

FC
USGS
OFR
80-903

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BOREHOLE GRAVITY PROGRAM OF THE
U.S. GEOLOGICAL SURVEY (1963-1975)--
BRIEF HISTORY AND BASIC DATA

By

Larry A. Beyer

UNIVERSITY OF UTAH
RESEARCH INSTITUTE
EARTH SCIENCE LAB.

Open-File Report
80-903

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

Any use of trade names and trademarks in this publication is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

July 1980

BOREHOLE GRAVITY PROGRAM OF THE
U.S. GEOLOGICAL SURVEY (1963-1975)--
BRIEF HISTORY AND BASIC DATA

By

Larry A. Beyer
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California

This report presents a brief historical account of the borehole gravity program of the U.S. Geological Survey from its inception in 1963 through 1975. Basic data from all borehole gravity surveys made from 1968 through September 1975 are given in the appendix.

BRIEF HISTORICAL ACCOUNT

The borehole gravity program of the Geological Survey began in the fall of 1963 when preliminary funding was received for the development of what was intended to be the first durable and reliable high-precision borehole gravity meter. Earlier individual efforts, mostly not publicized at the time, were made by British Petroleum, Shell Oil Company, and Exxon Corporation. Only the last of these resulted in a practical if somewhat fragile general purpose device. These efforts are a matter of published record (Gilbert, 1952; Goodell and Fay, 1964; Howell and others, 1966).

T. H. McCulloh who proposed and spearheaded the early work provided the following account of the U.S. Geological Survey's effort during 1963-1967.

"Initial scientific motivation developed during the period 1959-1963 while I was on the faculty at the University of California at Riverside and, for part of this period, on sabbatical leave to study rocks of the Po Basin in Italy. The principal push was to gain a capability to measure density in situ in very soft and highly porous rocks. The need for this arose

from an awareness that core recovery in such rocks ranges from impossible to difficult, that modification of the rocks during drilling and/or recovery may render core measurements invalid even where recovery is feasible, and that, in any case, core measurements are a very difficult means for developing valid porosity profiles. The use of borehole gravity for reservoir analysis was a serendipitous discovery that emerged from my work in the Santa Fe Springs oil field, California, during 1966-1967.

"A more immediate and practical motivation to develop a high precision borehole gravity meter emerged during early discussions with the Geological Survey in Washington, D.C., when the need became evident for accurate density profiles of the overburden above potential underground nuclear explosion sites. Much of the limited early funding for equipment acquisition came from the former Atomic Energy Commission (AEC) for this reason. V. R. Wilmarth and V. E. McKelvey, assistant chief geologists at the time, were the two decision makers who committed funds from both the Geological Survey and AEC at a crucial time in late 1963 when money was in very short supply. J. E. Schoellhamer and the Chief Geologist at the time, C. A. Anderson, played crucial roles in these early negotiations. Of singular importance was the decision made in late 1963 by Lucien LaCoste and Arnold Romberg to proceed with the development of a borehole gravity meter prior to the signing of a contract with the U.S. Geological Survey."

Initially, LaCoste and Romberg Company demonstrated that their gravity sensor could be modified in order to operate at a thermostated temperature of about 100°C, nearly twice the thermostated temperature of their existing

gravity meters. Then, a gimbal-type leveling system was designed and built to operate within the narrow confines of a well logging tool. Lastly, an electronic control system for remote operation of the gravity meter through 10,000 ft of multiconductor logging cable was designed and built, relying in part on existing control systems of underwater gravity meters and on experience gained from one test in 1963 of the remote operation of an underwater gravity meter through 4,000 ft of cable (Beyer and others, 1966).

During 1964-1965 while LaCoste and Romberg Company was proceeding with the development of their first borehole gravity meter, J. E. Schoellhamer, E. H. Pampeyan, and T. H. McCulloh assembled a well logging system, working mostly with modified surplus military equipment and a commercial wireline spool. This well logging system, although cumbersome, was to serve without fail from the first test surveys in January 1966 through 1975 (fig. 1) (McCulloh and others, 1967a). Crucial technical advice and help were furnished by the Los Angeles area offices of Baker Oil Tools, Inc., Dia-Log Company, and Lane Wells (now Dresser Atlas) and Mobil Oil Corporation during the design and construction of this logging system.

The first successful well test of LaCoste and Romberg borehole gravity meter no. 1 took place in April 1966 in an oil well furnished by Shell Oil Company in the Santa Fe Springs oil field, California (fig. 2). Between April 1966 and December 1967, eleven successful surveys, including one repeat survey, were made in five wells in the Santa Fe Springs oil field, one well in Montebello oil field, California, and four boreholes at the Nevada Test Site. The results of seven of these surveys are reported by McCulloh and others (1967b), McCulloh and others (1968), and Healy (1970).

In 1968 the borehole gravity project was shifted to the southwest part of the San Joaquin Basin, California, where between April 1968 and November 1969,

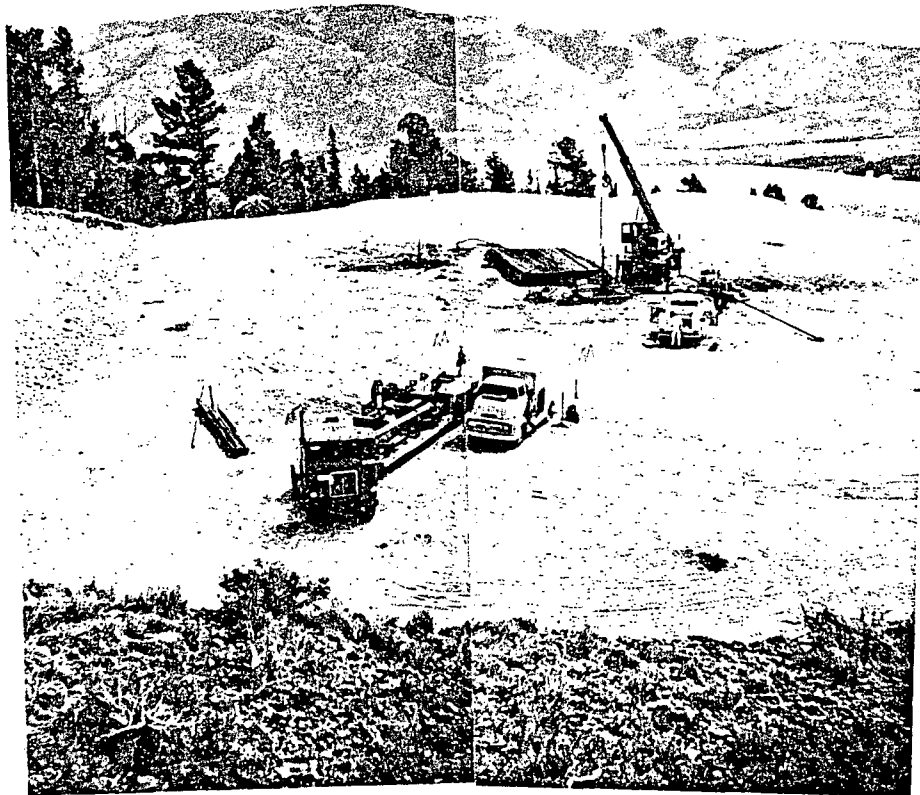


Figure 1. Borehole gravity survey at Mountain Fuel Supply Co., Dry Piney Unit 19, 15-27N-114W, Dry Piney oil field, Sublette County, Wyoming, September 12, 1975. Foreground: tractor-trailer with wireline hoist and precision cable measuring sheave at rear; instrument van from which gravity meter was operated. Background: crane truck used to assemble the 18-foot logging tool and support the two lead-in sheaves during well logging; tool truck nearby. See Beyer and Clutsom (1978b) for results of this study.



Figure 2. Dr. Lucien LaCoste standing beside the LaCoste & Romberg Company's borehole gravity meter No. 1 which is hanging outside of its pressure housing, Santa Fe Springs oil field, California, March 24, 1966, less than two weeks before the first fully successful well test.

nine borehole gravity surveys were made in the Midway-Sunset oil field as part of a study of the vertical gradient of gravity (Beyer, 1971). In December 1969 one borehole gravity survey was made in the Mount Poso oil field northeast of Bakersfield, California. In February 1970 a survey was attempted in the East Los Angeles oil field but serious mechanical and electronic problems severely limited the amount of useful data that were obtained.

Four borehole gravity surveys were made in June 1972 in the Midway-Sunset and Lost Hills oil fields, California, to investigate ways to interpret surveys in folded and steeply dipping strata (Beyer and others, 1975; Beyer, 1976). During 1973 and most of 1974 the borehole gravity program was recessed while the author was temporarily assigned to another project. One borehole gravity survey made during this period examined the density and porosity of about 1,400 ft of Quaternary sediments on the southwest margin of San Francisco Bay, California (Beyer and others, 1980).

After the hiatus of 1973 and most of 1974, the borehole gravity program was renewed with broadened objectives and increased funding and staff. Work was directed toward (1) expanded field application studies, (2) development of a smaller diameter, higher temperature borehole gravity meter, (3) feasibility studies of a borehole gravity gradiometer, and (4) development of a truck-mounted wireline hoist, mast system, and instrumentation van for logging wells.

Four borehole gravity surveys were made in June and July 1975 in the Midway-Sunset, Elk Hills, and Kern River oil fields, California, primarily to determine the porosities of poorly consolidated reservoir rocks targeted for enhanced oil recovery by thermal methods (Beyer, 1977, 1980). In August and September 1975 three surveys were made in oil wells in the Gebo, Garland, and Big Polecat oil fields in the Big Horn Basin, Wyoming, and one survey in the

Dry Piney oil field in the Thrust Belt of southwest Wyoming. These four surveys investigated the densities and porosities of clastic, evaporite and carbonate rocks of Mississippian through Late Cretaceous age (Beyer and Clutson, 1978a, 1978b, 1980a, 1980b). One survey was made during the fall of 1975 to study density variations in intrusive rocks near the San Andreas fault zone in central California (Schmoker, 1977).

In September 1973, T. H. McCulloh and the author prepared a proposal to develop a second-generation, smaller diameter, higher temperature borehole gravity meter and to examine the feasibility of designing a borehole gravity gradiometer. It had been recognized from the outset of the development of the first LaCoste and Romberg borehole gravity meter that the diameter, thermostating temperature, and limited range of its leveling gimbals would restrict surveys to 7-in. and larger diameter casing, depths at which temperatures did not exceed about 95°C, and relatively undeviated boreholes. Development of a second-generation, more widely usable borehole gravity meter was judged to be a timely and important goal. The potential advantages of a static- or dynamic-reading vertical gravity gradiometer for borehole surveying were discussed by Beyer (1971). A feasibility study of a borehole gradiometer was also judged to be worthwhile, although the probability for success was recognized as being considerably lower than for the second-generation borehole gravity meter.

The importance of the development of a new smaller diameter borehole gravity meter, the maximum diameter that would make such an instrument widely useful, and the intent of the U.S. Geological Survey to seek funding to develop this new instrument during the following fiscal year (1974-75), were conveyed to Lucien LaCoste in December 1973. In early 1974 a set of desirable instrument characteristics was sent to Dr. LaCoste. Frequent communications

between LaCoste and Romberg Company and the author took place during the first months of 1974 that led to a mutually acceptable set of specifications. Following a lengthy delay caused by budgetary and contractual negotiations, the U.S. Geological Survey awarded a contract to LaCoste and Romberg Company in June 1975. Subsequent industry orders, including one that preceded the U.S. Geological Survey contract by several weeks, have resulted in a total of eight smaller diameter borehole gravity meters (as of April 1980). These instruments are being used throughout North America and in many other parts of the world.

Feasibility of a static-reading borehole vertical gravity gradiometer was investigated by the author and R. H. Brune from June 1974 to February 1976. The author had carried on informal discussions about borehole gravity gradiometers with industrial research and development laboratories since December 1972. After a thorough study and with very limited funds for such an undertaking, a single contract was signed with the Arthur D. Little Company in May 1975 for a six-month feasibility investigation of their proposed static-reading, null-balance type of vertical gravity gradiometer (Beyer and Brune, 1980). Initial tests of a prototype were somewhat encouraging but inconclusive. Renewal of the contract was not possible because of insufficient funds.

During the early 1970's F. G. Clutsom designed and built a highly reliable FM control and telemetry system for the first LaCoste and Romberg borehole gravity meter that remains in operation today. During the fall of 1974 Clutsom began part-time work on the design of a new multiplexed digital acquisition and FM pulse control system for use with either the smaller diameter borehole gravity meter or a gradiometer, should the latter have become operational. Today this telemetry and control system operates the smaller diameter borehole gravity meter of the U.S. Geological Survey.

P V.

The preliminary design and early development of a less cumbersome truck-mounted wireline hoist, drawworks, and instrumentation van for logging wells was accomplished by Q. Gorton and the author during 1975 and 1976. Most equipment was acquired and a contract awarded to SIE, Inc., Fort Worth, Texas, in 1976 to finalize the design and construct the drawworks and assemble the system on a truck chassis furnished by the U.S. Geological Survey. In late 1976 S. L. Robbins assumed responsibility for this work (Robbins, 1979).

The borehole gravity program was headquartered at the facilities of the U.S. Geological Survey in Menlo Park, California, until 1976 when it was moved to similar facilities in Denver, Colorado.

ACKNOWLEDGEMENTS

Contributions to this pioneering period in the development of borehole gravimetry were made by many talented individuals from industry and government who were incredibly hardworking, ingenious, and dedicated. Special thanks is extended to everyone who helped make borehole gravimetry a successful well logging method during the period 1963 through 1975. An added sense of gratitude is expressed to those who contributed the most: Lucien LaCoste, George Hamilton, H. B. Parks, and Al Saunders of LaCoste and Romberg Company, and Thane H. McCulloh, Jack E. Schoellhamer, Fred G. Clutsom, Earl H. Pampeyan, Kenneth A. Pisciotto, and Robert H. Brune of the U.S. Geological Survey.

BIBLIOGRAPHY

- Beyer, L. A., 1971, The vertical gradient of gravity in vertical and near-vertical boreholes: U.S. Geological Survey Open-file Report 71-42, 229 p., 50 figs., 14 tables.
- _____ 1976, The interpretation of borehole gravity surveys (abs.): Program 46th Annual International Meeting Society of Exploration Geophysicists, October 24-28, 1976, p. 49-50. (Invited paper to session honoring L. L. Nettleton): Geophysics, v. 42, no. 1, p. 141.
- _____ 1977, Interpretation of borehole gravity in the southern San Joaquin Basin (abs.): Geophysics, v. 42, no. 5, p. 1100.
- _____ 1979, Borehole gravity study of the density and porosity of selected Frontier, Tensleep, and Madison reservoirs in the Bighorn Basin, Wyoming (abs.): American Association of Petroleum Geologists Bulletin, v. 63, no. 5, p. 822.
- _____ 1980, Borehole gravity surveys in the San Joaquin Basin--benefits of previous work and suggested future studies (abs.): Program 54th Annual Meeting, Pacific Sections, AAPG-SEPM-SEG, April 1980.
- Beyer, L. A., and Brune, R. H., 1980, Feasibility study of borehole gravity gradiometers: U.S. Geological Survey Open-file Report, in prep.
- Beyer, L. A., Brune, R. H., and Schmoker, J. W., 1975, Application of borehole gravity to exploration for petroleum: Program 50th Annual Pacific Section Meeting, AAPG-SEPM-SEG, April 23-25, 1975.
- Beyer, L.A., and Clutsom, F.G., 1978a, Density and porosity of oil reservoirs and overlying formations from borehole gravity measurements, Gebo oil field, Hot Springs County, Wyoming: U.S. Geological Survey Oil and Gas Investigations Chart OC-88, 3 plates, 20-page pamphlet with 6 figures and 3 tables.

_____ 1978b, Borehole gravity survey in the Dry Piney oil and gas field, Big Piney-La Barge area, Sublette County, Wyoming: U.S. Geological Survey Oil and Gas Investigations Chart OC-84, 2 plates, 9 page pamphlet with 3 figures and 2 tables.

_____ 1980a, Density and porosity of Upper Cretaceous through Permian formations from borehole gravity measurements, Big Polecat oil and gas field, Park County, Wyoming; U.S. Geological Survey Oil and Gas Investigations Chart OC-103, 3 pl., 12 p.

