

Bureau of Mines  
Report of Investigations 4769



GREEN RIVER OIL-SHALE RESERVES  
OF NORTHWESTERN COLORADO

BY CARL BELSER

United States Department of the Interior — February 1951

metadc38558

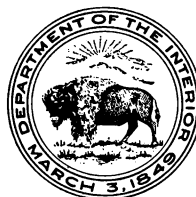




# GREEN RIVER OIL-SHALE RESERVES OF NORTHWESTERN COLORADO

BY CARL BELSER

\* \* \* \* \* **Report of Investigations 4769**



UNITED STATES DEPARTMENT OF THE INTERIOR  
Oscar L. Chapman, Secretary  
BUREAU OF MINES  
James Boyd, Director

---

Work on manuscript completed May 1950. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4769."

February 1951



# GREEN RIVER OIL-SHALE RESERVES OF NORTHWESTERN COLORADO

by

Carl Belser<sup>1/</sup>

---

---

## CONTENTS

	<u>Page</u>
Summary.....	1
Introduction.....	1
Acknowledgments.....	1
Geology.....	2
Sampling and assaying.....	3
General.....	3
Relative value of drill cores vs. drill cuttings and surface sampling.....	4
Assay logs.....	5
Vertical profile sections.....	6
Oil yield contour maps.....	7
Estimated reserves.....	7
Partly blocked shale.....	8
Inferred or probable shale.....	8
Conclusions.....	9

## TABLES

1. High-grade section of Mahogany ledge.....	10
2. 25-gallon section, including Mahogany ledge.....	11
3. 15-gallon shale diamond-drill holes.....	12
4. All shale over 10 gallons.....	13

---

<sup>1/</sup> Mining engineer, Bureau of Mines.

# ILLUSTRATIONS

Fig.		Follows page
1.	Map of northwestern Colorado.....	2
2.	Section A-A'.....	2
3.	Section B-B'.....	2
4.	Section C-C'.....	2
5.	Section D-D'.....	2
6.	Section E-E'.....	2
7.	Section F-F'.....	2
8.	Surface sections, Empire Gas & Fuel Co. ....	2
8A.	Surface sections, U. S. Geological Survey.....	2
9.	28-19-G well, General Petroleum Co. ....	2
10.	66-5-G well, General Petroleum Co. ....	2
11.	24-12-G well, General Petroleum Co. ....	2
12.	84-15-G well, General Petroleum Co. ....	2
13.	Hole G, Naval Oil Shale Reserve No. 1.....	2
14.	Hole F, Naval Oil Shale Reserve No. 1.....	2
15.	Hole I, Naval Oil Shale Reserve No. 1.....	2
16.	Hole L, Naval Oil Shale Reserve No. 1.....	2
17.	Hole J, Naval Oil Shale Reserve No. 1.....	2
18.	Hole E, Naval Oil Shale Reserve No. 1.....	2
19.	Hole D, Naval Oil Shale Reserve No. 1.....	2
20.	Columbia surface sampling, Columbia Oil Shale Co. .	2
21.	Bella Castle No. 1, Union Oil Co. of California...	2
22.	Linduar Point surface sampling, Union Oil Co. of California.....	2
23.	Lignum Vita No. 9, Union Oil Co. of California....	2
24.	Lignum Vita No. 13, Union Oil Co. of California...	2
25.	Hole H, Naval Oil Shale Reserve No. 1.....	2
26.	Summer's Camp hole, Sun Oil Co. ....	2
27.	Mager's Camp hole, Sun Oil Co. ....	2
28.	Bear Run hole, Sun Oil Co. ....	2
29.	Cottonwood surface sampling, S.O.S. oil shale property.....	2
30.	Syndicate No. 2, Standard Oil Co. of California...	2
31.	Syndicate No. 1, Standard Oil Co. of California...	2
32.	Surface section, Wayne M. Felts.....	2
33.	Hole K, Naval Oil Shale Reserve No. 1.....	2
34.	Hole B, Naval Oil Shale Reserve No. 1.....	2
35.	Hole C, Naval Oil Shale Reserve No. 1.....	2
36.	Hole A, Naval Oil Shale Reserve No. 1.....	2
37.	Surface sections, Naval Oil Shale Reserve No. 1...	2
38.	J. B. M. No. 6, Union Oil Co. of California.....	2
39.	Akolt No. 2, Standard Oil Co. of California.....	2
40.	Conn Creek surface section, Pure Oil Co. ....	2
41.	Newton Point surface sampling, Federal Oil Shale Co. ....	2
42.	Akolt No. 1, Standard Oil Co. of California.....	2
43.	Scott Fee No. 1, Standard Oil Co. of California...	2
44.	Akolt No. 3, Standard Oil Co. of California.....	2
45.	Battlement Mesa hole, Pure Oil Co. ....	2
46.	Echo No. 3 surface sampling, Federal Oil Shale Co.	4
47.	Specific gravity and oil yield of Colorado oil shales.....	4
48.	Contour map of 25-gallon shale (Mahogany ledge)...	6
49.	Contour map of 15-gallon shale.....	6

## SUMMARY

This report is the first of a series dealing with the oil-shale reserves of the Green River formation in the Rocky Mountain Region.

The known oil-shale reserves of northwestern Colorado at present considered to have economic value apparently are confined to the Piceance Creek basin between the Colorado and White Rivers.

The number of sampled sections is small, but there can be little doubt that the Piceance Creek basin is a potential source of enormous quantities of liquid fuels and the related byproducts obtained from oil-shale processing.

The partly blocked and inferred oil-shale reserves of 25-gallon-a-ton shale are estimated to have an oil yield of 125 billion barrels, and the reserves of 15-gallon-a-ton shale are estimated to have an oil yield of 494 billion barrels.

The number of available sampled sections is inadequate for making firm estimates.

## INTRODUCTION

The oil shales of the Green River formation in northwestern Colorado comprise an important natural resource for the production of synthetic liquid fuels. The area covered by the formation in Colorado is about 2,590 square miles (fig. 1).

Prior to 1944, a large amount of reconnaissance work had been done in estimating these reserves, but most of the sampled sections contained only occasional beds that had been assayed for oil content. In 1944, the assay logs of only five surface sections and one diamond-drill hole were available. Since that time oil companies have core-drilled 13 holes and taken eight surface sections. During the same period the Bureau of Mines core-drilled 12 holes, took two surface sections, and assayed the cuttings from four oil wells. A purpose of this report is to record all the sections assayed to date.

## ACKNOWLEDGMENTS

This report was prepared under the supervision of Emery M. Sipprelle, chief, Oil-Shale Mining Branch, Rifle, Colo.

Appreciation is expressed to the Columbia Oil Shale Co., the Federal Oil Shale Co., the Union Oil Co. of California, the Standard Oil Co. of California, the General Petroleum Corp., Wayne M. Felts, the Empire Gas & Fuel Co., the Sun Oil Co., and the Pure Oil Co. for their valuable assistance and cooperation.

Many of the analytical data were determined at the Bureau of Mines Petroleum and Oil-Shale Experiment Station, Laramie, Wyo., and special thanks are due to H. M. Thorne and K. W. Stanfield.

The valuable aid of D. C. Duncan and N. M. Denson of the U. S. Geological Survey for their help in identifying markers, especially in the Piceance area, is greatly appreciated.

The author is indebted to E. D. Gardner, Chief Mining Engineer, Bureau of Mines; Tell Ertl, formerly mining engineer in charge of the Bureau of Mines Oil-Shale Demonstration Mine; Virgil S. Nidiffer, engineering aid; and H. R. Garrett and R. G. Cooper, draftsmen, for their aid in making this report possible.

### GEOLOGY

The Green River formation was laid down as sediments in the bottoms of broad, shallow bodies of water during middle Eocene time. One of these lakes, known as Uinta Lake, covered northwestern Colorado and east-central Utah. A similar lake, known as Gosuite Lake, covered southwestern Wyoming. These two lakes were bounded by high hills, the drainage was to the south, and at times the lakes may have been connected.

In Colorado, the extreme fringes of the upper part of the Green River formation, with the exception of portions north of the White River and on Grand Mesa, have been eroded away. In the Parachute Creek area, the Green River formation is about 3,000 feet thick<sup>2/</sup> and has been divided into the following members:

Member	Thickness, feet	Characteristics
Evacuation Creek	1,000	Fine gray and brown sandstones with interbedded gray marlstones and a few thin beds of oil shale.
Parachute Creek	700 to 1,300	Black, brown, and gray marlstone, including the principal oil-shale units, a few thin altered tuff, analcite, and chert beds; sandstone tongues near base.
Garden Gulch	630 to 720	Gray marlstone, with some gray and brown shale and a few thin oil-shale beds.
Douglas Creek	430 to 470	Brown sandstone and gray shale with a few thin oil-shale beds.

The Green River formation overlies conformably the Wasatch formation of the lower Eocene and in places is overlain by the Bridger formation of the middle and upper Eocene or by lava flows.

<sup>2/</sup> Duncan, D. C., and Denson, N. M., Geology of Naval Oil-Shale Reserves 1 and 3, Garfield County, Colo.: U.S. Geol. Surv. Oil and Gas Investigations Preliminary Map 94, 1949.



# MAP OF NORTHWESTERN COLORADO

## SHOWING THE GREEN RIVER FORMATION WITH LOCATION OF SAMPLED OIL SHALE SECTIONS

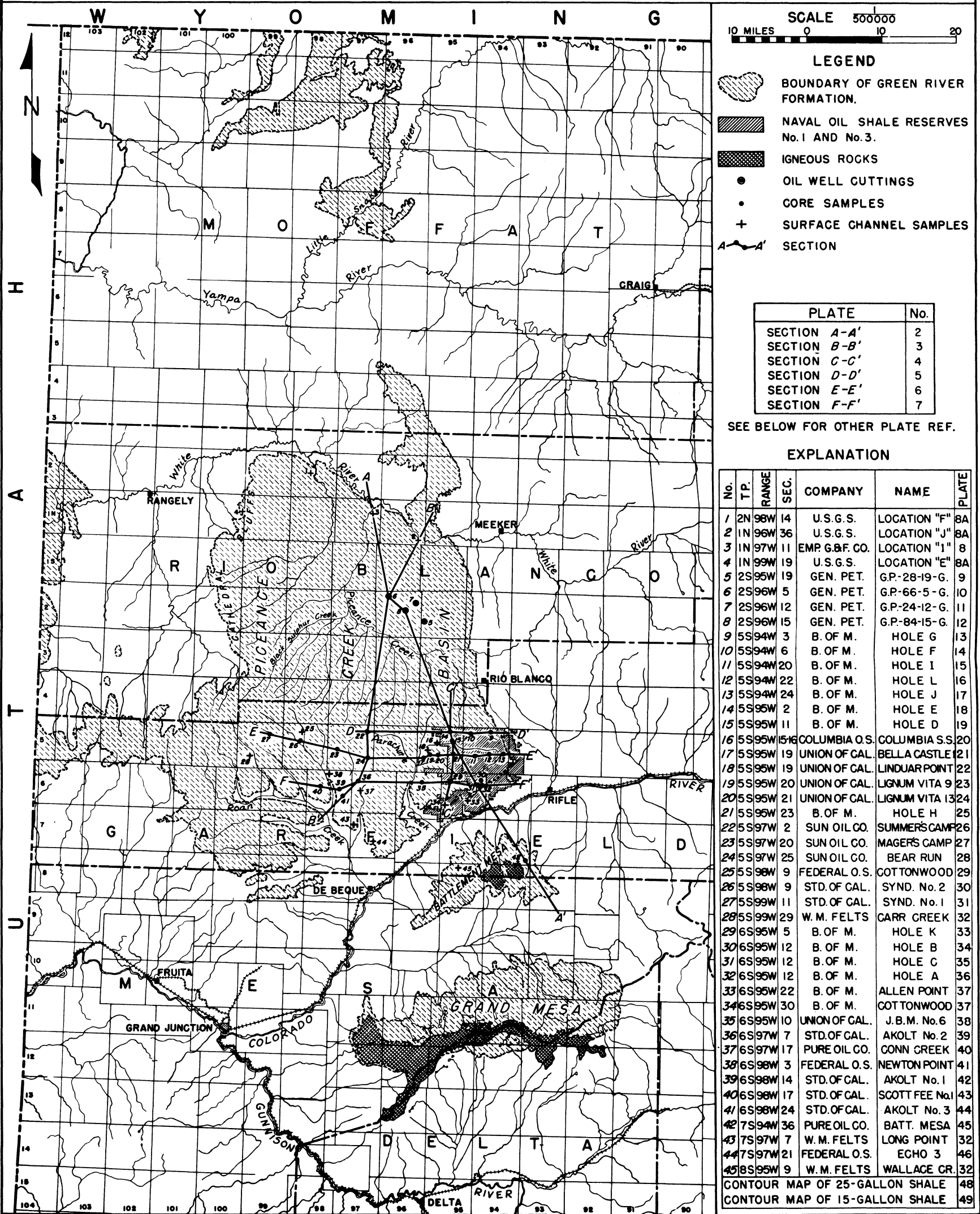


Figure 1.



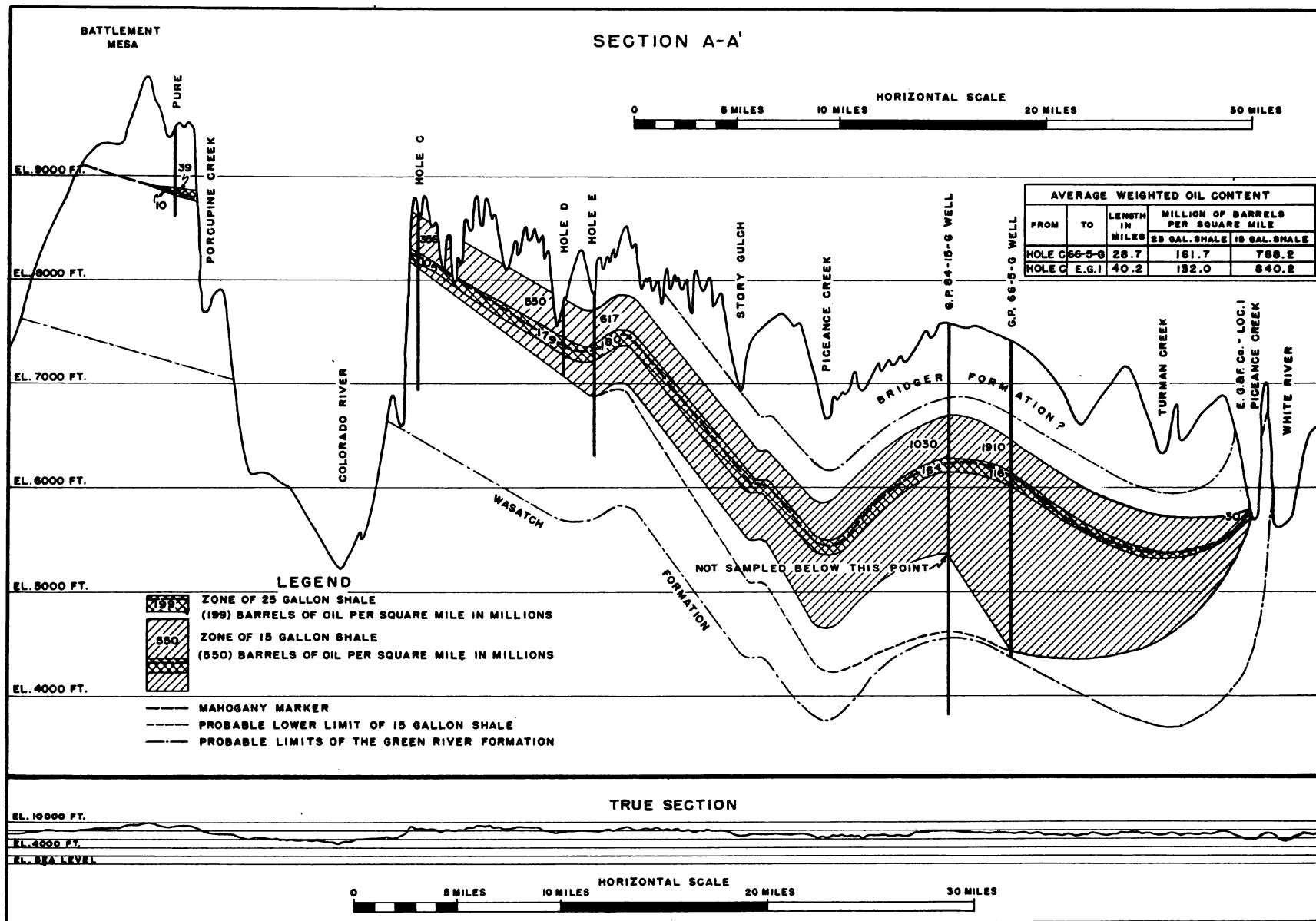


Figure 2.



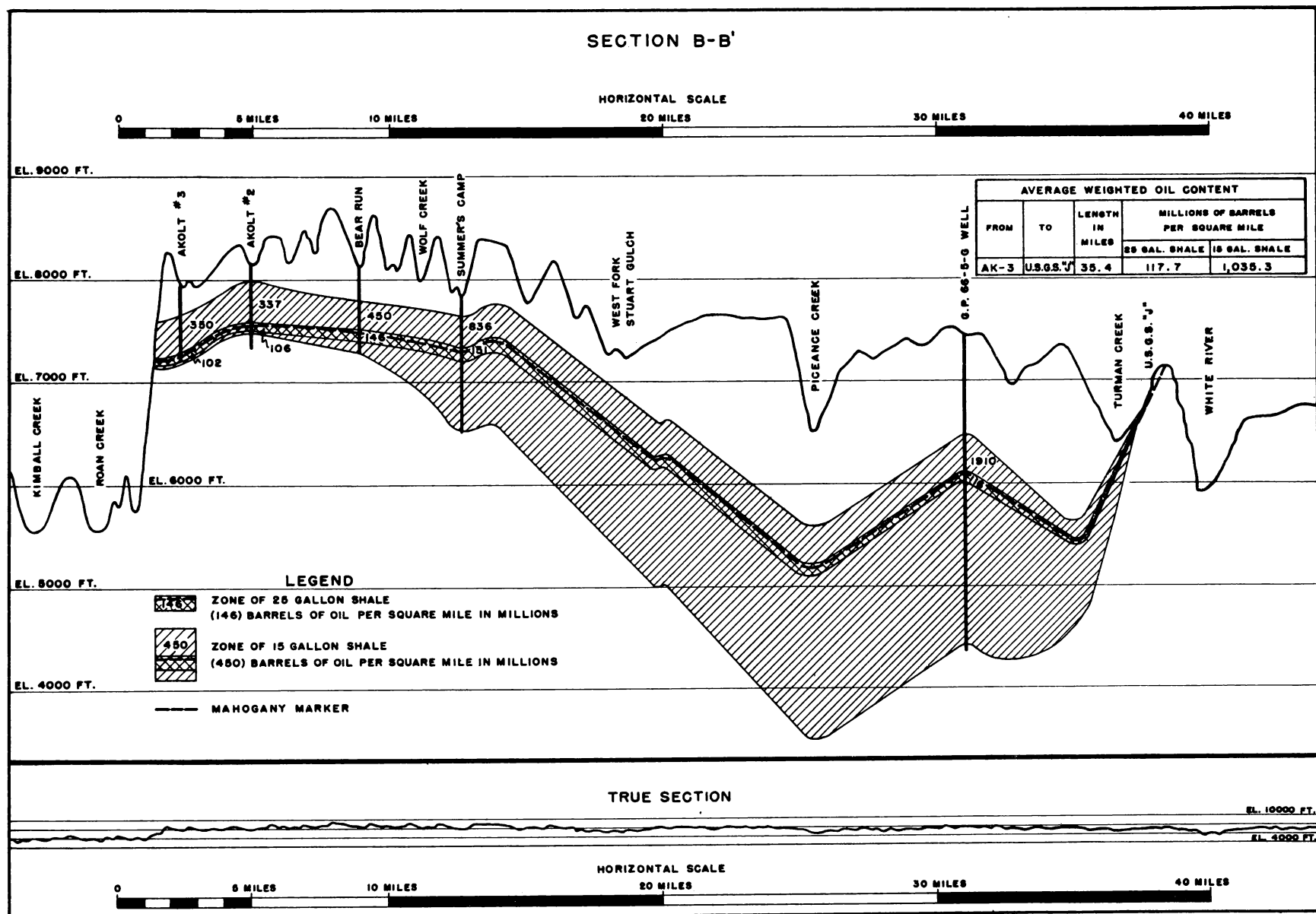


Figure 3.





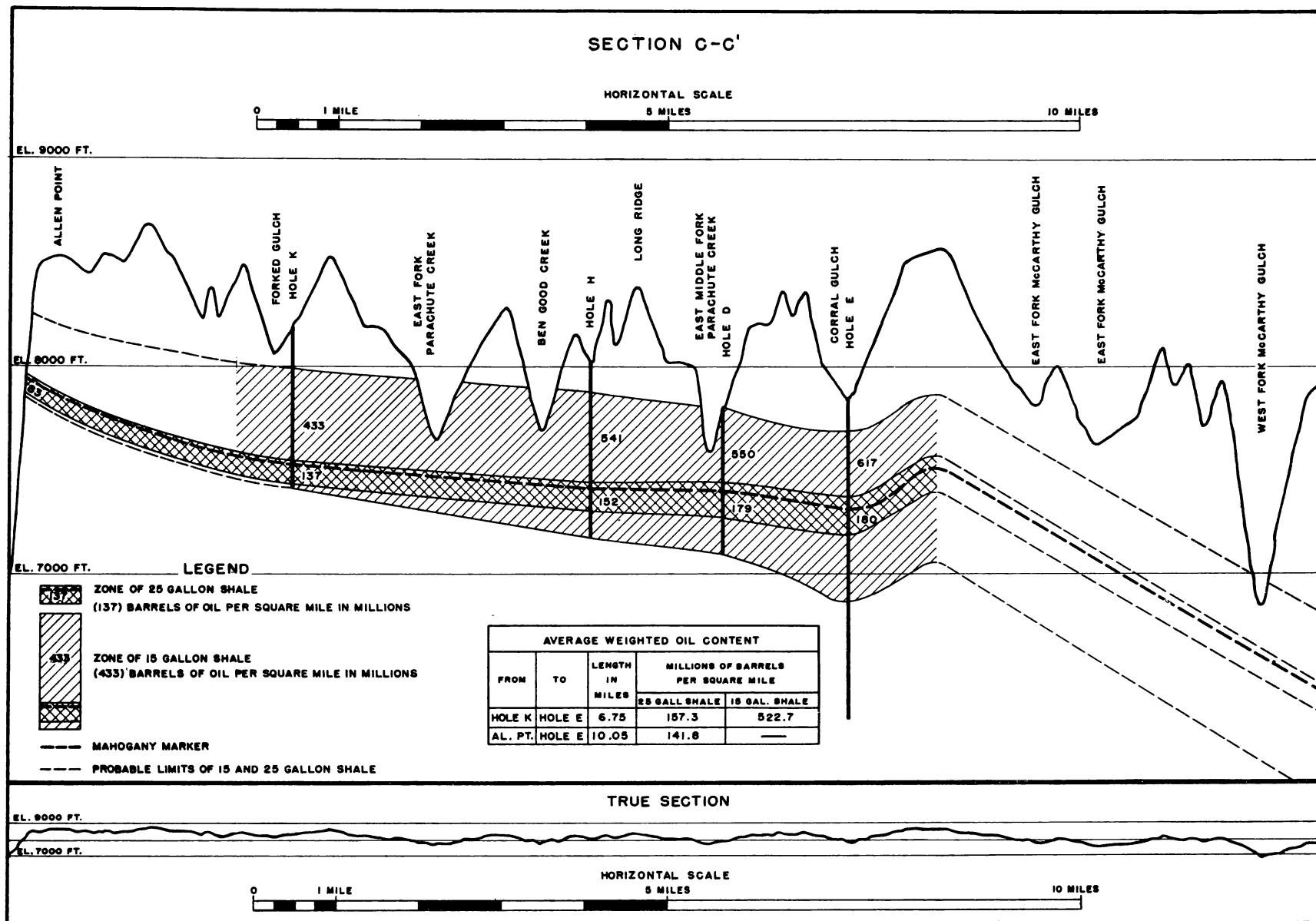


Figure 4.



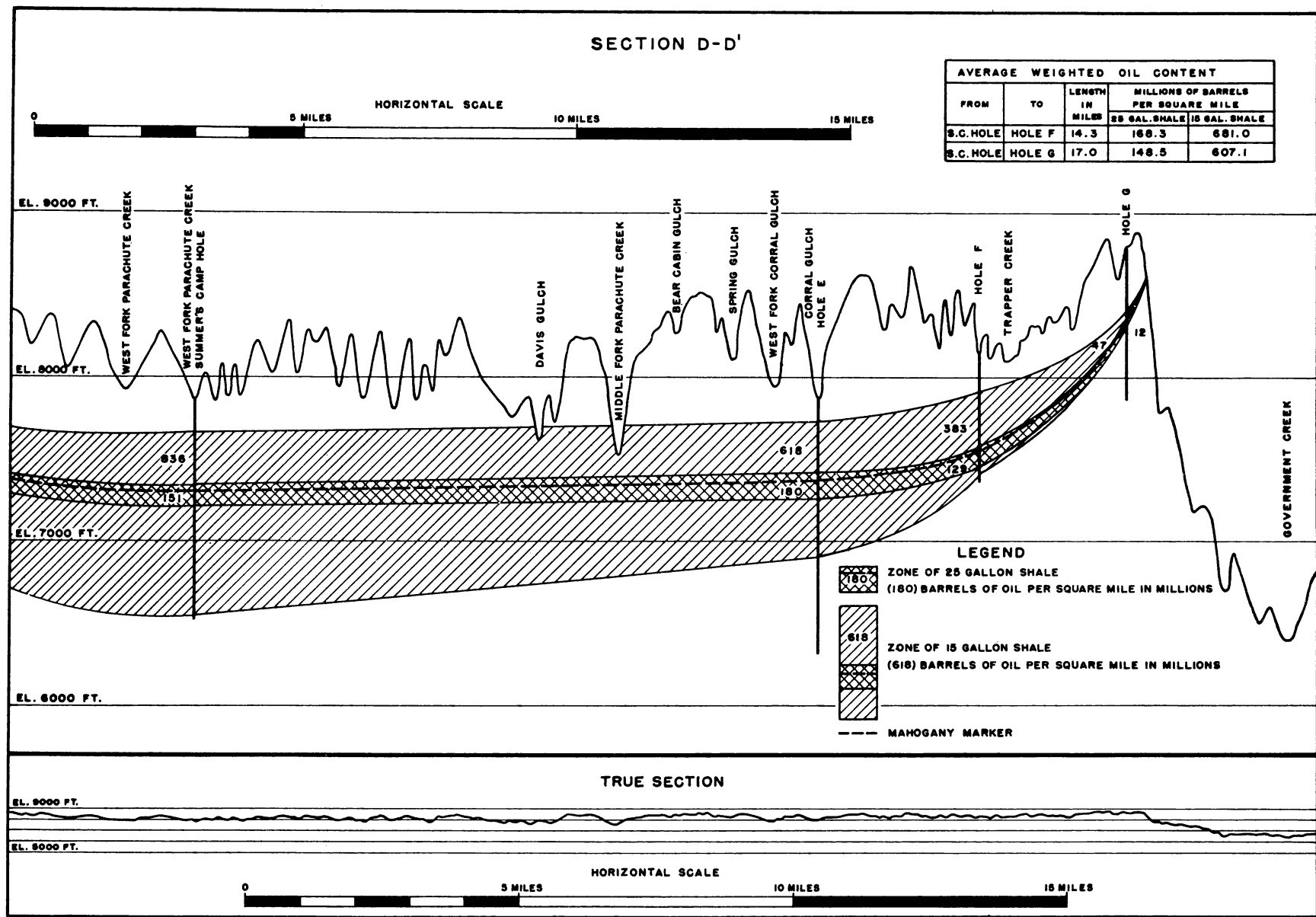


Figure 5.





