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Empirical Prediction of Near-Source Ground Motion For the Diablo Canyon Power Plant Site, San Luis Obispo County, California

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EMPIRICAL PREDICTION OF NEAR-SOURCE GROUND MOTION FOR THE DIABLO CANYON POWER PLANT SITE, SAN LUIS OBISPO COUNTY, CALIFORNIA

INTRODUCTION

In 1985, Pacific Gas and Electric Company (PG&E) initiated a three-year program to reassess the seismic design basis of their Diablo Canyon power plant, located in San Luis Obispo County, California, as part of a licensing condition imposed by the U. S. Nuclear Regulatory Commission (NRC). The results of the program have been summarized in a PG&E report entitled *Final Report of the Diablo Canyon Long Term Seismic Program for the Diablo Canyon Power Plant* (PG&E, 1988).

During this same period, NRC commissioned the U. S. Geological Survey to conduct an independent analysis of near-source ground motion for the Diablo Canyon site. This report documents the results of that study.* The first part of the report describes the near-source attenuation relationships developed during the course of the study. In the second part of the report, these attenuation relationships are used to provide estimates of peak acceleration, peak velocity, and five-percent damped pseudorelative velocity response spectra for several earthquake scenarios proposed for the nearby Hosgri fault.

GROUND-MOTION MODEL

The relationship used to model the near-source attenuation of strong ground motion is given by the expression,

$$\ln Y = a + bM + d \ln[R + c_1 \exp(c_2 M)] + eF + f_1 \tanh[f_2(M + f_3)] + g_1 \tanh(g_2 D) + \sum_{i=1}^{3} h_i K_i + \epsilon, \quad (1)$$

where Y is the strong-motion parameter of interest; M is earthquake magnitude [M_L for $M < 6.0$ and M_S for $M \geq 6.0$, consistent with the moment-magnitude scale proposed by Hanks and Kanamori (1979)]; R is distance to seismogenic rupture in kilometers; F is a parameter representing the type of faulting [$F = 0$ for strike-slip faults, $F = 1$ for oblique, reverse, or thrust faults (hereafter referred to simply as reverse faults)]; D is depth to basement rock (sediment depth) in kilometers; K_i is a parameter representing building effects ($K_1 = 1$ for embedded buildings 3-11 stories in height, $K_2 = 1$ for embedded buildings greater than 11 stories in height, $K_3 = 1$ for nonembedded buildings greater than 2 stories in height, $K_1 = K_2 = K_3 = 0$ for all other recording sites); ϵ is a random error term having a mean of zero and a standard deviation of σ, the standard error of

* This report supercedes two preliminary reports submitted to NRC in October, 1988 (Campbell, 1988a) and January, 1989 (Campbell, 1989).

regression; tanh(*) is the hyperbolic tangent function; and $a, b, \ldots, h_i$ are coefficients to be determined by the data.

The nonlinear term, $R + c_1 \exp(c_2 M)$, accommodates magnitude-dependent attenuation of ground motion. First proposed by Esteva (1970), this term has been used successfully by many investigators to model the near-source attenuation of both observed and simulated ground motions (*e.g.*, Campbell, 1981, 1987; Hadley *et al.*, 1982; Sadigh, 1983; among others). Note that when $c_2 = -b/d$, Y becomes totally independent of magnitude (*i.e.*, it "saturates") at $R = 0$, the presumed source of the ground motion.

Strong-motion parameters of interest in this study include peak horizontal acceleration (PHA), peak vertical acceleration (PVA), peak horizontal velocity (PHV), peak vertical velocity (PVV), and 15 horizontal and vertical components of five-percent damped pseudorelative velocity (PSRV) response spectra at periods ranging from 0.04 to 4.0 sec (PSRVH, PSRVV). Consistent with Campbell (1981, 1987), horizontal parameters of ground motion were computed from the arithmetic mean of the two recorded horizontal components of ground motion. Campbell (1982, 1985) has shown that the use of the mean horizontal component is statistically superior to the use of either the largest horizontal component or both horizontal components when regressing on strong-motion parameters.

For a specific earthquake, source-to-site distance (R) is defined as the shortest distance between a recording site and the assumed zone of seismogenic rupture. Implicit in this definition is the assumption that faulting within the sediments and shallow crust is not seismogenic—*i.e.*, it is associated with a very low dynamic stress drop—and does not contribute significantly to recorded strong ground motion at frequencies of engineering interest. In all cases, seismogenic rupture was carefully determined from spatial distributions of aftershocks, from earthquake modelling studies, from regional crustal velocity studies, and from geodetic and geologic data.

Unlike the distance measures proposed by Campbell (1981) and Shakal and Bernreuter (1981), the above definition of distance avoids ambiguities associated with the identification and specification of surface fault rupture and fault asperities (Boore and Joyner, 1982; Campbell, 1985). Asperities are patches of the fault that are believed to produce very high ground motions. In addition, Anderson and Luco (1983) found closest distance to seismogenic rupture to be analytically superior to the distance measure proposed by Joyner and Boore (1981) for characterizing the attenuation of ground motion from dipping faults.

Site response is characterized by depth to basement rock, D—also referred to as sediment depth. The importance of sediment depth in characterizing site amplification has been noted by many investigators, including Hanks (1975), Trifunac and Lee (1978, 1979), Rogers *et al.* (1985), Boore and Joyner (1984), King and Tucker (1984), Munguia and Brune (1984), Tucker and King (1984), Boore (1986, 1987), Campbell (1987), Savy (1987), Aki (1988), Bard *et al.* (1988), Campillo *et al.* (1988), Silva *et al.* (1988), Kawase and Aki (1989), and Yamanaka *et al.* (1989). Where possible, D has been determined from velocity profiles derived from *in-situ* measurements (*e.g.*, refraction and reflection experiments) or from seismological studies conducted within the vicinity of the site (Wheeler, 1989, in press). However, when such measurements were not available, depths were inferred from gravity and aeromagnetic data, from stratigraphic sequences, and from slope extrapolation. For the majority of sites, basement was identified as the top of crystalline or metamorphic rock. However, in some cases (*e.g.*, parts of the Livermore Basin, California), basement—or what geophysicists often refer to as "seismic basement"—was identified within the sedimentary sequence. Such "basement" sediments are characterized by high *in-situ* velocities, low velocity gradients, and small velocity impedance contrasts.

STRONG-MOTION DATA BASE

The strong-motion data base compiled for this study consists of near-source recordings from moderate-to-large earthquakes located throughout the world. The restriction to near-source distances—$R \leq 50$ km for $M \geq 6.25$ and $R \leq 30$ km for $M < 6.25$—was intended to minimize regional differences in anelastic attenuation while emphasizing those ground motions of greatest interest to earthquake engineers. Earthquakes were included only if they had seismogenic rupture within the shallow crust (depths shallower than about 25 km) in order to avoid potential differences in attenuation that might result from systematic differences in tectonic stresses and travel paths between deep and shallow earthquakes. Unlike other studies, shallow subduction earthquakes were specifically included in the current data base as a direct result of analyses by Boore (1986) and Youngs *et al.* (1988) suggesting that source processes and near-source ground motions are similar for shallow subduction and shallow crustal earthquakes

The data base compiled for this study (*Appendix*, Figs. 1–4) was modified from tabulations provided by Campbell (1981, 1987). Of particular note was the inclusion of strong-motion recordings from eleven additional earthquakes: the 1972 Stone Canyon, Calif., earthquake ($M_L = 4.7$), the 1976 Mesa de Andrade, Mexico, earthquake ($M_L = 5.3$), the 1976 Caldiran, Turkey, earthquake ($M_S = 7.3$), the 1984 Morgan Hill, Calif., earthquake ($M_S = 6.1$), the 1985 Central Chile earthquake ($M_S = 7.8$), the 1985 Michoacan, Mexico, earthquake ($M_S = 8.1$), the 1985 Michoacan, Mexico, aftershock ($M_S = 7.6$), the 1985 Nahanni, Canada, earthquake ($M_S = 6.9$), the 1986 North Palm Springs, Calif., earthquake ($M_S = 6.0$), the 1986 Chalfant Valley, Calif., earthquake ($M_S = 6.2$), and the 1987 Whittier Narrows, Calif., earthquake ($M_L = 5.9$). Because the Diablo Canyon power plant is sited on sedimentary rock, priority was given to strong-motion recordings on rock when selecting these additional earthquakes.

Strong-motion recordings were selected according to criteria proposed by Campbell (1987), with the following exceptions. First, the magnitude 5.0 cutoff was relaxed to include processed recordings from the $M_L = 4.7$ Stone Canyon earthquake, since a special aftershock study provided a reasonable basis for estimating the extent of seismogenic rupture during this earthquake. Second, soft-rock sites were included in order to provide recordings for site conditions similar to the Diablo Canyon site, and hard-rock sites were excluded based on a preliminary analysis indicating that both the frequency content and amplitudes of recordings obtained on soft rock (primarily sedimentary rock) were substantially different from those obtained on hard rock (primarily crystalline rock). Third, shallow-soil sites—sites with 1–10 m of soil overlaying rock—were excluded from analysis based on studies by Campbell (1987, 1988b) indicating that shallow soils can substantially amplify peak acceleration and short-period response spectra.

REGRESSION ANALYSES

Due to the small number of soft-rock recordings (*e.g.*, Table A–25), only soil sites were used in the initial regression analyses. Regression coefficients were determined from a weighted nonlinear regression analysis similar to that used by Campbell (1981, 1987). The technique is based on algorithms developed by More *et al.* (1980). Weights were used to compensate for the potential bias associated with the uneven distribution of recordings between earthquakes. However, the weighting scheme was slightly modified from that originally proposed by Campbell (1981, 1987). The modification was intended to reduce the bias associated with having multiple recordings from a single earthquake at the same site location, since these recordings have virtually identical source, path, and site effects. Consistent with the old weighting scheme, recordings from a given earthquake that fall within a specified distance interval were assigned the same weight as those from other earthquakes within the same interval. However, in order to implement the new scheme, recordings from a given earthquake that occurred at the same site location were assigned the same cumulative weight as a single recording. As before, ten distance intervals were used to establish the weights, with these intervals having approximately equal logarithmic increments between 0 and 56.6 km (Campbell, 1981, 1987).

The weight of each recording was computed from the following expression,

$$w_i = \frac{n/n_i}{\sum_{j=1}^{n} \frac{1}{n_j}}, \qquad (2)$$

where i is the index of the recording; $n_i = n_i^1 \cdot n_i^2$; n_i^1 is the number of recordings from the same earthquake that produced the i^{th} recording that fall within the same distance interval; n_i^2 is the number of recordings from the same earthquake that produced the i^{th} recording that occur at the same site location; and n is the total number of recordings. Note that the quantity n_i is not unique to a single recording; it is the same for all recordings from the same earthquake and site location that fall within the same distance interval. The above expression has been normalized to assure that the sum of the weights equals n, a constraint required in order to obtain a correct weighted estimate for the standard error, σ.

Other investigators have proposed different statistical methods to compensate for the potential bias associated with the uneven distribution of recordings between earthquakes. The two most notable are the two-step regression technique proposed by Joyner and Boore (1981) and the random-effects technique suggested by Brillinger and Preisler (1984). All three techniques are believed to give similar results.

Peak Parameters

For the analysis of peak parameters, coefficients a, b, c_i, d, e, g_i, and h_i were determined directly from the weighted nonlinear regression model described above. The results of this analysis are summarized in Tables 1–3, and plots of the attenuation relationships are displayed in Figures 5 and 6.

Response Spectra

Because of the multi-dimensional nature of pseudorelative velocity, the analysis of PSRV was considerably more complicated than the analysis of peak parameters. Direct regression analyses of the various spectral components led to an unacceptably large period-to-period variability in the regression coefficients and predicted spectra. This variability is believed to have been caused by three factors: (1) the relatively large number of parameters included in the attenuation relationship, (2) the relatively small number of PSRV spectra available, and (3) period-to-period variability in the numbers of recordings and their associated earthquakes.

When confronted with a similar result, Joyner and Boore (1982) and Joyner and Fumal (1985) successfully smoothed their regression coefficients to obtain well-behaved spectra. However, several unique factors made this type of approach virtually impossible in the present analysis. First, some of the regression coefficients—most notably c_1 and c_2—were found to be strongly correlated with one another, making it difficult to smooth them without extensive iteration. Second, the nonlinear form of Equation (1), together with the relatively large number of coefficients required to implement it, made it difficult to iterate during the smoothing process.

Therefore, rather than smooth the coefficients, the analysis was simplified by regressing on the ratio of PSRV to peak acceleration (PGA) rather than on PSRV alone—an approach adopted by many previous investigators for its simplicity (*e.g.*, Newmark and Hall, 1982; Sadigh, 1983; Campbell, 1985; Joyner and Boore, 1988). Besides giving more stable results, the analysis of PSRV/PGA has several advantages that makes it suitable for developing spectral attenuation relationships: (1) it simplifies the analysis by reducing the number of coefficients to be evaluated (*e.g.*, now only a, e, f_i, g_i, and h_i need be evaluated), (2) it minimizes the impact of period-to-period variability in the number of recordings and their associated earthquakes, and (3) it inherits some of the reliability associated with the prediction of PGA.

The above advantages notwithstanding, the prediction of PSRV from PGA has been criticized recently in the literature (*e.g.*, Joyner and Boore, 1988; Bender and Campbell, 1989). The major criticism concerns the use of peak acceleration to scale a fixed spectral shape—an approach which neglects differences in the observed frequency dependence of PSRV on magnitude, distance, and site conditions. The attenuation relationship used in the present study avoids such criticism by allowing PSRV/PGA to scale freely with each of these parameters.

Even with the simpler analysis, there were too many coefficients to insure convergence of the nonlinear algorithms. Therefore, it was necessary to perform the analysis in several steps—each step concentrating on a different set of parameters—until all of the coefficients were determined. With each successive step, an analysis of residuals was used to validate the appropriateness of the regression coefficients determined in each of the previous steps. The procedure can be likened to a stepwise regression analysis. In all cases, the horizontal and vertical components of ground motion were analyzed independently of one another to insure autonomy between components. The various steps are described below.

Step one. In the first step, the natural logarithm of PSRV/PGA—hereafter referred to simply as $\ln Y$—was plotted against magnitude and distance. The most important trend observed in these plots, for both vertical and horizontal components, was the strong correlation between $\ln Y$ and magnitude for periods exceeding about 0.3 sec. This trend was modelled by a hyperbolic tangent function [the function involving f_i in Equation (1)], because of its unique characteristics: (1) it is zero when its argument is zero, (2) it is nearly linear for relatively small values of its argument, and (3) it asymptotically approaches a constant at relatively large values of its argument.

At shorter periods, $\ln Y$ was observed to be independent of both magnitude and distance, indicating a one-to-one correspondence between PSRV and PGA at these periods. Also observed was a strong correlation between the vertical component of $\ln Y$ and distance for strike-slip earthquakes at periods exceeding about 0.075 sec, and a weak dependence of $\ln Y$ on distance at intermediate-to-long periods. Both of these trends were addressed during a later stage of analysis.

Step two. A weighted nonlinear regression analysis was used to determine coefficients a and f_i. However, in order to control excessive period-to-period variability in these coefficients, it was necessary to constrain f_2 and f_3 to be independent of period—a decision later verified by an analysis of residuals. It was also necessary to further constrain the value of f_3 to -4.7, when it became evident that its unconstrained absolute value, which was less than the smallest magnitude in the data base, predicted a negative correlation between $\ln Y$ and M for small-magnitude earthquakes. Careful analysis indicated that this negative correlation was caused by a low signal-to-noise ratio in the longer-period components of the small-magnitude spectra—the result of improper processing—and was not indicative of PSRV scaling in general. Because of this constraint, the attenuation relationships for PSRV are not valid for magnitudes less than about 4.7. In order to obtain sufficient autonomy between the various spectral components, coefficients a and f_1 were determined independently for each period.

Step three. Weighted residuals associated with the model developed in step two were plotted against magnitude, distance, and depth to basement rock. The plot with magnitude confirmed the validity of the regression analysis performed in step two. Besides the correlation with distance noted in step 1, the residuals were found to be strongly correlated with depth to basement rock, for periods exceeding 1.0 sec. The observed correlation with sediment depth indicated that D could be modelled by a hyperbolic tangent function [the function involving g_i in Equation (1)], consistent with the model proposed by Campbell (1987).

Step four. A weighted nonlinear regression analysis was used to determine a and g_i (note that a is reevaluated during each regression analysis in order to properly scale the residuals). To simplify the analysis, the magnitude term derived in step two was subtracted from $\ln Y$ in order to remove the modelled dependence on magnitude. As before, excessive period-to-period variability in the regression coefficients was controlled by constraining g_2 to be independent of period. However, in order to obtain sufficient autonomy between the various spectral components, coefficients a and g_1 were determined independently for each period.

The results of the regression analyses indicated that the modelled dependence of the vertical component of $\ln Y$ on D was very similar to that found for the horizontal component, except that the vertical ratio exhibited far greater period-to-period variability than the horizontal ratio. In order to control this variability, vertical coefficients g_1 and g_2 were constrained to be equal to those determined from the horizontal analysis, leaving a as the only independently determined coefficient.

Step five. Weighted residuals associated with the model developed in step four were plotted against magnitude, distance, and depth to basement rock. The plots with magnitude and depth to basement rock again confirmed the validity of the regression analyses performed in the previous steps. However, a significant correlation between the vertical component of $\ln Y$ and distance for periods exceeding 0.075 sec (first observed in step 1) was still present in the residuals at this stage. This behavior—visible at distances less than about 12 km for strike-slip earthquakes only—suggested that the close-in strike-slip spectra were possibly bimodal, possessing a "saddle" or "notch" at intermediate periods.

In an attempt to better understand the cause of this behavior, the recordings responsible for this trend were identified and inspected. This indicated that the low residuals were associated almost exclusively with near-source vertical recordings from the 1979 Imperial Valley earthquake, whose recordings clearly exhibited a strong bimodal shape (Brady *et al.*, 1980; Porter, 1983). Since it would not be prudent to allow a single earthquake to control the near-source shape of predicted strike-slip spectra, the observed trend in the residuals was not modelled in the present study. If in the future this behavior should prove to be common among all strike-slip earthquakes, the analyses will be modified accordingly.

Step six. Statistical tests were used to determine whether the residuals computed in step five were dependent on either fault type or building size and embedment. Although no significant dependence on fault type was found, the statistical tests did indicate that the effects of building size and embedment were statistically significant (*i.e.*, h_i was significantly different from zero at the 90-percent confidence level) at some periods. At long periods, the residuals, and therefore the ratios, were found to be significantly high for both embedded and nonembedded buildings greater than 2 stories in height (represented by parameters K_1, K_2, and K_3). At short and intermediate periods, the mean residuals associated with the vertical component of $\ln Y$ for these same building classifications were found to be significantly low. There was some indication at short periods that K_1 and K_2 might be dependent on distance; however, this dependence, first noted by Campbell (1987), was found to be controlled by only a few recordings and was not considered significant enough to be included in the present analysis.

Step seven. A weighted nonlinear regression analysis was used to determine coefficients a and h_i at all periods for which K_i was found to be statistically significant in step six. To simplify the analysis, the magnitude term developed in step two and the sediment-depth term developed in step four were subtracted from $\ln Y$ to remove the modelled dependence of these parameters. Autonomy between the various spectral components was maintained by performing the analysis independently for each spectral component.

Step eight. In the final step, attenuation relationships for ln PSRV were derived by combining the relationships developed for ln PGA and ln (PSRV/PGA) through the mathematical relationship,

$$\ln \text{PSRV} = \ln \text{PGA} + \ln (\text{PSRV}/\text{PGA}). \tag{3}$$

The resulting coefficients are listed in Tables 1–3 and the resulting spectra are plotted in Figures 7 and 8. As a final check on the results, weighted residuals for ln PSRV were calculated and plotted against magnitude, distance, and depth to basement rock; and statistical tests were used to determine the significance of both fault type and building size and embedment. With the possible exception of distance, no significant correlations were observed, confirming the validity of the multi-step regression procedure. Even the previously identified correlations with distance, except for those associated with the near-source vertical components of the 1979 Imperial Valley earthquake, were found to be generally weak (linear correlations less than about 0.2) and, therefore, were not considered important for the near-source distances of interest in this study.

The residuals computed during the final step were also used to estimate the standard errors listed in Tables 1 and 2. The reported standard errors, however, were adjusted to provide smoothed estimates of PSRV spectra at their upper fractiles. Two criteria were used to make these adjustments. First, no value of standard error was allowed to be less than that determined for ln PGA—a mathematical constraint required by Equation (3). Second, period-to-period variability in the standard errors was controlled by constraining them to be a smoothly varying function of period, consistent with their overall trend. In no case did this require individual errors to be increased by more than about 0.15 or decreased by more than about 0.02.

Significance of Results

Because of the nonlinear form of Equation (1), it is difficult to make specific statements concerning the statistical significance of the regression coefficients. A true test of significance requires a *Monte Carlo* simulation (Gallant, 1975); which, because of its complexity, was not feasible to perform for all of the relationships developed in this study.

In order to get a feeling for the significance of the results, however, a 1000-point *Monte Carlo* simulation was used to determine the significance of PHA regression coefficients a, b, c_1, c_2, d, h_1, and h_2 (Table 1). The simulation demonstrated that all seven coefficients are statistically significant at the 90-percent confidence level. Past experience indicates that one could expect similar results for PVA, PHV, and PVV.

Soft-Rock Sites

Due to the small number of soft-rock recordings, an analysis of residuals was used to assess whether the attenuation relationships developed for soil could be used to predict ground motions recorded on soft rock. For this purpose, weighted residuals for the soft-rock recordings were computed with respect to Equation (1) using the coefficients listed in Tables 1–3. In all cases, the mean weighted residuals were not found to be statistically significant at the 90-percent confidence level. Thus, it can be concluded that the attenuation relationships developed in this study can be used to estimate ground motions at soft-rock sites similar to Diablo Canyon. This conclusion, however, could change in the future as more soft-rock recordings become available.

DISCUSSION OF RESULTS

Ground-Motion Saturation. Consistent with Campbell (1987), the analysis of peak parameters and short-period response spectra supports ground-motion "saturation" at $R = 0$—the presumed source of the radiated ground motion—in accordance with some geophysicists' interpretation of earthquake rupture mechanics (*e.g.*, see Campbell, 1985). However, for periods greater than 0.3 sec, Equation (1) intentionally precludes complete saturation of PSRV by invoking a magnitude term that is independent of distance. The observed increase of f_1 with period, and the corresponding decrease in the saturation of spectral components, is believed to be generally consistent with simple source spectral scaling relations (*e.g.*, Aki, 1967; Brune, 1970).

Fault Type. Consistent with Campbell (1987), ground motions from reverse faults were found to be larger than those from strike-slip faults. However, since there were no normal-faulting earthquakes included in the data base, there was no basis with which to test McGarr's (1984) hypothesis that normal-faulting earthquakes are associated with smaller ground motions than either strike-slip or reverse-faulting earthquakes. Likewise, there was no basis for confirming Westaway and Smith's (1989) conclusions to the contrary.

Building Effects. Consistent with Campbell (1987), building effects were found to be significant. For example, recordings from buildings greater than 2 stories in height were found to have smaller peak accelerations and smaller short-period response spectral ordinates, and larger peak velocities and larger long-period response spectral ordinates, than recordings from small buildings and free-field sites. However, unlike the previous analysis, these effects were not modelled as being distance dependent. There was a tendency towards smaller short-period ground motions for large embedded buildings at small distances, but this effect was controlled by only a few recordings—primarily those from the 1957 Daly City and 1971 San Fernando earthquakes—and was not considered to be statistically significant. Likewise, the dependence of PHV on sediment depth, which in the previous analysis was found to depend on building size, was no longer found to be significantly correlated with building effects. The reader should be aware that the building effects modelled in the present study represent only a simple characterization of the complex soil-structure interaction (SSI) and embedment effects expected on the bases of analytical studies (*e.g.*, Wolf, 1985), and should not be used to model specific SSI or embedment effects. They are used here only to provide a first-order adjustment to free-field site conditions and, thus, provide a more robust estimate of free-field ground motion.

Source Directivity. Campbell (1987) included a parameter for source directivity based on three recordings that he believed were significantly amplified by a combination of site effects and source directivity. Each of these recordings had three properties in common: (1) unilateral rupture towards the recording site, (2) source-to-site azimuths that fell within 5-10 degrees of the direction of rupture, and (3) sediments over 5 km deep. These same recordings were found to have significantly higher ground motions in the present study as well. However, there has been a tendency among users to apply the previously developed "directivity" parameter—which Campbell (1987) suggests is a combination of near-maximum effects of both directivity and site amplification—to model the more common azimuthal effects normally ascribed to radiation pattern and simple source directivity. As a result, the directivity parameter proposed by Campbell (1987) was excluded from the present study. A precursory empirical analysis of simple source directivity, using recordings from several linear arrays, suggested that simple directivity effects may be present in the data; however, their modelling was beyond the scope of the this study.

Sediment Depth. Consistent with Campbell (1987), depth to basement rock was found to be important in amplifying peak horizontal velocity as well as horizontal and vertical response spectra for periods greater than 1.0 sec. The amplification increases rapidly with depth for small sediment depths and becomes stable at greater depths. The increase in g_1 with period indicates that the amount of amplification increases with period as well, broadening the spectral shape at larger depths. This is quantitatively similar to results presented by Trifunac and Lee (1978, 1979) and Rogers *et al.* (1985), and is qualitatively consistent with the dependence of PSRV on shear-wave velocity found by Joyner and Fumal (1985).

Distribution of Residuals. The standard errors of regression associated with PHA and PHV were found to be substantially larger than those estimated by Campbell (1987). Although part of this increase is due to the exclusion and simplification of parameters used to model source directivity and building effects, much of it is the result of increased dispersion associated with the added recordings. Also of note are the relatively large standard errors associated with vertical components and the tendency for long-period horizontal response spectra to have higher standard errors than short-period spectra. It is interesting to note that, in most cases, a chi-square test indicated that the distribution of weighted residuals could be rejected as being lognormal at the 90-percent confidence level. The tendency is for a more centered distribution of residuals than is expected from a lognormal distribution. As a result, the common assumption of lognormality will tend to increase the weight of the tails of the distribution and lead to an overestimation of ground motion at the upper fractiles. This overestimation can be avoided by making ground-motion estimates in terms of multiples of the standard error, without attempting to assign a specified fractile to the results.

GROUND-MOTION ESTIMATES FOR DIABLO CANYON

The attenuation relationships described in the previous section were used to develop site-specific estimates of free-field ground motion at the Diablo Canyon site for several earthquake scenarios. One of these scenarios was the Long Term Seismic Program (LTSP) analysis earthquake proposed by PG&E—a moment magnitude (M_w) 7.2 earthquake located on the Hosgri fault approximately 4.5 km from the site (PG&E, 1988). Seismic velocity profiles near the site (PG&E, 1988, Figs. 2-9, 4-13, and 5-5) infer a relatively strong velocity gradient within the shallow crust to a depth of approximately 4 km. Although rocks of the Franciscan Complex—usually considered to be basement rock—underlay the site at a depth of 1–2 km, the inferred velocity gradient in the upper 4 km is more representative of sedimentary rock than basement rock (R. Wheeler and K. Campbell, unpublished data). As a result, depth to basement rock was conservatively taken as 4 km for purposes of predicting ground motions at the Diablo Canyon site. This assumption, however, only affects estimates of peak horizontal velocity and response spectra at periods exceeding 1.0 sec. It should be noted that PG&E did not include sediment depth as a parameter in their analyses.

Estimates of peak acceleration and peak velocity for PG&E's proposed LTSP analysis earthquake and four other hypothetical earthquakes ranging in magnitude from 6.6 to 7.8 M_S are presented in Tables 4–7. M_S is considered equivalent to M_w for this and later computations, consistent with the definition of moment magnitude given by Hanks and Kanamori (1979). For convenience, the estimates have been segregated by fault type and uncertainty level.

If ground-motion estimates for each fault type are combined according to the weighting scheme proposed by PG&E (1988)—a weight of 0.65 for strike-slip faulting and a weight of 0.35 for reverse faulting—the weighted median and median-plus-one-standard-deviation (median+1σ) estimates for PHA and PHV are $0.59g$, $0.89g$, 74 cm/sec, and 109 cm/sec, respectively; and similar estimates for PVA and PVV are $0.67g$, $1.19g$, 26 cm/sec, and 43 cm/sec.

Five-percent damped pseudoabsolute acceleration (PSAA) spectra for PG&E's proposed LTSP analysis earthquake, estimated separately for strike-slip and reverse fault scenarios, are presented in Figures 9–12, and similar plots for two additional earthquake scenarios, M_S = 7.5 and 7.8, are presented in Figures 13–16. Weighted PSAA spectra for PG&E's proposed LTSP analysis earthquake, weighted by fault type according to the weighting scheme proposed by PG&E (1988), are presented in Figures 17 and 18.

Comparisons of the weighted PSAA spectra developed in this study (Figs. 17 and 18) with the largest of PG&E's weighted spectra—those based on attenuation relationships derived from regression analyses (their Figs. 4-23, 4-25, and 4-26)—are presented in Figures 19–22. These comparisons indicate that the median weighted spectra developed in the present study exceed PG&E's median weighted spectra for frequencies less than 3.5 Hz (horizontal) and 16 Hz (vertical), whereas PG&E's median spectra exceed those developed in this study for larger frequencies, up to the 25 Hz limit of the present study. Comparisons of the median+1σ spectra show similar results, with the spectra developed in this study exceeding PG&E's spectra for frequencies less than 7 Hz (horizontal) and 25 Hz (vertical), and PG&E's horizontal spectra exceeding the spectra developed in this study for larger frequencies, up to the 25 Hz limit of the present study.