_____ 1980b, Borehole gravity study of the density and porosity of the Madison Limestone and overlying formations from borehole gravity measurements, Garland oil field, Big Horn County, Wyoming: U.S. Geological Survey Oil and Gas Investigations Chart, in prep.

Beyer, L. A., Pisciotto, K., A., and Morgan, N., 1980, Density and porosity of Quaternary sediments based on borehole gravity measurements in NASA Ames Research Center Well No. 1, Santa Clara County, California: U.S. Geological Survey Open-file Report, in prep.

Beyer, L. A., von Huene, R. E., Lovett, J. R., and McCulloh, T. H., 1966, Measuring gravity on the sea floor in deep water: *Journal of Geophysical Research*, v. 71, no. 8, p. 2091-2100.

Gilbert, R. L. G., 1952, Gravity observations in a borehole: *Nature*, v. 170, no. 4323, p. 424-425.

Goodell, R. R., and Fay, C. H., 1964, Borehole gravity meter and its application: *Geophysics*, v. 29, no. 5, p. 774-782.

Healy, P. L., 1970, Calculated in situ bulk densities from subsurface gravity observations and density logs, Nevada Test Site and Hot Creek Valley, Nye County, Nevada, in *Geological Survey Research 1970*, Chapter 3: U.S. Geological Survey Professional Paper 700-B, p. B52-B62.

Howell, L. G., Heintz, K. O., and Barry, A., 1966, The development and use of a high-precision downhole gravity meter: *Geophysics*, v. 31, no. 4, p. 764-772.

McCulloh, T. H., LaCoste, L. J. B., Schoellhamer, J. E., and Pampeyan, E. H., 1967a, The U.S. Geological Survey-LaCoste and Romberg precise borehole gravimeter system--Instrumentation and support equipment, in *Geological Survey Research 1967: U.S. Geological Survey Professional Paper 575-D*, p. D92-D100.

McCulloh, T., H., Schoellhamer, J. E., Pampeyan, E. H., and Parks, H. B., 1967b, The U.S. Geological Survey-LaCoste and Romberg precise borehole gravimeter system--Test results, in *Geological Survey Research 1967: U.S. Geological Survey Professional Paper 575-D*, p. D101-D112.

McCulloh, T. H., Kandle, J. R., and Schoellhamer, J. E., 1968, Application of gravity measurements in wells to problems of reservoir evaluation: *Trans. 9th Annual Logging Symposium of Society of Professional Well Log Analysts*, June 23-26, 1968.

Robbins, S. L., 1979, Description of a special logging truck built for the U.S. Geological Survey for borehole gravity surveys: *U.S. Geological Survey Open-file Report 79-1511*, 67 p.

Schmoker, J. W., 1977, Density variations in a quartz diorite determined from borehole gravity measurements, San Benito County, California: *The Log Analyst*, v. 18, no. 2, p. 32-38.

APPENDIX

Basic data of twenty-two borehole gravity surveys
made between April 1968 and September 1975

Explanation of Tables

COLUMN 1

Sequential numbers for borehole gravity stations.

COLUMNS 2 & 3

Gravity station depths were calculated from cable length measurements and the datum given at the end of each table. The calibration of the cable measuring sheave is believed to be accurate to 0.03 percent or better, based on many tests with the well-conditioned logging cable.

COLUMN 4

Terrain corrections were calculated by the method described by Beyer and Corbato (1972). See additional notes at the end of each table.

COLUMN 5

Values of borehole gravity adjusted to an assumed zero value for the uppermost gravity station. These values are corrected for gravimeter calibration, predicted tidal gravity fluctuations, terrain effects, and gravimeter drift as reconstructed from repeated measurements made at a wellhead base station and downhole base stations.

COLUMN 6

Δg is obtained by forming the difference between successive pairs of values of terrain-corrected relative gravity.

COLUMN 7

Distances between adjacent stations (Δz) were determined in one of two ways. Values of Δz less than 50 feet usually were measured by hand-chaining flagged cable lengths under load between the winch and wellhead. Hand-chained Δz values are repeatable to the nearest 0.02 feet and are underlined in the tabulation. Values of Δz greater than 50 feet were determined from successive odometer readings of the cable measuring sheave and are repeatable to about 0.15 feet, based on many comparisons with hand-chained cable lengths. It was assumed that cable movement at the ground surface accurately reflected movement of the logging tool in the borehole.

COLUMN 8

Gravity difference (Δg) divided by depth difference (Δz) is the interval vertical gradient of gravity.

COLUMN 9

Interval density (ρ) was calculated with the equation:

$$\rho = (1/4\pi k) (F - \Delta g/\Delta z)$$

where k is the Newtonian gravitational constant and is equal to $6.6720 \pm 0.0041 \times 10^{-8} \text{ cm}^3/\text{g sec}^2$ (Taylor and Cohen, 1973) and $1/4\pi k$ is equal to 39.131 ± 0.024 in units of g/cm^3 , milligals, and feet.

F is the normal free-air vertical gradient of gravity that for the Geodetic Reference System of 1967 is given with sufficient accuracy by the equation

$$F = 0.094114 - 0.000134\sin^2\phi - 0.000000134h$$

where ϕ is latitude and h is elevation in feet.

COLUMN 10

Sequential numbers for intervals.

Note: The outer diameters of the borehole gravity meter sondes (5.9 inches for the 2,500 psi housing and 6.25 inches for the 12,000 psi housing) prevented entry into casing or liner smaller than 7-inch #23 in shallow wells and smaller than 7 5/8-inch in deeper wells. For this reason, many surveys listed on subsequent pages did not extend to the deepest parts of the wells.

WELL INFORMATION

Operator, Lease, Well, Location

Texaco Inc. Fee 22
2450' N & 960' W from SE corner, sec. 32, T.32 S., R.24 E. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

May 1937 3,102 feet (K.B.)

Log Runs

Electrical (2,600 to 3,095 feet)

Casing Record

11 3/4-inch casing cemented at 2,990 feet
6 5/8-inch liner to 3,095 feet with top at 2,917 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1541-2400 GMT April 12, 1968
- - - - - 0000-0218 GMT April 13, 1968

Lapse time from first to last gravity reading - 10:37 hours, minutes

Logged Depth - - - - - 2,906.7 feet (K.B.)

Number of borehole gravity stations - - - - - 23

Number of borehole gravity readings - - - - - 47

Number of downhole gravity bases - - - - - 7

Number of intervals - - - - - 22

Largest interval - - - - - 328.2 feet

Smallest interval - - - - - 7.0 feet

Percent of time spent at gravity stations - - - 63 percent

Percent of time spent moving logging tool - - - 36 percent

Average station time spent leveling and
reading gravimeter - - - - - 8.5 minutes

Other references to survey -- none

Datum for depth measurements -- surface casing flange (approximately 5 feet
below former K.B.)

Terrain corrections -- variable density used for terrain out to 103.6 miles

Survey team -- L. A. Beyer, J. E. Schoellhamer

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: TEXACO INC AMERICAN OILFIELDS FEE #22 3102 FT
 LOCATION: 32-32S-24E(M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA						BOREHOLE INTERVAL DATA			
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	0.0	5.0	1.452	0.0	8.544	178.88	.04776	1.812	1
2	178.9	183.9	1.551	8.544	4.206	92.19	.04562	1.896	2
3	271.1	276.1	1.600	12.750	9.434	235.84	.04000	2.116	3
4	506.9	511.9	1.716	22.184	12.381	328.24	.03772	2.205	4
5	835.1	840.1	1.882	34.565	4.481	120.11	.03731	2.221	5
6	955.3	960.3	1.946	39.046	7.835	207.92	.03769	2.206	6
7	1163.2	1168.2	2.060	46.881	12.489	328.13	.03806	2.191	7
8	1491.3	1496.3	2.247	59.370	12.485	330.93	.03773	2.204	8
9	1822.2	1827.2	2.440	71.855	12.419	325.03	.03821	2.185	9
10	2147.3	2152.3	2.628	84.274	12.315	328.04	.03754	2.211	10
11	2475.3	2480.3	2.817	96.589	4.663	124.70	.03739	2.217	11
12	2600.0	2605.0	2.888	101.252	0.566	<u>15.81</u>	.03593	2.274	12
13	2615.8	2620.8	2.897	101.820	2.469	64.05	.03855	2.171	13
14	2679.9	2684.9	2.933	104.289	0.292	<u>7.91</u>	.03691	2.235	14
15	2687.8	2692.8	2.937	104.581	1.217	32.02	.03801	2.192	15
16	2719.8	2724.8	2.955	105.798	2.653	70.04	.03788	2.197	16
17	2789.8	2794.8	2.994	108.451	0.556	13.47	.04128	2.064	17
18	2803.3	2808.3	3.002	109.007	0.670	16.46	.04070	2.087	18
19	2819.8	2824.8	3.011	109.677	0.725	19.05	.03806	2.190	19
20	2838.8	2843.8	3.022	110.402	0.257	<u>7.01</u>	.03666	2.245	20
21	2845.8	2850.8	3.026	110.659	1.624	41.90	.03876	2.163	21
22	2887.7	2892.7	3.049	112.283	0.494	13.97	.03536	2.296	22
23	2901.7	2906.7	3.057	112.777					

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: STANDARD OIL CO CALIFORNIA #302-25L 3175 FT
 LOCATION: 25-12N-24W(S.B.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER	
1	2	3	4	5	6	7	8	9	10	
1	0.0	3.3	1.365	0.0						
2	8.4	11.7	1.376	0.326	0.326	8.40	.03881	2.162	1	
3	308.7	312.0	1.790	13.449	13.123	300.28	.04370	1.971	2	
4	555.5	558.8	2.081	23.152	9.703	246.82	.03931	2.143	3	
5	636.7	640.0	2.171	26.275	3.123	81.21	.03846	2.176	4	
6	935.3	938.6	2.485	37.840	11.565	298.60	.03873	2.165	5	
7	964.8	968.1	2.515	38.958	1.118	29.53	.03786	2.199	6	
8	974.2	977.5	2.524	39.330	0.372	<u>9.33</u>	.03987	2.120	7	
9	1292.9	1296.2	2.834	51.588	12.258	318.77	.03845	2.176	8	
10	1415.2	1418.5	2.948	56.184	4.596	122.23	.03760	2.209	9	
11	1621.0	1624.3	3.135	64.002	7.818	205.82	.03798	2.194	10	
12	1891.0	1894.3	3.372	74.247	10.245	270.06	.03794	2.196	11	
13	1908.0	1911.3	3.387	74.881	0.634	<u>16.98</u>	.03734	2.219	12	
14	1949.1	1952.4	3.422	76.411	1.530	41.11	.03722	2.224	13	
15	2065.3	2068.6	3.520	80.779	4.368	116.13	.03761	2.208	14	
16	2195.0	2198.3	3.629	85.654	4.875	129.69	.03759	2.209	15	
17	2208.0	2211.3	3.640	86.159	0.505	<u>13.06</u>	.03867	2.167	16	
18	2246.1	2249.4	3.671	87.588	1.429	38.12	.03749	2.213	17	
19	2260.0	2263.3	3.682	88.129	0.541	<u>13.82</u>	.03915	2.148	18	
20	2277.3	2280.6	3.697	88.829	0.700	<u>17.36</u>	.04032	2.102	19	
21	2373.8	2377.1	3.775	92.563	3.734	96.47	.03871	2.165	20	
22	2411.8	2415.1	3.806	94.050	1.487	<u>37.97</u>	.03916	2.147	21	
23	2494.8	2498.1	3.873	97.332	3.282	83.01	.03954	2.133	22	
24	2573.6	2576.9	3.935	100.319	2.987	78.82	.03790	2.197	23	
25	2665.1	2668.4	4.008	103.813	3.494	91.48	.03819	2.185	24	
26	2674.1	2677.4	4.015	104.149	0.336	<u>9.00</u>	.03733	2.219	25	
					4.377	114.84	.03811	2.188	26	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: STANDARD OIL CO CALIFORNIA #302-25L 3175 FT
 LOCATION: 25-12N-24W(S.B.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER

27	2788.9	2792.2	4.104	108.526	3.465	93.09	.03722	2.223	27
28	2882.0	2885.3	4.176	111.991	0.524	<u>14.02</u>	.03737	2.217	28
29	2896.0	2899.3	4.186	112.515	0.376	<u>10.00</u>	.03760	2.208	29
30	2906.0	2909.3	4.194	112.891	3.138	83.98	.03737	2.217	30
31	2990.0	2993.3	4.258	116.029	2.174	59.06	.03681	2.239	31
32	3049.1	3052.4	4.302	118.203	1.157	<u>30.75</u>	.03763	2.207	32
33	3079.8	3083.1	4.326	119.360					

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. 54-33D
409' N & 1,998' W from SE corner, sec. 33, T.32 S., R.24 W. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

April 1936 3,138 feet (D.F.); deepened to 3,215 feet (D.F.) in 1961

Log Runs

Electrical (1,505-3,138 feet); Induction (3,139-3,210 feet)

Casing Record

8 5/8-inch casing cemented at 2,937 feet
7-inch liner to 3,138 feet with top at 2,909 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1348-2400 GMT June 26, 1968
- - - - - 0000-0214 GMT June 27, 1968
Lapse time from first to last gravity reading - 12:26 hours, minutes
Logged Depth - - - - - 2,628.7 feet (D.F.)
Number of borehole gravity stations - - - - - 34
Number of borehole gravity readings - - - - - 53
Number of downhole gravity bases - - - - - 4
Number of intervals - - - - - 33
Largest interval - - - - - 119.0 feet
Smallest interval - - - - - 13.9 feet
Percent of time spent at gravity stations - - - 77 percent
Percent of time spent moving logging tool - - - 23 percent
Average station time spent leveling and
reading gravimeter - - - - - 10.9 minutes
Other references to survey -- Beyer (1971, 1976, 1977)
Datum for depth measurements -- surface casing flange (4.4 feet below former D.F.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, J. E. Schoellhamer

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: STANDARD OIL CO CALIFORNIA #54-33D 3215 FT
 LOCATION: 33-32S-24E (M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	0.0	4.4	1.374	0.0					
2	8.4	12.8	1.369	0.356	0.356	8.40	.04238	2.023	1
3	48.4	52.8	1.355	2.306	1.950	39.99	.04876	1.773	2
4	158.4	162.8	1.408	7.092	4.786	110.04	.04349	1.979	3
5	267.2	271.6	1.487	11.862	4.770	108.74	.04387	1.964	4
6	376.5	380.9	1.573	16.486	4.624	109.35	.04229	2.026	5
7	486.0	490.4	1.660	20.853	4.367	109.44	.03990	2.119	6
8	595.2	599.6	1.749	25.086	4.233	109.25	.03875	2.165	7
9	704.6	709.0	1.837	29.274	4.188	109.44	.03827	2.183	8
10	814.0	818.4	1.926	33.571	4.297	109.34	.03930	2.143	9
11	923.4	927.8	2.015	37.778	4.207	109.43	.03844	2.176	10
12	1032.9	1037.3	2.103	41.949	4.171	109.52	.03808	2.190	11
13	1142.2	1146.6	2.191	46.168	4.219	109.23	.03863	2.169	12
14	1251.6	1256.0	2.279	50.366	4.198	109.42	.03837	2.179	13
15	1361.0	1365.4	2.367	54.552	4.186	109.42	.03826	2.183	14
16	1470.1	1474.5	2.453	58.692	4.140	109.09	.03795	2.195	15
17	1579.6	1584.0	2.540	62.826	4.134	109.47	.03776	2.203	16
18	1689.1	1693.5	2.627	66.954	4.128	109.49	.03770	2.205	17
19	1798.3	1802.7	2.713	71.054	4.100	109.27	.03752	2.212	18
20	1907.8	1912.2	2.798	75.161	4.107	109.49	.03751	2.212	19
21	1997.7	2002.1	2.868	78.517	3.356	89.89	.03733	2.219	20
22	2015.1	2019.5	2.881	79.173	0.656	<u>17.35</u>	.03781	2.201	21
23	2101.2	2105.6	2.947	82.489	3.316	86.10	.03851	2.173	22
24	2120.0	2124.4	2.962	83.176	0.687	<u>18.83</u>	.03648	2.252	23
25	2235.8	2240.2	3.050	87.567	4.391	115.83	.03791	2.197	24
26	2354.8	2359.2	3.140	91.940	4.373	119.02	.03674	2.242	25
					1.614	<u>42.98</u>	.03755	2.210	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TDI: STANDARD OIL CO CALIFORNIA #54-33D 3215 FT
 LOCATION: 33-32S-24E(M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
27	2397.8	2402.2	3.173	93.554					
28	2445.9	2450.3	3.209	95.405	1.851	48.09	.03849	2.174	27
29	2473.8	2478.2	3.229	96.437	1.032	<u>27.94</u>	.03694	2.234	28
30	2509.6	2514.0	3.256	97.789	1.352	35.71	.03786	2.198	29
31	2527.5	2531.9	3.269	98.525	0.736	<u>17.91</u>	.04109	2.072	30
32	2591.3	2595.7	3.317	100.935	2.410	63.85	.03774	2.203	31
33	2610.3	2614.7	3.331	101.690	0.755	<u>19.02</u>	.03970	2.126	32
34	2624.3	2628.7	3.341	102.202	0.512	<u>13.93</u>	.03675	2.241	33

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. 104-33D
500' S & 1,050' E from W 1/4 corner, sec. 33, T.32 S., R.24 E. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

April 1958 3,291 feet (D.F.)

