Appendix A

Development of Generic Shallow Shear-Wave Velocity Profiles

Figure A1 shows the median Vs profile for Vs30 of 428 m/s and the measured Vs data from (Wong *et al*., 2011). This profile represents an "average" profile at strong-motion stations in Hawaii that consists generally of thin soil over weathered basalt over basalt. This was the only Vs30 profile used in the deep GMM model in Wong *et al*., 2015.

Subsequent to the development of the deep Hawaii earthquake GMM a need arose for GMMs in a broad range of NEHRP categories to support the National Seismic Hazard Mapping Program. These NEHRP categories are A (1,500 m/s), B (1,080 m/s), B/C (760 m/s), C (530 m/s), C/D (365 m/s), D (260 m/s), D/E (185 m/s), and E (150 m/s).

The measured Vs data (Figure A1) was used to guide the construction of generic NEHRP profiles. The range of measured Vs30 values is from 133 m/s (NEHRP E) to 580 m/s (NEHRP C) (Table 1). Hence generic NEHRP Vs30 profiles C (530 m/s), C/D (365 m/s), D (260 m/s), D/E (185 m/s), and E (150 m/s) use measured profiles from Hawaii in the generic profile development. In contrast, the stiffer profiles A (1,500 m/s), B (1,080 m/s), and B/C (760 m/s) are constructed using NGA-W2 profiles from Kamai *et al.* (2013 and 2016) since there are currently no measured profiles with these Vs30s in Hawaii.

Also, it is very unlikely that there is a location on the Big Island that has a V_S30 of 760 m/s or higher as supported by the measured V_S30 values in Wong *et al*. (2011) having a maximum V_S30 of 580 m/s. However, GMMs for these stiffer profiles are required for implementation in the National Seismic Hazard Map for Hawaii.

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Five constraints were imposed in the development of the generic Vs models. First, the Vs at the surface increased with increasing Vs30. Second, the depth to rock (unweathered basalt with measured Vs of 500 to 650 m/s (Wong *et al*., 2011) was assumed to decrease as Vs30 increased. Third, the profiles were not allowed to cross in roughly the top 30 to 40 m, which is generally above the unweathered basalt section of the profile. In the deeper basalt section there were some minor cross-overs in the velocity between profiles caused by the different depths that the measured profiles for each of the Vs30 profiles from 150 to 530 m/s reached unweathered basalt (this is basically a shallow basin depth). Fourth, a regional crustal model (Wong *et al.*, 2015) was placed at the bottom of each profile to extend the profile down to seismogenic depths ranging from about 4 (shallow crustal) to 50 (deep) km. Fifth, the maximum soil and weathered basalt depth was constrained to be either 35 or 40 m. This range is from the measured profiles (Tables 1 and 3 of Wong *et al*., 2011) and an estimated maximum soil thickness in Hilo of about 30 m. The measured profile at the USDA Laboratory in Hilo had 35 m of very soft and soft soil (Wong *et al*., 2011). Development of the eight Vs30 NEHRP profiles is discussed individually below:

Vs30 185 and 150 m/s

These two profiles used the slower USDA Laboratory measured Vs profile as a model (Figure A2) and then the deeper sections are from the median 428 m/s model and the regional crustal model.

Vs30 260 m/s

Figure A3 shows the 260 m/s site class D profile compared to two measured profiles at Stations 2833 and 2836 (Wong *et al*., 2011) with Vs30 of 306 and 271 m/s, respectively. Both of the measured profiles have Vs30 greater than the target Vs30. The Vs30 for the mean profile is 267 m/s and the profile follows the measured profiles with a slight bias to lower Vs values, as appropriate above 40 m. Below 40 m, the mean profile follows the faster gradient imposed by the Vs30 365 m/s profile in Figure A4 (that was based on eight measurements). The generic profile does not capture the thick (~ 50 m) layer of lower velocity material (near 600 m/s) because the measured soft profile at the USDA Laboratory reaches 600 m/s near 35 m (Figure A2). Some of this variability (epistemic) in the measured Vs compared to the generic NEHRP Vs profiles is captured in the profile randomization that includes both velocity and depth to the regional crustal model (Wong *et al*., 2015). For example, for this profile the depth to the regional crustal model was randomized between 106 and 210 m.

Vs30 365 m/s

Figure A4 shows the 365 m/s site class C/D profile compared to nine measured profiles (Wong *et al*., 2011). The measured profiles range in Vs30 from 331 to 367 m/s with eight of the profiles having Vs30 less than 365 m/s. The Vs30 for the mean profile is 364 m/s and the profile follows the measured profiles with a slight bias to higher Vs values, as appropriate.

Vs30 530 m/s

Figure A5 shows the 530 m/s site class C profile compared to the two measured profiles at stations 2817 and 2852 (Table 1 of Wong *et al.*, 2011) with Vs30 values of 492 and 580 m/s, respectively. The Vs30 average of the two profiles is 536 m/s, close to the NEHRP target value of 530 m/s. Due to the constraints discussed above the Vs30 for this mean profile is slightly lower at 521 m/s and in general, the profile follows the two measured profiles to their maximum depth.

Vs30 760, 1,080 and 1,500 m/s

The Vs profile for the stiffest sites, 1,500 (NEHRP A), 1,080 (NEHRP B) and 760 m/s (NEHRP B/C), was modified from NGA-West2 western North America (WNA) Vs profiles in Kamai *et al*. (2013; 2016) and is shown in Figures A6, A7 and A8.

These profiles merge with the regional crustal model (Vs=1,200 m/s) at depths of about 45, 12.2 and 0 m for Vs30 760, 1,080 and 1,500 m/s, respectively. A gradient has been added to the top of the Vs30 1,500 m/s model starting at 1,225 m/s and reaching 1,550 m/s at a depth of 6.1 m. Note it is very unlikely that there is a location on the Big Island that has a V_S30 of 760 m/s or higher as supported by the measured V_S30 values in Wong *et al*. (2011) with a maximum V_S30 of 580 m/s. However, these stiffer profiles are required by the USGS for implementation in the National Seismic Hazard Mapping Program.

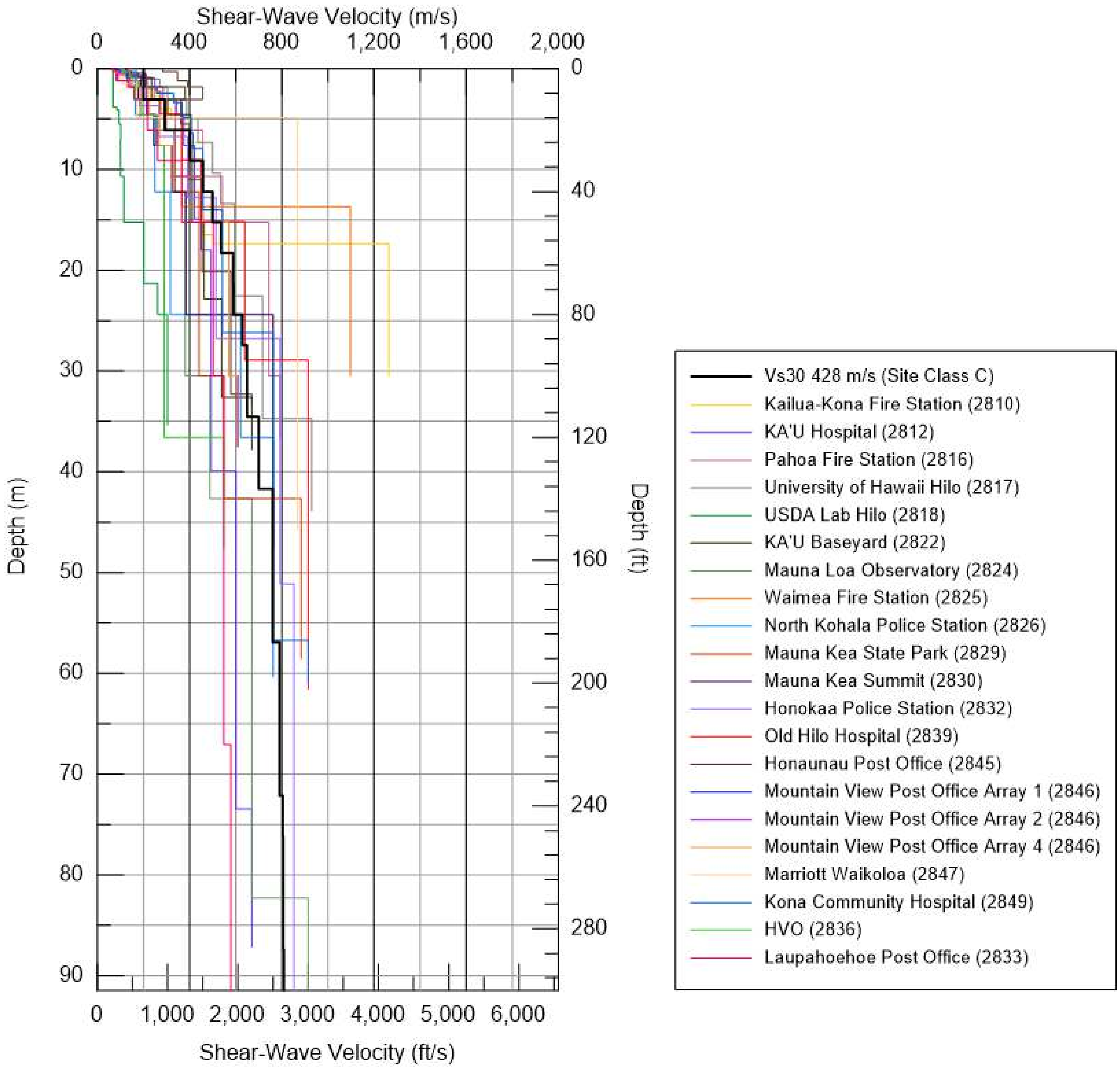

Figure A1. Median Vs profile for Vs30 428 m/s and measured Vs profiles from Wong *et al.* (2011) (modified from Wong *et al.*, 2015).

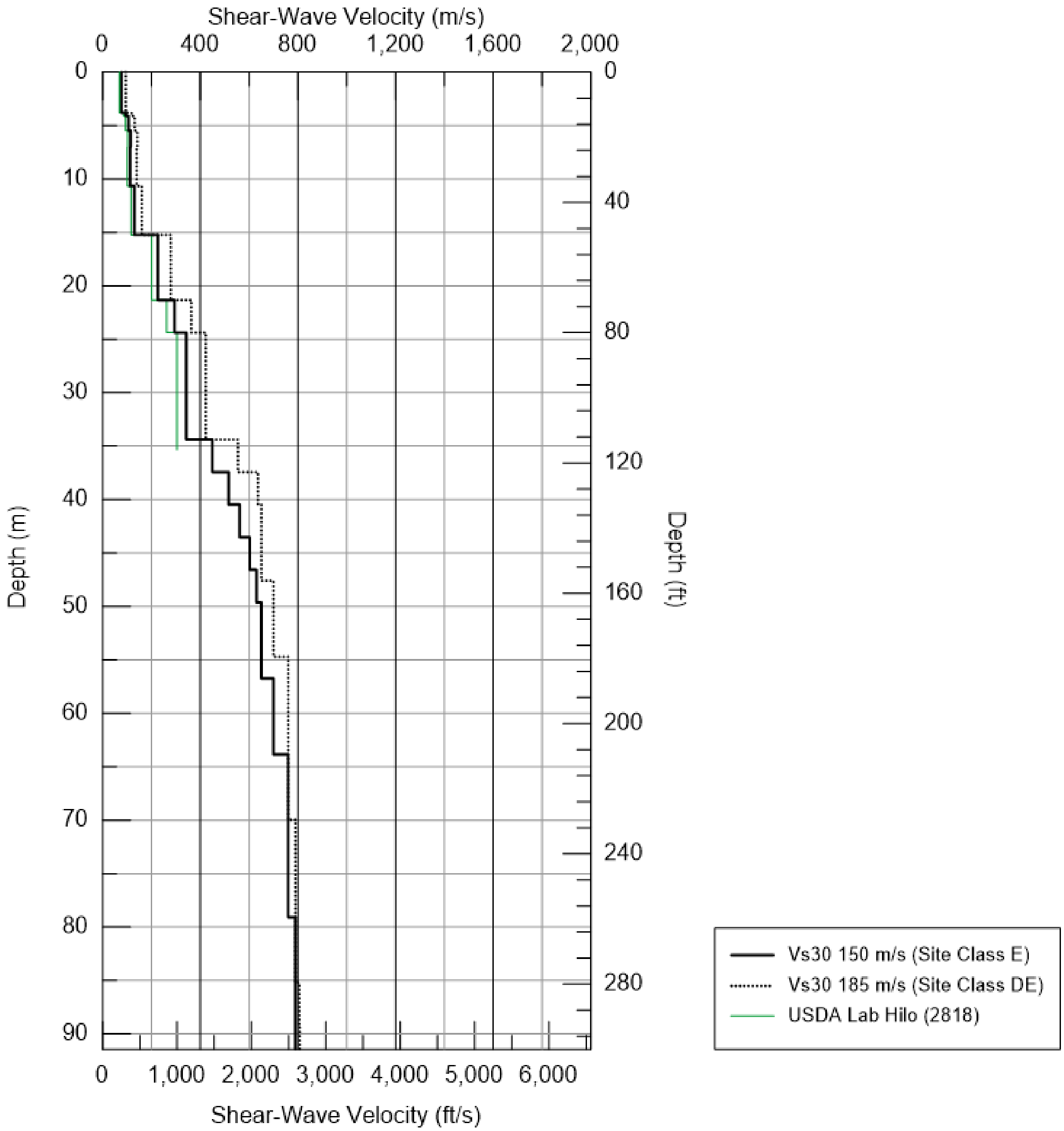

Figure A2. Median Vs profile for Vs30 150 and 185 m/s, and one measured Vs profile from Wong *et al.* (2011).

