Table 4.0.1-1. Number of permits issued for Geological and Geophysical Exploration in the Pacific OCS Region from table A-10, OCS Report MMS-98-0027 and MMS Pacific OCS Region records.

Fiscal Year	Total Number of Geological and Geophysical Permits	Geophysical Permits	Geological Permits	Permits for Deep Stratigraphic Tests	3-D Seismic Data Permits
1960-1968	153	132	21	0	0
1969	17	14	3	0	0
1970	6	5	1	0	0
1971	4	2	2	0	0
1972	4	4	0	0	0
1973	15	10	5	0	0
1974	36	29	7	0	0
1975	61	55	6	1	0
1976	32	30	2	0	1
1977	33	28	5	0	0
1978	38	30	8	1	0
1979	22	20	2	0	0
1980	31	27	4	0	0
1981	40	39	1	0	1
1982	62	60	2	0	5
1983	45	36	9	0	2
1984	56	42	14	0	8
1985	32	29	3	0	2
1986	20	19	1	0	5
1987	20	16	4	0	3
1988	33	25	8	0	2
1989	0	0	0	0	0
1990	4	3	1	0	0
Total	764	655	109	2	29

Table 4.0.1-2. Santa Barbara Channel and Santa Maria Basin* Geological and Geophysical Permits for the Pacific OCS Region.

Date	Geophysical Permits		Geological Permits Issued	
	Number Issued	Miles Run	Sampling	DST
1963	--	--	5	--
1964	2	0.02	1	--
1965	9	7634	--	--
1966	16	9607	1	--
1967	31	880	5	--
1968	12	10,187	1	--
1969	8	2968	--	--
1970	4	2750	--	--
1971	1	80	--	--
1972	3	120	--	--
1973	6	26,700	7	--
1974	23	58,401	--	--
1975	25	38,578	2	--
1976	21	23,551	2	--
1977	19	8507	3	--
1978	23	15,309	5	1
1979	19	15,528	1	--
1980	22	33,702	--	--
1981	27	29,634	1	--
1982	28	25,614	1	--
1983	25	14,282	6	--
1984	28	16,180	8	--
1985	16	0169	1	--
1986	15	12,960	--	--
1987	10	6032	1	--
1988	9	5118	3	--
1989	0	0	--	--
1990	1	230	1	--
Total	403	379,224	55	1

* All or a portion of the survey was conducted in the Santa Barbara Channel or Santa Maria Basin area.

Table 4.0.1-3. Offshore Pacific OCS Region 2D and 3D surveys by decade.

Type	1960-69	1970-79	1980-89	1990-95	Total
2-D	186	147	188	3	524
3-D	0	2	30	1	33

Source, MMS 1995

number of permits issued in the Pacific OCS Region for geological and geophysical surveys by fiscal year, 1960-1990. No G&G Permits Have been issued after 1990. Table 4.0.1-2 provides the number of G&G permits issued in the Santa Barbara Channel and Santa Maria Basin. These types of surveys are described below.

GEOLOGICAL SURVEYS

Geological surveys include bottom sampling, shallow coring, and drilling deep stratigraphic test wells. 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 is performed by conventional rotary drilling equipment to obtain a near-surface sample of the rocks of the seabed. A deep stratigraphic test, as defined in 30CFR 251.1, means drilling that involves the penetration into the sea bottom of more than 500 ft (152 meters). These wells 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.

GEOPHYSICAL SURVEYS

Geophysical surveys include two dimensional (2-D) and three dimensional (3-D) deep and shallow penetration surveys, Gravity, and Magnetic surveys. shows the number of offshore Pacific OCS 2-D and 3-D surveys conducted by decade. Table 4.0.1-3 includes 3-D surveys conducted on lease. On lease suverys do not require a permit. Common Depth Point (CDP) seismic information 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. The 3-D information is used to delineate, in greater detail than that of traditional 2-D information, geologic structures that may be associated with the occurrence of natural gas and oil. 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.

Magnetic surveys measure the magnetic field or its 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.

SITE SURVEYS FOR OCS EXPLORATION, DEVELOPMENT, AND PRODUCTION

Site Characterization surveys are conducted on lease to detect seafloor and subsurface geologic and manmade hazards. Survey data is analyzed to ensure safety of exploration and production wells and facilities and pipelines.

High-resolution or acoustic-profiling survey obtains information on the conditions existing at and near the surface of the seafloor. On lease deep penetration seismic surveys have been conducted (table 4.0.1-3 includes four 3-D surveys conducted on lease)

Geological/geotechnical samples taken at the site of bottom founded exploration and production platforms and within a proposed pipeline corridor are tested to categorize foundation-engineering conditions.

Underwater video/photography, hydrocarbon sniffer surveys, diver inspection, current velocity measurements, additional seafloor sampling and/or geologic age dating has been required to identify hazards, archaeological resources or sensitive habitats to ensure safety of personnel and equipment and protection (or avoidance) of archaeological resources, etc.

Platforms and pipelines installed in the Pacific OCS Region have been periodically inspected in accordance with applicable regulations and regional Notice to Lessees and Operators. Inspections for platforms could include visual, cathodic protection, magnetic particle, or ultrasonic testing.

Table 4.0.1-4. Pacific OCS Region Exploration Wells from USDOI, MMS, Pacific OCS Region, 1992. Dash indicates no drilling

Lease Sale Name, Date, Area	Number of Exploration Wells Drilled	Start Date of First and Last Well	
Sale P-1, 5-14-63, Northern California	20	9-20-63	9-1-67
Sale P-2 10-1-64, Oregon and Washington	12	4-24-65	7-11-67
Drainage Sale P3, 12-15-66, Santa Barbara Channel	6	2-18-67	5-10-67
Sale P-4, 2-6-68, Santa Barbara Channel	140	2-18-68	6-25-89
Sale 35, 12-11-75, Southern California	41	7-26-76	8-25-81
Sale 48, 6-29-79, Southern California and Santa Barbara	33	5-10-80	9-1-88
Sale 53, 5-28-81, Santa Maria Basin	55	3-21-82	6-15-86
Sale 68, 6-11-82, Southern California and Santa Barbara	17	11-20-83	9-22-89
RS-2, 8-5-82, Santa Maria Basin	1	8-15-86	8-15-86
Sale 73, 11-30-83, Santa Maria Basin	0	-	-
Sale 80, 10-17-84 Southern California and Santa Barbara	1	12-30-89	12-30-89
Total	326*		

* Does not include two Deep Stratigraphic Test wells

Routine inspections on pipelines include visual (diver and/or remotely operated vehicle), side scan sonar (SSS), and high resolution internal surveys.

EXPLORATION DRILLING

Exploration, as defined in 30 CFR 250.105, means the commercial search for oil, gas, or sulphur. Activities classified as exploration include but are not limited to: (1) G&G surveys using magnetic, gravity, seismic reflection, seismic refraction, gas sniffers, coring, or other systems to detect or imply the presence of oil, gas, or sulphur; and (2) Any drilling conducted for the purpose of searching for commercial quantities of oil, gas, and sulphur, including the drilling of any additional well needed to delineate any reservoir to enable the lessee to decide whether to proceed with development and production. The drilling is usually conducted from mobile drilling units such as a jackup, semi-submersible, or drillship. In the Pacific OCS Region there have been 326 exploration wells drilled, see table 4.0.1-4.

The California State Lands Commission, http://www.slc.ca.gov/about%5Four%5Fagency/energy%5Fresources.htm, reports the first California tideland oil well was drilled in 1896 in Santa Barbara County. Within 10 years, about 400 wells could be seen on the beach and just offshore. At that time, no State laws governed the extraction of oil and gas from State-owned lands and no revenues accrued to the State.

In 1921, the California Legislature authorized the issuance of prospecting permits and leases for oil and gas development of the State's tide and submerged lands by the Surveyor General, the predecessor of the California State Lands Commission. Exclusive jurisdiction over all oil and gas development on the State-owned property was given to the Commission by the Legislature in 1938.

The State now administers more than 100 sites on which oil companies have developed some 1,000 wells that take oil and gas from State lands. In addition, over 1,000 wells produce oil from granted tidelands in the city of Long Beach.

DEVELOPMENT AND PRODUCTION

Development activities include the installation of jackets, topsides, pipelines, and drilling. Production activities include bringing the oil and gas to the surface, handling oil and gas on the platform, and sending the oil and gas to shore. Table 4.0.1-5 shows information on Federal and State of California platforms, pipelines and production. Table 4.0.1-6 shows information on platform construction timing, production support activities, and decommissioning timing.