Log Runs

Electrical (90-3,290 feet)

Casing Record

14 1/2-inch surface casing cemented at 25 feet
8 5/8-inch casing run from surface and cemented at 3,110 feet
6 5/8-inch liner to 3,198 feet with top at 3,075 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1347-2400 GMT June 29, 1968
- - - - - 0000-0240 GMT June 30, 1968
Lapse time from first to last gravity reading - 12:53 hours, minutes
Logged Depth - - - - - 3,061.4 feet (D.F.)
Number of borehole gravity stations - - - - - 35
Number of borehole gravity readings - - - - - 53
Number of downhole gravity bases - - - - - 6
Number of intervals - - - - - 34
Largest interval - - - - - 164.3 feet
Smallest interval - - - - - 8.1 feet
Percent of time spent at gravity stations - - - 80 percent
Percent of time spent moving logging tool - - - 20 percent
Average station time spent leveling and
reading gravimeter - - - - - 11.7 minutes
Other references to survey -- Beyer (1971, 1976, 1977)
Datum for depth measurements -- surface casing flange (6.3 feet below former
derrick floor)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, J. E. Schoellhamer

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: STANDARD OIL CO CALIFORNIA #104-33D 3291 FT
 LOCATION: 33-325-24E(M.D.B.6M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
1	2	3	4	5	6	7	8	9	10	
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER	
1	0.0	6.3	1.422	0.0						
2	8.4	14.7	1.432	0.440	0.440	8.40	.05238	1.631	1	
3	78.1	84.4	1.502	3.704	3.264	69.72	.04682	1.849	2	
4	113.2	119.5	1.540	5.228	1.524	35.11	.04341	1.983	3	
5	183.3	189.6	1.618	8.135	2.907	70.04	.04150	2.057	4	
6	242.2	248.5	1.684	10.789	2.654	58.96	.04501	1.920	5	
7	405.8	412.1	1.864	17.887	7.098	163.61	.04338	1.983	6	
8	569.9	576.2	2.037	24.120	6.233	164.10	.03798	2.195	7	
9	733.9	740.2	2.202	30.250	6.130	164.01	.03738	2.218	8	
10	898.0	904.3	2.361	36.549	6.299	164.10	.03839	2.179	9	
11	1061.9	1068.2	2.513	42.918	6.369	163.86	.03887	2.160	10	
12	1225.9	1232.2	2.658	49.211	6.293	163.96	.03838	2.179	11	
13	1390.1	1396.4	2.799	55.405	6.194	164.25	.03771	2.205	12	
14	1554.1	1560.4	2.935	61.608	6.203	163.96	.03783	2.200	13	
15	1718.1	1724.4	3.066	67.802	6.194	164.06	.03775	2.203	14	
16	1882.3	1888.6	3.193	74.045	6.243	164.15	.03803	2.192	15	
17	2046.1	2052.4	3.317	80.149	6.104	163.81	.03726	2.222	16	
18	2210.2	2216.5	3.437	86.255	6.106	164.10	.03721	2.224	17	
19	2374.3	2380.6	3.554	92.363	6.108	164.11	.03722	2.224	18	
20	2428.8	2435.1	3.592	94.452	2.089	54.46	.03836	2.179	19	
21	2451.8	2458.1	3.609	95.281	0.829	23.06	.03595	2.273	20	
22	2538.3	2544.6	3.668	98.522	3.241	86.50	.03747	2.214	21	
23	2614.8	2621.1	3.721	101.359	2.837	76.51	.03708	2.229	22	
24	2673.5	2679.8	3.761	103.513	2.154	58.63	.03674	2.242	23	
25	2684.2	2690.5	3.768	103.923	0.410	10.72	.03825	2.183	24	
26	2712.3	2718.6	3.787	104.984	1.061	28.11	.03774	2.203	25	
					1.793	48.37	.03707	2.229	26	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: STANDARD OIL CO CALIFORNIA #104-33D 3291 FT
 LOCATION: 33-325-24E (M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
27	2760.7	2767.0	3.819	106.777					
28	2768.8	2775.1	3.825	107.121	0.344	<u>8.10</u>	.04247	2.018	27
29	2819.2	2825.5	3.858	109.011	1.890	<u>50.45</u>	.03746	2.214	28
30	2869.2	2875.5	3.891	110.913	1.902	<u>49.94</u>	.03809	2.189	29
31	2924.3	2930.6	3.927	112.986	2.073	<u>55.13</u>	.03760	2.208	30
32	2968.3	2974.6	3.956	114.610	1.624	<u>44.02</u>	.03689	2.236	31
33	3012.2	3018.5	3.984	116.235	1.625	<u>43.89</u>	.03702	2.231	32
34	3024.3	3030.6	3.992	116.688	0.453	<u>12.15</u>	.03728	2.221	33
35	3055.1	3061.4	4.012	117.782	1.094	<u>30.80</u>	.03552	2.290	34

WELL INFORMATION

Operator, Lease, Well, Location

Mobil Oil Corp. Julius 5
980' N & 620' E from SW corner, sec. 34, T.32 S., R.24 E. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

November 1945 2,871 feet (K.B.)

Log Runs

Electrical (50-2,871 feet)

Casing Record

8 5/8-inch casing landed at 2,871 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1355-2400 GMT July 2, 1968
- - - - - 0000-0153 GMT July 3, 1968
Lapse time from first to last gravity reading - 11:58 hours, minutes
Logged Depth - - - - - 2,824.9 feet (K.B.)
Number of borehole gravity stations - - - - - 27
Number of borehole gravity readings - - - - - 42
Number of downhole gravity bases - - - - - 6
Number of intervals - - - - - 26
Largest interval - - - - - 232.9 feet
Smallest interval - - - - - 14.0 feet
Percent of time spent at gravity stations - - - 77 percent
Percent of time spent moving logging tool - - - 23 percent
Average station time spent leveling and
reading gravimeter - - - - - 13.2 minutes
Other references to survey -- Beyer (1971, 1976, 1977)
Datum for depth measurements -- surface casing flange (approximately 6.3 feet
below former K.B.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, J. E. Schoellhamer
Remarks -- original K.B. elevation believed to be too high by about 13 feet

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MOBIL OIL CORP JULIUS #5 2871 FT
 LOCATION: 34-32S-24E(M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	0.0	6.3	1.362	0.0					
2	8.4	14.7	1.363	0.312	0.312	8.40	.03714	2.228	1
3	140.2	146.5	1.453	6.293	5.981	131.76	.04539	1.905	2
4	319.7	326.0	1.629	14.286	7.993	179.56	.04451	1.939	3
5	552.7	559.0	1.856	23.209	8.923	232.94	.03831	2.182	4
6	632.3	638.6	1.932	26.293	3.084	79.61	.03874	2.165	5
7	796.4	802.7	2.086	32.602	6.309	164.12	.03844	2.176	6
8	960.3	966.6	2.236	38.958	6.356	163.91	.03878	2.163	7
9	1124.4	1130.7	2.384	45.317	6.359	164.12	.03875	2.164	8
10	1288.4	1294.7	2.529	51.605	6.288	163.98	.03835	2.180	9
11	1452.4	1458.7	2.671	57.911	6.306	163.98	.03846	2.176	10
12	1616.5	1622.8	2.812	64.190	6.279	164.08	.03827	2.183	11
13	1780.4	1786.7	2.950	70.440	6.250	163.92	.03813	2.188	12
14	1944.6	1950.9	3.086	76.551	6.111	164.25	.03721	2.224	13
15	2108.6	2114.9	3.220	82.700	6.149	164.00	.03749	2.213	14
16	2272.6	2278.9	3.352	88.779	6.079	164.01	.03706	2.230	15
17	2461.7	2468.0	3.503	95.860	7.081	189.05	.03746	2.214	16
18	2483.8	2490.1	3.520	96.679	0.819	<u>22.16</u>	.03696	2.234	17
19	2551.8	2558.1	3.574	99.247	2.568	67.92	.03781	2.200	18
20	2620.8	2627.1	3.628	101.813	2.566	69.02	.03718	2.225	19
21	2634.8	2641.1	3.638	102.304	0.491	<u>14.02</u>	.03502	2.309	20
22	2671.8	2678.1	3.667	103.676	1.372	<u>37.01</u>	.03707	2.229	21
23	2720.3	2726.6	3.705	105.401	1.725	48.49	.03557	2.288	22
24	2756.9	2763.2	3.733	106.766	1.365	<u>36.63</u>	.03726	2.221	23
25	2774.8	2781.1	3.747	107.382	0.616	<u>17.89</u>	.03443	2.332	24
26	2802.9	2809.2	3.768	108.451	1.069	<u>28.04</u>	.03812	2.188	25
27	2818.6	2824.9	3.780	109.086	0.635	<u>15.78</u>	.04024	2.105	26

WELL INFORMATION

Operator, Lease, Well, Location

Mobil Oil Corp. Fried 9A
162' S & 679' E from NW corner of the S 1/2 of E 1/2 of W 1/2, sec. 25,
T.12 N., R.24 W. (S.B.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

November 1940 2,837 feet (D.F.)

Log Runs

Electrical (210-2,839 feet)

Casing Record

13 3/8-inch surface casing cemented at 206 feet
8 5/8-inch casing run from surface to 2,657 feet
6 5/8-inch liner to 2,875 feet with top at 2,632 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1418-2316 GMT July 4, 1968
Lapse time from first to last gravity reading - 8:58 hours, minutes
Logged Depth - - - - - 2,119.7 (D.F.)
Number of borehole gravity stations - - - - - 21
Number of borehole gravity readings - - - - - 33
Number of downhole gravity bases - - - - - 5
Number of intervals - - - - - 20
Largest interval - - - - - 170.6 feet
Smallest interval - - - - - 19.9 feet
Percent of time spent at gravity stations - - - 81 percent
Percent of time spent moving logging tool - - - 19 percent
Average station time spent leveling and
reading gravimeter - - - - - 13.2 minutes
Other references to survey -- Beyer (1971)
Datum for depth measurements -- surface casing flange (2.8 feet below former
derrick floor)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, J. E. Schoellhamer

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MOBIL OIL CORP FRIED (ALFORD) #9 3059 FT
 LOCATION: 25-12N-24W(S.B.B.M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER	
1	2	3	4	5	6	7	8	9	10	
1	0.0	2.8	1.390	0.0						
2	8.4	11.2	1.378	0.246	0.246	8.40	.02929	2.535	1	
3	176.1	178.9	1.435	7.591	7.345	167.68	.04380	1.967	2	
4	340.1	342.9	1.608	14.807	7.216	163.99	.04400	1.959	3	
5	504.1	506.9	1.778	21.253	6.446	164.00	.03930	2.143	4	
6	668.4	671.2	1.941	27.591	6.338	164.35	.03856	2.172	5	
7	832.6	835.4	2.098	33.960	6.369	164.14	.03880	2.162	6	
8	996.3	999.1	2.251	40.254	6.294	163.74	.03844	2.176	7	
9	1160.4	1163.2	2.399	46.557	6.303	164.13	.03840	2.178	8	
10	1185.2	1188.0	2.421	47.527	0.970	<u>24.74</u>	.03921	2.146	9	
11	1324.2	1327.0	2.544	52.775	5.248	139.02	.03775	2.203	10	
12	1488.5	1491.3	2.686	58.935	6.160	164.27	.03750	2.213	11	
13	1652.3	1655.1	2.826	65.057	6.122	163.86	.03736	2.218	12	
14	1822.9	1825.7	2.968	71.516	6.459	170.58	.03786	2.199	13	
15	1842.8	1845.6	2.985	72.256	0.740	<u>19.93</u>	.03713	2.227	14	
16	1895.7	1898.5	3.029	74.231	1.975	<u>52.92</u>	.03732	2.220	15	
17	1955.7	1958.5	3.078	76.514	2.283	59.93	.03809	2.189	16	
18	1988.8	1991.6	3.105	77.687	1.173	33.12	.03542	2.294	17	
19	2056.8	2059.6	3.160	80.175	2.488	68.05	.03656	2.249	18	
20	2089.7	2092.5	3.187	81.406	1.231	<u>32.90</u>	.03742	2.216	19	
21	2116.9	2119.7	3.208	82.490	1.084	<u>27.11</u>	.03999	2.115	20	

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. A.P.C. 76
720' N & 730' E from SW corner, sec. 36, T.12 N., R.24 W. (S.B.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

September 1954 2,650 feet (D.F.); deepened to 3,525 feet (D.F.) in
August 1959 PBD 3,400 feet (D.F.)

Log Runs

Electrical (158-3,519 feet)

Casing Record

20-inch surface casing cemented at 24 feet
13 3/8-inch casing cemented at 158 feet
8 5/8-inch casing cemented at 2,495 feet
6 5/8-inch liner to 3,398 feet with top at 2,465 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1624-2400 GMT November 13, 1969
 - - - - - 0000-0405 GMT November 14, 1969
Lapse time from first to last gravity reading - 11:41 hours, minutes
Logged Depth - - - - - 2,402.9 feet (D.F.)
Number of borehole gravity stations - - - - - 35
Number of borehole gravity readings - - - - - 52
Number of downhole gravity bases - - - - - 5
Number of intervals - - - - - 34
Largest interval - - - - - 164.5 feet
Smallest interval - - - - - 10.1 feet
Percent of time spent at gravity stations - - - 62 percent
Percent of time spent moving logging tool - - - 38 percent
Average station time spent leveling and
 reading gravimeter - - - - - 8.3 minutes
Other references to survey -- Beyer (1971, 1976, 1977, 1980)
Datum for depth measurements -- surface casing flange (4.9 feet below former D.F.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, D. Seals, J. E. Schoellhamer,
 T. H. McCulloh

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S. O. CO CALIF ANZA PACIFIC CORP #76 3525 FT
 LOCATION: 36-12N-24W(S.B.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	0.0	4.9	1.561	0.0					
2	8.4	13.3	1.567	0.423	0.423	8.40	.05036	1.711	1
3	101.4	106.3	1.651	4.236	3.813	92.96	.04102	2.076	2
4	265.9	270.8	1.845	10.945	6.709	164.52	.04078	2.095	3
5	379.3	384.2	1.964	15.352	4.407	113.43	.03885	2.161	4
6	429.4	434.3	2.016	17.262	1.910	50.09	.03813	2.189	5
7	506.6	511.5	2.094	20.011	2.749	77.21	.03560	2.288	6
8	586.1	591.0	2.174	22.873	2.862	79.52	.03599	2.272	7
9	596.3	601.2	2.184	23.231	0.358	<u>10.13</u>	.03534	2.298	8
10	624.2	629.1	2.212	24.184	0.953	27.93	.03412	2.346	9
11	673.7	678.6	2.262	25.931	1.747	49.48	.03531	2.299	10
12	693.0	697.9	2.281	26.722	0.791	<u>19.29</u>	.04101	2.076	11
13	733.8	738.7	2.321	28.184	1.462	<u>40.85</u>	.03579	2.280	12
14	757.5	762.4	2.345	29.115	0.931	23.65	.03937	2.140	13
15	840.2	845.1	2.426	32.437	3.322	82.70	.04017	2.109	14
16	860.8	865.7	2.446	33.205	0.768	20.65	.03719	2.225	15
17	872.8	877.7	2.458	33.679	0.474	<u>12.03</u>	.03940	2.139	16
18	894.2	899.1	2.479	34.462	0.783	<u>21.35</u>	.03667	2.246	17
19	921.7	926.6	2.506	35.746	1.284	<u>27.49</u>	.04671	1.853	18
20	1003.4	1008.3	2.585	39.712	3.966	81.71	.04854	1.781	19
21	1085.3	1090.2	2.663	43.477	3.765	81.95	.04594	1.883	20
22	1167.6	1172.5	2.742	47.134	3.657	82.31	.04443	1.942	21
23	1249.4	1254.3	2.819	50.807	3.673	81.71	.04495	1.921	22
24	1331.8	1336.7	2.896	54.658	3.851	82.40	.04674	1.852	23
25	1413.4	1418.3	2.971	58.383	3.725	81.61	.04564	1.894	24
26	1577.6	1582.5	3.121	65.341	6.958	164.22	.04237	2.022	25
					6.797	164.01	.04144	2.059	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S. O. CO CALIF ANZA PACIFIC CORP #76 3525 FT
 LOCATION: 36-12N-24W(S.B.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
27	1741.6	1746.5	3.268	72.138	1.598	42.51	.03759	2.209	27
28	1784.1	1789.0	3.306	73.736	4.090	99.76	.04100	2.076	28
29	1883.9	1888.8	3.394	77.826	1.025	<u>29.51</u>	.03473	2.321	29
30	1913.4	1918.3	3.419	78.851	6.238	157.03	.03972	2.126	30
31	2070.4	2075.3	3.555	85.089	3.517	83.61	.04206	2.034	31
32	2154.0	2158.9	3.626	88.606	3.434	80.21	.04281	2.005	32
33	2234.2	2239.1	3.694	92.040	3.568	81.91	.04356	1.975	33
34	2316.1	2321.0	3.763	95.608	3.572	81.91	.04361	1.973	34
35	2398.0	2402.9	3.831	99.180					

WELL INFORMATION

Operator, Lease, Well, Location

Texaco Inc. Fee 28
3,022' N & 1,439' W from SE corner, sec. 32, T.32 S., R.24 E. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

November 1937 3,278 feet (D.F.)