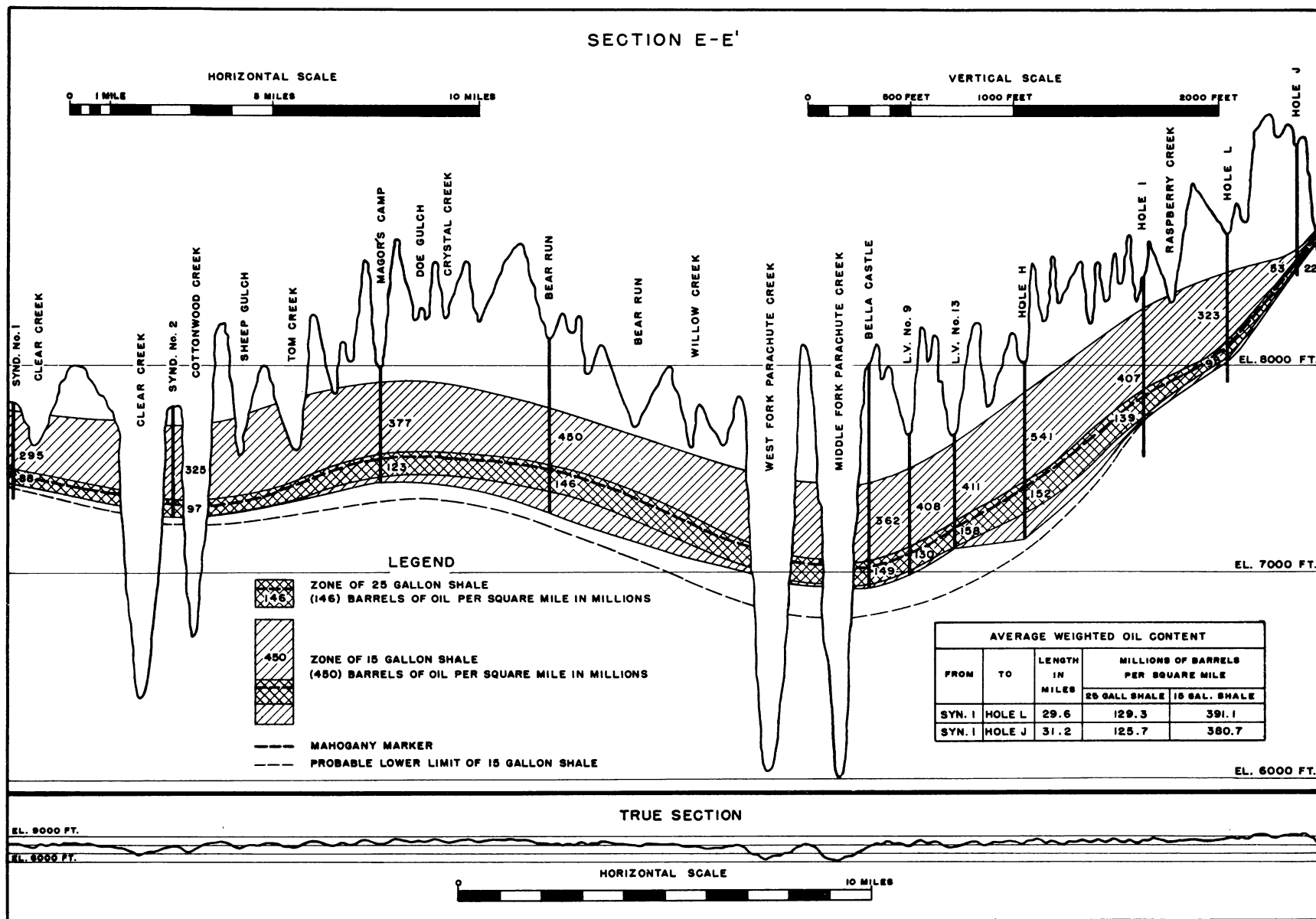


Figure 6.



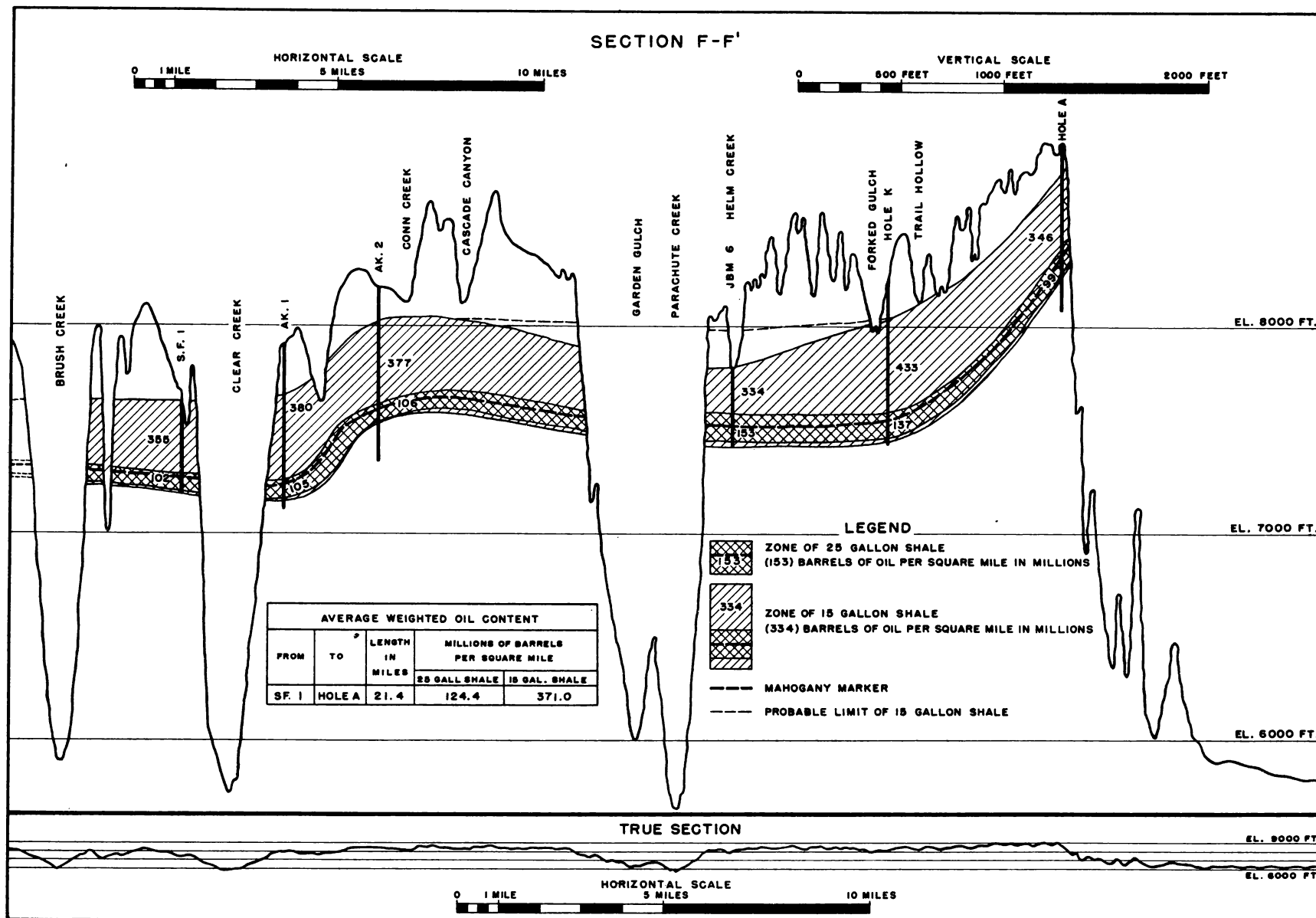


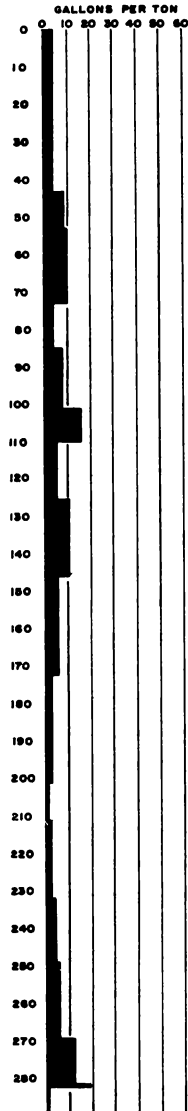
Figure 7.



# LOWER PICEANCE CREEK SURFACE SECTION EMPIRE GAS and FUEL COMPANY

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION TAKEN ON THE EAST SIDE OF LOWER PICEANCE CREEK (SECTIONS 11 AND 14, TOWNSHIP 1 NORTH, RANGE 97 WEST OF THE 6th PRINCIPAL MERIDIAN) AS INDICATED BY THE RESULTS FROM FIELD LABORATORY METHODS. (FIELD LOCATION 1)

RIO BLANCO COUNTY, COLORADO



TOTAL LENGTH OF SECTION.....289.1 FEET  
10.0 FT. OF PLUS 15 GALLON SHALE.....0.0 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
9.0 FT.	101.1 FT.	110.1 FT.	15.75	18,818,000	7,057,000
25.0 FT.	88.1 FT.	110.1 FT.	10.64	54,697,000	13,883,000
289.1 FT.	0.0 FT.	289.1 FT.	5.65	850,244,000	88,818,000

CHANNEL SAMPLES TAKEN BY THE EMPIRE GAS AND FUEL COMPANY

Figure 8.





**NORTH PICEANCE CREEK BASIN SURFACE SECTIONS  
UNITED STATES GEOLOGICAL SURVEY**

OIL YIELDS OF OIL SHALE BEDS IN THE GREEN RIVER FORMATION NEAR THE HEAD OF  
FLETCHER GULCH, THE MOUTH OF YELLOW CREEK, AND THE LO7 RANCH ON WHITE  
RIVER AS INDICATED BY PARTLY ASSAYED SURFACE SECTIONS SHOWN IN THE UNITED  
STATES GEOLOGICAL SURVEY BULLETIN 729.

RIO BLANCO COUNTY, COLORADO

**LOCATION "E"**

SECTION 19, TOWNSHIP 1 NORTH, RANGE 99 WEST OF THE 6th P.M.

SECTION 24, TOWNSHIP 1 NORTH, RANGE 100 WEST OF THE 6th P.M.

TOTAL LENGTH OF SECTION...874.8 FEET

45.7 FT. OF ESTIMATED PLUS 15 GALLON SHALE.....13.0 FT. OF ESTIMATED PLUS 30 GALLON SHALE

TOTAL LENGTH ASSAYED 5 FEET

BEST CONTINUOUS ASSAY 5 FEET OF 33.6 GAL. SHALE

**LOCATION "F"**

SECTIONS 10, 14, and 15, TOWNSHIP 2 NORTH, RANGE 98 WEST OF THE  
6th PRINCIPAL MERIDIAN

TOTAL LENGTH OF SECTION...1667.1 FEET

21.0 FT. OF ESTIMATED PLUS 15 GALLON SHALE.....0.0 FT. OF ESTIMATED PLUS 30 GALLON SHALE

TOTAL LENGTH ASSAYED 17.5 FEET

BEST ESTIMATED CONTINUOUS SHALE 5 FEET OF 25 GAL. SHALE

**LOCATION "J"**

SECTION 36, TOWNSHIP 1 NORTH, RANGE 96 WEST OF THE  
6th PRINCIPAL MERIDIAN

TOTAL LENGTH OF SECTION...1166.8 FEET

18.0 FT. OF ESTIMATED PLUS 15 GALLON SHALE.....0.0 FT. OF ESTIMATED PLUS 30 GALLON SHALE

TOTAL LENGTH ASSAYED 8.0 FEET

BEST CONTINUOUS ASSAY 3.7 FEET OF 12.5 GAL. SHALE

BEST CONTINUOUS SHALE SAMPLED				
LOCATION	LENGTH	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
"E"	5.0 FT.	33.6	9,200,000	7,360,000
"F"	5.0 FT.	25.0	9,702,000	8,775,000
"J"	3.7	12.5	7,973,000	2,373,000

THE OIL CONTENT SHOWN IN THE ABOVE PARTIALLY SAMPLED SECTIONS IS  
NOT CONSIDERED TO BE REPRESENTATIVE OF THE TRUE OIL SHALE CONTENT,  
BUT IS SHOWN BECAUSE THIS DATA HAS BEEN USED FOR AN AREA WHERE  
OTHER DATA WAS UNAVAILABLE IN THE MAKING OF PLATES 3, 48 AND 49.

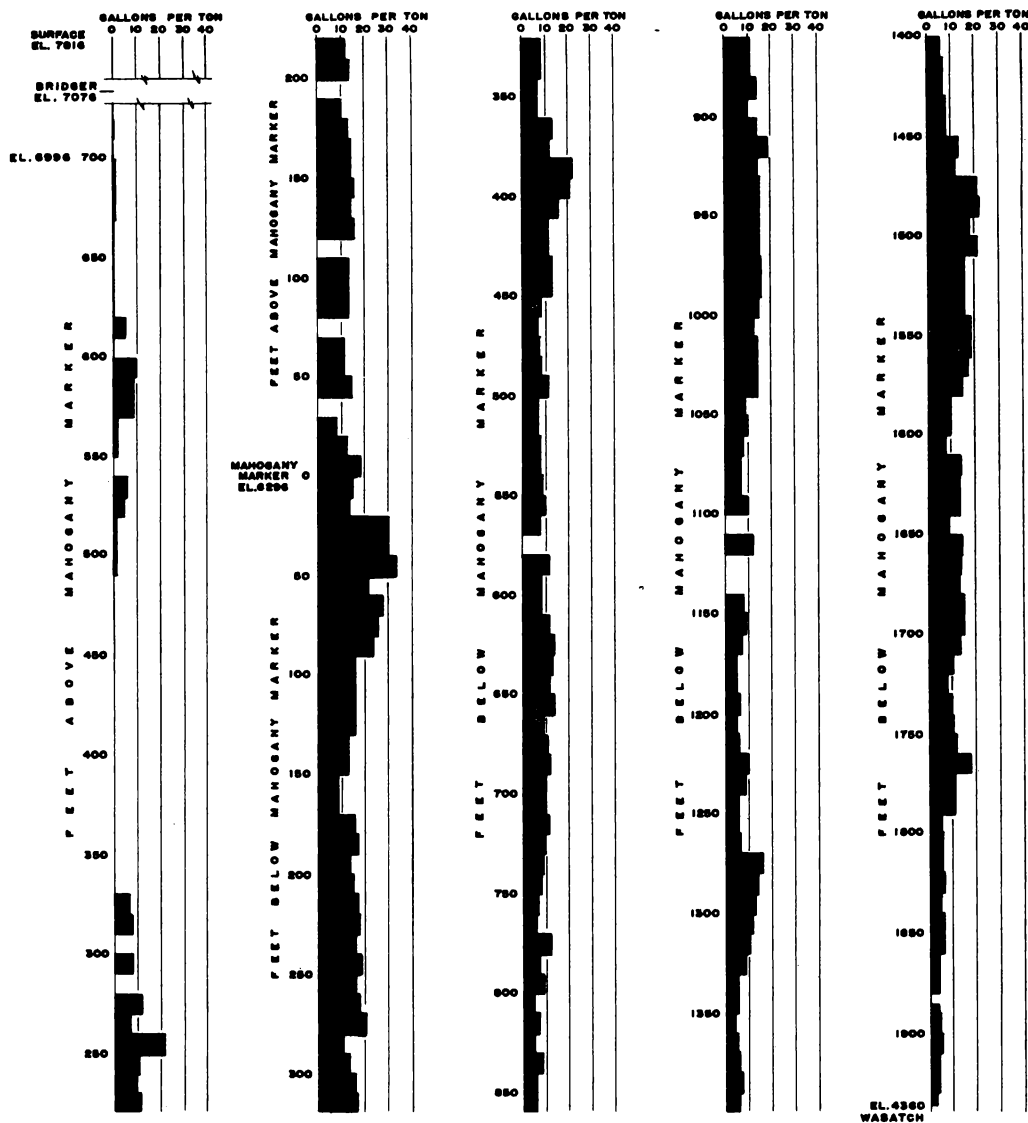
Figure 8A.



# **28-19-G WELL** **GENERAL PETROLEUM CORPORATION**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK, PARACHUTE CREEK AND GARDEN GULCH MEMBERS OF THE GREEN RIVER FORMATION ON THE UPPER SE. FLANK OF THE PICEANCE CREEK STRUCTURE, (SE. SW. SW. SECTION 19, TOWNSHIP 2 SOUTH, RANGE 95 WEST OF THE 6TH P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

RIO BLANCO COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 2656 FEET  
 470 FEET OF PLUS 15 GALLON SHALE . . . . . 30 FEET OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
70 ft.	-20 ft.	-90 ft.	27.54	133,677,000	87,654,000
90 ft.	-20 ft.	-110 ft.	24.93	174,658,000	103,672,000
680 ft.	+230 ft.	-480 ft.	18.00	1,431,361,000	811,200,000
2266 ft.	+330 ft.	-1936 ft.	11.56	4,906,344,000	1,350,138,000

ROTARY CUTTINGS DRILLED IN 1947

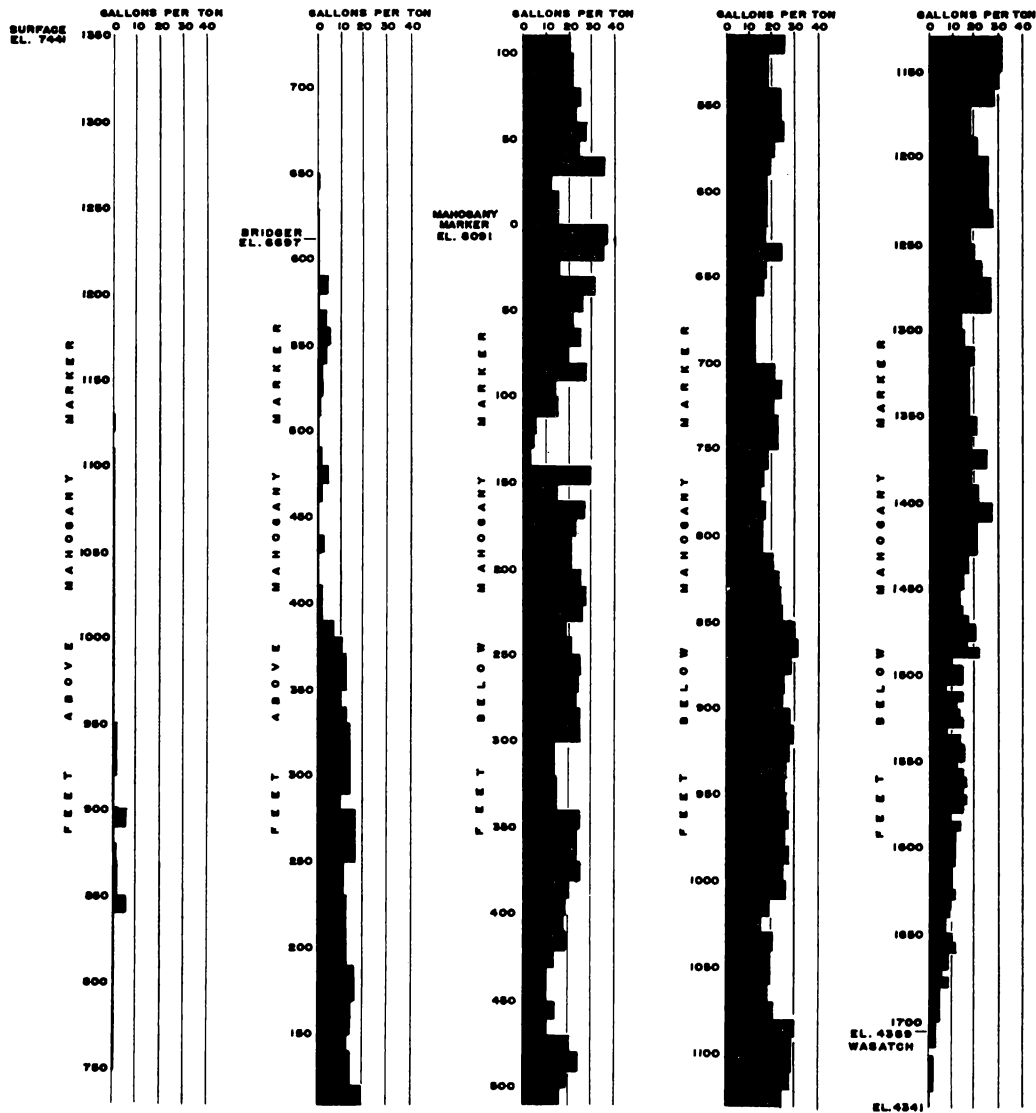
Figure 9.



# 66-5-G WELL GENERAL PETROLEUM CORPORATION

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK, PARACHUTE CREEK AND GARDEN GULCH MEMBERS OF THE GREEN RIVER FORMATION ON THE UPPER WEST FLANK OF THE PICEANCE CREEK STRUCTURE, (SE. NW. SE., SECTION 5, TOWNSHIP 2 SOUTH, RANGE 96 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

RIO BLANCO COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 2890 FEET  
1476 FEET OF PLUS 15 GALLON SHALE..... 90 FEET OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
90 ft.	0 ft.	-90 ft.	26.37	173,793,000	109,118,000
100 ft.	+10 ft.	-90 ft.	25.11	193,839,000	115,880,000
2070 ft.	+390 ft.	-1680 ft.	19.05	4,211,661,000	1,910,339,000

ROTARY CUTTINGS DRILLED IN 1947

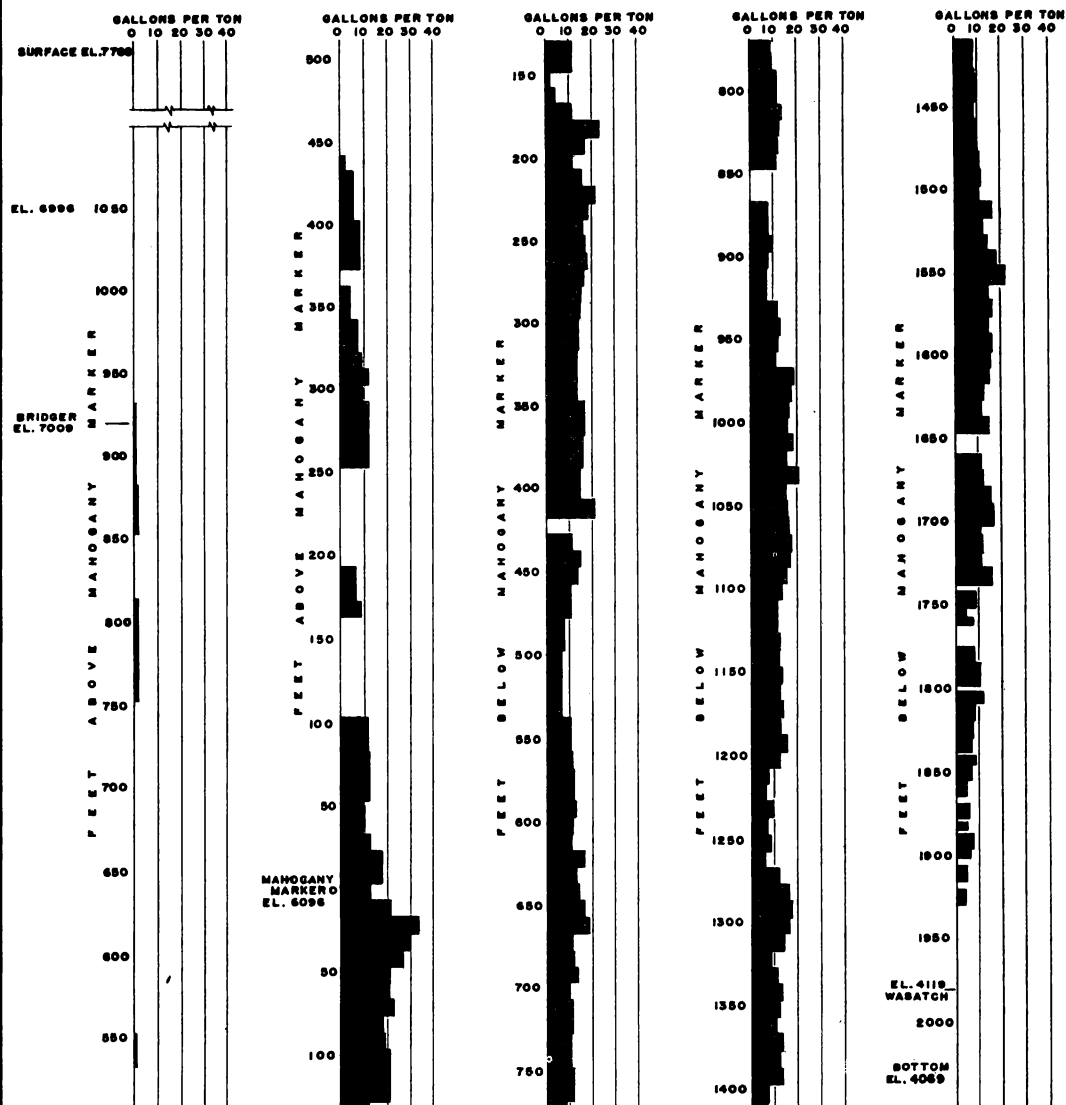
Figure 10.



# **24-12-G WELL** **GENERAL PETROLEUM CORPORATION**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK, PARACHUTE CREEK AND GARDEN GULCH MEMBERS OF THE GREEN RIVER FORMATION ON THE UPPER NW. FLANK OF THE PICEANCE CREEK STRUCTURE, (SE. SW. NW, SECTION 12, TOWNSHIP 2 SOUTH, RANGE 96 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

RIO BLANCO COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 3003 FEET  
 613.0 FEET OF PLUS 15 GALLON SHALE.....20 FEET OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
30 ft.	-17 ft.	-47 ft.	29.89	56,357,000	40,108,000
70 ft.	-7 ft.	-77 ft.	24.87	136,047,000	80,859,000
690 ft.	+23 ft.	-667 ft.	15.00	1,482,409,000	518,718,000
2,273 ft.	+343 ft.	-1,930 ft.	12.76	4,863,208,000	1,477,489,000

ROTARY CUTTINGS DRILLED IN 1947

Figure 11.

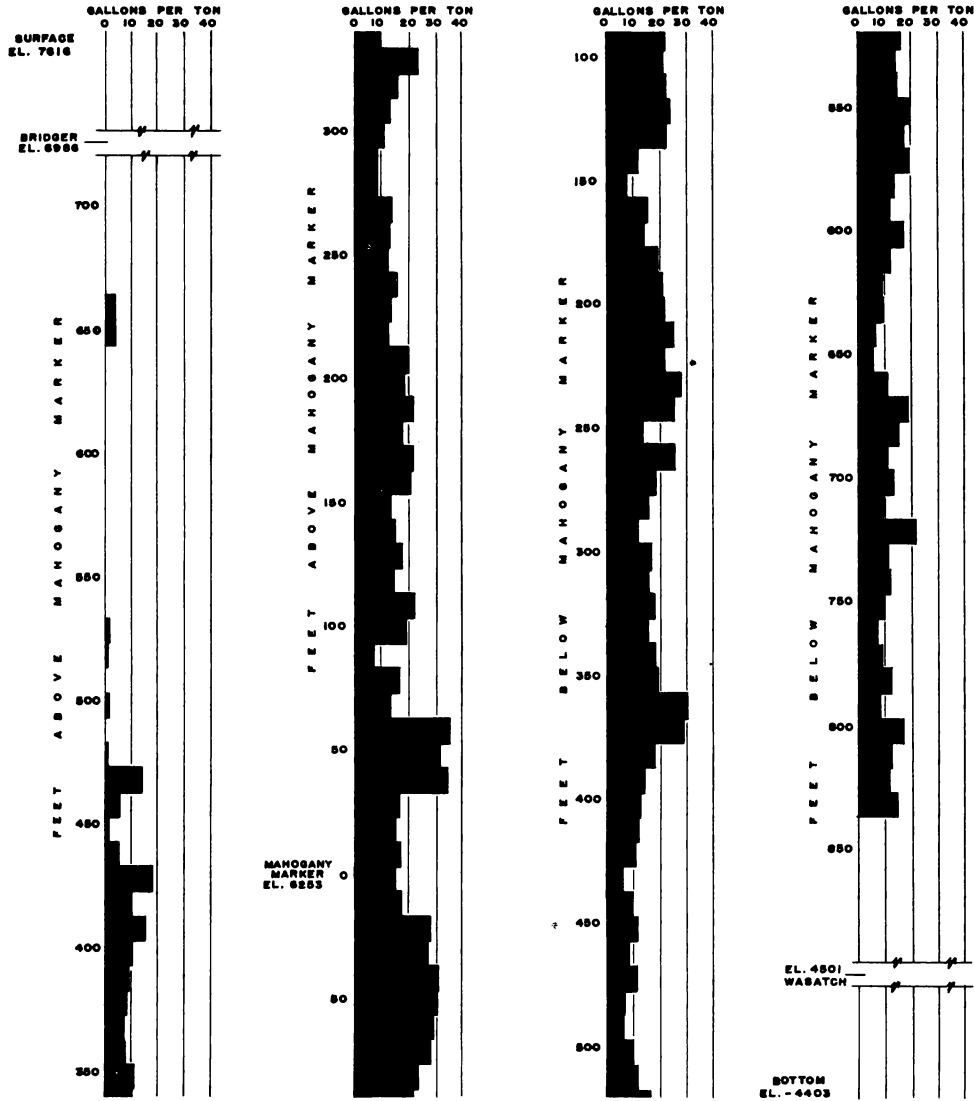




# **84-15-G WELL** **GENERAL PETROLEUM CORPORATION**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION NEAR THE TOP OF THE PICEANCE CREEK STRUCTURE, (SE. SE. NE., SECTION 15, TOWNSHIP 2 SOUTH, RANGE 96 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

RIO BLANCO COUNTY, COLORADO



TOTAL LENGTH OF SECTION..1500 FEET  
810 FT. OF PLUS 15 GALLON SHALE..... 60 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
60 FT.	+ 17 FT.	- 77 FT.	28.94	117,675,000	81,084,000
140 FT.	+ 63 FT.	- 77 FT.	25.39	270,894,000	183,762,000
1310 FT.	+ 473 FT.	- 837 FT.	15.75	2,745,880,000	1,029,705,000

ROTARY CUTTINGS DRILLED IN 1946

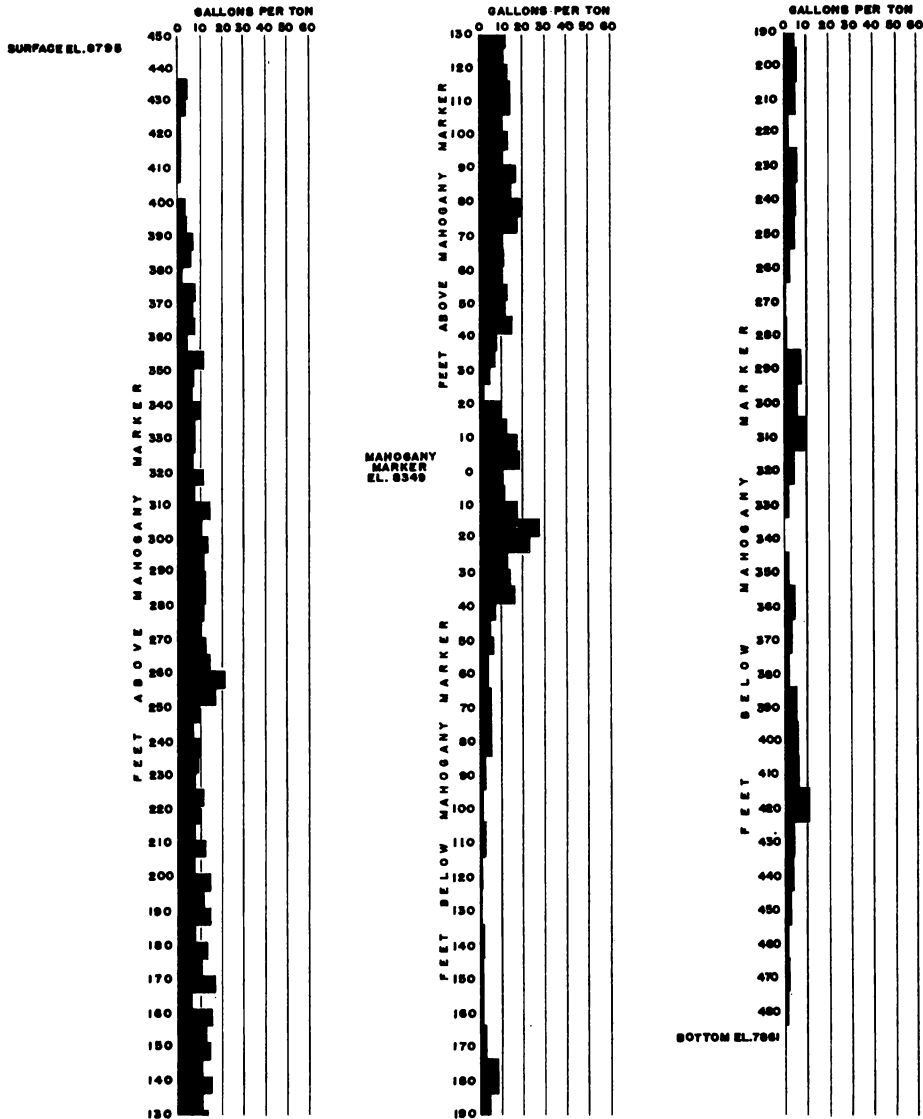
Figure 12.