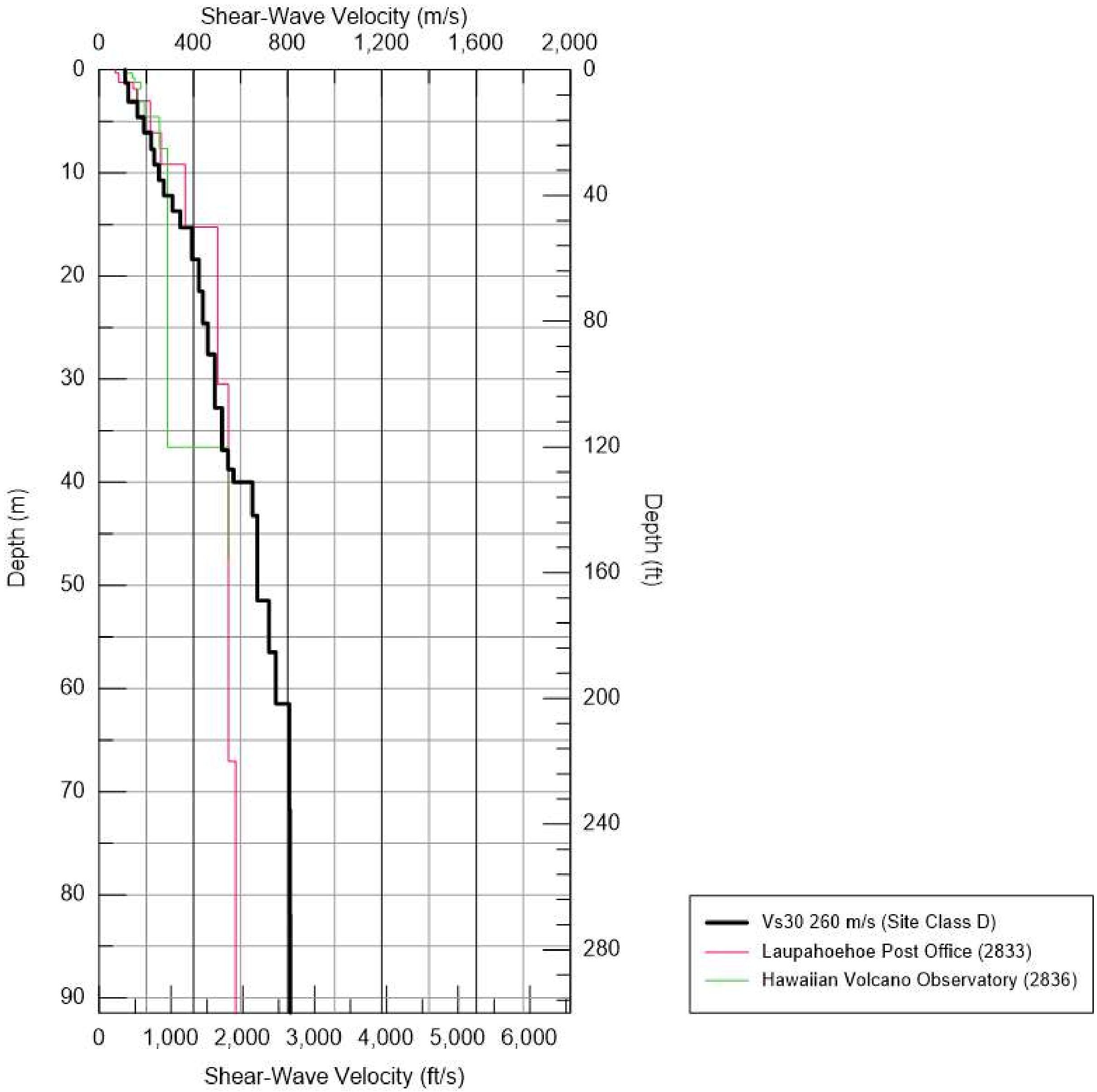

Figure A3. Median Vs profile for Vs30 260 m/s and measured Vs profiles from Wong *et al.* (2011).

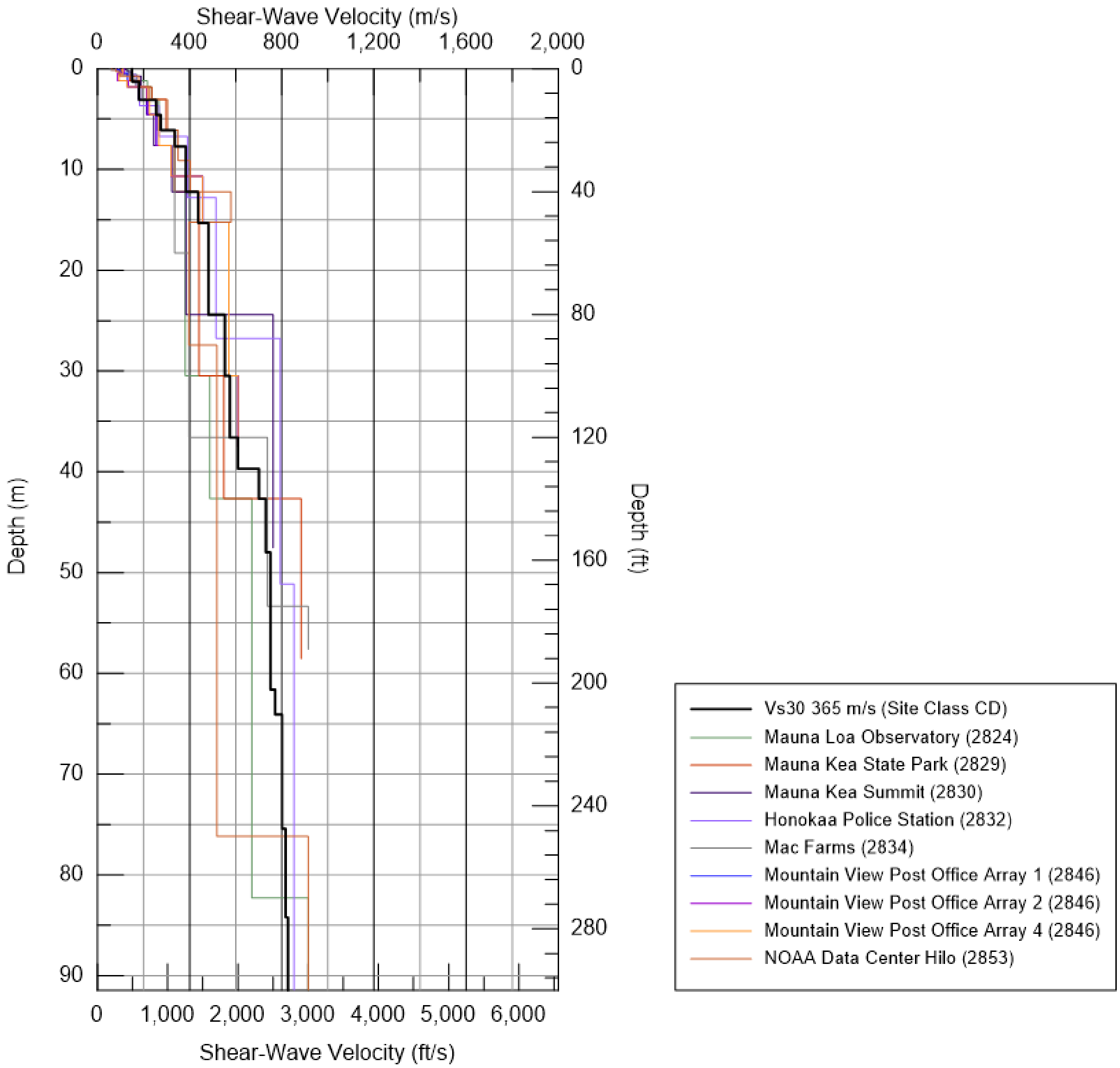

Figure A4. Median Vs profile for Vs30 365 m/s and measured Vs profiles from Wong *et al.* (2011).

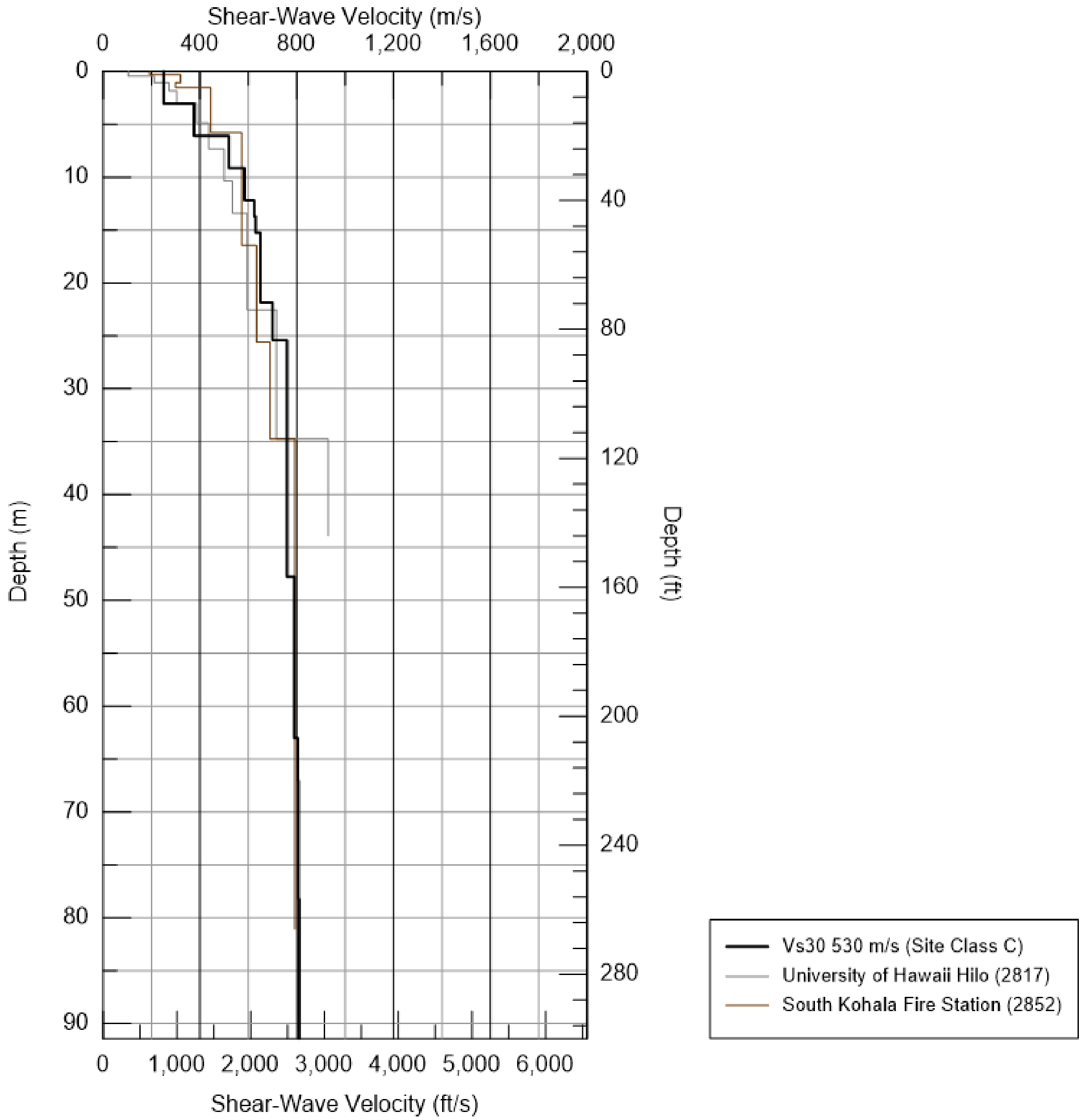

Figure A5. Median Vs profile for Vs30 530 m/s and measured Vs profiles from Wong *et al.* (2011).