Log Runs

Electrical (100-3,240 feet)

Casing Record

8 5/8-inch casing cemented at 3,116 feet
5-inch liner to 3,221 feet with top at 3,103 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 2310-2400 GMT November 15, 1969
- - - - - 0000-0348, 1555-2148 GMT November 16, 1969
Lapse time from first to last gravity reading - 10:31 hours, minutes
Logged Depth - - - - - 3,089.6 feet (D.F.)
Number of borehole gravity stations - - - - - 31
Number of borehole gravity readings - - - - - 50
Number of downhole gravity bases - - - - - 5
Number of intervals - - - - - 30
Largest interval - - - - - 328.3 feet
Smallest interval - - - - - 8.7 feet
Percent of time spent at gravity stations - - - 55 percent
Percent of time spent moving logging tool - - - 45 percent
Average station time spent leveling and
reading gravimeter - - - - - 7.0 minutes
Other references to survey -- Beyer (1971)
Datum for depth measurements -- surface casing flange (approximately 7 feet
below former D.F.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, D. Seals

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: TEXACO INC AMERICAN OILFIELDS FEE #28 3272 FT
 LOCATION: 32-32S-24E (M.D.B.M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	Δg/ΔZ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	0.0	7.0	1.427	0.0	0.336	8.40	.04000	2.116	1
2	8.4	15.4	1.416	0.336	2.299	50.41	.04561	1.896	2
3	58.8	65.8	1.359	2.635	7.631	164.27	.04645	1.863	3
4	223.1	230.1	1.269	10.266	7.122	163.81	.04348	1.980	4
5	386.9	393.9	1.238	17.388	0.749	17.06	.04390	1.963	5
6	403.9	410.9	1.237	18.137	0.337	<u>8.72</u>	.03865	2.169	6
7	412.7	419.7	1.237	18.474	1.762	45.40	.03881	2.162	7
8	458.1	465.1	1.237	20.236	3.422	92.88	.03684	2.239	8
9	550.9	557.9	1.243	23.658	5.999	163.82	.03662	2.248	9
10	714.8	721.8	1.271	29.657	6.109	163.96	.03726	2.223	10
11	878.7	885.7	1.314	35.766	2.218	57.12	.03883	2.161	11
12	935.8	942.8	1.331	37.984	2.026	52.03	.03894	2.157	12
13	987.9	994.9	1.348	40.010	2.068	55.02	.03759	2.210	13
14	1042.9	1049.9	1.367	42.078	12.338	328.28	.03758	2.210	14
15	1371.2	1378.2	1.496	54.416	6.254	164.12	.03811	2.189	15
16	1535.3	1542.3	1.568	60.670	6.336	163.96	.03864	2.168	16
17	1699.3	1706.3	1.643	67.006	6.197	164.02	.03778	2.202	17
18	1863.3	1870.3	1.720	73.203	6.250	164.02	.03811	2.189	18
19	2027.3	2034.3	1.799	79.453	6.252	164.01	.03812	2.188	19
20	2191.3	2198.3	1.879	85.705	6.104	164.12	.03719	2.225	20
21	2355.4	2362.4	1.959	91.809	6.141	164.16	.03741	2.216	21
22	2519.6	2526.6	2.040	97.950	6.233	164.07	.03799	2.193	22
23	2683.7	2690.7	2.121	104.183	1.021	<u>27.48</u>	.03715	2.226	23
24	2711.1	2718.1	2.135	105.204	1.087	<u>29.05</u>	.03742	2.215	24
25	2740.2	2747.2	2.149	106.291	0.406	<u>11.04</u>	.03678	2.241	25
26	2751.2	2758.2	2.155	106.697	1.306	<u>35.93</u>	.03635	2.257	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: TEXACO INC AMERICAN OILFIELDS FEE #28 3272 FT
 LOCATION: 32-325-24E (M.D.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA								BOREHOLE INTERVAL DATA	
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
27	2787.2	2794.2	2.172	108.003					
28	2803.9	2810.9	2.181	108.602	0.599	<u>16.75</u>	.03576	2.240	27
29	2903.1	2910.1	2.229	112.392	3.790	99.17	.03822	2.144	28
30	3011.4	3018.4	2.282	116.583	4.191	108.29	.03870	2.165	29
31	3082.6	3089.6	2.317	119.226	2.643	71.28	.03708	2.229	30

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TDI: SHELL OIL CO. VEDDER 431 2058 FT (PBD 1850 FT)
 LOCATION: 9-27S-28E MT. POSO OIL FIELD KERN CO. CAL.

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER

1	8.4	16.3	1.042	0.0	56.293	1283.79	.04385	1.965	1
2	1292.2	1300.1	-0.841	56.293	0.712	17.90	.03978	2.125	2
3	1310.1	1318.0	-0.853	57.005	0.818	18.86	.04337	1.984	3
4	1329.0	1336.9	-0.864	57.823	10.029	238.33	.04208	2.034	4
5	1567.3	1575.2	-1.001	67.852	1.073	27.25	.03938	2.140	5
6	1594.6	1602.5	-1.015	68.925	0.838	21.85	.03835	2.180	6
7	1616.4	1624.3	-1.027	69.763	0.510	12.80	.03984	2.122	7
8	1629.2	1637.1	-1.034	70.273	0.862	22.06	.03908	2.152	8
9	1651.3	1659.2	-1.045	71.135	1.232	30.82	.03997	2.117	9
10	1682.1	1690.0	-1.061	72.367	0.381	9.91	.03845	2.177	10
11	1692.0	1699.9	-1.067	72.748	0.870	21.02	.04139	2.062	11
12	1713.0	1720.9	-1.077	73.618	0.476	13.10	.03634	2.259	12
13	1726.1	1734.0	-1.084	74.094	0.476	11.75	.04051	2.096	13
14	1737.9	1745.8	-1.090	74.570	0.563	14.84	.03794	2.197	14
15	1752.7	1760.6	-1.097	75.133	1.049	27.25	.03850	2.175	15
16	1780.0	1787.9	-1.111	76.182	0.666	16.08	.04142	2.061	16
17	1796.1	1804.0	-1.119	76.848	0.219	5.91	.03705	2.231	17
18	1802.0	1809.9	-1.122	77.067	0.184	6.01	.03062	2.483	18
19	1808.0	1815.9	-1.125	77.251	0.753	18.93	.03978	2.125	19
20	1826.9	1834.8	-1.134	78.004					

WELL INFORMATION

Operator, Lease, Well, Location

Gulf Oil Exploration & Production Co. 110-5
725' N & 950' W from E 1/4 corner, sec. 30, T.26 S., R.21 E. (M.D.B.& M.)
Lost Hills oil field
Kern County, California

Date Completed and Total Depth

September 1969 905 feet (K.B.) PBD 844 feet (K.B.)

Log Runs

Induction-electrical (100-904 feet)
Density (30-904 feet)

Casing Record

7-inch 23# casing cemented at 849 feet
7-inch 26# liner to 891 feet with top at 849 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1624-1912 GMT June 13, 1972
Lapse time from first to last gravity reading - 2:48 hours, minutes
Logged Depth - - - - - 465.1 feet (K.B.)
Number of borehole gravity stations - - - - - 9
Number of borehole gravity readings - - - - - 12
Number of downhole gravity bases - - - - - 3
Number of intervals - - - - - 8
Largest interval - - - - - 91.6 feet
Smallest interval - - - - - 10.7 feet
Percent of time spent at gravity stations - - - 56 percent
Percent of time spent moving logging tool - - - 44 percent
Average station time spent leveling and
reading gravimeter - - - - - 7.8 minutes
Other references to survey -- none
Datum for depth measurements -- surface casing flange (11.9 feet below former K.B.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutson, K. A. Pisciotto
Remarks -- Top of very viscous low-gravity oil encountered at 458 feet. Narrow
clearance between logging tool and casing prevented tool from going down into
the viscous oil on a wireline. Intended survey depth was 844 feet (K.B.)

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: GULF OIL CORP. #110-5 905 FT
 LOCATION: 30-26S-22E(M.D.B.&M.) LOST HILLS OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	0.0	13.0	0.334	0.0	0.292	<u>10.69</u>	.02731	2.612	1
2	10.7	23.7	0.326	0.292	3.415	77.46	.04408	1.956	2
3	88.2	101.2	0.269	3.707	2.918	<u>68.88</u>	.04237	2.023	3
4	157.0	170.0	0.220	6.625	2.033	41.60	.04887	1.768	4
5	198.6	211.6	0.191	8.658	2.837	<u>64.01</u>	.04432	1.946	5
6	262.6	275.6	0.148	11.495	3.784	91.58	.04132	2.064	6
7	354.2	367.2	0.091	15.279	3.537	80.22	.04409	1.955	7
8	434.4	447.4	0.044	18.816	0.815	<u>17.71</u>	.04602	1.880	8
9	452.1	465.1	0.034	19.631					A

WELL INFORMATION

Operator, Lease, Well, Location

ARCO Oil and Gas Company Leutholtz A-20
1,582' S & 552' E from NW corner, sec. 72, T.11 N., R.23 W. (S.B.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

May 1956 3,330 feet (K.B.)

Log Runs

Electrical (70-3,324 feet); induction (3,081-3,324 feet); gamma ray-
neutron (3,070-3,327 feet)

Casing Record

13 3/8-inch surface casing cemented at 37 feet
8 5/8-inch casing run from surface and cemented at 3,078 feet
6 5/8-inch liner to 3,328 feet with top at 3,060 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1459-2400 GMT June 15, 1972
- - - - - 0000-0037 GMT June 16, 1972
Lapse time from first to last gravity reading - 9:38 hours, minutes
Logged Depth - - - - - 2,977.9 feet (K.B.)
Number of borehole gravity stations - - - - - 37
Number of borehole gravity readings - - - - - 47
Number of downhole gravity bases - - - - - 5
Number of intervals - - - - - 36
Largest interval - - - - - 200.6 feet
Smallest interval - - - - - 9.9 feet
Percent of time spent at gravity stations - - - 50 percent
Percent of time spent moving logging tool - - - 50 percent
Average station time spent leveling and
reading gravimeter - - - - - 6.2 minutes
Other references to survey -- Beyer (1976, 1977, 1980)
Datum for depth measurements -- surface casing flange (6.5 feet below former K.B.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: ATLANTIC RICHFIELD CO LEUTHOLTZ #A-20 3330 FT
 LOCATION: 22-11N-23W(S.B.B.6M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
1	2	3	4	5	6	7	8	9	10	
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER	
1	0.0	9.4	2.049	0.0						
2	9.8	19.2	2.076	0.357	0.357	<u>9.79</u>	.03648	2.253	1	
3	165.4	174.8	2.415	7.028	6.671	155.65	.04286	2.004	2	
4	315.5	324.9	2.680	13.308	6.280	150.01	.04186	2.043	3	
5	330.4	339.8	2.705	13.909	0.601	<u>14.98</u>	.04011	2.111	4	
6	347.6	357.0	2.733	14.493	0.584	<u>17.13</u>	.03411	2.346	5	
7	359.3	368.7	2.752	14.975	0.482	<u>11.75</u>	.04102	2.076	6	
8	391.4	400.8	2.804	16.128	1.153	<u>32.09</u>	.03593	2.275	7	
9	421.3	430.7	2.852	17.305	1.177	<u>29.88</u>	.03938	2.140	8	
10	507.2	516.6	2.985	20.496	3.191	85.93	.03714	2.228	9	
11	633.6	643.0	3.175	24.720	4.224	126.44	.03341	2.374	10	
12	714.4	723.8	3.293	27.361	2.641	80.73	.03272	2.401	11	
13	736.6	746.0	3.325	28.100	0.739	<u>22.25</u>	.03321	2.381	12	
14	777.6	787.0	3.384	29.379	1.279	<u>41.02</u>	.03118	2.461	13	
15	821.4	830.8	3.446	30.852	1.473	<u>43.80</u>	.03363	2.365	14	
16	834.6	844.0	3.465	31.228	0.376	<u>13.14</u>	.02861	2.561	15	
17	881.6	891.0	3.530	32.784	1.556	<u>46.98</u>	.03312	2.385	16	
18	1020.5	1029.9	3.722	37.852	5.068	138.91	.03648	2.253	17	
19	1093.3	1102.7	3.820	40.456	2.604	72.84	.03575	2.282	18	
20	1137.1	1146.5	3.879	41.862	1.406	<u>43.77</u>	.03212	2.424	19	
21	1184.1	1193.5	3.942	43.494	1.632	<u>47.06</u>	.03468	2.323	20	
22	1194.0	1203.4	3.955	43.743	0.249	<u>9.87</u>	.02521	2.694	21	
23	1294.1	1303.5	4.086	47.797	4.054	100.10	.04050	2.096	22	
24	1395.3	1404.7	4.217	51.905	4.108	101.19	.04060	2.092	23	
25	1494.3	1503.7	4.344	55.951	4.046	98.99	.04087	2.081	24	
26	1545.0	1554.4	4.408	58.013	2.062	<u>50.70</u>	.04057	2.089	25	
					2.036	<u>49.75</u>	.04092	2.079	26	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: ATLANTIC RICHFIELD CO LEUTHOLTZ #A-20 3330 FT
 LOCATION: 22-11N-23W(S.B.B.M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA								BOREHOLE INTERVAL DATA	
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
27	1594.8	1604.1	4.471	60.049	2.020	<u>49.68</u>	.04066	2.089	27
28	1644.4	1653.8	4.533	62.069	8.042	199.78	.04025	2.105	28
29	1844.2	1853.6	4.779	70.111	8.379	200.58	.04177	2.045	29
30	2044.8	2054.2	5.020	78.490	8.292	199.29	.04161	2.052	30
31	2244.1	2253.5	5.255	86.782	8.277	199.88	.04141	2.059	31
32	2444.0	2453.4	5.484	95.059	8.246	200.29	.04117	2.069	32
33	2644.3	2653.6	5.709	103.305	4.058	100.39	.04042	2.098	33
34	2744.6	2754.0	5.820	107.363	4.010	99.79	.04018	2.107	34
35	2844.4	2853.8	5.929	111.373	3.922	98.70	.03974	2.125	35
36	2943.1	2952.5	6.036	115.295	1.056	<u>25.42</u>	.04154	2.054	36
37	2968.5	2977.9	6.064	116.351					

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S. O. CO. CALIF ANZA PACIFIC CORP #4-4 2100 FT
 LOCATION: 36-12N-24W(S.B.B.&M.) MIDWAY-SUNSET OIL FIELD KERN CO CALIF.

