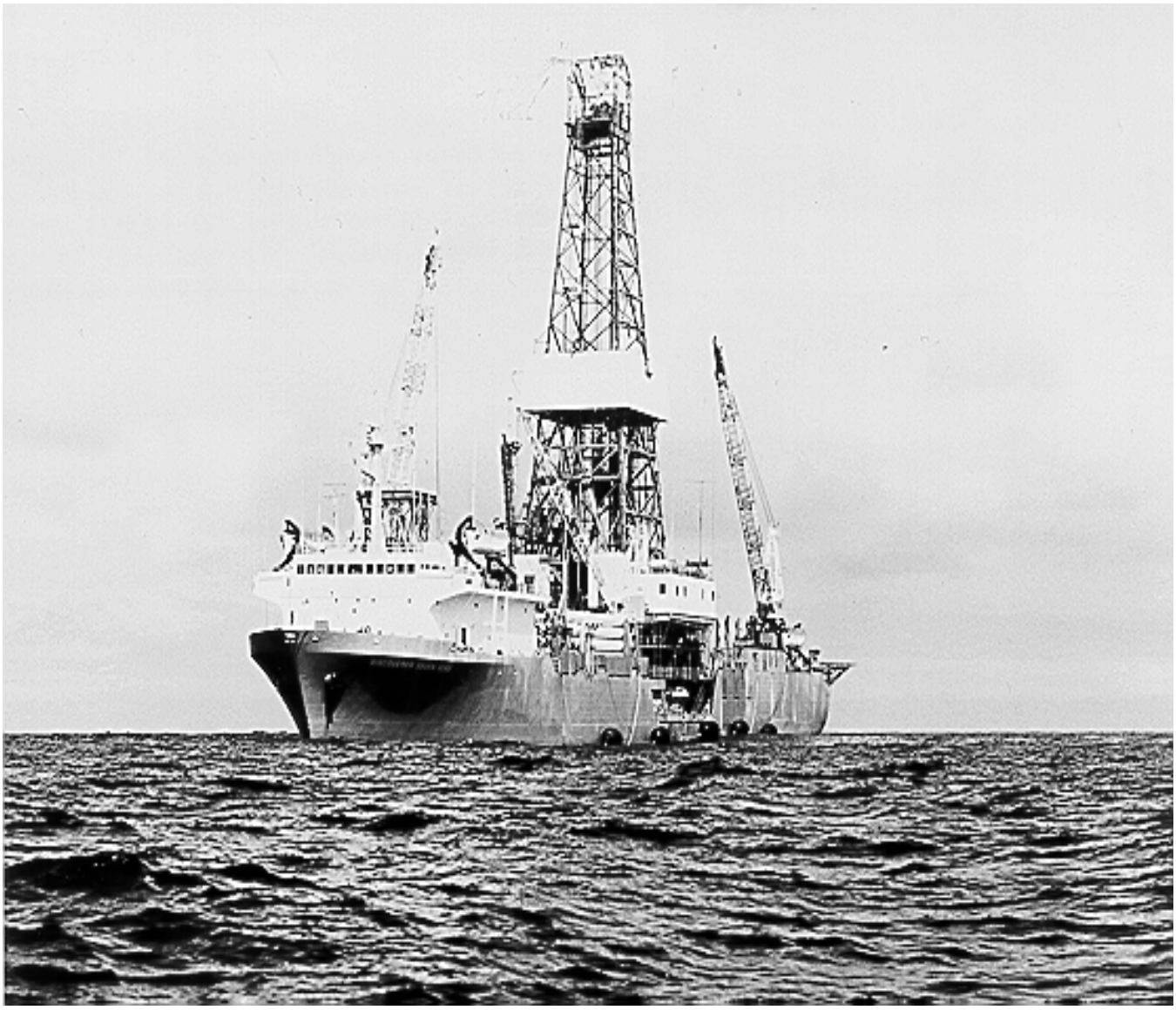
The earliest offshore oil production in the United States was developed off Summerland, California, in 1896 (fig. 4). The offshore portion of the field was an extension of an onshore discovery that had been made before 1894. The offshore wells were drilled from wooden piers extending out from the shoreline. In all, more than 400 shallow wells were drilled and completed at a depth of about 600 feet.

Courtesy of California Historical Society and American Petroleum Institute Photographic and Film Services.

**Figure 4.** Summerland Oil Field, California, in the late 1800's

The discovery of the Creole Field in 1938 in the Gulf of Mexico, 1 ½ miles from shore in 26 feet of water, marked the petroleum industry's first successful venture into open, unprotected waters. In November 1947, a discovery was made in Ship Shoal Block 32 off the Louisiana coast, 12 miles from shore in water 16 feet deep. This well was the first offshore well to be drilled out of sight of land. It was also the first offshore well drilled from a mobile drilling platform, thus initiating the technology that has subsequently been utilized to drill offshore oil and gas wells in the deeper waters of the United States.

As the search for oil and gas moved farther offshore and into deeper waters, industry has continued to expand drilling and production technology. The technology used for exploration and production of petroleum in deeper water illustrates these advancements. Conventional steel-jacketed production platforms stand in over 1,000 feet of water off southern California and in over 1,300 feet of water off the Louisiana coast. In 1983, a compliant guyed-tower production platform was installed in 1,000 feet of water, 110 miles southeast of New Orleans, Louisiana, and an exploration well in the Gulf recently has been drilled in 7,600 feet of water. In addition, offshore technology has seen the development of the tension leg platform, which is a semisubmersible drilling platform held in place by multiple cables anchored to the ocean floor. The tension of the cables makes the platform immune to heave, pitch, and role. In 1984, the drillship *Discoverer Seven Seas* drilled an exploratory well in over 6,900 feet of water off the coast of New Jersey (fig. 5). Our Nation's energy resources are now being produced in water depths exceeding 5,000 feet using subsea systems. In the often ice-bound waters of the Arctic, drilling units have evolved from the single-use artificial gravel islands to specially designed multiuse caisson-retained islands and ice-resistant mobile units of more conventional design.



Courtesy of Philips Petroleum Co. & American Petroleum Institute

**Figure 5.** *Discoverer Seven Seas* drillship (Atlantic)

# OCS Leasing Framework

A leasing schedule is the framework used to delineate the timing and planning procedures for individual sale areas.

Section 18 of the OCS Lands Act, which was added by the amendments of 1978, requires the Secretary of the Interior to prepare and maintain an OCS oil and gas leasing program that consists of both a schedule of lease sales for a 5-year period plus policies regarding the size, location, and timing for those sales.

The analysis supporting the 5-year program is based on the following factors:

- existing information concerning the geographical, geological, and ecological characteristics of such regions;
- the location of such regions with respect to, and the relative needs of, regional and national energy markets;
- the location of such regions with respect to other uses of the sea and seabed, including fisheries, navigation, existing or proposed sea lanes, potential sites of deep-water ports, and other anticipated uses of the resources and space of the OCS;
- the interest of potential oil and gas producers in the development of oil and gas resources as indicated by exploration or nomination;
- laws, goals, and policies of affected States that have been specifically identified by the Governors of such States as relevant matters for the Secretary's consideration;
- the relative environmental sensitivity and marine productivity of different areas of the OCS; and
- relevant environmental and predictive information for different areas of the OCS.

The schedule is continually being updated and revised within the Department of the Interior. Key considerations in this process are the three objectives of the leasing program: (1) orderly resource development, (2) protection of the environment, and (3) receipt of fair market value from the sale of leases and the production of oil and gas.

The following factors influence the areas that are selected for the schedule:

- initial assessments of oil and gas potential as estimated by both the Resource Evaluation Program and industry;
- environmental resources that might be affected by OCS development;

- the availability of technology; and
- the proximity to markets.

For the scheduling of sales, the OCS is divided into sections called “planning areas.” These planning areas are large, contiguous areas, usually embracing several million acres, designating specific regions of the OCS, i.e., North Atlantic Planning Area, Eastern Gulf of Mexico Planning Area, Navarin Basin (Alaska) Planning Area, and Beaufort Sea (Alaska) Planning Area. Currently the OCS is divided into 26 planning areas (see fig. 6). These planning areas are subdivided into 3-mile by 3-mile blocks.

