U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SEISMIC VELOCITIES AND GEOLOGICAL CONDITIONS AT TWELVE SITES SUBJECTED TO STRONG GROUND MOTION IN THE 1994 NORTHRIDGE, CALIFORNIA, EARTHQUAKE

by

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U.S. Geological Survey Open-File Report 96-740

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INTRODUCTION

The Northridge, California, earthquake of January 17, 1994 (moment magnitude 6.7) was perhaps the best recorded earthquake in history from the standpoint of strong ground motion. As part of the U.S. Geological Survey's ongoing program for documenting the relationship between strong ground motion and geologic and seismic site conditions, twelve boreholes, each approximately 100 meters deep, were drilled at sites affected by the Northridge earthquake. Ten of the boreholes were located at strong-motion recording sites; the other two were located at sites in the Sherman Oaks district of Los Angeles to evaluate an apparent relationship between site conditions and building damage noted there. At each site lithologic descriptions were compiled from observations of drill cuttings and cored samples. At each site four different types of electric logs were made, and downhole P- and S-wave velocities were measured. Preliminary results are presented in this report. The sites are shown in Figure 1 and listed in Table 1, which gives references to information regarding the strong-motion data. The Appendix contains, for each site, a location map, S- and P-wave record sections, a time-depth plot, velocity profiles with a simplified geologic log, and tables giving arrival times and velocity values.

REGIONAL GEOLOGIC SETTING

The San Fernando Valley (Figure 2) is one of several east-west-trending, deep, alluviated basins situated within the the Transverse Ranges structural province of southern California, a region noted for its intense and relatively young deformation and its locally complex structural setting. The regional geology has received recent intense scrutiny and reevaluation of its neotectonic setting, chiefly owing to the Northridge earthquake of 1/17/94 and the San Fernando earthquake of 2/9/71 (Wentworth et al., 1971). The San

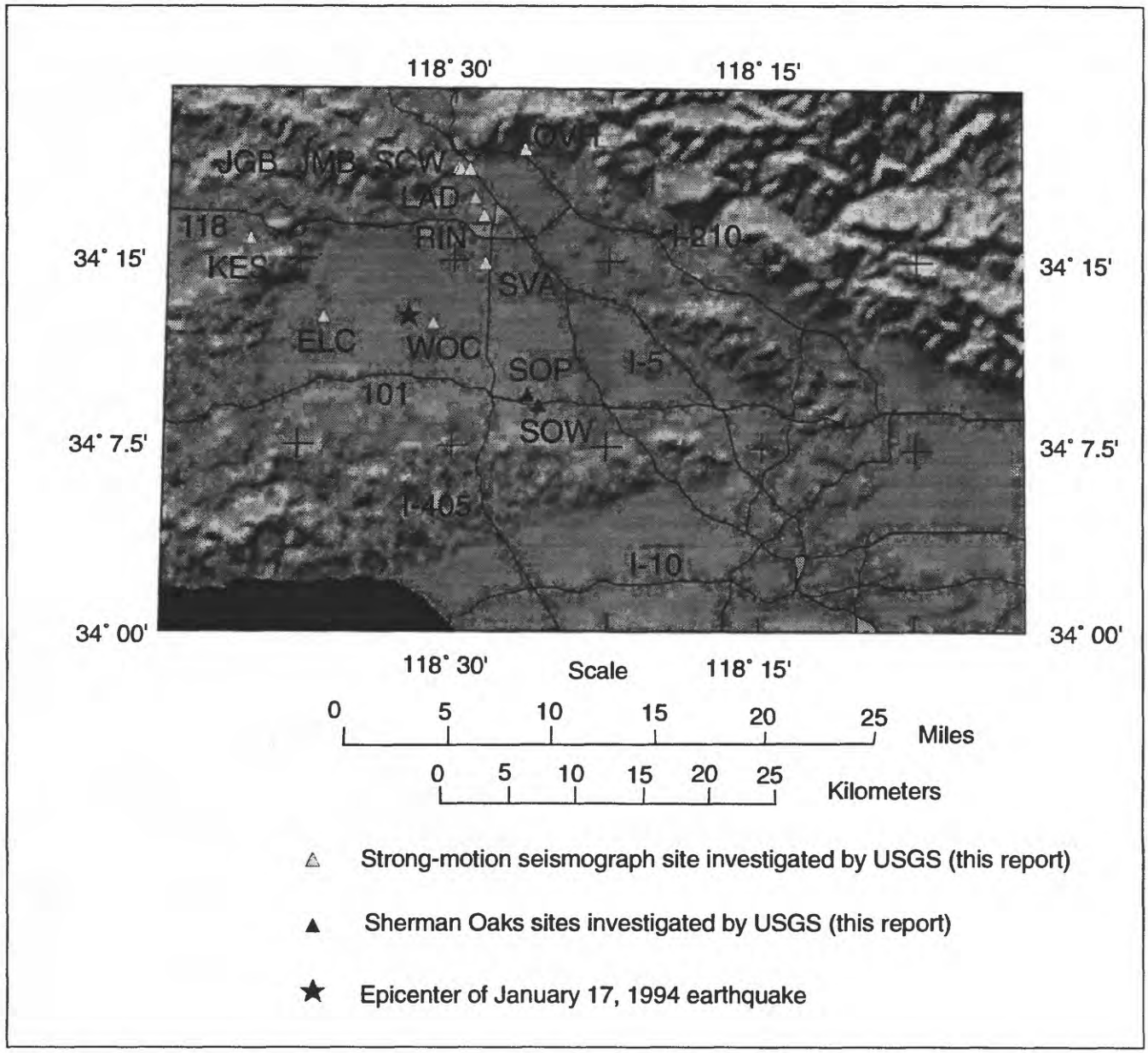


Figure 1. Regional map showing the locations of boreholes (triangles) included in this report. The epicenter of the January 17, 1994, Northridge, California, earthquake is indicated by the star.

TABLE 1. Site location and peak acceleration data.

Site No	STATION NAME	Borehole LATITUDE	Borehole LONGITUDE	SMA LATITUDE	SMA LONGITUDE	USGS SITE CODE	PEAK ACCEL (g) HORIZ.	VERT.	SOURCE g VALUES
1	Epiphany Lutheran Church	34.2117	118.6051	34.2117	118.6059	ELC	0.46	0.63	Trifunac et al, 1994
2	Jensen Generator Building	34.3130	118.4983	34.3130	118.4979	JGB	0.98	0.52	Porcella et al, 1994
3	Jensen Main Building	34.3111	118.4957	34.3115	118.4955	JMB	0.62	0.40	Porcella et al, 1994
4	Knolls Elem. School	34.2633	118.6664	34.2636	118.6663	KNO	0.94	0.43	Trifunac et al, 1994
5	Los Angeles Dam	34.2931	118.4839	34.2927	118.4839	LAD	0.43	0.32	LRB, 1994
6	Olive View Hospital	34.3281	118.4442	34.3276	118.4443	OVH	0.91	0.60	Shakal et al, 1994
7	Rinaldi Receiving Station	34.2810	118.4771	34.2810	118.4771	RIN	0.84	0.85	LRB, 1994
8	Sepulveda VA Hospital	34.2490	118.4772	34.2490	118.4778	SVA	0.94	0.48	Porcella et al, 1994
9	Sherman Oaks Park	34.1607	118.4394	N/A	N/A	SOP	N/A	N/A	Not an accelerograph site
10	Sherman Oaks Woodman	34.1543	118.4307	N/A	N/A	SOW	N/A	N/A	Not an accelerograph site
11	Sylmar Converter West	34.3117	118.4893	34.3119	118.4894	SCW	0.90	0.64	LRB, 1994
12	White Oak Church	34.2081	118.5171	34.2086	118.5171	WOC	0.51	xx	Trifunac et al, 1994

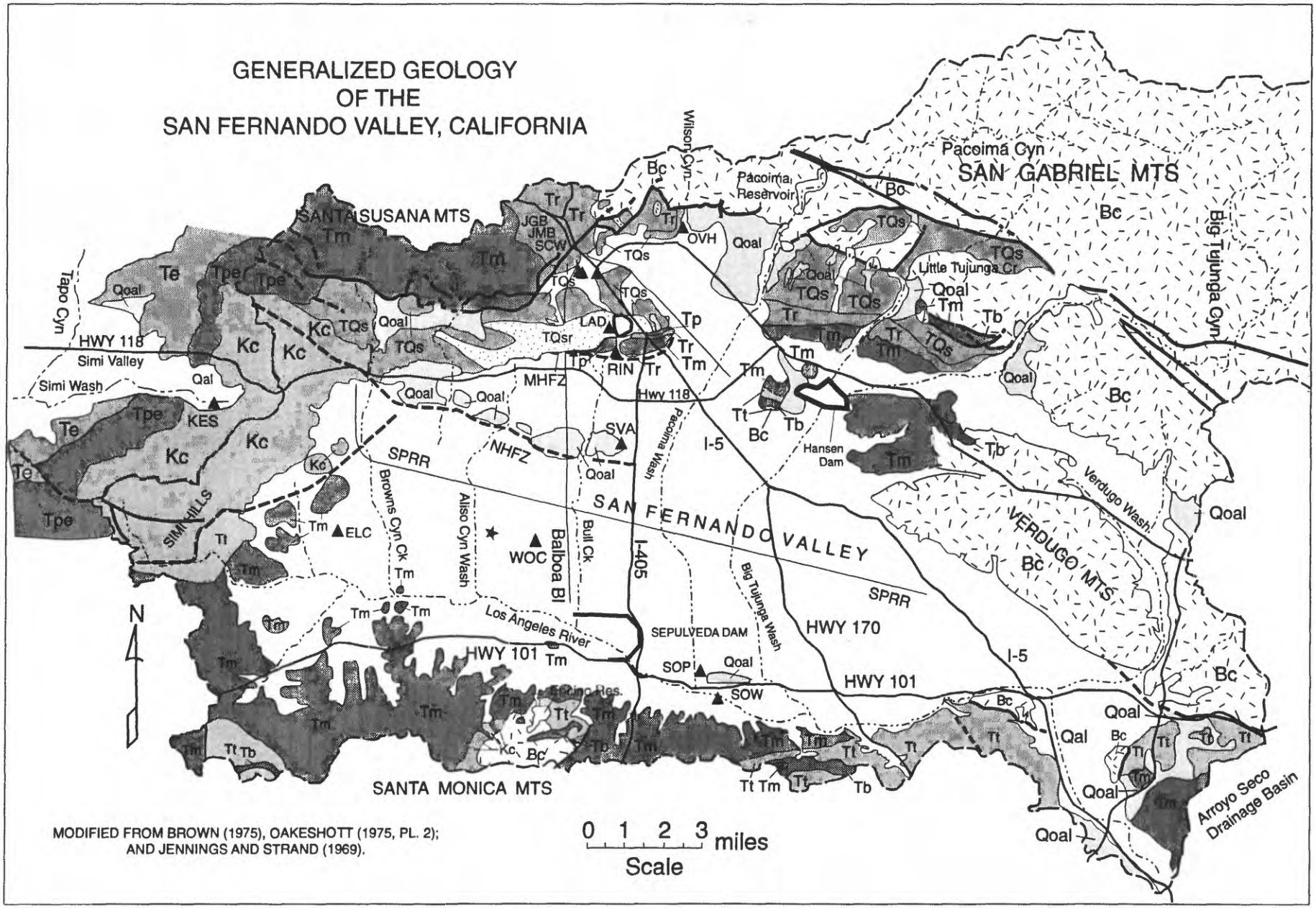
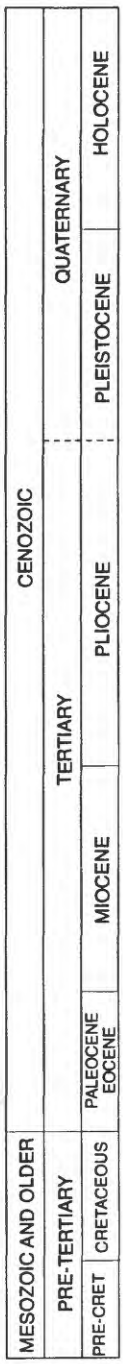


Figure 2. Generalized geologic map of San Fernando Valley. Triangles are borehole locations.



Qal — Alluvium, unconsolidated, poorly sorted alluvial fan deposits of gravel and sand east half of SF Valley and rather soft, fine sand, silt, and clay in west half of SF Valley.

Qls — Landslide deposits, not differentiated; arrows show direction of relative displacement of slide mass.

Qoal — Older alluvium, terrace deposits, plus Pacoima Formation of Oakeshott (1958). Poorly consolidated alluvial deposits of gravel, sand, silt, and clay. Noticeably deformed at ground surface. Weathering includes red and strong brown oxides.

TQs / TQsr — Saugus Formation (undifferentiated, or upper member) lower member (Qsr) is Sunshine Ranch member of Oakeshott (1950). Upper member continental folded conglomerate; lower member in part marine; Lower Saugus strata better consolidated than upper Saugus strata.

Tp — Pico Formation: blue, sandy shale, siltstone with sandstone and conglomerate lenses; mainly marine, often slightly cemented and consolidated.

Tr — Repetto: Blue and brown mudstone, siltstone, sandstone, and conglomerate; marine, arkosic.

Tm — Modelo (Puente) Formation: arkosic conglomerate, sandstone, and diatomaceous and silicious shales; marine.

Tt — Topanga Formation: Brown, tan and gray sandstone and conglomerate; marine. Includes interbedded andesite and basalt flows as map unit Tb.

Te / Tpe — Martinez, Domengine, and Las LLajas formations: Sandstone, dark shale, and conglomerate; marine, greenish-black. Includes marine deposits of Paleocene (Tpe) and Eocene (Te) age.

KTc — Chico Formation: Massive brown sandstone with subordinate thin beds of shale; marine. Locally known as Chatsworth Formation and is of late Cretaceous age.

Bc — Basement Complex: Includes undifferentiated metamorphic and granitic rocks of eastern basement complex of Yerkes (1965) and in Santa Monica Mountains, the Santa Monica Slate (western basement complex of Yerkes (1965); these suites have continental and oceanic crustal protoliths, respectively.

Freeway linework scanned from aerial photography, positioning is not precise.

Fault, dashed where location is approximate, dotted where concealed. Note: faults shown are schematically depicted and are not comprehensively mapped. NHFZ = Northridge Hills Fault Zone; MHFZ = Mission Hills Fault Zone;

SPRR = Southern Pacific Railroad

▲ ▲ Red (light) triangle is USGS study site at an accelerograph location; black (dark) triangle is USGS study site that does not correspond to an accelerograph site.

★ Epicenter of 1/17/94 Northridge, California, earthquake

Figure 2. Explanation.

Fernando Valley encompasses more than 300,000 acres below its drainage divides and above the confluence of the Los Angeles River with the Arroyo Seco; of these, about 120,000 acres comprise the relatively gently sloping, alluviated basin floor, now very densely populated with homes and businesses (Brown, 1975; California State Water Rights Board, 1962). The valley fill strongly reflects the geology of the surrounding mountains and foothills, a characteristic with implications for regional interpretations of shear wave velocity profiles. Consequently, conspicuous differences in sediment supply distinguish the eastern from the western portions of the San Fernando Valley, with the dividing line being the Bull Creek drainage, which is situated between Balboa Blvd. and Interstate 405.

The eastern half of the alluviated San Fernando Valley receives sediment from steep drainages characteristic of the rugged San Gabriel and Verdugo mountains. These mountainous terranes expose mainly crystalline granitic and metamorphic rocks of the eastern basement complex of Yerkes (1965). Consequently, the valley fill deposits located east of Interstate 405 are relatively coarse-textured and comprised of sand, gravel, and cobbles deposited by the powerful high-gradient streams draining such principal watercourses as Big Tujunga, Little Tujunga, and Pacoima canyons. These sediment transport systems have shunted the Los Angeles River southward nearly to the Santa Monica mountains, limiting the areal extent of the sediment eroded from the Santa Monica mountains.

The western half of the San Fernando Valley receives alluvial sediment from numerous drainages dissecting the Santa Monica mountains, the Santa Susana mountains, and the Simi Hills. These drainage basins are smaller than those of the San Gabriel mountains, and are eroding uplands comprised mainly of Mesozoic, Tertiary, and early Quaternary uplifted marine and nonmarine sandstones, siltstones, and mudrocks (Winterer and Durham, 1958, 1962). A small area of Santa Monica mountains exposes rocks of the western basement complex of Yerkes *et al.* (1965) locally represented by the Santa Monica slate. The valley's alluvial deposits thus are significantly more fine-textured at most localities west of Interstate 405 compared to those east of Interstate 405. The western portion of the valley contains significant occurrences of very shallow ground water (California State Water Rights Board (1962); Tinsley *et al.* (1985), Tinsley and Fumal (1985)). Areas characterized

by high sedimentation rates owing to persistent overbank flooding and fine-grained debris-flows (relatively common events prior to implementation of flood control measures in the western San Fernando Valley [King *et al.*, 1981]) and a persistence of shallow ground water are distinguished by relatively low values of shear strength and contained the lowest shear-wave velocities we measured in this study.

ACCELEOGRAPH SITES AND AREAL GEOLOGY

The sites we investigated and report here comprise a relevant set of data for exploring aspects of site dependent effects of the Northridge earthquake. However, we caution that these sites do not encompass a complete sampling of the region's varied geology. Six sites occur on recent alluvium deposited by streams draining Cretaceous and Tertiary marine sediments. Of these, five sites are located on relatively fine-textured surficial deposits (chiefly well bedded sequences composed of poorly consolidated loose to slightly dense silty sand, sandy silt, silt, and clayey silt) in the western half of the San Fernando Valley (ELC, RIN, WOC), in the south central San Fernando Valley (SOP, SOW) and one site is located in southeasternmost Simi Valley (KES) on sand and silt deposits derived from the Cretaceous Chatsworth Formation, (the sedimentary rock that forms the visually impressive brown-weathering sandstone that crops out in the northwestern San Fernando Valley and eastern Simi Valley). About 12 meters of Quaternary sediment overlies the Cretaceous bedrock at this point in Simi Valley. At one site (SVA), Pleistocene sandy and silty alluvial deposits overlie strata of the Saugus Formation or its stratigraphic equivalent.

Boreholes drilled at three sites (JMB, JGB, SCW) penetrated various thicknesses of fill and soft Holocene alluvial deposits before encountering the Saugus Formation of Winterer and Durham (1962). A fourth site, the Los Angeles Dam (LAD) site, is the only site we investigated that was within the lower (Sunshine Ranch) member of the Saugus Formation; shear-wave velocities for the LAD site are higher than those measured in the other Saugus Formation sites. The 12th and final site was located at Olive View Hospital, in coarse, gravelly alluvium derived from Wilson Canyon, which drains granitic and metamorphic rocks of the San Gabriel mountains. This site is the only site that encountered materials typical of much of the eastern half of the San Fernando Valley.

GEOLOGIC AND GEOPHYSICAL LOGS

Generalized logs of earth materials underlying the drill sites were prepared from (1) mud logs of cuttings that were noted during drilling, (2) "undisturbed"samples obtained using a Pitcher sampler, (which provided glimpses of the materials encountered at depth) and (3) a suite of geophysical logs (spontaneous potential, resistivity, caliper, and natural gamma ray logs, these logs are not included here, but will appear in a later report) obtained prior to installing and grouting the casing in the borehole. From these logs we can delineate the thickness and character of basin alluvial deposits and underlying bedrock. Electric logs enable findings to be correlated to other parts of the basin and to other basins in southern California. Physical properties noted in the abbreviated descriptions include; depth, color, texture or lithology of alluvial deposits, probably geologic age, and correlation with regionally mapped geologic units.

P- AND *S*-WAVE TRAVEL-TIME DATA

Shear waves were generated at the ground surface by an air-powered horizontal hammer (Liu, *et al.*, 1988) striking an anvil at either end of an aluminum channel 2.3 m long. The hammer was driven first in one direction and then in the other to generate pulses of opposite polarity. A switch attached to the shear source triggered the recorder and established the reference for timing arrivals. *P*-waves were made by striking a steel plate with a sledge hammer. A switch attached to the handle of the sledge hammer triggered the recorder. *P*- and *S*-wave sources were offset from the borehole to minimize the effect of waves traveling down the grout surrounding the casing. The offset was 4 m at all sites except Jensen Main Building, where it was 5 m. Travel times were corrected to vertical before used to determine velocity.

Downhole measurements were made at 2.5 m intervals with a three-component geophone clamped to the casing by an electrically-activated lever arm. A second three-component geophone was placed on the surface 5 to 10 m from the shear source for recording an on-scale reference trace, which was useful for amplitude studies and timing verification. The data were recorded on diskettes by a 12-channel recording system.

DETERMINING VELOCITY PROFILES

The procedure for determining velocities is summarized in Figure 3. The orientation of the downhole geophone could not be controlled when moving from one depth to the next, so, the orientation was unknown and changed with depth. To minimize the effects of those changes the horizontal components were rotated to the direction that maximized the integral square amplitude within a time interval containing the shear wave (Boatwright *et al.*, 1986). *P*- and *S*-wave arrival times were determined from the time series displayed on a 20-inch computer screen at each depth. The *P*-wave arrival time was obtained from the vertical trace, and the *S*-wave arrival times were obtained from the rotated horizontal traces for the two hammer blows in opposite directions and averaged. The arrivals were timed to the nearest millisecond, probably a realistic precision for clear arrivals uncontaminated by noise.

The *S*-wave travel-time data were analyzed first. A trial set of layer boundaries was chosen on the basis of the lithologic descriptions and the geophysical logs. Using a leastsquares program from Press *et al.* (1992), the travel-time data were fit with a continuous set of straight-line segments, hinged at the layer boundaries and fixed at zero at the surface. The travel times were weighted by the inverse of an assigned normalized variance. A normalized standard deviation of one was assigned to the clear arrivals and values up to five were assigned to the others. The residuals were examined, and additional layer boundaries were added, if their inclusion would significantly reduce the residuals. The *P*-wave travel time data were analyzed initially with the set of layer boundaries finally determined for the *S*-wave data. Then, layer boundaries were added if needed and deleted if not needed. Commonly, an additional layer boundary corresponding to the top of the zone of water saturation was needed to fit the *P*-wave data. *P*- and *S*-wave profiles for all twelve holes are plotted in the Appendix. The upper and lower bounds on the plots show approximate 68 percent confidence limits. The bounds are not symmetrical because they are based on the standard deviations of the slopes of the line segments fit to the travel time data. The slopes are the inverse of velocity.

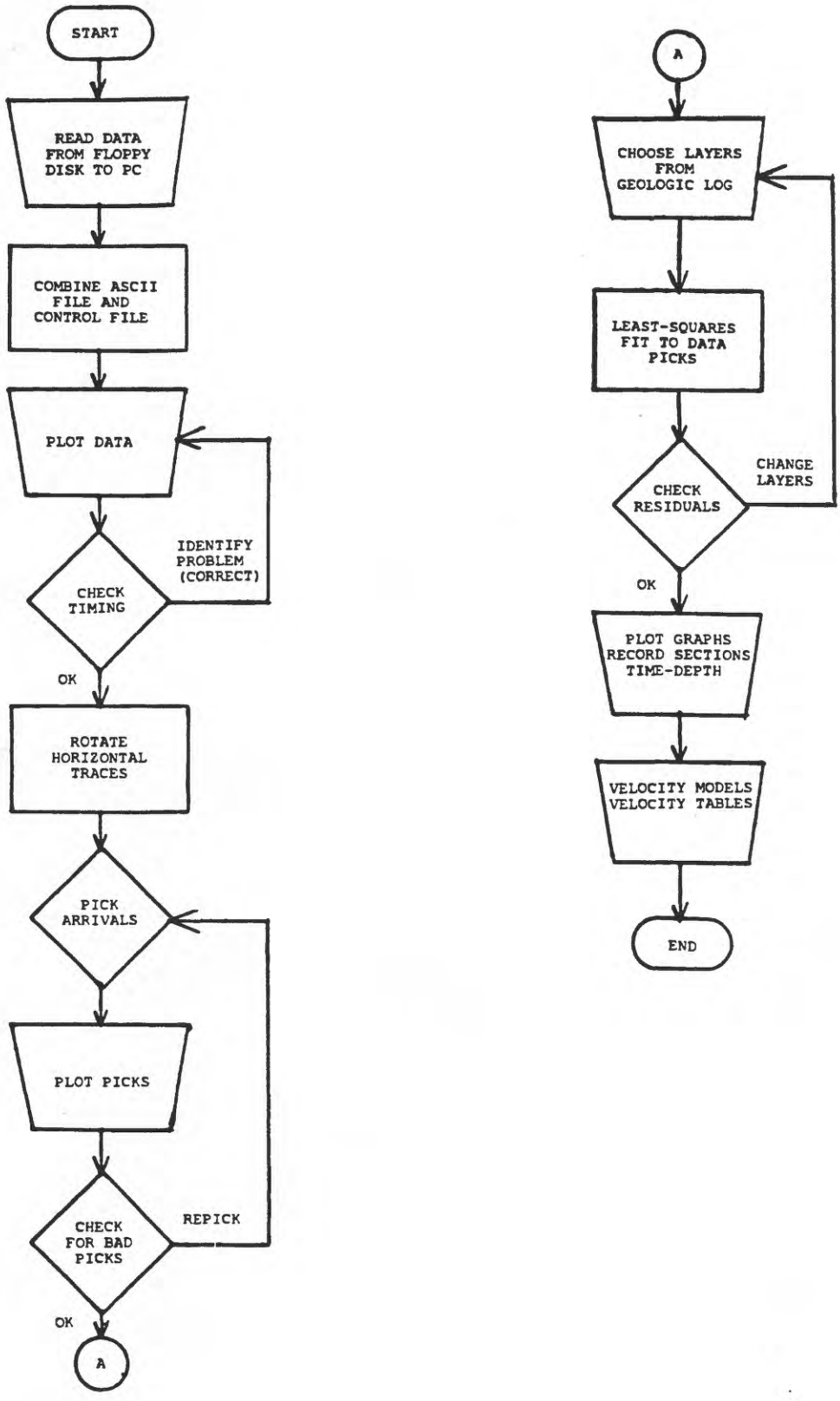


Figure 3. Flow-chart outlining the data processing and steps in the interpretation.

SUMMARY VELOCITY PROFILES

Figures 4-6 show the S-wave velocity profiles determined from the borehole measurements at the twelve sites. The velocity profiles are plotted at the same scale for ease of comparison. Figures 7-9 show the P-wave velocity profiles for the same sites as Figures 4-6, respectively.

ACKNOWLEDGMENTS

We are grateful to a large number who made this work possible by helping us gain access to the sites and permission to do the studies. These people include Mrs. Perry C. Norman, Mr. Bob Lancaster, Mr. Ezra Safdie, Mr. Ed Amador and Mr. Robert Bankeser (Sepulveda VA Hospital); Mr. Richard J. Proctor, Mr. Joe Vanderhorst, Mr. Ezell Culver of the Metropolitan Water District of Southern California (Jensen Main Building and Jensen Generator Building sites); Mr. Ron Tognazzini, Mr. Brent Hollingworth, Mr. Don Schauer, Mr. Jeff Owen, and Mr. Craig Davis of the Los Angeles Department of Water and Power (Rinaldi Receiving Station, Sylmar Converter West, and Los Angeles Dam); Mr. Mario Sewell, Mr. Brent McSwain, and Ms. Wendy Wilkinson of the Los Angeles City Recreation and Parks (Sherman Oaks Park); Ms. V. Carlsen and Mr. Robert Lambert (Epiphany Lutheran Church); Ms. Brooke Wolford and Ms. Cindy Trull of the Bank of America and Mr. Frank Adelman (White Oak Church site); Mr. Il Kim, Mr. Ed Teran, Mr. Alphonso Bragg, (Sherman Oaks Woodman); Mr. David Kanthak and Mr. Gary Nottingham of Simi Valley Unified School District (Knolls Elementary School);Dr. Anthony Shakal and Dr. Robert Darragh of California Division of Mines and Geology (Olive View Hospital site); Mr. Ronald Porcella and Mr. Richard Maley of the U.S. Geological Survey (Jensen Main Building, Jensen Generator Building and Sepulveda V.A. Hospital); Prof. Mihailo Trifunac of the University of Southern California (White Oak Church, Epiphany Lutheran Church, and Knolls Elementary School sites).

We also thank Mr. Robert Westerlund and Mr. Joel Johnson of the U.S. Geological Survey for their help with the S- and P-wave logging.

Mr. John Singer of the U.S. Geological Survey's Water Resources Division provided drilling and electric logging services at 9 sites; Pitcher Drilling Company of East Palo Alto, California, and Welenco Inc. of Bakersfield, California, provided drilling and electric logging at 3 sites.

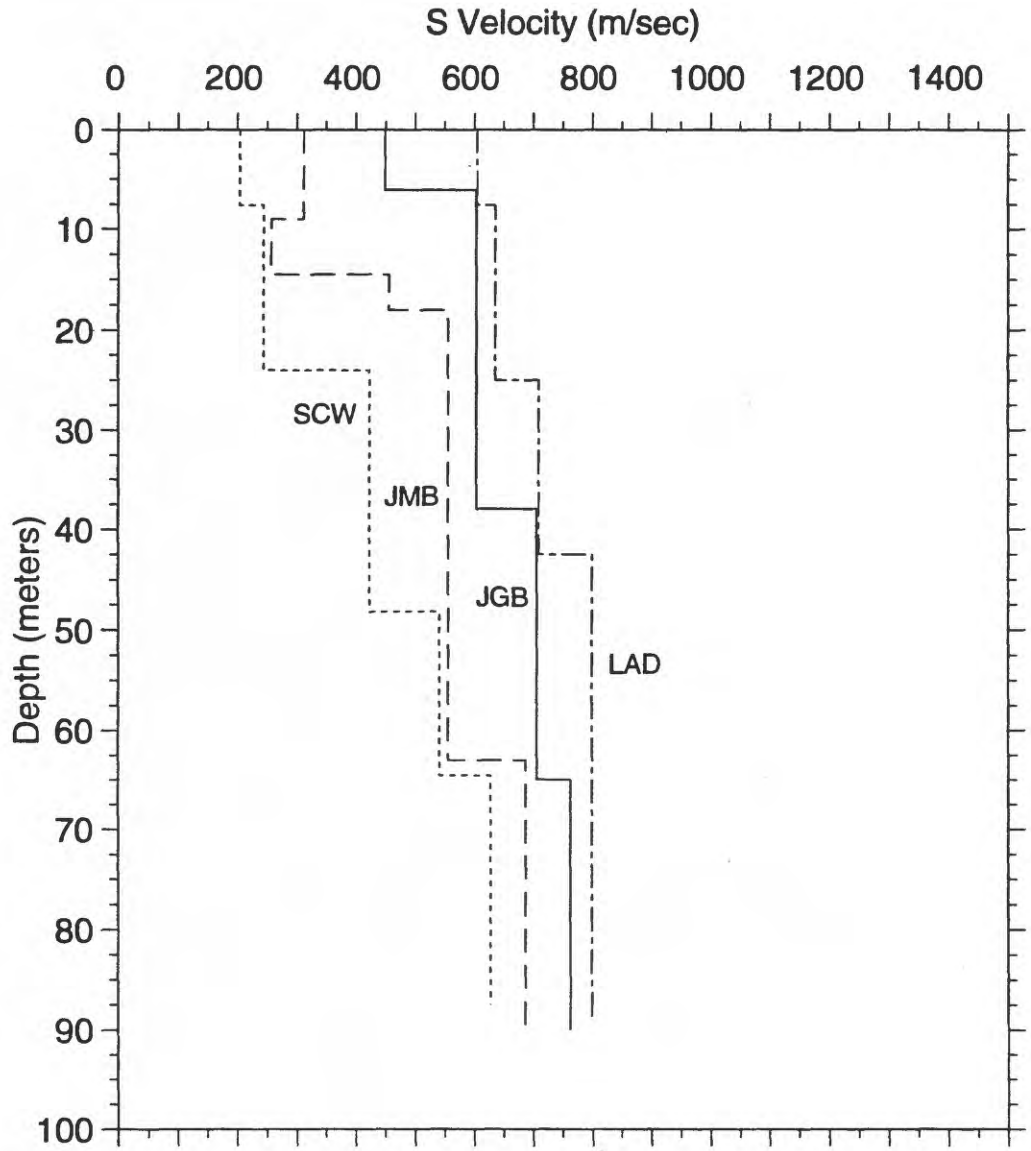


Figure 4. S-wave velocity models shown on the same figure for comparison. Sites JMB, JGB and SCW have various thicknesses of fill and soft Holocene alluvial deposits above the Saugus Formation. LAD is the only site we investigated within the lower (Sunshine Ranch) member of the Saugas Formation.

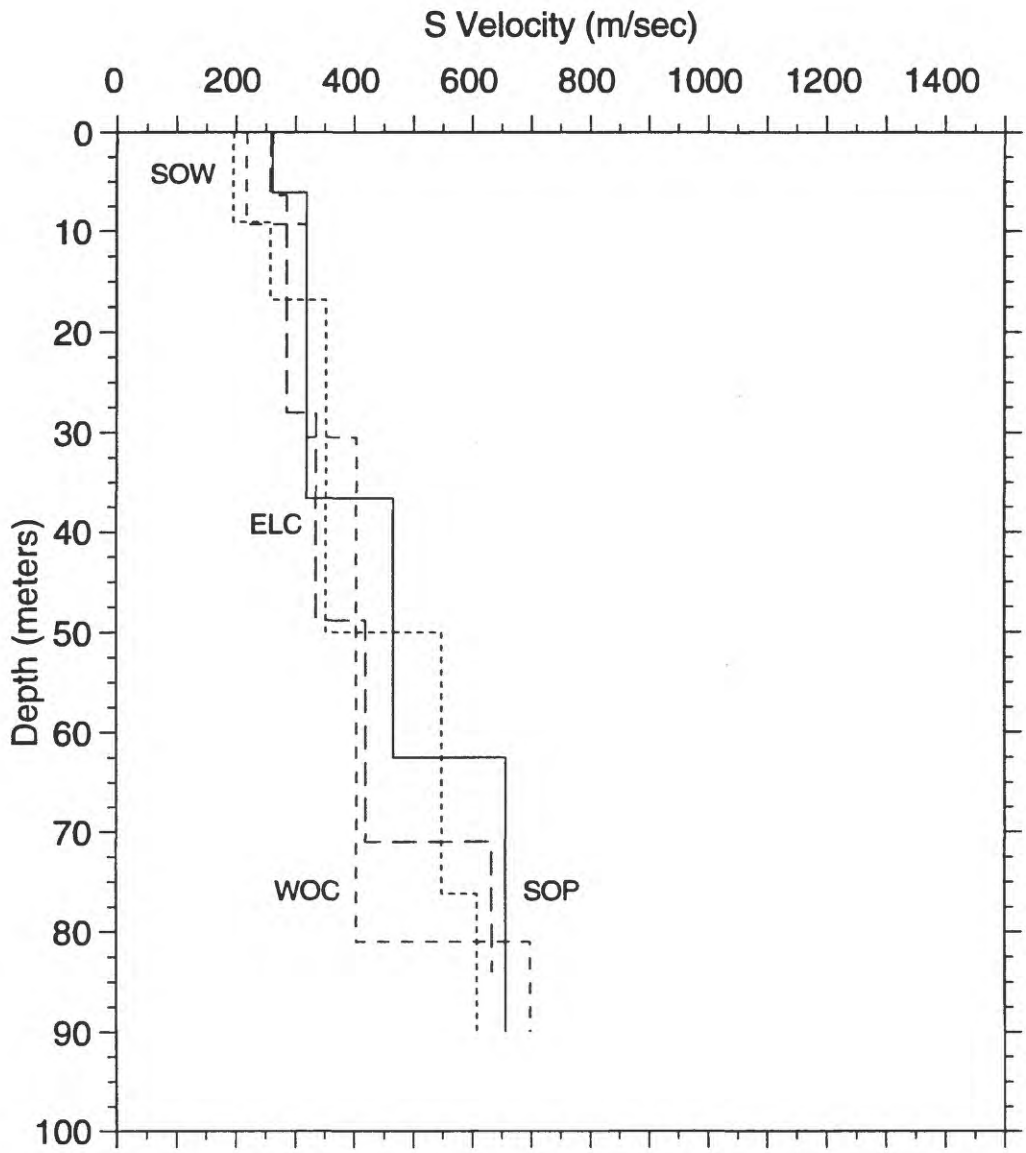


Figure 5. S-wave velocity models shown on the same figure for comparison. These sites all start in relatively soft, fine-textured Holocene alluvial deposits of the Los Angeles River and its tributaries in the San Fernando Valley. Drill holes apparently bottomed in Tertiary marine sedimentary rock (shales, siltstones).

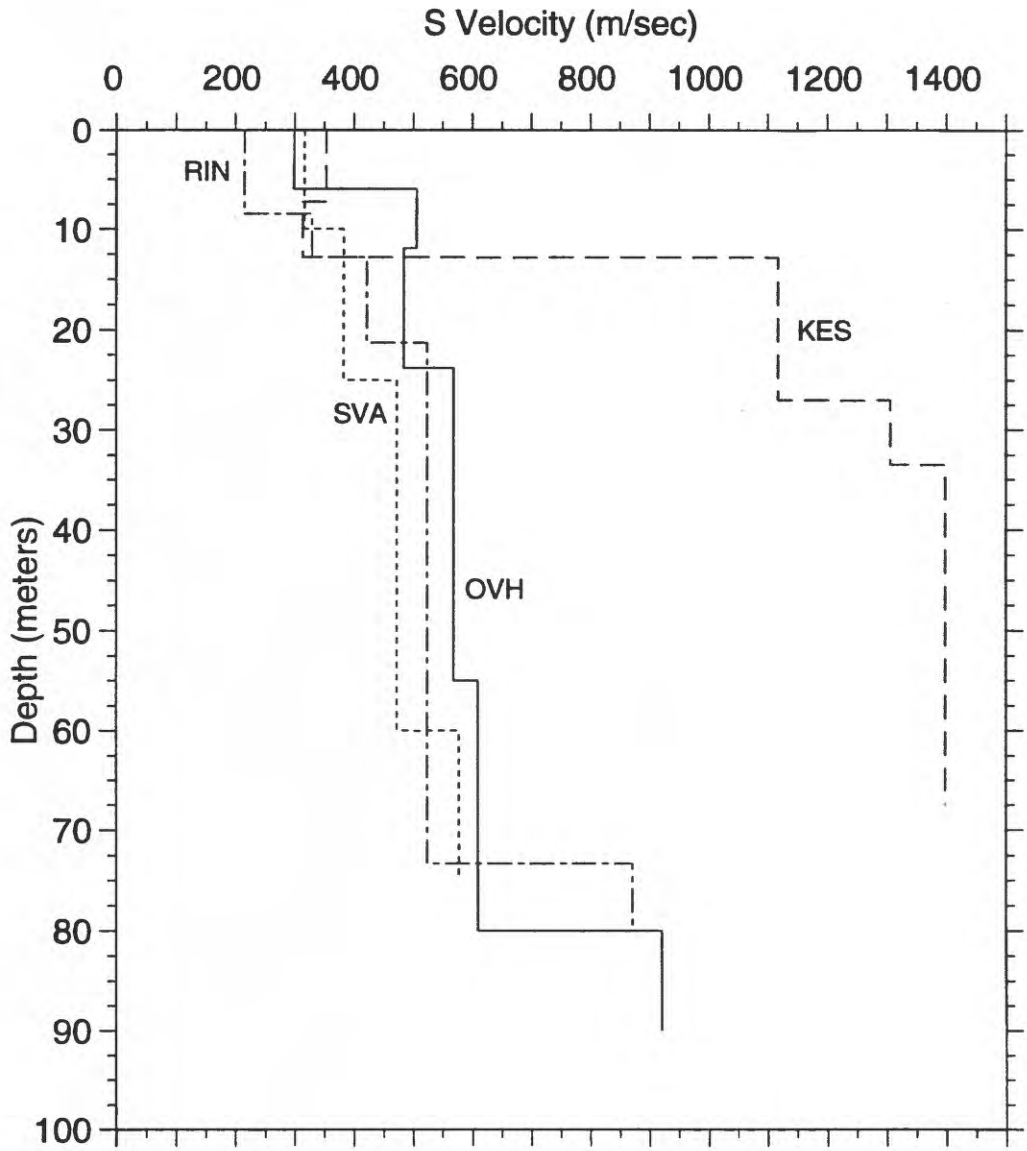


Figure 6. S-wave velocity models for sites, KES, OVH, RIN and SVA. All sites are drilled in sandy or coarser-textured alluvium. At RIN, the drillhole bottomed in marine Tertiary (RIN) mudstone; at KES, in Cretaceous marine sandstone; at OVH and SVA, in nonmarine Saugus(?) Formation or its possible equivalent.

