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COMPILATION OF 19 SONIC AND DENSITY LOGS FROM 10 OIL TEST WELLS IN SOUTHWESTERN OREGON

By

Thomas M. Brocher[1] and Elba Horta[1]

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[1]345 Middlefield Road, M/S 977, Menlo Park, CA 94025

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ABSTRACT

We have compiled 19 sonic and density logs from 10 oil test wells in southwestern Oregon to help determine the geometry and physical properties of two Cenozoic basins. Four oil test wells are located within the Coos Bay Basin; one lies offshore the Coos Bay Basin, and the remaining five wells are located within the southern Tyee Basin. These well logs sample Pleistocene to Eocene sedimentary (principally the Tyee and Umpqua Groups) and volcanic (Roseburg Formation and Siletz River) rocks. This report presents the locations, elevations, depths, stratigraphic and other information about the oil test wells, provides plots showing the density and sonic velocities as a function of depth for each well log, and provides a simple statistical analysis of the data to better understand the variations in sonic velocities and densities of Cenozoic sedimentary and volcanic rocks in southwestern Oregon. We also calculate and present two-way travel times from the sonic velocity logs.

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INTRODUCTION

We describe well log data from oil test wells that supplement ongoing studies of the crustal structure in the vicinity of Cape Blanco, southwest Oregon (Fig. 1) [Brocher and others, 1995; Davis, 1995]. Seismic profiles acquired there imaged crustal structure as well as the geometry of the subducting Gorda Plate in southwestern Oregon (Fig. 1).

We present data from 19 sonic and density logs from 10 oil test wells in southwest Oregon, to categorize the sonic velocities and densities of Cenozoic sedimentary basins there (Fig. 1). Four of the wells are from the Coos Bay Basin, one lies offshore the Coos Bay Basin (Amoco OCS P-0112 No. 1), and the other five wells are from the southern Tyee Basin. The 19 well logs sample Pleistocene to Eocene sedimentary rocks (principally of the Tyee and Umpqua Groups) as well as thick sections of Eocene Siletz River Volcanics (both the upper, tuff and breccia member, and the lower, pillow basalt member). (For a few of the wells we retain the published stratigraphic use of the Roseburg Formation, an older nomenclature referring to both sedimentary and volcanic rocks.) Newton [1980], Olmstead and others [1989], and Ryu and others [1992, 1996] describe the Coos Bay and southern Tyee Basins using data from these wells, but did not discuss the sonic velocities and densities measured in them.

Basic information about the wells is provided in Table 1. This information includes the locations, elevations, and depths of the wells, as well as the lease name, well number, operator, and completion year. In this table the wells are ordered alphabetically. This information is taken 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. Table 1 also summarizes the lithologies and stratigraphy encountered in the holes [Rau, 1973; McNeel, 1980a,b; 1984; Snaveley and others, 1981; Ryu and others, 1992, 1996]. Finally, Table 1 provides information on the type of sonic and density tool used to make the log, as well as other tools run simultaneously (normally caliper, spontaneous potential, and gamma-ray). Many of the sonic logs were made with older, short tools, with short spans between the source and receivers.

WELL LOG ANALYSIS

Sonic and density logs from the onshore wells 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 our sampling interval was not intended and 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. Logs from the offshore Amoco OCS P-0112 No. 1 well were digitized at 1 foot intervals.

For the sonic logs, we picked transit times as a function of depth. For the gamma-gamma density logs, we picked bulk density in g/cm^3 as a function of depth. For the neutron density porosity logs, we converted the logged density porosity (ϕ) back to formation density (ρ_{fd}) using $\rho_{fd} = \rho_m + (\rho_f - \rho_m)\phi$, where the matrix density $\rho_m = 2.65$ g/cm^3, and the fluid density $\rho_f = 1.0$ g/cm^3 [Ellis, 1987]. Roughly half of the logs analyzed here are plotted at a scale of 30.49 m = 5 cm (100 feet = 2 inches), the remainder are plotted at a scale of 30.49 m = 2.54 cm (100 feet = 1 inch). Depths are measured from an arbitrary reference datum, normally the Kelley Bushing (K.B.), located 3.65 m (12 feet) above ground level. Datum for the Amoco OCS P-0112 No. 1 is 129 m (424 feet) above the seafloor and 22 m (72 feet) above sealevel. The downhole depths reported here have not been corrected for this small upward shift. Cased intervals of the wells and sections identified on the logs as having cycle-skipping problems were not digitized. In some cases data from the logs were ignored: these data were associated with washouts, thick mudcake, invasion of drill fluids or large deviations from the general trend of density and sonic values having very limited depth extent, generally less than 10 meters [Ellis, 1987]. No editing of well data from the Amoco OCS P-0112 well was performed.

The digitized sonic-log data were converted from transit times to velocities (m/s) and both the sonic- and density-log depths were converted from feet to meters. Plots showing seismic velocities and densities as a function of depth for each well are presented in Figures 2 to 16.

Although we digitized all repeated passes of tools in sections of the wells, we do not show these redundant passes in Figures 2 to 16.

The quality of the logs vary but is generally moderate to high for the sonic velocity logs. The caliper records for the sonic logs indicate that the well diameter is generally close to the bit size and relatively smooth, with the exception of the Fat Elk No. 1 well, which is out of gauge between 1350 and 2100 feet (412 to 640 m). Caliper deviations on the sonic logs for the other logs are generally short, less than 30 m long. Thus, we believe the sonic velocity data reported here to be representative of formation velocites. Caliper records for the sonic logs for the Coos County No. 1 and 1-7 wells are particularly smooth.

Caliper records for the density logs, on the other hand, show substantial deviations from the bit size. Long sections of the Amoco-Weyerhauser B-1 well, the section of the Fat Elk No. 1 well between 1350 and 2100 feet (412 to 640 m), much of the Harris No. 1-4 and the Sawyer Rapids No. 1 wells are substantially out of gauge or even off-scale on the density log caliper scale. Shorter sections of the Sutherlin Unit No. 1 well are out of gauge on the caliper scale of the density log. We therefore attribute the generally low average densities of the Roseburg Formation and Siletz River volcanics in the Fat Elk No. 1, Harris No. 1-4, and Sutherlin Unit No. 1 wells to these large caliper deviations (Table 2). For these wells, the higher densities shown in the logs for the Roseburg Formation and Siletz River Volcanics may be more representative of the formation density than the lower densities found in regions of large caliper deviation.

We also calculated two-way travel times from the sonic velocity logs. These curves are plotted in Figures 18 to 26. This calculation required us to project the sonic velocities to the surface. In some cases, the uppermost velocities logged in the wells were too deep to allow projecting the velocity to the surface. In these cases, we calculated two-way travel times beginning at the uppermost of the logged velocities.

REGRESSION OF THE WELL LOG DATA

Table 2 presents average sonic velocities and densities determined at all the wells for several formations (including the Tyee Group and younger rocks, the Umpqua Group, Roseburg Formation, and Siletz River Volcanics). Figure 17 shows the same information plotted as velocity versus density. We describe this figure more fully in the Discussion. In Tables 1 and 2 we have inferred the top of volcanic units from the velocity and density at two wells (Coos County No. 1 and Westport No. 1)

At a few wells, the logs show a simple linear increase in sonic velocity with depth. These logs include those from Coos County No. 1-7, Harris No. 1-4, Sawyer Rapids No. 1, and Westport No. 1. Linear regression through the P-wave velocity data for the Coos County No. 1-7 log yields Vp (km/s) = 2.17 + 0.918Z for the Tertiary (predominately Eocene) sedimentary rocks, where Z is depth in km (Fig. 3). The R^2 for this regression is 0.683. Linear regression through the P-wave velocity data for the Westport No. 1 log yields Vp (km/s) = 2.27 + 1.569Z for the Coaledo Formation (Fig. 4). The R^2 for this regression is 0.618. Linear regression through the P-wave velocity data for the Harris No. 1-4 log yields Vp (km/s) = 2.70 + 1.349Z for the entire log, consisting of both sedimentary and volcanic rocks (Fig. 5). The R^2 for this regression is 0.574. Linear regression through the P-wave velocity data for the Sawyer Rapids No. 1 log yields Vp (km/s) = 3.43 + 0.620Z for the Eocene sedimentary rocks (Fig. 7). The R^2 for this regression is 0.515.

DATA AVAILABILITY

The picks of density and seismic velocity shown in Figures 2 to 26 are available in Excel5 spreadsheets using anonymous ftp. The anonymous ftp address is: andreas.wr.usgs.gov. Change the directory (cd) to pub/outgoing/blanco. Figures 2 to 16 reside in files named blanco.sonic.xl5.bin and blanco.density.xl5.bin, in Mac Binary II format. Sonic and density logs for Amoco OCS P-0112 No. 1 are named P112VELX.xl5.bin and P112RHOX.xl5.bin. Figure 17 is in a file named Figure17.bin. Figures 18-26 showing calculated two-way travel times versus depth are located in blanco.twt.xl5.bin and P112VELX.xl5.bin. Table 1 of this report is also in this ftp site, labeled as Table 1. The text is in a Word5 file named OFR98-237.text.

DISCUSSION

Velocity and density relations in Table 2 cluster into two distinct stratigraphic groups (Figure 17). Average velocities and densities from the sedimentary rocks lie close to the Nafe-Drake velocity-density curve (Nafe and Drake, 1957). The uppermost, sedimentary section of the Roseburg Formation, has the lowest average velocities and very low average densities (Figure 17). Average velocities and densities from Tyee Group and younger sedimentary rocks plot in a well-defined arcuate trend lying close to the Nafe-Drake curve (Nafe and Drake, 1957).

In contrast, the average velocities and densities for the volcanic units lie closer to a linear velocity-density relationship defined by Luetgert (1992). These volcanics include the lower section of the Roseburg Formation, which is correlative to the Siletz River Volcanics, and the breccia and pillow basalt sections of the Siletz River Volcanics. The highest average velocities and densities were found in the pillow basalt section of the Siletz River Volcanics (Figure 17). Due to well gauge problems, however, average densities at two of the wells sampling the pillow basalt members of the Siletz River Volcanic are too low, yielding values that are well off the empirical trends defined by either Nafe and Drake (1957) or Luetgert (1992).

The sedimentary rocks exhibit significant (up to 50%) regional variation in the average velocities and densities. For the Tyee Group and younger sedimentary rocks, average velocities from the wells within the Coos Bay Basin (Coos Co. No. 1 and No. 1-7, Fat Elk No. 1, and Westport No. 1; Fig. 1) are 0.4 to 1.4 km/s lower than those within the southern Tyee Basin (Table 2). Average densities of the Tyee Group and younger sedimentary rocks in the Coos Bay Basin are 0.09 to 0.25 g/cm^3 lower than those in the southern Tyee Basin.

Logs from two wells suggest that the velocities and densities of the Umpqua Group are slightly lower than those in the overlying Tyee Group (Table 2; Figure 17). The cross-cutting trend defined by the Umpqua Group results from the low average density of the Umpqua Group at the Sutherlin Unit No. 1 well, which in turn was caused by the large caliper deviations along most of the well.

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ABBREVIATIONS USED IN TABLE 1:

BHC - Borehole Compensated Sonic Log
CNFD - Compensated Neutron Formation Density
Cal. - Caliper
SP - Spontaneous Potential
GR - Gamma Ray

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

Table 1. Oil test well data

Leasename	No.	Operator	T	T	R	R	S	Latitude	Longitude	Depth (ft)	Depth (m)	Elev. (ft)	Elev. (m)	Year Compl.	Sonic	Density	Other Logs	Tertiary Units
Coos County	1	Northwest Expl.	S	27	W	13	14	43.22882	-124.21176	6821	2080	321	98	1980	BHC	CNFD	Cal., GR	EOCENE
																		Coaledo Fm. 0-3115' (0-950 m)
																		Top Looking Glass Fm. 3115' (950 m)
																		Top Roseburg Fm. 3520' (1073 m)
																		Inferred Top Siletz River Volcanics breccias 5144' (1568 m)
																		Inferred Top Siletz River Volcanics pillow lavas 6126' (1867 m)
Coos County	1-7	Warren Edward M	S	27	W	13	7	43.23921	-124.28501	2282	696	N/A	N/A	1963	T3R1R		Cal.	LATE EOCENE
																		Coaledo Fm.
Fat Elk	1	Northwest Expl.	S	28	W	13	15	43.14440	-124.23548	3117	950	688	210	1980	BHC	CNFD	Cal., GR	EOCENE
															T3R2R			Coaledo Fm. 0-840' (0-256 m)
																		Top Looking Glass Fm. 840' (256 m)
																		Top Roseburg Fm. 1260' (384 m)
Harris	1-4	Florida Expl. Co.	S	21	W	6	4	43.78019	-123.40889	10000	3049	798	243	1982	BHC	CNFD	Cal., GR	EOCENE
																		Base Tyee Mtn. Mbr. 1500' (457 m)
																		Top Umpqua Group 1500' (457 m)
																		Top Siletz River Volc. breccias 2200' (671 m)
																		Top Siletz River Volc. pillow lavas 4070' (1241 m)
OCS P-0112	1	AMOCO Prod.		0		0	0	43.24590	-124.59260	6146	1874	0	0	1967	N/A	N/A	N/A	Pleistocene 0-1250' (0-381 m)
																		Top/Pliocene 1250' (381 m)
																		Top/late Miocene 1710' (521 m)
																		Top/early Miocene 2370' (723 m)
																		Top/Oligocene 2690' (820 m)
																		Top/late Eocene 2900' 884 m)
																		Top/early Eocene 3280' (1000 m)
Sawyer Rapids	1	Northwest Expl.	S	23	W	9	3	43.60363	-123.74736	5363	1635	412	126	1980	BHC	CNFD	Cal., GR	EOCENE
															T3R2R			Top Elkton Fm. 0' (0 m)
																		Top Baughman Fm. 1090' (332 m)
																		Top Hubbard Creek Mbr. 1380' (421 m)
																		Top Tyee Mtn. Mbr. 1830' (558 m)
Sutherlin Unit	1	Mobil Oil	S	24	W	5	36	43.43764	-123.23752	13177	4017	511	156	1979	BHC	CNFD	Cal., GR	EOCENE
															T2R3R			Base Umpqua Group 4050' (1235 m)
																		Top Siletz River Volc. breccia 4050' (1235 m)
																		Top Siletz River Volc. pillow basalts 6760' (2061 m)
Westport	1	Northwest Expl.	S	26	W	13	16	43.31089	-124.24579	3700	1128	565	172	1980	BHC	CNFD	Cal., GR	EOCENE
															T3R2R			Coaledo Fm. 0-3116' (0-950 m)
																		Inferred top of Roseburg Fm. 3122' (952 m)
Weyerhauser B	1	AMOCO Prod.	S	25	W	9	13	43.39081	-123.71409	11330	3454	1455	443	1985	BHC	CNFD	Cal., GR	EOCENE
																		Base Elkton Fm 1460' (445 m)
																		Top Baughman Fm. 1460' (445 m)
																		Top Hubbard Creek Fm. 2480' (756 m)
																		Top Tyee Mtn. Mbr. 2950' (899 m)
																		Top Umpqua Group 5760' (1756 m)
																		Top Siletz River Volc. breccia 6860' (2091 m)
																		Top Siletz River Volc. pillows 8260' (2518 m)
Weyerhauser F	1	AMOCO Prod.	S	25	W	10	10	43.41285	-123.86373	4428	1350	891	272	1985	BHC	CNFD	Cal., GR,	EOCENE
																	SP	Baughman Fm. 0-440' (0-134 m)
																		Hubbard Creek Mbr. 440' (134 m)
																		Top Tyee Mtn. Mbr. 990' (302 m)
																		Top Umpqua Grp. 4490' (1369 m)

Table 2. Average velocities and densities of geologic formations.