BOREHOLE STATION DATA					BOREHOLE INTERVAL DATA				
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	0.0	0.1	1.508	0.0					
2	10.2	10.3	1.519	0.350	0.350	10.20	.03432	2.338	1
3	23.9	24.0	1.534	1.014	0.664	13.69	.04851	1.783	2
4	351.6	351.7	1.898	15.136	14.122	327.67	.04310	1.995	3
5	423.7	423.8	1.979	18.100	2.964	72.13	.04109	2.073	4
6	679.1	679.2	2.265	27.558	9.458	255.37	.03704	2.232	5
7	1007.1	1007.2	2.622	39.927	12.369	328.01	.03771	2.205	6
8	1194.1	1194.2	2.819	46.825	6.898	187.01	.03689	2.237	7
9	1214.2	1214.3	2.840	47.609	0.784	20.11	.03898	2.155	8
10	1335.2	1335.3	2.966	52.157	4.548	121.00	.03759	2.210	9

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. 3-1
193' S and 1,130' E from NW corner, sec. 29, T.26 S., R.21 E. (M.D.B.& M.)
Lost Hills oil field
Kern County, California

Date Completed and Total Depth

October 1947 2,680 feet (D.F.)

Log Runs

Electrical (20-2,680 feet)

Casing Record

14-inch surface casing cemented at 19 feet
7-inch 20# casing run from surface and cemented at 2,340 feet
5 1/2-inch casing to 2,678 feet with top at 2,305 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 0014-0352 GMT June 20, 1972
Lapse time from first to last gravity reading - 3:38 hours, minutes
Logged Depth - - - - - 2,217.6 feet (D.F.)
Number of borehole gravity stations - - - - - 19
Number of borehole gravity readings - - - - - 23
Number of downhole gravity bases - - - - - 3
Number of intervals - - - - - 18
Largest interval - - - - - 268.0 feet
Smallest interval - - - - - 31.3 feet
Percent of time spent at gravity stations - - - 61 percent
Percent of time spent moving logging tool - - - 39 percent
Average station time spent leveling and
reading gravimeter - - - - - 5.8 minutes
Other references to survey -- none
Datum for depth measurements -- surface casing flange (3.1 feet below former D.F.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S. O. CO. CALIF #3-1 2680 FT
 LOCATION: 29-265-21E (M.D.B.&M.) LOST HILLS OIL FIELD KERN CO CALIF.

BOREHOLE STATION DATA								BOREHOLE INTERVAL DATA	
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	0.0	3.1	0.329	0.0					
2	10.7	13.8	0.325	0.296	0.296	10.69	.02770	2.597	1
3	266.7	269.8	0.239	11.748	11.452	255.98	.04474	1.930	2
4	534.7	537.8	0.169	23.074	11.326	267.99	.04226	2.027	3
5	706.7	709.8	0.129	30.308	7.234	172.04	.04205	2.036	4
6	750.9	754.0	0.119	32.118	1.810	<u>44.23</u>	.04092	2.080	5
7	893.6	896.7	0.089	38.151	6.033	142.70	.04228	2.027	6
8	997.6	1000.7	0.068	42.904	4.753	103.98	.04571	1.893	7
9	1125.8	1128.9	0.042	48.505	5.601	128.24	.04368	1.972	8
10	1265.7	1268.8	0.015	54.899	6.394	139.81	.04573	1.892	9
11	1331.7	1334.8	0.002	57.877	2.978	66.06	.04508	1.917	10
12	1363.0	1366.1	-0.004	59.182	1.305	<u>31.30</u>	.04168	2.050	11
13	1475.6	1478.7	-0.025	63.816	4.634	112.57	.04117	2.071	12
14	1605.6	1608.7	-0.049	69.180	5.364	130.03	.04125	2.067	13
15	1745.5	1748.6	-0.075	75.157	5.977	139.91	.04272	2.010	14
16	1939.5	1942.6	-0.110	83.643	8.486	194.00	.04374	1.970	15
17	2019.1	2022.2	-0.124	86.961	3.318	79.53	.04172	2.049	16
18	2114.5	2117.6	-0.141	91.061	4.100	95.40	.04298	2.000	17
19	2214.5	2217.6	-0.159	95.365	4.304	100.09	.04300	1.999	18

WELL INFORMATION

Operator, Lease, Well, Location

National Aeronautics & Space Administration Ames Research Center 10-1
3,300' S & 450' W from NE corner, sec. 10, T.6 S., R.2 W. (M.D.B.& M.)
Ames Research Center
Mountain View, California

Date Completed and Total Depth

March 1973 1,427 feet (G.L.)

Log Runs

Induction-electrical (195-1,427 feet)
Density (195-1,426 feet)

Casing Record

unknown

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 0325-0735 GMT April 12, 1973
- - - - - 1423-1916 GMT April 13, 1973
Lapse time from first to last gravity reading - 9:03 hours, minutes
Logged Depth - - - - - 1,342.4 (G.L.)
Number of borehole gravity stations - - - - - 32
Number of borehole gravity readings - - - - - 40
Number of downhole gravity bases - - - - - 3
Number of intervals - - - - - 31
Largest interval - - - - - 140.9 feet
Smallest interval - - - - - 9.8 feet
Percent of time spent at gravity stations - - - 65 percent
Percent of time spent moving logging tool - - - 35 percent
Average station time spent leveling and
reading gravimeter - - - - - 8.8 minutes
Other references to survey -- Beyer (1976, 1977)
Datum for depth measurements -- surface casing flange (1.5 feet below G.L.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clustom, K. A. Pisciotto

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: NASA AMES RES. CEN. #10-1 1420 FT
 LOCATION: 10-65-2W AMES RES. CEN. MOFFETT FIELD, CALIF.

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	TERRAIN CORRECTION RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g / \Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
1	0.0	1.5	1.713	0.0	0.566	<u>15.50</u>	.03651	2.252	1
2	15.5	17.0	1.725	0.566	0.660	<u>15.87</u>	.04158	2.054	2
3	31.4	32.9	1.737	1.226	0.579	<u>14.01</u>	.04133	2.063	3
4	45.4	46.9	1.748	1.805	0.580	<u>15.18</u>	.03820	2.186	4
5	60.6	62.1	1.758	2.385	0.653	<u>15.26</u>	.04280	2.006	5
6	75.8	77.3	1.769	3.038	0.633	<u>14.97</u>	.04229	2.026	6
7	90.8	92.3	1.779	3.671	0.502	<u>14.59</u>	.03440	2.335	7
8	105.4	106.9	1.788	4.173	1.519	<u>30.27</u>	.05018	1.717	8
9	135.6	137.1	1.805	5.692	1.214	29.26	.04149	2.058	9
10	164.9	166.4	1.821	6.906	1.745	<u>46.18</u>	.03779	2.202	10
11	211.1	212.6	1.841	8.651	0.469	<u>9.75</u>	.04810	1.799	11
12	220.8	222.3	1.845	9.120	1.715	<u>41.79</u>	.04104	2.075	12
13	262.6	264.1	1.861	10.835	1.320	33.46	.03944	2.137	13
14	296.1	297.6	1.872	12.155	3.848	97.67	.03940	2.139	14
15	393.8	395.3	1.900	16.003	3.188	83.82	.03803	2.193	15
16	477.6	479.1	1.922	19.191	0.911	<u>19.13</u>	.04762	1.818	16
17	496.7	498.2	1.927	20.102	5.542	140.93	.03933	2.142	17
18	637.6	639.1	1.960	25.644	0.740	<u>17.05</u>	.04339	1.983	18
19	654.7	656.2	1.963	26.384	1.448	<u>38.20</u>	.03791	2.198	19
20	692.9	694.4	1.972	27.832	0.879	<u>21.78</u>	.04035	2.102	20
21	714.7	716.2	1.977	28.711	2.072	52.90	.03916	2.149	21
22	767.6	769.1	1.988	30.783	0.399	<u>10.71</u>	.03727	2.223	22
23	778.3	779.8	1.991	31.182	3.378	85.09	.03970	2.128	23
24	863.4	864.9	2.009	34.560	2.821	73.05	.03862	2.170	24
25	936.4	937.9	2.025	37.381	3.046	84.03	.03625	2.263	25
26	1020.4	1021.9	2.043	40.427	0.965	<u>23.98</u>	.04024	2.107	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: NASA AMES RES. CEN. #10-1 1420 FT
 LOCATION: 10-6S-2W AMES RES. CEN. MOFFETT FIELD, CALIF.

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
1	2	3	4	5	6	7	8	9	10	
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER	
27	1044.4	1045.9	2.048	41.392	4.019	110.84	.03626	2.263	27	
28	1155.3	1156.8	2.071	45.411	2.105	58.28	.03612	2.268	28	
29	1213.5	1215.0	2.083	47.516	0.828	<u>20.76</u>	.03989	2.121	29	
30	1234.3	1235.8	2.087	48.344	2.334	65.36	.03571	2.284	30	
31	1299.7	1301.2	2.101	50.678	1.469	<u>41.24</u>	.03563	2.287	31	
32	1340.9	1342.4	2.109	52.147						

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. O-2
1,946' W & 1,128' N of SE corner, sec. 26, T.32 S., R.23 E. (M.D.B.& M.)
Midway-Sunset oil field
Kern County, California

Date Completed and Total Depth

March 1975 1,321 feet (D.F.)

Log Runs

Dual induction-electrical, compensated neutron, borehole compensated sonic, compensated gamma-gamma with gamma ray and caliper (46-1,321 feet)

Casing Record

20-inch conductor cemented at 47 feet
10 3/4-inch casing run from surface and cemented at 1,006 feet
7-inch liner to 1,320 feet with top at 929 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1313-1818, 1955-2145 GMT June 11, 1975
Lapse time from first to last gravity reading - 6:55 hours, minutes
Logged Depth - - - - - 1,254.1 feet (D.F.)
Number of borehole gravity stations - - - - - 29
Number of borehole gravity readings - - - - - 39
Number of downhole gravity bases - - - - - 4
Number of intervals - - - - - 28
Largest interval - - - - - 195.5 feet
Smallest interval - - - - - 6.0 feet
Percent of time spent at gravity stations - - - 49 percent
Percent of time spent moving logging tool - - - 51 percent
Average station time spent leveling and
reading gravimeter - - - - - 5.2 minutes
Other references to survey -- Beyer (1976, 1977)
Datum for depth measurements -- surface casing flange (5.8 feet below former D.F.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto, J. W. Schmoker

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S.O.CO.CALIFORNIA C-2 1321 FT
 LOCATION: 26-325-23E MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER	
1	2	3	4	5	6	7	8	9	10	
1	0.0	5.8	1.667	0.0						
2	5.8	11.6	1.664	0.378	0.378	5.80	.06516	1.131	1	
3	178.4	184.2	1.508	7.805	7.427	172.63	.04302	1.998	2	
4	306.4	312.2	1.312	12.493	4.688	127.97	.03663	2.248	3	
5	405.1	410.9	1.148	16.607	4.114	98.75	.04166	2.051	4	
6	481.3	487.1	1.021	19.863	3.256	<u>76.15</u>	.04276	2.008	5	
7	499.3	505.0	0.992	20.646	0.783	<u>17.95</u>	.04362	1.974	6	
8	528.3	534.0	0.945	21.854	1.208	<u>29.00</u>	.04165	2.051	7	
9	723.8	729.6	0.642	30.502	8.648	195.53	.04423	1.950	8	
10	734.2	740.0	0.627	30.847	0.345	<u>10.40</u>	.03317	2.383	9	
11	794.2	800.0	0.540	33.474	2.627	<u>60.06</u>	.04374	1.969	10	
12	909.4	915.2	0.382	38.633	5.159	115.17	.04479	1.928	11	
13	979.9	985.7	0.290	41.378	2.745	<u>70.49</u>	.03894	2.157	12	
14	1009.0	1014.8	0.253	42.375	0.997	<u>29.12</u>	.03424	2.341	13	
15	1018.8	1024.5	0.241	42.696	0.321	<u>9.73</u>	.03299	2.389	14	
16	1040.9	1046.7	0.213	43.478	0.782	<u>22.19</u>	.03524	2.302	15	
17	1051.9	1057.7	0.200	43.893	0.415	<u>10.96</u>	.03787	2.199	16	
18	1073.7	1079.5	0.173	44.677	0.784	<u>21.82</u>	.03593	2.275	17	
19	1085.9	1091.7	0.158	45.100	0.423	<u>12.15</u>	.03482	2.318	18	
20	1106.2	1112.0	0.134	45.832	0.732	<u>20.32</u>	.03601	2.271	19	
21	1121.3	1127.1	0.116	46.374	0.542	<u>15.07</u>	.03598	2.273	20	
22	1145.1	1150.9	0.088	47.257	0.883	<u>23.82</u>	.03706	2.230	21	
23	1152.8	1158.6	0.078	47.582	0.325	<u>7.74</u>	.04201	2.036	22	
24	1161.3	1167.1	0.069	47.821	0.239	<u>8.47</u>	.02819	2.577	23	
25	1194.4	1200.2	0.030	49.017	1.196	<u>33.10</u>	.03613	2.267	24	
26	1205.3	1211.1	0.018	49.419	0.402	<u>10.95</u>	.03672	2.243	25	
					0.204	<u>5.99</u>	.03407	2.347	26	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S.O.CO.CALIFORNIA 0-2 1321 FT
 LOCATION: 26-32S-23E MIDWAY-SUNSET OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g / \Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm^3)	INTERVAL NUMBER

27	1211.3	1217.1	0.011	49.623	0.349	<u>10.16</u>	.03434	2.337	27
28	1221.5	1227.3	-0.001	49.972	0.943	<u>26.79</u>	.03520	2.303	28
29	1248.3	1254.1	-0.031	50.915					

WELL INFORMATION

Operator, Lease, Well, Location

Chevron U.S.A. Inc. 368-25S
330' N & 1,640' W from SE corner, sec. 25, T.30 S., R.24 E. (M.D.B.& M.)
Elk Hills oil field
Kern County, California

Date Completed and Total Depth

December 1943 8,990 feet (D.F.) PBD 8,950 feet (D.F.)

Log Runs

Electrical (515-8,982 feet), cased-hole gamma-ray neutron (1,200-4,000 feet) (run in 1964)

Casing Record

24-inch conductor pipe cemented at 24 feet
14 1/2-inch casing run from surface and cemented at 515 feet
8 5/8-inch casing run from surface and cemented at 8,730 feet
5 3/4-inch liner to 8,948 feet with top at 8,684 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1744-2400 GMT June 15, 1975
 - - - - - 0000-0031, 1412-2400 GMT June 16, 1975
 - - - - - 0000-0245 GMT June 17, 1975
Lapse time from first to last gravity reading - 19:20 hours, minutes
Logged Depth - - - - - 8,584.6 feet (D.F.)
Number of borehole gravity stations - - - - - 82
Number of borehole gravity readings - - - - - 95
Number of downhole gravity bases - - - - - 8
Number of intervals - - - - - 81
Largest interval - - - - - 534.7 feet
Smallest interval - - - - - 9.1 feet
Percent of time spent at gravity stations - - - 44 percent
Percent of time spent moving logging tool - - - 56 percent
Average station time spent leveling and
 reading gravimeter - - - - - 5.4 minutes
Other references to survey -- Beyer (1980)
Datum for depth measurements -- top of blowout preventor (1.3 feet above mat;
 4.8 feet below former derrick floor)
Terrain corrections -- variable density for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, J. W. Schmoker

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S.O.CO.CALIF. 368-255 8990 FT
 LOCATION: 25-30S-24E ELK HILLS NAVAL PETROL, RESERVE KERN CO. CAL.