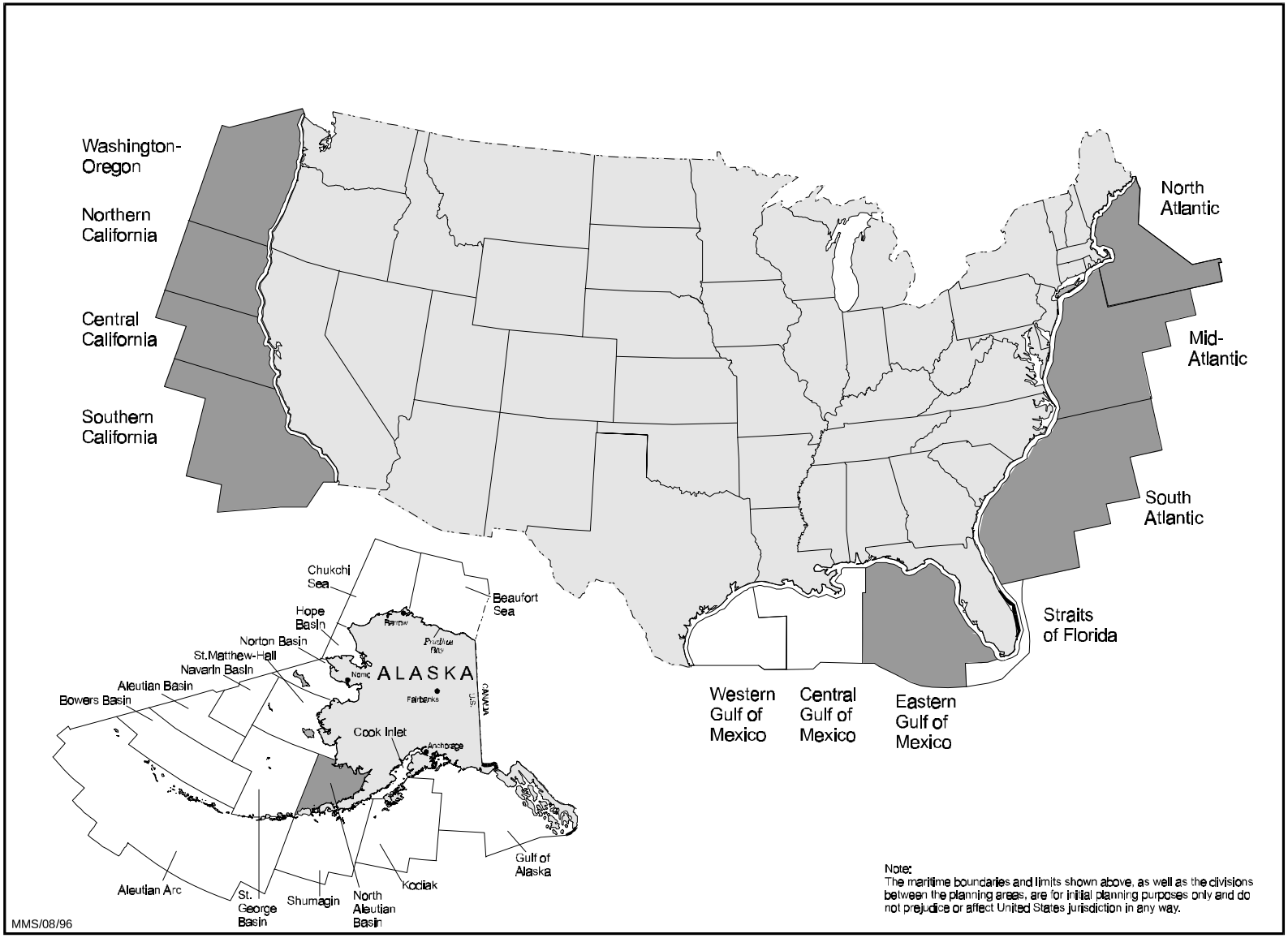



**Figure 6.** Federal Outer Continental Shelf Planning Areas Shaded areas represent those areas removed from consideration due to Presidential and congressional moratoria.

# RE Program Overview

The RE Program consists of seven major components:

1. Regulation of geological and geophysical (G&G) data collection;

2. G&G data acquisition and analyses;

3. Resource assessment;

4. Resource estimation;

5. Tract Evaluation/fair market value determination;

6. Reserves inventory; and

7. Technical information distribution.

These components all play a role in the program responsibilities that encompass all cycles of OCS activities. These responsibilities include the following:

- Obtain and analyze proprietary G&G data and information and conduct resource and reserves studies of OCS lands to determine: (1) whether geologic conditions for energy or nonenergy minerals exist; (2) where potential concentrations of resources and reserves are located; (3) the volume of the accumulations; and (4) the economic value of the resources and reserves.

- Advise Department and Bureau management on matters related to the OCS leasing and regulatory programs and issues from a petroleum geology and resource economic perspective.

- Collect economic data/conduct studies necessary to support the development of a 5-year leasing program and ensure that the public obtains fair market value from individual lease sales under that program.

- Publish/make available timely information pertinent to the mineral potential of the OCS to the public, academia, and private industry.

- Conduct continuing reviews of available bidding systems and specific bidding variables for leasing OCS tracts and their effectiveness in accomplishing the objectives of the OCSLA and Amendments.

- Improve partnership efforts with coastal States in identifying and evaluating Federal OCS nonenergy mineral resources with a focus on sand for shoreline protection, beach and barrier island restoration, and wetlands protection.

- Provide technical support to the Department of State to develop mechanisms for cooperation with counterpart agencies in foreign countries and respond to invitations to provide technical assistance.

- Develop procedures and regulations for processing and implementing laws related to offshore exploration and development, such as the Deep Water Royalty Relief Act.

## Regulation of G&G Data Collection

The only positive way of knowing whether an area contains petroleum is to drill one or more wells, but a number of geologic and geophysical techniques have been developed and refined over the years to assist in predicting whether there may be petroleum in an area. With these techniques, attempts are made to infer: (1) whether the requisite geologic conditions for petroleum occurrence exist, (2) where reservoirs are located, and (3) the size of the reservoirs and the probable volumes of petroleum that they may contain.

Most of the information used by both the Federal Government and industry to estimate or infer the oil and gas potential of an area is acquired by G&G surveys. A considerable amount of this information is collected by lessees or under prelease exploration permits issued by the MMS to specialized data-collection firms that sell or furnish the information to oil companies and to the DOI. Processing and approval of exploration permits are responsibilities of the Resource Evaluation Program and include: reviewing of applications for permits and agreements for OCS geologic or geophysical scientific research or exploration for mineral resources; issuing permits and agreements, including terms, conditions, and stipulations; monitoring permit activity; and corresponding with prospective permittees; and, basically, ensuring that G&G activities are carried out in an environmentally safe manner.

The objective of this component of the Resource Evaluation Program involves the development and implementation of the regulations, rules, and procedures that must be followed by any non-Federal party that collects prelease G&G data and information on the OCS for purposes related to mineral exploration, development, or production. The regulations governing prelease G&G exploration activities for oil, gas, and sulphur are set forth at 30 CFR Part 251 and those governing prospecting for minerals other than oil, gas, and sulphur are at 30 CFR Part 280. They govern the permitting, data acquisition, and release of information by MMS. The regulations prescribe when a permit or a notice is required, operating procedures, and conditions for release of data and information. They also prescribe reimbursement to permittees for reproduction costs of any data and information submitted to MMS. These regulations and associated permit forms are available at the MMS home page on the Internet.

The general purpose of the regulations is to ensure that prelease exploration, prospecting, and scientific research operations in Federal waters do not interfere with each other, with lease operations, or with other uses of the area. The regulations also encourage G&G

data acquisition while adequately protecting the investment of data gathered and still assuring equal access and competitive balance. Adherence to these regulations will ensure that exploration and research activities will be conducted in an environmentally safe manner.

The permits, issued by the Resource Evaluation Regional Supervisors, set forth the specific details for each data-gathering activity, which include the area where the data are collected, the timing of the data-gathering activity, approved equipment and methods, and other similar detailed information relevant to each specific permit.

This process is outlined in figure 7. After data have been collected by permittees, the MMS selectively acquires data that are needed to augment the existing database.

Industry uses these G&G data to determine the areas having potential for oil and gas production. Oil companies also use these data for preparing bids for lease sales. The MMS also acquires data that have been collected for scientific research activities for which an approved permit or filing of notice is required.

## G&G Data Acquisition and Analysis

As previously mentioned, the primary source of the G&G data and information used by the Resource Evaluation Program is the oil and gas industry, which conducts exploration, development, and production activities on OCS lands. While the MMS does not perform any direct data-collection activities, it does issue permits to industry for collecting prelease G&G data. Lessees and operators are also required by regulations to provide data from their leases to MMS. The MMS has access to the permitted data and information as a condition set forth in the permit. The MMS selectively obtains copies of data obtained from these activities. Data from prelease permits constitute approximately 90 percent of the MMS database. Permittees and lessees in their normal conduct of business are reimbursed for only the cost of data reproduction. However, if industry has collected data in areas not under MMS jurisdiction, e.g., State waters or adjacent foreign waters, and MMS selects such data, MMS pays the significantly higher “market price” for obtaining such data.

The extensive amount of data and information acquired by MMS is used by RE geologists, geophysicists, and petroleum engineers to perform a variety of analyses including (1) regional geologic studies to determine major areas of hydrocarbon potential on the OCS, (2) detailed evaluation of individual OCS tracts to determine the potential fair market value of the tract for bid evaluation purposes, and (3) estimation of the known discoveries of oil and gas as well as the development of resource estimates of possible occurrences of oil and gas yet to be discovered.

