

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RESULTS OF USGS OIL-SHALE CORE DRILLING IN THE EASTERN

UINTA BASIN, UTAH: RED WASH-1 DRILL HOLE

By

Richard W. Scott, Jr. and Michael P. Pantea

Open-File Report 82-965

1982

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and nomenclature.

CONTENTS

	Page
Introduction-----	1
Location -----	1
Drilling Notes -----	1
Water Quality Data -----	4
Cuttings Lithology -----	5
Core Lithology -----	14
Oil Yield Bar Graphs -----	34
Nahcolite Occurrence -----	38

ILLUSTRATIONS

	Page
Figure 1. Index map of a part of Uintah County, Utah showing the location of drill site RW-1-----	2
2. Oil yield bar graph for the RW-1 drill hole from Fischer assay analysis (1 inch = 100 feet)-----	34
3. Detailed oil yield bar graph for the RW-1 drill hole from Fischer assay analysis (1 inch = 20 feet)-----	35

Table

Table 1. Water quality data for the Birdsnest aquifer zone in the RW-1 drill hole -----	4
--	---

RESULTS OF USGS OIL-SHALE CORE DRILLING IN THE EASTERN UINTA
BASIN, UTAH: RED WASH-1 DRILL HOLE

by
Richard W. Scott, Jr. and Michael P. Pantea

INTRODUCTION

Two oil-shale core holes were drilled in the eastern Uinta Basin, Utah by the U.S. Geological Survey during the fall and winter of 1981-1982. These holes were drilled for the purpose of oil-shale resource evaluation in the presumed depositional center of the rich oil-shale sequence in the basin.

The drilling operations were contracted by the U.S. Geological Survey to Connors Drilling, Inc. of Lakewood, Colorado, and the field descriptions of the cuttings and core were done by Ameralda Resources, Inc. of Denver, Colorado, with revisions by the U.S. Geological Survey. Geophysical logging was done by BPB, Inc. of Grand Junction, Colorado, and the Fischer assay analysis of the core was performed by Dickinson Laboratories, Inc. of El Paso, Texas.

The water quality data were made available by Walt Holmes and Mike Enright of the U.S. Geological Survey in Salt Lake City, Utah.

Future work with the core material from the Red Wash-1 (RW-1) drill hole includes analysis of a composite standard sample of oil shale from the Mahogany oil-shale zone (which, in this hole, includes material from 2,600.0 feet deep to 2,733.0 feet deep) for major, minor, and trace elements by the U.S. Geological Survey. The core material is stored at the U.S. Geological Survey core storage facility in Arvada, Colorado.

The authors would like to thank W. B. Cashion, M. C. Smith, J. K. Pitman, C. J. Buntenbah, A. M. Schack, and L. P. Williams for their help in preparing this report.

LOCATION

The Red Wash-1 drill hole is located in the eastern part of the Uinta Basin, Utah, in SE 1/4 SE 1/4 NW 1/4 sec. 1, T. 9 S., R. 22 E., Salt Lake Prime Meridian (see fig. 1). The hole was drilled at the edge of an existing pad to minimize the environmental impact of the drilling operations. The RW-1 location is approximately 11.5 miles west-north-west of the town of Bonanza, Utah.

DRILLING NOTES

Both the rotary and cored intervals of the RW-1 hole were drilled with a 1981 Portadrill TKT Prospector truck-mounted rig.^{1/} The cored section was done with NC wireline equipment and a 20-foot core barrel. High-pressure air mist and foam were used as drilling fluids in the upper 2,100 feet of the hole and, below that, a saline mud circulation system was used.

^{1/}Use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

The hole was spudded in the Tertiary Uinta Formation and both the Uinta and Green River Formations contained small amounts of gas below depths of approximately 1,700 feet. A small pocket of high-pressure gas was encountered at 2,970 feet; the hole was terminated there. The abandoned hole which was drilled previously on the same pad reported a similar occurrence of high-pressure gas in the drilling log about 40 feet deeper. The drill rig was fitted with a blowout preventer, but it was felt that, without switching to conventional coring equipment with check valves in the drill pipe, the potential dangers of continuing outweighed the possible advantages.

The Uinta Formation contained vuggy zones from 433 to 476 feet and from 506 to 618 feet. The lower of these two zones had larger washouts as shown on the caliper log and produced water at a rate estimated to be approximately 25 gallons per minute. This water was not sampled for analysis.

The Birdsnest aquifer in the Parachute Creek Member of the Green River Formation was encountered at 2,021 feet in the RW-1 hole. The zone was approximately 80 feet thick with most of the vugs occurring in the upper 25 feet of the aquifer zone. This aquifer produced water at a rate estimated to be about 700 to 900 gallons per minute (see table 1, water quality data for the Birdsnest aquifer in the RW-1 drill hole). The RW-1 hole was cased with 7 inch casing to a depth of 2,132 feet for hydrologic monitoring. The casing was perforated with 3/4 inch holes, four shots per foot, from 2,034 to 2,044 feet.

TABLE 1: Water quality data
for the Birdsnest aquifer, RW-1 drill hole

Arsenic, dissolved	50	ug/l
Barium, dissolved	600	ug/l
Boron, dissolved	240,000	ug/l
Calcium, dissolved	0.2	mg/l
Carbon, organic, dissolved	60	mg/l
Chloride, dissolved	650	mg/l
Chromium, dissolved	3	ug/l
Fluoride, dissolved	450	mg/l
Iron, dissolved	300	ug/l
Lithium, dissolved	250	ug/l
Magnesium, dissolved	0.2	mg/l
Manganese, dissolved	30	ug/l
Mercury, dissolved	0.6	ug/l
Potassium, dissolved	60	mg/l
Silica, dissolved	less than 2	mg/l
Sodium, dissolved	41,000	mg/l
Sulfate, dissolved	3,500	mg/l
Zinc, dissolved	70	ug/l
Alkalinity, as CaCO ₃	105,000	mg/l
pH, field	9.5	
Specific conductance, laboratory	77,000	umhos
Specific conductance, field	116,000	umhos
Water temperature, field	28	degrees C
Sample taken at a depth of 2021 feet		

Water analysis by U.S. Geological Survey W.R.D. Central
Laboratory, Denver, Colorado. Lab ID: 1356606

LITHOLOGIC DESCRIPTION RED WASH NO. 1

SAMPLE CUTTINGS

Note: Approximations of oil-shale grade in the cuttings descriptions are based on color characteristics observed in the field and should be considered estimates. All depths are in feet.

Feet	Description
0-5	No sample
5-35	Sandstone, fine-grained, orangish-brown, unconsolidated
35-135	Clay and mudstone. Clay, dark-gray, unconsolidated; mudstone, dark-gray, poorly cemented
135-145	Sandstone, medium- to coarse-grained, medium-gray, hard, well-cemented, moderately well sorted; trace MnO ₂ staining
145-150	Siltstone, dark-gray, hard, well-cemented; trace MnO ₂ staining
150-155	Sandstone, fine-grained, hard, well-cemented, well-sorted, moderately silty
155-175	Sandstone, medium-grained, medium-gray, hard, moderately well sorted, moderately well cemented
175-185	Mudstone, dark-gray to black, moderately hard, brittle, slightly silty
185-190	Sandstone, fine-grained, medium- to dark-gray, hard, slightly silty
190-200	Mudstone, dark-gray to black, moderately hard, brittle, slightly silty
200-245	Sandstone, fine-grained, medium-gray, moderately hard, well-cemented, moderately well sorted, fine- to medium-grained from 205 to 210, slightly silty from 235 to 240
245-255	Shale, dark-gray to black, hard, brittle, slightly silty
255-260	Sandstone, fine-grained, medium-gray, moderately hard, well-cemented, moderately well sorted
260-280	Shale, dark-gray to black, hard, brittle, slightly silty
280-355	Sandstone, fine- to medium-grained, light- to medium-gray, moderately hard, well-cemented, moderately well sorted; slightly silty; trace MnO ₂ staining; trace finely disseminated pyrite

RED WASH NO. 1--continued

Feet	Description
355-360	Siltstone, light- to medium-gray, slightly argillaceous, slightly sandy
360-365	Sandstone and siltstone. Sandstone, fine- to medium-grained, light- to medium-gray, moderately hard, well-cemented, moderately well sorted; siltstone, light- to medium-gray, hard
365-430	Siltstone, light- to medium-gray, hard, slightly argillaceous, slightly oxidized from 395 to 400, slightly sandy from 405 to 410 and from 420 to 425
430-435	Sandstone, medium-grained, light- to medium-gray, hard, well-sorted, slightly silty
435-500	Siltstone, dark-gray, hard; trace fine-grained sandy material; trace finely disseminated pyrite
500-510	Sandstone, fine-grained, medium-gray to medium-green, hard, well-sorted; trace finely disseminated pyrite; slightly silty
510-590	Siltstone, medium-gray to light-brown and medium-green, very hard; trace finely disseminated pyrite; slightly sandy; trace shaly material from 555 to 560
590-595	Siltstone and sandstone. Siltstone, medium-gray to light-brown and medium-green, very hard; trace finely disseminated pyrite; sandstone, fine-grained, light-green to light-gray, hard, well-sorted; trace finely disseminated pyrite; slightly silty
595-615	Sandstone, fine- to medium-grained, light-green to light-gray, hard, well-sorted
615-630	Siltstone, medium-gray to medium-green, very hard, well-cemented; trace fine-grained sandy material; trace finely disseminated pyrite
630-635	Shale, dark-grayish-brown, hard, brittle, slightly silty; trace finely disseminated pyrite
635-655	Siltstone with sandstone interbedded. Siltstone, medium-greenish-gray, hard; trace pyrite; sandstone, fine-grained, light-greenish-gray, hard, well-sorted; trace finely disseminated pyrite
655-670	Sandstone, fine- to medium-grained, light-gray, moderately soft, poorly consolidated, saturated with heavy crude

RED WASH NO. 1--continued

Feet	Description
670-740	Sandstone and siltstone interbedded. Sandstone, fine-grained, light-green to light-gray, moderately hard; trace finely disseminated pyrite, trace fine- to medium-grained sandstone saturated with heavy crude from 670 to 680; siltstone, medium-green, hard; trace finely disseminated pyrite; trace very fine grained sandy material
740-780	Siltstone, dark-green to medium-grayish-green, moderately hard, moderately calcareous; trace finely disseminated pyrite; very fine grained, light-gray, sandy material common
780-785	Siltstone with sandstone interbedded. Siltstone, dark-green to medium-grayish green, moderately hard, moderately calcareous; sandstone, fine-grained, medium- to dark-gray, hard, well-sorted, slightly calcareous; trace finely disseminated pyrite
785-790	Sample missing
790-800	Siltstone, medium-gray to medium-grayish-green, moderately soft, slightly calcareous; trace finely disseminated pyrite; medium-grained, light-gray, poorly consolidated sandstone common from 795-800
800-810	Sandstone and siltstone. Sandstone, fine- to medium-grained, light-gray, poorly consolidated, slightly calcareous; siltstone, medium-grayish-green, moderately hard, moderately calcareous; trace pyrite
810-840	Sandstone, fine- to medium-grained, light- to medium-gray, moderately soft, poorly consolidated, moderately calcareous; trace gilsonite streaks; trace finely disseminated pyrite; trace dark-green silty material
840-850	Siltstone, light-gray to light-greenish-gray, moderately hard, brittle; trace finely disseminated pyrite; trace gilsonite streaks; trace very fine grained sandy material
850-885	Sandstone with siltstone interbedded. Sandstone, fine-grained, light-gray, moderately hard, moderately well consolidated; trace gilsonite streaks; siltstone, light-grayish-green, moderately hard, slightly calcareous
885-905	Siltstone with shale interbedded. Siltstone, dark-gray, hard, slightly calcareous; trace finely disseminated pyrite; trace fine-grained sandy material; shale, dark-greenish-gray, moderately hard, brittle, slightly silty

