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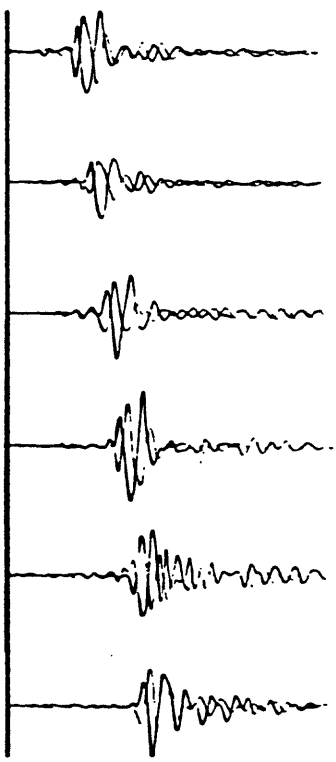
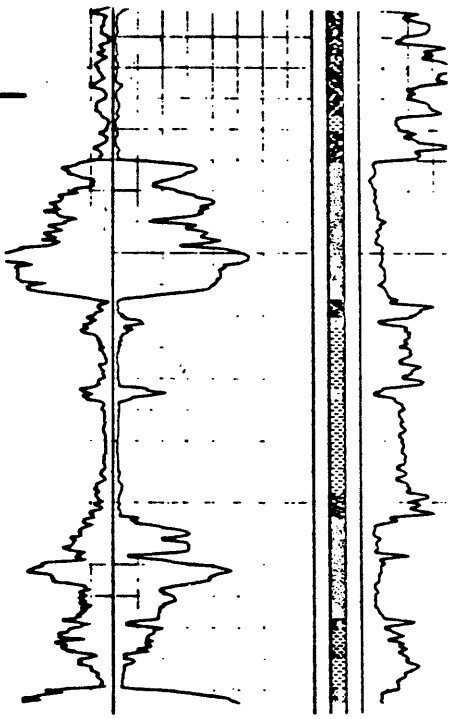
GEOLOGICAL SURVEY

GEOTECHNICAL INVESTIGATIONS AT STRONG-MOTION STATIONS IN THE IMPERIAL VALLEY, CALIFORNIA

Ronald L. Porcella

Open-File Report 84-562





Menlo Park, California

August 1984

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

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1984

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PREFACE

In the early 1970's the U.S. Geological Survey (USGS) began a program accumulating geotechnical and seismic data to be used in developing methods for estimating specific ground-response characteristics during strong local earthquakes. Recent site studies in the Los Angeles and San Francisco Bay regions indicate significant correlations exist between shear-wave velocity and various physical properties of the near-surface materials; these studies further suggest that these correlations can be used to define seismically-distinct map units. The selection of specific locations for investigation has been based on sites where ground-motion data were recorded during earthquakes (and nuclear explosions), the availability of detailed geologic maps, and the distribution of intensity data from selected earthquakes.

This study involved investigations at most of the Imperial Valley, California accelerograph stations, and was done because of the unique strong-motion data set recorded during the magnitude 6.5 earthquake of October 15, 1979. The project included the following investigations: (1) electronic cone-penetrometer soundings at nine stations; (2) drilling, sampling, and logging of 22 borings to depths of from about 30 to 244 m; (3) downhole P- and S-wave velocity surveys at 22 stations; (4) high-amplitude resonant column tests of undisturbed samples from several stations; and (5) numerous gamma, S-P, and resistivity logs and caliper and temperature measurements at selected stations. This study is just one part of an ongoing USGS program to compile geotechnical data at selected locations in various regions and to use these data to make detailed comparisons of the geologic and seismic characteristics that will provide a means for quantitatively estimating strong ground motion at a given site and facilitate the development of seismic zonation techniques applicable to other regions.

This report will focus on results of the electronic cone-penetration tests and, in particular, the downhole velocity surveys. Results of other investigations undertaken as part of this project will be discussed briefly and a reference regarding the availability of additional information or a report will be given.

INTRODUCTION

Geology And Seismicity

The Imperial Valley of California occupies the northcentral region of the Gulf of California structural province. This valley is part of a broad, deep, and structurally complex trough filled with Cenozoic deposits consisting of deltaic sediments of the nearby Colorado River and fan and alluvial materials transported from the surrounding mountain ranges, the Chocolate Mountains to the east and the Santa Rosa, Vallecito, and Coyote Mountains of the Peninsular Ranges to the west (Dibblee, 1954). Although fault-associated uplift has occurred along the borders of this linear trough, geophysical investigations and the geology of the bordering mountains indicate that this depression is not a simple graben structure (Biehler and others, 1964; Sharp, 1972). The entire northwest-trending province is characterized by a trend parallel to that of the San Andreas fault. While some conflict in this pattern exists in the northern end of the province, in the central part of the Imperial Valley there is a notable linearity and parallelism in the southernmost faults of the San Jacinto zone, which include the Superstition Mountains, Superstition Hills, and Imperial faults. These faults are generally vertical, are in some places marked by southwest-facing scarps, and usually display right-lateral offset.

Recent seismic refraction surveys by the U.S. Geological Survey indicate that the thickness of the sedimentary section along the axis of the trough varies from about 3.7 km at the Salton Sea to about 4.8 km at the U.S.-Mexico border (Fuis and others, 1982). P-wave velocity in this material ranges from about 1.5 km/s at the surface to about 5 km/s at the base of the section.

The uppermost crust in this area, into which the Imperial fault rupture extended in 1940, 1966, and 1979, is a thin layer of alluvial and lacustrine clay and sand deposits about 0.2-km thick. The P-wave velocity below the water table in this zone ranges from about 1.4 to at least 1.7 km/s; the S-wave velocity ranges from about 0.15 to at least 0.45 km/s (see section "downhole seismic data").

In recent years, the Imperial Valley of California has been one of the seismically most active regions in the United States. Considering even the scarcity of records from the early part of this century, no less than 13 earthquakes of intensity VIII or above have been attributed to the Imperial Valley region between 1906 and 1934 (Ulrich, 1941). Both theoretical and empirical investigations by Richter (1958) suggest that the type and complexity of earthquake sequences (mainshock/aftershock versus swarm-type acitivty) are most closely related to the tectonic complexity of the region. Tectonic studies of the Imperial Valley region by Sharp (1972), Henyey and Bischoff (1973), and Johnson and Hadley (1976) are in good agreement with Richter's (1958) suggestions, and emphasize the difficulty inherent in attempts at making definitive hazard evaluations for the Imperial Valley region. Nonetheless, empirical studies that define recurrence intervals for earthquakes in various magnitude ranges and for specific geologic regimes are quite common. Hileman and others (1973) used 786 earthquakes greater than magnitude 3.5 (between 1932 and 1971) as a data set to compute recurrence intervals for the Imperial Valley region of eight months for a magnitude 5-5.5 event and 6.7 years for a magnitude 6-6.5 event.

Through 1978 more than 250 accelerograms were recorded in the Imperial Valley since the first strong-motion instrument was installed at El Centro in 1932 (see table 1). A "projected history" of possible strong-motion recording

in the United States by Matthiesen (1978) suggested that a significant concentration of seismic activity throughout the second half (1920-1970) of the study period would have provided a fairly consistent rate of strong-motion recording in the Imperial Valley; he recommended that further development of the existing strong-motion network in that region was warranted and should proceed. Although no truly great (magnitude 8 or above) earthquakes have ever been reported in the Imperial Valley region, in terms of minor to moderate earthquakes the seismic activity has continued relatively uninterrupted throughout this century.

Table 1. - Selected accelerograms from the USGS Imperial Valley strong-motion network (from Porcella and Matthiesen, 1979a)

Event No.	Date	Time (PST)	Magnitude	Peak accl. (g)	Epicentral dist. (km)	Data report reference*
4	12/30/34	0552	6.5	0.18	64	B024
10	04/12/38	0825	3.0	.04	11	T274
11	06/05/38	1842	5.0	.04	34	T275
12	06/06/38	0435	4.0	.01	69	T276
14	05/18/40	2037	6.6	.31	09	A001,T277-T285
19	10/21/42	0822	6.5	.06	46	T286
22	01/23/51	2317	5.6	.03	30	T287
28	06/13/53	2017	5.5	.04	12	T288
31	11/12/54	0427	6.3	.02	160	T289
--	06/13/55	2347	3.8	.06	20	**
34	12/16/55	2117	4.3	.03	24	T290
35	12/16/55	2142	3.9	.01	24	T291
36	12/16/55	2207	5.4	.08	24	T292
37	02/09/56	0633	6.8	.05	120	A011
38	02/09/56	0725	6.4	.01	125	A012
51	08/07/66	0936	6.3	.01	147	T293
55	04/08/68	1829	6.5	.12	69	A019
--	04/28/69	1521	5.9	.02	272	**
--	09/30/71	1446	5.1	.03	48	**
--	12/06/74	1413	4.8	.16	16	**
--	01/23/75	0902	4.7	.13	11	**

Table 1. continued

Event No.	Date	Time (PST)	Magnitude	Peak accl. (g)	Epicentral dist. (km)	Data report reference*
--	06/19/75	2148	4.2	.10	10	**
--	06/20/75	1415	4.1	.15	06	**
--	04/14/76	0231	3.9	.14	05	**
--	11/04/76	0241	4.9	.11	12	**
--	10/21/77	0524	4.2	.13	05	**
--	10/28/77	1324	3.9	.16	05	**
--	10/29/77	2130	4.0	.14	05	**
--	11/13/77	1611	3.9	.50	03	**
--	11/13/77	1805	4.2	.41	03	**
--	11/13/77	2130	3.3	.25	03	**
--	11/13/77	2136	4.1	.23	05	**
--	05/02/78	0617	3.2	.05	02	**
--	06/13/79	1946	4.2	.06	20	**

* Reference: Strong-Motion Earthquake Accelerograms, Index Vol., Rept. No. EERL 76-02, Calif. Institute of Technology, Pasadena, Calif.

**Information about these accelerograms is available from the U.S. Geological Survey, Branch of Engineering Seismology and Geology, Menlo Park, Calif.

Imperial Valley Accelerograph Network

The beginning of strong-motion investigations in the United States was probably a direct result of discussions between Japanese and American engineers that took place at the 1929 World Engineering Congress in Tokyo, Japan. These discussions convinced the American engineers of the urgent need for the United States to move forward with the development of instrumentation that could record close-in ground motion during earthquakes of a potentially damaging level (Cloud, 1964). One eventual result of these discussions was an allocation of funds by the U.S. Congress in 1931 for the development and implementation of an engineering seismology program. The responsibility for this program was given to the U.S. Coast and Geodetic Survey, which was successful in developing a strong-motion recorder (accelerograph) and installing several in the southern California region in time to record the disastrous Long Beach earthquake of March 10, 1933. This event not only provided the first ground-motion information of engineering importance in the United States but proved to be a major impetus for the expansion of the United States strong-motion program. Within two years more than 50 accelerographs had been installed (mostly in California), including one on Commercial Avenue at El Centro, in the Imperial Valley, California (Porcella and Matthiesen, 1979b). This station was triggered in May 1940, and produced the well-known "El Centro accelerogram", frequently used worldwide in engineering design studies as typical ground motion from a strong local earthquake.

During the 1970's numerous additional accelerograph stations were established by the U.S. Geological Survey in the Imperial Valley as part of a cooperative network with the California Institute of Technology and the California Division of Mines and Geology. This specialized network was

designed to fulfill specific research needs in studies of source mechanics, wave propagation, ground-motion attenuation, local site effects, and structure response. This network has been described in Porcella and others (1982) and includes the following specialized arrays: The El Centro Array, containing 13 stations at 3- to 5-km spacings across and perpendicular to the Imperial fault; the 305-m-long Differential Array, containing 6 stations at various spacings such that the distances between pairs of stations are similar to the typical distances between supports for various long structures as well as to the half-wavelengths of relevant surface waves; and the Meloland Overcrossing at Interstate 8, containing 26 channels of centrally-recorded data from accelerometers located on the bridge embankments, the central pier, various points on the deck, and in the "freefield", 60 m west of the structure.

On October 15, 1979 a magnitude 6.5 earthquake ruptured the Imperial fault near El Centro, California, and triggered more than 50 accelerographs in the Imperial Valley region (fig. 1). The complete set of data is in several respects the most comprehensive collection of strong ground motion ever recorded during a single earthquake.

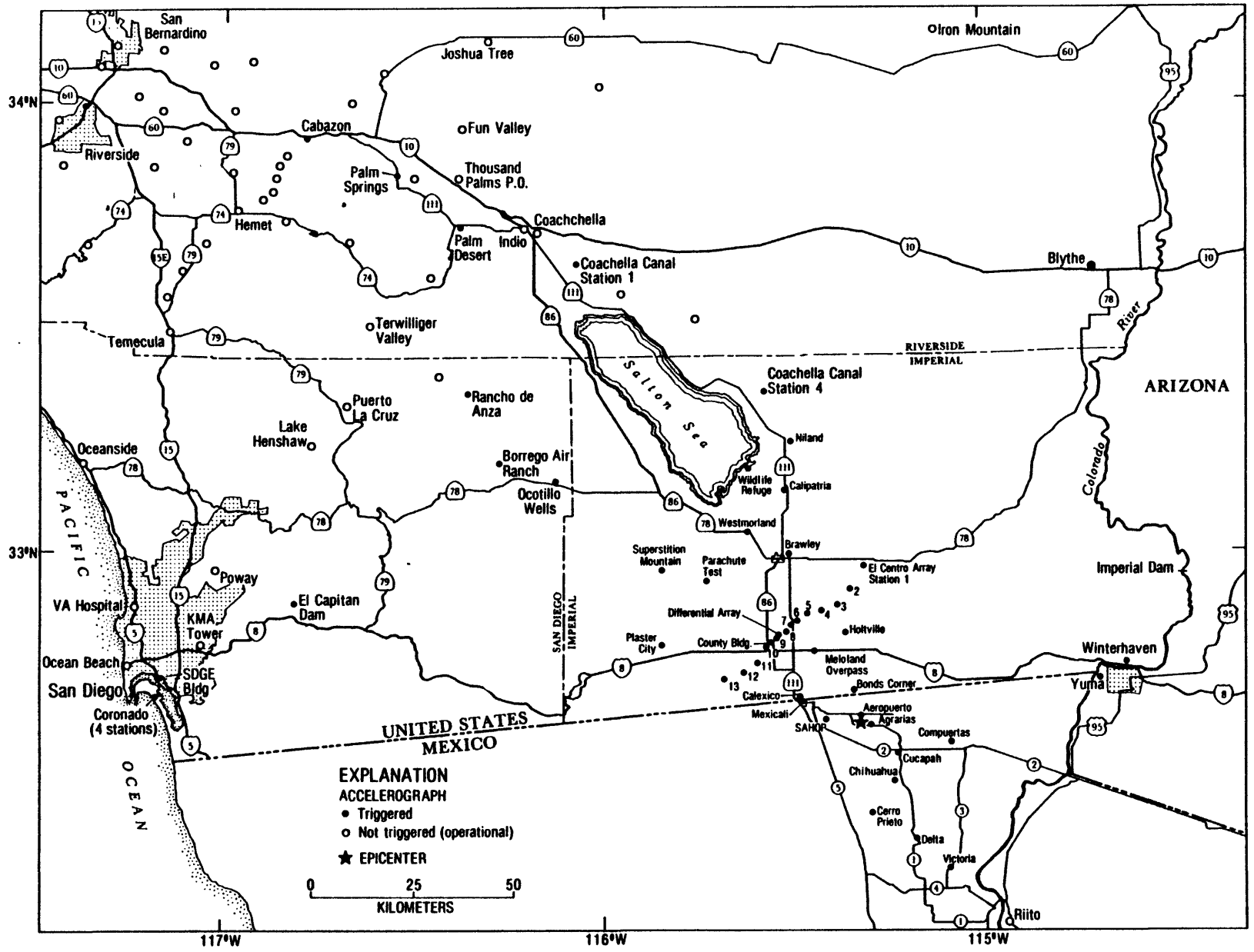


Figure 1. – Accelerograph stations in the Imperial Valley region during the October 15, 1979 earthquake (from Porcella and others, 1982).

1979 Strong-Motion Data Set

The main shock of the Imperial Valley earthquake of October 15, 1979 triggered all operational accelerographs within about 100 km of the epicenter and one as far away as 196 km (Porcella and Matthiesen, 1979b; fig. 1). Maximum horizontal ground accelerations greater than 50 percent g were measured at seven stations within 10 km of the Imperial fault rupture (fig. 2); maximum vertical ground acceleration (1.74g) was recorded within 2 km of the fault rupture and exhibits a strong-duration (greater than 0.10g) of more than 6 seconds (see appendix A). This close-in data is particularly significant in that it provides an improved basis for extending ground-motion predictions to small source-site distances (Joyner and Boore, 1981). In addition to the new information on ground motion within 15 km of ground rupture, recordings at greater distances show peak-acceleration values consistent with those recorded during previous earthquakes of similar magnitude (Boore and Porcella, 1982).

More than 80 aftershocks were recorded at U.S. Geological Survey stations during the first week after the October 15 main shock; 14 of these events were recorded at three or more stations. The entire aftershock data set contains ground motions from 21 stations within 30 km of the main-shock surface rupture and a total of more than 260 records, about 50 of which contain peak accelerations greater than 0.1 g. Because absolute time was recorded on many of the accelerograms, the complete data set contains significant new information that can be used in more detailed studies of source mechanism, wave propagation, and ground-motion attenuation (Porcella and others, 1982).

In order to more fully utilize this new wealth of ground-motion data, the U.S. Geological Survey outlined a project in 1980 to obtain soil samples and seismic velocities at Imperial Valley accelerograph stations; the project

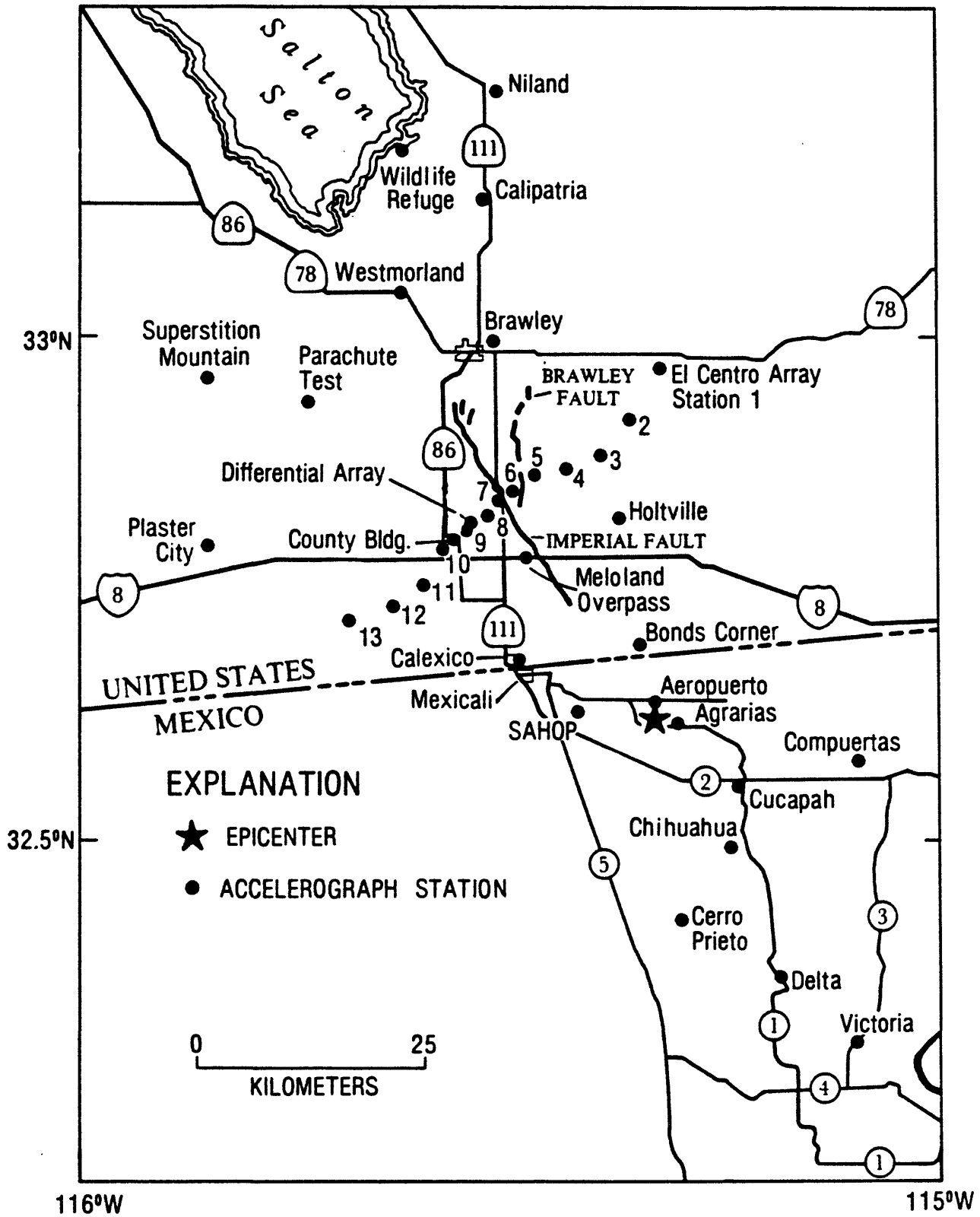


Figure 2. - Close-in strong-motion stations that triggered during the 1979 Imperial Valley earthquake. Stations in Mexico are operated jointly by the National University at Mexico City and the University of California at San Diego (from Porcella and others, 1982).

would provide detailed site data for comparative studies of geologic and seismic characteristics that might be related to the recorded motions. The influence of soil conditions on strong ground motion is an ongoing project at the U.S. Geological Survey and is being studied at numerous California sites, including many accelerograph stations. This present study will supplement investigations at nearly 50 sites in the Los Angeles basin region and at about 60 sites in the San Francisco Bay Area (see Fumal and others, 1981, for example). When completed, the project will provide site data on a regional scale for use in seismic zonation studies. This variety of data, although primarily from California sites, will be used to develop general zoning methods that can be applied to other seismically active regions. And so, while this Imperial Valley geotechnical investigation is just one part of a much broader effort, it is indeed a unique and important part.

FIELD INVESTIGATIONS

Cone-Penetration Tests

The first phase of the U.S. Geological Survey Imperial Valley geotechnical investigation included the recovery of detailed soils information at selected strong-motion sites where borings, velocity surveys, and other investigations might be performed. The U.S. Geological Survey contracted ERTEC Western (formerly Fugro), Inc., of Long Beach, California to perform electronic cone-penetration tests (CPT) at strong-motion recording stations in the Imperial Valley, California. A total of fourteen tests at nine sites were made during the period July 19-21, 1980 (appendix B). The purpose of the

tests was to define in great detail the soil profile at key accelerograph sites where strong ground motions were recorded during the October 15, 1979 Imperial Valley earthquake. These profiles also were used to assist in picking the depths at which soil samples would be taken during subsequent drilling operations.

The electronic CPT continuously measures the resistance of the soil to penetration by a cone-shaped probe with a conical tip (60^{o} apex angle) and a cylindrical friction sleeve. The probe cone has a cross-sectional area of 15 cm^2 and the sleeve has a surface area of 200 cm^2; the assembly contains strain gauges that allow simultaneous measurement of cone and sleeve resistance during penetration (ERTEC, 1981). Signals from the gauges are transmitted electrically to an analog strip-chart recorder mounted in the truck. The truck is also used to transport the test equipment and sounding rods and to provide the hydraulic thrust (up to about 18,000 kg.) necessary to drive the cone and rods into the soil. The analog records are then digitized and computer processed for further analyses, including calculation of friction ratios and replotting of the data for presentation at various scales (see fig. 3, for example). Additionally, one mechanical CPT was made by the U.S. Geological Survey at the Imperial County Services Building in El Centro, and numerous others were made at sites where serious ground failure occurred during the 1979 earthquake (Youd and Bennett, 1983). These CPT utilize a mechanical friction device that measures the cone resistance and the side (sleeve) resistance every 20 cm rather than continuously as does the electronic CPT.

Cone resistance, friction resistance, friction-ratio data, and soils information versus depth are presented in appendix B for each electronic CPT. These data are good indicators of several soil parameters commonly used in

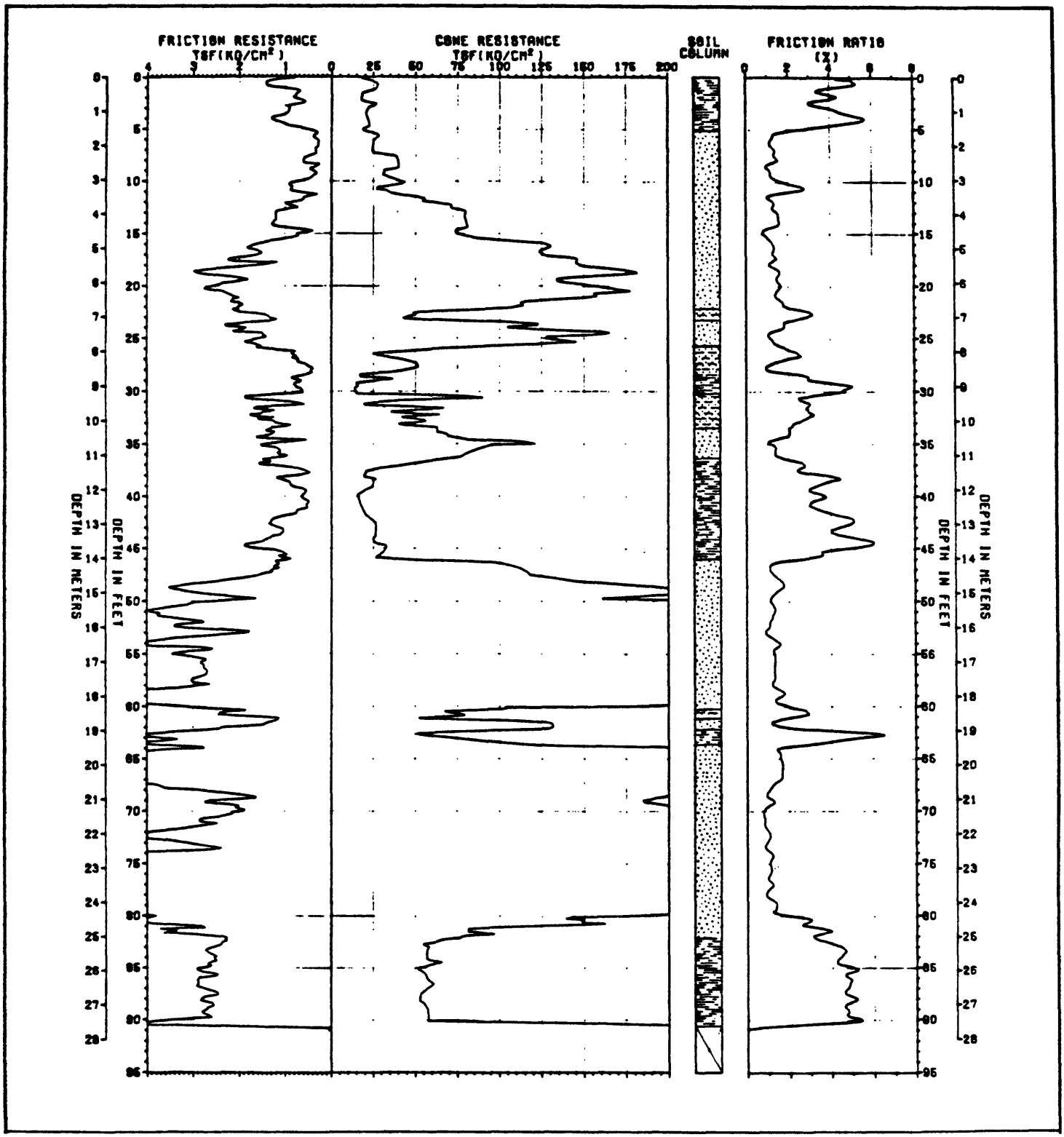


Figure 3. - Electronic cone-penetrometer test at Bonds Corner. See figure 4 for soil column explanation and append. B for complete set of CPT data (from ERTEC, 1981).

geotechnical investigations. The cone (end) resistance to soil penetration is a good indicator of in-situ shear strength. Because the finer-grained soil materials generally have a lower penetration resistance than coarser-grained materials the CPT data also can be used as a general indicator of soil type (ERTEC, 1981). As a specific identifier of soil type the direct ratio of sleeve resistance to cone resistance can be used to identify sands (approx. 1.5 to 2 percent) or clays (typically four percent or greater).

Because these CPT data were available before the drilling operations began, the precise depths at which undisturbed clay samples would be taken and standard penetration tests made were predetermined; this greatly reduced the guesswork and wasted drilling time associated with attempts to remove samples from irregular or too-thin layers of sand or clay. Average depth of penetration per site was 33.9 m. The cost in 1980 was about $450 per CPT, or about $20 per meter. In view of the more than $100-per-hour drilling expenses and the large number of samples taken (approx. 50), the CPT expense proved to be a good investment in terms of convenience, economics, and the additional detailed soils information the tests yielded.

Table 2. - Soil descriptions from CPT data at strong-motion stations

(from M.J. Bennett, USGS, unpublished data)

	Clay[1]	Intermediates[2]	Sand[3]
Array 4	30	02	68
5	77	08	15
6	56	04	40
7	52	16	31
8	79	05	16
10	43	07	50
Holtville	89	-	11
Bonds Corner	30	10	60
Diff. Array	75	11	13
Co. Serv. Bldg.	73	------ 27 ----------	

[1] percent clay, silty clay, and clayey silt.

[2] percent silty sand, sandy silt, and silt.

[3] percent sand. The near-surface sand in the Imperial Valley is very fine; much of this sand could be silty sand.

Notes:

Array 4: Depth of CPT is 30.2 m. This section consists of sand and clay. The upper 11.3 m contain thin interbeds of silty sand. The

contact with the underlying sand is sharp. Between 11.3 and 14.3 m dense sand and silty sand alternate in thin interbeds about 0.6 m thick. These interbeds show gradational contacts with other units. The sand between 14.3 and 30.2 m is very dense and very fine grained.

Array 5: Depth of CPT is 29.3 m. This section consists of mostly stiff silty clay; the relatively small amount of sand is dense and interbedded with clayey silt.

Array 6: Depth of CPT is 34.2 m. Medium stiff silty clays alternate with very dense sand. The beds range in thickness from 6.1 to 10.7 m. One thin interbed at 15.9 m shows grading from clayey silt to sandy silt to sand.

Array 7: Depth of CPT is 32.0 m. The upper 7.0 m consist of alternating 0.6- to 1.2-m beds of medium stiff clay and dense, fine sand. A moderately uniform, medium stiff, silty clay occurs between 6.7 and 20.7 m. Below the clay, dense to very dense sand alternates with silty sand and thin beds of clayey silt.

Array 8: Depth of CPT is 41.5 m. Most of the material in this section is soft to stiff clayey silt to clay. The sand is dense and occurs in beds about 2.4-m thick. The sand occurs at depths of 5.2, 25.0, 32.0, and 34.8 m.

Array 10: Depth of CPT is 44.2 m. The upper 28.7 m of this section contains medium stiff to stiff clayey silt and clay with 0.6- to 0.9-m-thick interbeds of sand. One 3.1-m-thick, very-dense sand interbed occurs between 18.9 and 22.0 m. Below 28.7 m the sand is massive and very dense. Contacts between the sand interbeds and fine sediment are sharp.

Holtville: Depth of CPT is 32.9 m. Most of the sediment is stiff clayey silt to clay; the only significant quantity of sand occurs in the upper 3.1 m and varies from loose to very dense.

Bonds Corner: Depth of CPT is 27.8 m. This section contains two distinct types of sand. The first type consists of very dense sand beds 4.6- to 6.1-m thick, has sharp contacts, and occurs below 14.0 m. The second type consists of dense sand with gradational contacts, and occurs above 14.0 m. Some loose sand occurs between 1.5 and 3.1 m. The clayey silt and clay is medium stiff to stiff and occurs mostly in beds 1.5-m to 2.4-m thick.

Differential Array: Depth of CPT is 29.9 m. In the upper 6.1 m soft to stiff clays alternate with dense sand and silty sand. Between 6.1 and 19.8 m the clay and clayey silt increase in stiffness with depth. Thin silty interbeds are common below 19.8 m. A dense sand with gradational contacts occurs at 25.6 m.

County Services Bldg.: Depth of CPT is 16.5 m. The upper 4.9 m consists of soft and stiff clayey silt and clay. The dense sand between 4.9 and 8.2 m has gradational contacts. The clayey silt below 8.2 m is stiff.

Drilling Operations

Twenty-two Imperial Valley accelerograph stations were selected as drilling sites at which subsequent velocity surveys would be performed; these 22 stations included the nine cone-penetration sites and all but three of the other stations where significant ground motions were recorded during the 1979 earthquake. The three stations omitted from this study are El Centro Array Station 1, Superstition Mountain, and the Meloland Overcrossing (see fig. 2). Array Station 1 is near the eastern edge of the valley where a near-surface (approx. 20 m) saturated sand serves as a confined aquifer under considerable artesian pressure; the Superstition Mountain station rests on Mesozoic granitic rock; and the Meloland Overcrossing station is located in the center-divide area of Interstate 8. The first two stations were omitted for economic reasons and the latter station because of time-consuming permitting procedures.

On September 22, 1980, Pitcher Drilling Company of Palo Alto, California, under contract to the U.S. Geological Survey began drilling at the first of 22 Imperial Valley strong-motion stations. The Parachute Test Site, Westmorland, Calipatria, Salton Sea, and Imperial County Services Building sites were drilled to depths of about 30 m; the original Commercial Avenue site (Array Station 9) was drilled to a depth of nearly 250 m; and the remaining 16 sites were drilled to depths of about 75 m. The deep hole (Array Station 9) was cased with 10.2-cm (4-inch) Poly-vinyl-chloride (PVC) pipe and the remaining boreholes with 7.6-cm (3-inch) PVC pipe both to insure future accessibility of the borehole as well as to provide a sturdy surface to which the downhole seismometer could be secured during subsequent velocity surveys. All boreholes were drilled using a Failing 1500 truck-mounted rotary drill rig and

tri-cone bit with mud/water circulation. Initially, the borehole/casing annuli (at 8 sites) were backfilled with 0.64-cm (1/4-inch) pea-sized gravel in order to improve coupling during the down-hole surveys; this practice was discontinued when artesian flows used the annulus gravel as conduit to the surface at Array Stations 3 and 6. Corrective measures included removing the casing and gravel to depths of 15 m (50 feet) and plugging the boreholes with concrete.

Numerous soil samples were collected during drilling operations from various depths in the boreholes at nearly all of the 22 locations (see table 3 for summary); figure 4 and appendix C contain soils information from all 22 stations. Samples from the "cuttings" were taken based on changes in the drill-rig reaction; a Pitcher core barrel and thin tube liners were used to remove 26 undisturbed clay samples; and 23 split-spoon samples were taken and standard-penetration tests made in primarily sand or silty sand materials (see appendix C). Most of the undisturbed clay samples were sent to the University of Texas at Austin where high-strain triaxial and resonant-column tests were performed on several of the samples from close-in stations (see Turner and Stokoe, 1982). Caliper, resistivity, and spontaneous potential measurements were made at 10 selected stations immediately after drilling and before casing the borehole; water-temperature and gamma-radiation tests also were run during the first several months after drilling at most of the 22 stations (see table 4 and figure 5; T.C. Urban, U.S. Geological Survey, unpublished data).

Table 3. - Summary boring-sample data from Imperial Valley strong-motion sites*

Station / Sample-depth (m)	Sd-St-Cl	W_n-W_l-W_p	SPT (N)	Density	Size D_{50}	Sediment type
Array 2 / 6.7	2-28-70	28-59-31	-	1.98	.001	silty clay
" 3/ 8.4	1-34-65	22-66-23	-	-	.002	Silty clay
" 3/ 36.8	91-9	-	83	-	.205	fine sand
" 4/ 6.3	2-22-76	x-71-25	-	-	.001	clay
" 4/ 9.8	0-25-75	27-70-30	-	1.94	.001	clay
" 4/ 15.3	78-19-3	-	51	-	.095	very fine sand
" 4/ 21.4	55-40-5	-	87+	-	.068	silty sand
" 5/ 2.7	10-86-4	-	8	-	.048	silt
" 5/ 11.7	3-43-54	x-57-27	-	-	.003	silty clay
" 5/ 14.2	17-73-10	-	37	-	.042	sandy silt
" 5/ 25.0	1-82-17	x-32-23	-	-	.017	silt
" 6/ 2.7	7-22-71	x-64-33	16	-	.001	silty clay
" 6/ 6.9	3-33-64	x-57-31	-	-	.002	silty clay
" 6/ 11.6	66-27-7	-	50+	-	.080	silty sand
" 6/ 14.3	0-60-40	x-45-29	-	-	.006	clayey silt
" 6/ 22.1	44-48-8	-	-	-	.056	sandy silt
" 6/ 29.0	1-48-51	28-66-30	43	-	.004	silty clay
" 7/ 2.7	3-49-48	31-54-27	10	-	.004	clayey silt
" 7/ 13.7	2-25-73	x-76-31	-	-	.001	silty clay
" 7/ 22.9	0-86-14	31-30-26	48	-	.014	silt

Table 3. - continued

Station / Sample-depth (m)		Sd-St-Cl	W_n-W_l-W_p	SPT (N)	Density	Size D_{50}	Sediment type
Array	7/ 26.5	13-76-11	31-49-26	-	-	.027	silt
"	8/ 5.2	65-34-1	-	46	-	.079	silty sand
"	8/ 16.2	5-38-57	x-49-28	-	2.04	.003	silty clay
"	8/ 22.1	1-19-80	x-80-39	-	-	.001	clay
"	8/ 25.0	0-58-42	26-45-27	29	-	.006	clayey silt
"	9/ 16.2	0-22-78	x-69-30	-	2.01	.001	clay
"	10/ 12.8	2-71-27	x-35-22	-	-	.013	clayey silt
"	10/ 36.6	87-13	-	50+	-	.137	fine sand
"	11/ 15.9	1-24-75	x-62-31	-	1.95	.001	clay
"	11/ 40.0	43-49-8	-	97	-	.059	sandy silt
"	12/ 10.2	2-78-20	x-34-24	-	-	.024	silt
"	12/ 27.8	66-	-	91+	-	.178	silty sand
"	13/ 25.9	87-13	-	83+	-	.138	fine sand
"	13/ 37.1	5-83-12	x-24-24	-	-	.028	silt
Diff. Array	DA/ 4.6	76-9-15	-	26	-	.115	very fine sand
	DA/ 8.2	2-37-61	x-53-23	-	-	.002	silty clay
	DA/ 25.9	1-27-72	25-63-33	39	-	.001	silty clay
Bonds Corner	BC/ 2.7	83-11-6	-	14	-	.113	very fine sand
	BC/ 22.6	95-5	-	50+	-	.220	fine sand

Table 3. - continued

Station / Sample depth (m)			Sd-St-Cl	W_n-W_l-W_p	SPT (N)	Density	Size D_{50}	Sediment type
Calexico	CX/	13.0	2-37-61	x-50-20	-	2.03	.002	silty clay
	CX/	32.0	63-	-	-	-	.130	silty sand
Holtville	HPO/	11.0	1-81-18	x-52-28	23	-	.019	silt
Brawley	BAP/	30.5	2-26-72	29-60-29	25	-	.002	silty clay
Imperial County Services Building	CSB/	4.7	6-37-57	27-59-26	-	-	.003	silty clay
	CSB/	4.9	0-19-81	27-75-38	-	-	.001	clay
	CSB/	5.0	16-72-12	-	-	-	.035	sandy silt
	CSB/	6.1	1-41-58	x-52-15	-	-	.002	silty clay
	CSB/	6.6	57-43-0	-	8	-	.065	silty sand
	CSB/	6.9	9-81-10	-	-	-	.043	silt
	CSB/	7.3	50-46-4	-	24	-	.063	silty sand

* See figure 4 for explanation of soil descriptions.

EXPLANATION

SOIL DESCRIPTIONS:

S(15,35,50):
Content by percent (Sand, Silt, Clay).
Sand = 2 mm to .063 mm.
Silt = .063 to .004 mm.
clay = less than .004 m.

NOTE: This sample contains 15% sand, 35% silt, and 50% clay.

A(27,65,25):
Percent water content
(natural water content, 27%; liquid limit, 65%; plastic limit, 25%).

5YR4/2:
Soil color
(from Munsell soil-color chart).

SPT:
Standard penetration test.
(N is number of blows to advance the sampler 0.3 m (1 ft.).

Density:
Wet bulk density; (in gm/cm^3).

Soil samples:
s = split spoon,
t = undisturbed pitcher tube,

Soil column:


sand,


silty sand and sandy silt,


clayey silt and silt,


clay and silty clay,


equal amounts of sediments shown.

Figure 4. – Summary of soils information.

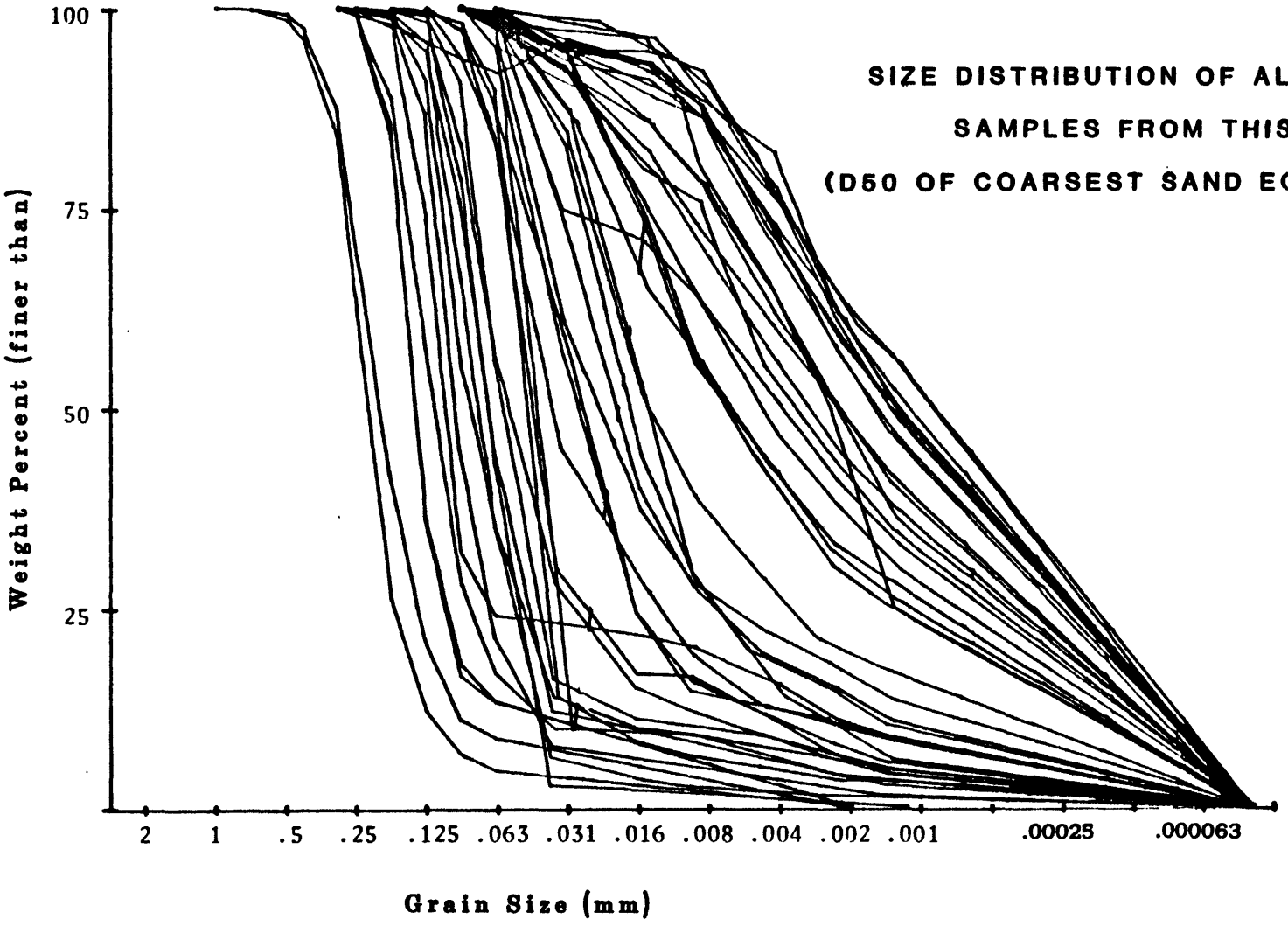
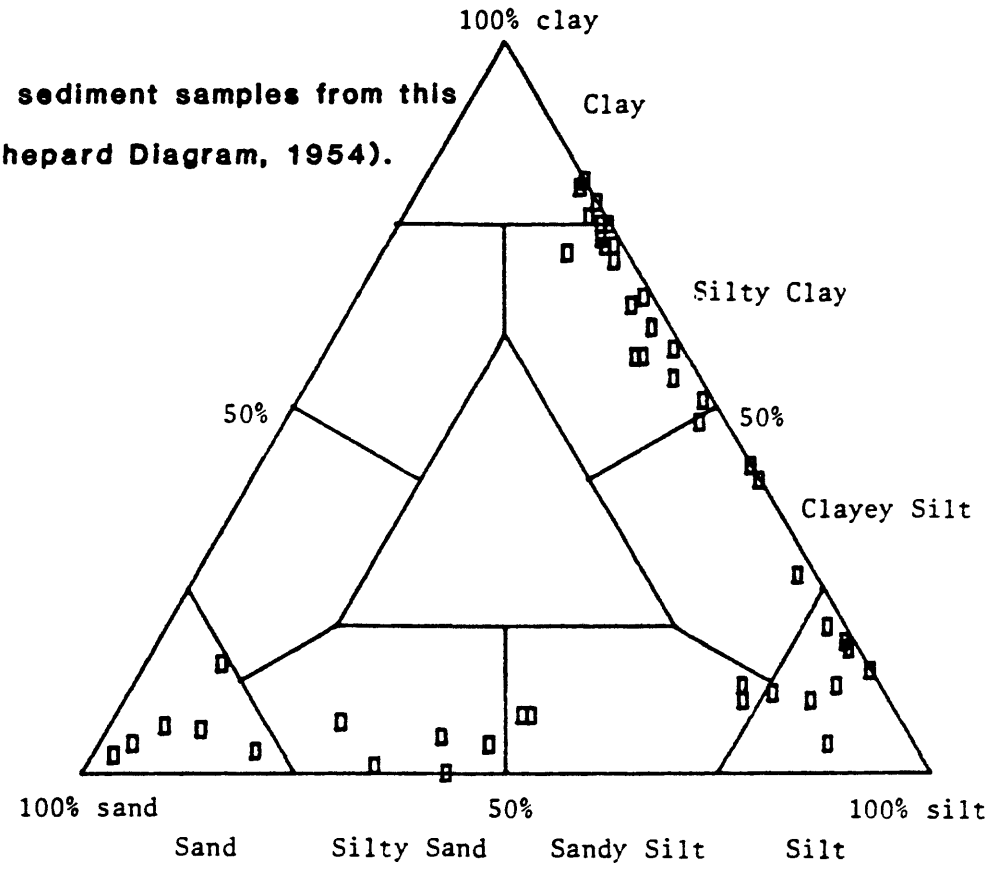
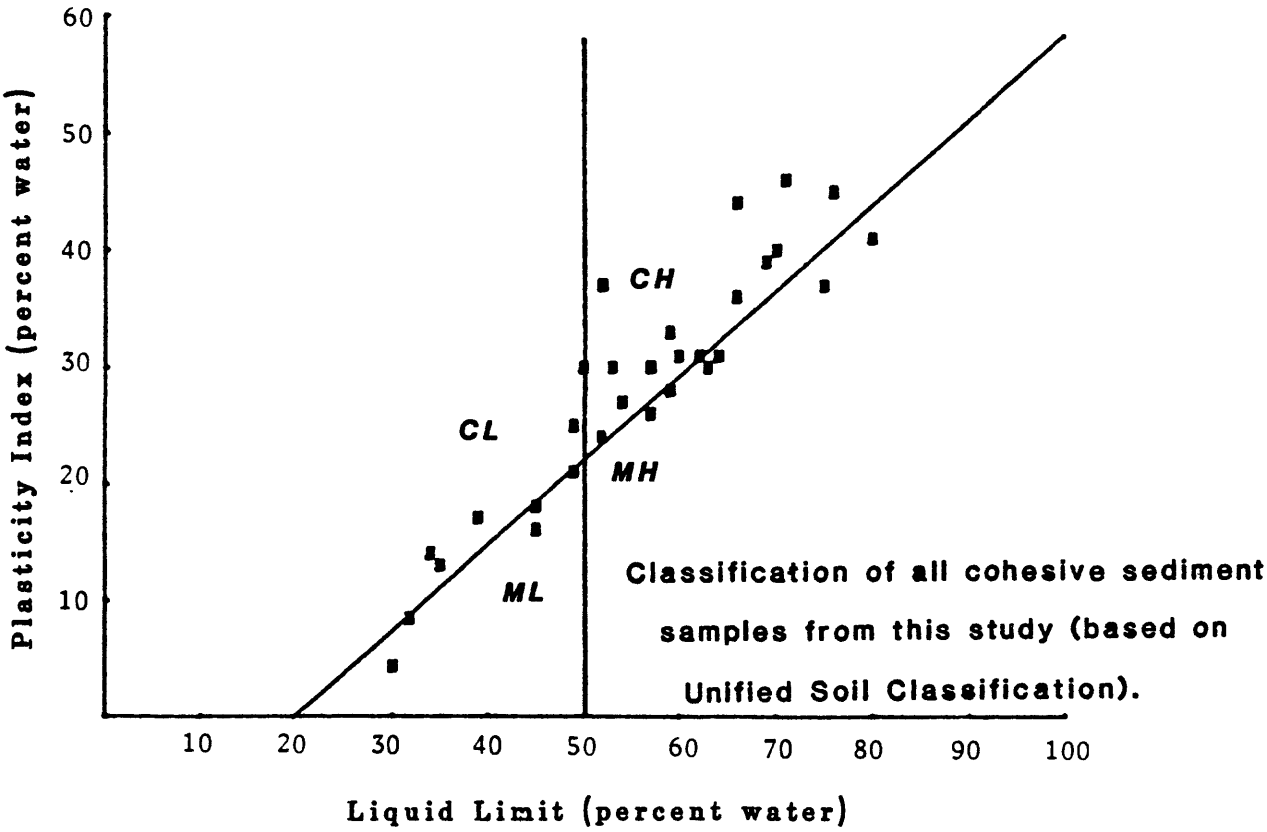


Figure 4. – continued.

Classification of all sediment samples from this study (based on Shepard Diagram, 1954).





Classification of all cohesive sediment samples from this study (based on Unified Soil Classification).

Figure 4. – continued.

BONDS CORNER
HIGHWAYS 98 AND 115
ELEVATION +29 FT

BOREHOLE DRILLED
SEPTEMBER 22, 1980

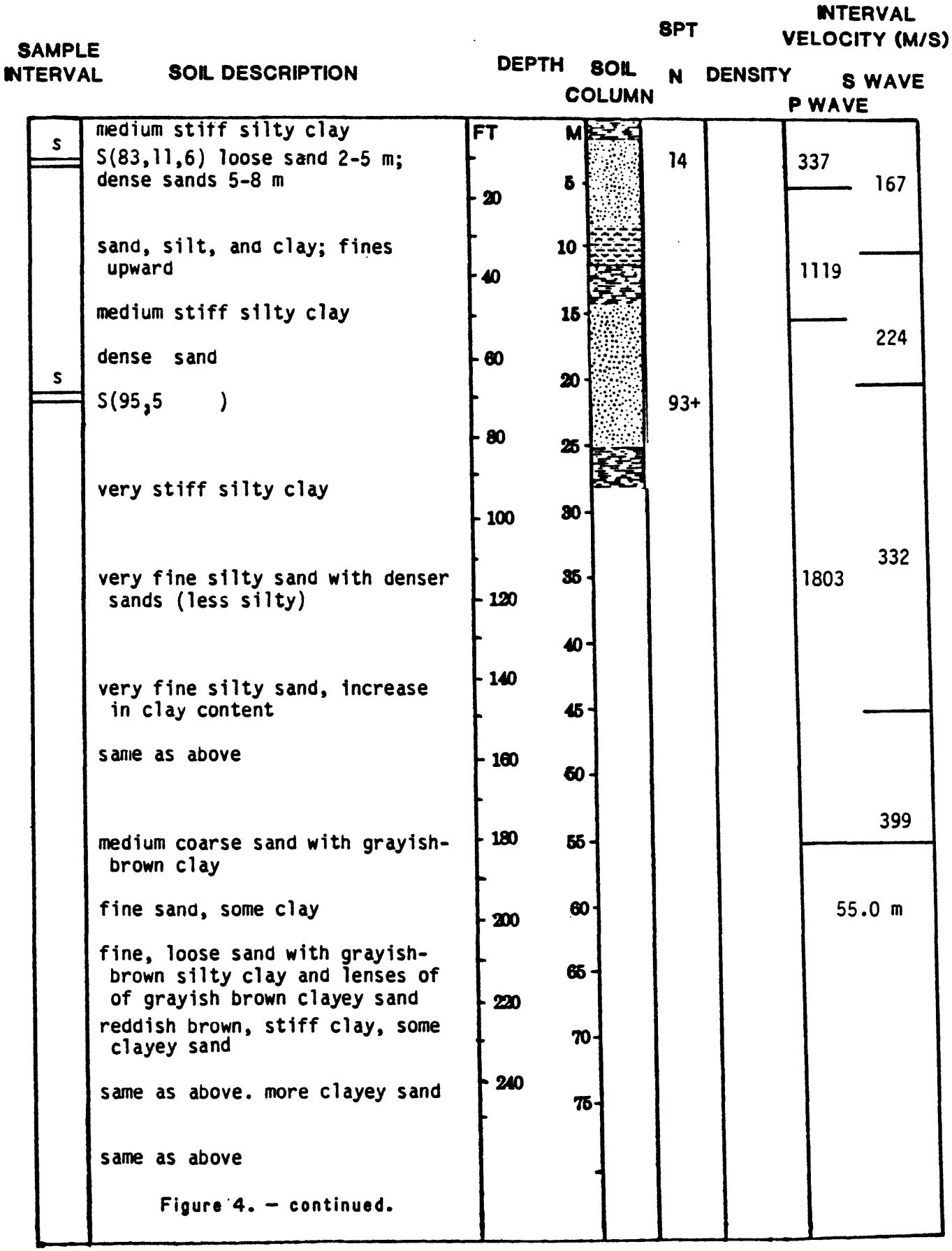


Figure 4. – continued.

TABLE 4. - Summary of borehole operations at Imperial Valley strong-motion stations (all depths are in meters)

Accelerograph station	1979 record digitized[1]	Boring/downhole survey depths	CPT depth	Other studies[2]
Array 1	yes	*	*	*
Array 2	yes	77.2/77.2	*	G,W
Array 3	yes	77.8/77.8	*	G,W
Array 4	yes	77.8/77.8	30.5	G,W
Array 5	yes	76.3/76.3	29.7	C,R,S,G,W
Array 6	yes	76.3/76.3	34.6	C,R,S,G,W
Array 7	yes	76.3/76.3	32.5	C,R,S,G,W
Array 8	yes	76.3/76.3	41.9	C,R,S
Array 9	yes**	244.4/244.0	*	G,W
Array 10	yes	76.3/76.3	44.4	C,R,S,G,W
Array 11	yes	76.3/76.3	*	C,R,S,G,W
Array 12	yes	76.3/29.0	*	C,R,S,G,W
Array 13	yes	76.3/76.3	*	C,R,S,G,W
Diff. Array	yes	76.3/76.3	30.5	C,R,S,G,W
I.C. Serv. Bldg.	yes	33.6/33.6	16.8	G
Bonds Corner	yes	76.3/76.3	27.9	G,W
Calexico	yes	76.3/76.3	*	G,W
Meloland O.C.	yes	*	*	*
Holtville	yes	76.3/76.3	33.2	C,R,S,G,W
Brawley	yes	76.3/49.4	*	G

Table 4. - continued

Accelerograph station	1979 record digitized[1]	Boring/downhole survey depths	CPT depth	Other studies[2]
Superstition Mtn.	yes	*	*	*
Parachute Test	yes	30.0/30.0	*	*
Westmorland	yes	30.8/30.8	*	*
Calipatria	yes	30.5/30.5	*	*
Salton Sea	no	30.5/30.5	*	*
Niland	yes	*	*	*
Coachella 4	yes	*	*	*
Rancho De Anza	no	*	*	*
Borrego Ranch	no	*	*	*
Ocotillo Wells	no	*	*	*
Plaster City	yes	*	*	*
Winterhaven	no	*	*	*
Yuma, Arizona	no	*	*	*

1 see Brady and others, 1980

* not applicable

** record not processed

2 C - caliper measurement

R - resistivity measurement

S - spontaneous potential measurement

G - gamma radiation measurement

W - water temperature measurement

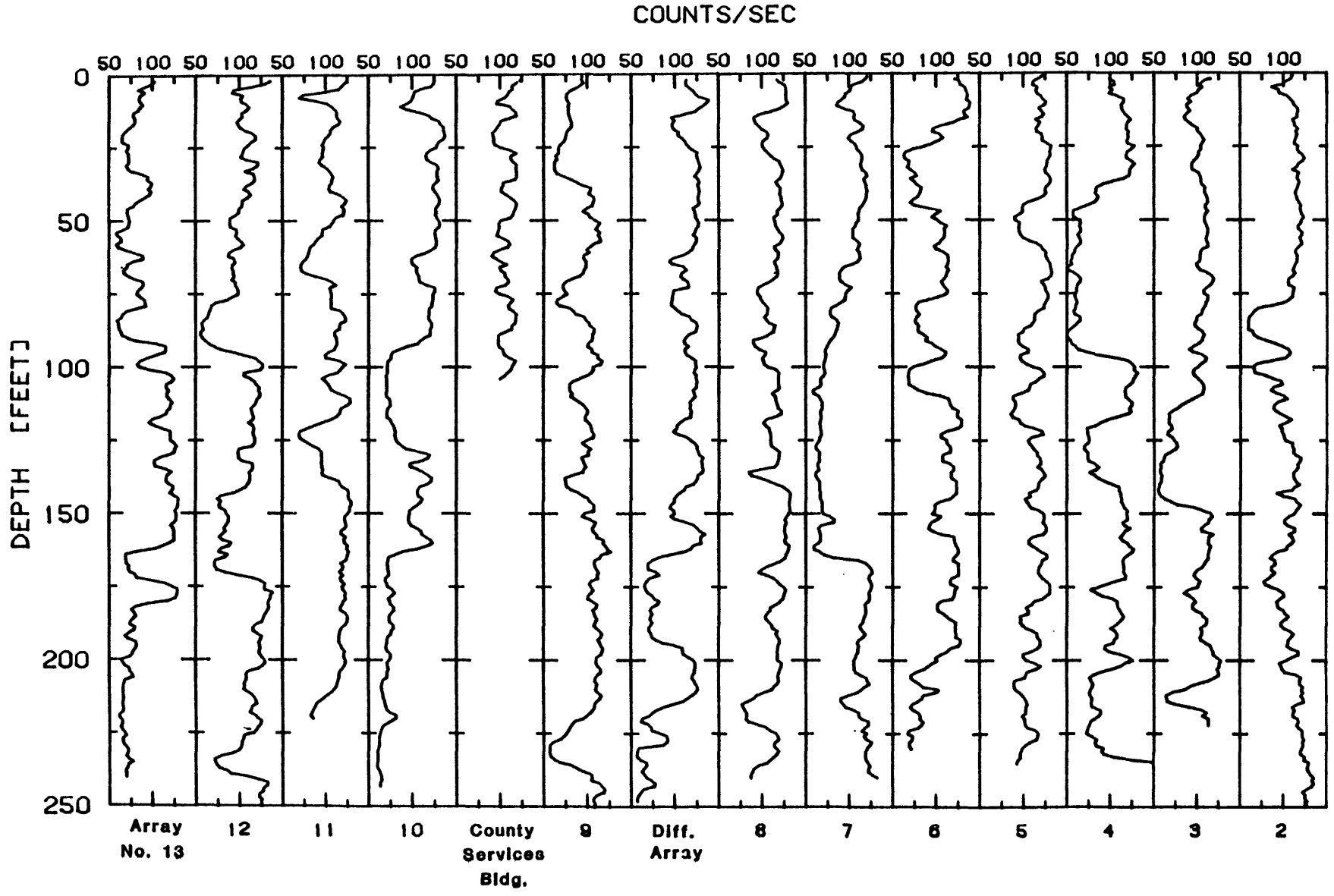


Figure 5. – Gamma radiation measurements at selected strong–motion stations (from T. Urban, USGS, unpublished data).

Downhole Velocity Surveys

The downhole velocity survey part of this study generally followed the established guidelines and procedures used during previous USGS surveys in the Los Angeles Basin and San Francisco Bay areas (see Gibbs and others, 1977; Fumal, 1978; and Fumal and others, 1981, for examples). The purpose of the downhole survey was to determine the velocity of compressional and shear waves traveling vertically from the surface to a portable borehole geophone. Schwarz and Musser (1972) discuss various techniques for making in-situ velocity surveys and describe advantages of the downhole method over refraction or interhole methods in horizontally layered near-surface materials. Much of the downhole survey technique used by USGS was developed by Warrick (1974) from the earlier works of Kobayashi (1959) and others.

Two different methods were used to generate compressional waves at each depth measured during this survey. The first utilized the vertical impact of a 9.1-kg- (20-lb) sledgehammer on a steel plate; the second method used the explosion of a blasting cap buried 1 m beneath the ground surface.

Shear waves were generated using the horizontal traction/slidehammer method. The front wheels of a pickup truck were parked on top of a large wooden plank (244 cm by 30 cm by 18 cm high) to firmly couple it to the ground. The ends of the plank were then impacted by a 30-kg slide hammer, which rolled along a steel pipe that passed completely through the center of the plank and extended about 75 cm beyond one end (fig. 6).