BOREHOLE STATION DATA					BOREHOLE INTERVAL DATA				
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	6.6	11.4	0.677	0.0	20.910	484.28	.04318	1.991	1
2	490.9	495.7	0.525	20.910	16.744	409.86	.04085	2.082	2
3	900.7	905.5	0.377	37.654	15.124	373.11	.04053	2.095	3
4	1273.8	1278.6	0.275	52.778	0.675	<u>16.71</u>	.04040	2.101	4
5	1290.6	1295.4	0.271	53.453	0.658	<u>14.54</u>	.04525	1.911	5
6	1305.1	1309.9	0.268	54.111	1.316	<u>30.16</u>	.04363	1.974	6
7	1335.3	1340.1	0.261	55.427	2.409	<u>60.29</u>	.03996	2.118	7
8	1395.5	1400.3	0.247	57.836	5.005	126.06	.03970	2.128	8
9	1521.6	1526.4	0.222	62.841	2.024	<u>49.76</u>	.04068	2.090	9
10	1571.4	1576.2	0.212	64.865	0.375	<u>9.08</u>	.04130	2.066	10
11	1580.4	1585.2	0.211	65.240	1.555	<u>39.83</u>	.03904	2.154	11
12	1620.3	1625.1	0.203	66.795	1.220	<u>31.06</u>	.03928	2.145	12
13	1651.3	1656.1	0.198	68.015	0.984	<u>25.05</u>	.03928	2.145	13
14	1676.4	1681.2	0.193	68.999	1.930	<u>48.73</u>	.03961	2.132	14
15	1725.1	1729.9	0.185	70.929	0.474	<u>11.02</u>	.04301	1.999	15
16	1736.1	1740.9	0.183	71.403	7.482	189.43	.03950	2.136	16
17	1925.6	1930.4	0.155	78.885	0.584	<u>13.88</u>	.04207	2.035	17
18	1939.4	1944.2	0.153	79.469	7.564	195.30	.03873	2.166	18
19	2134.8	2139.5	0.128	87.033	0.428	<u>10.73</u>	.03989	2.121	19
20	2145.5	2150.3	0.126	87.461	1.796	<u>44.85</u>	.04004	2.115	20
21	2190.3	2195.1	0.121	89.257	0.528	<u>13.08</u>	.04037	2.102	21
22	2203.4	2208.2	0.120	89.785	20.963	534.68	.03921	2.148	22
23	2738.1	2742.9	0.069	110.748	0.703	<u>18.05</u>	.03895	2.158	23
24	2756.1	2760.9	0.068	111.451	0.754	<u>19.40</u>	.03887	2.161	24
25	2775.5	2780.3	0.067	112.205	1.182	<u>31.05</u>	.03807	2.193	25
26	2806.6	2811.4	0.064	113.387	0.789	<u>19.86</u>	.03973	2.128	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S.O.CO.CALIF. 368-255 8990 FT
 LOCATION: 25-305-24E ELK MILLS NAVAL PETROL. RESERVE KERN CO. CAL.

BOREHOLE STATION DATA								BOREHOLE INTERVAL DATA	
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
27	2826.4	2831.2	0.063	114.176					
28	2905.6	2910.4	0.057	117.169	2.993	79.16	.03781	2.203	27
29	2928.8	2933.6	0.055	118.050	0.881	<u>23.19</u>	.03799	2.196	28
30	2971.9	2976.7	0.052	119.635	1.585	<u>43.12</u>	.03676	2.244	29
31	2995.7	3000.5	0.051	120.516	0.881	<u>23.74</u>	.03711	2.230	30
32	3007.8	3012.6	0.050	121.013	0.497	<u>12.17</u>	.04084	2.084	31
33	3097.5	3102.3	0.044	124.495	3.482	89.65	.03884	2.163	32
34	3108.5	3113.3	0.043	124.926	0.431	<u>11.07</u>	.03893	2.159	33
35	3188.3	3193.0	0.038	127.895	2.969	79.70	.03725	2.225	34
36	3238.4	3243.2	0.035	129.794	1.899	<u>50.11</u>	.03790	2.200	35
37	3248.3	3253.1	0.035	130.214	0.420	<u>9.99</u>	.04204	2.037	36
38	3288.3	3293.1	0.032	131.737	1.523	<u>39.99</u>	.03808	2.192	37
39	3347.3	3352.1	0.029	134.010	2.273	<u>58.95</u>	.03856	2.174	38
40	3400.8	3405.6	0.026	136.088	2.078	<u>53.52</u>	.03883	2.163	39
41	3446.5	3451.3	0.023	137.898	1.810	45.71	.03960	2.133	40
42	3524.5	3529.3	0.019	140.880	2.982	77.95	.03826	2.186	41
43	3536.7	3541.5	0.018	141.346	0.466	12.27	.03798	2.196	42
44	3576.3	3581.1	0.016	142.848	1.502	<u>39.54</u>	.03799	2.196	43
45	3588.5	3593.3	0.016	143.313	0.465	<u>12.24</u>	.03799	2.196	44
46	3674.5	3679.3	0.011	146.516	3.203	85.97	.03726	2.225	45
47	3689.4	3694.2	0.010	147.101	0.585	<u>14.92</u>	.03921	2.148	46
48	3790.6	3795.4	0.005	150.996	3.895	101.24	.03847	2.177	47
49	3821.5	3826.3	0.004	152.173	1.177	<u>30.87</u>	.03813	2.191	48
50	3849.2	3854.0	0.002	153.213	1.040	<u>27.65</u>	.03761	2.211	49
51	3908.6	3913.4	0.0	155.426	2.213	<u>59.39</u>	.03726	2.225	50
52	4159.6	4164.4	-0.012	164.728	9.302	251.00	.03706	2.233	51
					0.697	<u>18.65</u>	.03738	2.220	52

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TDI: S.O.CO.CALIF. 368-255 8990 FT
 LOCATION: 25-30S-24E ELK HILLS NAVAL PETROL. RESERVE KERN CO. CAL.

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g / \Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (σ / cm^3)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
53	4178.2	4183.0	-0.013	165.425					
54	4200.6	4205.4	-0.014	166.275	0.850	<u>22.42</u>	.03791	2.200	53
55	4222.4	4227.2	-0.015	167.083	0.808	<u>21.80</u>	.03706	2.233	54
56	4264.6	4269.4	-0.017	168.664	1.581	<u>42.14</u>	.03752	2.215	55
57	4299.2	4304.0	-0.018	169.958	1.294	<u>34.67</u>	.03732	2.223	56
58	4325.5	4330.3	-0.020	170.926	0.968	<u>26.24</u>	.03689	2.239	57
59	4335.2	4340.0	-0.020	171.308	0.382	<u>9.70</u>	.03937	2.143	58
60	4350.1	4354.9	-0.021	171.898	0.590	<u>14.95</u>	.03947	2.139	59
61	4362.1	4366.9	-0.021	172.368	0.470	<u>11.98</u>	.03923	2.148	60
62	4688.7	4693.5	-0.035	184.369	12.001	<u>326.59</u>	.03675	2.245	61
63	4707.7	4712.5	-0.036	185.037	0.668	<u>19.00</u>	.03516	2.307	62
64	4996.7	5001.5	-0.048	195.650	10.613	<u>289.01</u>	.03672	2.246	63
65	5295.9	5300.7	-0.060	206.378	10.728	<u>299.20</u>	.03586	2.280	64
66	5596.6	5601.4	-0.072	217.024	10.646	<u>300.74</u>	.03540	2.298	65
67	5896.1	5900.9	-0.084	227.587	10.563	<u>299.50</u>	.03527	2.304	66
68	6195.3	6200.1	-0.096	238.158	10.571	<u>299.18</u>	.03533	2.301	67
69	6495.9	6500.7	-0.107	248.787	10.629	<u>300.60</u>	.03536	2.300	68
70	6795.8	6800.6	-0.119	259.450	10.663	<u>299.89</u>	.03556	2.293	69
71	7095.8	7100.6	-0.130	269.600	10.150	<u>299.97</u>	.03384	2.360	70
72	7295.4	7300.2	-0.137	276.408	6.809	<u>199.60</u>	.03411	2.350	71
73	7560.4	7565.2	-0.147	285.141	8.732	<u>264.97</u>	.03296	2.395	72
74	7795.3	7800.1	-0.155	292.635	7.494	<u>234.95</u>	.03190	2.437	73
75	8006.2	8011.0	-0.162	299.385	6.750	<u>210.86</u>	.03201	2.432	74
76	8059.1	8063.9	-0.164	300.803	1.418	<u>52.95</u>	.02678	2.637	75
77	8089.0	8093.8	-0.165	301.675	0.872	<u>29.87</u>	.02919	2.543	76
78	8125.1	8129.9	-0.166	302.781	1.106	<u>36.16</u>	.03058	2.488	77
					3.689	<u>109.83</u>	.03359	2.371	78

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: S.O.CO.CALIF. 368-255 8990 FT
 LOCATION: 25-305-24E ELK HILLS NAVAL PETROL. RESERVE KERN CO. CAL.

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
79	8235.0	8239.8	-0.170	306.469	0.638	<u>24.03</u>	.02656	2.646	79
80	8259.0	8263.8	-0.171	307.108	3.256	88.15	.03694	2.240	80
81	8347.2	8352.0	-0.174	310.364	7.619	232.65	.03275	2.404	81
82	8579.8	8584.6	-0.181	317.983					

WELL INFORMATION

Operator, Lease, Well, Location

Tenneco Oil Co. Tenneco Fee A 121
317' N & 1,033' W from E 1/4 corner, sec. 25, T.28 S., R.27 E. (M.D.B.& M.)
Kern River oil field
Kern County, California

Date Completed and Total Depth

October 1967 1,225 feet (K.B.)

Log Runs

Induction-electrical (80-1,226 feet)

Casing Record

7-inch 23# casng from surface to 1,224 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1845-2400 GMT July 1, 1975
- - - - - 0000-0158 GMT July 2, 1975
Lapse time from first to last gravity reading - 7:13 hours, minutes
Logged Depth - - - - - 1,208.9 feet (K.B.)
Number of borehole gravity stations - - - - - 18
Number of borehole gravity readings - - - - - 28*
Number of downhole gravity bases - - - - - 3
Number of intervals - - - - - 17
Largest interval - - - - - 56.4 feet
Smallest interval - - - - - 6.6 feet
Percent of time spent at gravity stations - - - 60 percent
Percent of time spent moving logging tool - - - 40 percent
Average station time spent leveling and
reading gravimeter - - - - - 9.3 minutes**
Other references to survey -- Beyer (1976, 1977, 1980)
Datum for depth measurements -- surface casing flange (5 feet below former K.B.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutson, K. A. Pisciotto, J. W. Schmoker,
C. D. Cavit
Remarks -- *Includes gravity station readings at K.B. depths of 1152.1, 1162.1,
1190.9, and 1197.7 feet which were not usable because of uncontrolled drift of
gravity meter caused by unstable response of temperature thermostating circuit.
In this part of the well, temperature gradients were locally as large as
60°F/100 feet due to steam flooding.
**Includes effect of 43 minutes at one downhole station, excluding this
station, the average station time for the remaining 27 stations was 8.0
minutes.

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: TENNECO OIL CO FEE A 121 1225 FT
 LOCATION: 25-28S-27E KERN RIVER OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	750.0	755.0	0.408	0.0					
2	788.0	793.0	0.394	1.507	1.507	<u>38.00</u>	.03966	2.129	1
3	837.1	842.1	0.377	3.414	1.907	<u>49.05</u>	.03888	2.159	2
4	848.0	853.0	0.373	3.870	0.456	<u>10.91</u>	.04180	2.045	3
5	865.9	870.9	0.366	4.612	0.742	<u>17.93</u>	.04138	2.061	4
6	886.4	891.4	0.359	5.432	0.820	<u>20.45</u>	.04010	2.111	5
7	899.4	904.4	0.354	5.978	0.546	<u>13.03</u>	.04190	2.041	6
8	908.1	913.1	0.351	6.324	0.346	<u>8.67</u>	.03991	2.119	7
9	921.4	926.4	0.346	6.888	0.564	<u>13.33</u>	.04231	2.025	8
10	928.0	933.0	0.344	7.161	0.273	<u>6.63</u>	.04118	2.069	9
11	948.0	953.0	0.337	7.935	0.774	<u>19.95</u>	.03880	2.162	10
12	1004.4	1009.4	0.316	10.104	2.169	<u>56.42</u>	.03844	2.176	11
13	1020.1	1025.1	0.311	10.785	0.681	<u>15.65</u>	.04351	1.978	12
14	1066.2	1071.2	0.294	12.661	1.876	<u>46.09</u>	.04070	2.088	13
15	1104.1	1109.1	0.280	14.361	1.700	<u>37.95</u>	.04480	1.928	14
16	1137.1	1142.1	0.269	15.716	1.355	<u>32.97</u>	.04110	2.072	15
17	1172.2	1177.2	0.256	17.233	1.517	<u>35.08</u>	.04324	1.988	16
18	1203.9	1208.9	0.244	18.571	1.338	<u>31.74</u>	.04215	2.031	17

WELL INFORMATION

Operator, Lease, Well, Location

Getty Oil Co. Del Rey Fee 1-A
121' S & 177' W of center, sec. 5, T.29 S., R.28 E. (M.D.B.& M.)
Kern River oil field
Kern County, California

Date Completed and Total Depth

March 1957 982 feet (K.B.)

Log Runs

Electrical (70-977 feet)

Casing Record

10 3/4-inch casing run from surface and cemented at 724 feet
8 5/8-inch casing to 975 feet with top at 691 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 1544-1912 GMT July 2, 1975

Lapse time from first to last gravity reading - 3:28 hours, minutes

Logged Depth - - - - - 929.6 feet (K.B.)

Number of borehole gravity stations - - - - - 15

Number of borehole gravity readings - - - - - 24*

Number of downhole gravity bases - - - - - 2

Number of intervals - - - - - 14

Largest interval - - - - - 80.1 feet

Smallest interval - - - - - 8.7 feet

Percent of time spent at gravity stations - - - 58 percent

Percent of time spent moving logging tool - - - 42 percent

Average station time spent leveling and
reading gravimeter - - - - - 5.0 minutes

Other references to survey -- Beyer (1976, 1977, 1980)

Datum for depth measurements -- surface casing flange (6 feet below former K.B.)

Terrain corrections -- variable density used for terrain out to 103.6 miles

Survey team -- L. A. Beyer, F. G. Clustom, K. A. Pisciotto, J. W. Schmoker,
C. D. Cavit

Remarks -- *Includes gravity stations at K.B. depths of 832.3, 839.4, 889.7, and 899.5 feet which were not usable because of uncontrolled drift of gravity meter caused by unstable response of temperature thermostating circuit. In this part of the well, temperature gradients were locally as large as 110°F/100 feet due to steam flooding.

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: GETTY OIL CO DEL REY 1-A 975 FT
 LOCATION: 5-29S-28E KERN RIVER OIL FIELD KERN CO CALIF

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	498.1	504.1	0.585	0.0	1.291	<u>32.15</u>	.04016	2.109	1
2	530.3	536.3	0.587	1.291	0.343	<u>8.69</u>	.03947	2.136	2
3	539.0	545.0	0.587	1.634	2.628	<u>65.21</u>	.04030	2.104	3
4	604.2	610.2	0.594	4.262	0.537	<u>12.82</u>	.04189	2.042	4
5	617.0	623.0	0.596	4.799	0.909	<u>21.38</u>	.04252	2.017	5
6	638.4	644.4	0.599	5.708	1.517	<u>36.57</u>	.04148	2.057	6
7	675.0	681.0	0.604	7.225	1.086	<u>27.10</u>	.04007	2.113	7
8	702.1	708.1	0.609	8.311	0.858	<u>20.80</u>	.04125	2.066	8
9	722.9	728.9	0.613	9.169	0.685	<u>15.60</u>	.04391	1.962	9
10	738.5	744.5	0.616	9.854	0.694	<u>17.80</u>	.03899	2.155	10
11	756.3	762.3	0.620	10.548	0.734	<u>17.94</u>	.04091	2.080	11
12	774.2	780.2	0.624	11.282	1.472	<u>38.31</u>	.03842	2.177	12
13	812.5	818.5	0.632	12.754	0.874	<u>30.94</u>	.02825	2.575	13
14	843.4	849.4	0.640	13.628	3.021	<u>80.11</u>	.03771	2.205	14
15	923.6	929.6	0.661	16.649					

WELL INFORMATION

Operator, Lease, Well, Location

Marathon Oil Co. Utah Southern 19
1,950' FWL & 600' FSL, sec. 29, T.56 N., R.97 W.
Garland oil field
Big Horn County, Wyoming

Date Completed and Total Depth

October 1968 4,456 feet (K.B.)