Table 4.0.1-5. Existing surface structures, pipelines, and production offshore, Southern California.

Platforms					Pipelines			Production				
Structure	Operator	Location [1]	Well slots [1]	Year Installed	Pipelines; Size, Number, Type	Year Installed	Onshore Facility (pipeline destination)	Field	Date 1st Prod.	Peak Production: oil and gas [5]		Orig. Recoverable Reserves by Field; oil (MMbbl)/ gas (Bcf) [6]
										Volume (bbls/day) (MCF/day)	Year	
Federal Waters (All Platforms)												
Edith	Nuevo	Huntington Beach	72	1983	6" oil 6" gas	1983 1983	Elly Eva	Beta	01/21/84	7,040,164/ 2,698,056	1986/ 1985	105.60/ 33.5
Ellen	Aera	Huntington Beach	80	1980	N/A	N/A	N/A		01/13/81			
Elly [2]	Aera	Huntington Beach	Proc. Fac.[2]	1980	10" water 16" oil	1984 1980	Eureka Beta Pump St.		n/a			
Eureka	Aera	Huntington Beach	60	1984	12" oil 6" gas	1984	Elly		03/17/85			
Gail	Venoco	Port Hueneme	36	1987	8" oil 8" gas 8" gas	1987	Grace	Sockeye	08/08/88	3,098,035 / 8,666,353	1990/ 1992	70.83/ 163.45
Grace	Venoco	Mandalay	48	1979	10" oil 12"/10" gas	1980	Carpinteria	Santa Clara	07/25/80	3,037,231/ 9,201,110	1983/ 1984	49.76/ 80.13
Gilda	Nuevo	Mandalay	96	1981	12" oil/water 10" gas 6" water return	1981	Mandalay		12/19/81			
Gina	Nuevo	Port Hueneme	15	1980	10" oil/water 6" gas	1981	Mandalay	Hueneme	02/11/82	1,575,189/ 453,060	1983/ 1996	10.57/ 5.30
Habitat	Nuevo	Carpinteria	24	1981	12" gas	1983	Shore	Pitas Point	12/15/83	33,885/ 29,898,809	1985/ 1985	0.27/ 239.22
Hillhouse	Nuevo	Summerland	60	1969	8" oil 8" gas 6" spare	1969	Platform A	Dos Cuadras	07/21/70	27,752,972/ 15,483,685	1971/ 1971	256.8/ 137.6
A	Nuevo	Summerland	57	1968	12" oil 12" gas 6" water	1968	B tie- in		03/03/69			
B	Nuevo	Summerland	63	1968	12" oil 12" gas 6" water 6" water injection	1968 1968	Rincon P/F C		07/19/69			
C	Nuevo	Summerland	60	1977	6" oil 6" gas 6" water	1977	P/F B		08/01/77			
Henry	Nuevo	Carpinteria	24	1979	8" oil 8" water 6" gas	1979	Hillhouse	Carpinteria	05/15/80	6,777,575/ 4,749,410	1969/ 1969	66.3/ 55.0
Hogan	POOI	Carpinteria	66	1967	10" oil/water 12"gas 10" gas lift 4" water return	1967	La Conchita		06/10/68			
Houchin	POOI	Carpinteria	60	1968	10" oil/water 10" gas lift 12" gas 4" water return	1968	Hogan		04/28/69			
Heritage	Exxon Mobil	SYU	60	1989	20" oil/water 12" gas	1998	Harmony	Pescado Sacate	 12/18/93	18,696,920/ 19,085,872 1,886,475/ 1,754,738	1995/ 1999 2000:	110.79/ 222.32 70.83/ 163.45
Harmony	Exxon Mobil	SYU	60	1989	20" oil/water 12" water return 12" gas	1992 1992	Las Flores Hondo	Hondo	12/30/93	16,704,353/ 38,284,266	1996/ 1999	278.9/ 834.02
Hondo	Exxon Mobil	Gaviota	28	1976	14" oil/water 12" sour gas	1992 1983	Harmony Las Flores		04/02/81			

Table 4.0.1-5. Existing surface structures, pipelines, and production offshore, Southern California.(continued)

Platforms					Pipelines			Production				
Structure	Operator	Location [1]	Well slots [1]	Year Installed	Pipelines; Size, Number, Type	Year Installed	Onshore Facility (pipeline destination)	Field	Date 1st Prod.	Peak Production: oil and gas [5]		Orig. Recoverable Reserves by Field; oil (MMbbl)/ gas (Bcf) [6]
										Volume (bbls/day) (MCF/day)	Year	
Hermosa	Arguello, Inc.	Point Arguello	48	1985	24" oil/water 20" sour gas	1986	Gaviota	Pt Arguello	06/09/91	27,554,409/ 13,092,342	1994/ 1994	225.00/ 155.33
Harvest	Arguello, Inc.	Point Arguello	50	1985	12" oil/water 8" sour gas	1986	Hermosa		06/03/91			
Hildago	Arguello, Inc.	Point Arguello	56	1986	16" oil/water 10" sour gas	1987	Hermosa		05/27/91			
Irene	Torch	Point Pedernales	72	1985	20" oil/water 8" sour gas 8" water return	1986	Lompoc Oil and Gas Plant	Point Pedernales	04/13/87	7,283,392/ 2,592,970	1989/ 1995	77.3/ 25.5
Exxon OS&T (T)	Exxon	Gaviota	N/A	1981 Removed:1994	6" gas 8" water 12" oil	1981[3]	Hondo		n/a	N/A	N/A	N/A
State Waters [4]												
Emmy [a](P)	Aminoil	Huntington Beach	53	1963	8" oil/water 4" sour gas (low) 3" sour gas (high)	1988 (oil) 1993 (gas)	Aera Onshore Processing Facility	Huntington Beach	1932	45,733	1972	583.1 320.2
Eva (P)	Unocal	Huntington Beach	39	1964	8" oil/water 8" gas	1984	Fort Apache (Huntington Beach)					
Esther (P)	Chevron	Seal Beach	64	1990	3" gas 10" oil/ water	1981 (gas) 1995 (oil)	Huntington Beach	Belmont Offshore	1948	11,769	1968	63.9 40.8
Monterey (Belmont) (I)	THUMS	Seal Beach	70	1954	3" oil/water 3" gas	1954	Being Removed					
Chaffee (I)	THUMS	Long Beach	393	1966	8" oil/water 8" gas 12" water injection	1966 1993 1966 1993 1966	White Island	Wilmington	1939	177,468	1969	1502.5 574
Freeman (I)	THUMS	Long Beach	386	1966	8" oil/water 6" gas 12" water injection	1966	White Island					
White (I)	THUMS	Long Beach	338	1966	12" oil/water 12" gas 18" water injection	1987 1966 1966	Grissom Island					
Grissom (I)	THUMS	Long Beach	393	1966	14" oil/water 12" gas 10" water injection	1966	Shore					
Rincon (I)	Mobil	Rincon	68	1958	6" oil 6" gas	1988 (oil) 2000 (gas)	Rincon Onshore Facility	Rincon	1928	3,483	1960	36.8 36.8
Hope (P)	Chevron	Carpinteria	60	1965	10" gas 12" oil Now AGrace to Shore.@	1965	Carpinteria	Carpinteria	1966	28,699	1969	36.7 40.7 Abandoned
Heidi (P)	Chevron	Carpinteria	60	1965	10" gas lift 10" gas 10" oil	1965	Hope					
Hazel (P)	Chevron	Summerland	25	1958	8" out of service oil 6" gas 6" oil	1958	Carpinteria	Summerland	1958	10,391	1964	27.5 97.8 Abandoned
Hilda (P)	Chevron	Summerland	24	1960	8" out of service oil 6" gas 6" oil	1960	Hazel					
Holly (P)	ARCO	Goleta	30	1966	6" oil/water 6" gas	1966	Elwood Onshore Processing facility	S. Ellwood	1967	9,480	1984	69.4 49
Helen (P)	Texaco	Gaviota			CSLC	CSLC		Cuarta	1961	518	1962	.6 18.7 Abandoned
Herman (P)	Texaco	Pt. Conception			CSLC	CSLC		Conception	1961	13,703	1964	20.9 12.3 Removed

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[1] This is the number of well slots built into the platforms. Most platforms have fewer wells than slots.
[2] Platform Elly is an offshore processing facility to process production from Platforms E11en, Edith, and Eureka.
[3] Decommissioned 1994
[4] The type of structure is as follows: P - Platform I - Artificial Island T - Converted Tanker d: Offshore Storage and Treatment vessel
[5] For State facilities: Peak production refers to field. Peak gas production could not be obtained. The data sourcesis the CDOGGR publication PR06 "1998 Annual Report of the State Oil and Gas supervisor", published in 1999.
[6] By Field

Table 4.0.1-6. Existing surface structures offshore Southern California, construction timing, production support activities, and decommissioning timing.

