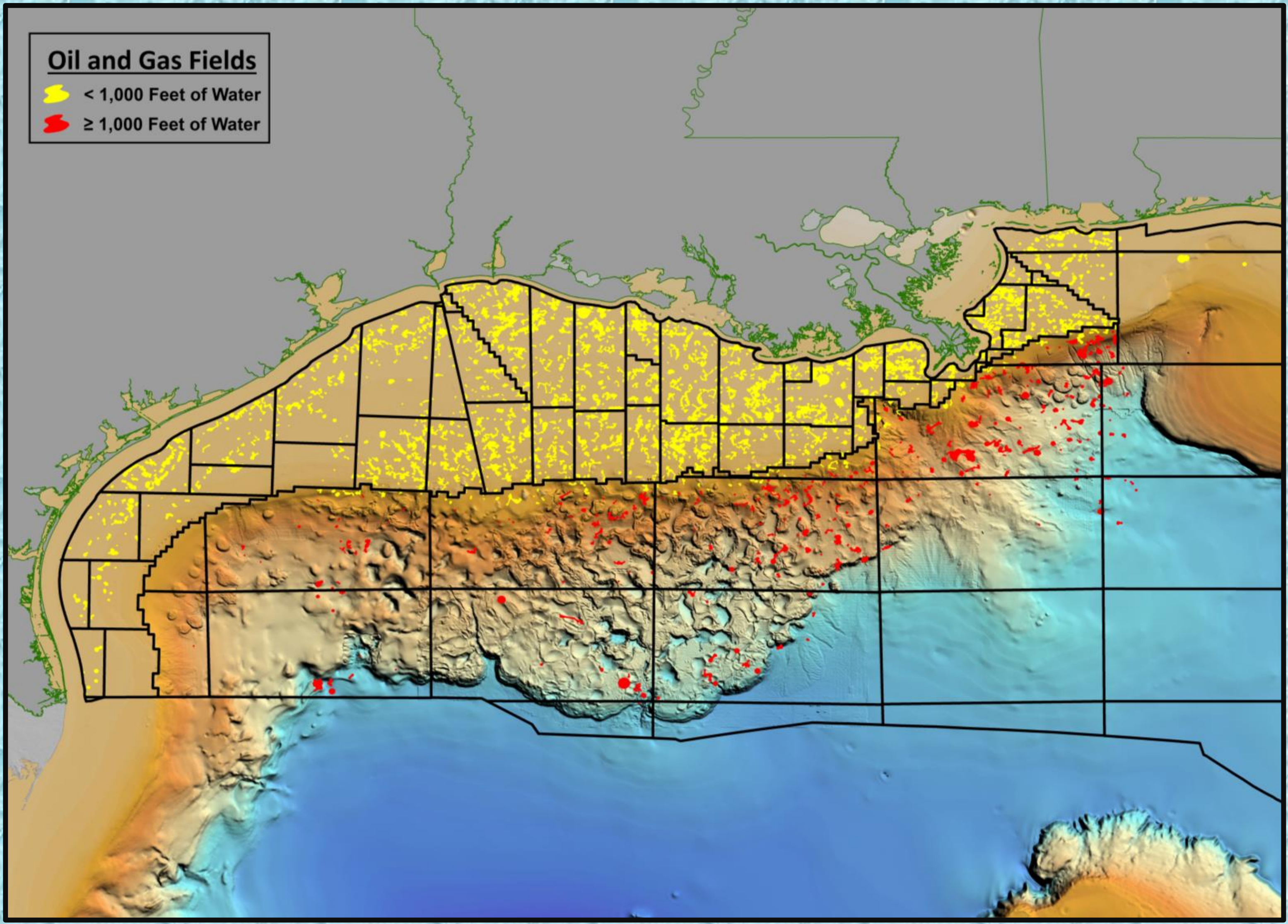
OCS Report
BOEM 2016-057

Deepwater Gulf of Mexico December 31, 2014



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
Office of Resource Evaluation

BOEM
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ON COVER—Multibeam bathymetry map of the northern Gulf of Mexico. Superimposed are protraction area boundaries and oil and gas field outlines in shallow water (<1,000 feet) and deepwater (≥1,000 feet). The bathymetric map is from the U.S. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Centers for Environmental Information (formerly the National Geophysical Data Center).

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A MESSAGE FROM THE REGIONAL DIRECTOR

The Gulf of Mexico is one of the world's prolific hydrocarbon basins, with a production history of more than 100 years. It is the primary offshore source of hydrocarbons for the United States, generating approximately 97 percent of all offshore oil and natural gas production. Of both onshore and offshore domestic production in 2014, the Gulf of Mexico supplied the Nation with 16 percent of the total oil and 4.5 percent of the total gas. Of this Gulf of Mexico production, wells in deepwater produced 82 percent of the oil and 54 percent of the natural gas.

Release of this publication marks the Bureau of Ocean Energy Management Gulf of Mexico OCS Region's 10th report highlighting oil and gas activities in the deepwater Gulf of Mexico, and the first since 2009. Since the first year of publication in 1997, we have witnessed the oil and gas industry forge new paths, overcome technological challenges, and move into deeper and deeper water to responsibly explore and develop the Nation's energy resources.

The Department of Interior's Bureau of Ocean Energy Management plays a critical role in the development of offshore energy and mineral resources for the Nation, with the Gulf of Mexico OCS Region at the forefront. The bureau is charged with providing access to and developing resources in a manner that is safe and environmentally sound, prevents waste, and provides a fair return for public resources.

As I look forward to the future of the Gulf of Mexico, I am very pleased to present this report on current deepwater activities related to leasing, seismic and well data, geology, reserves, and production.

Michael A. Celata
Regional Director
Gulf of Mexico OCS Region
Bureau of Ocean Energy Management

TABLE OF CONTENTS

A MESSAGE FROM THE REGIONAL DIRECTOR ii
FIGURES v
TABLES vii
ABBREVIATIONS AND ACRONYMS viii
ABOUT THIS REPORT 1
DEEPWATER HISTORY 3
LEASING 7
  5-Year OCS Oil and Gas Leasing Program 7
  Recent Lease Sales 8
    Central Lease Sale 235 8
    Western Lease Sale 246 8
    Central Lease Sale 241/Eastern Lease Sale 226 8
  Active Leases 12
  Initial Lease Term Periods 15
SEISMIC DATA 16
  Types of Seismic Data 16
  Coverage 18
WELL DATA 21
  Exploratory and Development Wells 21
  Drilling and Water Depths 22
GEOLOGY 25
  Overview 25
  Chronozones 25
  Deepwater Plays 28
    Plio-Pleistocene 30
    Miocene 30
    Lower Tertiary 32
    Jurassic Norphlet 39

RESERVES AND RESOURCES 45
Classification 45
Reserves Inventory 46
Resource Assessment 50
PRODUCTION 51
Facilities 51
Volumes 55
Rates 57
Pipelines 57
Lag Time 61
REFERENCES 62
CONTRIBUTING PERSONNEL 64
APPENDICES 65
Appendix A. Productive Deepwater Fields 65
Appendix B. Deepwater Production Facilities 72
Appendix C. Deepwater Fields and Associated Project Names 74
Appendix D. Deepwater Fields by Dominant Reservoir Age 83

FIGURES

Figure 1. Basemap illustrating planning areas, protraction areas, and water-depth categories referred to in this report. 2
Figure 2. Central Sale 235 geographic bid distribution. 9
Figure 3. Western Sale 246 geographic bid distribution. 10
Figure 4. Central Sale 241 geographic bid distribution. 11
Figure 5. Number of active leases for each deepwater interval at the end of each year. 12
Figure 6. Number of deepwater and shallow-water active leases at the end of each year. 13
Figure 7. Active leases at the end of 2014 by water-depth categories. 13
Figure 8. Geographic distribution of active leases by water depth. 14
Figure 9. Seismic acquisition geometries. 17
Figure 10. Seismic data obtained by BOEM by type. 20
Figure 11. Total number of deepwater wells drilled by water depth. 21
Figure 12. Deepwater exploratory wells drilled by water depth. 23
Figure 13. Deepwater development wells drilled by water depth. 23
Figure 14. Deepest well drilled by year with associated water depth. 24
Figure 15. Water-depth drilling records by year. 24
Figure 16. Generalized physiographic map of the Gulf of Mexico area. 29
Figure 17. Deepwater Plio-Pleistocene, Miocene, and Lower Tertiary trends. 31
Figure 18. Average porosities for deepwater reservoirs by age. 34
Figure 19. Deepwater Lower Tertiary porosity. 35
Figure 20. Deepwater Lower Tertiary permeability. 35
Figure 21. Well log response from the Great White Field. 36
Figure 22. Cobalt International Energy Lower Tertiary geologic model. 37
Figure 23. Well log responses from the Shenandoah and Cascade Fields. 38
Figure 24. Deepwater Norphlet trend. 40
Figure 25. Aeolian dune type change from shallow-water to deepwater Norphlet. 42
Figure 26. Well log response of the Vicksburg "B" discovery. 43
Figure 27. Porosity and permeability crossplot by Norphlet facies. 44
Figure 28. Net to gross sand crossplot by Norphlet facies. 44
Figure 29. BOEM (a) original reserves and (b) contingent resources. 46
Figure 30. Number of BOEM-designated fields in deepwater by discovery year through 2014. 47
Figure 31. Field reserves by discovery year for each deepwater category. 47
Figure 32. Estimated reserves of deepwater fields. 48
Figure 33. Deepwater fields discovered in the years 2010-2014. 49
Figure 34. Types of deepwater production facilities. 51
Figure 35. Water-depth ranges for installed deepwater production facilities through 2014. 52
Figure 36. Geographic distribution of deepwater production facilities through 2014. 53

Figure 37. Deepwater fields starting production in the years 2010-2014. 54
Figure 38. Estimated U.S. (a) oil and (b) gas production in 2014 55
Figure 39. Cumulative estimates of original reserves, production, and remaining reserves in deepwater. 56
Figure 40. Comparison of average annual shallow-water and deepwater (a) oil and (b) gas production. 58
Figure 41. Average production rates for shallow-water and deepwater (a) oil and (b) gas well completions. 59
Figure 42. Deepwater oil and gas pipelines. 60
Figure 43. Average time from leasing to first production for deepwater fields. 61

TABLES

Table 1. Initial lease term periods. 15
Table 2. Historical chronostratigraphy. 26
Table 3. Current Cenozoic chronostratigraphy. 27
Table 4. Current Mesozoic chronostratigraphy. 28
Table 5. Deepwater Norphlet lease sale information. 39
Table 6. Deepwater Norphlet well information. 41
Table 7. BOEM resource classification. 45
Table 8. 2010-2014 deepwater field discoveries. 49
Table 9. Undiscovered technically recoverable resources by age. 50
Table 10. 2010-2014 deepwater field production startups. 54
Table 11. Top 20 producing fields in 2014. 56
Table 12. Pleistocene-dominant fields and discoveries. 83
Table 13. Pliocene-dominant fields and discoveries. 84
Table 14. Upper Miocene-dominant fields and discoveries. 86
Table 15. Middle Miocene-dominant fields and discoveries. 87
Table 16. Lower Miocene-dominant fields and discoveries. 88
Table 17. Lower Tertiary-dominant fields and discoveries. 88

ABBREVIATIONS AND ACRONYMS

2D	two-dimensional
3D	three-dimensional
4D	time lapse
AC	Alaminos Canyon
AT	Atwater Valley
BBOE	billion barrels of oil equivalent
BOE	barrels of oil equivalent
BOEM	Bureau of Ocean Energy Management
BP	British Petroleum and bypass
CGG	Générale de Géophysique
CPA	Central Planning Area
CT	compliant tower
CZM	coastal zone management
DC	De Soto Canyon
DOCD	Development Operations Coordination Document
DOI	Department of the Interior
EA	environmental assessment
EB	East Breaks
EI	Eugene Island
EIS	environmental impact statement
EPA	Eastern Planning Area
FAZ	full azimuth
ft	feet
FP	fixed platform
FPSO	floating production, storage, and offloading facility
FPU	floating production unit
GB	Garden Banks
GC	Green Canyon
GOM	Gulf of Mexico
JU	Upper Jurassic
KC	Keathley Canyon
LL	Lloyd Ridge
m	meters
Ma	million years
MAZ	multi azimuth
MC	Mississippi Canyon
mD	millidarcy
MMBOE	million barrels of oil equivalent
mTLP	mini tension leg platform
N	north
NAZ	narrow azimuth
NEPA	National Environmental Policy Act
OBS	ocean-bottom survey
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PEA	programmatic environmental assessment
PGS	Petroleum Geo-Services
PI	Port Isabel
POE	Plan of Exploration
PSI	pounds per square inch
RAZ	rich azimuth
SE	Sigsbee Escarpment
semi	semisubmersible
TLP	tension leg platform
TVDSS	true vertical depth subsea
TVDT	true vertical depth thickness
U.S.	United States
VK	Viosca Knoll
WAZ	wide azimuth
WPA	Western Planning Area
WR	Walker Ridge

ABOUT THIS REPORT

The Bureau of Ocean Energy Management (BOEM) is a bureau in the United States Department of the Interior (DOI) that manages the offshore energy resources of the Outer Continental Shelf (OCS). Within BOEM, the Resource Evaluation Program supports all BOEM program areas through critical technical and economic analyses, including

- Geological and Geophysical Data Acquisition and Analysis
- Fair Market Value Determination
- Reserves Inventory
- Resource Assessment

Resource Evaluation functions are carried out by personnel located at Bureau Headquarters and the Regional OCS Offices of the Atlantic, Alaska, Gulf of Mexico, and Pacific. BOEM's Gulf of Mexico OCS Region is responsible for the United States portion of Gulf of Mexico (GOM) waters; therefore, the acronym GOM used throughout this report refers only to U.S. waters. The OCS is divided into several types of administrative geographical units, including three planning areas—the Western (WPA), the Central (CPA), and the Eastern (EPA)—and numerous protraction areas (**Figure 1**). Each protraction area is further divided into blocks approximately 9 square miles in area.

This publication by the Office of Resource Evaluation in the GOM Region presents leasing, seismic, well, geologic, reserves, and production information for the deepwater portion of the GOM. A variety of criteria can be used to define deepwater. The threshold separating shallow water and deepwater can range from 656 to 1,500 feet (ft), or 200 to 457 meters (m). For purposes of this report, deepwater is defined as water depths greater than or equal to 1,000 ft (305 m). Ultra-deepwater also is difficult to define precisely; for this report it is defined as water depths greater than or equal to 5,000 ft (1,524 m). Many of the data presented herein are subdivided according to the water-depth categories of 1,000, 2,500, 5,000, and 7,500 ft (305, 762, 1,524 , and 2,286 m). The bathymetric contour lines presented on several maps in this report are for reference only; they are not to be used for absolute depth measurements.

Most information in this report is gleaned from data as of the end of December 2014, except where noted. Crude oil and condensate are reported jointly as oil; associated and nonassociated gas are reported jointly as gas. Oil volumes are reported as stock tank barrels and gas as standard cubic feet. Oil-equivalent gas is a volume of gas (associated and/or nonassociated) expressed in terms of its energy equivalence to oil (i.e., 5,620 cubic feet of gas per barrel of oil) and is reported in barrels. The combined volume of oil and oil-equivalent gas is referred to as barrels of oil equivalent (BOE) and is reported in barrels.

It is important to note that the total number of fields, as defined by BOEM criteria, and the total number of operator-designated projects may not be the same. A field name is assigned to a lease or a group of leases by BOEM so that oil and natural gas resources, reserves, and production can be allocated on the basis of the unique geologic feature that contains the hydrocarbon accumulation(s). The field's identifying block number corresponds to the first lease qualified by BOEM as capable of production or the block where the primary structure is located. Therefore, more than one operator-designated project may be included in a single BOEM-designated field. Additionally, because BOEM-qualified leases can be placed in either new or preexisting fields as defined in the OCS Operations Field Directory, discoveries on newer leases can be placed into much older fields. Appendices **A**, **B**, **C**, and **D** provide detailed information for deepwater fields.

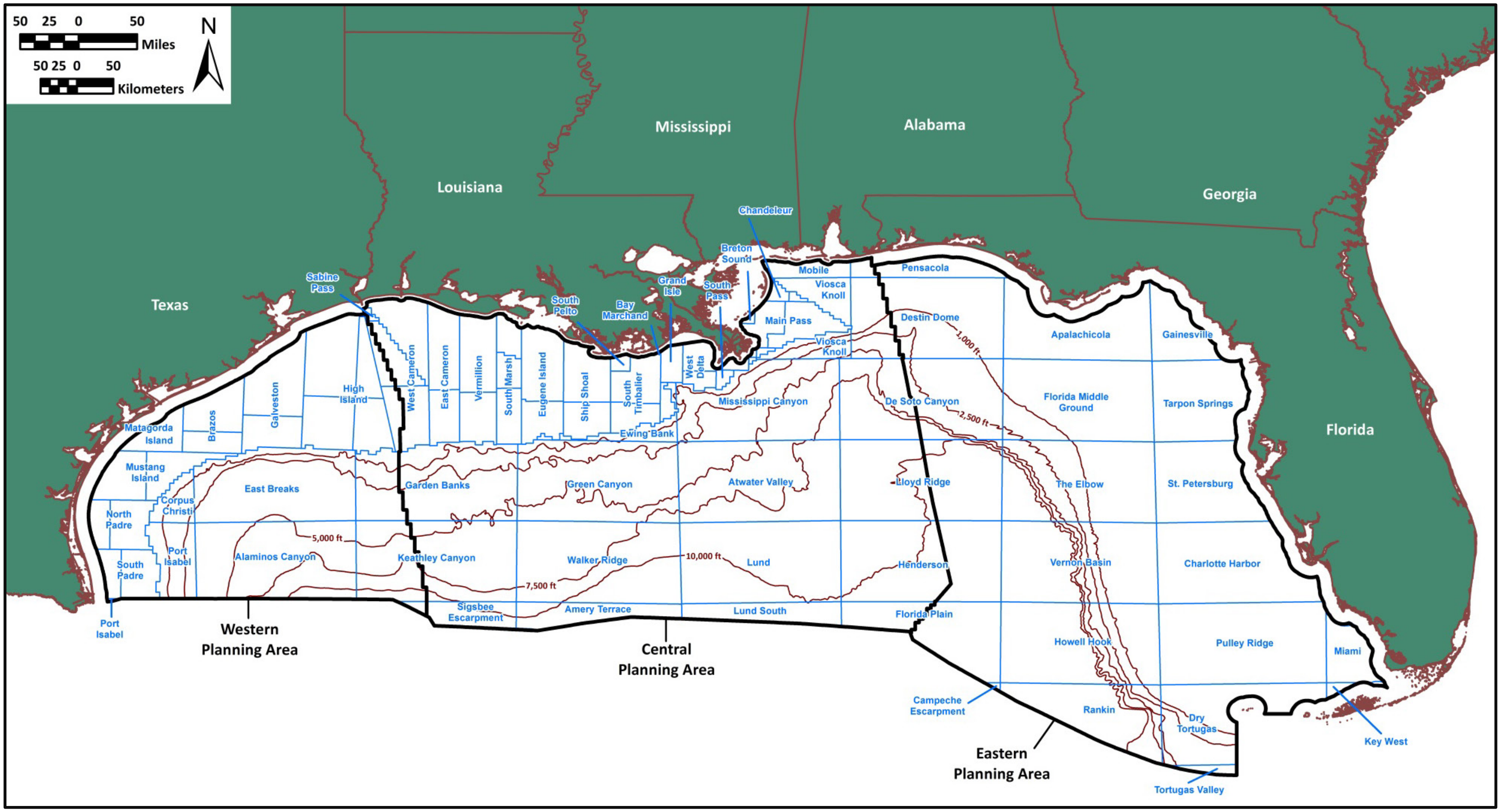


Figure 1. Basemap illustrating planning areas, protraction areas, and water-depth categories referred to in this report.

DEEPWATER HISTORY

Following is a summary of notable events that have occurred in the Gulf of Mexico, emphasizing deepwater.

1947

- The first well out of sight of land was drilled in Ship Shoal block 32 about 12 miles off the Louisiana coast in approximately 19 ft of water, marking the birth of the true "offshore" oil and gas industry.

1953

- The Submerged Lands Act was passed, which gave states the right to lease tracts for offshore drilling up to 3 to 9 nautical miles from the coast.
- The Outer Continental Shelf Lands Act (OCSLA) was passed, which gave the Department of the Interior the authority to issue leases beyond state jurisdiction.

1960s

- A series of turbidite probe studies by a number of universities and industrial companies confirmed an exploration play in deepwater.

1975

- The first deepwater well was drilled in MC block 194 in 1,022 ft of water resulting in the *Cognac* discovery.

1978

- The first production facility in deepwater was installed at the *Cognac* Field utilizing a fixed platform.

1979

- The first production from deepwater began from the *Cognac* Field.

1983

- The first compliant tower in deepwater was installed in MC block 280 at the *Lena* Field in 1,000 ft of water.
- Areawide leasing was implemented, based on a 5-year leasing plan for Federal waters, which expanded the area available for leasing and quickened the pace of sales.

1988

- The first subsea completion in deepwater occurred in EW block 999 at the GC029 Field in 1,462 ft of water.

1989

- The first TLP was installed in GC block 184 at the *Jolliet* Field in 1,760 ft of water.

1990

- The first subsalt discovery in deepwater was drilled in MC block 211 at the *Mica* Field in 4,356 ft of water.

1995

- The Deep Water Royalty Relief Act was passed, eliminating royalty payments (up to specified volumes) on new deepwater leases issued from 1996 to 2000 and allowed different levels of relief for leases issued before and after these dates.

1996

- The first deepwater well to encounter Wilcox-equivalent, Lower Tertiary sediments was drilled in AC block 600 at the *BAHA* prospect in 7,620 ft of water, proving a new exploration play in the ulta-deepwater.

1999

- Deepwater oil production overtook that of shallow water.

2002

- The first spar was installed in VK block 826 at the *Neptune* Field in 1,930 ft of water.

2003

- The first semisubmersible was installed in MC block 474 in 6,340 ft of water. Named the *Na Kika Hub*, the production platform collects gas from six fields.

2005

- Hurricanes Katrina and Rita left destructive paths, curtailing almost all oil and gas production from the Gulf of Mexico.

2006

- The first commercial, wide-azimuth seismic survey was acquired in deepwater.

2007

- The *Independence Hub* was installed in MC block 920 in 7,920 ft of water, claiming the world water-depth record for a semisubmersible. The hub hosts production from 11 fields.

2009

- The first FPU was installed in GC block 237 in 2,200 ft of water. The ship-shaped FPU acts as a hub for the *Boris* and *Phoenix* Fields.
- The *Perdido Hub* was installed in AC block 857 in 7,817 ft of water, claiming the world water-depth record for a spar. The hub hosts production from three fields.

2010

- The *Macondo* discovery blowout and explosion aboard the *Deepwater Horizon* drilling rig caused oil to flow into the Gulf of Mexico for 87 days before the well was sealed. A 6-month moratorium on all deepwater drilling on the OCS was declared shortly thereafter.
- The first floating, drilling, and production triple column spar structure (minDOC) was installed in MC block 941 in 4,050 ft of water. Named the *Telemark Hub*, the platform hosts production from three fields.

2011

- The first FPSO was utilized in WR block 249 in 8,300 ft of water, claiming the water-depth record for a production facility in the Gulf of Mexiico. The FPSO acts as a hub for the *Cascade* and *Chinook* Fields.
- The Bureau of Ocean Energy Management (BOEM) was created when the Minerals Management Service (MMS) was divided into three independent entities.

2014

- The largest (based on displacement) semisubmersible was installed at Walker Ridge block 718 in approximately 6,950 ft of water. The platform hosts production from the *Jack* and *St. Malo* Fields.

LEASING

5-Year OCS Oil and Gas Leasing Program

Section 18 of the OCS Lands Act (OCSLA) requires the Secretary of the Interior to prepare and maintain a 5-Year Program. The program reflects a proper balance among the potential for the discovery of oil and natural gas, the potential for environmental damage, and the potential for adverse effects on the coastal zone. The 5-Year Program also must provide for the receipt of fair market value by the Federal Government for land leased and rights conveyed.

When approved, the leasing program consists of scheduled lease sales for a 5-year period, along with policies pertaining to the size and location of sales and the receipt of fair market value. The purpose of a schedule is to increase the predictability of sales in order to facilitate planning by industry, affected states, and the general public. The schedule indicates the timing and location of sales and shows the presale steps in the process that lead to a competitive sealed bid auction for a specific OCS area. To facilitate the scheduling of and preparation for sales in the 5-Year Program, the OCS is divided into 26 administrative geographical units called planning areas. The Gulf of Mexico Region contains the Western, Central, and Eastern Planning Areas (**Figure 1**).

In preparing a new 5-Year Program, the Secretary solicits comments from coastal State Governors and localities, tribal governments, the public, the oil and natural gas industry, environmental groups, and affected Federal agencies. BOEM requests comments at the start of the process of developing a new program and following the issuance of each of the first two program proposals: (1) the draft proposed program with a 60-day comment period; and (2) the proposed program with a 90-day comment period. The third and last version, the proposed final program, is prepared with a 60-day notification period following submission to the President and Congress. After 60 days, if Congress does not object, the Secretary may approve the program.

In addition to the steps required by Section 18 of the OCSLA, the Secretary must comply with the requirements of the National Environmental Policy Act (NEPA). Additional scoping may occur and an environmental impact statement (EIS) on the 5-Year Program is prepared. During the comment period on the draft EIS, public hearings are held in various coastal locations around the Nation. After the receipt of comments, a final EIS is prepared. A record of decision that formalizes the alternatives that were selected from the final EIS is prepared.

Each lease sale proposed in the 5-Year Program's schedule must also undergo a NEPA evaluation and presale coordination steps required by Section 19 of the OCSLA. A Multisale EIS for the GOM that tiers from the 5-Year Program EIS is then prepared to analyze the potential impacts of a typical lease sale on the marine, coastal, and human environments. This Multisale EIS will serve as the only NEPA document prepared for the first proposed lease sale in the CPA and WPA. An environmental assessment (EA) that is specific to an individual lease sale is usually prepared following the publication of the Multisale EIS. New information and changes that have occurred since publication of the Multisale EIS are considered in each EA. Consultation is conducted with the states during this process, and consistency with each affected state's Coastal Zone Management (CZM) program is determined before the lease sale transpires.

The entire 5-Year Program process takes approximately 2½ to 3+ years to complete. The lease sale schedule is reviewed annually after its approval. The following listing shows the major sequential steps in the process after adoption of a 5-Year Program.

- Call for Information and Nominations and Notice of Intent to Prepare an EIS
- Area identification
- Draft EIS

- Public hearings
- Final EIS and CZM consistency determination
- Record of decision
- Sale-specific NEPA evaluation
- Proposed Notice of Sale
- Governor's comments
- Final Notice of Sale
- Sale
- Decision to accept or reject bids
- Issuance of leases

BOEM is currently operating under the OCS Oil and Gas Leasing Program for 2012-2017. This 5-Year Program proposes 12 oil and gas lease sales in the GOM—5 sales in the WPA, 5 sales in the CPA, and 2 sales in the EPA.

Recent Lease Sales

Central Lease Sale 235

Held on March 18, 2015, in New Orleans, bids for CPA Lease Sale 235 totaled $583,201,520, with $538,780,056 in high bids. This was the 7th sale scheduled in the OCS Oil and Gas Leasing Program for 2012-2017. BOEM received 195 bids from 42 companies on 169 blocks comprising just under 1 million acres offshore Alabama, Louisiana, and Mississippi (**Figure 2**). Approximately 70 percent of the blocks receiving bids were in water depths 400 m (1,312 ft) or deeper, and approximately 38 percent of the blocks receiving bids were in water depths greater than 1,600 m (5,249 ft). The block in the deepest water that received a bid is Lloyd Ridge 454 at 3,018 m (9,902 ft).

Lease Sale 235 ultimately resulted in the award of 161 leases. BOEM rejected high bids totaling $5,689,416 on 8 blocks as insufficient for fair market value. The accepted high bids for the sale totaled $533,090,640.

Western Lease Sale 246

Held on August 19, 2015, in New Orleans, bids for WPA Lease Sale 246 totaled $22,675,212. This was the 8th sale scheduled in the OCS Oil and Gas Leasing Program for 2012-2017. BOEM received 33 bids from 5 companies on 33 blocks comprising 190,080 acres offshore Texas (**Figure 3**). BHP Billiton placed 26 of the 33 bids, all in deepwater. Approximately 64 percent of the blocks receiving bids were in water depths greater than 1,600 m (5,249 ft). Lease Sale 246 ultimately resulted in the award of all 33 leases.

Central Lease Sale 241/Eastern Lease Sale 226

CPA Lease Sale 241 and EPA Lease Sale 226 were held on March 23, 2016, in New Orleans. While the restricted area available for the EPA sale garnered no bids, bids for CPA Lease Sale 241 totaled $179,172,819, with $156,385,610 in high bids. Central Sale 241 was the 10th sale scheduled in the OCS Oil and Gas Leasing Program for 2012-2017. BOEM received 148 bids from 30 companies on 128 blocks comprising 693,962.25 acres offshore Alabama, Louisiana, and Mississippi (**Figure 4**). Approximately 63 percent of the blocks receiving bids were in water depths 800 m (2,625 ft) or deeper. The block in the deepest water that received a bid is Walker Ridge 595 at 3,016 m (9,895 ft).

Lease Sale 241 ultimately resulted in the award of 121 leases. BOEM rejected high bids totaling $5,259,013 on 7 blocks as insufficient for fair market value. The accepted high bids for the sale totaled $151,126,597.

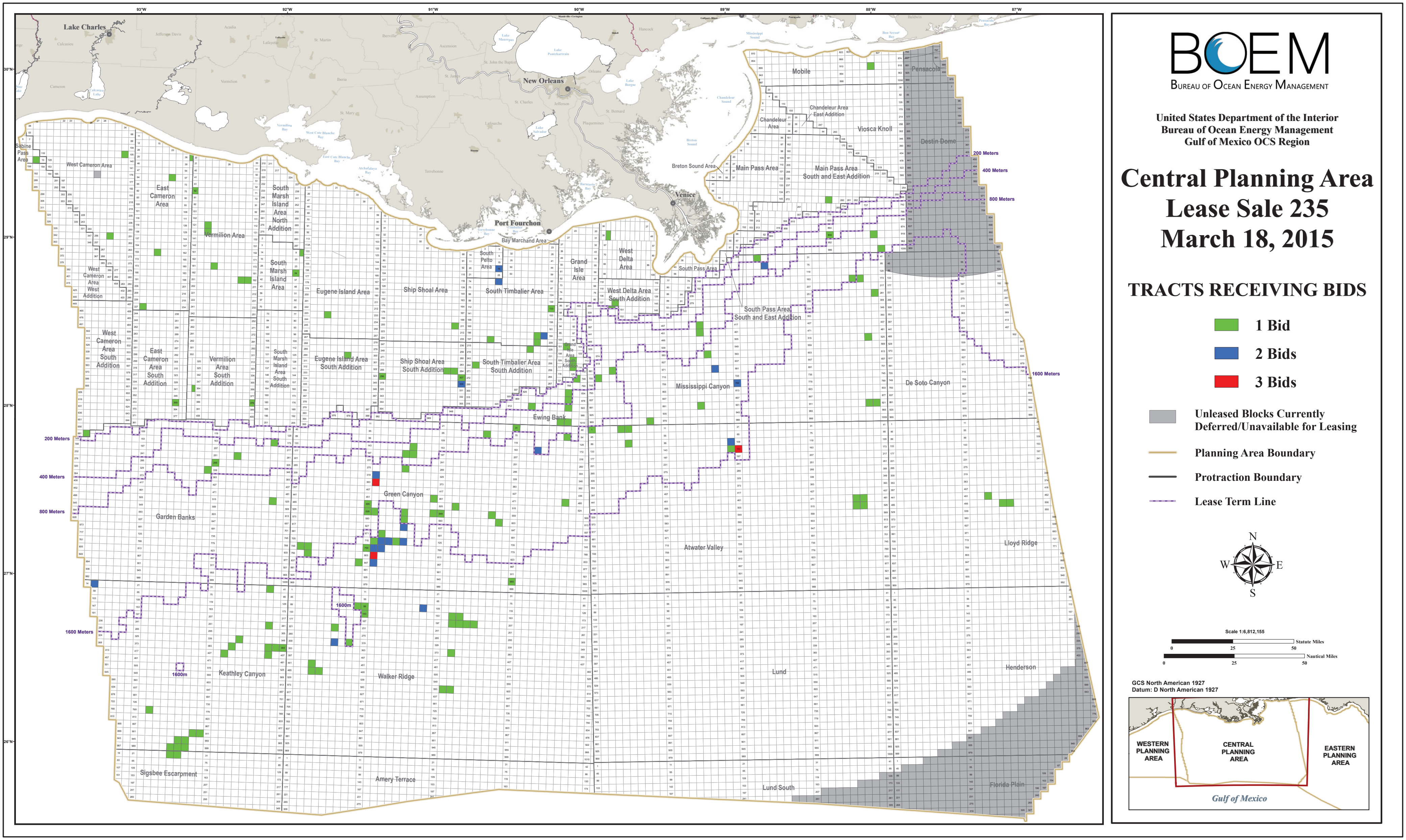


Figure 2. Central Sale 235 geographic bid distribution.

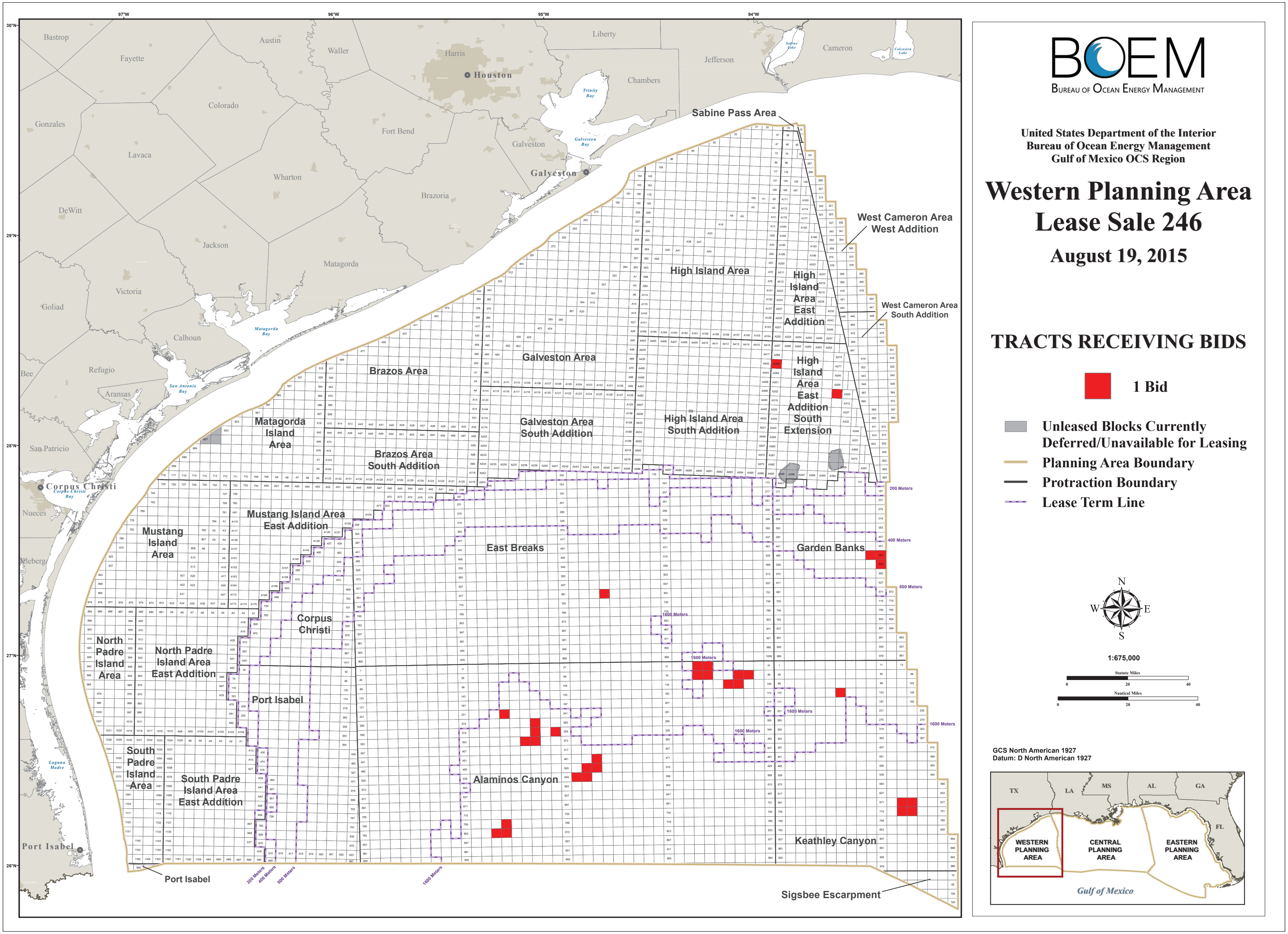


Figure 3. Western Sale 246 geographic bid distribution.