Well	Tyee and younger	Umpqua	Roseburg	Siletz River Volcanics breccia	Siletz River Volcanics pillow lavas
	Average Sonic Velocity (km/s)				
Coos County No.1	2.81	NA	2.62	3.81	4.11
Coos County No. 1-7	2.99	NA	NA	NA	NA
Fat Elk No.1	3.14	NA	2.75	NA	NA
Westport No.1	3.06	NA	4.05	NA	NA
Weyerhaeuser B-1	NA	NA	NA	NA	5.50
Weyerhaeuser F-1	4.36	NA	NA	NA	NA
Harris No. 1-4	3.52	3.10	NA	3.92	4.83
Sawyer Rapids No.1	3.96	NA	NA	NA	NA
Sutherlin Unit No.1	NA	3.97	NA	NA	5.77
	Average Density (g/cc)				
Coos County No.1	2.30	NA	2.36	2.41	2.49*
Fat Elk No.1	2.40	NA	2.34	NA	NA
Westport No.1	2.40	NA	2.49	NA	NA
Weyerhaeuser B-1	2.49	2.43	NA	2.67	2.72
Weyerhaeuser F-1	2.55	NA	NA	NA	NA
Harris No.1-4	2.51	2.51	NA	2.45	2.55*
Sawyer Rapids No.1	2.54	NA	NA	NA	NA
Sutherlin Unit No.1	NA	2.48	NA	2.48	2.52*

*Low densities associated with large caliper deviations in this well.

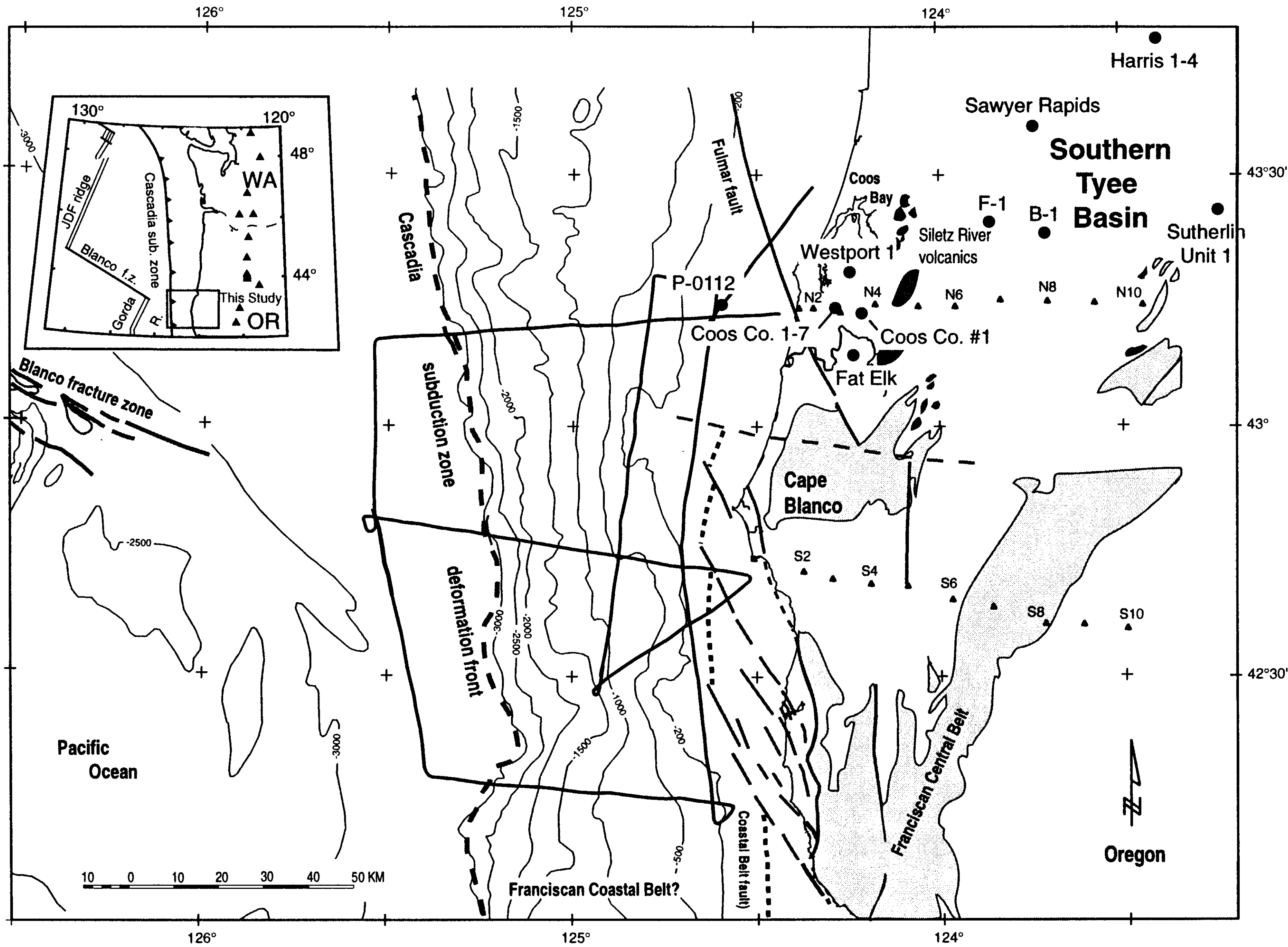


Figure 1. Map showing location of study area (inset). Wells analyzed in this report are shown as filled circles. Onshore stations (triangles numbered N1 to N10 and S1 to S10) recorded airgun shots along offshore seismic reflection lines (solid lines). Outcrops of Franciscan rocks and Siletz River volcanics are indicated by gray and black shaded patterns, respectively. Bathymetric contour interval is 500 m except along the shelf.

Coos County No. 1

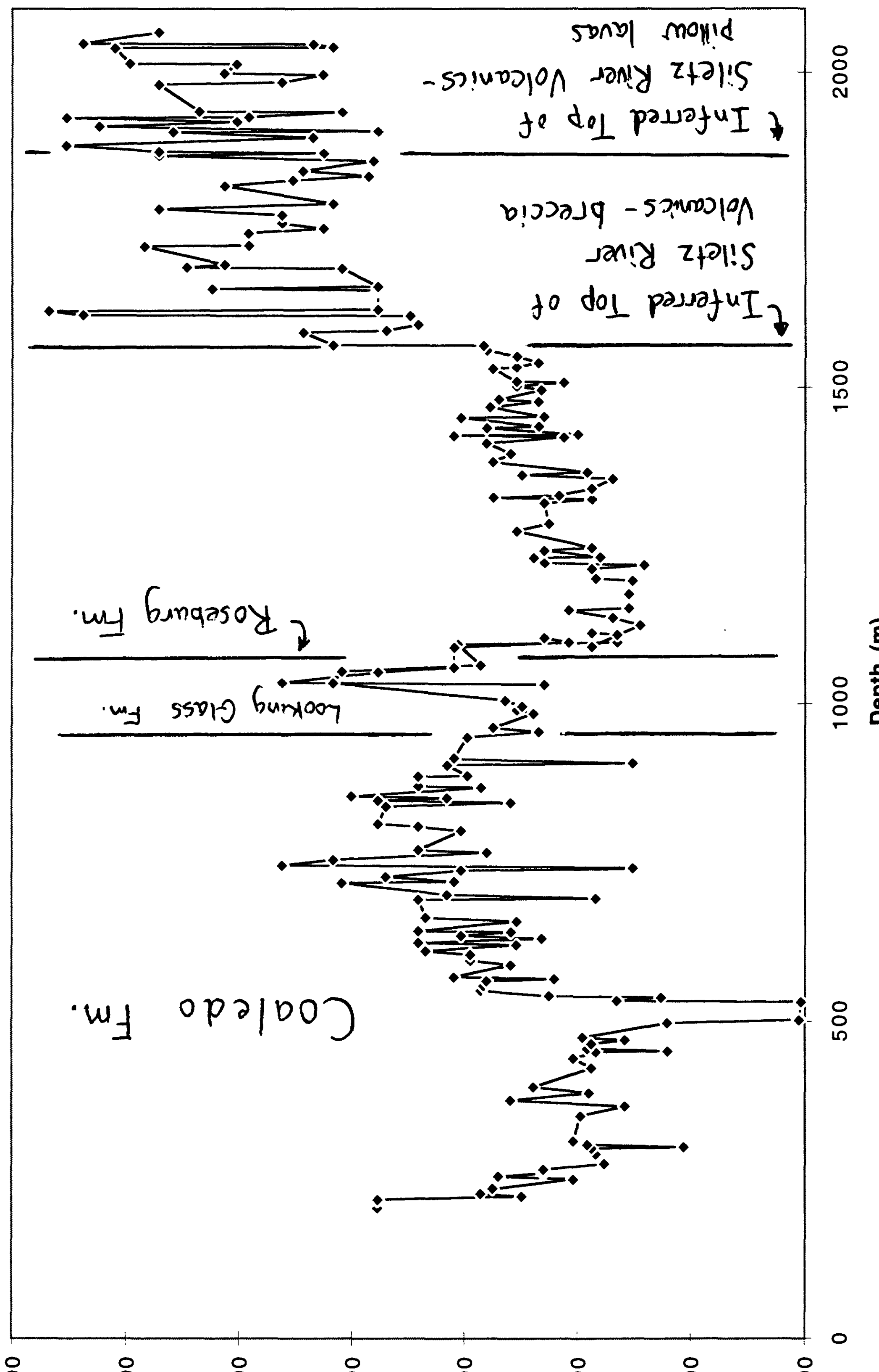


Figure 2.

Coos County No. 1-7

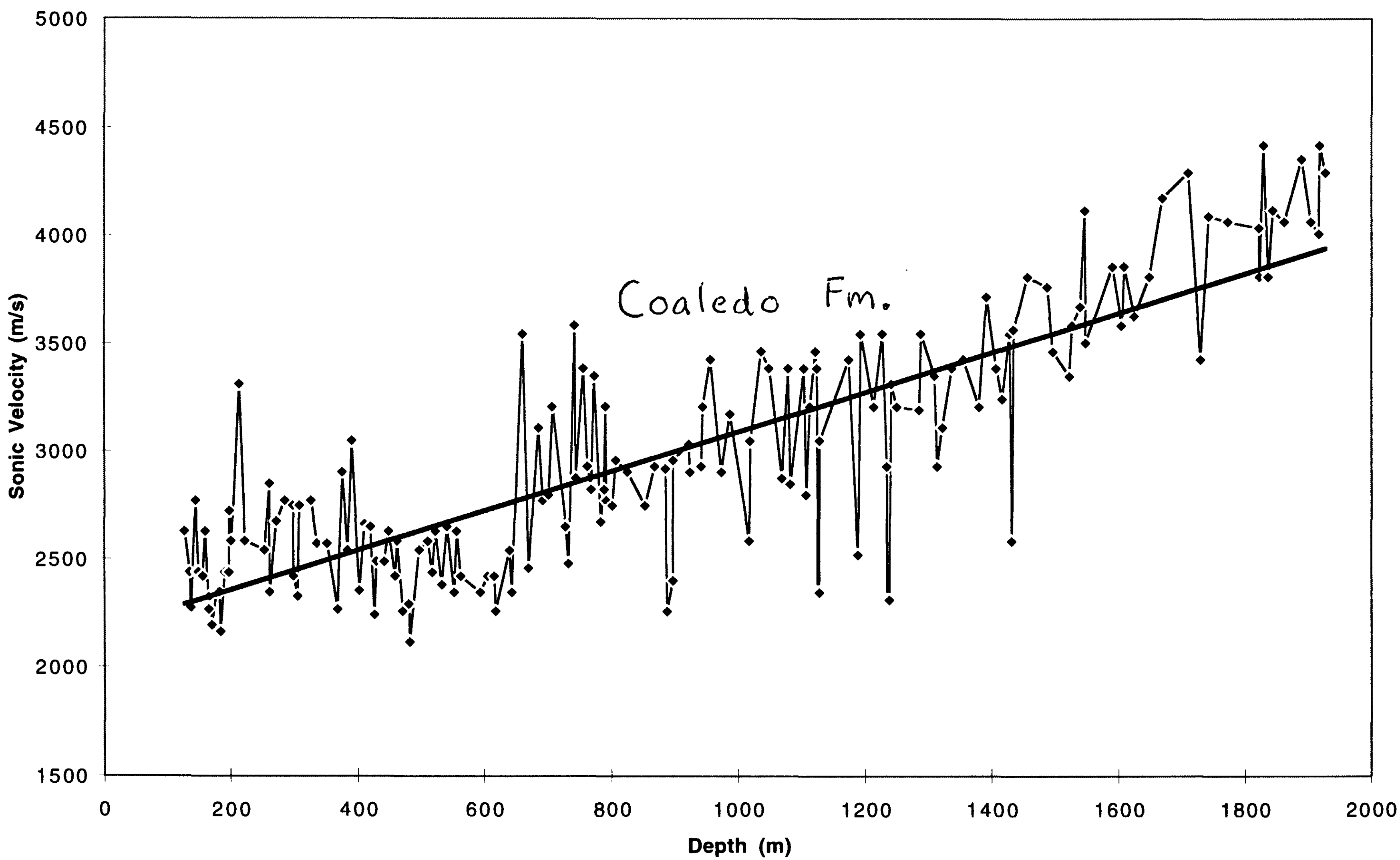


Figure 3.

