OCS Report
MMS 96-0047

Summary of the 1995 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf

As of January 1, 1995

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New Orleans
August 1996

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UNIT ABBREVIATIONS USED IN THIS REPORT

bbl..................barrels
Bbbl...............Billion barrels
Bbo................Billion barrels of oil
Bcfg...............Billion cubic feet of gas
BBOE............Billion barrels of oil-equivalent
bopd...............Barrels of oil per day
Mcf................Thousand cubic feet
MMbo............Million barrels of oil
MMcf.............Million cubic feet
MMcfd...........Million cubic feet per day
Tcf.................Trillion cubic feet
Tcfg...............Trillion cubic feet of gas

SUMMARY

This report summarizes the results of the 1995 assessment of the conventionally recoverable resources for the Gulf of Mexico and Atlantic Outer Continental Shelf (OCS). The OCS comprises the portion of the submerged seabed of the United States whose mineral estate is subject to Federal jurisdiction. The Minerals Management Service (MMS) and the U.S. Geological Survey (USGS) have previously completed several assessments of the undiscovered conventionally recoverable oil and gas resources of the United States OCS. The 1995 assessment was part of a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation. This appraisal considered data and information available as of January 1, 1995, and incorporated improved assessment methodologies.

Worldwide reliance on petroleum resources will continue to be the principal means to satisfy future energy demand for decades. Petroleum resources are usually considered as finite since they do not renew at a rate remotely approaching their consumption. Since petroleum also fuels the Nation's economy, there is considerable interest in the magnitude of the resource base from which future domestic discoveries and production will occur.

Resource estimates are just that— estimates. All methods of assessing potential quantities of conventionally recoverable resources are efforts in quantifying a value that will not be reliably known until the resource is nearly depleted. Thus, there is considerable uncertainty intrinsic to any estimate. Scientists can generate estimates of conventionally recoverable resources based on current geologic, engineering, and economic knowledge and a consideration of future conditions. The estimates incorporate uncertainty, but they cannot account for the unforeseen or serendipity. In spite of this inherent uncertainty, resource assessments are valuable input to developing energy policy and corporate planning. As such, resource estimates should be used as general indicators and not predictors of absolute volumes.

Hydrocarbon resource assessments have been performed by geologists, statisticians, and economists for decades. To be used effectively, a knowledge of the terminology, commodities, regions assessed, methodology, and statistical reporting conventions is essential. Much of the confusion attending the use of published petroleum resource and reserve estimates is the result of misunderstanding or interchanging the data and terminology. An ideal basis for the inevitable comparisons among assessments does not exist.

The petroleum commodities assessed in this study are crude oil, natural gas liquids (condensates), and natural gas that exist in conventional reservoirs and are producible with conventional recovery techniques. In developing these estimates it was necessary to make fundamental assumptions regarding future technology and economics. The inability to accurately predict the magnitude and effect of these factors introduces additional uncertainty to the resource assessment. Although not considered in this report, the continued expansion of the technological frontiers can be reasonably assumed to partially mitigate the impacts of a lower quality remaining resource base (smaller pool sizes, less concentrated accumulations, more remote locations) and less favorable economic conditions.

In this assessment the Atlantic and Gulf of Mexico continental margin was divided into two regions and three provinces (figure 1), which included 73 plays. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results reported as a range of values corresponding to different probabilities of occurrence. A good resource assessment model must appropriately express the effect of the various geologic, technologic, and economic forces that impact a forecast of quantities of undiscovered conventionally or economically recoverable resources (UCRR and UERR respectively). This resource assessment used a play analysis approach, which represents a major change from the procedures used by MMS for previous assessments (Cooke, 1985; Cooke and Dellagiarino, 1990). A major strength of this method is that it has a strong relationship between information derived from oil and gas exploration activities and the geologic model developed by the assessment team.

A significant aspect of the method used in this assessment of undiscovered resources involved the "matching" of existing discoveries with the projected pool size distributions of the geologic model. A more subjective variation of this process employing appropriately scaled analogs was used for conceptual and immature plays. This summary report does not present play level data and information. A subsequent, more detailed report will include for each play the assessment results, pool rank plots, maps, play descriptions, a series of additional analyses including discovery histories, and distributions for key geologic attributes.

The total conventionally recoverable hydrocarbon endowment of the Gulf of Mexico and Atlantic OCS as of January 1, 1995, is presented in

table 1. Conventionally recoverable resources are hydrocarbons potentially amenable to conventional production regardless of the size, accessibility, and economics of the accumulations assessed. The Atlantic and Gulf of Mexico OCS total endowment, which includes cumulative production, is estimated to be between 23.00 and 28.67 billion barrels of oil (Bbo) and 283.62 and 323.34 trillion cubic feet of gas (Tcfg). The mean estimate is 25.59 Bbo and 302.47 Tcfg. The range of estimates corresponds to a 95-percent probability (19 in 20 chance) and a 5-percent probability (1 in 20 chance) of there being more than those amounts, respectively. Fractile values are not additive. Nearly 15 Bbo and 179 Tcfg, or approximately 59 percent of this endowment, is represented by cumulative production, remaining proved and unproved reserves, and reserves appreciation. Undiscovered conventionally recoverable resources are believed to be discoverable and producible utilizing existing and reasonably foreseeable technology. The estimates of undiscovered conventionally recoverable oil resources range from 8.02 to 13.69 Bbbl, with a mean of 10.62 Bbbl; the estimates of gas range from 104.29 to 144.01 Tcf, with a mean of 123.14 Tcf. On a barrels of oil-equivalent (BOE) basis approximately 91 percent of the total hydrocarbon endowment and 78 percent of the undiscovered conventionally recoverable hydrocarbon resources are projected in the Gulf of Mexico Region.

There are beneath the Gulf of Mexico and Atlantic continental margin approximately 13.66 to 19.33 Bbbl of remaining conventionally recoverable oil, with a mean of 16.26 Bbbl. This includes remaining reserves (proved and unproved), reserves appreciation, and undiscovered conventionally recoverable resources. The estimate of remaining conventionally recoverable gas resources ranges from 170.98 to 210.70 Tcf, with a mean of 189.83 Tcf. Again, based on BOE, most of these resources, 86 percent, are believed to be in the Gulf of Mexico Region. An economic analysis determined the portion of the undiscovered conventionally recoverable

Table 1. Total hydrocarbon endowment, Gulf of Mexico and Atlantic continental margin.

	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
Gulf of Mexico and Atlantic Continental Margin									
Total Hydrocarbon Endowment	22.996	25.594	28.668	283.615	302.469	323.340	74.289	79.413	85.104
Risked UCRR	8.017	10.615	13.689	104.286	123.140	144.011	27.402	32.526	38.217
Unproved Reserves		0.886			4.713			1.724	
Reserves Appreciation		2.238			32.719			8.060	
Remaining Proved Reserves		2.516			29.259			7.722	
Cumulative Production		9.339			112.638			29.381	
Gulf of Mexico Region									
Total Hydrocarbon Endowment	21.017	23.323	26.117	261.652	274.990	289.615	68.105	72.253	76.877
Risked UCRR	6.038	8.344	11.138	82.323	95.661	110.286	21.218	25.366	29.990
Unproved Reserves		0.886			4.713			1.724	
Reserves Appreciation		2.238			32.719			8.060	
Remaining Proved Reserves		2.516			29.259			7.722	
Cumulative Production		9.339			112.638			29.381	
Atlantic Region									
Total Hydrocarbon Endowment	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Risked UCRR	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Unproved Reserves		0.000			0.000			0.000	
Reserves Appreciation		0.000			0.000			0.000	
Remaining Proved Reserves		0.000			0.000			0.000	
Cumulative Production		0.000			0.000			0.000	

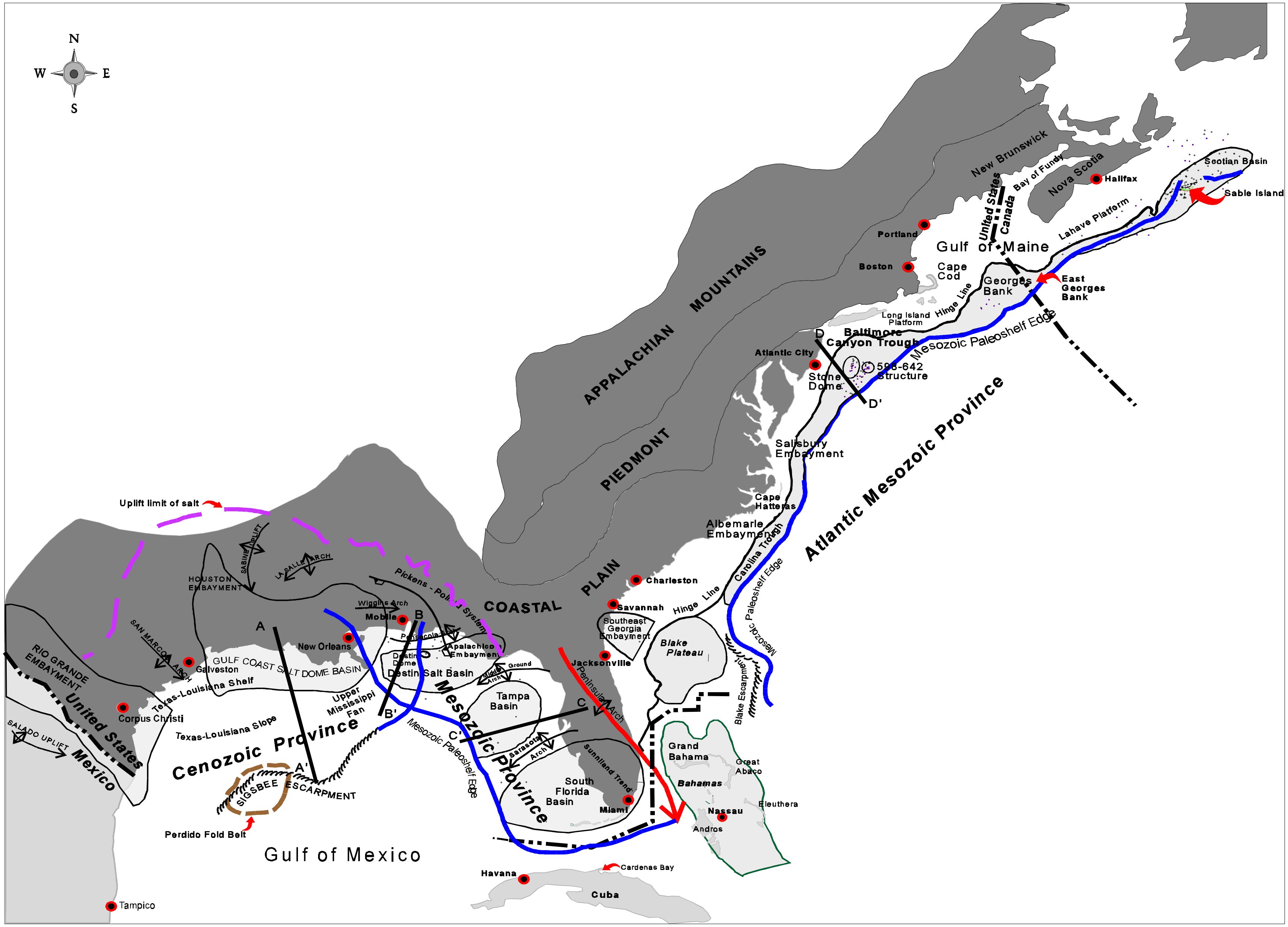

Figure 1. Physiographic map of the Gulf of Mexico and Atlantic continental margin.

resources that over the long run are anticipated to be commercially viable under a specific set of economic conditions. The basic economic analysis was performed at the prospect level with regional transportation infrastructure and costs considered at the area level. The economic evaluation was performed as both full- and half-cycle appraisals. Full-cycle analysis is measured from the point in time of a decision to explore. It considers all subsequent leasehold, geophysical, geological, exploration, and development costs in determining the economic viability of a prospect. In a half-cycle evaluation, leasehold and exploration costs, as well as delineation costs incurred prior to the field development decision, are assumed to be sunk costs and are not considered in the discounted cash flow calculations to determine whether a field is commercially viable.

Estimates of undiscovered economically recoverable resources are sensitive to price and technology assumptions and are primarily presented as a functional relationship to price, in the form of price-supply curves. Two specific prices from the distribution were chosen for discussion and are presented as base and high case scenarios. Table 2 presents the results of both the full- and half-cycle economic analysis for the Gulf of Mexico and Atlantic continental margin and at the regional level. In the full-cycle base case ($18.00 per barrel [bbl] and $2.11 per thousand cubic feet [Mcf]), the estimate of undiscovered economically recoverable oil resources ranges from 4.36 to 7.09 Bbo, with a mean of 5.35 Bbo. The gas estimates range from 57.25 to 70.70 Tcf, with a mean of 63.30 Tcf. Again, most of these resources, 92 percent, are forecast to be in the Gulf of Mexico Region. In the high case analysis ($30.00 per bbl and $3.52 per Mcf), the estimate of mean undiscovered economically recoverable resources increases by approximately 43 percent for oil and 35 percent for gas.

In the half-cycle base case analysis, the estimate

Table 2. Undiscovered economically recoverable resources, Gulf of Mexico and Atlantic continental margin.

	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
Gulf of Mexico and Atlantic Continental Margin									
Risked Full-Cycle									
@ $18/bbl & $2.11/Mcf	4.364	5.350	7.094	57.252	63.295	70.695	14.551	16.613	19.674
@ $30/bbl & $3.52/Mcf	6.632	7.672	9.367	79.526	85.684	92.942	20.783	22.918	25.905
Risked Half-Cycle									
@ $18/bbl & $2.11/Mcf	4.791	5.784	7.374	62.301	68.462	76.883	15.876	17.966	21.055
@ $30/bbl & $3.52/Mcf	7.019	8.077	9.892	83.936	89.895	97.023	21.954	24.072	27.156
Gulf of Mexico Region									
Risked Full-Cycle									
@ $18/bbl & $2.11/Mcf	4.016	4.941	6.627	53.737	57.941	62.162	13.577	15.251	17.688
@ $30/bbl & $3.52/Mcf	5.697	6.639	8.241	71.606	75.298	79.251	18.439	20.038	22.343
Risked Half-Cycle									
@ $18/bbl & $2.11/Mcf	4.350	5.306	6.967	58.428	62.300	66.495	14.747	16.391	18.799
@ $30/bbl & $3.52/Mcf	5.963	6.865	8.485	74.379	78.100	81.964	19.197	20.762	23.069
Atlantic Region									
Risked Full-Cycle									
@ $18/bbl & $2.11/Mcf	0.000	0.368	0.808	0.000	5.203	11.688	0.000	1.294	2.888
@ $30/bbl & $3.52/Mcf	0.587	1.063	1.644	5.855	10.479	16.444	1.628	2.927	4.570
Risked Half-Cycle									
@ $18/bbl & $2.11/Mcf	0.125	0.452	0.910	1.154	5.989	12.404	0.331	1.518	3.118
@ $30/bbl & $3.52/Mcf	0.788	1.234	1.854	7.242	11.966	17.661	2.076	3.363	4.997

of undiscovered economically recoverable oil resources ranges from 4.79 to 7.37 Bbo, with a mean of 5.78 Bbo. The gas estimates range from 62.30 to 76.88 Tcf, with a mean of 68.46 Tcf. This represents an increase of 8 percent over the equivalent full-cycle analysis. In the high case, the mean estimate of undiscovered economically recoverable resources increases by approximately 40 percent for oil and 31 percent for gas over the base case assessment.

Approximately 51 percent of the undiscovered conventionally recoverable oil and gas resources are economic in the base case, full-cycle analysis. The percentages increase to 72 percent of the oil and 70 percent of the gas in the high case scenario. In the half-cycle analysis these percentages are approximately 55 for both oil and gas in the base case and 76 and 73 percent, respectively, for oil and gas in the high case.

Although useful as a comparative measure of the total quantities of hydrocarbons estimated to exist in the study area, the assessment results do not imply a rate of discovery or a likelihood of discovery and production within a specific time frame. In other words, they cannot be used directly to draw conclusions concerning the rate of conversion of these resources to reserves and ultimately production.

INTRODUCTION

The MMS and the USGS recently completed an assessment of the undiscovered conventionally recoverable oil and gas resources of the United States, which reflects data and information available as of January 1, 1995 (USGS, 1995; MMS, 1996). This assessment is the culmination of a multi-year effort that included data and information not available at the time of the previous assessment (R.F. Mast et al., 1989; Cooke and Dellagiarino, 1990), incorporated advances in petroleum exploration and development technologies, and used new methods of resource assessment. This report summarizes the 1995 assessment of the conventionally recoverable hydrocarbon resources of the Gulf of Mexico and Atlantic OCS. It provides a more detailed presentation of the results previously reported in MMS (1996).

The principal purpose of this report is to present estimates of the total endowment of conventionally recoverable oil and gas that may be present beneath the Gulf of Mexico and Atlantic continental margin. Secondary objectives are to briefly describe the geologic and mathematical methodologies employed in the assessment, present an economic analysis of the undiscovered conventionally recoverable resources of the area, and provide a historical perspective in which to review the results.

Energy is the lifeblood of the world's economy. In 1994, oil and gas resources were the major contributor to the world energy supply, 38 and 22 percent, respectively (MacKenzie, 1996). Worldwide reliance on petroleum resources as the principal fuel to satisfy future energy demand is likely to continue for decades. However, petroleum resources are usually considered as finite since they do not renew at a rate remotely approaching their consumption. Since these minerals also power the Nation's economy, there is considerable interest in the magnitude of the resource base from which future domestic discoveries and production will occur. Knowledge concerning the potential quantities of remaining conventionally recoverable oil and gas resources is required by governments for strategic planning and formulating domestic land use, energy, and economic policies. Financial institutions and large corporations use resource estimates for long-term planning and decisions concerning investment options. Exploration companies use assessments to design exploration strategies and target expenditures. Petroleum industry trade associations use resource assessments to gauge trends and the relative health of the industry. The Gulf of Mexico OCS, which contributed 13 and 25 percent, respectively, of the United States domestic oil and gas production in 1994, is obviously a critical component of any deliberations concerning future domestic petroleum supplies (Francois, in press).

Uncertainty is inherent in estimating quantities of hydrocarbon resources prior to actual drilling. Imperfect knowledge is associated with almost every facet of the assessment process. It is vital to recognize that estimates are just that— estimates. The estimates presented in this report should be viewed as indicators and not predictors of the petroleum potential of the provinces and regions. It is also important to realize that the undiscovered conventionally recoverable resources estimated may not be found or, in fact, produced. It is, however, implied that these resources have some chance of existing, being discovered, and possibly produced.

Hydrocarbon plays, comprising pools that share common factors influencing the accumulation of hydrocarbons, were the basic building blocks for the assessment. The results were subsequently aggregated to the province and region levels. The assessment methodology incorporated existing data and information available from exploration and development activities, knowledge of particular plays, and assumptions regarding technology and costs. The results are presented as ranges of values with associated probabilities of occurrence. This summary report presents chronozone, province, and region level data and information. A subsequent report will include the assessment results for each play, including for example, pool rank plots and discovery histories, as well as maps and a geologic discussion.

ACKNOWLEDGMENTS

A project of this magnitude is the product of the efforts and talents of numerous MMS geoscientists, engineers, statisticians, and support staff. The basic play framework for the Gulf of Mexico Cenozoic Province relied heavily on previous work performed for the Atlas Series of Northern Gulf of Mexico Offshore Oil and Gas Reservoirs (Seni et al., 1995, Lore and Batchelder, 1995). This research was performed by MMS, the Texas Bureau of Economic Geology, Alabama Geological Survey, and Louisiana State University Center for Coastal, Energy, and Environmental Resources with financial support from the U.S. Department of Energy, Gas Research Institute, and MMS. As part of the play delineation effort MMS held workshops with attendees from the geological surveys and the oil and gas regulatory agencies of the Gulf Coast States and the U.S. Geological Survey.

Finally, an industry advisory committee reviewed the play definitions developed in that effort.

The assorted estimates of reserves are the ongoing product of the endeavors of the various geoscientists and petroleum engineers of the Reserves Section, Office of Resource Evaluation. These estimates are published in a detailed annual report. The assistance of Suzan Bacigalupi and Hong-I Yang in the analysis of the historical time series of reserve estimates was critical to the assessment of reserves appreciation and is gratefully acknowledged. The special efforts of Chee Yu and Christopher Schoennagel in manipulating the extensive reservoir database are also greatly appreciated.

The following individuals made significant contributions to this study as part of the various play delineation and assessment teams:

Randall Altobelli	Robert Kelly
Barbara Bascle	Clark Kinler
Eric Batchelder	Gregory Klocek
Taylor Blood	Robert McDonald
Ronald Brignac	Doran Mann
Robert Broome	David Marin
Grant Burgess	Thomas Mount
Gerald Crawford	Leslie Nixon
Gary Edson	Bruce Perry
Anton Friedman	Robert Peterson
John Haglund	Andrew Petty
Hossein Hekmatdoost	Courtney Reed
Jesse Hunt	Nancy Shepard
Kung Huang	Michael Smith
Eric Kazanis	Ronald Spraitzar

Several individuals are acknowledged for their significant contributions to this regional assessment with efforts primarily related to modifications to the various assessment models. Their patience and advice concerning implementation of these models are also gratefully acknowledged:

Harry Akers	Alaska Region, Anchorage, AK
John Buffington	Resource Evaluation Division, Herndon, VA
Barry Dickerson	Resource Evaluation Division, Herndon, VA
Nick Gasdaglis	Resource Evaluation Division, Herndon, VA
Glenn Lyddane	Resource Evaluation Division, Herndon, VA

Completion of this report would not have been possible without the contributions of several technical reviewers, Michael Dorner as technical editor, and the cartographic talents of Gerald Marchese and Joe Souhlas.

SOURCES OF DATA

The assessment of the total hydrocarbon endowment of the Atlantic and Gulf of Mexico OCS required the compilation and analysis of published information and vast amounts of geologic, geophysical, and engineering data obtained by industry and furnished to MMS from operations performed under permits or mineral leases. Since 1954, nearly 8,850 permits to conduct prelease geological or geophysical exploration have been issued in the study area. In addition, more than 12,050 leases have been awarded to industry for the exploration, development, and production of oil and gas. As a condition of these permits and leases, MMS has acquired approximately 1.2 million line-miles of two-dimensional common depth point (CDP) seismic data and 28,000 square miles of three-dimensional CDP seismic data. Moreover, MMS has accumulated geological information from over 31,000 wells drilled on the Gulf of Mexico and Atlantic continental margin. These activities resulted in the discovery in the Gulf of Mexico of 876 proved fields and 77 active unproved fields containing over 22,000 reservoirs. A single noncommercial discovery was made on the Atlantic OCS. The Canadian and Nova Scotian governments have released significant seismic and well data acquired from industry exploration activities on the Scotian shelf. This database in its entirety was the primary information source for the play delineation process, as well as the basis for determining key parameters of geologic variables and pool size distributions. Much of the geologic and reservoir information supporting this assessment for the Gulf of Mexico Region has been released and is available on the Internet at http://www.mms.gov/omm/gomr/. Additional, more detailed analyses are being released as part of an offshore Gulf of Mexico oil and gas play atlas series and subsequent reports related to the assessment of conventionally recoverable oil and gas resources.

COMMODITIES ASSESSED

The petroleum commodities assessed in this study are crude oil, natural gas liquids (condensates), and natural gas that exist in conventional reservoirs and are producible with conventional recovery techniques. Crude oil and natural gas liquids are reported jointly as oil; and associated, dissolved, and nonassociated gas are reported as gas. Oil volumes are reported as stock tank barrels and gas as standard cubic feet.

This report encompasses only a portion of all the oil and gas resources believed to exist on the Gulf of Mexico and Atlantic continental margin. This assessment does not include potentially large quantities of hydrocarbon resources that could be recovered from known and future fields by enhanced recovery techniques, gas in geopressured brines, natural gas hydrates (clathrates), or oil and gas that may be present in insufficient quantities or quality (low permeability "tight" reservoirs) to be produced via conventional recovery techniques. In some instances the boundary between these resources is rather indistinct; however, we have not included in this assessment any significant volume of unconventional resources. These unconventional resources have yet to be produced from the OCS; however, with improved extraction technologies and economic conditions they may become important future sources of domestic oil and gas production.

Estimates of the quantities of historical production, reserves, and future reserves appreciation are presented to provide a frame of reference for analyzing the estimates of undiscovered conventionally recoverable resources. Furthermore, reserves appreciation and undiscovered conventionally recoverable resources comprise the resource base from which the near to midterm future oil and gas supplies will emerge.

TERMINOLOGY

The terminology associated with resource assessments is involved, but must be understood to correctly interpret and apply the results. The lexicon used in this report conforms with past assessments and general industry usage. The definitions presented both here and in the glossary should be viewed as general explanations rather than strict technical definitions of the terms.

Conventionally recoverable: producible by natural pressure, pumping, or secondary recovery methods such as gas or water injection.

Marginal probability of hydrocarbons (Mp_{hc}): An estimate, expressed as a decimal fraction, of the chance that an oil or natural gas accumulation exists in the area under consideration. The area under consideration is typically a geologic entity, such as a pool, prospect, play, basin, or province; or a large geographic area such as a planning area or region. All estimates presented in this report reflect the probability that an area may be devoid of hydrocarbons or, in the case of estimates of economically recoverable resources, that commercial accumulations may not be present.

Resources: Concentrations in the Earth's crust of naturally occurring liquid or gaseous hydrocarbons that can conceivably be discovered and recovered. Normal use encompasses both discovered and undiscovered resources.

Recoverable resources: The volume of hydrocarbons that is potentially recoverable, regardless of the size, accessibility, recovery technique, or economics of the postulated accumulations.

> Conventionally recoverable resources: The volume of oil and natural gas that may be produced from a well bore as a consequence of natural pressure, artificial lift, pressure maintenance (gas or water injection), or other secondary recovery methods. They do not include quantities of hydrocarbon resources that could be recovered by enhanced recovery techniques, gas in geopressured brines, natural gas hydrates, or oil and gas that may be present in insufficient quantities or quality (low permeability "tight" reservoirs) to be produced via conventional recovery techniques.

> Economically recoverable resources: The volume of hydrocarbons that is potentially recoverable at a profit after considering the costs of production and the product prices.

Total hydrocarbon endowment: All conventionally recoverable oil and gas resources of an area.

Undiscovered resources: Resources postulated, on the basis of geologic knowledge and theory, to exist outside of known fields or accumulations. Included also are resources from undiscovered pools within known fields to the extent that they occur within separate plays.

> Undiscovered conventionally recoverable resources(UCRR): Resources in undiscovered accumulations analogous to those in existing fields producible with current recovery technology and efficiency, but without any consideration of economic viability. These accumulations are of sufficient size and quality to be amenable to conventional primary and

secondary recovery techniques. Undiscovered conventionally recoverable resources are primarily located outside of known fields.

Undiscovered economically recoverable resources (UERR): The portion of the undiscovered conventionally recoverable resources that is economically recoverable under imposed economic and technologic conditions.

Reserves: Hydrocarbon resources within known fields that can be profitably produced using current technology under existing economic conditions.

Cumulative production: The sum of all produced volumes of hydrocarbons prior to a specified point in time.

Original proved reserves: The quantities of proved reserves estimated to be initially recoverable prior to the start of production. Estimates of original proved reserves equal cumulative production plus remaining proved reserves.

Proved reserves: The quantities of hydrocarbons that can be estimated with reasonable certainty to be profitably recovered under current economic conditions. Current economic conditions include prices and costs prevailing at the time of the estimate.

Remaining proved reserves: The unproduced portion of the original proved reserves in a reservoir, field, or area.

Unproved reserves: Reserve estimates based on geologic and engineering information similar to that used in developing estimates of proved reserves, but technical, contractual, economic, or regulatory uncertainty precludes such reserves being classified as proved.

The major components of the above resource classification scheme can be seen in the diagram in figure 2. The scheme is dynamic with hydrocarbon resources migrating from one category to another over time. Resource availability is expressed in terms of the degree of certainty about the existence of the resource and the feasibility of its economic recovery. The overall movement of petroleum resources is to the right as accumulations are discovered and upward as

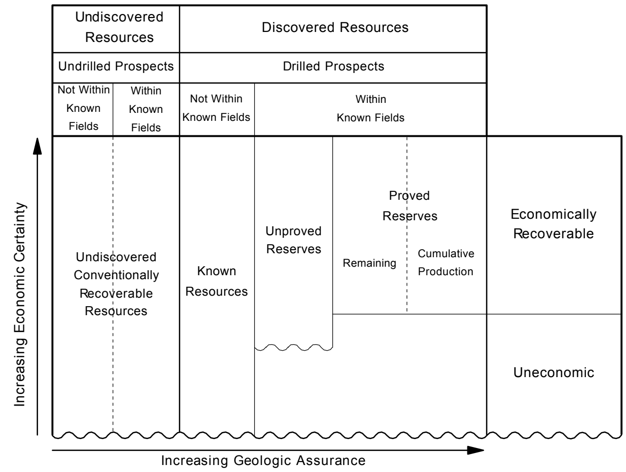

Figure 2. MMS classification scheme for conventionally recoverable petroleum resources.

development and production ensue. The degree of uncertainty as to the existence of resources decreases to the right in the diagram. The degree of economic viability decreases downward and also implies a decreasing certainty of technological recoverability.

Other key terms used in this report are included in the glossary.

ROLE OF TECHNOLOGY AND ECONOMICS IN RESOURCE ASSESSMENT

This study assesses only conventionally recoverable hydrocarbon resources. In developing these estimates it is necessary to make fundamental assumptions regarding future technology and economics. The inability to accurately predict the magnitude and effect of these factors introduces additional uncertainty to the resource assessment. There is a technologic and economic limit to the amount of in-place oil and gas resources that can be physically recovered from a reservoir. Within conventional reservoirs in the study area approximately 30 to 40 percent of the in-place oil and 65 to 80 percent of the in-place gas resources are typically recovered. Additional technologic and economic constraints are applicable to the circumstances under which exploration and development activities can occur, for example ultra-deep water. Continued expansion of the technological frontiers can be reasonably assumed to partially mitigate the impacts of a lower quality resource base and less favorable economic conditions.

Scientists can estimate the quantity of conventionally recoverable resources (both discovered and undiscovered) on the basis of the present state of geologic and engineering knowledge, modified by a subjective consideration of future technological advancement. However, the quantity of resources that may ever actually be produced is dependent in large part upon economics. Actual cost/price relationships are critical determinants. New capital intensive exploration and development technologies require higher product prices for implementation. Typically, as these high-cost technologies are more widely employed, costs decrease, resulting in even more widespread use of these techniques. On the other hand, new modest-cost exploitation technologies that increase recoveries or decrease finding, development, or operating costs can markedly increase estimates of conventionally recoverable resources without requiring an increase in product prices. A decrease in price as experienced in the late 1980's can be moderated or offset by the implementation of a technology that reduces unit costs or vice versa. Generally, the effects of price and technology can be considered interchangeable within the context of a resource assessment.

Another important aspect of the role of technology in a resource assessment is the ability through the deployment of new technology to re-think fundamental approaches to developing exploration play concepts. Basic geologic knowledge concerning the origin, migration, and entrapment of petroleum resources has remained relatively unchanged for the past several decades. However, scientific advances aided by new technologies have affected our ability to identify hydrocarbon plays and, thus, the assessment of the conventionally and economically recoverable resources in discovered and undiscovered accumulations and plays. A prime example of this is the "subsalt play" in the Gulf of Mexico. The recent, increased availability or access to massively parallel computers has made the depth migration of 3D seismic data practical in terms of computer time and costs. Subsequent exploration in the play has demonstrated that drilling is practical and the costs can be controlled as experience is gained and techniques developed. This type of technological advance is not explicitly considered in this resource assessment.

The National Research Council (1991) in its examination of the previous national resource assessment summarized the complex problems intrinsic to the conventional-unconventional and recoverable-unrecoverable boundaries and resource assessments. Both of these boundaries are in flux due to changing economic viability over time and are dependent upon a complex set of economic and technologic variables. Significant changes in the cost/price relationship or fundamental changes in technological capabilities can shift these boundaries, causing modifications in perceptions and the practical meaning of the definitions. Thus, uncertainties in economic and technological conditions contribute to the substantial uncertainties in the resource assessment.

A perceptive Lewis Weeks (1958) in considering this issue wrote nearly four decades ago:

> "While research adds to our proved reserves by developing new ways to find and produce oil, it is a field of activity whose advances are impossible to predict. This is because they depend to a large degree on such important, intangible human resources as initiative and ingenuity."
>
> "... man's mind is his most valuable asset— a 'natural resource' of unlimited potential— and the key to an abundant supply of fuel in the future."

Regional Geologic Framework

The petroleum accumulations of the Gulf of Mexico and Atlantic continental margin are within the offshore portion of the Gulf of Mexico basin and the western Atlantic shelf. This continental margin consists of two regions and three provinces. The Gulf of Mexico Region contains the Gulf of Mexico Cenozoic and Mesozoic Provinces and extends from offshore Texas to the Florida Peninsular Arch on the east and northeast and the U.S. International maritime boundary on the south and southeast. The Atlantic Region consists of a Mesozoic Province extending from the U.S.-Canadian offshore boundary south and west to the Florida Peninsular Arch, (figure 1). These regions exist as passive marine margins that originated during late Triassic and early Jurassic time with the breakup of Pangea when Africa/South America separated from North America. Initial sedimentary deposits were Triassic to lower Jurassic lacustrine and red bed clastics. Continental highlands provided the sediments deposited on the Atlantic shelf and the northern and northeastern Gulf of Mexico basin during the middle to late Jurassic. Clastic deposition continued in the Atlantic, although at a lower rate than in the Jurassic. While continentally derived sediments dominated deposition in the Atlantic through the late Jurassic, in the Gulf of Mexico massive evaporites and carbonates were beginning to form. During Cretaceous time a large stable carbonate platform developed with banks accumulating around the edges of the basin.

Gulf of Mexico Cenozoic Province

The Cenozoic Province covers an area from the U.S.-Mexico maritime boundary to the Federal waters offshore the Florida panhandle (figure 1). Water depths range from 10 feet to over 10,000 feet.

A general uplift of the North American continent during late Cretaceous and early Tertiary time provided vast amounts of clastic sediment that were transported into the northwestern Gulf of Mexico. As the basin subsided, these large volumes of sediment were deposited as successively younger wedges of off-lapping strata. The supply of sediment, being out of phase with the load-induced subsidence, created multiple transgressive and regressive depositional environments. During periods when subsidence was rapid and sediment supply was limited, retrogradational style deposits developed. When basin subsidence was minimal and the sediment load was sufficient, aggradational sands were deposited. A very large volume of clastics was supplied to the basin, related to mountain building during the Tertiary and later during the Quaternary due to continental glaciation. As a result basin subsidence was overwhelmed and the Gulf of Mexico margin prograded seaward. Sediments deposited along the outer shelf and upper slope spilled across the slope and out onto the basin floor as fan systems. Although not confined to a single depositional style, fans are unique enough to be recognized in the subsurface. These deposits— retrogradational, aggradational, progradational, and fans— were also modified and influenced by major marine transgressions.

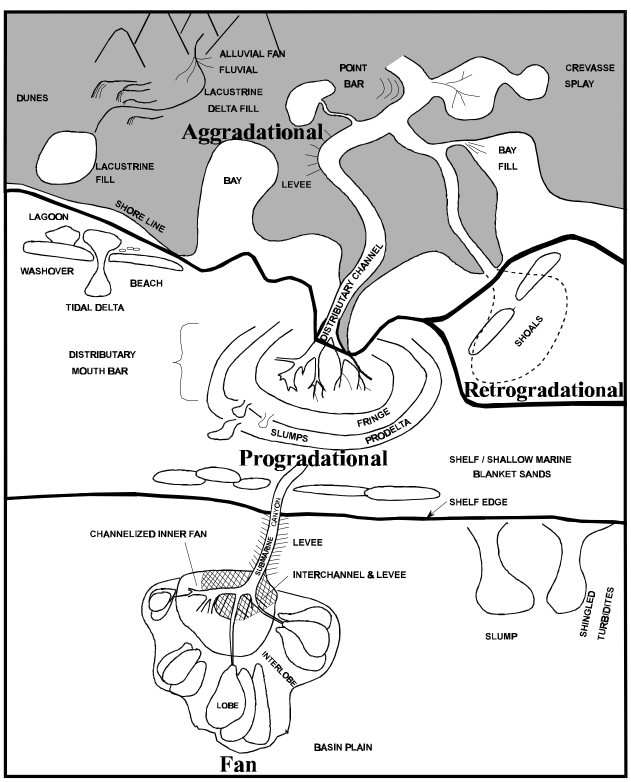

Figure 3. Model for deltaic deposition.