# HOLE G DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF TRAPPER'S CREEK  
(NW. SW. NE. SEC. 3, T5S., R 94W. OF THE 6th P.M.) AS INDICATED BY THE FISCHER  
METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..925 FEET  
85 FT. OF PLUS 15 GALLON SHALE .....0 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
10 ft.	- 14 ft.	- 24 ft.	25.00	19,403,000	11,549,000
60 ft.	+ 21 ft.	- 39 ft.	15.55	125,732,000	46,551,000
515 ft.	+ 401 ft.	- 114 ft.	10.11	1,127,849,000	271,489,000
921 ft.	+ 437 ft.	- 484 ft.	6.88	2,078,725,000	340,515,000

CORE SAMPLES DRILLED IN 1949

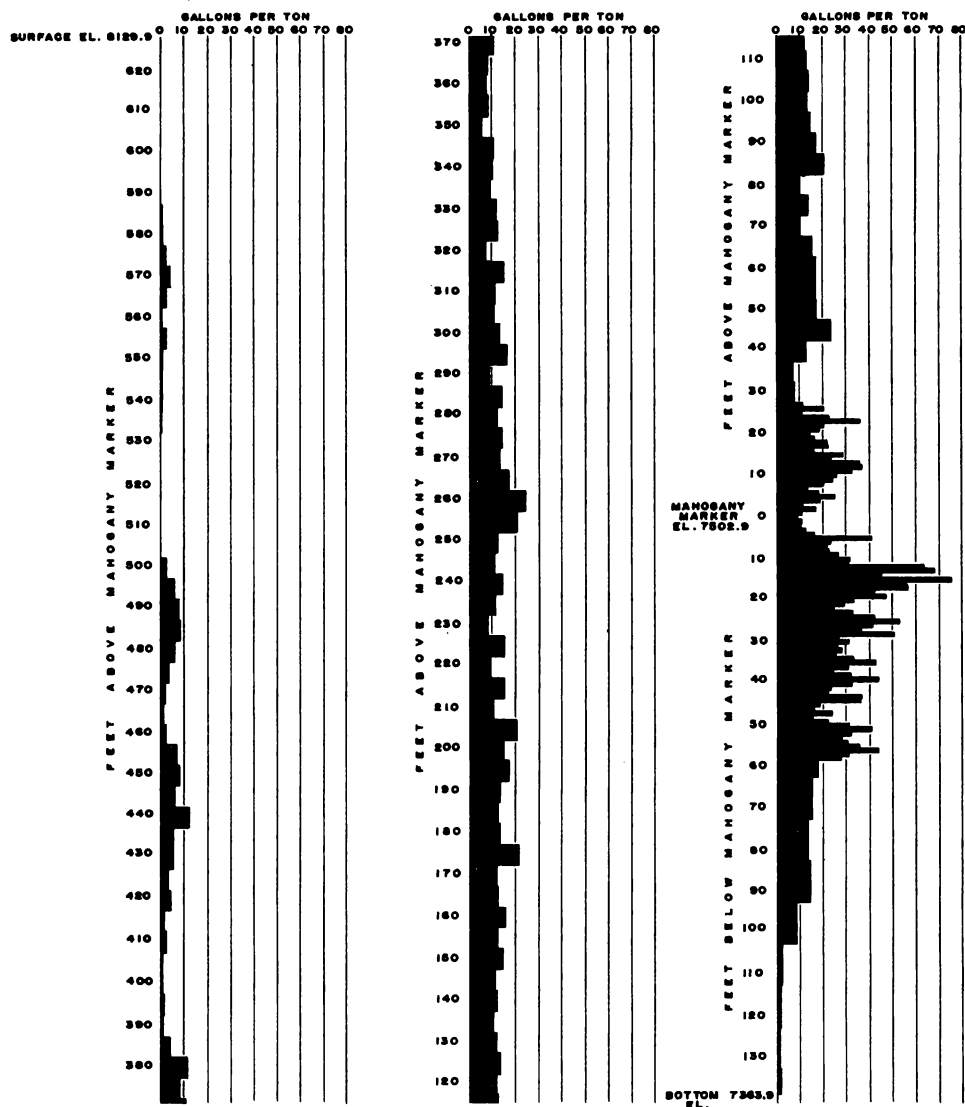
Figure 13.



# HOLE F DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION ON THE NORTH SIDE OF TRAPPER'S CREEK  
(NE. SE. SE., SECTION 6, TOWNSHIP 5 SOUTH, RANGE 94 WEST OF THE 6th P.M.) AS  
INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION...756 FEET  
105 FT. OF PLUS 15 GALLON SHALE.....38 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
72 FT.	+ 13 FT.	- 59 FT.	30.20	135,099,000	97,143,000
110 FT.	+ 27 FT.	- 83 FT.	25.47	212,740,000	129,012,000
510 FT.	+ 367 FT.	- 113 FT.	14.99	1,073,458,000	383,122,000
726	+ 567	- 139	11.13	1,577,081,000	417,926,000

CORE SAMPLES DRILLED IN 1949

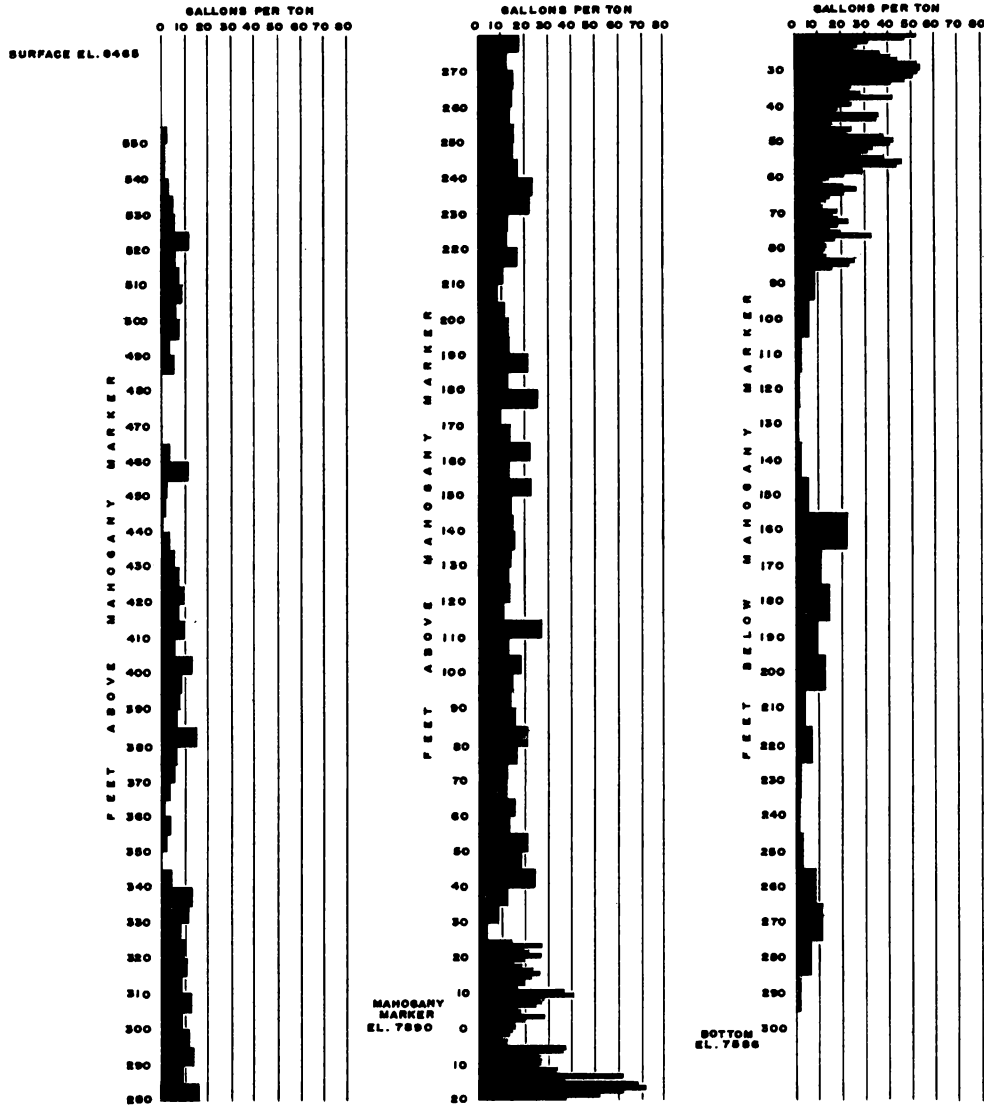
Figure 14.



# HOLE I DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION ON THE EAST SIDE OF YELLOW JACKET  
CREEK (NW. SE. NW., SECTION 20, TOWNSHIP 5 SOUTH, RANGE 94 WEST OF THE 6th P.M.)  
AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 859 FEET  
232 FT. OF PLUS 15 GALLON SHALE ..... 37 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
70 FT.	+11 FT.	-59 FT.	31.78	130,108,000	98,448,000
120 FT.	+25 FT.	-95 FT.	25.22	230,973,000	138,694,000
540 FT.	+435 FT.	-105 FT.	15.06	1,136,073,000	407,363,000
850 FT.	+585 FT.	-265 FT.	11.46	1,841,480,000	502,461,000

CORE SAMPLES DRILLED IN 1949

Figure 15.

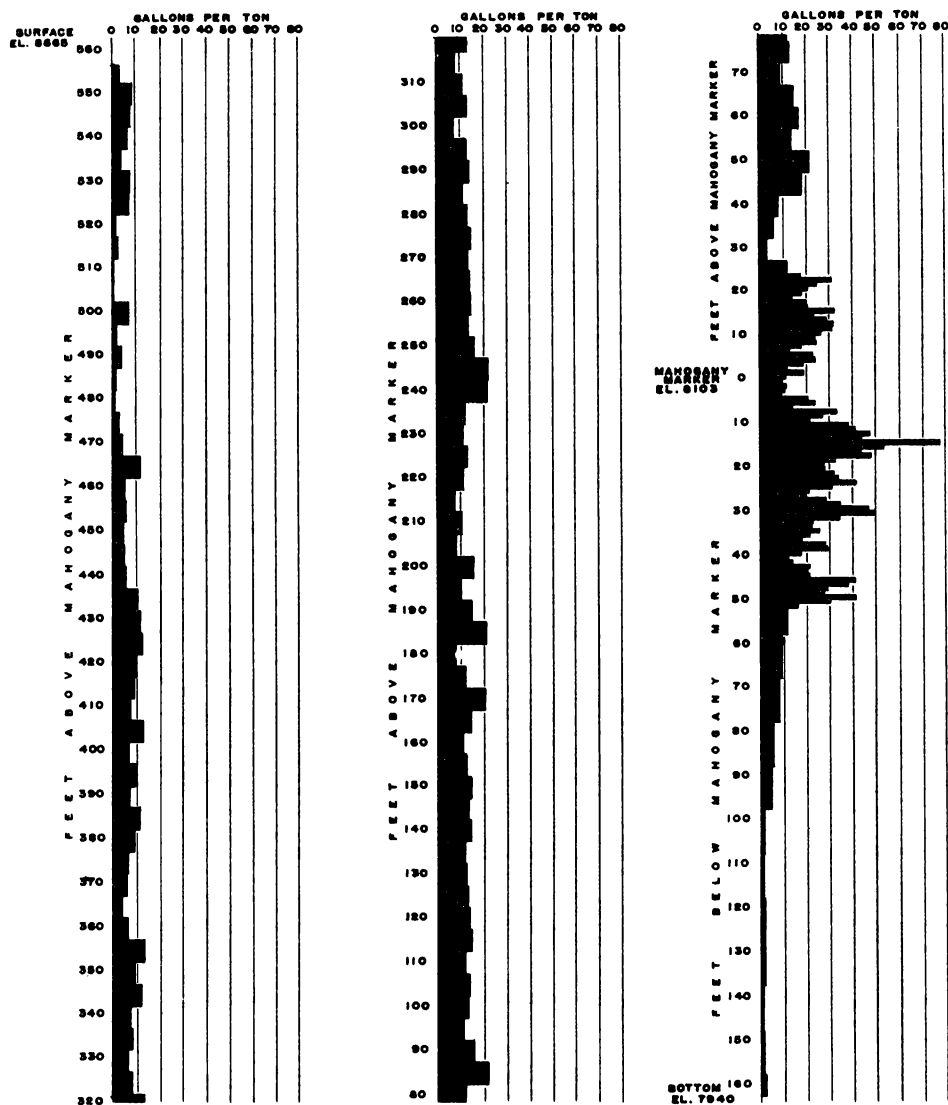




# HOLE L DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION ON THE SOUTH SLOPE OF NORTH WATER CREEK (NE. 1/4 SW. 1/4 NW. 1/4 SECTION 22, TOWNSHIP 5 SOUTH, RANGE 94 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION...719 FEET  
 140 FT. OF PLUS 15 GALLON SHALE.....24 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PERTON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
44 FT.	- 7 FT.	- 51 FT.	36.65	81,851,000	61,681,000
85 FT.	+ 27 FT.	- 58 FT.	24.97	164,901,000	98,038,000
430 FT.	+ 362 FT.	- 68 FT.	18.00	908,128,000	323,260,000
719 FT.	+ 556 FT.	- 163 FT.	10.78	1,566,181,000	401,986,000

CORE SAMPLES DRILLED IN 1949

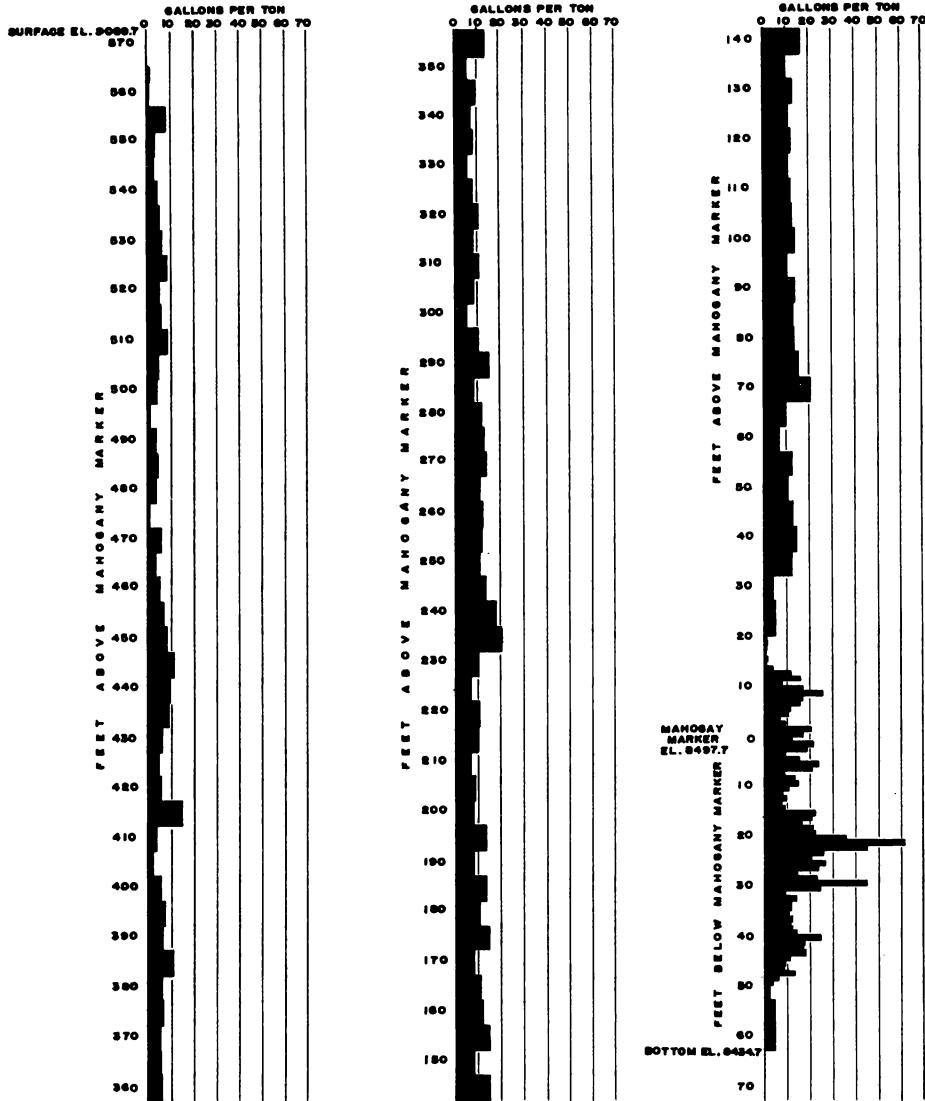
Figure 16.



# **HOLE J** **DRILLED BY THE BUREAU OF MINES** **ON NAVAL OIL SHALE RESERVE No. 1**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION NEAR THE HEAD OF THE EAST FORK OF PARACHUTE CREEK (SW, NW, NW, SECTION 24, TOWNSHIP 5 SOUTH, RANGE 94 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION... 628 FEET  
 87 FT. OF PLUS 15 GALLON SHALE..... 4 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
11 FT.	- 20 FT.	- 31 FT.	30.89	20,546,000	18,111,000
19 FT.	- 15 FT.	- 34 FT.	25.02	36,855,000	21,955,000
70 FT.	+ 20 FT.	- 80 FT.	15.18	147,114,000	83,174,000
607 FT.	+ 857 FT.	- 80 FT.	10.01	1,330,413,000	317,082,000
628 FT.	+ 565 FT.	- 63 FT.	9.78	1,379,423,000	321,208,000

CORE SAMPLES DRILLED IN 1949

Figure 17.

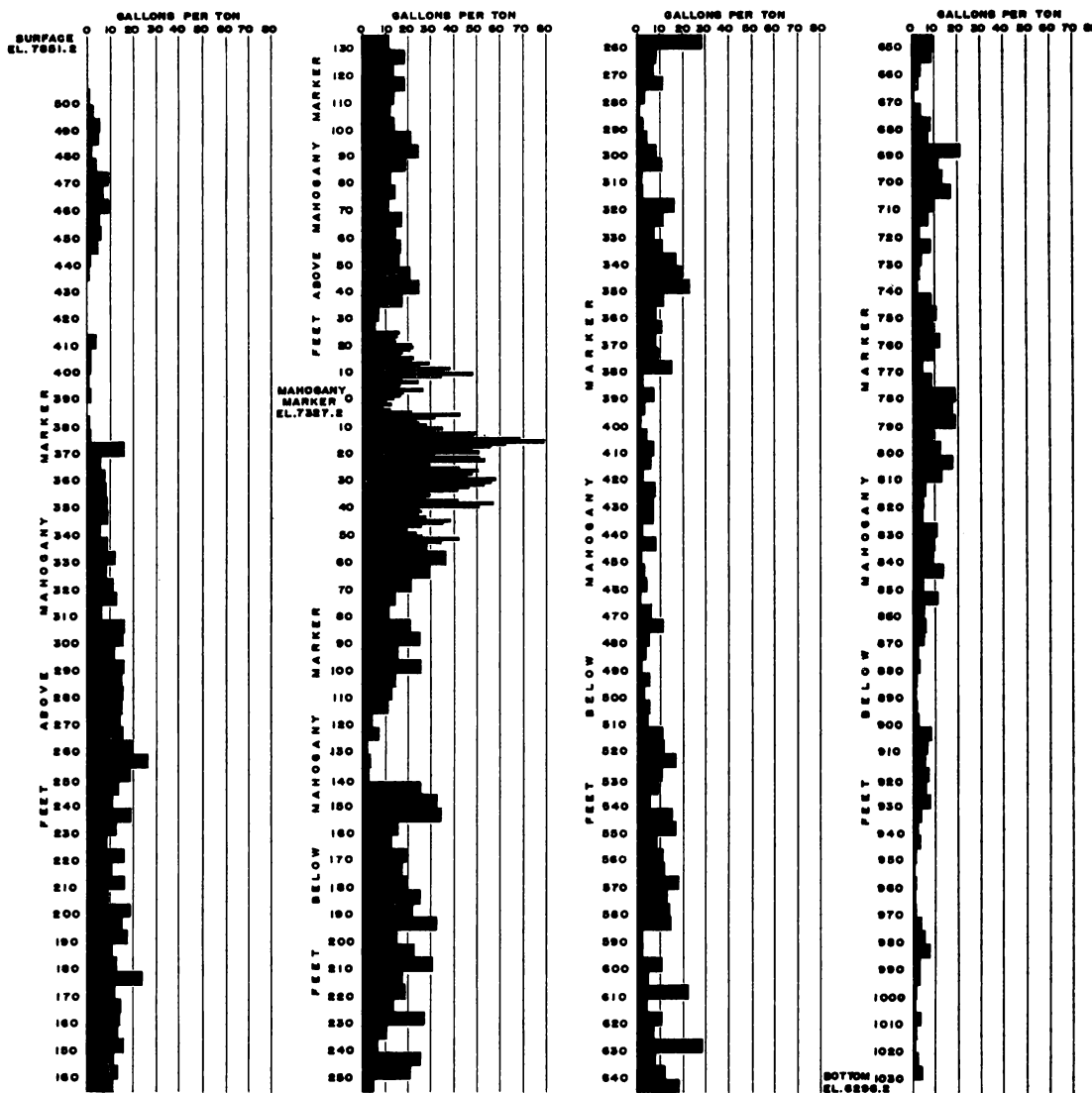


# HOLE E

DRILLED BY THE BUREAU OF MINES  
ON NAVAL OIL SHALE RESERVE No.1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION AT THE JUNCTION OF THE TWO MAIN FORKS  
OF CORRAL CREEK (SW. SW. NW., SECTION 2, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE  
6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE  
BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION...1536 FEET  
444 FT. OF PLUS 15 GALLON SHALE.....60 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
92 FT.	+ 21 FT.	- 71 FT.	31. 38	171,452,000	127,977,000
188 FT.	+ 54 FT.	-101 FT.	25. 25	300,187,000	180,458,000
620 FT.	+ 374 FT.	-446 FT.	18. 03	1,725,617,000	617,524,000
1536 FT.	+ 505 FT.	-1031 FT.	10. 99	3,340,278,000	674,039,000

CORE SAMPLES DRILLED IN 1949

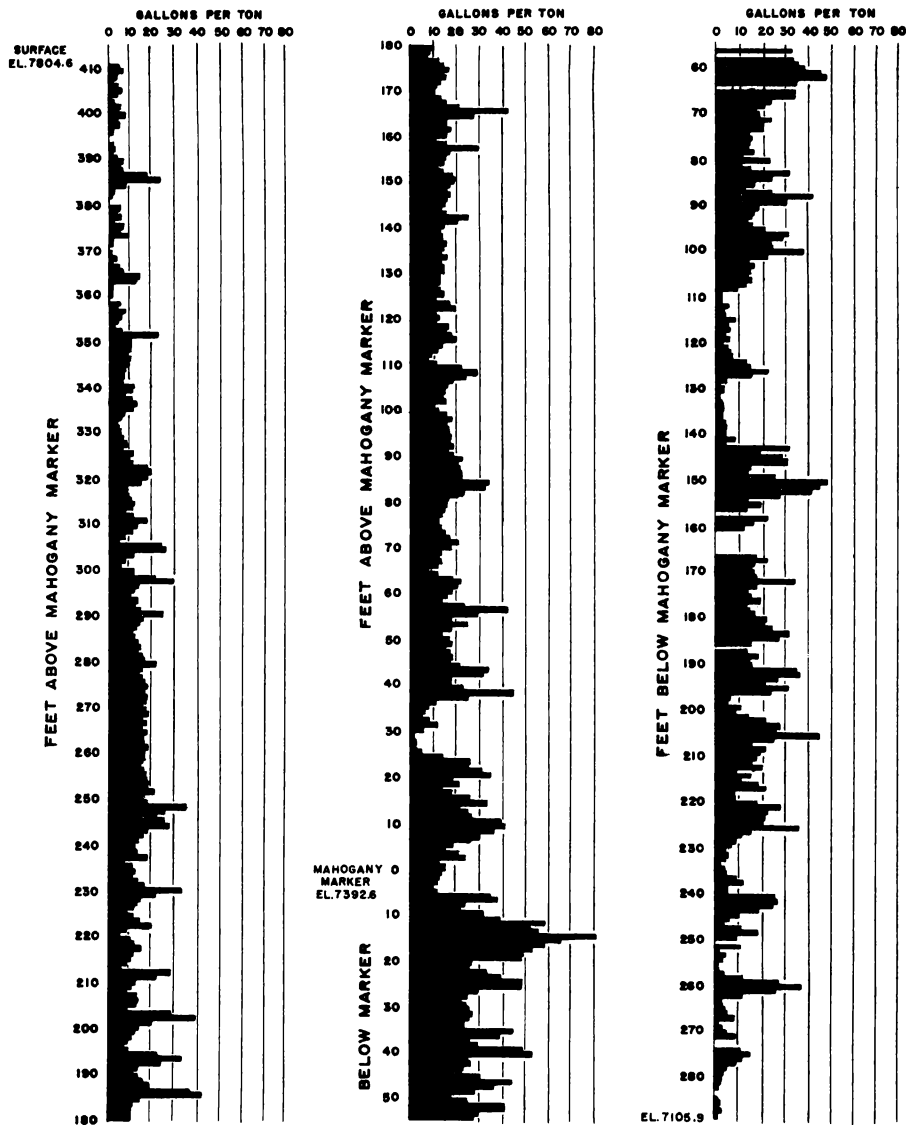
Figure 18.