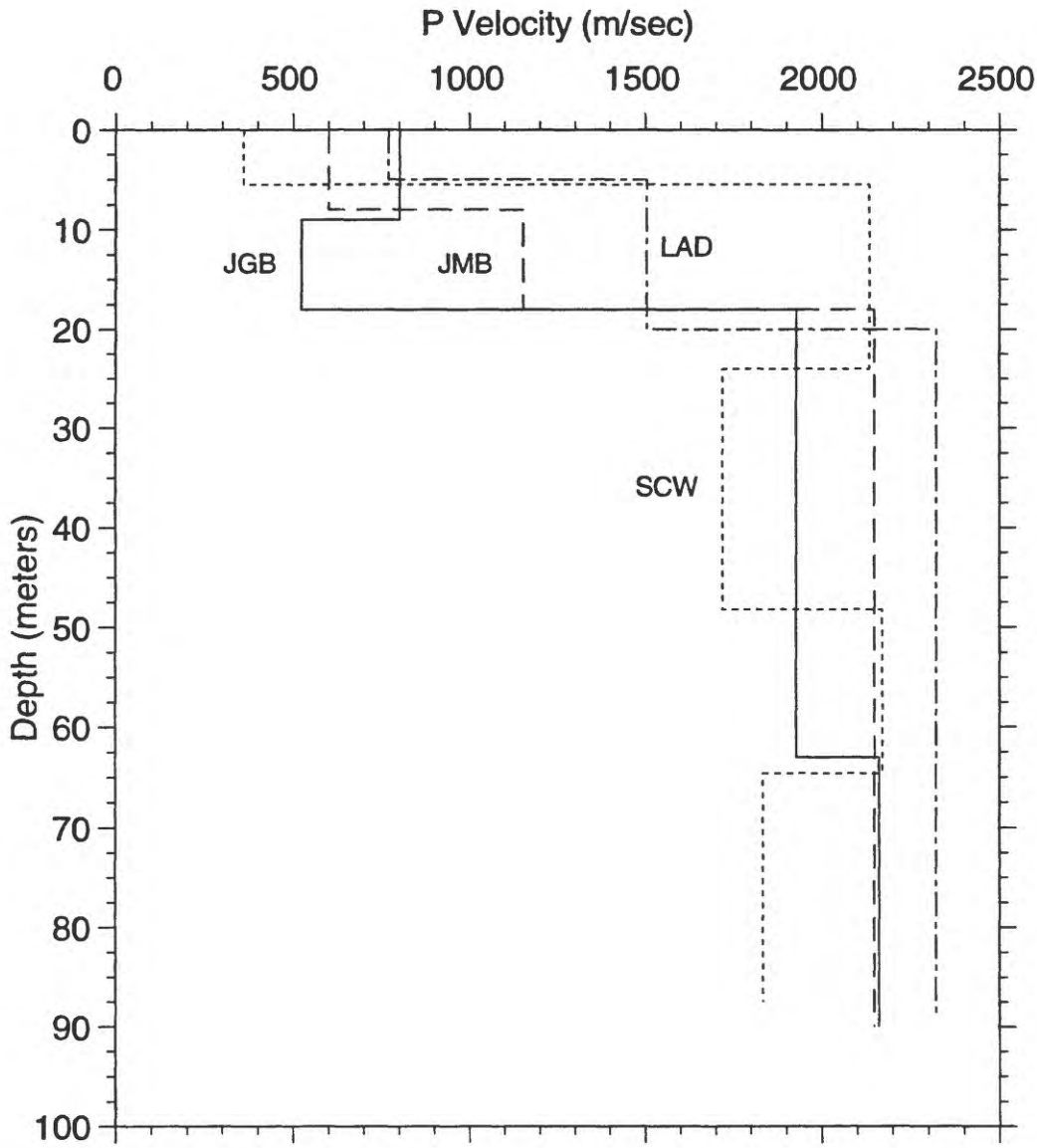


Figure 7. P-wave velocity models shown on the same figure for comparison.

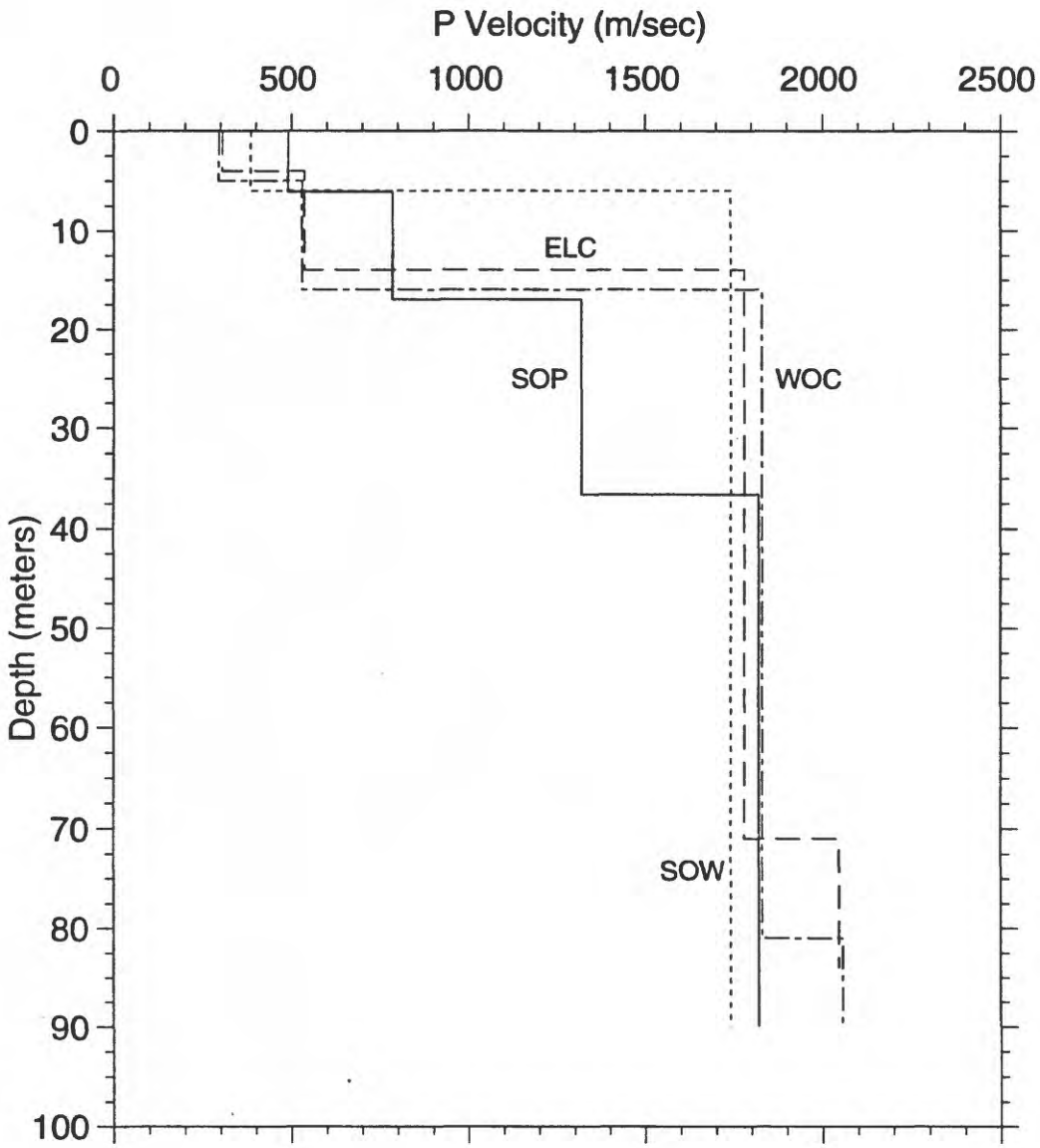


Figure 8. P-wave velocity models shown on the same figure for comparison.

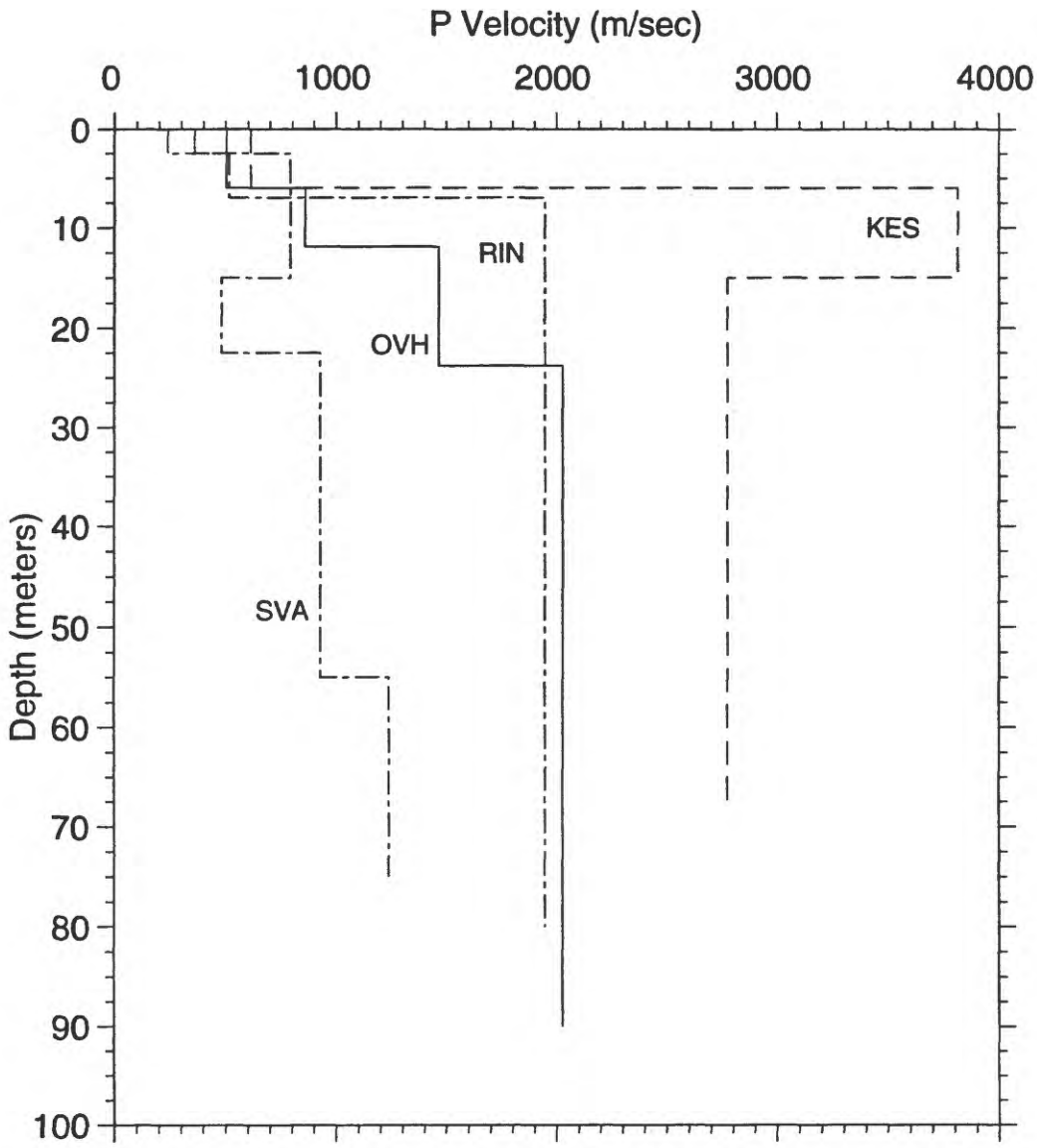


Figure 9. P-wave velocity models shown on the same figure for comparison.

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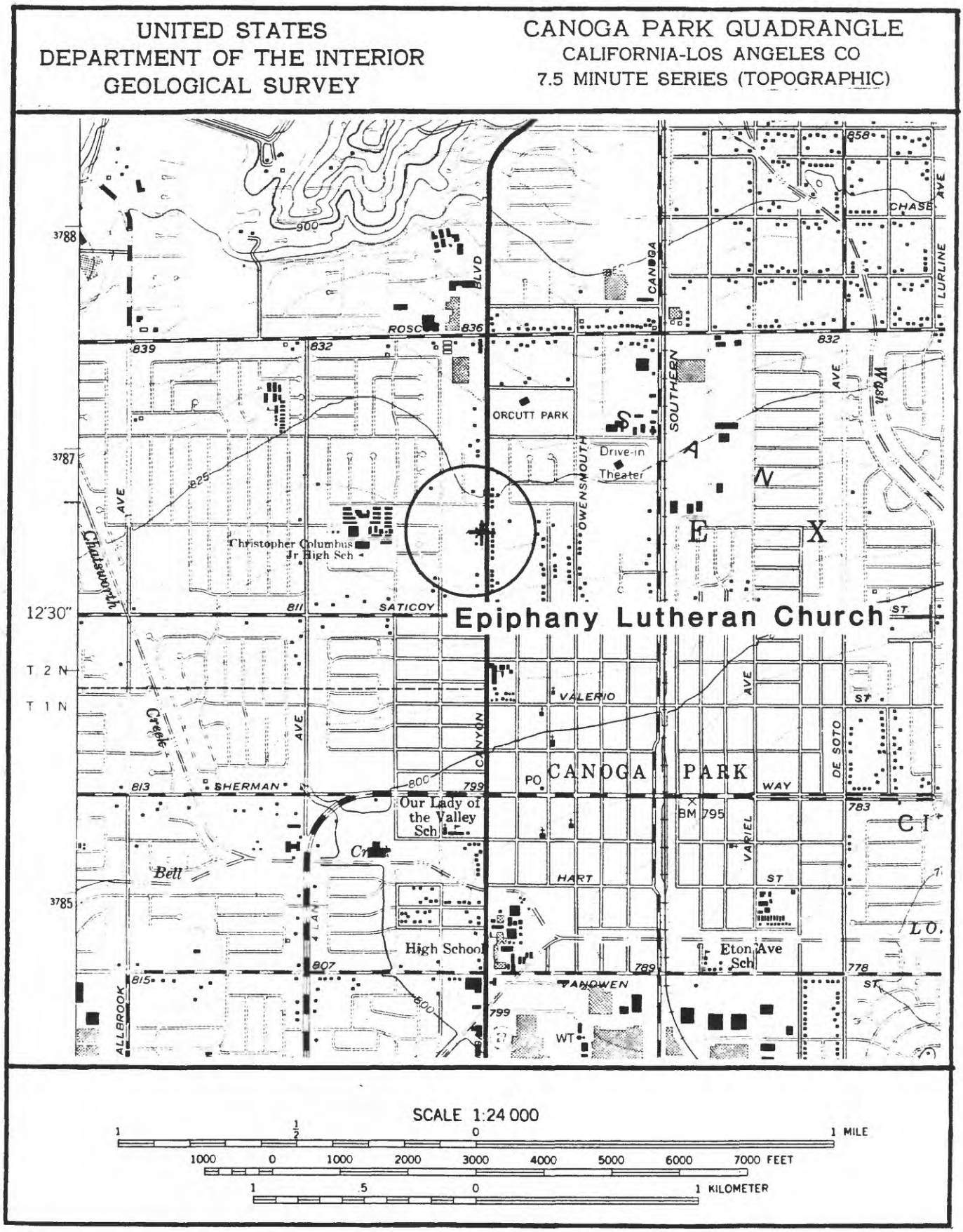

Figure 10. Site location map for the borehole at Epiphany Lutheran Church. The accelerograph is located approximately 50 meters from the borehole.

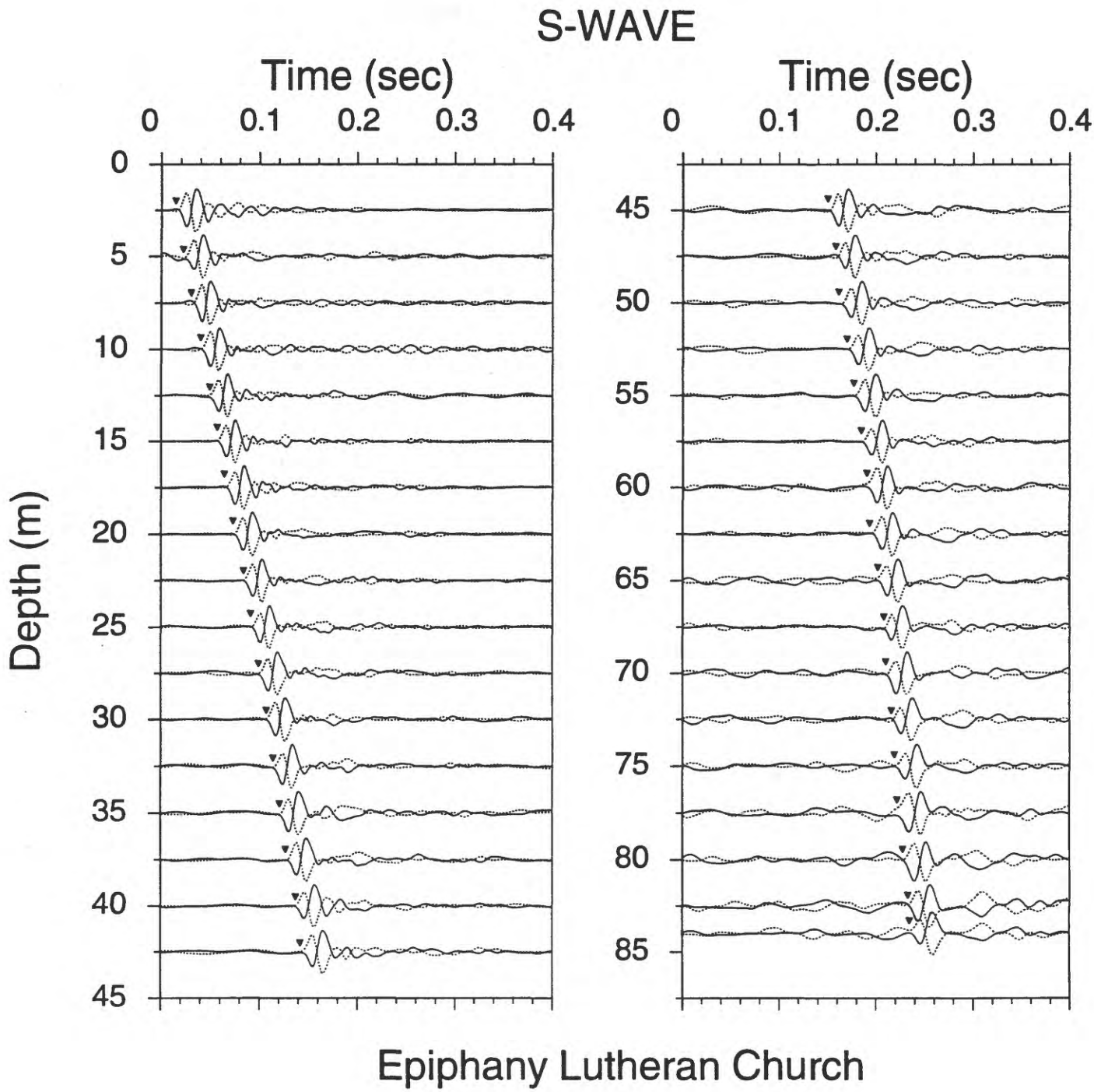

Figure 11. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

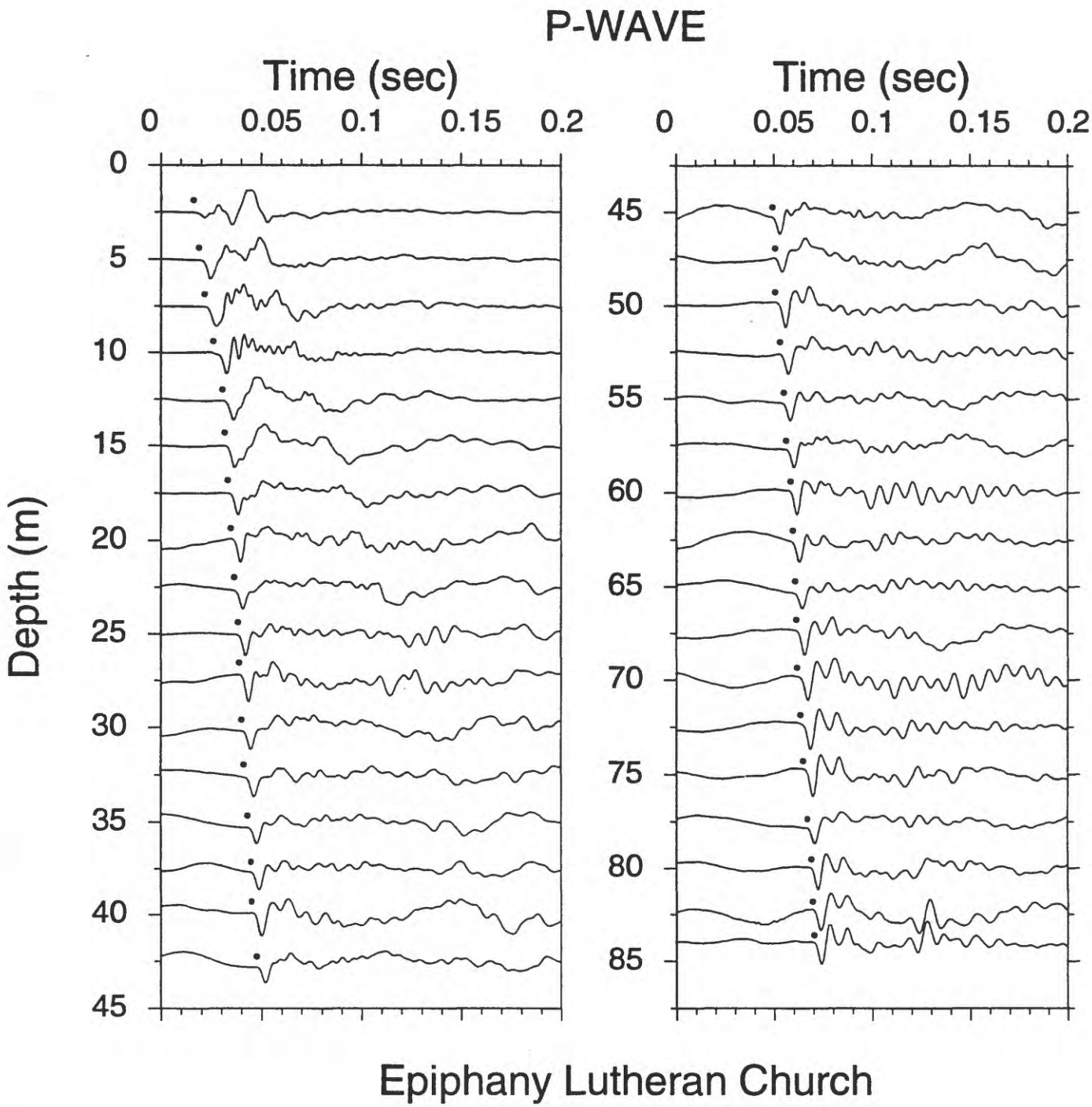

Figure 12. Vertical component record section. P-wave arrivals are indicated by the solid circles.

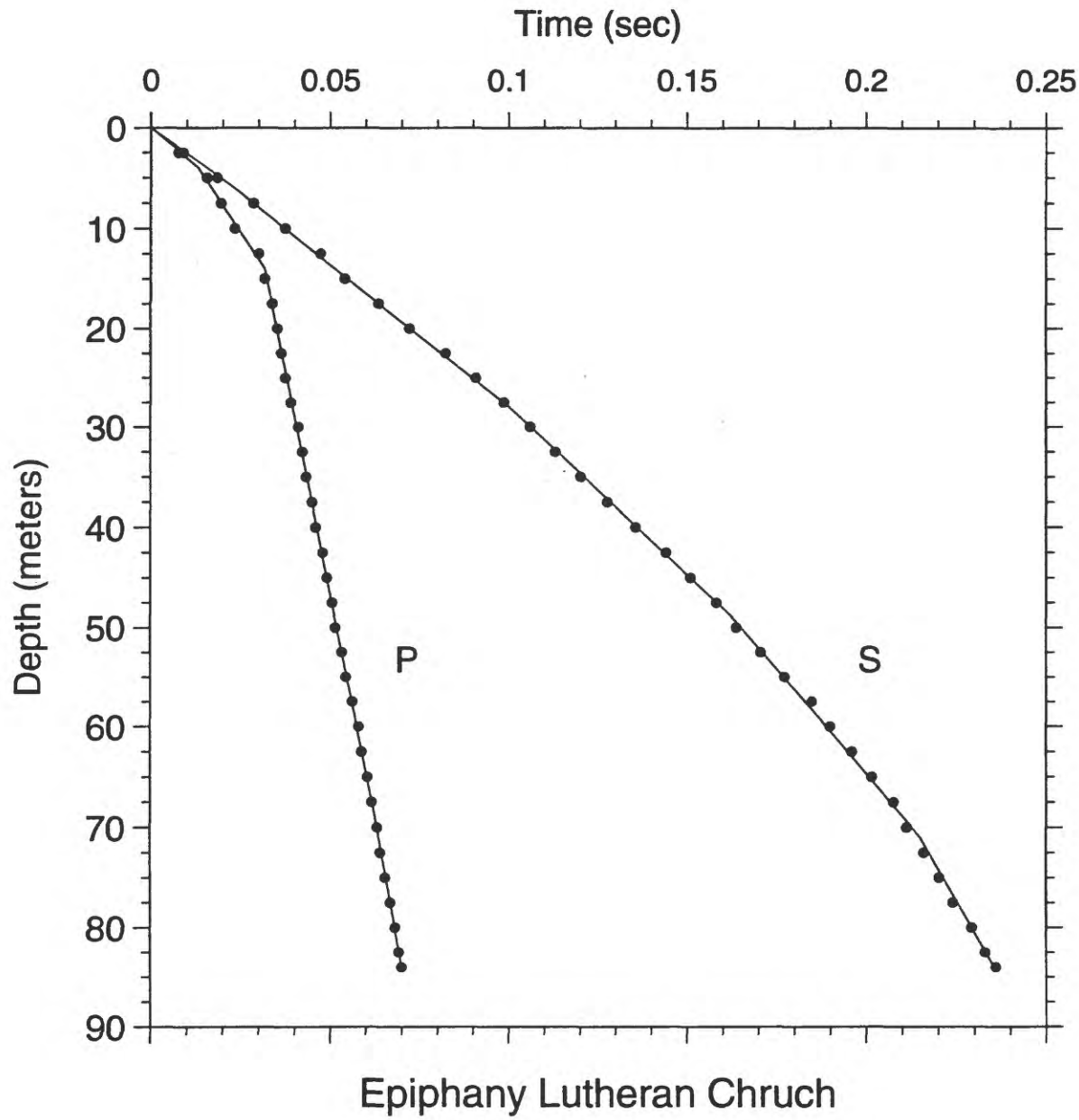

Figure 13. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

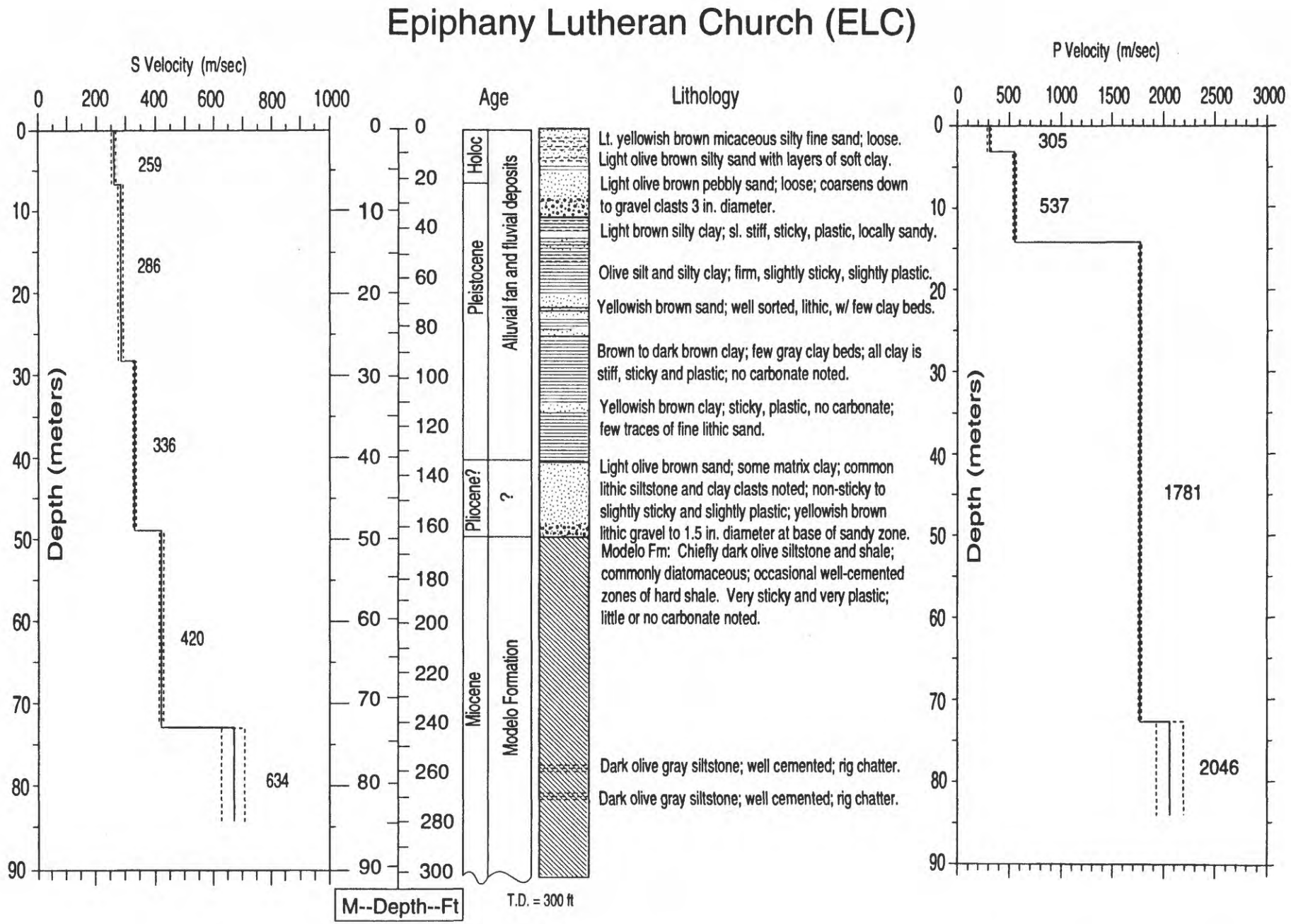

Figure 14. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 2. S-wave arrival times and velocity summaries for the Epiphany Lutheran Church site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0090	1	-.7
5.0	16.4	.0184	1	-.9
7.5	24.6	.0286	1	.0
10.0	32.8	.0375	1	.2
12.5	41.0	.0473	1	1.2
15.0	49.2	.0541	1	-.7
17.5	57.4	.0636	1	.0
20.0	65.6	.0722	1	-.1
22.5	73.8	.0823	1	1.2
25.0	82.0	.0908	1	1.0
27.5	90.2	.0986	1	.0
30.0	98.4	.1061	1	-.2
32.5	106.6	.1131	1	-.6
35.0	114.8	.1202	1	-1.0
37.5	123.0	.1277	1	-.9
40.0	131.2	.1357	1	-.4
42.5	139.4	.1442	1	.7
45.0	147.6	.1510	1	.0
47.5	155.8	.1582	1	-.2
50.0	164.0	.1639	1	-1.3
52.5	172.2	.1707	1	-.4
55.0	180.4	.1773	1	.2
57.5	188.6	.1848	1	1.8
60.0	196.9	.1900	1	1.0
62.5	205.1	.1960	1	1.1
65.0	213.3	.2016	1	.7
67.5	221.5	.2076	1	.8
70.0	229.7	.2113	1	-1.5
72.5	237.9	.2161	1	-1.4
75.0	246.1	.2203	2	-.6
77.5	254.3	.2241	2	-.6
80.0	262.5	.2293	2	.0
82.5	270.7	.2331	2	-.1
84.0	275.6	.2361	1	.5

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
6.4	6.4	259	254	264	21.0	21.0	849	832	866	.025
28.0	21.6	286	283	289	91.9	70.9	938	929	947	.100
48.8	20.8	336	332	339	160.1	68.2	1101	1090	1112	.162
71.0	22.2	420	415	426	232.9	72.8	1379	1361	1397	.215
84.0	13.0	634	607	664	275.6	42.7	2081	1991	2179	.236

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 3. P-wave arrival times and velocity summaries for the Epiphany Lutheran Church site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0076	1	-.6
5.0	16.4	.0156	1	.6
7.5	24.6	.0196	1	.0
10.0	32.8	.0234	1	-.9
12.5	41.0	.0301	1	1.2
15.0	49.2	.0317	1	-.6
17.5	57.4	.0339	1	.2
20.0	65.6	.0353	1	.2
22.5	73.8	.0364	1	-.1
25.0	82.0	.0375	1	-.4
27.5	90.2	.0390	1	-.3
30.0	98.4	.0412	1	.5
32.5	106.6	.0423	1	.2
35.0	114.8	.0433	1	-.2
37.5	123.0	.0449	1	.0
40.0	131.2	.0460	1	-.3
42.5	139.4	.0480	1	.3
45.0	147.6	.0492	1	.1
47.5	155.8	.0506	1	.1
50.0	164.0	.0516	1	-.3
52.5	172.2	.0534	1	.1
55.0	180.4	.0545	1	-.2
57.5	188.6	.0563	1	.2
60.0	196.9	.0581	1	.5
62.5	205.1	.0589	1	-.1
65.0	213.3	.0605	1	.1
67.5	221.5	.0617	1	-.1
70.0	229.7	.0633	1	.1
72.5	237.9	.0641	1	-.4
75.0	246.1	.0655	1	-.2
77.5	254.3	.0669	1	.0
80.0	262.5	.0683	1	.2
82.5	270.7	.0693	1	.0
84.0	275.6	.0701	1	.0

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
4.0	4.0	305	298	312	13.1	13.1	1001	978	1025	.013
14.0	10.0	537	527	548	45.9	32.8	1762	1729	1798	.032
71.0	57.0	1781	1767	1795	232.9	187.0	5844	5798	5890	.064
84.0	13.0	2046	1949	2154	275.6	42.7	6714	6394	7066	.070

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

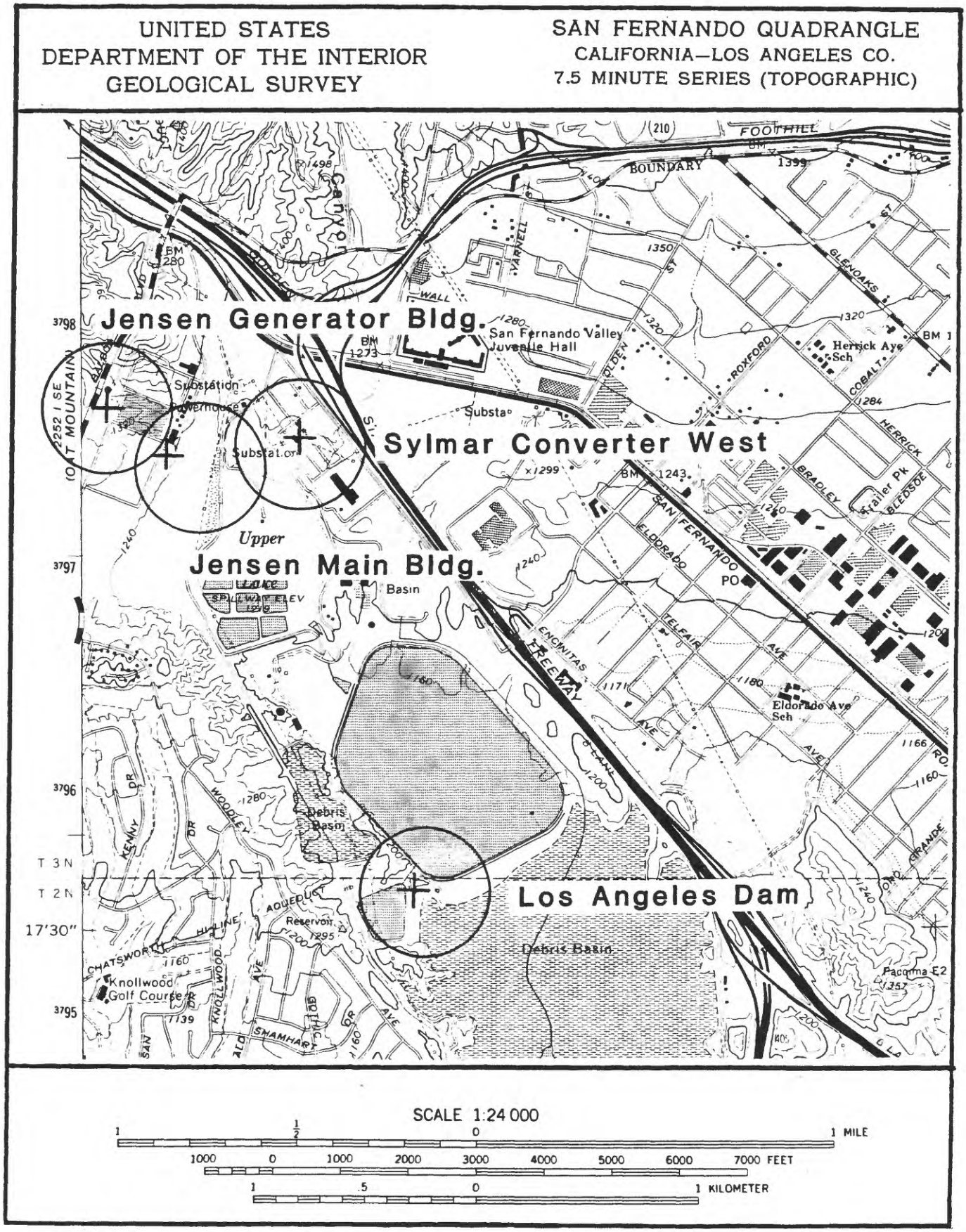

Figure 15. Site location map for the borehole at Jensen Generator Building. The accelerograph is located approximately 25 meters from the borehole.