An orthogonal seismometer (Marks product L-10, 14 Hz) was lowered to the bottom of the borehole and raised at 2.5-m intervals. At each level, the seismic signals generated by the vertical-hammer, explosive-cap, and two-each (reversed) horizontal-hammer sources were recorded separately on photographic

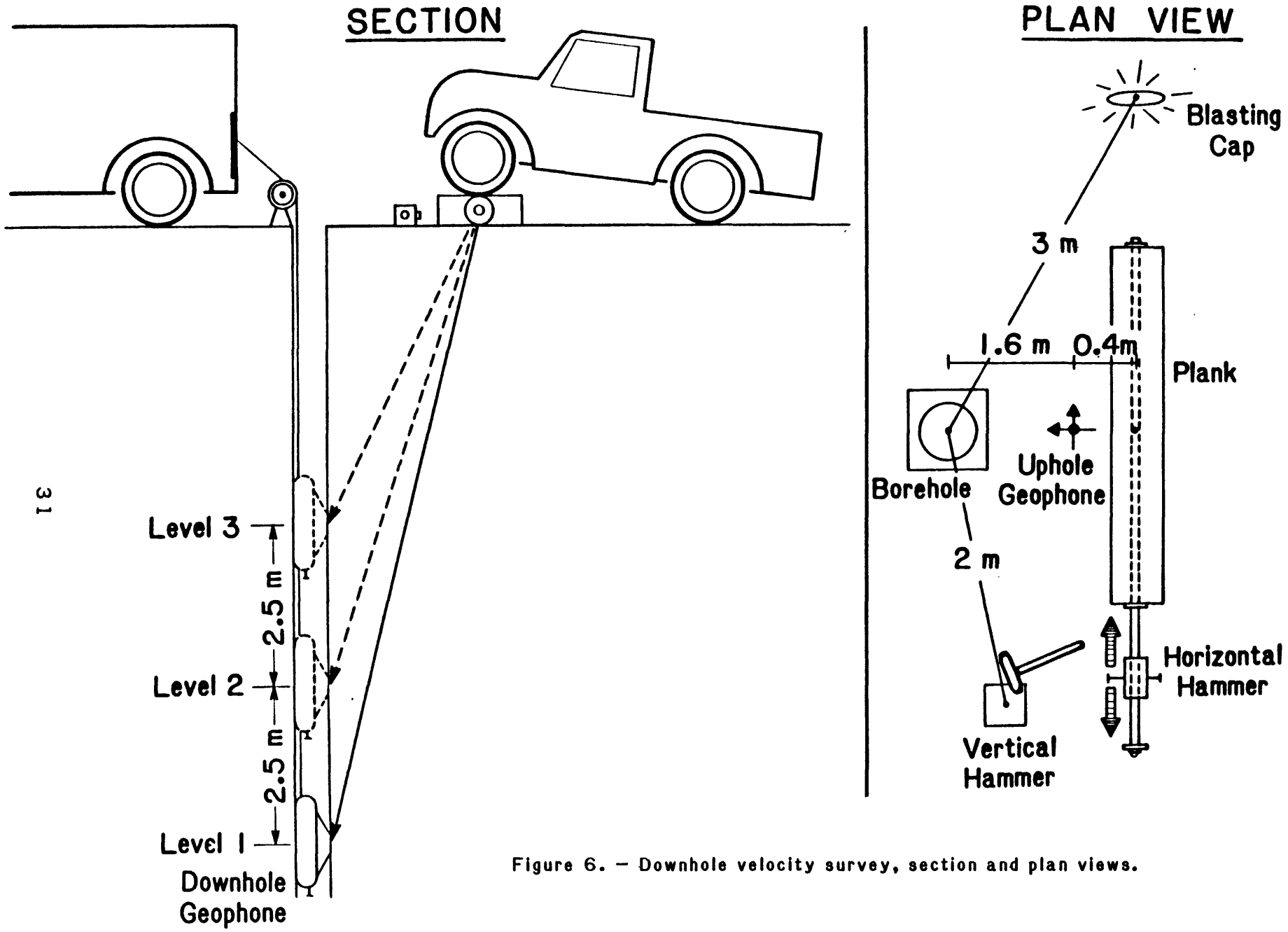


Figure 6. – Downhole velocity survey, section and plan views.

paper in a nearby truck. The horizontal hammer was impacted twice, once in each direction, in order to reverse the polarity of the shear wave; this method makes it easier to identify and pick the onset of shear-wave arrivals (see next section). Before raising the seismometer to the next level, the record was developed in the truck and inspected for the presence of good impulsive arrivals and a clear "zero time break". This "time break" is provided on the seismogram by (1) inertia switches attached to the sledge and slide hammers and (2) electrical impulse triggered by the same switch that detonates the explosive cap. The recording system was basically that described by Warrick and others (1961), but modified by the addition of 500 Hz galvos and increased (46 cm/s) paper speed; this system's response is essentially flat from 2 to at least 100 Hz (Gibbs and others, 1977).

The geometry and relative distances utilized in the surface configuration were the same for the surveys at all 22 strong-motion stations (see fig. 6). The seismic signal from the surface (uphole) geophone is used to reduce the uncertainties in the origin time for the S-wave recorded on the downhole geophone (see the following section). The four travel-time measurements (two horizontal, two vertical) were made at 2.5-m intervals throughout the borehole at all stations except two: at Holtville there were no measurements taken between 72.5 and 39.3 m due to equipment failure. At Array Station 9, the deep (244 m) hole, measurements were made at 5-m intervals below 75 m and at 2.5-m intervals above 75 m; no P-wave data were recovered above 40 m due to operator error (see appendix D). Also, a different and larger diameter seismometer (4-component) was used at Array Station 9. In this survey the seismometer package was lowered to the bottom of this deeper borehole by an electric winch and hydraulically clamped in place at each recording interval. The fourth component was a hydrophone that produced good, impulsive P-wave arrivals at many of the deeper levels where the geophone did not detect the relatively weaker seismic signals.

DOWNHOLE SEISMIC DATA

The first step in reducing the downhole seismic data was drafting all of the travel-time recordings from a given borehole onto time-depth record sections (fig. 7). For the S-wave survey, seismograms from the two opposite-direction impacts at each level were superimposed and then all levels were drafted together on a common-time base. This procedure is well worth the extra effort because it produces a visual aid from which the S-wave arrivals at each level can be easily identified by a 180^{o} phase shift; the arrival time can then be measured from that point on the superimposed records where the first 180^{o} phase inversion begins (see arrows, fig. 7). Recordings from the two mutually perpendicular, horizontal geophones (labelled H_1 and H_2) are each drafted on a separate time base in figure 7. Because the geophone package could not be oriented in the borehole, the S-arrival was measured from whichever geophone (H_1 or H_2) produced the most impulsive onset; that would sometimes vary, as the seismometer often rotated while being raised during the survey. Superimposed in column 3, figure 7 (labelled "vertical") are seismograms recorded on the vertical geophone during the compressional-wave surveys using the vertical-hammer and explosive-cap sources. Generally, the explosive-cap source produced P-waves that were slightly earlier, had higher amplitudes, and displayed sharper, more impulsive onsets than the vertical-hammer source. Overall, the explosive-cap source was consistently more impulsive at most of the sites and therefore was used in the calculation of all P-wave interval velocities (appendix E). The arrival times measured and interval P-wave velocities calculated using the vertical-hammer source are available in appendix D and appendix C, respectively.

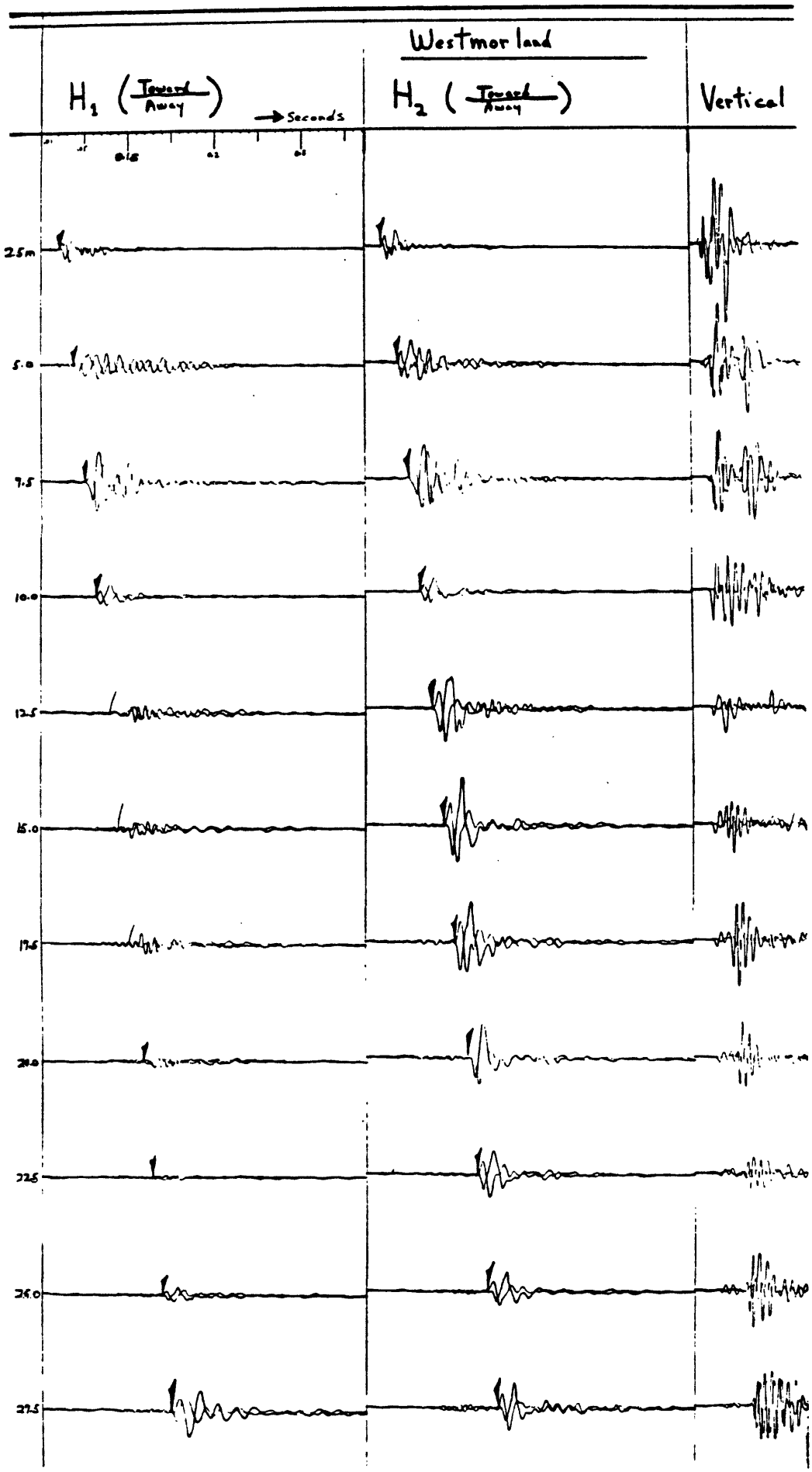


Figure 7. – Copy of downhole velocity survey record section for Westmorland Fire Station.

Many of the seismograms from the S-wave surveys contain varying levels of motion on the horizontal traces prior to the first S-wave arrivals. Most of this motion is probably related to ambient noise that is always present to some degree and is simply the result of the everyday traffic and farming activities that take place in an area such as the Imperial Valley. In some cases there may be P-wave energy generated by the horizontal hammer impact or by conversion of S to P at seismic boundaries. Compressional waves traveling in the borehole casing were very apparent on many of the P-wave survey seismograms and their velocity was calculated at about 430 m/s; this P-wave travel path also may be responsible for some of the early arrivals seen on the S-wave seismograms.

Calculation of the travel times for the S-wave arrivals involves measurement of the times t_1 and t_2 with respect to the time break t_o (see fig. 8). The "time break" is a break in the time line on the seismogram caused by interruption of the electric current passing through the slide-hammer inertia switch.

(1) t_1 = time of S-arrival at uphole geophone;

(2) t_2 = time of S-arrival at downhole geophone.

However, because of variations in t_1, an average value (t_a) is taken from the set of values $t_1 - t_o$ determined from all S-wave measurements made in the borehole. The S-wave travel time is thus given by

$$t_s = (t_2 - t_o) - t_a.$$

Because the horizontal source (plank) is offset 2 m from center of the borehole a corrected S-wave travel time (t_{sc}), which corresponds to the travel time for a vertical ray, is calculated by

$$t_{sc} = t_s \cdot t_c,$$

where t_c is the cosine of the angle of ray incidence.

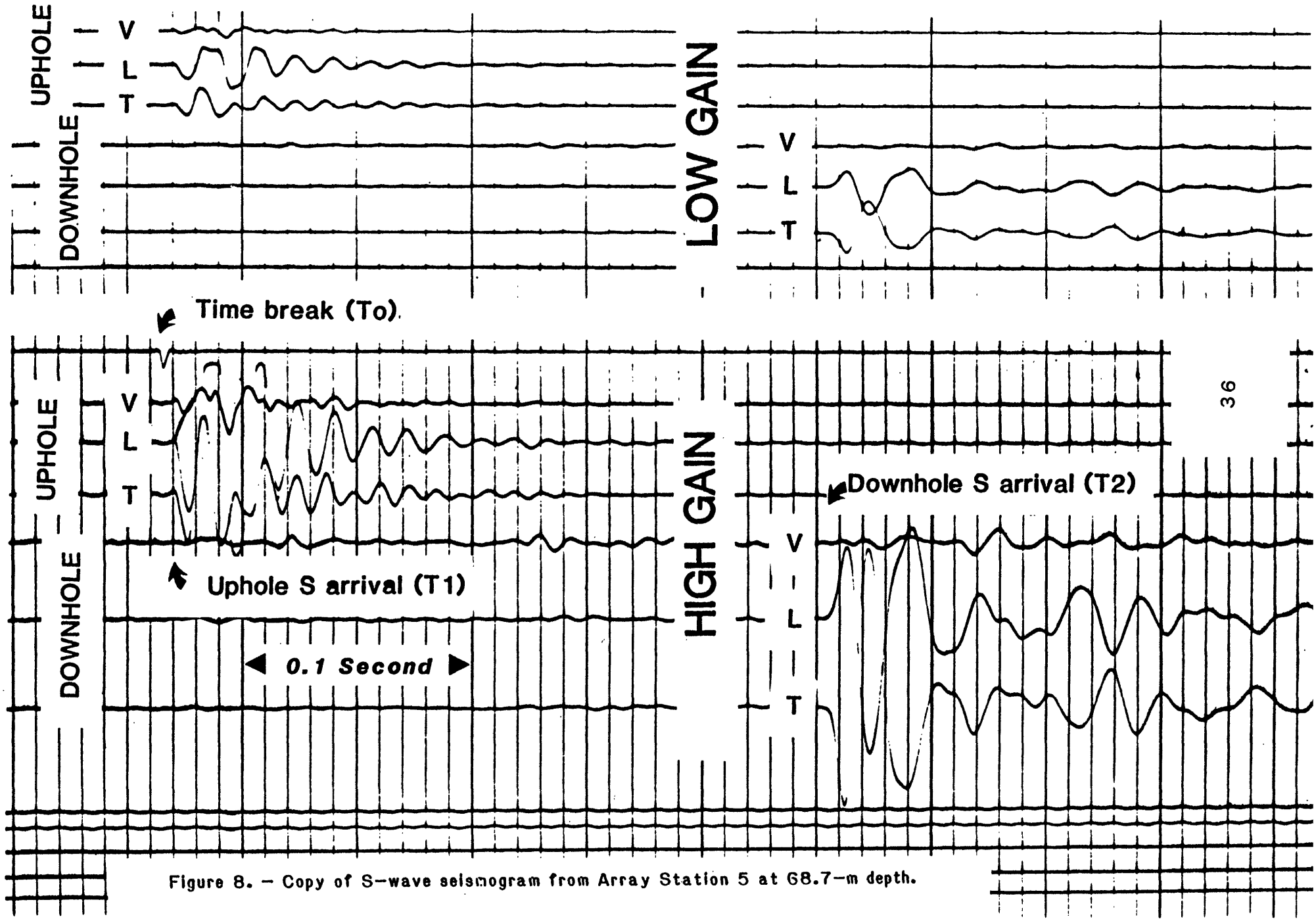


Figure 8. – Copy of S–wave seismogram from Array Station 5 at 68.7–m depth.

The compressional-wave travel times generated by the vertical hammer and explosive cap are calculated in much the same manner, except that no origin correction is necessary since the P-wave origin time is the same as the time break (t_o).

The measured P- and S-wave travel times are entered into a computer that makes the necessary corrections and calculates average and interval velocities (append. D) and generates plots of the interval velocities versus depth (see fig. 9, for example). The interval velocity plots include a sometimes arbitrary determination of depth intervals over which the velocity is relatively constant. The arrival times of good, impulsive P and S waves generally were measured to one-millisecond accuracy whereas non-impulsive arrivals commonly were measured to 2-3 millisecond accuracy. For consistency and in order to determine more accurate interval velocities from the seismic data as a whole, a point tangent to the onset was selected as the wave arrival time. Because virtually all 22 boreholes were logged at 2.5 m intervals the velocity "steps" seen in figure 9 and appendix E are real and can be adjusted only slightly; the long intervals of constant velocity shown on some of the logs are therefore representative and do not merely indicate a lack of data. In most of the boreholes below about 15-20 m the survey spacings could have been increased to at least 5 m without any loss of resolution. However, at Array Station 9, the constant shear-wave velocity below about 90 m was derived from measurements at 5-m spacings that yielded arrival-time differences of from 5 to 19 milliseconds. Because the arrival-time differences were randomly scattered throughout this section, these differences were clustered to give a 451 m/s (average) interval velocity. Velocities calculated for small depth intervals are subject to larger errors, especially the higher P-wave velocities (see appendix D). With the exception of Holtville, where only two travel-time measurements

were made below 39 m (due to instrument failure), all intervals with S-wave velocities greater than 250 m/s contain at least five travel-time measurements. This helps to reduce the margin of error when determining these higher velocities (smaller travel-time differences).

In general, the depth intervals for calculating interval velocities were chosen on the basis of (1) cone-penetration test data where available, (2) other soils information including borehole samples and cuttings, and (3), and most importantly, significant changes in the arrival-time differences at succeeding levels for all of the measurements made in the borehole. Typically, for the shear-wave measurements, these differences would average about 7 milliseconds near the bottom of the borehole and increase to an average of about 16 milliseconds near the surface; as an example, three intervals might be selected on the basis of arrival-time differences clustering around 7, 11, and 16 milliseconds. These clusterings were established only when the arrival-time differences appeared to be greater than normal fluctuations due to picking error (commonly 2 to 3 milliseconds) associated with the less impulsive shear-wave arrivals.

BONDS CORNER: S-WAVE VELOCITY

LATITUDE: 32.693N

LONGITUDE: 115.338W

DATE LOGGED: 02/17/81

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.008	0.068	0.060	167.	167.
20.0	0.008	0.112	0.104	191.	224.
45.0	0.006	0.187	0.180	250.	332.
55.0	0.006	0.212	0.205	268.	399.

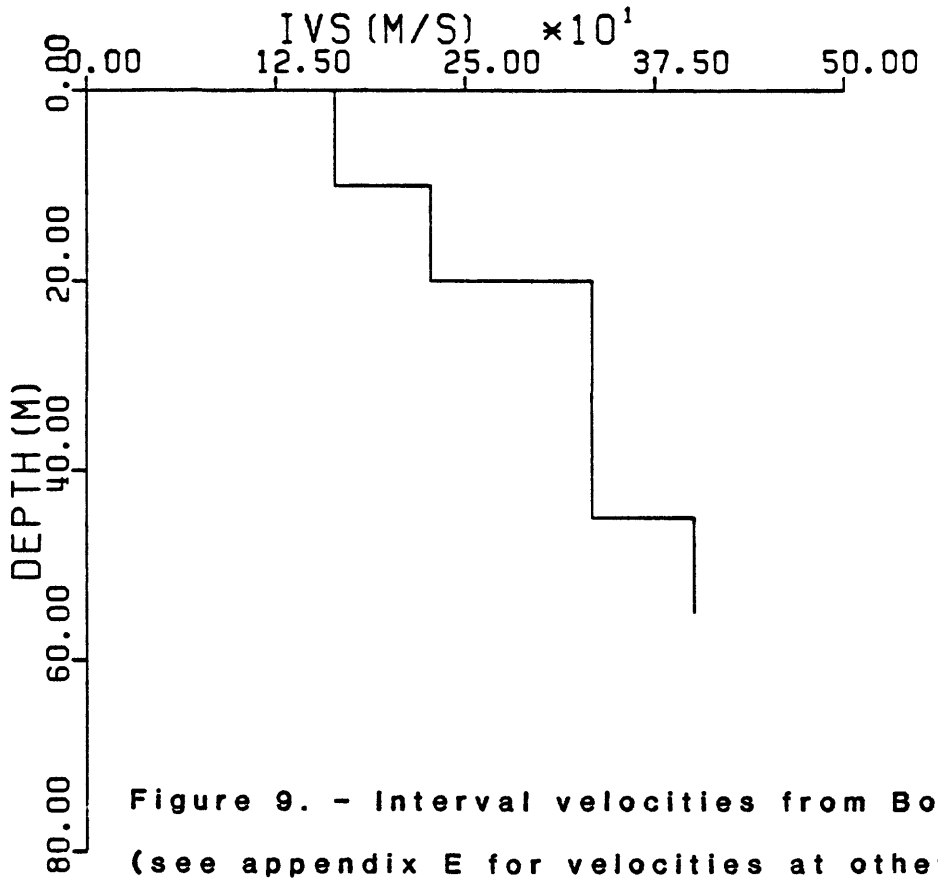


Figure 9. - Interval velocities from Bonds Corner (see appendix E for velocities at other stations).

BONDS CORNER; P-WAVE (PLATE) VELOCITY.

LATITUDE: 32.693N

LONGITUDE: 115.338W

DATE LOGGED: 02/17/81

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.016	0.015	337.	337.
15.0	0.024	0.024	631.	1119.
55.0	0.046	0.046	1196.	1803.

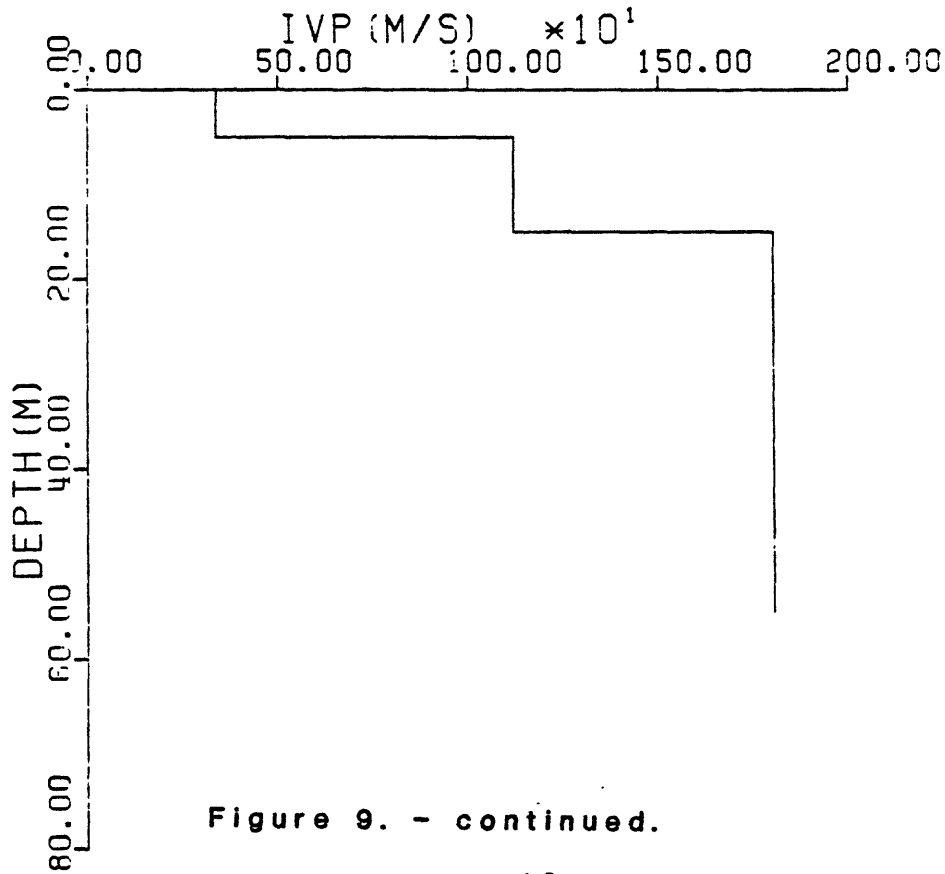


Figure 9. - continued.

SUMMARY AND CONCLUSIONS

The 1979 Imperial Valley earthquake (magnitude 6.5) produced the most comprehensive collection of far- and near-source ground-motion data ever recorded during a single earthquake. Because recent studies suggest significant correlations exist between shear-wave velocity and various properties of the near-surface material, a project was undertaken by USGS to determine the shear-wave velocity and other geotechnical site conditions at 22 strong-motion stations where significant ground motions were recorded during the 1979 event. The results of these investigations, together with similar investigations in the Los Angeles and San Francisco Bay regions (including many sites where strong-motion recordings have been made), will be used to make detailed comparisons of the geotechnical and seismic characteristics that will provide quantitative estimations of strong ground motion for a given site and facilitate the development of seismic-zonation techniques applicable to other regions.

P-wave velocities were consistent in the Imperial Valley, averaging about 700 m/s in the near-surface material. At many stations there was an abrupt increase at about 8 m to an average velocity of about 1500 m/s (fig. 10). This sudden increase is believed to be related to the water table, which in the Imperial Valley is quite shallow year around.

The lowest shear-wave velocity, 115 m/s, was recorded near the surface in a silty clay material at Array Station 3 near the east side of the valley. The highest S-wave velocity, 443 m/s, was recorded at a depth of from 10-30 m in a coarse-sand/fine-gravel material at the Parachute Test Site on the west side of the valley. Overall, the shear-wave velocities were quite similar, averaging about 170 m/s at the surface and gradually increasing to about 340 m/s near a 70-m-depth (fig. 11).

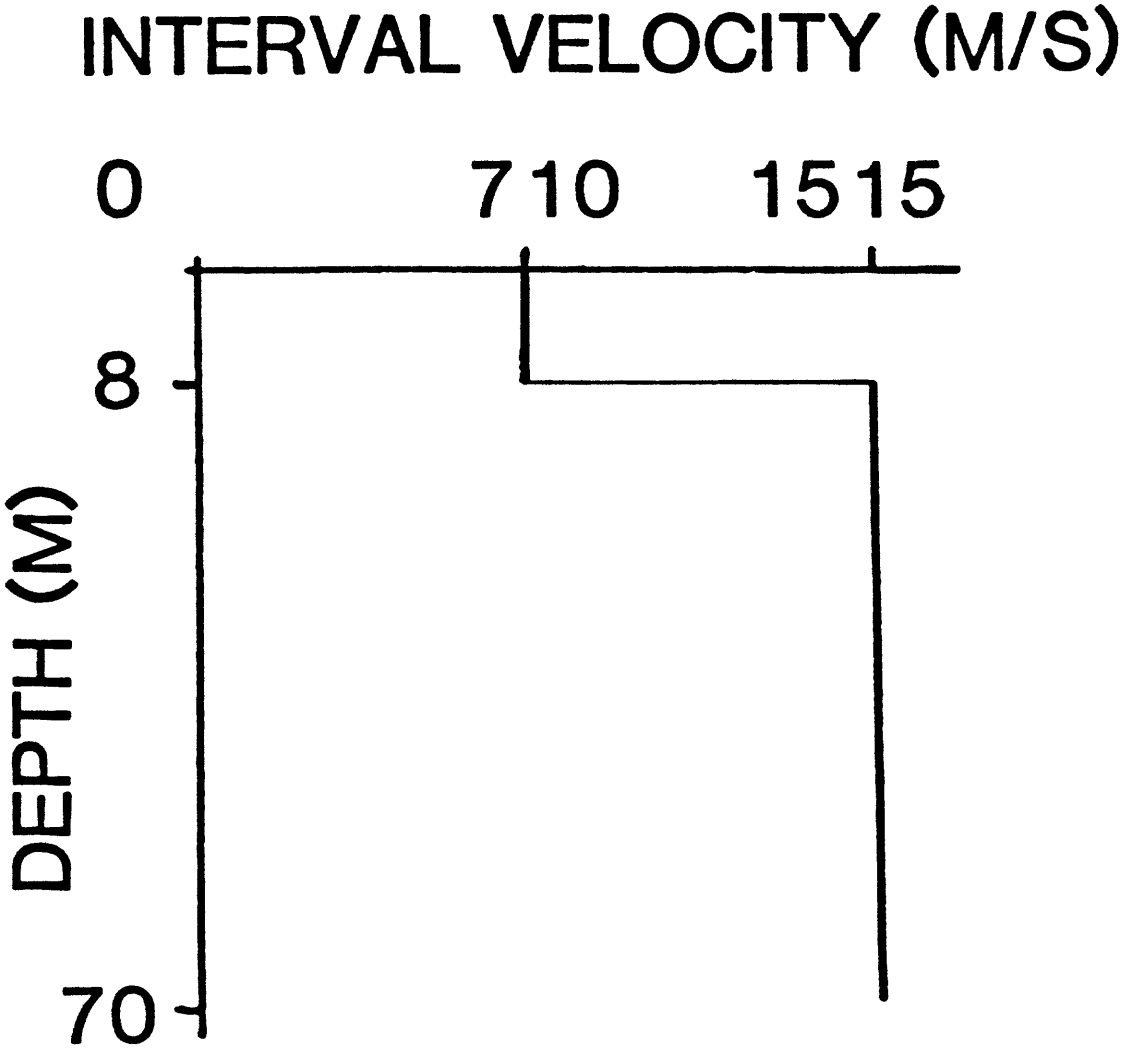


Figure 10. – Typical P–wave velocities in the Imperial Valley, California.

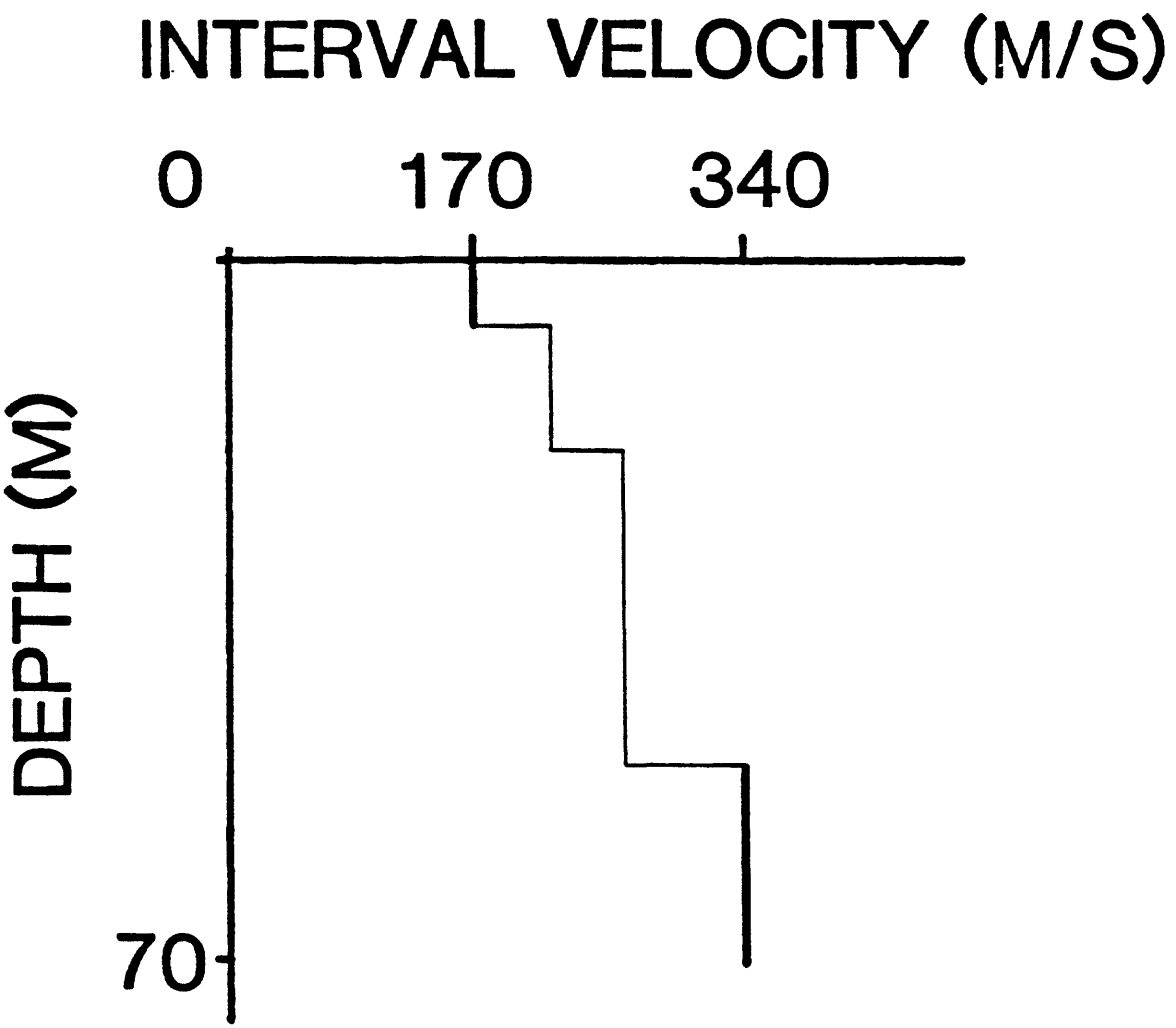


Figure 11. – Typical S–wave velocities in the Imperial Valley, California.

Because of the thick accumulation of Quaternary alluvial deposits in the Imperial Valley, none of the boreholes penetrated rock. The lithology in all 22 boreholes consists of interbedded sands, silts, and clays in widely varying proportions. The depth of burial appears to be more related to velocity than does lithology. In a few cases (Array Stations 6, 7, and 13, for example), there is some indication that higher S-wave velocities may be related to relatively thick layers of very dense or coarse sand. But in general, S-wave velocities increase smoothly with depth; P-wave velocities also increase smoothly with depth except for the previously-mentioned abrupt increase near the water table.

Figures 12 and 13 show comparisons between this study and two recent studies of shear-wave velocities in the Imperial Valley region. Velocities in the upper 12.5 m at Array Station 6 from this study are compared with those from a University of Texas study that used the spectral-analysis-of-surface-waves technique (fig. 12). This technique and results are discussed in a paper by Nazarian and Stokoe (1983). In figure 13 a comparison of the shear-wave velocities at the original El Centro Commercial-Avenue station (Array Station 9) is made between this study and one by Shannon and Wilson (1976) that also used the downhole technique. In both cases the comparisons are very favorable and thus bolster confidence in the results obtained at all 22 Imperial Valley, California strong-motion stations surveyed during this investigation.

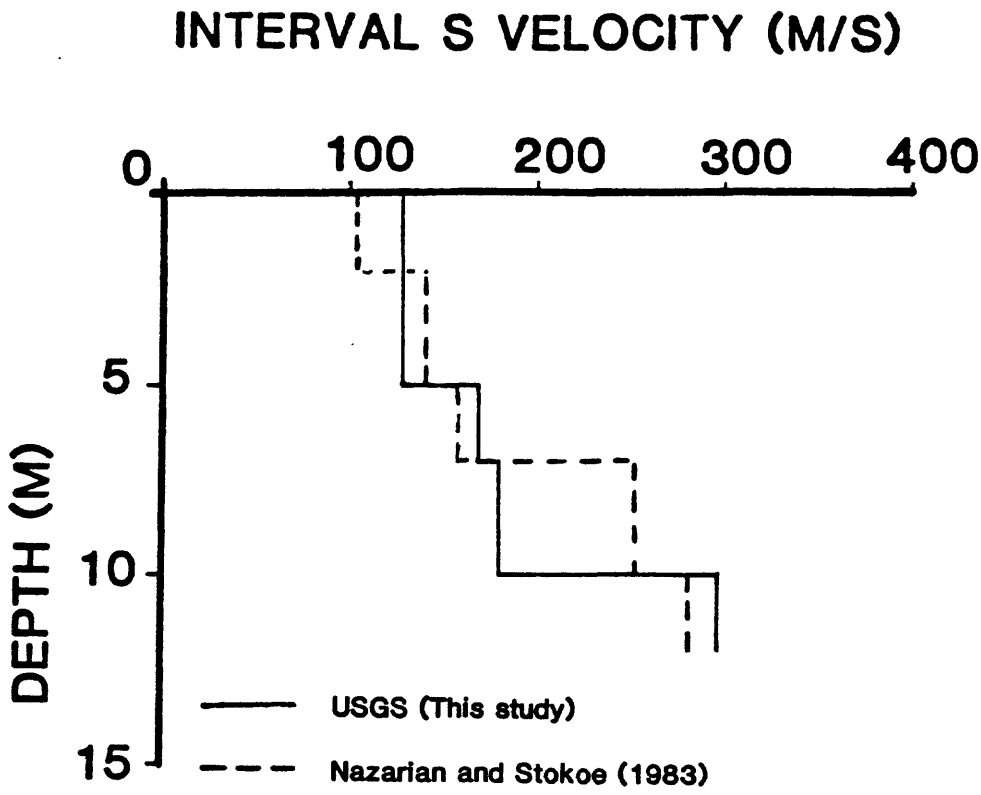


Figure 12. – Comparison of interval S–wave velocities at El Centro Array Station 6.

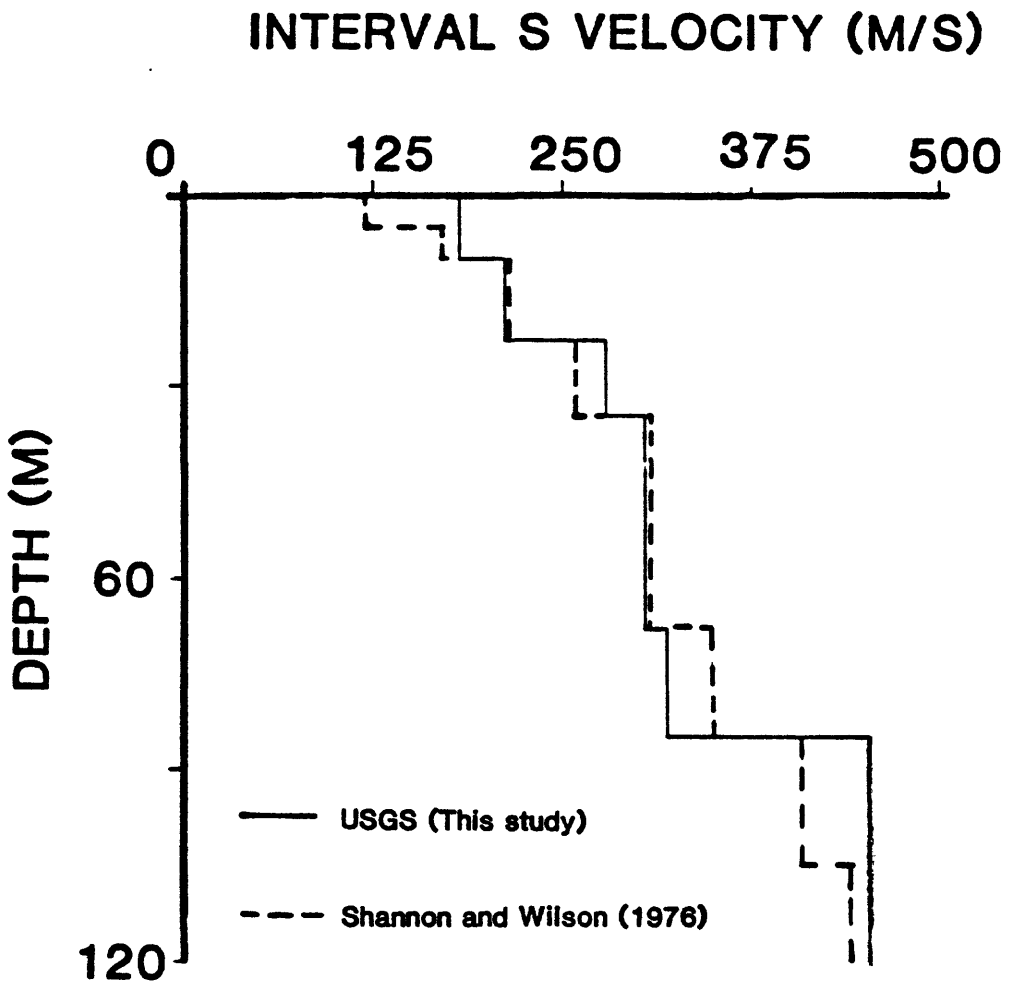


Figure 13. – Comparison of interval S–wave velocities at El Centro Array Station 9.

ACKNOWLEDGEMENTS

This project was supported by the National Science Foundation under Agreement No. PFR-8013665. Interpretations of the cone-penetrometer tests (CPT) were by M.J. Bennett and T.L. Youd of the U.S. Geological Survey (USGS). The CPT soil columns and descriptions (see appendix B) and soil data summary (tables 2 and 3) were provided by M.J. Bennett. A.V. Acosta, J.F. Gibbs, and D.A. Johnson of the USGS assisted with the downhole velocity surveys. T.E. Fumal, E.F. Roth, T.C. Urban, and R.E. Warrick of the USGS made useful suggestions and provided assistance at various times during the course of the field work. Special acknowledgement is given to W.B. Joyner of the USGS who suggested this project, obtained funding, and provided a computer program and helpful discussions and assistance throughout the course of this project. I am grateful to W.B. Joyner and R.E. Warrick for reviewing the manuscript and providing constructive criticism and significant improvements in its content and readability.

Appreciation is extended to the numerous property owners and public officials in the Imperial Valley for their assistance and for permission to perform the various investigations on their property. And special thanks to Mr. and Mrs. Jerry Pitchie (Array Station 6), Mr. Harley Baker (Array Station 3), and K. and Joe Omlin (Bonds Corner), for their patience, understanding, and sense of fair play during several periods of misfortune and hard luck.

REFERENCES

Biehler, S., R.L. Kovach, and C.R. Allen, 1964, Geophysical framework of the Gulf of California structural province: *American Association of Petroleum Geologists Memoir* **3**, p. 126-296.

Boore, D.M., and R.L. Porcella, 1982, Peak horizontal ground motions from the main shock: comparison with data from previous earthquakes, in the Imperial Valley, California, earthquake of October 15, 1979: *U.S. Geological Survey Professional Paper 1254*, p. 439-441.

Brady, A.G., V. Perez, and P.N. Mork, 1980, The Imperial Valley earthquake, October 15, 1979. Digitization and processing of accelerograph records: *U.S. Geological Survey Open-File Report 80-703*, 309 p.

Cloud, W.K., 1964, The cooperative program of earthquake investigation, in Carder, D.S., ed., Earthquake investigations in the western United States, 1931-1964: *U.S. Department of Commerce, Coast and Geodetic Survey Publication 41-2*, p. 3-4.

Dibblee, T.W., 1954, Geology of the Imperial Valley region, California in Jahns R.H., ed., Geology of southern California: *California Division of Mines and Geology Bulletin 170*, 1, ch. II, p. 21-28.

ERTEC, 1981, Cone penetration testing, strong-motion recording stations, Imperial Valley, California: *Prepared for the U.S. Geological Survey, Project No. 80-221*, ERTEC Western, Inc., Long Beach, California 90807.

Fuis, G.S., W.D. Mooney, J.H. Healey, G.A., McMechan, and W.J. Lutter, 1982, Crustal structure of the Imperial Valley region, in the Imperial Valley, California, earthquake of October 15, 1979: *U.S. Geological Survey Professional Paper 1254*, p. 25-49.

Fumal, T.E., 1978, Correlations between seismic wave velocities and physical properties of geologic materials, San Francisco Bay region, California: *U.S. Geological Survey Open-File Report 78-1067*, 114 p.

Fumal, T.E., J.F. Gibbs, and E.F. Roth, 1981, In-situ measurements of seismic velocity at 19 locations in the Los Angeles, California region: *U.S. Geological Survey Open-File Report 81-399*, 121 p.

Gibbs, J.F., T.E. Fumal, R.D. Borcherdt, and E.F. Roth, 1977, In-situ measurements of seismic velocities in the San francisco Bay region - part III: *U.S. Geological Survey Open-File Report 77-850*, 143 p.

Henyey, T.L., and J.L. Bischoff, 1973, Tectonic elements of the northern part of the Gulf of California: *Geological Society of America Bulletin*, **84**, p. 315-330.

Hileman, J.A., C.R. Allen, and J.M. Nordquist, 1973, Seismicity of the southern California region 1 January 1932 to 31 December 1972: *California Institute of Technology*, Seismological Laboratory, p. 72-75.

Johnson, C., and D. Hadley, 1976, Tectonic implications of the Brawley earthquake swarm, Imperial Valley, California, January 1975: *Seismological Society of America Bulletin*, **66**, p. 1133-1144.

Joyner, W.B., and D.M. Boore, 1981, Peak horizontal acceleration and velocity from strong-motion records including records from the 1979 Imperial Valley, California, earthquake: *Seismological Society of America Bulletin*, **71**, p. 2011-2038.

Kobayashi, N., 1959, A method of determining the underground structure by means of SH waves: *Zisin*, n. II, **12**, p. 19-24.

Matthiesen, R.B., 1978, On the development of strong-motion networks in the United States: *U.S. Geological Survey Open-File Report 78-1024*, 91 p.

Nazarian, S., and K.H. Stokoe, II, 1984, In-situ shear-wave velocities from spectral analysis of surface waves: *Proceedings, Eighth World Conference on Earthquake Engineering*, July 21-28, 1984, San Francisco, California, in press.

Porcella, R.L., and R.B. Mathiesen, 1979a, Strong-motion instrumentation in the Imperial Valley, California: *Proceedings, Symposium los Asentamientos Humanos en la Falla de San Andreas*, Instituto Tecnologico regional de Tijuana, B.C., September 5-8, 1979, p. 122-134.

_____, 1979b, Preliminary summary of the U.S. Geological Survey strong-motion records from the October 15, 1979 Imperial Valley earthquake: *U.S. Geological Survey Open-File Report 79-1654*, 41 p.

Porcella, R.L., R.B. Mathieson, and R.P. Maley, 1982, Strong-motion data recorded in the United States, in the Imperial Valley, California, earthquake of October 15, 1979: *U.S. Geological Survey Professional Paper 1254*, p. 289-318.

Richter C.F., 1958, Elementary seismology: San Francisco, Freeman and Company, p. 66-78.

Schwarz, S.D., and J.M. Musser, 1972, Various techniques for making in-situ shear-wave velocity measurements - a description and evaluation: *Proceedings of the International Microzonation Conference*, Seattle, Washington, II, p. 593-608.

Shannon and Wilson, Inc., and Agbabian Associates, 1976, Geotechnical and strong-motion earthquake data from U.S. accelerograph stations: *NUREG-0029*, 1, NRC-6, N.T.I.S., Springfield, Virginia 22161.

Sharp, R.V., 1972, Tectonic setting of the Salton Trough, in The Borrego Mountain earthquake of April 9, 1968: *U.S. Geological Survey Professional Paper 787*, p. 3-15.

Turner, E., and K.H. Stokoe, II, 1982, Static and dynamic properties of clayey soils subjected to the 1979 Imperial Valley earthquake: *Geotechnical Engineering Report GR82-26*, University of Texas, Austin, Texas.

Ulrich, F.P., 1941, The Imperial Valley earthquakes of 1940: *Bulletin, Seismological Society of America*, **31**, p. 13-31.

Warrick, R.E., 1974, Seismic investigation of a San Francisco Bay mud site: *Bulletin, Seismological Society of America*, **64**, n. 2, p. 375-385.

Warrick, R.E., D.B. Hoover, W.H. Jackson, L.C. Pakiser, and J.C. Roller, 1961, The specification and testing of a seismic refraction system for crustal studies: *Geophysics*, **26**, p. 820-824.

Youd, T.L., and M.J. Bennett, 1983, Liquefaction sites, Imperial Valley, California: *Journal of the Geotechnical Engineering Division, American Society of Civil Engineers*, **109**, n. 3, p. 440-457.

APPENDICES

NOTE: Stations are listed in the following order in Appendices B through E.

Bonds Corner

Calexico

Holtville

El Centro Array

Stations 2 through 13

El Centro Differential Array

Imperial County Services Building

Brawley

Westmorland

Parachute Test Site

Calipatria

Salton Sea

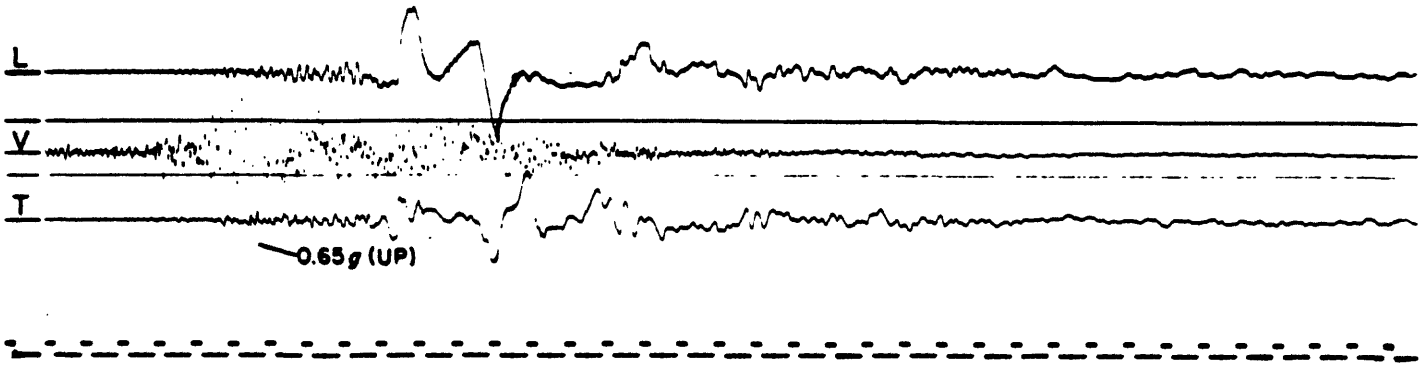
APPENDIX A.

SELECTED USGS ACCELEROGRAMS FROM

THE 1979 IMPERIAL VALLEY EARTHQUAKE

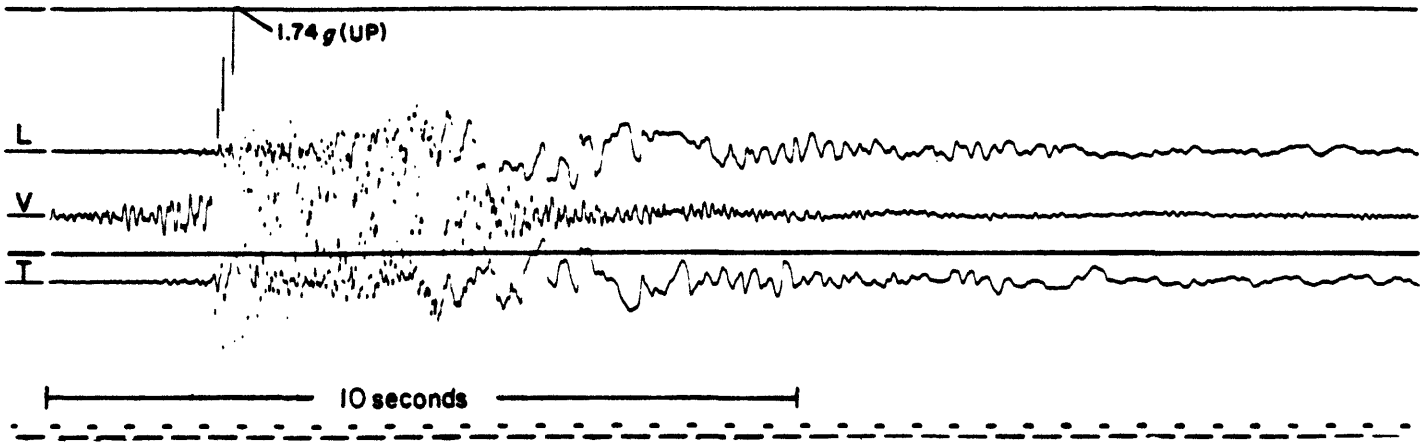
(from Porcella and others, 1982).

EL CENTRO ARRAY STATION 7

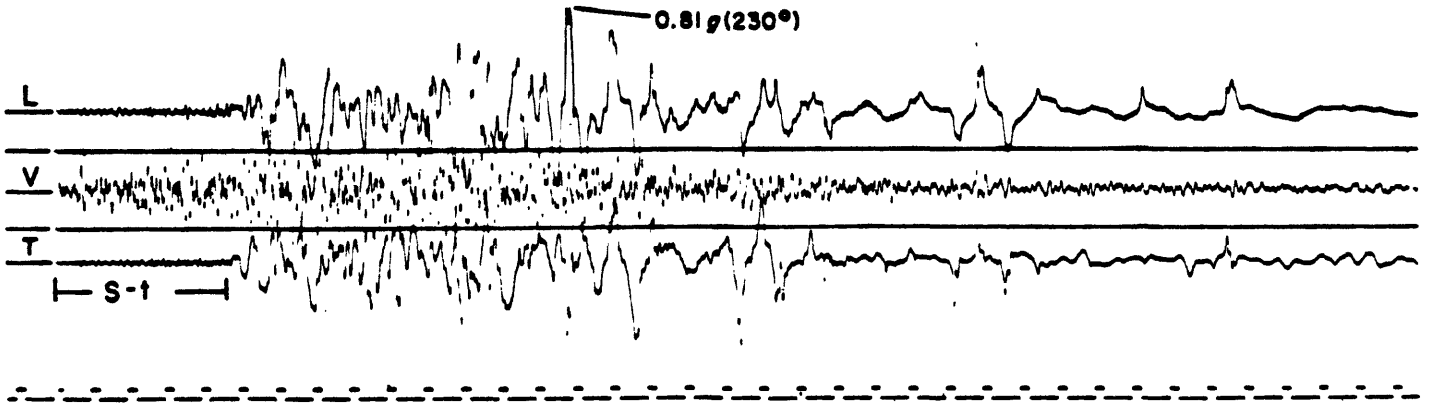


5cm

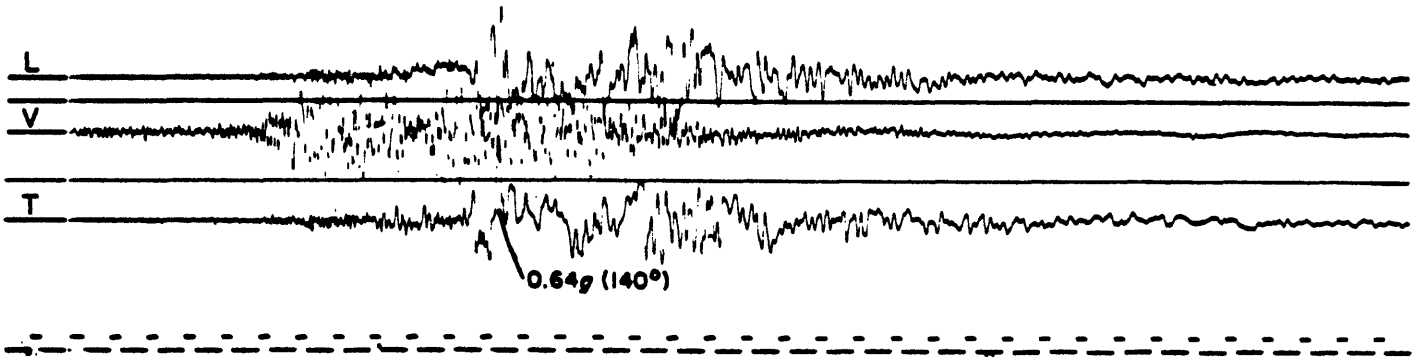
EL CENTRO ARRAY STATION 6



BONDS CORNER



EL CENTRO ARRAY STATION 8



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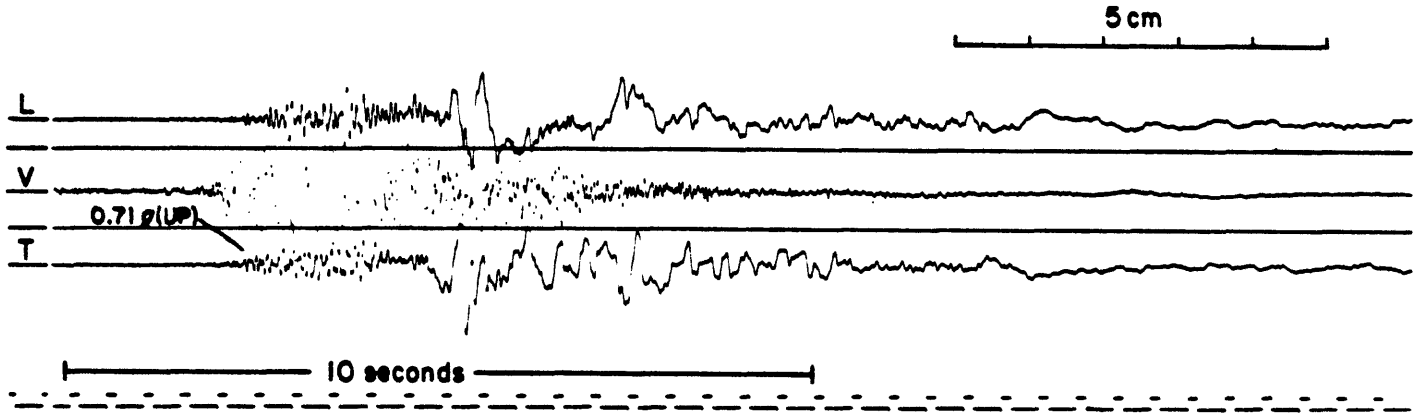
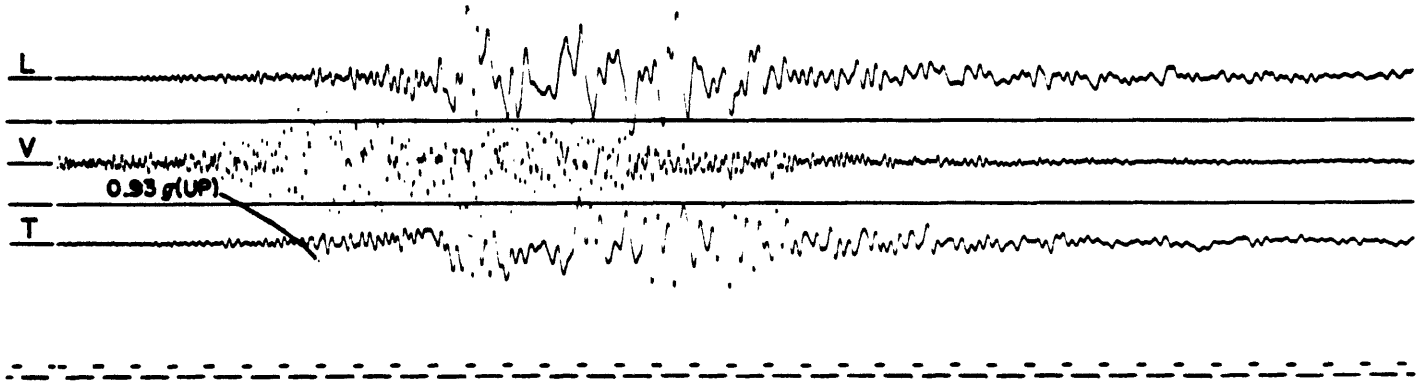
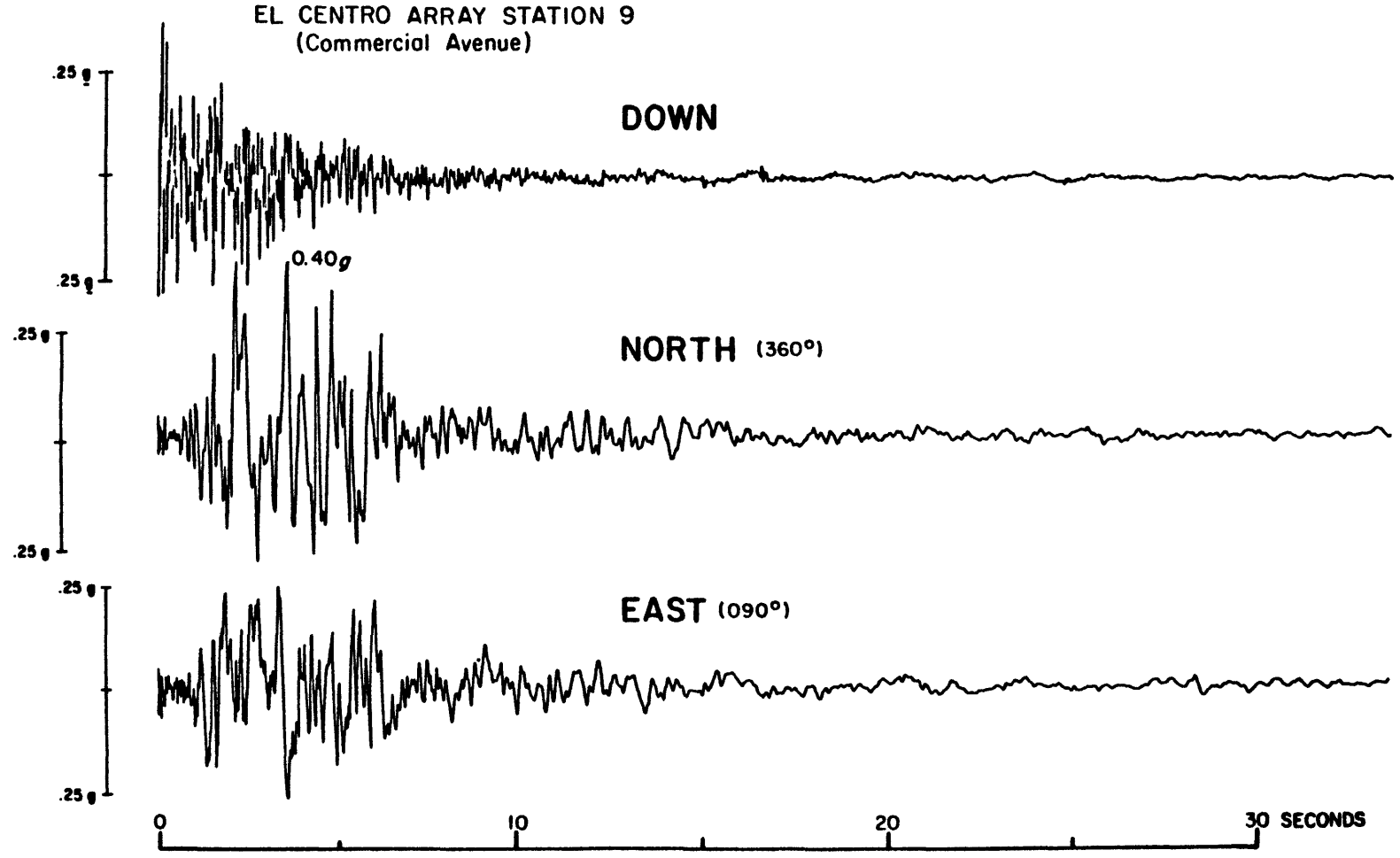
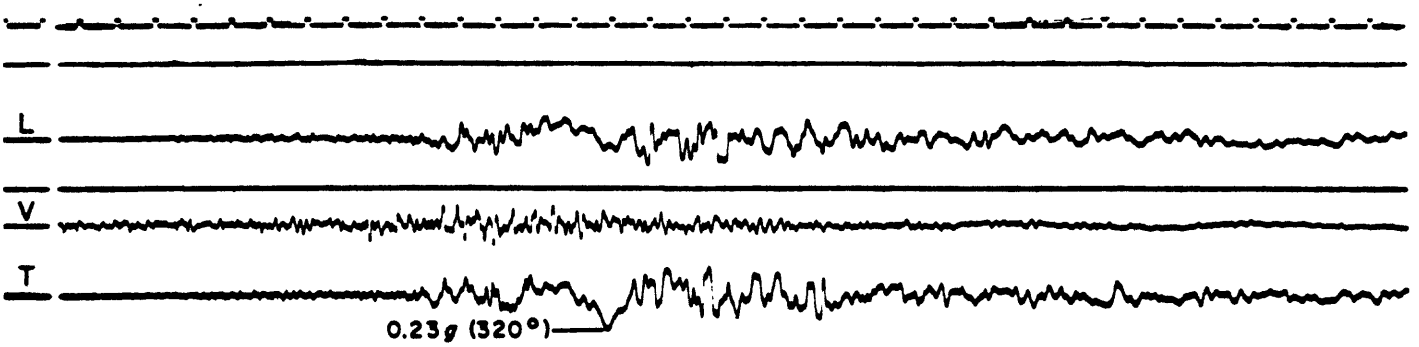