# **HOLE D** **DRILLED BY THE BUREAU OF MINES** **ON NAVAL OIL SHALE RESERVE No. 1**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION ON THE NORTH SIDE OF THE MIDDLE FORK OF PARACHUTE CREEK (SW 1/4 SW 1/4, SEC. 11, T. 5 S. R. 95 W. 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 701 FEET  
 316 FT. OF PLUS 15 GALLON SHALE ..... 74 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
92 FT.	+25 FT.	- 67 FT.	30.97	172,060,000	126,874,000
133 FT.	+25 FT.	-108 FT.	27.11	255,382,000	164,843,000
155 FT.	+47 FT.	-108 FT.	25.00	300,641,000	178,953,000
391 FT.	+163 FT.	-228 FT.	19.25	795,942,000	364,807,000
700 FT.	+411 FT.	-269 FT.	15.79	1,463,134,000	560,069,000

CORE SAMPLES DRILLED IN 1946

Figure 19.

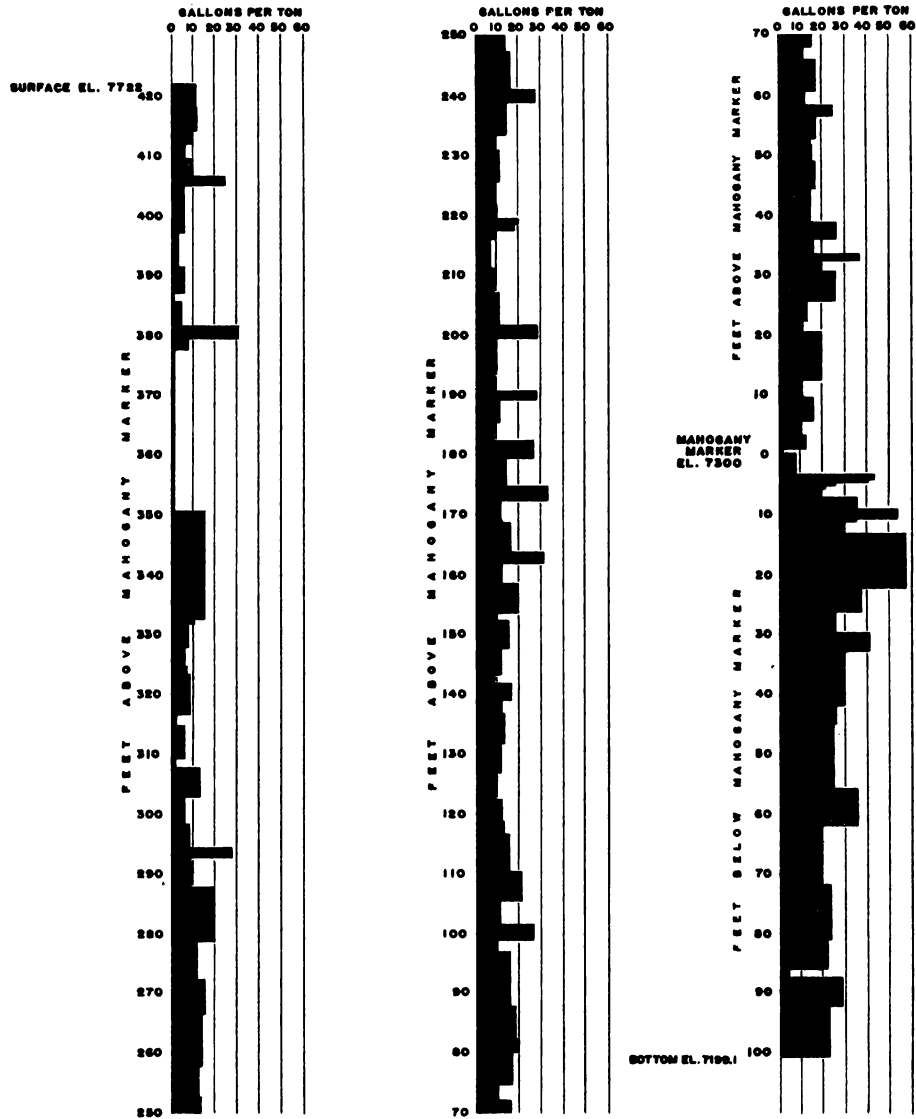




# **COLUMBIA SURFACE SAMPLING COLUMBIA OIL SHALE COMPANY**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE CLIFF EXPOSURES OF THE EAST MIDDLE FORK OF PARACHUTE CREEK (SECTIONS 15 AND 16, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE 6TH P.M. ASSAYED BY F.A. GOODALE.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION 523 FEET  
261 FT. OF PLUS 15 GALLON SHALE ..... 46 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
523 ft.	- 3.8 ft.	- 86.1 ft.	30.38	154,195,000	111,834,000
139.3 ft.	+38.4 ft.	-100.9 ft.	25.26	269,835,000	162,286,000
522.9 ft.	+422.0 ft.	-100.9 ft.	15.23	1,098,465,000	398,324,000

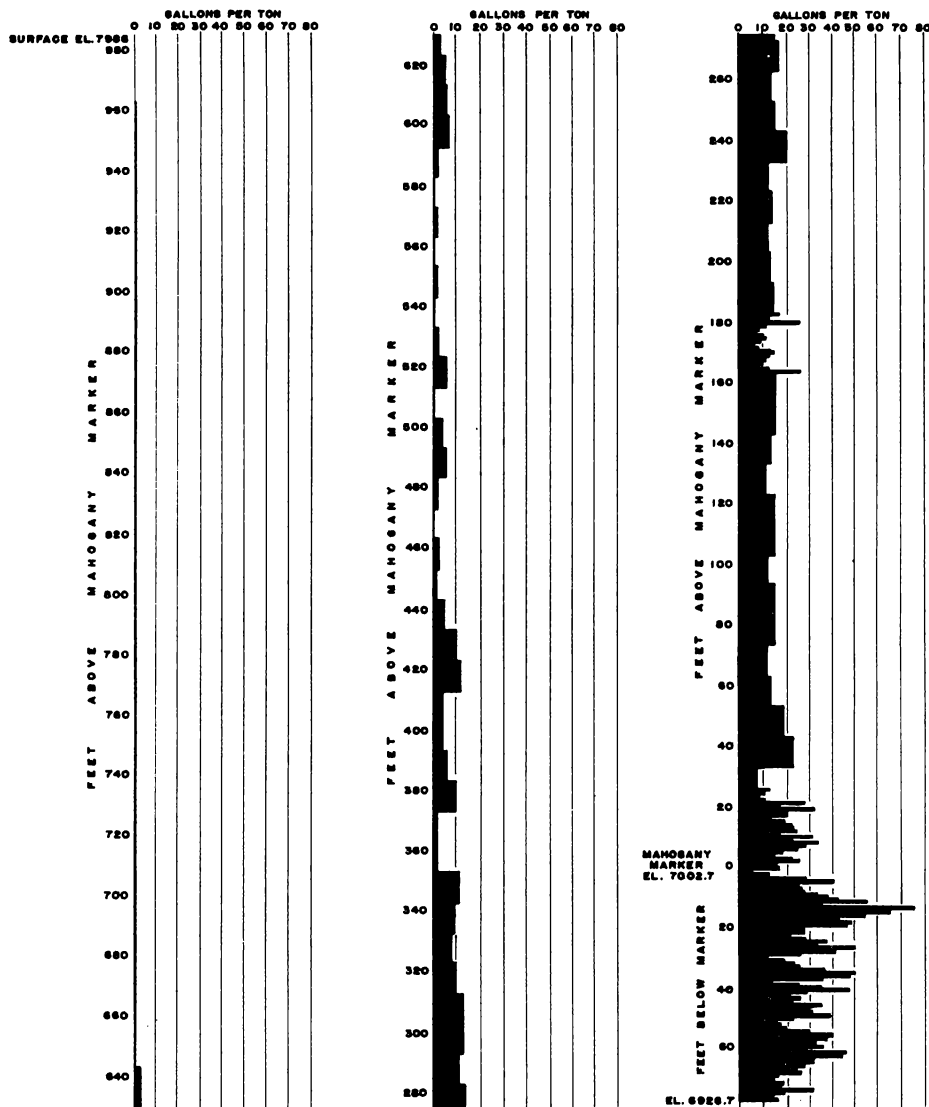
CHANNEL SAMPLES TAKEN IN 1926 BY F.A. GOODALE

Figure 20.



**BELLA CASTLE No.1**  
**UNION OIL COMPANY OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION NEAR THE TIP OF LINDAUR POINT,  
(NW. NW. SE., SECTION 19, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE 6th P.M.)  
GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..1033 FEET  
172 FT. OF PLUS 15 GALLON SHALE ..... 39 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
60 ft.	- 7 ft.	- 67 ft.	33.37	110,454,000	87,758,000
129 ft.	+ 53 ft.	- 76 ft.	25.07	250,097,000	149,284,000
479 ft.	+403 ft.	- 76 ft.	15.09	1,007,553,000	361,999,000
729 ft.	+653 ft.	- 76 ft.	10.78	1,587,954,000	407,575,000

CORE SAMPLES DRILLED IN 1948

Figure 21.

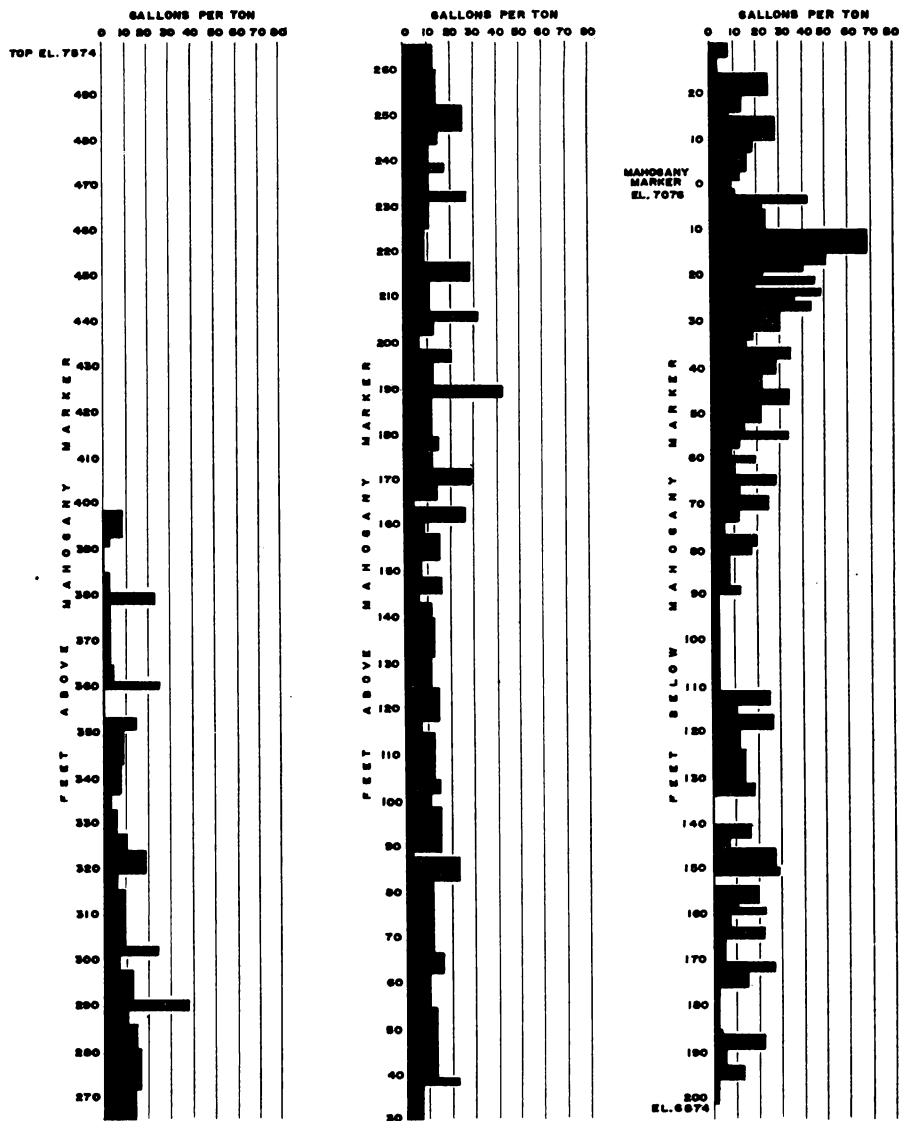


# LINDAUR POINT SURFACE SAMPLING

## UNION OIL COMPANY OF CALIFORNIA

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE CLIFF EXPOSURES OF LINDAUR POINT (EAST 1/2, SEC. 19, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..600 FEET  
174 FT. OF PLUS 15 GALLON SHALE.....35 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
52.5 ft.	-3.5 ft.	-56 ft.	32.89	96,933,000	78,908,000
95.9 ft.	+23.4 ft.	-72.5 ft.	25.25	185,726,000	111,657,000
427.2 ft.	+334.2 ft.	-91 ft.	15.05	899,683,000	322,100,000
278.5 ft.	+398 ft.	-202 ft.	13.41	1,233,676,000	393,896,000

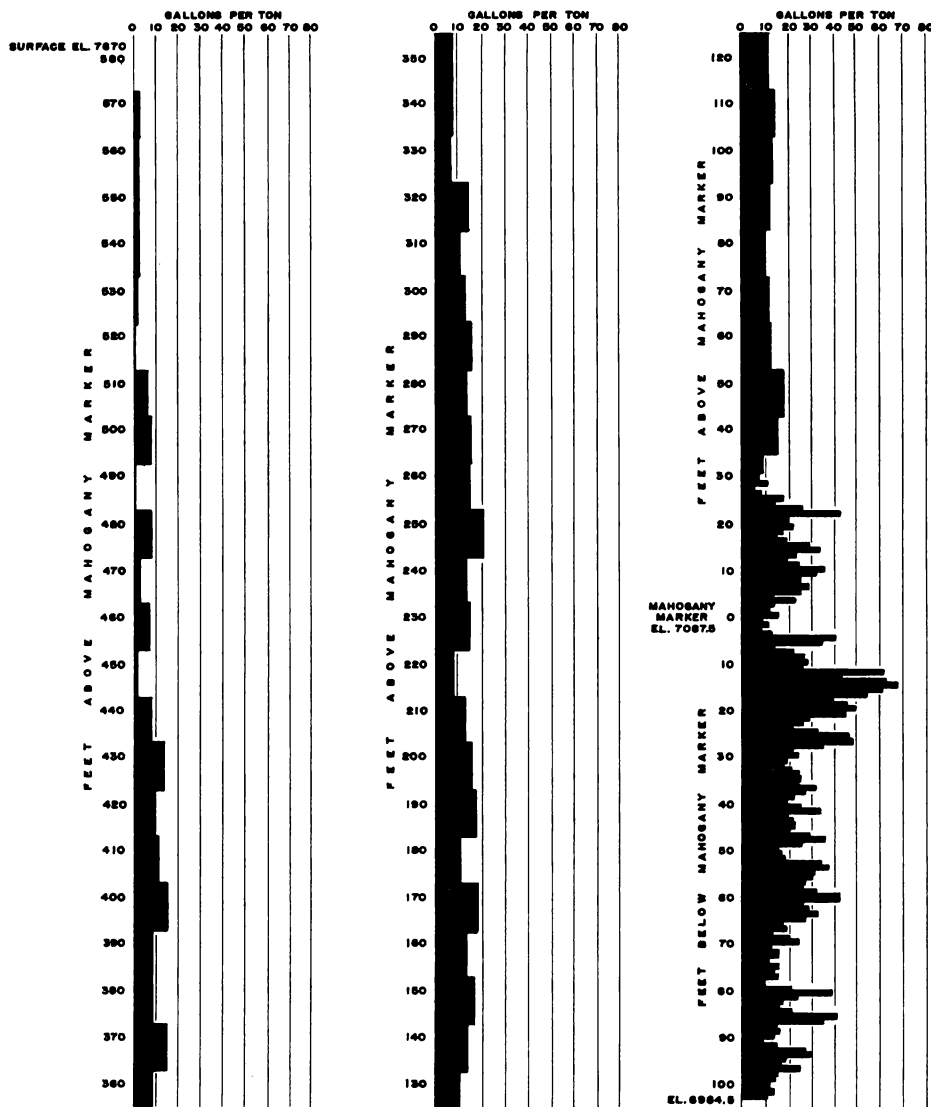
\* 21.5 FEET NOT ASSAYED

CHANNEL SAMPLES TAKEN BY RODERICK BURNHAM

Figure 22.



**LIGNUM VITA No.9**  
**UNION OIL COMPANY OF CALIFORNIA**  
OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION ON LINDAUR POINT (NE. NW. SE., SEC.  
20, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE 6th P.M.)  
**GARFIELD COUNTY, COLORADO**



TOTAL LENGTH OF SECTION..675 FEET  
196 FT. OF PLUS 15 GALLON SHALE ..... 33 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
60 ft.	- 8 ft.	- 68 ft.	29.80	112,880,000	80,196,000
111 ft.	+23 ft.	- 88 ft.	25.34	214,831,000	129,615,000
536 ft.	+433 ft.	-103 ft.	15.23	1,126,092,000	408,342,000
616 ft.	+513 ft.	-103 ft.	13.88	1,308,678,000	432,487,000

CORE SAMPLES DRILLED IN 1948

Figure 23.

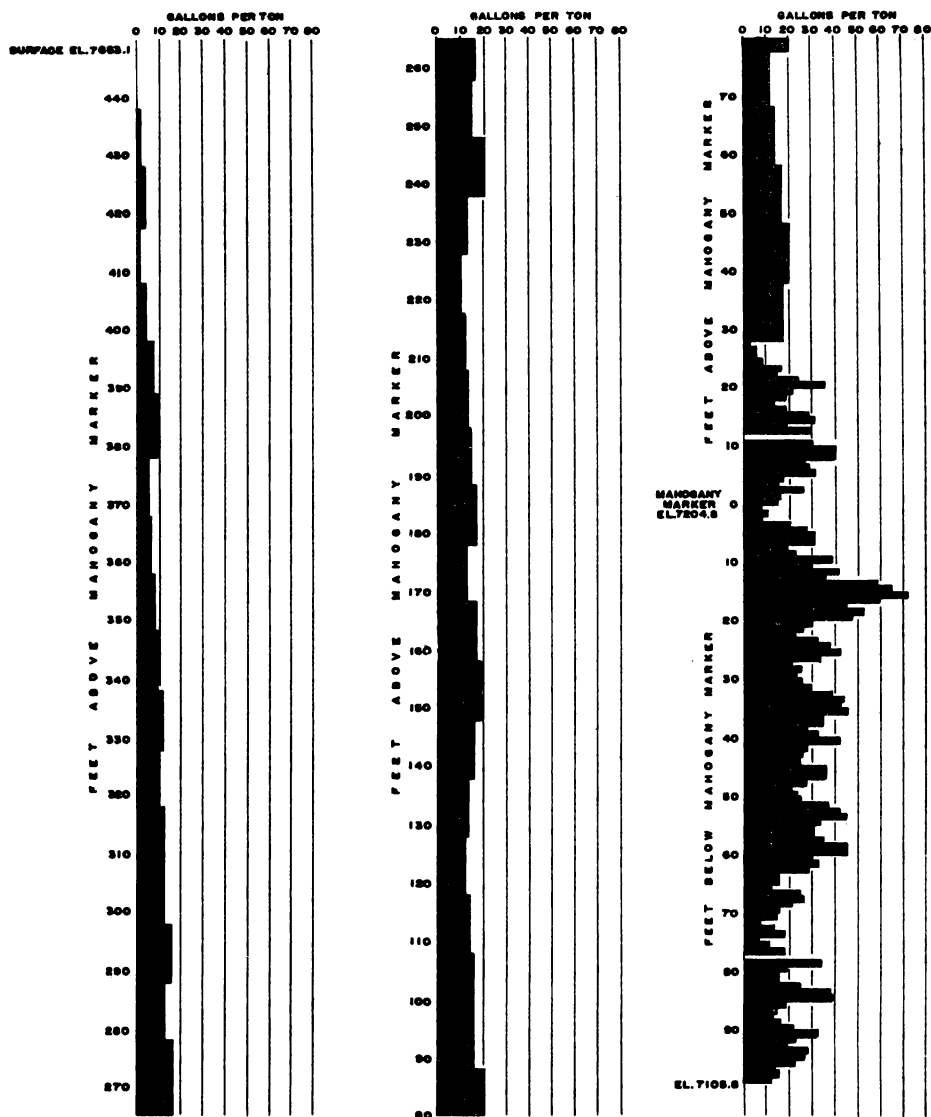




**LIGNUM VITA No. 13**  
**UNION OIL COMPANY OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION BETWEEN EAST MIDDLE FORK AND EAST  
FORK OF PARACHUTE CREEK (SE. SW. NE., SECTION 21, TOWNSHIP 5 SOUTH, RANGE 98 W.  
OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..547 FEET  
255 FT. OF PLUS 15 GALLON SHALE ..... 47 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
60 ft.	- 2 ft.	- 62 ft.	32.75	110,872,000	86,484,000
137 ft.	+ 38 ft.	- 99 ft.	24.98	265,765,000	158,067,000
537 ft.	+ 438 ft.	- 99 ft.	15.29	1,127,681,000	410,530,000

CORE SAMPLES DRILLED IN 1948

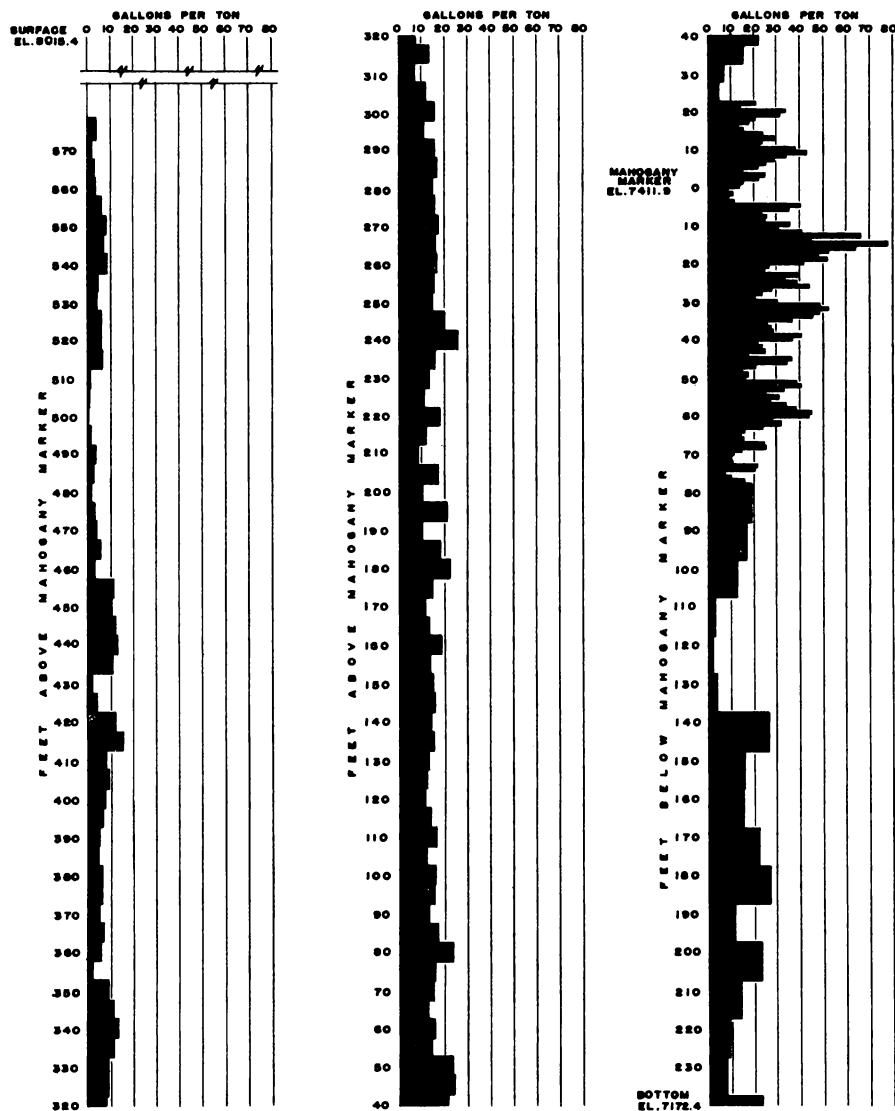
Figure 24.



# HOLE H DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION ON THE NORTH SLOPE NEAR BEN GOOD CREEK (SE. SE. NW., SECTION 23, TOWNSHIP 5 SOUTH, RANGE 95 WEST OF THE 6th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..819 FEET  
 350 FT. OF PLUS 15 GALLON SHALE.....41 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
78 FT.	+ 15 FT.	- 83 FT.	31.20	148,497,000	108,063,000
100 FT.	+ 23 FT.	- 77 FT.	28.00	190,328,000	126,884,000
130 FT.	+ 23 FT.	- 107 FT.	23.37	251,547,000	151,946,000
718 FT.	+ 478 FT.	- 240 FT.	18.03	1,510,954,000	540,706,000
819 FT.	+ 579 FT.	- 240 FT.	13.61	1,743,710,000	565,048,000

CORE SAMPLES DRILLED IN 1949

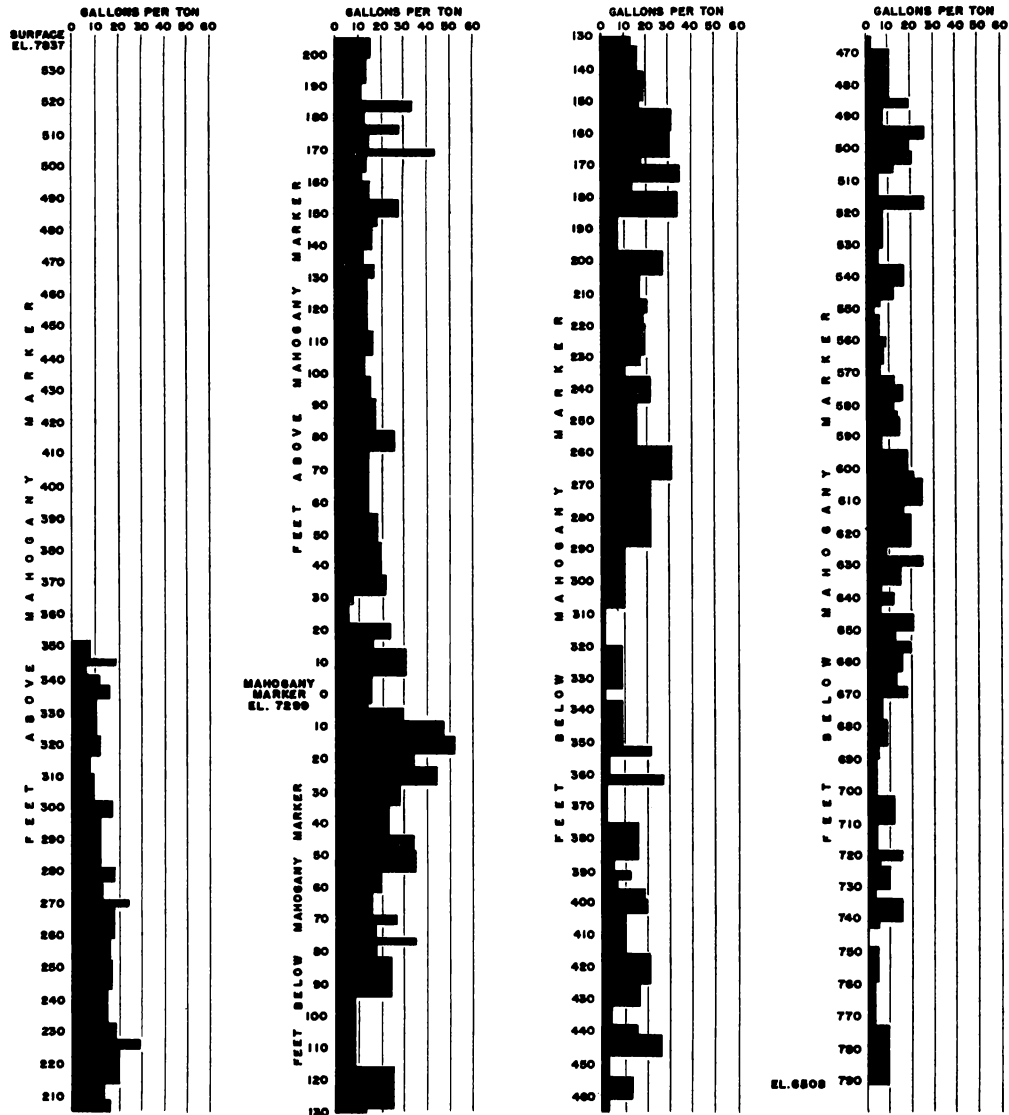
Figure 25.