Platforms			Construction	Production and Support Activities				Decommissioning
Structure	Operator	Location [1]	Year Installed	Field	Date 1st Prod.	Helicopter Trips per week with Yearly Total[4]	Crew and Supply Boat Trips with Yearly Total[4]	Actual or Estimated Removal Date [4]
Federal Waters (All Platforms)								
Edith	Nuevo	Huntington Beach	1983	Beta	01/21/84	0	3/wk - 156/yr 4/mo – 48/yr	2010-2015
Ellen	Aera	Huntington Beach	1980		01/13/81	4/month – 48/yr	21/wk – 1092/yr	2010-2015
Elly [2]	Aera	Huntington Beach	1980		n/a		3/wk – 156/yr	2010-2015
Eureka	Aera	Huntington Beach	1984		03/17/85			2010-2015
Gail	Venoco	Port Hueneme	1987	Santa Clara	08/08/88	0	17/wk – 884/yr	2015-2020
Grace	Venoco	Mandalay	1979		07/25/80	0	2/mo – 24/yr	2015-2020
Gilda	Nuevo	Mandalay	1981		12/19/81	0	17/wk – 884/yr	2012-2017
Gina	Nuevo	Port Hueneme	1980	Hueneme	02/11/82	0	1/wk – 52/yr	2012-2017
Habitat	Nuevo	Carpinteria	1981	Pitas Point	12/15/83	0	25/wk – 1300/yr	2015-2020
Hillhouse	Nuevo	Summerland	1969	Dos Cuadras	07/21/70		1/wk – 52/yr	2012-2017
A	Nuevo	Summerland	1968		03/03/69			2012-2017
B	Nuevo	Summerland	1968		07/19/69			2012-2017
C	Nuevo	Summerland	1977		08/01/77			2012-2017
Henry	Nuevo	Carpinteria	1979	Carpinteria	05/15/80			2012-2017
Hogan	POOI	Carpinteria	1967		06/10/68	0	21/wk – 1092/yr	2012-2017
Houchin	POOI	Carpinteria	1968		04/28/69		1/mo – 12/yr	2012-2017
Heritage	Exxon	SYU	1989	Pescado	12/18/93	2/day – 730/yr	25/wk – 1300/yr	2020-2025
Harmony	Exxon	SYU	1989	Hondo	12/30/93		3/wk – 156/yr	2020-2025
Hondo	Exxon	Gaviota	1976		04/02/81			2020-2025
Hermosa	Arguello, Inc.	Point Arguello	1985	Pt Arguello	06/09/91	5/day – 1825/yr	3/wk – 156/yr (Supply)	2015-2020
Harvest	Arguello, Inc.	Point Arguello	1985		06/03/91			2015-2020
Hildago	Arguello, Inc.	Point Arguello	1986		05/27/91			2015-2020
Irene	Torch	Point Pedernales	1985	Point Pedernales	04/13/87			2015-2020 (w/o Tranquillion Ridge Development) 2030-2035 (with Tranquillion Ridge Development)
Exxon OS&T (T)	Exxon	Gaviota	1981 Removed:1994		n/a			Removed 1994
State Waters [3]								
Emmy [a](P)	Aminoil	Huntington Beach	1963	Huntington Beach	1932	85/mo – 1020/ yr	15/mo – 180/yr (Work boat)	2010-2015
Eva (P)	Unocal	Huntington Beach	1964	Belmont Offshore	1948	-	20/wk – 1040/yr (Crew)	2010-2015
Esther (P)	Chevron	Seal Beach	1985			-	20/wk– 1040/yr (Crew)	2010-2015
Monterey (Belmont) (I)	THUMS	Seal Beach	1954	Wilmington	1939	- -	14/wk– 728/yr 1/wk– 52/yr	2001
Chaffee (I)	THUMS	Long Beach	1966					Unknown

Table 4.0.1-6. Existing surface structures offshore Southern California, construction timing, production support activities, and decommissioning timing (continued)

Platforms			**Construction**	**Production and Support Activities**				**Decommissioning**
Structure	Operator	Location [1]	Year Installed	Field	Date 1st Prod.	Helicopter Trips per week with Yearly Total[4]	Crew and Supply Boat Trips with Yearly Total[4]	Actual or Estimated Removal Date [4]
Freeman (I)	THUMS	Long Beach	1966			-	182/wk– 9464/yr (Crew) 42/week – 2184/yr (Barge)	
White (I)	THUMS	Long Beach	1966					
Grissom (I)	THUMS	Long Beach	1966					
Rincon (I)	Mobil	Rincon	1958	Rincon	1928	n/a	n/a	2005
Hope (P)	Chevron	Carpinteria	1965	Carpinteria	1966			Removed 1996
Heidi (P)	Chevron	Carpinteria	1965					Removed 1996
Hazel (P)	Chevron	Summerland	1958	Summerland	1958			Removed 1996
Hilda (P)	Chevron	Summerland	1960					Removed 1996
Holly (P)	ARCO	Goleta	1966	S. Ellwood	1967	-	25/wk (crew)	2015-2020
Helen (P)	Texaco	Gaviota	1960	Cuarta	1961			Removed 1988
Herman (P)	Texaco	Pt. Conception	1960	Conception	1961			Removed 1988

[1] Number refers to location on Figure POCS Region with Fields

[2] Platform Elly is an offshore processing facility to process production from Platforms E11en,.Edith and Eureka.

[3] The type of structure is as follows: P - Platform I - Artificial Island T - Converted Tanker d: Offshore Storage and Treatment vessel

[4] MMS estimates

Table 4.0.1-7. Estimates of vessel and helicopter traffic during construction.

Platform	Crew Boats	Supply Boats	Helicopters
Gail [1]			
- Construction	2/day	1/day	2/day
- Drilling	1/day	1/week	2/day
Habitat [2]			
- Construction	1/day	3/week	--
- Drilling	3/day	3/week	3/week
Harvest [3]			
- Installation	1/day	4/week	3/week
- Hookup & Commissioning	1/day	4/week	3/week
- Drilling	--	3/week	1.5/day
Hermosa and Hidalgo [3]	1/day	1/day	
- Installation	1/day	1/day	2/week
- Hookup & Commissioning	--	1/day	10/week
- Drilling			2/day
Irene [4]			
- Installation/Hookup	--	1 every 5 days	4 /day
- Drilling/Production	--	1 every 5 days	7 /day
Santa Ynez Unit Platforms [5]			
- Installation	N/A	N/A	N/A
- Hookup & Commissioning	N/A	N/A	N/A
- Drilling	40/week	4-15/week	2/day

The term N/A means not available.

[1] Minerals Management Service, 1986.

[2] Bureua of Land Management, Army Corps of Engineers, Geological Survey, California Coastal Commission, County of Santa Barbara, 1981.

[3] Minerals Management Service, California State Lands Commission, California Coastal Commission, and County of Santa Barbara, 1984.

[4] Minerals Management Service, California Coastal Commission, California State Lands Commission, and County of Santa Barbara, 1985

[5] Minerals Management Service, California State Lands Commission, and County of Santa Barbara, 1984.

SUPPORT ACTIVITIES

Vessels and helicopters provide transportation of necessary supplies and personnel to offshore platforms. Table 4.0.1-6 provides present-day estimates of vessel and helicopter support levels for production. Records of vessel and helicopter traffic were not kept during the development phase. Table 4.0.1-7 provides examples of estimates of vessel and helicopter traffic for the construction phase. The estimates are from the EIS's prepared for the Development and Production Plans.

Vessels are work boats and crew boats. Work boats carry large items to the platforms and originate from Port Hueneme. Crew boats carry personnel and may carry small items. Crewboats originate from Port Hueneme, Ventura Harbor, Carpenteria Pier, or Elwood Pier.

