

Resource Evaluation Report

Geological & Geophysical Data Acquisition

Outer Continental Shelf
Through 2016

By Kumkum Ray
And Paul Godfriaux

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Abbreviations

AVO	Amplitude Variation with Offset data
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CDP	Common Depth Point Seismic Data
CFR	Code of Federal Regulations
COST	Continental Offshore Stratigraphic Test
CSEM	Controlled Source Electromagnetic survey
DOI	Department of the Interior
DST	Deep Stratigraphic Test (well)
FY	Fiscal Year
G&G	Geological and Geophysical
GOM	Gulf of Mexico
GRAV	Gravity Data
HRD	High-Resolution seismic Data
MAG	Magnetic Data
MMS	Minerals Management Service
OBS	Ocean Bottom Seismometers
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
RE	Resource Evaluation
REP	Resource Evaluation Program
SEG	Society of Exploration Geophysicists
4-C	Four Component Seismic Data
2-D	Two-Dimensional Seismic Data
3-D	Three-Dimensional Seismic Data
4-D	Four-Dimensional Seismic Data

Introduction

This report addresses the general role of the Bureau of Ocean Energy Management's (BOEM) Resource Evaluation Program (REP) in geological and geophysical (G&G) data acquisition and permitting activities.

With regard to the REP, BOEM's regulations at 30 CFR Part 551 govern the process for prelease G&G exploration for oil, gas, and sulphur resources on the OCS. Part 551 applies not only to G&G exploration but to scientific research as well. The purpose of these regulations is to prescribe (1) when a permit or the filing of a notice is required to conduct G&G activities on the OCS and (2) operating procedures for conducting exploration, as well as requirements for disclosing data and information, conditions for reimbursing permittees for certain costs, and other conditions under which exploration shall be conducted. Similar regulations addressing prelease prospecting activities for minerals other than oil, gas, or sulphur can be found in 30 CFR Part 580.

In this report, the totals for permits issued, mileage acquired, and expenditures may have been influenced by overall trends of oil and gas prices, access limitation for OCS acreage due to legislative and presidential moratoria, and the shift of industry investment to international opportunities.

Permits, Data Acquisition, and Reimbursement

BOEM administers certain provisions of the Outer Continental Shelf Lands Act (OCSLA) through regulations found at Title 30 of the Code of Federal Regulations (CFR). BOEM's regulations govern oil and gas permitting, data acquisition and release, leasing, and post-lease operations on the Outer Continental Shelf (OCS).

The OCS is divided into planning areas for administrative purposes, as shown in Figure 1.

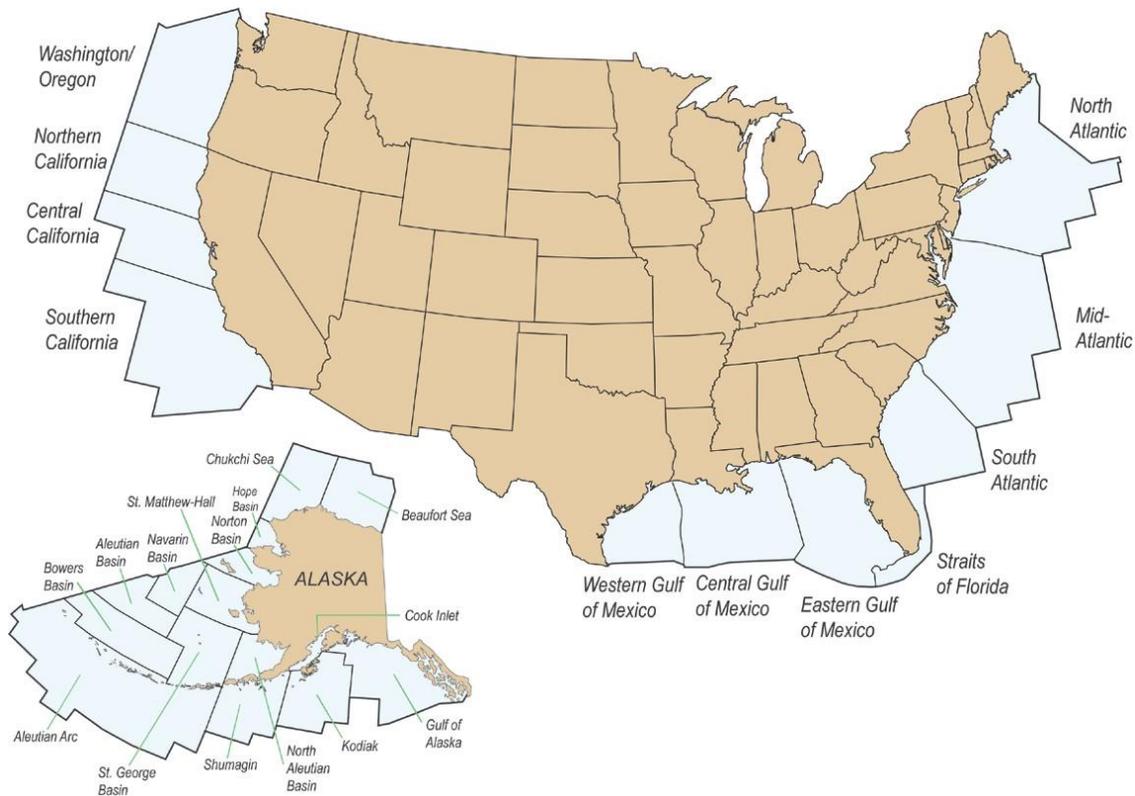


Figure 1: Outer Continental Shelf Planning Areas

G&G permits, issued by the Resource Evaluation (RE) Regional supervisors, set forth the specific requirements for each data-gathering activity, including the area where the data are collected, the timing of the activity, approved equipment and methods, environmental mitigations, and other relevant information. BOEM issues permits to industry to allow collection of prelease G&G data and approves the collection of post-lease G&G data to inform industry-submitted Exploration and/or Development Plans.

BOEM does not perform direct G&G seismic data acquisition activities. However, BOEM may obtain G&G data from lessees and permittees. By regulation BOEM has access to certain permitted seismic data and information (such as processed, analyzed or interpreted data) as soon as the data become available and lessees and operators are required, upon request, to provide BOEM with data collected on their leases. Data acquired via G&G permits constitute approximately 90 percent of the BOEM seismic database. For OCS data collected in the normal course of business, OCS permittees and lessees are only reimbursed for the cost of data reproduction. However, if industry has collected data in areas not under BOEM jurisdiction, e.g., State waters or adjacent foreign waters, and BOEM requests said data, BOEM pays the significantly higher “market price” for obtaining it.

Geophysical Data Surveys

Common Depth Point, 3-D, 4-D, 4-C, AVO, Gravity, and Magnetic Surveys

The two-dimensional (2-D) geophysical data in the BOEM inventory is common depth point (CDP) seismic information collected along a survey line. Also known as common midpoint or common reflection point data, it is derived from a common location in the ocean subbottom where sound waves originating from various positions of the seismic (sound) source near the ocean surface are reflected back toward the surface. Estimates of the amount of these data in the BOEM inventory by planning area are shown in Table 1.

While in the past a majority of data was collected in 2-D, currently a vast majority of geophysical data and information in the BOEM inventory is three-dimensional (3-D) seismic information; this is especially true in the GOM OCS. By collecting data along parallel, closely spaced survey lines, spatial relationships are determined in three dimensions.

A specialized processing technique that can be used with both 2-D and 3-D seismic data is Amplitude Variation with Offset (AVO). It involves the variation in amplitude of a seismic reflection with the angle of incidence or source-geophone distance and is processed using the raw data gathered. It can be used as a direct hydrocarbon gas indicator.

Another type of data acquisition is 2-D or 3-D four component (4-C) surveys, which involve the recording of marine seismic data with ocean bottom seismometers (OBS) on the sea floor, where each OBS consists of a hydrophone recording pressure changes of passing P-waves and three orthogonal geophones recording movement in three components of direction (x, y, and z axes) of passing shear waves (s-waves). Three dimensional 4-C is a recording of multiple parallel lines of seismometers achieved by recording seismic waves from each line simultaneously or in sequence by recording a line of geophones, moving the line a short distance and parallel to the previous line, etc.

Magnetic surveys measure the magnetic field or a component (such as the vertical component) at a series of different locations over an area of interest usually to locate

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

Controlled Source Electromagnetic (CSEM) surveys are being conducted in areas of the GOM. Although not a new technology, it is new for the deeper water provinces. It can be used with seismic data to generate direct recognition of hydrocarbon fluid resistivity in potential subsurface reservoirs.

The evolution of 3-D seismic data and information in conjunction with interactive computer workstations has made it possible to more closely define and assess the potential for oil and gas occurrence on the OCS, especially with regard to subsalt prospects. The 3-D information is used to delineate, in greater detail than that of traditional 2-D information, subsurface geologic conditions associated with the occurrence of oil and gas.