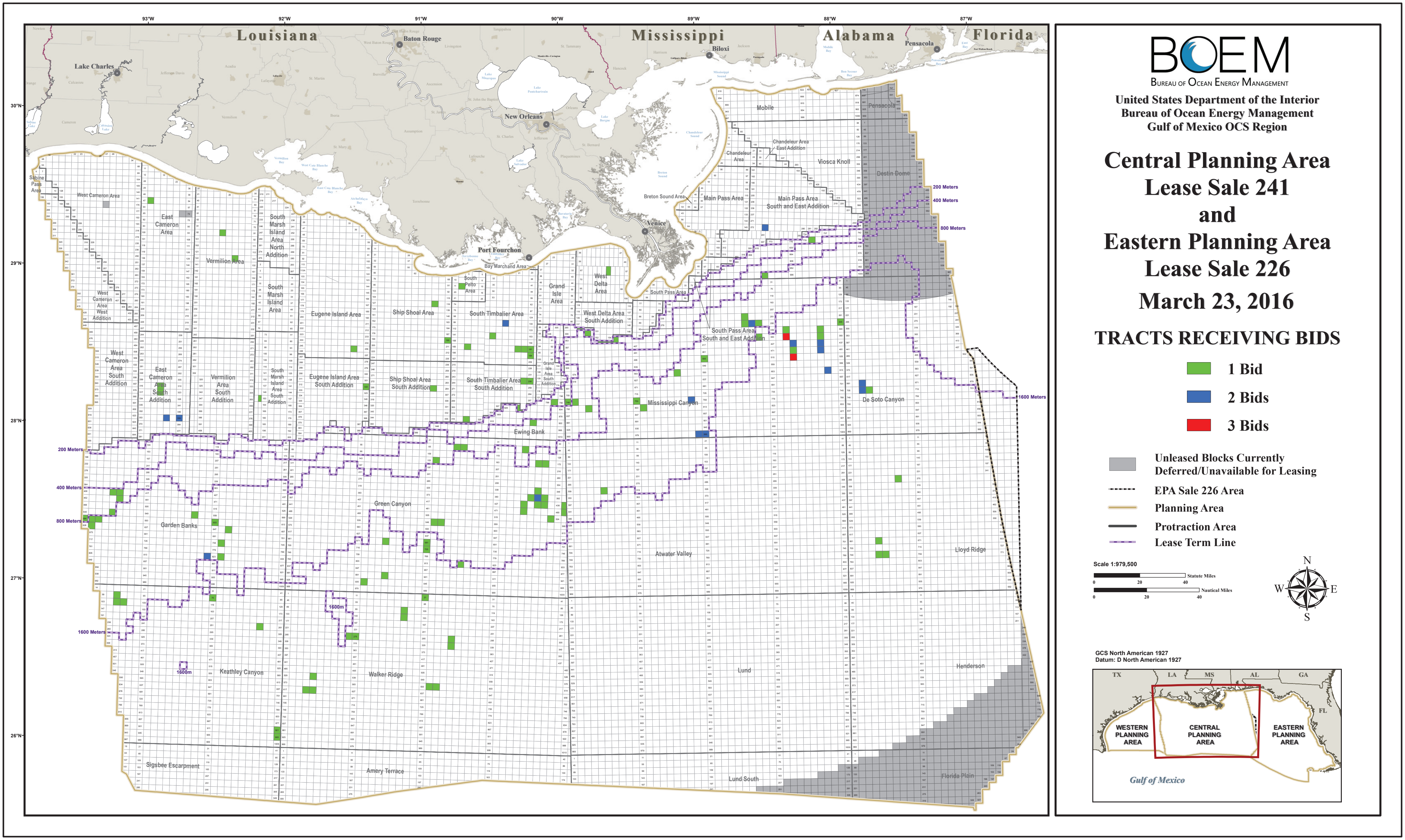
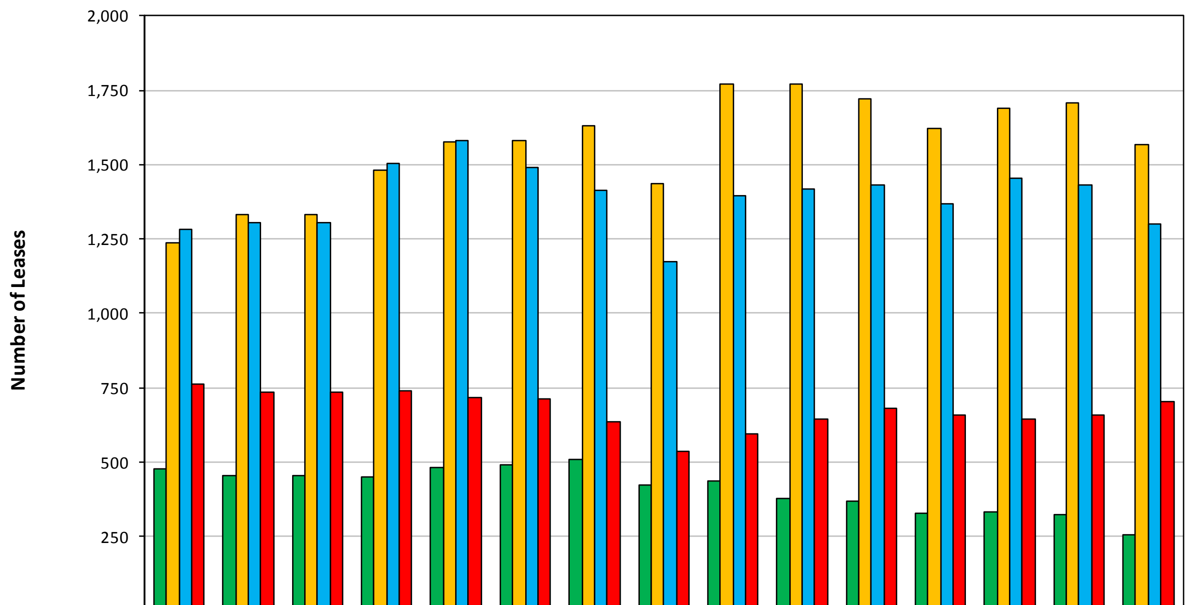


Figure 4. Central Sale 241 geographic bid distribution.

ACTIVE LEASES

Figure 5 shows the approximate number of active leases for each water-depth interval in deepwater for the last 15 years. Over this same time period, **Figure 6** compares the number of active leases in shallow water and deepwater. A decline in active leases in shallow water starting from 2004 to 2005 has been continuous, as opposed to the number of active leases in deepwater, which has remained between 3,500 and 4,500 for the last 15 years. Specifically for 2014, the total number of active leases for all water-depth categories was 5,303, of which 3,826 (72%) were located in water depths of 1,000 ft or greater (**Figure 6**). The greatest number of active leases in deepwater are located in water depths of 2,500 to 4,999 ft (**Figure 7**).

Figure 8 displays the geographic distribution of active leases following the two lease sales in 2015. The limited number of active leases in the EPA is related to leasing restrictions. Note that some active leases are associated with more than one block; therefore the map contains more highlighted blocks than the number of active leases. Additionally, lease status (active, expired, terminated, or relinquished) can change daily, so the active leases depicted in **Figure 8** is an approximation.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1,000 - 2,499 ft	478	456	456	450	482	492	510	422	434	379	369	326	331	325	254
2,500 - 4,999 ft	1,238	1,332	1,332	1,480	1,575	1,582	1,630	1,437	1,773	1,770	1,720	1,623	1,691	1,707	1,567
5,000 - 7,499 ft	1,283	1,304	1,304	1,504	1,583	1,490	1,414	1,175	1,395	1,416	1,431	1,369	1,455	1,431	1,300
≥ 7,500 ft	761	737	737	739	718	712	637	538	595	643	679	659	646	660	705

Number of Active Leases at the End of Each Year

Figure 5. Number of active leases for each deepwater interval at the end of each year.

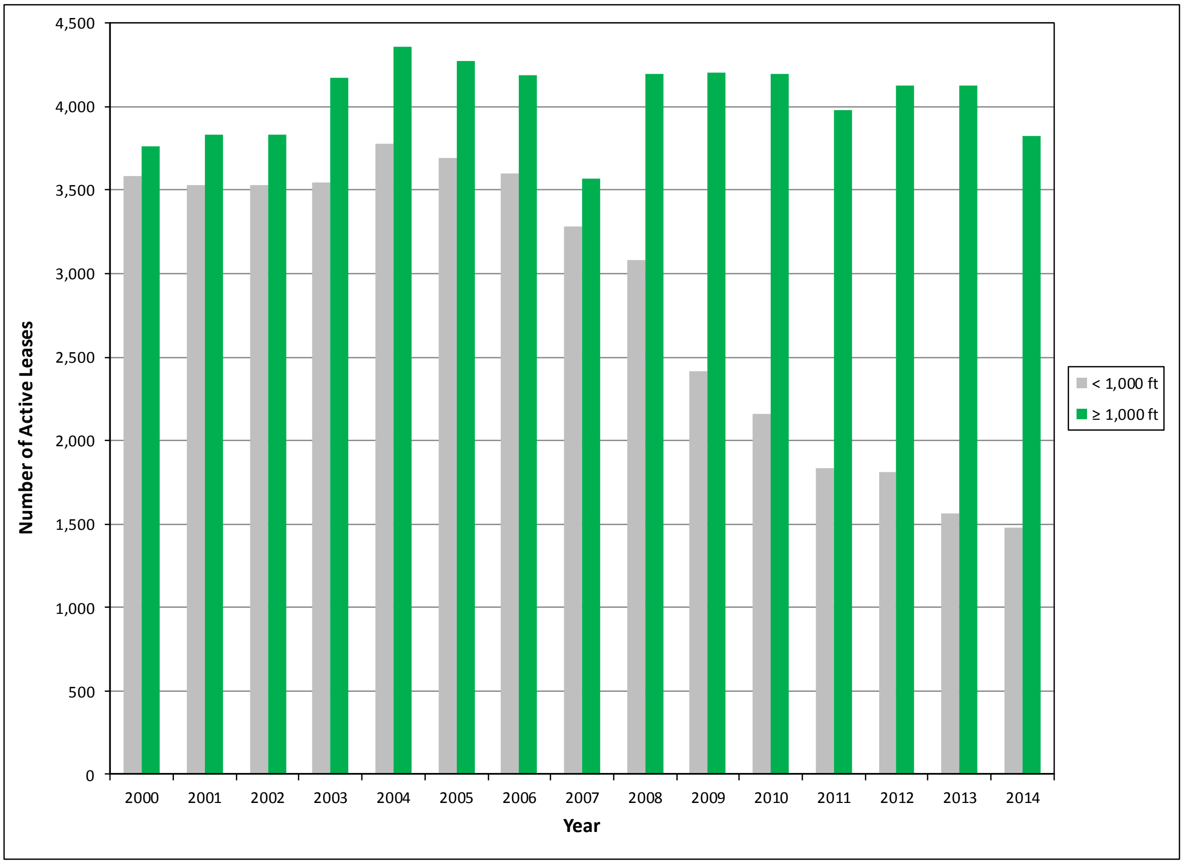


Figure 6. Number of deepwater and shallow-water active leases at the end of each year.

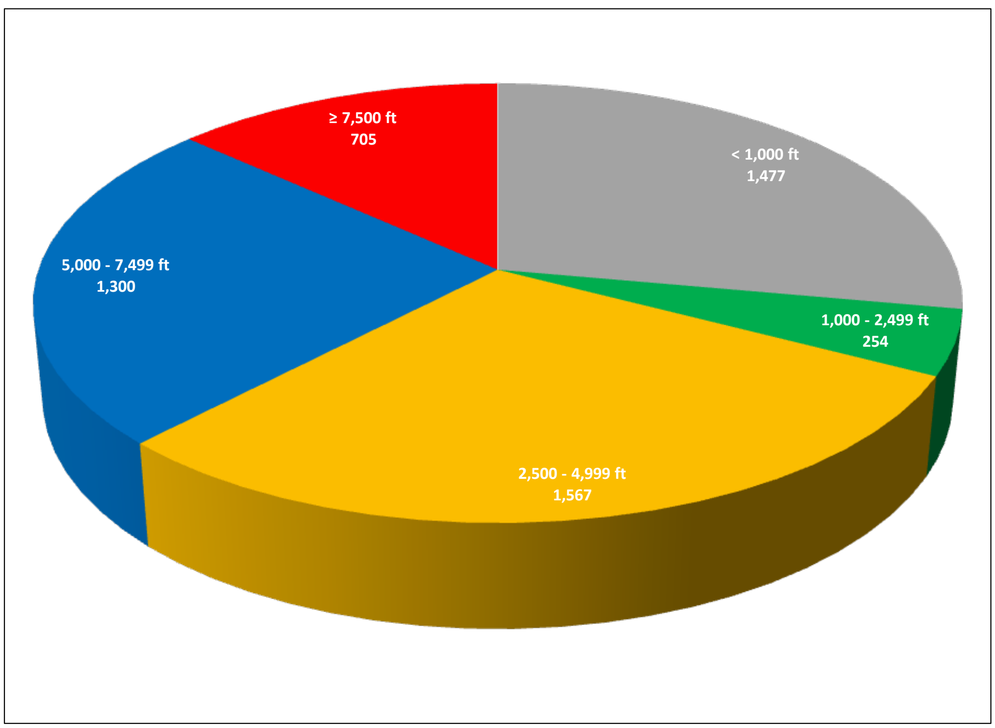


Figure 7. Active leases at the end of 2014 by water-depth categories.

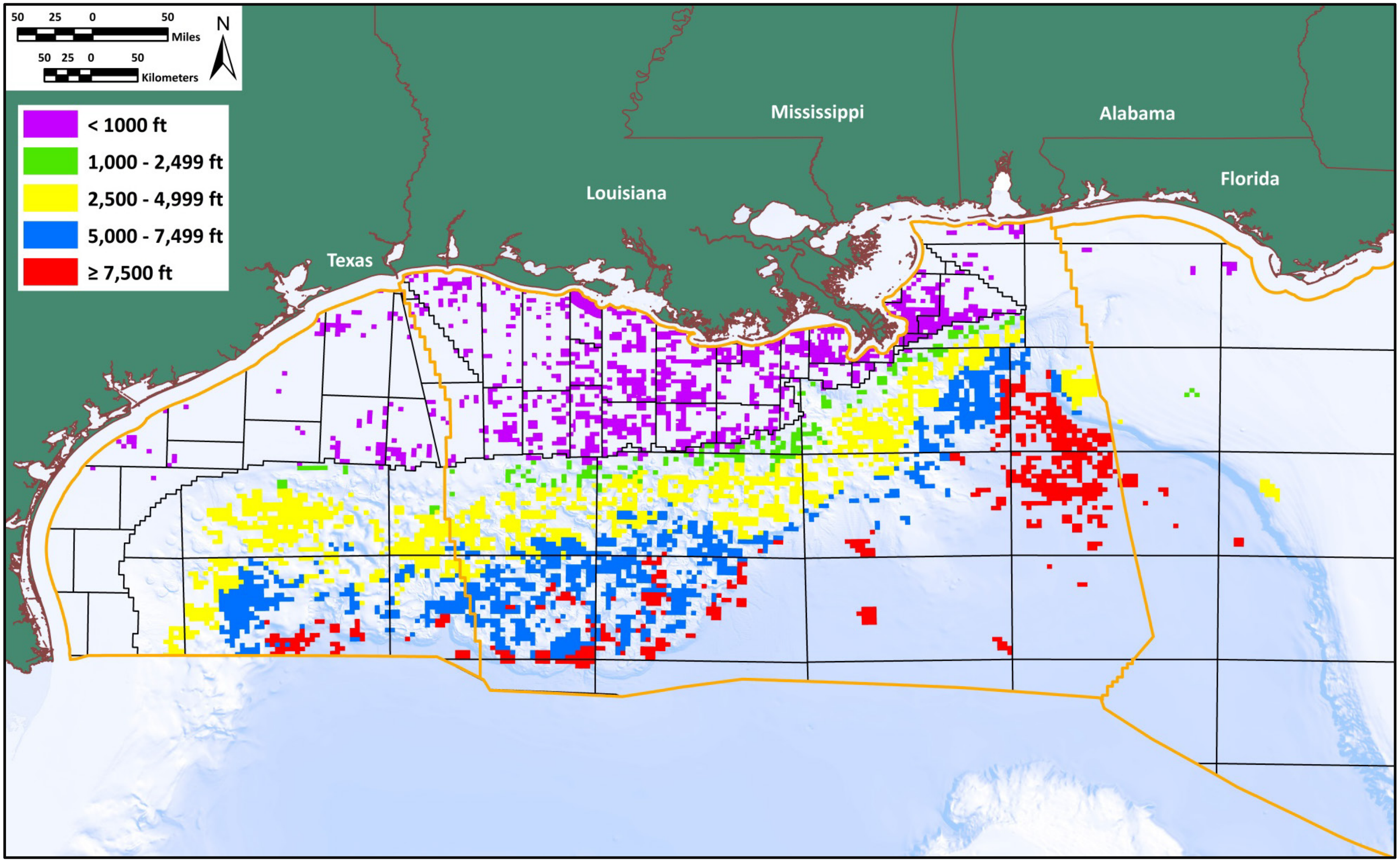


Figure 8. Geographic distribution of active leases by water depth.

INITIAL LEASE TERM PERIODS

Beginning with CPA Lease Sale 213 held on March 17, 2010, a change was made to the initial lease-term periods for leases in water depths of 400 m to less than 1,600 m (**Table 1**). In water depths of 400 m to less than 800 m, the previous 8-year lease period, which included a requirement that a well be drilled in the first 5 years, was replaced with a 5-year initial period for a lease, which may be extended by 3 years if a well has begun during the initial period. In water depths of 800 m to less than 1,600 m, a new lease period of 7 years replaces the previous 10-year lease period, with an extension of 3 years if a well has begun during the initial period. A 10-year initial lease period will be retained in water depths of at least 1,600 m.

Table 1. Initial lease term periods.

Water Depth (m)	Water Depth (ft)	Initial Lease Term Period
0 to <400	0 to <1,312	Standard initial period is 5 years. The lessee may earn an additional 3 years (i.e., for an 8-year extended intial period) if a well is spudded targeting hydrocarbons below 25,000 feet true vertical depth subsea during the first 5 years of the lease.
400 to <800	1,312 to <2,625	Standard initial period is 5 years. The lessee will earn an additional 3 years (i.e., for an 8-year extended initial period) if a well is spudded during the first 5 years of the lease.
800 to <1,600	2,625 to <5,249	Standard initial period is 7 years. The lessee will earn an additional 3 years (i.e., for a 10-year extended initial period) if a well is spudded during the first 7 years of the lease.
≥1,600	≥5,249	10 years

SEISMIC DATA

Types of Seismic Data

The Resource Evaluation Program within BOEM has a statutory responsibility for issuing geological and geophysical permits in Federal waters. This responsibility is defined in Section 11 of OCSLA and supporting regulations. The extensive amount of data and information obtained by BOEM is used by geologists, geophysicists, petroleum engineers, modelers and other specialists to perform a variety of analyses leading to Resource Assessment, Reserves Inventory, and determining Fair Market Value of auctioned tracts.

For the past 30 years, BOEM has issued permits for conventional two-dimensional (2D) and three-dimensional (3D) seismic surveys as well as for multi-component, high resolution, complex azimuth, and other advanced types of seismic surveys with the majority shot in the Gulf of Mexico OCS. The Resource Evaluation Program approves the seismic permits, and operators are required to provide certain data and information to BOEM. The process by which BOEM selectively obtains copies of the data and information from these pre-lease activities can be found at boem.gov.

During a typical marine seismic acquisition in the GOM, one or more vessels tow a number of parallel streamers (the receivers), several miles in length, separated by 75 to 150 ft. The seismic energy (the source) is produced by an array of air guns towed behind the vessel, generating highly pressurized air, and fired every 10 to 20 seconds. Depending on the survey design, the separation between the source and the receivers (the offset) can be varied. Up until the mid-1980s, the marine seismic surveys were predominantly 2D (i.e., imaging just one single vertical section at a time). During the 1990s, the need for more precise imaging of the subsurface drove the technology into the domain of 3D surveys, or large "data cubes," as opposed to the traditional 2D vertical section. Three-dimensional seismic data are huge volumes of digital energy recordings resulting from the transmission and reflection of sound waves through the earth. These large "data cubes" can be interpreted to reveal likely oil and gas accumulations. A dense volume of high-quality data reduces the inherent risks of traditional hydrocarbon exploration and allows imaging of previously hidden prospects.

Numerous deepwater exploration targets lie beneath an extensive salt canopy, more than 15,000 ft thick in some places. Early subsalt discoveries in deepwater, such as *Mad Dog* (GC826), *Thunder Horse* (MC778), *North Thunder Horse* (MC776), *Atlantis* (GC743), *Tahiti* (GC640), and *Shenzi* (GC654), demonstrated the importance of subsalt exploration in the deepwater GOM. Salt has a very high velocity when compared with the surrounding rocks, and a correction for this high velocity zone must be made to best image the sediments below the salt. Additionally, the imaging problems are compounded the thicker and more irregular the salt bodies are, which result in highly variable lateral velocities. One of the earliest solutions to adequately image prospects below thick salt canopies was the depth migration of seismic data, where velocity estimates of the sediment and salt (a "velocity model") are used to convert time to depth. Even rough estimates of velocity can greatly improve the quality of the migration. Large, nonexclusive (also known as multiclient or speculative), depth-processed 3D surveys allow the widespread use of this technology in the early phases of exploration.

Even with the advantages of depth-migrated 3D data, interpretation challenges, such as poor signal-to-noise ratio of subsalt events and incomplete reservoir illumination, remained. These problems were addressed mainly by such things as improved depth-migration algorithms, better noise attenuation, and better velocity models. However, it became apparent that another approach was needed to produce seismic images of reservoir-development quality in ultra-deep waters, where drilling a single exploration well can be cost prohibitive. It has long been recognized that acquiring seismic data with a range of source-receiver azimuths, or angles of incidence on the subsurface reflectors, illuminates the subsurface better than acquiring the same data using standard "narrow-azimuth" (NAZ) techniques (e.g., O'Connell et al., 1993). Coupled with robust depth-migration algorithms, "complex-azimuth" surveys improve signal-to-noise ratio and illumination in complex subsalt geology and provide natural attenuation of some multiples. Therefore, areas of the deepwater GOM where an extensive and thick salt canopy covers potential hydrocarbon targets, obscuring their seismic signature, are ideal areas for large, complex-azimuth surveys for exploration purposes. One such ideal area is the deepwater Lower Tertiary trend, which lies beneath thick, complex, allochthonous salt, making the prospects very difficult to image. Partly driven by the interest in the Lower Tertiary trend, the technology required (e.g., controlling the precise location of streamers, computing power) to make complex-azimuth acquisitions commercially viable only emerged in the last 10 years.

For conventional NAZ surveys, data are typically acquired using a single vessel sailing along a series of parallel lines, with the long, narrow shape of the towed receiver spread resulting in very limited azimuth sampling (**Figure 9**). The subsurface geology is therefore only illuminated in one shooting direction. In areas where the subsurface is simple, NAZ surveys may adequately illuminate the target rocks. However, where the subsurface geology is complicated by the presence of complex folding, faulting, and high velocity salt, bending and scattering of ray paths between the receivers and the target can result in uneven illumination of the reservoir.

Acquiring complex-azimuth seismic data has resulted in a much clearer image of the subsurface in these geologically complex areas. Four variations of towed-streamer geometries for acquiring complex-azimuth data are 1) multi azimuth (MAZ), 2) wide azimuth (WAZ), 3) rich azimuth (RAZ), and 4) full azimuth (FAZ) (**Figure 9**). In a MAZ survey, a single multistreamer recording vessel acquires data in multiple directions (Gaus and Hegna, 2003) resulting in azimuths clustered around the sail lines. Two to six 3D surveys are recorded over the same area at different azimuths to each other. The individual surveys are processed separately, and then combined, resulting in the same subsurface spot being illuminated by many different azimuths.

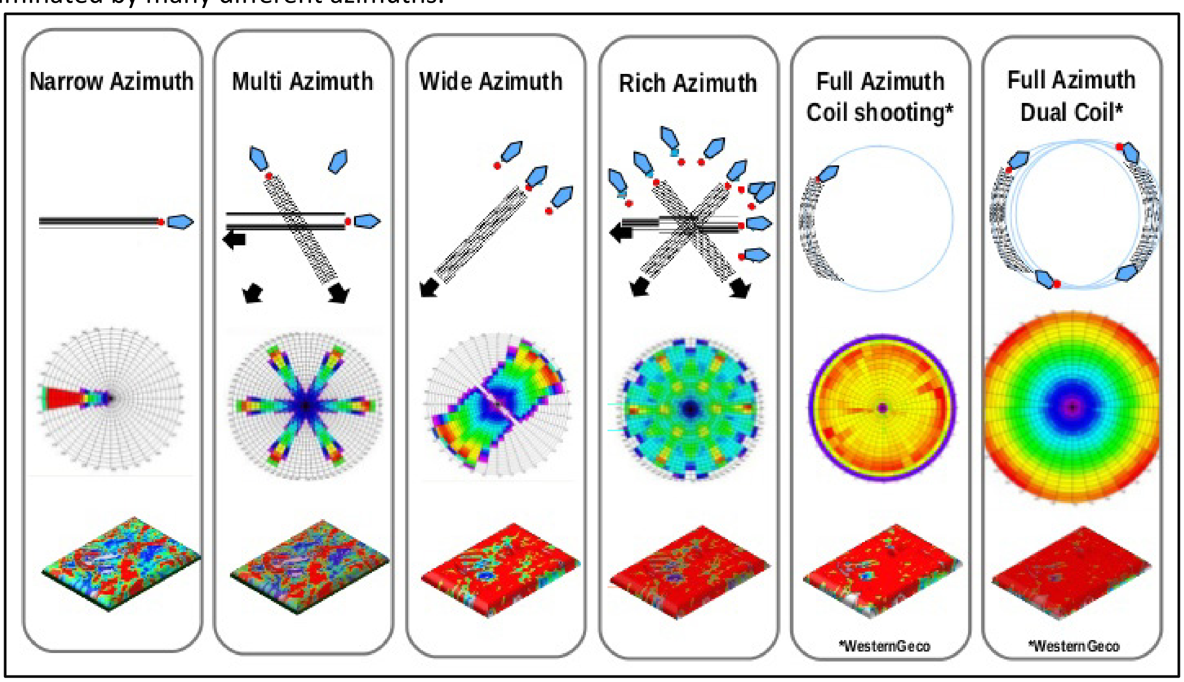


Figure 9. Seismic acquisition geometries, resulting azimuth ranges, 0 to 360, and planar view illumination. Offset corresponds to the distance from the center of each rose diagram. Azimuth corresponds to the angle within each rose diagram. The colors correspond to the number of traces recorded for each offset-azimuth combination, with purple and blue for a low number of traces, to green, yellow, and red for a high number of traces. (Image courtesy of WesternGeco. Coil surveys are a proprietary acquisition technique by WesternGeco.)

In a WAZ survey, a single multistreamer recording vessel and at least two source vessels shoot each source line multiple times in a single direction with increasing lateral offset with each sailing pass. Multiple source vessels make it possible to collect data from many different azimuths (Sukup, 2002). The first WAZ survey in the GOM was conducted by BP with the contractor CGGVeritas over the *Mad Dog* (GC826) Field in 2004-05, using one recording vessel and two source vessels. The WAZ data delivered a breakthrough in imaging and initiated a broad WAZ acquisition program to enhance the imaging of subsalt discoveries.

The RAZ geometry combines aspects of both the MAZ and WAZ methods, where multiple source lines are acquired in multiple directions. By combining the MAZ and WAZ techniques, any number of vessels in various configurations (WAZ) can be sailed in any number of directions (MAZ) (Howard, 2004). In 2006, WesternGeco combined the MAZ and WAZ techniques for such a survey in which a WAZ geometry was deployed in two opposite sailing directions for each of three different orientations, effectively covering the subsurface six times. When combined, the resulting 3D dataset contained contributions from a complete range of azimuths for most offsets. Acquired over the *Shenzi* (GC654) Field, this data was the world's first RAZ survey. While acquiring the *Shenzi* seismic survey, WesternGeco and BHP Billiton (operator) decided to continue firing sources and collecting data during line turns to examine the resulting data. The acquired data returned extremely encouraging results and led to subsequent tests using full circular geometries (known as coil shooting) for towed-streamer acquisition.

A coil-shot survey acquires data along circular paths by a vessel towing one or more sources and a spread of streamers, resulting in a high number of contributions for a complete range of azimuths for all offsets, known as full azimuth (FAZ) data. The circular paths are repeated in both inline and crossline directions to increase fold, offset, and azimuth distribution (Hager, 2010). To increase the source-receiver offset even more to adequately illuminate the subsurface under salt overhangs and areas with steep dip, two recording vessels with their own sources and two additional source vessels are utilized in what is known as dual-coil shooting. While WAZ acquisition has improved imaging in complex geologic settings, dual-coil FAZ acquisition, with its full range of azimuths and longer offsets, returns even more illumination of the subsurface and benefits noise reduction and multiple attenuation (Buia et al., 2008).

Some operators choose to acquire specialized seismic surveys using nodes or cables placed directly on the ocean bottom over a single field. Ocean-bottom surveys (OBS) using nodes and cables allow more flexibility to acquire data in obstructed areas; the receivers are coupled to the seafloor, which produces the ability to record shear waves; the distortion of the water column is eliminated; and complex-azimuth geometries can be utilized for increased subsurface illumination. Additionally, after production begins, the receivers can be placed in the same locations on the seafloor for acquisition of a time-lapse (4D) seismic survey to monitor fluid movement and reservoir changes.

Coverage

Figure 10 contains layered geographic data illustrating the locations of 1) NAZ 3D time-migrated surveys, 2) NAZ 3D depth-migrated surveys, 3) OBS and 4D surveys, 4) WAZ (the majority), MAZ, and RAZ surveys, and 5) FAZ surveys that have been acquired by industry and consultants and obtained by BOEM. Each type of data is represented as a layer that can be toggled on or off in the layers navigation pane. The first large, nonexclusive, towed-streamer NAZ surveys began to be acquired in the late-1980s. To date, hundreds of conventional, towed-streamer NAZ surveys have been acquired. These surveys, both time and depth migrated, cover most of the explored portions of the GOM, assisting exploration for over 25 years. Numerous field-level, exclusive, ocean-bottom surveys have been acquired, with several seismic acquisition companies also offering larger, nonexclusive, ocean-bottom surveys in the GOM.

In 2006, underwritten by Shell, WesternGeco acquired the first nonexclusive WAZ survey for exploratory purposes covering over 200 blocks. Because of the rapid acceptance of WAZ methodology and its benefits, most of the major seismic contractors to date have shot nonexclusive surveys in the deepwater GOM using WAZ acquisition techniques. BOEM has obtained approximately 30 large, nonexclusive WAZ surveys, covering the areal extent of the Lower Tertiary trend and other areas of interest in the deepwater GOM. Examples of large, nonexclusive WAZ datasets include the Crystal WATS surveys acquired by PGS and the various E-Octopus surveys acquired by WesternGeco.

The first commercial, multi-vessel FAZ seismic survey in the deepwater GOM was acquired in 2010 by WesternGeco in the East Breaks, Garden Banks, Alaminos Canyon, and Keathley Canyon areas. Named the Revolution I survey, it covers 130 blocks. Since then, WesternGeco has acquired 10 additional commercial FAZ surveys in the Revolution project from Alaminos Canyon to Green Canyon. Additionally, CGG has acquired three FAZ surveys covering parts of the Garden Banks, Keathley Canyon, Green Canyon, and Walker Ridge areas, and PGS has acquired a FAZ survey in the Garden Banks and Keathley Canyon areas.

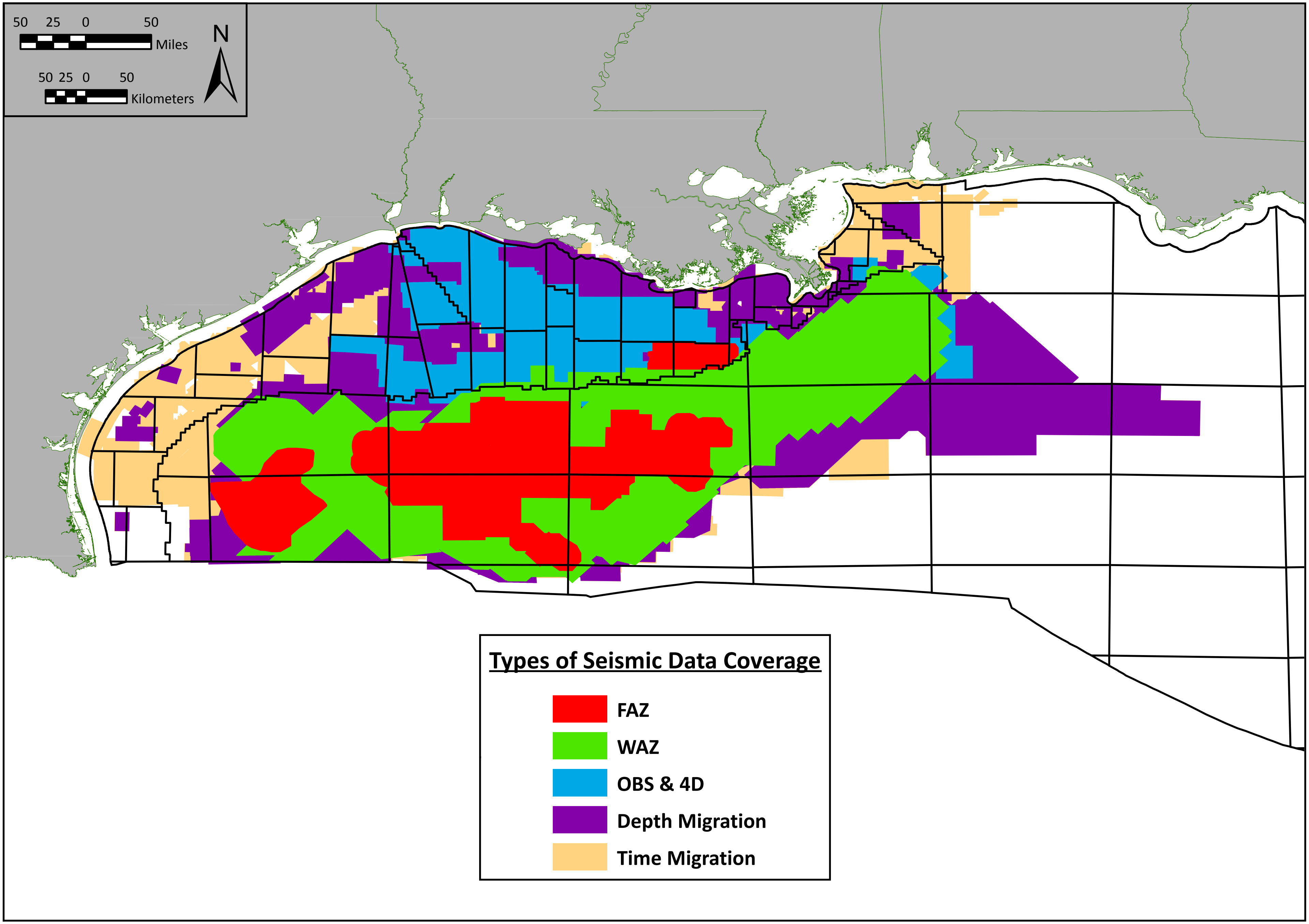
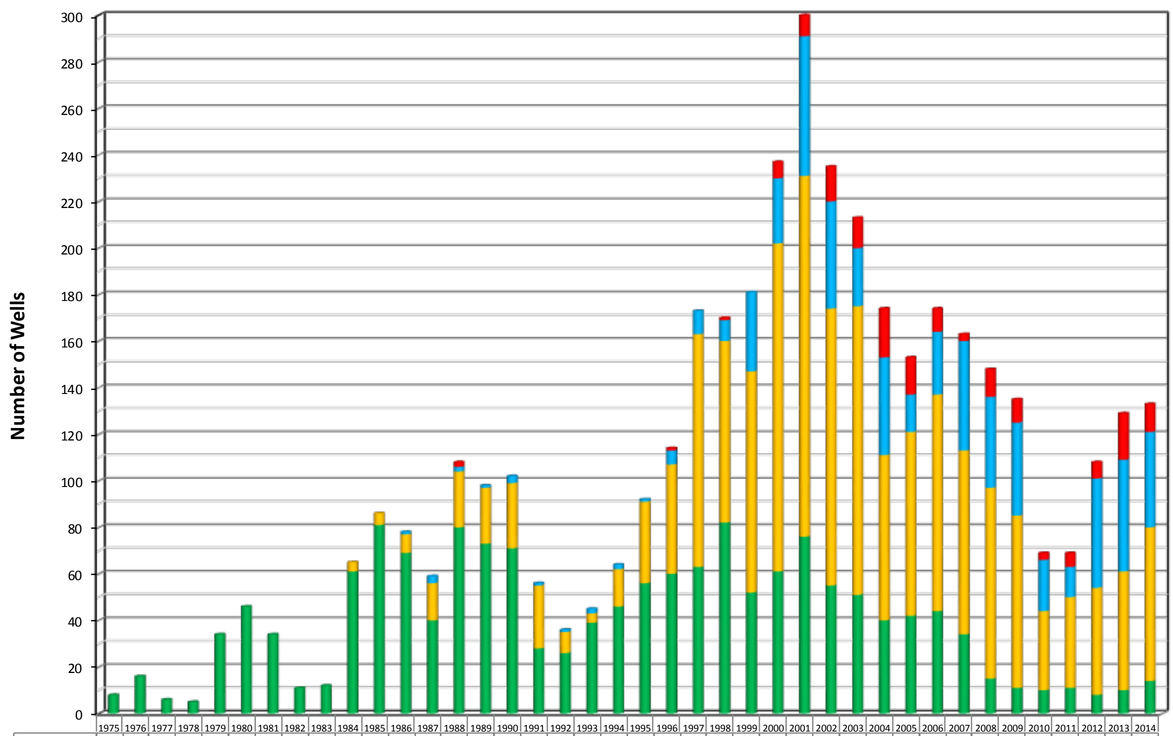


Figure 10. Seismic data obtained by BOEM by type. The data layers can be toggled on or off in the layers navigation pane.

WELL DATA

The first well drilled in the GOM in water depths of 1,000 ft or greater reached total depth in 1975 as part of the *Cognac* (MC194) Field. Through 2014, more than 4,100 wells have been drilled in the deepwater GOM. This number includes original wellbores, sidetracks, and bypasses. **Figure 11** shows the year these wells reached total depth, categorized by water-depth intervals. The depressed drilling numbers in 2010 and 2011 are caused by the repercussions of *Macondo*.



	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
≥ 7500 ft														2					
5,000 - 7,499 ft												1	3	2	1	3	1	1	2
2,500 - 4,999 ft										4	5	8	16	24	24	28	27	9	4
1,000 - 2,499 ft	8	16	6	5	34	46	34	11	12	61	81	69	40	80	73	71	28	26	39

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≥ 7500 ft			1		1		7	9	15	13	21	16	10	3	12	10	3	6	7	20	12
5,000 - 7,499 ft	2	1	6	10	9	34	28	60	46	25	42	16	27	47	39	40	22	13	47	48	41
2,500 - 4,999 ft	16	35	47	100	78	95	141	155	119	124	71	79	93	79	82	74	34	39	46	51	66
1,000 - 2,499 ft	46	56	60	63	82	52	61	76	55	51	40	42	44	34	15	11	10	11	8	10	14

Year

Figure 11. Total number of deepwater wells drilled by water depth.