Helicopters carry personnel and may carry small items. Helicopters originate from the Santa Barbara Airport or the Santa Maria Airport. The Lompoc and Orcutt airports have also been used in the past.

Based on table 4.0.1-7 we estimate vessel and helicopter traffic during construction: jacket and topsides installation, hookup and commissioning, and the initiation of drilling as follows; 1-to-6 supply boat trips/day, 1/day to 1/week crew boat trips, and 2-to-7 helicopter trips/day.

PRODUCED WATER

A well produces an emulsion of oil and water with gas in solution. Each platform sends the emulsion to a tank for separation of the gas. The gas is used for fuel, sent to shore, or injected. The emulsion may be sent to shore for processing or some or all processing may occur on the platform.

Processing of the emulsion removes impurities such as water and results in oil of a quality to be accepted into a pipeline for transport to a refinery. Wa-

Table 4.0.1-8. Producted water discharged by platform and by year in millions of gallons. Blank spaces are either no data or no discharge.

Year	Grace	Gail	Edith	Habitat	Harmony[1]	Ellen/ Elly	Gilda	Hogan[2]	Irene	Harvest	Hidalgo	Hermosa	A	B[3]	C	Hillhouse[4]	Gina	Total
1988	29.8	1.1					64	75.2	16.2				251.3	176.2			63.2	677.015
1989	24.2	5.3	10	5.4		36.2	178.4	71.2	21.1				332.3	225.5	257.6	31.3	185.4	1383.87
1990	36.3	19.5	47.6	7.8		158.5	187	65	98.4				239.9	211.2	226.3	110.9		1408.49
1991	25.9	13.6	6.9	11.5		33.6	132.6	76.3					255.4	140.6	51.9	84.4		832.651
1992	20.1	28.1	11.4	12.6			166.8	65.9					87.1	142.1	20.6	22.4		577.082
1993	4.1	49.8	11	13.5	28.2		185.4	76			7.2		243.1	87.8	23.3	131.3	1.2	861.86
1994		84.8	14.6	14.3	155.2		179.9	75.3		21.9	63.5	21	228.6	59.8	29.1	133.9	1.2	1083.085
1995		52.9	14.1	9.8	217.8		85.7	71		129.6	106.8	157.6	214.7	98.3	32.0	121.0		1311.36
1996		18.4	6.5	11.4	325.5		175	64.2		165.6	85.6	163.9	225.2	66.5	18.3	118.4	6.4	1450.91
1997		21.5	11.6	17.8	307		145.9	77.8		161.7	69.3	172.7	214.9	81.0		120.7	4.2	1406.091
1998		23.1	11.5	27.8	359		121.6	64.6		136.9	51.7	217.5	192.3	59.8		156.6	5.9	1428.392
1999		22	9.4	1.6	518		59.1	34.8		49.8	24	182.3	198.7	95.7		140.1	55.3	1390.82
Total	140.4	340.1	154.6	133.5	1910.7	228.3	1681.4	817.3	135.7	665.5	408.1	915.0	2683.6	1444.5	659.2	1171.1	322.7	

[1] Discharges produced water from production from Platforms Harmony, Heritage, and Hondo
[2] Discharges produced water from production from Platforms Hogan and Houchin.
[3] Discharges produced water from production from Platforms B and C
[4] Discharges produced water from production from Platforms Hillhouse and Henery.
Source: Operator collected data submitted to EPA in required Discharge Monitoring Reports

ter removed at a platform can be injected and/or discharged overboard in accordance with the National Pollution Discharge Elimination System Permit (NPDES). Water removed onshore can be can be injected onshore and/or sent to a platform offshore for injection or overboard discharge.

Table 4.0.1-8 shows discharges of produced water from 1988 through 1999 and are based on quarterly Discharge Monitoring Reports required by EPA as a condition of their NPDES Permit. Note, however, the volumes reported for Platforms Hidalgo and Hogan are for part of 1999 and not the entire year. There is little year to year consistency of discharges. There are a number of reasons for this inconsistency. For example, injection rates on offshore platforms vary, wells that produce high volumes of water may be uneconomic and may be shut-in or plugged, or a platform that pumps to another platform may cease or curtail processing emulsion. For purposes of analysis, we assume a platform may discharge up to 330 million gallons of produced water in any year with the exception of Platform Harmony. Platform Harmony discharges produced water from processing of oil and gas at Los Flores Canyon. Los Flores Canyon receives the combined production from Platforms Harmony, Heritage, and Hondo. Platform Harmony produced water discharges were 518 million gallons in 1999. The discharge volume is not expected to increase significantly.

DECOMMISSIONING

Decommissioning is the process leading to the removal of a production platform. Current state-of-the-art technology (reverse installation using heavy lift vessels) will likely be used to remove shallow water platforms. It is assumed that platforms would be completely removed unless other options are available in California by the State. All wells are permanently plugged, severed below the seafloor, and surface casing retrieved to the platform. All piping and vessels, including retrieved casing, are flushed, drained, and the fluids injected or sent to shore. The components of the topsides are removed and placed on barges. The jacket is severed from the seafloor, lifted to the surface, and placed on a barge. Large jackets may be cut off in smaller sections and placed on a barge. The barges transport removed equipment, topsides sections, and jacket to a port for scrapping.

One facility in Federal waters has been decommissioned: the Offshore Storage and Treatment (OS&T) vessel. Several facilities in State waters have been decommissioned (see table 4.0.1-6). Table 4.0.1-6 also provides estimated times for the decommissioning of existing facilities in Federal and State waters.

OFFSHORE TANKERING OPERATIONS

Oil spills resulting from vessel collisions and other marine transportation-related accidents have the potential to cause significant impacts on the marine, coastal, and human environments, and contribute to cumulative environmental impacts. Marine transportation of Alaskan and foreign-import oil is an activity that occurs offshore California. Table 4.0.1-9 shows volume and number of oil tankers offshore California visiting Ports of San Francisco and of Los Angeles/Long Beach and El Segundo In 2000, 877 oil tankers visited the ports of Los Angeles/Long Beach and El Segundo. Of these tankers, 192 were United States flagged oil tankers and 685 were foreign flagged oil tankers (personal communication Reed Crispino, Marine Exchange, March, 2001).

U.S. flagged oil tankers voluntarily stay 80 km (50 mi) off the California coastline, thus avoiding the Point Arguello platforms and the channel altogether. In total, about 90 percent of all crude oil tankers keep this distance. The small percentage of oil tankers that were not seaward of 80 km (50 mi) tend to be vessels that traverse the waters without entering a port in California. These vessels stay more than 40 km (25 mi) from the coast (Mike VanHouten, U.S. Coast Guard, pers. comm., April 23, 2001).

Table 4.0.1-9. Marine Tankering Of Oil Offshore California

	Volume[1] (bbl)	Annual Tanker Trips[2]
Persistent Oils		
From Alaska	193,196,481	495
Other	38,473,754	349
Total	231,620,235	844
Non-Persistent Oils3		
From Alaska	931,085	8
Other	30,674,487	839
Total	31,605,572	847
TOTAL	263,225,807	1,691

[1] Tanker trips estimated from origin to destination oil volume and average tanker loads. Average tanker loads per trip estimated from Western States Petroleum Association study "Tanker and Barge Movements Along the California Coast – 1992" by DNA Association, Sacramento, CA, September 24, 1993.

[2] 390,000 barrels/trip used to estimate Alaska crude oil southbound trips. 110,000 bbl/trip used to estimate all other oil tanker movements.

[3] Non-persistent oil means petroleum-based oil, such as gasoline, diesel or jet fuel, which evaporates relatively quickly. Such oil, at the time of shipment, consists of hydrocarbon fractions of which: (A) at least 50 percent, by volume, distills at a temperature of 340 degrees C (645 degrees F); and (B) at least 95 percent, by volume, distills at a temperature of 370 degrees C (700 degrees F).

There is no tankering of oil and gas production from existing Pacific Region OCS oil and gas operations. All of the oil and gas produced on the OCS is transported to shore by pipeline.

4.1 GEOLOGY

4.1.1 GEOLOGY AND PETROLEUM POTENTIAL

The proposed action occupies two distinctly different geologic regions off the California coast. The northern region is the offshore Santa Maria Basin. The southern region is the Santa Barbara-Ventura Basin. The submerged portion of the Santa Barbara-Ventura Basin is commonly referred to as the Santa Barbara Channel (Figure 1.0-1).