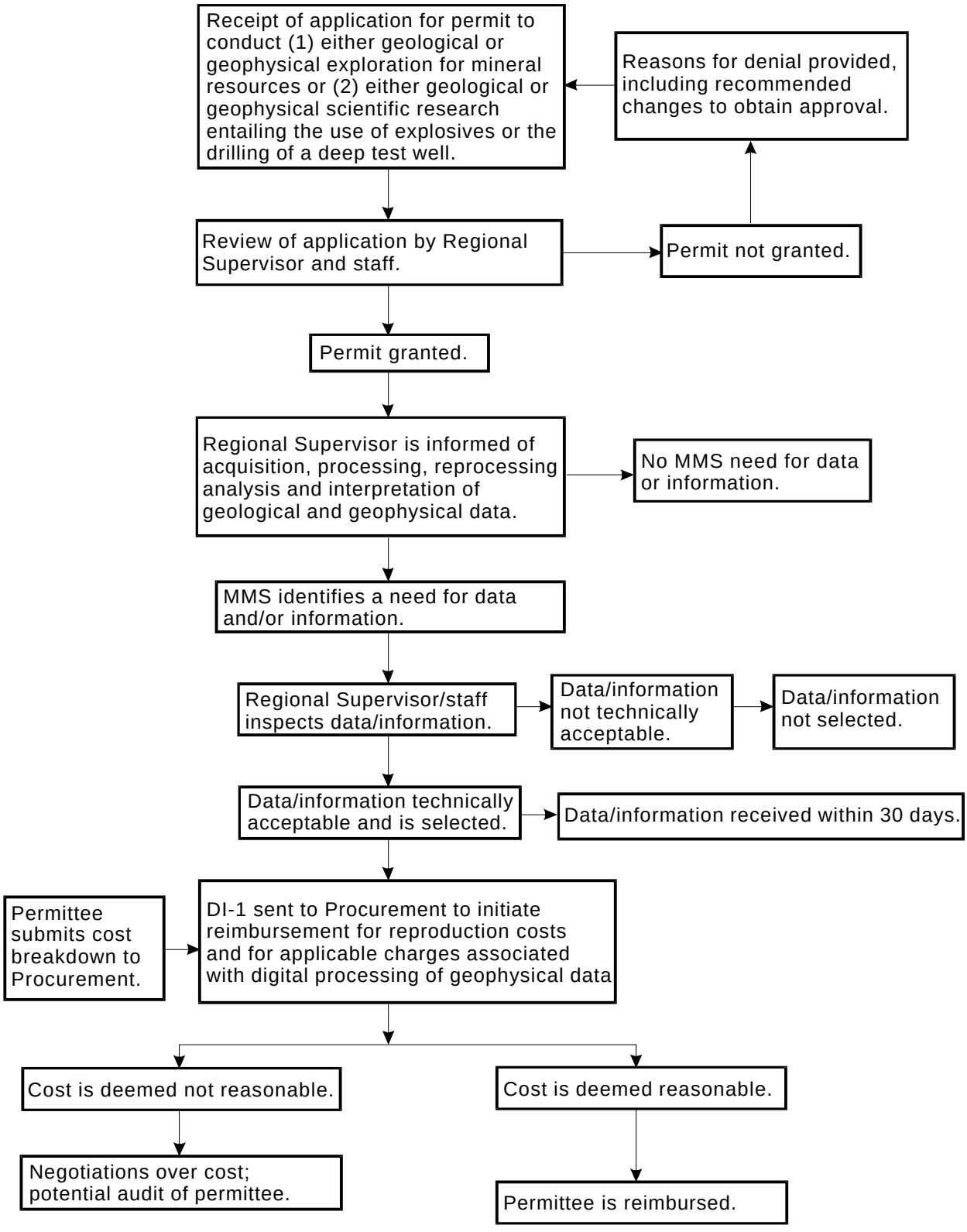



**Figure 7.** Flowchart of Permit and Data Acquisition Process

**Geophysical Surveys** — Geophysics is the application of the principles of physics at or near the surface of the Earth to determine the geology beneath the surface. In exploration geophysics, energy is transmitted into the Earth, and the recorded reflections provide the subsurface information used to delineate and identify geological structures and prospects. Geophysical surveys on the OCS include common depth point (CDP), gravity, magnetic, high-resolution, and three dimensional (3-D) surveys.

- A large percentage of the geophysical data in the MMS inventory is two-dimensional (2-D) CDP seismic information. Also known as common midpoint or common reflection point data, it is derived from a common location in the ocean subbottom where sound waves originating from various positions of the seismic (sound) source near the ocean surface are reflected toward the surface. The traces from different seismic profiles corresponding to the same reflection point are mathematically summed (stacked) for reflection points beneath the survey line. Simply, it measures the two-way travel time of an energy pulse from its source at the surface to various formations within the Earth strata and back to the surface. Present-day 2-D acquisitions, using digital recording and processing techniques, have been the basis for many prelease exploration judgments as MMS incorporates and builds its 3-D database.

- Magnetic surveys measure the magnetic field or its vertical component at a series of different locations over an area of interest. Aeromagnetic data consist of magnetic measurements made from an aircraft, and they offer measurements of larger areas. Magnetic and aeromagnetic acquisitions delineate anomalies caused by the changes in physical properties of the subsurface that lie beneath a thick layer of sediments.

- Gravity surveys produce measurements of the gravitational field at a series of different locations over an area of interest. The objective in exploration work is to map density differences that may indicate different rock types. Gravity data usually are displayed as anomaly maps.

- High-resolution surveys provide analysis of the shallow layers and identify potentially hazardous conditions such as surface faulting, potential slope failure areas, or shallow gas accumulations. In addition, these data are used to identify potential cultural and archaeological resources and are used in the assessment of nonenergy mineral resources.

- The evolution of 3-D seismic data and information, in conjunction with interactive computer workstations, has made it possible to more closely define and assess the potential for oil and gas occurrence on the OCS, especially with regard to subsalt prospects. The 3-D information is used to delineate, in greater detail than that of traditional 2-D information, subsurface geologic conditions associated with the occurrence of natural gas and oil. The products of a 3-D survey are three-dimensional data volumes (somewhat like cubes) as opposed to two-dimensional data

- slices of the subbottom. As a result, displays are used to determine structures and stratigraphy, delineate faults, tie wells to each other, and correlate seismic data with well logs. A 3-D representation of the subsurface yields superior resolution of seismic indicators, accuracy of data location, and the ability to obtain seismic cross sections oriented in any direction desired. Geological and engineering information is also enhanced by 3-D visualization, and economic analyses are also improved. This use directly results in a better ability to do the following:

  - **S** Determine fair market value for the OCS tracts being offered for lease;

  - **S** Assess undiscovered amounts of natural gas and oil;

  - **S** Quantify reserves of natural gas and oil on the OCS; and

  - **S** Perform postlease comparative analyses of company submitted bids for acceptance or rejection.

Workstations are essential to fully take advantage of the 3-D information as the use of it has become more sophisticated, evolving from a data tool to delineate reservoirs for development and production wells to that of an exploration tool. Most importantly, it allows for the tight integration and visualization of geophysical and geological data as well as a quick and accurate analysis of quantitative vs. qualitative parameters.

**Geological Surveys** — Geological surveying on the OCS consists of bottom sampling, shallow coring, and deep stratigraphic tests. These data are useful in determining the general geology of an area and whether the right types of rocks exist for petroleum formation and accumulation.

- Bottom samples are obtained by dropping a weighted tube to the ocean floor and recovering it with an attached wire line. Depending upon the nature of the ocean floor, penetration is normally limited to a few tens of feet. Bottom samples can also be obtained from dredging.

- Shallow coring is performed by conventional rotary drilling equipment to obtain a near-surface sample of the rocks of the seabed. Choice of location is carefully controlled to avoid any shallow (geological and manmade) hazards, for example, faults or environmentally sensitive areas. Penetration is limited to 50 feet of consolidated rock.

- In any planning area, deep stratigraphic test wells, commonly known as continental offshore stratigraphic test (COST) wells, can be drilled to determine the geological character of rock strata. The location of such wells is carefully controlled by a permit issued by the MMS. These tests, which may be more than 20,000 feet deep, provide information that can be used by the Government and industry to evaluate tracts to be offered in a lease sale. Basically, an operator sets up a consortium of other

companies where drilling costs are shared. The wells are drilled in accordance with MMS regulations. All stratigraphic tests must be completed 60 days before the sale and the information is released to the public 10 years after completion of the well or 60 calendar days after the issuance of the first oil and gas lease within 50 miles (80.5 km) of the well site. A discussion of the cost well program is described by Dellagiarino (1991).

The primary objective of the acquisition and analysis of G&G data is the development of maps identifying areas favorable for the accumulation of hydrocarbons. This is done by incorporating the data acquired through G&G surveys plus analyzing technical and scientific data and information to develop a basic knowledge of the geologic history of an area and its effects on hydrocarbon or strategic/critical minerals generation, distribution, and accumulation within the planning area.

## Resource Assessment and Estimation

The objective of this component of the RE program is to identify geologic plays on the OCS that offer the highest potential for natural gas and oil and development and production as well as nonenergy minerals. Following the identification of geologic plays, a thorough analysis of the play's hydrocarbon potential occurs. An assessment of the play's undiscovered resource potential, and its economic viability, is made using state-of-the-art computer-based geologic models. This will focus on the necessary studies to identify both environmental and operational constraints as well as assist in the consideration of eventual leasing decisions.

The relative success of this component requires access to and use of a broad array of G&G data, information, and studies. Long lead times are often required to identify and determine whether geologic conditions exist for accumulations of minerals, whether a basin may be oil- or gas-prone, and determining the presence of reservoir rocks, source rocks, and traps necessary for natural gas and oil accumulation. The results of this work are subject to change and are updated as new data and information are generated and acquired. In the early stages, this component will focus on regional areas, but as more data and information are acquired, the focus shifts to sale- and prospect-specific areas to be offered for lease, or which are related to a specific issue, (i.e., moratoria, marine sanctuaries, quantitative analysis of legislative proposal, etc.).

This information provides the basis for geological reports and associated maps that describe the geology, probability of hydrocarbon occurrence, resource potential, and potential shallow geologic hazards of the planning area. The geological reports include information concerning the regional geology and petroleum geology. The data, information, and analyses are used in the leasing process as input to the EIS as well as to other MMS and departmental decision and option documents. The maps and information also provide support for decisions made by the DOI.

process to industry interest in individual sales and aids in defining the final area identified for study in the sale-specific EIS.

Resource assessment work involves the study and analysis of the geology and geologic history of an area; the regional stratigraphy and geologic trends; major structural features; exploration history; study of source rocks, reservoir rocks, seals and trapping mechanism; and, the identification of the most prospective portions of a planning area in terms of hydrocarbon potential. This latter step serves as a complementary

As previously mentioned, assessment activities range from large scale (i.e., regional or OCS-wide) to sale-specific, i.e., individual prospects. Once a sale area has been identified, the emphasis of the RE Program shifts to more detailed mapping and analyses needed to estimate the resource potential of individual prospects within the area offered for sale. These prospect-specific data, maps, and analyses are also used to determine parameters for postsale bid analyses.