Exploratory and Development Wells

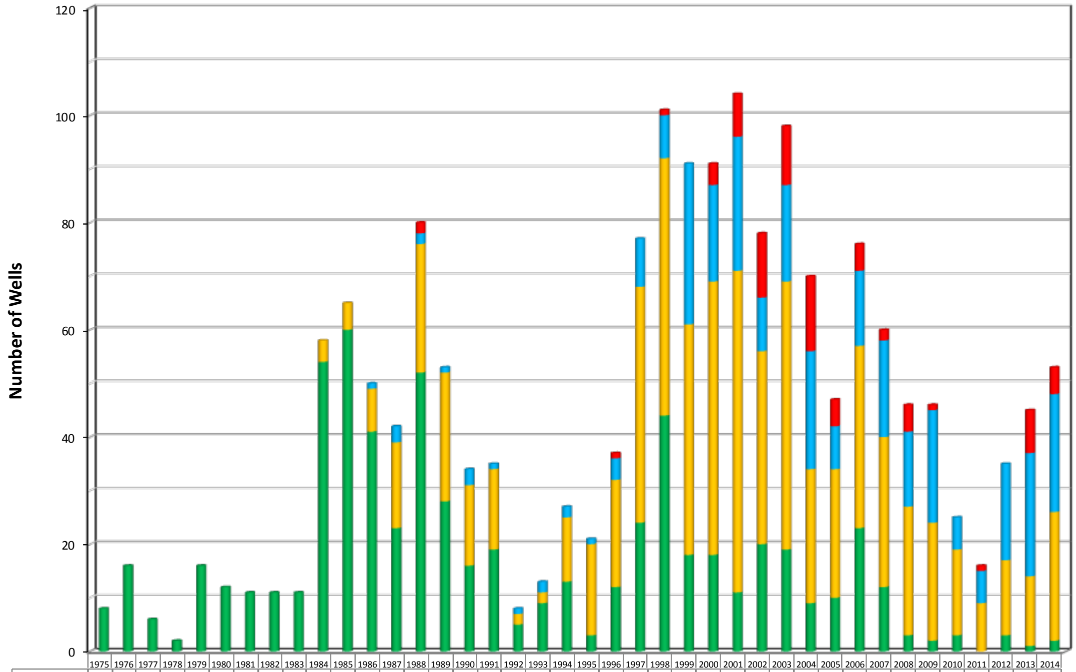
In this report, an "exploratory" well is defined as a hole drilled to find oil or gas in an area of the GOM with no previous wells or to find a new reservoir in a known field. Once a successful exploratory well has been drilled, one or more "appraisal" or "delineation" wells are drilled to establish the limits and productivity of the reservoir. A reservoir development plan is then prepared from information obtained during various exploration processes such as seismic surveys, geologic analysis, and from drilling the exploratory and appraisal wells. "Development wells" are drilled according to a predetermined pattern to maximize production from the reservoir, within economic limits, over a reasonable lifetime of production. These development wells include not only producing oil and gas wells, but also wells such as gas and water injection, which may be used to enhance recovery of the hydrocarbons. Because of economic considerations in the deepwater GOM, it is not unusual for an operator to use the initial exploration well to produce hydrocarbons from the reservoir. For purposes of this report, those wells are considered development wells at that point. Also, to separate post-reservoir-discovery activities, appraisal/delineation wells are counted as development wells. Approximately 57 percent of deepwater wells represent development activities.

Figure 12 shows the number of deepwater exploratory wells drilled each year by water-depth category. The first exploratory wells in more than 7,500 ft of water occurred in 1988 and include the discovery wells for the *Coulomb* (MC657) Field. Exploratory drilling in the deepwater GOM peaked in the late-1990s to early-2000s, resulting in numerous, large discoveries such as *Tahiti* (GC640), *North Thunder Horse* (MC776), *Atlantis* (GC743), *Great White* (AC857), *Shenzi* (GC654), *Tubular Bells* (MC682), *Devils Tower* (MC773), *Thunder Horse* (MC778), and *Mad Dog* (GC826).

Figure 13 shows the number of deepwater development wells drilled each year by water-depth category. Development drilling in the deepwater GOM peaked from 2000 to 2002 with nearly 500 wells. Contributing to this count are development wells at fields such as *Mars-Ursa* (MC807), *Nansen* (EB602), *Amberjack* (MC109), *Gunnison* (GB668), *Pompano* (VK990), and *Cognac* (MC194). The 12 development wells in more than 7,500 ft of water in 2013 represent activity at the Lower Tertiary *Great White* (AC857), *Chinook* (WR469), and *Cascade* (WR206) Fields, and the Pliocene *Hadrian South* (KC964) Field.

DRILLING AND WATER DEPTHS

The maximum drilling depth in deepwater has continually increased over time, reaching true vertical subsea depths (TVDSS) of more than 35,000 ft in 2009 (**Figure 14**). In August 2013, a well operated by Cobalt at the *Ardennes* prospect in Green Canyon block 896 was drilled to a record depth of 35,935 ft TVDSS. The well targeted Miocene and Lower Tertiary objectives, but found no commercial hydrocarbons. The increase in drilling depths with time may be attributed to several factors, including enhanced rig capabilities, deeper exploration targets, and the general trend toward greater water depths, as can be seen in **Figure 15**. In August 2008, a well operated by Murphy at the unsuccessful *Manhattan* prospect in Lloyd Ridge block 511 set a GOM water-depth drilling record of 10,141 ft.

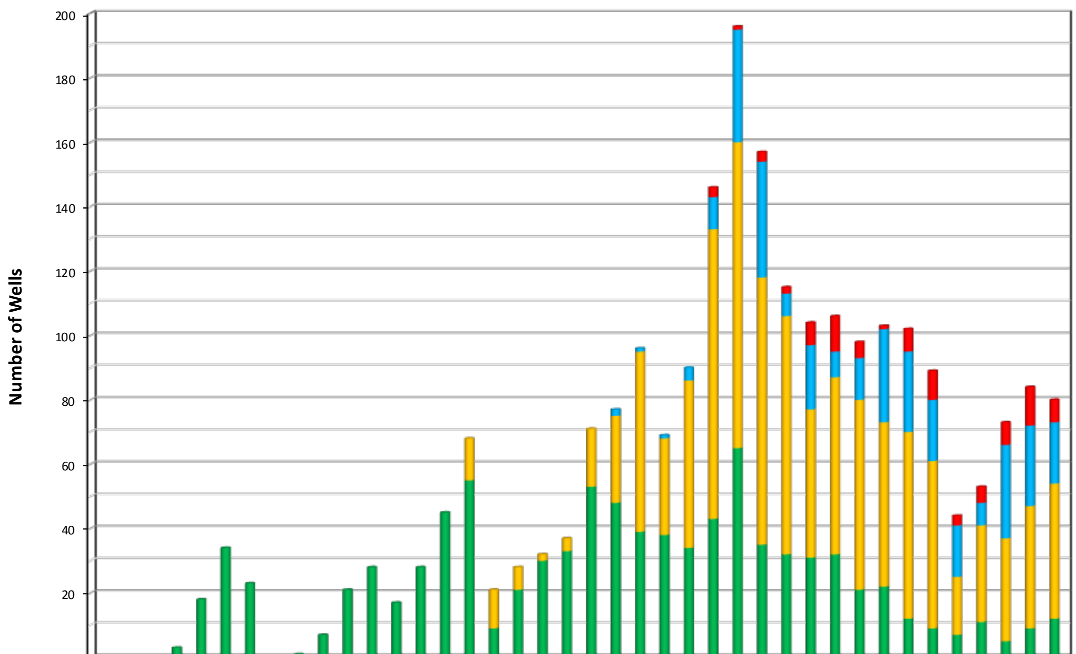


Water depth	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
≥ 7500 ft														2						
5,000 - 7,499 ft												1	3	2	1	3	1	1	2	2
2,500 - 4,999 ft										4	5	8	16	24	24	15	15	2	2	12
1,000 - 2,499 ft	8	16	6	2	16	12	11	11	11	54	60	41	23	52	28	16	19	5	9	13

Water depth	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≥ 7500 ft		1		1		4	8	12	11	14	5	5	2	5	1		1		8	5
5,000 - 7,499 ft	1	4	9	8	30	18	25	10	18	22	8	14	18	14	21	6	6	18	23	22
2,500 - 4,999 ft	17	20	44	48	43	51	60	36	50	25	24	34	28	24	22	16	9	14	13	24
1,000 - 2,499 ft	3	12	24	44	18	18	11	20	19	9	10	23	12	3	2	3		3	1	2

Year

Figure 12. Deepwater exploratory wells drilled by water depth.



Water depth	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
≥ 7500 ft																				
5,000 - 7,499 ft																				
2,500 - 4,999 ft																13	12	7	2	4
1,000 - 2,499 ft				3	18	34	23		1	7	21	28	17	28	45	55	9	21	30	33

Water depth	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≥ 7500 ft						3	1	3	2	7	11	5	1	7	9	3	5	7	12	7
5,000 - 7,499 ft		2	1	1	4	10	35	36	7	20	8	13	29	25	19	16	7	29	25	19
2,500 - 4,999 ft	18	27	56	30	52	90	95	83	74	46	55	59	51	58	52	18	30	32	38	42
1,000 - 2,499 ft	53	48	39	38	34	43	65	35	32	31	32	21	22	12	9	7	11	5	9	12

Year

Figure 13. Deepwater development wells drilled by water depth.

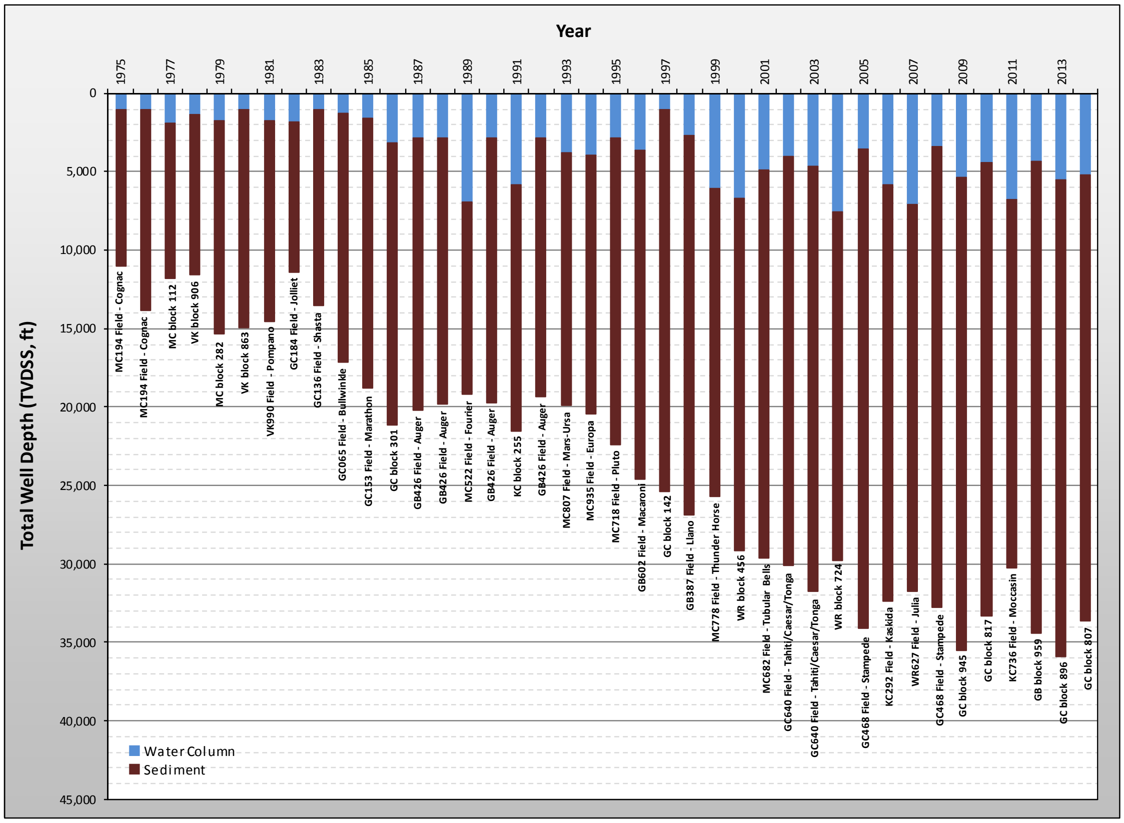


Figure 14. Deepest well drilled by year with associated water depth.

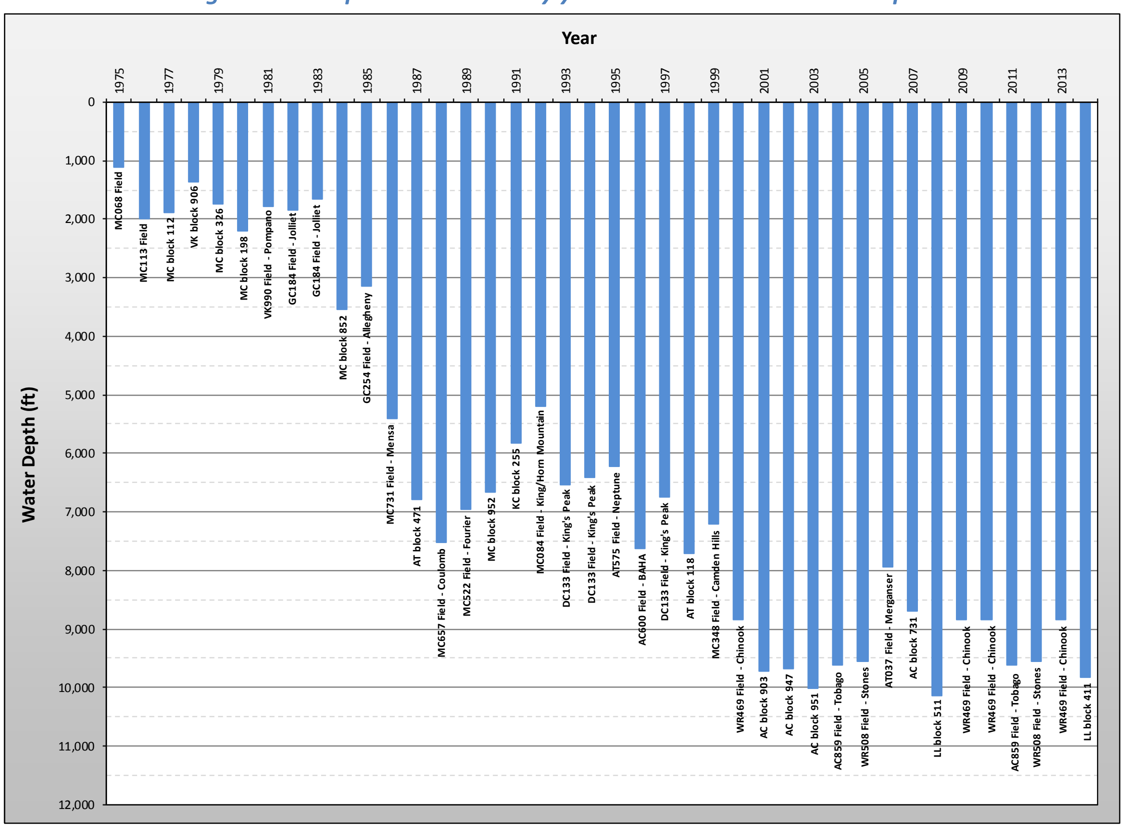


Figure 15. Water-depth drilling records by year.

GEOLOGY

OVERVIEW

The Gulf of Mexico is a basin that formed beginning in the Late Triassic to Early Jurassic Periods with the breakup of the Pangaean supercontinent when Africa and South America separated from North America (Martin, 1978; Salvador, 1987). This breakup event formed a series of northeast-southwest-trending rifts offset by northwest-southeast-trending transfer faults/zones. The rift grabens were active depocenters receiving lacustrine and alluvial deposits. During the Middle Jurassic, marine water sporadically entered the incipient GOM Basin, resulting in the deposition of thick evaporative deposits of the Louann Salt. During the Late Jurassic, a widespread marine transgression deposited an organic-rich carbonate mudstone (Smackover) that became a major hydrocarbon source rock for the GOM. A series of transgressions and regressions led to the deposition of high-energy siliciclastics and carbonates, which caused progradation of the shelf edge in the northeastern GOM Basin. During the Cretaceous Period, thick reef complexes developed along the shelf edge. These reef complexes interfingered with carbonates and siliciclastics in backreef areas. Carbonates and evaporites continued to dominate the depositional setting in the northeastern GOM Basin until the Middle Miocene, when Cenozoic clastic influx became significant enough to prograde onto and, subsequently, across the Cretaceous carbonate platform.

Uplift of the North American continent and the subsequent Laramide Orogeny in the Late Cretaceous provided the source for large amounts of siliciclastic sand and mud that were transported to the Texas and Louisiana coasts by the Mississippi River and other ancient river systems throughout the Cenozoic Era. The depocenters of these rivers generally shifted from west to east and prograded north to south through time. Deposition of these gulfward prograding depocenters was interrupted repeatedly by transgressions that reflected increases in relative sea level and resulted in the deposition of marine shales. Regional marine-shale wedges reflect these widespread periods of submergence of the continental platform. After these flooding events when relative sea level dropped, progradation resulted in deposition of progressively more sand-rich sediments of the next youngest depocenter.

Late in the Cenozoic, episodes of continental glaciation provided an increased clastic sediment load to the basin, resulting in the modern Texas and Louisiana shelf and slope that are characterized by massive amounts of clastic materials. This loading and subsequent deformation of the Louann Salt throughout time created many of the regional structures that are favorable for the entrapment of hydrocarbons.

CHRONOZONES

Traditionally, benthonic foraminifera biostratigraphic zones have been used with electric logs to subdivide the highly repetitive and structurally complex Cenozoic and Mesozoic sandstone packages, shale wedges, and carbonate sections present in the GOM into chronozones. Chronozone boundaries are typically defined by the maximum flooding surface of the aforementioned shale wedges (Morton et al., 1988). In Reed et al. (1987), BOEM integrated the benthonic foraminifera markers and electric log patterns with seismic data to establish a chronostratigraphic synthesis or temporal framework consisting of 26 Cenozoic chronozones in the OCS portion of the basin. Major flooding surfaces were important reference horizons for this grouping. With new information from the continual influx of drilling and seismic data, BOEM further refined the Cenozoic chronozones and delineated chronozones for the Mesozoic in the mid-1990s (**Table 2**).

Table 2. Historical chronostratigraphy.

Province	System	Series	Chronozone Name	Chronozone Number	Detailed Name	Detailed Number	Biozone
Cenozoic	Quaternary	Pleistocene	UPL	01	UPL-4	01	*Sangamon fauna*
					UPL-3	02	*Trimosina "A" 1st*
					UPL-2	03	*Trimosina "A" 2nd*
					UPL-1	04	*Hyalinea "B" / Trimosina "B"*
			MPL	05	MPL-2	05	*Angulogerina "B" 1st*
					MPL-1	06	*Angulogerina "B" 2nd*
			LPL	07	LPL-2	07	*Lenticulina 1*
					LPL-1	08	*Valvulineria "H"*
	Tertiary	Pliocene	UP	09	UP-1	09	*Buliminella 1*
			LP	10	LP-1	10	*Textularia "X"*
		Miocene	UM3	11	UM-3	11	*Robulus "E" / Bigenerina "A"*
					UM-2	12	*Cristellaria "K"*
			UM1	13	UM-1	13	*Discorbis 12*
			MM9	14	MM-9	14	*Bigenerina 2*
					MM-8	15	*Textularia "W"*
			MM7	16	MM-7	16	*Bigenerina humblei*
					MM-6	17	*Cristellaria "I"*
					MM-5	18	*Cibicides opima*
			MM4	19	MM-4	19	*Amphistegina "B"*
					MM-3	20	*Robulus 43*
					MM-2	21	*Cristellaria 54 / Eponides 14*
					MM-1	22	*Gyroidina "K"*
			LM4	23	LM-4	23	*Discorbis "B"*
					LM-3	24	*Marginulina "A"*
			LM2	25	LM-2	25	*Siphonina davisi*
			LM1	26	LM-1	26	*Lenticulina hanseni*
		Oligocene	UO	27	UO-2	27	*Discorbis Zone / Robulus "A"*
					UO-1	28	*Heterostegina texana*
			MO	29	MO-1	29	*Camerina "A"*
			LO	30	LO-1	30	*Textularia warreni*
		Eocene	UE	31	UE-2	31	*Hantkenina alabamensis*
					UE-1	32	*Camerina moodybranchensis*
			ME	33	ME-1	33	*Discorbis yeguaensis*
			LE	34	LE-1	34	*Globorotalia wilcoxensis*
		Paleocene	UL	35	UL-2	35	*Globorotalia velascoensis*
					UL-1	36	*Cristellaria longiforma*
			LL	37	LL-1	37	*Globorotalia uncinata*
Mesozoic	Cretaceous	Upper	UK5	38	UK-5	38	*Globotruncana mayaroensis*
					UK-4	39	*Globotruncana fornicata*
					UK-3	40	*Globotruncana concavata*
			UK2	41	UK-2	41	*Planulina eaglefordensis*
					UK-1	42	*Rotalipora cushmani*
		Lower	LK8	43	LK-8	43	*Lenticulina washitaensis*
					LK-7	44	*Cythereis fredericksburgensis*
			LK6	45	LK-6	45	*Eocytheropteron trinitiensis*
					LK-5	46	*Orbitolina texana*
					LK-4	47	*Rehacythereis? aff. R. glabrella*
			LK3	48	LK-3	48	
					LK-2	49	*Choffatella decipiens*
					LK-1	50	*Schuleridea acuminata*
	Jurassic	Upper	UJ4	51	UJ-4	51	*Epistomina uhligi*
					UJ-3	52	*Epistomina mosquensis*
					UJ-2	53	*Pseudocyclammina jaccardi*
					UJ-1	54	
		Middle	MJ	55	MJ	55	
		Lower	LJ	56	LJ	56	
	Triassic	Upper	UTR	57	UTR	57	
		Middle	MTR	58	MTR	58	
		Lower	LTR	59	LTR	59	

Because oil and gas exploration companies were increasingly relying on global nannoplanktic (coccolith) and planktic foraminiferal marker fauna, including planktic coiling changes and acmes, as well as extinction points, to define the Plio-Pleistocene boundary and the top of the Miocene (Picou et al., 1999), BOEM incorporated this global biozonation beginning in 2003 (**Table 3** and **Table 4**). Please see BOEM's official biostratigraphic chart for further details.

Table 3. Current Cenozoic chronostratigraphy.

Chronostratigraphy				Biostratigraphy	
Erathem	**System**	**Series**	**Chronozone**	**Foraminifer**	**Nannoplankton**
Cenozoic	Quaternary	Pleistocene	Upper Pleistocene	Globorotalia flexuosa Sangamon fauna	Emiliania huxleyi (base of acme) Gephyrocapsa oceanica (flood) Gephyrocapsa caribbeanica (flood)
			Middle Pleistocene	Trimosina "A"	Helicosphaera inversa Gephyrocapsa parallela Pseudoemiliania ovata
			Lower Pleistocene	Stilostomella antillea Trimosina "A" (acme) Hyalinea "B" / Trimosina "B" Angulogerina "B" Uvigerina hispida	Pseudoemiliania lacunosa "C" (acme) Calcidiscus macintyrei
	Neogene	Pliocene	Upper Pliocene	Globorotalia crassula (acme) Lenticulina 1 Globoquadrina altispira Textularia 1	Discoaster brouweri
			Lower Pliocene	Buccella hannai (acme) Buliminella 1 Globorotalia plesiotumida (acme)	Sphenolithus abies Sphenolithus abies "B" Discoaster quintatus
		Miocene – Upper	Upper Upper Miocene	Globorotalia menardii (coiling change right-to-left) Textularia "X" Robulus "E" Bigenerina "A" Cristellaria "K" Bolivina thalmanni	Discoaster quinqueramus Discoaster berggrenii "A" Minylithus convallis Catinaster mexicanus Discoaster prepentaradiatus (increase)
			Lower Upper Miocene	Discorbis 12 Bigenerina 2 Uvigerina 3	Helicosphaera walbersdorfensis Coccolithus miopelagicus
		Miocene – Middle	Upper Middle Miocene	Globorotalia fohsi robusta Textularia "W" Globorotalia peripheroacuta	Discoaster kugleri Discoaster kugleri (acme) Discoaster sanmiguelensis (increase)
			Middle Middle Miocene	Bigenerina humblei Cristellaria "I" Cibicides opima	Sphenolithus heteromorphus Sphenolithus heteromorphus (acme)
			Lower Middle Miocene	Cristellaria / Robulus / Lenticulina 53 Amphistegina "B" Robulus 43 Cibicides 38	Helicosphaera ampliaperta Discoaster deflandrei (acme) Discoaster calculosus
		Miocene – Lower	Upper Lower Miocene	Cristellaria 54 / Eponides 14 Gyroidina "K" Catapsydrax stainforthi	Reticulofenestra gartneri Sphenolithus disbelemnos
			Upper Lower Miocene	Discorbis "B" Marginulina "A"	Orthorhabdus serratus Triquetrorhabdulus carinatus
			Upper Lower Miocene	Siphonina davisi Lenticulina hanseni	Discoaster saundersi Helicosphaera recta
	Lower Tertiary (Paleogene)	Oligocene	Upper Oligocene	Robulus "A" Heterostegina texana Camerina "A" Bolivina mexicana	Dictyococcites bisectus Sphenolithus delphix
			Lower Oligocene	Nonion struma Textularia warreni	Sphenolithus pseudoradians Ismolithus recurvus
		Eocene	Upper Eocene	Hantkenina alabamensis Camerina moodybranchensis	Discoaster saipanensis Cribrocentrum reticulatum Sphenolithus obtusus
			Middle Eocene	Nonionella cockfieldensis Discorbis yeguaensis	Micrantholithus procerus Pemma basquensis Discoaster lodoensis
			Lower Eocene	Globorotalia wilcoxensis	Chiasmolithus californicus Toweius crassus Discoaster multiradiatus
		Paleocene	Upper Paleocene	Morozovella velascoensis Vaginulina longiforma Vaginulina midwayana	Fasciculithus tympaniformis
			Lower Paleocene	Globorotalia trinidadensis Globigerina eugubina	Chiasmolithus danicus

Table 4. Current Mesozoic chronostratigraphy.

Chronostratigraphy				Biostratigraphy*	
Erathem	**System**	**Series**	**Chronozone**	**Foraminifer & Ostracod (O)**	**Nannoplankton**
Mesozoic	Cretaceous	Upper	Upper Upper Cretaceous	Abathomphalus mayaroensis Rosita fornicata Dicarinella concavata Hedbergella amabilis	Micula decussata Lithastrinus moratus Stoverius achylosus
			Lower Upper Cretaceous	Planulina eaglefordensis Rotalipora cushmani Favusella washitaensis Rotalipora gandolfii	Lithraphidites acutus
		Lower	Upper Lower Cretaceous	Planomalina buxtorfi Cythereis fredericksburgensis (O)	Hayesites albiensis Braarudosphaera hockwoldensis Prediscosphaera columnata
			Middle Lower Cretaceous	Cytheridea goodlandensis (O) Dictyoconus walnutensis Eocytheropteron trinitiensis (O) Orbitolina texana	Rucinolithus irregularis
			Lower Lower Cretaceous	Ticinella bejaouaensis Choffatella decipiens Schuleridea lacustris (O) Schuleridea acuminata (O)	Nannoconus colomii Polycostella senaria
	Jurassic	Upper	Upper Jurassic	Gallaecytheridea postrotunda (O) Epistomina uhligi Epistomina mosquensis Alveosepta jaccardi Paalzowella feifeli	Hexalithus noelae Stephanolithion bigotii bigotii Stephanolithion bigotii maximum Stephanolithion speciosum
		Middle	Middle Jurassic	Epistomina regularis	Stephanolithion hexum

*All species represent extinction points. No biostratigraphic markers have been found older than Middle Jurassic.

Deepwater Plays

The deepwater portion of the GOM Basin generally corresponds to the modern slope. The slope occurs between the modern shelf edge and the Sigsbee Escarpment or large compressional structures in front of the Sigsbee Escarpment (**Figure 16**). The Sigsbee Escarpment is the southernmost extent of where large salt bodies override the abyssal plain. The slope contains a wide variety of salt-tectonic features. Very generally, the slope is characterized by displaced salt sheets (allochthons), with a gradual transition from small, isolated salt bodies (e.g., stocks, tongues, walls) in the upper slope to large, contiguous salt canopies in the lower slope. As a result of load-induced evacuation, flowing Jurassic Louann Salt has climbed the Mesozoic and Cenozoic stratigraphy as allochthonous tiers and glaciers in a prograding extensional setting with a compressional toe-of-slope.

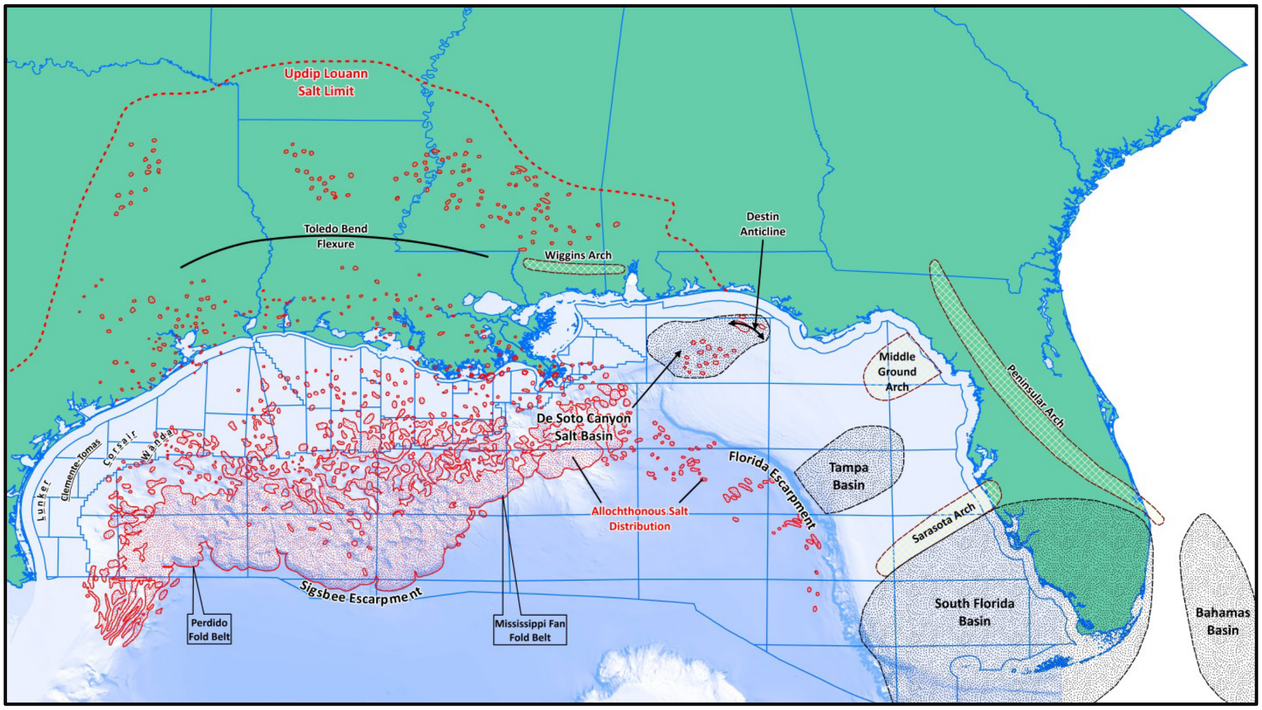


Figure 16. Generalized physiographic map of the Gulf of Mexico area. (Salt distribution after ***Simmons, 1992****.)*

As previously stated, during the early geologic history of the GOM, the Louann Salt was deposited within Jurassic rift basins. The salt was thickest in the grabens and thin or absent over the horst blocks. The salt was subsequently covered by overburden, causing a loading effect. The Louann Salt reacted by flowing to form pillows within the grabens. As deposition continued, the mobilized salt flowed out of the grabens onto the neighboring horst blocks, primarily in a southerly direction away from the source of sedimentation. Over time the salt remained at a consistent isostatic level by rising through the overburden often along reverse or thrust faults. As the salt withdrew from the grabens, topographic lows formed on the seafloor providing a focus for additional sediment deposition. With time, these topographic lows became salt-withdrawal basins ("minibasins") accumulating very thick sections of younger sediments.

In places, actively inflating salt extruded through to the seafloor and flowed laterally as a salt glacier (Fletcher et al., 1995). As salt extrusion continued, the salt glacier flowed up and across newly deposited sediment, meaning that as it moved away from its feeder, the salt climbed over progressively younger sediment. In fact, a single allochthon can become multiple tiers ascending into higher stratigraphic levels. Eventually, the allochthon became completely isolated from its feeder and could continue flowing only by withdrawing salt from its trailing edge (Fletcher et al., 1995; Schuster, 1995). Two end member structural systems have been recognized when allochthons are loaded and evacuated (Schuster, 1995). If the salt is not completely withdrawn from its trailing edge, smaller residual salt bodies are left behind. These fault-segmented bodies, or "roho" systems, are characterized by major, listric, down-to-the-basin growth faults that sole into the horizontal salt weld left by the evacuating salt. If the salt is completely withdrawn from its trailing edge, a stepped counter-regional system results. Strata above the deflating salt subside to form a landward-dipping, shallow flat step. The step resembles a growth fault, but the step is not a true fault over most of its length and actually is the salt weld left by the evacuating salt.

The entire process of salt evacuation, minibasin formation, and allochthon emplacement can repeat through time. In fact, an extensive paleo-salt canopy covered much of the shelf and slope during the

Upper Miocene. Subsequently, due to continental glaciation, renewed sediment loading during the Plio-Pleistocene created even younger minibasins where this paleo-canopy was located, squeezing the salt upward along a new series of counter-regional faults to form the modern Sigsbee Salt Canopy.

In the southern portion of the slope, several fold and thrust belts are present, including the Perdido and Mississippi Fan Fold Belts (**Figure 16**). These fold belts contain classic thrust-related structural features such as large folds, thrust-fault anticlines, duplexes, and imbricate faults, and represent the downslope part of a linked system in which upslope extension results in downdip compression (Rowan et al., 2000). In the upslope part of the system, differential loading from sediment progradation causes extension. Gravity gliding and/or spreading above a salt detachment translates into the contraction that results in the downslope fold belt.

Figure 17 contains layered geographic data illustrating Pleistocene, Pliocene, Upper Miocene, Middle Miocene, Lower Miocene, and Lower Tertiary fields in deepwater. The data points represent locations of the discovery wells for each field. Each geologic trend is represented as a layer that can be toggled on or off in the layers navigation pane. **Appendix D** contains tables of BOEM-designated fields and discoveries with reservoirs dominated by each of these geologic ages. Because the fields and discoveries in the tables may contain resources in reservoirs of other ages as well, they are a subset of the data points shown on **Figure 17**.

Plio-Pleistocene

The Plio-Pleistocene trend in deepwater has been extensively explored since the mid-1970s. Plio-Pleistocene targets in the deepwater GOM include minibasins situated above and below tabular salt bodies (**Figure 17**). Large (>50 MMBOE) Pleistocene discoveries include *Zinc* (MC354), *Magnolia* (GB783), and *Jolliet* (GC184), and large (>200 MMBOE) Pliocene discoveries include *Auger* (GB426), *Cognac* (MC194), *Holstein* (GC644), *Troika* (GC244), and *Baldpate* (GB260). Recent, large (>100 MMBOE) subsalt Pliocene discoveries include *Lucius* (KC875) and *Hadrian South* (KC964). Volumetric estimates of Plio-Pleistocene discoveries add up to approximately 31 percent of the total deepwater GOM oil and gas recoverable volumes.

Miocene

The Miocene trend in deepwater has been extensively explored since the mid-1980s. Miocene objectives in the deepwater GOM are typically located on the flanks of minibasins or in subsalt structures (**Figure 17**). The minibasins formed as the result of ongoing salt withdrawal and migration, as depositional depressions on top of the original salt canopies became filled with Upper Miocene, Pliocene, and Pleistocene sediment. Some of the largest deepwater discoveries in the GOM, such as the *Mars-Ursa* geologic complex, have been along the flanks of minibasins.

Numerous Miocene discoveries in deepwater are also found beneath the extensive salt canopies in the Perdido and Mississippi Fan Fold Belts. Many of the structures associated with these compressional fold belts contain very large Miocene discoveries, such as *Atlantis* (GC743) and *Mad Dog* (GC826). Other Miocene discoveries are associated with “turtle” structures. When salt entirely evacuates from its source due to sediment loading, the synclinal flanks of minibasins collapse leaving an inverted sediment pile anticline, or turtle structure. Such a turtle structure yielded *Thunder Horse* (MC778), one of the largest Miocene fields discovered in the northern GOM.

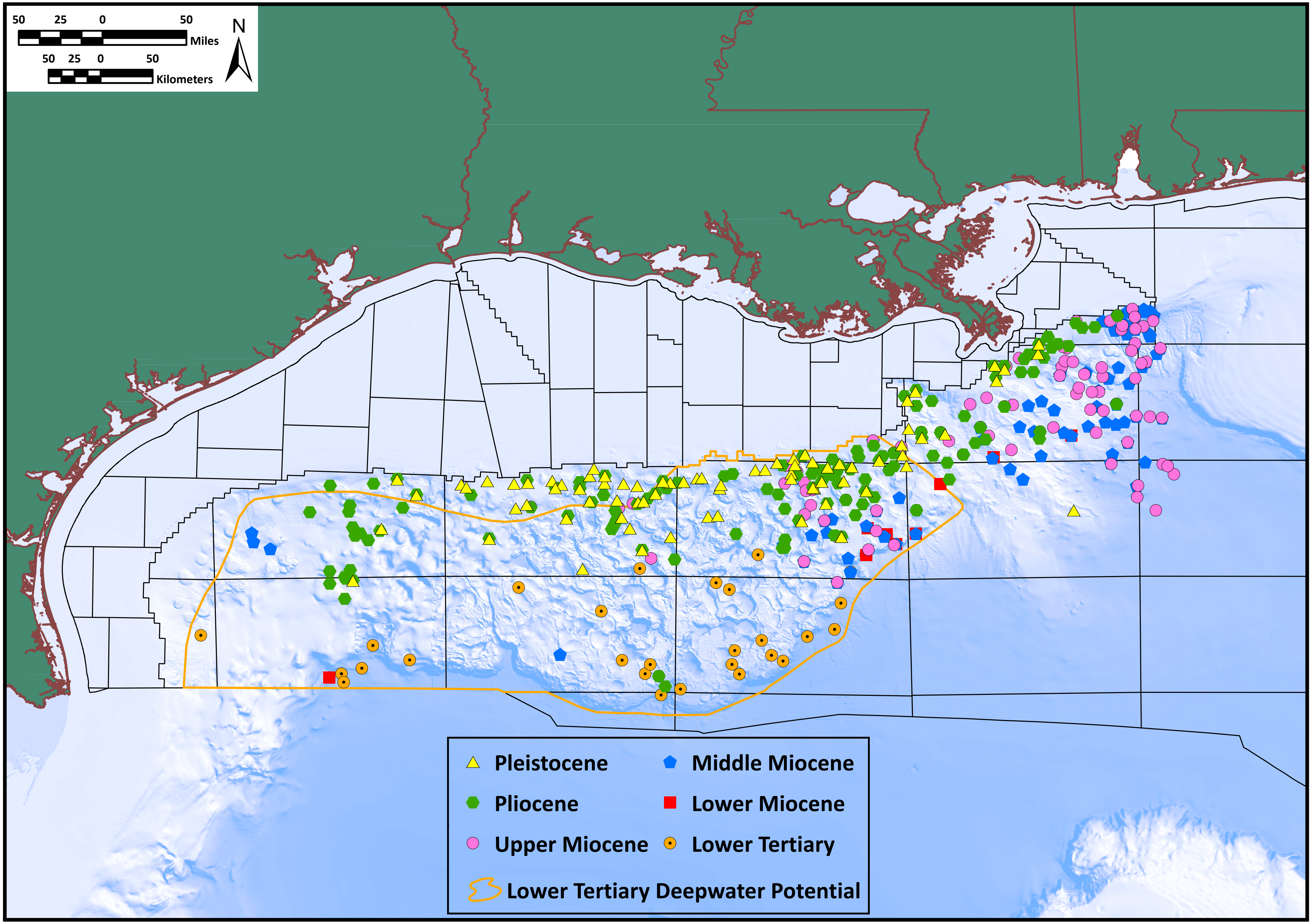


Figure 17. Deepwater Plio-Pleistocene, Miocene, and Lower Tertiary trends. The discoveries can be toggled on or off in the layers navigation pane.