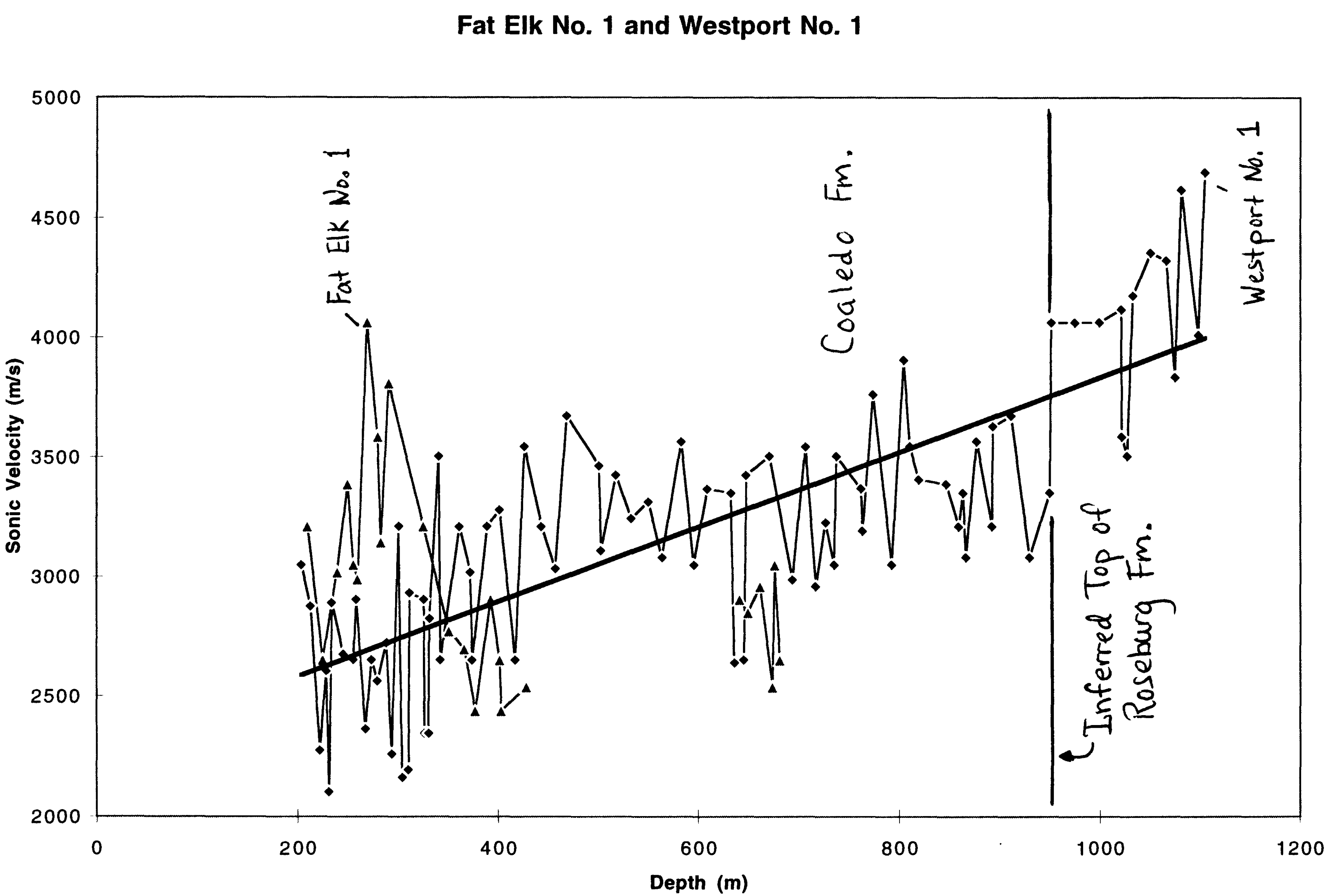

Fat Elk No. 1 and Westport No. 1
Sonic Velocity (m/s)
5000
4500
4000
3500
3000
2500
2000
0
200
400
600
800
1000
1200
Depth (m)
Fat Elk No. 1
Coaledo Fm.
Westport No. 1
Inferred Top of Roseburg Fm.

Figure 4.

Harris No. 1-4

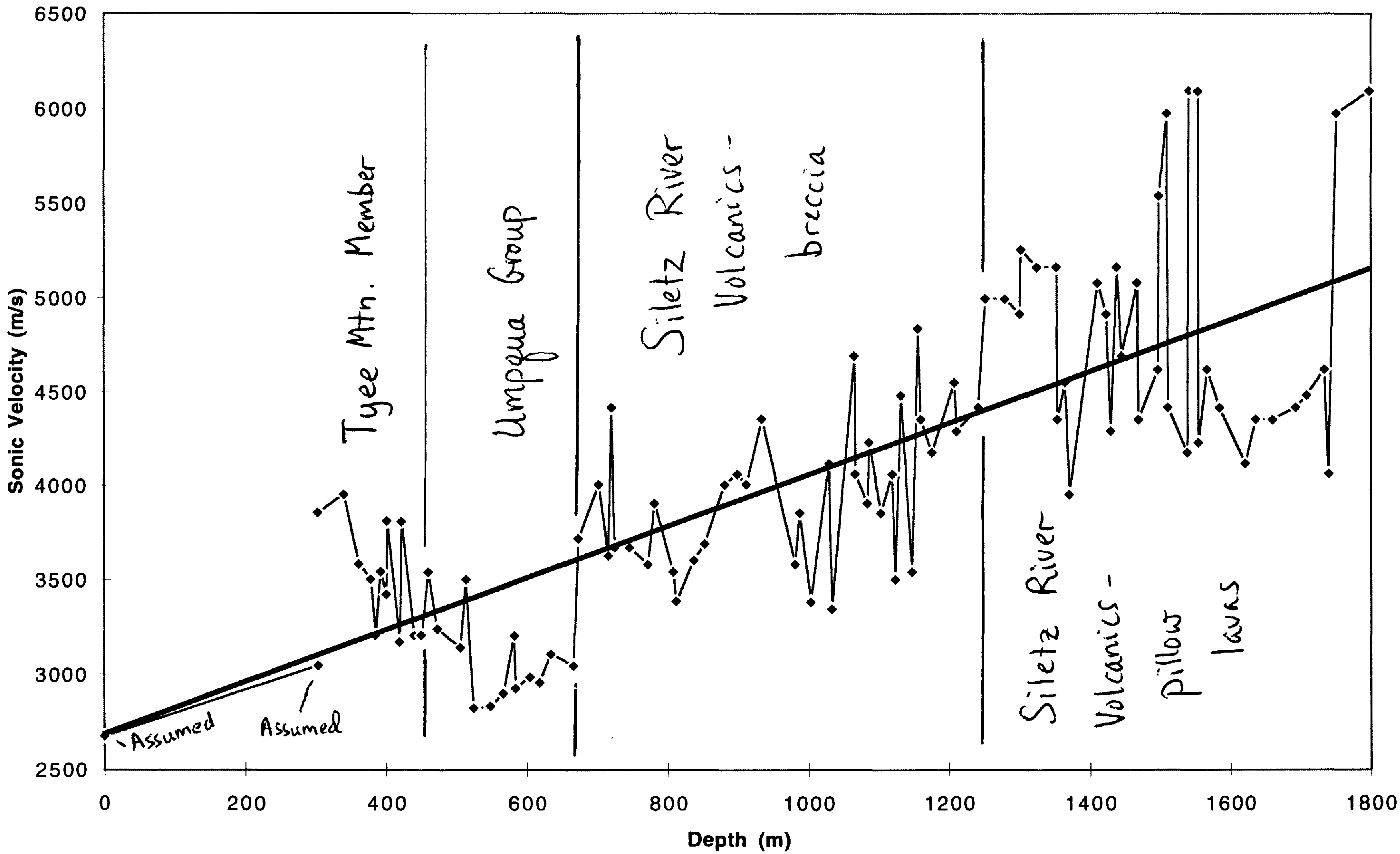


Figure 5.

P0112 No. 1

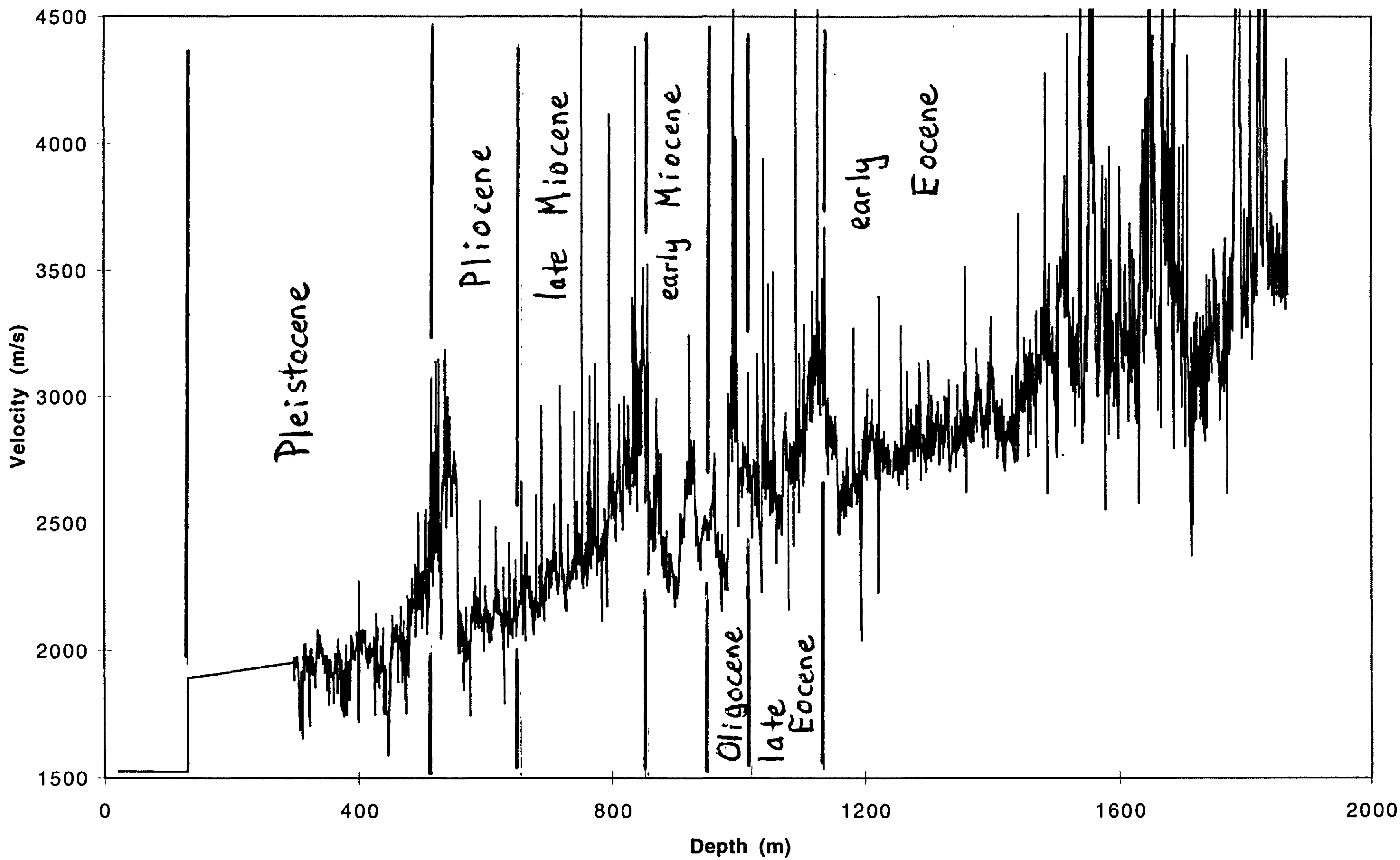
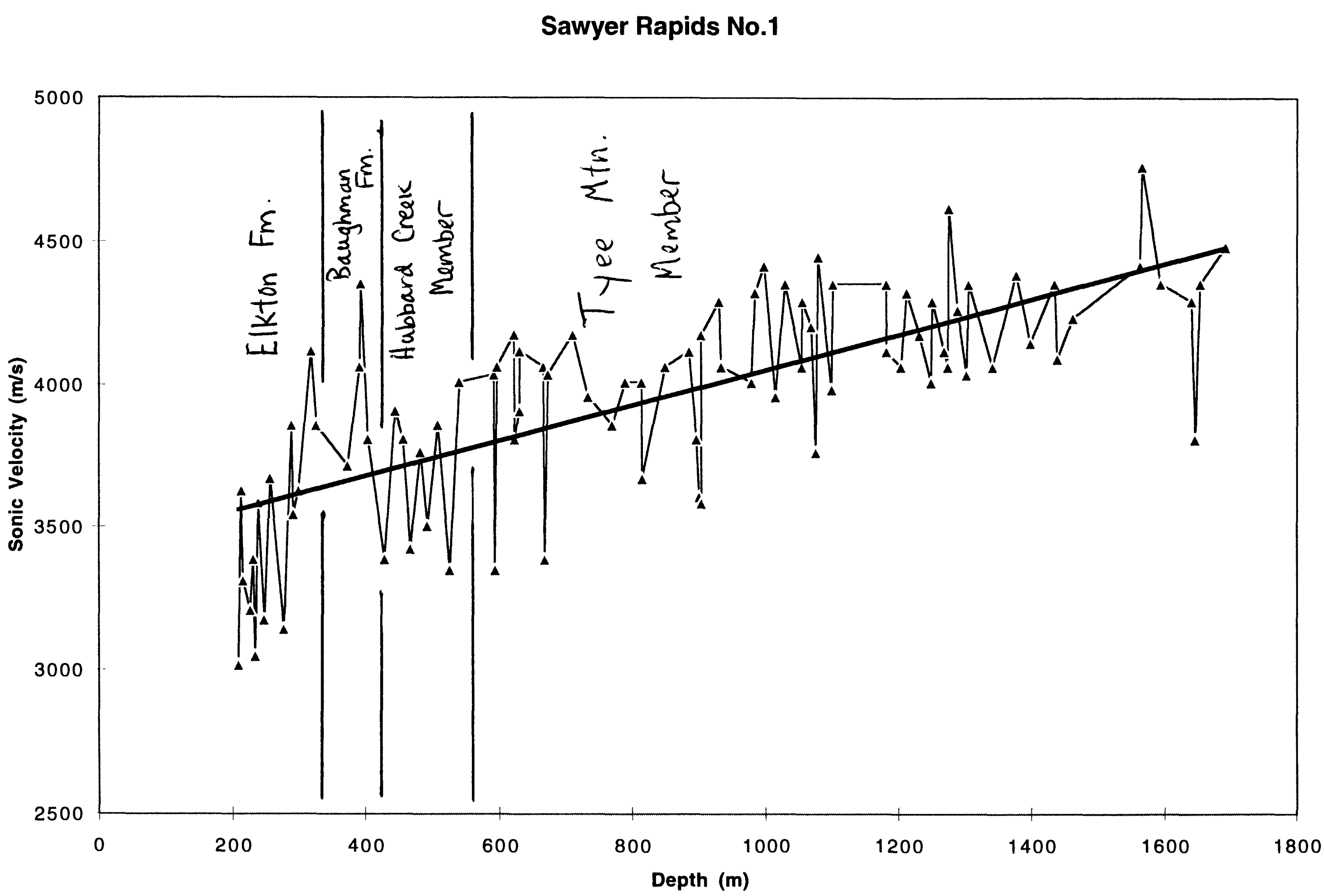
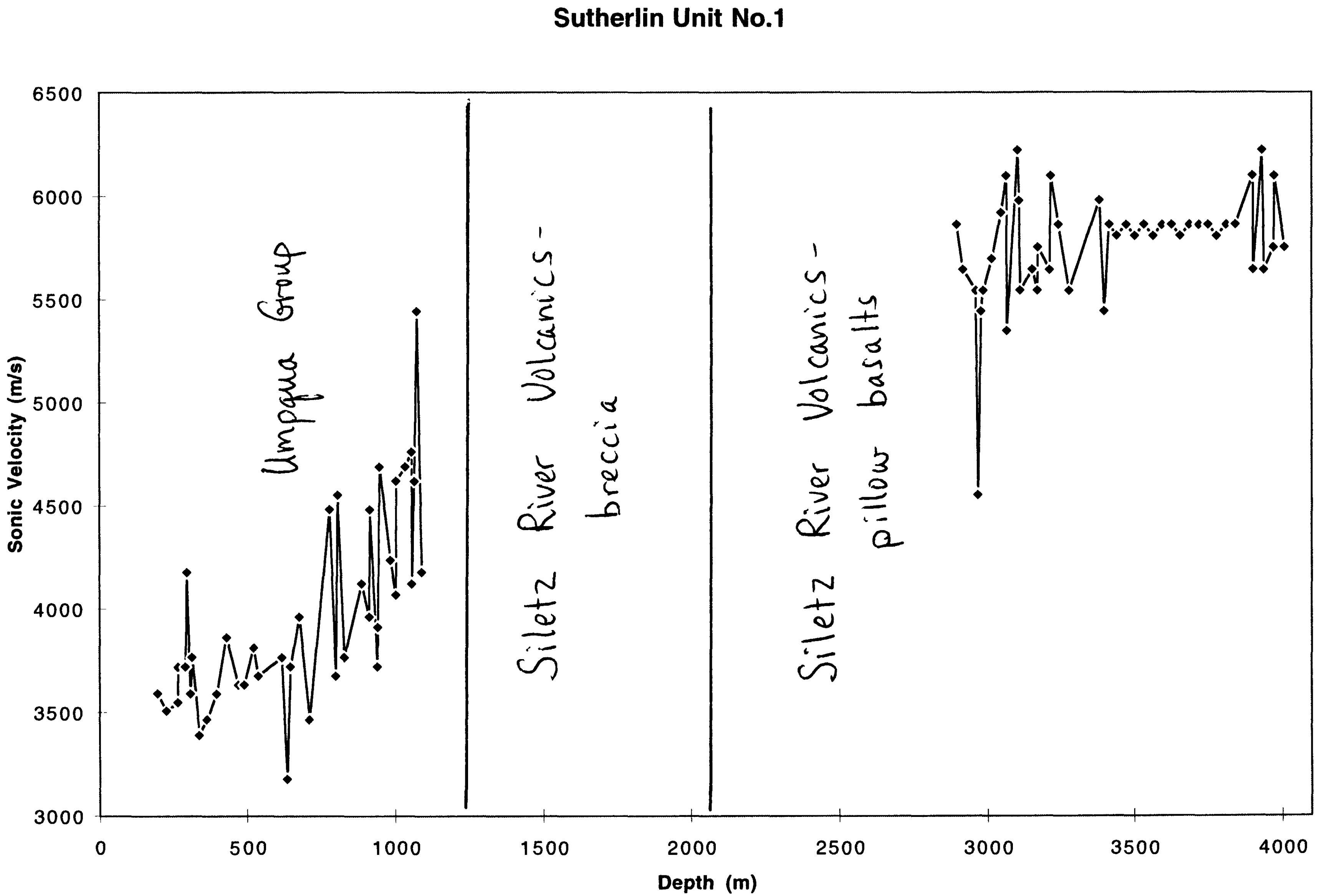