EL CENTRO DIFFERENTIAL ARRAY



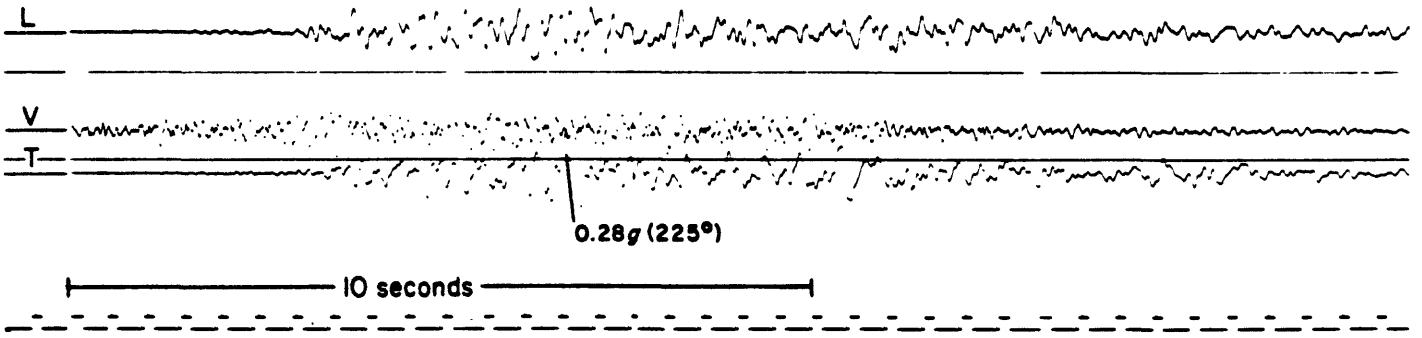

EL CENTRO ARRAY STATION 9
(Commercial Avenue)
.25 g
.25 g
DOWN
0.40g
.25 g
.25 g
NORTH (360°)
.25 g
.25 g
EAST (090°)
0
10
20
30 SECONDS

EL CENTRO ARRAY STATION 10

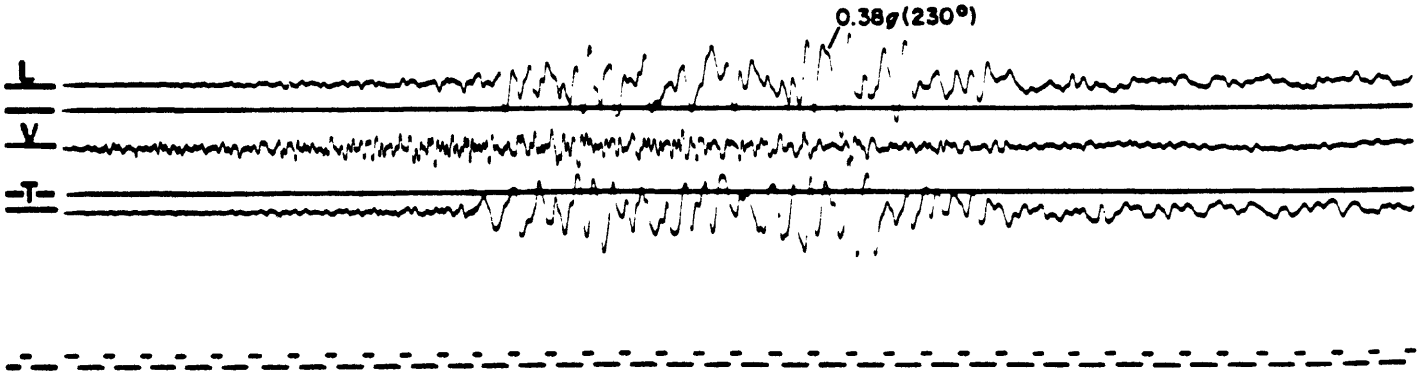


5cm

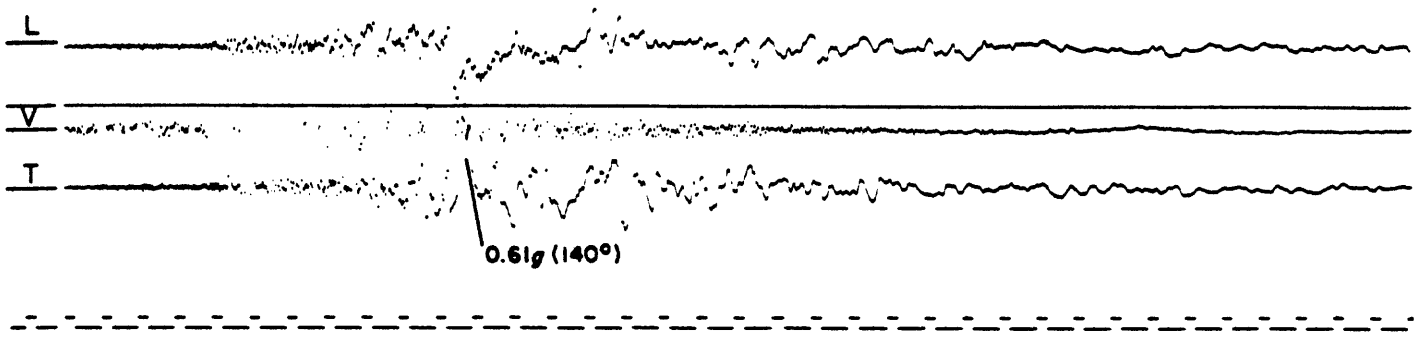
CALEXICO FIRE STATION



EL CENTRO ARRAY STATION 11

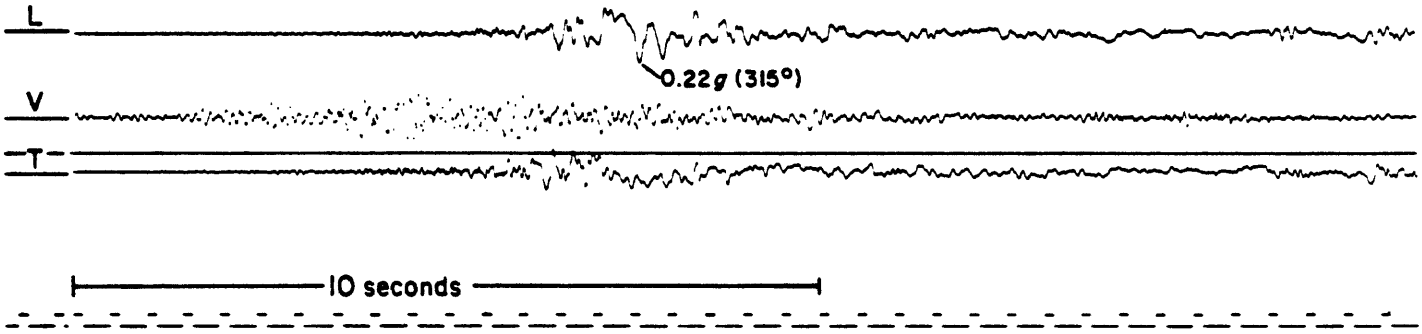


EL CENTRO ARRAY STATION 4

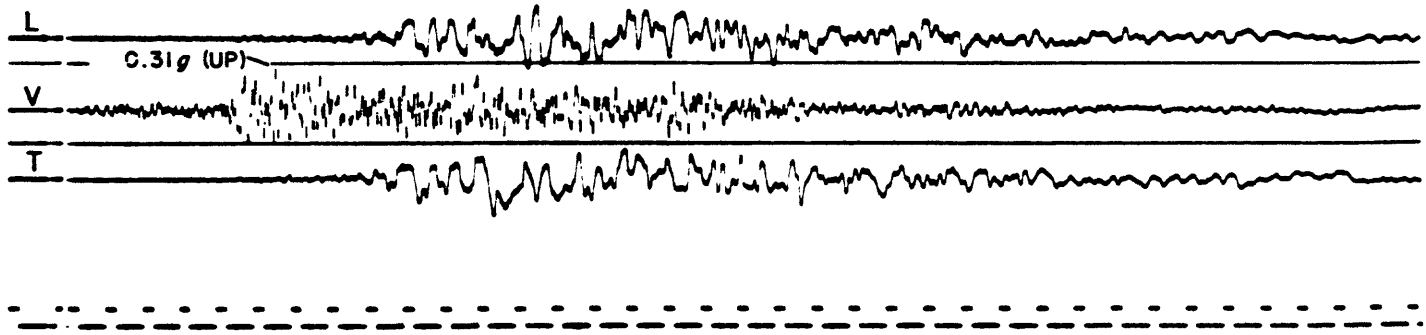


5cm

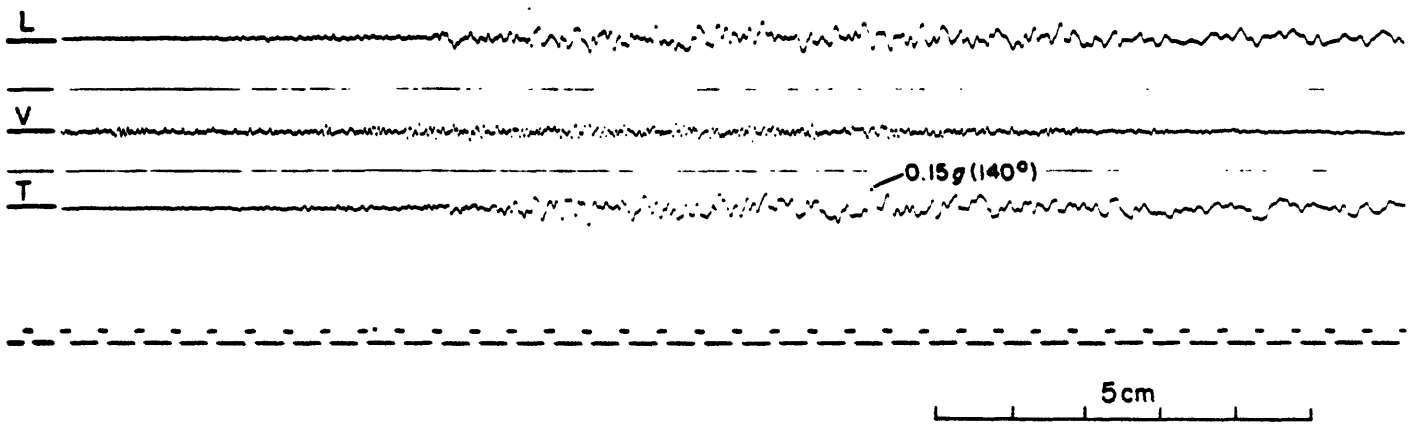
BRAWLEY AIRPORT



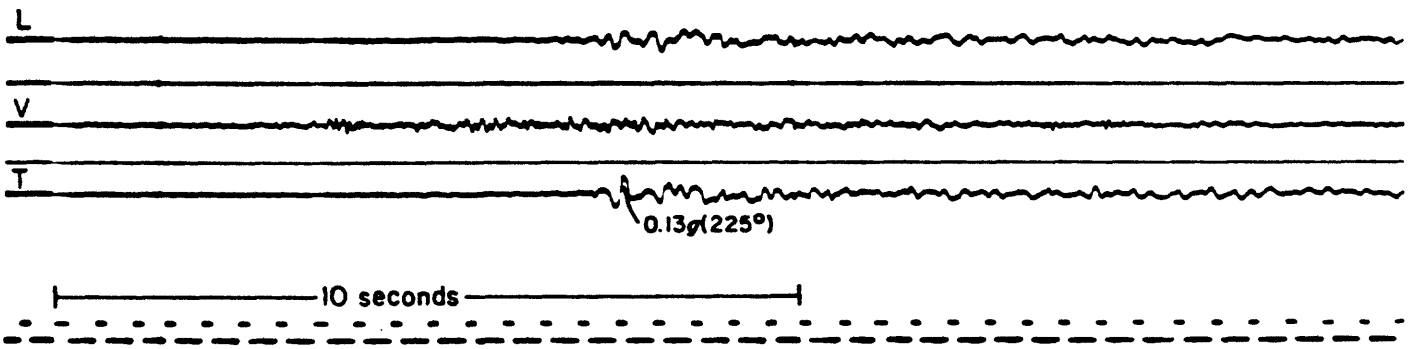
HOLTVILLE POST OFFICE



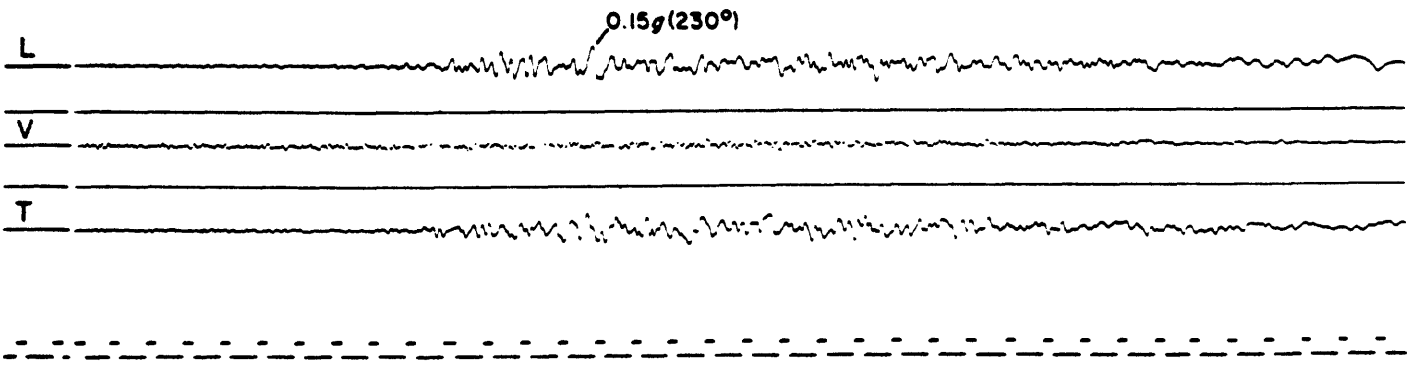
EL CENTRO ARRAY STATION 12



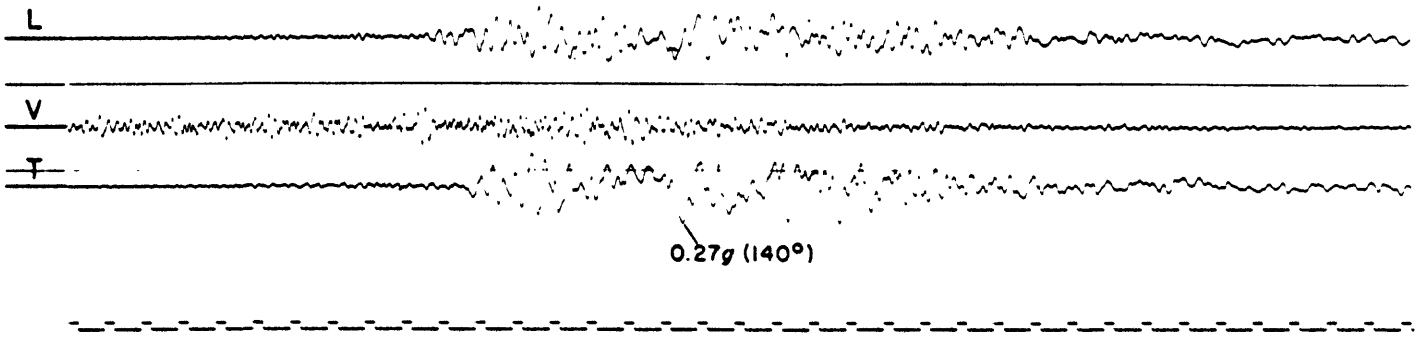
CALIPATRIA FIRE STATION



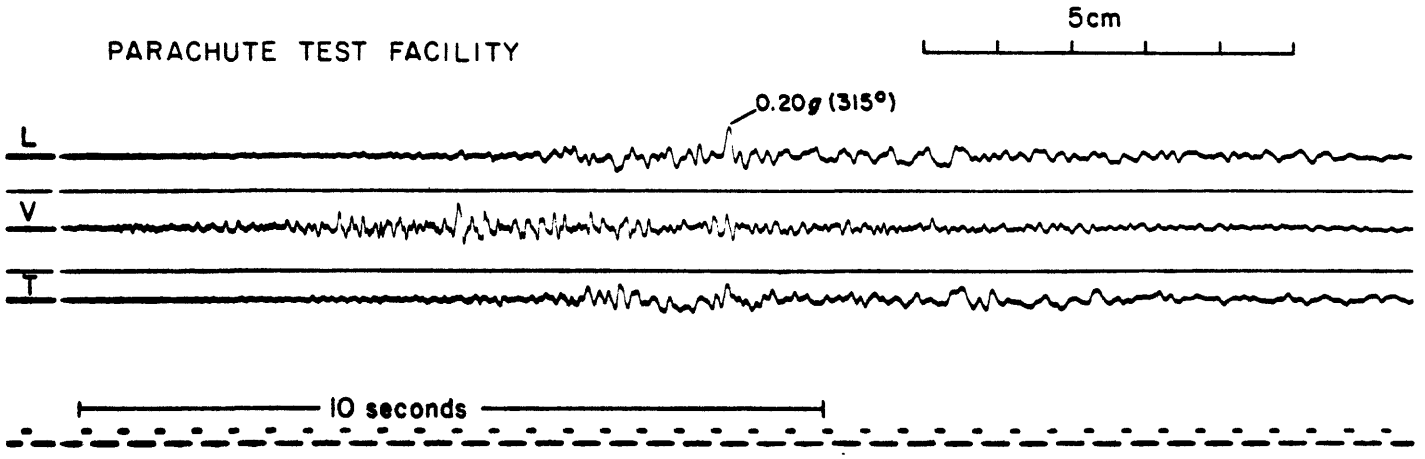
EL CENTRO ARRAY STATION 13



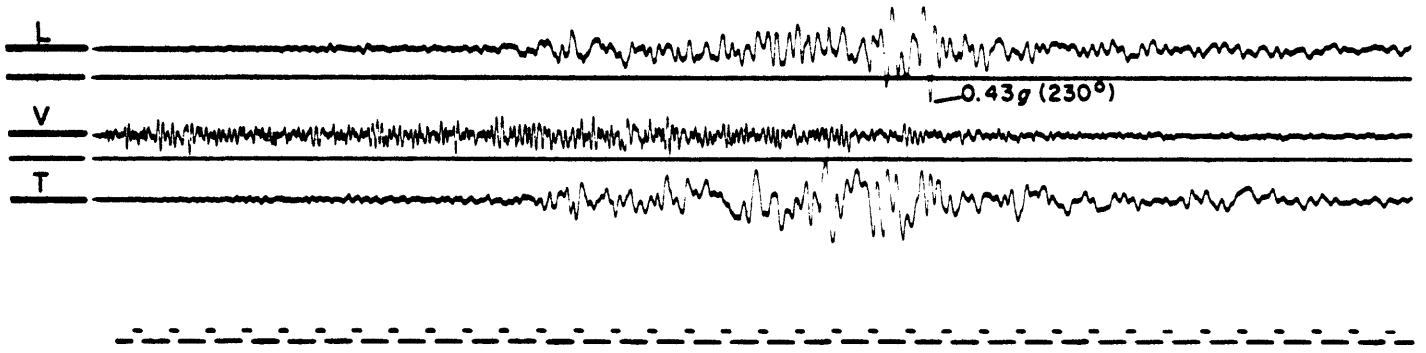
EL CENTRO ARRAY STATION 3



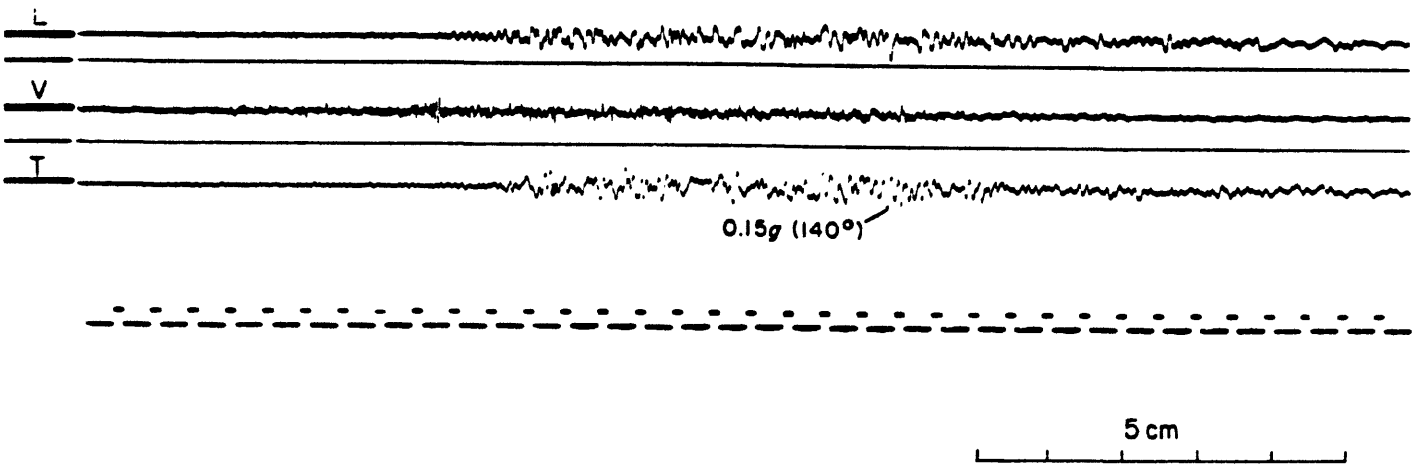
PARACHUTE TEST FACILITY



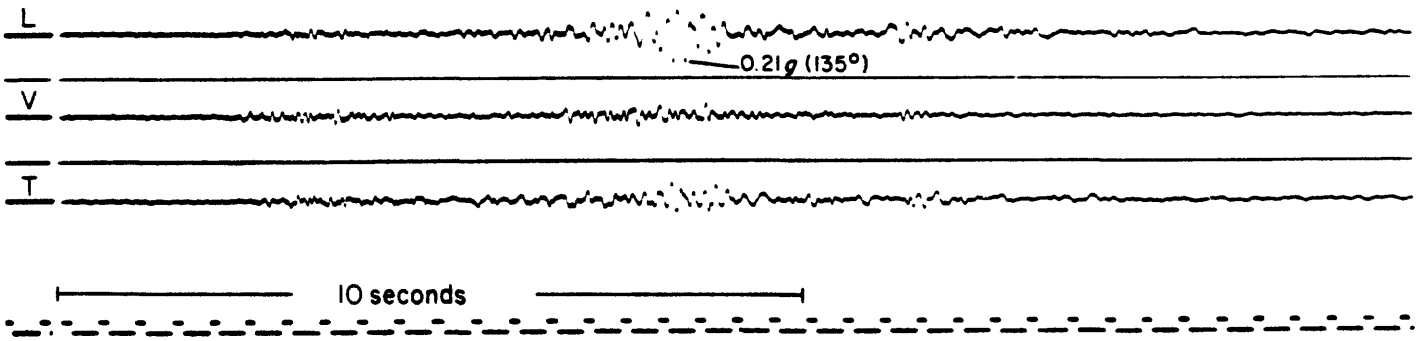
EL CENTRO ARRAY STATION 2



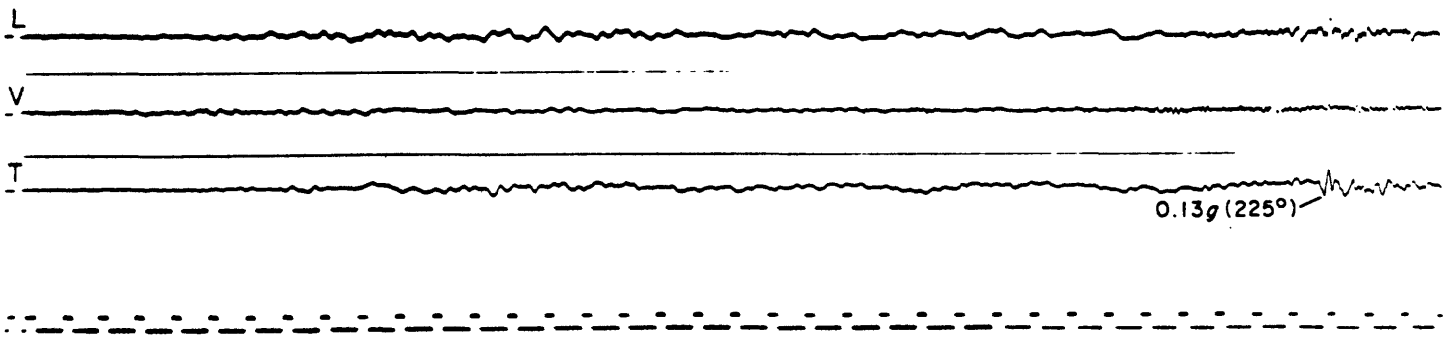
EL CENTRO ARRAY STATION I



SUPERSTITION MOUNTAIN



SALTON SEA WILDLIFE REFUGE

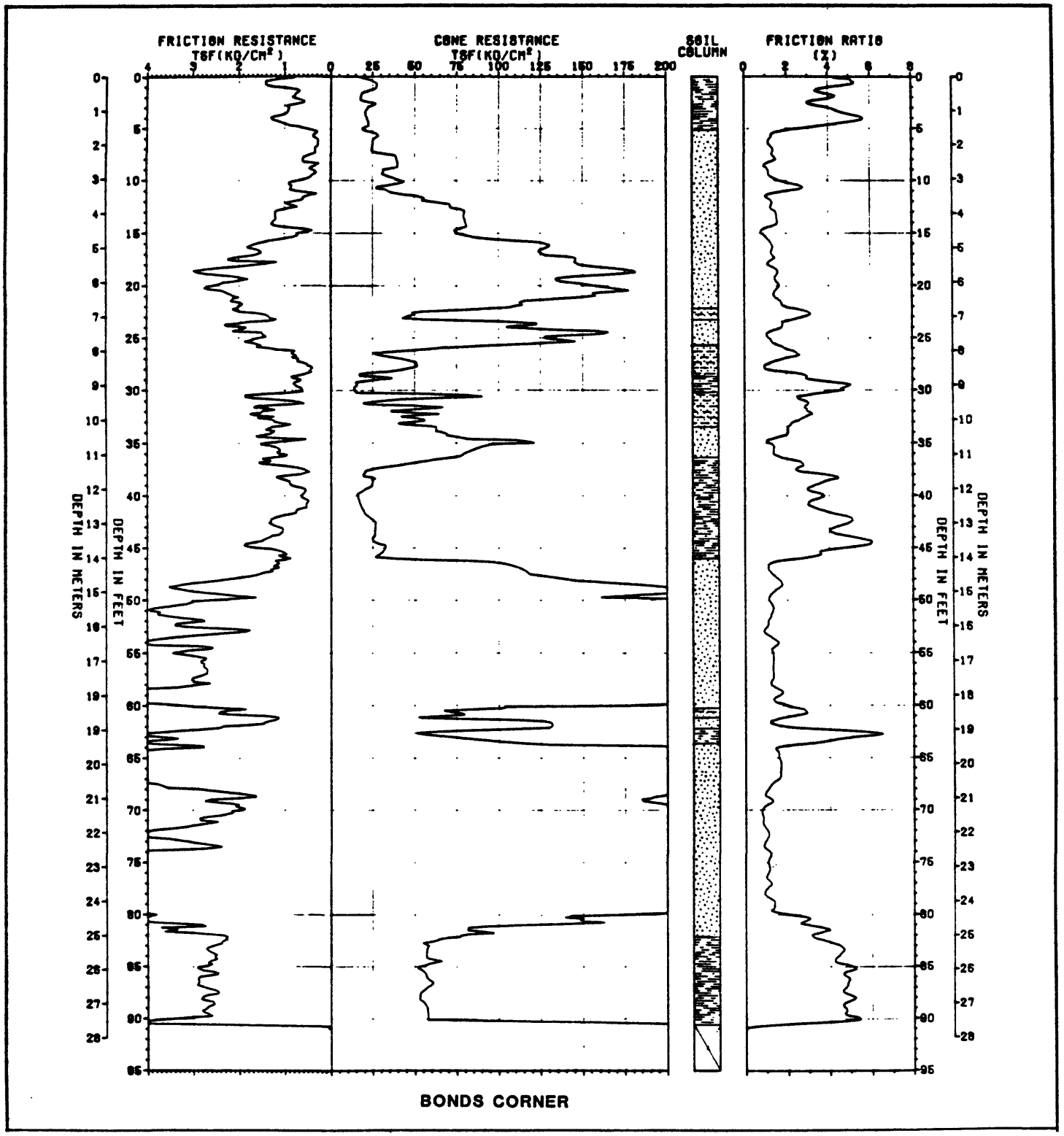


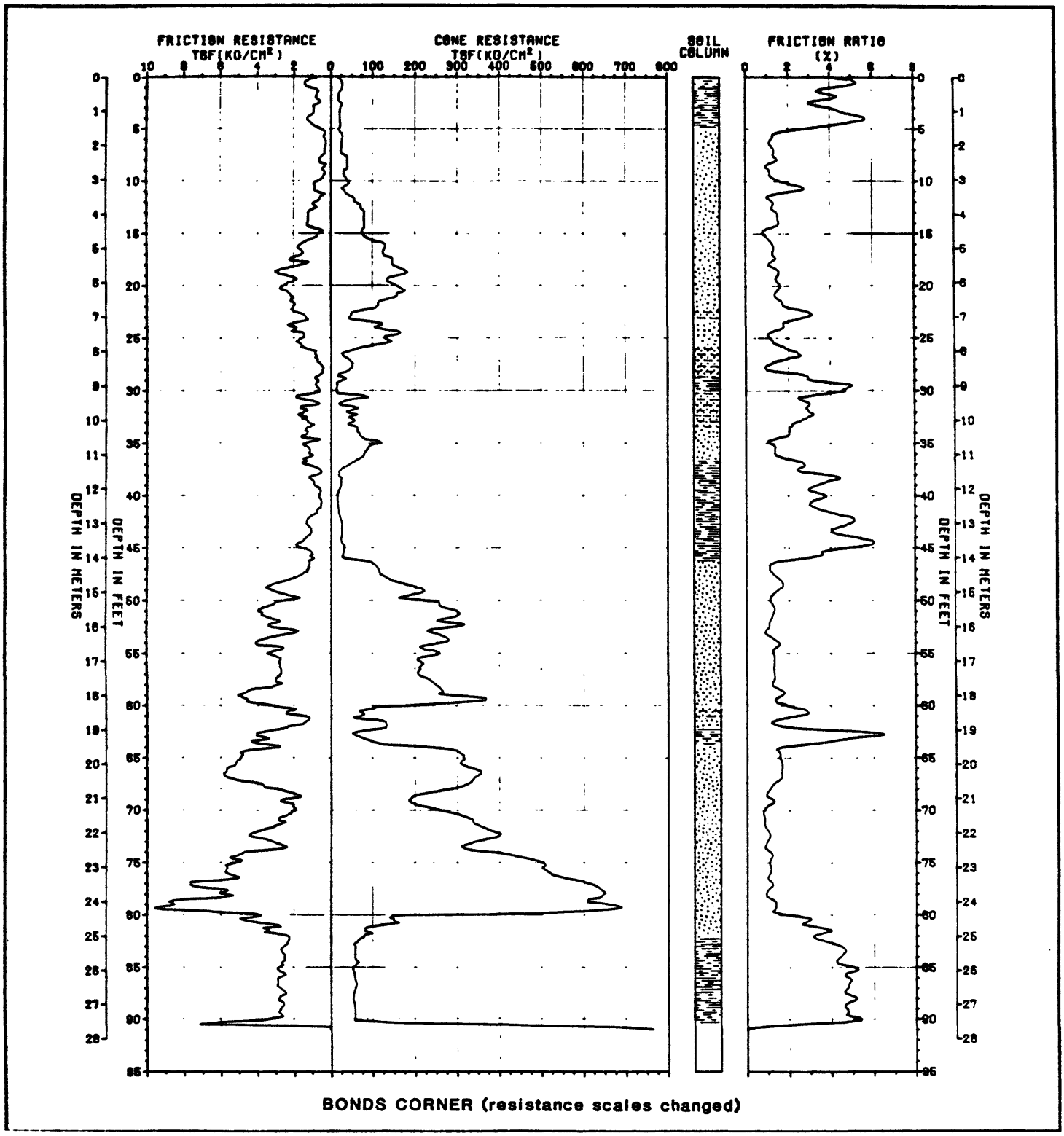
APPENDIX B.

CONE-PENETRATION TESTS

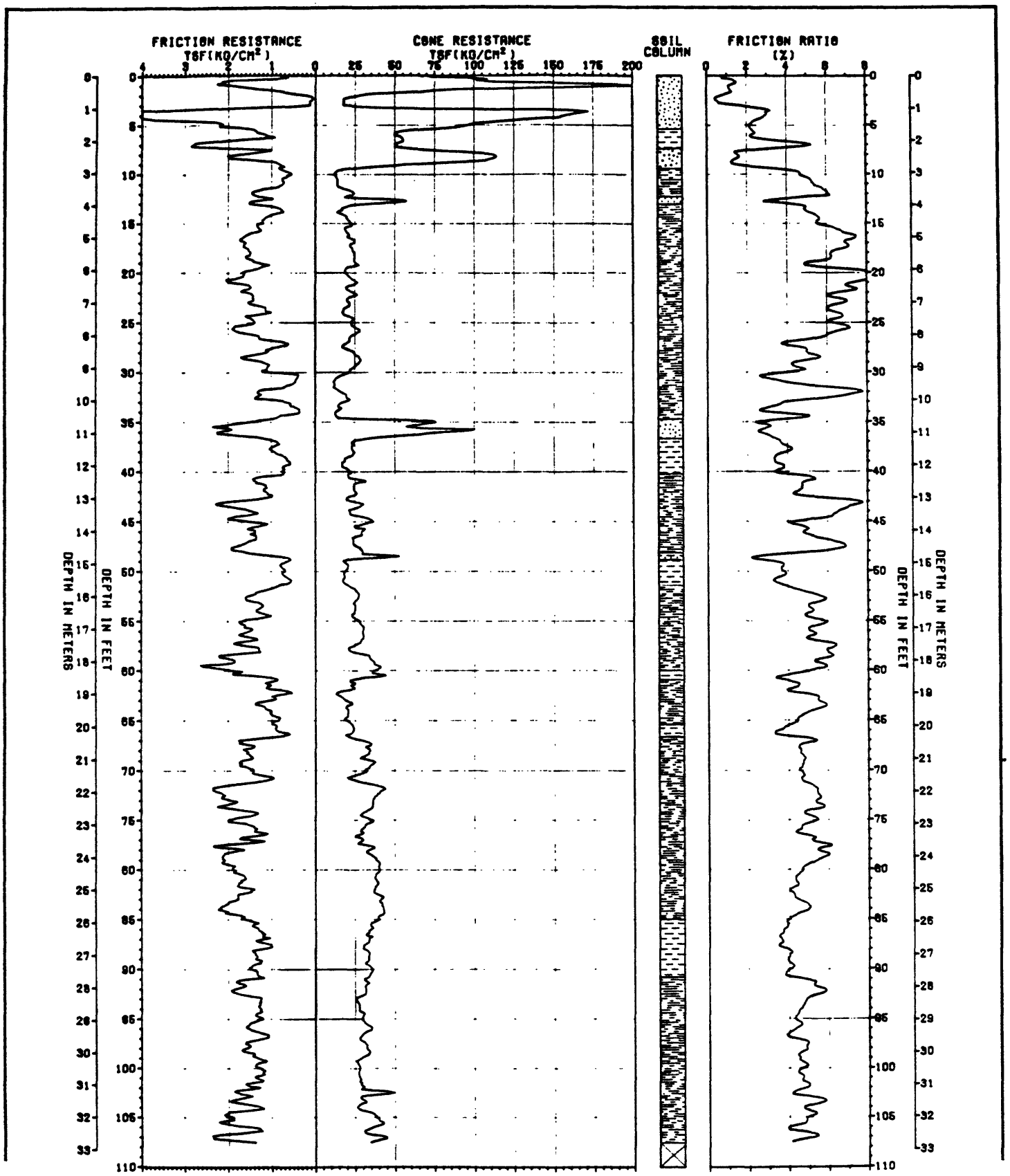
AT SELECTED ACCELEROGRAPH STATIONS

(from ERTEC, 1981).

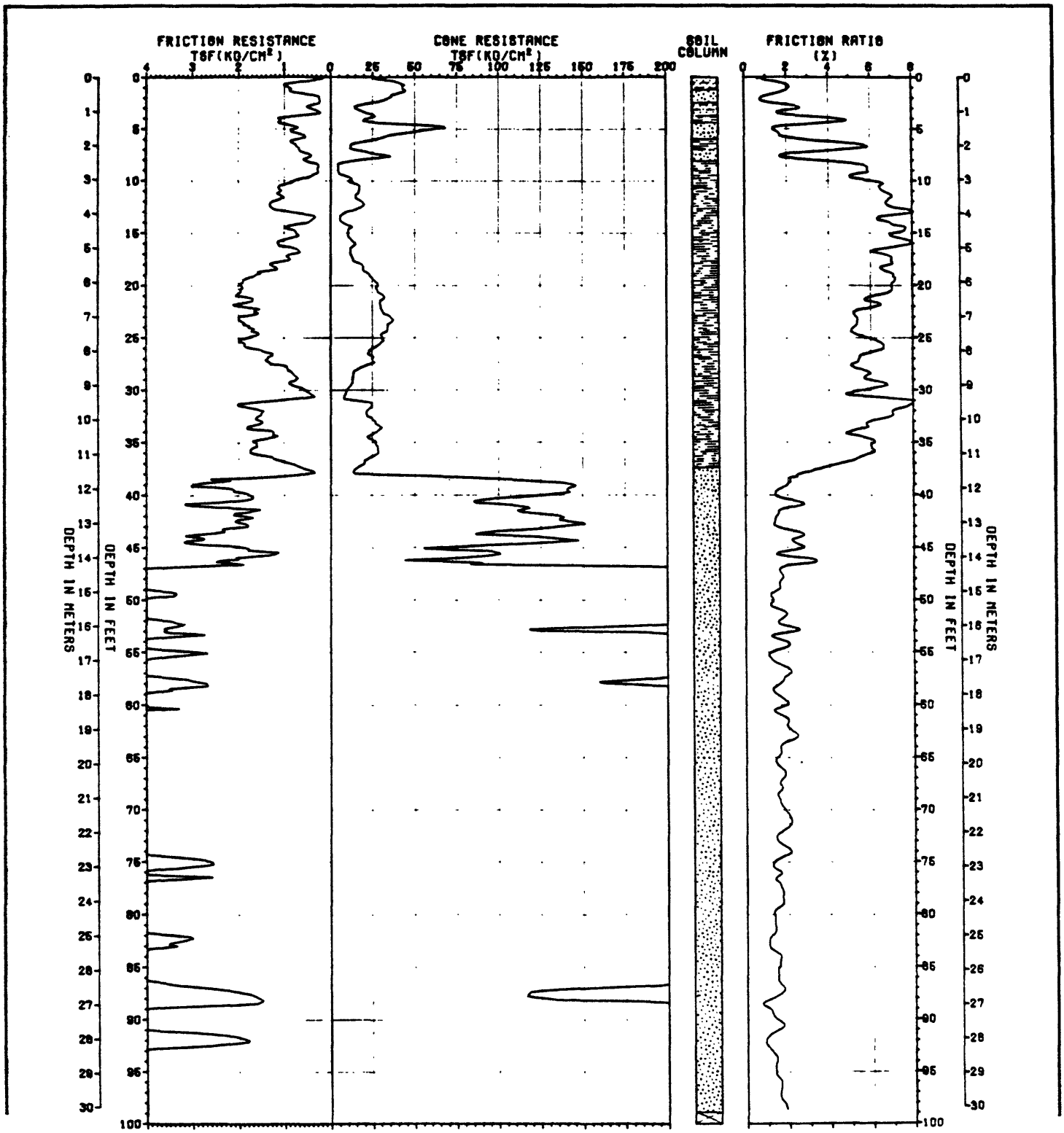

FRICTION RESISTANCE
TSF(KG/CM²)
CONE RESISTANCE
TSF(KG/CM²)
SOIL
COLUMN
FRICTION RATIO
(%)
DEPTH IN METERS
DEPTH IN FEET
BONDS CORNER



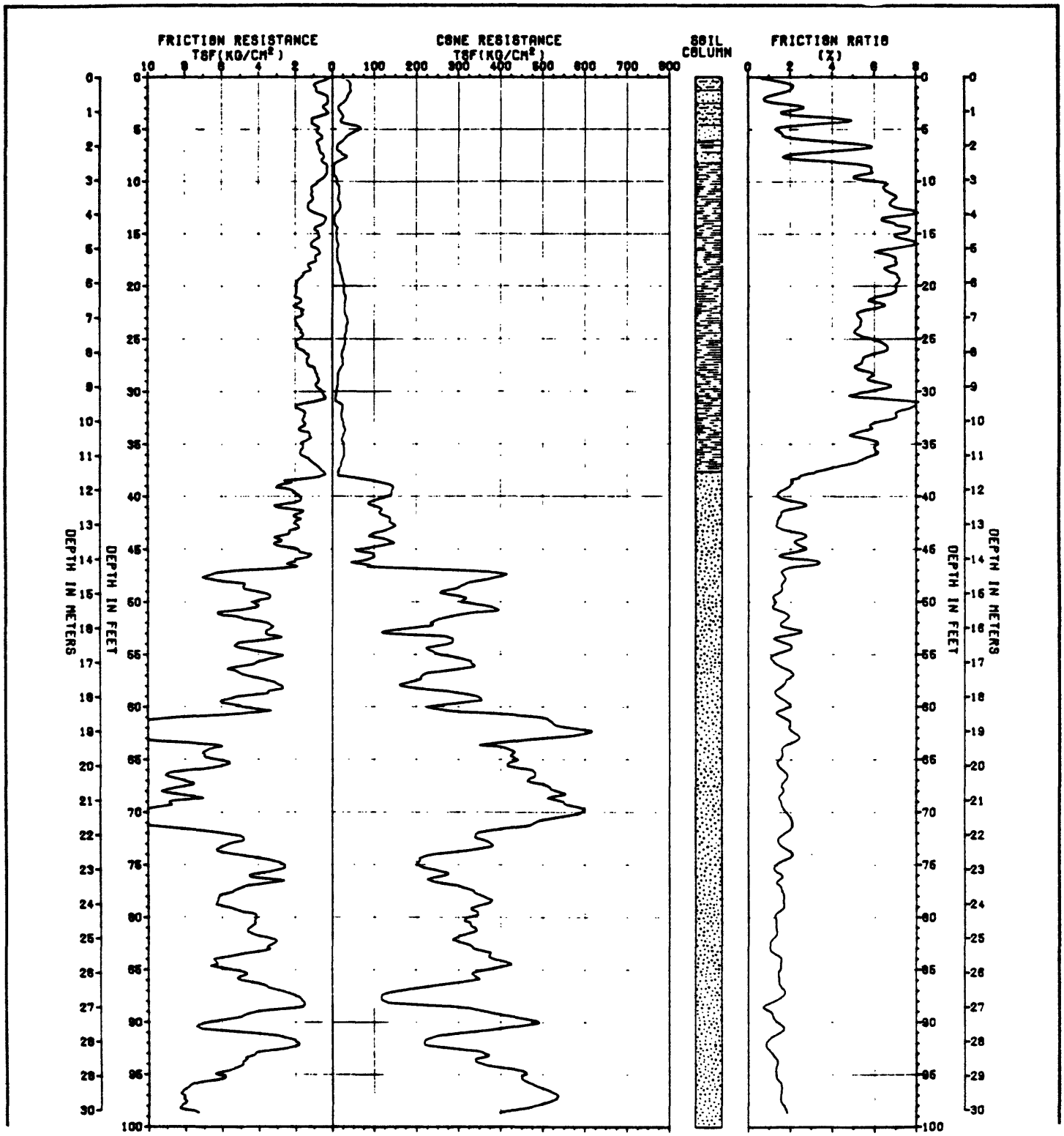
BONDS CORNER (resistance scales changed)



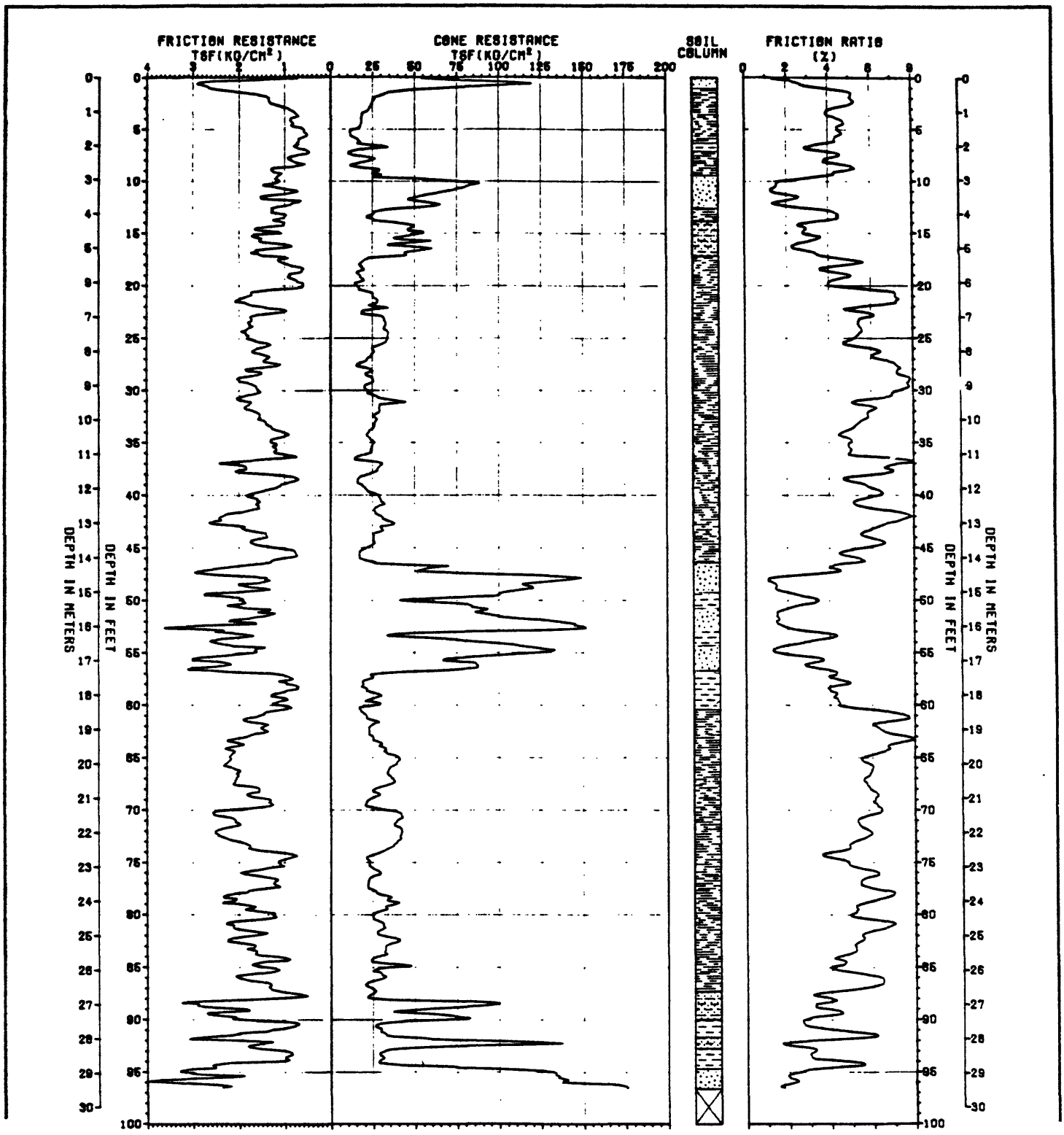
HOLTVILLE POST OFFICE



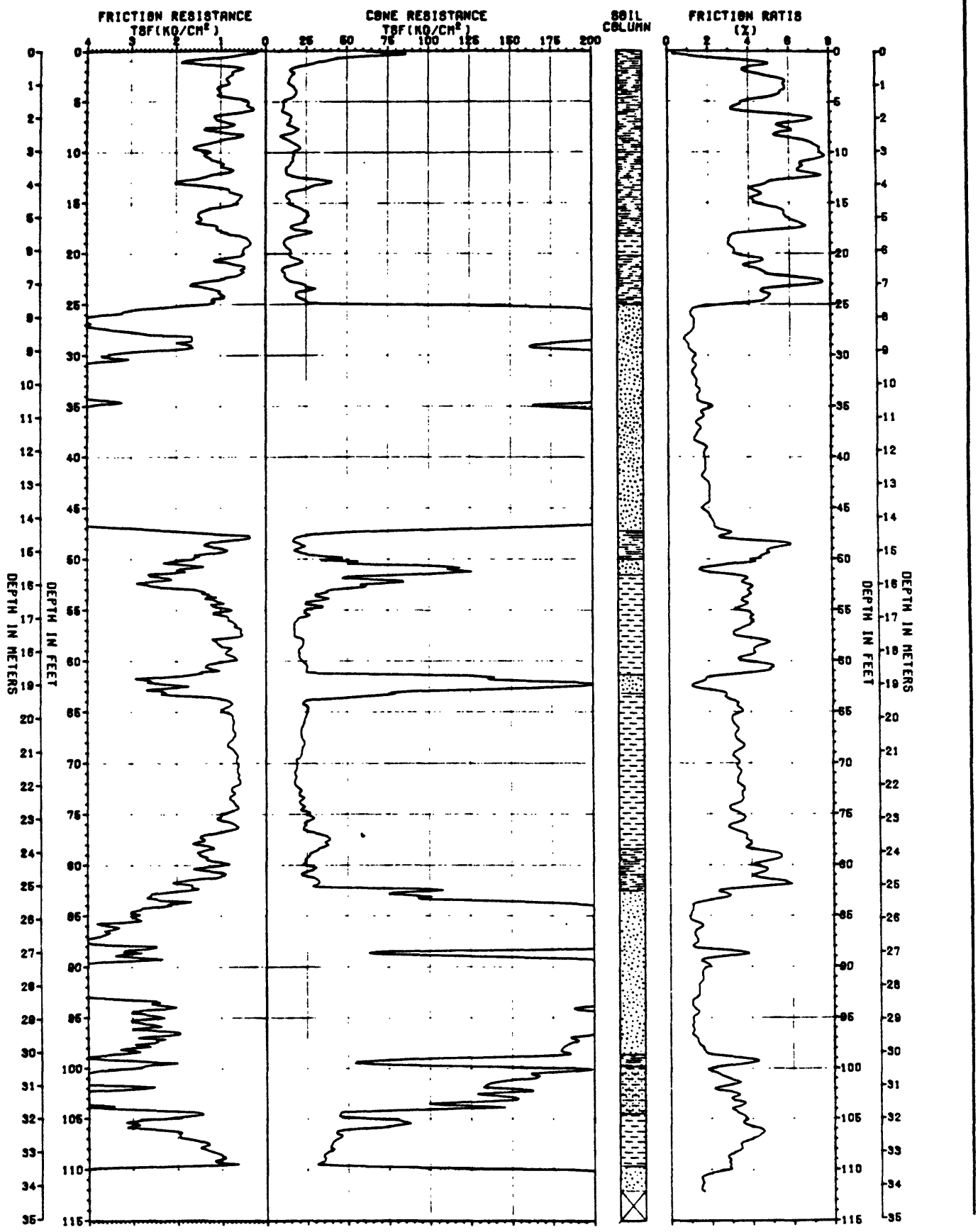
EL CENTRO ARRAY STATION 4



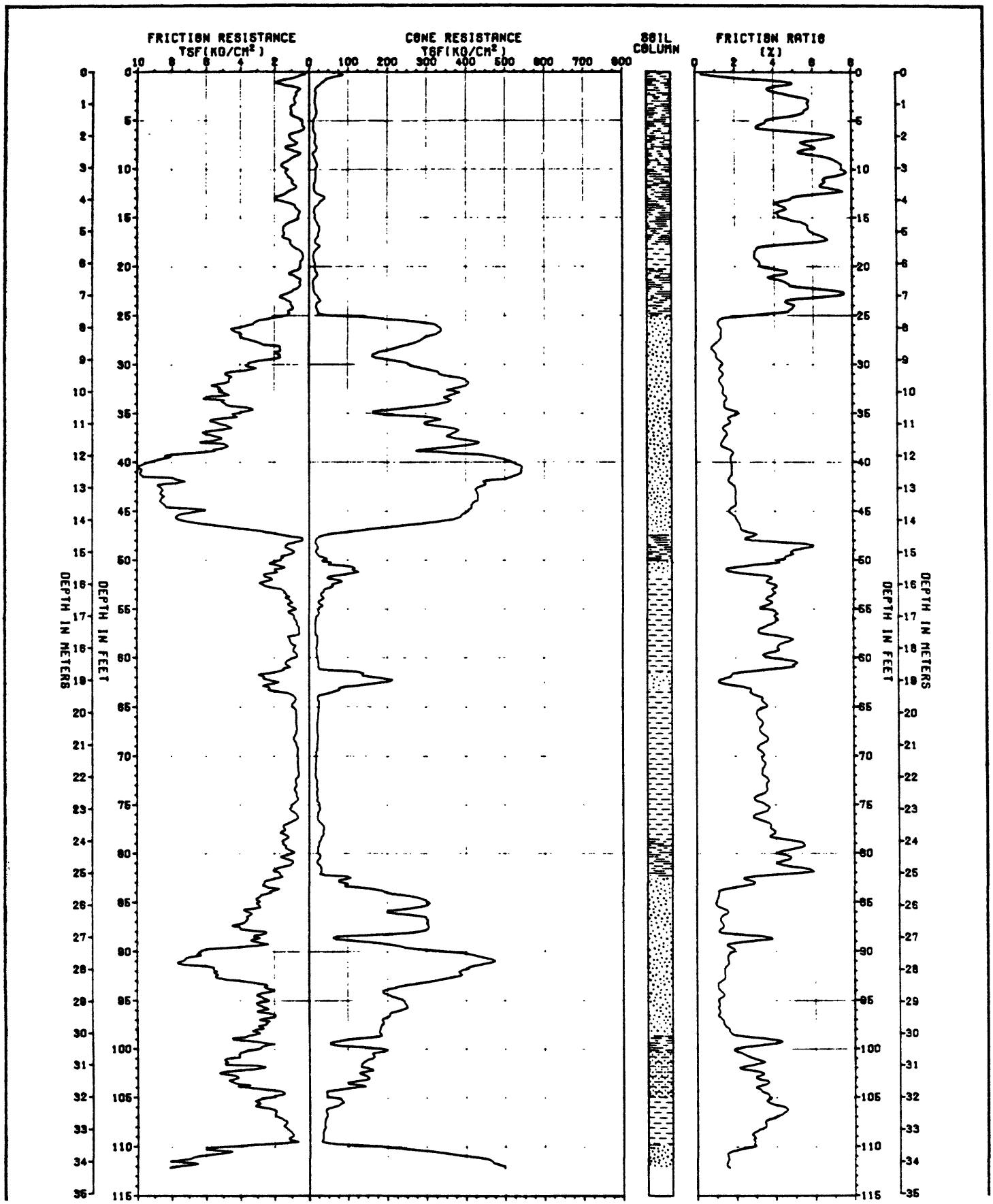
EL CENTRO ARRAY STATION 4 (resistance scales changed)