4.1.1.1 REGIONAL GEOLOGY – OFFSHORE SANTA MARIA BASIN

The offshore Santa Maria Basin is approximately 100 miles (160 km) by 25 miles (40 km) in size and occupies an area of about 2,500 sq. miles (6,400 sq. km) (Mayerson, 1997; McCulloch, 1987). It is located west and north of the Point Arguello area, along the coastline of Santa Barbara and San Luis Obispo counties. The basin trends north-northwest, as do most of its structural features (fault and fold trends). The offshore Santa Maria Basin is bounded on the east by the Hosgri and related fault zones, on the south by the "Amberjack High" (of Crain, et al., 1984), on the west by the Santa Lucia Bank, and on the north by the "San Martin Discontinuity" (of McCulloch, 1987). As a depositional center, the basin began to form in the late Oligocene to early Miocene [approximately 30 to 25 million years ago (mya)].

The stratigraphy of the offshore Santa Maria Basin is known from seafloor exposures, seismic methods, and boreholes drilled within the basin since 1964 (Figure 4.1.1.1-1). The stratigraphic terminology used offshore has been adapted from the geologic literature which first described onshore exposures of the rock formations. The distribution and nature of basement rocks within the basin is not well known. Hoskins and Griffiths (1971) suggest that granitic rocks, similar to those seen in the onshore Santa Maria Basin area, may underlie portions of the offshore basin. Granitic rocks have not been identified in any of the offshore wells, however, granite-derived coarse clastic rocks of Cretaceous(?) to Eocene(?) age have been identified on the Santa Lucia Bank and other localities, suggesting a nearby granitic source. Metamorphic basement rocks of the Mesozoic (late Jurassic to early Cretaceous) Franciscan Formation have been identified in wells and outcroppings. Magnetic and gravity anomaly data, cited by McCulloch (1987), indicate a complex basement rock distribution within the basin.

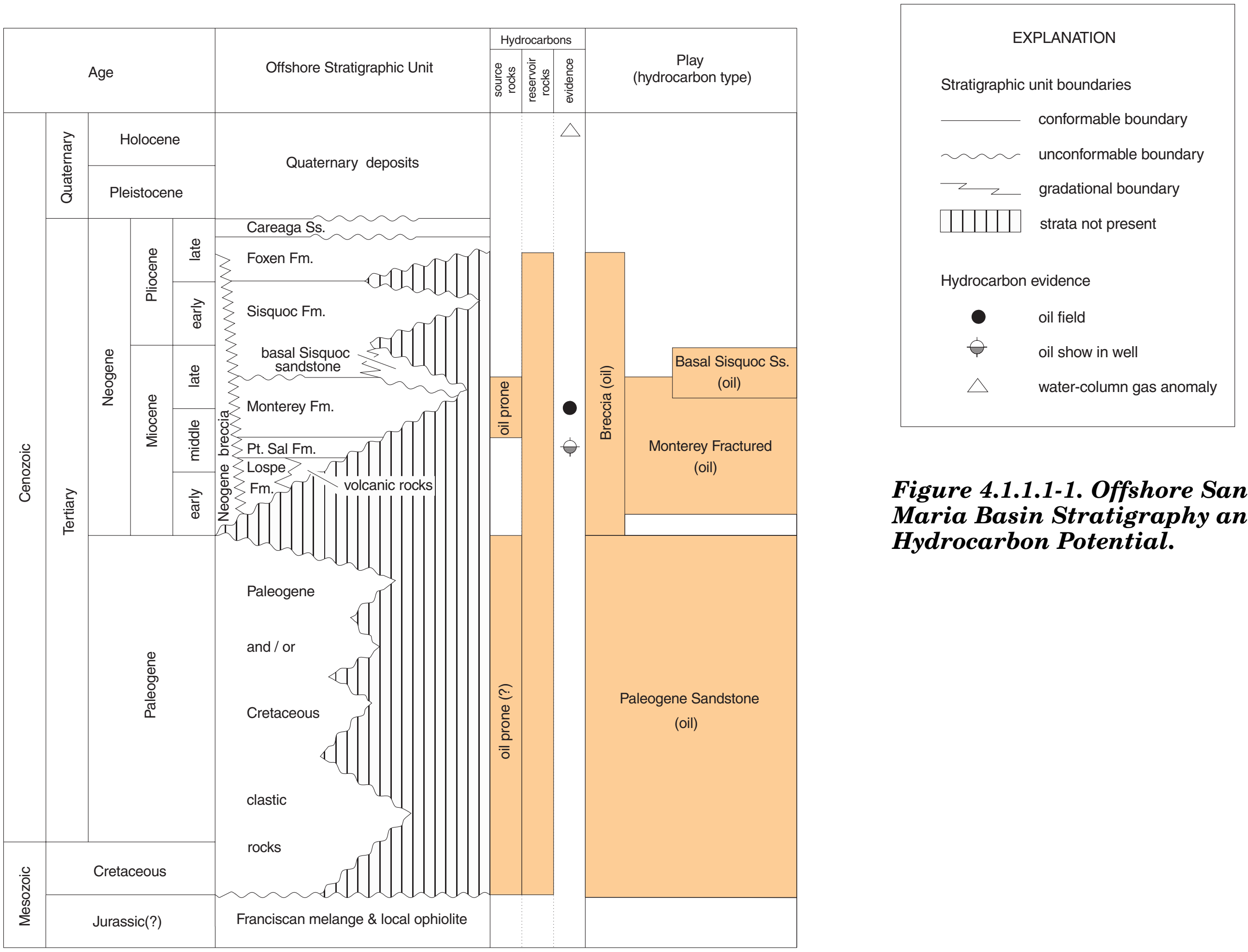

Figure 4.1.1.1-1. Offshore Santa Maria Basin Stratigraphy and Hydrocarbon Potential.

The oldest sedimentary rocks within the Neogene offshore depocenter are the non-marine to shallow-marine sandstones, conglomerates and tuffs of the lower Miocene(?) Lospe Formation and Tranquillon Volcanics. Unconformably overlying the Lospe Formation are a succession of deep marine, fine-grained sedimentary formations that span in age from early Miocene to present. This succession includes the mudstones and dolostones of the lower Miocene Point Sal Formation; the siliceous shales, porcelanites, cherts and dolostones of the middle to upper Miocene Monterey Formation; the diatomaceous and siliceous mudstones of the upper Miocene to lower Pliocene Sisquoc Formation; and the siltstones, claystones, and sandstones of the Pliocene to Holocene Foxen and Careaga Formations (Mayerson, 1997; Crain, et al., 1984). The Neogene sedimentary section within the basin varies from approximately 10,000 feet thick in the depocenters to less than 1,000 feet thick over high standing, eroded basement blocks (Mayerson, 1997; McCulloch, 1987).

The bioclastic, organic-rich Monterey Formation, was identified in the early 1900's as a prolific source rock for petroleum generation. In the onshore fields of the Santa Maria basin it was noted that where the brittle cherts and shales of the Monterey were fractured, it was also an important reservoir (Prutzman, 1913).

The Santa Maria Basin formed as a result of rapid subsidence initiated in the late Oligocene to early Miocene. Atwater (1970) attributed the simultaneous formation of several offshore basins along the California continental margin to a late Oligocene encounter of an oceanic spreading center and subduction-related trench. Blake, et al. (1978) suggested that the encounter initiated strike-slip tectonism along the margin. Seismic records within the basin suggest that compressional tectonics, expressed in folds and thrust faults, became the dominant structural style by Pliocene times.

4.1.1.2 REGIONAL GEOLOGY – SANTA BARBARA-VENTURA BASIN

The Santa Barbara-Ventura Basin is approximately 160 miles (260 km) by 40 (65 km) miles in size and occupies an area of about 6,400 sq miles (17,000 sq km). The west portion of the basin, commonly called the Santa Barbara Channel, is submerged and comprises an area of about 2,000 sq miles (5,200 sq km). The basin is located within the Transverse Ranges Province, so named because of the east-west trend of the basin's bounding mountain ranges. Those ranges include the Santa Ynez Mountains to the north, and the Santa Monica Mountains and Channel Islands to the south. The western extent of basin is less well defined and the "Amberjack High" (of Crain et al., 1984) is generally considered the boundary with the offshore Santa Maria Basin.