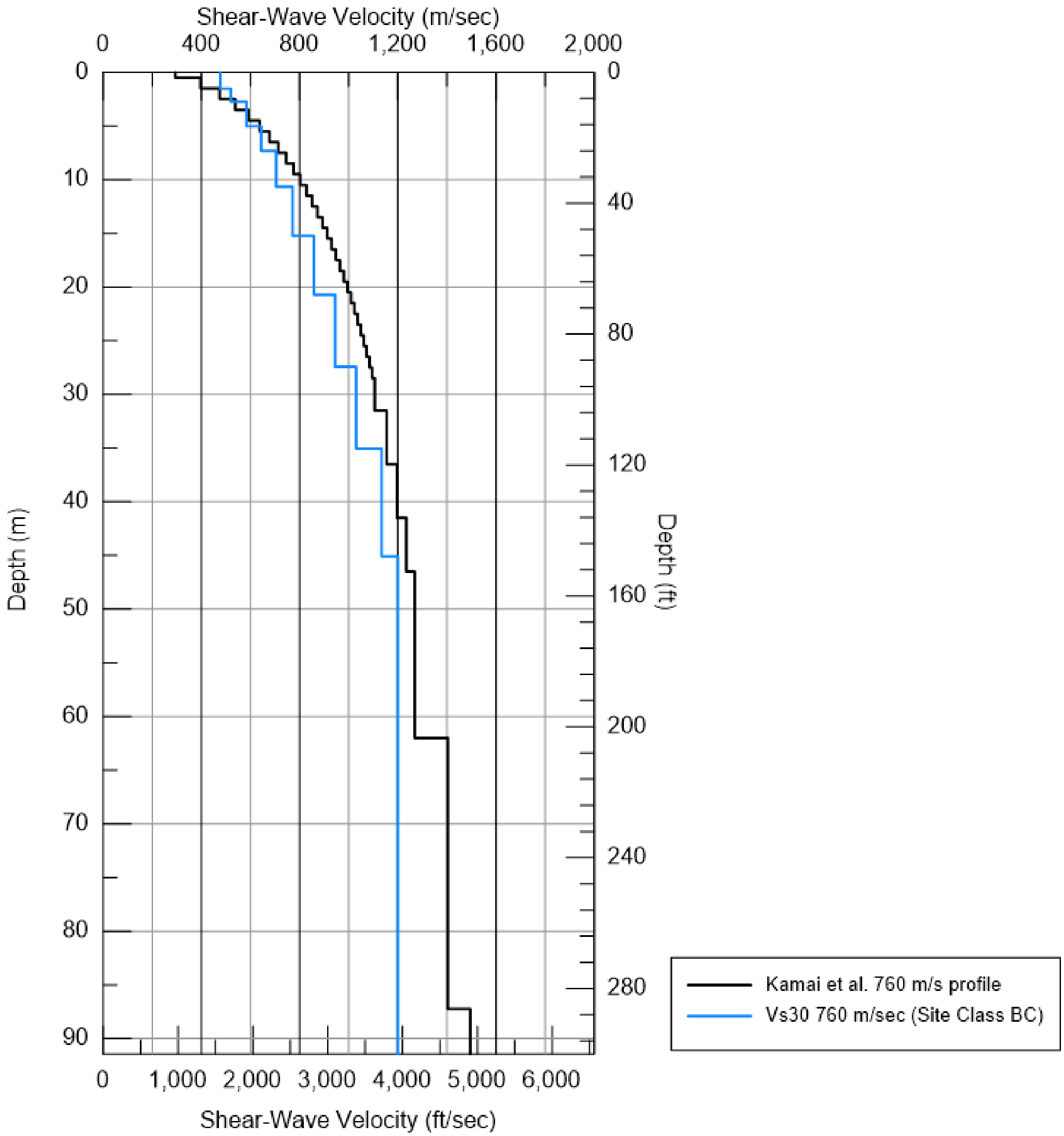

Figure A6. Median Vs profile for Vs30 760 m/s, based on NGA-West2 western North American (WNA) Vs profiles in Kamai *et al.* (2013; 2016).

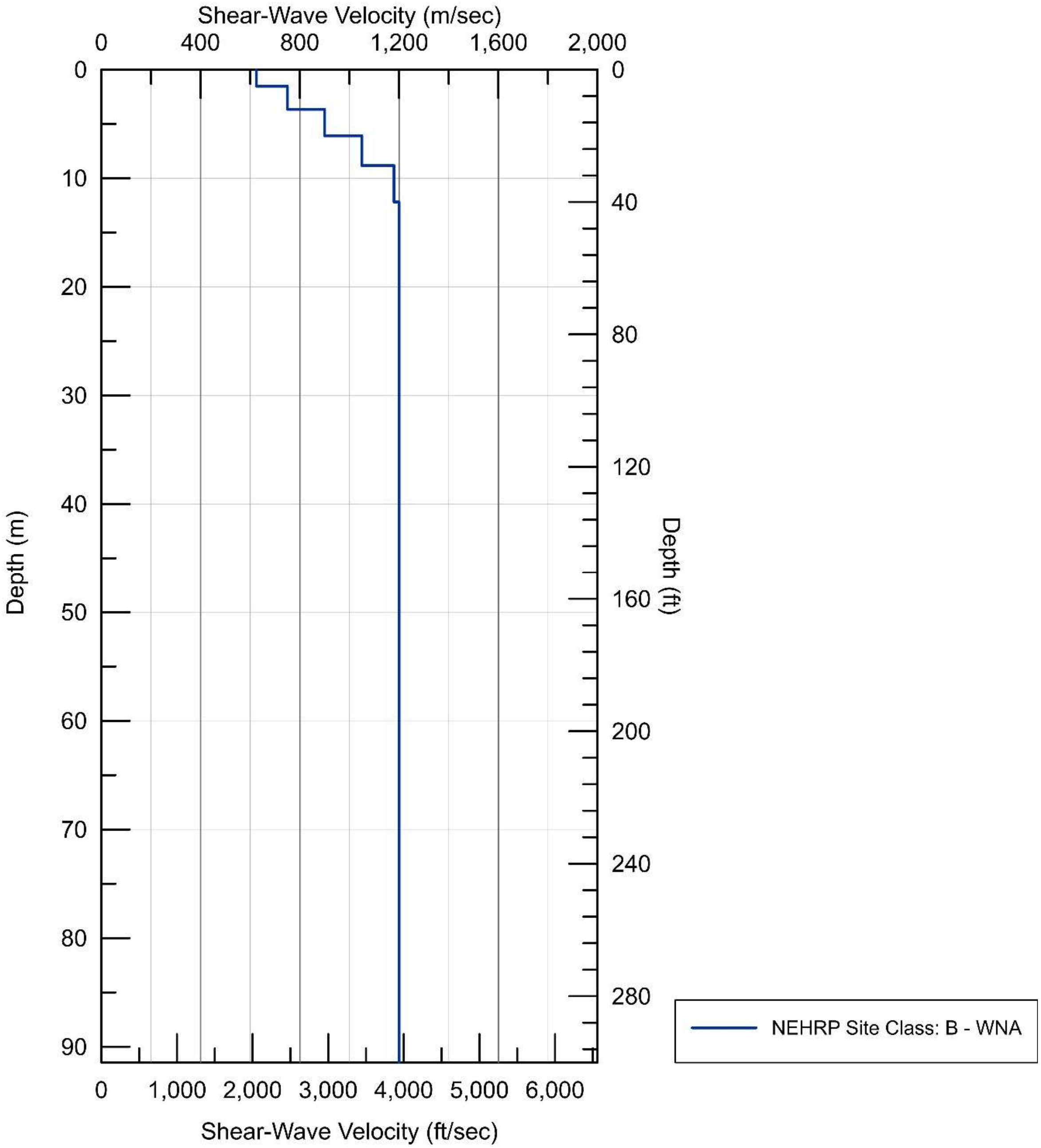

Figure A7. Median Vs profile for Vs30 1,080 m/s, based on NGA-West2 western North American (WNA) Vs profiles in Kamai *et al.* (2013; 2016).

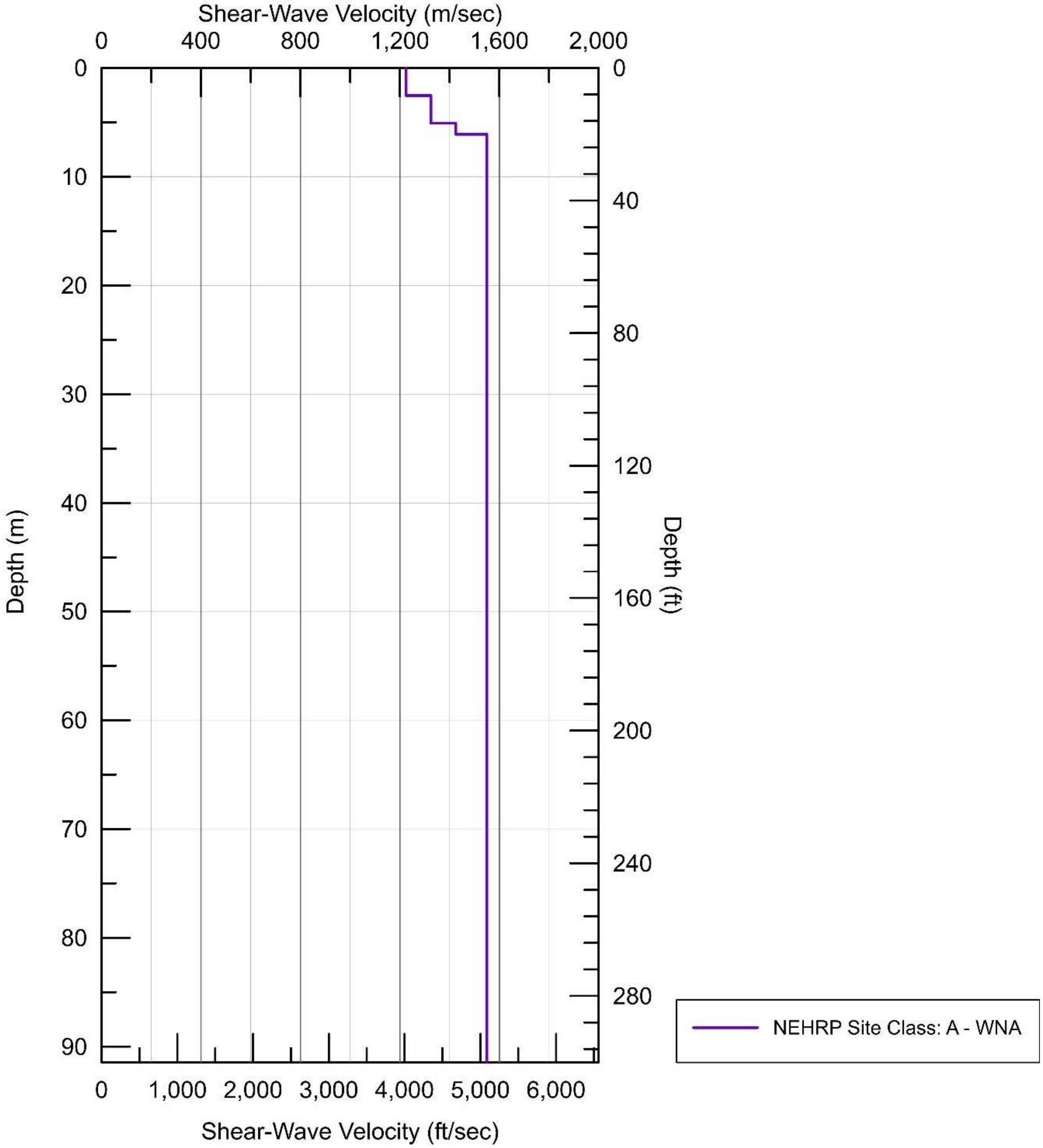

Figure A8. Median Vs profile for Vs30 1,500 m/s, based on NGA-West2 western North American (WNA) Vs profiles in Kamai *et al.* (2013; 2016).

Appendix B

Stochastic Ground Motion Model and FAS Inversion Methodology

STOCHASTIC GROUND MOTION MODEL

The band-limited white noise (BLWN) ground motion model first developed by Hanks and McGuire (1981) assumes a point source with energy distributed randomly over the duration of the source. The model assumes an ω^{-2} source model (Brune, 1970; 1971) with a single corner frequency and a constant stress drop (Boore, 1983). The acceleration spectral density, a(*f*), is given by

$$a(f) = C \frac{f^2}{1+\left(\frac{f}{f_c}\right)^2} \frac{M_o}{R} P(f)A(f)e^{\frac{\pi f R}{-\beta_o Q(f)}}$$

where f is frequency;
M_o is seismic moment;
R is distance to the equivalent point source;
B_o is shear-wave velocity at the source;
Q(*f*) is the frequency-dependent quality factor;
A(*f*) are near-surface amplification factors;
P(*f*) is the high-frequency truncation filter;
f_c is source corner frequency; and

$$C = \left(\frac{1}{\rho_o \beta_o^3}\right) (2)(0.55)\frac{1}{\sqrt{2}}\pi$$

where ρ_o is the density at the source. *C* is a constant that accounts for the free-surface effect (factor of 2), the S-wave source radiation pattern averaged over a sphere (0.55) (Boore, 1986),

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and the partition of energy into two horizontal components $\left(1/\sqrt{2}\right)$. In order to compute peak-time domain values, that is, peak acceleration and peak oscillator response, RVT is used to relate root-mean-square computations to peak value estimates (Boore, 1983; Boore and Joyner, 1984).

Source scaling is provided by specifying two independent parameters, M_o and the stress drop ($\Delta\sigma$). The stress drop relates f_c to M_o through the relation

$$fc = \beta_o \left(\frac{\Delta\sigma}{8.44\ M_o}\right)^{1/3}$$

The spectral shape of the single-corner-frequency ω^{-2} source model is then described by the two free parameters M_o and $\Delta\sigma$ (Silva, 1992). The corner frequency increases with the shear-wave velocity and stress drop, both of which are region dependent.

The P(*f*) filter models the observation that acceleration spectral density appears to fall off rapidly beyond some region-dependent maximum frequency. This observed phenomenon truncates the high-frequency part of the spectrum and is responsible for the band-limited nature of the model. In the Anderson and Hough (1984) attenuation model, the form of the P(*f*) filter is

$$P(f) = e^{-\pi f k(r)}$$

The function $\kappa(r)$ is a site- and distance-dependent parameter that represents the effect of intrinsic attenuation on the seismic waves as they propagate through the crust from source to receiver. The parameter κ depends weakly on the epicentral distance (r) and on both the shear-wave velocity (V_S) and quality factor (Q_S) averaged over a depth of H beneath the receiver or site. At zero epicentral distance, κ is given by

$$k(0) = \frac{H}{\overline{Vs}\ \overline{Qs}}$$

The value of $\kappa(0)$ (herein referred to as kappa) is attributed to attenuation in the very shallow crust directly beneath the site (Hough and Anderson, 1988). Silva and Darragh (1995) suggested that the predominant kappa effects extend from the surface down to several hundred meters and possibly as deep as 1–2 km. The intrinsic attenuation along this part of the path is thought to be frequency independent but site dependent (Hough *et al.*, 1988). For a typical western North America rock site, kappa values are in the range of about 0.02–0.06 s (Boore, 1986; Silva and Darragh, 1995). The acceleration spectral density, a(*f*), models direct shear waves in a homogeneous half-space (with effects of a velocity gradient through the A(*f*) filter). For vertically heterogeneous layered structures, the plane-wave propagators of Silva (1976) are used to propagate SH or P–SV motion through the layered structure.