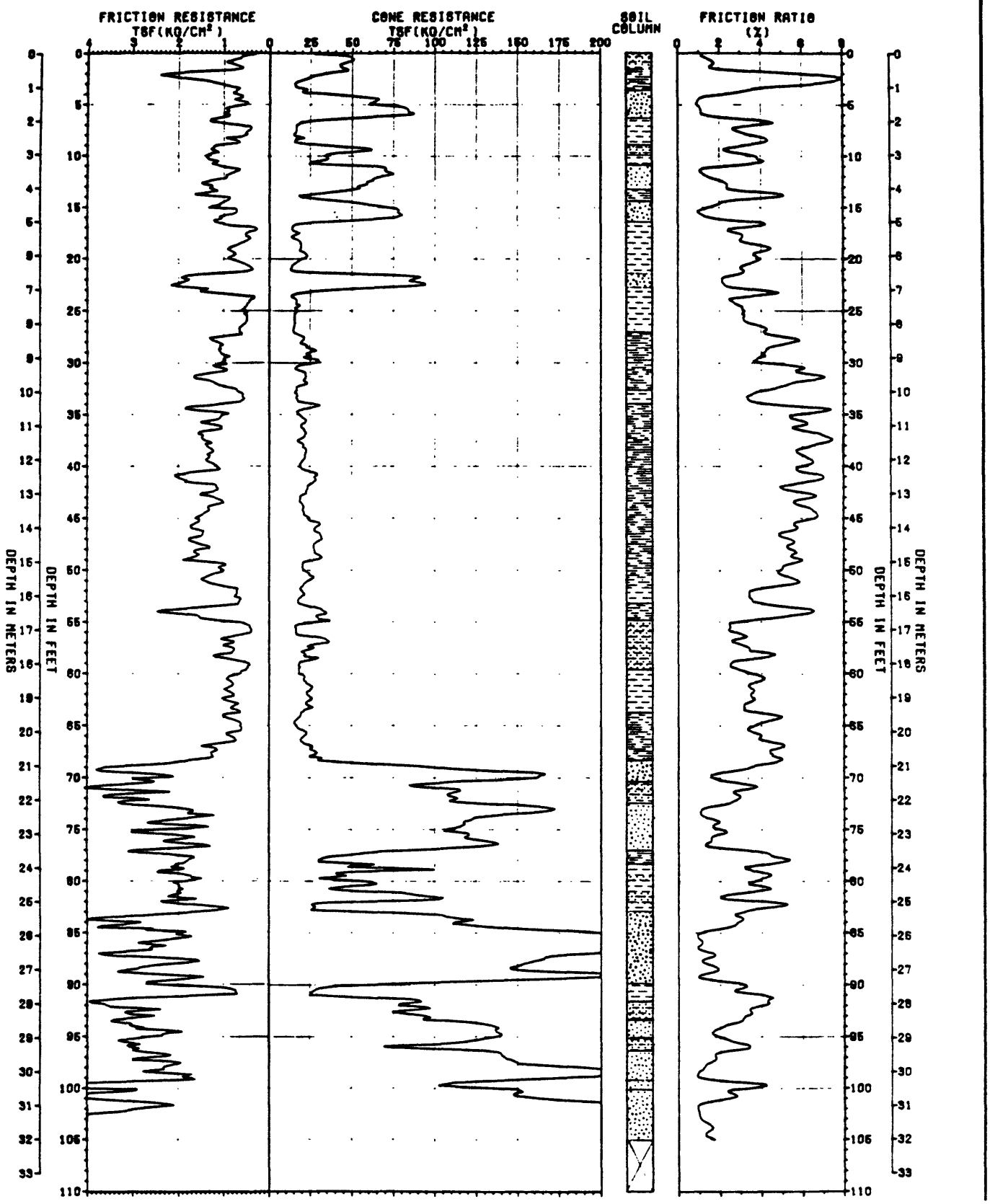
EL CENTRO ARRAY STATION 5



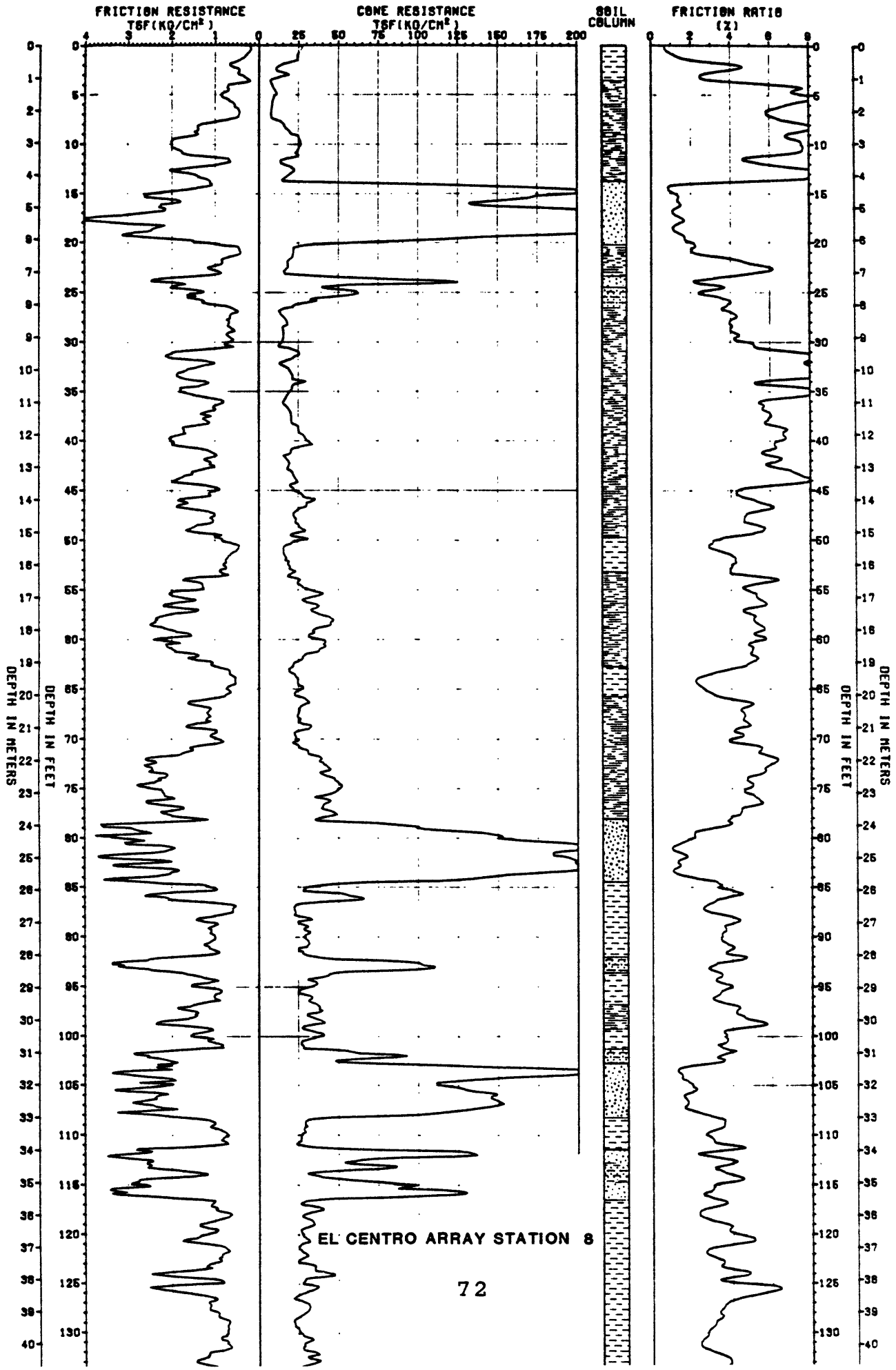
EL CENTRO ARRAY STATION 6

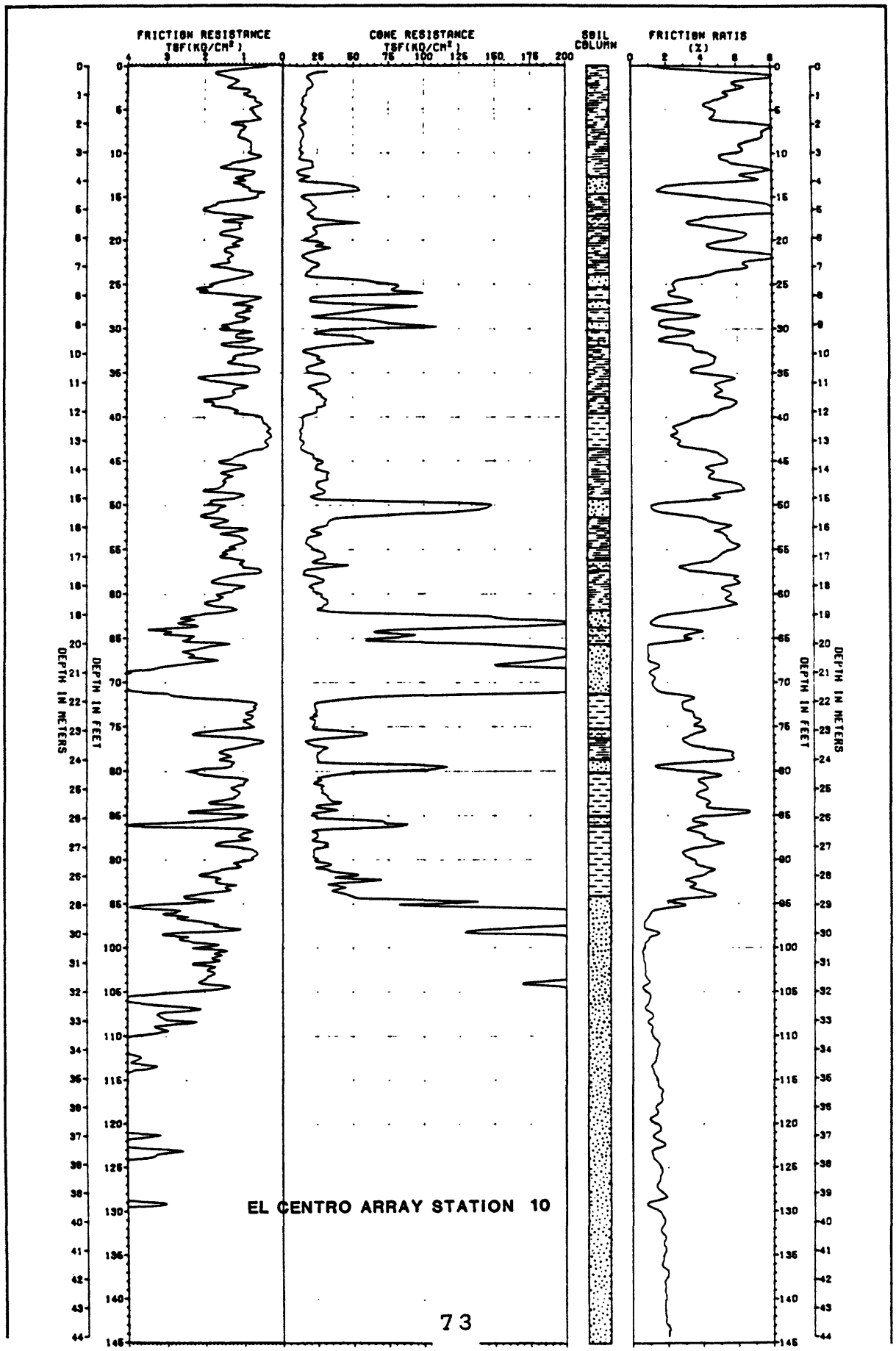


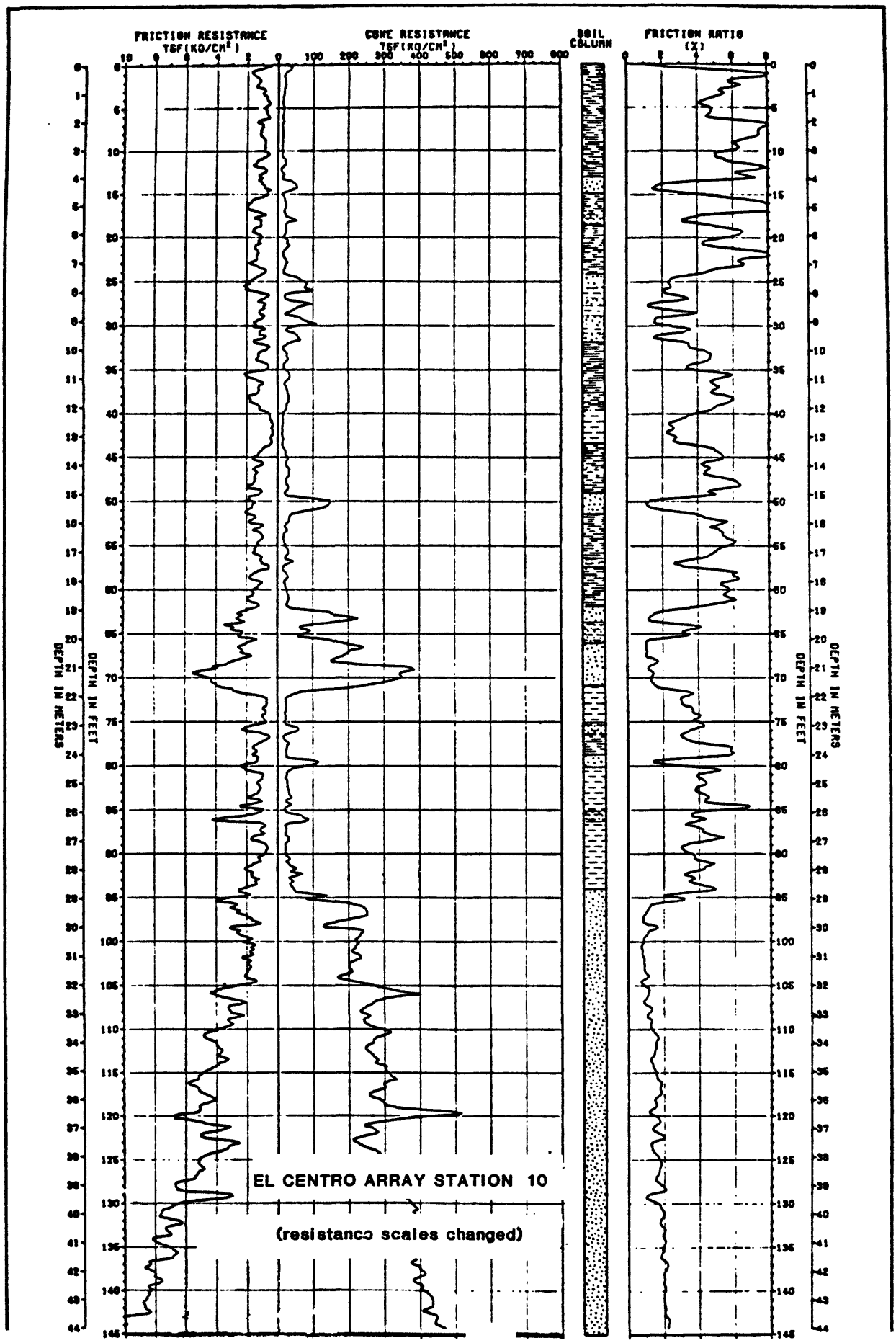
EL CENTRO ARRAY STATION 6 (resistance scales changed)

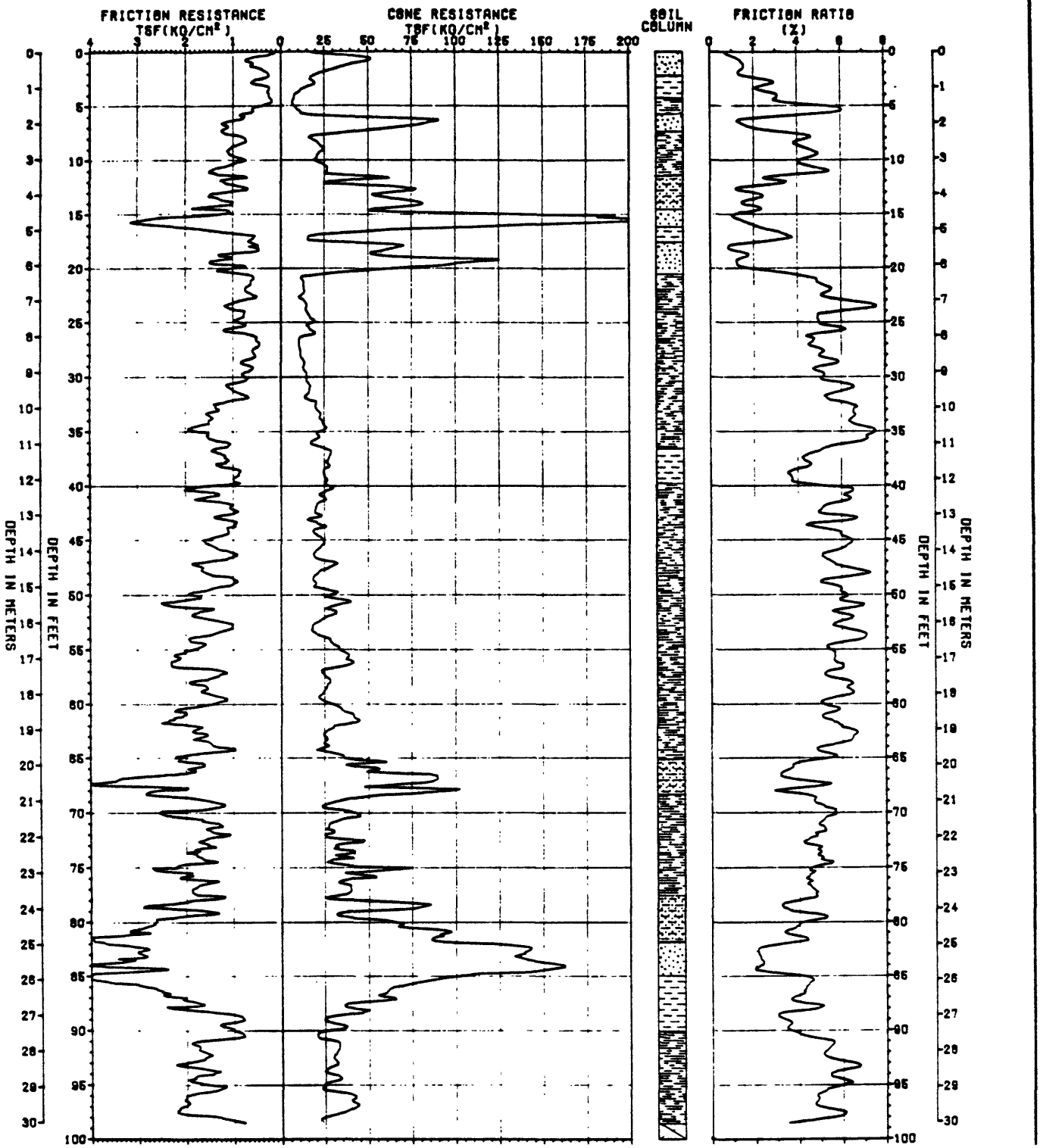


EL CENTRO ARRAY STATION 7

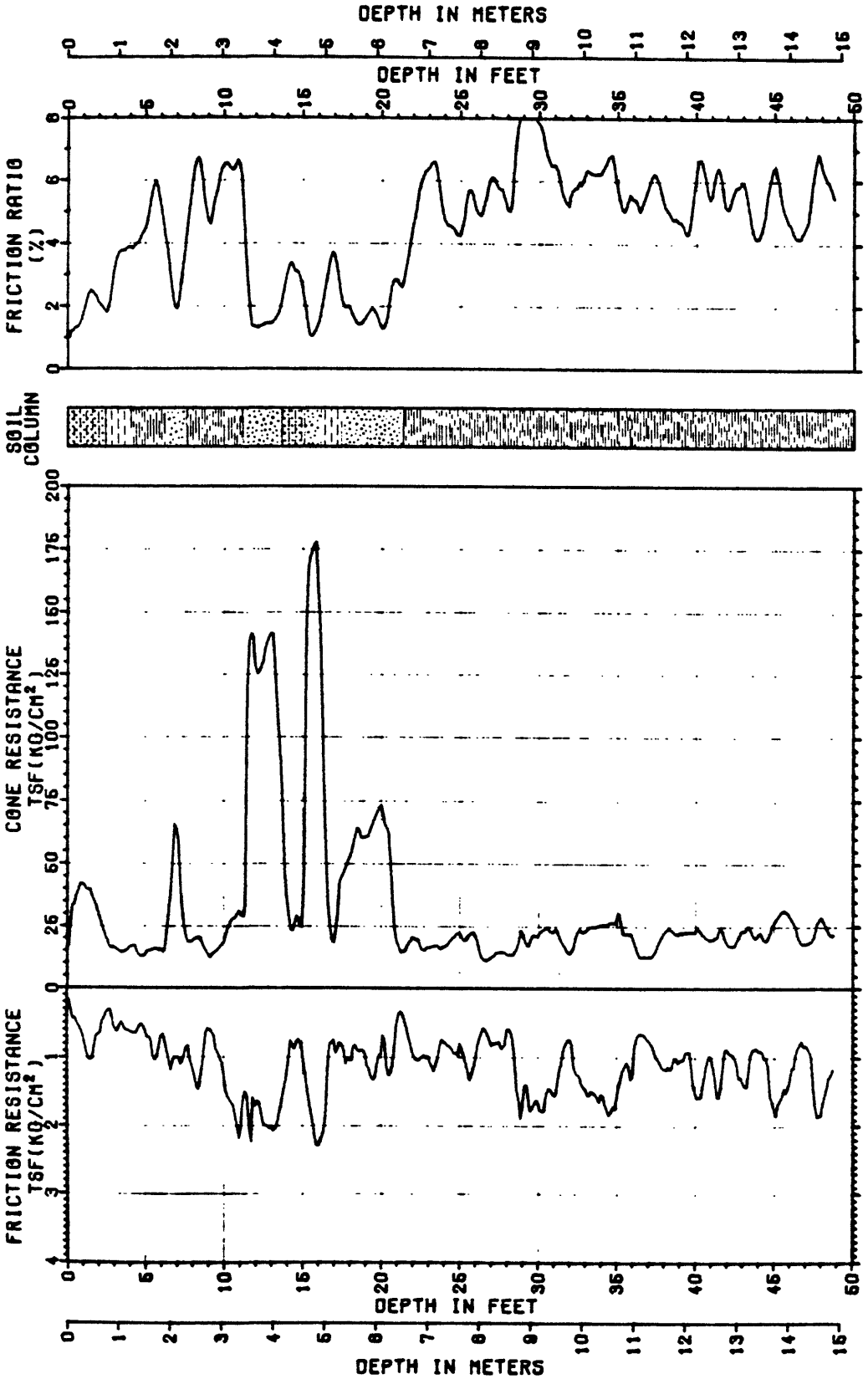

FRICTION RESISTANCE
TSF(KG/CM²)
CONE RESISTANCE
TSF(KG/CM²)
SOIL COLUMN
FRICTION RATIO
(%)
DEPTH IN METERS
DEPTH IN FEET
DEPTH IN FEET
DEPTH IN METERS
EL CENTRO ARRAY STATION 8

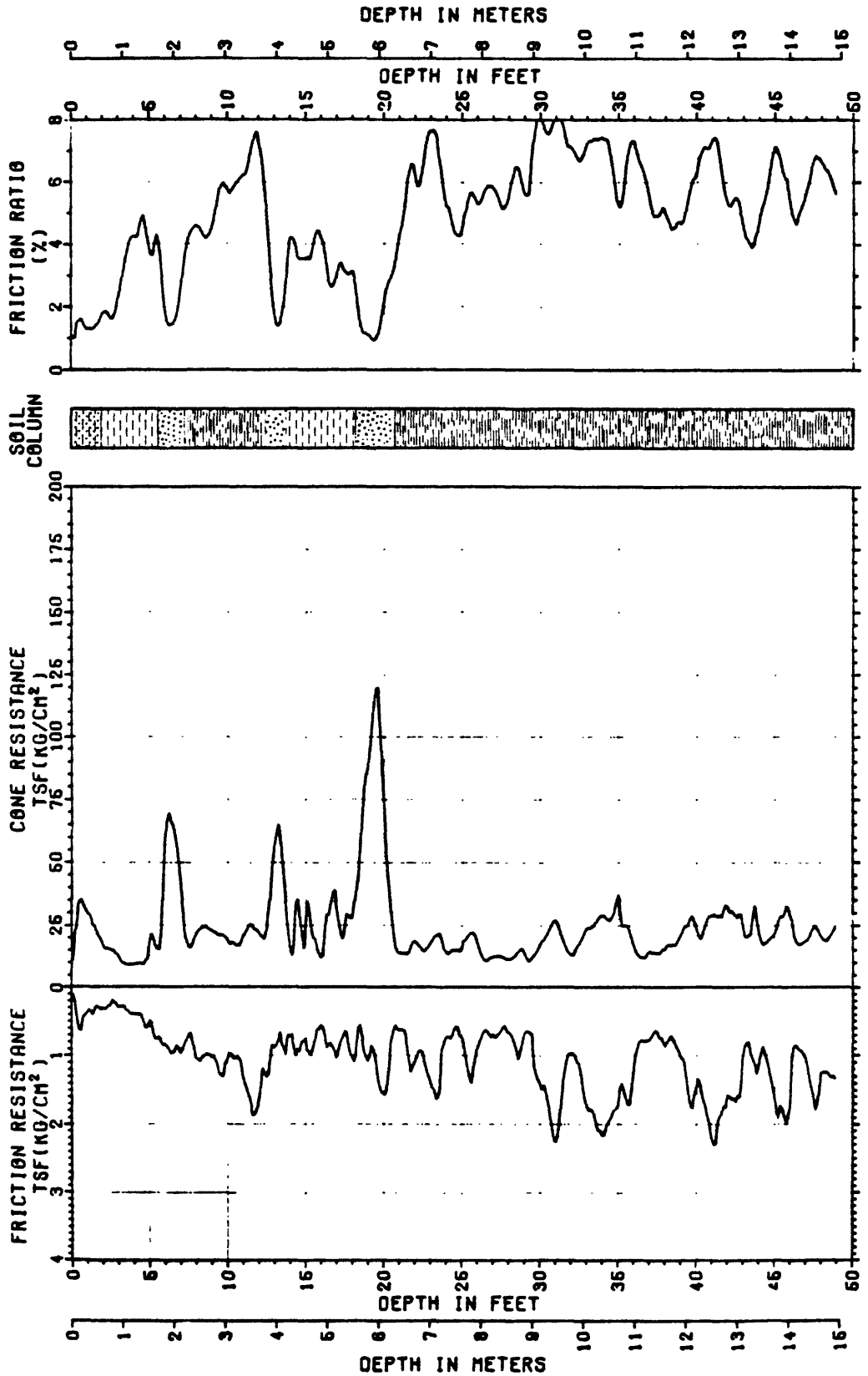

FRICTION RESISTANCE
TSF(KG/CM²)
CONE RESISTANCE
TSF(KG/CM²)
SOIL COLUMN
FRICTION RATIO
(%)
DEPTH IN METERS
DEPTH IN FEET
EL CENTRO ARRAY STATION 10

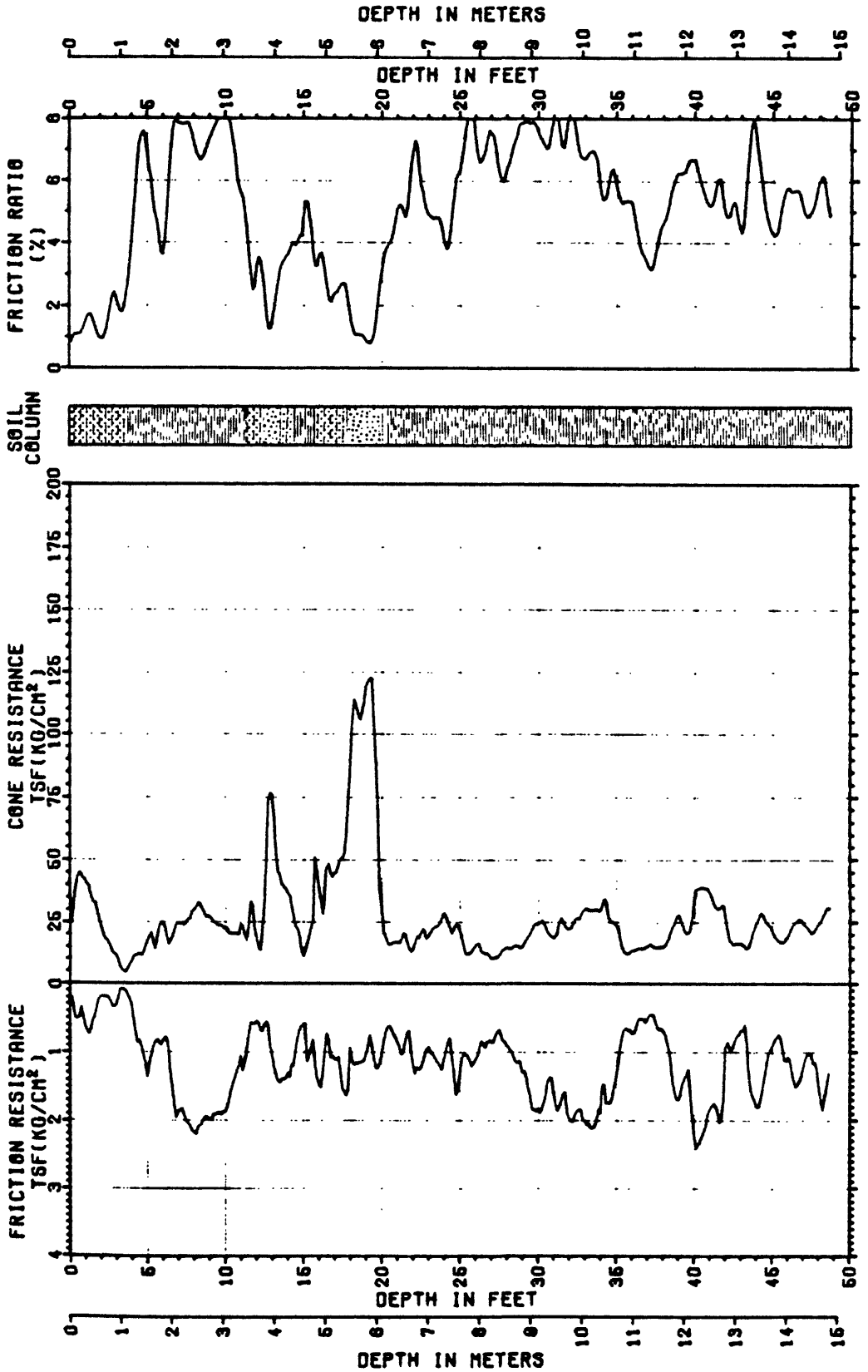

FRICTION RESISTANCE
TSF(KG/CM²)
CONE RESISTANCE
TSF(KG/CM²)
SOIL COLUMN
FRICTION RATIO
(%)
DEPTH IN METERS
DEPTH IN FEET
EL CENTRO ARRAY STATION 10
(resistance scales changed)

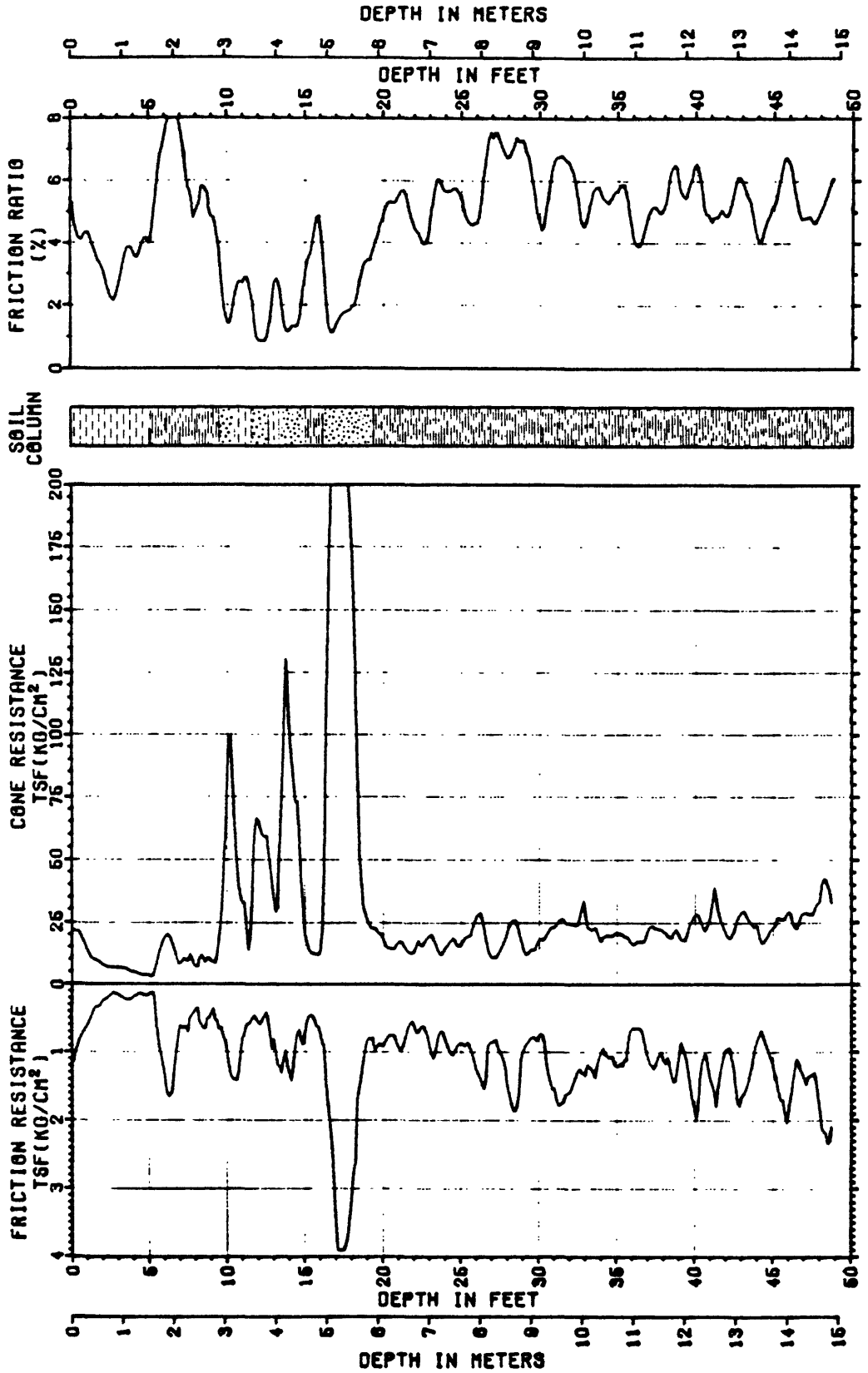


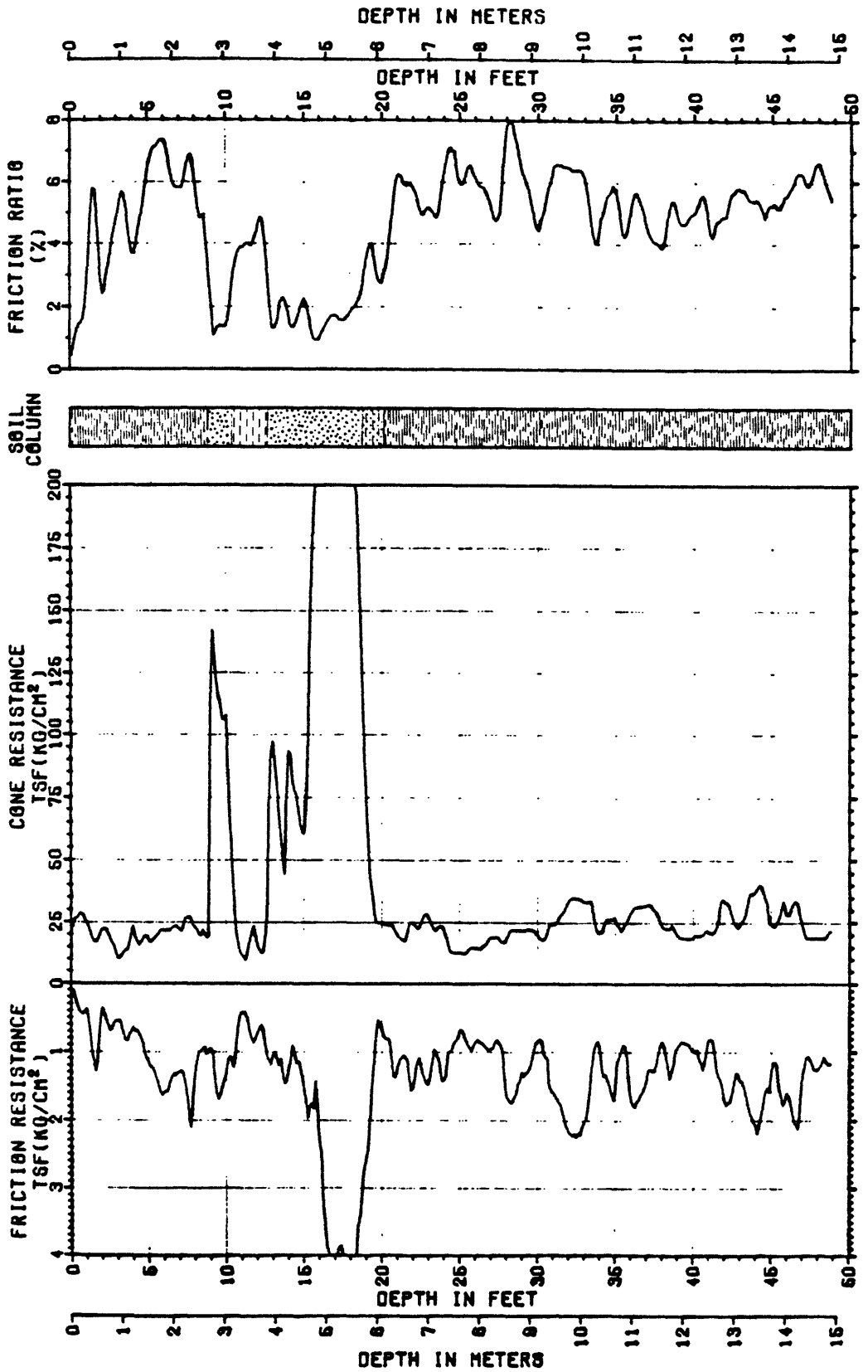
DIFFERENTIAL ARRAY STATION A

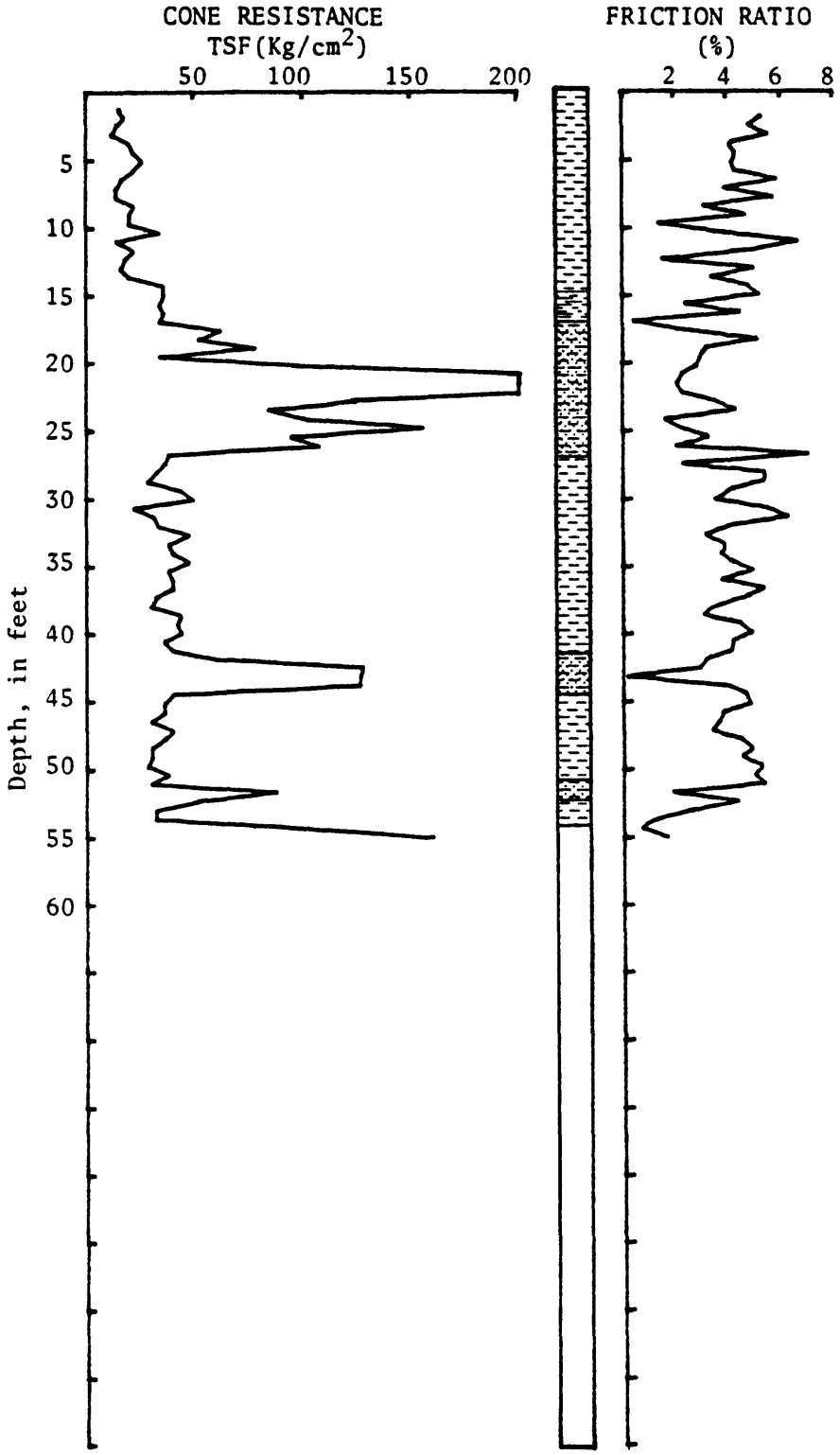

DEPTH IN METERS
DEPTH IN FEET
FRICTION RATIO (%)
SOIL COLUMN
CONE RESISTANCE TSF(KG/CM²)
FRICTION RESISTANCE TSF(KG/CM²)
DEPTH IN FEET
DEPTH IN METERS
DIFFERENTIAL ARRAY STATION B


DEPTH IN METERS
DEPTH IN FEET
FRICTION RATIO (%)
SOIL COLUMN
CONE RESISTANCE TSF(KG/CM²)
FRICTION RESISTANCE TSF(KG/CM²)
DEPTH IN FEET
DEPTH IN METERS
DIFFERENTIAL ARRAY STATION C


DEPTH IN METERS
DEPTH IN FEET
FRICTION RATIO (%)
SOIL COLUMN
CONE RESISTANCE TSF(KG/CM²)
FRICTION RESISTANCE TSF(KG/CM²)
DEPTH IN FEET
DEPTH IN METERS
DIFFERENTIAL ARRAY STATION D


DEPTH IN METERS
DEPTH IN FEET
FRICTION RATIO (%)
SOIL COLUMN
CONE RESISTANCE TSF(KG/CM²)
FRICTION RESISTANCE TSF(KG/CM²)
DEPTH IN FEET
DEPTH IN METERS
DIFFERENTIAL ARRAY STATION E


DEPTH IN METERS
DEPTH IN FEET
FRICTION RATIO (%)
SOIL COLUMN
CONE RESISTANCE TSF(KG/CM²)
FRICTION RESISTANCE TSF(KG/CM²)
DIFFERENTIAL ARRAY STATION F



IMPERIAL COUNTY SERVICES BUILDING

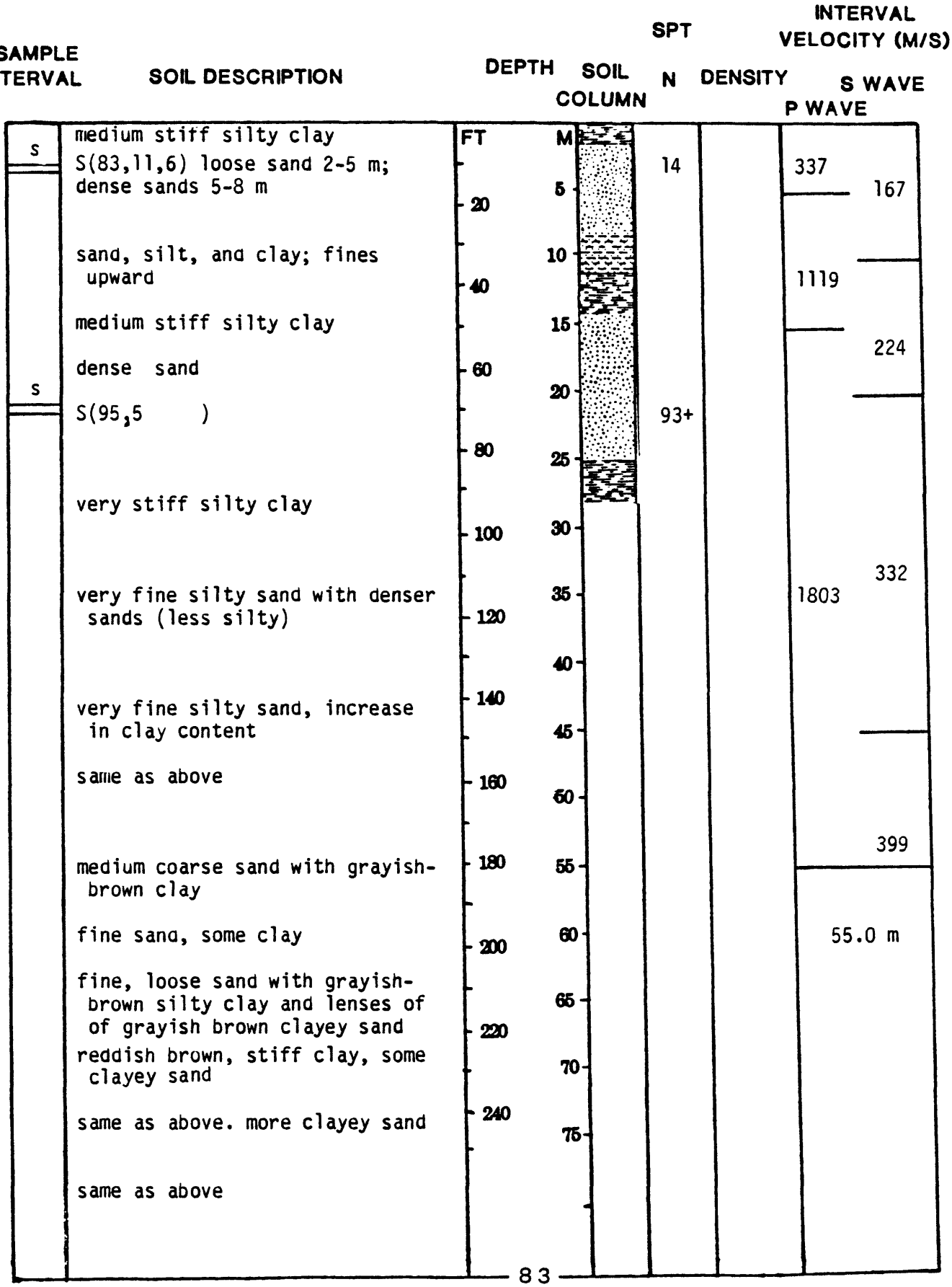
APPENDIX C.

SUMMARY OF SOILS INFORMATION.

NOTE: P-wave interval velocities listed in this Appendix were calculated from measurements that used the vertical-hammer source. See Appendix E for P-wave interval velocities taken from explosive-cap source.

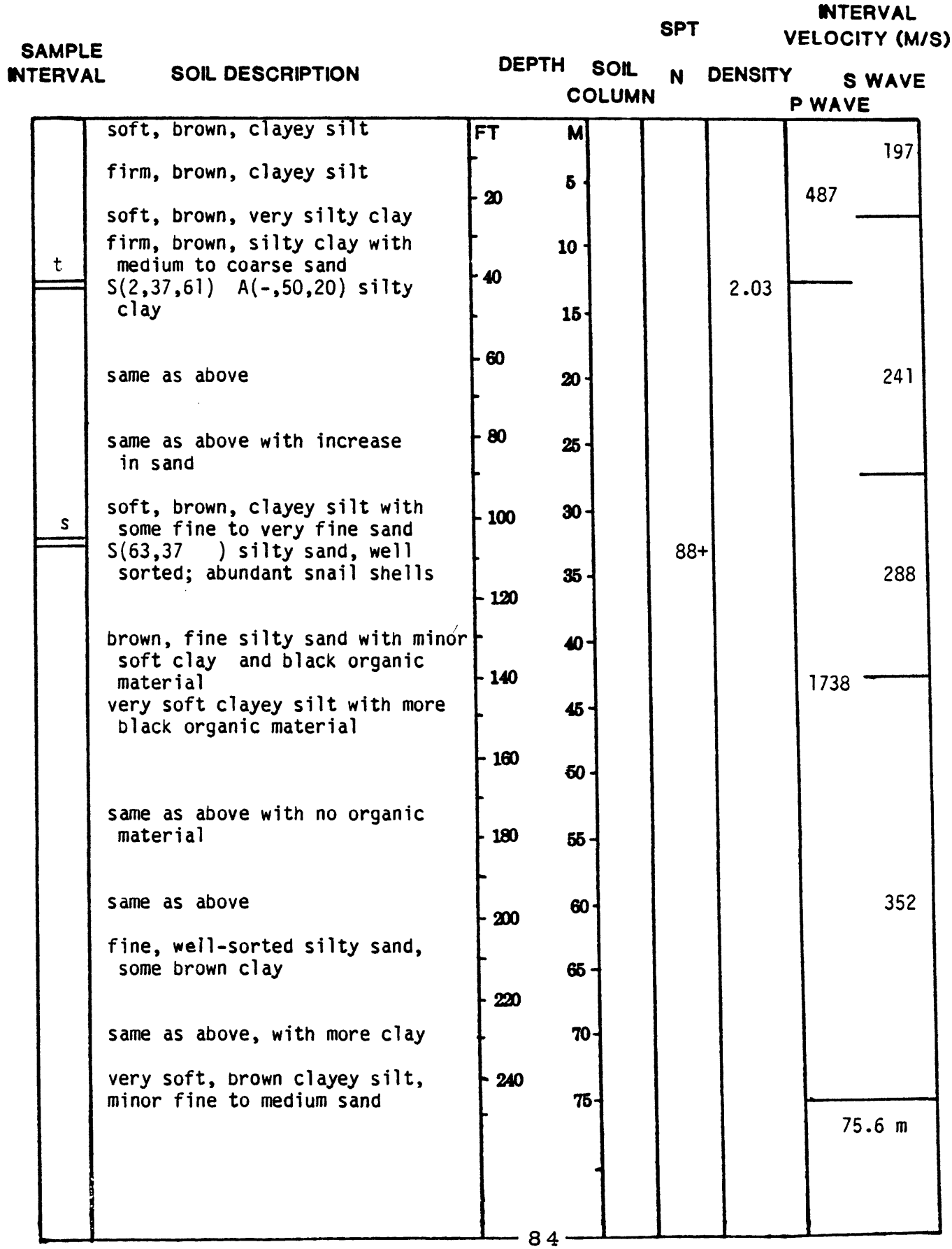
BONDS CORNER
HIGHWAYS 98 AND 115
ELEVATION +29 FT

BOREHOLE DRILLED
SEPTEMBER 22, 1980



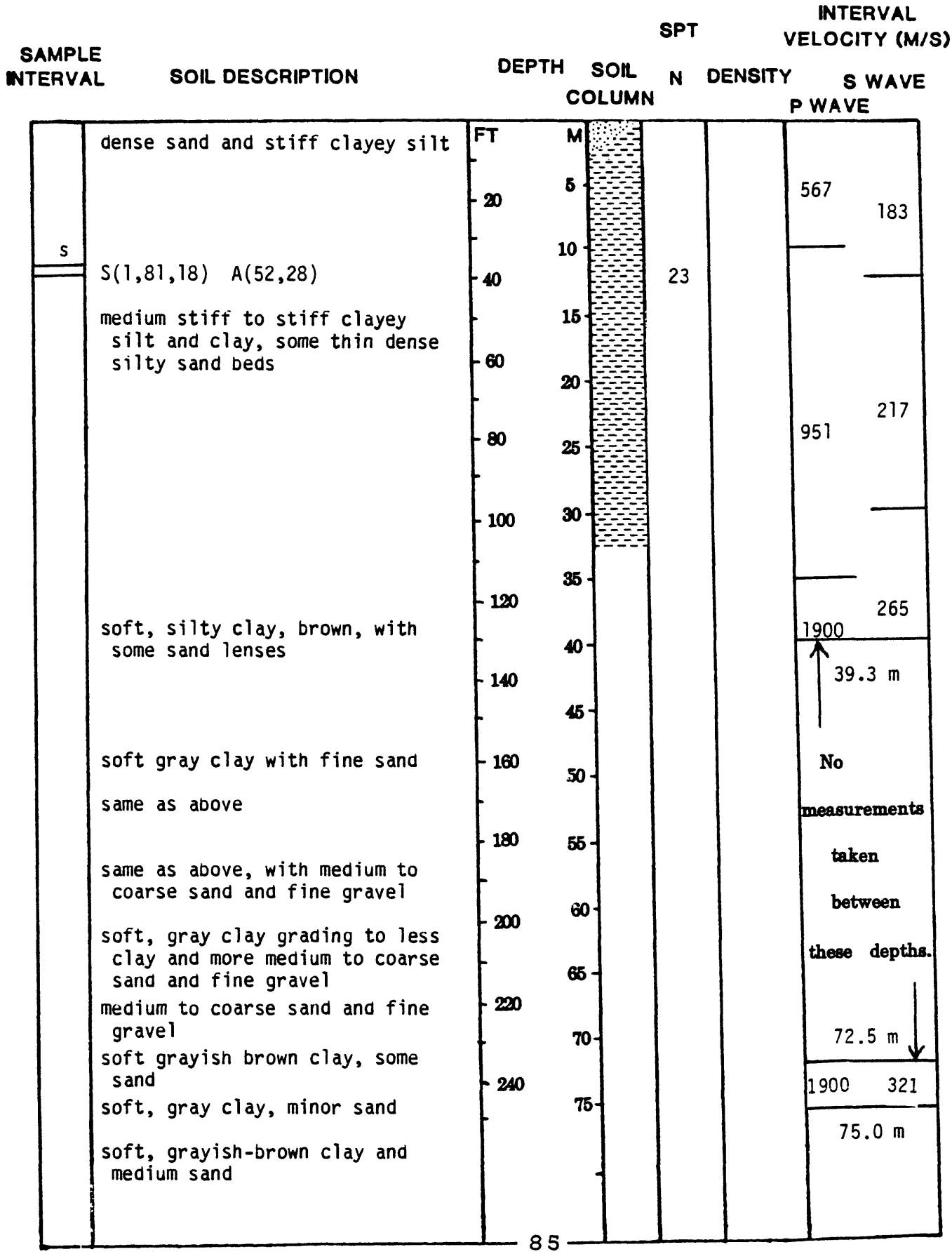
CALEXICO
FIRE STATION
ELEVATION SEA LEVEL

