

(200)
R 296
10.78-87



X

✓ UNITED STATES (DEPARTMENT OF THE INTERIOR)

GEOLOGICAL SURVEY. [Reports- Open file series]

Abstract ...

Introduction ...

Definition of reserve and resource terms ...

Application of terms in present report ...

Methods used for reserves and resources ...

Fields reported ...

Tables presented - Estimated Oil and Gas Reserves,
Gulf of Mexico Outer Continental Shelf,

Checkings ... January 1, 1977

References cited ...

TM
Lew
t wanal

By Floyd T. Bryan, John H. Knipmeyer, and E. Kenneth Schluntz



Superseded by Open File, Jan 1978, 79-551

Open-File Report 78-87

1978

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

CONTENTS

	Page
Abstract	1
Introduction	1
Definition of reserve and resource terms	2
Application of terms in present report	3
Methods used for reserves estimation	3
Fields reported	5
Studies conducted	5
Field-size distribution	8
Conclusions	8
References cited	10

ILLUSTRATIONS

Figure 1. Index map showing Outer Continental Shelf leasing areas off Texas and Louisiana	6
2. Histogram showing field-size distribution of gas fields	9
3. Histogram showing field-size distribution of oil fields, and oil and gas fields	9

TABLE

Table 1. Estimated demonstrated oil and gas reserves, January 1, 1977	7
--	---

Estimated Oil and Gas Reserves,
Gulf of Mexico Outer Continental Shelf,
January 1, 1977

By Floyd T. Bryan, John H. Knipmeyer, and E. Kenneth Schluntz

ABSTRACT

As of January 1, 1977, nearly 35 trillion cubic feet of gas and about 2.7 billion barrels of oil* are estimated to be the remaining reserves in 294 fields in the Gulf of Mexico Outer Continental Shelf off Texas and Louisiana. Twenty-seven additional fields, discovered since January 1, 1976, in these Federal waters are not yet sufficiently developed to permit a reasonably accurate estimate of measured reserves. Nearly 66 trillion cubic feet of gas and 6.9 billion barrels of oil are estimated to have been originally recoverable from 306 fields, 12 of which are not considered to have any remaining reserves.

Reserve estimates were made on a reservoir-by-reservoir basis for 146 fields and on a field-wide basis for the other 160 fields. The resulting estimates of original and remaining reserves are reported here in terms of geographic area within the Outer Continental Shelf and adjacent slope.

INTRODUCTION

This report, which supersedes USGS Open-File Report 77-71 (Bryan and Knipmeyer, 1977), presents estimates of original recoverable reserves, cumulative production through 1976, and estimates of remaining

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

recoverable reserves as of January 1, 1977. The estimates of remaining reserves were completed in September 1977.

Acknowledgments.--The estimates presented here incorporate contributions by various geologists, engineers, and other technical personnel of the U.S. Geological Survey's Metairie, La., Office.

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."

Attempts are being made to standardize hydrocarbon reserves terminology used by various agencies. The principal difference in definitions concerns whether or not the reservoir has been tested or "proven."

APPLICATION OF TERMS IN PRESENT REPORT

Many oil fields in the Gulf of Mexico Outer Continental Shelf (OCS) are undergoing fluid injection, and therefore recovery beyond primary production is in progress or can be anticipated. In many instances the reserves reported herein are demonstrated reserves--that is, they include both measured reserves estimated to be available by primary production methods and indicated reserves estimated to be available through use of secondary recovery methods such as fluid injection.

Gulf of Mexico OCS Order No. 4, "Suspensions and determination of well producibility," introduces a local variation in terminology. The Order provides criteria for determining, through evaluation of borehole logging and sampling, whether "****a well is capable of being produced in paying quantities" (U.S. Geological Survey, 1975, p. 4-2). The quality and quantity of the data vary from field to field. In some instances these "paying quantities" may not prove to be "economically extractable" accumulations and, except for the OCS Order, would 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 from data on

well logs. Isopach maps are made and planimetered, and the results converted to bulk volume by use of pyramidal formulas. Porosity of the rock and the amount of water in the pore space that also contains oil and gas 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 recovery-factor equations.