In a half-space model, the near-surface amplification factors, A(*f*), account for the increase in amplitude as the seismic energy travels through lower velocity crustal materials near the surface. These factors depend on average crustal and near-surface shear-wave velocity and density. Western United States amplification factors developed by Boore (1986) have typically been used in the past to account for the amplification by near-surface velocity gradients. If detailed shear-wave velocity data are available for a site, it is more desirable to use such information instead of amplification factors.

The anelastic path attenuation from the source to just below the site is modeled with the frequency-dependent quality factor Q(*f*) where $Q(f)=Q_o f^{\eta}$ and Q_o and η are model parameters. In the bilinear form, geometric attenuation is taken as $1/R$ or $\left(1/\sqrt{R}\right)$ for distances greater than 100 km.

In order to accommodate the effects of site-specific soil response, the BLWN power spectrum of the rock outcrop motion is propagated through the one-dimensional soil profile using the plane-wave propagators of Silva (1976). In this formulation, only S_H waves are considered. Arbitrary angles of incidence may be specified, but normal incidence is used throughout the present analyses.

In order to deal with possible material nonlinearities, the equivalent-linear formulation is used. RVT is used to predict peak time-domain values of shear strain based upon the shear-strain power spectrum. In this sense, the procedure is analogous to the computer program SHAKE (Schnabel et al., 1972) except that peak shear strains in SHAKE are measured in the time domain. The purely frequency-domain RVT approach obviates a time-domain control motion and, perhaps just as significantly, eliminates the need for a suite of analyses based on different input motions.

FAS INVERSION METHOLDOLOGY

In the inversion scheme, earthquake point-source, path and site parameters are obtained by using a Levenberg-Marquardt nonlinear least-squares inversion of Fourier amplitude spectra (FAS). The point-source parameters are those that are incorporated into the stochastic ground motion model described above.

The inversions are done on log-amplitude spectra since strong ground motion data appear to be log-normally distributed. This is consistent with the model being represented as a product (rather than sum) of models. The useable bandwidth for each amplitude spectrum computed from the SLg-wave window of the strong motion recordings was selected based on an examination of FAS at high and low frequencies, the filter corner frequencies and the noise in either the pre-event or coda time windows. The low-frequency limit is site-dependent and may be seen in the FAS (point-source model and data). In keeping with the model's simplicity, the point-source distance metric uses hypocentral distance for the inversions.

The geometrical spreading factor can accommodate either a bilinear or trilinear form, depending on trends of the residuals from the initial inversions. Once the optimal form is selected the inversions are repeated for final estimates of kappa, Q(f), **M,** and stress drop ($\Delta\sigma$). The geometrical spreading model should be regarded as an accommodation of a simple model to a change in the frequency-independent far-field fall-off due to the effects of crustal interfaces.

The inversion code permits multiple stations to be treated as the same site. The inversion scheme treats multiple earthquakes and sites simultaneously with the common frequency-dependent crustal path damping parameter Q(f). Distinct kappa values may be determined for each site and multiple stations (at varying distances) may be specified as belonging to a single site (or category).

The parameter covariance matrix is examined to determine which parameters may be resolved for each data set. Asymptotic standard errors are computed at the final iteration. The parameters which may be determined include: kappa, Q[f] model, Ro (cross-over distance from R^{-1} to $R^{-0.5}$ in the bilinear form), **M**, and corner frequency. Crustal and soil profile amplification are accommodated in the inversion scheme by incorporating the appropriate mean amplification function in the model spectrum.

To reduce the non-uniqueness inherent in inversion schemes, a suite of starting models is employed. The final set of parameters is selected based upon a visual inspection of the model fit to the FAS, the chi-square values, and the parameter covariance matrix.

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Appendix C

Crustal GMM Coefficients and Sigma Values

Table C1. Coefficients and Standard Errors for V_S30 150 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-12.69233	1.64091	3.20000	.00000	-1.89422	.14930	.00000	-.27992	.3866	1.2756	1.332897
.200	-8.77422	1.45379	3.50000	.00000	-2.04820	.13771	.00000	-.33978	.4094	1.1358	1.207332
.331	-4.66273	1.21469	3.80000	.00000	-2.41811	.13997	.00000	-.34608	.4781	.9702	1.081604
.501	-.84421	.99123	4.00000	.00000	-2.84022	.15017	.00000	-.33357	.5543	.8636	1.026184
.631	2.81197	.71563	4.20000	.00000	-3.32630	.18443	.00000	-.33010	.6183	.7680	.9859609
1.000	13.51442	-.32873	4.60000	.00000	-4.82239	.33458	.00000	-.31854	.6990	.6627	.9632094
1.349	21.65911	-1.31756	4.80000	.00000	-5.96890	.47585	.00000	-.28891	.7309	.6566	.9825164
1.995	26.47325	-1.71937	4.90000	.00000	-6.66762	.52223	.00000	-.24974	.7253	.5902	.9350915
2.512	29.74357	-2.08263	4.90000	.00000	-7.23778	.58194	.00000	-.23657	.7454	.5655	.9356343
3.311	37.07298	-2.95007	5.00000	.00000	-8.36127	.71381	.00000	-.21387	.7752	.5581	.9552020
4.169	46.54830	-3.92910	5.20000	.00000	-9.75429	.85504	.00000	-.18908	.7851	.5330	.9489315
5.012	44.60371	-3.85907	5.10000	.00000	-9.52258	.84894	.00000	-.17647	.7565	.5209	.9184929

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6.310	43.27945	-3.87522	5.00000	.00000	-9.41691	.86085	.00000	-.16574	.7485	.5103	.9059020
6.607	43.64014	-3.92958	5.00000	.00000	-9.48336	.87020	.00000	-.16314	.7502	.5113	.9078700
8.318	41.95651	-3.87512	4.90000	.00000	-9.28916	.86845	.00000	-.15395	.7574	.5184	.9178199
10.000	42.98182	-4.04797	4.90000	.00000	-9.47691	.89816	.00000	-.14469	.7638	.4997	.9127380
12.589	39.98228	-3.80803	4.80000	.00000	-9.05806	.86566	.00000	-.13695	.7455	.4866	.8902527
14.454	39.77138	-3.79197	4.80000	.00000	-9.04302	.86510	.00000	-.13572	.7381	.4887	.8852228
16.596	36.23857	-3.44597	4.70000	.00000	-8.51344	.81360	.00000	-.13721	.7353	.4918	.8846092
18.197	35.86794	-3.39960	4.70000	.00000	-8.46120	.80702	.00000	-.13873	.7284	.4852	.8752060
19.953	32.84651	-3.10617	4.60000	.00000	-7.99857	.76237	.00000	-.14048	.7249	.4890	.8736687
25.119	32.00853	-2.99776	4.60000	.00000	-7.87069	.74591	.00000	-.14520	.7171	.4846	.8654881
30.903	31.11209	-2.87756	4.60000	.00000	-7.72630	.72676	.00000	-.15116	.7096	.4793	.8563064
39.811	30.25219	-2.76067	4.60000	.00000	-7.58460	.70777	.00000	-.15726	.7018	.4744	.8471002
50.119	29.68590	-2.68299	4.60000	.00000	-7.48962	.69495	.00000	-.16144	.6974	.4768	.8448106
100.000	29.14579	-2.60861	4.60000	.00000	-7.39860	.68263	.00000	-.16565	.6932	.4774	.8416871
PGA	29.05542	-2.59586	4.60000	.00000	-7.37863	.67997	.00000	-.16529	.6922	.4774	.8409
PGV	16.07683	-.83229	3.90000	.00000	-4.79022	.45682	.00000	-.20432	.5283		

Table C2. Coefficients and Standard Errors for Vs30 185 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-13.19364	1.68037	3.10000	.00000	-1.83593	.14544	.00000	-.28148	.3724	1.2756	1.328848
.200	-8.79408	1.43896	3.50000	.00000	-2.06632	.14222	.00000	-.34248	.3810	1.1358	1.197999
.331	-4.28488	1.11086	3.80000	.00000	-2.51048	.15977	.00000	-.35034	.4421	.9702	1.066180

.501	-.47932	.87423	4.00000	.00000	-2.93176	.17056	.00000	-.33456	.5276	.8636	1.012011
.631	1.57935	.78998	4.10000	.00000	-3.15020	.16996	.00000	-.32264	.5860	.7680	.9660332
1.000	8.35410	.34371	4.40000	.00000	-4.04345	.21998	.00000	-.29742	.6509	.6627	.9288930
1.349	17.28152	-.52518	4.70000	.00000	-5.34888	.35015	.00000	-.28162	.6864	.6566	.9498782
1.995	26.75557	-1.62810	4.90000	.00000	-6.71290	.50911	.00000	-.24583	.7187	.5902	.9299817
2.512	31.18577	-1.99195	5.00000	.00000	-7.40066	.55927	.00000	-.22335	.7165	.5655	.9127774
3.311	31.47319	-2.10584	4.90000	.00000	-7.50354	.57767	.00000	-.20194	.7658	.5581	.9475892
4.169	37.42274	-2.73145	5.00000	.00000	-8.43049	.67351	.00000	-.18545	.7621	.5330	.9299921
5.012	39.52031	-3.02774	5.00000	.00000	-8.78509	.72108	.00000	-.17329	.7624	.5209	.9233584
6.310	41.67412	-3.34660	5.00000	.00000	-9.15102	.77233	.00000	-.16017	.7725	.5103	.9258307
6.607	42.04087	-3.39681	5.00000	.00000	-9.22402	.78164	.00000	-.15942	.7686	.5113	.9231326
8.318	40.79807	-3.42792	4.90000	.00000	-9.11464	.79508	.00000	-.15423	.7561	.5184	.9167474
10.000	38.68828	-3.33067	4.80000	.00000	-8.83502	.78481	.00000	-.14727	.7377	.4997	.8910115
12.589	36.48830	-3.22079	4.70000	.00000	-8.54079	.77318	.00000	-.14298	.7387	.4866	.8845662
14.454	36.66430	-3.27179	4.70000	.00000	-8.58560	.78298	.00000	-.13869	.7368	.4887	.8841392
16.596	36.26675	-3.23525	4.70000	.00000	-8.53532	.77836	.00000	-.13732	.7283	.4918	.8787993
18.197	33.34174	-2.97142	4.60000	.00000	-8.09078	.73865	.00000	-.13824	.7280	.4852	.8748732
19.953	33.01380	-2.93440	4.60000	.00000	-8.04500	.73351	.00000	-.13942	.7179	.4890	.8686204
25.119	29.65054	-2.60564	4.50000	.00000	-7.52549	.68302	.00000	-.14336	.7076	.4846	.8576334
30.903	28.87380	-2.50642	4.50000	.00000	-7.40161	.66727	.00000	-.14758	.7010	.4793	.8491934
39.811	27.84722	-2.37095	4.50000	.00000	-7.23140	.64501	.00000	-.15345	.6911	.4744	.8382570
50.119	27.23831	-2.28934	4.50000	.00000	-7.12908	.63145	.00000	-.15728	.6856	.4768	.8350962
100.000	26.58137	-2.20049	4.50000	.00000	-7.01758	.61659	.00000	-.16184	.6798	.4774	.8306858
PGA	26.45904	-2.18418	4.50000	.00000	-6.99144	.61318	.00000	-.16145	.6782	.4774	.8294
PGV	15.35176	-.78585	3.80000	.00000	-4.71966	.45311	.00000	-.19689	.5031		

Table C3. Coefficients and Standard Errors for Vs30 260 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-14.35371	1.79484	2.90000	.00000	-1.66745	.13007	.00000	-.28825	.3861	1.2756	1.332752
.200	-9.63654	1.51074	3.40000	.00000	-1.94809	.13306	.00000	-.34759	.4125	1.1358	1.208387
.331	-4.52783	1.11009	3.80000	.00000	-2.49561	.16327	.00000	-.35676	.4723	.9702	1.079053
.501	-.30511	.77396	4.00000	.00000	-2.99194	.19132	.00000	-.34351	.5085	.8636	.1002186
.631	2.01423	.62282	4.10000	.00000	-3.25746	.20131	.00000	-.33096	.5454	.7680	.9419583
1.000	7.07371	.32481	4.30000	.00000	-3.87826	.22334	.00000	-.29361	.6465	.6627	.9258151
1.349	10.51269	.10274	4.40000	.00000	-4.34111	.24548	.00000	-.26396	.6921	.6566	.9540053
1.995	13.49041	-.07927	4.40000	.00000	-4.74109	.26056	.00000	-.22238	.7132	.5902	.9257377
2.512	19.49423	-.57854	4.60000	.00000	-5.64339	.33567	.00000	-.20571	.7284	.5655	.9221480
3.311	24.32160	-1.07113	4.70000	.00000	-6.39802	.40954	.00000	-.18472	.7542	.5581	.9382394
4.169	29.20790	-1.52145	4.80000	.00000	-7.18386	.48002	.00000	-.16958	.7950	.5330	.9571385
5.012	31.05221	-1.75437	4.80000	.00000	-7.49281	.51675	.00000	-.15865	.8041	.5209	.9580781
6.310	30.56005	-1.84421	4.70000	.00000	-7.47969	.53572	.00000	-.15006	.8111	.5103	.9582741
6.607	31.01753	-1.90066	4.70000	.00000	-7.56496	.54571	.00000	-.14872	.8054	.5113	.9539900
8.318	33.39284	-2.24085	4.70000	.00000	-7.98795	.60413	.00000	-.14300	.7864	.5184	.9418936
10.000	34.64468	-2.46235	4.70000	.00000	-8.21594	.64198	.00000	-.13782	.7909	.4997	.9355335
12.589	32.41158	-2.35857	4.60000	.00000	-7.92393	.63118	.00000	-.13510	.7903	.4866	.9280915
14.454	30.22104	-2.21542	4.50000	.00000	-7.60779	.61167	.00000	-.13481	.7777	.4887	.9185015
16.596	28.14254	-2.08659	4.40000	.00000	-7.30054	.59390	.00000	-.13579	.7706	.4918	.9141618
18.197	28.35280	-2.13895	4.40000	.00000	-7.34680	.60392	.00000	-.13581	.7586	.4852	.9004960
19.953	28.30711	-2.15428	4.40000	.00000	-7.34798	.60734	.00000	-.13525	.7583	.4890	.9022971
25.119	27.49727	-2.09579	4.40000	.00000	-7.22715	.59882	.00000	-.13457	.7431	.4846	.8871499
30.903	24.50783	-1.82495	4.30000	.00000	-6.75313	.55607	.00000	-.13860	.7317	.4793	.8747076