# SUMMER'S CAMP HOLE SUN OIL COMPANY

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE WEST FORK OF PARACHUTE CREEK (NE NE SE, SECTION 2, TOWNSHIP 5 SOUTH, RANGE 97 WEST OF 6TH P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION -1329 FEET  
537 FT. OF PLUS 15 GALLON SHALE .....84 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
93.2 ft.	+15.2 ft.	-78 ft.	28.10	177,251,000	118,589,000
131 ft.	+37 ft.	-94 ft.	25.02	254,028,000	151,328,000
1111.6 ft.	+352 ft.	-759.6 ft.	15.01	2,339,723,000	836,172,000

CORE SAMPLES DRILLED IN 1948

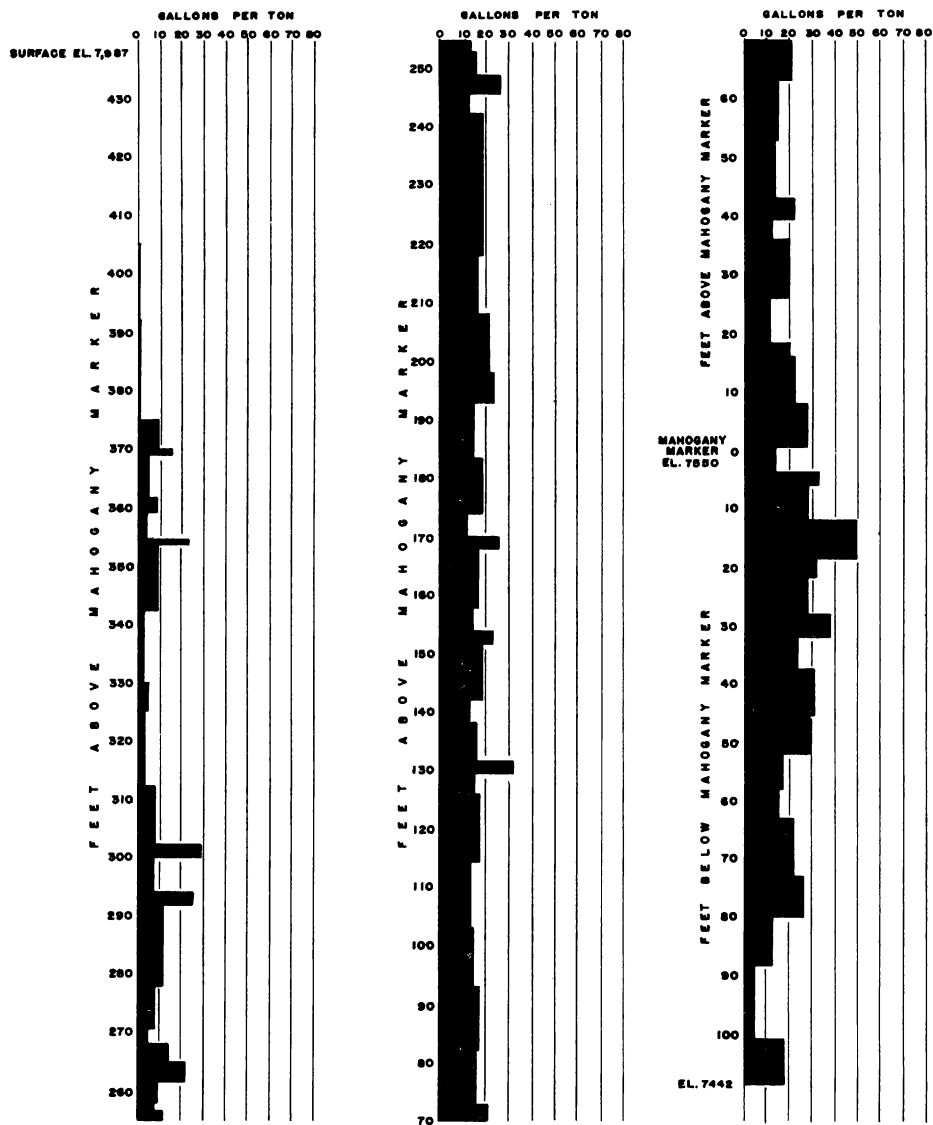
Figure 26.



# MAGER'S CAMP HOLE SUN OIL COMPANY

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF SLEEPY GULCH (SW NW NW, SECTION 20, TOWNSHIP 5 SOUTH, RANGE 97 WEST OF THE 6TH P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 545 FEET  
260 FT. OF PLUS 15 GALLON SHALE ..... 27 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
70 ft.	+ 18 ft.	- 52 ft.	28.69	132,645,000	90,609,000
106 ft.	+ 18 ft.	- 88 ft.	25.18	205,213,000	123,030,000
483.3 ft.	+ 375.3 ft.	- 108 ft.	15.68	1,011,791,000	377,254,000

CORE SAMPLES DRILLED IN 1948

Figure 27.

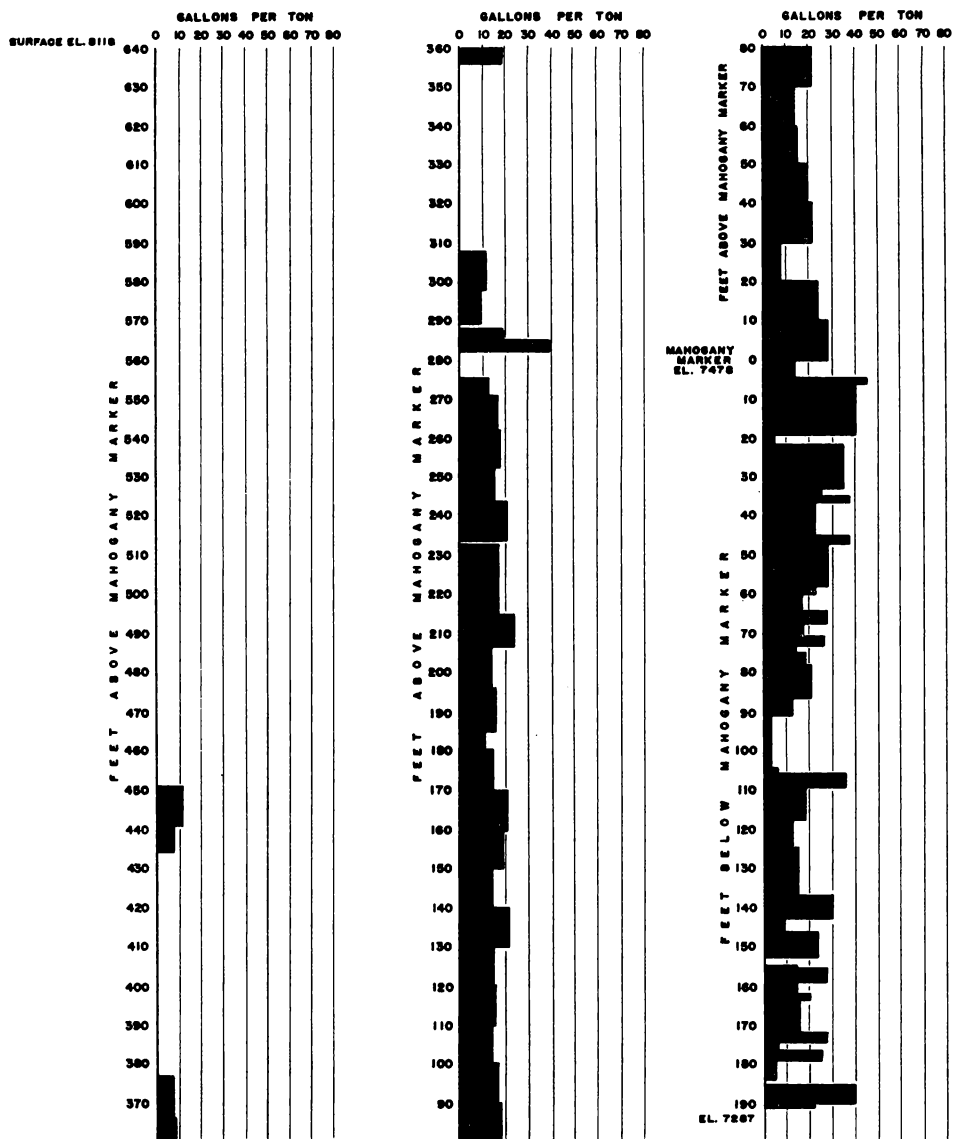




# **BEAR RUN HOLE SUN OIL COMPANY**

**OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF BEAR RUN GULCH  
(NW NW, SECTION 25, TOWNSHIP 5 SOUTH, RANGE 97 WEST OF THE 6TH P.M.)**

**GARFIELD COUNTY, COLORADO**



**TOTAL LENGTH OF SECTION - 831 FEET  
341 FT. OF PLUS 15 GALLON SHALE ..... 47 FT. OF PLUS 30 GALLON SHALE**

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
78 ft.	+ 20 ft.	- 58 ft.	28.54	147,979,000	100,555,000
126.5 ft.	+ 40 ft.	- 86.5 ft.	25.00	245,971,000	146,411,000
499 ft.	+ 308 ft.	- 191 ft.	18.55	1,019,262,000	450,174,000

**CORE SAMPLES DRILLED IN 1948**

Figure 28.

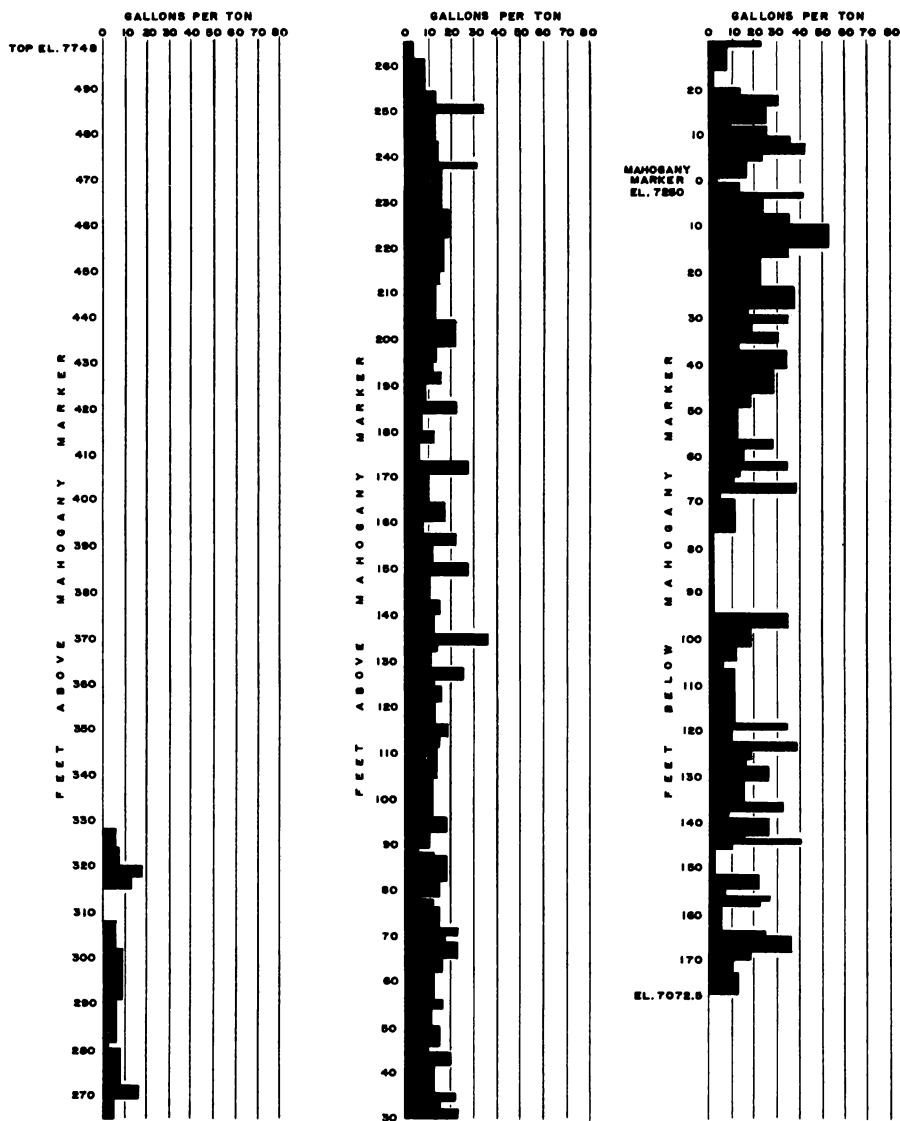


# COTTONWOOD SURFACE SAMPLING

## S.O.S. OIL SHALE PROPERTY

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE CLIFF EXPOSURES NEAR COTTONWOOD CREEK (NW. SW., SECTION 9, TOWNSHIP 5 SOUTH, RANGE 98 WEST OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION 505.5 FEET  
198 FT. OF PLUS 15 GALLON SHALE ..... 45 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS PER SQUARE MILE
43.5 ft.	- 3 ft.	-46.5 ft.	29.78	81,851,000	88,036,000
81 ft.	+10.5 ft.	-70.5 ft.	25.03	157,067,000	93,604,000
457 ft.	+279.5 ft.	-177.5 ft.	15.17	980,634,000	346,972,000
498.5 ft.	+328 ft.	-177.5 ft.	14.48	1,063,831,000	363,321,000

\* 7 FEET NOT SAMPLED

CHANNEL SAMPLES TAKEN IN 1926 BY FRED CARROLL

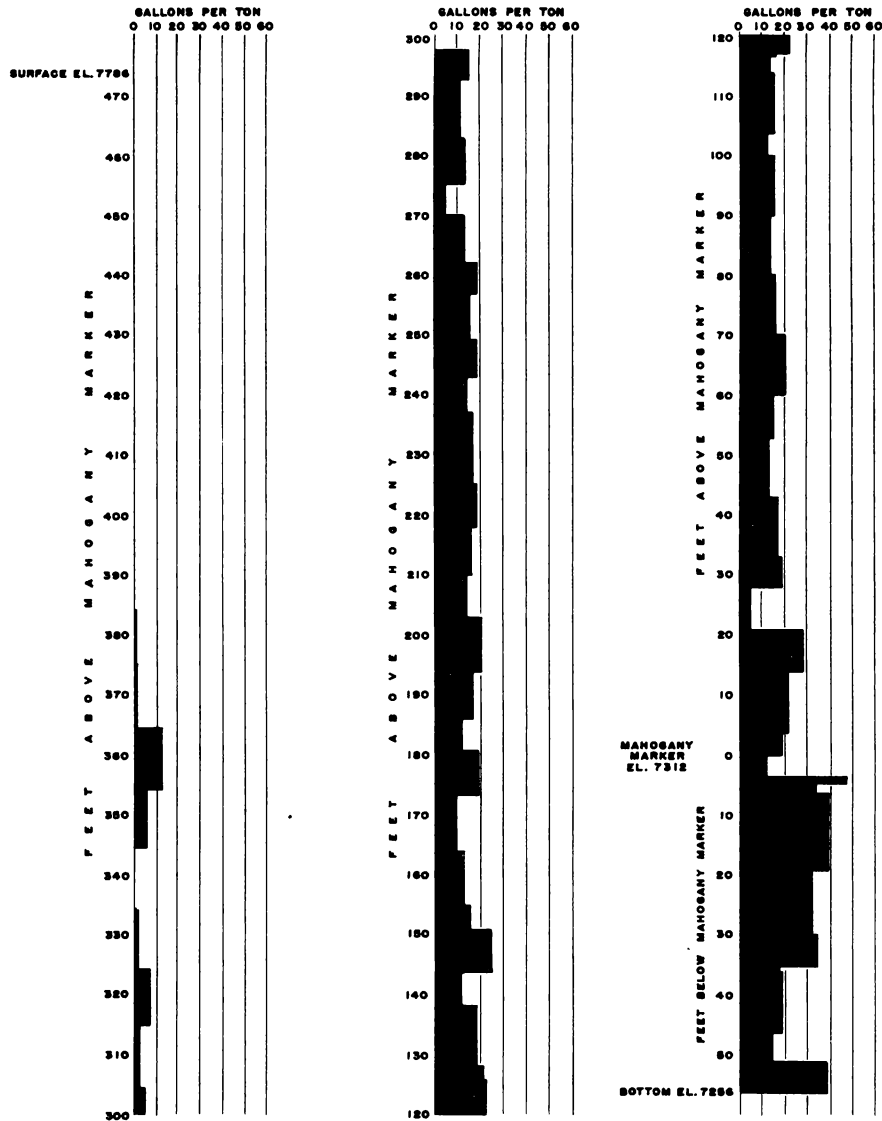
Figure 29.



# **SYNDICATE No. 2 STANDARD OIL COMPANY OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN  
RIVER FORMATION ON THE EAST SIDE OF CLEAR CREEK (SE. SW. SW., SECTION 9,  
T5S., R 9E W. OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 494 FEET  
235 FT. OF PLUS 15 GALLON SHALE ..... 37 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
77 FT.	* 21 FT.	- 56 FT.	27.16	147,337,000	95,278,000
84 FT.	+ 28 FT.	- 86 FT.	25.09	162,838,000	97,276,000
* 430 FT.	+ 384 FT.	- 86 FT.	15.09	904,487,000	324,369,000

\* 10 FEET NOT SAMPLED

CORE SAMPLES DRILLED IN 1948

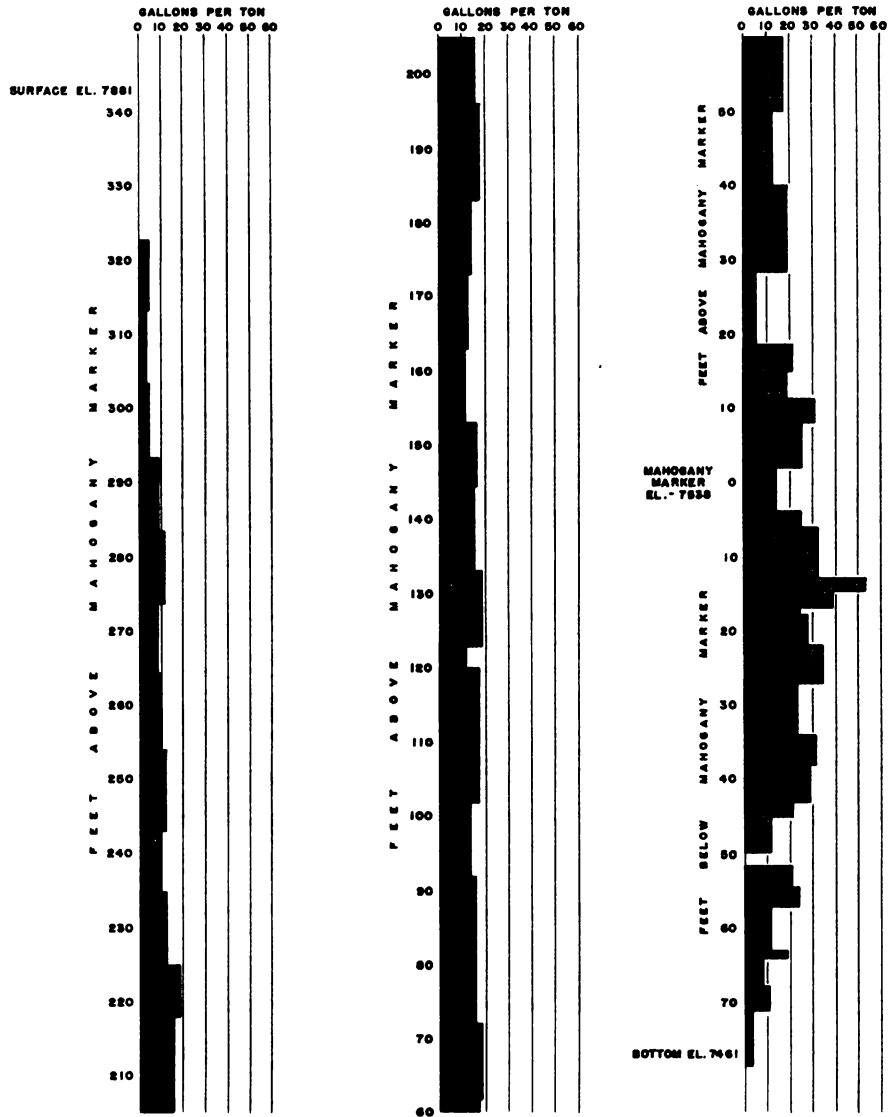
Figure 30.



# **SYNDICATE No. 1 STANDARD OIL COMPANY OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE S. FORK OF CLEAR CREEK (SE. SW. NW, SECTION 11, T5S., R 99 W. OF THE 61h P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 400 FEET  
207 FT. OF PLUS 15 GALLON SHALE ..... 23 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
50 FT.	* 15 FT.	- 45 FT.	26.91	114,971,000	73,664,000
75.5 FT.	* 18.5 FT.	- 87 FT.	25.24	146,222,000	87,872,000
* 388 FT.	* 313 FT.	- 77 FT.	15.17	815,583,000	294,581,000

\* 2 FEET NOT ASSAYED

CORE SAMPLES DRILLED IN 1948

Figure 31.

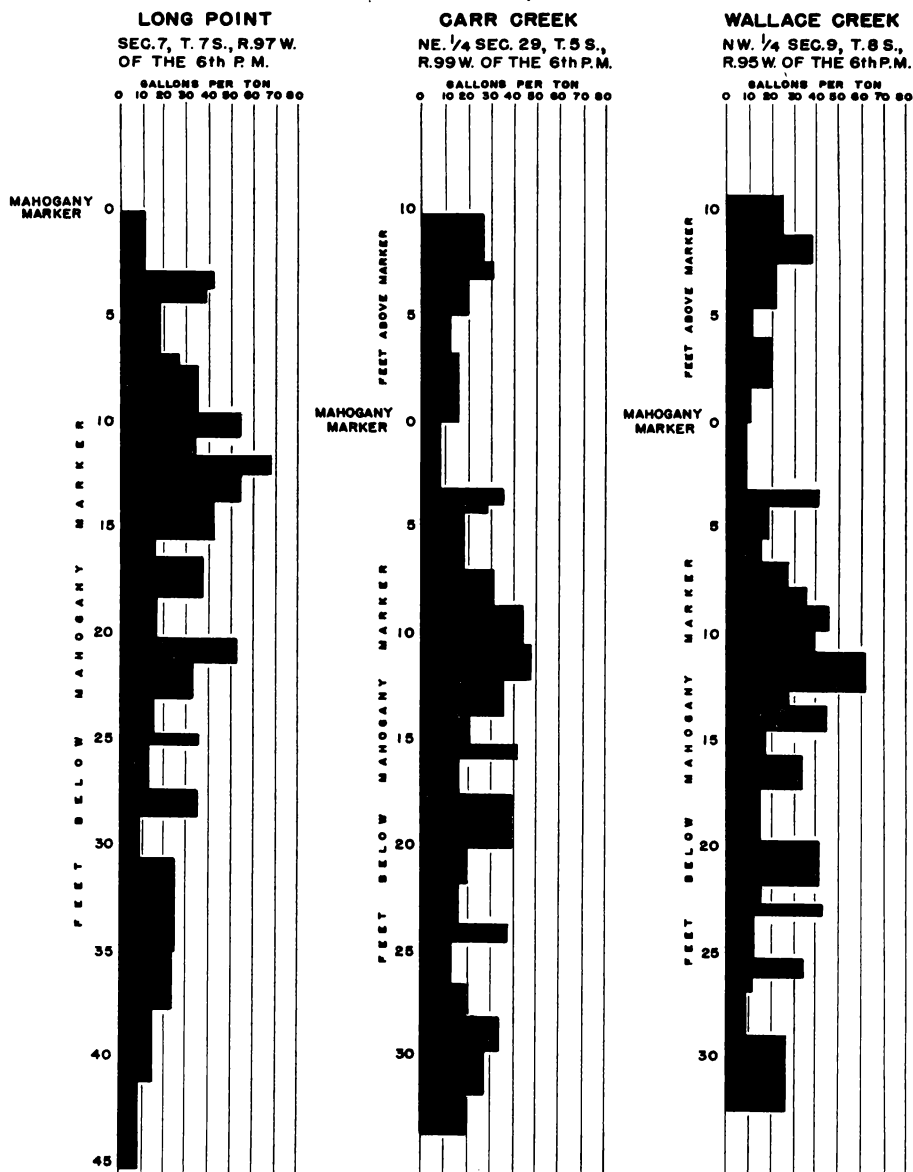




# SURFACE SECTIONS WAYNE M. FELTS

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION TAKEN FROM SURFACE EXPOSURES ON LONG POINT, CARR CREEK AND WALLACE CREEK, AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



PLACE	LENGTH OF SECTION	PLUS 15 GAL. SHALE	PLUS 30 GAL. SHALE
LONG POINT	45.3 FT.	30.4 FT.	15.7 FT.
GARR CREEK	43.5 FT.	36.6 FT.	13.6 FT.
WALLACE CREEK	43.2 FT.	28.6 FT.	12.9 FT.

SELECTED SECTIONS						
PLACE	LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQ. MILE	BBLS. PER SQ. MILE
LONG POINT	45.3 FT.	+ 0 FT.	-45.3 FT.	23.62	86,709,000	50,311,000
GARR CREEK	43.5 FT.	+10 FT.	-33.5 FT.	23.91	85,113,000	48,484,000
WALLACE CREEK	43.2 FT.	+10.8 FT.	-32.4 FT.	23.44	84,882,000	47,361,000

CHANNEL SAMPLES TAKEN 1946 BY WAYNE M. FELTS

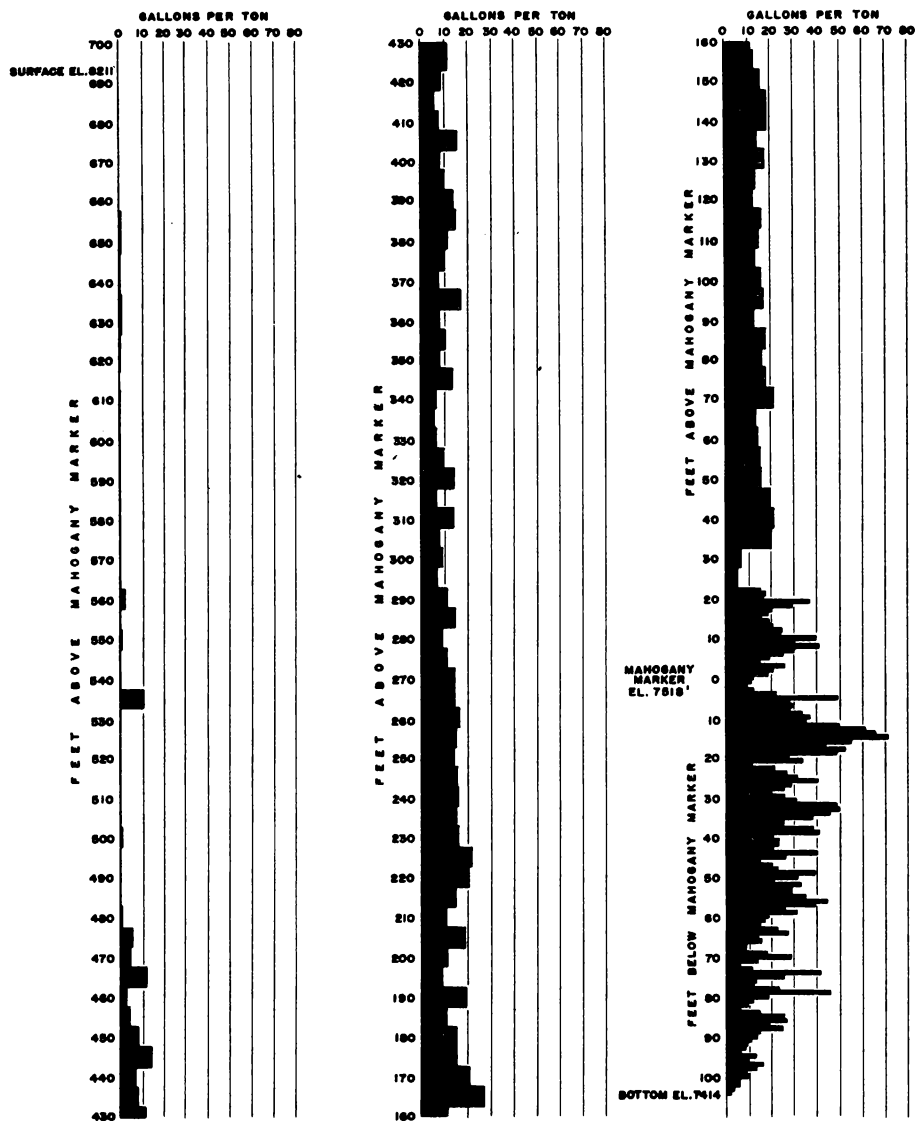
Figure 32.