Material balance.--The amount of oil and gas originally in place is determined from equations based on production, drop in reservoir pressure, and accompanying changes in the fluid being produced from the reservoir. The amount that can be recovered is estimated by the same method as in volumetric calculation.

Decline curves.--In the decline-curve method future production is estimated by extrapolating plots of various production data such as production rate, fluid percents, and pressure plotted against time and cumulative production. The original reserves are determined by adding past production to predicted future production.

Mathematical reservoir simulation.--In this method reservoir performance is simulated on a computer by means of many material balance calculations based on changes in reservoir conditions resulting from production. A standard reservoir-simulation computer program incorporates modifications based on local conditions.

FIELDS REPORTED

As of September 1977, 321 active fields in the federally controlled part of the Gulf of Mexico were listed by the U.S. Geological Survey Gulf of Mexico OCS Operations Field Names Committee. Of this number, 294 were considered sufficiently developed to warrant estimation of reserves for this study. An additional 12 fields, which are not listed by the Committee, were abandoned after significant production, but are reported herein, so as to complete the record of cumulative oil and gas production through December 31, 1976. (These 12 are represented in the original reserves and cumulative production columns of table 1, but are not considered to have any remaining recoverable reserves.) For any field that is partly in State waters and partly in Federal waters, reserves are estimated for the Federal portion only.

Estimates of all producing fields as well as all fields discovered prior to 1976 are included in area totals (table 1). The areas (fig. 1) are those delineated by the Bureau of Land Management for administrative purposes. The reserves reported in table 1 include estimates for 306 fields and constitute the current listing in the U.S. Geological Survey's Field and Reservoir Reserve Estimates (FRRE) data-processing system.

STUDIES CONDUCTED

Estimates of 146 fields reflect individual reservoir studies, many of them utilizing two of the methods previously discussed. For each of the 3,300 reservoirs in the 146 fields, a volumetric estimate was made, and for many of them, at least one other estimation method was also used. The subsequent performance of each reservoir is periodically compared to the original predictions. More than 150 additional reservoirs are being studied each month.

