ESTIMATION OF RESPONSE SPECTRA AND PEAK ACCELERATIONS FROM WESTERN NORTH AMERICAN EARTHQUAKES: AN INTERIM REPORT

By

David M. Boore, William B. Joyner, and Thomas E. Fumal

U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

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ABSTRACT

We have derived equations for predicting the larger horizontal and the random horizontal component of peak acceleration and of 2-, 5-, 10-, and 20- percent-damped pseudo-velocity response spectra for 46 periods ranging from 0.1 to 2.0 sec. The equations were obtained by fitting a functional form to empirical data using a two-stage regression method. 271 two-component recordings from 20 earthquakes were used to develop the equations for peak acceleration, and 112 two-component recordings from 14 earthquakes were used for the response spectral equations. The data included a subset of those used in earlier studies by us (Joyner and Boore, 1981, 1982), augmented by data from three recent earthquakes with magnitudes close to 7: 1989 Loma Prieta, 1992 Petrolia, and 1992 Landers. Besides the addition of new data, this study differs from our previous work in several ways: records at distances equal to and greater than the distance to the first record triggered by the S wave were not included (this resulted in eliminating 56 records from our previous data set for peak horizontal acceleration and 19 records from our previous data set for response spectra; in addition, 7 records providing peak acceleration values were removed for a variety of other reasons), we used weighted regression in the second stage of the two-stage regression, equations were evaluated at many more periods than previously and for four values of damping, and the smoothing of the regression coefficients over period was done by computer rather than by eye. In addition, we changed the way in which geologic conditions beneath the site are classified. Our previous studies used a binary rock/soil classification. In anticipation of future building code classifications, we now divide site geology into four classes, depending on the average shear-wave velocity in the upper 30m. Site class A includes sites where the average shear-wave velocity is greater than 750 m/s; site class B sites where the velocity is between 360 and 750 m/s; site class C sites where the velocity is between 180 and 360 m/s; and site class D sites where the velocity is less than 180 m/s (site class D class was poorly represented in the data set and has not been included in the analysis).

Compared to the predictions from our previous equations, the new results have a lower variance and show differences between site classes at all periods, not just at periods longer than about 0.3 sec. At distances within a few tens of kilometers the motions for our new class B and class C are similar to those for our old rock class and soil class respectively;

the motions for our new class A are lower than any of our previous predictions. At large distances the new equations predict larger motions, larger at 80 km by a factor of two or more.

INTRODUCTION

In earlier studies (Joyner and Boore, 1981; Joyner and Boore, 1982; and Joyner and Boore, 1988) we presented equations for peak horizontal acceleration, velocity, and response spectra as a function of earthquake magnitude, the distance from the earthquake source, and the type of geologic material underlying the site. These equations were based on data obtained through 1980, and they used a binary classification ("rock" and "soil") for the geologic materials. Many more data have been collected since 1980. In particular, three earthquakes in California (1989 Loma Prieta, 1992 Petrolia, and 1992 Landers) have provided data for a range of magnitude and distance, critical for engineering design, which was poorly represented in our previous work. Furthermore, it is likely that future editions of national building codes will use at least a four-fold classification of site geology, based on average shear velocity to a depth of about 30 m. Our long-term goal is to develop prediction equations incorporating all of the data recorded since our earlier work and to reprocess all of the data for the sake of uniformity and to extend the period range covered by the equations. We decided, however, that an interim report would be useful at this time. Most of the post-1980 data that we are not including in this interim study are for magnitudes and distances sampled relatively well in our previous studies, and we expect that the results of our final study will not change greatly from those in this interim report.

In this report we give only brief discussions of those matters that were explained in our previous reports; we concentrate instead on topics that are new in this study.

DATA

Ground Motion Data

The set of data to be used in the regression was chosen from the data used in our previous studies combined with recordings of the 1989 Loma Prieta, the 1992 Petrolia, and the 1992 Landers earthquakes. Most of the data were collected by the California Division of Mines and Geology's Strong-Motion Instrumention Program and the U.S. Geological Survey's National Strong-Motion Program.

As in our previous studies, we used values for peak acceleration scaled directly from accelerograms, rather than the processed, instrument-corrected values.. We did this to avoid bias in the peak values (e.g., Fig. 5 in Boore and Joyner, 1982) from the sparsely sampled older data. This bias is not such a problem with the more densely sampled recent data. With a few exceptions we used response spectra as provided by relevant agencies; the exceptions are the data collected by Southern California Edison Company and by S. Hough of the U.S. Geological Survey, for which we computed response spectra ourselves. (We use the notation *psv* for response spectra, and all uses of the term "response spectra" refer to pseudo-velocity response spectra, computed by multiplying the relative displacement spectra by the factor $2\pi/T$, where T is the undamped natural period of the oscillator [the *psv* provided by the U.S. Geological Survey for the Loma Prieta earthquake used the damped period, but in the worst case (20 percent damping) this amounts to a difference in response spectra of only 2 percent].)

As we did previously, to avoid bias due to soil-structure interaction, we did not use data from structures three stories or higher, from dam abutments, or from the base of bridge columns. In addition, we include no more than 1 station with the same site condition within a circle of radius 1 km. In such cases, we generally chose the station with the lowest database code number and excluded the others. The radius of 1 km is a somewhat arbitrary choice.

When a strong-motion instrument is triggered by the S wave, the strongest motion may be missed. In this study, unlike previous studies, we made a systematic effort to exclude records from instruments triggered by the S wave.

A strong-motion data set will be biased by any circumstance that causes low values of ground motion to be excluded because they are low, as happens when the ground motion is too weak to trigger the strong-motion instrument, when the ground motion is so weak that an instrument triggers on the S wave, or when records are not digitized because their amplitude is low. To avoid a bias toward larger values, we impose a distance cutoff for each earthquake, beyond which we ignore any data available for that earthquake. This cutoff should logically be a function of geologic condition and trigger level of the recording instrument. We have ignored geologic condition in the determination of cutoff distance in this report, but we have partially considered the effect of trigger level by distinguishing between those stations employing a trigger sensitive to horizontal motion and those that were triggered on the vertical component of motion. Potentially, every earthquake could have two cutoff distances, depending on the type of trigger used in the recorder. In fact, this was only necessary for the 1971 San Fernando earthquake, which occurred during the time of transition between older instruments that trigger on horizontal motion and newer instruments that employ vertical triggers. For peak acceleration, the cutoff distance is equal to the lesser of the distance to the first record triggered by the S wave and the closest distance to an operational nontriggered instrument. For response spectra we chose to presume that amplitude is a factor in deciding which records are digitized, and we set the cutoff distance to the lesser of the distance to the first digitized record triggered by the S wave, the distance to the closest non-digitized recording, and the closest distance to an operational nontriggered instrument. The cutoff distances are given in Table 1. In Table 1, the greater-than sign indicates that the cutoff distance is at an unknown distance greater than that indicated. For the Landers earthquake the digitizing of the analog records is in the early stages, and few records from digital instruments have been released. It is likely that the cutoff distance for response spectra for the 1992 Landers earthquake will increase in the future.

In our previous studies we ignored the possible bias introduced by including records triggered by the S wave. Using the cutoff distances shown in Table 1 resulted in the elimination of 56 records from the peak acceleration data and 19 records from the peak velocity data set, a significant fraction of the data used in our previous studies. In addition, 7 records were deleted because information was available only for one horizontal component, because the record was obtained on a dam abutment, or because available information indicated that the site was underlain by muskeg or peat. Table 2 contains a listing of the records used in the previous study that were eliminated from the current analysis.

Because of the relatively low sampling rate of the older data (unevenly sampled, but usually interpolated to 50 samples/s), the response spectra are not well determined at periods less than 0.1 s. At longer periods, low signal to noise and filter cutoffs employed in the processing limit the generally useful band to periods less than about 2 to 4 s (we hope to extend this range in the future by reprocessing the data). We have used response spectra for periods between a maximum range of 0.1 and 2 s.

The recording of the 1992 Petrolia earthquake at the Cape Mendocino station provided only lower bounds for the peak acceleration, and therefore the recording was not used for peak acceleration. According to numerical experiments mentioned by Shakal *et al.* (1992a), the high-frequency character of the acceleration trace associated with the peak motion makes the displacement and velocity records insensitive to the actual value of the peak motion. For this reason, we have used response spectra determined from the recording for periods greater than 0.1 sec in our analysis.

Predictor Variables

As before, we use moment magnitude as the measure of earthquake size and a distance equal to the closest horizontal distance from the station to the point on the earth's surface that lies directly above the rupture. We estimated the moment magnitudes and the areas of the rupture surface from a literature review of various published studies for each earthquake.

Unlike the earlier studies, we use a site classification scheme based on the shear velocity averaged over the upper 30m. This scheme, shown in Table 3, has been proposed by Roger Borcherdt and Thomas Fumal and is now being considered for use in the 1994 edition of the National Earthquake Hazard Reduction Program's recommended code provisions. When available, we used measurements from boreholes at the strong-motion sites. In most cases such measurements were not available, and then we estimated the site classifications by analogy with borehole measurements in similar geologic materials; the type of geologic materials underlying each site was obtained from site visits, consultation with geologists familiar with the area, and various geologic maps (in particular, the 1:250,000 scale maps published by the California Division of Mines and Geology; see also Fumal, 1991, who used more detailed maps). Although we expect that some of the site classifications will change as more data become available, we do not anticipate any significant changes in the regression coefficients as a result of such changes. Of the four site classes listed in Table 3, class D was poorly represented in the data set and has not been included in the analysis.

The earthquake–station pairs and the corresponding predictor variables are given in Tables 4 and 5 for peak acceleration and response spectra, respectively. The information in Tables 4 and 5 is sorted by date, site class, and distance, in that order. The site class is given in the column labeled G. In addition, Table 4 contains the peak acceleration values (space does not allow a comparable listing of response spectral values). In both tables a borehole number is given if the site classification is based on a nearby borehole. The borehole information is contained in Table 6. The distribution in magnitude and distance space is shown in Figure 1, where the data used previously (but not wiinowed out of the current data set) and the data from the three recent earthquakes are plotted with different symbols. It is clear that the recent data fill an important gap in the previous data set. It should also be noted that very few data are available for distances beyond about 80 km.

METHOD

The coefficients in the equations for predicting ground motion were determined using a weighted, two-stage regression procedure (Joyner and Boore, 1993). In the first stage, the distance dependence was determined along with a set of amplitude factors, one for each earthquake. In the second stage, the amplitude factors were regressed against magnitude to determine the magnitude dependence. The second-stage regression used a weighting matrix with zero off-diagonal terms (equation (34) in Joyner and Boore, 1993); the value of σ_e was determined by finding the value that satisfies (or the non-negative value that most nearly satisfies) equation (33) in Joyner and Boore (1993).

We fit the following functional form to the data:

$$\log Y = b_1 + b_2(\mathrm{M} - 6) + b_3(\mathrm{M} - 6)^2 + b_4 r + b_5 \log r + b_6 G_B + b_7 G_C + \epsilon_r + \epsilon_e, \qquad (1)$$

where

$$r = (d^2 + h^2)^{(1/2)}. \qquad (2)$$

In this equation Y is the ground motion parameter (in cm/s for response spectra and g for peak acceleration); the predictor variables are magnitude (M), distance (d, in km), and site classification ($G_B = 1$ for class B and zero otherwise; $G_C = 1$ for class C and zero otherwise); ϵ_r is an independent random variable that takes on a specific value for each record; and ϵ_e is an independent variable that takes on a specific value for each earthquake. The coefficients to be determined are b_1 through b_7, h, and the variance of ϵ_e and ϵ_r (σ_e^2 and σ_r^2, respectively). The earthquake-to-earthquake component of variability is represented by σ_e^2, and all other components of variability are represented by σ_r^2. Note that h is a fictitious depth that is determined by the regression. We present sets of equations for predicting both the larger of the two horizontal components and a randomly-oriented horizontal component of ground motion. To derive equations for the randomly-oriented component, we used the geometric mean of the two horizontal-component amplitudes for Y in equation (1) rather than choosing one of the horizontal components randomly. This will give the correct regression coefficients, but the variance of ϵ_r determined by the regression program will be reduced below that expected for the prediction of a random component of ground motion. To account for this, we computed the variance (σ_c^2) of the horizontal components from the following formula:

$$\sigma_c^2 = \frac{1}{nrecs} \sum_{j=1}^{nrecs} \{\frac{1}{2}[\log Y_{1j} - \log Y_{2j}]^2\}, \tag{3}$$

where Y_{ij} is the ith component from the jth recording and the sum is taken over all records for which both horizontal components were available. The few records that did not have both horizontal components were not included in the sum, although the one available component was used in the regression to determine the coefficients in equation (1)). The variance σ_r^2 is then given by

$$\sigma_r^2 = \sigma_1^2 + \sigma_c^2, \tag{4}$$

where σ_1^2 is the variance from the first stage of our two-stage regression. The overall variance is given by combining the individual variances:

$$\sigma_{\log Y}^2 = \sigma_r^2 + \sigma_e^2. \tag{5}$$

RESULTS

Equation (1) was fit to the data period-by-period at the 46 periods between 0.1 and 2.0 s for which the response spectral values had been computed. These periods are distributed in a generally logarithmic manner over the interval. The data and regression fit for the second stage of the regression analysis are shown in Figure 2, for the random horizontal component of peak acceleration and 5-percent damped response spectra; plots for the other values of damping and for the larger of the horizontal components are similar and are not included in this report.

Plots of the coefficients versus period showed them to have fluctuations that lead to somewhat jagged spectra at a fixed distance and magnitude; the amplitude of the fluctuations is comparable to the uncertainty in the estimated coefficients. Because we wish our equations to produce smooth response spectra, we have smoothed the coefficients over period. After some experimentation with various smoothing schemes, we adopted the least-squares fit of a cubic polynomial as the best representation of the smoothed coefficients. The unsmoothed and smoothed coefficients for the 5-percent damped response spectra for the random horizontal component are shown in Figure 3; figures for the other dampings and for the larger horizontal component are collected at the end of the report in a multipart figure labeled A1.

Comparisons of response spectra computed from the unsmoothed and the smoothed regression coefficients are given in Figures 4, 5, and 6 for combinations of magnitudes, site classes, and distances. These figures illustrate the jaggedness that motivated our smoothing of the coefficients and also demonstrates the effectiveness of the smoothing procedure.

The smoothed coefficients for the random horizontal component and the larger horizontal component are given in Table 7 and 8, respectively. Each table contains four parts, corresponding to dampings of 2, 5, 10, and 20 percent. Note in the column headings for the tables that the uncertainties σ_1, σ_c, σ_r, σ_e, and $\sigma_{\log Y}$ are represented by $S1$, SC, SR, SE, and $SLOGY$, respectively. The coefficients for predicting peak acceleration are given in Table 9.

Based on the magnitude and distance distribution shown in Figure 1, we stipulate that our equations not be used to predict motions at distances greater than 100 km or magnitudes less than 5.0 or greater than 7.7.

Several columns in Tables 7 and 8 have zero entries, for the following reasons. We initially fixed b_5 at -1, but this led to values of the coefficient b_4 greater than 0. Positive values of b_4 lead to unreasonable behavior at large distances. For this reason we set $b_4 = 0.0$ and solved for the geometrical-spreading surrogate, b_5. The "SC" column represents the variance due to the difference in amplitude of the two horizontal components of motion at a site; it obviously has no meaning when peak motions from the larger horizontal component is being considered, and therefore the "SC" entries in Table 8 are set to zero.

Plots of selected ground motions against distance computed from the coefficients in Tables 7b and 9 are shown in Figure 7.

RESIDUALS

An important step in a regression analysis is a study of the residual of the data about the regression fits. We have already shown one such comparison (Figure 2), in which no systematic departures from the assumed model can be seen. We have plotted residuals of the logarithms of ground motion against distance for different site and magnitude classes, and we again we see no systematic differences between the data and the predictions (Figure 8).

DISCUSSION AND CONCLUSIONS

How do the new equations compare to our previous equations? Because of the difference in site classification, we cannot make a direct comparison. Predicted *psv* from old and new equations are shown in Figure 9 as a function of period for two magnitudes, with different curves for the various site classes for distances of 0 and 20 km. In general, at these distances the new site class A has lower motions than we would have predicted for rock sites; the motions from the new site class C are similar to those from the old soil class and the motions for the new site class B are similar to those for the old rock class. We found that many of our previously-designated rock sites fell into the B class, and therefore at first glance it is not surprising that the old rock and new class B predictions are similar. On the other hand, our old soil class was made up of a combination of B and C sites, and therefore Figure 9 suggests that the average ground motion from our new equations and new site classes, for a specific collection of sites, would be lower than from our old equations and site classes. Note also that the difference between the various site classes persists to low periods, unlike our previous finding.

The new equations give higher values than the old equations at large distances. At 80 km the new equations give values for the average of site classes B and C that are a factor of two or more greater than the values given by the old equations for soil (Figure 10). To understand better the reasons for the higher values at large distances we performed a series of analyses of the old data set. The results show that using weighted regression for the second stage of the analysis, winnowing the data set on the basis of the distance cutoff table, assigning new site classes to the older data, and including the new data from the three recent earthquakes all contributed to increasing the values for large distances.

Although not shown in the figure, the variance of the ground motions has been reduced in our new results. This is shown in Table 10 for 5 percent damped *psv* at periods of 0.3 and 1.0 s. A series of analyses of the old data set shows that the primary cause of the reduction in variance is the winnowing of the data set. The use of weighted regression for the second stage also contributed to the reduction in variance.

Although this is not the place for an extended discussion of the variations in the coefficients and their possible physical interpretation, we point out that a number of trends are similar to those found in our previous work: with increasing T, the magnitude dependence increases, as do the site factors and the variance. The coefficient h generally decreases with increasing period.

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Table 1a. Cutoff distances for peak acceleration

EQ#	YEAR	NAME	CUTOFFDIST (km)
8	1940	Imperial Valley	> 12.0
18	1952	Kern County	148.0
32	1957	Daly City	> 8.0
50	1966	Parkfield	63.6
58	1968	Borrego Mt.	105.0
64	1970	Lytle Creek	13.0
65	1971	San Fernando	20.2 for H trigger, > 60.7 for V trigger
72	1972	Bear Valley	31.0
76	1972	Sitka	145.0
79	1972	Managua	> 5.0
84	1973	Pt. Mugu	50.0
97	1974	Hollister	> 17.0
109	1975	Oroville	8.0
137	1978	Santa Barbara	> 14.0
144	1979	St. Elias	> 25.4
146	1979	Coyote Lake	43.0
147	1979	Imperial Valley	64.0
153	1980	Livermore Valley1	> 40.3
154	1980	Livermore Valley2	> 48.3
155	1980	Horse Canyon	47.7
328	1989	Loma Prieta	80.9
349	1992	Petrolia	45.3
352	1992	Landers	119.9

Table 1b. Cutoff distance distances used for response spectra

EQ#	YEAR	NAME	CUTOFFDIST (km)
8	1940	Imperial Valley	> 12.0
18	1952	Kern County	148.0
32	1957	Daly City	> 8.0
50	1966	Parkfield	63.6
58	1968	Borrego Mt.	105.0
64	1970	Lytle Creek	13.0
65	1971	San Fernando	20.2 for H trigger; > 60.7 for V trigger
76	1972	Sitka	145.0
79	1972	Managua	> 5.0
144	1979	St. Elias	> 25.4
146	1979	Coyote Lake	43.0
147	1979	Imperial Valley	64.0
328	1989	Loma Prieta	68.7
349	1992	Petrolia	45.3
352	1992	Landers	65.4

Table 2a. Records from previous work eliminated from the current regression analysis of peak acceleration.

DATE	EARTHQUAKE	M	DIST	STATION	LAT.	LONG.
21-Jul-52	Kern County	7.40	148.0	San Luis Obispo	35.285	120.660
21-Jul-52	Kern County	7.40	359.0	Hawthorne, NV	38.550	118.630
21-Jul-52	Kern County	7.40	156.0	Colton: SCE Substn.	34.060	117.320
21-Jul-52	Kern County	7.40	224.0	Bishop	37.360	118.396
21-Jul-52	Kern County	7.40	293.0	Hollister City Hall	36.850	121.400
21-Jul-52	Kern County	7.40	370.0	El Centro Array Sta 9	32.794	115.549
28-Jun-66	Parkfield	6.10	63.6	San Luis Obispo	35.285	120.660
28-Jun-66	Parkfield	6.10	105.0	Taft	35.150	119.460
28-Jun-66	Parkfield	6.10	112.0	Buena Vista Pumping	35.160	119.350
28-Jun-66	Parkfield	6.10	123.0	Hollister City Hall	36.850	121.400
9-Apr-68	Borrego Mount	6.60	141.0	Devil Canyon	34.200	117.330
9-Apr-68	Borrego Mount	6.60	200.0	Pasadena - Old Seism Lab	34.150	118.170
9-Apr-68	Borrego Mount	6.60	105.0	Perris Dam	33.843	117.188
9-Apr-68	Borrego Mount	6.60	122.0	San Onofre	33.370	117.560
9-Apr-68	Borrego Mount	6.60	147.0	Cedar Springs - Pump House	34.310	117.300
9-Apr-68	Borrego Mount	6.60	197.0	Pasadena - Athenaeum	34.140	118.120
9-Apr-68	Borrego Mount	6.60	203.0	Pearblossom: Pumping Plant	34.510	117.920
9-Apr-68	Borrego Mount	6.60	130.0	Colton: SCE Substn.	34.060	117.320
9-Apr-68	Borrego Mount	6.60	187.0	Long Beach - Terminal Island	33.770	118.230
9-Apr-68	Borrego Mount	6.60	211.0	Hollywood Storage Bldg PE Lo	34.090	118.340
2-Oct-69	Santa Rosa, C	5.60	62.0	San Pablo	37.980	122.340
2-Oct-69	Santa Rosa, C	5.70	62.0	San Pablo	37.980	122.340
12-Sep-70	Lytle Creek	5.30	19.0	Cedar Springs - Miller Canyo	34.280	117.330
12-Sep-70	Lytle Creek	5.30	21.0	Devil Canyon	34.200	117.330
12-Sep-70	Lytle Creek	5.30	13.0	Wrightwood	34.360	117.630
12-Sep-70	Lytle Creek	5.30	22.0	Cedar Springs - Pump House	34.310	117.300
12-Sep-70	Lytle Creek	5.30	29.0	Colton: SCE Substn.	34.060	117.320
9-Feb-71	San Fernando	6.60	20.2	Lake Hughes Sta 9	34.610	118.560
9-Feb-71	San Fernando	6.60	21.1	Griffith Park Observatory	34.118	118.299
9-Feb-71	San Fernando	6.60	21.9	Pasadena - Old Seism Lab	34.150	118.170
9-Feb-71	San Fernando	6.60	87.0	Cedar Springs - Miller Canyo	34.280	117.330
9-Feb-71	San Fernando	6.60	23.4	Lake Hughes Sta 1	34.674	118.430
9-Feb-71	San Fernando	6.60	24.2	Castaic	34.560	118.660
9-Feb-71	San Fernando	6.60	28.6	Palmdale: Fire Station	34.578	118.113
9-Feb-71	San Fernando	6.60	37.4	Pearblossom: Pumping Plant	34.510	117.920
9-Feb-71	San Fernando	6.60	64.0	Fort Tejon	34.870	118.900
9-Feb-71	San Fernando	6.60	66.0	Edmonston Pumping	34.940	118.830
9-Feb-71	San Fernando	6.60	88.0	Cedar Springs - Pump House	34.310	117.300
9-Feb-71	San Fernando	6.60	24.6	Hollywood Storage Bldg PE Lo	34.090	118.340
9-Feb-71	San Fernando	6.60	46.7	Oso Pumping Plant	34.808	118.720
9-Feb-71	San Fernando	6.60	56.9	Palos Verdes Estates	33.801	118.387

9-Feb-71	San Fernando	6.60	61.4	Long Beach - Terminal Island	33.770	118.230
9-Feb-71	San Fernando	6.60	62.0	Port Hueneme	34.145	119.206
9-Feb-71	San Fernando	6.60	82.0	Wheeler Ridge	35.030	118.990
9-Feb-71	San Fernando	6.60	91.0	Colton: SCE Substn.	34.060	117.320
24-Feb-72	Bear Valley	5.30	31.0	Hollister City Hall	36.850	121.400
30-Jul-72	Sitka	7.70	300.0	Yakutat, Alaska	59.510	139.670
30-Jul-72	Sitka	7.70	145.0	Juneau	58.382	134.642
21-Feb-73	Point Mugu	5.60	50.0	Jensen Filter Plant	34.312	118.496
1-Aug-75	Oroville	6.00	8.0	Oroville	39.550	121.500
1-Aug-75	Oroville	6.00	32.0	Paradise	39.727	121.681
1-Aug-75	Oroville	6.00	31.0	Chico	39.717	121.815
1-Aug-75	Oroville	6.00	30.0	Marysville	39.149	121.577
28-Feb-79	St. Elias	7.60	40.0	Munday Creek, Alaska	60.023	141.966
6-Aug-79	Coyote Lake	5.80	1.6	Coyote Lake Dam	37.118	121.550
6-Aug-79	Coyote Lake	5.80	23.4	Corralitos	37.046	121.803
6-Aug-79	Coyote Lake	5.80	38.9	Capitola	36.974	121.952
15-Oct-79	Imperial Vall	6.50	64.0	Yuma	32.730	114.700
24-Jan-80	Livermore Val	5.80	10.8	Delta Pumping Plant	37.800	121.620
27-Jan-80	Livermore Val	5.50	11.1	Delta Pumping Plant	37.800	121.620
25-Feb-80	Horse Canyon	5.30	53.1	Whitewater Cyn	33.989	116.655
25-Feb-80	Horse Canyon	5.30	47.7	Fun Valley	33.925	116.389
25-Feb-80	Horse Canyon	5.30	49.2	Cabazon	33.918	116.782

Table 2b. Records from previous work eliminated from the current regression of response spectra.

DATE	EARTHQUAKE	M	DIST	STATION	LAT.	LONG.
28-Jun-66	Parkfield	6.10	63.6	San Luis Obispo	35.285	120.660
28-Jun-66	Parkfield	6.10	105.0	Taft	35.150	119.460
12-Sep-70	Lytle Creek	5.30	19.0	Cedar Springs - Miller Canyo	34.280	117.330
12-Sep-70	Lytle Creek	5.30	13.0	Wrightwood	34.360	117.630
9-Feb-71	San Fernando	6.60	20.2	Lake Hughes Sta 9	34.610	118.560
9-Feb-71	San Fernando	6.60	21.1	Griffith Park Observatory	34.118	118.299
9-Feb-71	San Fernando	6.60	21.9	Pasadena - Old Seism Lab	34.150	118.170
9-Feb-71	San Fernando	6.60	23.4	Lake Hughes Sta 1	34.674	118.430
9-Feb-71	San Fernando	6.60	24.2	Castaic	34.560	118.660
9-Feb-71	San Fernando	6.60	28.6	Palmdale: Fire Station	34.578	118.113
9-Feb-71	San Fernando	6.60	37.4	Pearblossom: Pumping Plant	34.510	117.920
9-Feb-71	San Fernando	6.60	64.0	Fort Tejon	34.870	118.900
9-Feb-71	San Fernando	6.60	66.0	Edmonston Pumping	34.940	118.830
9-Feb-71	San Fernando	6.60	24.6	Hollywood Storage Bldg PE Lo	34.090	118.340
9-Feb-71	San Fernando	6.60	46.7	Oso Pumping Plant	34.808	118.720
9-Feb-71	San Fernando	6.60	56.9	Palos Verdes Estates	33.801	118.387
9-Feb-71	San Fernando	6.60	61.4	Long Beach - Terminal Island	33.770	118.230
9-Feb-71	San Fernando	6.60	62.0	Port Hueneme	34.145	119.206
9-Feb-71	San Fernando	6.60	82.0	Wheeler Ridge	35.030	118.990

Table 3. Definition of site class

SITE CLASS	RANGE OF SHEAR VELOCITIES*
A	greater than 750 m/s
B	360 m/s to 750 m/s
C	180 m/s to 360 m/s
D	less than 180 m/s

* Shear velocity is averaged over the upper 30 m.

Table 4. Records used the development of the equations for peak acceleration.

