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COMPILATION OF 71 ADDITIONAL SONIC AND DENSITY LOGS FROM 59 OIL TEST  
WELLS IN THE SAN FRANCISCO BAY AREA, CALIFORNIA

By

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## **ABSTRACT**

Several relatively thick ( $>3$  km deep) Cenozoic basins, including the Livermore and the San Pablo basins, may locally enhance strong ground motions in the San Francisco Bay area, California. As part of a crustal-scale, three-dimensional seismic velocity and density model for the Bay area, we have compiled data from sonic and density logs from oil test wells in the Bay area to better understand strong motion resonances generated by these basins. As a followup to a previous U.S. Geological Survey Open-file Report 97-687 that compiled 61 sonic and density logs from 51 oil test wells from the Bay Area, we have compiled here an additional 71 sonic and density logs from 59 oil test wells. Fifty-eight of the oil test wells are new to this report. The well data are primarily from the Vacaville, Pittsburg, Brentwood, and Hollister oil fields, and Salinas Valley, and provide measurements from the surface to as deep as 5 km. More than half of the wells are located in San Benito and Monterey counties. The logs were hand digitized at non-uniform intervals between 3 and 30 m to capture the significant variations with depth for frequencies up to 2 Hz. This report (1) presents the locations, elevations, depths, stratigraphic and other information about the oil test wells, and (2) provides plots showing the density, sonic velocities, and two-way travel time as a function of depth for each sonic log.

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## INTRODUCTION

Several relatively thick (>3 km deep) Cenozoic basins in the San Francisco Bay area, California, including the Livermore and San Pablo basins (Fig. 1), are defined by inversion of gravity anomalies, seismic reflection and refraction profiles, and borehole control [Meltzer et al., 1987; Smith, 1992; Wright and Smith, 1992; Jachens et al., 1995]. We have compiled sonic and density logs from oil test wells in the Bay area as part of a crustal-scale three-dimensional seismic velocity and density model for the Bay area being developed to better understand strong motion resonances generated by these basins. Brocher et al. [1997] compiled 59 sonic and density logs from 51 oil test wells in the San Francisco Bay area (Fig. 1).

We present data from an additional 71 sonic and density logs from 59 oil test wells in the Bay area to categorize the velocities and densities of these Cenozoic sedimentary basins. The data include logs for 58 wells not discussed by Brocher et al. [1997]. The well data are primarily from the Vacaville, Pittsburg, Brentwood, and Hollister oil fields, and Salinas Valley (Fig. 1), and provide measurements from the surface to as deep as 5 km subsurface.

The locations, elevations, and depths of the oil test wells, as well as the lease name, well number, operator, name of the oil field, and completion year are presented in Table 1. In this table the wells are ordered by latitude from north to south. This information is taken without verification from the Well History Control System (WHCS) One-line File, an on-line digital well-log database leased from Petroleum Information by the USGS Office of Energy Resources at Denver. Because the logs were run over a 32-year interval between 1958 and 1990, Table 1 provides information on the type of sonic and density tool used to make the log, as well as the other tools which were run simultaneously with these tools (normally caliper, spontaneous potential, and gamma-ray). Many of the sonic logs were made using older tools with short spans between the source and receivers.

Table 2 provides information on the lithologies and stratigraphy encountered in the holes, taken from the compilation of Bay area wells by Powell et al. [1997]. Age control, either from unpublished hydrocarbon industry sources or from Special Reports by the California Division of

Mines and Geology, is currently available for 23 of the 59 wells. Most wells penetrated sedimentary units of Eocene to Cretaceous age, although a few Eocene units were penetrated. In Table 2, we have tabulated the depths to the tops (and in some cases, the bases) of these Miocene to Cretaceous units.

## WELL LOG ANALYSIS

Sonic and density logs were hand digitized at non-uniform intervals between 3 and 30 m to capture the significant variations of the logs with depth for frequencies up to 2 Hz. The sampling interval was adequate to estimate linear trends in the data over these intervals. We note that this sampling interval is not sufficiently dense for the calculation of high-frequency (say >10 Hz) synthetic seismograms. For higher-frequency synthetics, it would be necessary to redigitize the logs with a finer sampling interval.

For the 45 sonic logs, we picked transit times ( $\mu\text{s}/\text{ft}$ ) as a function of depth down the well. For the gamma-gamma density logs, we picked bulk density in  $\text{g}/\text{cm}^3$  as a function of depth down the well. For the neutron density porosity logs, we converted the logged density porosity ( $\phi$ ) back to formation density ( $\rho_{fd}$ ) using  $\rho_{fd} = \rho_m + (\rho_f - \rho_m)\phi$ , where the matrix density  $\rho_m = 2.65 \text{ g}/\text{cm}^3$ , and the fluid density  $\rho_f = 1.0 \text{ g}/\text{cm}^3$  [Ellis, 1987]. Well depths are measured from an arbitrary reference datum on the drilling platform, usually located about 4 m (12 feet) above ground level. The downhole depths reported here have not been corrected to the ground level datum. Cased intervals of the wells and open-hole sections identified on the logs as having cycle skipping problems were not digitized. In some cases log data associated with washouts, thick mudcake, invasion of drill fluids or large deviations from the general trend of density and sonic values that generally have less than 10 meters depth extent were ignored [Ellis, 1987].

The digitized sonic log data were converted from transit times to velocities (m/s) and both the sonic- and density-logs depths were converted from feet to meters. Figures 2 to 72 show sonic velocities and densities as a function of depth for each well.

We caution that we have not attempted to independently verify the accuracy of the data that are presented here in digital form. In commercial, open-hole geophysical well logging, there are many sources of possible errors. Independent data for verification could be bulk density measurements of core samples for the density logs and (downhole) seismic check-shot surveys for the sonic logs. Thus, we have not yet determined the absolute and relative accuracy of these digital data. Thick mudcake noted between 360 m and 600 m depth for the Plaskett No. A-1 well may be responsible for the lowered densities measured in this depth interval (Fig. 67).

Oil test wells having the longest sonic logs include: Atlantic Richfield Company/Mantelli #1 (Fig. 14), Standard Oil Co. of Calif./Simon Newman #1 (Fig. 25), Humble Oil and Refining Co./Wico-Bankhead No.1 (Fig. 19), K.L. Burns Co./Simon-Newman 12-1 (Fig. 26), Humble Oil and Refining Co./Myrvin C. Carey et UX #1 (Fig. 16), Brazos Oil and Gas Co./Antioch Unit A No.1 (Fig. 10), Shell Oil Co./Pagano #2-4 (Fig. 21), Gulf Oil Corp; (Chevron)/Porter Sesnon No.1 (Fig. 9), and Phillips Petroleum Co./Vierra A No.1 (Fig. 20). The longest density logs are from the following wells: Standard Oil Co. of Calif./Smart et al #48-9 (Fig. 68), Standard Oil Co. of Calif./Simon-Newman #1 (Fig. 55), Chevron USA Inc./United California Bank No. 1 Redrill No.1 (Fig. 48), and Atlantic Richfield Co./Mantelli #1 (Fig. 52).

We have calculated two-way travel times from the sonic logs and displayed these in Figures 73 to 117. In most cases, this calculation required us to extrapolate sonic velocities to the surface. In some cases, the distance over which the first measured sonic velocity was judged to be too great to extrapolate it to the surface. In these cases, we calculated two-way travel times starting at the top of the sonic log.

## **DATA AVAILABILITY**

The compiled density and sonic logs and calculated travel time curves shown in Figures 2 to 117 are available as Excel5 spreadsheets using anonymous ftp. The anonymous ftp address is: andreas.wr.usgs.gov. Change the directory (cd) to /pub/outgoing/sfbay. The files are named Sonic.xl5.bin and Density.xl5.bin (Excel5), in Mac Binary II format. Tables 1 and 2 of this report



is also in this ftp site, labeled as Table 1 and Table 2. The Open-file Report text is available in Word6 as OFR98-xxx.wd.bin.

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ABBREVIATIONS USED IN TABLE 1:

BHC - Borehole Compensated Sonic Log  
CNFD - Compensated Neutron Formation Density  
CFD gg - Compensated Formation Density (gamma-gamma)  
CNF (ds) - Compensated Neutron Formation Density (Dual Spaced)  
Cal. - Caliper  
D.F. - Drilling Floor  
G.L. - Ground Level  
GR - Gamma Ray  
K.B. - Kelly Bushing  
SP - Spontaneous Potential  
TD - Total Depth

T3R3R - Sonic tool spacing (in feet) between transmitter (T) and receivers (R)

Table 1. Oil test well locations

Operator	Leasename	Well No.	T	R	S	Field	Latitude	Longitude	TD (ft)	TD (m)	Elev. (ft)	Elev. (m)	Datum	Year Comp.	Sonic Log	Density Log	Other Logs
Kadane G E & Son	West Durnnigan	1-13 N	12 W	2	13	West Durnnigan	38.88721	-122.03090	7005	2136	316	96	KB	1961	T3R3R		SP
Chevron USA	Sun Lepori	1 N	12 W	16	19	Point Arena	38.88275	-123.67830	6361	1939	113	34	KB	1963	T3R1R		SP
Texaco	English Creek	3 N	7 W	1	32	Vacaville Area	38.41397	-122.00098	4910	1497	385	117	KB	1959	T3R3R		SP
Occidental Pet	Capital Company	1 N	7 W	1	32	Vacaville	38.40979	-121.99197	5855	1785	283	86	KB	1961	T3R3R		SP
McCulloch Oil O	McCulloch-Macdon	1 N	6 W	1	32	Vacaville	38.32020	-121.99295	5354	1632	844	257	KB	1958	T3R3R		SP
Chevron USA	Arnold Ranch #1	1 N	4 W	2	26	Wildcat	38.15831	-122.05733	1901	580	14	4	DF	1983	BHC 2'	FDC	Cal., GR, SP
Chevron USA	United California	1 N	3 W	1	24	Honker Bay	38.08267	-121.91872	7600	2317	20	12	GL	1980	BHC	CNFD	Cal., GR, SP
Chevron USA	Perry #1	2 N	2 W	1	8	Los Medanos	38.03431	-121.99451	4053	1236	187	57	KB	1981	BHC	CNFD	Cal., GR, SP
Chevron USA	Perry #1	2 N	2 W	1	8	Los Medanos	38.03431	-121.99451	3000	915	187	57	KB	1981	BHC	CNFD	Cal., GR, SP
Gulf Oil Corp	Sasnon/ Porter	1 N	2 E	2	25	Oakley	37.99702	-121.69957	9018	2749	18	5	KB	1963	T3R3R		Cal., SP
Brazos O&G	Antioch Unit A	1 N	2 E	2	28	SE Antioch	37.98875	-121.75655	9179	2798	131	40	KB	1962	T3R3R		Cal., SP
Prewett Gas Uni		1 N	1 E	2	6	Antioch	37.96278	-121.80122	8000	2439	275	84	KB	1963	T3R3R		Cal., SP
Shell Oil	Heidorn	2-4 N	1 E	2	4	Brentwood	37.96321	-121.75728	11472	3498	138	42	DF	1961	T3R1R		Cal., SP
Shell Oil	L and W	2-14 N	1 E	2	14	NE Brentwood	37.93684	-121.71762	7306	2227	93	28	DF	1962	T3R1R	CNFD	Cal., SP
Atlantic Richfield	Mantelli	1 N	1 E	4	14	Wildcat	37.92865	-121.49559	16335	4980	4	1	KB	1971	BHC T3R2R		Cal., GR, SP
Exxon Corp	Myrvin C. Carey	1 N	1 E	2	7	South Pittsburg	37.95045	-121.79082	9030	2753	282	86	KB	1963	T3R1R		Cal., SP
Shell Oil	Ginochio	4-4 N	1 E	1	4	SE Pittsburg Area	37.95963	-121.86142	6798	2073	723	220	DF	1964	T3R1R		Cal., SP
Chevron USA	Trollman	1 N	1 W	4	3	Richmond Area	37.95716	-122.29100	6396	1950	580	177	DF	1966	BHC T3R2R		Cal., SP
Shell Oil	Cunha	1-1 N	1 E	2	1	Brentwood	37.96660	-121.70491	7694	2346	76	23	KB	1963	T3R1R		Cal., SP
Exxon Corp	Wico-Bankhead	1 S	1 E	4	34	Bethany	37.96556	-121.52349	11000	3354	17	5	KB	1962	T3R1R		Cal., SP
Phillips Petro.	Vierra A	1 S	1 E	3	9	Wildcat	37.86034	-121.64894	8733	2663	119	36	KB	1981	BHC	CNFD	Cal., GR, SP
Shell Oil	Pagano	No. 2 S	1 E	3	4	Byron	37.87874	-121.64203	9004	2745	46	14	DF	1964	T3R1R		Cal., SP
Helm Co and Sum	Sproule	1 S	1 E	3	11	SE Byron	37.85452	-121.61049	10046	3063	20	6	KB	1964	BHC T3R2R		Cal., SP
Brown/ E C Oper	Lupin	2 S	3 E	3	8	SW Livermore	37.68600	-121.67139	5645	1721	860	262	KB	1967	BHC T3R2R	CFD 99	Cal.
Brown/ E C Oper	Lupin	3 S	3 E	3	8	SW Livermore	37.68419	-121.66911	5503	1678	957	292	KB	1967	BHC T3R2R		Cal., SP
Johnston/ M L	Franzen	1 S	8 E	8	17	NW Gustine	37.24153	-121.11357	3618	1103	258	79	KB	1970	BHC T3R2R		Cal., SP
Standard Oil	Simon Newman	1 S	8 E	8	7	SE Quinto Prospect	37.24867	-121.12303	10985	3349	259	79	GL	1972	BHC T3R2R	CNFD	Cal., GR, SP
Burns R L Corp	Simon-Newman	12-1 S	8 E	7	12	Wildcat	37.25756	-121.15624	11220	3421	482	147	KB	1977	BHC T3R2R	Den	Cal., GR
Brown/ E C	Mello	1 S	9 E	9	20	Ingomar	37.14093	-121.09000	7020	2140	142	43	KB	1967	BHC T3R2R		SP
Occidental Pet	Sargent	1 S	11 E	3	36	Sargent	36.92953	-121.58679	6972	2126	449	137	KB	1967	BHC T3R2R	CFD 99	Cal., GR
Occidental Pet	Bingaman	1 S	12 E	3	34	Aromas	36.83914	-121.61877	7130	2174	554	169	KB	1967	BHC T3R2R		Cal., GR
Santa Fe Energy	Law	80X-1 S	14 E	6	7	Wildcat	36.72423	-121.34576	2076	633	1132	345	KB	1980	BHC	CNFD	Cal., GR, SP
USGS	Law	CB-1 S	14 E	6	7	Hollister	36.72423	-121.34576	6224	1898				1979	BHC	CNFD	Cal., GR, SP
Holmes/ W W	Towle	1-12 S	15 E	7	12	Emmett	36.64900	-121.15012	2395	730	1259	384	KB	1958	T3R3R		SP
C.L. Mueller	Sun McDonald	#1-36 S	16 E	10	36	Vallecitos	36.49553	-120.82805	3600	1098	2246	685	KB	1987	BHC	CFD	Cal., GR
Texaco Inc.	Chesholm	1 S	16 E	5	18	Gonzales Prospect	36.53761	-121.45883	2304	702	150	46	KB	1980	BHC		Cal., GR
Standard Oil of Amer.	Tamnehill Ranch	9 S	18 E	8	15	Wildcat	36.36895	-121.09242	643	196	1285	392	KB	1976		CNFD	Cal., GR
Standard Oil of Amer.	Tamnehill Ranch	10 S	18 E	8	23	San Lorenzo	36.35265	-121.06948	964	294	953	291	KB	1976		CNFD	Cal., GR
Ferguson&Bosworth	Kin-Ark-Pura	1 S	18 E	6	19	Greenfield	36.35651	-121.35345	4029	1228	698	213	KB	1965	T3R3R		GR
Texaco Inc.	Clark	1 S	18 E	6	16	Rancho Los Coche	36.37077	-121.31924	2336	712	263	80	KB	1977	BHC		Cal., GR
Phillips Petrol.	Olsen	A-2 S	18 E	6	29	Wildcat	36.33731	-121.34622	6004	1830	704	215	GL	1982	BHC	CNFD	Cal., GR
Standard	Keenan	37 S	19 E	7	29	Monroe Swell	36.24445	-121.23781	2831	863	722	220	DF	1966	BHC TR2R		Cal., SP
Seaboard Oil & Gas	DeAlvarez	#21-5 S	19 E	10	5	Lewis Creek	36.31306	-120.91725	6506	1984	1046	319	KB	1965	T3R3R		Cal., SP
Phillips Petro.	A. Doud	1 S	19 E	6	13	Wildcat	36.27676	-121.26707	3753	1144	1002	305	KB	1987	BHC	CNLD	Cal., GR
Century Oil	Doud	15 S	19 E	7	19	Monroe Swell	36.26299	-121.24698	3349	1021	793	242	KB	1976		CNFD	Cal., GR
Energy Prod & S	Burnett	1 S	19 E	7	19	Monroe Swell	36.25807	-121.25319	2415	736	946	288	KB	1980			

Table 1. Oil test well locations

Koch Explor.	Arroyo Seco Fed.	48X-11 S	19 E	5 11	Wildcat	36.28720	-121.39651	6127	1868	2340	713 GR	1984 5' BHC		Cal., GR
Phillips Petrol.	Hansen	1 S	19 E	6 11	Wildcat	36.29761	-121.28543	4343	1324	378	115 KB	1990 Long Spacing	CNLD	Cal., GR, SP
Texas Pacific	Eade	1 S	19 E	10 12	Spanish Flats	36.29739	-120.84625	6619	2018	2764	843 KB	1977	CNFD	Cal., GR
Cities Service	Plaskett	1-A S	20 E	8 20	Jolon Hunter Liggett			4063	1239	1271	388 GL	1969 T3R3R	gg	Cal., GR, SP
Cities Service	1-Wallace-A	Redrill 2 S	20 E	6 2	Greenfield	36.22670	-121.27917	10842	3305	720	220 KB	1973 BHC T3R2R	CFD gg	Cal., GR, SP
Chevron	Section 8, Thompson	1 S	20 E	7 8	Thompson Canyon			6245	1904	945	288 GL	1981 BHC	CNFD	BS, Cal., GR
Richard R. Thorup	Thomas Doud Est.	4-D S	20 E	8 32	San Bernabe	36.14284	-121.12820	2058	627	503	153 GL	1960 T3R3R		SP
Pennant Operati	Doud	3-D S	20 E	8 32	King City	36.14284	-121.12820	2158	658	578	176 KB	1962 T3R3R		SP
Standard Oil	Smart et al	48-9 S	20 E	7 9	Thompson Canyon	36.20052	-121.21835	7027	2142	700	213 DF	1968	CFD gg	Cal.
Standard	Sumner & Gould	18-14 S	20 E	6 14	North Oat Hills			3294	1004	873	266 GL	1967	CFD gg	Cal., GR
Chevron		#4-1 S	20 E	15 7	West Coalanga	36.20863	-120.38519	1758	536	906	276 GL	1980	Densilog	Cal., GR
Beach, Church, Bell	Salinas Land Co.	1 S	20 E	8 18	King City	36.18861	-121.14882	1200	366	389	119 KB	1960 T3R3R		SP

Table 2. Borehole Stratigraphy

Well Name	Depth (feet) (Top of Fm.)	Depth (m) (Top of Fm.)
<u>West Dunnigan No. 1-13</u>		
All Upper Cretaceous		
<u>Sun Lepori No. 1</u>		
All Miocene		
<u>English Creek Core Hole No. 3</u>		
Markley (U. Eocene)		
Nortonville (U. Eocene)	1260	384
Domengine (M. Eocene)	2110	643
Capay (L. Eocene)	2210	673
Paleocene	3410	1040
Upper Cretaceous	4300	1310
<u>Capital Company No. 1</u>		
Capay		
Upper Cretaceous	4576	1395
<u>McCulloch-Macson UHL No. 1</u>		
All Upper Cretaceous		
<u>Arnold Ranch #1 Redrill #1</u>		
Eocene/Paleocene		
<u>United California Bank No. 1</u>		
Markley (U. Eocene)		
Nortonville (U. Eocene)	6620	2018
<u>Boylan Unit One</u>		
Nortonville (U. Eocene)		
Domengine (M. Eocene)	1500	457
Cretaceous	1810	551
<u>Perry #1 Redrill</u>		
Markley (U. Eocene)		
Nortonville (U. Eocene)	2180	665
Markley (U. Eocene)	2500	762
Nortonville (U. Eocene)	3650	1112
Domengine (M. Eocene)	3950	1204
<u>Perry #1 Redrill #2</u>		
Markley (U. Eocene)		
Nortonville (U. Eocene)	2030	619
Domengine (M. Eocene)	2510	765

Table 2. Borehole Stratigraphy

<u>Porter Sesnon No. 1</u>		
Markley (U. Eocene)		
Nortonville (U. Eocene)	4592	1400
Domengine (M. Eocene)	5103	1556
Capay (L. Eocene)	5858	1786
Hamilton SS (L. Eocene)	6914	2108
<u>Antioch Unit A No. 1</u>		
Domengine ( M. Eocene)		
Capay (L. Eocene)	3686	1124
Hamilton SS (L. Eocene)	4845	1477
Martinez (freshwater)	5290	1612
Martinez (Paleocene)	5625	1714
Cretaceous	7444	2270
<u>Prewett Gas Unit No. 1</u>		
Meganos (Paleocene)		
Martinez (Paleocene)	4600	1402
Base of Martinez (Paleocene)	6400	1951
<u>Heidorn No. 2-4</u>		
Martinez (Paleocene)		
Cretaceous	5180	1580
<u>L and W No. 2-14</u>		
Base of Domengine (M. Eocene)	2780	848
Base of Capay (L. Eocene)	4105	1251
Base of Meganos (L. Eocene)	4700	1432
Channel Fill	6540	1994
Fault (?)	6540	1994
<u>Mantelli #1</u>		
Sidney/Nortonville (U. Eocene)		
Domengine (M. Eocene)	4720	1440
Capay (L. Eocene)	5300	1615
Cretaceous C/D/E zones	5600	1707
Cretaceous F/G/H zones	13300	4055
Basement	15250	4649
<u>S.O. Trollman No. 1</u>		
Upper Tertiary		
Tice Fm.	1710	521
Oursan	2280	695
Claremont	2600	792
Sobrante	3000	914

Table 2. Borehole Stratigraphy

Unconformity	3400	1036
Trollman SS	3400	1036
Lower Miocene	3800	1145
Nortonville (U. Eocene)	4800	1463
Undiff. Eocene	5040	1536
Martinez (Paleocene)	5846	1783
<u>Pagano No. 2-4</u>		
Nortonville (U. Eocene)		
Unconformity	4170	1271
Domengine (M. Eocene)	4140	1262
Martinez (Paleocene)	4700	1433
Danian	6000	1829
Starkey SS (U. Cretaceous)	6100	1859
Tracy sand (U. Cretaceous)	7200	2195
Delta shale (U. Cretaceous)	7500	2280
Winters sand (U. Cretaceous)	8550	2606
<u>Lupin #2</u>		
All Cretaceous		
<u>Lupin No. 3 Redrill</u>		
All Cretaceous		
<u>Simon Newman #1</u>		
Nonmarine Miocene		
Eocene A zone	3220	981
Upper Cretaceous	3740	1140
C/D zones	7200	2195
<u>Mello #1</u>		
Laguna Seca		
Garzas SS	3500	1067
Cretaceous	4170	1271

# WELLS WITH SONIC OR DENSITY LOGS

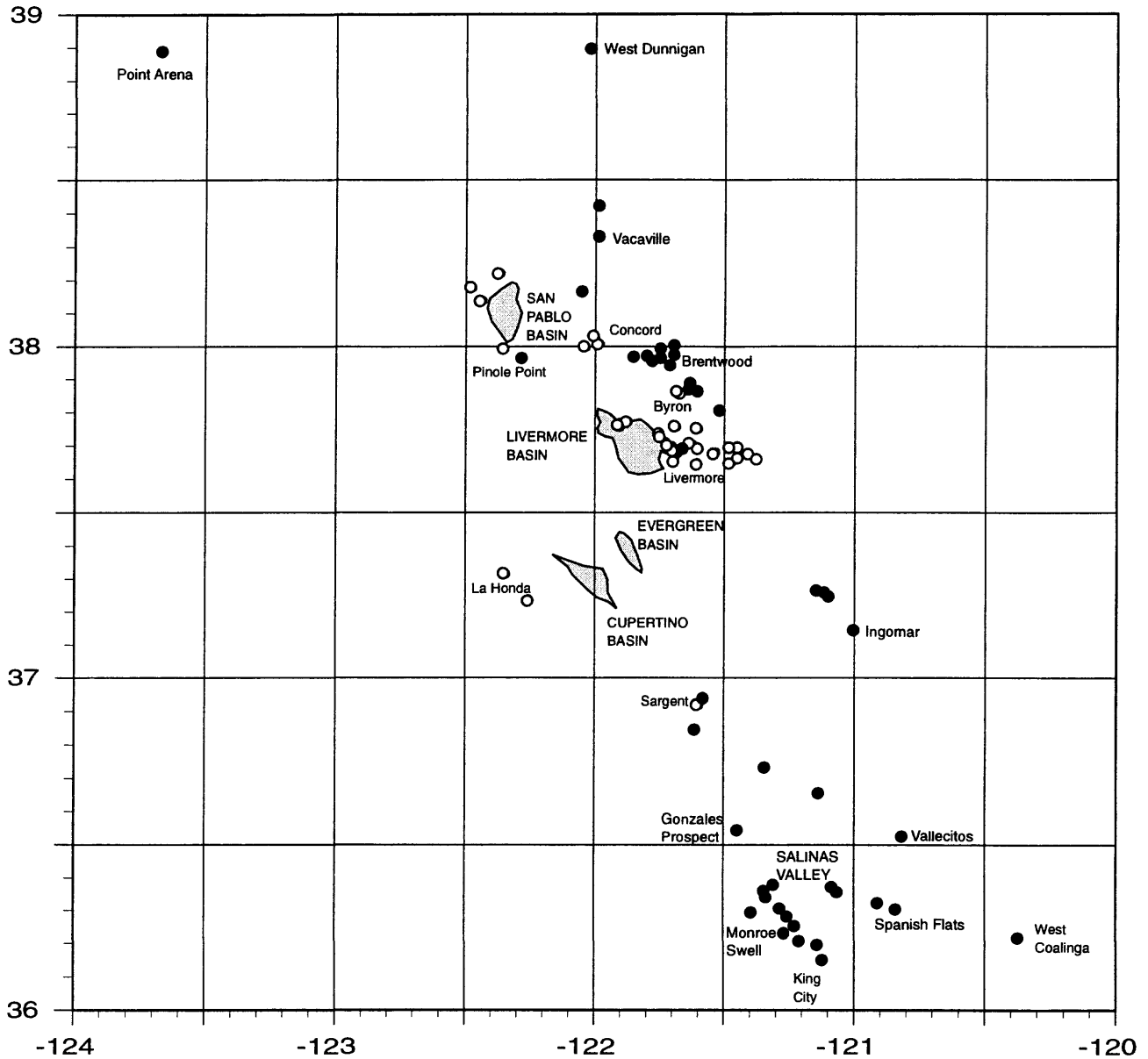


Figure 1. Map showing locations of wells having sonic or density log values tabulated in this report (solid filled circles). Shaded regions show selected Cenozoic basins inferred from inversion of gravity data [Jachens et al., 1995]. Selected oil fields are labeled (e.g. Concord, Livermore, La Honda, and Sargent fields). Locations of sonic and density well logs discussed by Brocher et al. (1997) are shown as open circles.



**G.E. Kadane and Sons, West Dunnigan No. 1-13**

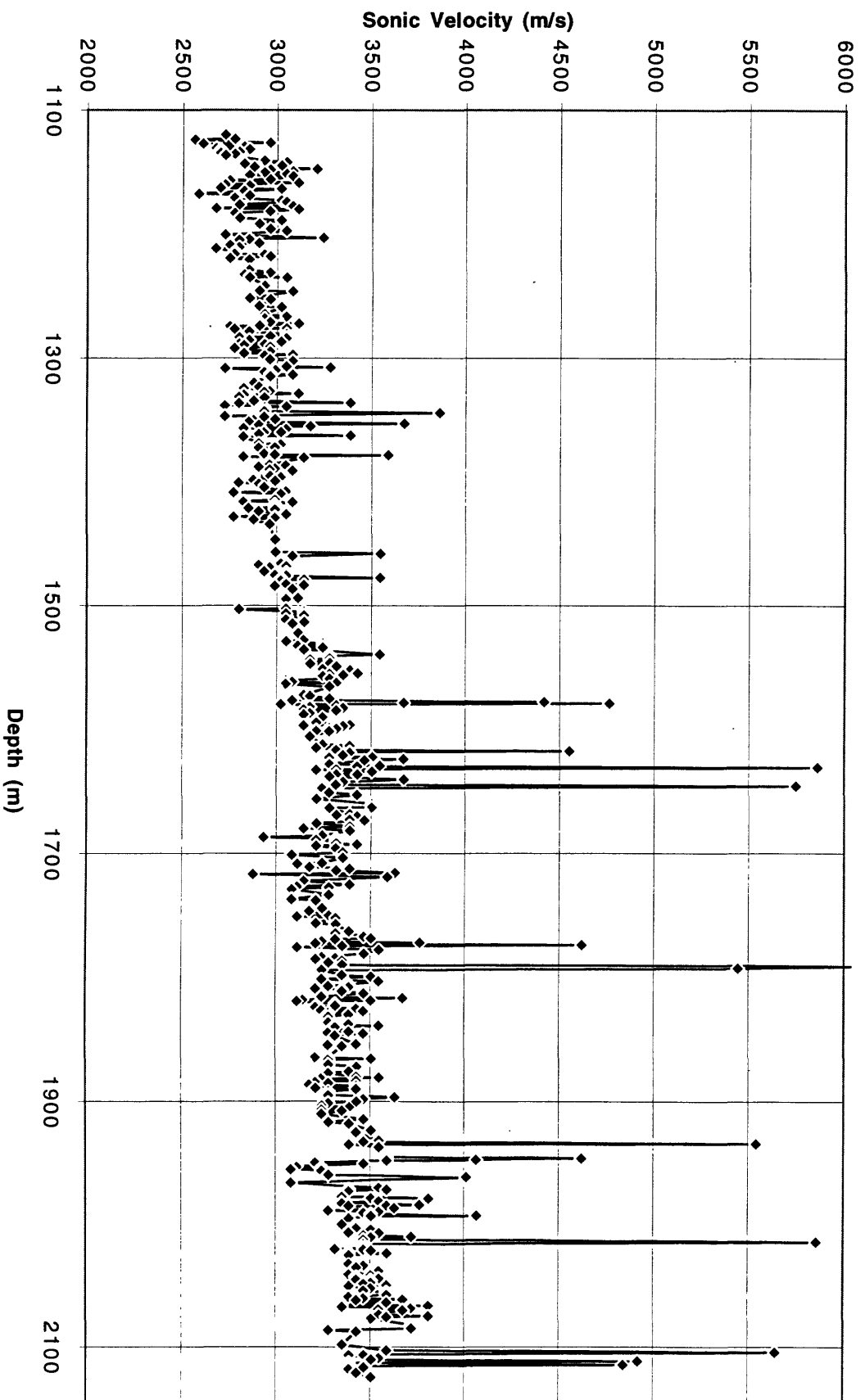


Figure 2.

Standard Oil Company of California, Sun-Leperi No. 1

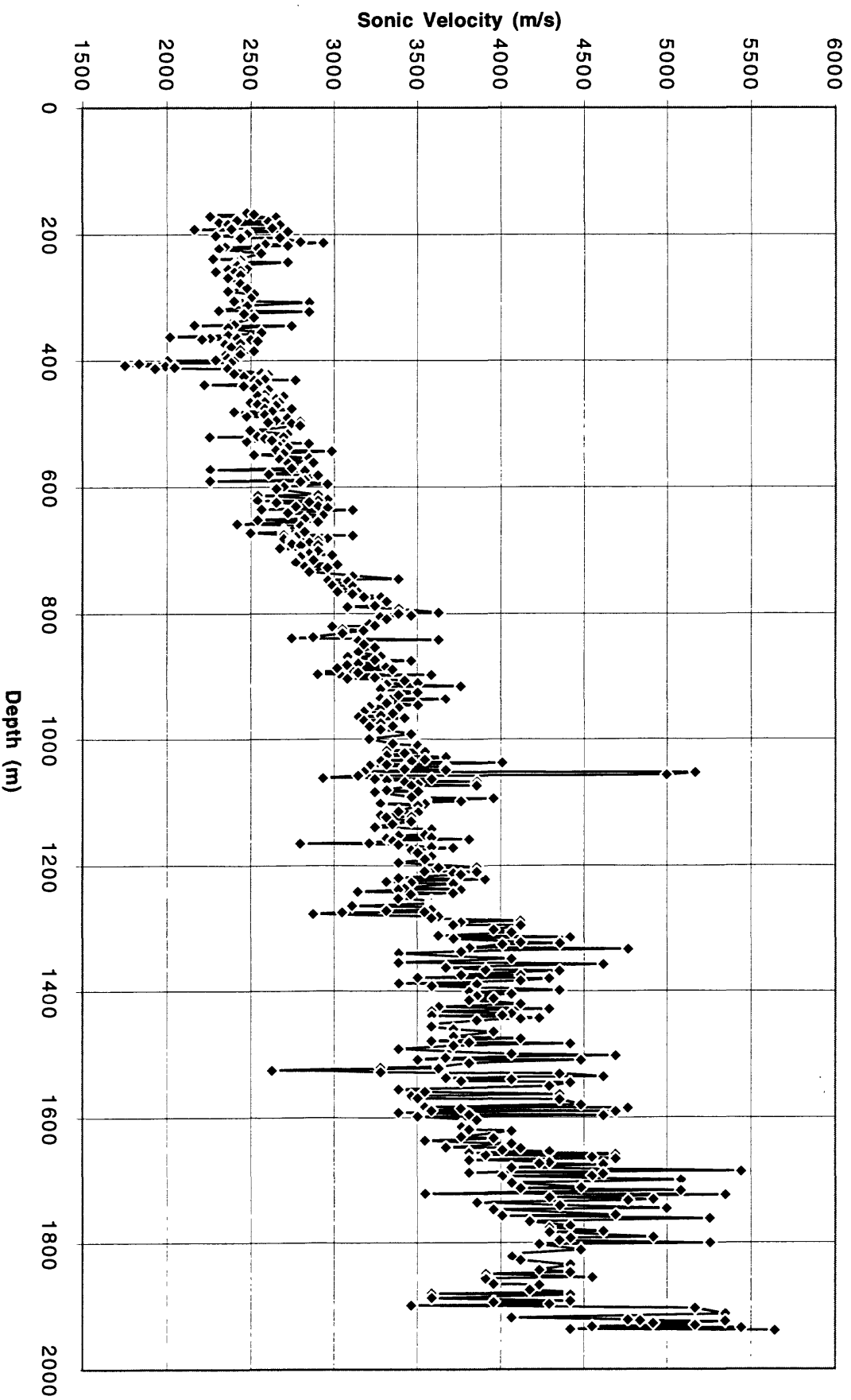


Figure 3.

**Texaco Incorporated, English Creek Core Hole No. 3**

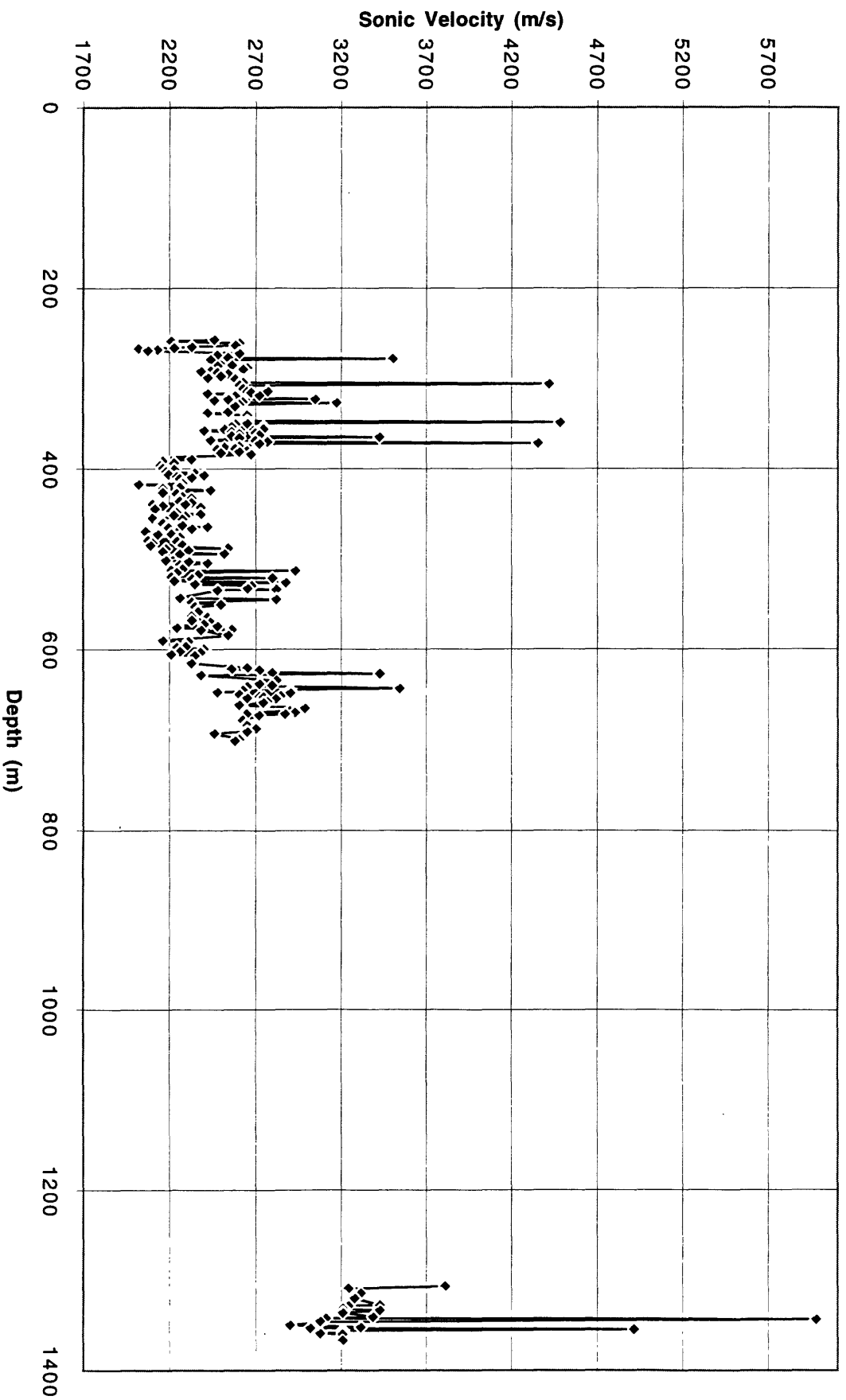


Figure 4.

Occidental Petroleum Corporation, Capital Company No. 1

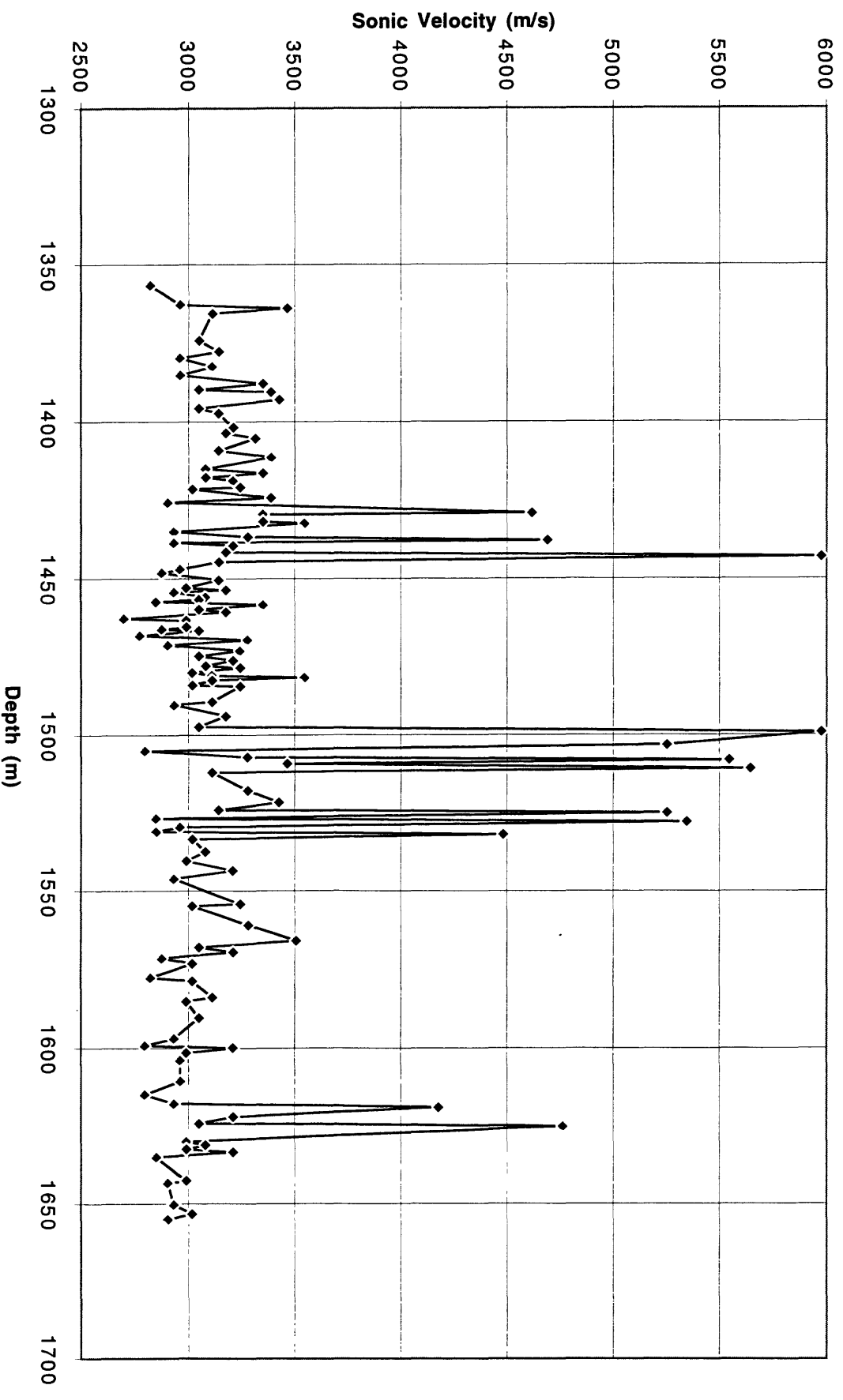


Figure 5.

McCulloch Oil Exploration Inc; McCulloch-Macdon UHL No. 1

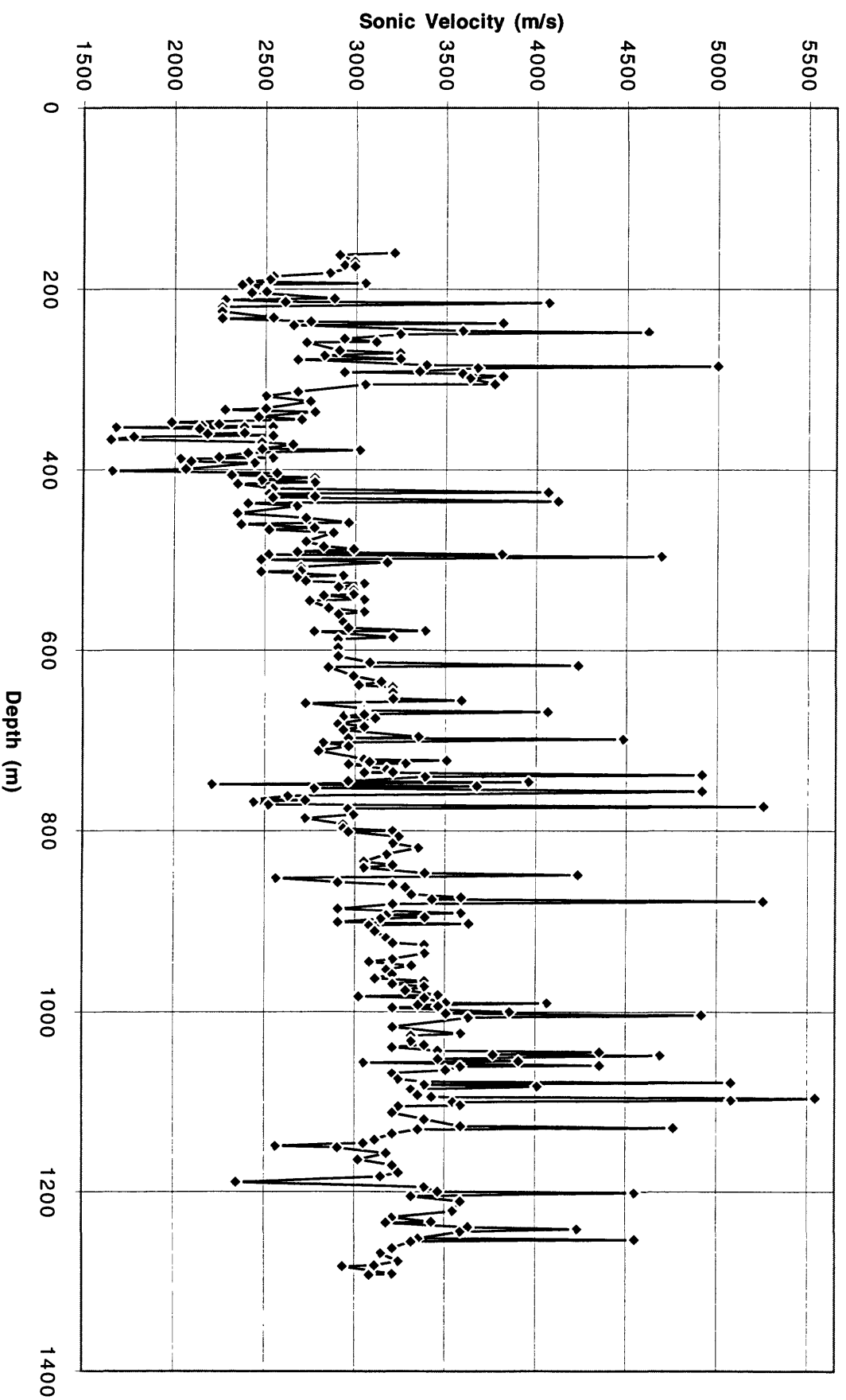


Figure 6.

**Chevron USA Inc; Arnold Ranch #1**

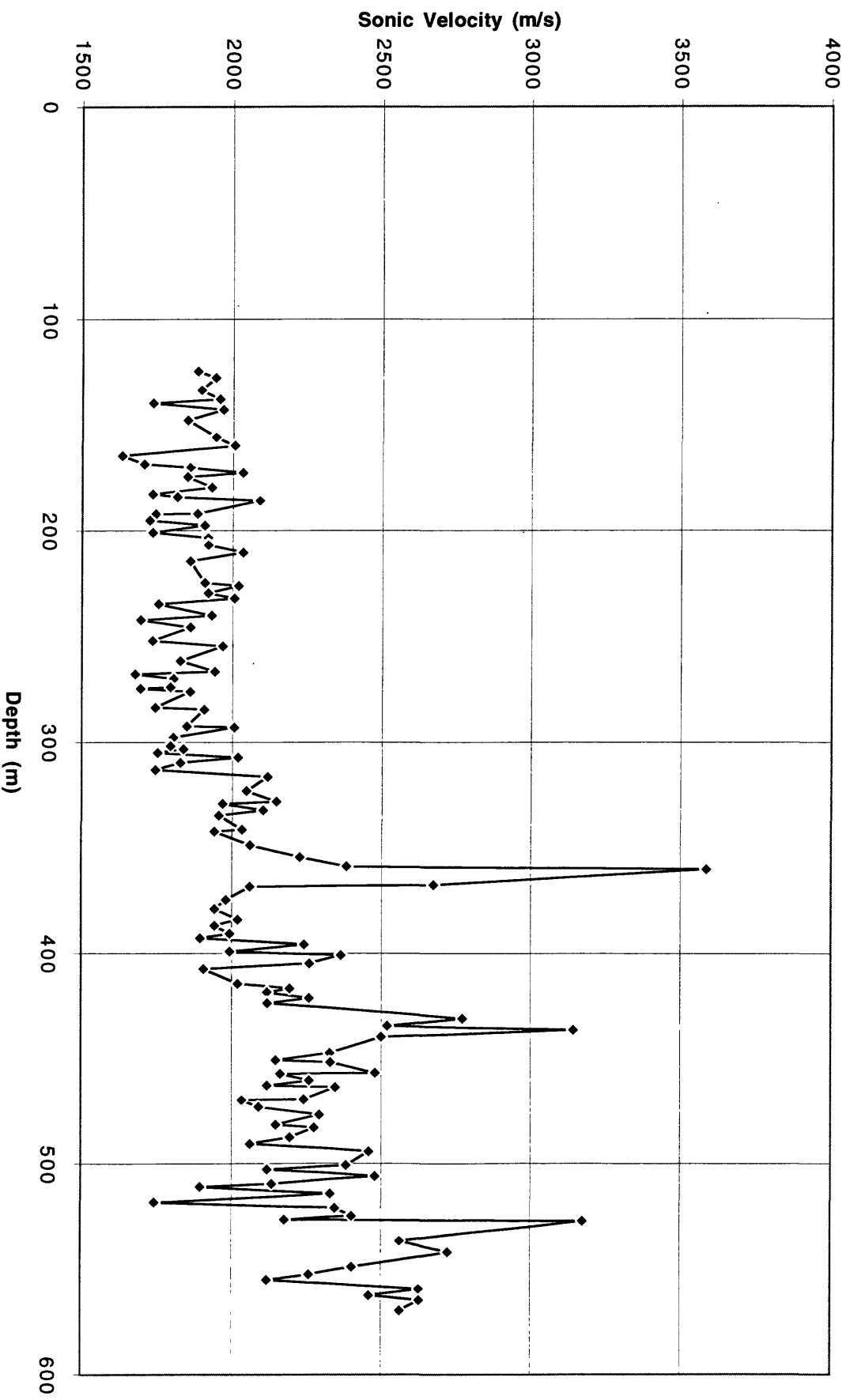


Figure 7.

**Chevron USA Inc; Chevron-Arnold Ranch #1 Redrill #1**

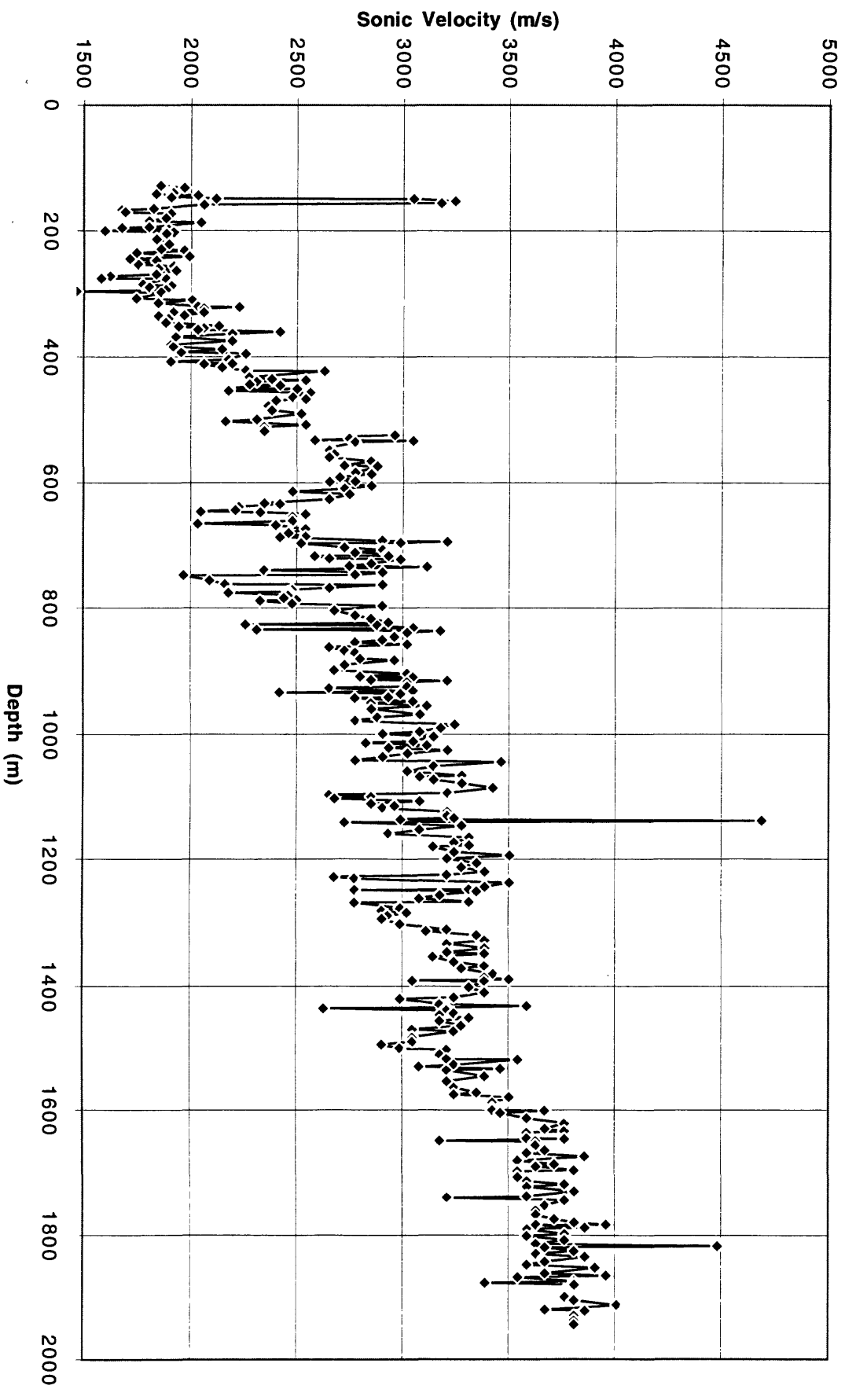


Figure 8.

**Gulf Oil Corporation (Chevron), Porter Sesonon No. 1**

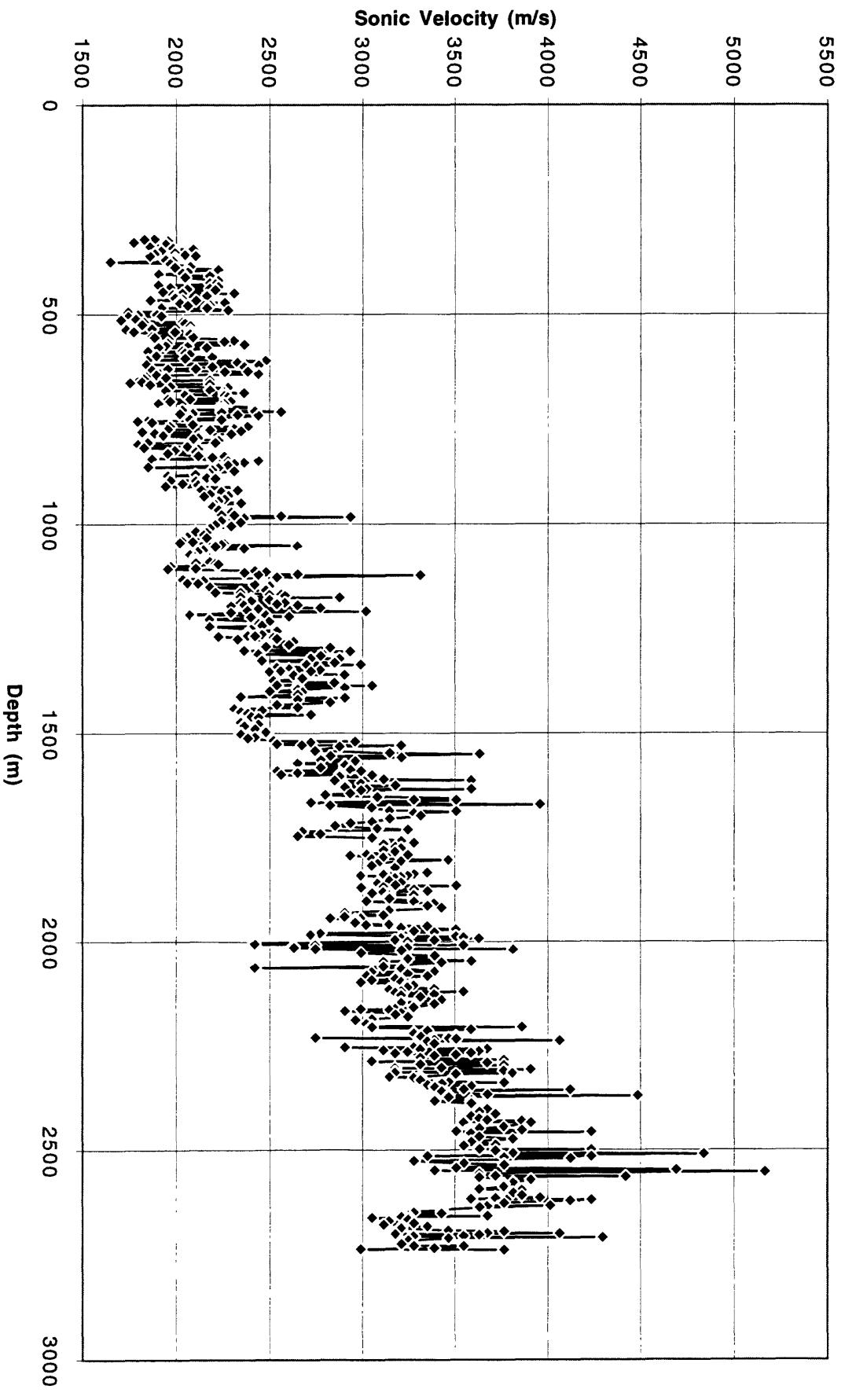


Figure 9.