Log Runs

Inductional-electrical, laterolog, borehole-compensated gamma-gamma,
sonic, sidewall neutron porosity

Casing Record

13 3/8-inch surface casing cemented at 171 feet
8 5/8-inch casing run from surface to 4,452.5 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 2230-2400 GMT August 26, 1975
- - - - - 0000-0616 GMT August 27, 1975
- - - - - 0333-0457, 0725-1637, 2019-2400 GMT August 28, 1975
- - - - - 0000-0141 GMT August 29, 1975

Lapse time from first to last gravity reading - 23:44 hours, minutes

Logged Depth - - - - - 4,398.2 feet (K.B.)

Number of borehole gravity stations - - - - - 69

Number of borehole gravity readings - - - - - 101

Number of downhole gravity bases - - - - - 10

Number of intervals - - - - - 68

Largest interval - - - - - 741.6 feet

Smallest interval - - - - - 6.1 feet

Percent of time spent at gravity stations - - - 37 percent

Percent of time spent moving logging tool - - - 63 percent

Average station time spent leveling and
reading gravimeter - - - - - 5.2 minutes

Other references to survey -- Beyer (1979); Beyer and Clutsom (1980b)

Datum for depth measurements -- top of blowout preventor (2.3 feet above flange of
surface casing; 7.7 feet below former K.B.)

Terrain corrections -- variable density used for terrain out to 103.6 miles

Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto, C. D. Cavit

Remarks -- Borehole deviation from the vertical between 3,600 and 4,050 feet partly
exceeded range of leveling gimbal of gravity meter. Repeated traverses up and
down this interval eventually resulted in successful gravity measurements at
all except 5 stations. This difficulty plus minor malfunctions of one level
system of the gravity meter were responsible for the lengthy duration of this
survey. Δz intervals are corrected for borehole deviation from the vertical.

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MARATHON OIL CO UTAH SOUTHERN 19 4456 FT
 LOCATION: 29-56N-97W GARLAND OIL FIELD BIG HORN CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOOB (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (δ/cm^3)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	11.5	19.2	0.472	0.0					
2	753.0	760.7	0.869	22.748	22.748	741.56	.03068	2.478	1
3	842.1	849.8	0.874	25.439	2.691	89.09	.03021	2.496	2
4	956.8	964.5	0.880	29.124	3.685	114.73	.03213	2.421	3
5	967.6	975.3	0.881	29.498	0.374	<u>10.78</u>	.03471	2.320	4
6	993.6	1001.3	0.882	30.383	0.885	<u>26.00</u>	.03404	2.346	5
7	1008.1	1015.8	0.883	30.886	0.503	<u>14.50</u>	.03471	2.320	6
8	1033.8	1041.5	0.884	31.731	0.845	<u>25.70</u>	.03289	2.392	7
9	1329.0	1336.7	0.899	41.350	9.619	295.13	.03262	2.402	8
10	1644.6	1652.3	0.919	51.392	10.042	315.65	.03186	2.432	9
11	1656.6	1664.3	0.919	51.743	0.351	<u>11.97</u>	.02937	2.530	10
12	1757.5	1765.2	0.927	54.927	3.184	100.96	.03160	2.442	11
13	1872.6	1880.3	0.935	58.355	3.428	115.03	.02987	2.510	12
14	1951.2	1958.9	0.942	60.649	2.294	78.61	.02924	2.535	13
15	2028.4	2036.1	0.948	62.828	2.179	77.22	.02827	2.573	14
16	2107.8	2115.4	0.955	65.709	2.881	79.35	.03636	2.256	15
17	2168.9	2176.6	0.961	67.696	1.987	61.15	.03253	2.406	16
18	2182.1	2189.8	0.962	68.118	0.422	<u>13.17</u>	.03207	2.424	17
19	2194.8	2202.4	0.963	68.495	0.377	<u>12.68</u>	.02976	2.515	18
20	2276.9	2284.6	0.971	70.896	2.401	82.11	.02928	2.534	19
21	2287.7	2295.4	0.972	71.179	0.283	<u>10.82</u>	.02618	2.655	20
22	2305.8	2313.5	0.974	71.753	0.574	<u>18.13</u>	.03170	2.439	21
23	2356.9	2364.6	0.979	73.495	1.742	<u>51.11</u>	.03412	2.344	22
24	2406.7	2414.4	0.984	74.942	1.447	<u>49.82</u>	.02908	2.541	23
25	2635.9	2643.6	1.007	81.703	6.761	229.17	.02957	2.522	24
26	2712.0	2719.7	1.015	83.898	2.195	76.12	.02893	2.547	25
					0.829	<u>29.92</u>	.02778	2.592	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MARATHON OIL CO UTAH SOUTHERN 19 4456 FT
 LOCATION: 29-56N-97W GARLAND OIL FIELD BIG HORN CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
27	2741.9	2749.6	1.018	84.727	3.461	123.71	.02803	2.583	27
28	2865.7	2873.4	1.032	88.188	2.520	101.96	.02475	2.711	28
29	2967.6	2975.3	1.044	90.708	2.546	89.79	.02841	2.568	29
30	3057.4	3065.1	1.054	93.254	5.910	214.20	.02766	2.597	30
31	3271.6	3279.3	1.079	99.164	0.537	21.35	.02523	2.692	31
32	3293.0	3300.7	1.082	99.701	6.052	228.38	.02661	2.638	32
33	3521.3	3529.0	1.109	105.753	0.266	<u>8.31</u>	.03218	2.420	33
34	3529.6	3537.3	1.110	106.019	0.199	<u>6.05</u>	.03305	2.386	34
35	3535.7	3543.4	1.111	106.218	1.194	<u>46.90</u>	.02559	2.678	35
36	3582.6	3590.3	1.117	107.412	1.030	<u>42.01</u>	.02464	2.716	36
37	3624.6	3632.3	1.122	108.442	5.234	200.83	.02621	2.654	37
38	3825.4	3833.1	1.147	113.676	1.011	<u>38.00</u>	.02675	2.633	38
39	3863.4	3871.1	1.152	114.687	0.438	<u>12.98</u>	.03393	2.352	39
40	3876.4	3884.1	1.153	115.125	0.436	<u>14.05</u>	.03119	2.460	40
41	3890.5	3898.2	1.155	115.561	1.154	<u>46.45</u>	.02499	2.702	41
42	3936.9	3944.6	1.161	116.715	0.744	<u>28.70</u>	.02606	2.661	42
43	3965.6	3973.3	1.165	117.459	0.875	<u>35.15</u>	.02502	2.701	43
44	4000.8	4008.5	1.169	118.334	0.230	<u>7.96</u>	.02902	2.544	44
45	4008.7	4016.4	1.170	118.564	0.876	<u>31.99</u>	.02750	2.604	45
46	4040.7	4048.4	1.174	119.440	0.265	<u>8.37</u>	.03179	2.436	46
47	4049.1	4056.8	1.175	119.705	0.469	<u>18.38</u>	.02563	2.677	47
48	4067.5	4075.2	1.178	120.174	0.249	<u>11.38</u>	.02197	2.821	48
49	4078.8	4086.5	1.179	120.423	0.284	<u>9.46</u>	.03012	2.501	49
50	4088.3	4096.0	1.180	120.707	0.666	<u>25.36</u>	.02636	2.649	50
51	4113.7	4121.4	1.183	121.373	0.401	<u>16.01</u>	.02512	2.697	51
52	4129.7	4137.4	1.186	121.774	0.837	34.72	.02418	2.734	52

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MARATHON OIL CO UTAH SOUTHERN 19 4456 FT
 LOCATION: 29-56N-97W GARLAND OIL FIELD BIG HORN CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
53	4164.4	4172.1	1.190	122.611	0.198	<u>6.66</u>	.02981	2.514	53
54	4171.1	4178.8	1.191	122.809	0.337	<u>11.21</u>	.03013	2.501	54
55	4182.3	4190.0	1.192	123.146	0.362	<u>13.80</u>	.02631	2.651	55
56	4196.1	4203.8	1.194	123.508	0.334	<u>10.80</u>	.03097	2.468	56
57	4206.9	4214.6	1.195	123.842	0.508	<u>17.30</u>	.02945	2.528	57
58	4224.2	4231.9	1.198	124.350	0.405	<u>14.02</u>	.02895	2.547	58
59	4238.2	4245.9	1.199	124.755	0.455	<u>18.68</u>	.02440	2.725	59
60	4256.9	4264.6	1.202	125.210	0.544	<u>19.55</u>	.02788	2.589	60
61	4276.4	4284.1	1.204	125.754	0.393	<u>15.84</u>	.02487	2.707	61
62	4292.3	4300.0	1.206	126.147	0.251	<u>8.90</u>	.02827	2.574	62
63	4301.2	4308.9	1.207	126.398	0.442	<u>17.28</u>	.02564	2.677	63
64	4318.4	4326.1	1.210	126.840	0.661	<u>24.00</u>	.02760	2.600	64
65	4342.4	4350.1	1.213	127.501	0.382	<u>15.00</u>	.02551	2.682	65
66	4357.4	4365.1	1.215	127.883	0.240	<u>11.07</u>	.02173	2.830	66
67	4368.5	4376.2	1.216	128.123	0.328	<u>14.23</u>	.02311	2.776	67
68	4382.7	4390.4	1.218	128.451	0.218	<u>7.80</u>	.02804	2.583	68
69	4390.5	4398.2	1.219	128.669					

WELL INFORMATION

Operator, Lease, Well, Location

Phillips Petroleum Co. Big Polecat 1 (formerly Mule Creek Oil Co. No. 1
Unit State)
2,310' EWL & 660' NSL, sec. 16, T.57 N., R.98 W.
Big Polecat oil field
Park County, Wyoming

Date Completed and Total Depth

July 1954 5,572 feet (K.B.)

Log Runs

Electrical (200-5,562 feet), gamma ray-neutron (16-5,566 feet), cased-
hole gamma ray-neutron (5,300-5,556 feet) (run in 1968)

Casing Record

10 3/4-inch surface casing cemented at 200 feet
7-inch 23# casing run from surface to 5,569 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 0258-0547, 1435-2332 GMT August 30, 1975
Lapse time from first to last gravity reading - 11:46 hours, minutes
Logged Depth - - - - - 5,368.1 feet (K.B.)
Number of borehole gravity stations - - - - - 39
Number of borehole gravity readings - - - - - 50
Number of downhole gravity bases - - - - - 6
Number of intervals - - - - - 38
Largest interval - - - - - 764.2 feet
Smallest interval - - - - - 7.0 feet
Percent of time spent at gravity stations - - - 34 percent
Percent of time spent moving logging tool - - - 66 percent
Average station time spent leveling and
reading gravimeter - - - - - 4.8 minutes
Other references to survey -- Beyer (1979); Beyer and Clutsom (1980a)
Datum for depth measurements -- working flange (9.5 feet below former K.B.)
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto, C. D. Cavit

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: PHILLIPS PETROLEUM CO. BIG POLE CAT 1
 LOCATION: 16-57N-98W BIG POLE CAT OIL FIELD PARK CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER	
1	2	3	4	5	6	7	8	9	10	
1	5.8	15.3	0.723	0.0						
2	480.2	489.7	1.443	15.626	15.626	474.37	.03294	2.389	1	
3	496.2	505.7	1.443	16.246	0.620	<u>16.07</u>	.03857	2.169	2	
4	517.1	526.6	1.443	17.004	0.758	<u>20.87</u>	.03632	2.257	3	
5	820.0	829.5	1.362	26.347	9.343	302.89	.03085	2.471	4	
6	1489.5	1499.0	0.974	45.908	19.561	669.53	.02922	2.535	5	
7	2253.7	2263.2	0.464	67.717	21.809	764.20	.02854	2.562	6	
8	2423.3	2432.8	0.356	72.552	4.835	169.60	.02851	2.563	7	
9	2443.7	2453.2	0.343	73.222	0.670	<u>20.34</u>	.03292	2.391	8	
10	2504.0	2513.5	0.306	75.043	1.821	60.35	.03018	2.498	9	
11	2513.9	2523.4	0.299	75.360	0.317	<u>9.91</u>	.03198	2.428	10	
12	2525.1	2534.6	0.292	75.776	0.416	<u>11.20</u>	.03717	2.225	11	
13	2704.0	2713.5	0.184	81.226	5.450	178.88	.03047	2.487	12	
14	2742.6	2752.1	0.161	82.522	1.296	<u>38.56</u>	.03361	2.364	13	
15	2809.5	2819.0	0.122	84.670	2.148	66.95	.03208	2.424	14	
16	3100.7	3110.2	-0.042	93.525	8.855	291.21	.03041	2.489	15	
17	3479.9	3489.4	-0.238	105.013	11.488	379.21	.03029	2.494	16	
18	3487.0	3496.5	-0.242	105.189	0.176	<u>7.03</u>	.02500	2.701	17	
19	3689.3	3698.8	-0.339	111.101	5.912	202.33	.02922	2.536	18	
20	3814.1	3823.6	-0.396	114.523	3.422	124.81	.02742	2.607	19	
21	3835.8	3845.3	-0.406	115.100	0.577	<u>21.72</u>	.02657	2.640	20	
22	3979.3	3988.8	-0.469	119.532	4.432	143.47	.03089	2.471	21	
23	4074.0	4083.5	-0.510	122.370	2.838	94.68	.02998	2.507	22	
24	4286.9	4296.4	-0.597	128.283	5.913	212.89	.02777	2.593	23	
25	4454.0	4463.5	-0.662	132.898	4.615	167.11	.02762	2.599	24	
26	4485.2	4494.7	-0.674	133.720	0.822	<u>31.24</u>	.02631	2.651	25	
					3.680	130.19	.02827	2.574	26	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: PHILLIPS PETROLEUM CO. BIG POLE CAT 1
 LOCATION: 16-57N-98W BIG POLE CAT OIL FIELD PARK CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
27	4615.4	4624.9	-0.722	137.400					
28	4623.2	4632.7	-0.725	137.592	0.192	<u>7.77</u>	.02472	2.713	27
29	4687.0	4696.5	-0.748	139.367	1.775	63.85	.02780	2.592	28
30	4697.0	4706.5	-0.752	139.627	0.260	<u>10.02</u>	.02593	2.666	29
31	4778.1	4787.6	-0.781	141.738	2.111	81.01	.02606	2.660	30
32	4808.8	4818.3	-0.791	142.426	0.688	<u>30.73</u>	.02239	2.804	31
33	5039.0	5048.5	-0.869	148.426	6.000	230.19	.02606	2.660	32
34	5278.7	5288.2	-0.945	154.592	6.166	239.70	.02572	2.674	33
35	5308.6	5318.1	-0.954	155.237	0.645	<u>29.90</u>	.02157	2.837	34
36	5323.5	5333.0	-0.959	155.544	0.307	<u>14.97</u>	.02050	2.878	35
37	5333.4	5342.9	-0.962	155.776	0.232	<u>9.82</u>	.02364	2.755	36
38	5351.6	5361.1	-0.967	156.171	0.395	<u>18.24</u>	.02165	2.833	37
39	5358.6	5368.1	-0.970	156.350	0.179	<u>6.96</u>	.02572	2.674	38

WELL INFORMATION

Operator, Lease, Well, Location

Conoco Inc. Gebo Unit 28
2,310' FSL & 1,650' FEL, sec. 23, T.44 N., R.95 W.
Gebo oil field
Hot Springs County, Wyoming

Date Completed and Total Depth

August 1948 6,608 feet (K.B.) PBD 5,125 feet (K.B.)

Log Runs

Electrical (269-6,606 feet), cased-hole compensated gamma ray-neutron
(4,400-5,116 feet) (run in 1974)

Casing Record

10 3/4-inch surface casing cemented at 269 feet
7-inch 23# casing run from surface to 5,144 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 0310-1710 GMT September 5, 1975

Lapse time from first to last gravity reading - 14 hours

Logged Depth - - - - - 5,093.0 feet (K.B.)

Number of borehole gravity stations - - - - - 75

Number of borehole gravity readings - - - - - 86

Number of downhole gravity bases - - - - - 8

Number of intervals - - - - - 74

Largest interval - - - - - 713.8 feet

Smallest interval - - - - - 6.2 feet

Percent of time spent at gravity stations - - - 56 percent

Percent of time spent moving logging tool - - - 44 percent

Average station time spent leveling and
reading gravimeter - - - - - 5.5 minutes

Other references to survey -- Beyer and Clutsom (1978); Beyer (1979)

Datum for depth measurements -- working flange (1 foot above surface casing
flange; 10.1 feet below K.B.)