The stratigraphy of the Santa Barbara Channel area is known from coastal exposures, sea floor exposures, and numerous boreholes drilled offshore since the 1890's (Figure 4.1.1.2-1). The basin is probably underlain by a metamorphic or metasedimentary basement complex. Schists (similar to the Catalina Schist) and ophiolite-like rocks are noted in exposures on Santa Cruz Island and are reported in several boreholes (Vedder, 1987). Granitic rocks have been noted in the basin margins and granite-derived sediments within the basin suggest the possibility of granitic basement as well.

The oldest rocks drilled within the Channel area date to the Mesozoic. The Mesozoic and Paleogene-aged rocked within the basin were probably deposited in a forearc basin setting. This Cretaceous(?) to Oligocene sequence of rock formations suggest deposition within a basin adjacent to a paleosubduction zone. Rocks of this type are widely distributed throughout California and Baja California and are often referred to as the "Great Valley Sequence." A thorough review of basement strata and the Great Valley Sequence in the Santa Barbara Channel and adjacent areas is found in Vedder (1987).

At some point near the end of the Paleogene, approximately 38 to 35 mya, probably related to the regional structural event described by Atwater (1970), clockwise rotation of the forearc sequence began to form the Transverse Ranges Province. Kamerling and Luyendyk (1979) document up to 120 degrees of rotation based on paleomagnetic data. By 20 mya, the transform boundary between the North American and Pacific plates was the San Andreas Fault. The result of these regional stresses resulted in the formation of several small tectonic basins (including the Santa Maria, Santa Barbara-Ventura, and Los Angeles basins) with localized structural complexities.

The Neogene sedimentary record indicates a predominant marine depositional environment. Microfaunal evidence in the paleontological record suggests that deposition in the Santa Barbara-Ventura basin occurred in outer neritic to bathyal depths (S. Drewry, personal communication). Basin subsidence continues in the depocenters today; however, in the past 5 million years, the rate of terrigenous sedimentation has filled the eastern portion of the basin, leaving only the Santa Barbara Channel area submerged. Major structural features in the basin, including the San Cayetano, Santa Susana, and Oakridge thrust faults, and the Ventura, Rincon, and Montalvo anticlines suggest crustal shortening within the basin. Sylvester and Brown (1988) indicate that several of these features may be geologically quite young (less than 1 million years old).

A regional unconformity of non-marine, transitional, and shallow marine rocks of the Sespe and Alegria formations marks the end of the Oligocene. During the Miocene, the sedimentary rocks record a sudden deepening of the basin, as indicated by the transition form the nearshore Vaqueros Sandstone to the deepwater Rincon and Monterey Formations. The Rincon Formation is composed of clay shales, mudstones, and siltstones. The Monterey Formation is composed of bioclastic siliceous and phosphatic shales, cherts, and calcareous and carbonaceous shales and marls. Early Miocene basin-edge marine fan facies are also noted in the record.

The Miocene to Pliocene transition is recorded in the coeval Sisquoc and Modelo Formations. The Sisquoc Formation is characterized by fine-grained, terrigenous-rich diatomaceous deposits. The Modelo Formation differs from the Sisquoc in that it contains occasional thick sandstone beds. Blake (1988) suggests that the increase in fine- and coarse-grained sediments in these deepwater formations is the result global sea level changes.

Pliocene sedimentation in the eastern portion of the basin is characterized by an influx of coarse-grained material in volumes overtaking the rate of subsidence and compaction. Paleobathymetric data clearly records the shoaling of the basin. The Repetto and Pico Formations are composed of turbidite-derived sands, siltstones, and shales. Generally, bed thickness and the sand-to-shale ratio of the formations increase up-section, while the depositional environment shallows. In the western portion of the basin, turbidite deposition is largely absent. Pliocene-aged sediments there are generally fine-grained and derived from nearby upland sources.

4.1.1.3 PETROLEUM POTENTIAL

The project areas in both the offshore Santa Maria Basin and the Santa Barbara Channel are areas of proven petroleum potential. Natural oil, tar, and gas seepage in the nearshore and offshore areas were known to the Indian inhabitants of coastal southern California in prehistoric times (Heizer, 1943). Early European explorers also noted the occurrence of hydrocarbon seeps, particularly along the northern coastline of the Santa Barbara Channel (Wilkinson , 1971).

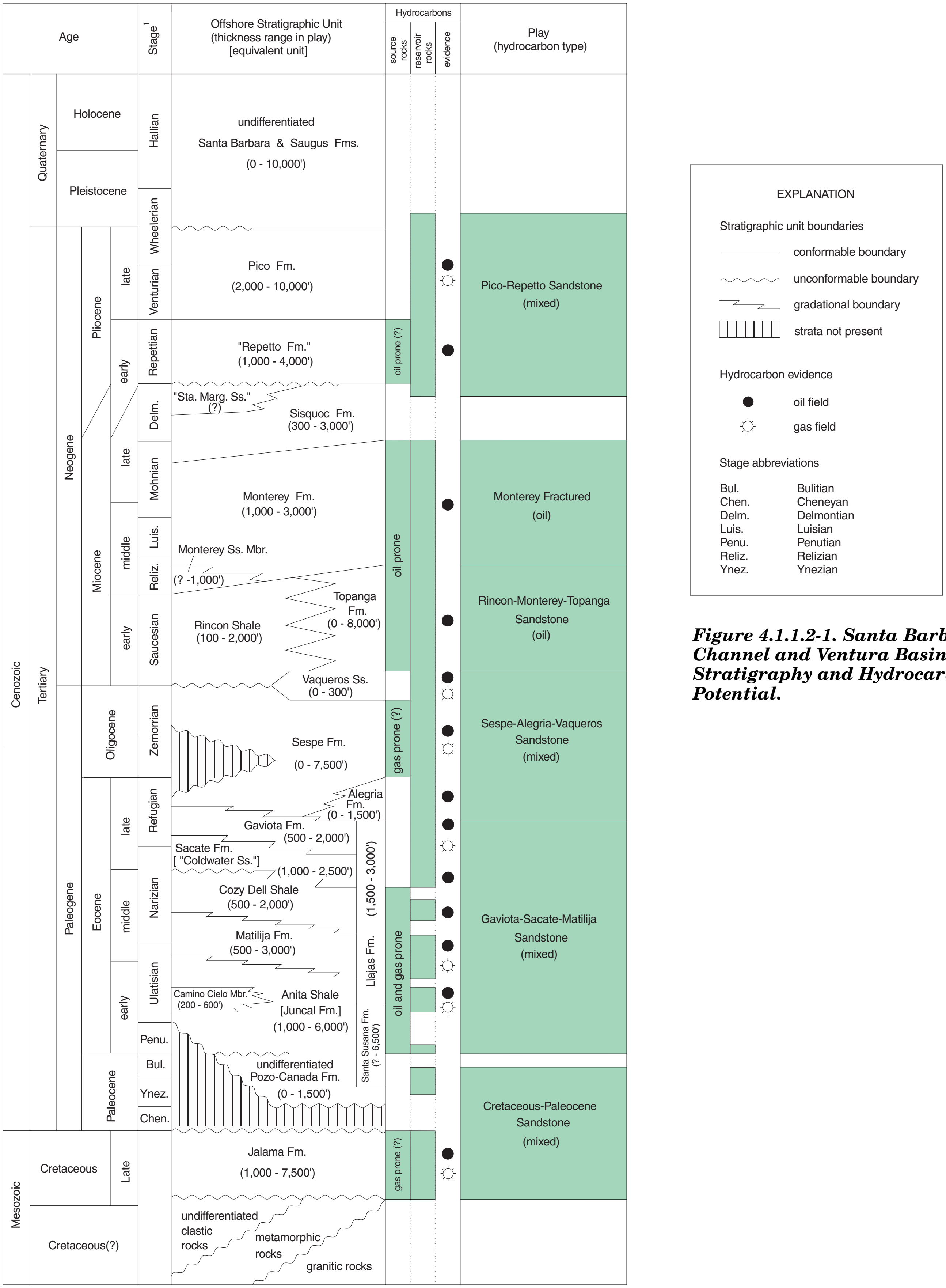

Figure 4.1.1.2-1. Santa Barbara Channel and Ventura Basin, Stratigraphy and Hydrocarbon Potential.