Large (>200 MMBOE) Upper Miocene discoveries include the *Mars-Ursa* (MC807) and *King/Horn Mountain* (MC084) complexes and *Salsa* (GB171). Large (>300 MMBOE) Middle Miocene discoveries include the *Tahiti/Caesar/Tonga* (GC640) complex, *North Thunder Horse* (MC776), *Stampede* (GC468), *Atlantis* (GC743), and *Tubular Bells* (MC682). Large (>150 MMBOE) Lower Miocene discoveries include *Shenzi* (GC654), *Vito* (MC940), *Thunder Horse* (MC778), and *Mad Dog* (GC826). Volumetric estimates of Miocene discoveries add up to approximately 53 percent of the total deepwater GOM oil and gas recoverable volumes.

Lower Tertiary

The Lower Tertiary geologic trend in the deepwater GOM has emerged as one of the world's leading exploration plays due to significant, recent discoveries from Alaminos Canyon to Walker Ridge. However, long before the 1996 *BAHA* well in the Alaminos Canyon Protraction Area confirmed the presence of Wilcox-equivalent, Lower Tertiary rocks in the deepwater GOM, the Lower Tertiary play was explored onshore. Lower Tertiary rocks are exposed in onshore outcrops in all of the Gulf Coast states. Onshore, the Oligocene Frio Formation and Paleocene to Eocene members of the Wilcox Group have a long drilling and production history. These onshore reservoirs are situated in areas of predominantly deltaic to shallow-marine sediments, with the paleo-shelf margins located onshore across the northern GOM. Large Lower Tertiary paleocanyons, which could have channeled sediments from the shelf to the deepwater, occur from onshore Texas to Louisiana. A northward-thinning Lower Tertiary wedge across the modern abyssal plain in the Walker Ridge, Atwater Valley, and Lund Protraction Areas also suggests a southern source, possibly from the Yucatan or Cuba.

As previously mentioned, the first well to penetrate Wilcox-equivalent, Lower Tertiary rocks in the deepwater GOM occurred in 1996 in Alaminos Canyon block 600, when four of the world's largest companies at the time—Texaco, Amoco, Shell, and Mobil—decided to proceed with the drilling of a giant anticlinal structure they dubbed *BAHA* (an acronym representing the first letter of each company's name for the prospect). In a then record setting 7,620 ft of water, the well logged 15 ft of oil in the Eocene and was dubbed a dry hole. Even though technical difficulties forced drilling to stop before the target depth (Mesozoic fractured carbonates), the value of the well was that it found thick sands where the companies thought none would exist. It took 5 years for the companies to integrate the well data with seismic data and decide the best place to drill next before the *BAHA* #2 well reached total depth in Alaminos Canyon block 557. It too was commercially unsuccessful, but the well confirmed the extensive and continual nature of the thick Lower Tertiary sands, dubbed the "Whopper Sand." The well also demonstrated that because of the very deep waters, deep reservoirs, and unexpected pressure regimes, the cost of drilling a well in this environment was enormous. Therefore, to be economic in these conditions, true discoveries would have to be large.

Over the past 15 years, the wells in this deepwater trend have targeted basinal turbidite systems that are age equivalent to the Texas Wilcox Group (Paleocene to Eocene) and have confirmed the presence of a regionally continuous Lower Tertiary sediment system. **Figure 17** illustrates an approximate areal extent of the Lower Tertiary trend, as well as the geographic distribution of significant Lower Tertiary discoveries that have been placed in BOEM-designated fields. Large (>100 MMBOE) Lower Tertiary discoveries include *Buckskin* (KC block 872), *Great White* (AC857), *Anchor* (GC block 807), *Tiber* (KC block 102), *St. Malo* (WR678), and *Kaskida* (KC292). Volumetric estimates of the discoveries so far in the trend add up to approximately 14 percent of the total deepwater GOM oil and gas recoverable volumes.

Structural styles/exploration targets include 4-way closure, 3-way closure against salt, and turtle structures. Just over half of the 49 drilled structures in the trend have been successful. Despite this success, the play presents several technical challenges, including

- very deep water,
- remote location from existing infrastructure,
- a thick, overlying salt layer of complex shape,
- very deep, high-pressure/high temperature reservoirs,
- high well costs,
- reservoir porosity and permeability anisotropy, and
- low gas to oil ratios.

Issues of water depth and proximity to current development infrastructure began to be addressed in 2009 with the installation of the Perdido Regional Host spar in Alaminos Canyon block 857 in 7,817 ft of water, a world water-depth record for a spar. The spar hosts production from the *Great White* (AC857) and *Tobago/Silvertip* (AC859) Fields. Because of the spar's remote location, 77 mi of oil export pipeline and 107 miles of gas export pipeline were installed with the production facility. First production at the facility occurred in 2010. The installation of the northern GOM's first floating production, storage, and offloading (FPSO) facility occurred in 2011 at Walker Ridge block 249 in approximately 8,200 ft of water. The FPSO began collecting production from the *Cascade* (WR206) and *Chinook* (WR469) Fields in 2012. The largest (based on displacement) semisubmersible production platform in the GOM was installed in early 2014 at Walker Ridge block 718 in approximately 6,950 ft of water. The semisubmersible hosts production from the *Jack* (WR759) and *St. Malo* (WR678) Fields. A large diameter (24 inch) oil export pipeline approximately 140 miles in length was installed from the platform to the GC019 Field platform. The pipeline is the first large-diameter, ultra-deepwater pipeline in the Walker Ridge area of the Lower Tertiary trend. Production from the fields began in late 2014. In 2016, the *Stones* (WR508) Field will feature the use of the northern GOM's second FPSO. The FPSO will be installed in approximately 9,500 ft of water, setting the world water-depth record for a production facility. Also in 2016, the *Julia* (WR627) Field will be produced as a subsea tieback to the *Jack/St. Malo* semisubmersible.

The Lower Tertiary Trend in ultra-deepwater areas is complicated by a salt-canopy system that overlies much of the targeted sediments. Salt canopy thicknesses can vary from 5,000 to 20,000 ft in the area, and with water depths up to 10,000 ft, the drill targets can be very deep—25,000 to 35,000 ft. Because seismic energy travels at much higher velocities in salt compared to the clastic sediment in the GOM, conventional images of Lower Tertiary targets beneath salt canopies using narrow-azimuth 3D data are often hindered by blind spots. Wide-azimuth acquisition began producing dramatic improvements in subsalt imaging beginning in the mid-2000s. Advancements in seismic acquisition and depth modeling continues to this day, with full-azimuth, dual coil shooting becoming prevalent, and powerful migration and depth-modeling algorithms now the norm.

Because Lower Tertiary reservoirs in the ultra-deepwater GOM are typically 20,000+ psi and 30,000+ ft deep, advancements and continuing improvements in drilling technology have had to occur to explore and develop this geologic trend economically. Single-trip, multi-zone technologies for use in very deep wells have been developed to minimize hole trips, and new designs and advancements in casings, elastomers, electronics, flow controls, metallurgy, packers, safety valves, and stimulation fluids continue to facilitate exploration and development.

Lower Tertiary reservoirs are often referred to as "tight," because more diagenesis has occurred within these older rocks, decreasing the porosity and permeability. The average porosity of the play is much lower than the more prolific Miocene and younger producers in deepwater (**Figure 18** and **Figure 19**). Moreover, permeabilities, which are key to hydrocarbon flow, are quite low in comparison to that of the high-rate producing Miocene reservoirs (e.g., *North Thunder Horse*, *Thunder Horse*, *Mars-Ursa*). These Miocene reservoirs typically have permeabilities in the 0.5 to 3 darcy range. The average permeability of typical deepwater Lower Tertiary sands is about 25 millidarcys (**Figure 20**). These low values impact how well and how long these reservoirs can produce. During the current early stage of production from the tight Lower Tertiary reservoirs, companies have typically utilized a combination of frac-packing, which opens fractures in the reservoir allowing oil to flow more easily into the wellbore, and subsea boosting, to increase the flow of oil from the well head to the production platform above. As Lower Tertiary reservoirs continue to produce, observations of how they behave will benefit future enhanced recovery methods.

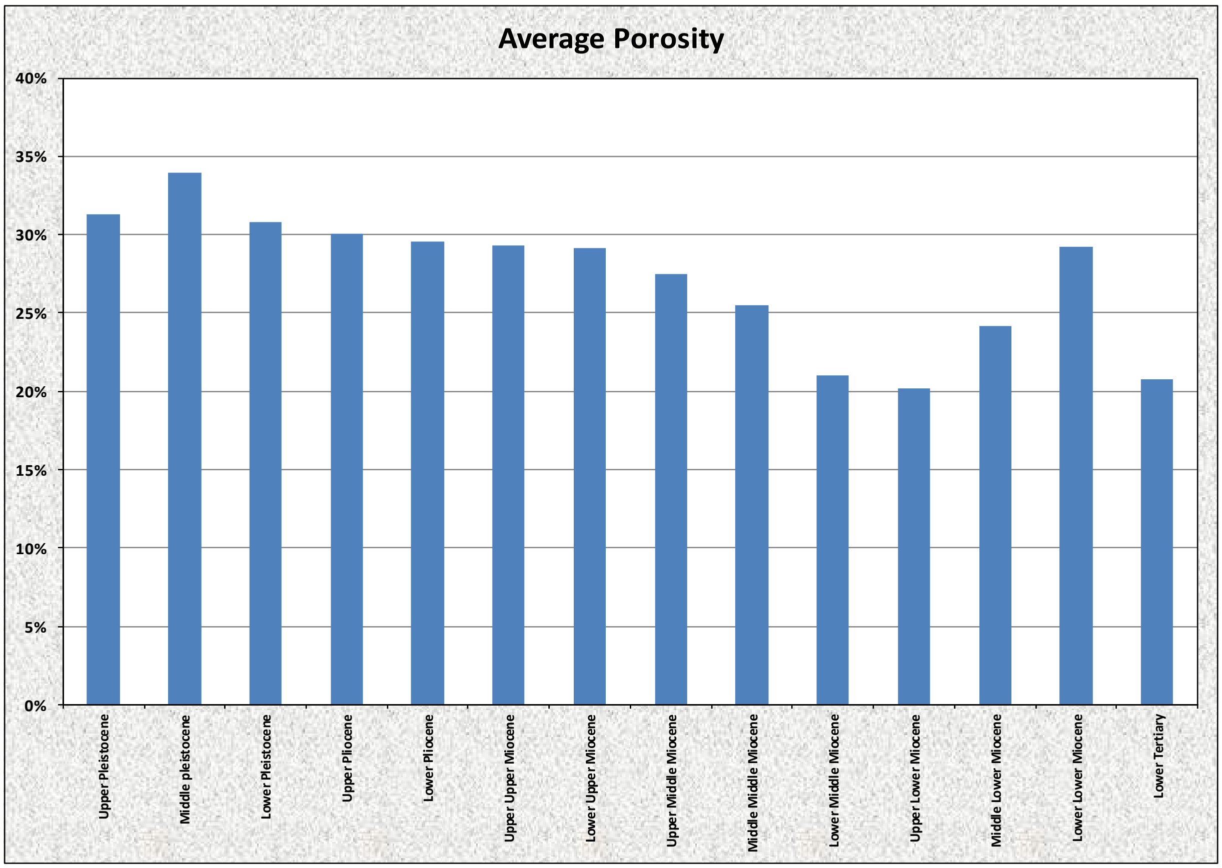


Figure 18. Average porosities for deepwater reservoirs by age.

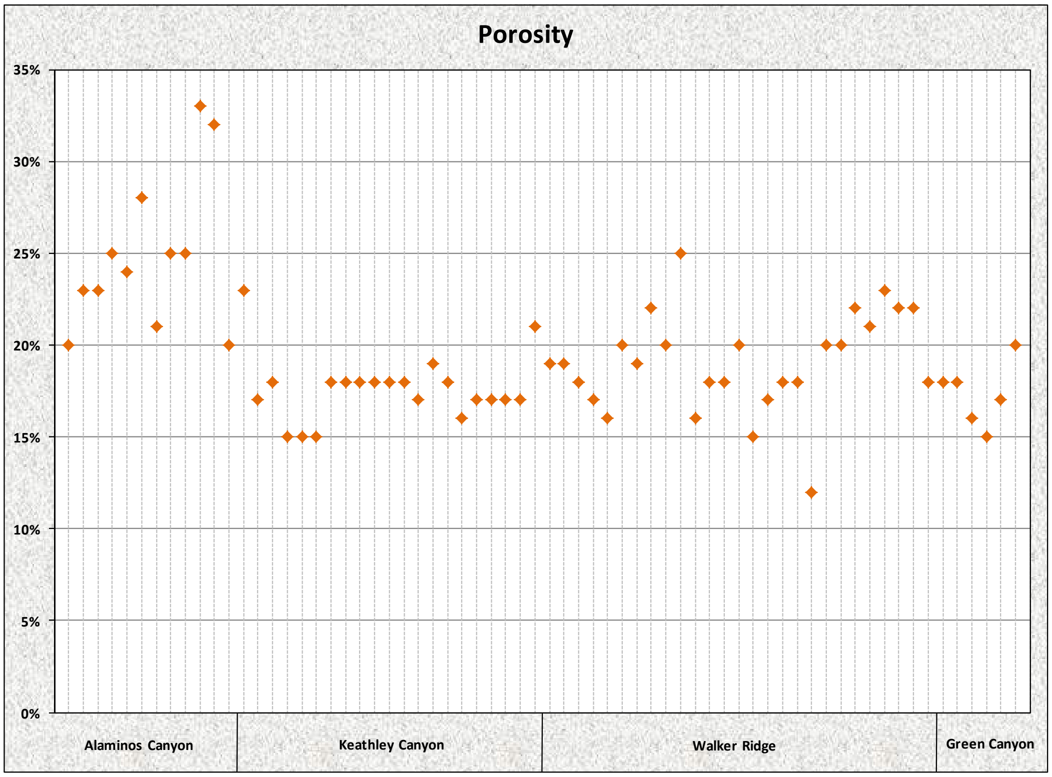


Figure 19. Deepwater Lower Tertiary porosity.

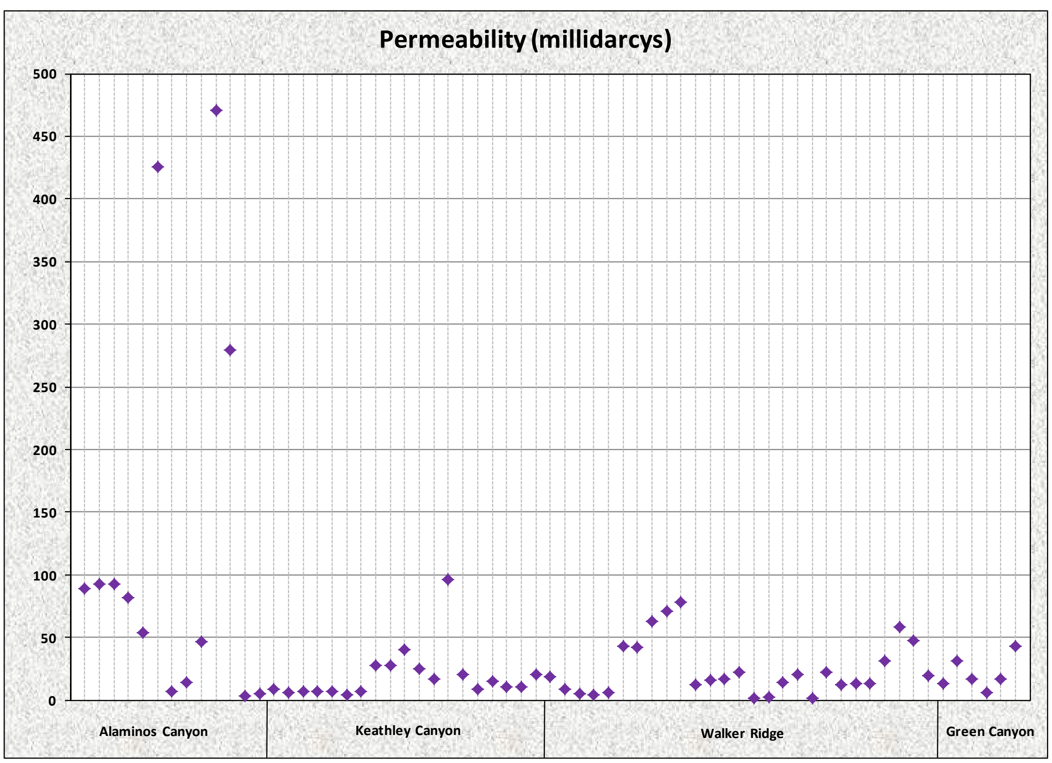


Figure 20. Deepwater Lower Tertiary permeability.

Based on regional petrophysical analyses of wells that penetrate Wilcox Group age-equivalent sediments in deepwater, a few generalized trends have been delineated. There are two trends that occur in the Alaminos Canyon Area. The first trend is the aforementioned "Whopper Sand," which is age equivalent to the Wilcox 4 interval (**Figure 21**) across the play area to the east. The "Whopper Sand" can be found in the *BAHA* (AC600), *Great White* (AC857), and *Trident* (AC block 903) areas. Consisting of amalgamated sheet sands, this interval generally contains a high sand content (~70%) and is very thick (>1,000 ft) (Berman and Rosenfeld, 2007). The "Whopper Sand" interval consists of clean, thick sandstone packages and forms abrupt contacts with the overlying and underlying shales. The second trend in the Alaminos Canyon Area occurs locally in the *Great White* Field at the top of the Lower Eocene Wilcox 1 interval (**Figure 21**). The youngest sandstone in the Wilcox 1 interval exhibits better reservoir quality, including higher porosity and permeability, than the older Wilcox sand intervals in the field.

Overall for the entire play, sand accumulations vary from west to east. In the Alaminos Canyon Area, Wilcox Group age-equivalent sediments tend to have low sand-to-shale ratios. Moving east toward the Walker Ridge Area, the sediments tend to have higher sand-to-shale ratios, as well as an overall increase in porosity and permeability.

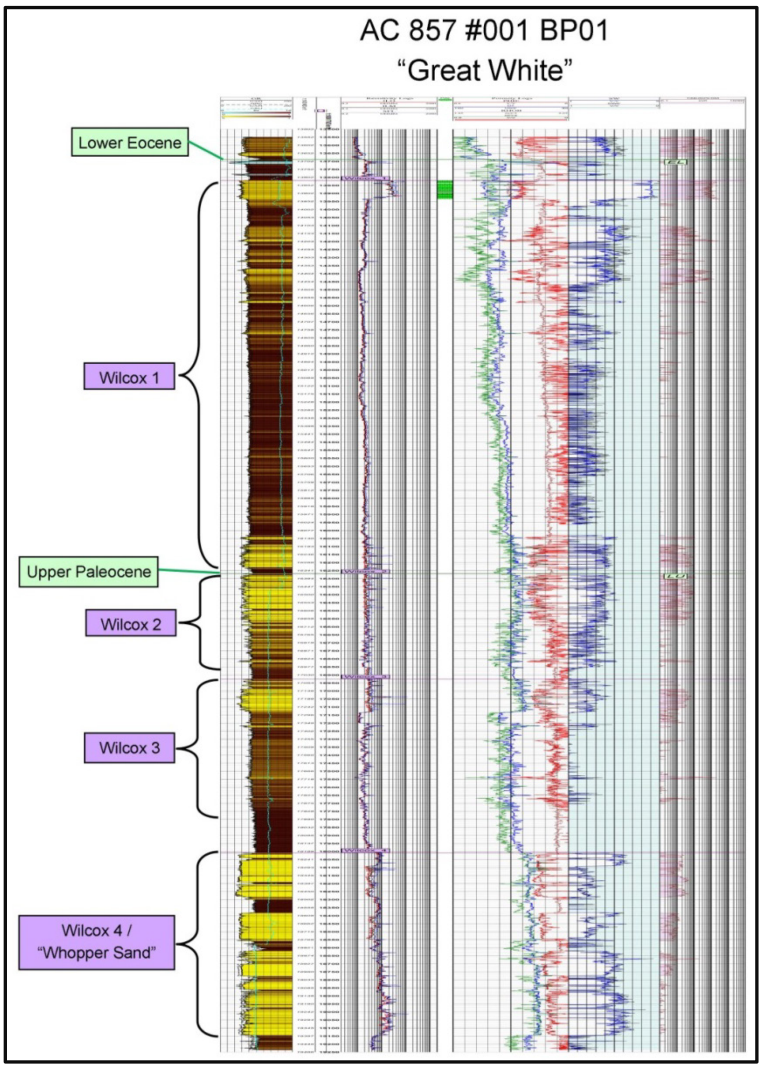


Figure 21. Well log response from the Great White Field.

In the last few years, a geologic model has been proposed to separate the paleo-delta system of the play into an "inboard" and "outboard" trend (Cobalt International Energy, 2013). Early discoveries, such as *Jack* (WR759), *St. Malo* (WR678), *Cascade* (WR206), and *Chinook* (WR469), all are located in the distal, or outboard, portion of the paleo-delta system (**Figure 22**). Because the outboard portion of the play is beyond the seismically-obscuring, allochthonous salt canopy, these prospects were targeted first. The inboard portion of the play, being closer to the clastic source, potentially contains better porosity and permeability, but it also lies beneath the very thick, highly rugose salt canopy. Until the advent of commercially available, complex-azimuth seismic data, the inboard portion of the play was unproven. However, recent discoveries in the inboard portion of the play, including *Shenandoah* (WR051), *North Platte* (GB block 959), and *Anchor* (GC block 807), are beginning to prove the Cobalt geologic model. **Figure 23** illustrates the well log responses from the inboard *Shenandoah* and the outboard *Cascade* Fields.

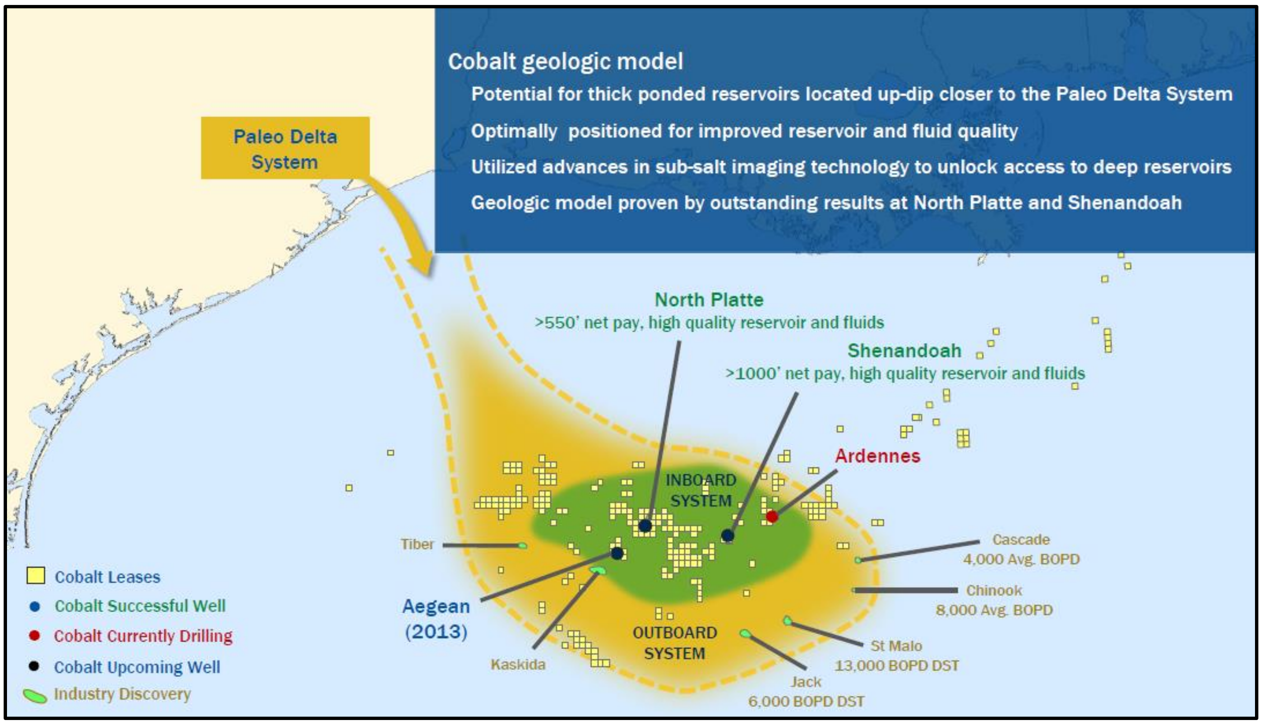


Figure 22. Cobalt International Energy Lower Tertiary geologic model.

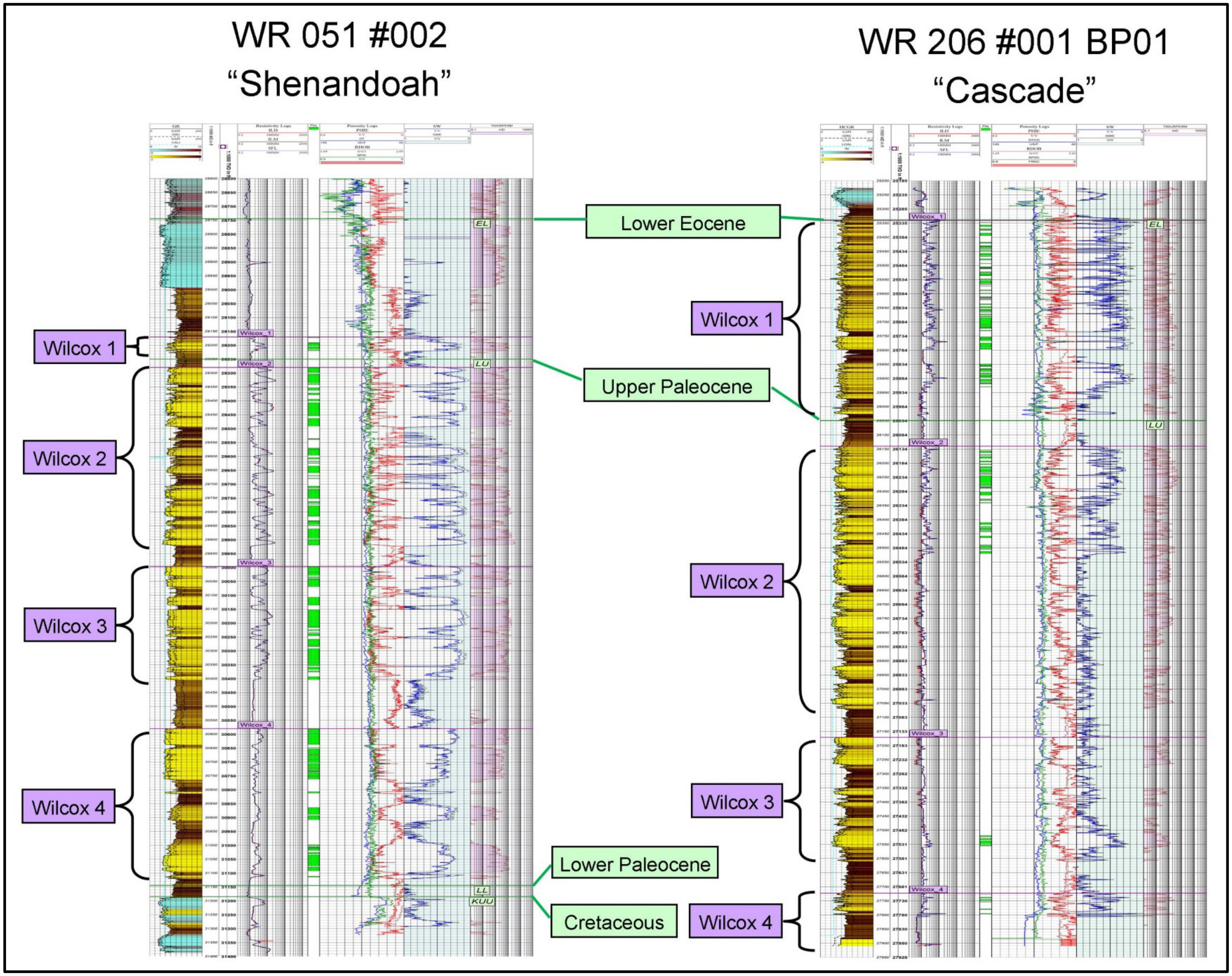


Figure 23. Well log responses from the Shenandoah and Cascade Fields.

Jurassic Norphlet

A very active exploration trend for over a decade in the deepwater Mesozoic Era is the Jurassic Norphlet aeolian dune play. The onset of the deepwater portion of the Norphlet play was initiated in 2003 by Shell Offshore and Nexen Petroleum with the drilling of their *Shiloh* prospect in De Soto Canyon block 269 (Sale 181). The well encountered approximately 100 ft of oil column within the aeolian Norphlet section of the Upper Jurassic. The drilling of this single well greatly reduced the inherent risks of the play by proving the presence of hydrocarbon source rock (Smackover), reservoir rock (Norphlet), and vertical and horizontal seals (also Smackover). A working petroleum system had been established. The operator has since reclassified *Shiloh* as a "non-commercial" discovery.

Shiloh, along with the *Vicksburg "B"* well (DC block 353) drilled in 2007, extended the gas producing shallow-water play from the Mobile Bay/Destin Dome areas southward into the oil prone deepwater (>7,200 ft water depth) protractions of Mississippi Canyon and De Soto Canyon.

Oil industry majors and larger independents have been the most active participants in acquiring available lease blocks in the eastern part of the Central Planning Area and the western portion of the Eastern Planning Area. Primary protractions of interest include De Soto Canyon, Lloyd Ridge, and Mississippi Canyon, where the primary reservoir is aeolian dune sands with secondary possibilities that may include aeolian and coastal sand sheets situated above the Louann Salt. Ten lease sales have been held since the drilling of the *Shiloh* well in 2003, with 350 blocks (2,016,000 acres) leased. Bonus bids accepted for the tracts have totaled $937,112,947 (**Table 5**).

Table 5. Deepwater Norphlet lease sale information.

Lease Sale	Date	Planning Area	Number of Blocks Receiving Bids	Total of High Bids	Participating Companies
Sale 197	March 2005	EPA	12	$6,974,531	Anadarko Petroleum, Devon Energy, Dominion Exploration and Production, Helis Oil and Gas, Houston Energy, Newfield Exploration, Petrobras America, Red Willow Offshore, Spinnaker Exploration
Sale 205	October 2007	CPA	96	$418,728,078	Anadarko Exploration and Production, Eni Petroleum US, Hess Corporation, KNOC USA, LLOG Exploration Offshore, Marathon Oil, Mariner Energy, Murphy Exploration and Production, Nexen Petroleum Offshore, Petrobras America, Shell Offshore, Stephens Production, Stone Energy
Sale 224	March 2008	EPA	36	$64,713,213	BHP Billiton, Eni Petroleum US, BP Exploration and Production
Sale 208	March 2009	CPA	13	$6,476,545	Anadarko Petroleum, Shell Offshore
Sale 213	March 2010	CPA	8	$9,662,605	BHP Billiton, Murphy Exploration and Production, Shell Offshore, Statoil Gulf Properties
Sale 216/222	June 2012	CPA	54	$85,101,084	Anadarko US Offshore, BHP Billiton, BP Exploration and Production, Chevron USA, Ecopetrol America, LLOG Exploration Offshore, Murphy Exploration and Production, Nexen Petroleum, Nobel Energy, Shell Offshore, Statoil Gulf of Mexico, Stone Energy
Sale 227	March 2013	CPA	59	$179,459,461	Anadarko US Offshore, Apache Deepwater, BHP Billiton, Chevron USA, Ecopetrol America, Eni Petroleum, LLOG Bluewater Holding, Murphy Exploration and Production, Repsol Exploration, Shell Offshore, Stone Energy, Venari Offshore
Sale 225	March 2014	EPA	0	$0	
Sale 231	March 2014	CPA	66	$161,113,401	BP Exploration & Production, BHP Billiton, Chevron USA, Cobalt International, Ecopetrol America, Murphy Exploration & Production, Noble Energy, Ridgewood Energy, Shell Offshore, Statoil Gulf of Mexico, Total Exploration & Production USA, Venari Offshore
Sale 235	March 2015	CPA	6	$4,884,029	Cobalt Int'l Energy, Shell Offshore, Total Exploration and Production USA
Sale 226	March 2016	EPA	0	$0	
Sale 241	March 2016	CPA	6	$28,807,716	Chevron USA, Exxon/Mobil, Shell Offshore

A total of 30 wells have been drilled to test/evaluate the Norphlet section of the Upper Jurassic in deepwater, resulting in 5 discoveries (**Figure 24** and **Table 6**).

In the Central Planning Area, 28 wells have been drilled, 16 of which are classified as exploratory, 6 are categorized as delineation, and the remaining 6 were lost due to mechanical problems or shallow water flow. All of these wells are located in northwest De Soto Canyon and northeast Mississippi Canyon. Water depths in this area are in excess of 7,000 ft. Average drilling footage for the wellbores reaching total depth is approximately 25,000 ft with overall drilling times of 100 to 150 days per well.

In the Eastern Planning Area, 2 wells have been drilled, with one classified as exploratory and the other was lost due to shallow water flow problems. The borehole is located on the Florida Escarpment in block 726 of south-central De Soto Canyon. The wellbore is situated in 3,575 ft of water and was drilled to 18,365 ft. Drilling time was 44 days.

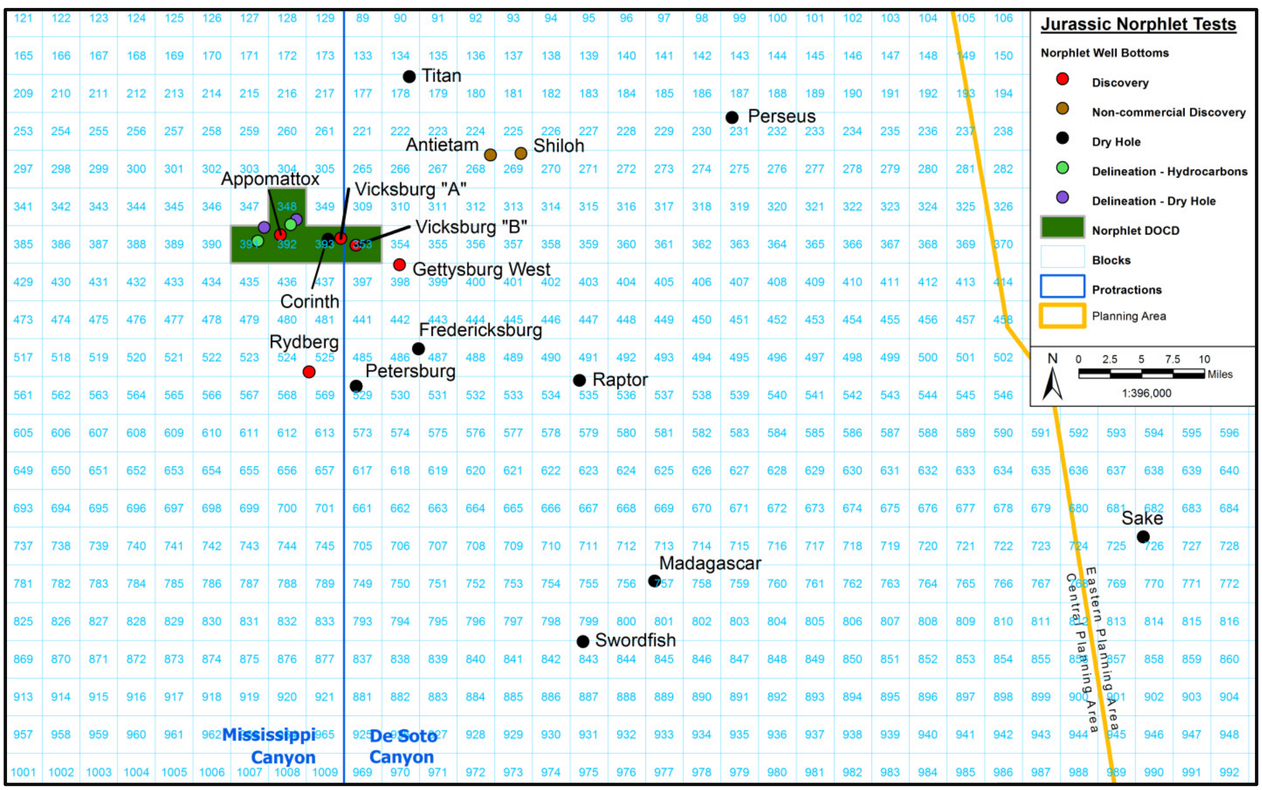


Figure 24. Deepwater Norphlet trend.

Table 6. Deepwater Norphlet well information.

Planning Area	Year	Prospect Name	Location	Lease	Type of Well	Number of Wells	Operator	Partner(s)	Norphlet Section Result
CPA	2003	Shiloh	DC Block 269	G23502	Exploratory	1	Shell	Nexen	non-commercial
CPA	2007	Vicksburg "B"	DC Block 353	G25852	Exploratory	1	Shell	Nexen	**Discovery**
CPA	2008	Fredericksburg	DC Block 486	G25855	Exploratory	1	Shell	Nexen, Plains	dry
CPA	2009	Appomattox	MC Block 392	G26253	Exploratory	1	Shell	Nexen	**Discovery**
CPA	2009	Appomattox	MC Block 392	G26253	Delineation	3/1 lost	Shell	Nexen	both positive
CPA	2009	Antietam	DC Block 268	G23501	Exploratory	3/2 lost	Shell	Nexen	non-commercial
CPA	2011	Appomattox	MC Block 348	G19939	Delineation	2	Shell	Nexen	1 positive/1 dry
CPA	2012	Appomattox	MC Block 391	G26252	Delineation	2	Shell	Nexen	1 positive/1 dry
CPA	2013	Raptor	DC Block 535	G23520	Exploratory	1	Anadarko	BHP Billiton	dry*
CPA	2013	Madagascar	DC Block 757	G31570	Exploratory	1	Marathon	Murphy, Ecopetrol	dry
CPA	2013	Swordfish	DC Block 843	G23540	Exploratory	1	Shell	Eni, Nexen	dry
CPA	2013	Petersburg	DC Block 529	G23517	Exploratory	1	Shell	Nexen	dry
CPA	2013	Vicksburg "A"	MC Block 393	G26254	Exploratory	1	Shell	Nexen	**Discovery**
CPA	2013	Corinth	MC Block 393	G26254	Exploratory	2/1 lost	Shell	Nexen	dry
CPA	2014	Rydberg	MC Block 525	G31507	Exploratory	2/1 lost	Shell	Nexen, Ecopetrol	**Discovery**
CPA	2014	Titan	DC Block 178	G25850	Exploratory	3/1 lost	Murphy	Ecopetrol, Venari	1 non-commercial/1 dry
CPA	2014	Perseus	DC Block 231	G33780	Exploratory	1	Statoil	BHP Billiton, Marathon	dry
CPA	2014	Gettysburg West	DC Block 398	G25854	Exploratory	1	Shell	Nexen	**Discovery**
EPA	2013	Sake	DC Block 726	G32014	Exploratory	2/1 lost	BHP Billiton	Statoil	dry

*The *Raptor* well did reveal 150 ft of oil in the younger Jurassic section.