39.811	23.67945	-1.73010	4.30000	.00000	-6.61713	.54052	.00000	-.14177	.7221	.4744	.8639929
50.119	23.09489	-1.65994	4.30000	.00000	-6.51861	.52873	.00000	-.14419	.7175	.4768	.8614781
100.000	22.39352	-1.57310	4.30000	.00000	-6.39882	.51398	.00000	-.14734	.7119	.4774	.8571537
PGA	22.30187	-1.55880	4.30000	.00000	-6.37736	.51072	.00000	-.14672	.71144	.4774	.8578
PGV	14.66968	-.75914	3.70000	.00000	-4.70358	.45882	.00000	-.18164	.5243		

Table C4. Coefficients and Standard Errors for Vs30 365 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-14.90354	1.85488	2.90000	.00000	-1.58566	.12030	.00000	-.29728	.3831	1.2756	1.331886
.200	-10.47331	1.59148	3.30000	.00000	-1.81477	.12087	.00000	-.35424	.4161	1.1358	1.209620
.331	-5.00108	1.16029	3.80000	.00000	-2.42774	.15631	.00000	-.36186	.4800	.9702	1.082445
.501	-.73342	.81024	4.00000	.00000	-2.93365	.18683	.00000	-.34845	.5113	.8636	1.003610
.631	1.68809	.63636	4.10000	.00000	-3.21847	.20079	.00000	-.33559	.5477	.7680	.9432918
1.000	7.13072	.24902	4.30000	.00000	-3.91056	.23837	.00000	-.29855	.6116	.6627	.9017904
1.349	10.79472	-.03598	4.40000	.00000	-4.42784	.27156	.00000	-.26869	.6393	.6566	.9164214
1.995	13.92087	-.30043	4.40000	.00000	-4.87604	.30130	.00000	-.22558	.7179	.5902	.9293635
2.512	17.15407	-.49325	4.50000	.00000	-5.35135	.32506	.00000	-.20107	.7612	.5655	.9482699
3.311	21.41014	-.82771	4.60000	.00000	-6.00587	.37333	.00000	-.17930	.7875	.5581	.9652109
4.169	23.37461	-1.02097	4.60000	.00000	-6.34039	.40334	.00000	-.16322	.8046	.5330	.9651270
5.012	24.93800	-1.17987	4.60000	.00000	-6.60933	.42943	.00000	-.15331	.8314	.5209	.9811029
6.310	27.34521	-1.48185	4.60000	.00000	-7.00808	.47891	.00000	-.14480	.8387	.5103	.9817453
6.607	27.89548	-1.55521	4.60000	.00000	-7.10133	.49126	.00000	-.14366	.8258	.5113	.9712741

8.318	29.53385	-1.78086	4.60000	.00000	-7.41676	.53109	.00000	-.13617	.7994	.5184	.9527743
10.000	28.20260	-1.74082	4.50000	.00000	-7.25641	.52914	.00000	-.13329	.8002	.4997	.9434088
12.589	27.30592	-1.78899	4.40000	.00000	-7.16301	.54227	.00000	-.13319	.8081	.4866	.9432949
14.454	27.96499	-1.91810	4.40000	.00000	-7.29420	.56582	.00000	-.13173	.7895	.4887	.9285139
16.596	25.90233	-1.80073	4.30000	.00000	-6.99013	.54985	.00000	-.13201	.7867	.4918	.9277738
18.197	25.91920	-1.83006	4.30000	.00000	-7.00435	.55594	.00000	-.13239	.7907	.4852	.9276991
19.953	23.88298	-1.68952	4.20000	.00000	-6.68792	.53463	.00000	-.13309	.7824	.4890	.9226434
25.119	23.52147	-1.70415	4.20000	.00000	-6.65023	.53957	.00000	-.13434	.7560	.4846	.8979828
30.903	22.75054	-1.64369	4.20000	.00000	-6.53022	.53053	.00000	-.13679	.7490	.4793	.8892297
39.811	21.94363	-1.56600	4.20000	.00000	-6.39750	.51788	.00000	-.13971	.7383	.4744	.8775776
50.119	21.37331	-1.50684	4.20000	.00000	-6.30212	.50803	.00000	-.14149	.7311	.4768	.8728377
100.000	20.64147	-1.42407	4.20000	.00000	-6.17683	.49391	.00000	-.14410	.7238	.4774	.8670624
PGA	20.58466	-1.41581	4.20000	.00000	-6.16192	.49169	.00000	-.14324	.7231	.4774	.8665
PGV	13.12894	-.62021	3.60000	.00000	-4.50438	.44333	.00000	-.18596	.5198		

Table C5. Coefficients and Standard Errors for Vs30 428 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-15.19784	1.90028	2.90000	.00000	-1.54536	.11537	.00000	-.30120	.3726	1.2756	1.328904
.200	-10.71071	1.61659	3.30000	.00000	-1.78403	.11728	.00000	-.35703	.3910	1.1358	1.201217
.331	-5.24628	1.18420	3.80000	.00000	-2.39631	.15279	.00000	-.36419	.4532	.9702	1.070831
.501	-.97830	.83131	4.00000	.00000	-2.90421	.18404	.00000	-.35075	.4919	.8636	.9938666
.631	1.48968	.64607	4.10000	.00000	-3.20088	.20003	.00000	-.33732	.5343	.7680	.9355750

1.000	7.05101	.22829	4.30000	.00000	-3.92056	.24294	.00000	-.29920	.6426	.6627	.9230959
1.349	10.66644	-.04191	4.40000	.00000	-4.41850	.27296	.00000	-.26955	.6368	.6566	.9146791
1.995	15.40632	-.43346	4.40000	.00000	-5.13011	.32339	.00000	-.22784	.6466	.5902	.8754586
2.512	17.27335	-.59059	4.50000	.00000	-5.41213	.34345	.00000	-.20377	.7065	.5655	.9049489
3.311	19.41612	-.75243	4.60000	.00000	-5.73872	.36436	.00000	-.17824	.7426	.5581	.9289405
4.169	21.22878	-.88364	4.60000	.00000	-6.01767	.38218	.00000	-.16204	.7578	.5330	.9264718
5.012	24.83756	-1.19754	4.60000	.00000	-6.60747	.43276	.00000	-.15270	.7880	.5209	.9446063
6.310	24.65807	-1.28310	4.60000	.00000	-6.62166	.44902	.00000	-.14261	.8033	.5103	.9516812
6.607	25.00269	-1.32047	4.60000	.00000	-6.68548	.45564	.00000	-.14106	.8034	.5113	.9523021
8.318	26.72766	-1.55790	4.60000	.00000	-7.00238	.49733	.00000	-.13575	.8355	.5184	.9832593
10.000	25.42663	-1.52143	4.50000	.00000	-6.86383	.49534	.00000	-.13222	.8147	.4997	.9557386
12.589	26.97275	-1.74579	4.40000	.00000	-7.13266	.53623	.00000	-.13127	.8225	.4866	.9556599
14.454	25.42663	-1.70772	4.40000	.00000	-6.91502	.53347	.00000	-.13121	.8092	.4887	.9453213
16.596	25.31010	-1.74063	4.30000	.00000	-6.92114	.54121	.00000	-.13069	.7790	.4918	.9212536
18.197	23.21994	-1.58948	4.30000	.00000	-6.59887	.51833	.00000	-.13128	.7643	.4852	.9053030
19.953	23.09248	-1.59088	4.20000	.00000	-6.58967	.51990	.00000	-.13283	.7577	.4890	.9017929
25.119	21.23085	-1.49661	4.20000	.00000	-6.30799	.50735	.00000	-.13454	.7445	.4846	.8883228
30.903	20.66127	-1.46626	4.20000	.00000	-6.22043	.50331	.00000	-.13658	.7405	.4793	.8820821
39.811	20.04865	-1.41386	4.20000	.00000	-6.12221	.49519	.00000	-.13960	.7309	.4744	.8713611
50.119	19.50112	-1.36578	4.20000	.00000	-6.03003	.48720	.00000	-.14119	.7221	.4768	.8653131
100.000	18.73341	-1.28380	4.20000	.00000	-5.89812	.47320	.00000	-.14400	.7128	.4774	.8579013
PGA	18.67909	-1.27680	4.20000	.00000	-5.88336	.47114	.00000	-.14312	.7121	.4774	.8573
PGV	12.77377	-.59006	3.60000	.00000	-4.47669	.44189	.00000	-.18818	.5039		

Table C6. Coefficients and Standard Errors for Vs30 530 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-15.70250	1.95736	2.80000	.00000	-1.45569	.10622	.00000	-.30744	.3528	1.2756	1.323489
.200	-10.93376	1.65285	3.30000	.00000	-1.74195	.11191	.00000	-.36216	.3634	1.1358	1.192519
.331	-6.04163	1.26021	3.70000	.00000	-2.25721	.14099	.00000	-.36847	.4005	.9702	1.049613
.501	-1.29240	.87728	4.00000	.00000	-2.84878	.17718	.00000	-.35395	.4560	.8636	.9765967
.631	1.25369	.67569	4.10000	.00000	-3.16012	.19617	.00000	-.34026	.5170	.7680	.9258041
1.000	6.85477	.23616	4.30000	.00000	-3.89880	.24310	.00000	-.30200	.5824	.6627	.8822478
1.349	10.56733	-.07379	4.40000	.00000	-4.42871	.28097	.00000	-.27186	.6668	.6566	.9358130
1.995	13.97374	-.41849	4.40000	.00000	-4.93825	.32546	.00000	-.23079	.6973	.5902	.9135445
2.512	15.88206	-.61695	4.40000	.00000	-5.24764	.35380	.00000	-.20725	.6952	.5655	.8961548
3.311	18.03911	-.80805	4.40000	.00000	-5.59024	.38020	.00000	-.18076	.7333	.5581	.9215229
4.169	19.70215	-.92336	4.40000	.00000	-5.84740	.39590	.00000	-.16301	.7848	.5330	.9486834
5.012	21.02148	-1.03819	4.40000	.00000	-6.07017	.41379	.00000	-.15168	.7844	.5209	.9416051
6.310	24.64531	-1.30643	4.50000	.00000	-6.65529	.45646	.00000	-.14173	.8184	.5103	.9644608
6.607	25.00777	-.134016	4.50000	.00000	-6.71640	.46209	.00000	-.14037	.8251	.5113	.9706790
8.318	24.72683	-1.40483	4.40000	.00000	-6.71801	.47609	.00000	-.13420	.7873	.5184	.9426452
10.000	26.01249	-1.56856	4.40000	.00000	-6.96623	.50638	.00000	-.13200	.7650	.4997	.9137424
12.589	27.27882	-1.77106	4.40000	.00000	-7.21109	.54332	.00000	-.13012	.7782	.4866	.9178098
14.454	25.50016	-1.68058	4.30000	.00000	-6.95687	.53189	.00000	-.12961	.7805	.4887	.9208735
16.596	23.72271	-1.58750	4.20000	.00000	-6.69752	.51980	.00000	-.13007	.7831	.4918	.9247232
18.197	23.79793	-1.62919	4.20000	.00000	-6.72667	.52856	.00000	-.13097	.7783	.4852	.9171532
19.953	22.02051	-1.51930	4.10000	.00000	-6.45252	.51236	.00000	-.13142	.7736	.4890	.9151928
25.119	21.84634	-1.56141	4.10000	.00000	-6.44792	.52224	.00000	-.13350	.7488	.4846	.8919298
30.903	19.61937	-1.40448	4.00000	.00000	-6.09483	.49812	.00000	-.13590	.7313	.4793	.8743731

39.811	19.06739	-1.37853	4.00000	.00000	-6.00962	.49485	.00000	-.13833	.7209	.4744	.8629903
50.119	18.56849	-1.33799	4.00000	.00000	-5.92705	.48832	.00000	-.14006	.7112	.4768	.8562381
100.000	19.27022	-1.38064	4.10000	.00000	-6.03413	.49464	.00000	-.14280	.7009	.4774	.8480399
PGA	19.25381	-1.37968	4.10000	.00000	-6.02726	-6.02726	.00000	-.14172	.6998	.4774	.8471
PGV	12.31387	-.53167	3.60000	.00000	-4.42465	-4.42465	.00000	-.19744	.4784		

Table C7. Coefficients and Standard Errors for Vs30 760 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-16.07739	1.99692	2.80000	.00000	-1.41449	.10118	.00000	-.31138	.3618	1.2756	1.325916
.200	-11.21796	1.67885	3.30000	.00000	-1.71272	.10846	.00000	-.36544	.3777	1.1358	1.196954
.331	-6.31976	1.27385	3.70000	.00000	-2.23711	.13967	.00000	-.37034	.4343	.9702	1.062970
.501	-1.59169	.89174	4.00000	.00000	-2.82243	.17611	.00000	-.35661	.4767	.8636	.9864319
.631	.95326	.68439	4.10000	.00000	-3.13975	.19606	.00000	-.34250	.5154	.7680	.9249114
1.000	6.70174	.19920	4.30000	.00000	-3.93011	.25129	.00000	-.30248	.5781	.6627	.8794152
1.349	10.48506	-.11811	4.40000	.00000	-4.47259	.29008	.00000	-.27125	.6092	.6566	.8956831
1.995	13.74480	-.42077	4.40000	.00000	-4.94146	.32682	.00000	-.22914	.6643	.5902	.8886116
2.512	15.57489	-.57308	4.40000	.00000	-5.20939	.34553	.00000	-.20499	.7041	.5655	.9030765
3.311	19.42413	-.86915	4.50000	.00000	-5.81266	.38841	.00000	-.18000	.7329	.5581	.9212047
4.169	21.19987	-1.01613	4.50000	.00000	-6.10069	.40997	.00000	-.16275	.7529	.5330	.9224681
5.012	22.62015	-1.14773	4.50000	.00000	-6.34543	.43119	.00000	-.15172	.7597	.5209	.9211303
6.310	22.35435	-1.19335	4.40000	.00000	-6.34551	.44127	.00000	-.14128	.7667	.5103	.9209968
6.607	22.66839	-1.22722	4.40000	.00000	-6.40412	.44731	.00000	-.13957	.7656	.5113	.9206363