DATE	EARTHQUAKE	M	DIST	STATION	LAT.	LONG.	G	HOLE	PA_H1	PA_H2	REFERENCE
19-May-40	Imperial Vall	7.00	12.0	El Centro Array Sta 9	32.794	115.549	C	107	.359	.224	CIT: EERL 76-02
21-Jul-52	Kern County	7.40	42.0	Taft	35.150	119.460	B	201	.196	.177	CIT: EERL 76-02
21-Jul-52	Kern County	7.40	85.0	Santa Barbara	34.420	119.700	B	96	.135	.090	CIT: EERL 76-02
21-Jul-52	Kern County	7.40	109.0	Pasadena - Athenaeum	34.140	118.120	B	92	.054	.048	CIT: EERL 76-02
21-Jul-52	Kern County	7.40	107.0	Hollywood Storage Bldg PE Lo	34.090	118.340	C	63	.062	.044	CIT: EERL 76-02
22-Mar-57	Daly City	5.30	8.0	San Fran.: Golden Gate Park	37.770	122.480	A	173	.127	.105	CIT: EERL 76-02
28-Jun-66	Parkfield	6.10	16.1	Cholame-Shandon: Temblor	35.710	120.170	B	200	.411	.282	CIT: EERL 76-02
28-Jun-66	Parkfield	6.10	17.3	Parkfield: Cholame 12W	35.639	120.404	B		.072	.066	CIT: EERL 76-02
28-Jun-66	Parkfield	6.10	6.6	Parkfield: Cholame 2	35.733	120.288	C	228	.509		CIT: EERL 76-02
28-Jun-66	Parkfield	6.10	9.3	Parkfield: Cholame 5W	35.697	120.328	C	197	.467	.403	CIT: EERL 76-02
28-Jun-66	Parkfield	6.10	13.0	Parkfield: Cholame 8W	35.671	120.359	C	198	.279	.276	CIT: EERL 76-02
9-Apr-68	Borrego Mount	6.60	45.0	El Centro Array Sta 9	32.794	115.549	C	107	.142	.061	CIT: EERL 76-02
9-Feb-71	San Fernando	6.60	17.0	Lake Hughes Sta 12	34.570	118.560	B	86	.374	.288	CIT: EERL 76-02
9-Feb-71	San Fernando	6.60	25.7	Pasadena - Athenaeum	34.140	118.120	B	92	.114	.103	CIT: EERL 76-02
9-Feb-71	San Fernando	6.60	60.7	Wrightwood	34.360	117.630	B	88	.057	.047	CIT: EERL 76-02
9-Feb-71	San Fernando	6.60	19.6	Lake Hughes Sta 4	34.650	118.478	C	71	.200	.159	CIT: EERL 76-02
30-Jul-72	Sitka	7.70	45.0	Sitka	57.060	135.320	A		.110	.090	USDC: USEQ72
23-Dec-72	Managua	6.20	5.0	Managua: ESSO Refinery	12.145	86.322	C		.390	.330	USGS: Circ. 713
21-Feb-73	Point Mugu	5.60	16.0	Port Hueneme	34.145	119.206	C		.130	.080	USGS: Circ. 713
28-Nov-74	Hollister	5.20	17.0	Hollister - Sago Vault	36.765	121.446	A		.011	.008	USGS: Brady
28-Nov-74	Hollister	5.20	8.0	San Juan Bautista	36.846	121.536	B		.120	.050	USGS: Circ. 717-A
28-Nov-74	Hollister	5.20	10.0	Gavilon College Geol Bldg	36.973	121.568	B		.140	.100	USGS: Circ. 717-A
28-Nov-74	Hollister	5.20	10.0	Hollister City Hall	36.850	121.400	C		.170	.100	USGS: Circ. 717-A
13-Aug-78	Santa Barbara	5.10	0.0	Santa Barbara	34.420	119.700	B	96	.210	.100	CDMG: OSMS PR 22
13-Aug-78	Santa Barbara	5.10	11.0	UCSB: Physical Plant	34.422	119.851	B		.390	.240	CDMG: OSMS PR 22
13-Aug-78	Santa Barbara	5.10	14.0	Goleta Substation	34.470	119.890	B		.280	.240	CDMG: OSMS PR 22
28-Feb-79	St. Elias	7.60	25.4	Icy Bay	59.968	141.643	B		.160	.110	USGS: Circ. 818-A
6-Aug-79	Coyote Lake	5.80	9.1	Gilroy Array 1	36.973	121.572	A	192	.127	.100	USGS: Circ. 854-C
6-Aug-79	Coyote Lake	5.80	1.2	Gilroy Array 6	37.026	121.484	B	196	.419	.344	USGS: Circ. 854-C
6-Aug-79	Coyote Lake	5.80	17.9	San Juan Bautista	36.846	121.536	B		.110	.090	USGS: OFR 79-385

6-Aug-79	Coyote Lake	5.80	19.2	San Juan Bautista: Overpass	36.862	121.578	B		.120	.080	USGS: OFR 79-385
6-Aug-79	Coyote Lake	5.80	30.0	Halls Valley	37.338	121.714	B		.044	.040	USGS: OFR 79-385
6-Aug-79	Coyote Lake	5.80	3.7	Gilroy Array 4	37.005	121.522	C	195	.257	.236	USGS: Circ. 854-C
6-Aug-79	Coyote Lake	5.80	5.3	Gilroy Array 3	36.987	121.536	C	194	.267	.260	USGS: Circ. 854-C
6-Aug-79	Coyote Lake	5.80	7.4	Gilroy Array 2	36.982	121.556	C	193	.263	.196	USGS: Circ. 854-C
15-Oct-79	Imperial Vall	6.50	14.0	Parachute Test Site	32.929	115.699	B	116	.200	.110	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	23.5	Cerro Prieto	32.420	115.301	B		.167	.149	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	26.0	Superstition Mtn	32.955	115.823	B		.210	.120	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	.5	El Centro: Meloland Overpass	32.773	115.447	C		.320	.300	CDMG: OSMS PR 26
15-Oct-79	Imperial Vall	6.50	.6	El Centro Array Sta 7	32.829	115.504	C	105	.520	.360	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	1.3	El Centro Array Sta 6	32.839	115.487	C	104	.720	.450	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	1.4	Aeropuerto	32.651	115.332	C		.316	.240	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	2.6	Bonds Corner	32.693	115.338	C	97	.810	.660	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	3.8	El Centro Array Sta 8	32.810	115.530	C	106	.640	.500	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	4.0	El Centro Array Sta 5	32.855	115.466	C	103	.560	.400	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	5.1	El Centro: Differential Arra	32.796	115.535	C	112	.510	.370	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	6.2	El Centro Array Sta 9	32.794	115.549	C	107	.400	.270	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	6.8	El Centro Array Sta 4	32.864	115.432	C	102	.610	.380	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	7.5	Holtville	32.812	115.377	C	99	.260	.220	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	7.6	El Centro: Imp. Cnty Cntr FF	32.793	115.560	C	113	.240	.240	CDMG: OSMS PR 26
15-Oct-79	Imperial Vall	6.50	8.4	Mexicali SAHOP	32.618	115.428	C		.459	.311	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	8.5	El Centro Array Sta 10	32.780	115.567	C	108	.230	.200	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	8.5	Brawley	32.991	115.512	C	114	.220	.170	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	10.6	Calexico	32.669	115.492	C		.280	.220	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	12.6	El Centro Array Sta 11	32.752	115.594	C	109	.380	.380	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	12.9	Cucapah	32.545	115.235	C		.310		USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	15.0	Westmorland	33.037	115.623	C	115	.110	.080	CDMG: OSMS PR 26
15-Oct-79	Imperial Vall	6.50	16.0	El Centro Array Sta 2	32.916	115.366	C	100	.430	.330	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	17.7	Chihuahua	32.484	115.240	C		.267	.263	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	18.0	El Centro Array Station 12	32.718	115.637	C	110	.150	.110	USGS: A
15-Oct-79	Imperial Vall	6.50	22.0	El Centro Array Sta 1	32.960	115.319	C		.150	.150	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	22.0	El Centro Array Sta 13	32.709	115.683	C	111	.150	.120	USGS: A
15-Oct-79	Imperial Vall	6.50	23.0	Calipatria	33.130	115.520	C	117	.130	.086	USGS: Porcella
15-Oct-79	Imperial Vall	6.50	23.2	Compuertas	32.572	115.083	C		.188	.149	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	32.0	Plaster City	32.790	115.860	C		.066	.049	USGS: Porcella
15-Oct-79	Imperial Vall	6.50	32.7	Delta	32.356	115.195	C		.349	.235	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	36.0	Niland	33.239	115.512	C		.100	.070	CDMG: OSMS PR 26
15-Oct-79	Imperial Vall	6.50	43.5	Victoria	32.289	115.103	C		.163	.122	USGS: PP 1254
15-Oct-79	Imperial Vall	6.50	49.0	Coachella Canal Sta 4	33.360	115.590	C		.140	.110	USGS: OFR 79-1654
15-Oct-79	Imperial Vall	6.50	60.0	Ocotillo Wells	33.140	116.130	C		.049	.043	USGS: Porcella
24-Jan-80	Livermore Val	5.80	20.8	Antioch	38.015	121.813	B		.045	.010	USGS+CDMG
24-Jan-80	Livermore Val	5.80	33.1	Mission San Jose	37.530	121.919	B	224	.056	.050	USGS+CDMG
24-Jan-80	Livermore Val	5.80	40.3	APEEL Array Sta 3E	37.657	122.061	B	158	.065	.060	USGS+CDMG
24-Jan-80	Livermore Val	5.80	15.7	San Ramon: Eastman Kodak Bld	37.729	121.928	C		.154	.060	USGS+CDMG
24-Jan-80	Livermore Val	5.80	16.7	San Ramon	37.780	121.980	C		.052	.040	USGS+CDMG
24-Jan-80	Livermore Val	5.80	28.5	Tracy	37.766	121.421	C		.086	.050	USGS+CDMG
27-Jan-80	Livermore Val	5.50	10.1	Morgan Territory Park	37.819	121.795	B		.267	.190	USGS+CDMG
27-Jan-80	Livermore Val	5.50	26.5	Antioch: Contra Loma Park	37.972	121.829	B		.026	.030	USGS+CDMG
27-Jan-80	Livermore Val	5.50	29.0	Mission San Jose	37.530	121.919	B	224	.039		USGS+CDMG
27-Jan-80	Livermore Val	5.50	30.9	Antioch	38.015	121.813	B		.112	.050	USGS+CDMG
27-Jan-80	Livermore Val	5.50	37.8	APEEL Array Sta 3E	37.657	122.061	B	158	.065	.040	USGS+CDMG
27-Jan-80	Livermore Val	5.50	4.0	Livermore: Fagundes Ranch	37.753	121.772	C		.259	.220	USGS+CDMG
27-Jan-80	Livermore Val	5.50	17.7	San Ramon: Eastman Kodak Bld	37.729	121.928	C		.275	.090	USGS+CDMG
27-Jan-80	Livermore Val	5.50	22.5	San Ramon	37.780	121.980	C		.058	.040	USGS+CDMG
27-Jan-80	Livermore Val	5.50	48.3	Oakland: 2-Story Office Bldg	37.806	122.267	C	133	.026	.020	USGS+CDMG

25-Feb-80	Horse Canyon	5.30	5.8	Terwilliger Valley: Snodgras	33.480	116.590	A		.123	.088	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	12.0	Pinyon Flat Observatory	33.607	116.453	A		.133	.118	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	12.1	Anza Fire Station	33.555	116.673	A		.073	.067	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	36.1	Sage	33.580	116.931	A		.111	.084	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	20.6	Hurkey Creek Park	33.676	116.680	B		.097	.076	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	20.6	Rancho de Anza	33.348	116.400	B		.096	.096	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	25.3	Puerta La Cruz	33.324	116.683	B		.181	.114	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	36.3	Cranston Forest Sta	33.740	116.840	B		.110	.094	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	41.4	Borrego Springs: Air Ranch	33.190	116.280	B		.040	.032	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	43.6	San Jacinto: Soboda	33.797	116.880	B		.047	.044	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	44.4	N. Palm Sprngs: P. O.	33.920	116.540	B		.022	.017	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	35.9	Thousand Palms	33.817	116.390	C		.082	.050	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	38.5	Indio: So. Calif Gas Co.	33.747	116.214	C		.094	.060	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	46.1	Hemet City Library	33.748	116.966	C		.057	.046	USGS: Circ. 854-B
25-Feb-80	Horse Canyon	5.30	47.1	San Jacinto	33.784	116.948	C		.080	.062	USGS: Circ. 854-B
18-Oct-89	Loma Prieta	6.92	10.5	Gilroy Array 1	36.973	121.572	A	192	.500	.430	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	29.9	Hollister - Sago Vault	36.765	121.446	A		.060	.040	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	32.5	Cherry Flat Reservoir	37.396	121.756	A		.090	.070	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	34.1	SAGO South A	36.753	121.396	A	211	.070	.070	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	42.7	Monterey City Hall	36.597	121.897	A	209	.070	.070	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	67.6	S. San Fran.: Sierra Pt.	37.674	122.388	A	220	.110	.060	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	69.0	Bear Valley Sta 7	36.483	121.180	A		.040	.060	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	72.6	San Fran.: Fire Station 17	37.728	122.385	A		.110	.070	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	75.9	San Fran.: Diamond Heights	37.740	122.433	A	216	.120	.100	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	77.2	Piedmont Jr High Schl	37.823	122.233	A	212	.080	.070	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	78.5	San Fran.: Rincon Hill	37.786	122.391	A	213	.090	.080	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	79.5	Yerba Buena Island	37.807	122.361	A		.060	.030	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	80.5	San Fran.: Pacific Heights	37.790	122.429	A	214	.050	.060	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	0.0	Corralitos	37.046	121.803	B	130	.500	.640	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	8.6	Capitola	36.974	121.952	B	219	.470	.540	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	10.9	Gavilon College Geol Bldg	36.973	121.568	B		.370	.330	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	11.7	Saratoga	37.255	122.031	B		.340	.530	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	12.0	Saratoga: West Valley Coll.	37.262	122.009	B		.330	.260	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	12.3	Gilroy: Old Firehouse	37.009	121.569	B		.250	.280	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	12.5	Santa Cruz	37.001	122.060	B	225	.440	.470	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	13.2	San Jose: Santa Teresa Hills	37.210	121.803	B		.280	.270	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	19.9	Gilroy Array 6	37.026	121.484	B	196	.170	.130	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	20.0	Anderson Dam	37.166	121.628	B	142	.250	.260	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	21.7	Coyote Lake Dam: Downstream	37.124	121.551	B		.190	.170	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	29.3	Halls Valley	37.338	121.714	B		.110	.130	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	36.1	Calaveras Reservoir South	37.452	121.807	B	143	.130	.080	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	38.7	Woodside	37.429	122.258	B	132	.080	.080	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	42.0	Mission San Jose	37.530	121.919	B	224	.110	.130	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	46.4	APEEL Array Sta 9	37.478	122.321	B	1	.110	.120	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	46.5	APEEL Array Sta 7	37.484	122.313	B	164	.090	.160	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	46.6	APEEL Array Sta 10	37.465	122.343	B	12	.090	.100	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	48.7	Belmont	37.512	122.308	B	210	.100	.110	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	49.9	Sunol Fire Station	37.597	121.880	B	141	.070	.100	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	53.0	Lower Crystal Springs Dam	37.529	122.361	B		.060	.090	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	53.7	Bear Valley Sta 5	36.673	121.195	B	145	.070	.070	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	56.0	APEEL Array Sta 3E	37.657	122.061	B	158	.080	.080	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	57.7	Hayward: BART Station FF	37.670	122.086	B		.160	.160	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	58.7	Hayward City Hall: N. FF	37.679	122.082	B	137	.060	.060	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	77.6	Big Sur State Park	36.255	121.782	B		.050	.060	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	12.1	Gilroy Array 2	36.982	121.556	C	193	.330	.370	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	14.0	Gilroy Array 3	36.987	121.536	C	194	.370	.550	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	15.8	Gilroy Array 4	37.005	121.522	C	195	.220	.420	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	24.3	Gilroy Array 7	37.033	121.434	C	131	.330	.230	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	25.4	Hollister: Airport	36.888	121.413	C	147	.290	.270	USGS: OFR 89-568

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18-Oct-89	Loma Prieta	6.92	27.0	Agnew	37.397	121.952	C	221	.160	.170	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	27.5	Sunnyvale	37.402	122.024	C	136	.220	.190	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	27.8	Hollister: City Hall Annex	36.851	121.402	C		.230	.250	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	31.4	Milpitas	37.430	121.897	C		.100	.140	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	31.4	Salinas	36.671	121.642	C		.120	.090	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	34.8	Palo Alto: 2-Story Office Bl	37.453	122.112	C	128	.200	.210	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	35.0	Stanford: SLAC Test Lab	37.419	122.205	C	134	.290	.190	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	42.4	Fremont	37.535	121.929	C	140	.150	.200	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	50.9	Bear Valley Sta 12	36.658	121.249	C	144	.170	.160	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	56.3	APEEL Array Sta 2E	37.657	122.083	C	150	.140	.180	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	61.6	Dublin Fire Station	37.709	121.932	C		.080	.090	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	63.2	San Fran.: Airport	37.622	122.398	C	123	.330	.240	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	67.3	Bear Valley Sta 10	36.532	121.143	C	146	.100	.130	USGS: OFR 89-568
18-Oct-89	Loma Prieta	6.92	68.8	Livermore: Fagundes Ranch	37.753	121.772	C		.040	.040	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	75.2	Alameda: Naval Air Station	37.785	122.303	C	119	.260	.200	NCEL: Lew2
18-Oct-89	Loma Prieta	6.92	76.3	Oakland: 2-Story Office Bldg	37.806	122.267	C	133	.200	.260	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	78.6	Los Banos	37.106	120.825	C		.050	.050	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	78.8	Oakland: Outer Harbor Wharf	37.816	122.314	C	122	.290	.270	CDMG: OSMS 89-06
18-Oct-89	Loma Prieta	6.92	80.5	Greenfield	36.321	121.243	C		.080	.080	CDMG: OSMS 89-06
25-Apr-92	Petrolia	7.10	0.0	Petrolia	40.324	124.286	B		.690	.620	CDMG: OSMS 92-05
25-Apr-92	Petrolia	7.10	1.9	Bunker Hill FAA Site	40.498	124.294	B		.210	.180	USGS: Porcella
25-Apr-92	Petrolia	7.10	9.8	Centerville Beach	40.563	124.348	B		.480	.320	USGS: Porcella
25-Apr-92	Petrolia	7.10	12.3	Rio Dell	40.503	124.100	B		.390	.550	CDMG: OSMS 92-05
25-Apr-92	Petrolia	7.10	13.7	Fortuna: supermarket FF	40.584	124.145	B		.120	.120	CDMG: OSMS 92-05
25-Apr-92	Petrolia	7.10	14.6	Fortuna: Fire Station	40.599	124.154	B		.280	.320	USGS: Porcella
25-Apr-92	Petrolia	7.10	17.6	Loleta Fire Station	40.644	124.219	B		.260	.260	USGS: Porcella
25-Apr-92	Petrolia	7.10	23.9	Coll. of the Redwoods	40.699	124.200	B		.180	.140	USGS: Porcella
25-Apr-92	Petrolia	7.10	27.8	South Bay Union School	40.735	124.207	B		.200	.150	USGS: Porcella
25-Apr-92	Petrolia	7.10	32.6	Shelter Cove	40.026	124.069	B		.180	.240	CDMG: OSMS 92-05
25-Apr-92	Petrolia	7.10	35.8	Eureka: Apartment Bldg FF	40.801	124.148	B		.170	.160	CDMG: OSMS 92-05
25-Apr-92	Petrolia	7.10	10.0	Ferndale Fire Station	40.576	124.262	C		.300	.370	USGS: Porcella
28-Jun-92	Landers	7.30	2.1	Upper Johnson Valley	34.568	116.612	A		.880	.630	SCE
28-Jun-92	Landers	7.30	27.6	Whitewater Cyn	33.989	116.655	A		.120	.120	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	37.6	Snow Creek	33.888	116.684	A		.060	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	41.9	Twentynine Palms	34.021	116.009	A		.090	.070	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	51.3	Silent Valley (Poppet Flat)	33.851	116.852	A		.060	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	56.2	Keenwild	33.707	116.716	A	208	.030	.030	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	60.1	Lake Cahuilla	33.628	116.280	A		.050	.060	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	60.8	Pinyon Flat Observatory	33.607	116.453	A		.040	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	68.2	Tripp Flats	33.602	116.755	A		.042	.053	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	68.3	Amboy	34.560	115.743	A		.150	.120	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	69.7	Red Montain	33.630	116.847	A		.060	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	70.2	Anza Fire Station	33.555	116.673	A		.030	.020	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	78.0	Winchester: Hidden Valley	33.681	117.056	A		.030	.040	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	78.7	Sage	33.580	116.931	A		.140	.130	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	83.7	Winchester: Bergman Ranch	33.640	117.094	A		.050	.060	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	86.0	Mills Filter Plant	33.920	117.320	A		.040	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	89.0	Chihuahua Valley	33.382	116.690	A		.030	.030	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	89.4	Murrieta Hot Spr	33.599	117.132	A		.040	.040	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	89.4	Hinds Pumping Plant	33.709	115.628	A		.050	.040	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	93.3	Palmdale: Black Butte	34.586	117.728	A		.040	.040	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	95.9	Riverside: Santa Ana R. Brdg	33.968	117.447	A		.050	.030	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	97.4	Palomar Mtn	33.353	116.862	A		.020	.020	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	97.6	Rancho Cucamonga: Deer Cyn.	34.169	117.579	A		.080	.080	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	99.4	Wrightwood: Jackson Flat	34.381	117.737	A		.040	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	100.1	Mt. Baldy	34.233	117.661	A		.050	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	104.8	Paradise Springs Camp	34.397	117.805	A		.030	.030	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	112.2	Pearblossom: Pallet Creek	34.458	117.909	A		.040	.060	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	117.9	Littlerock: Brainard Canyon	34.486	117.980	A		.030	.040	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	11.3	Joshua Tree	34.131	116.314	B		.290	.280	CDMG: OSMS 92-07

28-Jun-92	Landers	7.30	17.7	Morongo Valley: MVB	34.049	116.576	B		.207	.188	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	22.5	Desert Hot Springs	33.962	116.509	B		.170	.150	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	22.8	Coolwater Generating Station	34.852	116.858	B		.430	.280	SCE
28-Jun-92	Landers	7.30	25.8	Fun Valley	33.925	116.389	B		.220	.220	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	27.7	North Palm Springs	33.924	116.547	B		.136	.134	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	27.8	Mission Creek Fault	33.905	116.419	B		.137	.087	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	37.7	Barstow	34.887	117.047	B		.150	.140	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	45.4	Big Bear Lake - Civic Cntr G	34.238	116.935	B		.180	.170	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	45.4	Forest Falls	34.088	116.919	B		.100	.120	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	57.0	Mill Creek	34.080	117.044	B		.130	.140	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	57.8	Hurkey Creek Park	33.676	116.680	B		.040	.060	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	59.5	Cranston Forest Sta Garage	33.738	116.838	B		.050	.070	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	61.7	San Jacinto Tunnel	33.821	116.967	B		.070	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	62.4	Garner Valley	33.616	116.627	B		.080	.090	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	62.6	Hesperia	34.405	117.311	B		.060	.060	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	64.1	Mentone	34.068	117.120	B		.080	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	65.0	Fort Irwin	35.268	116.684	B		.120	.110	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	65.6	Pine Meadow Ranch	33.578	116.589	B		.050	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	66.9	San Bern.: E. Highlands Plnt	34.122	117.158	B		.060	.060	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	71.9	Highland	34.136	117.213	B		.080	.090	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	74.8	Reche Canyon	34.004	117.223	B		.040	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	76.0	San Bern.: N. F St.	34.183	117.295	B		.120	.120	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	76.1	Loma Linda: North FF	34.051	117.248	B		.080	.090	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	77.5	Phelan	34.467	117.520	B		.100	.090	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	79.0	Cahuilla Valley	33.512	116.800	B		.050	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	79.4	Tule Canyon	33.461	116.642	B		.050	.030	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	80.6	Devore Water Dept.	34.235	117.407	B		.060	.060	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	81.2	San Bern.: S. B. Valley Coll	34.086	117.309	B		.100	.110	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	83.7	Colton: 1-story gym	34.072	117.335	B		.060		CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	84.7	San Bern.: Rialto F. S.	34.134	117.368	B		.060	.060	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	85.7	Lytle Creek	34.251	117.490	B		.080	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	86.4	Wrightwood: Nielson Ranch	34.314	117.545	B		.080	.090	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	88.3	Baker	35.272	116.066	B		.110	.110	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	89.6	Rancho de Anza	33.348	116.400	B		.070	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	92.4	Boron	35.002	117.650	B		.090	.130	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	93.1	Wrightwood: Swarthout Valley	34.369	117.658	B	88	.080	.120	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	95.0	Puerta La Cruz	33.324	116.683	B		.050	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	96.2	Riverside Airport	33.951	117.446	B		.040	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	99.2	Etiwanda	34.091	117.527	B		.100	.050	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	101.7	Rancho Cucamonga: Law Cntr	34.104	117.574	B		.120	.070	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	105.7	San Antonio Dam	34.156	117.675	B		.040	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	107.4	Valyermo	34.444	117.851	B		.080	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	116.1	Weymouth Filtr Plnt	34.115	117.778	B		.070	.050	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	118.2	Littlerock: Post Office	34.522	117.991	B	77	.060	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	26.3	Yermo	34.903	116.823	C		.250	.150	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	36.7	Palm Springs	33.829	116.501	C		.090	.090	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	37.7	Thousand Palms	33.817	116.390	C		.120	.100	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	49.6	Indio: Jackson Road	33.746	116.215	C		.130	.290	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	52.6	Indio: Fairgrounds	33.715	116.221	C		.100	.080	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	54.9	Indio - Coachella Canal	33.717	116.156	C		.120	.100	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	65.5	San Jacinto: Valley Cemetary	33.760	116.960	C		.050	.050	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	66.8	Hemet City Library	33.748	116.966	C		.050	.070	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	69.1	Hemet Fire Station	33.729	116.979	C		.100	.090	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	72.6	Mecca Fire Station	33.572	116.076	C		.090	.070	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	72.7	Redlands	34.066	117.214	C		.120	.100	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	77.5	Mecca - CVWD	33.564	115.987	C		.120	.120	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	79.0	San Bern.: Cnty Gov. Cntr FF	34.106	117.287	C		.060	.070	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	79.6	San Bern.: 1-story commrcl b	34.098	117.293	C		.220	.110	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	79.9	San Bern.: E & Hospitality	34.065	117.292	C		.090	.080	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	86.8	Salton Sea: Park Hq (N. Shor	33.504	115.913	C		.140	.110	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	87.3	Desert Shores	33.426	116.078	C		.050	.050	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	98.7	Temecula	33.496	117.149	C		.080	.070	CDMG: OSMS 92-07
28-Jun-92	Landers	7.30	98.7	Durmid	33.421	115.831	C		.060	.100	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	105.6	Salton City	33.280	115.984	C		.130	.150	CDMG: OSMS 92-09
28-Jun-92	Landers	7.30	106.2	Borrego Springs: Clinic	33.202	116.326	C		.040	.030	USGS: OFR 93-xxx

28-Jun-92	Landers	7.30	115.3	Prado Dam	33.888	117.640	C	.090	.080	USGS: OFR 93-xxx
28-Jun-92	Landers	7.30	117.6	Pomona	34.056	117.748	C	.050	.070	CDMG: OSMS 92-07

Expanded References for Table 4:

ShortRef	LongRef
CDMG: OSMS 89-06	Shakal et al. (1989)
CDMG: OSMS 92-05	Shakal et al. (1992a)
CDMG: OSMS 92-07	Calif. Div. Mines and Geology (1992)
CDMG: OSMS 92-09	Shakal et al. (1992b)
CDMG: OSMS PR 22	Porter (1978)
CDMG: OSMS PR 26	McJunkin and Ragsdale (1980a)
CDMG: OSMS PR 28	McJunkin and Ragsdale (1980b)
CIT: EERL 76-02	Calif. Inst. of Technology (1976)
NCEL: Lew2	T. K. Lew (1990)
SCE	S. Cal. Edison memorandom dated July 30, 1992, from T. A. Kelly
USDC: USEQ72	U. S. Dept. of Commerce (1974)
USGS+CDMG	PGA_H1 from USGS: Circ. 914; the others are from CDMG: OSMS PR 28.
USGS: A	horiz. from USGS: OFR 79-1654; vert. scaled by R. L. Porcella
USGS: Brady	A. G. Brady (U.S. Geological Survey, written commun., 1977)
USGS: Circ. 713	U.S. Geological Survey (1974)
USGS: Circ. 717-A	U.S. Geological Survey (1975)
USGS: Circ. 818-A	U.S. Geological Survey (1979)
USGS: Circ. 854-B	U.S. Geological Survey (1980a)
USGS: Circ. 854-C	U.S. Geological Survey (1980b)
USGS: Circ. 914	U.S. Geological Survey (1981)
USGS: OFR 79-1654	Porcella and Matthiesen (1979)
USGS: OFR 79-385	PGA_H1 provided by R. L. Porcella (written commun.); other values in Porcella et al. (1979)
USGS: OFR 89-568	Maley et al. (1989)
USGS: OFR 93-xxx	Etheredge et al. (1993)
USGS: PP 1254	Brune et al. (1982)
USGS: Porcella	R. L. Porcella (U.S. Geological Survey, written commun, various years)

Table 5. Records used in the development of the equations for response spectra.