As 3-D seismic technology evolved, the use of 3-D reflection techniques not only portrayed subsurface structure and stratigraphy, but revealed information about fluids within the subsurface. Three dimensional seismic surveys that are shot over the same area at different times can detect, where present, changes from one fluid to another, e.g., oil to water, fluid flows, and pressure changes.

Thus, time-lapse 3-D seismic surveys, known more commonly as 4-D seismic surveys, have been used to monitor fluid movement in producing reservoirs where changes in fluid content are imaged with seismic techniques over a period of time. Its chief use to date has been reservoir management, e.g., determining where and how long to drain hydrocarbon-bearing areas and to monitor gas injection or steam or water flooding during enhanced recovery operations.

Geological Data Collection

Bottom Sampling and Shallow Coring

Bottom samples are obtained by dropping a weighted tube to the ocean floor and recovering it with an attached wire line. They can also be obtained from dredging. Shallow coring (no deeper than 500 ft.) is performed by conventional rotary drilling equipment to obtain a near-surface sample of the rocks of the seabed.

Deep Stratigraphic Tests

A deep stratigraphic test, as defined in 30 CFR 551.1, means, “drilling that involves the penetration into the sea bottom of more than 500 feet (152 meters).” These wells are known as Continental Offshore Stratigraphic Test (COST) wells and are drilled primarily to gather geological information. Conversely, shallow test drilling, as defined in the same regulations, means, “drilling into the sea bottom to depths less than those specified in the definition of a

deep stratigraphic test.” Three COST wells have encountered hydrocarbons: the COST B-3 (Atlantic), Point Conception No.1 (California), and the Norton COST No. 2 (Alaska). A discussion of the deep stratigraphic test program is described by Dellagiarino (1991) in OCS Report # MMS-90-0028.

G&G Data Release

Regulations at 30 CFR § 551.14(b)(1) and § 550.197 provide the release times of proprietary G&G data and information. Prelease geophysical information will not be released to the public for 25 years; raw geophysical data is held for 50 years before it is released to the public. The proprietary term for geological information is 10 years. The first geophysical data sets were released in 2001, which included data sets from southern Alaska, the Arctic, the Bering Sea, Southern California through Washington/ Oregon, the North, Mid, and South Atlantic planning areas, and in Eastern, Central, and Western GOM areas. The proprietary term for a COST well is 25 years or, if a lease sale is held in the area, 60 days after the issuance of a lease within 50 geographic miles of the test. The actual data may be searched for and downloaded at the National Archive of Marine Seismic Surveys (NAMSS) <https://walrus.wr.usgs.gov/NAMSS/>. Also additional information can be found at the BOEM regional homepage at <http://www.boem.gov/BOEM-Regions/>.

Analysis of Present BOEM Data Coverage on the OCS

Mileage/Blocks

A leading indicator of the amount of OCS oil and gas activity is the number and associated mileage of prelease exploration permits that BOEM issues to industry each year. Table 1 shows the 2-D seismic data coverage, by region and planning area that BOEM has in its inventory. The grid coverage is not uniform over the planning areas. Tables 2, 3, and 4 summarize BOEM data acquisitions through 2016. It should be noted that 3-D seismic information, which is reported as coverage of OCS blocks, in the BOEM inventory is comparable to the 2-D holdings in that 308,000 blocks of 3-D information compares favorably to about 3.1 million line miles of conventional 2-D seismic information.

BOEM has not acquired all of the permit data shot and recorded by industry primarily because of the data quality or the redundancy of data shot on the OCS by different companies. Since the early 1990s, BOEM, as well as industry, have increased its acquisition of 3-D seismic data in concert with the development and use of interactive workstations. In some areas in which BOEM has previously obtained 2-D or 3-D seismic information, it continues to acquire new information that is derived from state-of-the-art acquisition methods and equipment or from previously acquired data that are reprocessed using more modern techniques.

BOEM’s OCS Regions (GOM, Pacific, Alaska and Atlantic) formerly spent funds on pre-lease high-resolution data (HRD), as these data were acquired under exclusive contract rather

than under permit. A change in policy in 1982 altered this situation. Under the previous program, BOEM directly acquired pre-lease, tract-specific, shallow hazards data. Under the area wide leasing program, the detailed shallow hazards analysis function was shifted to the post sale phase, and the responsibility for site-specific hazards data collection was placed on the lessee as a condition to obtain an approved Exploration or Development Production Plan from BOEM and a drilling permit through the Bureau of Safety and Environmental Enforcement (BSEE). If industry continues to conduct prelease hazards surveys, G&G permits must be obtained from BOEM. Shallow hazards survey data and information are available to BOEM and BSEE under terms of permit or lease and regulations.

Geological and/or Geophysical Exploration Permits

Another important indicator of OCS oil and gas activity is the number of permits issued and the areas for which the permits are issued. On average, BOEM has issued approximately 220 permits per year. The greatest number for one year was 574 in 1983.

Table 5 presents the statistics of G&G exploration permitting for the OCS since 1960, with a differentiation between geological permits and geophysical permits from 1969 to 2016.

BOEM tracks G&G permits by calendar year. (Tables A-2, A-6, A-10, and A-14 show total permits per Region.) They demonstrate that most OCS oil and gas activity has been in the GOM. The GOM has issued 83 percent of all permits and is followed by the Alaska Region with 8 percent. The Pacific Region has issued 6 percent of the permits, followed by the Atlantic Region with about 2 percent.

It should be noted that since 1969, approximately 94 percent of the permits issued were for geophysical exploration and that geological exploration permits accounted for only 5 percent. While the total number of 3-D permits compared to all permits issued is rather small (11 percent) when compared with the total geophysical permits issued, over the past 10 years, 185 3-D permits have averaged 32 percent of geophysical permits during that period. Permits for deep stratigraphic test wells or COST wells make up about 5 percent of all geological permits.

Permitting for all Regions has declined since the number of permits peaked in 1983. Some regional differences can be detected that are related to leasing moratoria, operating conditions such as hurricanes/arctic ice, and the discovery of new hydrocarbon plays.

Expenditures

BOEM records financial and procurement transactions by fiscal year (FY). All figures and tables involving the BOEM data acquisition from permittees are based on a fiscal year that begins on October 1 and extends through the following September 30.

Tables 6 and 7 show the total expenditures for G&G data since 1968 for those data presented in Table 4. Tables 6 and 7 show the distribution of G&G expenditures by Region. The GOM and Alaska have the largest portion of the expenditures with 41 and 36 percent

respectively. Alaska has over twice the offshore area of the other three Regions combined. On the other hand, the GOM, with over 95 percent of OCS production, possesses the largest database.

The Atlantic Region (13 percent of the expenditures) and the Pacific (9 percent) are comparable. The Pacific Region has the smallest slice of the expenditures for G&G data because much of the California OCS and offshore Washington and Oregon have been under moratoria since the 1980s. The moratoria expired on September 30, 2008. The main difference between the Atlantic and Pacific Regions, according to Table 7, is the acquisition of high-resolution data in the Atlantic.

The GOM Region's dominant role in establishing the offshore industry is apparent by its acquisition of the majority of the data before 1976 and closer to 100 percent since 1990. Between 1976 and 1989, a significant portion of BOEM's G&G data acquisition budget has been expended by the Alaska Region. However, since the 1990s and up through the present as the level of activity dropped in Alaska, most of the BOEM G&G data acquisition budget has been allocated for data in the GOM.

The average cost per mile for data was high in the Alaska Region from the late 1970s into the 1990s and for the Atlantic Region in the 1980s. The Alaska Region purchased a large amount of data collected in State waters (1979 to 1990), and BOEM was required to pay full market price for this non-OCS dataset. The price varied from \$1,500 to \$6,000 per mile and is reflected in the unusually high average cost per mile shown in Table 8.

Overall, the early to mid-1980s saw a dramatic increase in expenditures by MMS, a predecessor agency to BOEM, as more reprocessed data were acquired to address area wide leasing and a more aggressive proposed Five-Year OCS leasing schedule. However, due to regulatory changes in reimbursement procedures in 1986, the cost per mile has dropped dramatically. With a moderated Five-Year Leasing Schedule and new exploration theatres worldwide, total expenditures have steadily decreased from the 1980s to the present.

Comparisons to Industry

While BOEM does not acquire all industry data, it does acquire a vast majority of it. For example, BOEM has acquired approximately 90 percent of the data collected by industry on the Alaska OCS. Alaska remains a large frontier area with limited data coverage by industry, a fact that necessitates BOEM to acquire as much of these data as feasible. In recent years, while BOEM has acquired the data from most 3-D surveys and most large 2-D surveys shot in the GOMR, it has not needed to acquire the volume that industry obtains to reprocess. This is partly due to industry frequently reprocessing portions of the seismic surveys, particularly around their prospective targets.