Since its formation in 1982, the MMS has completed systematic assessments of Federal OCS undiscovered oil and natural gas resources. These "National" assessments are the results of a multiyear effort by the DOI's MMS to assess the undiscovered crude oil and natural gas resources of the Nation's OCS areas. These studies were performed concurrently with an effort by the U.S. Geological Survey (USGS) to assess the undiscovered oil and natural gas resources of the onshore areas of the United States and the adjacent waters within the boundaries of the coastal States. The current assessment estimates the undiscovered conventionally recoverable oil and natural gas resources located outside of known oil and gas fields on the OCS. The assessment considers recent geophysical, geological, technological, and economic information and uses a play analysis approach of resource appraisal. Areas assessed by MMS are depicted in figures 8, 9, 10, and 11.

The MMS RE Program focuses upon developing estimates of the possible amounts of undiscovered natural gas and oil that may exist under Federal waters. The estimates are developed using complex computer models and methodologies that incorporate specific geologic information, mathematical and statistical analyses, risk and probability theories, and a variety of assumptions pertaining to economic scenarios, petroleum engineering data, and a variety of additional technical assumptions. Resource estimates can address vast areas, such as the Gulf of Mexico, offshore Alaska, or the entire OCS, but are also made for smaller areas, such as a particular lease sale or deferral option. The estimation process requires that estimates be developed for conventionally recoverable natural gas and oil quantities that may exist but are yet to be discovered, as well as estimates for those resources that may be economically viable for exploration, development, and production under varying economic scenarios (see Appendix A). For many OCS planning areas, estimates of undiscovered resources on tracts currently leased are estimated separately from those on unleased lands. All of these must be periodically revised as economic scenarios and the lease inventory changes in each planning area.

Resource estimates must also be developed to support critical analyses of potential impacts of policy options, legislative proposals, EIS's, and industry activities affecting OCS natural gas and oil activities—both current and future.

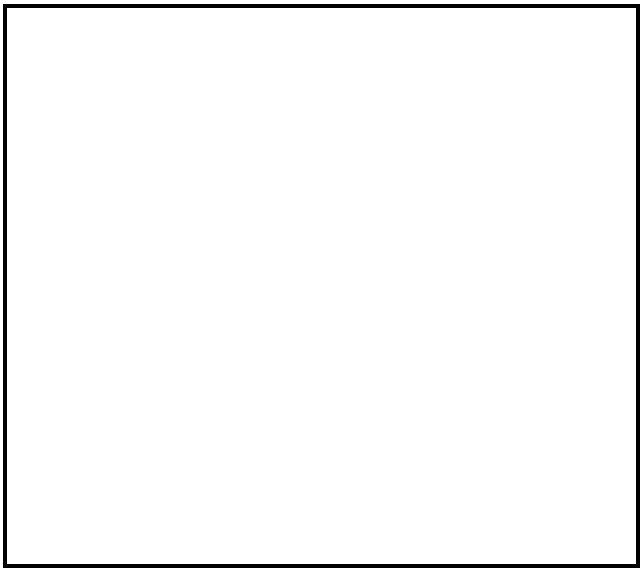


**Figure 3.** Assessed Provinces of the Alaska OCS

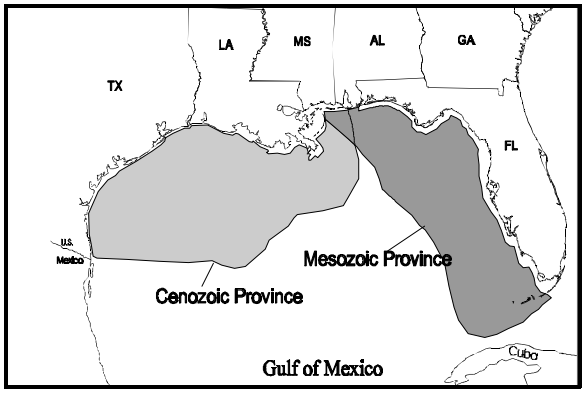



**Figure 10**. Assessed Provinces of the Gulf of Mexico OCS

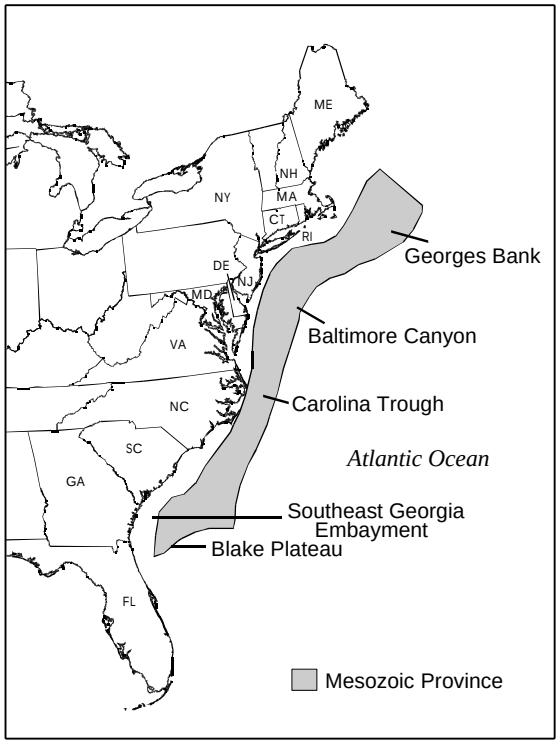



**Figure 9.** Assessed Provinces of the Atlantic OCS

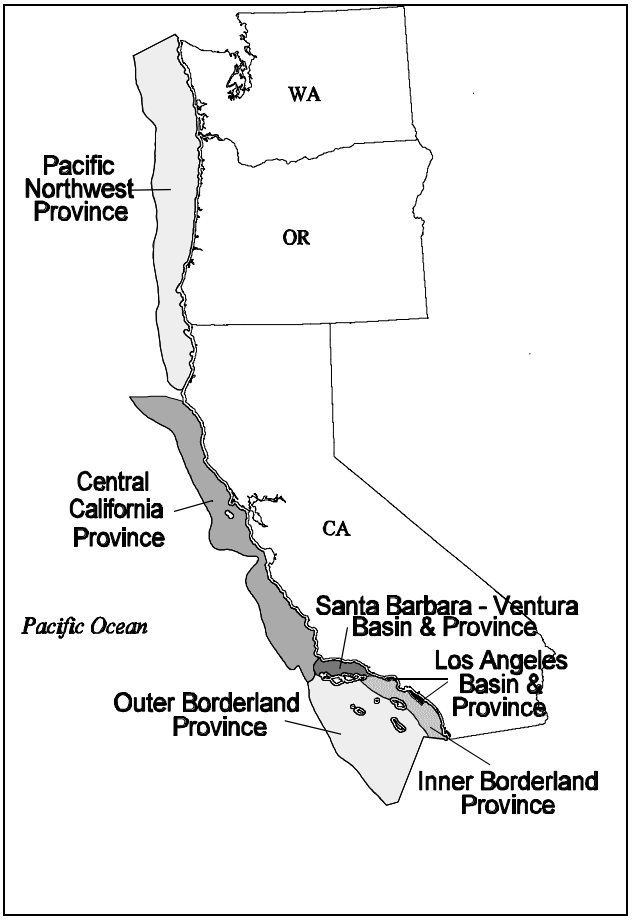



**Figure 11.** Assessed Provinces of the Pacific OCS

Estimates of undiscovered resources are presented in two categories:

- Undiscovered conventionally recoverable resources
- Undiscovered economically recoverable resources

Undiscovered conventionally recoverable resources refer to quantities of hydrocarbon resources expected to be present in undiscovered pools within a play, using technology and exploration and development efficiency available or reasonably foreseeable at the time of the assessment. No explicit consideration for economic viability was implied in the estimation of the undiscovered conventionally recoverable resources. The estimates of undiscovered conventionally recoverable resources are presented as a range of values corresponding to different probabilities of occurrence.

Undiscovered economically recoverable resources are the portion of undiscovered conventionally recoverable resources that can be explored, developed, and commercially produced at given cost and price considerations using present or reasonably foreseeable technology. The estimates of economically recoverable resources are presented as a range of resource values corresponding to different resource prices.

The available methods of estimating oil and natural gas resources for an area are many and differ significantly. The MMS has two primary methods: (1) number and size assessment and (2) subjective methods. Number and size assessment models require information on the number and size of accumulations discovered in a region. Consequently, discovery process models provide reliable results only in mature areas with a significant number of discoveries. The subjective methods rely less on historical records of exploration efforts and discovery records and more on descriptive geologic characteristics of a province, basin, or play. The quantities of undiscovered oil and natural gas are then estimated by quantifying volumetric reservoir variables and estimating the number of accumulations expected to exist. In both methods, a thorough analysis of the subjective probabilities (risks) of occurrence of variables leading to the formation, migration, trapping, and preservation of hydrocarbons at a play, basin, or province level is critical.

The Petroleum Exploration and Resource Evaluation System (PETRIMES), a probabilistic play analysis model, developed by the Geological Survey of Canada, was chosen by MMS to be the basic platform for the present assessment of undiscovered conventionally recoverable resources. Most of the resource assessment models currently used by industry and other government agencies provide estimated resources in aggregated numbers representing total resources as a distribution. However, to support MMS planning and decisionmaking related to OCS exploration and development, a knowledge of the potential number and size of undiscovered pools is essential. The PETRIMES attributes include the assessment and reporting of the:

- number of pools/accumulations that remain to be discovered;
- size range of the undiscovered pools/accumulations;
- reservoir characteristics of the undiscovered pools/accumulations;

- pool size distributions that relate to the geologic model; and
- resource data in a manner suitable for economic analyses.

The PETRIMES, however, was designed to assess a single-commodity play, such as an oil play or a natural gas play. Because many OCS plays are mixed plays containing both oil and natural gas pools and because a separate estimation of both liquid (condensates and oil) and natural gas (associated natural gas and nonassociated natural gas) phases is required for an accurate economic evaluation, the MMS modified PETRIMES for OCS resource estimation. The modified version is called the Geologic Resource Assessment Program (GRASP).