RED WASH NO. 1--continued

Feet	Description
905-910	Shale with sandstone interbedded. Shale, dark-greenish-gray, moderately hard, brittle, slightly silty; sandstone, fine-grained, light-gray, moderately hard, brittle
910-920	Sandstone, fine- to medium-grained, light-gray, moderately soft, poorly consolidated, moderately calcareous
920-935	Sandstone with siltstone interbedded. Sandstone, fine-grained, light-gray, hard, well sorted, moderately well cemented; trace finely disseminated pyrite, slightly silty; siltstone, medium- to dark-gray, moderately hard, brittle, slightly argillaceous, slightly calcareous
935-940	Siltstone, medium- to dark-gray, moderately hard, brittle, slightly argillaceous, slightly calcareous; trace fine-grained sandy material
940-955	Siltstone with shale interbedded. Siltstone, medium- to dark-gray, moderately hard, brittle; shale, light-gray, moderately hard, brittle, moderately silty
955-960	Sandstone, fine-grained, light-gray, soft, poorly consolidated; abundant silty material
960-975	Siltstone, medium-gray to medium-green, hard, slightly calcareous, slightly argillaceous; abundant fine- to medium-grained, light-gray, sandy material from 960-965; trace fine-grained sandy material from 965-975
975-1005	Sandstone, medium-grained, light- to medium-gray, soft, poorly consolidated, slightly calcareous; trace finely disseminated pyrite; medium-gray silty material common
1005-1025	Sandstone, fine- to medium-grained, medium-gray, soft, poorly consolidated, slightly to moderately calcareous; trace finely disseminated pyrite; slightly silty
1025-1040	Siltstone, dark-gray, moderately hard, brittle, slightly calcareous; trace fine-grained sandy material
1040-1050	Siltstone with shale interbedded. Siltstone, dark-gray, moderately hard, brittle, slightly calcareous; shale, light-gray, hard, brittle, slightly calcareous; slightly silty
1050-1065	Siltstone, medium- to dark-gray, hard, moderately brittle, slightly argillaceous, slightly calcareous; trace fine-grained sandy material

RED WASH NO. 1--continued

Feet	Description
1065-1070	Siltstone with shale interbedded. Siltstone, medium- to dark-gray, hard, moderately brittle, slightly argillaceous, slightly calcareous; shale, light-gray, hard, brittle, slightly calcareous, slightly silty
1070-1090	Sandstone, medium- to coarse-grained, light- to medium-gray, moderately hard, moderately well consolidated; trace silty material
1090-1100	Sandstone with siltstone interbedded. Sandstone, medium- to coarse-grained, light- to medium-gray, moderately hard, moderately well consolidated; siltstone, medium-grayish-green, hard, moderately calcareous; trace finely disseminated pyrite; fine-grained sandy material common
1100-1180	Siltstone, medium- to dark-gray, hard, slightly brittle, slightly calcareous, slightly argillaceous; trace fine-grained, light-gray sandstone from 1125-1130 and from 1150-1155; trace finely disseminated pyrite; trace shaly material
1180-1225	Siltstone with sandstone interbedded. Siltstone, medium- to dark-gray, hard, slightly brittle, slightly calcareous, slightly argillaceous; sandstone, fine-grained, light-gray, hard, well-sorted, slightly calcareous, slightly argillaceous; trace dark-reddish-brown shaly material from 1210 to 1215
1225-1245	Siltstone, dark-gray, moderately hard, brittle, moderately calcareous; trace finely disseminated pyrite; trace fine-grained sandy material
1245-1250	Siltstone with sandstone interbedded. Siltstone, dark-gray, moderately hard, brittle, moderately calcareous; sandstone, fine grained, hard, moderately calcareous, slightly silty; trace gilsonite streaks
1250-1255	Siltstone with shale interbedded. Siltstone, dark-gray, moderately hard, brittle, moderately calcareous; shale, medium-gray, moderately hard, brittle; trace fine-grained sandy material
1255-1265	Siltstone with sandstone interbedded. Siltstone, dark-gray, moderately hard, brittle, moderately calcareous; sandstone, fine-grained, hard, moderately calcareous, slightly silty; trace gilsonite streaks
1265-1270	Sandstone, fine- to medium-grained, medium- to dark-gray, hard, very calcareous, slightly silty; trace finely disseminated pyrite

RED WASH NO. 1--continued

Feet	Description
1270-1300	Sandstone with siltstone interbedded. Sandstone, fine- to medium-grained, medium- to dark-gray, hard, very calcareous, slightly silty; siltstone, medium-gray, hard, brittle; trace fine-grained sandy material; trace shale from 1275-1280
1300-1310	Siltstone, medium- to dark-gray, hard, brittle; trace finely disseminated pyrite; trace fine-grained sandy material
1310-1325	Siltstone with sandstone interbedded. Siltstone, medium- to dark-gray, hard, brittle; sandstone, fine-grained, light-gray; trace gilsonite streaks; trace finely disseminated pyrite; slightly calcareous, slightly silty
1325-1330	Sandstone, fine- to medium-grained, light- to medium-gray, very hard, slightly calcareous; trace light-gray silty material; trace gilsonite streaks; trace marlstone
1330-1345	Sandstone with siltstone interbedded. Sandstone, fine- to medium-grained, light- to medium-gray, very hard, slightly calcareous; siltstone, light-gray to dark-gray, hard, brittle, moderately calcareous; trace possible low-grade oil shale
1345-1350	Sandstone, fine-grained, light-gray, moderately hard, well-sorted, moderately calcareous; trace finely disseminated pyrite; trace gilsonite streaks
1350-1380	Sandstone with siltstone interbedded. Sandstone, fine-grained, light-gray, moderately hard, well-sorted, moderately calcareous; siltstone, medium-gray, moderately hard, brittle, slightly calcareous; trace light-brown oil shale from 1350-1370; light- to medium-brown, medium-grade oil-shale common from 1370 to 1380
1380-1400	Siltstone, dark-gray hard, brittle, slightly calcareous; trace very fine sandy material; trace light- to medium-brown oil shale
1400-1425	Siltstone with sandstone interbedded. Siltstone, dark-gray, hard, brittle, slightly calcareous; sandstone, fine- to medium-grained, moderately hard; trace finely disseminated pyrite; trace gilsonite streaks; light- to medium-brown, low- to medium-grade oil-shale common
1425-1470	Sandstone, fine- to medium-grained, moderately hard, interbedded with dark-gray siltstone from 1455 to 1460; trace marlstone and low-grade oil shale

RED WASH NO. 1--continued

Feet	Description
1470-1495	Sandstone with siltstone interbedded. Sandstone, fine- to medium-grained, moderately hard; siltstone, medium- to dark-gray, very hard, moderately calcareous; finely disseminated pyrite common; trace low-grade oil shale from 1480 to 1485 and from 1490 to 1495
1495-1525	Sandstone and siltstone. Sandstone, fine-grained, light-gray, moderately hard, slightly calcareous, moderately silty; trace finely disseminated pyrite; siltstone, medium- to dark-gray, very hard, brittle; trace finely disseminated pyrite
1525-1540	Siltstone, dark-gray, very hard, brittle; trace finely disseminated pyrite; marlstone and low-grade oil-shale common
1540-1605	Sandstone, fine- to medium-grained, light-gray, moderately hard, moderately well consolidated, slightly calcareous; trace gilsonite streaks; trace finely disseminated pyrite; abundant marlstone and very low-grade oil shale from 1550 to 1560; silty material common
1605-1660	Siltstone, light- to medium-gray, hard, brittle, slightly calcareous; trace finely disseminated pyrite; trace marlstone and very low-grade oil shale from 1615 to 1620
1660-1695	Sandstone, fine-grained, light- to medium-gray, moderately hard, moderately well consolidated, slightly calcareous, moderately silty; trace finely disseminated pyrite
1695-1705	Oil shale, light- to medium-brown, hard, brittle, low grade, slightly marly; trace silty material
1705-1710	Oil shale, sandstone, and siltstone interbedded. Oil shale, light- to medium-brown, hard, brittle, low-grade; sandstone, fine-grained, light- to medium-gray, moderately hard, moderately well consolidated, slightly calcareous; siltstone, light- to dark-gray, hard, brittle
1710-1730	Siltstone and sandstone interbedded. Siltstone, light- to dark-gray, hard, brittle; sandstone, fine-grained, light- to medium-gray, moderately hard, moderately well consolidated, slightly calcareous; very low to low-grade oil-shale common from 1710 to 1720; trace coarse-grained sandy material from 1720-1730
1730-1760	Siltstone, dark-grayish-brown, very hard, moderately brittle, slightly calcareous; trace finely disseminated pyrite; trace very fine-grained sandy material

RED WASH NO. 1--continued

Feet	Description
1760-1785	Siltstone with sandstone interbedded. Siltstone, dark-grayish-brown, very hard, moderately brittle, slightly calcareous; sandstone, fine- to medium-grained, light-gray, moderately hard, moderately sorted, moderately consolidated, slightly calcareous; trace finely disseminated pyrite; trace marlstone and very low-grade oil shale; chert pebbles abundant from 1750-1755.
1785-1835	Sandstone, medium- to coarse-grained, light- to medium-gray, soft, poorly sorted, poorly consolidated, slightly calcareous; trace silty material; asphaltic resin abundant from 1815 to 1835
1835-1845	Siltstone, light- to medium-gray, hard, slightly calcareous; trace finely disseminated pyrite; abundant medium- to coarse-grained, light- to medium-gray, poorly consolidated sandstone, possibly due to cave
1845-1870	Sandstone with siltstone interbedded. Sandstone, medium- to coarse-grained, light- to medium-gray, soft, poorly sorted, poorly consolidated; siltstone, light- to medium-gray, hard
1870-1875	Sandstone, fine-grained, light- to medium-gray, moderately hard, slightly calcareous, slightly silty; abundant asphaltic resin
1875-1880	Sandstone with siltstone interbedded. Sandstone, fine-grained, light- to medium-gray, moderately hard, slightly calcareous; siltstone, light-gray, moderately hard, slightly calcareous; moderate amount of fine-grained sandy material; asphaltic resin abundant
1880-1950	Siltstone, medium-gray, moderately hard, slightly calcareous; moderate amount of fine-grained sandy material; trace finely disseminated pyrite; trace chert from 1920 to 1925
1950-1960	Oil shale with siltstone. Oil shale, medium-brown, low- to medium-grade, moderately hard, brittle, slightly marly, highly calcareous; siltstone, medium-gray, moderately hard, may be due to cave. TOP OF THE GREEN RIVER FORMATION - PARACHUTE CREEK MEMBER AT 1950.0.
1960-2020	Oil shale, medium-brown, low- to medium-grade; moderately hard; brittle, very calcareous; trace pyrite