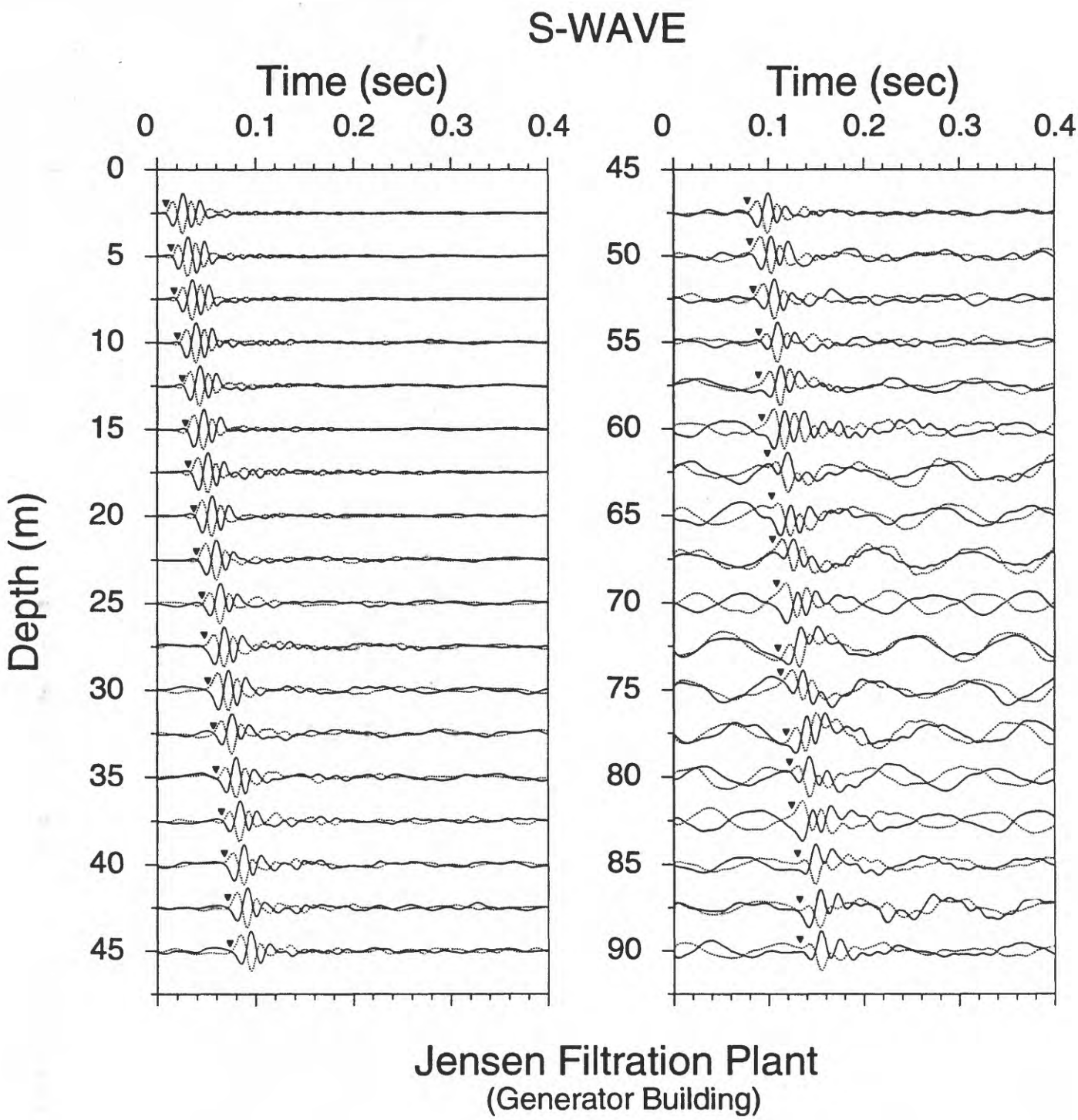

Figure 16. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

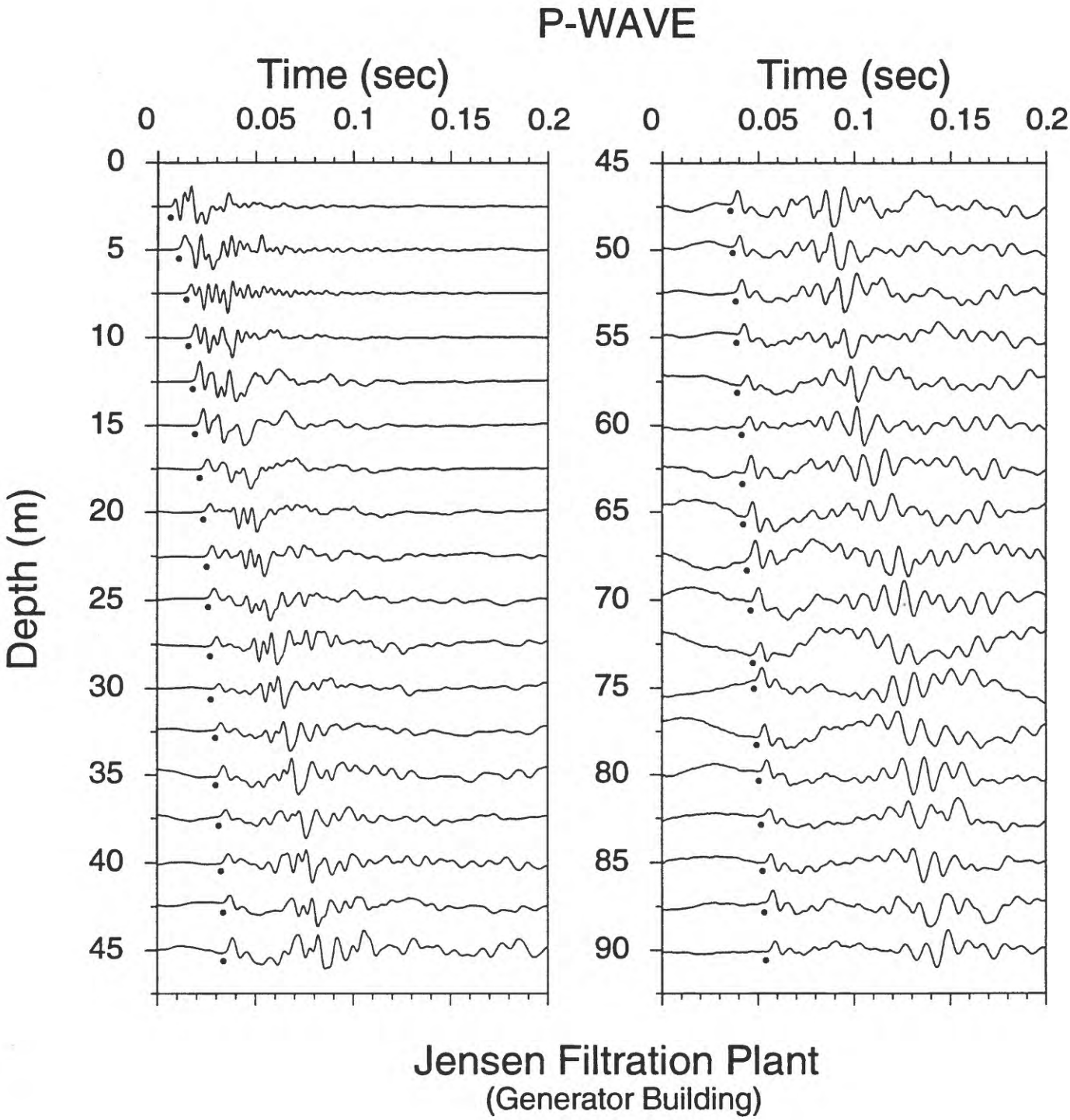

Figure 17. Vertical component record section. P-wave arrivals are indicated by the solid circles.

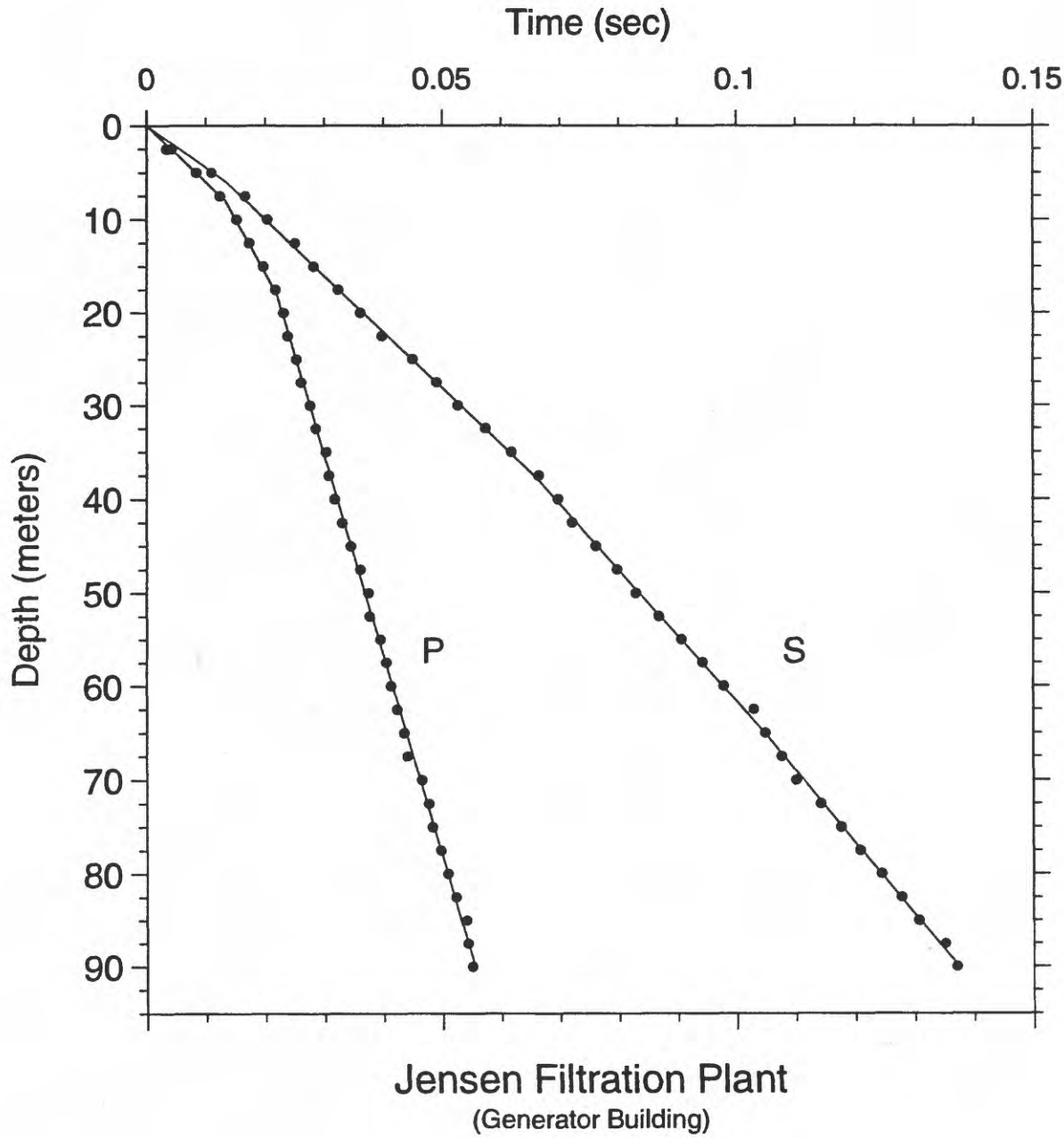

Figure 18. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

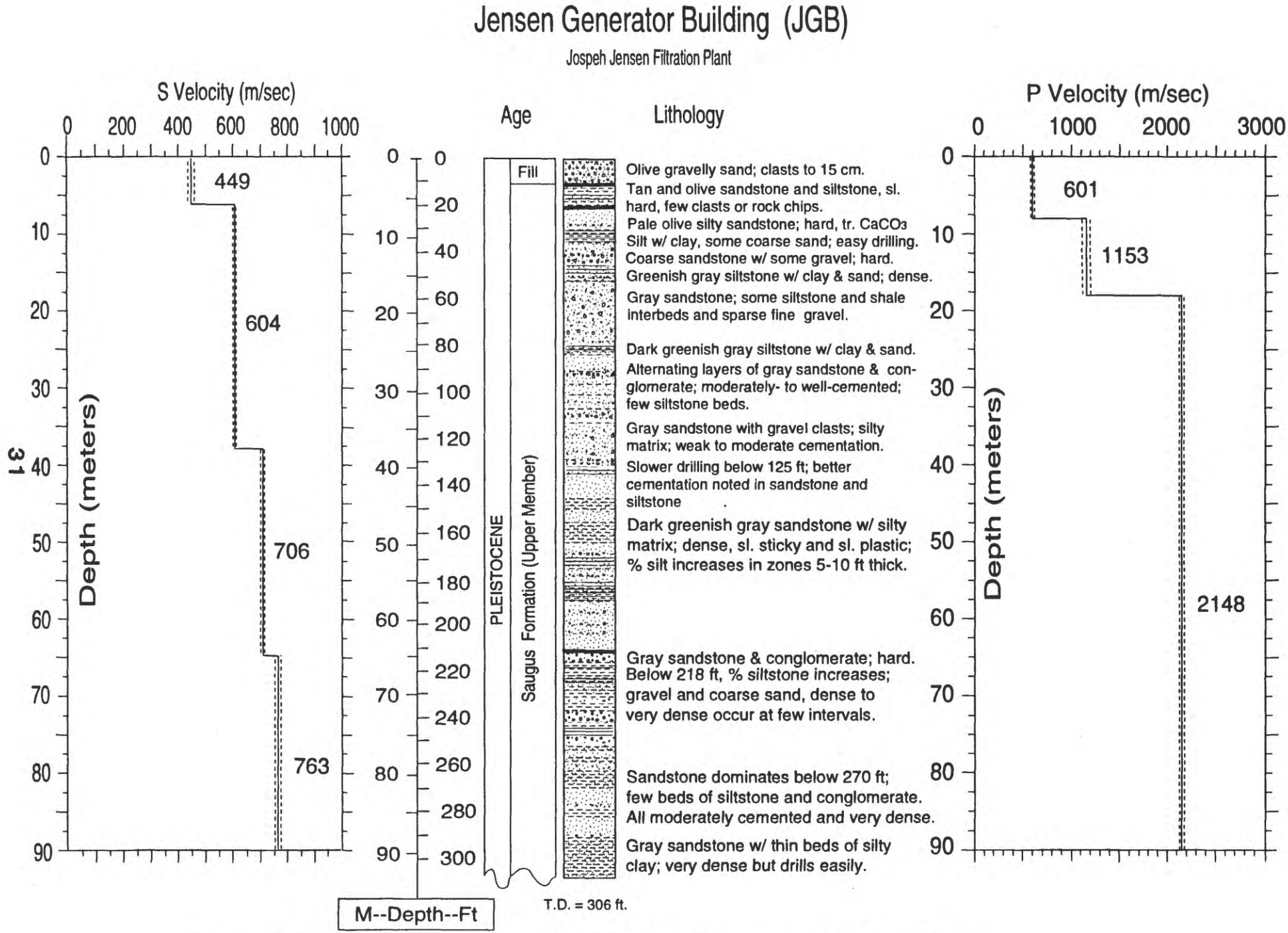

Figure 19. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 4. S-wave arrival times and velocity summaries for the Jensen Generator Building site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0042	1	-1.4
5.0	16.4	.0109	1	-.2
7.5	24.6	.0166	1	.7
10.0	32.8	.0204	1	.4
12.5	41.0	.0250	1	.8
15.0	49.2	.0282	1	-.1
17.5	57.4	.0324	1	-.1
20.0	65.6	.0361	1	-.5
22.5	73.8	.0398	1	-.9
25.0	82.0	.0450	1	.1
27.5	90.2	.0491	1	.1
30.0	98.4	.0527	1	-.5
32.5	106.6	.0574	1	.1
35.0	114.8	.0618	1	.4
37.5	123.0	.0664	1	.8
40.0	131.2	.0697	1	.5
42.5	139.4	.0721	1	-.7
45.0	147.6	.0761	1	-.2
47.5	155.8	.0797	1	-.2
50.0	164.0	.0829	1	-.5
52.5	172.2	.0868	1	-.1
55.0	180.4	.0906	1	.1
57.5	188.6	.0942	1	.2
60.0	196.9	.0978	1	.2
62.5	205.1	.1028	1	1.7
65.0	213.3	.1048	1	.1
67.5	221.5	.1076	1	-.3
70.0	229.7	.1100	1	-1.2
72.5	237.9	.1142	1	-.3
75.0	246.1	.1176	1	-.2
77.5	254.3	.1208	1	-.2
80.0	262.5	.1244	1	.1
82.5	270.7	.1278	1	.2
85.0	278.9	.1307	1	-.2
87.5	287.1	.1351	1	.9
90.0	295.3	.1371	1	-.3

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
6.1	6.1	449	439	459
38.0	31.9	604	599	609
65.0	27.0	706	699	713
90.0	25.0	763	752	774

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
20.0	20.0	1472	1441	1505	.014
124.7	104.7	1982	1965	1999	.066
213.3	88.6	2316	2292	2340	.105
295.3	82.0	2502	2466	2540	.137

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 5. P-wave arrival times and velocity summaries for the Jensen Generator Building site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0033	1	-.9
5.0	16.4	.0084	1	.1
7.5	24.6	.0124	1	-.1
10.0	32.8	.0152	1	.2
12.5	41.0	.0173	1	.1
15.0	49.2	.0197	1	.3
17.5	57.4	.0218	1	.3
20.0	65.6	.0231	1	.2
22.5	73.8	.0238	1	-.3
25.0	82.0	.0253	1	.1
27.5	90.2	.0261	1	-.3
30.0	98.4	.0276	1	.0
32.5	106.6	.0286	1	-.1
35.0	114.8	.0304	1	.5
37.5	123.0	.0308	1	-.3
40.0	131.2	.0318	1	-.4
42.5	139.4	.0331	1	-.3
45.0	147.6	.0345	1	-.1
47.5	155.8	.0361	1	.4
50.0	164.0	.0375	1	.6
52.5	172.2	.0377	1	-.3
55.0	180.4	.0395	1	.3
57.5	188.6	.0405	1	.1
60.0	196.9	.0413	1	-.2
62.5	205.1	.0423	1	-.4
65.0	213.3	.0435	1	-.4
67.5	221.5	.0441	1	-.9
70.0	229.7	.0465	1	.3
72.5	237.9	.0477	1	.3
75.0	246.1	.0483	1	-.2
77.5	254.3	.0497	1	.0
80.0	262.5	.0509	1	.1
82.5	270.7	.0523	1	.3
85.0	278.9	.0541	1	.9
87.5	287.1	.0543	1	.0
90.0	295.3	.0551	1	-.4

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
8.0	8.0	601	590	613	26.2	26.2	1973	1935	2011	.013
18.0	10.0	1153	1113	1195	59.1	32.8	3782	3653	3921	.022
90.0	72.0	2148	2133	2163	295.3	236.2	7046	6998	7096	.056

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

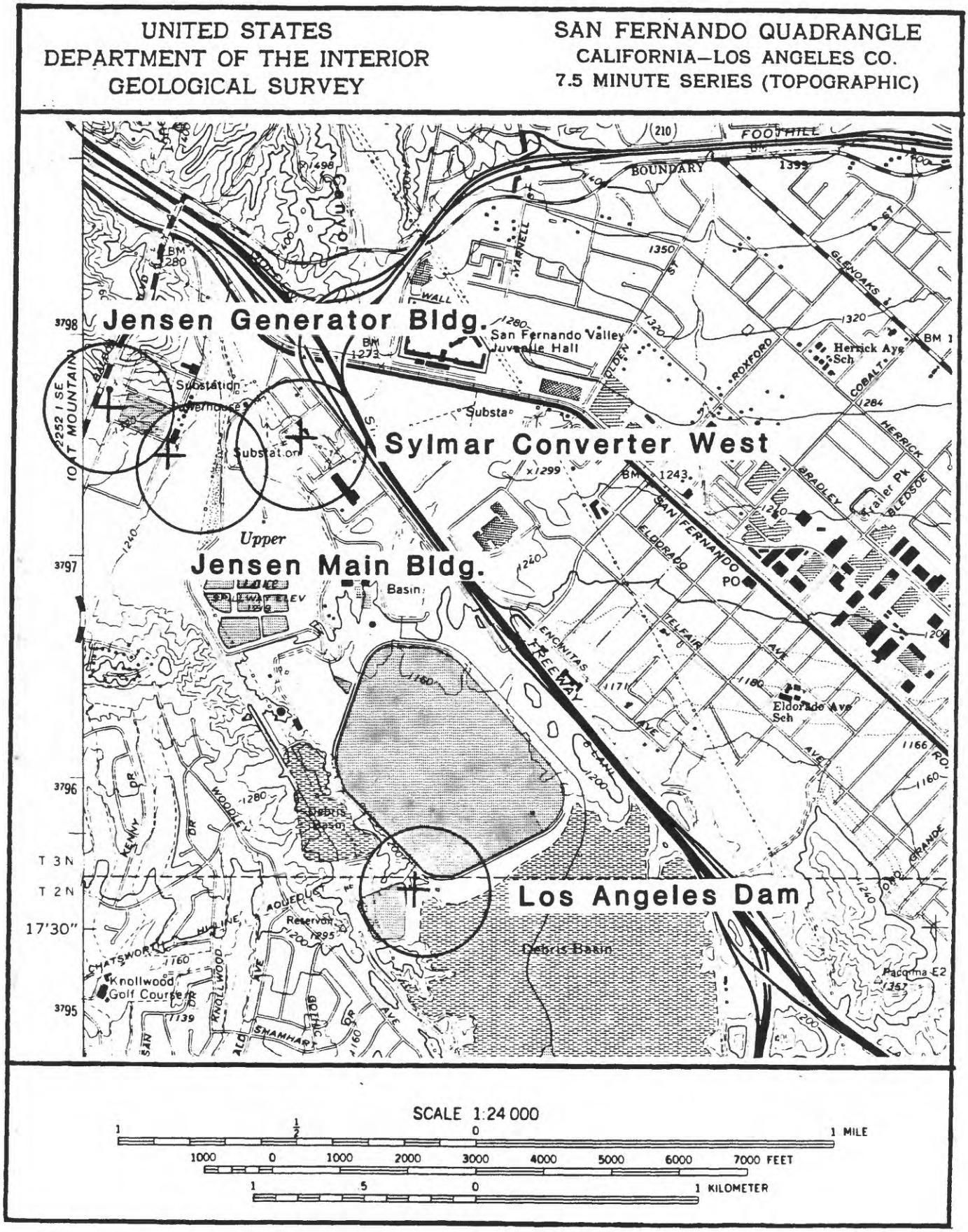

Figure 20. Site location map for the borehole at Jensen Main Building. The accelerograph is located approximately 40 meters from the borehole.

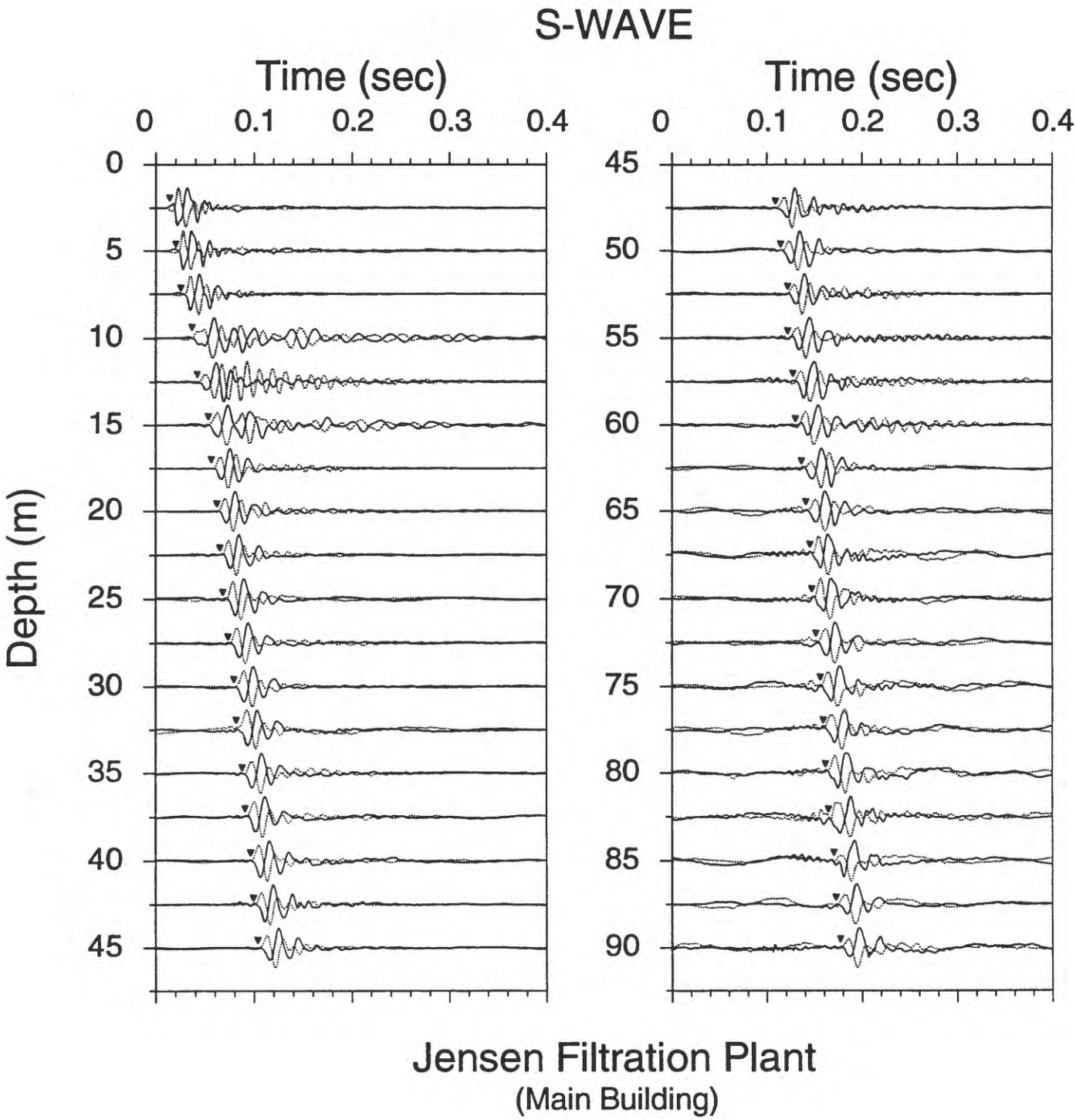

Figure 21. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

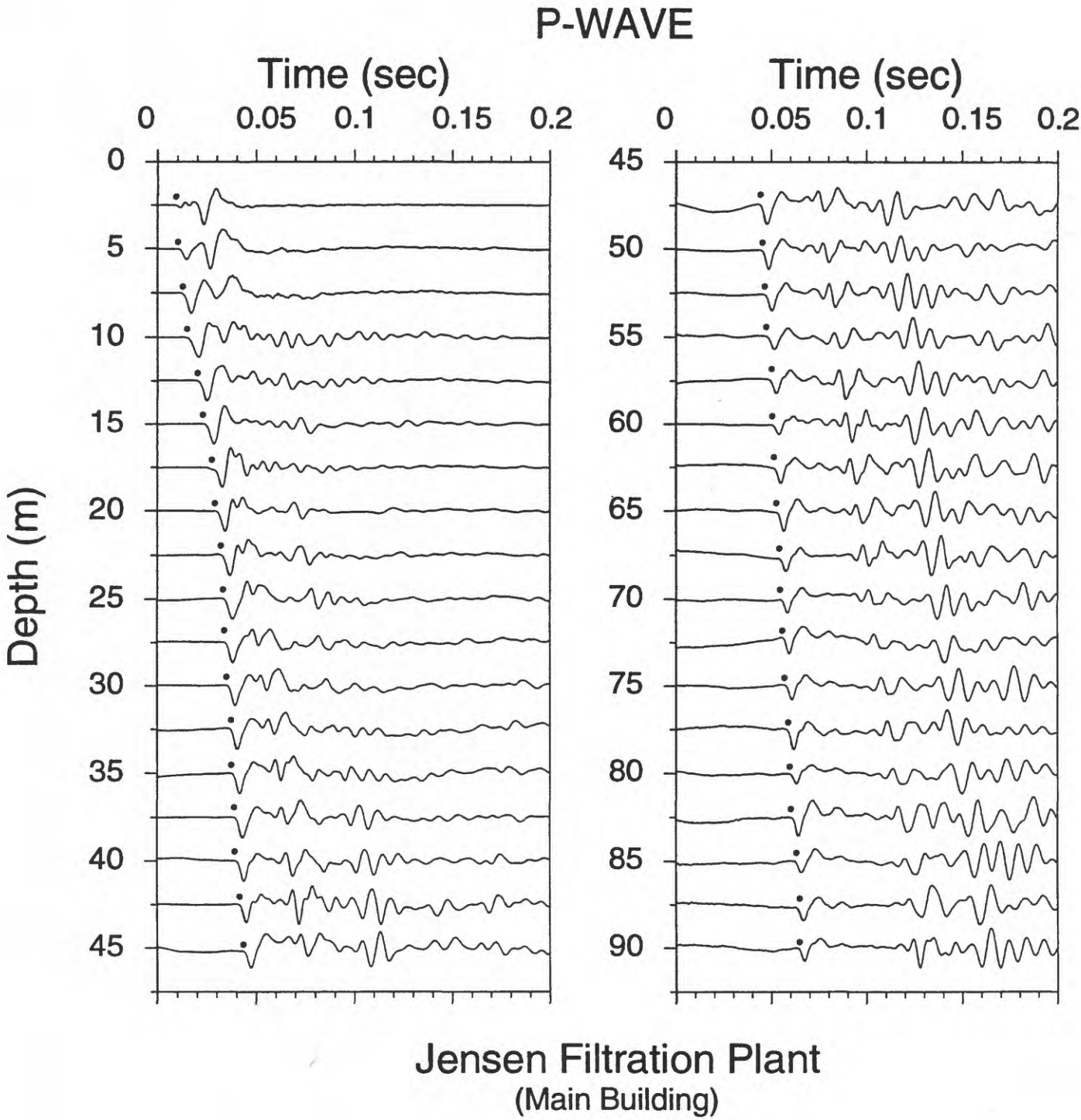

Figure 22. Vertical component record section. P-wave arrivals are indicated by the solid circles.

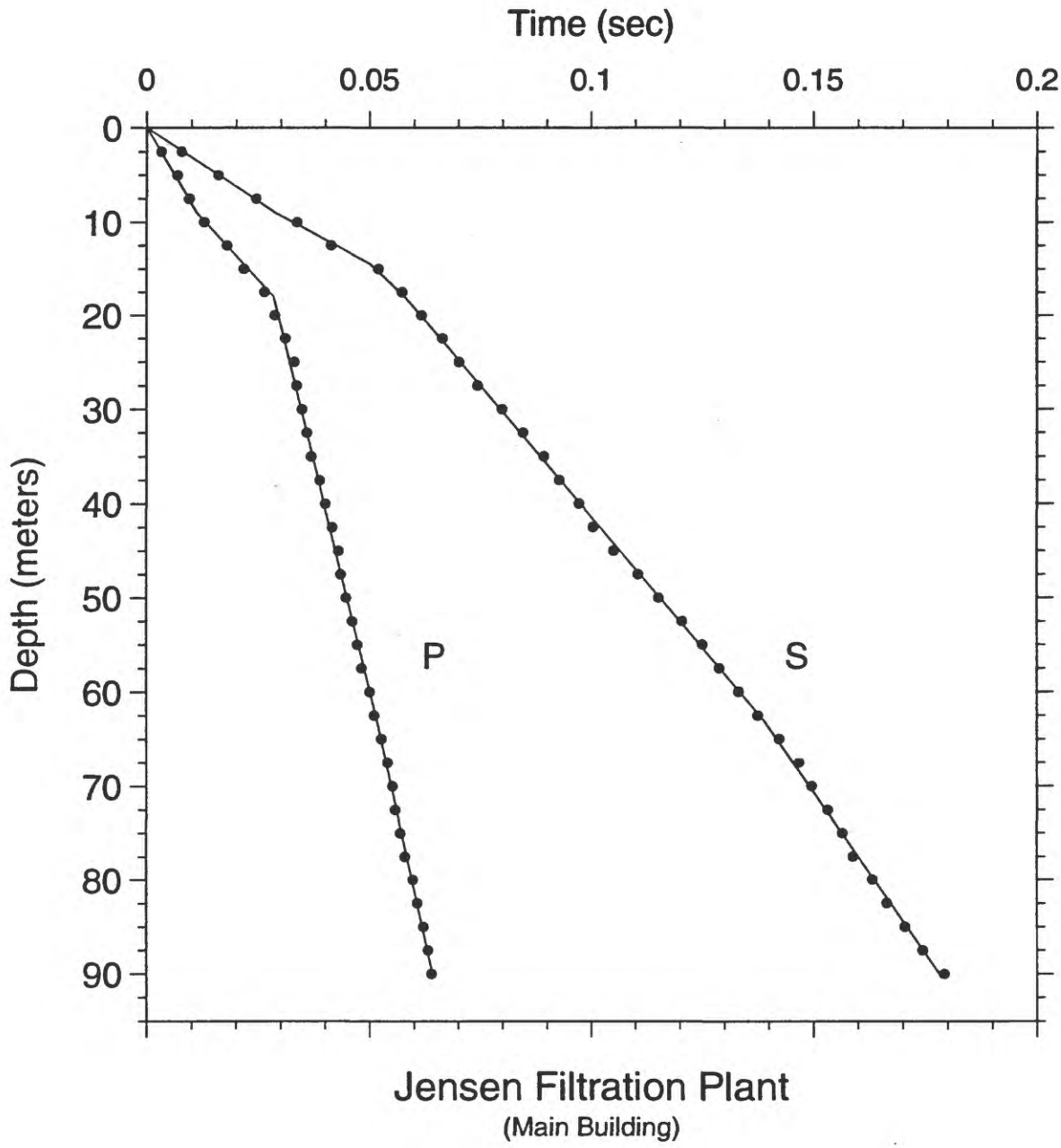

Figure 23. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

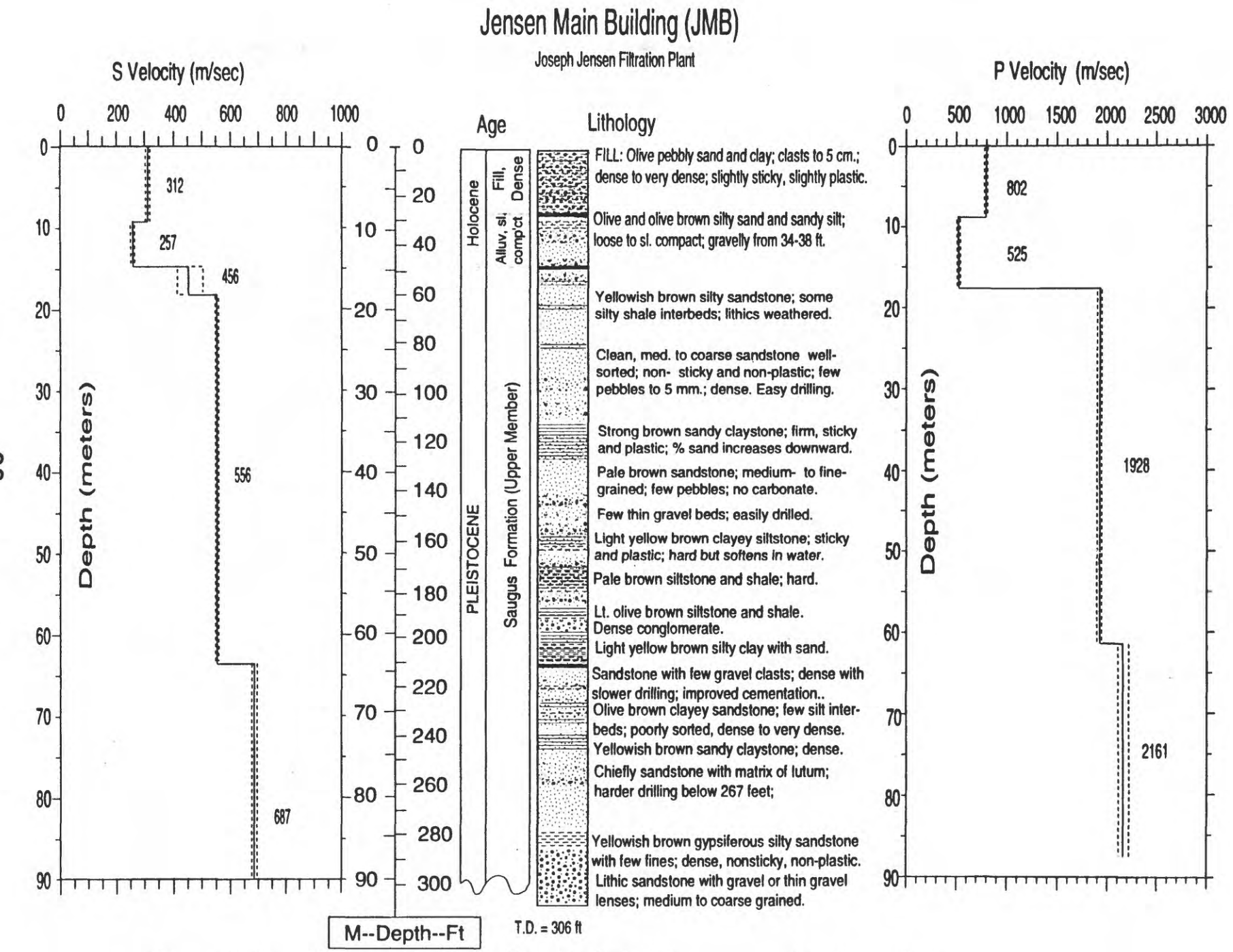

Figure 24. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 6. S-wave arrival times and velocity summaries for the Jensen Main Building site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0077	1	-.3
5.0	16.4	.0159	1	-.1
7.5	24.6	.0245	1	.4
10.0	32.8	.0337	2	.5
12.5	41.0	.0414	1	-1.1
15.0	49.2	.0520	1	.7
17.5	57.4	.0573	1	.5
20.0	65.6	.0617	1	.2
22.5	73.8	.0664	1	.4
25.0	82.0	.0702	1	-.3
27.5	90.2	.0744	1	-.6
30.0	98.4	.0799	1	.4
32.5	106.6	.0846	1	.6
35.0	114.8	.0893	1	.8
37.5	123.0	.0928	1	-.2
40.0	131.2	.0972	1	-.3
42.5	139.4	.1005	1	-1.5
45.0	147.6	.1051	1	-1.4
47.5	155.8	.1106	1	-.4
50.0	164.0	.1152	1	-.3
52.5	172.2	.1205	1	.5
55.0	180.4	.1251	1	.6
57.5	188.6	.1289	1	-.1
60.0	196.9	.1333	1	-.2
62.5	205.1	.1376	1	-.4
65.0	213.3	.1424	1	.6
67.5	221.5	.1468	1	1.4
70.0	229.7	.1496	1	.5
72.5	237.9	.1532	1	.5
75.0	246.1	.1565	1	.1
77.5	254.3	.1589	1	-1.1
80.0	262.5	.1633	1	-.3
82.5	270.7	.1665	1	-.8
85.0	278.9	.1705	1	-.4
87.5	287.1	.1745	1	-.1
90.0	295.3	.1793	1	1.1

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
9.0	9.0	312	305	319
14.5	5.5	257	246	270
18.0	3.5	456	415	507
63.0	45.0	556	553	559
90.0	27.0	687	678	696

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
29.5	29.5	1023	1001	1045	.029
47.6	18.0	845	807	886	.050
59.1	11.5	1497	1361	1664	.058
206.7	147.6	1823	1813	1834	.139
295.3	88.6	2253	2224	2283	.178

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 7. P-wave arrival times and velocity summaries for the Jensen Main Building site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0032	1	.1
5.0	16.4	.0068	1	.6
7.5	24.6	.0095	1	.2
10.0	32.8	.0129	1	-.2
12.5	41.0	.0180	1	.1
15.0	49.2	.0218	1	-.9
17.5	57.4	.0264	1	-1.0
20.0	65.6	.0287	1	-.7
22.5	73.8	.0311	1	.4
25.0	82.0	.0331	1	1.1
27.5	90.2	.0336	1	.3
30.0	98.4	.0348	1	.2
32.5	106.6	.0359	1	.0
35.0	114.8	.0369	1	-.3
37.5	123.0	.0388	1	.3
40.0	131.2	.0401	1	.3
42.5	139.4	.0417	1	.6
45.0	147.6	.0431	1	.7
47.5	155.8	.0436	1	-.1
50.0	164.0	.0448	1	-.2
52.5	172.2	.0462	1	-.1
55.0	180.4	.0473	1	-.3
57.5	188.6	.0483	1	-.6
60.0	196.9	.0501	1	-.1
62.5	205.1	.0511	1	-.4
65.0	213.3	.0527	1	.1
67.5	221.5	.0541	1	.3
70.0	229.7	.0552	1	.2
72.5	237.9	.0558	1	-.3
75.0	246.1	.0570	1	-.3
77.5	254.3	.0580	1	-.4
80.0	262.5	.0598	1	.2
82.5	270.7	.0608	1	.1
85.0	278.9	.0622	1	.3
87.5	287.1	.0632	1	.1
90.0	295.3	.0640	1	-.2

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
9.0	9.0	802	782	825	29.5	29.5	2633	2564	2705	.011
18.0	9.0	525	513	536	59.1	29.5	1721	1684	1760	.028
63.0	45.0	1928	1904	1952	206.7	147.6	6324	6246	6404	.052
90.0	27.0	2161	2106	2219	295.3	88.6	7089	6908	7279	.064

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

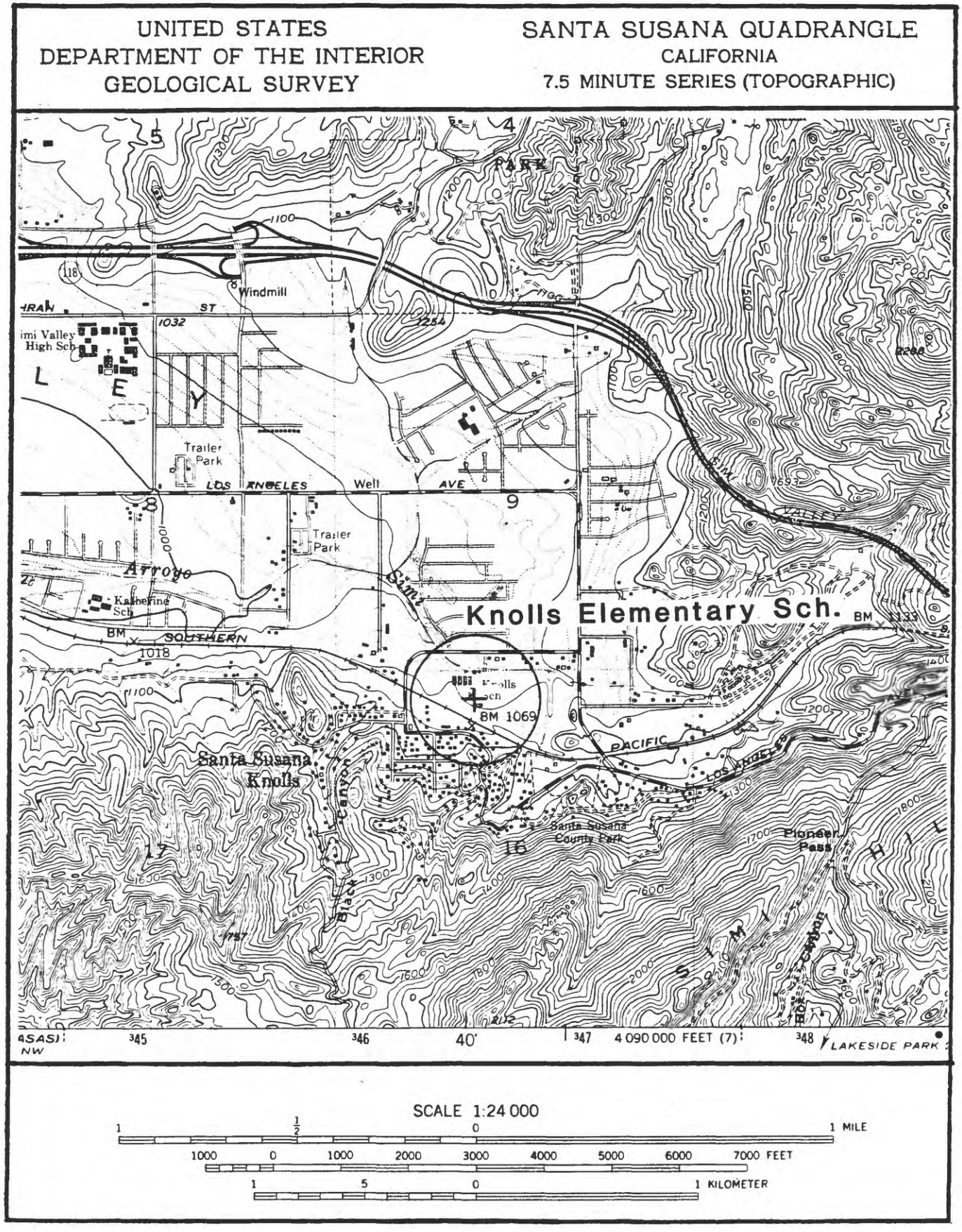

Figure 25. Site location map for the borehole at Knolls Elementary School. The accelerograph is located approximately 25 meters from the borehole.