# HOLE K DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION NEAR THE EAST PRONG OF FORKED GULCH (SW. SW. SW. SEC. 5, T6S., R 95 W. OF THE 8th P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 797 FEET  
240 FT. OF PLUS 15 GALLON SHALE ..... 37 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
62 FT.	+ 23 FT.	- 59 FT.	29.22	155,081,000	107,855,000
119 FT.	+ 23 FT.	- 96 FT.	25.01	230,805,000	137,439,000
575 FT.	+ 473 FT.	- 102 FT.	15.03	1,209,950,000	432,989,000

CORE SAMPLES DRILLED IN 1948

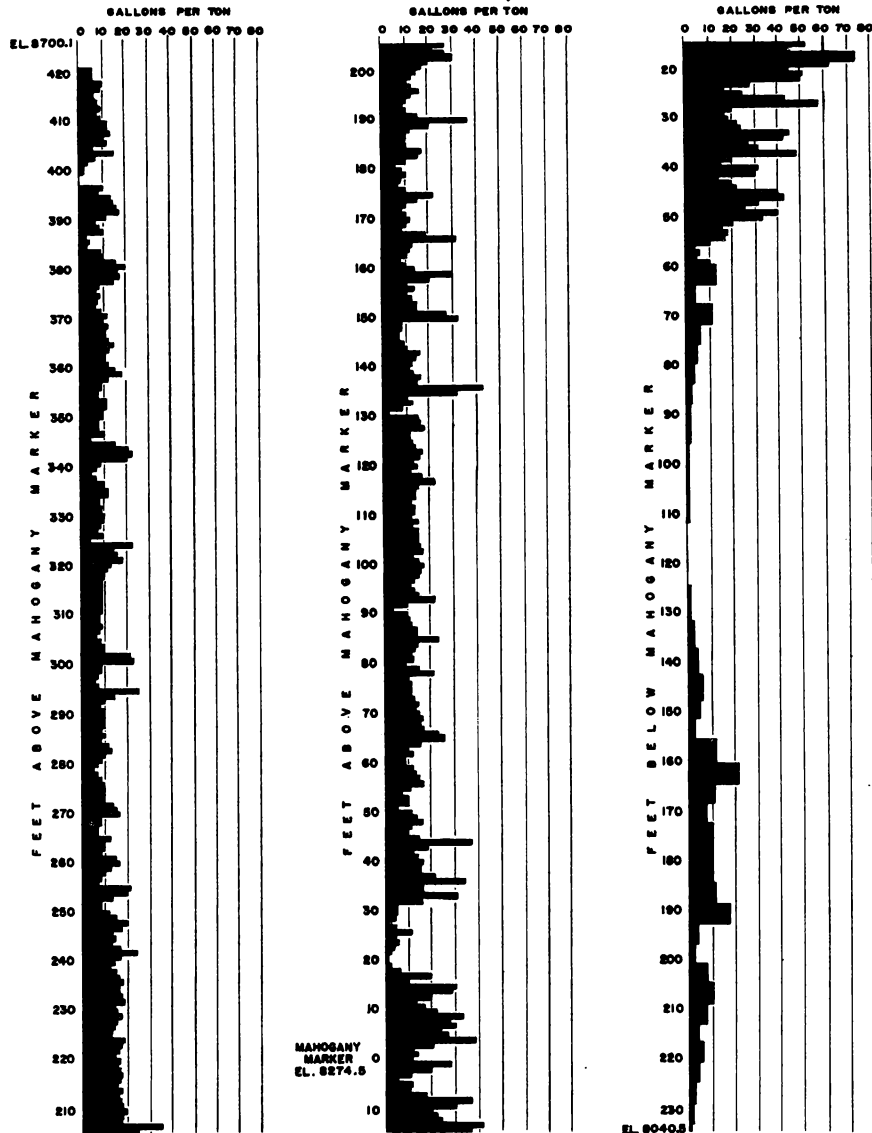
Figure 33.



# **HOLE B** **DRILLED BY THE BUREAU OF MINES** **ON NAVAL OIL SHALE RESERVE No. 1**

OIL YIELDS OF OIL SHALE BEDS IN THE EVAGUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF THE SOUTH PRONG OF THE EAST FORK OF PARACHUTE CREEK (SE. 1/4 NW. 1/4, SEC. 12, T. 8 S., R. 95 W. OF THE 6TH PM.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 655 FEET  
 178 FT. OF PLUS 15 GALLON SHALE..... 37 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
72 ft.	+ 17 ft.	- 55 ft.	27.789	137,664,000	91,084,000
82 ft.	+ 17 ft.	- 65 ft.	25.430	158,625,000	96,045,000
423 ft.	+ 368 ft.	- 55 ft.	15.000	883,745,000	315,623,000
649 ft.	+ 420 ft.	- 229 ft.	11.655	1,397,154,000	387,710,000

CORE SAMPLES DRILLED IN 1945

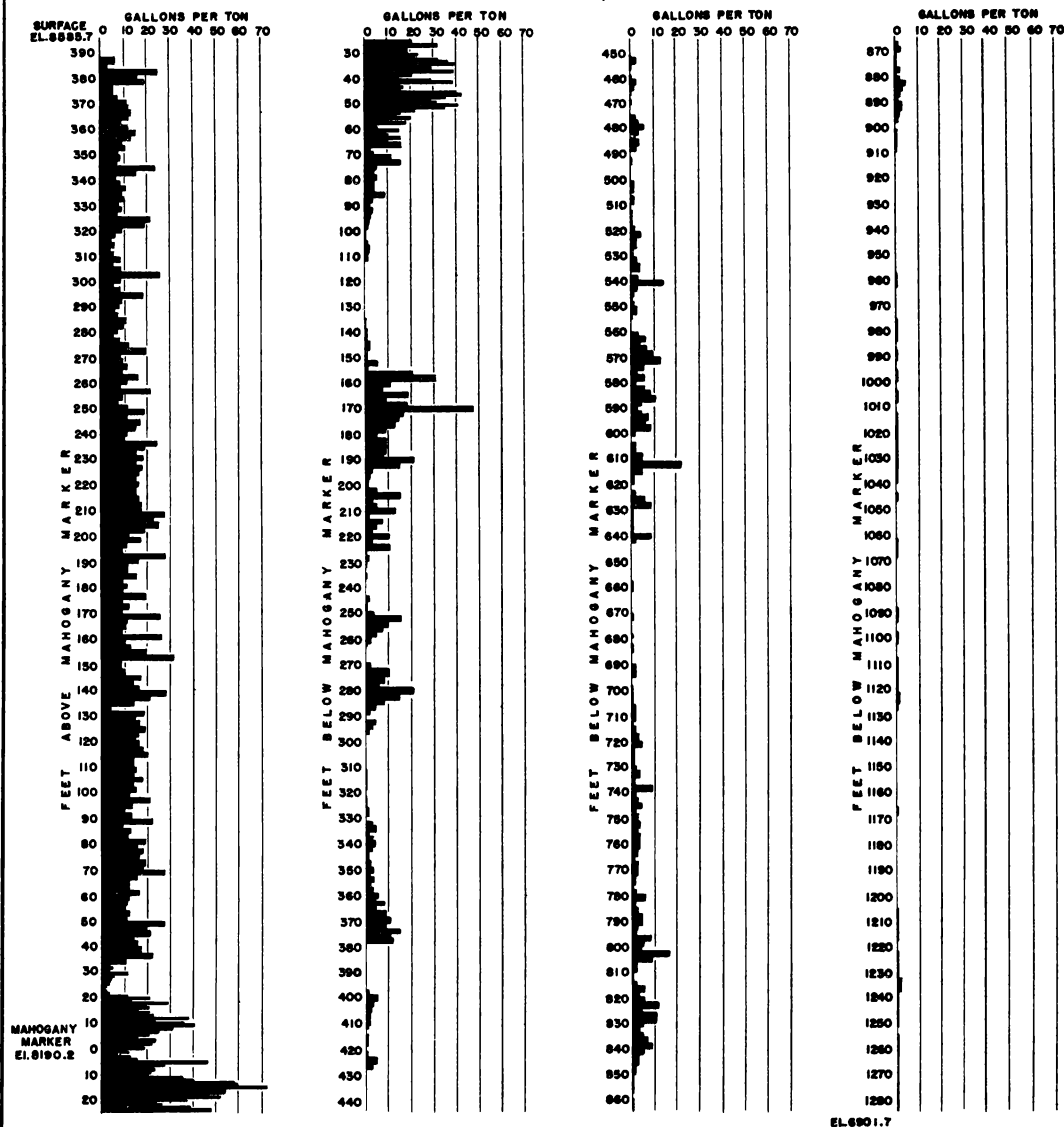
Figure 34.



# HOLE C DRILLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE EVAGUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF THE SOUTH PRONG  
OF THE EAST FORK OF PARACHUTE CREEK (SW. 1/4 NW. 1/4 SEC. 12, T. 6 S., R. 96 W. OF  
THE 6TH P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION  
OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 1677 FEET  
212 FT. OF PLUS 15 GALLON SHALE ..... 35 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
74 FT.	+ 21 FT.	- 53 FT.	28.55	140,368,000	95,417,000
90 FT.	+ 21 FT.	- 69 FT.	25.19	174,352,000	104,570,000
475 FT.	+ 388 FT.	- 87 FT.	14.96	998,353,000	355,604,000
581 FT.	+ 388 FT.	- 193 FT.	13.17	1,239,139,000	388,559,000
787 FT.	+ 388 FT.	- 399 FT.	10.61	1,716,107,000	433,521,000

CORE SAMPLES DRILLED IN 1945-6

Figure 35.

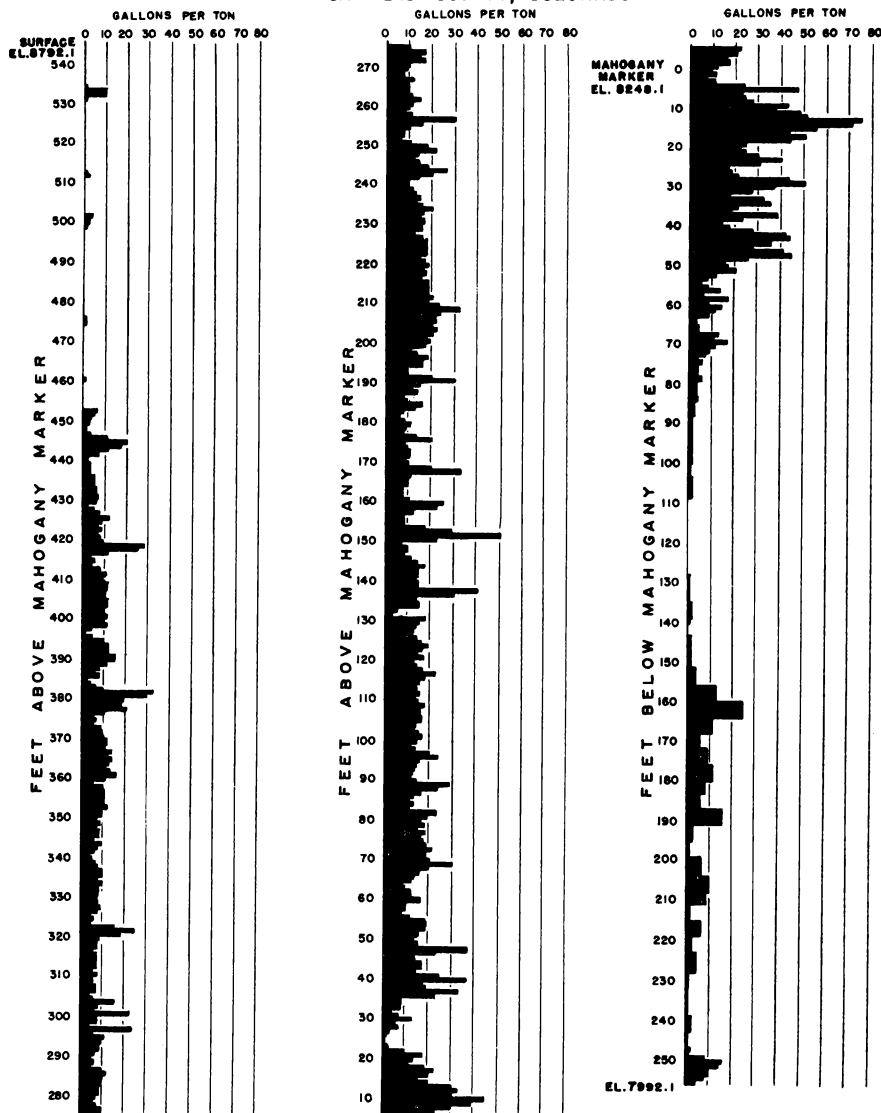




# **HOLE A** **DRILLED BY THE BUREAU OF MINES** **ON NAVAL OIL SHALE RESERVE No. 1**

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION NEAR THE HEAD OF THE SOUTH PRONG OF THE EAST FORK OF PARACHUTE CREEK (NE. 1/4 SEC. 12, T6S., R9S. W. OF THE 6TH P.M.) AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

## **GARFIELD COUNTY, COLORADO**



TOTAL LENGTH OF SECTION - 799 FEET  
 183 FT. OF PLUS 15 GALLON SHALE ..... 37 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
73 FT.	+23 FT.	- 50 FT.	27.688	139,197,000	91,784,000
85 FT.	+23 FT.	- 62 FT.	25.140	164,733,000	98,604,000
460 FT.	+396 FT.	- 64 FT.	15.056	966,405,000	346,433,000
646 FT.	+456 FT.	-190 FT.	12.278	1,388,651,000	406,948,000
711 FT.	+456 FT.	-255 FT.	11.536	1,538,246,000	422,505,000

CORE SAMPLES DRILLED IN 1945

Figure 36.



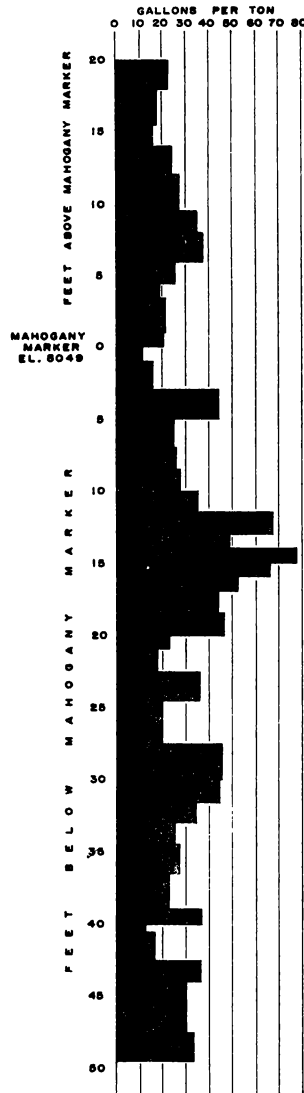
# SURFACE SECTIONS SAMPLED BY THE BUREAU OF MINES ON NAVAL OIL SHALE RESERVE No. 1

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION TAKEN FROM SURFACE EXPOSURES ON COTTONWOOD POINT AND ALLEN POINT, AS INDICATED BY THE FISCHER METHOD AT THE LARAMIE STATION OF THE BUREAU OF MINES.

GARFIELD COUNTY, COLORADO

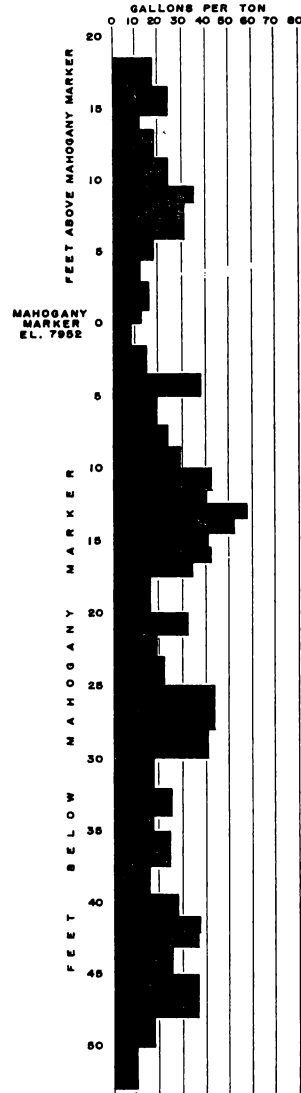
## COTTONWOOD POINT

NW. 1/4 SE. 1/4 SEC. 22, T.6S  
R. 95 W. OF THE 6th P. M.



## ALLEN POINT

NW. 1/4 NW. 1/4 SEC. 30, T.6S.  
R. 95 W. OF THE 6th P. M.



PLACE	LENGTH OF SECTION	PLUS 15 GAL. SHALE	PLUS 30 GAL. SHALE
COTTONWOOD POINT	69.5 FT.	68.0 FT.	32.5 FT.
ALLEN POINT	71.5 FT.	61.5 FT.	24.0 FT.

SELECTED SECTIONS						
PLACE	LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQ. MILE	BBLs. PER SQ. MILE
COTTONWOOD POINT	69.5 FT.	+20 FT.	-49.5 FT.	30.16	130,443,000	93,670,000
ALLEN POINT	44.5 FT.	-3.5 FT.	-48.0 FT.	29.96	83,635,000	59,660,000
ALLEN POINT	71.5 FT.	+18.5 FT.	-53.0 FT.	25.16	138,556,000	83,002,000

CHANNEL SAMPLES TAKEN IN 1944

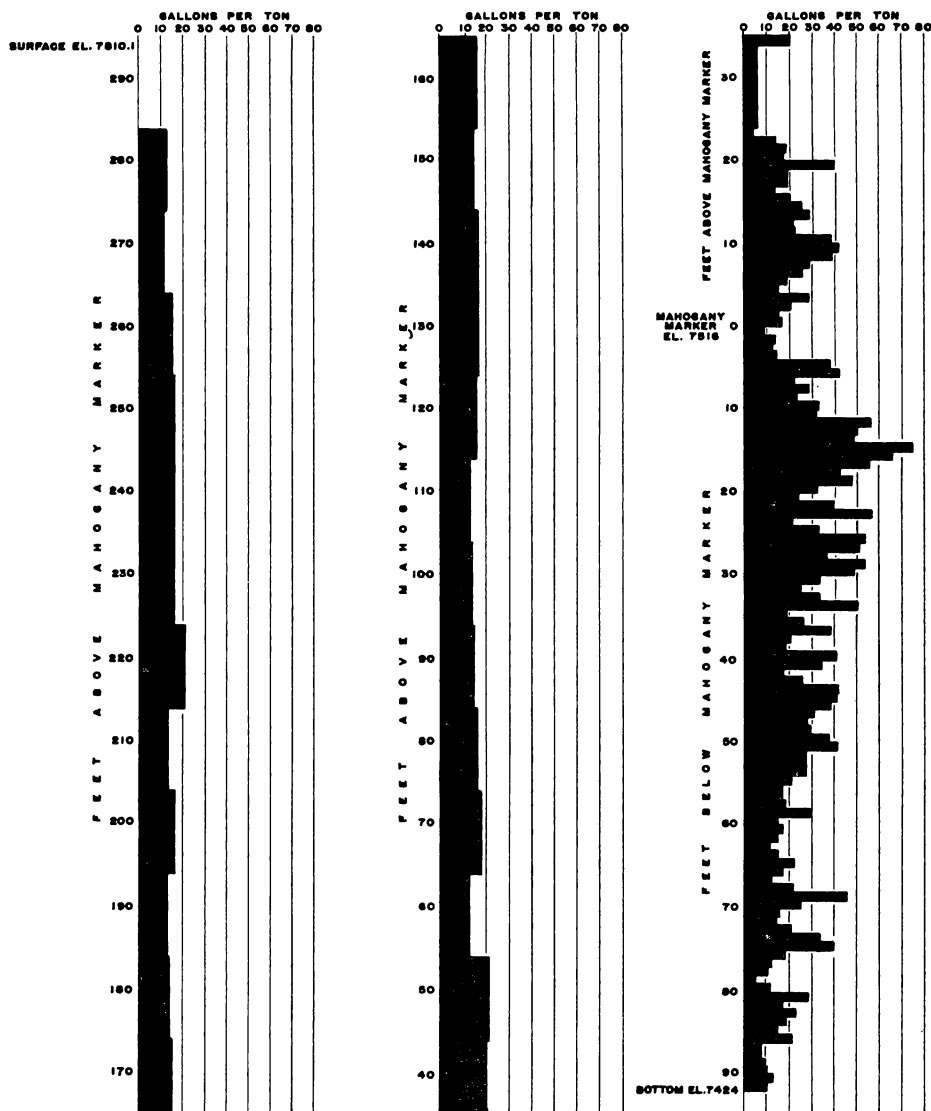
Figure 37.



**J. B. M. No.6  
UNION OIL COMPANY  
OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN  
RIVER FORMATION ON THE EAST SIDE OF PARACHUTE CREEK (NW. SE. NW, SECTION  
10, T.6S., R.96 W. OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 376 FEET  
213. FT. OF PLUS 15 GALLON SHALE ..... 39 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
90 FT.	+14 FT.	-76 FT.	30.02	189,056,000	120,854,000
130 FT.	+54 FT.	-76 FT.	25.50	251,382,000	152,607,000
376 FT.	+284 FT.	-92 FT.	18.18	770,670,000	333,880,000

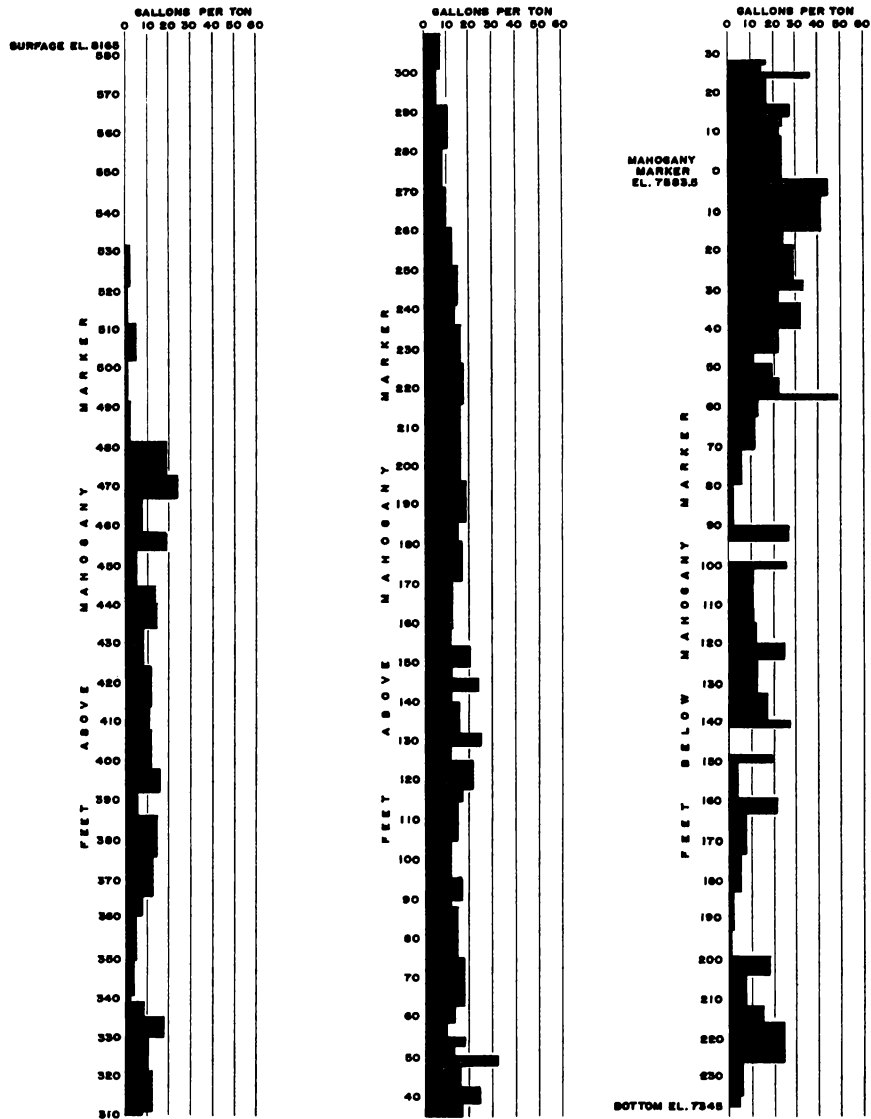
CORE SAMPLES DRILLED IN 1948

Figure 38.



# AKOLT No.2 STANDARD OIL COMPANY OF CALIFORNIA

OIL YIELDS OF OIL SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK  
MEMBERS OF THE GREEN RIVER FORMATION NEAR THE NORTH END OF CONN CREEK  
(SW. SE. NE., SECTION 7, TOWNSHIP 6 SOUTH, RANGE 97 WEST OF THE 6th P.M.)  
GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION..770 FEET  
280 FT. OF PLUS 15 GALLON SHALE ..... 23 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
71.5 FT.	+25.5 FT.	-46 FT.	27.64	136,465,000	89,482,000
90 FT.	+28.5 FT.	-61.5 FT.	25.48	174,045,000	105,887,000
502 FT.	+440.5 FT.	-61.5 FT.	15.00	1,056,703,000	377,354,000
770 FT.	+531.5 FT.	-238.5 FT.	11.33	1,669,972,000	450,496,000

CORE SAMPLES DRILLED IN 1948

Figure 39.

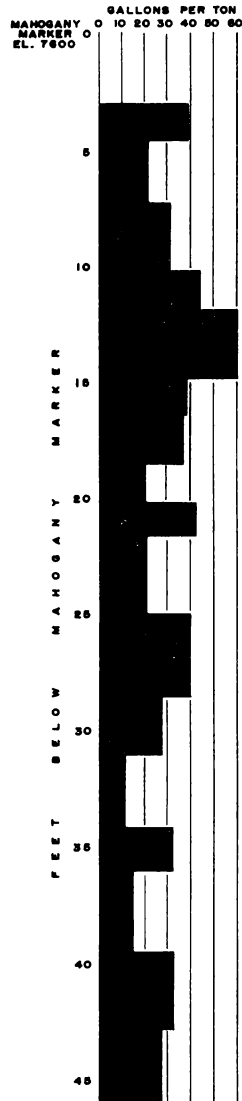




# CONN CREEK SURFACE SECTION PURE OIL COMPANY

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION TAKEN FROM A SURFACE EXPOSURE ON THE WEST FORK OF CONN CREEK (NE. 1/4 SW. 1/4 NW. 1/4 SECTION 17, TOWNSHIP 6 SOUTH, RANGE 97 WEST OF THE 6th P.M.).

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION...43 FEET  
39.6 FT. OF PLUS 15 GALLON SHALE . . . . . 22.8 FT. OF PLUS 30 GALLON SHALE

WEIGHTED SECTION					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
43 FT.	- 3 FT.	- 46 FT.	29.76	80,903,000	57,326,000

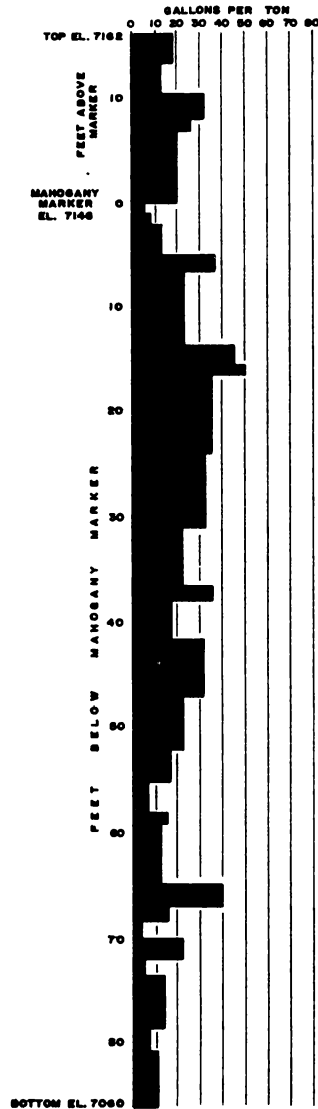
CHANNEL SAMPLES TAKEN IN 1921

Figure 40.