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TABLE 1
Regression Coefficients: Horizontal Components

Parameter, Y	Period (sec)	No. Eq.	No. Rec.	a	b	c_1	c_2	d	e	f_1	f_2	f_3	g_1	g_2	σ
PHA, g		25	200	-2.470	1.08	0.311	0.597	-1.81	0.382						0.421
PHV, cm/sec		21	152	-1.974	1.34	0.00935	1.01	-1.32	0.327				1.16	0.0776	0.395
PSRVH, cm/sec	0.04	15	86	-0.648	1.08	0.311	0.597	-1.81	0.382						0.42
	0.05	20	142	-0.379	1.08	0.311	0.597	-1.81	0.382						0.44
	0.075	21	144	0.251	1.08	0.311	0.597	-1.81	0.382						0.46
	0.10	21	144	0.754	1.08	0.311	0.597	-1.81	0.382						0.48
	0.15	21	144	1.424	1.08	0.311	0.597	-1.81	0.382						0.50
	0.20	21	144	1.788	1.08	0.311	0.597	-1.81	0.382						0.50
	0.30	21	144	2.170	1.08	0.311	0.597	-1.81	0.382						0.50
	0.40	21	144	2.009	1.08	0.311	0.597	-1.81	0.382	0.425	0.570	-4.7			0.50
	0.50	21	144	1.930	1.08	0.311	0.597	-1.81	0.382	0.685	0.570	-4.7			0.50
	0.75	21	144	1.612	1.08	0.311	0.597	-1.81	0.382	1.27	0.570	-4.7			0.50
	1.0	21	144	1.268	1.08	0.311	0.597	-1.81	0.382	1.74	0.570	-4.7			0.50
	1.5	21	144	0.487	1.08	0.311	0.597	-1.81	0.382	2.43	0.570	-4.7	0.344	0.553	0.50
	2.0	21	144	0.040	1.08	0.311	0.597	-1.81	0.382	2.83	0.570	-4.7	0.469	0.553	0.50
	3.0	21	144	-0.576	1.08	0.311	0.597	-1.81	0.382	3.17	0.570	-4.7	0.623	0.553	0.50
	4.0	20	127	-0.766	1.08	0.311	0.597	-1.81	0.382	3.08	0.570	-4.7	0.857	0.553	0.50

TABLE 2
Regression Coefficients: Vertical Components

Parameter, Y	Period (sec)	No. Eq.	No. Rec.	a	b	c_1	c_2	d	e	f_1	f_2	f_3	g_1	g_2	σ
PVA, g		24	197	-4.003	0.978	0.0536	0.674	-1.45	0.239						0.569
PVV, cm/sec		21	150	-4.336	1.72	0.00594	1.14	-1.51	0.337						0.520
PSRVV, cm/sec	0.04	15	85	-2.082	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.05	20	141	-1.634	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.075	21	142	-0.903	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.10	21	142	-0.488	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.15	21	142	-0.125	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.20	21	142	0.157	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.30	21	142	0.356	0.978	0.0536	0.674	-1.45	0.239						0.62
	0.40	21	142	0.188	0.978	0.0536	0.674	-1.45	0.239	0.214	0.546	-4.7			0.62
	0.50	21	142	0.038	0.978	0.0536	0.674	-1.45	0.239	0.435	0.546	-4.7			0.62
	0.75	21	142	-0.035	0.978	0.0536	0.674	-1.45	0.239	0.719	0.546	-4.7			0.62
	1.0	21	142	-0.448	0.978	0.0536	0.674	-1.45	0.239	1.37	0.546	-4.7			0.62
	1.5	21	141	-1.287	0.978	0.0536	0.674	-1.45	0.239	2.18	0.546	-4.7	0.344	0.553	0.62
	2.0	21	141	-1.580	0.978	0.0536	0.674	-1.45	0.239	2.36	0.546	-4.7	0.469	0.553	0.62
	3.0	20	125	-1.741	0.978	0.0536	0.674	-1.45	0.239	2.24	0.546	-4.7	0.623	0.553	0.62
	4.0	17	119	-1.975	0.978	0.0536	0.674	-1.45	0.239	2.46	0.546	-4.7	0.857	0.553	0.62

TABLE 3
Regression Coefficients: Building Effects

Horizontal Components					Vertical Components				
Parameter, Y	Period (sec)	h_1	h_2	h_3	Parameter, Y	Period (sec)	h_1	h_2	h_3
PHA, g		-0.180	-0.489		PVA, g			-0.392	
PHV, cm/sec					PVV, cm/sec		0.366		0.388
PSRVH, cm/sec	0.04	-0.180	-0.489		PSRVV, cm/sec	0.04		-0.392	-0.103
	0.05	-0.180	-0.489			0.05	-0.083	-0.712	-0.264
	0.075	-0.180	-0.489			0.075	-0.206	-0.582	-0.371
	0.10	-0.180	-0.489			0.10	-0.197	-0.650	-0.370
	0.15	-0.180	-0.489			0.15		-0.392	
	0.20	-0.180	-0.489			0.20		-0.392	
	0.30	-0.180	-0.489			0.30		-0.392	
	0.40	-0.180	-0.489			0.40		-0.347	
	0.50	-0.180	-0.489			0.50		-0.153	
	0.75	-0.180	-0.489			0.75		-0.347	
	1.0	-0.180	-0.219			1.0		-0.278	
	1.5	-0.180	0.074			1.5		0.284	0.619
	2.0	-0.180	0.072			2.0		0.437	0.992
	3.0	0.218	0.391	0.663		3.0	0.291	0.691	1.15
	4.0	0.330	0.503	0.759		4.0	0.085	0.722	1.10

TABLE 4
Site-Specific Estimates of Peak Horizontal Acceleration: Diablo Canyon Site, California ($R = 4.5$ km)

Magnitude, $M_S (M_w)$	Peak Horizontal Acceleration (g)			
	Strike Slip		Oblique/Reverse/Thrust	
	Median	Median+1σ	Median	Median+1σ
6.6	0.446	0.679	0.653	0.994
6.9	0.476	0.725	0.698	1.06
7.2	0.504	0.768	0.739	1.13
7.5	0.530	0.807	0.776	1.18
7.8	0.553	0.842	0.810	1.23

TABLE 5
Site-Specific Estimates of Peak Vertical Acceleration: Diablo Canyon Site, California ($R = 4.5$ km)

Magnitude, $M_S(M_w)$	Peak Vertical Acceleration (g)			
	Strike Slip		Oblique/Reverse/Thrust	
	Median	Median+1σ	Median	Median+1σ
6.6	0.474	0.837	0.601	1.06
6.9	0.544	0.961	0.691	1.22
7.2	0.615	1.09	0.782	1.38
7.5	0.687	1.21	0.872	1.54
7.8	0.756	1.34	0.960	1.70

TABLE 6
Site-Specific Estimates of Peak Horizontal Velocity: Diablo Canyon Site, California ($R = 4.5$ km, $D = 4$ km)

Magnitude, $M_S(M_w)$	Peak Horizontal Velocity (g)			
	Strike Slip		Oblique/Reverse/Thrust	
	Median	Median+1σ	Median	Median+1σ
6.6	50.6	75.1	70.2	104.2
6.9	58.1	86.2	80.6	119.6
7.2	64.9	96.4	90.1	133.7
7.5	71.0	105.4	98.5	146.2
7.8	76.1	113.0	105.6	156.7

TABLE 7
Site-Specific Estimates of Peak Vertical Velocity: Diablo Canyon Site, California ($R = 4.5$ km, $D = 4$ km)

Magnitude, $M_S(M_w)$	Peak Vertical Velocity (g)			
	Strike Slip		Oblique/Reverse/Thrust	
	Median	Median+1σ	Median	Median+1σ
6.6	17.8	29.9	24.9	41.9
6.9	20.2	34.0	28.4	47.7
7.2	22.4	37.6	31.3	52.7
7.5	24.1	40.5	33.8	56.8
7.8	25.5	42.9	35.7	60.1