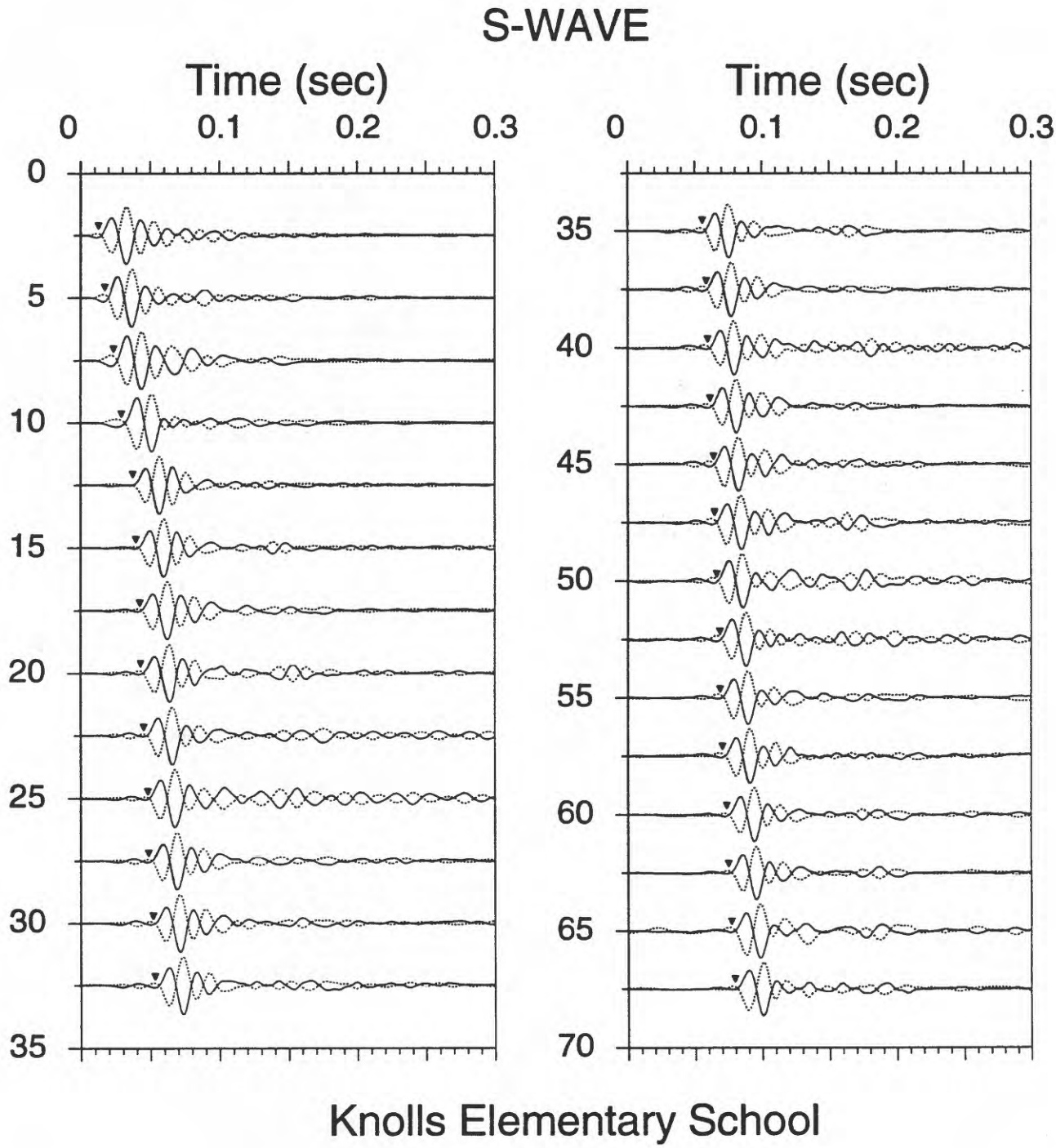

Figure 26. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

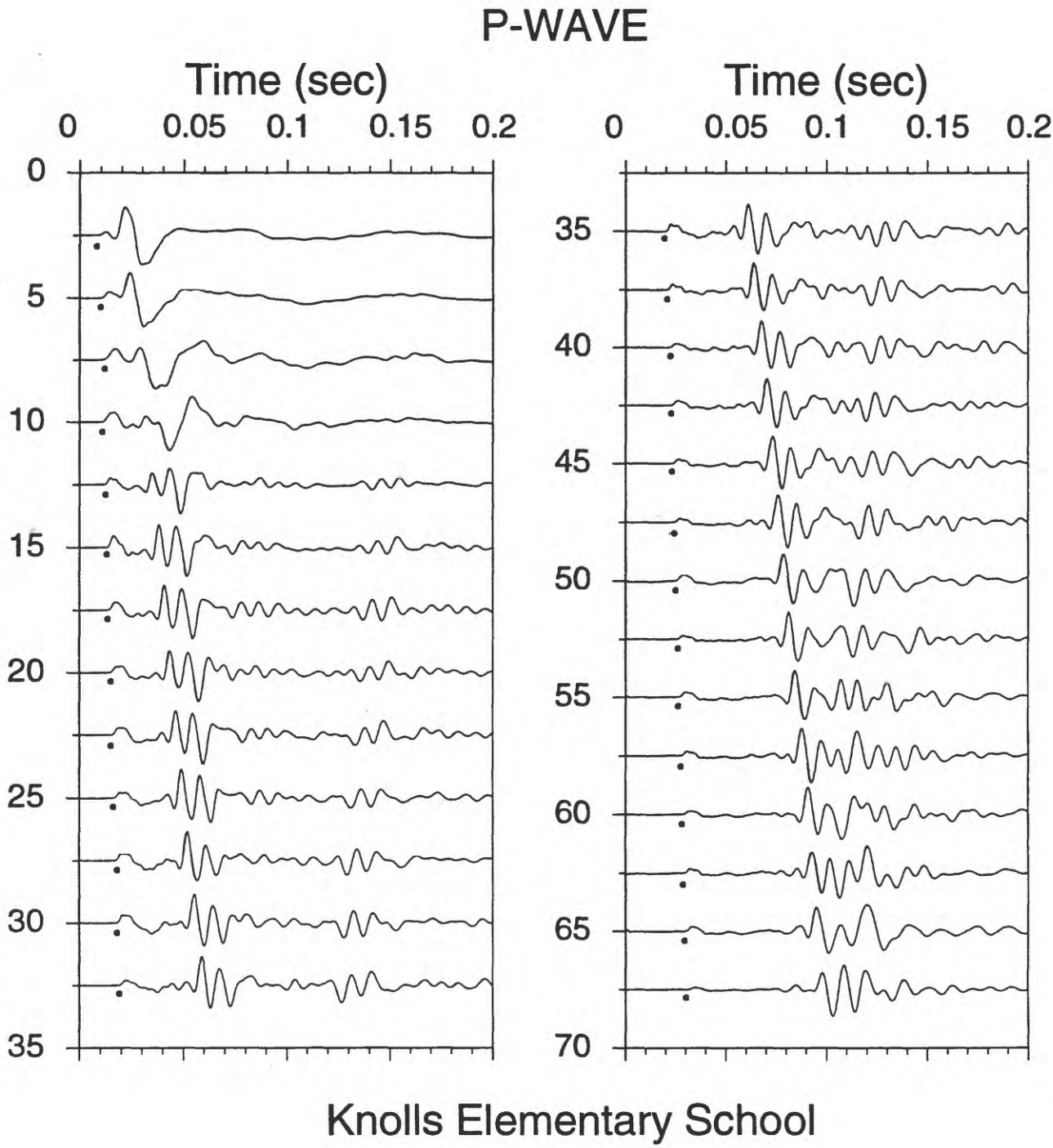

Figure 27. Vertical component record section. P-wave arrivals are indicated by the solid circles.

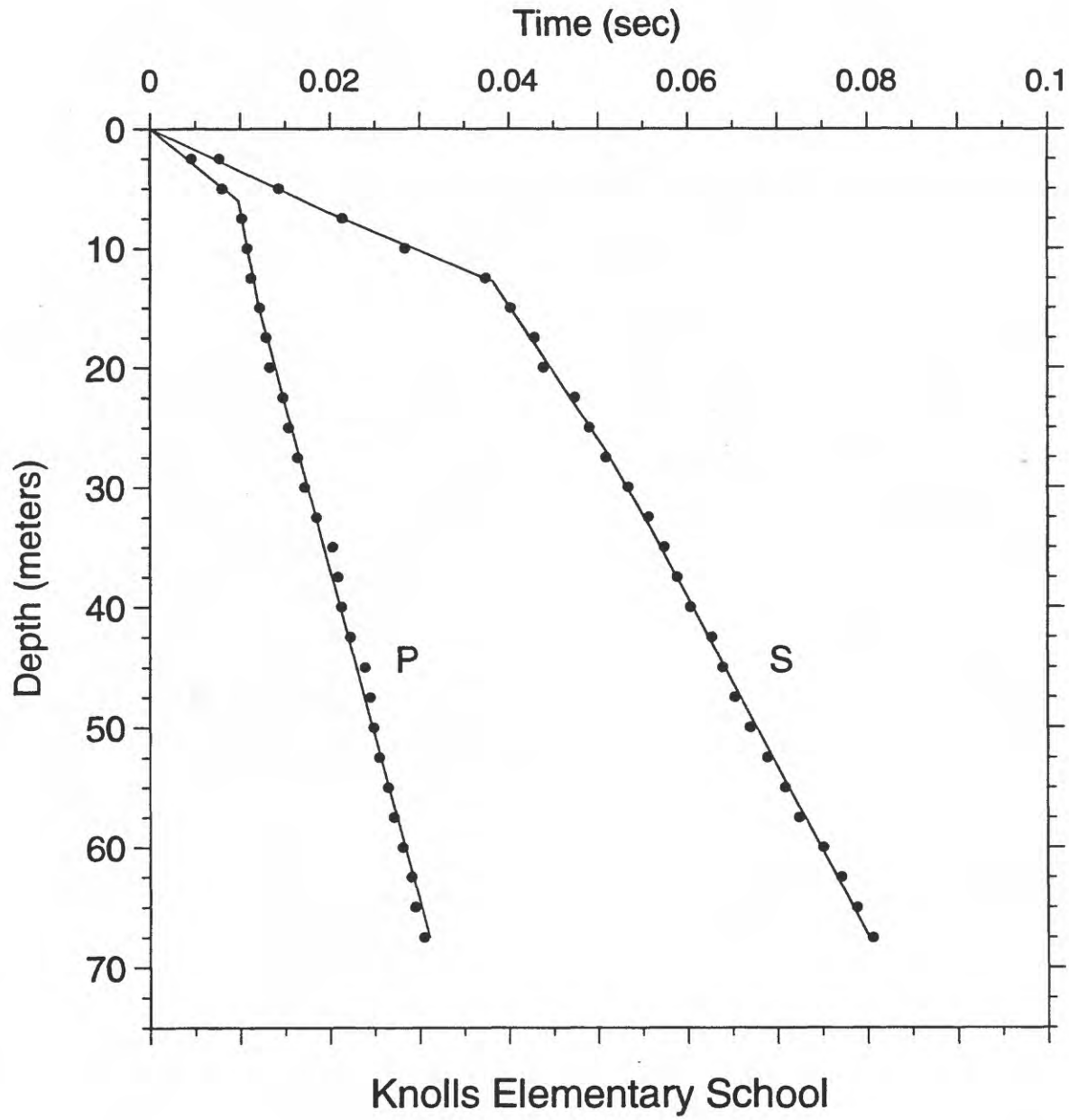

Figure 28. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

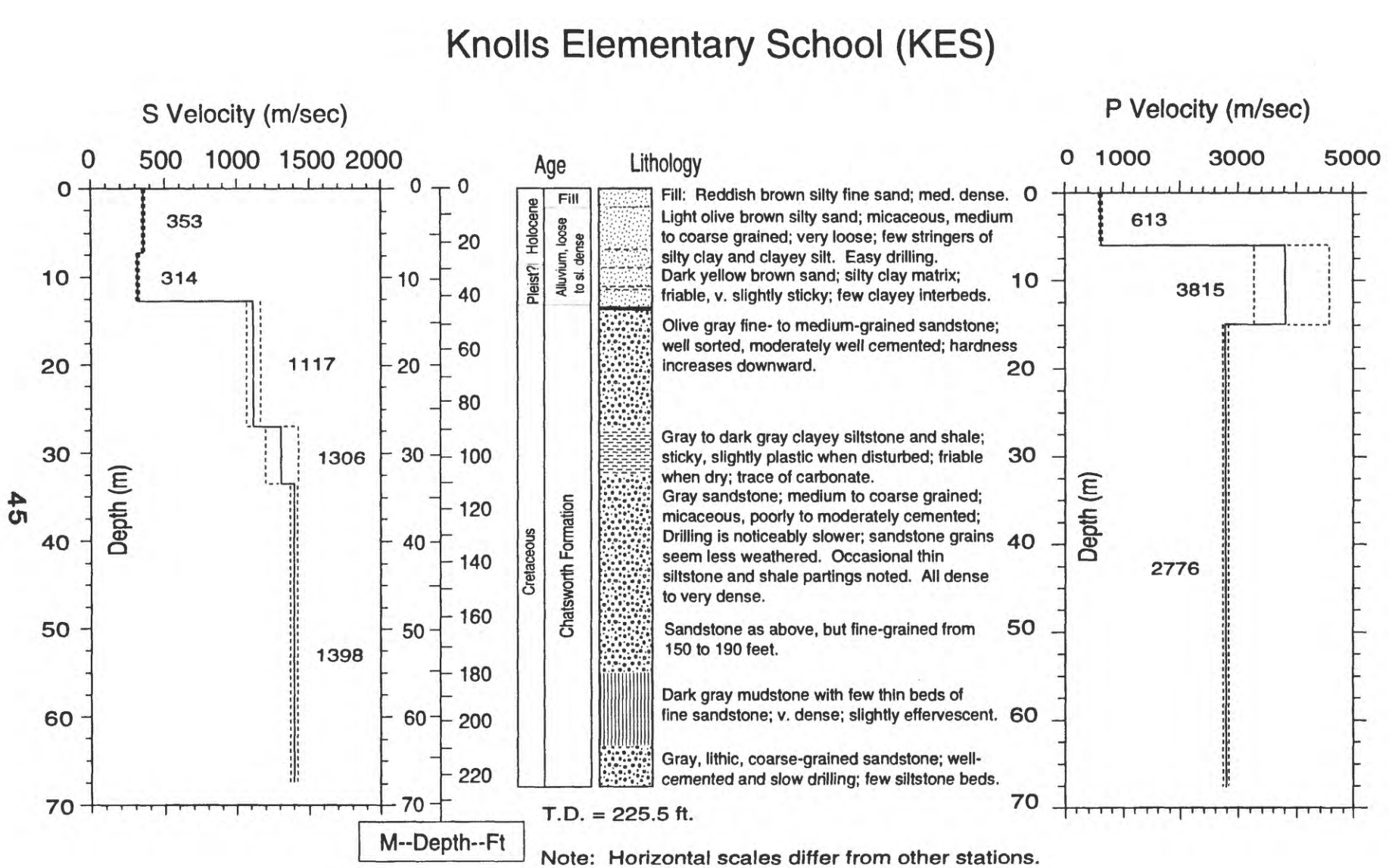

Figure 29. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 8. S-wave arrival times and velocity summaries for the Knolls Elementary School site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0077	1	.6
5.0	16.4	.0143	1	.2
7.5	24.6	.0214	1	.1
10.0	32.8	.0284	1	-.8
12.5	41.0	.0374	1	.2
15.0	49.2	.0402	1	.1
17.5	57.4	.0429	1	.5
20.0	65.6	.0439	1	-.7
22.5	73.8	.0474	1	.6
25.0	82.0	.0490	1	-.1
27.5	90.2	.0509	1	-.4
30.0	98.4	.0534	1	.2
32.5	106.6	.0556	1	.5
35.0	114.8	.0574	1	.5
37.5	123.0	.0588	1	.1
40.0	131.2	.0603	1	-.2
42.5	139.4	.0627	1	.4
45.0	147.6	.0639	1	-.2
47.5	155.8	.0653	1	-.6
50.0	164.0	.0670	1	-.7
52.5	172.2	.0689	1	-.5
55.0	180.4	.0709	1	-.3
57.5	188.6	.0724	1	-.6
60.0	196.9	.0751	1	.3
62.5	205.1	.0771	1	.5
65.0	213.3	.0788	1	.4
67.5	221.5	.0806	1	.4

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
7.3	7.3	353	347	360
12.8	5.5	314	305	324
27.0	14.2	1117	1071	1166
33.5	6.5	1306	1202	1429
67.5	34.0	1398	1375	1422

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
24.0	24.0	1159	1139	1181	.021
42.0	18.0	1031	1000	1064	.038
88.6	46.6	3663	3515	3825	.051
109.9	21.3	4284	3944	4687	.056
221.5	111.5	4587	4510	4666	.080

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 9. P-wave arrival times and velocity summaries for the Knolls Elementary School site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0046	1	.5
5.0	16.4	.0080	1	-.2
7.5	24.6	.0102	1	.0
10.0	32.8	.0108	1	.0
12.5	41.0	.0112	1	-.3
15.0	49.2	.0122	1	.1
17.5	57.4	.0129	1	-.1
20.0	65.6	.0133	1	-.6
22.5	73.8	.0148	1	.0
25.0	82.0	.0154	1	-.4
27.5	90.2	.0164	1	-.3
30.0	98.4	.0172	1	-.4
32.5	106.6	.0185	1	.0
35.0	114.8	.0203	1	.9
37.5	123.0	.0209	1	.6
40.0	131.2	.0213	1	.1
42.5	139.4	.0223	1	.2
45.0	147.6	.0239	1	.9
47.5	155.8	.0245	1	.6
50.0	164.0	.0249	1	.1
52.5	172.2	.0255	1	-.2
55.0	180.4	.0265	1	-.1
57.5	188.6	.0271	1	-.4
60.0	196.9	.0281	1	-.3
62.5	205.1	.0291	1	-.2
65.0	213.3	.0295	1	-.7
67.5	221.5	.0305	2	-.3

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
6.0	6.0	613	594	634
15.0	9.0	3815	3275	4568
67.5	52.5	2776	2730	2823

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
19.7	19.7	2011	1948	2079	.010
49.2	29.5	12517	10746	14986	.012
221.5	172.2	9107	8958	9261	.031

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

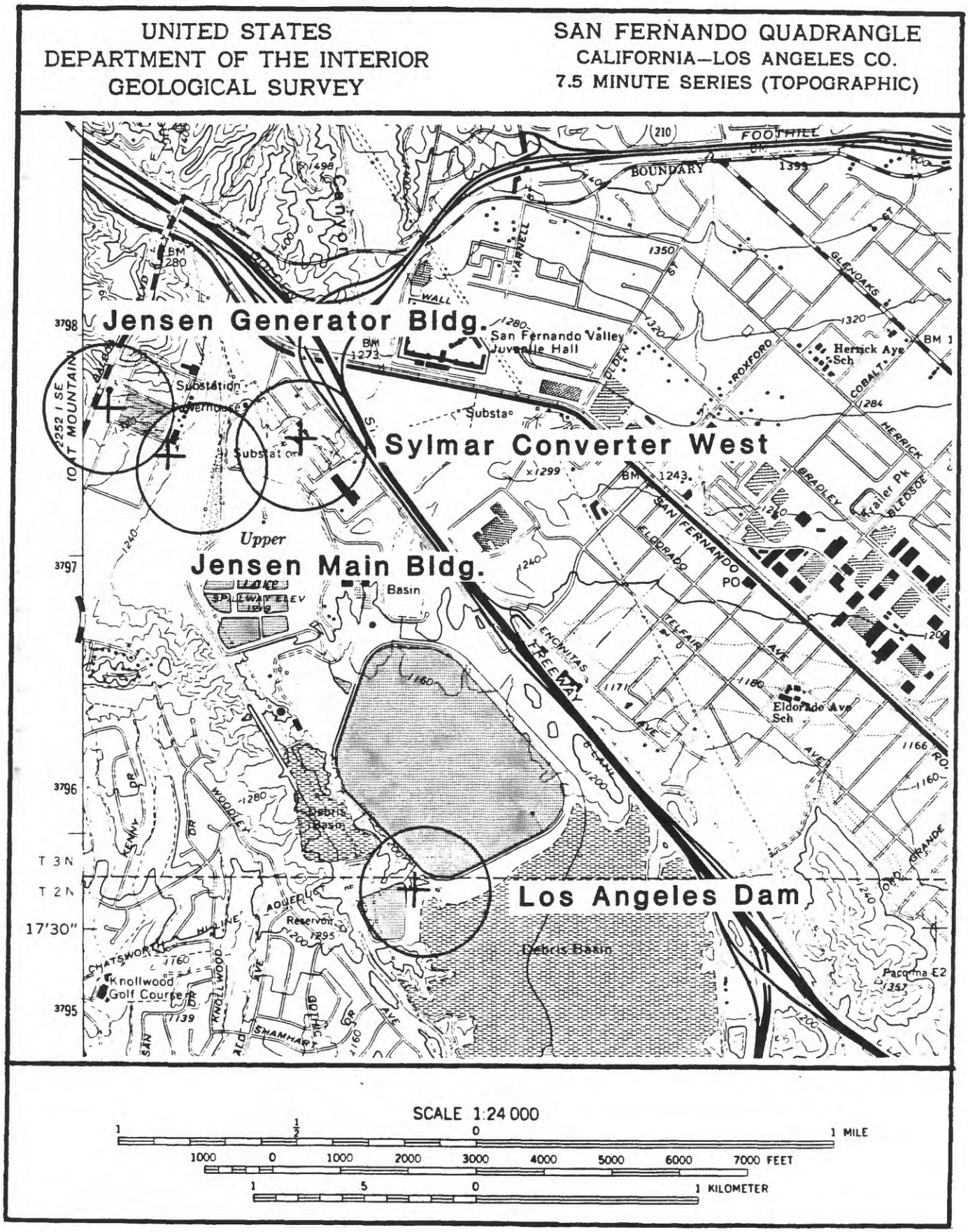

Figure 30. Site location map for the borehole at Los Angeles Dam. The accelerograph is located approximately 35 meters from the borehole.

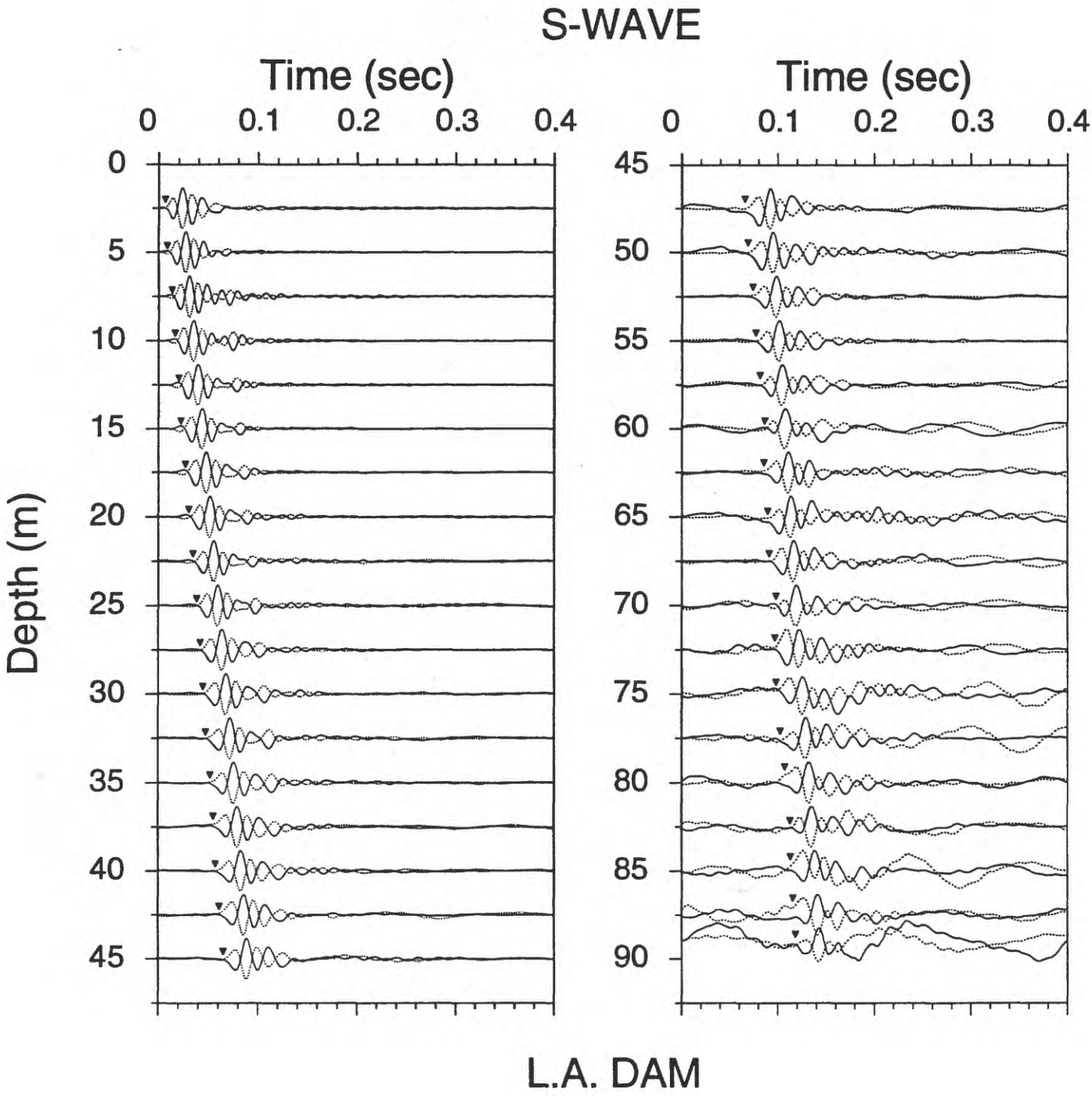

Figure 31. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

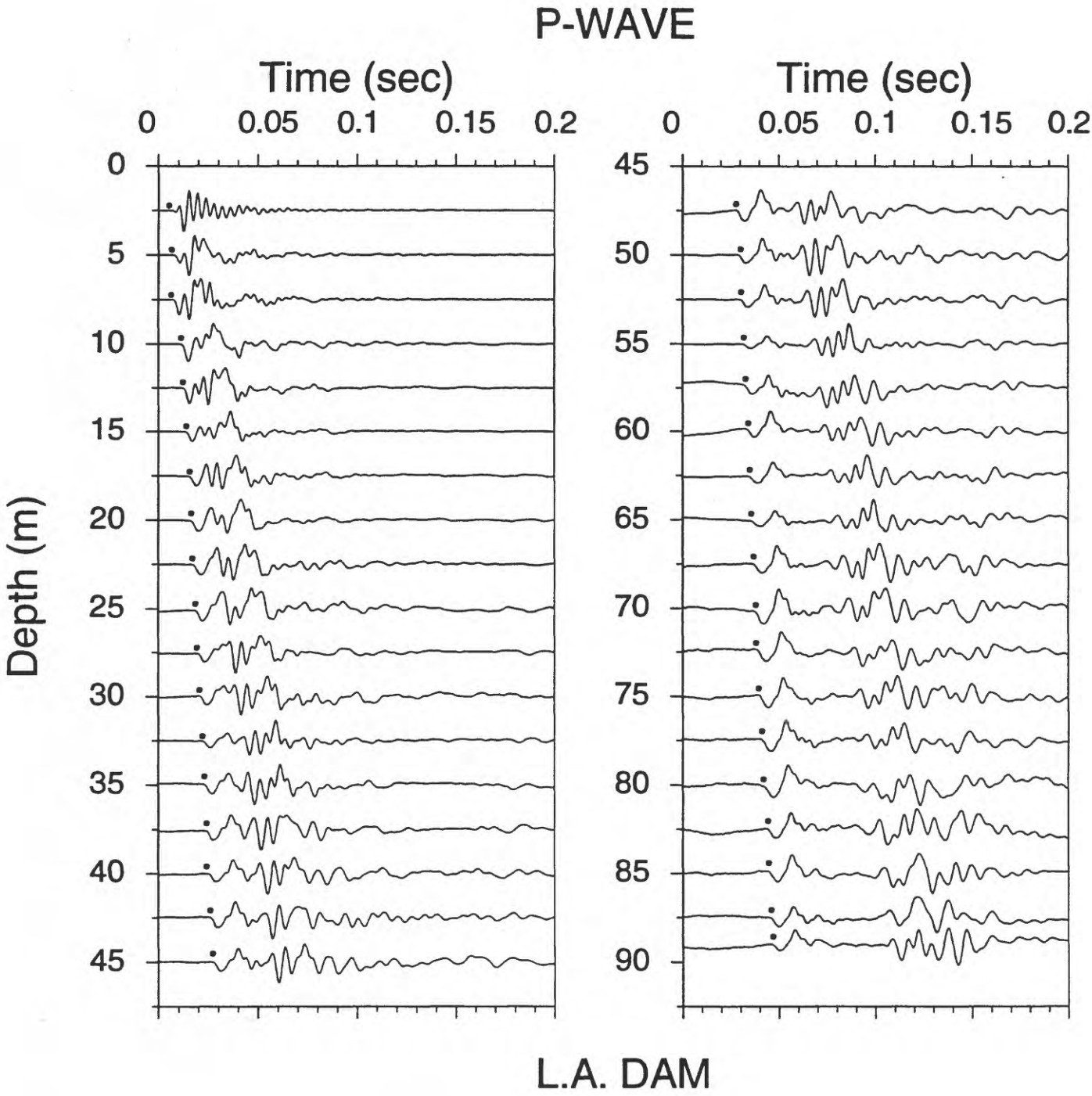

Figure 32. Vertical component record section. P-wave arrivals are indicated by the solid circles.

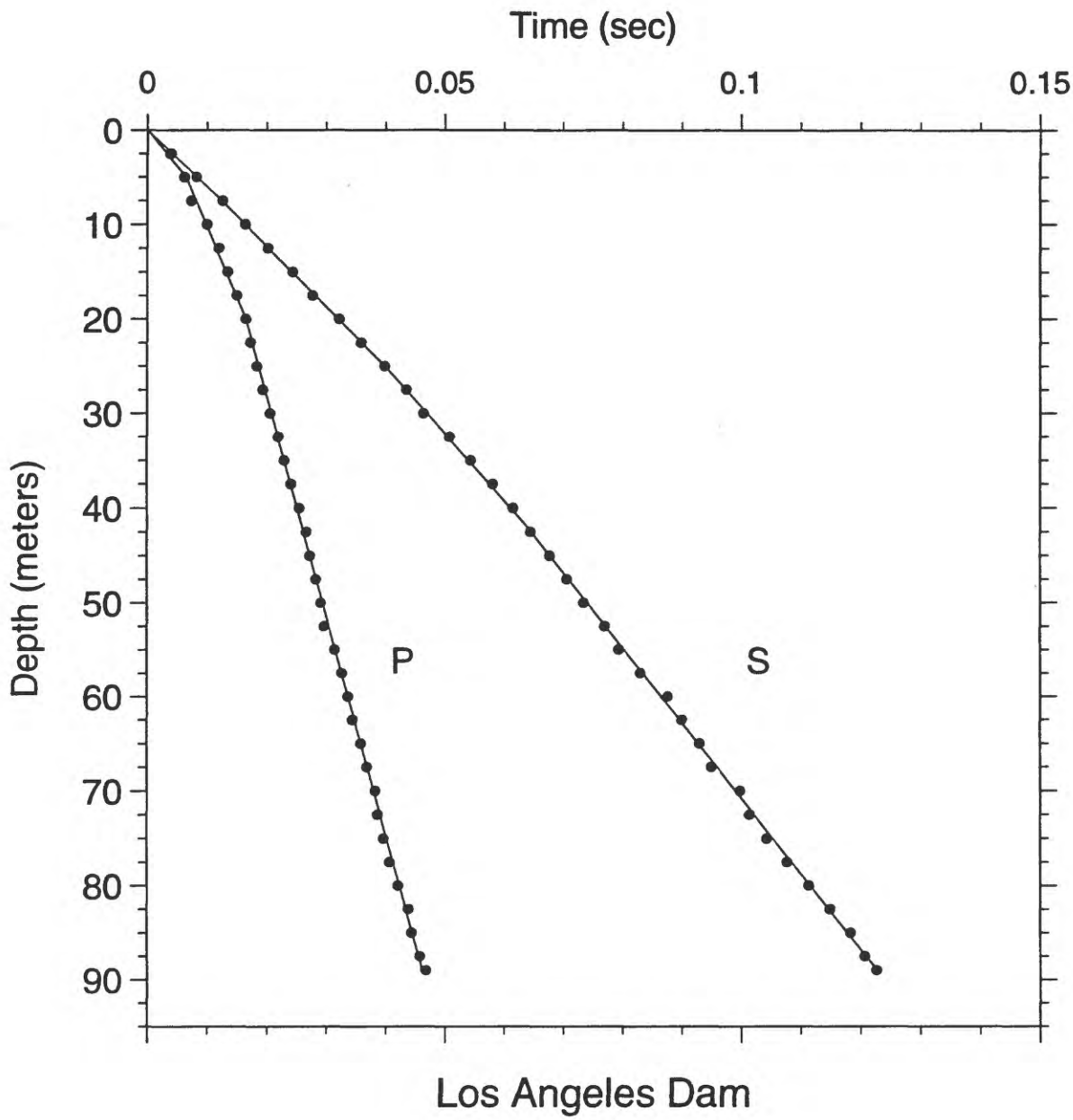

Figure 33. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

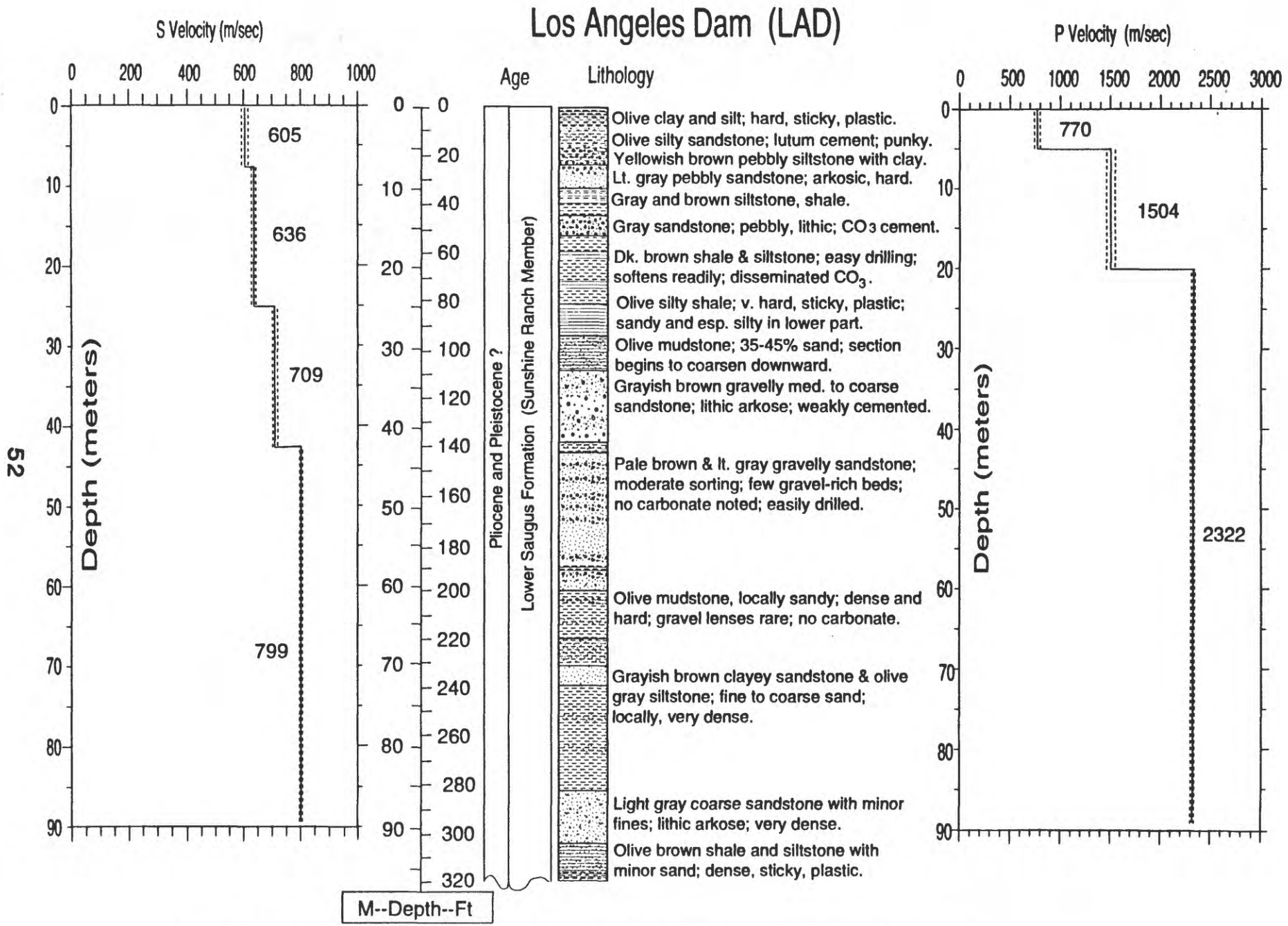

Figure 34. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 10. S-wave arrival times and velocity summaries for the Los Angeles Dam site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0038	1	-.3
5.0	16.4	.0082	1	-.1
7.5	24.6	.0126	1	.2
10.0	32.8	.0164	1	.1
12.5	41.0	.0202	1	-.1
15.0	49.2	.0244	1	.2
17.5	57.4	.0277	1	-.4
20.0	65.6	.0322	1	.1
22.5	73.8	.0359	1	-.1
25.0	82.0	.0399	1	.0
27.5	90.2	.0435	1	.0
30.0	98.4	.0464	1	-.6
32.5	106.6	.0508	1	.3
35.0	114.8	.0544	1	.4
37.5	123.0	.0581	1	.6
40.0	131.2	.0615	1	.4
42.5	139.4	.0645	1	-.1
45.0	147.6	.0677	1	.0
47.5	155.8	.0706	1	-.2
50.0	164.0	.0734	1	-.6
52.5	172.2	.0770	1	-.1
55.0	180.4	.0794	1	-.8
57.5	188.6	.0830	1	-.4
60.0	196.9	.0876	1	1.1
62.5	205.1	.0900	1	.4
65.0	213.3	.0930	1	.3
67.5	221.5	.0950	1	-.9
70.0	229.7	.0998	1	.8
72.5	237.9	.1014	2	-.4
75.0	246.1	.1043	2	-.5
77.5	254.3	.1077	2	-.3
80.0	262.5	.1113	2	-.1
82.5	270.7	.1149	1	.3
85.0	278.9	.1183	3	.2
87.5	287.1	.1207	3	-.1
89.0	292.0	.1227	3	.0

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
7.6	7.6	605	593	617	24.9	24.9	1985	1946	2025	.013
25.0	17.4	636	627	645	82.0	57.1	2086	2058	2115	.040
42.5	17.5	709	701	718	139.4	57.4	2328	2299	2357	.065
89.0	46.5	799	794	805	292.0	152.6	2622	2604	2640	.123

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 11. P-wave arrival times and velocity summaries for the Los Angeles Dam site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0040	1	.8
5.0	16.4	.0062	1	-.3
7.5	24.6	.0074	1	-.8
10.0	32.8	.0100	1	.2
12.5	41.0	.0120	1	.5
15.0	49.2	.0135	1	.4
17.5	57.4	.0150	1	.2
20.0	65.6	.0165	1	.0
22.5	73.8	.0173	1	-.2
25.0	82.0	.0184	1	-.2
27.5	90.2	.0194	1	-.3
30.0	98.4	.0206	1	-.2
32.5	106.6	.0220	1	.2
35.0	114.8	.0230	1	.1
37.5	123.0	.0241	1	.1
40.0	131.2	.0255	1	.4
42.5	139.4	.0267	1	.5
45.0	147.6	.0273	1	.1
47.5	155.8	.0283	1	.0
50.0	164.0	.0291	1	-.3
52.5	172.2	.0297	1	-.8
55.0	180.4	.0315	1	.0
57.5	188.6	.0327	1	.1
60.0	196.9	.0337	1	.0
62.5	205.1	.0345	1	-.3
65.0	213.3	.0359	1	.1
67.5	221.5	.0369	1	.0
70.0	229.7	.0383	1	.3
72.5	237.9	.0387	1	-.4
75.0	246.1	.0397	1	-.4
77.5	254.3	.0407	1	-.5
80.0	262.5	.0421	1	-.2
82.5	270.7	.0439	1	.5
85.0	278.9	.0444	1	-.1
87.5	287.1	.0458	1	.3
89.0	292.0	.0468	1	.6

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
5.0	5.0	770	744	799
20.0	15.0	1504	1463	1548
89.0	69.0	2322	2305	2339

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
16.4	16.4	2528	2441	2620	.006
65.6	49.2	4935	4799	5079	.016
292.0	226.4	7618	7562	7675	.046

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

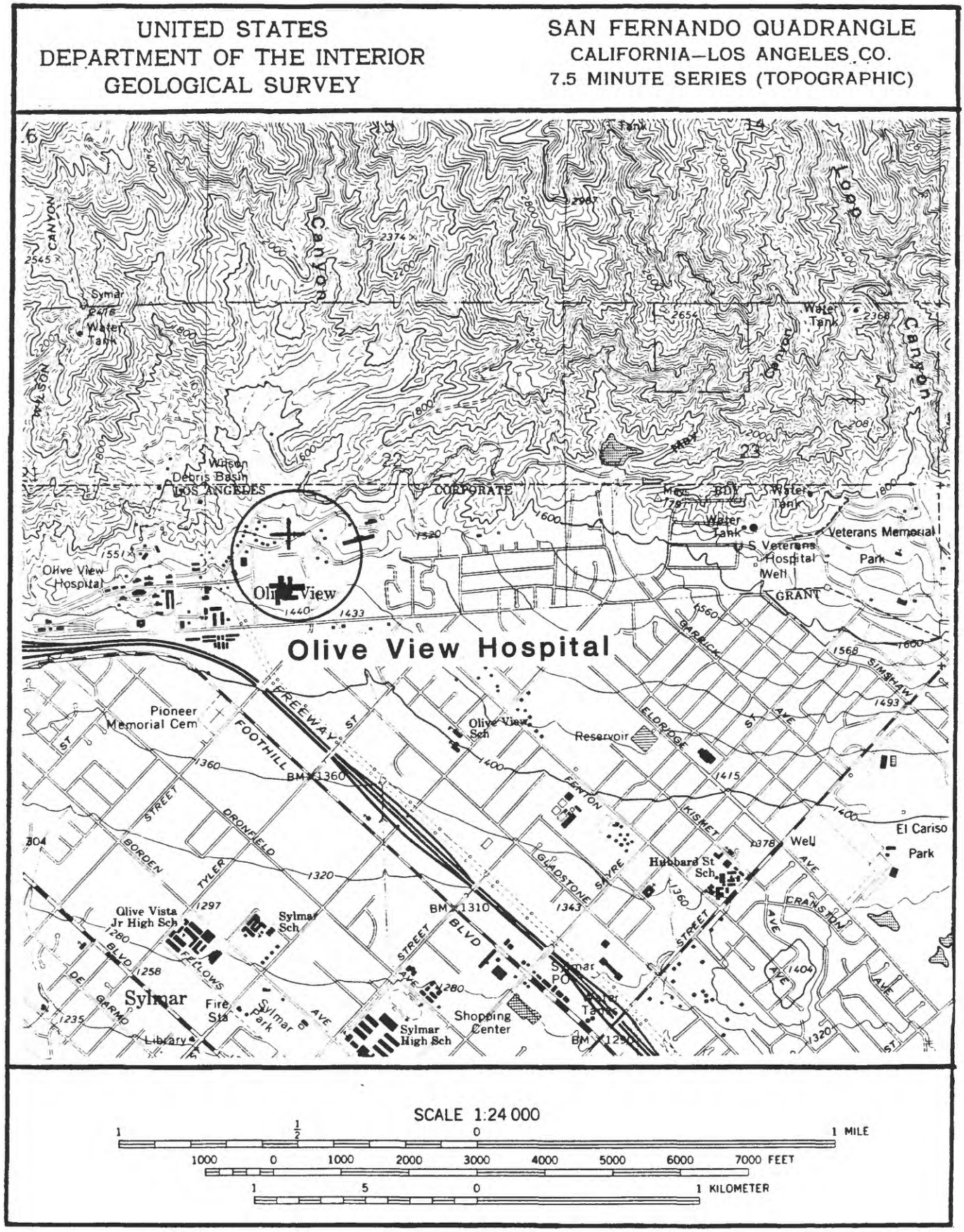

Figure 35. Site location map for the borehole at Olive View Hospital. The accelerograph is located approximately 30 meters from the borehole.