Likewise, MMS modified the Probabilistic Resource Estimates Offshore (PRESTO) model, used in previous MMS assessments, to accept the GRASP outputs for the number and sizes of pools to determine the economically recoverable resources at the geologic basin. As an improvement, estimates are made for economically recoverable resources over a range of specific fixed prices. These results are then reported as a continuous price-supply curve depicting the resultant price-resource relationships for geologic basins, provinces, or other areas being studied.

## Tract Evaluation/Fair Market Value Determination

Tract evaluation analyses estimate economic values for rights to mineral resources on individual OCS tracts. The MMS uses the values to determine if the high bids received for leases on tracts represent Fair Market Value (FMV) as mandated by the OCSLA (see Appendix B for guidelines). Immediately after a lease sale at which bids are read publicly, MMS begins the process of determining whether a bid can be accepted and a lease issued. Acceptance of a bid is based on a two-phase process.

Phase 1 of the process is conducted on a tract-by-tract basis and is normally completed fairly early following the bid opening. It is designed to accept those high bids where the competitive market can be relied upon to assure receipt of FMV or where Government data indicate the tract does not contain an viable prospect.

Those high bids not accepted in Phase 1 receive further evaluation in Phase 2. For those high bids, MMS geologists, geophysicists, and petroleum engineers prepare detailed estimates of the economic value of oil and gas resources on each tract in Phase 2. The high bids are then compared to Government estimates of value. Most analyses are undertaken based upon data available at the time of the sale; however, additional geophysical and geological data may be obtained after the sale at the discretion of the Regional Director. Generally, the Regional Director must accept or reject all bids within 90 days after the date on which they are opened. Any bid not accepted within 90 days is rejected. Companies have 15 days to appeal any rejection. The reader is referred to Appendix B for a complete discussion of Phase 1 and Phase 2.

The resource economic value of tracts offered for lease is determined by calculating the amount of economically recoverable resources, estimating recovery factors, production profiles, exploration and development costs, operating costs, revenue streams, and performing a discounted cash-flow analysis. The MMS uses a computer simulation model to perform this task. The model also incorporated geologic and economic risking.

The computer model uses the MONTE CARLO or range-of-values technique of handling calculations with uncertain input data. The MMS refers to this as the MONTCAR methodology (see Appendix C). It provides a means to handle a series of subjective judgments about each variable. The burden of expressing the uncertainty is transferred from one or two individuals to the many experts in the various disciplines involved in the evaluation. As with other models, research is constantly being done to refine the methodology and procedures involved with MONTCAR.

After completing the evaluations and analyses for a specific lease sale, the prospect-specific analyses are incorporated into the regional maps and analyses, and the process is repeated for the next sale.

## Reserve Inventory

"Reserves" are that portion of an identified oil or gas resource that can be extracted using current technology. The RE Program develops independent estimates of original amounts of natural gas and oil in discovered fields by conducting field reserve studies on the OCS and periodically revises the estimates of remaining natural gas and oil to reflect new discoveries or development information and annual production. The reserves inventory component of the RE Program assigns new producible leases to fields, establishes field limits and develops independent estimates of amounts of natural gas and oil (reserves and resources) associated with known fields by conducting field studies and reviews of fields, sands and reservoirs. A field is an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same general geological structural feature and/or stratigraphic trapping condition. Hydrocarbons (gas and oil) estimated on the basis of geologic knowledge to exist outside of known accumulations are undiscovered resources. Hydrocarbons whose location and quantity are known or estimated from specific geologic evidence are discovered resources. Reserves are quantities of hydrocarbons that are anticipated to be recovered from known accumulations from a given date forward. All reserve estimates involve some degree of uncertainty, depending on the amount of reliable geologic and engineering data available and the interpretation of the data. The relative degree of uncertainty may be conveyed by placing reserves into one of two principal classifications, either unproved or proved. Unproved reserves are the quantities of hydrocarbons that can be estimated with some certainty to be potentially recoverable from known reservoirs, assuming future economic conditions and technological developments. Proved reserves are the quantities of hydrocarbons that can be estimated with reasonable certainty to be commercially recoverable from known reservoirs and under current economic conditions, operating methods, and government regulations.

Field naming and reserves accountability are dependent on the drilling and development phases of fields. When a lease is qualified as producible based on a new discovery well, the field limits associated with the new lease are defined through geophysical mapping using computer workstations and software. The new lease is either assigned to an existing field or becomes a new field discovery in the unproved category. When a field is in the unproved category, geophysical mapping and limited well data are the basis for defining reservoir limits and the associated reserve estimate. These estimates are reevaluated once a field is moved into the proved category and more data become available. Well logs, well field data, seismic data, and production data are continuously analyzed throughout the productive life of the field to improve the accuracy of the reserve estimate. As a producing field nears the end of its productive life (depletion), the proved reserve estimate approaches zero, but the field may have a resource estimates associated with undrilled and/or untested traps.

The primary benefit of the RE Program reserve estimates activity, however, is that the detailed geological, geophysical, and engineering information necessary to estimate these amounts of natural gas and oil is also used in performing other RE Program functions in areas with known fields — including tract evaluation, resource estimation, resource assessment, future production projections, and numerous specific field performance studies. Studies of unproven fields are continuing, especially in light of royalty reduction efforts, since any royalty rate reductions may help these fields become economically viable to develop and produce. The interim geologic information and engineering reviews supporting the reserves estimation function produce vital information for other OCS program activities as well as Royalty Management Program functions. Cooperative efforts with the Energy Information Administration (EIA) of the Department of Energy allows EIA to use MMS estimates to verify reporting standards and procedures by natural gas and oil companies and as critical input to their macroeconomic modeling efforts.

Geologic maps and/or reserves estimates are prepared for active and depleted proved fields and unproved fields. Future workloads include (1) mapping and evaluating new fields; (2) evaluating discoveries that have not yet qualified as fields; (3) providing detailed analog field studies in support of lease sale prospect evaluations; (4) placing new producible leases in fields and determining the field limit; (5) maintaining the reserves inventory database by adding new completions to existing fields; and (6) enhancing the National Assessment as new pay sands in fields are identified. Geologic studies of proved and unproved fields continue at a consistent level attempting to reflect the discovery of new fields both in deep-water portions as well as the new discoveries on the shelf. The work associated with this effort is vital to the evaluation of exploration and production incentives and legislation considered by Congress and the Department.

The MMS continues various cooperative reserve studies of offshore proved fields. As development activities related to offshore projects in frontier areas progress, MMS will become more involved with detailed geologic modeling and reserves estimation for those projected fields.

## Technical Information Distribution

The RE Program develops important technical information regarding the hydrocarbon resources on the Federal OCS that may be useful to industry, Federal and State agencies, and the general public. An objective of the OCSLA is that such nonproprietary data and information be made available in a timely manner to assist States, local governments, industry, and the general public to participate in policy and planning decisions related to management of OCS resources.

In taking steps to address the need to make information available, the RE Program has traditionally prepared OCS reports on the geology of OCS planning areas, certain offshore wells, G&G data acquisition, the deep stratigraphic test (COST) wells, and production projections for the OCS. Publicly available reports and information are available on the Internet at http://www.mms.gov.

Products disseminated through the RE Program include:

- Offshore Northern Gulf of Mexico (GOM) Oil and Gas Atlas Series: The goal of the atlas is the classification and organization of offshore Gulf of Mexico reservoirs into plays based upon geologic and engineering attributes covering two volumes. Volume I covers reservoirs of Miocene age and older. Volume II covers reservoirs of Pliocene and Pleistocene age.

- An Indicated Hydrocarbon List: The list identifies unleased Central and Western GOM tracts that have wellbores with indicated hydrocarbons, and it is made available to the public approximately 3 months prior to each GOM lease sale.

- A Field Names Master List: This report is updated quarterly and provides the public a list of the field name designations for all active and expired leases that have been determined to be producible.

- Geological Reports: This report is prepared on a planning area to provide data and information on the general areawide geology of the planning area, resource potential, and environmental geology and geohazards analyses. The information from this report is used in the preparation of the EIS.

- Reserves Reports: These reports individually update the reserves totals for the GOM and Pacific Regions and provide reserve and resource data by area and geologic age, as well as an analysis of field-size distribution and reservoir-size distribution as well as discussions of production trends and discovery trends.

- An Assessment of Undiscovered Hydrocarbon Potential of the Nation's OCS: This project provides the assessment of undiscovered, conventionally recoverable and economical recoverable resources on the OCS. Individual regional reports were also prepared.

- Data Acquisition Reports: This report updates the kinds and amounts of G&G data in the MMS inventory.

- Proceedings from the Continental Margins Symposia: In an effort to broaden the base of data and information on the offshore, the MMS entered into a cooperative agreement with the Texas Bureau of Economic Geology (BEG), University of Texas at Austin. The BEG acted as a central contact between the MMS and the Geological Surveys of coastal States and monitored multidiscipline, scientific activities conducted by the Surveys for the MMS. The three general areas that the cooperative effort addresses are: (1) strategic/critical minerals, (2) geologic studies relating to hydrocarbon resources, and (3) environmental geology.

- Data Sharing Agreements: Per section 8(g) and 26(d) of the OCSLA, coastal States may enter into data sharing agreements with the Department regarding the viewing and, in some cases, copying of selected offshore information within the State's seaward boundary.

## Glossary

**2-D Seismic**—A seismic survey where a line of geophones captures enough information to generate a two-dimensional (height and length) image of the Earth's subsurface directly below it.

**3-D Seismic**—A seismic survey where a three-dimensional image of the subsurface can be developed by combining numerous energy sources and multiple lines of geophones; the image consists of height, length, and side to side information that gives better resolution to the subsurface.