**Brazos Oil and Gas Company, Antioch Unit A No. 1**

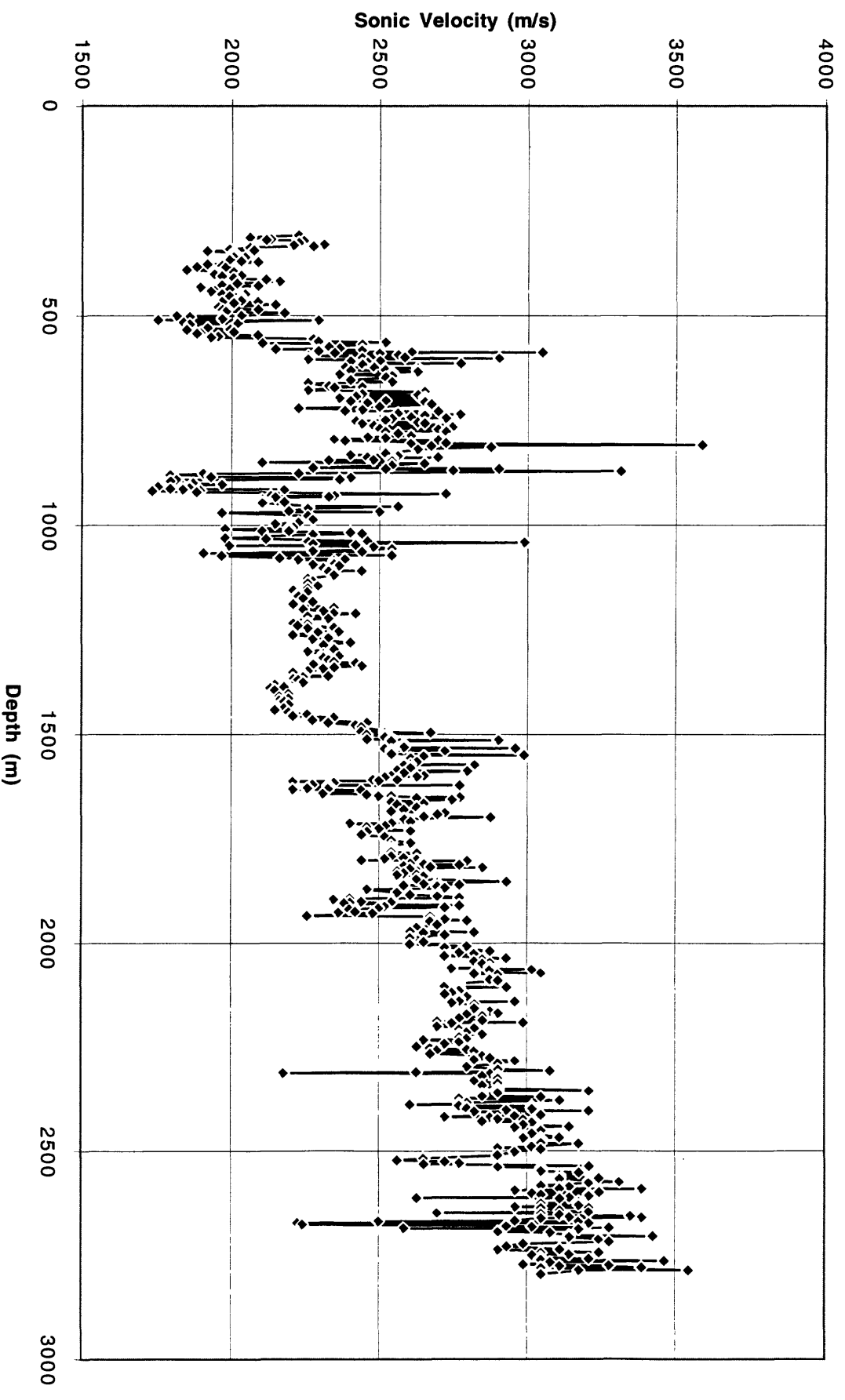


Figure 10.

**Brazos Oil and Gas Company, Prewett Gas Unit No. 1**

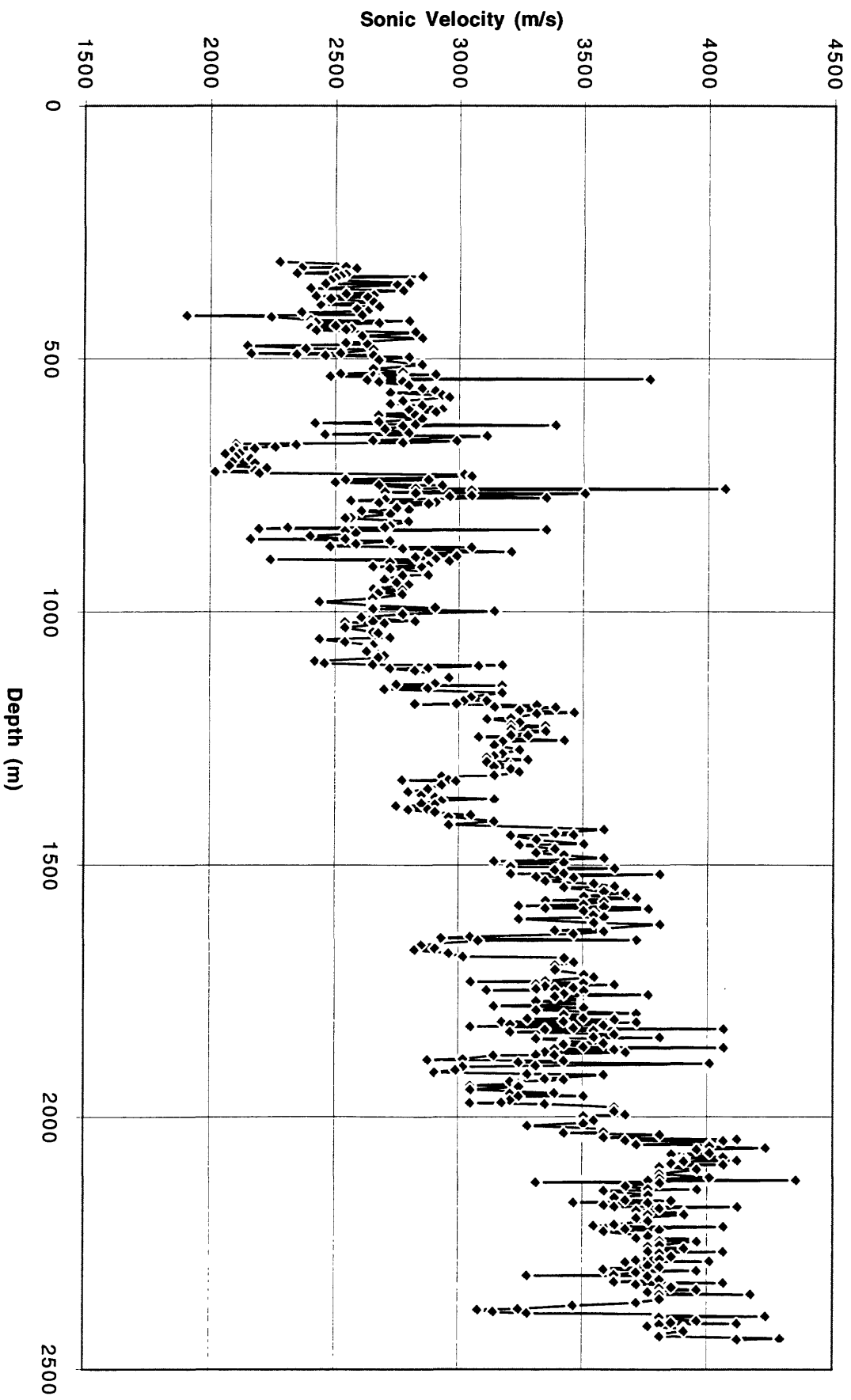


Figure 11.

Shell Oil Company, Heidorn No. 2-4

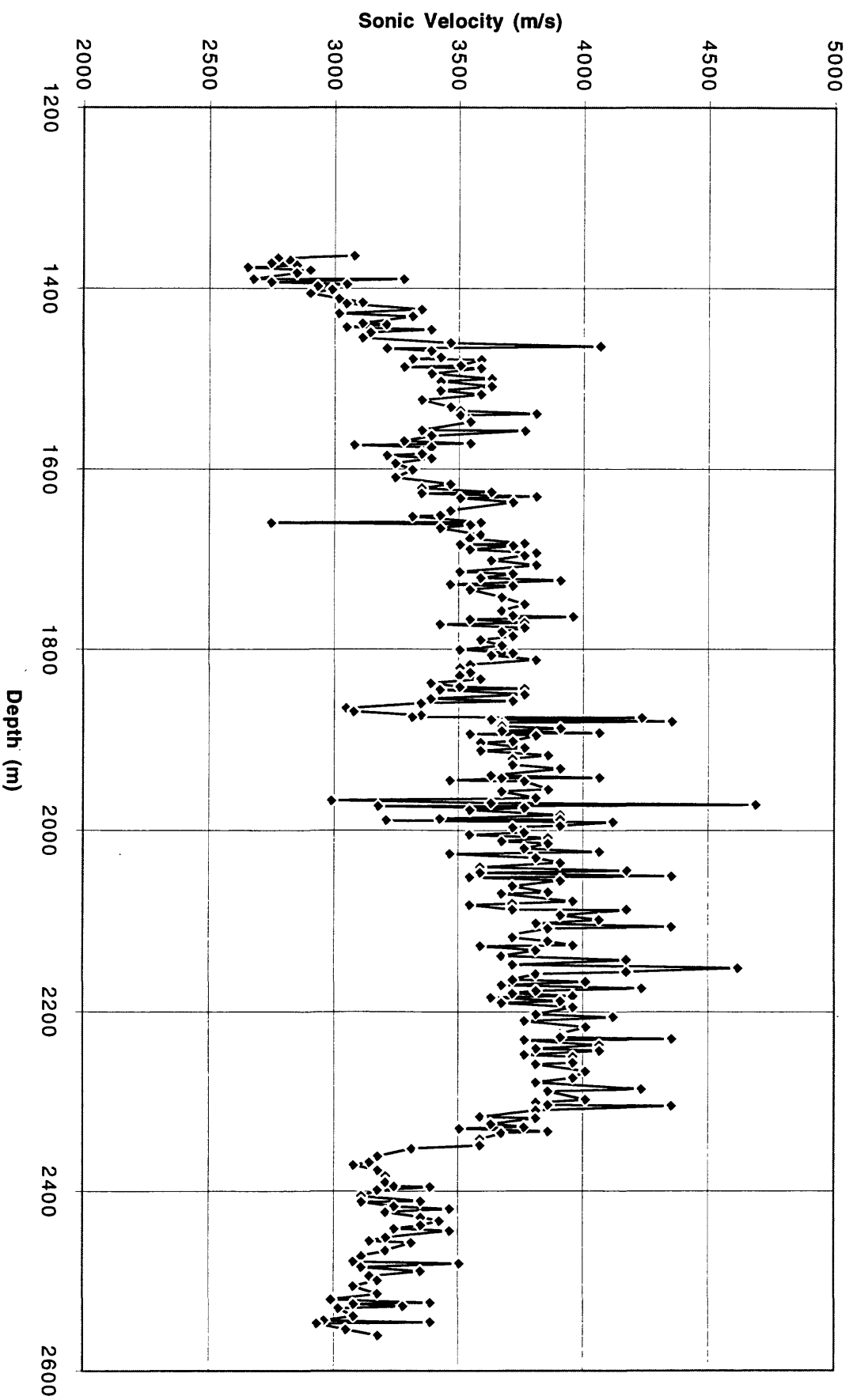


Figure 12.

Shell Oil Company, L and W No. 2-14

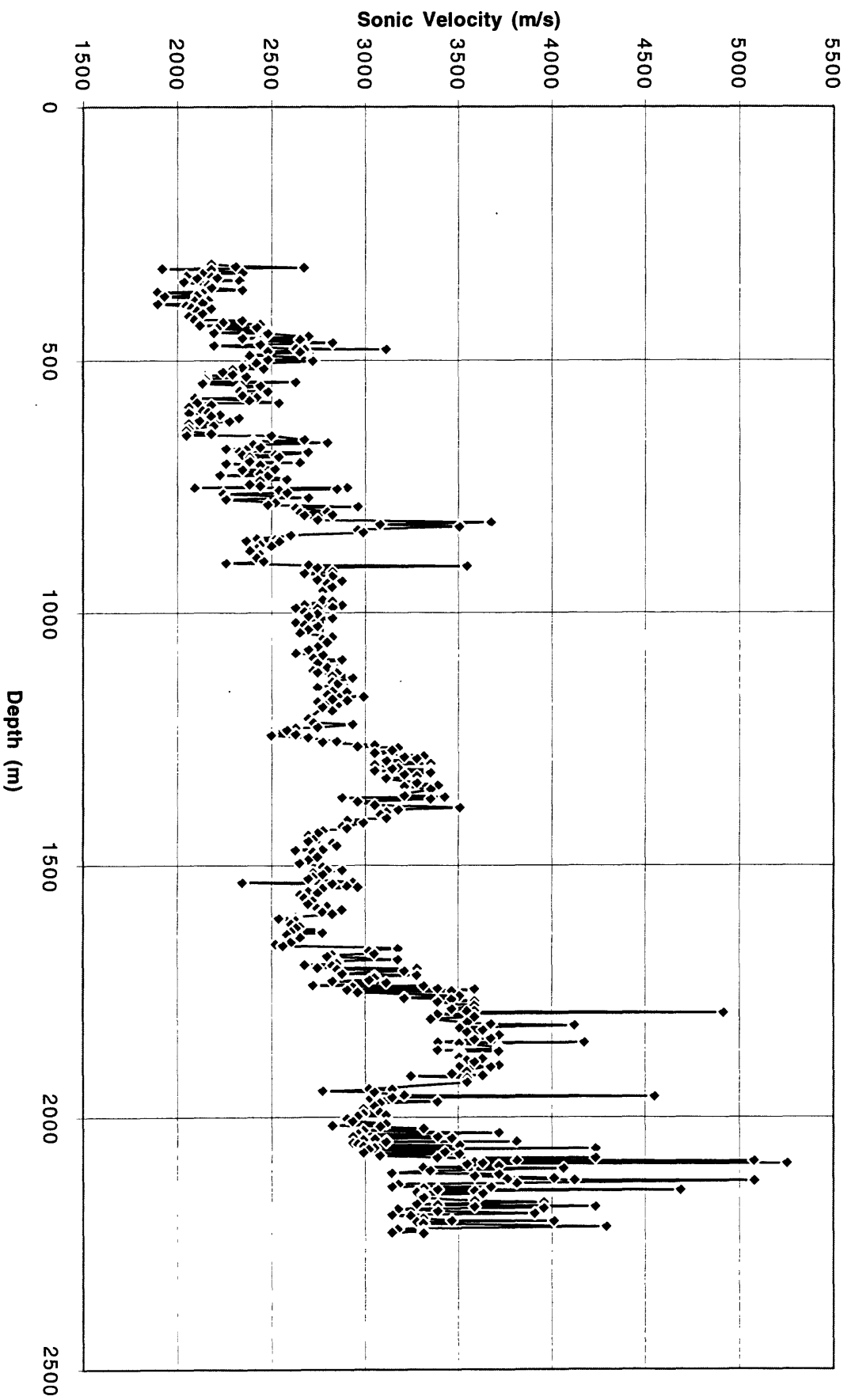


Figure 13.

Atlantic Richfield Company, Mantelli #1

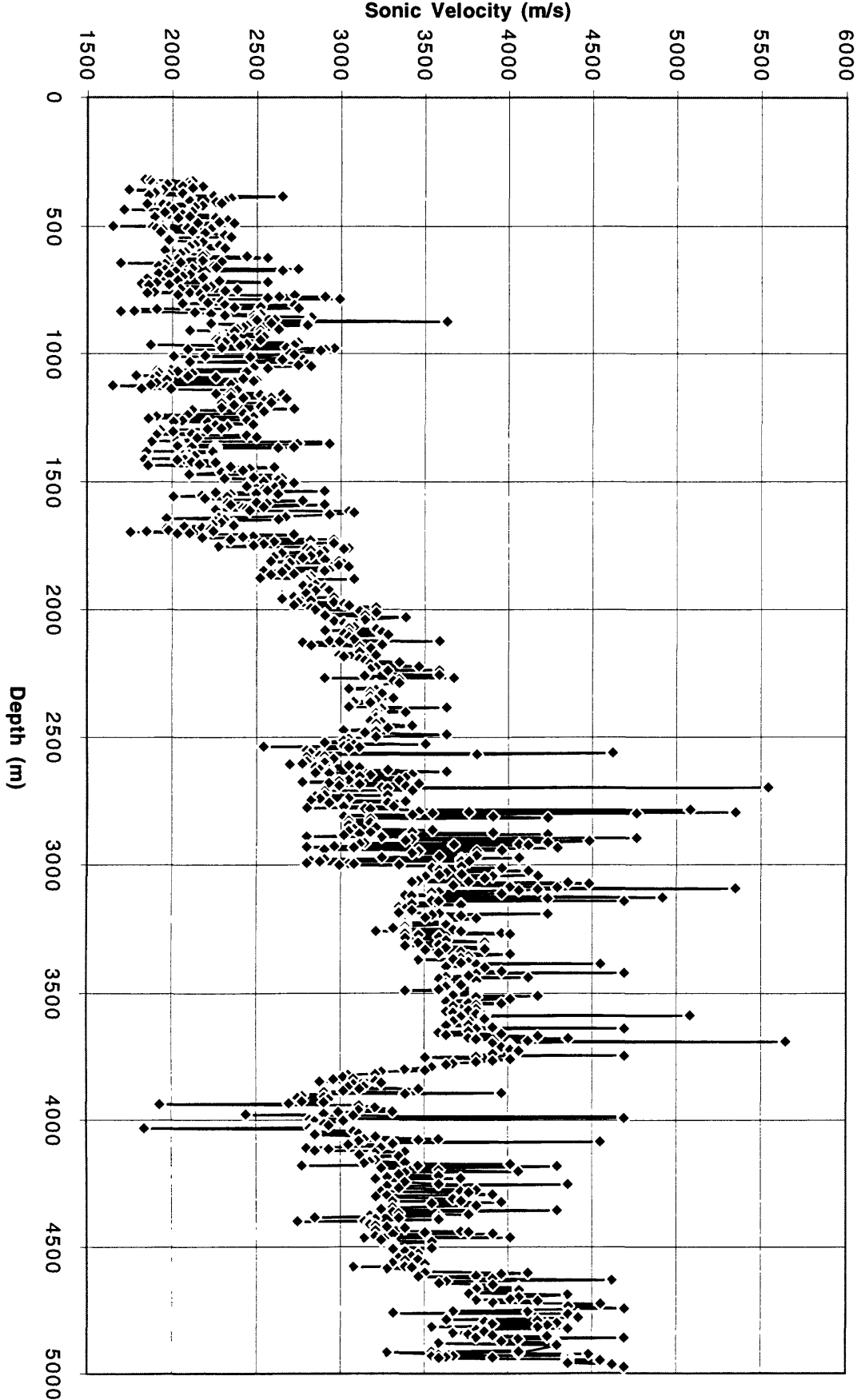


Figure 14.

Humble Oil Refining Co; Myrvin C. Carey et UX No. 1

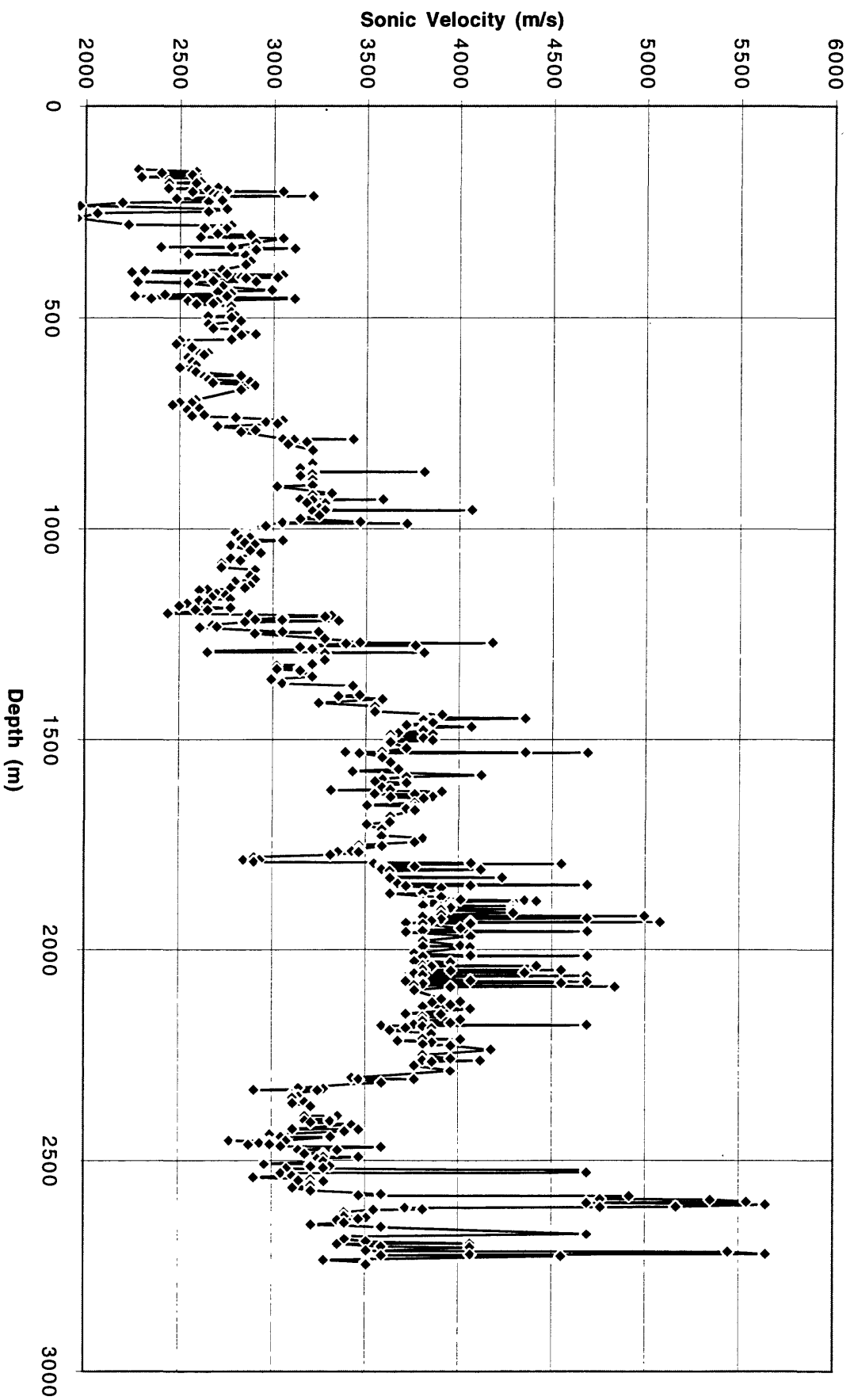


Figure 15.

Shell Oil Company, Shell Ginochio #4-4

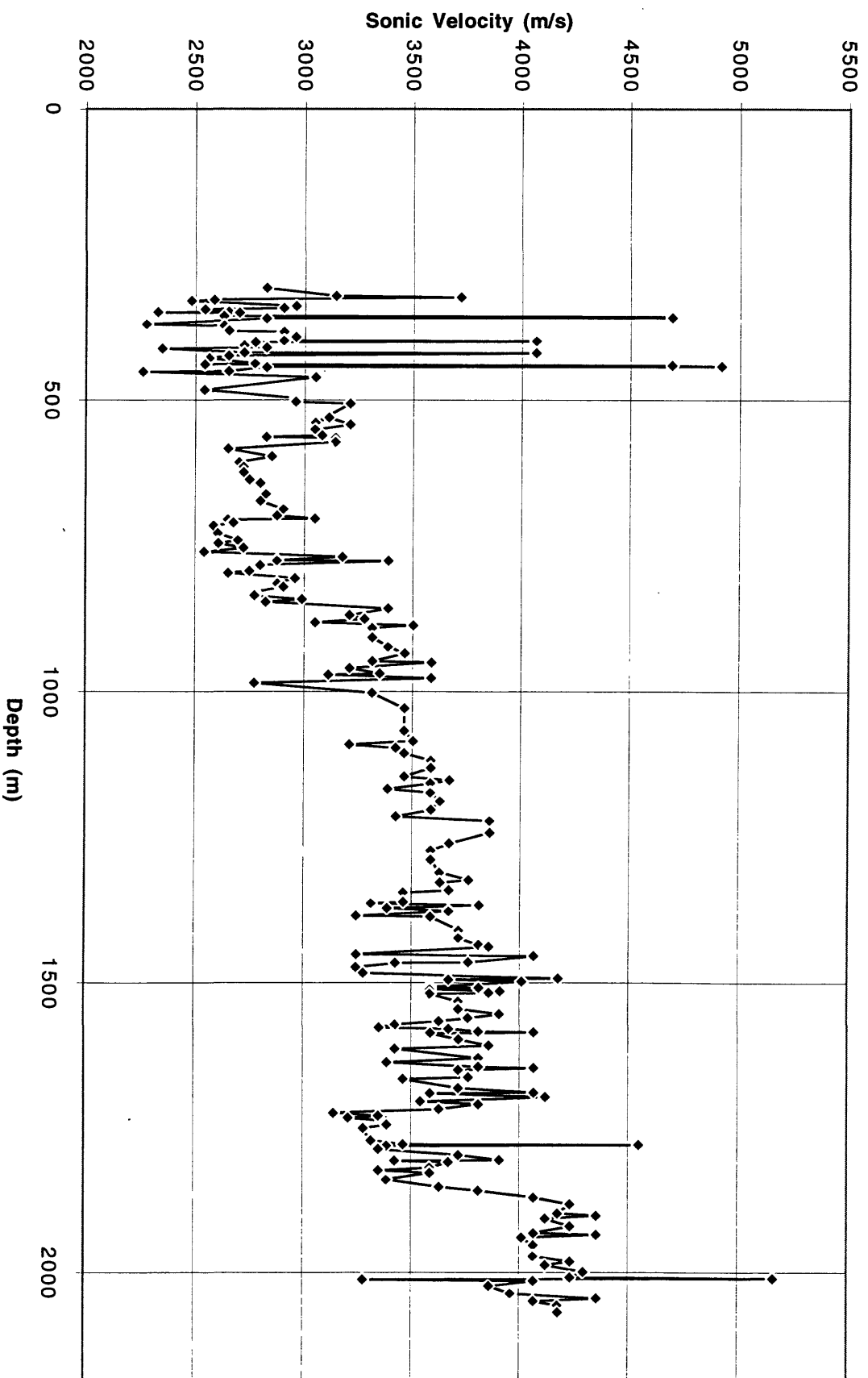


Figure 16.

Standard Oil Company of California, S.O. Trollman No. 1

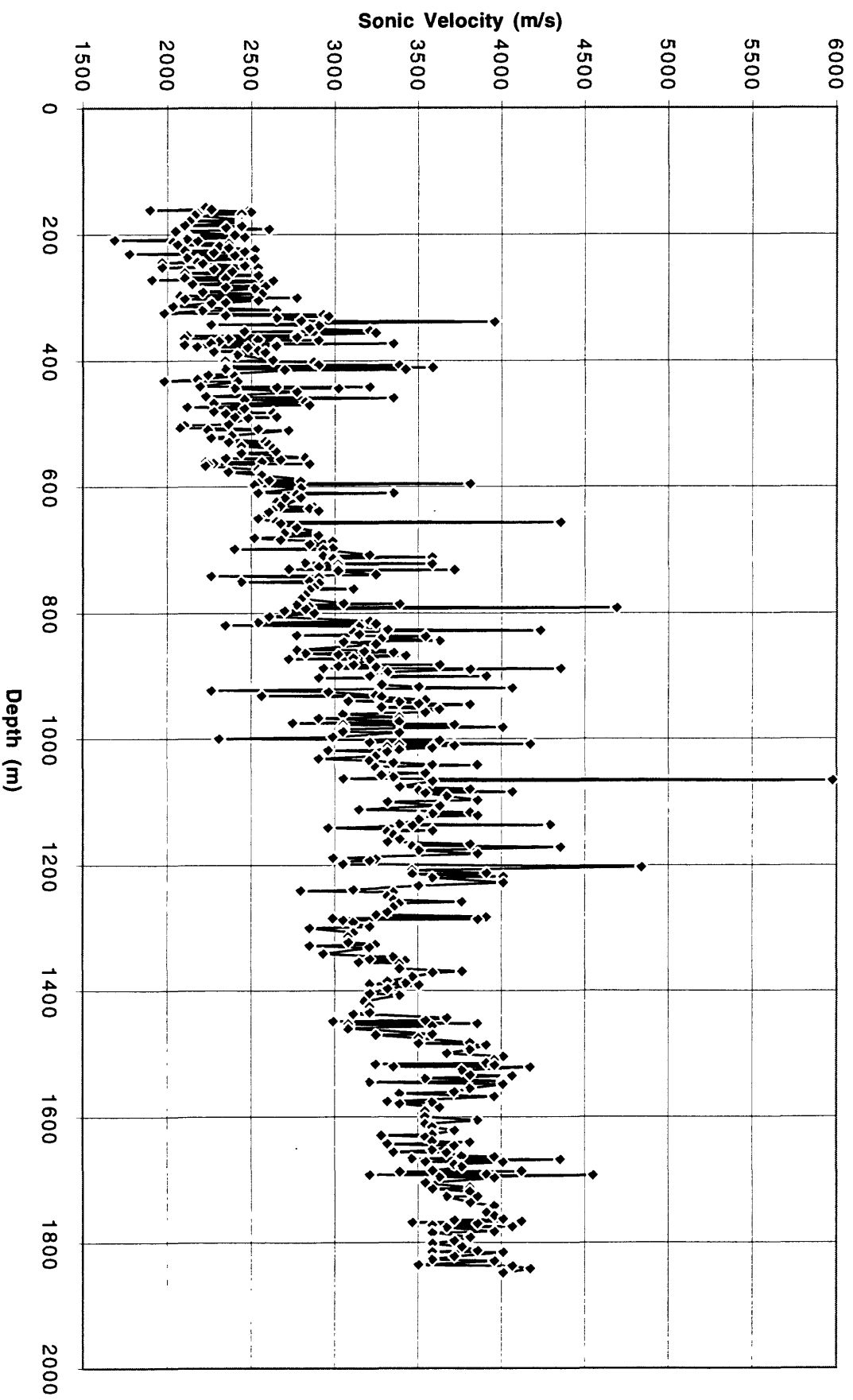


Figure 17.



Shell Oil Company, Cunha No. 1-1

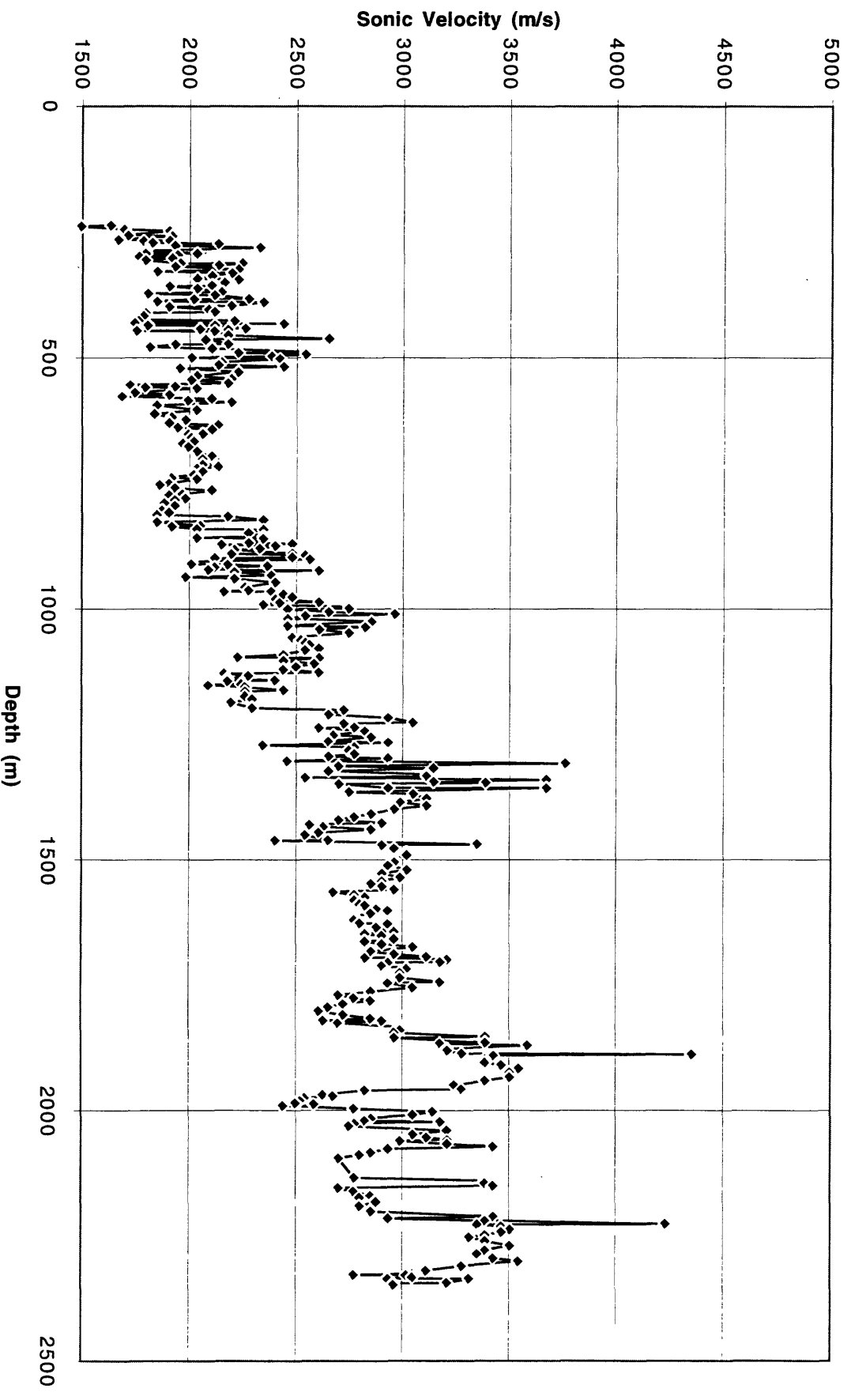
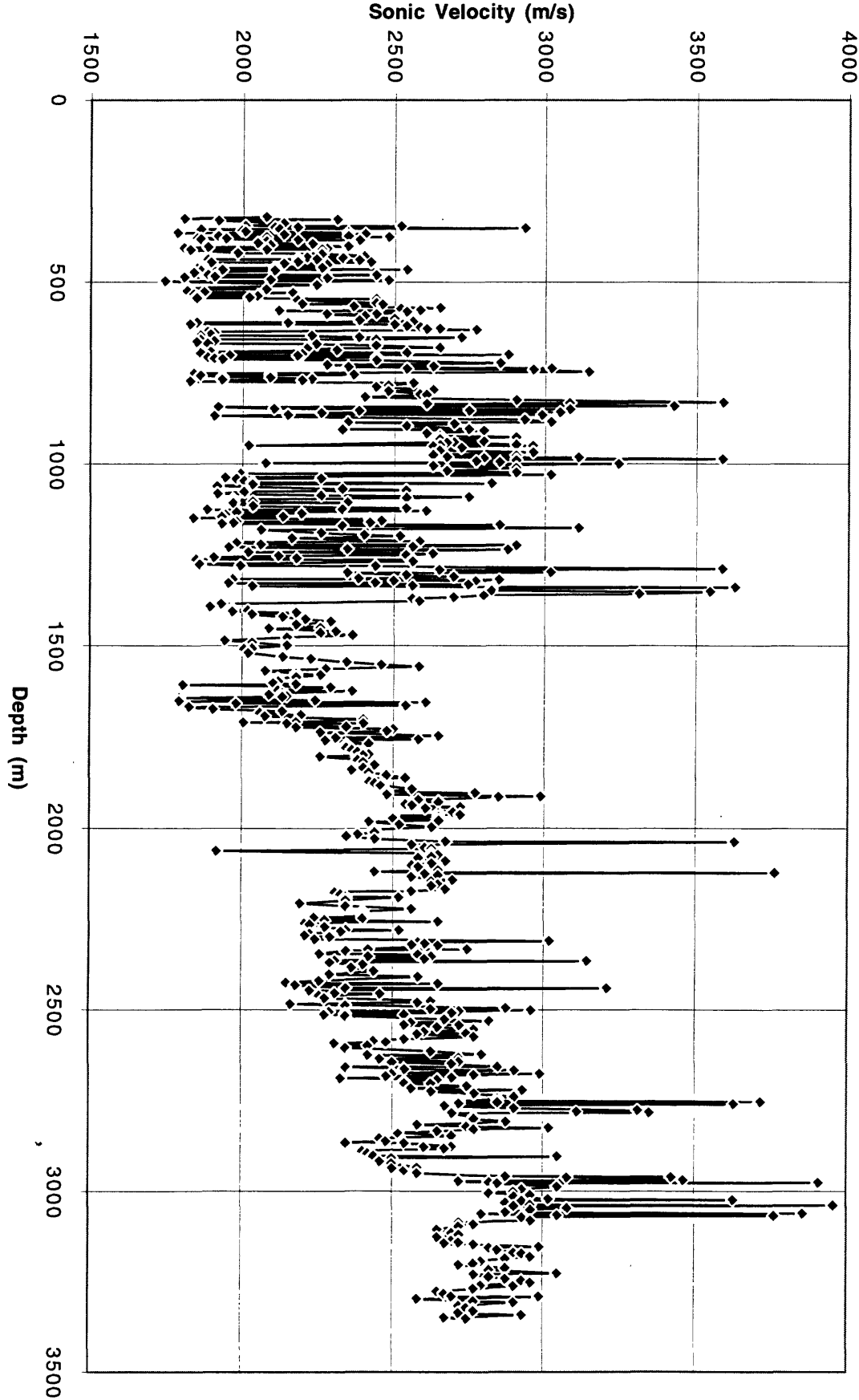


Figure 18.

**Humble Oil and Refining Company, Wico-Bankhead No. 1**



**Figure 19.**

Phillips Petroleum Company, Vierra A No. 1

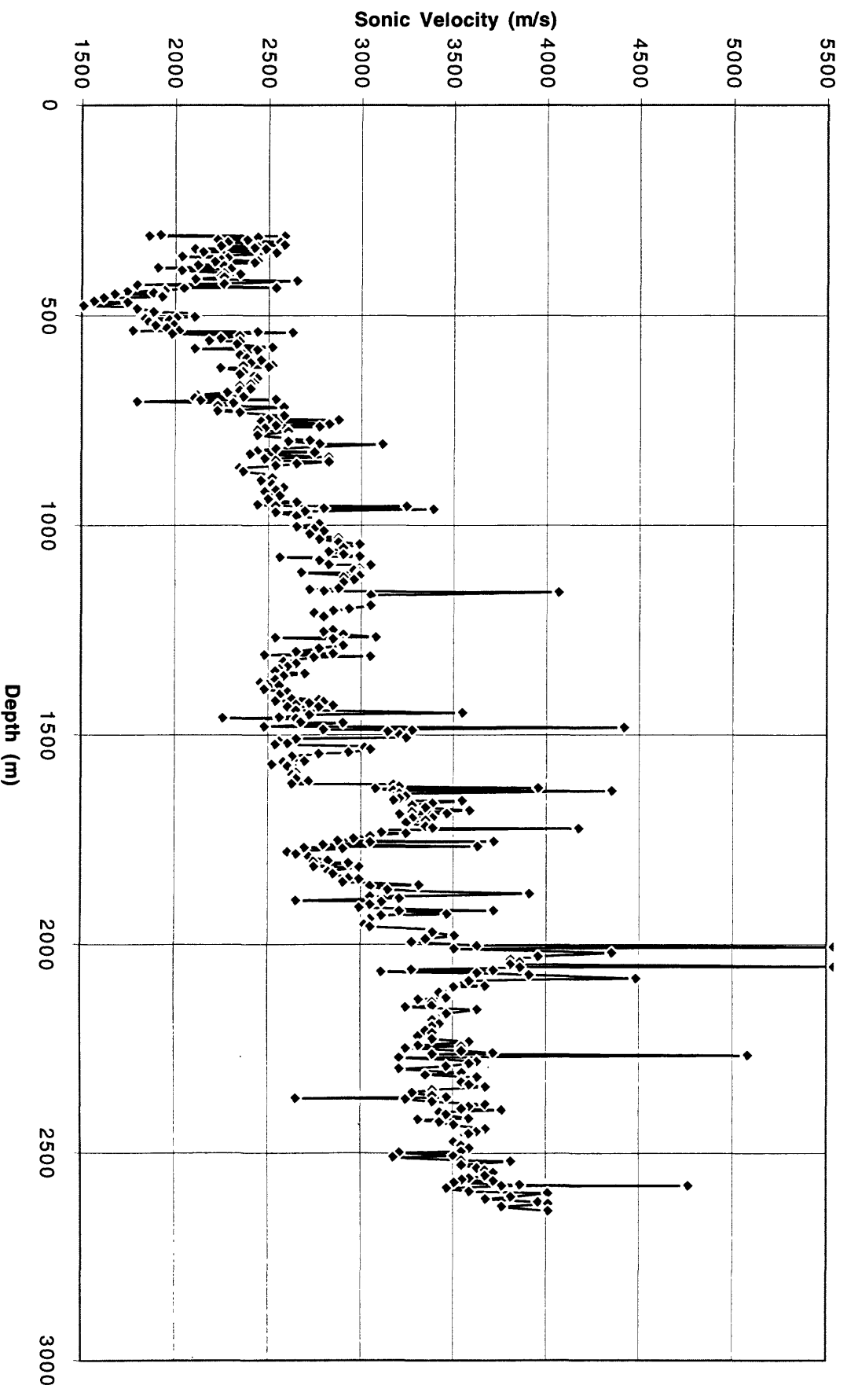


Figure 20.

Shell Oil Company, Pagano No. 2-4

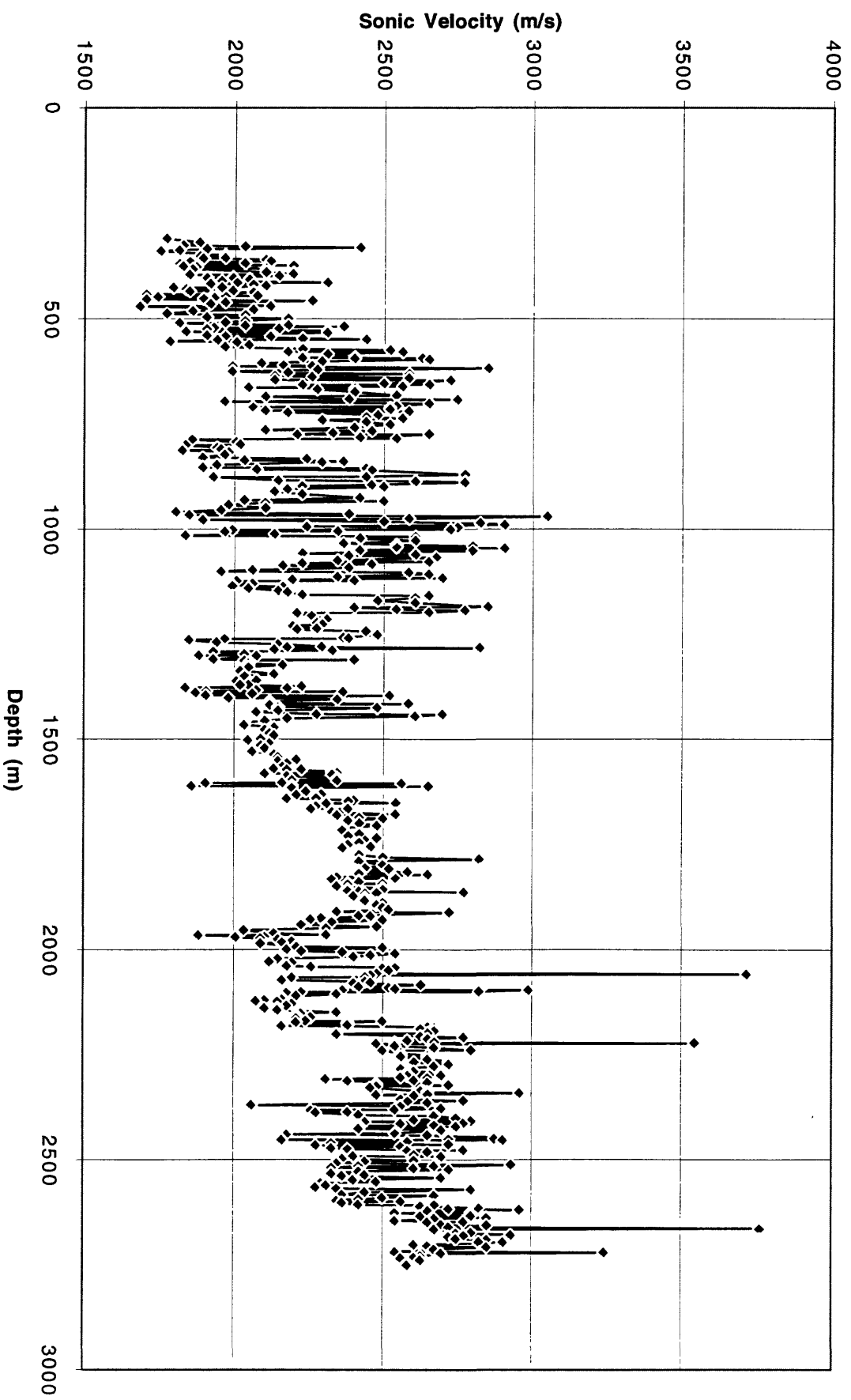


Figure 21.

**Helm Oil Company and Robert Sumpf, Sproule No. 1**

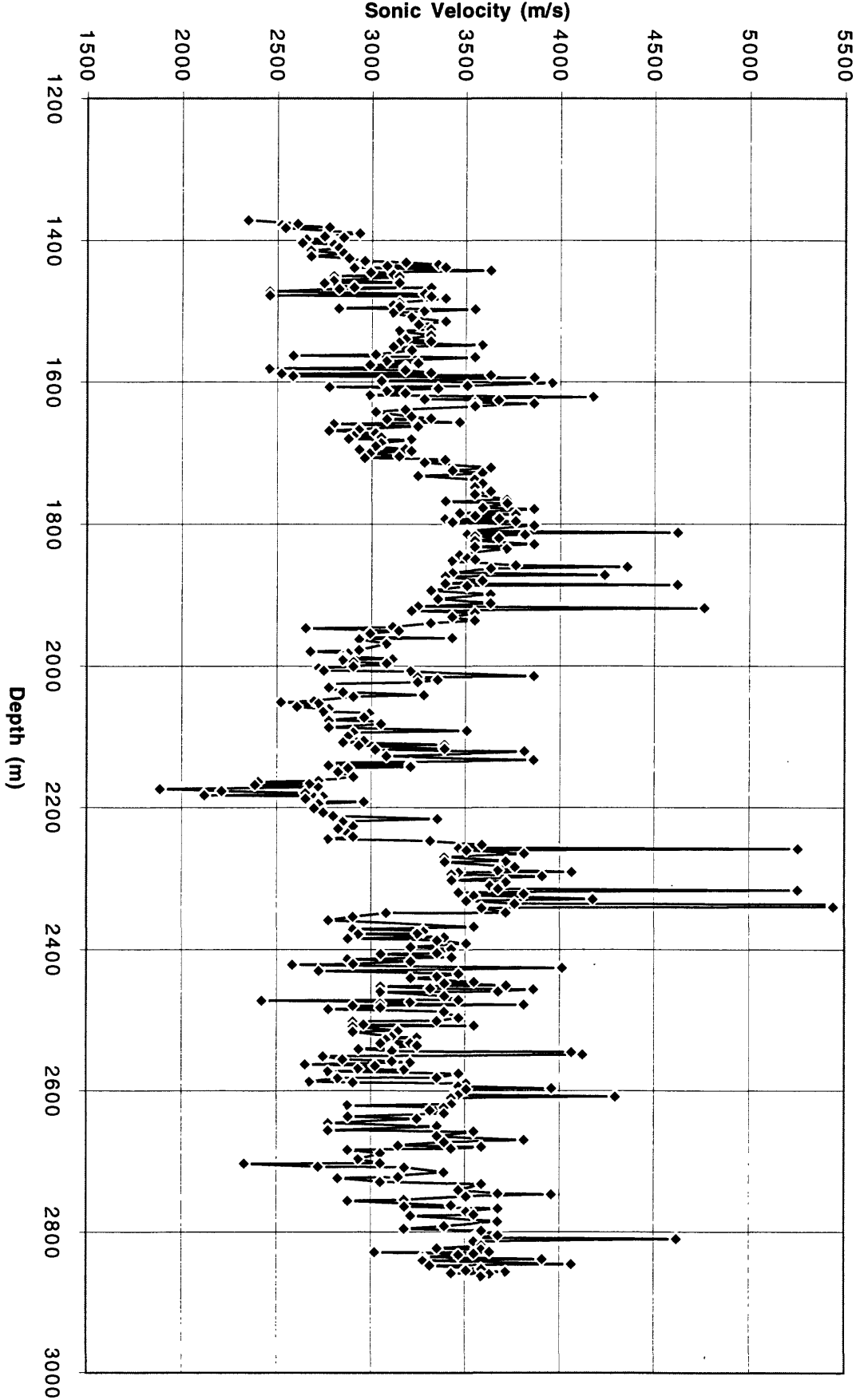


Figure 22.

**E.C. Brown Operator, Lupin No. 3 (Redrill)**

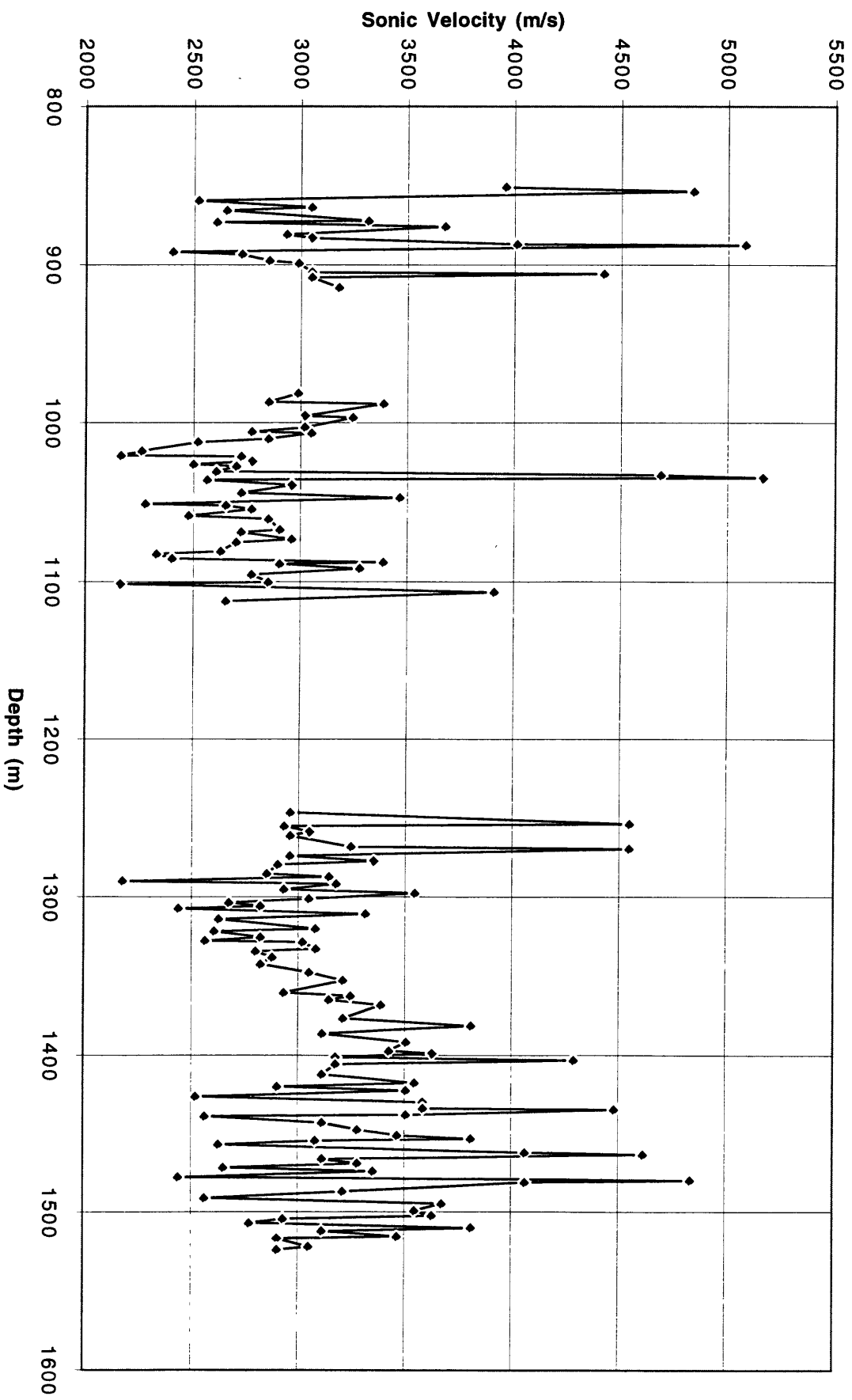


Figure 23.

Milton L. Johnston Operator, Frazen #1

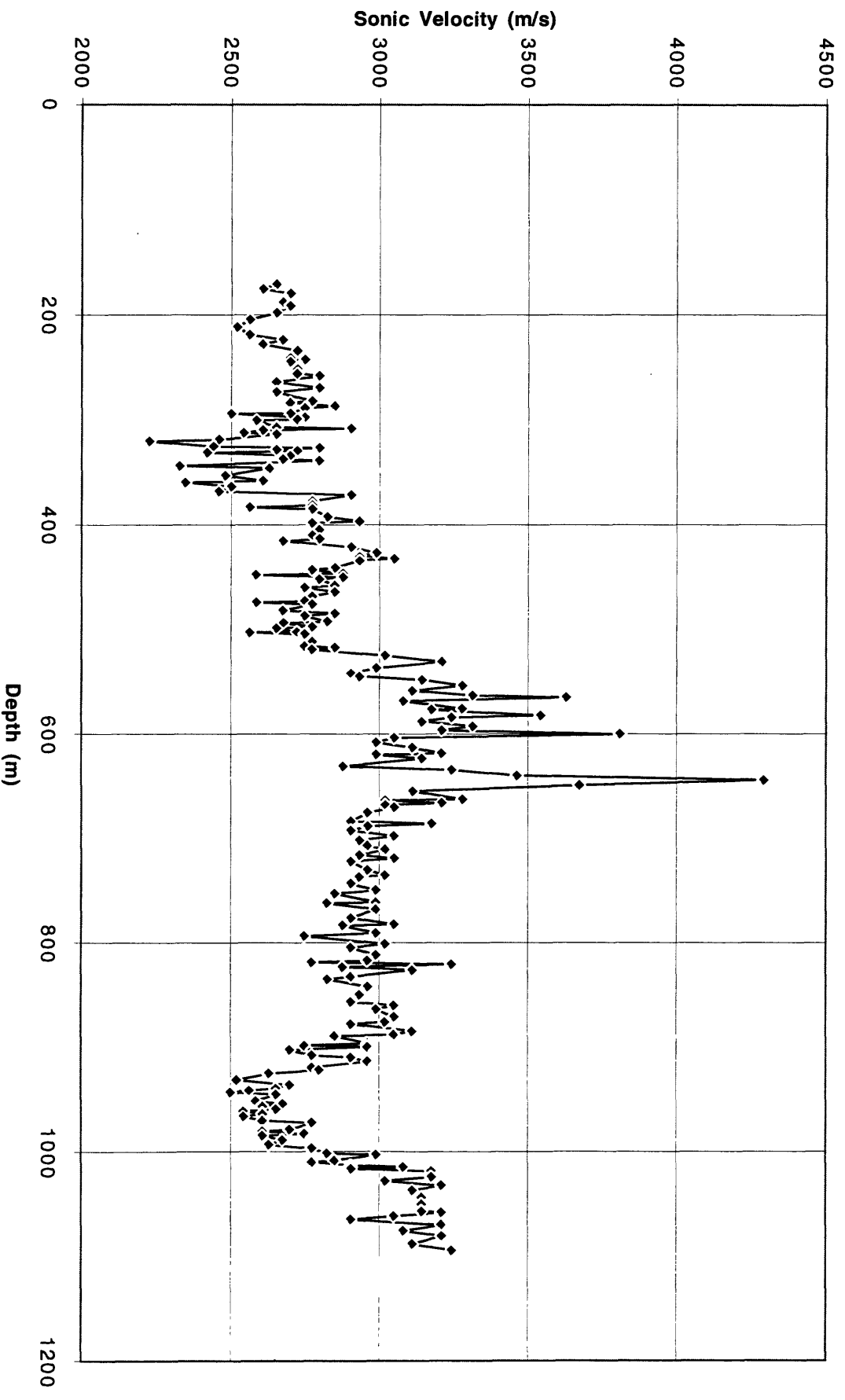


Figure 24.

**Standard Oil Company of California, Simon Newman #1**

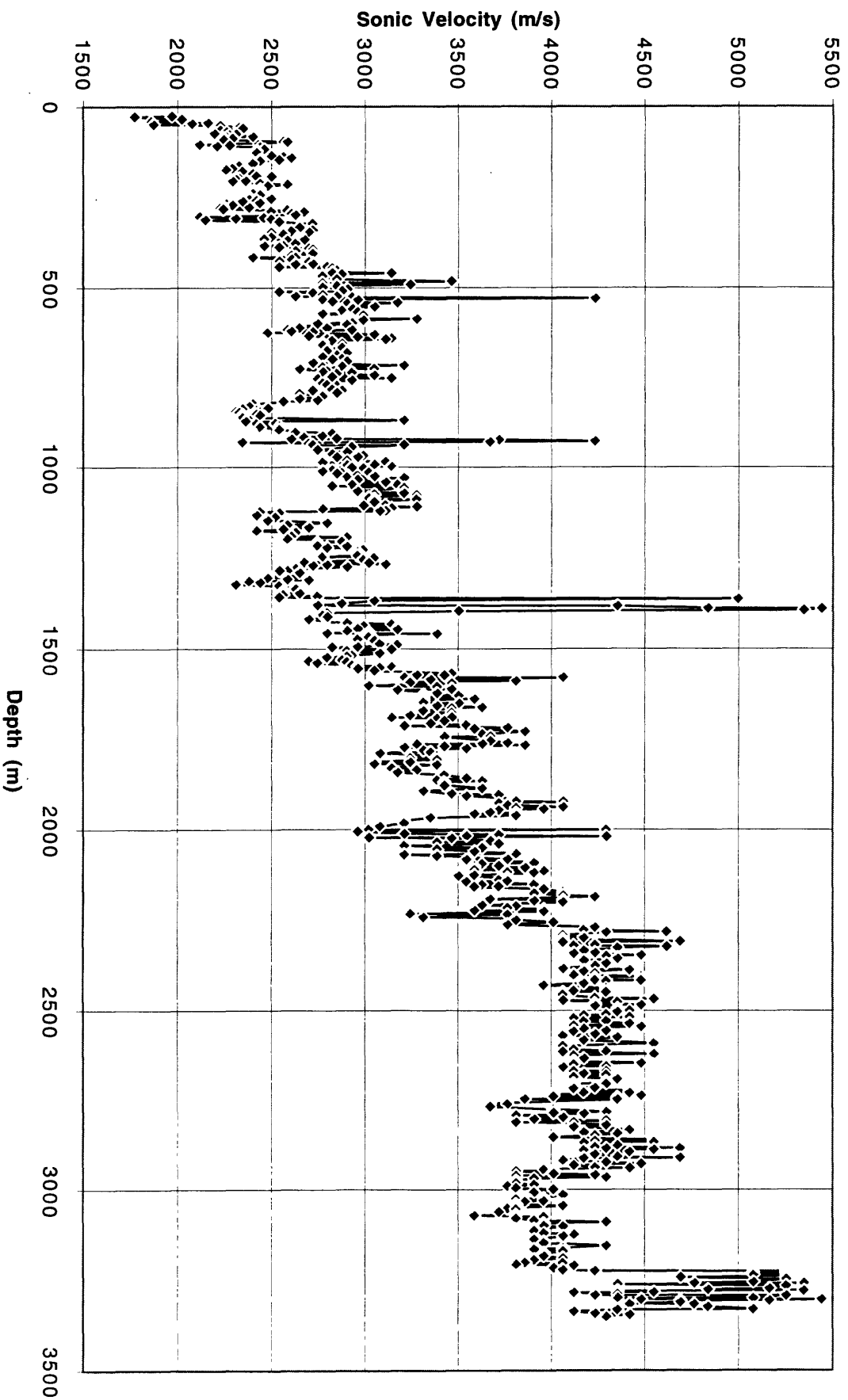


Figure 25.