DATE	EARTHQUAKE	M	DIST	STATION	LAT.	LONG.	G	HOLE	SOURCE
19-May-40	Imperial Vall	7.00	12.0	El Centro Array Sta 9	32.794	115.549	C	107	n
21-Jul-52	Kern County	7.40	42.0	Taft	35.150	119.460	B	201	n
21-Jul-52	Kern County	7.40	85.0	Santa Barbara	34.420	119.700	B	96	n
21-Jul-52	Kern County	7.40	109.0	Pasadena - Athenaeum	34.140	118.120	B	92	n
21-Jul-52	Kern County	7.40	107.0	Hollywood Storage Bldg PE Lo	34.090	118.340	C	63	n
22-Mar-57	Daly City	5.30	8.0	San Fran.: Golden Gate Park	37.770	122.480	A	173	n
28-Jun-66	Parkfield	6.10	16.1	Cholame-Shandon: Temblor	35.710	120.170	B	200	n
28-Jun-66	Parkfield	6.10	17.3	Parkfield: Cholame 12W	35.639	120.404	B		n
28-Jun-66	Parkfield	6.10	6.6	Parkfield: Cholame 2	35.733	120.288	C	228	n
28-Jun-66	Parkfield	6.10	9.3	Parkfield: Cholame 5W	35.697	120.328	C	197	n
28-Jun-66	Parkfield	6.10	13.0	Parkfield: Cholame 8W	35.671	120.359	C	198	n
9-Apr-68	Borrego Mount	6.60	45.0	El Centro Array Sta 9	32.794	115.549	C	107	n
9-Feb-71	San Fernando	6.60	17.0	Lake Hughes Sta 12	34.570	118.560	B	86	n
9-Feb-71	San Fernando	6.60	25.7	Pasadena - Athenaeum	34.140	118.120	B	92	n
9-Feb-71	San Fernando	6.60	60.7	Wrightwood	34.360	117.630	B	88	n
9-Feb-71	San Fernando	6.60	19.6	Lake Hughes Sta 4	34.650	118.478	C	71	n
30-Jul-72	Sitka	7.70	45.0	Sitka	57.060	135.320	A		n
23-Dec-72	Managua	6.20	5.0	Managua: ESSO Refinery	12.145	86.322	C		n
28-Feb-79	St. Elias	7.60	25.4	Icy Bay	59.968	141.643	B		n
6-Aug-79	Coyote Lake	5.80	9.1	Gilroy Array 1	36.973	121.572	A	192	n
6-Aug-79	Coyote Lake	5.80	1.2	Gilroy Array 6	37.026	121.484	B	196	n
6-Aug-79	Coyote Lake	5.80	3.7	Gilroy Array 4	37.005	121.522	C	195	n
6-Aug-79	Coyote Lake	5.80	5.3	Gilroy Array 3	36.987	121.536	C	194	n
6-Aug-79	Coyote Lake	5.80	7.4	Gilroy Array 2	36.982	121.556	C	193	n
15-Oct-79	Imperial Vall	6.50	14.0	Parachute Test Site	32.929	115.699	B	116	n
15-Oct-79	Imperial Vall	6.50	26.0	Superstition Mtn	32.955	115.823	B		n
15-Oct-79	Imperial Vall	6.50	.6	El Centro Array Sta 7	32.829	115.504	C	105	n
15-Oct-79	Imperial Vall	6.50	1.3	El Centro Array Sta 6	32.839	115.487	C	104	n
15-Oct-79	Imperial Vall	6.50	2.6	Bonds Corner	32.693	115.338	C	97	n
15-Oct-79	Imperial Vall	6.50	3.8	El Centro Array Sta 8	32.810	115.530	C	106	n
15-Oct-79	Imperial Vall	6.50	4.0	El Centro Array Sta 5	32.855	115.466	C	103	n
15-Oct-79	Imperial Vall	6.50	5.1	El Centro: Differential Arra	32.796	115.535	C	112	n
15-Oct-79	Imperial Vall	6.50	6.8	El Centro Array Sta 4	32.864	115.432	C	102	n
15-Oct-79	Imperial Vall	6.50	7.5	Holtville	32.812	115.377	C	99	n

15-Oct-79	Imperial Vall	6.50	8.5	El Centro Array Sta 10	32.780	115.567	C	108	n
15-Oct-79	Imperial Vall	6.50	8.5	Brawley	32.991	115.512	C	114	n
15-Oct-79	Imperial Vall	6.50	10.6	Calexico	32.669	115.492	C		n
15-Oct-79	Imperial Vall	6.50	12.6	El Centro Array Sta 11	32.752	115.594	C	109	n
15-Oct-79	Imperial Vall	6.50	16.0	El Centro Array Sta 2	32.916	115.366	C	100	n
15-Oct-79	Imperial Vall	6.50	18.0	El Centro Array Station 12	32.718	115.637	C	110	n
15-Oct-79	Imperial Vall	6.50	22.0	El Centro Array Sta 1	32.960	115.319	C		n
15-Oct-79	Imperial Vall	6.50	22.0	El Centro Array Sta 13	32.709	115.683	C	111	n
15-Oct-79	Imperial Vall	6.50	23.0	Calipatria	33.130	115.520	C	117	n

18-Oct-89	Loma Prieta	6.92	10.5	Gilroy Array 1	36.973	121.572	A	192	c
18-Oct-89	Loma Prieta	6.92	29.9	Hollister - Sago Vault	36.765	121.446	A		u
18-Oct-89	Loma Prieta	6.92	32.5	Cherry Flat Reservoir	37.396	121.756	A		u
18-Oct-89	Loma Prieta	6.92	34.1	SAGO South A	36.753	121.396	A	211	c
18-Oct-89	Loma Prieta	6.92	42.7	Monterey City Hall	36.597	121.897	A	209	c
18-Oct-89	Loma Prieta	6.92	67.6	S. San Fran.: Sierra Pt.	37.674	122.388	A	220	c

18-Oct-89	Loma Prieta	6.92	0.0	Corralitos	37.046	121.803	B	130	c
18-Oct-89	Loma Prieta	6.92	8.6	Capitola	36.974	121.952	B	219	c
18-Oct-89	Loma Prieta	6.92	10.9	Gavilon College Geol Bldg	36.973	121.568	B		c
18-Oct-89	Loma Prieta	6.92	11.7	Saratoga	37.255	122.031	B		c
18-Oct-89	Loma Prieta	6.92	12.0	Saratoga: West Valley Coll.	37.262	122.009	B		c
18-Oct-89	Loma Prieta	6.92	12.3	Gilroy: Old Firehouse	37.009	121.569	B		c
18-Oct-89	Loma Prieta	6.92	12.5	Santa Cruz	37.001	122.060	B	225	c
18-Oct-89	Loma Prieta	6.92	13.2	San Jose: Santa Teresa Hills	37.210	121.803	B		c
18-Oct-89	Loma Prieta	6.92	19.9	Gilroy Array 6	37.026	121.484	B	196	c
18-Oct-89	Loma Prieta	6.92	20.0	Anderson Dam	37.166	121.628	B	142	u
18-Oct-89	Loma Prieta	6.92	21.7	Coyote Lake Dam: Downstream	37.124	121.551	B		c
18-Oct-89	Loma Prieta	6.92	29.3	Halls Valley	37.338	121.714	B		c
18-Oct-89	Loma Prieta	6.92	36.1	Calaveras Reservoir South	37.452	121.807	B	143	u
18-Oct-89	Loma Prieta	6.92	38.7	Woodside	37.429	122.258	B	132	c
18-Oct-89	Loma Prieta	6.92	42.0	Mission San Jose	37.530	121.919	B	224	c
18-Oct-89	Loma Prieta	6.92	46.4	APEEL Array Sta 9	37.478	122.321	B	1	u
18-Oct-89	Loma Prieta	6.92	46.5	APEEL Array Sta 7	37.484	122.313	B	164	c
18-Oct-89	Loma Prieta	6.92	46.6	APEEL Array Sta 10	37.465	122.343	B	12	c
18-Oct-89	Loma Prieta	6.92	48.7	Belmont	37.512	122.308	B	210	c
18-Oct-89	Loma Prieta	6.92	49.9	Sunol Fire Station	37.597	121.880	B	141	u
18-Oct-89	Loma Prieta	6.92	53.0	Lower Crystal Springs Dam	37.529	122.361	B		c
18-Oct-89	Loma Prieta	6.92	53.7	Bear Valley Sta 5	36.673	121.195	B	145	u
18-Oct-89	Loma Prieta	6.92	56.0	APEEL Array Sta 3E	37.657	122.061	B	158	c
18-Oct-89	Loma Prieta	6.92	57.7	Hayward: BART Station FF	37.670	122.086	B		c
18-Oct-89	Loma Prieta	6.92	58.7	Hayward City Hall: N. FF	37.679	122.082	B	137	u

18-Oct-89	Loma Prieta	6.92	12.1	Gilroy Array 2	36.982	121.556	C	193	c
18-Oct-89	Loma Prieta	6.92	14.0	Gilroy Array 3	36.987	121.536	C	194	c
18-Oct-89	Loma Prieta	6.92	15.8	Gilroy Array 4	37.005	121.522	C	195	c
18-Oct-89	Loma Prieta	6.92	24.3	Gilroy Array 7	37.033	121.434	C	131	c
18-Oct-89	Loma Prieta	6.92	25.4	Hollister: Airport	36.888	121.413	C	147	u
18-Oct-89	Loma Prieta	6.92	27.0	Agnew	37.397	121.952	C	221	c
18-Oct-89	Loma Prieta	6.92	27.5	Sunnyvale	37.402	122.024	C	136	u
18-Oct-89	Loma Prieta	6.92	27.8	Hollister: City Hall Annex	36.851	121.402	C		u
18-Oct-89	Loma Prieta	6.92	31.4	Milpitas	37.430	121.897	C		c
18-Oct-89	Loma Prieta	6.92	31.4	Salinas	36.671	121.642	C		c
18-Oct-89	Loma Prieta	6.92	34.8	Palo Alto: 2-Story Office Bl	37.453	122.112	C	128	c
18-Oct-89	Loma Prieta	6.92	35.0	Stanford: SLAC Test Lab	37.419	122.205	C	134	u
18-Oct-89	Loma Prieta	6.92	42.4	Fremont	37.535	121.929	C	140	u
18-Oct-89	Loma Prieta	6.92	50.9	Bear Valley Sta 12	36.658	121.249	C	144	u
18-Oct-89	Loma Prieta	6.92	56.3	APEEL Array Sta 2E	37.657	122.083	C	150	c
18-Oct-89	Loma Prieta	6.92	61.6	Dublin Fire Station	37.709	121.932	C		u
18-Oct-89	Loma Prieta	6.92	63.2	San Fran.: Airport	37.622	122.398	C	123	c
18-Oct-89	Loma Prieta	6.92	67.3	Bear Valley Sta 10	36.532	121.143	C	146	u

25-Apr-92	Petrolia	7.10	0.0	Cape Mendocino	40.348	124.352	B		c
25-Apr-92	Petrolia	7.10	0.0	Petrolia	40.324	124.286	B		c

25-Apr-92	Petrolia	7.10	12.3	Rio Dell•	40.503	124.100	B	c
25-Apr-92	Petrolia	7.10	13.7	Fortuna: supermarket FF	40.584	124.145	B	c
25-Apr-92	Petrolia	7.10	32.6	Shelter Cove	40.026	124.069	B	c
25-Apr-92	Petrolia	7.10	35.8	Eureka: Apartment Bldg FF	40.801	124.148	B	c
28-Jun-92	Landers	7.30	2.1	Upper Johnson Valley	34.568	116.612	A	s
28-Jun-92	Landers	7.30	41.9	Twentynine Palms	34.021	116.009	A	c
28-Jun-92	Landers	7.30	51.3	Silent Valley (Poppet Flat)	33.851	116.852	A	c
28-Jun-92	Landers	7.30	11.3	Joshua Tree	34.131	116.314	B	c
28-Jun-92	Landers	7.30	17.7	Morongo Valley: MVB	34.049	116.576	B	g
28-Jun-92	Landers	7.30	22.5	Desert Hot Springs	33.962	116.509	B	c
28-Jun-92	Landers	7.30	22.8	Coolwater Generating Station	34.852	116.858	B	s
28-Jun-92	Landers	7.30	27.7	North Palm Springs	33.924	116.547	B	g
28-Jun-92	Landers	7.30	27.8	Mission Creek Fault	33.905	116.419	B	g
28-Jun-92	Landers	7.30	37.7	Barstow	34.887	117.047	B	c
28-Jun-92	Landers	7.30	65.0	Fort Irwin	35.268	116.684	B	c
28-Jun-92	Landers	7.30	26.3	Yermo	34.903	116.823	C	c
28-Jun-92	Landers	7.30	36.7	Palm Springs	33.829	116.501	C	c
28-Jun-92	Landers	7.30	54.9	Indio - Coachella Canal	33.717	116.156	C	c

Footnotes for Table 5:

CODE	REFERENCE
c	Response spectra from the California Strong-Motion Instrumentation Program.
g	Response spectra computed from digital uncorrected acceleration time series recorded on temporary deployments of GEOS instruments; data provided by S. Hough.
n	Response spectra from tapes distributed by the World Data Center A for Solid Earth Geophysics, National Geophysical Data Center, Boulder, Colorado; primary data providers are the U.S. Geological Survey and the California Strong-Motion Instrumentation Program.
s	Response spectra computed from digital uncorrected acceleration time series provided by Dennis Ostrom of the Southern California Edison Company.
u	Response spectra from U. S. Geological Survey computer files, provided by P. Mork.

Table 6: Borehole Information (AvgVel in m/s).

HOLE#	SITE NAME	LAT.	LONG.	AVGVEL	COMMENTS	REFERENCE
1	Pulgas Water Temple (APEEL #9 ?)	37.478	122.322	454	tt extrapolated 1.9m	Gibbs et al. (1975)
12	Pise Lookout (APEEL #10)	37.461	122.343	401	tt extrapolated 2.2m	Gibbs et al. (1975)
29	Upper Van Norman Dam	34.314	118.491	282	tt extrapolated 3.7m	Gibbs et al. (1980)
63	Hollywood Storage	34.087	118.338	318	no tt extrapolation	Fumal et al. (1982b)
71	Camp Munz	34.652	118.480	351	tt extrapolated 3.5m	Fumal et al. (1982b)
73	Lake Hughes Fire Station	34.665	118.429	424	tt extrapolated 3m	Fumal et al. (1982b)
77	Littlerock P.O.	34.521	117.981	455	tt extrapolation 2m	Fumal et al. (1982b)
78	Pearblossom Pump Plant	34.510	117.922	520	tt extrapolation 5m	Fumal et al. (1982b)
79	Palmdale Holiday Inn	34.581	118.123	561	no tt extrapolation	Fumal et al. (1982b)
80	Palmdale Fire Station	34.575	118.102	448	no tt extrapolation	Fumal et al. (1982b)
81	Wheeler Ridge	35.026	118.992	347	no tt extrapolation; long. in OFR off by 1 deg.	Fumal et al. (1984)
82	Edmonston Pump Plant	34.941	118.824	674	tt extrapolation 0.5m	Fumal et al. (1984)
83	Fort Tejon	34.871	118.898	397	no tt extrapolation	Fumal et al. (1984)
84	Oso Pumping Plant	34.811	118.721	309	tt extrapolated 3m	Fumal et al. (1984)
86	Elizabeth Lake Fire Station	34.571	118.560	600	no tt extrapolation	Fumal et al. (1984)
87	Warm Springs Camp	34.608	118.558	882	tt extrapolated 9m	Fumal et al. (1984)
88	Wrightwood	34.361	117.633	482	no tt extrapolation	Fumal et al. (1984)
89	Allen Ranch	34.277	117.334	811	tt extrapolated 7.5m	Fumal et al. (1984)
90	Cedar Springs Dam	34.308	117.315	480	no tt extrapolation	Fumal et al. (1984)
92	Caltech Athenaeum	34.136	118.121	417	tt extrapolated 6m	Fumal et al. (1984)
93	Caltech Old Seismo Lab	34.148	118.171	984	tt extrapolated 5m	Fumal et al. (1984)
94	Griffith Observatory	34.120	118.299	789	tt extrapolated 7m	Fumal et al. (1984)
95	Palos Verdes	33.800	118.388	302	assumed 1000m/s for last 3.5m	Fumal et al. (1984)
96	Santa Barbara Court House	34.424	119.701	508	tt extrapolated 6m	Fumal et al. (1984)
97	Bonds Corner	32.693	115.338	224		Porcella (1984)
99	Holtville P.O.	32.812	115.377	201		Porcella (1984)
100	El Centro Array 2	32.916	115.366	190		Porcella (1984)
101	El Centro Array 3	32.894	115.380	165		Porcella (1984)
102	El Centro Array 4	32.864	115.432	211		Porcella (1984)
103	El Centro Array 5	32.855	115.466	207		Porcella (1984)
104	El Centro Array 6	32.839	115.487	201		Porcella (1984)
105	El Centro Array 7	32.829	115.504	211		Porcella (1984)
106	El Centro Array 8	32.811	115.532	205		Porcella (1984)
107	El Centro Array 9	32.794	115.549	213		Porcella (1984)
108	El Centro Array 10	32.780	115.567	203		Porcella (1984)
109	El Centro Array 11	32.752	115.594	196		Porcella (1984)
110	El Centro Array 12	32.718	115.637	210	tt extrapolated 2.5m	Porcella (1984)
111	El Centro Array 13	32.709	115.683	252		Porcella (1984)
112	El Centro Differential Array	32.796	115.535	200		Porcella (1984)
113	Imperial County Services Bldg	32.793	115.564	189		Porcella (1984)
114	Brawley Airport	32.988	115.509	210		Porcella (1984)
115	Westmorland Fire Station	33.037	115.623	195		Porcella (1984)
116	Parachute Test Site	32.930	115.700	370	tt extrapolated 1.3m	Porcella (1984)
117	Calipatria Fire Station	33.130	115.520	197	tt extrapolated 5.9m	Porcella (1984)
118	Salton Sea Wildlife Refuge	33.180	115.620	169	tt extrapolated 2.3m	Porcella (1984)
119	Alameda Naval Air Station	37.785	122.308	191		Gibbs et al. (1992)
122	Oakland Outer Harbor Wharf	37.813	122.318	251		Gibbs et al. (1992)
123	San Francisco Airport	37.622	122.398	224		Gibbs et al. (1992)
124	Treasure Island	37.826	122.373	171		Gibbs et al. (1992)
128	Palo Alto 2 story	37.454	122.112	207		J.F. Gibbs, written comm., 1993
129	Presidio	37.791	122.458	594		J.F. Gibbs, written comm., 1993
130	Corralitos	37.046	121.804	460		J.F. Gibbs, written comm., 1993
131	Gilroy #7	37.649	121.434	333		J.F. Gibbs, written comm., 1993
132	Woodside	37.429	122.255	455		J.F. Gibbs, written comm., 1993
133	Oakland 2-story	37.807	122.263	315		J.F. Gibbs, written comm., 1993
134	SLAC 2	37.420	122.201	344		J.F. Gibbs, written comm., 1993
136	Sunnyvale	37.403	122.025	268		J.F. Gibbs, written comm., 1993
137	Hayward City Hall	37.681	122.081	743		J.F. Gibbs, written comm., 1993
139	Emeryville	37.841	122.295	196		J.F. Gibbs, written comm., 1993
140	Fremont	37.535	121.930	283		J.F. Gibbs, written comm., 1993
141	Sunol	37.597	121.880	405		J.F. Gibbs, written comm., 1993

142	Anderson Dam	37.164	121.631	506		J.F. Gibbs, written comm., 1993
143	Calaveras Reservoir	37.453	121.807	482		J.F. Gibbs, written comm., 1993
144	Bear Valley #12 (Williams Ranch)	36.664	121.249	330		J.F. Gibbs, written comm., 1993
145	Bear Valley #5 (Callens Ranch)	36.673	121.195	391		J.F. Gibbs, written comm., 1993
146	Bear Valley #10 (Webb Ranch)	36.531	121.144	311		J.F. Gibbs, written comm., 1993
147	Hollister Airport	36.889	121.411	218		J.F. Gibbs, written comm., 1993
150	John Muir School (APEEL #2E ?)	37.656	122.084	276	tt extrapolated 0.7m	Gibbs et al. (1976)
158	Cal State Hayward	37.657	122.060	522	tt extrapolated 4.4m	Gibbs et al. (1976)
164	Pulgas Tunnel (APEEL #7 ?)	37.486	122.314	435	no tt extrapolation	Gibbs et al. (1976)
170	Bridgeway Park	37.529	122.253	134	tt extrapolated 0.4m	Gibbs et al. (1977)
173	Prayerbook Cross	37.774	122.477	732	tt extrapolated 11m	Gibbs et al. (1977)
182	KGEI (APEEL #1)	37.544	122.235	115	tt extrapolated 1.2m	Gibbs et al. (1977)
190	Audubon School	37.568	122.258	133	tt extrapolated 2.5m	Gibbs et al. (1977)
192	Gavilon Water Tank (Gilroy #1)	36.974	121.572	1415	tt extrapolated 10.7m	Fumal et al. (1982a)
193	Mission Trails Motel (Gilroy #2)	36.981	121.554	309	no tt extrapolation	Fumal et al. (1982a)
194	Gilroy Sewage Trtmnt (Gilroy #3)	36.986	121.536	306	no tt extrapolation	Fumal et al. (1982a)
195	San Ysidro School (Gilroy #4)	37.000	121.521	223	tt extrapolated 0.4m	Fumal et al. (1982a)
196	Canada Road (Gilroy #6)	37.027	121.485	714	tt extrapolated 2.5m; basis for extrapolation not well	Fumal et al. (1982a)
197	Cockrum's Garage (Cholame-Shndn 5)	35.696	120.328	278	no tt extrapolation	Fumal et al. (1982a)
198	Shandon Pump Station (Cholame 8)	35.671	120.358	260	tt extrapolated 1.7m	Fumal et al. (1982a)
200	Temblor II	35.708	120.171	509	tt extrapolated 2.3m	Fumal et al. (1982a)
201	Lincoln School (Taft)	35.149	119.456	429	no tt extrapolation	Fumal et al. (1982a)
208	Keenwild	33.714	116.711	811	hole is 391m N212E of the coords above	Fletcher et al. (1990); Aster and Shearer (1991a, 1991b)
209	Monterey	36.597	121.897	769	extrpltd 10.4m to bottom (need 10.4m of slower 921 m/s	EPRI/CUREE
210	Belmont	37.512	122.308	645	no tt extrapolation	EPRI/CUREE
211	Sago South (Hollister Hills)	36.753	121.396		a range of velocities given, corresp. to 71 and 31 msec	EPRI/CUREE
212	Piedmont Jr. High School	37.823	122.233	1224	extrpltd 4.9m top,4m bottom (nd 4.9m of 250m/s for 750m	EPRI/CUREE
213	San Francisco, Rincon Hill	37.786	122.391	1154	extrpltd 2.7 m to surf, 5.5m to dpth (nd 2.7m of 165m/s	EPRI/CUREE
214	San Francisco, Pacific Heights	37.790	122.429	1429	no tt extrapolation	EPRI/CUREE
216	San Francisco, Diamond Heights	37.740	122.433	1034	used shallow vel. to fill in gap from 10m to 14m, so Av	EPRI/CUREE
217	Point Bonita	37.820	122.520	1875	tt extrapolated 2m to surface (need 2m of 84m/s to give	EPRI/CUREE
219	Capitola	36.974	121.952	484	tt extrapolated 1.8m to surface (need 73m/s to reduce a	EPRI/CUREE
220	So. San Francisco, Sierra Point	37.674	122.388	1071	tt extrpltd 4m to surf (need 4m of 233 m/s to lower avg	EPRI/CUREE
221	Agnews Hospital	37.397	121.952	270	no tt extrapolation	EPRI/CUREE
224	Mission San Jose	37.530	121.919	405	no tt extrapolation	EPRI/CUREE
225	Santa Cruz	37.001	122.060	698	tt extrapolated 16m to depth (need over 20,000 m/s to g	EPRI/CUREE
228	Parkfield #2	35.733	120.288	194	tt based on velocity vrs depth plot	R. E. Warrick, written comm.

Note: AVGVEL = 30m divided by the travel time to 30m; units are m/s.

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Table 7a. Smoothed coefficients of equations for the random horizontal component of 2 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.797	.341	-.118	.00000	-.951	.020	.106	6.60	.205	.087	.223	.006	.223
.11	1.874	.337	-.120	.00000	-.957	.047	.129	7.09	.202	.092	.222	.006	.222
.12	1.934	.335	-.120	.00000	-.959	.070	.149	7.43	.199	.096	.221	.007	.221
.13	1.980	.334	-.119	.00000	-.960	.090	.167	7.65	.197	.100	.221	.008	.221
.14	2.016	.333	-.118	.00000	-.959	.108	.184	7.79	.196	.103	.221	.009	.222
.15	2.044	.333	-.116	.00000	-.957	.123	.200	7.86	.194	.106	.221	.010	.221
.16	2.065	.334	-.114	.00000	-.954	.137	.214	7.88	.193	.109	.222	.011	.222
.17	2.082	.335	-.111	.00000	-.950	.149	.228	7.86	.193	.111	.223	.013	.223
.18	2.094	.336	-.109	.00000	-.946	.160	.241	7.81	.192	.113	.223	.015	.223
.19	2.103	.337	-.106	.00000	-.942	.169	.252	7.74	.192	.115	.224	.016	.224
.20	2.108	.339	-.104	.00000	-.937	.178	.264	7.65	.192	.116	.224	.018	.225
.22	2.114	.342	-.098	.00000	-.927	.194	.284	7.43	.191	.119	.225	.021	.226
.24	2.112	.345	-.093	.00000	-.918	.207	.302	7.18	.191	.122	.227	.025	.228
.26	2.107	.349	-.087	.00000	-.908	.218	.319	6.91	.192	.124	.229	.028	.230
.28	2.098	.353	-.082	.00000	-.898	.227	.334	6.64	.192	.126	.230	.032	.232
.30	2.087	.357	-.077	.00000	-.889	.235	.348	6.37	.193	.128	.232	.035	.234
.32	2.074	.361	-.073	.00000	-.880	.243	.360	6.10	.193	.129	.232	.038	.235
.34	2.061	.364	-.068	.00000	-.871	.249	.372	5.84	.194	.130	.234	.041	.237
.36	2.047	.368	-.064	.00000	-.863	.255	.382	5.59	.195	.131	.235	.044	.239
.38	2.032	.372	-.060	.00000	-.855	.260	.392	5.36	.195	.132	.235	.047	.240
.40	2.018	.375	-.056	.00000	-.847	.264	.401	5.13	.196	.133	.237	.050	.242
.42	2.004	.379	-.053	.00000	-.840	.269	.410	4.92	.197	.134	.238	.052	.244
.44	1.989	.382	-.049	.00000	-.834	.273	.418	4.72	.197	.135	.239	.055	.245
.46	1.976	.385	-.046	.00000	-.827	.276	.425	4.53	.198	.136	.240	.058	.247
.48	1.962	.388	-.043	.00000	-.821	.279	.432	4.35	.199	.137	.242	.060	.249
.50	1.949	.391	-.040	.00000	-.816	.282	.438	4.18	.199	.137	.242	.062	.249
.55	1.918	.399	-.034	.00000	-.803	.289	.453	3.82	.201	.139	.244	.068	.254
.60	1.889	.405	-.029	.00000	-.792	.295	.465	3.51	.203	.140	.247	.073	.257
.65	1.864	.412	-.024	.00000	-.782	.300	.476	3.27	.204	.141	.248	.078	.260
.70	1.841	.417	-.020	.00000	-.774	.304	.486	3.07	.205	.142	.249	.082	.263
.75	1.820	.423	-.017	.00000	-.768	.308	.494	2.92	.206	.143	.251	.086	.265
.80	1.802	.427	-.014	.00000	-.762	.312	.501	2.82	.208	.144	.253	.090	.269
.85	1.787	.432	-.012	.00000	-.758	.315	.508	2.75	.209	.145	.254	.094	.271
.90	1.773	.436	-.010	.00000	-.754	.318	.513	2.72	.209	.145	.254	.097	.272
.95	1.762	.440	-.009	.00000	-.751	.321	.518	2.71	.210	.146	.256	.100	.275
1.00	1.752	.444	-.008	.00000	-.749	.324	.523	2.74	.211	.147	.257	.103	.277
1.10	1.737	.450	-.007	.00000	-.747	.330	.530	2.86	.212	.148	.259	.109	.281
1.20	1.729	.456	-.007	.00000	-.746	.335	.535	3.06	.213	.149	.260	.113	.283
1.30	1.725	.461	-.008	.00000	-.748	.339	.540	3.34	.214	.151	.262	.118	.287
1.40	1.726	.465	-.010	.00000	-.751	.344	.543	3.67	.215	.152	.263	.121	.290
1.50	1.731	.469	-.013	.00000	-.756	.349	.545	4.05	.215	.153	.264	.125	.292
1.60	1.739	.472	-.016	.00000	-.762	.353	.546	4.47	.215	.154	.264	.128	.294
1.70	1.749	.474	-.019	.00000	-.768	.358	.547	4.93	.216	.155	.266	.131	.296
1.80	1.763	.477	-.023	.00000	-.776	.362	.547	5.42	.216	.156	.266	.133	.298
1.90	1.778	.479	-.027	.00000	-.784	.366	.547	5.93	.216	.157	.267	.135	.299
2.00	1.796	.480	-.032	.00000	-.793	.371	.546	6.47	.216	.158	.268	.138	.301