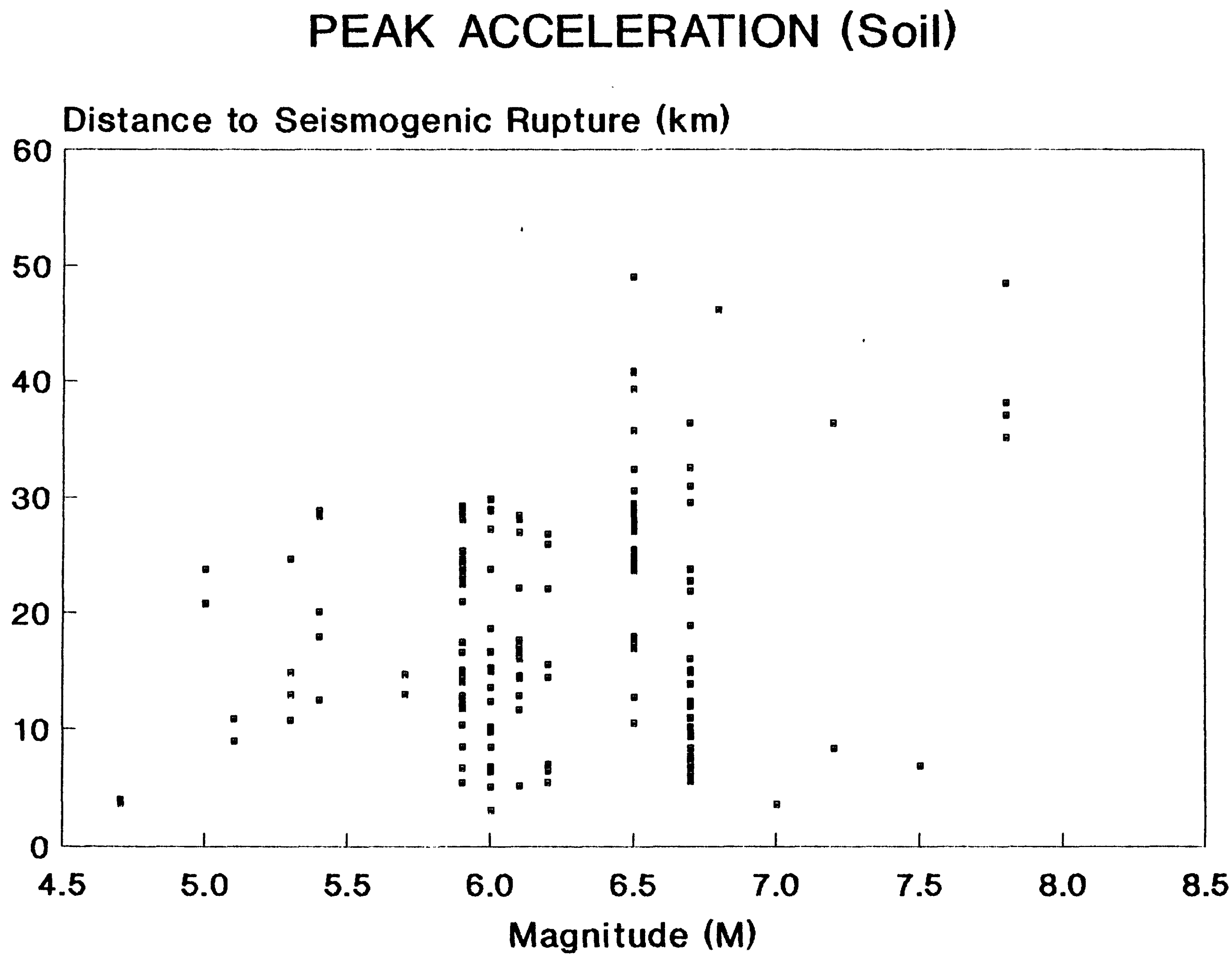

Fig. 1--Magnitude versus distance

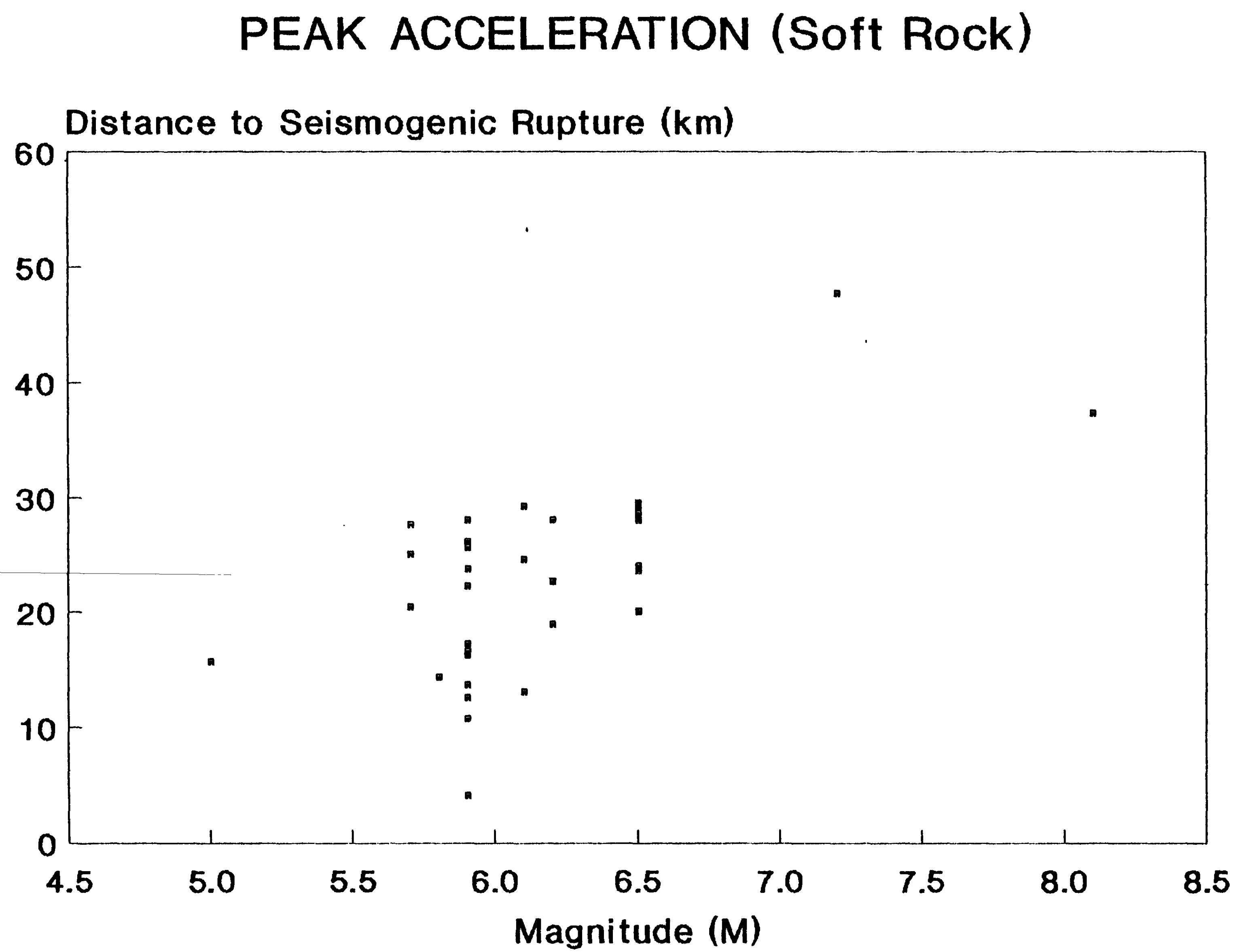

Fig. 2--Magnitude versus distance

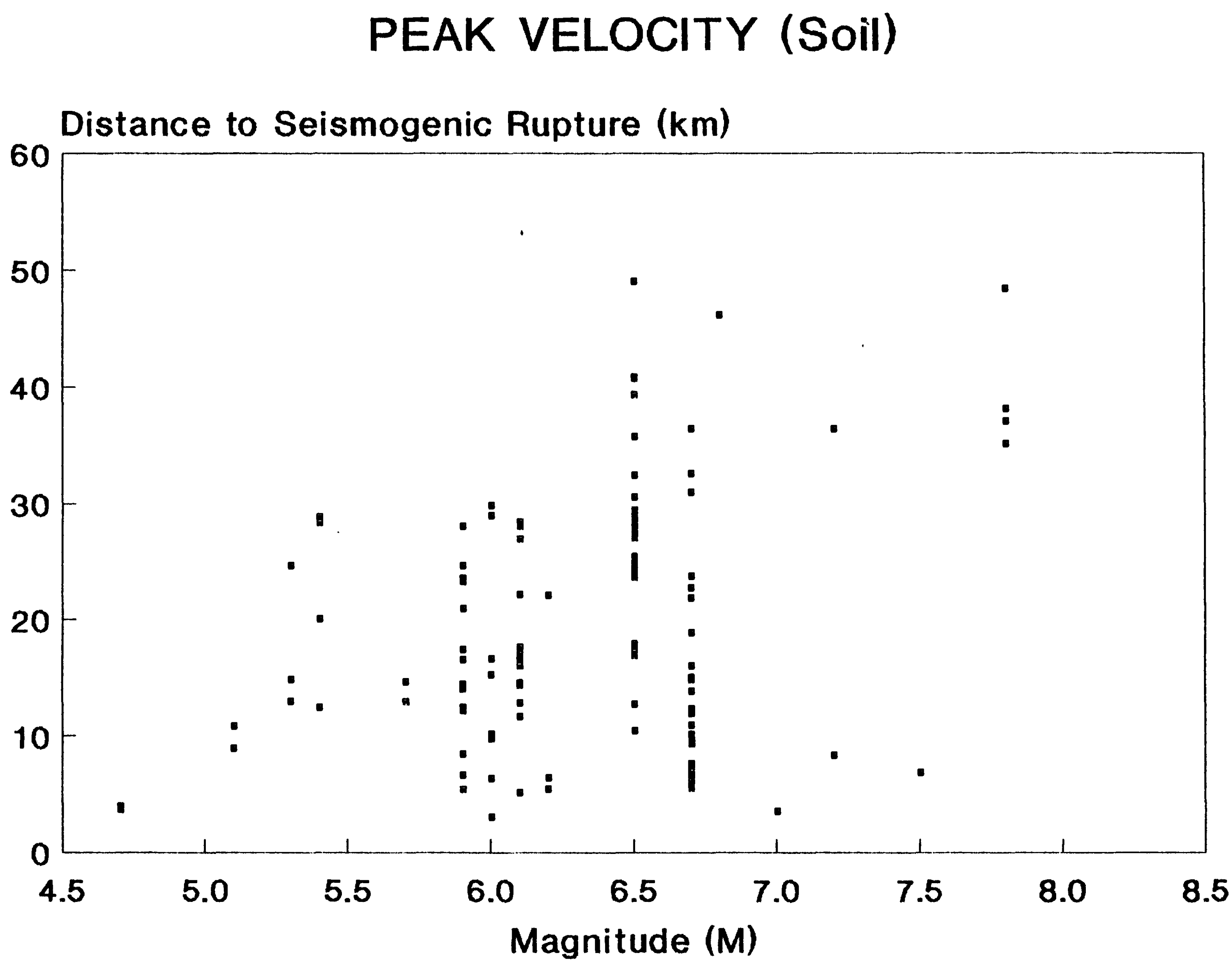

Fig. 3--Magnitude versus distance

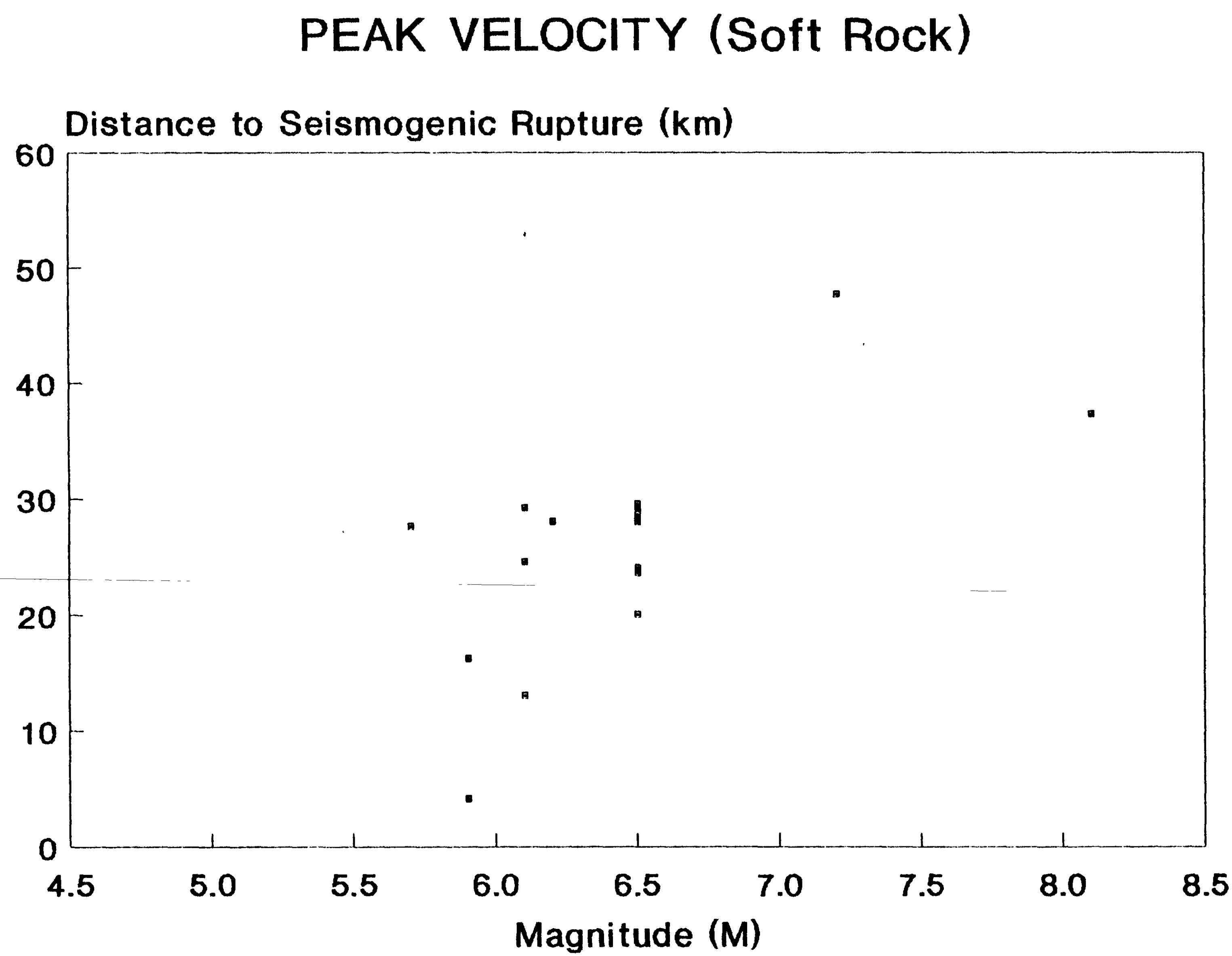

Fig. 4--Magnitude versus distance

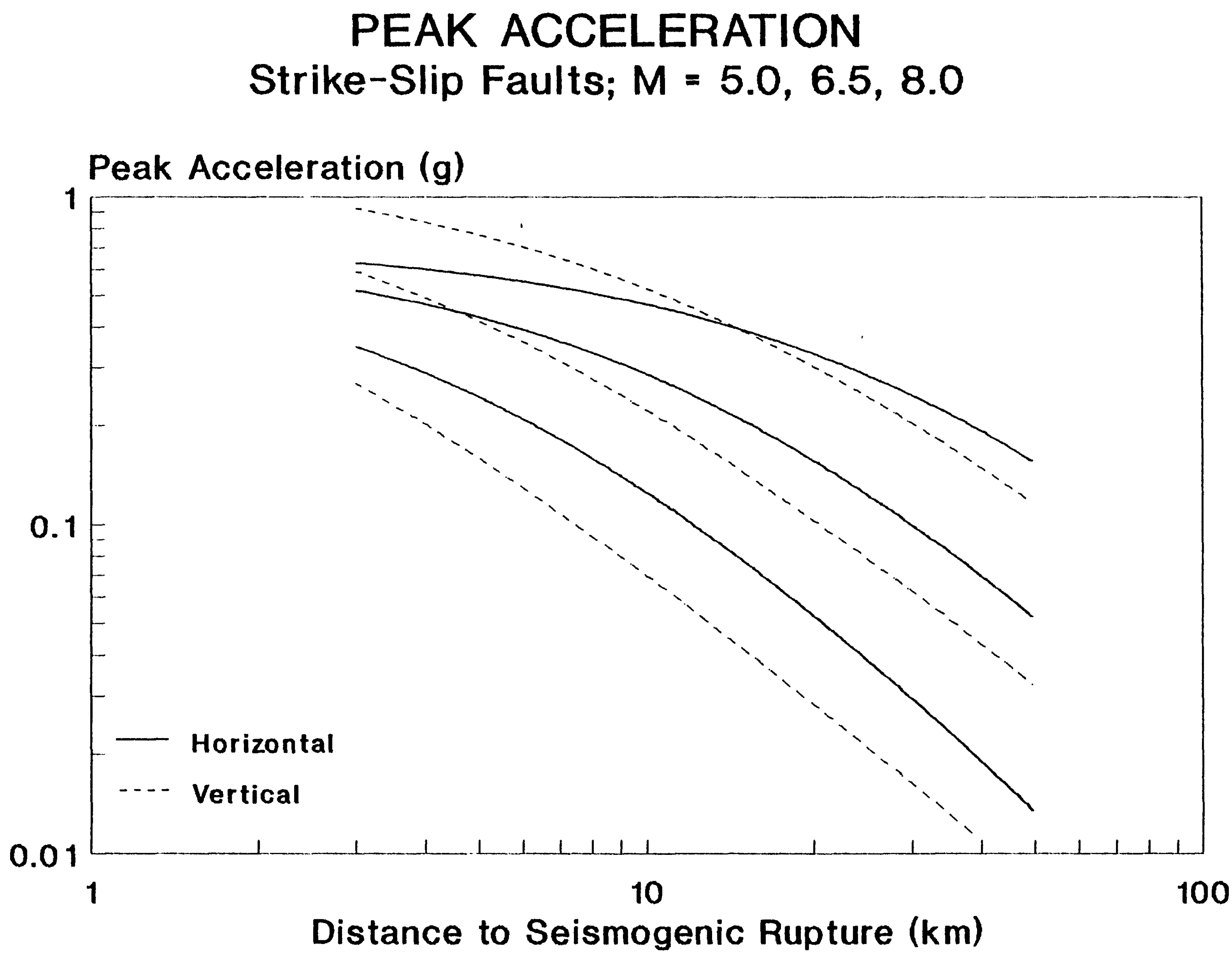

Fig. 5--Attenuation Relationships

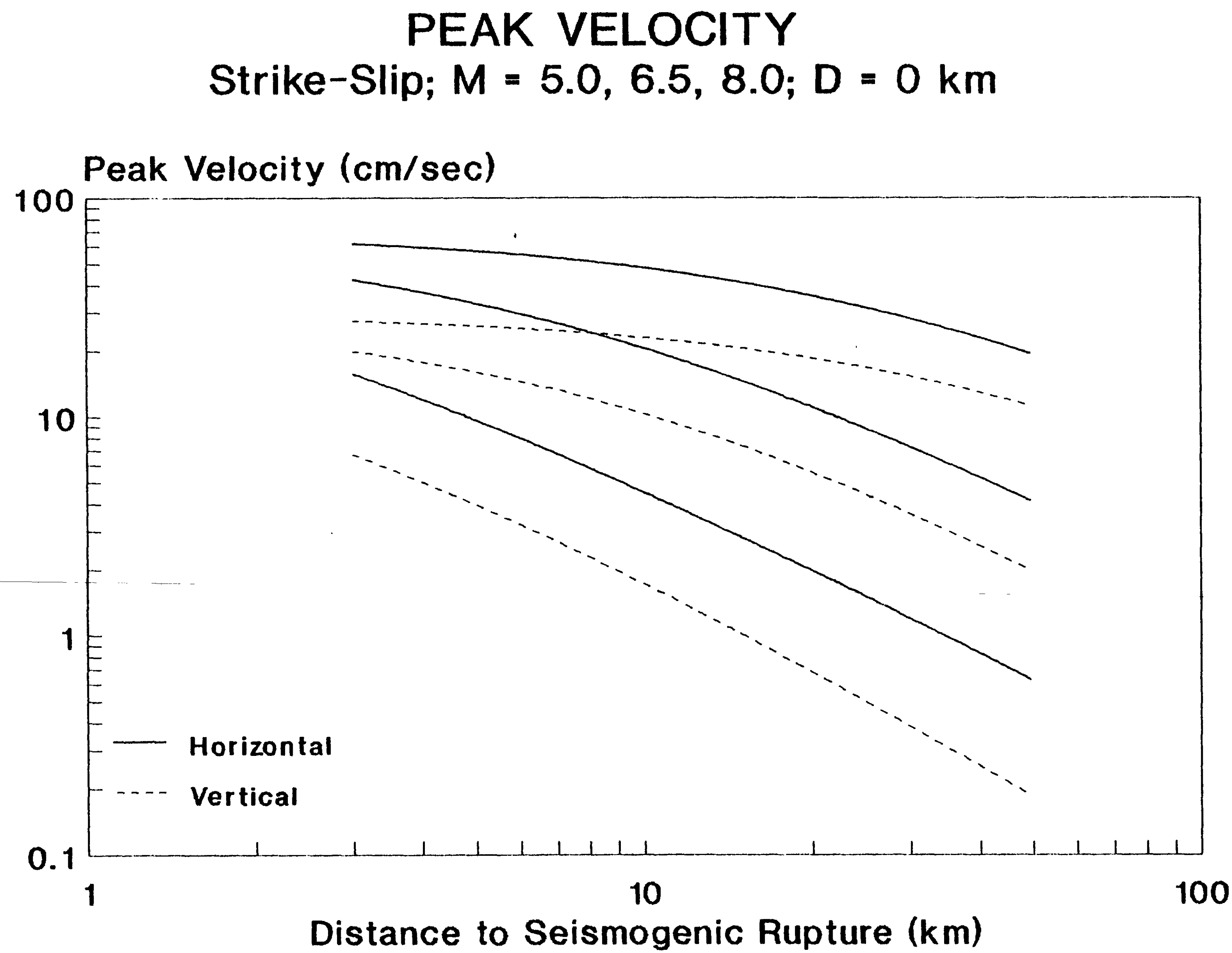

Fig. 6--Attenuation Relationships

5% DAMPED PSRV SPECTRA
Strike-Slip; M = 5.0, 6.5, 8.0; D = 0 km

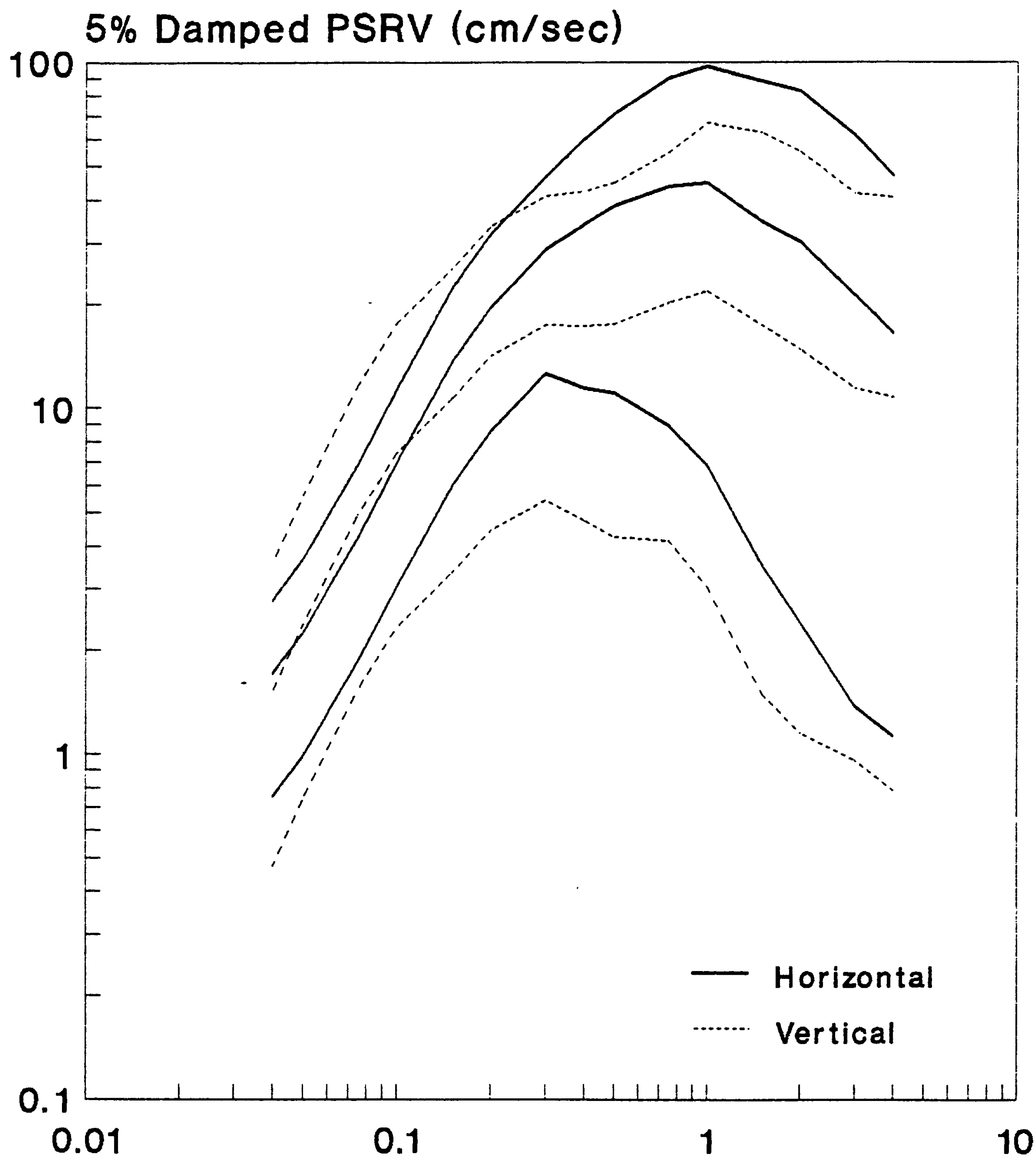

Fig. 7--Pseudorelative velocity spectra

5% DAMPED PSRV SPECTRA
Strike-Slip; R = 10, 25, 50 km; D = 0 km

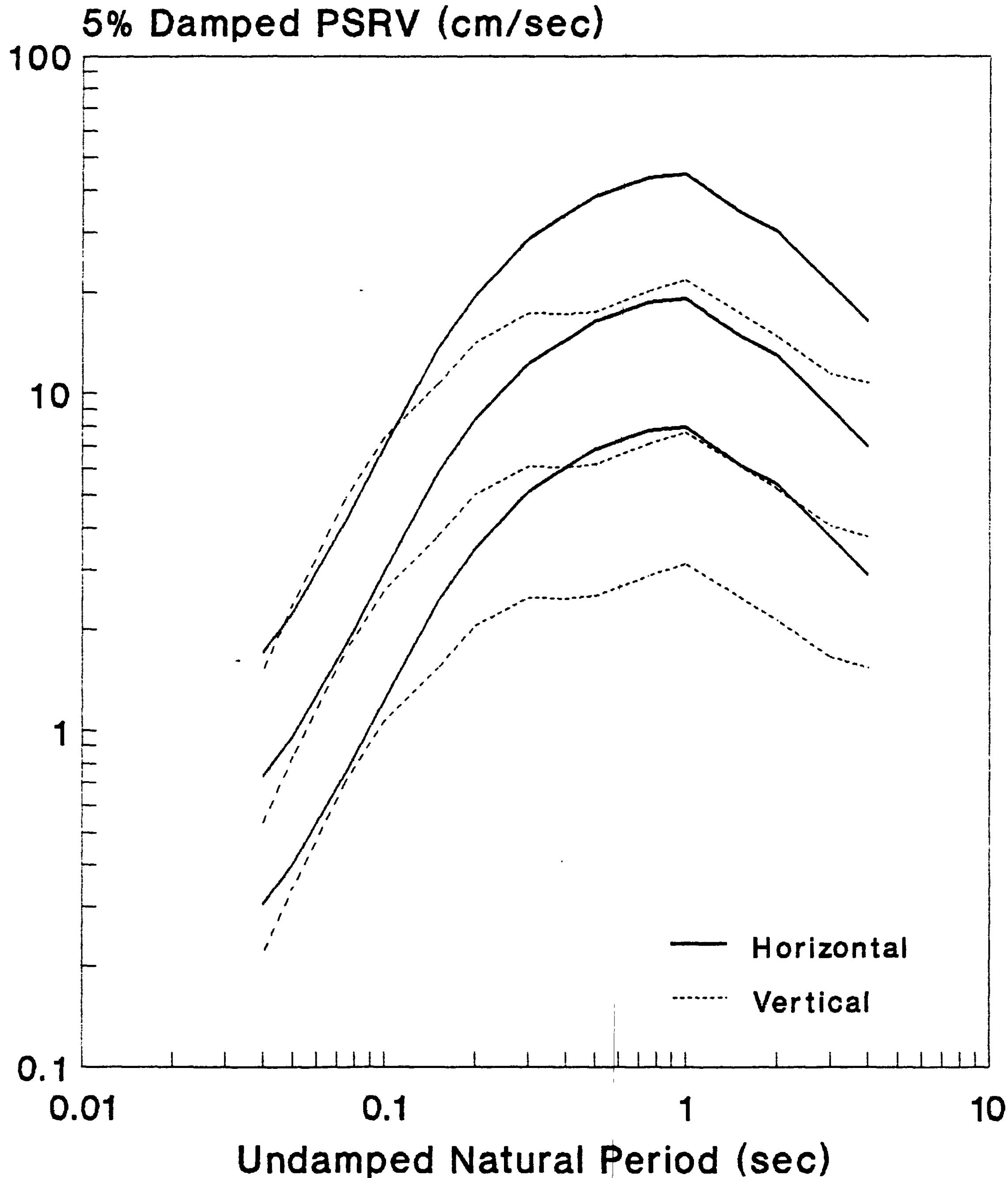

Fig. 8--Pseudorelative velocity spectra

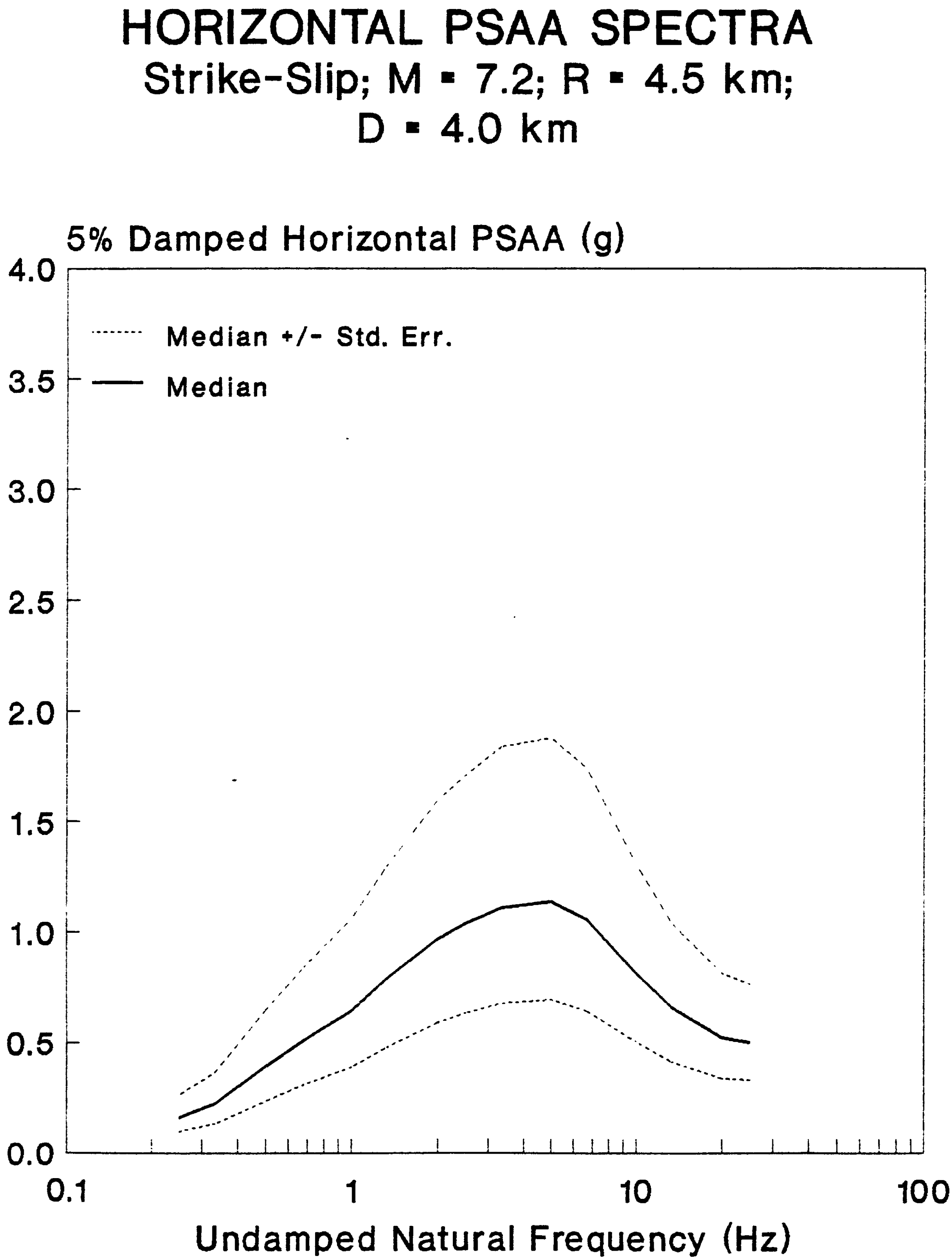

Fig. 9--Predicted LTSP analysis spectra

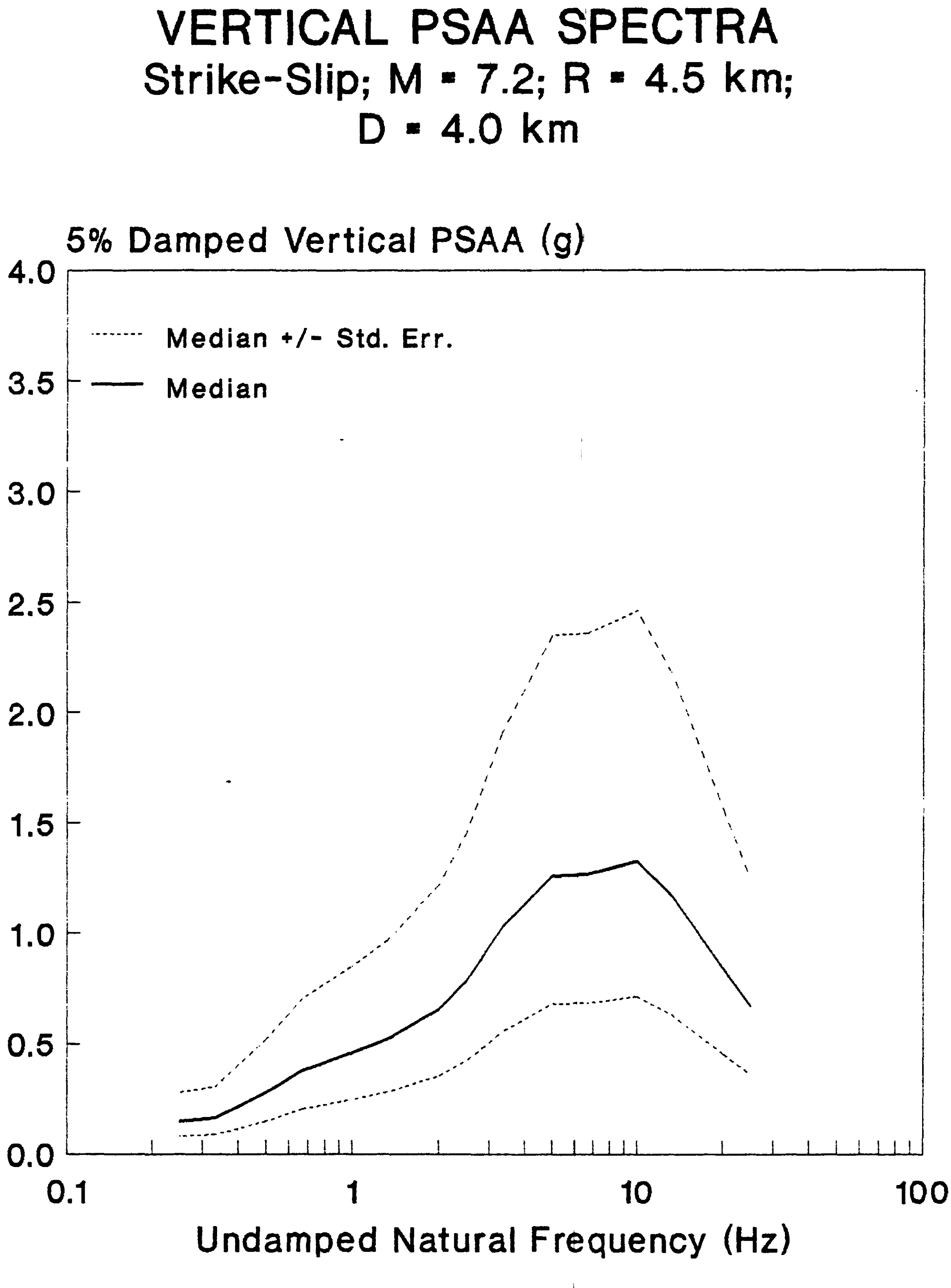

Fig. 10--Predicted LTSP analysis spectra

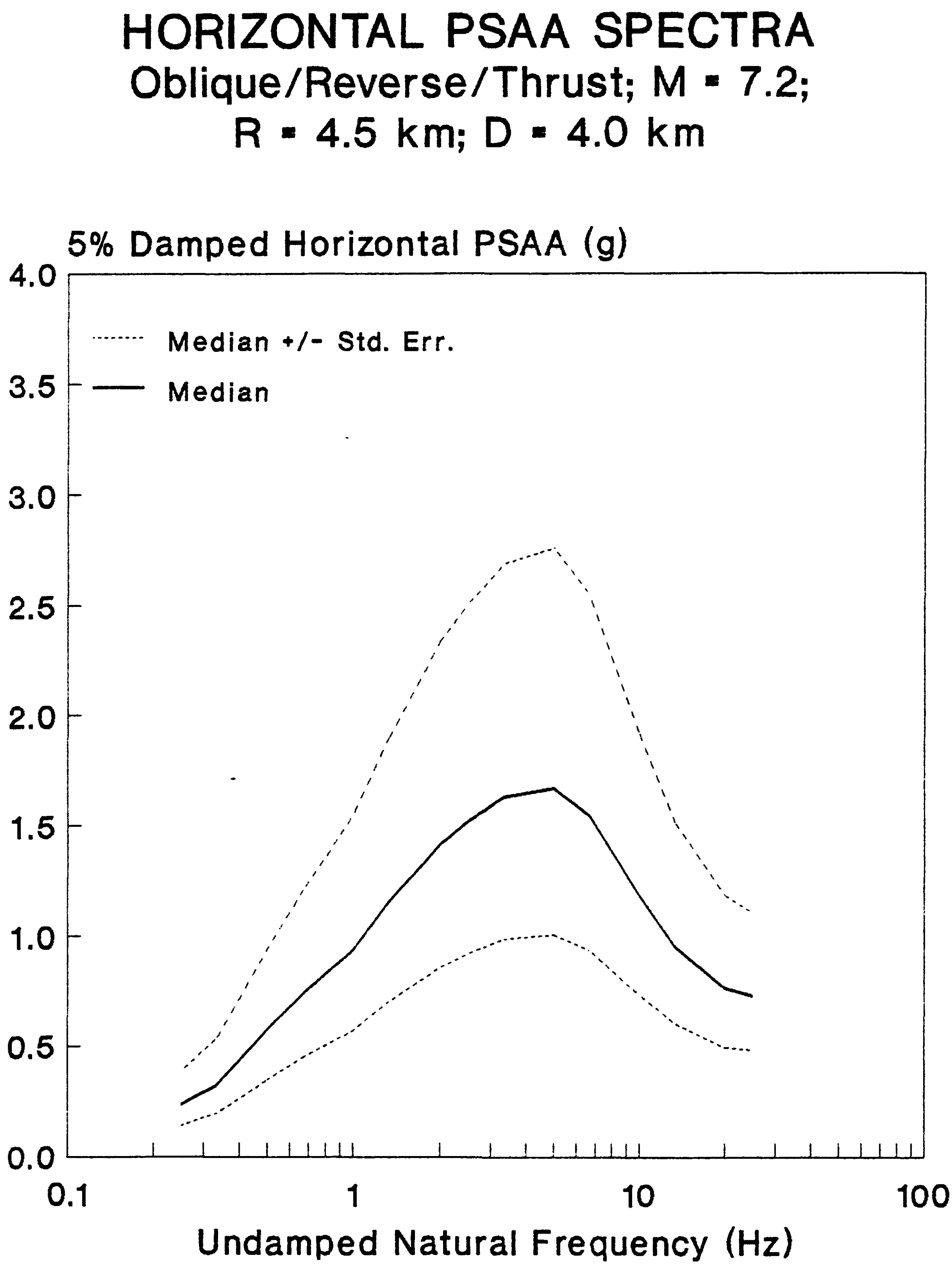

Fig. 11--Predicted LTSP analysis spectra

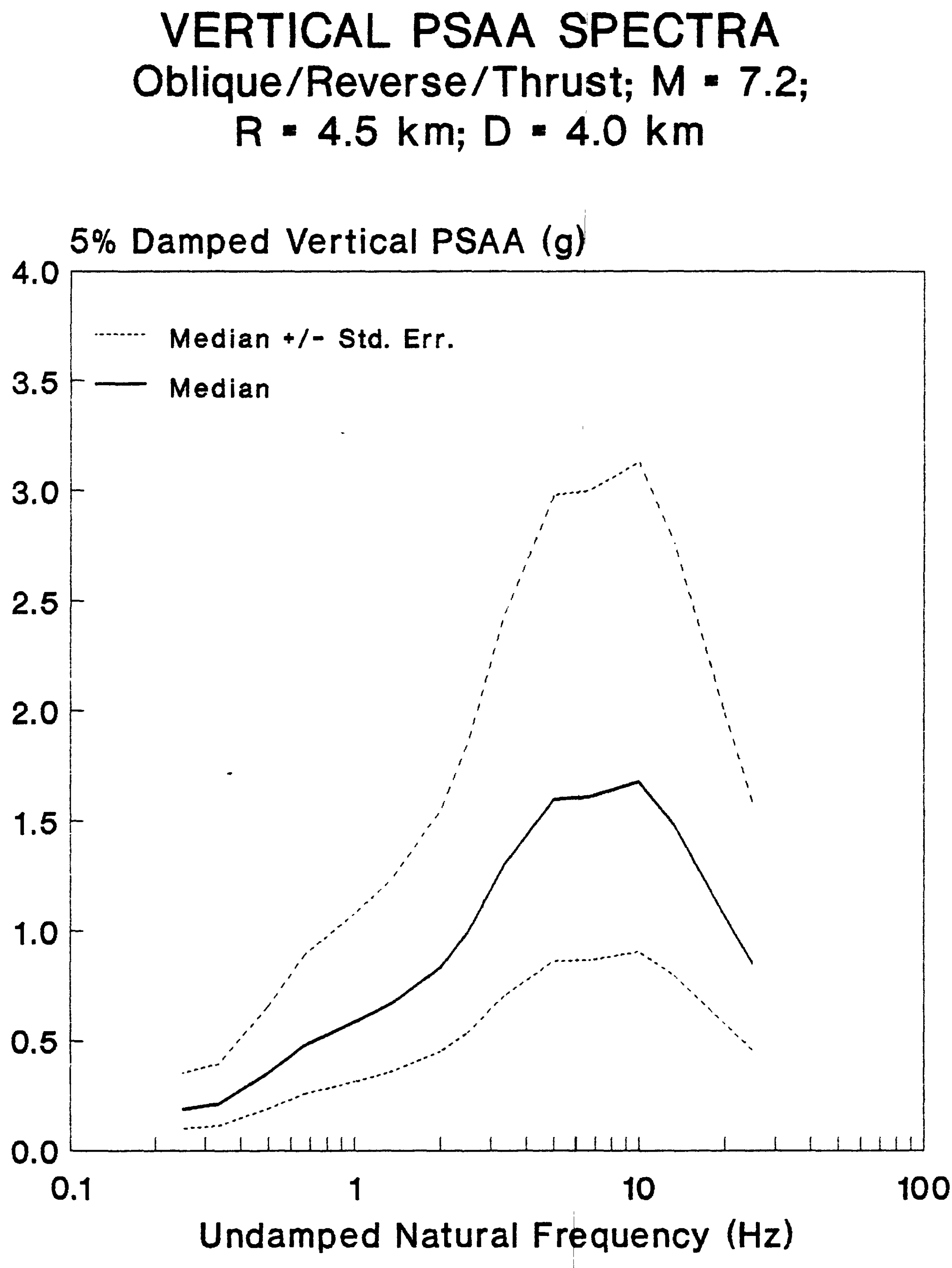

Fig. 12--Predicted LTSP analysis spectra

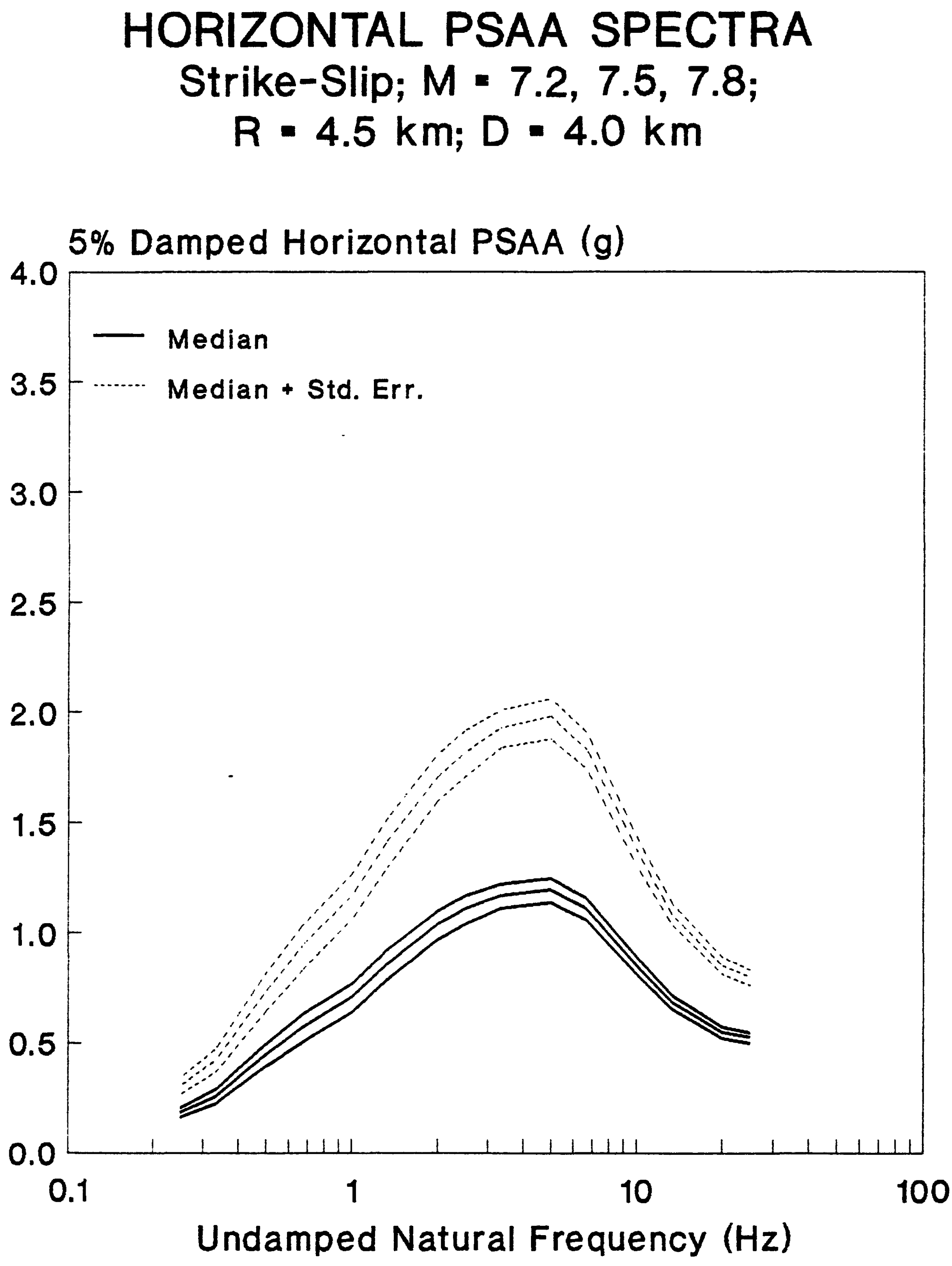

Fig. 13--Predicted LTSP analysis spectra

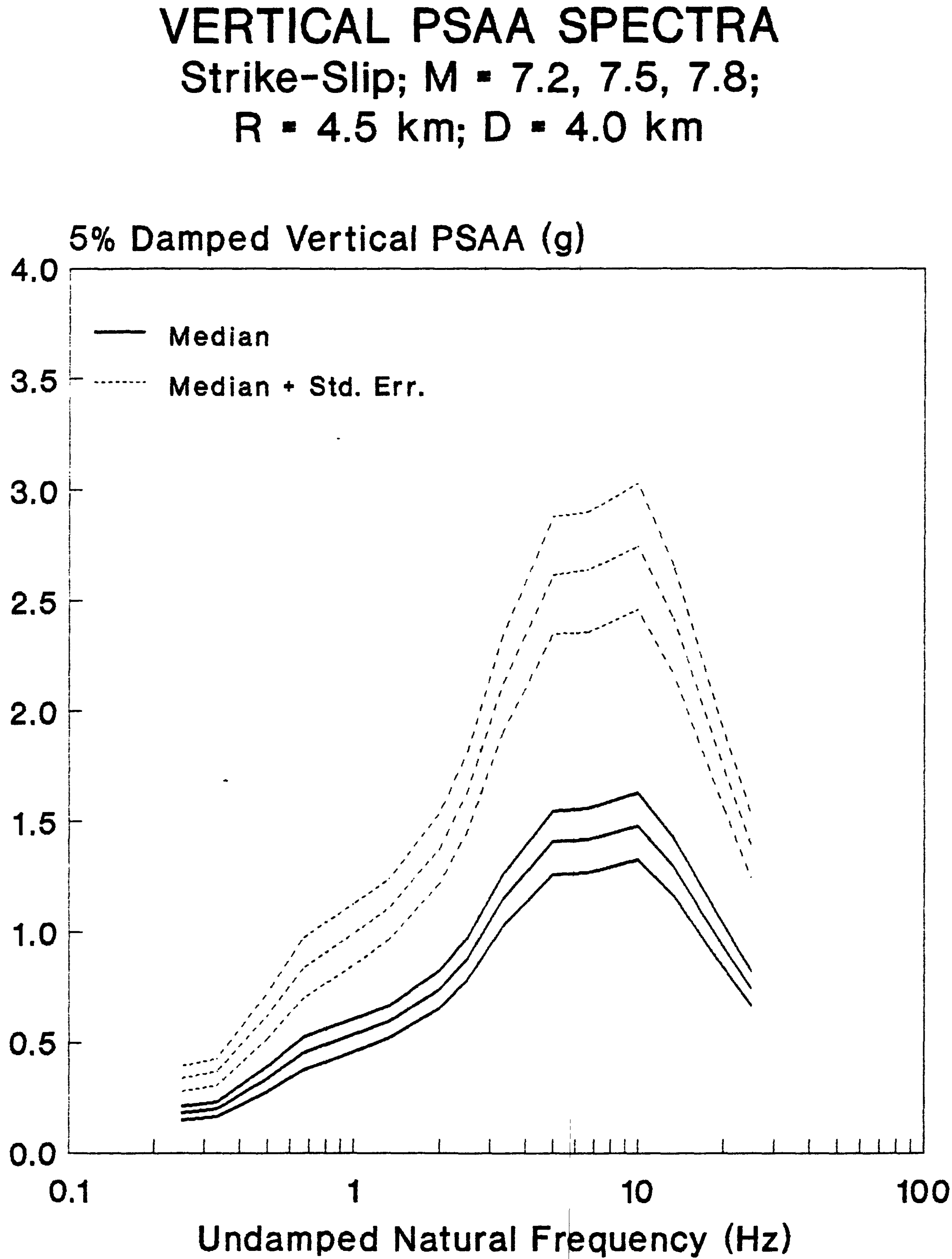

Fig. 14--Predicted LTSP analysis spectra

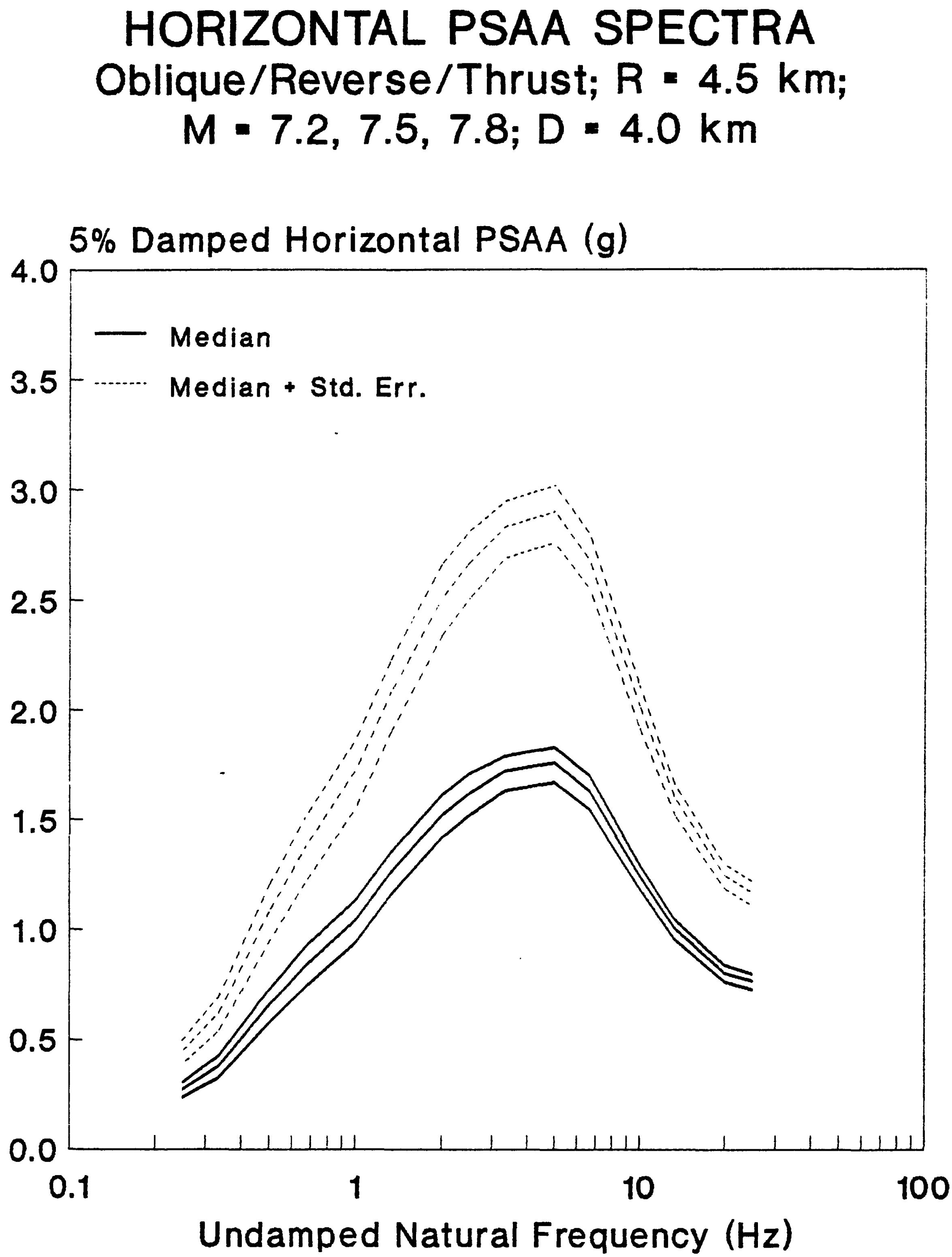

Fig. 15--Predicted LTSP analysis spectra

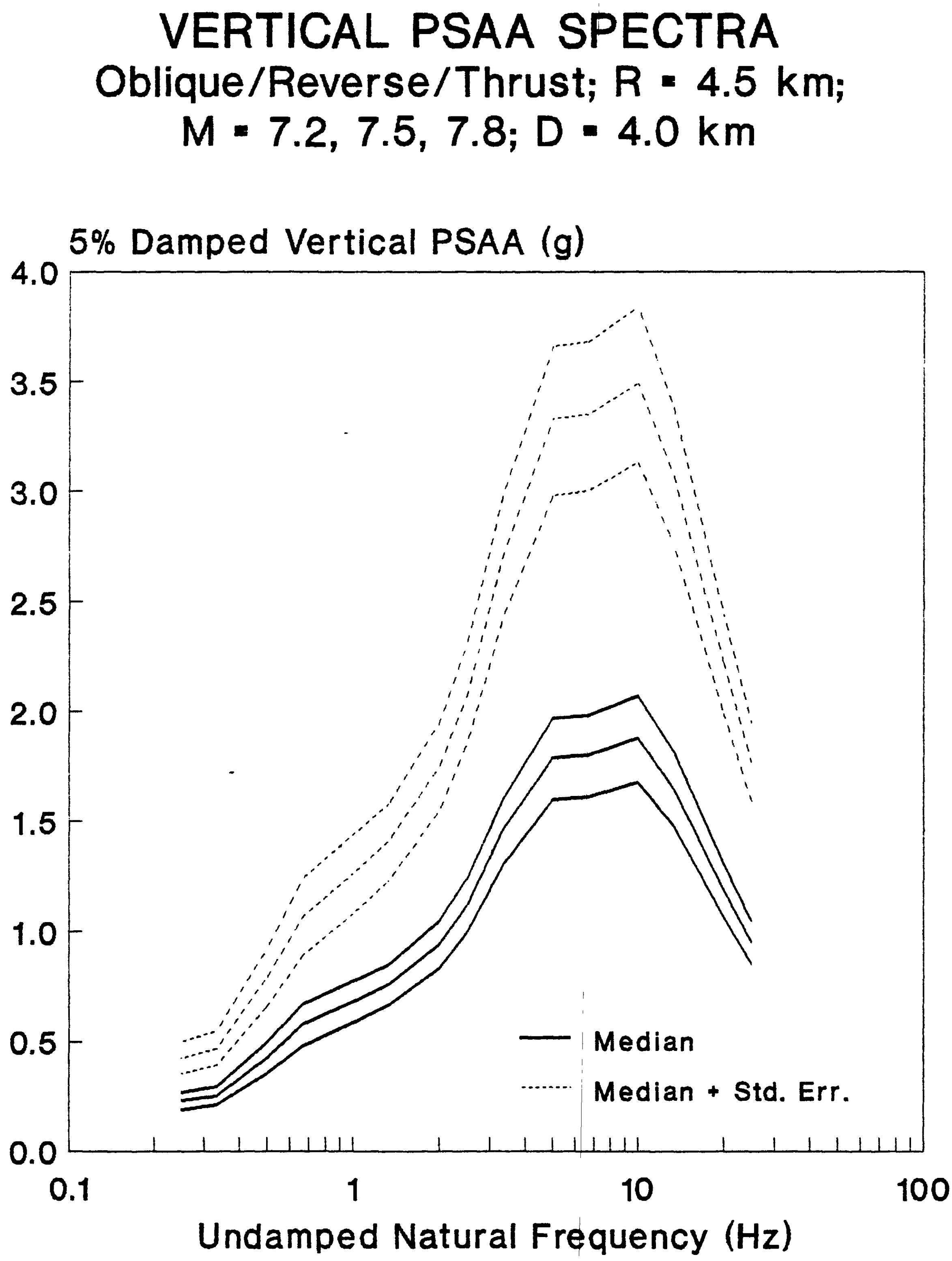

Fig. 16--Predicted LTSP analysis spectra

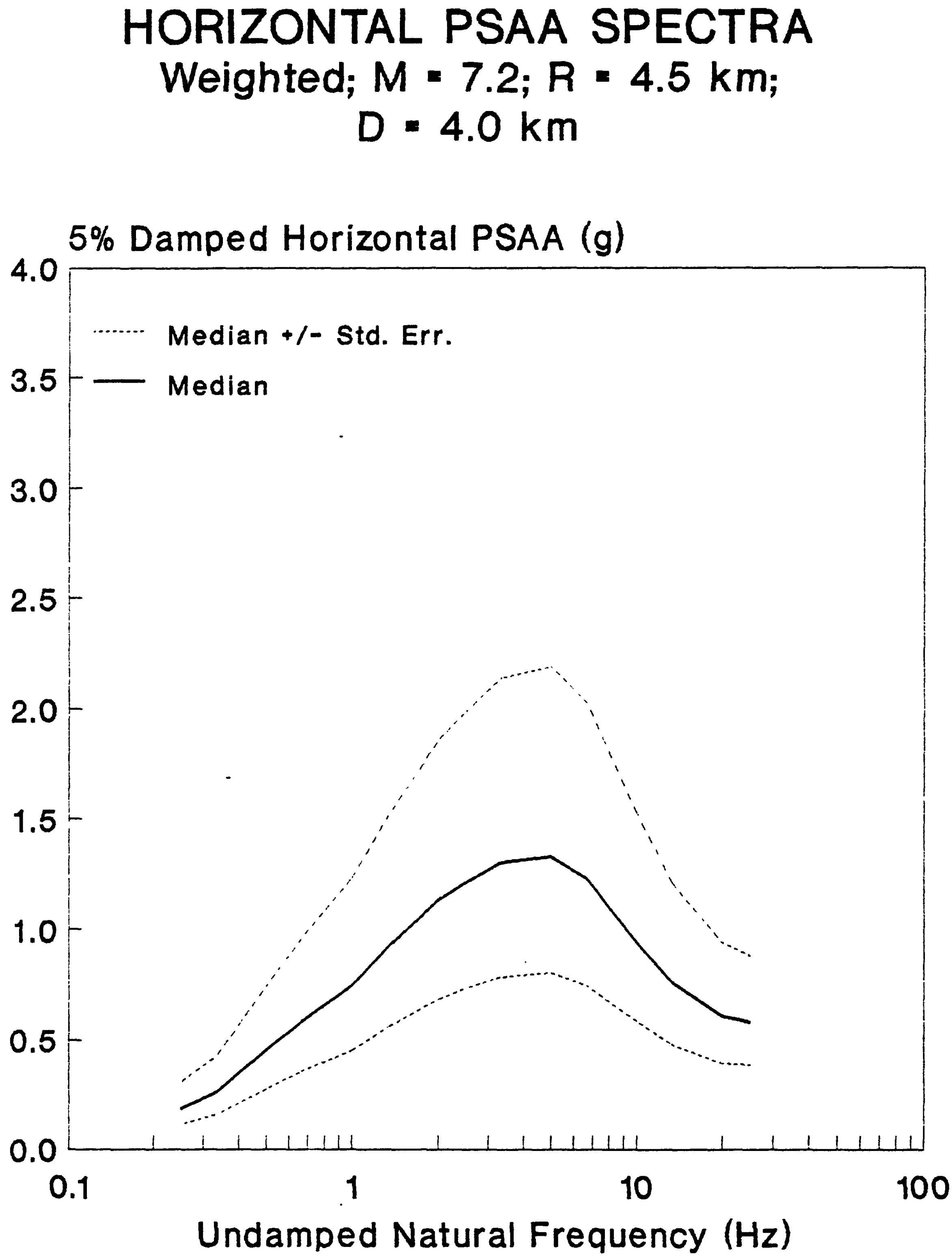

Fig. 17--Predicted LTSP analysis spectra

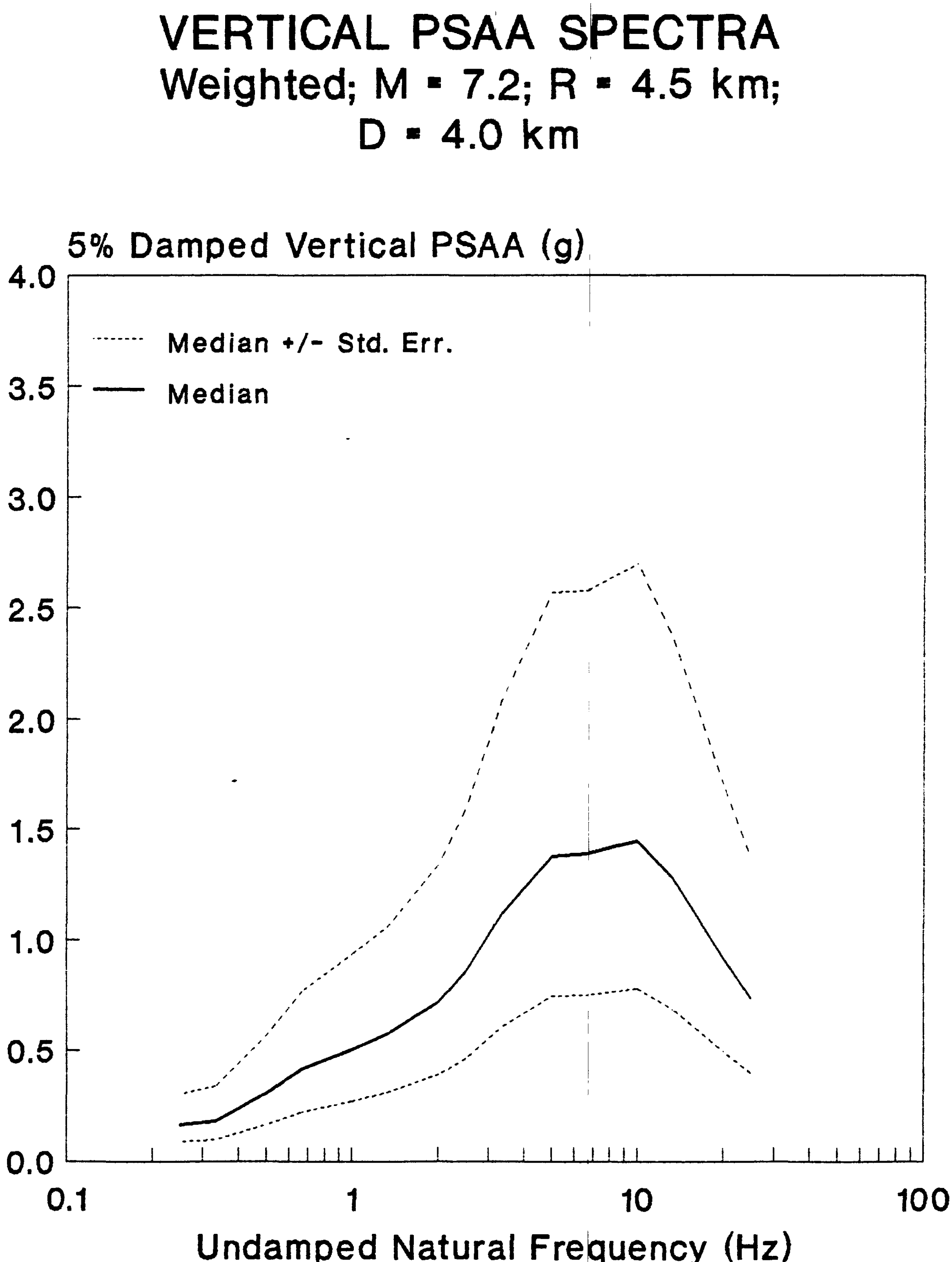

Fig. 18--Predicted LTSP analysis spectra

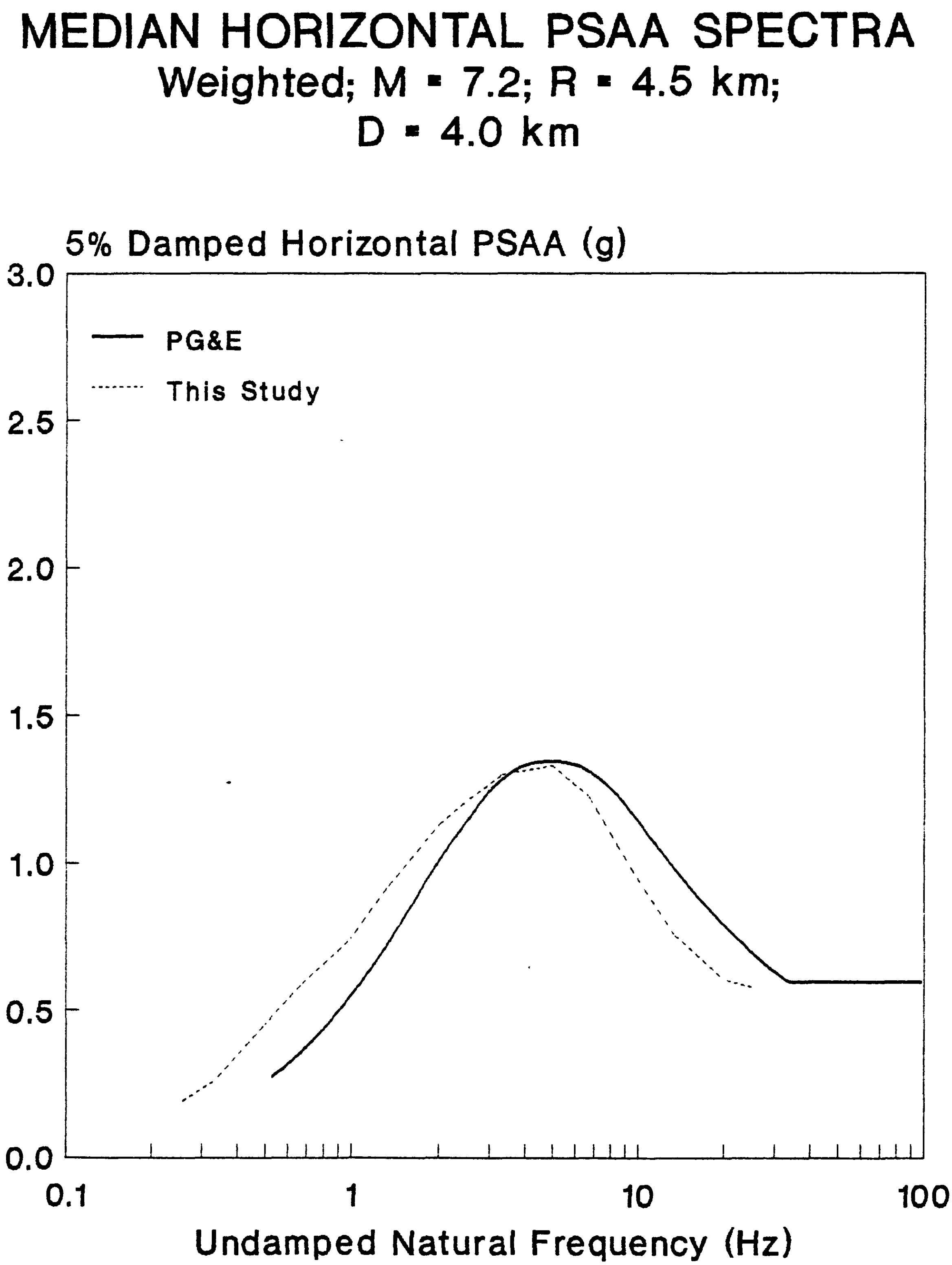

Fig. 19--Comparison of analysis spectra

MEDIAN VERTICAL PSAA SPECTRA
Weighted; M = 7.2; R = 4.5 km; D = 4.0 km

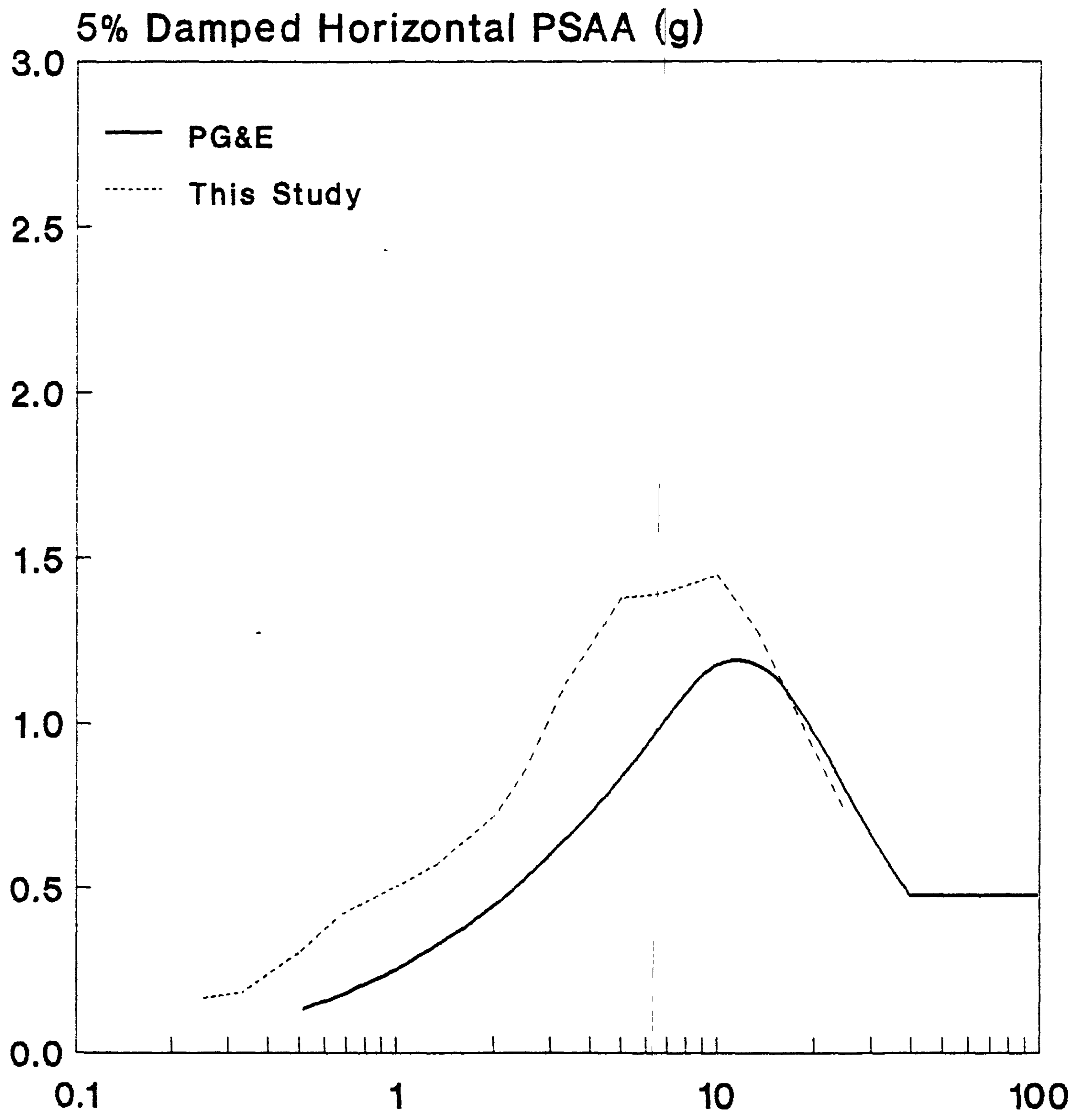

Fig. 20--Comparison of analysis spectra

84% HORIZONTAL PSAA SPECTRA
Weighted; M = 7.2; R = 4.5 km; D = 4.0 km

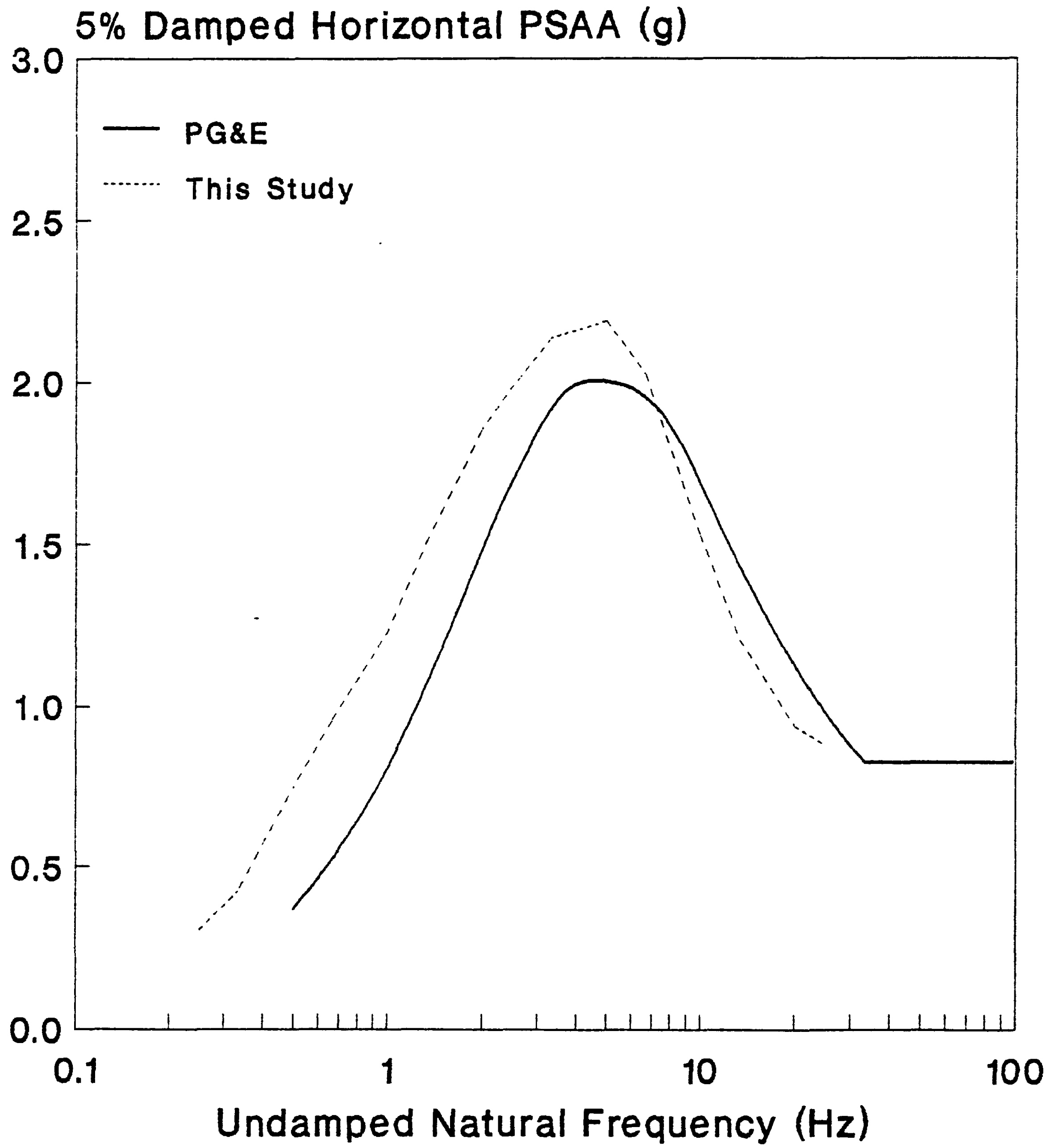

Fig. 21--Comparison of analysis spectra

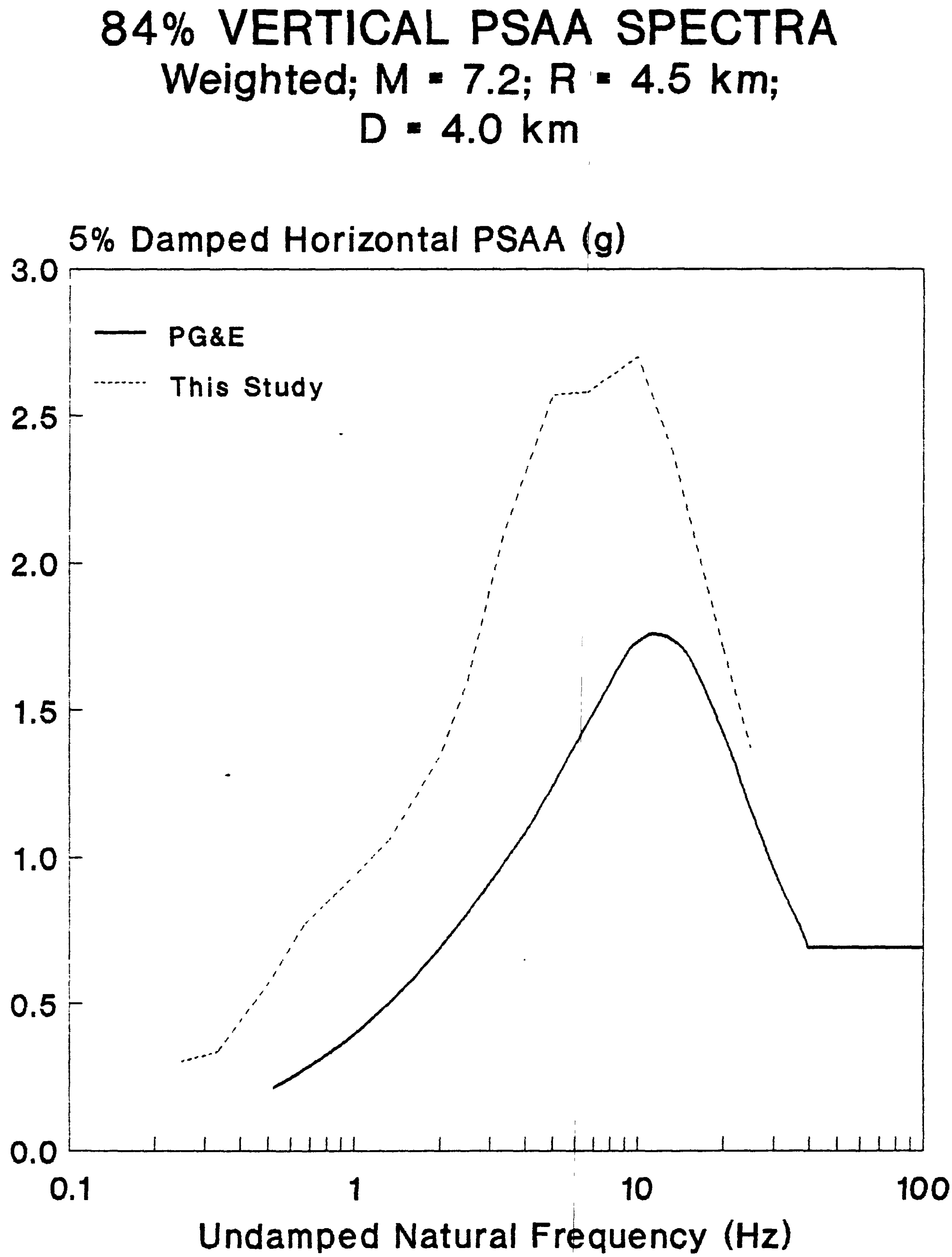

Fig. 22--Comparison of analysis spectra

APPENDIX—STRONG-MOTION DATA

TABLE A–1*

Earthquake Data—Soil Sites: Peak Parameters

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records			
					PHA	PVA	PHV	PVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	4	4	4
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	5	5	4	4
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1	1	1
POINT MUGU, CALIF.	02/21/73	14:45:57	5.9	R	1	1	0	0
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1	1	1
MESA DE ANDRADE, MEXICO	12/07/76	12:59:56	5.3	S	1	0	0	0
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	3	3	3	3
TABAS, IRAN	09/16/78	15:35:57	7.5	T	1	1	1	1
MALIBU, CALIF.	01/01/79	23:14:39	5.0	R	2	2	0	0
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	41	41	38	38
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	22	21	21	20
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	3	2	3	2
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	14	14	4	4
CHALFANT VALLEY, CALIF.	07/21/86	14:42:27	6.2	S	6	6	0	0
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	32	32	9	9

*** Parameter definitions may be found on page 115.**

TABLE A–2
Strong-Motion Data—Soil Sites: Peak Parameters

Earthquake	Year	Station No.	*R* (km)	PHA (*g*)	PVA (*g*)	PHV (cm/sec)	PVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	0.200	0.285	22.5	29.5
		288	22.0	0.149	0.152	22.9	12.0
IMPERIAL VALLEY, CALIF.	1940	117	8.3	0.292	0.278	34.4	10.2
KERN COUNTY, CALIF.	1952	1095	48.4	0.186	0.123	16.7	6.7
DALY CITY, CALIF.	1957	1049	24.6	0.038	0.023	1.6	0.5
		1065	14.8	0.053	0.036	2.2	1.2
		1078	14.8	0.047	0.034	3.8	1.4
		1080	12.9	0.083	0.050	4.6	2.3
PARKFIELD, CALIF.	1966	36226	10.1	0.278	0.138	11.3	4.5
		36227	6.3	0.435	0.181	24.0	6.8
		36228	3.0	0.509	0.349	78.1	14.1
		36229	15.2	0.069	0.061	7.5	4.7
BORREGO MTN, CALIF.	1968	117	46.1	0.102	0.036	20.3	3.4
LYTLE CREEK, CALIF.	1970	112	20.0	0.068	0.044	3.5	1.2
		113	28.8	0.042	0.042	2.2	1.5
		116	17.9	0.175	0.100		
		274	28.3	0.092	0.055	4.3	2.0
		290	12.4	0.176	0.076	8.8	2.5
SAN FERNANDO, CALIF.	1971	142	27.4	0.095	0.031	17.4	6.2
		160	29.0	0.244	0.085	18.6	9.7
		163	29.4	0.097	0.058	16.4	10.0
		166	29.4	0.229	0.081	20.1	9.6
		175	29.2	0.147	0.083	20.8	9.9
		181	29.0	0.143	0.086	16.9	9.0
		184	28.3	0.089	0.058	13.0	4.6
		187	28.5	0.158	0.072	13.2	4.8
		205	32.4	0.075	0.052	17.6	7.1
		208	28.2	0.130	0.057	20.4	7.3
		211	27.8	0.151	0.070	19.4	7.1
		223	28.1	0.106	0.084	21.1	0.9
		229	40.7	0.064	0.028	14.0	5.4
		232	24.1	0.211	0.118	18.8	6.4
		235	24.1	0.115	0.085	17.4	7.0
		238	23.8	0.094	0.062	13.0	5.6
		244	39.3	0.035	0.047	10.4	6.9
		247	40.8	0.043	0.025	12.1	5.7
		253	17.9	0.235	0.101	24.5	9.4
		262	25.4	0.134	0.105	11.8	7.7
		264	24.5	0.198	0.108	13.1	9.0
		267	17.2	0.188	0.146	11.6	6.0
		288	35.7	0.098	0.047	16.3	6.7
		413	29.3	0.106	0.071	14.6	4.9
		416	28.3	0.149	0.041	17.9	7.2
		425	28.2	0.097	0.079	13.5	5.7
		428	28.6	0.084	0.034	26.8	6.2
		437	30.5	0.106	0.052	19.1	8.9
		443	28.6	0.130	0.049	22.1	5.2
		446	23.6	0.151	0.081	12.1	7.5

TABLE A-2 (Continued)

Earthquake	Year	Station No.	R (km)	PHA (g)	PVA (g)	PHV (cm/sec)	PVV (cm/sec)