K.L. Burns Corporation, Simon-Newman #12-1

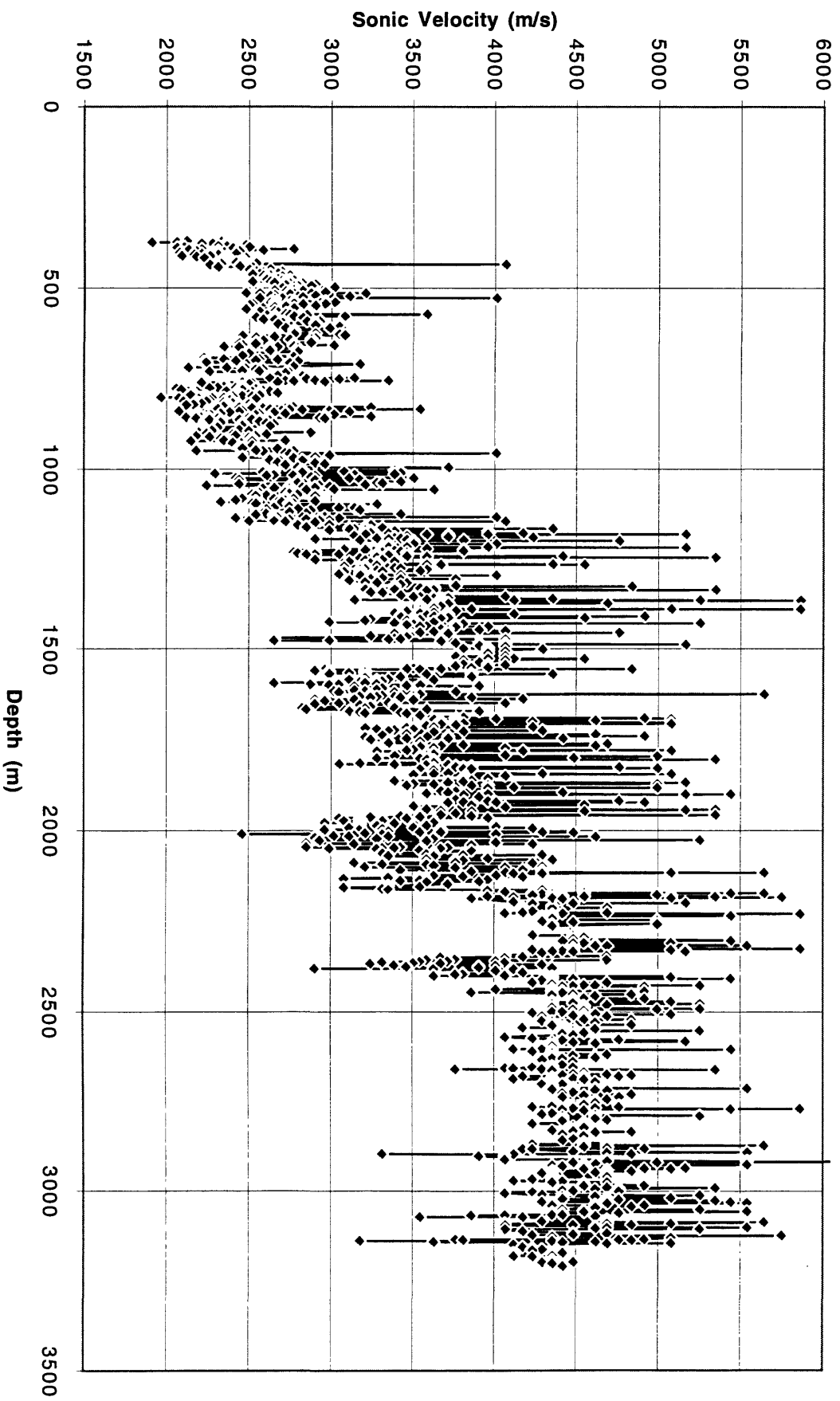


Figure 26.

**E.C. Brown, Operator, Mello #1**

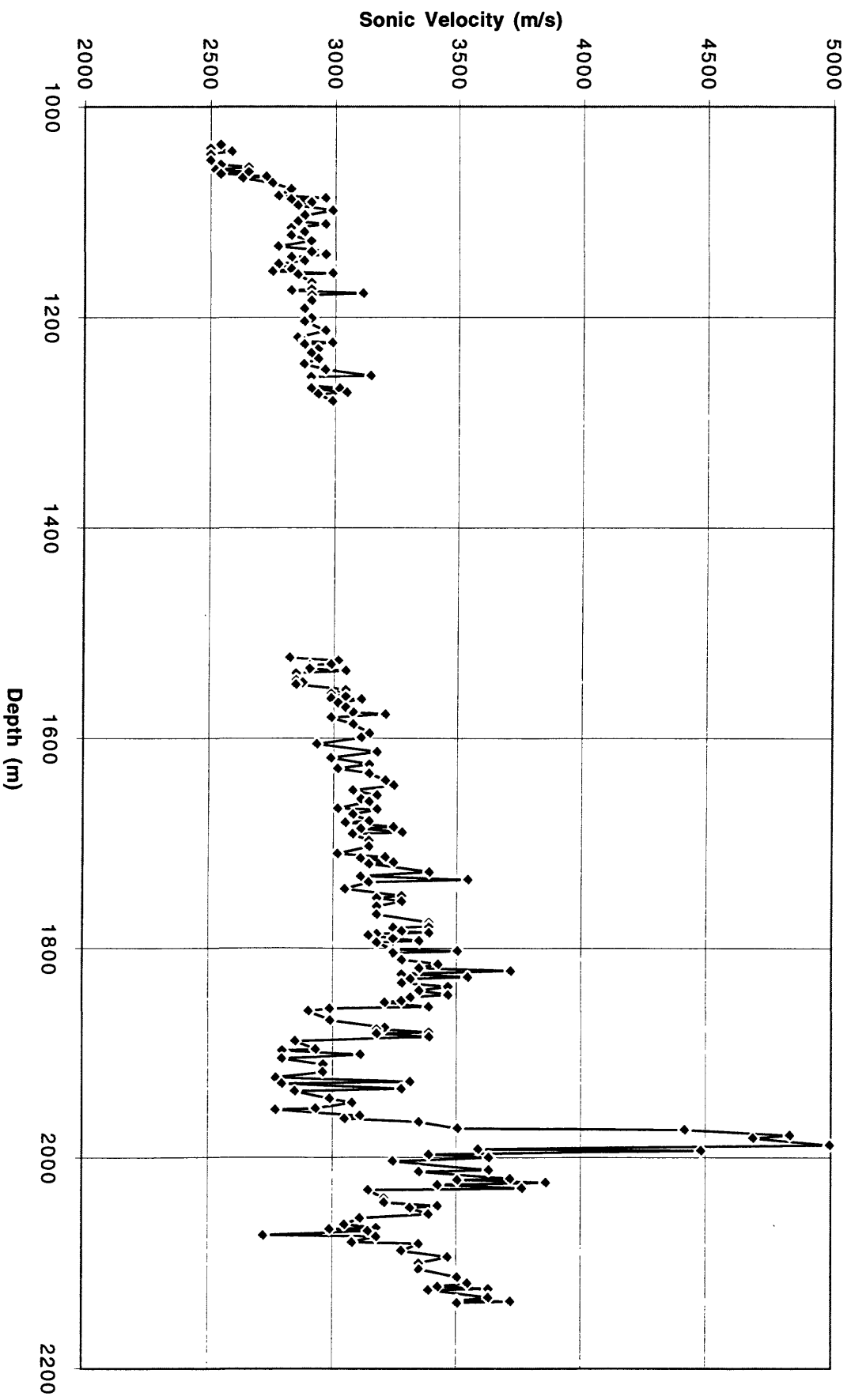


Figure 27.

Occidental Petroleum Corporation, Bingaman #1

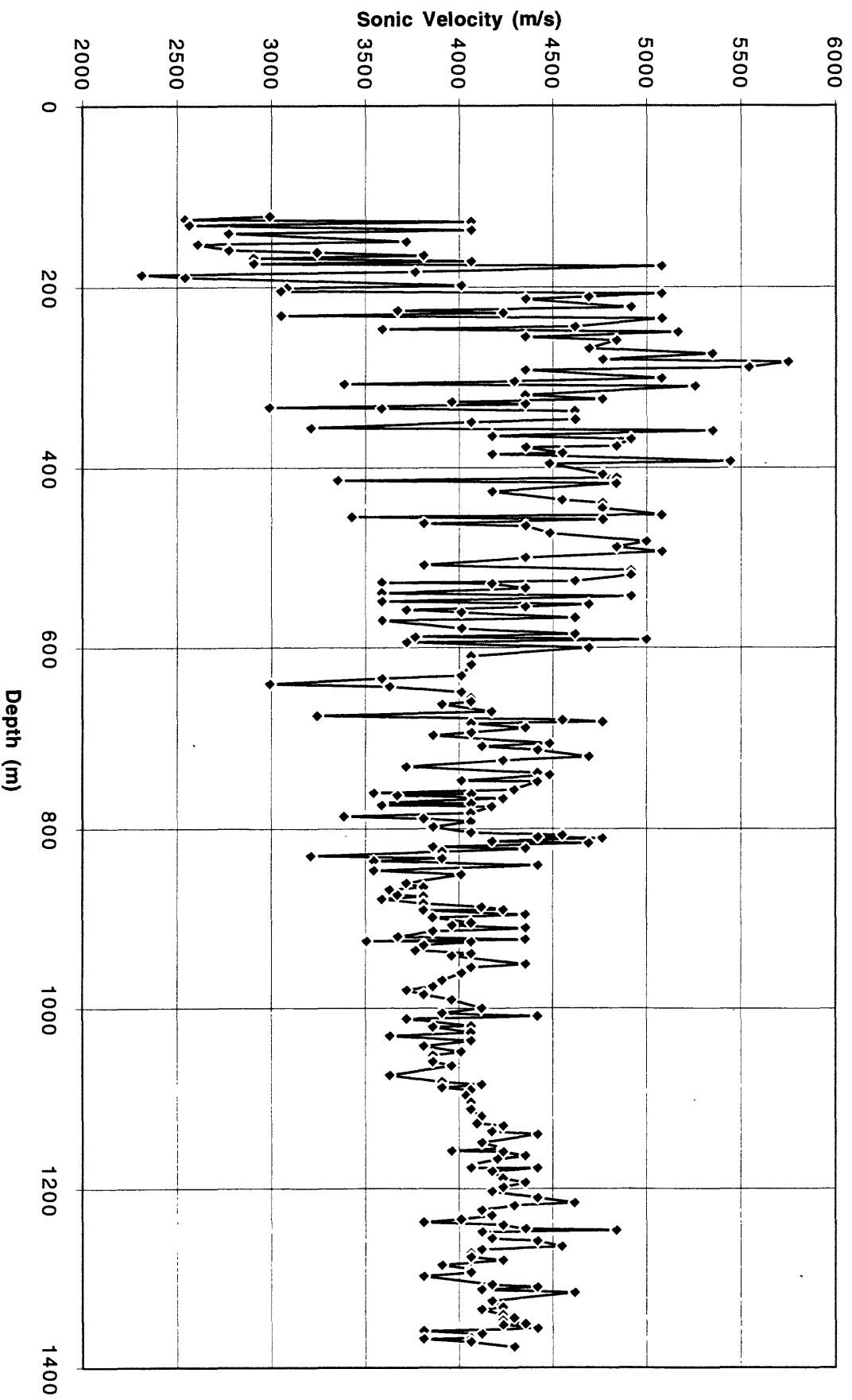


Figure 28.

**Santa Fe Energy Company, Law #80X-1**

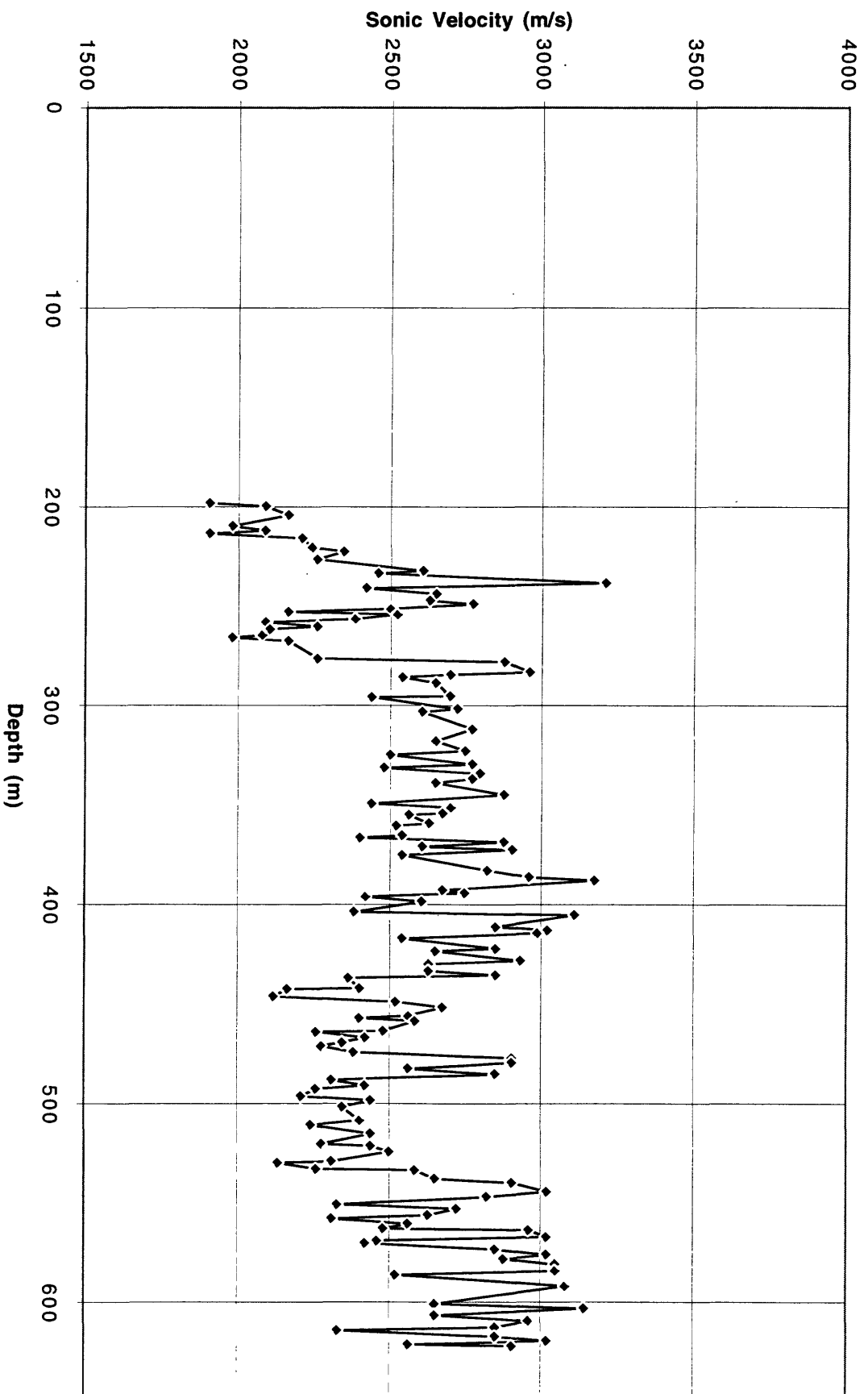


Figure 29.

U.S. Geological Survey, Law #CB-1

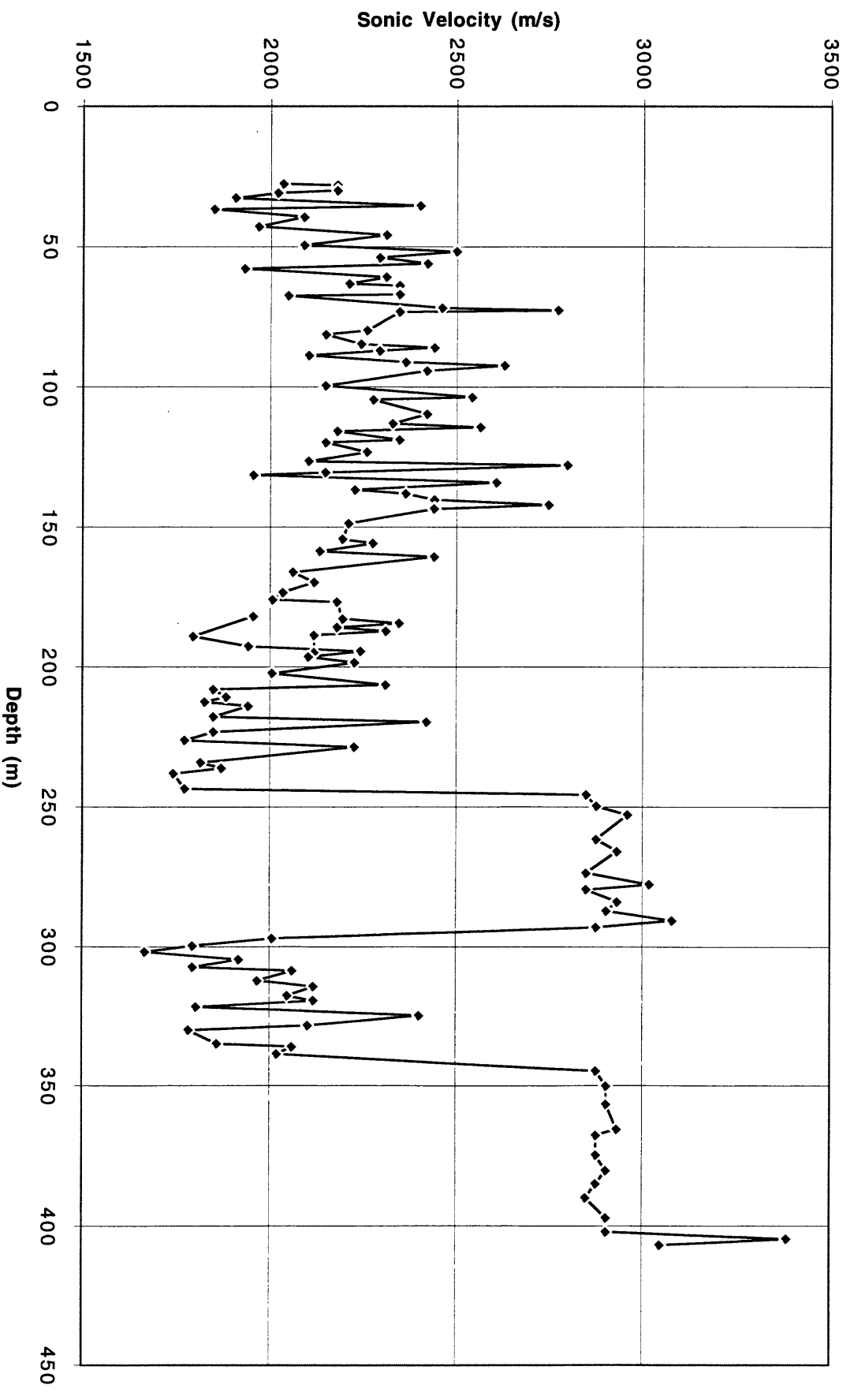


Figure 30.

W.W. Holmes, Towle No. 1-12

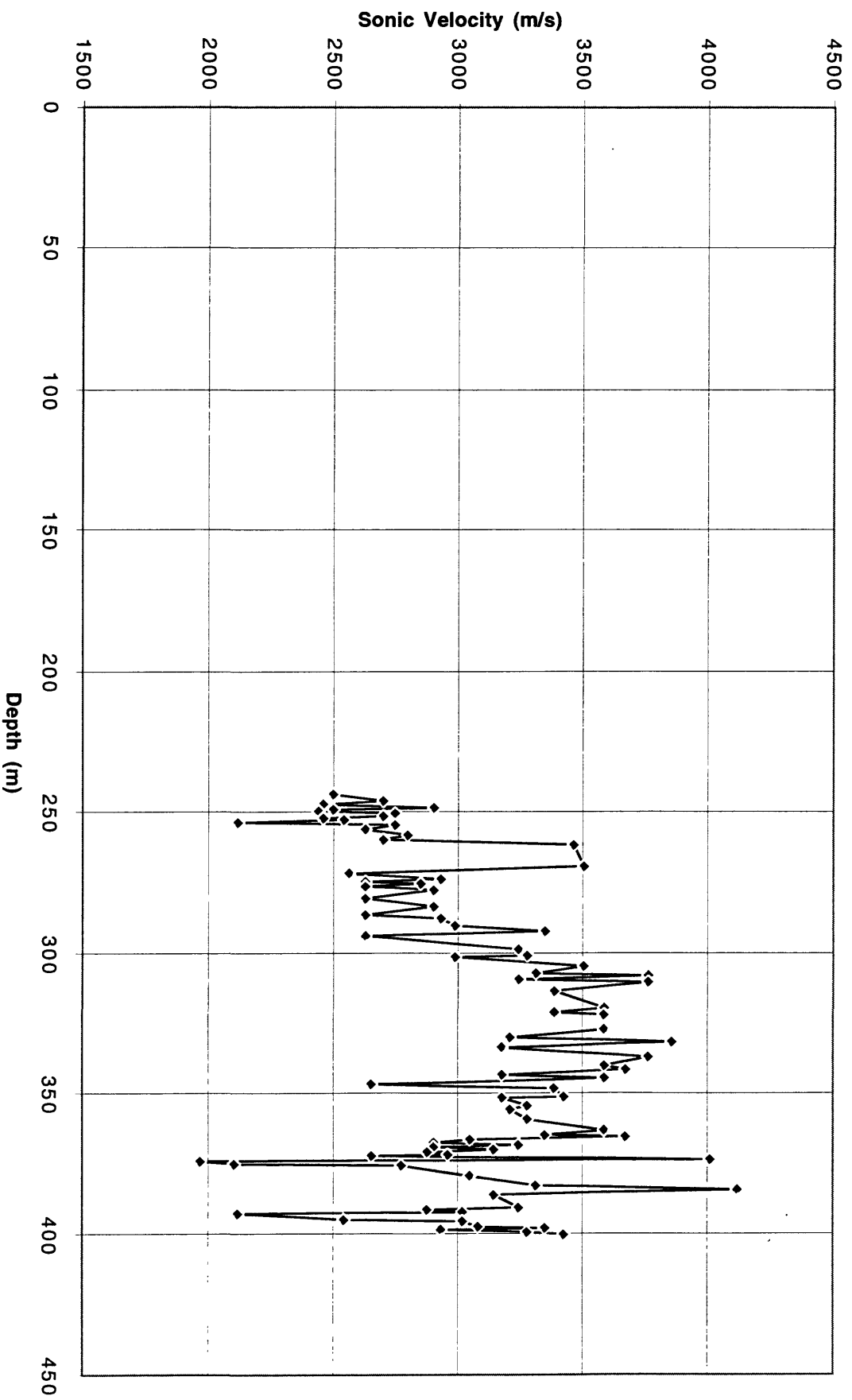


Figure 31.

**Texaco-AGIP, Chesholm #1**

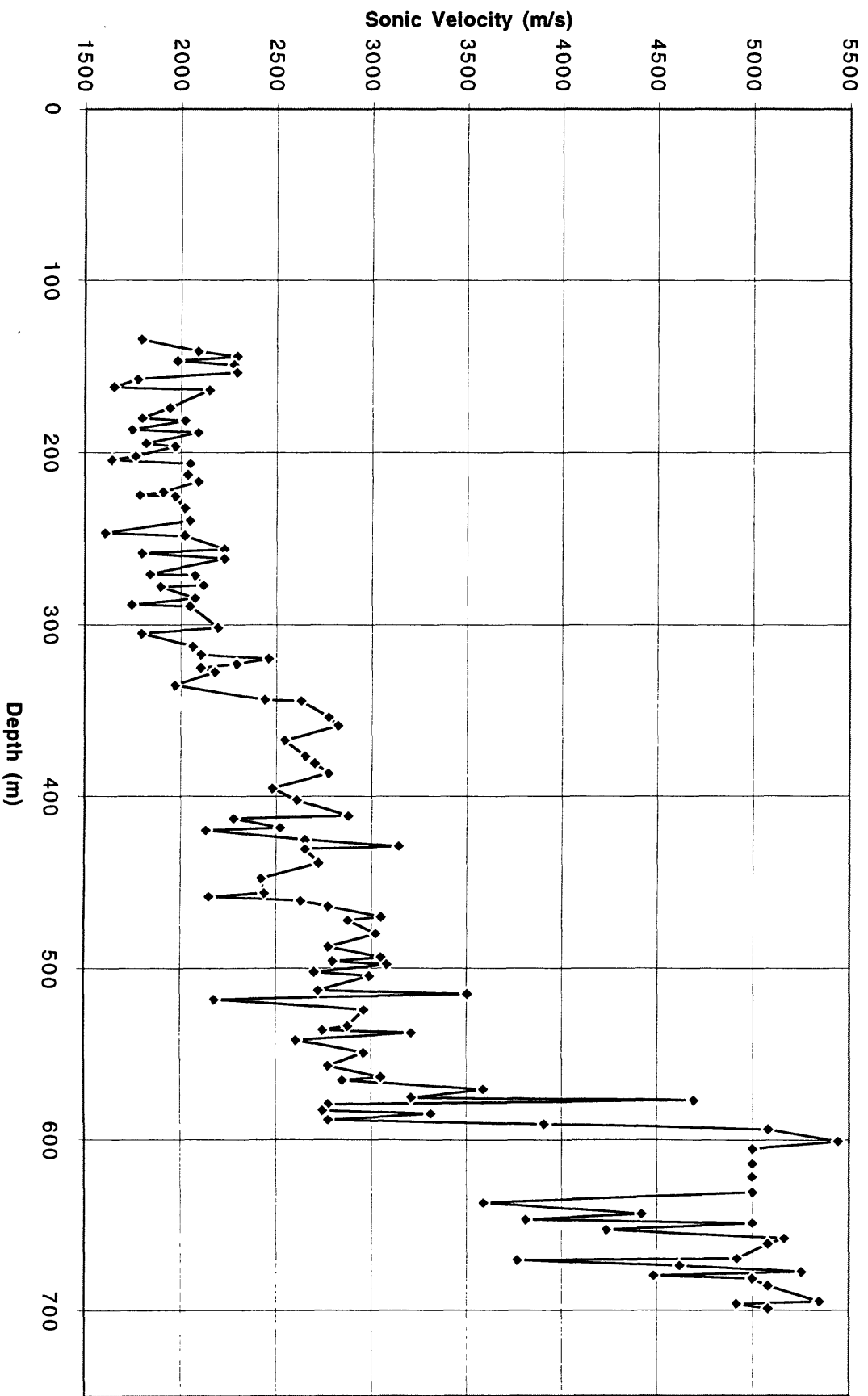


Figure 32.

Phillips Petroleum Company, Olsen No. A-2

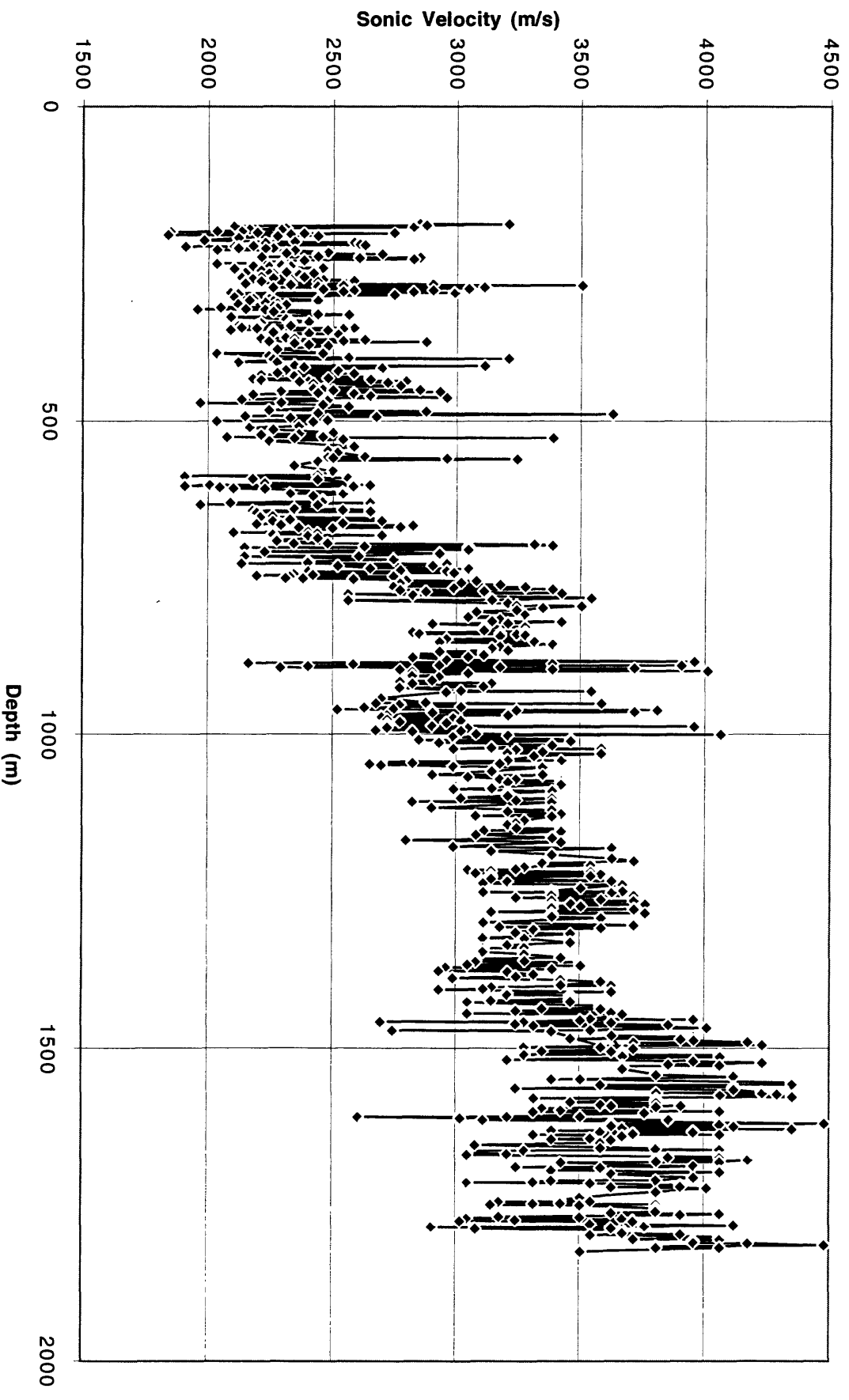


Figure 33.



Ferguson and Bosworth, Kin-Ark-Pura No. 1

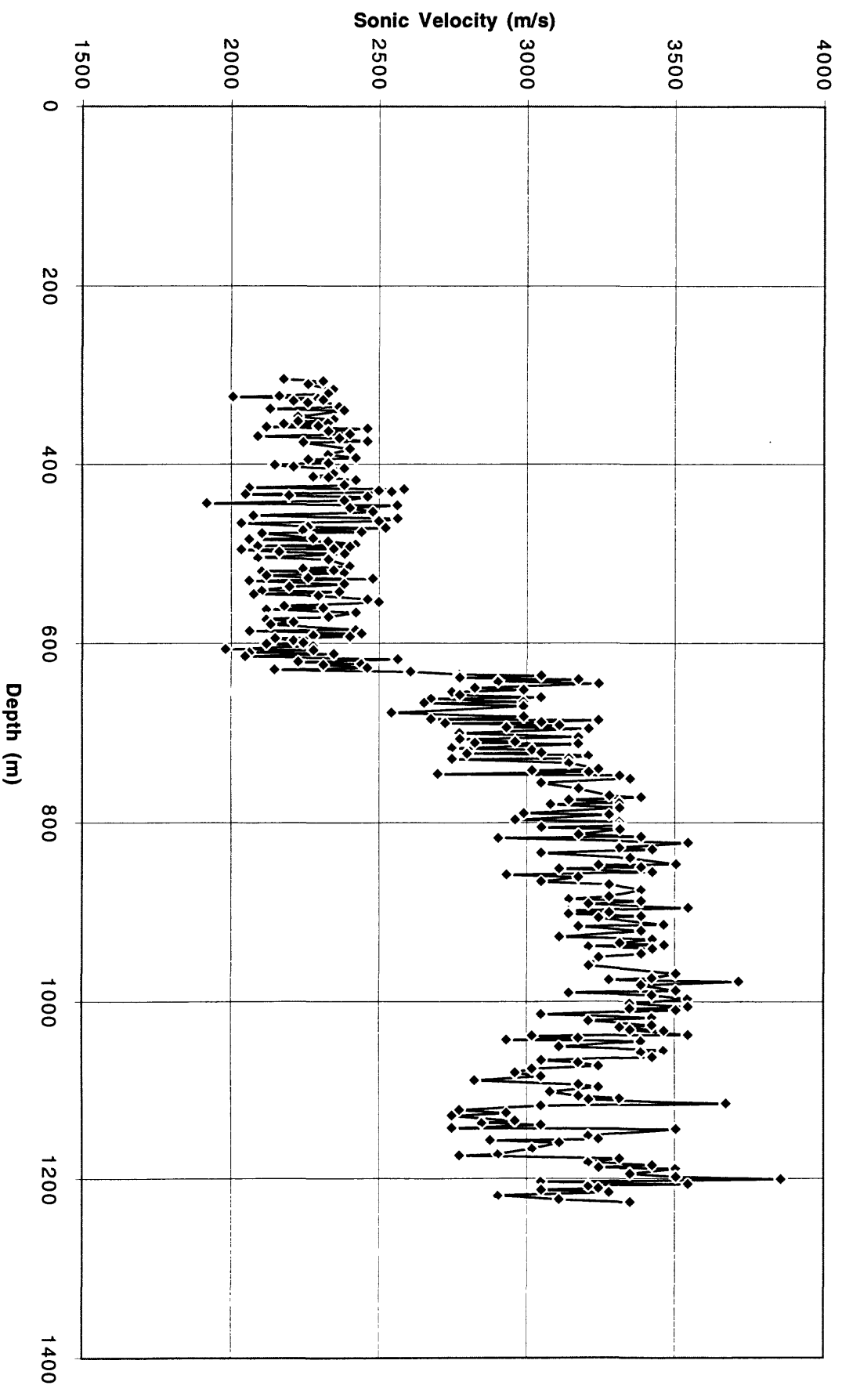


Figure 34.

**Texaco Incorporated, Clark #1**

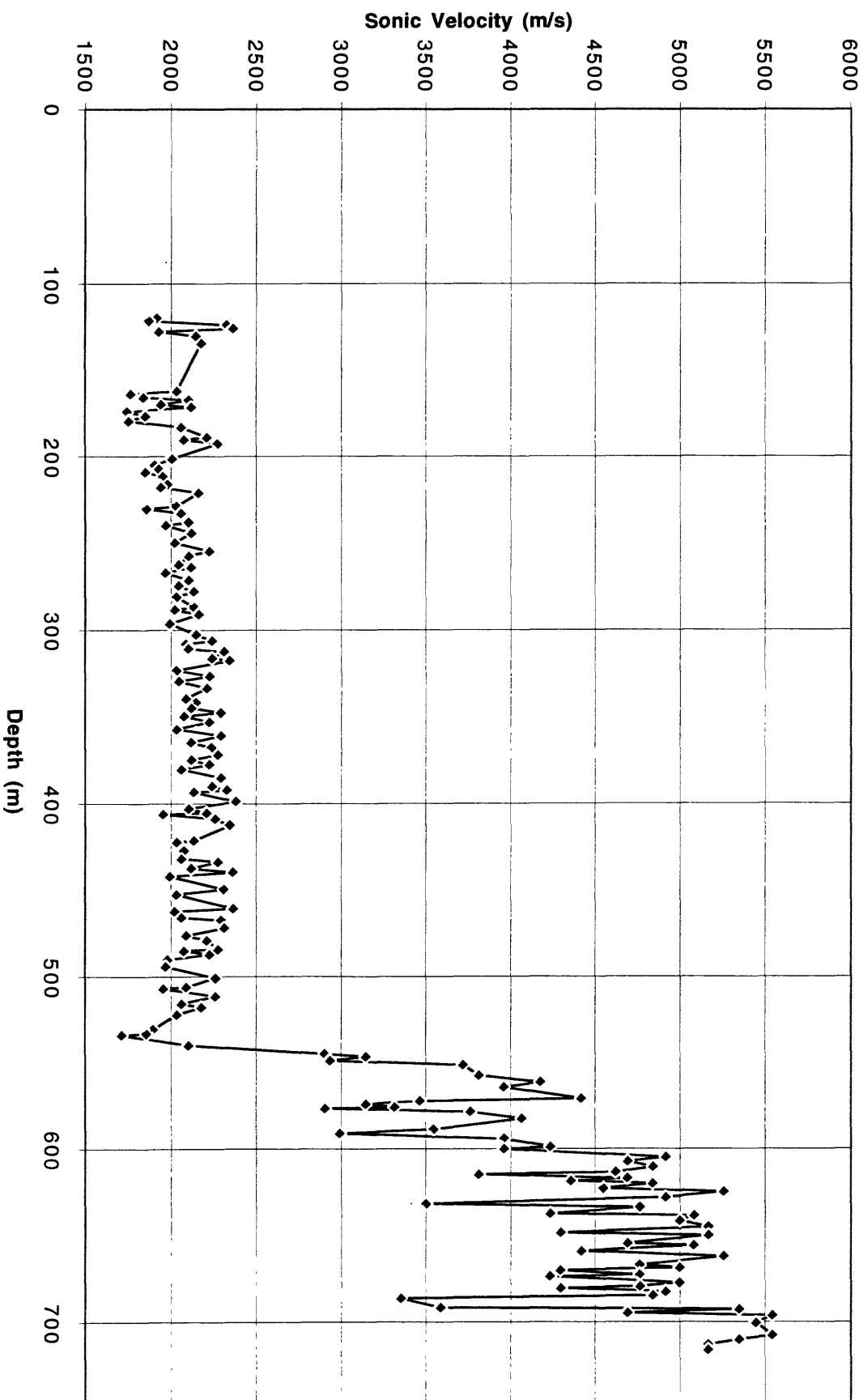


Figure 35.

Standard Oil Company of California, Keenan #37

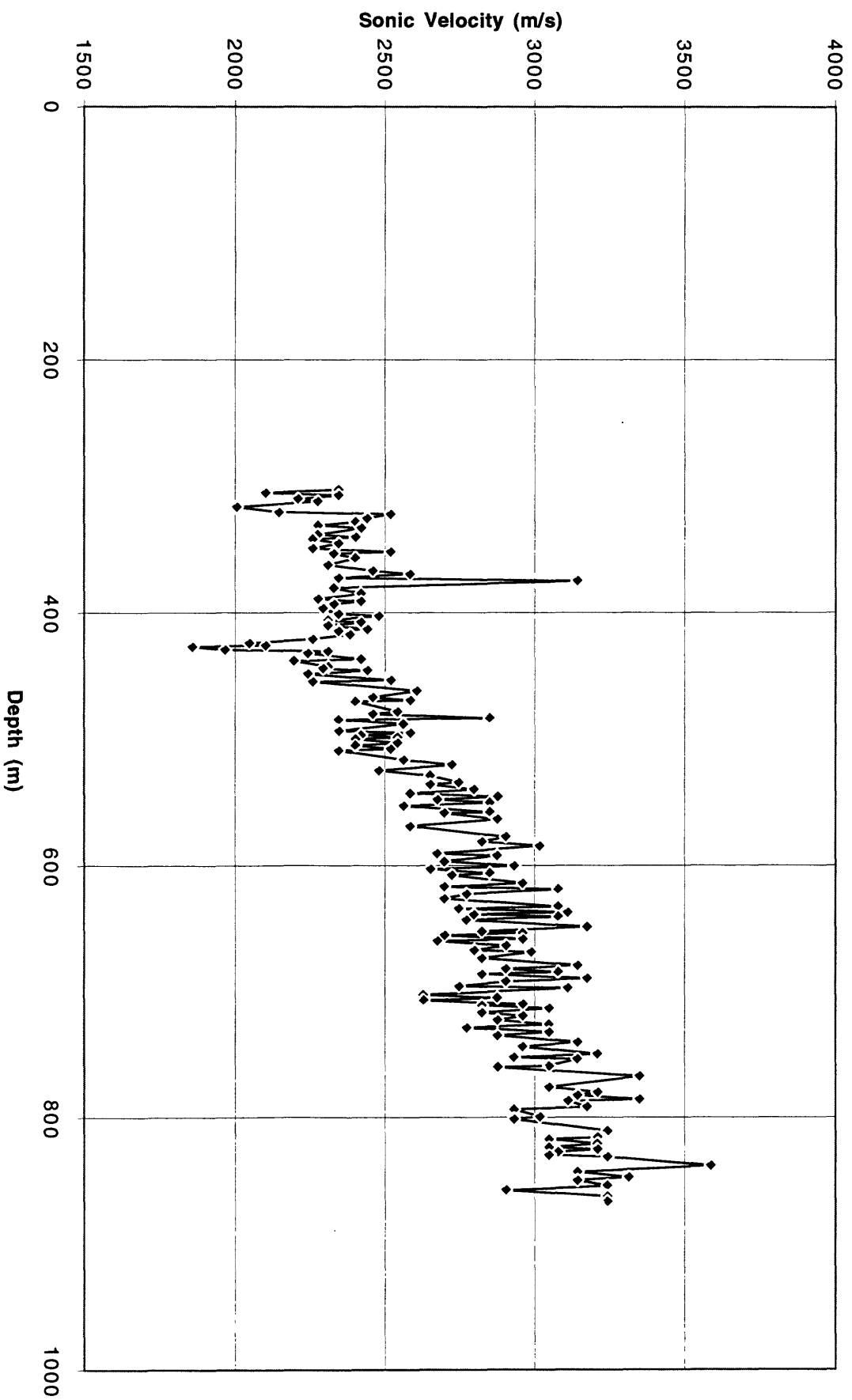


Figure 36.

Seaboard Oil and Gas Company, De Alvarez No. 21-5

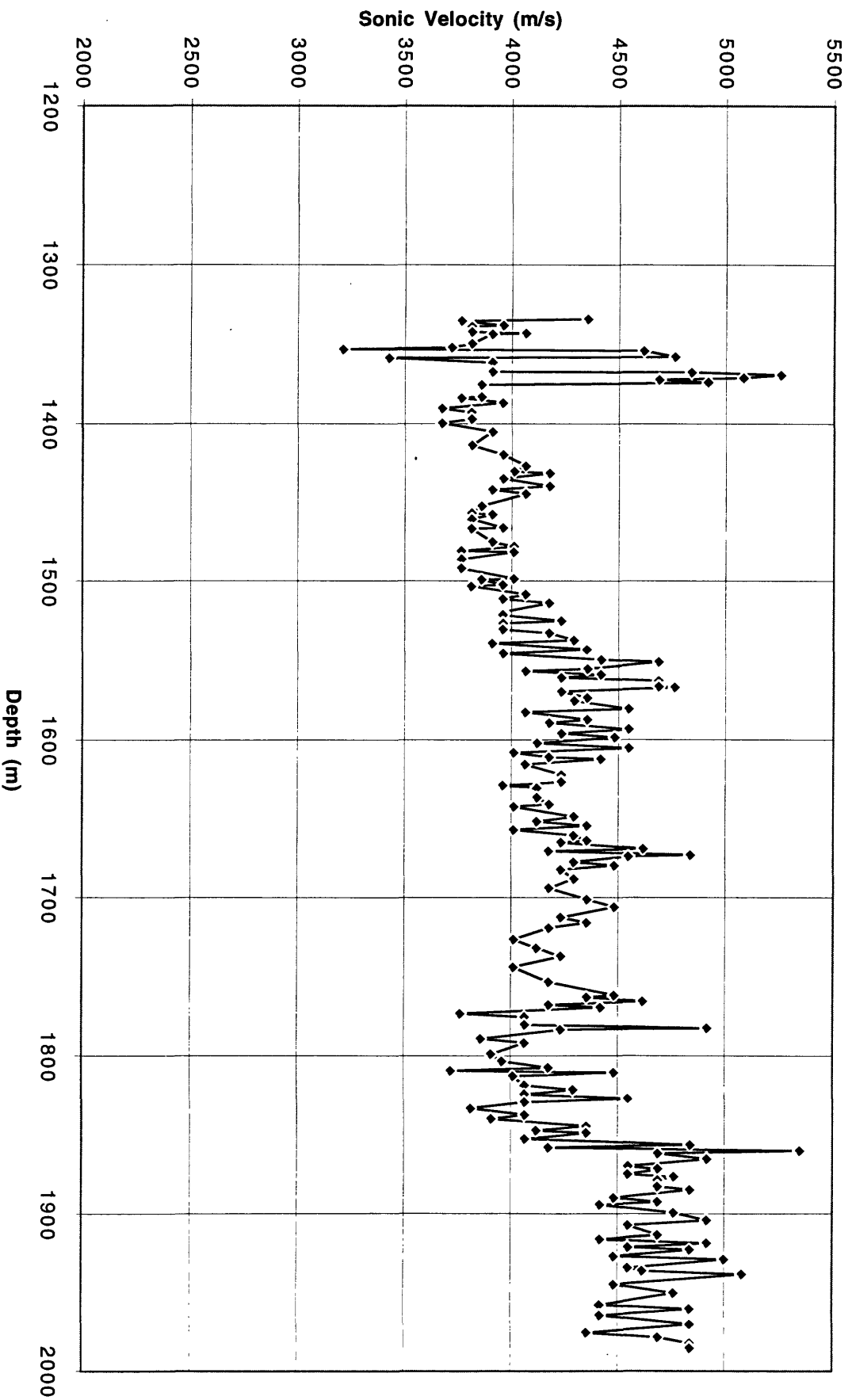


Figure 37.

Phillips Petroleum Company, Doud A #1

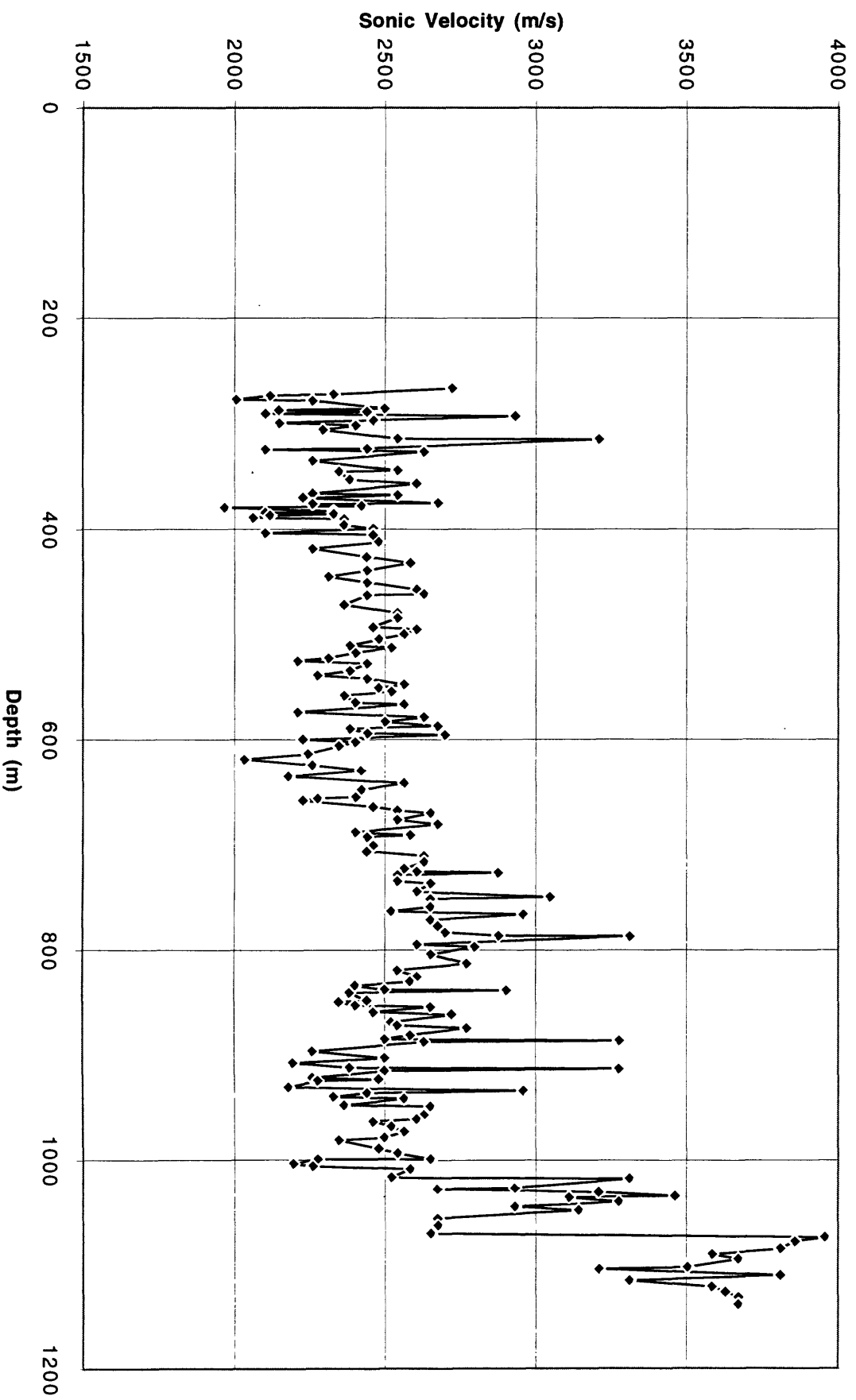


Figure 38.

Koch Exploration Company, Arroyo Seco Fed. No. 48X-11

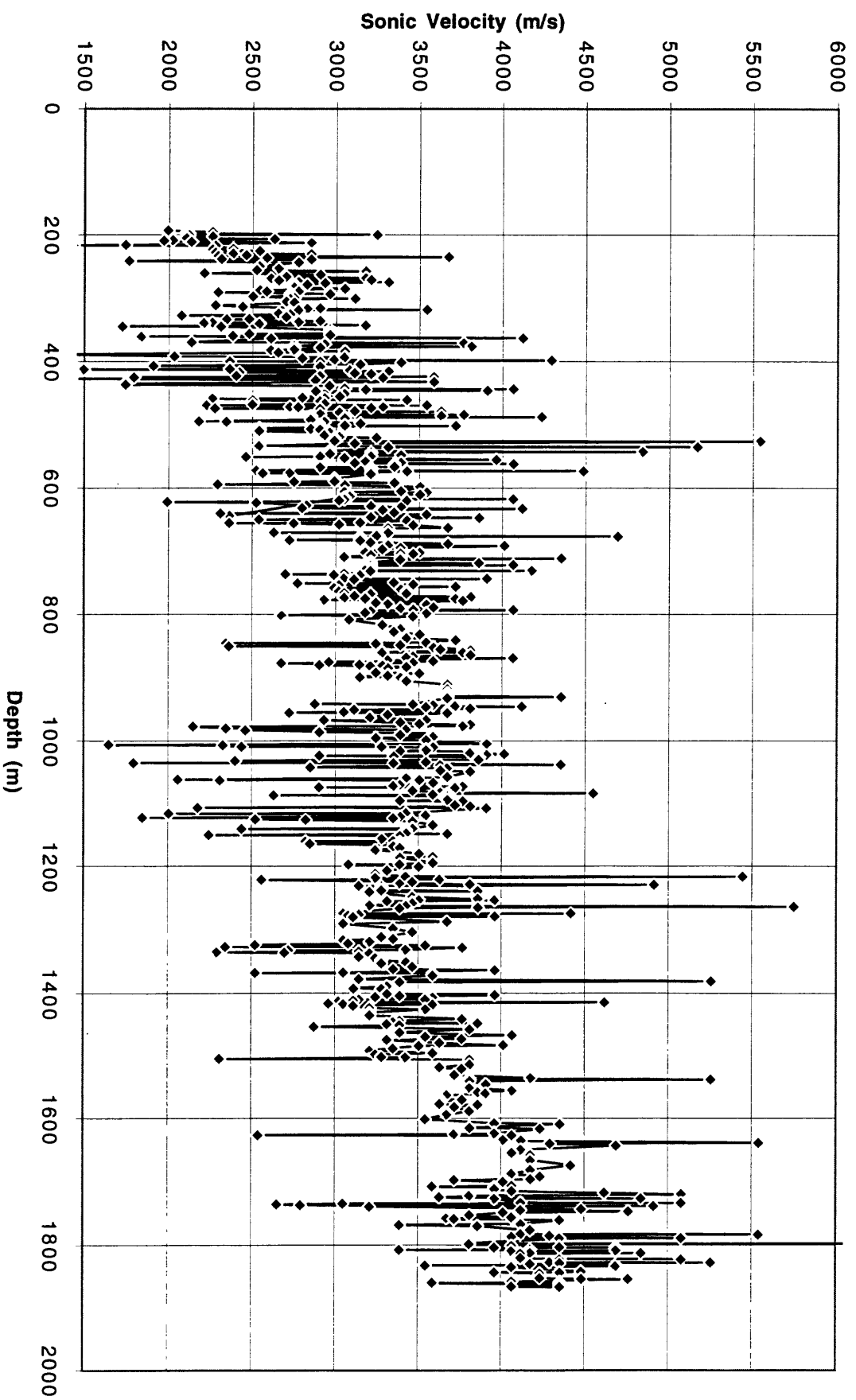


Figure 39.

Phillips Petroleum, Hansen #1

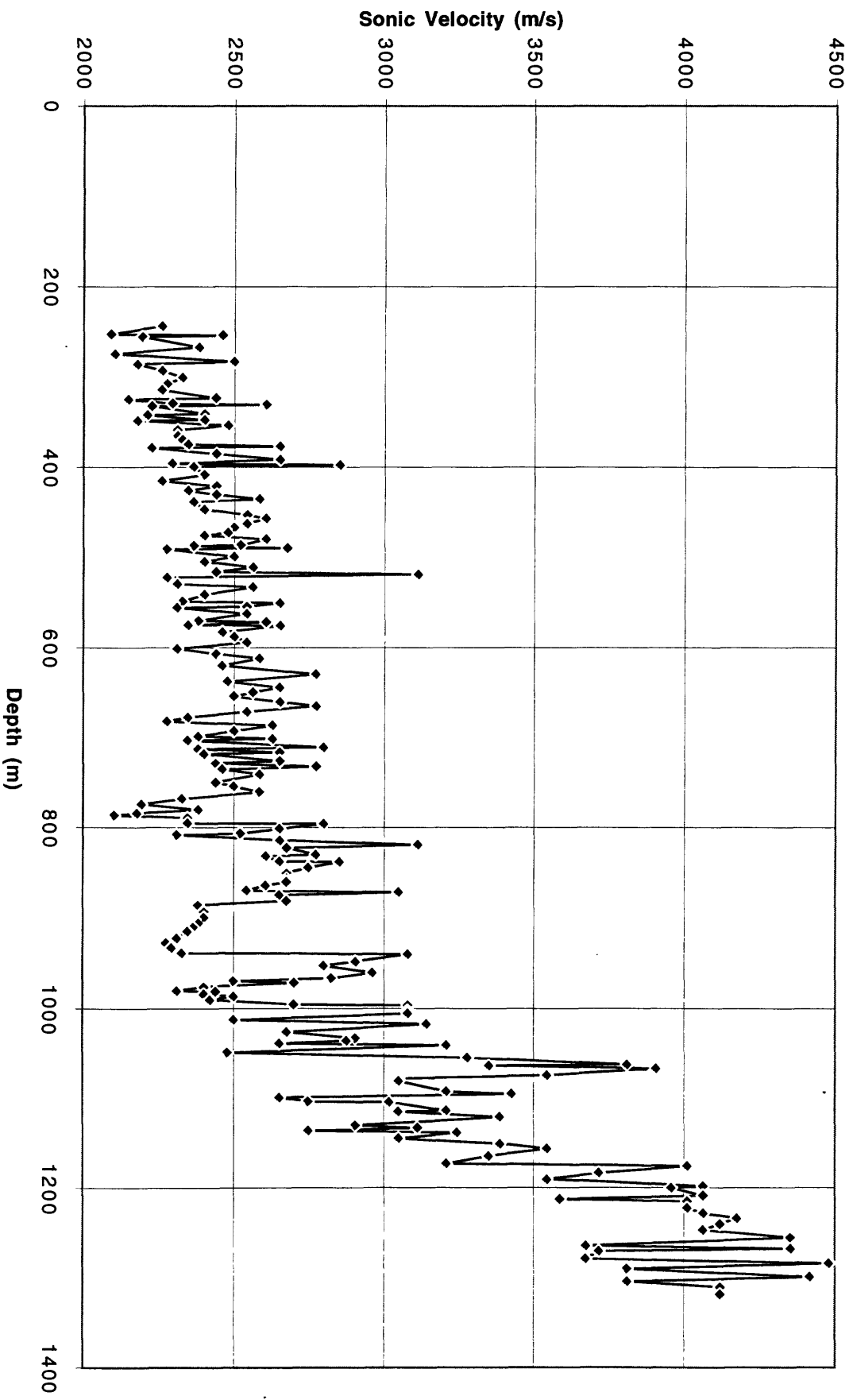


Figure 40.