Cenozoic Chronostratigraphy

Geologic Time (M.Y.)	System	Series	Chronozone	Biozone
~0.01	Quaternary	Pleistocene	UPL	Sangamon fauna Trimosina "A" 1st Trimosina "A" 2 st Hyalinea "B" / Trimosina "B"
			MPL	Angulogerina "B"
			LPL	Lenticulina 1 Valvulineria "H"
~2.8	Tertiary	Pliocene	UP	Buliminella 1
			LP	Textularia "X"
~5.5		Miocene	UM3	Robulus "E" / Bigenerina "A" Cristellaria "K"
			UM1	Discorbis 12
			MM9	Bigenerina 2 Textularina "W"
			MM7	Bigenerina humblei Cristellaria "I" Cibicides opima
			MM4	Amphistegina "B" Robulus 43 Cristellaria 54 / Eponides 14 Gyroidina "K"
			LM4	Discorbis "B" Marginulina "A"
			LM2	Siphonina davisi
			LM1	Lenticulina hanseni
~24.8		Oligocene	OL1 [O]	Bolivina perca
~38.0		Eocene	[E]	
~55.0		Paleocene	[L]	
~63.0				

(Modified from Melancon, et al., 1995)

Figure 4. Chronostratigraphic chart, Gulf of Mexico Cenozoic Province.

This basic deltaic depositional model as shown in figure 3 was the foundation for play delineation within the province. The major flooding events of the Cenozoic and detailed paleontological analysis provided the basis for the Cenozoic chronostratigraphic column (figure 4). The chronostratigraphy, coupled with the distinct depositional styles and environments of this model— retrogradational, aggradational, progradational, and fans— recognized by a combination of spontaneous potential (SP) curve characteristics, ecozone data, and seismic character, are the principal basis for play delineation in the Cenozoic Province (Seni et al., 1995; Lore and Batchelder, 1995).

During the Jurassic, massive amounts of salt precipitated as the basin was periodically separated

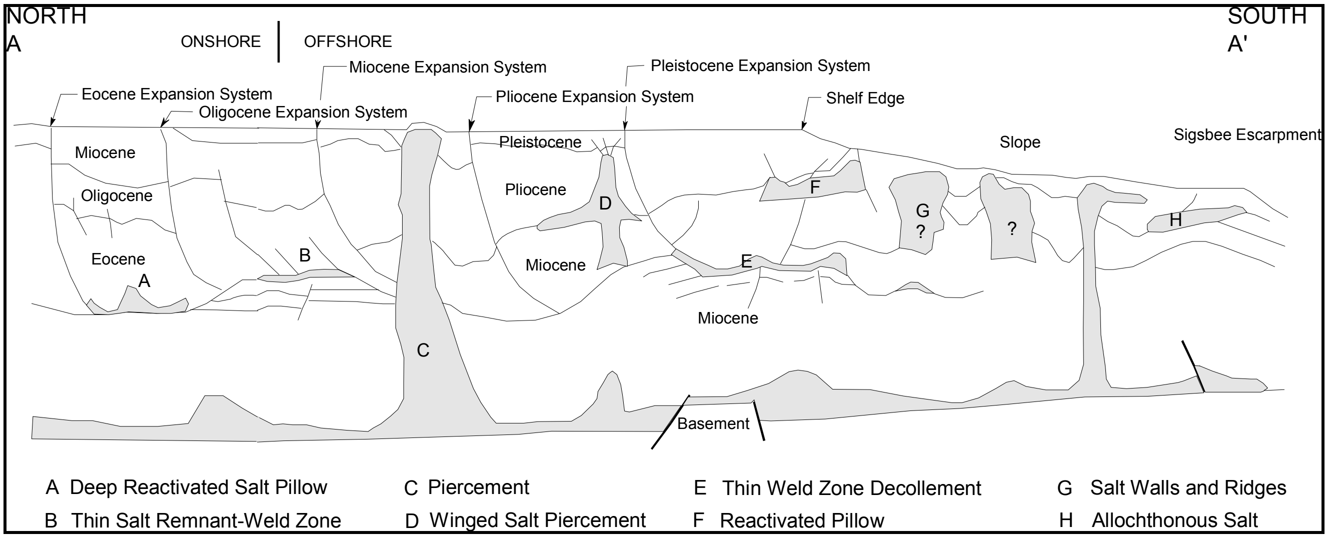

Figure 5. Cross-section A-A', Gulf of Mexico Cenozoic Province. (Modified from Brooks, 1993).

from open ocean waters. Subsequent loading of the salt by large volumes of Mesozoic and Cenozoic sediments deformed the salt. Until relatively recently almost all Gulf of Mexico salt structures were thought to be piercement-type structures connected to the original salt deposits. With recent developments in the collection and analysis of seismic data, including 3D, the salt in the Gulf of Mexico is recognized to exist in a series of salt provinces, each having a distinct style of salt emplacement (figure 5). Salt in the form of diapirs penetrated the late Miocene sediments, then flowed downdip due to the influence of gravity and pressure, resulting in large sheets of salt that deformed owing to subsequent sediment loading. The recognition that salt exists as lenses, winged salt piercements, and allochthonous sheets has led to the exploration of those sediments that lie below the salt. In 1993 the "Mahogany" prospect offshore Louisiana confirmed that the sediments that lie below salt can contain hydrocarbons in economic quantities.

Since the first Federal oil and gas lease sale in 1954, there have been 71 lease offerings within the Cenozoic Province, resulting in over 11,000 leases encompassing approximately 57 million acres. In the more than 50 years of petroleum exploration in the Gulf of Mexico, over 31,000 boreholes have been drilled in the Federal waters of this province. Since 1976, nearly 5.4 million line-miles of seismic data have been collected by industry in the area. In the Cenozoic Province 867 fields have been discovered and produced. Original proved reserves are estimated to have been 11.86 Bbo and 140.33 Tcfg. Remaining proved reserves in the 811 active fields at year-end 1994 were 2.52 Bbo and 27.86 Tcfg (table 3).

The potential for significant additional discoveries on the shelf of the Central and Western Gulf of Mexico is excellent, despite almost 50 years of extensive drilling in this area. The potential that does exist in the area, however, is primarily dependent upon deeper drilling or discoveries being made sub-salt. However, the greatest part of the hydrocarbon potential of the province, 72 percent, lies in the deep-water slope (fan) deposits.

Gulf of Mexico Mesozoic Province

The eastern portion of the Gulf of Mexico OCS, a passive margin underlain by Mesozoic and Cenozoic sediments, extends from the Florida Peninsula Arch on the east and southeast, through the South Florida Basin, and northwestward approximately to Mobile Bay providing an exploration frontier covering 76 million acres (119,000 square miles) (figure 1). Most of the siliciclastics are derived from erosion of the ancestral Appalachian Mountain system. A thick Cretaceous age carbonate platform is present in the eastern Gulf of Mexico. Carbonate reefs and banks are associated with the shelf edge and the South Florida Basin. The sedimentary section attains a thickness exceeding 30,000 feet in the South Florida Basin and eastern portion of the Gulf of Mexico Basin. Water depths range from 20 to 10,000 feet.

Figure 6 is a chronostratigraphic chart of the Gulf of Mexico and Atlantic Mesozoic Provinces. The geologic history of the northern Gulf of Mexico during the Mesozoic began with the breakup of the Pangean supercontinent about 200 million years ago. A series of Late Triassic-Early Jurassic rift basins formed as grabens in what is now onshore Georgia, Florida,

Table 3. Reserves and undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin by geologic age.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

		Reserves												Risked Undiscovered Conventionally Recoverable Resources									
		Cumulative Production			Remaining Proved			Appreciation			Unproved			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
		Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
Gulf of Mexico Region		9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	6.038	8.344	11.138	82.323	95.661	110.286	21.218	25.366	29.990
Cenozoic Province		9.339	112.440	29.346	2.516	27.885	7.478	2.238	31.564	7.854	0.885	4.117	1.617	1.00	4.428	6.291	8.584	74.766	87.553	101.639	18.199	21.870	25.977
Quaternary System		3.261	46.085	11.461	1.055	11.050	3.021	1.087	13.210	3.438	0.372	1.775	0.687	1.00	2.064	2.648	3.326	26.116	31.560	37.668	6.944	8.263	9.731
Pleistocene Series		3.261	46.085	11.461	1.055	11.050	3.021	1.087	13.210	3.438	0.372	1.775	0.687	1.00	2.064	2.648	3.326	26.116	31.560	37.668	6.944	8.263	9.731
Chronozone	UPL	0.398	12.842	2.683	0.346	3.227	0.920	0.292	3.836	0.975	0.115	0.424	0.190	1.00	0.962	1.336	1.791	9.813	11.316	12.957	2.785	3.350	3.982
	MPL	0.667	10.779	2.585	0.178	2.278	0.583	0.193	2.804	0.692	0.021	0.466	0.104	1.00	0.186	0.234	0.288	2.429	3.331	4.419	0.641	0.827	1.043
	LPL	2.196	22.464	6.193	0.531	5.545	1.518	0.602	6.570	1.771	0.236	0.885	0.393	1.00	0.815	1.078	1.388	12.970	16.913	21.536	3.257	4.087	5.039
Tertiary System		6.078	66.355	17.885	1.461	16.835	4.457	1.151	18.354	4.416	0.513	2.342	0.930	1.00	2.198	3.643	5.574	46.782	55.994	66.272	10.785	13.607	16.854
Pliocene Series		2.756	17.357	5.844	0.656	4.361	1.432	0.464	3.479	1.083	0.305	0.820	0.451	1.00	0.788	0.961	1.155	7.452	8.922	10.562	2.193	2.548	2.938
Chronozone	UP	1.221	10.178	3.032	0.355	2.658	0.828	0.266	2.180	0.654	0.234	0.728	0.364	1.00	0.340	0.407	0.482	3.258	3.631	4.030	0.943	1.053	1.171
	LP	1.535	7.179	2.812	0.301	1.703	0.604	0.198	1.299	0.429	0.071	0.092	0.087	1.00	0.426	0.554	0.704	4.065	5.291	6.726	1.210	1.495	1.819
Miocene Series		3.322	48.998	12.041	0.805	12.474	3.025	0.687	14.875	3.333	0.208	1.522	0.479	1.00	1.559	1.880	2.240	35.278	41.486	48.341	7.981	9.262	10.665
Chronozone	UM3	2.220	10.290	4.052	0.392	2.534	0.843	0.330	2.347	0.748	0.122	0.480	0.207	1.00	0.348	0.452	0.574	3.970	4.671	5.446	1.085	1.284	1.504
	UM1	0.512	8.572	2.037	0.163	2.019	0.522	0.111	1.782	0.428	0.015	0.677	0.136	1.00	0.286	0.362	0.449	3.502	4.087	4.731	0.937	1.089	1.255
	MM9	0.225	5.313	1.170	0.166	1.613	0.453	0.139	1.585	0.421	0.070	0.301	0.124	1.00	0.238	0.340	0.465	4.649	5.532	6.515	1.116	1.324	1.555
	MM7	0.149	10.886	2.086	0.032	1.717	0.338	0.050	2.449	0.486	<0.001	0.008	0.001	1.00	0.259	0.348	0.455	8.797	12.457	16.953	1.864	2.565	3.412
	MM4	0.143	7.372	1.455	0.033	1.870	0.366	0.034	2.727	0.519	<0.001	0.012	0.002	1.00	0.197	0.226	0.257	4.650	5.158	5.699	1.036	1.144	1.258
	LM4	0.031	2.377	0.454	0.005	0.850	0.156	0.009	1.492	0.274	0.001	0.041	0.008	1.00	0.065	0.101	0.148	3.596	4.681	5.953	0.712	0.934	1.195
	LM2	0.030	2.440	0.464	0.008	1.188	0.219	0.007	1.595	0.291	<0.001	0.001	<0.001	1.00	0.018	0.025	0.035	2.122	2.528	2.979	0.399	0.475	0.560
	LM1	0.012	1.748	0.323	0.006	0.683	0.128	0.007	0.898	0.166	<0.001	0.002	<0.001	1.00	0.018	0.025	0.035	1.978	2.370	2.808	0.373	0.447	0.530
Oligocene/Eocene Series		0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.126	0.803	2.327	2.844	5.586	9.576	0.558	1.797	4.032
Chronozone	O/E	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.126	0.803	2.327	2.844	5.586	9.576	0.558	1.797	4.032
Paleocene Series		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone	L	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mesozoic Province		<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	0.001	0.596	0.107	1.00	1.360	2.053	2.933	7.106	8.108	9.194	2.678	3.495	4.455
Cretaceous System		<0.001	<0.001	<0.001	0.000	0.000	0.000	<0.001	<0.001	<0.001	0.001	0.150	0.028	1.00	0.905	1.433	2.121	0.519	0.939	1.525	1.026	1.600	2.343
Upper Cretaceous Series		0	0	0	0	0	0	0	0	0	0	0	0	0.56	0.000	0.045	0.190	0.000	0.070	0.257	0.000	0.057	0.226
Chronozone	UK	0	0	0	0	0	0	0	0	0	0	0	0	0.56	0.000	0.045	0.190	0.000	0.070	0.257	0.000	0.057	0.226
Lower Cretaceous Series		<0.001	<0.001	<0.001	0.000	0.000	0.000	<0.001	<0.001	<0.001	0.001	0.150	0.028	1.00	0.921	1.388	1.980	0.530	0.869	1.320	1.042	1.542	2.171
Chronozone	LK	<0.001	<0.001	<0.001	0.000	0.000	0.000	<0.001	<0.001	<0.001	0.001	0.150	0.028	1.00	0.921	1.388	1.980	0.530	0.869	1.320	1.042	1.542	2.171
Jurassic System		<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	<0.001	0.446	0.079	1.00	0.375	0.620	0.947	6.490	7.169	7.890	1.561	1.896	2.273
Upper Jurassic Series		<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	<0.001	0.446	0.079	1.00	0.375	0.620	0.947	6.490	7.169	7.890	1.561	1.896	2.273
Chronozone	UU	<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	<0.001	0.446	0.079	1.00	0.375	0.620	0.947	6.490	7.169	7.890	1.561	1.896	2.273
Middle Jurassic Series		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone	MU	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lower Jurassic Series		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone	LU	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Triassic System		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Triassic Series		0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone	UTR	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 3--continued. Reserves and undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin by geologic age. (Note: Summation of individual resource values may differ from total due to independent computer runs and rounding.)

	Reserves												Risked Undiscovered Conventionally Recoverable Resources									
	Cumulative Production			Remaining Proved			Appreciation			Unproved			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
Atlantic Region	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Mesozoic Province	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Cretaceous System	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.431	0.722	1.143	7.840	11.767	18.813	1.985	2.816	4.190
Upper Cretaceous Series	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone UK	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lower Cretaceous Series	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.431	0.722	1.143	7.840	11.767	18.813	1.985	2.816	4.190
Chronozone LK	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.431	0.722	1.143	7.840	11.767	18.813	1.985	2.816	4.190
Jurassic System	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.762	1.549	2.714	9.040	15.712	24.847	2.584	4.345	6.716
Upper Jurassic Series	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.527	1.020	1.733	6.135	10.210	17.331	1.791	2.837	4.201
Chronozone UU	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.527	1.020	1.733	6.135	10.210	17.331	1.791	2.837	4.201
Middle Jurassic Series	0	0	0	0	0	0	0	0	0	0	0	0	0.93	0.000	0.529	1.163	0.000	5.502	10.426	0.000	1.508	2.830
Chronozone MU	0	0	0	0	0	0	0	0	0	0	0	0	0.93	0.000	0.529	1.163	0.000	5.502	10.426	0.000	1.508	2.830
Lower Jurassic Series	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone LU	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Triassic System	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Triassic Series	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chronozone UTR	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

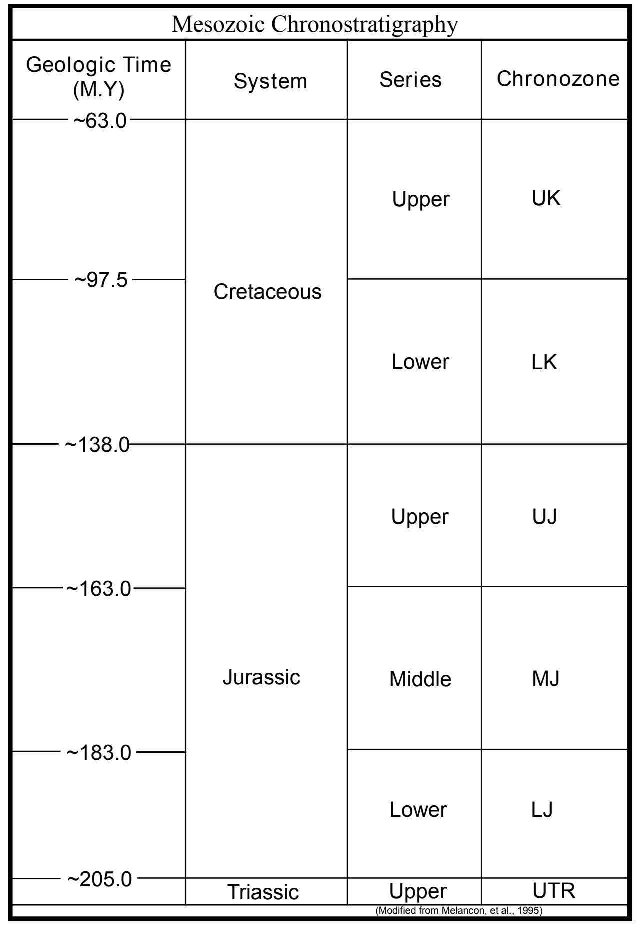

Figure 6. Chronostratigraphic chart, Gulf of Mexico and Atlantic Mesozoic Province.

Mississippi, Alabama, Louisiana, and Texas, as well as the central Gulf of Mexico. The Wiggins Arch and parts of the Sarasota Arch represent Paleozoic remnants left behind during the rifting stage.The grabens were active depocenters receiving alluvial, fluvial, delta plain, lacustrine, and marine deposits similar to those found along the Atlantic margin. Marine incursions resulted in the deposition of thick shallow-water salt deposits in the Gulf of Mexico. The Upper Jurassic is characterized by a series of clastic and carbonate transgressive sequences, resulting in a seaward progradation of the shelf. As the shelf prograded, a shelf-edge reef complex developed in the Early Cretaceous, resulting in a thick sequence of carbonate rock subsequently overlain by Upper Cretaceous clastics. The maximum thicknesses attained by the Upper Jurassic sediments exceed 5,000 feet, the Lower Cretaceous 10,000 feet, the Upper Cretaceous 5,000 feet, and the Cenozoic 5,000 feet.

Federal oil and gas lease sales have been held

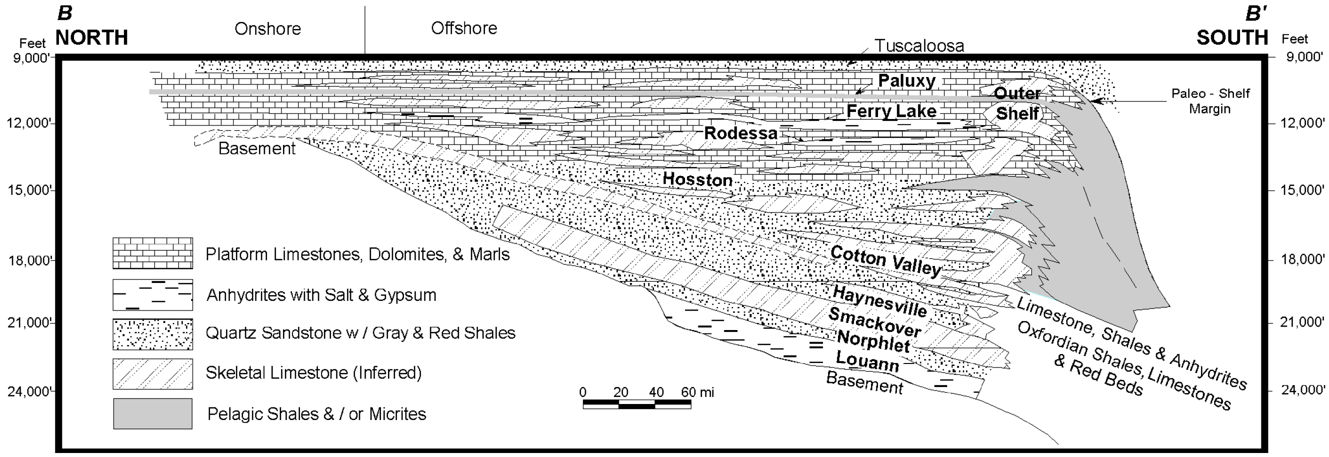

Figure 7. Cross-section B-B', Gulf of Mexico Mesozoic Province. (Modified from McFarlan and Menes, 1991).

within the Mesozoic Province since 1959. Nearly 500 OCS leases encompassing 2.5 million acres have been awarded. Approximately 125 wells targeting or penetrating the Mesozoic section have been drilled with approximately 27 finding commercially recoverable hydrocarbons in 11 fields. The remaining offshore wells have been dry or have encountered subeconomic quantities of oil and gas.

The Upper Jurassic Norphlet clastic play is the most productive offshore play in the Gulf of Mexico Mesozoic Province, with six fields in Alabama State waters and nine in Federal OCS waters. Reservoir depths range from 20,000 to 25,000 feet. Original proved reserves in the Norphlet Formation were estimated in 1994 to be 1.57 Tcfg and a minor volume of condensate; unproved reserves were 0.45 Tcfg with a small amount of condensate. Seven wells in the Lower Cretaceous patch reef trend encountered oil and gas, all in the Main Pass Block 253 and the Viosca Knoll Block 252 fields. Among the nineteen Destin Dome exploration wells, two had oil and condensate shows in the Norphlet Formation (figure 7). The two main exploration targets offshore south Florida are the Sunniland Formation, or its stratigraphic equivalents, and the Brown Dolomite Zone of the Lehigh Acres Formation (figure 8). Six wells drilled on the Sarasota Arch penetrated these horizons; however, only a single poor show was encountered in one well. Two wells, one State and one Federal OCS, in the Florida Keys area had Lower Cretaceous oil shows. The Sunniland Formation is productive onshore from 14 fields with estimated original proved reserves of 110 Mmbo.

Three prospective chronozones have been identified in the Gulf of Mexico Mesozoic Province: Upper Cretaceous, Lower Cretaceous, and Upper Jurassic. Potential traps are related to folded structures, faults (normal and growth), and permeability pinchouts against nonporous shales, mudstones, evaporites, and carbonates. Major offshore discoveries have been established in the Norphlet Trend offshore Mobile Bay. Areas of potential discoveries within the Mesozoic section extend from the Louisiana-Mississippi border, Alabama and Florida State-Federal boundaries, through the Tampa and South Florida Basins to the U.S.-Cuba

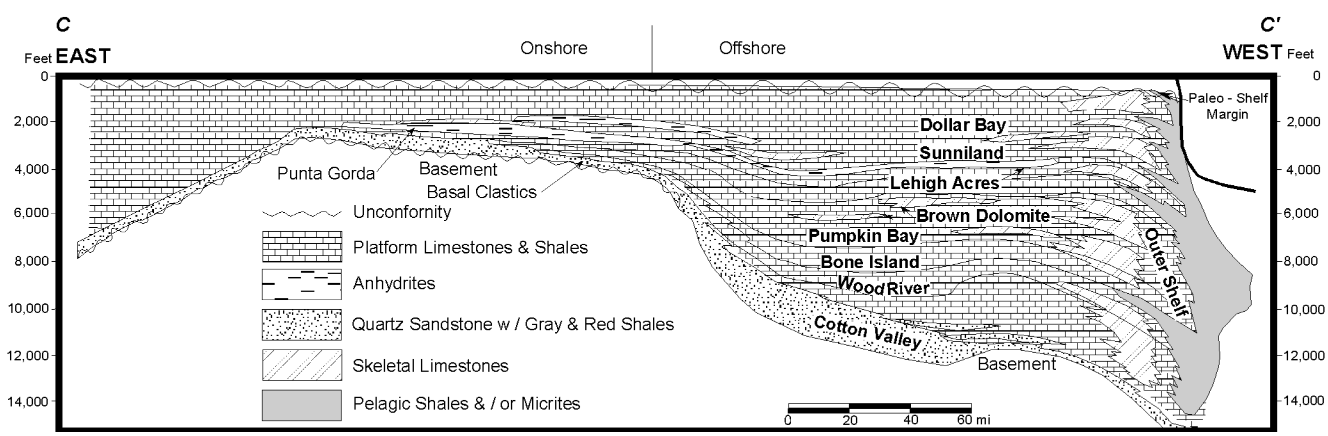

Figure 8. Cross-section C-C', Gulf of Mexico Mesozoic Province. (Modified from McFarlan and Menes, 1991).

International Boundary.

Potential Mesozoic reservoirs are postulated within the Mississippi fan and Perdido foldbelts and other large structures of the deepwater central and western Gulf of Mexico. The existence of these reservoirs below Cenozoic sediments is highly speculative. These potential plays were not assessed at this time due to their low probability of existence and the high degree of uncertainty concerning their reservoir characteristics and the actual occurrence of hydrocarbon accumulations.

Atlantic Mesozoic Province

The Atlantic OCS is a passive margin, underlain by Mesozoic and Cenozoic sediments, extending from the U.S.-Canadian offshore border to the Florida Peninsula Arch. The margin encompasses an area of approximately 135 million acres (211,000 square miles) (figure 1). In the northern and central portions of the province the sediments underlying the shelf are siliciclastic, derived from erosion of the Appalachian Mountain system, and platform and reefal carbonates immediately seaward of the terrigenous detritus. Carbonate rocks predominate in the southern part of the Atlantic OCS. The sedimentary section attains thicknesses exceeding 40,000 feet. Water depths range from 80 to 12,000 feet.

Late Triassic continental rifting initiated a system of faults paralleling the Appalachian Mountains and extending from southeast Newfoundland to southeast Georgia and then westward into Texas. These faults developed into rift basins filled with nonmarine red bed and lacustrine deposits. The easternmost band of these rifts functioned as southwestward extensions of the Tethys Seaway, accommodating marine sediments, including evaporites. A regional post rift unconformity (PRU) overlies the rift sedimentary sequence under the shelf. The PRU represents a 20-million-year hiatus and is overlain by the Middle Jurassic to Recent progradational, post-rift sediments. As evident from seismic data, the postrift sequence is structurally uncomplicated; growth faults, which appear to sole out into deep strata, and their associated rollover structures follow the northeast-southwest regional structural grain. Jurassic sediments include siliciclastic basin infill and platform carbonates overlain by Cretaceous clastics. The maximum thickness attained by the Middle Jurassic sediments exceeds 10,000 feet, the Upper Jurassic 6,000 feet, the Lower and Upper Cretaceous 5,000 feet each, and the Cenozoic 3,000 feet (figure 9).

In 1976, the first U.S. Atlantic offshore lease sale was held, Mid-Atlantic Sale 40, in the Baltimore Canyon Trough area. Successful bids were submitted for 93 leases, which included both the Great Stone Dome and the Hudson Canyon Block 598-642 structures. The former prospect was tested by seven exploration wells, which were all dry, and the latter by eight wells, five of which had significant but subeconomic hydrocarbon flows, mostly natural gas (95 million cubic feet per day [MMcfd] from Upper Jurassic intervals and 640 barrels of oil per day [bopd] from the Lower Cretaceous).

Nine Atlantic OCS sales occurred in the North, Mid-, and South Atlantic Planning Areas. Fifty-one wells were drilled, 5 of which were Continental Offshore Stratigraphic Test (COST) wells sited off-structure by industry consortiums in the 1970's to gain stratigraphic data. Most of the exploration wells were drilled on paleoshelf anticlinal structures, targeting siliciclastic reservoirs. However, three wells (Shell Wilmington Canyon 372-1, 586-1, and 587-1) tested the Upper Jurassic-Lower Cretaceous shelf-edge reef, backreef, and carbonate platform offshore New Jersey.

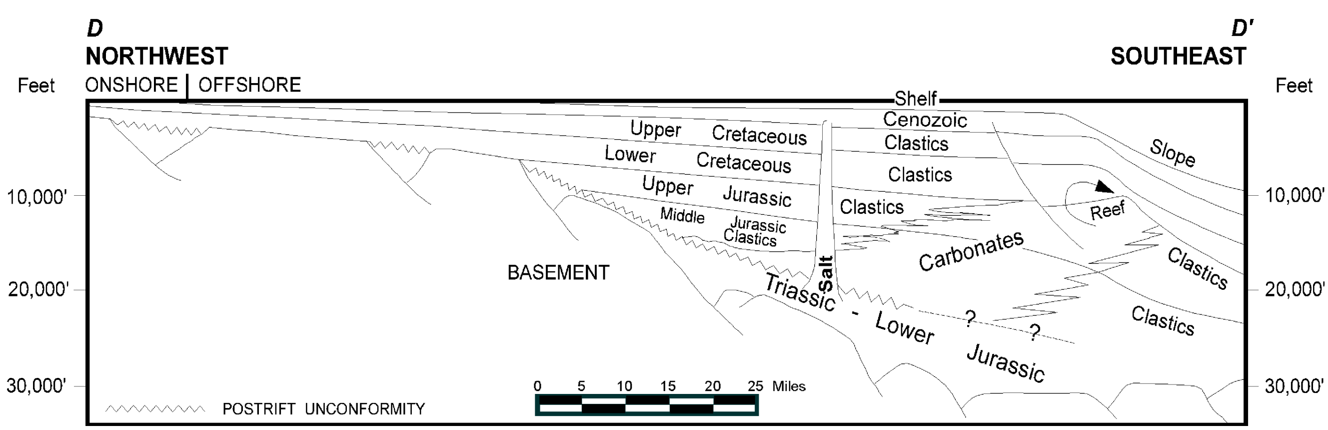

Figure 9. Cross-section D-D', Atlantic Mesozoic Province.

One well (Shell Baltimore Rise 93-1) near the shelf edge penetrated a thick Lower Cretaceous deltaic sequence offshore Maryland. Excluding the Hudson Canyon Block 598-642 structure, all wells were dry or contained only minor shows.

Altogether, 433 Federal leases have been issued in the Atlantic Region for petroleum exploration. Currently 53 leases, all in the Mid- and South Atlantic Planning Areas, remain active under Suspensions of Operation.

GENERAL MODELING APPROACH

Previous MMS assessments presented estimates of undiscovered conventionally recoverable oil and gas resources as cumulative distributions of the quantities of resources expected in a particular area. Knowledge of both the total amount of recoverable oil and gas and the number and size distribution of individual accumulations are important factors that must be considered in formulating a corporate exploration strategy or national policy. The methodology used in this assessment provides this information in the form of pool rank plots for each play.

Estimates of undiscovered economically recoverable oil and gas resources were also previously presented only as cumulative distributions at discrete sets of economic conditions. In this assessment these estimates are also presented as price-supply curves which show incrementally the costs associated with transforming a volume of undiscovered conventionally recoverable resources to economically recoverable resources.

Reserves

The MMS scheme of classifying conventionally recoverable hydrocarbons can be seen in figure 2, a modified McKelvey diagram. With increasing economic certainty, resources progress from uneconomic to marginally economic. With increasing geologic assurance, hydrocarbon accumulations advance from resources to unproved reserves. Reserves can be classified as proved when sufficient economic and geologic knowledge exists to confirm the likely commercial production of a specific volume of hydrocarbons. Proved reserves must at the time of the estimate either have facilities that are operational to process and transport those reserves to market, or a commitment or reasonable expectation to install such facilities in the future (SPE, 1987).

Reserves are frequently estimated at different stages in the exploration and development of a hydrocarbon accumulation, i.e., after exploration and delineation drilling, during development drilling, after some production and, finally, after production has been well established. Different methods of estimating the volume of reserves are appropriate at each stage. Reserve estimating procedures generally progress from volumetric to performance-based techniques as the field matures. The relative uncertainty associated with these estimates decreases as more subsurface information and production history become available.

Volumetric estimates are based on subsurface geologic information from wells, geophysical data, and limited production and test data. An estimate of the volume of hydrocarbon-bearing rock is determined and an estimate of the recovery factor applied to calculate reserves (Arps, 1956; Wharton, 1948).

Performance-based methods are primarily variations of production decline curve analyses. Generally, they involve plotting production rate versus time or cumulative production and projecting the trend to the economic limit of the accumulation. These empirical extrapolations assume that whatever factors have caused the historical trend in the curve will continue to uniformly govern the trend in the future (Arps, 1945).

Cumulative production is a measured quantity that can be accurately determined. Estimates of original proved reserves are uncertain; however, normal industry practice has been to calculate reserves through a deterministic process and present the results as single point estimates. The uncertainty associated with these estimates is less than with comparable estimates of volumes of unproved reserves and considerably less than estimates of undiscovered resources.

Reserves Appreciation

Reserves appreciation or reserves growth is the observed incremental increase through time in the estimates of original proved reserves of an oil and gas field. The reserves growth phenomenon is the result of numerous factors that occur as a field is developed and produced:

- an increased understanding of the petroleum reservoir.
- physical expansion of the field.
- improved recoveries due to experience with actual field performance, the implementation of new technology, and/or changes in the cost-price relationships.
- standard industry practices for reporting proved reserves.

Growth functions can be used to calculate an estimate of a field's size at a future date. In this assessment, growth factors were calculated from the MMS data set of 876 OCS fields with proved reserves at the end of 1994. Annual growth factors (AGF's) were calculated by dividing the estimate of original reserves for all fields of the same age by the estimate of original reserves for the same fields in the previous year. The same fields are included in both the numerator and denominator. The set of fields used to calculate AGF's is likely to differ from one year to the next as some fields are depleted and abandoned and others are discovered. Growth factors can also be expressed as cumulative growth factors (CGF's), which represent the ratio of the size of a field several years after discovery to the initial estimate of its size in the year of discovery. The assumptions central to this approach are that:

- the amount of growth in any year is proportional to the size of the field.
- this proportionality varies inversely with the age of the field.
- the age of the field is a reasonable proxy for the degree to which the factors causing appreciation have operated.
- the factors causing future appreciation will result in patterns and magnitudes of growth similar to that observed in the past.

The objective of the reserves appreciation effort in this resource assessment was to (1) estimate the quantity of reserves from known fields that, because of the reserves appreciation phenomenon, will ultimately contribute to the future oil and gas supply and (2) explicitly incorporate field growth in the discovery history, which forms the basis for projecting future discoveries within defined plays. The second objective represents the first effort in a large-scale assessment to explicitly incorporate reserves appreciation as an integral part of the forecast of the number and sizes of future discoveries.

The estimate of total reserves appreciation in known fields to a particular point in time, the year 2020 in this assessment, was developed by applying regression analyses to the observed field-level AGF's to develop a function relating the AGF's to the age of the field. The modeled CGF's were then calculated from the model AGF's. Figure 10 presents the actual observed and modeled growth factors. Over time the AGF values asymptotically approach a value of 1.00, coinciding with no growth, and the CGF values

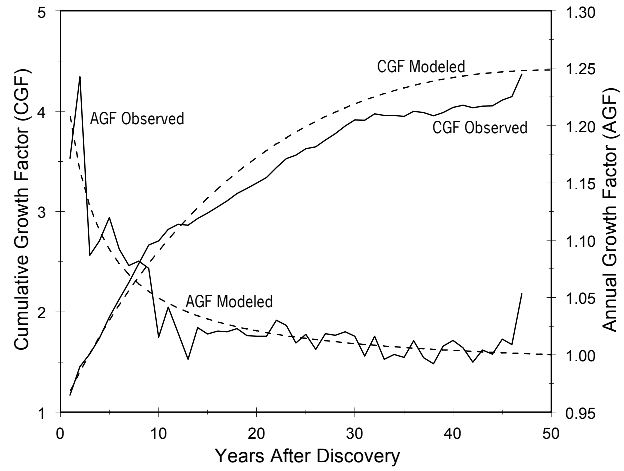

Figure 10. Annual and cumulative reserves growth curves, Gulf of Mexico Region.

asymptotically approach a limit of about 4.4, also representing no additional appreciation with time. These limiting bounds of the curves are a function of the volume of the original in-place resource.