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

**Area of Hydrocarbon Potential**—That part of the planning area which has the primary geologic characteristics favorable for the generation and the accumulations of hydrocarbons.

**Bid**—An offer for an OCS lease submitted by a potential lessee in the form of a cash bonus dollar amount or other commitments, as specified in the final notice of sale.

**Bidding System**—A combination of terms and conditions under which a bid is submitted. The economic terms include, but are not necessarily limited to (1) the minimum bid per acre; (2) the yearly rental; (3) the minimum royalty; and (4) the royalty or profit share rates imposed on future production from those tracts leased. See "Royalty."

**Bidding Unit**—All unleased Federal portions of two or more blocks, whose combined acreage is 5,760 acres or less, which is offered in a specific lease sale as a single leasable entity. See "Tract."

**Block**—A geographical area of approximately 9 square miles (5,760 acres), which is used in official MMS protraction diagrams or leasing maps. See "Tract."

**Bonus**—A payment equal to the high bid submitted by the successful bidder for the right to be awarded an oil and gas lease.

**Cap Rock**—An impermeable rock overlying an oil or gas reservoir that tends to prevent migration of fluids from the reservoir.

**Continental Margin**—A zone separating the emergent continents from the deep sea bottom.

**Continental Shelf**—A gently sloping submerged marginal zone of the continents extending from the shore outward through shallow waters to the continental slope.

**Continental Slope**—A relatively steep, narrow feature paralleling the continental shelf—the region in which the steepest descent to the ocean bottom occurs.

**Crude Oil**—A mixture of liquid hydrocarbons that exists in natural underground reservoirs as distinguished from refined oils manufactured from it and does not include liquid hydrocarbons produced from tar sand, gilsonite, oil shale, or coal.

**Development**—Activities following exploration including the installation of facilities and the drilling and completion of wells for production purposes.

**Development Tract**—A tract located on a common geologic structure with a leased tract, in which the leased tract has proven hydrocarbons.

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

**Drainage Tract**—A tract sharing a common reservoir with a leased tract containing hydrocarbons.

**Drillship**—A self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

**Economically Recoverable Resource Estimate**—Those resources both identified and undiscovered, that are commercially producible. The sum of reserves, inferred reserves, and undiscovered economically recoverable resources.

**Environmental Impact Statement**—An analysis required by NEPA in relation to any major action proposed by the Federal Government that could have a significant effect on the human environment.

**Exclusive Economic Zone**—The maritime region adjacent to the territorial sea, extending 200 nautical miles from the baselines of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

**Exploration**—The process of searching for minerals preliminary to development. Exploration activities include (1) geophysical surveys, (2) any drilling to locate an oil or gas reservoir, and (3) the drilling of additional wells after a discovery to delineate a reservoir. It enables the lessee to determine whether to proceed with development and production.

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

**Field**—An area within which hydrocarbons have been concentrated and trapped in economically producible quantities in one or more structural or stratigraphically related reservoirs.

**Formation**—A bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

**Gas Hydrates**—Icelike structures of gas and water in which gas molecules are trapped within a framework or cage of water molecules.

**Geology Report**—A report prepared for each sale providing information on the general geology, resource potential, environmental geology, and geohazards of the planning area.

**Lease**—A contract authorizing exploration for and development and production of minerals for a specified period of time over a given area. The meaning of "Lease" depends upon its use in context.

**Lease Sale**—An MMS proceeding by which leases for certain OCS tracts are offered for sale by competitive sealed bidding and during which bids are received, announced, and recorded.

**Lease Term**—Duration of a lease. Oil and gas leases are issued for an initial period of 5 years or not to exceed 10 years where such longer period is necessary to encourage exploration and development in areas because of unusually deep water or other unusually adverse conditions. Once production is reached, the term continues as long as there is production in paying quantities.

**Lessee**—A person or persons to whom a lease is awarded; the recipient of a lease. See "Operator."

**Limestone**—A rock that is formed chiefly through the accumulation of organic remains such as shells and corals consisting mainly of calcium carbonate.

**Minimum Economic Field Size**—The lowest amount of resources for a prospect that would give that prospect a positive resource economic value.

**Natural Gas**—A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in gaseous phase at the surface or in solution with crude oil in natural underground reservoirs at reservoir conditions.

**Net Profit Share**—A bidding system for leasing tracts on the OCS that uses the cash bonus as the bid variable and requires a fixed annual rental payment and net profit share payments at a fixed percentage rate that is constant for the duration of the lease.

**Official Protraction Diagram**—Leasing maps that designate a planning area by using the Universal Transverse Mercator Grid System and is divided into blocks.

**Operator**—The individual, partnership, firm, or corporation having control or management of operations on a leased area or a portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of rights under an approved operating agreement.

**Outer Continental Shelf**—The part of the continental shelf seaward of the line that marks State ownership; that part of the offshore lands under Federal jurisdiction.

**Permeability**—The measure of a rock's ability to transmit fluids; a measure of the ease with which fluids can flow through a porous rock.

**Petroleum**—An oily, flammable bituminous liquid that occurs in the upper strata of the Earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

**Porosity**—The ratio of the holes, voids, or pores in a rock to its total volume or size. Also, a measure of the capability to contain fluids within void spaces in a rock.

**Production**—The phase of oil and gas operations that deals with bringing the well fluids to the surface and separating them, storing them, gauging them, and otherwise preparing the products for shipment.

**Proprietary Information**—Geologic and geophysical data, information, and derivatives thereof that cannot be released to the public for a specified term because of Federal law, regulations, or statutes, or because of contractual requirements.

**Proven Tract**—A previously leased tract, which is now expired, that contains known hydrocarbon reserves. The volume of reserves may or may not be known.

**Qualified Bidder**—A bidding entity or person who has met the appropriate requirements of 30 CFR 256, Subpart G and of the notice of sale.

**Reserves**—That portion (in barrels or cubic feet) of an identified oil or gas resource that can be economically produced using current technology.

**Reservoir**—A subsurface, porous, permeable rock body in which oil or gas or both have accumulated.

**Resources**—Concentrations of naturally occurring solid, liquid, or gaseous materials in or on the Earth's crust. These include both identified and undiscovered resources.

**Royalty**—A share of the minerals (oil and gas) produced from a lease; the percentage of oil and gas production, usually fixed at 12 ½ percent or 16 2/3 percent, either in money or in kind, which a lessee is required to pay the Treasury Department.

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

**Seismic**—Pertaining to, characteristic of, or produced by earthquakes or Earth vibrations; having to do with elastic waves in the Earth.

**Seismic Survey**—A method of geophysical prospecting using the generation, reflection, refraction, detection, and analysis of elastic waves in the Earth.

**Shale**—An indurated rock that is formed by the consolidation of clay or mud.

**Sliding Scale Royalty**—A bidding system for leasing tracts on the OCS that uses cash bonus as the bid variable and where the royalty payment is not fixed but is dependent upon the value of production during each calendar quarter.

**Source Bed**—Rocks containing relatively large amounts of organic matter that is transformed into hydrocarbons.

**Spud**—To begin drilling a well.

**Statute Mile**—A common measure of distance equal to 5,280 feet (1,609 meters).

**Stratum (pl. Stata)**—A tabular mass or thin sheet of rock made up usually of a series of layers lying between beds of other kinds.

**Tract**—A designation assigned, for administrative and statutory purposes, to a block or combination of blocks that are identified by an official protraction diagram prepared by the MMS. A lease is granted for a tract. A tract may not exceed 5,760 acres unless it is determined that a larger area is necessary to comprise a reasonable economic production unit. See "Block" and "Bidding Unit."

**Trap**—A geologic feature that permits the accumulation and prevents the escape of accumulated fluids (hydrocarbons) from the reservoir.

**Undiscovered Conventionally Recoverable Resources**—That portion of the hydrocarbon potential that is producible, using present or foreseeable technology without consideration of economic feasibility.

**Undiscovered Economically Recoverable Resources**—Resources outside of known fields estimated to exist in potential commercial accumulations. The presence of these resources is postulated on the basis of geologic, engineering, and economic inferences.

**Viable Prospect**—A prospect having a "most probable" conditional resource level that exceeds the minimum economic field size for that particular cost regime.

**Wildcat Tract**—A tract that is not a drainage, development, or proven tract, and has a high risk in addition to sparse well control.

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# Appendix A.
## Resource Estimation Methodology

### Estimating Undiscovered Conventionally Recoverable Resources

The general methodology of assessing oil and natural gas resources for the three types of plays using GRASP is similar. A simplified diagram of the assessment process is presented in figure A-1. The basic steps are listed below.