Cities Service Oil Company, Plaskett No. A-1

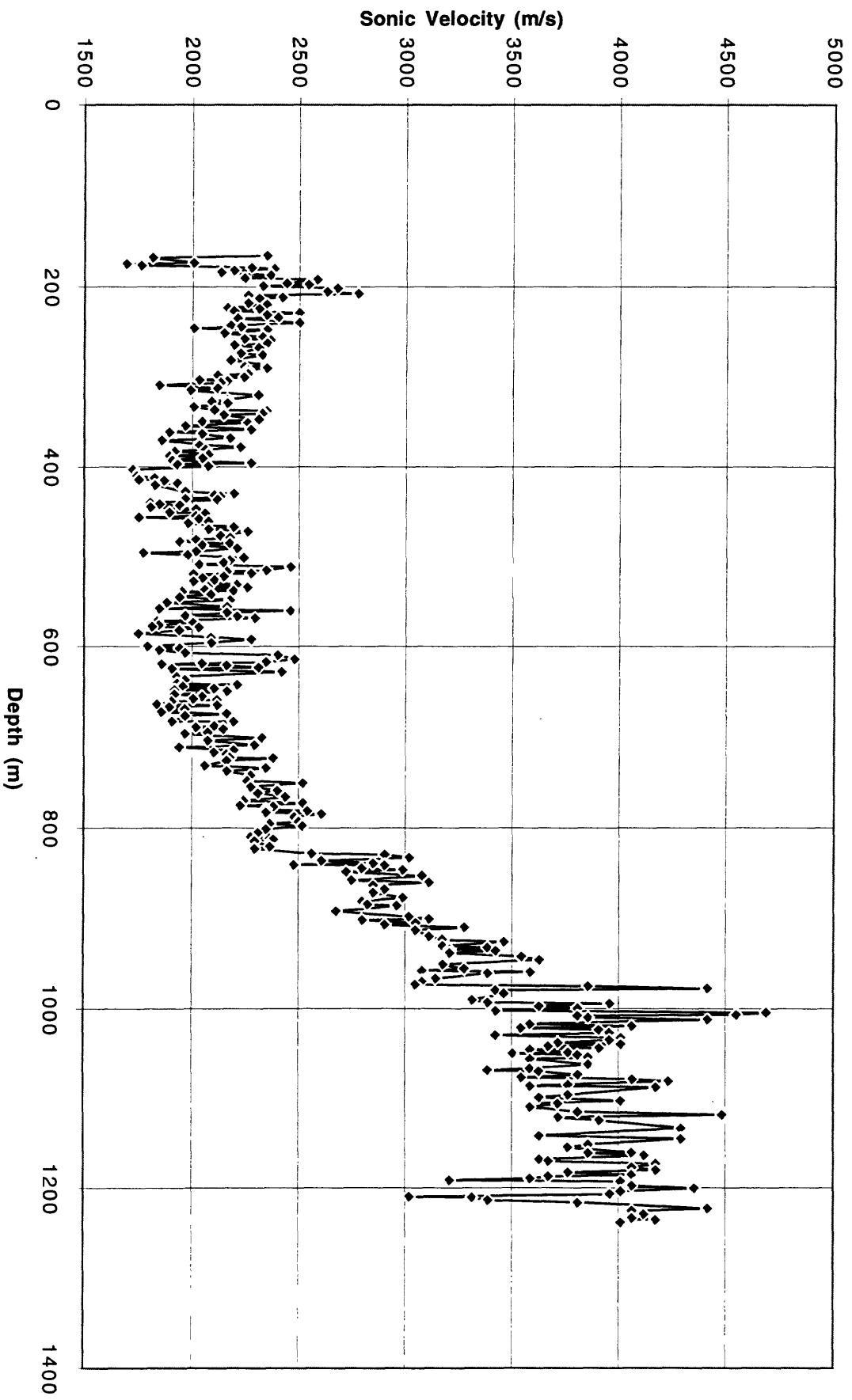


Figure 41.



Cities Service Oil Company, 1-Wallace-A Redrill #2

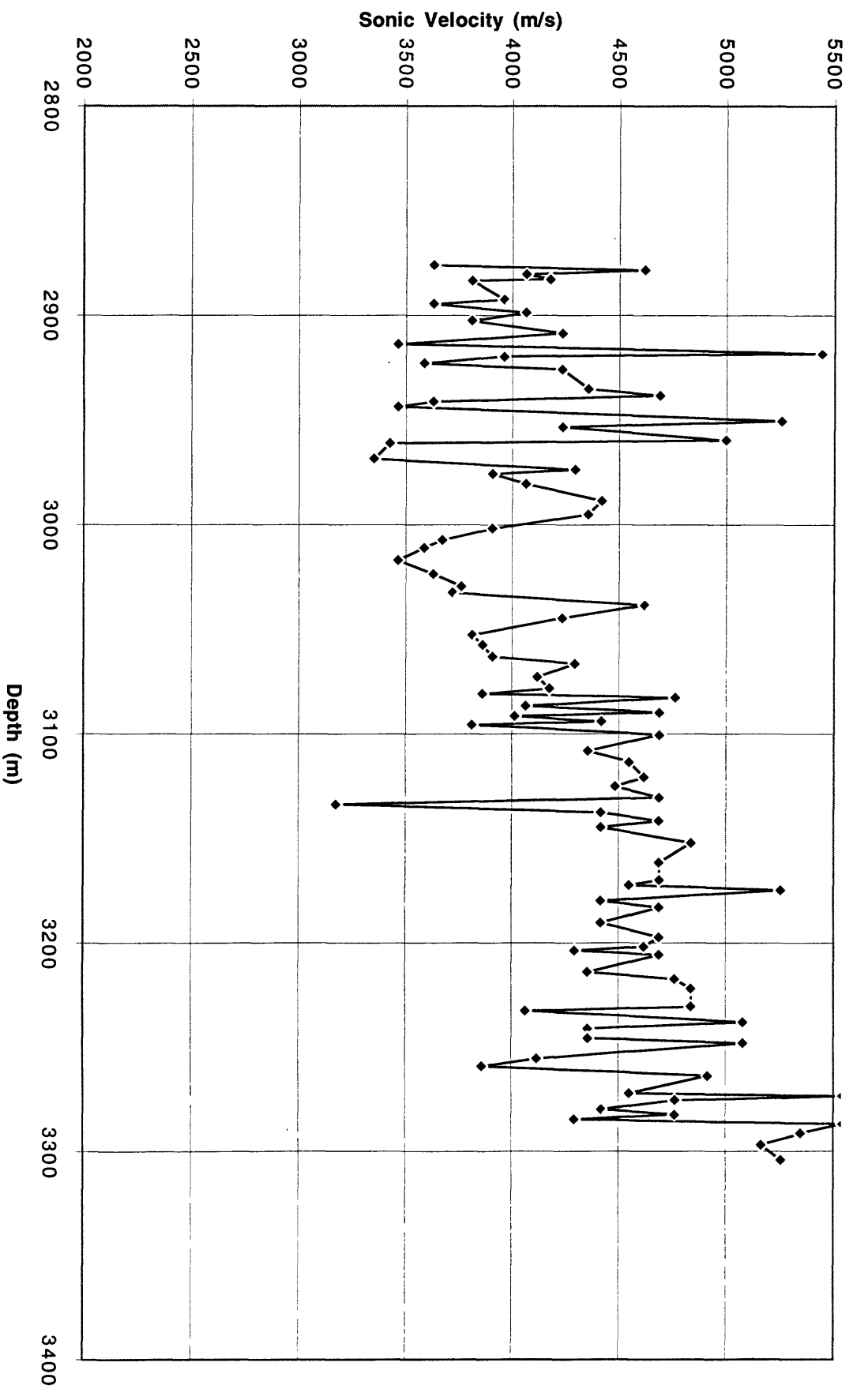


Figure 42.

**Chevron USA Inc; Section 8, Thompson Canyon USL #1**

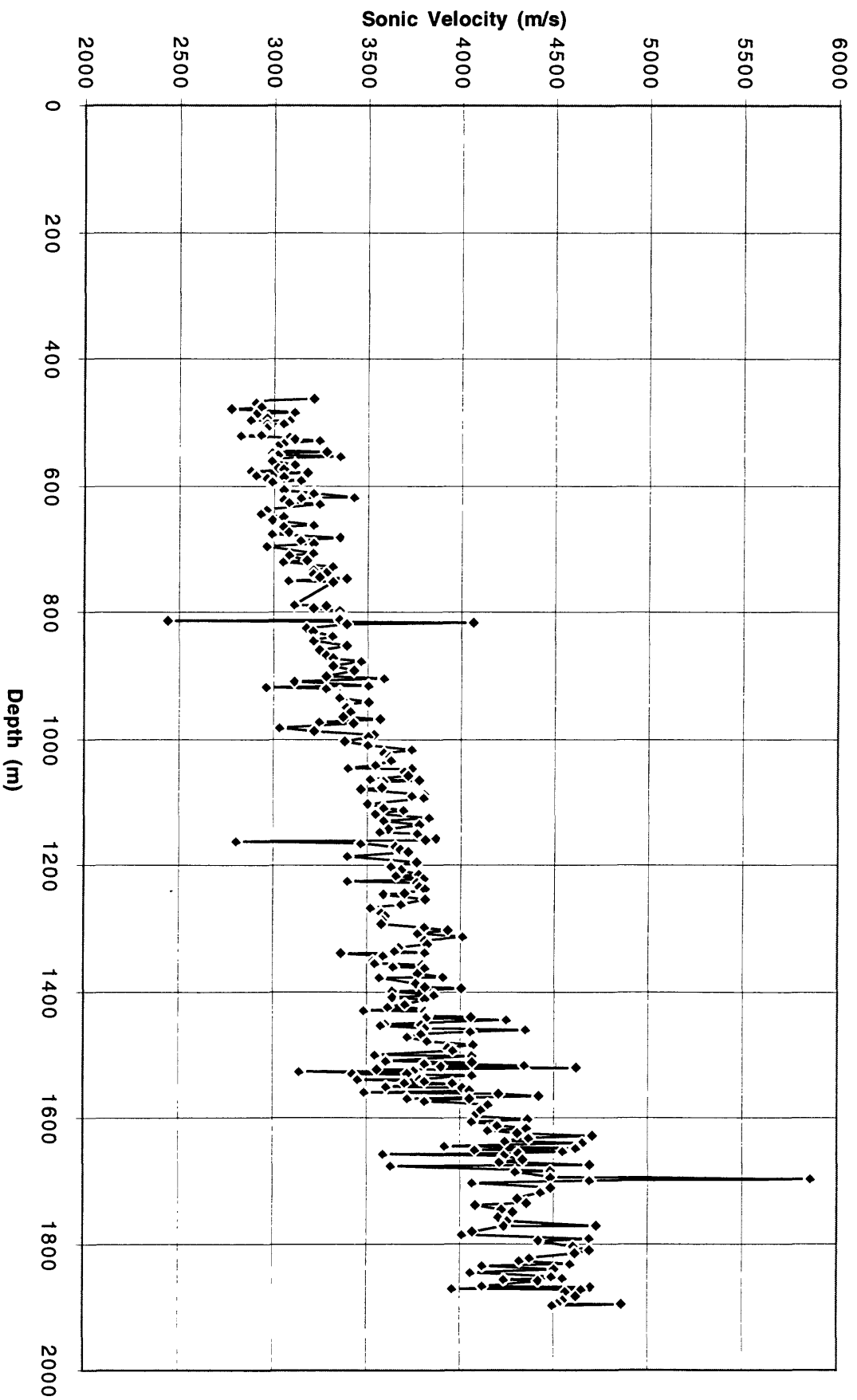


Figure 43.

**Richard R. Thorup, Operator, Thomas Doud Estate #4**

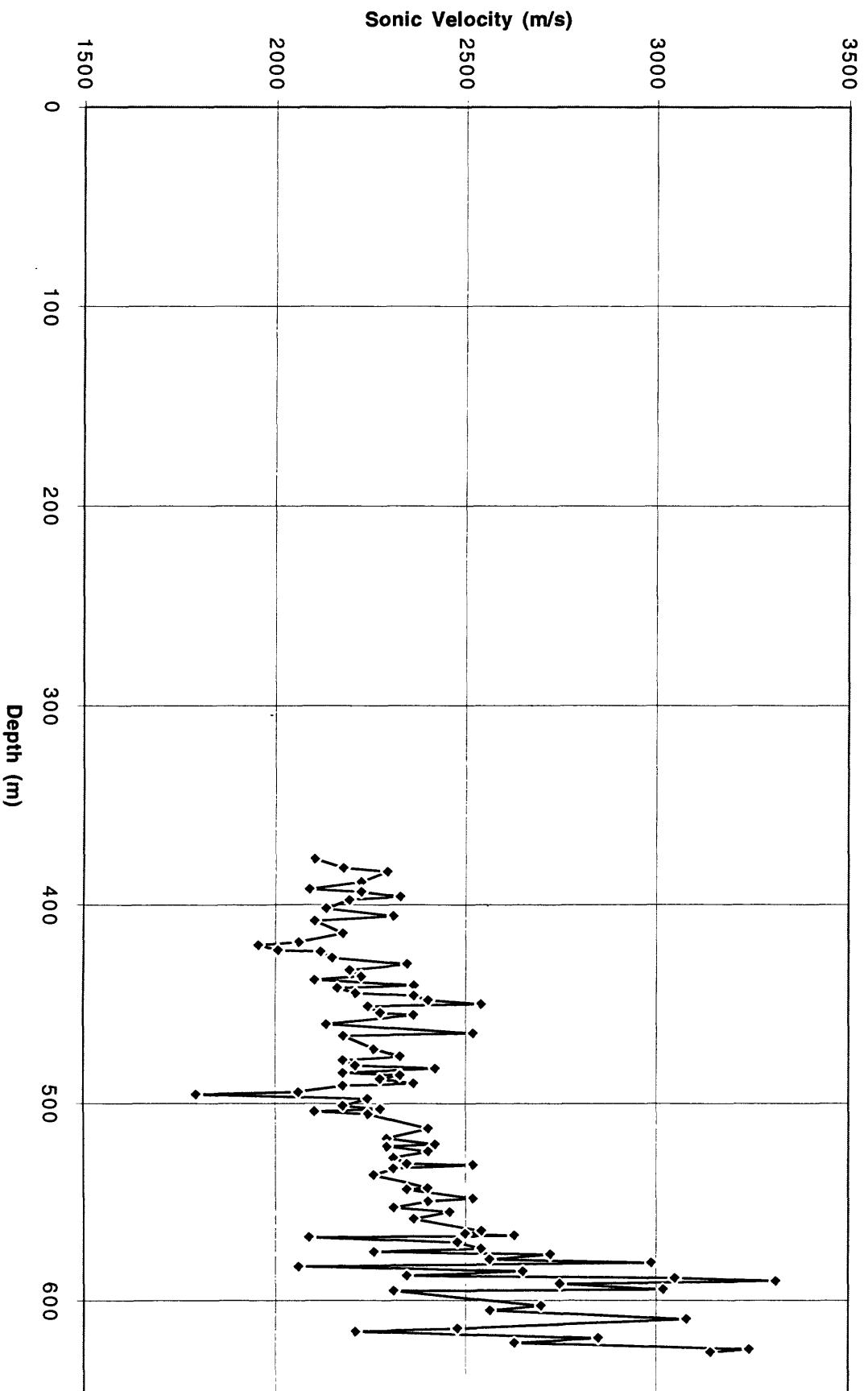


Figure 44.

**Pennant Operating Company, BCB-Doud D-3-32 Redrill**

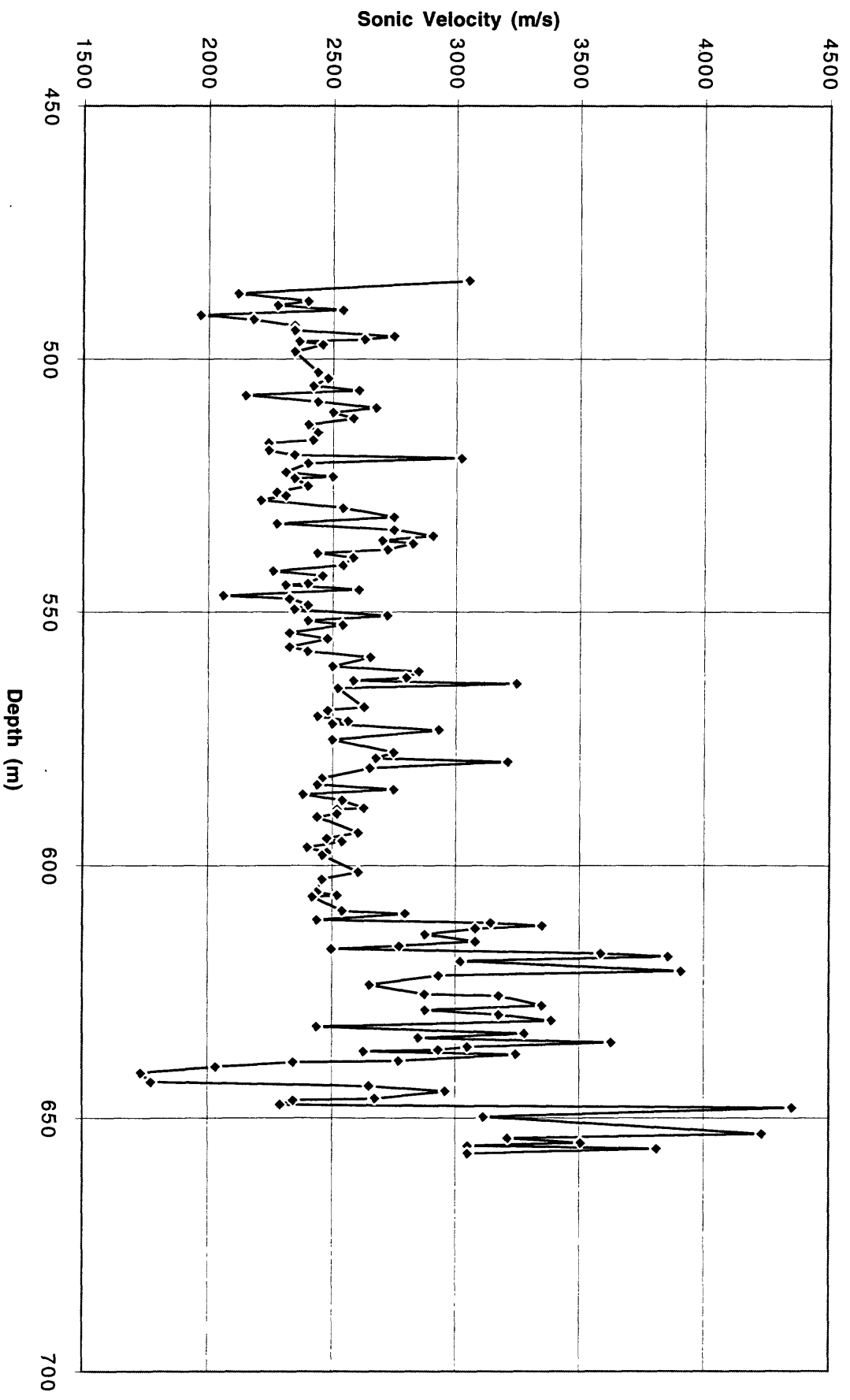


Figure 45.

**Beach, Church, and Bell, Salinas Land Co. #1**

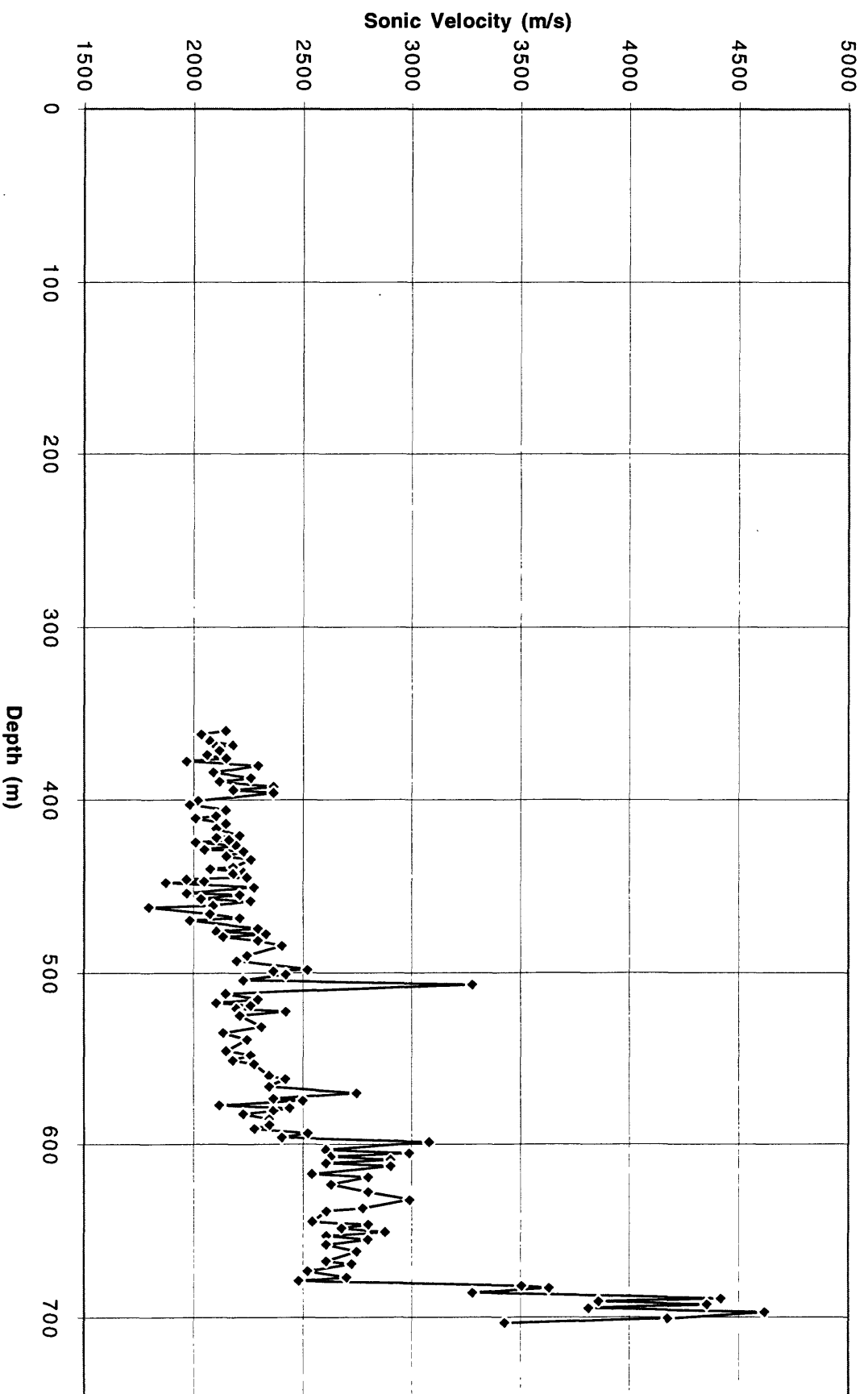


Figure 46.

**Chevron USA Inc; Arnold Ranch #1**

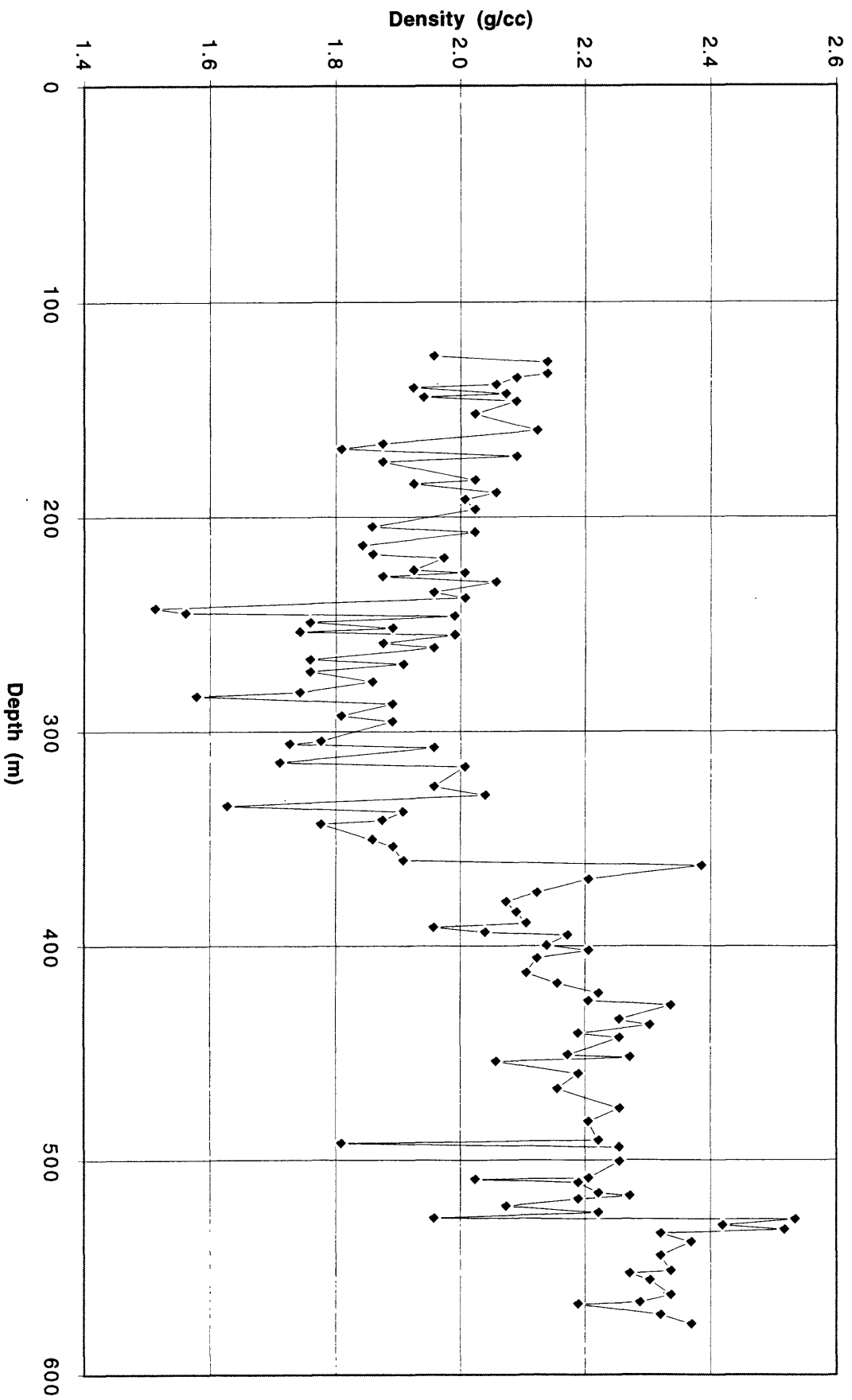


Figure 47.

**Chevron USA Inc; Arnold Ranch #1 Redrill #1**

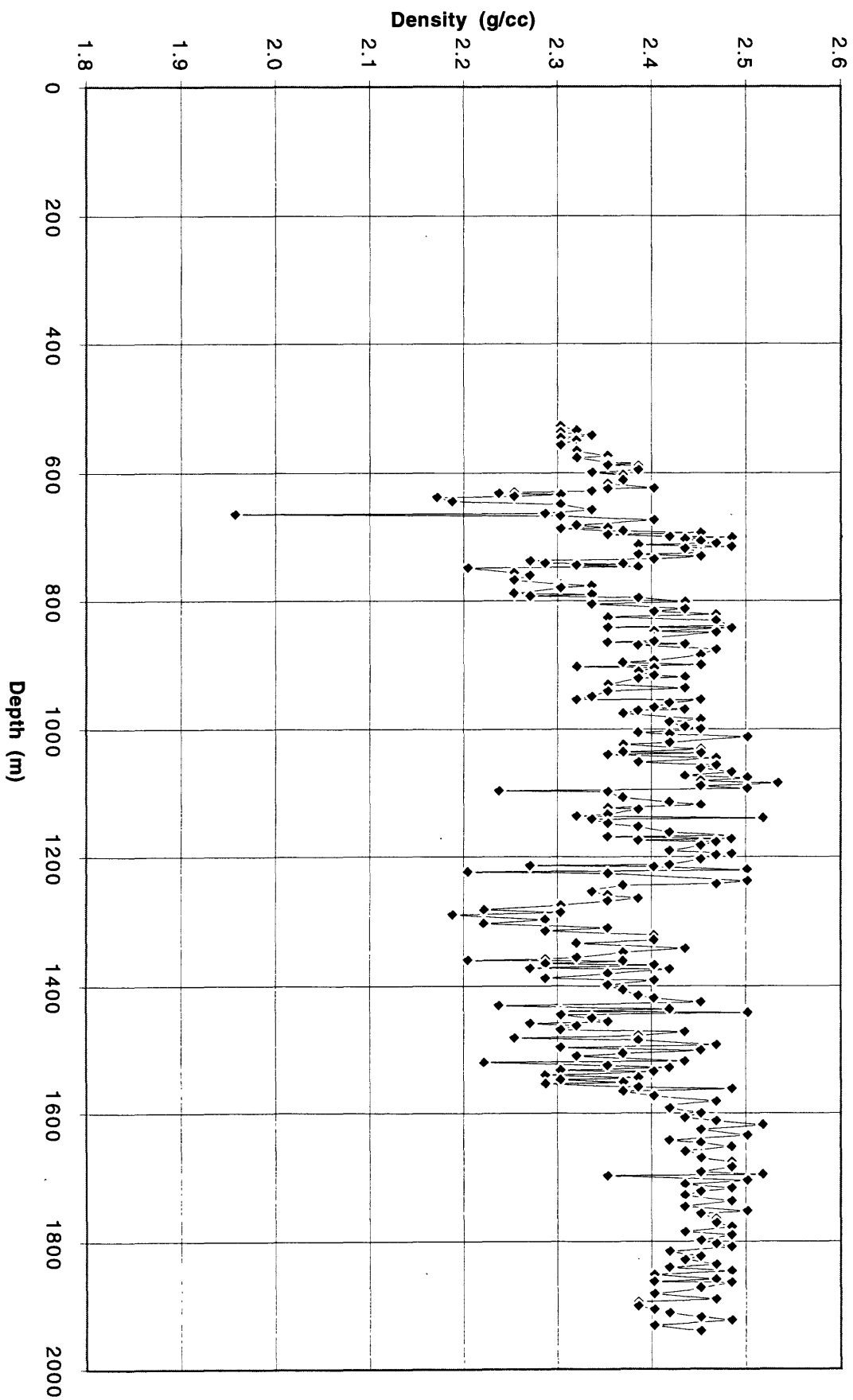


Figure 48.

**Chevron USA Inc; United California Bank No. 1 Redrill No. 1**

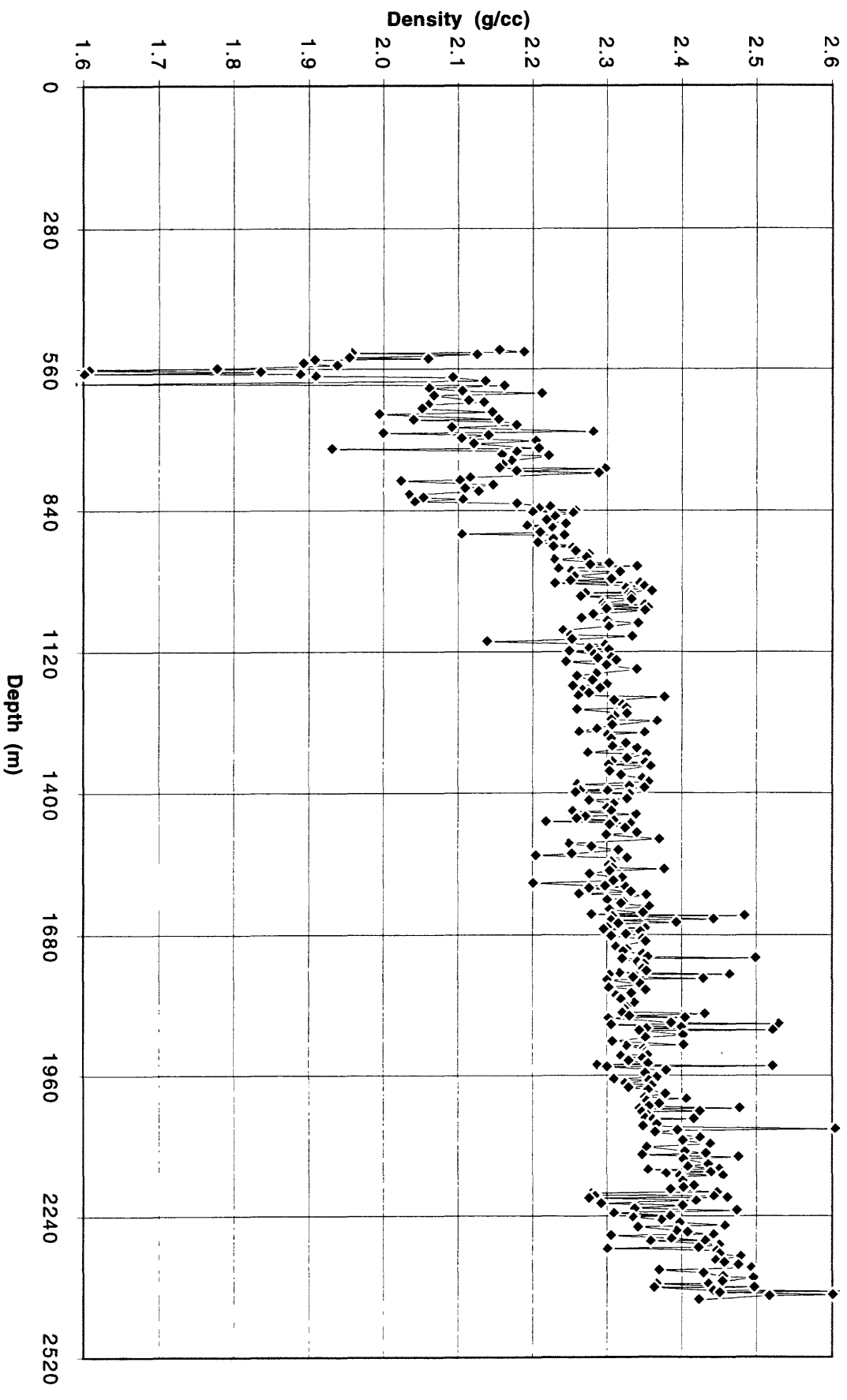


Figure 49.



**Chevron USA Inc; Perry #1 Redrill**

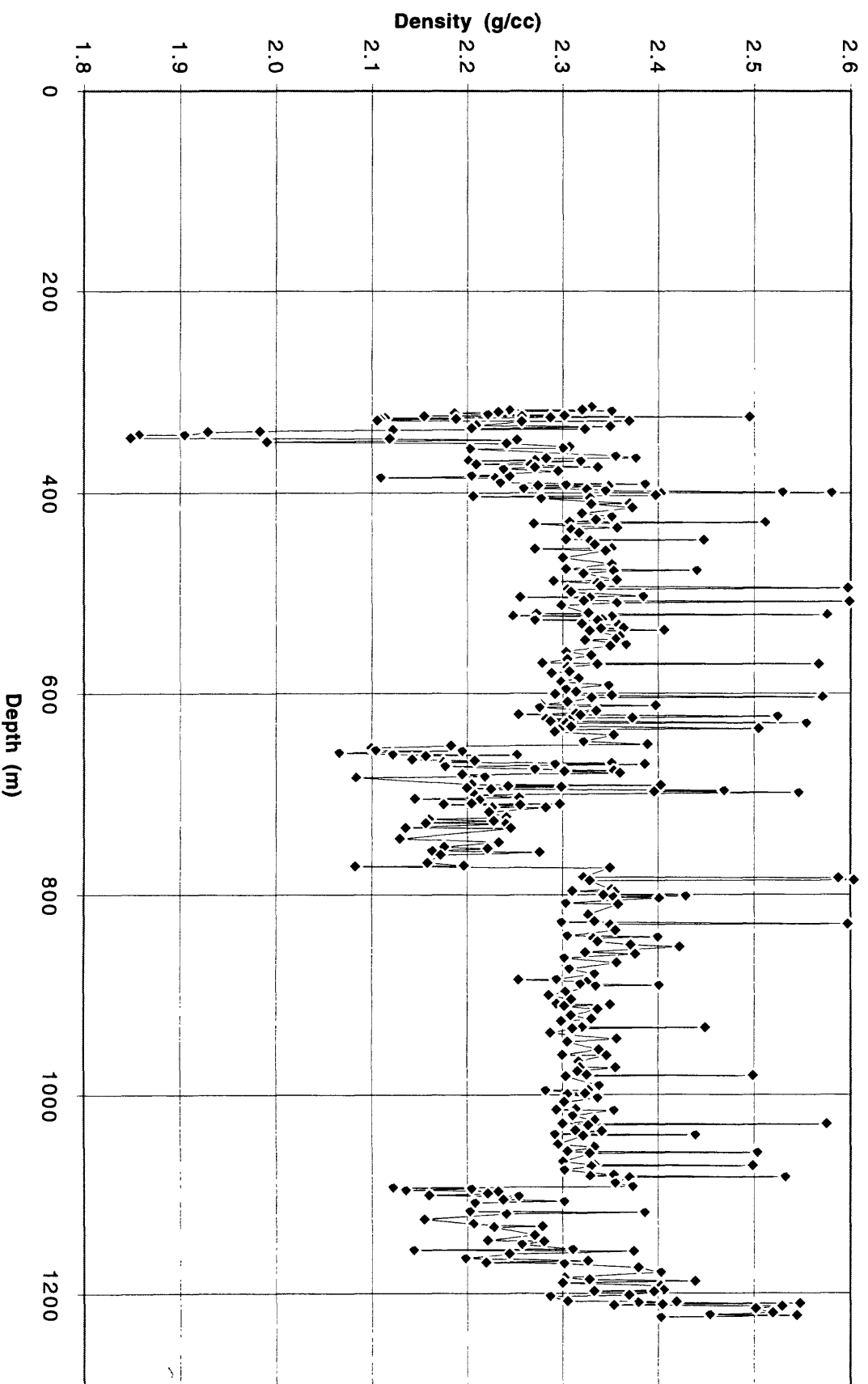


Figure 50.

Chevron USA Inc; Perry #1 Redrill #2

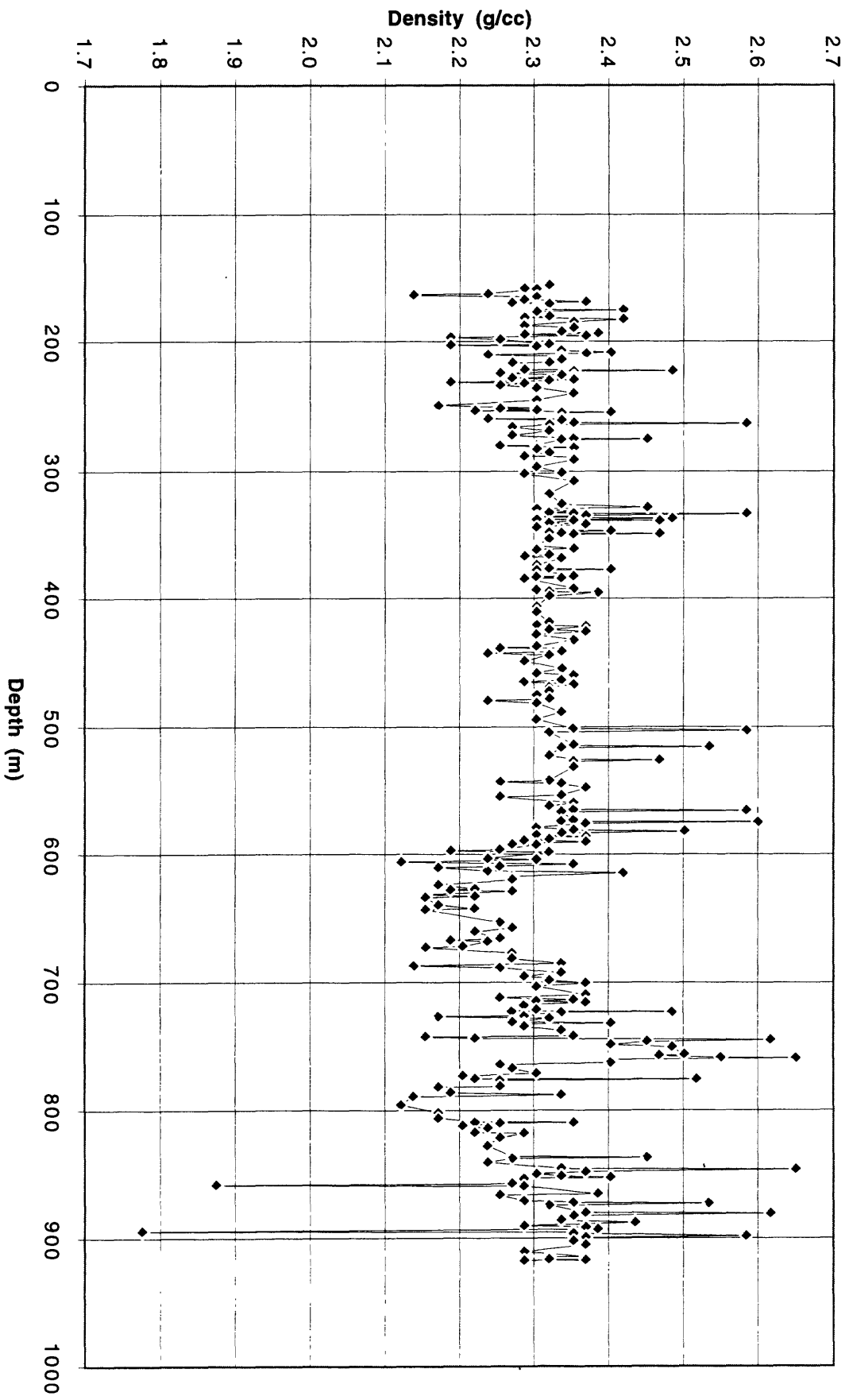


Figure 51.

Atlantic Richfield Company, Mantelli #1

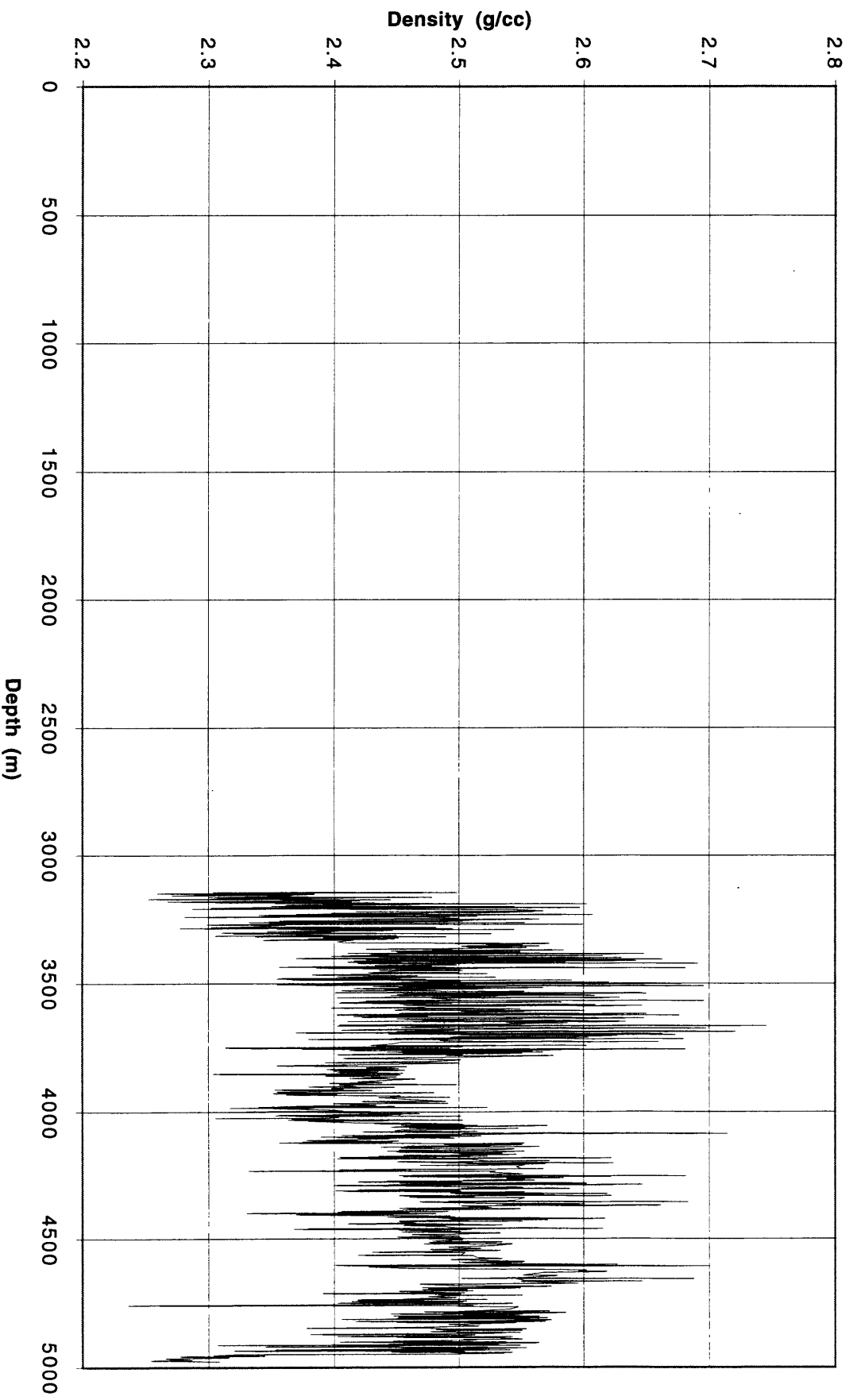


Figure 52.

Phillips Petroleum Company, Vierra A No. 1

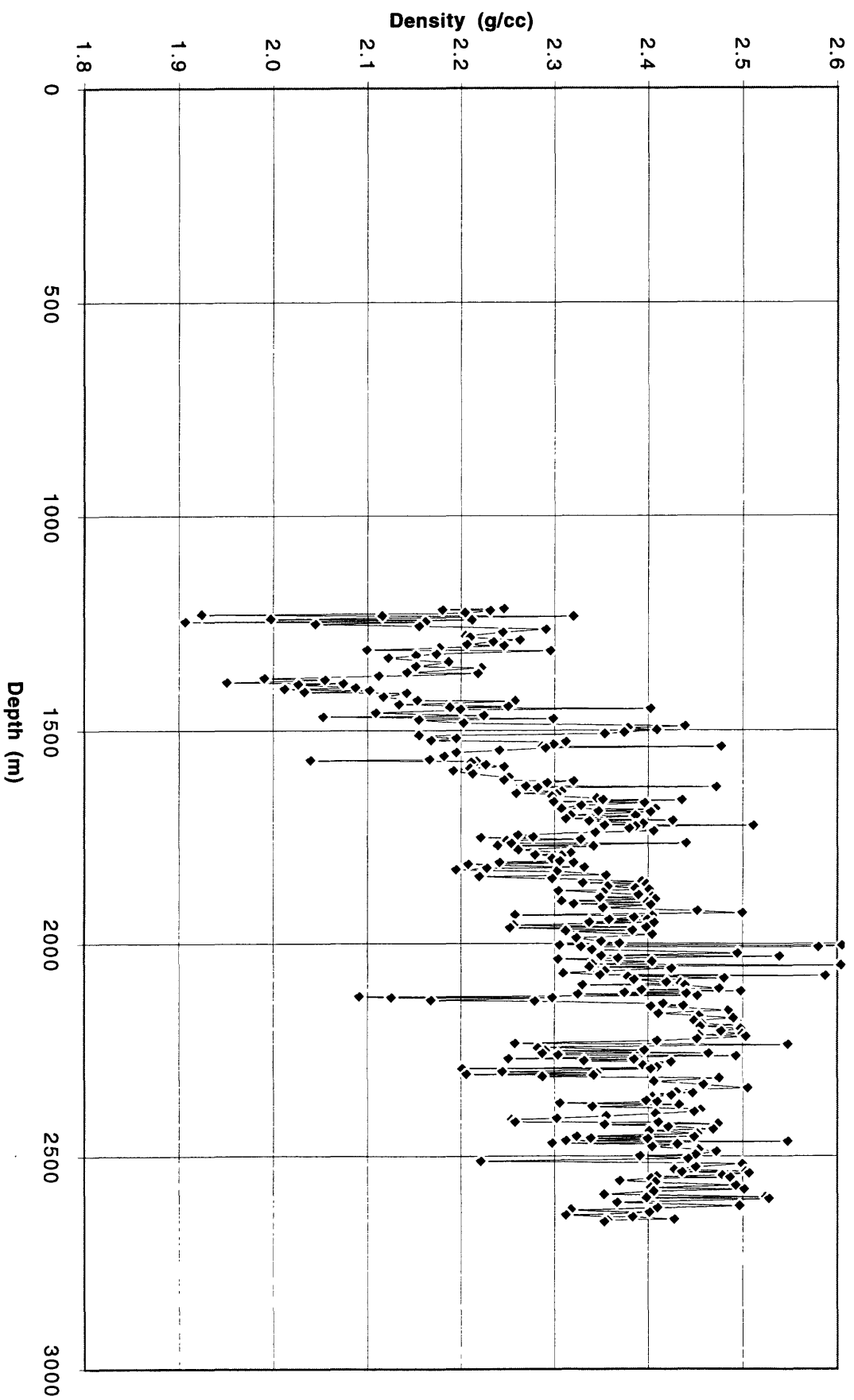


Figure 53.

# E.C. Brown Petroleum, Lupin #2

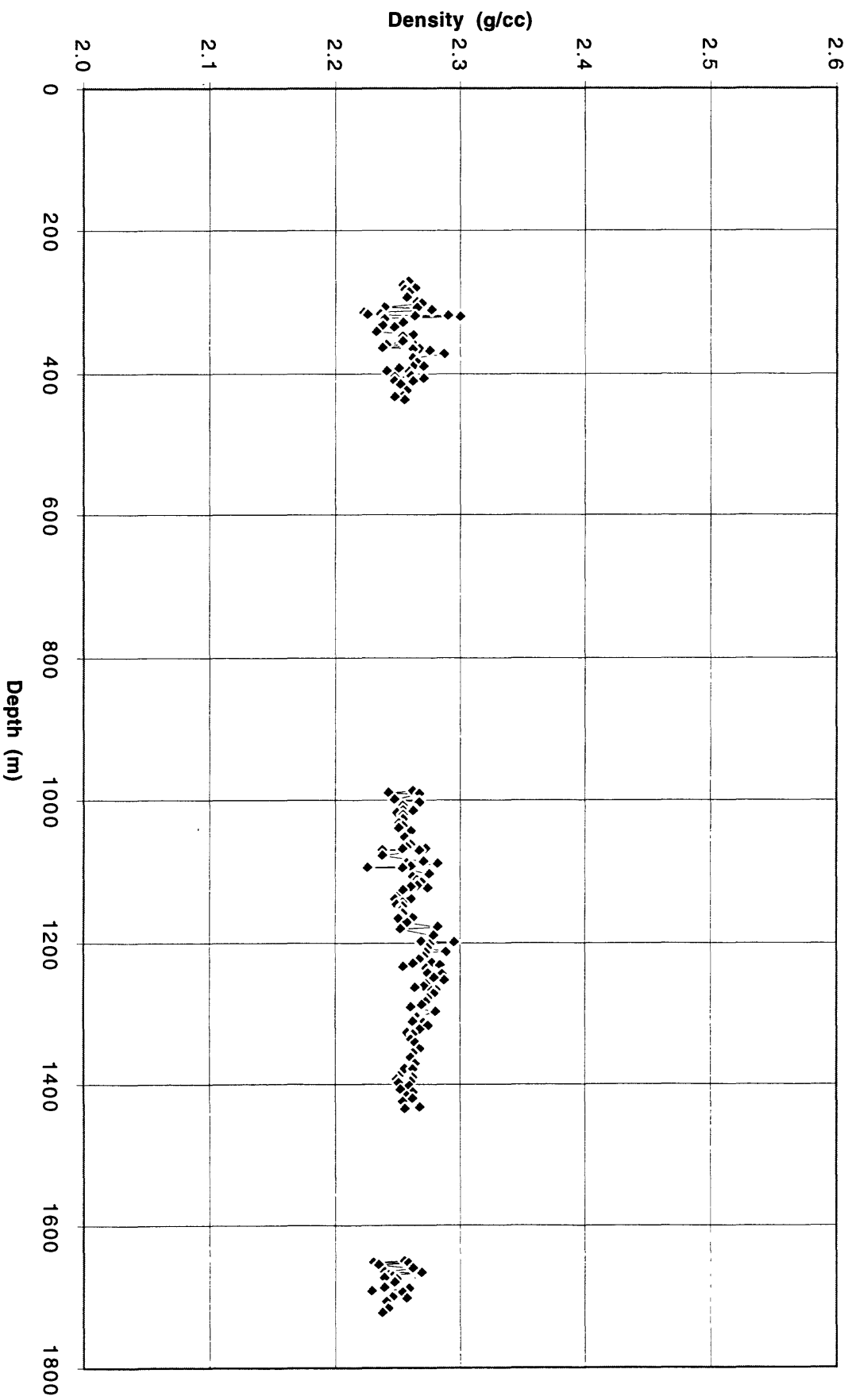


Figure 54.

**Standard Oil Company of California, Simon-Newman #1**

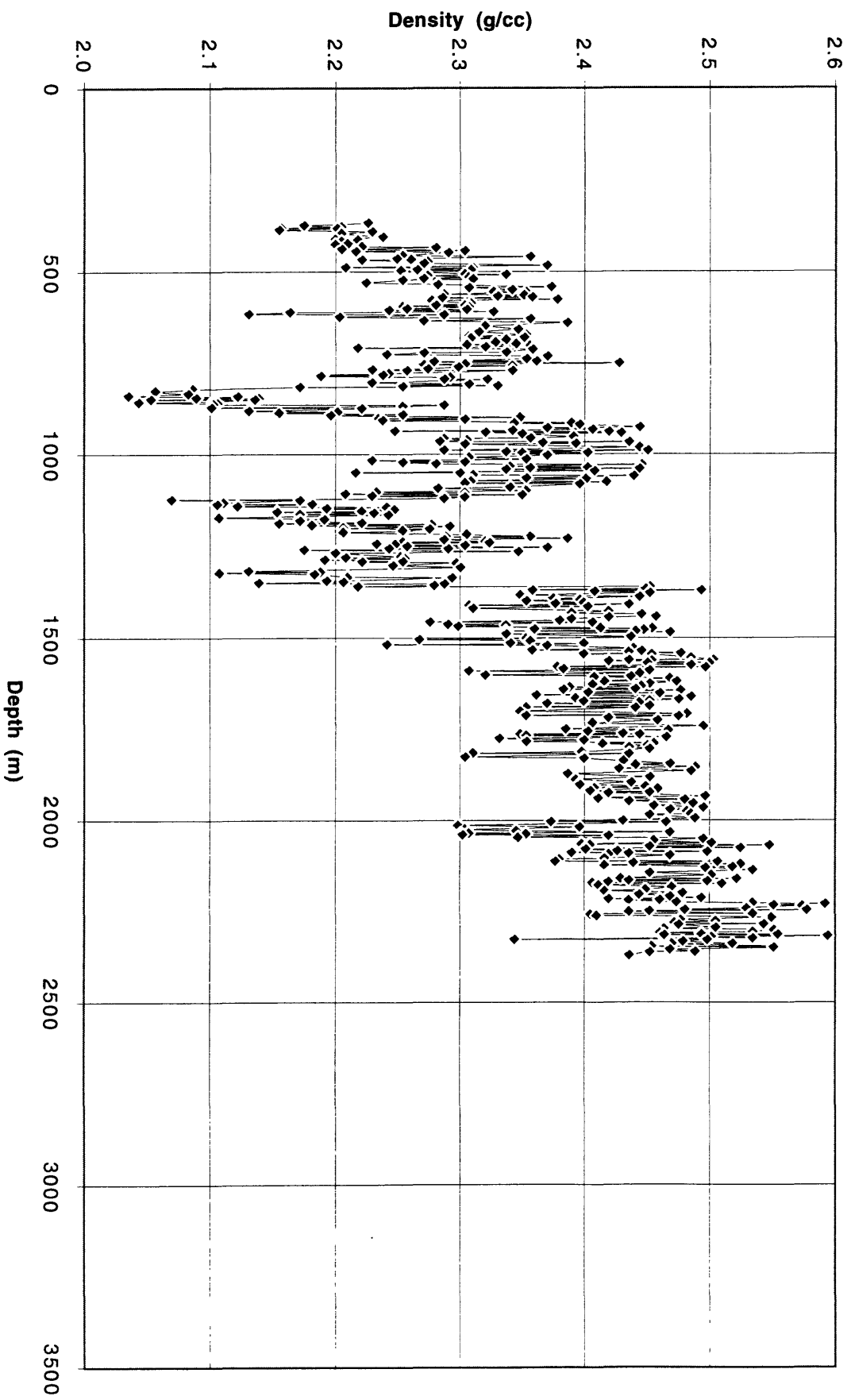


Figure 55.