Fig. 6



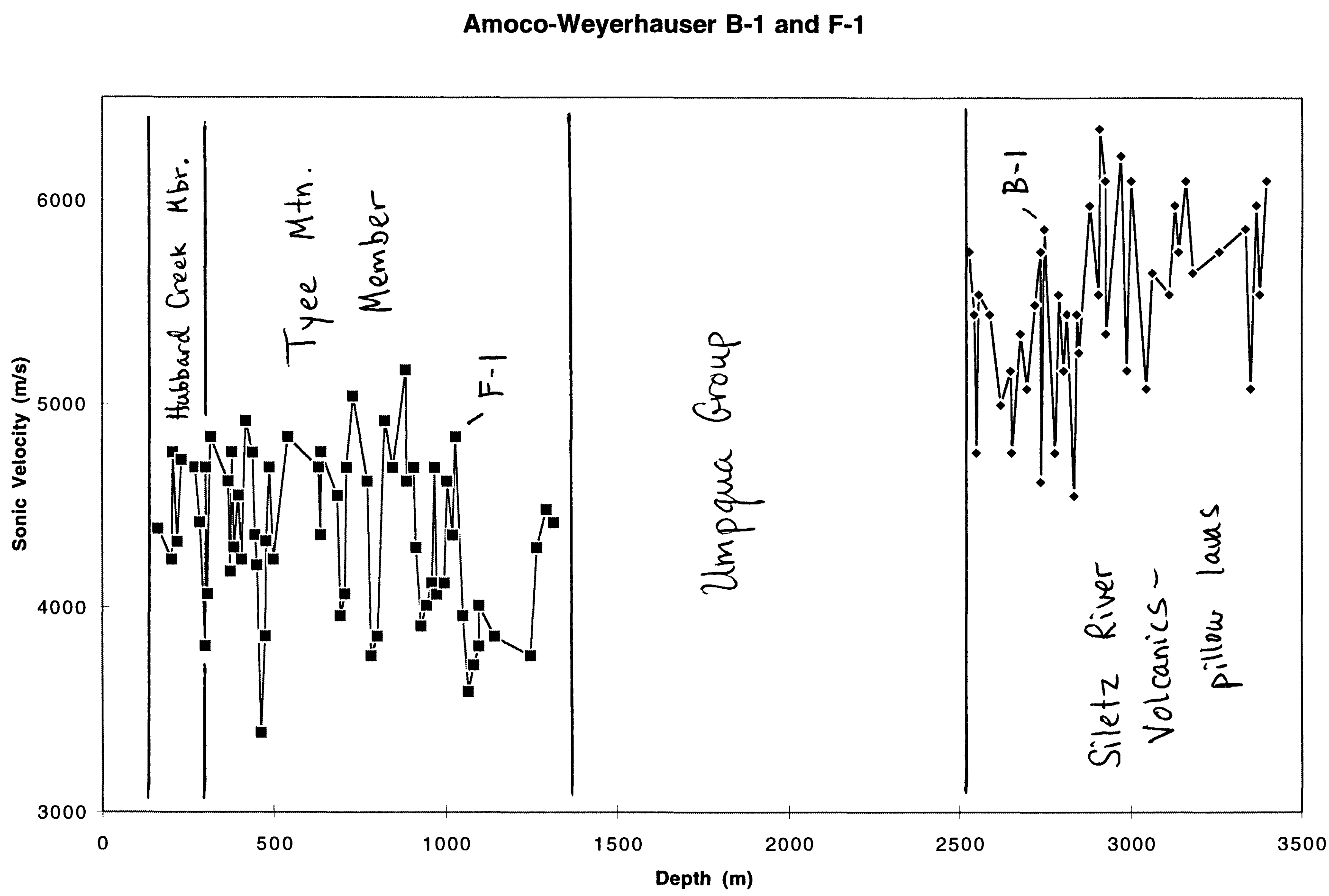
Sawyer Rapids No.1
Sonic Velocity (m/s)
5000
4500
4000
3500
3000
2500
Depth (m)
0
200
400
600
800
1000
1200
1400
1600
1800
Elkton Fm.
Baughman Fm.
Hubbard Creek Member
Tyee Mtn. Member

Figure 7.



Sutherlin Unit No.1
Sonic Velocity (m/s)
6500
6000
5500
5000
4500
4000
3500
3000
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
4000
Umpqua Group
Siletz River Volcanics -
breccia
Siletz River Volcanics -
pillow basalts

Figure 8.



Amoco-Weyerhauser B-1 and F-1
Sonic Velocity (m/s)
6000
5000
4000
3000
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
Hubbard Creek Mbr.
Tyee Mtn. Member
F-1
Umpqua Group
B-1
Siletz River Volcanics - pillow lavas

Figure 9.

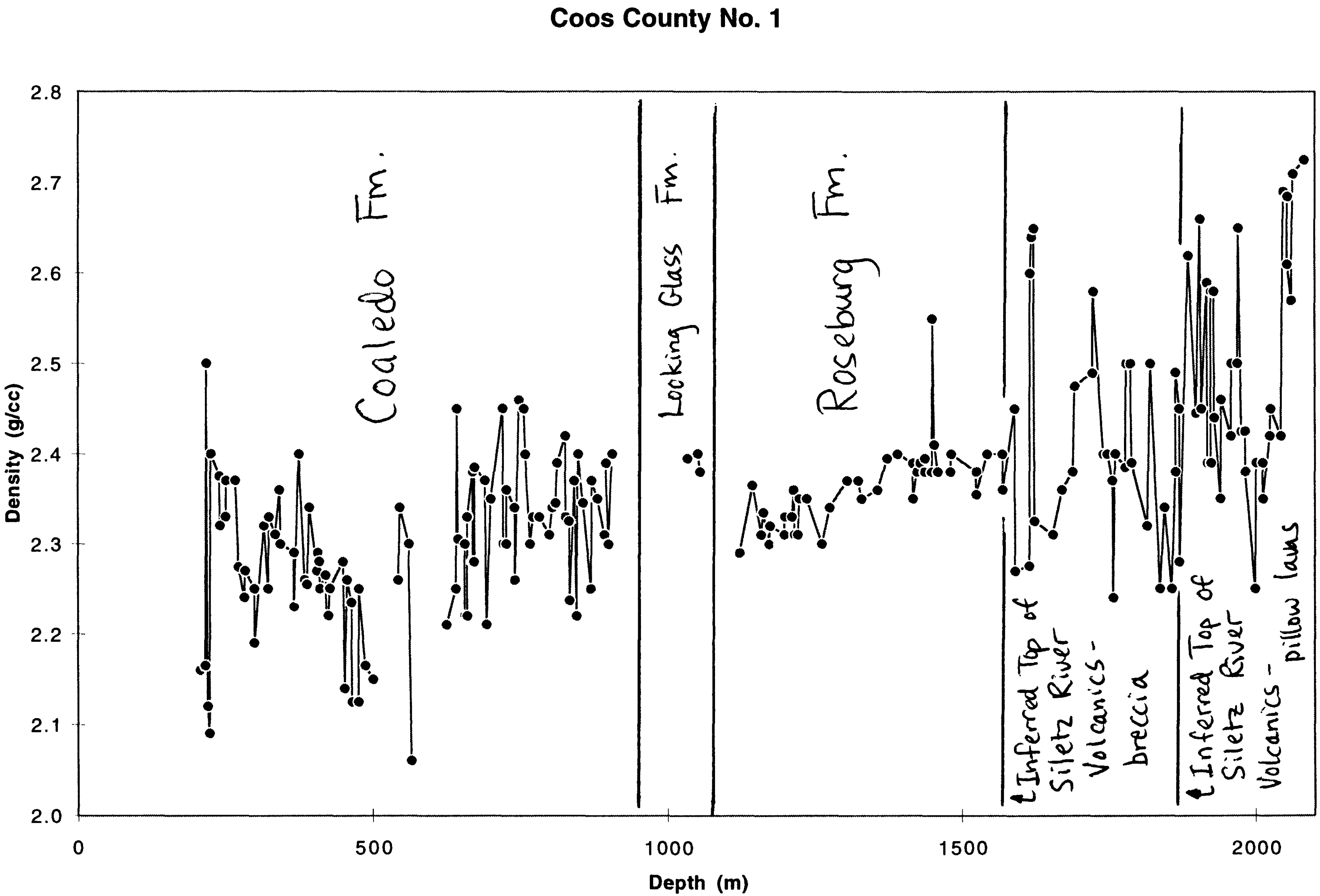

Coos County No. 1
Density (g/cc)
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
Depth (m)
0
500
1000
1500
2000
Coaledo Fm.
Looking Glass Fm.
Roseburg Fm.
Inferred Top of Siletz River Volcanics - breccia
Inferred Top of Siletz River Volcanics - pillow lavas

Figure 10.

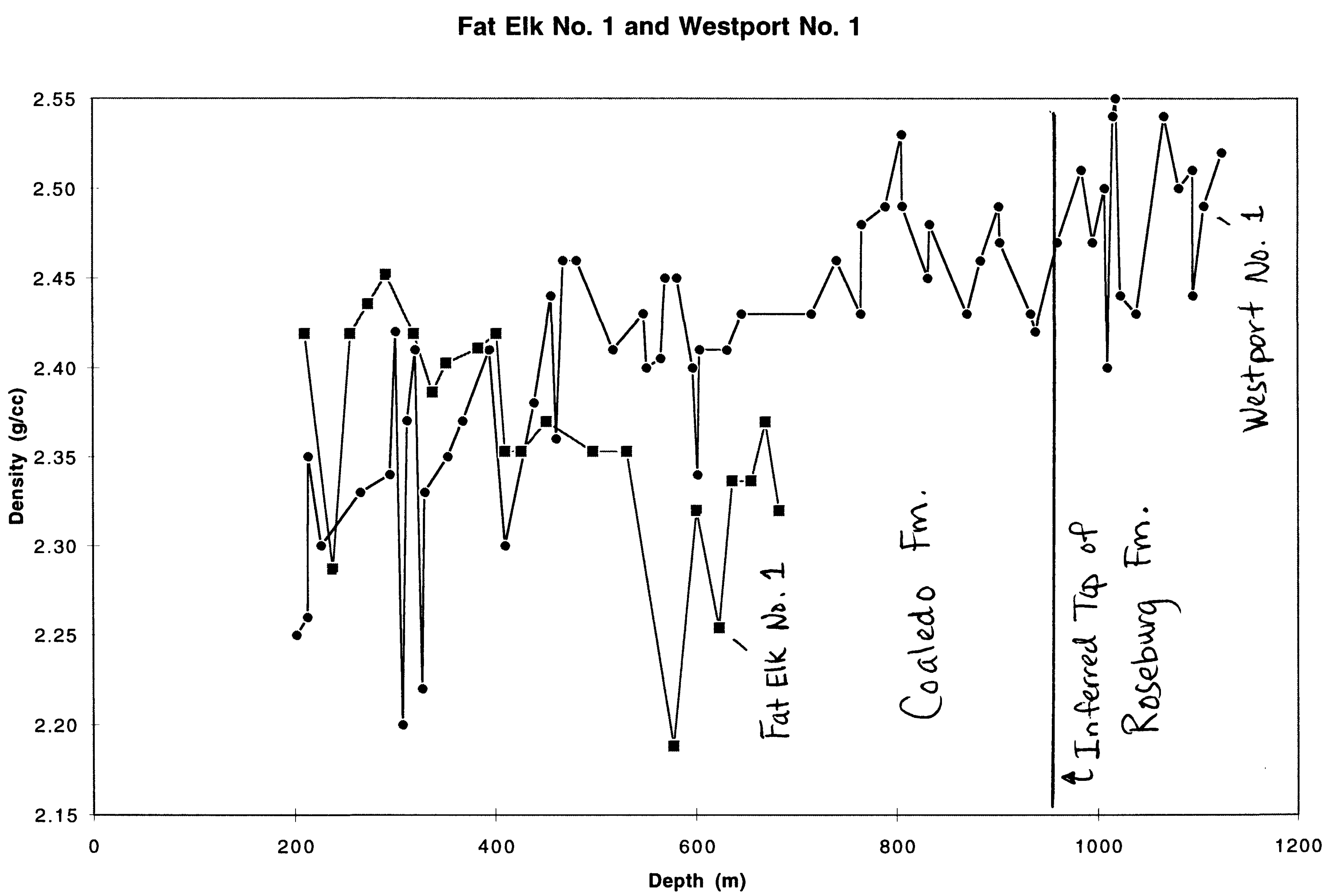

Fat Elk No. 1 and Westport No. 1
Density (g/cc)
2.55
2.50
2.45
2.40
2.35
2.30
2.25
2.20
2.15
Depth (m)
0
200
400
600
800
1000
1200
Fat Elk No. 1
Coaledo Fm.
Inferred Top of Roseburg Fm.
Westport No. 1

Figure 11.