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

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Table 7b. Smoothed coefficients of equations for the random horizontal component of 5 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.653	.327	-.098	.00000	-.934	.046	.136	6.27	.191	.083	.208	.003	.208
.11	1.725	.318	-.100	.00000	-.937	.071	.156	6.65	.189	.087	.208	.005	.208
.12	1.782	.313	-.101	.00000	-.939	.093	.174	6.91	.187	.091	.208	.008	.208
.13	1.828	.309	-.101	.00000	-.939	.111	.191	7.08	.186	.094	.208	.010	.209
.14	1.864	.307	-.100	.00000	-.938	.127	.206	7.18	.185	.097	.209	.012	.209
.15	1.892	.305	-.099	.00000	-.937	.140	.221	7.23	.185	.100	.210	.015	.211
.16	1.915	.305	-.098	.00000	-.935	.153	.234	7.24	.184	.102	.210	.017	.211
.17	1.933	.305	-.096	.00000	-.933	.163	.246	7.21	.184	.104	.211	.019	.212
.18	1.948	.306	-.094	.00000	-.930	.173	.258	7.16	.184	.106	.212	.021	.213
.19	1.959	.308	-.092	.00000	-.927	.182	.269	7.10	.184	.108	.213	.023	.215
.20	1.967	.309	-.090	.00000	-.924	.190	.279	7.02	.184	.109	.214	.025	.215
.22	1.978	.313	-.086	.00000	-.918	.203	.297	6.83	.185	.112	.216	.029	.218
.24	1.982	.318	-.082	.00000	-.912	.214	.314	6.62	.185	.114	.217	.033	.220
.26	1.982	.323	-.078	.00000	-.906	.224	.329	6.39	.186	.116	.219	.036	.222
.28	1.979	.329	-.073	.00000	-.899	.232	.343	6.17	.187	.118	.221	.040	.225
.30	1.974	.334	-.070	.00000	-.893	.239	.356	5.94	.187	.120	.222	.043	.226
.32	1.967	.340	-.066	.00000	-.888	.245	.367	5.72	.188	.121	.224	.046	.228
.34	1.959	.345	-.062	.00000	-.882	.251	.378	5.50	.189	.122	.225	.048	.230
.36	1.950	.350	-.059	.00000	-.877	.256	.387	5.30	.190	.123	.226	.051	.232
.38	1.940	.356	-.055	.00000	-.872	.260	.396	5.10	.191	.125	.228	.054	.235
.40	1.930	.361	-.052	.00000	-.867	.264	.405	4.91	.192	.125	.229	.056	.236
.42	1.920	.365	-.049	.00000	-.862	.267	.413	4.74	.193	.126	.230	.058	.238
.44	1.910	.370	-.047	.00000	-.858	.271	.420	4.57	.193	.127	.231	.061	.239
.46	1.900	.375	-.044	.00000	-.854	.273	.427	4.41	.194	.128	.232	.063	.241
.48	1.890	.379	-.042	.00000	-.850	.276	.433	4.26	.195	.129	.234	.065	.243
.50	1.881	.384	-.039	.00000	-.846	.279	.439	4.13	.196	.129	.235	.067	.244
.55	1.857	.394	-.034	.00000	-.837	.284	.452	3.82	.198	.131	.237	.071	.248
.60	1.835	.403	-.030	.00000	-.830	.289	.464	3.57	.199	.133	.239	.076	.251
.65	1.815	.411	-.026	.00000	-.823	.293	.474	3.36	.201	.134	.242	.079	.254
.70	1.797	.418	-.023	.00000	-.818	.297	.483	3.20	.202	.135	.243	.083	.257
.75	1.781	.425	-.020	.00000	-.813	.300	.490	3.07	.203	.136	.244	.086	.259
.80	1.766	.431	-.018	.00000	-.809	.303	.497	2.98	.204	.137	.246	.089	.261
.85	1.753	.437	-.016	.00000	-.805	.306	.503	2.92	.205	.138	.247	.092	.264
.90	1.742	.442	-.015	.00000	-.802	.309	.508	2.89	.206	.139	.249	.095	.266
.95	1.732	.446	-.014	.00000	-.800	.312	.513	2.88	.207	.140	.250	.097	.268
1.00	1.724	.450	-.014	.00000	-.798	.314	.517	2.90	.208	.141	.251	.100	.270
1.10	1.710	.457	-.013	.00000	-.795	.319	.523	2.99	.209	.143	.253	.104	.274
1.20	1.701	.462	-.014	.00000	-.794	.324	.528	3.14	.210	.145	.255	.108	.277
1.30	1.696	.466	-.015	.00000	-.793	.328	.532	3.36	.211	.146	.257	.111	.280
1.40	1.695	.469	-.017	.00000	-.794	.333	.535	3.62	.212	.148	.259	.114	.283
1.50	1.696	.471	-.019	.00000	-.796	.338	.537	3.92	.212	.150	.260	.117	.285
1.60	1.700	.472	-.022	.00000	-.798	.342	.538	4.26	.212	.151	.260	.119	.286
1.70	1.706	.473	-.025	.00000	-.801	.347	.539	4.62	.212	.153	.261	.122	.289
1.80	1.715	.472	-.029	.00000	-.804	.351	.539	5.01	.212	.154	.262	.124	.290
1.90	1.725	.472	-.032	.00000	-.808	.356	.538	5.42	.212	.156	.263	.126	.292
2.00	1.737	.471	-.037	.00000	-.812	.360	.537	5.85	.212	.157	.264	.128	.293

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 7c. Smoothed coefficients of equations for the random horizontal component of 10 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.529	.324	-.090	.00000	-.914	.074	.160	5.91	.180	.084	.199	.007	.199
.11	1.593	.314	-.091	.00000	-.915	.095	.179	6.18	.179	.087	.199	.010	.199
.12	1.644	.307	-.091	.00000	-.915	.113	.196	6.35	.178	.090	.199	.012	.200
.13	1.685	.302	-.091	.00000	-.915	.129	.211	6.46	.177	.092	.199	.015	.200
.14	1.719	.299	-.090	.00000	-.914	.142	.225	6.52	.177	.094	.200	.017	.201
.15	1.747	.297	-.089	.00000	-.913	.154	.239	6.54	.177	.096	.201	.019	.202
.16	1.769	.297	-.088	.00000	-.912	.164	.251	6.53	.177	.098	.202	.022	.204
.17	1.787	.297	-.086	.00000	-.911	.173	.262	6.50	.177	.099	.203	.024	.204
.18	1.802	.297	-.084	.00000	-.909	.182	.273	6.46	.177	.101	.204	.026	.205
.19	1.815	.299	-.083	.00000	-.908	.189	.283	6.40	.177	.102	.204	.028	.206
.20	1.825	.300	-.081	.00000	-.906	.196	.292	6.33	.178	.103	.206	.030	.208
.22	1.839	.305	-.077	.00000	-.903	.207	.309	6.17	.178	.106	.207	.034	.210
.24	1.847	.310	-.073	.00000	-.900	.217	.325	5.99	.179	.108	.209	.037	.212
.26	1.852	.315	-.069	.00000	-.896	.225	.338	5.81	.180	.109	.210	.040	.214
.28	1.853	.321	-.066	.00000	-.893	.232	.351	5.62	.181	.111	.212	.044	.217
.30	1.852	.327	-.062	.00000	-.890	.238	.362	5.44	.182	.112	.214	.046	.219
.32	1.850	.333	-.059	.00000	-.887	.244	.373	5.27	.183	.114	.216	.049	.221
.34	1.846	.339	-.056	.00000	-.884	.249	.383	5.09	.184	.115	.217	.052	.223
.36	1.842	.345	-.053	.00000	-.881	.253	.391	4.93	.185	.116	.218	.054	.225
.38	1.836	.351	-.050	.00000	-.878	.257	.400	4.78	.186	.117	.220	.056	.227
.40	1.830	.356	-.047	.00000	-.875	.260	.407	4.63	.187	.118	.221	.059	.229
.42	1.824	.362	-.045	.00000	-.873	.263	.414	4.49	.188	.119	.222	.061	.231
.44	1.818	.367	-.042	.00000	-.870	.266	.421	4.36	.189	.120	.224	.063	.233
.46	1.811	.372	-.040	.00000	-.868	.269	.427	4.23	.189	.121	.224	.065	.234
.48	1.805	.377	-.038	.00000	-.866	.271	.433	4.12	.190	.122	.226	.067	.236
.50	1.798	.381	-.036	.00000	-.863	.273	.439	4.01	.191	.123	.227	.068	.237
.55	1.782	.392	-.032	.00000	-.858	.278	.451	3.77	.193	.125	.230	.072	.241
.60	1.766	.402	-.028	.00000	-.854	.283	.461	3.57	.194	.126	.231	.076	.243
.65	1.752	.411	-.025	.00000	-.850	.287	.471	3.41	.196	.128	.234	.079	.247
.70	1.738	.419	-.023	.00000	-.846	.290	.479	3.28	.197	.129	.235	.082	.249
.75	1.725	.426	-.021	.00000	-.843	.293	.486	3.18	.199	.131	.238	.085	.253
.80	1.714	.432	-.019	.00000	-.840	.296	.492	3.10	.200	.132	.240	.088	.255
.85	1.703	.438	-.018	.00000	-.837	.299	.497	3.05	.201	.134	.242	.090	.258
.90	1.694	.443	-.017	.00000	-.835	.302	.502	3.03	.202	.135	.243	.092	.260
.95	1.685	.447	-.016	.00000	-.833	.304	.506	3.02	.203	.136	.244	.094	.262
1.00	1.678	.451	-.016	.00000	-.831	.307	.510	3.03	.204	.137	.246	.096	.264
1.10	1.665	.458	-.016	.00000	-.827	.311	.516	3.09	.205	.139	.248	.100	.267
1.20	1.656	.463	-.016	.00000	-.825	.316	.521	3.21	.207	.142	.251	.103	.271
1.30	1.649	.466	-.018	.00000	-.823	.320	.525	3.37	.208	.144	.253	.105	.274
1.40	1.645	.468	-.020	.00000	-.821	.325	.527	3.56	.209	.145	.254	.108	.276
1.50	1.643	.469	-.022	.00000	-.820	.329	.529	3.79	.209	.147	.256	.110	.278
1.60	1.642	.470	-.025	.00000	-.819	.333	.531	4.04	.210	.149	.257	.112	.281
1.70	1.644	.469	-.028	.00000	-.819	.337	.531	4.32	.211	.151	.259	.114	.283
1.80	1.647	.468	-.032	.00000	-.819	.341	.532	4.61	.211	.153	.261	.115	.285
1.90	1.651	.466	-.035	.00000	-.819	.346	.531	4.92	.211	.154	.261	.116	.286
2.00	1.656	.464	-.039	.00000	-.819	.350	.531	5.25	.211	.156	.262	.118	.288

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 7d. Smoothed coefficients of equations for the random horizontal component of 20 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.404	.312	-.081	.00000	-.892	.106	.191	5.66	.169	.086	.190	.022	.191
.11	1.457	.306	-.082	.00000	-.893	.121	.207	5.79	.169	.089	.191	.023	.192
.12	1.500	.302	-.081	.00000	-.893	.135	.222	5.86	.169	.091	.192	.024	.193
.13	1.535	.300	-.080	.00000	-.893	.146	.235	5.89	.169	.093	.193	.025	.195
.14	1.564	.299	-.079	.00000	-.894	.157	.247	5.90	.170	.095	.195	.026	.196
.15	1.589	.299	-.078	.00000	-.894	.166	.259	5.88	.170	.096	.195	.028	.197
.16	1.609	.299	-.076	.00000	-.894	.174	.270	5.85	.171	.098	.197	.029	.199
.17	1.626	.300	-.075	.00000	-.893	.182	.280	5.80	.171	.099	.198	.031	.200
.18	1.640	.302	-.073	.00000	-.893	.188	.290	5.75	.172	.100	.199	.032	.202
.19	1.652	.304	-.071	.00000	-.893	.194	.298	5.69	.172	.101	.199	.034	.202
.20	1.662	.306	-.070	.00000	-.892	.200	.307	5.63	.173	.102	.201	.035	.204
.22	1.677	.312	-.066	.00000	-.891	.210	.322	5.49	.174	.103	.202	.038	.206
.24	1.688	.317	-.063	.00000	-.891	.219	.336	5.35	.175	.105	.204	.041	.208
.26	1.695	.323	-.060	.00000	-.889	.226	.349	5.20	.176	.106	.205	.044	.210
.28	1.699	.329	-.056	.00000	-.888	.233	.361	5.06	.177	.107	.207	.047	.212
.30	1.702	.335	-.054	.00000	-.887	.239	.371	4.92	.178	.108	.208	.049	.214
.32	1.702	.341	-.051	.00000	-.886	.244	.381	4.79	.178	.109	.209	.052	.215
.34	1.702	.347	-.048	.00000	-.885	.249	.390	4.67	.179	.110	.210	.054	.217
.36	1.701	.352	-.046	.00000	-.884	.253	.398	4.55	.180	.111	.211	.056	.219
.38	1.699	.358	-.044	.00000	-.883	.257	.405	4.43	.181	.112	.213	.058	.221
.40	1.696	.363	-.042	.00000	-.882	.260	.412	4.33	.182	.113	.214	.061	.223
.42	1.693	.368	-.040	.00000	-.881	.263	.419	4.23	.183	.113	.215	.063	.224
.44	1.690	.373	-.038	.00000	-.880	.266	.425	4.13	.184	.114	.216	.064	.226
.46	1.687	.378	-.036	.00000	-.879	.269	.431	4.04	.184	.115	.217	.066	.227
.48	1.683	.383	-.034	.00000	-.878	.271	.436	3.96	.185	.116	.218	.068	.229
.50	1.679	.387	-.033	.00000	-.877	.273	.441	3.88	.186	.116	.219	.070	.230
.55	1.670	.397	-.030	.00000	-.874	.279	.452	3.72	.187	.118	.221	.073	.233
.60	1.660	.407	-.027	.00000	-.872	.283	.462	3.58	.189	.120	.224	.077	.237
.65	1.650	.415	-.025	.00000	-.870	.286	.470	3.46	.191	.121	.226	.080	.240
.70	1.641	.423	-.024	.00000	-.867	.290	.477	3.37	.192	.123	.228	.082	.242
.75	1.633	.430	-.022	.00000	-.865	.292	.483	3.31	.193	.124	.229	.085	.245
.80	1.625	.436	-.021	.00000	-.863	.295	.488	3.26	.194	.126	.231	.087	.247
.85	1.617	.441	-.021	.00000	-.862	.297	.493	3.22	.196	.127	.234	.089	.250
.90	1.611	.446	-.020	.00000	-.860	.299	.496	3.20	.197	.128	.235	.091	.252
.95	1.604	.451	-.020	.00000	-.858	.301	.500	3.20	.198	.130	.237	.093	.254
1.00	1.599	.455	-.020	.00000	-.856	.302	.503	3.21	.199	.131	.238	.094	.256
1.10	1.589	.462	-.021	.00000	-.853	.305	.507	3.25	.201	.134	.242	.096	.260
1.20	1.581	.467	-.023	.00000	-.850	.307	.510	3.34	.202	.137	.244	.098	.263
1.30	1.575	.471	-.025	.00000	-.848	.309	.512	3.45	.204	.139	.247	.100	.266
1.40	1.570	.474	-.027	.00000	-.845	.311	.514	3.58	.205	.142	.249	.101	.269
1.50	1.567	.476	-.030	.00000	-.843	.312	.514	3.74	.207	.145	.253	.102	.273
1.60	1.565	.478	-.033	.00000	-.841	.314	.514	3.91	.208	.147	.255	.103	.275
1.70	1.564	.478	-.036	.00000	-.839	.315	.513	4.10	.209	.150	.257	.103	.277
1.80	1.564	.478	-.040	.00000	-.837	.316	.512	4.30	.210	.152	.259	.104	.279
1.90	1.565	.478	-.044	.00000	-.835	.317	.510	4.52	.211	.154	.261	.104	.281
2.00	1.567	.477	-.048	.00000	-.833	.318	.508	4.74	.212	.157	.264	.104	.284

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 8a. Smoothed coefficients of equations for the larger horizontal compnent of 2 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.858	.337	-.122	.00000	-.951	.013	.101	6.48	.207	.000	.207	.000	.207
.11	1.939	.339	-.125	.00000	-.959	.040	.123	6.99	.206	.000	.206	.000	.206
.12	2.001	.340	-.127	.00000	-.964	.063	.143	7.33	.205	.000	.205	.000	.205
.13	2.050	.341	-.128	.00000	-.965	.083	.162	7.57	.204	.000	.204	.002	.204
.14	2.089	.343	-.128	.00000	-.965	.100	.178	7.71	.203	.000	.203	.005	.203
.15	2.118	.344	-.128	.00000	-.964	.116	.194	7.78	.203	.000	.203	.008	.203
.16	2.142	.346	-.126	.00000	-.961	.129	.208	7.80	.203	.000	.203	.011	.203
.17	2.160	.348	-.125	.00000	-.958	.141	.221	7.78	.203	.000	.203	.013	.203
.18	2.173	.349	-.123	.00000	-.954	.152	.233	7.73	.203	.000	.203	.016	.204
.19	2.183	.351	-.121	.00000	-.949	.162	.245	7.66	.203	.000	.203	.018	.204
.20	2.190	.353	-.119	.00000	-.945	.171	.256	7.57	.203	.000	.203	.020	.204
.22	2.197	.356	-.115	.00000	-.935	.186	.275	7.35	.203	.000	.203	.024	.204
.24	2.198	.360	-.110	.00000	-.924	.199	.293	7.10	.203	.000	.203	.028	.205
.26	2.193	.363	-.105	.00000	-.914	.210	.309	6.83	.204	.000	.204	.031	.206
.28	2.186	.366	-.100	.00000	-.904	.219	.323	6.55	.204	.000	.204	.034	.207
.30	2.176	.369	-.096	.00000	-.895	.228	.336	6.28	.205	.000	.205	.038	.208
.32	2.165	.372	-.091	.00000	-.885	.235	.348	6.01	.205	.000	.205	.040	.209
.34	2.153	.375	-.087	.00000	-.876	.242	.359	5.75	.206	.000	.206	.043	.210
.36	2.140	.378	-.082	.00000	-.868	.247	.370	5.50	.207	.000	.207	.046	.212
.38	2.127	.380	-.078	.00000	-.860	.253	.379	5.26	.207	.000	.207	.049	.213
.40	2.114	.383	-.074	.00000	-.853	.257	.388	5.04	.208	.000	.208	.051	.214
.42	2.101	.386	-.071	.00000	-.846	.262	.396	4.83	.208	.000	.208	.054	.215
.44	2.088	.388	-.067	.00000	-.839	.266	.404	4.62	.209	.000	.209	.056	.216
.46	2.075	.391	-.064	.00000	-.833	.269	.411	4.44	.209	.000	.209	.058	.217
.48	2.063	.393	-.060	.00000	-.827	.273	.417	4.26	.210	.000	.210	.061	.219
.50	2.051	.396	-.057	.00000	-.822	.276	.424	4.10	.211	.000	.211	.063	.220
.55	2.022	.401	-.050	.00000	-.810	.283	.438	3.73	.212	.000	.212	.068	.223
.60	1.997	.407	-.044	.00000	-.801	.289	.450	3.44	.213	.000	.213	.074	.225
.65	1.974	.412	-.038	.00000	-.793	.295	.461	3.20	.214	.000	.214	.079	.228
.70	1.954	.417	-.033	.00000	-.787	.300	.471	3.02	.215	.000	.215	.083	.230
.75	1.937	.421	-.029	.00000	-.782	.304	.479	2.88	.216	.000	.216	.088	.233
.80	1.922	.426	-.025	.00000	-.779	.308	.486	2.79	.216	.000	.216	.093	.235
.85	1.909	.430	-.022	.00000	-.777	.312	.493	2.73	.217	.000	.217	.097	.238
.90	1.899	.434	-.019	.00000	-.776	.316	.499	2.72	.218	.000	.218	.101	.240
.95	1.890	.438	-.016	.00000	-.776	.320	.504	2.73	.218	.000	.218	.106	.242
1.00	1.883	.441	-.014	.00000	-.776	.323	.509	2.77	.219	.000	.219	.110	.245
1.10	1.875	.448	-.011	.00000	-.780	.330	.517	2.92	.220	.000	.220	.118	.250
1.20	1.872	.455	-.009	.00000	-.786	.336	.524	3.17	.221	.000	.221	.125	.254
1.30	1.875	.461	-.008	.00000	-.794	.342	.529	3.48	.221	.000	.221	.133	.258
1.40	1.881	.467	-.008	.00000	-.804	.348	.534	3.85	.222	.000	.222	.140	.262
1.50	1.892	.472	-.008	.00000	-.815	.353	.537	4.27	.222	.000	.222	.147	.266
1.60	1.906	.477	-.009	.00000	-.828	.359	.540	4.73	.222	.000	.222	.154	.270
1.70	1.922	.482	-.010	.00000	-.841	.365	.542	5.23	.222	.000	.222	.160	.274
1.80	1.941	.487	-.012	.00000	-.856	.370	.544	5.76	.223	.000	.223	.167	.279
1.90	1.963	.491	-.014	.00000	-.871	.376	.545	6.31	.223	.000	.223	.173	.282
2.00	1.986	.496	-.017	.00000	-.886	.381	.546	6.89	.223	.000	.223	.179	.286

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 8b. Smoothed coefficients of equations for the larger horizontal component of 5 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.700	.321	-.104	.00000	-.921	.039	.128	6.18	.194	.000	.194	.000	.194
.11	1.777	.320	-.110	.00000	-.929	.065	.150	6.57	.194	.000	.194	.000	.194
.12	1.837	.320	-.113	.00000	-.934	.087	.169	6.82	.193	.000	.193	.000	.193
.13	1.886	.321	-.116	.00000	-.938	.106	.187	6.99	.193	.000	.193	.001	.193
.14	1.925	.322	-.117	.00000	-.939	.123	.203	7.09	.193	.000	.193	.005	.193
.15	1.956	.323	-.117	.00000	-.939	.137	.217	7.13	.194	.000	.194	.008	.194
.16	1.982	.325	-.117	.00000	-.939	.149	.230	7.13	.194	.000	.194	.011	.194
.17	2.002	.326	-.117	.00000	-.938	.159	.242	7.10	.194	.000	.194	.014	.195
.18	2.019	.328	-.115	.00000	-.936	.169	.254	7.05	.194	.000	.194	.016	.195
.19	2.032	.330	-.114	.00000	-.934	.177	.264	6.98	.195	.000	.195	.018	.196
.20	2.042	.332	-.112	.00000	-.931	.185	.274	6.90	.195	.000	.195	.021	.196
.22	2.056	.336	-.109	.00000	-.926	.198	.291	6.70	.196	.000	.196	.025	.198
.24	2.064	.341	-.105	.00000	-.920	.208	.306	6.48	.197	.000	.197	.029	.199
.26	2.067	.345	-.101	.00000	-.914	.217	.320	6.25	.198	.000	.198	.032	.201
.28	2.066	.349	-.096	.00000	-.908	.224	.333	6.02	.199	.000	.199	.036	.202
.30	2.063	.354	-.092	.00000	-.902	.231	.344	5.79	.200	.000	.200	.039	.204
.32	2.058	.358	-.088	.00000	-.897	.236	.354	5.57	.201	.000	.201	.042	.205
.34	2.052	.362	-.083	.00000	-.891	.241	.363	5.35	.201	.000	.201	.045	.206
.36	2.045	.366	-.079	.00000	-.886	.245	.372	5.14	.202	.000	.202	.048	.208
.38	2.038	.369	-.076	.00000	-.881	.249	.380	4.94	.203	.000	.203	.050	.209
.40	2.029	.373	-.072	.00000	-.876	.252	.388	4.75	.204	.000	.204	.053	.211
.42	2.021	.377	-.068	.00000	-.871	.255	.395	4.58	.205	.000	.205	.056	.213
.44	2.013	.380	-.065	.00000	-.867	.258	.401	4.41	.205	.000	.205	.058	.213
.46	2.004	.383	-.061	.00000	-.863	.261	.407	4.26	.206	.000	.206	.061	.215
.48	1.996	.386	-.058	.00000	-.859	.263	.413	4.11	.207	.000	.207	.063	.216
.50	1.988	.390	-.055	.00000	-.856	.265	.418	3.97	.207	.000	.207	.065	.217
.55	1.968	.397	-.048	.00000	-.848	.270	.430	3.67	.209	.000	.209	.071	.221
.60	1.949	.404	-.042	.00000	-.842	.275	.441	3.43	.210	.000	.210	.076	.223
.65	1.932	.410	-.037	.00000	-.837	.279	.451	3.23	.211	.000	.211	.081	.226
.70	1.917	.416	-.033	.00000	-.833	.283	.459	3.08	.212	.000	.212	.086	.229
.75	1.903	.422	-.029	.00000	-.830	.287	.467	2.97	.213	.000	.213	.091	.232
.80	1.891	.427	-.025	.00000	-.827	.290	.474	2.89	.214	.000	.214	.095	.234
.85	1.881	.432	-.022	.00000	-.826	.294	.481	2.85	.215	.000	.215	.100	.237
.90	1.872	.436	-.020	.00000	-.825	.297	.486	2.83	.216	.000	.216	.104	.240
.95	1.864	.440	-.018	.00000	-.825	.301	.492	2.84	.216	.000	.216	.109	.242
1.00	1.858	.444	-.016	.00000	-.825	.305	.497	2.87	.217	.000	.217	.113	.245
1.10	1.849	.452	-.014	.00000	-.828	.312	.506	3.00	.218	.000	.218	.121	.249
1.20	1.844	.458	-.013	.00000	-.832	.319	.514	3.19	.219	.000	.219	.129	.254
1.30	1.842	.464	-.012	.00000	-.837	.326	.521	3.44	.219	.000	.219	.136	.258
1.40	1.844	.469	-.013	.00000	-.843	.334	.527	3.74	.220	.000	.220	.143	.262
1.50	1.849	.474	-.014	.00000	-.851	.341	.533	4.08	.220	.000	.220	.151	.267
1.60	1.857	.478	-.016	.00000	-.859	.349	.538	4.46	.220	.000	.220	.157	.270
1.70	1.866	.482	-.019	.00000	-.868	.357	.543	4.86	.220	.000	.220	.164	.274
1.80	1.878	.485	-.022	.00000	-.878	.365	.547	5.29	.221	.000	.221	.171	.279
1.90	1.891	.488	-.025	.00000	-.888	.373	.551	5.74	.221	.000	.221	.177	.283
2.00	1.905	.491	-.028	.00000	-.898	.381	.554	6.21	.221	.000	.221	.183	.287

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 8c. Smoothed coefficients of equations for the larger horizontal component of 10 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.563	.324	-.106	.00000	-.886	.067	.142	5.60	.187	.000	.187	.000	.187
.11	1.629	.322	-.110	.00000	-.894	.091	.166	5.88	.186	.000	.186	.000	.186
.12	1.684	.321	-.112	.00000	-.899	.111	.187	6.07	.185	.000	.185	.000	.185
.13	1.728	.321	-.113	.00000	-.903	.128	.205	6.20	.185	.000	.185	.000	.185
.14	1.764	.321	-.114	.00000	-.906	.142	.221	6.26	.185	.000	.185	.003	.185
.15	1.794	.322	-.113	.00000	-.908	.155	.235	6.29	.185	.000	.185	.006	.185
.16	1.819	.324	-.112	.00000	-.909	.165	.248	6.29	.185	.000	.185	.009	.185
.17	1.840	.325	-.111	.00000	-.910	.174	.260	6.26	.185	.000	.185	.011	.185
.18	1.858	.327	-.110	.00000	-.910	.182	.271	6.22	.186	.000	.186	.014	.187
.19	1.872	.329	-.108	.00000	-.910	.189	.281	6.16	.186	.000	.186	.016	.187
.20	1.885	.331	-.107	.00000	-.909	.196	.290	6.10	.187	.000	.187	.018	.188
.22	1.903	.336	-.103	.00000	-.908	.206	.306	5.94	.187	.000	.187	.023	.188
.24	1.916	.341	-.099	.00000	-.906	.215	.320	5.77	.188	.000	.188	.027	.190
.26	1.924	.345	-.095	.00000	-.904	.222	.333	5.59	.189	.000	.189	.030	.191
.28	1.929	.350	-.091	.00000	-.901	.228	.344	5.41	.190	.000	.190	.034	.193
.30	1.932	.355	-.087	.00000	-.899	.232	.354	5.23	.192	.000	.192	.037	.196
.32	1.933	.359	-.083	.00000	-.896	.237	.363	5.06	.193	.000	.193	.041	.197
.34	1.932	.363	-.079	.00000	-.893	.240	.371	4.89	.194	.000	.194	.044	.199
.36	1.930	.368	-.076	.00000	-.891	.243	.378	4.73	.195	.000	.195	.047	.201
.38	1.928	.372	-.072	.00000	-.888	.246	.385	4.58	.195	.000	.195	.050	.201
.40	1.924	.376	-.069	.00000	-.886	.249	.391	4.43	.196	.000	.196	.052	.203
.42	1.921	.380	-.066	.00000	-.884	.251	.397	4.29	.197	.000	.197	.055	.205
.44	1.917	.383	-.063	.00000	-.882	.253	.402	4.17	.198	.000	.198	.058	.206
.46	1.912	.387	-.060	.00000	-.879	.255	.408	4.04	.199	.000	.199	.060	.208
.48	1.908	.390	-.057	.00000	-.878	.257	.412	3.93	.200	.000	.200	.063	.210
.50	1.903	.394	-.055	.00000	-.876	.258	.417	3.83	.201	.000	.201	.065	.211
.55	1.892	.402	-.049	.00000	-.871	.262	.427	3.60	.202	.000	.202	.071	.214
.60	1.880	.409	-.044	.00000	-.868	.265	.436	3.41	.204	.000	.204	.077	.218
.65	1.869	.415	-.039	.00000	-.865	.269	.444	3.26	.206	.000	.206	.082	.222
.70	1.859	.421	-.035	.00000	-.863	.272	.451	3.14	.207	.000	.207	.087	.225
.75	1.850	.427	-.032	.00000	-.861	.275	.458	3.05	.208	.000	.208	.092	.227
.80	1.841	.432	-.029	.00000	-.859	.278	.464	2.99	.210	.000	.210	.097	.231
.85	1.833	.436	-.027	.00000	-.858	.281	.469	2.96	.211	.000	.211	.101	.234
.90	1.826	.441	-.025	.00000	-.858	.284	.474	2.94	.212	.000	.212	.106	.237
.95	1.820	.445	-.023	.00000	-.857	.287	.479	2.95	.213	.000	.213	.110	.240
1.00	1.814	.448	-.021	.00000	-.857	.291	.484	2.97	.213	.000	.213	.114	.242
1.10	1.806	.455	-.020	.00000	-.858	.297	.492	3.07	.215	.000	.215	.122	.247
1.20	1.799	.460	-.019	.00000	-.859	.304	.500	3.22	.216	.000	.216	.129	.252
1.30	1.795	.465	-.019	.00000	-.862	.312	.507	3.41	.217	.000	.217	.136	.256
1.40	1.793	.468	-.019	.00000	-.865	.319	.514	3.64	.218	.000	.218	.143	.261
1.50	1.793	.472	-.020	.00000	-.869	.327	.520	3.90	.219	.000	.219	.149	.265
1.60	1.795	.474	-.022	.00000	-.873	.335	.526	4.18	.219	.000	.219	.155	.268
1.70	1.797	.477	-.024	.00000	-.877	.343	.531	4.49	.220	.000	.220	.161	.273
1.80	1.802	.479	-.027	.00000	-.882	.351	.536	4.82	.220	.000	.220	.167	.276
1.90	1.807	.480	-.030	.00000	-.887	.359	.541	5.16	.220	.000	.220	.173	.280
2.00	1.814	.481	-.033	.00000	-.893	.367	.546	5.52	.220	.000	.220	.178	.283

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

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Table 8d. Smoothed coefficients of equations for the larger horizontal component of 20 percent damped PSV (cm/s; distance in km).