The oldest fields in the data set were 47 years old. The appreciation model used in this assessment projects no growth for fields 50+ years of age. This is a reasonable conclusion since it fit well with the observed data and does not entail extending projections considerably beyond the time frame of the observations. Since the age and estimate of original proved reserves in the fields as of December 31, 1994, were known, the growth model was applied to this set of fields to develop an aggregate estimate of appreciation through the year 2020.

The second objective of the reserves appreciation effort was to explicitly consider field growth in the measure of past performance. Previous assessments assumed incorrectly that the ultimate sizes of existing discoveries were known at the time of the assessment. This is a critical assumption since in this assessment the methodology requires information related to past performance as the basis for projecting future discoveries within plays. Reliably determining the estimated ultimate reserves of the discovered fields, the largest field in particular, is central to the assessment process used by MMS. The appreciation model developed from the entire set of OCS fields was applied to the pool size distribution for each individual play to appreciate the discovered pools prior to applying the matching techniques described below.

A more detailed discussion of reserves appreciation and the approach used in this study is included in appendix A.

Undiscovered
Conventionally Recoverable Resources

Geologists, statisticians, and economists have been performing resource assessments for decades in an attempt to estimate the future petroleum supply in an area. The demands of and uses for these assessments have led to the evolution of increasingly complex quantitative techniques and procedures to meet the challenge. Generally, the evolution has been from deterministic to stochastic methods, incorporating sensitivity and risk analyses. Scientific disciplines involved in the assessment process have evolved in parallel with the methodology from geology to a complex multi-disciplinary array of geology, geophysics, petroleum engineering, economics, and statistics.

The basic building block of this assessment of undiscovered conventionally recoverable resources is the play. A play is defined primarily on the basis of the geologic parameters that are responsible for a petroleum accumulation. The significance of the play analysis approach is that it explicitly links the observed outcomes of oil and gas exploration and development activities to the assessment. The impacts of economics and technological advances can be clearly observed at the play and basin level. At higher levels, such as national or regional aggregations, these effects are often masked (Grace, 1991). The play analysis technique can be incorporated into probabilistic models to yield a number of possible future outcomes from exploration and development in the area under consideration. The strengths of this procedure are that it deals with natural exploration units— plays, prospects, pools, and fields, and with specified pool or field size distributions. This process also provides for the systematic documentation, integration, and analysis of the play's geologic model and exploration history, and an assessment of the size and number of undiscovered hydrocarbon accumulations. The assessment results in terms of ranked pool plots can be readily used for economic analyses and discovery forecasting.

The assessment of the undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin was performed irrespective of any consideration of economic constraints using a computer program called GRASP (Geologic Resources ASsessment Program). The program was adapted by MMS from the Geological Survey of Canada's PETRIMES (PETroleum Resources Information Management and Evaluation System) program.

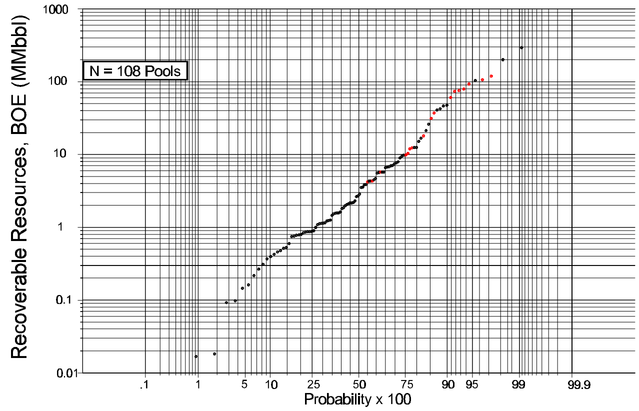

Figure 11. Sample pool size distribution.

It has been recognized empirically for decades that within any petroleum province, and particularly within plays, the size distribution of accumulations is highly skewed, i.e., there are many small accumulations and a very few large ones (Arps and Roberts, 1958; Kaufman, 1963; McCrossan, 1969; Barouch and Kaufman, 1977; Forman and Hinde, 1985). Commonly the large deposits contain the majority of the resources. Kaufman (1965), Meisner and Demirmen (1981), Crovelli (1984), Davis and Chang (1989), and Power (1992), among others, have reviewed the lognormal distribution and the many properties that make it a reasonable choice as a probability model for the relative frequency distribution of pool sizes in a play. The ultimate choice, however, of a particular probability model is subjective.

The fact that the logarithms of pool sizes are normally distributed and that distributions can therefore be completely specified by the mean (μ, a statistical measure of central tendency) and variance (σ^2, a measure of the amount of dispersion in a set of data) of the log-transformed data constitutes the major assumption of the GRASP model. A convenient characteristic of lognormal distributions is that a plot of the log of the values in the distribution approximates a straight line (figure 11).

The objectives of the assessment of undiscovered conventionally recoverable resources were to:

- estimate the number of undiscovered pools,
- estimate the sizes of the undiscovered pools,
- estimate reservoir characteristics of the undiscovered pools,
- provide adequate information for economic analysis, and
- validate exploration concepts and geologic models against known information.

A comprehensive resource assessment must combine within the context of the play model empirical field data with information acquired from regional analysis and comparative studies. In the GRASP model, exploration data are expressed as probability distributions. The major strengths of probabilistic methods are the formal recognition of uncertainty; the ability to enable professionals to make judgments in their areas of expertise without requiring additional, often arbitrary, judgment; and the useful, added dimension provided to the analysis and results. The model relies heavily on the technical judgments of the geoscientist teams working with the other assessors.

The basic procedures used in this resource assessment were the pool generation and matching processes described by Lee and Wang (1986). The major steps (figure 12) include:

- play delineation,
- compilation of relevant play data,
- estimation of the pool size distribution,
- estimation of the number of pools distribution,
- estimation of individual rank pool sizes,
- iterative testing of statistical best fits with the geologic play model and exploration and discovery history,
- matching of discovery data with forecast pool sizes, and
- estimation of the resource distribution of the play.

The minimum information required for an effective assessment of undiscovered petroleum in a play can be developed from estimates of the size distribution of the potential pools in the play and the range in the number of possible pools (N), assuming that the play exists, in conjunction with an assessment of the appropriate marginal probability (MP_{hc}). Pool size distributions describing the size range of individual pools in the play and their frequency of occurrence are the most important elements of the resource appraisal process. The pool size distribution is a function of the geologic model for the play. It describes the expected population of pools that would result from repeated exploration of a particular play model. The number of pools distribution is derived from a consideration of the number of existing discoveries, the number of prospects, average prospect risk, areal extent of the play, and the degree of exploration maturity for the play.

Next, the pool size distribution is conditioned on the existing discoveries. The pool size distribution is ascertained by the matching process where hypothetical pool size distributions are determined stochastically from different values for the parameters N, μ, and σ^2. The model selects values from the distribution of each parameter and generates pool rank plots. The potential resource size of each individual pool is assumed to be lognormally distributed. The discovered pools are then matched to the predicted pool size distribution for each iteration. The best statistical fits are then presented for further analysis. Statistical "goodness-of-fit" tests are applied, but the implications of the best statistical solutions must be subjectively compared with the geologic model. Since there is no unique measure to determine the best model for the play, selection of the appropriate match is one of the most challenging aspects of the resource assessment process.

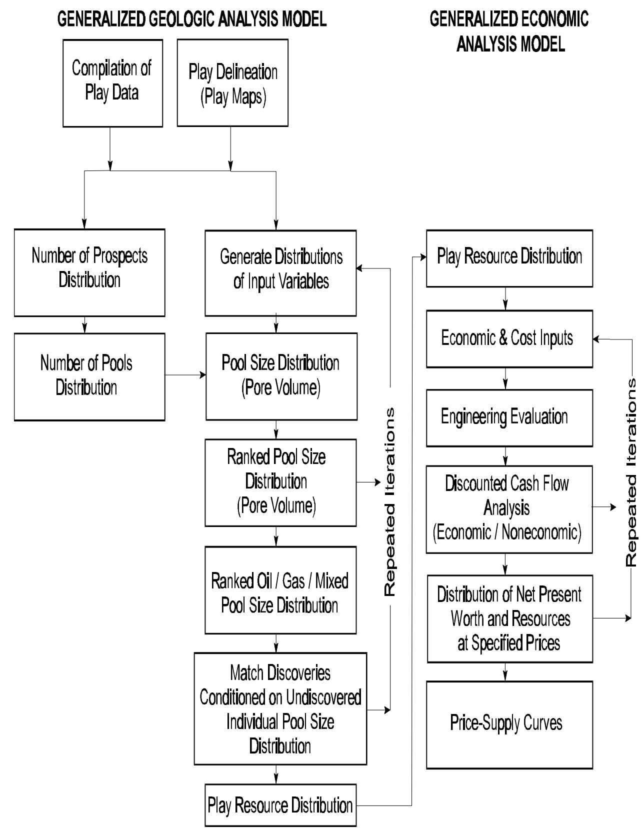

Figure 12. Generalized resource assessment process flowchart.

In the matching process the discoveries in a play are recognized as a sample taken from the play's population of pool sizes. The standard statistical practice of estimating the population μ and σ^2 from the sample is valid only if the sample is assumed to be a random sample from the pool population, or is large enough to represent the distribution of the population. In reality neither of these situations is usually valid.

Large pools are usually discovered early because the largest prospects are generally defined and drilled first— the principle of resource exhaustion. The sample set is usually clearly biased. The undrilled prospects will include a disproportionate number of small pools. The effect of this bias in the selection process is a progressive change in the pool size distribution through time. If the population is lognormal, samples at different times will also tend to be lognormal. These sample distributions will migrate downward from an initial distribution with unrealistically high μ and low σ^2 values. Therefore, μ of the sample would be an overestimate and σ^2 an underestimate of the population parameters. Kaufman et al. (1975) illustrated this process through a series of Monte Carlo simulations of a random discovery process in a hypothetical basin.

The matching process requires a careful consideration of all available information pertaining to the play: petroleum geology, discovery history, play maturity, etc. Typically, this is accomplished by responding to questions such as:

- Has the largest pool been discovered? If not, what are the largest pools that could remain to be discovered?
- How many undrilled prospects are likely to remain in the play? What is their size distribution and average prospect risk?
- How does the play's exploration and discovery history fit the pool size distribution?
- Do the parameters of the predicted pool size distributions relate logically with similar plays?

The responses to these and similar questions may lead to changes in the distribution parameters. This is an iterative process that permits the assessor to challenge the geologic model, consider the feedback from "what if" analyses, and refine the model as new information becomes available. For each play there is a set of μ, σ^2, and N values related to the play's geologic model. Different geological models may have different values for these parameters and thus different pool size distributions.

Once a final acceptable model has been determined, additional modules constrain predicted pool size ranges by the discovered sizes. The subjective process of matching discoveries to the pool size distributions further reduces the uncertainty associated with the potential resource volume of the play. The rank pool size plots and cumulative resource distributions of figures 13 and 14 illustrate this process. Discovered pools are shown as single point values, dots, and projected undiscovered pools as distributions in the form of bars. The length of the bar represents the F_{95} to F_5 estimate of pool size. The undiscovered pool sizes must fit within the discoveries. Figure 13 is an example of a pool rank plot and resource distribution from a very mature progradational play. Contrast this with figure 14, which is an example of an immature play with considerable remaining potential. Notice that in both figures the range of possible sizes for individual pools decreases in proximity to discovered pools. These figures illustrate the greater uncertainty in individual pool sizes and aggregate play resource distributions associated with conceptual and immature plays, which have not been demonstrated to contain significant quantities of hydrocarbons and/or discovered pools. Generally, the greater the number of discoveries in the play the less uncertainty in the number and sizes of undiscovered pools, therefore the less uncertainty in the total quantity of undiscovered resources for the play. The relatively narrow range of values associated with the distribution for the mature play is a reflection of the resource size constraints imposed by the discoveries. A more comprehensive description of PETRIMES is found in Lee and Wang (1990).

Disparate approaches to resource assessment are appropriate for different plays, particularly if, as in the Atlantic and Gulf of Mexico OCS, there are different levels of exploration maturity with very diverse amounts of geophysical, geological, and production data available. In established plays in mature basins the geologic concepts are well understood and the data are both abundant and reliable. At the other end of the spectrum are plays in immature basins where their premise is based solely on regional analysis and comparisons with plays in analog basins. The available data may consist only of regional geophysical information and the results from a few exploratory wells. In the latter situation the extensive database of the mature play is replaced in large part by subjective judgments and experience gained from observations in more mature areas. The key problem in assessing the immature or conceptual play is in the selection of an appropriate analog(s). A suitable analog is an established play that possesses geological attributes similar to the play being assessed. The use of the analog requires subjective modification of the play model through the appropriate scaling of the factors (μ, σ^2, N, and MP_{hc}) affecting the forecast for the play being assessed.

The basic pool level data used in this resource

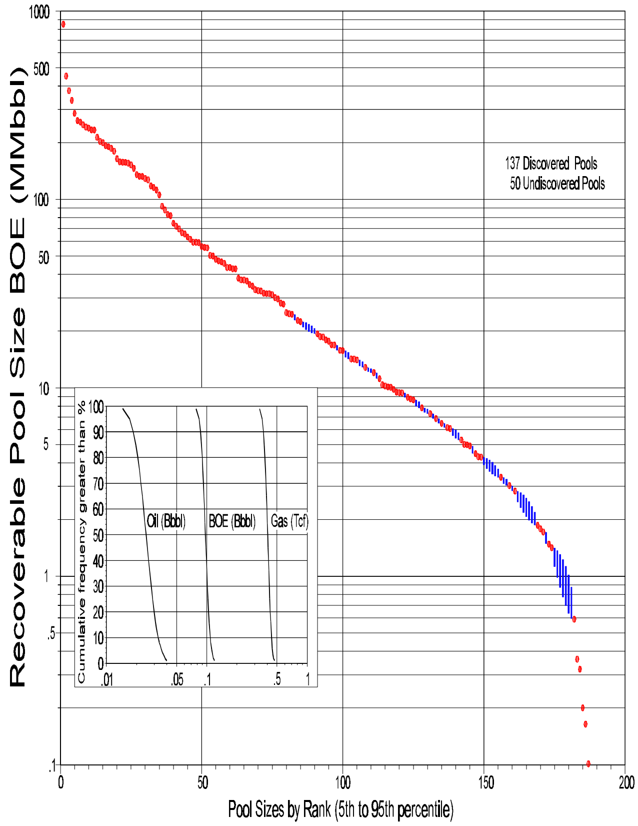

Figure 13. Sample pool rank plot and cumulative resource distribution, mature play.

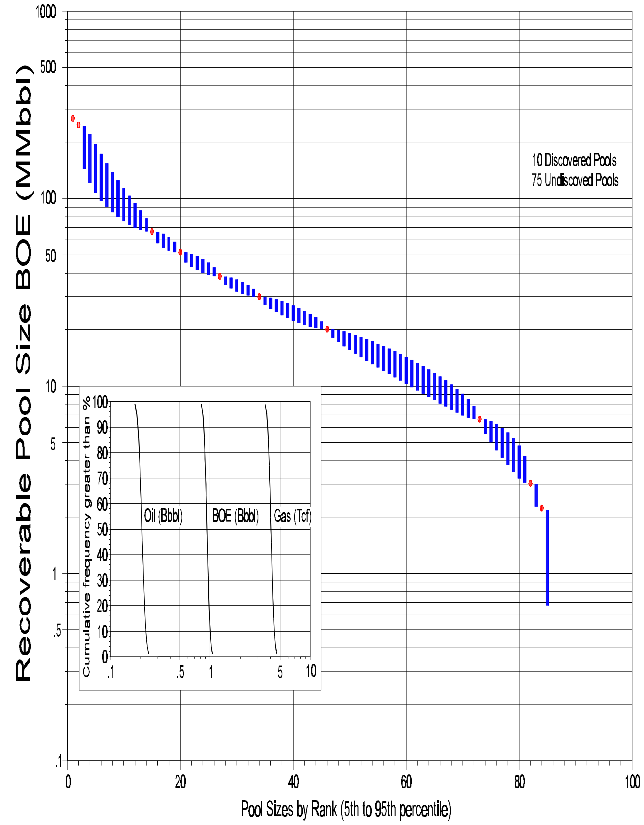

Figure 14. Sample pool rank plot and cumulative resource distribution, immature play.

assessment for the Cenozoic Province of the Gulf of Mexico have been released on the Internet at http://www.mms.gov/omm/gomr/. The Mesozoic provinces of the Gulf of Mexico and Atlantic OCS have a limited amount of direct information available. Only the Upper Jurassic clastic play (Norphlet Formation) in the Gulf of Mexico has more than one significant hydrocarbon accumulation. It was therefore essential to identify analogous plays to properly assess these provinces. Identifying adequate analogs in the Gulf of Mexico Mesozoic Province was not difficult since there has been an extensive record of exploration onshore within the Mesozoic section. Two analog areas were identified as possible models for assessing the clastic plays in the Atlantic OCS: the onshore U.S. Gulf Coast and the Scotian Shelf offshore Canada. The carbonate plays in the Atlantic were modeled using the Gulf Coast carbonate plays as analogs with subjective judgment to appropriately scale the parameters of the pool size distributions.

Serendipitous plays, those found as surprises, were not considered in this assessment. These unknown plays do not have a geologic model that can be logically assessed, and rather than add resources without a framework to determine where and how much, these potential resources were not included.

Cumulative probability distributions of undiscovered conventionally recoverable resources for areas larger than the play were developed by statistically aggregating the probability distributions for individual plays to progressively higher levels using the computer program FASPAGG (Fast Appraisal System for Petroleum AGGregation) (Crovelli, 1986; Crovelli and Balay, 1986). The aggregation hierarchy was play, chronozone, series, system, era, region, and the combined Gulf of Mexico and Atlantic continental margin. An estimate of the degree of geologic dependency was incorporated at each level of aggregation. For instance, plays were aggregated within chronozones on the basis of estimates of the geologic dependence among the plays. The dependence reflects commonality among the plays with respect to factors controlling the occurrence of hydrocarbons at the play level: charge, reservoir, and trap. Dependencies also reflect the degree of coexistence among the plays. Values for dependency can range from one, in which case each play would not exist if the other(s) did not exist, to zero, in which case the existence of each play is totally independent from all others. A very accurate dependency value is impossible to derive because of the geological complexity of the plays. Therefore, a dependency value of 0.5 was generally used for all aggregations except when regions were aggregated. Regions were assumed to be independent.

Undiscovered Economically Recoverable Resources

The objective of the economic analysis phase of the assessment was to estimate the portion of the undiscovered conventionally recoverable resources that is expected to be commercially viable in the long term under a specific set of economic conditions. The profitability of a newly discovered field depends on its expected size, oil and gas mix, depth, location, production characteristics, and the point in time at which profitability is measured. Commercial viability or profitability is measured in this study from the two perspectives referred to as full- and half-cycle analysis. Full-cycle analysis considers all leasehold, geophysical, geological, and exploration costs incurred subsequent to a decision to explore in determining the economic viability of a prospect. The decision point is whether or not to explore. However, in the exploration process, fields are often discovered that cannot support both exploration and development costs. Some of these fields can be profitably developed once discovered. In a half-cycle analysis, leasehold and exploration costs, as well as delineation costs that are incurred prior to the field development decision, are assumed to be sunk and are not used in the discounted cash flow calculations to determine whether a field is commercially viable. The decision point is whether or not to proceed with development. It is assumed in this analysis that the operator is a rational decisionmaker; an investment will not be undertaken unless the full costs of the venture are recovered.

Profitability in this assessment was an expected positive aftertax net present worth determined by discounting all future cash flows back to the appropriate decision point (to explore or to develop and produce) at a 12-percent discount rate. In neither the full- nor the half-cycle scenario is lease acquisition or other pre-decision point leasehold costs considered in the evaluation. The economic analysis involves determining, under each scenario, the marginal profitable pool size, which is defined to yield exactly a 12-percent rate of return. Pools larger than this size yield greater rates of return. The basic economic test is performed at the prospect level with regional transportation infrastructure considered at the area level.

Since the marginal pool is generally found at the smaller end of the pool size distribution, if this size is significantly in error the impact on the overall assessment is not likely to be substantiative. Moreover, the half-cycle analysis, which treats lease acquisition, exploration, and delineation costs as sunk, recognizes the smaller pool that would be economic to develop and produce once found. However, except under rare circumstances, these pools would not typically be exploration targets. Therefore, the expected total economic resource should be somewhere between the comparable full- and half-cycle analysis results.

The ranked pool size distributions and the geologic risk factors ($1\text{-}MP_{hc}$) generated by GRASP are the key geologic inputs to the PRESTO (Probabilistic Resource ESTimates— Offshore) economic model. The Gulf of Mexico and Atlantic Regions both contain "stacked plays," i.e., plays that overlie other plays at different depths. In determining the economic viability of such plays, assessors considered the concurrent exploration, development, and production of possible pools in these plays to properly determine the economic viability of the prospect's resources. If stacked plays were not considered, the estimates of undiscovered economically recoverable resources would be overly conservative.

Exploration and development scenarios, assumptions about the timing and cost of exploration, delineation, development, and transportation activities, were developed specifically for each region, province, planning area, and water depth category. These scenarios were based upon logical sequences of events that incorporated past experience, current conditions, and foreseeable development strategies.

Estimates of the undiscovered economically recoverable resources were then derived through a stochastic discounted cash flow simulation process (figure 12), using either a full- or half-cycle approach, for specific product prices by:

- subjecting each play's pool size distributions to a simulated drilling of the geologic prospects, thus determining which prospects and sizes are simulated to be "discovered" on each iteration;
- determining the profitability of each "discovered" prospect in a play using discounted cash flow analysis;
- developing an aggregate discounted cash flow analysis for the play's "discovered" resources;
- determining if the play's total resources are sufficient to cover shared transportation costs to the regional system;
- determining if the "economic" resources for the

area/region will cover the transportation of all products to market;
- judging all resources uneconomic if the appropriate economic test is failed;
- summing the resources that exceed the economic hurdles, then storing the volumes as a distribution of undiscovered economically recoverable resources at that specific price; and
- repeating the process for 1,000 iterations at numerous prices and then generating a distribution curve.

The estimates of undiscovered economically recoverable resources were developed using the following economic criteria:

- 3-percent inflation rate
- constant real oil and gas prices (no real price changes)
- 12-percent discount rate (aftertax rate-of-return)
- 35-percent Federal income tax rate
- 12.5-percent or 16.7-percent royalty rate, as appropriate[1]
- natural gas prices related to oil prices at 66 percent of the oil energy equivalent price
- exploration, development, and transportation costs and tariffs with their associated development scheduling scenarios for each relevant area.

Estimates of undiscovered economically recoverable resources are sensitive to price and technology assumptions and are presented primarily as price-supply curves (figure 15), which describe a functional relationship between economically recoverable resources and product price. The price-supply curves developed in this assessment are marginal cost curves representing the incremental costs per unit of cumulative output (undiscovered economically recoverable resources). The price-supply curves portray the estimated quantity of undiscovered conventionally recoverable resources that could be profitably produced under a specific set of economic, cost, and technological assumptions. The curves are unconstrained by alternative sources of hydrocarbons (investment opportunities or market supply and demand) or the effects of time in these analyses. Generally, price and cost (technology) can be considered as equal substitutions for one another. It should be noted that entire resource distributions are generated at each price level, but all of the price-supply curves presented in this report will be the mean case curves.

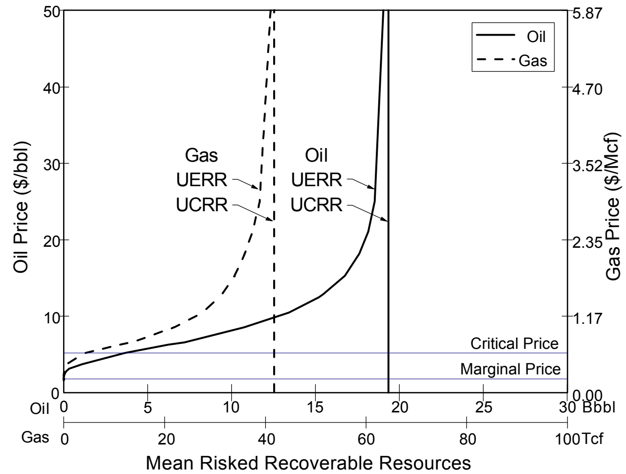

Figure 15. Sample price-supply curve.

Shown are separate curves for oil and gas resources. The two commodity prices are displayed on the y-axes, and a horizontal line drawn from the price axis to the curve yields the quantity of economically recoverable resources at the selected price. The curves represent mean values at any specific price. It is important that the user realize that the oil and gas prices are not independent. That is, one specific oil price cannot be used to obtain an oil resource, and a separate gas price used to determine a gas resource. The gas price is dependent on the oil price and the two must be used in tandem to calculate resource volumes. Furthermore, the two hydrocarbons frequently occur together and the individual pool economics are calculated using the coupled pricing.

Two horizontal lines within the graph indicate the critical and marginal prices. Values above the critical price indicate that there was at least one prospect that was simulated as economic at these prices on each trial. Below the marginal price, no prospects were commercially viable. At prices between the critical and the marginal price, a prospect was determined to be economic on some iterations. The two vertical lines indicate the mean estimates of undiscovered conventionally recoverable natural gas and oil resources. As prices increase, the estimate of

[1] The royalty rates used in the economic analysis were those in effect as of the date of the assessment, January 1, 1995. The Deep Water Royalty Relief Act was signed into law on November 28, 1995; therefore, the impact of this legislation on the profitability of eligible fields is not considered in this resource assessment.

economically recoverable resources approaches this limit. A more detailed description of the PRESTO model and its use in the National Assessment is contained in MMS (1996).

ASSESSMENT RESULTS

The results of this assessment are presented primarily at the province and region level in this report. The Gulf of Mexico Region consists of two provinces: the Cenozoic and the Mesozoic; and four planning areas: Western Gulf of Mexico, Central Gulf of Mexico, Eastern Gulf of Mexico, and the Straits of Florida. The Atlantic Region consists of one province, the Mesozoic; and three planning areas: North Atlantic, Mid-Atlantic, and South Atlantic. The total hydrocarbon endowment of the Gulf of Mexico and Atlantic continental margin is presented by region, province, and water depth in Appendix D, and by region, planning area, and water depth in Appendix E.

Reserves

Tables 3 and 4 present the results of the assessment of conventionally recoverable petroleum resources of the Gulf of Mexico and Atlantic continental margin. The original proved reserves in the 876 proved fields within the entire Gulf of Mexico Region are estimated to be 11.86 Bbo of oil and 141.90 Tcfg; 157 fields were classified as oil and 719 as gas fields (Melancon et al., 1995). Included are 133 fields that are depleted and abandoned. Nearly 100 percent of the oil and 99 percent of the gas original proved reserves are within the Cenozoic Province. With the exception of thesmall, abandoned Main Pass Block 253 field, all of the original proved reserves in the Mesozoic Province are in the Upper Jurassic Norphlet clastic play. At yearend 1994, original proved reserves in the OCS portion of the Norphlet play were estimated to be 1.57 Tcfg and 0.12 MMbbl of condensate.

There are 77 active unproved fields in the Gulf of Mexico Region. Preliminary estimates of unproved reserves in these fields are 0.89 Bbo and 4.71 Tcfg. Approximately 100 percent of the oil and 87 percent of the gas unproved reserves are located within the Cenozoic Province. Unproved reserves within the Norphlet clastic play are 0.45 Tcfg and 0.04 MMbbl of condensate. There are no reserves identified in the Atlantic Mesozoic Province.

Hydrocarbon reserves are unevenly distributed in terms of depositional style and age. Table 4 and figure 16 present the distribution of reserves and undiscovered conventionally recoverable resources by depositional style in the Gulf of Mexico Province.

Table 4. Reserves and undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin by depositional style and lithology. (Note: Summation of individual resource values may differ from total due to independent computer runs and rounding.)

	Reserves												Risked Undiscovered Conventionally Recoverable Resources									
	Cumulative Production			Remaining Proved			Appreciation			Unproved			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
Gulf of Mexico Region	9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	6.038	8.344	11.138	82.323	95.661	110.286	21.218	25.366	29.990
Cenozoic Province	9.339	112.440	29.346	2.516	27.885	7.478	2.238	31.564	7.854	0.885	4.117	1.617	1.00	4.428	6.291	8.584	74.766	87.553	101.639	18.199	21.870	25.977
Retrogradational	0.115	3.289	0.700	0.023	0.599	0.130	0.012	0.934	0.178	0.000	0.000	0.000	1.00	0.016	0.027	0.041	0.680	0.812	0.960	0.141	0.171	0.205
Aggradational	0.980	6.537	2.143	0.104	1.699	0.406	0.047	1.644	0.340	<0.001	0.005	0.001	1.00	0.036	0.062	0.096	1.073	1.280	1.511	0.237	0.290	0.349
Progradational	6.687	83.554	21.554	1.163	15.831	3.980	0.971	18.487	4.260	0.061	0.492	0.148	1.00	0.502	0.673	0.876	14.699	16.651	18.760	3.205	3.636	4.101
Fan	1.526	16.902	4.533	1.190	8.705	2.739	1.193	9.126	2.817	0.824	3.568	1.459	1.00	3.942	4.723	5.594	52.390	61.645	71.869	13.594	15.692	17.982
Other	0.031	2.158	0.416	0.036	1.051	0.223	0.015	1.373	0.259	<0.001	0.052	0.009	1.00	0.128	0.807	2.335	3.994	7.164	11.576	0.730	2.082	4.405
Mesozoic Province	<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	0.001	0.596	0.107	1.00	1.360	2.053	2.933	7.106	8.108	9.194	2.678	3.495	4.455
Clastics	<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	<0.001	0.446	0.079	1.00	0.374	0.674	1.090	6.491	7.301	8.172	1.550	1.973	2.461
Carbonates	<0.001	<0.001	<0.001	0.000	0.000	0.000	<0.001	<0.001	<0.001	0.001	0.150	0.028	1.00	0.908	1.379	1.981	0.511	0.807	1.191	1.025	1.523	2.150
Atlantic Region	0	0	0	0	0	0	0	0	0	0	0	0	N/A	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Mesozoic Province	0	0	0	0	0	0	0	0	0	0	0	0	N/A	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
Clastics	0	0	0	0	0	0	0	0	0	0	0	0	N/A	1.282	1.943	2.784	14.697	25.612	40.575	4.231	6.500	9.413
Carbonates	0	0	0	0	0	0	0	0	0	0	0	0	N/A	0.000	0.329	1.037	0.000	1.868	4.351	0.000	0.661	1.782

Historically, the progradational sands have been the most prolific producers of oil and gas. Sixty-six percent of the oil (7.85 Bbo) and 71 percent of the gas (99.39 Tcf) original proved reserves occur in progradational sands. An additional 0.97 Bbo and 18.49 Tcfg are projected to be added through reserves appreciation to reservoirs currently producing from progradational deposits. The progradational depositional style results in favorable associations of reservoir, source, and seal; and is characterized by alternating reservoir-quality sandstones and thick sealing shales. Progradational deposits coincide with areas having large growth faults, rollover anticlines, and diapiric salt. All of these factors contribute to the high productivity of these sediments (Seni et al., 1994). Fan deposits rank next in demonstrated productivity with 23 (2.72 Bbo) and 18 (25.61 Tcfg) percent, respectively, of the original proved oil and gas reserves and anticipated reserves growth of an additional 1.19 Bbo and 9.13 Tcfg . Reflecting their increasing importance in the reserves base, the fan-type deposits contain the largest amounts of unproved reserves of oil and gas, more than 0.82 Bbo and 3.57 Tcfg. Aggradational style deposits contain 9 percent of the oil (1.08 Bbo) and 5 percent of the gas (8.24 Tcfg) original proved reserves. The remaining 2 percent of the oil (0.21 Bbo) and 5 percent of the gas (7.10 Tcfg) proved reserves are within the retrogradational or combination style deposits.

Proved reserves have been discovered in the Gulf of Mexico Region in sediments ranging in age from Upper Jurassic to Pleistocene (table 3, figure 17). Miocene age sediments are the most prolific to date, containing original proved reserves of 4.13 Bbo and 61.47 Tcfg, or 35 and 43 percent, respectively, of the region total. Pleistocene reservoirs are next with 4.32 Bbo (36 percent) and 57.14 Tcfg (40 percent). Pliocene age deposits contain 3.41 Bbo (29 percent) and 21.72 Tcfg (15 percent) of the original proved reserves with a significant, but relatively minor amount of gas present in Upper Jurassic sediments.

Reserves Appreciation

Since reserves appreciation in the Gulf of Mexico OCS has routinely exceeded new field discoveries and contributed the bulk of annual additions to proved reserves, it must be an important consideration in any analysis of future oil and gas

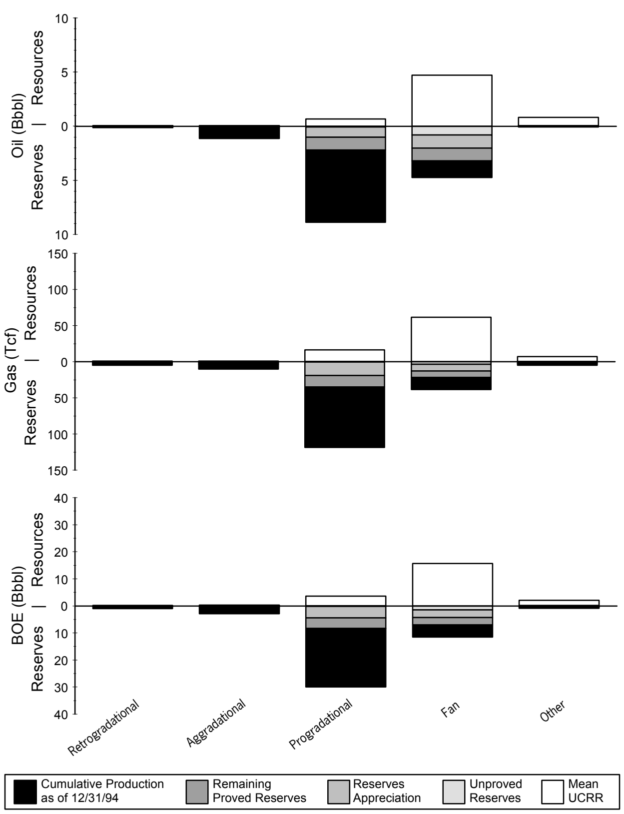

Figure 16. Total hydrocarbon endowment by depositional style, Gulf of Mexico Cenozoic Province.

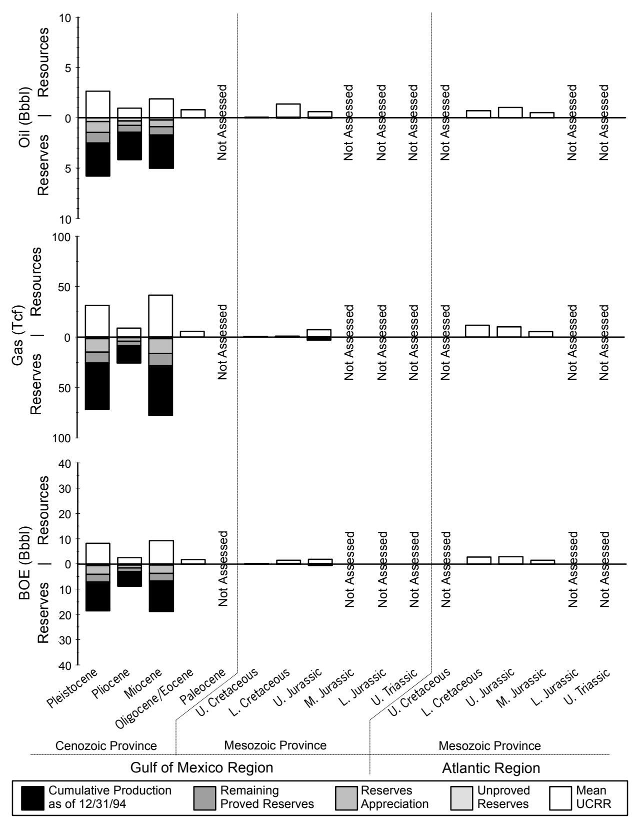

Figure 17. Total hydrocarbon endowment by age, Gulf of Mexico and Atlantic continental margin.

supplies. This study estimates reserves appreciation through the year 2020 in the 743 active fields in the Gulf of Mexico OCS with remaining proved reserves as of yearend 1994 to be 2.24 Bbo and 32.72 Tcfg (table 3). This estimate compares favorably to the yearend 1994 estimates of remaining proved reserves, which are 2.52 Bbo and 29.26 Tcfg. Of the reserves appreciation, all but 1.16 Tcfg and 2.25 MMbbls of condensate are attributable to fields in the Cenozoic Province. Since there are no proved reserves in the Atlantic Mesozoic Province, there is no reserves appreciation.