Shell (operator), via press releases, has announced five significant deepwater discoveries associated with the Jurassic Norphlet play. *Appomattox* (MC 392), *Vicksburg "A"* (MC 393), *Vicksburg "B"* (DC 353), *Rydberg* (MC 525), and *Gettysburg West* (DC 398) are located in the northwest Desoto Canyon and northeast Mississippi Canyon protractions (**Figure 24**). These wells penetrated significant oil bearing sand intervals at depths in excess of 24,000 ft. The operator, along with their partners, has drilled delineation wells in blocks (MC 348 and MC 391) adjacent to *Appomattox* and *Vicksburg "B"*. Shell has estimated the discovered resources associated with these prospects are in excess of 800 MMBOE.

A Supplemental Exploration Plan for the *"Appomattox – Vicksburg"* complex has been submitted by the operator, to be followed by a plan of development (Development Operations Coordination Document) at a later date. The plan calls for the drilling of an additional 44 wells. Of those, 4 will be exploratory, 24 will be development, and 16 will be pressure maintenance injectors. The proposed start date for the project is currently January of 2016, with the completion of the program occurring some time in 2026. Shell continues to assess the Norphlet aeolian reservoir and its associated oil characteristics to determine the optimum development procedures.

Whole core examination along with the analysis of associated well logs established a dune type change in the aeolian deposits from the individual seif (longitudinal) and star dune setting in the north to an area with barchan (horned) dunes in a coalesced or erg type environment in the south (**Figure 25**) (Godo et al., 2011). In addition to two sequences of barchanoid dunes (both sinuous and straight-crested forms), these core and log analyses also identified three additional large scale depositional intervals: 1) interbedded lacustrine mudrocks, 2) stacked aeolian sheets and/or sheetflood facies, and 3) mixed coastal sand sheets with some waterlain sabkha facies (Godo et al., 2011).

The structure of each Norphlet prospect is contained within and controlled by tectonic rafts that detached along the Florida Escarpment and translated basinward by gravity gliding on the autochthonous Louann Salt in the late Jurassic to early Cretaceous (Pilcher et al., 2014). A common Norphlet well log response is illustrated in **Figure 26** with the *Vicksburg "B"* discovery in DC block 353. The Norphlet section, deposited on the Louann Salt, consists of clean, blocky, medium to fine-grained aeolian dune deposits. Some wells drilled to date also contain a Norphlet fluvial section consisting of alternating shale and channel sand beds. Porosities, permeabilities, and net-to-gross intervals all decrease toward the east as fluvial interaction increases away from the well-developed dune field to the west (**Figure 27** and **Figure 28**). The Norphlet section is overlain by the Smackover Formation, which is a clean and blocky carbonate section that acts as both the seal and hydrocarbon source for Norphlet reservoirs. The Smackover can have either an abrupt or gradational contact with the top of the Norphlet.

Primary play risks found to date within the deepwater area include the presence of a reservoir, reservoir quality, and hydrocarbon properties including the presence of asphaltenes, which can restrict hydrocarbon flow. Additional risks include timing (trap creation relative to hydrocarbon creation and expulsion) and trap seal (vertical and horizontal) for hydrocarbon preservation.

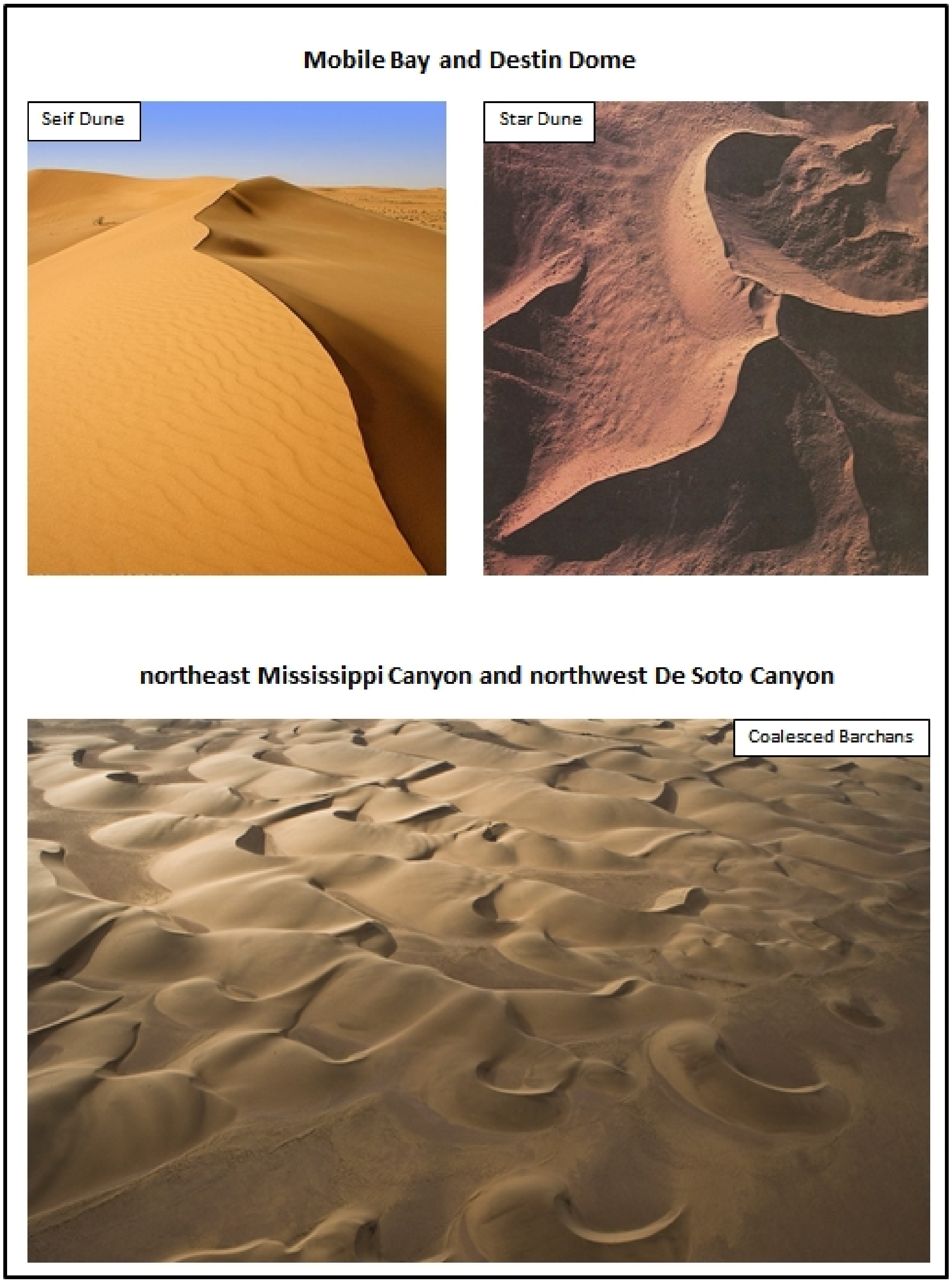


Figure 25. Aeolian dune type change from shallow-water to deepwater Norphlet.

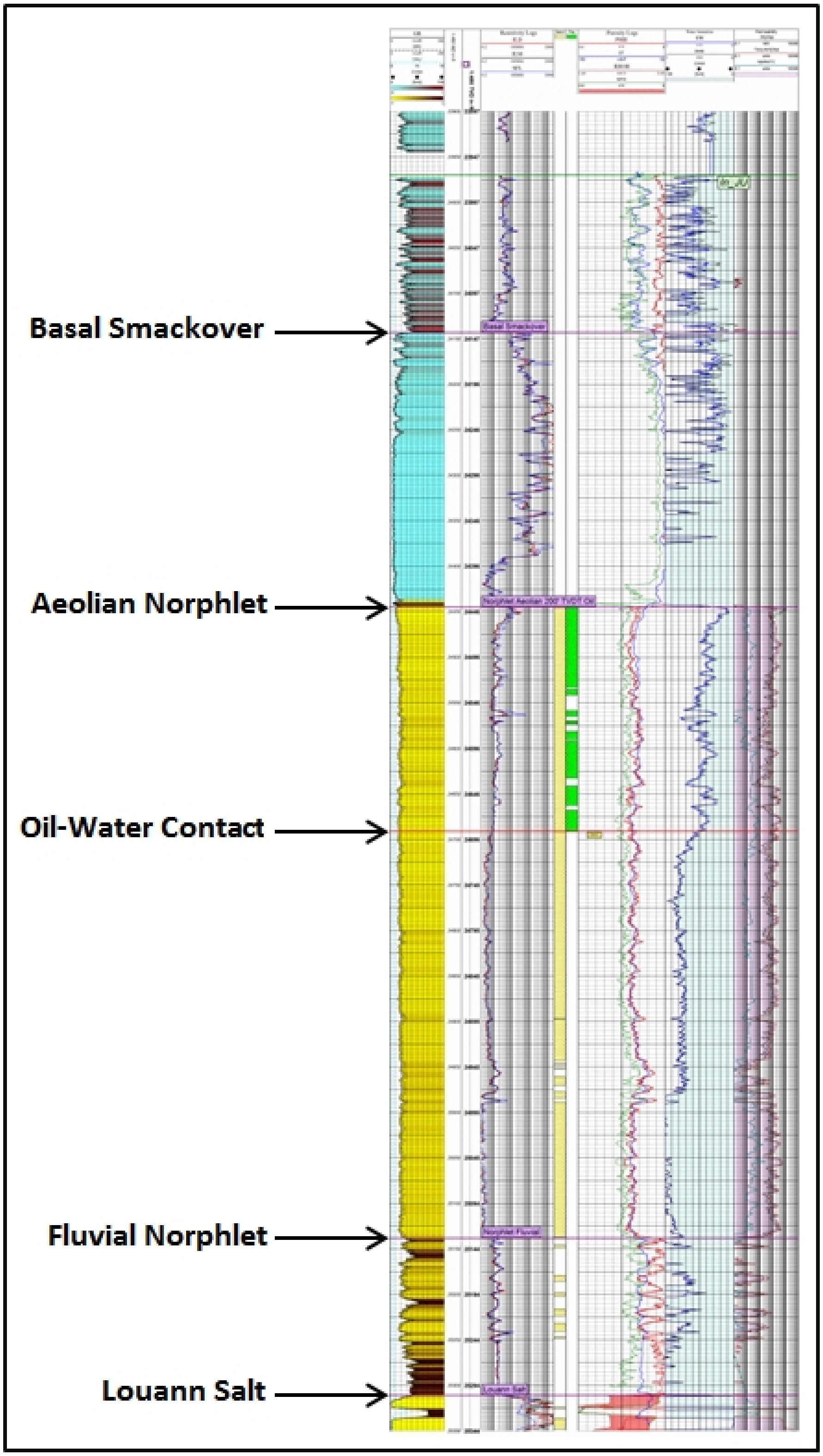


Figure 26. Well log response of the Vicksburg "B" discovery.

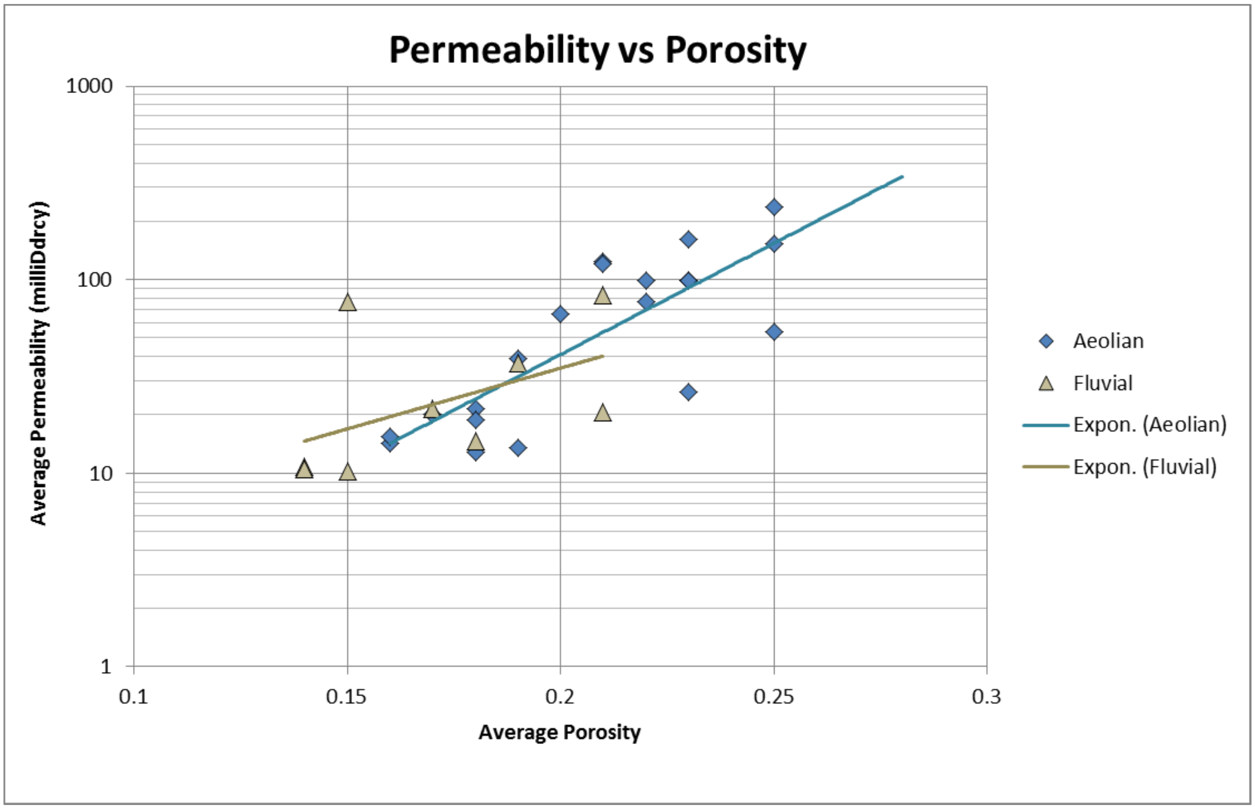


Figure 27. Porosity and permeability crossplot by Norphlet facies.

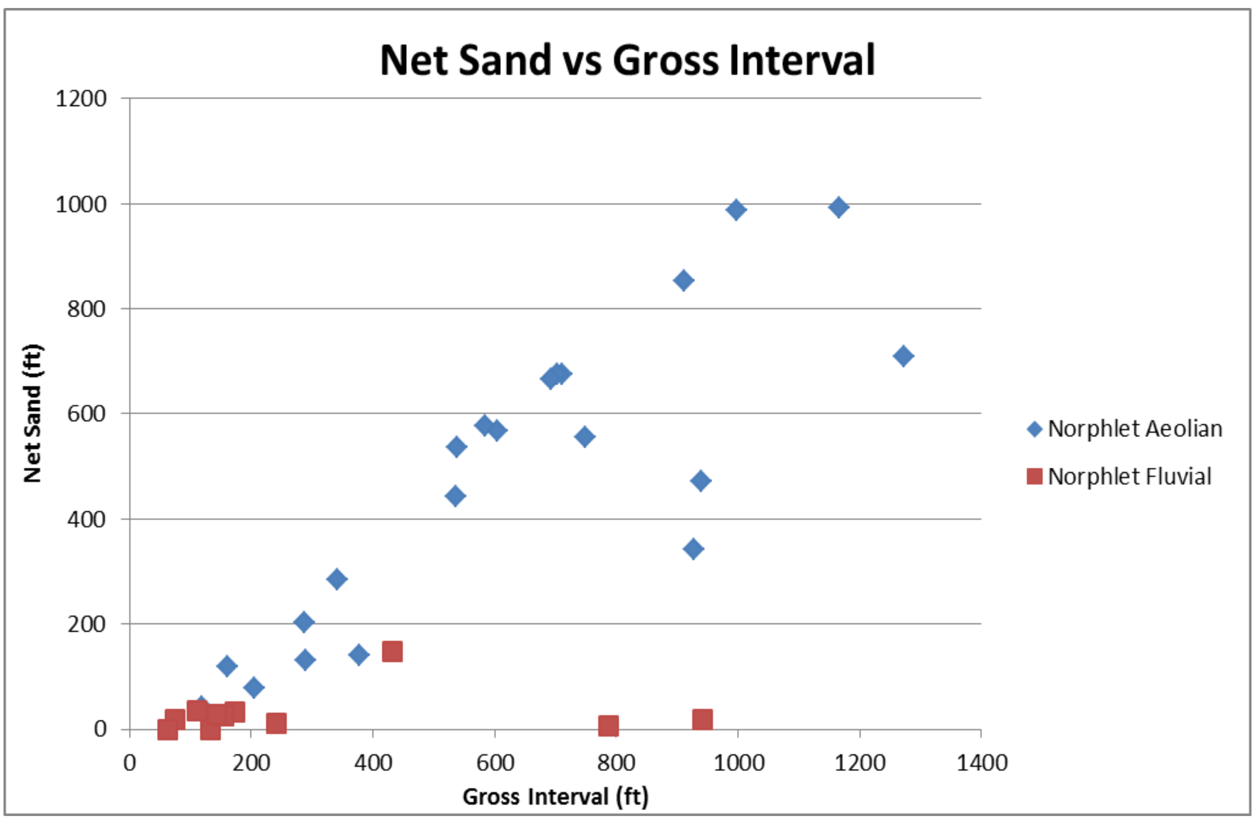


Figure 28. Net to gross sand crossplot by Norphlet facies.

RESERVES AND RESOURCES

Classification

Table 7 shows the system of resource classification used by BOEM (Burgess et al., 2016). Once a successful exploratory well is drilled, the process BOEM uses to move its resource estimates to reserves generally proceeds as follows:

- At the point in time a discovery is made, the identified accumulation of hydrocarbons is classified as Contingent Resources, since a development project has not yet been identified.

- When the lessee makes a formal commitment to develop and produce the accumulation, it is classified as Reserves Justified for Development.

- During the period when infrastructure is being constructed and installed, the accumulation is classified as Undeveloped Reserves.

- After the equipment is in place and production of the accumulation has begun, the status becomes Developed Producing Reserves.

- Fields that are depleted or have expired, relinquished, or terminated without production are classified as Developed Non-Producing.

Table 7. BOEM resource classification.

BOEM Resource Classification	
Classes	**Sub-Classes**
Cumulative Production	
Reserves	Developed Producing
	Developed Non-Producing
	Undeveloped
	Reserves Justified for Development
Contingent Resources	
Unrecoverable	
Undiscovered Resources	
Unrecoverable	

Increasing Chance of Commerciality

Reserves Inventory

BOEM's reserves inventory for the GOM contains volumetric estimates of 56.8 BBOE, with 13.4 BBOE coming from deepwater fields (**Figure 29a**). Reportable contingent resources increase BOEM estimated volumes in the GOM by 5.2 BBOE (**Figure 29b**), with 79 percent of those resources in deepwater. Contingent resources can be found in oil and gas fields where the lessee has not made a formal commitment to develop the project; in leases that have not yet qualified and have not been placed in a field; and in fields that expired, relinquished, or terminated without production. These resources do not represent all the resources in the GOM. As new drilling and development occur, additional hydrocarbon volumes may become reportable.

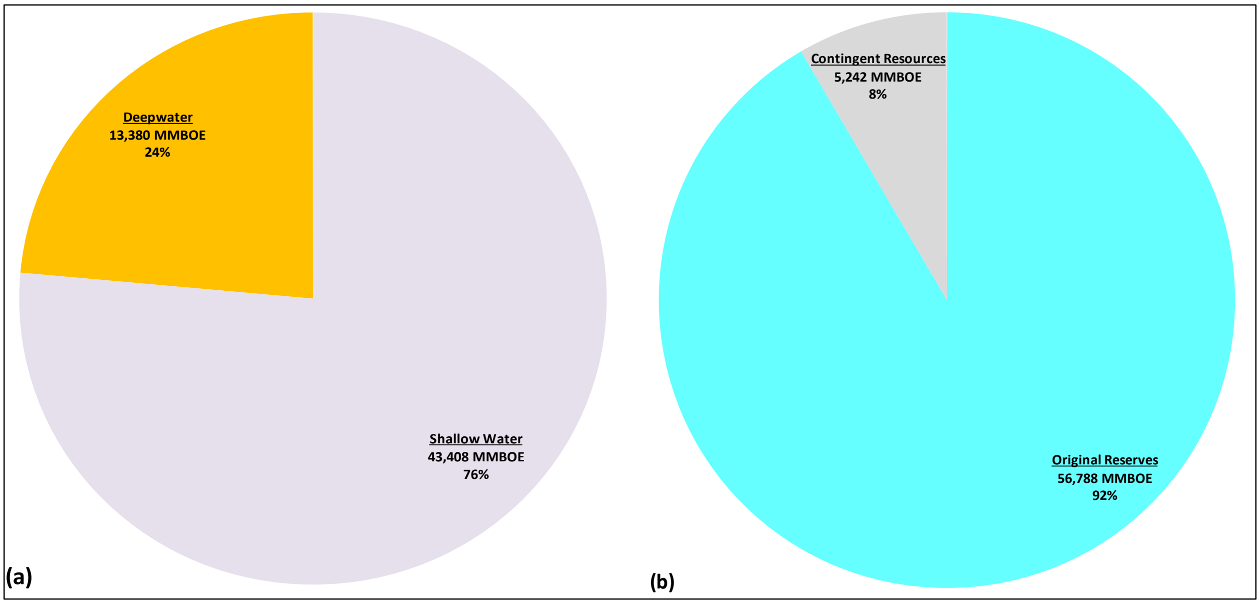


Figure 29. BOEM (a) original reserves and (b) contingent resources.

The number of BOEM-designated fields in deepwater by discovery year is shown in **Figure 30**. There were 270 deepwater fields with reserves or contingent resources at the end of 2014.

Figure 31 displays BOEM estimates of the reserves portion of **Table 7** assigned by field discovery year and divided by water-depth categories. Over the past 40 years, reserves inventory contributions from discoveries in shallow water (<1,000 ft) have generally become insignificant, as the modern-day shelf plays are very mature and heavily explored. Deepwater contributions to the reserves inventory began in 1975 with the discovery of the *Cognac* (MC194) Field in 1,022 ft of water. In 1989, the discovery of the *Mars-Ursa* (MC807 and MC809) Field in an average water depth of 3,341 ft added substantial volumes. Lower Tertiary discoveries in ultra-deepwater began contributing to the reserves inventory in 2002 with the discovery of the *Great White* (AC857) and *Cascade* (WR206) Fields. The low volumes of reserves additions for the past decade can be partly explained by BOEM's field-qualification process. Because BOEM-qualified leases can be placed in either new or preexisting fields as defined in the OCS Operations Field Directory, discoveries on newer leases can be placed into much older fields, taking on the older field's discovery date. Therefore, reserves allocated to newer leases can be included with older fields in **Figure 31**. This happens more often in shallow water where the field density is high, and new discoveries often share the same geologic feature with existing fields. **Appendix C** lists discoveries contained within BOEM-designated fields in deepwater. Additionally, **Figure 31** does not include volumetric estimates from the contingent resources portion of **Table 7**. The volumetric estimates for a discovery remains as contingent resources until an operator commits to a development project. For example, the discovery of the *Anchor* prospect (GC block 807) in 2014 in approximately 5,200 ft of water contains substantial

Lower Tertiary volumes but is only in the appraisal phase of drilling to determine the best development option. Therefore, the discovery remains a contingent resource.

Figure 32 illustrates the locations and estimated sizes of 171 fields in deepwater with proved reserves or reserves justified for development. The fields have a wide geographic distribution and range in geologic age from Pleistocene through Paleocene. Over the last 5 years, BOEM has recognized 27 new deepwater fields (**Figure 33**). Most of these fields are classified as contingent resources, as there has not yet been a development commitment by the operator (**Table 8**).

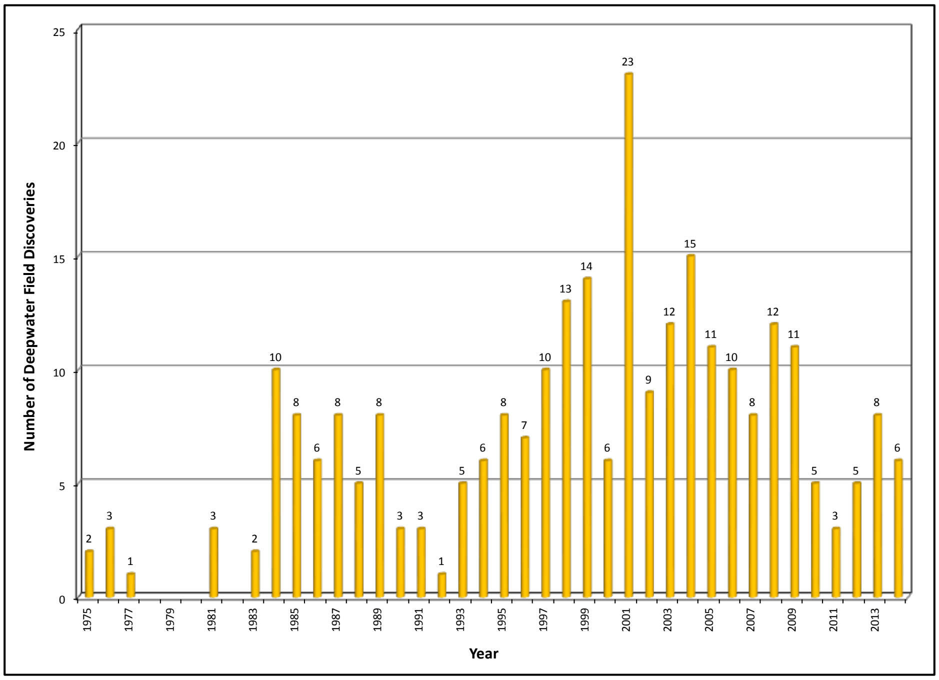


Figure 30. Number of BOEM-designated fields in deepwater by discovery year through 2014.

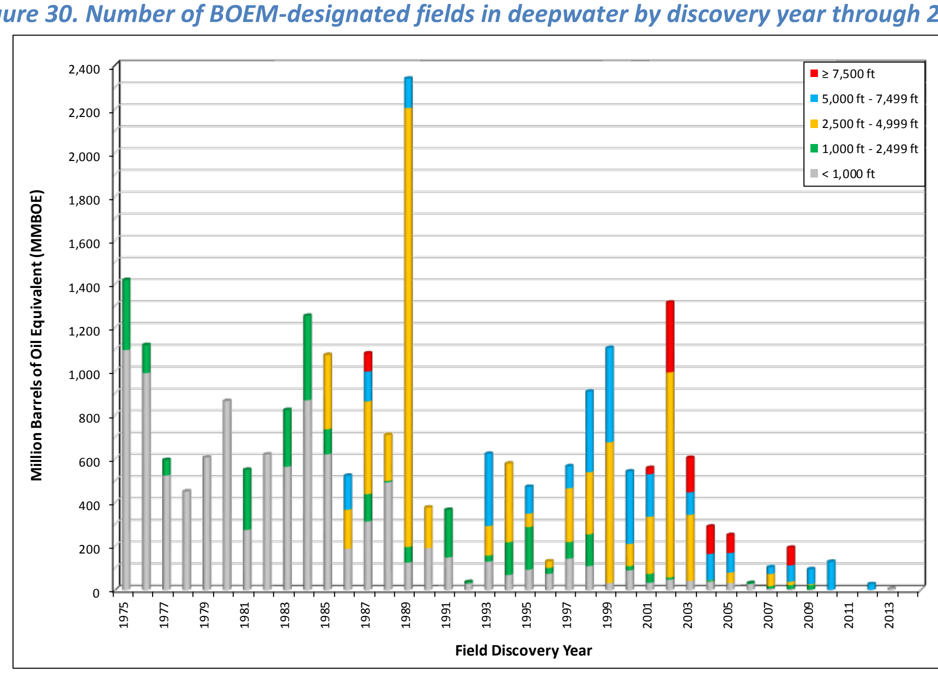


Figure 31. Field reserves by discovery year for each deepwater category.

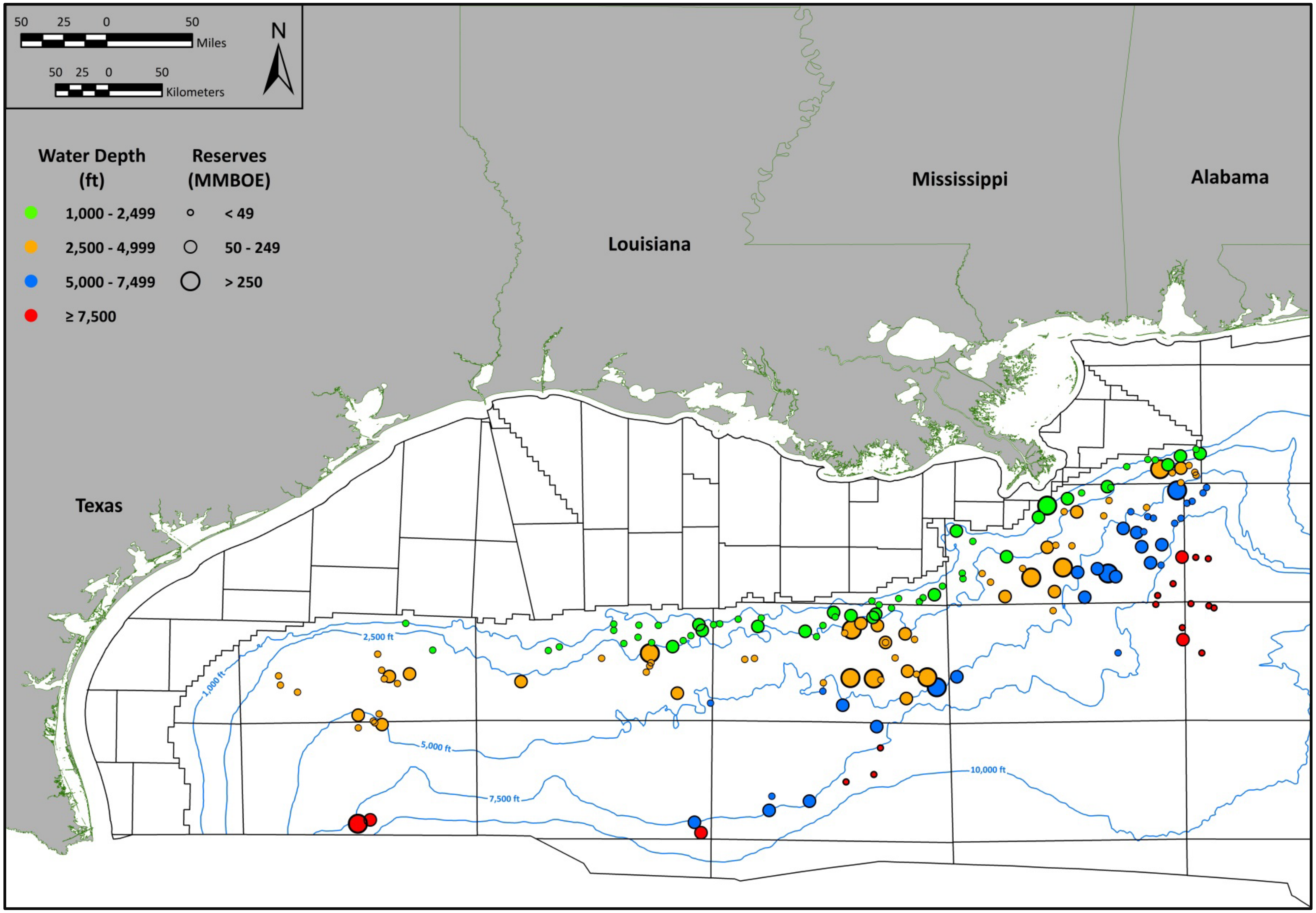


Figure 32. Estimated reserves of deepwater fields.

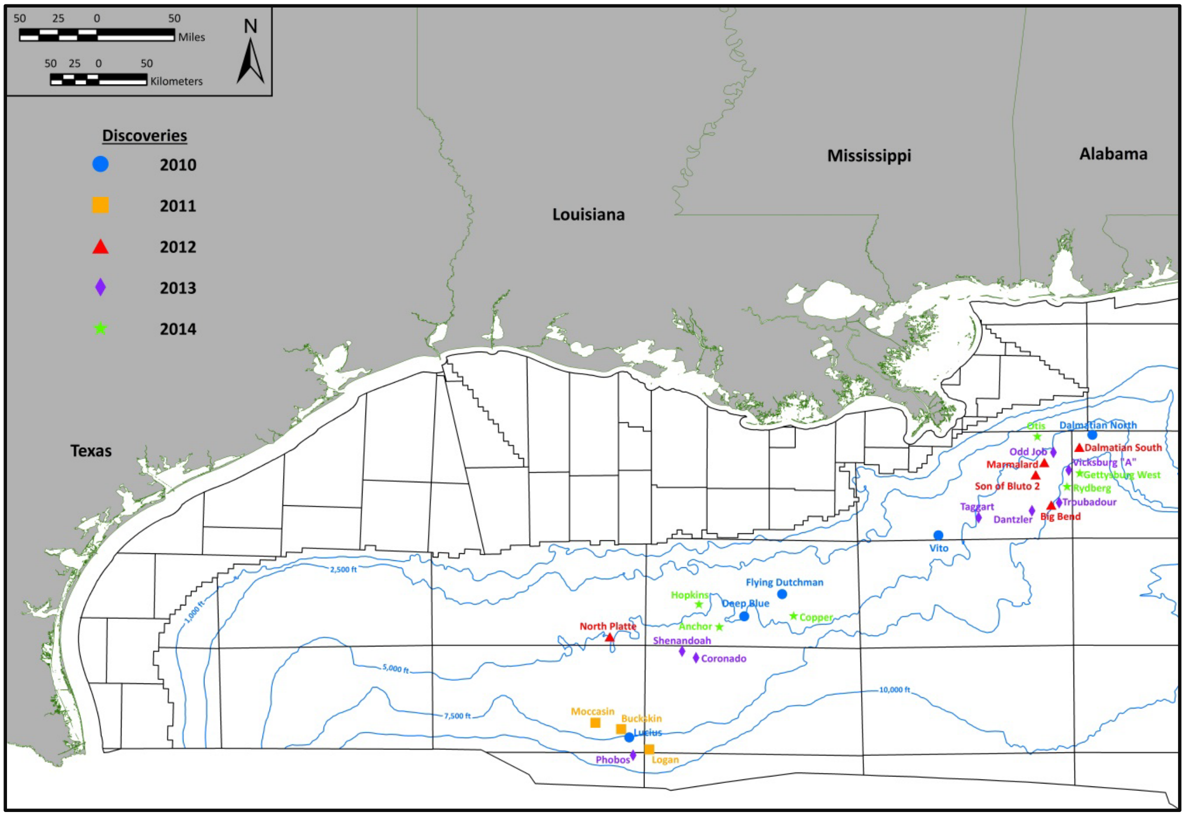


Figure 33. Deepwater fields discovered in the years 2010-2014.

Table 8. 2010-2014 deepwater field discoveries.

Field or Block	Nickname	Reservoir Age	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
KC875	Lucius	Pliocene, Miocene	7,106	23-Jan-10	18-Jan-15		Developed Producing
MC940	Vito	Miocene	4,025	29-Mar-10			Contingent Resources
GC511	Flying Dutchman	Miocene	3,831	17-Apr-10		01-Apr-11	Contingent Resources
DC004	Dalmatian North	Miocene	5,822	30-Apr-10	01-Jun-14		Developed Producing
GC723	Deep Blue	Miocene	5,040	03-May-10		01-May-12	Contingent Resources
KC736	Moccasin	Lower Tertiary	6,591	04-Aug-11			Contingent Resources
KC785	Buckskin[1]	Lower Tertiary	6,749	13-Sep-11			Contingent Resources
WR969	Logan	Lower Tertiary	7,532	20-Sep-11			Contingent Resources
MC431	Son of Bluto 2	Miocene	6,426	14-Mar-12			Reserves Justified for Development
MC300	Marmalard	Miocene	5,939	03-May-12			Reserves Justified for Development
DC134	Dalmatian South	Miocene	6,318	27-Sep-12			Reserves Justified for Development
GB block 959	North Platte	Lower Tertiary	4,434	01-Nov-12			Contingent Resources
MC698	Big Bend	Miocene	7,221	15-Nov-12			Reserves Justified for Development
WR block 098	Coronado	Miocene, Lower Teriary	5,856	27-Jan-13		01-Nov-14	Contingent Resources
WR051	Shenandoah[2]	Lower Tertiary	5,841	29-Jan-13			Contingent Resources
SE039	Phobos	Lower Tertiary	8,553	09-Apr-13			Contingent Resources
MC393	Vicksburg "A"	Norphlet	7,374	17-May-13			Contingent Resources
MC block 699	Troubadour	Miocene	7,273	10-Aug-13			Contingent Resources
MC816	Taggart	Pliocene	5,534	30-Aug-13			Contingent Resources
MC214	Odd Job	Miocene	5,931	17-Sep-13			Contingent Resources
MC782	Dantzler	Miocene	6,575	20-Nov-13			Contingent Resources
MC block 525	Rydberg	Norphlet	7,456	03-Jun-14			Contingent Resources
MC079	Otis	Miocene	3,861	28-Jul-14			Contingent Resources
GC block 733	Copper	Pliocene, Miocene	4,483	19-Aug-14			Contingent Resources
DC398	Gettysburg West	Norphlet	7,579	28-Nov-14			Contingent Resources
GC block 807	Anchor	Lower Tertiary	5,207	28-Nov-14			Contingent Resources
GC block 627	Hopkins	Pliocene	4,416	01-Dec-14			Contingent Resources

[1]The discovery well for the *Buckskin* Prospect reached total depth in 2008 in KC872. KC785 represents appraisal drilling.

[2]The discovery well for the *Shenandoah* Prospect reached total depth in 2009 in WR052 and qualified for field status with appraisal drilling in WR051 in 2013.

RESOURCE ASSESSMENT

BOEM provides estimates of the undiscovered resources portion of **Table 7** approximately every 5 years. In each assessment, the undiscovered resources located outside of known oil and gas fields for the GOM portion of the OCS is modeled using the reserves inventory estimates for each field in the GOM. The latest assessment (in work) was performed with reserves estimates as of the end of 2013.

The observed incremental increase through time in the estimates of reserves of an oil and/or gas field is known as reserves appreciation or growth. It is that part of the known resources over reserves that will be added to existing fields through extension, revision, improved recovery, and the addition of new reservoirs. For the assessment of undiscovered resources, a growth factor is applied to the original reserve estimates to account for appreciation. Reported herein as total grown reserves in barrels is the combined volume of oil and oil-equivalent gas known as barrels of oil equivalent, or BOE.

