

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Estimated Oil and Gas Reserves,
Southern California Outer Continental Shelf,
January 1, 1977

By
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This report has not been edited for conformity
with Geological Survey editorial standards or
stratigraphic nomenclature

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ABSTRACT

As of January 1, 1977, approximately 1,450 billion cubic feet of gas and about 670 million barrels of oil* are estimated as remaining recoverable reserves in 11 of the 12 fields in the Outer Continental Shelf (OCS) off Southern California. No estimates were made for the unnamed field on lease P-0234 because well testing was not sufficient to allow a reasonable assessment. Of the 12 recognized fields, only two are producing and none is completely developed. Limits of many of the fields will be further defined by anticipated additional exploratory drilling. Original recoverable reserves in 11 fields are estimated to have been approximately 1,530 billion cubic feet of gas and about 830 million barrels of oil.

Reserve estimates for nine fields were based on individual volumetric reservoir studies. Decline curve and volumetric analyses were used to estimate reserves in two fields. The estimates of original and remaining reserves are reported as one total for oil and one for gas within the Southern California OCS.

*The term "oil" as used in this report includes crude oil, condensate and gas-plant liquids.

INTRODUCTION

This report presents estimates of original recoverable oil and gas reserves, cumulative production through 1976, and estimates of remaining recoverable reserves as of January 1, 1977, on the Outer Continental Shelf (OCS) off Southern California. The study was completed in November 1977.

ACKNOWLEDGMENTS - The estimates presented here represent the combined efforts of geologists, geophysicists, petroleum engineers and other technical personnel within the U.S. Geological Survey. Major contributions were made by Messrs. M.N. Fernandez, G.B. Goodfellow, M.A.H. Ibrahim, G.L. Lore, R.L. Phair, S.E. Prensky. This report is analogous to others prepared by Bryan and Knipmeyer (1977) and Bryan and others (1978).

DEFINITION OF RESERVE AND RESOURCE TERMS

The reserve and resource terminology in this report conforms with that published by Miller and others (1975, p. 8-9). The quoted definitions of terms applicable to this report are:

"Resources.--Concentrations of naturally occurring solid, liquid, or gaseous materials in or on the Earth's crust in such form that economic extraction of a commodity is currently or potentially feasible."

"Reserves.--That portion of the identified resource which can be economically extracted."

"Measured reserves.--That part of the identified resource which can be economically extracted using existing technology, and whose amount is estimated from geologic evidence supported directly by engineering measurements.***"

"Indicated reserves.--Reserves that include additional recoveries in known reservoirs (in excess of the measured reserves) which engineering knowledge and judgment indicate will be economically available by application of fluid injection, whether or not such a program is currently installed (API, 1974). In this study indicated reserves are equivalent to API indicated additional reserves."

"Demonstrated reserves.--A collective term for the sum of measured and indicated reserves."

APPLICATION OF TERMS IN PRESENT REPORT

"Measured reserves" as used in this report comprises recoverable hydrocarbons within boundaries defined by the use of both seismic interpretation and well control in fields where well control was sparse.

Two producing oil fields in the Southern California Outer Continental Shelf--Dos Cuadras Offshore and Carpinteria Offshore--are undergoing fluid injection, and therefore recovery beyond primary production is in progress or can be anticipated. For some remaining fields, where it was determined that "indicated reserves" could be anticipated by comparison with similar producing fields, "indicated reserves" were included with the "measured reserves" for a total estimate of "demonstrated reserves."

Pacific Area OCS Order No. 4, "Suspensions and determination of well producibility," provides criteria for determining, through evaluation of borehole testing, whether a well is capable of being produced in paying quantities (U.S. Geological Survey, 1976).

The quality and quantity of the data vary from field to field. In some instances these "paying quantities" as defined in the OCS Order may not prove to be "economically extractable" reserves. These accumulations would generally be omitted from reserve calculations. They are included here, however, because they may be necessary for effective planning and lease management.

METHODS USED FOR RESERVES ESTIMATION

Volumetric calculation.--The amount of original oil and gas in place is estimated from the bulk volume of the reservoir as mapped, using data from drill holes and seismic profiles. Net oil and gas sand thickness maps are made and planimetered, and the results converted to bulk volume by use of pyramidal formulae. Porosity of the rock and the amount of water, oil, and gas in the pore space are interpreted from borehole logs and the analyses of cores. The total amount of oil and gas in place is converted to standard conditions by analysis of pressure, volume, and temperature relationships and the use of standard correlation charts.

The amount of the original oil and gas in place that can be recovered is estimated from knowledge of the reservoir-drive mechanism, spacing of the wells, and American Petroleum Institute (API) recovery-factor equations (Arps and others, 1967, p. 19-20).

Decline-curves.--In the decline-curve method, future production is estimated by extrapolating plots of production rates against time. The original reserves are determined by adding past production to predicted future production.