		452	27.1	0.080	0.039	14.1	5.9
		455	27.7	0.186	0.042	15.7	4.5
		458	12.7	0.115	0.111	30.1	18.0
		461	16.9	0.142	0.120	19.2	7.9
		466	17.7	0.189	0.108	25.6	9.3
		469	29.2	0.201	0.164	19.2	10.2
		475	25.1	0.109	0.106	11.1	6.7
		482	28.1	0.119	0.084	13.7	8.1
		1052	49.0	0.100	0.041	7.3	3.6
		24231	27.0	0.092	0.072	8.4	4.5
		24236	25.0	0.134	0.058	18.2	6.0
		24271	27.7	0.133	0.102	16.5	11.7
		24303	25.0	0.202	0.119	18.8	5.5
		24386	10.4	0.199	0.178	26.8	32.0
STONE CANYON, CALIF.	1972	1202	3.6	0.197	0.089	6.6	3.0
		1210	3.9	0.140	0.078	4.7	2.2
MANAGUA, NICARAGUA	1972	3501	5.4	0.370	0.326	32.7	17.4
POINT MUGU, CALIF.	1973	272	24.0	0.105	0.040		
HOLLISTER, CALIF.	1974	1028	10.8	0.131	0.075	8.5	2.8
		47126	8.9	0.084	0.053	4.9	1.7
GAZLI, U.S.S.R.	1976	9600	3.5	0.677	1.350	66.0	61.9
MESA DE ANDRADE, MEXICO	1976	6609	10.7	0.240			
SANTA BARBARA, CALIF.	1978	283	14.6	0.154	0.080	10.9	3.2
		25091	12.9	0.331	0.136	32.9	10.4
		25302	14.6	0.177	0.068	13.8	2.9
TABAS, IRAN	1978	9801	6.8	0.904	0.745	105.8	41.4
MALIBU, CALIF.	1979	657	20.7	0.040	0.020		
		757	23.7	0.045	0.020		
ST ELIAS, ALASKA	1979	2734	36.4	0.136	0.064	27.3	20.3
COYOTE LAKE, CALIF.	1979	47126	14.4	0.110	0.123	6.1	4.6
		47380	8.4	0.225	0.176	21.0	6.6
		47381	6.6	0.258	0.152	23.1	7.0
		57191	28.0	0.045	0.025	2.9	1.2
		57382	5.4	0.243	0.430	28.7	15.4
IMPERIAL VALLEY, CALIF.	1979	117	8.3	0.335	0.380		
		412	10.1	0.205	0.111	43.3	8.7
		931	18.8	0.134	0.074	18.5	6.9
		942	5.6	0.458	1.750	35.5	56.4
		952	5.6	0.458	0.566	65.3	38.4
		955	6.9	0.432	0.250	57.4	14.4
		958	6.7	0.550	0.478	50.6	22.4
		5028	5.5	0.405	0.627	76.5	25.9
		5051	15.0	0.159	0.163	15.9	7.1
		5052	32.5	0.052	0.027	4.5	2.5
		5053	11.9	0.241	0.199	17.8	6.2
		5054	6.1	0.691	0.444	43.8	12.2
		5055	9.3	0.241	0.250	46.6	9.9
		5056	16.0	0.144	0.071	12.9	3.6
		5057	10.9	0.246	0.135	41.5	8.5

TABLE A–2 (Continued)

Earthquake	Year	Station No.	R (km)	PHA (g)	PVA (g)	PHV (cm/sec)	PVV (cm/sec)
		5058	13.8	0.375	0.145	37.1	11.5
		5059	22.7	0.128	0.048	14.4	3.4
		5060	7.5	0.194	0.153	36.2	8.6
		5061	23.7	0.106	0.056	13.7	4.0
		5062	29.5	0.060	0.030		
		5115	12.3	0.366	0.119	28.9	6.7
		5165A	7.5	0.421	0.752	55.2	20.0
		5165B	7.5	0.352	0.537	36.3	14.3
		5165C	7.5	0.337	0.626	35.3	15.4
		5165D	7.5	0.323	0.661	36.0	16.4
		5165E	7.5	0.308	0.495	35.9	14.7
		5165F	7.5	0.388	0.507	37.5	10.3
		5165G	7.5	0.407	0.399	37.1	14.5
		6605	21.8	0.294	0.152	27.0	4.9
		6610	30.9	0.146	0.058	7.0	1.3
		6616	5.7	0.293	0.145	32.0	4.7
		6617	5.7	0.315	0.139	35.5	3.1
		6618	5.5	0.296	0.907	36.3	10.7
		6619	10.0	0.337	0.390	23.8	8.4
		6621	7.6	0.263	0.215	25.7	5.2
		6622	14.8	0.168	0.073	11.8	3.6
		01335	9.4	0.225	0.251	50.3	17.4
		01336A	5.5	0.308	0.256	81.3	29.3
		01336B	5.5	0.303	0.172		
		11023	36.4	0.091	0.035	10.1	4.0
		11369	16.0	0.094	0.086	20.5	7.1
MORGAN HILL, CALIF.	1984	1652	5.1	0.358	0.214	26.2	9.6
		1656A	28.0	0.098	0.232	9.9	6.6
		1656B	28.0	0.096	0.213	9.9	6.2
		1656D	28.1	0.079	0.245	8.7	9.0
		1656E	28.2	0.098	0.284	10.9	9.8
		1656F	28.2	0.091	0.251	11.5	8.0
		9101	12.8	0.179	0.090	9.5	4.3
		9102A	11.6	0.365	0.500		
		9102B	11.6	0.298	0.151	18.0	7.8
		9102C	11.6	0.372	0.234	20.9	8.6
		9102D	11.6	0.275		11.5	
		47380	16.7	0.192	0.597	8.7	9.7
		47381	16.0	0.200	0.388	11.4	9.0
		57064	26.9	0.025	0.021	3.1	1.6
		57066	22.1	0.033	0.016	5.6	3.1
		57191	5.1	0.236	0.110	26.1	12.0
		57355	17.0	0.060	0.035	10.7	3.8
		57356	16.6	0.059	0.045	9.5	3.5
		57357	17.6	0.038	0.026	8.3	3.3
		57382	14.3	0.295	0.402	18.0	11.0
		57425	14.5	0.154	0.454	6.2	4.4
		58235	28.4	0.072	0.037	4.6	2.5

TABLE A–2 (Continued)

Earthquake	Year	Station No.	R (km)	PHA (g)	PVA (g)	PHV (cm/sec)	PVV (cm/sec)
CENTRAL CHILE	1985	4487	37.0	0.553	0.834	31.3	18.8
		4490	35.1	0.235		22.9	
		4491	38.1	0.291	0.184	28.4	8.1
N. PALM SPRINGS, CALIF.	1986	5069	18.6	0.134	0.085		
		5070	8.4	0.692	0.778		
		5071	12.3	0.223	0.348		
		5072	5.0	0.580	0.438		
		5073	13.5	0.216	0.376		
		5075	23.7	0.072	0.055		
		5219	28.8	0.101	0.058		
		9001	6.7	0.845	0.480		
		12025	16.6	0.183	0.192	11.9	6.6
		12149	9.7	0.302	0.563	26.2	19.6
		12204	28.9	0.250	0.208	9.4	6.4
		12284	27.2	0.095	0.090		
		12299	14.9	0.175	0.130		
		22170	29.8	0.060	0.042	4.0	3.8
CHALFANT VALLEY, CALIF.	1986	9300	26.8	0.030	0.020		
		54100	22.0	0.210	0.130		
		54171	15.5	0.250	0.140		
		54388	14.4	0.205	0.170		
		54428	6.9	0.435	0.350		
		54T03	25.9	0.160	0.090		
WHITTIER NARROWS, CALIF.	1987	132	28.7	0.090	0.050		
		288	14.0	0.255	0.170		
		289	10.3	0.275	0.460		
		482	12.8	0.280	0.190		
		634A	15.0	0.195	0.090		
		634C	15.0	0.165	0.070		
		804	11.7	0.515	0.260		
		951A	22.4	0.130	0.090		
		5106	28.8	0.090	0.050		
		5129	12.5	0.400	0.520		
		5164	28.5	0.080	0.050		
		5239A	15.0	0.185	0.130		
		5239B	15.0	0.150	0.100		
		5239C	15.0	0.160	0.100		
		14196	23.5	0.246	0.072	12.5	2.8
		14241	29.2	0.055	0.050		
		14242	24.6	0.195	0.086	17.5	2.8
		14311	28.6	0.100	0.050		
		14368	16.5	0.181	0.164	20.9	3.0
		14403	20.9	0.340	0.105	18.1	3.1
		24236	23.1	0.090	0.040		
		24303	23.2	0.166	0.080	8.1	3.1
		24332	29.1	0.050	0.030		
		24370	25.0	0.190	0.100		
		24385	25.3	0.200	0.060		
		24389	29.2	0.090	0.040		

TABLE A–2 (Continued)