Seepage oil was an important commodity to both the Indians and the early European settlers of the region. Fischer (1977) noted that most of the offshore seepage occurred in areas where the Monterey or Sisquoc formations are exposed at or near the seafloor, and where active faulting or growing folds were observed.

Active exploration for oil began in the Santa Barbara-Ventura Basin as early as the 1860's with the oil tunnels dug into the seeps of the Santa Paula area. The earliest offshore oil exploration occurred at Summerland in the 1890's, where the onshore field there was extended offshore by drilling on the beach and from piers (Galloway, 1997). Offshore oil exploration progressed in the Santa Barbara Channel area with several coastal oil field discoveries in the 1920's and 1930's. These included the Rincon, Ellwood, and Capitan oil fields. Initially, the offshore portions of these fields were developed by wells drilled from piers and by wells drilled directionally from onshore locations. The prototype for the modern oil platform, known as the "Steel Island," was constructed on the offshore portion of the Rincon oil field in 1931 (Galloway, 1992).

Following World War II, the advances in petroleum exploration technology (such as the invention of mobile offshore drilling vessels and the development of computer processing techniques for seismic reflection data) led to further exploration, discovery, and production of the region's hydrocarbon resources. In the late 1940's, 1950's, and 1960's several more nearshore and offshore oil and gas field discoveries were made. Most of these were in the Santa Barbara-Ventura basin, with the exception of the Guadalupe oil field near the mouth of the Santa Maria River.

On Federal OCS lands (those lands in excess of three geographic miles seaward of the coast) oil exploration began in the 1950's with the drilling of coreholes and the mapping of the subsurface features through the use of early seismic reflection profiling techniques. The first Federal OCS leasing in the area (Lease Sale P-1, 1963) included leases in the Santa Maria basin, which led to the drilling of one oil well in 1965, approximately 12 miles southwest of Oceano (Webster, 1983). Following a 1965 U.S. Supreme Court decision, settling the jurisdiction over the Santa Barbara Channel area, leasing, exploration, and development of the Federal lands in the Santa Barbara-Ventura basin proceeded.

Since the 1960's, several large oil and gas fields have been discovered and developed in and around the project areas. Most of the proposed projects in this EIS have been explored and have undeveloped discoveries on them.

4.1.2 GEOLOGIC HAZARDS

The principal geologic hazards in the region are (1) earthquakes, (2) tsunamis, (3) mass wasting, and (4) shallow gas. There exists no credible threat of local volcanic activity.

4.1.2.1 HISTORIC EARTHQUAKES

Southern California is located along a seismically active plate margin (Figures 4.1.2.1-1. "Late Quaternary Fault Map" and Figure 4.1.2.1-2. "Seismicity Map," both modified after Jacobs Engineering Group, 1988). The major transform fault in the region is the San Andreas Fault. The last significant earthquake along the segment of the fault which borders the Santa Barbara and Ventura county areas happened in 1857, and is known as the "Fort Tejon" quake. Davis, et al. (1982) postulate an 8.3 magnitude earthquake in their planning scenario, modeled on the 1857 quake.

Several significant (Richter magnitude 6 or greater, or Modified Mercalli intensity scale VIII or greater) earthquakes have occurred in historic times near the project areas. Earthquake magnitudes were first measured on instruments in 1903. However, prior to the 1930's and the advent of the widespread use of seismographs and the establishment of seismological networks, the epicentral locations of these significant earthquakes are conjectural.

On December 21, 1812, an earthquake centered in the Santa Barbara county area, possibly in the western Santa Barbara Channel, damaged or destroyed several of the old Spanish missions, including Mission La Purisima in Lompoc (destroyed), the Mission Santa Barbara (severely damaged), and the Mission Santa Inez (damaged). The 1812 earthquake occurred in an area that was sparsely populated. The main shock was preceded by about 15 minutes by a foreshock of considerable strength. The main shock was felt over a wide area of California. Damage from the quake would rate approximately level IX to X on the Mercalli scale. The approximate Richter magnitude would have been greater than 7. Mission Fathers report suspending a ball from a chain at the Santa Barbara Presidio and watching it move continuously for twenty-three days (George Pararas-Carayannis website). A series of aftershocks were recorded for a least three months following the main quake (Townley, 1939).

There are no reports of ground rupture from the December 21 earthquake. This had led researchers to postulate that the quake occurred along an offshore fault, such as the North Channel Slope fault or the offshore southern branch of the Santa Ynez fault (Yerkes, 1980, 1981). The evidence for an offshore source is equivocal. Recent quakes in southern California demonstrate that even large seismic events do

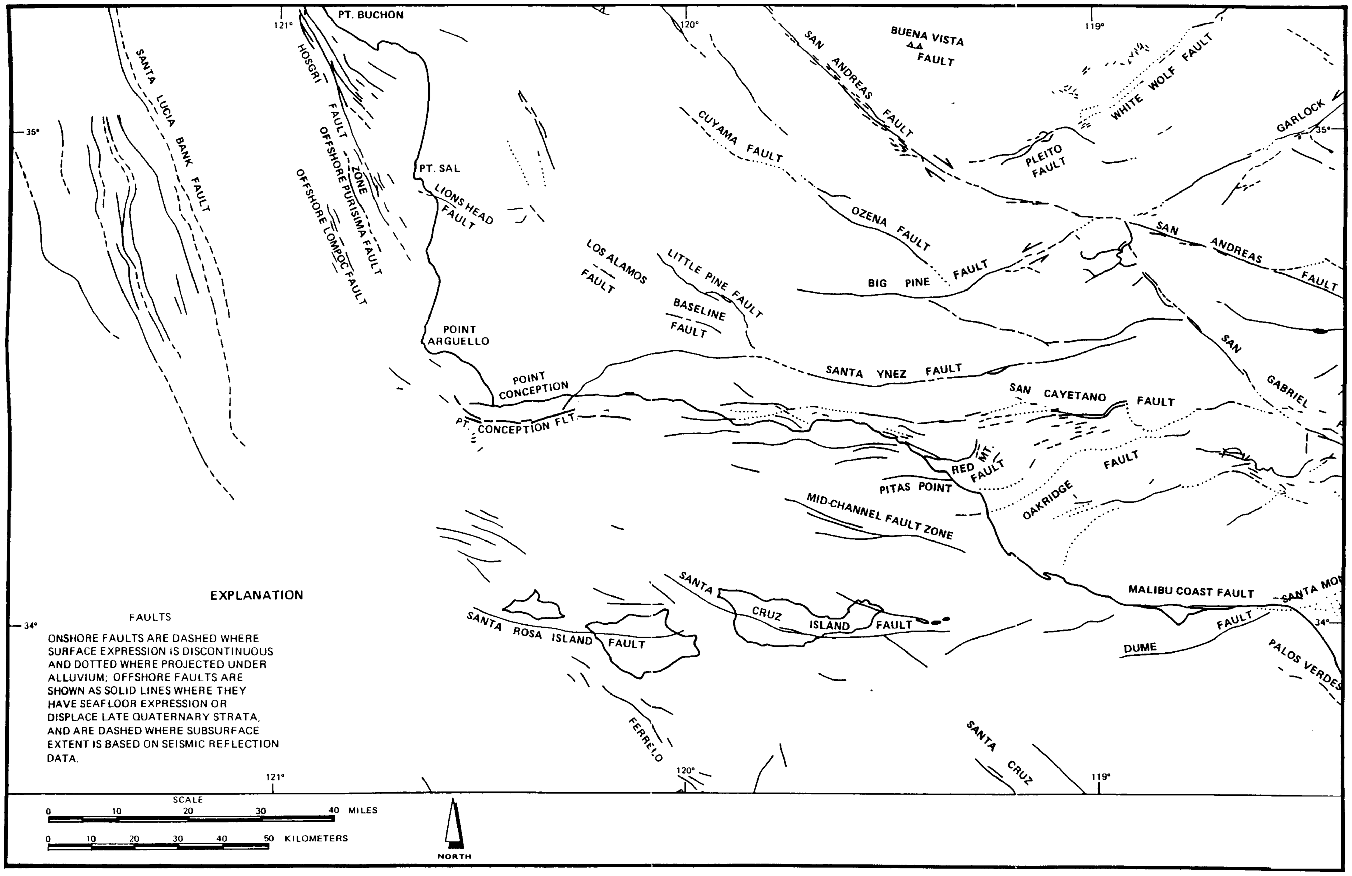

Figure 4.1.2.1-1. Late Quaternary Fault Map Of Western Transverse Range Region.

not necessarily produce significant surface rupture.