BOREHOLE DRILLED
NOVEMBER 5, 1980



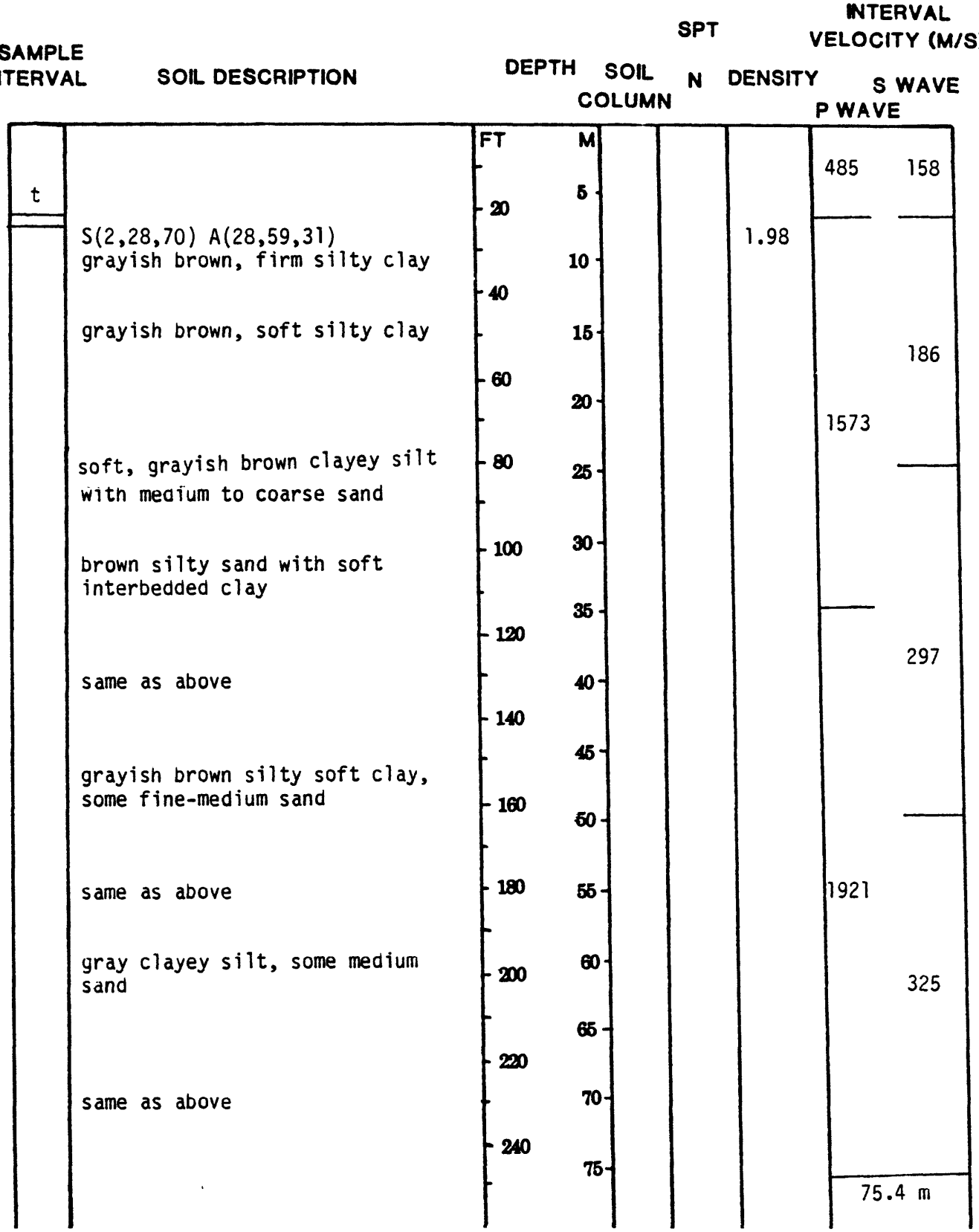
HOLTVILLE
POST OFFICE
ELEVATION -12 FT

BOREHOLE DRILLED
OCTOBER 8, 1980



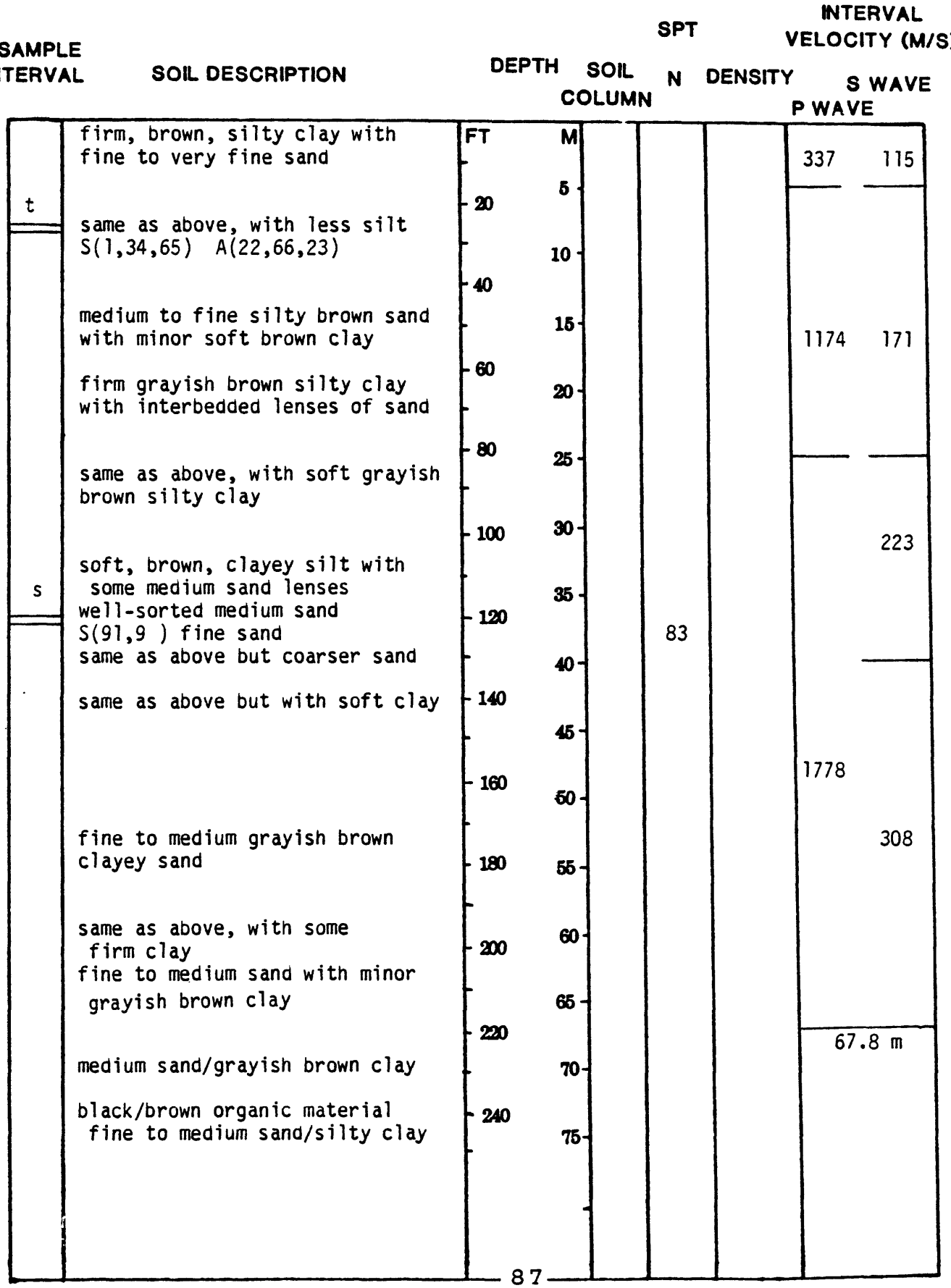
EL CENTRO ARRAY STATION 2
KEYSTONE ROAD
ELEVATION -56 FT

BOREHOLE DRILLED
NOVEMBER 3, 1980



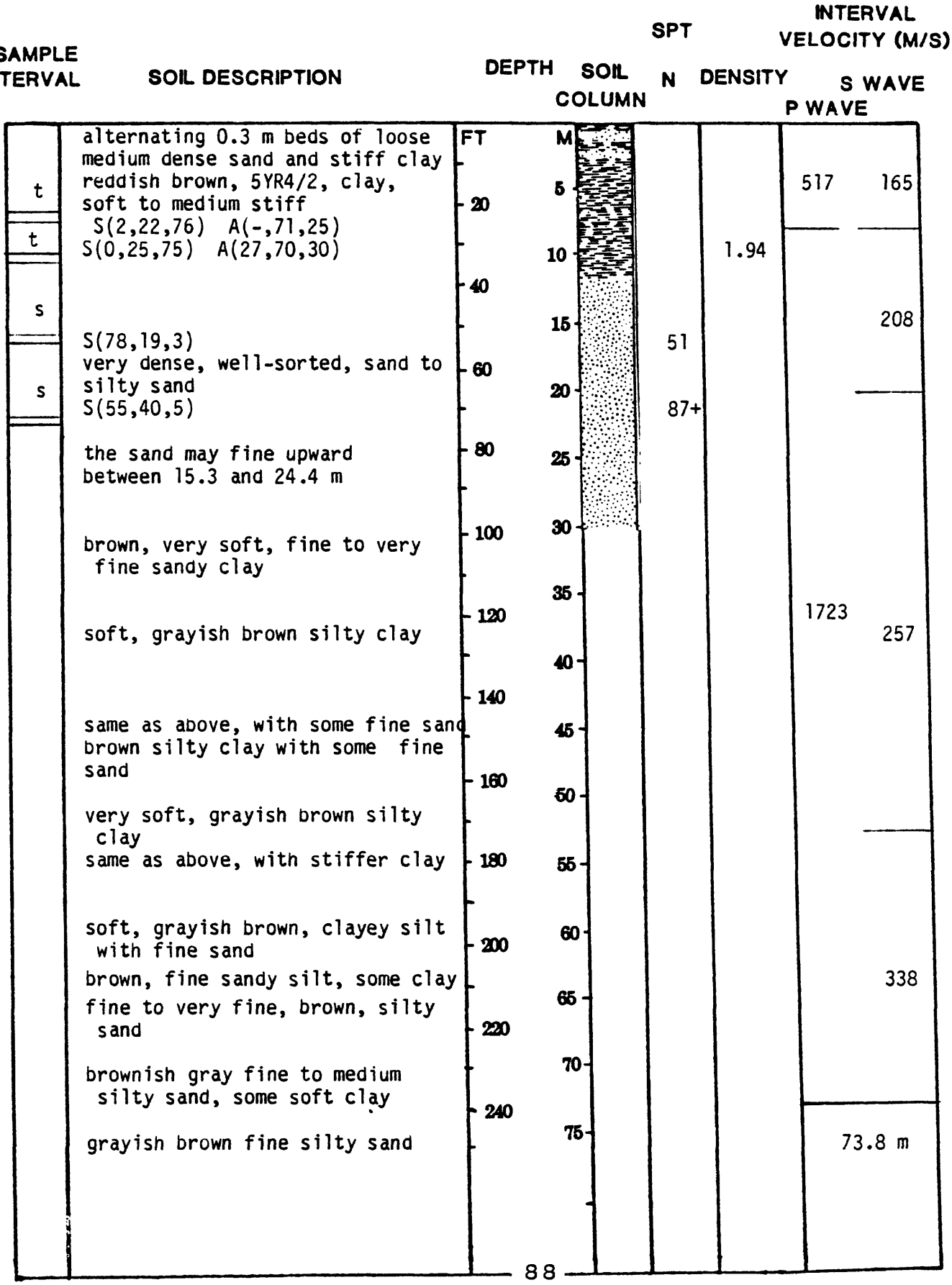
EL CENTRO ARRAY STATION 3
PINE UNION SCHOOL
ELEVATION -66 FT

BOREHOLE DRILLED
NOVEMBER 2, 1980



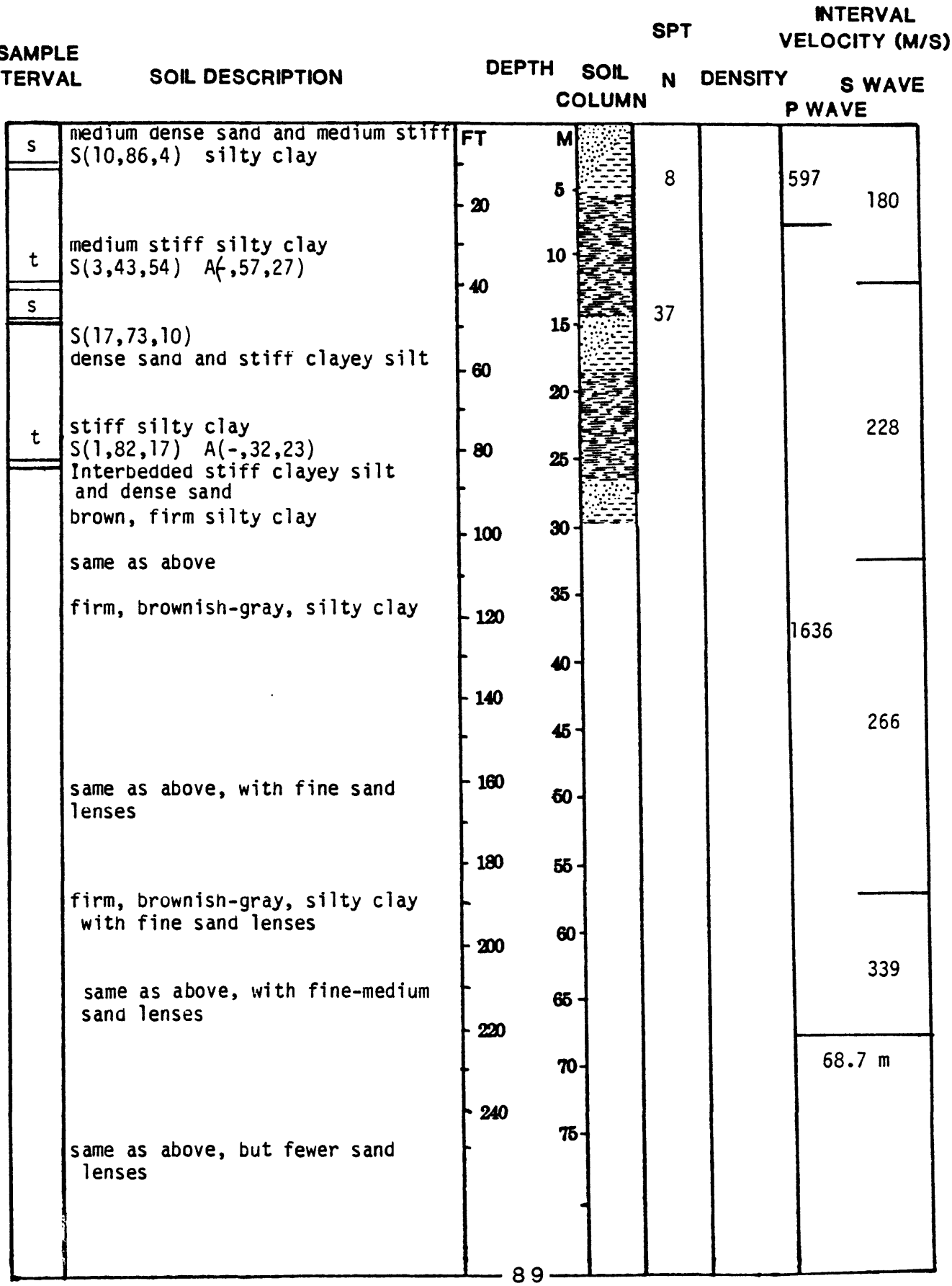
EL CENTRO ARRAY STATION 4
ANDERSON ROAD
ELEVATION -90 FT

BOREHOLE DRILLED
OCTOBER 31, 1980



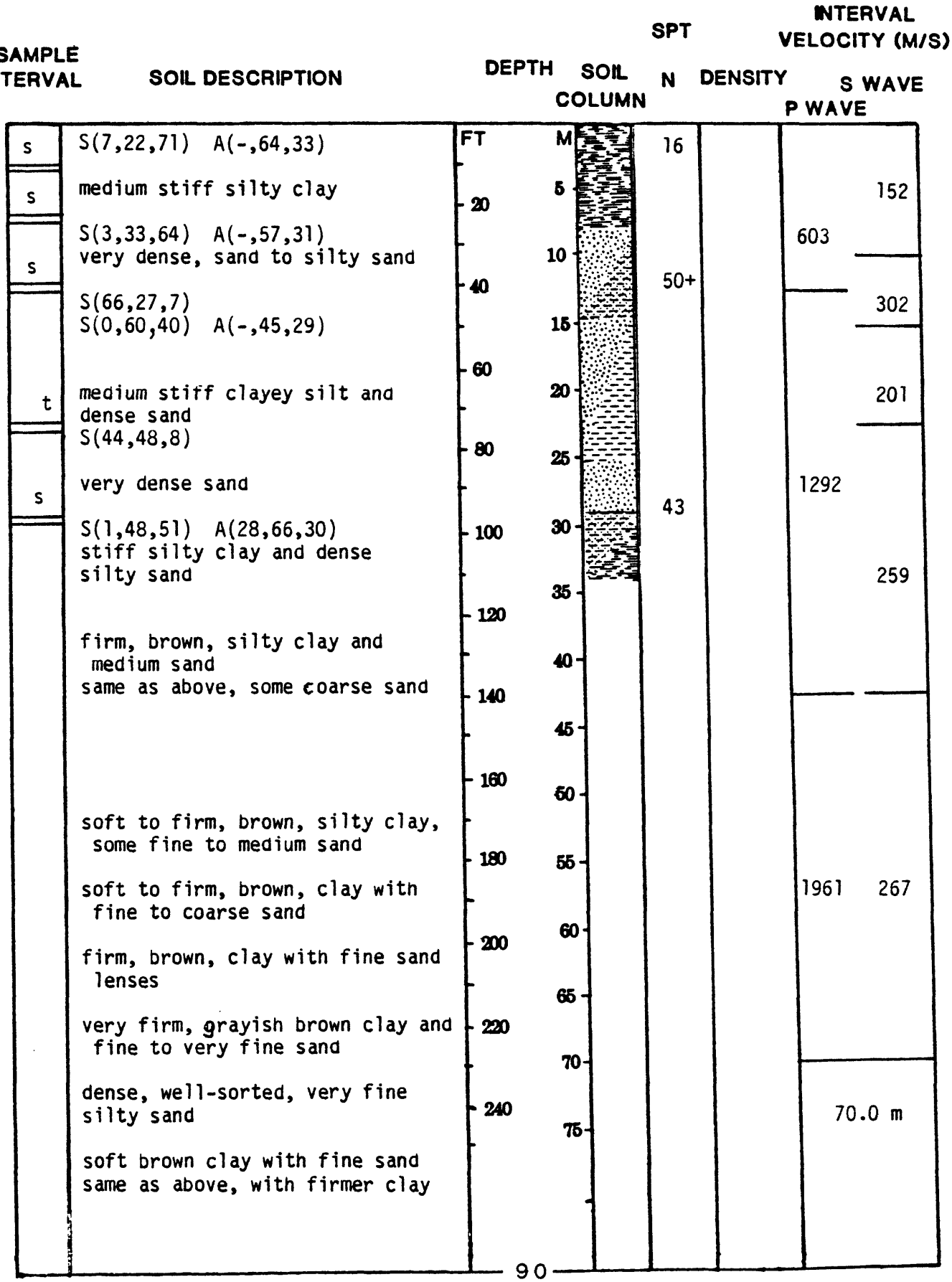
EL CENTRO ARRAY STATION 5
JAMES ROAD
ELEVATION -95 FT

BOREHOLE DRILLED
SEPTEMBER 24, 1980



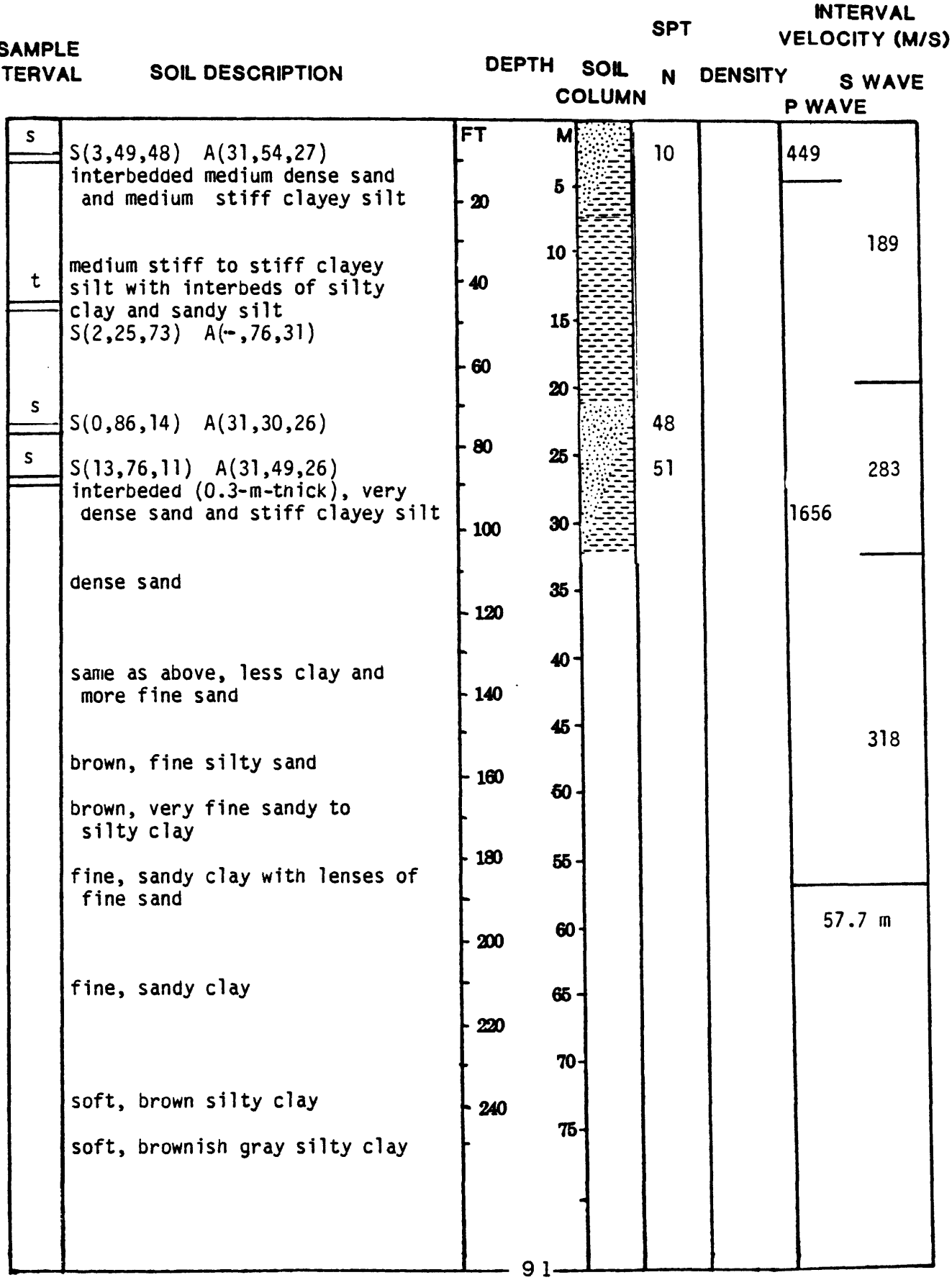
EL CENTRO ARRAY STATION 6
HUSTON ROAD
ELEVATION -100 FT

BOREHOLE DRILLED
OCTOBER 2, 1980



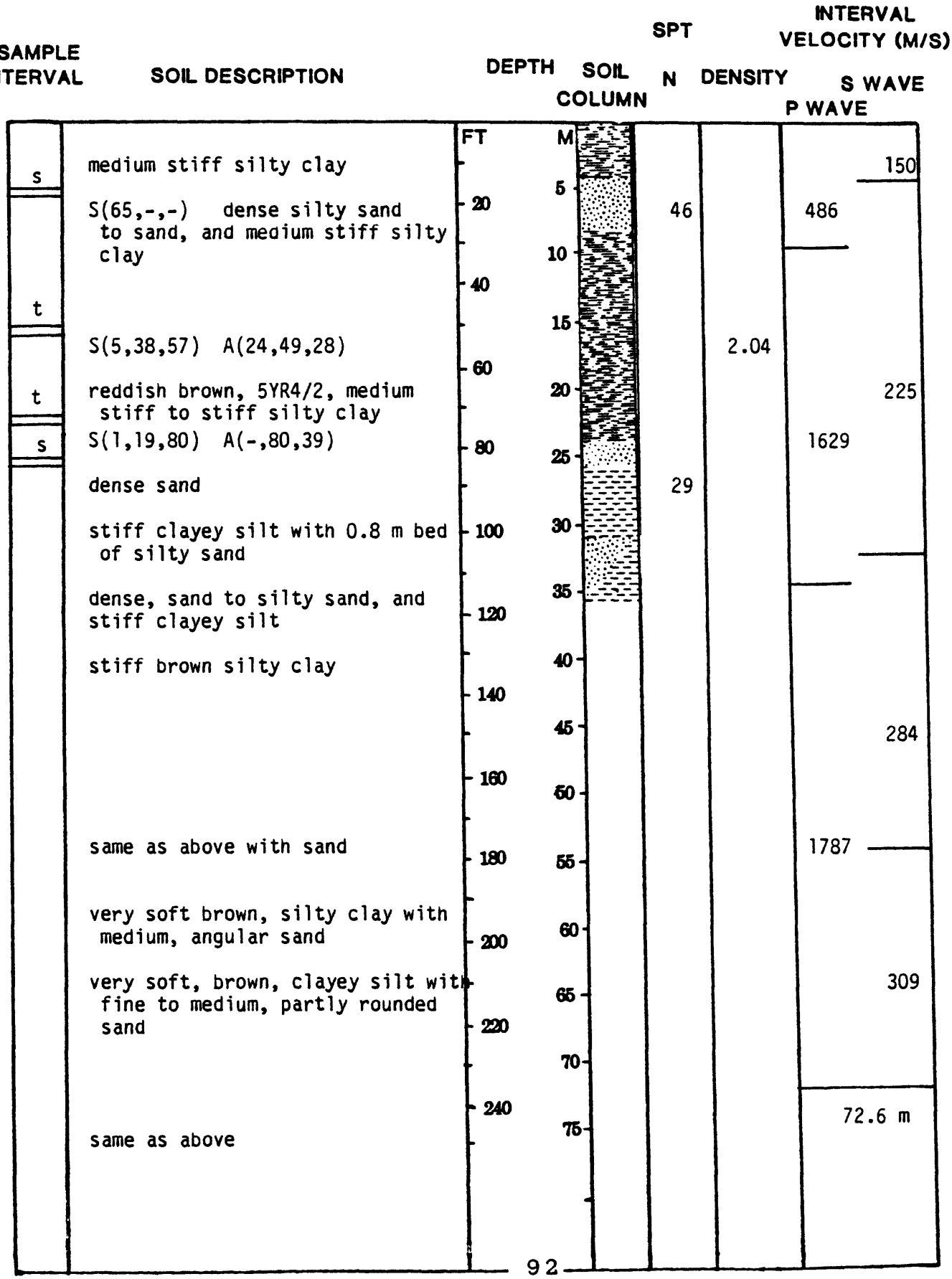
EL CENTRO ARRAY STATION 7
IMPERIAL VALLEY COLLEGE
ELEVATION -66 FT

BOREHOLE DRILLED
SEPTEMBER 25
AND 26, 1980



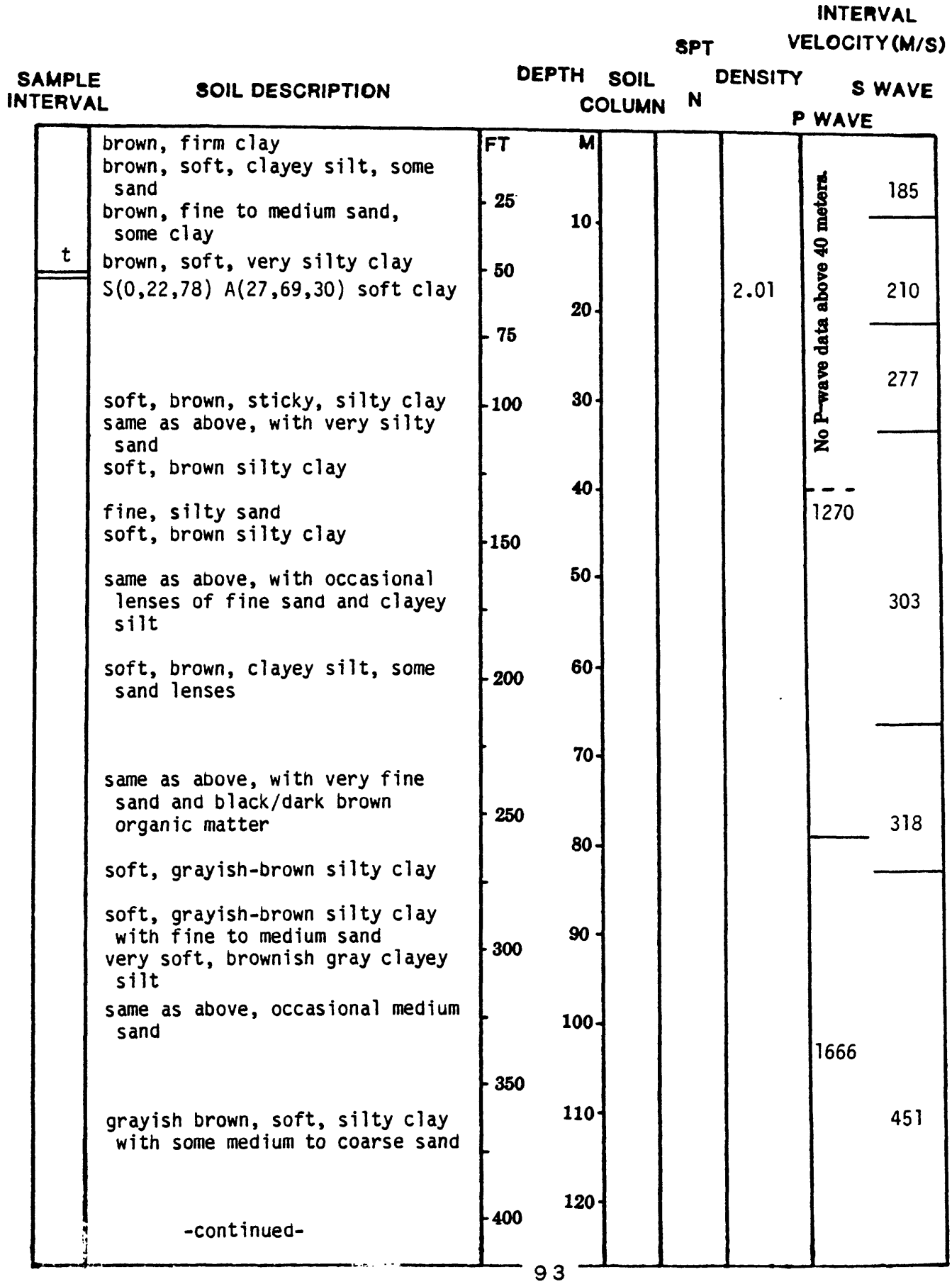
EL CENTRO ARRAY STATION 8
CRUICKSHANK ROAD
ELEVATION -53 FT

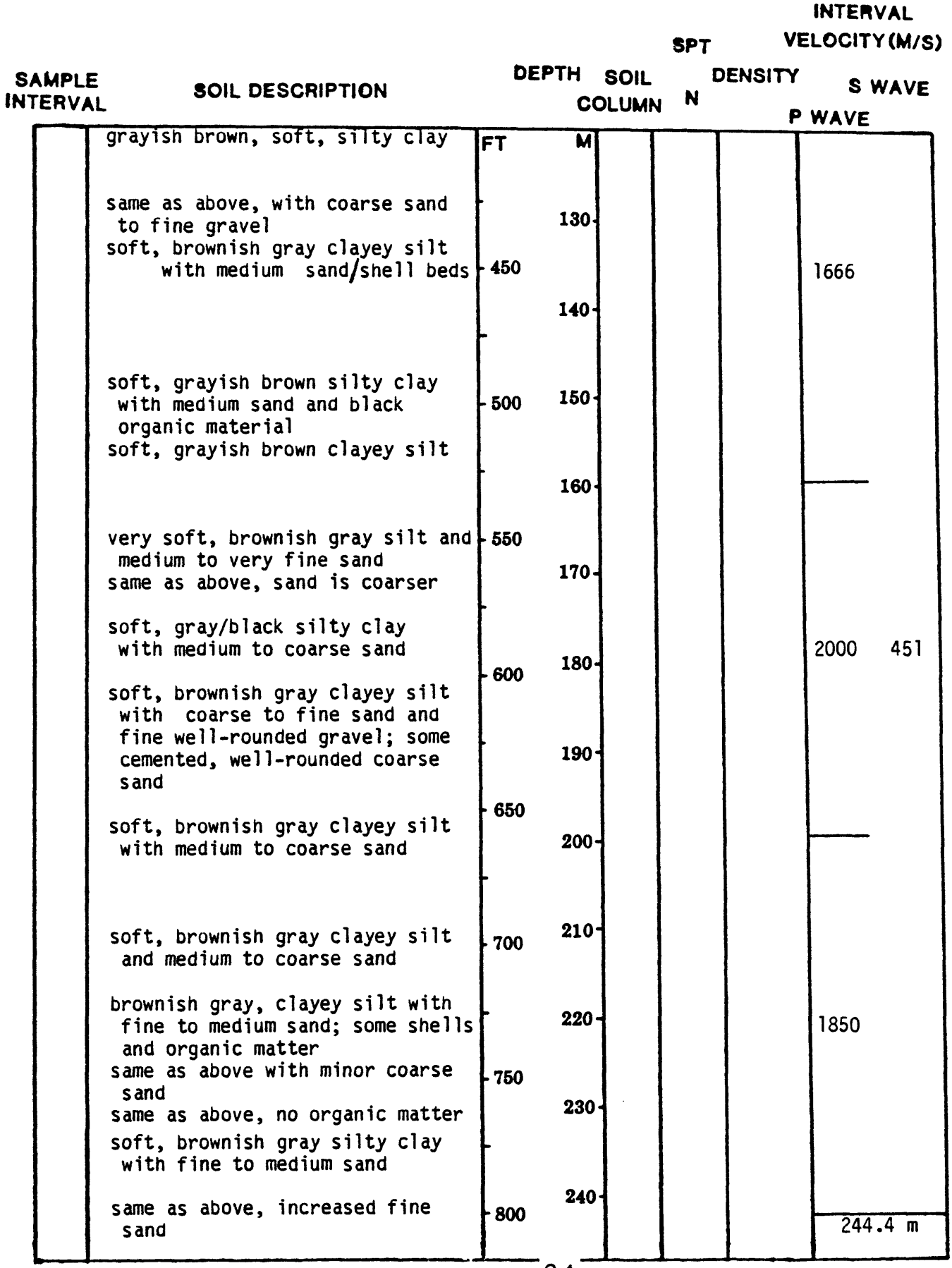
BOREHOLE DRILLED
OCTOBER 5, 1980



EL CENTRO ARRAY STATION 9
COMMERCIAL AVENUE
ELEVATION -47 FT

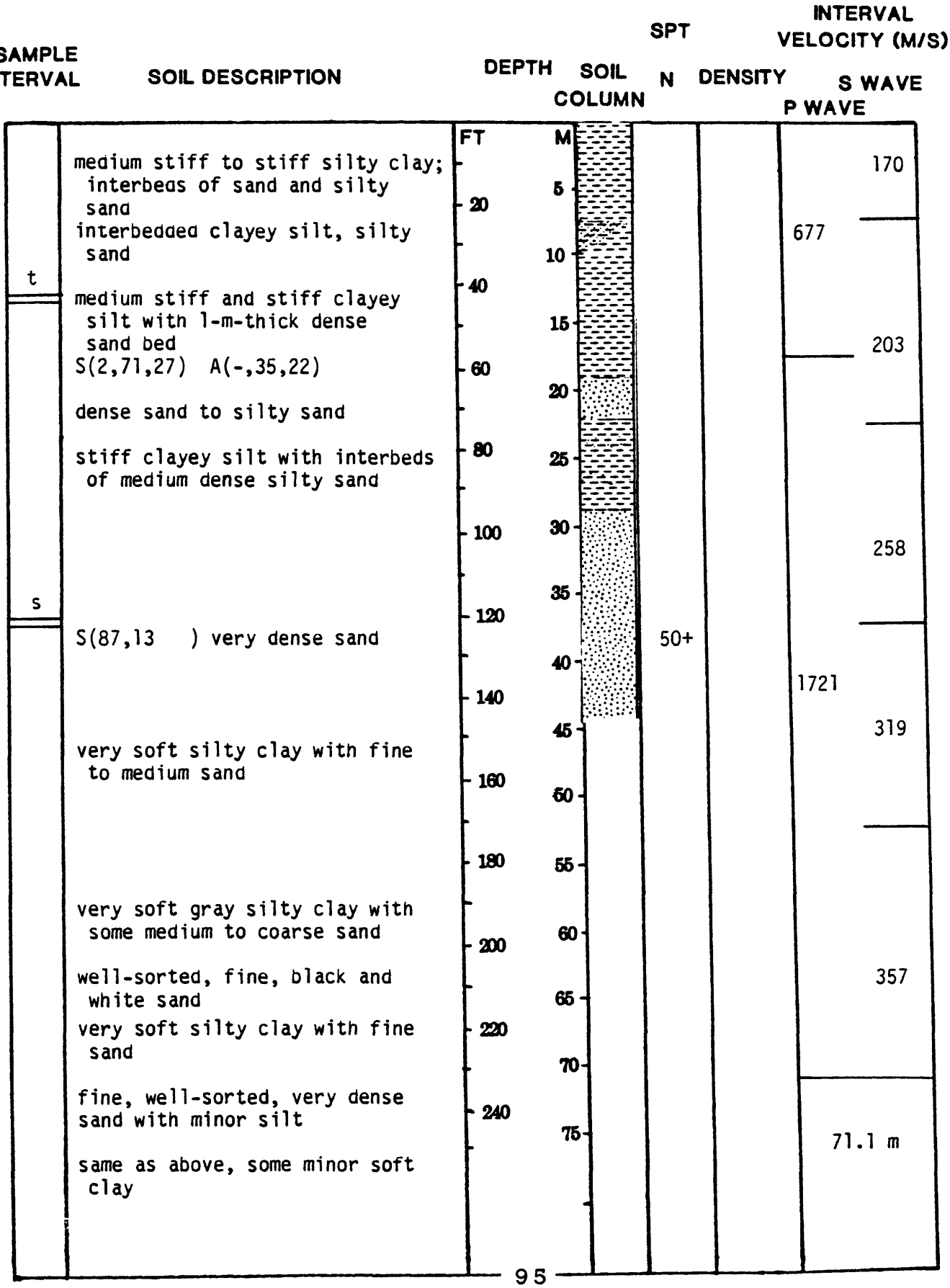
BOREHOLE DRILLED
NOVEMBER 14, 15,
AND 16, 1980




SAMPLE INTERVAL
SOIL DESCRIPTION
DEPTH
FT
M
SOIL COLUMN
SPT N
DENSITY
INTERVAL VELOCITY (M/S)
P WAVE
S WAVE
grayish brown, soft, silty clay
same as above, with coarse sand to fine gravel
soft, brownish gray clayey silt with medium sand/shell beds
soft, grayish brown silty clay with medium sand and black organic material
soft, grayish brown clayey silt
very soft, brownish gray silt and medium to very fine sand
same as above, sand is coarser
soft, gray/black silty clay with medium to coarse sand
soft, brownish gray clayey silt with coarse to fine sand and fine well-rounded gravel; some cemented, well-rounded coarse sand
soft, brownish gray clayey silt with medium to coarse sand
soft, brownish gray clayey silt and medium to coarse sand
brownish gray, clayey silt with fine to medium sand; some shells and organic matter
same as above with minor coarse sand
same as above, no organic matter
soft, brownish gray silty clay with fine to medium sand
same as above, increased fine sand
450
500
550
600
650
700
750
800
130
140
150
160
170
180
190
200
210
220
230
240
1666
2000
451
1850
244.4 m

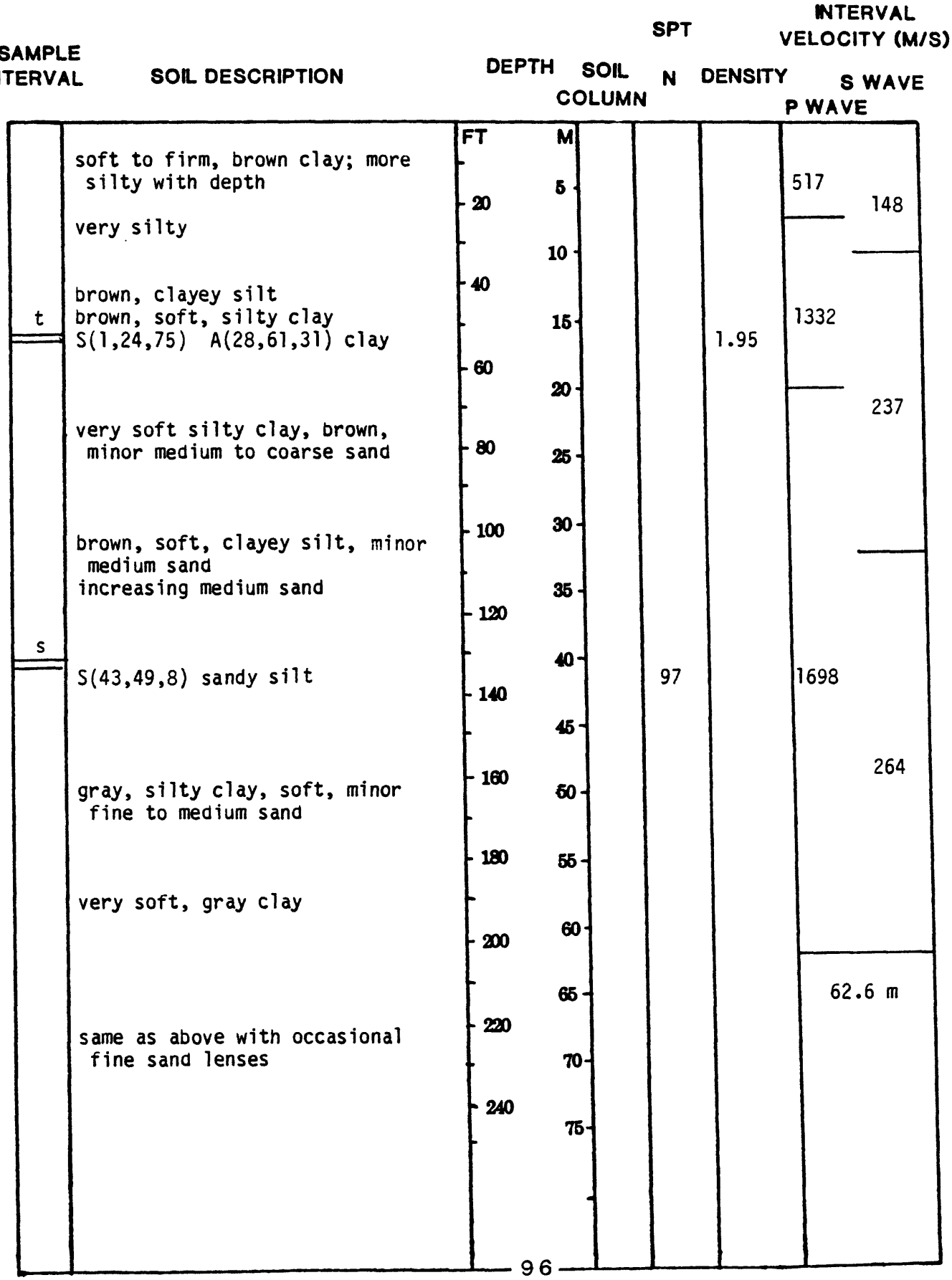
EL CENTRO ARRAY STATION 10
COMMUNITY HOSPITAL
ELEVATION -36 FT

BOREHOLE DRILLED
OCTOBER 17, 1980



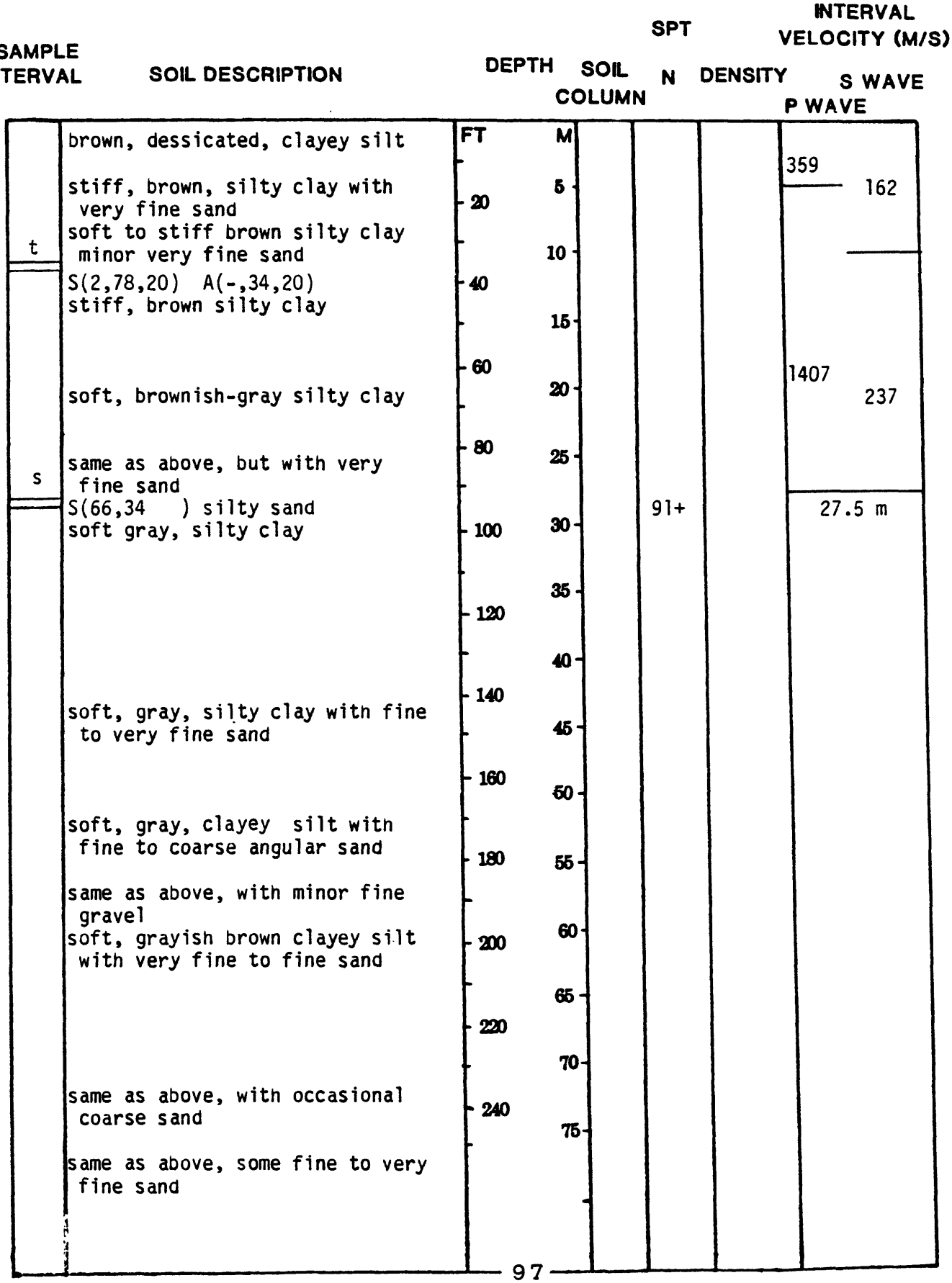
EL CENTRO ARRAY STATION 11
McCABE SCHOOL
ELEVATION -25 FT

BOREHOLE DRILLED
OCTOBER 18
AND 19, 1980



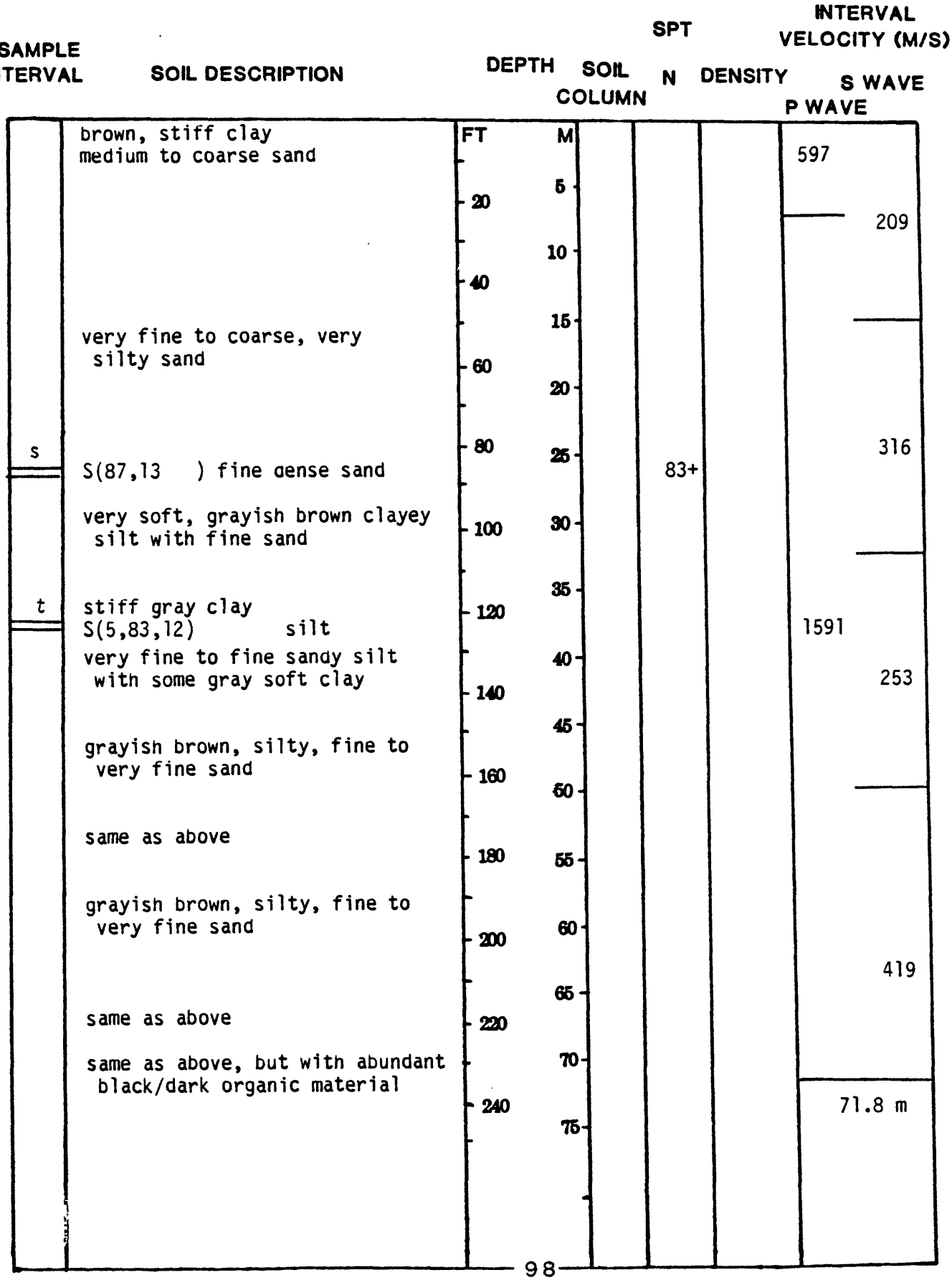
EL CENTRO ARRAY STATION 12
BROCKMAN ROAD
ELEVATION -24 FT

BOREHOLE DRILLED
OCTOBER 22, 1980



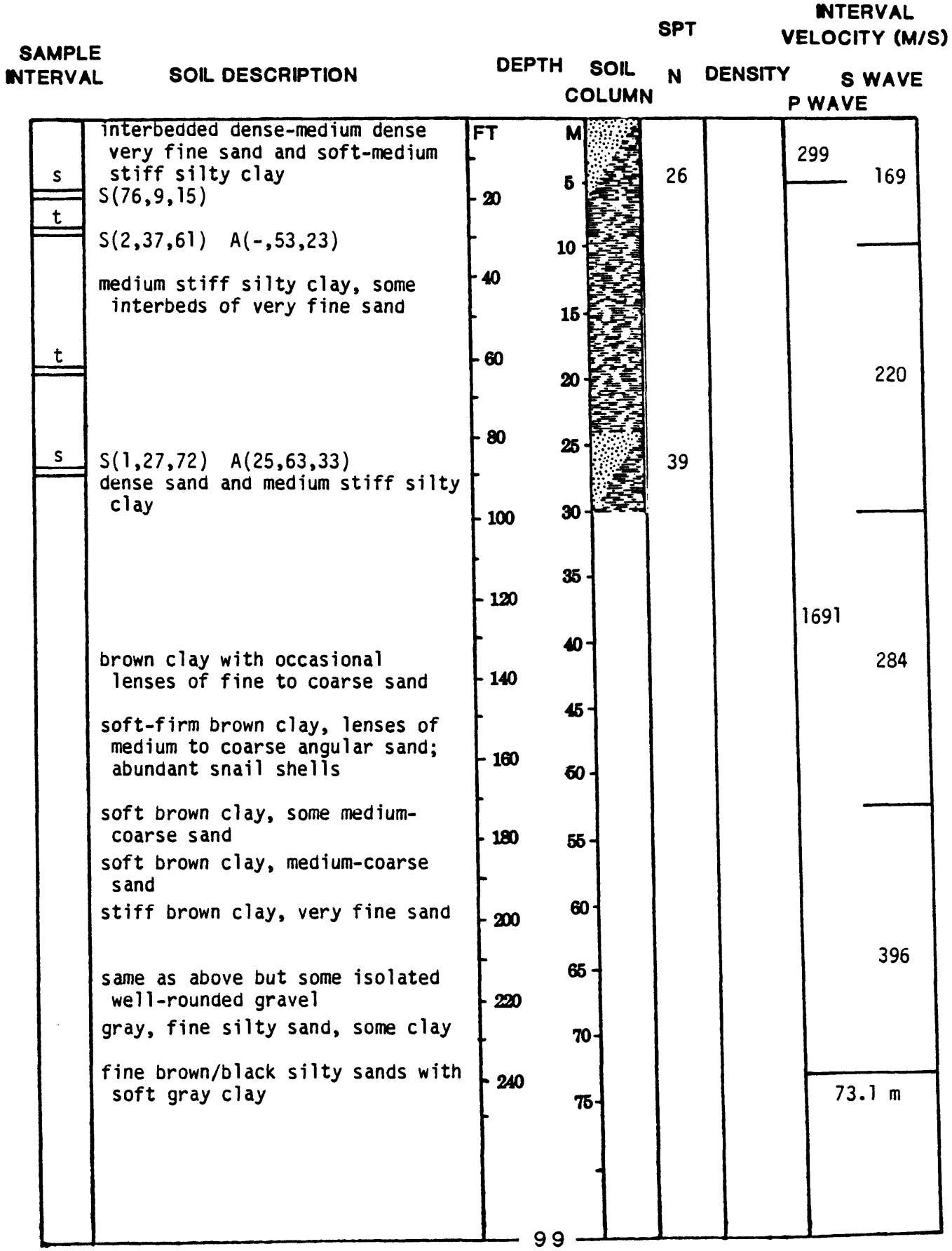
EL CENTRO ARRAY STATION 13
STROBEL RESIDENCE
ELEVATION -20 FT

BOREHOLE DRILLED
OCTOBER 21, 1980



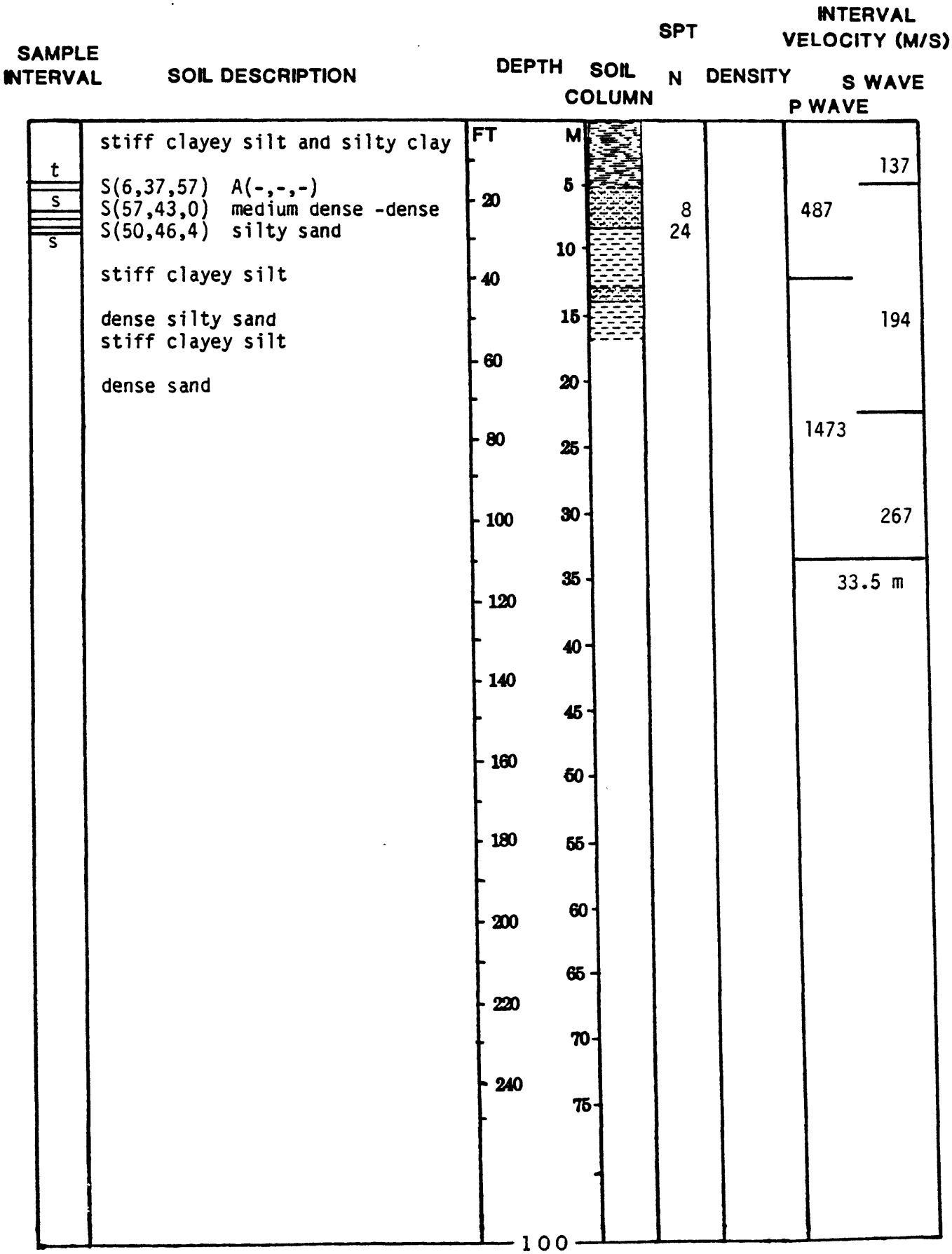
DIFFERENTIAL ARRAY
DOGWOOD ROAD
ELEVATION -50 FT

BOREHOLE DRILLED
OCTOBER 3, 4,
AND 5, 1980



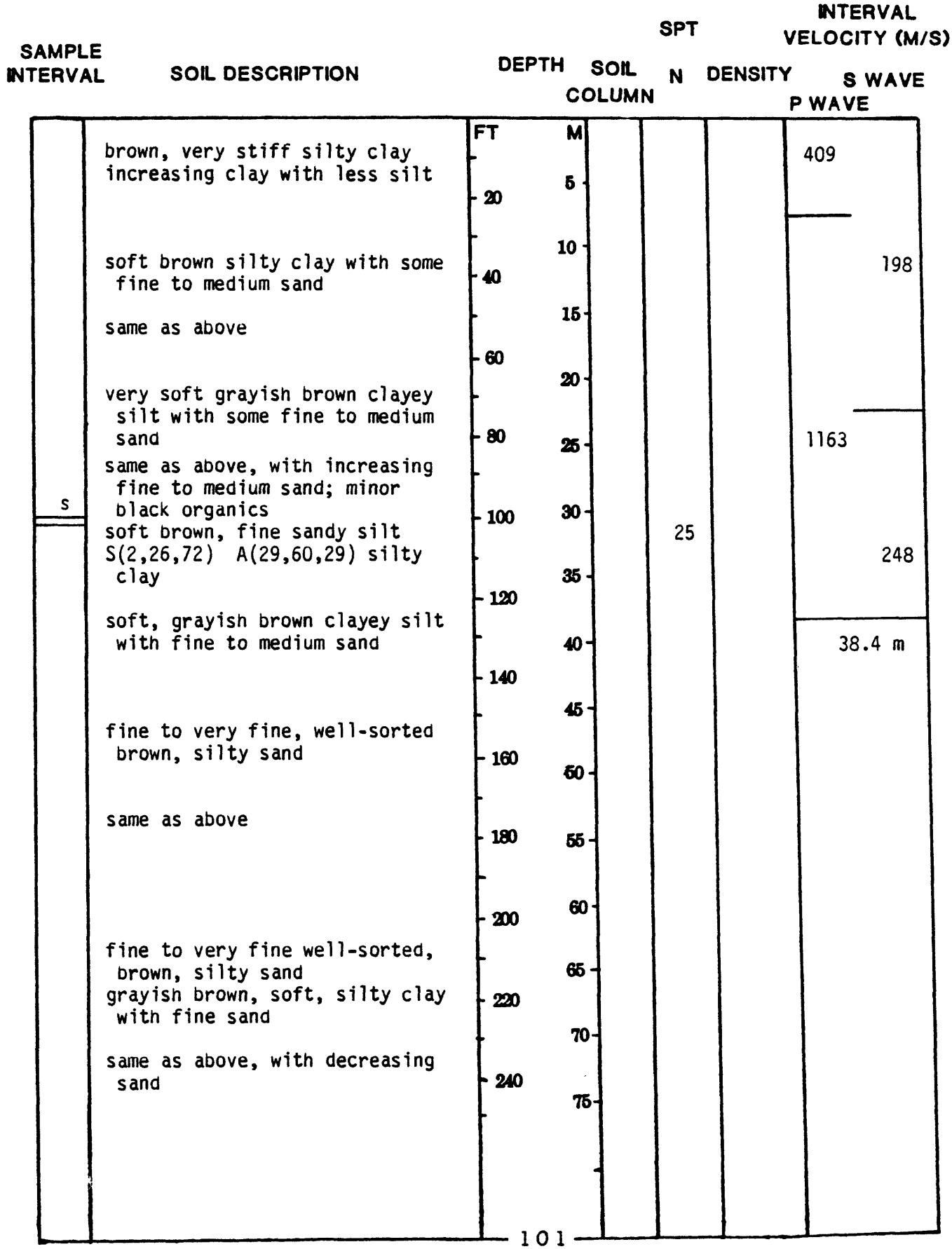
EL CENTRO
IMPERIAL COUNTY SERVICES BUILDING
ELEVATION -45 FT

BOREHOLE DRILLED
JANUARY 29, 1981



BRAWLEY
MUNICIPAL AIRPORT
ELEVATION -133 FT

BOREHOLE DRILLED
OCTOBER 30, 1980



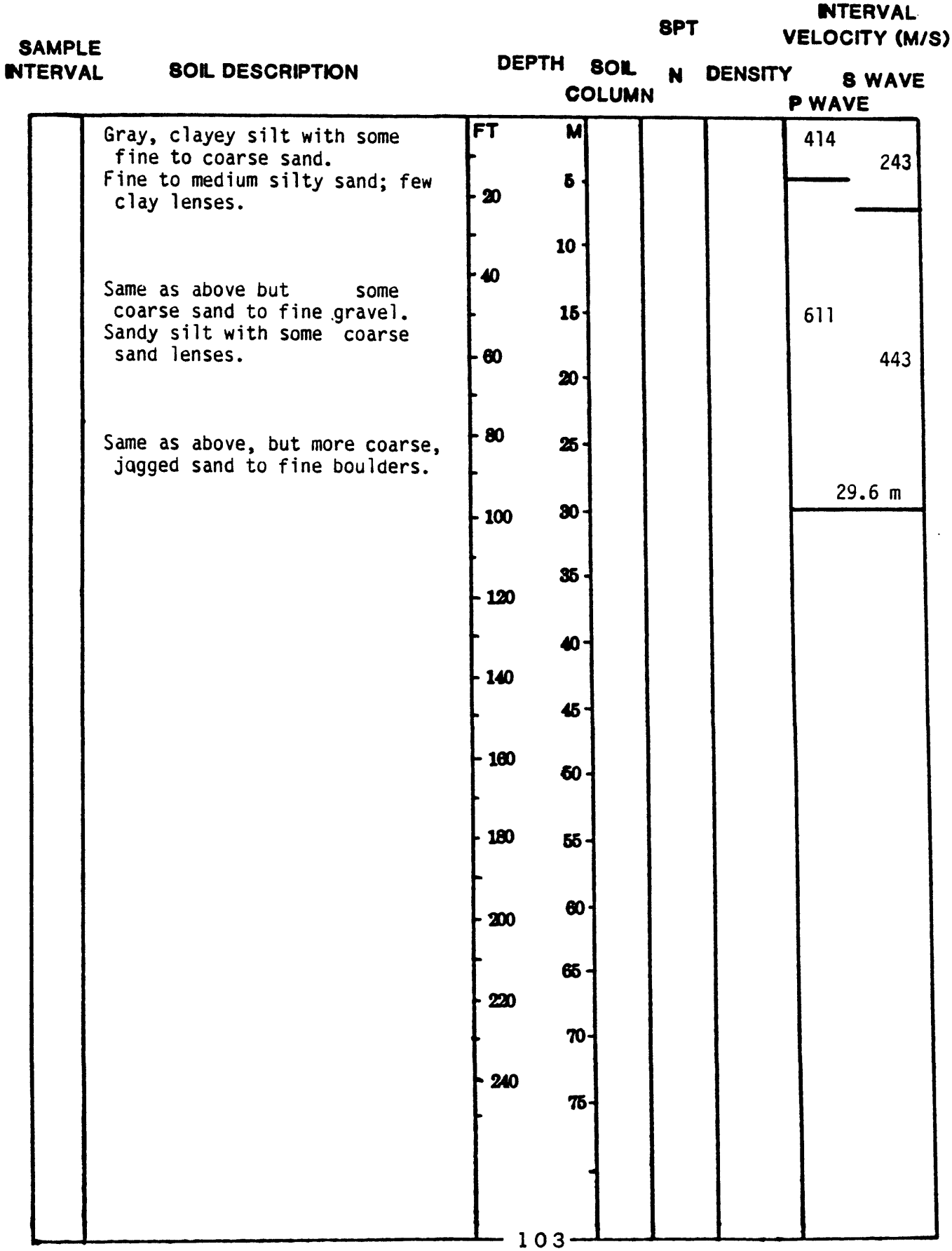
WESTMORLAND
FIRE STATION
ELEVATION -165 FT

BOREHOLE DRILLED
AUGUST 28, 1981

SAMPLE INTERVAL	SOIL DESCRIPTION	DEPTH FT	DEPTH M	SOIL COLUMN	SPT N	DENSITY	INTERVAL VELOCITY (M/S) S WAVE	INTERVAL VELOCITY (M/S) P WAVE
	Soft to very soft silty clay.	20	5					392
							160	
	Brown clayey silt with inter-bedded fine to coarse sand.	40	10					
	Soft clay with very fine sandy silt.		15				190	
	Same as above but with black organic matter at about 45 ft.	60	20					1818
	Same as above but coarse sand lenses replace organic material.							
	Stiff to very stiff silty brown clay with some fine to coarse sand lenses.	80	25					
							231	
	Very soft, brown clayey silt.	100	30					
	Same as above but with fine to very fine sand.		35					30.5 m
		120						
			40					
		140						
			45					
		160						
			50					
		180						
			55					
		200						
			60					
			65					
		220						
			70					
		240						
			75					

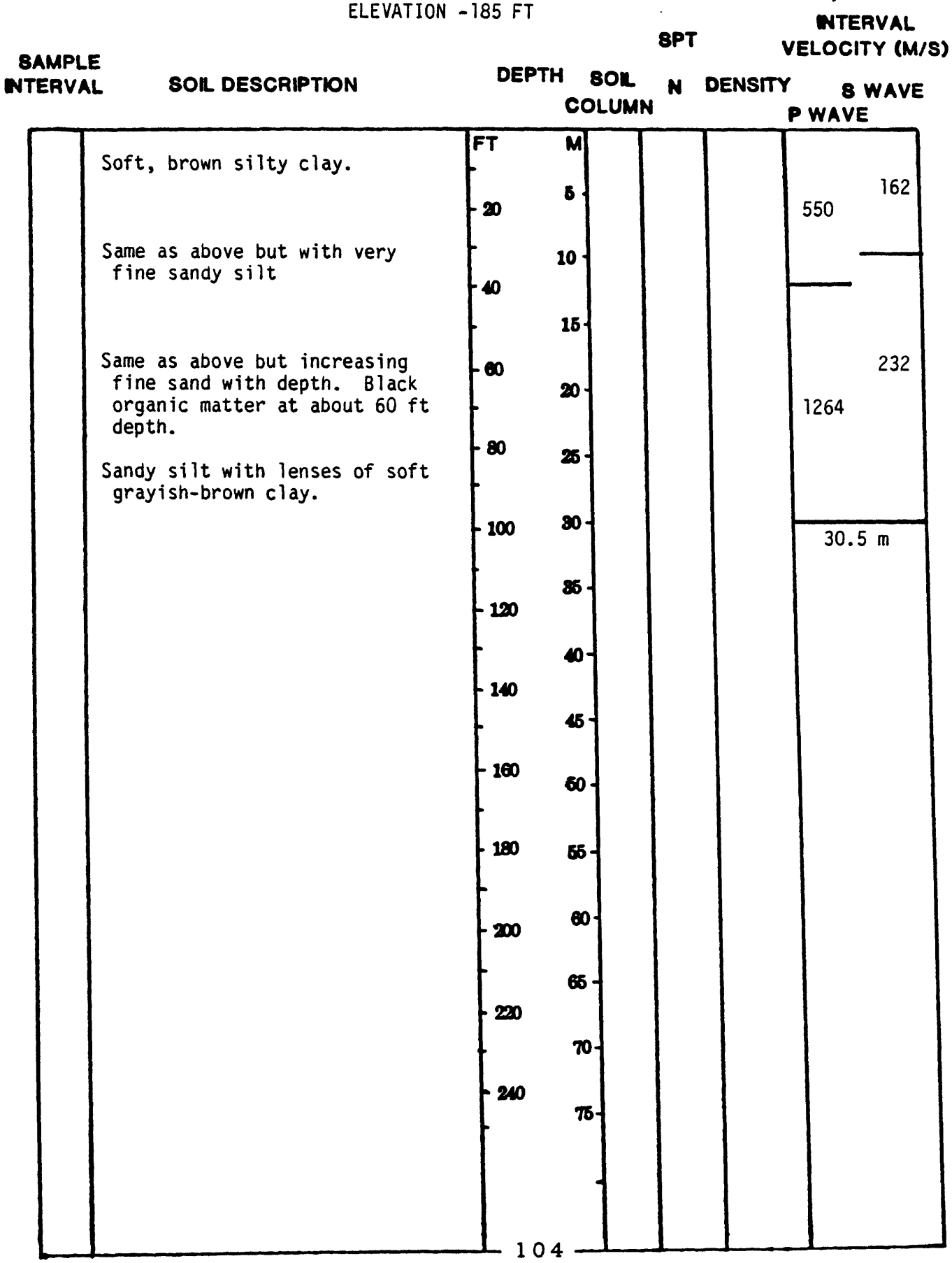
PARACHUTE TEST SITE
IMLER ROAD
ELEVATION +50 FT

BOREHOLE DRILLED
AUGUST 28, 1981



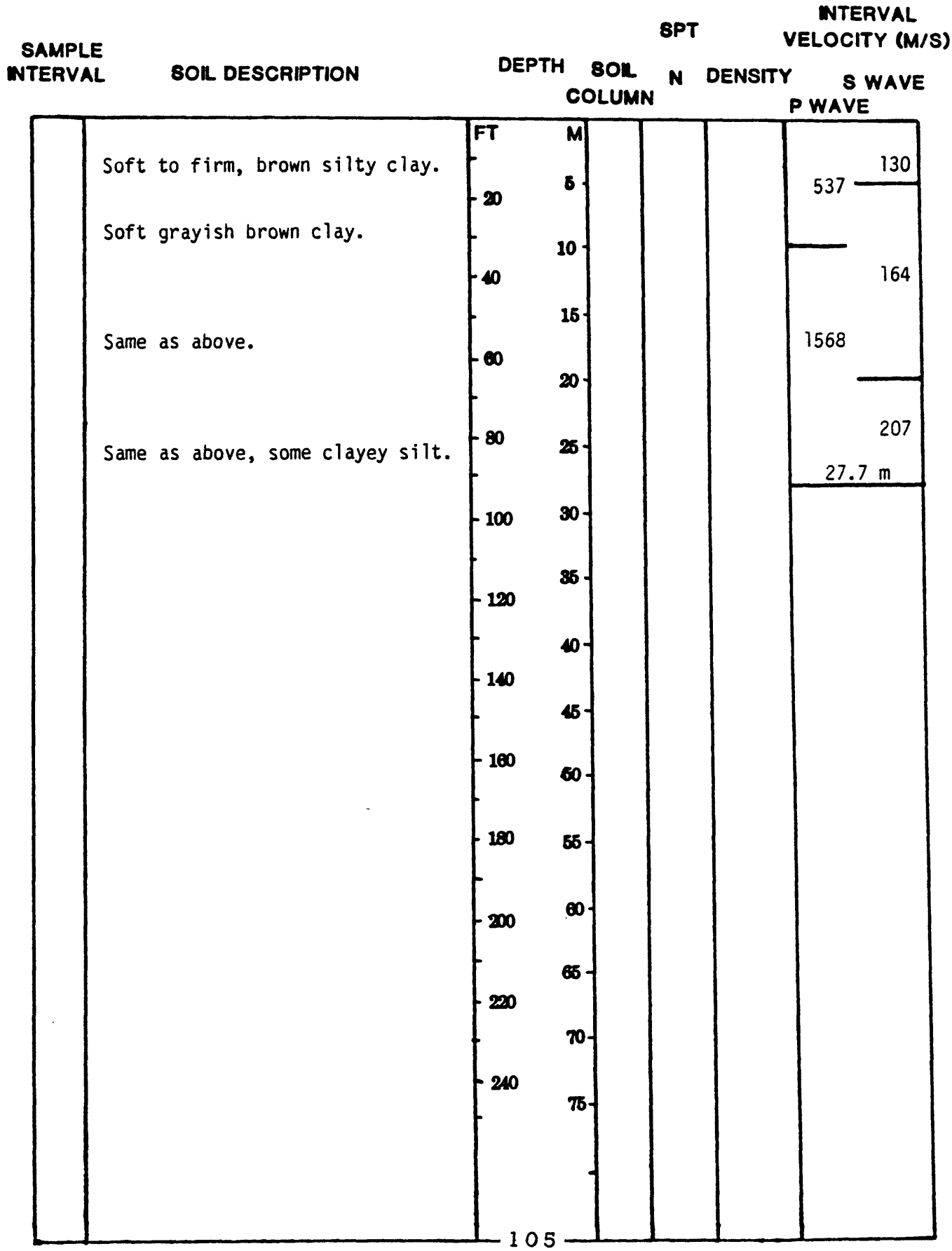
CALIPATRIA
FIRE STATION
ELEVATION -185 FT

BOREHOLE DRILLED
AUGUST 29, 1981



SALTON SEA
WILDLIFE REFUGE
ELEVATION -225 FT

BOREHOLE DRILLED
AUGUST 29, 1981



APPENDIX D.