1. Compile play data.

2. Generate pool size distribution from probabilistic distributions of volumetric reservoir parameters.

3. Generate a number of pools distribution.

4. Determine individual oil, natural gas, and mixed pool sizes by rank.

5. Establish individual pool size rank conditional to discovery data.

6. Generate play potential resources distribution.

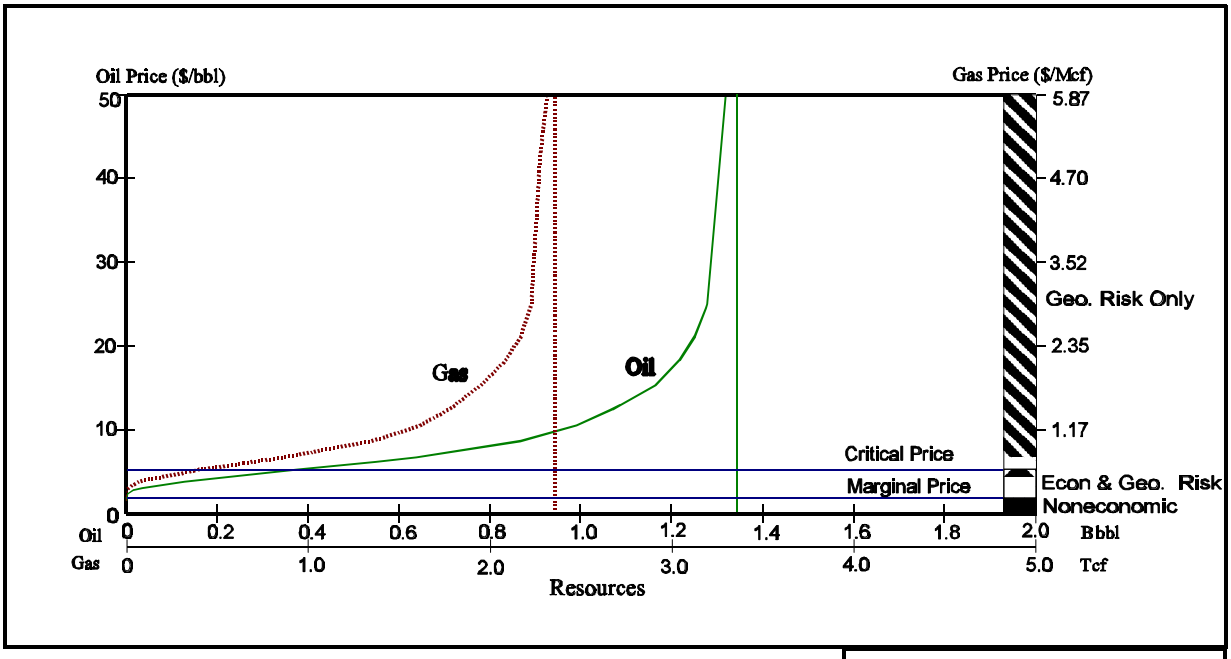


**Figure A-1**. Sample Price-Supply Curve

Legend For Column Results
Bbbl = billion barrels
BOE = barrels of oil equivalent
Mcf = thousand cubic feet
Tcf = trillion cubic feet

In recognition of the differences in the extent of data and information available among the OCS areas (attributable mostly to the degree of past exploration and development activities), some variances in the use of GRASP modules and procedures were incorporated. The frontier and conceptual plays, in which available data are sparse and good analogs are not identified, are analyzed through the subjective method using GRASP. In this method, individual distributions of input variables are subjectively prepared and, through GRASP, ranked pool size distributions are generated. Most plays in the Alaska OCS and the Pacific OCS were analyzed this way. In the case of frontier plays for which the assessors feel confident that an analog exists, such as in the Atlantic OCS, the analyst can generate a pool size distribution from the statistical parameters of the appropriately scaled ranked pool size distribution of the analog plays and can estimate the play resources using GRASP.

For established plays, such as those in the Gulf of Mexico and in southern California where significant amounts of pool data are available from discovered fields, a pool size distribution curve for a play can be generated from the distribution of discovered pools.

The estimates of undiscovered oil and natural gas resources attributed to basins, provinces, regions, or other areas are derived by statistically aggregating the play-level resource distributions of the plays of that area.

### Estimating Undiscovered Economically Recoverable Resources

Generally, the field-size distributions (generated by GRASP) and geologic risk factors are the basic geologic inputs into the PRESTO model. The costs of exploration, development, and transportation, as well as tariffs based upon logical exploration, development, production, and transportation scenarios, were estimated for each OCS region, province, basin, or other operational subarea where activities, costs, or other circumstances warranted. Estimates of economically recoverable resources are then derived for a specific price by (1) subjecting the distributions to multiple computer iterations simulating the drilling of the hydrocarbon accumulations associated with the areas; (2) determining which fields and sizes are simulated to be discovered on each iteration; and (3) determining a discounted-cash-flow analysis for the area's resources using specified economic parameters. The resources that would exceed the economic hurdles are then totaled and become one data point on the price-supply curve. The process is repeated for numerous prices, and a continuous distribution curve is then generated.

The Gulf of Mexico, Atlantic, and the Pacific contain stacked plays (i.e., plays overlie other plays at different depths). In determining the economic viability of such plays, assessors needed to consider the concurrent exploration, development, and production of possible pools in these plays. Otherwise, the estimates would be overly conservative.

The current estimates of undiscovered economically recoverable OCS oil and natural gas resources were developed using the following assumptions:

- Fixed prices (no real price changes)
- 12-percent discount rate (after tax rate-of-return)

- 12.5-percent or 16.7-percent royalty rate
- 35-percent tax rate
- 3-percent inflation rate
- Cost of exploration, development, and transportation, and tariffs with their associated development scheduling scenarios for each OCS region and portions of regions when conditions warrant
- Natural gas prices related to oil prices at 66 percent of the oil-energy equivalent

# Appendix B.
## Fair Market Guidelines

### Summary of MMS Procedures for Determining Bid Adequacy at Offshore Oil Lease Sales: Effective August 1997 with Sale 168

The MMS has modified its existing bid adequacy procedures for ensuring receipt of fair market value on OCS oil and gas leases. In Phase 1 these procedures establish a new number of bids rule for acceptance of selected tracts. In Phase 2 these procedures expand the scope of tract evaluation; replace the geometric average evaluation of tract with a revised arithmetic average measure of the tract; eliminate the one-eighth rule for anomalous bids; and clarify the treatment of tracts identified as having unusual bidding patterns.

These changes were made following a review of bidding activity in OCS sales. The new number of bids rule relies more on market-determined factors to ensure receipt of fair market value. This new rule, along with expansion of evaluation procedures beyond only tract-specific assessments, will allow for earlier acceptance on tracts that would be accepted later in the evaluation process. The revised average measure is designed to generate a better estimate of tract value when all bids fall below the Government's original estimate of tract value. The stricter screening rules associated with the revised average measure eliminate the need for the one-eighth rule. The Regional Director's expanded authority to handle documented instances of unusual bidding patterns provides flexibility to modify certain acceptance rules and allows for a decision to reject the high bid on identified tracts.

The following set of bid adequacy procedures incorporates the most recent changes. During the bid review process, MMS conducts evaluations in a two-phased process for bid adequacy determination. In Phase 1 we review the bid for legal sufficiency[1] and anomalies[2] to establish the set of qualified bids[3] to be evaluated.

(1) Phase 1 partitions the tracts receiving bids into three general categories:

- Those tracts that the MMS identifies as being nonviable[4] based on adequate data and maps;

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[1] Legal bids are those bids that comply with MMS regulations (30 CFR 256) and the Notice of Sale. Any illegal high bid will be returned to the bidder.

[2] Anomalous bids include all but the highest bid submitted for a tract by the same company, parent or subsidiary (bidding alone or jointly). Such bids are excluded when applying the number of bids rule or any bid adequacy measure.

[3] Qualified bids are those bids that are legal and not anomalous.

[4] Nonviable tracts or prospects are those geographic or geologic configurations of hydrocarbons whose risk weighted most probable resource size is below the minimum economic field size for the relevant cost regime and anticipated future prices. The risk used is below the lowest level anticipated for any tract or prospect in the same cost regime.

- Those tracts where competitive market forces can be relied upon to assure fair market value; and

- Those tracts where opportunities for strategic underbidding, information asymmetry, collusion, and other noncompetitive practices are greatest and where the Government has the most detailed and reliable data.

Based on these categories, four Phase 1 rules are applied to all tracts receiving bids:

- Pass directly to Phase 2 for further evaluation all tracts that require additional information to make a determination on viability or tract type and all drainage and development tracts.

- Accept the highest qualified bid on confirmed and wildcat tracts receiving three or more qualified bids where the third highest such bid on the tract is at least 50 percent of the highest qualified bid.

- Pass to Phase 2 confirmed and wildcat tracts receiving either one or two qualified bids, or three or more qualified bids where the third highest such bid is less than 50 percent of the highest qualified bid.

- Accept the highest qualified bid on confirmed and wildcat tracts determined to be nonviable.

In assuring the integrity of the bidding process, the Regional Director may identify an unusual bidding pattern[5] at any time during the bid review process, but before a tract is accepted. If the finding is documented, the Regional Director has discretionary authority, after consultation with the Solicitor, to pass those tracts so identified to Phase 2 for further analysis. The Regional Director may eliminate all but the highest of the unusual bids from consideration when applying any bid adequacy rule, may choose not to apply a bid adequacy rule, or may reject the tract's highest qualified bid.

Phase 1 procedures are generally completed fairly early following the bid opening.

(2) Phase 2 applies criteria designed to resolve bid adequacy assessments by analyzing, partitioning, and evaluating tracts in two steps:

- Further mapping and/or analysis is done to review, modify, and finalize viability determinations and tract classifications.

- Tracts identified as being viable must undergo an evaluation to determine if fair market value has been received.

[5] Within the context of our bid adequacy procedures, the term "unusual bidding patterns" typically refers to a situation in which there is an excessive amount of coincident bidding by different companies on a set of tracts in a sale. Other forms of unusual bidding patterns exist as well, and generally involve anti-competitive practices, e.g., when there is an uncommon absence of competition among companies active in a sale on a set of prospective tracts.

After completing these two steps, the following rules and procedures are used in Phase 2.

- Accept the highest qualified bid on all tracts determined to be nonviable.

- Accept newly classified confirmed and wildcat tracts having three or more qualified bids where the third highest such bid is at least 50 percent of the highest qualified bid.

- Determine whether any categorical fair market evaluation technique(s) will be used. If so:

  - Evaluate, define and identify the appropriate threshold measure(s).

  - Accept all tracts whose individual cash flow values, if estimated by MMS and used in the bid adequacy procedures, would result in satisfaction of the threshold categorical requirements.