RED WASH NO. 1--continued

Feet	Description
2020-2130	Oil shale, medium-brown, low- to medium-grade, moderately hard, brittle, very calcareous; trace pyrite; numerous greenish-gray shale fragments from 2040 to 2060; trace dark-gray to black shale fragments; abundant nahcolite; top of Birdsnest aquifer at 2021.0.
2130-2160	Samples missing
2160.0	Core point

CORE LITHOLOGY
U.S. GEOLOGICAL SURVEY RED WASH #1

Feet	Description
2160.0-2161.0	1.0 foot core loss, 2160.0 is core point
2161.0-2162.1	Oil shale, light- to medium-brown, massive and evenly bedded, competent; few small scattered white nahcolite bands; interval is rubblized, drill induced
2162.1-2169.6	Oil shale, light-brown, evenly bedded with trace streaked and irregular bedding, competent; 0.4 foot band of translucent, medium- to dark-brown, coarse-crystalline nahcolite at 2164.0; trace gilsonite streaks; trace asphalt streaks and leaf fossils; 0.05 foot band of milky white, altered nahcolite at 2167.8; black and white, altered nahcolite streaks and stringers common; 0.2 foot band of black and white, altered nahcolite with bladed and radial structure at 2168.7
2169.6-2173.5	Oil shale, medium-brown, evenly bedded and massive with some looped and streaked-bedding, competent; trace dark-brown to black asphaltic tuff streaks, stringers, and 0.1 foot band at 2169.6; 0.3 foot bands of white, altered pin-point nahcolite at 2170.6 and 2171.1; pin-point nahcolite abundant from 2170.6-2173.5; gradational contact
2173.5-2186.1	Oil shale, marly, buff to light-brown, evenly bedded with trace massive bedding, competent; abundant altered white pin-point nahcolite from 2173.5-2179.1; 0.5 foot bed of medium- to dark-brown, coarse-crystalline nahcolite with bladed and radial structure at 2179.3, 0.6 foot bed at 2180.9, 0.2 foot pod at 2182.0 and 0.1 foot pod at 2183.2; trace black and white nahcolite streaks and stringers; light- to medium-brown porous nahcolite streaks and stringers common; tan to buff marlstone streaks and stringers common; trace gilsonite streaks; trace light- to medium-brown oil-shale streaks and stringers
2186.1-2189.9	Oil shale, medium-brown, evenly bedded with trace contorted bedding, competent; abundant white altered nahcolite streaks, stringers, and blebs; 0.2 foot band of dark-brown nahcolite with bladed and radial structure at 2187.1 and 0.3 foot band at 2187.7; trace medium- to dark-brown oil-shale streaks, stringers, and blebs
2189.9-2195.7	Oil shale, light- to medium-brown, massive with trace even, contorted, and inclined bedding, competent; abundant white pin-point nahcolite streaks, stringers, and blebs; 0.2 foot band of dark-brown nahcolite at 2193.6; 0.05 foot stringer of black and white altered nahcolite at 2190.2

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2195.7-2197.3	Oil shale, dark-brown, evenly bedded with some looped and contorted bedding, competent; altered white pin-point nahcolite common; fairly low density
2197.3-2211.6	Oil shale, medium- to dark-brown, evenly bedded with trace irregular bedding, competent; 0.4 foot bands of medium- to dark-brown, coarsely crystalline nahcolite with bladed and radial structure at 2203.7 and 2206.4, 0.3 foot bands 2207.3 and 2208.1; abundant dark-brown oil-shale streaks, stringers, and blebs; 1.2 foot solution fracture at 2200.0 sealed with asphalt; few scattered altered white nahcolite streaks and stringers
2211.6-2215.4	Oil shale, light- to medium-brown, massive with even bedding, competent; 0.05 foot stringer of altered white nahcolite at 2215.1; trace medium- to dark-brown oil-shale streaks and blebs
2215.4-2220.4	Oil shale, medium-brown, even and massive bedding, competent; 0.2 foot bands of dark-brown, coarsely crystalline nahcolite with bladed and radial structure at 2215.4 and 2218.4
2220.4-2236.2	Oil shale, light-brown to medium-grayish-brown, massive and evenly bedded with trace contorted bedding, very competent; 0.2 foot band of dark-brown to black, coarsely crystalline nahcolite at 2235.4; greenish-gray to black pyritic tuff streaks, stringers, and blebs common and 0.2 foot pod at 2224.4; gilsonite streaks common; 0.2 foot band of buff marlstone at 2231.5; gradational contact
2236.2-2252.4	Oil shale, medium-brown, massive and evenly bedded with trace contorted bedding, competent; 0.3 foot bands of translucent, dark-brown to black coarsely crystalline nahcolite with bladed and radial structure at 2241.2, 2242.2, and 2244.0, 0.1 foot band 2245.9, 0.2 foot bands at 2246.0 and 2249.0, 0.7 foot bands at 2246.3 and 2250.2 and 0.2 foot pod at 2243.0; green to gray pyritic tuff streaks, stringers, and blebs common; gilsonite streaks common; trace asphalt streaks; 0.05 foot stringer of dark-brown to black oil shale at 2252.0

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2252.4-2263.8	Oil shale, light- to medium-olive-brown, massive with even bedding trace looped bedding, inclined and streaked bedding, competent; 0.1 foot band of dark-brown to black nahcolite at 2252.7; 0.05 foot stringer at 2253.5; 0.2 foot bands of coarsely crystalline nahcolite with bladed and radial structure at 2255.7, 2256.7, and 2260.5; 0.1 foot bands at 2256.4 and 2257.9; trace altered black and white nahcolite streaks and stringers; dark-brown asphaltic tuff streaks and stringers common; green to gray pyritic tuff streaks, stringers and blebs common; trace gilsonite streaks, 0.1 foot band of dark-brown oil shale at 2261.8, 0.05 foot stringer at 2261.6; gradational contact
2263.8-2265.2	Oil shale, light-brown, even and streaked bedding, competent; marlstone streaks and stringers fairly common; gradational contact
2265.2-2271.2	Oil shale, medium-brown, even with trace massive bedding, good competence; 0.2 foot band of dark-brown to black, coarsely crystalline nahcolite with bladed and radial structure at 2265.3; 0.05 foot stringer of altered black and white nahcolite at 2267.6; green to gray pyritic tuff streaks, stringers, and blebs common; trace dark-brown asphaltic tuff streaks and blebs; gilsonite streaks common
2271.2-2274.4	Oil shale, light-brown to buff, massive with trace even bedding, very competent; abundant green to gray granular pyritic tuff streaks, stringers, and blebs; trace asphaltic tuff streaks; gilsonite streaks common
2274.4-2279.8	Oil shale, medium-brown, even with trace massive bedding, competent; abundant green to gray pyritic tuff streaks, stringers and blebs; dark-brown asphaltic tuff streaks common; light-brown to buff marlstone stringers common; 0.7 foot zone of dark-brown oil-shale stringers and bands
2279.8-2298.3	Oil shale, light-olive-brown, evenly bedded with trace looped bedding, very competent; trace greenish-gray pyritic tuff streaks; medium- to dark-brown oil-shale streaks and bands common; trace medium- to dark-brown asphaltic tuff streaks and stringers
2298.3-2301.7	Oil shale, medium- olive-brown, evenly bedded with looped bedding, very competent; dark olive-brown oil-shale streaks, stringers, and bands common; trace greenish-gray pyritic tuff streaks and blebs; a 0.05 foot medium-brown, asphaltic tuff stringer at 2300.5

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2301.7-2320.0	Oil shale, light- to medium-olive-brown, evenly bedded with trace streaked and irregular bedding, competent; trace dark-olive-brown oil-shale stringers and laminae; trace greenish-gray pyritic tuff streaks; trace white, kaolinitic(?) tuff streaks; a 0.5 foot bed of dark-olive-brown oil shale from 2308.4 to 2308.9
2320.0-2326.7	Oil shale, light- to medium-olive-brown, evenly bedded with trace streaked and irregular bedding, very competent; medium- to dark-olive brown oil-shale streaks and stringers common; slightly darker from 2324.2 to 2325.1; greenish-gray pyritic tuff streaks and blebs common; trace gilsonite streaks; trace tan marly streaks
2326.7-2328.5	Oil shale, light-olive-brown to tan, evenly bedded with trace streaked bedding, competent; trace greenish-gray pyritic tuff streaks; trace gilsonite streaks; numerous partings and high-angle fractures
2328.5-2330.5	Oil shale, medium- and dark-olive-brown, even and irregular bedding, very competent; medium- to dark-brown asphaltic tuff streaks and blebs common
2330.5-2339.1	Oil shale, light-olive-brown, evenly bedded with trace streaked bedding, very competent; greenish-gray pyritic tuff streaks and blebs common; a 0.1 foot medium-brown tuff streak with white kaolinite(?) and dark-brown asphaltic filling at 2337.6; numerous high angle fractures from 2330.5 to 2335.1
2339.1-2342.1	Oil shale, medium-olive-brown, evenly bedded with trace streaked bedding, very competent; trace gilsonite streaks; trace greenish-gray pyritic tuff streaks; a 0.3 foot medium brown tuff band at 2340.2
2342.1-2346.3	Oil shale, light-olive-brown to tan, evenly bedded with trace streaked bedding, very competent; tan to buff marly stringers and laminae common; greenish-gray pyritic tuff streaks common; trace gilsonite streaks
2346.3-2347.8	Oil shale, medium- and dark-olive-brown, evenly bedded with some streaked and looped bedding, very competent; dark-brown asphaltic tuff streaks, stringers, and blebs common; trace tan marly streaks
2347.8-2354.7	Oil shale, light- to medium-olive-brown, evenly bedded with streaked and irregular bedding, competent; dark-olive-brown oil-shale streaks common; greenish-gray pyritic tuff stringers and blebs common; trace dark-gray-brown tuff streaks and bands