OCS fields were not projected to grow appreciably beyond 50 years after discovery. On balance, the model used in this assessment of reserves appreciation is apt to be conservative. The oldest fields are generally the largest, contribute the bulk of the original proved reserves, and are also most likely to experience growth beyond 50 years of age. Although the total volume of hydrocarbons presumed to be available through future reserves growth is substantial, the resources associated with this phenomenon are attainable only in relatively small increments.

The effects of incorporating reserves appreciation explicitly into the assessment process are rather subtle. In mature plays with reasonably complete pool size distributions, the commonly older large accumulations are not projected to experience significant growth as expressed as a percentage of the current estimate of field size. Consistent with the concept of resource exhaustion, smaller accumulations, which are generally younger, experience proportionately more appreciation and grow to fill "gaps" in the pool size distribution, leaving behind gaps in their old, smaller size position in the distribution. This occurs with all pools throughout the distribution. Conversely, in immature plays the overall empirical distribution is not well developed. The largest pools will be projected to experience significant appreciation, creating gaps in the projected pool size distribution, which will then accommodate significant-sized pools. The effect of explicitly considering reserves appreciation is that an assessment for an active, mature play that acknowledges reserves growth will tend to result in a smaller estimate of resources remaining to be discovered than one that does not incorporate the reserves appreciation phenomenon. Alternatively, a resource assessment for moderately mature to immature plays will project larger quantities of undiscovered resources when appreciation is considered.

Undiscovered Conventionally Recoverable Resources

The Gulf of Mexico and Atlantic continental margin is estimated to contain, at the mean level, undiscovered conventionally recoverable resources of 10.62 Bbo and 123.14 Tcfg. Total hydrocarbon volumes range from 8.02 to 13.69 Bbo and 104.29 to 144.01 Tcfg (figure 18, table 1). The Gulf of Mexico Region is projected to contain about 78 percent of the mean oil and gas resources.

Gulf of Mexico Region

Plays were assessed in 14 chronozones in the Cenozoic Province and 3 chronozones in the Mesozoic Province. The mean level assessment of undiscovered conventionally recoverable resources for the Gulf of Mexico Region is 8.34 Bbo and 95.66 Tcfg. The 95th percentile resource estimates are 6.04 Bbo and 82.32 Tcfg, and the 5th percentile estimates, 11.14 Bbo and 110.29 Tcfg. The Cenozoic Province is forecast, at the mean level, to contain 75 percent of the oil and 92 percent of the gas undiscovered resources in the region.

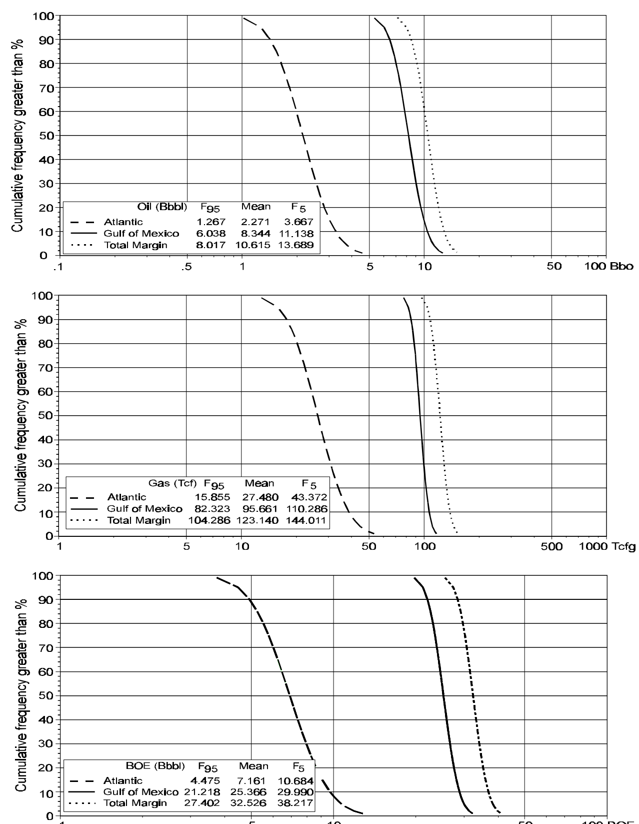

Figure 18. Cumulative probability distributions of undiscovered conventionally recoverable resources, Gulf of Mexico and Atlantic continental margin.

Gulf of Mexico Cenozoic Province

A potential 6.29 Bbo and 87.55 Tcfg in undiscovered conventionally recoverable resources is expected in the Cenozoic Province (table 3). The ranges are 4.43 to 8.58 Bbo and 74.77 to 101.64 Tcfg. The greatest amount of undiscovered conventionally recoverable resources is anticipated to occur in the fans (table 4, figure 19). The mean values for fan deposits are 4.72 Bbo and 61.65 Tcfg. Values range from 3.94 to 5.59 Bbo and from 52.39 to 71.87 Tcfg. Second to the fans are the progradational sands with mean values for resources of 0.67 Bbo and 16.65 Tcfg. The 95th and 5th percentile values are 0.50 and 0.88 Bbo and 14.70 to 18.76 Tcfg. Contrasted with the distribution of original proved reserves, the fan facies are expected to contain 75 and 70 percent, respectively, of the undiscovered conventionally recoverable oil and gas resources, and the more thoroughly explored progradational facies only 11 and 19 percent, respectively (table 4, figure 19). Fan deposits are less explored, occurring in deeper water or below historical depths of exploration on the shelf. Successful play and prospect models capable of significantly reducing the uncertainty and risk associated with these targets have only recently become widely available.

Table 3 and figure 20 present the assessment results at the series level. The Pleistocene Series contains the greatest amount of oil resources, 2.65 Bbo at the mean level (42 percent of the total Cenozoic Province oil resource), and the Miocene Series the greatest potential for additional gas, 41.49 Tcfg (47 percent of the province total). The corresponding 95th and 5th percentiles for the Pleistocene are 2.06 and 3.33 Bbo, and for the Miocene 35.28 and 48.34 Tcfg.

Gulf of Mexico Mesozoic Province

The Gulf of Mexico Mesozoic Province is assessed to have mean undiscovered conventionally recoverable resources of approximately 2.05 Bbo and 8.11 Tcfg or 3.50 BBOE (table 3). Figure 20 depicts the distribution of the undiscovered conventionally recoverable resources of the province by series. The Cretaceous System represents 46 percent and the Jurassic System 54 percent of the total. Carbonate rocks are expected to contain 44 percent and clastic rocks 56 percent of the undiscovered conventionally recoverable resources (table 4, figure 21). Areas of potential discoveries extend from the Mississippi,

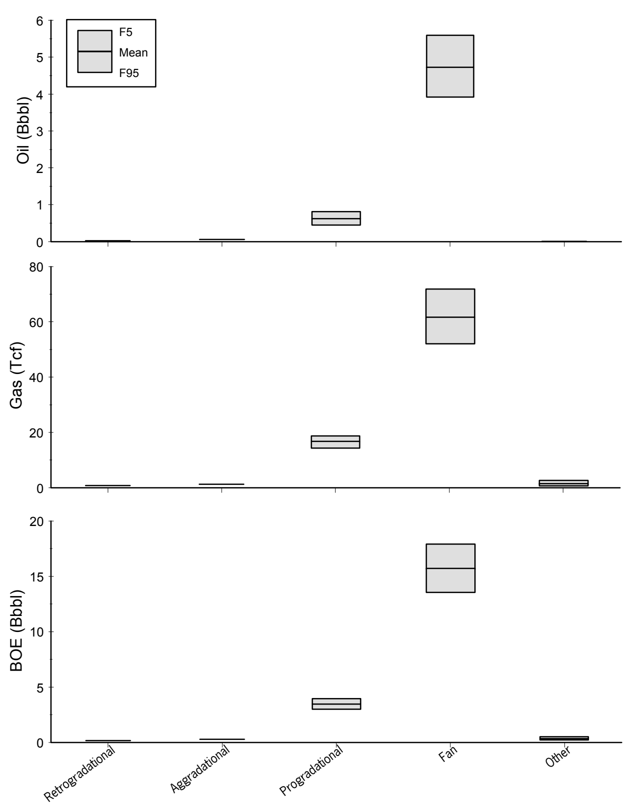

Figure 19. Undiscovered conventionally recoverable resources by depositional style, Gulf of Mexico Cenozoic Province.

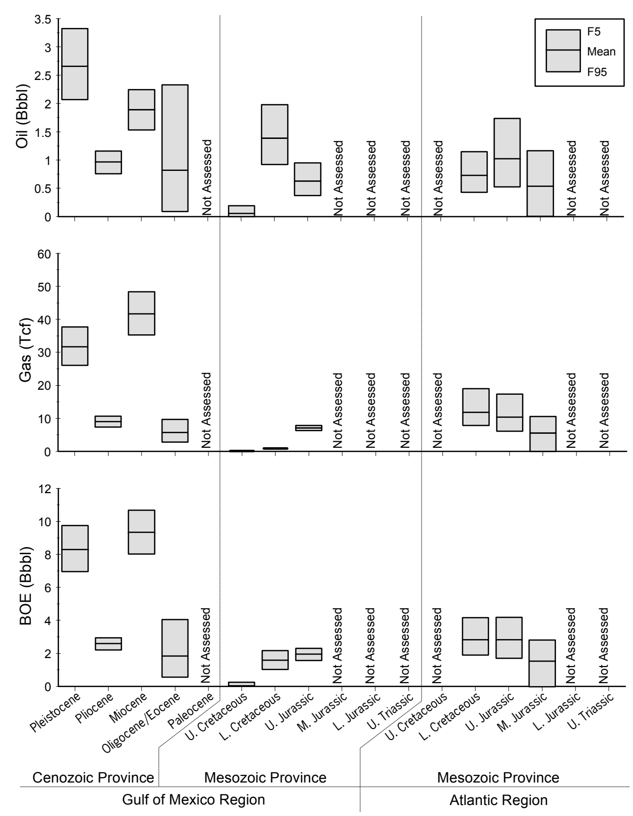

Figure 20. Undiscovered conventionally recoverable resources by age, Gulf of Mexico and Atlantic continental margin.

Alabama, and Florida State-Federal boundaries through the Tampa and South Florida Basins to the U.S.-Cuba International Boundary.

The greatest amount of undiscovered conventionally recoverable resources is expected to occur in Upper Jurassic clastic sediments of the Norphlet Formation. These resources are mainly gas, with 7.12 Tcfg and 0.59 Bbo at the mean value. Values for the 95th and 5th percentiles are 6.47 and 7.81 Tcfg and 0.36 and 0.86 Bbo. This represents, at the mean value, 88 percent of the province total for gas and 29 percent for oil. Second in magnitude to the Upper Jurassic clastic resources are Lower Cretaceous carbonates, which briefly produced in the Main Pass Block 253 field. These resources are chiefly oil, with 1.35 Bbo (66 percent) and 0.76 Tcfg (9 percent) projected at the mean value. The estimates range from 0.91 to 1.90 Bbo and 0.49 to 1.10 Tcfg.

Lower Cretaceous age sediments have the greatest potential for oil, 1.39 Bbo, and Upper Jurassic the greatest potential for gas, 7.17 Tcfg, at the mean value. These estimates represent, at the mean value, 68 percent of the undiscovered conventionally recoverable resources for oil and 88 percent for gas. The corresponding range for the Lower Cretaceous is 0.92 to 1.98 Bbo and for the Upper Jurassic 6.49 to 7.89 Tcfg.

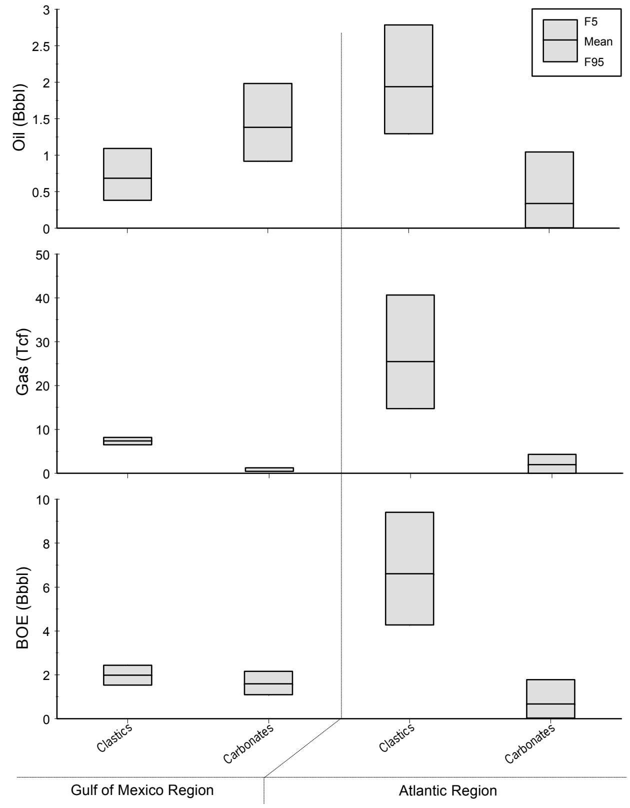

Figure 21. Undiscovered conventionally recoverable resources by lithology, Gulf of Mexico and Atlantic Mesozoic Provinces.

Atlantic Region

The Atlantic Region consists of a single geologic province, the Atlantic Mesozoic Province, which is estimated to have, at the mean level, undiscovered conventionally recoverable resources of approximately 2.27 Bbo and 27.48 Tcfg (7.16 BBOE). Sixty-eight percent of the total resource is gas (table 3). The Cretaceous System contains 39 percent and the Jurassic System 61 percent of the total undiscovered resource. Carbonate rocks are projected to contain 9 percent and clastic rocks 91 percent of the total resources (table 4, figure 21).

The greatest amount of undiscovered conventionally recoverable resources is expected to occur in Lower Cretaceous clastic sediments with 0.72 Bbo and 11.77 Tcfg at the mean value. This represents 43 and 33 percent of the undiscovered conventionally recoverable resources for oil and gas. Values for the 95th and 5th percentiles are 0.43 and 1.14 Bbo and 7.84 and 18.81 Tcfg. Second in magnitude to the Lower Cretaceous clastic resources are Upper Jurassic clastic sediments, containing mainly gas, with 0.82 Bbo and 8.95 Tcfg at the mean value. These estimates comprise 36 percent of the undiscovered conventionally recoverable oil resources and 33 percent of the gas resources. The estimates range from 0.55 to 1.15 Bbo and 6.40 to 13.27 Tcfg.

Upper Jurassic reservoirs have the greatest potential for oil, 1.02 Bbo, and Lower Cretaceous the greatest potential for gas, 11.77 Tcfg, at the mean value. This represents, at the mean level, 45 percent of the undiscovered conventionally recoverable resources for oil, and 43 percent for gas. The corresponding 95th and 5th percentiles for the Upper Jurassic Series are 0.53 Bbo and 1.73 Bbo and for the Lower Cretaceous 7.84 Tcfg and 18.81 Tcfg.

Undiscovered Economically Recoverable Resources

Results of the assessment are reported here at the province and region level. Included in appendices D and E are the results of the economic analysis by region, planning area, and water depth. Table 2 presents the mean results of the economic analysis at two discrete price levels, a base case of $18.00 per bbl and $2.11 per Mcf, roughly approximating current prices, and a high case corresponding to historical high prices of $30.00 per bbl and $3.52 per Mcf.

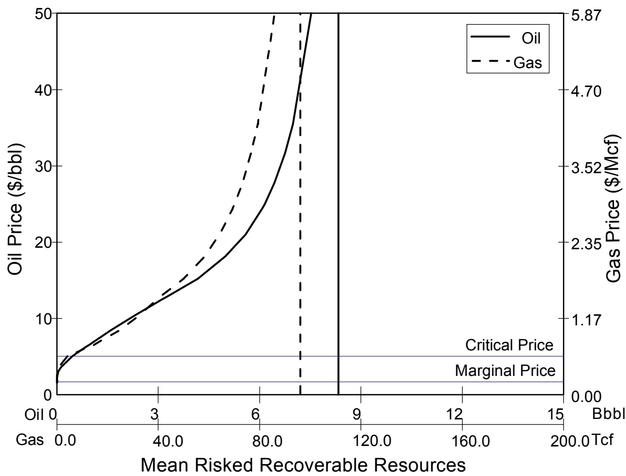

Figure 22. Mean full-cycle price-supply curve, Gulf of Mexico Region.

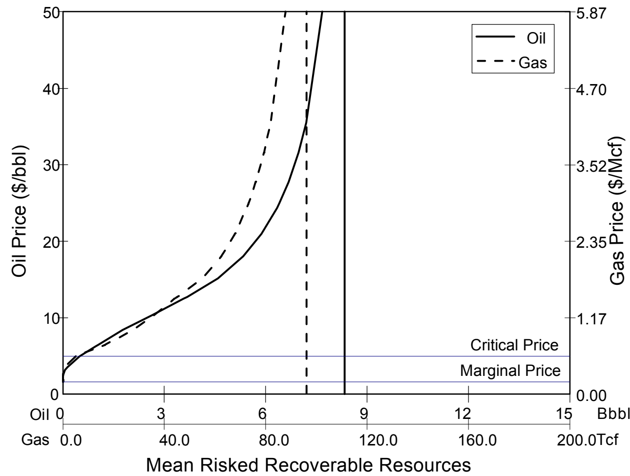

Figure 23. Mean half-cycle price-supply curve, Gulf of Mexico Region.

The results of the base case full-cycle analysis project, at the mean level, undiscovered economically recoverable resources of 5.35 Bbo and 63.30 Tcfg for the entire Gulf of Mexico and Atlantic continental margin, representing about half of the estimate of undiscovered conventionally recoverable oil and gas resources. This estimate increases in the high case to 7.67 Bbo and 85.68 Tcfg. Half-cycle considerations only modestly increase the mean estimates to 5.78 Bbo and 68.46 Tcfg in the base case and 8.08 Bbo and 89.90 Tcfg in the high case.

Approximately 92 percent of the undiscovered economically recoverable petroleum resources in the full-cycle base case scenario are projected in the Gulf of Mexico Region. In the full-cycle high price scenario the relatively higher cost resources in the Atlantic Region become economic and the Gulf of Mexico contribution decreases slightly to 87 percent.

Gulf of Mexico Region

Figure 22 is the mean full-cycle price-supply curve for the Gulf of Mexico Region. The vertical lines represent the mean estimate of undiscovered conventionally recoverable oil and gas, 8.34 Bbo and 95.66 Tcfg, respectively. Over the range of historical oil and gas prices, the curves rapidly approach the estimate of undiscovered conventionally recoverable oil and gas. At a base case price scenario 59 percent of the undiscovered conventionally recoverable oil and 61 percent of the gas are economic. This increases to about 80 percent for both oil and gas at the higher price scenario. More than 1.70 Bbo and 20.36 Tcfg of the undiscovered conventionally recoverable resources require prices above historical highs to be recovered profitably.

Figure 23 is the mean half-cycle price-supply curve for the Gulf of Mexico Region. At the base case price scenario about 60 percent of the undiscovered conventionally recoverable oil and gas resources are economic. This increases to 79 percent at the higher price scenario. The percent increase in economically recoverable resources from the full- to the half-cycle analysis is relatively small, ranging from just over 3 percent to about 7.5 percent. The smallest increase occurs in well-explored, mature areas (i.e., shallow-water Central Gulf of Mexico) where the necessary exploration and delineation costs compared to development costs may be minimal for the marginal pool size. The largest increases occur in frontier areas where a more extensive exploration and delineation program is required to justify development. There is less of a difference between the full- and half-cycle analyses in the high case than in the base case because the size of the marginal pool in the high case is not affected by removing consideration of exploration and delineation costs to the same extent as in the lower price scenario. The smaller the marginal pool size the greater the number of potentially economic pools at each price scenario.

Atlantic Region

The picture is significantly different for the Atlantic Region. The full-cycle price-supply curve for the Atlantic Region (figure 24) is much steeper than the comparable Gulf of Mexico Region curve (figure 22). Over the range of historical oil and gas prices the estimates of economically recoverable resources do not approach the mean estimates of undiscovered

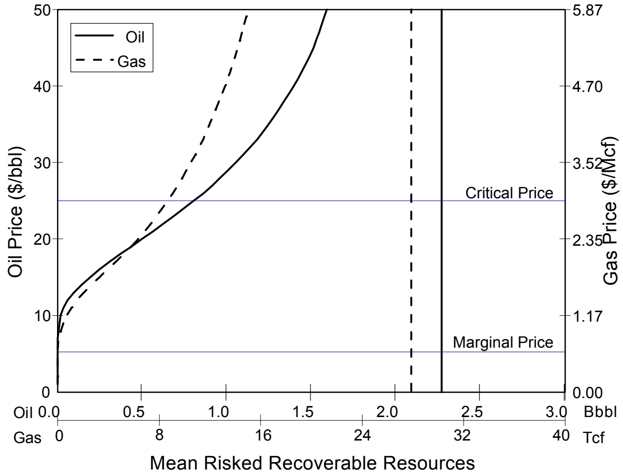

Figure 24. Mean full-cycle price-supply curve, Atlantic Region.

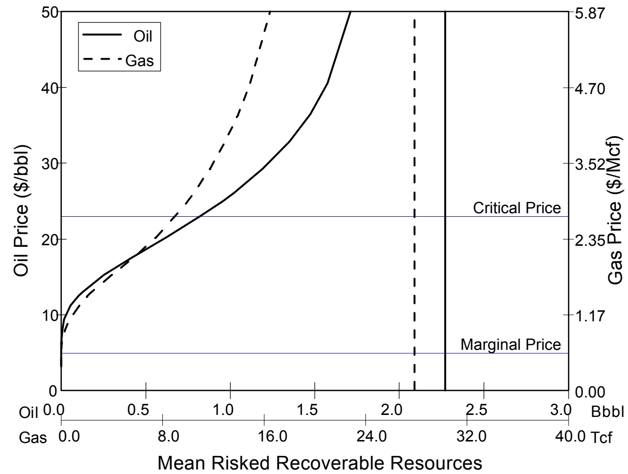

Figure 25. Mean half-cycle price-supply curve, Atlantic Region.

conventionally recoverable oil and gas resources. The marginal price in the Atlantic is $5.20 per bbl and $0.60 per Mcf, similar to the critical price in the Gulf of Mexico. The critical price in the Atlantic Region is significantly higher, $25.00 per bbl and $2.95 per Mcf. This dramatically illustrates the impact of a lack of regional transportation infrastructure and the relatively low potential in the lower cost, shallow-water nearshore areas. Table 2 presents the mean results of the economic analysis at the two discrete price levels. At the base case price scenario only 16 percent of the undiscovered conventionally recoverable oil (0.37 Bbo) and 19 percent of the gas (5.20 Tcfg) are economic. This increases to 47 and 38 percent (1.06 Bbo and 10.48 Tcfg), respectively, at the higher price scenario.

Figure 25 presents the half-cycle price-supply curves. The marginal price in the Atlantic is $4.90 per bbl and $0.60 per Mcf. The critical price is significantly higher, $22.95 per bbl and $2.70 per Mcf. In the base case half-cycle scenario, the mean estimate of economically recoverable resources increases by 84 MMbo and 786 Bcfg over the full-cycle analysis. At the base case price scenario 20 percent of the undiscovered conventionally recoverable oil (0.45 Bbo) and 22 percent of the gas (5.99 Tcfg) are economic. This increases to 54 and 44 percent (1.23 Bbo and 11.97 Tcfg), respectively, at the higher price scenario.

The percent increase in economically recoverable resources from the mean full- to half-cycle analysis is much larger than in the Gulf of Mexico Region, ranging from just over 14 percent to almost 23 percent. This is the result of the Atlantic Region being a frontier area requiring a much more extensive, time consuming, and expensive exploration and delineation program than the Gulf of Mexico. As such, the removal of the exploration and delineation scenarios with their associated costs and timing has a much greater impact on the marginal pool size in the Atlantic than it does in the Gulf of Mexico Region.

<u>Total Hydrocarbon Endowment</u>

The total hydrocarbon endowment of the Gulf of Mexico and Atlantic continental margin ranges between 23.00 and 28.67 Bbo and 283.62 and 323.34 Tcfg, with a mean estimate of 25.59 Bbo and 302.47 Tcfg (table 1). Figure 26 presents the distribution of the Gulf of Mexico Region total hydrocarbon endowment by resource category. The Gulf of Mexico Region mean endowment is 23.32 Bbo and 274.99 Tcfg, or 72.25 BBOE. Sixty-five percent of the total endowment is in the various reserve categories. Approximately 51 percent is original proved reserves. After nearly 50 years of exploration and development nearly half of the mean endowment is represented by future reserves appreciation and undiscovered conventionally recoverable resources. In the base case full-cycle scenario, 86 percent of the total endowment is economic. This increases to nearly 93 percent at the high case scenario. In the half-cycle analysis 88 percent of the total endowment is economic at the base case and 94 percent in the high case.

Figure 17 displays the distribution of the Gulf of Mexico and Atlantic continental margin total hydrocarbon endowment by geologic age. Pleistocene Series pools are projected to ultimately contain the greatest amount of oil resources in the region, 8.42 Bbbl (mean), and the Miocene Series, with 119.35 Tcf (mean), the largest quantity of gas. Within the Gulf of

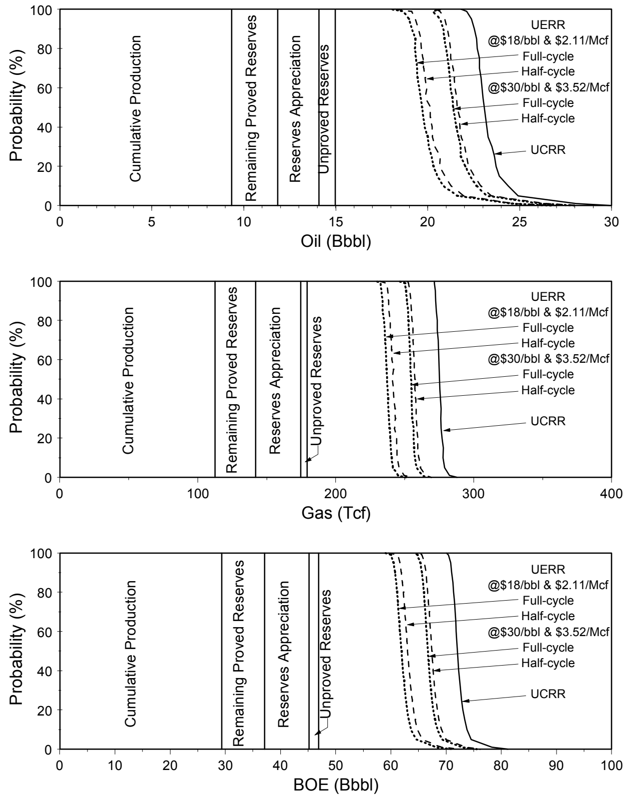

Figure 26. Total hydrocarbon endowment of the Gulf of Mexico Region by resource category.

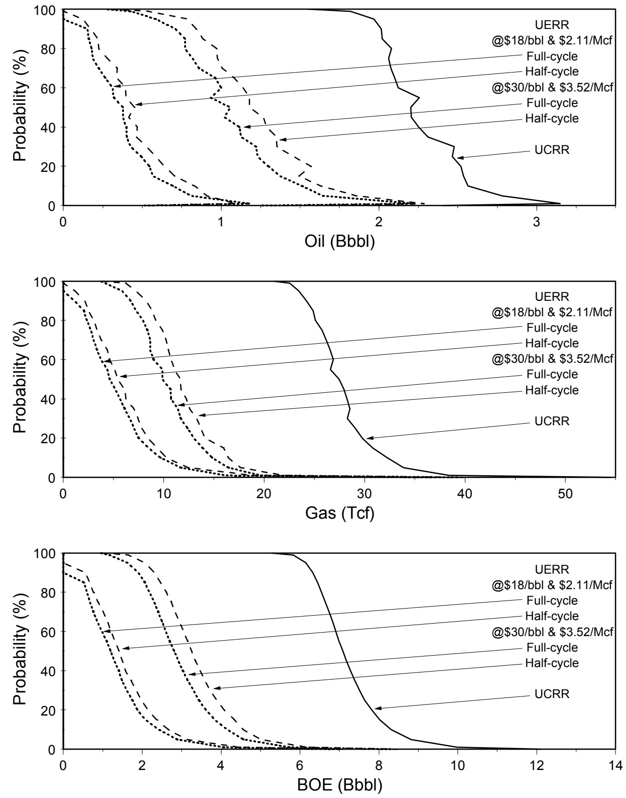

Figure 27. Total hydrocarbon endowment of the Atlantic Region by resource category.

Mexico Mesozoic Province, Lower Cretaceous reservoirs are anticipated to be the largest potential source of oil resources. The currently productive Upper Jurassic Norphlet Formation will continue to contribute the bulk of the ultimate gas resources. Since there are no reserves in the Atlantic Region, the total endowment equals the undiscovered conventionally recoverable resources, which range between 1.27 and 3.67 Bbo and 15.86 and 43.37 Tcfg, with a mean estimate of 2.27 Bbo and 27.48 Tcfg (figure 27). Upper Jurassic deposits are assessed as having the largest oil resource potential, and Lower Cretaceous sediments a slightly higher gas potential.

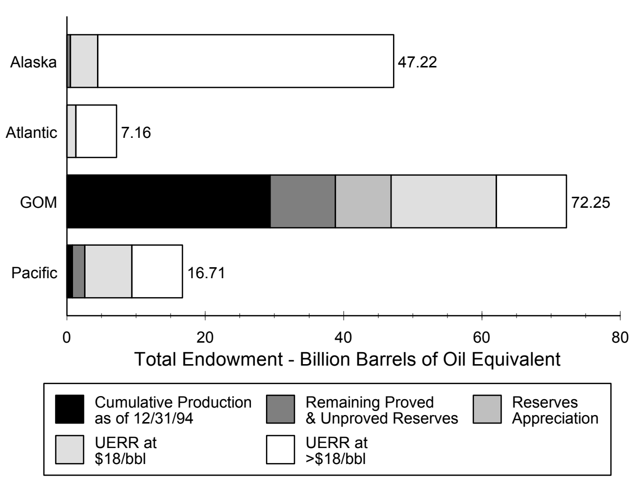

Figure 28. Total hydrocarbon endowment of the OCS Regions by resource category, mean full-cycle analysis.

Comparison with Results for Other OCS Regions

In an attempt to place the resource assessment of the Gulf of Mexico and Atlantic OCS in a national perspective, the total hydrocarbon endowment (mean case, full-cycle analysis) of the entire U.S. OCS is shown in figure 28. The Gulf of Mexico Region is second to the Alaska Region in terms of the potential quantities of undiscovered conventionally recoverable petroleum resources. However, in the Gulf of Mexico Region the various categories of reserves, with 46.89 BBOE, approach the total mean endowment of the Alaska Region. The total mean endowment of the Gulf of Mexico Region is greater than that of all other regions combined, 72.25 versus 71.09 BBOE. The

Gulf of Mexico Region has a larger percentage of both its total endowment, 86 percent, and the undiscovered conventionally recoverable resources, 60 percent, economically recoverable (base case, full-cycle). The Atlantic Region, with a total hydrocarbon endowment of 7.16 BBOE, ranks last of the four OCS regions.

Comparisons With Selected Previous Assessments

Resource assessment is an imprecise science. Uncertainty abounds! There is little in the way of laws and hard-and-fast rules to guide an assessment. The art of the resource assessment employs a multi-faceted analytical procedure. Results are not generally repeatable by different assessors, each using different methodologies, within what most observers would view as reasonable margins of error. There is no single definitive assessment procedure appropriate to all situations that has been demonstrated to be "correct."

If a reviewer is determined to compare petroleum estimates, then to do so properly it is first necessary to ascertain that they cover the same things. They should be identical in terms of:

- commodities assessed,
- categories of resources assessed,
- areas assessed,
- reporting of statistical data, e.g., ranges and probabilities, and
- technological and economic conditions incorporated.

As discussed earlier, the last item may be the most troublesome to deal with since these conditions are rarely explicitly stated or easily measured. Irrespective of modifications in methodology, changes in basic geologic knowledge, economic conditions, and technology make it difficult to compare estimates over time.

Some reviewers of assessments of the same area made by different assessors using different techniques have postulated a relationship between the relative magnitude of the assessment and the methodology employed. Miller (1986) generalized that play analysis methods and those using pool size distributions provide more conservative estimates, and volumetric yield methods produce the more optimistic assessments. The assessments presented in this section were developed using varied assessment techniques.

MMS 1987 versus 1995 Assessment Results

Although the results of this assessment are not directly comparable with previous assessments, comparisons will inevitably be made. This section highlights some of the key differences between this assessment and MMS's previous comprehensive assessment (Cooke and Dellagiarino, 1990). The estimates from the two assessments that are most appropriate for comparison are presented in Table 5.

The methodology employed in 1987 is documented in Cooke and Dellagiarino (1990). It differs most importantly from this assessment in that the technique involved a projection from the largest undiscovered fields "identified" in the economic assessment to the smallest assessed size. These "identified" undiscovered fields were developed from a summation of prospects approach. The 1995 assessment also included discovered appreciated pools as an integral part of the methodology. Both assessments present estimates of undiscovered conventionally recoverable resources and economically recoverable resources under two scenarios. There are other major differences in resource assessment methodologies employed in the economic evaluations, such as use of internal discounted cash flow analysis (1995) versus exogenously determined minimum economic field sizes (1987) and the incorporation of significant changes in economic assumptions, exploration and development costs, and exploitation scenarios, all of which significantly impacted the results. Figure 29 shows the notable differences in economic parameters embodied in the base case for the 1995 assessment and the primary case of the prior MMS assessment. The economic factors having the greatest impact on the results compared with 1987 were the assumption of no real price change and a considerably higher discount rate used in this assessment. Both of these changes resulted in significant downward pressure on the estimate of volumes of undiscovered economically recoverable hydrocarbon resources.

Gulf of Mexico Region

Figure 30 is a comparison of the mean results from the two assessments for the Gulf of Mexico Region. Undiscovered conventionally recoverable resources were referred to as the undiscovered resource base in the 1987 assessment. Comparing the risked mean estimates from the 1987 primary case and 1995 base case half-cycle assessments, the total endowment increased by 10.00 BBOE (2.29 Bbo and 43.32 Tcfg). An additional 9.07 BBOE (2.41 Bbo and 37.46 Tcfg) were produced between the assessments, and remaining proved reserves decreased by 4.31 BBOE (1.36 Bbo

Table 5. Comparison of the results of MMS assessments of conventionally recoverable petroleum resources, 1987 and 1995.

	Gulf of Mexico Region (Including Straits of Florida)			Atlantic Region (Excluding Straits of Florida)		
	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)
Cumulative Production						
1987	6.93	75.18	20.31	0.00	0.00	0.00
1995	9.34	112.64	29.38	0.00	0.00	0.00
Remaining Proved Reserves						
1987	3.88	45.82	12.03	0.00	0.00	0.00
1995	2.52	29.26	7.72	0.00	0.00	0.00
Reserves Appreciation						
1987[1]	0.50	5.75	1.52	0.00	0.00	0.00
1995	2.24	32.72	8.06	0.00	0.00	0.00
Unproved Reserves						
1987	0.07	1.20	0.28	0.00	0.00	0.00
1995	0.89	4.71	1.72	0.00	0.00	0.00
Undiscovered Resource Base						
1987[2]	9.65	103.72	28.11	0.88	16.65	3.84
Undiscovered Conventionally Recoverable Resources						
1995[2]	8.34	95.66	25.37	2.27	27.48	7.16
Undiscovered Economically Recoverable Resources						
Primary Case 1987[2]	5.70	64.44	17.17	0.19	4.40	0.97
Base Case, Half-Cycle 1995[2]	5.31	62.30	16.39	0.45	5.99	1.52
Alternative Case 1987[2]	7.09	78.68	21.09	0.33	6.81	1.54
High Case, Half-Cycle 1995[2]	6.87	78.10	20.76	1.23	11.97	3.36
Total Hydrocarbon Endowment						
1987[1]	21.03	231.67	62.25	0.88	16.65	3.84
1995[1]	23.32	274.99	72.25	2.27	27.48	7.16

Note:
[1] Mean estimate
[2] Risked mean estimate

and 16.56 Tcfg). This represents an overall increase of 4.76 BBOE (1.05 Bbo and 20.90 Tcfg) in the estimates of original proved reserves. Estimates of reserves appreciation in 1987 were developed by direct subjective assessment. The more rigorous approach of this assessment resulted in a substantial increase of 6.54 BBOE (1.74 Bbo and 26.97 Tcfg) in future resources attributable to this phenomenon. Estimates of unproved reserves increased by 1.44 BBOE (0.82 Bbo and 3.51 Tcfg) from the 1987 assessment.