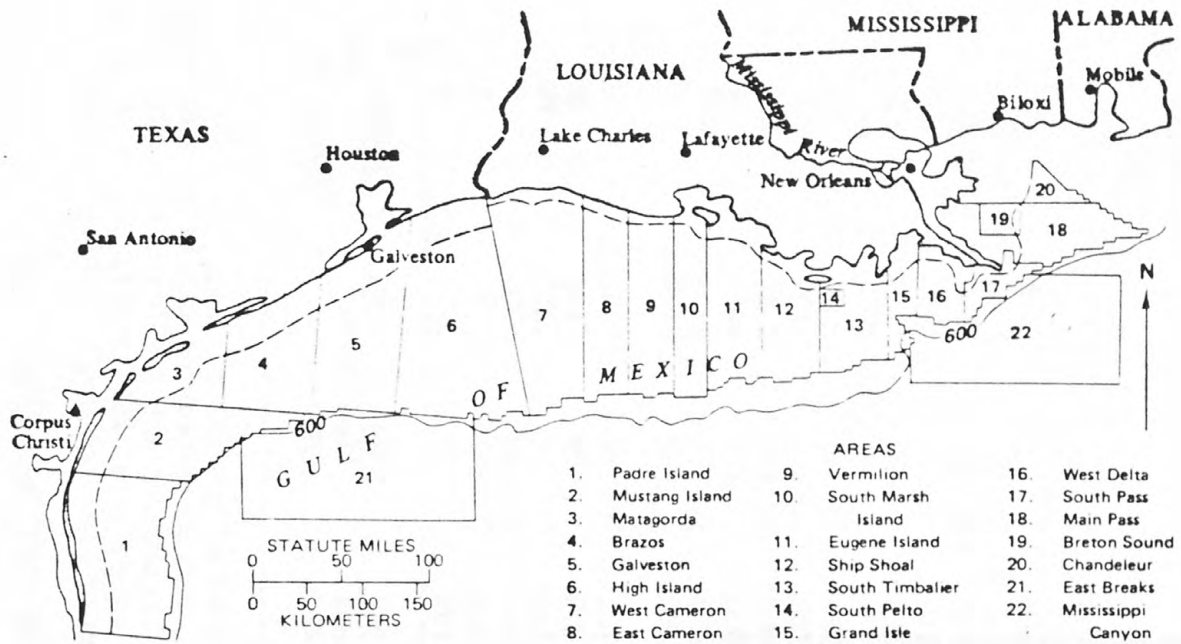


Figure 1.—Index map showing Outer Continental Shelf leasing areas off Texas and Louisiana. Dashed lines, shown at 3 marine leagues (9 nautical miles) from the Texas coast and 3 nautical miles from the Louisiana coast, indicate boundary between State and Federal waters. Solid line indicates 600-foot water depth.

Table 1.--Estimated demonstrated oil and gas reserves for 306 fields,
Gulf of Mexico Outer Continental Shelf and Slope, January 1, 1977

[Demonstrated reserves: the sum of measured and indicated reserves.
Liquids expressed in millions of barrels, gas in billions of cubic feet.
"Liquids" include crude oil, condensate, and gas-plant products sold;
"gas" includes both associated and nonassociated dry gas. Remaining
recoverable reserves estimated as of January 1, 1977]

Area (fig. 1)	Fields ^{1/} (total 306)	Original recoverable "Ultimate" reserves		Cumulative production		Remaining recoverable reserves	
		Liquids	Gas	Liquids	Gas	Liquids	Gas
Mustang Island.....	3	0	190	0	0	0	190
Brazos.....	5	5.9	340	1.9	150	4	190
Galveston ^{2/}	4	33	1560	24	600	9	960
High Island.....	25	53	3770	5	520	48	3250
West Cameron.....	43	126	10300	58	4100	68	6200
East Cameron.....	28	123	6100	54	2900	69	3200
Vermilion.....	35	245	7300	125	4300	120	3000
South Marsh Island..	30	390	7500	160	3400	230	4100
Eugene Island.....	35	820	8000	510	4000	310	4000
Ship Shoal.....	27	810	6900	490	3700	320	3200
South Timbalier ^{3/} ...	16	1040	3100	710	1800	330	1300
South Pelto.....	2	61	100	34	60	27	40
Grand Isle.....	12	880	2700	630	1400	250	1300
West Delta.....	13	1040	3140	700	2090	340	1050
South Pass.....	8	600	1610	350	810	250	800
Main Pass.....	17	560	2400	270	1000	290	1400
Mississippi Canyon..	3	73	530	0	0	73	530
Total.....	306	6859.9	65,540	4121.9	30,830	2738	34,710

^{1/} Represents 294 of the 321 active (Sept. 1977) fields and 12 formerly productive, now-abandoned fields.

^{2/} And East Breaks area.

Reserve estimates for the remaining 160 fields in FRRE were made on a field-wide basis from production studies or, for nonproducing fields, from volumetric studies.