FIELDS REPORTED

As of January 1, 1977, 12 fields in the federally controlled part of the Southern California OCS were recognized as producing or capable of producing based on the "producible in paying quantities" criterion (fig. 1). Seven of the fields are oil fields and five are combination oil and gas fields. Reserve estimates were made on 11 of the 12 fields. One oil field studied, the unnamed field on lease P-0234, did not have sufficient testing to permit a reasonable estimate. Reserves are estimated for the Federal portion only of fields lying partly in State waters and partly in Federal waters.

Estimates of the combined totals for 11 fields within the Southern California OCS are reported in table 1. Separate totals are given for oil and gas. The totals are reported as composite numbers to protect the proprietary nature of the data used to make the estimates.

STATUS OF DEVELOPMENT

As of January 1, 1977, none of the fields in the Southern California OCS was fully developed. Of the 12 recognized fields, only two--Dos Cuadras Offshore and Carpinteria Offshore--have platforms installed and are presently producing. A platform is set on a third field, Hondo Offshore, and development drilling began in 1977. Additional exploratory drilling is anticipated in many of the remaining nine fields to further define productive limits and aid in effective development.

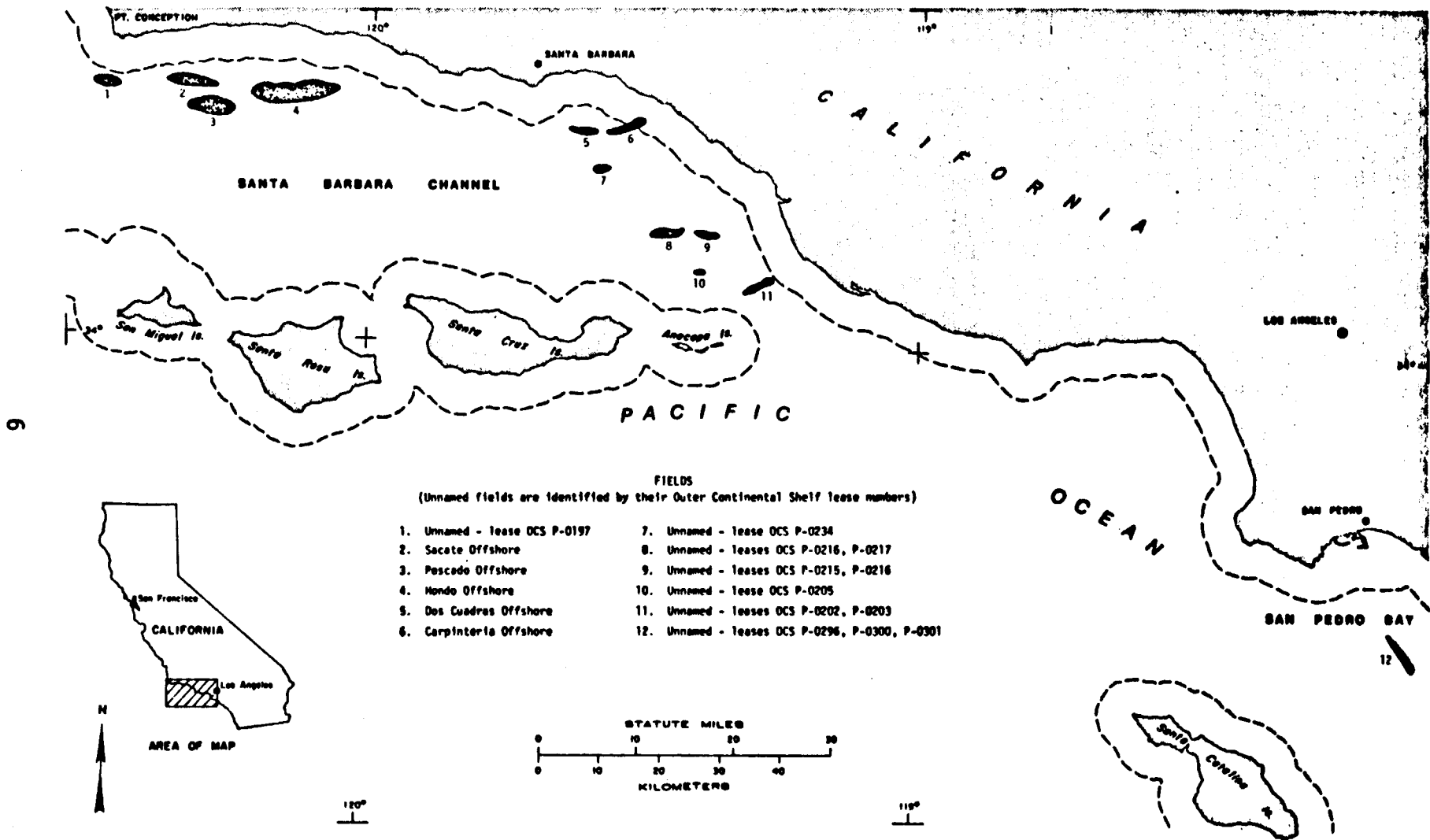


Figure 1. Recognized discoveries of federally controlled oil and oil and gas fields in the Southern California Outer Continental Shelf. Dashed lines indicate 3-nautical-mile boundary between State and Federal waters.