Occidental Petroleum Corp; Sargent #1

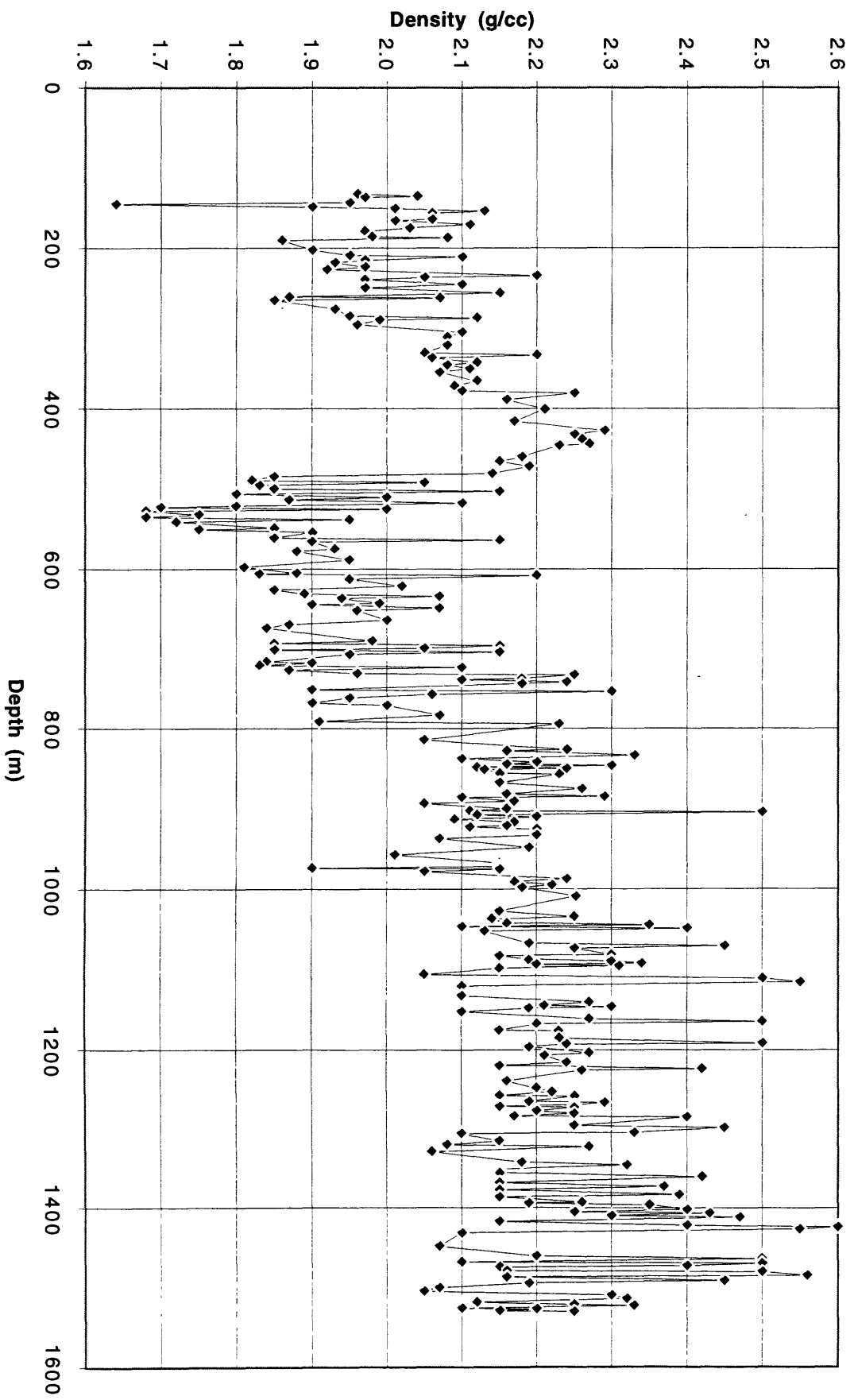


Figure 56.

U.S. Geological Survey, Law #CB-1

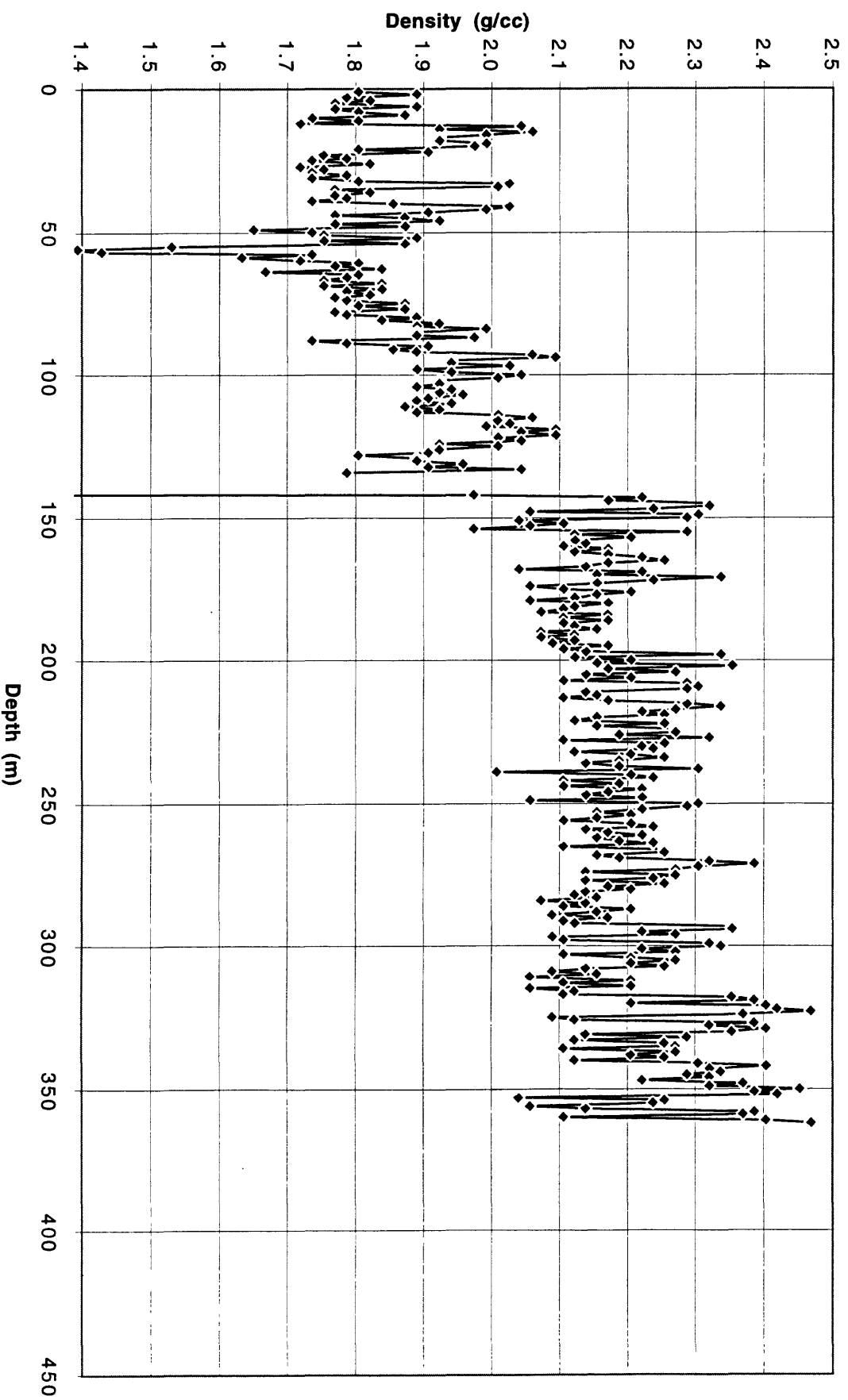


Figure 57.



**Santa Fe Energy Company, Law #80X-1 Redrill**

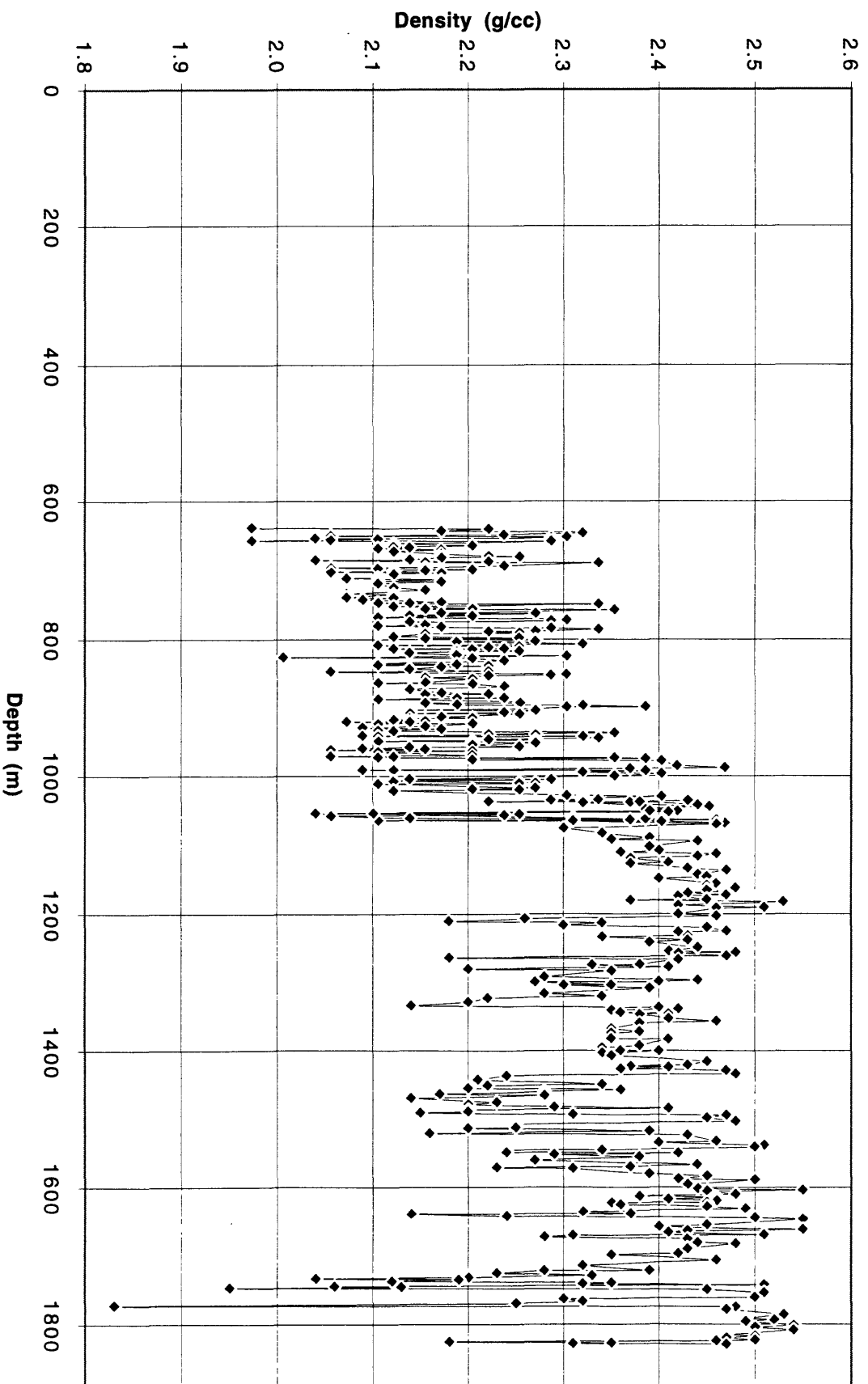


Figure 58.

C. Lee Mueller, Sun McDonald #1-36

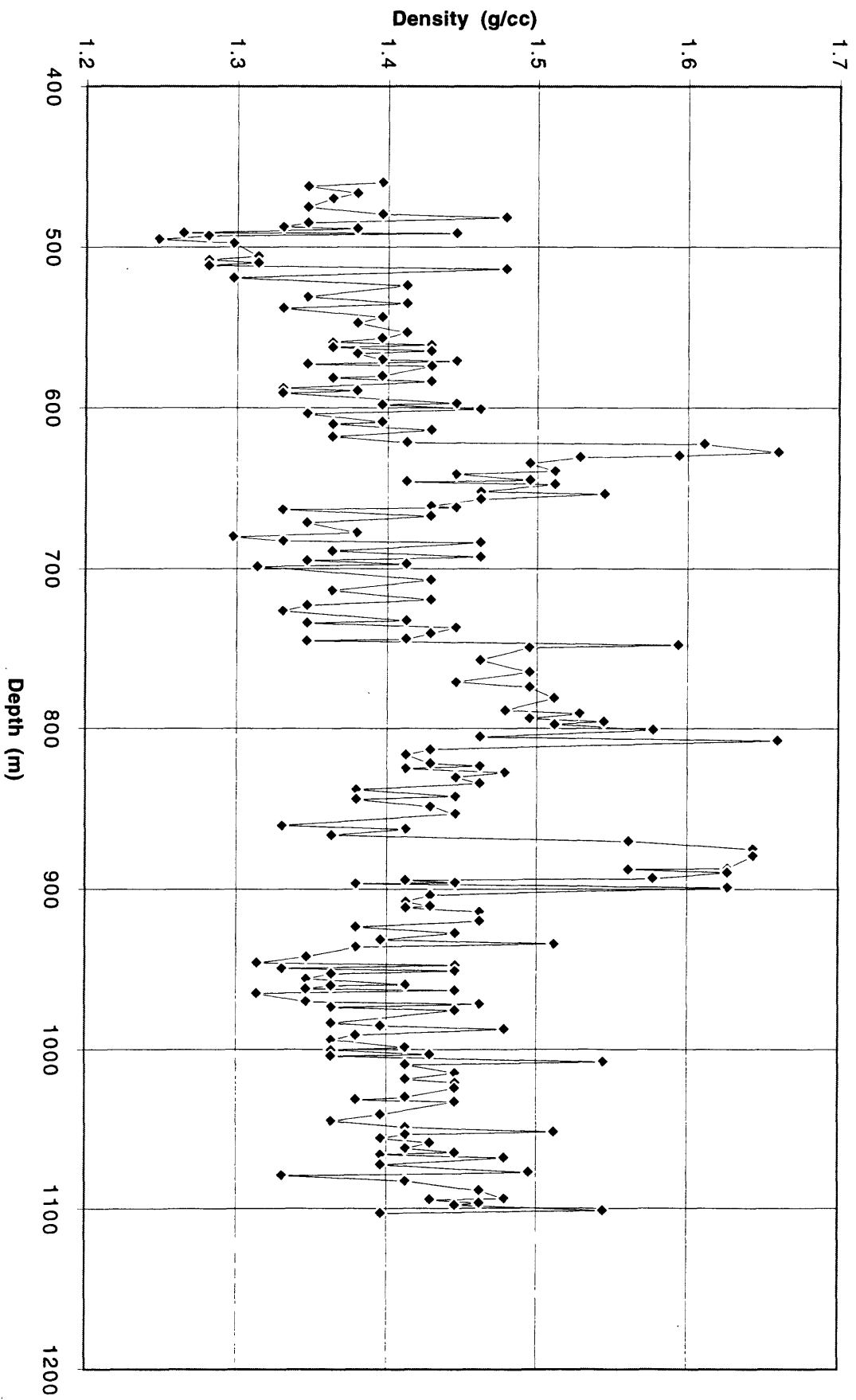


Figure 59.

# Standard Oil Company of California, Tannehill Ranch Core Hole #9

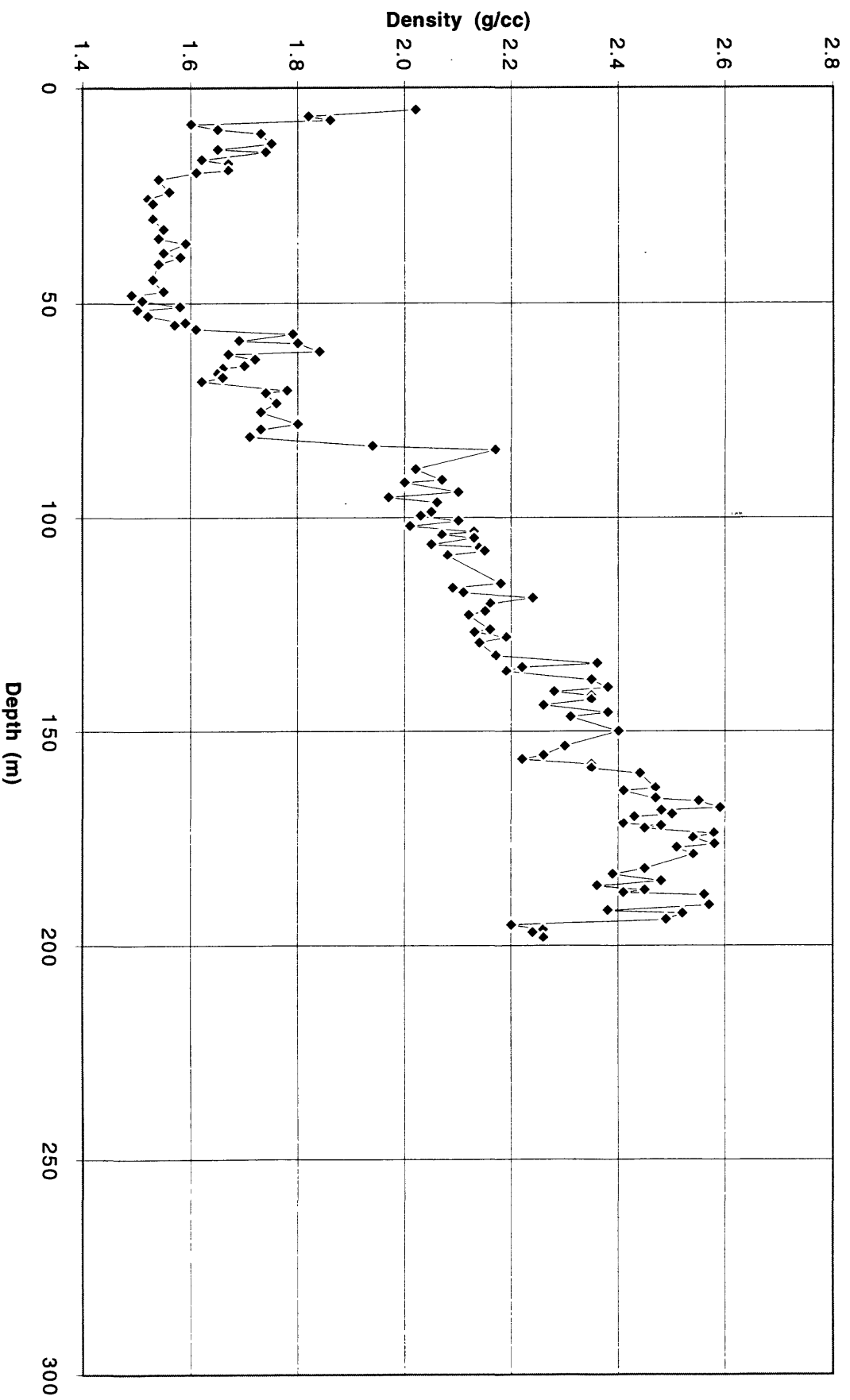


Figure 60.

Standard Oil Company of California, Tannehill Ranch Core Hole #10

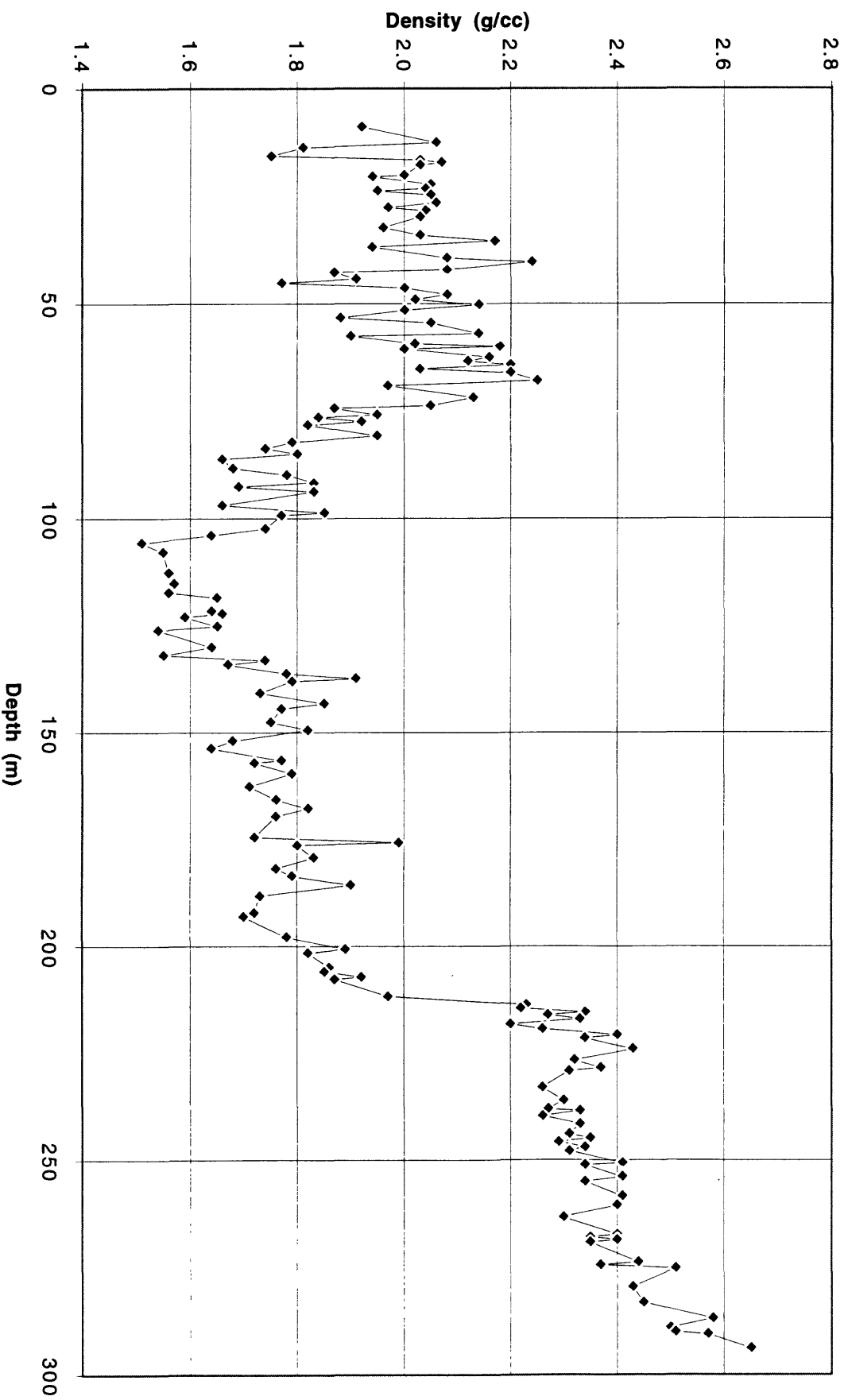


Figure 61.

Phillips Petroleum Company, Olsen No. A-2

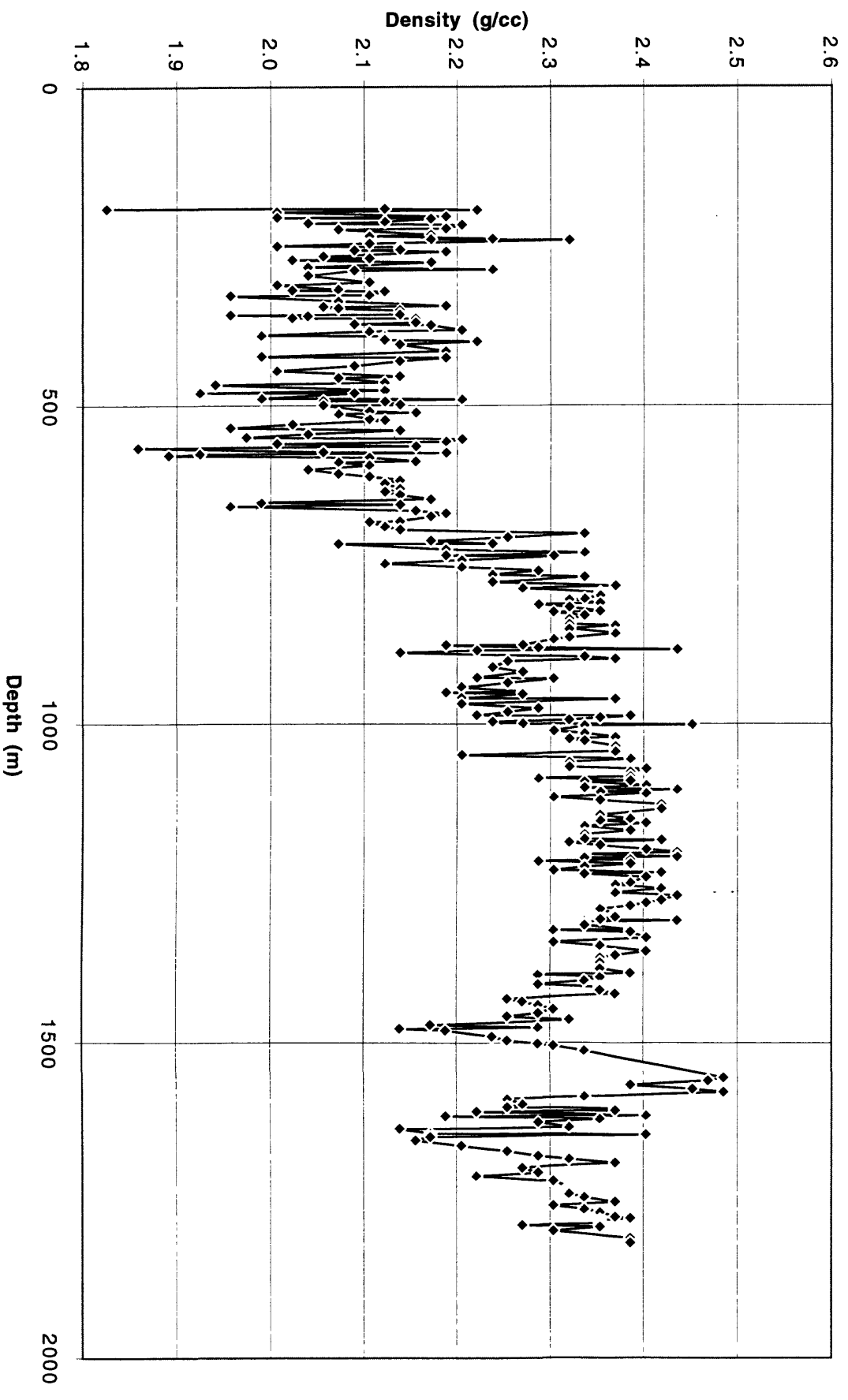


Figure 62.

# Century Oil Management, Doud #15

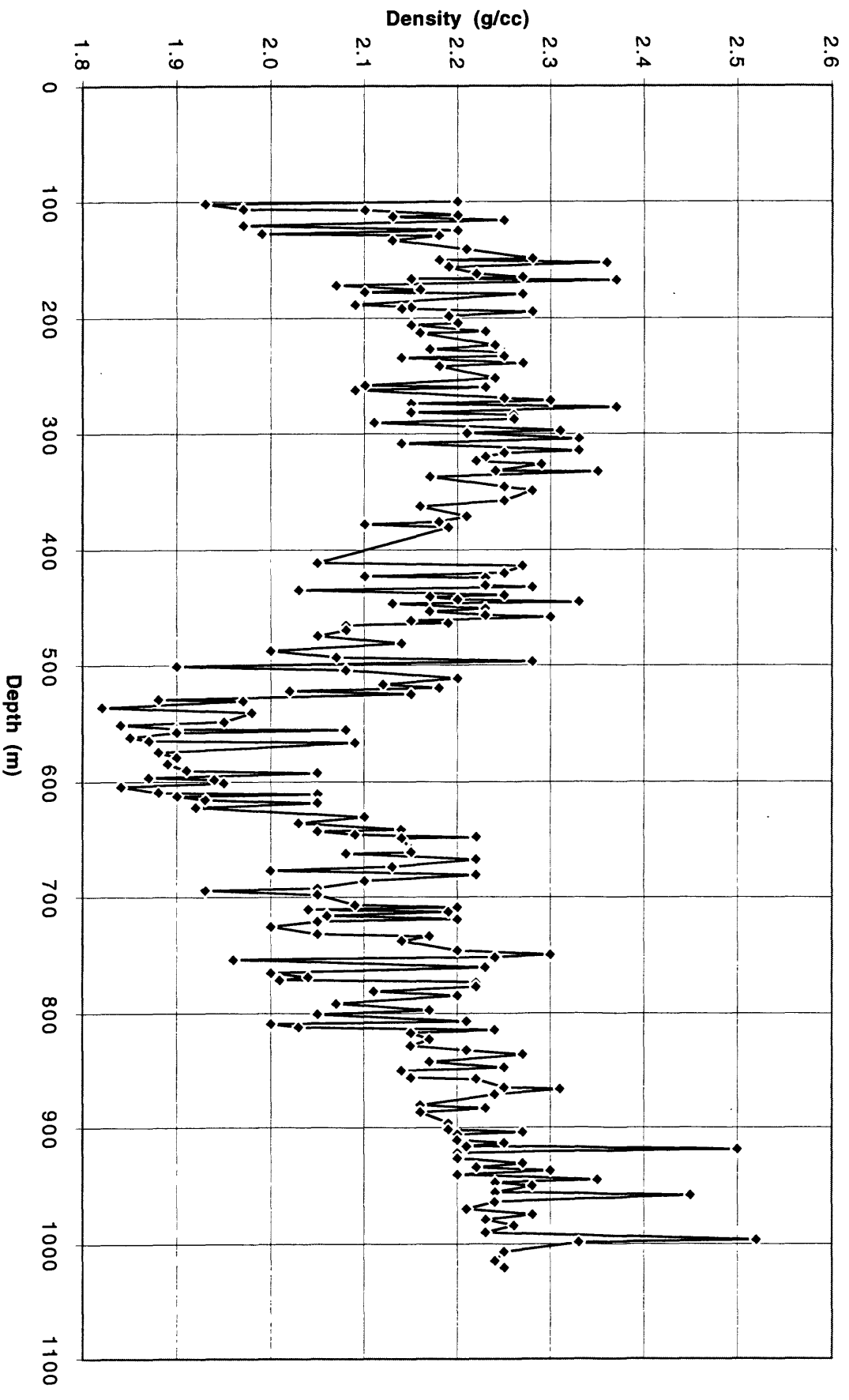


Figure 63.

Phillips Petroleum Company, Doud A #1

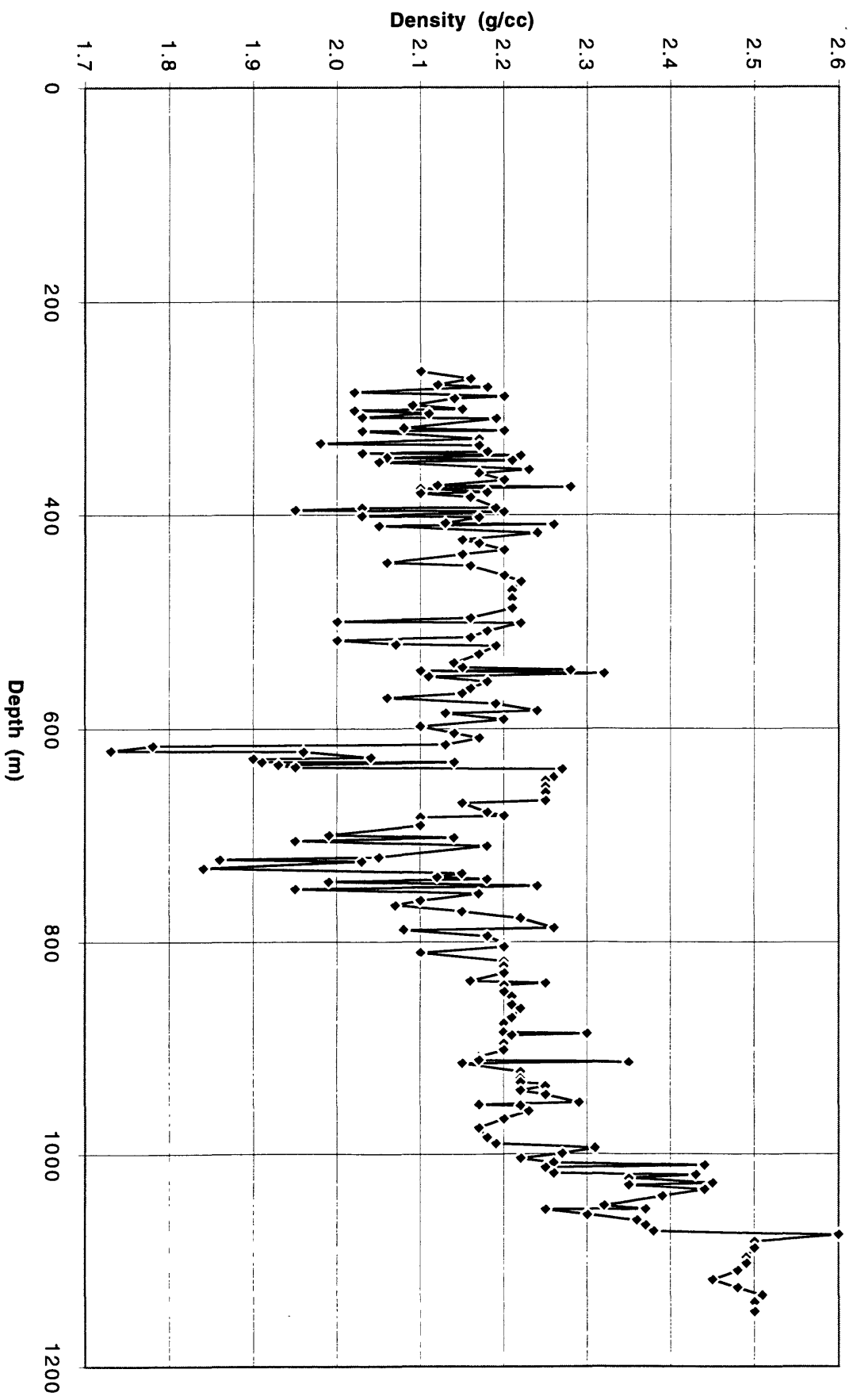


Figure 64.

Phillips Petroleum Company, Hansen #1

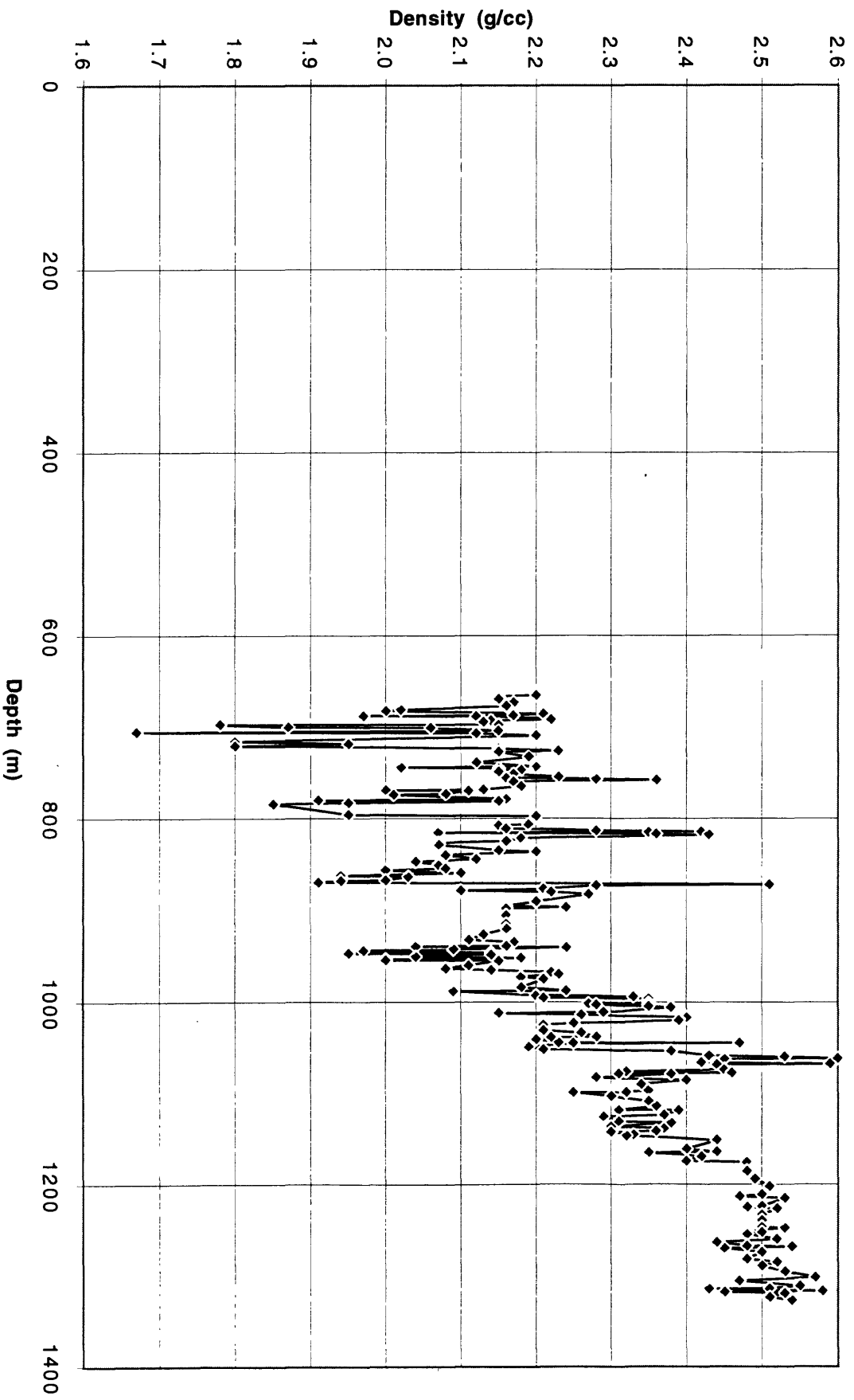


Figure 65.



**Texas Pacific Oil Company, Eade No. 1**

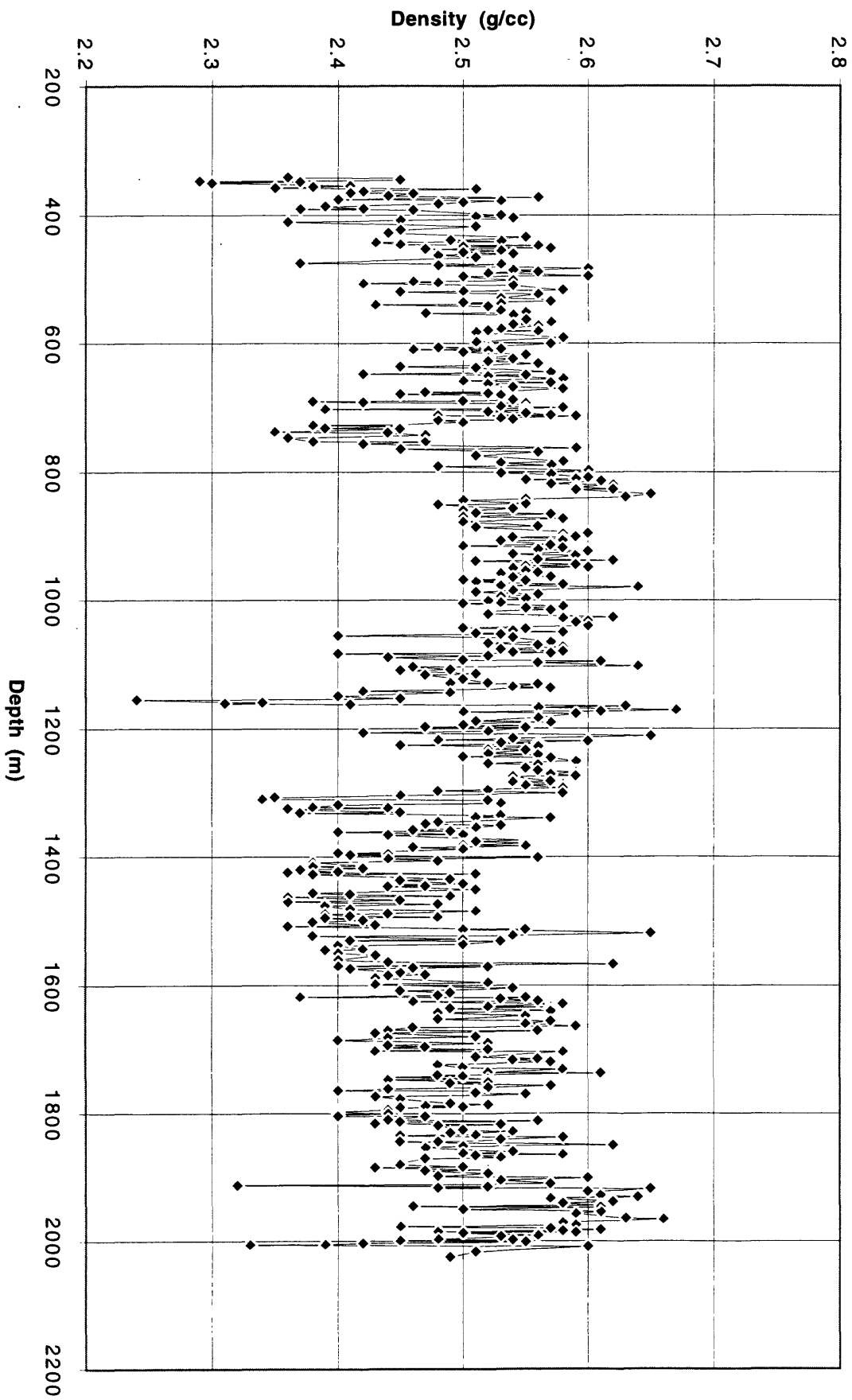


Figure 66.

Cities Service Oil Company, Plaskett No. A-1

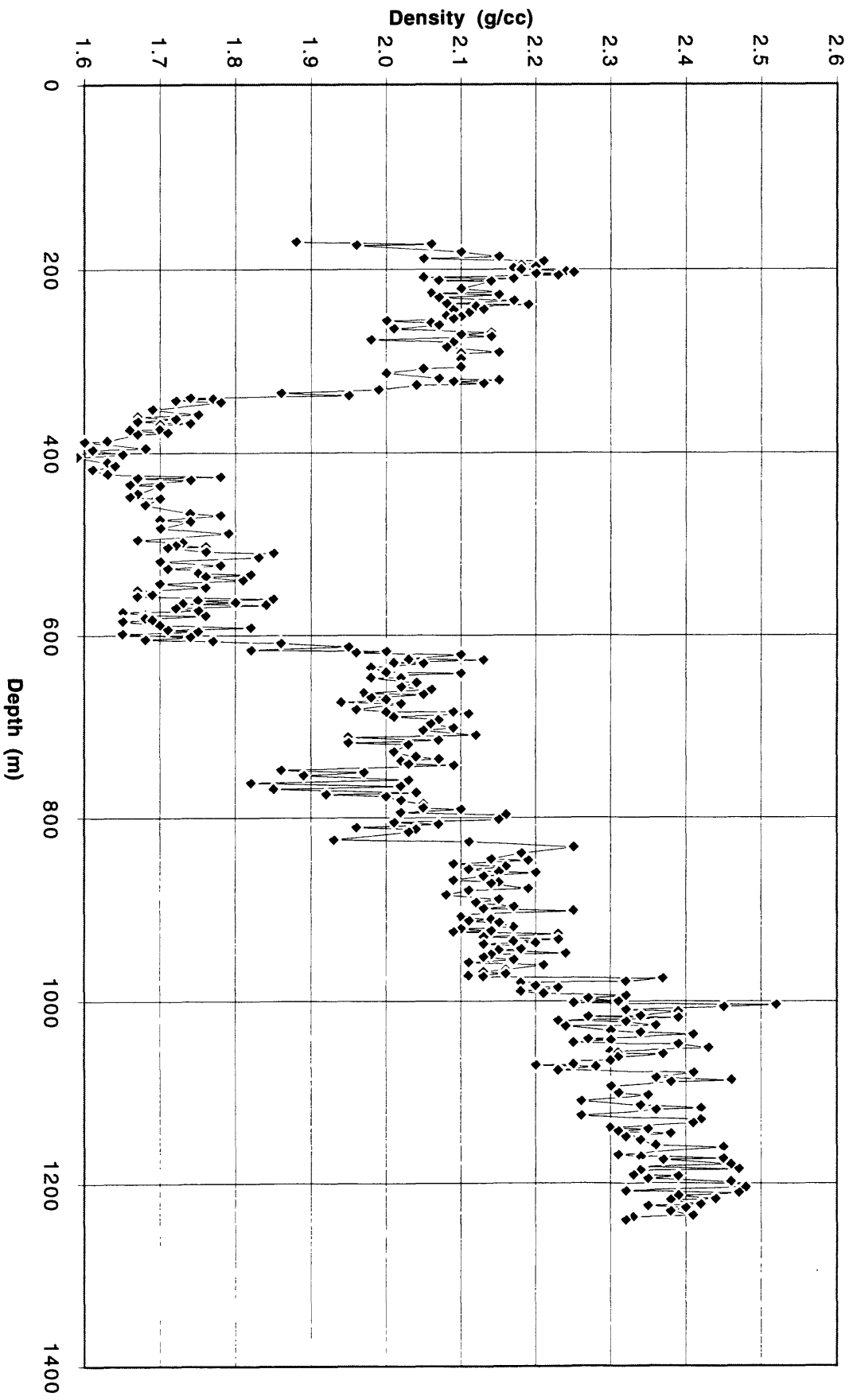


Figure 67.

Standard Oil Company of California, Smart Et Al

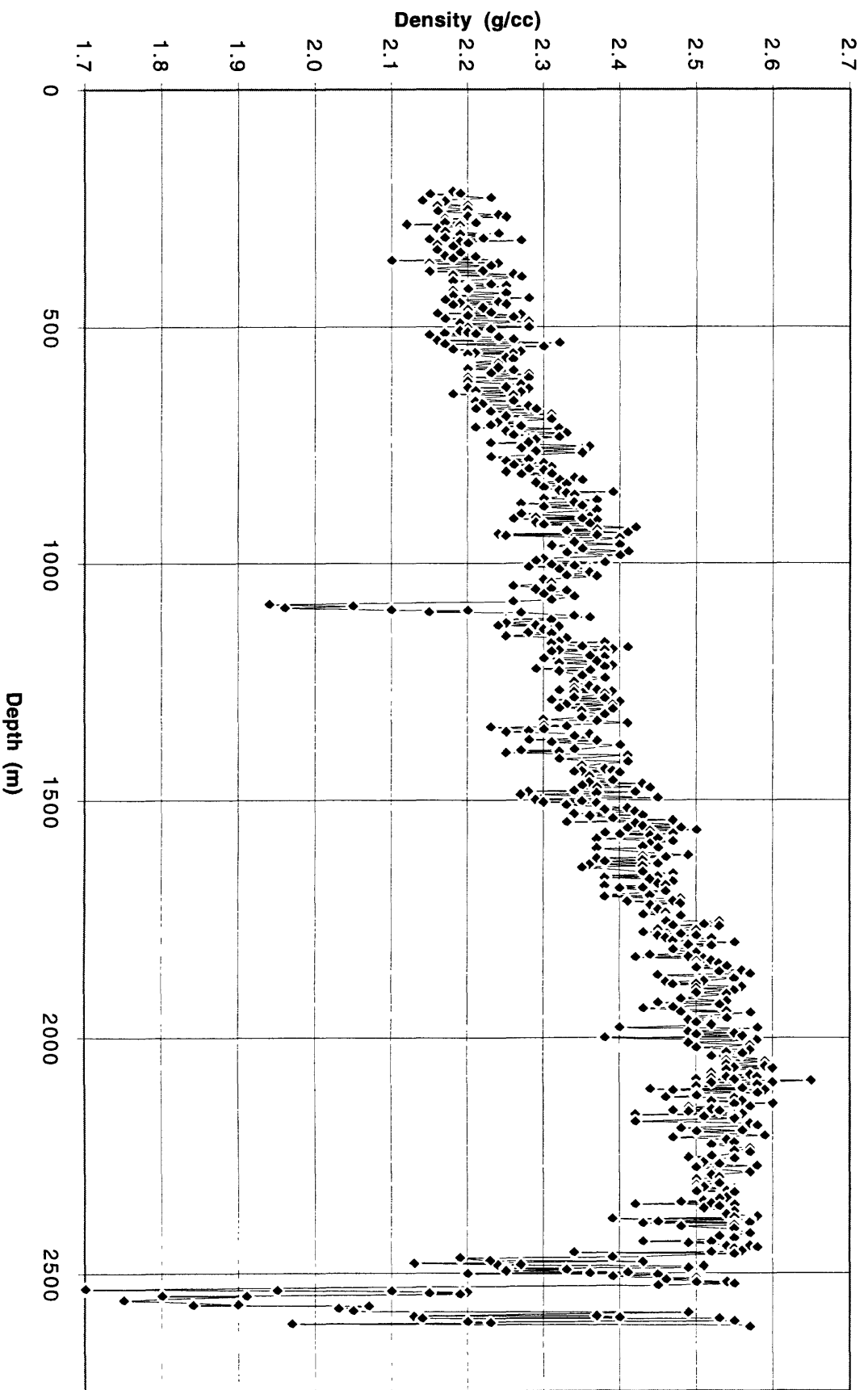


Figure 68.

Cities Service Oil Co; 1-Wallace-A Redrill #2

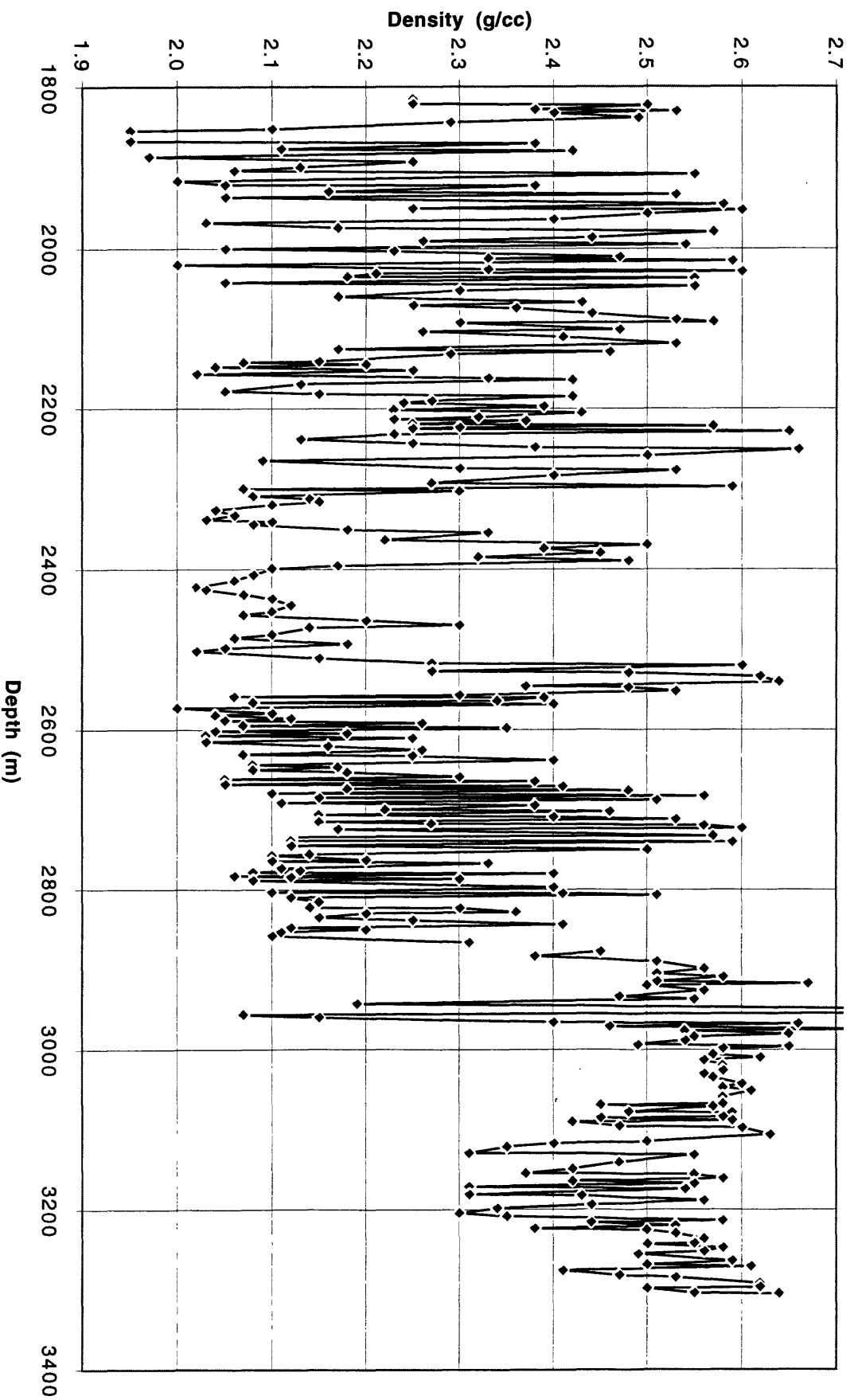


Figure 69.

**Chevron USA Inc; Section 8, Thompson Canyon USL #1**

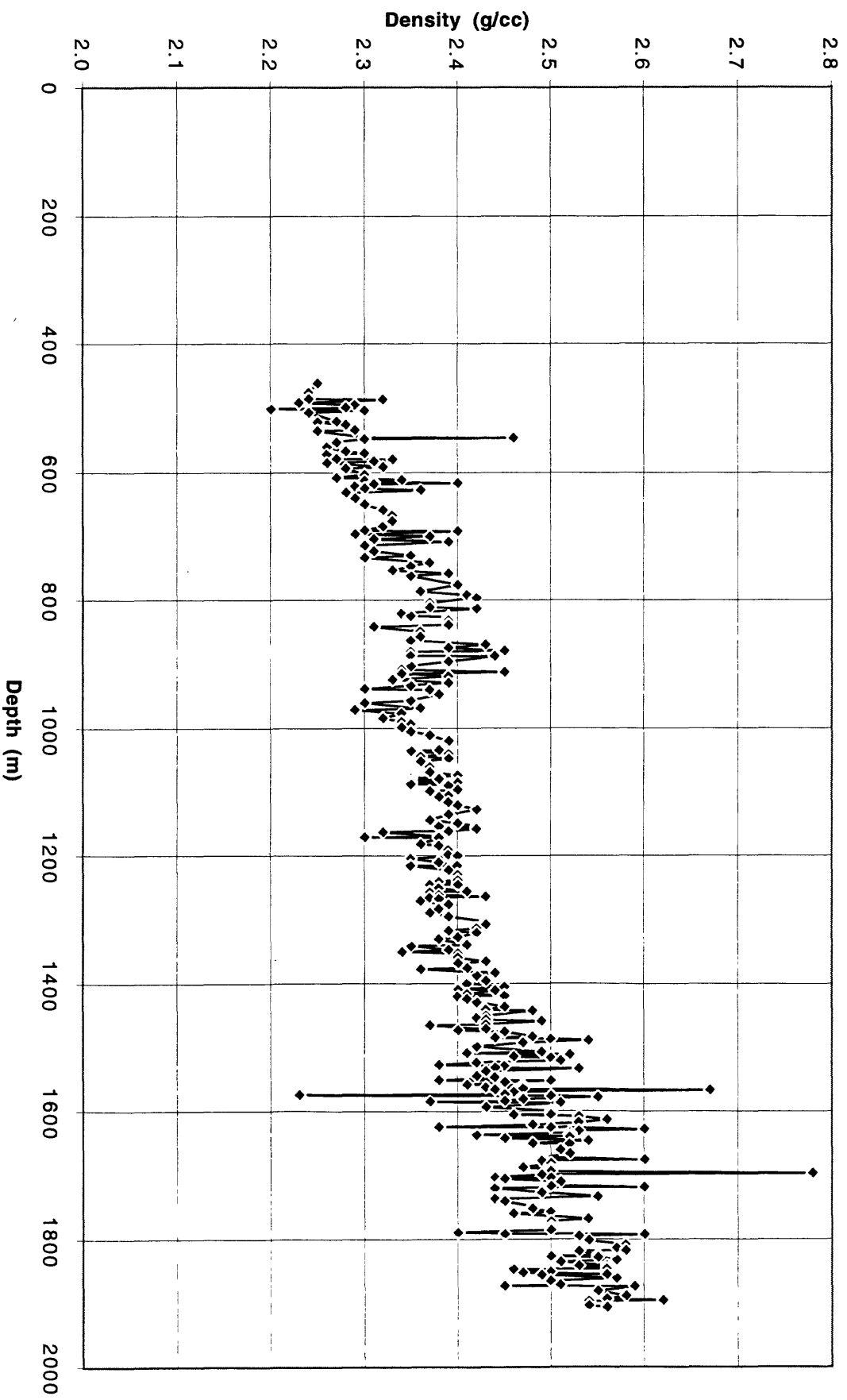


Figure 70.

**Standard Oil Company of California, Sumner & Gould No. 18-14**

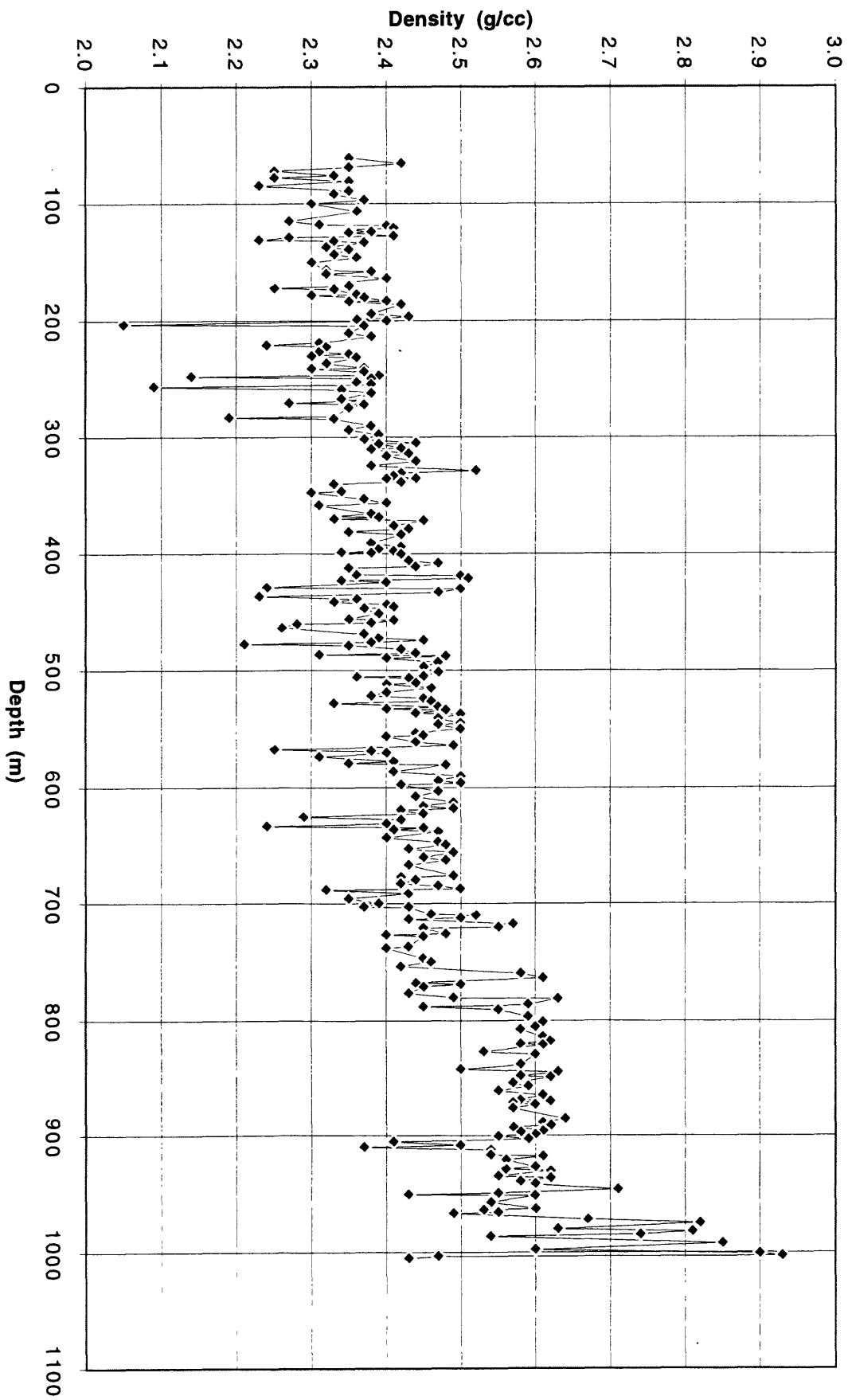


Figure 71.