MMS acquired more data in the Atlantic Region than industry in 1976 and 1983. Before 1976, MMS limited its acquisition of new data because industry had shown very little interest in leasing this frontier area. During the period 1976 to 1984, MMS not only acquired most of

the industry data, but purchased much of the pre-1976 data.

In 2014 there was a resurgence of G&G oil and gas permit applications in the Atlantic OCS (see <https://www.boem.gov/Currently-submitted-Atlantic-OCS-Region-Permits/>). This was likely due to the release of the Atlantic G&G Activities Programmatic Environmental Impact Statement (PEIS) in 2014, and a proposed Atlantic lease sale in 2021 under the 2017-2022 Draft Proposed Five Year Program. In July 2015, BOEM approved a permit application (E14-008 to ARKeX Limited) to conduct a multi-client Airborne Gravity Gradient and Magnetic operations on the Atlantic OCS. This permit has since expired. As of July 2016, BOEM has approved a permit application (E15-002 to NEOS Geosolutions Inc.) for CGG to conduct a multi-client Airborne Gravity Gradient and Magnetic operation on behalf of NEOS Geosolutions, in the U.S. Atlantic OCS. The only other approved permits in the Atlantic are shallow hazard surveys conducted for marine minerals projects.

In conclusion, totals for mileage acquired, permits issued, and expenditures can be influenced by trends of oil and gas prices, access limitation for OCS acreage due to legislative and presidential moratoria, and the shift of industry investment to international opportunities.

FY 2015 Updates

- **Shell Pulls out of Chukchi Sea:** In September 2015, Shell abandoned its Alaska Arctic drilling. Shell said it made a marginal discovery of oil and gas with its summer exploration in the Chukchi Sea but not enough to continue searching in the foreseeable future.
- **AVO Data:** In the Gulf of Mexico, new AVO data is being purchased at the request of the Resource Evaluation's Geological and Geophysical (G&G) Section in the GOM to assist with prospect and fair market evaluations. Purchasing entire AVO surveys is more practical from a data storage and organizational perspective than purchasing data over specific lease blocks.
- **G&G Data Reimbursement Rate Drop:** BSEE's Acquisition Operations conducted a market survey in December 2015 to establish current industry pricing. Industry responses to the survey and an analysis of occupational categories and associated labor rates indicated that the \$20.48/gigabyte rate was no longer a fair reimbursement rate for G&G data. BSEE has recommended a new reimbursement rate of \$2/gigabyte for all G&G data.

FY 2016 Updates

- **2017-2022 Five-Year Plan:** The Proposed Final Program was published on November 18, 2016 and was approved by the Secretary of the Interior on January 17, 2017. It includes ten Area-wide GOM sales and one sale in the Cook Inlet Program Area offshore Alaska. No lease sales are scheduled for the Pacific or Atlantic OCS.
- **Draft Programmatic Environmental Impact Statement (PEIS):** On September 30, 2016, BOEM published a draft PEIS to evaluate potential environmental effects of multiple Geological and Geophysical (G&G) activities on the Gulf of Mexico OCS. These activities include, but are not limited to, seismic surveys, side scan sonar surveys, electromagnetic surveys, and geological and geochemical sampling. The Draft PEIS considers G&G activities for the three program areas managed by BOEM: Oil and gas exploration and development; renewable energy; and marine minerals.
- **Delmarva Project:** Resource Evaluation G&G funds, in the amount of \$ 310,000 were applied to a Delaware Geological Survey co-operative agreement managed by BOEM's Marine Minerals Branch, for additional collection of cores and possibly geophysical data in the Mid-Atlantic.
- **President Obama Withdraws Portions of OCS:** On December 21, 2016, the President announced his withdrawal, under the Outer Continental Shelf Lands Act section 12(a), of the entire Chukchi Sea Planning Area, portions of the Beaufort Planning Area, and 31 discrete canyons in the Atlantic OCS from oil and gas leasing consideration. These withdrawal areas encompass 3.8 million acres in the north and mid-Atlantic Ocean off the East Coast and 115 million acres in the Arctic Ocean. Including previous presidential withdrawals, this action restricts nearly 125 million acres in the offshore Arctic from future oil and gas activity.
- **BOEM Denies Atlantic Seismic G&G Permits -** On January 6, 2017, BOEM announced the denial of six pending geophysical and geological (G&G) permit applications to conduct airgun seismic surveys in the Mid- and South Atlantic Planning Areas of the Atlantic Ocean.

Table 1. Summary of Estimates of CDP (2-D) Seismic Miles in the BOEM Inventory Through FY 2016 by Planning Area (Rounded off to Nearest 1,000 Miles)

Planning Area	Estimated Mileage
Alaska	
Gulf of Alaska	36,000
Cook Inlet	21,000
Kodiak	23,000
Shumagin	10,000
North Aleutian	43,000
St. George Basin	50,000
Aleutian Arc	< 500
Bowers Basin	<1,000
Aleutian Basin	<1,000
St. Matthew-Hall	10,000
Norton Basin	25,000
Navarin Basin	55,000
Hope Basin	9,000
Chukchi Sea	115,000
Beaufort Sea	<u>77,000</u>
Total	477,000
Atlantic	
North Atlantic	93,000
Mid-Atlantic	60,000
South Atlantic	54,000
Straits of Florida	<u>7,000</u>
Total	214,000
Gulf of Mexico	
Eastern GOM	231,000
Central GOM	1,508,000
Western GOM	<u>560,000</u>
Total	2,299,000
Pacific	
Southern California	85,000
Central California	21,000
Northern California	19,000
Wash./Oregon	<u>8,000</u>
Total	133,000

Figures may vary by 1-2%

Table 2. Summary of 2-D Seismic Data Acquisition for FY 1968-2016

FY	Total Miles
1968-1975	269,814
1976	108,922
1977	42,808
1978	54,426
1979	31,489
1980	19,400
1981	69,904
1982	79,961
1983	120,743
1984	89,853
1985	71,521
1986	47,287
1987	113,680
1988	78,920
1989	53,494
1990	85,280
1991	40,513
1992	49,191
1993	25,482
1994	7,138
1995	8,930
1996	33,296
1997	39,682
1998	90,981
1999	30,135
2000	64,710
2001	6,668
2002	1,506
2003	48,154
2004	101,282
2005	48,829
2006	170,379
2007	108,080
2008	2,953
2009	35,130
2010	195,487
2011	135,884
2012	46,923
2013	46,694
2014	248
2015	147,555
2016	299,028
Total	3,122,360

Figures may vary by 1-2%.

Table 3. Summary of 3-D Seismic Data Acquisition for FY 1968-2016

FY	Total Blocks
1968-1992	0
1993	1,563
1994	1,420
1995	1,826
1996	1,470
1997	3,129
1998	3,460
1999	3,226
2000	6,161
2001	3,602
2002	7,182
2003	6,272
2004	6,193
2005	4,996
2006	6,495
2007	11,855
2008	22,606
2009	27,547
2010	23,137
2011	9,259
2012	37,092
2013	34,132
2014	21,294
2015	33,427
2016	30,764
Total	308,108

Figures may vary by 1-2%.

Table 4. Summary of Geological and Geophysical Data Acquisition by Data Type and Region, FY 1968-2016

Data Type	Region	Mileage*
2-D Seismic	Alaska	476,608
	Atlantic	213,936
	Gulf of Mexico	2,298,975
	Pacific	<u>132,841</u>
	Total	3,122,360
High Resolution	Alaska	59,855
	Atlantic	49,509
	Gulf of Mexico	145,768
	Pacific	<u>30,582</u>
	Total	285,714
CDP Interpretations	Alaska	84,683
	Atlantic	44,801
	Gulf of Mexico	139,418
	Pacific	<u>42,365</u>
	Total	311,267
Gravity and Magnetics	Alaska	372,764
	Atlantic	15,783
	Gulf of Mexico	672,588
	Pacific	<u>110,150</u>
	Total	1,171,285
3-D Seismic	Alaska	853
	Atlantic	0
	Gulf of Mexico	307,203
	Pacific	<u>52</u>
	Total	308,108
3-D/4-C	Alaska	0
	Atlantic	0
	Gulf of Mexico	37
	Pacific	<u>0</u>
	Total	37
AVO	Alaska	81
	Atlantic	0
	Gulf of Mexico	15,798
	Pacific	<u>0</u>
	Total	15,879
Deep Stratigraphic Tests	Alaska	14
	Atlantic	5
	Gulf of Mexico	6
	Pacific	<u>2</u>
	Total	27

*3-D seismic, 3-D/4-C data, and AVO are measured in blocks and Deep Stratigraphic Test units are wells drilled.