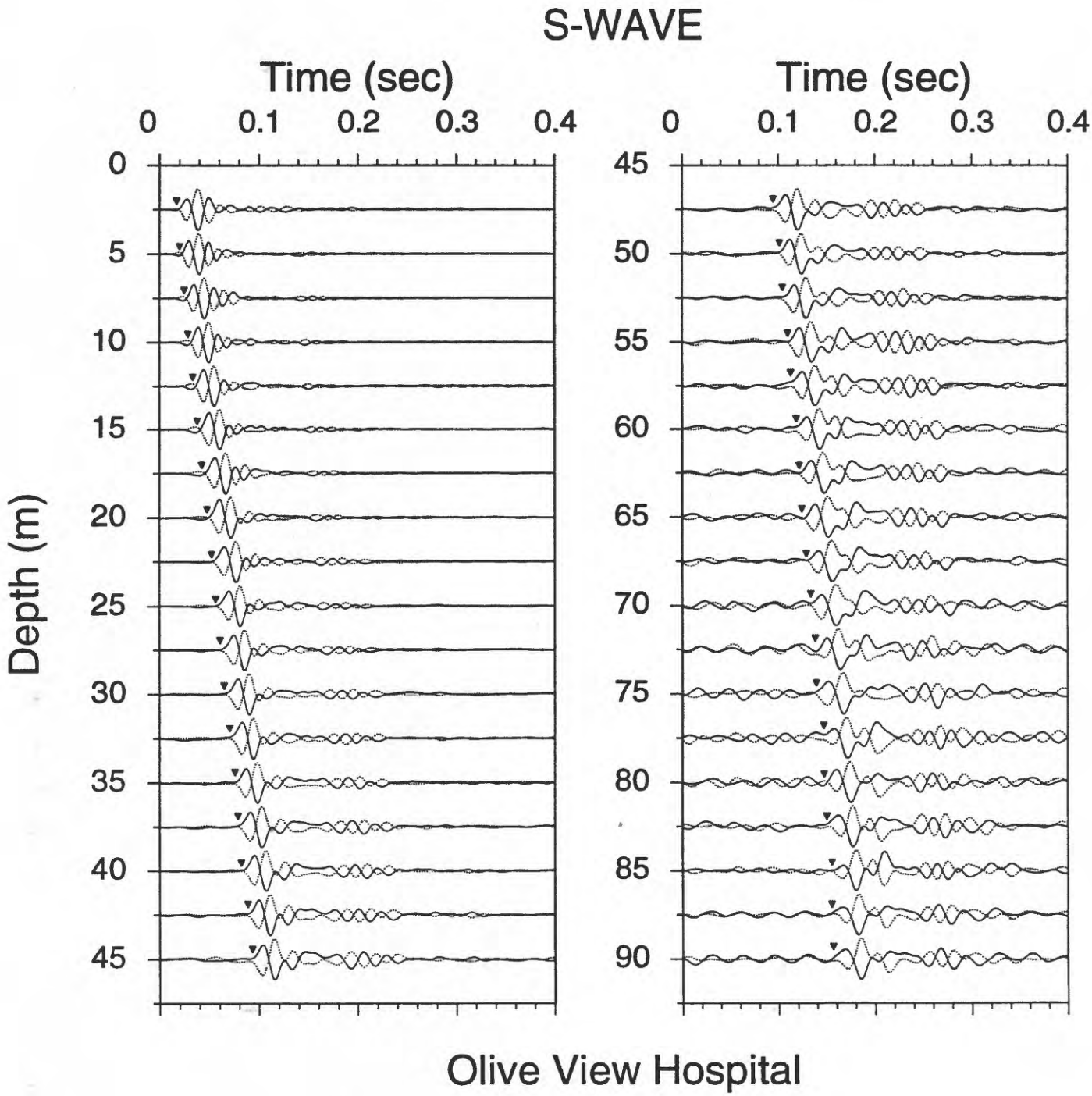

Figure 36. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

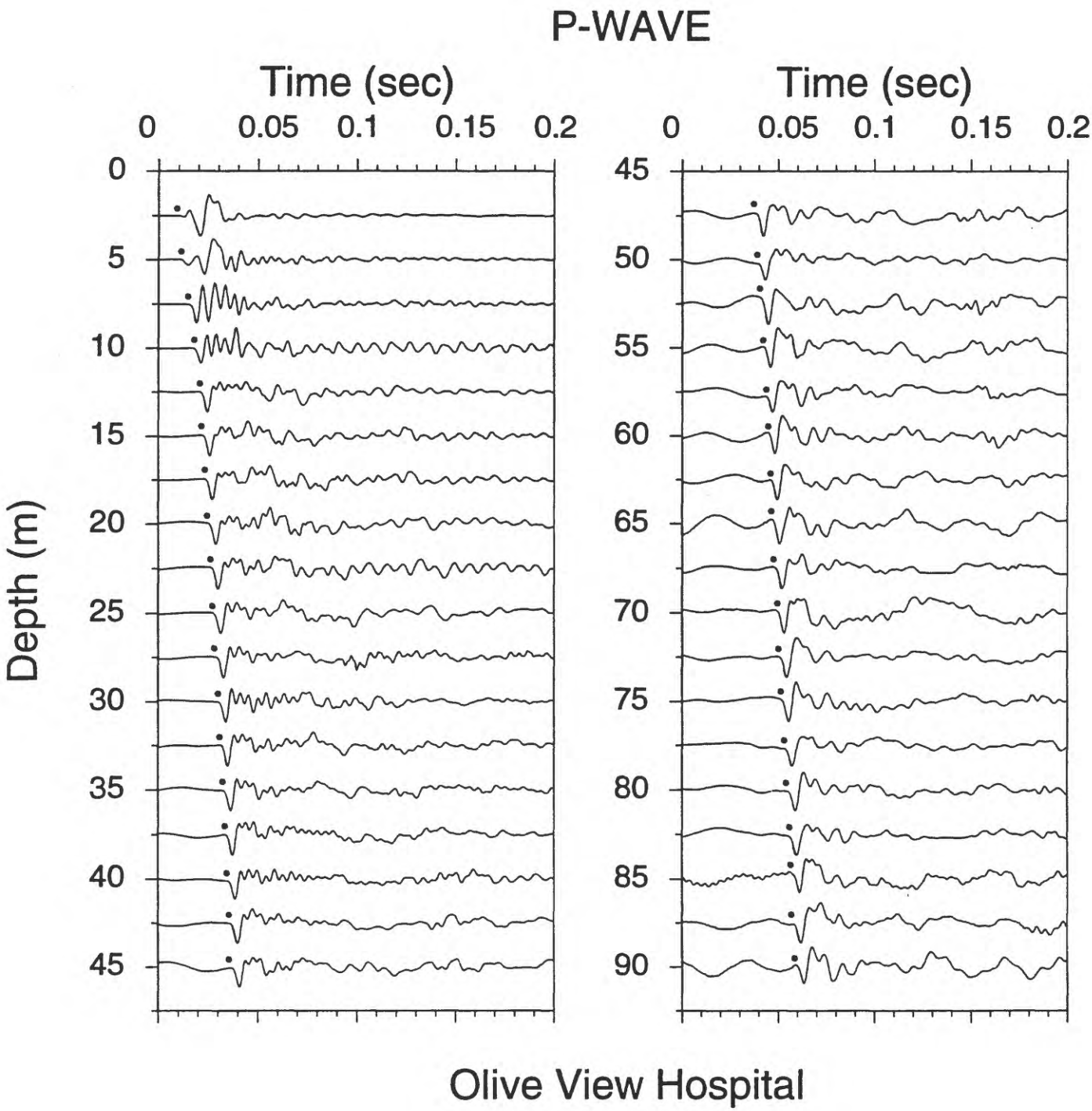

Figure 37. Vertical component record section. P-wave arrivals are indicated by the solid circles.

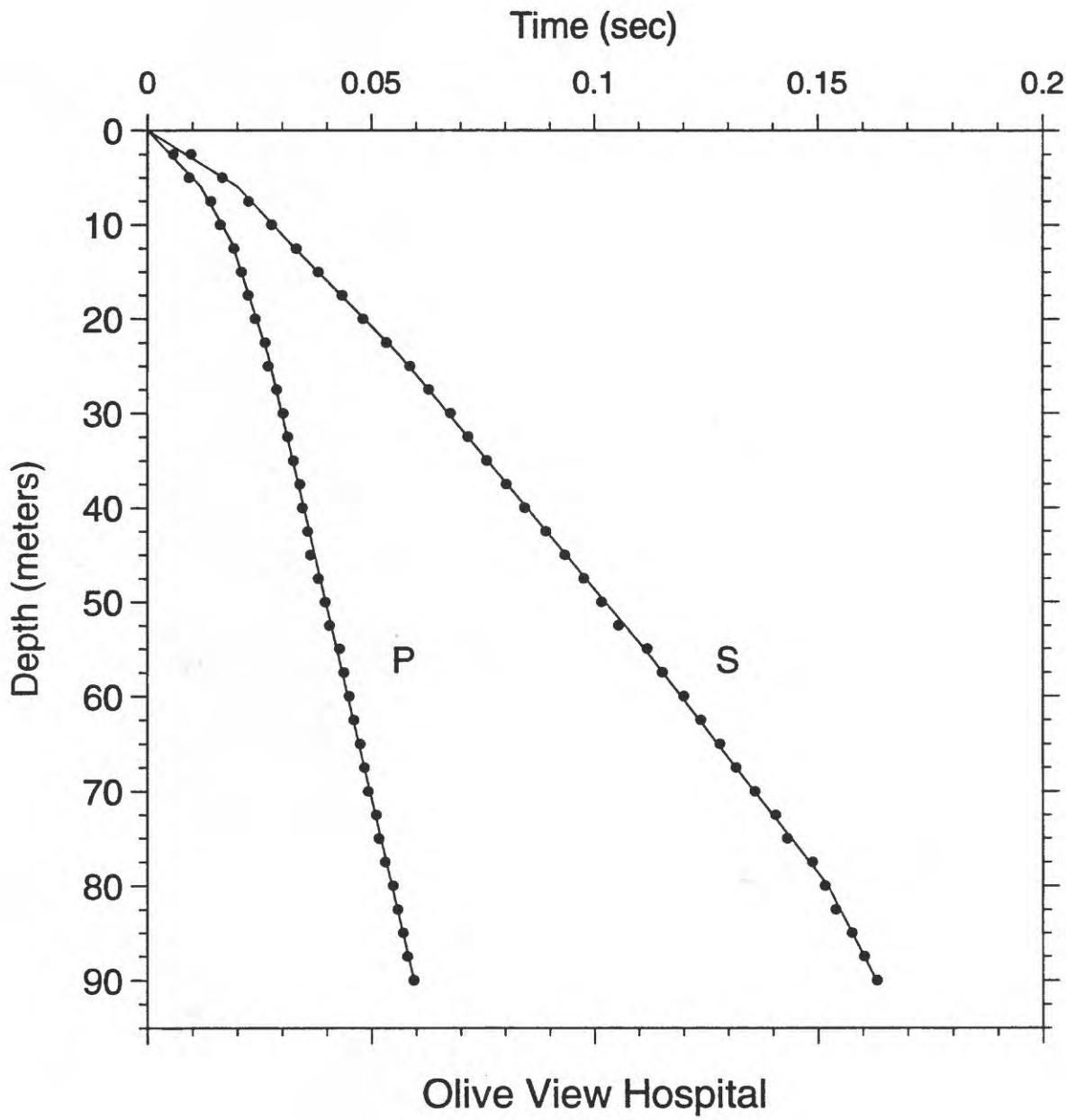

Figure 38. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

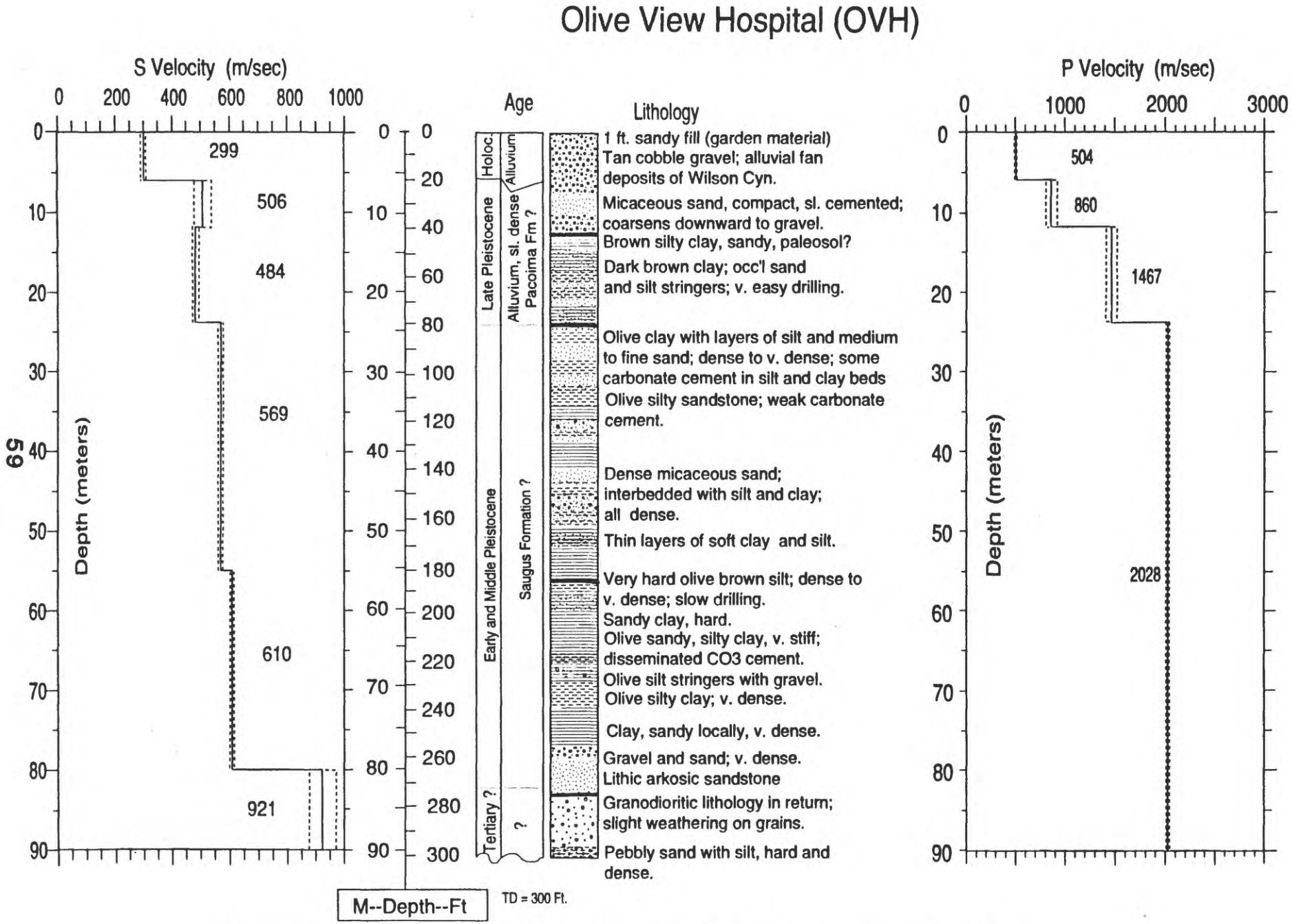

Figure 39. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 12. S-wave arrival times and velocity summaries for the Olive View Hospital site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0097	1	1.3
5.0	16.4	.0166	1	-.1
7.5	24.6	.0225	1	-.5
10.0	32.8	.0277	1	-.3
12.5	41.0	.0332	1	.2
15.0	49.2	.0382	1	.1
17.5	57.4	.0435	1	.2
20.0	65.6	.0482	1	-.3
22.5	73.8	.0534	1	-.2
25.0	82.0	.0587	1	.3
27.5	90.2	.0629	1	.1
30.0	98.4	.0678	1	.6
32.5	106.6	.0717	1	.1
35.0	114.8	.0759	1	-.1
37.5	123.0	.0803	1	-.1
40.0	131.2	.0844	1	-.4
42.5	139.4	.0892	1	.0
45.0	147.6	.0934	1	-.2
47.5	155.8	.0977	1	-.3
50.0	164.0	.1017	1	-.7
52.5	172.2	.1055	1	-1.3
55.0	180.4	.1119	1	.7
57.5	188.6	.1153	1	.0
60.0	196.9	.1201	1	.7
62.5	205.1	.1239	1	.4
65.0	213.3	.1282	1	.6
67.5	221.5	.1318	1	.1
70.0	229.7	.1360	1	.2
72.5	237.9	.1406	1	.7
75.0	246.1	.1432	1	-.8
77.5	254.3	.1488	1	.7
80.0	262.5	.1516	1	-.6
82.5	270.7	.1540	1	-.9
85.0	278.9	.1576	1	.0
87.5	287.1	.1604	1	.1
90.0	295.3	.1632	1	.2

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
6.0	6.0	299	292	306
11.9	5.9	506	478	537
23.8	11.9	484	474	494
55.0	31.2	569	564	573
80.0	25.0	610	604	616
90.0	10.0	921	876	971

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
19.7	19.7	982	959	1005	.020
39.0	19.4	1660	1569	1762	.032
78.1	39.0	1588	1555	1622	.056
180.4	102.4	1865	1852	1879	.111
262.5	82.0	2001	1981	2021	.152
295.3	32.8	3023	2875	3187	.163

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 13. P-wave arrival times and velocity summaries for the Olive View Hospital site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0057	1	.7
5.0	16.4	.0093	1	-.6
7.5	24.6	.0141	1	.4
10.0	32.8	.0162	1	-.4
12.5	41.0	.0193	1	.1
15.0	49.2	.0210	1	.1
17.5	57.4	.0225	1	-.1
20.0	65.6	.0241	1	-.2
22.5	73.8	.0263	1	.3
25.0	82.0	.0270	1	-.5
27.5	90.2	.0289	1	.2
30.0	98.4	.0303	1	.4
32.5	106.6	.0313	1	.1
35.0	114.8	.0326	1	.2
37.5	123.0	.0340	1	.4
40.0	131.2	.0346	1	-.3
42.5	139.4	.0358	1	-.3
45.0	147.6	.0364	1	-.9
47.5	155.8	.0382	1	-.4
50.0	164.0	.0397	1	-.1
52.5	172.2	.0407	1	-.3
55.0	180.4	.0429	1	.6
57.5	188.6	.0439	1	.4
60.0	196.9	.0451	1	.4
62.5	205.1	.0461	1	.1
65.0	213.3	.0475	1	.3
67.5	221.5	.0485	1	.1
70.0	229.7	.0493	1	-.4
72.5	237.9	.0511	1	.2
75.0	246.1	.0517	1	-.4
77.5	254.3	.0531	1	-.3
80.0	262.5	.0549	1	.3
82.5	270.7	.0559	1	.1
85.0	278.9	.0571	1	.0
87.5	287.1	.0581	1	-.2
90.0	295.3	.0595	1	.0

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
6.0	6.0	504	491	517
11.9	5.9	860	807	921
23.8	11.9	1467	1413	1526
90.0	66.2	2028	2014	2043

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
19.7	19.7	1653	1610	1698	.012
39.0	19.4	2823	2649	3022	.019
78.1	39.0	4814	4635	5007	.027
295.3	217.2	6655	6607	6703	.060

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

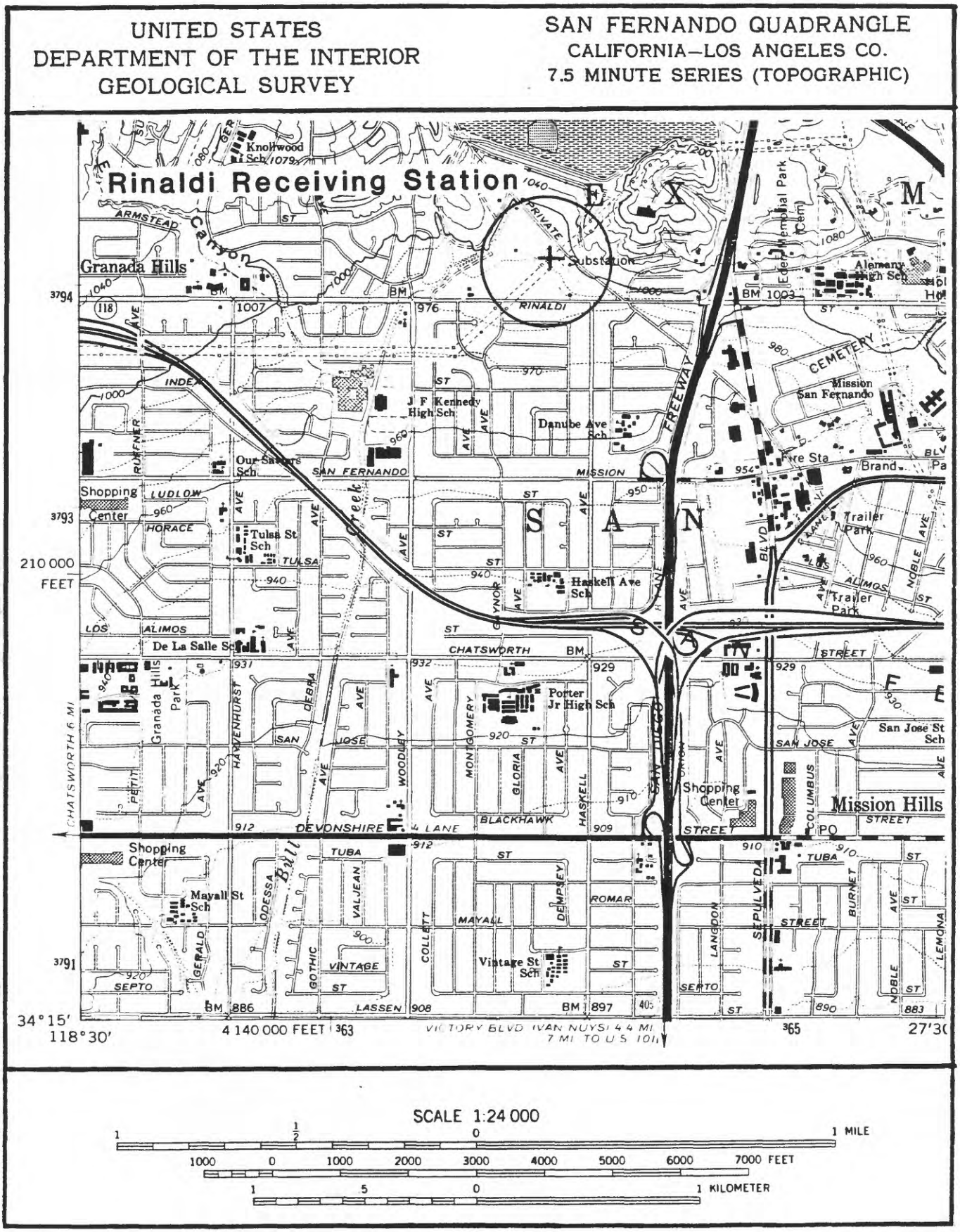

Figure 40. Site location map for the borehole at Rinaldi Receiving Station. The accelerograph is located approximately 10 meters from the borehole.

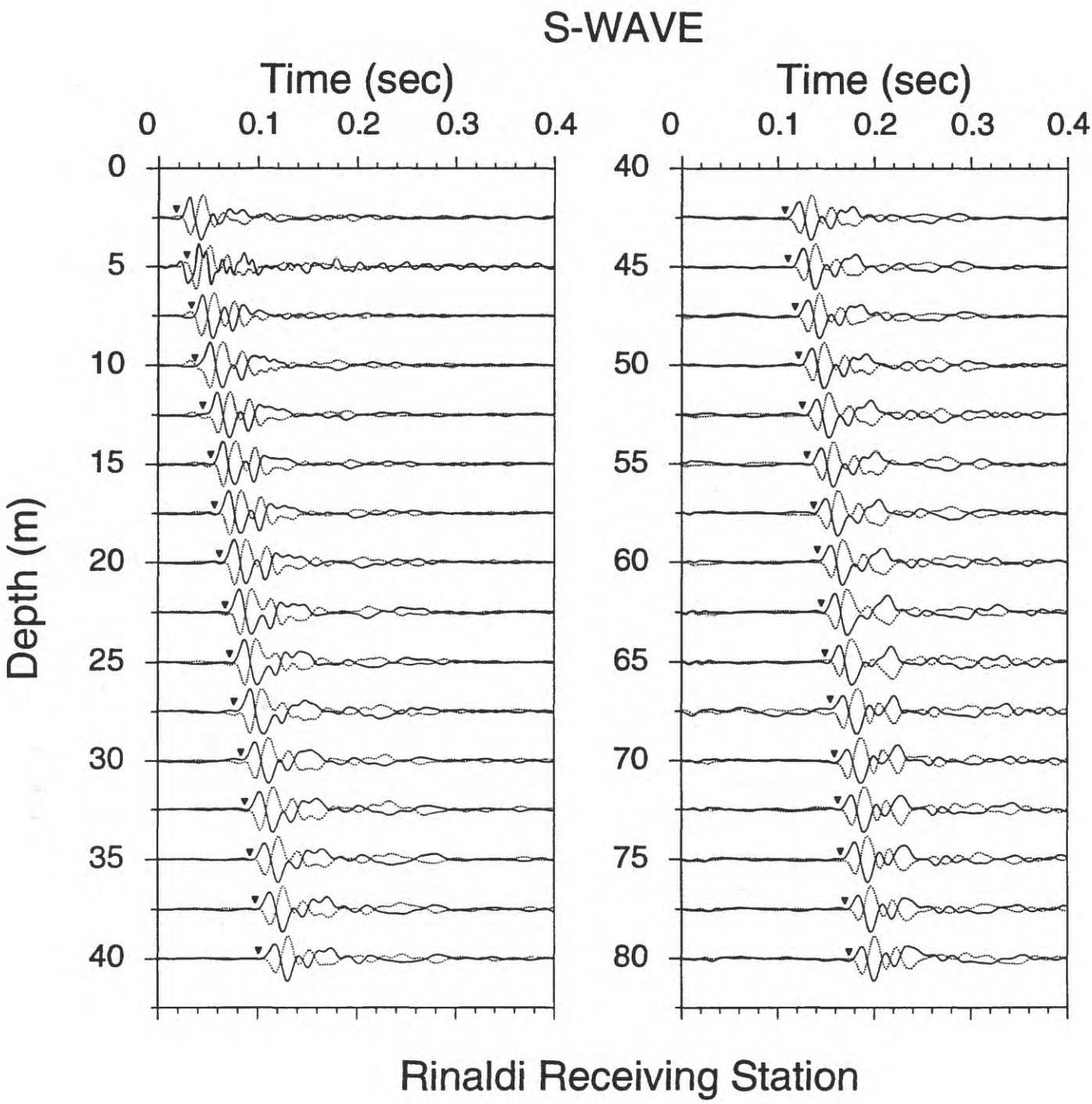

Figure 41. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

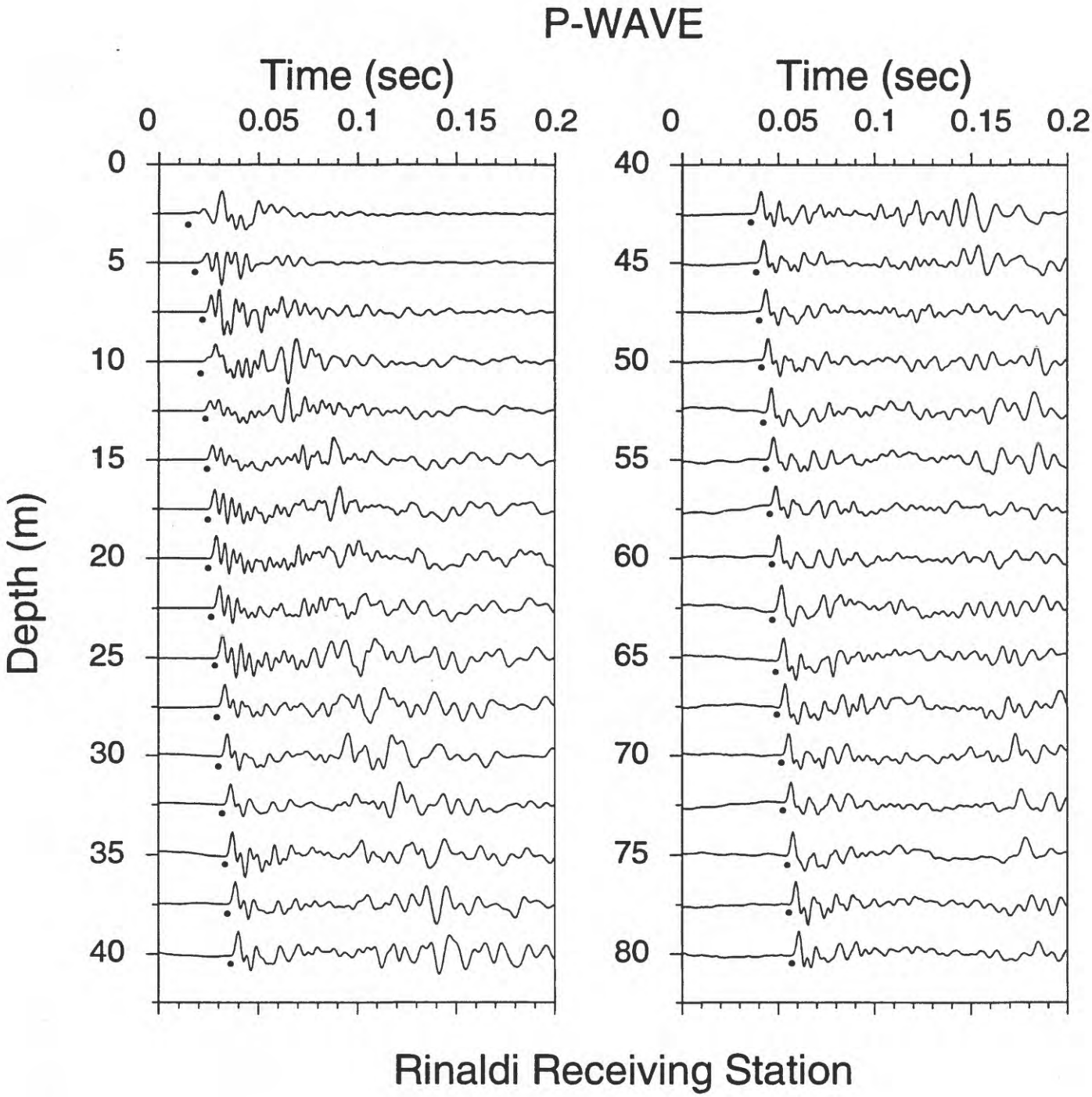

Figure 42. Vertical component record section. P-wave arrivals are indicated by the solid circles.