Earthquake	Year	Station No.	R (km)	PHA (g)	PVA (g)	PHV (cm/sec)	PVV
		24390	29.1	0.065	0.020		
		24400	12.4	0.442	0.142	17.4	5.3
		24401	14.0	0.169	0.137	8.9	6.6
		24402	17.4	0.240	0.175	7.5	3.1
		24461	12.1	0.347	0.199	19.3	5.9
		24463	14.7	0.155	0.090		

TABLE A-3

Station Data—Soil Sites

Station No.	Recording Station	Housing	No. of Stories	Location	D (km)	Geology
112	CEDAR SPRING PUMP PLNT	BLDG	1	GRND	0.092	A
113	COLTON SCE SUBSTATION	BLDG	1	GRND	0.180	A
116	DEVILS CYN FILTER PLNT	BLDG	1	GRND	0.015	A
117	EL CENTRO STA 9	BLDG	2	BSMT	5.000	A
131	LONG BEACH PUB UTL BLG	BLDG	4	BSMT	2.600	B
132	LONG BEACH CSULB	BLDG	9	BSMT	5.500	B
142	LA 120 N ROBERTSON	BLDG	9	BSMT	3.400	A
160	LA 533 S FREMONT	BLDG	10	BSMT	3.000	B
163	LA 611 W SIXTH ST	BLDG	42	BSMT	3.000	A
166	LA 646 S OLIVE	BLDG	7	GRND	3.000	A
175	LA 808 S OLIVE	BLDG	8	GRND	2.900	A
181	LA 1640 MARENGO	BLDG	7	GRND	3.400	B
184	LA 1900 AVE OF STARS	BLDG	27	BSMT	3.700	B
187	LA 1901 AVE OF STARS	BLDG	20	BSMT	3.700	B
205	LA 3440 UNIVERSITY	BLDG	12	BSMT	4.600	A
208	LA 3470 WILSHIRE	BLDG	12	BSMT	2.900	B
211	LA 3550 WILSHIRE	BLDG	20	BSMT	2.900	A
223	LA 4680 WILSHIRE	BLDG	6	BSMT	3.000	B
229	LA 5250 CENTURY	BLDG	7	GRND	2.400	B
232	LA 6430 SUNSET	BLDG	15	GRND	2.900	A
235	LA 6464 SUNSET	BLDG	11	BSMT	2.900	A
238	LA 7080 HOLLYWOOD BLV	BLDG	11	BSMT	2.900	A
244	LA 8639 LINCOLN	BLDG	12	BSMT	2.400	B
247	LA 9841 AIRPORT BLVD	BLDG	14	BSMT	2.400	B
253	LA 14724 VENTURA	BLDG	14	GRND	1.800	A
262	PALMDALE FIRE STA	BLDG	1	GRND	0.200	A
264	PASADENA MILLIKAN LIB	BLDG	9	BSMT	0.910	B
267	PASADENA JPL BLDG 180	BLDG	9	BSMT	0.220	B
272	PORT HUENEME NAVAL LAB	BLDG	1	GRND	6.000	A
274	SAN BERN HALL OF RCRDS	BLDG	6	BSMT	1.100	A
283	SANTA BARBARA CRTHS	BLDG	2	BSMT	8.500	B
288	VERNON CMD TERMINAL	BLDG	6	BSMT	6.700	A
289	WHITTIER NARROWS UPSTM	SHLT	0	GRND	2.500	A
290	WRIGHTWOOD	BLDG	2	GRND	0.068	B
412	EL CENTRO STA 10	BLDG	1	GRND	4.900	A
413	LA 1177 S BEVERLY DR	BLDG	7	BSMT	4.100	B
416	BH 9100 WILSHIRE	BLDG	10	BSMT	3.700	A
425	LA 1700 CENTURY PARKE	BLDG	15	BSMT	3.700	B
428	LA 5900 WILSHIRE	BLDG	31	BSMT	3.500	B
437	LA 1150 S HILL	BLDG	10	BSMT	3.700	A
443	LA 6200 WILSHIRE	BLDG	17	GRND	3.700	A
446	LA 1760 N ORCHID	BLDG	23	GRND	2.900	A
452	BV HILL 435 N OAKHURST	BLDG	10	BSMT	3.800	A
455	BH 450 N ROXBURY	BLDG	10	GRND	3.700	A
458	LA 15107 VAN OWEN	BLDG	7	BSMT	2.900	A
461	LA 15910 VENTURA	BLDG	16	BSMT	1.800	A
466	LA 15250 VENTURA	BLDG	12	BSMT	1.800	A
469	LA 1625 W OLYMPIC	BLDG	10	GRND	2.900	B

TABLE A-3 (Continued)

Station No.	Recording Station	Housing	No. of Stories	Location	D (km)	Geology
475	PASADENA ATHENAEUM CIT	BLDG	2	BSMT	0.910	B
482	ALHAMBRA 900 S FREMONT	BLDG	12	BSMT	1.200	B
634A	NORWALK 12400 IMP FF S	SHLT	0	GRND	7.000	A
634C	NORWALK 12400 IMPERIAL	BLDG	7	BSMT	7.000	A
657	SANTA MONICA 201 OCEAN	BLDG	18	BSMT	1.900	B
757	SEPULVEDA CONTROL FAC	BLDG	9	BSMT	1.600	B
804	WHITTIER 7215 BRIGHT	BLDG	10	BSMT	5.900	A
931	EL CENTRO STA 12	SHLT	0	GRND	4.400	A
942	EL CENTRO STA 6	BLDG	1	GRND	5.600	A
951A	BREA DAM DOWNSTREAM	SHLT	0	GRND	4.800	A
952	EL CENTRO STA 5	SHLT	0	GRND	5.700	A
955	EL CENTRO STA 4	SHLT	0	GRND	5.600	A
958	EL CENTRO STA 8	SHLT	0	GRND	5.100	A
1028	HOLLISTER CITY HALL	BLDG	1	BSMT	1.700	A
1049	OAKLAND CITY HALL	BLDG	15	BSMT	0.200	B
1052	OSO PUMPING PLANT	SHLT	0	GRND	3.000	A
1065	SF ALEXANDER BLDG	BLDG	15	BSMT	0.043	A
1078	SF SO PACIFIC BLDG	BLDG	12	BSMT	0.087	F
1080	SF STATE BLDG	BLDG	6	BSMT	0.062	A
1095	TAFT LINCOLN SCHOOL	BLDG	1	BSMT	6.400	A
1202	STONE CANYON EAST	BLDG	1	GRND	2.400	A
1210	BEAR VALLEY STA 1	BLDG	1	GRND	0.380	A
1652	ANDERSON DAM DWNSTREAM	SHLT	0	GRND	0.034	A
1656A	HOLLISTER DIF ARRAY SMA	SHLT	0	GRND	1.500	A
1656B	HOLLISTER D.A. STA 1	SHLT	0	GRND	1.500	A
1656D	HOLLISTER.D.A. STA 3	SHLT	0	GRND	1.500	A
1656E	HOLLISTER D.A. STA 4	SHLT	0	GRND	1.500	A
1656F	HOLLISTER D.A. STA 5	SHLT	0	GRND	1.500	A
2734	ICY BAY	BLDG	1	GRND	6.100	F
3501	MANAGUA ESSO REFINERY	BLDG	1	GRND	2.000	A
4487	LLOLLEO	BLDG	1	BSMT	0.040	B
4490	EL ALMENDRAL,VALPARAIS	BLDG	1	GRND	0.060	A
4491	VINA DEL MAR	BLDG	10	BSMT	0.075	B
5028	EL CENTRO STA 7	BLDG	1	GRND	5.400	A
5051	PARACHUTE TEST SITE	BLDG	1	GRND	4.800	A
5052	PLASTER CITY	BLDG	1	GRND	0.800	A
5053	CALEXICO FIRE STA	BLDG	1	GRND	5.000	A
5054	BONDS CORNER	BLDG	1	GRND	4.800	A
5055	HOLTVILLE POST OFFICE	BLDG	1	GRND	5.300	A
5056	EL CENTRO STA 1	BLDG	1	GRND	3.500	A
5057	EL CENTRO STA 3	BLDG	1	GRND	5.700	A
5058	EL CENTRO STA 11	BLDG	1	GRND	5.000	A
5059	EL CENTRO STA 13	SHLT	0	GRND	3.400	A
5060	BRAWLEY AIRPORT	BLDG	1	GRND	5.200	A
5061	CALIPATRIA FIRE STA	BLDG	2	GRND	5.100	A
5062	SALTON SEA	BLDG	1	GRND	2.100	A
5069	FUN VALLEY RESERVOIR	BLDG	1	GRND	0.110	A
5070	N PALM SPRINGS P.O.	BLDG	1	GRND	1.000	A
5071	MORONGO VALLEY FIRE ST	BLDG	1	GRND	0.160	A

TABLE A-3 (Continued)

Station No.	Recording Station	Housing	No. of Stories	Location	*D* (km)	Geology
5072	WHITEWATER TROUT FARM	BLDG	1	GRND	0.027	A
5073	CABAZON PO	BLDG	1	GRND	1.200	A
5075	FOREST FALLS PO	BLDG	1	GRND	0.100	A
5106	LONG BEACH VA HOSPITAL	BLDG	11	BSMT	4.600	B
5115	EL CENTRO STA 2	SHLT	0	GRND	5.500	A
5129	LA BULK MAIL CENTER	BLDG	4	GRND	5.500	A
5164	WEYMOUTH FILTER PLANT	BLDG	1	GRND	0.300	B
5165A	EL CENTRO DF.ARRAY-SMA	SHLT	0	GRND	5.000	A
5165B	EL CENTRO DIFF.ARRAY 1	VLT	0	GRND	5.000	A
5165C	EL CENTRO DIFF.ARRAY 2	VLT	0	GRND	5.000	A
5165D	EL CENTRO DIFF.ARRAY 3	VLT	0	GRND	5.000	A
5165E	EL CENTRO DIFF.ARRAY 4	VLT	0	GRND	5.000	A
5165F	EL CENTRO DIFF.ARRAY 5	VLT	0	GRND	5.000	A
5165G	EL CENTRO DIFF.ARRAY 6	VLT	0	GRND	5.000	A
5219	CHERRY VALLEY	BLDG	1	GRND	0.079	A
5239A	NORWALK 12440 IMP FF N	SHLT	0	GRND	7.000	A
5239B	NORWALK 12440 IMP FF S	SHLT	0	GRND	7.000	A
5239C	NORWALK 12440 IMPERIAL	BLDG	7	BSMT	7.000	A
6605	MEX DELTA	SHLT	0	GRND	7.500	A
6609	MEX RIITO	SHLT	0	GRND	8.000	A
6610	MEX VICTORIA	SHLT	0	GRND	7.000	A
6616	MEX AEROPUERTO	SHLT	0	GRND	4.800	A
6617	MEX CUCUPAH	SHLT	0	GRND	6.000	A
6618	MEX AGRARIAS	SHLT	0	GRND	5.000	A
6619	MEX MEXICALI(FLORES)	BLDG	1	GRND	5.500	A
6621	MEX CHIHUAHUA	SHLT	0	GRND	6.000	A
6622	MEX COMPUERTAS	SHLT	0	GRND	4.500	A
9001	DEVERS SUBSTATION	BLDG	1	GRND	1.000	B
9101	IBM SAN JOSE BLDG 28 FF	VLT	0	GRND	0.400	A
9102A	IBM SANTA TERESA FREEFIEL	VLT	0	GRND	0.061	A
9102B	IBM SANTA TERESA BLDG 'L'	BLDG	1	GRND	0.061	A
9102C	IBM SANTA TERESA BLDG 'D'	BLDG	4	GRND	0.061	A
9102D	IBM SANTA TERESA BLDG 'J'	BLDG	1	BSMT	0.061	A
9300	LONG VALLEY FIRE STA	BLDG	1	GRND	0.200	B
9600	KARAKYR, U.S.S.R.	BLDG	1	GRND	1.400	A
9801	TABAS, IRAN	BLDG	1	GRND	2.000	A
01335	EL CENTRO - IMPERIAL CO.	SHLT	0	GRND	4.800	A
01336A	EL CENTRO - RT. 8/MELOLAN	VLT	0	GRND	4.500	A
01336B	EL CENTRO - RT. 8/MELOLAN	BRDG	1	GRND	4.500	A
11023	NILAND	BLDG	1	GRND	2.200	A
11369	WESTMORLAND	BLDG	2	GRND	5.200	A
12025	PALM SPRINGS - AIRPORT	SHLT	0	GRND	0.670	A
12149	DESERT HOT SPRINGS	BLDG	1	GRND	0.700	A
12204	SAN JACINTO - SOBOBA (HeA	BLDG	1	GRND	0.100	B
12284	PALM DESERT - KIEWIT BUIL	BLDG	4	GRND	1.000	A
12299	PALM SPRINGS - DESERT HOS	BLDG	4	BSMT	0.900	A
14196	INGLEWOOD - UNION OIL	SHLT	0	GRND	7.100	B
14241	LONG BEACH - RECREATION P	SHLT	0	GRND	4.500	B
14242	LONG BEACH - RANCHO LOS C	SHLT	0	GRND	4.600	A

TABLE A–3 (Continued)

Station No.	Recording Station	Housing	No. of Stories	Location	D (km)	Geology
14311	LONG BEACH - STATE UNIV.	BLDG	5	BSMT	5.500	B
14368	DOWNEY	BLDG	1	GRND	9.500	A
14403	L. A. - 116TH ST. SCH. (L	BLDG	1	GRND	6.700	B
22170	JOSHUA TREE	BLDG	1	GRND	0.200	A
24231	L. A. - UCLA MATH - SCIEN	BLDG	7	BSMT	1.200	B
24236	L. A. - HOLLYWOOD STORAGE	BLDG	14	BSMT	2.500	A
24271	LAKE HUGHES #1 (LHA)	BLDG	1	GRND	3.000	A
24303	L. A. - HOLLYWOOD STORAGE	SHLT	0	GRND	2.500	A
24332	L. A. - BULLOCK'S CENTURY	BLDG	3	BSMT	4.200	B
24370	BURBANK - CALIFORNIA FED.	BLDG	6	GRND	0.200	A
24385	BURBANK - PACIFIC MANOR	BLDG	10	GRND	0.200	A
24386	VAN NUYS - HOLIDAY INN	BLDG	7	GRND	4.200	A
24389	CENTURY CITY - LACC NORTH	SHLT	0	GRND	4.200	B
24390	CENTURY CITY - LACC SOUTH	SHLT	0	GRND	4.200	B
24400	L. A. - OBREGON PARK (LAA	BLDG	1	GRND	3.800	A
24401	SAN MARINO - SW. ACADEMY	BLDG	1	GRND	1.500	B
24402	ALTADENA - EATON CANYON P	BLDG	1	GRND	0.900	A
24461	ALHAMBRA - FREMONT SCHOOL	BLDG	1	GRND	1.200	B
24463	L. A. - SEARS WAREHOUSE	BLDG	5	BSMT	4.300	A
25091	SANTA BARBARA - UNIV OF C	BLDG	1	GRND	8.400	A
25302	SANTA BARBARA - FREITAS B	BLDG	4	BSMT	8.500	B
36226	PARKFIELD - CHOLAME 8 WES	BLDG	1	GRND	1.900	B
36227	PARKFIELD - CHOLAME 5 WES	SHLT	0	GRND	1.100	A
36228	PARKFIELD - CHOLAME 2 WES	SHLT	0	GRND	3.000	A
36229	PARKFIELD - CHOLAME 12 WE	SHLT	0	GRND	2.600	A
47126	SAN JUAN BAUTISTA FIRE ST	BLDG	1	GRND	0.430	A
47380	GILROY #2	SHLT	0	GRND	0.180	A
47381	GILROY #3	SHLT	0	GRND	1.100	A
54100	BENTON	BLDG	1	GRND	1.200	A
54171	BISHOP LA WATER DEPT	BLDG	1	GRND	1.200	A
54388	BISHOP - 873 NORTH MAIN S	BLDG	2	GRND	1.200	A
54428	CHALFANT - ZACK BROTHERS	BLDG	1	GRND	1.000	A
54T03	CROWLEY LAKE - SHEHORN RE	BLDG	1	GRND	0.096	A
57064	FREMONT - MISSION SAN JOS	BLDG	1	GRND	2.300	B
57066	AGNEWS - STATE HOSPITAL	BLDG	1	GRND	0.400	A
57191	HALLS VALLEY	SHLT	0	GRND	0.016	A
57355	SAN JOSE - G. W. SAVINGS	BLDG	10	BSMT	0.340	A
57356	SAN JOSE - TOWN PARK TOWE	BLDG	10	GRND	0.340	A
57357	SAN JOSE - SANTA CLARA CO	BLDG	13	BSMT	0.340	A
57382	GILROY #4	BLDG	1	GRND	1.400	A
57425	GILROY #7 (MANTELLI RANCH	SHLT	0	GRND	0.540	A
58235	SARATAGO - WEST VALLEY CO	BLDG	1	GRND	2.700	B

TABLE A-4

Earthquake Data—Soil Sites: 0.04 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	4
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	4	4
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	2	2
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	8	7
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	9	9

TABLE A-5

Earthquake Data—Soil Sites: 0.05 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	4
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	4	4
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	3	3
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	35	35
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	17	16
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	1	1
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	4	4
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	9	9

TABLE A–6

Earthquake Data—Soil Sites: 0.075–1.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	4
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	4	4
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	3	3
TABAS, IRAN	09/16/78	15:35:57	7.5	T	1	1
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	35	35
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	17	16
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	2	1
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	4	4
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	9	9

TABLE A–7

Earthquake Data—Soil Sites: 1.5–2.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	*M*	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	3
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	4	4
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	3	3
TABAS, IRAN	09/16/78	15:35:57	7.5	T	1	1
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	35	35
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	17	16
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	2	1
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	4	4
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	9	9

TABLE A–8

Earthquake Data—Soil Sites: 3.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	4	1
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	4	1
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
TABAS, IRAN	09/16/78	15:35:57	7.5	T	1	1
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	35	35
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	17	16
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	2	1
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	3	3
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	2	2

TABLE A-9

Earthquake Data—Soil Sites: 4.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	*M*	Fault Type	No. of Records	
					PSRVH	PSRVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	2	2
IMPERIAL VALLEY, CALIF.	05/19/40	04:36:41	7.2	S	1	1
KERN COUNTY, CALIF.	07/21/52	11:52:14	7.8	R	1	1
DALY CITY, CALIF.	03/22/57	19:44:29	5.3	S	3	0
PARKFIELD, CALIF.	06/28/66	04:26:14	6.0	S	4	4
BORREGO MTN, CALIF.	04/09/68	02:28:59	6.8	S	1	1
LYTLE CREEK, CALIF.	09/12/70	14:30:53	5.4	R	3	0
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	44	44
STONE CANYON, CALIF.	09/04/72	18:04:41	4.7	S	2	2
MANAGUA, NICARAGUA	12/23/72	06:29:45	6.2	S	1	1
HOLLISTER, CALIF.	11/28/74	23:01:25	5.1	S	2	2
GAZLI, U.S.S.R.	05/17/76	02:58:41	7.0	R	1	1
TABAS, IRAN	09/16/78	15:35:57	7.5	T	1	1
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	1
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	5	5
IMPERIAL VALLEY, CALIF.	10/15/79	23:16:55	6.7	S	35	35
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	16	15
CENTRAL CHILE	03/03/85	22:46:57	7.8	T	2	1
N. PALM SPRINGS, CALIF.	07/08/86	09:20:44	6.0	S	2	2

TABLE A-10
Strong-Motion Data—Soil Sites: 0.04 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	1.890	3.480
		288	22.0	1.027	1.350
IMPERIAL VALLEY, CALIF.	1940	117	8.3	1.970	2.620
KERN COUNTY, CALIF.	1952	1095	48.4	1.115	0.711
DALY CITY, CALIF.	1957	1049	24.6	0.208	0.109
		1065	14.8	0.281	0.242
		1078	14.8	0.292	0.183
		1080	12.9	0.479	0.292
PARKFIELD, CALIF.	1966	36226	10.1	1.625	0.706
		36227	6.3	2.570	1.000
		36228	3.0	3.070	1.580
		36229	15.2	0.389	0.333
BORREGO MTN, CALIF.	1968	117	46.1	0.604	0.205
LYTLE CREEK, CALIF.	1970	112	20.0	0.426	0.328
		113	28.8	0.293	0.226
		274	28.3	0.560	0.350
		290	12.4	1.074	0.434
SAN FERNANDO, CALIF.	1971	142	27.4	0.581	0.171
		160	29.0	1.495	0.574
		163	29.4	0.593	0.358
		166	29.4	1.430	0.455
		175	29.2	0.877	0.493
		181	29.0	0.831	0.485
		184	28.3	0.548	0.366
		187	28.5	1.019	0.424
		205	32.4	0.456	0.350
		208	28.2	0.811	0.305
		211	27.8	0.939	0.485
		223	28.1	0.636	0.447
		229	40.7	0.376	0.181
		232	24.1	1.190	0.818
		235	24.1	0.757	0.523
		238	23.8	0.588	0.389
		244	39.3	0.215	0.272
		247	40.8	0.255	0.167
		253	17.9	1.465	0.749
		262	25.4	0.807	0.551
		264	24.5	1.220	0.635
		267	17.2	1.117	0.820
		288	35.7	0.595	0.272
		413	29.3	0.683	0.470
		416	28.3	0.907	0.272
		425	28.2	0.586	0.401
		428	28.6	0.524	0.220
		437	30.5	0.655	0.320
		443	28.6	0.808	0.300
		446	23.6	0.935	0.574
		452	27.1	0.494	0.246

TABLE A–10 (Continued)

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	1.170	0.274
		458	12.7	0.697	0.683
		461	16.9	0.890	0.645
		466	17.7	1.173	0.663
		469	29.2	1.263	0.968
		475	25.1	0.709	0.683
		482	28.1	0.755	0.544
		1052	49.0	0.626	0.233
		24231	27.0	0.552	0.427
		24236	25.0	0.819	0.325
		24271	27.7	0.817	0.597
		24303	25.0	1.225	0.604
		24386	10.4	1.224	1.080
STONE CANYON, CALIF.	1972	1202	3.6	1.132	0.564
		1210	3.9	0.928	0.450
MANAGUA, NICARAGUA	1972	3501	5.4	2.120	1.910
HOLLISTER, CALIF.	1974	1028	10.8	0.785	0.432
		47126	8.9	0.484	0.332
GAZLI, U.S.S.R.	1976	9600	3.5	6.245	21.400
IMPERIAL VALLEY, CALIF.	1979	5165C	7.5	2.120	5.960
		5165D	7.5	2.015	4.210
MORGAN HILL, CALIF.	1984	1652	5.1	2.270	3.270
		1656A	28.0	0.604	1.460
		9101	12.8	1.140	1.220
		9102B	11.6	1.880	1.240
		9102C	11.6	2.375	1.490
		9102D	11.6	1.735	0.000
		57356	16.6	0.363	0.244
		57357	17.6	0.239	0.131
WHITTIER NARROWS, CALIF.	1987	14196	23.5	1.520	0.488
		14242	24.6	1.229	0.610
		14368	16.5	1.100	1.550
		14403	20.9	2.120	0.726
		24303	23.2	1.038	0.528
		24400	12.4	2.680	1.050
		24401	14.0	1.061	1.270
		24402	17.4	1.550	1.080
		24461	12.1	2.175	1.380

TABLE A–11

Strong-Motion Data—Soil Sites: 0.05 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	2.190	4.220
		288	22.0	1.405	1.310
IMPERIAL VALLEY, CALIF.	1940	117	8.3	2.870	3.730
KERN COUNTY, CALIF.	1952	1095	48.4	1.395	0.897
DALY CITY, CALIF.	1957	1049	24.6	0.273	0.171
		1065	14.8	0.368	0.252
		1078	14.8	0.390	0.220
		1080	12.9	0.616	0.353
PARKFIELD, CALIF.	1966	36226	10.1	2.125	1.090
		36227	6.3	3.325	1.590
		36228	3.0	3.840	2.110
		36229	15.2	0.532	0.455
BORREGO MTN, CALIF.	1968	117	46.1	0.770	0.262
LYTLE CREEK, CALIF.	1970	112	20.0	0.558	0.412
		113	28.8	0.395	0.307
		274	28.3	0.697	0.480
		290	12.4	1.380	0.589
SAN FERNANDO, CALIF.	1971	142	27.4	0.723	0.232
		160	29.0	1.905	0.693
		163	29.4	0.743	0.452
		166	29.4	1.775	0.632
		175	29.2	1.120	0.660
		181	29.0	1.025	0.584
		184	28.3	0.760	0.521
		187	28.5	1.350	0.554
		205	32.4	0.586	0.475
		208	28.2	1.026	0.422
		211	27.8	1.250	0.762
		223	28.1	0.848	0.602
		229	40.7	0.499	0.247
		232	24.1	1.485	0.925
		235	24.1	0.993	0.760
		238	23.8	0.774	0.536
		244	39.3	0.271	0.345
		247	40.8	0.336	0.210
		253	17.9	2.055	0.912
		262	25.4	1.053	0.749
		264	24.5	1.545	0.866
		267	17.2	1.450	1.240
		288	35.7	0.750	0.391
		413	29.3	0.964	0.630
		416	28.3	1.140	0.358
		425	28.2	0.752	0.579
		428	28.6	0.660	0.269
		437	30.5	0.810	0.434
		443	28.6	1.035	0.384
		446	23.6	1.240	1.010
		452	27.1	0.639	0.340

TABLE A–11 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	1.525	0.457
		458	12.7	0.900	0.937
		461	16.9	1.190	1.040
		466	17.7	1.525	1.160
		469	29.2	1.650	1.380
		475	25.1	0.857	0.846
		482	28.1	1.040	0.805
		1052	49.0	0.805	0.338
		24231	27.0	0.715	0.566
		24236	25.0	1.039	0.493
		24271	27.7	1.027	0.843
		24303	25.0	1.680	0.899
		24386	10.4	1.545	1.390
STONE CANYON, CALIF.	1972	1202	3.6	1.645	0.806
		1210	3.9	1.232	0.680
MANAGUA, NICARAGUA	1972	3501	5.4	2.785	2.850
HOLLISTER, CALIF.	1974	1028	10.8	1.003	0.554
		47126	8.9	0.667	0.525
GAZLI, U.S.S.R.	1976	9600	3.5	12.000	37.300
SANTA BARBARA, CALIF.	1978	283	14.6	1.089	0.771
		25091	12.9	2.500	1.070
		25302	14.6	0.939	0.582
ST ELIAS, ALASKA	1979	2734	36.4	1.069	0.549
COYOTE LAKE, CALIF.	1979	47126	14.4	0.829	1.040
		47380	8.4	2.380	2.670
		47381	6.6	2.335	3.530
		57191	28.0	0.335	0.198
		57382	5.4	1.900	4.550
IMPERIAL VALLEY, CALIF.	1979	412	10.1	1.720	1.300
		931	18.8	1.270	1.450
		942	5.6	5.175	21.000
		952	5.6	5.455	9.140
		955	6.9	3.895	4.560
		958	6.7	4.825	7.710
		5028	5.5	3.115	8.230
		5051	15.0	1.345	1.500
		5052	32.5	0.412	0.363
		5053	11.9	1.965	3.070
		5054	6.1	6.565	7.710
		5055	9.3	1.965	4.700
		5056	16.0	1.640	1.020
		5057	10.9	2.250	1.800
		5058	13.8	2.910	2.010
		5059	22.7	1.053	0.804
		5060	7.5	1.810	2.270
		5061	23.7	0.837	0.800
		5115	12.3	3.335	2.350
		5165A	7.5	3.585	7.760
		5165B	7.5	2.890	8.190

TABLE A–11 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		5165C	7.5	2.985	8.630
		5165D	7.5	2.545	6.970
		6605	21.8	2.895	2.770
		6610	30.9	1.630	0.772
		6616	5.7	4.370	3.580
		6617	5.7	5.550	2.160
		6618	5.5	3.895	12.200
		6619	10.0	6.375	7.300
		6621	7.6	2.135	3.730
		6622	14.8	1.465	1.650
		01335	9.4	1.820	3.850
		01336A	5.5	2.380	3.440
		11023	36.4	0.701	0.441
		11369	16.0	0.786	0.981
MORGAN HILL, CALIF.	1984	1652	5.1	3.030	5.210
		1656A	28.0	0.761	1.750
		9101	12.8	1.425	1.420
		9102B	11.6	2.450	1.700
		9102C	11.6	2.875	1.720
		9102D	11.6	2.495	0.000
		47380	16.7	1.600	6.320
		47381	16.0	1.615	6.320
		57064	26.9	0.186	0.218
		57066	22.1	0.271	0.135
		57191	5.1	1.915	0.983
		57355	17.0	0.472	0.300
		57356	16.6	0.463	0.340
		57357	17.6	0.302	0.213
		57382	14.3	2.360	3.630
		57425	14.5	1.290	7.540
		58235	28.4	0.564	0.376
CENTRAL CHILE	1985	4491	38.1	2.235	2.800
N. PALM SPRINGS, CALIF.	1986	12025	16.6	1.775	2.920
		12149	9.7	2.575	7.320
		12204	28.9	2.165	1.750
		22170	29.8	0.469	0.457
WHITTIER NARROWS, CALIF.	1987	14196	23.5	2.175	0.732
		14242	24.6	1.705	1.010
		14368	16.5	1.475	2.050
		14403	20.9	2.680	1.150
		24303	23.2	1.395	1.030
		24400	12.4	4.015	1.810
		24401	14.0	1.610	1.690
		24402	17.4	2.045	1.500
		24461	12.1	3.150	2.190

TABLE A-12

Strong-Motion Data—Soil Sites: 0.075 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	3.505	7.870
		288	22.0	2.380	2.440
IMPERIAL VALLEY, CALIF.	1940	117	8.3	4.200	6.680
KERN COUNTY, CALIF.	1952	1095	48.4	2.175	1.540
DALY CITY, CALIF.	1957	1049	24.6	0.455	0.455
		1065	14.8	0.691	0.551
		1078	14.8	0.613	0.828
		1080	12.9	1.043	0.818
PARKFIELD, CALIF.	1966	36226	10.1	4.635	4.700
		36227	6.3	5.700	4.190
		36228	3.0	5.970	6.450
		36229	15.2	1.310	1.270
BORREGO MTN, CALIF.	1968	117	46.1	1.268	0.523
LYTLE CREEK, CALIF.	1970	112	20.0	1.215	1.430
		113	28.8	0.692	0.678
		274	28.3	1.330	0.932
		290	12.4	2.845	1.380
SAN FERNANDO, CALIF.	1971	142	27.4	1.335	0.554
		160	29.0	3.365	1.780
		163	29.4	1.740	0.935
		166	29.4	3.290	1.390
		175	29.2	2.090	1.260
		181	29.0	1.880	1.060
		184	28.3	1.885	1.180
		187	28.5	3.175	0.874
		205	32.4	0.984	0.793
		208	28.2	1.920	0.757
		211	27.8	2.040	2.310
		223	28.1	1.615	1.490
		229	40.7	0.933	0.516
		232	24.1	3.060	2.340
		235	24.1	1.935	1.780
		238	23.8	1.415	0.993
		244	39.3	0.426	0.640
		247	40.8	0.558	0.442
		253	17.9	4.105	1.410
		262	25.4	2.400	1.670
		264	24.5	2.350	1.960
		267	17.2	2.380	2.640
		288	35.7	1.185	0.739
		413	29.3	1.715	1.610
		416	28.3	2.470	0.889
		425	28.2	1.565	1.140
		428	28.6	1.022	0.483
		437	30.5	1.605	0.942
		443	28.6	1.980	0.765
		446	23.6	2.355	1.860
		452	27.1	1.205	0.709

TABLE A–12 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	2.870	0.770
		458	12.7	1.610	1.800
		461	16.9	2.655	2.400
		466	17.7	2.645	1.610
		469	29.2	2.920	2.690
		475	25.1	1.485	1.640
		482	28.1	2.155	1.420
		1052	49.0	1.295	0.503
		24231	27.0	1.570	1.180
		24236	25.0	1.770	1.230
		24271	27.7	1.925	2.390
		24303	25.0	3.735	2.540
		24386	10.4	2.530	2.370
STONE CANYON, CALIF.	1972	1202	3.6	3.295	2.380
		1210	3.9	2.050	1.170
MANAGUA, NICARAGUA	1972	3501	5.4	5.135	6.780
HOLLISTER, CALIF.	1974	1028	10.8	1.670	1.070
		47126	8.9	1.180	1.630
GAZLI, U.S.S.R.	1976	9600	3.5	24.900	55.100
SANTA BARBARA, CALIF.	1978	283	14.6	2.025	1.440
		25091	12.9	4.800	1.780
		25302	14.6	1.760	1.040
TABAS, IRAN	1978	9801	6.8	16.300	21.500
ST ELIAS, ALASKA	1979	2734	36.4	1.675	0.953
COYOTE LAKE, CALIF.	1979	47126	14.4	1.400	2.220
		47380	8.4	5.110	5.420
		47381	6.6	4.845	5.420
		57191	28.0	0.604	0.366
		57382	5.4	3.255	9.210
IMPERIAL VALLEY, CALIF.	1979	412	10.1	4.795	2.830
		931	18.8	2.715	2.080
		942	5.6	7.635	42.000
		952	5.6	10.195	14.500
		955	6.9	5.255	6.940
		958	6.7	11.450	11.600
		5028	5.5	4.905	17.900
		5051	15.0	2.545	2.490
		5052	32.5	1.028	0.681
		5053	11.9	4.190	4.220
		5054	6.1	11.695	11.600
		5055	9.3	3.505	8.930
		5056	16.0	3.810	1.770
		5057	10.9	4.715	4.430
		5058	13.8	4.965	4.090
		5059	22.7	2.665	1.230
		5060	7.5	3.755	4.640
		5061	23.7	1.740	1.660
		5115	12.3	6.950	4.710
		5165A	7.5	6.420	29.000