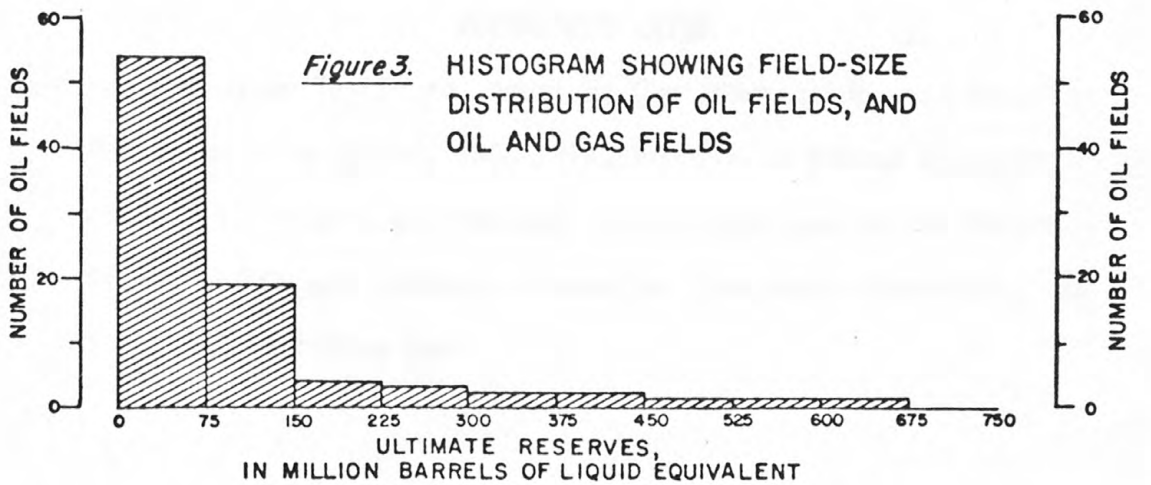
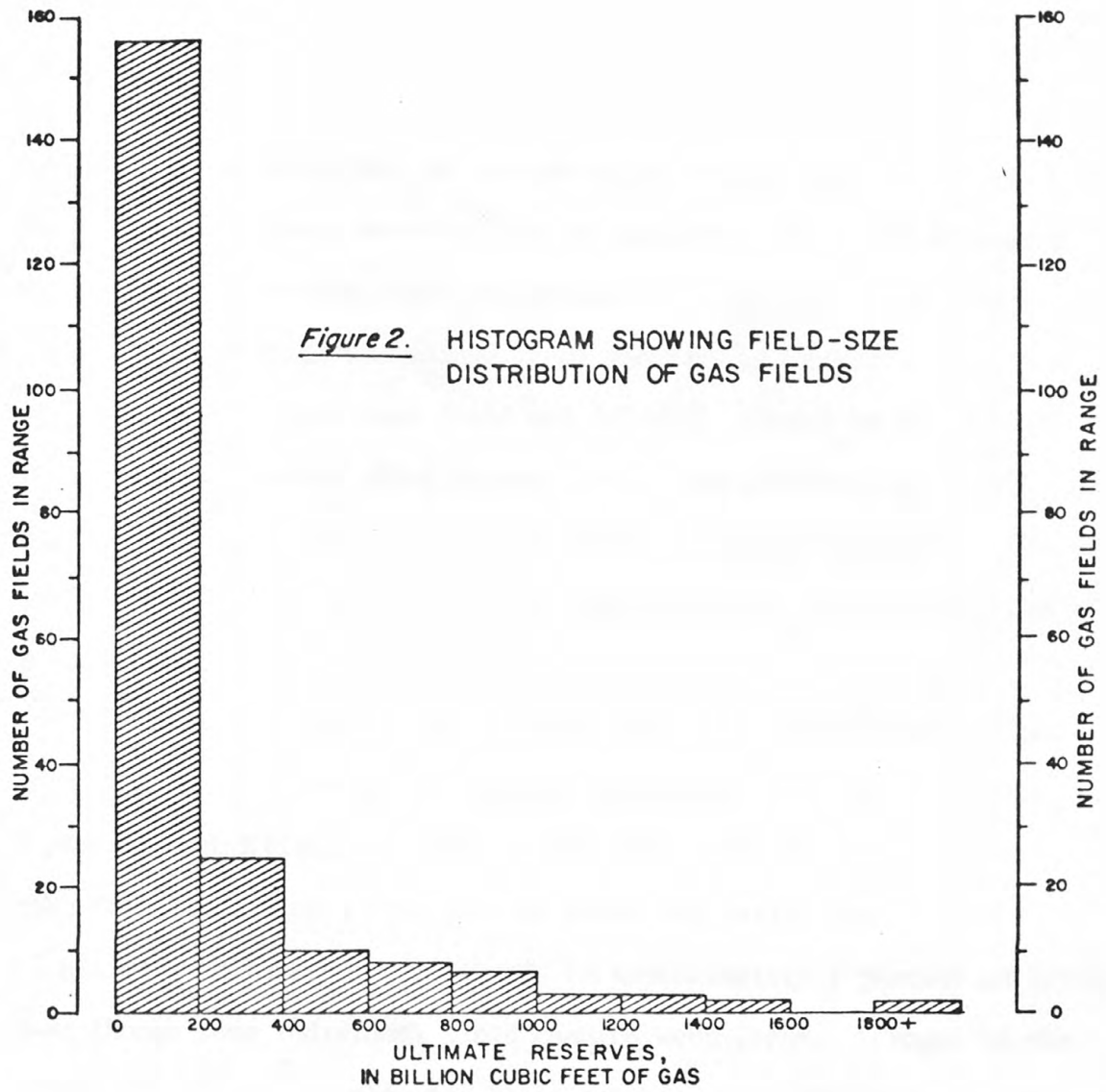
Each abandoned lease that had significant production of oil or gas is assigned a figure for original recoverable hydrocarbons equal to the amount actually produced, regardless of whether that study was on a reservoir-by-reservoir basis or a field-wide basis. Past oil and gas production is thereby reported, although by definition no recoverable reserves remain in relinquished tracts.