T(s)	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
.10	1.444	.324	-.102	.00000	-.874	.107	.177	5.43	.178	.000	.178	.001	.178
.11	1.499	.326	-.104	.00000	-.880	.122	.195	5.57	.178	.000	.178	.003	.178
.12	1.544	.328	-.105	.00000	-.884	.135	.211	5.66	.177	.000	.177	.004	.177
.13	1.582	.331	-.105	.00000	-.888	.146	.225	5.70	.177	.000	.177	.006	.177
.14	1.613	.333	-.105	.00000	-.890	.156	.238	5.71	.177	.000	.177	.008	.177
.15	1.640	.336	-.104	.00000	-.892	.164	.250	5.70	.177	.000	.177	.010	.177
.16	1.662	.338	-.103	.00000	-.894	.172	.261	5.67	.177	.000	.177	.012	.177
.17	1.681	.341	-.101	.00000	-.895	.179	.271	5.63	.177	.000	.177	.015	.178
.18	1.697	.343	-.100	.00000	-.896	.185	.281	5.58	.178	.000	.178	.017	.179
.19	1.711	.346	-.098	.00000	-.897	.190	.289	5.53	.178	.000	.178	.019	.179
.20	1.723	.348	-.097	.00000	-.897	.195	.297	5.47	.179	.000	.179	.021	.180
.22	1.742	.353	-.093	.00000	-.898	.204	.312	5.33	.179	.000	.179	.025	.181
.24	1.756	.357	-.089	.00000	-.898	.212	.325	5.19	.181	.000	.181	.029	.183
.26	1.766	.362	-.086	.00000	-.897	.218	.336	5.05	.182	.000	.182	.033	.185
.28	1.774	.366	-.082	.00000	-.897	.223	.347	4.91	.183	.000	.183	.037	.187
.30	1.779	.370	-.079	.00000	-.896	.228	.356	4.77	.184	.000	.184	.040	.188
.32	1.783	.374	-.075	.00000	-.895	.233	.365	4.64	.185	.000	.185	.044	.190
.34	1.785	.377	-.072	.00000	-.894	.237	.373	4.52	.186	.000	.186	.047	.192
.36	1.786	.381	-.069	.00000	-.893	.240	.380	4.40	.187	.000	.187	.051	.194
.38	1.787	.384	-.066	.00000	-.893	.243	.387	4.29	.188	.000	.188	.054	.196
.40	1.787	.388	-.063	.00000	-.892	.246	.393	4.18	.189	.000	.189	.057	.197
.42	1.786	.391	-.061	.00000	-.891	.249	.399	4.09	.190	.000	.190	.060	.199
.44	1.785	.394	-.058	.00000	-.890	.251	.404	3.99	.191	.000	.191	.062	.201
.46	1.783	.397	-.056	.00000	-.889	.254	.409	3.91	.192	.000	.192	.065	.203
.48	1.782	.399	-.053	.00000	-.888	.256	.414	3.83	.193	.000	.193	.068	.205
.50	1.780	.402	-.051	.00000	-.888	.258	.418	3.75	.194	.000	.194	.070	.206
.55	1.774	.408	-.046	.00000	-.886	.262	.428	3.59	.196	.000	.196	.076	.210
.60	1.769	.414	-.042	.00000	-.885	.266	.437	3.46	.198	.000	.198	.082	.214
.65	1.763	.419	-.039	.00000	-.883	.270	.444	3.36	.200	.000	.200	.087	.218
.70	1.758	.424	-.036	.00000	-.882	.273	.451	3.28	.201	.000	.201	.092	.221
.75	1.752	.429	-.033	.00000	-.882	.276	.457	3.22	.203	.000	.203	.096	.225
.80	1.747	.433	-.031	.00000	-.881	.279	.462	3.18	.204	.000	.204	.101	.228
.85	1.743	.437	-.029	.00000	-.881	.281	.467	3.16	.206	.000	.206	.105	.231
.90	1.739	.441	-.027	.00000	-.881	.284	.472	3.15	.207	.000	.207	.108	.233
.95	1.735	.444	-.026	.00000	-.881	.286	.476	3.16	.208	.000	.208	.112	.236
1.00	1.732	.447	-.025	.00000	-.881	.288	.479	3.17	.209	.000	.209	.115	.239
1.10	1.726	.453	-.024	.00000	-.881	.293	.485	3.25	.211	.000	.211	.121	.243
1.20	1.722	.458	-.024	.00000	-.882	.297	.491	3.35	.213	.000	.213	.127	.248
1.30	1.719	.463	-.024	.00000	-.884	.301	.495	3.49	.215	.000	.215	.132	.252
1.40	1.718	.467	-.025	.00000	-.886	.305	.499	3.65	.216	.000	.216	.136	.255
1.50	1.718	.471	-.027	.00000	-.888	.308	.502	3.84	.218	.000	.218	.140	.259
1.60	1.719	.475	-.028	.00000	-.890	.312	.505	4.04	.219	.000	.219	.144	.262
1.70	1.720	.478	-.031	.00000	-.892	.315	.507	4.25	.220	.000	.220	.148	.265
1.80	1.723	.481	-.033	.00000	-.895	.319	.509	4.48	.221	.000	.221	.151	.268
1.90	1.726	.483	-.036	.00000	-.898	.322	.511	4.72	.221	.000	.221	.154	.269
2.00	1.730	.486	-.039	.00000	-.901	.326	.512	4.97	.222	.000	.222	.157	.272

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 9. Coefficients of equations for the random and larger horizontal components of peak acceleration (in g; distance in km).

Component	B1	B2	B3	B4	B5	B6	B7	H	S1	SC	SR	SE	SLOGY
random	-.105	.229	0.0	0.0	-.778	.162	.251	5.57	.186	.098	.210	.093	.230
larger	-.038	.216	0.0	0.0	-.777	.158	.254	5.48	.193	.000	.193	.068	.205

The equations are to be used for 5.0 <= M <= 7.7 and d <= 100.0 km.

Table 10. Comparison of uncertainies in the old and new regression results.

T(sec)	SLOGY-OLD	SLOGY-NEW
0.3	0.28	0.23
1.0	0.34	0.27

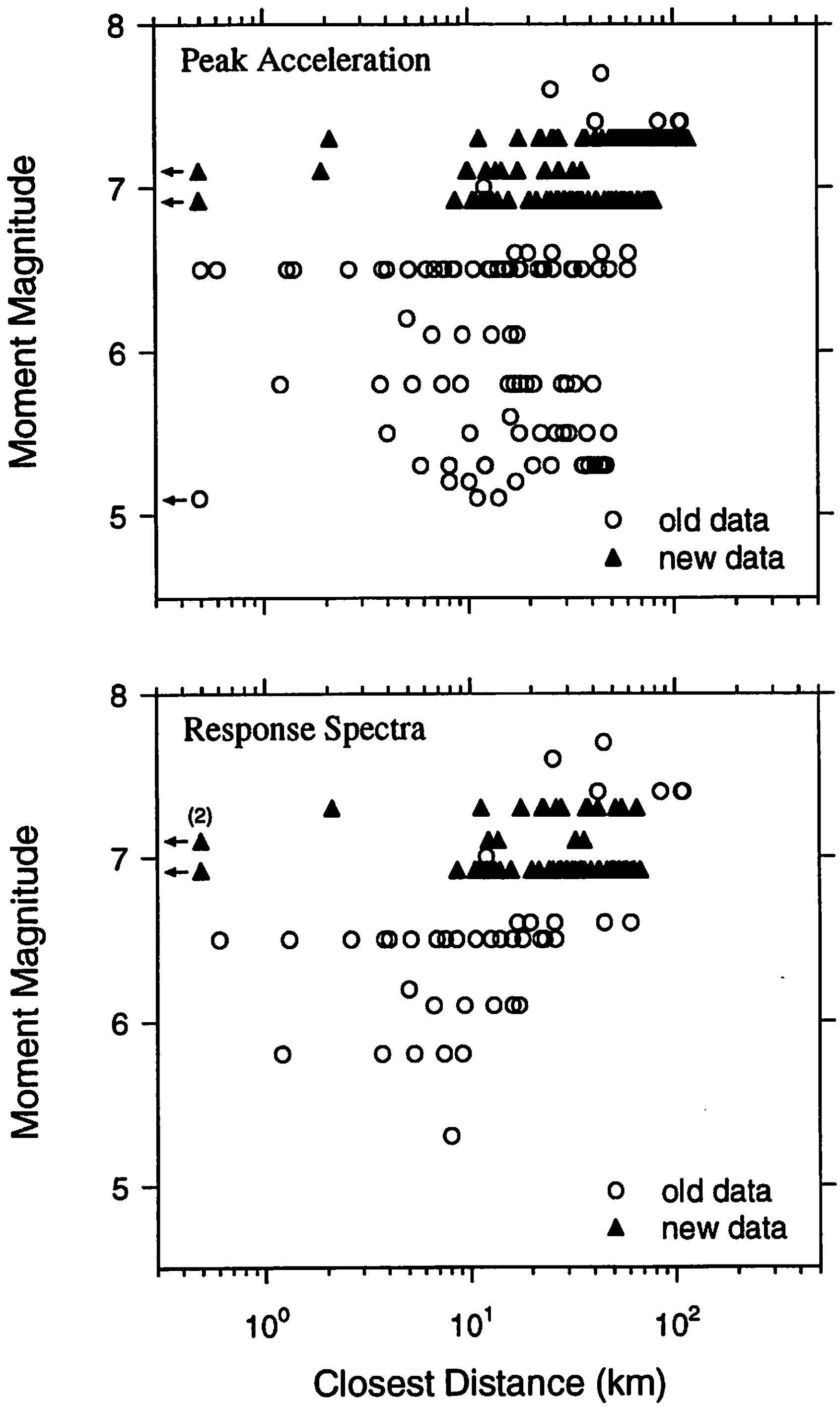

Figure 1. The distribution of the data in magnitude and distance space (each point represents a recording). The data points labeled old data are the ones that were also used in previous studies. The top frame is for the peak acceleration data set and the bottom is for the response spectral data set.

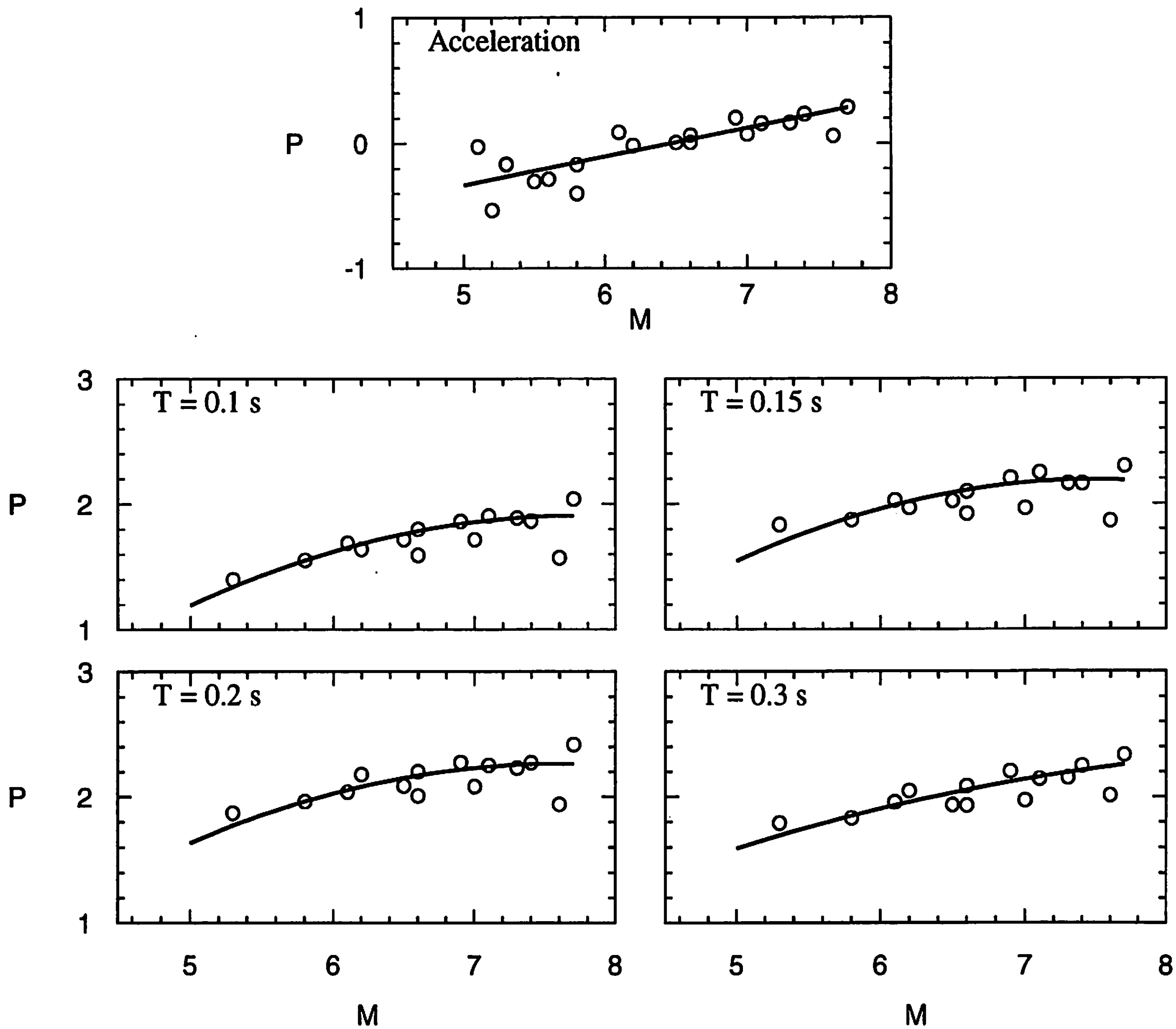

Figure 2a. The data and regression for the second stage of the analysis, for peak acceleration and 5 percent damped response spectra at selected periods.

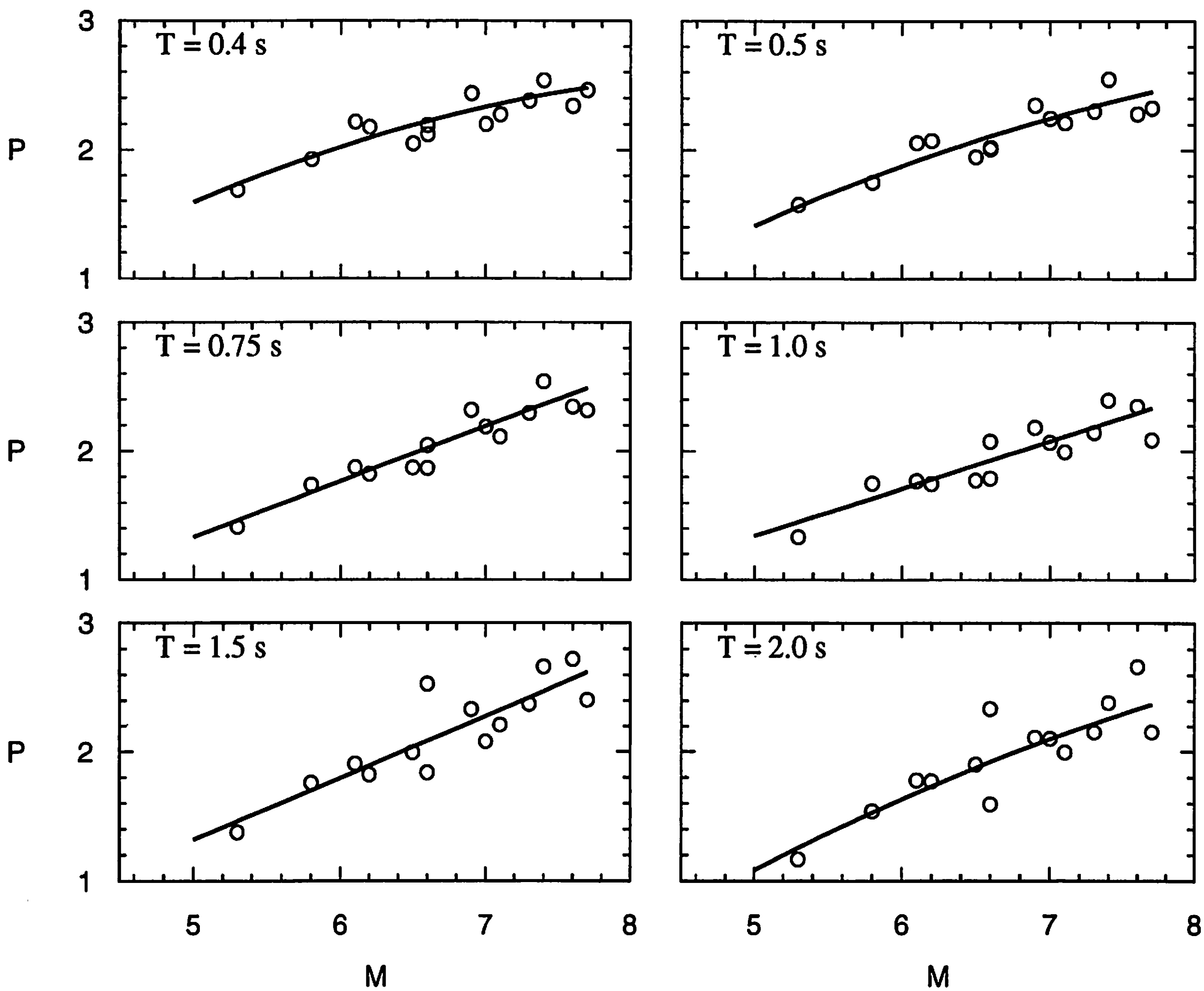

Figure 2b. The data and regression for the second stage of the analysis, for peak acceleration and 5 percent damped response spectra at selected periods.

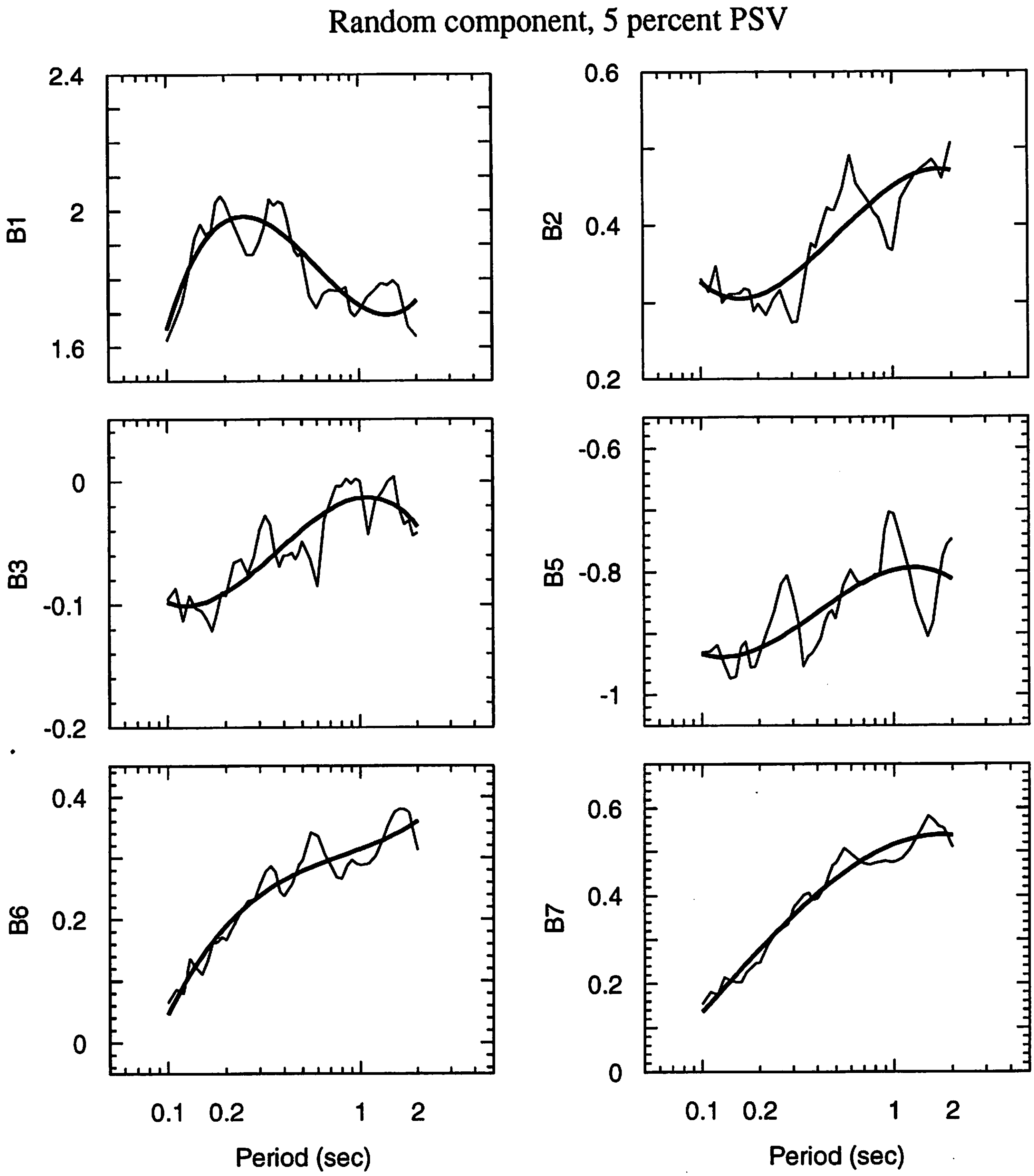

Figure 3a. The unsmoothed and smoothed coefficients (light and heavy lines, respectively) for the 5 percent damped response spectra of the random horizontal component.

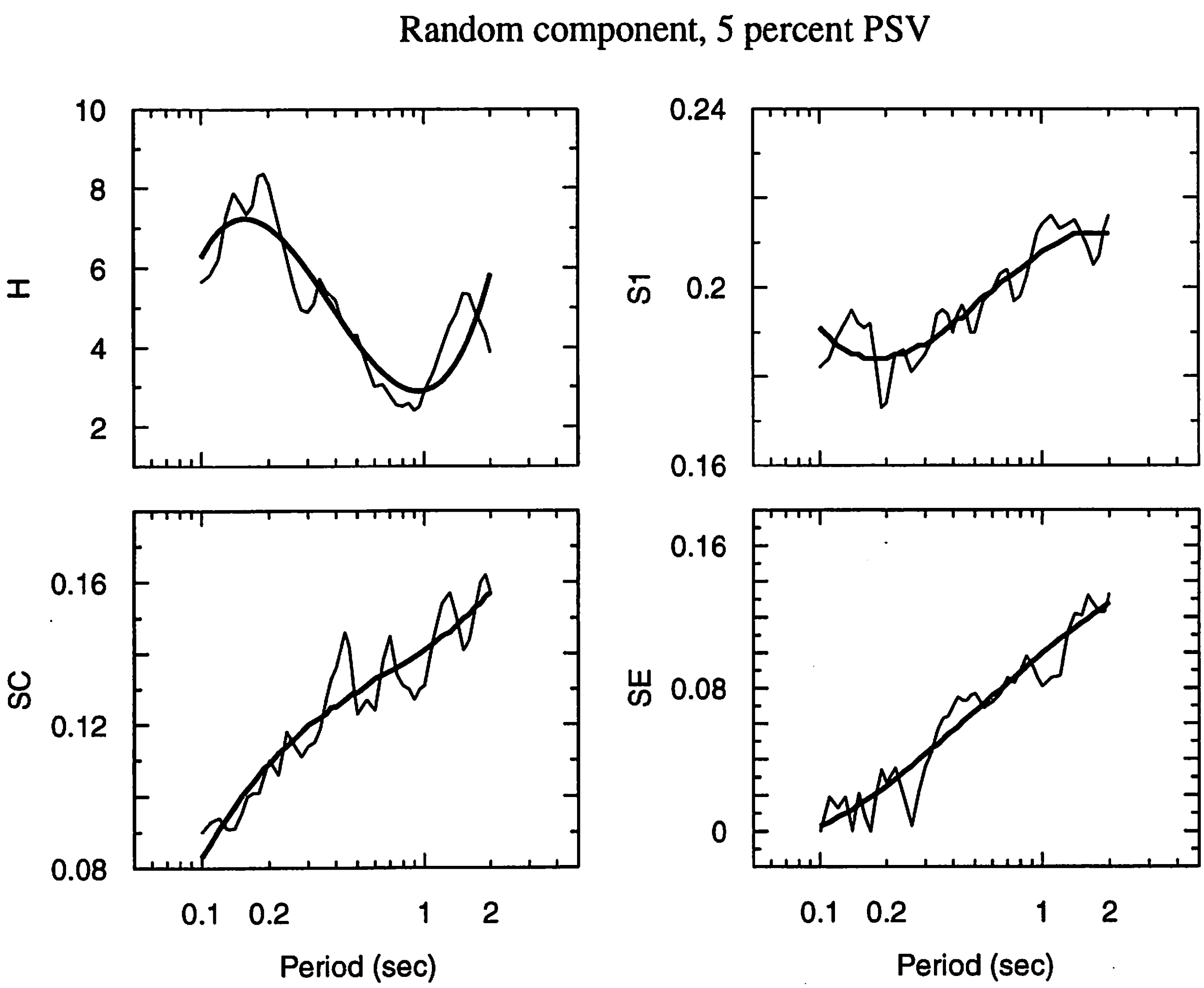

Figure 3b. The unsmoothed and smoothed coefficients (light and heavy lines, respectively) for the 5 percent damped response spectra of the random horizontal component.

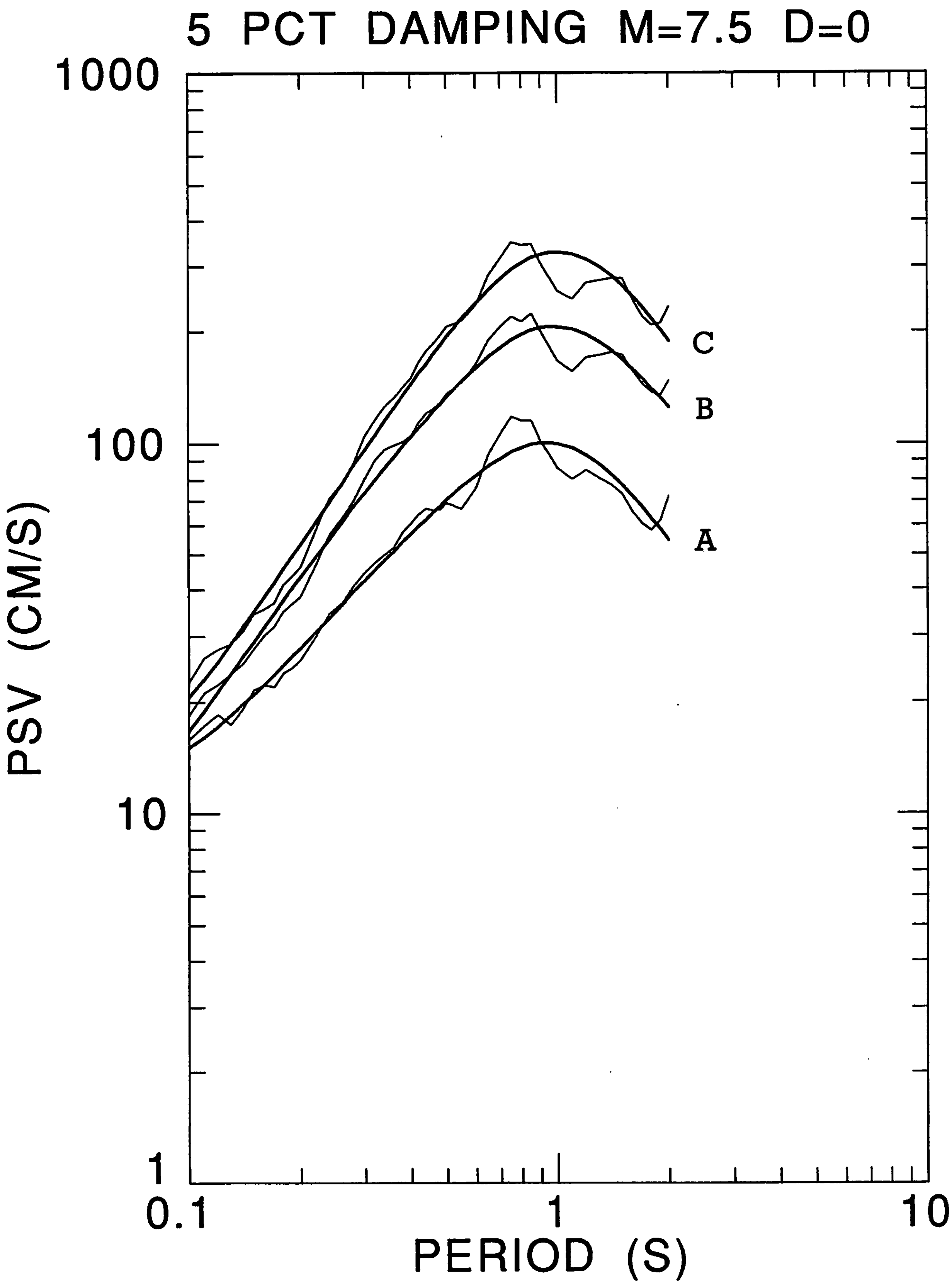

Figure 4. 5 percent damped, random component response spectra for magnitude 7.5 at 0 km distance, predicted from the unsmoothed and smoothed regression coefficients. The three sets of curves are for site classes A, B, and C.