The 1995 estimate of the potential volumes of undiscovered conventionally recoverable resources decreased by 2.74 BBOE (1.31 Bbo and 8.06 Tcfg) from the 1987 assessment. Mean estimates of undiscovered economically recoverable resources decreased by 390 MMbo and 2.14 Tcfg in the base case and 220 MMbo and 580 Bcfg in the high case. In the 1987 assessment 645 of the existing 729 fields were studied and estimates of reserves reported. The additional 277 proved and 77 unproved fields considered in this assessment contain an estimated 1.77 Bbo and 16.12 Tcfg (4.64 BBOE) of original reserves. These reserves represent resources that can be presumed to have moved from the undiscovered resource base of 1987. If this adjustment is made to the 1987 assessment, the 1995 mean estimate of undiscovered conventionally recoverable resources then represents an increase of 0.46 Bbo and 8.06 Tcfg over the comparable 1987 estimate.

	1987	1995
Economic Parameters		
Time periods	period 1, 3 years period 2, remaining years	period 1, life of evaluation
Starting oil price	primary case, $18.00 / bbl alternative case, $30.00 / bbl	base case, $18.00 / bbl high case, $30.00 / bbl
Starting gas price	primary case, $1.80 / Mcf alternative case, $3.00 / Mcf	base case, $2.11 / bbl high case, $3.52 / bbl
Real oil price growth rates	period 1, -4%,-3%,-2% period 2, 3%,4%,5%	constant, 0%
Real gas price growth rates	period 1, -3%,-2%,-1% period 2, 4.5%,5.5%,6.5%	constant, 0%
Inflation	period 1, 4% period 2, 7%	constant, 3%
After-tax rate of return	triangular, 6%,8%,10%	constant, 12%
Scenario	half-cycle	full-cycle half-cycle
Analysis method	non-price-cupply	price-supply

Figure 29. Significant differences in economic parameters between 1987 and 1995 MMS resource assessments.

Atlantic Region

Figure 31 is a comparison of the mean results of the two assessments for the Atlantic Region. Mean estimates of undiscovered conventionally recoverable resources increased by 3.32 BBOE (1.39 Bbo and 10.83 Tcfg), a 158 and 65 percent increase, respectively, for oil and gas. This is primarily the result of a fundamental difference in the assessed prospectiveness of the region's plays. Some of the increase is attributable to more fully developed analogs; however, it is also attributable to the different methodologies employed. An example of the methodological impact is the reliance on identified prospects in 1987. These prospects, which were the basis for the assessment of both the resource base and the undiscovered economically recoverable resources, were economically truncated in each of the different cost regimes. The use in the 1995 assessment of complete pool size distributions based on geologic analogs and mapped prospects resulted in a fuller consideration of the possible numbers and sizes of undiscovered pools. This change has contributed to a higher assessment of the undiscovered conventionally recoverable resources.

Contrasting the 1987 and 1995 assessments of undiscovered economically recoverable resources, the potential volumes of economic resources increased by 260 MMbo and 1.59 Tcfg in the base case and 900 MMbo and 5.16 Tcfg in the high case.

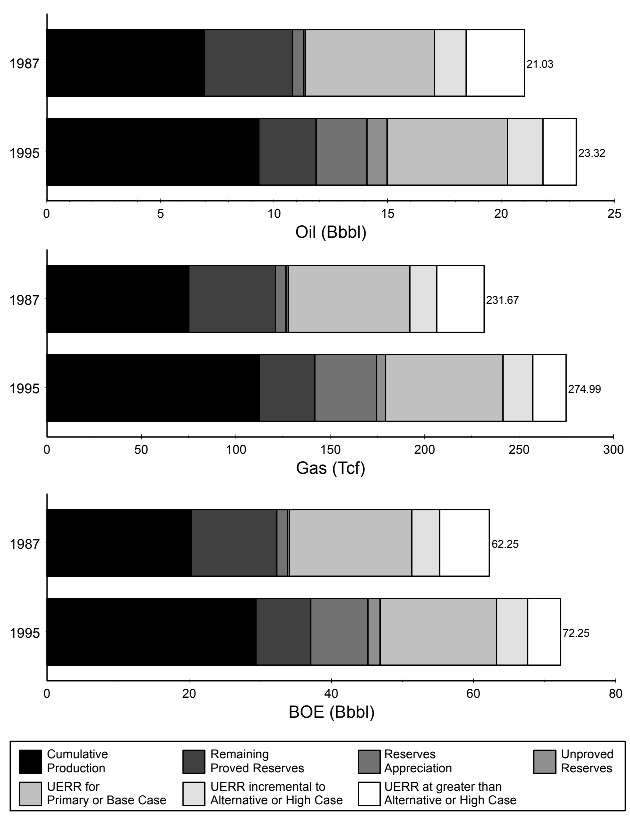

Figure 30. Comparison of 1987 and 1995 MMS resource assessment results, Gulf of Mexico Region.

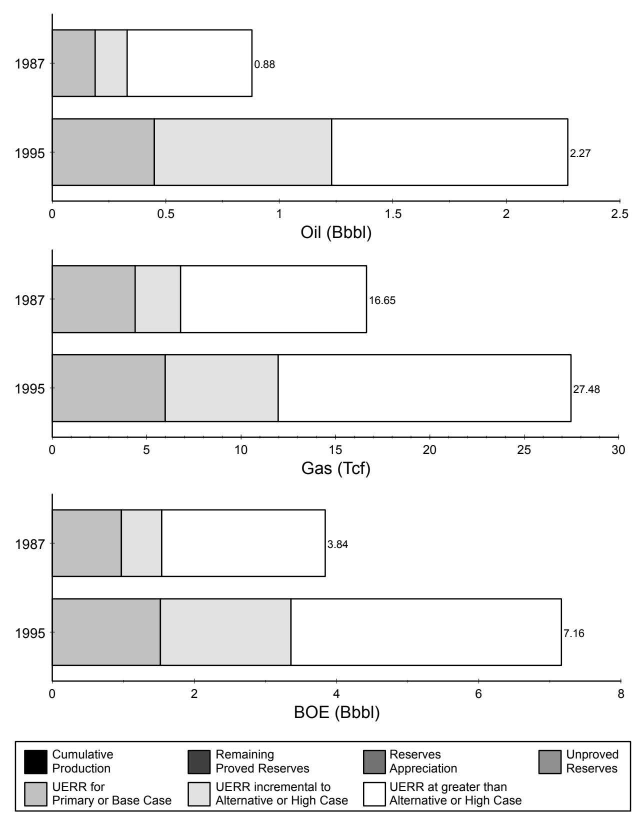

Figure 31. Comparison of 1987 and 1995 MMS resource assessment results, Atlantic Region.

Selected Other Assessments

Estimates of the potential quantities of undiscovered hydrocarbon resources have been made periodically by numerous organizations, companies, government agencies, and individuals. Many of these have been published. Most of these assessments, however, have dealt with the entire United States and provide little additional regional detail, beyond possibly breaking out the lower 48 onshore/offshore and Alaska onshore/offshore. The estimates of undiscovered resources shown in figures 32 and 33 and table 6 were all represented as economically recoverable conventional resources (at least as pertains to the OCS). Although the method of analysis differs in each study, most present the estimates under a range of economic assumptions, generally expressed as moderate and high-price scenarios. Some present results under different technology advancement assumptions. An attempt was made to select as similar cases as possible to allow for some reasonable degree of comparison. The most complete series of estimates are the biennial assessments of gas resources prepared by the Potential Gas Committee (PGC).

The overall range of the estimates of undiscovered economically recoverable resources has been expansive. During the 25-year interval represented, estimates of undiscovered economically recoverable resources for the Gulf of Mexico Region ranged from 1.3 to 30.0 Bbo and 25.2 to 240.0 Tcfg. In the Atlantic Region the range was from 0.2 to 15.0 Bbo and 4.4 to 82.5 Tcfg. The high estimates in both regions were by the U.S. Geological Survey in 1974. The general tendency over time is a declining trend in the estimates.

Methodological approaches used by the various individuals and organizations vary from simple Delphi and volumetric yield approaches; geologic analogy; statistical techniques, such as finding rates and discovery process models; to summation of prospects and play assessment approaches using discounted cash flow analysis. It is often difficult to determine in each assessment what is measured with respect to conventional/unconventional resources. The estimates presented all appear to have no time limit, although they assume discovery and recovery under the economic and technological trends prevailing at the time of the assessment.

The degree to which variations among the

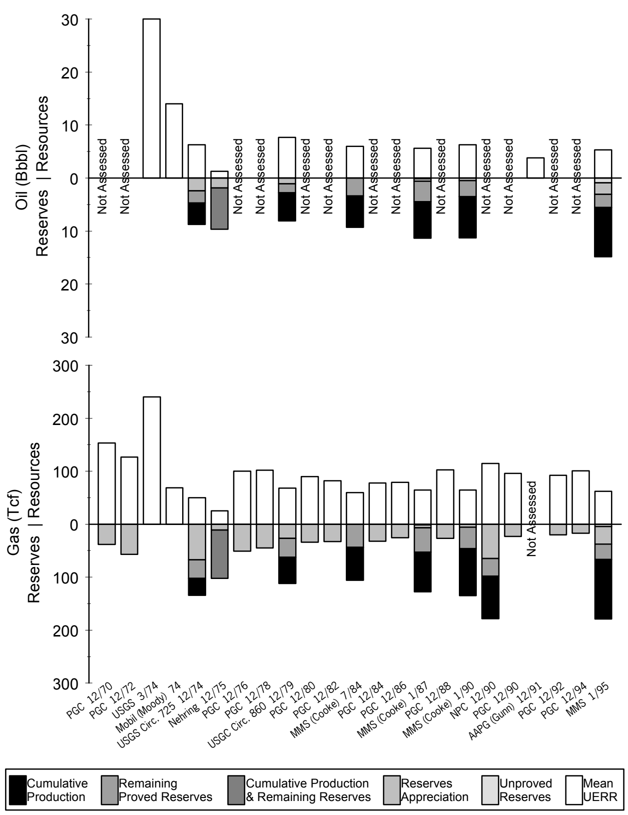

Figure 32. Comparison of selected estimates of economically recoverable oil and gas resources, Gulf of Mexico Region.

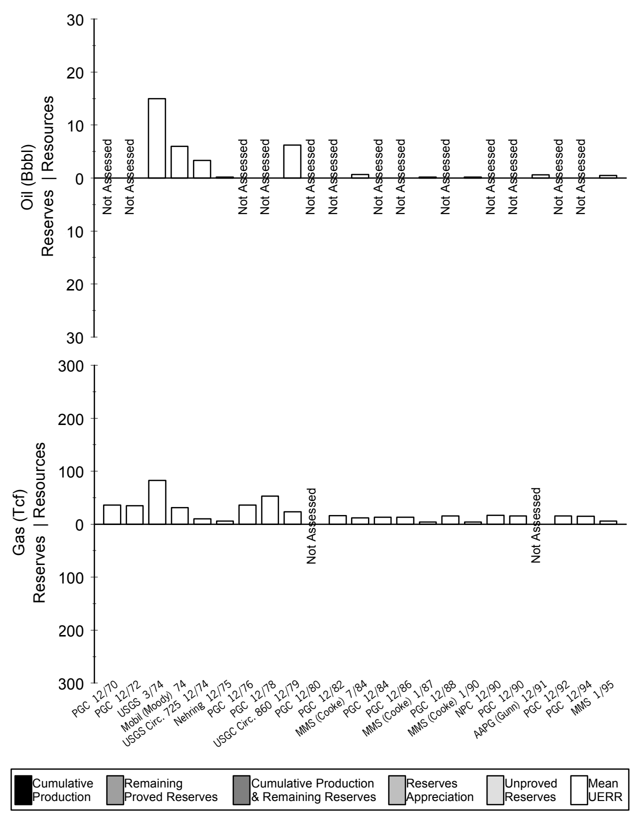

Figure 33. Comparison of selected estimates of economically recoverable oil and gas resources, Atlantic Region.

Table 6. Selected estimates of economically recoverable oil and gas resources, Gulf of Mexico and Atlantic continental margin.

Source	Effective Date	Reserves: Cumulative Production Oil (Bbbl)	Cumulative Production Gas (Tcf)	Remaining Proved Oil (Bbbl)	Remaining Proved Gas (Tcf)	Reserves Appreciation Oil (Bbbl)	Reserves Appreciation Gas (Tcf)	Unproved Oil (Bbbl)	Unproved Gas (Tcf)	Mean Undiscovered Economically Recoverable Resources Oil (Bbbl)	Mean Undiscovered Economically Recoverable Resources Gas (Tcf)	Comments
Gulf of Mexico Region												
Potential Gas Committee	12/70	*	*	*	*	*	38.0	*	*	*	153.0	1,2,13,18
Potential Gas Committee	12/72	*	*	*	*	*	57.0	*	*	*	127.0	1,2,13,18
USGS	3/74	*	*	*	*	*	*	*	*	30.0	240.0	1,14,20
Mobil (Moody)	74	*	*	*	*	*	*	*	*	14.0	69.0	1,19
USGS Circ. 725	12/74	4.1	32.1	2.3	35.3	2.4	27.0	*	*	6.3	50.0	1,5,6,20
Nehring	12/75	*	*	7.8	91.1	1.9	11.0	*	*	1.3	25.2	1,7,15,17
Potential Gas Committee	12/76	*	*	*	*	*	51.0	*	*	*	100.0	1,2,13,18
Potential Gas Committee	12/78	*	*	*	*	*	45.0	*	*	*	102.0	1,2,13,18
USGS Circ. 860	12/79	5.6	49.7	1.7	35.6	1.0	26.7	*	*	8.1	71.8	1,5,6,22
Potential Gas Committee	12/80	*	*	*	*	*	34.0	*	*	*	90.0	1,2,13,21
Potential Gas Committee	12/82	*	*	*	*	*	33.0	*	*	*	82.0	1,2,13,21
MMS (Cooke)	7/84	5.9	62.5	3.4	43.7	*	*	*	*	6.0	59.8	4,12,23
Potential Gas Committee	12/84	*	*	*	*	*	32.0	*	*	*	77.9	1,2,13,21
Potential Gas Committee	12/86	*	*	*	*	*	25.5	*	*	*	79.1	1,2,13,21
MMS (Cooke)	1/87	6.9	75.2	3.9	45.8	0.5	5.8	0.1	1.2	5.7	64.4	4,9,12,16,23
Potential Gas Committee	12/88	*	*	*	*	*	26.5	*	*	*	102.4	1,2,13,21
MMS (Cooke)	1/90	7.8	88.9	3.0	40.2	0.5	5.8	*	*	6.4	64.9	4,9,12,16,23
NPC	12/90	*	80.3	*	33.4	*	64.7	*	*	*	114.5	1,8
Potential Gas Committee	12/90	*	*	*	*	*	23.0	*	*	*	95.8	1,2,13,21
AAPG (Gunn)	12/91	*	*	*	*	*	*	*	*	3.8	*	1,11,23
Potential Gas Committee	12/92	*	*	*	*	*	20.1	*	*	*	92.1	1,2,13,21
Potential Gas Committee	12/94	*	*	*	*	*	17.2	*	*	*	100.5	1,2,13,23
MMS	1/95	9.3	112.6	2.5	29.3	2.2	32.7	0.9	4.7	5.3	62.3	4,10,12,23
Atlantic Region												
Potential Gas Committee	12/70	*	*	*	*	*	*	*	*	*	36.0	1,3,13,18
Potential Gas Committee	12/72	*	*	*	*	*	*	*	*	*	35.0	1,3,13,18
USGS	3/74	*	*	*	*	*	*	*	*	15.0	82.5	1,14,20
Mobil (Moody)	74	*	*	*	*	*	*	*	*	6.0	31.0	1,19
USGS Circ. 725	12/74	*	*	*	*	*	*	*	*	3.3	10.0	1,6,20
Nehring	12/75	*	*	*	*	*	*	*	*	0.2	6.0	1,7,15,17
Potential Gas Committee	12/76	*	*	*	*	*	*	*	*	*	36.0	1,3,13,18
Potential Gas Committee	12/78	*	*	*	*	*	*	*	*	*	53.0	1,3,13,18
USGS Circ. 860	12/79	*	*	*	*	*	*	*	*	6.2	23.7	1,6,22
Potential Gas Committee	12/80	*	*	*	*	*	*	*	*	*	*	1,3,13,21
Potential Gas Committee	12/82	*	*	*	*	*	*	*	*	*	16.0	1,3,13,21
MMS (Cooke)	7/84	*	*	*	*	*	*	*	*	0.7	12.2	5,12,23
Potential Gas Committee	12/84	*	*	*	*	*	*	*	*	*	13.2	1,3,13,21
Potential Gas Committee	12/86	*	*	*	*	*	*	*	*	*	13.2	1,3,13,21
MMS (Cooke)	1/87	*	*	*	*	*	*	*	*	0.2	4.4	5,9,12,16,23
Potential Gas Committee	12/88	*	*	*	*	*	*	*	*	*	15.5	1,3,13,21
MMS (Cooke)	1/90	*	*	*	*	*	*	*	*	0.2	4.4	5,9,12,16,23
NPC	12/90	*	*	*	*	*	*	*	*	*	17.0	1,8
Potential Gas Committee	12/90	*	*	*	*	*	*	*	*	*	15.5	1,3,13,21
AAPG (Gunn)	12/91	*	*	*	*	*	*	*	*	0.6	*	1,11,23
Potential Gas Committee	12/92	*	*	*	*	*	*	*	*	*	15.5	1,3,13,21
Potential Gas Committee	12/94	*	*	*	*	*	*	*	*	*	15.2	1,3,13,23
MMS	1/95	*	*	*	*	*	*	*	*	0.5	6.0	5,10,12,23

* Not reported or not assessed
[1] Includes state waters
[2] Includes west Florida shelf
[3] Excludes west Florida shelf
[4] Includes Florida Straits planning area
[5] Excludes Florida Straits planning area
[6] Includes NGL with oil
[7] Cumulative production includes remaining proved reserves
[8] Current technology case
[9] Primary case
[10] Base case
[11] $20/bbl case
[12] Half-cycle evaluation
[13] Most likely values
[14] Mid-point of reported range
[15] Appreciation is F_{50} estimate
[16] Appreciation is mean estimate
[17] Sum of F_{50} values
[18] 0-1500 feet water depth
[19] 0-6000 feet water depth
[20] 0-200 meters water depth
[21] 0-1000 meters water depth
[22] 0-2500 meters water depth
[23] No water depth limit reported

reported assessments are attributable to different perceptions of the magnitude and distribution of the resource base is impossible to determine. What is certain, however, is that the estimates have a time dimension that impacted the degree of basic geologic knowledge available to the assessors, as well as their technological and economic perceptions. In the case of the Gulf of Mexico Region an example of the changing information base available to the assessor is the additional 663 fields with original proved reserves of 4.38 Bbo and 69.5 Tcfg discovered during the period covered by the estimates.

CONCLUSIONS

Prior to 1995 there were 876 fields with proved reserves in the Gulf of Mexico OCS. Included in this number were 133 fields that were depleted and abandoned. Only a single noncommercial discovery exists in the Atlantic Region. Cumulative production was 9.34 Bbo and 112.64 Tcfg. Remaining proved reserves totaled 2.52 Bbo and 29.26 Tcfg; thus, 79 percent of the current estimate of original proved reserves in these fields have been produced. Reserves appreciation curves constructed from historical Gulf of Mexico offshore fields indicate that, on average, the estimate of proved reserves in a newly discovered OCS field is anticipated to increase by a factor of 4.4 over the field's life. In active proved fields discovered prior to year-end 1994, reserves appreciation to the year 2020 is estimated to be 2.24 Bbo and 32.72 Tcfg, a quantity of resources that exceeds the estimate of remaining proved reserves at the same point in time.

The mean estimate of undiscovered conventionally recoverable resources beneath the Gulf of Mexico and Atlantic continental margin is 10.62 Bbo and 123.14 Tcfg. Nearly 78 percent of these resources are projected to be in the Gulf of Mexico. Assuming existing and reasonably foreseeable technology, an estimated 13.66 to 19.33 Bbo and 170.98 to 210.70 Tcfg of remaining conventionally recoverable resources (remaining reserves, reserves appreciation, and undiscovered conventionally recoverable resources) exist within the study area. Approximately 86 percent of these remaining resources (mean BOE) are believed to be located in the Gulf of Mexico Region.

The results of the economic analysis must be viewed in the long-term. Full-cycle economic analysis estimates the expected profitability at the time of the exploration decision. Half-cycle analysis considers exploration and delineation as sunk costs; the decision point is whether or not to proceed with development. In mature, well developed areas half-cycle analysis generally results in modest increases in the estimate of economically recoverable resources over the equivalent full-cycle case, e.g., 3 to 9 percent in the Gulf of Mexico Region. In frontier areas such as the Atlantic Region, the difference can be more significant, ranging between 6 and 34 percent. The basic presentation of the results of the economic analysis is in the form of price-supply curves.

The results of the base case full-cycle analysis project, at the mean level, undiscovered economically recoverable resources of 5.35 Bbo and 63.30 Tcfg for the entire Gulf of Mexico and Atlantic continental margin. This represents about half of the mean estimate of undiscovered conventionally recoverable oil and gas resources. The estimate of the undiscovered economically recoverable resources increases in the high case to 7.67 Bbo and 85.68 Tcfg. Approximately 92 percent of the undiscovered economically recoverable petroleum resources in the full-cycle base case scenario are projected in the Gulf of Mexico Region. As higher cost Atlantic OCS resources become economic in the full-cycle high price scenario, this decreases slightly to 87 percent.

In the Gulf of Mexico Region base case full-cycle scenario, 59 percent (4.94 Bbo) of the undiscovered conventionally recoverable oil and 61 percent (57.94 Tcfg) of the gas are economic. This increases to about 80 percent (6.64 Bbo and 75.30 Tcfg) for both oil and gas at the higher price scenario. Results for the Atlantic Region are markedly different. At the base case price scenario, only 16 percent (0.37 Bbo) of the undiscovered conventionally recoverable oil and 19 percent (5.20 Tcfg) of the gas are economic. This increases to 47 (1.06 Bbo) and 38 percent (10.48 Tcfg), respectively, at the higher price scenario.

The mean estimate of the total hydrocarbon endowment of the Gulf of Mexico and Atlantic continental margin is 25.59 Bbo and 302.47 Tcfg (79.41 BBOE). The Gulf of Mexico Region mean endowment is 23.32 Bbo and 274.99 Tcfg, or 72.25 BBOE. Sixty-five percent of the Gulf of Mexico total endowment is in the various reserves categories. Approximately 51 percent is original proved reserves. After nearly 50 years of exploration and development, nearly half of the mean endowment is represented by future reserves appreciation and undiscovered conventionally recoverable resources. In the base case full-cycle scenario, 86 percent of the total endowment is economic. This increases to nearly 93 percent at the high case scenario. The Atlantic Region total endowment equals the undiscovered conventionally recoverable resources, with a mean estimate of 2.27 Bbo and 27.48 Tcfg.

From a national perspective the Gulf of Mexico Region is second to the Alaska Region in terms of the potential quantities of undiscovered conventionally recoverable petroleum resources. In the Gulf of Mexico Region the volumes of conventionally recoverable resources represented by the various categories of reserves, 46.89 BBOE, approach the total mean endowment of the Alaska Region. The total mean hydrocarbon endowment of the Gulf of Mexico Region is greater than that of all other regions combined, 72.25 versus 71.09 BBOE. The Gulf of Mexico Region also has a larger percentage of both its total endowment, 86 percent, and the undiscovered conventionally recoverable resources, 60 percent, estimated to be economically recoverable at near current oil and gas prices and specified economic conditions. The Atlantic Region, with a total hydrocarbon endowment of 7.16 BBOE, ranks last of the four OCS regions.

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GLOSSARY

Allocthonous: Formed elsewhere than at its present location.

Alluvial deposits: A general description of all sediments deposited on land by streams.

Assessment: The estimation of potential amounts of conventionally recoverable hydrocarbon resources.

Basin: An area in which a thick sequence (typically thicknesses of 1 kilometer or greater) of sedimentary rocks is preserved.

Barrels of oil equivalent (BOE): The sum of gas resources expressed in terms of their energy equivalence to oil plus the oil volume. The conversion factor of 5,620 standard cubic feet of gas equals 1 BOE is based on the average heating values of domestic hydrocarbons.

Bias: A systematic distortion of a statistical result. This differs from a random error, which is symmetrically dispersed around the results and therefore, on average, balances the error.

Chance: See "probability"or "risk."

Chronozone: A body of rock formed during the same span of time. In this report boundaries are defined by biostratigraphic and correlative seismic markers.

Condensate: Hydrocarbons associated with saturated gas present in the gaseous state at reservoir conditions, but produced as liquid hydrocarbons at the surface.

Continental margin: The composite continental rise, continental slope, and continental shelf as a single entity. The term, as used in this report, applies only to the portion of the margin whose mineral estate is under Federal jurisdiction; geographically synonymous with Outer Continental Shelf.

Continental rise: The base of the continental slope, which in places is marked by a more gently dipping surface that leads seaward to the ocean floor.

Continental shelf: The shallow, gradually sloping zone extending from the sea margin to a depth at which there is a marked steep descent to the ocean bottom.

Continental slope: The portion of the continental margin extending seaward from the continental shelf to the continental rise or ocean floor.

Cumulative probability distributions: A distribution showing the probability of a given amount or more occurring. These distributions include the values for the resource estimates presented throughout this report: a low estimate having a 95 percent probability (19 in 20 chance) of at least that amount (F_{95}), a high estimate having a 5 percent probability (1 in 20 chance) of at least that amount (F_5), and a mean (μ) estimate representing the average of all possible values. Values of the fractiles are not additive. These distributions are often referred to as S-curves.

Dependency, geologic: An estimate that reflects the relative degree of commonality among the plays with respect to factors controlling the occurrence of hydrocarbons at the play level: charge, reservoir, and trap. Dependencies reflect the degree of coexistence among the plays. Values for dependency can range from one, in which case each play would not exist if the other(s) did not exist, to zero, in which case the existence of each play is totally independent from all others.

Deterministic: A process in which future states can be forecast exactly from knowledge of the present state and rules governing the process. It contains no random or uncertain components.

Development: Activities following exploration, including the installation of production facilities and the drilling and completion of wells for production.

Discounted cash flow analysis: An analysis of future anticipated expenditures and revenues associated with a project discounted back to time zero (usually the present) at a rate typically representing the average opportunity cost or cost of capital of the investor or a desired rate of return.

Exploration: The process of searching for minerals prior to development. Exploration activities include geophysical surveys, drilling to locate hydrocarbon reservoirs, and the drilling of delineation wells to determine the extent and quality of an existing discovery prior to a development decision.

Facies: The aspects, appearance, and characteristics of a rock unit, usually reflecting the conditions of origin.

Field: A producible accumulation of hydrocarbons consisting of a single pool or multiple pools related to the same geological structure and/or stratigraphic condition. In general usage this term refers to a commercial accumulation.

Marginal field: A field containing quantities of hydrocarbon reserves that are barely profitable to develop.

Fluvial deposits: A general description of all sediments deposited in water by streams.

Formation: A mappable sedimentary rock unit of distinctive lithology.

Frequency: The number of times an indicated event occurs within a specified interval.

Full-cycle economic analysis: Full-cycle analysis considers all leasehold (excluding lease acquisition), geophysical, geological and exploration costs in determining the economic viability of a prospect. The decision point is whether or not to explore.

Gas, natural: A mixture of gaseous hydrocarbons (typically methane with lesser amounts of ethane, propane, butane, pentane, and possibly some nonhydrocarbon gases).

Associated gas: The volume of natural gas that occurs in crude oil reservoirs as free gas.

Dissolved gas: The volume of natural gas that occurs as gas in solution with crude oil reservoirs.

Nonassociated gas: The volume of natural gas that occurs in reservoirs and is not in contact with significant quantities of crude oil.

Half-cycle economic analysis: Half-cycle analysis considers all leasehold and exploration costs, as well as delineation costs, that are incurred prior to the field development decision, to be sunk; these costs are not utilized in the discounted cash flow calculations to determine whether a field is commercially profitable. The decision point is whether or not to develop and produce the field.

Hydrocarbon maturation: The process by which organic material trapped in source rocks is transformed naturally by heat and pressure through time and depth of burial into oil and/or gas.

Hydrocarbons: Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbons include crude oil and natural gas.

Lacustrine deposits: A general description for all sediments deposited in lakes.

Lognormal distribution: A variable in which the logarithms of the values are normally distributed. Lognormal pool or field distributions are highly skewed, having very few large values and very many low values.

Marginal probability: A probability value that depends only on a single condition where one or more other conditions exist.

Mean (μ): A statistical measure of central tendency; the average or expected value, calculated by summing all values and dividing by the number of values.

Model: A geologic hypothesis expressed in mathematical form.

Monte Carlo simulation: A method of approximating solutions of problems by iterative sampling from simulated random or pseudo-random processes.

Oil, crude: A mixture of hydrocarbons that exists naturally in the liquid phase in subsurface reservoirs.

Outer Continental Shelf (OCS): The part of the continental margin, including the slope and rise, beyond the line that marks the boundary of state ownership; that part of the seabed under Federal jurisdiction.

Play: A group of known and/or postulated pools that share common geologic, geographic, and temporal properties, such as history of hydrocarbon generation, migration, reservoir development, and entrapment.

Pool: A discovered or undiscovered hydrocarbon accumulation, typically within a single stratigraphic interval.

Price-supply curves: A plot portraying volumes of undiscovered economically recoverable resources at various oil and gas prices. As price increases (or costs decrease) the amount of economically recoverable resources approaches the estimate of the undiscovered conventionally recoverable resources.

Critical price: The minimum value at which at least one prospect is profitable under the specified economic and technological conditions.

Marginal price: The minimum value at which at least one prospect might be profitable under the specified economic and technological conditions.

Probability: A means of expressing an outcome on a numerical scale that ranges from impossibility to absolute certainty. The chance that a specified event will occur.

Prospect: A geologic feature having the potential for trapping and accumulating hydrocarbons; a pool(s) or potential field.

Province: A large area unified geologically by means of a single dominant structural element or a number of contiguous elements.

Random: Occurring or observed without bias, so the appearance of any value within the range of the variable is determined only by chance.

Random variable: A variable whose particular values cannot be predicted, but whose behavior is governed by a probability distribution.

Reserves appreciation: That part of the known resources over and above proved reserves that will be added to existing fields through extension, revision, improved recovery, and the addition of new pools or reservoirs. Also referred to as reserves growth or field growth.

Reservoir: A subsurface, porous, permeable rock body in which an isolated accumulation of oil and/or gas is stored.

Resource assessment: The estimation of potential amounts of recoverable resources. The focus is normally on conventionally recoverable hydrocarbons.

Risk: The chance or probability that a particular event will not occur; the complement of marginal probability or success.

Economic risk: The chance that no commercial accumulation of hydrocarbons will exist in the area under consideration, e.g., prospect, play, or area. The chance that an area may not contain hydrocarbons or the volume present may be noncommercial is incorporated in the economic risk.

Geologic risk: The chance that recoverable hydrocarbons will not exist in the area under consideration, e.g., zone, prospect, play, or area. The commercial viability of an accumulation is not a consideration.

Seal: Impervious rocks above, below, and/or lateral to the reservoir rock that form a barrier to migrating hydrocarbons.

Sediment: Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, or ice and has come to rest on the earth's surface, either above or below sea level.

Carbonate: A sediment consisting chiefly of carbonate, commonly calcium carbonate, that precipitates from an aqueous solution that originates as a chemical process, or more commonly, as a biological process, i.e., reef building.

Clastic: A sediment that originates in another form, but the effects of erosion and transportation have redeposited the sediment away from its site of origin.

Evaporite: A nonclastic sediment that results from the complete evaporation of seawater or brines, e.g., halite (salt), aragonite, and anhydrite.

Skewness: Asymmetry in a frequency distribution.

Source rock: A sedimentary rock, commonly a shale or limestone, whose organic matter has been transformed naturally by heat and pressure through time and depth of burial into oil and/or gas. This transformation is referred to as generation or maturation.

Standard deviation (σ): A measure of the amount of dispersion in a set of data; the square root of the variance.

Stochastic: A process in which each observation possesses a random variable.

Sunk costs: Capital costs already incurred, and not considered in an evaluation. They will not affect the future profitability of a project measured at a point in time subsequent to their expenditure.

Trap: A barrier to hydrocarbon migration that allows oil and gas to accumulate in a reservoir.

Structural trap: A trap that results from folding, faulting, or other deformation of the rock.

Stratigraphic trap: A trap that results from changes in the lithologic character of the rock.

Unconformity: A lack of continuity between rock units in contact, corresponding to a gap in the geologic record.

Variance (σ^2): A measure of the amount of dispersion in a set of data. The variance is equal to the mean of the squared differences of the data values from the mean of the data or the mean of the squares of the data, less the square of the mean.

APPENDIX A. RESERVES APPRECIATION IN THE GULF OF MEXICO REGION

Estimates of the quantity of original proved reserves (cumulative production plus remaining proved reserves) in a field typically increase as the field is developed and produced. Characteristically, the relative magnitude of this growth is proportionally larger the younger the field. This appreciation phenomenon is complex and incompletely understood. It is, however, a consequence of a multitude of factors, which include:

- areal extension of existing reservoirs (extensions).
- discovery of new reservoirs (additions).
- increases in expected ultimate recovery in existing reservoirs as production experience is gained (revisions).
- improved recovery technologies (revisions).
- increases in prices and/or reductions in costs, which reflect the influences of market economics and technology (revisions).
- field expansion via mergers with newer fields (extensions).
- systematic assessment bias toward conservativism, which typically exists in initial estimates of field sizes (revisions).

Growth functions can be used to calculate an estimate of a field's size at a future date. In modeling reserves growth the age of the field is typically used as a surrogate for the degree of field development, primarily because it is easy to determine and simple to use. The degree of development represents the opportunity for the previously listed cause agents to impact the estimates of field reserves. Techniques for modeling reserves appreciation have been almost universally applied to large areas, such as countries, states, provinces, and basins, using highly aggregated data.

The approach employed in this study was to calculate annual growth factors (AGF's) as first implemented by Arrington (1960). This technique utilizes the age of the field as measured by years after discovery as the variable to represent the degree of field maturity. These factors were calculated from the MMS data set of 876 OCS fields with proved reserves. The procedure involves developing AGF's from equation 1:

$$AGF = \sum_{d} c(d,e+1) / \sum_{d} c(d,e) \qquad (1)$$

where c(d,e) is the estimate of the quantity of reserves discovered in fields of age d, as estimated in year e or (e+1).

The same fields are included in both the numerator and denominator. The set of fields used to calculate AGF's is likely to differ from one year to the next as some fields are depleted and abandoned and others are discovered. The assumptions central to this approach are that the amount of growth in any year is proportional to the size of the field and that this proportionality varies inversely with the age of the field.

Growth factors can also be expressed from equation 2 as cumulative growth factors (CGF's), which represent the ratio of the size of a field n years after discovery to the initial estimate of its size in the year of discovery.

$$CGF = c(d,e+n)/c(d,e) \qquad (2)$$

where c(d,e) is as described above and n is the time in years between the early estimate year, e, and the late estimate year, e+n.

The objectives of the reserves appreciation effort in the resource assessment were twofold: first, to estimate the quantity of reserves from known fields that, owing to the reserves appreciation phenomenon, will contribute to the Nation's future oil and gas supply; and second, to explicitly incorporate field growth in the measure of past performance, which forms the basis for projecting future discoveries within defined plays. The latter objective represents the first effort in a large-scale assessment to explicitly incorporate the reserves appreciation phenomenon as an integral component in developing the forecast of the number and sizes of future discoveries. Previous resource assessments addressed field growth only within the context of the first objective.