FIELD-SIZE DISTRIBUTION

The distribution of the various sizes of fields are shown in figures 2 and 3. Figure 2 shows the field-size distribution of initially recoverable reserves of 219 gas fields. Figure 3 shows, combined, the field-size distribution of the initially recoverable reserves of 66 oil fields and 21 oil and gas fields. For convenience of comparison in figure 3, gas reserves are expressed in terms of liquids; in the conversion, based on equivalent heating values, 6,000 cubic feet of gas is equivalent to 1 barrel of liquid. Both histograms exhibit a log-normal distribution. In each category most of the fields are in the smallest class, but most of the reserves are in the larger fields. More than 75 percent of the gas reserves (fig. 2) are in the larger fields; more than 85 percent of the liquid reserves (fig. 3) are in the larger fields.

CONCLUSIONS

The 306 oil and gas fields studied in the federally controlled part of the Gulf of Mexico contained original reserves estimated at nearly



66,000 billion cubic feet of gas and 6,900 million barrels of oil. Remaining recoverable reserves, as of January 1, 1977, are estimated at 35,000 billion cubic feet of gas and 2,700 million barrels of oil.

The most significant change since the previous report is the addition of 52 fields (one field was deleted), almost 80 percent of which were discovered after January 1975. The additions are 6 oil fields, 44 gas fields, and 2 fields with oil and gas reserves. Seven fields, previously described as oil and gas fields, are now considered to be principally gas fields.

Estimated reserves of the 52 newly reported fields increased the total estimated ultimate recoverable gas by 9 percent and the oil by 3 percent. Modified estimates for the additional 46 fields, which have been studied on a reservoir-by-reservoir basis, changed the total of estimated ultimate reserves only by approximately 1 percent on balance, even though some individual field changes were large. Changes in the estimates made on a field-wide basis resulted in a reduction, on balance, especially the estimated oil reserves in the Grand Isle and Vermilion Areas.

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.

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. (Superseded by present report).

Miller, Betty M., and others, 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, May 1975, OCS Orders 1 through 12, governing oil, gas, and sulphur leases in the Outer Continental Shelf, Gulf of Mexico area, 76 p.

USGS LIBRARY RESTON



3 1818 00072937 4