Harris No. 1-4

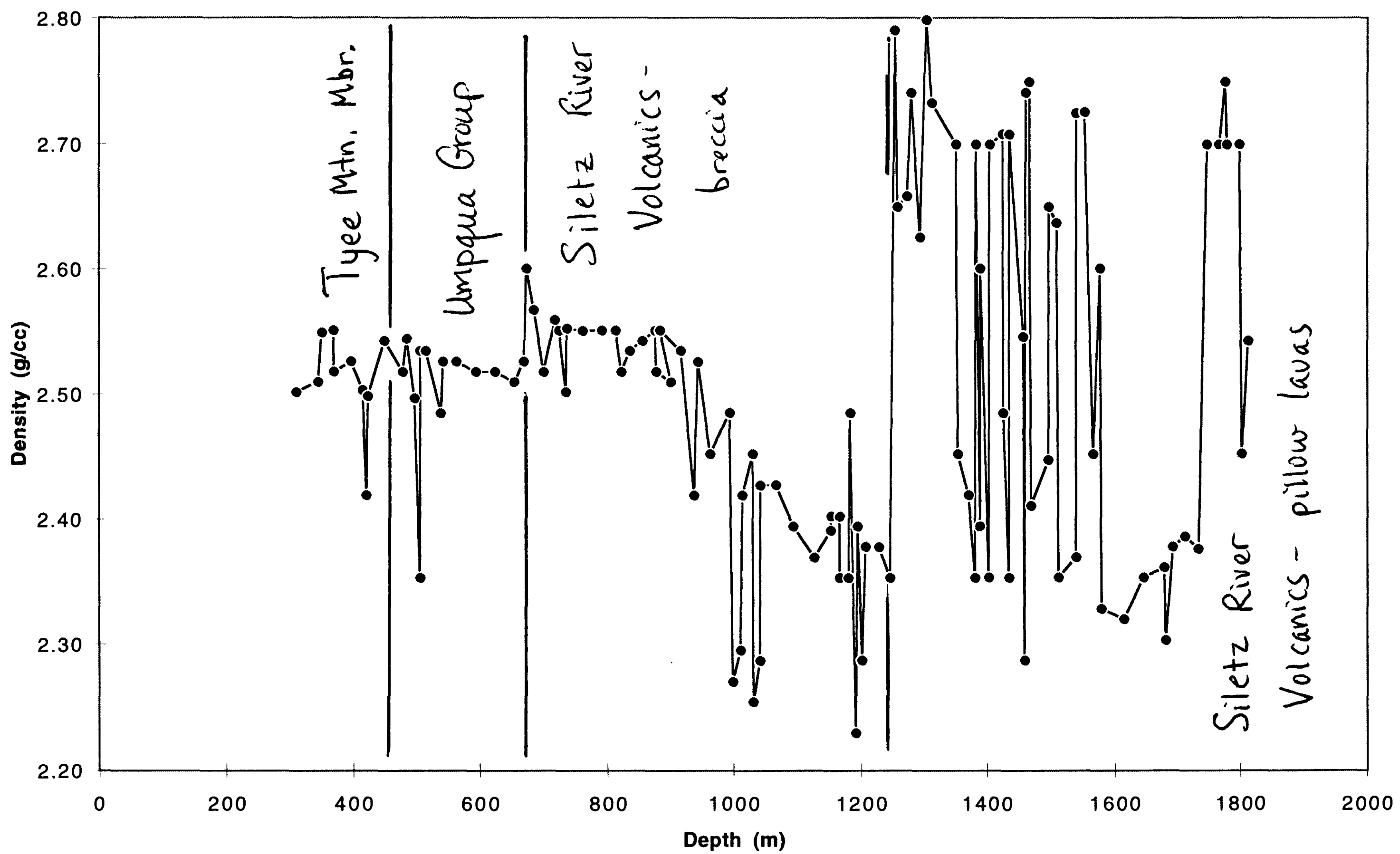


Figure 12.

P0122 Density

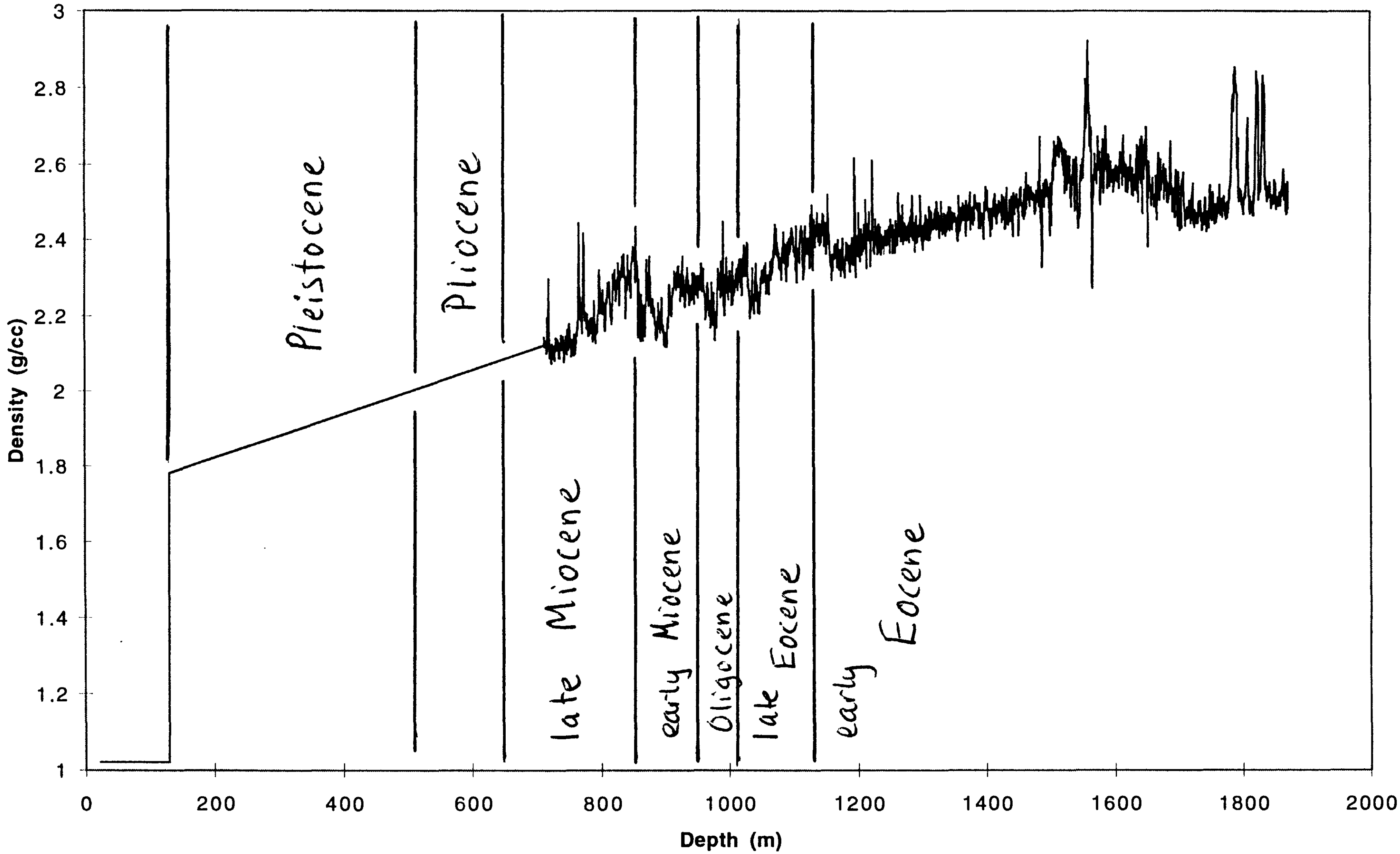


Fig. 13

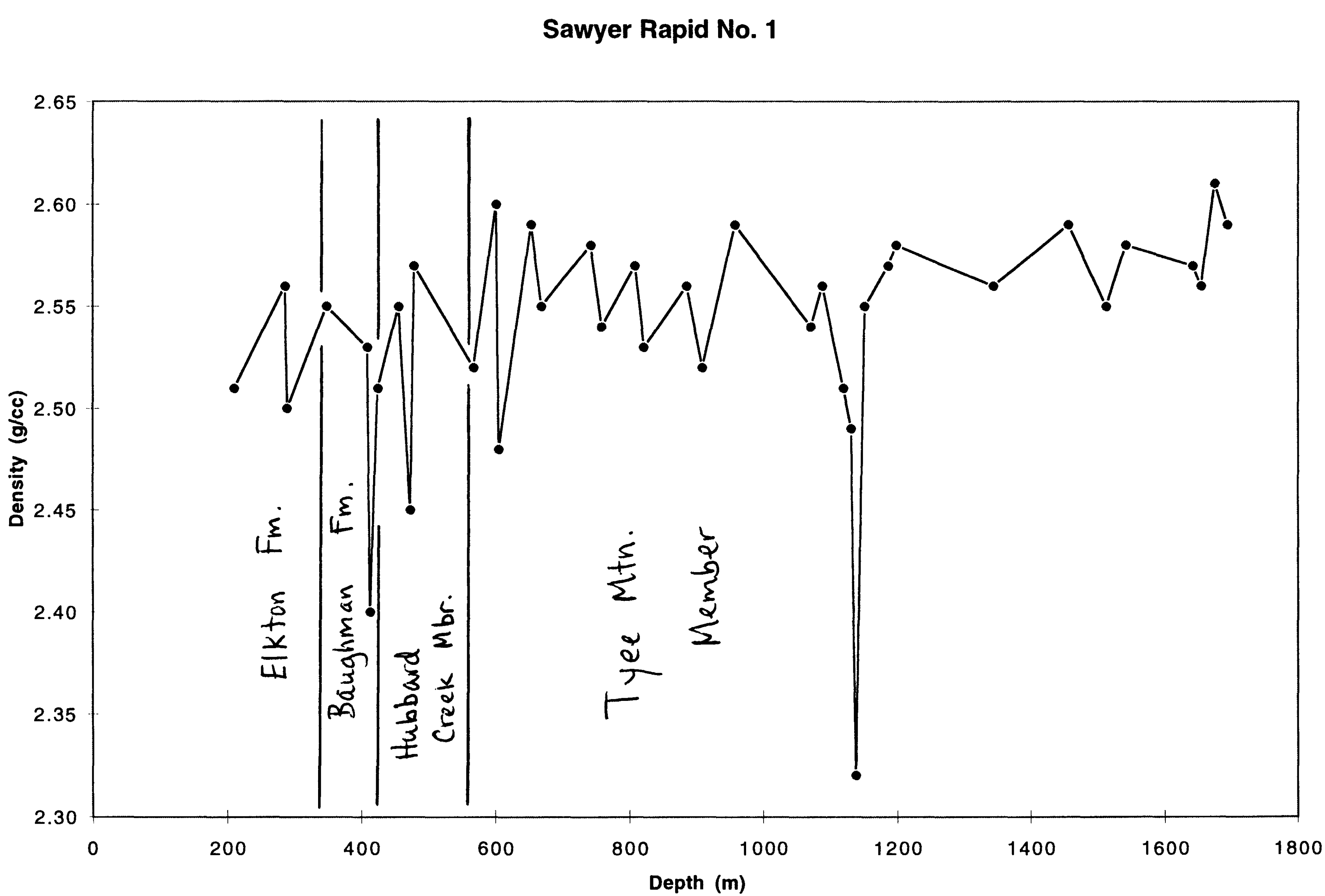

Sawyer Rapid No. 1
Density (g/cc)
2.65
2.60
2.55
2.50
2.45
2.40
2.35
2.30
0
200
400
600
800
1000
1200
1400
1600
1800
Depth (m)
Elkton Fm.
Baughman Fm.
Hubbard Creek Mbr.
Tyee Mtn. Member

Figure 14.