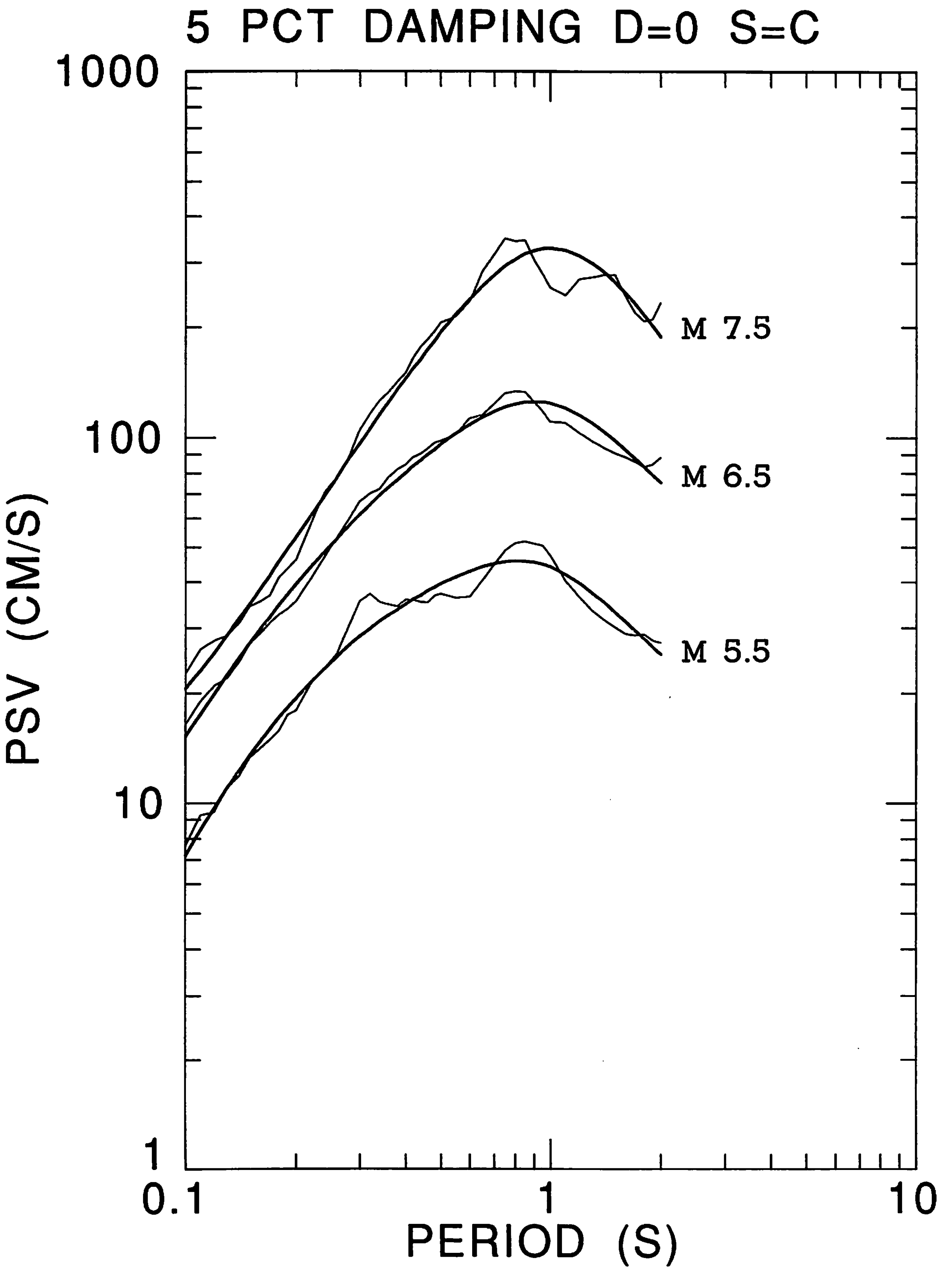

Figure 5. 5 percent damped, random component response spectra for site class C at 0 km distance, predicted from the unsmoothed and smoothed regression coefficients. The three sets of curves are for magnitudes 5.5, 6.5, and 7.5.

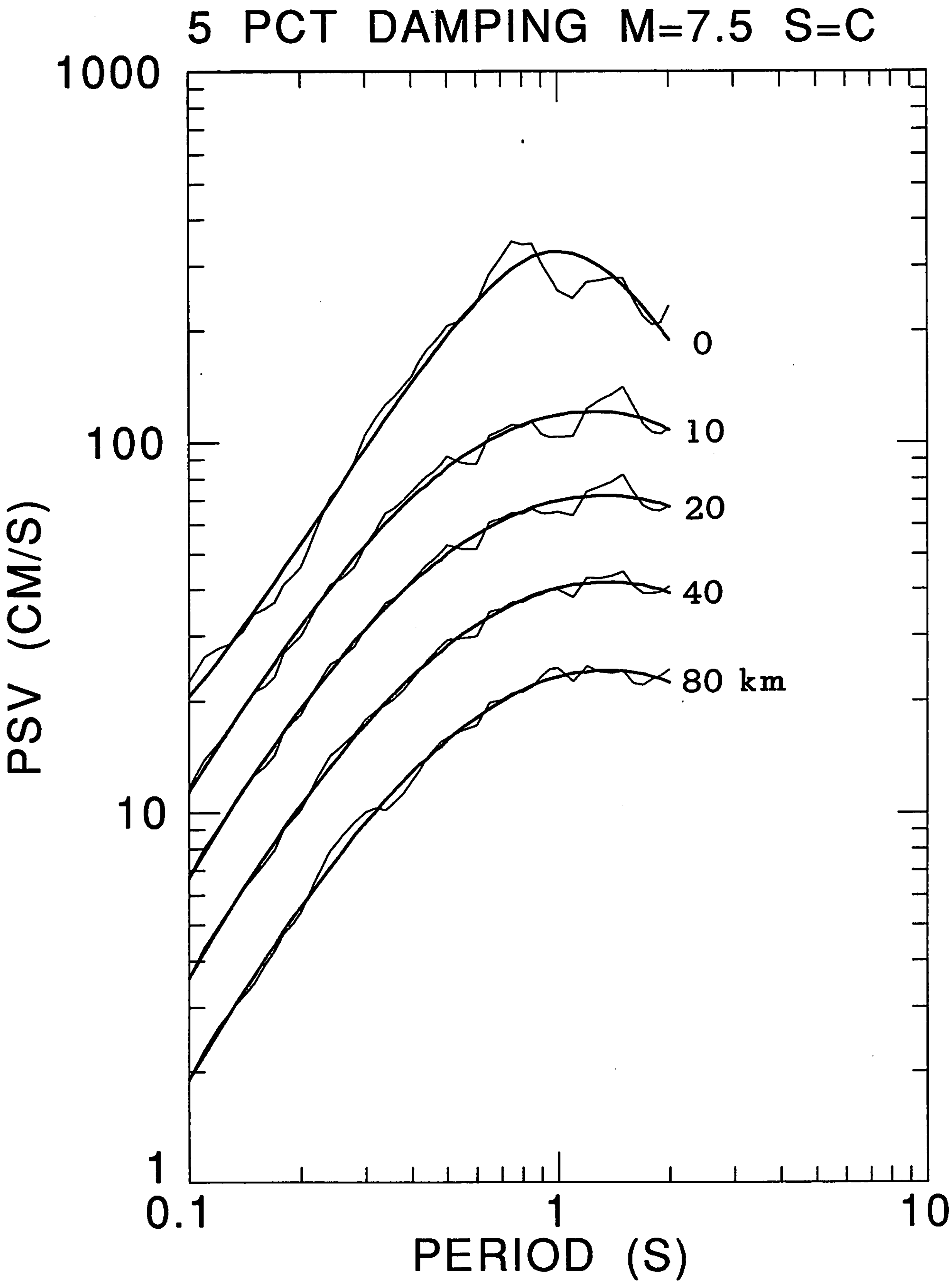

Figure 6. 5 percent damped, random component response spectra for magnitude 7.5 and site class C , predicted from the unsmoothed and smoothed regression coefficients. The five sets of curves are for distances of 0, 10, 20, 40, and 80 km.

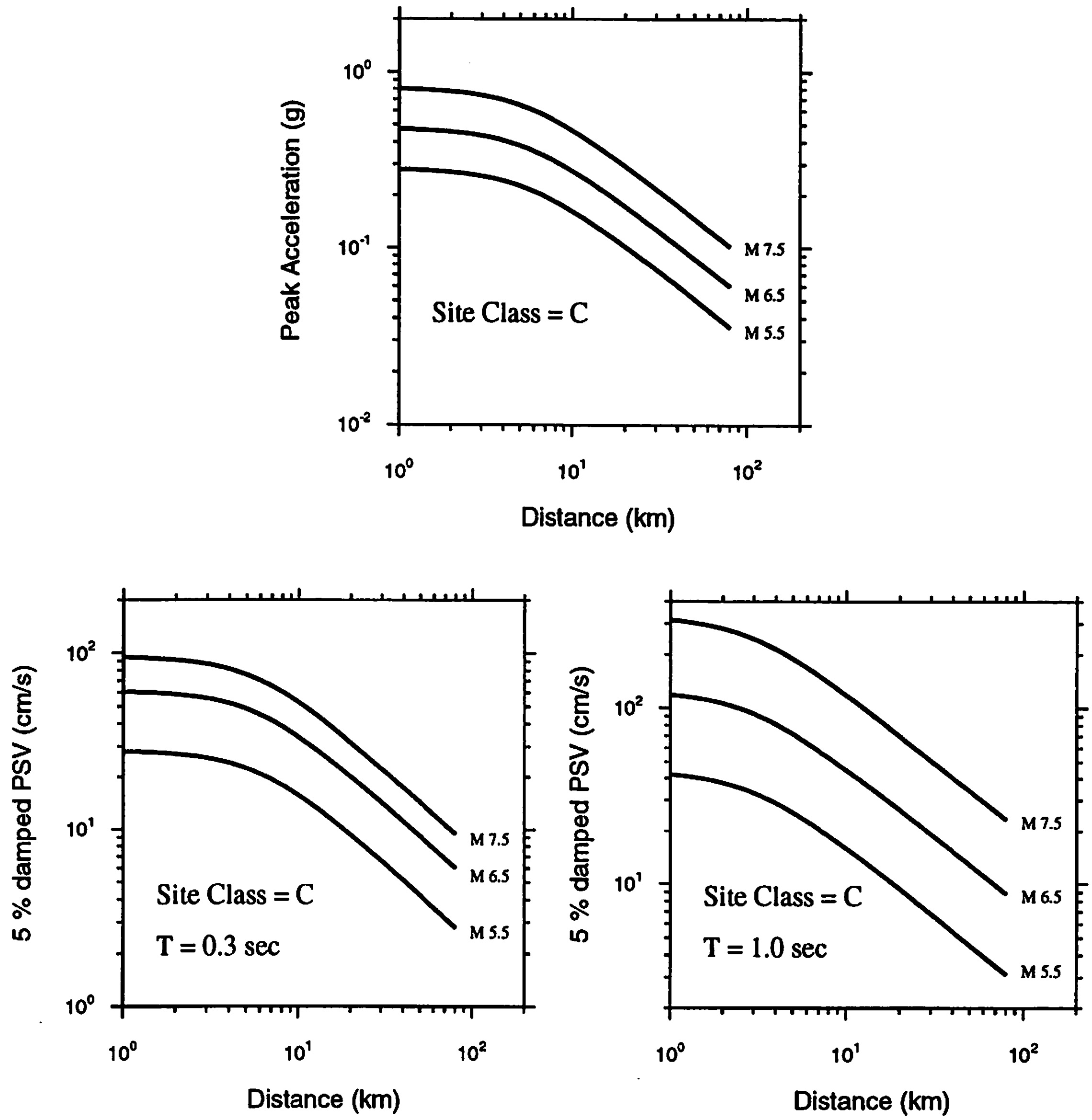

Figure 7. Attenuation with distance of peak acceleration and response spectra for the random horizontal component.

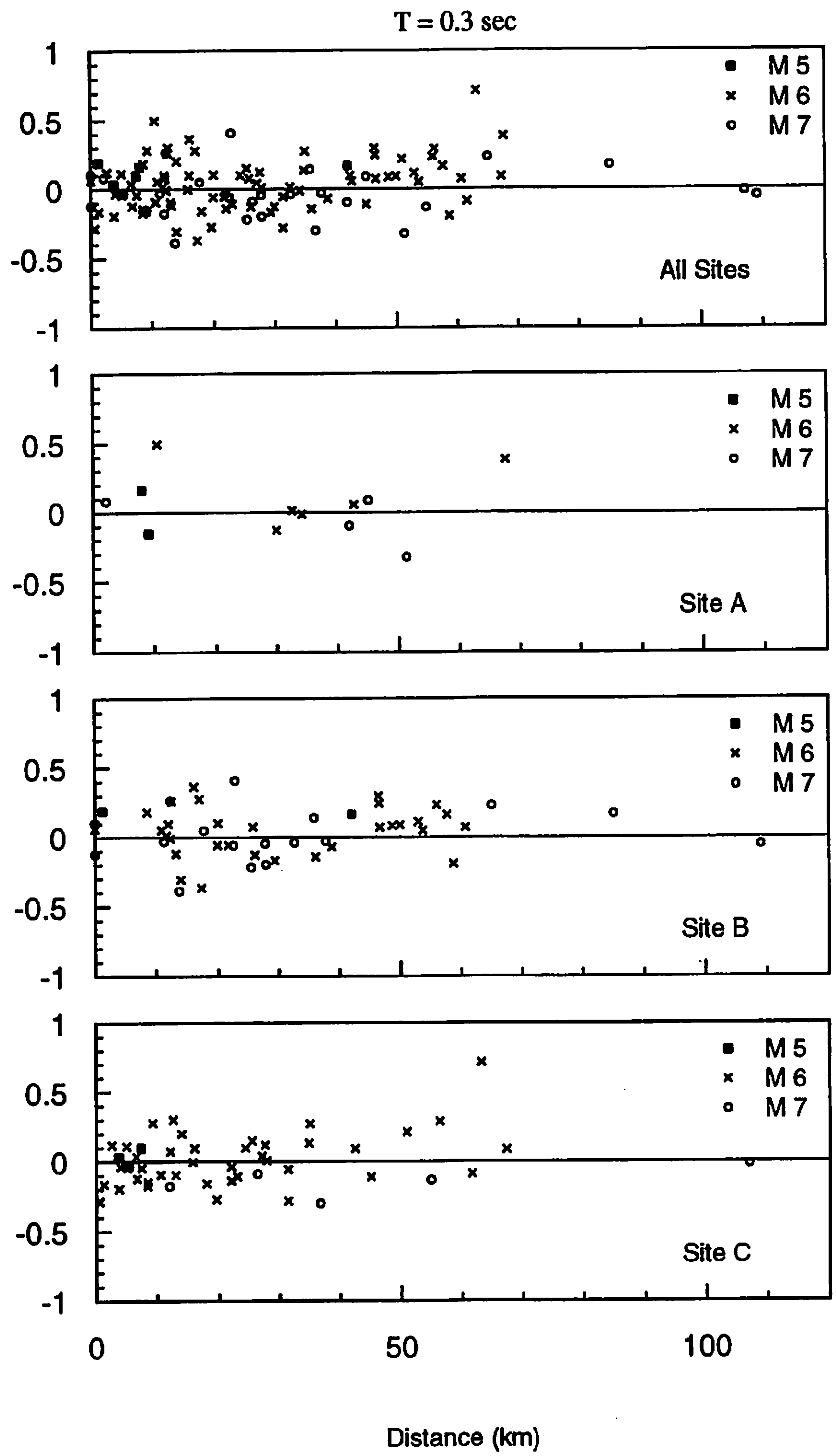

Figure 8a. Residuals ($\log Y_{observed} - \log Y_{predicted}$), as a function of distance for magnitude groups and site classes.

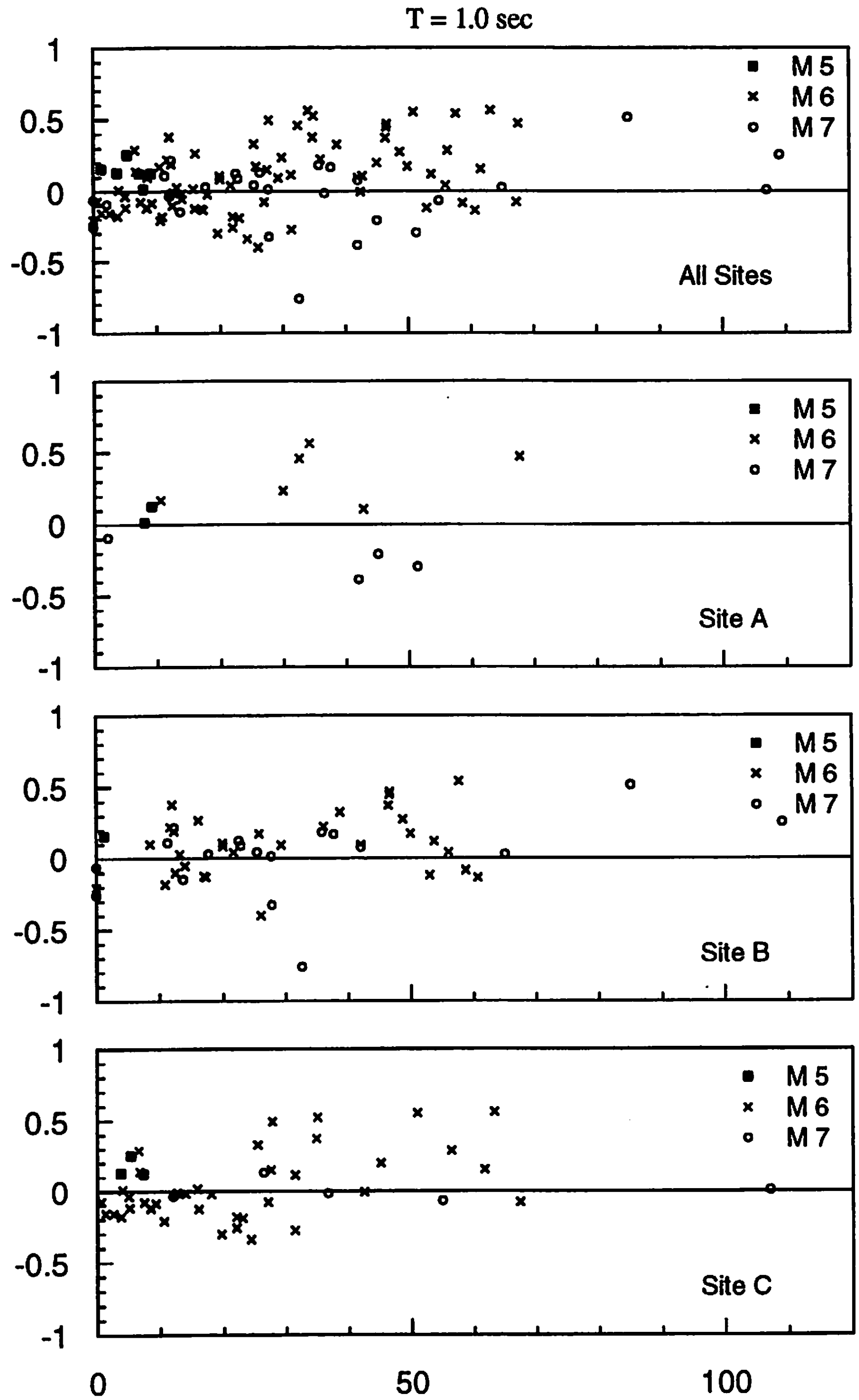

Figure 8b. Residuals ($\log Y_{observed} - \log Y_{predicted}$), as a function of distance for magnitude groups and site classes.

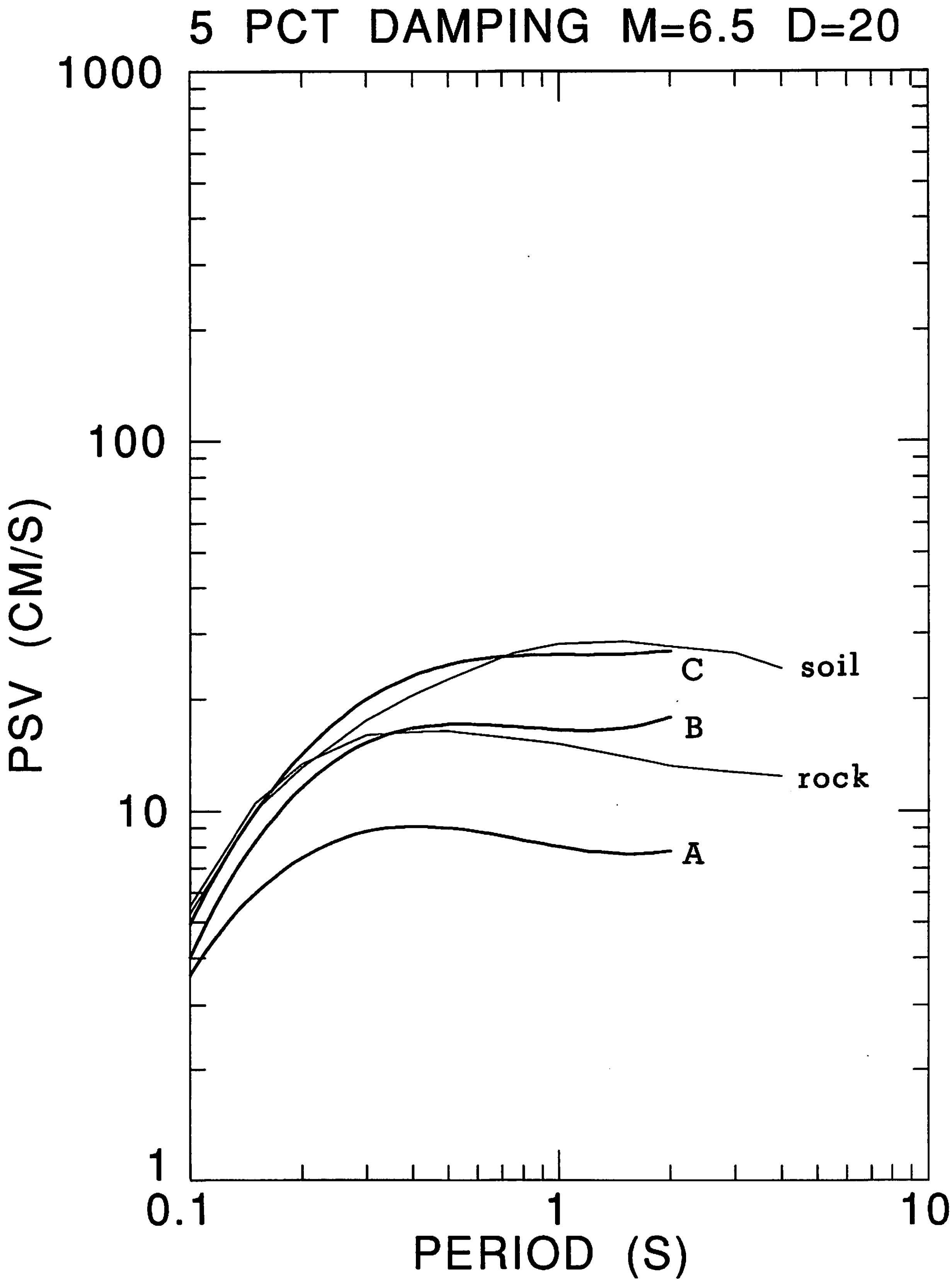

Figure 9a. Comparison of random component, 5 percent damped response spectra computed from our previous equations and our new equations for the various site classes.

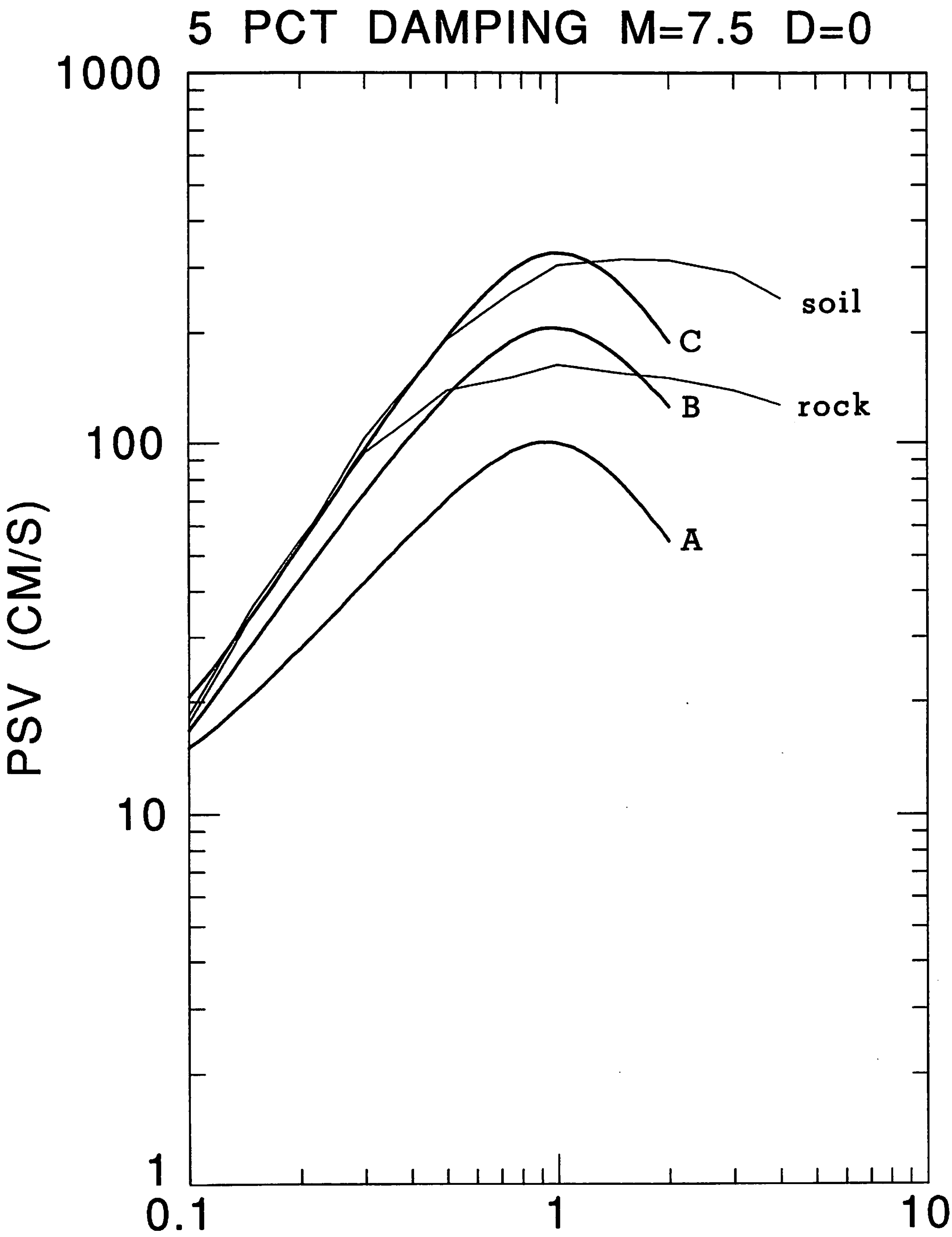

Figure 9b. Comparison of random component, 5 percent damped response spectra computed from our previous equations and our new equations for the various site classes.

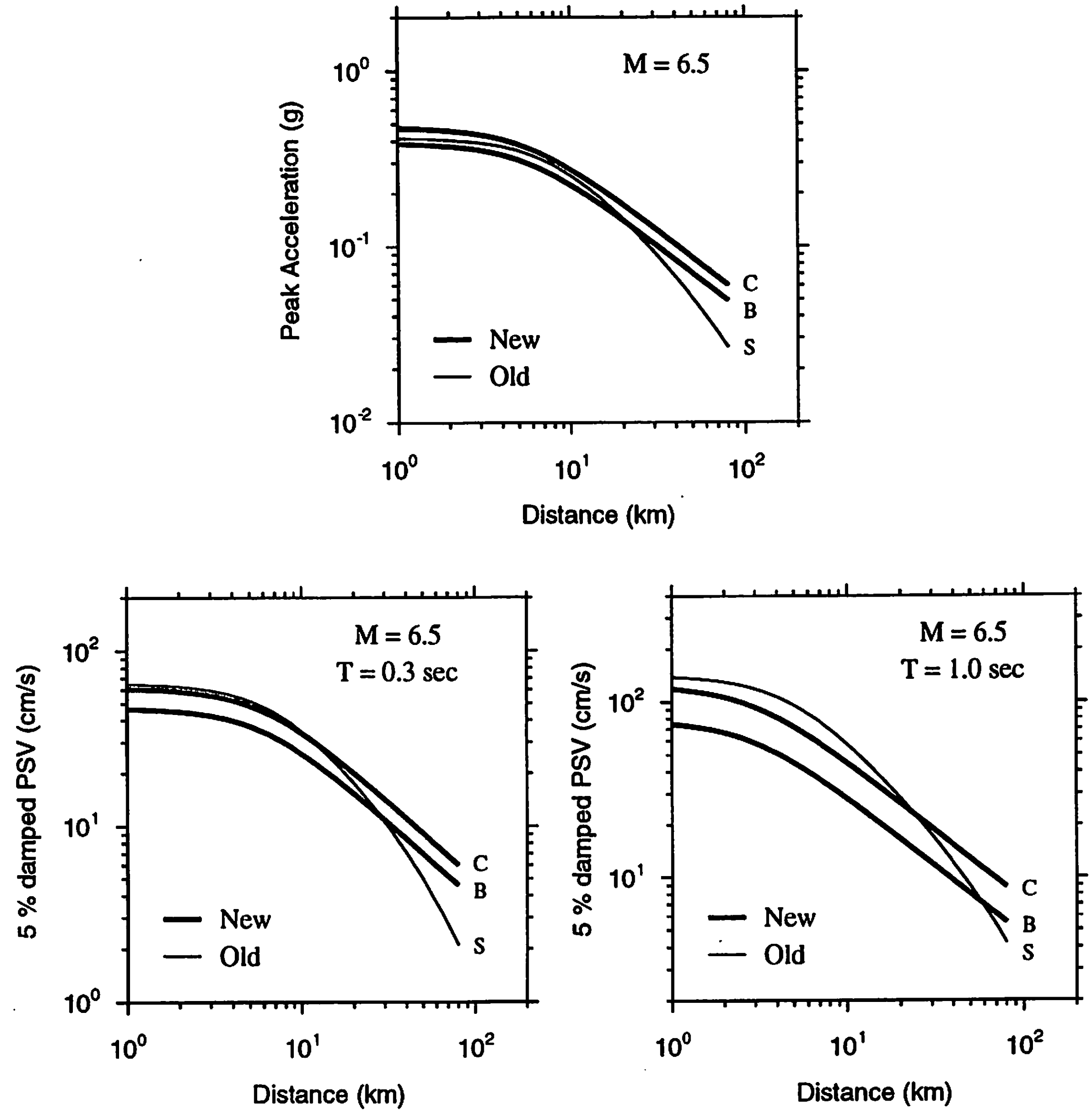

Figure 10a. Comparison of ground motions computed from our previous equations and our new equations as a function of distance for magnitudes 6.5 and 7.5 and soil site classes.