TABLE A–12 (Continued)

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		5165B	7.5	4.595	28.400
		5165C	7.5	4.550	29.600
		5165D	7.5	4.575	20.400
		6605	21.8	5.215	5.810
		6610	30.9	3.225	3.000
		6616	5.7	6.610	5.220
		6617	5.7	10.400	5.390
		6618	5.5	5.330	14.400
		6619	10.0	10.020	10.200
		6621	7.6	4.330	9.350
		6622	14.8	3.750	3.460
		01335	9.4	3.485	6.220
		01336A	5.5	3.785	4.530
		11023	36.4	1.245	1.190
		11369	16.0	1.503	3.390
MORGAN HILL, CALIF.	1984	1652	5.1	5.115	5.820
		1656A	28.0	1.570	3.630
		9101	12.8	3.690	2.810
		9102B	11.6	4.670	2.470
		9102C	11.6	5.320	3.320
		9102D	11.6	4.545	0.000
		47380	16.7	2.860	11.100
		47381	16.0	2.685	9.320
		57064	26.9	0.313	0.439
		57066	22.1	0.418	0.242
		57191	5.1	3.925	1.410
		57355	17.0	0.706	0.752
		57356	16.6	0.719	0.734
		57357	17.6	0.449	0.429
		57382	14.3	4.280	9.980
		57425	14.5	2.130	9.350
		58235	28.4	0.936	0.551
CENTRAL CHILE	1985	4490	35.1	3.495	0.000
		4491	38.1	4.180	3.060
N. PALM SPRINGS, CALIF.	1986	12025	16.6	4.445	3.990
		12149	9.7	5.525	14.200
		12204	28.9	3.985	3.380
		22170	29.8	0.859	0.887
WHITTIER NARROWS, CALIF.	1987	14196	23.5	5.305	2.090
		14242	24.6	2.990	1.850
		14368	16.5	2.935	5.440
		14403	20.9	5.335	3.230
		24303	23.2	3.190	2.460
		24400	12.4	8.005	3.150
		24401	14.0	2.885	3.450
		24402	17.4	5.030	3.300
		24461	12.1	6.225	4.900

TABLE A-13

Strong-Motion Data—Soil Sites: 0.1 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	4.570	8.430
		288	22.0	3.925	3.380
IMPERIAL VALLEY, CALIF.	1940	117	8.3	6.925	13.800
KERN COUNTY, CALIF.	1952	1095	48.4	3.520	2.770
DALY CITY, CALIF.	1957	1049	24.6	0.826	0.637
		1065	14.8	1.211	0.701
		1078	14.8	0.975	0.978
		1080	12.9	2.070	0.968
PARKFIELD, CALIF.	1966	36226	10.1	6.910	4.190
		36227	6.3	9.285	4.110
		36228	3.0	8.480	12.700
		36229	15.2	1.940	2.270
BORREGO MTN, CALIF.	1968	117	46.1	1.750	1.210
LYTLE CREEK, CALIF.	1970	112	20.0	2.085	1.230
		113	28.8	1.180	1.140
		274	28.3	2.390	2.090
		290	12.4	5.700	2.150
SAN FERNANDO, CALIF.	1971	142	27.4	2.365	0.851
		160	29.0	5.360	2.900
		163	29.4	2.665	2.150
		166	29.4	5.615	2.970
		175	29.2	3.310	1.860
		181	29.0	3.490	1.900
		184	28.3	3.670	1.870
		187	28.5	5.805	1.800
		205	32.4	1.570	1.250
		208	28.2	2.705	1.410
		211	27.8	3.365	3.150
		223	28.1	2.480	2.060
		229	40.7	1.510	0.635
		232	24.1	5.805	3.170
		235	24.1	2.755	2.100
		238	23.8	2.445	2.080
		244	39.3	0.755	1.000
		247	40.8	0.934	0.744
		253	17.9	6.740	3.280
		262	25.4	4.955	4.390
		264	24.5	3.660	2.950
		267	17.2	4.940	2.790
		288	35.7	1.800	1.320
		413	29.3	3.380	2.900
		416	28.3	3.770	1.550
		425	28.2	2.585	1.700
		428	28.6	1.420	0.719
		437	30.5	3.290	1.570
		443	28.6	3.200	1.200
		446	23.6	3.535	2.240
		452	27.1	1.870	1.270

TABLE A-13 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	5.665	1.450
		458	12.7	3.265	3.400
		461	16.9	3.685	3.380
		466	17.7	4.230	2.190
		469	29.2	5.220	4.980
		475	25.1	2.515	2.950
		482	28.1	4.420	3.990
		1052	49.0	2.160	0.940
		24231	27.0	2.430	3.910
		24236	25.0	3.285	2.000
		24271	27.7	2.450	3.150
		24303	25.0	7.860	4.170
		24386	10.4	4.460	3.990
STONE CANYON, CALIF.	1972	1202	3.6	8.230	3.950
		1210	3.9	3.860	1.920
MANAGUA, NICARAGUA	1972	3501	5.4	9.580	10.200
HOLLISTER, CALIF.	1974	1028	10.8	3.210	2.040
		47126	8.9	3.205	2.790
GAZLI, U.S.S.R.	1976	9600	3.5	26.800	65.400
SANTA BARBARA, CALIF.	1978	283	14.6	3.290	2.650
		25091	12.9	6.740	2.980
		25302	14.6	2.490	2.120
TABAS, IRAN	1978	9801	6.8	26.100	21.400
ST ELIAS, ALASKA	1979	2734	36.4	2.165	1.200
COYOTE LAKE, CALIF.	1979	47126	14.4	2.515	5.450
		47380	8.4	8.685	9.200
		47381	6.6	9.240	5.690
		57191	28.0	0.875	0.775
		57382	5.4	4.910	19.900
IMPERIAL VALLEY, CALIF.	1979	412	10.1	5.265	4.740
		931	18.8	3.945	3.200
		942	5.6	14.900	88.500
		952	5.6	13.615	24.600
		955	6.9	10.225	6.250
		958	6.7	19.600	14.200
		5028	5.5	7.345	18.000
		5051	15.0	3.735	4.560
		5052	32.5	1.655	1.100
		5053	11.9	8.525	8.740
		5054	6.1	17.250	14.200
		5055	9.3	6.585	9.820
		5056	16.0	7.270	2.620
		5057	10.9	10.900	8.170
		5058	13.8	9.060	5.430
		5059	22.7	4.035	1.910
		5060	7.5	4.870	11.500
		5061	23.7	2.665	3.140
		5115	12.3	11.050	5.370
		5165A	7.5	11.250	30.700

TABLE A–13 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	7.230	26.300
		5165C	7.5	7.350	28.700
		5165D	7.5	7.310	21.400
		6605	21.8	10.865	5.740
		6610	30.9	3.925	3.560
		6616	5.7	14.030	4.480
		6617	5.7	13.500	6.990
		6618	5.5	8.180	8.700
		6619	10.0	9.990	20.300
		6621	7.6	6.385	9.640
		6622	14.8	6.610	2.230
		01335	9.4	6.030	15.000
		01336A	5.5	5.355	5.860
		11023	36.4	2.235	1.700
		11369	16.0	2.630	4.200
MORGAN HILL, CALIF.	1984	1652	5.1	7.930	7.140
		1656A	28.0	2.680	6.740
		9101	12.8	4.225	3.700
		9102B	11.6	6.860	2.880
		9102C	11.6	8.040	4.580
		9102D	11.6	5.770	0.000
		47380	16.7	4.190	12.600
		47381	16.0	5.055	11.000
		57064	26.9	0.545	0.678
		57066	22.1	0.691	0.422
		57191	5.1	6.195	2.640
		57355	17.0	0.953	0.958
		57356	16.6	1.000	1.240
		57357	17.6	0.620	0.500
		57382	14.3	7.655	17.300
		57425	14.5	4.620	11.100
		58235	28.4	1.490	0.866
CENTRAL CHILE	1985	4490	35.1	6.245	0.000
		4491	38.1	5.940	6.320
N. PALM SPRINGS, CALIF.	1986	12025	16.6	6.870	5.560
		12149	9.7	10.200	14.500
		12204	28.9	6.945	8.710
		22170	29.8	1.715	1.360
WHITTIER NARROWS, CALIF.	1987	14196	23.5	9.475	4.800
		14242	24.6	4.205	2.920
		14368	16.5	4.520	7.390
		14403	20.9	10.760	3.840
		24303	23.2	7.665	3.400
		24400	12.4	12.050	6.450
		24401	14.0	6.170	3.560
		24402	17.4	7.380	6.960
		24461	12.1	10.150	7.060

TABLE A–14

Strong-Motion Data—Soil Sites: 0.15 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	8.570	22.900
		288	22.0	5.330	5.260
IMPERIAL VALLEY, CALIF.	1940	117	8.3	11.360	10.300
KERN COUNTY, CALIF.	1952	1095	48.4	6.920	6.270
DALY CITY, CALIF.	1957	1049	24.6	2.090	0.894
		1065	14.8	1.790	1.780
		1078	14.8	2.305	1.460
		1080	12.9	4.365	2.130
PARKFIELD, CALIF.	1966	36226	10.1	17.950	4.270
		36227	6.3	17.500	9.350
		36228	3.0	17.500	13.600
		36229	15.2	3.480	4.570
BORREGO MTN, CALIF.	1968	117	46.1	3.515	1.480
LYTLE CREEK, CALIF.	1970	112	20.0	4.175	1.290
		113	28.8	3.210	3.070
		274	28.3	5.575	3.860
		290	12.4	7.710	2.570
SAN FERNANDO, CALIF.	1971	142	27.4	4.825	1.590
		160	29.0	9.690	3.530
		163	29.4	4.685	2.570
		166	29.4	10.400	4.390
		175	29.2	7.445	4.060
		181	29.0	7.110	4.110
		184	28.3	5.795	2.410
		187	28.5	12.950	2.970
		205	32.4	2.880	2.570
		208	28.2	5.880	4.570
		211	27.8	6.690	5.110
		223	28.1	5.450	4.750
		229	40.7	2.740	1.320
		232	24.1	11.900	6.630
		235	24.1	6.135	5.360
		238	23.8	5.065	3.910
		244	39.3	1.395	1.380
		247	40.8	1.615	0.861
		253	17.9	14.600	5.360
		262	25.4	6.745	4.650
		264	24.5	7.580	4.450
		267	17.2	5.575	4.320
		288	35.7	4.150	3.530
		413	29.3	4.420	2.770
		416	28.3	8.920	2.000
		425	28.2	4.535	2.820
		428	28.6	2.670	1.320
		437	30.5	5.465	3.050
		443	28.6	6.020	2.310
		446	23.6	8.925	5.050
		452	27.1	3.695	1.510

TABLE A–14 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	7.900	2.770
		458	12.7	6.530	4.930
		461	16.9	7.100	5.540
		466	17.7	9.505	5.330
		469	29.2	11.050	12.600
		475	25.1	4.230	4.570
		482	28.1	7.225	4.620
		1052	49.0	4.940	3.070
		24231	27.0	5.070	6.170
		24236	25.0	5.640	3.020
		24271	27.7	5.220	5.490
		24303	25.0	11.650	3.960
		24386	10.4	8.970	8.360
STONE CANYON, CALIF.	1972	1202	3.6	15.450	3.970
		1210	3.9	6.570	3.800
MANAGUA, NICARAGUA	1972	3501	5.4	17.600	32.400
HOLLISTER, CALIF.	1974	1028	10.8	7.660	3.320
		47126	8.9	3.330	3.110
GAZLI, U.S.S.R.	1976	9600	3.5	34.050	47.800
SANTA BARBARA, CALIF.	1978	283	14.6	7.225	4.740
		25091	12.9	13.600	5.580
		25302	14.6	8.310	3.700
TABAS, IRAN	1978	9801	6.8	62.750	41.200
ST ELIAS, ALASKA	1979	2734	36.4	3.965	1.810
COYOTE LAKE, CALIF.	1979	47126	14.4	3.890	7.920
		47380	8.4	18.450	10.600
		47381	6.6	17.900	8.900
		57191	28.0	1.915	1.200
		57382	5.4	8.985	14.300
IMPERIAL VALLEY, CALIF.	1979	412	10.1	10.225	6.650
		931	18.8	7.620	4.570
		942	5.6	15.350	86.200
		952	5.6	23.300	20.100
		955	6.9	14.250	9.540
		958	6.7	24.450	22.000
		5028	5.5	12.850	14.800
		5051	15.0	7.805	8.800
		5052	32.5	3.830	2.130
		5053	11.9	12.095	13.200
		5054	6.1	34.900	22.000
		5055	9.3	12.700	17.400
		5056	16.0	8.060	2.220
		5057	10.9	17.950	7.070
		5058	13.8	19.700	9.100
		5059	22.7	6.845	2.220
		5060	7.5	9.530	6.940
		5061	23.7	4.935	3.580
		5115	12.3	30.000	5.280
		5165A	7.5	31.400	21.800

TABLE A–14 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		5165B	7.5	17.300	19.900
		5165C	7.5	16.150	19.800
		5165D	7.5	15.100	17.400
		6605	21.8	18.750	7.280
		6610	30.9	9.355	2.020
		6616	5.7	14.300	5.950
		6617	5.7	21.800	6.470
		6618	5.5	8.705	7.130
		6619	10.0	20.500	21.100
		6621	7.6	9.465	10.100
		6622	14.8	7.525	2.570
		01335	9.4	9.620	14.800
		01336A	5.5	9.360	8.900
		11023	36.4	4.235	1.940
		11369	16.0	3.405	5.660
MORGAN HILL, CALIF.	1984	1652	5.1	15.150	6.300
		1656A	28.0	4.855	16.000
		9101	12.8	7.745	6.110
		9102B	11.6	14.750	6.470
		9102C	11.6	21.100	6.370
		9102D	11.6	16.450	0.000
		47380	16.7	9.225	20.500
		47381	16.0	13.265	21.000
		57064	26.9	1.054	1.650
		57066	22.1	1.630	0.894
		57191	5.1	11.265	4.240
		57355	17.0	1.570	2.420
		57356	16.6	2.360	2.460
		57357	17.6	1.008	1.050
		57382	14.3	13.065	15.900
		57425	14.5	7.785	7.160
		58235	28.4	2.980	1.840
CENTRAL CHILE	1985	4490	35.1	11.255	0.000
		4491	38.1	15.950	8.500
N. PALM SPRINGS, CALIF.	1986	12025	16.6	10.300	5.770
		12149	9.7	24.200	34.000
		12204	28.9	14.650	5.920
		22170	29.8	3.990	2.820
WHITTIER NARROWS, CALIF.	1987	14196	23.5	19.050	6.120
		14242	24.6	8.150	6.660
		14368	16.5	7.585	13.900
		14403	20.9	20.450	5.720
		24303	23.2	9.870	2.170
		24400	12.4	24.200	9.250
		24401	14.0	9.170	5.440
		24402	17.4	10.470	9.270
		24461	12.1	23.550	13.400

TABLE A–15

Strong-Motion Data—Soil Sites: 0.2 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	15.750	16.500
		288	22.0	9.435	8.330
IMPERIAL VALLEY, CALIF.	1940	117	8.3	17.900	10.100
KERN COUNTY, CALIF.	1952	1095	48.4	11.950	7.260
DALY CITY, CALIF.	1957	1049	24.6	2.945	1.270
		1065	14.8	3.530	4.060
		1078	14.8	5.040	2.050
		1080	12.9	5.495	3.450
PARKFIELD, CALIF.	1966	36226	10.1	22.800	4.650
		36227	6.3	23.200	8.610
		36228	3.0	16.000	11.900
		36229	15.2	3.795	4.170
BORREGO MTN, CALIF.	1968	117	46.1	5.105	3.300
LYTLE CREEK, CALIF.	1970	112	20.0	4.995	1.770
		113	28.8	3.845	2.920
		274	28.3	8.395	5.260
		290	12.4	10.055	2.640
SAN FERNANDO, CALIF.	1971	142	27.4	6.870	3.150
		160	29.0	13.700	6.220
		163	29.4	5.970	4.390
		166	29.4	17.750	5.560
		175	29.2	9.825	4.880
		181	29.0	11.800	7.520
		184	28.3	6.220	5.030
		187	28.5	11.050	6.300
		205	32.4	4.805	3.610
		208	28.2	9.410	5.080
		211	27.8	10.050	3.630
		223	28.1	7.070	3.280
		229	40.7	3.840	2.490
		232	24.1	15.450	7.010
		235	24.1	11.405	4.700
		238	23.8	6.070	4.550
		244	39.3	2.540	4.650
		247	40.8	3.060	1.860
		253	17.9	19.450	7.800
		262	25.4	9.395	8.660
		264	24.5	11.735	8.740
		267	17.2	9.775	9.220
		288	35.7	7.315	4.420
		413	29.3	8.205	4.930
		416	28.3	10.950	3.790
		425	28.2	6.515	5.260
		428	28.6	4.715	2.000
		437	30.5	5.840	3.350
		443	28.6	9.430	2.740
		446	23.6	15.350	5.460
		452	27.1	4.925	2.120

TABLE A–15 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	15.150	3.400
		458	12.7	8.930	10.800
		461	16.9	8.545	4.880
		466	17.7	15.950	7.900
		469	29.2	11.440	8.050
		475	25.1	7.740	4.900
		482	28.1	7.265	6.170
		1052	49.0	7.950	2.770
		24231	27.0	8.495	7.060
		24236	25.0	9.945	5.590
		24271	27.7	6.455	7.110
		24303	25.0	15.750	5.110
		24386	10.4	13.950	12.700
STONE CANYON, CALIF.	1972	1202	3.6	13.850	6.140
		1210	3.9	10.400	10.000
MANAGUA, NICARAGUA	1972	3501	5.4	32.600	28.000
HOLLISTER, CALIF.	1974	1028	10.8	11.030	3.670
		47126	8.9	7.285	4.440
GAZLI, U.S.S.R.	1976	9600	3.5	40.950	75.300
SANTA BARBARA, CALIF.	1978	283	14.6	6.800	5.430
		25091	12.9	15.950	5.990
		25302	14.6	7.200	4.750
TABAS, IRAN	1978	9801	6.8	93.200	51.500
ST ELIAS, ALASKA	1979	2734	36.4	6.020	2.950
COYOTE LAKE, CALIF.	1979	47126	14.4	8.555	8.360
		47380	8.4	23.000	14.800
		47381	6.6	16.150	5.560
		57191	28.0	3.225	2.820
		57382	5.4	15.200	16.800
IMPERIAL VALLEY, CALIF.	1979	412	10.1	14.350	8.020
		931	18.8	11.800	3.220
		942	5.6	20.500	70.300
		952	5.6	29.400	25.000
		955	6.9	27.900	10.500
		958	6.7	28.800	18.100
		5028	5.5	19.850	10.600
		5051	15.0	12.240	14.500
		5052	32.5	6.145	2.810
		5053	11.9	17.500	8.290
		5054	6.1	54.500	18.100
		5055	9.3	21.550	12.900
		5056	16.0	8.460	3.990
		5057	10.9	24.100	5.480
		5058	13.8	34.650	13.400
		5059	22.7	11.800	3.340
		5060	7.5	14.750	8.850
		5061	23.7	9.080	6.720
		5115	12.3	27.750	4.940
		5165A	7.5	30.150	15.800

TABLE A–15 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	22.900	16.700
		5165C	7.5	18.850	17.300
		5165D	7.5	20.500	16.500
		6605	21.8	18.950	7.510
		6610	30.9	15.850	2.280
		6616	5.7	17.500	5.490
		6617	5.7	33.800	5.870
		6618	5.5	8.950	7.100
		6619	10.0	41.850	17.400
		6621	7.6	15.050	10.600
		6622	14.8	10.780	3.330
		01335	9.4	16.850	8.690
		01336A	5.5	14.400	16.000
		11023	36.4	7.645	3.360
		11369	16.0	4.580	4.290
MORGAN HILL, CALIF.	1984	1652	5.1	16.150	7.710
		1656A	28.0	11.750	15.800
		9101	12.8	16.700	7.910
		9102B	11.6	31.050	11.300
		9102C	11.6	44.050	11.900
		9102D	11.6	29.600	0.000
		47380	16.7	11.400	15.900
		47381	16.0	11.750	12.700
		57064	26.9	1.445	1.510
		57066	22.1	2.645	1.550
		57191	5.1	14.450	6.320
		57355	17.0	2.820	2.230
		57356	16.6	2.960	2.010
		57357	17.6	1.665	1.780
		57382	14.3	21.450	19.700
		57425	14.5	10.350	6.680
		58235	28.4	6.315	2.720
CENTRAL CHILE	1985	4490	35.1	14.950	0.000
		4491	38.1	26.450	16.100
N. PALM SPRINGS, CALIF.	1986	12025	16.6	11.465	6.430
		12149	9.7	26.750	26.900
		12204	28.9	25.750	10.200
		22170	29.8	4.445	3.200
WHITTIER NARROWS, CALIF.	1987	14196	23.5	18.850	5.110
		14242	24.6	12.700	8.330
		14368	16.5	12.100	6.250
		14403	20.9	30.850	7.820
		24303	23.2	12.830	3.330
		24400	12.4	41.900	12.500
		24401	14.0	9.850	7.490
		24402	17.4	15.100	7.260
		24461	12.1	21.950	10.100

TABLE A-16

Strong-Motion Data—Soil Sites: 0.3 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
LONG BEACH, CALIF.	1933	131	6.4	23.300	17.500
		288	22.0	15.350	6.780
IMPERIAL VALLEY, CALIF.	1940	117	8.3	26.500	10.700
KERN COUNTY, CALIF.	1952	1095	48.4	17.950	10.500
DALY CITY, CALIF.	1957	1049	24.6	3.220	1.010
		1065	14.8	7.305	3.330
		1078	14.8	4.915	2.790
		1080	12.9	10.470	7.980
PARKFIELD, CALIF.	1966	36226	10.1	17.650	3.960
		36227	6.3	51.800	7.750
		36228	3.0	35.600	13.700
		36229	15.2	5.585	2.870
BORREGO MTN, CALIF.	1968	117	46.1	8.400	3.330
LYTLE CREEK, CALIF.	1970	112	20.0	8.040	3.200
		113	28.8	5.260	2.420
		274	28.3	10.445	5.130
		290	12.4	18.800	7.210
SAN FERNANDO, CALIF.	1971	142	27.4	10.650	2.390
		160	29.0	21.350	8.560
		163	29.4	7.620	5.160
		166	29.4	17.350	5.330
		175	29.2	12.150	12.900
		181	29.0	15.650	6.270
		184	28.3	13.750	5.160
		187	28.5	13.050	5.790
		205	32.4	8.820	8.280
		208	28.2	19.100	5.410
		211	27.8	19.550	5.490
		223	28.1	8.980	4.550
		229	40.7	6.210	2.400
		232	24.1	19.700	3.860
		235	24.1	13.850	4.850
		238	23.8	12.900	6.170
		244	39.3	4.050	5.030
		247	40.8	4.395	2.310
		253	17.9	34.450	13.500
		262	25.4	14.200	7.820
		264	24.5	22.850	7.850
		267	17.2	19.100	16.800
		288	35.7	11.290	7.060
		413	29.3	13.650	6.500
		416	28.3	18.200	5.110
		425	28.2	12.150	13.500
		428	28.6	8.085	3.760
		437	30.5	9.065	4.370
		443	28.6	15.200	5.770
		446	23.6	14.350	15.200
		452	27.1	7.890	4.950

TABLE A–16 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	16.950	5.330
		458	12.7	13.800	16.100
		461	16.9	12.250	6.810
		466	17.7	23.250	13.300
		469	29.2	19.150	8.030
		475	25.1	15.750	10.400
		482	28.1	14.900	5.210
		1052	49.0	8.650	2.530
		24231	27.0	10.080	6.250
		24236	25.0	18.450	5.180
		24271	27.7	11.100	4.450
		24303	25.0	21.000	3.910
		24386	10.4	26.050	28.700
STONE CANYON, CALIF.	1972	1202	3.6	16.600	7.190
		1210	3.9	11.905	8.170
MANAGUA, NICARAGUA	1972	3501	5.4	52.100	20.500
HOLLISTER, CALIF.	1974	1028	10.8	19.750	8.360
		47126	8.9	10.000	4.590
GAZLI, U.S.S.R.	1976	9600	3.5	56.250	82.300
SANTA BARBARA, CALIF.	1978	283	14.6	14.940	14.400
		25091	12.9	26.250	16.100
		25302	14.6	16.600	5.750
TABAS, IRAN	1978	9801	6.8	77.400	42.500
ST ELIAS, ALASKA	1979	2734	36.4	12.250	4.310
COYOTE LAKE, CALIF.	1979	47126	14.4	10.640	8.960
		47380	8.4	31.100	9.430
		47381	6.6	26.750	5.640
		57191	28.0	5.130	4.240
		57382	5.4	34.650	19.700
IMPERIAL VALLEY, CALIF.	1979	412	10.1	25.000	7.240
		931	18.8	15.100	4.520
		942	5.6	41.250	52.300
		952	5.6	47.900	20.100
		955	6.9	34.100	12.200
		958	6.7	34.400	15.100
		5028	5.5	31.750	24.300
		5051	15.0	10.005	5.650
		5052	32.5	6.020	2.810
		5053	11.9	26.100	10.400
		5054	6.1	78.300	15.100
		5055	9.3	36.100	13.600
		5056	16.0	13.350	4.260
		5057	10.9	24.150	4.970
		5058	13.8	57.500	10.100
		5059	22.7	17.300	3.540
		5060	7.5	27.150	6.630
		5061	23.7	14.150	4.400
		5115	12.3	31.050	6.450
		5165A	7.5	43.200	18.200

TABLE A-16 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	39.850	16.900
		5165C	7.5	34.250	17.300
		5165D	7.5	35.750	16.300
		6605	21.8	31.100	11.100
		6610	30.9	13.200	1.990
		6616	5.7	35.550	6.110
		6617	5.7	26.900	2.960
		6618	5.5	18.850	7.830
		6619	10.0	36.050	7.110
		6621	7.6	23.500	7.810
		6622	14.8	17.350	4.320
		01335	9.4	18.950	11.300
		01336A	5.5	27.450	15.900
		11023	36.4	13.600	4.280
		11369	16.0	7.230	7.680
MORGAN HILL, CALIF.	1984	1652	5.1	43.600	12.000
		1656A	28.0	8.935	14.900
		9101	12.8	23.950	6.430
		9102B	11.6	35.100	13.800
		9102C	11.6	39.050	18.100
		9102D	11.6	23.000	0.000
		47380	16.7	17.650	12.100
		47381	16.0	19.700	11.000
		57064	26.9	2.840	1.840
		57066	22.1	4.090	2.050
		57191	5.1	23.050	11.500
		57355	17.0	4.065	2.170
		57356	16.6	6.095	2.670
		57357	17.6	3.530	2.670
		57382	14.3	33.400	13.200
		57425	14.5	22.050	5.640
		58235	28.4	11.920	2.770
CENTRAL CHILE	1985	4490	35.1	34.200	0.000
		4491	38.1	23.050	19.000
N. PALM SPRINGS, CALIF.	1986	12025	16.6	13.900	7.850
		12149	9.7	41.150	15.400
		12204	28.9	15.150	6.350
		22170	29.8	6.630	3.840
WHITTIER NARROWS, CALIF.	1987	14196	23.5	18.300	6.250
		14242	24.6	24.500	6.630
		14368	16.5	17.250	5.920
		14403	20.9	24.950	5.790

TABLE A-17

Strong-Motion Data—Soil Sites: 0.4 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	19.900	20.700
		288	22.0	15.100	13.800
IMPERIAL VALLEY, CALIF.	1940	117	8.3	36.700	12.400
KERN COUNTY, CALIF.	1952	1095	48.4	23.650	13.800
DALY CITY, CALIF.	1957	1049	24.6	2.420	1.100
		1065	14.8	4.470	1.580
		1078	14.8	5.015	3.430
		1080	12.9	9.370	6.120
PARKFIELD, CALIF.	1966	36226	10.1	22.100	6.530
		36227	6.3	59.400	12.800
		36228	3.0	95.500	16.800
		36229	15.2	6.030	4.010
BORREGO MTN, CALIF.	1968	117	46.1	10.490	4.010
LYTLE CREEK, CALIF.	1970	112	20.0	7.265	2.670
		113	28.8	5.030	1.820
		274	28.3	6.905	2.900
		290	12.4	19.600	4.010
SAN FERNANDO, CALIF.	1971	142	27.4	15.750	3.990
		160	29.0	23.850	7.620
		163	29.4	13.000	5.160
		166	29.4	18.700	6.300
		175	29.2	17.750	9.630
		181	29.0	17.800	5.410
		184	28.3	15.200	8.940
		187	28.5	19.300	6.150
		205	32.4	10.605	8.840
		208	28.2	19.650	4.700
		211	27.8	21.050	6.150
		223	28.1	14.150	5.740
		229	40.7	7.110	2.950
		232	24.1	24.900	8.480
		235	24.1	15.800	7.420
		238	23.8	14.750	7.620
		244	39.3	6.895	3.330
		247	40.8	5.280	2.310
		253	17.9	35.250	13.200
		262	25.4	11.725	10.300
		264	24.5	26.100	23.900
		267	17.2	25.500	15.400
		288	35.7	14.850	4.290
		413	29.3	16.300	12.600
		416	28.3	22.750	5.440
		425	28.2	21.900	8.430
		428	28.6	12.650	7.820
		437	30.5	12.550	5.560
		443	28.6	21.600	5.560
		446	23.6	20.050	5.940
		452	27.1	13.650	6.660

TABLE A-17 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	23.150	4.670
		458	12.7	20.550	17.300
		461	16.9	19.150	15.200
		466	17.7	38.450	21.000
		469	29.2	18.900	12.300
		475	25.1	18.550	11.000
		482	28.1	16.500	7.930
		1052	49.0	9.695	5.130
		24231	27.0	9.300	5.640
		24236	25.0	21.350	5.540
		24271	27.7	13.500	6.860
		24303	25.0	23.450	5.720
		24386	10.4	32.350	26.900
STONE CANYON, CALIF.	1972	1202	3.6	9.040	2.740
		1210	3.9	8.655	3.560
MANAGUA, NICARAGUA	1972	3501	5.4	64.200	13.700
HOLLISTER, CALIF.	1974	1028	10.8	24.800	8.890
		47126	8.9	10.575	4.240
GAZLI, U.S.S.R.	1976	9600	3.5	81.900	59.500
SANTA BARBARA, CALIF.	1978	283	14.6	11.895	9.290
		25091	12.9	40.400	20.600
		25302	14.6	10.200	3.270
TABAS, IRAN	1978	9801	6.8	98.100	54.300
ST ELIAS, ALASKA	1979	2734	36.4	19.100	4.680
COYOTE LAKE, CALIF.	1979	47126	14.4	13.900	8.710
		47380	8.4	29.300	9.760
		47381	6.6	29.550	6.540
		57191	28.0	8.670	4.370
		57382	5.4	41.300	9.150
IMPERIAL VALLEY, CALIF.	1979	412	10.1	25.700	5.530
		931	18.8	18.500	4.410
		942	5.6	41.800	50.500
		952	5.6	69.850	37.700
		955	6.9	42.150	14.800
		958	6.7	47.100	15.000
		5028	5.5	38.500	22.700
		5051	15.0	16.000	8.120
		5052	32.5	7.385	3.060
		5053	11.9	32.200	9.800
		5054	6.1	123.150	15.000
		5055	9.3	34.500	14.700
		5056	16.0	10.850	3.520
		5057	10.9	27.450	4.920
		5058	13.8	50.800	7.000
		5059	22.7	17.300	3.310
		5060	7.5	20.350	5.860
		5061	23.7	11.450	4.760
		5115	12.3	32.650	7.410
		5165A	7.5	60.300	8.250

TABLE A–17 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	57.450	8.750
		5165C	7.5	53.550	8.840
		5165D	7.5	52.400	8.800
		6605	21.8	36.350	10.800
		6610	30.9	12.950	3.460
		6616	5.7	35.900	4.510
		6617	5.7	32.900	3.740
		6618	5.5	27.650	10.800
		6619	10.0	52.550	7.600
		6621	7.6	34.400	9.270
		6622	14.8	19.000	5.680
		01335	9.4	24.900	13.100
		01336A	5.5	38.300	19.900
		11023	36.4	14.745	4.210
		11369	16.0	10.585	8.010
MORGAN HILL, CALIF.	1984	1652	5.1	60.000	24.200
		1656A	28.0	11.270	11.800
		9101	12.8	27.500	4.520
		9102B	11.6	51.900	21.600
		9102C	11.6	69.100	21.400
		9102D	11.6	20.800	0.000
		47380	16.7	12.500	9.700
		47381	16.0	14.350	8.260
		57064	26.9	3.890	2.010
		57066	22.1	4.800	2.850
		57191	5.1	28.050	12.800
		57355	17.0	6.615	2.620
		57356	16.6	9.510	2.330
		57357	17.6	4.435	1.820
		57382	14.3	30.350	15.900
		57425	14.5	19.400	5.590
		58235	28.4	9.105	2.400
CENTRAL CHILE	1985	4490	35.1	26.500	0.000
		4491	38.1	29.300	16.800
N. PALM SPRINGS, CALIF.	1986	12025	16.6	14.200	9.700
		12149	9.7	48.750	19.900
		12204	28.9	20.200	7.490
		22170	29.8	7.430	4.620
WHITTIER NARROWS, CALIF.	1987	14196	23.5	14.800	3.680
		14242	24.6	20.000	4.670
		14368	16.5	20.300	6.830
		14403	20.9	28.500	7.540
		24303	23.2	13.300	3.760
		24400	12.4	37.700	10.400
		24401	14.0	14.650	11.300
		24402	17.4	16.250	5.230
		24461	12.1	37.100	15.600