**Chevron USA Inc; #4-1**

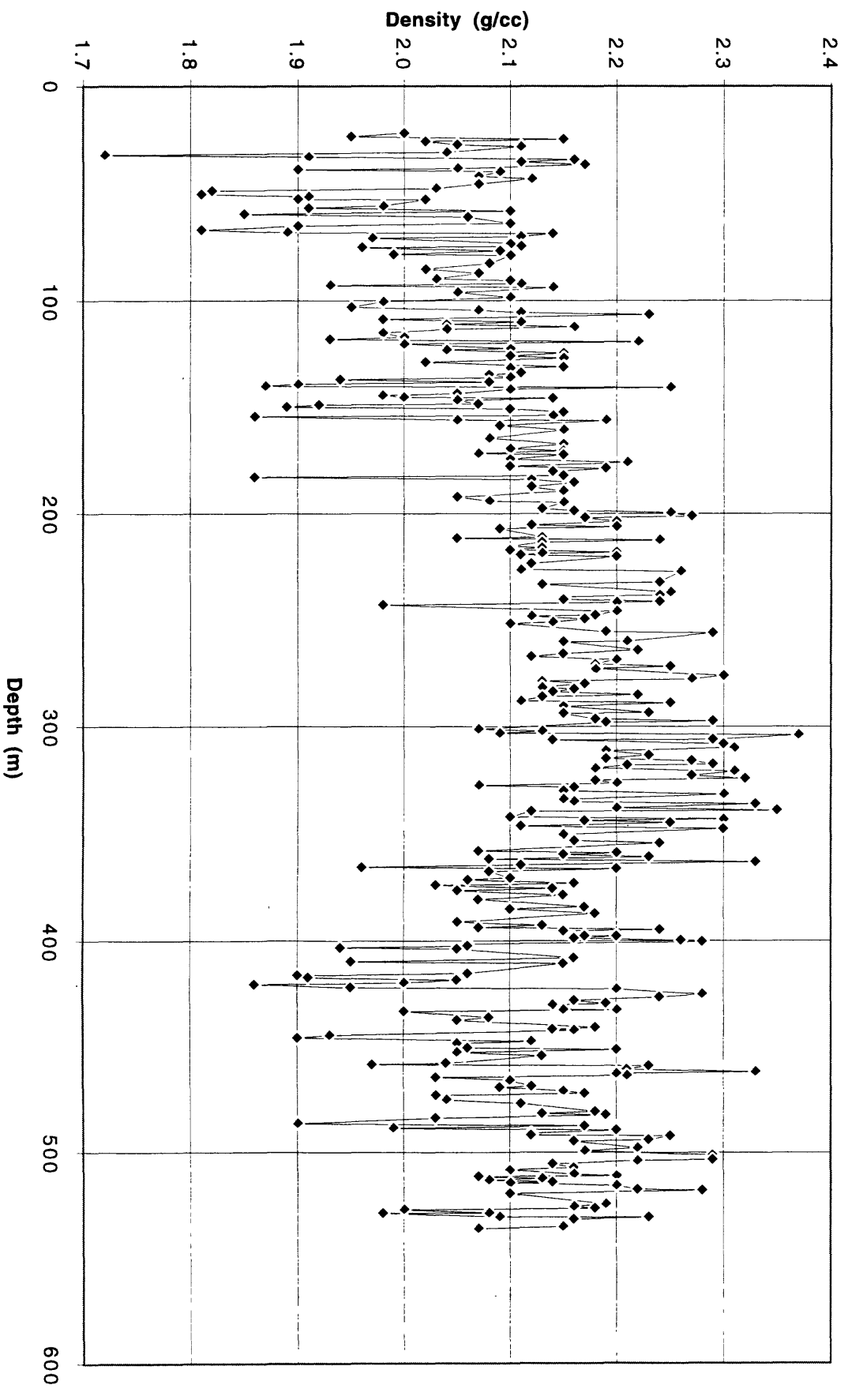


Figure 72.

G.E. Kadane and Sons, West Dunnigan No. 1-13

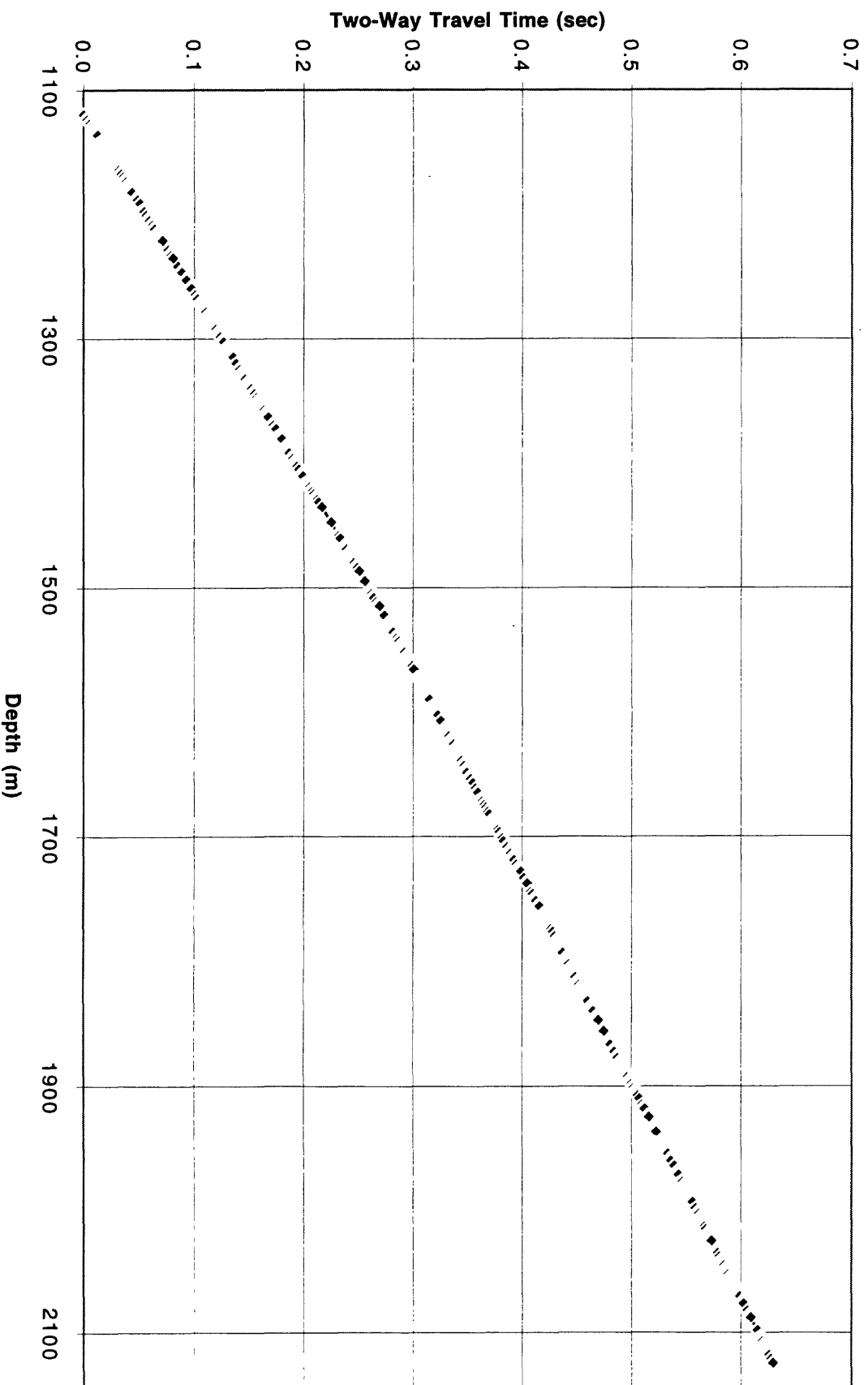


Figure 73.



# Standard Oil Company of California, Sun-Leperi No. 1

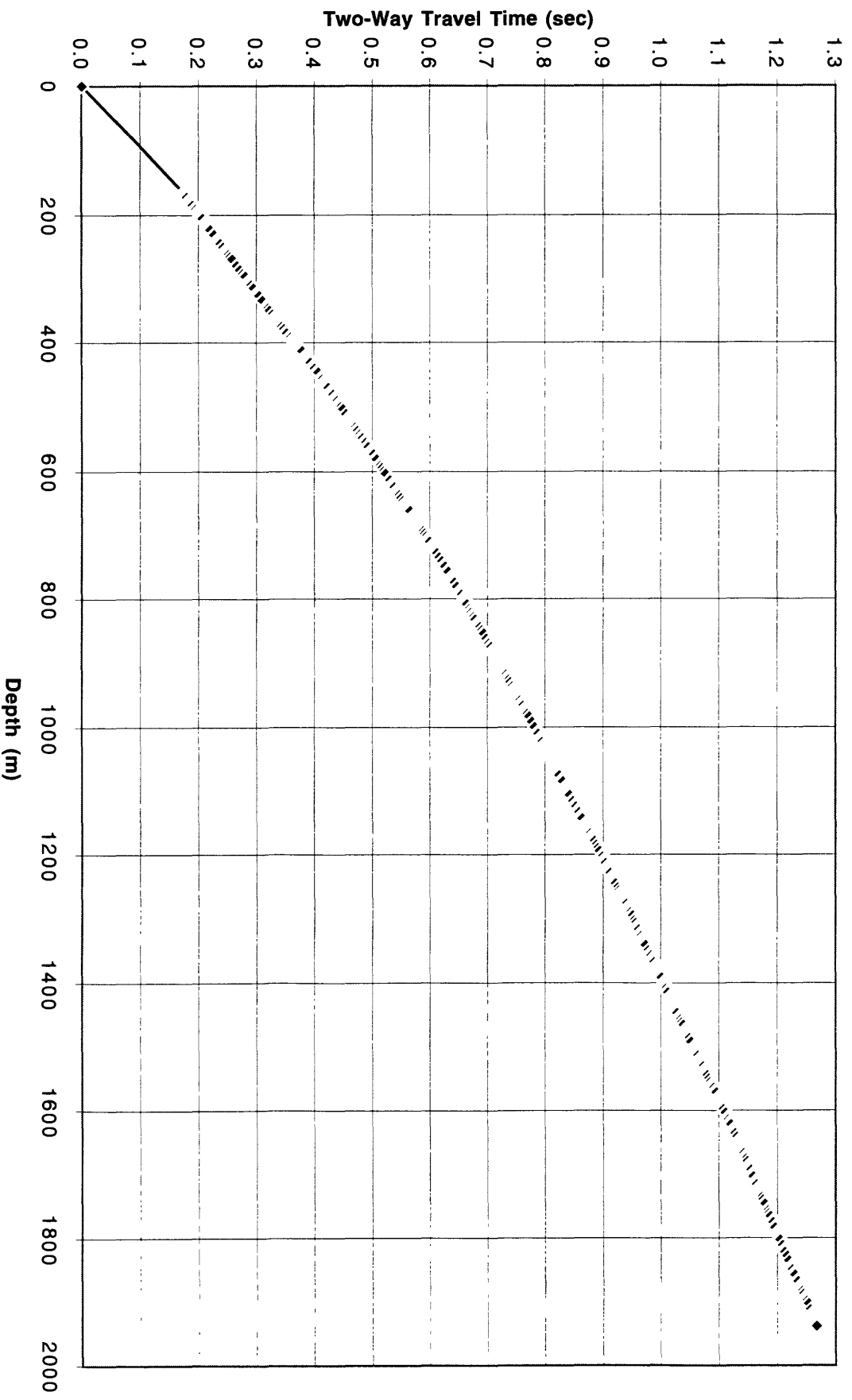


Figure 74.

# Texaco Incorporated, English Creek Core Hole No. 3

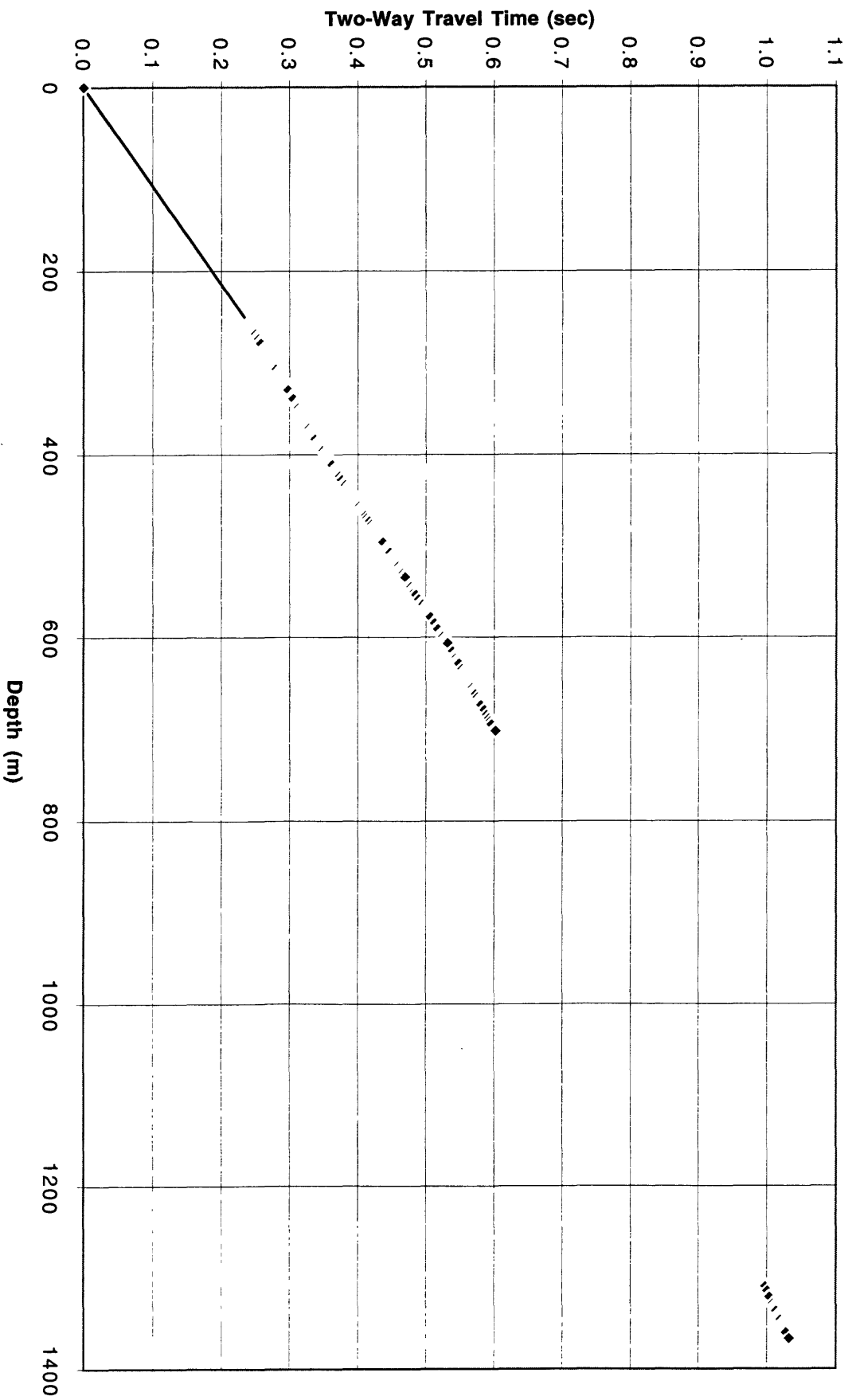


Figure 75.

Occidental Petroleum Corporation, Capital Company No. 1

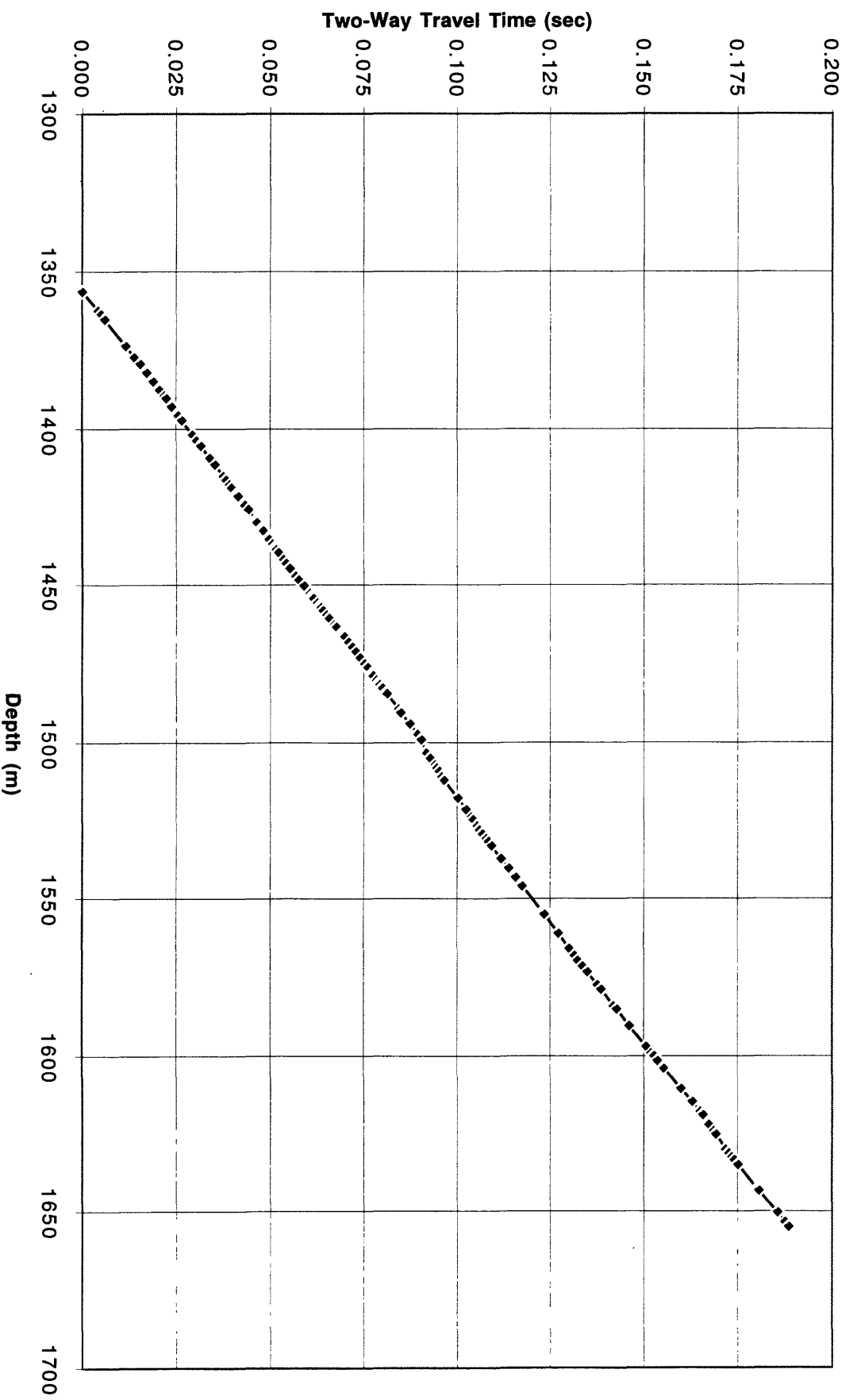


Figure 76.

McCulloch Oil Exploration Inc; McCulloch-Macson UHL No. 1

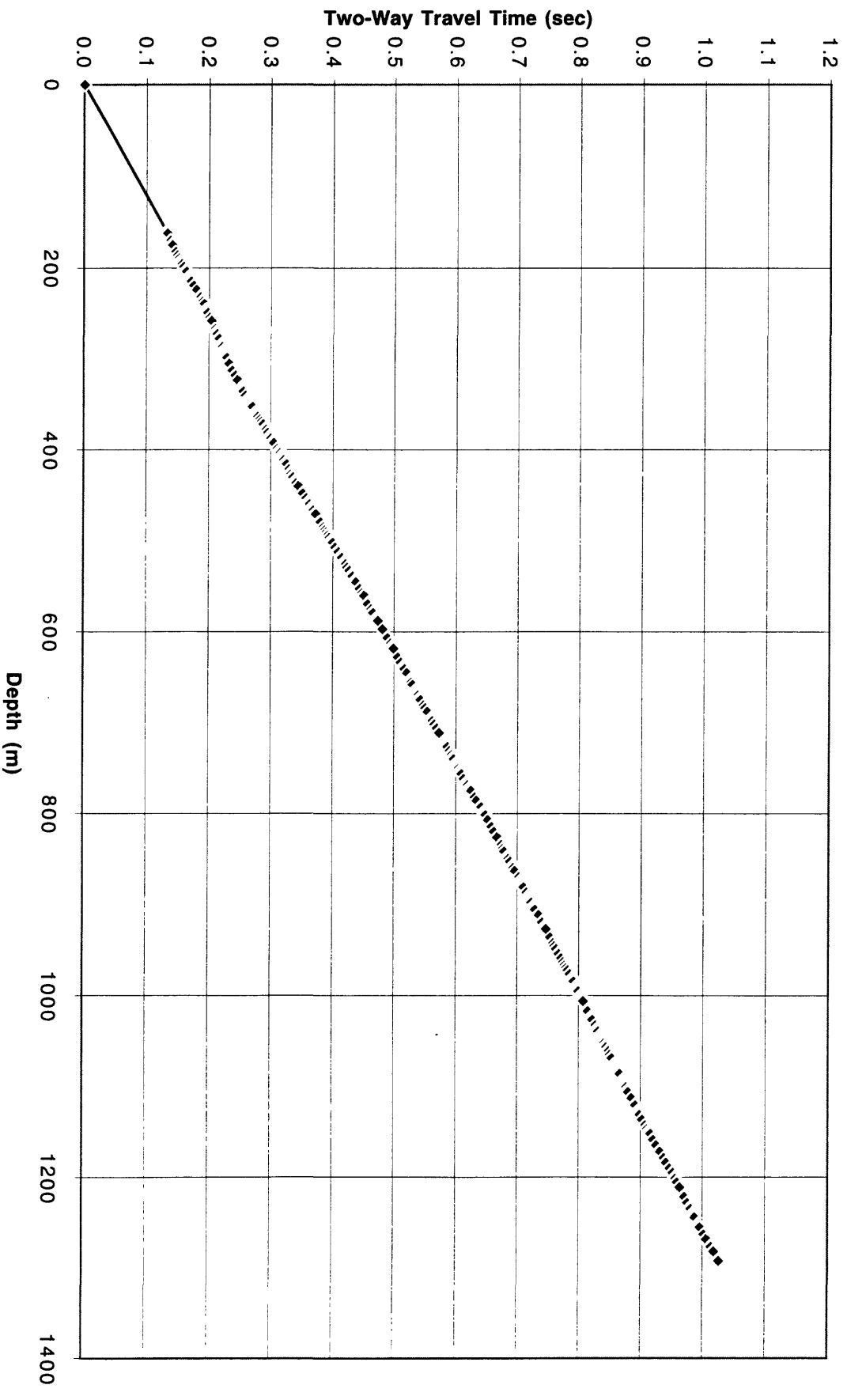


Figure 77.

**Chevron USA Inc; Arnold Ranch #1**

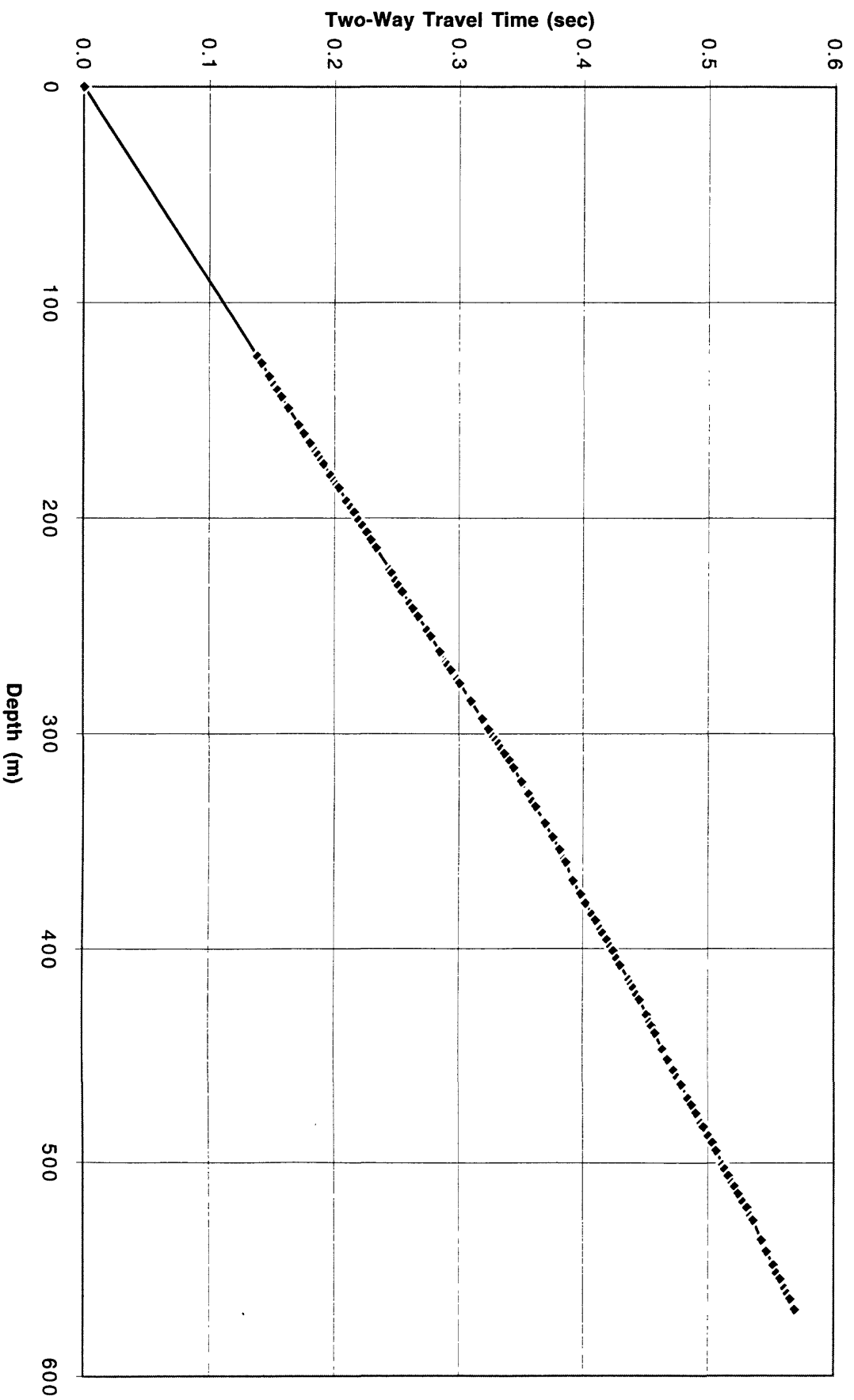


Figure 78.

**Chevron USA Inc; Chevron-Arnold Ranch #1 Redrill #1**

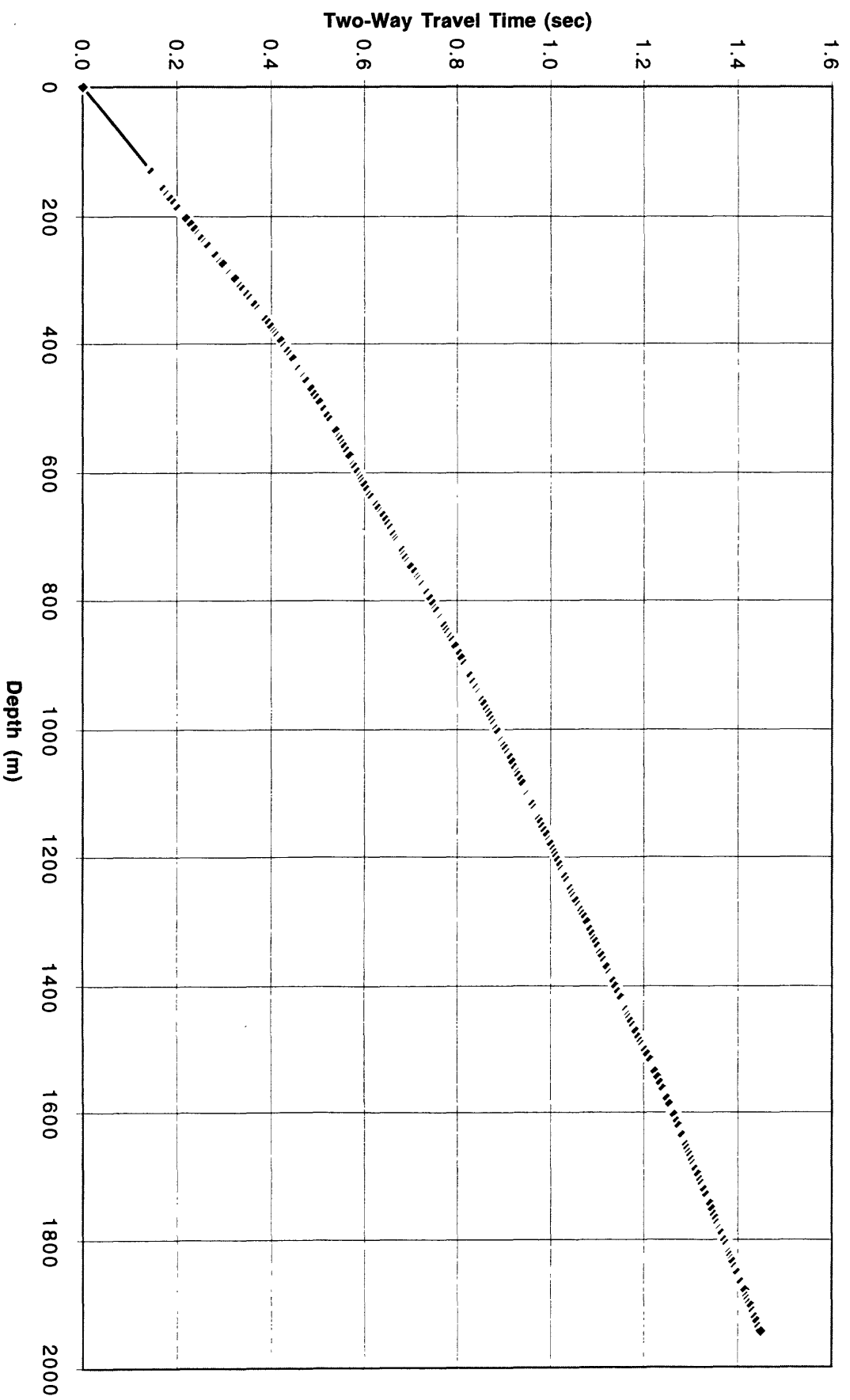


Figure 79.

**Gulf Oil Corporation (Chevron), Porter Seson No. 1**

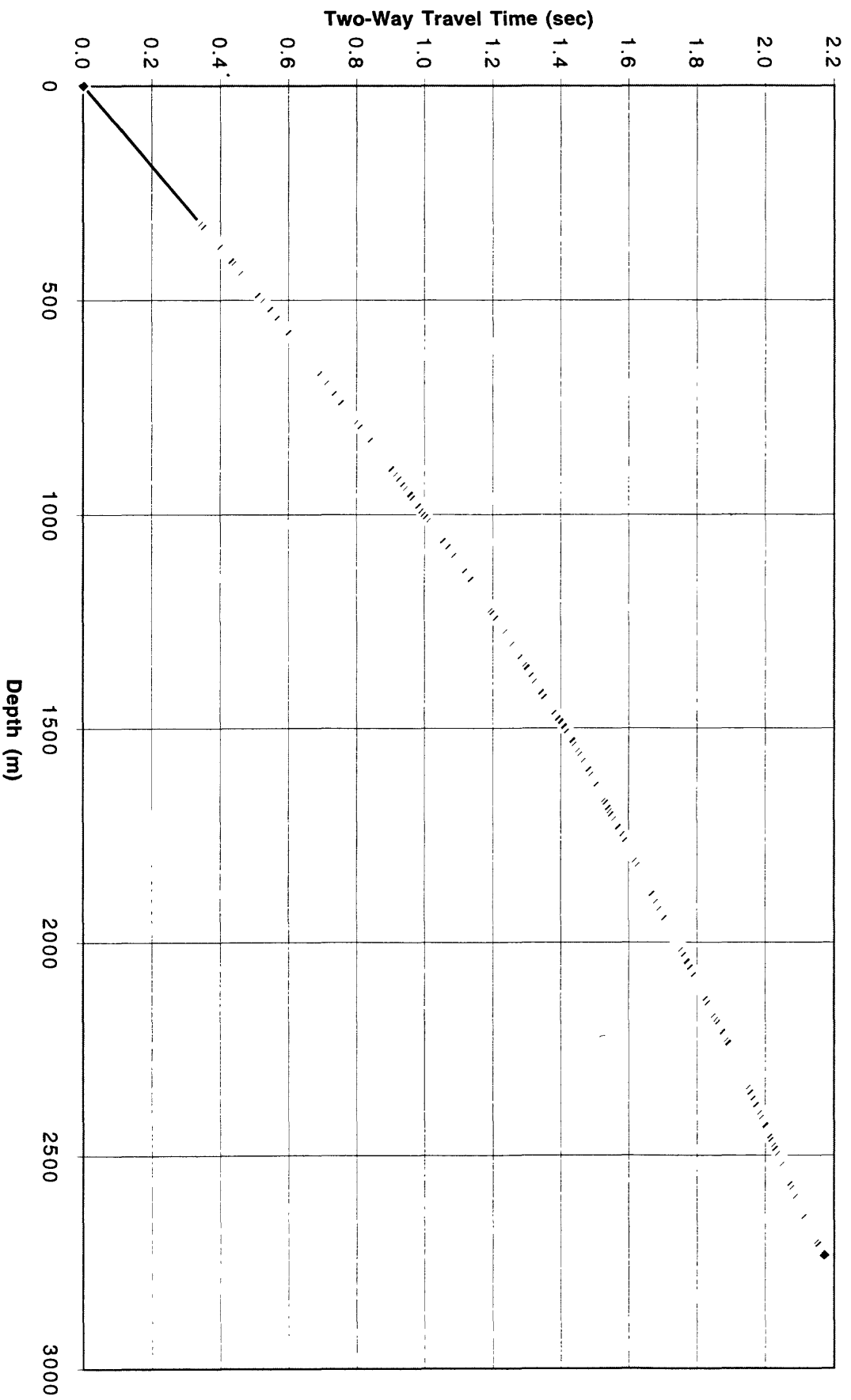


Figure 80.

**Brazos Oil and Gas Company, Antioch Unit A No. 1**

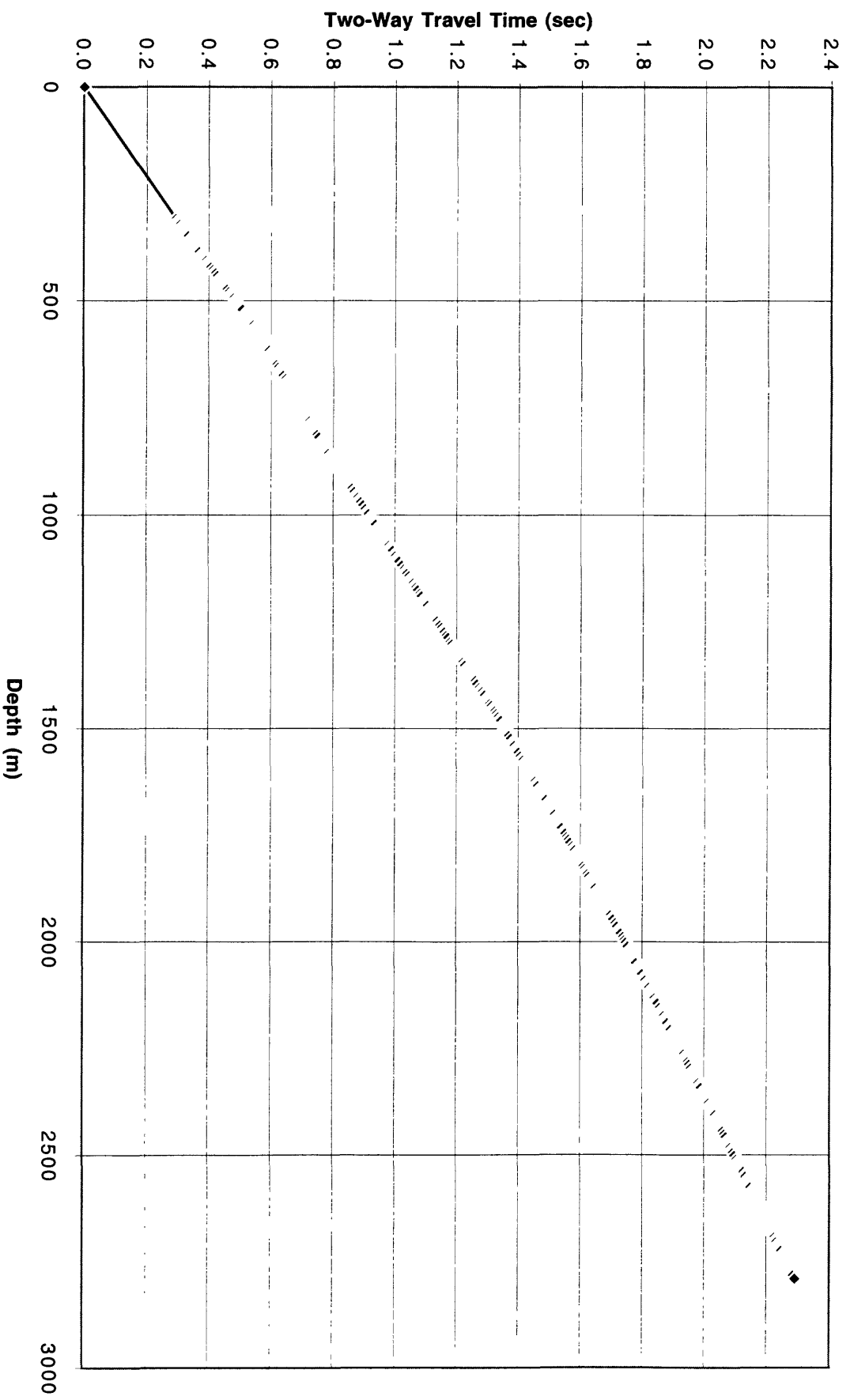


Figure 81.



# Brazos Oil and Gas Company, Prewett Gas Unit No. 1

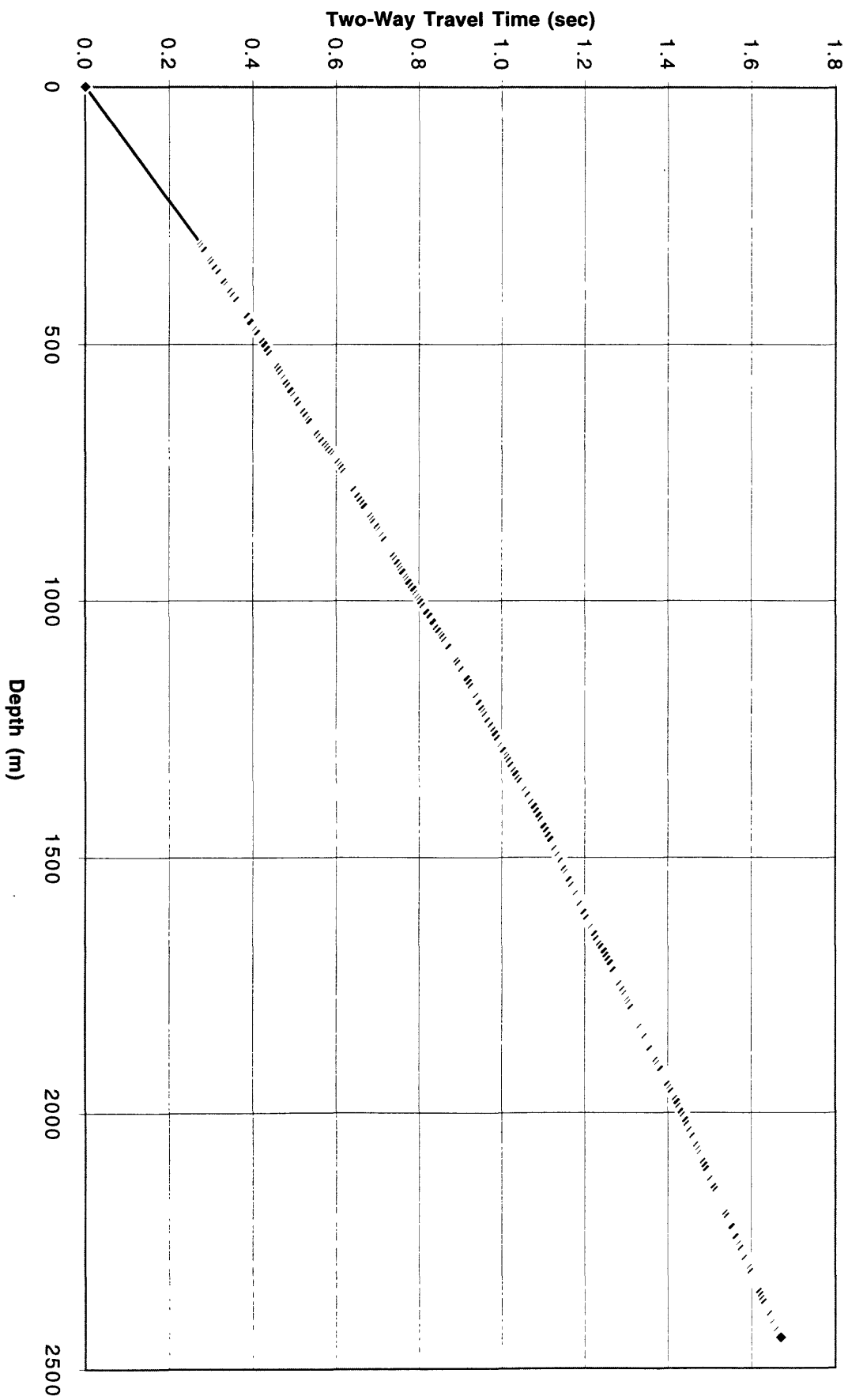


Figure 82.

Shell Oil Company, Heidorn No. 2-4

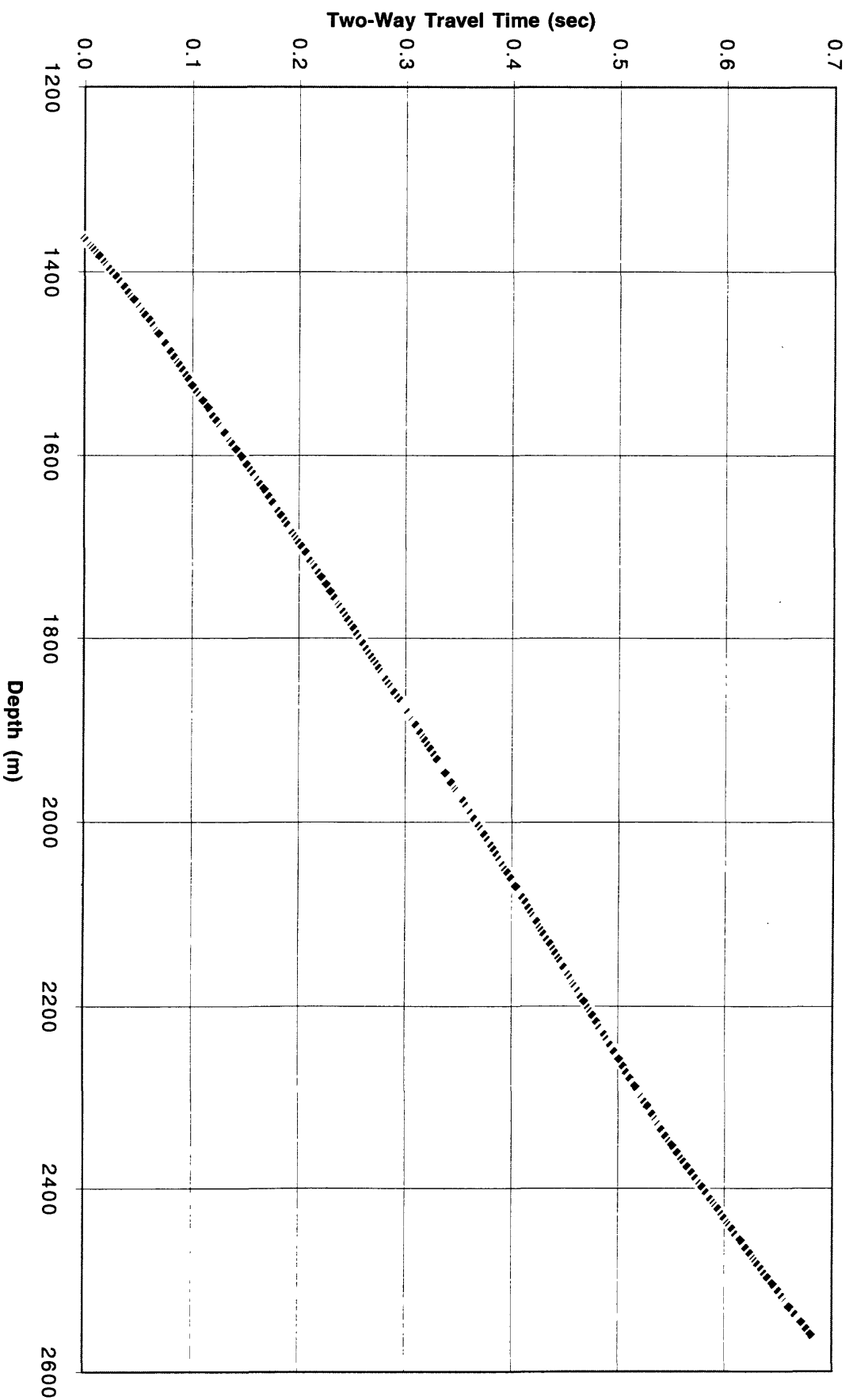


Figure 83.

Shell Oil Company, L and W No. 2-14

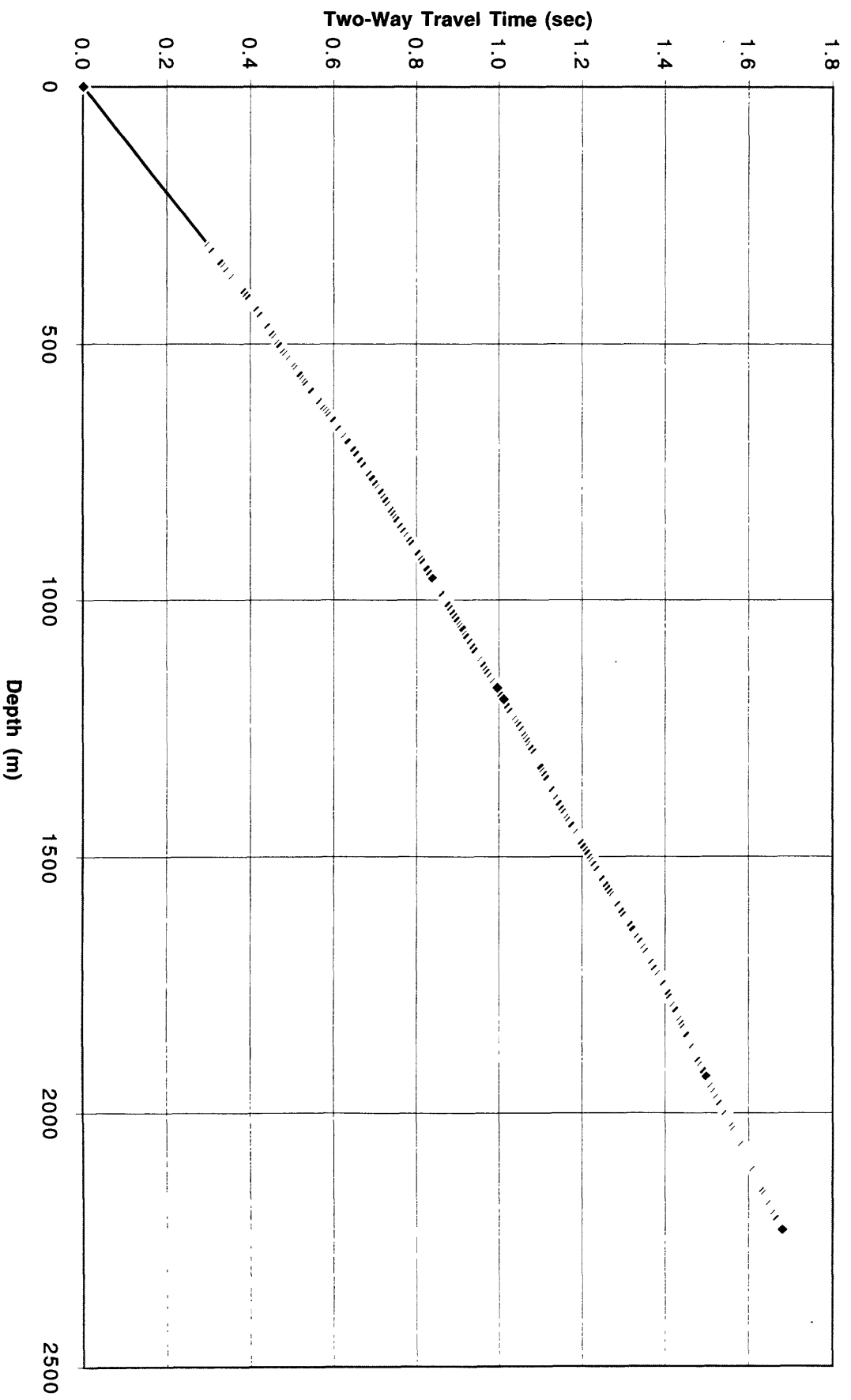


Figure 84.

**Atlantic Richfield Company, Mantelli #1**

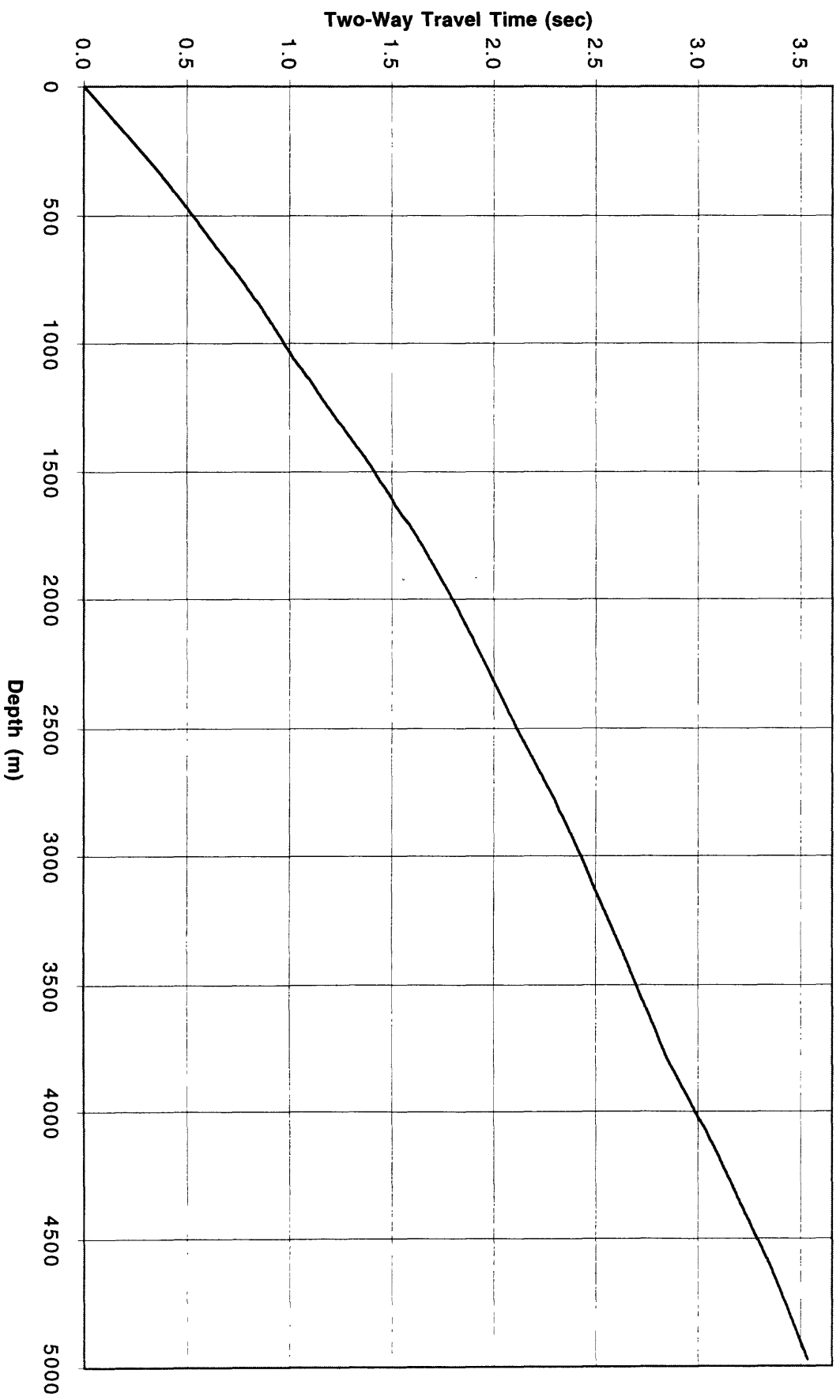


Figure 85.

**Humble Oil Refining Co; Myrvin C. Carey et UX No. 1**

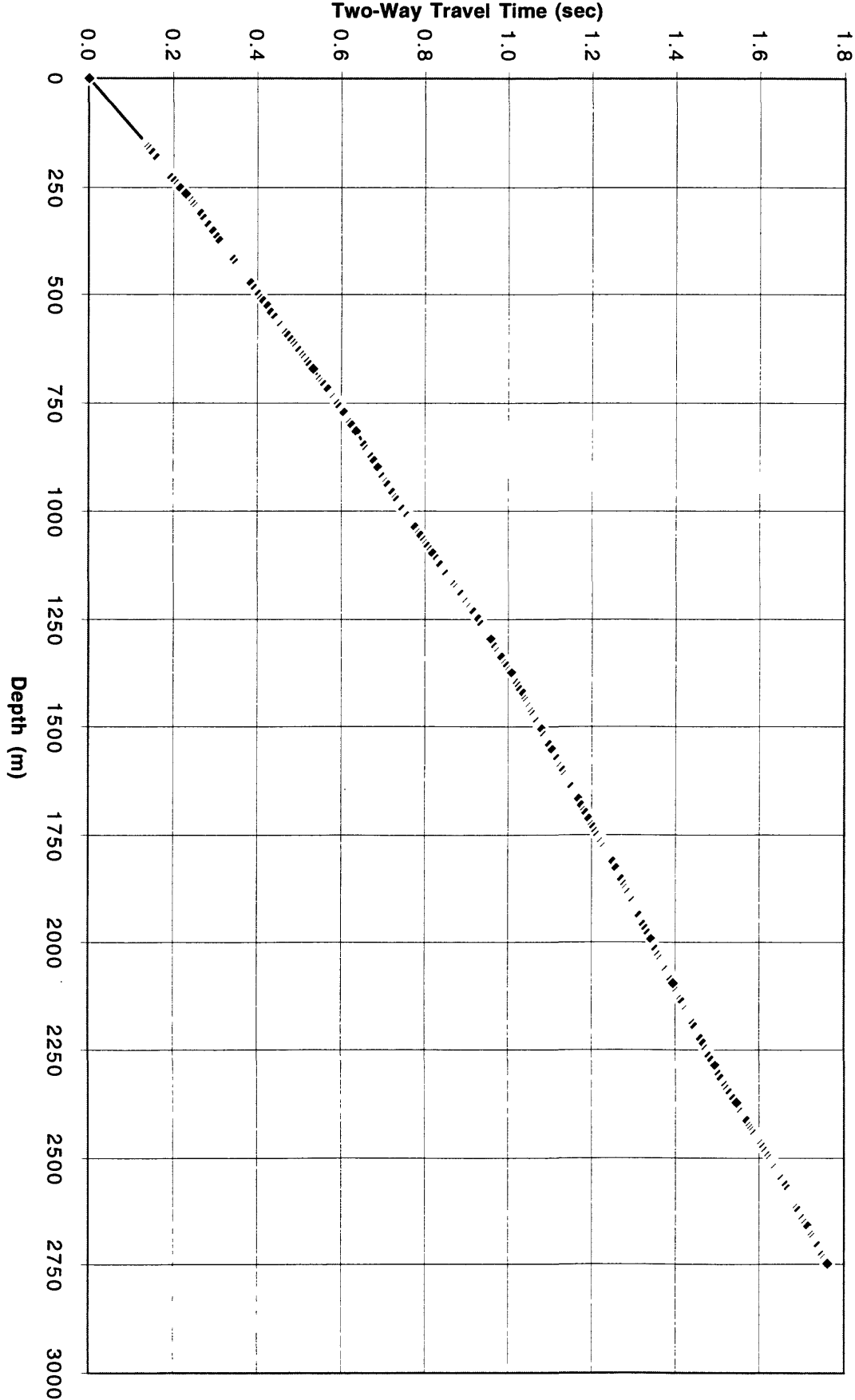


Figure 86.