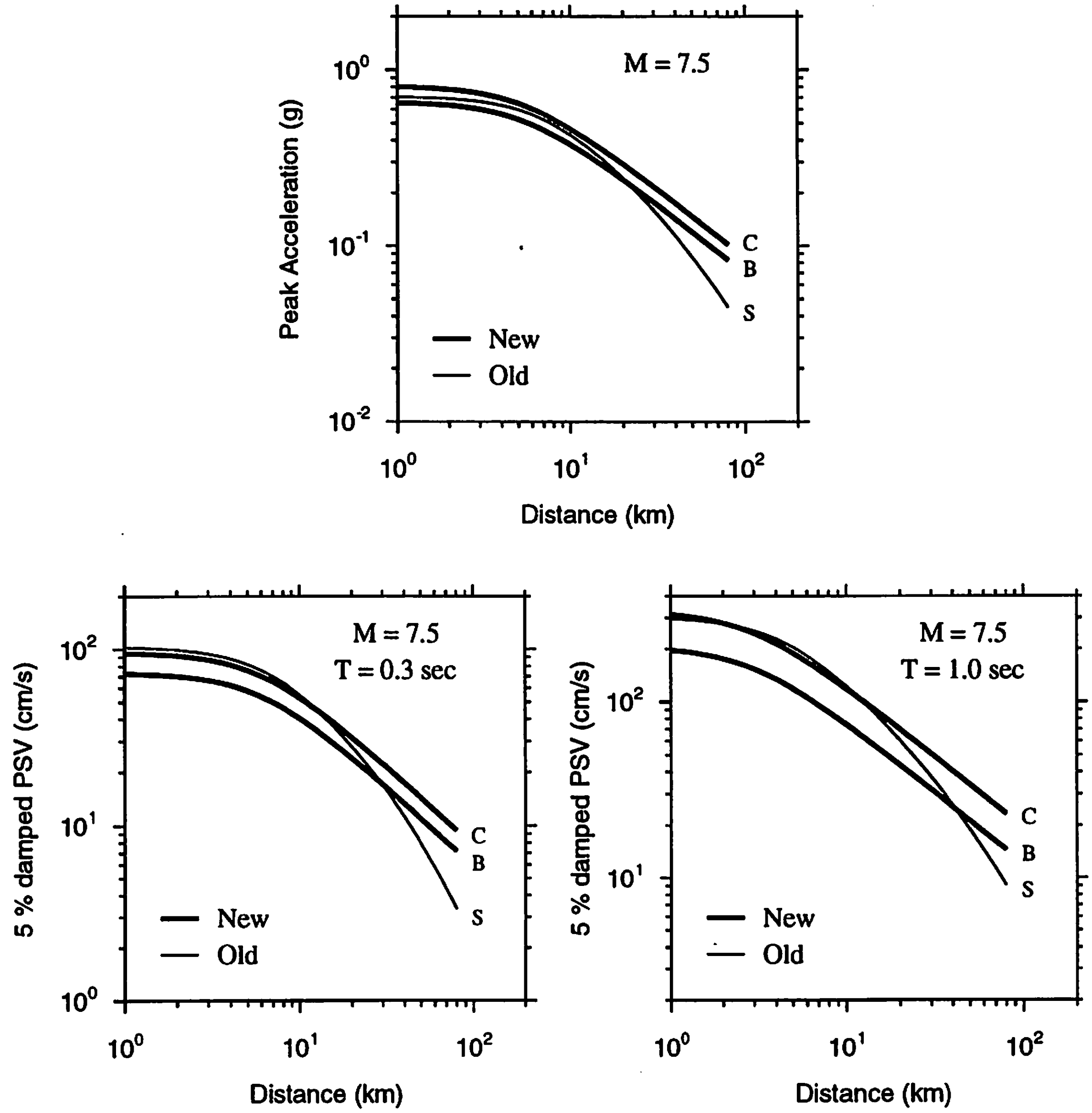

Figure 10b. Comparison of ground motions computed from our previous equations and our new equations as a function of distance for magnitudes 6.5 and 7.5 and soil site classes.

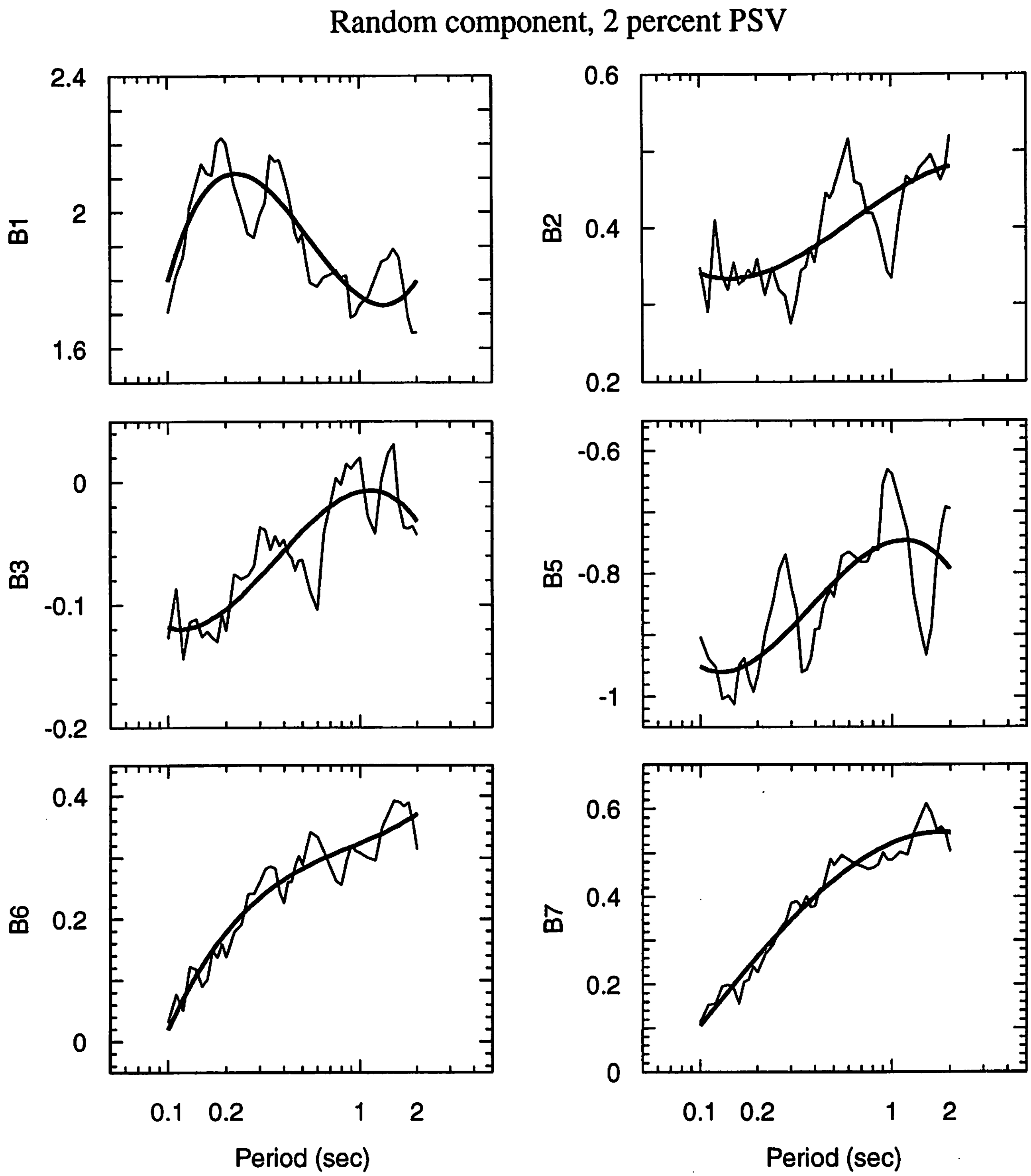

Figure A1a. Smoothed and unsmoothed regression coefficients.

Random component, 2 percent PSV

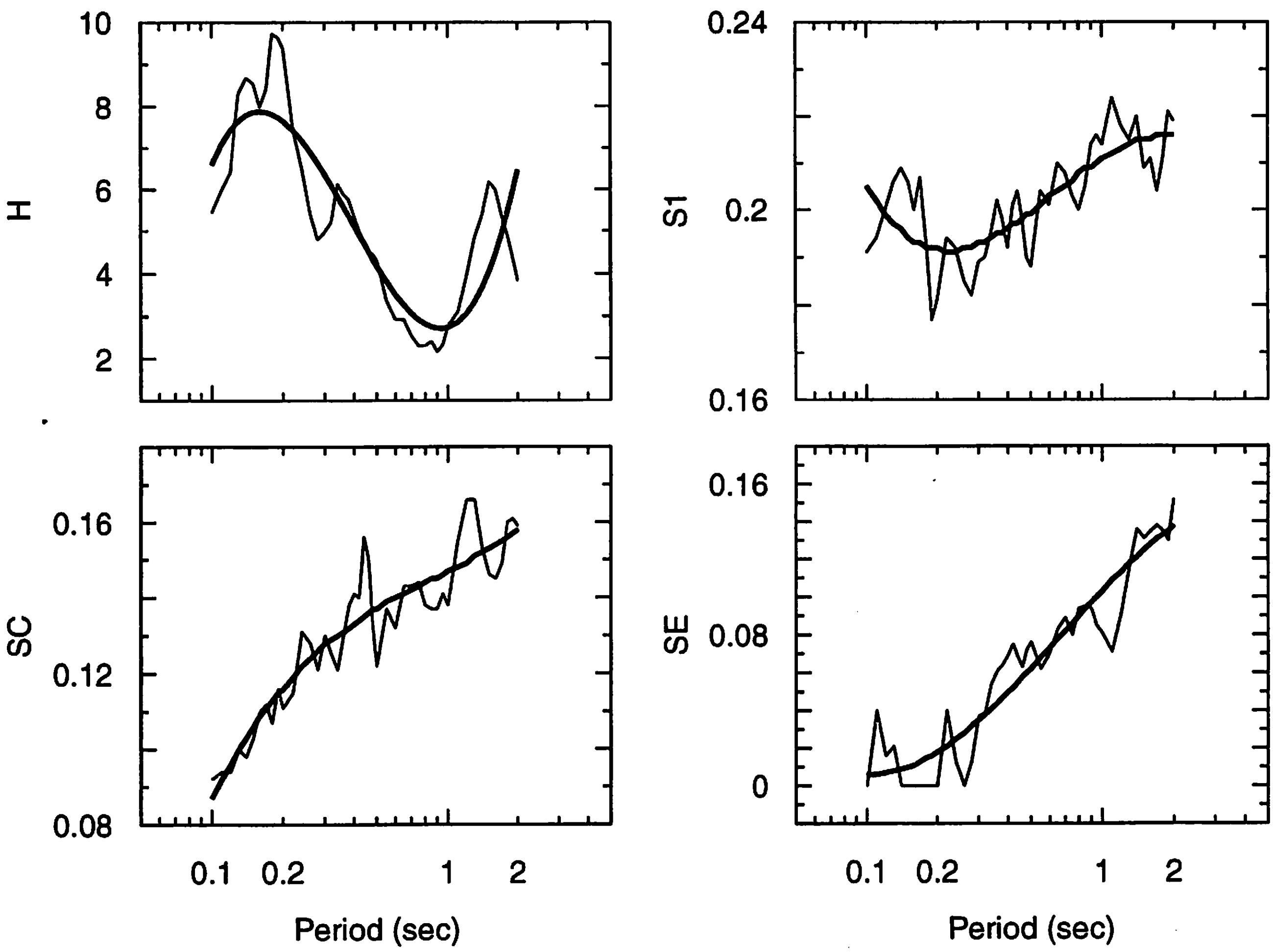

Figure A1b. Smoothed and unsmoothed regression coefficients.

Random component, 10 percent PSV

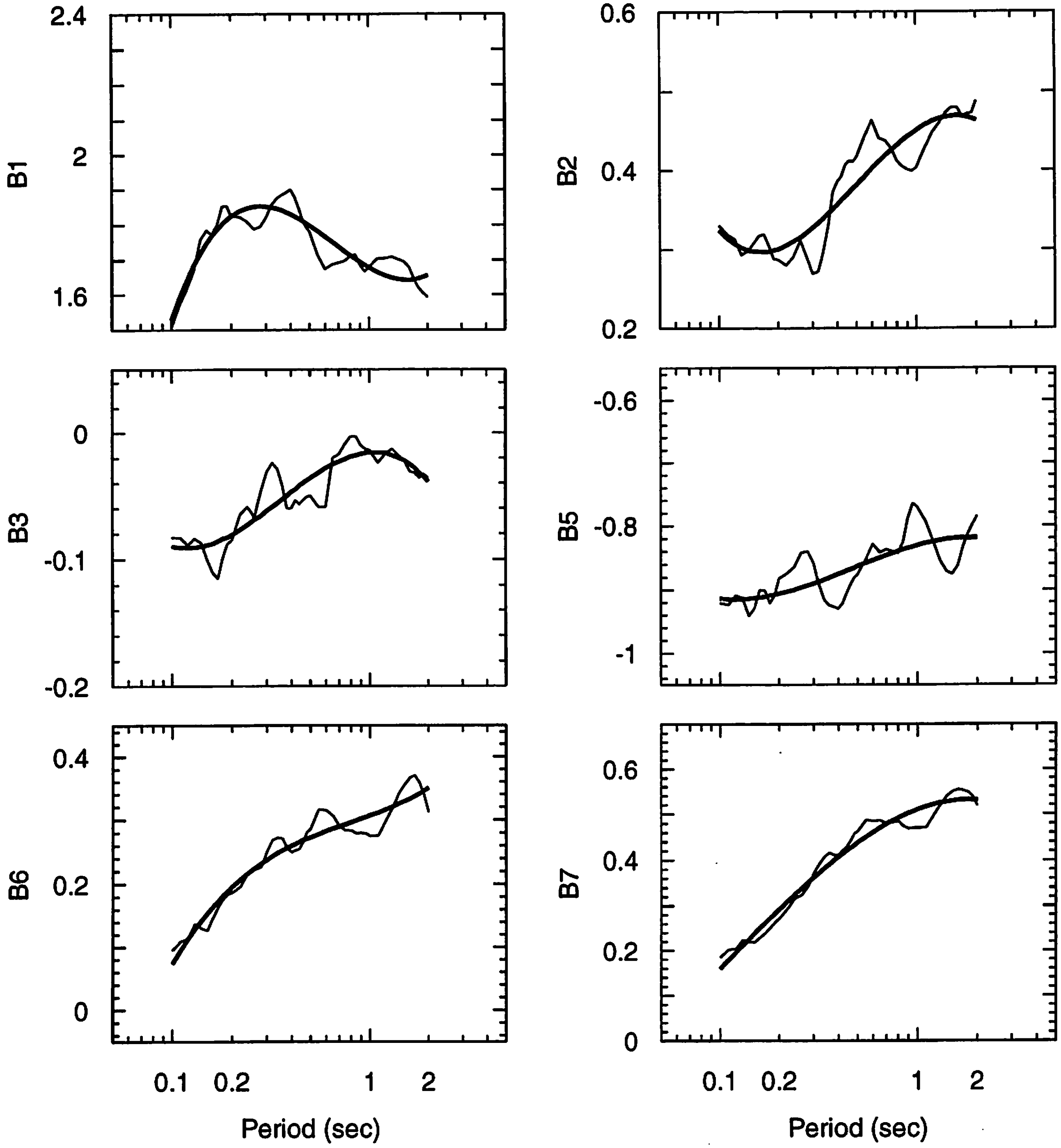

Figure A1c. Smoothed and unsmoothed regression coefficients.

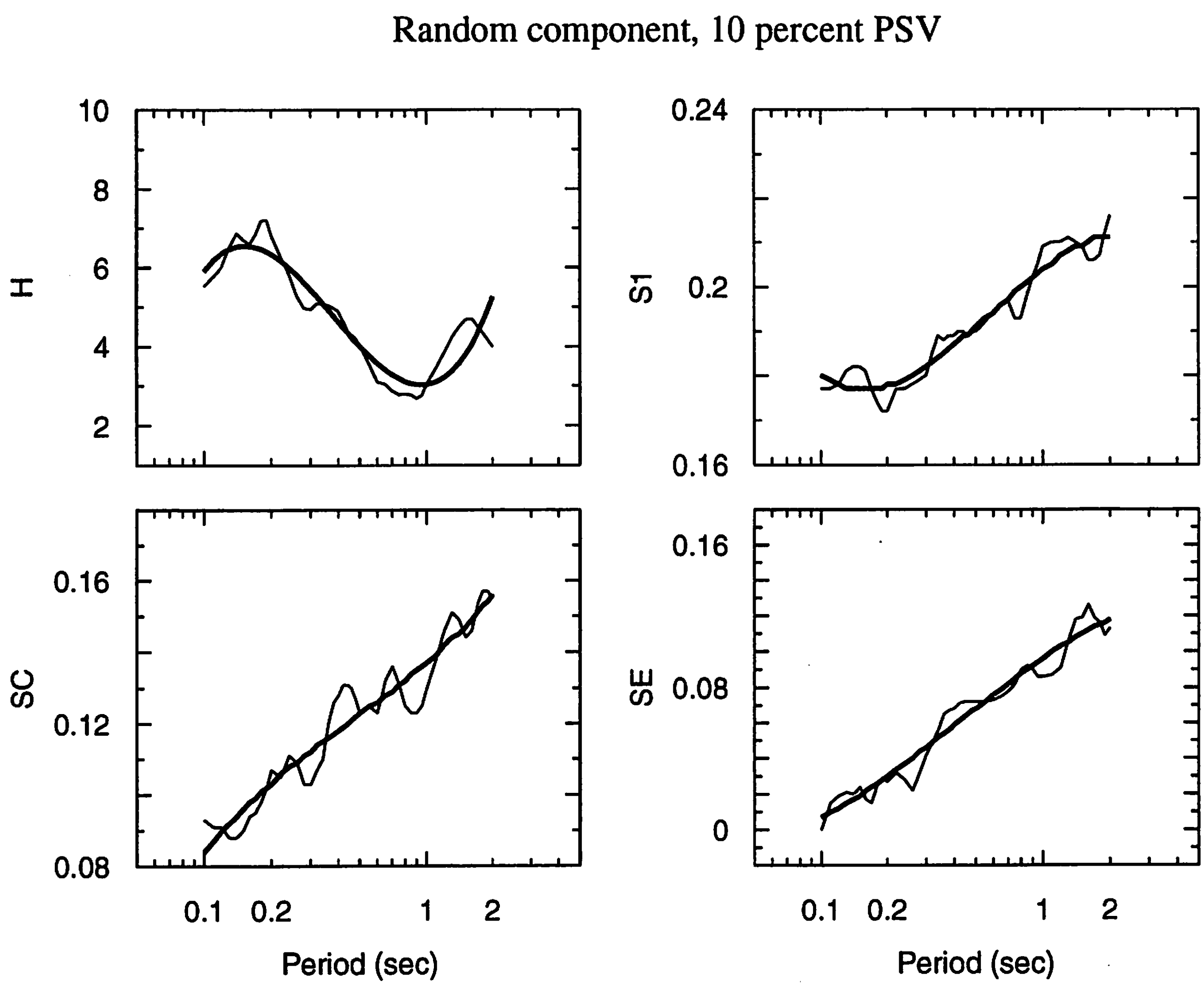

Figure A1d. Smoothed and unsmoothed regression coefficients.

Random component, 20 percent PSV

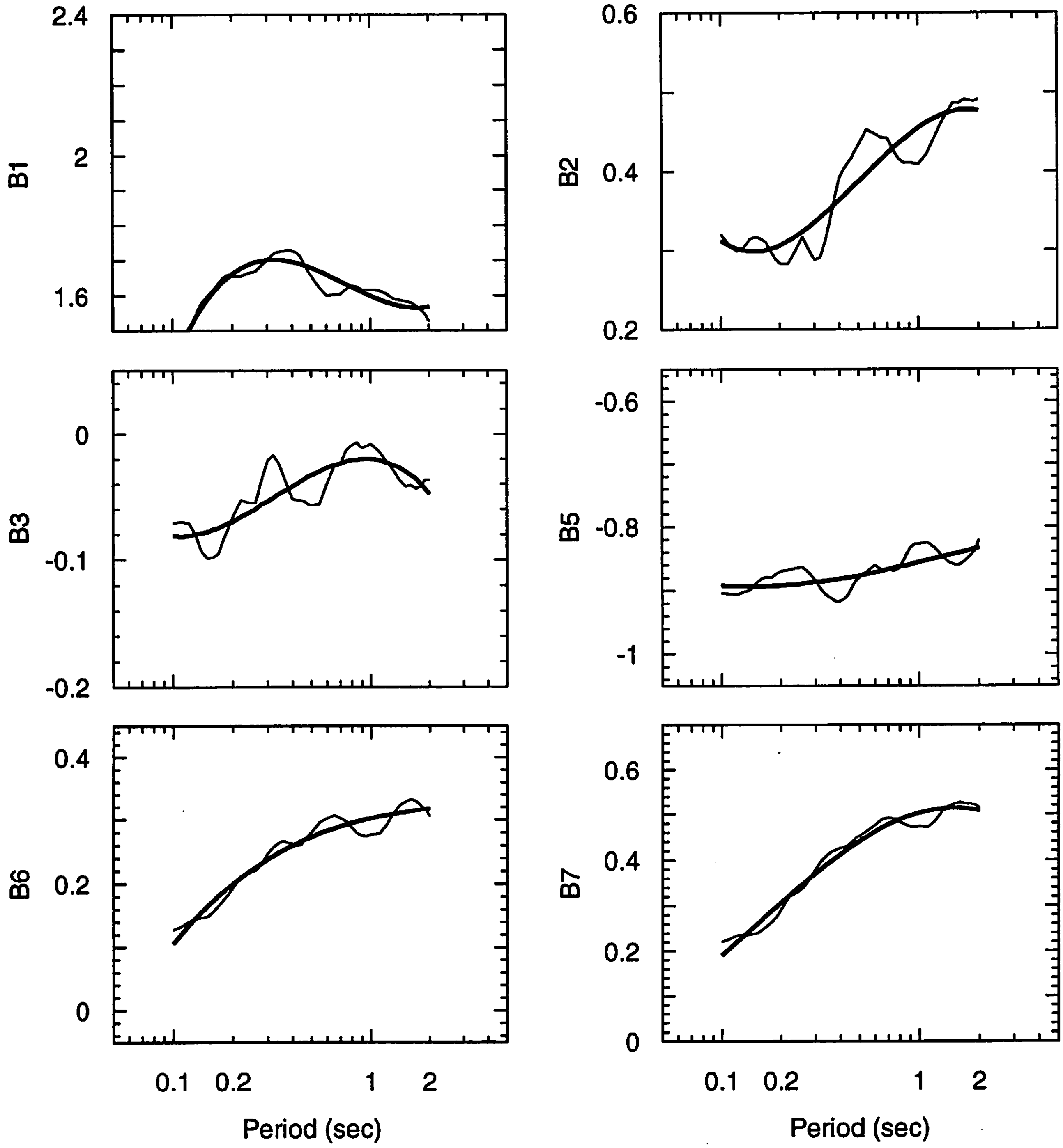

Figure A1e. Smoothed and unsmoothed regression coefficients.

Random component, 20 percent PSV

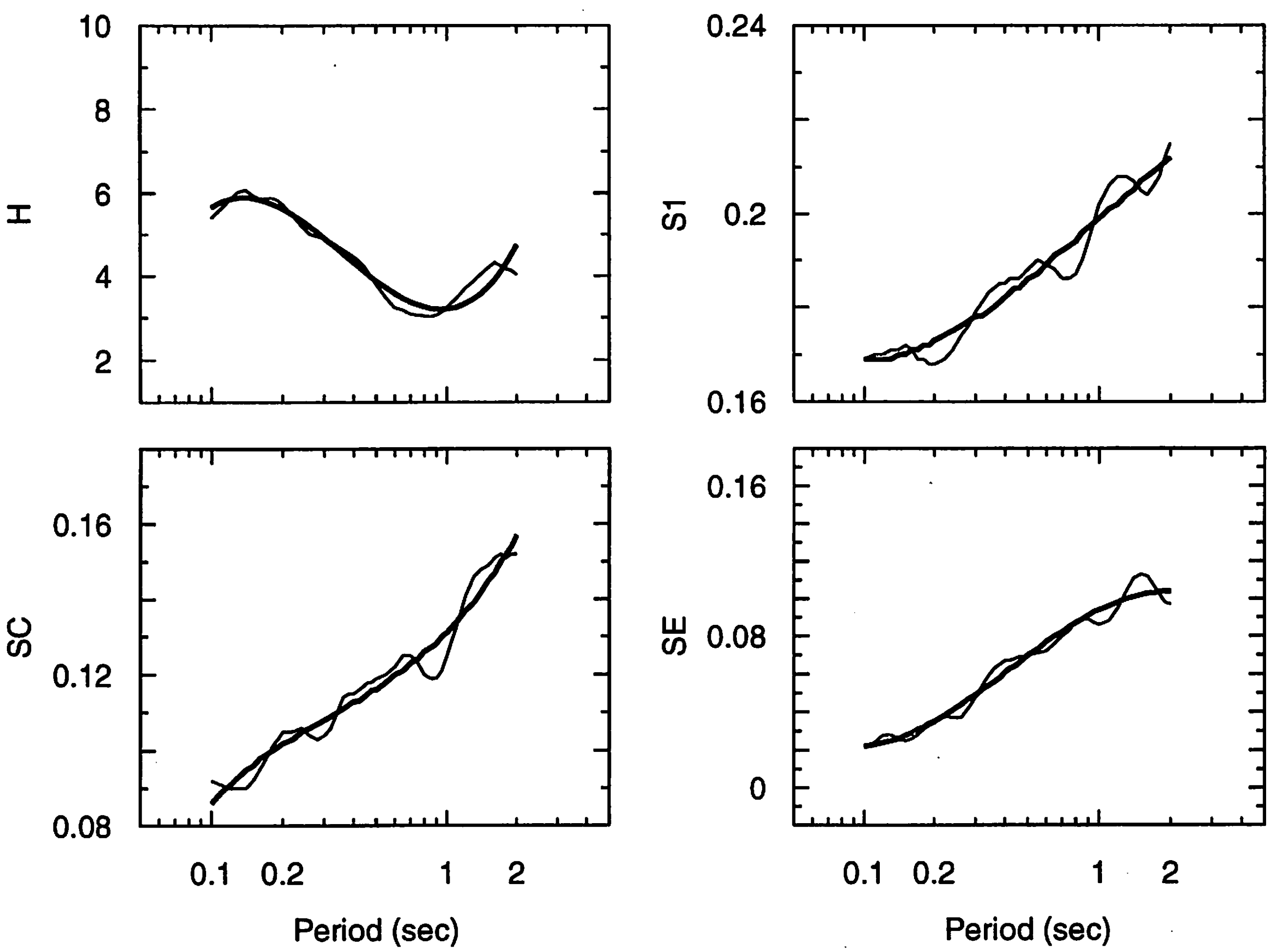

Figure A1f. Smoothed and unsmoothed regression coefficients.