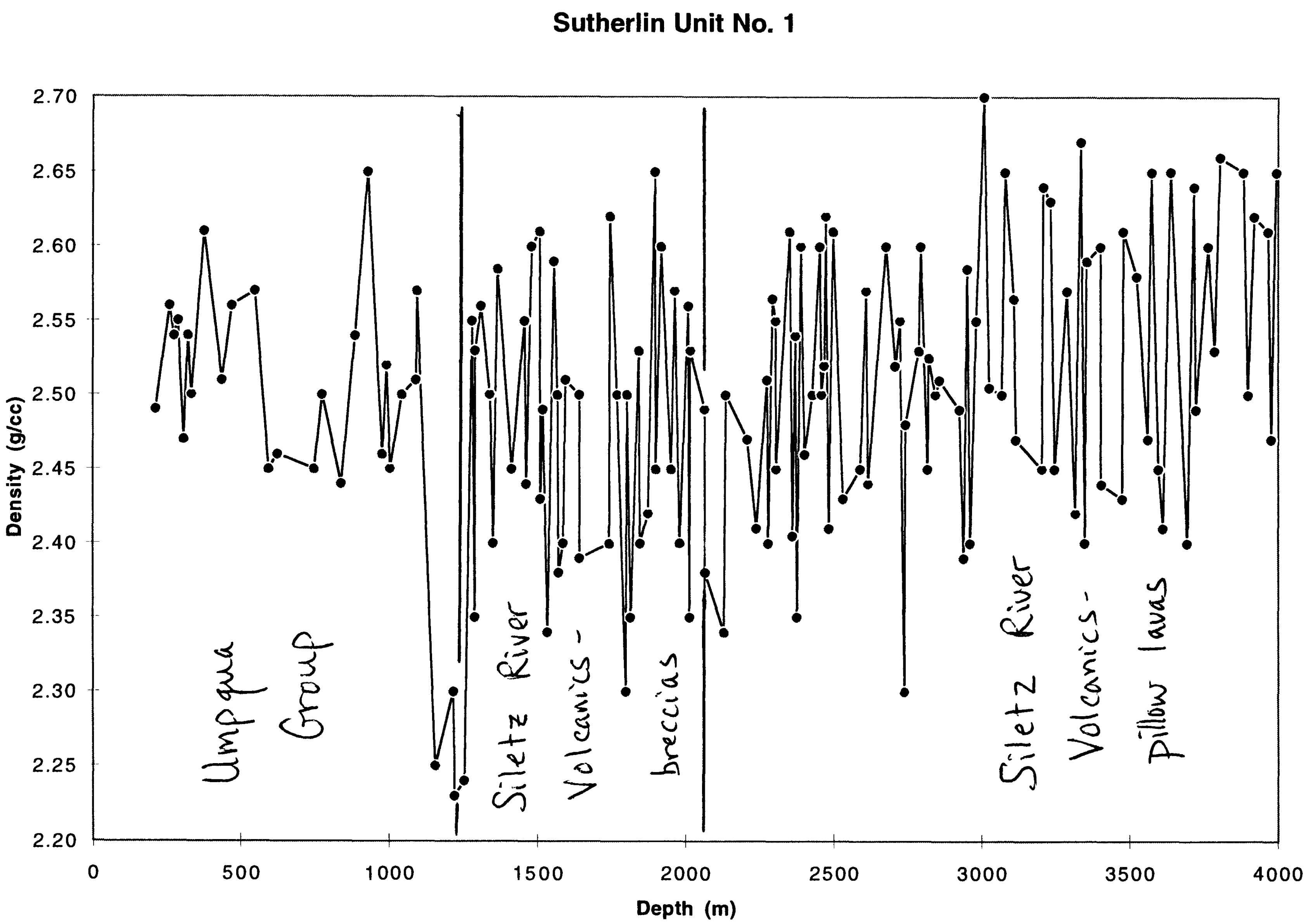

Sutherlin Unit No. 1
Density (g/cc)
2.70
2.65
2.60
2.55
2.50
2.45
2.40
2.35
2.30
2.25
2.20
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
4000
Umpqua Group
Siletz River Volcanics - breccias
Siletz River Volcanics - pillow lavas

Figure 15.

Amoco-Weyerhauser B-1 and F-1

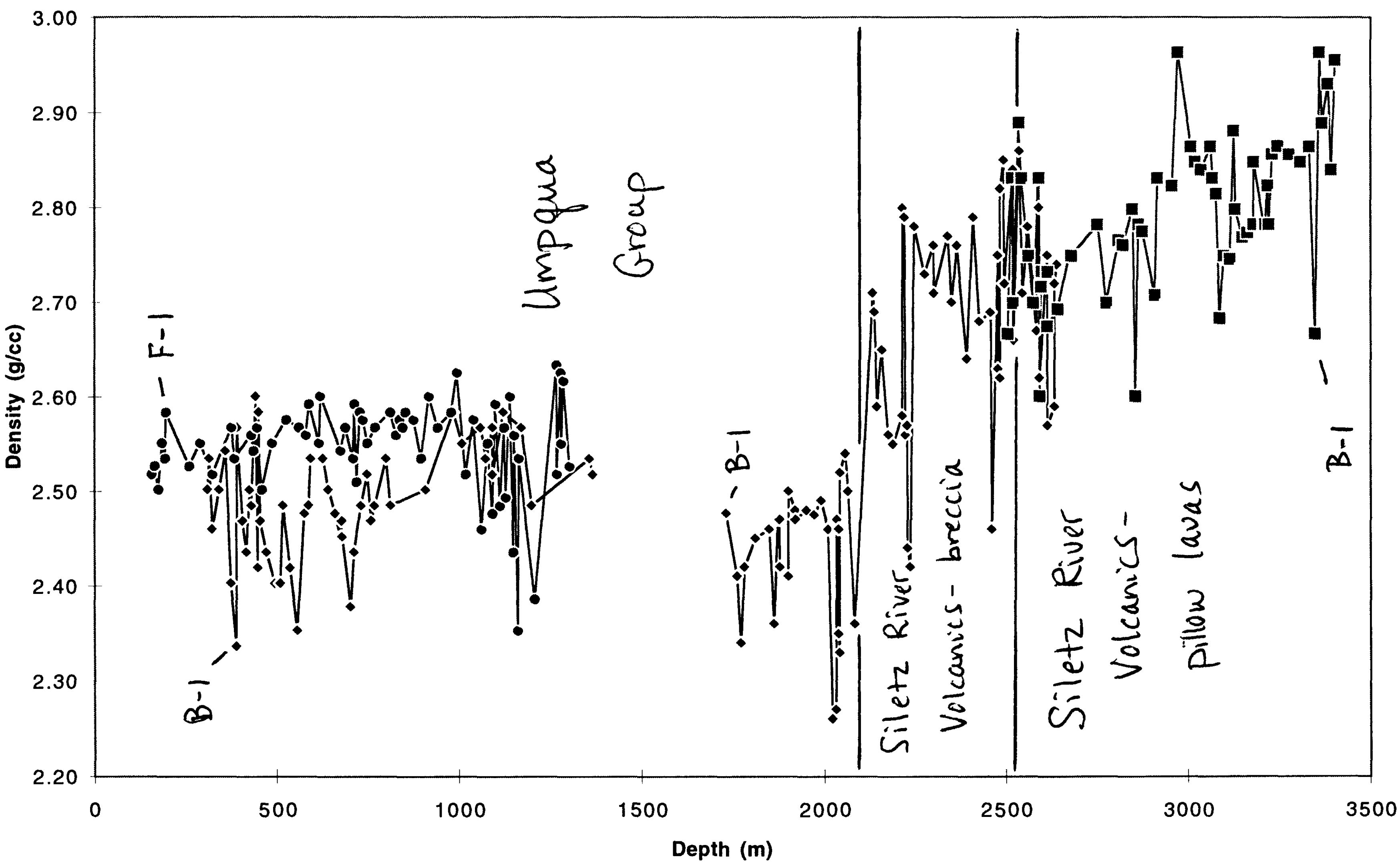


Figure 16.

Southwestern Oregon Velocity-Density Relations

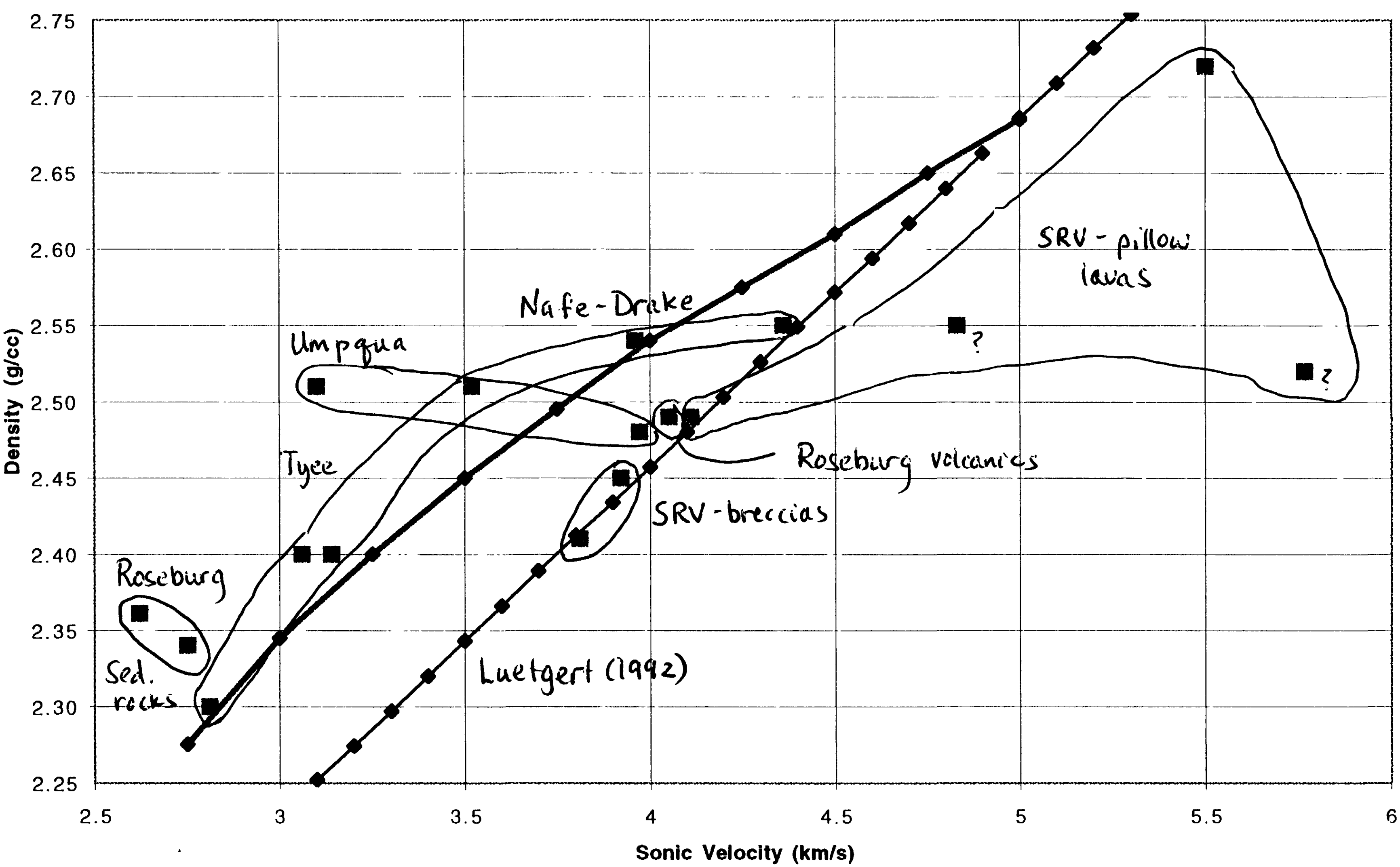


Fig. 17

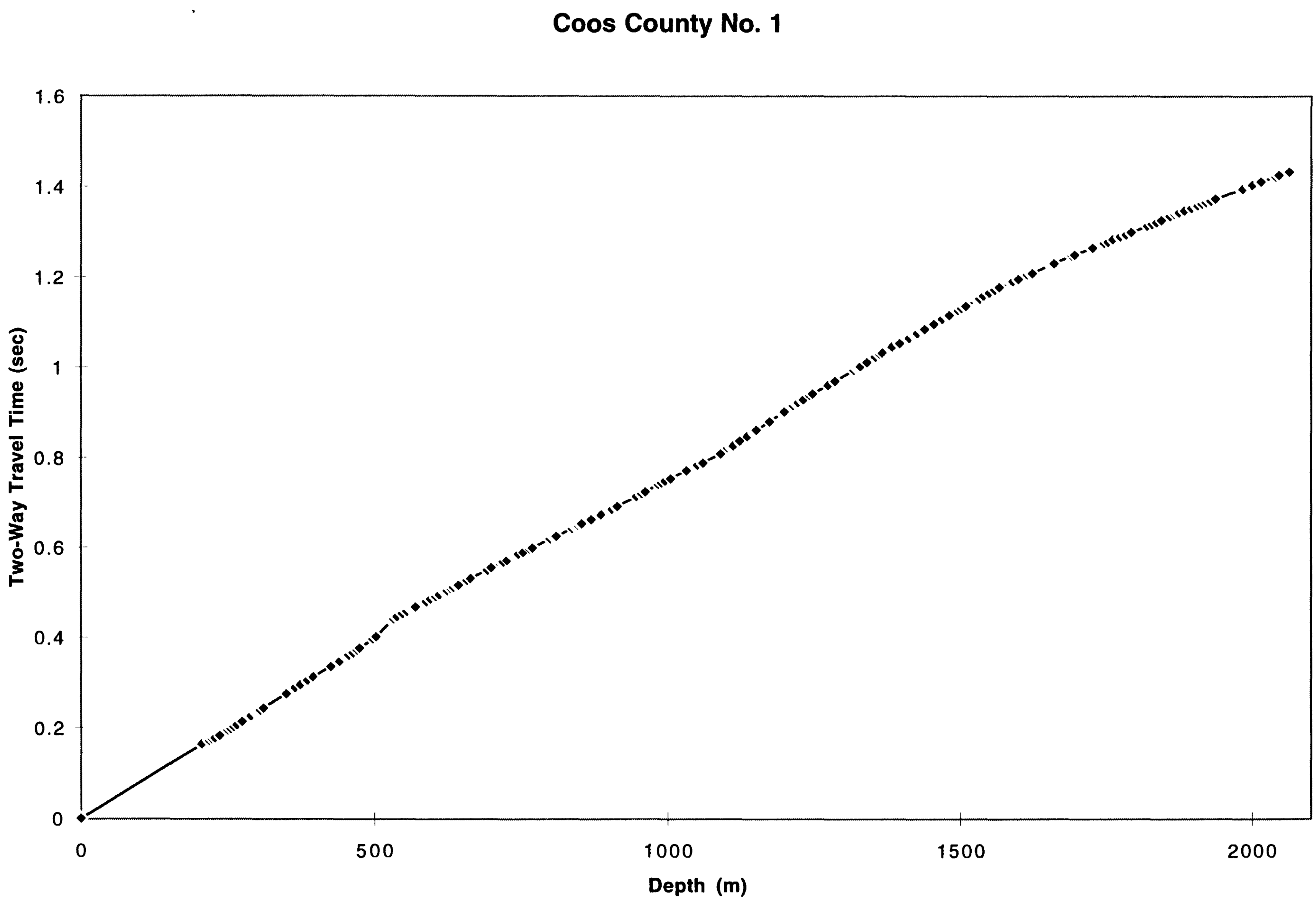

Coos County No. 1
Two-Way Travel Time (sec)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
Depth (m)

Figure 18.