Shell Oil Company, Shell Ginochio #4-4

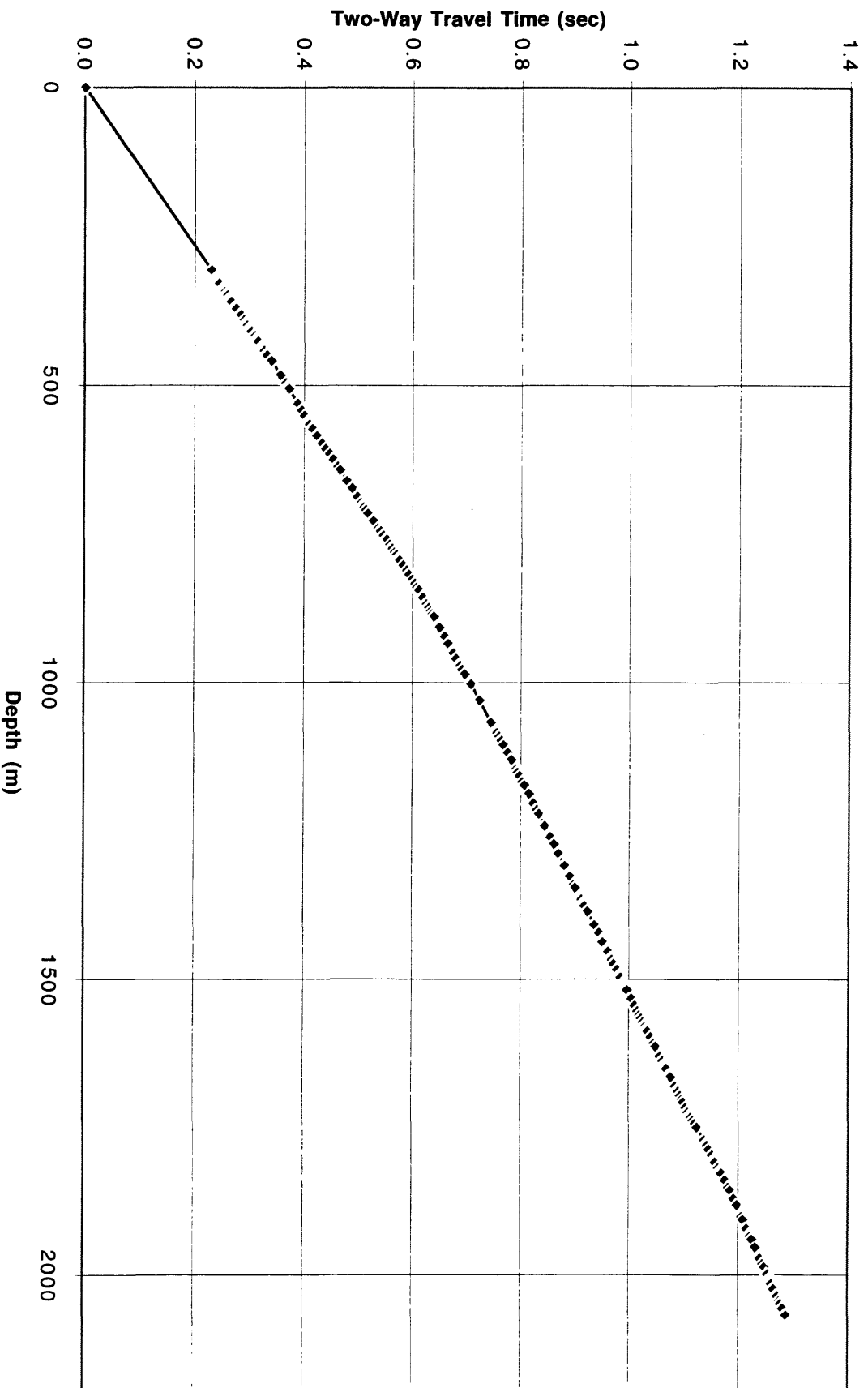


Figure 87.

Standard Oil Company of California, S.O. Trollman No. 1

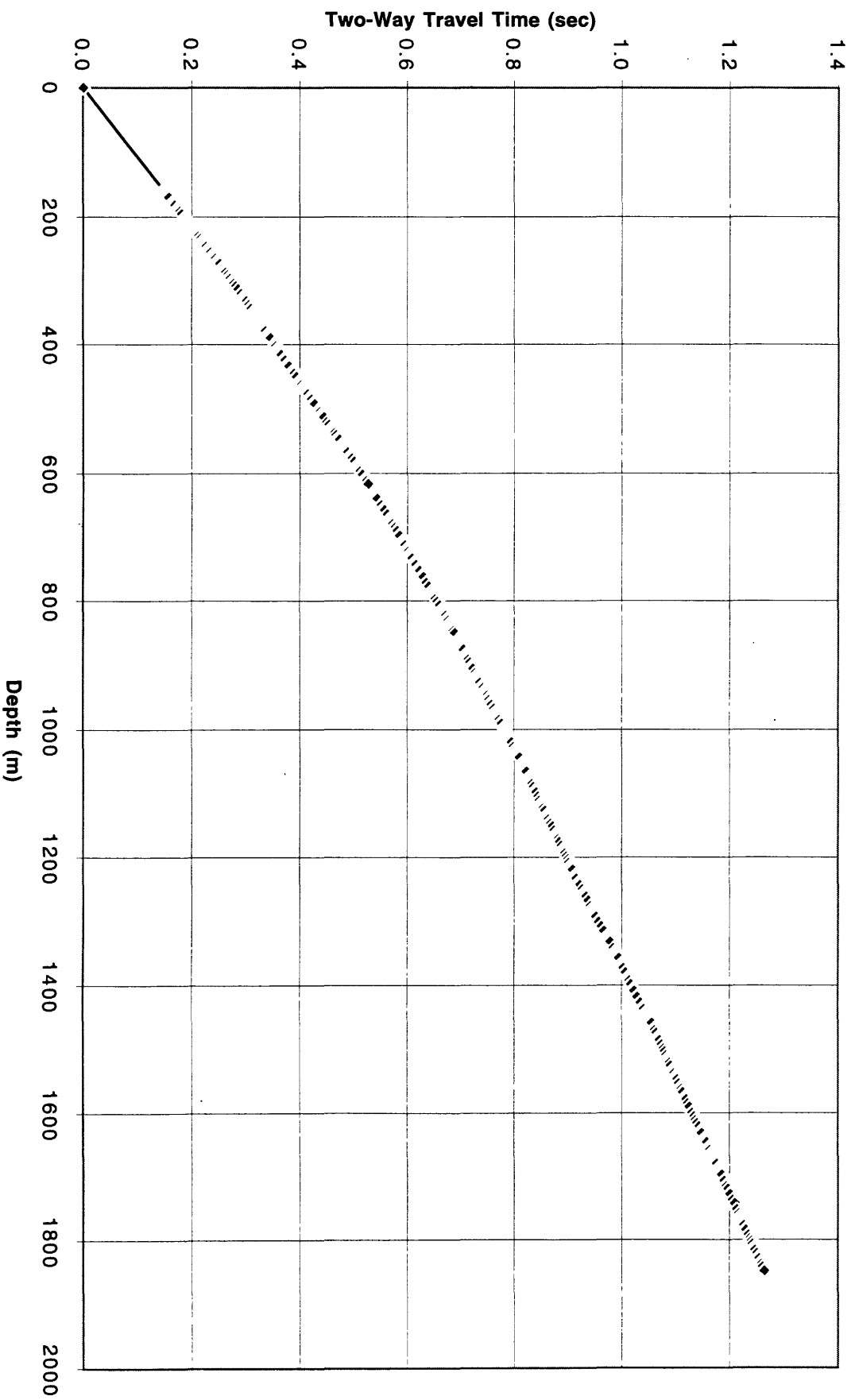


Figure 88.

Shell Oil Company, Cunha No. 1-1

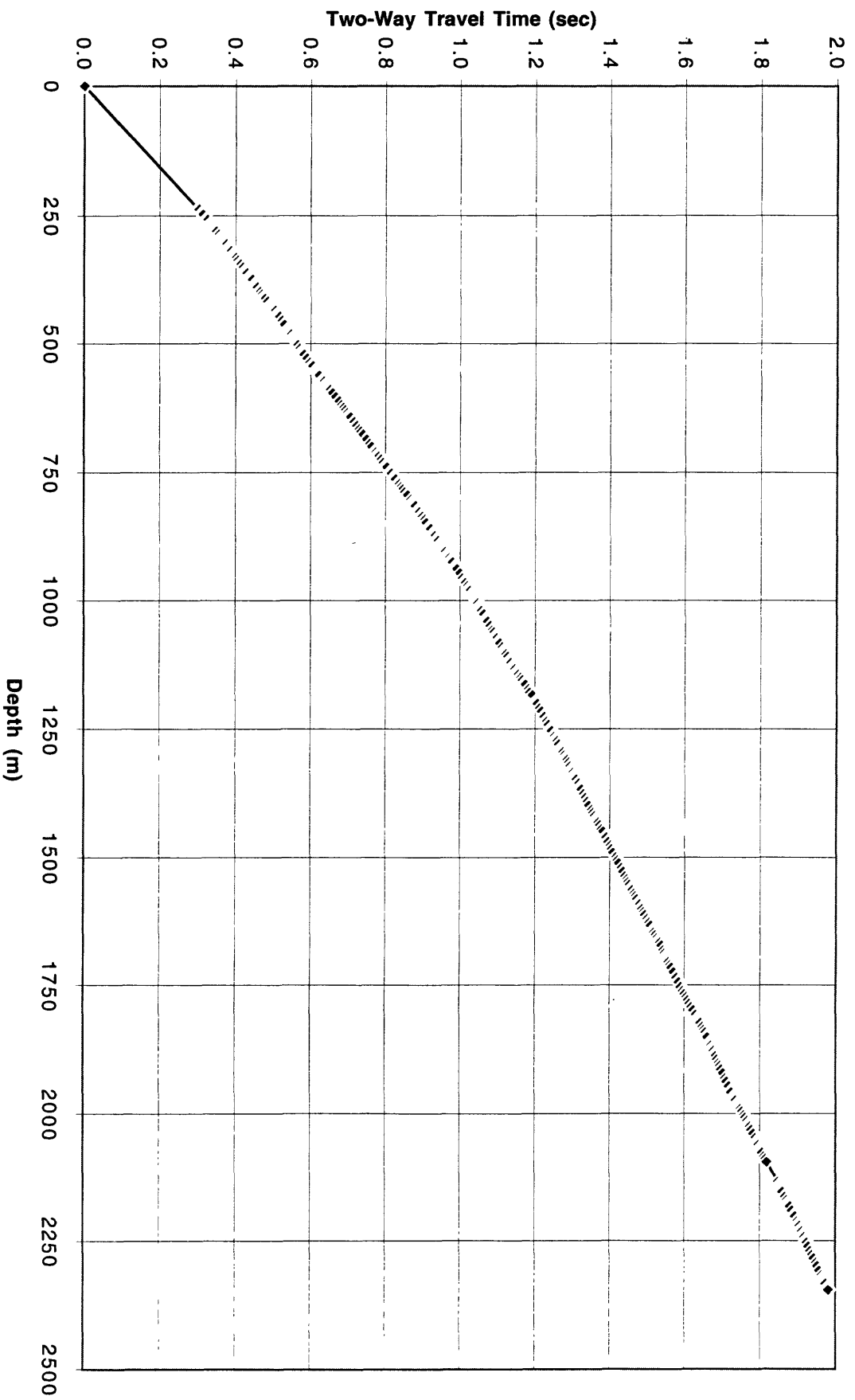


Figure 89.



# Humble Oil and Refining Company, Wico-Bankhead No. 1

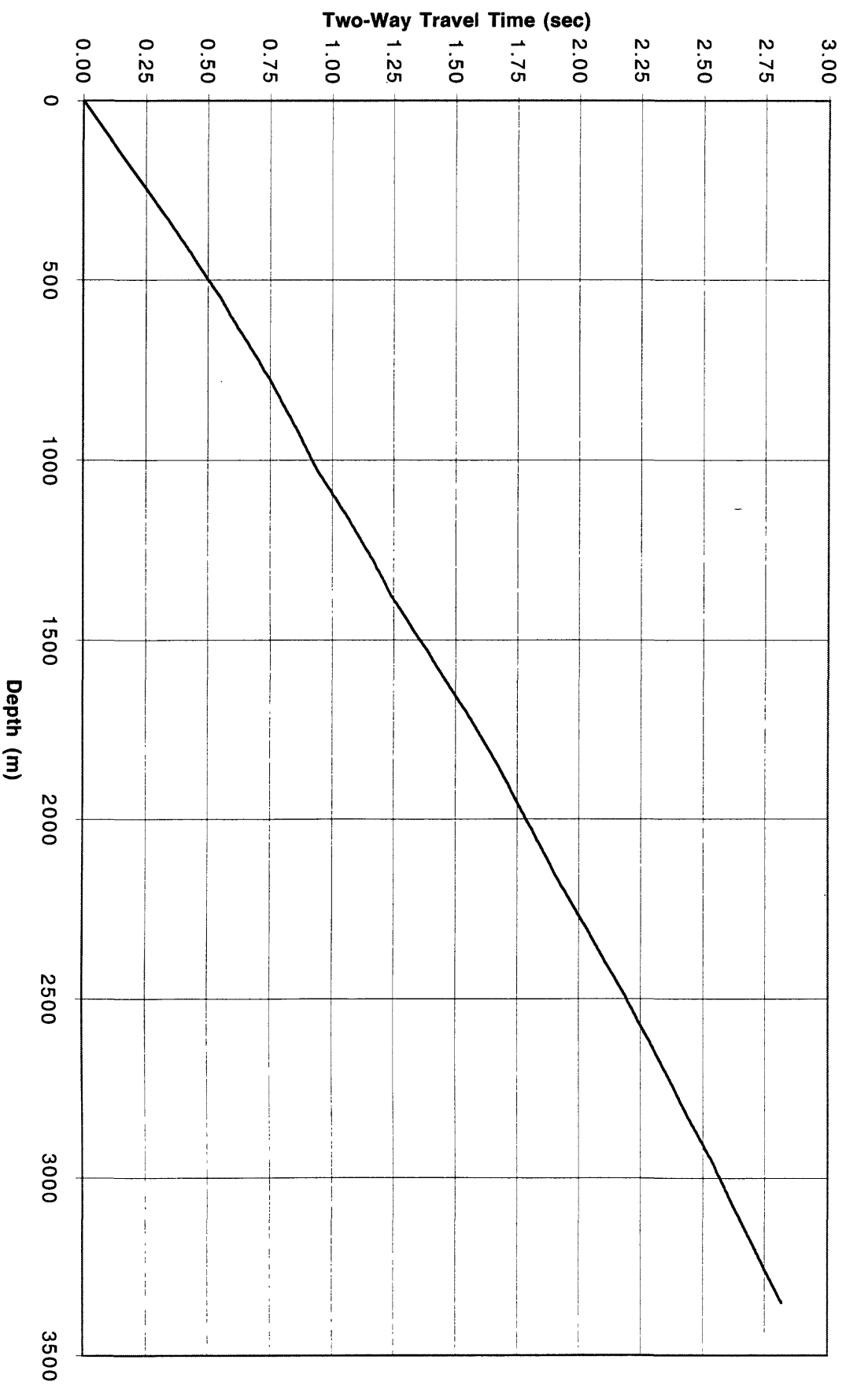


Figure 90.

Phillips Petroleum Company, Vierra A No. 1

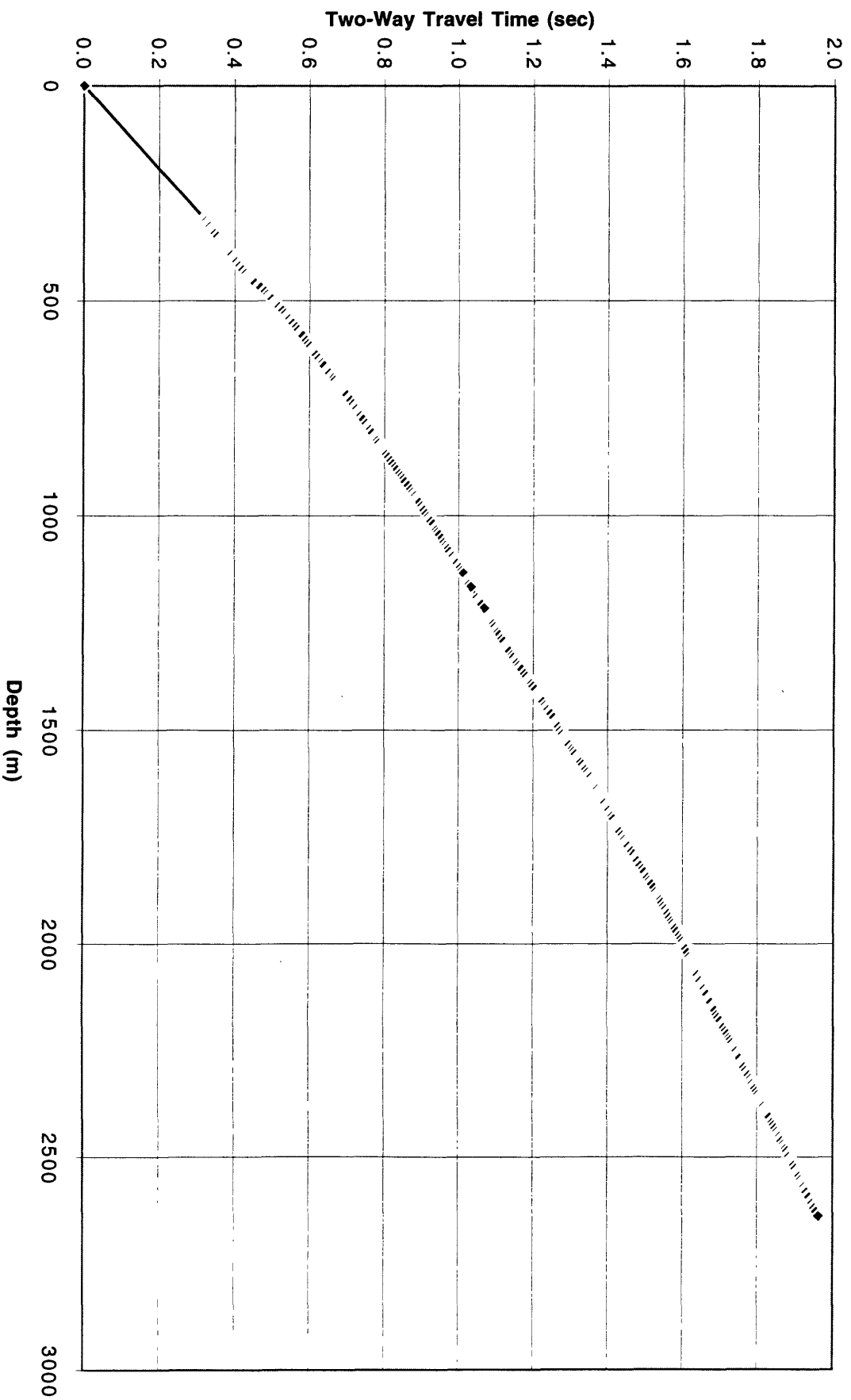


Figure 91.

Shell Oil Company, Pagano No. 2-4

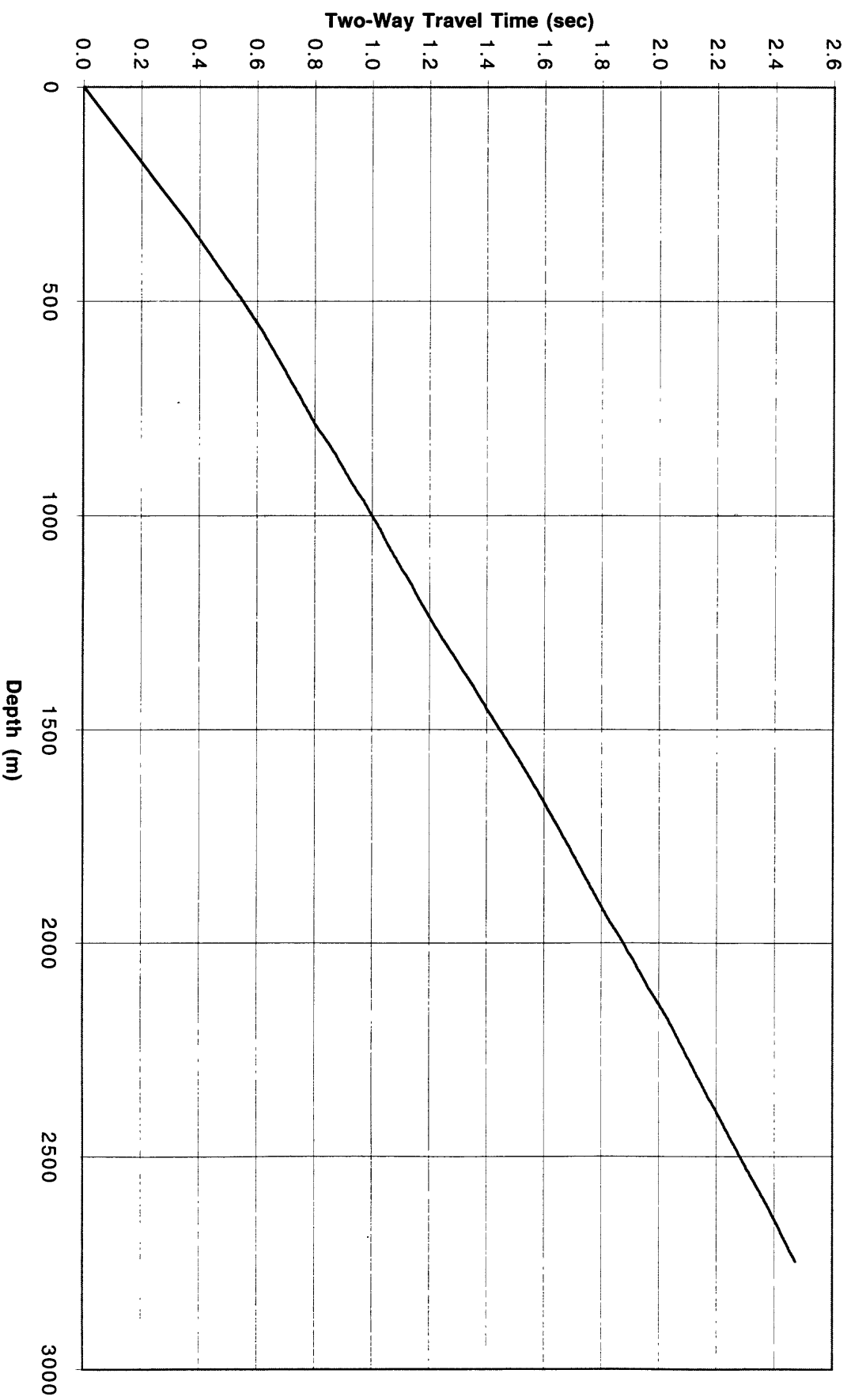


Figure 92.

# Helm Oil Company and Robert Sumpf, Sproule No. 1

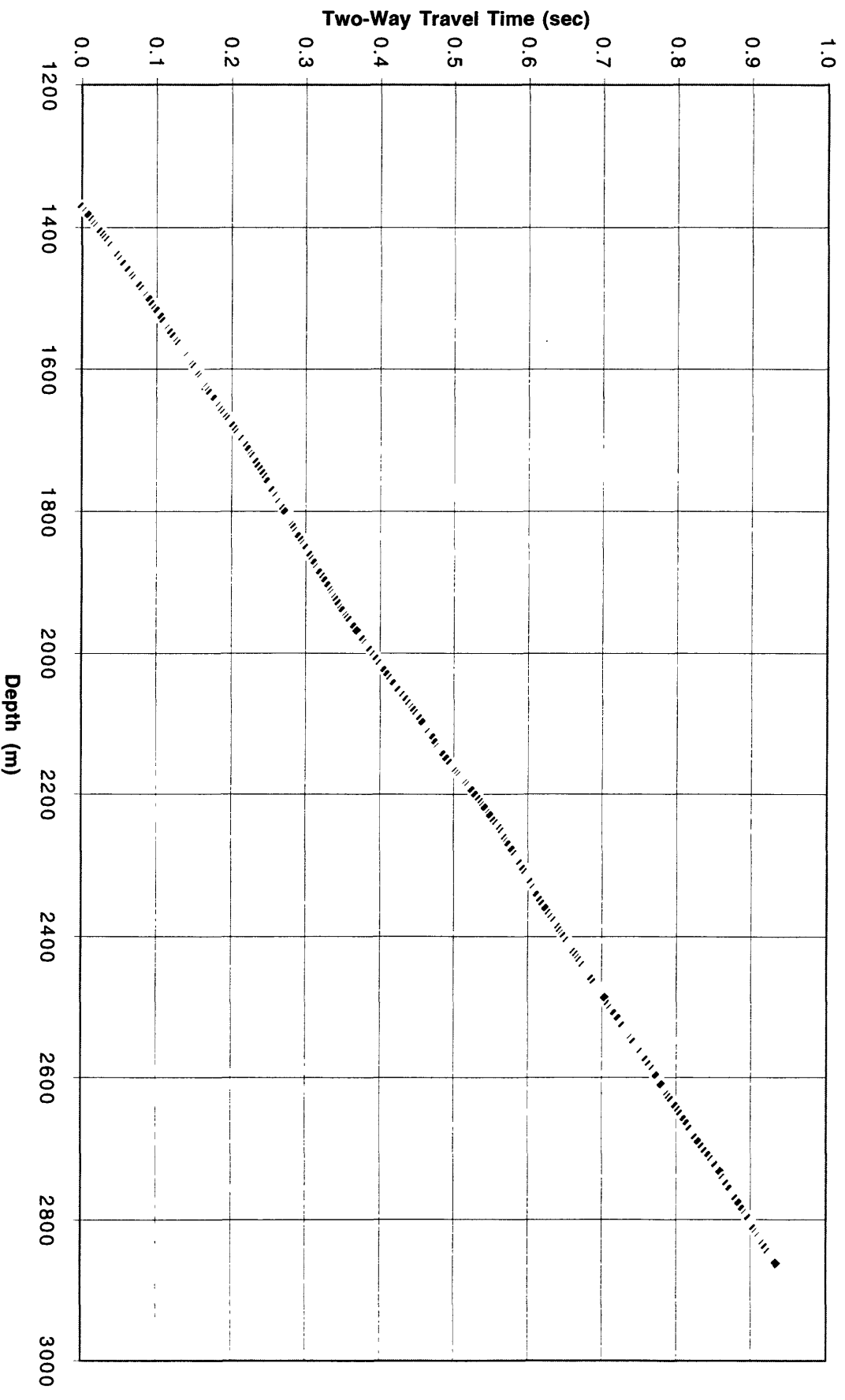


Figure 93.

# E.C. Brown Operator, Lupin No. 3 (Redrill)

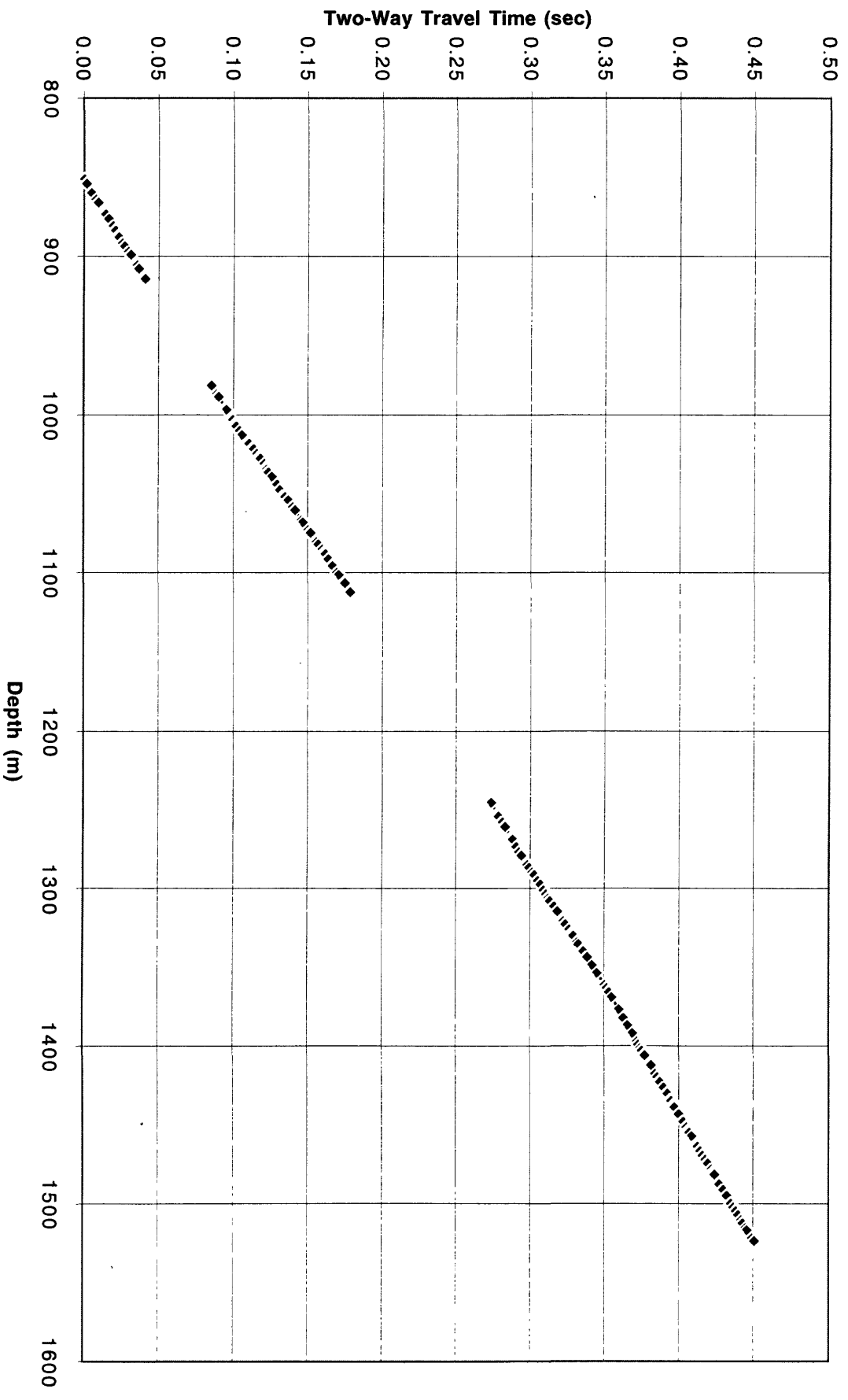


Figure 94.

Milton L. Johnston Operator, Frazen #1

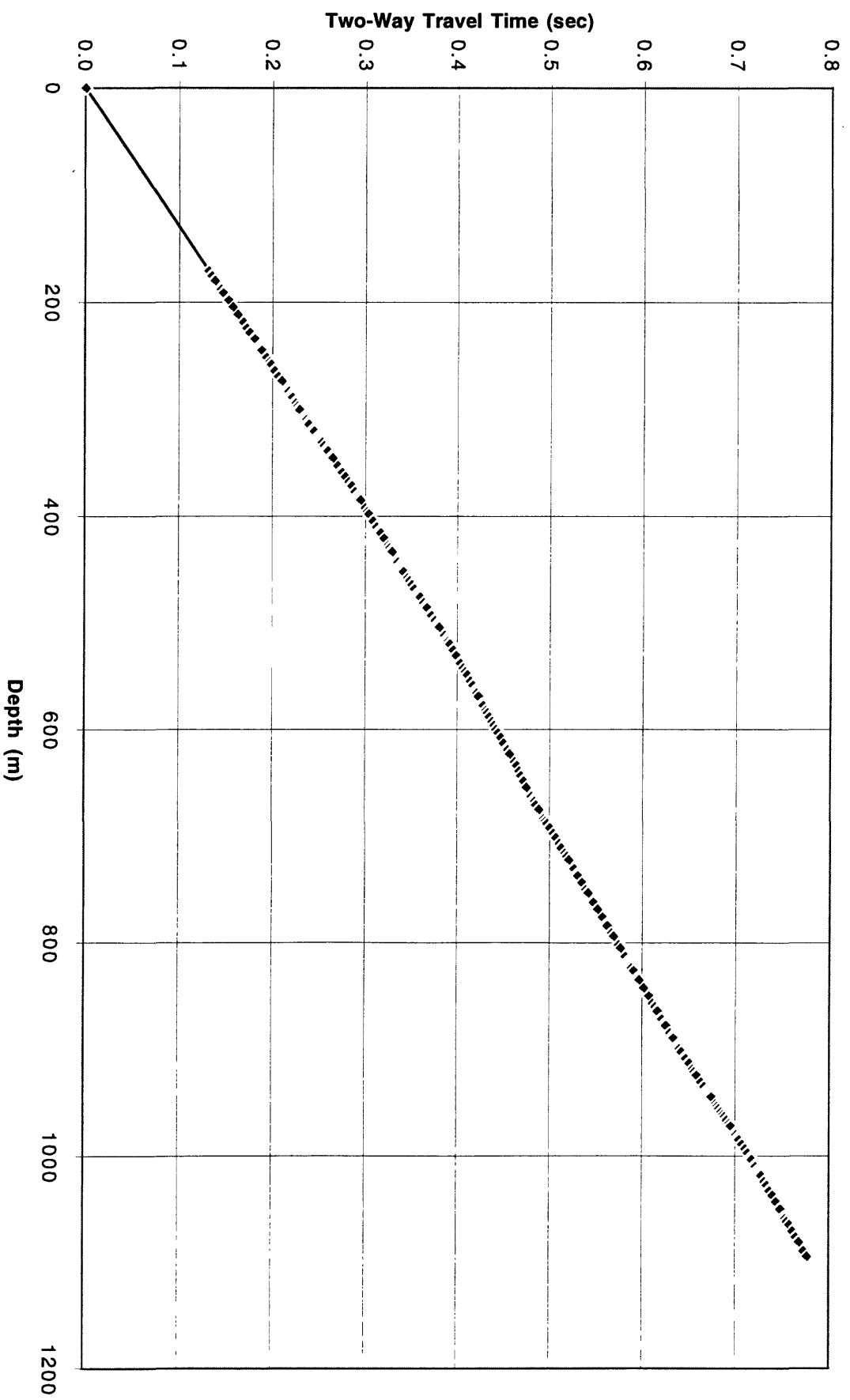


Figure 95.

**Standard Oil Company of California, Simon Newman #1**

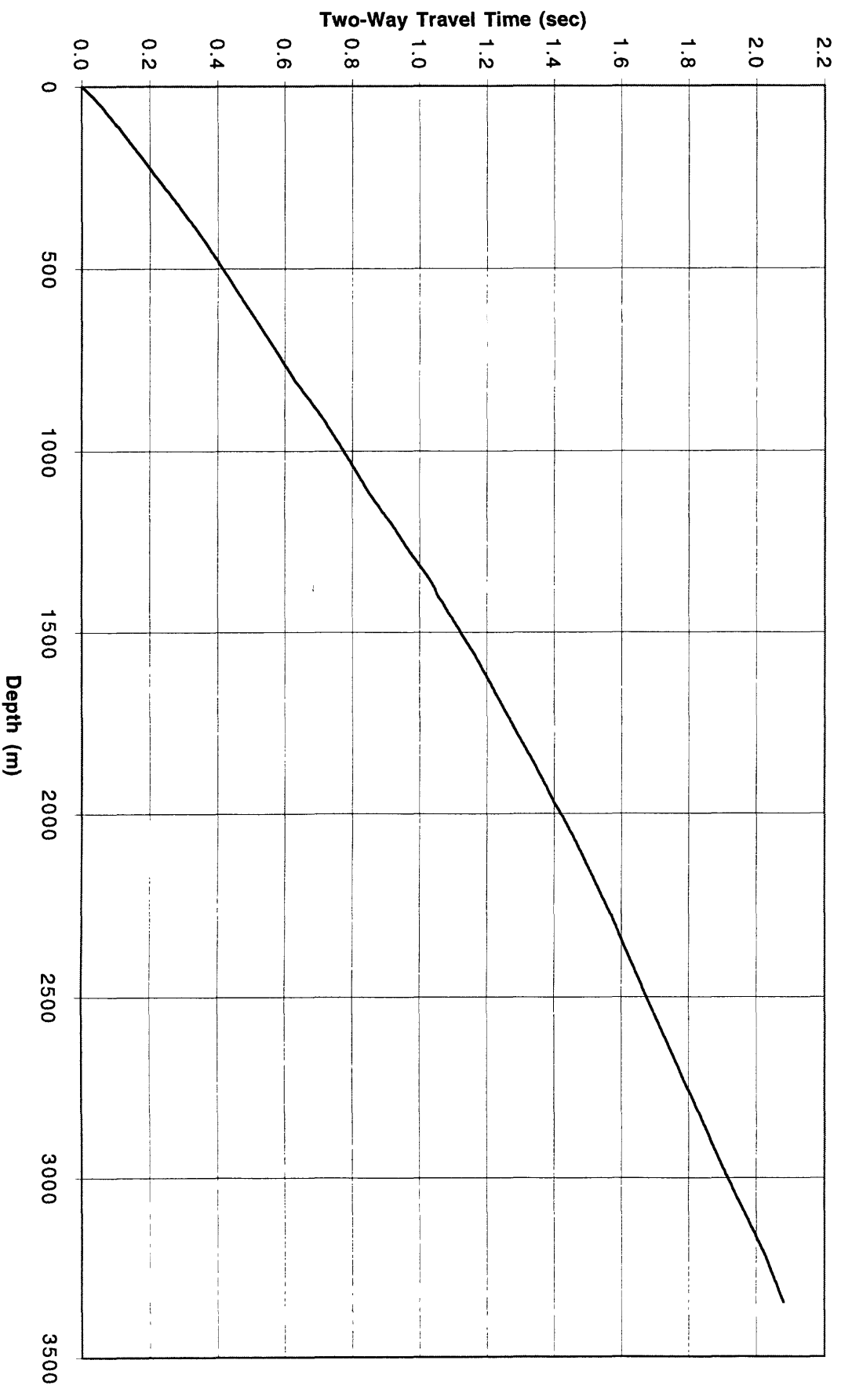


Figure 96.

**K.L. Burns Corporation, Simon-Newman #12-1**

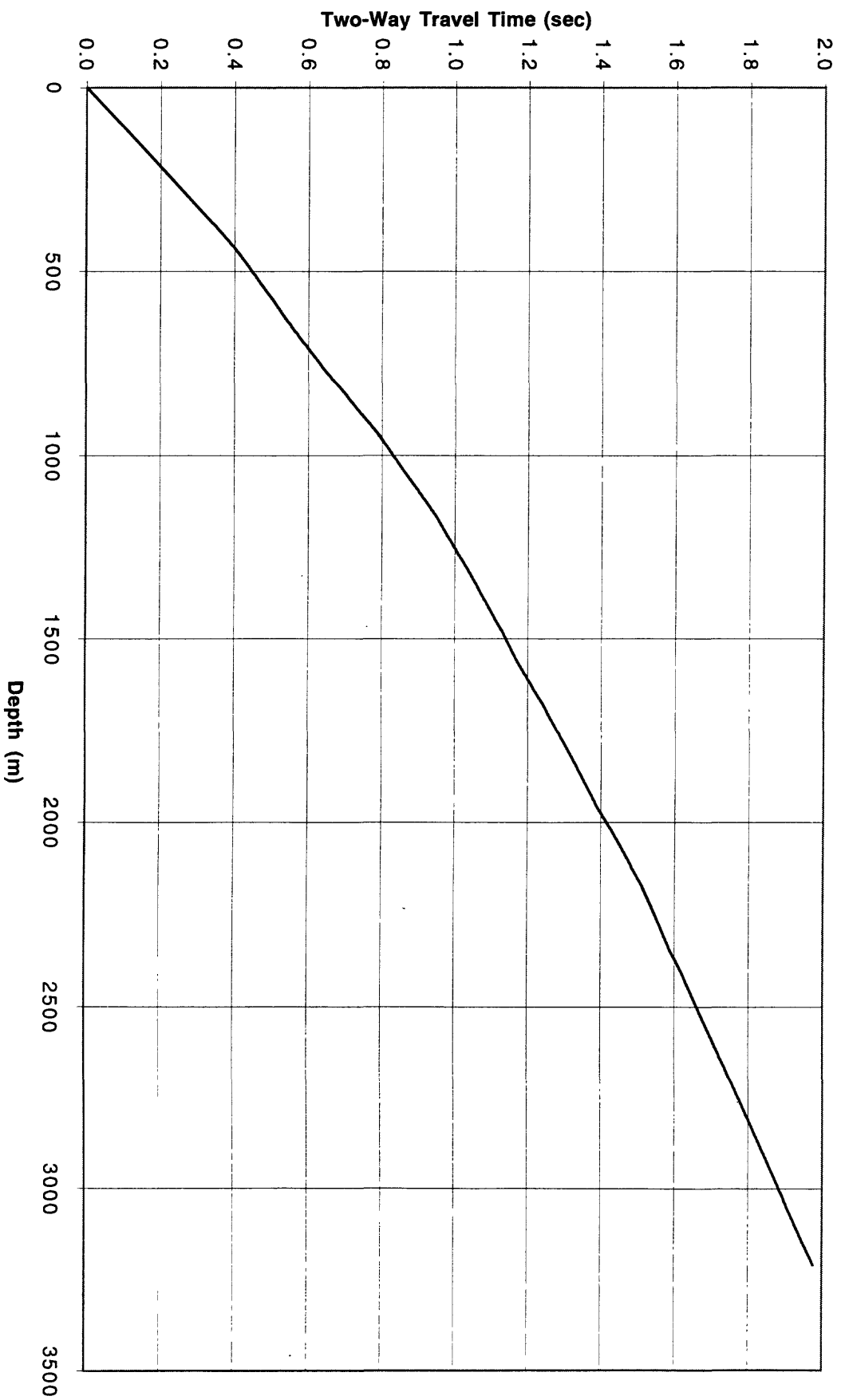


Figure 97.



**E.C. Brown, Operator, Mello #1**

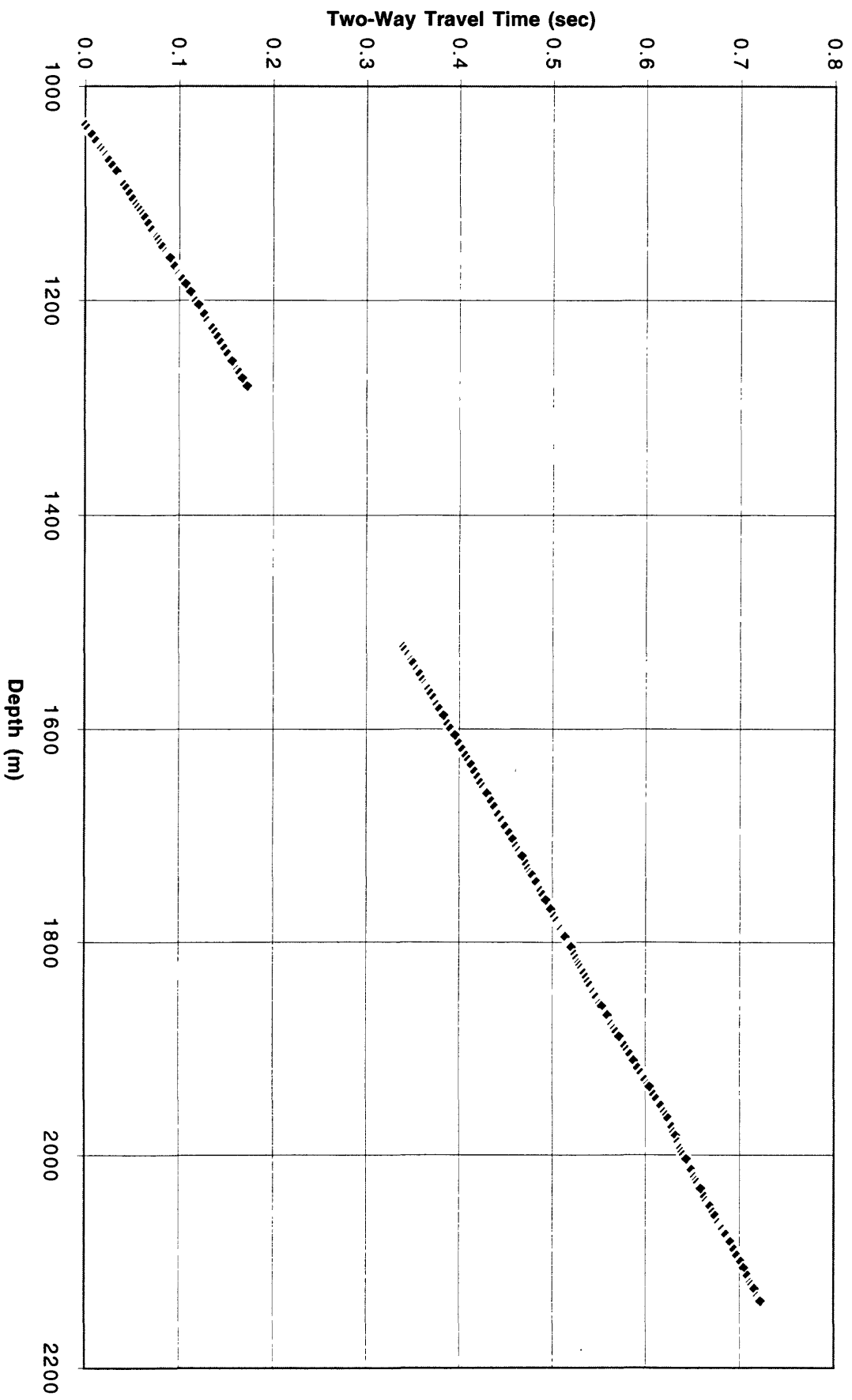


Figure 98.

Occidental Petroleum Corporation, Bingaman #1

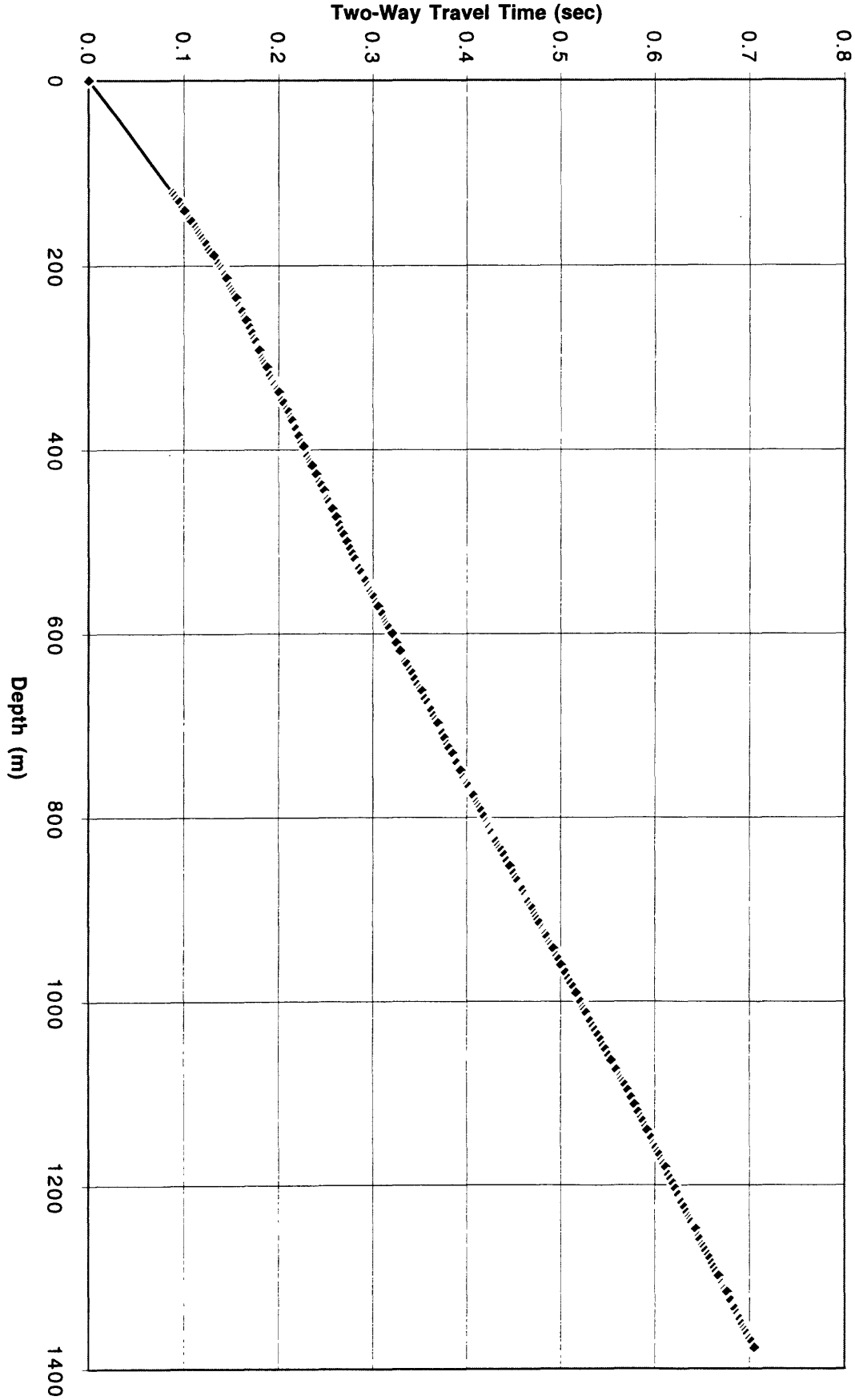


Figure 99.

**Santa Fe Energy Company, Law #80X-1**

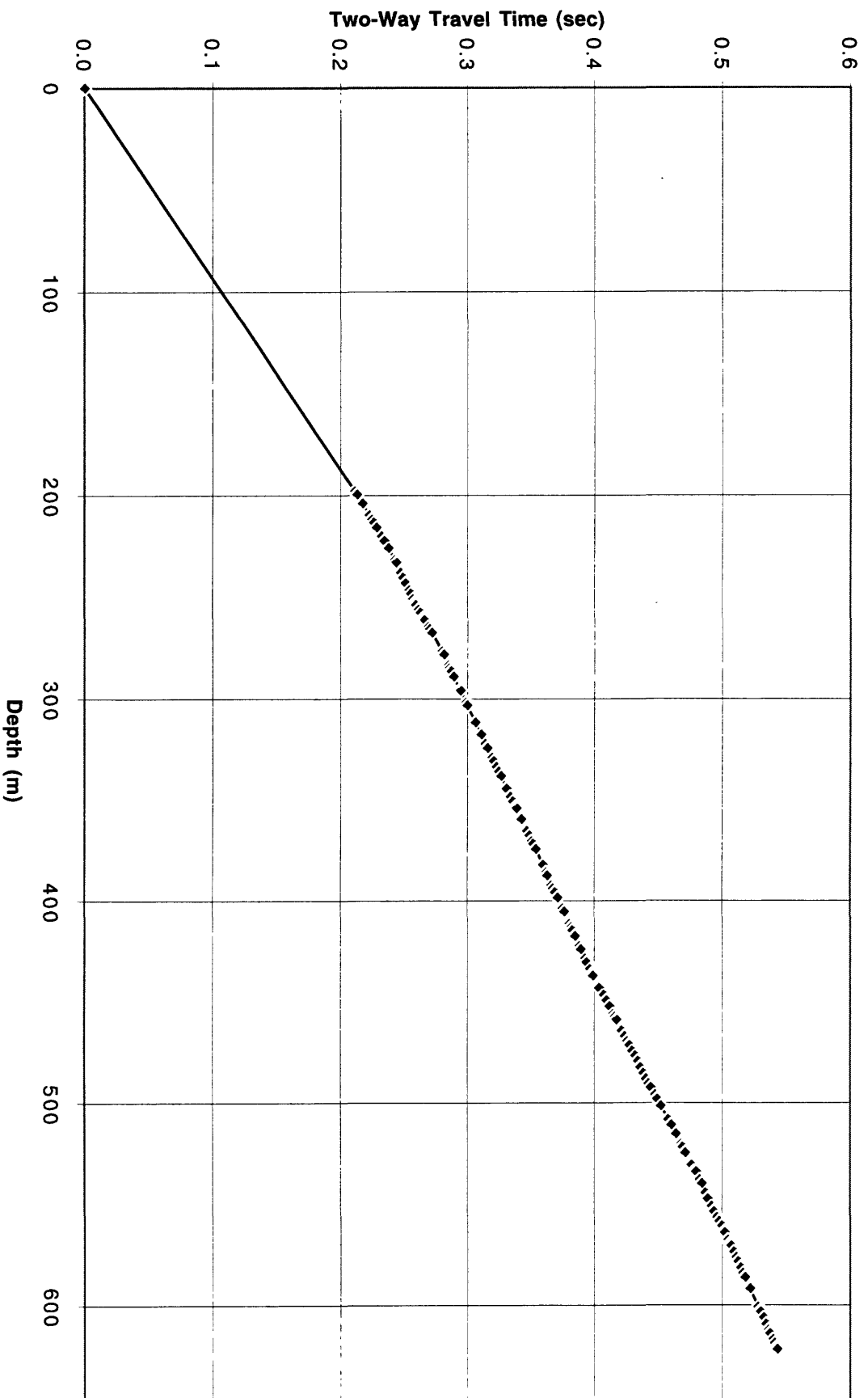


Figure 100.

U.S. Geological Survey, Law #CB-1

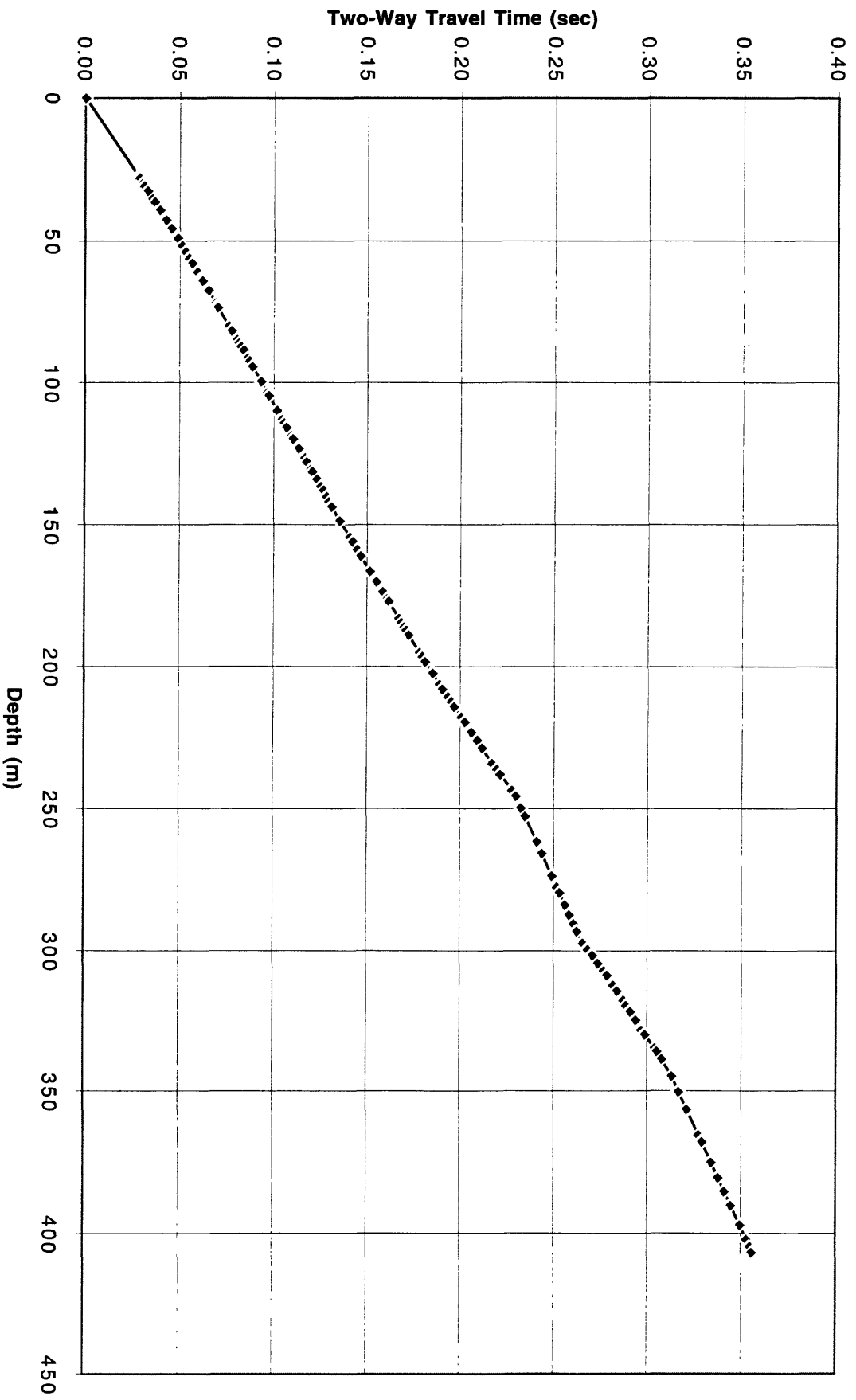


Figure 101.

W.W. Holmes, Towle No. 1-12

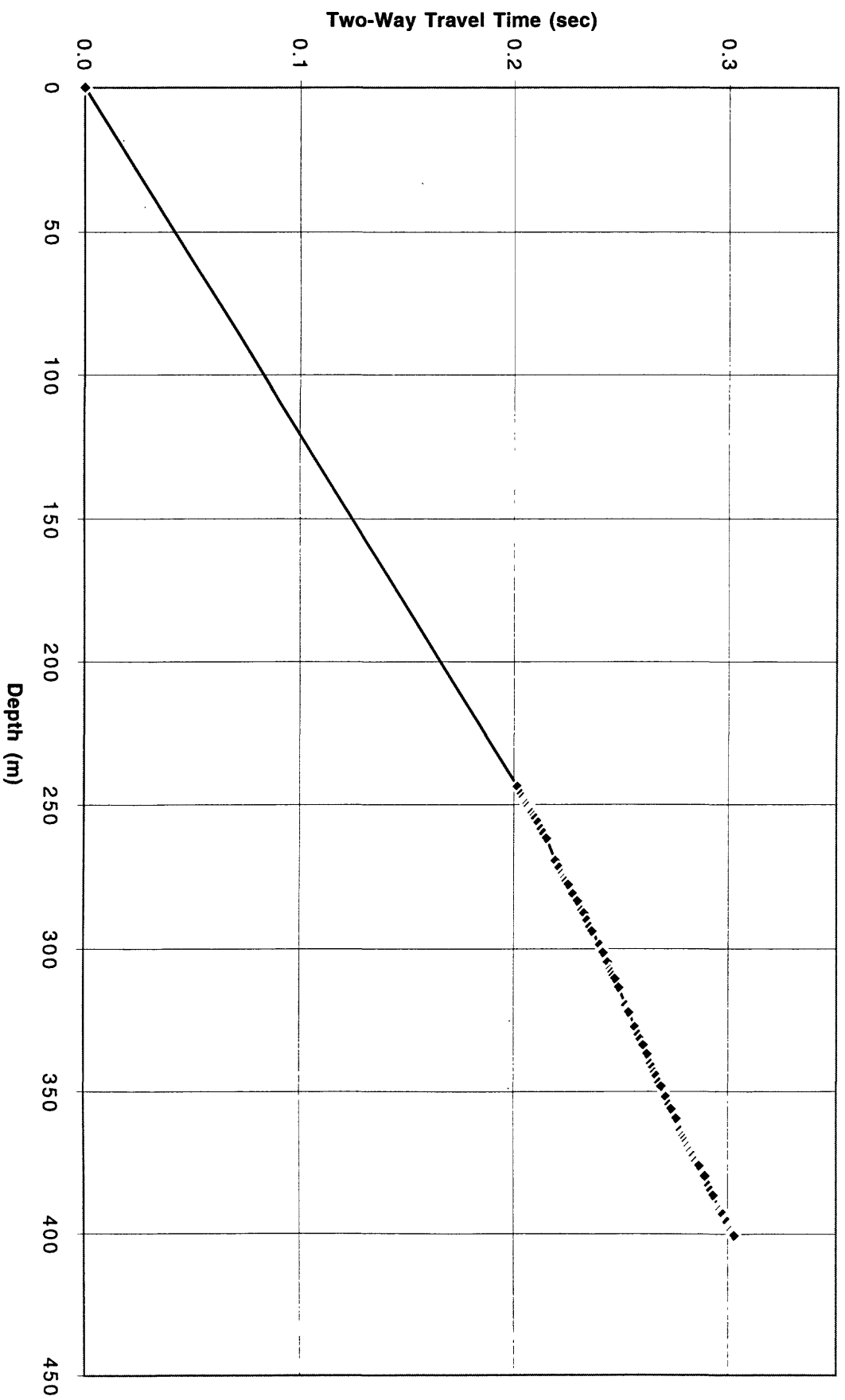


Figure 102.