8.318	24.12291	-1.39341	4.40000	.00000	-6.67951	.47756	.00000	-.13311	.7725	.5184	.9303197
10.000	23.18347	-1.37453	4.30000	.00000	-6.56811	.47798	.00000	-.12976	.7558	.4997	.9060540
12.589	22.31324	-1.36426	4.20000	.00000	-6.47038	.48047	.00000	-.12769	.7454	.4866	.8901690
14.454	22.69928	-1.43410	4.20000	.00000	-6.55795	.49446	.00000	-.12767	.7462	.4887	.8919878
16.596	21.11329	-1.35791	4.10000	.00000	-6.32642	.48488	.00000	-.12833	.7426	.4918	.8906863
18.197	21.11927	-1.38114	4.10000	.00000	-6.34191	.49021	.00000	-.12885	.7380	.4852	.8832118
19.953	19.49197	-1.26593	4.00000	.00000	-6.08766	.47253	.00000	-.12931	.7392	.4890	.8863057
25.119	18.06259	-1.18715	3.90000	.00000	-5.87261	.46191	.00000	-.13111	.7555	.4846	.8975620
30.903	17.92045	-1.20062	3.90000	.00000	-5.86142	.46570	.00000	-.13299	.7549	.4793	.8942049
39.811	17.40417	-1.19515	3.90000	.00000	-5.78455	.46629	.00000	-.13621	.7253	.4744	.8666692
50.119	16.82685	-1.16893	3.90000	.00000	-5.68937	.46249	.00000	-.13895	.7144	.4768	.8588979
100.000	17.24628	-1.21208	4.00000	.00000	-5.75070	.46938	.00000	-.14292	.6878	.4774	.8372452
PGA	17.13204	-1.20352	4.00000	.00000	-5.72670	.46719	.00000	-.14231	.6844	.4774	.8345
PGV	10.89224	-.40124	3.50000	.00000	-4.23673	.41962	.00000	-.19760	.4824		

Table C8. Coefficients and Standard Errors for Vs30 1080 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-16.25670	2.02096	2.80000	.00000	-1.38545	.09737	.00000	-.31511	.3571	1.2756	1.324642
.200	-11.36847	1.69993	3.30000	.00000	-1.68801	.10522	.00000	-.36887	.3719	1.1358	1.195137
.331	-6.48545	1.29604	3.70000	.00000	-2.21000	.13630	.00000	-.37332	.4221	.9702	1.058044
.501	-1.77648	.92028	4.00000	.00000	-2.78726	.17173	.00000	-.35924	.4707	.8636	.9835464
.631	.76984	.71363	4.10000	.00000	-3.10407	.19161	.00000	-.34477	.5035	.7680	.9183335

1.000	6.50828	.21606	4.30000	.00000	-3.90645	.24934	.00000	-.30449	.5635	.6627	.8698871
1.349	10.29307	-.10381	4.40000	.00000	-4.44633	.28846	.00000	-.27277	.6084	.6566	.8951392
1.995	13.61576	-.42921	4.40000	.00000	-4.93645	.32970	.00000	-.23108	.6505	.5902	.8783430
2.512	15.50359	-.60408	4.40000	.00000	-5.22168	.35276	.00000	-.20699	.6761	.5655	.8814202
3.311	17.72611	-.82521	4.40000	.00000	-5.58438	.38536	.00000	-.18188	.6932	.5581	.8899449
4.169	19.47596	-1.00146	4.40000	.00000	-5.88134	.41307	.00000	-.16456	.7144	.5330	.8913228
5.012	20.81498	-1.13064	4.40000	.00000	-6.11272	.43410	.00000	-.15315	.7331	.5209	.8993178
6.310	22.40769	-1.28594	4.40000	.00000	-6.39676	.46065	.00000	-.14218	.7481	.5103	.9055715
6.607	22.71156	-1.31593	4.40000	.00000	-6.45211	.46592	.00000	-.14039	.7516	.5113	.9090271
8.318	22.21752	-1.31371	4.30000	.00000	-6.40947	.46841	.00000	-.13333	.7662	.5184	.9250952
10.000	23.22242	-1.40958	4.30000	.00000	-6.59942	.48626	.00000	-.12959	.7733	.4997	.9207025
12.589	22.42362	-1.37659	4.20000	.00000	-6.50795	.48430	.00000	-.12683	.7820	.4866	.9210340
14.454	22.95399	-1.43367	4.20000	.00000	-6.61553	.49558	.00000	-.12598	.7823	.4887	.9223997
16.596	21.58647	-1.35098	4.10000	.00000	-6.41588	.48428	.00000	-.12568	.7790	.4918	.9212536
18.197	21.79868	-1.38267	4.10000	.00000	-6.46452	.49084	.00000	-.12575	.7758	.4852	.9150326
19.953	20.28014	-1.28304	4.00000	.00000	-6.22990	.47591	.00000	-.12603	.7715	.4890	.9134184
25.119	18.87089	-1.21770	3.90000	.00000	-6.02753	.46829	.00000	-.12745	.7590	.4846	.9005100
30.903	17.36066	-1.13350	3.80000	.00000	-5.79682	.45656	.00000	-.12923	.7492	.4793	.8893982
39.811	17.15664	-1.15033	3.80000	.00000	-5.77816	.46133	.00000	-.13161	.7446	.4744	.8828843
50.119	15.36392	-1.03981	3.70000	.00000	-5.48466	.44406	.00000	-.13430	.7246	.4768	.8674004
100.000	16.49999	-1.18349	3.90000	.00000	-5.66690	.46861	.00000	-.14020	.6921	.4774	.8407814
PGA	16.31762	-1.17330	3.90000	.00000	-5.63243	.46634	.00000	-.13988	.6881	.4774	.8346
PGV	10.55000	-.35673	3.50000	.00000	-4.19532	.41473	.00000	-.20550	.4691		

Table C9. Coefficients and Standard Errors for Vs30 1500 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-16.44065	2.03994	2.80000	.00000	-1.37085	.09545	.00000	-.31641	.3583	1.2756	1.324966
.200	-11.48095	1.70249	3.30000	.00000	-1.68898	.10550	.00000	-.36877	.3717	1.1358	1.195074
.331	-6.60644	1.28420	3.70000	.00000	-2.22510	.13914	.00000	-.37189	.4119	.9702	1.054016
.501	-1.86329	.90457	4.00000	.00000	-2.80543	.17490	.00000	-.35821	.4643	.8636	.9804997
.631	.72537	.68975	4.10000	.00000	-3.13014	.19575	.00000	-.34335	.4991	.7680	.9159284
1.000	6.42075	.21818	4.30000	.00000	-3.90468	.24863	.00000	-.30345	.5664	.6627	.8717685
1.349	10.17112	-.09873	4.40000	.00000	-4.44264	.28767	.00000	-.27274	.6054	.6566	.8931029
1.995	13.47447	-.40616	4.40000	.00000	-4.91804	.32501	.00000	-.23021	.6524	.5902	.8797511
2.512	15.44042	-.61296	4.40000	.00000	-5.23324	.35450	.00000	-.20656	.6731	.5655	.8791211
3.311	17.67890	-.83551	4.40000	.00000	-5.59778	.38728	.00000	-.18110	.6988	.5581	.8943138
4.169	19.41548	-.99937	4.40000	.00000	-5.88699	.41248	.00000	-.16369	.7202	.5330	.8959783
5.012	20.77758	1.13487	4.40000	.00000	-6.12493	.43478	.00000	-.15227	.7345	.5209	.9004594
6.310	22.38266	1.29975	4.40000	.00000	-6.41524	.46328	.00000	-.14141	.7490	.5103	.9063151
6.607	22.68901	1.32638	4.40000	.00000	-6.46940	.46785	.00000	-.13958	.7527	.5113	.9099369
8.318	22.19347	1.32914	4.30000	.00000	-6.42884	.47137	.00000	-.13256	.7644	.5184	.9236049
10.000	23.19162	1.42897	4.30000	.00000	-6.61927	.49003	.00000	-.12886	.7717	.4997	.9193591
12.589	22.38657	1.39567	4.20000	.00000	-6.52703	.48803	.00000	-.12604	.7785	.4866	.9180643
14.454	21.14860	1.31533	4.10000	.00000	-6.34677	.47686	.00000	-.12508	.7817	.4887	.9218909
16.596	21.60330	1.36136	4.10000	.00000	-6.43987	.48613	.00000	-.12454	.7841	.4918	.9255702
18.197	21.87417	1.38906	4.10000	.00000	-6.49600	.49177	.00000	-.12436	.7859	.4852	.9236113
19.953	20.42827	1.28535	4.00000	.00000	-6.27101	.47585	.00000	-.12432	.7875	.4890	.9269721
25.119	19.30900	1.21542	3.90000	.00000	-6.11174	.46667	.00000	-.12465	.7922	.4846	.9286647
30.903	18.06549	1.13695	3.80000	.00000	-5.92459	.45551	.00000	-.12545	.7966	.4793	.9296774

39.811	18.05173	1.16741	3.80000	.00000	-5.94216	.46273	.00000	-.12707	.7977	.4744	.9281060
50.119	16.32087	1.07317	3.70000	.00000	-5.66510	.44866	.00000	-.12936	.7820	.4768	.9158943
100.000	15.66781	1.11454	3.80000	.00000	-5.55430	.45726	.00000	-.13663	.7130	.4774	.8580675
PGA	15.39305	1.10031	3.80000	.00000	-5.50442	.45440	.00000	-.13677	.7055	.4774	.8518
PGV	10.53370	-.37189	3.50000	.00000	-4.23064	.42027	.00000	-.20041	.4729		

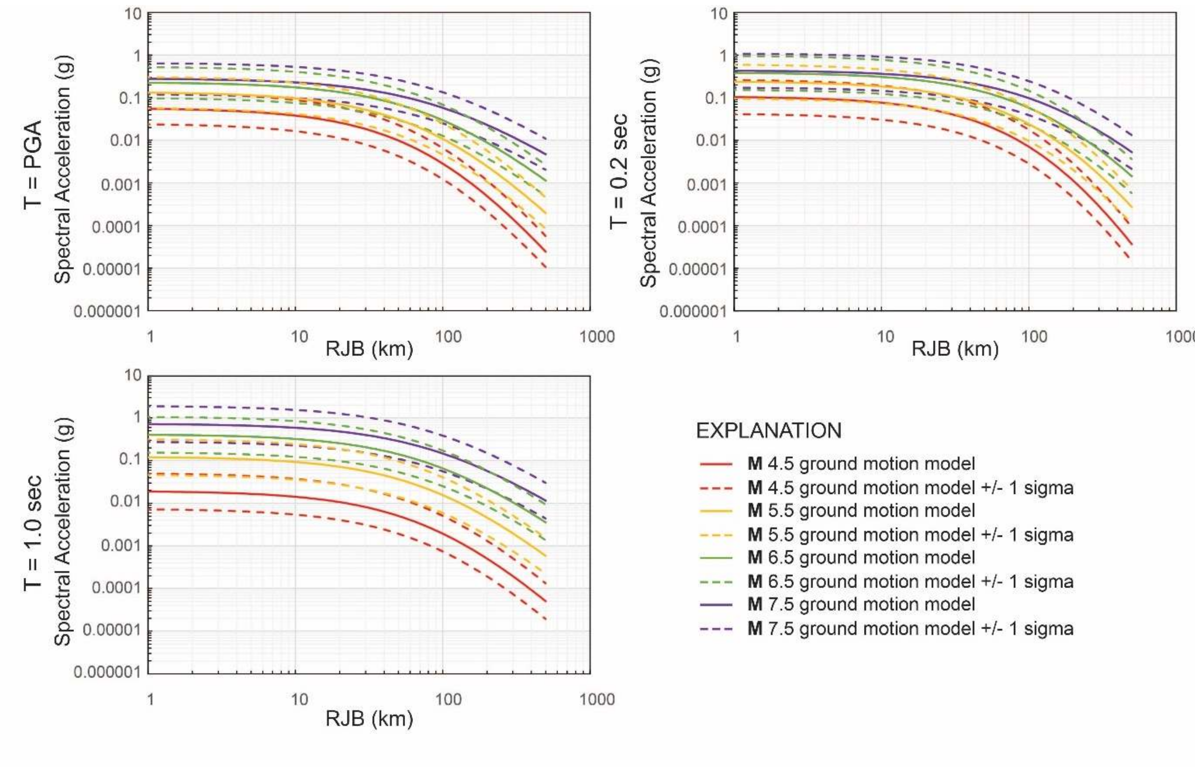

Figure C1. Ground motion models for PGA, 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 150 m/s.