Figures may vary 1-2%.

Table 5. Total Number of Permits Issued for Geological and Geophysical Exploration

Year	A	B	C	D	E	F	G
1960-1968	2,353	---	---	---	---	---	---
1969	258	249	9	0	0	0	0
1970	213	203	10	0	0	0	0
1971	210	205	5	0	0	0	0
1972	220	210	10	0	0	0	0
1973	339	321	18	0	0	0	0
1974	357	345	12	2	0	0	0
1975	510	487	23	3	0	0	0
1976	420	400	20	7	0	0	0
1977	452	436	16	4	0	0	0
1978	342	329	13	2	0	0	0
1979	276	265	11	0	0	0	0
1980	318	302	16	1	0	0	0
1981	394	383	11	0	0	0	0
1982	502	490	12	3	0	0	0
1983	574	542	32	1	16	0	0
1984	543	518	25	0	18	0	0
1985	398	382	16	0	38	0	0
1986	211	207	4	0	32	0	0
1987	298	282	16	0	42	0	0
1988	313	289	24	0	45	0	0
1989	249	237	12	1	47	0	0
1990	251	241	9	0	57	1	0
1991	170	156	12	0	45	2	0
1992	141	137	3	0	53	1	0
1993	147	135	11	0	70	1	0
1994	133	117	16	0	53	0	0
1995	104	92	11	0	50	1	0
1996	136	120	16	0	59	0	0
1997	159	139	20	0	69	0	1
1998	157	143	14	0	59	0	1
1999	111	98	13	0	44	0	0
2000	80	73	5	0	32	2	0
2001	110	103	7	0	33	0	0
2002	80	75	5	0	20	0	3
2003	107	100	3	0	29	4	2
2004	103	91	10	0	21	2	0
2005	101	93	6	0	25	2	0
2006	86	81	2	0	24	3	0
2007	95	92	2	0	32	1	0
2008	112	104	1	2	23	7	0
2009	80	64	8	0	9	8	1
2010	55	46	4	0	8	5	1
2011	42	33	3	0	19	6	0
2012	44	38	2	0	20	4	4
2013	47	40	2	0	15	5	4
2014	68	65	3	0	22	0	3
2015	74	67	6	0	15	0	0
2016	23	22	1	0	22	1	0
Total	12,566	9,647	510	26	1,166	56	20

Dashed lines = Individual breakouts not established

A=Total Number of Geological, Geophysical, and Strategic Minerals Permits Issued

B=Number of Geophysical Permits Issued

C=Number of Geological Permits Issued

D=Number of Geological Permits Issued for Deep Stratigraphic Tests

E=Number of Geophysical Permits Issued for 3-D Seismic Data

F=Number of Permits Issued for Strategic (Nonenergy) Minerals

G=Number of Permits Issued for 4-D Seismic Data

Figures may vary 1-2%.

Table 6. Summary of Total Annual Expenditures by BOEM for Geological and Geophysical Data Acquisition Only by Region, FY 1968-2016 (in dollars)

FY	Alaska	Atlantic	Gulf of Mexico	Pacific	Total
1968-1975	3,162,548	361,686	9,414,042	1,443,987	14,891,780*
1976	3,496,607	2,504,710	3,281,698	581,670	9,914,882*
1977	450,161	2,287,390	3,764,678	1,147,968	7,719,974*
1978	3,421,269	906,989	1,842,701	416,463	6,587,422
1979	6,240,687	232,085	1,573,094	2,272,407	11,020,298*
1980	6,972,885	4,469,762	4,388,508	1,412,062	17,243,217
1981	6,842,045	1,530,898	1,168,618	866,656	10,408,217
1982	1,864,661	1,945,270	2,943,602	1,996,271	8,749,804
1983	5,673,514	1,738,427	3,802,409	1,312,596	12,526,946
1984	4,751,354	1,580,008	4,246,742	1,286,598	11,864,702
1985	3,676,375	318,261	2,959,989	861,687	7,816,312
1986	2,904,246	87,307	1,834,553	363,564	5,189,670
1987	2,579,190	438,792	1,840,609	939,558	5,798,149
1988	1,382,560	71,510	1,078,713	114,168	2,646,951
1989	389,960	259,629	913,481	96,354	1,659,424
1990	886,402	150	865,083	0	1,751,635
1991	539,986	2,790	1,003,066	31,000	1,576,842
1992	99,797	1,932	794,104	0	1,490,798**
1993	322,410	0	1,014,853	26,700	1,363,963
1994	582,132	0	760,245	11,806	1,454,183**
1995	379,395	0	628,752	21,125	1,142,817**
1996	283,764	0	1,697,494	40,867	2,022,125
1997	204,655	0	1,180,893	19,594	1,471,967**
1998	278,606	0	1,804,694	10,264	2,094,400**
1999	543,775	0	1,400,781	13,350	1,957,906
2000	354,448	0	2,053,285	7,148	2,414,881***
2001	67,324	0	1,283,496	0	1,350,820***
2002	762,911	0	944,923	0	1,707,834**
2003	0	1,080,000	445,868	0	1,525,868
2004	0	250,000	739,561	0	989,561
2005	22,000	168,000	507,379	0	697,379
2006	53,826	0	310,403	0	364,229
2007	198,555	0	584,400	0	782,955
2008	44,645	246,500	935,163	0	1,226,308
2009	392	0	950,002	0	950,394
2010	31,154	0	357,260	0	388,414
2011	65	0	170,430	0	170,495
2012	0	0	555,004	0	555,004
2013	0	0	358,790	0	358,790
2014	0	0	682,929	0	682,929
2015	1,574	0	436,676	17,600	455,850
2016	23,310	310,000	56,485	89,500	479,295
Total	59,489,188	20,792,096	67,575,456	15,400,963	165,465,390

* Included in the budget for these years were General Account funds that were transferred to the U.S. Geological Survey, Branch of Marine Geology, for G&G data acquisition. These accounts included \$509,517 in the interval between FY 1968-1975, \$50,197 in FY 1976, \$69,777 in FY 1977, and \$702,025 in FY 1979.

**Included in the budget for these years were funds that were used for special projects related to G&G activities. In FY 1992, \$494,965 was obligated toward the purchase of geologic interpretive workstations and \$100,000 was obligated toward the initiation of the Offshore Northern Gulf of Mexico Oil and Gas Atlas Series. In FY 1994, \$100,000 was again obligated toward the preparation of the Offshore Northern Gulf of Mexico Oil and Gas Atlas and in FY 1995, \$100,000 was obligated toward the completion of the Atlas, and \$13,545 was obligated toward finalization of a well log data conversion contract in the Gulf of Mexico. In FY 1997, \$5,000 was obligated towards the curation of Atlantic well samples. In FY 1998, \$836 was obligated toward updating the MMS AAPG CD-ROM investment. In FY2002, funds were obligated towards a T-3 Data Access Line, Gravity/Magnetics Interpretations; JIP hydrates participation, and the Earth Model Project.

***Includes \$353,111 carried over by the Gulf of Mexico from 1999 and \$228,496 carried over from 2000.

Figures are rounded and may vary by 1-2%

Table 7. Summary of Geological and Geophysical Data Acquisition Expenditures by Data Type and Region, FY 1968-2016

Data Type	Region	Expenditures (\$)*
Alaska		
2-D Seismic		40,949,737
High Resolution		11,125,798
CDP Interpretations		439,793
Gravity and Magnetics		1,027,108
3-D Seismic		1,511,327
3-D/4-C		0
AVO		28,048
Total		55,081,811
Atlantic		
2-D Seismic		9,027,538
High Resolution		9,751,232
CDP Interpretations		55,274
Gravity and Magnetics		2,902
3-D Seismic		0
3-D/4-C		0
AVO		0
Total		18,836,946
Gulf of Mexico		
2-D Seismic		32,274,621
High Resolution		12,729,139
CDP Interpretations		856,526
Gravity and Magnetics		774,483
3-D Seismic		12,967,601
3-D/4-C		2,787
AVO		273,451
Total		59,878,608
Pacific		
2-D Seismic		9,553,194
High Resolution		3,696,394
CDP Interpretations		72,175
Gravity and Magnetics		534,363
3-D Seismic		27,925
3-D/4-C		0
AVO		0
Total		13,884,051

*BOEM has had additional expenditures through its G&G data acquisition budget for other general purchases such as field tapes, special processing, navigation tapes, interpretive hardware and software for evaluation purposes, and geological studies, scanning, and acquisition of digital tapes of in-house analog data.

Figures may vary 1-2%.