The undiscovered resources resulting from the assessment are categorized as undiscovered technically recoverable resources (UTRR) that may be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods. The assessment does not include (1) quantities of hydrocarbon resources that could be recovered by enhanced recovery techniques, (2) gas in geopressured brines, (3) natural gas hydrates, or (4) oil and natural gas that may be present in insufficient quantities or quality (low permeability “tight” reservoirs) to be produced by conventional recovery techniques. Herein, UTRR is reported at the mean percentile level—the average or expected value.

Table 9 presents total grown reserves and UTRR values by major geologic age categories for shallow water and deepwater combined, and for only deepwater. Overall, deepwater plays are expected to contain, by far, the most undiscovered resources over the heavily-explored plays in shallow water. Shallow-water plays generally contain most of the total grown reserves, with the exception of the deepwater Lower Tertiary trend, where numerous deepwater discoveries are associated with large compressional folds. The total grown reserves in the deepwater Mesozoic section are contained in the deepwater portion of the Jurassic Norphlet play.

Table 9. Undiscovered technically recoverable resources by age.

Stratigraphic Section				Shallow and Deepwater GOM		Deepwater GOM	
Numerical Age (Ma)	Erathem	System	Series	Total Grown Reserves (BBOE)	Undiscovered Technically Recoverable Resources (mean, BBOE)	Total Grown Reserves (BBOE)	Undiscovered Technically Recoverable Resources (mean, BBOE)
1.80—	Cenozoic	Quaternary	Pleistocene	72.847	39.287	24.687 (34%)	32.886 (84%)
		Neogene	Pliocene				
23.03—			Miocene				
		Lower Tertiary (Paleogene)	Oligocene	5.482	21.597	4.710 (86%)	16.762 (78%)
			Eocene				
66.0—			Paleocene				
	Mesozoic	Cretaceous	Upper	1.053	12.805	0.285 (27%)	9.357 (73%)
~145.0—			Lower				
		Jurassic	Upper				
166.1 ±1.2 ↓			Middle (part)				

PRODUCTION

Facilities

Just as leasing, drilling, and discoveries progressed into deeper waters with time, so did production. Development strategies vary for deepwater, depending on reserve size, proximity to infrastructure, operating considerations (such as well interventions), economic considerations, water depth, and an operator's interest in establishing a production hub for the area. An operator has a choice of numerous platform types (**Figure 34**). Which type of facility an operator chooses depends on numerous factors, including payload, drilling/intervention capabilities, dry tree and/or wet tree capability, water depth rating, motion characteristics, seafloor topography, constructability, and fabrication time, among others. The challenge is to select the platform type and capabilities that fit the reservoir depletion plan and site characteristics while satisfying commercial and strategic objectives.

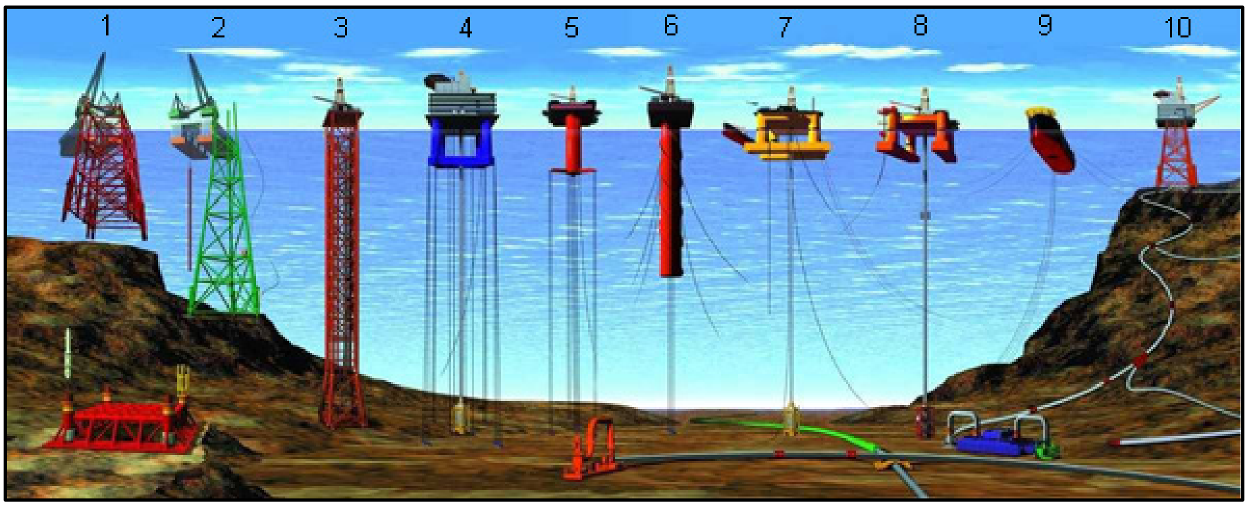


Figure 34. Types of deepwater production facilities include: 1, 2) fixed platforms; 3) compliant tower; 4, 5) tension leg and mini tension leg platforms; 6) spar; 7, 8) semisubmersibles; 9) floating production, storage, and offloading facility; and 10) subsea completion and tieback to a host facility. (Image courtesy of the National Oceanic and Atmospheric Administration.)

Some discoveries in the deepwater GOM are too small to be economically developed as stand-alone projects. In these instances, an operator may decide to use subsea technology to control and produce the wells, "tying back" the wells to existing production facilities. These facilities may be located many miles away from the actual wells. Subsea systems are capable of producing hydrocarbons from reservoirs covering the entire range of water depths that industry is exploring. They range in complexity from a single subsea well producing to a nearby fixed platform, tension leg platform (TLP), or floating production facility (e.g., semisubmersible) to multiple wells producing through a manifold and pipeline system to a distant production facility. Subsea systems have been, and will continue to be, a key component in the development of deepwater discoveries. Subsea systems generally consist of multiple pieces of equipment located on the seafloor; this equipment allows the production of hydrocarbons in water depths that would normally preclude installing conventional fixed or bottom-founded platforms. The economics of deepwater development have improved by connecting multiple subsea projects to a single production facility. From the first subsea completion in 1988 to the end of 2014, there are over 500 wells in the deepwater GOM that contain at least one subsea completion, the production from which is or once was tied back to existing production facilities.

Figure 35 shows the actual water-depth applications for the current production facilities in the deepwater GOM through 2014. Fixed platforms and compliant towers can only be utilized in water depths less than 2,000 ft, as they are extensions of shallow-water technology. Tension leg platforms have been utilized in water depths of less than 5,000 ft in the GOM. Semisubmersibles and spars can be utilized in a wide range of water depths, including ultra-deepwater (>5,000 ft). The *Independence Hub* in Mississippi Canyon is the deepest application of a semisubmersible production platform in 7,920 ft of water. The *Perdido Hub* in Alaminos Canyon holds the record of deepest water depth for a spar in 7,817 ft. Ship-shaped production platforms can be utilized in a wide range of water depths. The *BW Pioneer* FPSO is the deepest water-depth application of any production platform in the GOM at 8,200 ft in Walker Ridge. **Appendix B** provides details such as installation dates for these production facilities. The geographic distribution for these 53 installations is shown in **Figure 36**. Over the last 5 years, there have been production startups from 23 deepwater fields (**Figure 37**). Six of these fields are providing the first production from the Lower Tertiary trend (**Table 10**).

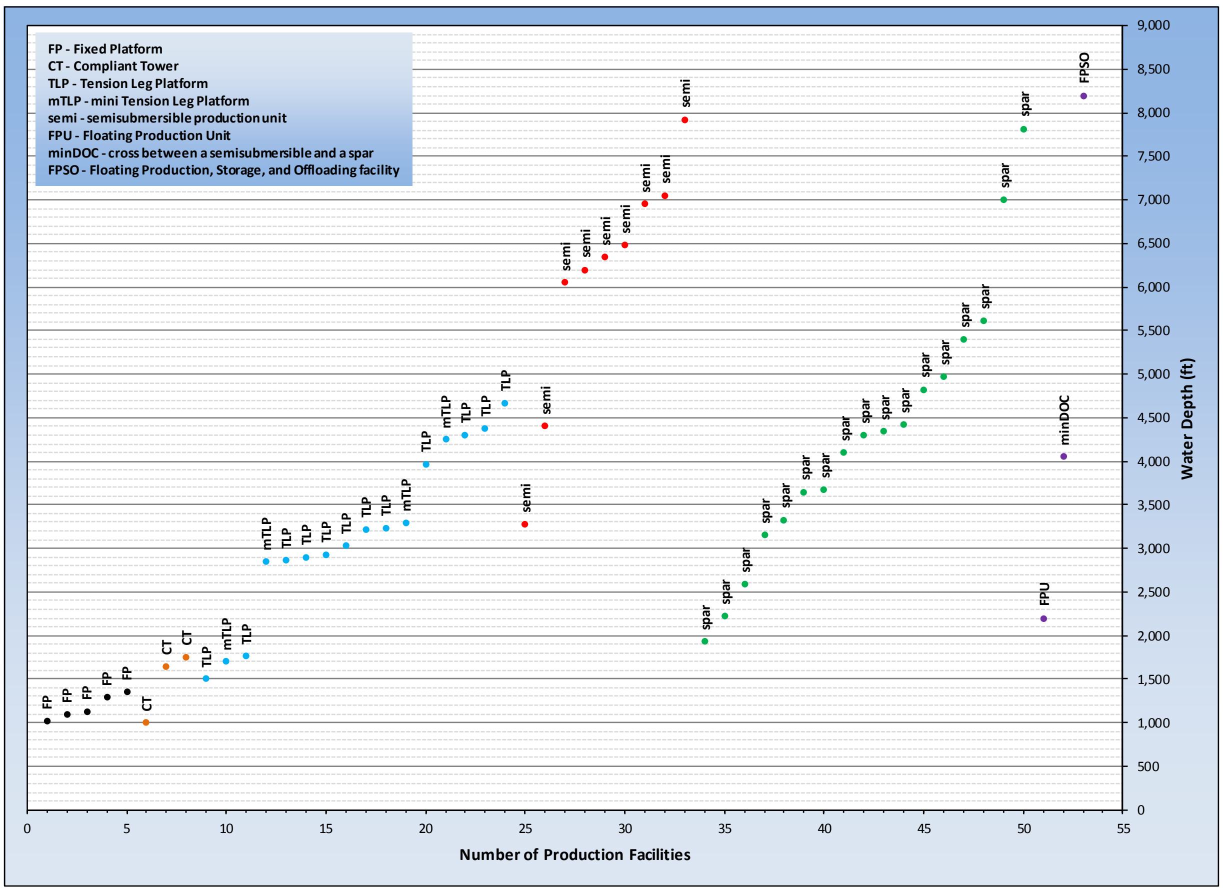


Figure 35. Water-depth ranges for installed deepwater production facilities through 2014.

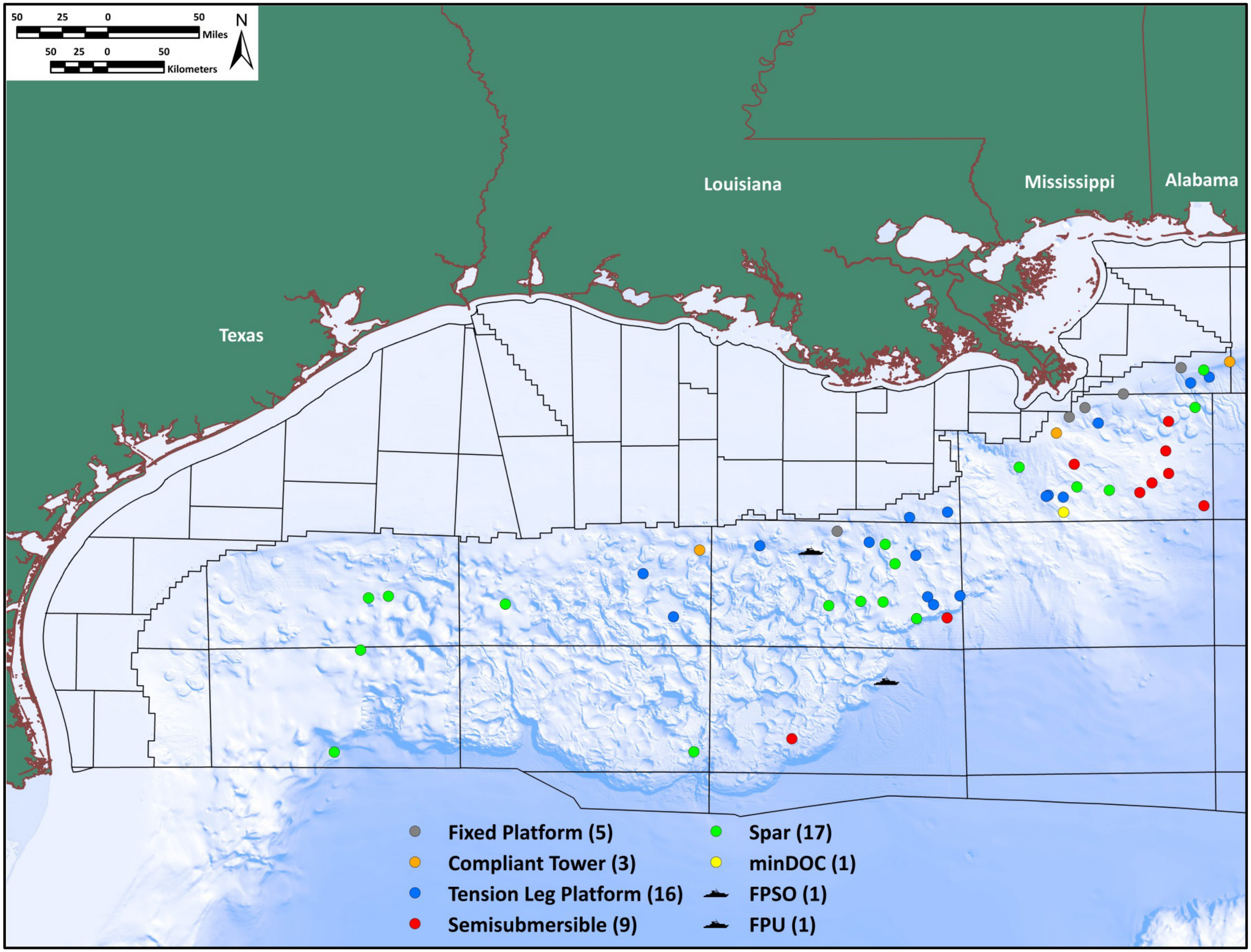


Figure 36. Geographic distribution of deepwater production facilities through 2014.

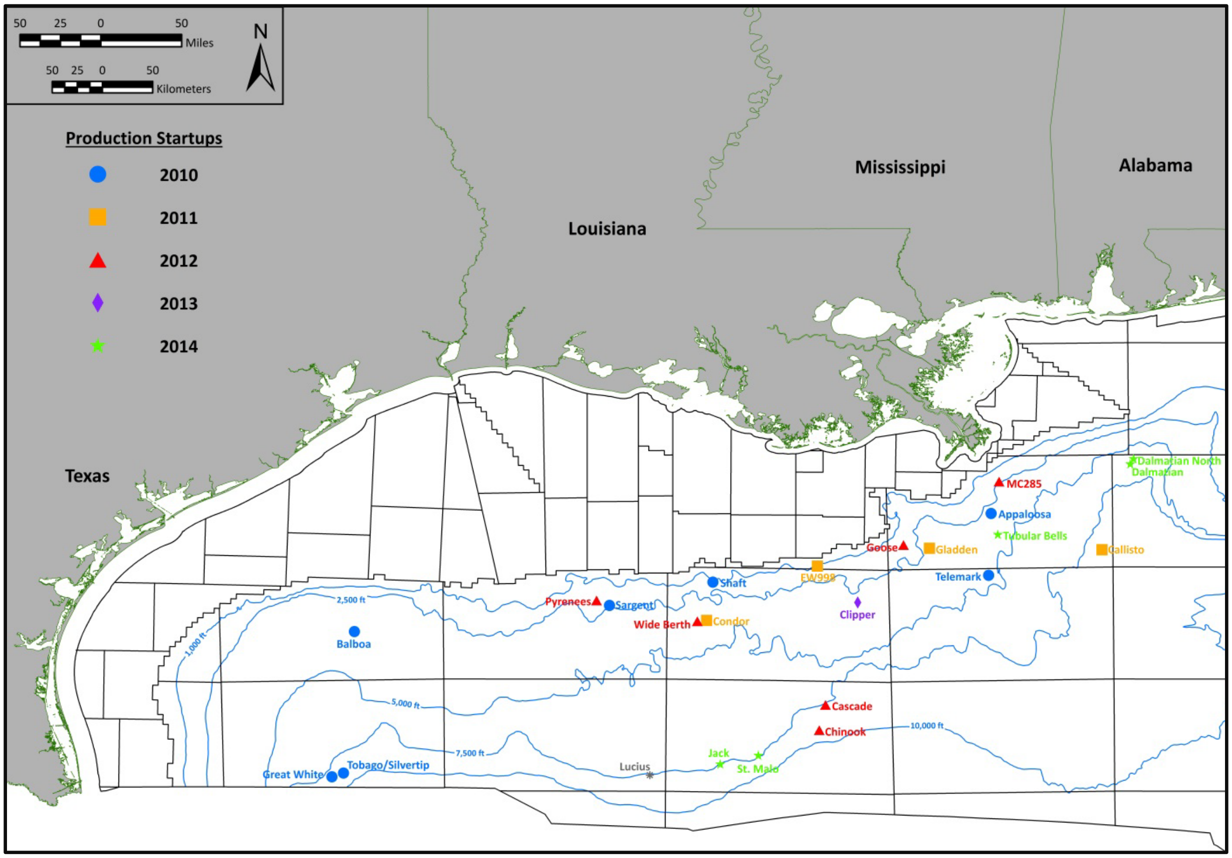


Figure 37. Deepwater fields starting production in the years 2010-2014.

Table 10. 2010-2014 deepwater field production startups.

Field	Nickname	Water Depth (average in ft)	Reservoir Age	Discovery Date	First Production Date	Development System
GC141	Shaft	1,016	Pliocene	29-Jun-08	01-Feb-10	subsea
AC857	Great White	7,918	Lower Tertiary	18-May-02	01-Mar-10	*Perdido* spar
AT063	Telemark	4,412	Middle Miocene	11-Feb-00	01-Mar-10	subsea to *ATP Titan* minDOC
GB339	Sargent	2,180	Pleistocene	22-Nov-08	01-Mar-10	subsea
AC859	Tobago/Silvertip	9,436	Lower Tertiary	17-Apr-04	01-Dec-10	subsea to *Perdido* spar
EB597	Balboa	3,352	Pliocene	02-Jul-01	01-Dec-10	subsea
MC503[1]	Appaloosa	2,833	Upper Miocene	11-Dec-07	01-Dec-10	subsea
MC876	Callisto	7,789	Upper Miocene	08-Mar-01	01-Jan-11	subsea to *Independence Hub* semisubmersible
MC800	Gladden	3,116	Upper Miocene	29-Apr-08	01-Feb-11	subsea to MC582 spar
EW998		1,313	Pliocene	27-Feb-09	01-Mar-11	subsea
GC448	Condor	3,266	Pleistocene	23-Jan-08	01-Jun-11	subsea
WR206	Cascade	8,148	Lower Tertiary	14-Apr-02	01-Feb-12	subsea to *BW Pioneer* FPSO
GB293	Pyrenees	2,079	Pliocene	14-Apr-09	09-Feb-12	subsea
GC490	Wide Berth	3,714	Pleistocene	25-Oct-09	01-Apr-12	subsea
MC285[2]		2,902	Pliocene	01-Sep-87	01-Apr-12	subsea
WR469	Chinook	8,841	Lower Tertiary	19-Jun-03	01-Sep-12	subsea to *BW Pioneer* FPSO
MC751	Goose	1,589	Pliocene	15-Dec-02	01-Nov-12	subsea
GC299	Clipper	3,429	Pliocene	05-Oct-05	01-Mar-13	subsea
DC048	Dalmatian	5,876	Middle Miocene	29-Sep-08	01-Apr-14	subsea to VK786 compliant tower
DC004	Dalmatian North	5,822	Middle Miocene	30-Apr-10	01-Jun-14	subsea to VK786 compliant tower
MC682	Tubular Bells	4,521	Middle Miocene	17-Oct-03	01-Nov-14	subsea to *Gulfstar 1* spar
WR678	St. Malo	6,951	Lower Tertiary	13-Oct-03	01-Dec-14	subsea to WR block 718 semisubmersible
WR759	Jack	6,963	Lower Tertiary	09-Jul-04	01-Dec-14	subsea to WR block 718 semisubmersible
KC875	Lucius[3]	7,106	Pliocene	23-Jan-10	18-Jan-15	subsea to spar

[1]The MC503 Field also contains the *Who Dat* discovery, which began production in 2011 with a subsea tieback to the MC block 547 semisubmersible.
[2]The production was from Lease G21750/MC block 241. Production ceased 05-Mar-2015 and the lease is terminated.
[3]The *Lucius* Field began production within 3 weeks of the turn of 2015.

VOLUMES

Figure 38a and **Figure 38b** illustrate the relevance of the GOM to the Nation's energy supply. The GOM supplied approximately 16 percent of the Nation's domestic oil and 4.5 percent of the Nation's domestic gas production in 2014. Most of the oil volume and over half of the gas volume came from the deepwater GOM. In fact, approximately 82 percent of the oil production and 54 percent of the natural gas production from the GOM in 2014 were from wells in deepwater.

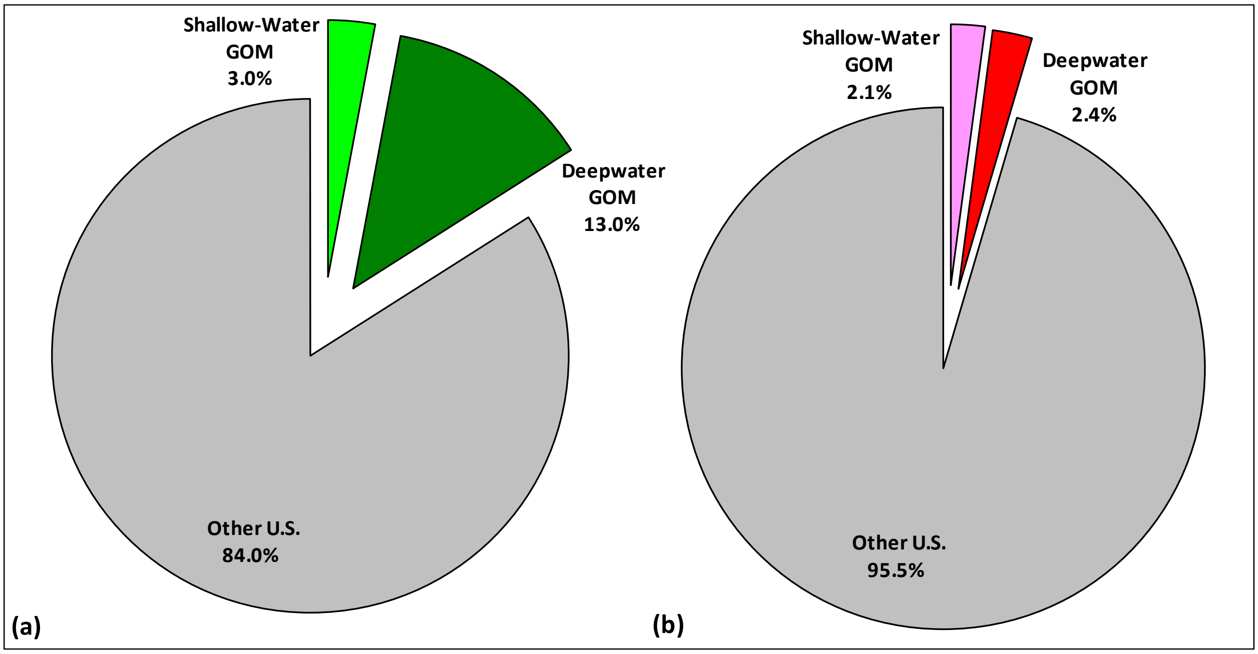


Figure 38. Estimated U.S. (a) oil and (b) gas production in 2014.

Figure 39 displays BOEM cumulative estimates of original reserves, production, and remaining reserves in deepwater. Production from deepwater began in 1979 from the *Cognac* (MC194) Field and remained relatively flat until the mid-to-late 1980s, when fields such as *Mars-Ursa* (MC807) came online. The sharp decrease in reserves from 2008 to 2009 reflects the adoption by BOEM of a modified petroleum resources classification framework based on the Society of Petroleum Engineers Petroleum Resources Management System (SPE et al., 2007). Because of the new definitions, numerous fields with no development project commitment from the operator were reclassified from reserves to contingent resources.

Table 11 shows the 20 most prolific producing fields in the GOM for the year 2014. All but one of the fields are in deepwater. The top three producers averaged over 100,000 BOE per day. Nine of the fields produce from ultra-deep water depths (≥5,000 ft), with production from two of those fields—*Great White* and *Chinook*—coming from the Lower Tertiary trend. *East Anstey*, *Fourier*, and *Kepler* are subsea tiebacks to the *Na Kika* semisubmersible located in Mississippi Canyon block 474 in 6,378 ft of water, showing the importance of subsea technology and central production hubs in ultra-deepwater.

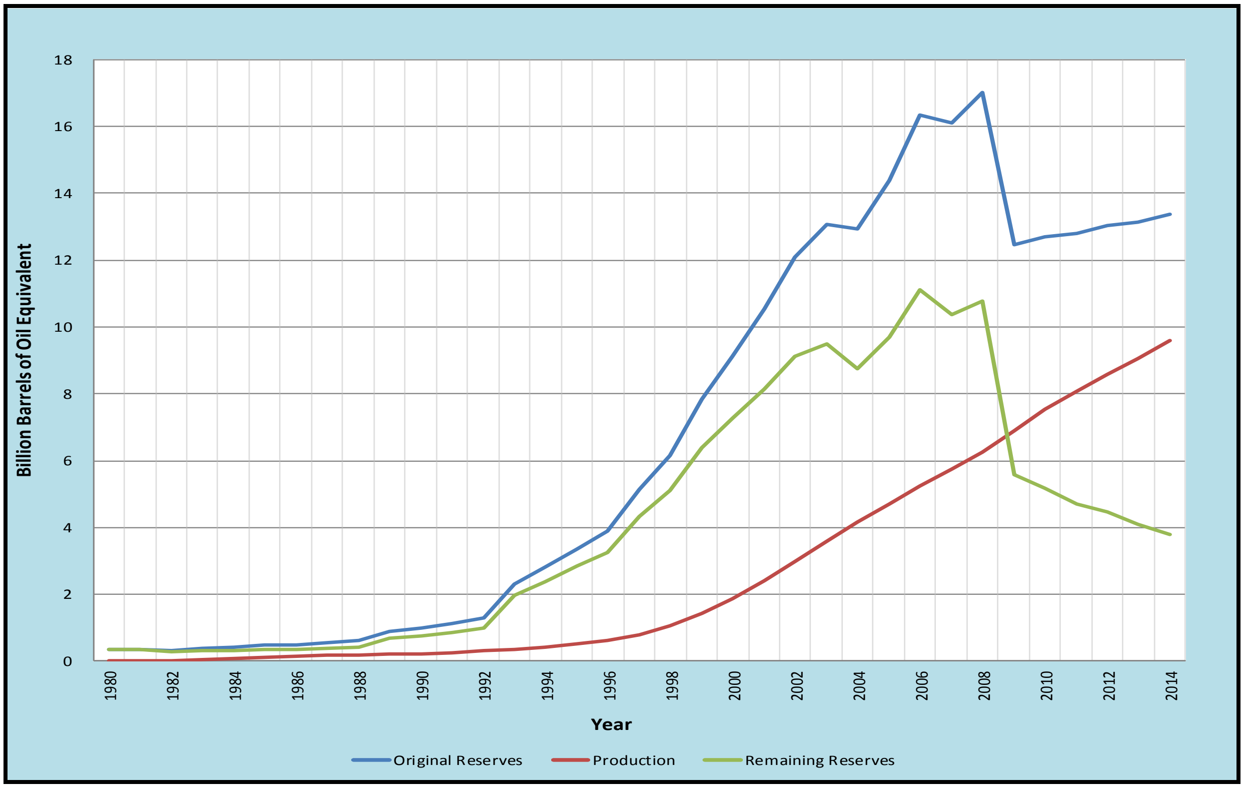


Figure 39. Cumulative estimates of original reserves, production, and remaining reserves in deepwater.

Table 11. Top 20 producing fields in 2014.

Field	Project Name	Water Depth (ft)	2014 Production (BOE)	2014 Average Daily Production (BOE/Day)	Production Facility
MC807	Mars-Ursa	3,341	60,387,579	165,445	tension leg platform
GC743	Atlantis	6,285	46,125,947	126,372	semisubmersible
GC654	Shenzi	4,304	36,698,464	100,544	tension leg platform
GC640	Tahiti/Caesar/Tonga	4,326	35,156,047	96,318	spar/subsea
AC857	Great White	7,918	29,377,812	80,487	*Perdido* spar/subsea
GB171	Salsa	1,195	20,594,551	56,423	subsea
MC546	Leo	2,537	20,469,723	56,081	*Who Dat* semisubmersible/subsea
MC776	North Thunder Horse	5,668	18,893,374	51,763	subsea to *Thunder Horse* semisubmersible
MC778	Thunder Horse	6,077	15,399,575	42,191	semisubmersible
MC607	East Anstey	6,536	15,200,804	41,646	subsea to *Na Kika* semisubmersible
GB387	Llano	2,313	14,858,733	40,709	subsea
GC826	Mad Dog	4,783	11,027,184	30,211	spar
MC084	King/Horn Mountain	5,285	10,989,619	30,109	spar/subsea
GB426	Auger	2,847	7,679,099	21,039	tension leg platform
WR469	Chinook	8,841	7,191,776	19,703	subsea to *BW Pioneer* FPSO
MC522	Fourier	6,884	6,785,255	18,590	subsea to *Na Kika* semisubmersible
GC644	Holstein	4,341	6,511,575	17,840	spar
GB260	Baldpate	1,605	6,218,016	17,036	compliant tower
EI330		248	6,180,811	16,934	
MC383	Kepler	5,741	5,731,233	15,702	subsea to *Na Kika* semisubmersible

Figure 40a and **Figure 40b** compare shallow-water and deepwater oil and gas production, respectively, since production from the GOM began. Oil production from shallow water dominated until production from numerous, large deepwater discoveries ramped up beginning in the mid-1990s. Beginning in the year 1999, more oil has been produced from the deepwater areas of the GOM than from shallow waters. To date, deepwater oil production peaked in 2009. Gas production from the GOM has always been dominantly from shallow waters. This production has steeply declined, however, beginning in the late-1990s. In fact, gas production has declined so much that for the first time ever, gas production from deepwater was slightly higher than that from shallow water beginning in 2014.

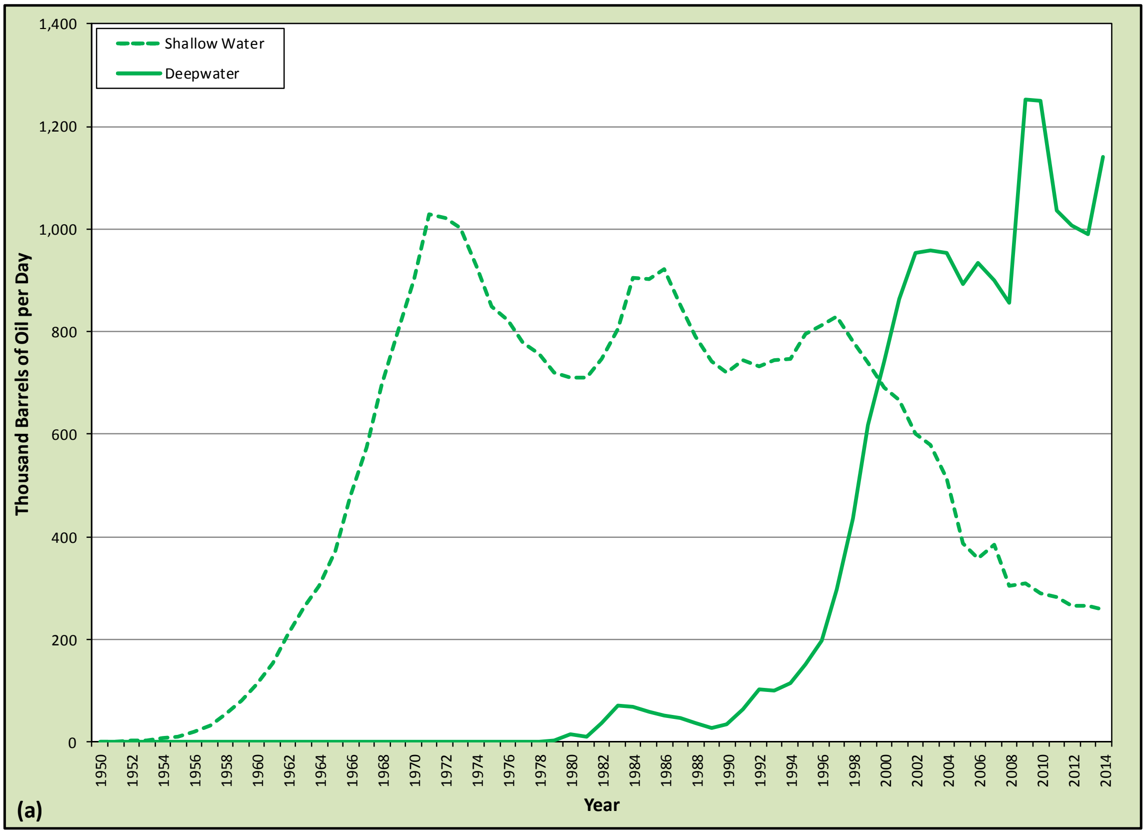
RATES

Deepwater reservoirs have proved to have excellent productive capacity, distribution, and continuity when compared to correlative-age, shelf deltaic sands, which tend to be discontinuous and compartmentalized. Numerous turbidite sands characteristic of the deepwater GOM have produced in excess of 35,000 barrels of oil per day and 140 million cubic feet of gas per day. These productivities far exceed those in the deltaic, discontinuous, compartmentalized reservoirs typical on the shelf. The productivity is possible because these sands can have laterally extensive 30+ percent porosities and 1+ darcy permeabilities.

Figure 41a and **Figure 41b** compare monthly rates of shallow-water and deepwater oil and gas production, respectively, since 1992. The average deepwater oil completion for December 2014 produced at about 24 times the rate of the average shallow-water oil completion for that same month. The average deepwater gas completion for December 2014 produced at about 8 times the rate of the average shallow-water gas completion during that same month.

PIPELINES

The infrastructure needed to bring deepwater production online continues to develop over time. **Figure 42** shows the framework of major oil and gas pipelines in the GOM that connect deepwater segments to shore.



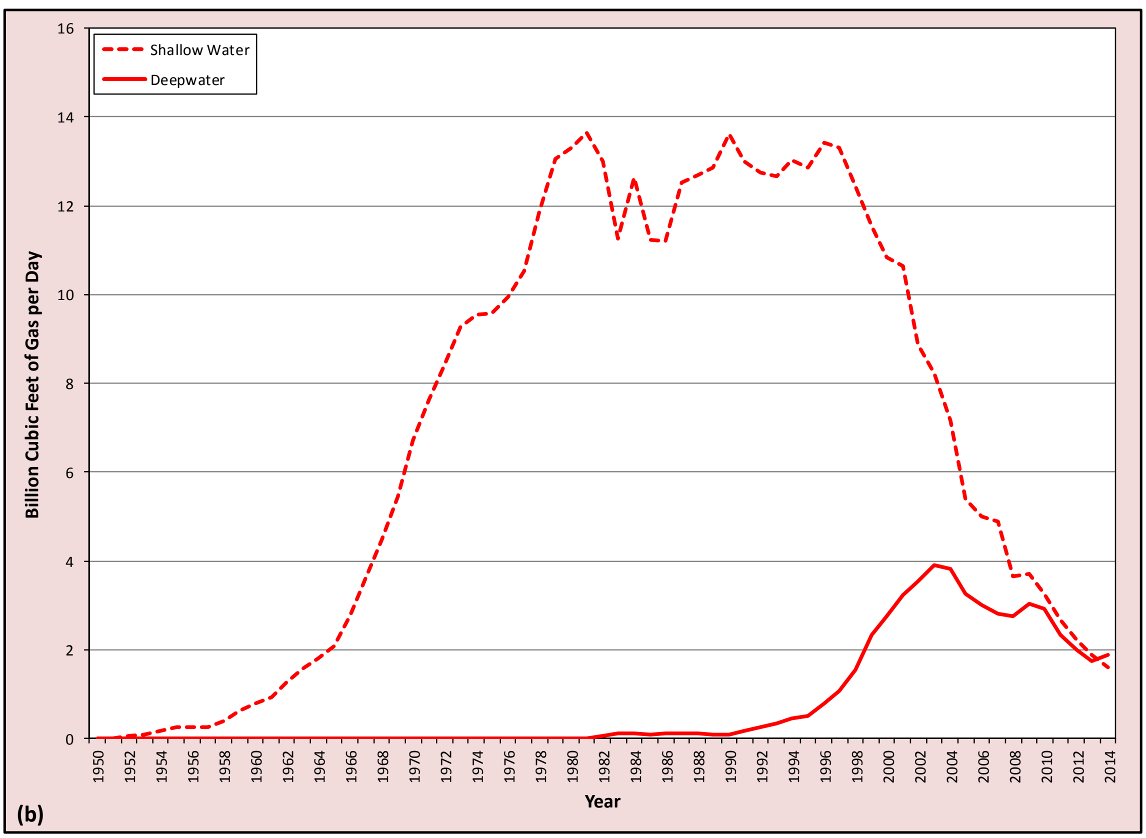


Figure 40. Comparison of average annual shallow-water and deepwater (a) oil and (b) gas production.