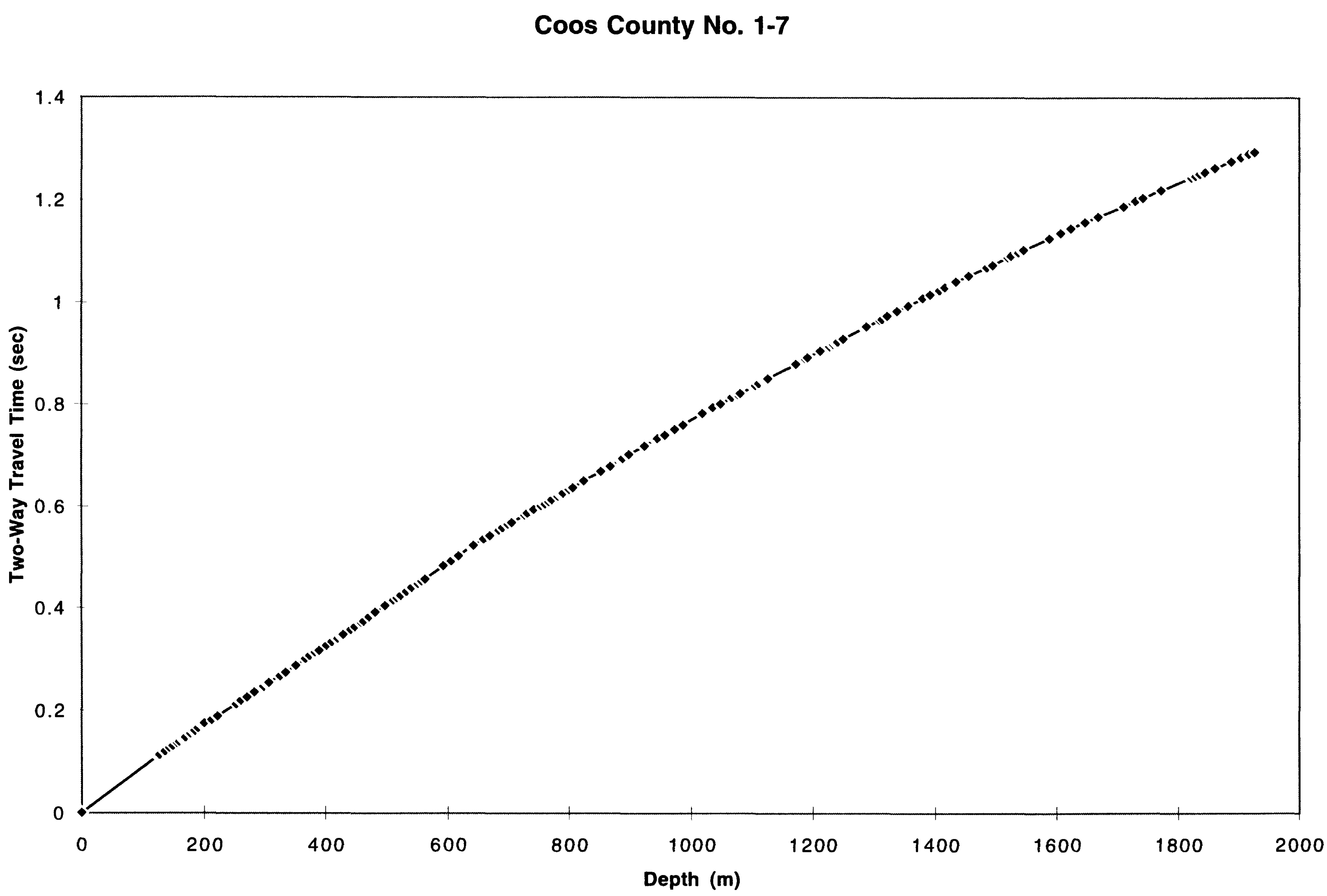

Coos County No. 1-7
Two-Way Travel Time (sec)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Depth (m)

Figure 19.

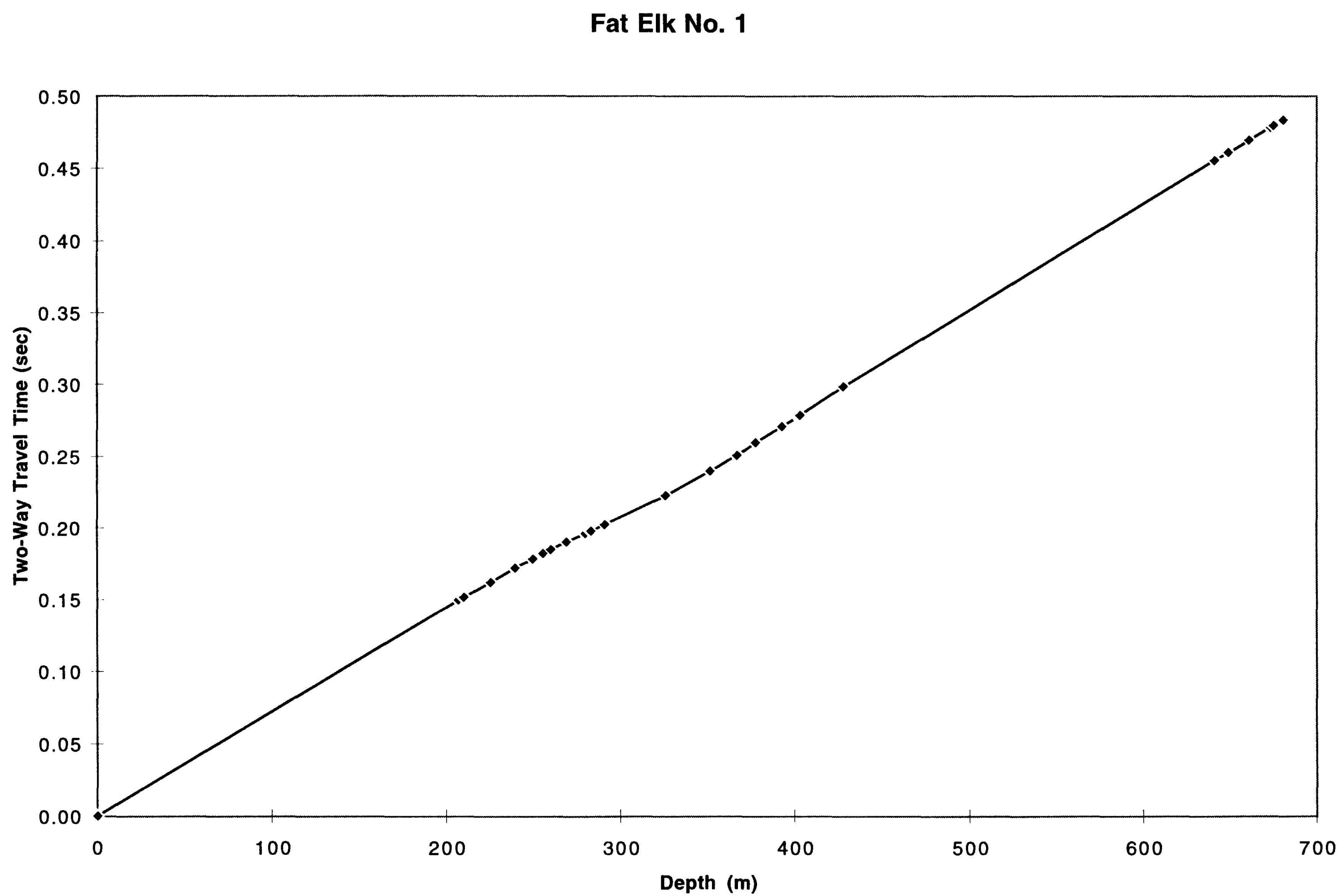

Fat Elk No. 1
Two-Way Travel Time (sec)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
100
200
300
400
500
600
700
Depth (m)

Figure 20.

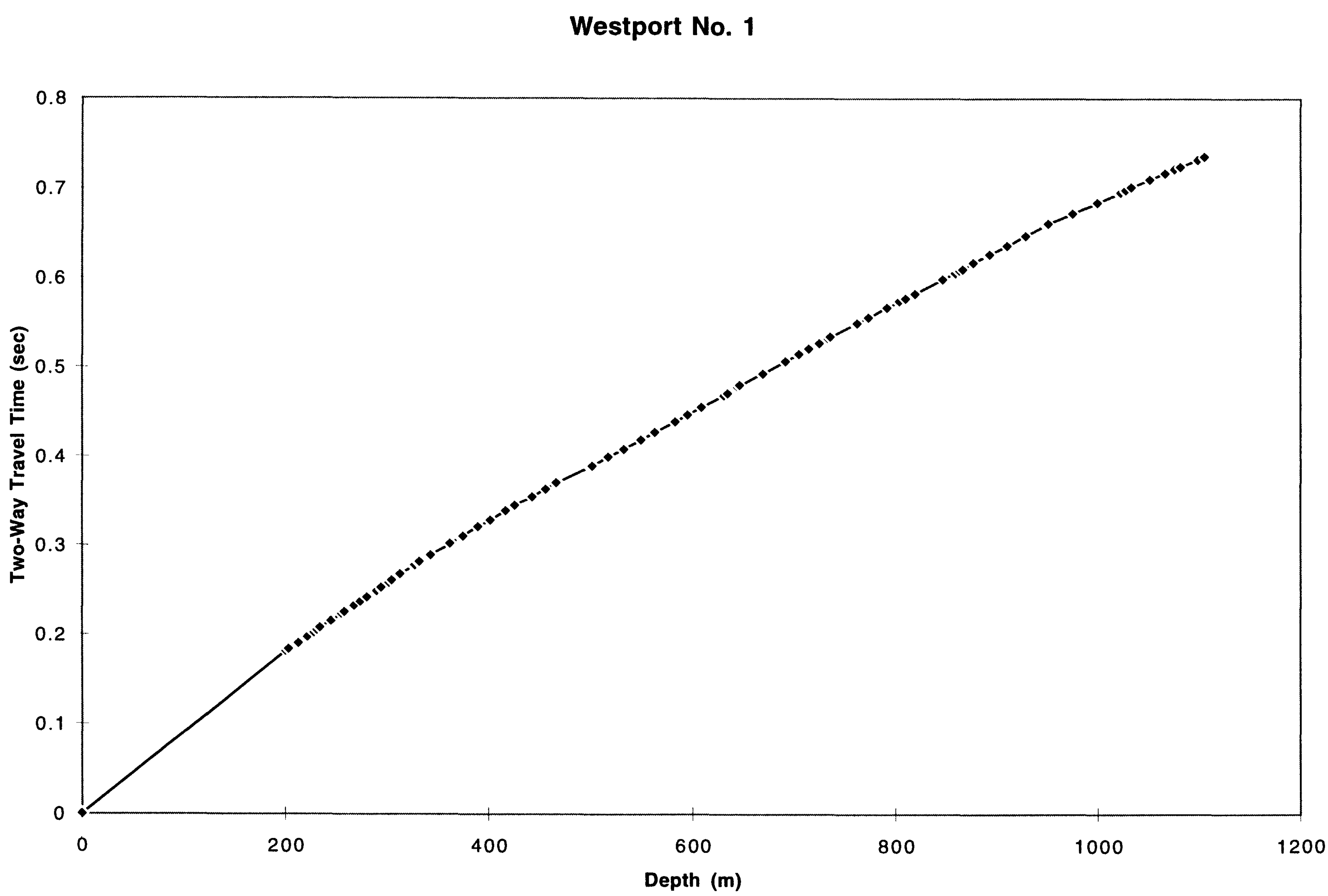

Westport No. 1
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Two-Way Travel Time (sec)
0
200
400
600
800
1000
1200
Depth (m)

Figure 21.

Harris No. 1-4

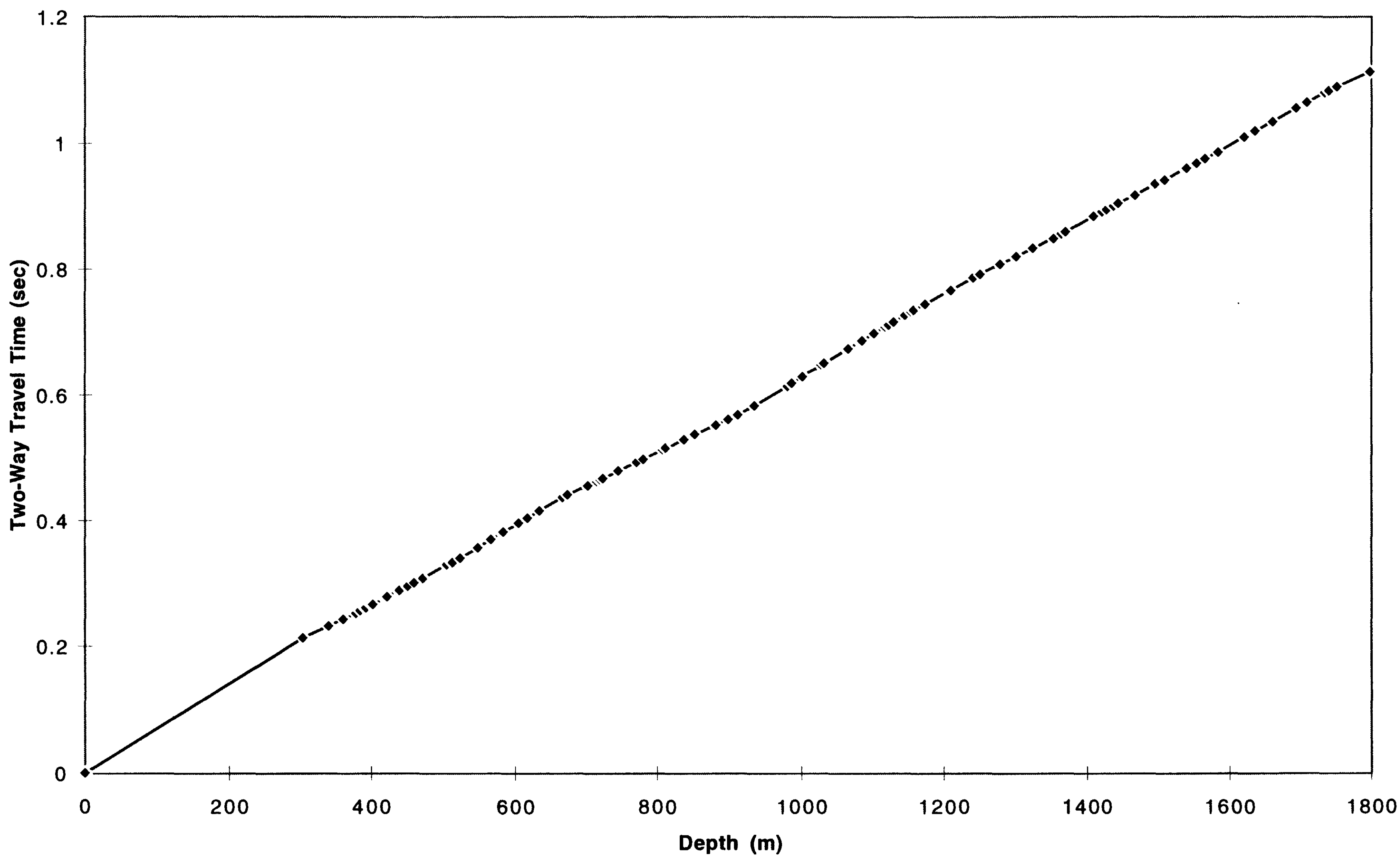


Figure 22.