Table 8. Summary of Average Cost Per Mile by BOEM for 2-D Seismic Data, FY 1968-2016

FY	Average Cost (\$/Mile)
1968-1975	33.60
1976	34.90
1977	30.00
1978	73.60
1979	99.70
1980	91.50
1981	100.70
1982	107.00
1983	102.50
1984	121.10
1985	105.90
1986	102.00
1987	48.30
1988	32.70
1989	26.10
1990	18.00
1991	19.86
1992	7.49
1993	13.33
1994	75.84
1995	22.02
1996	39.04
1997	5.45
1998	3.18
1999	1.40
2000	1.29
2001	68.61/1.34*
2002	2.11*
2003	470.81/0.99*
2004	1.83
2005	0.21
2006	0.17
2007	0.12
2008	161.09/0.49
2009	6.19
2010	0.08
2011	0.11
2012	0.06
2013	0.15
2014	1.21
2015	0.05
2016	0.02

The \$68.61 total includes the cost for data in Cuban waters at the market price. The average cost per line mile for data in Federal waters is \$1.34. Likewise, \$470.81 represents the market costs to acquire offshore Canadian data and the average cost per line mile for data in Federal waters is \$3.79 as is the \$161.09 and \$0.49. The \$2.11 total includes velocity models for depth data.

Figures may vary 1-2%

Note: Summaries reflect average cost per mile for all CDP Information acquired both State and Federal. Average costs reflect only those dollars assigned to the bureauwide G&G budget and do not reflect monies allocated from Regional funds.

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Table A-1. Summary of Geological and Geophysical Data Acquisition by FY for Alaska

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	AVO	DST
1968-1975	70,306	5,500	32,819	55,710	0	0	1
1976	37,785	19,163	30,164	0	0	0	4
1977	11,952	5,606	21,700	23,470	0	0	4
1978	28,524	0	0	36,625	0	0	0
1979	8,538	5,412	0	25,465	0	0	0
1980	10,109	7,703	0	0	0	0	1
1981	35,430	4,590	0	14,969	0	0	0
1982	16,624	0	0	0	0	0	2
1983	51,903	0	0	0	0	0	2
1984	30,961	7,904	0	5,850	0	0	0
1985	30,270	0	0	0	0	0	0
1986	21,603	1,600	0	0	0	0	0
1987	49,532	470	0	80,826	0	0	0
1988	14,963	1,741	0	0	0	0	0
1989	3,136	166	0	9,543	0	0	0
1990	8,557	0	0	11,046	0	0	0
1991	3,964	0	0	1,500	0	0	0
1992	0	0	0	0	0	0	0
1993	1,893	0	0	0	0	0	0
1994	2,422	0	0	102,845	0	0	0
1995	737	0	0	3,000	0	0	0
1996	315	0	0	0	0	0	0
1997	382	0	0	0	3*	0	0
1998	273	0	0	0	0	0	0
1999	0	0	0	0	7*	0	0
2000	0	0	0	0	12*	0	0
2001	0	0	0	0	0	0	0
2002	0	0	0	0	11*	0	0
2003	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	32,281	0	0	1,915	204	0	0
2008	0	0	0	0	54	0	0
2009	0	0	0	0	20	0	0
2010	0	0	0	0	315	66*	0
2011	486	0	0	0	227	15*	0
2012	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0
2015	3,662	0	0	0	0	0	0
2016	0	0	0	0	0	0	0
Total	476,608	59,855	84,683	372,764	853*	81*	14

*Acquisition for 3-D seismic and AVO data are measured in blocks; all other acquisitions in this table are measured in miles. The DST dates are assigned based upon completion dates and are measured in terms of wells completed. All other data are measured in terms of miles.

Table A-2. Number of Permits Issued for Geological and Geophysical Exploration in Alaska

Year	A	B	C	D	E	F
1960-1968	75	---	---	---	---	---
1969	31	28	3	0	0	0
1970	40	36	4	0	0	0
1971	27	26	1	0	0	0
1972	17	17	0	0	0	0
1973	33	32	1	0	0	0
1974	47	44	3	0	0	0
1975	82	74	8	1	0	0
1976	69	61	8	4	0	0
1977	33	29	4	4	0	0
1978	9	8	1	0	0	0
1979	32	30	2	0	0	0
1980	41	36	5	1	0	0
1981	54	49	5	0	0	0
1982	85	79	6	3	0	0
1983	103	80	23	1	0	0
1984	70	62	8	0	0	0
1985	63	56	7	0	0	0
1986	18	17	1	0	0	0
1987	18	14	4	0	0	0
1988	13	9	4	0	0	0
1989	17	14	3	0	0	0
1990	19	15	3	0	0	1
1991	7	4	1	0	0	2
1992	7	6	0	0	0	1
1993	11	10	0	0	2	1
1994	3	3	0	0	1	0
1995	1	1	0	0	1	0
1996	6	6	0	0	5	0
1997	5	4	1	0	0	0
1998	2	2	0	0	2	0
1999	2	2	0	0	2	0
2000	1	1	0	0	1	0
2001	0	0	0	0	0	0
2002	1	1	0	0	0	0
2003	1	1	0	0	0	0
2004	1	1	0	0	1	0
2005	1	1	0	0	1	0
2006	4	4	0	0	3	0
2007	5	4	1	0	3	0
2008	4	4	0	0	4	0
2009	1	1	0	0	1	0
2010	2	2	0	0	1	0
2011	0	0	0	0	0	0
2012	2	1	0	0	0	1
2013	1	1	0	0	0	0
2014	3	3	0	0	3	0
2015	1	1	0	0	1	0
2016	0	0	0	0	0	0
Total	1,068	880	107	14	32	6

Dashed lines = Individual breakouts not established

A=Total Number of Geological, Geophysical, and Strategic Minerals Permits

B=Number of Geophysical Permits

C=Number of Geological Permits

D=Number of Geological Permits Issued for Deep Stratigraphic Tests E=Number of Geophysical Permits Issued for 3-D

Seismic Data F=Number of Permits Issued for Strategic (Nonenergy) Minerals

Table A-3. Summary of Expenditures by BOEM for Geological and Geophysical Data Acquisition by FY for Alaska (in dollars)

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	AVO	DST
1968-1975	2,803,939	119,700	160,832	7,515	0	0	0
1976	1,628,153	1,598,789	268,961	0	0	0	0
1977	271,035	36,473	10,000	49,450	0	0	0
1978	2,956,280	0	0	408,679	0	0	0
1979	2,180,700	2,019,512	0	125,148	0	0	0
1980	1,086,423	5,789,936	0	0	0	0	0
1981	5,231,130	1,531,458	0	69,286	0	0	0
1982	1,817,736	0	0	0	0	0	0
1983	5,673,514	0	0	0	0	0	0
1984	4,118,626	19,238	0	27,072	0	0	0
1985	3,669,129	0	0	0	0	0	0
1986	2,780,556	950	0	0	0	0	0
1987	2,301,780	400	0	249,951	0	0	0
1988	1,339,007	3,425	0	0	0	0	0
1989	347,872	5,917	0	21,851	0	0	0
1990	832,476	0	0	51,681	0	0	0
1991	518,613	0	0	15,573	0	0	0
1992*	0	0	0	0	0	0	0
1993	139,117	0	0	0	0	0	0
1994	579,129	0	0	0	0	0	0
1995	167,170	0	0	750	0	0	0
1996	113,071	0	0	0	0	0	0
1997	195,855	0	0	0	0	0	0
1998	192,947	0	0	0	0	0	0
1999	0	0	0	0	358,155	0	0
2000	0	0	0	0	348,073	0	0
2001*	0	0	0	0	0	0	0
2002	0	0	0	0	762,911	0	0
2003*	0	0	0	0	0	0	0
2004*	0	0	0	0	0	0	0
2005*	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	2,329	0	0	152	29,226	0	0
2008	0	0	0	0	9,401	0	0
2009*	0	0	0	0	392	0	0
2010*	0	0	0	0	3,106	28,048	0
2011*	2	0	0	0	63	0	0
2012	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0
2015	1,574	0	0	0	0	0	0
2016	0	0	0	0	0	0	0
Total	40,948,163	11,125,798	439,793	1,027,108	1,511,327	28,048	0

*In FY 1992 and 2003, the Alaska Region spent funds from the G&G budget and Regional funds to acquire digital copies of data already in their inventory and did not acquire any new or additional data. In FY 2001, the Region spent funds to acquire digital copies of seismic information already in their inventory as well as a paleontological study. In FY 2003, 2004, 2005, 2009, 2010, and 2011 funds were also spent to scan in house data. Also, in FY 2004, funds went toward Geoframe support efforts. In FY 2005 funds also went towards a biostratigraphic data base.

Note: NA represents “not applicable” as no G&G funds are used to acquire information from a DST. Where no DST was completed, a zero is entered into the expenditure column.