DOWNHOLE VELOCITY SURVEY:

ARRIVAL TIMES AND VELOCITIES.

BONDS CORNER; HIGHWAYS 98 & 115.

LATITUDE: 32.693N

LONGITUDE: 115.336W

DATE LOGGED: 02/17/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: DATA FROM SECOND SURVEY PERFORMED AT THIS SITE.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.007	0.023	0.013	197.	197.
5.0	0.008	0.043	0.034	149.	119.
7.5	0.007	0.053	0.045	168.	227.
10.0	0.008	0.068	0.060	167.	163.
12.5	0.008	0.079	0.071	175.	222.
15.0	0.007	0.091	0.083	180.	205.
17.5	0.007	0.102	0.095	185.	225.
20.0	0.008	0.112	0.105	191.	246.
22.5	0.008	0.120	0.113	199.	310.
25.0	0.007	0.129	0.122	205.	276.
27.5	0.008	0.134	0.127	217.	495.
30.0	0.008	0.141	0.134	224.	355.
32.5	0.008	0.149	0.142	229.	311.
35.0	0.008	0.155	0.148	237.	415.
37.5	0.008	0.161	0.154	243.	415.
40.0	0.007	0.171	0.164	244.	250.
42.5	0.007	0.177	0.170	250.	410.
45.0	0.008	0.187	0.180	250.	250.
47.5	0.008	0.192	0.185	257.	499.
50.0	0.007	0.199	0.192	260.	357.
52.5	0.007	0.205	0.198	265.	418.
55.0	0.008	0.212	0.205	268.	357.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.014	0.011	229.	229.
5.0	0.016	0.015	337.	537.
7.5	0.018	0.017	451.	986.
10.0	0.019	0.019	537.	2019.
12.5	0.022	0.022	575.	808.
15.0	0.024	0.024	631.	1210.
17.5	0.025	0.025	705.	2384.
20.0	0.026	0.026	773.	2421.
22.5	0.028	0.028	807.	1238.
25.0	0.030	0.030	836.	1241.
27.5	0.031	0.031	889.	2466.
30.0	0.032	0.032	940.	2473.
32.5	0.033	0.033	987.	2479.
35.0	0.035	0.035	1002.	1247.
37.5	0.036	0.036	1043.	2485.
40.0	0.037	0.037	1082.	2488.
42.5	0.039	0.039	1091.	1248.
45.0	0.040	0.040	1126.	2491.
47.5	0.042	0.042	1132.	1249.
50.0	0.043	0.043	1164.	2493.
52.5	0.045	0.045	1166.	1249.
55.0	0.046	0.046	1196.	2494.

CALEXICO FIRE STATION; FIFTH & MAIN.

LATITUDE: 32.68?N

LONGITUDE: 115.49?W

DATE LOGGED: 02/06/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
DP GROUND 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.011 S

COMMENTS: DATA FROM UPPER 30M RECOVERED DURING SECOND SURVEY ON 3/5/82.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.010	0.019	0.006	400.	400.
5.0	0.010	0.038	0.025	199.	133.
7.5	0.010	0.050	0.036	199.	198.
10.0	0.010	0.060	0.048	208.	241.
12.5	0.010	0.070	0.058	215.	245.
15.0	0.010	0.079	0.067	223.	273.
17.5	0.010	0.091	0.079	220.	207.
20.0	0.010	0.103	0.092	218.	207.
22.5	0.010	0.113	0.102	221.	249.
25.0	0.010	0.123	0.112	224.	249.
27.5	0.010	0.132	0.121	228.	277.
30.0	0.010	0.140	0.129	233.	311.
32.5	0.011	0.150	0.139	234.	249.
35.0	0.012	0.157	0.146	240.	356.
37.5	0.012	0.165	0.154	244.	312.
40.0	0.012	0.173	0.162	247.	312.
42.5	0.012	0.184	0.173	240.	227.
45.0	0.012	0.190	0.179	252.	416.
47.5	0.011	0.197	0.186	256.	357.
50.0	0.012	0.206	0.195	257.	278.
52.5	0.011	0.212	0.201	261.	416.
55.0	0.012	0.220	0.209	263.	312.
57.5	0.012	0.226	0.215	268.	416.
60.0	0.012	0.230	0.219	274.	624.
62.5	0.012	0.237	0.226	277.	357.
65.0	0.011	0.245	0.234	278.	312.
67.5	0.012	0.255	0.244	277.	250.
70.0	0.012	0.263	0.252	278.	312.
72.5	0.012	0.268	0.257	282.	499.
75.0	0.010	0.278	0.268	283.	510.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.015	0.012	213.	213.
5.0	0.018	0.017	299.	500.
7.5	0.020	0.019	388.	957.
10.0	0.024	0.024	425.	594.
12.5	0.026	0.026	467.	1108.
15.0	0.027	0.027	500.	2294.
17.5	0.029	0.029	507.	1220.
20.0	0.031	0.031	548.	1229.
22.5	0.032	0.032	700.	2431.
25.0	0.033	0.033	760.	2430.
27.5	0.035	0.035	786.	1244.
30.0	0.037	0.037	813.	1244.
32.5	0.038	0.038	857.	2475.
35.0	0.040	0.040	876.	1240.
37.5	0.041	0.041	910.	2483.
40.0	0.042	0.042	954.	2486.
42.5	0.043	0.043	989.	2488.
45.0	0.045	0.045	1001.	1248.
47.5	0.047	0.047	1012.	1248.
50.0	0.048	0.048	1042.	2492.
52.5	0.050	0.050	1051.	1249.
55.0	0.051	0.051	1079.	2494.
57.5	0.052	0.052	1106.	2494.
60.0	0.054	0.054	1112.	1249.
62.5	0.056	0.056	1117.	1249.
65.0	0.057	0.057	1141.	2496.
67.5	0.058	0.058	1164.	2496.
70.0	0.060	0.060	1167.	1249.
72.5	0.061	0.061	1189.	2497.
75.0	0.062	0.062	1220.	3095.

HOLTVILLE POST OFFICE.

LATITUDE: 32.812N

LONGITUDE: 115.377W

DATE LOGGED: 02/16/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: NO DATA AT 40-70M DEPTHS; LOWER TWO DEPTHS SURVEYED ON 2/6/81.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
4.5	0.006	0.022	0.012	204.	204.
5.0	0.006	0.033	0.025	202.	200.
7.5	0.006	0.042	0.034	218.	258.
10.0	0.006	0.062	0.055	183.	124.
12.5	0.006	0.076	0.069	182.	176.
15.0	0.006	0.087	0.080	188.	224.
17.5	0.006	0.100	0.093	188.	191.
20.0	0.006	0.109	0.102	196.	275.
22.5	0.006	0.117	0.110	204.	310.
25.0	0.006	0.131	0.124	201.	178.
27.5	0.006	0.143	0.136	202.	208.
30.0	0.006	0.150	0.149	201.	192.
32.5	0.006	0.164	0.157	207.	311.
35.0	0.007	0.178	0.171	204.	178.
37.5	0.006	0.185	0.178	210.	350.
39.3	0.007	0.191	0.184	213.	299.
72.5	0.008	0.295	0.289	251.	319.
75.0	0.008	0.302	0.296	254.	357.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
4.5	0.011	0.009	291.	291.
5.0	0.013	0.012	414.	718.
7.5	0.010	0.015	985.	758.
10.0	0.018	0.018	567.	1141.
12.5	0.020	0.020	633.	1191.
15.0	0.022	0.022	686.	1215.
17.5	0.032	0.032	550.	450.
20.0	0.034	0.034	591.	1227.
22.5	0.036	0.036	627.	1233.
25.0	0.036	0.036	697.	93518.
27.5	0.039	0.039	707.	830.
30.0	0.040	0.040	752.	4405.
32.5	0.041	0.041	794.	4972.
35.0	0.044	0.044	797.	832.
37.5	0.045	0.045	835.	4981.
39.3	0.046	0.046	855.	1792.
72.5	0.093	0.093	1151.	1949.
75.0	0.095	0.095	1134.	1249.

EL CENTRO ARRAY STATION 2; KEYSTONE ROAD.

LATITUDE: 32.916N

LONGITUDE: 115.366W

DATE LOGGED: 01/29/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLAIN 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.010 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.010	0.040	0.023	107.	107.
5.0	0.010	0.043	0.031	163.	347.
7.5	0.010	0.059	0.047	159.	150.
10.0	0.010	0.072	0.061	154.	146.
12.5	0.010	0.086	0.075	157.	175.
15.0	0.010	0.100	0.089	168.	176.
17.5	0.010	0.116	0.105	160.	155.
20.0	0.010	0.126	0.117	170.	207.
22.5	0.010	0.140	0.129	174.	207.
25.0	0.010	0.152	0.142	177.	207.
27.5	0.010	0.160	0.150	184.	310.
30.0	0.010	0.168	0.158	190.	311.
32.5	0.010	0.177	0.167	195.	277.
35.0	0.010	0.185	0.175	200.	311.
37.5	0.010	0.191	0.181	207.	415.
40.0	0.010	0.203	0.193	208.	208.
42.5	0.010	0.211	0.201	212.	312.
45.0	0.010	0.219	0.209	215.	312.
47.5	0.010	0.228	0.218	218.	277.
50.0	0.010	0.236	0.226	221.	312.
52.5	0.010	0.243	0.233	225.	357.
55.0	0.010	0.250	0.240	229.	357.
57.5	0.010	0.258	0.248	232.	312.
60.0	0.010	0.265	0.255	235.	357.
62.5	0.010	0.272	0.262	239.	357.
65.0	0.010	0.281	0.271	240.	275.
67.5	0.010	0.290	0.280	241.	276.
70.0	0.010	0.296	0.286	245.	416.
72.5	0.010	0.304	0.294	247.	312.
75.4	0.010	0.314	0.304	248.	290.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.014	0.011	229.	229.
5.0	0.014	0.013	365.	1210.
7.5	0.016	0.015	485.	1010.
10.0	0.017	0.017	600.	2066.
12.5	0.018	0.018	703.	2264.
15.0	0.019	0.019	796.	2350.
17.5	0.020	0.020	881.	2310.
20.0	0.023	0.023	874.	829.
22.5	0.024	0.024	941.	2451.
25.0	0.026	0.026	965.	1243.
27.5	0.027	0.027	1021.	2471.
30.0	0.028	0.028	1074.	2477.
32.5	0.031	0.031	1050.	832.
35.0	0.033	0.033	1062.	1247.
37.5	0.033	0.033	1136.	301578.
40.0	0.035	0.035	1144.	1248.
42.5	0.036	0.036	1182.	2490.
45.0	0.037	0.037	1217.	2492.
47.5	0.039	0.039	1219.	1249.
50.0	0.040	0.040	1251.	2494.
52.5	0.041	0.041	1281.	2494.
55.0	0.042	0.042	1310.	2495.
57.5	0.044	0.044	1308.	1249.
60.0	0.045	0.045	1334.	2496.
62.5	0.047	0.047	1330.	1249.
65.0	0.048	0.048	1355.	2497.
67.5	0.049	0.049	1378.	2497.
70.0	0.051	0.051	1373.	1250.
72.5	0.052	0.052	1395.	2497.
75.4	0.054	0.054	1397.	1449.

EL CENTRO ARRAY 3; FIRE UNION SCHOOL.

LATITUDE: 32.694N

LONGITUDE: 115.380W

DATE LOGGED: 02/07/81

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GROPH.	1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
4.5	0.004	0.032	0.022	114.	114.
5.0	0.004	0.031	0.044	114.	115.
7.5	0.004	0.065	0.059	127.	163.
10.0	0.004	0.081	0.076	132.	151.
12.5	0.004	0.094	0.089	141.	167.
15.0	0.004	0.110	0.105	143.	154.
17.5	0.004	0.124	0.119	147.	177.
20.0	0.004	0.138	0.133	150.	177.
22.5	0.004	0.149	0.144	156.	225.
25.0	0.004	0.165	0.161	156.	156.
27.5	0.004	0.176	0.172	160.	220.
30.0	0.004	0.188	0.182	165.	249.
32.5	0.004	0.200	0.196	166.	178.
35.0	0.003	0.223	0.219	160.	109.
37.5	0.004	0.223	0.219	171.	54471.
40.0	0.004	0.252	0.248	176.	277.
42.5	0.004	0.256	0.254	182.	415.
45.0	0.004	0.242	0.238	184.	621.
47.5	0.004	0.253	0.249	191.	227.
50.0	0.004	0.262	0.258	194.	277.
52.5	0.004	0.272	0.268	196.	250.
55.0	0.004	0.280	0.276	199.	312.
57.5	0.004	0.288	0.284	203.	312.
60.0	0.004	0.298	0.294	204.	250.
62.5	0.004	0.308	0.304	206.	250.
65.0	0.004	0.315	0.311	209.	357.
67.8	0.004	0.322	0.318	213.	399.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
4.5	0.012	0.009	267.	267.
5.0	0.010	0.015	337.	456.
7.5	0.017	0.016	457.	1592.
10.0	0.018	0.018	567.	2042.
12.5	0.023	0.023	550.	494.
15.0	0.025	0.025	605.	1206.
17.5	0.027	0.027	654.	1223.
20.0	0.028	0.028	716.	2414.
22.5	0.030	0.030	753.	1237.
25.0	0.032	0.032	784.	1240.
27.5	0.033	0.033	836.	2463.
30.0	0.035	0.035	859.	1244.
32.5	0.036	0.036	904.	2476.
35.0	0.036	0.036	974.	267579.
37.5	0.037	0.037	1015.	2485.
40.0	0.039	0.039	1027.	1248.
42.5	0.041	0.041	1036.	1248.
45.0	0.042	0.042	1072.	2490.
47.5	0.044	0.044	1081.	1248.
50.0	0.046	0.046	1088.	1249.
52.5	0.047	0.047	1118.	2493.
55.0	0.049	0.049	1123.	1249.
57.5	0.051	0.051	1126.	1249.
60.0	0.052	0.052	1154.	2495.
62.5	0.053	0.053	1180.	2496.
65.0	0.054	0.054	1204.	2496.
67.8	0.056	0.056	1211.	1399.

EL CENTRO ARRAY STATION 4; ANDERSON ROAD.

LATITUDE: 32.864N

LONGITUDE: 115.432W

DATE LOGGED: 01/27/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
OF GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: POOR S-WAVE ARRIVALS THROUGHOUT SECTION (P TO S...).

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
4.5	0.007	0.016	0.007	357.	357.
5.0	0.007	0.036	0.027	186.	126.
7.5	0.007	0.054	0.045	165.	135.
10.0	0.007	0.068	0.060	167.	174.
12.5	0.007	0.080	0.072	173.	204.
15.0	0.007	0.091	0.083	180.	224.
17.5	0.007	0.102	0.094	185.	225.
20.0	0.007	0.113	0.105	190.	245.
22.5	0.007	0.122	0.115	195.	276.
25.0	0.007	0.135	0.128	195.	226.
27.5	0.007	0.141	0.134	205.	311.
30.0	0.008	0.149	0.142	212.	311.
32.5	0.007	0.161	0.154	211.	208.
35.0	0.007	0.169	0.162	216.	311.
37.5	0.007	0.179	0.172	218.	250.
40.0	0.007	0.188	0.181	221.	277.
42.5	0.007	0.198	0.191	223.	250.
45.0	0.007	0.209	0.202	223.	227.
47.5	0.007	0.219	0.212	224.	250.
50.0	0.007	0.229	0.222	225.	250.
52.5	0.007	0.239	0.232	226.	250.
55.0	0.007	0.247	0.240	229.	312.
57.5	0.007	0.254	0.247	233.	357.
60.0	0.007	0.263	0.256	235.	278.
62.5	0.007	0.275	0.268	233.	208.
65.0	0.007	0.282	0.275	237.	357.
67.5	0.007	0.288	0.281	240.	416.
70.0	0.007	0.293	0.286	245.	499.
72.5	0.007	0.301	0.294	247.	312.
73.8	0.007	0.302	0.295	250.	1295.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
4.5	0.013	0.010	240.	240.
5.0	0.014	0.013	385.	878.
7.5	0.015	0.014	517.	1672.
10.0	0.016	0.016	637.	2091.
12.5	0.018	0.016	705.	1199.
15.0	0.019	0.019	790.	2360.
17.5	0.020	0.020	881.	2410.
20.0	0.021	0.021	957.	2439.
22.5	0.023	0.023	982.	1241.
25.0	0.024	0.024	1045.	2466.
27.5	0.026	0.026	1060.	1245.
30.0	0.027	0.027	1114.	2476.
32.5	0.028	0.028	1163.	2483.
35.0	0.029	0.029	1209.	2466.
37.5	0.031	0.031	1211.	1245.
40.0	0.033	0.033	1214.	1248.
42.5	0.035	0.035	1216.	1248.
45.0	0.036	0.036	1251.	2492.
47.5	0.038	0.038	1251.	1249.
50.0	0.039	0.039	1283.	2494.
52.5	0.041	0.041	1261.	1249.
55.0	0.042	0.042	1310.	2495.
57.5	0.044	0.044	1308.	1249.
60.0	0.046	0.046	1305.	1249.
62.5	0.047	0.047	1330.	2496.
65.0	0.048	0.048	1355.	2497.
67.5	0.050	0.050	1351.	1250.
70.0	0.051	0.051	1373.	2497.
72.5	0.053	0.053	1368.	1250.
73.8	0.053	0.053	1393.	1846386.

EL CENTRO ARRAY STATION 5; JAMES ROAD.

LATITUDE: 32.855N

LONGITUDE: 115.466W

DATE LOGGED: 01/10/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.006	0.029	0.017	144.	144.
5.0	0.007	0.039	0.030	167.	199.
7.5	0.007	0.050	0.042	180.	211.
10.0	0.007	0.065	0.057	175.	163.
12.5	0.007	0.077	0.069	180.	204.
15.0	0.007	0.087	0.079	189.	240.
17.5	0.007	0.097	0.090	195.	247.
20.0	0.007	0.107	0.100	201.	248.
22.5	0.007	0.120	0.113	200.	192.
25.0	0.007	0.133	0.126	199.	194.
27.5	0.007	0.144	0.137	201.	220.
30.0	0.007	0.152	0.145	207.	311.
32.5	0.006	0.164	0.157	207.	208.
35.0	0.007	0.172	0.165	212.	311.
37.5	0.007	0.182	0.175	214.	249.
40.0	0.007	0.192	0.185	216.	250.
42.5	0.006	0.202	0.195	218.	250.
45.0	0.007	0.211	0.204	221.	277.
47.5	0.006	0.221	0.214	222.	250.
50.0	0.007	0.230	0.223	224.	277.
52.5	0.007	0.239	0.232	226.	277.
55.0	0.007	0.248	0.241	228.	278.
57.5	0.007	0.258	0.251	229.	250.
60.0	0.006	0.265	0.258	233.	357.
62.5	0.007	0.273	0.266	235.	312.
65.0	0.007	0.281	0.274	237.	312.
67.5	0.007	0.288	0.281	240.	357.
68.7	0.007	0.291	0.284	242.	400.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.013	0.010	246.	246.
5.0	0.013	0.012	414.	1303.
7.5	0.013	0.013	597.	5093.
10.0	0.014	0.013	726.	2142.
12.5	0.016	0.016	791.	1207.
15.0	0.017	0.017	890.	2377.
17.5	0.018	0.018	979.	2421.
20.0	0.020	0.020	1005.	1239.
22.5	0.021	0.021	1070.	2459.
25.0	0.023	0.023	1090.	1244.
27.5	0.024	0.024	1149.	2475.
30.0	0.026	0.026	1156.	1246.
32.5	0.027	0.027	1206.	2484.
35.0	0.029	0.029	1209.	1248.
37.5	0.030	0.030	1252.	2488.
40.0	0.032	0.032	1252.	1248.
42.5	0.033	0.033	1289.	2491.
45.0	0.035	0.035	1287.	1249.
47.5	0.037	0.037	1285.	1249.
50.0	0.038	0.038	1317.	2494.
52.5	0.040	0.040	1315.	1249.
55.0	0.041	0.041	1342.	2495.
57.5	0.043	0.043	1338.	1249.
60.0	0.044	0.044	1364.	2496.
62.5	0.046	0.046	1359.	1249.
65.0	0.048	0.048	1355.	1249.
67.5	0.049	0.049	1378.	2497.
68.7	0.050	0.050	1375.	1200.

EL CENTRO ARRAY STATION 6; HUSTON ROAD.

LATITUDE: 32.839N

LONGITUDE: 115.487W

DATE LOGGED: 01/15/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.009 S

COMMENTS: 1.74g MAX VERTICAL ACCEL RECORDED HERE DURING 1979 EVENT.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.009	0.032	0.018	137.	137.
5.0	0.009	0.068	0.036	137.	137.
7.5	0.009	0.062	0.051	146.	167.
10.0	0.009	0.070	0.060	152.	173.
12.5	0.009	0.084	0.074	168.	299.
15.0	0.009	0.092	0.083	182.	304.
17.5	0.009	0.104	0.095	185.	206.
20.0	0.009	0.116	0.107	187.	207.
22.5	0.008	0.129	0.120	188.	191.
25.0	0.009	0.138	0.129	194.	276.
27.5	0.008	0.148	0.139	198.	249.
30.0	0.009	0.158	0.149	201.	249.
32.5	0.008	0.165	0.156	208.	355.
35.0	0.009	0.174	0.165	212.	271.
37.5	0.009	0.185	0.176	213.	221.
40.0	0.008	0.194	0.185	216.	271.
42.5	0.009	0.206	0.197	216.	204.
45.0	0.009	0.215	0.206	218.	277.
47.5	0.009	0.222	0.213	223.	350.
50.0	0.008	0.231	0.222	225.	277.
52.5	0.008	0.241	0.232	226.	250.
55.0	0.008	0.251	0.242	227.	250.
57.5	0.009	0.261	0.252	228.	250.
60.0	0.009	0.270	0.261	230.	276.
62.5	0.009	0.279	0.270	231.	276.
65.0	0.008	0.292	0.283	230.	192.
67.5	0.009	0.303	0.294	229.	227.
70.0	0.009	0.309	0.300	233.	416.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.018	0.014	178.	178.
5.0	0.010	0.015	337.	3125.
7.5	0.019	0.015	409.	714.
10.0	0.018	0.018	567.	-3331.
12.5	0.021	0.021	603.	810.
15.0	0.022	0.022	688.	2335.
17.5	0.023	0.023	760.	2394.
20.0	0.025	0.025	804.	1233.
22.5	0.028	0.028	807.	829.
25.0	0.031	0.031	809.	830.
27.5	0.033	0.033	830.	1243.
30.0	0.034	0.034	884.	2471.
32.5	0.036	0.036	904.	1245.
35.0	0.038	0.038	923.	1246.
37.5	0.039	0.039	963.	2484.
40.0	0.041	0.041	977.	1247.
42.5	0.044	0.044	967.	833.
45.0	0.045	0.045	1001.	2489.
47.5	0.048	0.048	1034.	2491.
50.0	0.048	0.048	1042.	1249.
52.5	0.050	0.050	1051.	1249.
55.0	0.051	0.051	1079.	2494.
57.5	0.052	0.052	1106.	2494.
60.0	0.053	0.053	1133.	2495.
62.5	0.055	0.055	1137.	1249.
65.0	0.056	0.056	1161.	2496.
67.5	0.057	0.057	1185.	2496.
70.0	0.058	0.058	1207.	2497.

EL CENTRO ARRAY STATION 7; IMPERIAL VALLEY COLLEGE.

LATITUDE: 32.829N

LONGITUDE: 115.504W

DATE LOGGED: 02/11/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: MOVE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.007	0.028	0.016	153.	153.
5.0	0.007	0.042	0.032	154.	155.
7.5	0.007	0.050	0.041	181.	270.
10.0	0.007	0.063	0.055	183.	187.
12.5	0.007	0.077	0.069	181.	176.
15.0	0.007	0.089	0.081	185.	206.
17.5	0.007	0.101	0.093	188.	205.
20.0	0.006	0.114	0.106	188.	191.
22.5	0.007	0.123	0.115	195.	275.
25.0	0.007	0.132	0.124	201.	270.
27.5	0.007	0.141	0.134	206.	276.
30.0	0.007	0.149	0.142	212.	311.
32.5	0.008	0.158	0.151	216.	277.
35.0	0.008	0.166	0.159	221.	311.
37.5	0.007	0.174	0.167	225.	312.
40.0	0.007	0.182	0.175	229.	312.
42.5	0.007	0.189	0.182	234.	350.
45.0	0.007	0.198	0.191	236.	277.
47.5	0.007	0.206	0.199	239.	312.
50.0	0.007	0.213	0.206	243.	357.
52.5	0.007	0.220	0.213	247.	357.
55.0	0.007	0.228	0.221	249.	312.
57.5	0.007	0.237	0.230	250.	276.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.010	0.006	320.	320.
5.0	0.012	0.011	449.	750.
7.5	0.013	0.013	597.	1761.
10.0	0.014	0.014	726.	2142.
12.5	0.015	0.015	844.	2307.
15.0	0.017	0.017	890.	1226.
17.5	0.018	0.018	979.	2421.
20.0	0.020	0.020	1005.	1239.
22.5	0.021	0.021	1070.	2459.
25.0	0.023	0.023	1090.	1244.
27.5	0.024	0.024	1149.	2475.
30.0	0.026	0.026	1155.	1246.
32.5	0.028	0.028	1163.	1247.
35.0	0.029	0.029	1209.	2486.
37.5	0.031	0.031	1211.	1248.
40.0	0.032	0.032	1252.	2490.
42.5	0.034	0.034	1251.	1249.
45.0	0.035	0.035	1287.	2492.
47.5	0.036	0.036	1321.	2493.
50.0	0.038	0.038	1317.	1249.
52.5	0.040	0.040	1313.	1249.
55.0	0.041	0.041	1342.	2495.
57.5	0.043	0.043	1338.	1249.

EL CENTRO ARRAY STATION 8; CRUICKSHANK ROAD.

LATITUDE: 32.811N

LONGITUDE: 115.532W

DATE LOGGED: 01/26/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.005	0.026	0.016	154.	152.
5.0	0.005	0.041	0.033	149.	147.
7.5	0.005	0.051	0.045	168.	227.
10.0	0.005	0.063	0.057	176.	201.
12.5	0.004	0.076	0.070	178.	189.
15.0	0.005	0.089	0.083	180.	190.
17.5	0.005	0.101	0.095	183.	206.
20.0	0.005	0.111	0.106	189.	248.
22.5	0.005	0.122	0.117	193.	226.
25.0	0.005	0.131	0.126	199.	276.
27.5	0.005	0.140	0.135	204.	276.
30.0	0.004	0.151	0.146	206.	227.
32.5	0.005	0.161	0.156	209.	249.
35.0	0.005	0.167	0.162	216.	415.
37.5	0.005	0.178	0.173	217.	227.
40.0	0.005	0.187	0.182	220.	277.
42.5	0.005	0.195	0.190	224.	312.
45.0	0.005	0.203	0.198	227.	312.
47.5	0.004	0.214	0.209	227.	227.
50.0	0.005	0.224	0.219	228.	250.
52.5	0.005	0.230	0.225	233.	416.
55.0	0.005	0.240	0.235	234.	250.
57.5	0.005	0.247	0.242	238.	357.
60.0	0.005	0.253	0.248	242.	416.
62.5	0.005	0.265	0.260	240.	208.
65.0	0.006	0.276	0.270	238.	192.
67.5	0.005	0.283	0.278	243.	499.
70.0	0.005	0.289	0.284	247.	416.
72.6	0.005	0.297	0.292	249.	325.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.015	0.012	213.	213.
5.0	0.017	0.016	317.	514.
7.5	0.019	0.019	409.	971.
10.0	0.021	0.021	480.	1119.
12.5	0.022	0.022	575.	2209.
15.0	0.023	0.023	658.	2327.
17.5	0.024	0.024	734.	2369.
20.0	0.025	0.025	773.	1233.
22.5	0.027	0.027	837.	2444.
25.0	0.030	0.030	830.	830.
27.5	0.032	0.032	862.	1243.
30.0	0.034	0.034	884.	1244.
32.5	0.036	0.036	904.	1245.
35.0	0.036	0.036	974.	2675?9.
37.5	0.037	0.037	1015.	2485.
40.0	0.037	0.037	1082.	994063.
42.5	0.039	0.039	1091.	1248.
45.0	0.041	0.041	1099.	1248.
47.5	0.043	0.043	1106.	1249.
50.0	0.044	0.044	1137.	2493.
52.5	0.046	0.046	1142.	1249.
55.0	0.047	0.047	1171.	2494.
57.5	0.048	0.048	1199.	2495.
60.0	0.049	0.049	1225.	2495.
62.5	0.051	0.051	1226.	1249.
65.0	0.052	0.052	1251.	2496.
67.5	0.054	0.054	1251.	1249.
70.0	0.055	0.055	1273.	2497.
72.6	0.057	0.057	1274.	1299.

EL CENTRO ARRAY STATION 9; COMMERCIAL AVENUE.

LATITUDE: 32.794N

LONGITUDE: 115.549W

DATE LOGGED: 04/04/61

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: STATION ESTABLISHED 1932; RECORDED 1940 & 1979 EVENTS.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.007	0.018	0.009	291.	291.
5.0	0.007	0.031	0.022	224.	163.
7.5	0.007	0.047	0.039	194.	153.
10.0	0.007	0.062	0.054	185.	164.
12.5	0.007	0.074	0.066	189.	204.
15.0	0.007	0.086	0.078	192.	206.
17.5	0.007	0.098	0.090	194.	207.
20.0	0.007	0.110	0.102	195.	207.
22.5	0.006	0.121	0.114	198.	226.
25.0	0.007	0.128	0.121	207.	354.
27.5	0.006	0.139	0.132	209.	226.
30.0	0.007	0.148	0.141	213.	277.
32.5	0.007	0.156	0.149	219.	311.
35.0	0.008	0.166	0.159	220.	249.
37.5	0.007	0.175	0.168	224.	277.
40.0	0.007	0.182	0.175	229.	356.
42.5	0.007	0.192	0.185	230.	250.
45.0	0.007	0.199	0.192	235.	356.
47.5	0.007	0.204	0.197	241.	499.
50.0	0.007	0.216	0.209	239.	208.
52.5	0.007	0.221	0.214	246.	499.
55.0	0.007	0.234	0.227	242.	192.
57.5	0.007	0.242	0.235	245.	312.
60.0	0.007	0.253	0.246	244.	227.
62.5	0.007	0.258	0.251	249.	499.
65.0	0.007	0.264	0.257	253.	416.
67.5	0.007	0.273	0.266	254.	278.
70.0	0.006	0.280	0.273	257.	357.
72.5	0.006	0.290	0.283	256.	250.
75.0	0.007	0.300	0.293	256.	250.
80.0	0.007	0.312	0.305	262.	416.
85.0	0.007	0.328	0.321	265.	312.
90.0	0.007	0.342	0.335	269.	357.
95.0	0.007	0.350	0.343	277.	624.
100.0	0.007	0.357	0.350	285.	714.
105.0	0.006	0.363	0.356	295.	833.
110.0	0.006	0.368	0.361	305.	999.
115.0	0.007	0.380	0.373	308.	417.
120.0	0.006	0.386	0.379	317.	833.
125.0	0.007	0.393	0.386	324.	714.
130.0	0.006	0.406	0.399	326.	385.
135.0	0.007	0.417	0.410	329.	454.
140.0	0.007	0.428	0.421	333.	454.
145.0	0.007	0.441	0.434	334.	385.
150.0	0.007	0.451	0.444	338.	500.
155.0	0.007	0.459	0.452	343.	625.
160.0	0.007	0.470	0.463	346.	454.
165.0	0.007	0.487	0.480	344.	294.
170.0	0.007	0.500	0.493	345.	385.
175.0	0.007	0.512	0.505	347.	417.
180.0	0.007	0.521	0.514	350.	555.
185.0	0.007	0.532	0.525	352.	455.
190.0	0.007	0.539	0.532	357.	714.
195.0	0.007	0.551	0.544	358.	417.
200.0	0.007	0.558	0.551	363.	714.
205.0	0.007	0.570	0.563	364.	417.
210.0	0.009	0.583	0.576	365.	385.
215.0	0.007	0.596	0.589	365.	385.
220.0	0.008	0.608	0.601	366.	417.
225.0	0.008	0.621	0.614	366.	385.
230.0	0.008	0.637	0.630	365.	312.
235.0	0.008	0.652	0.645	364.	333.
240.0	0.008	0.662	0.655	366.	500.
244.4	0.007	0.681	0.674	363.	232.

EL CENTRO ARRAY STATION 9; COMMERCIAL AVENUE.

LATITUDE: 32.794N

LONGITUDE: 115.549W

DATE LOGGED: 04/04/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: STATION ESTABLISHED 1932; RECORDED 1940 & 1979 EVENTS.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				
22.5				
25.0				
27.5				
30.0				
32.5				
35.0				
37.5				
40.0	0.043	0.043	931.	
42.5	0.044	0.044	967.	2488.
45.0	0.045	0.045	1001.	2489.
47.5	0.046	0.046	1034.	2491.
50.0	0.047	0.047	1065.	2492.
52.5	0.049	0.049	1072.	1249.
55.0	0.050	0.050	1101.	2494.
57.5	0.051	0.051	1128.	2495.
60.0	0.052	0.052	1154.	2495.
62.5	0.054	0.054	1158.	1249.
65.0	0.055	0.055	1182.	2496.
67.5	0.057	0.057	1185.	1249.
70.0	0.059	0.059	1187.	1249.
72.5	0.063	0.063	1151.	625.
75.0	0.061	0.061	1230.	-1251.
80.0	0.063	0.063	1270.	2498.
85.0	0.067	0.067	1269.	1250.
90.0	0.070	0.070	1286.	1666.
95.0	0.073	0.073	1302.	1666.
100.0	0.075	0.075	1334.	2499.
105.0	0.078	0.078	1346.	1666.
110.0	0.080	0.080	1375.	2499.
115.0	0.085	0.085	1353.	1000.
120.0	0.087	0.087	1380.	2499.
125.0	0.089	0.089	1405.	2499.
130.0	0.093	0.093	1398.	1250.
135.0	0.096	0.096	1406.	1666.
140.0	0.098	0.098	1429.	2499.
145.0	0.102	0.102	1422.	1250.
150.0	0.105	0.105	1429.	1666.
155.0	0.108	0.108	1435.	1666.
160.0	0.111	0.111	1442.	1666.
165.0	0.113	0.113	1460.	2500.
170.0	0.115	0.115	1478.	2500.
175.0	0.118	0.118	1483.	1667.
180.0	0.120	0.120	1500.	2500.
185.0	0.123	0.123	1504.	1667.
190.0	0.125	0.125	1520.	2500.
195.0	0.128	0.128	1524.	1667.
200.0	0.131	0.131	1527.	1667.
205.0	0.135	0.135	1519.	1250.
210.0	0.137	0.137	1533.	2500.
215.0	0.140	0.140	1536.	1667.
220.0	0.143	0.143	1539.	1667.
225.0	0.146	0.146	1541.	1667.
230.0	0.149	0.149	1544.	1667.
235.0	0.151	0.151	1556.	2500.
240.0	0.153	0.153	1569.	2500.
244.4	0.155	0.155	1577.	2200.

No P-wave data above 40 m due to operator error.

EL CENTRO ARRAY STATION 10; COMMUNITY HOSPITAL.

LATITUDE: 32.780N

LONGITUDE: 115.56/W

DATE LOGGED: 01/13/61

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: EQUIPMENT ERRATIC; POOR P ARRIVALS; CAP DEPTH VARIABLE.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.006	0.028	0.017	151.	151.
5.0	0.006	0.038	0.029	173.	201.
7.5	0.006	0.053	0.045	168.	150.
10.0	0.006	0.065	0.057	175.	201.
12.5	0.007	0.077	0.069	180.	204.
15.0	0.006	0.088	0.080	186.	224.
17.5	0.007	0.102	0.095	185.	177.
20.0	0.005	0.112	0.105	191.	248.
22.5	0.006	0.126	0.119	190.	178.
25.0	0.006	0.135	0.128	196.	276.
27.5	0.006	0.149	0.142	194.	178.
30.0	0.006	0.155	0.146	203.	413.
32.5	0.006	0.164	0.157	207.	277.
35.0	0.006	0.171	0.164	214.	356.
37.5	0.009	0.184	0.177	212.	192.
40.0	0.006	0.191	0.184	217.	356.
42.5	0.007	0.199	0.192	221.	312.
45.0	0.009	0.208	0.201	224.	277.
47.5	0.009	0.215	0.208	228.	356.
50.0	0.010	0.223	0.216	231.	312.
52.5	0.009	0.231	0.224	234.	312.
55.0	0.007	0.237	0.230	239.	416.
57.5	0.006	0.245	0.238	242.	312.
60.0	0.006	0.251	0.244	246.	416.
62.5	0.006	0.256	0.251	249.	357.
65.0	0.010	0.265	0.256	252.	357.
67.5	0.006	0.270	0.263	257.	499.
70.0	0.006	0.275	0.268	261.	499.
71.1	0.007	0.283	0.276	258.	137.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.015	0.012	213.	213.
5.0	0.015	0.014	354.	1129.
7.5	0.015	0.014	517.	4414.
10.0	0.015	0.015	680.	11618.
12.5	0.011	0.011	1151.	-650.
15.0	0.012	0.012	1261.	2420.
17.5	0.026	0.026	677.	179.
20.0	0.027	0.027	744.	2417.
22.5	0.028	0.028	807.	2441.
25.0	0.033	0.033	760.	500.
27.5	0.028	0.028	985.	-503.
30.0	0.035	0.035	859.	357.
32.5	0.030	0.030	1085.	-502.
35.0	0.031	0.031	1131.	2485.
37.5	0.035	0.035	1073.	625.
40.0	0.035	0.035	1144.	4165&7.
42.5	0.041	0.041	1038.	417.
45.0	0.039	0.039	1155.	-1254.
47.5	0.043	0.043	1106.	525.
50.0	0.043	0.043	1164.	674451.
52.5	0.056	0.056	938.	192.
55.0	0.047	0.047	1171.	-278.
57.5	0.049	0.049	1174.	1249.
60.0	0.050	0.050	1201.	2495.
62.5	0.053	0.053	1180.	833.
65.0	0.054	0.054	1204.	2496.
67.5	0.055	0.055	1228.	2496.
70.0	0.057	0.057	1229.	1249.
71.1	0.057	0.057	1248.	1514249.

EL CENTRO ARRAY STATION 11; McCABE SCHOOL.

LATITUDE: 32.792N

LONGITUDE: 115.594W

DATE LOGGED: 01/23/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: EXCELLENT S ARRIVALS.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.005	0.017	0.009	267.	267.
5.0	0.005	0.041	0.033	150.	104.
7.5	0.005	0.057	0.050	149.	149.
10.0	0.005	0.074	0.068	148.	144.
12.5	0.005	0.085	0.079	158.	221.
15.0	0.005	0.095	0.089	168.	245.
17.5	0.005	0.105	0.099	176.	246.
20.0	0.005	0.116	0.110	181.	225.
22.5	0.005	0.125	0.120	188.	275.
25.0	0.005	0.135	0.130	193.	249.
27.5	0.005	0.148	0.143	193.	192.
30.0	0.005	0.158	0.153	197.	249.
32.5	0.005	0.168	0.163	200.	249.
35.0	0.005	0.175	0.170	206.	356.
37.5	0.005	0.185	0.180	209.	249.
40.0	0.005	0.195	0.190	211.	250.
42.5	0.005	0.202	0.197	216.	359.
45.0	0.005	0.211	0.206	219.	277.
47.5	0.005	0.221	0.216	220.	250.
50.0	0.005	0.232	0.227	220.	227.
52.5	0.005	0.244	0.239	220.	208.
55.0	0.005	0.253	0.248	222.	277.
57.5	0.005	0.264	0.259	222.	227.
60.0	0.005	0.272	0.267	225.	312.
62.6	0.005	0.282	0.277	226.	260.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.014	0.014	178.	178.
5.0	0.013	0.012	414.	-1259.
7.5	0.015	0.014	517.	1032.
10.0	0.017	0.017	600.	1149.
12.5	0.018	0.018	703.	2264.
15.0	0.020	0.020	757.	1219.
17.5	0.022	0.022	801.	1230.
20.0	0.024	0.024	837.	1236.
22.5	0.025	0.025	904.	2449.
25.0	0.027	0.027	929.	1242.
27.5	0.028	0.028	985.	2470.
30.0	0.030	0.030	1002.	1245.
32.5	0.031	0.031	1050.	2480.
35.0	0.033	0.033	1062.	1247.
37.5	0.034	0.034	1105.	2486.
40.0	0.035	0.035	1144.	2489.
42.5	0.037	0.037	1150.	1248.
45.0	0.038	0.038	1185.	2491.
47.5	0.040	0.040	1189.	1249.
50.0	0.041	0.041	1220.	2493.
52.5	0.043	0.043	1222.	1249.
55.0	0.045	0.045	1223.	1249.
57.5	0.046	0.046	1251.	2495.
60.0	0.047	0.047	1277.	2496.
62.6	0.049	0.049	1278.	1299.

EL CENTRO ARRAY STATION 12; BRUCKMAN ROAD.

LATITUDE: 32.718N

LONGITUDE: 115.637W

DATE LOGGED: 01/28/81

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: CASING TO 27.54 DEPTH.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.007	0.018	0.009	291.	291.
5.0	0.007	0.036	0.027	186.	136.
7.5	0.007	0.053	0.044	169.	143.
10.0	0.007	0.070	0.062	162.	144.
12.5	0.007	0.082	0.074	169.	204.
15.0	0.007	0.090	0.082	182.	304.
17.5	0.007	0.100	0.092	189.	247.
20.0	0.007	0.121	0.113	176.	119.
22.5	0.007	0.127	0.120	188.	410.
25.0	0.007	0.136	0.129	194.	276.
27.5	0.007	0.143	0.136	203.	354.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.013	0.010	246.	246.
5.0	0.015	0.014	359.	662.
7.5	0.015	0.014	517.	4414.
10.0	0.018	0.018	567.	792.
12.5	0.020	0.020	633.	1191.
15.0	0.021	0.021	721.	2343.
17.5	0.023	0.023	760.	1228.
20.0	0.026	0.026	773.	829.
22.5	0.028	0.028	807.	1238.
25.0	0.029	0.029	865.	2457.
27.5	0.030	0.030	919.	2467.

EL CENTRO ARRAY STATION 13; STROBEL RESIDENCE.

LATITUDE: 32.709N

LONGITUDE: 115.663W

DATE LOGGED: 02/15/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.011 S

COMMENTS: NONE.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.011	0.033	0.017	145.	145.
5.0	0.011	0.041	0.028	179.	234.
7.5	0.011	0.052	0.040	189.	212.
10.0	0.011	0.063	0.051	196.	220.
12.5	0.011	0.072	0.060	207.	270.
15.0	0.011	0.083	0.071	210.	225.
17.5	0.011	0.090	0.079	223.	351.
20.0	0.011	0.097	0.086	233.	353.
22.5	0.011	0.105	0.094	240.	310.
25.0	0.011	0.114	0.103	243.	277.
27.5	0.011	0.123	0.112	246.	277.
30.0	0.010	0.130	0.119	252.	356.
32.5	0.011	0.138	0.127	256.	312.
35.0	0.011	0.150	0.139	252.	208.
37.5	0.010	0.161	0.150	250.	227.
40.0	0.011	0.171	0.160	250.	250.
42.5	0.011	0.179	0.168	253.	312.
45.0	0.011	0.190	0.179	251.	227.
47.5	0.011	0.197	0.186	255.	357.
50.0	0.011	0.207	0.196	255.	250.
52.5	0.011	0.214	0.203	259.	357.
55.0	0.012	0.221	0.210	262.	357.
57.5	0.011	0.226	0.215	267.	499.
60.0	0.011	0.233	0.222	270.	357.
62.5	0.011	0.238	0.227	275.	499.
65.0	0.010	0.242	0.231	281.	624.
67.5	0.011	0.249	0.238	284.	357.
70.0	0.011	0.254	0.243	288.	499.
71.8	0.010	0.259	0.248	290.	360.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.009	0.007	356.	356.
5.0	0.011	0.010	490.	785.
7.5	0.013	0.013	597.	1065.
10.0	0.014	0.014	728.	2142.
12.5	0.015	0.015	844.	2307.
15.0	0.017	0.017	890.	1226.
17.5	0.018	0.018	979.	2421.
20.0	0.020	0.020	1005.	1239.
22.5	0.021	0.021	1076.	2459.
25.0	0.023	0.023	1090.	1244.
27.5	0.024	0.024	1149.	2475.
30.0	0.026	0.026	1156.	1246.
32.5	0.028	0.028	1163.	1247.
35.0	0.029	0.029	1209.	2486.
37.5	0.031	0.031	1211.	1248.
40.0	0.032	0.032	1252.	2490.
42.5	0.034	0.034	1251.	1249.
45.0	0.035	0.035	1287.	2492.
47.5	0.037	0.037	1285.	1249.
50.0	0.039	0.039	1283.	1249.
52.5	0.040	0.040	1313.	2495.
55.0	0.042	0.042	1310.	1249.
57.5	0.043	0.043	1338.	2496.
60.0	0.045	0.045	1334.	1249.
62.5	0.047	0.047	1330.	1249.
65.0	0.048	0.048	1355.	2497.
67.5	0.050	0.050	1351.	1250.
70.0	0.052	0.052	1347.	1250.
71.8	0.053	0.053	1355.	1799.

EL CENTRO DIFFERENTIAL ARRAY; DOG WOOD ROAD

LATITUDE: 32.796N

LONGITUDE: 115.533W

DATE LOGGED: 01/25/81

DISTANCE(M) TO BOREHOLE FROM:
PLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: STATION CONTAINS ANALOG & DIGITAL RECORDERS.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.009	0.030	0.017	144.	144.
5.0	0.008	0.039	0.029	173.	215.
7.5	0.008	0.054	0.045	166.	160.
10.0	0.008	0.068	0.059	169.	174.
12.5	0.008	0.081	0.072	173.	189.
15.0	0.008	0.091	0.082	182.	245.
17.5	0.008	0.102	0.094	187.	225.
20.0	0.008	0.114	0.106	189.	207.
22.5	0.008	0.125	0.117	193.	220.
25.0	0.008	0.135	0.127	197.	249.
27.5	0.008	0.145	0.137	201.	249.
30.0	0.008	0.158	0.150	200.	192.
32.5	0.007	0.163	0.155	210.	496.
35.0	0.008	0.173	0.165	212.	249.
37.5	0.008	0.183	0.175	214.	249.
40.0	0.008	0.190	0.182	220.	355.
42.5	0.007	0.199	0.191	223.	277.
45.0	0.007	0.208	0.200	225.	277.
47.5	0.008	0.213	0.207	229.	350.
50.0	0.007	0.223	0.217	230.	250.
52.5	0.007	0.237	0.229	229.	208.
55.0	0.008	0.241	0.233	236.	623.
57.5	0.008	0.248	0.240	240.	357.
60.0	0.008	0.254	0.246	244.	410.
62.5	0.008	0.264	0.256	244.	250.
65.0	0.008	0.273	0.265	245.	278.
67.5	0.008	0.279	0.271	249.	410.
70.0	0.007	0.284	0.276	254.	499.
73.1	0.007	0.289	0.281	260.	619.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.014	0.011	229.	229.
5.0	0.018	0.017	299.	832.
7.5	0.020	0.019	388.	957.
10.0	0.021	0.021	486.	1972.
12.5	0.022	0.022	575.	2209.
15.0	0.023	0.023	656.	2327.
17.5	0.024	0.024	734.	2359.
20.0	0.026	0.026	773.	1234.
22.5	0.028	0.028	807.	1238.
25.0	0.029	0.029	865.	2457.
27.5	0.030	0.030	919.	2467.
30.0	0.032	0.032	940.	1245.
32.5	0.034	0.034	956.	1240.
35.0	0.036	0.036	974.	1247.
37.5	0.037	0.037	1015.	2465.
40.0	0.038	0.038	1054.	2487.
42.5	0.040	0.040	1064.	1248.
45.0	0.041	0.041	1099.	2491.
47.5	0.042	0.042	1132.	2492.
50.0	0.044	0.044	1137.	1249.
52.5	0.046	0.046	1142.	1249.
55.0	0.047	0.047	1171.	2494.
57.5	0.048	0.048	1199.	2495.
60.0	0.050	0.050	1201.	1249.
62.5	0.052	0.052	1203.	1249.
65.0	0.053	0.053	1227.	2496.
67.5	0.054	0.054	1251.	2497.
70.0	0.056	0.056	1251.	1249.
73.1	0.057	0.057	1283.	3095.

IMPERIAL COUNTY SERVICES BUILDING; EL CENTRO.

LATITUDE: 32.793N

LONGITUDE: 115.564W

DATE LOGGED: 02/11/81

DISTANCE(M) TO BOREHOLE FROM:
BLANK 2.00
PLATE 2.00
CAP 3.00
UP GEOPH. 1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: BOREHOLE MIDWAY BETWEEN BLDG & FREEFIELD SITE.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.000	0.021	0.010	241.	241.
5.0	0.007	0.047	0.036	137.	90.
7.5	0.007	0.057	0.048	157.	224.
10.0	0.008	0.075	0.066	154.	136.
12.5	0.008	0.084	0.075	166.	267.
15.0	0.008	0.102	0.093	160.	138.
17.5	0.008	0.108	0.100	176.	405.
20.0	0.008	0.121	0.113	177.	191.
22.5	0.008	0.135	0.127	177.	178.
25.0	0.008	0.144	0.136	184.	270.
27.5	0.008	0.156	0.148	186.	208.
30.0	0.008	0.167	0.159	189.	226.
32.5	0.008	0.174	0.166	196.	355.
35.5	0.008	0.176	0.168	199.	496.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.013	0.010	246.	246.
5.0	0.019	0.018	283.	334.
7.5	0.021	0.020	370.	945.
10.0	0.023	0.023	443.	1105.
12.5	0.026	0.026	487.	901.
15.0	0.027	0.027	560.	2274.
17.5	0.029	0.029	607.	1220.
20.0	0.030	0.030	670.	2407.
22.5	0.031	0.031	729.	2434.
25.0	0.033	0.033	760.	1240.
27.5	0.035	0.035	786.	1242.
30.0	0.037	0.037	813.	1244.
32.5	0.039	0.039	835.	1245.
35.5	0.040	0.040	839.	997.

BRAWLEY AIRPORT.

LATITUDE: 32.98N

LONGITUDE: 115.509W

DATE LOGGED: 01/14/81

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: PLATE ARRIVALS POOR, SEE CAP DATA; PHASE CHANGE @ 12.5/13M DEPTH

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.007	0.024	0.013	190.	190.
5.0	0.008	0.032	0.023	216.	252.
7.5	0.007	0.042	0.034	223.	236.
10.0	0.007	0.054	0.046	218.	204.
12.5	0.007	0.067	0.059	211.	190.
15.0	0.007	0.082	0.074	202.	166.
17.5	0.007	0.095	0.087	200.	191.
20.0	0.007	0.107	0.099	201.	207.
22.5	0.007	0.121	0.113	198.	178.
25.0	0.008	0.130	0.122	204.	276.
27.5	0.007	0.141	0.134	206.	220.
30.0	0.007	0.150	0.143	210.	277.
32.5	0.007	0.161	0.154	212.	227.
35.0	0.007	0.170	0.163	215.	277.
37.5	0.007	0.181	0.174	216.	227.
38.4	0.007	0.185	0.178	216.	225.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.014	0.011	229.	229.
5.0	0.017	0.016	317.	515.
7.5	0.019	0.018	409.	971.
10.0	0.020	0.020	510.	1995.
12.5	0.022	0.022	575.	1184.
15.0	0.023	0.023	656.	2327.
17.5	0.025	0.025	705.	1225.
20.0	0.028	0.028	716.	827.
22.5	0.030	0.030	753.	1237.
25.0	0.032	0.032	784.	1240.
27.5	0.034	0.034	811.	1242.
30.0	0.038	0.038	791.	624.
32.5	0.040	0.040	814.	1245.
35.0	0.041	0.041	855.	2478.
37.5	0.048	0.048	810.	500.
38.4	0.045	0.045	854.	-904.

WESTMORLAND FIRE STATION.

LATITUDE: 33.03°N

LONGITUDE: 115.623°W

DATE LOGGED: 03/03/82

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: V. GOOD, IMPULSIVE S ARRIVALS THROUGHOUT.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.006	0.021	0.012	201.	201.
5.0	0.005	0.039	0.031	159.	131.
7.5	0.004	0.050	0.043	173.	210.
10.0	0.004	0.064	0.056	173.	174.
12.5	0.004	0.079	0.073	171.	164.
15.0	0.007	0.090	0.084	178.	224.
17.5	0.004	0.102	0.096	182.	206.
20.0	0.006	0.116	0.110	181.	178.
22.5	0.004	0.127	0.121	185.	226.
25.0	0.006	0.138	0.132	189.	226.
27.5	0.006	0.150	0.145	190.	208.
30.0	0.005	0.159	0.154	195.	277.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.010	0.008	320.	320.
5.0	0.015	0.014	359.	409.
7.5	0.021	0.020	370.	393.
10.0	0.026	0.025	392.	460.
12.5	0.027	0.027	469.	2144.
15.0	0.028	0.028	540.	2286.
17.5	0.029	0.029	607.	2363.
20.0	0.031	0.031	648.	1229.
22.5	0.033	0.033	685.	1235.
25.0	0.034	0.034	735.	2445.
27.5	0.035	0.035	788.	2460.
30.0	0.036	0.036	835.	2469.

PARACHUTE TEST SITE: IMLER ROAD.

LATITUDE: 32.93N

LONGITUDE: 115.70W

DATE LOGGED: 03/04/82

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: POOR, NON-IMPULSIVE S ARRIVALS THROUGHOUT.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.006	0.015	0.007	363.	363.
5.0	0.006	0.030	0.022	226.	164.
7.5	0.006	0.038	0.031	244.	290.
10.0	0.006	0.043	0.036	277.	466.
12.5	0.006	0.049	0.042	296.	405.
15.0	0.007	0.054	0.047	316.	488.
17.5	0.006	0.061	0.054	321.	354.
20.0	0.006	0.066	0.060	336.	494.
22.5	0.006	0.073	0.067	338.	355.
25.0	0.007	0.078	0.072	349.	497.
28.7	0.006	0.085	0.079	365.	526.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.012	0.009	267.	267.
5.0	0.013	0.012	414.	926.
7.5	0.014	0.014	554.	1716.
10.0	0.019	0.019	537.	490.
12.5	0.023	0.023	550.	613.
15.0	0.026	0.026	582.	817.
17.5	0.031	0.031	566.	497.
20.0	0.036	0.036	558.	498.
22.5	0.041	0.041	551.	498.
25.0	0.046	0.046	545.	499.
28.7	0.051	0.051	564.	737.

CALIPATRIA FIRE STATION.

LATITUDE: 33.13N

LONGITUDE: 115.52W

DATE LOGGED: 03/01/82

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.004	0.026	0.017	146.	146.
5.0	0.004	0.041	0.034	146.	146.
7.5	0.004	0.055	0.049	152.	168.
10.0	0.004	0.067	0.062	162.	200.
12.5	0.004	0.077	0.072	173.	243.
15.0	0.004	0.087	0.082	182.	245.
17.5	0.004	0.097	0.092	189.	247.
20.0	0.004	0.108	0.103	193.	220.
22.5	0.004	0.120	0.116	195.	207.
24.1	0.004	0.127	0.123	197.	227.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.012	0.009	267.	267.
5.0	0.015	0.014	359.	549.
7.5	0.017	0.016	457.	1000.
10.0	0.020	0.020	510.	785.
12.5	0.023	0.023	550.	807.
15.0	0.025	0.025	605.	1206.
17.5	0.027	0.027	652.	1223.
20.0	0.029	0.029	693.	1431.
22.5	0.030	0.030	753.	2436.
24.1	0.032	0.032	756.	797.

SALTON SEA WILDLIFE REFUGE.

LATITUDE: 33.18N

LONGITUDE: 115.62W

DATE LOGGED: 03/02/82

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

HAMMER USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
2.5	0.006	0.028	0.017	146.	146.
5.0	0.006	0.047	0.038	131.	120.
7.5	0.007	0.060	0.052	144.	177.
10.0	0.006	0.075	0.068	148.	191.
12.5	0.006	0.088	0.081	154.	188.
15.0	0.006	0.102	0.095	158.	176.
17.5	0.006	0.119	0.112	156.	146.
20.0	0.006	0.136	0.129	155.	146.
22.5	0.006	0.147	0.140	160.	225.
25.0	0.006	0.160	0.154	163.	191.
27.7	0.005	0.173	0.167	166.	207.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
2.5	0.011	0.009	291.	291.
5.0	0.014	0.013	385.	567.
7.5	0.017	0.016	457.	729.
10.0	0.019	0.019	537.	1134.
12.5	0.021	0.021	603.	1168.
15.0	0.023	0.023	658.	1212.
17.5	0.025	0.025	705.	1225.
20.0	0.026	0.026	773.	4421.
22.5	0.027	0.027	837.	2444.
25.0	0.028	0.028	890.	2459.
27.7	0.030	0.030	926.	1342.

APPENDIX E.

INTERVAL VELOCITIES FROM DOWNHOLE SURVEY.

BONDS CORNER: S-WAVE VELOCITY

LATITUDE: 32.693N

LONGITUDE: 115.338W

DATE LOGGED: 02/17/81

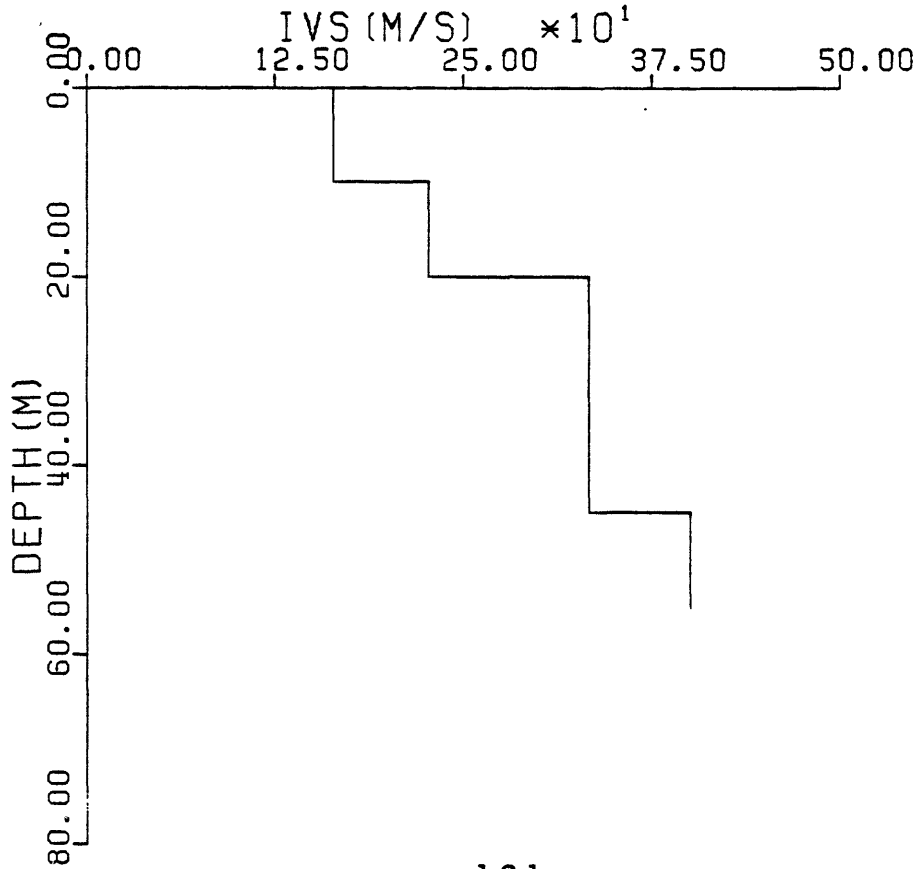
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.008	0.068	0.060	167.	167.
20.0	0.008	0.112	0.104	191.	224.
45.0	0.006	0.187	0.180	250.	332.
55.0	0.006	0.212	0.205	268.	399.