The working hypothesis for this effort was that OCS fields in the Gulf of Mexico characteristically grow at a lower rate and possibly for a shorter duration than onshore fields; therefore, growth functions specific to the OCS were required. Previous work by Drew and Lore (1992) with the MMS data series supports this premise. CGF's calculated using the MMS data were in the range of 4.5 for OCS fields, while studies using the American Petroleum Institute/American Gas Association/Canadian Petroleum Association (1967 to 1979) and EIA data series developed CGF's that were generally considerably higher, in the range of 4.0 to 9.3 (EIA, 1990; NPC, 1992; Root and Mast, 1993). The NPC

(1992), using the EIA oil and gas integrated field file (OGIFF) data series, also noted that the initial determination of proved reserves and estimates of field size were typically reported later for offshore fields than for onshore fields. The overall lower growth rates observed for OCS fields are interpreted to reflect better initial estimates than for typical onshore fields. The better initial estimates are probably the result of a combination of factors:

- the incorporation of high quality marine seismic data in the initial estimate, thus providing a better measure of the ultimate lateral extent of reservoirs.
- the drilling of additional exploration and/or delineation wells offshore and the integration of these data with seismic data prior to field development decisions.
- the additional years elapsed after field discovery prior to the initial estimate of proved reserves.
- lower well costs and greater availability of well locations onshore result in more optimal placement of development wells and more complete reservoir drainage.
- the obligation of the assessor to not intentionally underestimate reserves. This is inherent in requirements to more accurately reflect reserves potential at the time development decisions are made because of the increased capital requirements and more rigorous design criteria for offshore versus onshore infrastructure.

The technique to resolving the first objective, estimating the total reserves appreciation in known fields to a particular point in time, was relatively straightforward. Regression analyses were applied to the observed field-level AGF's to develop a function relating the AGF's to the age of the field. Equation 3 is the model used as the basis for the projection.

$$AGF = 0.984467 + 0.828228/(y + 2.7) \quad (3)$$

where y is the age of the field in years. The correlation coefficient for this model was 0.8165, indicating a high degree of correspondence between the observed results and the outcomes predicted by the model. The table presents the actual observed and modeled growth factors. Note that with time the AGF's asymptotically approach a value of 1.00, coinciding with no growth, and the CGF values asymptotically approach a limit of about 4.4, also representing no additional appreciation with time. These limiting bounds of the curves are a function of the volume of the original in-place resource.

The oldest fields in the data set were 47 years old. The appreciation model (equation 3) implies no

Table A. Observed and modeled reserves growth factors for 876 proved fields, Gulf of Mexico.

Year After Discovery	Annual Growth Factor		Cumulative Growth Factor	
	Observed	Modeled	Observed	Modeled
1	1.17132	1.20831	1.17132	1.20831
2	1.24264	1.16069	1.45552	1.40247
3	1.08683	1.12977	1.58191	1.58447
4	1.09934	1.10808	1.73905	1.75572
5	1.11969	1.09203	1.94720	1.91730
6	1.09219	1.07967	2.12670	2.07005
7	1.07791	1.06985	2.29240	2.21464
8	1.08188	1.06187	2.48010	2.35166
9	1.07531	1.05526	2.66687	2.48161
10	1.01532	1.04968	2.70772	2.60490
11	1.04166	1.04492	2.82051	2.72191
12	1.01905	1.04081	2.87425	2.83299
13	0.99612	1.03722	2.86311	2.93844
14	1.02384	1.03406	2.93135	3.03852
15	1.01805	1.03126	2.98427	3.13351
16	1.02075	1.02876	3.04629	3.22362
17	1.02007	1.02651	3.10733	3.30907
18	1.02288	1.02448	3.17844	3.39007
19	1.01684	1.02263	3.23196	3.46680
20	1.01626	1.02095	3.28450	3.53944
21	1.01624	1.01941	3.33782	3.60815
22	1.03012	1.01800	3.43837	3.67310
23	1.02582	1.01669	3.52714	3.73442
24	1.01036	1.01549	3.56369	3.79225
25	1.01779	1.01437	3.62709	3.84673
26	1.00490	1.01333	3.64485	3.89799
27	1.01845	1.01235	3.71210	3.94614
28	1.01712	1.01145	3.77563	3.99131
29	1.02001	1.01059	3.85117	4.03359
30	1.01625	1.00980	3.91374	4.07310
31	0.99899	1.00904	3.90979	4.10994
32	1.01614	1.00834	3.97288	4.14419
33	0.99601	1.00767	3.95703	4.17597
34	1.00036	1.00704	3.95845	4.20534
35	0.99768	1.00644	3.94929	4.23241
36	1.01222	1.00587	3.99753	4.25724
37	0.99739	1.00533	3.98710	4.27993
38	0.99220	1.00482	3.95599	4.30055
39	1.00765	1.00433	3.98627	4.31916
40	1.01244	1.00386	4.03585	4.33585
41	1.00607	1.00342	4.06034	4.35068
42	0.99366	1.00300	4.03459	4.36371
43	1.00423	1.00259	4.05164	4.37501
44	1.00048	1.00220	4.05357	4.38465
45	1.01379	1.00183	4.10948	4.39267
46	1.00896	1.00147	4.14631	4.39914
47	1.05342	1.00113	4.36782	4.40412
48		1.00080		4.40766
49		1.00049		4.40980
50		1.00018		4.41061

growth for fields 50+ years of age. This is a reasonable conclusion since it fit well with the observed data and does not entail extending projections considerably beyond the time frame of the observations. This assumption is conservative when compared to the 60 to 138 years' duration of reserves growth assumed by other assessments (Hubbert, 1974; Root, 1981; EIA, 1990; NPC, 1992; Root and Mast, 1993). These assessments, however, addressed the United States as a whole and not specifically the OCS with its unique development considerations and higher economic thresholds.

The second objective of the reserves appreciation effort was to explicitly embody field growth in the measure of past performance. Incorporating reserves growth at this point in the assessment process addresses a systemic bias inherent in previous assessments, which assumed the ultimate size of existing discoveries was known at the time of the assessment. This is critical since in this assessment past performance forms the basis for projecting future discoveries within plays. The appreciation model developed from the entire set of OCS fields was applied to the pool size distribution for each individual play. Historical data related to the number and size of accumulations in conjunction with the current geologic knowledge concerning the play are fit to the statistical model that allows extrapolation of past performance into the future. Accurately measuring past performance is crucial to an assessment process that extrapolates past performance or relies on analogies with other areas to predict future performance. Reliably determining the estimated ultimate reserves of the discovered fields, the largest field in particular, is central to the assessment process used by MMS. Thus, it is imperative that the reserves appreciation phenomenon be considered as an integral part of the assessment process. This was accomplished in this study by appreciating the discovered pools prior to applying the matching techniques.

Since reserves appreciation in the Gulf of Mexico OCS has routinely exceeded new field discoveries and contributed the bulk of annual additions to proved reserves, it is an important consideration in any analysis of future oil and gas supplies. As with previous assessments of reserves appreciation, it was implicitly assumed that estimates of original proved reserves in recently discovered fields will exhibit the same pattern and relative magnitude of growth as fields in the historical data set. This study estimates reserves appreciation through the year 2020 in the 743 active fields in the Gulf of Mexico OCS with remaining proved reserves as of yearend 1994 to be 2.24 Bbo and 32.72 Tcfg . This compares favorably to the yearend 1994 estimates of remaining proved reserves, which are 2.52 Bbo and 29.26 Tcfg. All but 1.16 Tcfg and 2.25 MMbbls of condensate are attributable to fields in the Cenozoic Province. OCS fields are not projected to grow appreciably beyond 50 years after discovery. On balance, the assessment of aggregate reserves appreciation in this study is apt to be conservative, particularly since the oldest fields are generally the largest, contributing the bulk of the original proved reserves, and are also likely to experience growth beyond 50 years of age. Although the total volume of hydrocarbons presumed to be available through future reserves growth is substantial, the resources associated with this phenomenon are attainable only in relatively small increments.

The effects of incorporating reserves appreciation explicitly into the assessment process are rather subtle. In mature plays with reasonably complete pool size distributions, the commonly older large accumulations are not projected to experience significant growth as expressed as a percentage of the current estimate of field size. Consistent with the concept of resource exhaustion, smaller accumulations, which are generally younger, experience proportionately more appreciation and grow to fill "gaps" in the pool size distribution, leaving behind gaps in their old, smaller size position in the distribution. This occurs with all pools throughout the distribution. Conversely, in immature plays the overall empirical distribution is not well developed. The largest pools will be projected to experience significant appreciation, creating gaps in the projected pool size distribution, which will then accommodate significant-sized pools. The effect of explicitly considering reserves appreciation is that an assessment for an active, mature play that acknowledges reserves growth will tend to result in a smaller estimate of the quantity of resources remaining to be discovered than one that does not incorporate the reserves appreciation phenomenon. Alternatively, a resource assessment for moderately mature to immature plays will project larger quantities of undiscovered resources when appreciation is considered.

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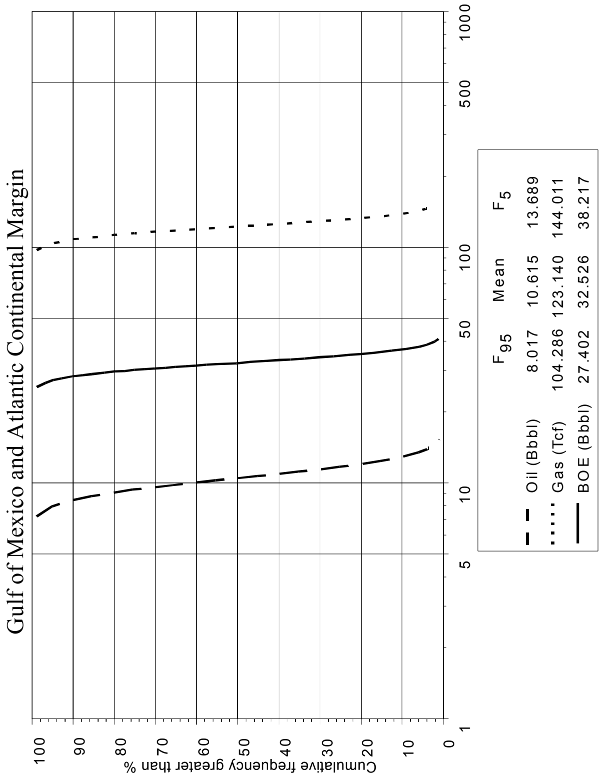
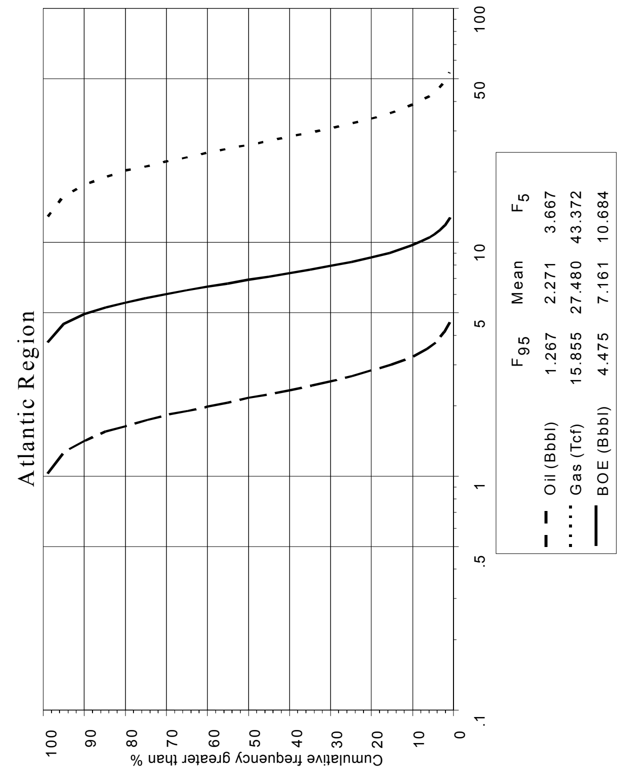
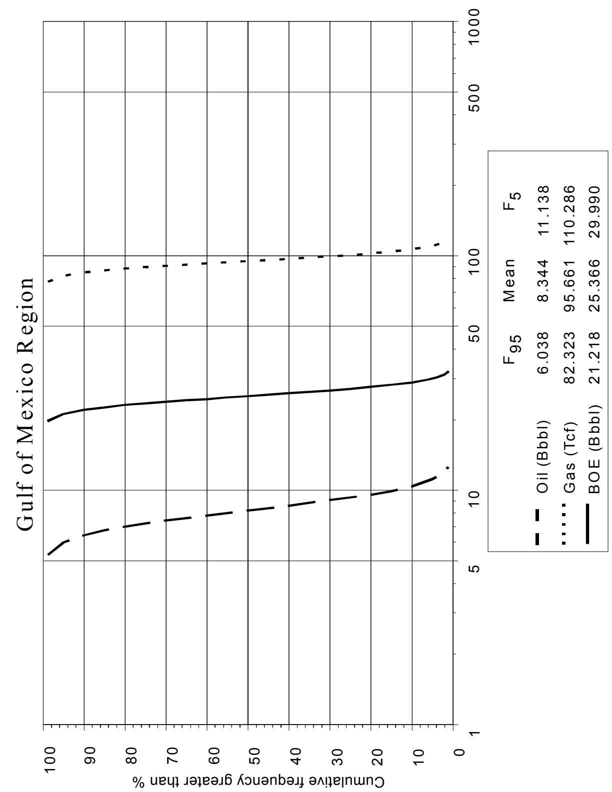
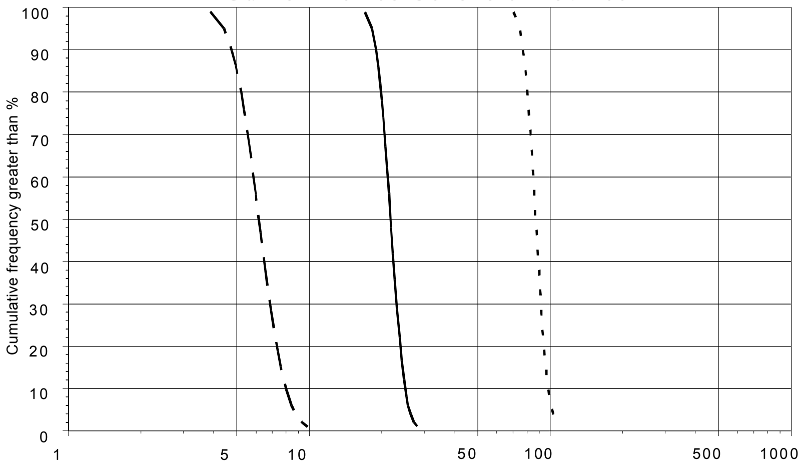
APPENDIX B. CUMULATIVE PROBABILITY DISTRIBUTIONS, GULF OF MEXICO AND ATLANTIC CONTINENTAL MARGIN BY REGION, PROVINCE, SYSTEM, AND SERIES





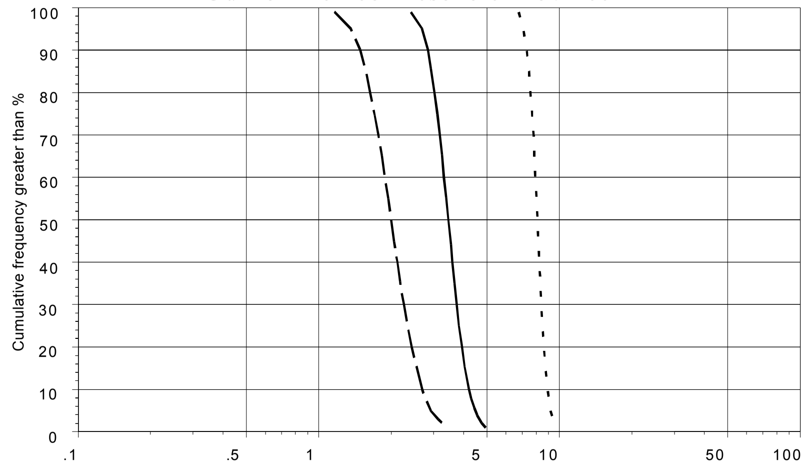


Gulf of Mexico Cenozoic Province



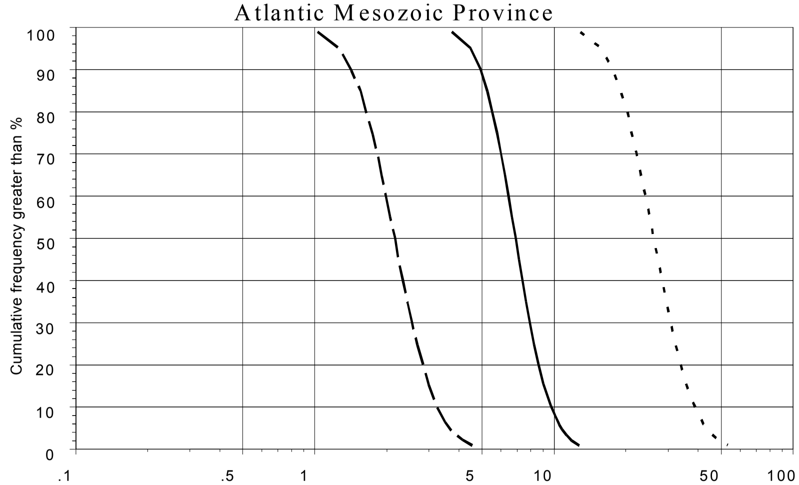
	F_{95}	Mean	F_5
Oil (Bbbl)	4.428	6.291	8.584
Gas (Tcf)	74.766	87.553	101.639
BOE (Bbbl)	18.199	21.870	25.977

Gulf of Mexico Mesozoic Province



	F_{95}	Mean	F_5
Oil (Bbbl)	1.360	2.053	2.933
Gas (Tcf	7.106	8.108	9.194
BOE (Bbbl)	2.678	3.495	4.455

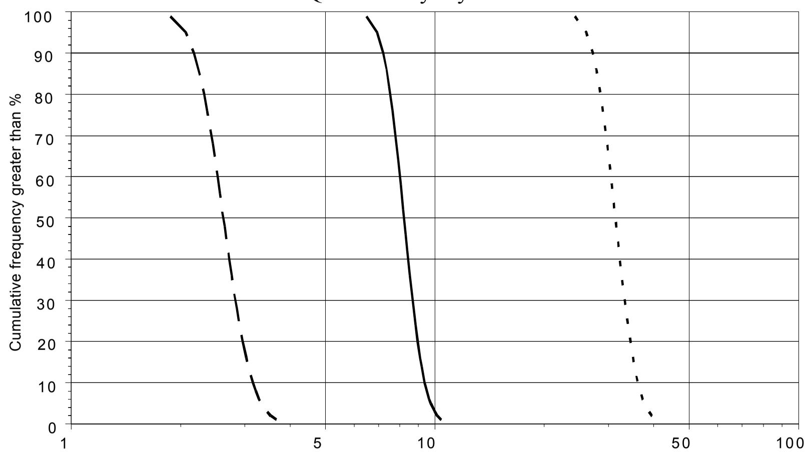
Atlantic Mesozoic Province



	F_{95}	Mean	F_5
Oil (Bbbl)	1.267	2.271	3.667
Gas (Tcf)	15.855	27.480	43.372
BOE (Bbbl)	4.475	7.161	10.684

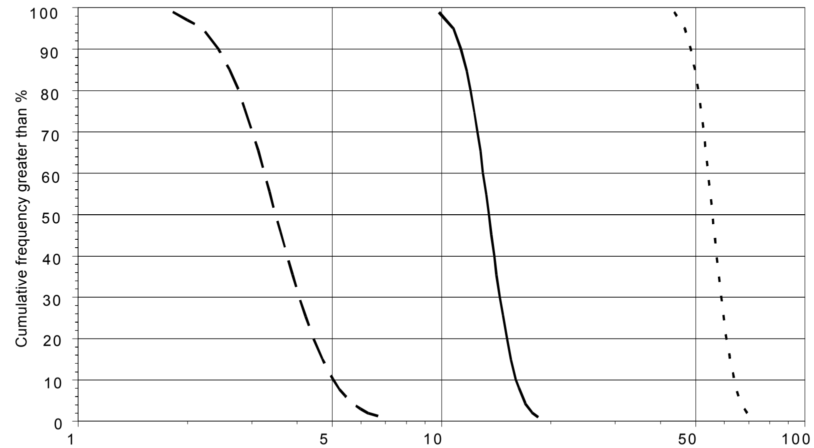
Gulf of Mexico Region

Quaternary System



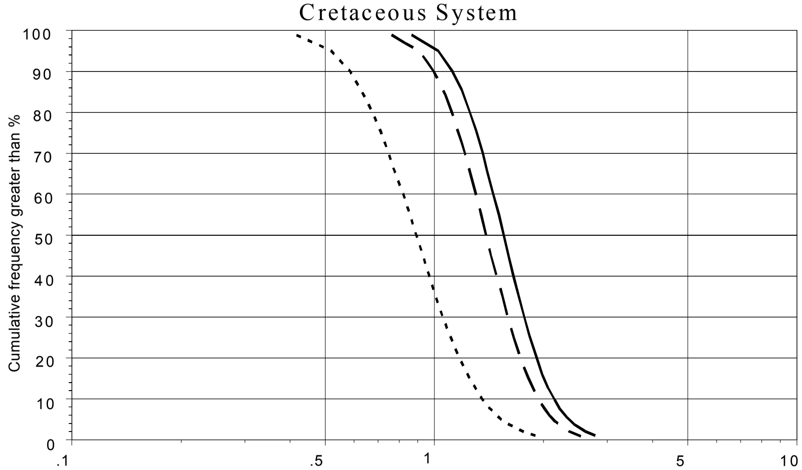
	F_{95}	Mean	F_5
Oil (Bbbl)	2.064	2.648	3.326
Gas (Tcf)	26.116	31.560	37.668
BOE (Bbbl)	6.944	8.263	9.731

Tertiary System



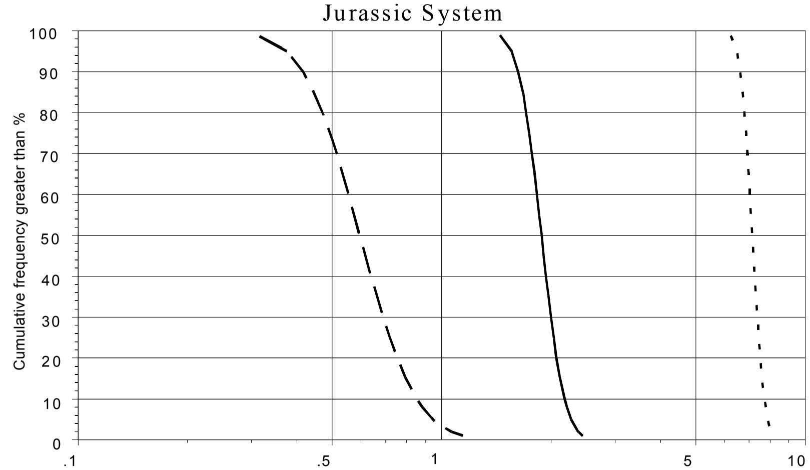
	F_{95}	Mean	F_5
Oil (Bbbl)	2.198	3.643	5.574
Gas (Tcf)	46.782	55.994	66.272
BOE (Bbbl)	10.785	13.607	16.854

Cretaceous System



	F_{95}	Mean	F_5
Oil (Bbbl)	0.905	1.433	2.121
Gas (Tcf)	0.519	0.939	1.525
BOE (Bbbl)	1.026	1.600	2.343

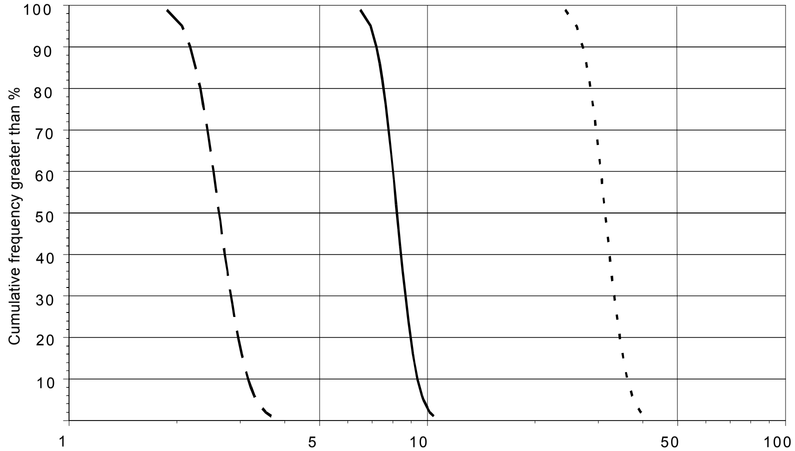
Jurassic System



	F_{95}	Mean	F_5
Oil (Bbbl)	0.375	0.620	0.947
Gas (Tcf)	6.490	7.169	7.890
BOE (Bbbl)	1.561	1.896	2.273

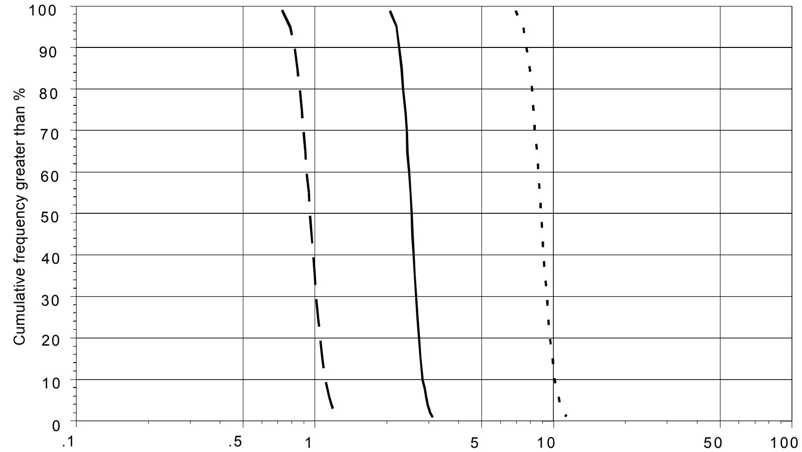
Gulf of Mexico Region

Pleistocene Series



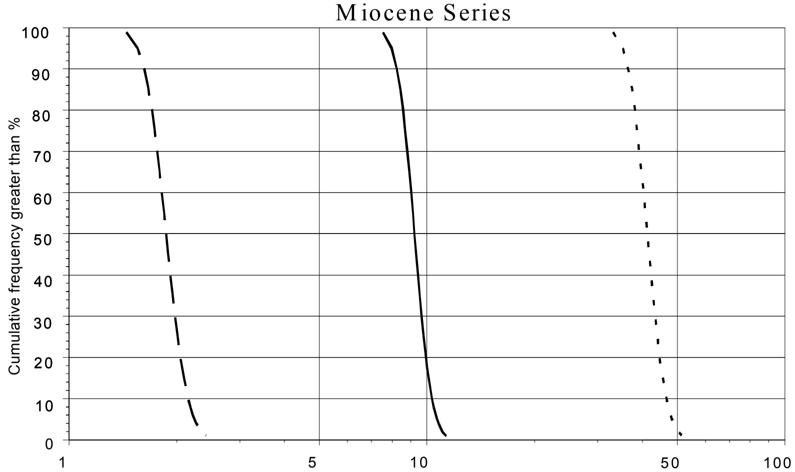
	F_{95}	Mean	F_5
Oil (Bbbl)	2.064	2.648	3.326
Gas (Tcf)	26.116	31.560	37.668
BOE (Bbbl)	6.944	8.263	9.731

Pliocene Series



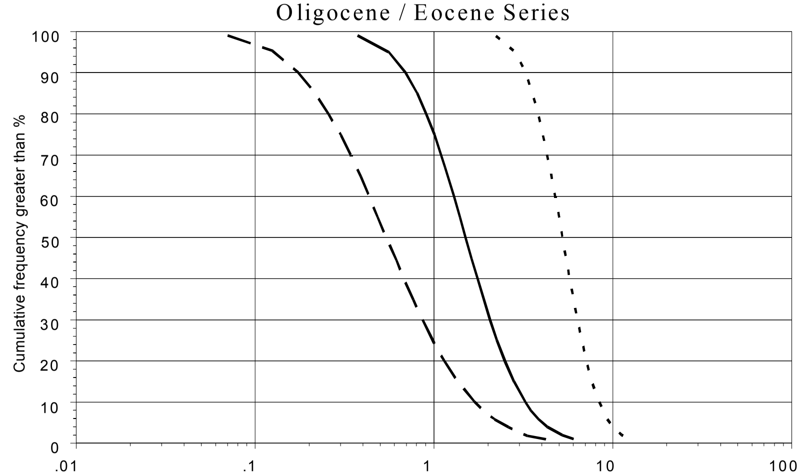
	F_{95}	Mean	F_5
Oil (Bbbl)	0.788	0.961	1.155
Gas (Tcf)	7.452	8.922	10.562
BOE (Bbbl)	2.193	2.548	2.938

Miocene Series



	F_{95}	Mean	F_5
Oil (Bbbl)	1.559	1.880	2.240
Gas (Tcf)	35.278	41.486	48.341
BOE (Bbbl)	7.981	9.262	10.665

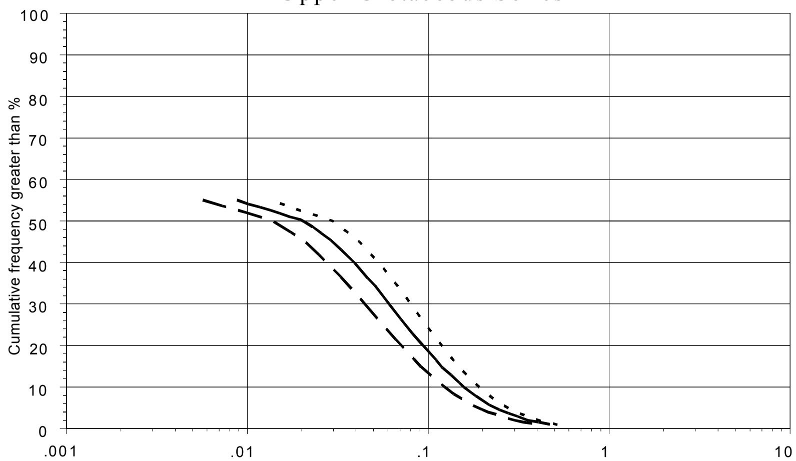
Oligocene / Eocene Series



	F_{95}	Mean	F_5
Oil (Bbbl)	0.126	0.803	2.327
Gas (Tcf)	2.844	5.586	9.576
BOE (Bbbl)	0.558	1.797	4.032

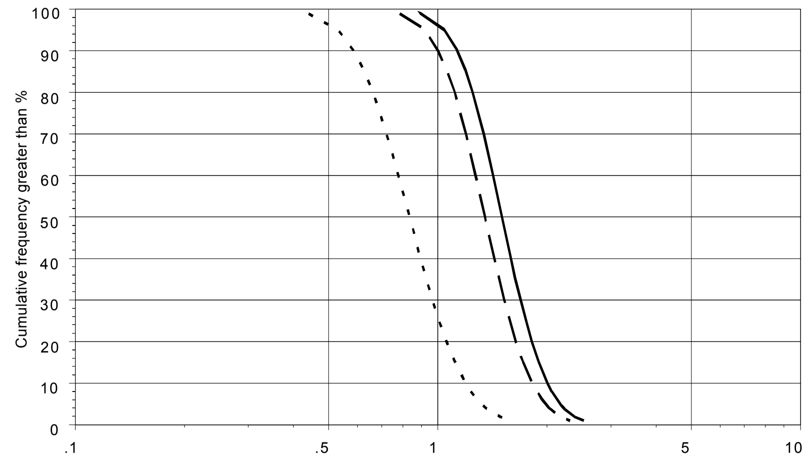
Gulf of Mexico Region

Upper Cretaceous Series



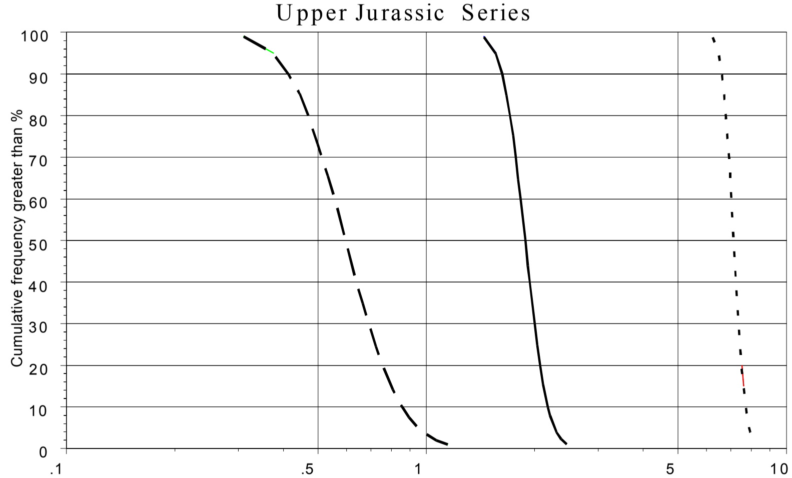
	F_{95}	Mean	F_5
Oil (Bbbl)	0.000	0.045	0.190
Gas (Tcf)	0.000	0.070	0.257
BOE (Bbbl)	0.000	0.057	0.226

Lower Cretaceous Series



	F_{95}	Mean	F_5
Oil (Bbbl)	0.921	1.388	1.980
Gas (Tcf)	0.530	0.869	1.320
BOE (Bbbl)	1.042	1.542	2.171

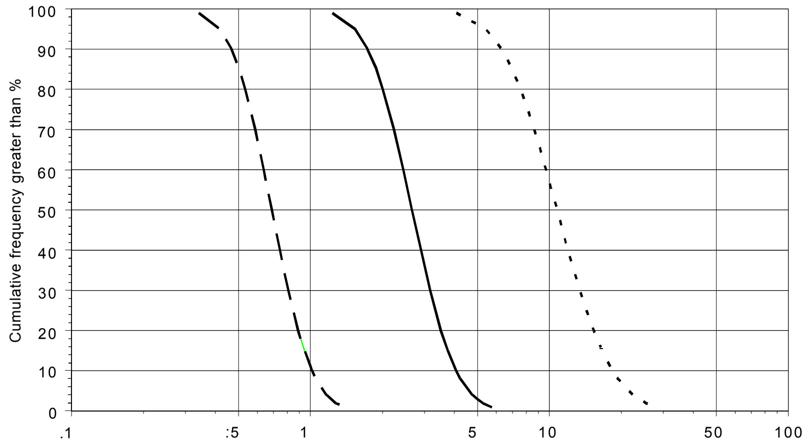
Upper Jurassic Series



	F_{95}	Mean	F_5
Oil (Bbbl)	0.375	0.620	0.947
Gas (Tcf)	6.490	7.169	7.890
BOE (Bbbl)	1.561	1.896	2.273

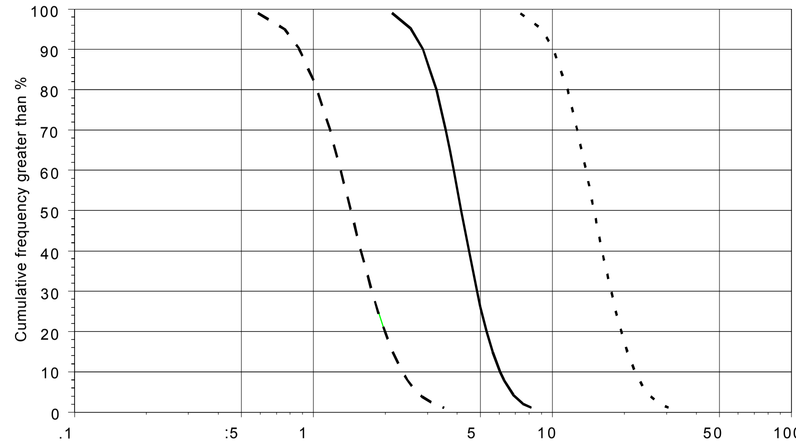
Atlantic Region

Cretaceous System / Lower Cretaceous Series



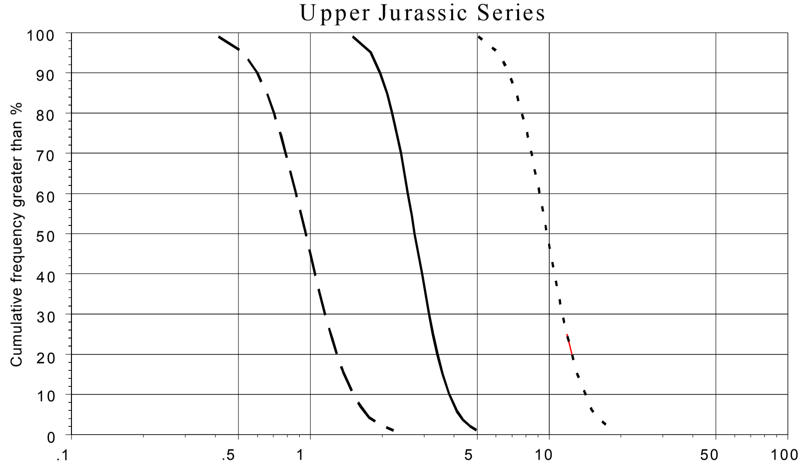
	F_{95}	Mean	F_5
Oil (Bbbl)	0.431	0.722	1.143
Gas (Tcf)	7.840	11.767	18.813
BOE (Bbbl)	1.985	2.816	4.190

Jurassic System



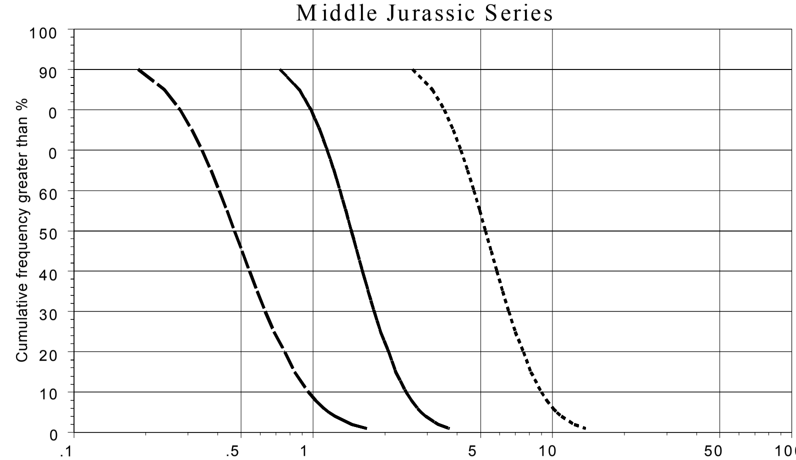
	F_{95}	Mean	F_5
Oil (Bbbl)	0.762	1.549	2.714
Gas (Tcf)	9.040	15.712	24.847
BOE (Bbbl)	2.584	4.345	6.716

Upper Jurassic Series



	F_{95}	Mean	F_5
Oil (Bbbl)	0.527	1.020	1.733
Gas (Tcf)	6.135	10.210	17.331
BOE (Bbbl)	1.791	2.837	4.201

Middle Jurassic Series



	F_{95}	Mean	F_5
Oil (Bbbl)	0.000	0.529	1.163
Gas (Tcf)	0.000	5.502	10.426
BOE (Bbbl)	0.000	1.508	2.830

Appendix C. Map of Gulf of Mexico and Atlantic Continental Margin Planning Areas with Bathymetry

APPENDIX D. TOTAL HYDROCARBON ENDOWMENT OF THE GULF OF MEXICO AND ATLANTIC CONTINENTAL MARGIN BY REGION, PROVINCE, AND WATER DEPTH

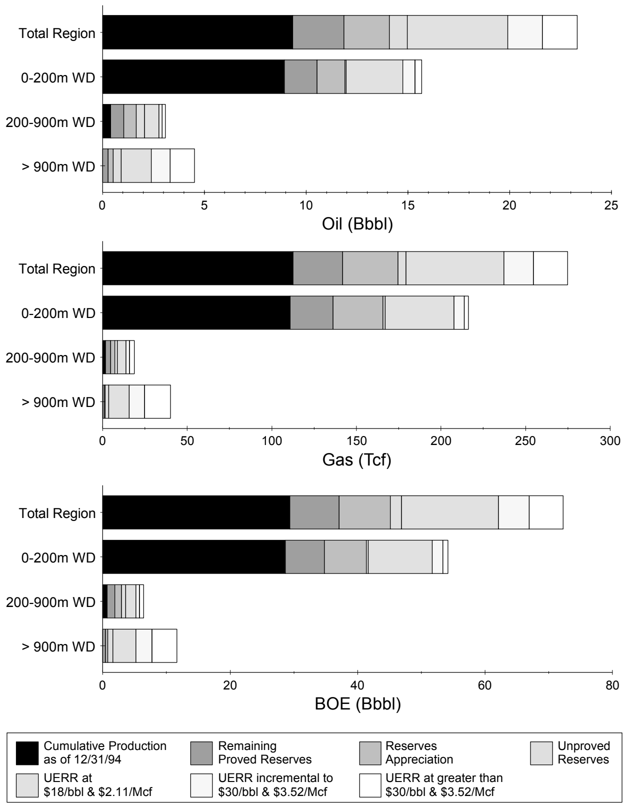


Figure D-1. Total hydrocarbon endowment of the Gulf of Mexico Region by water depth.