Interestingly, the December 21 temblor was the second large earthquake that month to rock southern California. On December 8, another earthquake, best remembered for damaging the Mission San Juan Capistrano, was noted in the Mission journals. The December 8 shock may have been epicentered in the Wrightwood area, on the San Andreas Fault (Townley, 1939; Jacoby, et al., 1988). It is unclear to seismologists if these earthquakes are in any way related. The December 21 earthquake purportedly spawned a minor tsunami in the Santa Barbara Channel, which will be discussed below.

On January 9, 1857, a great quake, with a probable magnitude of over 8 on the Richter scale, was felt over a wide area of California, Mexico, and neighboring states. The surface rupture from this earthquake reached from the area near Parkfield, CA, to Cajon Pass, near San Bernardino – a distance of over 200 miles (300 km). This earthquake was preceded by two M=6 +/- foreshocks in the Parkfield area. Shaking during the main shock lasted up to three minutes. At Fort Tejon and other places along the rupture, the Mercalli intensity reached XII (highest level of destruction). In Santa Barbara, over 40 miles away from the San Andreas fault, strong shaking lasted over one minute, but the damage was negligible. California was still sparsely populated in 1857 and few deaths resulted from this quake.

A swarm of earthquakes severely damaged the Los Alamos area of northern Santa Barbara County, from July 27 to July 31, 1902. The largest of the temblors, on July 31, registered an intensity of VIII on the Modified Mercalli scale. Older adobe and masonry buildings suffered more damage than wood-framed buildings. Noticeable aftershocks continued for several months (Townley, 1939)

In the early morning hours of June 29, 1925, several small foreshocks rocked the Santa Barbara area. Most residents of that city were awakened at 6:44 a.m. by the M=6.8 main shock. The shaking lasted about 20 seconds. The epicenter of the quake was located in the Santa Barbara Channel, about 8 miles southwest of the city. This earthquake caused considerable damage in the old business district and accounted for several deaths. The failure of the Sheffield Dam near Santa Barbara is attributable to liquefaction of the underlying soils (Willis, 1925).

On November 4, 1927, in the pre-dawn hours a very strong earthquake struck the offshore Santa

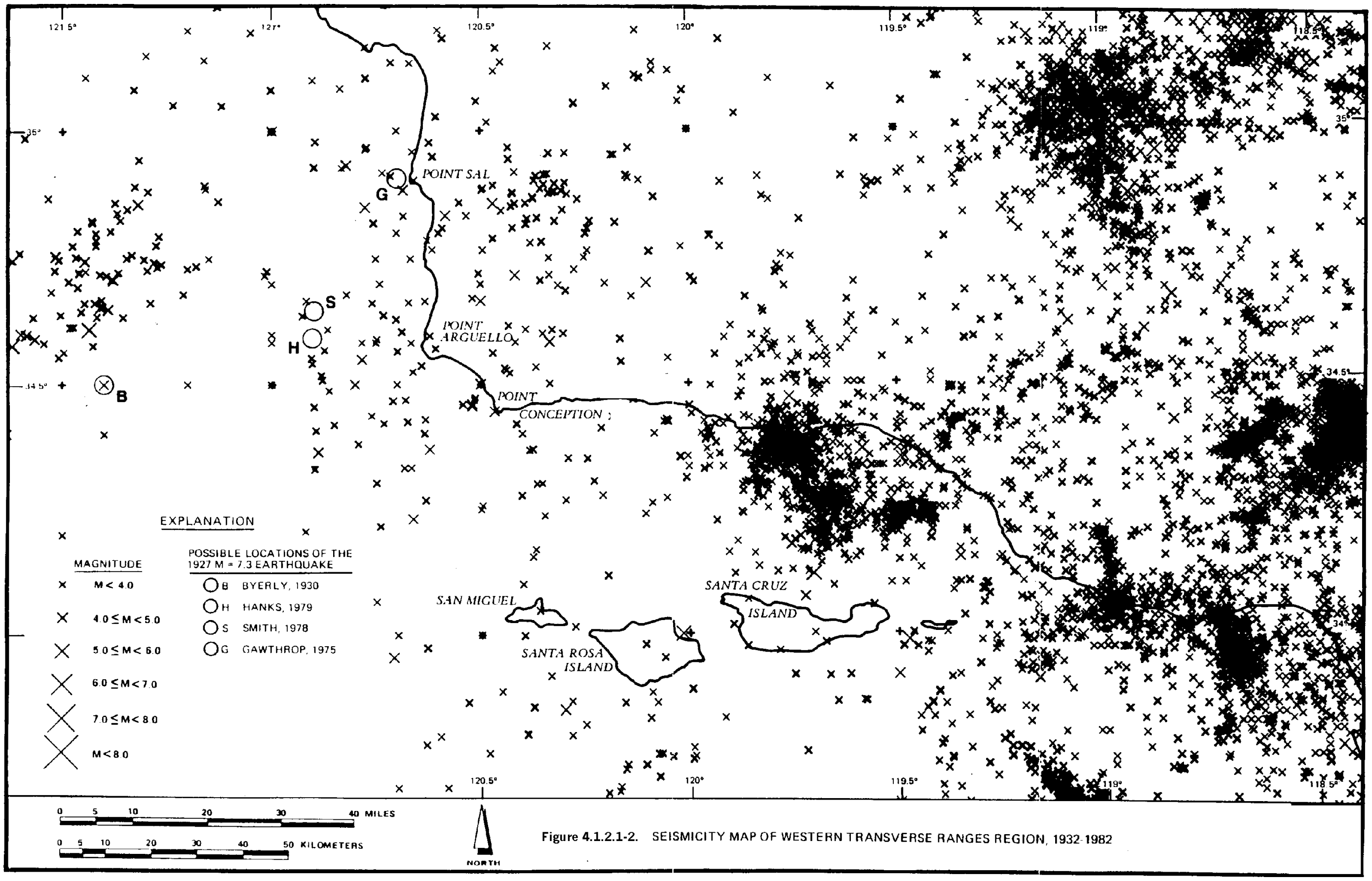

Figure 4.1.2.1-2. Seismicity Map Of Western Transverse Ranges Region, 1932-1982.

Maria basin. This quake is alternatively known in the literature as the "Point Arguello" earthquake or the "Lompoc" earthquake. Both the magnitude and location of this earthquake are a source of controversy. The quake was witnessed both on shore and at sea (Townley, 1927; Byerly, 1930; Gawthrop, 1978; Hanks, 1979; Helmberger, et al., 1992; Satake and Somerville, 1992). Gawthrop (1978), analyzing the recorded aftershock sequence, concluded the main shock was located near the coast, possibly on the Hosgri Fault system. The recent re-analysis of the 1927 earthquake by Helmberger, et al. (1992), and the analysis of the related tsunami by Satake and Somerville (1992), suggest the earthquake occurred far from the coast, in deep water, on a thrust fault related to the southern portion of the Santa Lucia Bank fault zone.

The earthquake occurred during the pre-dawn hours, at about 5:51 a.m. It was felt over a wide area of southern California. The captains of two vessels within 20 miles of the probable epicenter noted similar phenomena in their logs, including a shuddering sensation, as if the ship was running aground. They also noted a second seismic event 20 minutes later. Another ship's captain was startled to find the ocean surface littered with dead or stunned fish later that morning. These observations are attributable to "sea quake" – a shock wave propagated through the water column (Institute for Crustal Studies, UCSB, website).

Coastal and inland towns, 20-30 miles from the epicenter, registered Mercalli intensity ratings as great as IX to X. Reports from ranches and small communities nearest the epicenter suggest shaking strong enough to throw objects into the air and to knock standing people from their feet. Landslides, sand boils, and local liquefaction gave evidence to the severity of this quake. This earthquake spawned a small tsunami (see below for further discussion).

A moderate earthquake, registering about magnitude 6, struck the coastal communities of Santa Barbara, Carpinteria, and Summerland at 11:50 p.m. on June 30, 1941. The epicenter of the earthquake was located in the Santa Barbara Channel about 2 miles (3 km) south of Summerland (Ulrich, 1942). The slight damage from this quake, particularly in Santa Barbara (six miles from the epicenter), is a testament to revisions in the building codes following the 1925 Santa Barbara and 1933 Long Beach earthquakes.

A very large earthquake struck the Kern County