BONDS CORNER; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.693N

LONGITUDE: 115.338W

DATE LOGGED: 02/17/81

DISTANCE(M) TO BOREHOLE FROM:

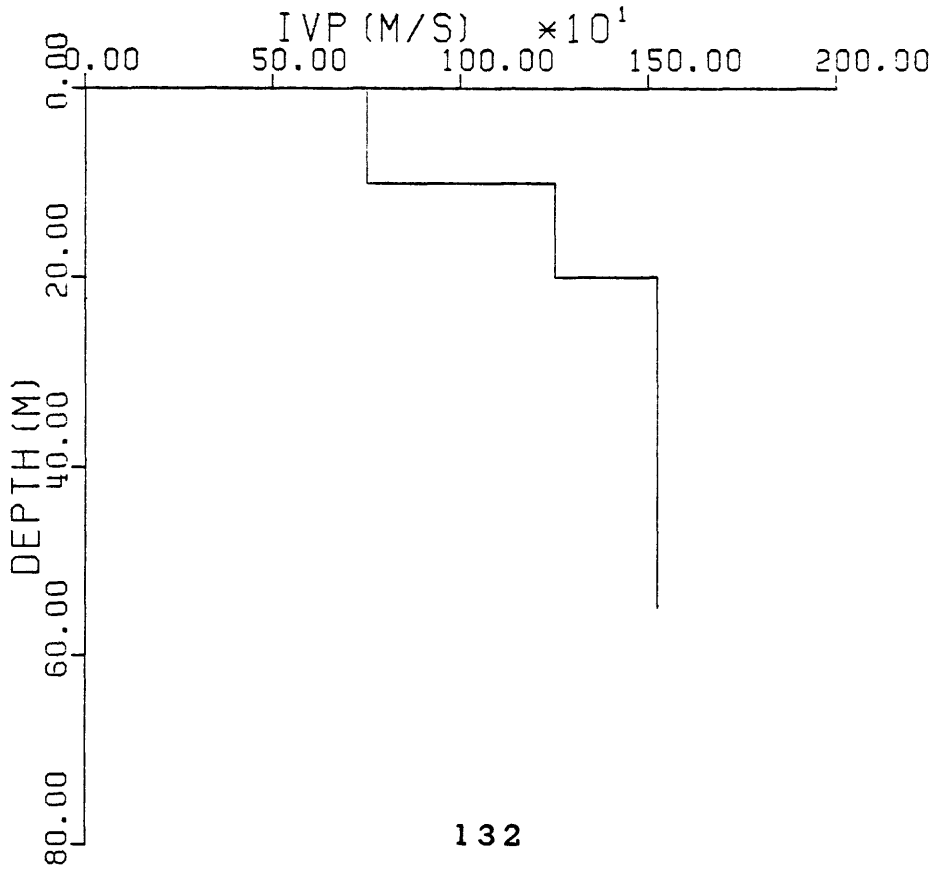
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.012	0.011	791.	791.
20.0	0.020	0.020	962.	1195.
55.0	0.043	0.043	1258.	1510.



CALEXICO F.S.; S-WAVE VELOCITY.

LATITUDE: 32.669N

LONGITUDE: 115.492W

DATE LOGGED: 02/06/81

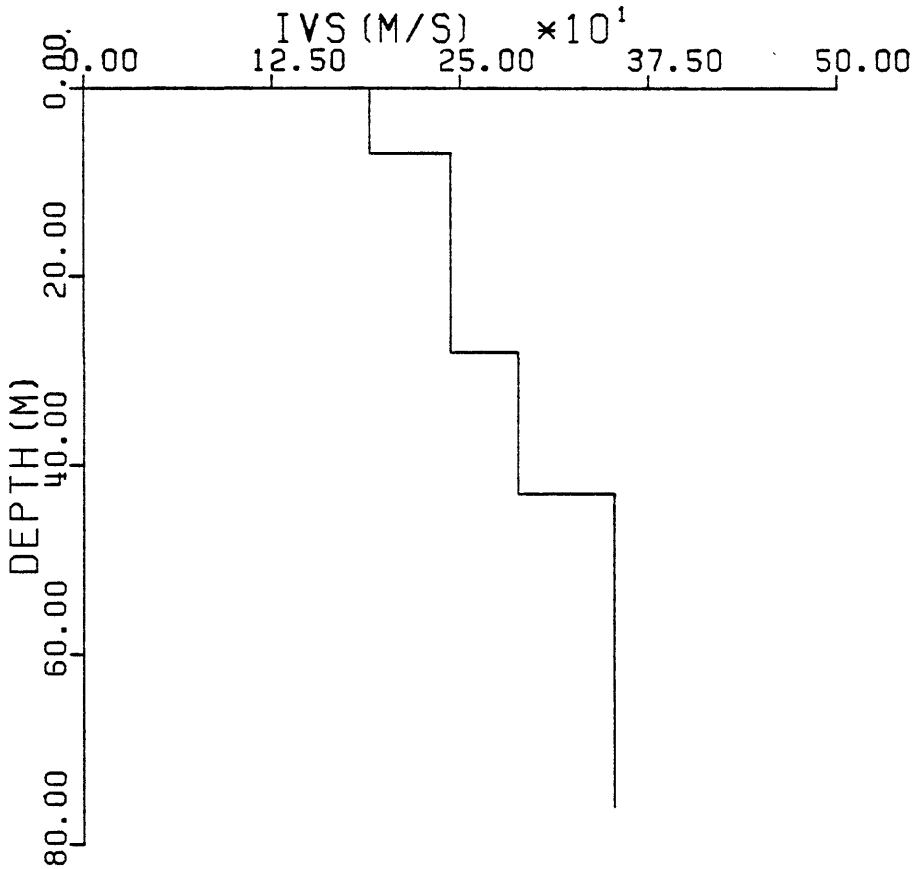
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.011 S

COMMENTS: UPPER 30M LOGGED ON 3/5/82; DATA FROM TWO SURVEYS COMBINED.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
7.5	0.010	0.050	0.038	197.	197.
27.5	0.010	0.132	0.121	227.	241.
42.5	0.012	0.184	0.173	245.	288.
75.6	0.010	0.278	0.267	283.	352.



CALEXICO F. S.; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.669N

LONGITUDE: 115.492W

DATE LOGGED: 02/06/81

DISTANCE(M) TO BOREHOLE FROM:

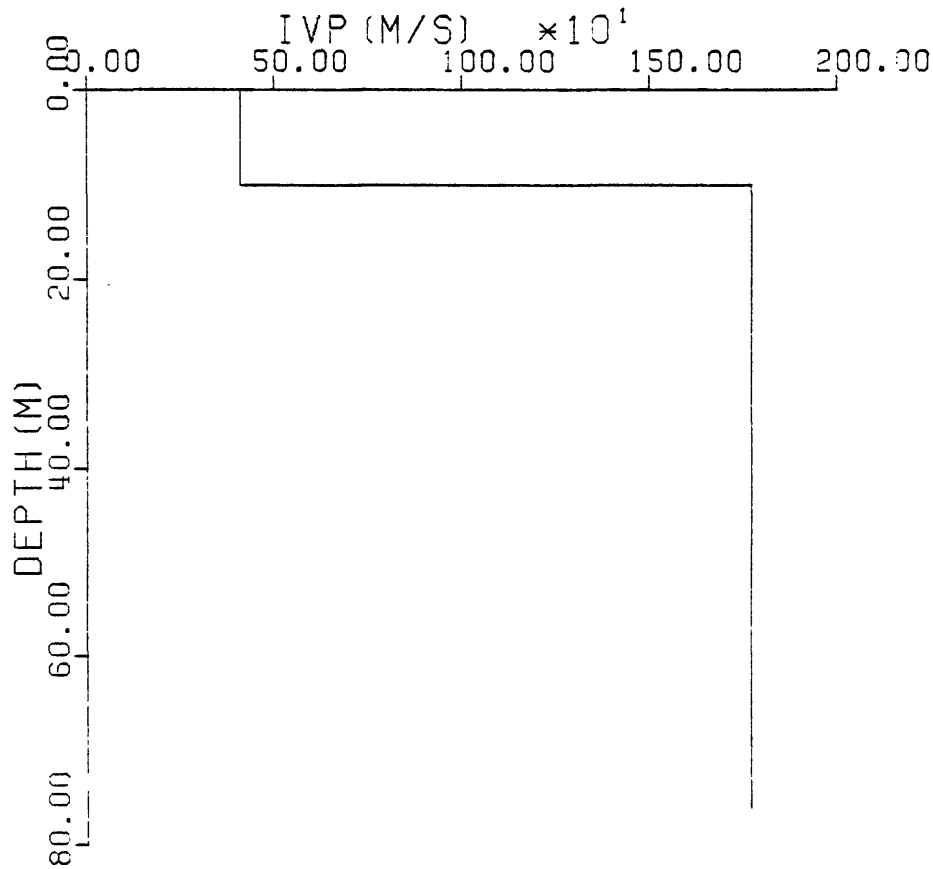
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.010 S

COMMENTS: UPPER 30M LOGGED ON 3/5/82; DATA FROM TWO SURVEYS COMBINED.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.022	0.021	431.	431.
75.6	0.059	0.059	1265.	1723.



HOLTVILLE P. O.; S-WAVE VELOCITY.

LATITUDE: 32.812N

LONGITUDE: 115.377W

DATE LOGGED: 02/16/81

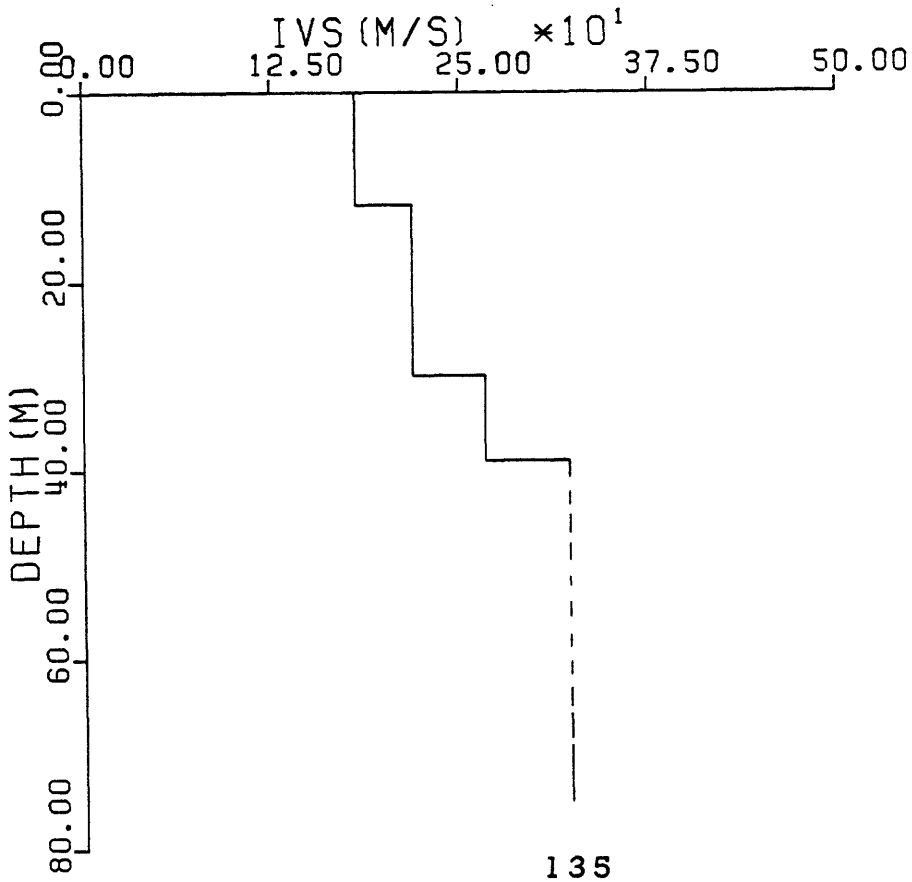
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: **No measurements taken at depths between 39.3 and 72.5 m.**

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
12.5	0.006	0.076	0.068	183.	183.
30.0	0.006	0.156	0.149	201.	217.
39.3	0.007	0.191	0.184	214.	265.
75.0	0.008	0.302	0.295	254.	321.



HOLTVILLE P. O.; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.812N

LONGITUDE: 115.377W

DATE LOGGED: 02/16/81

DISTANCE(M) TO BOREHOLE FROM:

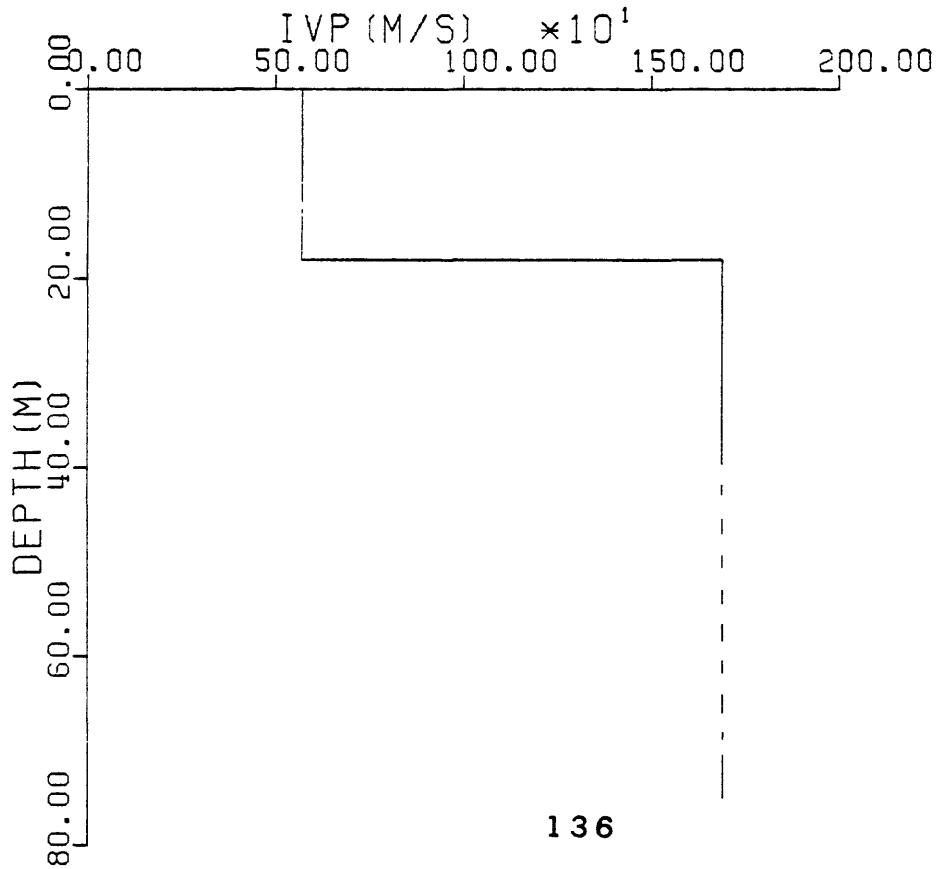
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: **No measurements taken at depths between 39.3 and 72.5 m.**

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
17.5	0.029	0.029	578.	578.
75.0	0.063	0.063	1176.	1671.



EL CENTRO ARRAY 2; S-WAVE INTERVAL VELOCITY.

LATITUDE: 32.916N

LONGITUDE: 115.366W

DATE LOGGED: 01/29/81

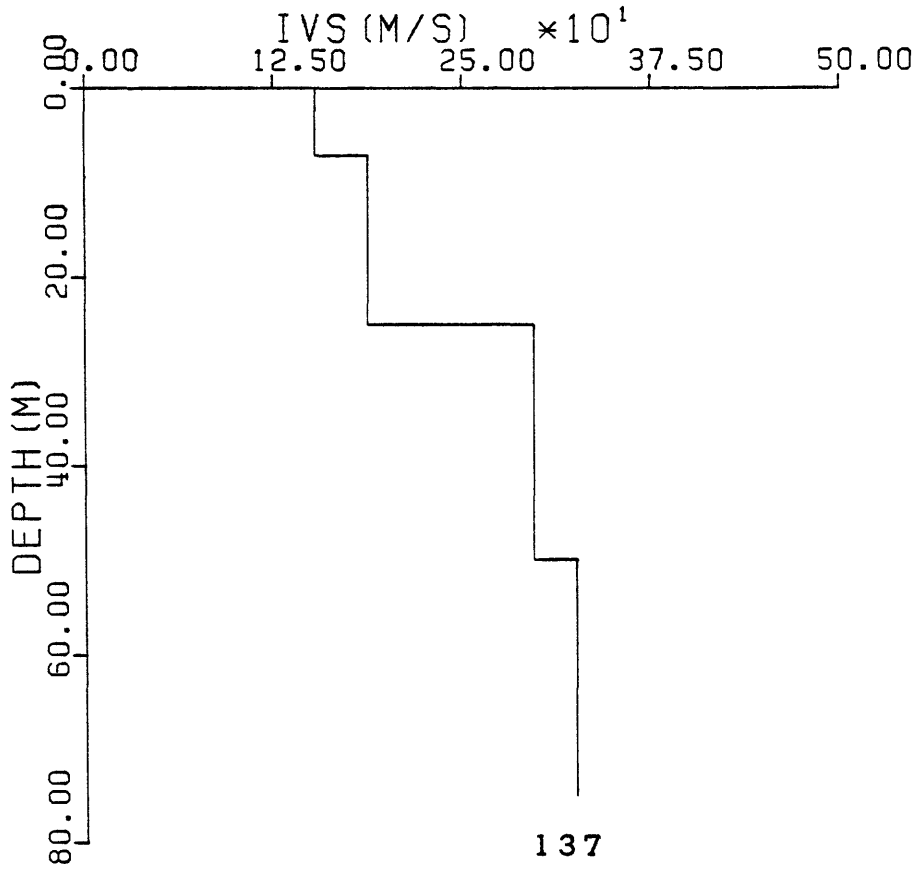
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.010 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
7.5	0.010	0.059	0.047	158.	158.
25.0	0.010	0.152	0.142	177.	186.
50.0	0.010	0.236	0.226	221.	297.
75.4	0.010	0.314	0.304	248.	325.



EL CENTRO ARRAY 2; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.916N

LONGITUDE: 115.366W

DATE LOGGED: 01/29/81

DISTANCE(M) TO BOREHOLE FROM:

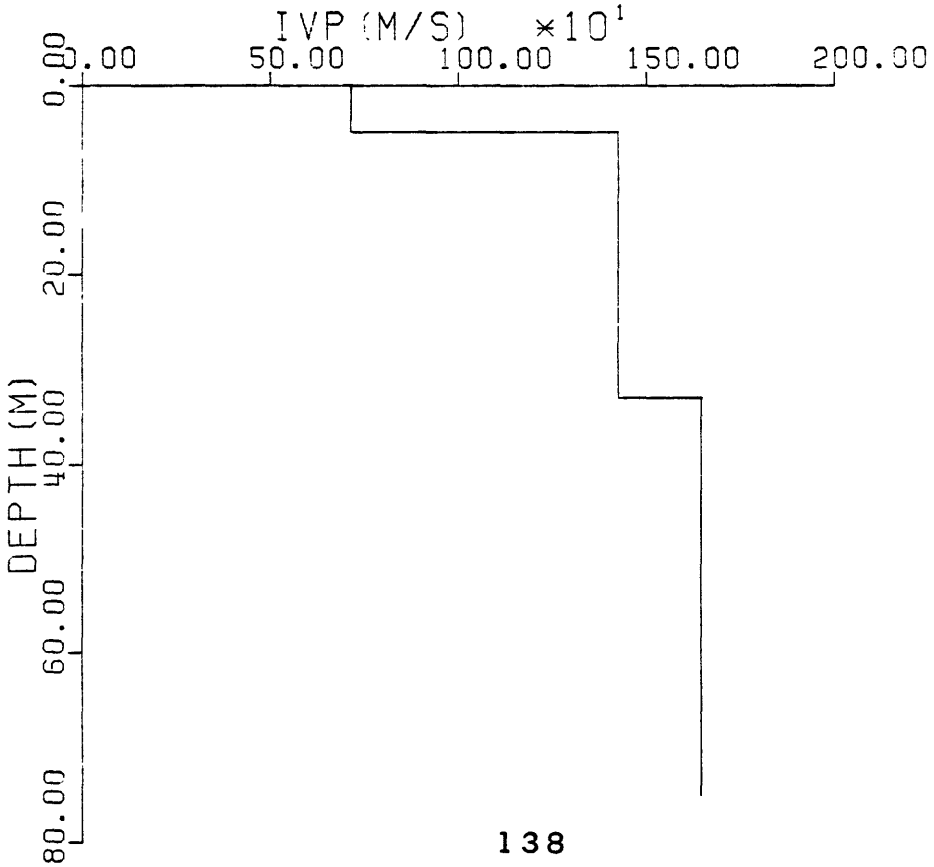
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.010 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.007	0.006	714.	714.
32.5	0.025	0.025	1266.	1426.
75.4	0.051	0.051	1460.	1645.



EL CENTRO ARRAY 3; S-WAVE INTERVAL VELOCITY.

LATITUDE: 32.894N

LONGITUDE: 115.380W

DATE LOGGED: 02/07/81

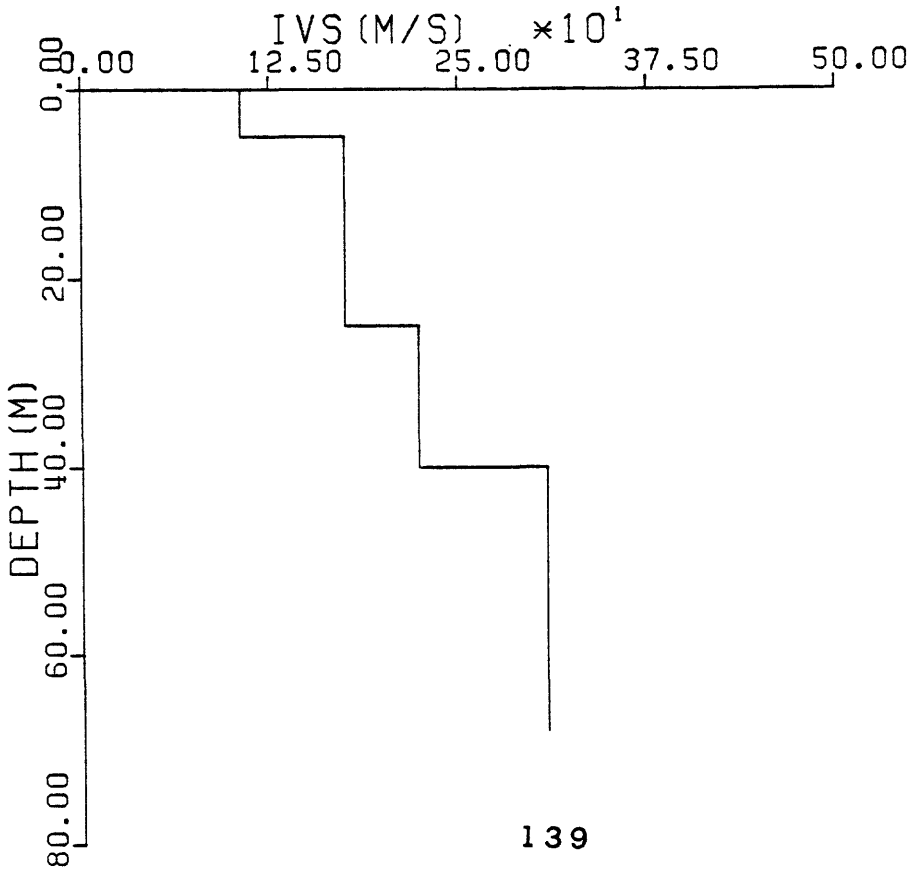
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
5.0	0.004	0.051	0.044	115.	115.
25.0	0.004	0.165	0.160	156.	171.
40.0	0.004	0.232	0.228	176.	223.
67.8	0.004	0.322	0.318	213.	308.



EL CENTRO ARRAY 3; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.894N

LONGITUDE: 115.380W

DATE LOGGED: 02/07/81

DISTANCE(M) TO BOREHOLE FROM:

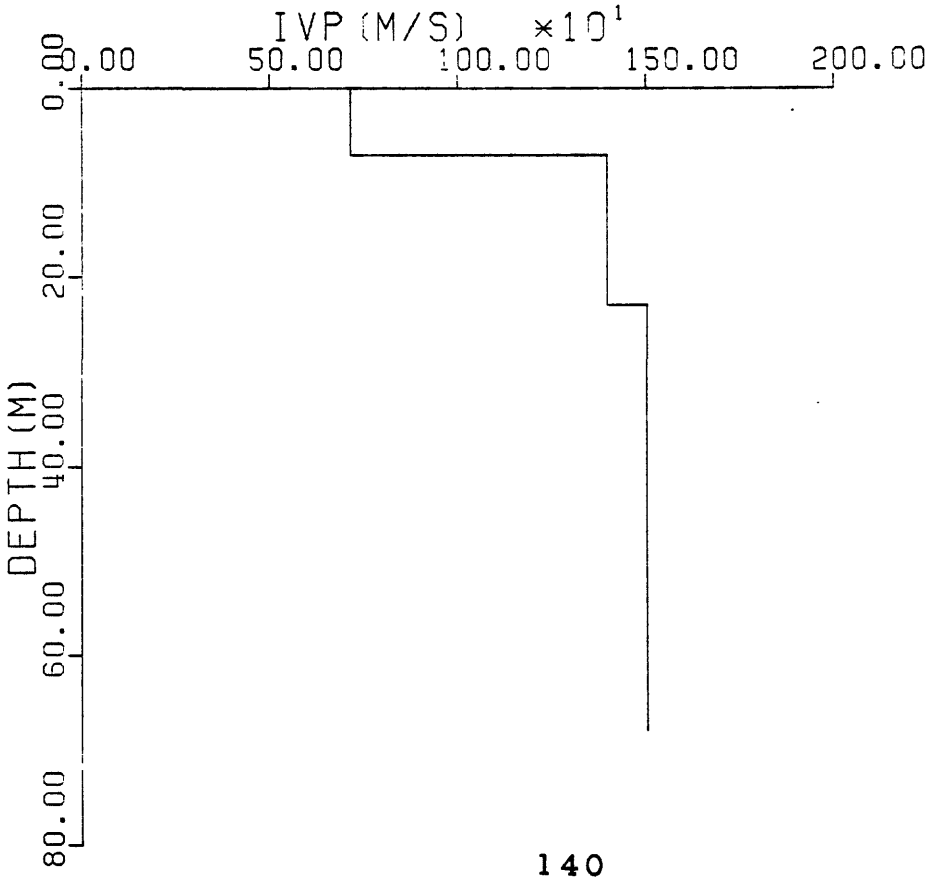
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
7.5	0.010	0.009	716.	716.
22.5	0.020	0.020	1085.	1398.
67.8	0.050	0.050	1337.	1503.



EL CENTRO ARRAY 4; S-WAVE INTERVAL VELOCITY.

LATITUDE: 32.864N

LONGITUDE: 115.432W

DATE LOGGED: 01/27/81

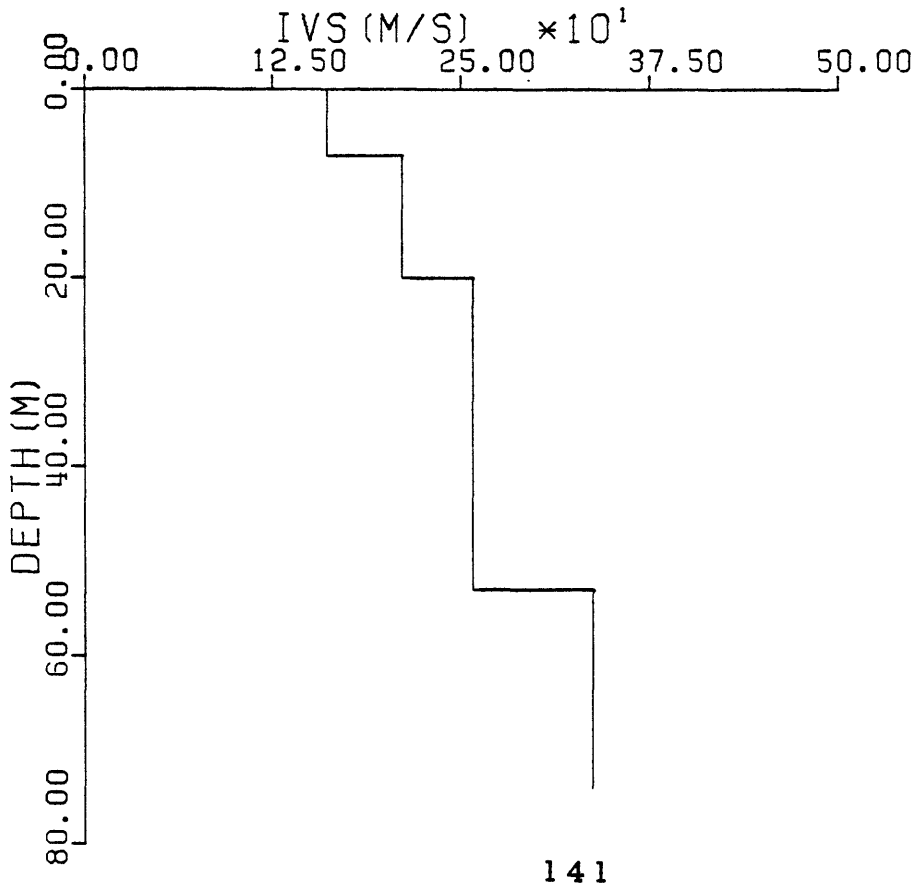
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NOISY S-WAVE ARRIVALS THROUGHOUT SURVEY.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
7.5	0.007	0.054	0.045	165.	165.
20.0	0.007	0.113	0.105	190.	208.
52.5	0.007	0.239	0.232	226.	257.
73.8	0.007	0.302	0.295	250.	338.



EL CENTRO ARRAY 4; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.864N

LONGITUDE: 115.432W

DATE LOGGED: 01/27/81

DISTANCE(M) TO BOREHOLE FROM:

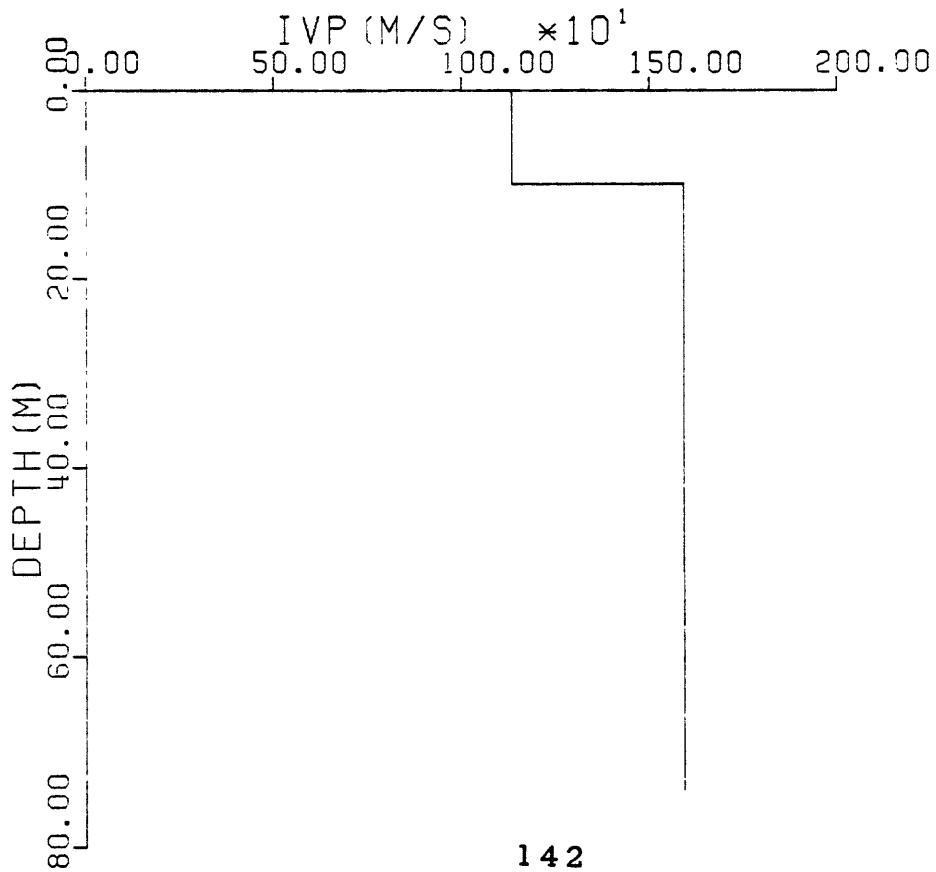
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NOISY S ARRIVALS THROUGHOUT SURVEY.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.009	0.009	1054.	1054.
73.8	0.049	0.049	1487.	1578.



EL CENTRO ARRAY 5; S-WAVE INTERVAL VELOCITY.

LATITUDE: 32.855N

LONGITUDE: 115.466W

DATE LOGGED: 01/16/81

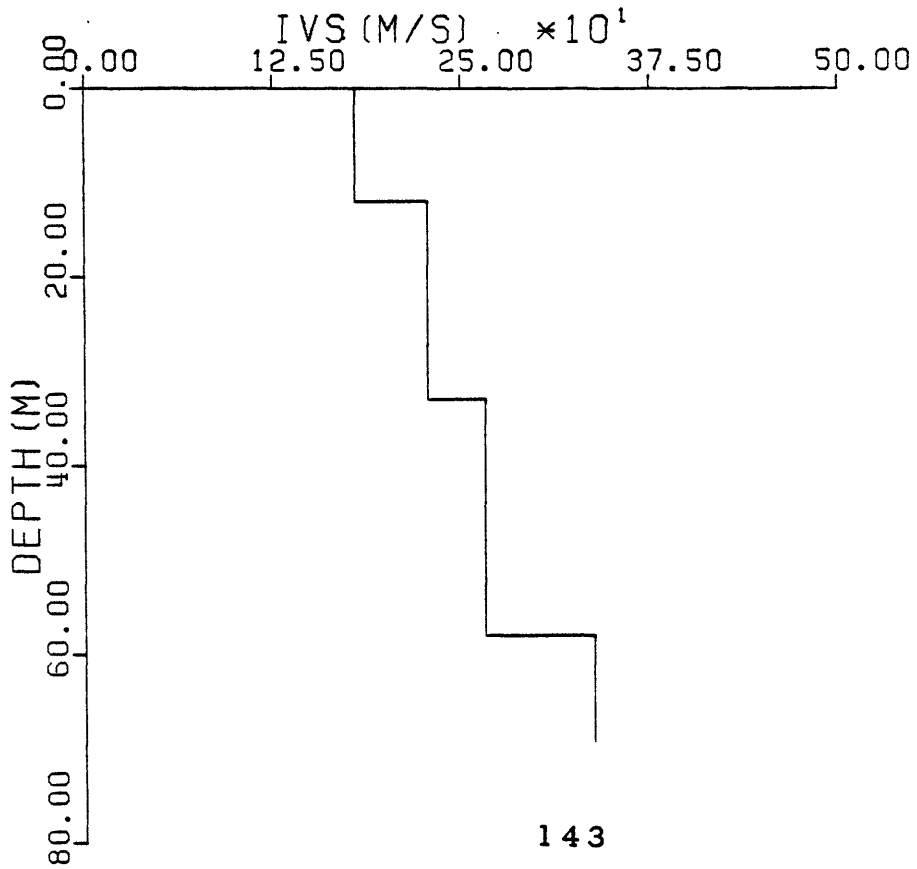
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
12.5	0.007	0.077	0.069	180.	180.
32.5	0.006	0.164	0.157	207.	228.
57.5	0.007	0.258	0.251	229.	266.
68.7	0.007	0.291	0.284	242.	339.



EL CENTRO ARRAY 5; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.855N

LONGITUDE: 115.466W

DATE LOGGED: 01/16/81

DISTANCE(M) TO BOREHOLE FROM:

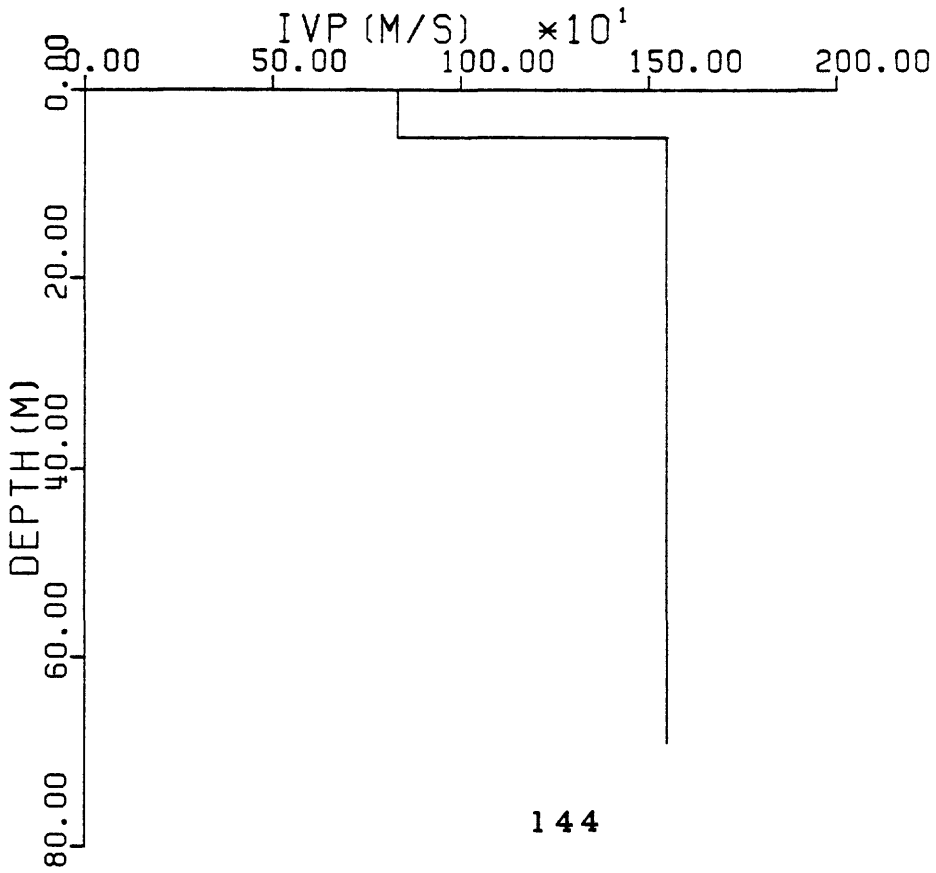
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.006	0.005	833.	833.
68.7	0.046	0.046	1473.	1548.



EL CENTRO ARRAY 6; S-WAVE VELOCITY.

LATITUDE: 32.839N

LONGITUDE: 115.487W

DATE LOGGED: 01/15/81

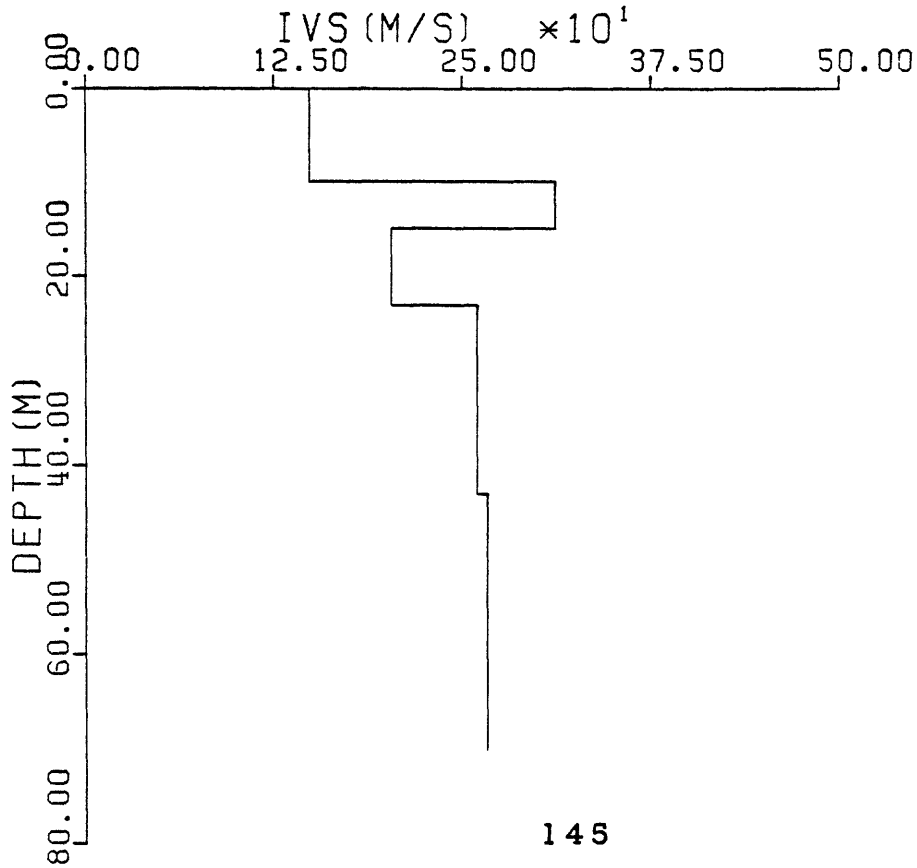
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.009 S

COMMENTS: 1.74G MAX. VERT. ACCEL. RECORDED HERE DURING 1979 EVENT.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.009	0.076	0.066	152.	152.
15.0	0.009	0.092	0.082	182.	302.
22.5	0.008	0.129	0.120	188.	201.
42.5	0.009	0.206	0.197	216.	259.
70.0	0.009	0.309	0.300	233.	267.



EL CENTRO ARRAY 6; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.839N

LONGITUDE: 115.487W

DATE LOGGED: 01/15/81

DISTANCE(M) TO BOREHOLE FROM:

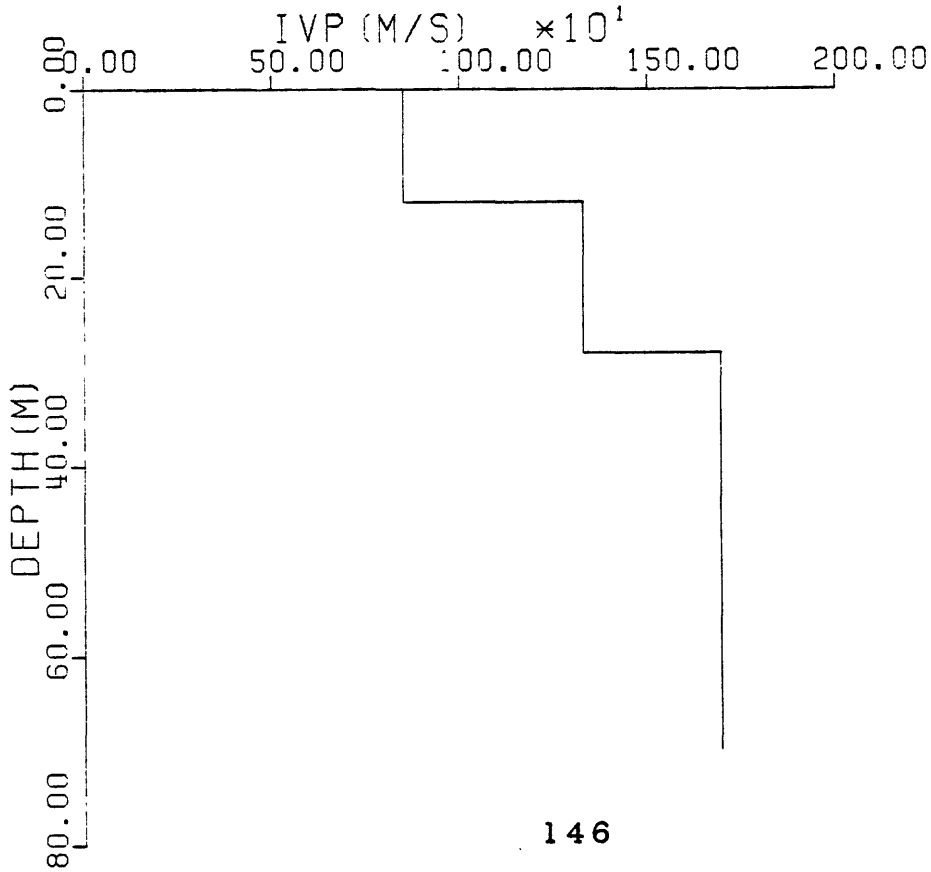
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.009 S

COMMENTS: 1.74G MAX. VERT. ACCEL. RECORDED HERE DURING 1979 EVENT.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
12.5	0.014	0.014	849.	849.
27.5	0.025	0.025	1067.	1328.
70.0	0.050	0.050	1381.	1692.



EL CENTRO ARRAY 7; S-WAVE VELOCITY.

LATITUDE: 32.829N

LONGITUDE: 115.504W

DATE LOGGED: 02/11/81

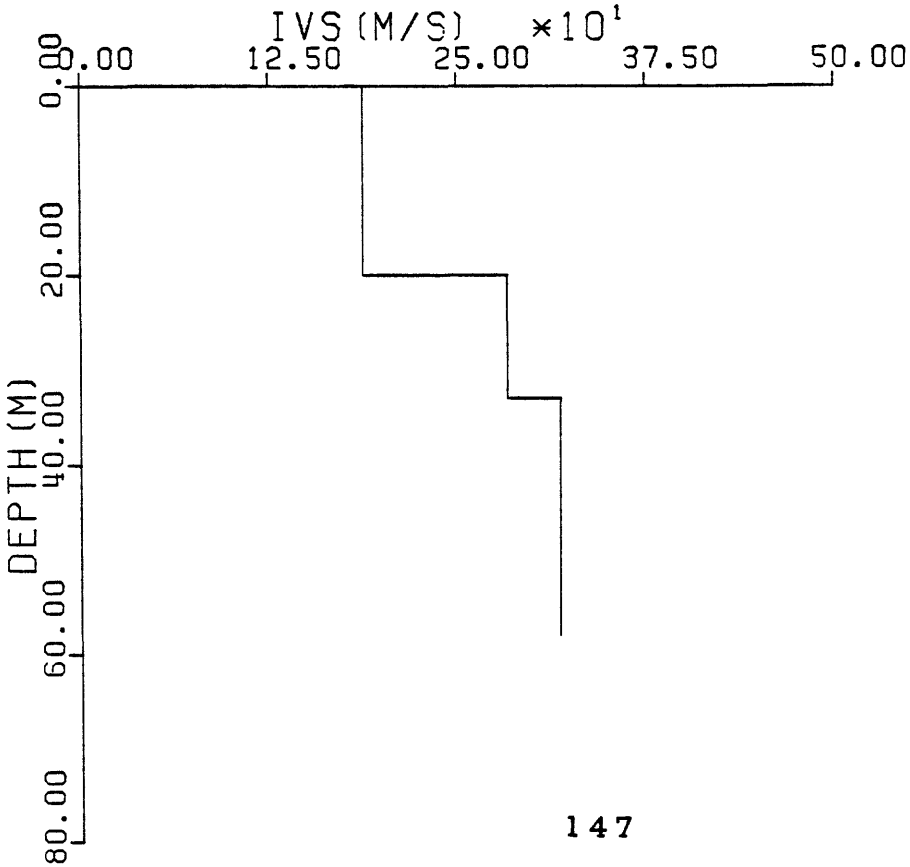
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
20.0	0.008	0.114	0.106	189.	189.
32.5	0.008	0.158	0.150	217.	283.
57.7	0.007	0.237	0.229	252.	318.



EL CENTRO ARRAY 7; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.829N

LONGITUDE: 115.504W

DATE LOGGED: 02/11/81

DISTANCE(M) TO BOREHOLE FROM:

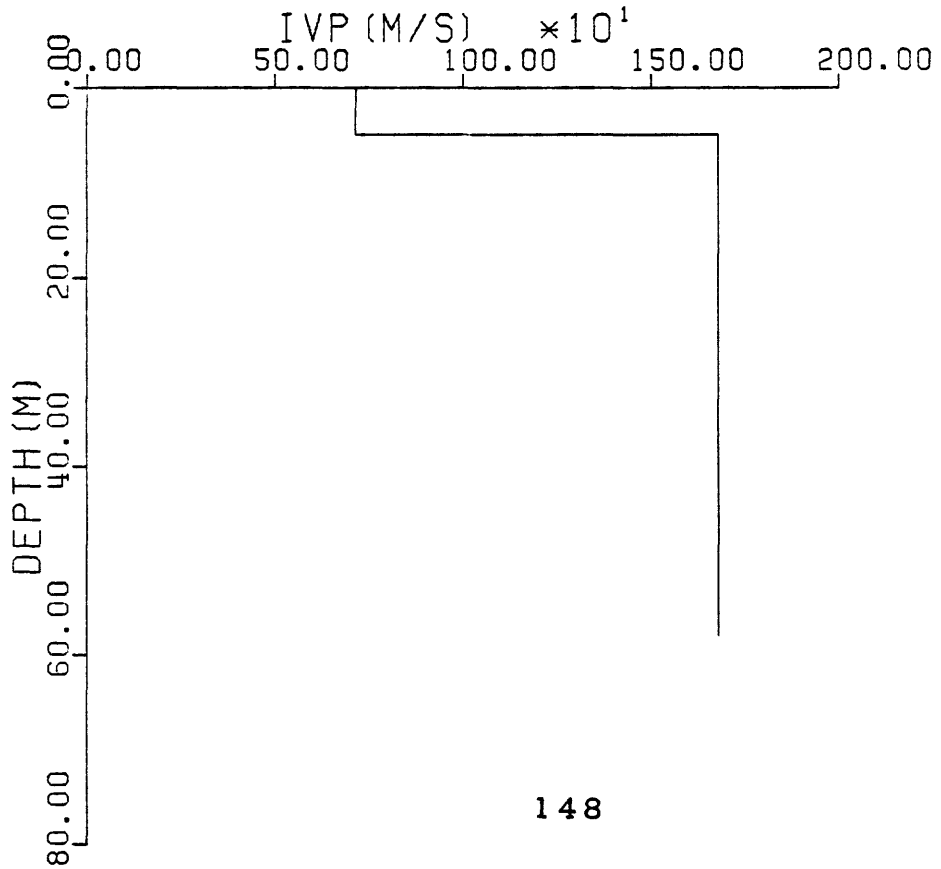
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.007	0.006	714.	714.
57.7	0.037	0.037	1535.	1681.



EL CENTRO ARRAY 8; S-WAVE VELOCITY.

LATITUDE: 32.811N

LONGITUDE: 115.532W

DATE LOGGED: 01/26/81

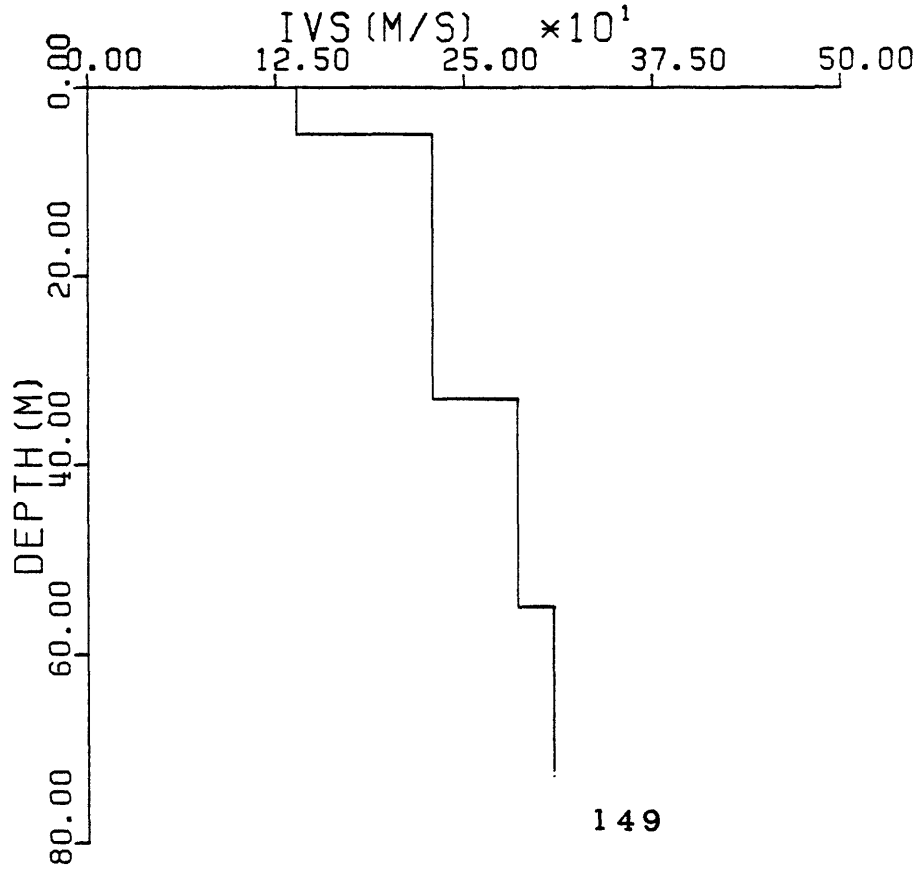
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
5.0	0.005	0.041	0.033	150.	150.
32.5	0.005	0.161	0.156	209.	225.
55.0	0.005	0.240	0.235	234.	284.
72.6	0.005	0.297	0.292	249.	309.



EL CENTRO ARRAY 8; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.811N

LONGITUDE: 115.532W

DATE LOGGED: 01/26/81

DISTANCE(M) TO BOREHOLE FROM:

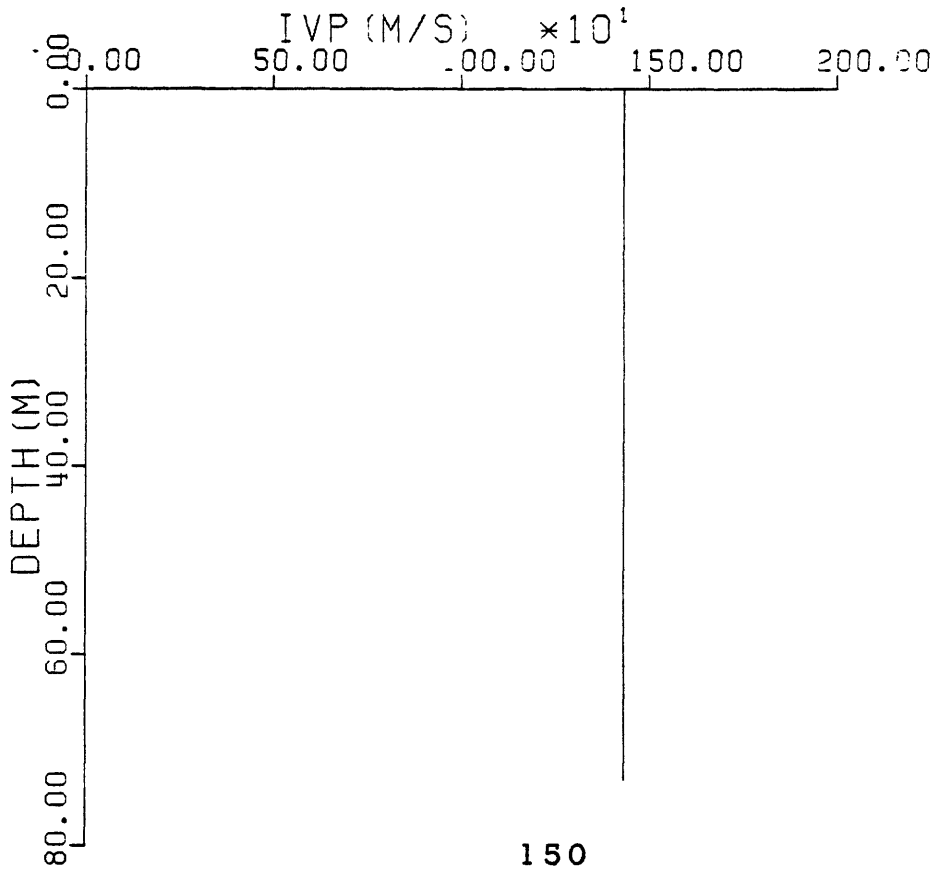
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
72.6	0.050	0.050	1433.	1433.



EL CENTRO ARRAY 9; S-WAVE VELOCITY.

LATITUDE: 32.794N

LONGITUDE: 115.549W

DATE LOGGED: 04/04/81

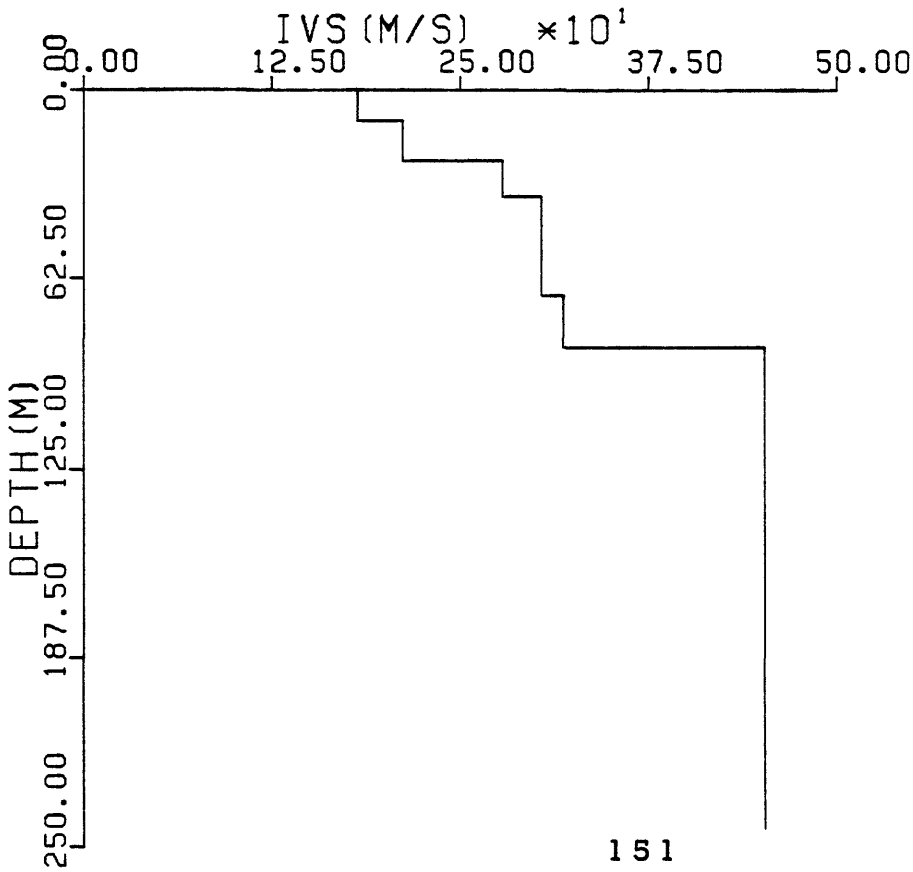
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: 1940 AND 1979 IMPERIAL VALLEY EVENTS RECORDED AT THIS SITE.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.007	0.062	0.054	185.	185.
22.5	0.006	0.121	0.114	198.	210.
35.0	0.008	0.166	0.159	220.	277.
67.5	0.007	0.273	0.266	254.	303.
85.0	0.007	0.328	0.321	265.	318.
244.4	0.007	0.681	0.674	363.	451.



EL CENTRO ARRAY 9; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.794N

LONGITUDE: 115.549W

DATE LOGGED: 04/04/81

DISTANCE(M) TO BOREHOLE FROM:

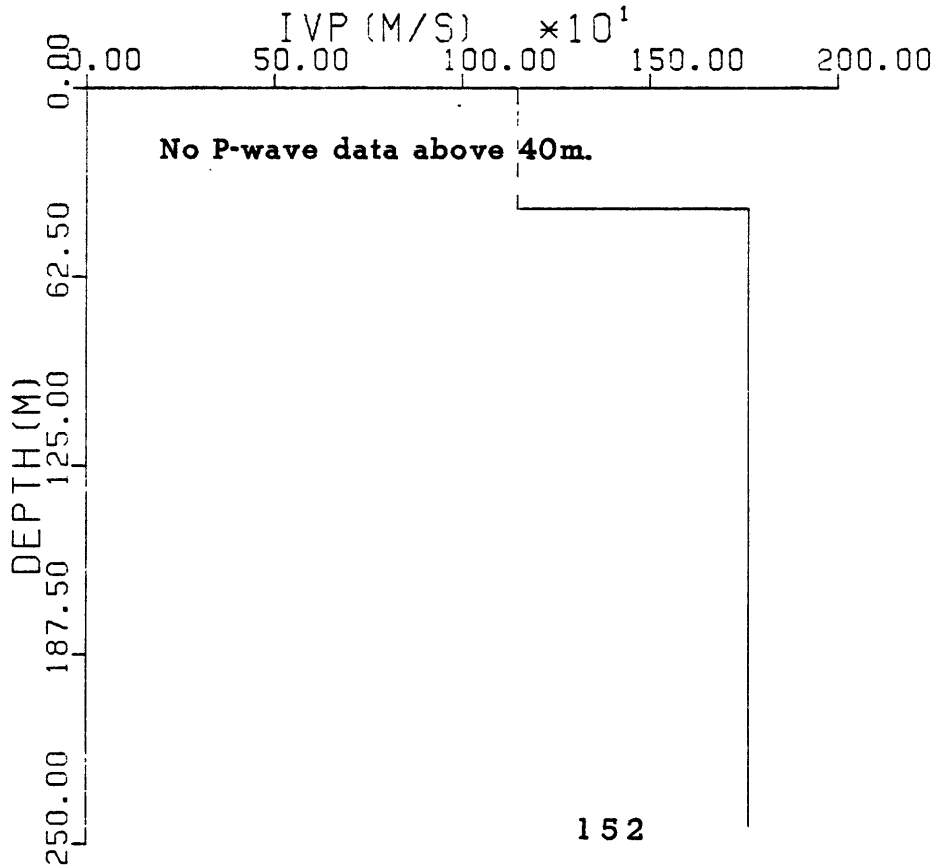
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: 1940 AND 1979 IMPERIAL VALLEY EVENTS RECORDED AT THIS SITE.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
40.0	0.034	0.034	1150.	1150.
244.4	0.150	0.150	1623.	1761.