TABLE A–18

Strong-Motion Data—Soil Sites: 0.5 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
LONG BEACH, CALIF.	1933	131	6.4	32.900	21.900
		288	22.0	17.200	11.400
IMPERIAL VALLEY, CALIF.	1940	117	8.3	57.000	12.000
KERN COUNTY, CALIF.	1952	1095	48.4	28.300	14.200
DALY CITY, CALIF.	1957	1049	24.6	4.510	1.970
		1065	14.8	4.965	1.540
		1078	14.8	6.855	4.670
		1080	12.9	10.775	3.530
PARKFIELD, CALIF.	1966	36226	10.1	23.250	4.650
		36227	6.3	57.150	15.900
		36228	3.0	114.000	18.000
		36229	15.2	6.690	4.600
BORREGO MTN, CALIF.	1968	117	46.1	11.255	3.020
LYTLE CREEK, CALIF.	1970	112	20.0	5.235	1.660
		113	28.8	4.280	1.530
		274	28.3	4.800	2.170
		290	12.4	25.300	6.220
SAN FERNANDO, CALIF.	1971	142	27.4	17.750	4.500
		160	29.0	30.500	12.000
		163	29.4	15.850	4.930
		166	29.4	21.250	5.990
		175	29.2	19.600	7.770
		181	29.0	19.300	4.550
		184	28.3	10.550	5.490
		187	28.5	12.200	5.510
		205	32.4	12.250	10.100
		208	28.2	19.650	5.990
		211	27.8	19.500	7.320
		223	28.1	15.800	6.430
		229	40.7	9.120	3.350
		232	24.1	17.850	11.200
		235	24.1	14.300	8.740
		238	23.8	14.650	6.050
		244	39.3	8.155	4.340
		247	40.8	8.370	3.200
		253	17.9	26.800	8.640
		262	25.4	17.350	11.300
		264	24.5	25.300	19.500
		267	17.2	17.350	10.000
		288	35.7	13.800	4.830
		413	29.3	14.350	12.600
		416	28.3	22.700	6.680
		425	28.2	16.500	6.500
		428	28.6	13.550	8.200
		437	30.5	15.350	7.110
		443	28.6	21.850	8.910
		446	23.6	11.805	7.260
		452	27.1	12.550	8.590

TABLE A–18 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	19.750	5.410
		458	12.7	18.350	14.900
		461	16.9	21.200	9.680
		466	17.7	21.900	9.830
		469	29.2	22.800	10.400
		475	25.1	15.500	5.970
		482	28.1	18.700	7.900
		1052	49.0	8.645	4.800
		24231	27.0	7.570	6.170
		24236	25.0	20.500	7.870
		24271	27.7	20.900	9.120
		24303	25.0	23.550	5.080
		24386	10.4	32.250	18.600
STONE CANYON, CALIF.	1972	1202	3.6	6.050	2.570
		1210	3.9	5.890	2.950
MANAGUA, NICARAGUA	1972	3501	5.4	68.850	19.900
HOLLISTER, CALIF.	1974	1028	10.8	26.150	5.400
		47126	8.9	8.830	2.700
GAZLI, U.S.S.R.	1976	9600	3.5	91.000	89.700
SANTA BARBARA, CALIF.	1978	283	14.6	21.385	12.400
		25091	12.9	57.650	18.600
		25302	14.6	18.100	6.560
TABAS, IRAN	1978	9801	6.8	123.000	39.800
ST ELIAS, ALASKA	1979	2734	36.4	22.000	6.420
COYOTE LAKE, CALIF.	1979	47126	14.4	18.300	10.900
		47380	8.4	22.550	8.680
		47381	6.6	23.950	5.030
		57191	28.0	4.815	2.870
		57382	5.4	43.800	7.960
IMPERIAL VALLEY, CALIF.	1979	412	10.1	35.550	9.630
		931	18.8	16.000	4.690
		942	5.6	46.600	43.000
		952	5.6	79.150	35.000
		955	6.9	51.500	16.400
		958	6.7	54.900	13.700
		5028	5.5	53.000	24.300
		5051	15.0	23.350	7.680
		5052	32.5	5.350	2.650
		5053	11.9	40.450	7.150
		5054	6.1	103.950	13.700
		5055	9.3	37.650	10.400
		5056	16.0	13.900	4.390
		5057	10.9	40.850	8.940
		5058	13.8	51.300	6.900
		5059	22.7	15.600	4.830
		5060	7.5	23.850	6.440
		5061	23.7	8.785	5.220
		5115	12.3	41.000	7.240
		5165A	7.5	65.300	13.400

TABLE A–18 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	65.950	12.800
		5165C	7.5	64.250	12.900
		5165D	7.5	63.600	12.400
		6605	21.8	50.550	10.600
		6610	30.9	10.240	1.980
		6616	5.7	38.650	6.430
		6617	5.7	40.400	4.130
		6618	5.5	41.650	10.600
		6619	10.0	56.500	10.900
		6621	7.6	42.150	7.790
		6622	14.8	18.500	5.970
		01335	9.4	48.300	15.600
		01336A	5.5	48.000	21.000
		11023	36.4	14.500	5.430
		11369	16.0	16.700	8.740
MORGAN HILL, CALIF.	1984	1652	5.1	72.650	16.900
		1656A	28.0	12.000	13.900
		9101	12.8	32.650	7.630
		9102B	11.6	29.100	12.800
		9102C	11.6	35.600	13.400
		9102D	11.6	16.050	0.000
		47380	16.7	15.700	5.770
		47381	16.0	22.400	8.280
		57064	26.9	4.855	2.690
		57066	22.1	6.895	2.920
		57191	5.1	47.200	23.100
		57355	17.0	11.140	4.880
		57356	16.6	11.205	3.710
		57357	17.6	6.755	2.140
		57382	14.3	41.800	15.200
		57425	14.5	15.750	6.830
		58235	28.4	6.720	2.740
CENTRAL CHILE	1985	4490	35.1	36.550	0.000
		4491	38.1	50.100	14.500
N. PALM SPRINGS, CALIF.	1986	12025	16.6	15.200	8.890
		12149	9.7	39.250	27.400
		12204	28.9	20.750	11.900
		22170	29.8	9.325	6.600
WHITTIER NARROWS, CALIF.	1987	14196	23.5	24.600	3.380
		14242	24.6	33.400	5.790
		14368	16.5	31.550	5.920
		14403	20.9	33.550	4.220
		24303	23.2	16.650	7.190
		24400	12.4	35.950	8.180
		24401	14.0	13.345	11.300
		24402	17.4	26.050	7.110
		24461	12.1	29.150	8.760

TABLE A–19

Strong-Motion Data—Soil Sites: 0.75 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
LONG BEACH, CALIF.	1933	131	6.4	25.000	17.000
		288	22.0	24.000	7.570
IMPERIAL VALLEY, CALIF.	1940	117	8.3	59.300	10.200
KERN COUNTY, CALIF.	1952	1095	48.4	29.850	16.900
DALY CITY, CALIF.	1957	1049	24.6	2.660	1.310
		1065	14.8	2.795	1.520
		1078	14.8	6.365	2.590
		1080	12.9	9.490	3.150
PARKFIELD, CALIF.	1966	36226	10.1	19.250	9.750
		36227	6.3	30.350	8.560
		36228	3.0	132.000	32.000
		36229	15.2	6.910	5.030
BORREGO MTN, CALIF.	1968	117	46.1	15.550	2.520
LYTLE CREEK, CALIF.	1970	112	20.0	4.875	3.100
		113	28.8	2.895	2.640
		274	28.3	5.320	1.770
		290	12.4	19.450	9.040
SAN FERNANDO, CALIF.	1971	142	27.4	16.900	6.830
		160	29.0	25.700	7.820
		163	29.4	18.800	7.820
		166	29.4	26.350	8.610
		175	29.2	27.800	8.000
		181	29.0	25.000	8.330
		184	28.3	10.560	5.560
		187	28.5	12.350	7.570
		205	32.4	14.440	4.850
		208	28.2	24.400	7.290
		211	27.8	21.400	7.240
		223	28.1	22.100	10.100
		229	40.7	12.650	3.660
		232	24.1	19.900	8.150
		235	24.1	20.900	9.910
		238	23.8	12.100	8.100
		244	39.3	10.060	3.000
		247	40.8	7.860	3.380
		253	17.9	25.200	10.100
		262	25.4	16.650	9.250
		264	24.5	25.100	13.900
		267	17.2	19.200	7.190
		288	35.7	15.250	4.110
		413	29.3	14.450	6.250
		416	28.3	18.350	6.170
		425	28.2	8.545	5.540
		428	28.6	23.500	12.200
		437	30.5	18.950	6.880
		443	28.6	19.750	8.360
		446	23.6	12.865	12.700
		452	27.1	12.900	6.630

TABLE A–19 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	12.200	6.220
		458	12.7	25.000	16.100
		461	16.9	33.800	13.100
		466	17.7	21.150	11.300
		469	29.2	23.500	8.260
		475	25.1	17.400	6.220
		482	28.1	25.600	15.100
		1052	49.0	8.700	3.710
		24231	27.0	10.685	5.740
		24236	25.0	21.400	9.700
		24271	27.7	38.750	31.200
		24303	25.0	21.950	6.730
		24386	10.4	44.200	18.600
STONE CANYON, CALIF.	1972	1202	3.6	7.945	2.430
		1210	3.9	4.120	2.380
MANAGUA, NICARAGUA	1972	3501	5.4	48.000	19.000
HOLLISTER, CALIF.	1974	1028	10.8	12.905	3.620
		47126	8.9	10.845	2.710
GAZLI, U.S.S.R.	1976	9600	3.5	98.350	97.000
SANTA BARBARA, CALIF.	1978	283	14.6	21.585	14.800
		25091	12.9	90.900	34.000
		25302	14.6	16.400	6.170
TABAS, IRAN	1978	9801	6.8	204.000	49.800
ST ELIAS, ALASKA	1979	2734	36.4	29.550	16.000
COYOTE LAKE, CALIF.	1979	47126	14.4	19.050	7.620
		47380	8.4	33.100	13.000
		47381	6.6	40.750	10.900
		57191	28.0	5.510	2.570
		57382	5.4	46.350	10.000
IMPERIAL VALLEY, CALIF.	1979	412	10.1	26.050	7.890
		931	18.8	20.500	5.470
		942	5.6	79.800	39.500
		952	5.6	61.600	23.000
		955	6.9	61.750	11.900
		958	6.7	54.800	20.600
		5028	5.5	124.900	22.600
		5051	15.0	14.000	6.970
		5052	32.5	5.140	2.600
		5053	11.9	30.950	6.150
		5054	6.1	114.000	20.600
		5055	9.3	40.450	15.200
		5056	16.0	14.000	4.290
		5057	10.9	41.000	6.710
		5058	13.8	49.350	7.140
		5059	22.7	15.250	4.030
		5060	7.5	28.200	9.080
		5061	23.7	13.600	8.200
		5115	12.3	37.550	7.980
		5165A	7.5	77.150	13.700

TABLE A–19 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	79.550	12.700
		5165C	7.5	78.650	12.900
		5165D	7.5	78.900	13.100
		6605	21.8	65.250	13.500
		6610	30.9	10.030	2.680
		6616	5.7	41.650	6.870
		6617	5.7	55.500	2.780
		6618	5.5	50.700	8.210
		6619	10.0	49.200	13.900
		6621	7.6	75.350	13.900
		6622	14.8	16.900	6.650
		01335	9.4	52.800	15.400
		01336A	5.5	74.650	32.900
		11023	36.4	10.605	5.290
		11369	16.0	14.600	10.700
MORGAN HILL, CALIF.	1984	1652	5.1	60.350	11.600
		1656A	28.0	24.150	6.840
		9101	12.8	13.050	5.490
		9102B	11.6	24.150	10.600
		9102C	11.6	26.050	11.100
		9102D	11.6	17.000	0.000
		47380	16.7	16.275	8.460
		47381	16.0	22.100	7.700
		57064	26.9	3.990	2.740
		57066	22.1	10.005	2.770
		57191	5.1	59.450	39.900
		57355	17.0	16.250	7.640
		57356	16.6	17.150	6.400
		57357	17.6	14.550	3.860
		57382	14.3	33.150	8.280
		57425	14.5	9.280	4.780
		58235	28.4	7.595	3.680
CENTRAL CHILE	1985	4490	35.1	69.550	0.000
		4491	38.1	96.550	23.600
N. PALM SPRINGS, CALIF.	1986	12025	16.6	25.550	8.200
		12149	9.7	36.850	25.400
		12204	28.9	17.550	11.500
		22170	29.8	11.900	7.700
WHITTIER NARROWS, CALIF.	1987	14196	23.5	34.250	6.020
		14242	24.6	42.800	4.140
		14368	16.5	59.300	6.580
		14403	20.9	45.600	7.290
		24303	23.2	23.850	5.490
		24400	12.4	34.450	11.500
		24401	14.0	25.455	21.200
		24402	17.4	22.000	5.870
		24461	12.1	44.450	18.900

TABLE A–20

Strong-Motion Data—Soil Sites: 1.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	41.950	21.900
		288	22.0	31.000	8.330
IMPERIAL VALLEY, CALIF.	1940	117	8.3	61.850	9.450
KERN COUNTY, CALIF.	1952	1095	48.4	26.500	10.200
DALY CITY, CALIF.	1957	1049	24.6	2.760	0.800
		1065	14.8	2.550	1.380
		1078	14.8	11.225	2.480
		1080	12.9	4.220	2.110
PARKFIELD, CALIF.	1966	36226	10.1	23.500	11.600
		36227	6.3	25.900	10.800
		36228	3.0	77.700	32.000
		36229	15.2	9.105	6.830
BORREGO MTN, CALIF.	1968	117	46.1	24.500	3.630
LYTLE CREEK, CALIF.	1970	112	20.0	3.605	1.790
		113	28.8	2.245	2.170
		274	28.3	5.235	1.990
		290	12.4	10.995	4.110
SAN FERNANDO, CALIF.	1971	142	27.4	30.350	5.790
		160	29.0	33.650	9.550
		163	29.4	23.950	10.700
		166	29.4	28.850	7.440
		175	29.2	35.850	13.700
		181	29.0	26.400	10.200
		184	28.3	15.800	8.840
		187	28.5	17.700	8.660
		205	32.4	25.800	8.940
		208	28.2	33.750	12.000
		211	27.8	30.000	11.700
		223	28.1	28.850	18.100
		229	40.7	13.150	2.770
		232	24.1	35.200	19.200
		235	24.1	30.850	15.800
		238	23.8	15.900	11.800
		244	39.3	9.275	6.400
		247	40.8	12.700	4.600
		253	17.9	21.400	14.800
		262	25.4	22.500	19.400
		264	24.5	25.600	13.100
		267	17.2	23.350	5.410
		288	35.7	26.800	5.540
		413	29.3	16.800	4.520
		416	28.3	21.200	8.080
		425	28.2	12.400	11.300
		428	28.6	27.050	11.000
		437	30.5	31.850	10.900
		443	28.6	21.000	8.790
		446	23.6	17.700	12.100
		452	27.1	18.250	8.030

TABLE A–20 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		455	27.7	19.350	12.800
		458	12.7	32.500	18.900
		461	16.9	31.050	11.700
		466	17.7	26.450	14.300
		469	29.2	33.950	13.200
		475	25.1	23.000	8.260
		482	28.1	28.750	21.800
		1052	49.0	9.260	4.600
		24231	27.0	9.720	6.070
		24236	25.0	30.950	9.170
		24271	27.7	42.800	23.600
		24303	25.0	31.500	8.480
		24386	10.4	43.050	29.200
STONE CANYON, CALIF.	1972	1202	3.6	9.380	2.870
		1210	3.9	3.465	2.710
MANAGUA, NICARAGUA	1972	3501	5.4	48.450	25.600
HOLLISTER, CALIF.	1974	1028	10.8	10.725	2.910
		47126	8.9	6.090	1.540
GAZLI, U.S.S.R.	1976	9600	3.5	96.250	78.900
SANTA BARBARA, CALIF.	1978	283	14.6	15.860	12.300
		25091	12.9	74.100	37.900
		25302	14.6	17.000	4.810
TABAS, IRAN	1978	9801	6.8	106.500	84.100
ST ELIAS, ALASKA	1979	2734	36.4	43.850	20.300
COYOTE LAKE, CALIF.	1979	47126	14.4	12.450	7.090
		47380	8.4	37.900	11.600
		47381	6.6	60.850	10.300
		57191	28.0	6.555	2.050
		57382	5.4	55.700	17.600
IMPERIAL VALLEY, CALIF.	1979	412	10.1	38.750	15.100
		931	18.8	27.350	5.290
		942	5.6	81.300	48.700
		952	5.6	85.200	24.100
		955	6.9	81.050	15.100
		958	6.7	55.200	27.900
		5028	5.5	103.500	45.300
		5051	15.0	19.250	7.970
		5052	32.5	6.325	3.450
		5053	11.9	26.550	4.930
		5054	6.1	68.050	27.900
		5055	9.3	46.500	8.650
		5056	16.0	13.650	4.830
		5057	10.9	31.500	7.930
		5058	13.8	36.700	9.790
		5059	22.7	17.100	6.630
		5060	7.5	39.050	15.100
		5061	23.7	15.200	8.340
		5115	12.3	27.300	9.920
		5165A	7.5	57.250	22.800

TABLE A–20 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	61.400	19.900
		5165C	7.5	59.850	19.900
		5165D	7.5	59.550	20.000
		6605	21.8	58.100	10.700
		6610	30.9	10.580	2.680
		6616	5.7	49.550	6.310
		6617	5.7	51.800	5.800
		6618	5.5	42.200	7.930
		6619	10.0	45.350	13.800
		6621	7.6	55.750	8.080
		6622	14.8	12.250	4.990
		01335	9.4	60.600	19.200
		01336A	5.5	61.100	41.000
		11023	36.4	16.550	6.610
		11369	16.0	14.900	17.000
MORGAN HILL, CALIF.	1984	1652	5.1	45.700	16.900
		1656A	28.0	21.400	5.790
		9101	12.8	23.250	5.180
		9102B	11.6	23.800	9.470
		9102C	11.6	26.450	10.300
		9102D	11.6	16.050	0.000
		47380	16.7	14.450	8.130
		47381	16.0	25.900	8.280
		57064	26.9	6.380	4.880
		57066	22.1	15.150	5.230
		57191	5.1	45.800	18.500
		57355	17.0	25.150	8.030
		57356	16.6	24.050	6.100
		57357	17.6	20.650	9.930
		57382	14.3	41.900	9.090
		57425	14.5	6.695	3.730
		58235	28.4	7.265	7.640
CENTRAL CHILE	1985	4490	35.1	74.900	0.000
		4491	38.1	84.100	24.200
N. PALM SPRINGS, CALIF.	1986	12025	16.6	26.450	13.300
		12149	9.7	45.350	27.900
		12204	28.9	18.050	12.400
		22170	29.8	9.230	7.640
WHITTIER NARROWS, CALIF.	1987	14196	23.5	23.375	3.960
		14242	24.6	35.400	4.220
		14368	16.5	45.850	2.620
		14403	20.9	32.800	4.800
		24303	23.2	17.750	6.050
		24400	12.4	38.450	10.500
		24401	14.0	19.720	10.900
		24402	17.4	13.155	8.510
		24461	12.1	42.550	13.600

TABLE A–21

Strong-Motion Data—Soil Sites: 1.5 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	33.400	49.300
		288	22.0	23.050	12.200
IMPERIAL VALLEY, CALIF.	1940	117	8.3	44.500	10.600
KERN COUNTY, CALIF.	1952	1095	48.4	28.700	13.300
DALY CITY, CALIF.	1957	1049	24.6	2.270	0.000
		1065	14.8	2.505	1.450
		1078	14.8	9.265	1.420
		1080	12.9	3.415	0.897
PARKFIELD, CALIF.	1966	36226	10.1	15.800	13.500
		36227	6.3	17.000	9.320
		36228	3.0	121.000	37.300
		36229	15.2	18.300	9.780
BORREGO MTN, CALIF.	1968	117	46.1	42.550	5.610
LYTLE CREEK, CALIF.	1970	112	20.0	2.285	0.889
		113	28.8	1.725	1.060
		274	28.3	2.645	1.590
		290	12.4	6.490	1.580
SAN FERNANDO, CALIF.	1971	142	27.4	20.050	9.400
		160	29.0	26.800	12.600
		163	29.4	21.650	14.100
		166	29.4	26.900	14.400
		175	29.2	26.950	10.900
		181	29.0	30.900	9.270
		184	28.3	20.850	11.800
		187	28.5	22.650	11.800
		205	32.4	29.400	14.600
		208	28.2	28.700	23.300
		211	27.8	27.900	19.400
		223	28.1	25.450	11.900
		229	40.7	18.650	5.460
		232	24.1	20.750	12.000
		235	24.1	18.900	10.400
		238	23.8	21.450	13.300
		244	39.3	14.850	8.660
		247	40.8	16.550	6.880
		253	17.9	28.950	20.000
		262	25.4	40.900	18.300
		264	24.5	19.950	7.140
		267	17.2	14.150	7.190
		288	35.7	19.750	10.800
		413	29.3	22.000	7.140
		416	28.3	25.900	8.360
		425	28.2	14.850	13.300
		428	28.6	34.400	11.200
		437	30.5	30.600	7.240
		443	28.6	20.100	11.600
		446	23.6	18.325	14.200
		452	27.1	14.800	8.150

TABLE A-21 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	19.950	9.500
		458	12.7	56.750	37.300
		461	16.9	46.050	24.100
		466	17.7	37.700	24.500
		469	29.2	28.200	16.500
		475	25.1	15.150	6.350
		482	28.1	28.550	13.200
		1052	49.0	13.800	7.750
		24231	27.0	10.630	15.000
		24236	25.0	34.050	14.700
		24271	27.7	30.100	24.600
		24303	25.0	32.950	12.700
		24386	10.4	73.400	38.300
STONE CANYON, CALIF.	1972	1202	3.6	6.535	2.000
		1210	3.9	3.020	1.460
MANAGUA, NICARAGUA	1972	3501	5.4	42.200	28.100
HOLLISTER, CALIF.	1974	1028	10.8	9.150	3.610
		47126	8.9	3.825	1.370
GAZLI, U.S.S.R.	1976	9600	3.5	106.850	62.700
SANTA BARBARA, CALIF.	1978	283	14.6	15.050	18.800
		25091	12.9	62.600	19.600
		25302	14.6	17.700	7.670
TABAS, IRAN	1978	9801	6.8	115.000	38.800
ST ELIAS, ALASKA	1979	2734	36.4	69.750	41.200
COYOTE LAKE, CALIF.	1979	47126	14.4	11.555	4.960
		47380	8.4	33.500	6.560
		47381	6.6	31.650	17.600
		57191	28.0	3.655	2.620
		57382	5.4	33.750	17.900
IMPERIAL VALLEY, CALIF.	1979	412	10.1	72.000	16.400
		931	18.8	32.600	8.330
		942	5.6	84.050	64.300
		952	5.6	65.350	42.700
		955	6.9	73.800	27.300
		958	6.7	76.850	11.300
		5028	5.5	94.650	64.200
		5051	15.0	21.250	11.100
		5052	32.5	7.045	5.400
		5053	11.9	32.400	5.900
		5054	6.1	53.200	11.300
		5055	9.3	50.050	9.650
		5056	16.0	15.600	5.550
		5057	10.9	44.950	7.270
		5058	13.8	58.400	7.060
		5059	22.7	23.150	7.410
		5060	7.5	46.550	15.100
		5061	23.7	17.050	8.500
		5115	12.3	29.400	6.660
		5165A	7.5	80.650	38.700

TABLE A–21 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	82.950	38.600
		5165C	7.5	83.300	39.400
		5165D	7.5	81.800	39.800
		6605	21.8	69.700	18.500
		6610	30.9	8.545	2.190
		6616	5.7	64.400	6.650
		6617	5.7	57.400	5.170
		6618	5.5	66.400	13.000
		6619	10.0	45.500	15.200
		6621	7.6	45.150	8.410
		6622	14.8	12.700	4.930
		01335	9.4	87.850	31.400
		01336A	5.5	102.600	46.900
		11023	36.4	13.150	8.420
		11369	16.0	17.800	13.500
MORGAN HILL, CALIF.	1984	1652	5.1	21.100	12.500
		1656A	28.0	22.500	6.120
		9101	12.8	20.450	5.640
		9102B	11.6	19.600	8.090
		9102C	11.6	20.950	8.420
		9102D	11.6	14.950	
		47380	16.7	15.300	6.910
		47381	16.0	19.750	12.500
		57064	26.9	7.870	5.560
		57066	22.1	11.700	9.500
		57191	5.1	31.150	9.320
		57355	17.0	25.600	9.930
		57356	16.6	25.150	11.400
		57357	17.6	15.700	12.900
		57382	14.3	28.550	19.200
		57425	14.5	6.995	3.960
		58235	28.4	7.835	5.540
CENTRAL CHILE	1985	4490	35.1	52.750	
		4491	38.1	48.000	16.700
N. PALM SPRINGS, CALIF.	1986	12025	16.6	18.850	29.200
		12149	9.7	37.450	12.600
		12204	28.9	10.545	7.490
		22170	29.8	11.460	5.870
WHITTIER NARROWS, CALIF.	1987	14196	23.5	10.285	2.740
		14242	24.6	17.550	1.960
		14368	16.5	19.950	2.900
		14403	20.9	15.550	2.590
		24303	23.2	10.370	5.610
		24400	12.4	22.550	6.450
		24401	14.0	16.070	6.200
		24402	17.4	7.665	4.340
		24461	12.1	27.450	7.930

TABLE A–22

Strong-Motion Data—Soil Sites: 2.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	27.750	32.500
		288	22.0	29.600	11.900
IMPERIAL VALLEY, CALIF.	1940	117	8.3	61.700	12.500
KERN COUNTY, CALIF.	1952	1095	48.4	23.250	8.710
DALY CITY, CALIF.	1957	1049	24.6	1.765	
		1065	14.8	2.460	1.880
		1078	14.8	4.165	1.390
		1080	12.9	3.620	0.676
PARKFIELD, CALIF.	1966	36226	10.1	14.800	8.710
		36227	6.3	26.700	8.660
		36228	3.0	115.000	17.900
		36229	15.2	16.000	11.100
BORREGO MTN, CALIF.	1968	117	46.1	42.400	7.930
LYTLE CREEK, CALIF.	1970	112	20.0	1.521	0.930
		113	28.8	1.745	0.716
		274	28.3	2.630	1.580
		290	12.4	4.265	1.280
SAN FERNANDO, CALIF.	1971	142	27.4	22.650	15.800
		160	29.0	25.450	11.800
		163	29.4	18.100	12.400
		166	29.4	21.150	11.800
		175	29.2	24.350	12.600
		181	29.0	17.450	10.600
		184	28.3	14.950	11.200
		187	28.5	15.950	10.600
		205	32.4	19.200	15.000
		208	28.2	28.700	24.100
		211	27.8	29.850	27.400
		223	28.1	27.450	29.700
		229	40.7	12.650	8.640
		232	24.1	27.100	8.910
		235	24.1	26.250	9.960
		238	23.8	14.300	6.710
		244	39.3	10.075	14.600
		247	40.8	12.600	12.200
		253	17.9	42.900	33.500
		262	25.4	29.350	15.300
		264	24.5	26.800	8.380
		267	17.2	16.000	6.350
		288	35.7	18.500	11.000
		413	29.3	16.350	13.900
		416	28.3	18.000	20.600
		425	28.2	14.600	9.750
		428	28.6	34.200	16.000
		437	30.5	26.300	12.300
		443	28.6	25.500	16.600
		446	23.6	14.850	8.530
		452	27.1	16.350	15.100

TABLE A–22 (Continued)

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	15.200	6.960
		458	12.7	70.200	67.600
		461	16.9	50.400	13.100
		466	17.7	61.000	20.400
		469	29.2	25.500	17.400
		475	25.1	20.450	6.250
		482	28.1	27.200	8.260
		1052	49.0	13.950	5.160
		24231	27.0	9.580	7.010
		24236	25.0	29.650	9.930
		24271	27.7	18.500	21.000
		24303	25.0	29.400	9.040
		24386	10.4	70.500	72.100
STONE CANYON, CALIF.	1972	1202	3.6	5.190	2.500
		1210	3.9	2.980	2.080
MANAGUA, NICARAGUA	1972	3501	5.4	48.100	23.000
HOLLISTER, CALIF.	1974	1028	10.8	6.605	2.390
		47126	8.9	3.935	2.670
GAZLI, U.S.S.R.	1976	9600	3.5	85.650	45.400
SANTA BARBARA, CALIF.	1978	283	14.6	13.210	9.600
		25091	12.9	40.900	7.780
		25302	14.6	9.280	5.250
TABAS, IRAN	1978	9801	6.8	158.500	66.100
ST ELIAS, ALASKA	1979	2734	36.4	99.750	78.100
COYOTE LAKE, CALIF.	1979	47126	14.4	7.760	6.770
		47380	8.4	23.450	8.520
		47381	6.6	29.400	12.900
		57191	28.0	2.785	2.310
		57382	5.4	24.200	26.400
IMPERIAL VALLEY, CALIF.	1979	412	10.1	76.250	14.800
		931	18.8	34.100	9.000
		942	5.6	127.000	54.300
		952	5.6	90.650	46.600
		955	6.9	96.050	27.900
		958	6.7	67.400	15.800
		5028	5.5	103.350	57.300
		5051	15.0	25.900	13.100
		5052	32.5	7.005	5.910
		5053	11.9	22.400	10.100
		5054	6.1	64.950	15.800
		5055	9.3	47.400	16.300
		5056	16.0	23.200	5.850
		5057	10.9	55.950	9.630
		5058	13.8	58.250	11.800
		5059	22.7	21.550	6.480
		5060	7.5	46.550	15.600
		5061	23.7	15.550	5.390
		5115	12.3	46.900	8.690
		5165A	7.5	74.550	30.600

TABLE A-22 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		5165B	7.5	77.700	29.400
		5165C	7.5	77.100	28.800
		5165D	7.5	76.650	28.600
		6605	21.8	59.600	20.200
		6610	30.9	10.245	3.320
		6616	5.7	51.100	5.420
		6617	5.7	45.800	6.050
		6618	5.5	75.150	11.100
		6619	10.0	39.800	8.660
		6621	7.6	36.850	8.640
		6622	14.8	12.400	7.610
		01335	9.4	65.250	32.000
		01336A	5.5	127.350	61.600
		11023	36.4	11.950	4.670
		11369	16.0	28.100	15.700
MORGAN HILL, CALIF.	1984	1652	5.1	24.400	17.300
		1656A	28.0	11.800	4.780
		9101	12.8	11.400	4.320
		9102B	11.6	16.400	6.360
		9102C	11.6	17.200	6.250
		9102D	11.6	13.250	
		47380	16.7	12.920	6.300
		47381	16.0	24.150	11.400
		57064	26.9	7.440	3.810
		57066	22.1	14.700	11.300
		57191	5.1	20.235	8.860
		57355	17.0	24.550	9.120
		57356	16.6	22.150	9.350
		57357	17.6	19.750	9.800
		57382	14.3	17.250	14.200
		57425	14.5	4.365	2.380
		58235	28.4	9.475	6.250
CENTRAL CHILE	1985	4490	35.1	31.300	
		4491	38.1	29.450	12.400
N. PALM SPRINGS, CALIF.	1986	12025	16.6	20.300	15.700
		12149	9.7	34.300	11.600
		12204	28.9	6.225	4.390
		22170	29.8	6.935	4.900
WHITTIER NARROWS, CALIF.	1987	14196	23.5	5.790	1.600
		14242	24.6	11.900	1.650
		14368	16.5	11.270	2.590
		14403	20.9	7.760	2.020
		24303	23.2	9.580	4.520
		24400	12.4	15.200	5.080
		24401	14.0	10.715	4.470
		24402	17.4	7.120	4.320
		24461	12.1	14.400	6.430

TABLE A–23

Strong-Motion Data—Soil Sites: 3.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
LONG BEACH, CALIF.	1933	131	6.4	19.400	37.100
		288	22.0	35.800	19.800
IMPERIAL VALLEY, CALIF.	1940	117	8.3	59.800	13.200
KERN COUNTY, CALIF.	1952	1095	48.4	21.650	11.400
DALY CITY, CALIF.	1957	1049	24.6	1.550	
		1065	14.8	1.245	1.610
		1078	14.8	2.840	
		1080	12.9	3.595	
PARKFIELD, CALIF.	1966	36226	10.1	13.300	12.100
		36227	6.3	20.850	9.120
		36228	3.0	85.800	9.320
		36229	15.2	14.400	21.000
BORREGO MTN, CALIF.	1968	117	46.1	35.050	14.800
LYTLE CREEK, CALIF.	1970	112	20.0	2.020	
		113	28.8	1.670	
		274	28.3	2.675	1.230
		290	12.4	2.835	
SAN FERNANDO, CALIF.	1971	142	27.4	24.700	12.600
		160	29.0	37.600	20.100
		163	29.4	37.200	19.900
		166	29.4	36.450	19.100
		175	29.2	41.900	17.300
		181	29.0	26.300	13.900
		184	28.3	21.350	10.700
		187	28.5	20.000	10.500
		205	32.4	31.850	22.500
		208	28.2	39.100	17.400
		211	27.8	34.000	17.900
		223	28.1	30.100	13.500
		229	40.7	21.650	16.600
		232	24.1	30.700	12.000
		235	24.1	30.100	12.900
		238	23.8	19.700	7.090
		244	39.3	17.300	21.100
		247	40.8	19.900	17.500
		253	17.9	71.250	16.700
		262	25.4	11.650	8.330
		264	24.5	17.900	10.200
		267	17.2	11.350	11.100
		288	35.7	26.600	22.600
		413	29.3	23.950	11.000
		416	28.3	29.050	12.800
		425	28.2	22.650	8.760
		428	28.6	44.050	7.060
		437	30.5	54.100	18.200
		443	28.6	33.500	6.930
		446	23.6	17.250	10.600
		452	27.1	20.800	13.500