Larger component, 2 percent PSV

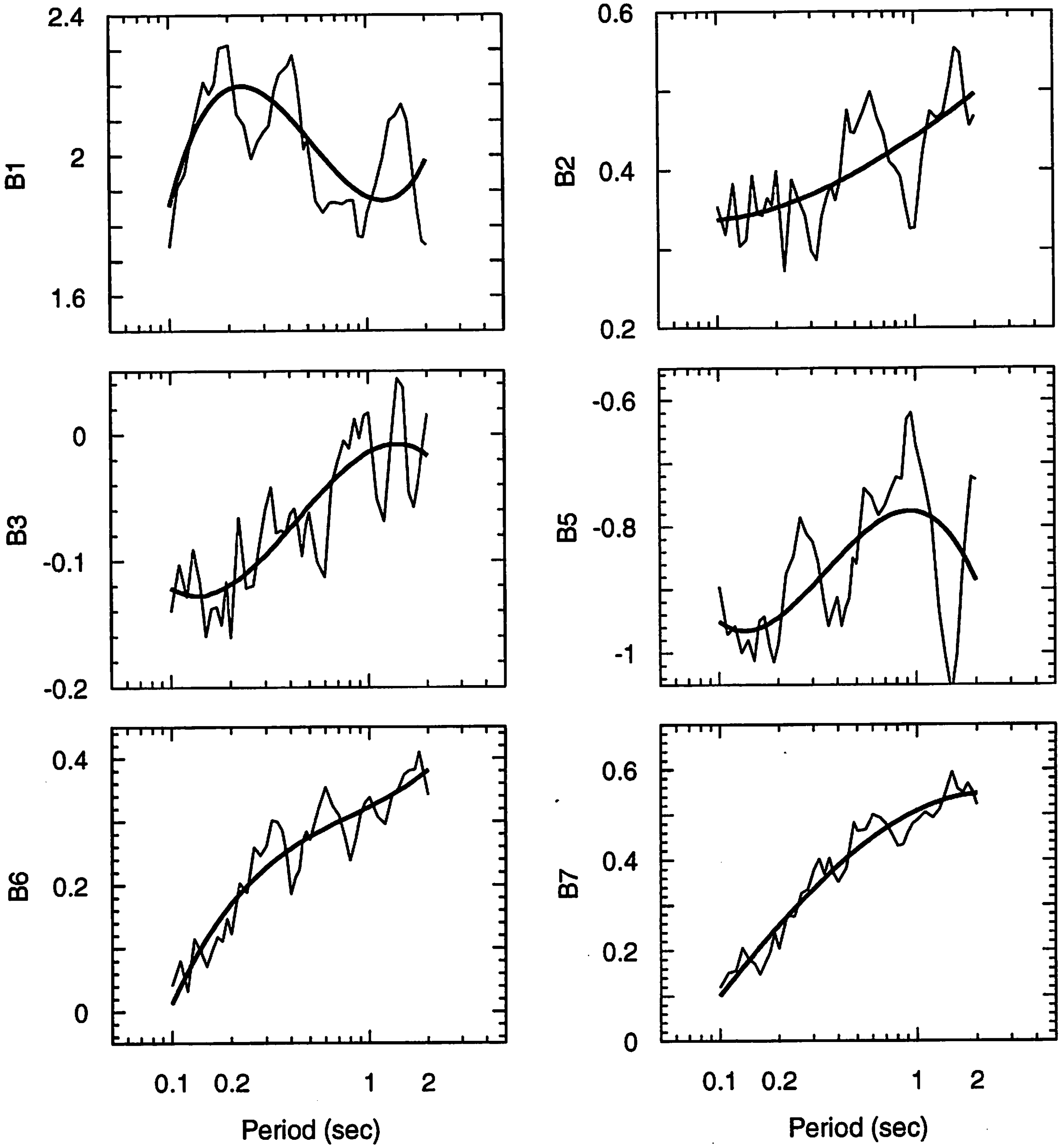

Figure A1g. Smoothed and unsmoothed regression coefficients.

Larger component, 2 percent PSV

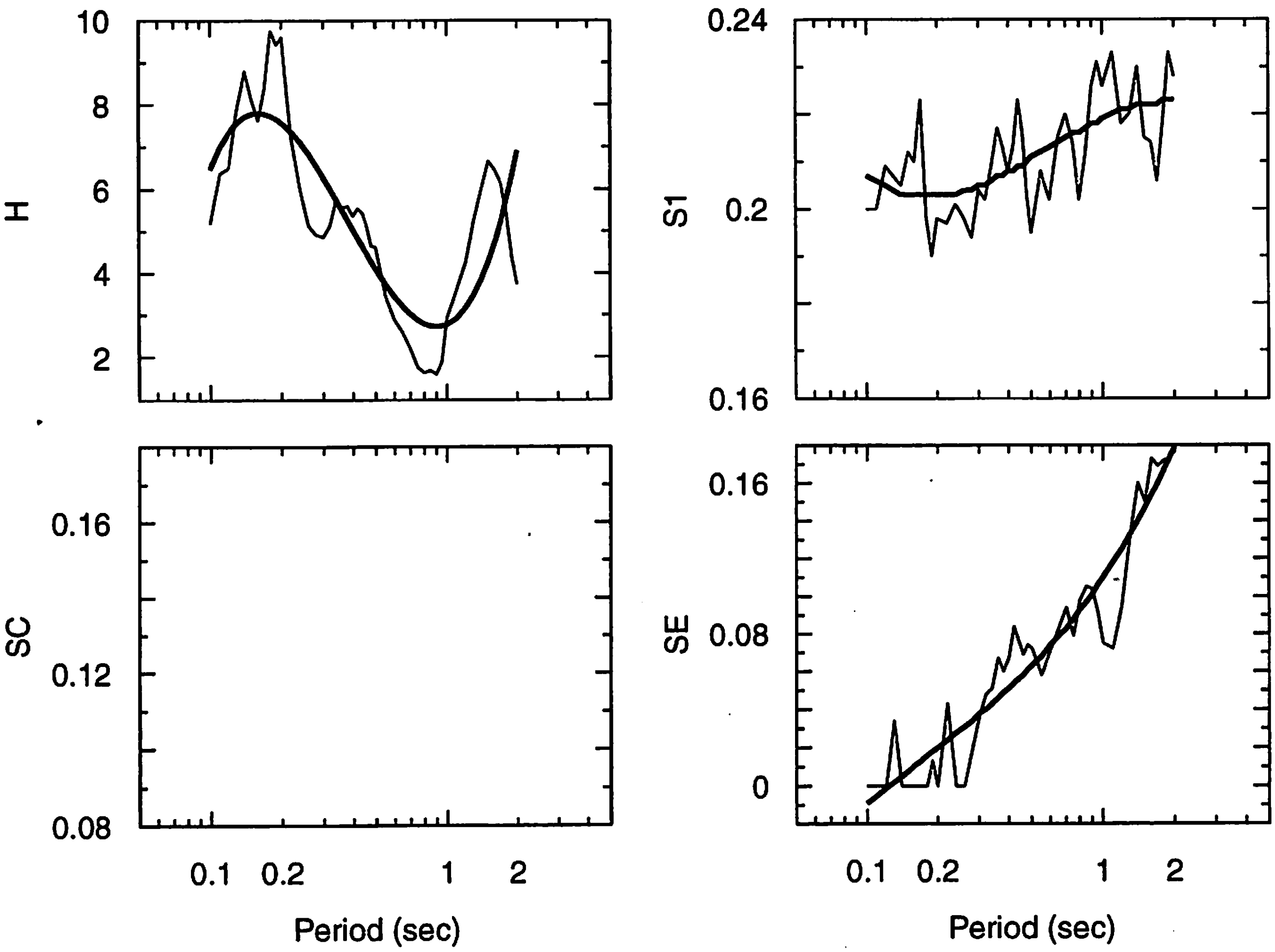

Figure A1h. Smoothed and unsmoothed regression coefficients.

Larger component, 5 percent PSV

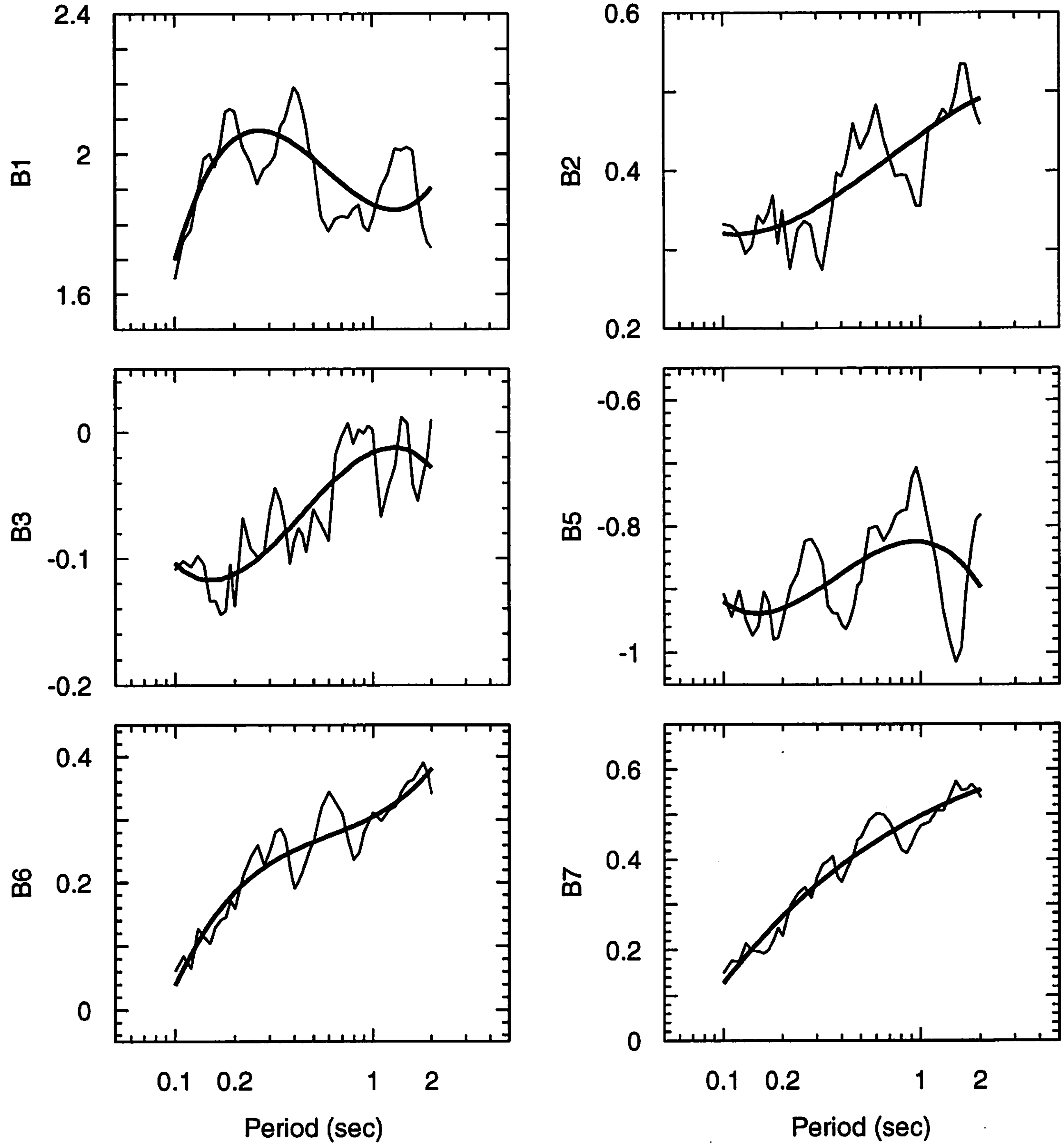

Figure A1i. Smoothed and unsmoothed regression coefficients.

Larger component, 5 percent PSV

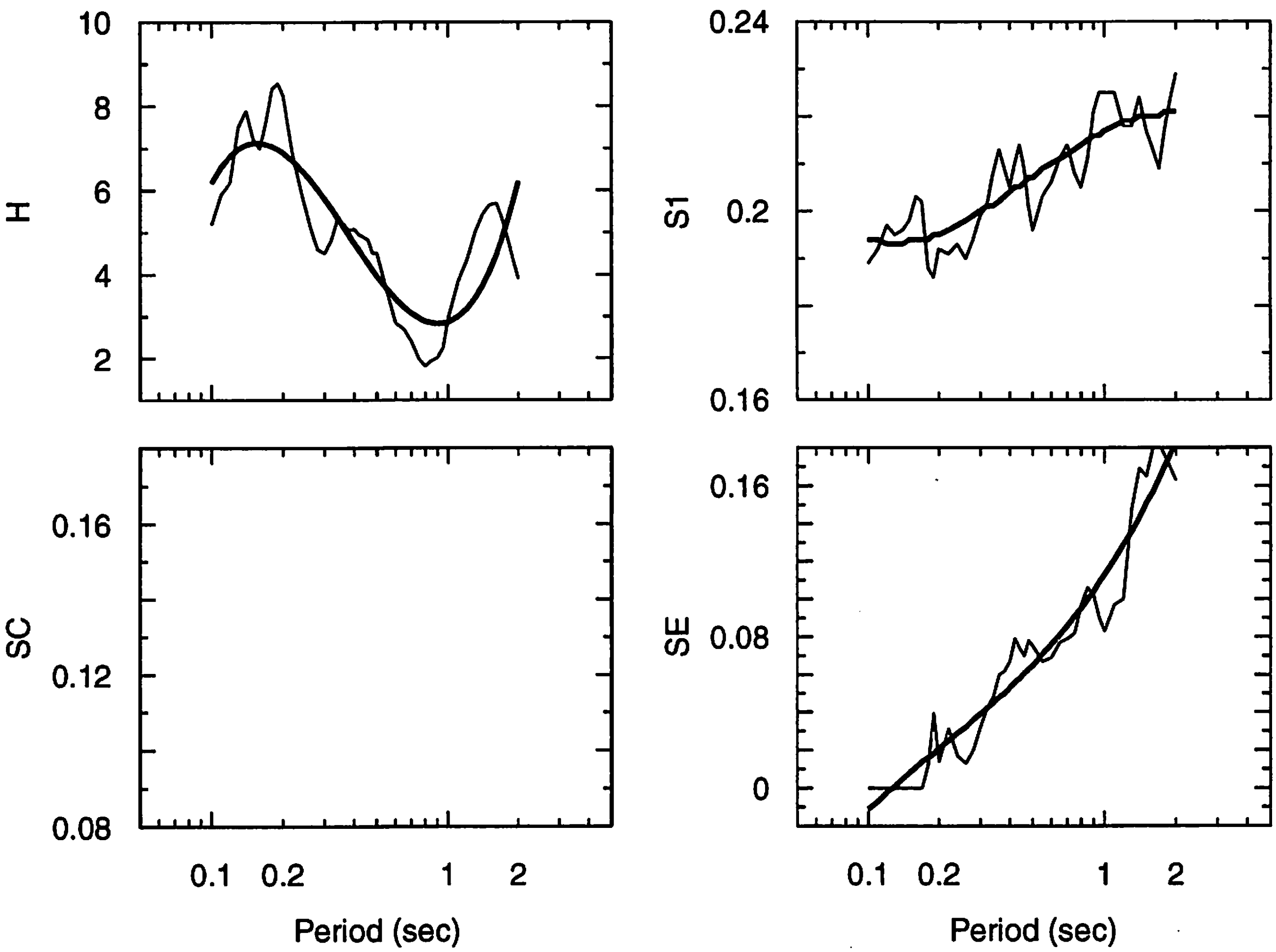

Figure A1j. Smoothed and unsmoothed regression coefficients.

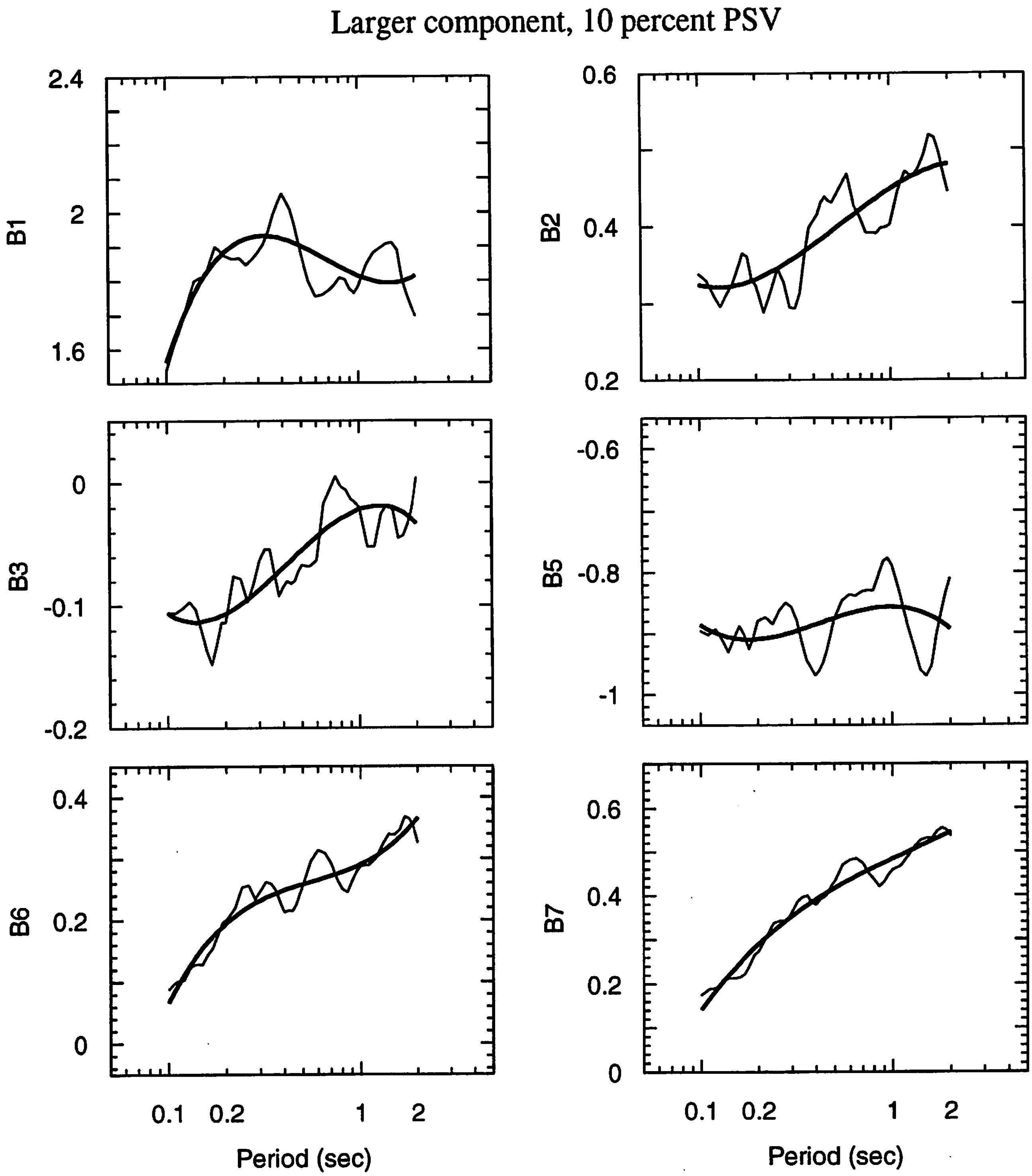

Figure A1k. Smoothed and unsmoothed regression coefficients.

Larger component, 10 percent PSV

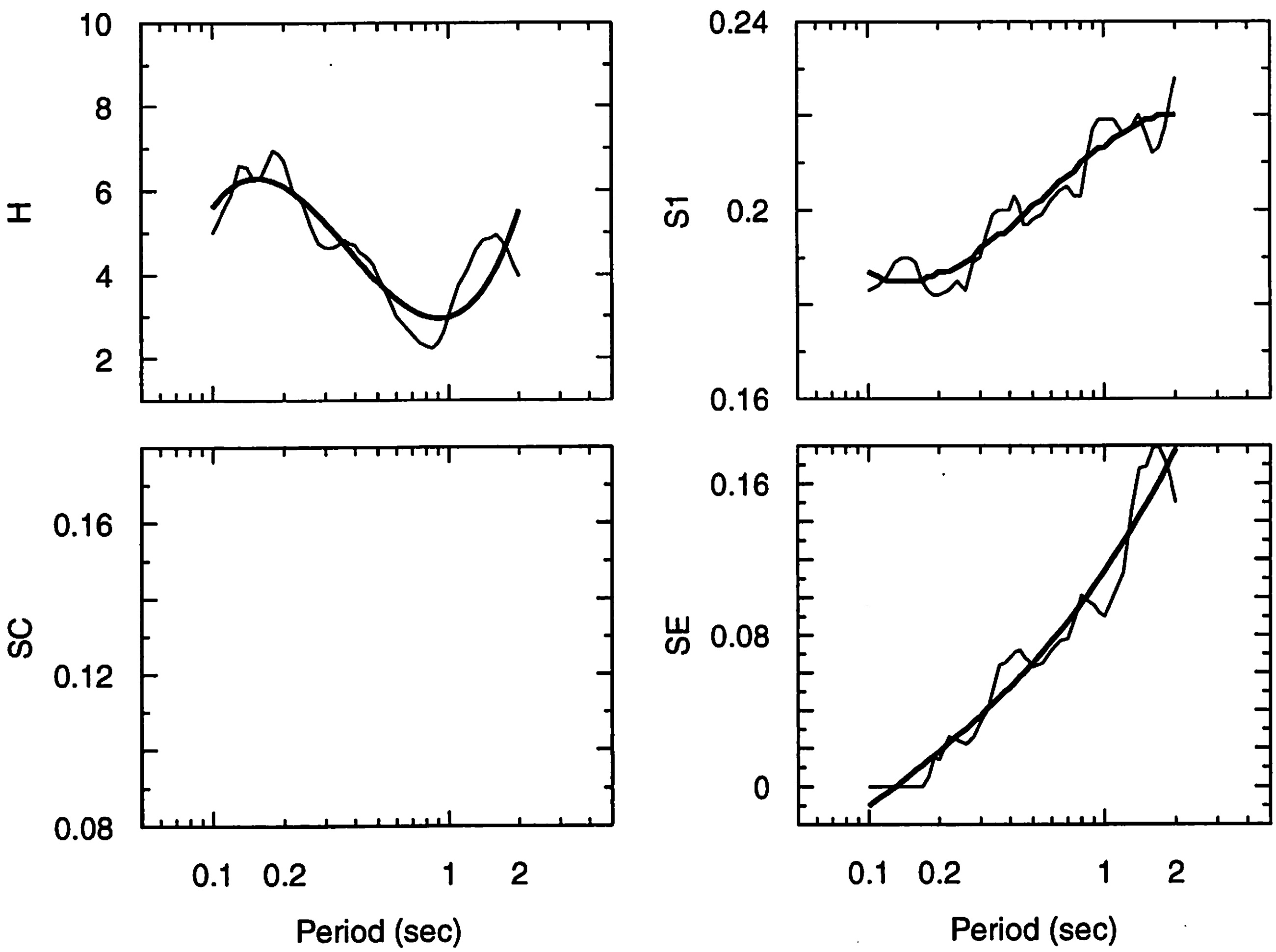

Figure A11. Smoothed and unsmoothed regression coefficients.

Larger component, 20 percent PSV

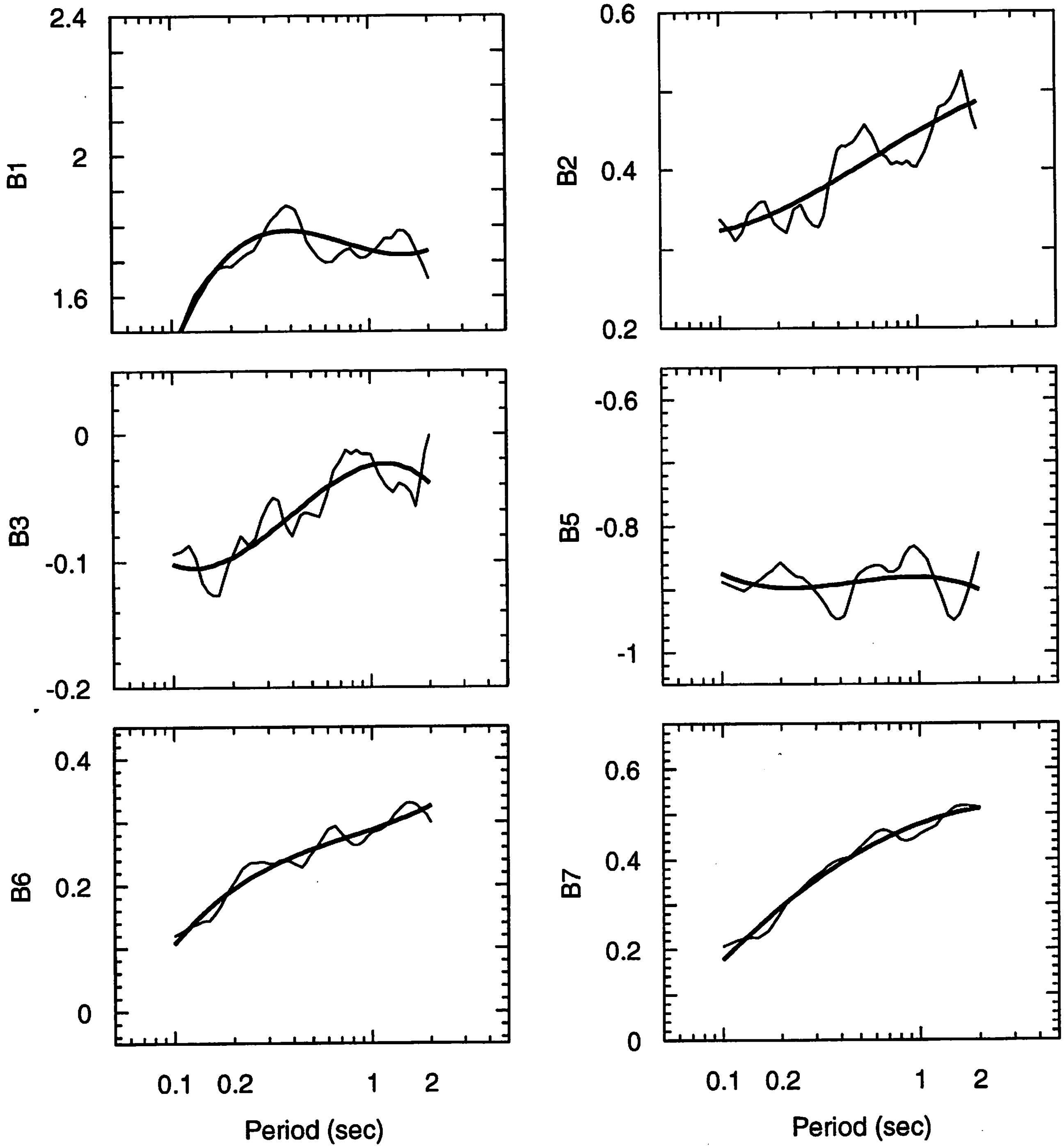

Figure A1m. Smoothed and unsmoothed regression coefficients.

Larger component, 20 percent PSV

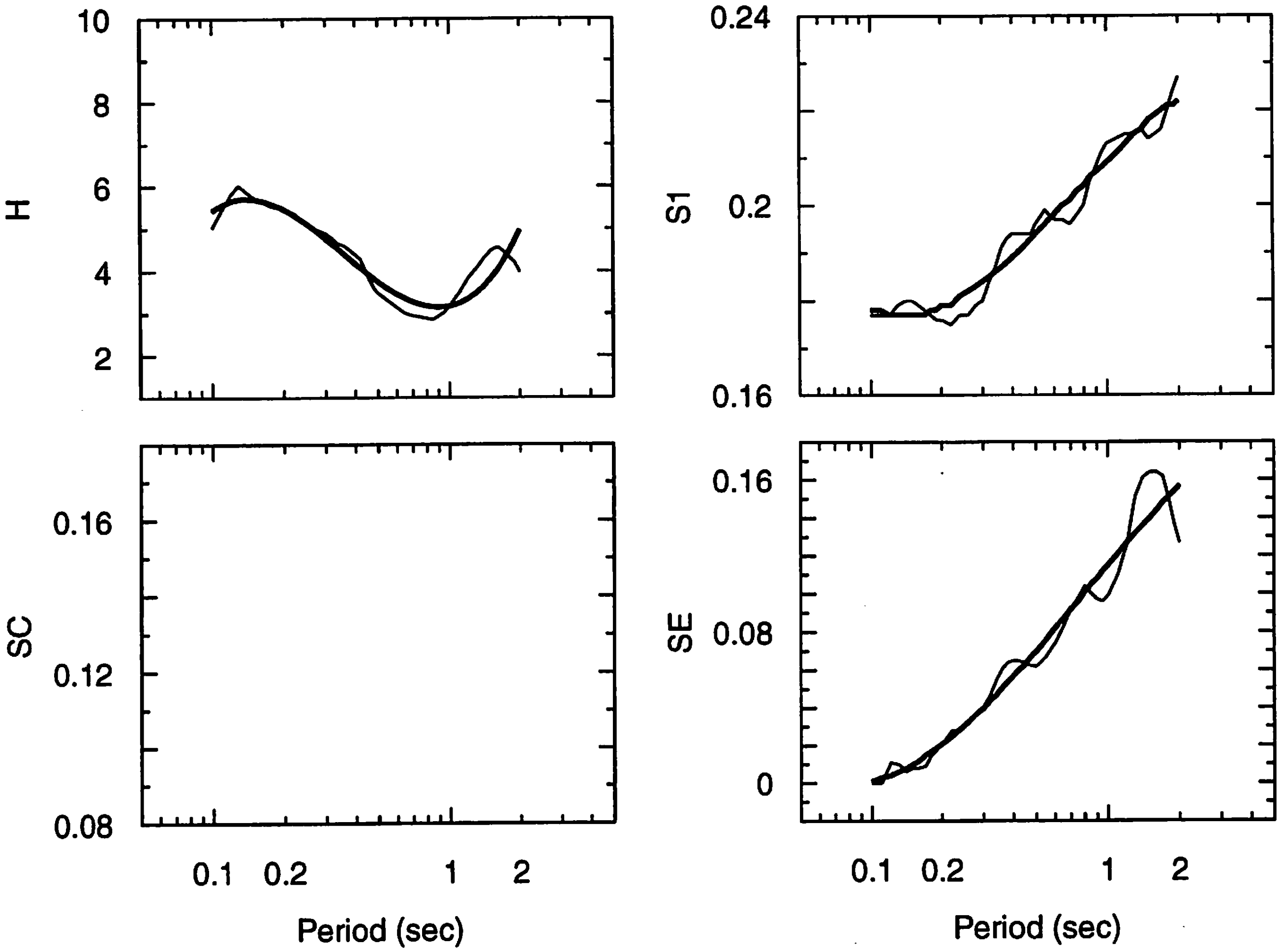

Figure A1n. Smoothed and unsmoothed regression coefficients.