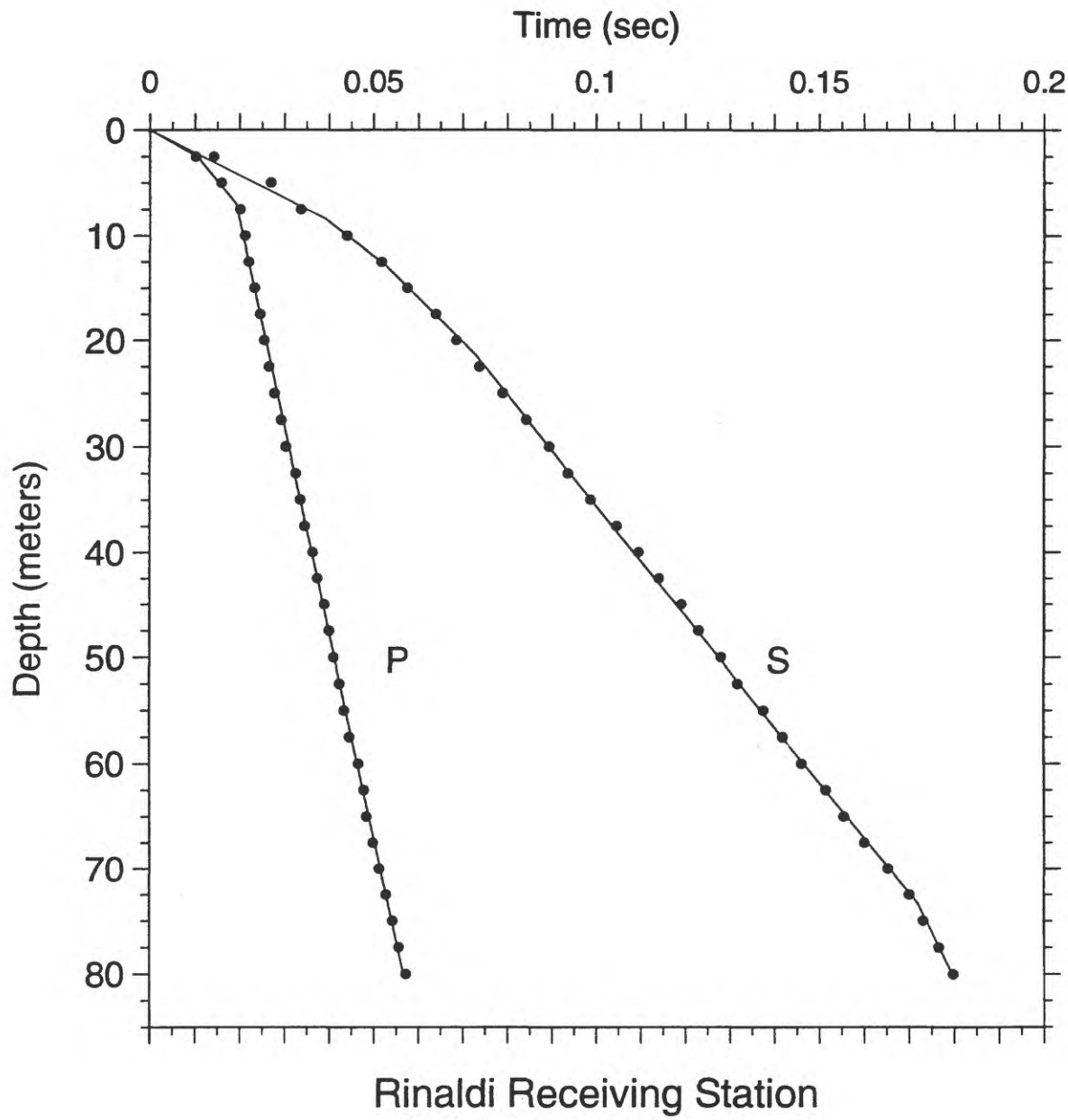

Figure 43. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

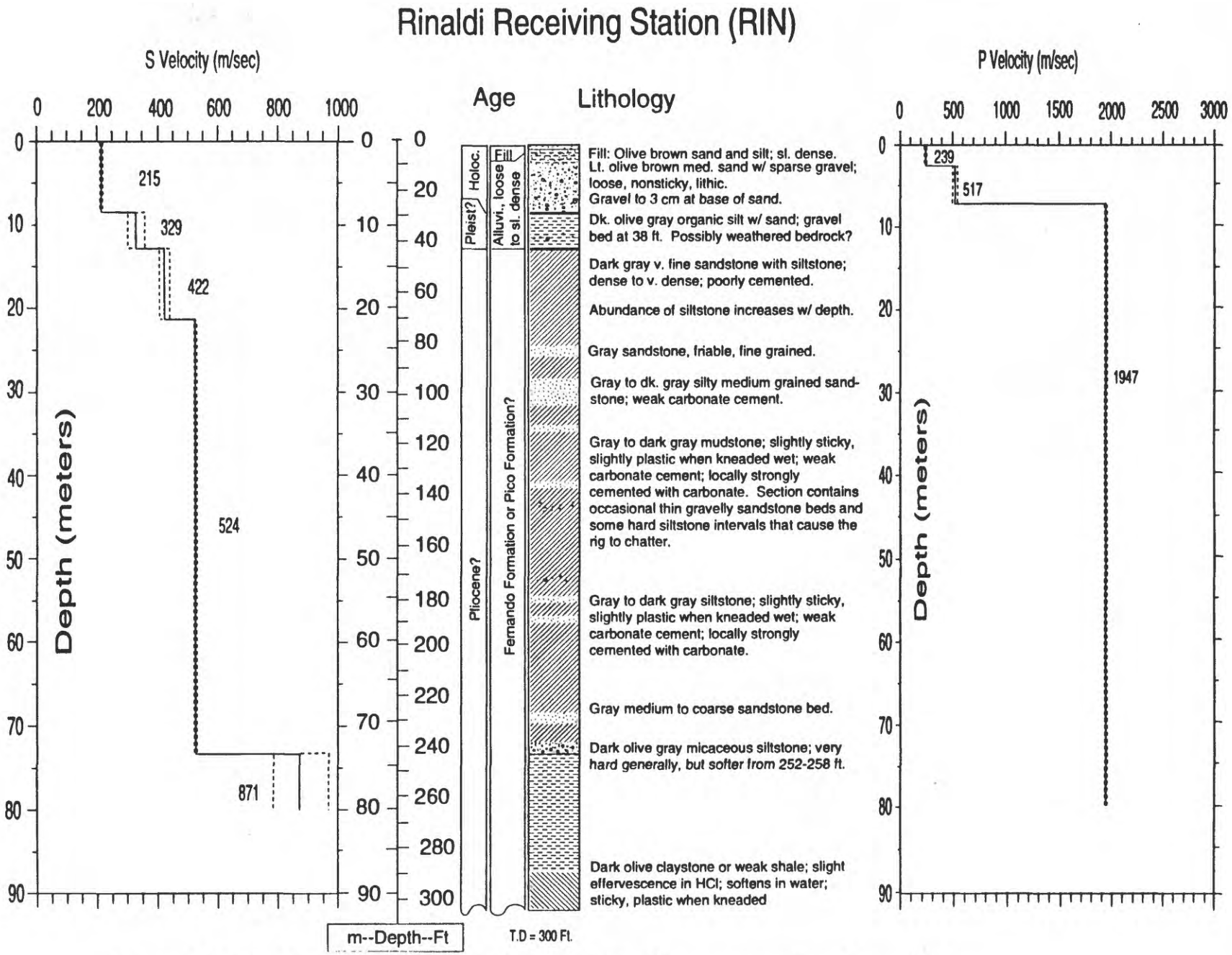

Figure 44. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 14. S-wave arrival times and velocity summaries for the Rinaldi Receiving Station site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0142	1	2.6
5.0	16.4	.0270	3	1.3
7.5	24.6	.0337	1	-1.1
10.0	32.8	.0440	1	.0
12.5	41.0	.0518	1	.2
15.0	49.2	.0576	1	-.2
17.5	57.4	.0640	1	.3
20.0	65.6	.0686	1	-1.0
22.5	73.8	.0738	1	-1.2
25.0	82.0	.0790	1	-.7
27.5	90.2	.0843	1	-.2
30.0	98.4	.0894	1	.1
32.5	106.6	.0937	1	-.4
35.0	114.8	.0988	1	.0
37.5	123.0	.1046	1	1.0
40.0	131.2	.1095	1	1.1
42.5	139.4	.1141	1	1.0
45.0	147.6	.1191	1	1.2
47.5	155.8	.1230	1	.3
50.0	164.0	.1280	1	.6
52.5	172.2	.1318	1	-.4
55.0	180.4	.1376	1	.6
57.5	188.6	.1419	1	.2
60.0	196.9	.1461	1	-.4
62.5	205.1	.1515	1	.2
65.0	213.3	.1555	1	-.5
67.5	221.5	.1601	1	-.7
70.0	229.7	.1653	1	-.3
72.5	237.9	.1701	1	-.3
75.0	246.1	.1732	1	-.6
77.5	254.3	.1766	1	-.1
80.0	262.5	.1798	1	.2

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
8.5	8.5	215	211	220	27.9	27.9	706	693	720	.039
12.8	4.3	329	303	359	42.0	14.1	1079	994	1179	.053
21.3	8.5	422	406	440	69.9	27.9	1385	1332	1443	.073
73.3	52.0	524	521	527	240.5	170.6	1720	1710	1730	.172
80.0	6.7	871	785	979	262.5	22.0	2858	2574	3211	.180

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 15. P-wave arrival times and velocity summaries for the Rinaldi Receiving Station site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0102	1	-.3
5.0	16.4	.0159	1	.6
7.5	24.6	.0201	1	.7
10.0	32.8	.0212	1	.5
12.5	41.0	.0221	1	.1
15.0	49.2	.0234	1	.1
17.5	57.4	.0246	1	.0
20.0	65.6	.0255	1	-.3
22.5	73.8	.0266	1	-.5
25.0	82.0	.0278	1	-.6
27.5	90.2	.0293	1	-.4
30.0	98.4	.0303	1	-.7
32.5	106.6	.0326	1	.3
35.0	114.8	.0336	1	.1
37.5	123.0	.0346	1	-.2
40.0	131.2	.0364	1	.3
42.5	139.4	.0374	1	.0
45.0	147.6	.0390	1	.3
47.5	155.8	.0401	1	.1
50.0	164.0	.0411	1	-.2
52.5	172.2	.0425	1	.0
55.0	180.4	.0435	1	-.3
57.5	188.6	.0447	1	-.4
60.0	196.9	.0467	1	.3
62.5	205.1	.0479	1	.2
65.0	213.3	.0485	1	-.5
67.5	221.5	.0499	1	-.3
70.0	229.7	.0513	1	-.2
72.5	237.9	.0529	1	.1
75.0	246.1	.0543	1	.2
77.5	254.3	.0557	1	.3
80.0	262.5	.0573	1	.6

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
2.5	2.5	239	231	247	8.2	8.2	784	758	811	.010
7.0	4.5	517	495	542	23.0	14.8	1698	1625	1777	.019
80.0	73.0	1947	1935	1959	262.5	239.5	6387	6348	6427	.057

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

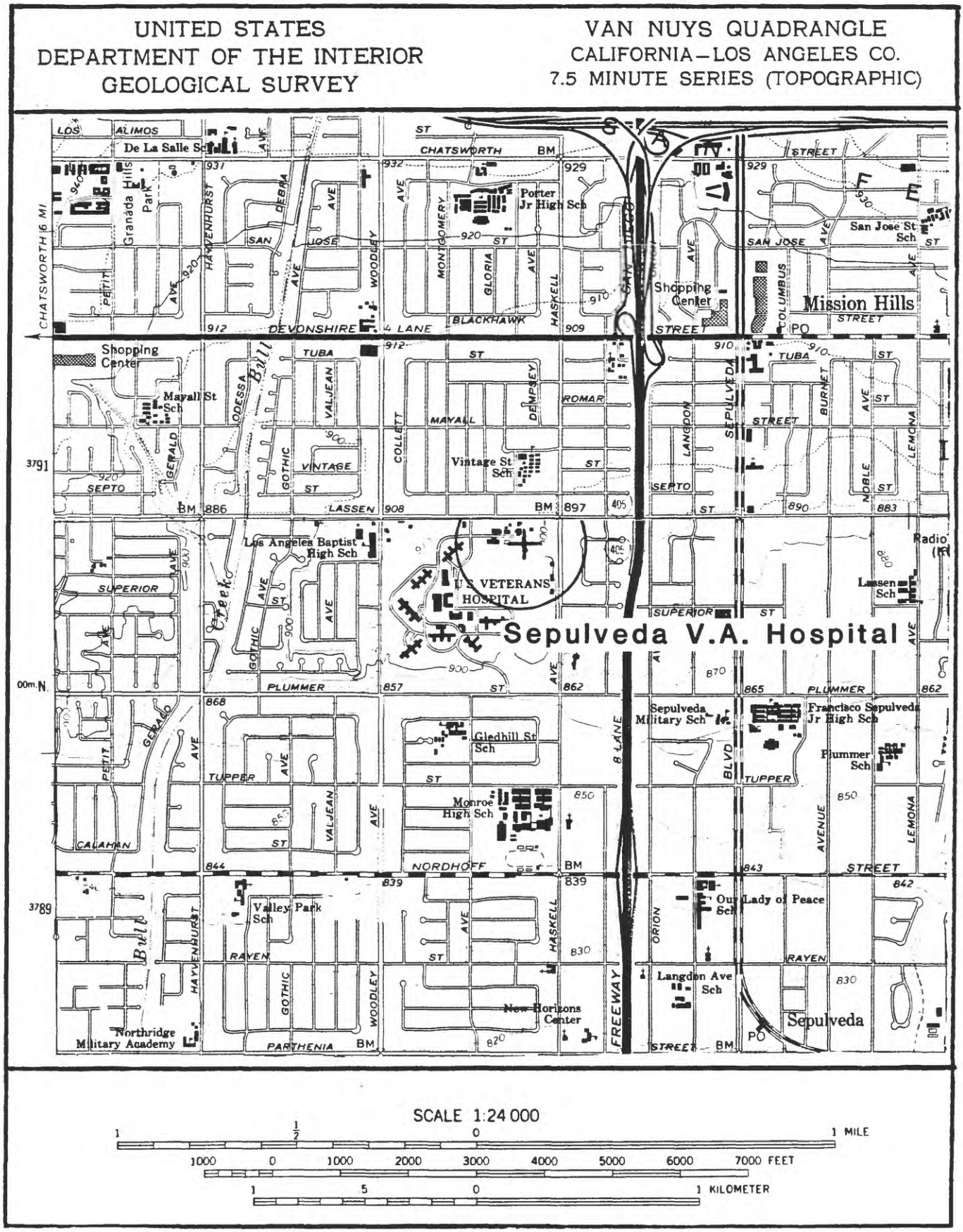

Figure 45. Site location map for the borehole at Sepulveda V.A. Hospital. The accelerograph is located approximately 30 meters from the borehole.

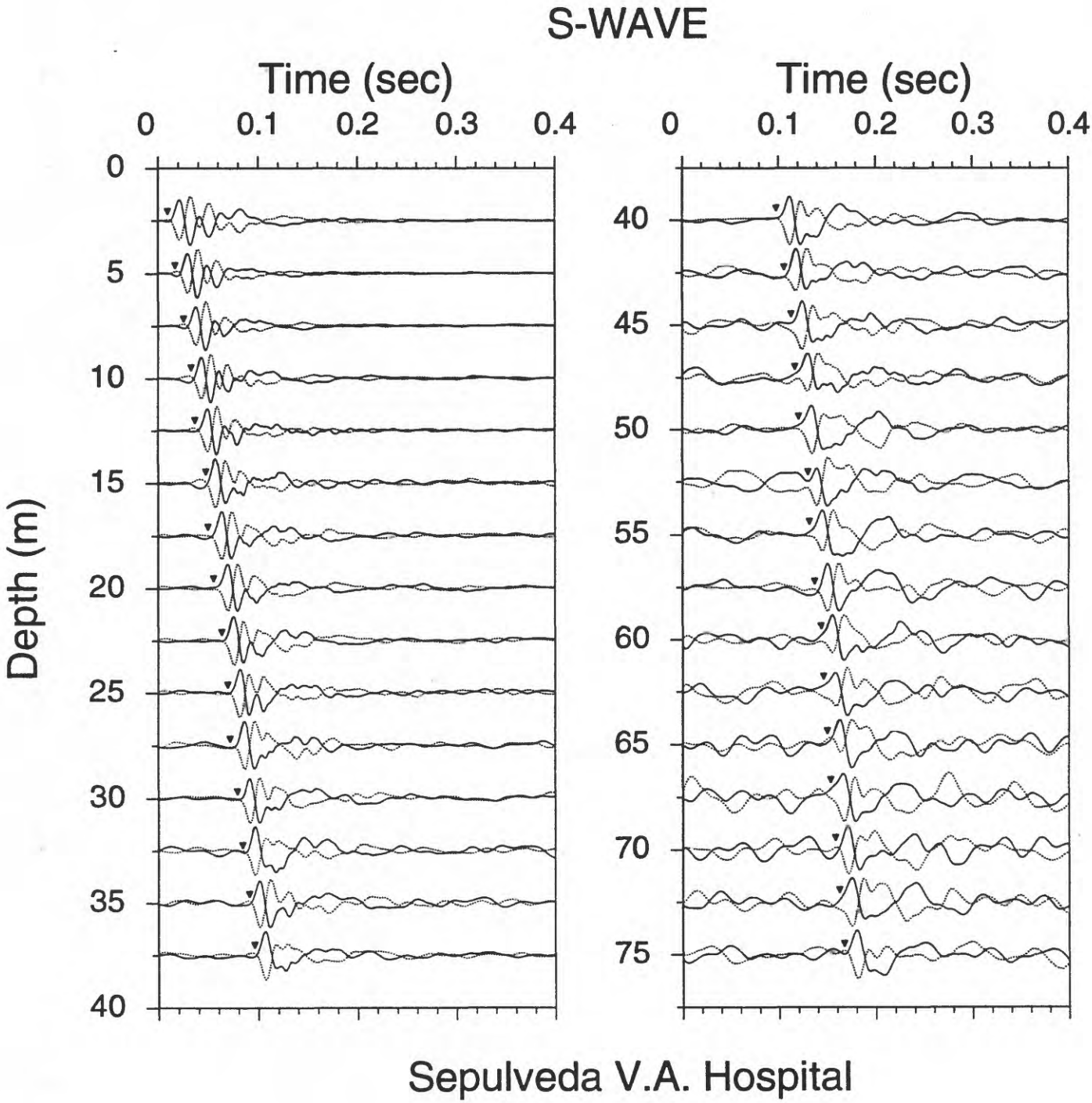

Figure 46. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

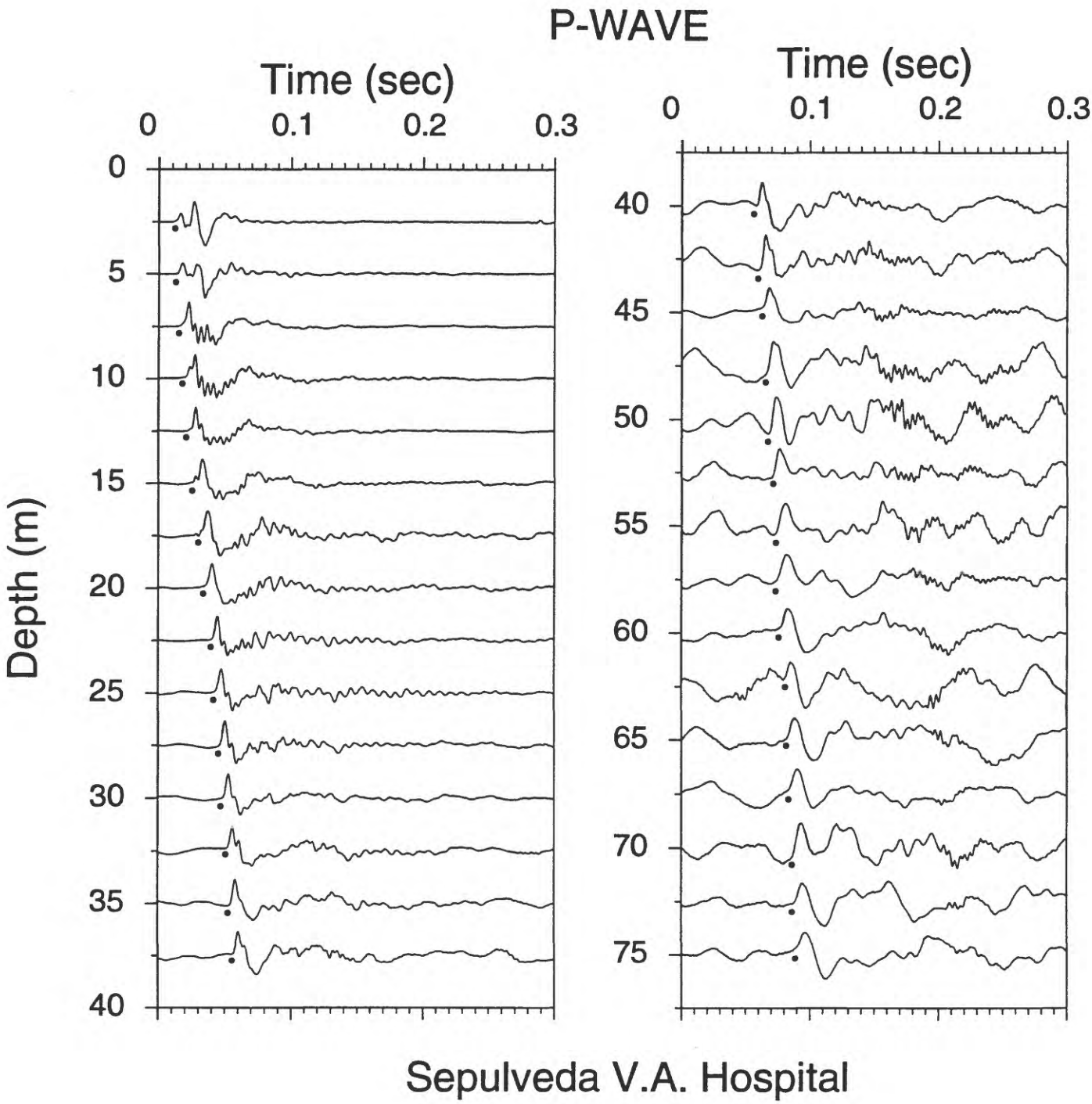

Figure 47. Vertical component record section. P-wave arrivals are indicated by the solid circles.

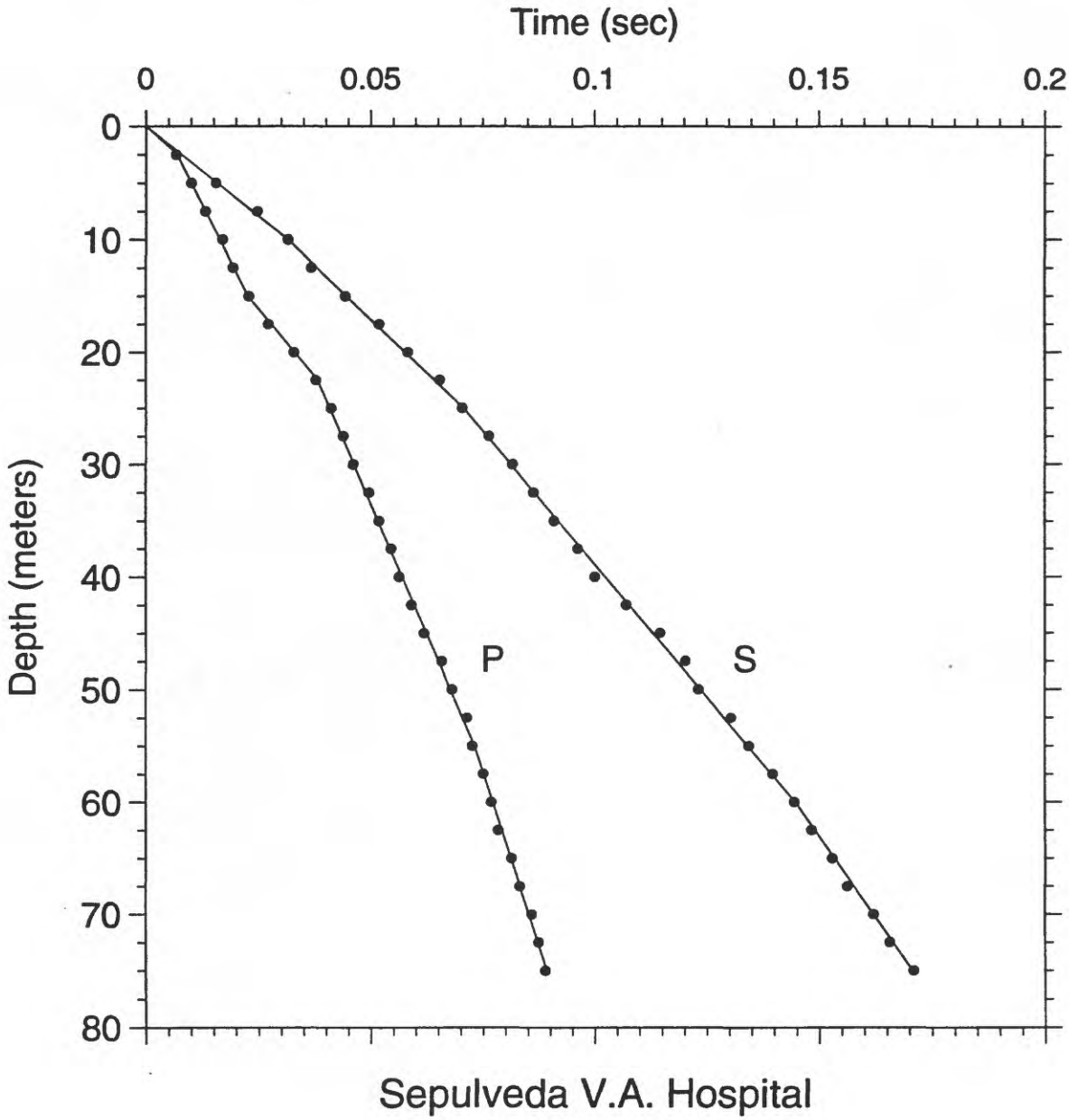

Figure 48. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

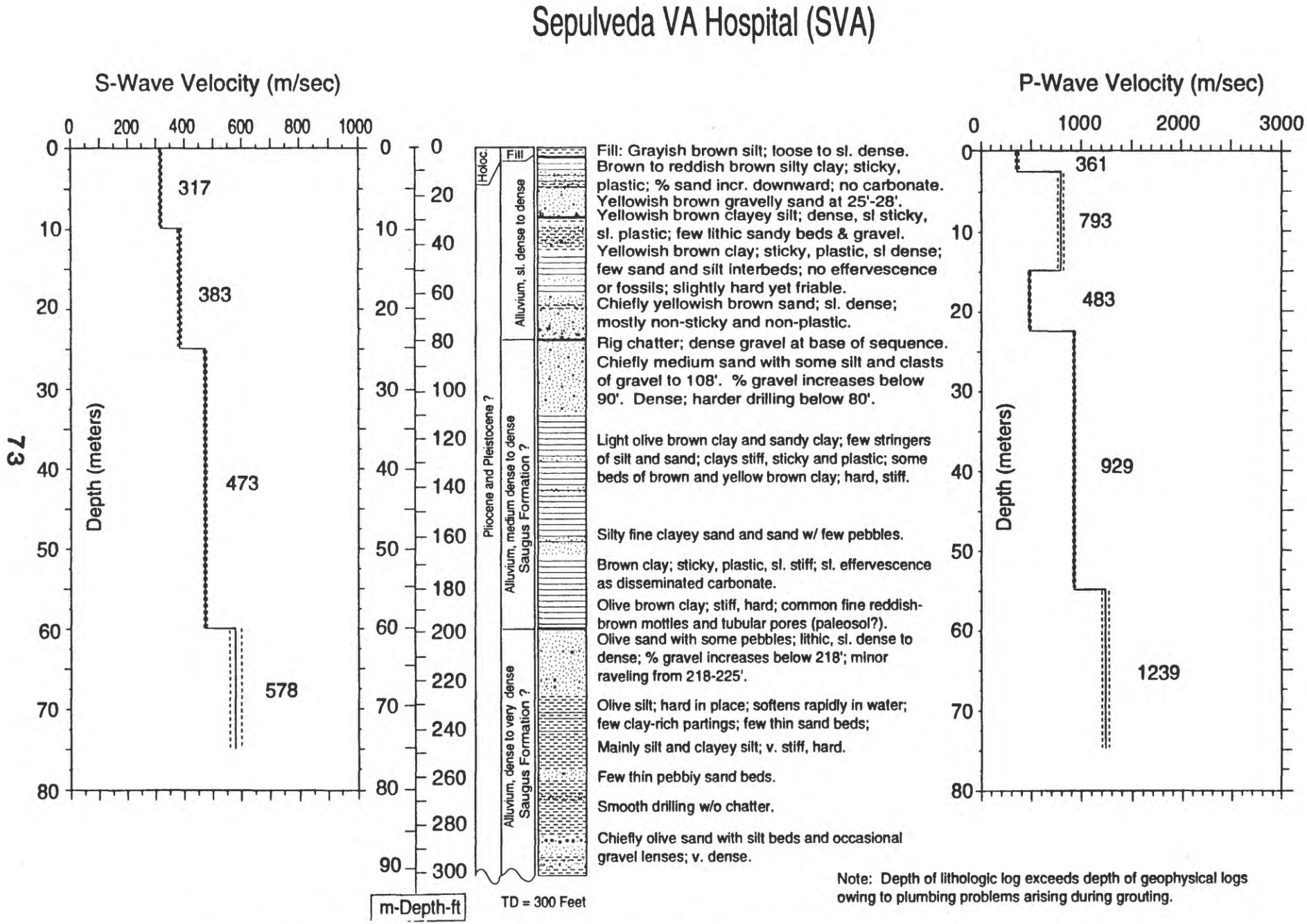

Figure 49. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 16. S-wave arrival times and velocity summaries for the Sepulveda VA Hospital site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0066	1	-1.3
5.0	16.4	.0155	1	-.3
7.5	24.6	.0247	1	1.1
10.0	32.8	.0315	1	.0
12.5	41.0	.0368	1	-1.2
15.0	49.2	.0444	1	-.2
17.5	57.4	.0519	1	.8
20.0	65.6	.0583	1	.7
22.5	73.8	.0654	1	1.2
25.0	82.0	.0705	1	-.2
27.5	90.2	.0764	1	.4
30.0	98.4	.0817	1	.4
32.5	106.6	.0864	1	-.2
35.0	114.8	.0910	1	-.9
37.5	123.0	.0963	1	-.9
40.0	131.2	.1001	1	-2.3
42.5	139.4	.1071	1	-.6
45.0	147.6	.1146	2	1.1
47.5	155.8	.1202	2	1.3
50.0	164.0	.1232	2	-.3
52.5	172.2	.1304	1	1.5
55.0	180.4	.1344	2	.1
57.5	188.6	.1397	1	.2
60.0	196.9	.1445	2	-.2
62.5	205.1	.1483	3	-.3
65.0	213.3	.1529	2	-.3
67.5	221.5	.1563	3	-.5
70.0	229.7	.1621	1	.0
72.5	237.9	.1657	2	-.3
75.0	246.1	.1710	1	.3

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
10.0	10.0	317	312	322
25.0	15.0	383	376	389
60.0	35.0	473	468	478
75.0	15.0	578	558	599

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
32.8	32.8	1041	1025	1058	.032
82.0	49.2	1255	1233	1278	.071
196.9	114.8	1551	1536	1567	.145
246.1	49.2	1895	1830	1965	.171

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 17. P-wave arrival times and velocity summaries for the Sepulveda VA Hospital site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0067	1	-.2
5.0	16.4	.0101	1	.0
7.5	24.6	.0132	1	.0
10.0	32.8	.0170	1	.6
12.5	41.0	.0194	1	-.1
15.0	49.2	.0229	1	.2
17.5	57.4	.0272	1	-.7
20.0	65.6	.0329	1	-.1
22.5	73.8	.0378	1	-.4
25.0	82.0	.0412	1	.3
27.5	90.2	.0439	1	.3
30.0	98.4	.0461	1	-.2
32.5	106.6	.0497	1	.7
35.0	114.8	.0519	1	.2
37.5	123.0	.0546	1	.2
40.0	131.2	.0564	1	-.7
42.5	139.4	.0591	1	-.6
45.0	147.6	.0619	1	-.5
47.5	155.8	.0658	1	.7
50.0	164.0	.0682	1	.4
52.5	172.2	.0715	1	1.0
55.0	180.4	.0727	1	-.5
57.5	188.6	.0751	1	-.1
60.0	196.9	.0769	1	-.3
62.5	205.1	.0784	1	-.8
65.0	213.3	.0814	1	.1
67.5	221.5	.0833	1	.0
70.0	229.7	.0860	1	.7
72.5	237.9	.0875	1	.2
75.0	246.1	.0890	1	-.3

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
2.5	2.5	361	343	381	8.2	8.2	1184	1125	1250	.007
15.0	12.5	793	766	823	49.2	41.0	2603	2514	2699	.023
22.5	7.5	483	470	496	73.8	24.6	1584	1541	1628	.038
55.0	32.5	929	919	939	180.4	106.6	3049	3016	3081	.073
75.0	20.0	1239	1208	1271	246.1	65.6	4064	3962	4171	.089

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

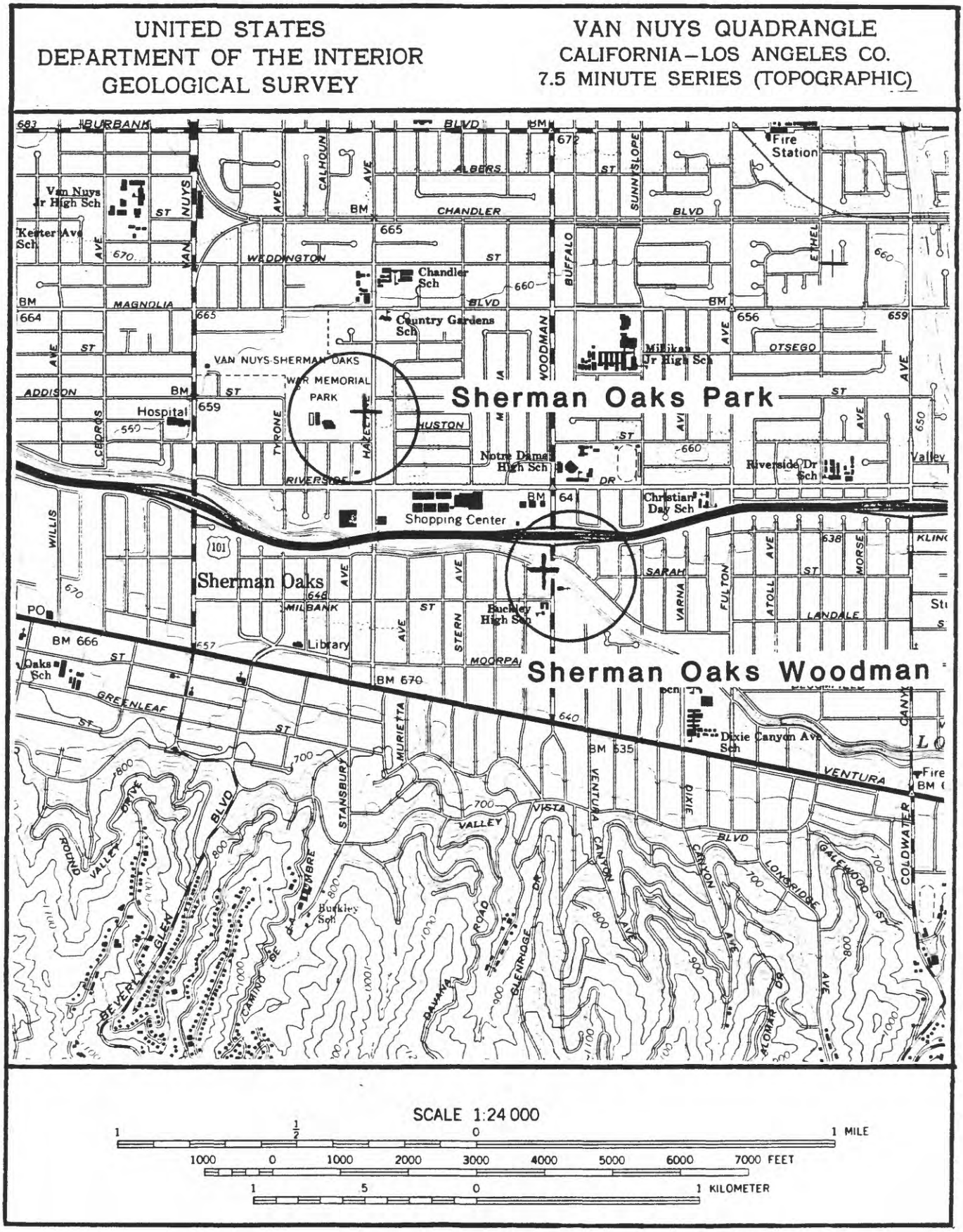

Figure 50. Site location map for the borehole at Sherman Oaks Park. No accelerograph is located at this site.

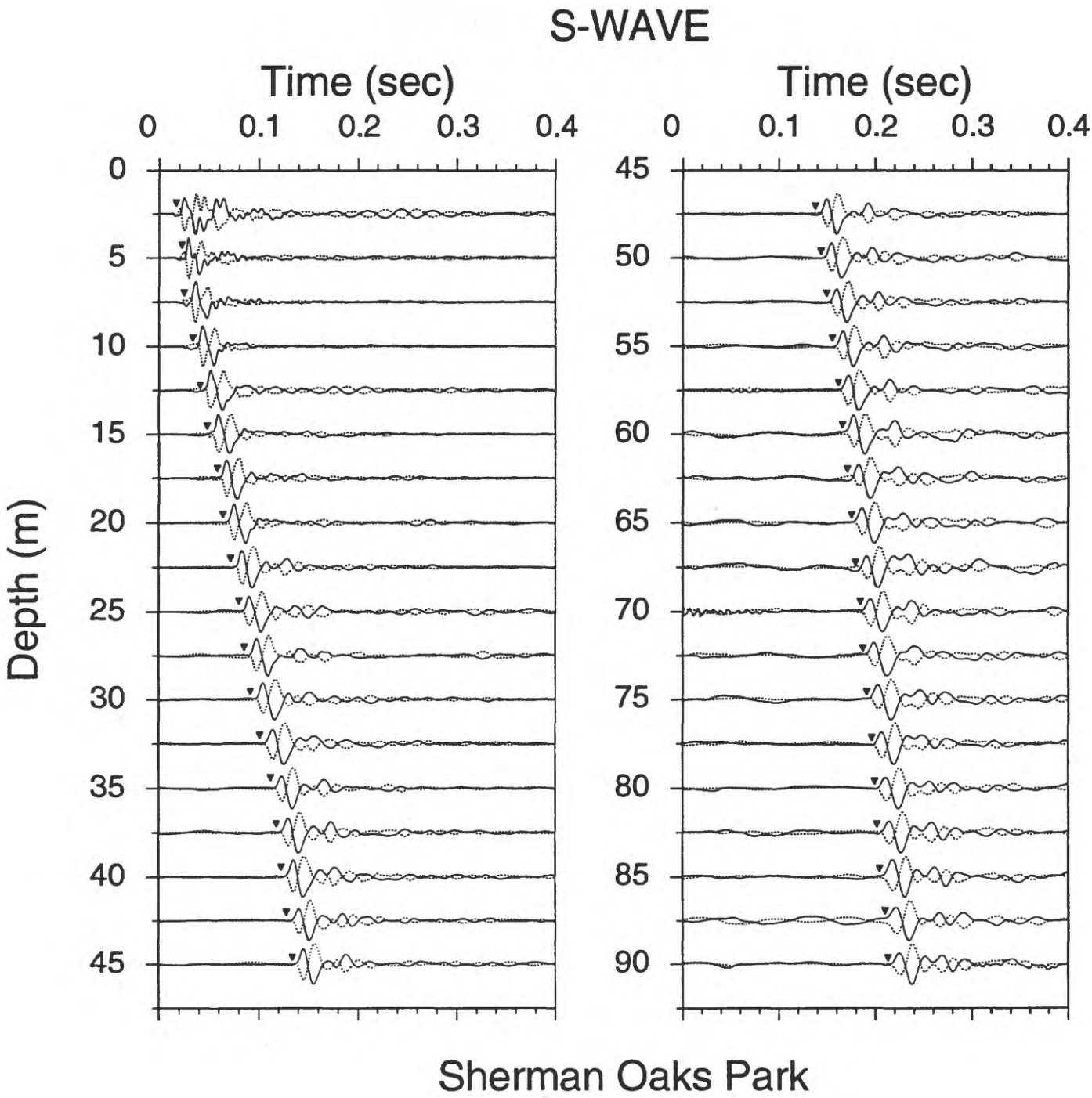

Figure 51. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

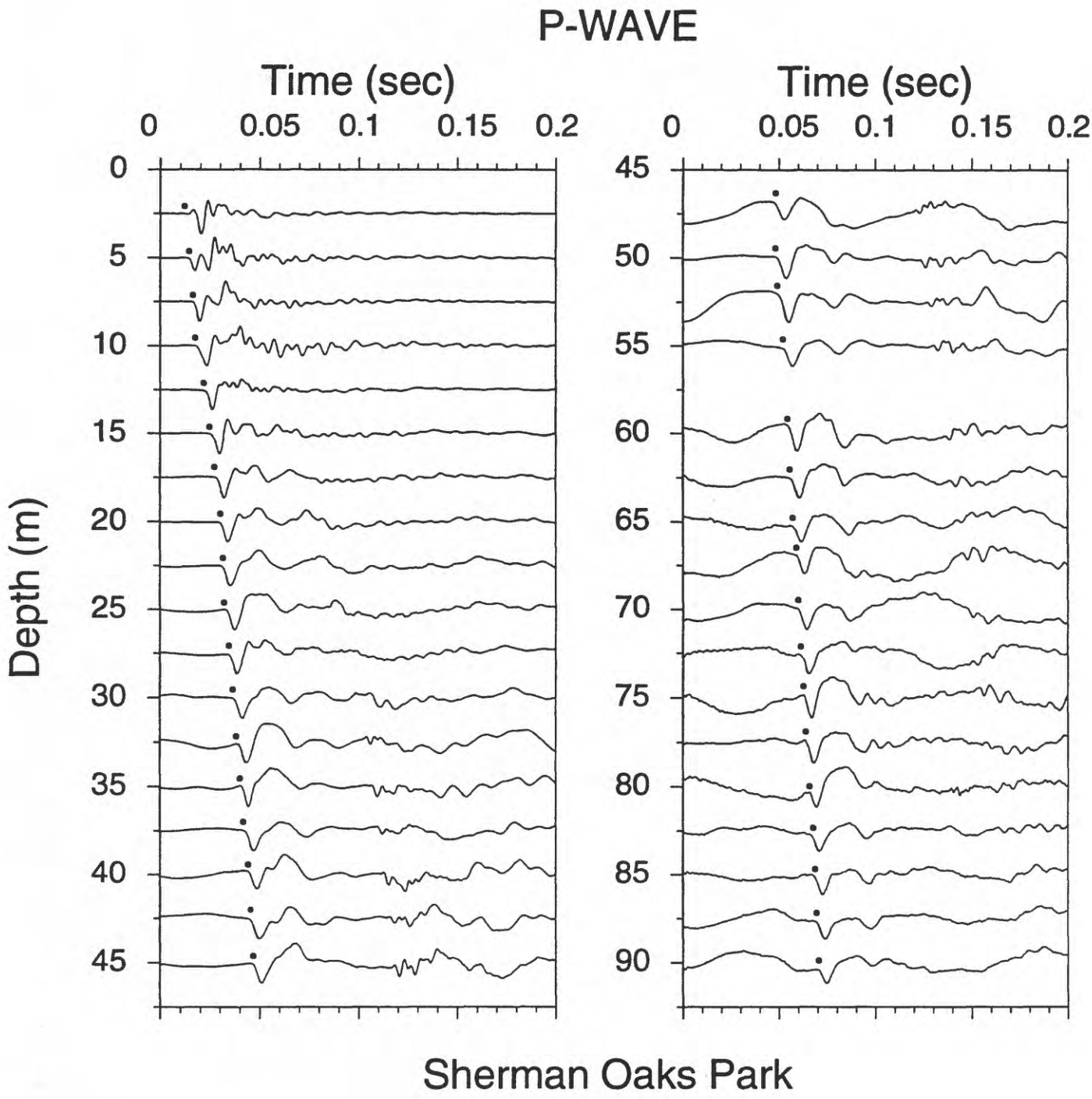

Figure 52. Vertical component record section. P-wave arrivals are indicated by the solid circles.