TABLE A-23 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		455	27.7	25.850	10.800
		458	12.7	61.600	60.500
		461	16.9	52.700	20.200
		466	17.7	73.400	31.000
		469	29.2	40.500	22.300
		475	25.1	14.650	9.930
		482	28.1	27.700	12.200
		1052	49.0	6.910	2.420
		24231	27.0	11.950	5.050
		24236	25.0	32.850	10.700
		24271	27.7	9.740	11.300
		24303	25.0	32.850	7.720
		24386	10.4	68.550	85.100
STONE CANYON, CALIF.	1972	1202	3.6	4.780	3.320
		1210	3.9	3.300	4.210
MANAGUA, NICARAGUA	1972	3501	5.4	34.000	25.900
HOLLISTER, CALIF.	1974	1028	10.8	3.520	1.660
		47126	8.9	2.095	2.510
GAZLI, U.S.S.R.	1976	9600	3.5	80.100	78.300
TABAS, IRAN	1978	9801	6.8	140.500	87.100
ST ELIAS, ALASKA	1979	2734	36.4	66.000	40.900
COYOTE LAKE, CALIF.	1979	47126	14.4	6.335	5.610
		47380	8.4	12.880	4.460
		47381	6.6	18.250	6.060
		57191	28.0	1.960	1.580
		57382	5.4	13.100	17.200
IMPERIAL VALLEY, CALIF.	1979	412	10.1	76.500	31.500
		931	18.8	32.450	16.300
		942	5.6	187.500	40.300
		952	5.6	153.000	38.600
		955	6.9	101.350	39.400
		958	6.7	75.050	14.800
		5028	5.5	142.500	28.600
		5051	15.0	29.150	10.800
		5052	32.5	6.360	4.350
		5053	11.9	24.800	13.900
		5054	6.1	36.300	14.800
		5055	9.3	87.250	15.200
		5056	16.0	17.600	5.970
		5057	10.9	68.450	21.100
		5058	13.8	58.300	33.700
		5059	22.7	24.200	6.840
		5060	7.5	58.700	13.700
		5061	23.7	24.000	5.850
		5115	12.3	43.100	13.800
		5165A	7.5	71.600	21.800
		5165B	7.5	71.900	20.400
		5165C	7.5	71.900	21.000
		5165D	7.5	72.000	21.300

TABLE A-23 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		6605	21.8	55.900	27.600
		6610	30.9	9.275	3.890
		6616	5.7	31.800	9.170
		6617	5.7	35.900	6.460
		6618	5.5	39.550	17.700
		6619	10.0	34.000	4.270
		6621	7.6	27.150	5.810
		6622	14.8	9.020	4.590
		01335	9.4	80.950	29.300
		01336A	5.5	150.750	48.100
		11023	36.4	18.550	5.900
		11369	16.0	34.850	7.580
MORGAN HILL, CALIF.	1984	1652	5.1	24.700	9.060
		1656A	28.0	7.740	5.710
		9101	12.8	7.745	2.060
		9102B	11.6	10.420	4.680
		9102C	11.6	10.320	4.770
		9102D	11.6	8.355	
		47380	16.7	5.755	2.230
		47381	16.0	17.700	5.720
		57064	26.9	4.700	3.330
		57066	22.1	15.450	3.250
		57191	5.1	12.700	3.730
		57355	17.0	17.500	4.320
		57356	16.6	18.000	3.580
		57357	17.6	23.350	6.990
		57382	14.3	20.100	12.100
		57425	14.5	4.060	2.470
		58235	28.4	6.490	3.990
CENTRAL CHILE	1985	4490	35.1	19.000	
		4491	38.1	16.650	8.820
N. PALM SPRINGS, CALIF.	1986	12025	16.6	13.450	5.640
		12149	9.7	23.050	5.590
		12204	28.9	3.840	2.270
WHITTIER NARROWS, CALIF.	1987	14196	23.5	5.600	1.240
		24400	12.4	8.255	2.590

TABLE A-24

Strong-Motion Data—Soil Sites: 4.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV
LONG BEACH, CALIF.	1933	131	6.4	28.450	37.600
		288	22.0	33.400	19.000
IMPERIAL VALLEY, CALIF.	1940	117	8.3	43.450	12.100
KERN COUNTY, CALIF.	1952	1095	48.4	17.950	12.400
DALY CITY, CALIF.	1957	1049	24.6	1.030	
		1078	14.8	1.990	
		1080	12.9	2.735	
PARKFIELD, CALIF.	1966	36226	10.1	14.300	6.270
		36227	6.3	14.750	9.680
		36228	3.0	61.200	9.980
		36229	15.2	13.150	7.140
BORREGO MTN, CALIF.	1968	117	46.1	27.250	11.500
LYTLE CREEK, CALIF.	1970	112	20.0	2.400	
		274	28.3	3.400	
		290	12.4	2.255	
SAN FERNANDO, CALIF.	1971	142	27.4	32.350	14.400
		160	29.0	41.400	27.400
		163	29.4	37.200	28.700
		166	29.4	39.850	29.000
		175	29.2	44.050	29.200
		181	29.0	29.850	18.700
		184	28.3	35.450	9.140
		187	28.5	30.800	9.170
		205	32.4	48.600	29.700
		208	28.2	39.350	23.000
		211	27.8	38.350	19.500
		223	28.1	58.050	14.700
		229	40.7	45.850	21.200
		232	24.1	44.200	11.600
		235	24.1	43.450	10.300
		238	23.8	26.300	8.280
		244	39.3	28.800	25.200
		247	40.8	41.650	21.600
		253	17.9	60.700	16.700
		262	25.4	10.190	7.010
		264	24.5	14.310	11.900
		267	17.2	14.900	9.600
		288	35.7	40.250	22.000
		413	29.3	39.350	6.860
		416	28.3	41.000	14.400
		425	28.2	33.150	10.200
		428	28.6	72.900	16.200
		437	30.5	48.900	31.200
		443	28.6	61.950	14.600
		446	23.6	26.350	12.900
		452	27.1	27.900	10.600
		455	27.7	29.600	7.700
		458	12.7	68.050	27.900

TABLE A-24 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
		461	16.9	39.250	11.400
		466	17.7	60.700	25.400
		469	29.2	39.250	32.300
		475	25.1	13.040	12.800
		482	28.1	21.650	15.900
		1052	49.0	5.120	1.970
		24231	27.0	16.600	7.010
		24236	25.0	47.900	14.800
		24271	27.7	7.745	6.830
		24303	25.0	47.250	12.800
		24386	10.4	54.600	71.100
STONE CANYON, CALIF.	1972	1202	3.6	6.300	2.800
		1210	3.9	4.825	3.680
MANAGUA, NICARAGUA	1972	3501	5.4	25.850	23.000
HOLLISTER, CALIF.	1974	1028	10.8	2.185	0.899
		47126	8.9	1.580	1.700
GAZLI, U.S.S.R.	1976	9600	3.5	104.700	96.600
TABAS, IRAN	1978	9801	6.8	173.500	54.200
ST ELIAS, ALASKA	1979	2734	36.4	27.900	25.300
COYOTE LAKE, CALIF.	1979	47126	14.4	4.240	4.040
		47380	8.4	8.925	3.010
		47381	6.6	11.020	4.050
		57191	28.0	2.350	1.510
		57382	5.4	10.265	7.490
IMPERIAL VALLEY, CALIF.	1979	412	10.1	66.750	32.300
		931	18.8	31.700	24.100
		942	5.6	170.000	57.300
		952	5.6	130.200	34.900
		955	6.9	103.500	58.500
		958	6.7	85.000	12.900
		5028	5.5	118.700	33.700
		5051	15.0	34.050	23.500
		5052	32.5	7.865	5.940
		5053	11.9	24.600	5.950
		5054	6.1	27.650	12.900
		5055	9.3	90.900	31.000
		5056	16.0	23.950	11.400
		5057	10.9	65.050	42.500
		5058	13.8	44.050	43.500
		5059	22.7	22.250	11.800
		5060	7.5	50.700	13.500
		5061	23.7	22.200	8.240
		5115	12.3	46.850	32.600
		5165A	7.5	67.950	45.100
		5165B	7.5	68.800	44.800
		5165C	7.5	70.350	45.800
		5165D	7.5	71.050	46.100
		6605	21.8	35.450	37.000
		6610	30.9	9.625	2.760

TABLE A–24 (Continued)

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
		6616	5.7	16.435	5.900
		6617	5.7	29.300	3.560
		6618	5.5	28.800	14.300
		6619	10.0	17.450	4.030
		6621	7.6	29.050	7.880
		6622	14.8	12.780	2.760
		01335	9.4	74.250	24.700
		01336A	5.5	107.250	25.000
		11023	36.4	16.200	10.700
		11369	16.0	39.400	14.800
MORGAN HILL, CALIF.	1984	1652	5.1	12.150	4.640
		1656A	28.0	4.250	2.770
		9101	12.8	4.385	2.210
		9102B	11.6	8.275	4.310
		9102C	11.6	7.865	3.980
		9102D	11.6	6.380	
		47380	16.7	3.890	2.410
		47381	16.0	10.950	5.110
		57064	26.9	3.240	2.160
		57066	22.1	11.125	2.590
		57191	5.1	9.350	3.430
		57355	17.0	8.265	3.350
		57356	16.6	7.925	3.840
		57357	17.6	9.825	3.120
		57382	14.3	14.100	7.620
		58235	28.4	4.025	2.870
CENTRAL CHILE	1985	4490	35.1	14.450	
		4491	38.1	10.860	4.740
N. PALM SPRINGS, CALIF.	1986	12025	16.6	6.210	3.810
		12149	9.7	18.000	4.500

TABLE A–25

Earthquake Data—Soft-Rock Sites: Peak Parameters

Earthquake	Date (UTC)	Time (UTC)	*M*	Fault Type	No. of Records			
					PHA	PVA	PHV	PVV
LONG BEACH, CALIF.	03/11/33	01:54:08	6.2	S	1	1	1	1
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	11	11	11	11
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	3	3	1	1
BISHOP, CALIF.	10/04/78	16:42:49	5.8	S	1	1	0	0
MALIBU, CALIF.	01/01/79	23:14:39	5.0	R	1	1	0	0
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	0	1	0
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	4	3	3	3
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	4	4	4	4
MICHOACHAN, MEXICO	09/19/85	13:17:49	8.1	T	1	1	1	1
CHALFANT VALLEY, CALIF.	07/21/86	14:42:27	6.2	S	4	4	0	0
WHITTIER NARROWS, CALIF.	10/01/87	14:42:17	5.9	T	11	11	0	0

TABLE A–26

Strong-Motion Data—Soft-Rock Sites: Peak Parameters

Earthquake	Year	Station No.	R (km)	PHA (g)	PVA (g)	PHV (cm/sec)	PVV (cm/sec)
LONG BEACH, CALIF.	1933	136	28.0	0.081	0.063	20.5	9.1
SAN FERNANDO, CALIF.	1971	110	24.0	0.312	0.180	21.9	6.2
		137	28.3	0.162	0.078	20.7	10.2
		151	29.5	0.121	0.056	19.5	7.8
		154	29.2	0.152	0.073	16.7	9.5
		157	29.2	0.140	0.060	17.4	10.6
		172	28.6	0.120	0.066	18.6	8.7
		190	29.2	0.077	0.060	12.7	7.1
		202	28.0	0.122	0.061	18.0	6.8
		217	28.0	0.159	0.077	20.1	9.1
		226	23.6	0.164	0.134	19.8	9.8
		24464	20.0	0.168	0.085	13.6	5.0
SANTA BARBARA, CALIF.	1978	106	27.6	0.055	0.024	4.0	4.9
		25255B	20.4	0.040	0.030		
		25291	25.0	0.060	0.030		
BISHOP, CALIF.	1978	54214C	14.3	0.215	0.170		
MALIBU, CALIF.	1979	5080	15.6	0.055	0.050		
ST ELIAS, ALASKA	1979	2765	47.7	0.053		8.9	
COYOTE LAKE, CALIF.	1979	47315A	16.2	0.099	0.045	6.4	2.5
		47315B	16.2	0.112	0.061	6.5	2.4
		57007	23.7	0.030			
		57383	4.1	0.372	0.153	34.5	16.5
MORGAN HILL, CALIF.	1984	47315A	29.2	0.054	0.033	2.3	1.7
		47315B	29.2	0.042	0.033	1.9	1.7
		57007	24.5	0.097	0.047	8.7	3.8
		57383	13.0	0.261	0.426	23.9	14.5
MICHOACHAN, MEXICO	1985	6521	37.3	0.112	0.079	6.4	5.2
CHALFANT VALLEY, CALIF.	1986	54214A	22.6	0.080	0.050		
		54214B	22.6	0.075	0.080		
		54214C	22.6	0.260	0.110		
		54424	18.9	0.180	0.140		
WHITTIER NARROWS, CALIF.	1987	108B	26.1	0.190	0.070		
		697	22.2	0.220	0.100		
		698	28.0	0.075	0.040		
		709	10.7	0.400	0.380		
		872	16.5	0.135	0.070		
		5233	17.2	0.150	0.070		
		5244	13.6	0.280	0.130		
		23328A	25.6	0.068	0.065		
		23328B	25.6	0.060	0.040		
		24464	26.1	0.100	0.070		
		24468	12.5	0.345	0.140		

TABLE A-27
Station Data—Soft-Rock Sites

Station No.	Recording Station	Housing	No. of Stories	Location	D (km)	Geology
106	CACHUMA DAM TOE	DAM	0	TOE	1.400	C
108B	CARBON CANYON DAM LT ABUT	DAM	0	ABUT	5.000	C
110	CASTAIC RIDGE RT	SHLT	0	GRND	10.000	C
136	LA SUBWAY TERML TUNL	BLDG	12	BSMT	3.400	C
137	LA WATER AND POWER BLD	BLDG	15	BSMT	2.900	C
151	LA 250 E FIRST ST	BLDG	15	BSMT	3.200	C
154	LA 420 S GRAND	BLDG	14	BSMT	3.400	C
157	LA 445 FIGUEROA	BLDG	39	BSMT	3.000	C
172	LA 800 W FIRST ST	BLDG	32	BSMT	2.900	C
190	LA 2011 ZONAL	BLDG	9	BSMT	3.100	C
202	LA 3435 WILSHIRE	BLDG	31	BSMT	2.900	C
217	LA 3710 WILSHIRE	BLDG	11	BSMT	2.900	C
226	LA 4867 SUNSET	BLDG	8	BSMT	2.600	C
697	ORANGE CO RESERVOIR	DAM	0	ABUT	4.800	C
698	DIEMER FILTER PLANT	BLDG	2	BSMT	5.600	C
709	GARVEY RES CON BLDG	BLDG	1	ABUT	2.700	C
872	LA 1111 SUNSET	BLDG	7	BSMT	2.900	C
2765	MUNDAY CREEK	SHLT	0	GRND		C
5080	MONTE NIDO FIRE STA	BLDG	1	GRND	1.200	C
5233	LA 1100 WILSHIRE	BLDG	33	BSMT	3.300	C
5244	LA 4407 JASPER ST	BLDG	1	GRND	1.100	C
6521	INFIERNILLO DAM R ABUT	DAM	0	ABUT		C
23328A	PUDDINGSTONE DAM - LEFT A	DAM	0	ABUT	0.500	C
23328B	PUDDINGSTONE DAM - RIGHT	DAM	0	ABUT	0.500	C
24464	L. A. - NORTH HOLLYWOOD S	BLDG	20	BSMT	2.100	C
24468	L. A. - CSULÀ ADMIN. BUIL	BLDG	8	BSMT	2.000	C
25255B	GIBRALTAR DAM - RIGHT ABU	DAM	0	ABUT	1.800	C
25291	JUNCAL DAM A - LEFT ABUT.	DAM	0	ABUT	4.000	C
47315A	SAN JUAN BAUTISTA-101/156	BRDG	1	GRND	0.015	C
47315B	SAN JUAN BAUTISTA-101/156	BRDG	1	GRND	0.015	C
54214A	LONG VALLEY DAM - DOWNSTR	DAM	0	GRND	0.070	C
54214B	LONG VALLEY DAM - LEFT AB	DAM	0	ABUT	0.130	C
54214C	LONG VALLEY DAM - UL ABUT	DAM	0	ABUT	0.150	C
54424	BISHOP - PARADISE LODGE	BLDG	1	GRND	0.300	C
57007	CORRALITOS	SHLT	0	GRND	3.800	C
57383	GILROY #6	SHLT	0	GRND	0.500	C

TABLE A-28

Earthquake Data—Soft-Rock Sites: 0.04 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	11	11
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	1	1

TABLE A-29

Earthquake Data—Soft-Rock Sites: 0.05–2.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	11	11
SANTA BARBARA, CALIF.	08/13/78	22:54:52	5.7	R	1	1
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	0
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	3	3
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	4	4

TABLE A-30

Earthquake Data—Soft-Rock Sites: 3.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	11	11
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	0
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	3	3
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	4	4

TABLE A-31

Earthquake Data—Soft-Rock Sites: 4.0 sec Pseudorelative Velocity

Earthquake	Date (UTC)	Time (UTC)	M	Fault Type	No. of Records	
					PSRVH	PSRVV
SAN FERNANDO, CALIF.	02/09/71	14:00:42	6.5	R	11	11
ST ELIAS, ALASKA	02/28/79	21:27:08	7.2	T	1	0
COYOTE LAKE, CALIF.	08/06/79	17:05:22	5.9	S	3	3
MORGAN HILL, CALIF.	04/24/84	21:15:19	6.1	S	2	2

TABLE A-32

Strong-Motion Data—Soft-Rock Sites: 0.04 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	1.920	1.070
		137	28.3	0.964	0.467
		151	29.5	0.706	0.366
		154	29.2	0.927	0.442
		157	29.2	0.845	0.333
		172	28.6	0.731	0.396
		190	29.2	0.468	0.358
		202	28.0	0.763	0.366
		217	28.0	0.973	0.475
		226	23.6	1.010	0.739
		24464	20.0	1.020	0.488
MORGAN HILL, CALIF.	1984	47315A	29.2		0.207
		47315B	29.2	0.274	

TABLE A-33

Strong-Motion Data—Soft-Rock Sites: 0.05 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	2.465	1.320
		137	28.3	1.235	0.604
		151	29.5	0.923	0.511
		154	29.2	1.173	0.602
		157	29.2	1.088	0.442
		172	28.6	0.947	0.648
		190	29.2	0.627	0.521
		202	28.0	1.001	0.653
		217	28.0	1.235	0.632
		226	23.6	1.420	1.150
		24464	20.0	1.365	0.749
SANTA BARBARA, CALIF.	1978	106	27.6	0.369	0.301
ST ELIAS, ALASKA	1979	2765	47.7	0.401	
COYOTE LAKE, CALIF.	1979	47315A	16.2	0.760	0.387
		47315B	16.2	0.916	0.519
		57383	4.1	2.975	1.360
MORGAN HILL, CALIF.	1984	47315A	29.2	0.352	0.290
		47315B	29.2	0.348	0.376
		57007	24.5	0.768	0.379
		57383	13.0	2.175	3.730

TABLE A-34

Strong-Motion Data—Soft-Rock Sites: 0.075 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	3.910	2.640
		137	28.3	2.625	1.340
		151	29.5	2.185	1.100
		154	29.2	1.995	1.330
		157	29.2	1.840	0.729
		172	28.6	1.670	1.450
		190	29.2	1.150	1.600
		202	28.0	1.760	1.070
		217	28.0	1.990	1.200
		226	23.6	2.400	2.500
		24464	20.0	2.565	2.220
SANTA BARBARA, CALIF.	1978	106	27.6	0.618	0.494
ST ELIAS, ALASKA	1979	2765	47.7	0.623	
COYOTE LAKE, CALIF.	1979	47315A	16.2	1.260	0.746
		47315B	16.2	1.355	0.895
		57383	4.1	4.670	4.100
MORGAN HILL, CALIF.	1984	47315A	29.2	0.648	0.572
		47315B	29.2	0.726	0.856
		57007	24.5	1.415	0.782
		57383	13.0	4.570	6.480

TABLE A-35

Strong-Motion Data—Soft-Rock Sites: 0.1 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	7.430	3.730
		137	28.3	4.905	2.230
		151	29.5	3.595	2.440
		154	29.2	3.655	2.460
		157	29.2	3.345	1.640
		172	28.6	2.985	1.920
		190	29.2	1.860	2.670
		202	28.0	4.420	2.380
		217	28.0	3.395	2.110
		226	23.6	3.620	3.230
		24464	20.0	3.810	3.150
SANTA BARBARA, CALIF.	1978	106	27.6	1.110	0.630
ST ELIAS, ALASKA	1979	2765	47.7	0.880	
COYOTE LAKE, CALIF.	1979	47315A	16.2	2.040	1.320
		47315B	16.2	2.230	1.640
		57383	4.1	7.080	6.950
MORGAN HILL, CALIF.	1984	47315A	29.2	1.085	0.838
		47315B	29.2	1.220	1.100
		57007	24.5	2.150	1.390
		57383	13.0	7.480	12.400

TABLE A-36

Strong-Motion Data—Soft-Rock Sites: 0.15 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	15.850	8.430
		137	28.3	6.555	3.660
		151	29.5	4.735	2.410
		154	29.2	5.750	2.720
		157	29.2	5.045	3.710
		172	28.6	5.015	3.020
		190	29.2	4.165	2.180
		202	28.0	9.460	3.350
		217	28.0	5.560	4.170
		226	23.6	8.255	5.560
		24464	20.0	7.520	2.920
SANTA BARBARA, CALIF.	1978	106	27.6	1.918	1.480
ST ELIAS, ALASKA	1979	2765	47.7	1.685	
COYOTE LAKE, CALIF.	1979	47315A	16.2	2.905	3.020
		47315B	16.2	3.685	3.090
		57383	4.1	13.000	6.980
MORGAN HILL, CALIF.	1984	47315A	29.2	2.080	2.220
		47315B	29.2	2.180	2.690
		57007	24.5	5.260	3.250
		57383	13.0	15.400	28.700

TABLE A-37

Strong-Motion Data—Soft-Rock Sites: 0.2 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	19.750	20.500
		137	28.3	6.755	3.660
		151	29.5	7.150	4.900
		154	29.2	8.235	3.230
		157	29.2	9.030	5.210
		172	28.6	8.000	3.710
		190	29.2	4.990	3.020
		202	28.0	9.360	4.190
		217	28.0	9.925	8.910
		226	23.6	16.150	5.920
		24464	20.0	15.400	5.180
SANTA BARBARA, CALIF.	1978	106	27.6	3.135	2.830
ST ELIAS, ALASKA	1979	2765	47.7	2.750	
COYOTE LAKE, CALIF.	1979	47315A	16.2	6.545	4.920
		47315B	16.2	7.330	5.880
		57383	4.1	23.150	10.700
MORGAN HILL, CALIF.	1984	47315A	29.2	3.010	2.290
		47315B	29.2	3.450	2.190
		57007	24.5	7.455	3.960
		57383	13.0	29.050	26.400

TABLE A–38

Strong-Motion Data—Soft-Rock Sites: 0.3 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	27.400	17.400
		137	28.3	15.050	6.150
		151	29.5	11.800	4.140
		154	29.2	12.700	3.990
		157	29.2	13.200	5.130
		172	28.6	13.500	5.030
		190	29.2	7.455	4.060
		202	28.0	9.500	3.510
		217	28.0	22.700	15.000
		226	23.6	28.700	7.440
		24464	20.0	18.100	8.990
SANTA BARBARA, CALIF.	1978	106	27.6	5.080	5.490
ST ELIAS, ALASKA	1979	2765	47.7	4.890	
COYOTE LAKE, CALIF.	1979	47315A	16.2	9.815	4.800
		47315B	16.2	10.350	5.380
		57383	4.1	45.550	15.800
MORGAN HILL, CALIF.	1984	47315A	29.2	3.515	1.620
		47315B	29.2	2.970	1.670
		57007	24.5	9.630	3.760
		57383	13.0	31.150	21.600

TABLE A–39

Strong-Motion Data—Soft-Rock Sites: 0.4 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	35.850	10.900
		137	28.3	16.350	5.990
		151	29.5	17.450	4.930
		154	29.2	20.450	5.080
		157	29.2	18.200	6.780
		172	28.6	14.800	9.600
		190	29.2	11.810	5.510
		202	28.0	9.335	5.390
		217	28.0	20.850	11.900
		226	23.6	21.900	9.250
		24464	20.0	16.400	8.280
SANTA BARBARA, CALIF.	1978	106	27.6	3.680	6.350
ST ELIAS, ALASKA	1979	2765	47.7	8.355	
COYOTE LAKE, CALIF.	1979	47315A	16.2	12.020	3.300
		47315B	16.2	16.100	5.190
		57383	4.1	55.400	13.800
MORGAN HILL, CALIF.	1984	47315A	29.2	6.235	2.450
		47315B	29.2	7.750	2.620
		57007	24.5	15.950	5.840
		57383	13.0	21.850	18.100

TABLE A-40

Strong-Motion Data—Soft-Rock Sites: 0.5 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	45.850	13.400
		137	28.3	14.450	10.500
		151	29.5	18.250	5.820
		154	29.2	22.700	6.120
		157	29.2	21.900	6.530
		172	28.6	15.300	7.850
		190	29.2	10.195	6.170
		202	28.0	14.200	4.950
		217	28.0	22.600	6.320
		226	23.6	21.500	9.220
		24464	20.0	15.200	8.380
SANTA BARBARA, CALIF.	1978	106	27.6	4.975	5.390
ST ELIAS, ALASKA	1979	2765	47.7	10.550	
COYOTE LAKE, CALIF.	1979	47315A	16.2	16.400	3.330
		47315B	16.2	18.350	3.790
		57383	4.1	52.200	10.400
MORGAN HILL, CALIF.	1984	47315A	29.2	4.915	2.690
		47315B	29.2	5.840	2.620
		57007	24.5	20.450	9.520
		57383	13.0	26.450	19.300

TABLE A-41

Strong-Motion Data—Soft-Rock Sites: 0.75 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	38.850	8.380
		137	28.3	25.350	7.620
		151	29.5	25.400	6.530
		154	29.2	20.200	12.400
		157	29.2	23.550	11.400
		172	28.6	21.450	11.700
		190	29.2	17.000	8.310
		202	28.0	14.550	5.410
		217	28.0	21.650	9.600
		226	23.6	31.900	13.000
		24464	20.0	20.850	6.500
SANTA BARBARA, CALIF.	1978	106	27.6	6.690	5.610
ST ELIAS, ALASKA	1979	2765	47.7	13.975	
COYOTE LAKE, CALIF.	1979	47315A	16.2	14.850	4.550
		47315B	16.2	16.250	4.320
		57383	4.1	57.100	27.700
MORGAN HILL, CALIF.	1984	47315A	29.2	4.280	2.230
		47315B	29.2	5.510	2.170
		57007	24.5	16.300	7.720
		57383	13.0	58.050	24.300

TABLE A–42

Strong-Motion Data—Soft-Rock Sites: 1.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	40.150	6.780
		137	28.3	21.450	12.400
		151	29.5	27.650	7.520
		154	29.2	27.250	12.900
		157	29.2	35.450	11.400
		172	28.6	31.000	15.900
		190	29.2	18.250	8.480
		202	28.0	26.900	10.800
		217	28.0	25.400	25.600
		226	23.6	51.700	21.000
		24464	20.0	16.900	6.710
SANTA BARBARA, CALIF.	1978	106	27.6	8.075	5.840
ST ELIAS, ALASKA	1979	2765	47.7	23.150	
COYOTE LAKE, CALIF.	1979	47315A	16.2	10.365	4.010
		47315B	16.2	10.810	4.140
		57383	4.1	58.750	29.000
MORGAN HILL, CALIF.	1984	47315A	29.2	3.605	3.020
		47315B	29.2	2.970	2.720
		57007	24.5	23.400	13.100
		57383	13.0	52.900	20.000

TABLE A–43

Strong-Motion Data—Soft-Rock Sites: 1.5 sec Pseudorelative Velocity

Earthquake	Year	Station No.	*R* (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	26.000	7.370
		137	28.3	31.000	10.100
		151	29.5	25.850	6.220
		154	29.2	25.650	13.500
		157	29.2	26.350	12.100
		172	28.6	34.650	9.960
		190	29.2	20.300	5.210
		202	28.0	21.950	18.500
		217	28.0	25.800	20.300
		226	23.6	18.100	14.400
		24464	20.0	24.600	12.400
SANTA BARBARA, CALIF.	1978	106	27.6	8.180	8.620
ST ELIAS, ALASKA	1979	2765	47.7	13.705	
COYOTE LAKE, CALIF.	1979	47315A	16.2	5.340	2.870
		47315B	16.2	5.560	2.870
		57383	4.1	46.300	19.700
MORGAN HILL, CALIF.	1984	47315A	29.2	3.300	3.150
		47315B	29.2	3.860	2.790
		57007	24.5	13.350	5.690
		57383	13.0	40.900	13.100

TABLE A–44

Strong-Motion Data—Soft-Rock Sites: 2.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	18.950	7.770
		137	28.3	19.200	11.200
		151	29.5	14.700	10.400
		154	29.2	18.600	13.800
		157	29.2	20.500	12.800
		172	28.6	21.550	10.900
		190	29.2	14.750	6.220
		202	28.0	23.800	21.700
		217	28.0	29.950	27.700
		226	23.6	29.350	14.400
		24464	20.0	15.400	9.140
SANTA BARBARA, CALIF.	1978	106	27.6	6.430	3.210
ST ELIAS, ALASKA	1979	2765	47.7	13.550	
COYOTE LAKE, CALIF.	1979	47315A	16.2	4.370	2.200
		47315B	16.2	4.635	2.170
		57383	4.1	35.550	16.600
MORGAN HILL, CALIF.	1984	47315A	29.2	3.875	2.030
		47315B	29.2	3.350	1.860
		57007	24.5	6.730	3.560
		57383	13.0	19.505	6.530

TABLE A–45

Strong-Motion Data—Soft-Rock Sites: 3.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV
SAN FERNANDO, CALIF.	1971	110	24.0	12.875	6.580
		137	28.3	35.550	18.900
		151	29.5	29.750	17.700
		154	29.2	36.300	17.900
		157	29.2	35.100	20.200
		172	28.6	34.200	18.000
		190	29.2	26.700	13.000
		202	28.0	30.200	18.600
		217	28.0	35.700	17.000
		226	23.6	28.650	26.200
		24464	20.0	13.450	5.590
ST ELIAS, ALASKA	1979	2765	47.7	11.160	
COYOTE LAKE, CALIF.	1979	47315A	16.2	3.375	1.250
		47315B	16.2	3.320	1.200
		57383	4.1	17.500	12.200
MORGAN HILL, CALIF.	1984	47315A	29.2	3.745	1.730
		47315B	29.2	3.400	2.260
		57007	24.5	4.130	2.670
		57383	13.0	11.760	9.140

TABLE A–46

Strong-Motion Data—Soft-Rock Sites: 4.0 sec Pseudorelative Velocity

Earthquake	Year	Station No.	R (km)	PSRVH (cm/sec)	PSRVV (cm/sec)
SAN FERNANDO, CALIF.	1971	110	24.0	10.125	7.290
		137	28.3	35.050	26.700
		151	29.5	32.900	25.100
		154	29.2	36.750	26.900
		157	29.2	35.800	25.600
		172	28.6	35.200	25.900
		190	29.2	26.800	17.600
		202	28.0	37.700	23.200
		217	28.0	37.700	19.800
		226	23.6	37.700	21.500
		24464	20.0	17.450	8.150
ST ELIAS, ALASKA	1979	2765	47.7	7.455	
COYOTE LAKE, CALIF.	1979	47315A	16.2	1.880	0.975
		47315B	16.2	1.915	1.370
		57383	4.1	12.555	8.860
MORGAN HILL, CALIF.	1984	47315A	29.2		1.570
		47315B	29.2	2.640	
		57383	13.0	10.465	5.000

Parameter Definitions:

Ground-Motion Parameters: PHA = Peak horizontal acceleration; PVA = Peak vertical acceleration; PHV = peak horizontal velocity; PVV = Peak vertical velocity; PSRVH = Horizontal pseudorelative velocity; PSRVV = Vertical pseudorelative velocity.

Magnitude: $M = M_L$ for $M < 6.0$; $M = M_S$ for $M \geq 6.0$.

Distance: R = Closest distance to seismogenic rupture.

Fault Type: R = Reverse and reverse-oblique; S = strike slip; T = thrust and thrust-oblique.

Instrument Housing: BLDG = Building; BRDG = Bridge; DAM = Dam; SHLT = Shelter; VLT = Vault.

Instrument Location: ABUT = Abutment of dam; BSMT = Basement level; GRND = Ground level; TOE = Toe of dam.

Geology: A = Recent alluvium (Holocene soils); B = Older alluvium and terrance deposits (Pleistocene soils); C = Soft rock (primarily sedimentary rock).