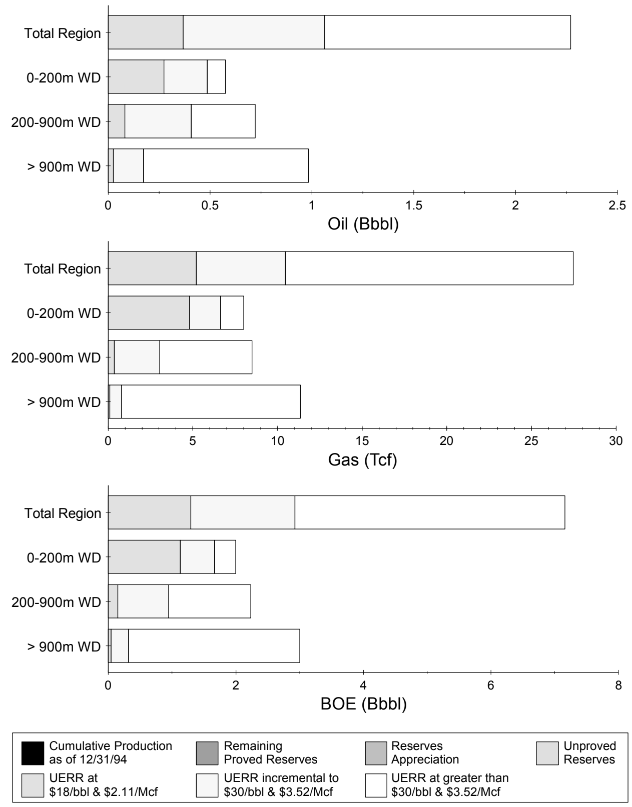


Figure D-3. Total hydrocarbon endowment of the Atlantic Region, (Atlantic Mesozoic Province), by water depth.

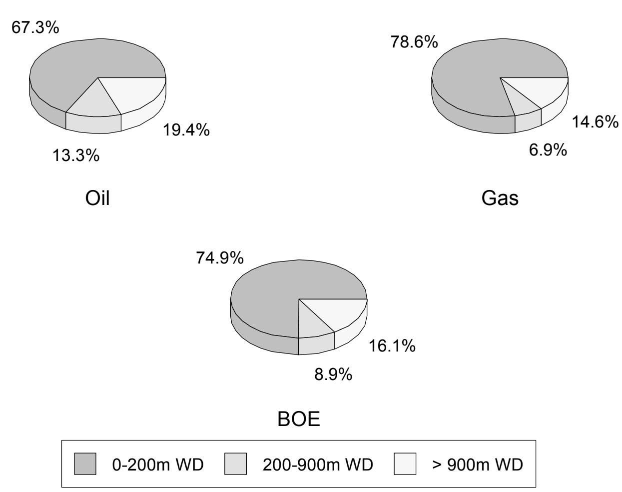


Figure D-2. Total hydrocarbon endowment of the Gulf of Mexico Region by water depth.

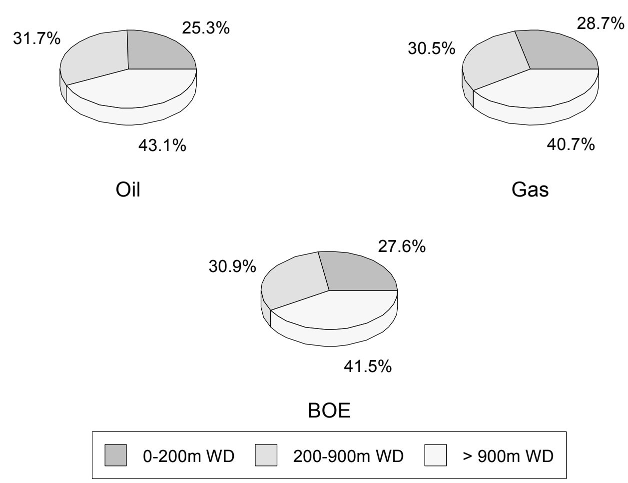


Figure D-4. Total hydrocarbon endowment of the Atlantic Region, (Atlantic Mesozoic Province), by water depth.

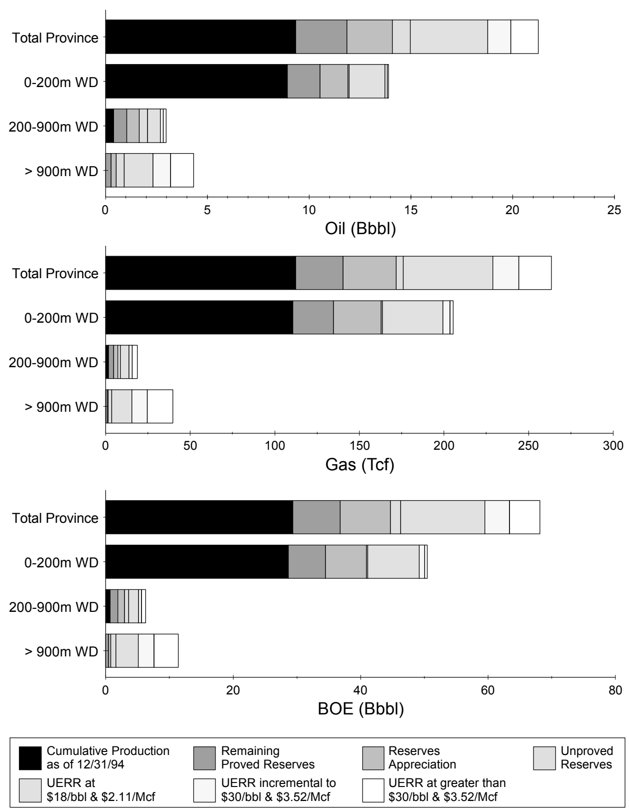


Figure D-5. Total hydrocarbon endowment of the Gulf of Mexico Cenozoic Province by water depth.

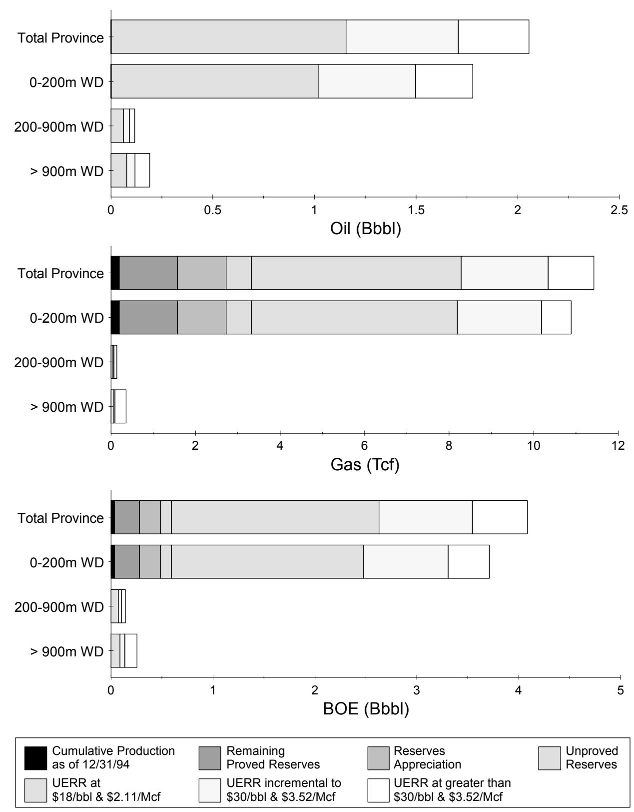


Figure D-7. Total hydrocarbon endowment of the Gulf of Mexico Mesozoic Province by water depth.

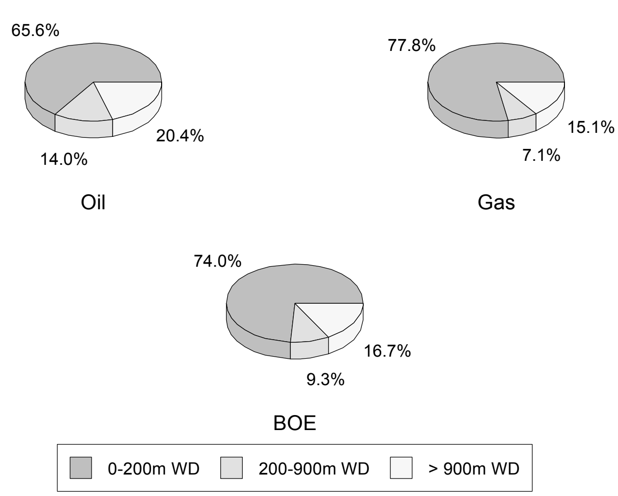


Figure D-6. Total hydrocarbon endowment of the Gulf of Mexico Cenozoic Province by water depth.

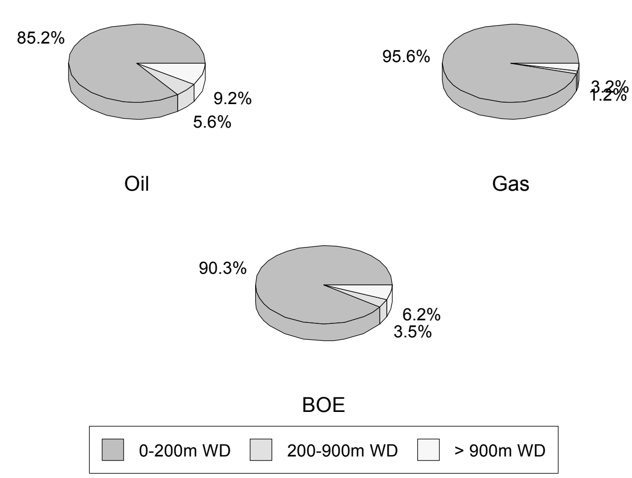


Figure D-8. Total hydrocarbon endowment of the Gulf of Mexico Mesozoic Province by water depth.

Table D-1. Reserves and undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, province, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Reserves													Risked Undiscovered Conventionally Recoverable Resources								
	Cumulative Production			Remaining Proved			Appreciation			Unproved			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)		F_{95}	Mean	F_{5}	F_{95}	Mean	F_{5}	F_{95}	Mean	F_{5}
GOM/Atl Continental Margin	9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	8.017	10.615	13.689	104.286	123.140	144.011	27.402	32.526	38.217
0 - 200m WD	8.938	110.949	28.680	1.597	25.290	6.097	1.371	29.435	6.609	0.074	1.326	0.311	1.00	3.881	4.292	4.576	53.916	57.315	63.854	13.474	14.491	15.938
200 - 900m WD	0.401	1.689	0.701	0.643	3.064	1.188	0.614	2.563	1.070	0.411	1.350	0.651	1.00	1.430	1.749	2.276	16.843	18.712	20.831	4.427	5.078	5.983
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.401	2.037	0.762	1.00	3.839	4.571	6.406	44.978	47.868	51.163	11.842	13.088	15.510
Gulf of Mexico Region	9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	6.038	8.344	11.138	82.323	95.661	110.286	21.218	25.366	29.990
0 - 200m WD	8.938	110.949	28.680	1.597	25.290	6.097	1.371	29.435	6.609	0.074	1.326	0.311	1.00	3.296	3.712	4.178	47.936	49.331	50.721	11.825	12.490	13.203
200 - 900m WD	0.401	1.689	0.701	0.643	3.064	1.188	0.614	2.563	1.070	0.411	1.350	0.651	1.00	0.825	1.033	1.355	9.105	10.208	11.628	2.445	2.849	3.424
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.401	2.037	0.762	1.00	2.955	3.593	5.367	34.152	36.513	39.420	9.032	10.090	12.381
Cenozoic Province	9.339	112.440	29.346	2.516	27.885	7.478	2.238	31.564	7.854	0.885	4.117	1.617	1.00	4.428	6.291	8.584	74.766	87.553	101.639	18.199	21.870	25.977
0 - 200m WD	8.938	110.751	28.645	1.597	23.916	5.853	1.371	28.280	6.403	0.073	0.730	0.204	1.00	1.747	1.934	2.132	40.131	41.759	43.618	8.888	9.365	9.893
200 - 900m WD	0.401	1.689	0.701	0.643	3.064	1.188	0.614	2.563	1.070	0.411	1.350	0.651	1.00	0.744	0.911	1.174	8.937	10.072	11.693	2.334	2.703	3.255
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.401	2.037	0.762	1.00	2.828	3.400	5.079	33.414	36.159	39.613	8.773	9.834	12.127
Mesozoic Province	<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	0.001	0.596	0.107	1.00	1.360	2.053	2.933	7.106	8.108	9.194	2.678	3.495	4.455
0 - 200m WD	<0.001	0.198	0.035	<0.001	1.374	0.244	<0.001	1.155	0.206	0.001	0.596	0.107	1.00	1.404	1.777	2.247	7.157	7.567	8.050	2.678	3.123	3.679
200 - 900m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.00	0.071	0.117	0.190	0.091	0.139	0.225	0.087	0.142	0.230
>900m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.00	0.087	0.191	0.371	0.223	0.359	0.529	0.127	0.255	0.465
Atlantic Region	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.418	0.576	0.669	4.790	8.004	14.557	1.271	2.000	3.259
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.524	0.722	0.995	6.994	8.512	10.519	1.769	2.236	2.867
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.753	0.983	1.385	9.695	11.353	13.485	2.478	3.003	3.784
Mesozoic Province	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.418	0.576	0.669	4.790	8.004	14.557	1.271	2.000	3.259
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.524	0.722	0.995	6.994	8.512	10.519	1.769	2.236	2.867
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.753	0.983	1.385	9.695	11.353	13.485	2.478	3.003	3.784

Table D-2. Estimates of undiscovered economically recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, province, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Risked Undiscovered Economically Recoverable Resources Full-Cycle @ $18.00/bbl and $2.11/Mcf										Risked Undiscovered Economically Recoverable Resources Half-Cycle @ $18.00/bbl and $2.11/Mcf									
	MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
GOM/Atl Continental Margin	1.00	4.364	5.350	7.094	57.252	63.295	70.695	14.551	16.613	19.674	1.00	4.791	5.784	7.374	62.301	68.462	76.883	15.876	17.966	21.055
0 - 200m WD	1.000	2.651	3.043	3.385	40.514	45.512	52.431	9.860	11.142	12.714	1.000	2.769	3.209	3.551	43.237	48.100	54.919	10.462	11.768	13.323
200 - 900m WD	1.000	0.485	0.782	1.294	3.961	5.633	8.650	1.190	1.784	2.833	1.000	0.536	0.849	1.353	4.451	6.319	9.979	1.328	1.973	3.129
>900m WD	1.000	0.808	1.497	3.196	8.859	12.140	15.620	2.384	3.657	5.975	1.000	1.039	1.708	3.388	10.611	13.992	17.220	2.927	4.198	6.452
Gulf of Mexico Region	1.00	4.016	4.941	6.627	53.737	57.941	62.162	13.577	15.251	17.688	1.00	4.350	5.306	6.967	58.428	62.300	66.495	14.747	16.391	18.799
0 - 200m WD	1.00	2.374	2.771	3.186	38.807	40.722	42.653	9.279	10.017	10.775	1.00	2.497	2.901	3.322	41.085	42.859	44.855	9.808	10.527	11.304
200 - 900m WD	1.00	0.476	0.701	1.030	3.859	5.200	6.817	1.162	1.626	2.243	1.00	0.513	0.736	1.056	4.381	5.633	7.383	1.292	1.739	2.369
>900m WD	1.00	0.830	1.477	3.170	8.627	12.053	15.275	2.365	3.621	5.888	1.00	1.008	1.670	3.360	10.665	13.822	16.857	2.906	4.130	6.360
Cenozoic Province	1.00	3.005	3.794	5.338	48.764	53.028	56.780	11.682	13.230	15.441	1.00	3.253	4.053	5.632	52.603	56.600	60.148	12.613	14.125	16.334
0 - 200m WD	1.00	1.600	1.759	1.982	33.984	35.818	37.656	7.647	8.132	8.682	1.00	1.623	1.792	2.006	35.346	37.144	38.995	7.913	8.401	8.944
200 - 900m WD	1.00	0.454	0.635	0.902	3.843	5.169	6.942	1.138	1.554	2.138	1.00	0.489	0.665	0.935	4.175	5.584	7.335	1.232	1.659	2.240
>900m WD	1.00	0.738	1.406	3.069	8.743	12.016	15.715	2.294	3.544	5.865	1.00	0.931	1.603	3.231	10.608	13.810	17.570	2.818	4.060	6.358
Mesozoic Province	1.00	0.759	1.154	1.672	3.921	4.969	5.892	1.457	2.038	2.720	1.00	0.835	1.266	1.796	4.982	5.792	6.612	1.721	2.297	2.972
0 - 200m WD	1.00	0.727	1.021	1.497	3.606	4.874	5.889	1.369	1.889	2.545	1.00	0.749	1.111	1.602	4.861	5.687	6.442	1.614	2.123	2.748
200 - 900m WD	0.88	0.000	0.061	0.140	0.000	0.048	0.137	0.000	0.070	0.164	0.92	0.000	0.066	0.143	0.000	0.053	0.136	0.000	0.075	0.167
>900m WD	0.40	0.000	0.077	0.300	0.000	0.054	0.223	0.000	0.086	0.340	0.47	0.000	0.086	0.304	0.000	0.060	0.214	0.000	0.097	0.342
Atlantic Region	0.92	0.000	0.368	0.808	0.000	5.203	11.688	0.000	1.294	2.888	0.97	0.125	0.452	0.910	1.154	5.989	12.404	0.331	1.518	3.118
0 - 200m WD	0.90	0.000	0.274	0.427	0.000	4.810	12.027	0.000	1.129	2.567	0.94	0.037	0.313	0.447	0.378	5.279	12.398	0.105	1.252	2.653
200 - 900m WD	0.22	0.000	0.083	0.449	0.000	0.375	2.933	0.000	0.150	0.971	0.31	0.000	0.118	0.519	0.000	0.652	3.629	0.000	0.234	1.165
>900m WD	0.05	0.000	0.026	0.146	0.000	0.104	0.656	0.000	0.045	0.262	0.08	0.000	0.040	0.311	0.000	0.157	1.381	0.000	0.068	0.557
Mesozoic Province	0.92	0.000	0.368	0.808	0.000	5.203	11.688	0.000	1.294	2.888	0.97	0.125	0.452	0.910	1.154	5.989	12.404	0.331	1.518	3.118
0 - 200m WD	0.90	0.000	0.274	0.427	0.000	4.810	12.027	0.000	1.129	2.567	0.94	0.037	0.313	0.447	0.378	5.279	12.398	0.105	1.252	2.653
200 - 900m WD	0.22	0.000	0.083	0.449	0.000	0.375	2.933	0.000	0.150	0.971	0.31	0.000	0.118	0.519	0.000	0.652	3.629	0.000	0.234	1.165
>900m WD	0.05	0.000	0.026	0.146	0.000	0.104	0.656	0.000	0.045	0.262	0.08	0.000	0.040	0.311	0.000	0.157	1.381	0.000	0.068	0.557

Table D-3. Estimates of undiscovered economically recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, province, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Risked Undiscovered Economically Recoverable Resources Full-Cycle @ $30.00/bbl and $3.52/Mcf										Risked Undiscovered Economically Recoverable Resources Half-Cycle @ $30.00/bbl and $3.52/Mcf									
	MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
GOM/Atl Continental Margin	1.00	6.632	7.672	9.367	79.526	85.684	92.942	20.783	22.918	25.905	1.00	7.019	8.077	9.892	83.936	89.895	97.023	21.954	24.072	27.156
0 - 200m WD	1.000	3.429	3.857	4.218	49.936	53.379	59.400	12.315	13.355	14.788	1.000	3.527	3.924	4.277	50.646	54.133	60.227	12.539	13.556	14.994
200 - 900m WD	1.000	0.817	1.272	1.826	7.400	10.283	12.844	2.134	3.102	4.112	1.000	0.997	1.349	1.869	8.758	11.245	13.726	2.556	3.350	4.312
>900m WD	1.000	1.802	2.569	4.385	18.749	22.078	25.626	5.138	6.498	8.945	1.000	1.984	2.822	4.641	20.819	24.603	28.461	5.689	7.200	9.705
Gulf of Mexico Region	1.00	5.697	6.639	8.241	71.606	75.298	79.251	18.439	20.038	22.343	1.00	5.963	6.865	8.485	74.379	78.100	81.964	19.197	20.762	23.069
0 - 200m WD	1.00	2.980	3.368	3.856	45.136	46.745	48.159	11.012	11.686	12.425	1.00	3.018	3.423	3.905	45.852	47.318	48.730	11.177	11.843	12.575
200 - 900m WD	1.00	0.651	0.870	1.196	5.993	7.244	8.747	1.718	2.159	2.752	1.00	0.672	0.892	1.205	6.358	7.602	9.166	1.803	2.245	2.836
>900m WD	1.00	1.731	2.398	4.158	18.492	21.216	24.342	5.021	6.173	8.490	1.00	1.873	2.545	4.303	20.385	23.056	26.086	5.500	6.648	8.944
Cenozoic Province	1.00	4.175	4.927	6.539	64.580	68.220	71.732	15.666	17.066	19.302	1.00	4.374	5.096	6.704	67.102	70.826	74.216	16.314	17.699	19.909
0 - 200m WD	1.00	1.717	1.876	2.061	38.128	39.868	41.827	8.502	8.970	9.503	1.00	1.715	1.884	2.075	38.606	40.284	42.166	8.584	9.053	9.577
200 - 900m WD	1.00	0.609	0.772	1.045	5.863	7.163	8.790	1.652	2.047	2.609	1.00	0.620	0.792	1.070	6.329	7.518	9.114	1.746	2.130	2.692
>900m WD	1.00	1.646	2.273	3.908	18.115	21.132	24.862	4.870	6.033	8.331	1.00	1.810	2.416	4.064	20.020	22.975	26.616	5.372	6.504	8.799
Mesozoic Province	1.00	1.259	1.706	2.225	6.530	7.024	7.477	2.421	2.956	3.555	1.00	1.318	1.766	2.278	6.682	7.202	7.585	2.507	3.047	3.628
0 - 200m WD	1.00	1.104	1.496	1.971	6.505	6.864	7.302	2.262	2.717	3.270	1.00	1.164	1.543	2.017	6.660	7.027	7.464	2.349	2.794	3.345
200 - 900m WD	1.00	0.041	0.092	0.165	0.017	0.071	0.163	0.044	0.104	0.194	1.00	0.044	0.094	0.168	0.027	0.077	0.159	0.049	0.108	0.196
>900m WD	0.74	0.000	0.118	0.318	0.000	0.089	0.233	0.000	0.134	0.360	0.81	0.000	0.127	0.321	0.000	0.100	0.267	0.000	0.145	0.368
Atlantic Region	1.00	0.587	1.063	1.644	5.855	10.479	16.444	1.628	2.927	4.570	1.00	0.788	1.234	1.854	7.242	11.966	17.661	2.076	3.363	4.997
0 - 200m WD	1.00	0.338	0.486	0.578	3.361	6.653	13.179	0.936	1.669	2.923	1.00	0.346	0.499	0.586	3.600	6.848	13.395	0.987	1.718	2.970
200 - 900m WD	0.95	0.044	0.408	0.740	0.209	3.047	5.276	0.081	0.950	1.679	0.98	0.225	0.463	0.809	1.514	3.622	5.648	0.495	1.108	1.814
>900m WD	0.42	0.000	0.173	0.638	0.000	0.798	3.572	0.000	0.315	1.273	0.63	0.000	0.277	0.759	0.000	1.505	4.446	0.000	0.545	1.551
Mesozoic Province	1.00	0.587	1.063	1.644	5.855	10.479	16.444	1.628	2.927	4.570	1.00	0.788	1.234	1.854	7.242	11.966	17.661	2.076	3.363	4.997
0 - 200m WD	1.00	0.338	0.486	0.578	3.361	6.653	13.179	0.936	1.669	2.923	1.00	0.346	0.499	0.586	3.600	6.848	13.395	0.987	1.718	2.970
200 - 900m WD	0.95	0.044	0.408	0.740	0.209	3.047	5.276	0.081	0.950	1.679	0.98	0.225	0.463	0.809	1.514	3.622	5.648	0.495	1.108	1.814
>900m WD	0.42	0.000	0.173	0.638	0.000	0.798	3.572	0.000	0.315	1.273	0.63	0.000	0.277	0.759	0.000	1.505	4.446	0.000	0.545	1.551

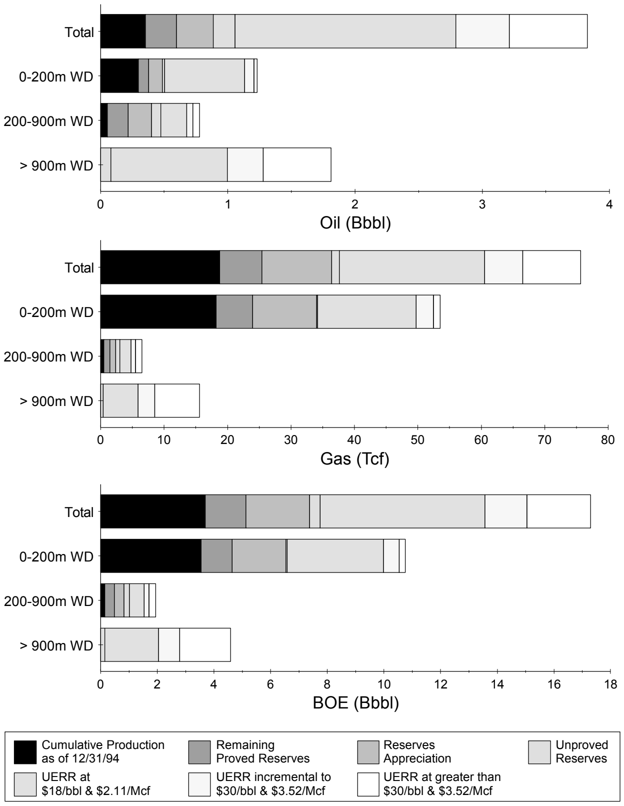


Figure E-1. Total hydrocarbon endowment of the Western Gulf of Mexico Planning Area by water depth.

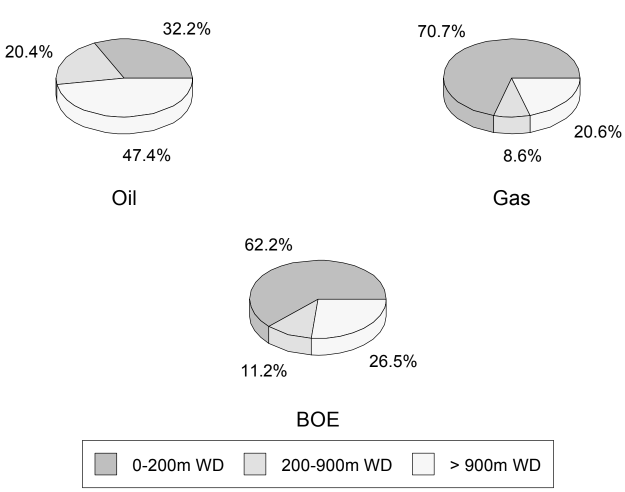


Figure E-2. Total hydrocarbon endowment of the Western Gulf of Mexico Planning Area by water depth.

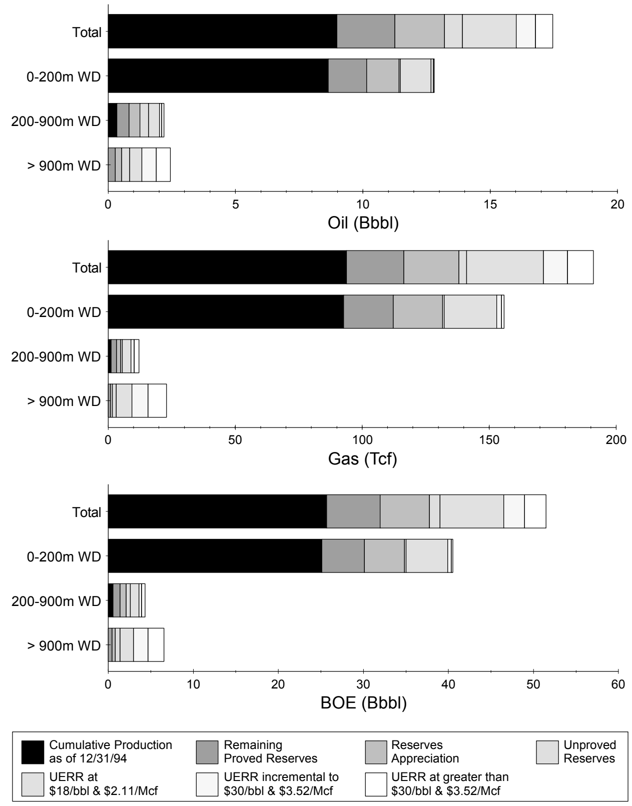


Figure E-3. Total hydrocarbon endowment of the Central Gulf of Mexico Planning Area by water depth.

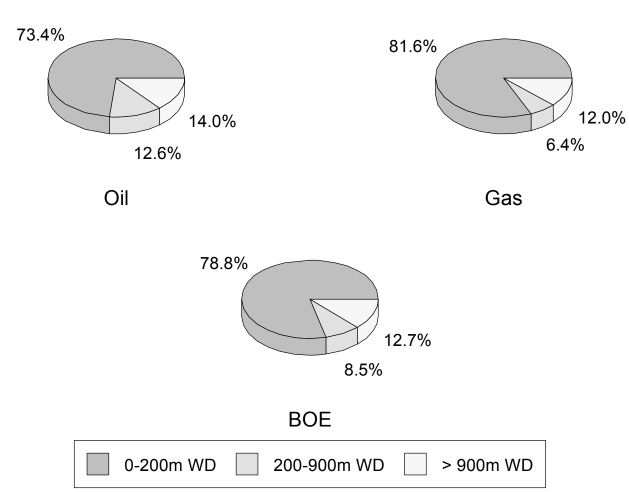


Figure E-4. Total hydrocarbon endowment of the Central Gulf of Mexico Planning Area by water depth.

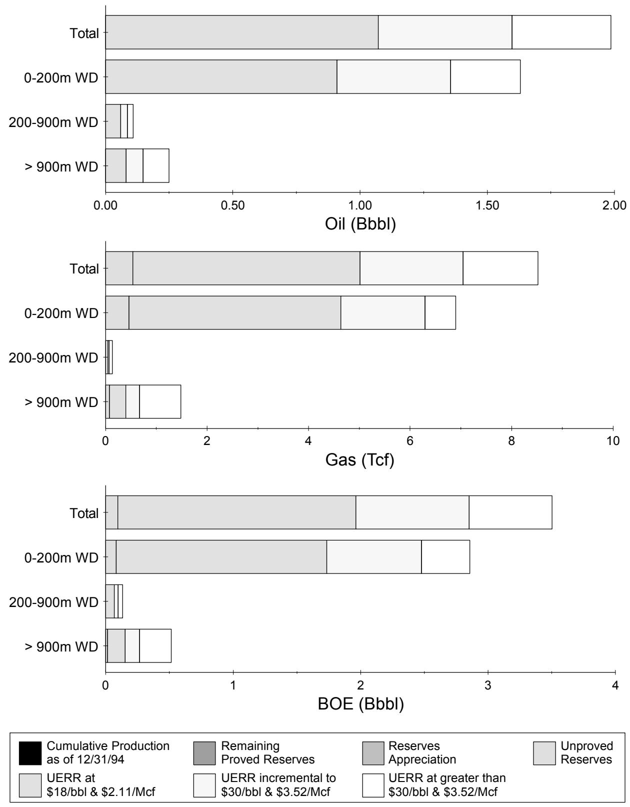


Figure E-5. Total hydrocarbon endowment of the Eastern Gulf of Mexico Planning Area by water depth.