**Texaco-AGIP, Chesholm #1**

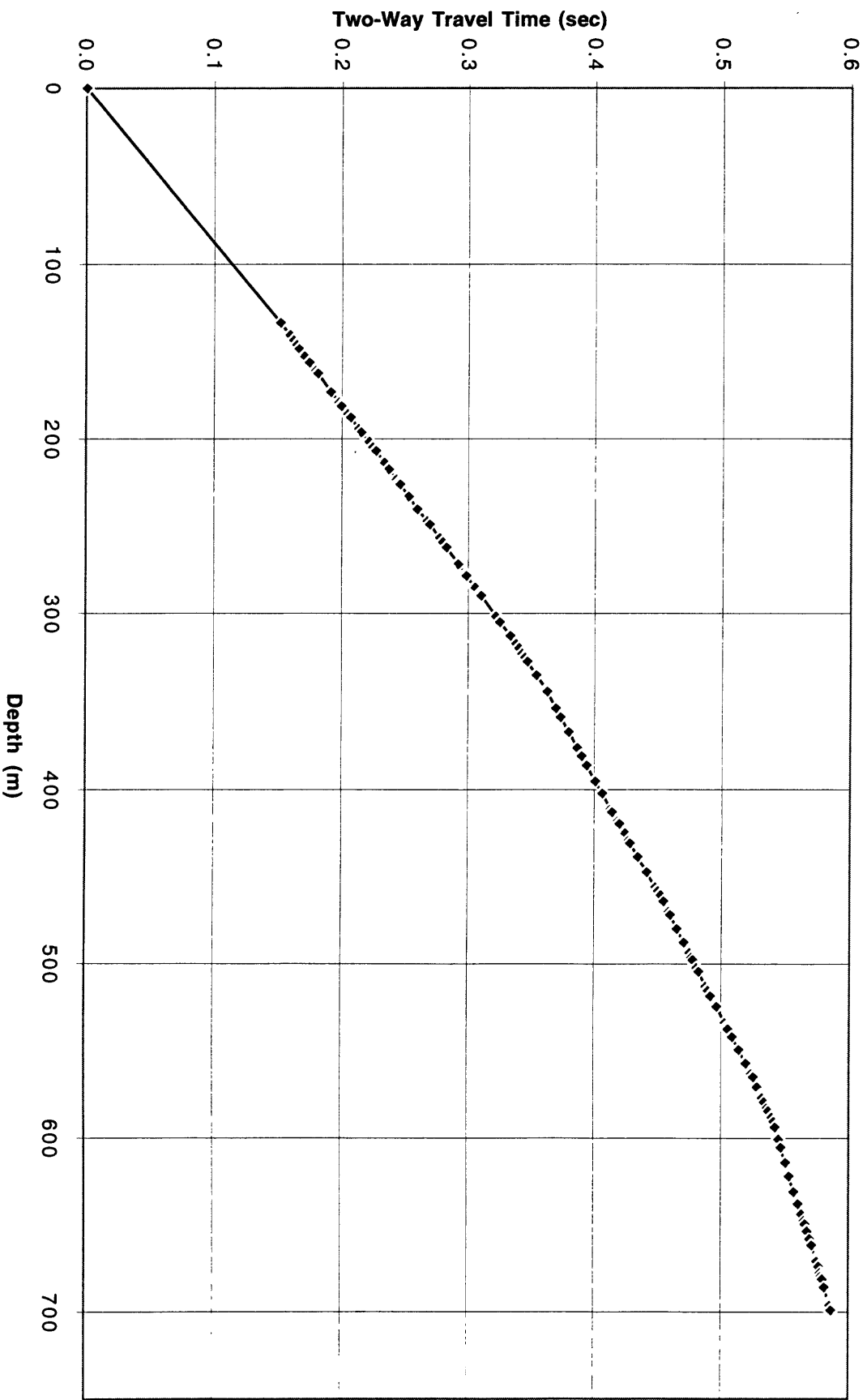


Figure 103.

Phillips Petroleum Company, Olsen No. A-2

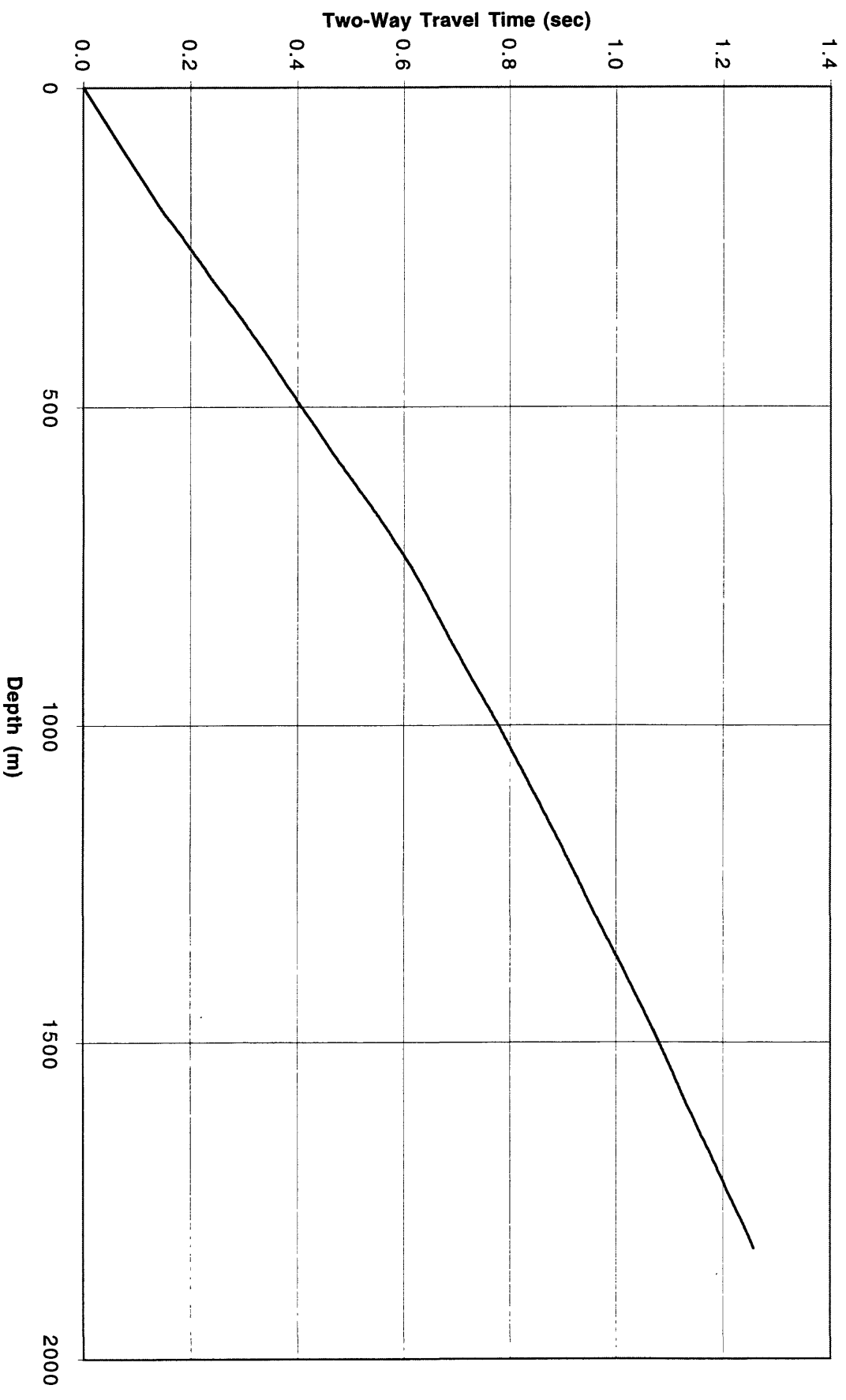


Figure 104.

Ferguson and Bosworth, Kin-Ark-Pura No. 1

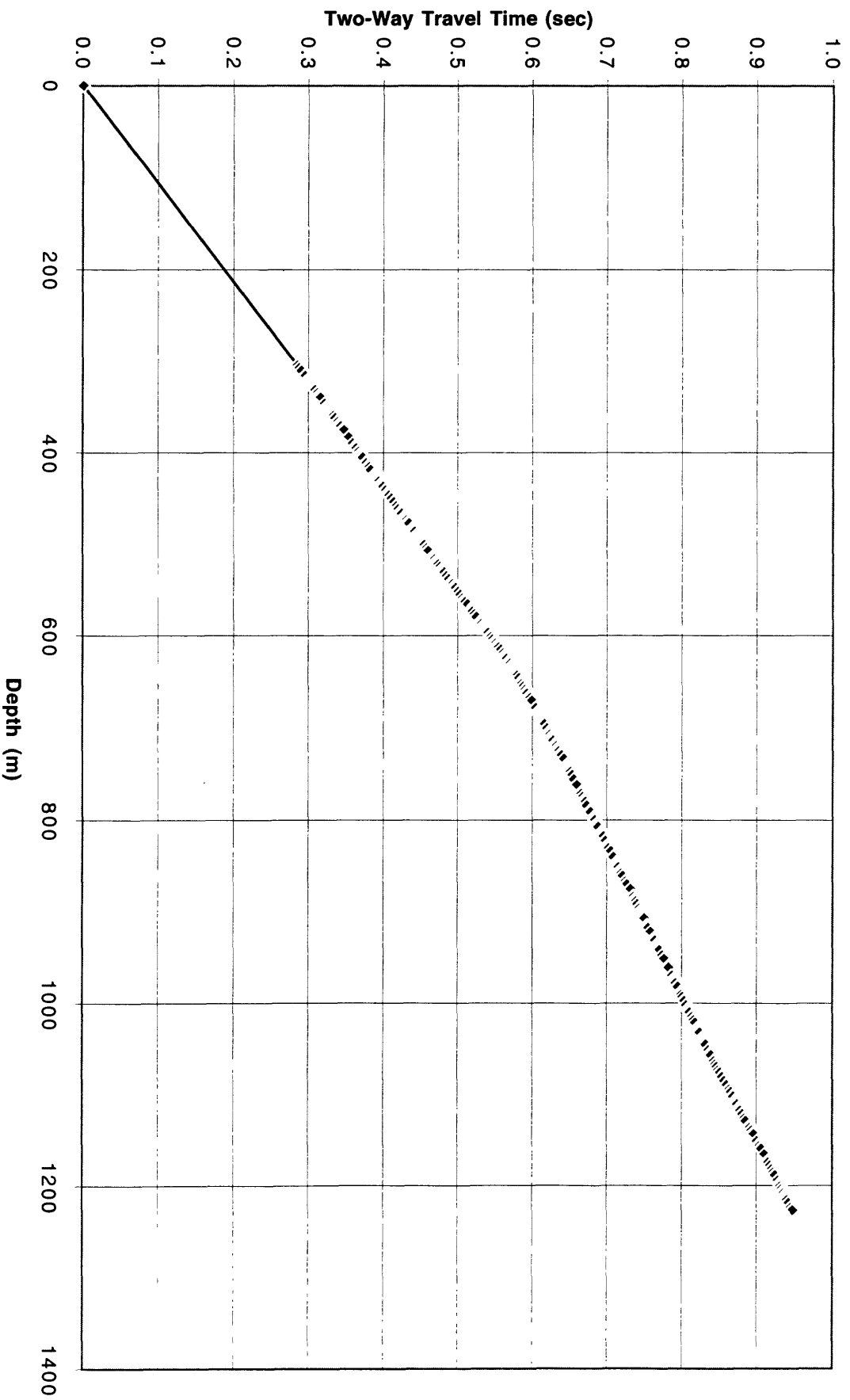


Figure 105.



**Texaco Incorporated, Clark #1**

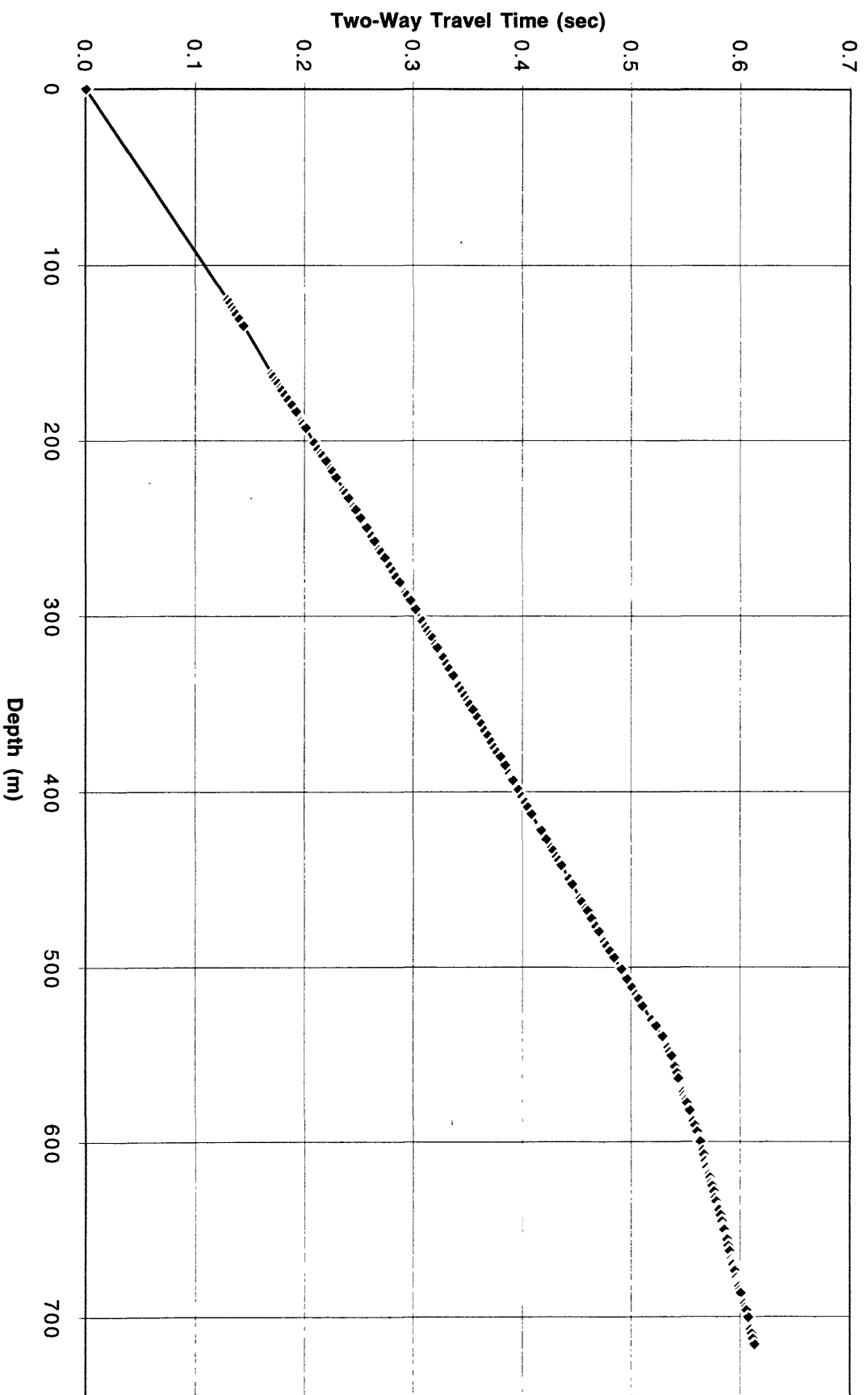


Figure 106.

Standard Oil Company of California, Keenan #37

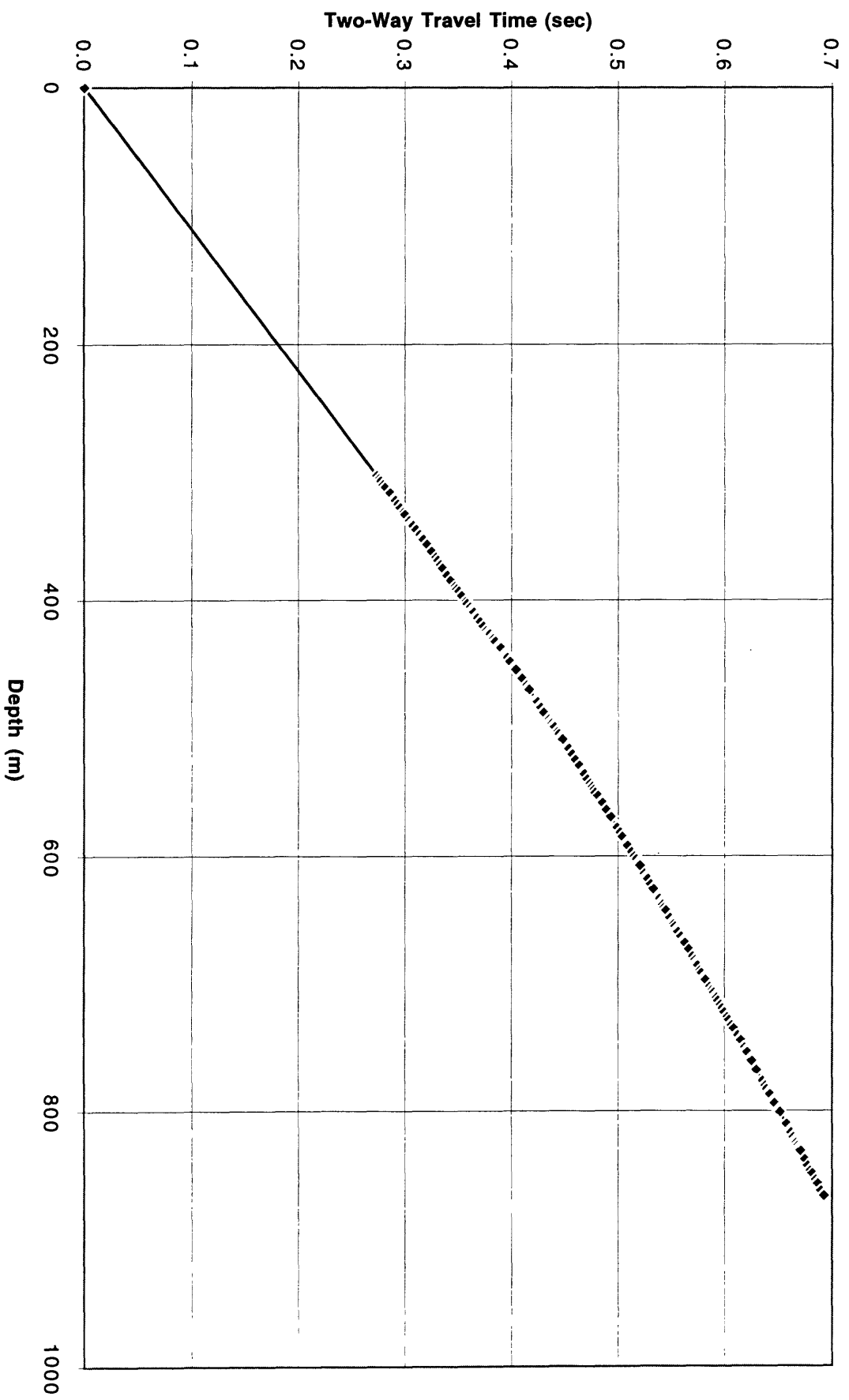


Figure 107.

Seaboard Oil and Gas Company, De Alvarez No. 21-5

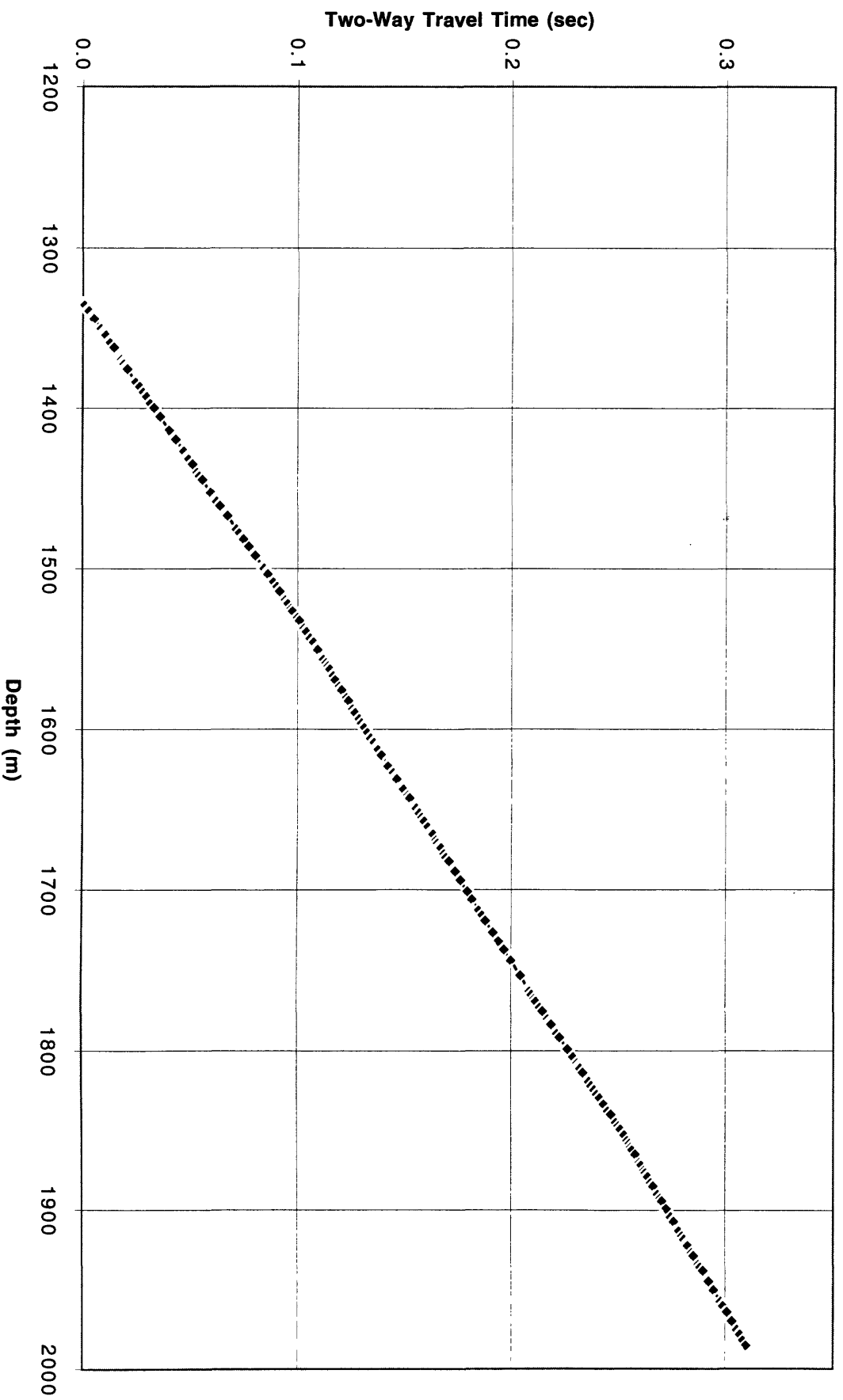


Figure 108.

Phillips Petroleum Company, Doud A #1

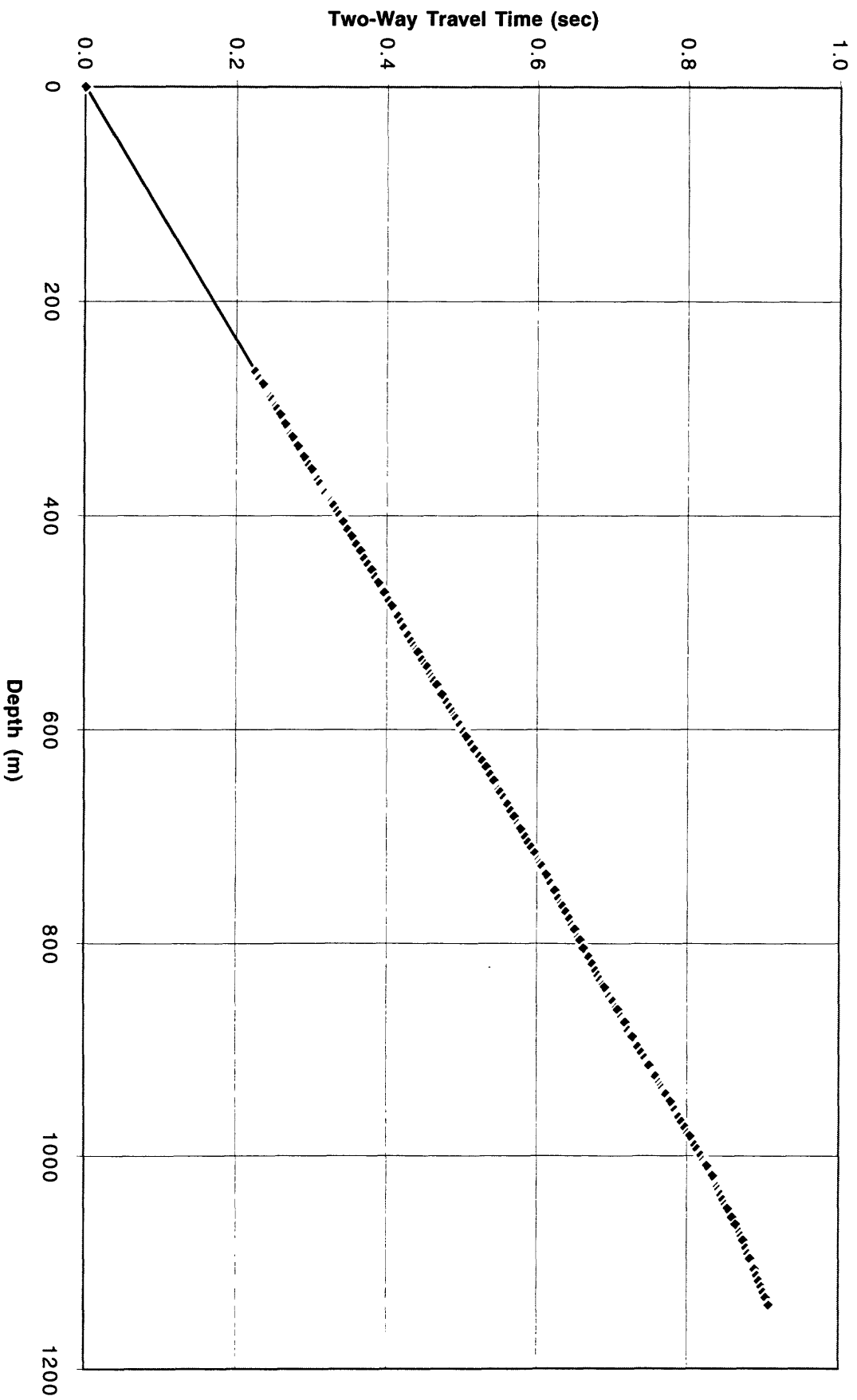


Figure 109.

Koch Exploration Company, Arroyo Seco Fed. No. 48X-11

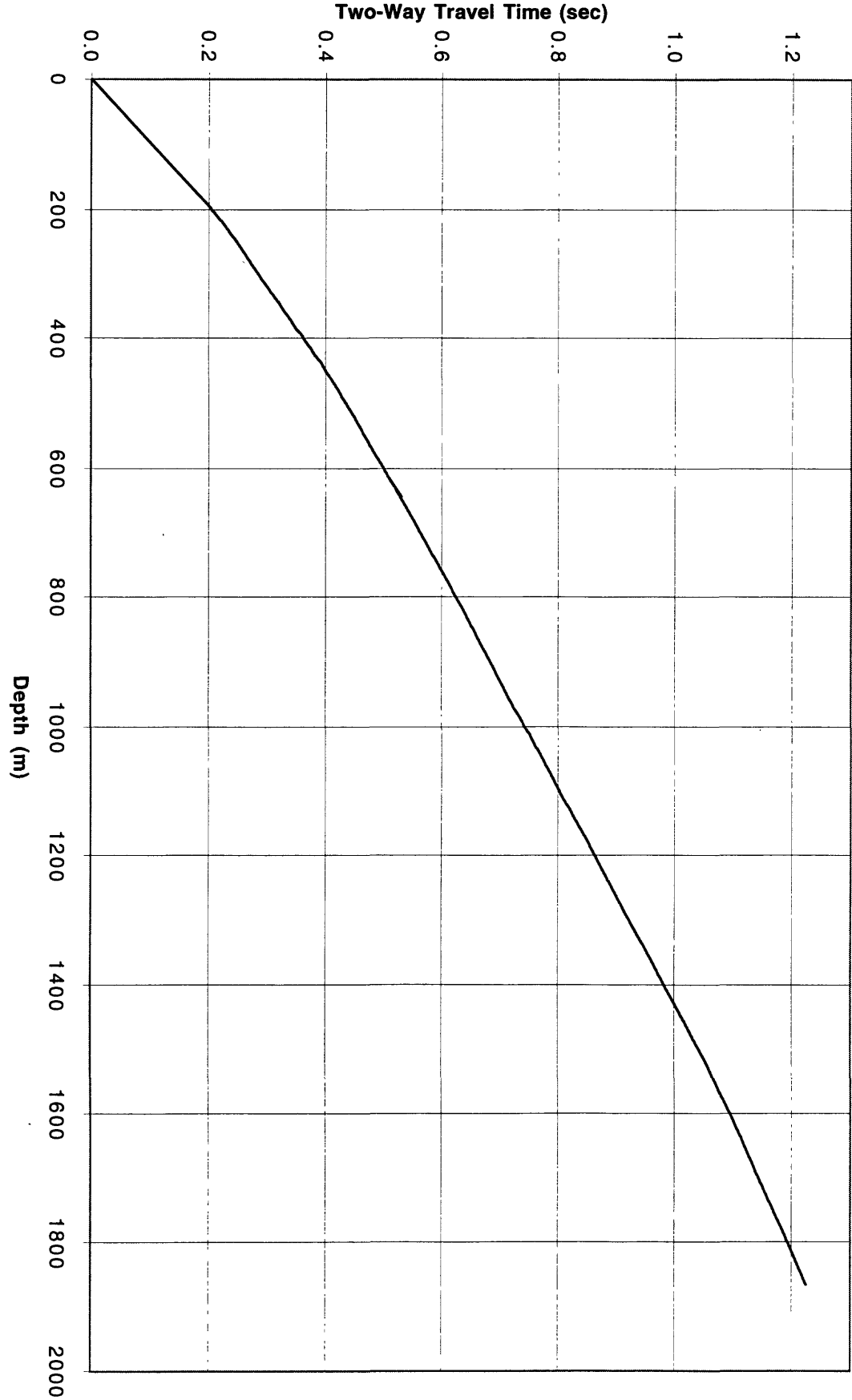


Figure 110.

Phillips Petroleum, Hansen #1

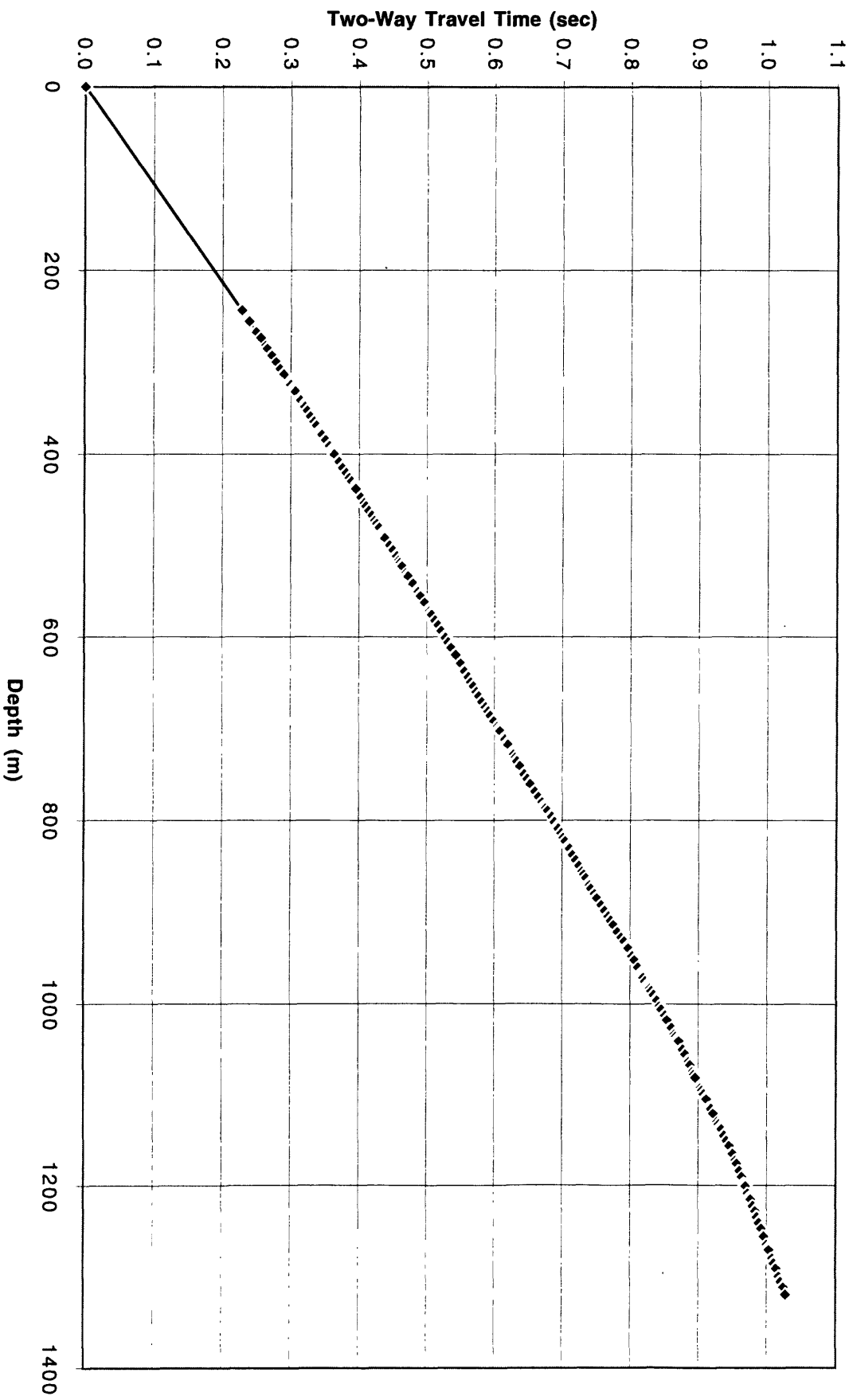


Figure 111.

Cities Service Oil Company, Plaskett No. A-1

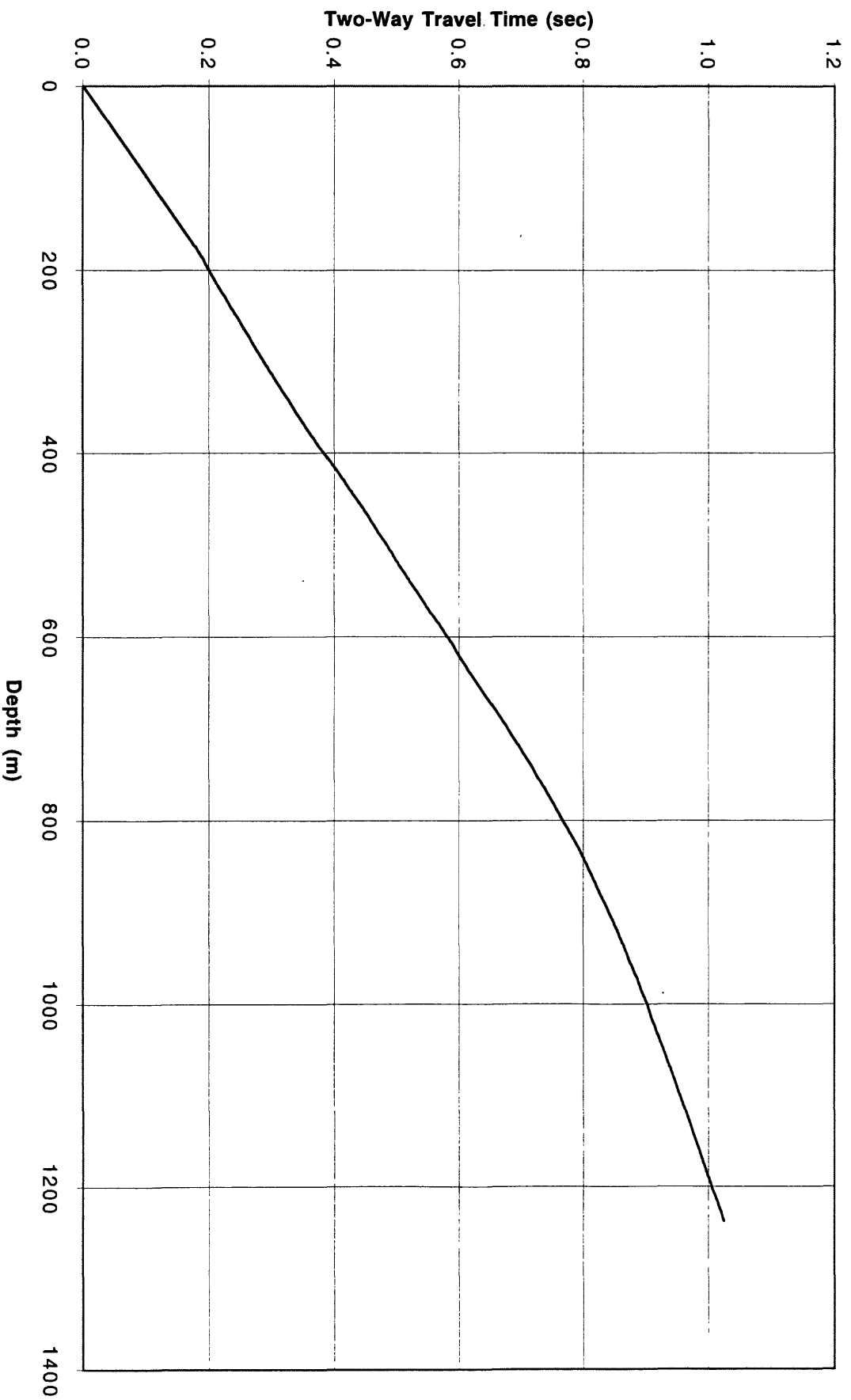


Figure 112.

**Cities Service Oil Company, 1-Wallace-A Redrill #2**

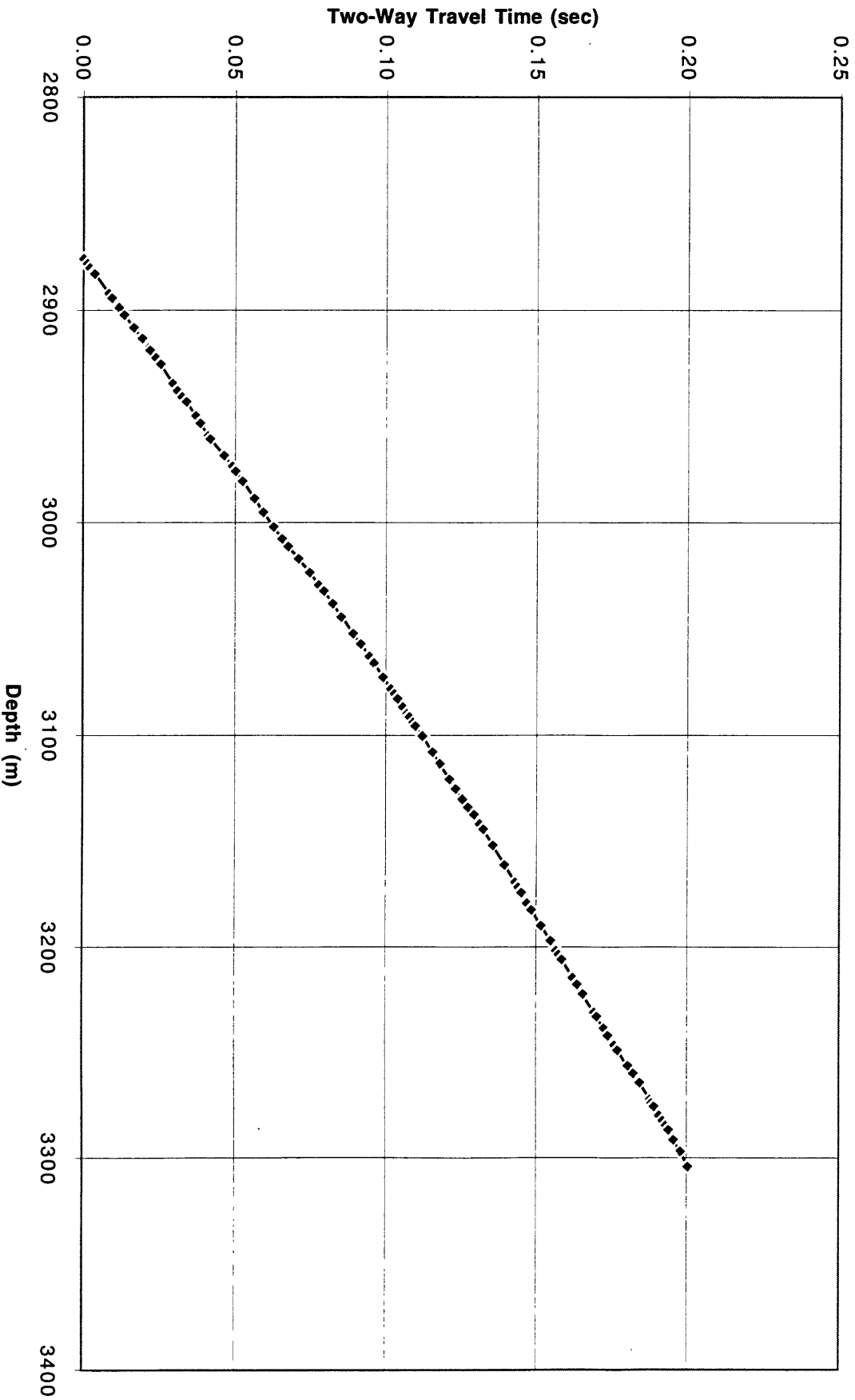


Figure 113.



**Chevron USA Inc; Section 8, Thompson Canyon USL #1**

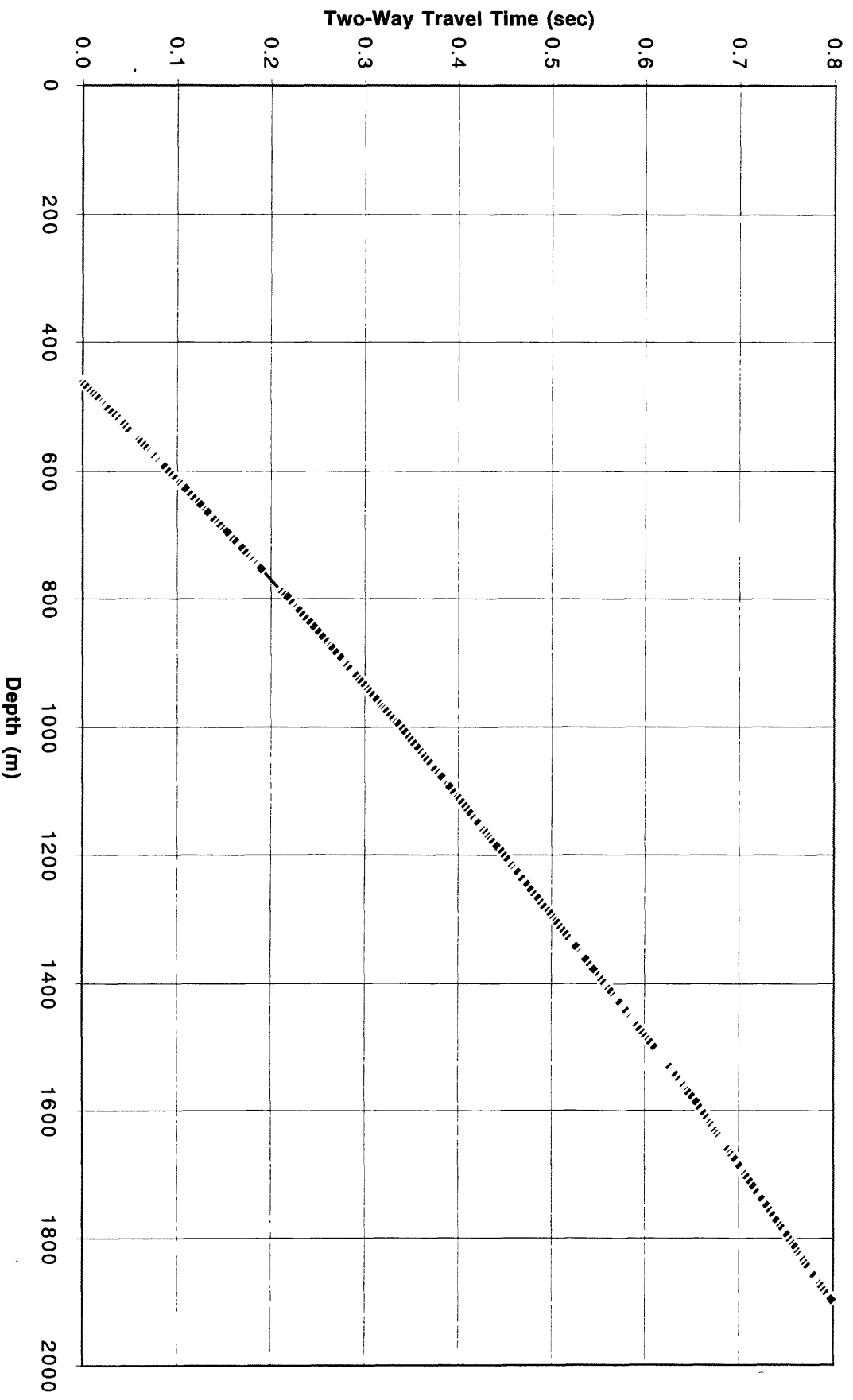


Figure 114.

**Richard R. Thorup, Operator, Thomas Doud Estate #4**

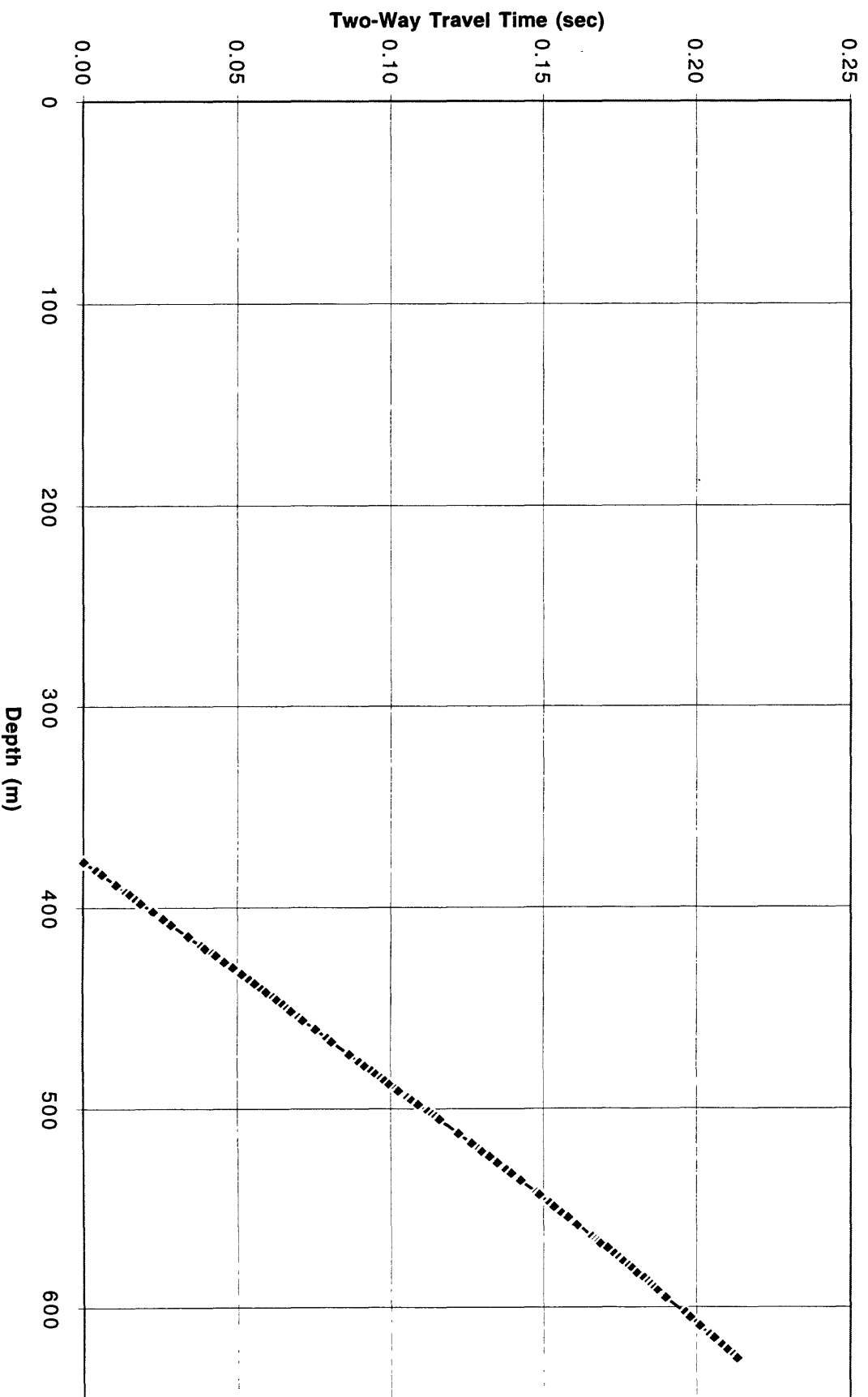


Figure 115.

**Pennant Operating Company, BCB-Doud D-3-32 Redrill**

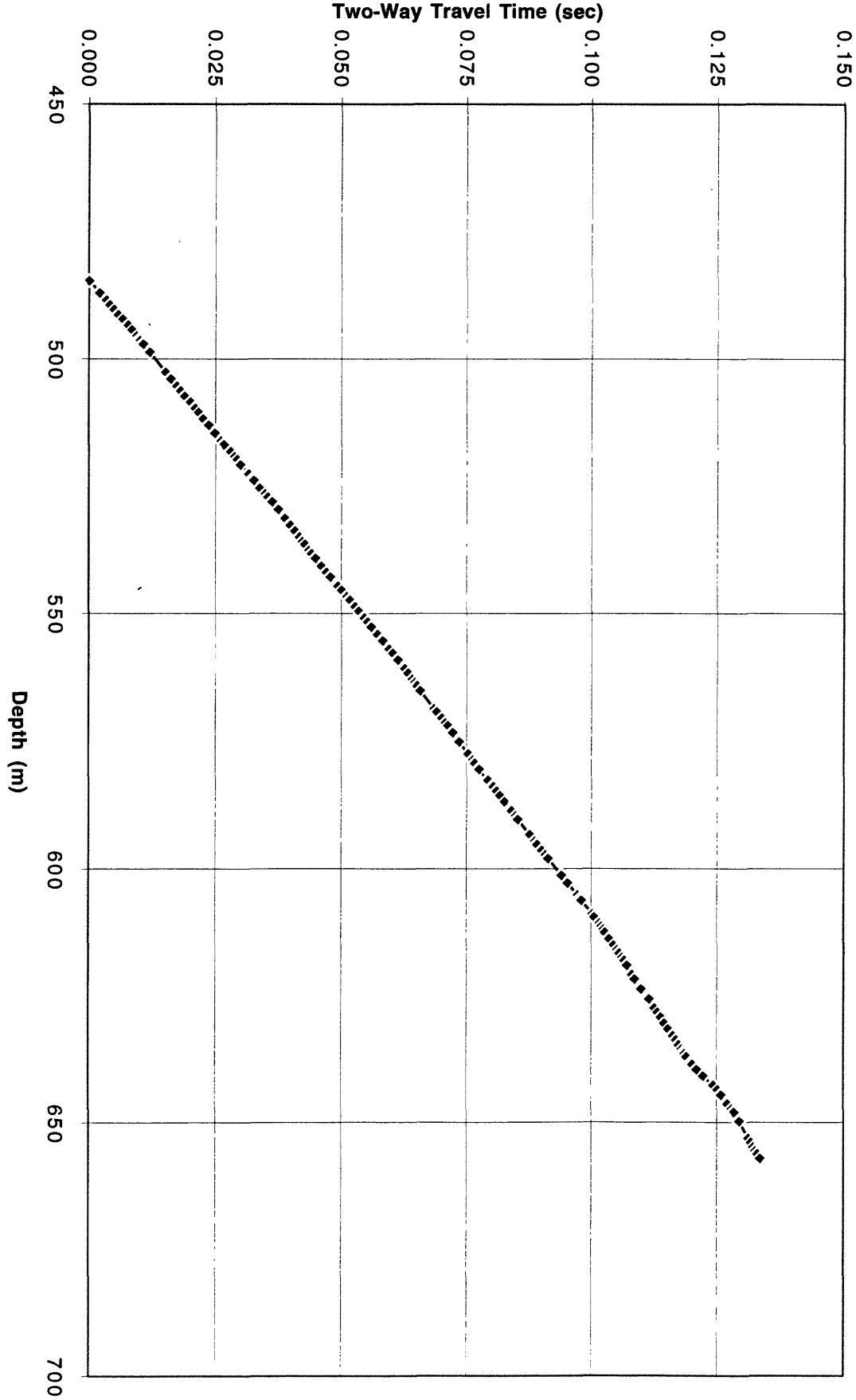


Figure 116.

**Beach, Church, and Bell, Salinas Land Co. #1**

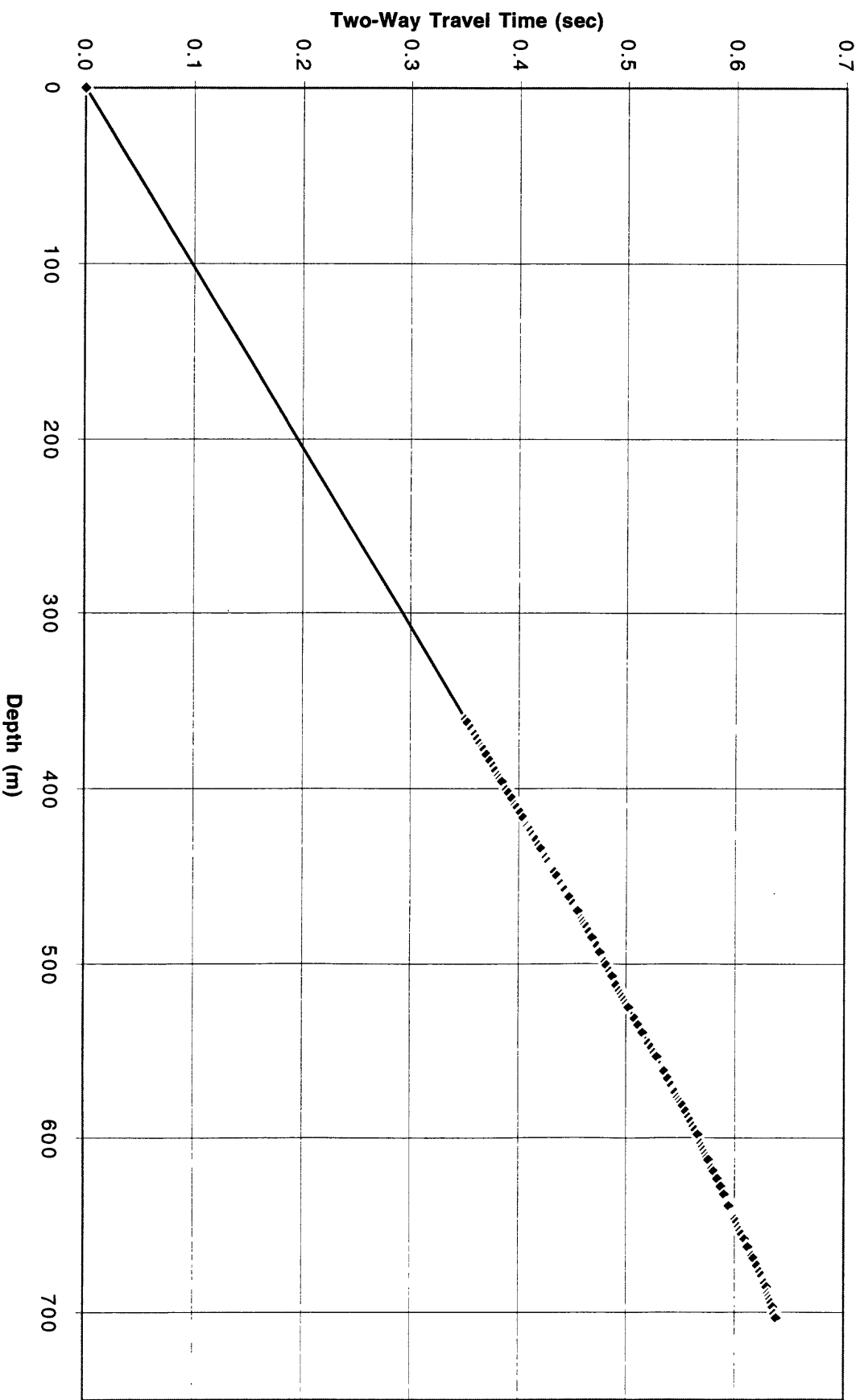


Figure 117.