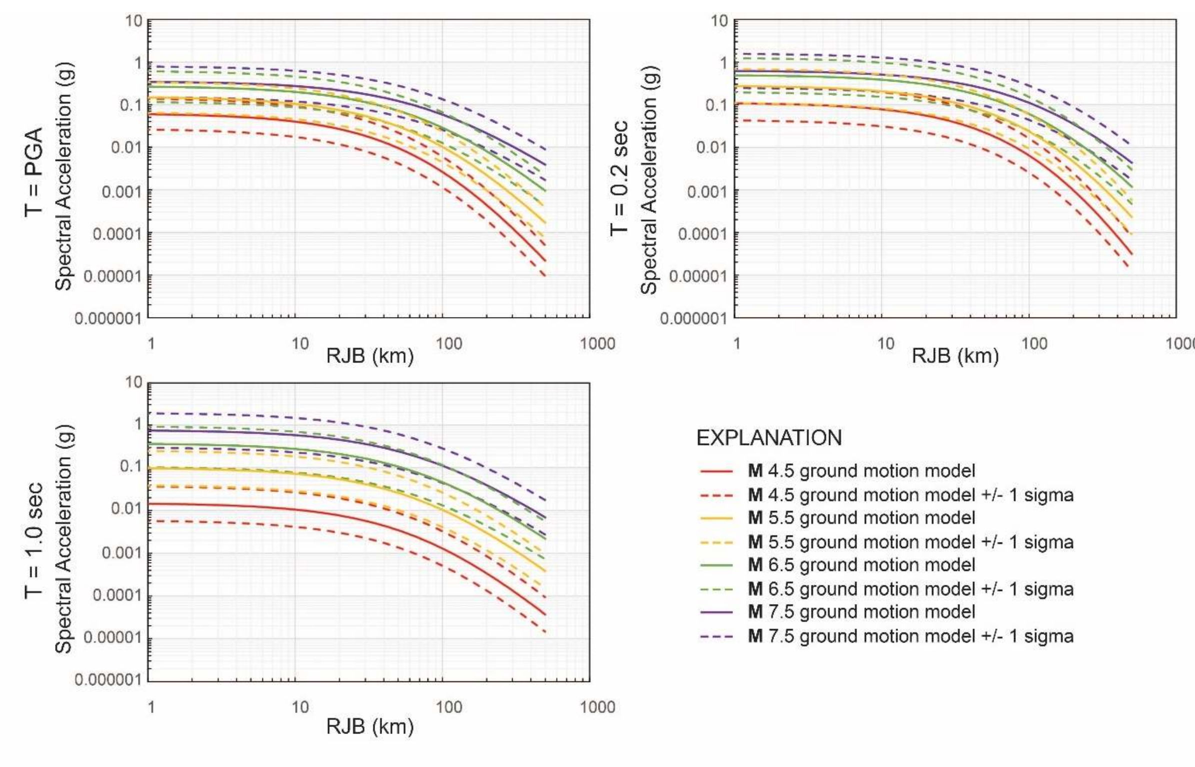

Figure C2. Ground motion models for PGA, 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 185 m/s.

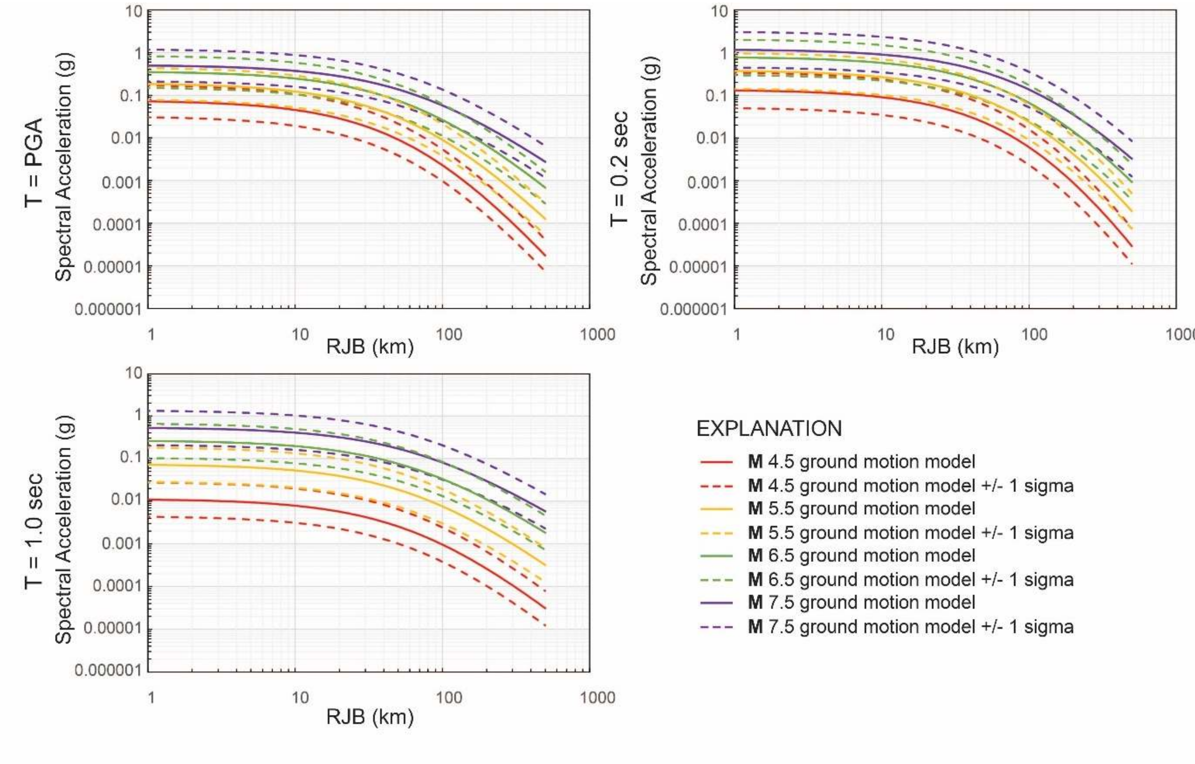

Figure C3. Ground motion models for PGA, 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 260 m/s.

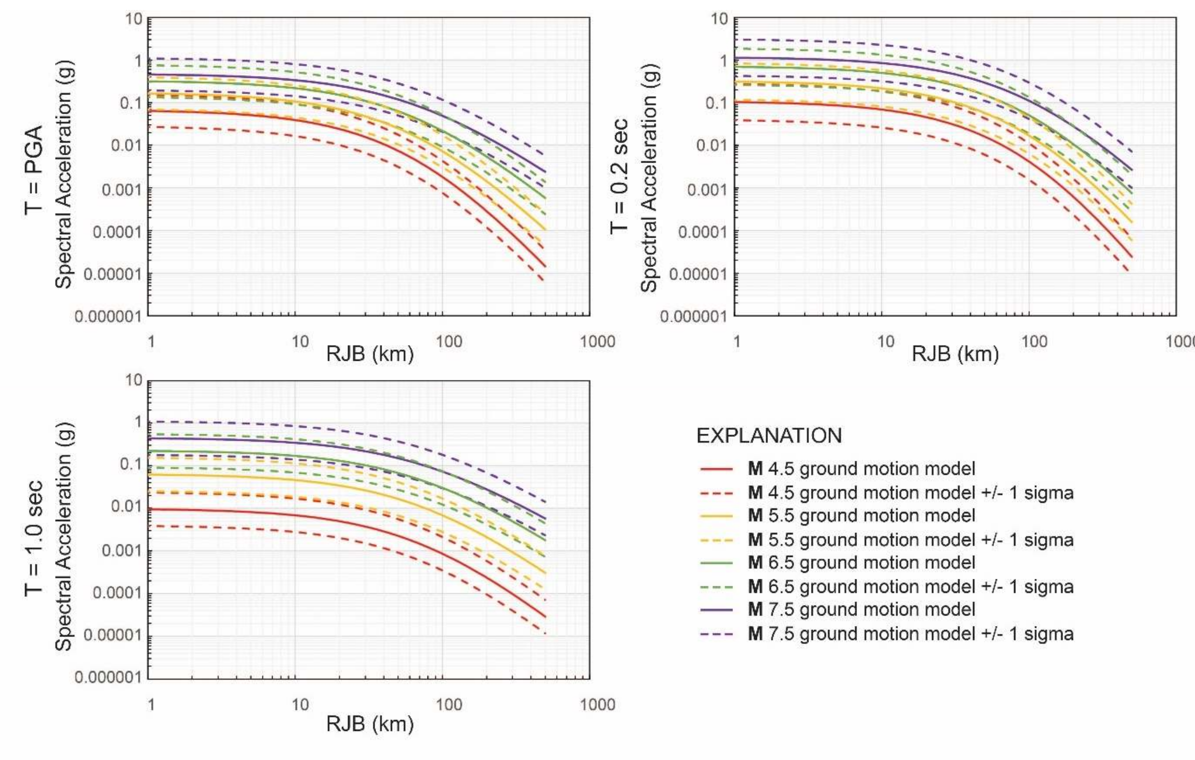

Figure C4. Ground motion models for PGA, 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 365 m/s.

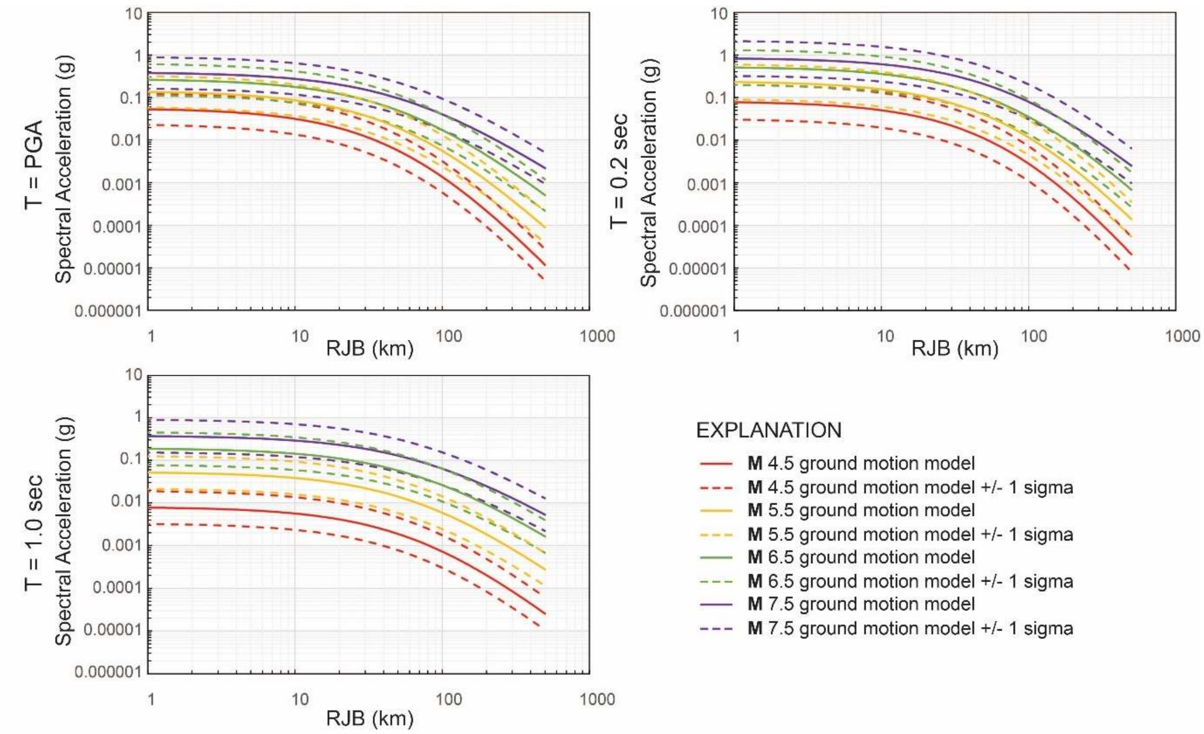

Figure C5. Ground motion models for PGA, 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 530 m/s.

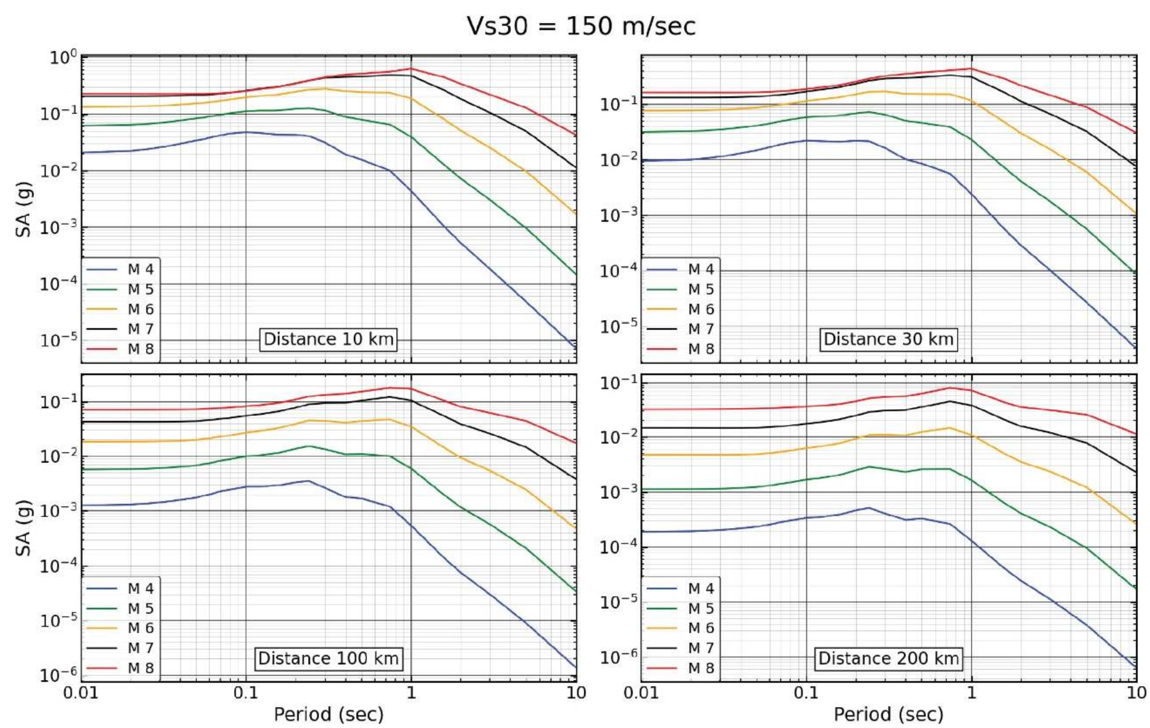

Figure C6. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 150 m/s.