Table A-4. Summary of Average Cost Per Mile by BOEM for 2-D Seismic Data by FY for Alaska (in dollars)

Year	Average Cost (\$/Mile)
1968-1975	39.88
1976	43.09
1977	22.68
1978	103.64
1979	255.41
1980	107.47
1981	147.65
1982	109.34
1983	109.31
1984	133.03
1985	121.21
1986	128.71
1987	46.47
1988	89.49
1989	110.93
1990	97.29
1991	130.85
1992	0
1993	73.48
1994	239.18
1995	475.85
1996	358.96
1997	512.71
1998	706.77
1999	0
2000	0
2001	0
2002	0
2003	0
2004	0
2005	0
2006	0
2007	0
2008	0.07
2009	0
2010	0
2011	0.04
2012	0
2013	0
2014	0
2015	0.43
2016	0

Note: Summaries reflect average cost per mile for all CDP Information acquired both State and Federal. Average costs reflect only those dollars assigned to the bureauwide G&G budget and do not reflect monies allocated from Regional funds. Zero indicates G&G dollars were not spent on CDP information.

Atlantic Tables

Table A-5. Summary of Geological and Geophysical Data Acquisition by FY for the Atlantic

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	DST
1968-1975	41,958	1,740	11,802	14,267	0	0
1976	25,211	23,867	29,822	1,076	0	2
1977	21,032	6,100	3,177	440	0	2
1978	14,281	0	0	0	0	0
1979	6,877	0	0	0	0	1
1980	585	10,660	0	0	0	0
1981	9,950	7,142	0	0	0	0
1982	19,074	0	0	0	0	0
1983	30,077	0	0	0	0	0
1984	9,386	0	0	0	0	0
1985	1,640	0	0	0	0	0
1986	424	0	0	0	0	0
1987	2,356	0	0	0	0	0
1988	827	0	0	0	0	0
1989	2,730	0	0	0	0	0
1990	31	0	0	0	0	0
1991	1,042	0	0	0	0	0
1992	2,377	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	23,109	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	969	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016 ¹	0	0	0	0	0	0
Total	213,936	49,509	44,801	15,783	0	5

Note: The DST dates are assigned based upon completion dates and are measured in terms of wells completed. All other data are measured in terms of miles. ¹In 2016 \$310,000 of G&G funds were applied to the Marine Minerals Branch Delmarva Project for cores and geophysical surveys, not included in above table.

Table A-6. Number of Permits Issued for Geological and Geophysical Exploration in the Atlantic

Year	A	B	C	D	E	F
1960-1968	45	---	---	---	---	---
1969	7	7	0	0	0	0
1970	4	3	1	0	0	0
1971	4	4	0	0	0	0
1972	4	4	0	0	0	0
1973	4	4	0	0	0	0
1974	2	2	0	0	0	0
1975	29	23	6	1	0	0
1976	35	28	7	3	0	0
1977	20	20	0	0	0	0
1978	17	13	4	1	0	0
1979	9	9	0	0	0	0
1980	15	15	0	0	0	0
1981	17	16	1	0	0	0
1982	11	11	0	0	0	0
1983	10	10	0	0	0	0
1984	6	6	0	0	0	0
1985	2	1	1	0	0	0
1986	3	2	1	0	0	0
1987	2	0	2	0	0	0
1988	4	4	0	0	0	0
1989	0	0	0	0	0	0
1990	1	1	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	1	0	0	0	0	1
1996	0	0	0	0	0	0
1997	2	1	1	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	1	0	0	0	0	1
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	2	0	0	0	0	2
2005	2	0	0	0	0	2
2006	0	0	0	0	0	0
2007	1	0	0	0	0	1
2008	2	0	0	0	0	2
2009	2	0	0	0	0	2
2010	0	0	0	0	0	0
2011	5	0	0	0	0	5
2012	2	0	0	0	0	2
2013	3	0	0	0	0	3
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	1	0	1	0	0	1
Total	275	184	25	5	0	22

Dashed lines = Individual breakouts not established

A=Total Number of Geological, Geophysical, and Strategic Minerals Permits

B=Number of Geophysical Permits

C=Number of Geological Permits

D=Number of Geological Permits Issued for Deep Stratigraphic Tests E=Number of Geophysical

Permits Issued for 3-D Seismic Data F=Number of Permits Issued for Strategic (Nonenergy) Minerals

Table A-7. Summary of Expenditures by BOEM for Geological and Geophysical Data Acquisition by FY for the Atlantic (in dollars)

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	DST
1968-1975	309,029	4,900	---	---	0	0
1976	196,687	2,256,167	45,282	2,902	0	NA
1977	242,868	1,968,513	9,992	0	0	NA
1978	581,562	0	0	0	0	0
1979	119,250	0	0	0	0	NA
1980	51,096	4,278,448	0	0	0	0
1981	179,682	1,243,204	0	0	0	0
1982	1,882,723	0	0	0	0	0
1983	1,718,584	0	0	0	0	0
1984	1,500,298	0	0	0	0	0
1985	287,135	0	0	0	0	0
1986	87,307	0	0	0	0	0
1987	438,792	0	0	0	0	0
1988	71,510	0	0	0	0	0
1989	120,042	0	0	0	0	0
1990	150	0	0	0	0	0
1991	2,790	0	0	0	0	0
1992	1,933	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	1,080,000	0	0	0	0	0
2004*	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	156,100	0	0	0	0	0
2009**	0	0	0	0	0	0
2010**	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016 ¹	0	0	0	0	0	0
Total	7,947,538	9,751,232	55,274	2,902	0	0

*In FY 2004, funds were expended to vectorize Atlantic data and a geologic report for offshore Nova Scotia was purchased

**In FY 2009 and 2010, \$56,100 and \$17,634 respectively was used to purchase reprocessed seismic data that was already owned by BOEM

¹ FY 2016 G&G funds in the amount of \$310,000 were applied to Marine Minerals Branch to fund the Delmarva Project.

Note: The abbreviation NA represents “not applicable” as no G&G funds are used to acquire information from a DST. Where no DST was completed, a zero is entered into the expenditure column. Dashed lines = No expenditures are available for CDP interpretations or gravity and magnetic data for 1968-1975.

Table A-8. Summary of Average Cost Per Mile by BOEM for 2-D Seismic Data by FY for the Atlantic (in dollars)

Year	Average Cost (\$/Mile)
1968-1975	7.37
1976	7.80
1977	11.55
1978	40.72
1979	17.34
1980	87.34
1981	18.06
1982	98.70
1983	57.14
1984	159.85
1985	175.08
1986	205.91
1987	186.24
1988	86.47
1989	43.97
1990	4.84
1991	2.68
1992	0.81
1993	---
1994	---
1995	---
1996	---
1997	---
1998	---
1999	---
2000	---
2001	---
2002	---
2003*	470.81
2004	---
2005	---
2006	---
2007	---
2008	161.09
2009	---
2010	---
2011	---
2012	---
2013	---
2014	---
2015	---
2016	---

*Data acquired in offshore Canada at market prices.
Dashed lines indicate no funding for that year.

Note: Summaries reflect average cost per mile for all CDP Information acquired both State and Federal. Average costs reflect only those dollars assigned to the bureauwide G&G budget and do not reflect monies allocated from Regional funds.

Gulf of Mexico Tables

Table A-9. Summary of Geological and Geophysical Data Acquisition by FY for the Gulf of Mexico

Year	2-D	HRD	Interpretations	Grav/Mag	3-D*	3-D/4-C*	AVO*	DST
1968-1975	143,458	88,549	120,038	19,670	0	0	0	2
1976	31,474	9,367	19,380	56,272	0	0	0	0
1977	4,485	18,119	0	0	0	0	0	0
1978	7,188	8,275	0	0	0	0	0	0
1979	11,681	5,018	0	0	0	0	0	0
1980	4,758	15,940	0	0	0	0	0	0
1981	16,454	500	0	0	0	0	0	0
1982	28,700	0	0	0	0	0	0	0
1983	26,290	0	0	0	0	0	0	0
1984	40,828	0	0	0	0	0	0	0
1985	31,430	0	0	0	0	0	0	0
1986	22,616	0	0	0	0	0	0	0
1987	43,073	0	0	0	0	0	0	0
1988	56,265	0	0	0	0	0	0	0
1989	43,121	0	0	0	0	0	0	1
1990	76,692	0	0	0	0	0	0	0
1991	35,507	0	0	0	0	0	0	0
1992	46,814	0	0	0	0	0	0	0
1993	23,589	0	0	0	1,563	0	0	0
1994	4,416	0	0	0	1,420	0	0	0
1995	8,193	0	0	0	1,826	0	0	0
1996	32,797	0	0	0	1,458	0	0	0
1997	39,300	0	0	0	3,105	0	0	0
1998	90,708	0	0	178,305	3,452	0	0	0
1999	30,135	0	0	52,000	3,219	0	0	0
2000	64,710	0	0	284,084	6,138	0	0	0
2001	6,668	0	0	0	3,602	0	0	0
2002	1,506	0	0	0	7,171	0	0	0
2003	25,045	0	0	0	6,272	0	1,492	0
2004	101,282	0	0	0	6,193	37	67	0
2005	48,829	0	0	0	4,996	0	0	0
2006	170,379	0	0	0	6,495	0	0	0
2007	75,799	0	0	0	11,651	0	0	0
2008	1,984	0	0	79,082	22,552	0	0	0
2009	35,130	0	0	0	27,527	0	0	3
2010	195,487	0	0	0	22,822	0	0	0
2011	135,398	0	0	0	9,032	0	0	0
2012	46,923	0	0	0	37,092	3846	0	0
2013	46,694	0	0	0	34,132	420	0	0
2014	248	0	0	0	21,294	3651	1,896	0
2015	143,893	0	0	3,175	33,427	541	3,248	0
2016	299,028**	0	0	0	30,764	0	9,095	0
Total	2,298,975	145,768	139,418	672,588	308,108	8495	15,798	6

Note: *Acquisitions for 3-D seismic, 3-D/4-C data, and AVO data are measured in blocks; all other acquisitions, in this table are measured in miles. The DST dates are assigned based upon completion dates and are measured in terms of wells completed.