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2354.7-2356.4	Oil shale, medium- and dark-olive-brown, even and irregular bedding, very competent; dark-brown tuff streaks and bands common; trace asphaltic tuff streaks and blebs; trace greenish-gray pyritic tuff streaks
2356.4-2358.7	Oil shale, light- to medium-olive-brown, evenly bedded, very competent; greenish-gray pyritic tuff streaks common; trace dark-olive-brown oil-shale streaks and laminae
2358.7-2362.7	Oil shale, medium-olive-brown, evenly bedded with some streaked bedding, very competent; greenish-gray pyritic tuff streaks and blebs common; few scattered dark-brown asphaltic tuff streaks and stringers; trace tan marly streaks; gradational contact
2362.7-2366.5	Oil shale, light- to medium-olive-brown, evenly bedded with trace streaked bedding, very competent; greenish-gray pyritic tuff streaks and stringers common; trace dark-olive brown oil-shale streaks and laminae
2366.5-2373.2	Oil shale, medium- and dark-olive-brown banded, evenly bedded with trace streaked and irregular bedding, very competent; trace tan marly streaks; medium-brown asphaltic tuff streaks and stringers common with a 0.1 foot band at 2368.5; trace greenish-gray pyritic tuff streaks
2373.2-2391.9	Oil shale, medium-olive-brown, even bedding, very competent; dark-olive-brown oil-shale stringers and laminae common; trace dark-brown asphaltic tuff streaks and blebs; drill induced rubble from 2378.1 to 2379.7; trace greenish-gray pyritic tuff streaks and blebs; trace gilsonite streaks; a long high-angle fracture from 2380.0 to 2383.7; a 0.1 foot medium-brown, irregular, slightly pyritic tuff stringer at 2386.4; a 0.2 foot medium-brown tuff band at 2386.8; gradational contact
2391.9-2395.8	Oil shale, light- to medium-olive-brown, even bedding with some streaks, very competent; greenish-gray pyritic tuff streaks, stringers and blebs common; trace medium-brown asphaltic tuff streaks; trace gilsonite streaks
2395.8-2408.9	Oil shale, medium- to dark-olive-brown, evenly bedded with some streaked bedding, very competent; dark-brown asphaltic tuff streaks, stringers, and blebs common; trace tan marly streaks and stringers; greenish-gray pyritic tuff streaks common; gradational contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2408.9-2410.5	Oil shale, light- to medium-olive-brown, even bedding with some streaks, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs; trace light-tan to buff marlstone streaks; trace clear to white calcite(?) stringers
2410.5-2422.6	Oil shale, medium- to dark-olive-brown, even to irregular bedding with trace of streaks and looped and contorted bedding, competent; a 0.4 foot band of dark-olive-brown oil shale at 2412.4 and 2422.2, a 0.2 foot band at 2421.6; abundant dark-brown to black asphaltic tuff streaks, stringers and blebs, a 0.1 foot band at 2412.8 and 2418.9; few scattered greenish-gray pyritic tuff streaks, stringers, and blebs; sharp contact
2422.6-2426.1	Oil shale, light- to medium-olive-brown, even bedding with massive and trace contorted bedding, very competent; greenish-gray, pyritic tuff streaks and blebs common; trace dark-brown to black asphaltic tuff streaks and blebs; trace gilsonite streaks; trace asphalt streaks
2426.1-2431.8	Oil shale, medium- to dark-olive-brown, even bedding with streaks, looped and contorted bedding, competent; greenish-gray, pyritic tuff streaks, stringers, and blebs common; few scattered dark-brown to black asphaltic tuff streaks, stringers and blebs; few scattered dark-brown oil-shale streaks and stringers; abundant asphalt streaks; sharp contact
2431.8-2433.3	Oil shale, light- to medium-olive-brown, evenly bedded and massive with a few streaks, competent; trace greenish-gray pyritic tuff streaks and stringers; trace medium- to dark-olive-brown oil-shale stringers; trace asphalt streaks
2433.3-2441.3	Oil shale, medium- to dark-olive to gray-brown, even bedding with trace contorted and looped bedding and streaks, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs; few scattered dark-brown to black asphaltic tuff streaks and stringers, a 0.1 foot band at 2433.3; a 0.1 foot band of dark-brown oil shale at 2440.0
2441.3-2445.1	Oil shale, light- to medium-olive-brown, evenly bedded with trace contorted bedding, competent; few scattered greenish-gray pyritic tuff streaks, stringers, and blebs; few scattered dark-brown asphaltic tuff streaks and stringers; a 0.1 foot band at 2444.3; trace medium- to dark-brown oil-shale streaks and stringers; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2445.1-2446.5	Oil shale, dark-olive-brown to black, contorted and even bedding, competent; few scattered greenish-gray pyritic tuff streaks and blebs; trace dark-brown asphaltic tuff streaks and stringers; trace light-brown to buff oil-shale streaks and stringers; fairly low density
2446.5-2451.8	Oil shale, medium-olive-brown, evenly bedded with massive and trace contorted bedding, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs; trace dark-brown to black asphaltic tuff streaks and blebs; trace white to buff marlstone streaks and stringers; a 0.9 foot bed of light-brown to buff oil shale at 2450.9; gradational contact
2451.8-2454.4	Oil shale, medium- to dark-olive-brown, evenly bedded with trace looped, inclined and contorted bedding, competent; a 0.5 foot band of dark-olive-brown to black oil shale at 2453.2, a 0.4 foot band at 2454.0; trace dark-brown asphaltic tuff streaks and blebs; trace asphalt streaks; trace gilsonite streaks; sharp contact
2454.4-2459.8	Oil shale, light- to medium-olive-brown, evenly bedded and massive with trace contorted bedding, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs, a 0.1 foot band at 2457.0 and 2457.6; few scattered dark-brown asphaltic tuff streaks, stringers, and blebs; gradational contact
2459.8-2464.5	Oil shale, medium- to dark-olive-brown, massive and evenly bedded with trace contorted bedding, competent; few scattered dark-brown asphaltic tuff streaks and blebs; trace dark-olive-brown to black oil-shale streaks; a 5.9 foot fracture from 2461.8 to 2467.7; sharp contact
2464.5-2468.3	Oil shale, medium-olive-brown, evenly bedded with trace streaked and contorted bedding, competent; abundant dark-brown asphaltic tuff streaks, stringers, and blebs; few scattered greenish-gray pyritic tuff streaks, stringers, and blebs; few scattered dark-olive-brown oil-shale streaks and stringers; trace gilsonite streaks; few scattered light-olive-brown to buff oil-shale streaks and stringers
2468.3-2470.1	Oil shale, dark-olive-brown to black, looped, streaked, contorted with trace massive bedding, competent; few scattered greenish-gray pyritic tuff streaks and blebs; trace light- to medium-olive-brown oil-shale stringers and bands; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2470.1-2483.1	Oil shale, medium- to dark-olive-brown, evenly bedded with trace contorted bedding, competent; abundant dark-brown to black asphaltic tuff streaks, stringers, and blebs with 0.1 foot bands at 2473.1, 2473.2, 2474.3, 2477.2 and 2480.1 and a 0.2 foot band at 2474.7; trace greenish-gray pyritic tuff streaks and blebs; trace gilsonite streaks; few scattered dark-olive-brown oil-shale streaks and stringers, a 0.2 foot band at 2475.1 and 2478.6; a 5.0 foot fracture from 2470.1 to 2475.1; a 5.7 foot fracture from 2477.2 to 2482.9; gradational contact
2483.1-2488.5	Oil shale, medium-olive-brown, even, looped, contorted and streaked bedding, competent; abundant dark-brown to black asphaltic tuff streaks, stringers, and blebs, 0.1 foot bands at 2483.9, 2484.4, and 2487.2, a 0.5 foot zone of contorted streaks and stringers at 2484.7; trace greenish-gray pyritic tuff streaks and blebs; trace gilsonite streaks; trace dark-olive-brown oil-shale streaks and stringers; gradational contact
2488.5-2492.4	Oil shale, light- to medium-olive, even with trace contorted bedding, competent; greenish-gray pyritic tuff streaks, stringers, and blebs common, a 0.1 foot zone of streaks and stringers at 2490.4; trace dark-brown asphaltic tuff streaks and stringers; trace asphalt streaks; a 0.1 foot band of dark-olive brown oil shale at 2490.5; gradational contact
2492.4-2499.2	Oil shale, medium-olive-brown, even with contorted bedding, competent; abundant dark-brown to black asphaltic tuff streaks, stringers, and blebs with 0.2 foot bands at 2493.6, 2496.2, and 2497.,0 and 0.1 foot bands at 2496.7 and 2493.9 and a 0.4 foot zone of streaks and stringers at 2494.2; trace greenish-gray pyritic tuff streaks and blebs; trace white to buff marlstone streaks and stringers; gradational contact
2499.2-2514.1	Oil shale, medium- to dark-olive-brown, even with trace streaked and contorted bedding, competent; abundant dark-brown to black asphaltic tuff streaks, stringers, and blebs with a 0.5 foot band at 2510.7 and 0.1 foot bands at 2504.2, 2504.3, 2512.4, a 0.2 foot band at 2509.1; trace gilsonite streaks; a 8.6 foot fracture from 2501.6 to 2510.2; gradational contact; a 1.6 foot core loss from 2500.0 to 2501.6