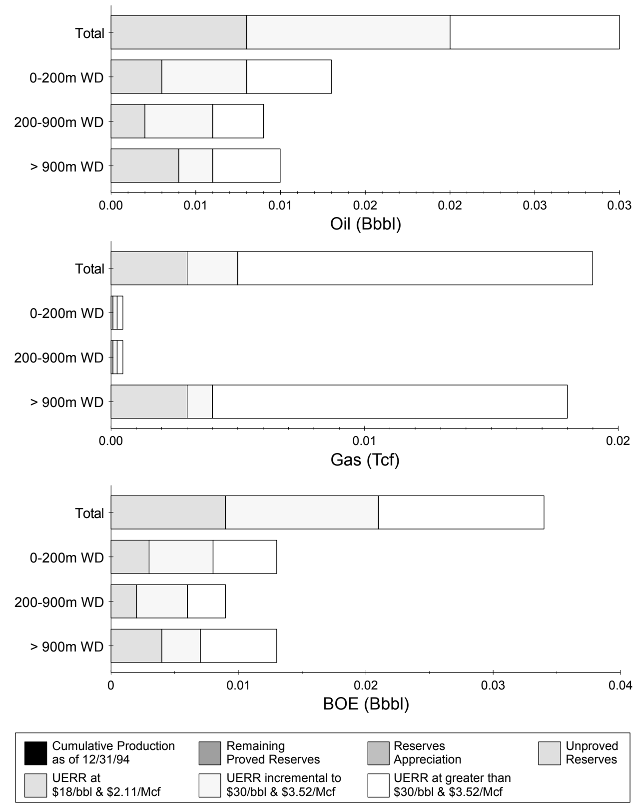


Figure E-7. Total hydrocarbon endowment of the Straits of Florida Planning Area by water depth.

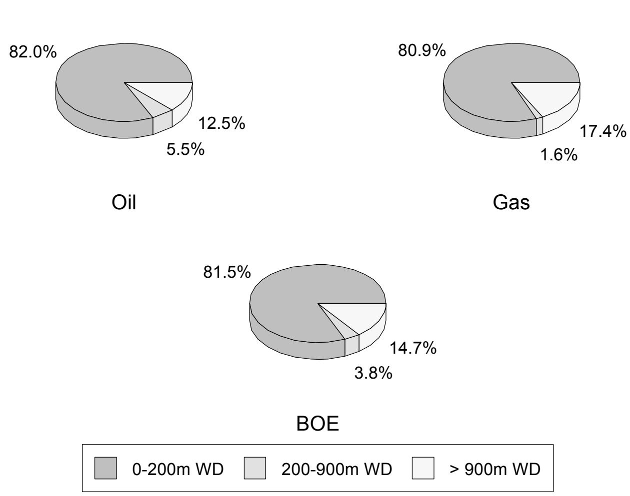


Figure E-6. Total hydrocarbon endowment of the Eastern Gulf of Mexico Planning Area by water depth.

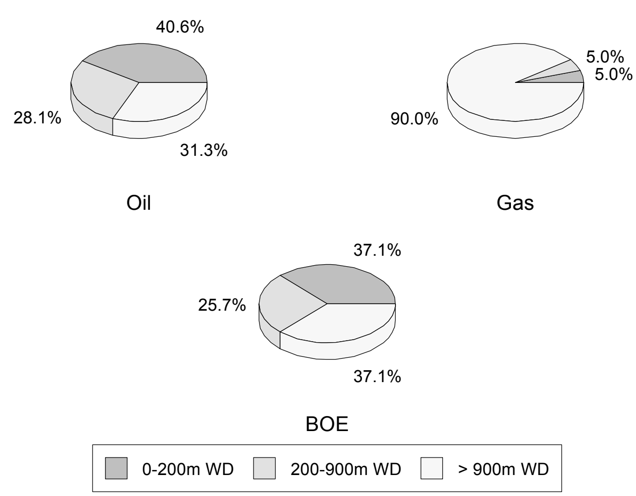


Figure E-8. Total hydrocarbon endowment of the Straits of Florida Planning Area by water depth.

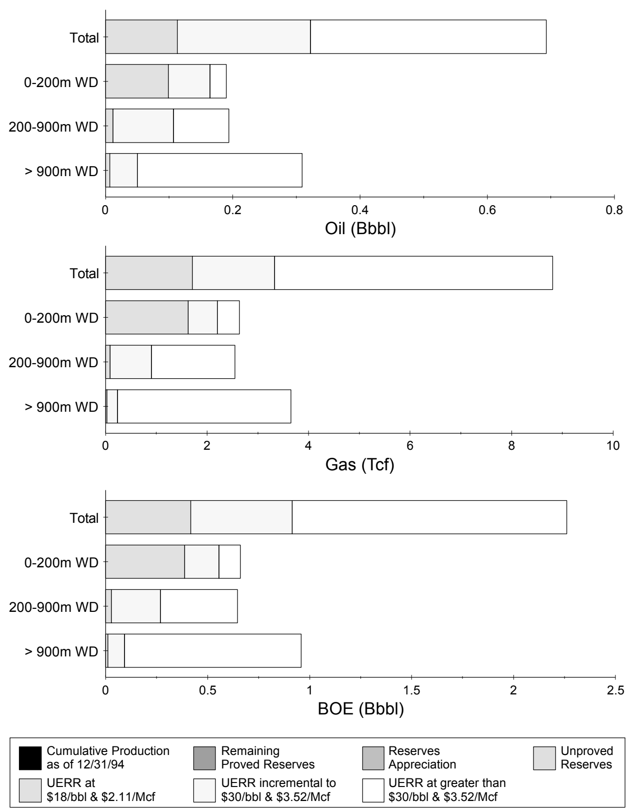


Figure E-9. Total hydrocarbon endowment of the North Atlantic Planning Area by water depth.

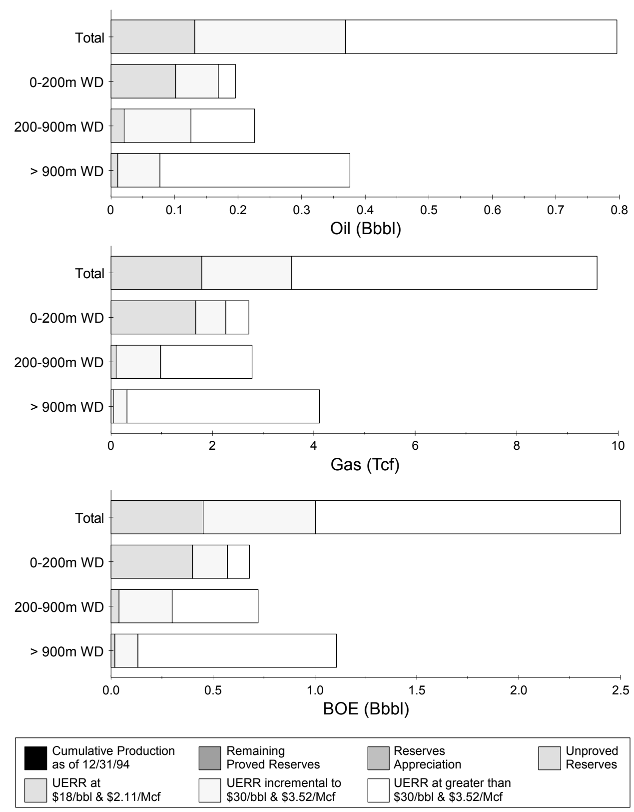


Figure E-11. Total hydrocarbon endowment of the Mid-Atlantic Planning Area by water depth

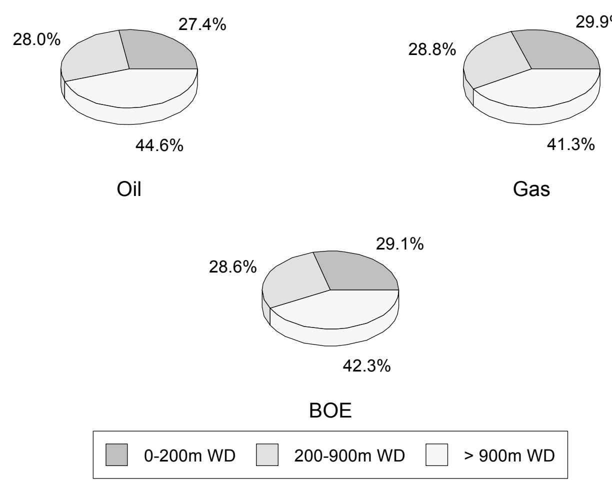


Figure E-10. Total hydrocarbon endowment of the North Atlantic Planning Area by water depth

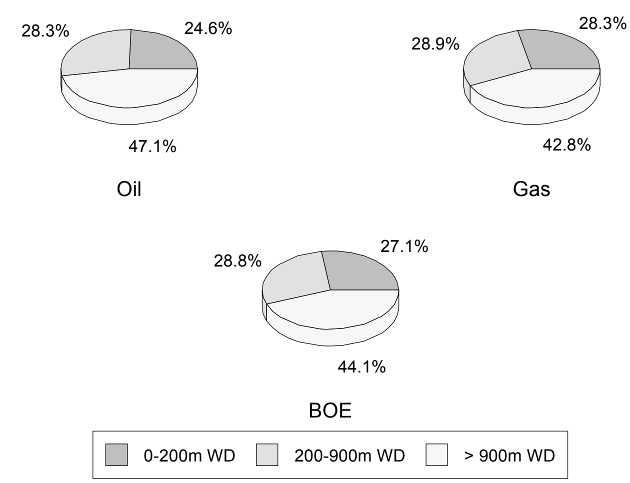


Figure E-12. Total hydrocarbon endowment of the Mid-Atlantic Planning Area by water depth

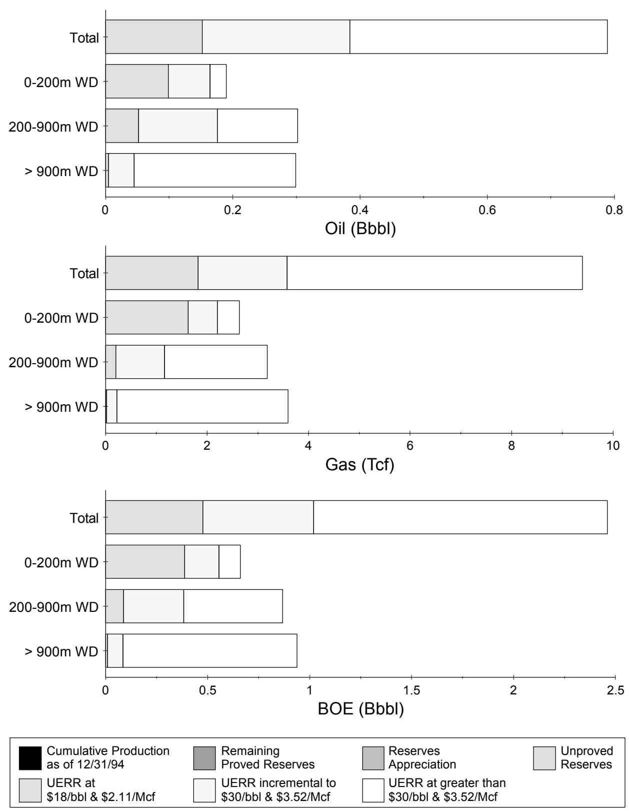


Figure E-13. Total hydrocarbon endowment of the South Atlantic Planning Area by water depth

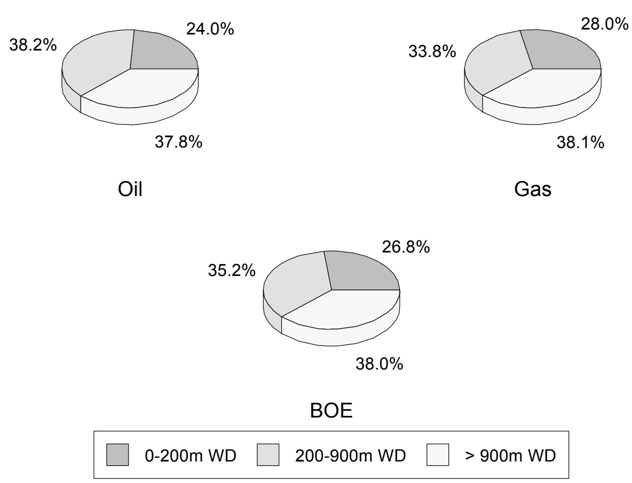


Figure E-14. Total hydrocarbon endowment of the South Atlantic Planning Area by water depth

Table E-1. Reserves and undiscovered conventionally recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, planning area, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Reserves												Risked Undiscovered Conventionally Recoverable Resources									
	Cumulative Production			Remaining Proved			Appreciation			Unproved			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)	Oil (Bbbl)	Gas (Tcf)	BOE (Bbbl)		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
GOM/Atl Continental Margin	9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	8.017	10.615	13.689	104.286	123.140	144.011	27.402	32.526	38.217
0 - 200m WD	8.938	110.949	28.680	1.597	25.290	6.097	1.371	29.435	6.609	0.074	1.326	0.311	1.00	3.881	4.292	4.576	53.916	57.315	63.854	13.474	14.491	15.938
200 - 900m WD	0.401	1.689	0.701	0.643	3.064	1.188	0.614	2.563	1.070	0.411	1.350	0.651	1.00	1.430	1.749	2.276	16.843	18.712	20.831	4.427	5.078	5.983
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.401	2.037	0.762	1.00	3.839	4.571	6.406	44.978	47.868	51.163	11.842	13.088	15.510
Gulf of Mexico Region	9.339	112.638	29.381	2.516	29.259	7.722	2.238	32.719	8.060	0.886	4.713	1.724	1.00	6.038	8.344	11.138	82.323	95.661	110.286	21.218	25.366	29.990
0 - 200m WD	8.938	110.949	28.680	1.597	25.290	6.097	1.371	29.435	6.609	0.074	1.326	0.311	1.00	3.296	3.712	4.178	47.936	49.331	50.721	11.825	12.490	13.203
200 - 900m WD	0.401	1.689	0.701	0.643	3.064	1.188	0.614	2.563	1.070	0.411	1.350	0.651	1.00	0.825	1.033	1.355	9.105	10.208	11.628	2.445	2.849	3.424
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.401	2.037	0.762	1.00	2.955	3.593	5.367	34.152	36.513	39.420	9.032	10.090	12.381
Western Planning Area	0.353	18.757	3.690	0.243	6.693	1.434	0.291	11.011	2.250	0.171	1.190	0.383	1.00	2.178	2.769	4.460	35.238	38.061	41.149	8.448	9.542	11.781
0 - 200m WD	0.298	18.233	3.542	0.080	5.730	1.100	0.108	10.100	1.905	0.018	0.155	0.046	1.00	0.639	0.728	0.851	17.933	19.320	20.815	3.830	4.166	4.554
200 - 900m WD	0.055	0.524	0.148	0.163	0.963	0.334	0.183	0.911	0.345	0.072	0.639	0.186	1.00	0.233	0.307	0.417	3.025	3.501	4.028	0.771	0.930	1.133
>900m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.081	0.396	0.151	1.00	1.128	1.731	3.340	13.274	15.223	17.913	3.490	4.439	6.527
Central Planning Area	8.986	93.881	25.691	2.273	22.566	6.288	1.947	21.708	5.810	0.715	2.986	1.245	1.00	3.317	3.550	3.809	48.175	49.978	52.061	11.889	12.443	13.073
0 - 200m WD	8.640	92.716	25.138	1.517	19.560	4.997	1.263	19.335	4.704	0.056	0.712	0.183	1.00	1.215	1.342	1.524	22.410	23.565	24.538	5.202	5.535	5.890
200 - 900m WD	0.346	1.165	0.553	0.480	2.101	0.854	0.431	1.652	0.725	0.339	0.711	0.465	1.00	0.451	0.604	0.874	5.660	6.581	8.334	1.458	1.775	2.357
>900m WD	0.000	0.000	0.000	0.276	0.905	0.437	0.253	0.721	0.381	0.320	1.563	0.597	1.00	1.528	1.605	1.678	18.766	19.840	21.021	4.868	5.135	5.418
Eastern Planning Area	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	<0.001	0.537	0.096	1.00	1.575	1.985	2.451	7.466	7.981	8.722	2.903	3.406	4.003
0 - 200m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	<0.001	0.459	0.082	1.00	1.269	1.630	2.086	6.117	6.439	6.725	2.357	2.776	3.283
200 - 900m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.00	0.064	0.109	0.180	0.092	0.138	0.229	0.080	0.133	0.220
>900m WD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	<0.001	0.078	0.014	1.00	0.151	0.249	0.391	0.938	1.408	2.247	0.318	0.500	0.791
Straits of FL Planning Area	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.022	0.031	0.044	0.014	0.019	0.025	0.025	0.034	0.048
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.009	0.013	0.019	0.001	0.001	0.001	0.009	0.013	0.019
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.006	0.009	0.013	<0.001	0.001	0.001	0.006	0.009	0.013
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.004	0.010	0.019	0.011	0.018	0.026	0.006	0.013	0.023
Atlantic Region	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1.267	2.271	3.667	15.855	27.480	43.372	4.475	7.161	10.684
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.418	0.576	0.669	4.790	8.004	14.557	1.271	2.000	3.259
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.524	0.722	0.995	6.994	8.512	10.519	1.769	2.236	2.867
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.753	0.983	1.385	9.695	11.353	13.485	2.478	3.003	3.784
North Atlantic Planning Area	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.596	0.693	0.806	7.523	8.812	10.910	1.935	2.261	2.747
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.138	0.190	0.221	1.581	2.641	4.804	0.419	0.660	1.075
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.149	0.194	0.257	2.093	2.549	3.053	0.522	0.647	0.801
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.238	0.309	0.407	3.153	3.651	4.364	0.799	0.958	1.184
Mid-Atlantic Planning Area	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.666	0.796	1.004	8.144	9.588	11.624	2.116	2.502	3.072
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.142	0.196	0.227	1.629	2.721	4.949	0.432	0.680	1.108
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.168	0.226	0.293	2.316	2.783	3.415	0.580	0.722	0.901
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.271	0.376	0.588	3.482	4.110	5.011	0.891	1.107	1.479
South Atlantic Planning Area	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.676	0.789	1.029	7.822	9.396	11.643	2.068	2.461	3.101
0 - 200m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.138	0.190	0.221	1.581	2.641	4.804	0.419	0.660	1.075
200 - 900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.198	0.302	0.521	2.532	3.184	4.164	0.649	0.868	1.262
>900m WD	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0.235	0.299	0.390	3.101	3.592	4.249	0.786	0.938	1.146

Table E-2. Estimates of undiscovered economically recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, planning area, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Risked Undiscovered Economically Recoverable Resources Full-Cycle @ $18.00/bbl and $2.11/Mcf										Risked Undiscovered Economically Recoverable Resources Half-Cycle @ $18.00/bbl and $2.11/Mcf									
	MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
GOM/Atl Continental Margin	1.00	4.364	5.350	7.094	57.252	63.295	70.695	14.551	16.613	19.674	1.00	4.791	5.784	7.374	62.301	68.462	76.883	15.876	17.966	21.055
0 - 200m WD	1.00	2.651	3.043	3.385	40.514	45.512	52.431	9.860	11.142	12.714	1.00	2.769	3.209	3.551	43.237	48.100	54.919	10.462	11.768	13.323
200 - 900m WD	1.00	0.485	0.782	1.294	3.961	5.633	8.650	1.190	1.784	2.833	1.00	0.536	0.849	1.353	4.451	6.319	9.979	1.328	1.973	3.129
>900m WD	1.00	0.808	1.497	3.196	8.859	12.140	15.620	2.384	3.657	5.975	1.00	1.039	1.708	3.388	10.611	13.992	17.220	2.927	4.198	6.452
Gulf of Mexico Region	1.00	4.016	4.941	6.627	53.737	57.941	62.162	13.577	15.251	17.688	1.00	4.350	5.306	6.967	58.428	62.300	66.495	14.747	16.391	18.799
0 - 200m WD	1.00	2.374	2.771	3.186	38.807	40.722	42.653	9.279	10.017	10.775	1.00	2.497	2.901	3.322	41.085	42.859	44.855	9.808	10.527	11.304
200 - 900m WD	1.00	0.476	0.701	1.030	3.859	5.200	6.817	1.162	1.626	2.243	1.00	0.513	0.736	1.056	4.381	5.633	7.383	1.292	1.739	2.369
>900m WD	1.00	0.830	1.477	3.170	8.627	12.053	15.275	2.365	3.621	5.888	1.00	1.008	1.670	3.360	10.665	13.822	16.857	2.906	4.130	6.360
Western Planning Area	1.00	1.053	1.734	3.260	20.110	22.897	26.386	4.632	5.808	7.955	1.00	1.262	1.900	3.418	22.012	24.920	28.234	5.179	6.334	8.442
0 - 200m WD	1.00	0.530	0.630	0.742	14.162	15.564	17.219	3.050	3.399	3.806	1.00	0.551	0.650	0.764	14.866	16.258	17.837	3.196	3.542	3.938
200 - 900m WD	1.00	0.122	0.204	0.313	1.082	1.796	2.580	0.314	0.523	0.772	1.00	0.146	0.222	0.352	1.276	2.048	2.692	0.373	0.586	0.831
>900m WD	1.00	0.276	0.916	2.535	3.053	5.508	8.496	0.820	1.896	4.046	1.00	0.396	1.052	2.686	4.434	6.677	9.578	1.185	2.240	4.390
Central Planning Area	1.00	1.857	2.115	2.428	27.572	30.216	32.718	6.763	7.492	8.250	1.00	1.945	2.216	2.557	29.416	31.904	34.306	7.179	7.893	8.661
0 - 200m WD	1.00	1.095	1.212	1.406	19.453	20.713	21.695	4.557	4.898	5.267	1.00	1.117	1.236	1.434	20.350	21.570	22.531	4.738	5.074	5.443
200 - 900m WD	1.00	0.281	0.431	0.692	2.214	3.382	5.200	0.675	1.032	1.617	1.00	0.285	0.445	0.693	2.484	3.565	5.450	0.727	1.079	1.663
>900m WD	1.00	0.352	0.477	0.601	4.186	6.190	8.195	1.097	1.578	2.060	1.00	0.424	0.538	0.667	4.848	6.816	8.759	1.286	1.751	2.226
Eastern Planning Area	1.00	0.676	1.071	1.508	3.492	4.476	5.601	1.298	1.868	2.504	1.00	0.763	1.170	1.640	4.337	5.220	6.283	1.535	2.099	2.758
0 - 200m WD	1.00	0.599	0.909	1.358	3.272	4.177	4.764	1.181	1.652	2.206	1.00	0.656	1.002	1.457	4.182	4.839	5.300	1.400	1.863	2.400
200 - 900m WD	0.88	0.000	0.059	0.137	0.000	0.047	0.134	0.000	0.067	0.161	0.92	0.000	0.064	0.139	0.000	0.053	0.145	0.000	0.073	0.164
>900m WD	0.51	0.000	0.080	0.232	0.000	0.322	1.502	0.000	0.138	0.499	0.61	0.000	0.093	0.254	0.000	0.382	1.524	0.000	0.161	0.525
Straits of FL Planning Area	0.67	0.000	0.008	0.022	0.000	0.003	0.009	0.000	0.009	0.024	0.75	0.000	0.009	0.024	0.000	0.003	0.010	0.000	0.010	0.025
0 - 200m WD	0.45	0.000	0.003	0.009	0.000	<0.001	<0.001	0.000	0.003	0.009	0.51	0.000	0.003	0.010	0.000	<0.001	<0.001	0.000	0.003	0.010
200 - 900m WD	0.45	0.000	0.002	0.006	0.000	<0.001	<0.001	0.000	0.002	0.006	0.51	0.000	0.002	0.007	0.000	<0.001	<0.001	0.000	0.002	0.007
>900m WD	0.39	0.000	0.004	0.015	0.000	0.003	0.011	0.000	0.004	0.017	0.47	0.000	0.004	0.015	0.000	0.003	0.011	0.000	0.005	0.017
Atlantic Region	0.92	0.000	0.368	0.808	0.000	5.203	11.688	0.000	1.294	2.888	0.97	0.125	0.452	0.910	1.154	5.989	12.404	0.331	1.518	3.118
0 - 200m WD	0.90	0.000	0.274	0.427	0.000	4.810	12.027	0.000	1.129	2.567	0.94	0.037	0.313	0.447	0.378	5.279	12.398	0.105	1.252	2.653
200 - 900m WD	0.22	0.000	0.083	0.449	0.000	0.375	2.933	0.000	0.150	0.971	0.31	0.000	0.118	0.519	0.000	0.652	3.629	0.000	0.234	1.165
>900m WD	0.05	0.000	0.026	0.146	0.000	0.104	0.656	0.000	0.045	0.262	0.08	0.000	0.040	0.311	0.000	0.157	1.381	0.000	0.068	0.557
North Atlantic Planning Area	0.91	0.000	0.113	0.219	0.000	1.707	3.871	0.000	0.417	0.908	0.95	0.024	0.139	0.274	0.250	1.937	4.171	0.069	0.484	1.017
0 - 200m WD	0.91	0.000	0.099	0.157	0.000	1.626	3.942	0.000	0.388	0.859	0.95	0.024	0.112	0.164	0.230	1.784	4.061	0.065	0.430	0.886
200 - 900m WD	0.10	0.000	0.012	0.120	0.000	0.092	0.873	0.000	0.028	0.276	0.16	0.000	0.020	0.144	0.000	0.155	1.075	0.000	0.047	0.335
>900m WD	0.05	0.000	0.007	0.037	0.000	0.026	0.165	0.000	0.011	0.066	0.08	0.000	0.010	0.082	0.000	0.040	0.334	0.000	0.017	0.142
Mid-Atlantic Planning Area	0.94	0.016	0.132	0.263	0.081	1.795	4.143	0.031	0.451	1.000	0.97	0.045	0.160	0.349	0.456	2.068	4.166	0.126	0.528	1.090
0 - 200m WD	0.91	0.000	0.102	0.162	0.000	1.675	4.061	0.000	0.400	0.885	0.95	0.024	0.116	0.169	0.237	1.838	4.184	0.067	0.443	0.913
200 - 900m WD	0.21	0.000	0.021	0.140	0.000	0.103	0.824	0.000	0.039	0.286	0.29	0.000	0.032	0.152	0.000	0.190	1.231	0.000	0.066	0.371
>900m WD	0.04	0.000	0.011	0.036	0.000	0.044	0.199	0.000	0.019	0.071	0.07	0.000	0.021	0.157	0.000	0.073	0.638	0.000	0.034	0.271
South Atlantic Planning Area	0.94	0.021	0.152	0.323	0.124	1.826	4.364	0.043	0.477	1.099	0.97	0.048	0.183	0.413	0.506	2.086	4.542	0.138	0.554	1.221
0 - 200m WD	0.91	0.000	0.099	0.157	0.000	1.626	3.942	0.000	0.388	0.859	0.95	0.024	0.112	0.164	0.230	1.784	4.061	0.065	0.430	0.886
200 - 900m WD	0.22	0.000	0.052	0.280	0.000	0.203	1.199	0.000	0.088	0.494	0.31	0.000	0.066	0.302	0.000	0.303	1.463	0.000	0.120	0.562
>900m WD	0.05	0.000	0.005	0.029	0.000	0.021	0.135	0.000	0.009	0.053	0.08	0.000	0.008	0.066	0.000	0.033	0.272	0.000	0.014	0.115

Table E-3. Estimates of undiscovered economically recoverable resources of the Gulf of Mexico and Atlantic continental margin by region, planning area, and water depth.

Note: Summation of individual resource values may differ from total values due to independent computer runs and rounding.

	Risked Undiscovered Economically Recoverable Resources Full-Cycle @ $30.00/bbl and $3.52/Mcf										Risked Undiscovered Economically Recoverable Resources Half-Cycle @ $30.00/bbl and $3.52/Mcf									
	MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)			MPhc	Oil (Bbbl)			Gas (Tcf)			BOE (Bbbl)		
		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5		F_{95}	Mean	F_5	F_{95}	Mean	F_5	F_{95}	Mean	F_5
GOM/Atl Continental Margin	1.00	6.632	7.672	9.367	79.526	85.684	92.942	20.783	22.918	25.905	1.00	7.019	8.077	9.892	83.936	89.895	97.023	21.954	24.072	27.156
0 - 200m WD	1.00	3.429	3.857	4.218	49.936	53.379	59.400	12.315	13.355	14.788	1.00	3.527	3.924	4.277	50.646	54.133	60.227	12.539	13.556	14.994
200 - 900m WD	1.00	0.817	1.272	1.826	7.400	10.283	12.844	2.134	3.102	4.112	1.00	0.997	1.349	1.869	8.758	11.245	13.726	2.556	3.350	4.312
>900m WD	1.00	1.802	2.569	4.385	18.749	22.078	25.626	5.138	6.498	8.945	1.00	1.984	2.822	4.641	20.819	24.603	28.461	5.689	7.200	9.705
Gulf of Mexico Region	1.00	5.697	6.639	8.241	71.606	75.298	79.251	18.439	20.038	22.343	1.00	5.963	6.865	8.485	74.379	78.100	81.964	19.197	20.762	23.069
0 - 200m WD	1.00	2.980	3.368	3.856	45.136	46.745	48.159	11.012	11.686	12.425	1.00	3.018	3.423	3.905	45.852	47.318	48.730	11.177	11.843	12.575
200 - 900m WD	1.00	0.651	0.870	1.196	5.993	7.244	8.747	1.718	2.159	2.752	1.00	0.672	0.892	1.205	6.358	7.602	9.166	1.803	2.245	2.836
>900m WD	1.00	1.731	2.398	4.158	18.492	21.216	24.342	5.021	6.173	8.490	1.00	1.873	2.545	4.303	20.385	23.056	26.086	5.500	6.648	8.944
Western Planning Area	1.00	1.543	2.156	3.825	26.106	28.891	32.189	6.188	7.297	9.553	1.00	1.653	2.259	3.916	27.652	30.517	33.796	6.574	7.689	9.930
0 - 200m WD	1.00	0.620	0.703	0.826	16.839	18.269	19.727	3.616	3.954	4.336	1.00	0.620	0.707	0.829	17.138	18.529	19.995	3.669	4.004	4.387
200 - 900m WD	1.00	0.175	0.253	0.400	1.829	2.502	2.922	0.500	0.699	0.920	1.00	0.184	0.264	0.391	2.086	2.693	3.227	0.555	0.743	0.965
>900m WD	1.00	0.590	1.198	2.817	5.915	8.126	10.992	1.643	2.644	4.773	1.00	0.678	1.288	2.903	7.148	9.316	12.175	1.950	2.946	5.069
Central Planning Area	1.00	2.636	2.863	3.164	37.436	39.758	41.988	9.297	9.937	10.635	1.00	2.695	2.925	3.224	38.400	40.673	42.914	9.527	10.162	10.860
0 - 200m WD	1.00	1.158	1.295	1.488	21.517	22.618	23.565	4.986	5.320	5.681	1.00	1.168	1.302	1.487	21.705	22.808	23.789	5.030	5.361	5.720
200 - 900m WD	1.00	0.357	0.520	0.780	3.669	4.683	6.571	1.010	1.353	1.950	1.00	0.362	0.529	0.800	3.830	4.846	6.654	1.044	1.391	1.984
>900m WD	1.00	0.946	1.051	1.148	11.059	12.509	14.118	2.914	3.276	3.660	1.00	1.006	1.094	1.186	11.587	13.078	14.725	3.068	3.421	3.806
Eastern Planning Area	1.00	1.196	1.597	2.072	5.691	6.509	7.346	2.208	2.756	3.379	1.00	1.243	1.658	2.130	6.012	6.747	7.618	2.312	2.858	3.485
0 - 200m WD	1.00	0.996	1.356	1.820	5.464	5.838	6.109	1.969	2.395	2.907	1.00	1.041	1.403	1.870	5.617	5.968	6.272	2.040	2.465	2.986
200 - 900m WD	1.00	0.034	0.086	0.160	0.013	0.070	0.154	0.036	0.098	0.187	1.00	0.040	0.088	0.160	0.024	0.077	0.167	0.044	0.102	0.190
>900m WD	0.91	0.000	0.147	0.301	0.000	0.594	1.667	0.000	0.253	0.598	0.95	0.023	0.162	0.301	0.033	0.682	1.790	0.029	0.284	0.620
Straits of FL Planning Area	1.00	0.009	0.020	0.034	0.001	0.005	0.010	0.010	0.021	0.036	1.00	0.010	0.021	0.034	0.002	0.006	0.011	0.010	0.022	0.036
0 - 200m WD	1.00	0.004	0.008	0.014	<0.001	<0.001	0.001	0.004	0.008	0.015	1.00	0.004	0.009	0.015	<0.001	<0.001	0.001	0.004	0.009	0.015
200 - 900m WD	1.00	0.002	0.006	0.010	<0.001	<0.001	<0.001	0.002	0.006	0.010	1.00	0.003	0.006	0.010	<0.001	<0.001	<0.001	0.003	0.006	0.010
>900m WD	0.74	0.000	0.006	0.016	0.000	0.004	0.011	0.000	0.007	0.018	0.80	0.000	0.006	0.016	0.000	0.005	0.013	0.000	0.007	0.018
Atlantic Region	1.00	0.587	1.063	1.644	5.855	10.479	16.444	1.628	2.927	4.570	1.00	0.788	1.234	1.854	7.242	11.966	17.661	2.076	3.363	4.997
0 - 200m WD	1.00	0.338	0.486	0.578	3.361	6.653	13.179	0.936	1.669	2.923	1.00	0.346	0.499	0.586	3.600	6.848	13.395	0.987	1.718	2.970
200 - 900m WD	0.95	0.044	0.408	0.740	0.209	3.047	5.276	0.081	0.950	1.679	0.98	0.225	0.463	0.809	1.514	3.622	5.648	0.495	1.108	1.814
>900m WD	0.42	0.000	0.173	0.638	0.000	0.798	3.572	0.000	0.315	1.273	0.63	0.000	0.277	0.759	0.000	1.505	4.446	0.000	0.545	1.551
North Atlantic Planning Area	1.00	0.202	0.322	0.440	1.884	3.328	5.555	0.538	0.914	1.428	1.00	0.237	0.373	0.519	2.182	3.767	6.031	0.626	1.043	1.592
0 - 200m WD	1.00	0.112	0.164	0.194	1.123	2.200	4.350	0.312	0.555	0.968	1.00	0.115	0.167	0.191	1.195	2.263	4.444	0.328	0.570	0.982
200 - 900m WD	0.90	0.000	0.107	0.186	0.000	0.905	1.519	0.000	0.268	0.457	0.96	0.054	0.122	0.193	0.390	1.079	1.658	0.124	0.314	0.489
>900m WD	0.42	0.000	0.050	0.196	0.000	0.238	1.063	0.000	0.092	0.385	0.63	0.000	0.083	0.223	0.000	0.467	1.402	0.000	0.166	0.472
Mid-Atlantic Planning Area	1.00	0.207	0.369	0.580	1.971	3.566	5.796	0.557	1.003	1.611	1.00	0.256	0.424	0.655	2.426	4.066	6.269	0.688	1.148	1.770
0 - 200m WD	1.00	0.116	0.169	0.199	1.157	2.267	4.482	0.322	0.572	0.997	1.00	0.119	0.173	0.197	1.231	2.332	4.579	0.338	0.587	1.011
200 - 900m WD	0.94	0.006	0.126	0.217	0.022	0.978	1.663	0.010	0.300	0.513	0.98	0.077	0.144	0.227	0.454	1.173	1.853	0.157	0.352	0.557
>900m WD	0.40	0.000	0.077	0.309	0.000	0.313	1.298	0.000	0.132	0.540	0.61	0.000	0.114	0.340	0.000	0.561	1.713	0.000	0.214	0.645
South Atlantic Planning Area	1.00	0.210	0.384	0.620	1.997	3.578	5.971	0.565	1.020	1.683	1.00	0.268	0.440	0.675	2.437	4.078	6.425	0.702	1.165	1.818
0 - 200m WD	1.00	0.112	0.164	0.194	1.123	2.200	4.350	0.312	0.555	0.968	1.00	0.115	0.167	0.191	1.195	2.263	4.444	0.328	0.570	0.982
200 - 900m WD	0.95	0.035	0.176	0.425	0.143	1.161	2.143	0.061	0.382	0.806	0.98	0.081	0.196	0.447	0.593	1.367	2.344	0.187	0.440	0.864
>900m WD	0.42	0.000	0.045	0.191	0.000	0.223	1.000	0.000	0.085	0.369	0.63	0.000	0.078	0.209	0.000	0.448	1.343	0.000	0.158	0.448

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 allottee, 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.