TABLE 1--Estimated demonstrated oil and gas reserves for 11 fields,
Southern California Outer Continental Shelf,

January 1, 1977

("Demonstrated reserves": the sum of measured and indicated reserves. Oil expressed in millions of barrels, gas in billions of cubic feet. "Oil" includes crude oil, condensate, and gas-plant products sold; "gas" includes both associated and non-associated dry gas. Cumulative production through 1976. Remaining recoverable reserves estimated as of January 1, 1977)

<u>HYDROCARBON</u>	<u>ORIGINAL RECOVERABLE RESERVES</u>	<u>CUMULATIVE PRODUCTION</u>	<u>REMAINING RECOVERABLE RESERVES</u>
Oil.	829	156	673
Gas.	1,530	79	1,451

STUDIES CONDUCTED

Estimates of the two producing fields were made on the basis of volumetric and decline curve analyses. Individual reservoirs in each field were grouped for volumetric calculations and decline curve analyses were made on a lease-by-lease basis. The remaining nine fields were studied on a reservoir-by-reservoir basis and the reserve estimates were made by the volumetric method. A total of 87 reservoirs were analyzed in this study.

FIELD-SIZE DISTRIBUTION

Figure 2 shows the field-size distribution of the original recoverable reserves of 6 oil fields and 5 oil and gas fields. For convenience of comparison, gas reserves are expressed in terms of oil based on equivalent heating values (6,000 cubic feet of gas

is equivalent to 1 barrel of oil). This histogram exhibits a log-normal distribution, with a majority of the fields in the 0-100 million barrel category. More than 75 percent of the combined reserves, however, are in the larger fields.

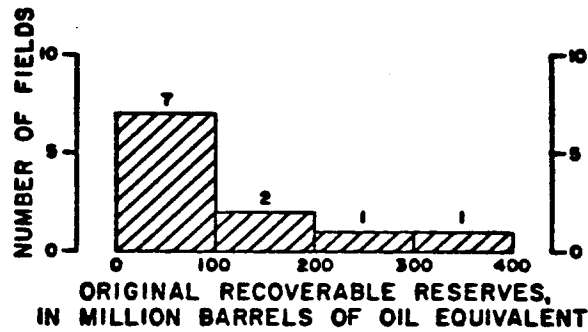


Figure 2. HISTOGRAM SHOWING FIELD-SIZE DISTRIBUTION OF OIL FIELDS, AND OIL AND GAS FIELDS

CONCLUSIONS

Original reserves estimated at 829 million barrels of oil and 1,530 billion cubic feet of gas were contained in 11 of the 12 fields in the federally controlled part of the Southern California Outer Continental Shelf. As of January 1, 1977, remaining recoverable reserves were estimated to be 673 million barrels of oil and 1,451 billion cubic feet of gas. One field was not included in the estimate because testing was too limited to permit a reasonable evaluation. Anticipated future exploration and development, together with additional studies, will add to and refine the current reserve estimates.

REFERENCES CITED

- American Petroleum Institute, American Gas Association, and Canadian Petroleum Association, 1966-1974, Reports on proved reserves of crude oil, natural gas liquids, and natural gas in the United States and Canada (annual volumes for the years 1966-1974): New York, Am. Petroleum Inst.
- Arps, J.J., Brons, Folkert, van Everdingen, A.F., Buchwald, R.W., and Smith, A.E., 1967, A statistical study of recovery efficiency: Am. Petroleum Inst. Bull. D14, 33p.
- Bryan, F.T., and Knipmeyer, J.H., 1977, Estimated oil and gas reserves, Gulf of Mexico Outer Continental Shelf, January 1, 1976: U.S. Geol. Survey Open-File Report 77-71, 10 p.
- Bryan, F.T., Knipmeyer, J.H., and Schluntz, E.K., 1978, Estimated oil and gas reserves, Gulf of Mexico Outer Continental Shelf, January 1, 1977: U.S. Geol. Survey Open-File Report 78-87, 11 p. (Supersedes Bryan and Knipmeyer report)
- Miller, B.M., Thomsen, H.L., Dolton, G.L., Coury, A.B., Hendricks, T.A., Lennartz, F.E., Powers, R.B., Sable, E.G., and Varnes, K.L., 1975, Geological estimates of undiscovered recoverable oil and gas resources in the United States: U.S. Geol. Survey Circ. 725, 78 p.
- U.S. Geological Survey, [1976], OCS Order No. 4 (June 1, 1971), Suspensions and determination of well producibility, in Notice to lessees and operators of Federal oil and gas leases in the Outer Continental Shelf, Pacific area--OCS orders: U.S. Geol. Survey. (Available from U.S. Geological Survey Oil and Gas Supervisor, Pacific Area, 7211 Federal Building, 300 N. Los Angeles Street, Los Angeles, Calif. 90012)