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2514.1-2530.1	Oil shale, medium-olive-brown, even with trace contorted and streaked bedding, competent; abundant dark-brown to black asphaltic tuff streaks, stringers, and blebs; a 0.1 foot band of medium-gray shale at 2527.5; sharp contact
2530.1-2532.9	Oil shale and tuff interbedded. Oil shale, light- to medium-olive-brown, contorted bedding, competent; tuff, dark-brown to black, asphaltic, hard, coarsely granular; few scattered greenish-gray pyritic tuff streaks and blebs; sharp contact; WAVY TUFF BED AT 2530.1
2532.9-2535.3	Oil shale, medium-olive-brown, even with trace contorted bedding, competent; few scattered dark-brown to black asphaltic tuff streaks, stringers, and blebs, a 0.3 foot band at 2534.6; trace greenish-gray pyritic tuff streaks and blebs; trace light-olive-brown to buff oil-shale streaks and stringers
2535.3-2544.9	Oil shale, medium- to dark-olive-brown, even with trace streaked bedding, competent; few scattered dark-brown asphaltic tuff streaks, stringers, and blebs; trace greenish-gray pyritic tuff streaks and blebs; numerous dark-olive-brown oil-shale streaks and stringers with a 0.3 foot band at 2540.0; gradational contact
2544.9-2549.6	Oil shale, light- to medium-olive-brown, evenly bedded, competent; numerous dark-brown asphaltic tuff streaks and blebs; numerous greenish-gray pyritic tuff streaks and blebs; gradational contact
2549.6-2561.3	Oil shale, medium-olive-brown, even with trace contorted bedding, competent; numerous dark-brown to black asphaltic tuff streaks, stringers, and blebs; a 5.5 foot solution fracture zone well-cemented with asphaltic resin from 2553.9 to 2559.4; gradational contact
2561.3-2564.6	Oil shale, medium- to dark-olive-brown, even bedding, competent; trace dark-brown to black asphaltic tuff streaks and blebs; a 0.7 foot band of light- to medium-olive-brown oil shale at 2563.9; sharp contact
2564.6-2569.0	Oil shale, dark-olive-brown to black, even, contorted, streaked and inclined bedding, competent; trace greenish-gray pyritic tuff streaks and blebs; few scattered light- to medium-olive-brown oil-shale streaks and stringers; fairly low density; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2569.0-2577.9	Oil shale, light- to medium-olive-brown, even with trace contorted bedding, competent; numerous dark-brown to black asphaltic tuff streaks, stringers, and blebs; few scattered greenish-gray pyritic tuff streaks, stringers, and blebs; few scattered medium- to dark-olive-brown oil-shale streaks and stringers with 0.3 foot bands at 2570.2 and 2571.6; numerous white to buff marlstone streaks and stringers
2577.9-2581.3	Oil shale, medium- to dark-olive-brown, even and massive bedding, competent; few scattered dark-brown asphaltic tuff streaks and blebs; trace greenish-gray pyritic tuff streaks and stringers; few scattered dark-olive-brown to black oil-shale streaks and stringers with a 0.3 foot band at 2578.2
2581.3-2582.8	Oil shale, light-olive-brown to buff, even bedding, very competent; few scattered greenish-gray pyritic tuff streaks and stringers; trace dark-brown asphaltic tuff streaks and blebs; few scattered marlstone streaks and stringers; sharp contact
2582.8-2584.1	Oil shale, dark-olive-brown to black, even with trace contorted bedding, competent; trace greenish-gray pyritic tuff streaks; trace dark-brown asphaltic tuff streaks and blebs; a 0.05 foot stringer of light-gray to light-brown tuff at 2583.2
2584.1-2595.5	Oil shale, marly; light-olive-brown to buff to light-gray-brown, even with trace contorted and irregular bedding, competent; few scattered greenish-gray pyritic tuff streaks; abundant dark-brown to black, bleeding asphaltic tuff streaks, stringers, and blebs, with a 0.1 foot band at 2584.2 and a 0.2 foot band at 2589.7 and a 0.05 foot stringer at 2591.0; numerous white to buff marlstone streaks and stringers with a 0.2 foot band at 2591.8; a 0.9 foot band of medium- to dark-brown crystalline nahcolite at 2592.5 and 0.1 foot vugs at 2591.7 and 2592.3; TOP "A" GROOVE at 2586.0 feet
2595.5-2597.9	Marlstone, light-gray to light-brownish-gray, even bedding, competent; numerous dark-brown asphalt streaks and stringers; gradational contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2597.9-2600.2	Oil shale, marly; light-olive-brown to buff to light-gray-brown, even, massive and streaked bedding, competent; few scattered dark-brown to black asphaltic tuff streaks and blebs; numerous dark-brown asphalt streaks and blebs; trace greenish-gray, pyritic tuff streaks and stringers; a 0.1 foot pod of dark-brown nahcolite with bladed and radial structure at 2600.3; few scattered light- to medium-brown tuff streaks and stringers; numerous light-olive-brown to gray marlstone streaks and stringers; sharp contact
2600.2-2604.6	Oil shale and nahcolite. Oil shale, medium-brown, even bedding, competent; nahcolite, medium- to dark-brown, very competent; prominent bladed and radial structure; TOP OF MAHOGANY OIL-SHALE ZONE at 2600.4
2604.6-2608.2	Oil shale, marly; light-olive-brown to buff, irregular, inclined and contorted bedding, competent; few scattered greenish-gray pyritic tuff streaks and blebs; trace dark-brown to black asphaltic tuff streaks and blebs; trace gilsonite streaks; trace asphalt streaks; few scattered medium-olive-brown oil-shale streaks and stringers
2608.2-2609.9	Marlstone and tuff interbedded. Marlstone, light-gray and brown to buff, contorted bedding, competent; trace kerogen; tuff, dark-brown to black, contorted bedding, bleeding asphalt; numerous medium-olive-brown oil-shale streaks and stringers; few scattered greenish-gray pyritic tuff streaks and stringers; sharp contact
2609.9-2616.1	Oil shale, medium- to dark-olive-brown, contorted with irregular and wavy bedding, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs with a 0.1 foot band at 2610.0; abundant dark-brown to black bleeding asphaltic tuff streaks, stringers, and blebs, with 0.1 foot bands at 2610.5, 2615.4 and 2615.6; sharp contact
2616.1-2620.8	Oil shale, light- to medium-olive-brown, even with trace contorted bedding, competent; numerous medium- to dark-brown asphaltic tuff streaks, stringers, and blebs; trace greenish-gray pyritic tuff streaks and blebs; few scattered light-brown to buff marlstone streaks and stringers; few scattered medium-olive-brown oil-shale streaks and stringers
2620.8-2632.8	Oil shale, light-olive-brown to buff to light-gray-brown, marly, even with trace contorted bedding, competent; few scattered brown asphaltic tuff streaks and stringers; few scattered greenish-gray pyritic tuff streaks and stringers, and a 0.3 foot band at 2627.5; numerous buff to light-gray marlstone streaks and stringers; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2632.8-2634.6	Oil shale, dark-mahogany-brown to black, even with streaked and looped bedding, competent; few scattered greenish-gray pyritic streaks and blebs; few scattered medium- to dark-brown asphaltic tuff streaks and blebs; trace light- to medium-olive-brown oil-shale streaks and stringers; gradational contact
2634.6-2636.8	Oil shale, medium-olive-brown, even with trace contorted bedding, very competent; trace greenish-gray pyritic tuff streaks and blebs; few scattered dark-brown asphaltic tuff streaks and stringers; gradational contact
2636.8-2639.3	Oil shale, light- to medium-olive-brown, even with contorted bedding, competent; few scattered medium- to dark-brown asphaltic tuff streaks and stringers; few scattered buff to light-gray marlstone streaks and stringers; sharp contact
2639.3-2654.2	Oil shale, very dark-mahogany-brown, even and contorted with trace streaked and looped bedding, competent; abundant medium- to dark-brown asphaltic tuff streaks, stringers, and blebs; few scattered greenish-gray pyritic tuff streaks and blebs; numerous light- to medium-olive-brown oil-shale streaks and stringers, predominantly in the zone of contorted bedding from 2645.2 to 2648.0; sharp contact
2654.2-2660.4	Oil shale, light- to medium-olive-brown, even with contorted and trace streaked bedding, competent; few scattered dark-brown to black asphaltic tuff streaks and blebs; trace greenish-gray to black pyritic tuff streaks; a 0.7 foot band of very dark-mahogany-brown to black oil shale at 2656.9; sharp contact
2660.4-2669.6	Oil shale, medium- to dark-mahogany-brown; even, streaked looped and irregular bedding, competent; abundant greenish-gray pyritic tuff streaks and blebs, and a 0.1 foot band at 2662.7; few scattered dark-brown asphaltic tuff streaks and blebs; a 0.6 foot bed of very dark-mahogany-brown oil shale at 2660.9; numerous dark- to very dark mahogany brown oil-shale streaks and stringers; sharp contact
2669.6-2672.9	Oil shale, light- to medium-olive-brown, even with streaked and contorted bedding, competent; few scattered dark-brown asphaltic tuff streaks; trace greenish-gray pyritic tuff streaks; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2672.9-2674.8	Oil shale, dark-mahogany-brown; contorted, streaked, looped, and irregular bedding, competent; few greenish-gray pyritic tuff streaks and stringers; numerous dark-brown to black asphaltic tuff streaks and blebs; few scattered medium-olive-brown oil-shale streaks and stringers
2674.8-2679.8	Oil shale, light- to medium-olive-brown, evenly bedded, competent; few scattered greenish-gray pyritic tuff streaks, stringers, and blebs; few scattered dark-brown to black asphaltic tuff streaks and blebs, and a 0.1 foot band at 2673.5; moderately low density; sharp contact
2679.8-2681.4	Oil shale, medium-olive-brown, massive with streaked bedding, competent; abundant green to gray pyritic tuff streaks; trace asphalt streaks; trace dark-brown asphaltic tuff streaks; sharp contact
2681.4-2683.6	Nahcolite with oil shale. Nahcolite, clear to light-brown to dark-brown, coarsely crystalline, very hard with bladed and radial structure; oil shale, medium- to dark-mahogany-brown, massive bedding broken up by nahcolite, competent, very calcareous, very cohesive
2683.6-2689.0	Oil shale, medium- to dark-mahogany-brown, inclined, contorted, streaked and looped bedding, very competent; numerous green to gray to black pyritic tuff streaks and blebs; few scattered dark-brown to black asphaltic tuff streaks and stringers; trace dark-brown asphalt streaks; gradational contact
2689.0-2695.5	Oil shale, light- to medium-olive-brown, even with trace contorted and streaked bedding, competent; few scattered dark-brown to black asphaltic tuff streaks and blebs, 0.1 foot pod at 2694.5; trace green to gray pyritic tuff streaks and blebs; numerous buff to light-gray marlstone streaks and stringers; trace asphalt streaks; sharp contact
2695.5-2698.5	Oil shale, medium- to dark-mahogany-brown, even, streaked, contorted and looped bedding, competent; few scattered dark-brown to black bleeding asphaltic tuff streaks and blebs, 0.1 foot pod at 2696.3 and 0.1 foot pod at 2696.6; trace green to gray pyritic tuff streaks; few scattered light- to medium-brown tuff blebs and streaks; gradational contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2698.5-2704.6	Oil shale, light-olive-brown to light-gray-brown, marly, even and massive with trace contorted and streaked bedding, competent; abundant light-grayish brown marlstone streaks and 0.1 foot band at 2700.2 and 0.2 foot band at 2700.4; numerous greenish-gray to black pyritic tuff streaks, stringers, and blebs, 0.1 foot pod at 2699.2; trace dark-brown asphaltic tuff streaks and blebs; numerous light- to medium-olive-brown oil-shale streaks and stringers; few scattered medium- to dark-mahogany-brown oil-shale streaks and stringers, 0.2 foot band at 2702.4 and 0.2 foot band at 2703.7; trace gilsonite streaks; sharp contact
2704.6-2707.8	Marlstone, light-gray to light-grayish-brown, massive and streaked bedding, competent; trace kerogen; few scattered green to gray pyritic tuff stringers, streaks, and blebs; trace medium- to dark-brown asphaltic tuff streaks, stringers, and blebs and 0.1 foot zone of dark-brown stringers at 2705.1; few scattered light-olive-brown oil-shale streaks and stringers; sharp contact
2707.8-2710.5	Oil shale, medium-olive-brown to medium-gray-brown, streaked and contorted with trace even bedding, competent; 0.4 foot band of brown to gray asphaltic tuff with black asphalt filled pores at 2710.0; few scattered green to gray pyritic tuff streaks and blebs; few scattered dark-brown asphaltic tuff streaks, stringers, and blebs and 0.1 foot bands at 2709.8 and 2710.0; trace asphalt streaks; sharp contact
2710.5-2711.8	Oil shale, medium- to dark-mahogany-brown, even with trace streaked and irregular bedding, very competent; trace greenish-gray pyritic tuff streaks; few scattered light- to medium-olive-brown oil-shale streaks and stringers; sharp contact
2711.8-2718.1	Oil shale, light-olive-brown, streaked and looped with trace even bedding, competent; numerous green to gray pyritic tuff stringers, streaks, and blebs; few scattered dark-brown to black asphaltic tuff streaks and blebs; trace white to buff argillaceous tuff streaks and stringers; sharp contact
2718.1-2720.7	Oil shale, medium- to dark-olive-brown to gray-brown, even and streaked with trace contorted bedding, competent; few scattered very dark- mahogany- brown to black oil-shale streaks, stringers and 0.6 foot band at 2718.1; few scattered dark-brown asphaltic tuff streaks and blebs; trace greenish-gray pyritic tuff streaks and blebs; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2720.7-2727.7	Oil shale, light- to medium-olive-brown to grayish-brown, marly, streaked, looped, and contorted with trace even bedding, competent; few scattered medium-olive-brown oil-shale streaks and stringers and 0.6 foot band at 2726.6; numerous white to light-grayish-brown marlstone streaks, stringers, and blebs and 0.6 foot band at 2723.2, 0.3 foot band at 2724.5, 0.1 foot bands at 2722.8, 2722.9, 2723.9 and 2726.5; few scattered dark-brown asphaltic tuff streaks and stringers, some with white calcite(?) centers; few scattered green to gray pyritic tuff streaks and stringers; 0.3 foot solution fracture, sealed with asphalt at 2725.0; sharp contact
2727.7-2733.5	Oil shale, medium- to dark-mahogany-brown, contorted, streaked and even bedding, competent; numerous medium- to dark-brown to black asphaltic tuff streaks, stringers, and blebs and 0.6 foot band at 2727.8, 0.8 foot band at 2729.1, 0.1 foot band at 2728.6, 2729.0, and 2732.4; few scattered green to gray pyritic tuff streaks, stringers, and blebs; gradational contact
2733.5-2760.6	Oil shale, very light olive brown to light-gray-brown, marly, even with massive, streaked and trace contorted bedding, competent; numerous greenish-gray pyritic tuff streaks, stringers, and blebs; numerous medium- to dark-brown asphaltic tuff streaks, stringers, and blebs and 0.1 foot bands at 2734.6 and 2738.6; few scattered light- to medium-brown pin-point nahcolite streaks and stringers and 0.1 foot zones at 2741.1, 2743.9 and 2744.7; numerous light-gray to light-grayish-brown marlstone streaks and stringers and 1.1 foot bed at 2756.1, 0.3 foot bands at 2754.3, 2734.9, 2744.1, 2744.8, and 2748.0, 0.2 foot bands at 2739.0, 2742.8, and 2748.4, 0.1 foot bands at 2735.2, 2759.1, 2758.2, 2758.0, 2757.6, 2749.1, 2749.3, 2747.8, 2745.3, and 2745.5; 1.2 foot zone of abundant green to gray pyritic tuff streaks, stringers, and blebs at 2751.5; 0.4 foot bands of marlstone at 2756.9 and 2758.4; sharp contact
2760.6-2774.8	Marlstone, very light-brown to light-gray, massive with streaked, looped and contorted bedding, competent; trace kerogen; numerous greenish-gray to black pyritic tuff streaks, stringers, and blebs, and 0.2 foot band at 2774.0; 0.2 foot band of medium-gray to brown tuff at 2762.1; gradational contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2774.8-2779.8	Oil shale, very light-brown to buff, marly, even with trace streaked and off-set bedding, poorly competent; abundant shaly partings throughout unit; few scattered greenish-gray pyritic tuff streaks and stringers; 0.2 foot band of light-olive-brown oil shale at 2779.2, 0.3 foot band at 2779.5; sharp contact
2779.8-2809.9	Marlstone, light-gray to light-brownish-gray, massive with even, streaked, and trace contorted bedding, fairly competent; abundant asphalt streaks, 7.0 foot zone at 2781.0, 0.4 foot zone at 2794.0, and 2.0 foot zone at 2795.8; few scattered green to gray pyritic tuff streaks, stringers, and blebs; gradational contact
2809.9-2813.2	Oil shale, light-brown to light-grayish-brown, marly, even and massive with trace streaked bedding, competent; abundant light- to dark-brown asphaltic tuff streaks, stringers, and blebs; trace green to gray pyritic tuff streaks; few scattered light-gray to light-grayish-brown marlstone streaks and stringers; sharp contact
2813.2-2817.6	Oil shale, medium- to dark-olive-brown, contorted and streaked with looped and irregular bedding, very competent; 1.0 foot bed of dark-brown nahcolite with bladed and radial structure at 2816.4, 0.3 foot band at 2814.9; few scattered greenish-gray pyritic tuff streaks and blebs; 0.2 foot zone of white and black speckled nahcolite with capillary-type structure; few scattered dark-brown asphaltic tuff streaks and blebs; sharp contact
2817.6-2820.1	Oil shale, light- to medium-olive-brown, even with streaked and trace contorted bedding, competent; abundant greenish-gray pyritic tuff streaks, stringers, and blebs; 0.1 foot band of buff to light-brown blebs of marlstone with pyritic tuff streaks and shale; sharp contact
2820.1-2825.1	Oil shale, medium- to dark-olive-brown, streaked with inclined and trace looped and contorted bedding, competent; 0.3 foot band of dark-brown nahcolite with bladed and radial structure at 2822.9 and 0.2 foot band at 2823.5; sharp contact
2825.1-2828.5	Marlstone, light-gray to light-brownish-gray, streaked with inclined and contorted bedding, competent; trace kerogen; few scattered light-olive-brown oil-shale streaks and stringers; few scattered dark-brown bleeding asphaltic tuff streaks and blebs; 0.4 foot zone of medium-brown nahcolite and greenish-gray pyritic tuff stringers at 2825.4 and 0.1 foot zone at 2826.5; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2828.5-2830.6	Oil shale, light- to medium-olive-brown, streaked with trace contorted bedding, competent; few scattered green to gray pyritic tuff streaks, stringers, and blebs; few scattered medium- to dark-olive brown oil-shale streaks and stringers; sharp contact
2830.6-2839.1	Oil shale, light- to medium-olive-brown to grayish-brown, marly, evenly bedded with contorted, streaked, and inclined bedding, competent; numerous light-grayish-brown to dark-brown nahcolite streaks, stringers, and blebs and 0.4 foot band of coarsely crystalline nahcolite with bladed and radial structure at 2833.5, 0.1 foot band at 2834.0, 0.1 foot pod at 2834.2; 0.1 foot band of light-grayish-brown tuff with disseminated nahcolite and green to gray pyritic streaks at 2835.1 and 2837.0; numerous green to gray pyritic tuff streaks, stringers, and blebs and 0.1 foot band at 2832.2; 0.3 foot band of light- to medium-brown to greenish-brown argillaceous tuff at 2835.7; 0.9 foot light-gray to light-grayish-brown marlstone band with trace kerogen at 2837.1; trace asphalt streaks; sharp contact
2839.1-2842.1	Oil shale, medium- to dark-olive-brown to grayish brown, contorted and even bedding, competent; few scattered green to gray pyritic tuff streaks, stringers, and blebs and 0.1 foot pod at 2841.3; few scattered dark-brown asphaltic streaks and stringers, and 0.1 foot band at 2840.7 and 2841.9; trace light-olive-brown to buff oil-shale streaks and stringers; sharp contact
2842.1-2847.7	Oil shale, light- to medium-olive-brown to grayish brown, marly, even with streaked, off-set, massive and contorted bedding, fairly competent; few scattered very light-brown to gray marlstone streaks and stringers and 0.1 foot bands at 2843.4 and 2847.3, 0.2 foot band at 2847.0; numerous green to gray pyritic tuff streaks, stringers and blebs; few scattered dark-brown to black bleeding asphaltic tuff streaks and blebs; trace asphalt streaks; gradational contact
2847.7-2851.8	Oil shale, medium- to dark-olive-brown, streaked with looped and contorted bedding, competent; numerous green to gray pyritic tuff streaks, stringers and blebs and 0.6 foot zone of pyritic streaks and stringers interbedded with marlstone; few scattered very light brown to light-gray marlstone streaks and stringers; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2851.8-2857.4	Oil shale and marlstone interbedded. Oil shale, light- to medium-olive-brown to grayish brown, even with streaked and contorted bedding, fairly competent; few scattered medium- to dark-olive-brown oil-shale streaks and stringers and 0.4 foot band at 2854.1, 0.1 foot band at 2856.6; marlstone, light- to medium-gray to brownish gray, massive bedding, competent; trace kerogen; few scattered medium- to dark-brown asphaltic tuff streaks and blebs and 0.1 foot band at 2855.2; sharp contact
2857.4-2860.1	Oil shale, dark-olive brown, streaked with contorted and trace looped bedding, competent; few scattered greenish-gray pyritic tuff streaks and blebs; 0.1 foot band of light- to medium-gray fine-grained tuff at 2858.7; few scattered medium- to dark-brown asphaltic tuff streaks and blebs and 0.3 foot band at 2858.9; trace asphalt streaks; sharp contact
2860.1-2863.6	Oil shale, light-olive-brown to light- to medium-gray-brown, marly, even with massive and trace contorted bedding, fairly competent; numerous green to gray pyritic tuff streaks and stringers; 0.3 foot band of medium- to dark-brown oil shale at 2862.8; 1.2 foot solution fracture at 2861.2 sealed with asphalt and white kaolinite(?); sharp contact
2863.6-2873.8	Oil shale, medium- to dark-olive-brown to medium-grayish-brown, streaked and irregular with contorted and even bedding, competent; 0.3 foot zone of medium- to dark-brown asphaltic tuff streaks and stringers at 2863.9, 0.4 foot band at 2864.4; numerous green to gray pyritic tuff streaks, stringers, and blebs and 0.1 foot pod at 2871.6; few scattered very light-olive-brown to buff oil-shale streaks and stringers and 0.9 foot bed at 2870.4; sharp contact
2873.8-2878.2	Oil shale, marly; very light-olive-brown to light-grayish brown, even and massive with trace streaked bedding, competent; marly from 2874.8 to 2875.8; trace greenish-gray pyritic streaks and stringers; 0.1 foot band of light-grayish-brown tuff at 2875.1; sharp contact