# **NEWTON POINT SURFACE SAMPLING FEDERAL OIL SHALE COMPANY**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN  
RIVER FORMATION ON THE CLIFF EXPOSURES NORTH OF THE TRAIL ON NEWTON  
POINT (SE. SW. SW., SECTION 3, TOWNSHIP 6 SOUTH, RANGE 98 WEST OF THE 6TH P.M.)  
GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 102 FEET  
71 FT. OF PLUS 15 GALLON SHALE.....32 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
48 FT.	-5.6 FT.	-53.6 FT.	29.15	90,688,000	62,942,000
72.7 FT.	+16 FT.	-56.7 FT.	25.07	140,925,000	84,119,000
102 FT.	+16 FT.	-86 FT.	21.75	203,038,000	105,145,000

CHANNEL SAMPLES

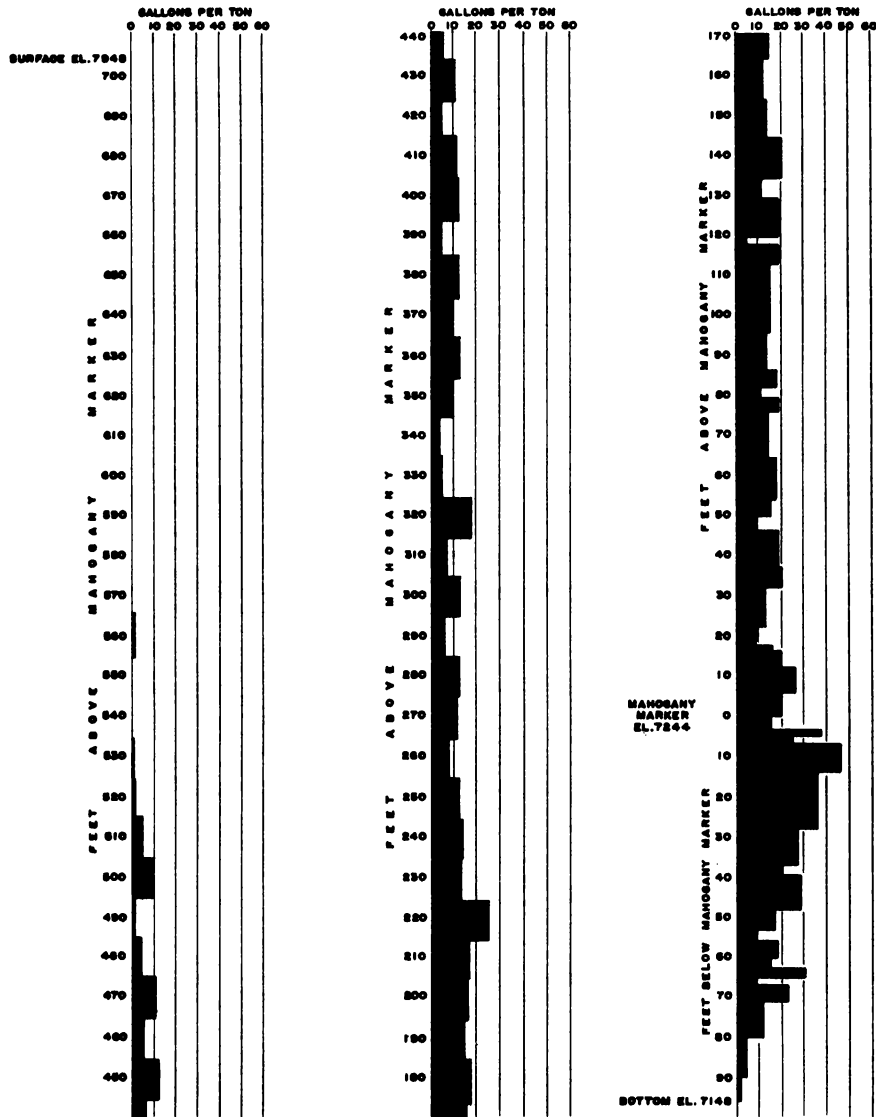
Figure 41.



# AKOLT No.1 STANDARD OIL COMPANY OF CALIFORNIA

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE EAST SIDE OF CLEAR CREEK (NE. NW. SW. SECTION 14, T6S., R 98 W. OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 660 FEET  
226 FT. OF PLUS 15 GALLON SHALE ..... 25 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
59 FT.	+ 16 FT.	- 53 FT.	28.27	131,084,000	88,232,000
82.5 FT.	+ 17.5 FT.	- 71 FT.	29.89	170,922,000	104,847,000
504 FT.	+ 24 FT.	- 80 FT.	18.03	1,080,808,000	379,545,000
660 FT.	+ 564 FT.	- 96 FT.	12.36	1,419,540,000	417,750,000

CORE SAMPLES DRILLED IN 1948

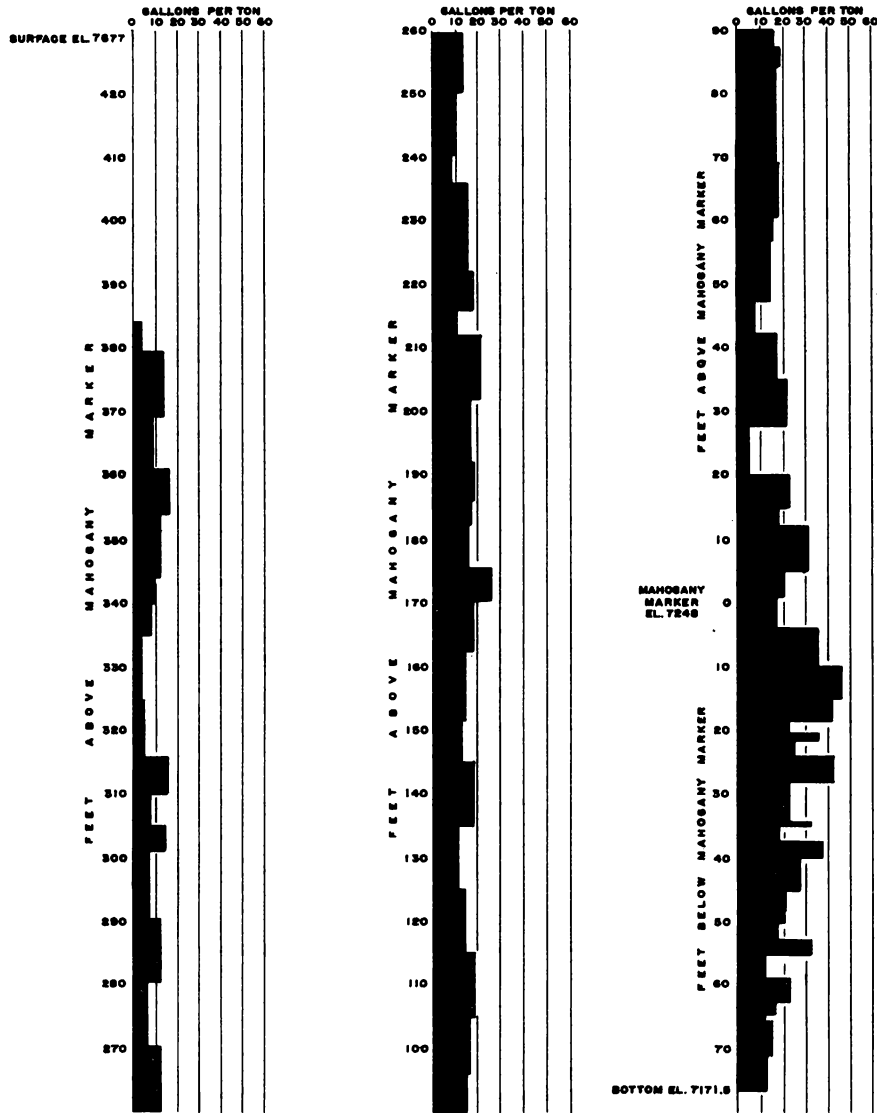
Figure 42.



**SCOTT FEE No.1  
STANDARD OIL COMPANY  
OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN  
RIVER FORMATION BETWEEN BRUSH CREEK AND CLEAR CREEK, (NE. SE. NE., SECTION  
17, TOWNSHIP 6 SOUTH, RANGE 98 WEST OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION .460.5 FEET  
238 FT. OF PLUS 15 GALLON SHALE ..... 32 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
75 FT.	+20 FT.	-55 FT.	27.47	143,211,000	93,867,000
96.5 FT.	+20 FT.	-66.5 FT.	25.76	166,992,000	102,422,000
460.5 FT.	+38.4 FT.	-76.5 FT.	15.43	965,875,000	354,844,000

CORE SAMPLES DRILLED IN 1948

Figure 43.

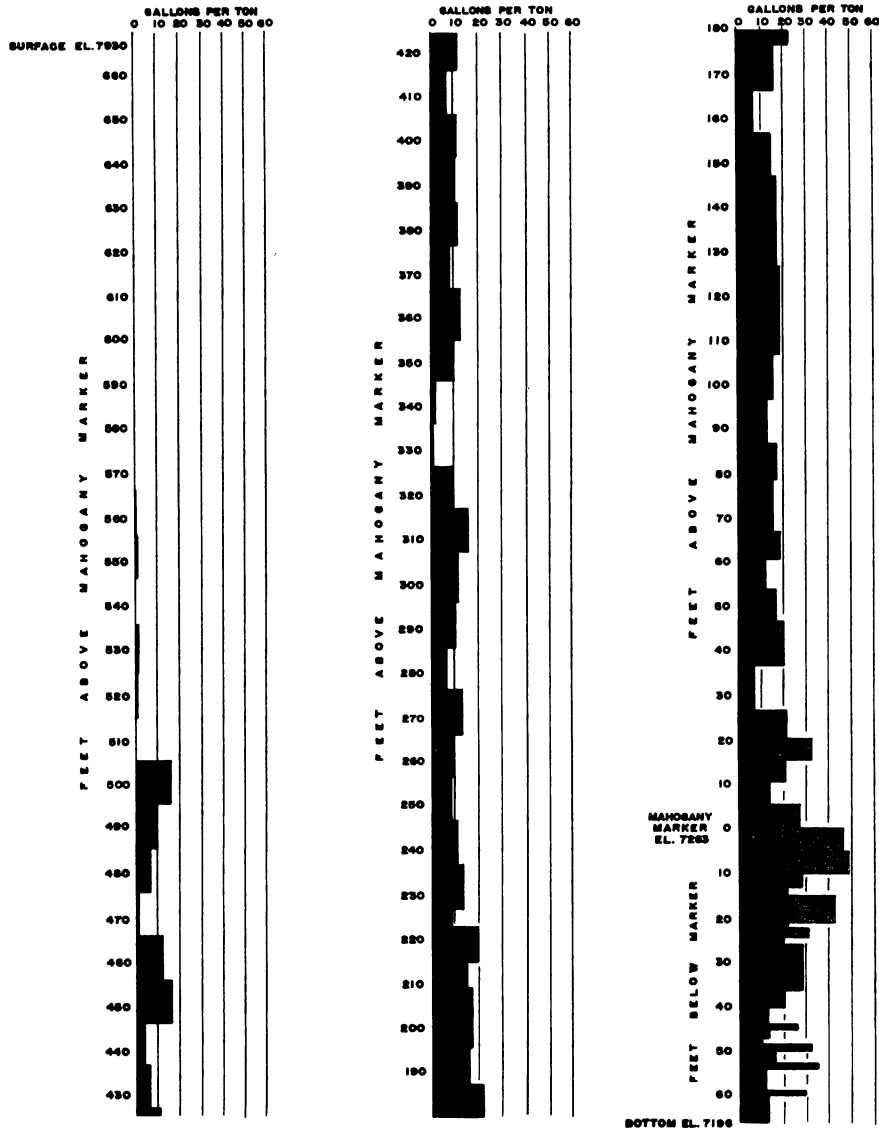




# **AKOLT No.3** **STANDARD OIL COMPANY** **OF CALIFORNIA**

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN  
 RIVER FORMATION BETWEEN CLEAR CREEK AND CONN CREEK ( S.W. SW, SECTION  
 24, TOWNSHIP 6 SOUTH, RANGE 96 WEST OF THE 6th P.M.)

GARFIELD COUNTY, COLORADO



SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
72 FT.	+27 FT.	-45 FT.	27.37	137,580,000	69,656,000
87 FT.	+27 FT.	-60 FT.	25.47	168,246,000	102,023,000
464 FT.	+397 FT.	-67 FT.	15.05	976,302,000	349,842,000
634 FT.	+567 FT.	-67 FT.	12.49	1,362,194,000	405,091,000

CORE SAMPLES DRILLED IN 1948

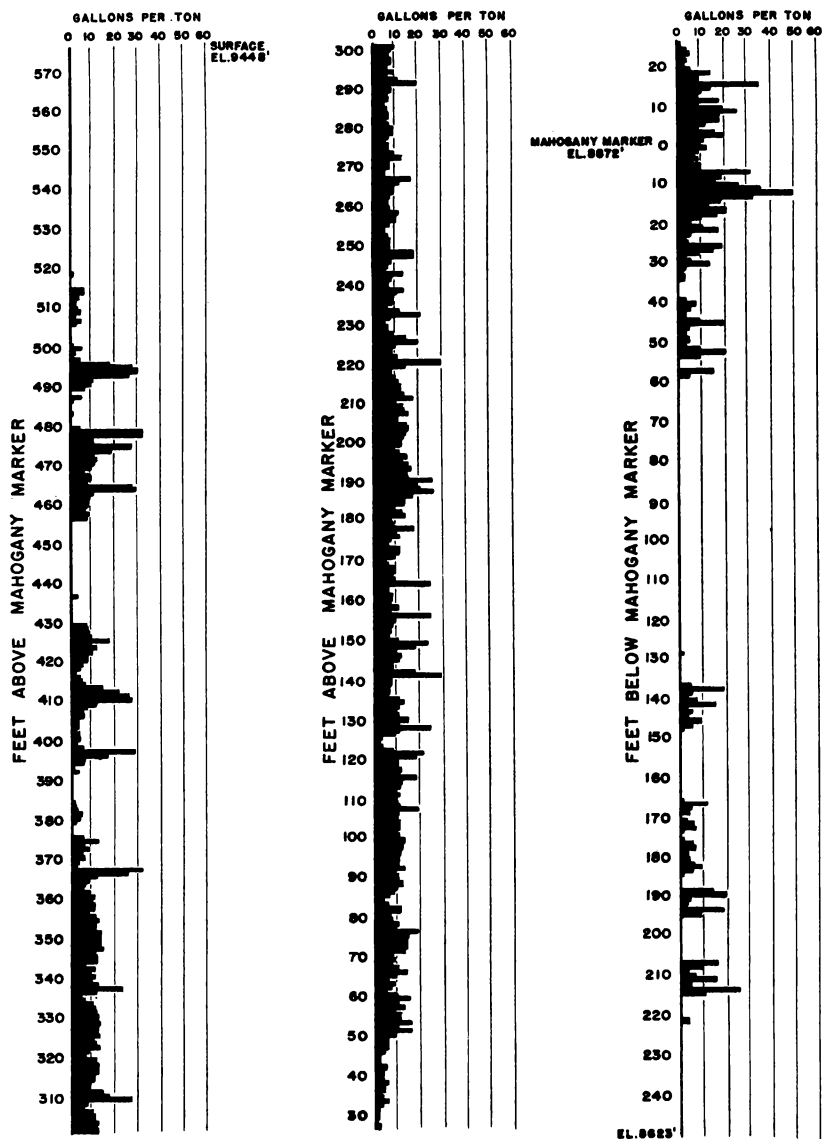
Figure 44.



# BATTLEMENT MESA HOLE PURE OIL COMPANY

OIL YIELDS OF OIL-SHALE BEDS IN THE EVACUATION CREEK AND PARACHUTE CREEK MEMBERS OF THE GREEN RIVER FORMATION ON THE NORTH SIDE OF BATTLEMENT MESA NEAR BEAVER CREEK (SW NW, SECTION 36, TOWNSHIP 7 SOUTH, RANGE 94 WEST OF THE 6TH P.M.) AS ASSAYED BY PAUL S. NICE.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION - 825 FEET  
82 FT. OF PLUS 15 GALLON SHALE..... 8 FT. OF PLUS 30 GALLON SHALE

SELECTED SECTIONS					
LENGTH	FROM	TO	GALLONS PER TON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
9 Ft.	- 7 Ft.	-16 Ft.	24.890	17,480,000	10,359,000
51 Ft.	+ 20 Ft.	-31 Ft.	15.140	107,220,000	38,650,000
555 Ft.	+497 Ft.	-58 Ft.	11.707	1,283,945,000	341,180,000

CORE SAMPLES DRILLED IN 1923

Figure 45.



The Green River epoch has been estimated by Bradley<sup>3/</sup> as lasting 5 to 8 million years, deposition occurring at a rate of approximately 1 foot in 2,000 years. Depending on the periodic rainfall, the lakes ranged from fresh-water lakes to brackish marshes.

In general, the oil shale is a magnesium marlstone rich in organic matter. The organic matter is chiefly remains of primitive aquatic plants and animals, the major part of which is a structureless amorphous material derived from the partial putrefaction of aquatic organisms that grew in the lakes. The organic matter called kerogen is thermally decomposed by the application of heat of the order of 800°F. and higher. The resultant liquid product obtained by condensing the hydrocarbon vapors formed is shale oil.

The kerogen content of the oil shale is highest near the center of the old lake basins, diminishing in all directions toward the shore facies. The sandy shore facies continue for a considerable distance after all appreciable organic content has disappeared.

The Mahogany marker, which is a widely used reference bed in the main oil-shale zone, is an altered tuff layer 3 to 8 inches thick, composed mostly of minute crystals of analcite. This bed was deposited presumably as a nearly horizontal ash or volcanic dust layer in the oil shale sequence. Its position with respect to the assay logs is shown in figures 8 to 46.

After desposition of the Green River formation and perhaps to a small degree during its deposition, movements of the earth's crust deepened parts of the sedimentary basins and elevated other parts. The amounts of these vertical movements is indicated by the different elevations of the Mahogany marker which is about 2,000 feet below sea level at Roosevelt, Utah, 5,100 feet above sea level near the junction of Black Sulphur and Piceance Creeks, 8,200 feet at the oil-shale mine and 10,000 feet on Grand Mesa.

The lowest part of Lake Uinta in northwestern Colorado apparently corresponds to the present trough of the Piceance Creek Basin. This trough has a strike of N. 20° W., and its low point appears to be near the junction of Black Sulphur and Piceance Creeks. Post Green River movement accented the depth of the basin and caused gentle southeast-northwest folding with some parallel faulting. The results from the partial sampling of the Piceance Creek basin indicate that the organic content of the oil shales increases as the low of the old lake basin is approached (see figs. 2 to 7).

## SAMPLING AND ASSAYING

### General

A total of 45 assayed sections are available, 26 of which are cores from diamond-drill holes, 4 are rotary cuttings from oil wells, and 15 are channel samples from cliff outcrops. The locations of these sampled sections are shown on figure 1, and the individual assay logs are shown on figures 8 to 45.

---

<sup>3/</sup> Bradley, W. H., Origin and Microfossils of the Oil Shale of the Green River Formation of Colorado and Utah: U. S. Geol. Surv. Prof. Paper 168, 1931, 58 pp.

All Bureau of Mines and General Petroleum Corp. samples were assayed by the modified Fischer method at the Laramie station of the Bureau of Mines. All core-drill samples taken by the Union Oil Co., Standard Oil Co. of California, and Sun Oil Co. were assayed by the modified Fischer method in their respective laboratories. The remaining assayed sections, mostly taken between 1920 and 1930, were assayed by other methods.

#### Relative Value of Drill Cores vs. Drill Cuttings and Surface Sampling

No accurate check between core samples and oil-well cuttings is available at this time. A comparison of the core and cuttings obtained near the bottom of 66-5-G well indicates that assays of rotary-drilled oil-well cuttings through the Green River formation are fairly reliable but do not show the true highs and lows obtained by core samples. Wire line core samples were obtained from the lower portion of the well. These samples, as received by the Bureau of Mines, consisted of several thin disks from each foot of core. Weighted assays of the core obtained between 2,800 feet and 2,964 feet show 132 feet of core (32 feet not cored) containing an average of 16.41 gallons of oil per ton. For the same section the cuttings averaged 14.28 gallons of oil a ton. From 2,800 feet to 3,013 feet, 181 feet of core average 12.91 gallons of oil a ton, whereas the corresponding cuttings averaged 13 gallons of oil a ton. The apparent increased ratio of oil in the cuttings in this longer section was largely due to mud lag, as in this lower portion of the hole the oil content of the core tapered off sharply. In the Bureau of Mines diamond-drilling operations, cores through the Green River oil shales were closely measured and weighted. It was found that the loss in overgrinding was only 0.74 percent in the higher-grade shales (Mahogany ledge section), whereas it was 8.18 percent in the lower-grade shales and 16.64 percent through the siltstones and sandstones. A survey of Carter-Stanolind's Ute Tribal No. 1 well showed the diameter of the hole through the overlying 5,825 feet of Uinta formation to range from 9 to 16 inches, whereas through the 3,565 feet of Green River formation the hole retained an approximately constant 9-inch diameter.

The above indicates that Green River oil-shale cuttings would be diluted rather than enriched by caving and raveling. It is not known whether the fines passing through the screens with the mud effect the sample.

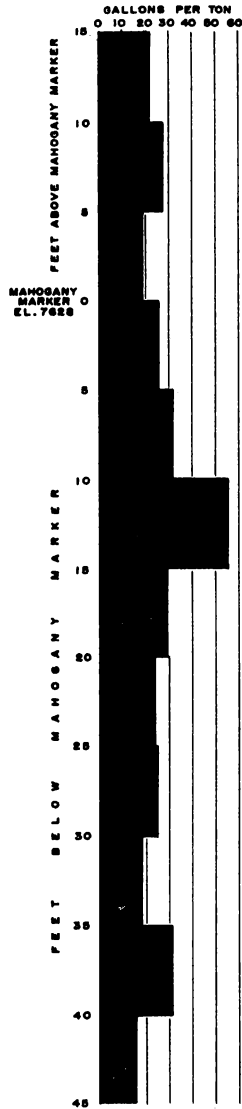
The assay results obtained from sampling clean surface exposures apparently are about 15 percent under those obtained from nearby core holes. In places, considerable portions of good oil shale are covered by surface debris. Some of the short surface sections taken at these sites are not representative and in some cases the rich Mahogany ledge may have been missed entirely. Most of the well-taken longer surface sections are in areas that have been core drilled.

Information from short surface sections has been used only in those portions of the area where more reliable data are unavailable.

# ECHO No. 3 SURFACE SAMPLING FEDERAL OIL SHALE COMPANY

OIL YIELDS OF OIL SHALE BEDS IN THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION ON THE CLIFF EXPOSURES BETWEEN BODISH GULCH AND LOGAN WASH (SW. 1/4 SE. 1/4 SE. 1/4 SECTION 21, TOWNSHIP 7 SOUTH, RANGE 97 WEST OF THE 6th P.M.) AS INDICATED BY DETERMINATIONS MADE BY ROBERT A. BAXTER.

GARFIELD COUNTY, COLORADO



TOTAL LENGTH OF SECTION....60 FEET  
60 FT. OF PLUS 15 GALLON SHALE.....15 FT. OF PLUS 30 GALLON SHALE

WEIGHTED SECTION					
LENGTH	FROM	TO	GALLONS PERTON	TONS PER SQUARE MILE	BARRELS OF OIL PER SQUARE MILE
60 FT.	+ 15 FT.	- 45 FT.	26.32	115,417,000	72,328,000

CHANNEL SAMPLES TAKEN IN 1949

Figure 46.





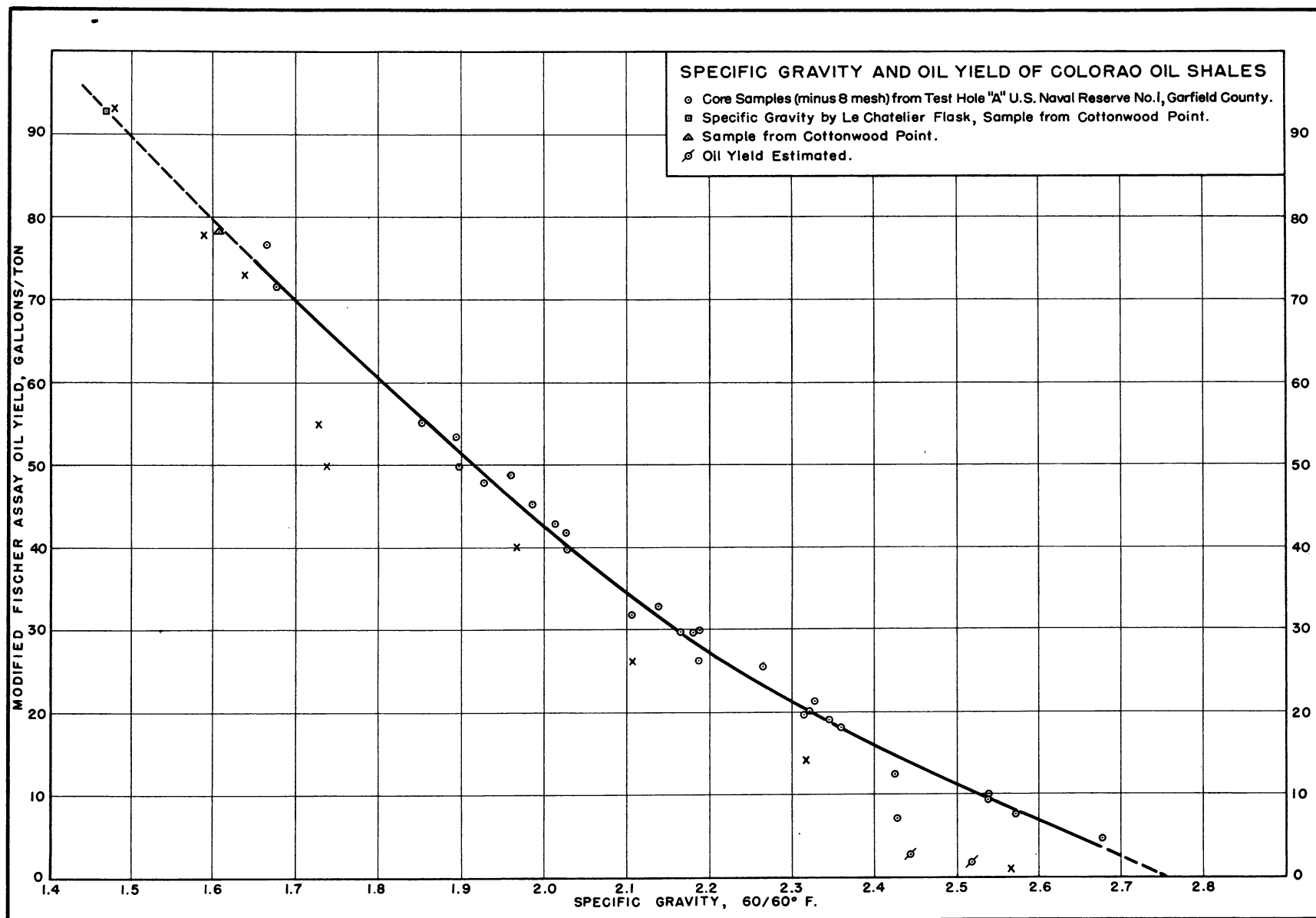


Figure 47.



## Assay Logs

The oil yield of the samples in each section has been plotted in the form of assay logs. Individual assay logs differ in scale as to the vertical distance and oil yield. In comparing various sections this must be taken into consideration. Apparent gaps in assay logs, especially when the oil yield is fair or good both above and below the gap generally, are due to lost samples.

The total length of section represents the total length sampled or studied and, with core samples or rotary cuttings, does not necessarily conform with the depth of the hole. The number of feet of plus 15-gallon and plus 30-gallon shale has been shown, so that these sections can be compared with sections taken by Dean E. Winchester.<sup>4/</sup> Plus 30-gallon shale means all shale that sampled over 30 gallons of oil a ton. For example, in a 5-foot section if each foot assays in order 50.8, 29.3, 30.2, 23.1, and 35.9 gallons per ton, there would be only 3 feet of plus 30-gallon shale, even though the average of all 5 feet is 33.8 gallons per ton of shale.

The table at the bottom of each assay log showing selected sections, in general shows a high-grade section averaging 28 to 33 gallons per ton near the Mahogany marker, an average 25-gallon-a-ton section known as the Mahogany ledge, an average 15-gallon-a-ton section, and an average 10-gallon-a-ton section. Twenty-five-gallon-a-ton shale is at present considered to be potential economic grade. However, future methods of mining, retorting, or extraction in place might make a lower-grade oil shale of economic importance.

All selected sections are weighted, both for sample widths and specific gravity. The Laramie station of the Bureau of Mines has made a specific-gravity curve for the oil shales of the Green River formation in Colorado (see fig. 47) on which the specific gravity of the oil shale varies in an inverse curve with the oil yield. An example of weighting samples follows:

Two contiguous, flat, 1-foot beds of oil shale have oil contents of 1 and 80 gallons a ton, respectively. An arithmetical average for the two beds would be  $\frac{1 + 80}{2} = 40.5$  gallons. The specific gravity (from chart) of

1-gallon shale is 2.74 and of 80-gallon shale is 1.60. The average specific gravity is  $\frac{1.60 + 2.74}{2} = 2.17$ . By the specific-gravity curve, this is the

specific gravity for oil shale containing 29.3 gallons of oil per ton - a difference of 11.2 gallons of oil a ton from the arithmetical average. Arithmetical averages are always higher than weighted averages. As some of the sections often include several hundred individual samples of various lengths, a special table has been prepared showing the specific gravity, weight per cubic foot, and the gallons per cubic foot by one-gallon-a-ton intervals from 1 to 80. This method has been found to be more accurate and faster. In making calculations such as these, the number of gallons of oil in a square-foot column equal to the height of the section is calculated and then divided by the height of the column, in feet, to obtain the average oil yield per cubic foot.

---

<sup>4/</sup> Winchester, D. E., Oil Shale of the Rocky Mountain Region: U. S. Geol. Surv. Bull. 729, 1923, 204 pp.

Each selected section shows the thickness, the location as regards the entire section, the weighted average oil yield per ton of shale, the weight of the section in tons per square mile of 640 acres, and the oil yield per square mile in barrels of 42 gallons, as indicated by the selected section.

The type of samples and the data taken are shown at the bottom of the assay log.