Terrain corrections -- variable density used for terrain out to 103.6 miles

Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto, C. D. Cavit

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: CONTINENTAL OIL CO. GEBO UNIT 28 660R FT
 LOCATION: 23-44N-95W GEBO OIL FIELD HOT SPRINGS CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	5.8	15.9	0.561	0.0	20.769	713.81	.02910	2.539	1
2	719.6	729.7	-0.787	20.769	17.905	605.58	.02957	2.521	2
3	1325.2	1335.3	-0.478	38.674	0.342	<u>12.47</u>	.02741	2.606	3
4	1337.7	1347.8	-0.470	39.016	0.326	<u>11.95</u>	.02727	2.611	4
5	1349.6	1359.7	-0.463	39.342	0.304	<u>11.39</u>	.02671	2.634	5
6	1361.0	1371.1	-0.457	39.646	0.304	<u>10.78</u>	.02820	2.575	6
7	1371.8	1381.9	-0.450	39.950	0.500	<u>17.97</u>	.02782	2.590	7
8	1389.8	1399.8	-0.440	40.450	0.721	<u>23.17</u>	.03112	2.461	8
9	1412.9	1423.0	-0.426	41.171	0.561	<u>17.03</u>	.03294	2.390	9
10	1429.9	1440.0	-0.416	41.732	0.397	<u>11.98</u>	.03314	2.382	10
11	1441.9	1452.0	-0.409	42.129	3.153	94.78	.03327	2.377	11
12	1536.7	1546.8	-0.353	45.282	0.172	<u>6.23</u>	.02759	2.599	12
13	1542.9	1553.0	-0.349	45.454	1.905	59.76	.03188	2.431	13
14	1602.7	1612.8	-0.314	47.359	0.525	<u>15.17</u>	.03460	2.325	14
15	1617.9	1628.0	-0.305	47.884	1.748	54.87	.03186	2.432	15
16	1672.7	1682.8	-0.272	49.632	0.326	<u>10.35</u>	.03151	2.446	16
17	1683.1	1693.2	-0.266	49.958	0.909	<u>28.92</u>	.03143	2.449	17
18	1712.0	1722.1	-0.249	50.867	2.472	79.31	.03117	2.459	18
19	1791.3	1801.4	-0.202	53.339	0.462	<u>13.88</u>	.03330	2.376	19
20	1805.2	1815.3	-0.194	53.801	0.758	<u>23.22</u>	.03264	2.402	20
21	1828.4	1838.5	-0.180	54.559	1.104	<u>34.58</u>	.03193	2.430	21
22	1863.0	1873.1	-0.160	55.663	11.319	357.06	.03170	2.438	22
23	2220.1	2230.2	0.046	66.982	5.687	180.08	.03158	2.443	23
24	2400.1	2410.2	0.146	72.669	0.460	<u>15.93</u>	.02887	2.549	24
25	2416.1	2426.2	0.155	73.129	0.424	<u>14.01</u>	.03027	2.495	25
26	2430.1	2440.2	0.162	73.553	4.841	162.92	.02971	2.516	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: CONTINENTAL OIL CO. GEBO UNIT 28 6608 FT
 LOCATION: 23-44N-95W GEBO OIL FIELD HOT SPRINGS CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA			
1	2	3	4	5	6	7	8	9	10	
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS/FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER	
27	2593.0	2603.1	0.251	78.394	4.817	164.41	.02930	2.533	27	
28	2757.4	2767.5	0.337	83.211	1.377	43.50	.03165	2.441	28	
29	2800.9	2811.0	0.360	84.588	0.343	<u>10.24</u>	.03350	2.369	29	
30	2811.1	2821.2	0.365	84.931	0.509	<u>15.75</u>	.03230	2.415	30	
31	2826.9	2837.0	0.374	85.440	0.435	<u>13.48</u>	.03229	2.416	31	
32	2840.4	2850.5	0.380	85.875	1.576	52.67	.02992	2.509	32	
33	2893.0	2903.1	0.408	87.451	0.701	<u>21.83</u>	.03211	2.423	33	
34	2914.9	2925.0	0.419	88.152	4.295	151.05	.02844	2.567	34	
35	3065.9	3076.0	0.495	92.447	7.408	261.08	.02837	2.569	35	
36	3327.0	3337.1	0.622	99.855	0.321	<u>11.06</u>	.02905	2.543	36	
37	3338.1	3348.2	0.627	100.176	7.693	286.92	.02681	2.631	37	
38	3625.0	3635.1	0.761	107.869	0.469	<u>16.84</u>	.02785	2.590	38	
39	3641.8	3651.9	0.769	108.338	0.758	<u>24.41</u>	.03104	2.465	39	
40	3666.2	3676.3	0.780	109.096	0.862	<u>29.95</u>	.02879	2.553	40	
41	3696.2	3706.3	0.793	109.958	0.904	<u>26.81</u>	.03371	2.361	41	
42	3723.0	3733.1	0.806	110.862	9.706	377.02	.02574	2.672	42	
43	4100.0	4110.1	0.970	120.568	8.724	326.13	.02675	2.633	43	
44	4426.1	4436.2	1.105	129.292	1.832	75.92	.02413	2.736	44	
45	4502.1	4512.2	1.136	131.124	1.255	54.57	.02300	2.780	45	
46	4556.6	4566.7	1.157	132.379	0.556	<u>19.30</u>	.02880	2.553	46	
47	4575.9	4586.0	1.165	132.935	0.327	<u>10.83</u>	.03020	2.499	47	
48	4586.8	4596.9	1.169	133.262	0.569	<u>22.26</u>	.02557	2.680	48	
49	4609.0	4619.1	1.178	133.831	0.334	<u>10.79</u>	.03093	2.470	49	
50	4619.8	4629.9	1.182	134.165	0.628	<u>25.07</u>	.02506	2.700	50	
51	4644.9	4655.0	1.192	134.793	0.508	<u>19.90</u>	.02553	2.681	51	
52	4664.8	4674.9	1.200	135.301	0.551	<u>23.80</u>	.02315	2.774	52	

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: CONTINENTAL OIL CO. GEBO UNIT 28 6608 FT
 LOCATION: 23-44N-95W GEBO OIL FIELD HOT SPRINGS CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
1	2	3	4	5	6	7	8	9	10
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
53	4688.6	4698.7	1.209	135.852					
54	4728.0	4738.1	1.225	136.742	0.890	<u>39.41</u>	.02258	2.797	53
55	4750.9	4761.0	1.234	137.316	0.574	<u>22.94</u>	.02502	2.701	54
56	4765.1	4775.2	1.239	137.643	0.327	<u>14.18</u>	.02305	2.778	55
57	4784.7	4794.8	1.247	138.093	0.450	<u>19.57</u>	.02299	2.781	56
58	4826.8	4836.9	1.263	139.116	1.023	<u>42.16</u>	.02427	2.731	57
59	4849.8	4859.9	1.271	139.802	0.686	<u>22.97</u>	.02987	2.512	58
60	4859.9	4870.0	1.275	140.090	0.288	<u>10.10</u>	.02849	2.565	59
61	4872.2	4882.3	1.280	140.418	0.328	<u>12.31</u>	.02664	2.638	60
62	4889.6	4899.7	1.287	140.916	0.498	<u>17.33</u>	.02875	2.556	61
63	4902.1	4912.2	1.291	141.259	0.343	<u>12.50</u>	.02742	2.607	62
64	4935.0	4945.1	1.304	142.164	0.905	<u>32.94</u>	.02748	2.605	63
65	4958.0	4968.1	1.312	142.819	0.655	<u>23.02</u>	.02844	2.567	64
66	4975.8	4985.9	1.319	143.276	0.457	<u>17.76</u>	.02574	2.673	65
67	4988.6	4998.7	1.324	143.651	0.375	<u>12.82</u>	.02927	2.535	66
68	4996.6	5006.7	1.327	143.912	0.261	<u>8.01</u>	.03255	2.407	67
69	5004.9	5015.0	1.330	144.162	0.250	<u>8.28</u>	.03020	2.499	68
70	5017.8	5027.9	1.335	144.512	0.350	<u>12.90</u>	.02713	2.619	69
71	5045.6	5055.7	1.345	145.335	0.823	<u>27.78</u>	.02963	2.521	70
72	5052.8	5062.9	1.348	145.573	0.238	<u>7.24</u>	.03287	2.394	71
73	5065.2	5075.3	1.352	145.875	0.302	<u>12.39</u>	.02435	2.728	72
74	5074.7	5084.8	1.356	146.168	0.293	<u>9.49</u>	.03090	2.471	73
75	5082.9	5093.0	1.359	146.413	0.245	<u>8.25</u>	.02968	2.519	74

WELL INFORMATION

Operator, Lease, Well, Location

Mountain Fuel Supply Co. Dry Piney Unit 19
778' FNL & 1,809' FWL, sec. 15, T.27 N., R.114 W.
Dry Piney oil field
Sublette County, Wyoming

Date Completed and Total Depth

August 1971 11,200 feet (K.B.) PBD is 11,110 feet (K.B.)

Log Runs

Dual induction laterolog 9995-11,200 feet), four-arm continuous dipmeter
6,820-11,200 feet), borehole compensated sonic-gamma ray (5,300-11,200
feet), borehole compensated gamma-gamma (6,400-11,200 feet)

Casing Record

20-inch conductor pipe cemented at 44 feet
10 3/4-inch casing cemented at 995 feet
7-inch 23# casing run from surface to 11,199 feet

BOREHOLE GRAVITY SURVEY

Time and date - - - - - 2345-2400 GMT September 11, 1975
- - - - - 0000-0855 GMT September 12, 1975
Lapse time from first to last gravity reading - 9:10 hours, minutes
Logged Depth - - - - - 4,953.9 feet (K.B.)
Number of borehole gravity stations - - - - - 43
Number of borehole gravity readings - - - - - 54*
Number of downhole gravity bases - - - - - 8
Number of intervals - - - - - 42
Largest interval - - - - - 439.9 feet
Smallest interval - - - - - 9.9 feet
Percent of time spent at gravity stations - - - 51 percent
Percent of time spent moving logging tool - - - 49 percent
Average station time spent leveling and
reading gravimeter - - - - - 5.2 minutes
Other references to survey -- Beyer and Clutsom (1978b); Beyer (1979)
Datum for depth measurements -- top blowout preventer
Terrain corrections -- variable density used for terrain out to 103.6 miles
Survey team -- L. A. Beyer, F. G. Clutsom, K. A. Pisciotto
Remarks -- *Four gravity stations were not usable because of uncontrolled drift of
the gravity meter during period of instrument tares.

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MOUNTAIN FUEL SUPPLY CO. DRY PINEY UNIT 19 11200 FT
 LOCATION: 15-27N-114W DRY PINEY FIELD GREATER BIG PINEY-LA BARGE AREA SUBLETTE CO WYO

BOREHOLE STATION DATA							BOREHOLE INTERVAL DATA		
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	ΔZ (FEET)	$\Delta g/\Delta Z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (g/cm ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
1	5.8	23.1	5.023	0.0					
2	387.4	404.7	0.254	11.287	11.287	381.59	.02958	2.518	1
3	792.4	809.7	-3.077	22.003	10.716	405.05	.02646	2.641	2
4	1232.3	1249.6	-5.633	33.205	11.202	439.86	.02547	2.680	3
5	1582.8	1600.1	-7.250	41.941	8.736	350.48	.02493	2.701	4
6	1782.3	1799.6	-8.069	47.059	5.118	199.53	.02565	2.673	5
7	1982.2	1999.5	-8.837	51.878	4.819	199.93	.02410	2.734	6
8	2182.2	2199.5	-9.562	56.537	4.659	199.93	.02330	2.765	7
9	2356.6	2373.9	-10.165	60.640	4.103	174.39	.02353	2.756	8
10	2512.1	2529.4	-10.684	64.518	3.878	155.54	.02493	2.701	9
11	2552.1	2569.4	-10.815	65.479	0.961	<u>40.05</u>	.02399	2.738	10
12	2691.2	2708.5	-11.263	68.869	3.390	139.07	.02438	2.723	11
13	2741.1	2758.4	-11.421	70.032	1.163	<u>49.93</u>	.02329	2.766	12
14	2782.4	2799.7	-11.550	70.958	0.926	<u>41.26</u>	.02244	2.799	13
15	2872.0	2889.3	-11.828	72.961	2.003	89.59	.02236	2.802	14
16	2932.0	2949.3	-12.011	74.429	1.468	59.96	.02449	2.719	15
17	2982.1	2999.4	-12.164	75.552	1.123	<u>50.16</u>	.02238	2.801	16
18	2992.3	3009.6	-12.194	75.820	0.268	<u>10.22</u>	.02623	2.651	17
19	3002.2	3019.5	-12.224	76.164	0.344	<u>9.88</u>	.03482	2.315	18
20	3012.1	3029.4	-12.254	76.477	0.313	<u>9.87</u>	.03171	2.436	19
21	3022.1	3039.4	-12.284	76.773	0.296	<u>10.04</u>	.02947	2.524	20
22	3032.1	3049.4	-12.314	77.054	0.281	<u>9.93</u>	.02830	2.570	21
23	3062.1	3079.4	-12.404	78.032	0.978	<u>30.00</u>	.03260	2.402	22
24	3082.2	3099.5	-12.464	78.647	0.615	<u>20.13</u>	.03055	2.482	23
25	3132.2	3149.5	-12.612	80.205	1.558	<u>50.05</u>	.03113	2.459	24
26	3182.3	3199.6	-12.759	81.654	1.449	<u>50.09</u>	.02893	2.545	25
					5.746	200.13	.02871	2.554	26

USGS BOREHOLE GRAVITY SURVEY
 OPERATOR/LEASE/WELL/TD: MOUNTAIN FUEL SUPPLY CO. DRY PINEY UNIT 19 11200 FT
 LOCATION: 15-27N-114W DRY PINEY FIELD GREATER BIG PINEY-LA BARGE AREA SUBLETTE CO WYO

BOREHOLE STATION DATA					BOREHOLE INTERVAL DATA				
GRAVITY STATION NUMBER	GRAVITY STATION DEPTH RELATIVE TO WELL HEAD (FEET)	GRAVITY STATION DEPTH RELATIVE TO WELL LOGS (FEET)	TERRAIN CORRECTION (MILLIGALS)	RELATIVE GRAVITY (MILLIGALS)	TERRAIN-CORRECTED Δg (MILLIGALS)	Δz (FEET)	$\Delta g/\Delta z$ (MILLIGALS / FOOT)	INTERVAL DENSITY (G/CM ³)	INTERVAL NUMBER
1	2	3	4	5	6	7	8	9	10
27	3382.5	3399.8	-13.337	87.400	5.738	199.83	.02871	2.554	27
28	3582.3	3599.6	-13.898	93.138	5.864	200.03	.02932	2.531	28
29	3782.3	3799.6	-14.444	99.002	5.862	200.23	.02928	2.532	29
30	3982.5	3999.8	-14.977	104.864	5.792	199.93	.02897	2.544	30
31	4182.5	4199.8	-15.496	110.656	2.738	94.68	.02892	2.546	31
32	4277.2	4294.5	-15.738	113.394	3.301	115.03	.02870	2.555	32
33	4392.2	4409.5	-16.028	116.695	1.792	62.25	.02879	2.552	33
34	4454.4	4471.7	-16.183	118.487	1.460	51.98	.02809	2.579	34
35	4506.4	4523.7	-16.311	119.947	2.768	96.97	.02855	2.561	35
36	4603.4	4620.7	-16.549	122.715	2.232	78.82	.02831	2.570	36
37	4682.2	4699.5	-16.741	124.947	1.981	70.03	.02829	2.571	37
38	4752.2	4769.5	-16.910	126.928	0.674	<u>24.04</u>	.02804	2.581	38
39	4776.3	4793.6	-16.967	127.602	1.407	<u>50.51</u>	.02785	2.588	39
40	4826.8	4844.1	-17.088	129.009	0.810	<u>26.38</u>	.03070	2.477	40
41	4853.2	4870.5	-17.150	129.819	1.115	<u>39.47</u>	.02825	2.573	41
42	4892.6	4909.9	-17.244	130.934	1.300	<u>43.92</u>	.02960	2.520	42
43	4936.6	4953.9	-17.347	132.234					