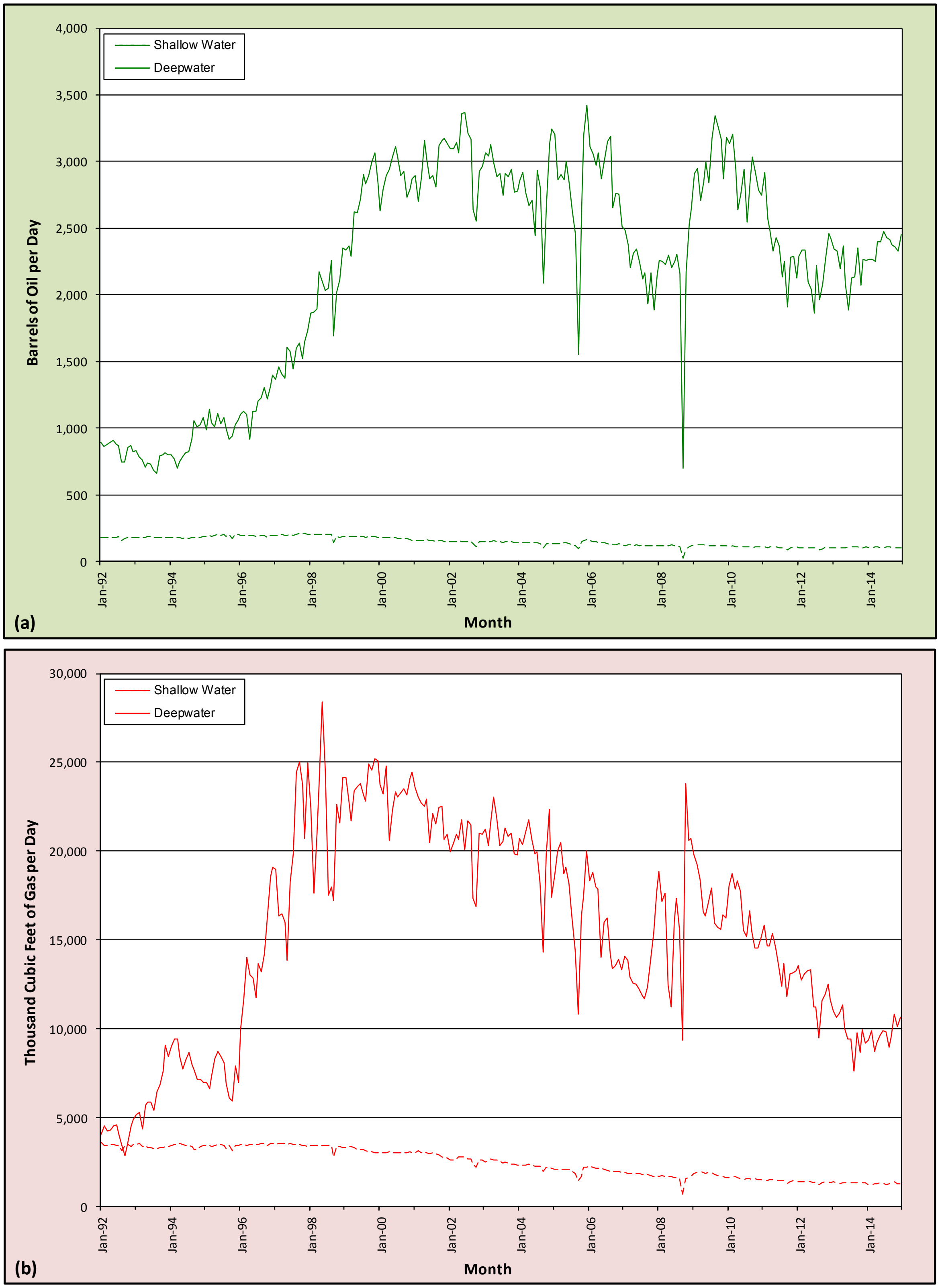


Figure 41. Average production rates for shallow-water and deepwater (a) oil and (b) gas well completions.

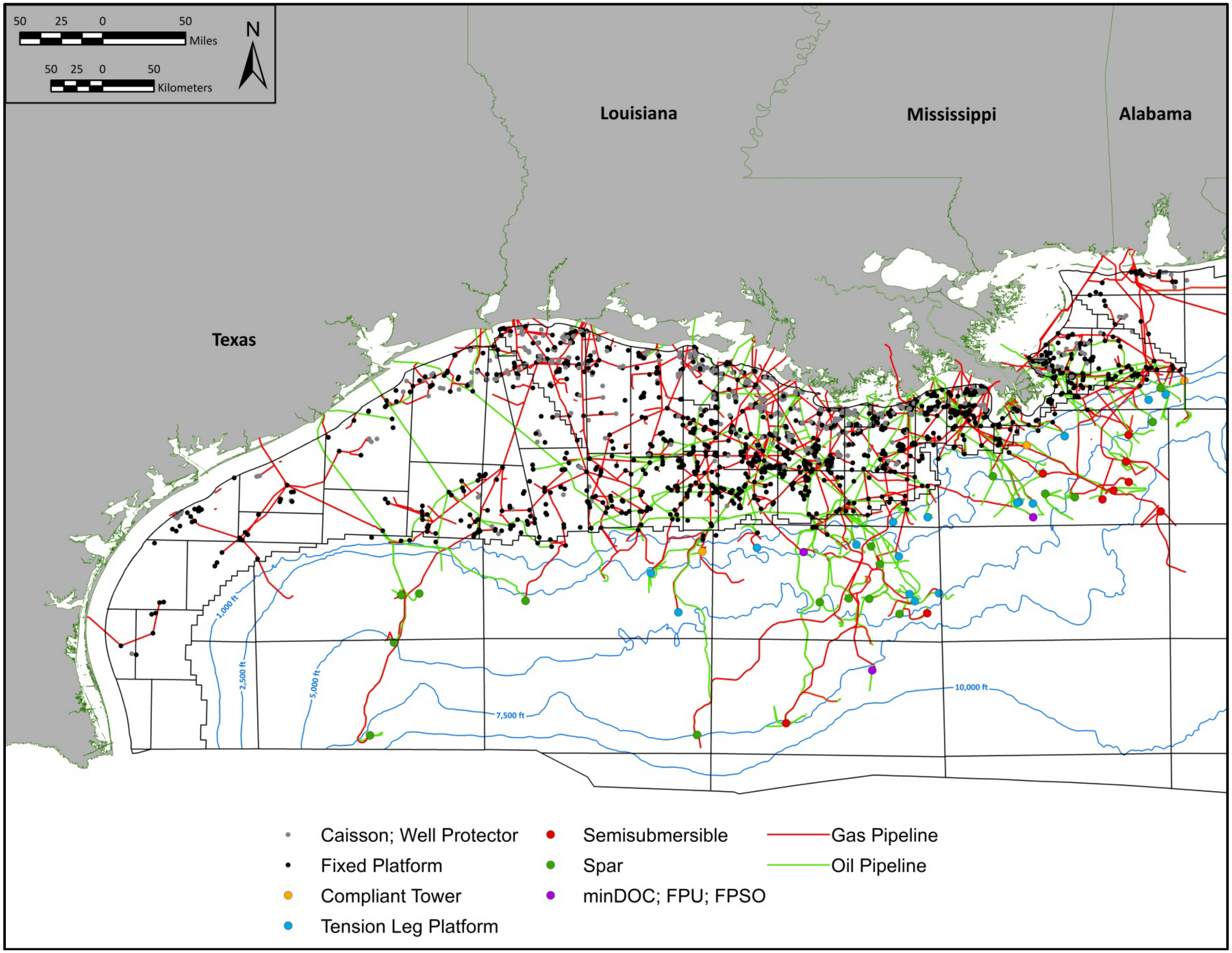


Figure 42. Deepwater oil and gas pipelines.

Lag Time

With complex deepwater developments, it has not been uncommon to have a considerable lag time between leasing and first production. The *Thunder Horse* (MC778) Field, for example, was leased in 1988, the first well was drilled in 1999, and production began in 2008. **Figure 43** illustrates average lags associated with deepwater operations. This figure uses data from the productive deepwater fields listed in **Appendix A** and demonstrates the lags between leasing and the total depth date of the first well drilled and from first well to first production. There has been no production from leases acquired post-2009.

Time to first production after a prospective lease has been acquired was considerable throughout the 1980s. In fact, prior to 1990, some subsea projects were waiting on an installation of a host facility. Lag times have decreased dramatically since the early-1990s. Numerous factors contribute to this trend, such as expanding infrastructure in ultra-deep waters and improvements in subsea tieback and development technology. Generally, once a facility is in place, the amount of time from first well to production is greatly decreased. For example, the *Independence Hub* facility was successfully installed in early 2007, and the time from first well to production for the *Q* Field (MC961) was just over 2 years.

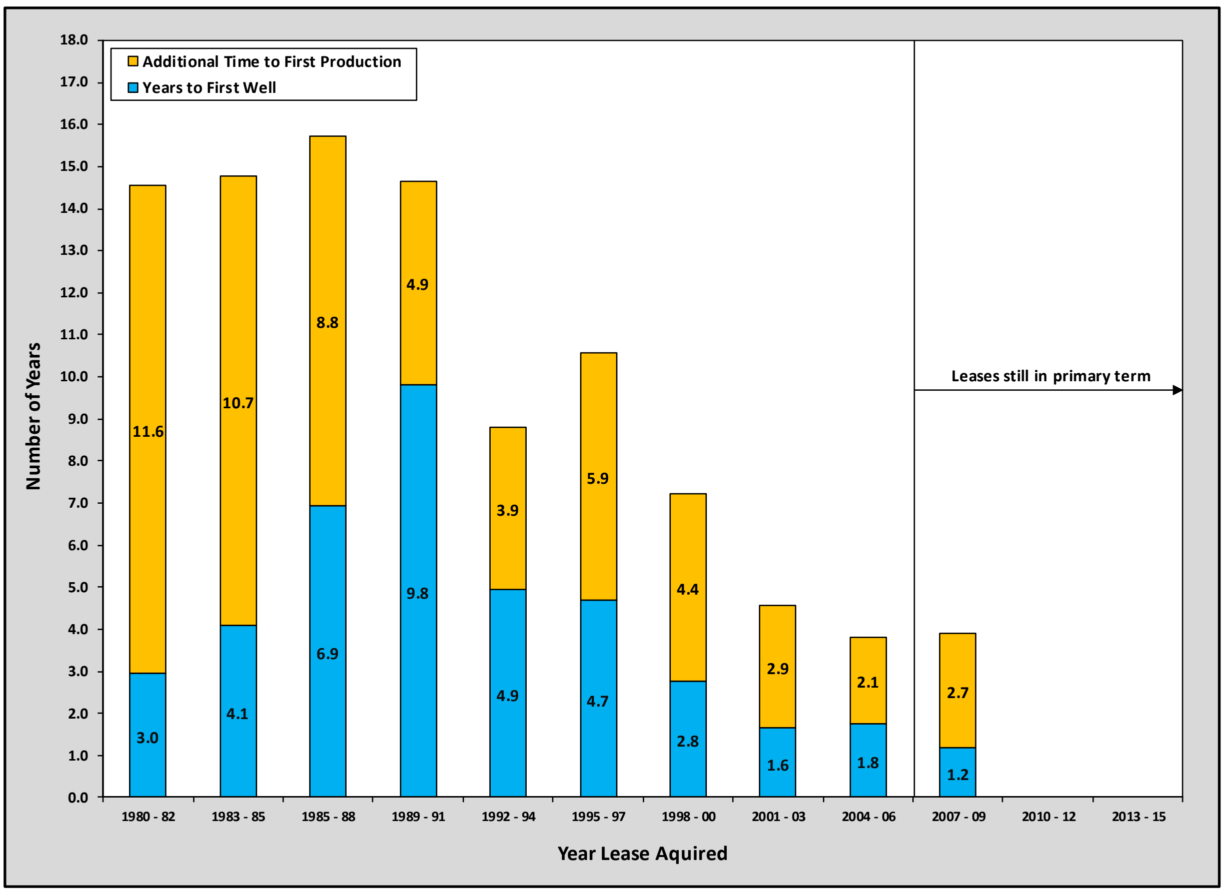


Figure 43. Average time from leasing to first production for deepwater fields.

REFERENCES

Berman, A. E., and J. H. Rosenfeld, 2007, A new depositional model for the deep-water Gulf of Mexico Wilcox equivalent Whopper Sand: changing the paradigm, in L. Kennan, J. Pindell, and N. C. Rosen, eds., The Paleogene of the Gulf of Mexico and Caribbean Basins: processes, events, and petroleum systems: Proceedings of the 27th Annual Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists Foundation Bob F. Perkins Research Conference, Houston, Texas, p. 284-297.

Buia, M., P. E. Flores, D. Hill, E. Palmer, R. Ross, R. Walker, M. Houbiers, M. Thompson, S. Laura, C. Menlikli, N. Moldoveanu, and E. Snyder, Autumn 2008, shooting seismic surveys in circles: Oilfield Review, v. 20, no. 3, p. 18-31.

Burgess, G. L., E. G. Kazanis, and N. K. Shepard, 2016, Estimated oil and gas reserves, Gulf of Mexico OCS Region, December 31, 2014: U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, OCS Report BOEM 2016-024, 29 p.

Cobalt International Energy, June 2013 Investor Presentation, http://www.cobaltintl.com/investor-center (accessed July 1, 2016).

Fletcher, R. C., M. R. Hudec, and I. A. Watson, 1995, Salt glacier and composite salt-sediment models for the emplacement and early burial of allochthonous salt sheets, in M. P. A. Jackson, D. G. Roberts, and S. Snelson, eds., Salt tectonics: a global perspective: American Association of Petroleum Geologists Memoir 65, p. 77-108.

Gaus, D., and S. Hegna, 2003, Improved imaging by pre-stack depth migration of multi-azimuth towed streamer seismic data: 65th European Association of Geoscientists & Engineers Conference and Exhibition, Expanded Abstracts.

Godo, T. J., E. Chuparova, and D.E. McKinney, 2011, Norphlet aeolian sand fairway established in the deep water Gulf of Mexico: AAPG Annual Conference Abstract.

Hager, E., 2010, Full azimuth seismic acquisition with coil shooting: 8th Biennial International Conference & Exposition on Petroleum Geophysics, Hyderabad, India, P-224, 5 p.

Howard, M. S., 2004, Rich azimuth marine acquisition: European Association of Geoscientists & Engineers Research Workshop: Advances in Seismic Acquisition Technology, Rhodes, Greece.

Martin, R. G., 1978, Northern and eastern Gulf of Mexico continental margin stratigraphic and structural framework, in A. H. Bouma, G. T. Moore, and J. M. Coleman, eds., Framework, facies, and oil-trapping characteristics of the upper continental margin: American Association of Petroleum Geologists Studies in Geology, no. 7, p. 21-42.

Morton, R. A., L. A. Jirik, and W. E. Galloway, 1988, Middle-Upper Miocene depositional sequences of the Texas coastal plain and continental shelf: geologic framework, sedimentary facies, and hydrocarbon plays: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations 174, 40 p.

O'Connell, J., M. Kohli, and S. Amos, 1993, Bullwinkle: a unique 3-D experiment: Geophysics, v. 58, p. 167-176.

Picou, E. B., B. F. Perkins, N. C. Rosen, and M. J. Nault, eds., 1999, Gulf of Mexico Basin biostratigraphic index microfossils: a geoscientist's guide to foraminifers and nannofossils Oligocene through Pleistocene: Gulf Coast Section of Society of Economic Paleontologists and Mineralogists, CD-ROM.

Pilcher, R. S., R. T. Murphy, and J. M. Ciosek, November 2014, Jurassic raft tectonics in the northeastern Gulf of Mexico: Interpretation, v. 2, no. 4, p. SM39-SM55.

Reed, J. C., C. L. Leyendecker, A. S. Khan, C. J. Kinler, P. F. Harrison, and G. P. Pickens, 1987, Correlation of Cenozoic sediments—Gulf of Mexico outer continental shelf, part 1: Galveston area, offshore Texas, through Vermilion area, offshore Louisiana: Minerals Management Service OCS Report MMS 87-0026, 35 p. plus appendices.

Rowan, M. G., B. D. Trudgill, and J. C. Fiduk, 2000, Deep water, salt-cored foldbelts: lessons from the Mississippi Fan and the Perdido Foldbelts, northern Gulf of Mexico, in W. Moriak, and M. Talwani, eds., Atlantic rifts and continental margins: American Geophysical Union Geophysical Monograph, v. 115, p. 173-191.

Salvador, A., 1987, Late Triassic-Jurassic paleogeography and origin of Gulf of Mexico Basin: American Association of Petroleum Geologists Bulletin, v. 11, p. 1-14.

Schuster, D. C., 1995, Deformation of allochthonous salt and evolution of related salt-structural systems, eastern Louisiana Gulf Coast, in M. P. A. Jackson, D.G. Roberts, and S. Snelson, eds., Salt tectonics: a global perspective: American Association of Petroleum Geologists Memoir 65, p. 177-198.

Simmons, G. R., 1992, The regional distribution of salt in the north-western Gulf of Mexico: styles of emplacement and implications for early tectonic history [Ph. D. thesis]: Texas A&M University, College Station, Texas, 183 p.

Society of Petroleum Engineers (SPE), American Association of Petroleum Geologists (AAPG), World Petroleum Council (WPC), and Society of Petroleum Evaluation Engineers (SPEE), 2007, Petroleum Resources Management System, 49 p.

Sukup, D. V., 2002, Wide-azimuth marine acquisition by the helix method: The Leading Edge, v. 21, no. 8, p. 791-794.

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APPENDICES

Appendix A. Productive Deepwater Fields

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
MC194	Cognac	1,022	01-Jul-75	01-Sep-79		fixed platform
MC281	Lena	1,005	01-May-76	01-Jan-84		compliant tower
GC029		1,565	01-Jan-84	01-Nov-88	01-Dec-90	subsea to semisubmersible
GC075		2,172	01-May-85	01-Nov-88	01-Apr-90	subsea
GC065	Bullwinkle	1,337	01-Oct-83	01-Jul-89		fixed platform
GC184	Jolliet	1,718	01-Jul-81	01-Nov-89		tension leg platform
MC109	Amberjack	1,044	13-Nov-83	01-Oct-91		fixed platform
MC354	Zinc	1,493	01-Aug-77	01-Aug-93	01-May-10	subsea
MC445	Diamond	2,095	05-Dec-92	01-Oct-93	01-Sep-99	subsea
VK783	Tahoe/SE Tahoe	1,328	01-Dec-84	01-Jan-94		subsea
GB426	Auger	2,847	01-May-87	01-Apr-94		tension leg platform
VK990	Pompano	1,436	01-May-81	01-Oct-94		fixed platform
GB388	Cooper	2,209	16-Mar-89	01-Sep-95	29-May-15	semisubmersible
VK862		1,049	01-Oct-76	01-Dec-95		subsea
GC072[2]	Popeye	2,019	10-Jul-85	01-Jan-96		subsea
GC110	Rocky	1,959	07-Aug-87	01-Jan-96		subsea
GC116	Popeye	2,120	01-Feb-85	01-Jan-96		subsea
GB387	Llano	2,313	03-Oct-94	01-May-96		subsea
MC807	Mars-Ursa	3,341	01-Apr-89	01-Jul-96		tension leg platform
VK825	Neptune	1,864	01-Nov-87	01-Mar-97		spar/subsea
MC731	Mensa	5,286	01-Dec-86	01-Jul-97	01-Mar-14	subsea
VK956	Ram-Powell	3,238	01-May-85	01-Sep-97		tension leg platform
GC244	Troika	2,795	30-May-94	01-Nov-97		subsea
EW963	Arnold	1,682	12-Jun-96	01-May-98		subsea

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
GB171	Salsa	1,195	18-Apr-84	01-Aug-98		subsea
GB260	Baldpate	1,605	01-Nov-91	01-Sep-98		compliant tower
EW921	Morpeth	1,712	30-Jul-89	01-Oct-98		tension leg platform/subsea
GC205	Genesis	2,792	01-Sep-88	01-Jan-99		spar
EW1006	Manta Ray	1,851	26-Jan-88	01-Mar-99		subsea
GB367	Dulcimer	1,123	09-Feb-98	01-Apr-99	01-Mar-02	subsea
MC292	Gemini	3,529	07-Sep-95	01-May-99		subsea
GB602	Macaroni	3,688	21-Jan-96	01-Aug-99		subsea
GC112	Angus	1,845	08-Jun-97	01-Sep-99		subsea
GC254	Allegheny	3,248	01-Jan-85	01-Oct-99		tension leg platform
VK915	Marlin	3,446	01-Jun-93	01-Nov-99		tension leg platform
MC718	Pluto	2,802	20-Oct-95	01-Dec-99	01-May-11	subsea
VK823	Virgo	1,142	01-Jan-93	01-Dec-99		fixed platform
MC935	Europa	3,871	22-Apr-94	01-Feb-00		subsea
EB945	Diana	4,646	01-Aug-90	01-May-00	01-Aug-14	subsea
VK786	Petronius	1,795	14-Jul-95	01-Jul-00		compliant tower
AC025	Hoover	4,807	30-Jan-97	01-Sep-00		spar
GB200	Northwestern	1,391	14-May-98	01-Nov-00		subsea
MC068		1,214	09-Dec-75	01-Jan-01	01-Oct-05	subsea
VK914	Nile	3,535	30-Apr-97	01-Apr-01	01-Jul-09	subsea
MC211	Mica	4,321	01-May-90	01-Jun-01		subsea
GC236	Phoenix[3]	2,021	01-Oct-84	01-Jul-01		floating production unit
GC158	Brutus	2,940	01-Mar-89	01-Aug-01		tension leg platform
EW958	Prince	1,526	20-Jul-94	01-Sep-01		tension leg platform
GB409	Ladybug	1,358	13-May-97	01-Sep-01		subsea
EB949	Marshall	4,376	30-Jul-98	01-Oct-01		subsea
GB559	Oregano	3,398	27-Mar-99	01-Oct-01		subsea
EB205	Pilsner	1,094	02-May-01	01-Dec-01	31-Dec-15	subsea

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
EW878		1,543	03-Jul-00	01-Dec-01		subsea
GB516	Serrano	3,340	23-Jul-96	01-Dec-01	01-Jul-13	subsea
MC899	Crosby	4,148	04-Jan-98	01-Dec-01		subsea
VK873	Einset	3,584	01-Mar-88	01-Dec-01	01-Jul-08	subsea
EB602	Nansen	3,692	25-Sep-99	01-Jan-02		spar
MC029	Pompano I	2,040	04-Mar-98	01-Jan-02		subsea
AC024	Madison	4,856	25-Jun-98	01-Feb-02		subsea
GC472	King Kong	3,813	01-Feb-89	01-Feb-02	01-Dec-12	subsea
VK742	Petronius	1,192	08-Aug-97	01-Feb-02		compliant tower
MC084	King/Horn Mountain	5,286	01-Jan-93	01-Apr-02		spar/subsea
EB421	Lost Ark	2,754	31-Jan-01	01-Jun-02	01-Oct-09	subsea
EB642	Boomvang West	3,749	31-Oct-99	01-Jun-02		subsea
EB688	Boomvang East	3,756	01-May-88	01-Jun-02	01-Apr-10	subsea
GC177	Sangria	1,487	22-Aug-99	01-Jun-02	01-Mar-05	subsea
EB643	Boomvang North	3,397	13-Dec-97	01-Aug-02		spar
DC133	King's Peak	6,509	01-Mar-93	01-Sep-02	01-Mar-13	subsea
MC305	Aconcagua	7,043	21-Feb-99	01-Oct-02	01-Dec-13	subsea
MC348[4]	Camden Hills	7,223	04-Aug-99	01-Oct-02		subsea
GB205		1,330	25-Jul-02	01-Dec-02	01-Jan-12	subsea
GC243	Aspen	3,039	27-Jan-01	01-Dec-02		subsea
GC282	Boris[3]	2,367	29-Sep-01	01-Feb-03		floating production unit
EB579	Falcon	3,454	27-Mar-01	01-Mar-03		subsea
MC582	Medusa	2,136	23-Aug-98	01-Jun-03		spar/subsea
MC243	Matterhorn	2,780	01-Sep-90	01-Nov-03		tension leg platform
MC522	Fourier	6,884	01-Jul-89	01-Nov-03		subsea to *Na Kika* semisubmersible
MC607	East Anstey	6,536	12-Nov-97	01-Nov-03		subsea to *Na Kika* semisubmersible
GB668	Gunnison	3,064	09-May-00	01-Dec-03		spar
EB759	Harrier	4,114	28-Jan-03	01-Jan-04	01-Sep-08	subsea

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
MC066	Ochre	1,144	25-Oct-02	01-Jan-04	01-Jun-10	subsea
AC065	Diana South	4,852	24-Mar-97	01-Mar-04		subsea
MC383	Kepler	5,741	01-Aug-87	01-Apr-04		subsea to *Na Kika* semisubmersible
MC429	Ariel	6,132	20-Nov-95	01-Apr-04		subsea to *Na Kika* semisubmersible
MC773	Devils Tower	5,352	13-Dec-99	01-May-04		spar
EB668	Raptor	3,710	13-Sep-03	01-Jun-04	01-Sep-11	subsea
MC657	Coulomb	7,558	01-Nov-87	01-Jun-04		subsea to *Na Kika* semisubmersible
GB877	Red Hawk	5,329	15-Aug-01	01-Jul-04	01-Oct-09	spar
GC608	Marco Polo	4,290	21-Apr-00	01-Jul-04		tension leg platform
GB208		1,267	01-Sep-91	01-Nov-04	01-Nov-08	subsea
GB379		2,047	01-Jul-85	01-Dec-04	01-Nov-11	subsea
GB783	Magnolia	4,659	03-May-99	01-Dec-04		tension leg platform
GC339	Front Runner	3,327	23-Jan-01	01-Dec-04		spar
GC644	Holstein	4,341	09-Jan-99	01-Dec-04		spar
GC137		1,173	02-Mar-04	01-Jan-05		subsea
GC826	Mad Dog	4,783	24-Nov-98	01-Jan-05		spar
GC562	K2	4,034	14-Aug-99	01-May-05		subsea
GC178	Baccarat	1,404	11-May-04	01-Aug-05	01-Jun-09	subsea
VK962	Swordfish	4,676	15-Nov-01	01-Oct-05		subsea
GC768	Ticonderoga	5,258	10-Sep-04	01-Feb-06		subsea
GC680	Constitution	4,998	31-Oct-01	01-Mar-06		spar
MC252	Rigel	5,077	29-Nov-99	01-Mar-06		subsea
MC299	Seventeen Hands	5,881	04-May-01	01-Mar-06	01-Sep-11	subsea
MC755	Gomez	2,941	19-Mar-86	01-Mar-06	01-Oct-13	semisubmersible
EB430	SW Horseshoe	2,285	03-May-00	01-May-06		subsea
VK917	Swordfish	4,372	08-Dec-01	01-Oct-06		subsea
GC195	Tiger	1,844	25-May-06	01-Jan-07	01-Jun-09	subsea
GB244	Cottonwood	2,089	15-Aug-01	01-Feb-07		subsea

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
GC640	Tahiti/Caesar/Tonga	4,326	29-Mar-02	01-Apr-07		spar/subsea
LL005	Atlas NW	8,807	13-Jan-04	01-Jul-07	01-Feb-12	subsea to *Independence Hub* semisubmersible
LL050	Atlas	8,944	29-May-03	01-Jul-07	01-Feb-12	subsea to *Independence Hub* semisubmersible
MC506	Wrigley	3,682	06-Feb-05	01-Jul-07		subsea
AT037	Merganser	7,938	28-Nov-01	01-Aug-07	01-Sep-14	subsea to *Independence Hub* semisubmersible
LL001	Mondo NW	8,351	08-Jan-05	01-Aug-07		subsea to *Independence Hub* semisubmersible
DC621	Spiderman/Amazon	8,082	29-Nov-03	01-Sep-07	28-May-15	subsea to *Independence Hub* semisubmersible
MC707	Valley Forge	1,538	20-Jun-07	01-Sep-07		subsea
AT261	Vortex	8,344	02-Dec-02	01-Oct-07	01-Sep-12	subsea to *Independence Hub* semisubmersible
AT349	Jubilee	8,778	30-Mar-03	01-Oct-07		subsea to *Independence Hub* semisubmersible
DC618	San Jacinto	7,805	24-Apr-04	01-Oct-07	01-Feb-12	subsea to *Independence Hub* semisubmersible
GC654	Shenzi/Genghis Khan[5]	4,304	02-Dec-02	01-Oct-07		tension leg platform/subsea
GC743	Atlantis	6,285	12-May-98	01-Oct-07		semisubmersible
LL399	Cheyenne	8,986	20-Jul-04	01-Oct-07	01-Jan-14	subsea to *Independence Hub* semisubmersible
MC961	Q	7,926	17-Jun-05	01-Oct-07	01-Apr-14	subsea to *Independence Hub* semisubmersible
MC161		2,924	16-Jul-05	01-Nov-07		subsea
MC696	Blind Faith	6,952	30-May-01	01-Nov-07		semisubmersible
GB302		2,346	01-Feb-91	01-Jan-08		subsea
AT426	Bass Lite	6,623	25-Jan-01	01-Feb-08	01-Dec-14	subsea
MC778	Thunder Horse	6,077	01-Apr-99	01-Jun-08		semisubmersible
VK821		1,030	24-Apr-08	01-Jun-08		subsea
AT575	Neptune	6,205	26-Sep-95	01-Jul-08		tension leg platform
GC646	Daniel Boone	4,230	10-Jan-04	01-Aug-08		subsea
GC385	Pegasus	3,514	28-Apr-05	01-Dec-08		subsea
GB462	Geauxpher	2,789	25-Jan-07	01-May-09		subsea
MC776	North Thunder Horse/Thunder Hawk[6]	5,668	23-Jul-00	01-Jun-09		subsea/semisubmersible
EB992	Rockefeller	4,865	28-Nov-95	01-Aug-09	01-Jan-13	subsea

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
MC546[7]	Leo	2,537	01-Feb-86	01-Oct-09		subsea
VK1003	Ida/Fastball	4,914	15-Apr-07	01-Oct-09	01-Sep-14	subsea
GC141	Shaft	1,016	29-Jun-08	01-Feb-10		subsea
AC857	Great White	7,918	18-May-02	01-Mar-10		*Perdido* spar
AT063	Telemark	4,412	11-Feb-00	01-Mar-10		subsea to *ATP Titan* minDOC
GB339	Sargent	2,180	22-Nov-08	01-Mar-10		subsea
AC859	Tobago/Silvertip	9,436	17-Apr-04	01-Dec-10		subsea to *Perdido* spar
EB597	Balboa	3,352	02-Jul-01	01-Dec-10		subsea
MC503[7]	Appaloosa	2,833	11-Dec-07	01-Dec-10		subsea
MC876	Callisto	7,789	08-Mar-01	01-Jan-11		subsea to *Independence Hub* semisubmersible
MC800	Gladden	3,116	29-Apr-08	01-Feb-11		subsea to MC582 spar
EW998		1,313	27-Feb-09	01-Mar-11		subsea
GC448	Condor	3,266	23-Jan-08	01-Jun-11		subsea
WR206	Cascade	8,148	14-Apr-02	01-Feb-12		subsea to *BW Pioneer* FPSO
GB293	Pyrenees	2,079	14-Apr-09	09-Feb-12		subsea
GC490	Wide Berth	3,714	25-Oct-09	01-Apr-12		subsea
MC285		2,902	01-Sep-87	01-Apr-12		subsea
WR469	Chinook	8,841	19-Jun-03	01-Sep-12		subsea to *BW Pioneer* FPSO
MC751	Goose	1,589	15-Dec-02	01-Nov-12		subsea
GC299	Clipper	3,429	05-Oct-05	01-Mar-13		subsea
DC048	Dalmatian	5,876	29-Sep-08	01-Apr-14		subsea to VK786 compliant tower
DC004	Dalmatian North	5,822	30-Apr-10	01-Jun-14		subsea to VK786 compliant tower
MC682	Tubular Bells	4,521	17-Oct-03	01-Nov-14		subsea to *Gulfstar 1* spar
WR678	St. Malo	6,951	13-Oct-03	01-Dec-14		subsea to WR block 718 semisubmersible
WR759	Jack	6,963	09-Jul-04	01-Dec-14		subsea to WR block 718 semisubmersible
KC875	Lucius	7,106	23-Jan-10	18-Jan-15		subsea to spar
MC431	Son of Bluto 2	6,426	14-Mar-12	2015		subsea to *Delta House* semisubmersible
MC300	Marmalard	5,939	03-May-12	2015		subsea to *Delta House* semisubmersible

Field	Nickname	Water Depth[1] (ft)	Discovery Date	First Production Date	Expiration Date	Development System
MC698	Big Bend	7,221	15-Nov-12	2015		subsea to *Thunder Hawk* semisubmersible
KC964	Hadrian South	7,508	21-Sep-08	2015		subsea to *Lucius* spar
WR508	Stones	8,988	10-Mar-05	2016		FPSO
WR627	Julia	7,121	07-Apr-07	2016		subsea to *Jack/St. Malo* semisubmersible
MC948	Freedom (Gunflint)	6,097	15-Aug-08	2016		subsea to *Tubular Bells Gulfstar 1* spar
GC859	Heidelberg	5,327	23-Jan-09	2016		spar
DC134	Dalmatian South	6,318	27-Sep-12	2016		subsea to VK786 compliant tower
WR029	Big Foot[8]	5,444	02-Dec-05	2018		tension leg platform

[1]Average water depth of all the wells in the field.

[2]The leases in the GC072 Field are in a Producing Unit.

[3]The *Typhoon* and *Boris* TLP was destroyed by Hurricane Rita in 2005. A floating production unit was installed in 2009 and the project was renamed *Phoenix.*

[4]The unit lease in the MC348 Field is held by a pending Suspension of Production.

[5]*Genghis Khan* began production in 2007 with a subsea tieback to the *Marco Polo* TLP. *Shenzi* began production in 2009 and utilizes its own TLP.

[6]*North Thunder Horse* is a subsea tieback to the *Thunder Horse* semisubmersible, and *Thunder Hawk* utilizes its own semisubmersible.

[7]The MC546 and MC503 Fields produce via subsea tiebacks to the *Who Dat* semisubmersible in MC block 547 and to the platform in MC block 365.

[8]The TLP for *Big Foot* was moved back to protected waters after several pre-installed tendons lost buoyancy. Production has been pushed back from 2015 to 2018.