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2878.2-2884.6	Oil shale, medium- to dark-olive-brown to medium-grayish-brown, even and massive with streaked and contorted bedding, competent; numerous medium to dark-brown asphaltic tuff streaks, stringers, and blebs and 0.1 foot bands at 2878.7 and 2878.9; trace greenish-gray pyritic tuff streaks and blebs; few scattered medium- to dark-olive-brown streaks and stringers and 0.2 foot band at 2881.5, 0.3 foot band at 2878.2; gradational contact
2884.,6-2893.8	Marlstone, light-gray to light-brownish-gray, streaked with even bedding, competent; trace kerogen; few scattered green to gray pyritic tuff streaks and blebs; few scattered dark-brown asphalt streaks and stringers and 0.1 foot zone of asphalt stringers at 2892.9; sharp contact
2893.8-2903.3	Oil shale, medium- to dark-olive-brown, streaked and contorted with trace looped and even bedding, competent; numerous white to dull gray pin-point calcite(?) streaks, stringers, and blebs; numerous medium- to dark-brown to black bleeding asphaltic tuff streaks, stringers, and blebs and 0.1 foot bands at 2896.5, 2900.9, 2900.0, 2902.3, and 2902.9, 0.2 foot band with pod of white altered pyritic tuff at 2901.9; few scattered, very light-brown to gray marlstone streaks, stringers, and blebs and 0.9 foot bed at 2898.2, 0.2 foot band at 2899.2; trace asphalt streaks; sharp contact
2903.3-2913.0	Claystone, light-green to light-brownish-gray, massive with even and streaked bedding, competent, fairly soft; the only CO ₃ content is in marlstone bands; 1.1 foot bed of light-brown to grayish buff marlstone at 2903.4, 0.4 foot band at 2904.8; numerous green to gray pyritic tuff streaks, stringers, and blebs; few scattered medium- to dark-brown asphaltic tuff streaks and stringers; few scattered white pin-point calcite(?) streaks and stringers; trace asphalt streaks; few scattered black gilsonite streaks and stringers; sharp contact
2913.0-2917.8	Oil shale, medium- to dark-olive-brown, contorted, streaked and even bedding, competent; abundant very dark-brown to black oil-shale streaks and stringers and 0.4 foot bands at 2913.1 and 2914.1, 0.2 foot bands at 2913.8 and 2914.7, and 0.1 foot bands at 2913.6, 2917.2, and 2916.5; few scattered dark-brown to black bleeding asphaltic tuff streaks, stringers, and pods