- Conduct a full-scale evaluation, which could include the use of MONTCAR[6], on all remaining tracts[7] passed to Phase 2 and still awaiting an acceptance or rejection decision. Compare the highest qualified bid on each of these remaining tracts to two measures of bid adequacy: the Mean Range of Values (MROV)[8] and the Adjusted Delayed Value (ADV).[9]

  - Accept the highest qualified bid for those tracts where such a bid equals or exceeds the tract's ADV.

  - Reject the highest qualified bid on drainage and development tracts receiving three or more qualified bids where such a bid is less than one-sixth of the tract's MROV.

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[6] MONTCAR is a probabilistic, cash flow computer simulation model designed to conduct a resource-economic evaluation that results in an estimate of the expected net present value of a tract (or prospect) along with other measures. (A description of MONTCAR is provided in Appendix C.)

[7] These include tracts not accepted by a categorical rule that are classified as drainage and development tracts and those classified as confirmed and wildcat tracts that are viable and received (a) one or two qualified bids, or (b) three or more qualified bids where the third highest such bid is less than 50 percent of the highest qualified bid.

[8] The MROV is a dollar measure of a tract's expected net present private value, given that the tract is leased in the current sale, allowing for exploration and economic risk, and including tax consequences including depletion of the cash bonus.

[9] The ADV is the minimum of the MROV and the Delayed MROV (DMROV). The DMROV is a measure used to determine the size of the high bid needed in the current sale to equalize it with the discounted sum of the bonus and royalties expected in the next sale, less the forgone royalties from the current sale. The bonus for the next sale is computed as the MROV associated with the delay in leasing under the projected economic, engineering, and geological conditions, including drainage. If the high bid exceeds the DMROV, then the leasing receipts from the current sale are expected to be greater than those from the next sale, even in cases where the MROV exceeds the high bid.

- **S** Reject the highest qualified bid on drainage and development tracts receiving one or two qualified bids and on confirmed and wildcat tracts receiving only one qualified bid where the high bid is less than the tract's ADV.

- Select from the outstanding tracts[10] those (a) drainage and development tracts having three or more qualified bids with the third highest such bid being at least 25 percent of the highest qualified bid and (b) confirmed and wildcat tracts having two or more qualified bids with the second highest such bid being at least 25 percent of the highest qualified bid. Compare the highest qualified bid on each of these selected, outstanding tracts to the tract's Revised Arithmetic Measure (RAM).[11] For all these tracts:

  - **S** Accept the highest qualified bid where such a bid equals or exceed the tract's RAM.

  - **S** Reject the highest qualified bid where such a bid is less than the tract's RAM.

- Reject the highest qualified bid on all leftover tracts, i.e., those that were in the "outstanding" set above but not selected for comparison to the RAM.

In some cases where the high bid is less than the MROV, the present value of Government receipts may be larger if the high bid is accepted rather than rejected. This can be the case because (1) reoffering a rejected tract results in a delay in receiving bonuses and future royalties and (2) during the interval between the current sale and reoffering, some of the tract's resources may be drained to an adjacent tract. These elements are accounted for in the DMROV, which is computed as follows:

1. Using a model such as MONTCAR, an MROV along with royalty receipts (in present value terms) is estimated at the time of the next sale, when the tract is assumed to be reoffered if its high bid is rejected in the current sale.

2. The calculation of the MROV and royalties from the next sale reflect adjustments in prices, costs, and drainage during the time interval between sales.

3. Royalties (in present value terms) are estimated under the assumption that the tract's high bid is accepted in the current sale.

[10] These consist of those tracts having a highest qualified bid that does not exceed the MROV or the ADV, and are either (a) drainage or development tracts receiving three or more qualified bids with the highest such bid exceeding one-sixth of the tract's MROV, or (b) confirmed and wildcat tracts that are viable and receive two or more qualified bids.

[11] The RAM is the arithmetic average of the MROV and all qualified bids on the tract that are equal to at least 25 percent of the high bid.

4. The DMROV is computed as the difference between the discounted sum of the MROV and royalties from the next sale, and the royalties from the current sale. Under the input assumptions used, a tract whose high bid is below the MROV but exceeds the DMROV will generate a greater amount of leasing receipts if it is accepted in the current sale rather than rejected and reoffered in the next sale.

The Phase 2 bid adequacy determinations are normally completed sequentially over a period ranging between 21 and 90 days after the sale. The total evaluation period can be extended, if needed, at the Regional Director's discretion (61 FR 34730, July 3, 1996).

## Definitions Used by MMS in Bid Adequacy Procedures

**Adjusted Delayed Value (ADV):** The minimum of the MROV and the DMROV.

**Anomalous Bids:** All but the highest bid submitted for a tract by the same company—parent or subsidiary (bidding alone or jointly).

**Confirmed Tract:** A previously leased tract having a well(s) that encountered hydrocarbons and may have produced. It contains some oil and/or gas resources whose volume may or may not be known.

**Delayed Mean Range of Values (DMROV):** A measure of the current sale's high bid needed to ensure that leasing receipts from this sale will exceed those in a subsequent sale if the high bid is rejected and the tract reoffered.

**Development Tract:** A tract that has nearby productive (past or currently capable) wells with indicated hydrocarbons and which is not interpreted to have a productive reservoir extending under the tract. There should be evidence supporting the interpretation that at least part of the tract is on the same general structure as the proven productive well.

**Drainage Tract:** A tract that has a nearby well that is capable of producing oil or gas, and the tract could incur drainage if and when such a well is placed on production. The reservoir, from which the nearby well is capable of producing, is interpreted to extend under the drainage tract to some extent.

**Legal Bids:** Those bids on a tract that comply with MMS regulations and the Notice of Sale.

**Mean Range of Values (MROV):** A dollar measure of the MMS estimate of a tract's expected net present private value, given that the tract is leased in the current sale.

**Nonviable Tract/Prospect:** A tract or prospect is that geographic or geologic configuration of hydrocarbons whose risk weighted most probable resource size is below the minimum economic field size for the relevant cost regime and anticipated future prices. The risk used is below the lowest level anticipated for any tract or prospect in the same cost regime.

**Qualified Bids:** The bids on a tract that are legal bids and not anomalous.

**Revised Arithmetic Average Measure (RAM):** The arithmetic average of the MROV and all qualified bids on the tract that are equal to at least 25 percent of the high bid.

**Viable Tract/Prospect:** A tract or prospect having a resource level (obtained by using most probable inputs from ranges of values for appropriate parameters) that exceeds the minimum economic field size for that particular cost regime.

**Wildcat Tract:** A tract that has neither nearby productive (past or currently capable) wells nor is interpreted to have a productive reservoir extending under the tract. It has high risk in addition to sparse well control.

# Appendix C.
## MONTCAR Methodology

Determination of the resource economic value of a tract offered for lease involves calculating the amount of economically recoverable resources, estimating recovery factors, production profiles, exploration and development costs, operating costs, and performing a discounted cash-flow analysis. The MMS uses a computer simulation model to determine the resource economic value of certain OCS tracts offered for lease by the Federal Government.

The computer model utilizes the MONTE CARLO or range-of-values technique of handling calculations with uncertain input data. It provides a means to handle a series of subjective judgments about each individual variable. The burden of expressing the uncertainty is transferred from one or two individuals to the many experts in the various disciplines involved in the evaluation. This method explicitly recognizes the probabilistic nature of all variables affecting the evaluation and calculates a large number of possible outcomes based upon random samples from input probability distributions.

Much of the geologic and engineering data (e.g., areal extent and thickness of the hydrocarbon pay zone, porosity, initial water saturation, recovery factors, production rates, product prices, costs, etc.) used to evaluate a tract is known with varying degrees of uncertainty. Providing a single number for the resource economic value of a tract is somewhat misleading since it provides no insight as to the relative uncertainty involved. The MONTE CARLO technique provides a range of resource economic values (net present worth (NPW)) for the tract with the probability of each value occurring being a direct consequence of the data uncertainty.

The logic of the MONTE CARLO simulation method can be described as a four-step process.

Step 1. Estimate the range and distribution of possible values of each variable that will affect the ultimate outcome of the venture. This requires judgments from geophysicists, geologists, paleontologists, stratigraphers, economists, and engineers. The most critical step in the process is quantifying the uncertainty involved through the use of these probability distributions. The amount of data concerning the prospect in question, the amount of information about the trend within which a prospect is located, and the experience of the scientists making the evaluation will dictate the type and shape of the probability distribution curves for each variable.

Step 2. Select, at random, one value from the distribution of each variable. Compute the tract value using this combination of selected values. This determines one point in the final distribution of possible tract values. Select, at random, a second value from the distribution of each of the variables. Again compute the resulting tract value. This is the second point in the distribution of possible tract values. The random selection is statistically done in such a way that, if a large number of random selections are made (1,000 or more), the distribution of the randomly selected values closely resembles the distribution that was read in.

Step 3. Repeat the process 1,000 or more times, each time with a set of values selected at random from the distribution of each variable. Enough combinations of variables should be considered to adequately describe the shape and range of the distribution of tract values. For each trial (1 of the 1,000 or more repetitions) the tracts Net Present Worth (NPW) is determined from the combination of sample outcomes from each variable.

Step 4. The means of the productive and dry NPW distributions are determined, the probability of hydrocarbons being present, and factors for bonus write-off and depletion are applied to determine the expected (risked) NPW of the tract. This is the mean of the range of values (MROV) commonly referred to as the Government's reservation price. A distribution of the MROV is also developed.

The program also calculates what the expected NPW would be today if a tract was not leased until a later date, taking into account differences in income and excise tax payments and royalty or profit share payments; this is called the delayed MROV (DMROV).

The method in effect constitutes a shift of emphasis regarding subjective judgments. Instead of requiring a single judgment about how a series of variables will interact collectively, a series of judgments are made on how each individual variable will occur.


**The Department of the Interior Mission**

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


**The Minerals Management Service Mission**

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.