Appendix B. Deepwater Production Facilities

Area	Block	Water Depth (ft)	Type	Installation Date	Project
MC	194	1,023	FP	01-Jan-78	Cognac
MC	280	1,000	CT	01-Jan-83	Lena
GC	65	1,353	FP	01-Jan-88	Bullwinkle
GC	184	1,760	TLP	01-Jan-89	Jolliet
MC	109	1,100	FP	01-Jan-91	Amberjack
GB	426	2,860	TLP	05-Feb-94	Auger
VK	989	1,290	FP	19-Aug-94	Pompano
MC	807	2,933	TLP	18-Jul-96	Mars A
VK	826	1,930	spar	19-Nov-96	Neptune
VK	956	3,216	TLP	21-May-97	Ram Powell
GB	260	1,648	CT	31-May-98	Balpate
GC	205	2,590	spar	21-Jul-98	Genesis
EW	921	1,700	mTLP	10-Aug-98	Morpeth
MC	809	3,970	TLP	28-Dec-98	Ursa
VK	915	3,236	TLP	27-Jul-99	Marlin
GC	254	3,294	mTLP	19-Aug-99	Allegheny
VK	823	1,130	FP	17-Sep-99	Virgo
AC	25	4,825	spar	25-Apr-00	Hoover
VK	786	1,754	CT	28-Apr-00	Petronius
GC	158	2,900	TLP	20-Jun-01	Brutus
EW	1003	1,500	TLP	18-Jul-01	Prince
EB	602	3,675	spar	10-Nov-01	Nansen
EB	643	3,650	spar	28-Apr-02	Boomvang
MC	127	5,400	spar	29-Jun-02	Horn Mountain
MC	474	6,340	semi	02-Aug-03	Na Kika Hub
MC	243	2,850	mTLP	03-Aug-03	Matterhorn
MC	582	2,223	spar	08-Aug-03	Medusa
GB	668	3,150	spar	09-Dec-03	Gunnison
GC	608	4,300	TLP	24-Jan-04	Marco Polo
MC	773	5,610	spar	19-Feb-04	Devils Tower
GC	645	4,340	spar	03-Jun-04	Holstein
GC	782	4,420	spar	30-Jul-04	Mad Dog
GC	338	3,330	spar	02-Aug-04	Front Runner
GB	783	4,670	TLP	05-Aug-04	Magnolia
MC	778	6,200	semi	01-Apr-05	Thunder Horse
GC	680	4,970	spar	27-Dec-05	Constitution
GC	787	7,050	semi	16-Jan-07	Atlantis
MC	920	7,920	semi	11-Jun-07	Independence Hub

Area	Block	Water Depth (ft)	Type	Installation Date	Project
GC	613	4,250	mTLP	16-Oct-07	Neptune
MC	650	6,480	semi	18-Apr-08	Blind Faith
GC	641	4,100	spar	08-Aug-08	Tahiti
GC	653	4,375	TLP	25-Aug-08	Shenzi
GC	237	2,200	FPU	11-Jun-09	Phoenix
MC	736	6,050	semi	07-Aug-09	Thunder Hawk
AC	857	7,817	spar	12-Nov-09	Perdido Hub
MC	941	4,050	minDOC	06-Mar-10	Telemark/Mirage/Morgus
WR	249	8,200	FPSO	30-Jun-11	Cascade/Chinook
MC	547	3,280	semi	12-Jul-11	Who Dat Hub
MC	807	3,028	TLP	30-Jul-13	Mars B
WR	718	6,950	semi	05-Jan-14	Jack/St. Malo
KC	875	7,000	spar	17-Mar-14	Lucius
MC	254	4,400	semi	08-Oct-14	Delta House Hub
MC	724	4,300	spar	01-Nov-14	Tubular Bells

FP - Fixed Platform

CT - Compliant Tower

TLP - Tension Leg Platform

mTLP - mini Tension Leg Platform

semi - semisubmersible production unit

FPU - Floating Production Unit

minDOC - cross between a semisubmersible and a spar

FPSO - Floating Production, Storage, and Offloading facility

APPENDIX C. DEEPWATER FIELDS AND ASSOCIATED PROJECT NAMES

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
AC block 200	Bohemia	Bohemia
AC block 739	Diamondback	Diamondback
AC block 903	Trident	Trident
AC024	Madison	Madison
AC025	Hoover	Hoover
AC065	Diana South	Diana South
AC600	BAHA	BAHA
AC818	Tiger	Tiger
AC857	Great White	Gotcha
AC857	Great White	Great White
AC859	Tobago	Tobago
AC859	Tobago	Silvertip
AT block 182	Sturgis	Sturgis
AT008	Cyclops	Cyclops
AT037	Merganser	Merganser
AT063	Telemark	Telemark
AT140	Claymore	Claymore
AT153	San Patricio	San Patricio
AT261	Vortex	Vortex
AT349	Jubilee	Jubilee
AT349	Jubilee	Jubilee Extension
AT398	Bonsai	Bonsai
AT426	Bass Lite	Bass Lite
AT575	Neptune	Neptune
DC block 268	Antietam	Antietam
DC block 269	Shiloh	Shiloh
DC block 353	Vicksburg	Vicksburg
DC block 486	Fredericksburg	Fredericksburg
DC004	Dalmatian North	Dalmatian
DC048	Dalmatian	Dalmatian
DC133	King's Peak	King's Peak
DC134	Dalmatian South	Dalmatian South
DC398	Gettysburg West	Gettysburg West
DC618	San Jacinto	San Jacinto
DC621	Spiderman/Amazon	Spiderman
DC621	Spiderman/Amazon	Spiderman/Amazon
EB block 301	Conga	Conga

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
EB block 414		
EB197		
EB205	Pilsner	Pilsner
EB377		
EB421	Lost Ark	Lost Ark
EB430	SW Horseshoe	SW Horseshoe
EB579	Falcon	Falcon
EB579	Falcon	Tomahawk
EB597	Balboa	Balboa
EB602	Nansen	La Salle
EB602	Nansen	Nansen
EB602	Nansen	Navajo
EB602	Nansen	West Navajo
EB642	Boomvang West	Boomvang West
EB643	Boomvang North	Balboa
EB643	Boomvang North	Boomvang North
EB643	Boomvang North	Hack Wilson
EB668	Raptor	Raptor
EB688	Boomvang East	Boomvang East
EB759	Harrier	Harrier
EB945	Diana	Diana
EB949	Marshall	Marshall
EB992	Rockefeller	Rockefeller
EW1006	Manta Ray	Manta Ray
EW878		
EW921	Morpeth	Black Widow
EW921	Morpeth	Morpeth
EW958	Prince	Prince
EW963	Arnold	Arnold
EW998		
GB block 605	Winter	Winter
GB block 949		
GB block 959	North Platte	North Platte
GB171	Salsa	Conger
GB171	Salsa	Salsa
GB171	Salsa	Salsa West
GB200	Northwestern	Northwestern
GB200	Northwestern	Tulane
GB205		

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
GB208		
GB244	Cottonwood	Cottonwood
GB254	Moccasin	Brass
GB260	Baldpate	Baldpate
GB260	Baldpate	Penn State
GB269	Mosquito Hawk	Mosquito Hawk
GB293	Pyrenees	Pyrenees
GB302	GB302	GB 302
GB302	GB302	Powerplay
GB339	Sargent	
GB367	Dulcimer	Dulcimer
GB379		
GB387	Llano	Habanero
GB387	Llano	Llano
GB387	Llano	Travis
GB388	Cooper	Cooper
GB409	Ladybug	Ladybug
GB412	Ptolemy	Ptolemy
GB426	Auger	Auger
GB426	Auger	Cardamom
GB462	Geauxpher	Bushwood
GB462	Geauxpher	Geauxpher
GB462	Geauxpher	Noonan
GB516	Serrano	Ozona
GB516	Serrano	Serrano
GB559	Oregano	Oregano
GB602	Macaroni	Macaroni
GB668	Gunnison	Dawson
GB668	Gunnison	Dawson Deep
GB668	Gunnison	Durango
GB668	Gunnison	Gunnison
GB700	Shiner Deep	Shiner Deep
GB783	Magnolia	Magnolia
GB783	Magnolia	Entrada
GB873		
GB877	Red Hawk	Red Hawk
GC block 245		
GC block 304	Angostura	Angostura
GC block 376		

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
GC block 432	Samurai	Samurai
GC block 627	Hopkins	Hopkins
GC block 733	Copper	Copper
GC block 807	Anchor	Anchor
GC021		
GC027	Double Corona	Double Corona
GC029		
GC039		
GC065	Bullwinkle	Bullwinkle
GC065	Bullwinkle	Rocky
GC069	El Toro	El Toro
GC070		
GC072	Popeye	Popeye
GC075		
GC082	Healey	Hurley
GC110	Rocky	Lorien
GC110	Rocky	Manatee
GC110	Rocky	Marathon
GC110	Rocky	Rocky
GC112	Angus	Angus
GC114	Gretchen	Gretchen
GC116	Popeye	Popeye
GC137		
GC141	Shaft	Shaft
GC147		
GC153	Marathon	Marathon
GC158	Brutus	Brutus
GC158	Brutus	Citrine
GC166	Bison	Bison
GC177	Sangria	Sangria
GC178	Baccarat	Baccarat
GC184	Jolliet	Jolliet
GC195	Tiger	Tiger
GC205	Genesis	Genesis
GC205	Genesis	Glider
GC228	Sable	Sable
GC236	Phoenix	Phoenix
GC243	Aspen	Aspen
GC244	Troika	Droshky

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
GC244	Troika	Troika
GC254	Allegheny	Allegheny
GC282	Boris	Boris
GC282	Boris	Little Burn
GC299	Clipper	Clipper
GC299	Clipper	The Experience
GC339	Front Runner	Front Runner
GC339	Front Runner	Quatrain
GC379	Hornet	Hornet
GC385	Pegasus	Pegasus
GC416	McKinley	McKinley
GC448	Condor	GC 448
GC463		
GC468	Stampede	Knotty Head
GC468	Stampede	Pony
GC472	King Kong	King Kong
GC472	King Kong	Yosemite
GC490	Wide Berth	Wide Berth
GC506	Fuji	Dominica
GC506	Fuji	Fuji
GC507	Ness	Ness
GC511	Flying Dutchman	Flying Dutchman
GC562	K2	Grand Cayman
GC562	K2	K2
GC562	K2	K2 North
GC562	K2	Timon
GC599	Friesian	Friesian
GC608	Marco Polo	Marco Polo
GC640	Tahiti/Caesar/Tonga	Caesar
GC640	Tahiti/Caesar/Tonga	Tahiti
GC640	Tahiti/Caesar/Tonga	Tonga
GC644	Holstein	Holstein
GC646	Daniel Boone	Daniel Boone
GC654	Shenzi	Genghis Khan
GC654	Shenzi	Shenzi
GC680	Constitution	Constitution
GC691	Poseidon	Poseidon
GC723	Deep Blue	Deep Blue
GC743	Atlantis	Atlantis

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
GC767	Conquest	Conquest
GC768	Ticonderoga	Ticonderoga
GC823	Puma	Puma
GC826	Mad Dog	Mad Dog
GC826	Mad Dog	Mad Dog South
GC859	Heidelberg	Heidelberg
GC955	Mission Deep	Mission Deep
KC block 102	Tiber	Tiber
KC block 681	Sardinia	Sardinia
KC block 872	Buckskin	Buckskin
KC292	Kaskida	Kaskida
KC736	Moccasin	Moccasin
KC785	Buckskin	Buckskin
KC875	Lucius	Lucius
KC875	Lucius	North Hadrian
KC964	Hadrian South	Hadrian South
LL block 095	Daredevil	Daredevil
LL001	Mondo NW	Mondo NW
LL001	Mondo NW	Mondo NW/Dachshund South
LL005	Atlas NW	Atlas NW
LL050	Atlas	Atlas
LL399	Cheyenne	Cheyenne
MC block 204	Redrock	Redrock
MC block 525	Rydberg	Rydberg
MC block 699	Troubadour	Troubadour
MC026	Supertramp	Supertramp
MC029	Pompano I	Pompano I
MC066	Ochre	Ochre
MC068		
MC079	Otis	Otis
MC084	King/Horn Mountain	Horn Mountain
MC084	King/Horn Mountain	King
MC109	Amberjack	Amberjack
MC109	Amberjack	Orion
MC113		
MC161		
MC162	Nirvana	Nirvana
MC194	Cognac	Cognac
MC211	Mica	Mica

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
MC214	Odd Job	Odd Job
MC243	Matterhorn	Mandy
MC243	Matterhorn	Matterhorn
MC252	Rigel	Rigel
MC281	Lena	Lena
MC285		
MC292	Gemini	Gemini
MC292	Gemini	Raton
MC299	Seventeen Hands	Seventeen Hands
MC300	Marmalard	Marmalard
MC305	Aconcagua	Aconcagua
MC348	Camden Hills	Camden Hills
MC354	Zinc	Zinc
MC383	Kepler	Kepler
MC392	Appomattox	Appomattox
MC393	Corinth	Corinth
MC427	La Femme	La Femme
MC429	Ariel	Ariel
MC431	Son Of Bluto 2	Son Of Bluto 2
MC445	Diamond	Diamond
MC455		
MC503	Appaloosa	Appaloosa
MC503	Appaloosa	Who Dat
MC506	Wrigley	Wrigley
MC509	Hawkes	Hawkes
MC522	Fourier	Fourier
MC522	Fourier	Herschel
MC546	Leo	Leo
MC546	Leo	Longhorn
MC546	Leo	Longhorn North
MC546	Leo	Ringo
MC546	Leo	Who Dat
MC555	Timber Wolf	Timber Wolf
MC561	Monet	Monet
MC582	Medusa	Killer Bee
MC582	Medusa	Medusa
MC582	Medusa	North Medusa
MC582	Medusa	Zia
MC607	East Anstey	East Anstey

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
MC607	East Anstey	Isabela
MC657	Coulomb	Coulomb
MC682	Tubular Bells	Tubular Bells
MC696	Blind Faith	Blind Faith
MC698	Big Bend	Big Bend
MC707	Valley Forge	Valley Forge
MC709		
MC718	Pluto	Pluto
MC718	Pluto	Pluto/Juno
MC731	Mensa	Mensa
MC737	Thunder Ridge	Thunder Ridge
MC751	Goose	Goose
MC755	Gomez	Anduin
MC755	Gomez	Gomez
MC773	Devils Tower	Devils Tower
MC773	Devils Tower	Goldfinger
MC773	Devils Tower	Triton
MC776	North Thunder Horse	North Thunder Horse
MC776	North Thunder Horse	Thunder Bird
MC776	North Thunder Horse	Thunder Hawk
MC776	North Thunder Horse	Thunder Horse
MC778	Thunder Horse	Thunder Horse
MC782	Dantzler	Dantzler
MC800	Gladden	Gladden
MC807	Mars-Ursa	Deimos
MC807	Mars-Ursa	King
MC807	Mars-Ursa	Mars
MC807	Mars-Ursa	Princess
MC807	Mars-Ursa	Ursa
MC816	Taggart	Taggart
MC849	Slammer	Slammer
MC876	Callisto	Callisto
MC899	Crosby	Crosby
MC899	Crosby	Mirage
MC899	Crosby	Morgus
MC929		
MC935	Europa	Europa
MC940	Vito	Vito
MC948	Freedom	Gunflint

BOEM Field or Discovery Name	BOEM Nickname	Operator Nicknames Within BOEM Fields
MC961	Q	Q
PI525		
SE039	Phobos	Phobos
VK1003	Ida/Fastball	Fastball
VK742	Petronius	Petronius
VK783	Tahoe/SE Tahoe	Tahoe
VK783	Tahoe/SE Tahoe	Tahoe Southeast
VK786	Petronius	Perseus
VK786	Petronius	Petronius
VK821		
VK823	Virgo	Virgo
VK825	Neptune	Neptune
VK825	Neptune	Triton
VK827	Tahoe/SE Tahoe	Tahoe
VK862		
VK864	Dionysus	Dionysus
VK873	Einset	Einset
VK914	Nile	Nile
VK915	Marlin	Marlin
VK917	Swordfish	Swordfish
VK956	Ram-Powell	Ram-Powell
VK962	Swordfish	Swordfish
VK990	Pompano	Pompano I
VK990	Pompano	Pompano II
WR block 098	Coronado	Coronado
WR block 544	Tucker	Tucker
WR block 724	Das Bump	Das Bump
WR029	Big Foot	Big Foot
WR051	Shenandoah	Shenandoah
WR206	Cascade	Cascade
WR469	Chinook	Chinook
WR508	Stones	Stones
WR627	Julia	Julia
WR678	St. Malo	St. Malo
WR759	Jack	Jack
WR848	Hal	Hal
WR969	Logan	Logan

Appendix D. Deepwater Fields by Dominant Reservoir Age

Table 12. Pleistocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
MC068		Pleistocene	1,214	09-Dec-75	01-Jan-01	01-Oct-05	Developed Non-producing
MC354	Zinc	Pleistocene	1,493	01-Aug-77	01-Aug-93	01-May-10	Developed Non-producing
GC184	Jolliet	Pleistocene	1,718	01-Jul-81	01-Nov-89		Developed Producing
GC029		Pleistocene	1,565	01-Jan-84	01-Nov-88	01-Dec-90	Developed Non-producing
GC153	Marathon	Pleistocene	1,687	01-Apr-84		01-Dec-90	Contingent Resources
GC021		Pleistocene	1,224	01-Oct-84		01-Feb-91	Contingent Resources
GC075		Pleistocene	2,172	01-May-85	01-Nov-88	01-Apr-90	Developed Non-producing
GB379		Pleistocene	2,047	01-Jul-85	01-Dec-04	01-Nov-11	Developed Non-producing
GC228	Sable	Pleistocene	1,694	01-Jul-85		01-Sep-96	Contingent Resources
AT001		Pleistocene	2,381	14-May-86		01-Jun-89	Contingent Resources
EW1006	Manta Ray	Pleistocene	1,851	26-Jan-88	01-Mar-99		Developed Producing
GC027	Double Corona	Pleistocene	1,593	01-Jul-89		01-Dec-90	Contingent Resources
GC162		Pleistocene	2,583	01-Jul-89		01-Oct-90	Contingent Resources
GB208		Pleistocene	1,267	01-Sep-91	01-Nov-04	01-Nov-08	Developed Non-producing
GB254	Moccasin	Pleistocene	1,920	23-Jul-93		01-Nov-00	Contingent Resources
GC block 245	Olivella	Pleistocene	2,821	21-Sep-95		01-Oct-07	Contingent Resources
GB409	Ladybug	Pleistocene	1,358	13-May-97	01-Sep-01		Developed Producing
EB block 301	Conga	Pleistocene	1,983	06-Dec-97		01-Dec-04	Contingent Resources
GB367	Dulcimer	Pleistocene	1,123	09-Feb-98	01-Apr-99	01-Mar-02	Developed Non-producing
GB783	Magnolia	Pleistocene	4,659	03-May-99	01-Dec-04		Developed Producing
EW878		Pleistocene	1,543	03-Jul-00	01-Dec-01		Developed Producing
AT426	Bass Lite	Pleistocene	6,623	25-Jan-01	01-Feb-08	01-Dec-14	Developed Non-producing
GB244	Cottonwood	Pleistocene	2,089	15-Aug-01	01-Feb-07		Developed Producing
GC379	Hornet	Pleistocene	3,878	14-Dec-01		01-Jun-12	Contingent Resources
GC507	Ness	Pleistocene	4,001	27-Dec-01		01-Jun-13	Contingent Resources
GB205		Pleistocene	1,330	25-Jul-02	01-Dec-02	01-Jan-12	Developed Non-producing
GB700	Shiner Deep	Pleistocene	4,542	13-Sep-03		01-Nov-07	Contingent Resources
GC137		Pleistocene	1,173	02-Mar-04	01-Jan-05		Developed Producing
GC178	Baccarat	Pleistocene	1,404	11-May-04	01-Aug-05	01-Jun-09	Developed Non-producing
GC448	Condor	Pleistocene	3,266	23-Jan-08	01-Jun-11		Developed Producing
GB339	Sargent	Pleistocene	2,180	22-Nov-08	01-Mar-10		Developed Producing
GB block 605	Winter	Pleistocene	3,411	05-Feb-09			Contingent Resources
GB block 949		Pleistocene	4,987	26-Jun-09			Contingent Resources
GC490	Wide Berth	Pleistocene	3,714	25-Oct-09	01-Apr-12		Developed Producing

Table 13. Pliocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
MC194	Cognac	Pliocene	1,022	01-Jul-75	01-Sep-79		Developed Producing
MC113		Pliocene	1,857	01-Jan-76		01-Nov-77	Contingent Resources
MC281	Lena	Pliocene	1,005	01-May-76	01-Jan-84		Developed Producing
VK862		Pliocene	1,049	01-Oct-76	01-Dec-95		Developed Producing
VK864	Dionysus	Pliocene	1,482	01-Oct-81		01-Oct-85	Contingent Resources
GC065	Bullwinkle	Pliocene	1,337	01-Oct-83	01-Jul-89		Developed Producing
MC109	Amberjack	Pliocene	1,044	13-Nov-83	01-Oct-91		Developed Producing
GC039		Pliocene	1,976	01-Apr-84		01-Aug-03	Contingent Resources
GC070		Pliocene	1,618	01-Jun-84		01-Dec-88	Contingent Resources
GB412	Ptolemy	Pliocene	1,390	01-Jul-84		01-Dec-88	Contingent Resources
GC069	El Toro	Pliocene	1,437	13-Sep-84		01-Dec-00	Contingent Resources
GC236	Phoenix	Pliocene	2,021	01-Oct-84	01-Jul-01		Developed Producing
GC254	Allegheny	Pliocene	3,248	01-Jan-85	01-Oct-99		Developed Producing
GC116	Popeye	Pliocene	2,120	01-Feb-85	01-Jan-96		Developed Producing
GC072	Popeye	Pliocene	2,019	10-Jul-85	01-Jan-96		Developed Non-producing*
EB377		Pliocene	2,450	01-Oct-85		01-Aug-89	Contingent Resources
GC166	Bison	Pliocene	2,348	01-Mar-86		01-Dec-94	Contingent Resources
MC755	Gomez	Pliocene	2,941	19-Mar-86	01-Mar-06	01-Oct-13	Developed Non-producing
GB426	Auger	Pliocene	2,847	01-May-87	01-Apr-94		Developed Producing
GC110	Rocky	Pliocene	1,959	07-Aug-87	01-Jan-96		Developed Producing
MC285		Pliocene	2,902	01-Sep-87	01-Apr-12		Developed Producing
MC929		Pliocene	2,250	01-Nov-87		01-May-89	Contingent Resources
EB688	Boomvang East	Pliocene	3,756	01-May-88	01-Jun-02	01-Apr-10	Developed Non-producing
GC205	Genesis	Pliocene	2,792	01-Sep-88	01-Jan-99		Developed Producing
GC472	King Kong	Pliocene	3,813	01-Feb-89	01-Feb-02	01-Dec-12	Developed Non-producing
GC158	Brutus	Pliocene	2,940	01-Mar-89	01-Aug-01		Developed Producing
GB388	Cooper	Pliocene	2,209	16-Mar-89	01-Sep-95	29-May-15	Developed Non-producing
EW921	Morpeth	Pliocene	1,712	30-Jul-89	01-Oct-98		Developed Producing
EB945	Diana	Pliocene	4,646	01-Aug-90	01-May-00	01-Aug-14	Developed Non-producing
MC243	Matterhorn	Pliocene	2,780	01-Sep-90	01-Nov-03		Developed Producing
GB302		Pliocene	2,346	01-Feb-91	01-Jan-08		Developed Producing
GB260	Baldpate	Pliocene	1,605	01-Nov-91	01-Sep-98		Developed Producing
MC445	Diamond	Pliocene	2,095	05-Dec-92	01-Oct-93	01-Sep-99	Developed Non-producing
MC026	Supertramp	Pliocene	1,272	27-May-94		01-Jun-97	Contingent Resources
GC244	Troika	Pliocene	2,795	30-May-94	01-Nov-97		Developed Producing
EW958	Prince	Pliocene	1,526	20-Jul-94	01-Sep-01		Developed Producing
GB387	Llano	Pliocene	2,313	03-Oct-94	01-May-96		Developed Producing
GC506	Fuji	Pliocene	4,256	30-Jan-95		01-Dec-99	Contingent Resources
EB992	Rockefeller	Pliocene	4,865	28-Nov-95	01-Aug-09	01-Jan-13	Developed Non-producing
GB602	Macaroni	Pliocene	3,688	21-Jan-96	01-Aug-99		Developed Producing
GB269	Mosquito Hawk	Pliocene	1,049	06-Mar-96		01-Sep-98	Contingent Resources
EW963	Arnold	Pliocene	1,682	12-Jun-96	01-May-98		Developed Producing
GB516	Serrano	Pliocene	3,340	23-Jul-96	01-Dec-01	01-Jul-13	Developed Non-producing
AC025	Hoover	Pliocene	4,807	30-Jan-97	01-Sep-00		Developed Producing
AC065	Diana South	Pliocene	4,852	24-Mar-97	01-Mar-04		Developed Producing
AT008	Cyclops	Pliocene	3,135	26-Apr-97		01-Apr-98	Contingent Resources
GC112	Angus	Pliocene	1,845	08-Jun-97	01-Sep-99		Developed Producing
EB643	Boomvang North	Pliocene	3,397	13-Dec-97	01-Aug-02		Developed Producing
GB200	Northwestern	Pliocene	1,391	14-May-98	01-Nov-00		Developed Producing
AC block 200	Bohemia	Pliocene	5,088	17-May-98		01-Oct-05	Contingent Resources
AC024	Madison	Pliocene	4,856	25-Jun-98	01-Feb-02		Developed Producing
GC416	McKinley	Pliocene	4,019	14-Jul-98		01-Apr-00	Contingent Resources
EB949	Marshall	Pliocene	4,376	30-Jul-98	01-Oct-01		Developed Producing
MC582	Medusa	Pliocene	2,136	23-Aug-98	01-Jun-03		Developed Producing

Table 13 (continued). Pliocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
GC644	Holstein	Pliocene	4,341	09-Jan-99	01-Dec-04		Developed Producing
GB559	Oregano	Pliocene	3,398	27-Mar-99	01-Oct-01		Developed Producing
GC177	Sangria	Pliocene	1,487	22-Aug-99	01-Jun-02	01-Mar-05	Developed Non-producing
EB602	Nansen	Pliocene	3,692	25-Sep-99	01-Jan-02		Developed Producing
EB642	Boomvang West	Pliocene	3,749	31-Oct-99	01-Jun-02		Developed Producing
GC114	Gretchen	Pliocene	2,506	18-Dec-99		01-Jul-08	Contingent Resources
EB430	SW Horseshoe	Pliocene	2,285	03-May-00	01-May-06		Developed Producing
GB668	Gunnison	Pliocene	3,064	09-May-00	01-Dec-03		Developed Producing
GC339	Front Runner	Pliocene	3,327	23-Jan-01	01-Dec-04		Developed Producing
EB421	Lost Ark	Pliocene	2,754	31-Jan-01	01-Jun-02	01-Oct-09	Developed Non-producing
EB205	Pilsner	Pliocene	1,094	02-May-01	01-Dec-01	12-Dec-15	Developed Non-producing
EB597	Balboa	Pliocene	3,352	02-Jul-01	01-Dec-10		Developed Producing
GB877	Red Hawk	Pliocene	5,329	15-Aug-01	01-Jul-04	01-Oct-09	Developed Non-producing
GC282	Boris	Pliocene	2,367	29-Sep-01	01-Feb-03		Developed Producing
GC680	Constitution	Pliocene	4,998	31-Oct-01	01-Mar-06		Developed Producing
MC849	Slammer	Pliocene	3,600	19-Mar-02		01-Jun-09	Contingent Resources
MC066	Ochre	Pliocene	1,144	25-Oct-02	01-Jan-04	01-Jun-10	Developed Non-producing
MC751	Goose	Pliocene	1,589	15-Dec-02	01-Nov-12		Developed Producing
GC646	Daniel Boone	Pliocene	4,230	10-Jan-04	01-Aug-08		Developed Producing
GC767	Conquest	Pliocene	5,116	13-Aug-04		01-Jun-13	Contingent Resources
GC768	Ticonderoga	Pliocene	5,258	10-Sep-04	01-Feb-06		Developed Producing
EB197		Pliocene	1,249	09-Dec-04		01-Nov-12	Contingent Resources
GC385	Pegasus	Pliocene	3,514	28-Apr-05	01-Dec-08		Developed Producing
GC299	Clipper	Pliocene	3,429	05-Oct-05	01-Mar-13		Developed Producing
AT140	Claymore	Pliocene	3,739	05-May-06		01-Dec-07	Contingent Resources
GB462	Geauxpher	Pliocene	2,789	25-Jan-07	01-May-09		Developed Producing
GC082	Healey	Pliocene	2,391	15-Feb-07		01-Apr-14	Contingent Resources
MC707	Valley Forge	Pliocene	1,538	20-Jun-07	01-Sep-07		Developed Producing
EB block 414		Pliocene	2,727	26-Nov-07		01-Nov-08	Contingent Resources
GC141	Shaft	Pliocene	1,016	29-Jun-08	01-Feb-10		Developed Producing
KC964	Hadrian South	Pliocene	7,508	21-Sep-08			Undeveloped
EW998		Pliocene	1,313	27-Feb-09	01-Mar-11		Developed Producing
GB293	Pyrenees	Pliocene	2,079	14-Apr-09	09-Feb-12		Developed Producing
KC875	Lucius	Pliocene	7,106	23-Jan-10	18-Jan-15		Developed Producing
MC816	Taggart	Pliocene	5,534	30-Aug-13			Contingent Resources
GC block 627	Hopkins	Pliocene	4,416	01-Dec-14			Contingent Resources

*leases in a Producing Unit

Table 14. Upper Miocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
VK990	Pompano	Upper Miocene	1,436	01-May-81	01-Oct-94		Developed Producing
GB171	Salsa	Upper Miocene	1,195	18-Apr-84	01-Aug-98		Developed Producing
VK783	Tahoe/SE Tahoe	Upper Miocene	1,328	01-Dec-84	01-Jan-94		Developed Producing
MC455		Upper Miocene	1,400	01-Feb-86		01-May-89	Contingent Resources
MC546	Leo	Upper Miocene	2,537	01-Feb-86	01-Oct-09		Developed Producing
MC731	Mensa	Upper Miocene	5,286	01-Dec-86	01-Jul-97	01-Mar-14	Developed Non-producing
MC383	Kepler	Upper Miocene	5,741	01-Aug-87	01-Apr-04		Developed Producing
VK873	Einset	Upper Miocene	3,584	01-Mar-88	01-Dec-01	01-Jul-08	Developed Non-producing
MC807	Mars-Ursa	Upper Miocene	3,341	01-Apr-89	01-Jul-96		Developed Producing
MC522	Fourier	Upper Miocene	6,884	01-Jul-89	01-Nov-03		Developed Producing
MC211	Mica	Upper Miocene	4,321	01-May-90	01-Jun-01		Developed Producing
MC084	King/Horn Mountain	Upper Miocene	5,286	01-Jan-93	01-Apr-02		Developed Producing
VK823	Virgo	Upper Miocene	1,142	01-Jan-93	01-Dec-99		Developed Producing
DC133	King's Peak	Upper Miocene	6,509	01-Mar-93	01-Sep-02	01-Mar-13	Developed Non-producing
MC935	Europa	Upper Miocene	3,871	22-Apr-94	01-Feb-00		Developed Producing
MC162	Nirvana	Upper Miocene	3,454	30-Nov-94		01-Jun-10	Contingent Resources
MC292	Gemini	Upper Miocene	3,529	07-Sep-95	01-May-99		Developed Producing
MC718	Pluto	Upper Miocene	2,802	20-Oct-95	01-Dec-99	01-May-11	Developed Non-producing
MC429	Ariel	Upper Miocene	6,132	20-Nov-95	01-Apr-04		Developed Producing
MC899	Crosby	Upper Miocene	4,148	04-Jan-98	01-Dec-01		Developed Producing
MC029	Pompano I	Upper Miocene	2,040	04-Mar-98	01-Jan-02		Developed Producing
GC463		Upper Miocene	4,032	01-Dec-98		01-Apr-99	Contingent Resources
MC305	Aconcagua	Upper Miocene	7,043	21-Feb-99	01-Oct-02	01-Dec-13	Developed Non-producing
GC608	Marco Polo	Upper Miocene	4,290	21-Apr-00	01-Jul-04		Developed Producing
GC243	Aspen	Upper Miocene	3,039	27-Jan-01	01-Dec-02		Developed Producing
MC876	Callisto	Upper Miocene	7,789	08-Mar-01	01-Jan-11		Developed Producing
MC299	Seventeen Hands	Upper Miocene	5,881	04-May-01	01-Mar-06	01-Sep-11	Developed Non-producing
AT349	Jubilee	Upper Miocene	8,778	30-Mar-03	01-Oct-07		Developed Producing
LL050	Atlas	Upper Miocene	8,944	29-May-03	01-Jul-07	01-Feb-12	Developed Non-producing
DC621	Spiderman/Amazon	Upper Miocene	8,082	29-Nov-03	01-Sep-07	28-May-15	Developed Non-producing
LL005	Atlas NW	Upper Miocene	8,807	13-Jan-04	01-Jul-07	01-Feb-12	Developed Non-producing
DC618	San Jacinto	Upper Miocene	7,805	24-Apr-04	01-Oct-07	01-Feb-12	Developed Non-producing
LL399	Cheyenne	Upper Miocene	8,986	20-Jul-04	01-Oct-07	01-Jan-14	Developed Non-producing
MC427	La Femme	Upper Miocene	5,782	02-Dec-04			Contingent Resources
MC161		Upper Miocene	2,924	16-Jul-05	01-Nov-07		Developed Producing
AT398	Bonsai	Upper Miocene	3,619	14-Aug-05		01-Feb-07	Contingent Resources
LL block 95	Daredevil	Upper Miocene	9,112	14-Sep-05		01-Feb-13	Contingent Resources
MC block 204	Redrock	Upper Miocene	3,334	06-Apr-06		01-Apr-13	Contingent Resources
GC195	Tiger	Upper Miocene	1,844	25-May-06	01-Jan-07	01-Jun-09	Developed Non-producing
GC block 376		Upper Miocene	3,037	04-Jul-06		01-Apr-07	Contingent Resources
GB873		Upper Miocene	4,705	09-Dec-06		01-Jun-07	Contingent Resources
MC503	Appaloosa	Upper Miocene	2,833	11-Dec-07	01-Dec-10		Developed Producing
MC800	Gladden	Upper Miocene	3,116	29-Apr-08	01-Feb-11		Developed Producing
MC561	Monet	Upper Miocene	6,295	03-Jun-08		01-Jan-09	Contingent Resources
GC511	Flying Dutchman	Upper Miocene	3,831	17-Apr-10		01-Apr-11	Contingent Resources
MC431	Son of Bluto 2	Upper Miocene	6,426	14-Mar-12			Reserves Justified for Development
MC782	Dantzler	Upper Miocene	6,575	20-Nov-13			Contingent Resources

Table 15. Middle Miocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
VK956	Ram-Powell	Middle Miocene	3,238	01-May-85	01-Sep-97		Developed Producing
MC657	Coulomb	Middle Miocene	7,558	01-Nov-87	01-Jun-04		Developed Producing
VK825	Neptune (VK)	Middle Miocene	1,864	01-Nov-87	01-Mar-97		Developed Producing
VK915	Marlin	Middle Miocene	3,446	01-Jun-93	01-Nov-99		Developed Producing
VK786	Petronius	Middle Miocene	1,795	14-Jul-95	01-Jul-00		Developed Producing
VK914	Nile	Middle Miocene	3,535	30-Apr-97	01-Apr-01	01-Jul-09	Developed Non-producing
VK742	Petronius	Middle Miocene	1,192	08-Aug-97	01-Feb-02		Developed Producing
MC607	East Anstey	Middle Miocene	6,536	12-Nov-97	01-Nov-03		Developed Producing
GC743	Atlantis	Middle Miocene	6,285	12-May-98	01-Oct-07		Developed Producing
VK827	Tahoe/SE Tahoe	Middle Miocene	2,104	08-Nov-98		01-Apr-01	Contingent Resources
MC348	Camden Hills	Middle Miocene	7,223	04-Aug-99	01-Oct-02		Developed Non-producing*
MC252	Rigel	Middle Miocene	5,077	29-Nov-99	01-Mar-06		Developed Producing
GC955	Mission Deep	Middle Miocene	7,120	13-Dec-99		01-Apr-09	Contingent Resources
MC773	Devils Tower	Middle Miocene	5,352	13-Dec-99	01-May-04		Developed Producing
AT063	Telemark	Middle Miocene	4,412	11-Feb-00	01-Mar-10		Developed Producing
MC776	North Thunder Horse	Middle Miocene	5,668	23-Jul-00	01-Jun-09		Developed Producing
EB579	Falcon	Middle Miocene	3,454	27-Mar-01	01-Mar-03		Developed Producing
MC696	Blind Faith	Middle Miocene	6,952	30-May-01	01-Nov-07		Developed Producing
AT153	San Patricio	Middle Miocene	4,785	09-Aug-01		01-Feb-02	Contingent Resources
MC555	Timber Wolf	Middle Miocene	4,749	30-Oct-01		01-May-10	Contingent Resources
VK962	Swordfish	Middle Miocene	4,676	15-Nov-01	01-Oct-05		Developed Producing
MC509	Hawkes	Middle Miocene	4,082	20-Nov-01		01-Apr-09	Contingent Resources
AT037	Merganser	Middle Miocene	7,938	28-Nov-01	01-Aug-07	01-Sep-14	Developed Non-producing
VK917	Swordfish	Middle Miocene	4,372	08-Dec-01	01-Oct-06		Developed Producing
GC640	Tahiti/Caesar/Tonga	Middle Miocene	4,326	29-Mar-02	01-Apr-07		Developed Producing
AT261	Vortex	Middle Miocene	8,344	02-Dec-02	01-Oct-07	01-Sep-12	Developed Non-producing
EB759	Harrier	Middle Miocene	4,114	28-Jan-03	01-Jan-04	01-Sep-08	Developed Non-producing
EB668	Raptor	Middle Miocene	3,710	13-Sep-03	01-Jun-04	01-Sep-11	Developed Non-producing
MC682	Tubular Bells	Middle Miocene	4,521	17-Oct-03	01-Nov-14		Developed Producing
GC823	Puma	Middle Miocene	4,155	05-Nov-03		01-Jul-09	Contingent Resources
KC block 681	Sardinia	Middle Miocene	6,345	18-Aug-04		01-Dec-08	Contingent Resources
LL001	Mondo NW	Middle Miocene	8,351	08-Jan-05	01-Aug-07		Developed Producing
MC506	Wrigley	Middle Miocene	3,682	06-Feb-05	01-Jul-07		Developed Producing
MC961	Q	Middle Miocene	7,926	17-Jun-05	01-Oct-07	01-Apr-14	Developed Non-producing
WR029	Big Foot	Middle Miocene	5,444	02-Dec-05			Reserves Justified for Development
GC468	Stampede	Middle Miocene	3,494	24-Jun-06			Contingent Resources
GC599	Fresian	Middle Miocene	3,838	08-Oct-06		01-May-11	Contingent Resources
MC737	Thunder Ridge	Middle Miocene	6,108	27-Oct-06			Contingent Resources
VK1003	Ida/Fastball	Middle Miocene	4,914	15-Apr-07	01-Oct-09	01-Sep-14	Developed Non-producing
VK821		Middle Miocene	1,030	24-Apr-08	01-Jun-08		Developed Producing
MC948	Feedom (Gunflint)	Middle Miocene	6,097	15-Aug-08			Reserves Justified for Development
DC048	Dalmatian	Middle Miocene	5,876	29-Sep-08	01-Apr-14		Developed Producing
GC859	Heidelberg	Middle Miocene	5,327	23-Jan-09			Reserves Justified for Development
GC block 432	Samurai	Middle Miocene	3,390	14-Jun-09			Contingent Resources
GC block 304	Angostura	Middle Miocene	3,877	28-Aug-09			Contingent Resources
DC004	Dalmatian North	Middle Miocene	5,822	30-Apr-10	01-Jun-14		Developed Producing
GC723	Deep Blue	Middle Miocene	5,040	03-May-10		01-May-12	Contingent Resources
MC300	Marmalard	Middle Miocene	5,939	03-May-12			Reserves Justified for Development
DC134	Dalmatian South	Middle Miocene	6,318	27-Sep-12			Reserves Justified for Development
MC698	Big Bend	Middle Miocene	7,221	15-Nov-12			Reserves Justified for Development
MC block 699	Troubadour	Middle Miocene	7,273	10-Aug-13			Contingent Resources
MC214	Odd Job	Middle Miocene	5,931	17-Sep-13			Contingent Resources

*unit lease held by pending Suspension of Production

Table 16. Lower Miocene-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
AT575	Neptune (AT)	Lower Miocene	6,205	26-Sep-95	01-Jul-08		Developed Producing
GC826	Mad Dog	Lower Miocene	4,783	24-Nov-98	01-Jan-05		Developed Producing
MC778	Thunder Horse	Lower Miocene	6,077	01-Apr-99	01-Jun-08		Developed Producing
GC562	K2	Lower Miocene	4,034	14-Aug-99	01-May-05		Developed Producing
GC654	Shenzi	Lower Miocene	4,304	02-Dec-02	01-Oct-07		Developed Producing
AT block 182	Sturgis	Lower Miocene	3,710	01-Jul-03		01-Jun-11	Contingent Resources
MC940	Vito	Lower Miocene	4,025	29-Mar-10			Contingent Resources

Table 17. Lower Tertiary-dominant fields and discoveries.

Field or Block	Nickname	Dominant Age of Reservoirs	Water Depth (average in ft)	Discovery Date	First Production Date	Expiration Date	BOEM Resource Classification
PI525		Lower Tertiary	3,381	30-Apr-96		01-Nov-96	Contingent Resources
AC600	BAHA	Lower Tertiary	7,620	23-May-96		01-Dec-01	Contingent Resources
AC block 903	Trident	Lower Tertiary	9,693	01-Jul-01		01-Oct-08	Contingent Resources
WR206	Cascade	Lower Tertiary	8,148	14-Apr-02	01-Feb-12		Developed Producing
AC857	Great White	Lower Tertiary	7,918	18-May-02	01-Mar-10		Developed Producing
WR469	Chinook	Lower Tertiary	8,841	19-Jun-03	01-Sep-12		Developed Producing
WR678	St. Malo	Lower Tertiary	6,951	13-Oct-03	01-Dec-14		Developed Producing
AC818	Tiger	Lower Tertiary	9,004	28-Feb-04		01-Oct-08	Contingent Resource
AC859	Tobago/Silvertip	Lower Tertiary	9,436	17-Apr-04	01-Dec-10		Developed Producing
WR759	Jack	Lower Tertiary	6,963	09-Jul-04	01-Dec-14		Developed Producing
WR block 724	Das Bump	Lower Tertiary	7,591	04-Sep-04		01-Sep-06	Contingent Resources
WR508	Stones	Lower Tertiary	8,988	10-Mar-05			Reserves Justified for Development
AC block 739	Diamondback	Lower Tertiary	6,857	18-Apr-05		01-Oct-05	Contingent Resources
KC292	Kaskida	Lower Tertiary	5,798	22-May-06			Contingent Resources
WR block 544	Tucker	Lower Tertiary	6,844	28-Jun-06		01-Jan-07	Contingent Resources
WR627	Julia	Lower Tertiary	7,121	07-Apr-07			Reserves Justified for Development
WR848	Hal	Lower Tertiary	7,657	15-Jan-08		01-Aug-08	Contingent Resources
KC block 872	Buckskin	Lower Tertiary	6,921	25-Nov-08			Contingent Resources
KC block 102	Tiber	Lower Tertiary	4,132	15-Aug-09			Contingent Resources
KC736	Moccasin	Lower Tertiary	6,591	04-Aug-11			Contingent Resources
KC785	Buckskin	Lower Tertiary	6,749	13-Sep-11			Contingent Resources
WR969	Logan	Lower Tertiary	7,532	20-Sep-11			Contingent Resources
GB block 959	North Platte	Lower Tertiary	4,434	01-Nov-12			Contingent Resources
WR block 098	Coronado	Lower Tertiary	5,856	27-Jan-13		01-Nov-14	Contingent Resources
WR051	Shenandoah	Lower Tertiary	5,841	29-Jan-13			Contingent Resources
SE039	Phobos	Lower Tertiary	8,553	09-Apr-13			Contingent Resources
GC block 807	Anchor	Lower Tertiary	5,207	28-Nov-14			Contingent Resources

Department of the Interior (DOI)

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 communities.

Bureau of Ocean Energy Management (BOEM)

The Bureau of Ocean Energy Management works to manage the exploration and development of the Nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development, and environmental reviews and studies.