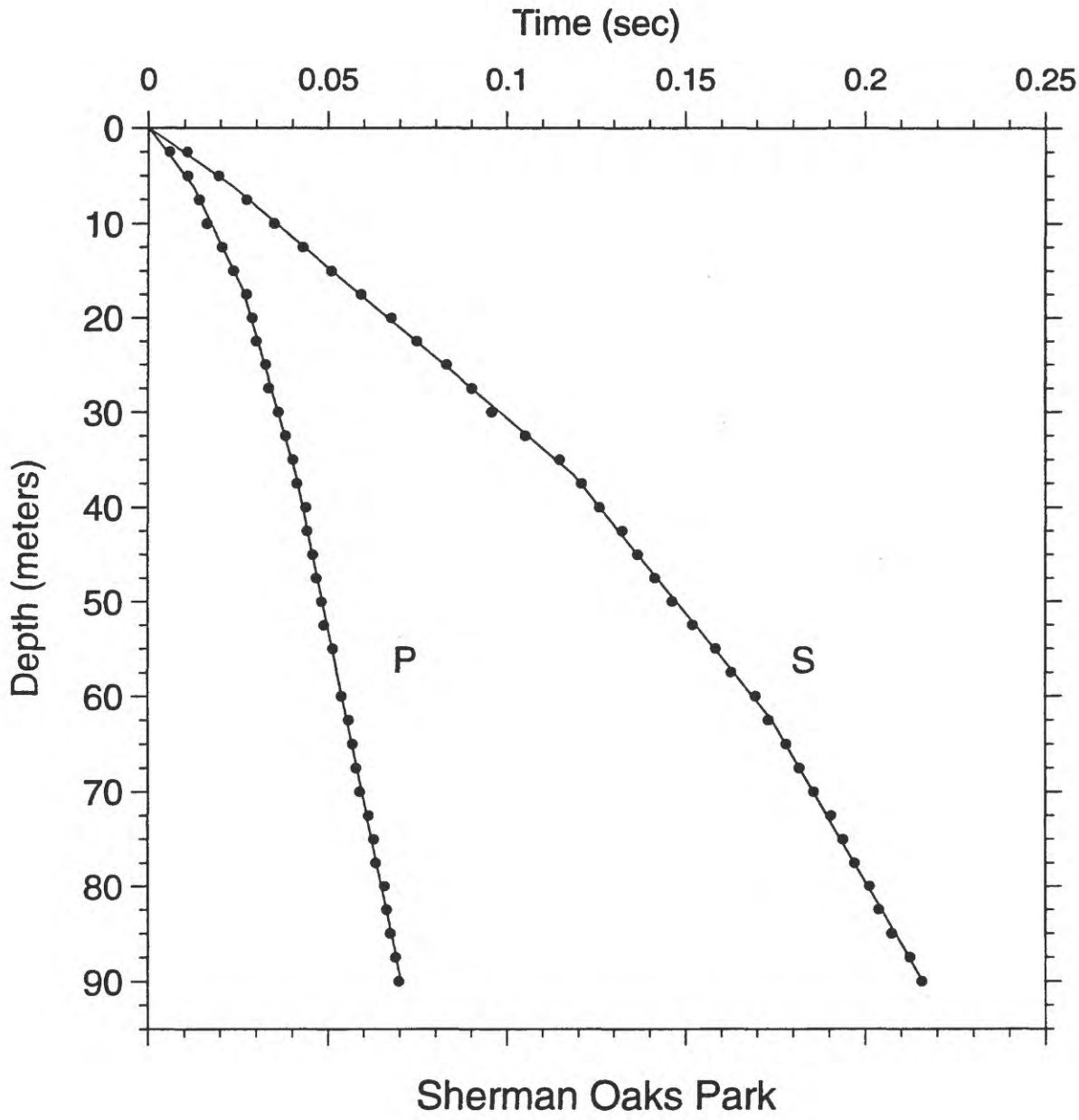

Figure 53. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

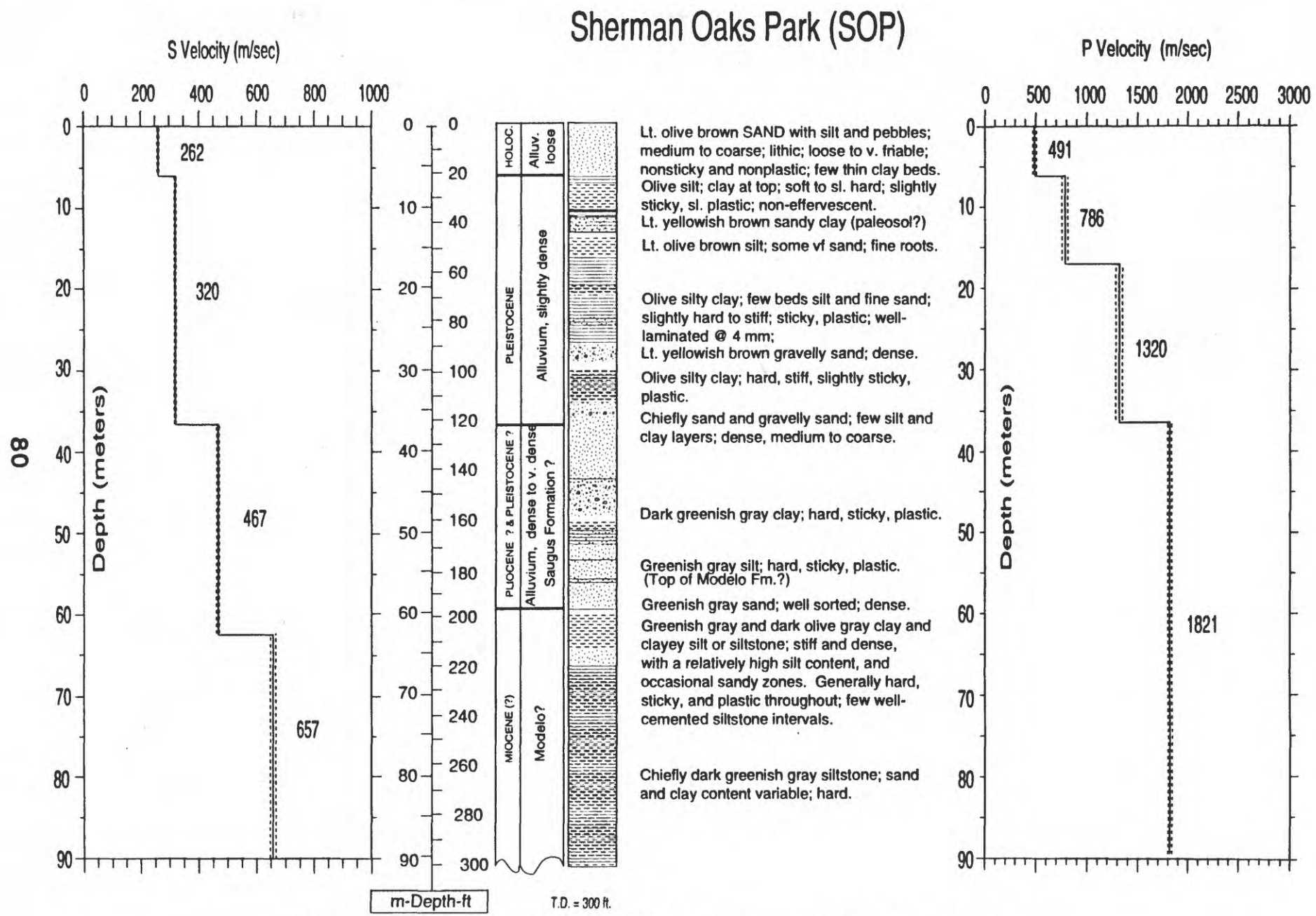

Figure 54. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 18. S-wave arrival times and velocity summaries for the Sherman Oaks Park site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0107	1	1.1
5.0	16.4	.0194	1	.3
7.5	24.6	.0272	1	-.5
10.0	32.8	.0349	1	-.6
12.5	41.0	.0430	1	-.3
15.0	49.2	.0510	1	-.1
17.5	57.4	.0593	1	.3
20.0	65.6	.0677	1	.9
22.5	73.8	.0748	1	.2
25.0	82.0	.0831	1	.7
27.5	90.2	.0903	1	.1
30.0	98.4	.0959	1	-2.1
32.5	106.6	.1052	1	-.6
35.0	114.8	.1148	1	1.1
37.5	123.0	.1209	1	.3
40.0	131.2	.1260	1	.1
42.5	139.4	.1324	1	1.1
45.0	147.6	.1367	1	.0
47.5	155.8	.1415	1	-.5
50.0	164.0	.1463	1	-1.1
52.5	172.2	.1520	1	-.7
55.0	180.4	.1584	1	.3
57.5	188.6	.1628	1	-.6
60.0	196.9	.1696	1	.8
62.5	205.1	.1732	1	-.9
65.0	213.3	.1781	1	.2
67.5	221.5	.1817	1	.0
70.0	229.7	.1857	1	.2
72.5	237.9	.1905	1	1.2
75.0	246.1	.1939	1	.8
77.5	254.3	.1971	1	.2
80.0	262.5	.2013	1	.6
82.5	270.7	.2038	1	-.7
85.0	278.9	.2074	1	-1.0
87.5	287.1	.2124	1	.2
90.0	295.3	.2158	1	-.2

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
6.1	6.1	262	258	266
36.6	30.5	320	318	322
62.5	25.9	467	463	471
90.0	27.5	657	648	667

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
20.0	20.0	859	845	873	.023
120.1	100.1	1049	1043	1056	.119
205.1	85.0	1532	1519	1546	.174
295.3	90.2	2156	2126	2187	.216

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 19. P-wave arrival times and velocity summaries for the Sherman Oaks Park site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0058	1	.7
5.0	16.4	.0109	1	.7
7.5	24.6	.0141	1	-.1
10.0	32.8	.0162	1	-1.2
12.5	41.0	.0205	1	-.1
15.0	49.2	.0237	1	.0
17.5	57.4	.0273	1	.6
20.0	65.6	.0289	1	.3
22.5	73.8	.0300	1	-.5
25.0	82.0	.0326	1	.3
27.5	90.2	.0336	1	-.6
30.0	98.4	.0362	1	.1
32.5	106.6	.0382	1	.2
35.0	114.8	.0402	1	.3
37.5	123.0	.0413	1	-.3
40.0	131.2	.0438	1	.8
42.5	139.4	.0443	1	-.1
45.0	147.6	.0458	1	.0
47.5	155.8	.0468	1	-.3
50.0	164.0	.0483	1	-.2
52.5	172.2	.0489	1	-1.0
55.0	180.4	.0514	1	.2
60.0	196.9	.0539	1	-.1
62.5	205.1	.0559	1	.5
65.0	213.3	.0569	1	.2
67.5	221.5	.0579	1	-.2
70.0	229.7	.0589	1	-.6
72.5	237.9	.0614	1	.5
75.0	246.1	.0629	1	.7
77.5	254.3	.0634	1	-.2
80.0	262.5	.0659	1	.9
82.5	270.7	.0664	1	.1
85.0	278.9	.0674	1	-.3
87.5	287.1	.0689	1	-.2
90.0	295.3	.0699	1	-.6

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
6.1	6.1	491	477	506	20.0	20.0	1611	1566	1660	.012
17.0	10.9	786	758	816	55.8	35.8	2579	2488	2677	.026
36.6	19.6	1320	1288	1353	120.1	64.3	4330	4225	4441	.041
90.0	53.4	1821	1800	1842	295.3	175.2	5975	5907	6044	.070

Explanation:

d(m) = depth in meters
d(ft) = depth in feet
t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
sig = sigma, standard deviation normalized to the standard deviation of best picks
rsdl/sig = least-squares residual divided by sigma
dtb(m) = depth to bottom in meters
thk(m) = thickness of layer in meters
v(m/s) = velocity in meters per second
vl(m/s) = lower limit of velocity in meters per second *
vu(m/s) = upper limit of velocity in meters per second
dtb(ft) = depth to bottom of layer in feet
thk(ft) = thickness of layer in feet
v(ft/s) = velocity in feet per second
vl(ft/s) = lower limit of velocity in feet per second
vu(ft/s) = upper limit of velocity in feet per second
ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

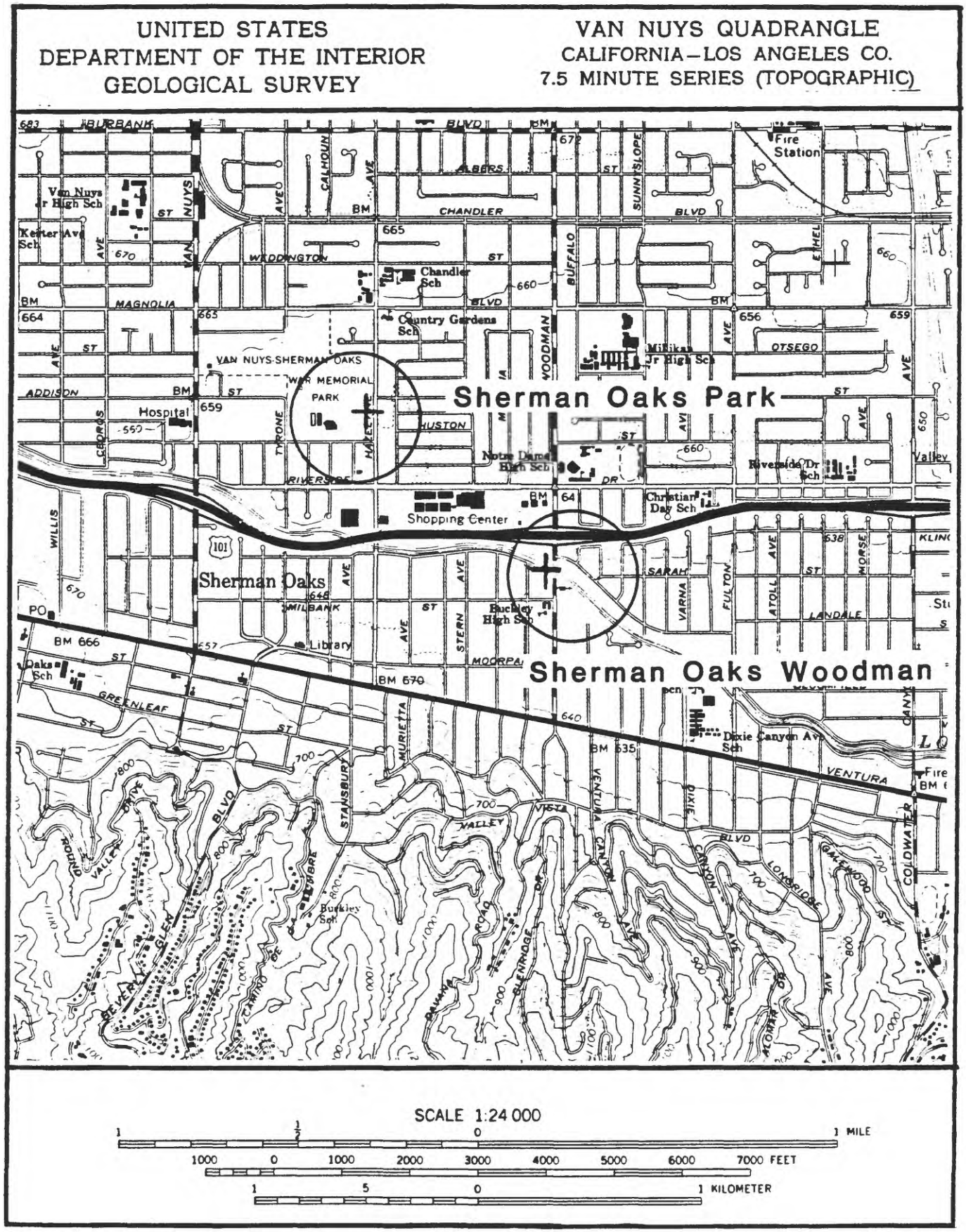

Figure 55. Site location map for the borehole at Sherman Oaks Woodman. No accelerograph is located at this site.

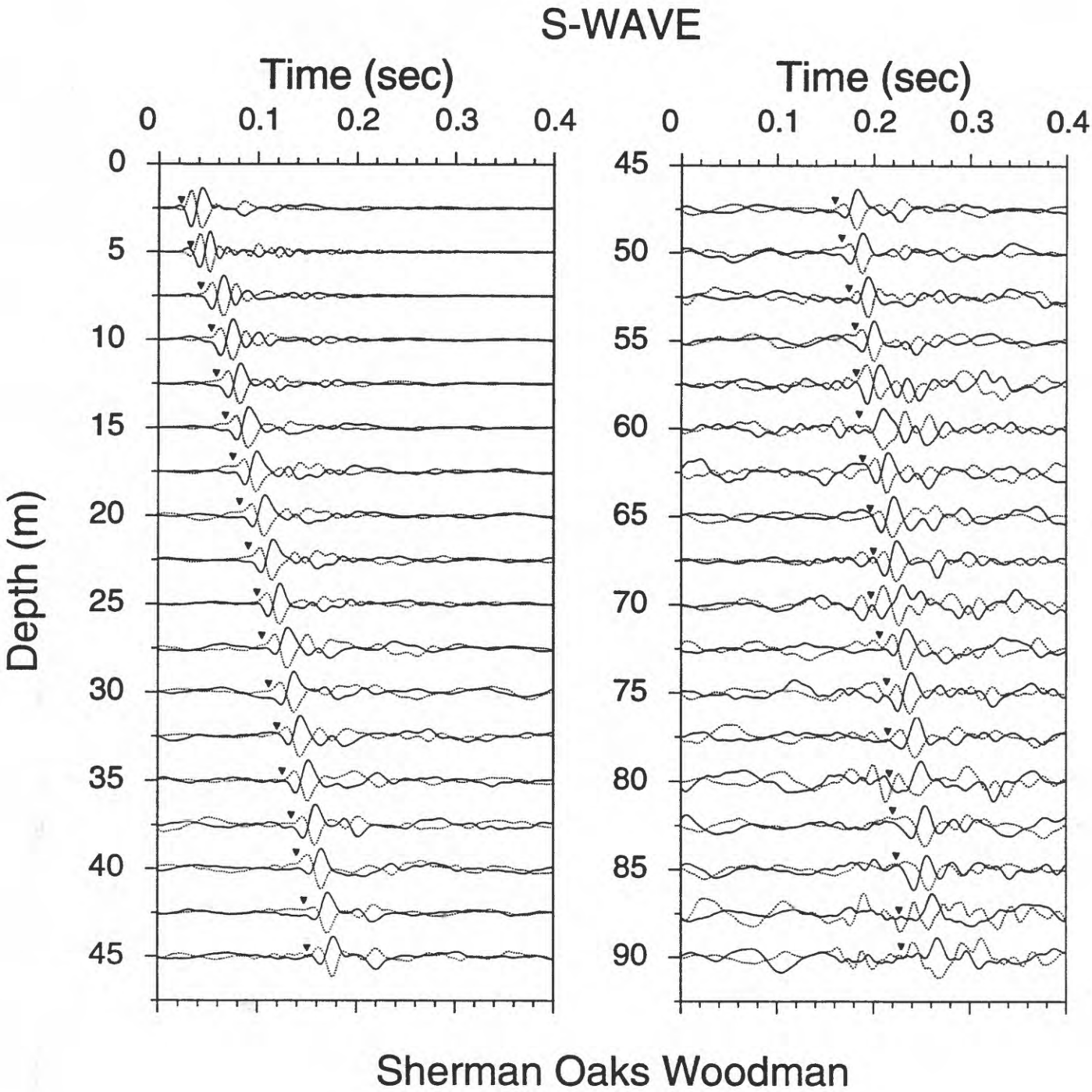

Figure 56. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

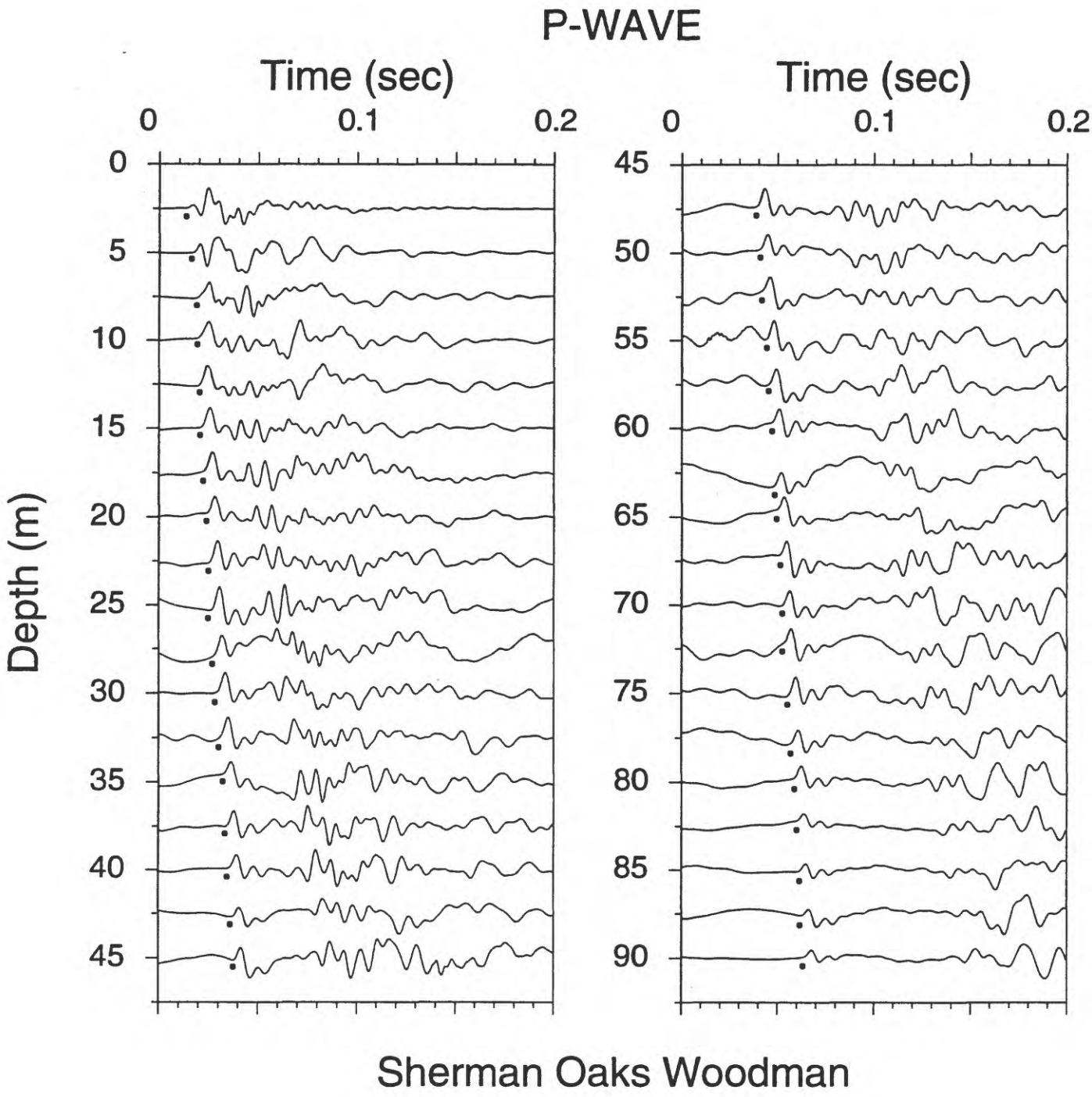

Figure 57. Vertical component record section. P-wave arrivals are indicated by the solid circles.

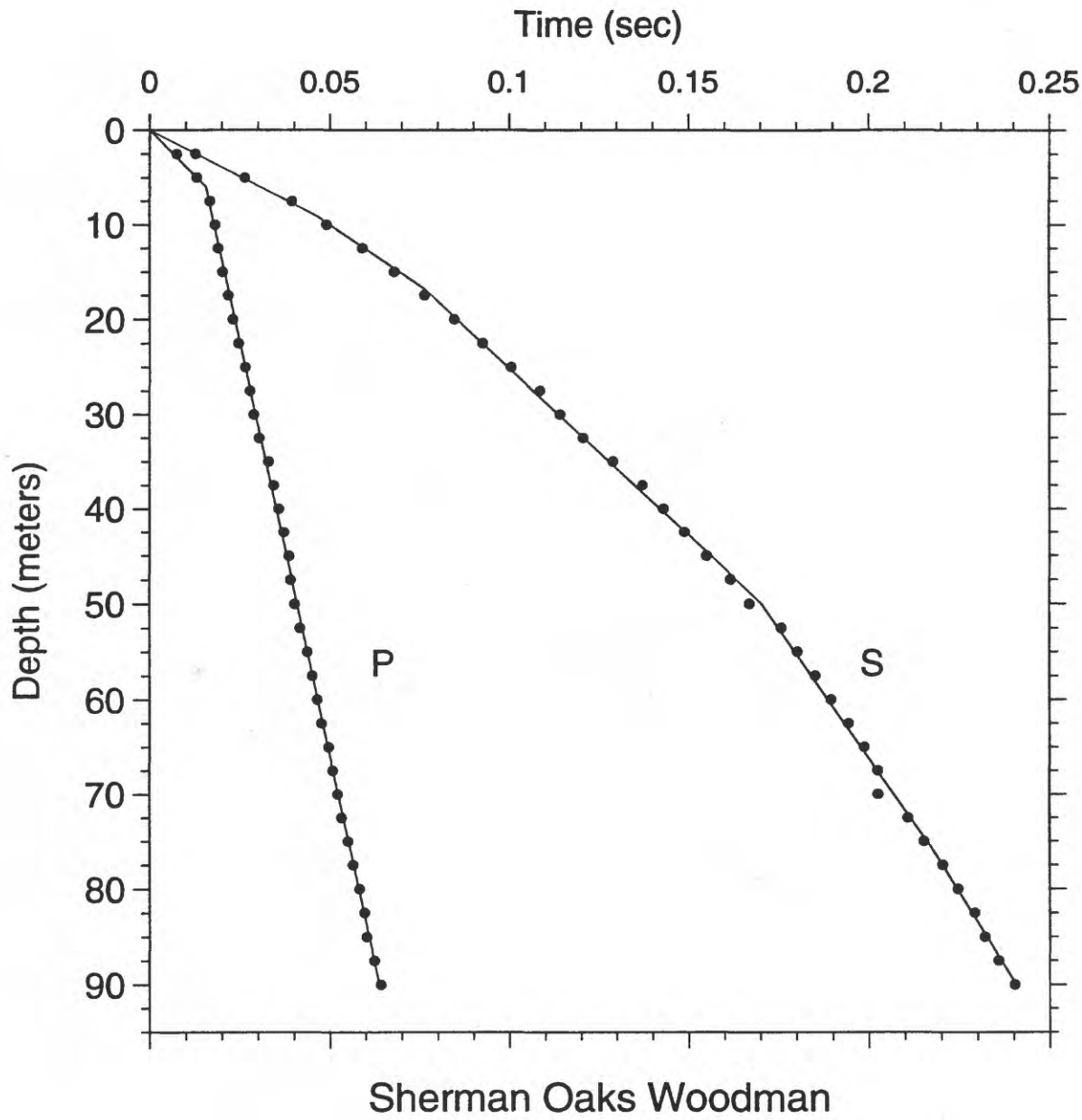

Figure 58. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

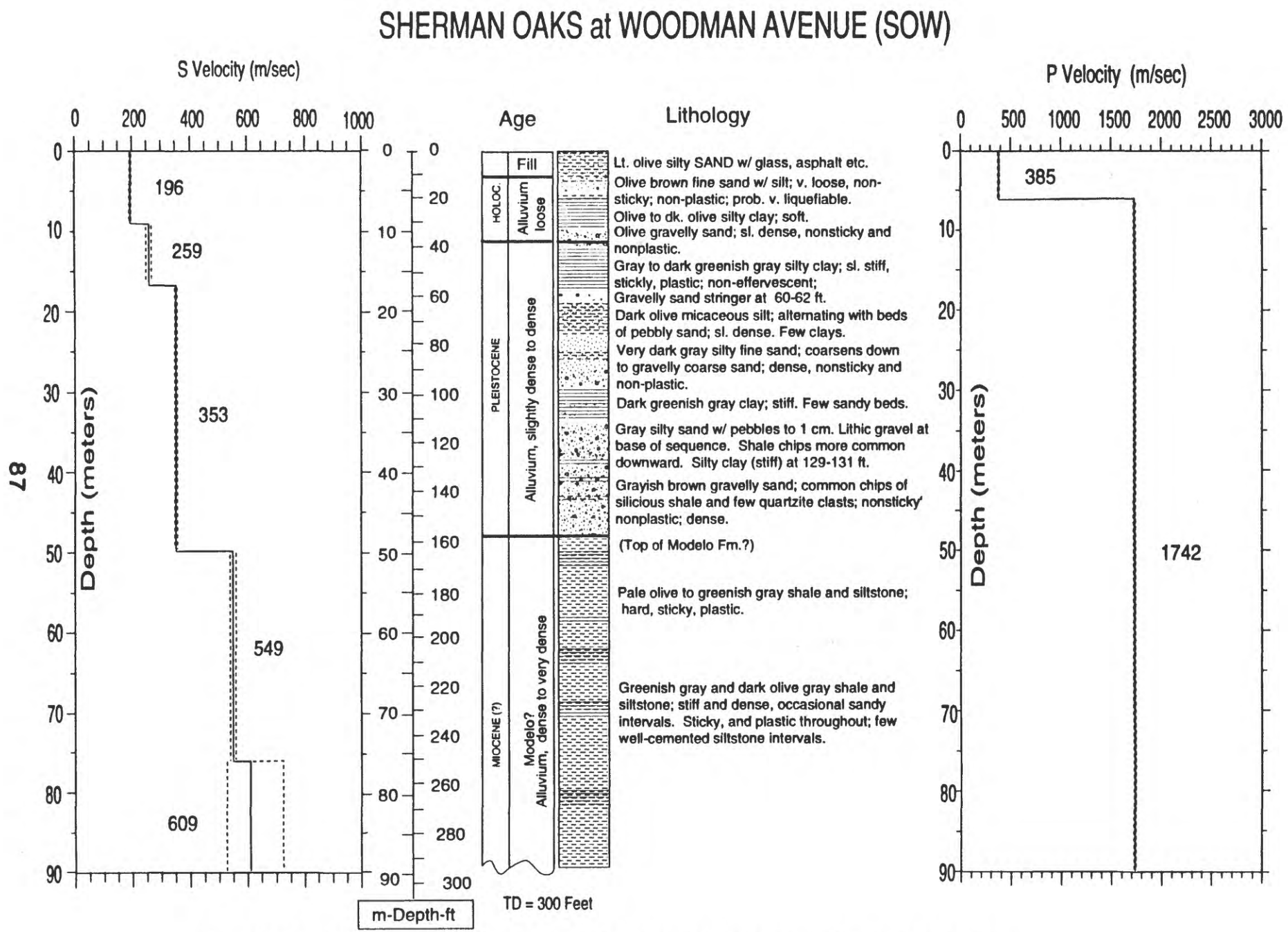

Figure 59. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 20. S-wave arrival times and velocity summaries for the Sherman Oaks Woodman site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0127	1	-.1
5.0	16.4	.0263	1	.8
7.5	24.6	.0394	1	1.1
10.0	32.8	.0492	1	-.8
12.5	41.0	.0591	1	-.5
15.0	49.2	.0680	1	-1.3
17.5	57.4	.0764	1	-1.9
20.0	65.6	.0847	1	-.7
22.5	73.8	.0926	1	.2
25.0	82.0	.1005	1	1.0
27.5	90.2	.1086	1	2.0
30.0	98.4	.1142	1	.5
32.5	106.6	.1207	1	-.1
35.0	114.8	.1290	1	1.1
37.5	123.0	.1372	1	2.2
40.0	131.2	.1431	1	1.0
42.5	139.4	.1489	1	-.3
45.0	147.6	.1550	1	-1.2
47.5	155.8	.1618	1	-1.5
50.0	164.0	.1671	1	-3.3
52.5	172.2	.1759	1	.9
55.0	180.4	.1803	1	.8
57.5	188.6	.1852	2	.6
60.0	196.9	.1896	3	.3
62.5	205.1	.1944	1	1.2
65.0	213.3	.1988	2	.5
67.5	221.5	.2026	1	.3
70.0	229.7	.2027	3	-1.4
72.5	237.9	.2109	1	-.5
75.0	246.1	.2153	1	-.7
77.5	254.3	.2205	1	.2
80.0	262.5	.2247	4	.1
82.5	270.7	.2293	3	.3
85.0	278.9	.2321	4	-.1
87.5	287.1	.2360	5	-.1
90.0	295.3	.2404	5	-.1

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
9.1	9.1	196	192	199
16.8	7.7	259	250	268
50.0	33.2	353	349	356
76.2	26.2	549	538	559
90.0	13.8	609	527	722

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
29.9	29.9	642	631	653	.046
55.1	25.3	848	820	879	.076
164.0	108.9	1157	1147	1168	.170
250.0	86.0	1800	1767	1835	.218
295.3	45.3	1998	1728	2368	.241

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 21. P-wave arrival times and velocity summaries for the Sherman Oaks Woodman site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0074	1	.9
5.0	16.4	.0131	1	.1
7.5	24.6	.0168	1	.4
10.0	32.8	.0182	1	.3
12.5	41.0	.0190	1	-.3
15.0	49.2	.0203	1	-.4
17.5	57.4	.0218	1	-.4
20.0	65.6	.0231	1	-.5
22.5	73.8	.0246	1	-.5
25.0	82.0	.0265	1	.0
27.5	90.2	.0279	1	.0
30.0	98.4	.0289	1	-.5
32.5	106.6	.0304	1	-.4
35.0	114.8	.0330	1	.8
37.5	123.0	.0344	1	.7
40.0	131.2	.0358	1	.7
42.5	139.4	.0372	1	.7
45.0	147.6	.0386	1	.6
47.5	155.8	.0391	1	-.3
50.0	164.0	.0403	1	-.5
52.5	172.2	.0417	1	-.6
55.0	180.4	.0437	1	.0
57.5	188.6	.0451	1	.0
60.0	196.9	.0465	1	-.1
62.5	205.1	.0477	1	-.3
65.0	213.3	.0497	1	.3
67.5	221.5	.0509	1	.0
70.0	229.7	.0523	1	.0
72.5	237.9	.0533	1	-.4
75.0	246.1	.0551	1	-.1
77.5	254.3	.0565	1	-.1
80.0	262.5	.0583	1	.2
82.5	270.7	.0597	1	.2
85.0	278.9	.0603	1	-.6
87.5	287.1	.0625	1	.1
90.0	295.3	.0643	1	.5

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
6.0	6.0	385	382	389	19.7	19.7	1263	1252	1275	.016
90.0	84.0	1742	1733	1752	295.3	275.6	5716	5687	5746	.064

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

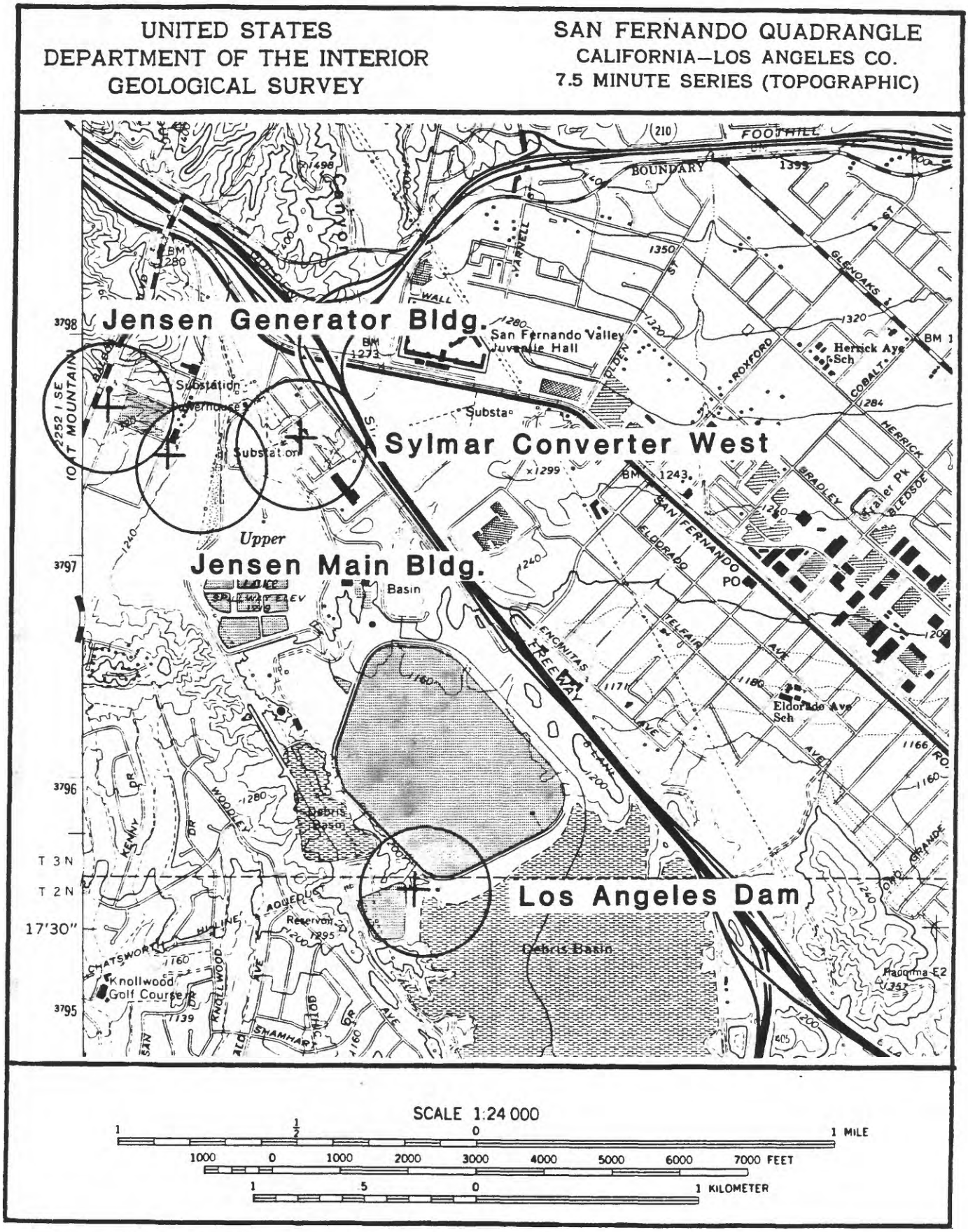

Figure 60. Site location map for the borehole at Sylmar Converter West. The accelerograph is located approximately 10 meters from the borehole.