OCS P-0112 No. 1

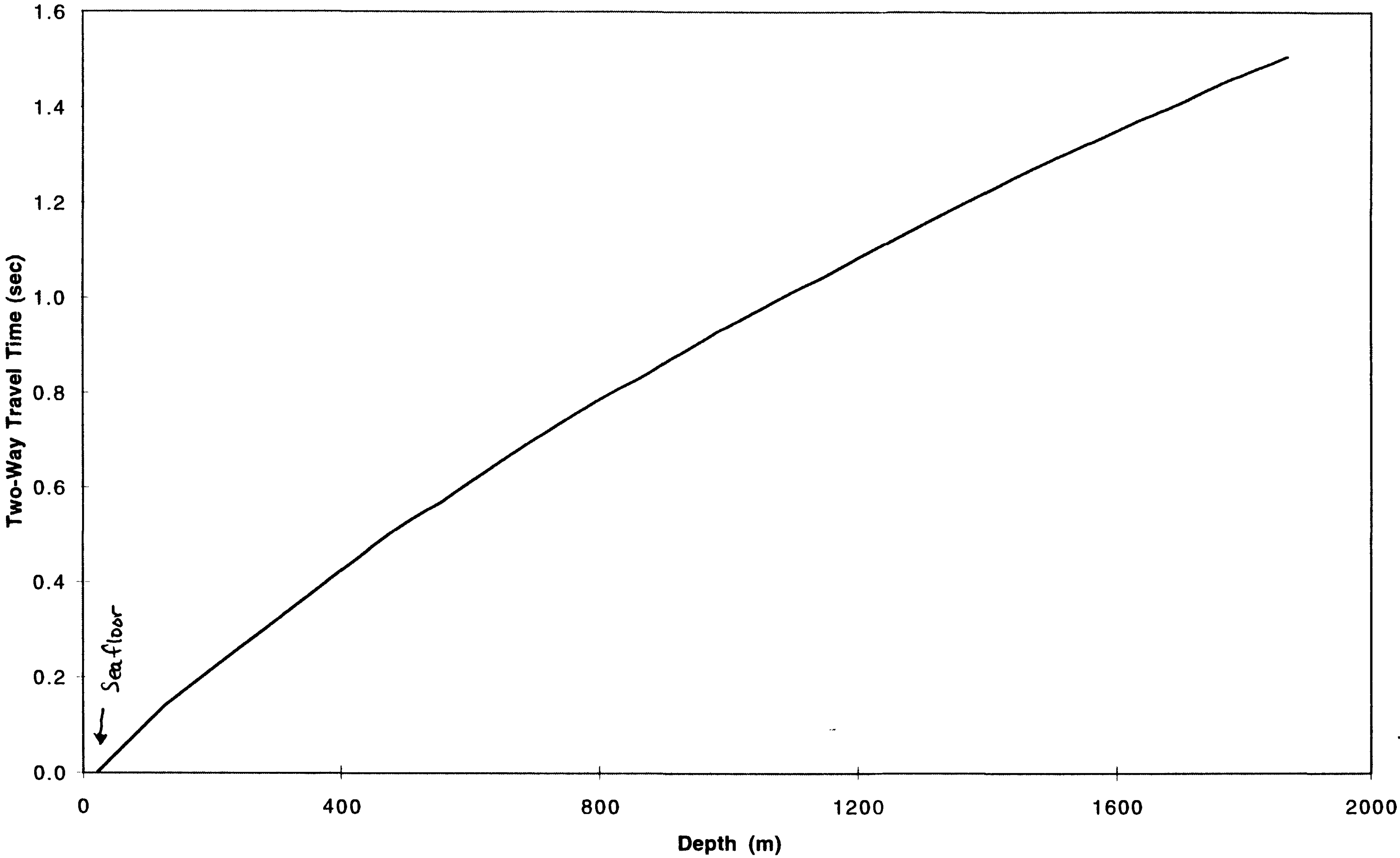


Fig. 23

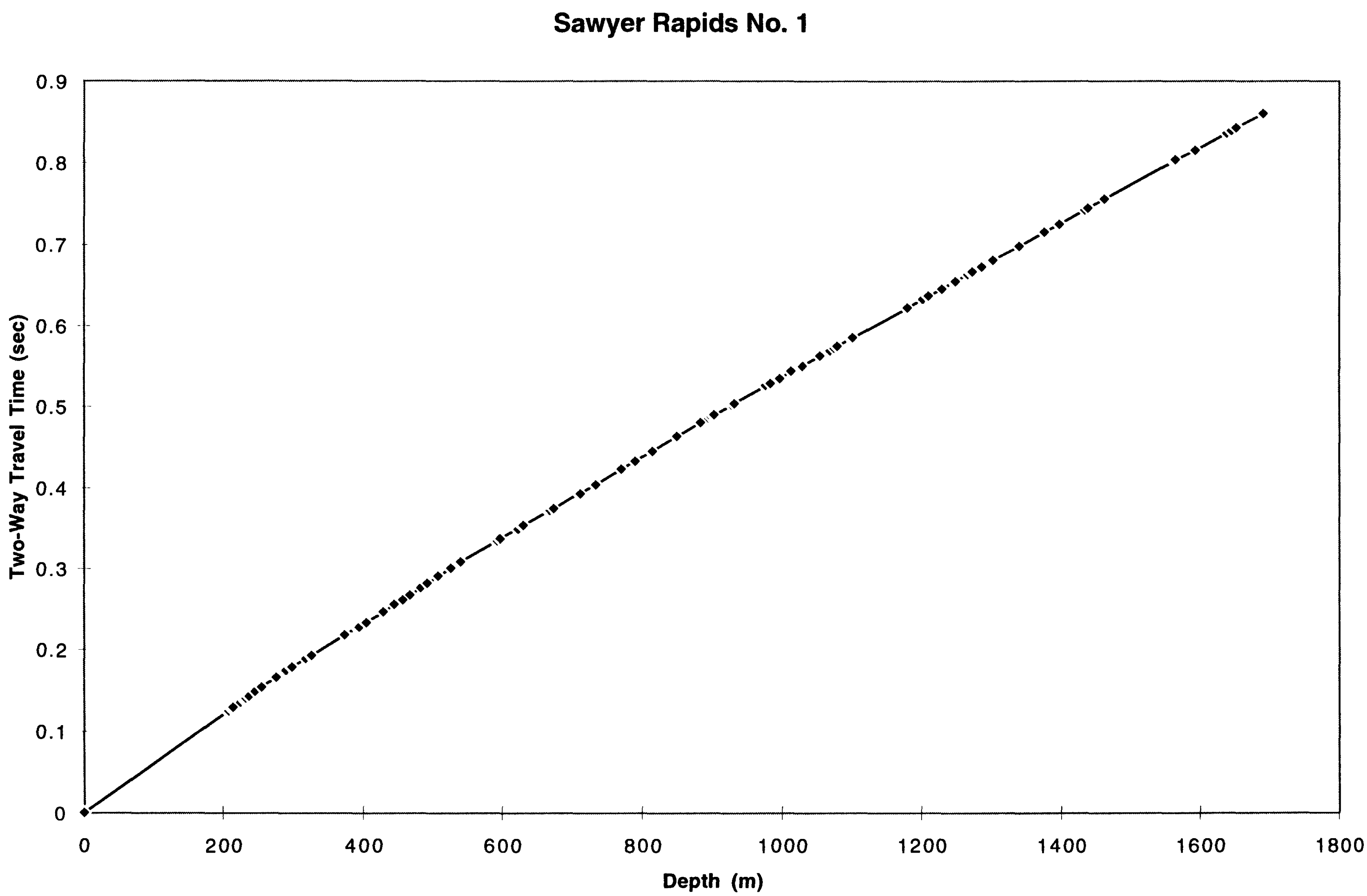

Sawyer Rapids No. 1
Two-Way Travel Time (sec)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (m)
0
200
400
600
800
1000
1200
1400
1600
1800

Figure 24.

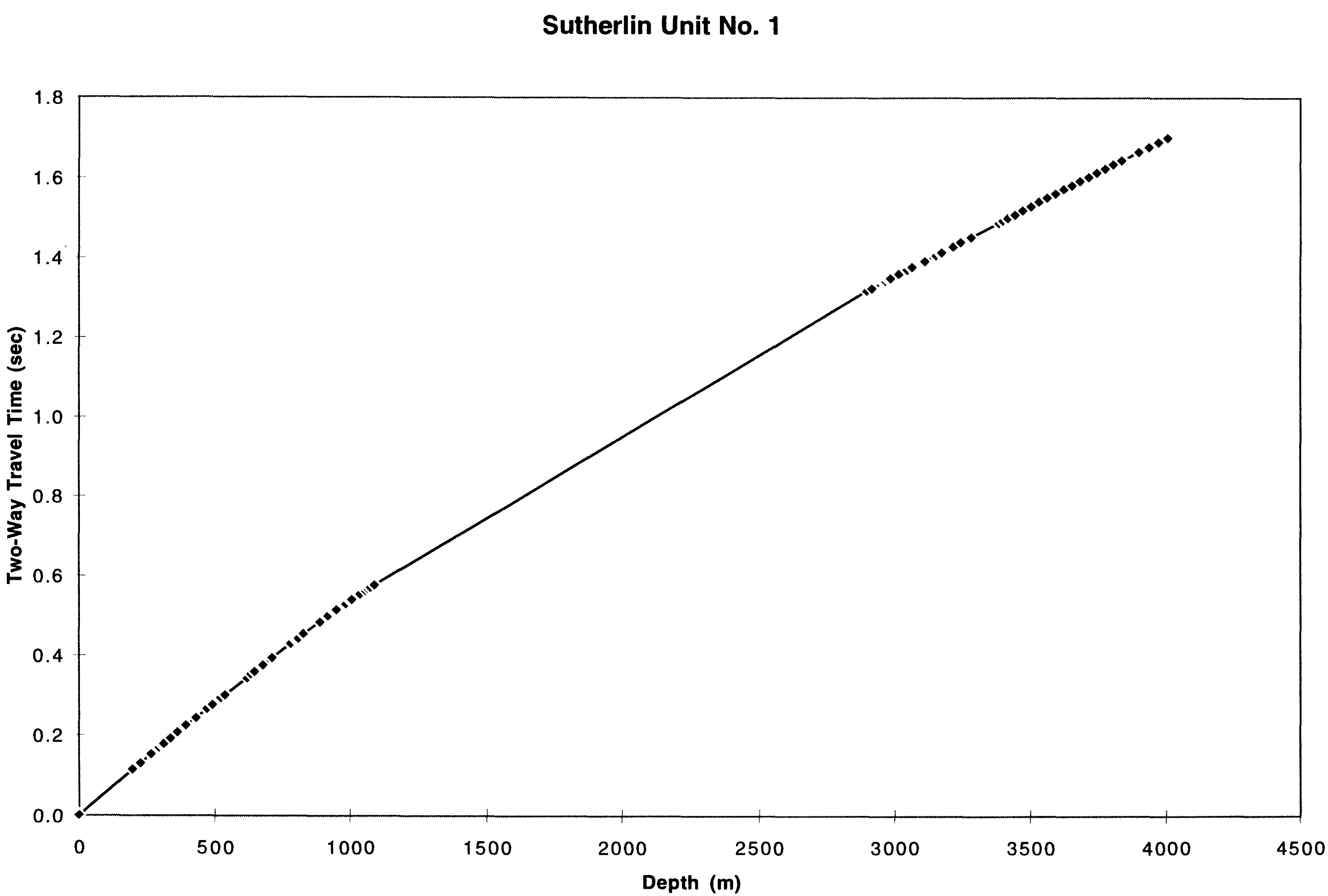

Sutherlin Unit No. 1
Two-Way Travel Time (sec)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Depth (m)

Figure 25.

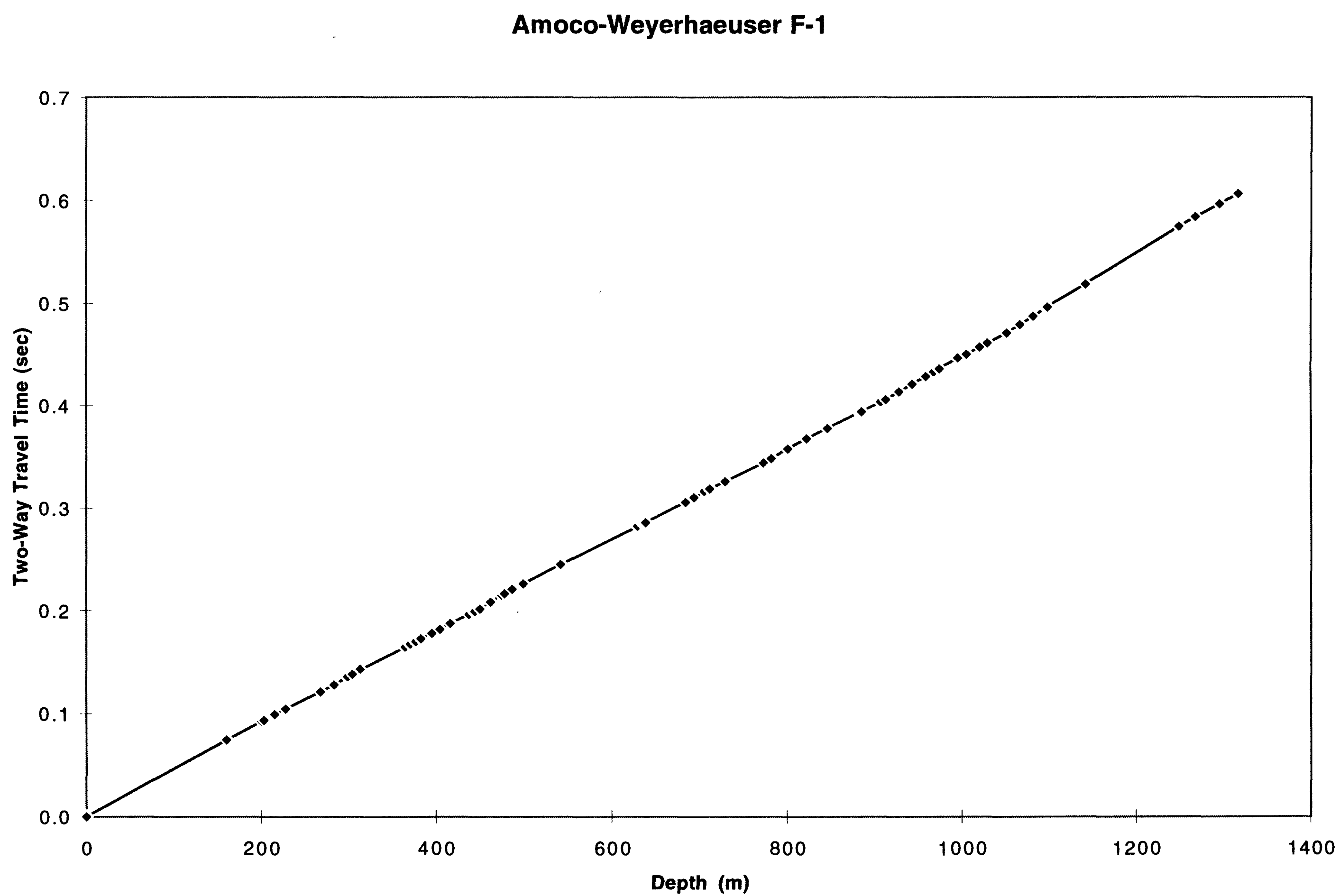

Amoco-Weyerhaeuser F-1
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Two-Way Travel Time (sec)
0
200
400
600
800
1000
1200
1400
Depth (m)

Figure 26.