EL CENTRO ARRAY 10; S-WAVE VELOCITY.

LATITUDE: 32.780N

LONGITUDE: 115.567W

DATE LOGGED: 01/13/81

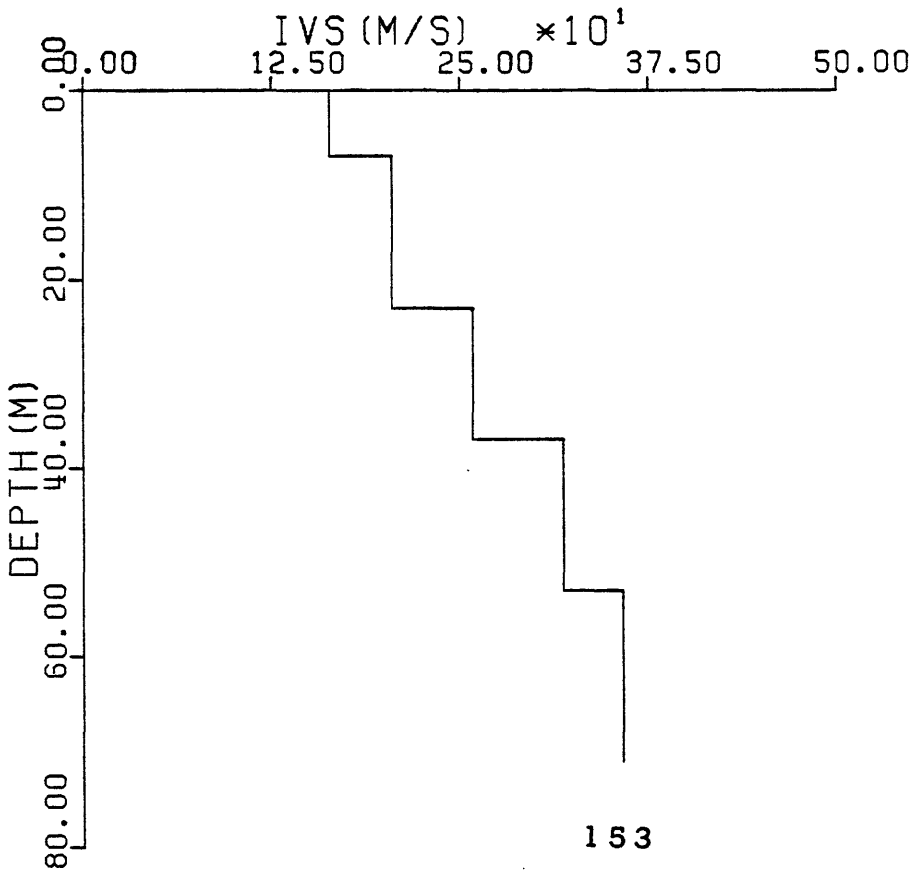
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
7.5	0.006	0.053	0.044	170.	170.
22.5	0.006	0.126	0.118	190.	203.
37.5	0.009	0.184	0.176	213.	258.
52.5	0.009	0.231	0.223	235.	319.
71.1	0.007	0.283	0.275	258.	357.



EL CENTRO ARRAY 10; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.780N

LONGITUDE: 115.567W

DATE LOGGED: 01/13/81

DISTANCE(M) TO BOREHOLE FROM:

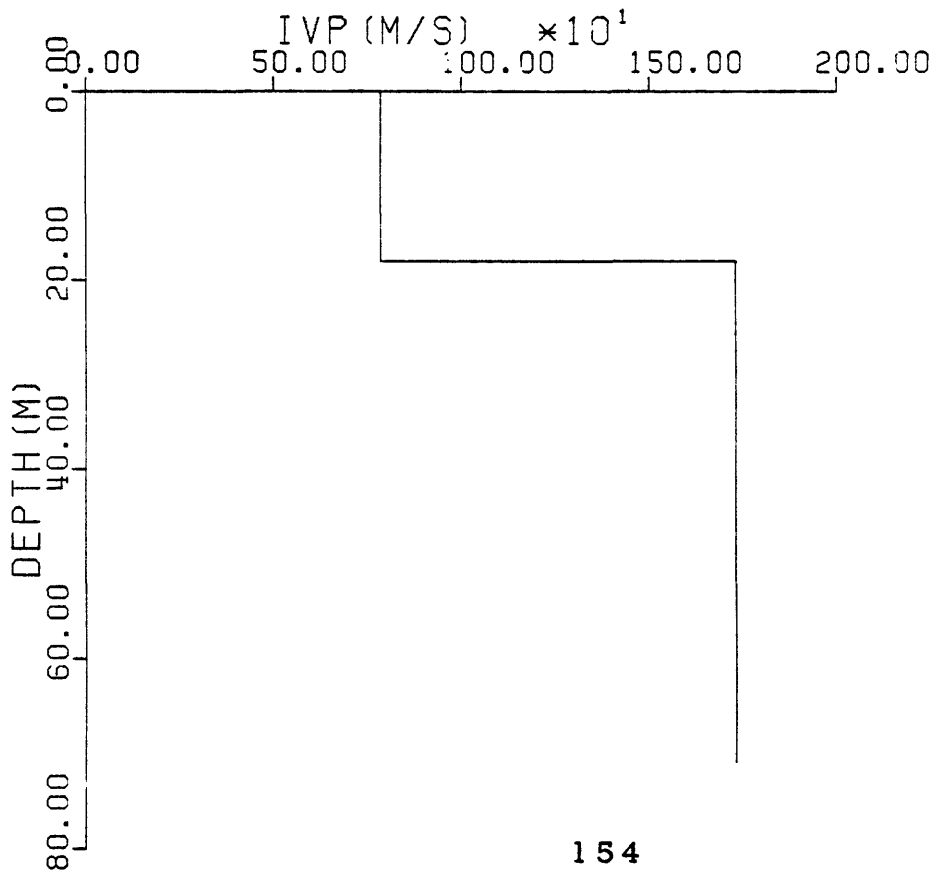
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: POOR, INCONSISTENT P ARRIVALS (PLATE & CAP).

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
17.5	0.021	0.021	799.	799.
71.1	0.052	0.052	1349.	1713.



EL CENTRO ARRAY 11; S-WAVE VELOCITY.

LATITUDE: 32.752N

LONGITUDE: 115.594W

DATE LOGGED: 01/23/81

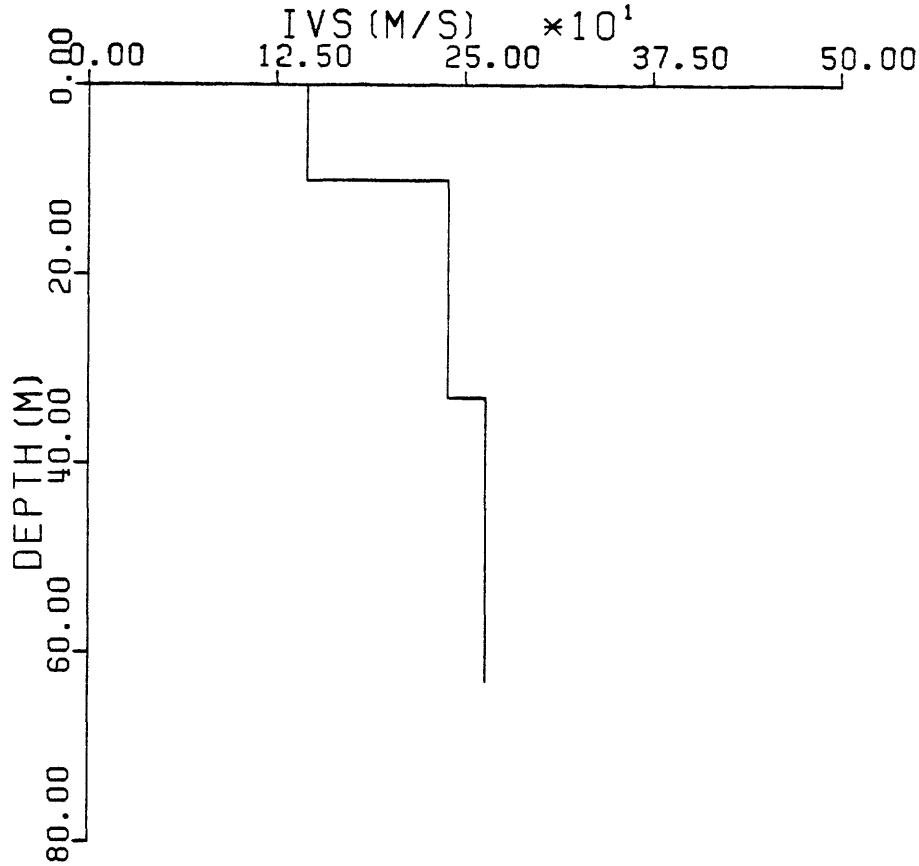
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: EXCELLENT S-WAVE ARRIVALS THROUGHOUT SURVEY.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.005	0.074	0.068	148.	148.
32.5	0.005	0.168	0.163	200.	237.
62.6	0.005	0.282	0.277	226.	264.



EL CENTRO ARRAY 11; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.752N

LONGITUDE: 115.594W

DATE LOGGED: 01/23/81

DISTANCE(M) TO BOREHOLE FROM:

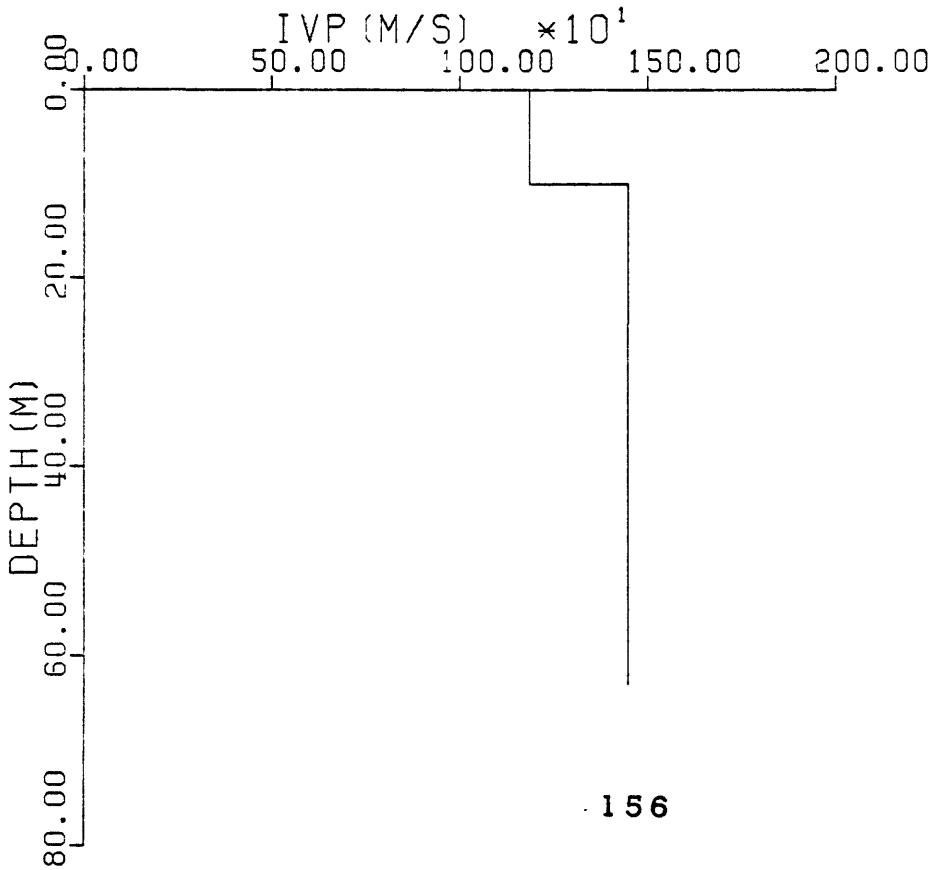
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS:

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.008	0.008	1186.	1186.
62.6	0.044	0.044	1402.	1447.



EL CENTRO ARRAY 12; S-WAVE VELOCITY.

LATITUDE: 32.718N

LONGITUDE: 115.637W

DATE LOGGED: 01/28/81

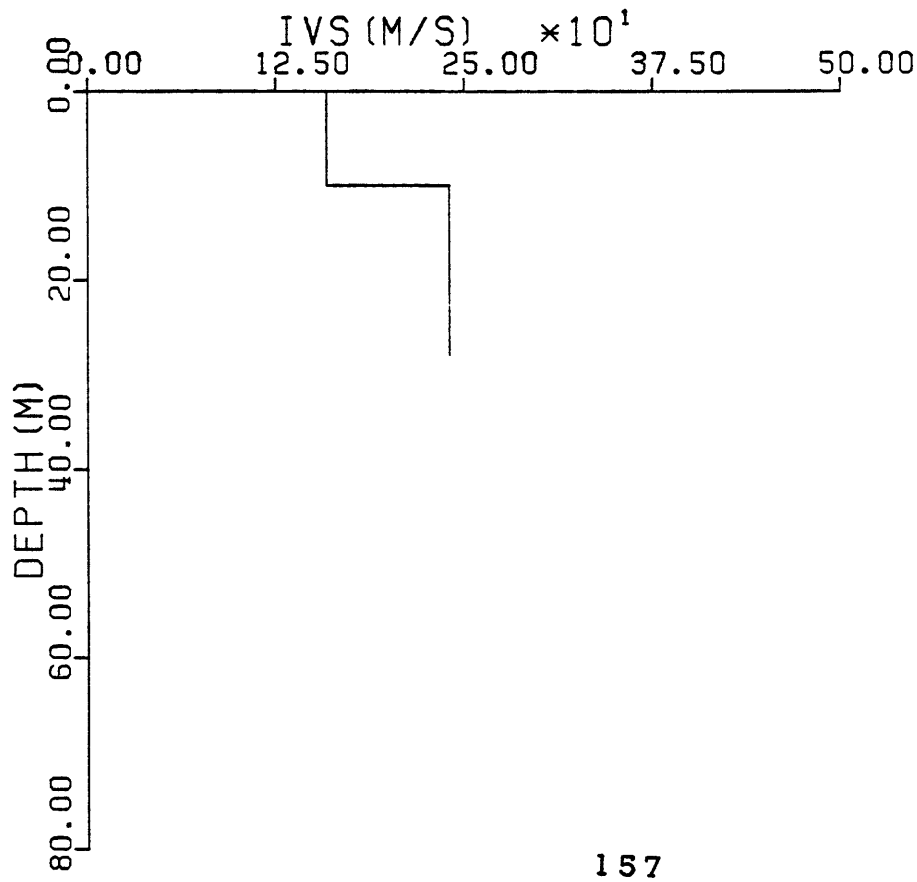
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.007	0.070	0.062	162.	162.
27.5	0.007	0.143	0.136	203.	237.



EL CENTRO ARRAY 12; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.718N

LONGITUDE: 115.637W

DATE LOGGED: 01/28/81

DISTANCE(M) TO BOREHOLE FROM:

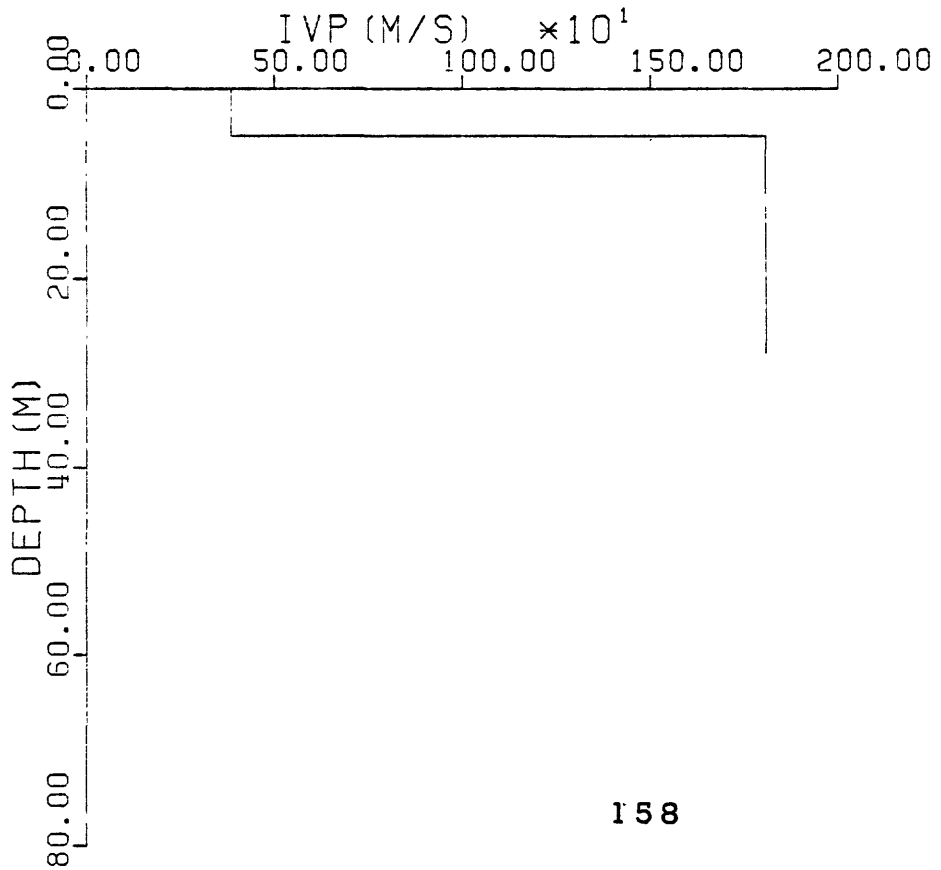
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.013	0.010	385.	385.
27.5	0.023	0.023	1160.	1807.



EL CENTRO ARRAY 13; S-WAVE VELOCITY.

LATITUDE: 32.709N

LONGITUDE: 115.683W

DATE LOGGED: 02/15/81

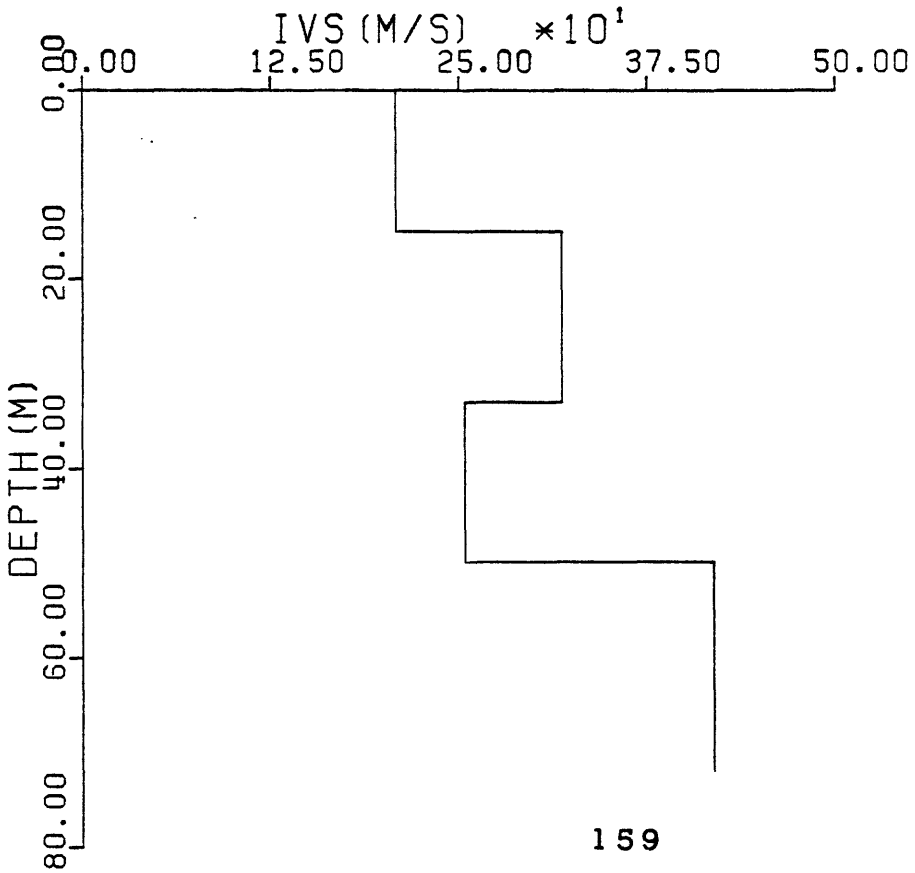
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.011 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
15.0	0.011	0.083	0.072	209.	209.
32.5	0.011	0.138	0.127	256.	316.
50.0	0.011	0.207	0.196	255.	253.
71.8	0.010	0.259	0.248	289.	419.



EL CENTRO ARRAY 13; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.709N

LONGITUDE: 115.683W

DATE LOGGED: 02/15/81

DISTANCE(M) TO BOREHOLE FROM:

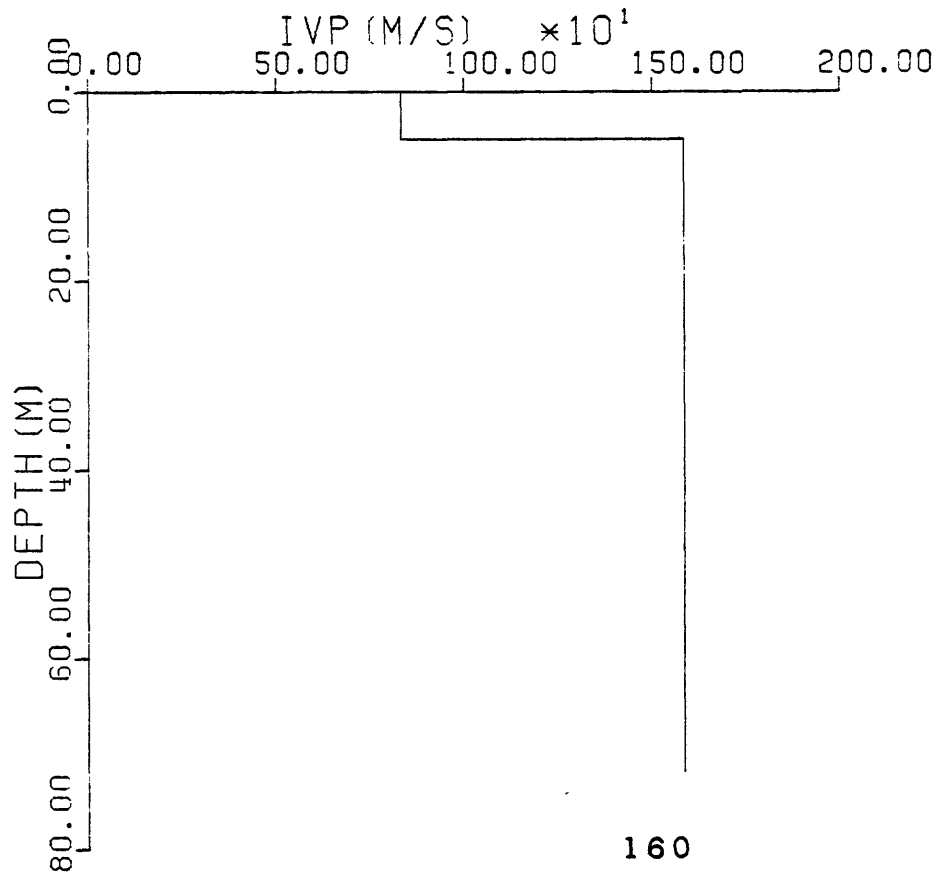
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.010 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.006	0.005	833.	833.
71.8	0.047	0.047	1508.	1585.



EL CENTRO DIFF. ARRAY; S-WAVE VELOCITY.

LATITUDE: 32.796

LONGITUDE: 115.535W

DATE LOGGED: 01/25/81

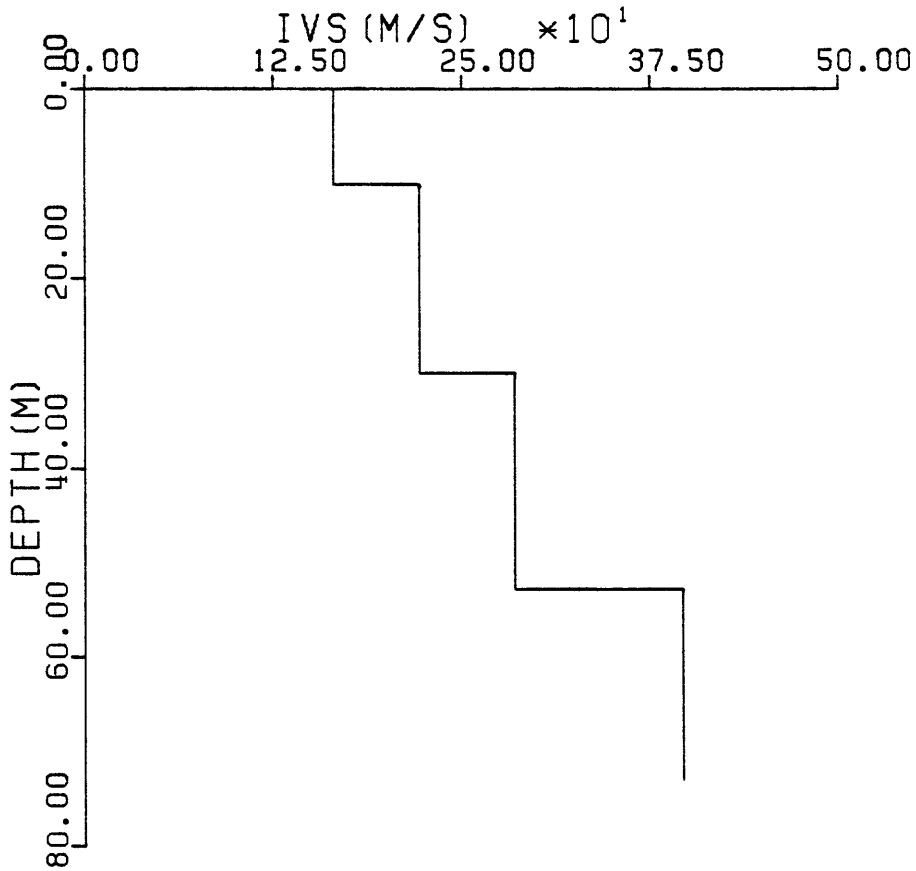
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.008	0.068	0.059	169.	169.
30.0	0.008	0.158	0.150	200.	220.
52.5	0.007	0.237	0.229	229.	284.
73.1	0.007	0.289	0.281	260.	396.



EL CENTRO DIFF. ARRAY; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.796N

LONGITUDE: 115.535W

DATE LOGGED: 01/25/81

DISTANCE(M) TO BOREHOLE FROM:

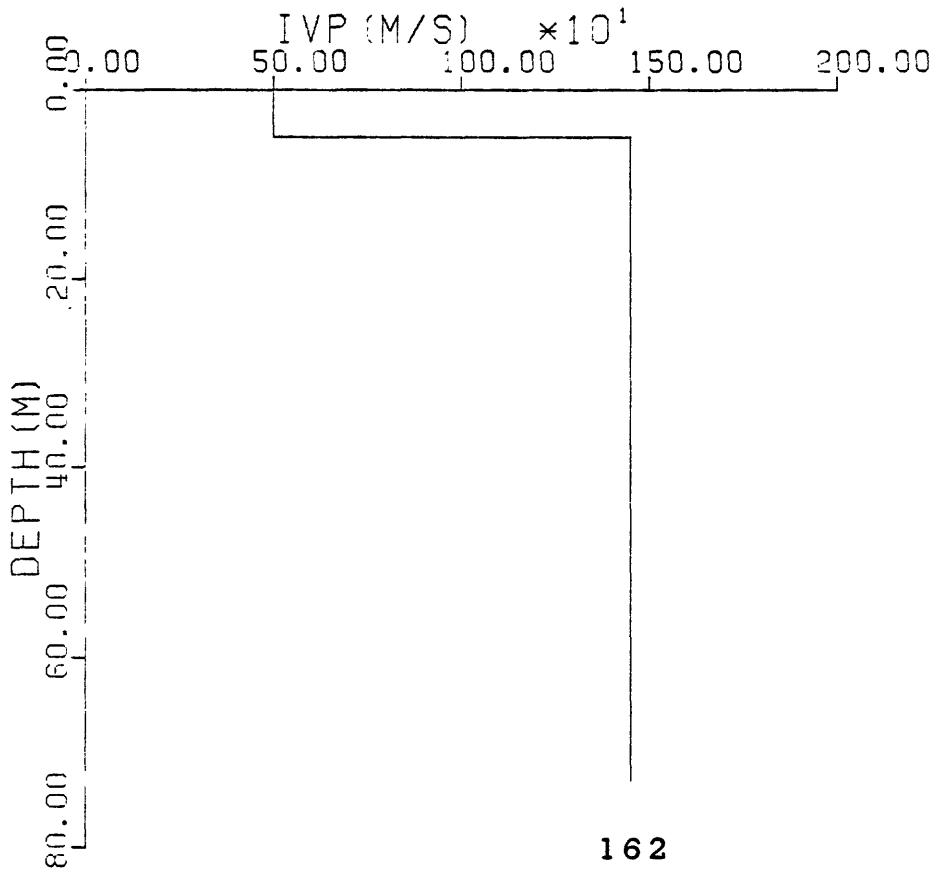
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.010	0.008	500.	500.
73.1	0.055	0.055	1312.	1450.



IMPERIAL CO SERV BLDG; S-WAVE VELOCITY.

LATITUDE: 32.793N

LONGITUDE: 115.564W

DATE LOGGED: 02/11/81

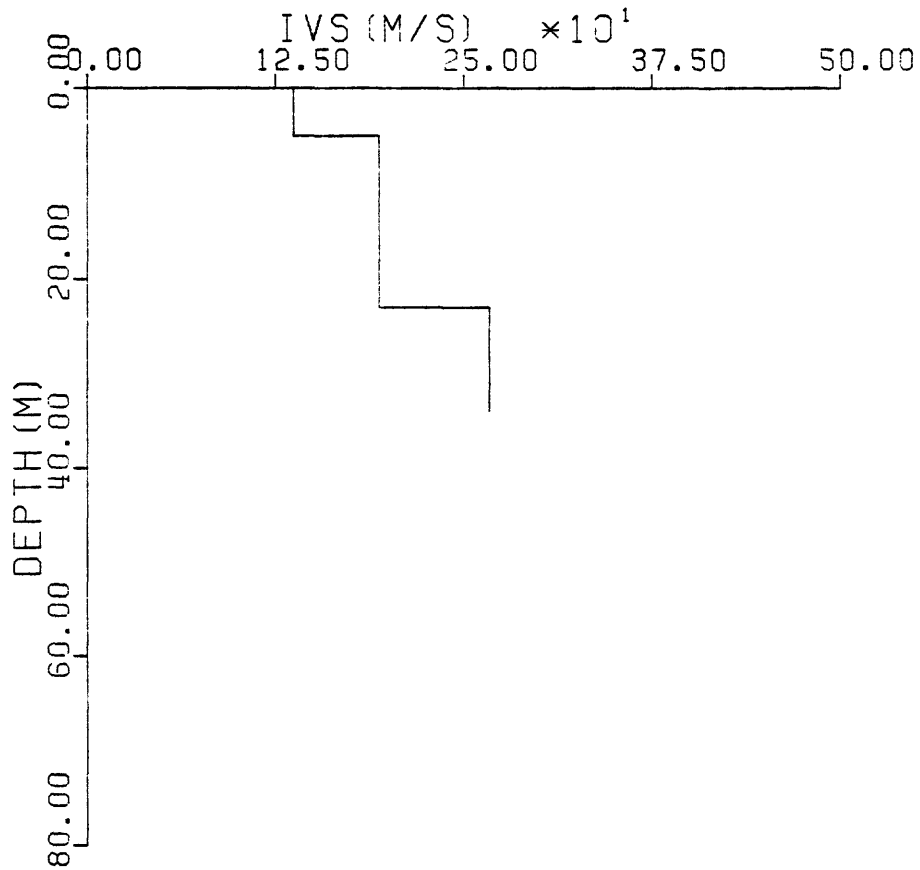
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: BOREHOLE MIDWAY BETWEEN BLDG. AND FREEFIELD SITES.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
5.0	0.007	0.047	0.037	137.	137.
22.5	0.008	0.135	0.127	177.	194.
33.5	0.008	0.176	0.168	199.	267.



IMPERIAL CO SERV BLDG; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.793N

LONGITUDE: 115.564W

DATE LOGGED: 02/11/81

DISTANCE(M) TO BOREHOLE FROM:

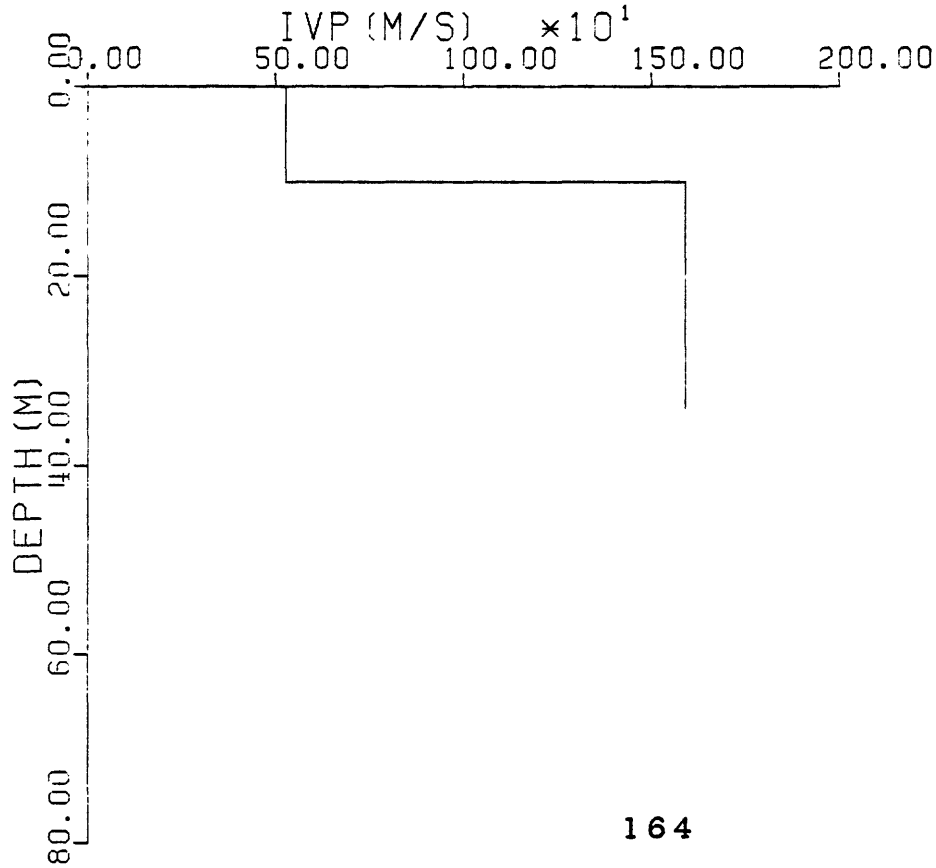
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.008 S

COMMENTS: BOREHOLE MIDWAY BETWEEN BUILDING AND FREEFIELD SITE.

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.018	0.017	527.	527.
33.5	0.032	0.032	1020.	1589.



BRAWLEY AIRPORT; S-WAVE VELOCITY.

LATITUDE: 32.988N

LONGITUDE: 115.509W

DATE LOGGED: 01/14/81

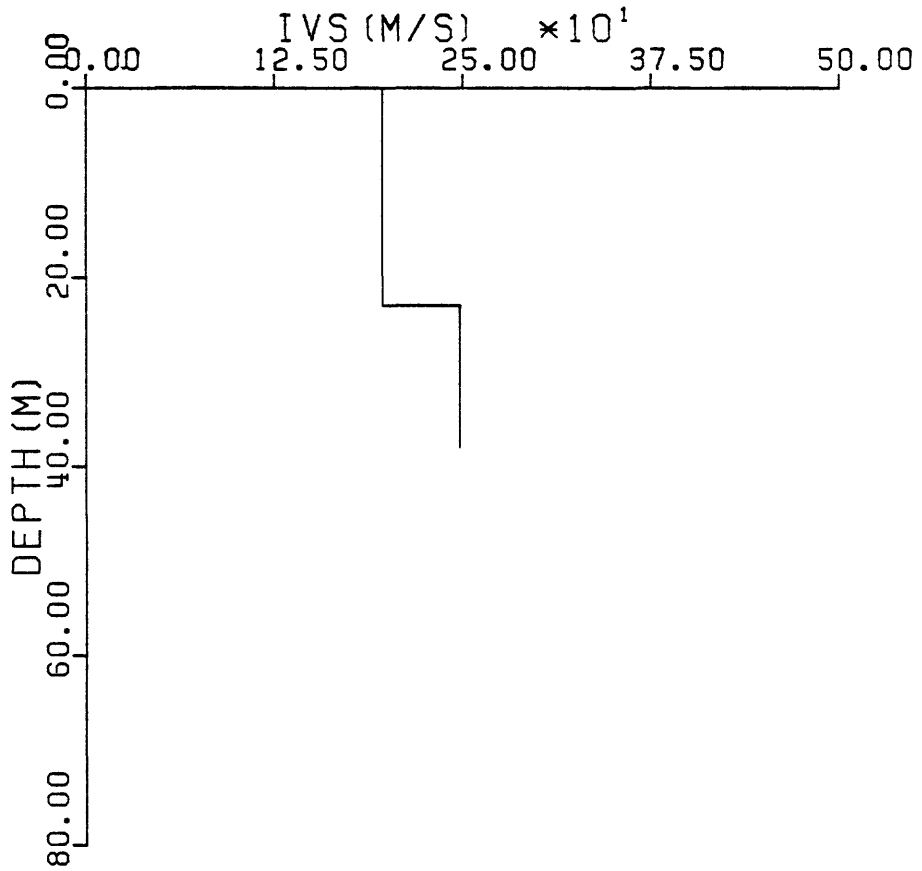
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
22.5	0.007	0.121	0.114	198.	198.
38.4	0.007	0.185	0.178	216.	248.



BRAWLEY AIRPORT; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.988N

LONGITUDE: 115.509W

DATE LOGGED: 01/14/81

DISTANCE(M) TO BOREHOLE FROM:

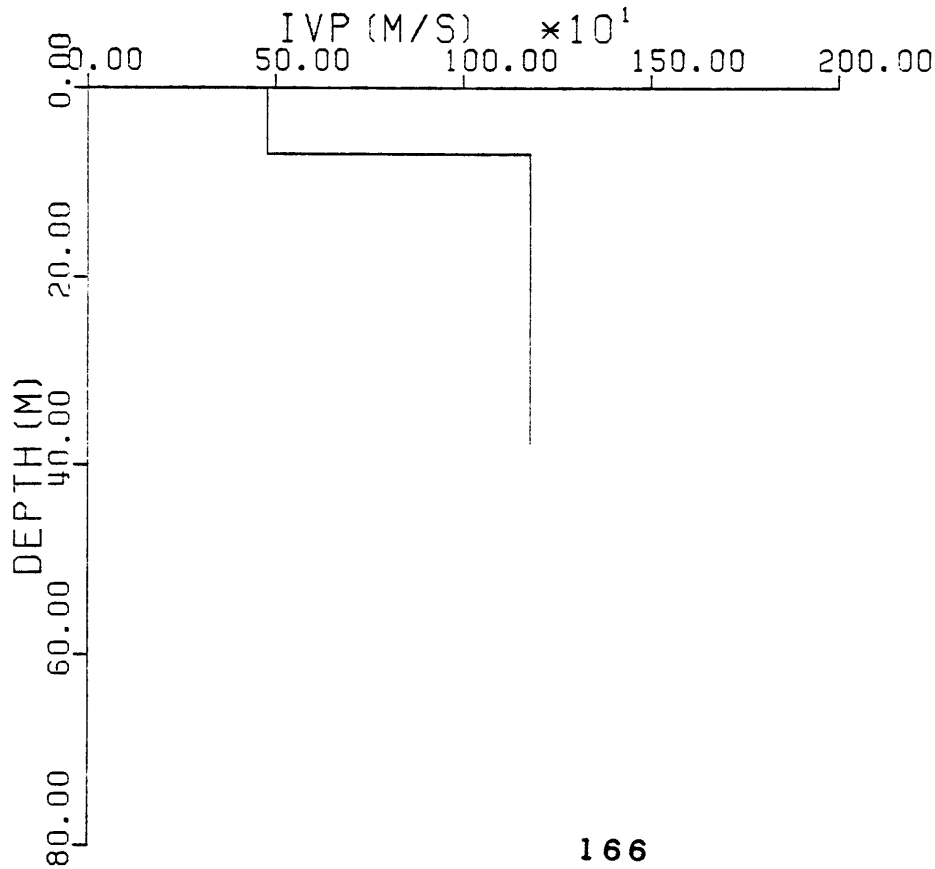
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.60

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.007 S

COMMENTS:

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
7.5	0.015	0.014	477.	477.
38.4	0.040	0.040	938.	1177.



WESTMORLAND F. S.; S-WAVE VELOCITY.

LATITUDE: 33.037N

LONGITUDE: 115.623W

DATE LOGGED: 03/03/82

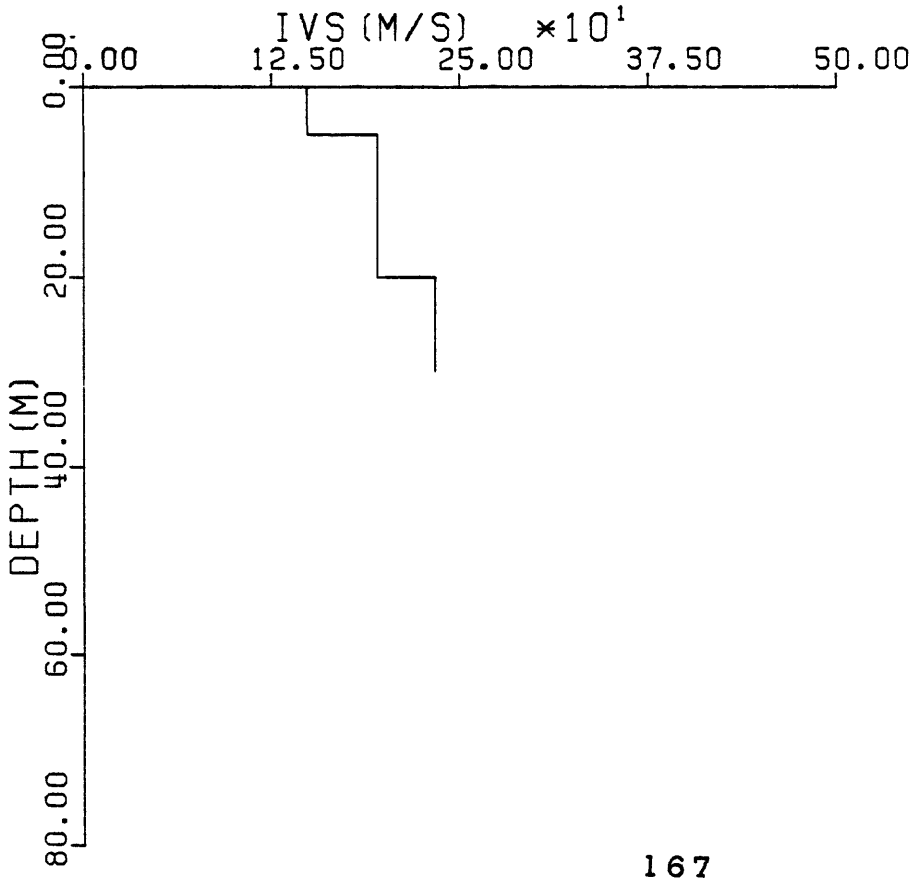
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: EXCELLENT S-WAVE ARRIVALS THROUGHOUT SURVEY.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
5.0	0.005	0.039	0.031	160.	160.
20.0	0.006	0.116	0.110	182.	190.
30.0	0.005	0.159	0.153	196.	231.



WESTMORLAND F. S.; P-WAVE (CAP) VELOCITY.

LATITUDE: 33.037N

LONGITUDE: 115.623W

DATE LOGGED: 03/03/82

DISTANCE(M) TO BOREHOLE FROM:

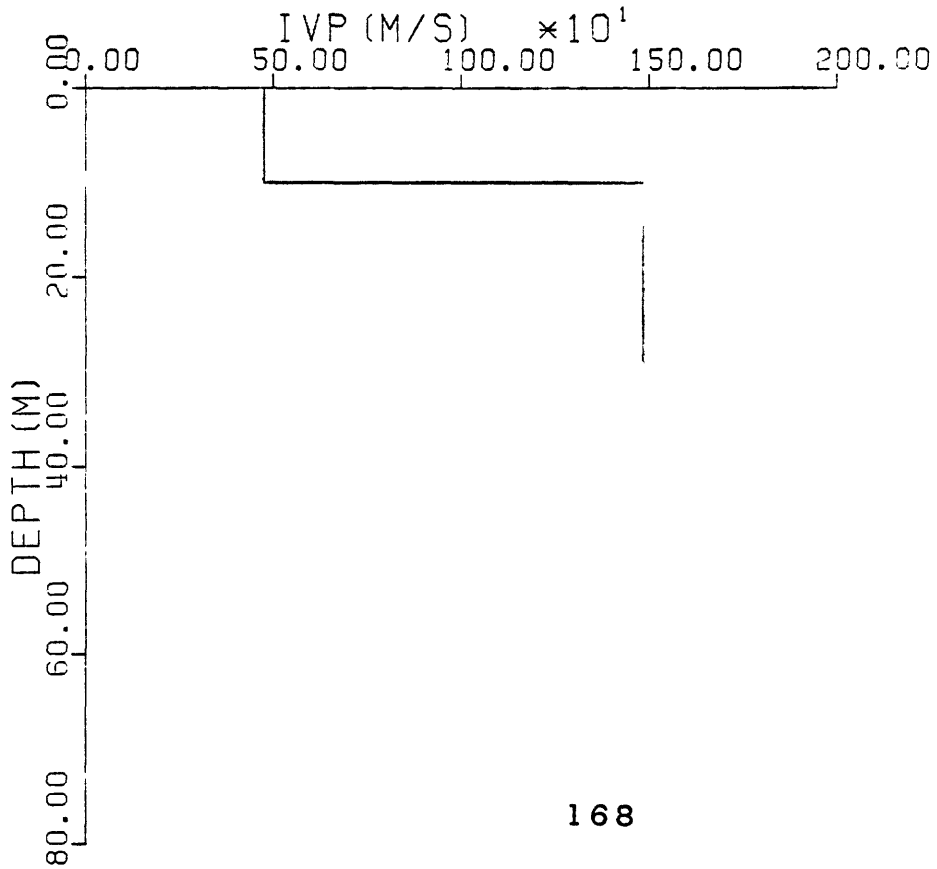
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
10.0	0.020	0.019	474.	474.
30.0	0.032	0.032	911.	1498



PARACHUTE TEST SITE; S-WAVE VELOCITY.

LATITUDE: 32.93N

LONGITUDE: 115.70W

DATE LOGGED: 03/04/82

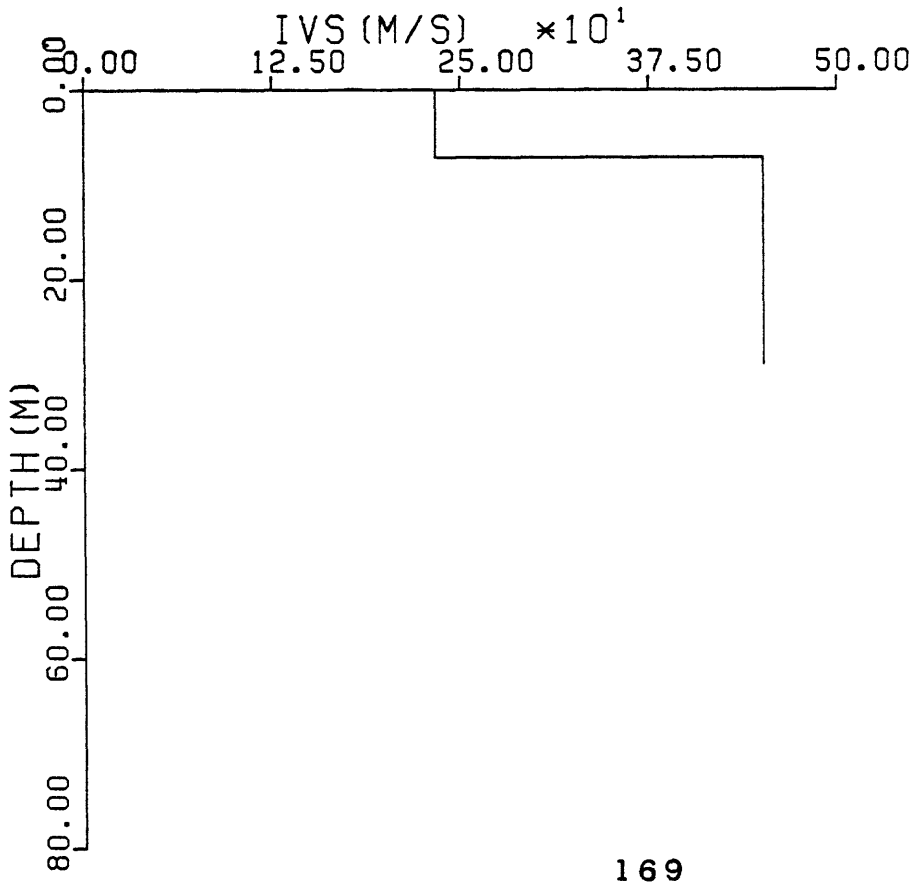
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: ERRATIC S ARRIVALS THROUGHOUT SURVEY.

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
7.5	0.006	0.038	0.031	243.	243.
28.7	0.006	0.085	0.079	364.	443.



PARACHUTE TEST SITE; P-WAVE (CAP) VELOCITY.

LATITUDE: 32.93N

LONGITUDE: 115.70W

DATE LOGGED: 03/04/82

DISTANCE(M) TO BOREHOLE FROM:

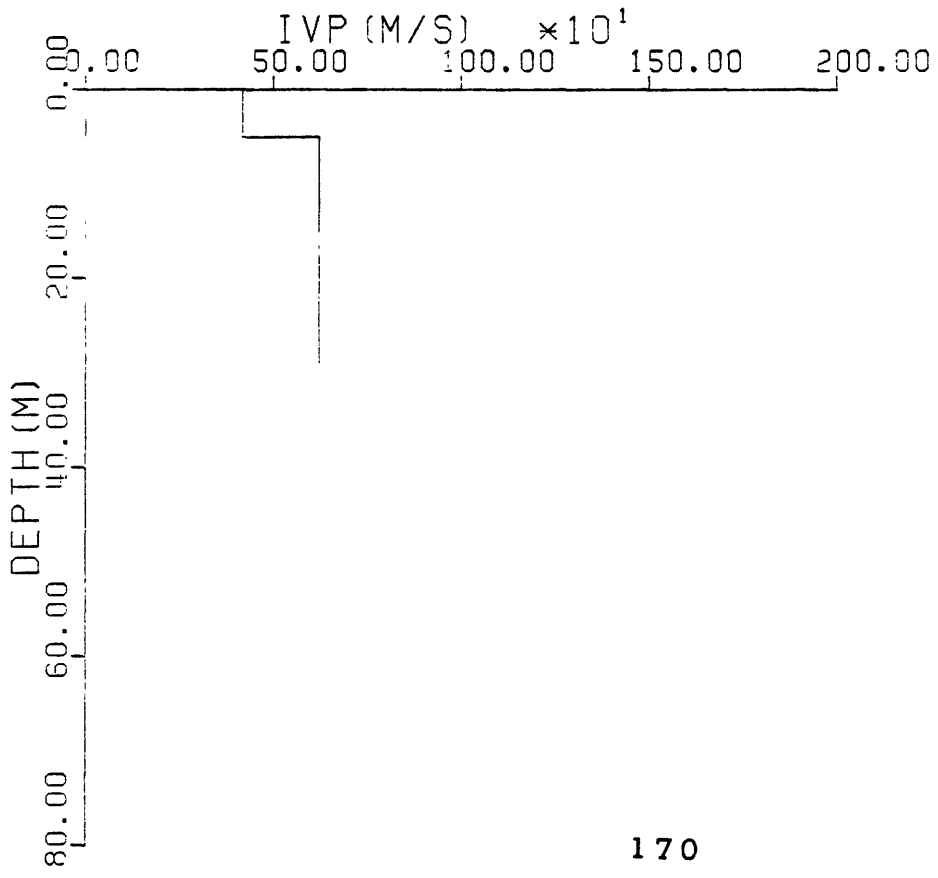
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
5.0	0.012	0.010	417.	417.
28.7	0.048	0.048	580.	622.



CALIPATRIA F. S.; S-WAVE VELOCITY.

LATITUDE: 33.13N

LONGITUDE: 115.52W

DATE LOGGED: 03/01/82

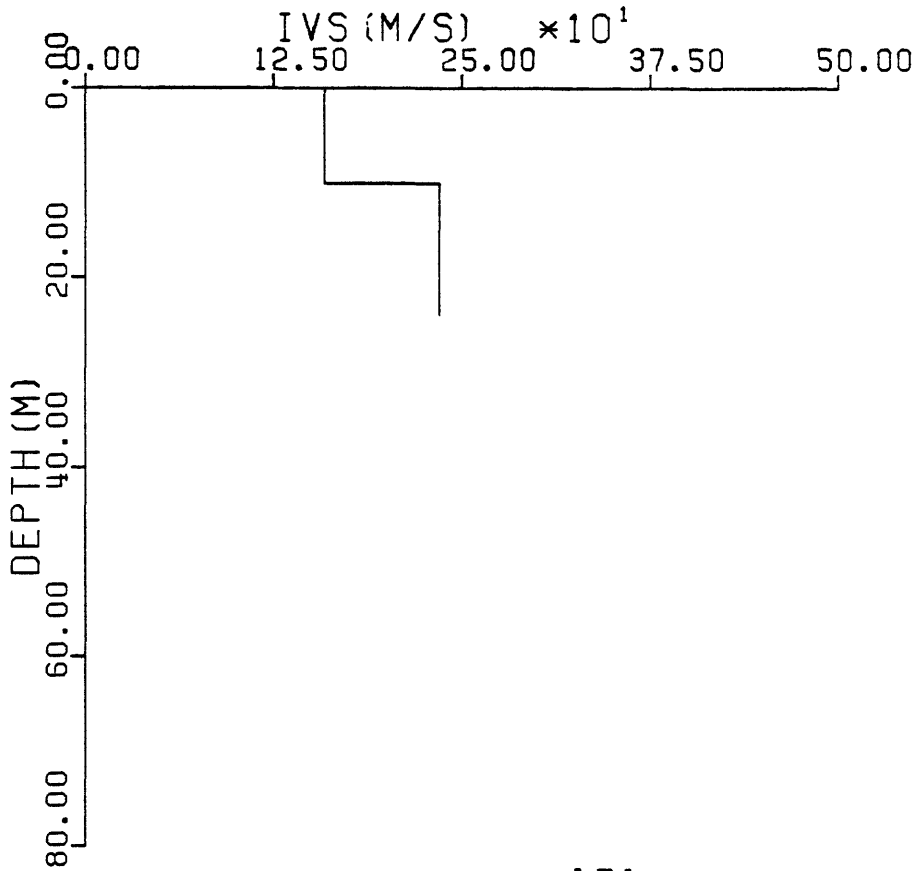
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
10.0	0.004	0.067	0.062	162.	162.
24.1	0.004	0.127	0.123	197.	232.



CALIPATRIA F. S.; P-WAVE (CAP) VELOCITY.

LATITUDE: 33.13N

LONGITUDE: 115.52W

DATE LOGGED: 03/01/82

DISTANCE(M) TO BOREHOLE FROM:

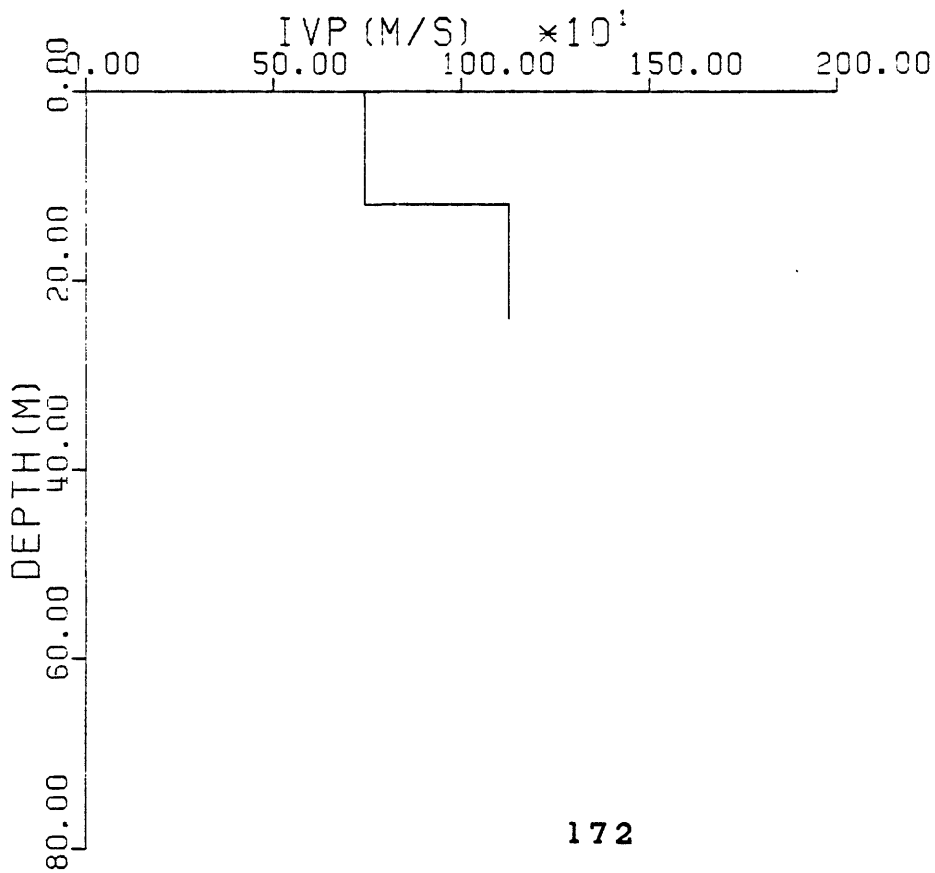
PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.004 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
12.5	0.016	0.015	743.	743.
24.1	0.026	0.026	896.	1126.



SALTON SEA W. R.; S-WAVE VELOCITY.

LATITUDE: 33.18N

LONGITUDE: 115.62W

DATE LOGGED: 03/02/82

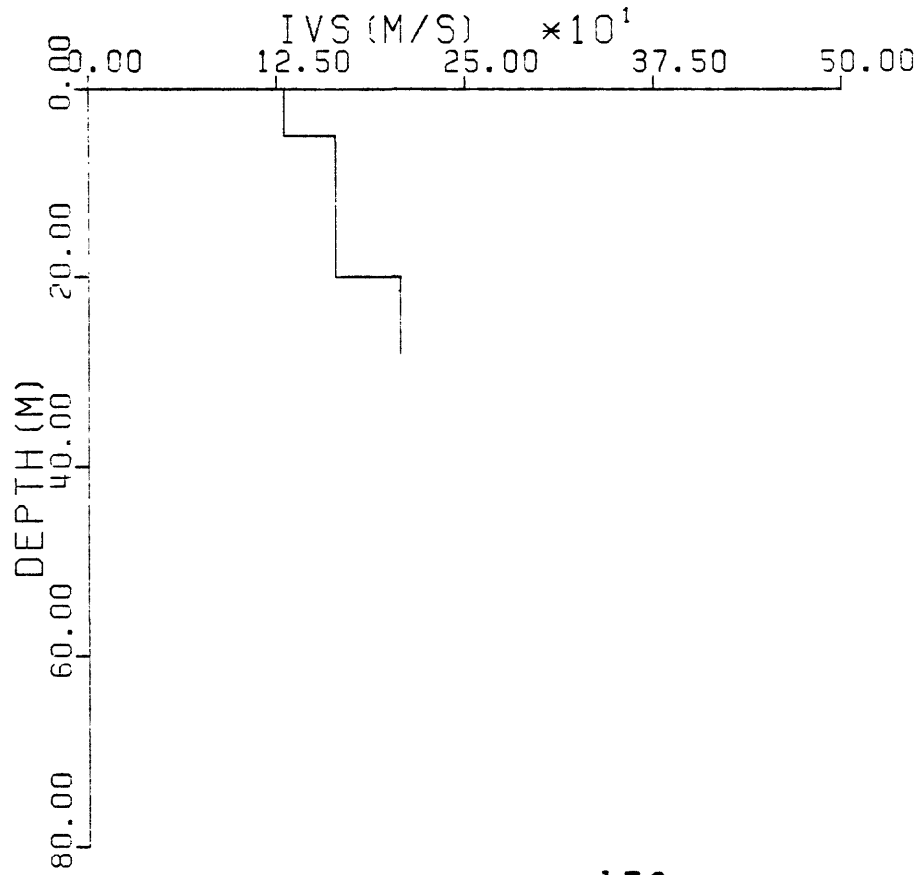
DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

AVERAGE ORIGIN CORRECTION: 0.006 S

COMMENTS: NONE

DEPTH (M)	ORIGIN CORR (S)	S-WAVE ARRIVAL (S)	CORR S TIME (S)	AVG VEL S WAVE (M/S)	INT VEL S WAVE (M/S)
5.0	0.006	0.047	0.038	130.	130.
20.0	0.006	0.136	0.130	154.	164.
27.7	0.005	0.173	0.167	166.	207.



SALTON SEA W. R.; P-WAVE (CAP) VELOCITY.

LATITUDE: 33.18N

LONGITUDE: 115.62W

DATE LOGGED: 03/02/82

DISTANCE(M) TO BOREHOLE FROM:

PLANK	2.00
PLATE	2.00
CAP	3.00
UP GEOPH.	1.70

CAP USED FOR P-WAVE VELOCITY

AVERAGE ORIGIN CORRECTION: 0.005 S

COMMENTS: NONE

DEPTH (M)	P-WAVE ARRIVAL (S)	CORR P TIME (S)	AVG VEL P WAVE (M/S)	INT VEL P WAVE (M/S)
12.5	0.015	0.015	792.	792.
27.7	0.025	0.025	1075.	1472.