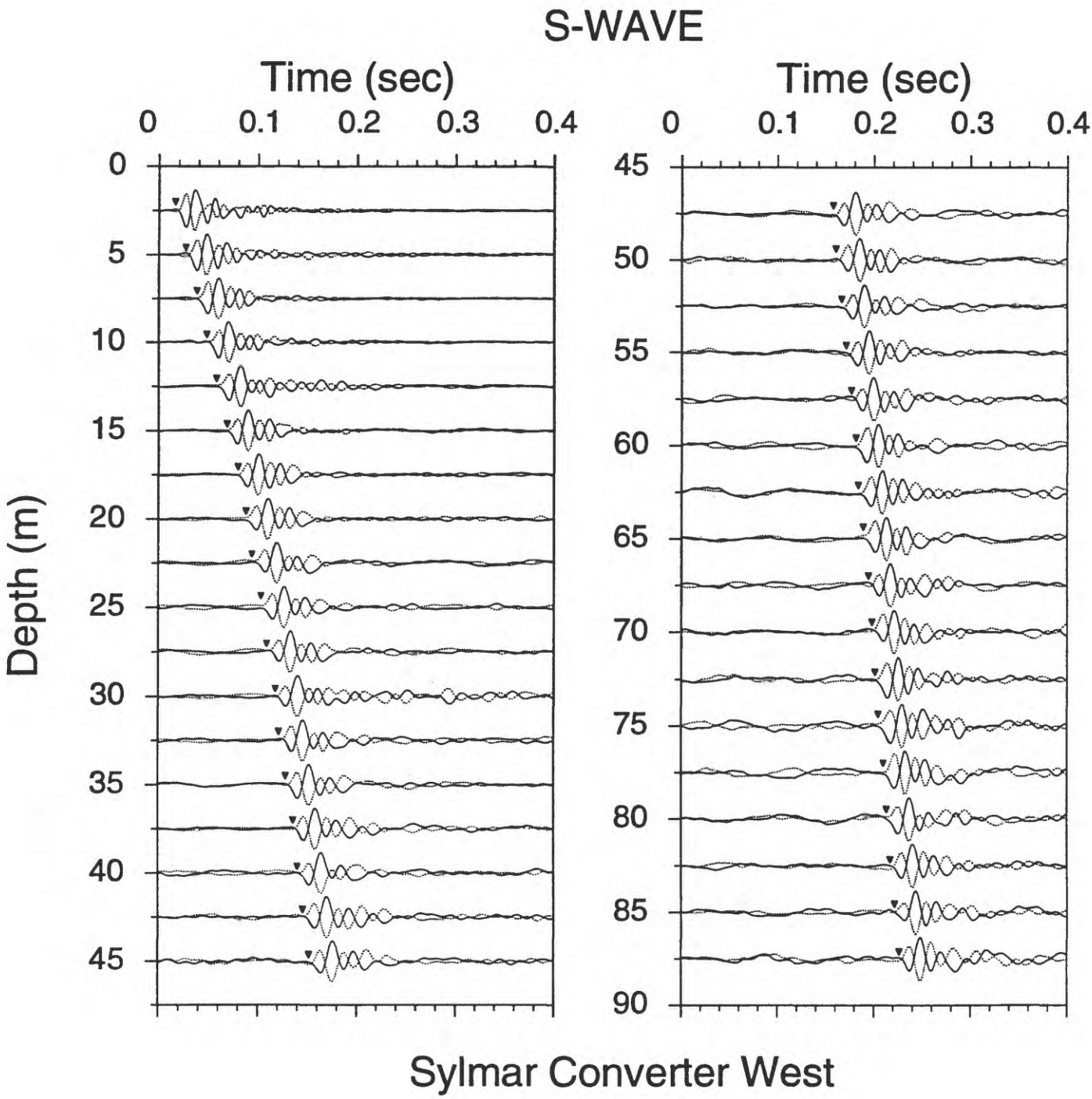

Figure 61. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

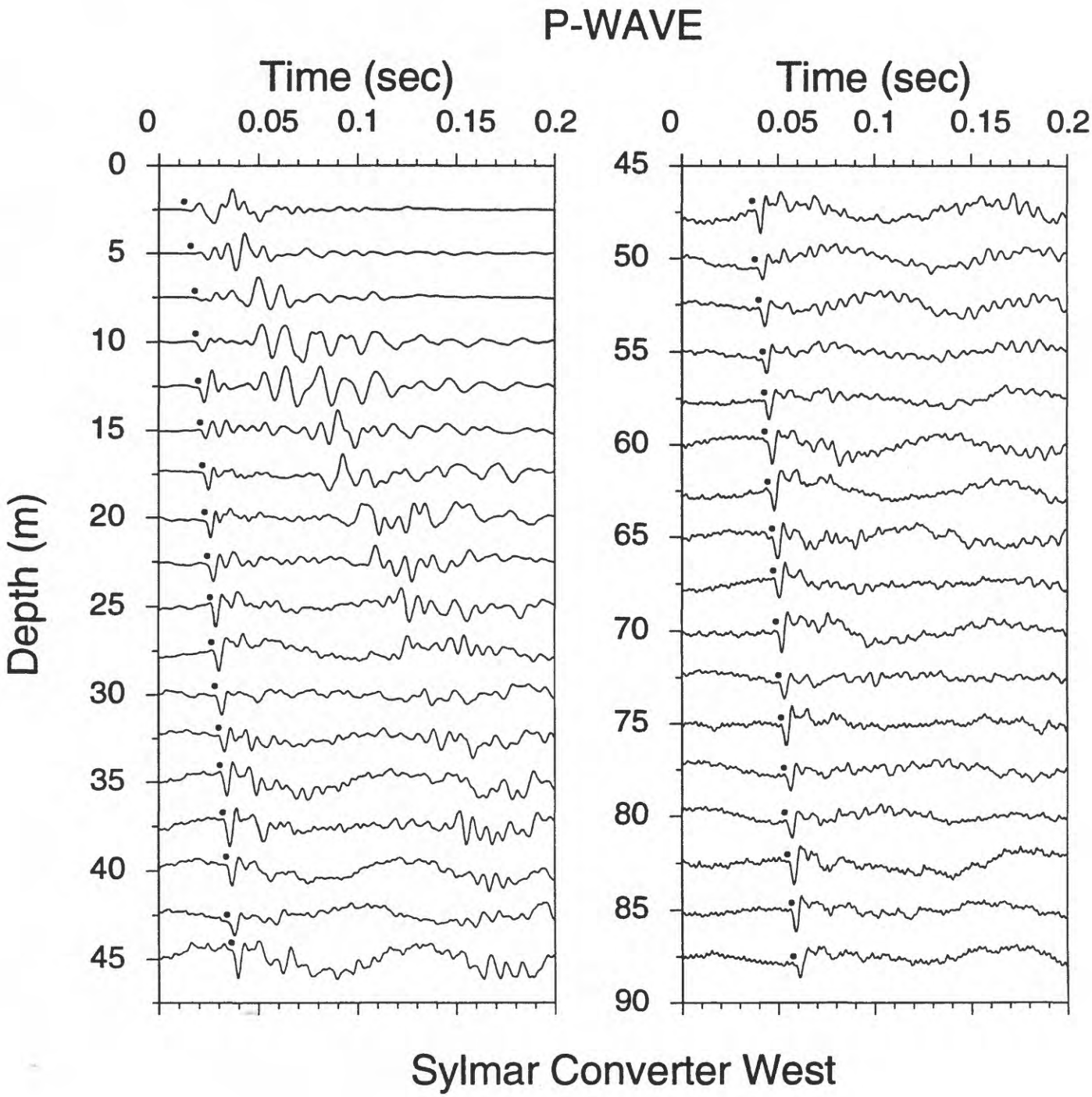

Figure 62. Vertical component record section. P-wave arrivals are indicated by the solid circles.

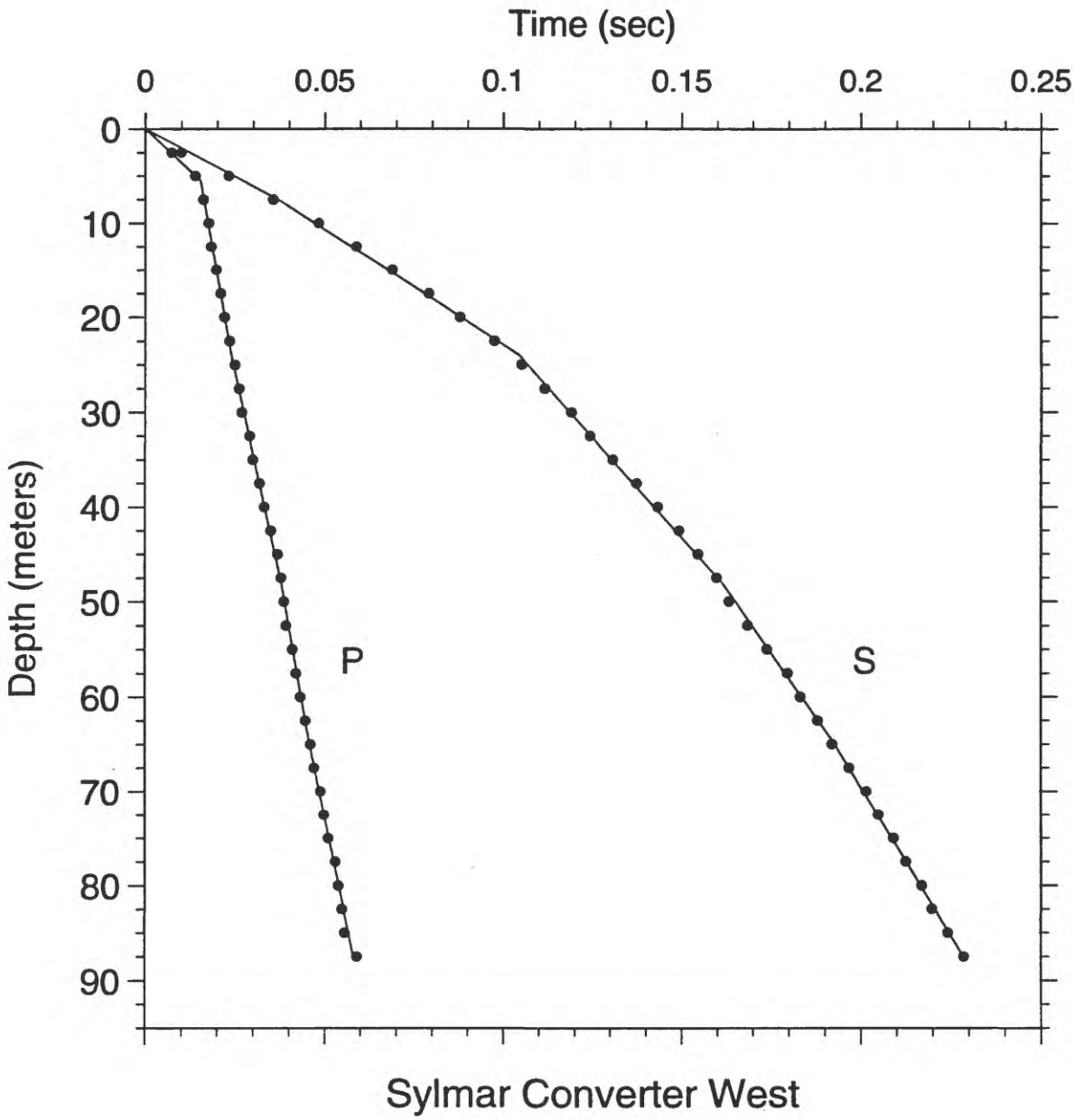

Figure 63. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

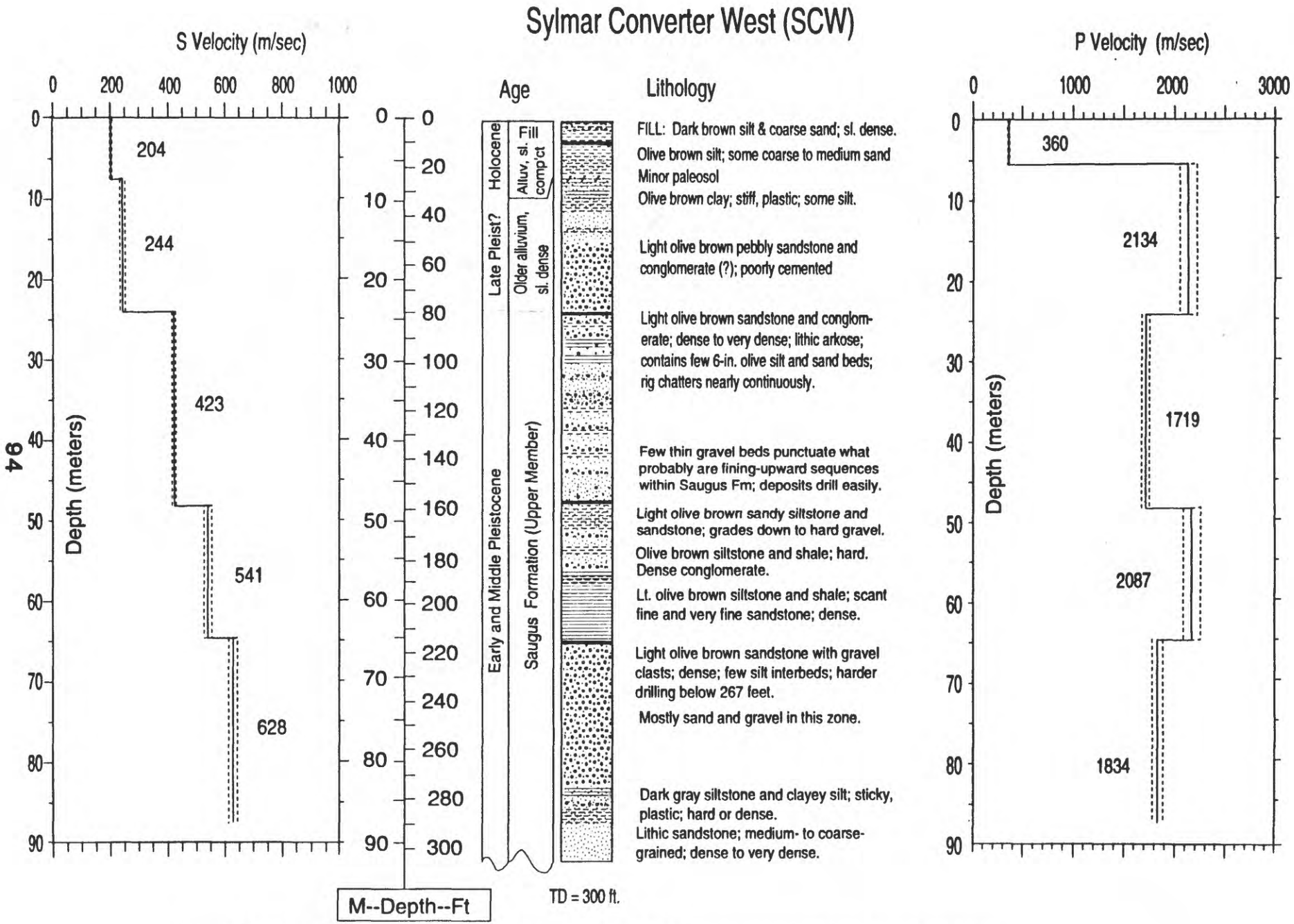

Figure 64. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 22. S-wave arrival times and velocity summaries for the Sylmar Converter West site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0099	1	-2.4
5.0	16.4	.0231	1	-1.4
7.5	24.6	.0356	1	-1.2
10.0	32.8	.0482	1	1.1
12.5	41.0	.0588	1	1.4
15.0	49.2	.0688	1	1.2
17.5	57.4	.0790	1	1.2
20.0	65.6	.0879	1	-.2
22.5	73.8	.0975	1	-.8
25.0	82.0	.1051	1	-1.7
27.5	90.2	.1116	1	-1.1
30.0	98.4	.1191	1	.5
32.5	106.6	.1243	1	-.2
35.0	114.8	.1308	1	.4
37.5	123.0	.1374	1	1.0
40.0	131.2	.1433	1	1.0
42.5	139.4	.1493	1	1.1
45.0	147.6	.1546	1	.5
47.5	155.8	.1598	1	-.2
50.0	164.0	.1633	1	-1.7
52.5	172.2	.1685	1	-1.1
55.0	180.4	.1739	1	-.3
57.5	188.6	.1796	1	.7
60.0	196.9	.1832	1	-.3
62.5	205.1	.1880	1	-.1
65.0	213.3	.1920	1	-.6
67.5	221.5	.1967	1	.1
70.0	229.7	.2015	1	.9
72.5	237.9	.2049	1	.3
75.0	246.1	.2091	1	.5
77.5	254.3	.2125	1	.0
80.0	262.5	.2169	1	.4
82.5	270.7	.2197	1	-.8
85.0	278.9	.2242	1	-.3
87.5	287.1	.2286	1	.1

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)	dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
7.6	7.6	204	201	207	24.9	24.9	668	658	679	.037
24.0	16.4	244	241	248	78.7	53.8	802	792	812	.104
48.2	24.2	423	417	429	158.1	79.4	1387	1368	1406	.162
64.6	16.4	541	528	555	211.9	53.8	1774	1731	1819	.192
87.5	22.9	628	613	643	287.1	75.1	2059	2011	2111	.228

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 23. P-wave arrival times and velocity summaries for the Sylmar Converter West site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0072	1	.3
5.0	16.4	.0139	1	.0
7.5	24.6	.0161	1	-.1
10.0	32.8	.0176	1	.2
12.5	41.0	.0183	1	-.3
15.0	49.2	.0197	1	.0
17.5	57.4	.0209	1	.0
20.0	65.6	.0220	1	-.1
22.5	73.8	.0234	1	.2
25.0	82.0	.0249	1	.4
27.5	90.2	.0261	1	.1
30.0	98.4	.0268	1	-.6
32.5	106.6	.0290	1	.1
35.0	114.8	.0300	1	-.3
37.5	123.0	.0318	1	.0
40.0	131.2	.0332	1	-.1
42.5	139.4	.0350	1	.3
45.0	147.6	.0369	1	.7
47.5	155.8	.0379	1	.3
50.0	164.0	.0387	1	-.2
52.5	172.2	.0393	1	-.7
55.0	180.4	.0411	1	-.1
57.5	188.6	.0421	1	-.2
60.0	196.9	.0433	1	-.2
62.5	205.1	.0447	1	.1
65.0	213.3	.0461	1	.3
67.5	221.5	.0471	1	-.1
70.0	229.7	.0489	1	.4
72.5	237.9	.0499	1	.0
75.0	246.1	.0511	1	-.2
77.5	254.3	.0531	1	.5
80.0	262.5	.0539	1	-.1
82.5	270.7	.0549	1	-.4
85.0	278.9	.0557	1	-1.0
87.5	287.1	.0591	1	1.0

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
5.5	5.5	360	354	366
24.0	18.5	2134	2051	2222
48.2	24.2	1719	1682	1757
64.6	16.4	2170	2087	2260
87.5	22.9	1834	1783	1887

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
18.0	18.0	1181	1163	1200	.015
78.7	60.7	7000	6731	7291	.024
158.1	79.4	5639	5519	5764	.038
211.9	53.8	7120	6847	7416	.046
287.1	75.1	6016	5851	6191	.058

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

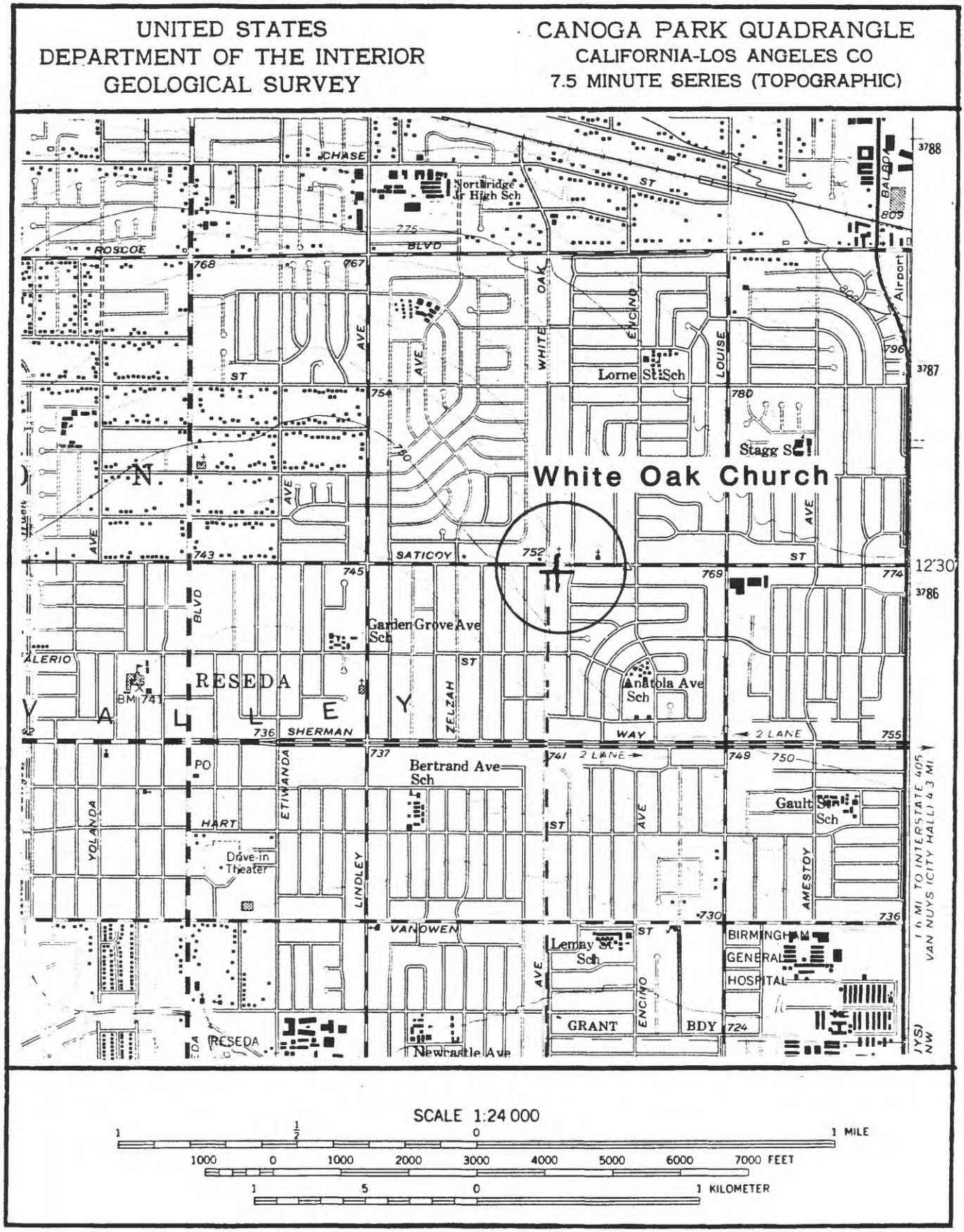

Figure 65. Site location map for the borehole at White Oak Church. The accelerograph is located approximately 50 meters from the borehole.

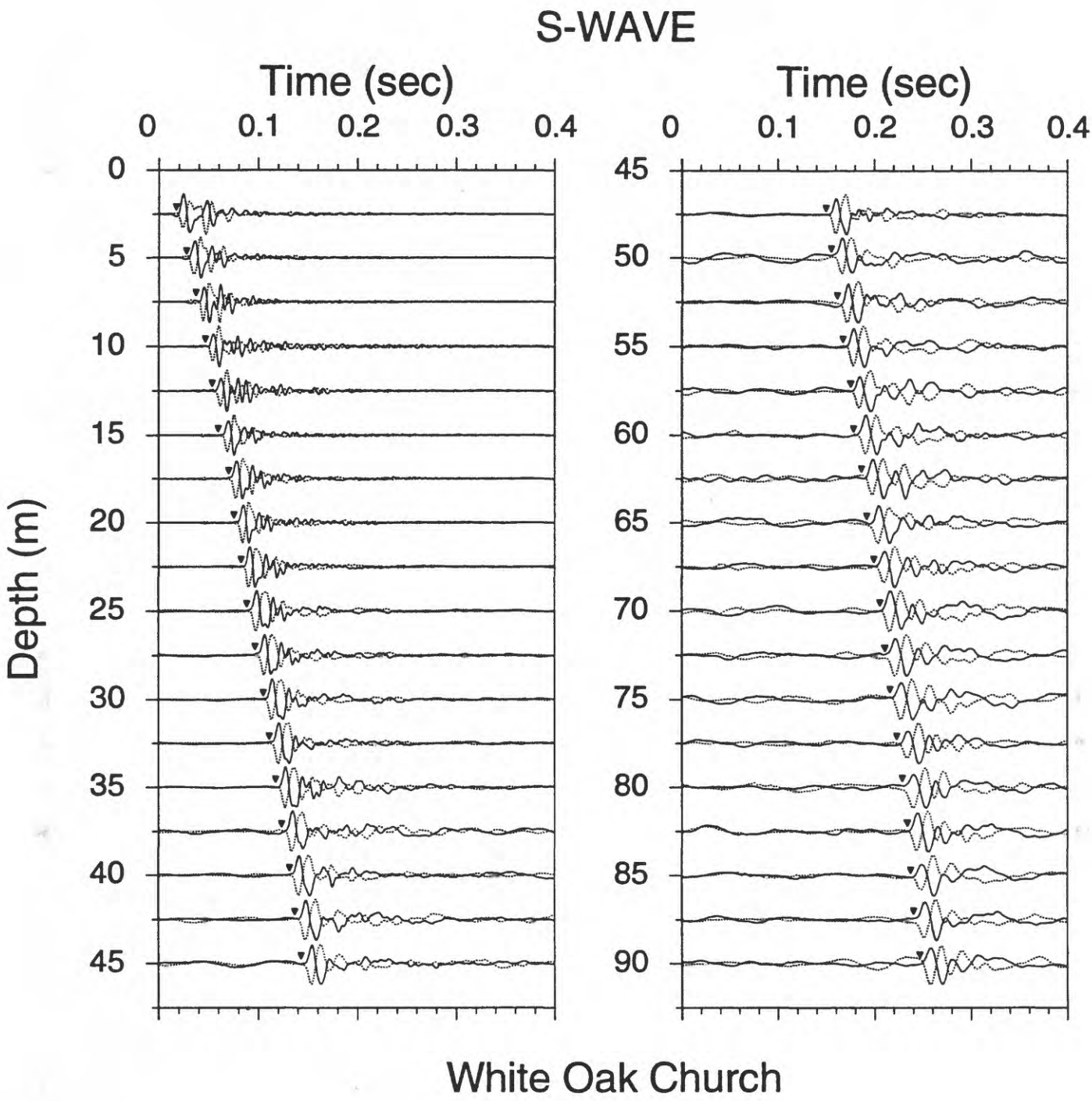

Figure 66. Horizontal component record section (from impacts in opposite directions) superimposed for identification of S-wave onset. Approximate S-wave time picks are indicated by the inverted triangles.

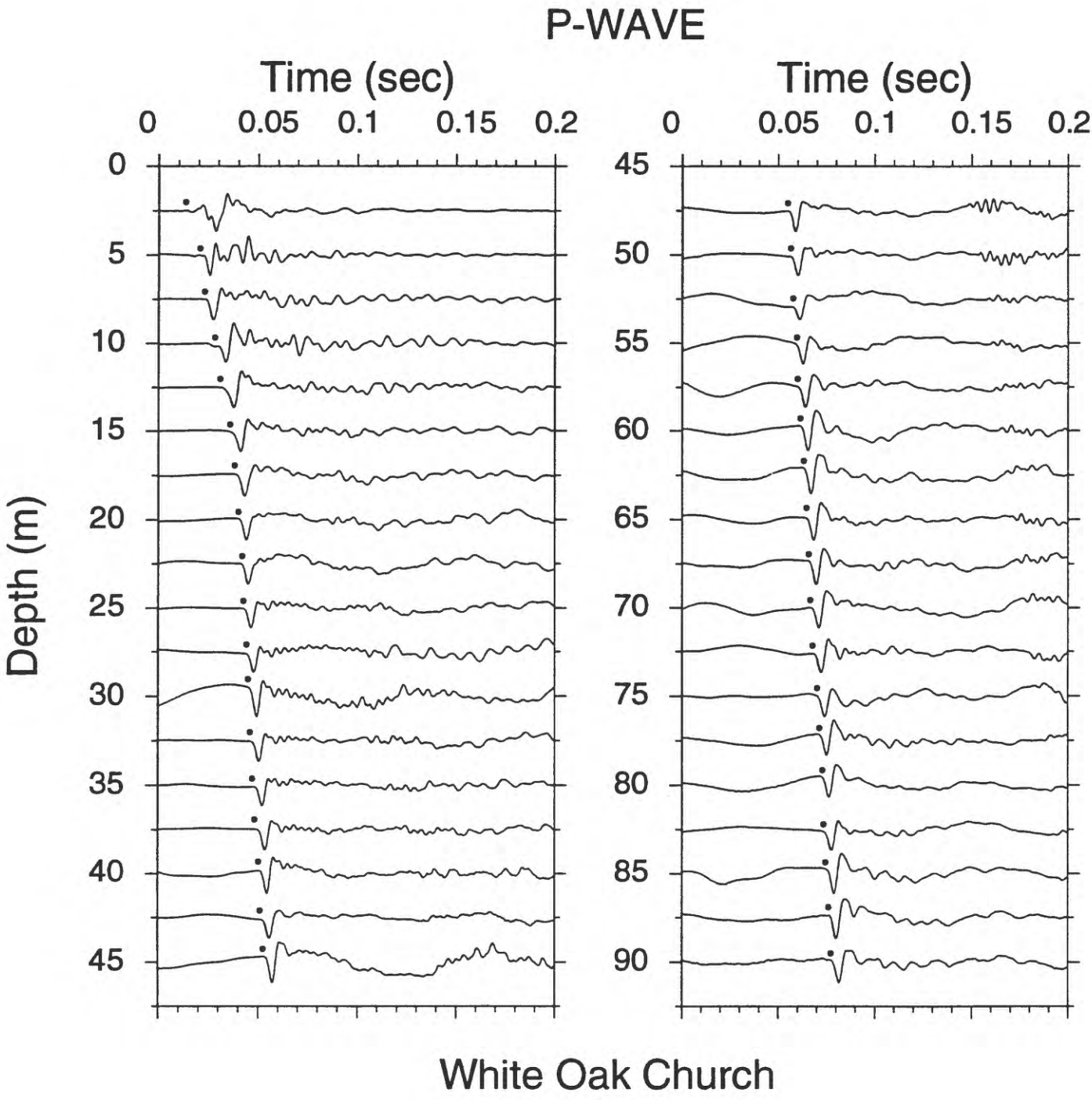

Figure 67. Vertical component record section. P-wave arrivals are indicated by the solid circles.

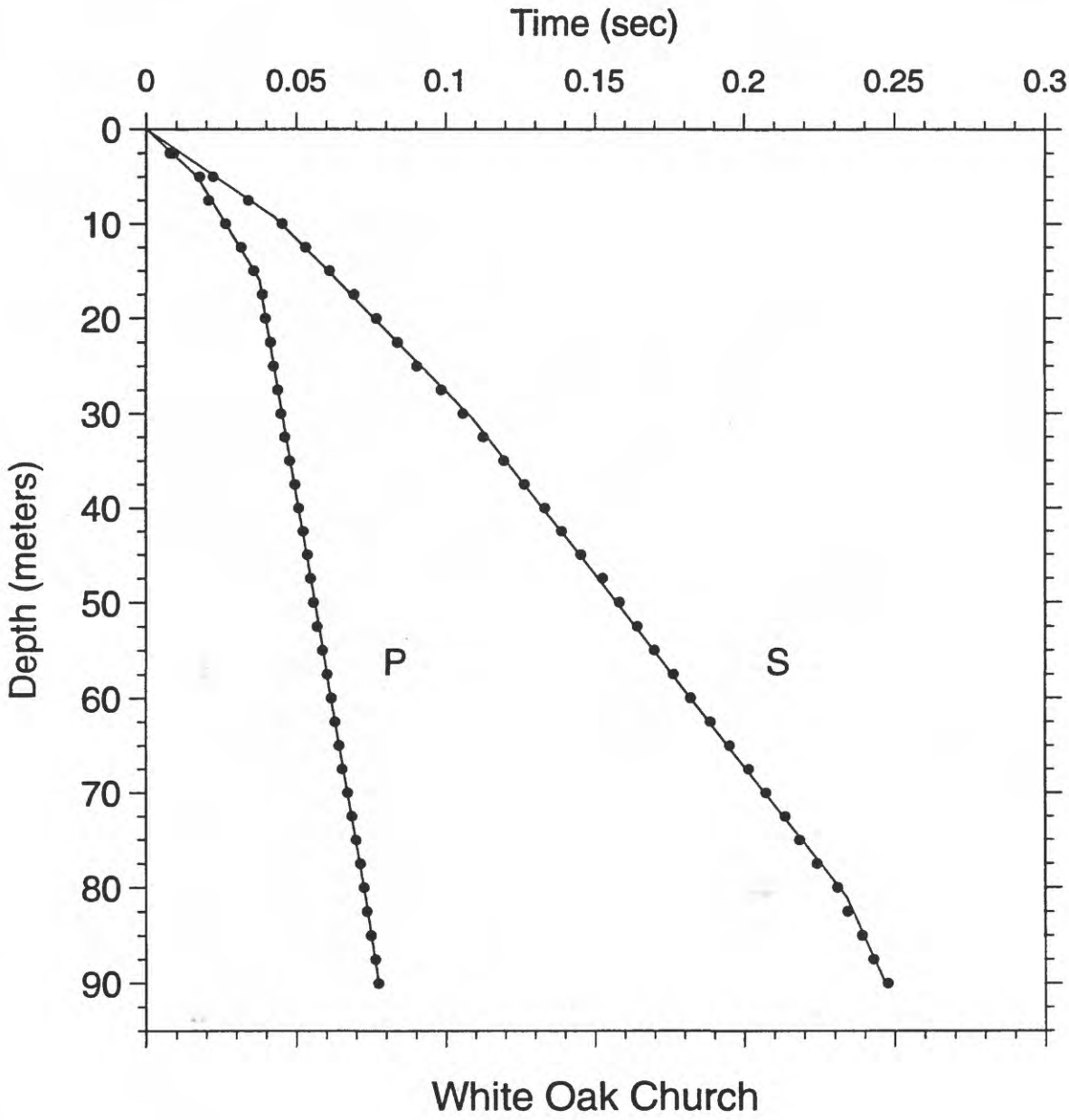

Figure 68. Time-depth graph of P-wave and S-wave picks. Line segments show the hinged-least-squares fit to the data points.

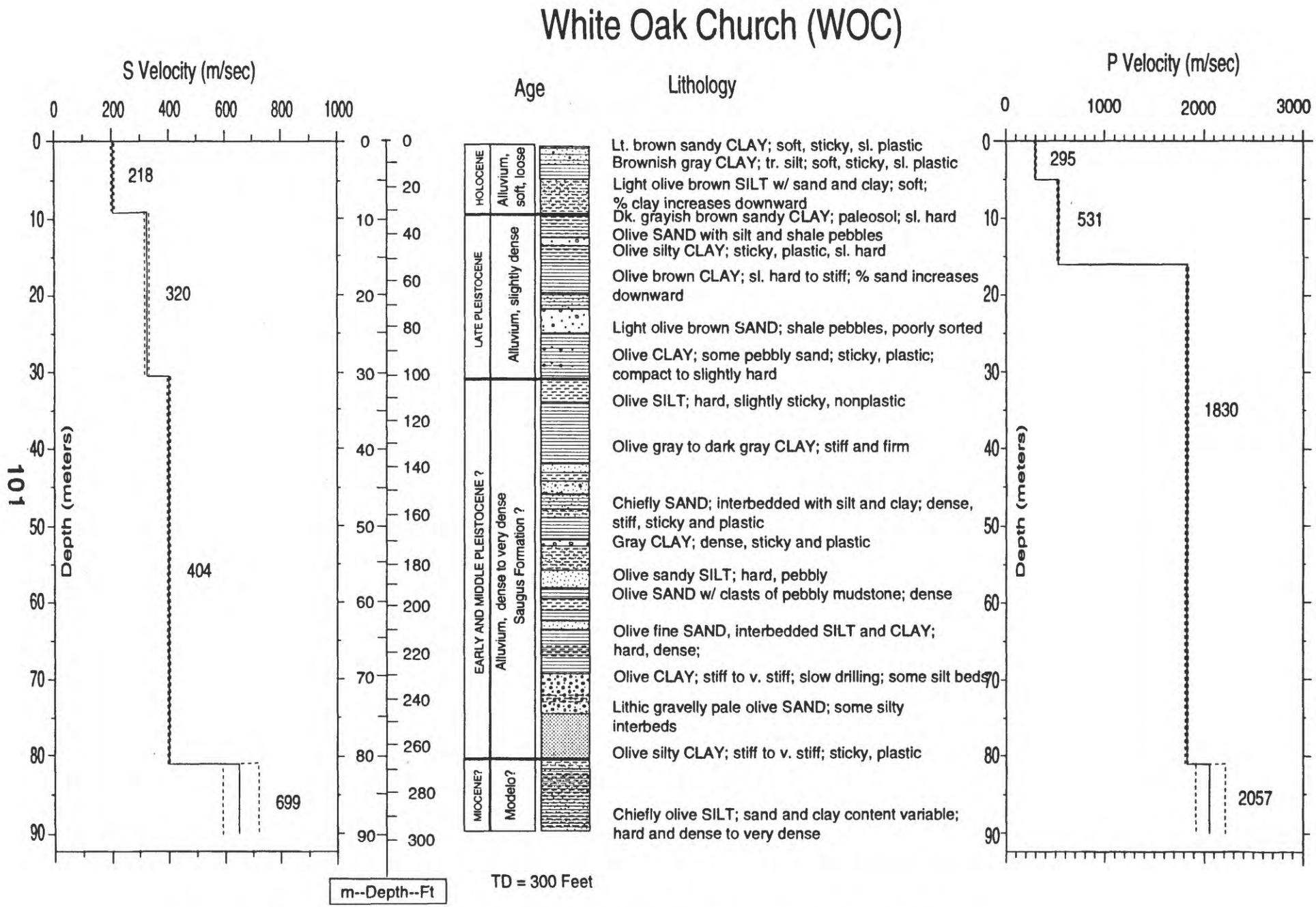

Figure 69. S- and P-wave velocity profiles with dashed lines representing plus and minus one standard deviation. Simplified geologic log is shown for correlation with velocities.

TABLE 24. S-wave arrival times and velocity summaries for the White Oak Church site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0091	1	-2.4
5.0	16.4	.0222	1	-.8
7.5	24.6	.0339	1	-.5
10.0	32.8	.0453	1	.4
12.5	41.0	.0530	1	.3
15.0	49.2	.0611	1	.6
17.5	57.4	.0694	1	1.0
20.0	65.6	.0769	1	.7
22.5	73.8	.0839	1	-.1
25.0	82.0	.0904	1	-1.4
27.5	90.2	.0986	1	-1.0
30.0	98.4	.1059	1	-1.6
32.5	106.6	.1127	1	-1.3
35.0	114.8	.1196	1	-.6
37.5	123.0	.1265	1	.1
40.0	131.2	.1333	1	.7
42.5	139.4	.1390	1	.2
45.0	147.6	.1454	1	.4
47.5	155.8	.1527	1	1.6
50.0	164.0	.1583	1	1.0
52.5	172.2	.1643	1	.8
55.0	180.4	.1700	1	.3
57.5	188.6	.1764	1	.5
60.0	196.9	.1822	1	.1
62.5	205.1	.1888	1	.5
65.0	213.3	.1952	1	.7
67.5	221.5	.2016	1	.9
70.0	229.7	.2073	1	.4
72.5	237.9	.2137	1	.6
75.0	246.1	.2185	1	-.8
77.5	254.3	.2243	1	-1.2
80.0	262.5	.2311	1	-.6
82.5	270.7	.2345	1	-1.8
85.0	278.9	.2393	1	-.6
87.5	287.1	.2431	1	-.3
90.0	295.3	.2478	1	.8

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
9.3	9.3	218	215	220
30.5	21.2	320	316	323
81.0	50.5	404	402	406
90.0	9.0	699	654	751

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
30.5	30.5	715	706	723	.043
100.1	69.6	1049	1038	1059	.109
265.7	165.7	1324	1318	1331	.234
295.3	29.5	2293	2145	2464	.247

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits

TABLE 25. P-wave arrival times and velocity summaries for the White Oak Church site.

d(m)	d(ft)	t(sec)	sig	rsdl/sig
2.5	8.2	.0078	1	-.7
5.0	16.4	.0178	1	.8
7.5	24.6	.0208	1	-.9
10.0	32.8	.0264	1	.0
12.5	41.0	.0316	1	.5
15.0	49.2	.0358	1	.0
17.5	57.4	.0388	1	.3
20.0	65.6	.0398	1	-.1
22.5	73.8	.0415	1	.3
25.0	82.0	.0425	1	-.1
27.5	90.2	.0439	1	-.1
30.0	98.4	.0450	1	-.3
32.5	106.6	.0463	1	-.4
35.0	114.8	.0479	1	-.2
37.5	123.0	.0497	1	.3
40.0	131.2	.0509	1	.1
42.5	139.4	.0524	1	.2
45.0	147.6	.0538	1	.3
47.5	155.8	.0548	1	-.1
50.0	164.0	.0558	1	-.4
52.5	172.2	.0570	1	-.6
55.0	180.4	.0588	1	-.2
57.5	188.6	.0605	1	.2
60.0	196.9	.0619	1	.2
62.5	205.1	.0631	1	.0
65.0	213.3	.0645	1	.1
67.5	221.5	.0655	1	-.3
70.0	229.7	.0673	1	.1
72.5	237.9	.0687	1	.2
75.0	246.1	.0701	1	.2
77.5	254.3	.0715	1	.2
80.0	262.5	.0727	1	.1
82.5	270.7	.0737	1	-.2
85.0	278.9	.0751	1	.0
87.5	287.1	.0765	1	.2
90.0	295.3	.0775	1	-.1

dtb(m)	thk(m)	v(m/s)	vl(m/s)	vu(m/s)
5.0	5.0	295	291	299
16.0	11.0	531	524	539
81.0	65.0	1830	1820	1841
90.0	9.0	2057	1920	2215

dtb(ft)	thk(ft)	v(ft/s)	vl(ft/s)	vu(ft/s)	ttb(s)
16.4	16.4	967	954	981	.017
52.5	36.1	1743	1719	1767	.038
265.7	213.3	6005	5970	6041	.073
295.3	29.5	6748	6300	7266	.078

Explanation:
- d(m) = depth in meters
- d(ft) = depth in feet
- t(sec) = arrival time in seconds (S-wave arrival times are the average of picks from traces obtained from hammer blows differing in direction by 180°)
- sig = sigma, standard deviation normalized to the standard deviation of best picks
- rsdl/sig = least-squares residual divided by sigma
- dtb(m) = depth to bottom in meters
- thk(m) = thickness of layer in meters
- v(m/s) = velocity in meters per second
- vl(m/s) = lower limit of velocity in meters per second *
- vu(m/s) = upper limit of velocity in meters per second
- dtb(ft) = depth to bottom of layer in feet
- thk(ft) = thickness of layer in feet
- v(ft/s) = velocity in feet per second
- vl(ft/s) = lower limit of velocity in feet per second
- vu(ft/s) = upper limit of velocity in feet per second
- ttb(s) = time to bottom of layer in seconds

*see text for explanation of velocity limits