CORE LITHOLOGY USGS RED WASH #1--continued

Feet	Description
2917.8-2929.7	Marlstone, very light brown to light-brownish-gray, massive with even bedding, very competent; trace kerogen; 0.7 foot solution fracture sealed with asphalt and small clear crystals of calcite(?) at 2919.0; few scattered light- to medium-olive-brown oil-shale streaks and stringers and 0.5 foot band at 2929.2; numerous green to gray pyritic tuff streaks; trace white pin-point calcite(?) streaks and stringers; sharp contact
2929.7-2937.6	Claystone, light-greenish-gray, streaked and even bedding, competent; trace kerogen; numerous green to gray pyritic tuff streaks and stringers; few scattered light-olive-brown to light-grayish-brown oil-shale streaks and stringers; trace gilsonite streaks; sharp contact
2937.6-2955.2	Marlstone, light-gray to very light brown, massive with trace streaked and contorted bedding, competent; numerous gray to green pyritic tuff streaks and stringers; few scattered medium-brown asphaltic tuff streaks and stringers; trace white pin-point calcite(?) streaks and stringers; trace asphalt streaks; sharp contact
2955.2-2962.7	Mudstone, light- to medium-grayish-brown, even bedding, fairly competent; few scattered medium- to dark-olive-brown to grayish-brown oil-shale streaks and stringers and 0.4 foot band at 2955.2; trace kerogen in oil-shale band; numerous greenish-gray pyritic tuff streaks and blebs; few scattered dark-brown asphalt streaks and stringers; trace dark-brown asphaltic tuff streaks and stringers; trace white pin-point calcite(?) streaks and blebs; gradational contact
2962.7-2970.0	Marlstone, very light brown to light-gray, massive with trace even and streaked bedding, competent; abundant gilsonite streaks, stringers, and pin-point streaks; few scattered green to gray pyritic tuff streaks and blebs; trace dark-brown asphaltic tuff streaks and blebs and 0.05 foot stringer at 2965.6; total depth at 2970.0
2970.0	Total depth

Company U.S. Geological Survey		
Well No. Red Wash - 1		
State Utah	County Uintah	
T. 9 S.	R. 22 E.	S. 1

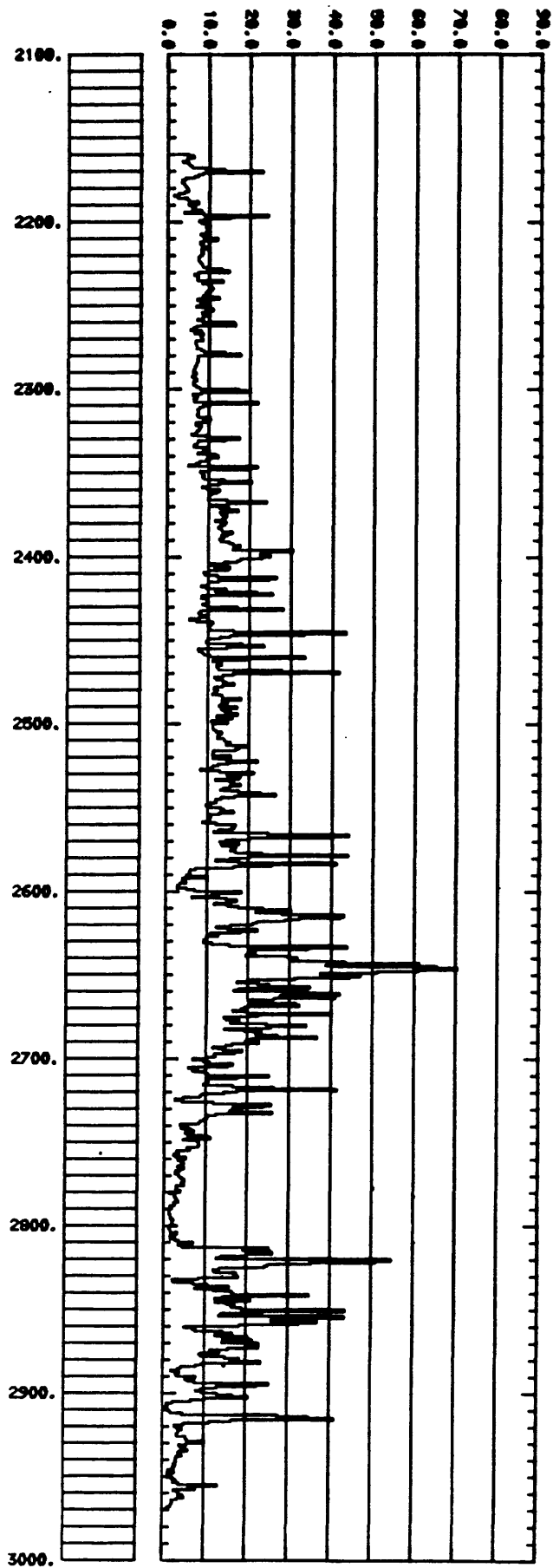


Figure 2: Oil-yield bar graph of the RW-1 drill hole from Fischer assay analysis (in gallons of oil per ton); 1" = 100'

Company U.S. Geological Survey		
Well No. Red Wash - 1		
State Utah	County Uintah	
T. 9 S.	R. 22 E.	S. 1

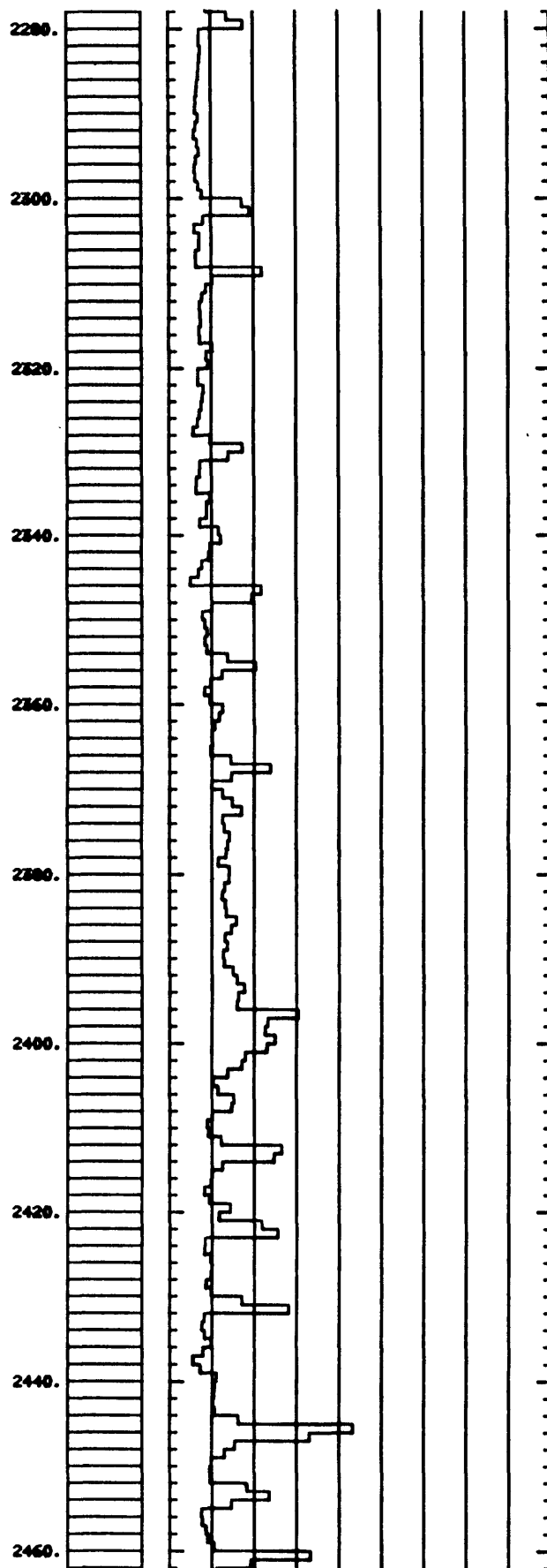
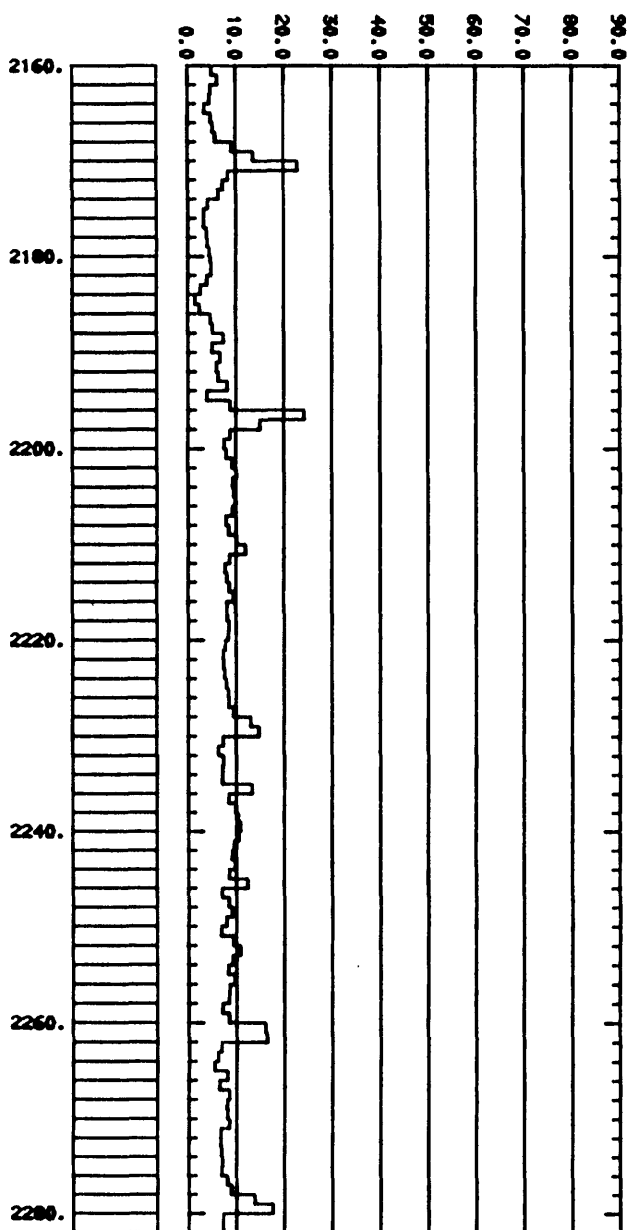