#### VERTICAL PROFILE SECTIONS

Six vertical sections (figs. 2, 3, 4, 5, 6, and 7) have been made of the Piceance Creek basin. The locations of these sections are shown on figure 1. They are not straight-line sections, but run from hole to hole. All sections have an exaggerated vertical scale, so that the 15-gallon and 25-gallon-a-ton shale can be shown. A true section is shown below each exaggerated section. The two small folds shown in A-A' and B-B' have not been surveyed, and the faults parallel to the folding near the Piceance Creek wells have not been mapped. Because contour maps were not available for the area north of township 4 south, the surface elevations in the north portion of the map had to be drawn in from a few known bench marks and may be in error. The west portion of section E-E' runs northwesterly, and the last three holes are at a lower elevation than if they were on the east-west line of the rest of the section.

Each section contains a table showing the average oil yield for 15- and 25-gallon shale in millions of barrels per square mile and the length of the section taken. The average oil yield has been weighted for the varying distances between sampled sections.

Beginning at the south end of the basin, the three east-west sections show the following average oil content:

Section	From-	To-	Length, miles	Barrels of oil per square mile	
				25-gallon shale	15-gallon shale
F-F'	S.F. #1	Hole A	21.4	124,000,000	371,000,000
E-E'	Syn. #1	Hole L	29.6	129,000,000	391,000,000
D-D'	S.C. hole	Hole F	14.3	163,000,000	681,000,000

In section E-E', 6 of the 10 diamond-drill holes did not penetrate through the middle oil-shale zone. If this zone had been sampled, the 15-gallon shale in section E-E' would contain about 430 million barrels of oil per square mile. The distance between adjacent east-west sections is roughly 3-1/2 miles, and indications are that the oil content of the shale is increasing to the north or toward the center of the basin.

A tabulation of the two long north-south sections is given below:

Section	From-	To-	Length, miles	Barrels of oil per square mile	
				25-gallon shale	15-gallon shale
A-A'	Hole C	66-5-G	28.7	162,000,000	788,000,000
A-A'	Hole C	E.G. "1"	42.00	132,000,000	840,000,000
B-B'	Ak. No. 3	U.S.G.S. "J"	35.4	118,000,000	1,035,000,000

CONTOUR MAP OF 25-GALLON SHALE (MAHOGANY LEDGE)  
PICEANCE CREEK BASIN








RIO BLANCO & GARFIELD COUNTIES, COLORADO

CONTOURS IN MILLIONS OF BARRELS PER SQUARE MILE  
JULY 1950

SCALE

10 MILES 0 10 20  
500000

LEGEND

-  BOUNDARY OF GREEN RIVER FORMATION
-  NAVAL OIL SHALE RESERVES No. 1 AND No. 2
-  IGNEOUS ROCKS
-  OIL WELL CUTTINGS
-  SURFACE CHANNEL SAMPLES
-  CORE SAMPLES
-  AREA ESTIMATED IN REPORT

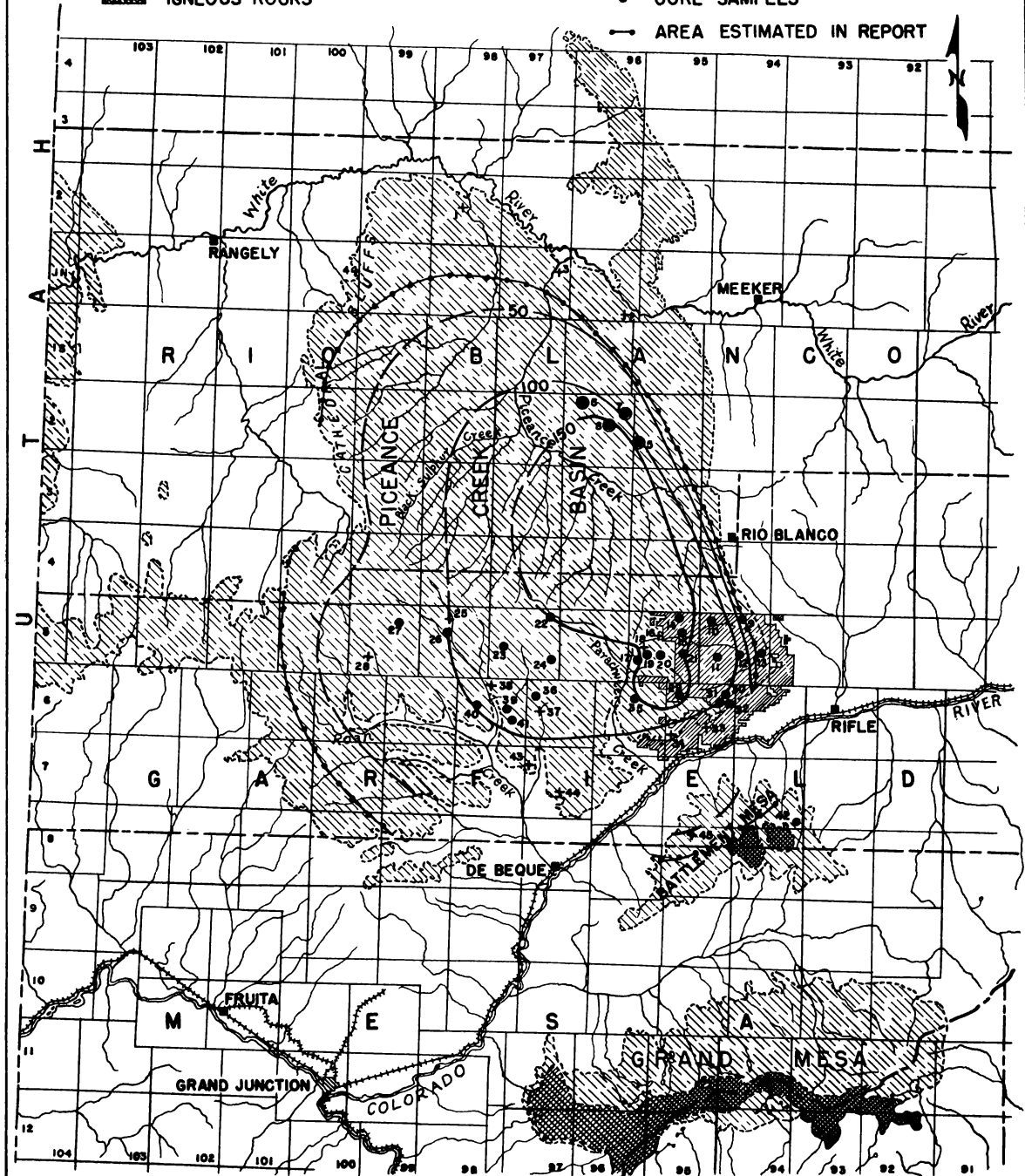


Figure 48.



**CONTOUR MAP OF 15-GALLON SHALE  
PICEANCE CREEK BASIN  
RIO BLANCO & GARFIELD COUNTIES, COLORADO**  
CONTOURS IN MILLIONS OF BARRELS PER SQUARE MILE  
JULY 1950

SCALE  
10 MILES 0 10 20

**LEGEND**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li> BOUNDARY OF GREEN RIVER FORMATION</li> <li> NAVAL OIL SHALE RESERVES No.1 AND No.2</li> <li> IGNEOUS ROCKS</li> </ul> | <ul style="list-style-type: none"> <li> OIL WELL CUTTINGS</li> <li> SURFACE CHANNEL SAMPLES</li> <li> CORE SAMPLES</li> <li> AREA ESTIMATED IN REPORT</li> </ul> |
|---|--|

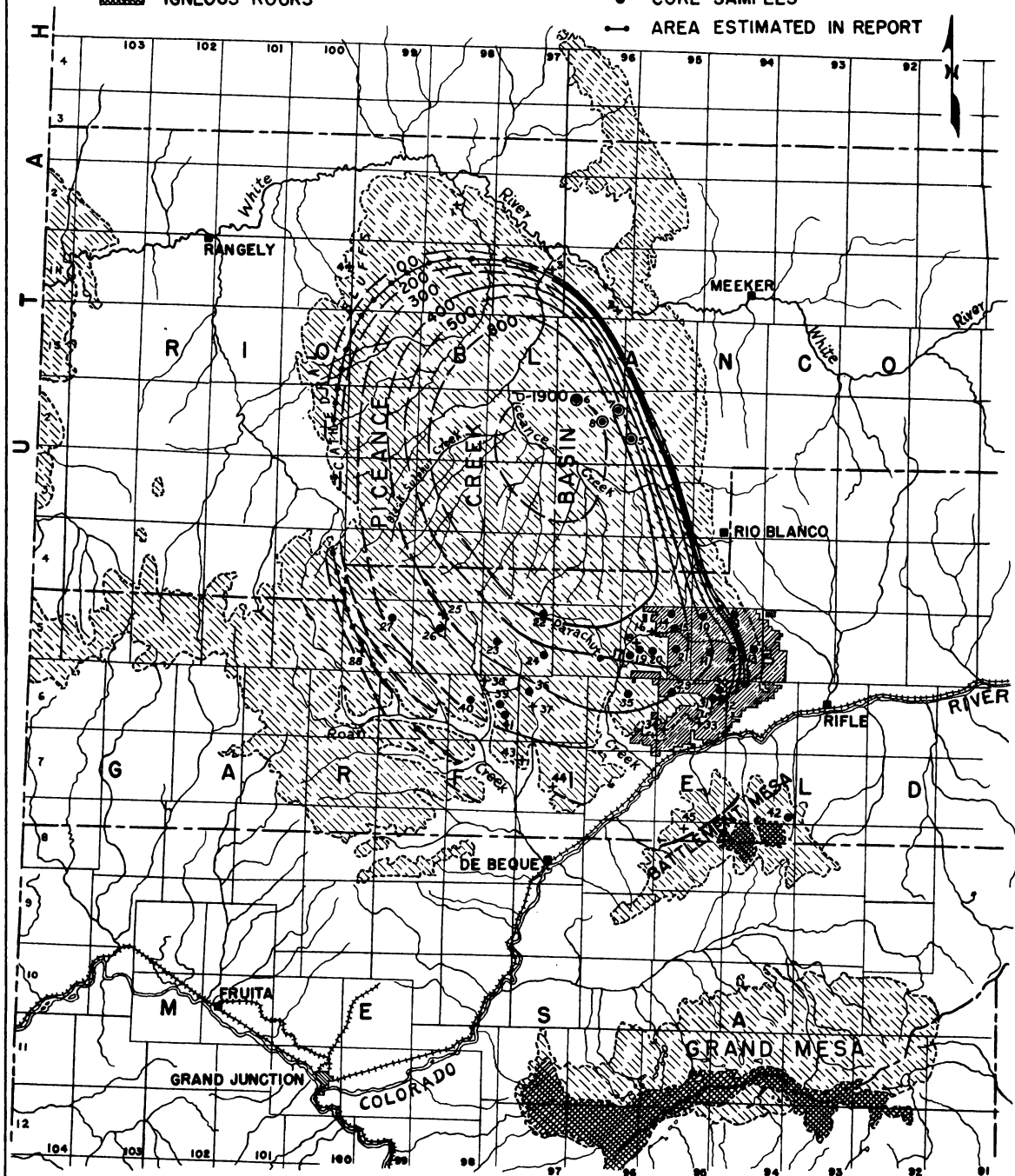


Figure 49.





Green River oil shale seems to offer a resistance to electrical current in direct relationship to oil content. A comparison, by electric logs, of the resistivity curves of General Petroleum's holes 84-15-G and 66-5-G indicates that the unsampled lower 900 feet of 84-15-G contains as much oil as the equivalent section in 66-5-G. If hole 84-15-G were figured on a basis of 1,900,000,000 barrels of oil per square mile for the 15-gallon shale, the average oil content of 15-gallon shale for section A-A' would be 1,098,000 barrels of oil per square mile for a distance of 28.7 miles and 1,061,000,000 barrels for the 40.2-mile distance.

If Bradley's theory is correct that the organic content of the shale is greatest near the centers of the old lake basins, decreasing in all directions toward the shore facies (this has been substantiated by assayed sections), then any section taken through the center basin should give an approximate average oil yield for the shale. Sections A-A' and B-B' do not pass through the center of the basin but are fairly close to it in the region of the General Petroleum wells.

#### OIL YIELD CONTOUR MAPS

Contour maps showing the extent of the 25-gallon shale (Mahogany ledge section, fig. 48) and the 15-gallon shale (500-foot measure, fig. 49) have been prepared.

The contour lines on these maps represent millions of barrels of oil yield per square mile rather than elevations. The thickness of continuous bed which will yield either 25 or 15 gallons per ton is the basis for calculating the number of barrels per square mile between contour lines. For example, on the 25-gallon-per-ton contour map, the dotted contour line encloses an area having a minimum continuous thickness of 30 feet of 25-gallon-per-ton shale and a minimum yield of 29 million barrels per square mile. This thickness increases to about 47 feet at the 50-million contour line and 140 feet at the 150-million contour. Similarly on the 15-gallon-per-ton contour maps, the dotted contour line encloses an area having a minimum continuous thickness of 200 feet of 15-gallon-per-ton shale and a minimum yield of 150 million barrels per square mile. The thickness of the 15-gallon shale increases to 1,064 feet at the 800-million-barrel contour.

The dotted contour line on each map encloses an area slightly larger than the 1,000 square-mile area considered as a basis for estimates in this report. In the southern portion of the basin, the location of the contours is fairly well governed by assay results from core holes, however, in the Cathedral Bluffs and northern portions of the basin, their location has been inferred from very sketchy channel sampling. It is possible that accurate sampling in these areas would show the contours extending outward much farther toward the edge of the basin than is shown on the maps.

#### ESTIMATED RESERVES

The area of the Piceance Creek basin between the Colorado and White Rivers contains approximately 1,650 square miles of Green River formation, of which about 1,000 square miles is thought to contain oil shale of potential

economic importance. In estimating 25-gallon shale, no consideration has been given to 400 feet of 25.4-gallon shale that occurs 800 to 1,200 feet below the marker in General Petroleum's 66-5-G well (fig. 10) and which is also indicated by electric log to be in its 84-15-G well.

The tabulated results from the 25 diamond-drill cores and the cuttings from four oil wells are shown in tables 1, 2, 3, and 4. This tabulation includes a high-grade section averaging 28 to 33 gallons a ton, an average 25-gallon-a-ton section, an average 15-gallon-a-ton section, and an average 10-gallon-a-ton section. Each of these sections has been broken down into the following five groups; all diamond-drill holes, all diamond-drill holes except marginal holes G and J, General Petroleum wells, all holes, and all holes except marginal holes G and J.

Omitting marginal holes G and J, the average oil yield for 25-gallon-a-ton shale is 127 million barrels of oil per square mile, and for a 15-gallon-a-ton shale it is 414 million barrels of oil per square mile. If the four General Petroleum wells are included, these figures become 125 million and 500 million, respectively. The diamond-drill holes are all on the south end of the basin.

Estimates of reserves are based on total oil yield and do not take into consideration any losses in mining or processing. All 15-gallon-shale estimates include the 25-gallon shale.

#### Partly Blocked Shale

Sample data are meager, but the oil-shale deposit is remarkably uniform, increasing in oil content as the center of the basin is approached. With this in mind, the 23 diamond-drill holes partly block an area at the south end of the basin of approximately 300 square miles, and the four General Petroleum wells partly block an area of approximately 40 square miles. The estimated partly blocked reserves are shown below:

Location	Area, square miles	25-gallon shale			15-gallon shale		
		Thickness, feet	Oil gal. per ton	Bbl. of oil (in millions)	Thickness, feet	Oil gal. per ton	Bbl. of oil (in millions)
South end	300	109.3	25.22	38,138	537.9	15.42	124,274
G.P. wells	40	100.0	25.12	4,637	1,187.5	16.95	39,699
Total...	340			42,775			163,973

1/ All 15-gallon estimates include the 25-gallon shale.

#### Inferred or Probable Shale

From the sections taken by Dean E. Winchester from the Cathedral Bluffs portion of the basin, it is possible to infer that the whole basin contains approximately 1,000 square miles of Green River oil shale, of which the remaining portion of 660 square miles, not included as partly blocked shale, is classified as inferred or probable shale in the following table:

Grade of shale	Area, square miles	Thickness, feet	Oil, gal. per ton	Total barrels of oil
25-gallon...	660	107.9	25.21	82,798,000,000
15-gallon...	660	634.1	15.83	329,743,000,000

Total partly blocked and inferred shale is shown below:

Class of reserve	Area, square miles	Barrels of oil in millions	
		25-gallon shale	15-gallon shale
Partly blocked.....	340	42,775	163,973
Inferred.....	660	82,798	329,743
Total.....	1,000	125,573	493,716

#### CONCLUSIONS

A more accurate estimate of oil-shale reserves in northwestern Colorado has been made possible by additional sampling. It is indicated that the reserves are much larger than originally reported. The sampling data are too meager to attempt to make a firm estimate of the total oil-shale reserves that may be contained in the basin. Information from additional drilling may necessitate a revision of estimates, vertical sections, and assay contours.

# OIL YIELD OF SHALE PENETRATED BY DIAMOND-DRILL HOLES AND OIL WELLS

TABLE 1. - High-grade section of Mahogany Ledge (all diamond-drill holes)

Hole	Thickness, (feet)	Oil gallons per ton	Gal. square ft. column	Tons per square mile	Barrels of oil per square mile
A.....	73.0	27.69	138.282	139,197,000	91,764,000
B.....	72.0	27.79	136.800	137,664,000	91,084,000
C.....	74.0	28.55	143,708	140,368,000	95,417,000
D.....	92.0	30.97	190.898	172,060,000	126,874,000
E.....	92.0	31.35	192.841	171,452,000	127,977,000
F.....	72.0	30.20	146.379	135,099,000	97,143,000
G.....	10.0	25.00	17.405	19,403,000	11,549,000
H.....	78.0	31.20	162.871	145,497,000	108,083,000
I.....	70.0	31.78	148.352	130,108,000	98,448,000
J.....	11.0	30.89	22.777	20,546,000	15,111,000
K.....	82.0	29.22	162.278	155,061,000	107,855,000
L.....	44.0	31.65	92.949	81,851,000	61,681,000
B.R. ....	78.0	28.54	151.442	147,979,000	100,555,000
M.C. ....	70.0	28.69	136.513	132,645,000	90,609,000
S.C. ....	93.2	28.10	178.675	177,251,000	118,589,000
AK. 1.....	69.0	28.27	132.992	131,084,000	88,232,000
AK. 2.....	71.5	27.54	134.854	136,465,000	89,482,000
AK. 3.....	72.0	27.37	135.084	137,580,000	89,656,000
S.F. 1.....	75.0	27.47	141.157	143,211,000	93,667,000
Sy. 1.....	60.0	26.91	110.982	114,971,000	73,664,000
Sy. 2.....	77.0	27.16	143.509	147,337,000	95,278,000
B.C. 1.....	60.0	33.37	132.160	110,454,000	87,758,000
J.B.M. 6....	90.0	30.02	182.070	169,095,000	120,834,000
L.V. 9.....	60.0	29.80	120.660	112,880,000	80,196,000
L.V. 13.....	60.0	32.75	130.280	110,872,000	86,454,000
Total.....	1750.7		3,385.918		
Average.....	68.2	29.33	1.985	128,687,000	89,866,000

All diamond-drill holes except marginal holes G and J

Total.....	1684.7		3,345.726		
Average.....	73.2	29.35	1.986	138,104,000	96,508,000

General Petroleum wells

28-19-G	70.0	27.54	132.020	133,677,000	87,654,000
24-12-G	30.0	29.89	60.500	56,357,000	40,108,000
66-5-G	90.0	26.37	163.710	173,793,000	109,118,000
84-15-G	60.0	28.94	117.970	117,675,000	81,084,000
Total.....	250.0		474.200		
Average.....	62.5	27.76	1.897	119,124,000	78,735,000

All holes

Total.....	1955.7		3,860.118		
Average.....	67.4	29.13	1.974	127,349,000	88,326,000

All holes except marginal holes G and J

Total.....	1934.7		3,819.936		
Average.....	71.7	29.13	1.974	135,475,000	93,962,000

TABLE 2. - 25-gallon section, including Mahogany Ledge (all diamond-drill holes)

Hole	Thickness, feet	Oil, gal. per ton	Gal. square ft. column	Tons per square mile	Barrels of oil per square mile
A.....	85.0	25.14	148.575	164,735,000	98,604,000
B.....	82.0	25.43	144.711	158,625,000	96,045,000
C.....	90.0	25.19	157.615	174,352,000	104,570,000
D.....	155.0	25.00	269.775	300,641,000	178,953,000
E.....	155.0	25.25	271.813	300,167,000	180,458,000
F.....	110.0	25.47	194.337	212,740,000	129,012,000
G.....	10.0	25.00	17.405	19,403,000	11,549,000
H.....	130.0	25.37	228.915	251,547,000	151,946,000
I.....	120.0	25.22	210.314	230,973,000	138,694,000
J.....	19.0	25.02	33.079	36,855,000	21,955,000
K.....	119.0	25.01	207.167	230,805,000	137,439,000
L.....	85.0	24.97	147.771	164,901,000	93,038,000
B.R. ....	126.5	25.00	220.539	245,971,000	146,411,000
M.C. ....	106.0	25.18	186.297	205,213,000	123,030,000
S.C. ....	131.0	25.02	228.115	254,028,000	151,328,000
AK. 1.....	88.5	26.69	157.508	170,922,000	104,547,000
AK. 2.....	90.0	25.48	159.155	174,045,000	105,587,000
AK. 3.....	87.0	25.47	153.696	168,246,000	102,029,000
S.F. 1.....	86.5	25.76	154.352	166,992,000	102,422,000
Sy. 1.....	75.5	25.24	128.898	146,220,000	87,872,000
Sy. 2.....	84.0	25.09	146.561	162,838,000	97,276,000
B.C. 1.....	129.0	25.07	224.928	250,097,000	149,284,000
J.B.M. 6....	130.0	25.50	229.980	251,352,000	152,607,000
L.V. 9.....	111.0	25.34	195,362	214,831,000	129,615,000
L.V. 13.....	137.0	24.98	238.198	265,765,000	158,067,000
Total.....	2542.0		4,455.066		
Average.....	101.7	25.22	1.753	196,989,000	118,287,000

All diamond-drill holes except marginal holes G and J

Total.....	2513.0		4,404.582		
Average.....	109.3	25.22	1.753	211,709,000	127,126,000

General Petroleum wells

28-19-G	90.0	24.93	156.240	174,658,000	103,672,000
24-12-G	70.0	24.87	121.310	136,047,000	80,559,000
66-5-G	100.0	25.11	174,600	193,839,000	115,888,000
84-15-G	140.0	25.39	246.820	270,894,000	163,762,000
Total.....	400.0		698.970		
Average....	100.0	25.12	1.747	193,839,000	115,934,000

All holes

Total.....	2942.0		5,154.036		
Average....	101.4	25.21	1.752	196,431,000	117,905,000

All holes except marginal holes G and J

Total.....	2913.0		5,103.552		
Average....	107.9	25.21	1.752	209,004,000	125,452,000

TABLE 3. - 15-gallon shale diamond-drill holes

Hole	Thickness, feet	Oil, gal. per ton	Gal. square foot column	Tons per square mile	Barrels of oil per square mile
A.....	460.0	15.06	523.020	966,405,000	346,433,000
B.....	423.0	15.00	479.259	883,745,000	315,623,000
C.....	475.0	14.96	536.750	998,353,000	355,604,000
D.....	700.0	15.79	823.800	1,463,134,000	550,069,000
E.....	820.0	15.03	930.537	1,725,617,000	617,524,000
F.....	510.0	14.99	577.177	1,073,458,000	383,122,000
G.....	60.0	15.55	70.120	125,732,000	46,551,000
H.....	718.0	15.03	814.616	1,510,954,000	540,706,000
I.....	540.0	15.06	614.044	1,136,073,000	407,363,000
J.....	70.0	15.18	80.143	147,114,000	53,174,000
K.....	575.0	15.03	652.717	1,209,950,000	432,989,000
L.....	430.0	15.00	487.046	905,128,000	323,260,000
B.R. ....	449.0	18.55	665.220	1,019,262,000	450,174,000
M.C. ....	483.3	15.66	568.447	1,011,791,000	377,254,000
S.C. ....	1,111.6	15.01	1,255.664	2,339,723,000	836,172,000
AK. 1.....	504.0	15.03	571.996	1,060,606,000	379,545,000
AK. 2.....	502.0	15.00	568.904	1,056,703,000	377,394,000
AK. 3.....	464.0	15.05	527.163	976,302,000	349,842,000
S.F. 1.....	460.5	15.43	534.439	965,875,000	354,844,000
Sy. 1.....	388	15.17	443.851	815,583,000	294,581,000
Sy. 2.....	430	15.09	489.556	904,487,000	324,969,000
B.C. 1.....	479.0	15.09	545.378	1,007,553,000	361,999,000
J.B.M. 6....	376.0	18.18	502.399	770,670,000	333,590,000
L.V. 9.....	536.0	15.23	615.207	1,126,092,000	408,342,000
L.V. 13.....	537.0	15.29	618.448	1,127,681,000	410,530,000
Total.....	12,501.4		14,500.901		
Average.....	500.1	15.42	1.160	1,049,008,000	385,136,000

All diamond-drill holes except marginal holes G and J

Total.....	12,371.4		14,350.638		
Average.....	537.9	15.42	1.160	1,128,295,000	414,245,000

General Petroleum wells

28-19-G.....	680.0	15.00	770.440	1,431,361,000	511,200,000
24-12-G.....	690.0	15.00	781.770	1,452,409,000	518,718,000
66-5-G.....	2,070.0	19.05	2,877.300	4,211,551,000	1,910,339,000
84-15-G.....	1,310.0	15.75	1,548.420	2,745,880,000	1,029,705,000
Total.....	4,750.0		5,977.530		
Average.....	1,187.5	16.95	1.259	2,459,237,000	992,478,000

All holes

Total.....	17,251.4		20,478.431		
Average.....	594.9	15.83	1.187	1,243,628,000	468,729,000

All holes minus marginal holes G and J

Total.....	17,121.4		20,328.168		
Average.....	634.1	15.83	1.187	1,325,562,000	499,611,000

TABLE 4. - All shale over 10 gallons (all diamond-drill holes)

Hole	Thickness, feet	Oil, gal. per ton	Gallons square foot column	Tons per square mile	Barrels of oil per square mile
A.....	711.0	11.54	637.056	1,538,246,000	422,505,000
B.....	649.0	11.66	586.696	1,397,154,000	387,710,000
C.....	787.0	10.61	653.210	1,716,107,000	433,521,000
D.....	700.0	15.79	828.800	1,463,134,000	550,069,000
E.....	1,536.0	10.99	1,316.136	3,340,278,000	874,039,000
F.....	726.0	11.13	629.164	1,577,081,000	417,926,000
G.....	515.0	10.11	408.971	1,127,849,000	271,489,000
H.....	819.0	13.61	851.193	1,743,710,000	565,045,000
I.....	850.0	11.46	756.284	1,841,480,000	502,461,000
J.....	607.0	10.01	477.763	1,330,413,000	317,082,000
K.....	575.0	15.03	652.717	1,209,950,000	432,989,000
L.....	719.0	10.78	605.082	1,566,181,000	401,986,000
B.R. ....	499.0	18.55	665.220	1,019,262,000	450,174,000
M.C. ....	483.3	15.66	568.447	1,011,791,000	377,254,000
S.C. ....	1,143.0	14.76	1,272.424	2,410,757,000	847,209,000
Ak. 1....	660.0	12.36	628.962	1,419,540,000	417,750,000
Ak. 2....	770.0	11.33	766.628	1,669,972,000	450,495,000
Ak. 3....	634.0	12.49	609.618	1,362,194,000	405,091,000
S.F. 1...	460.5	15.43	534.439	965,875,000	354,844,000
Sy. 1....	398.0	14.85	446.941	838,833,000	296,587,000
Sy. 2....	430.0	15.09	489.556	904,487,000	324,969,000
B.C. 1...	729.0	10.78	614.059	1,587,954,000	407,575,000
J.B.M. 6.	376.0	18.18	502.399	770,670,000	333,590,000
L.V. 9...	616.0	13.88	651.747	1,308,678,000	432,487,000
L.V. 13..	537.0	15.29	618.448	1,127,681,000	410,530,000
Total....	929.8		16,771.960		
Average..	677.2	12.91	0.991	1,450,011,000	445,706,000

All diamond-drill holes except marginal holes G and J

Total....	15,807.8		15,885.226		
Average..	687.3	13.12	1.005	1,469,164,000	458,939,000

General Petroleum wells

28-19-G..	2,266.0	11.56	2,032.070	4,905,344,000	1,350,138,000
24-12-G..	2,273.0	12.76	2,227.540	4,863,208,000	1,477,489,000
66-5-G...	2,070.0	19.05	2,877.300	4,211,551,000	1,910,339,000
84-15-G..	1,310.0	15.75	1,548.420	2,745,880,000	1,029,705,000
Total....	7,919.0		8,685.330		
Average..	1,979.8	14.46	1.097	4,185,886,000	1,441,141,000

All holes

Total....	24,848.8		25,457.290		
Average..	856.9	13.40	1.024	1,827,513,000	583,064,000

All holes except marginal holes G and J

Total....	23,726.8		24,570.556		
Average..	878.8	13.57	1.036	1,871,644,000	604,719,000