**High figure is due to purchase of reprocessed old data and not due to new acquisitions.

Figures may vary by 1-2%

Table A-10. Number of Permits Issued for Geological and Geophysical Exploration in the Gulf of Mexico

Year	A	B	C	D	E	F	G
1960-1968	2,071	---	---	---	---	---	---
1969	207	204	3	0	0	0	0
1970	166	162	4	0	0	0	0
1971	179	175	4	0	0	0	0
1972	198	188	10	0	0	0	0
1973	272	264	8	0	0	0	0
1974	284	275	9	2	0	0	0
1975	353	348	5	0	0	0	0
1976	292	289	3	0	0	0	0
1977	368	361	7	0	0	0	0
1978	278	278	0	0	0	0	0
1979	211	204	7	0	0	0	0
1980	231	225	6	0	0	0	0
1981	283	280	3	0	0	0	0
1982	344	341	3	0	0	0	0
1983	416	416	0	0	16	0	0
1984	411	408	3	0	18	0	0
1985	300	295	5	0	38	0	0
1986	170	169	1	0	32	0	0
1987	258	252	6	0	42	0	0
1988	263	251	12	0	45	0	0
1989	232	223	9	1	47	0	0
1990	227	222	5	0	57	0	0
1991	163	152	11	0	45	0	0
1992	134	131	3	0	53	0	0
1993	136	125	11	0	68	0	0
1994	130	114	16	0	52	0	0
1995	102	91	11	0	49	0	0
1996	130	114	16	0	54	0	0
1997	152	134	18	0	69	0	1
1998	155	141	14	0	57	0	1
1999	109	96	13	0	42	0	0
2000	78	72	5	0	31	1	0
2001	110	103	7	0	33	0	0
2002	79	74	5	0	20	0	3
2003	106	99	3	0	28	4	2
2004	100	90	10	0	14	0	0
2005	98	92	6	0	24	0	0
2006	82	77	2	0	21	3	0
2007	89	88	1	0	29	0	0
2008	106	100	1	2	19	5	0
2009	77	63	8	0	8	6	1
2010	53	44	4	0	7	5	1
2011	37	33	3	0	19	1	0
2012	40	37	2	0	20	1	4
2013	43	39	2	0	15	2	4
2014	65	62	3	0	19	0	3
2015	73	17	9	0	14	0	0
2016	22	22	0	0	22	0	0
Total	10,483	8,040	297	5	1,127	28	20

Dashed lines = Individual breakouts not established; A=Total Number of Geological, Geophysical, and Strategic Minerals Permits; B=Number of Geophysical Permits; C=Number of Geological Permits; D=Number of Geological Permits Issued for Deep Stratigraphic Tests; E=Number of Geophysical Permits Issued for 3-D Seismic Data; F=Number of Permits Issued for Strategic (Nonenergy) Minerals; G=Number of Permits Issued for 4-D Seismic Data

Figures may vary by 1-2%.

Table A-11. Summary of Expenditures by BOEM for Geological and Geophysical Data Acquisition by FY for the Gulf of Mexico (in dollars)

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	DST
1968-1975	5,255,068	2,795,562	722,442	129,500	0	0
1976	1,489,665	514,141	134,084	385,234	0	0
1977	579,583	3,072,088	0	0	0	0
1978	330,183	1,438,856	0	0	0	0
1979	492,299	949,697	0	0	0	0
1980	388,329	3,926,990	0	0	0	0
1981	939,506	31,805	0	0	0	0
1982	2,936,727	0	0	0	0	0
1983	3,678,684	0	0	0	0	0
1984	3,999,326	0	0	0	0	0
1985	2,768,574	0	0	0	0	0
1986	1,600,031	0	0	0	0	0
1987	1,824,927	0	0	0	0	0
1988	1,075,515	0	0	0	0	0
1989	885,748	0	0	0	0	0
1990	704,670	0	0	0	0	0
1991	289,266	0	0	0	0	0
1992	376,893	0	0	0	0	0
1993	200,407	0	0	0	537,908	0
1994	26,946	0	0	0	647,592	0
1995	21,535	0	0	0	592,223	0
1996	1,151,587	0	0	0	526,471	0
1997	44,103	0	0	0	1,150,050	0
1998	96,771	0	0	12,000	1,289,773	0
1999*	42,227	0	0	3,000	1,154,577	0
2000	83,359	0	0	10,070	1,816,038	0
2001	457,463	0	0	0	729,196	0
2002	3,185	0	0	0	341,756	0
2003	24,902	0	0	0	288,443	0
2004	185,470	0	0	0	283,346	0
2005*	10,445	0	0	0	216,934	0
2006	29,071	0	0	0	281,331	0
2007	10,126	0	0	0	429,173	0
2008	965	0	0	9,679	628,018	0
2009*	217,613	0	0	0	507,389	0
2010	16,170	0	0	0	341,090	0
2011	15,307	0	0	0	155,123	0
2012	2,672	0	0	0	134,734	0
2013	7,146	0	0	0	256,756	0
2014	300	0	0	0	172,454	0
2015	5,935	0	0	0	430,741	0
2016	5,922	0	0	0	56,485	0
Total	32,274,621	12,729,139	856,526	549,483	12,967,601	0

*In FY 1999, the Gulf of Mexico Region also spent funds to acquire digital copies of data and information that were already in their inventory or purchased as two differing displays. In FY 2005, funds were allocated for scanning of in house data. In FY 2009, \$225,000 was spent on a gravity study.

Figures may vary by 1-2%

Note: The abbreviation NA represents “not applicable” as no G&G funds are used to acquire Information from a DST. Where no DST was completed, a zero is entered into the expenditure column.

Table A-12. Summary of Average Cost Per Mile by BOEM for 2-D Seismic Data by FY for the Gulf of Mexico (in dollars)

Year	Average Cost (\$/Mile)
1968-1975	36.63
1976	47.33
1977	129.23
1978	45.94
1979	42.15
1980	81.62
1981	57.10
1982	102.33
1983	139.93
1984	97.96
1985	88.09
1986	70.75
1987	42.37
1988	19.12
1989	20.54
1990	9.19
1991	8.14
1992	8.05
1993	8.49
1994	6.10
1995	2.63
1996	35.11
1997	1.01
1998	1.07
1999	1.40
2000	1.29
2001	68.61/1.34*
2002	2.11*
2003	0.99
2004	1.83
2005	0.21
2006	0.17
2007	0.01
2008	0.49
2009	6.19
2010	0.08
2011	0.11
2012	0.06
2013	0.15
2014	1.21
2015	0.04
2016	0.02

*The \$68.61 total includes the cost for data in Cuban waters at the market price. The average cost per line mile for data in Federal waters is \$1.34.

*The \$2.11 total includes velocity models for depth data.

Figures may vary by 1-2-%

Note: Summaries reflect average cost per mile for all CDP Information acquired both State and Federal. Average costs reflect only those dollars assigned to the bureauwide G&G budget and do not reflect monies allocated from Regional funds.