Figure 3: Oil yield bar graph for the RW-1 drill hole from Fischer assay analysis (1" = 20')

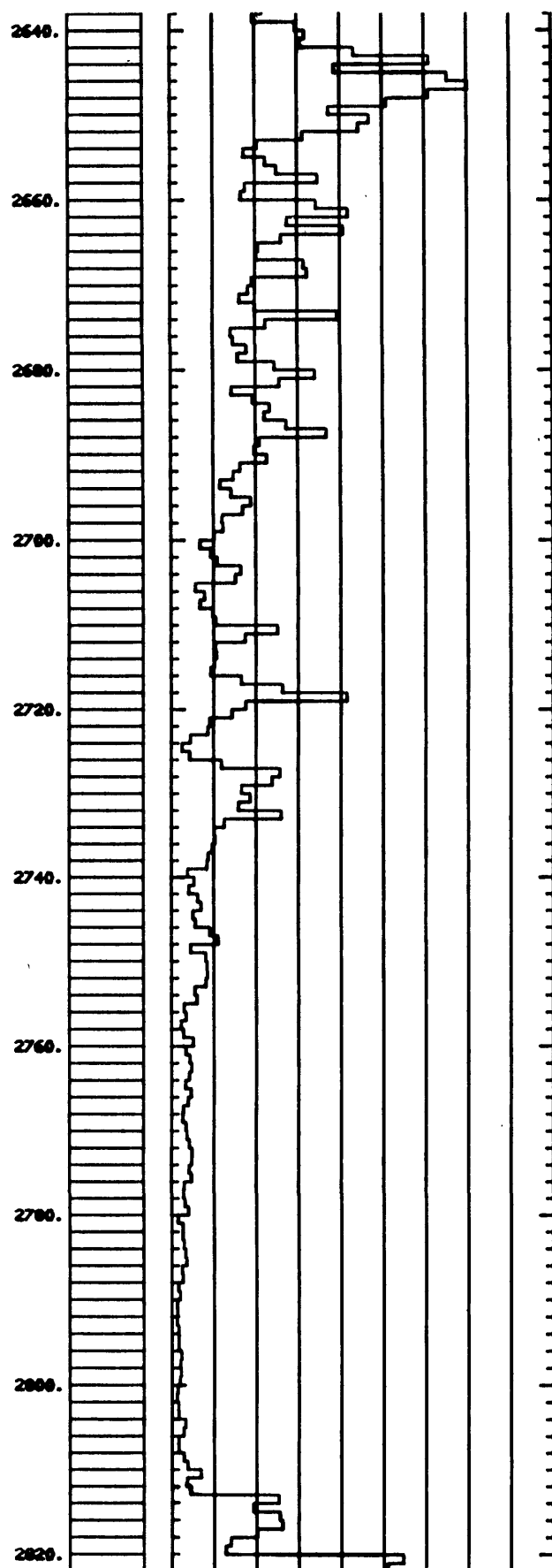
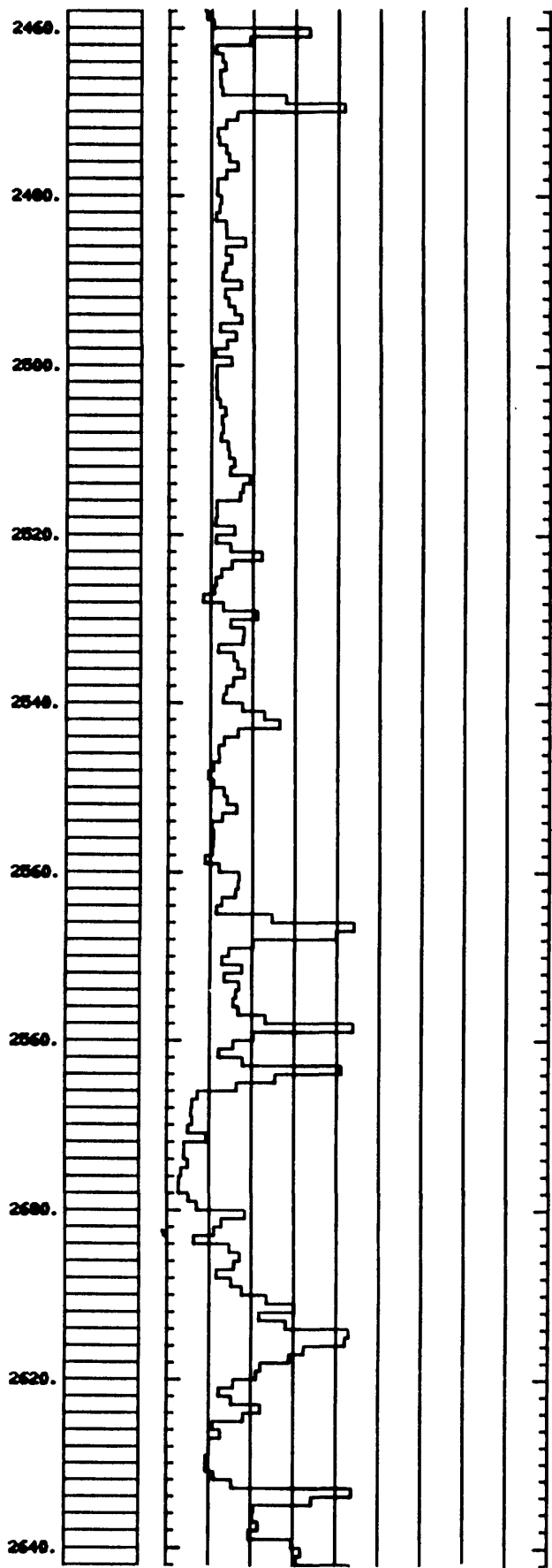


Figure 3: (continued)

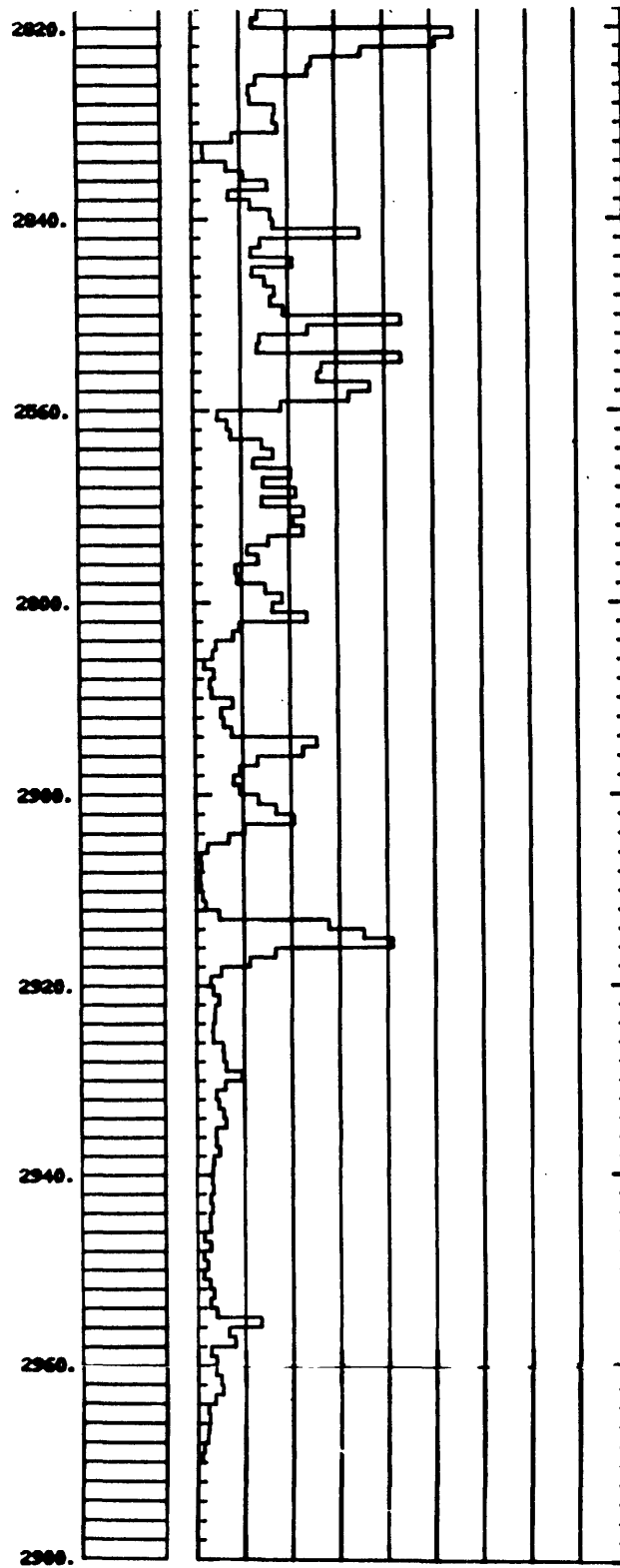


Figure 3: (continued)

Nahcolite Occurrence

Red Wash #1

Nahcolite was observed in the rotary cuttings, however, because of the high solubility of nahcolite in drilling fluids, an accurate percentage of nahcolite could not be determined. Evidence of nahcolite was observed in the rotary cuttings from 2,120 feet to 2,130 feet.

A visual estimate of the percentage of nahcolite per 10 feet of core was recorded throughout the cored interval. The zones of nahcolite mineralization are as follows:

8%	from 2,160 to 2,170
31%	from 2,170 to 2,180
15%	from 2,180 to 2,190
3%	from 2,190 to 2,200
14%	from 2,200 to 2,210
5%	from 2,210 to 2,220
2%	from 2,230 to 2,240
25%	from 2,240 to 2,250
15%	from 2,250 to 2,260
5%	from 2,260 to 2,270
22%	from 2,280 to 2,290
15%	from 2,810 to 2,820
10%	from 2,820 to 2,830
10%	from 2,830 to 2,840

No large void spaces from the leaching of nahcolite was observed in the core.