Pacific Tables

Table A-13. Summary of Geological and Geophysical Data Acquisition by FY for the Pacific

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	DST
1968-1975	14,092	9,971	15,552	87,637	0	1
1976	14,452	2,429	2,288	1,851	0	0
1977	5,339	5,979	24,525	3,950	0	0
1978	4,433	1,155	0	0	0	1
1979	4,393	6,578	0	0	0	0
1980	3,948	4,470	0	0	0	0
1981	8,070	0	0	3,662	0	0
1982	15,563	0	0	13,050	0	0
1983	12,473	0	0	0	0	0
1984	8,678	0	0	0	0	0
1985	8,181	0	0	0	0	0
1986	2,644	0	0	0	0	0
1987	18,719	0	0	0	0	0
1988	6,865	0	0	0	0	0
1989	4,507	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	300	0	0	0	0	0
1995	0	0	0	0	0	0
1996	184	0	0	0	12*	0
1997	0	0	0	0	21*	0
1998	0	0	0	0	8*	0
1999	0	0	0	0	0	0
2000	0	0	0	0	11*	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
Total	132,841	30,582	42,365	110,150	52*	2

*Acquisitions for 3-D seismic data are measured in blocks; all other acquisitions in this table are measured in miles. The DST dates are assigned based upon completion dates and are measured in terms of wells completed.

Table A-14. Number of Permits Issued for Geological and Geophysical Exploration in the Pacific

Year	A	B	C	D	E	F
1960-1968	162	---	---	---	---	---
1969	13	10	3	0	0	0
1970	3	2	1	0	0	0
1971	0	0	0	0	0	0
1972	1	1	0	0	0	0
1973	30	21	9	0	0	0
1974	24	24	0	0	0	0
1975	46	42	4	1	0	0
1976	24	22	2	0	0	0
1977	31	26	5	0	0	0
1978	38	30	8	1	0	0
1979	24	22	2	0	0	0
1980	31	26	5	0	0	0
1981	40	38	2	0	0	0
1982	62	59	3	0	0	0
1983	45	36	9	0	0	0
1984	56	42	14	0	0	0
1985	33	30	3	0	0	0
1986	20	19	1	0	0	0
1987	20	16	4	0	0	0
1988	33	25	8	0	0	0
1989	0	0	0	0	0	0
1990	4	3	1	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
Total	740	494	84	2	0	0

Dashed lines = Individual breakouts not established

A=Total Number of Geological, Geophysical, and Strategic Minerals Permits

B=Number of Geophysical Permits

C=Number of Geological Permits

D=Number of Geological Permits Issued for Deep Stratigraphic Tests

E=Number of Geophysical Permits Issued for 3-D Seismic Data F=Number of

Permits Issued for Strategic (Nonenergy) Minerals

Table A-15. Summary of Expenditures by BOEM for Geological and Geophysical Data Acquisition by FY for the Pacific (in dollars)

Year	2-D	HRD	Interpretations	Grav/Mag	3-D	DST
1968-1975	697,733	175,000	49,617	415,913	0	NA
1976	486,139	57,660	20,596	17,275	0	0
1977	188,930	752,400	1,962	11,796	0	0
1978	137,754	23,685	0	0	0	NA
1979	346,612	1,588,695	0	0	0	0
1980	249,048	1,098,954	0	0	0	0
1981	689,372	0	0	20,029	0	0
1982	1,918,891	0	0	69,350	0	0
1983	1,309,608	0	0	0	0	0
1984	1,262,030	0	0	0	0	0
1985	848,777	0	0	0	0	0
1986	356,700	0	0	0	0	0
1987	921,422	0	0	0	0	0
1988	93,748	0	0	0	0	0
1989	44,273	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	443	0	0	0	0	0
1995	0	0	0	0	0	0
1996	1,714	0	0	0	10,452	0
1997	0	0	0	0	13,479	0
1998	0	0	0	0	3,344	0
1999*	0	0	0	0	0	0
2000	0	0	0	0	650	0
2001	0	0	0	0	0	0
2002*	0	0	0	0	0	0
2003*	0	0	0	0	0	0
2004*	0	0	0	0	0	0
2005*	0	0	0	0	0	0
2006*	0	0	0	0	0	0
2007*	0	0	0	0	0	0
2008*	0	0	0	0	0	0
2009*	0	0	0	0	0	0
2010*	0	0	0	0	0	0
2011*	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015**	0	0	0	0	0	0
2016***	0	0	0	0	0	0
Total	9,553,194	3,696,394	72,175	534,363	27,925	0

* In FY 1999 and 2002, the Pacific Region spent funds to acquire digital copies of data already in their inventory and did not acquire any new or additional data. From FY 2003 through 2011 funds were allocated for scanning of in-house data. In FY 2009, 2010, and 2011, these totals were \$50,000, \$25,000, and \$25,000 respectively. In addition, in FY 2010, \$6,200 were allocated for a GIS-UDRIL mapping tool.

** In FY 2015, \$17,600 was spent for software

*** In FY 2016 \$89,500 was spent on a scan map project (Caltech Co-Op) and to purchase maps from the T.W. Dibblee Digital Geological Map Collection. **Note:** The abbreviation NA represents “not applicable” as no G&G funds are used to acquire Information from a DST. Where no DST was completed, a zero is entered into the expenditure column.

Table A-16. Summary of Average Cost Per Mile by BOEM for 2-D Seismic Data by FY for the Pacific (in dollars)

Year	Average Cost (\$/Mile)
1968-1975	49.51
1976	33.64
1977	35.39
1978	31.08
1979	78.90
1980	63.08
1981	85.42
1982	123.30
1983	105.00
1984	145.43
1985	103.75
1986	134.91
1987	49.22
1988	13.66
1989	9.82
1990	0
1991	0
1992	---
1993	0
1994	1.48
1995	0
1996	9.32
1997	0
1998	0
1999	0
2000	0
2001	---
2002	---
2003	---
2004	---
2005	---
2006	---
2007	---
2008	---
2009	---
2010	---
2011	---
2012	---
2013	---
2014	---
2015	---
2016	---

Note: Summaries reflect average cost per mile for all CDP information acquired both State and Federal. Average costs reflect only those dollars assigned to the bureauwide G&G budget and do not reflect monies allocated from Regional funds.

Dashed line indicates no funding for that year. Zero indicates G&G dollars were not spent on CDP information.

Glossary

AVO – The variation in the amplitude of a seismic reflection with the angle of incidence or source geophone distance. It depends on changes in velocity, density, and Poisson's Ratio.

Block - a geographically defined section of the Outer Continental Shelf (OCS) designated by a number on an Official Protraction Diagram or Leasing Map prepared by the Bureau of Ocean Energy Management (BOEM). A block normally is a 9-square-mile area (3 miles x 3 miles) consisting of 5,760 acres. A single block is the smallest unit that can be leased for oil and gas exploration on the OCS.

Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE)
– Predecessor agency to the Bureau of Ocean Energy Management.

Common Depth Point - a common location in the ocean subbottom where sound waves originating from various positions of the seismic (sound) source near the ocean surface are reflected back toward the surface. The traces from different seismic profiles corresponding to the same reflection point are mathematically summed (stacked) for reflection points beneath the survey line. Also known as common midpoint or common reflection point.

COST Wells - Continental Offshore Stratigraphic Test Wells - deep stratigraphic wells drilled to determine the geological character or stratigraphy of rock strata. These wells, which may be more than 20,000 feet deep, provide information that can be used by Government and industry to evaluate tracts to be offered in a lease sale.

Fair Market Value - the amount in cash, or on terms reasonably equivalent to cash, for which in all probability the property would be sold by a knowledgeable purchaser who desired, but is not obligated, to buy. This market value that is sought is not merely theoretical or hypothetical, but represents, insofar as it is possible to estimate, the actual selling price.

High-Resolution - a range of seismic frequencies above the normal range of frequencies used in exploration, with an improvement in resolution in the shallow portions of the subbottom but with less total penetration into the subbottom.

Lease - any form of authorization that is used under section 8 or maintained under section 6 of the Outer Continental Shelf Lands Act (OCSLA) and that authorizes exploration for and development and production of minerals or the area covered by that authorization, whichever is required of the context.

Lease Sale - a BOEM proceeding by which leases for certain OCS tracts are offered for sale by competitive bidding and during which bids are received, publicly announced, and recorded.

Minerals Management Service (MMS) – Predecessor agency to the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE).

Outer Continental Shelf - all submerged lands lying seaward and outside of the area of lands beneath navigable waters as defined in section 2 of the Submerged Lands Act and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control.

Outer Continental Shelf Lands Act - law passed by Congress on August 7, 1953, and amended in 1975, 1978, and 1985.

Permit - the contract or agreement, other than a lease, approved for a specified period of not more than 1 year under which a person acquires the right to conduct (1) geological exploration for mineral resources, (2) geophysical exploration for mineral resources, (3) geological scientific research, or (4) geophysical scientific research.

Planning Area - a subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the Department of the Interior's (DOI) offshore oil and gas leasing program.

Shallow Hazards - potential geological and manmade hazards to exploration on the OCS that are in the shallow portion of the seafloor. Examples include seismicity, active faults, shallow gas deposits, steep slopes, unstable soil conditions, pipelines, anchors, and sunken ships. Shallow hazards may occur in shallow or deep waters.



The Department of the Interior Mission

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