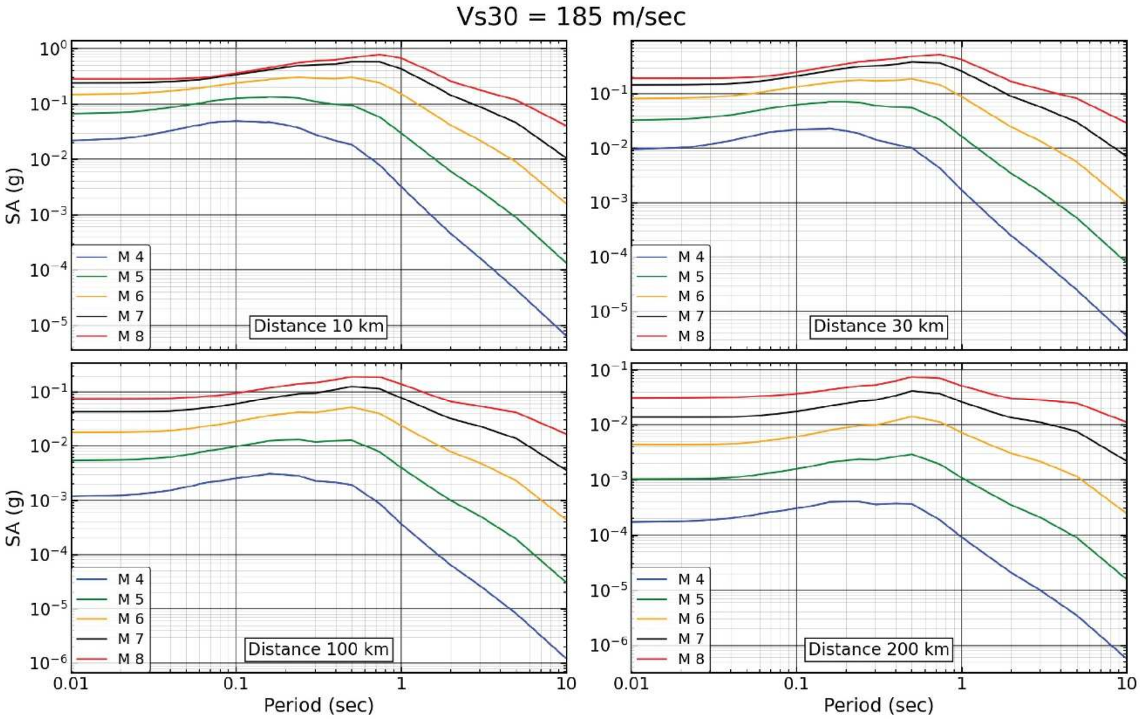

Figure C7. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 185 m/s.

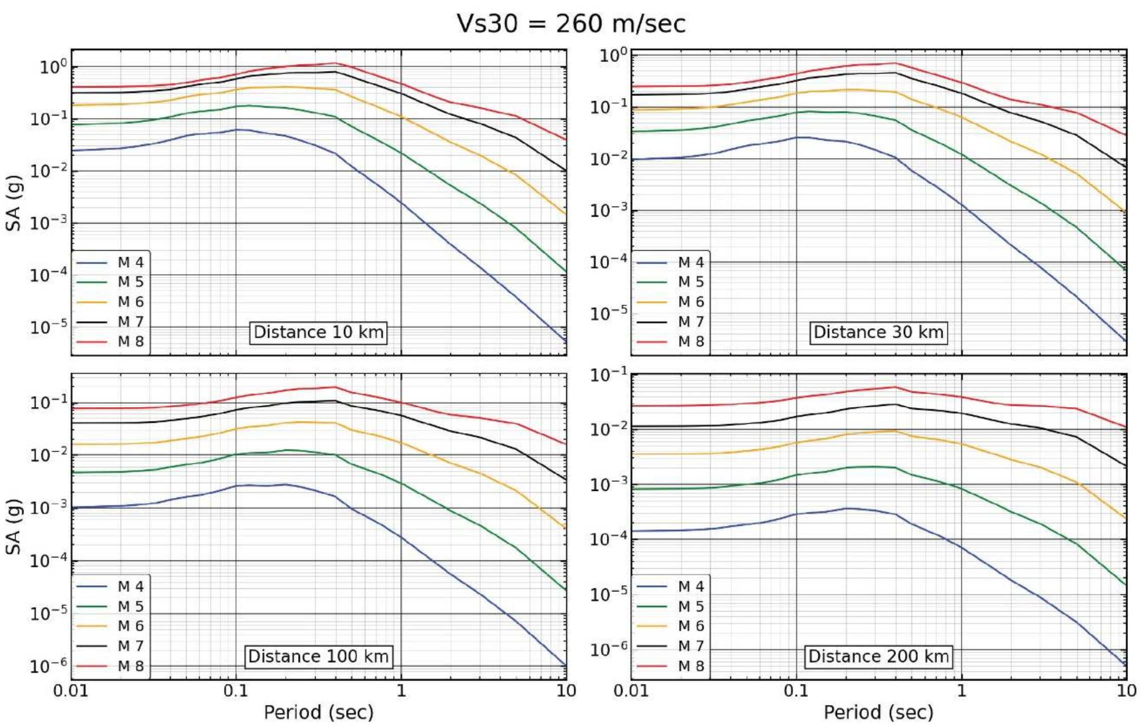

Figure C8. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 260 m/s.

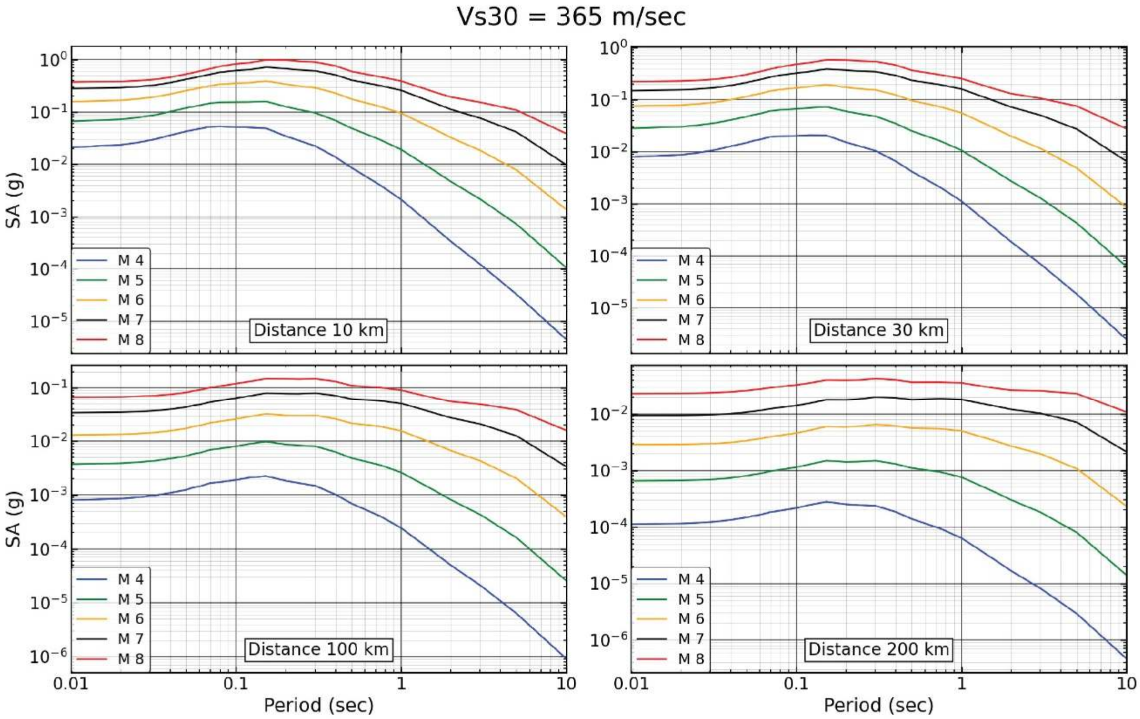

Figure C9. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 365 m/s.

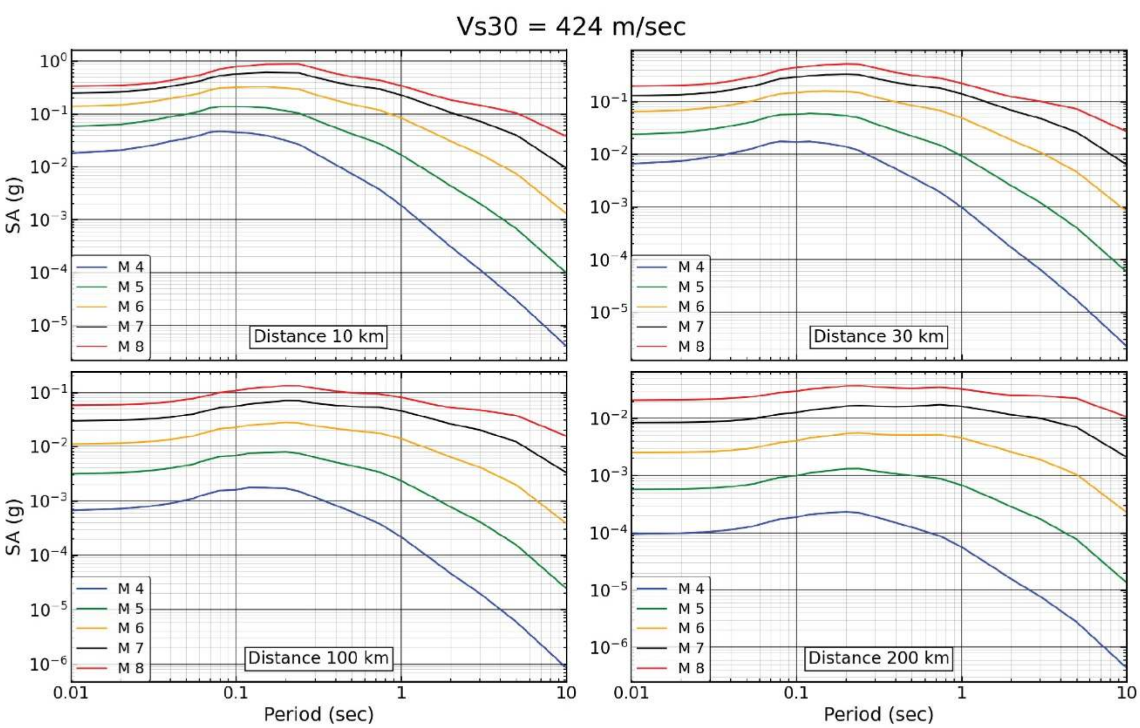

Figure C10. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 424 m/s.

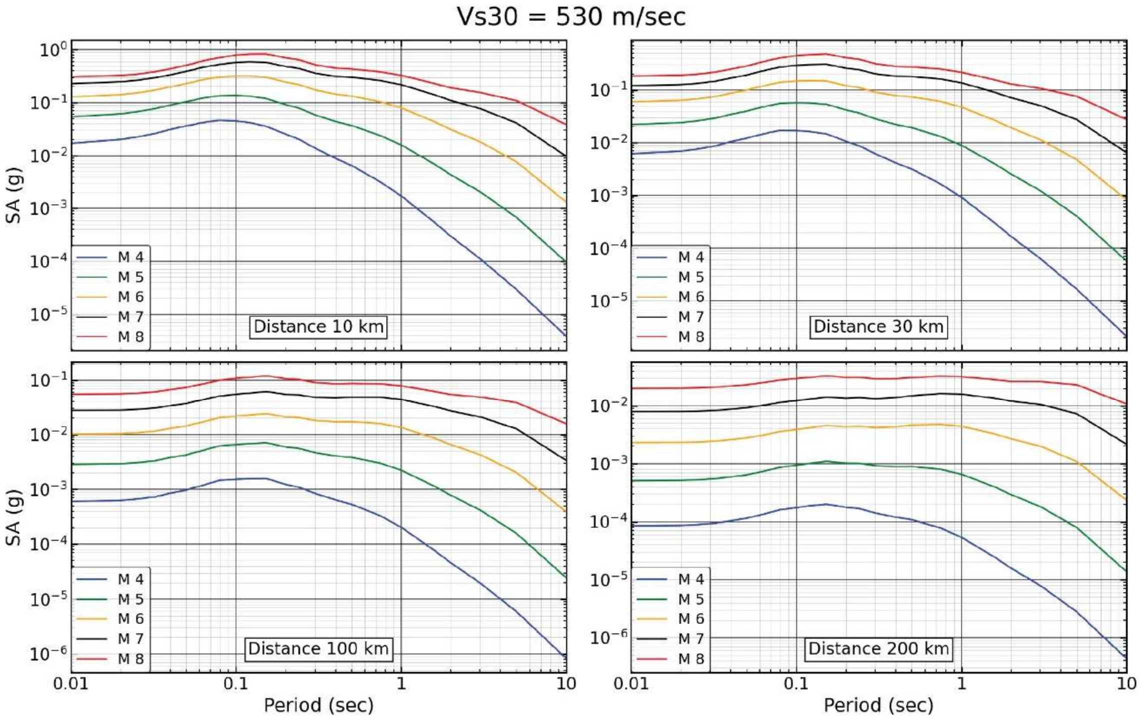

Figure C11. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 530 m/s.

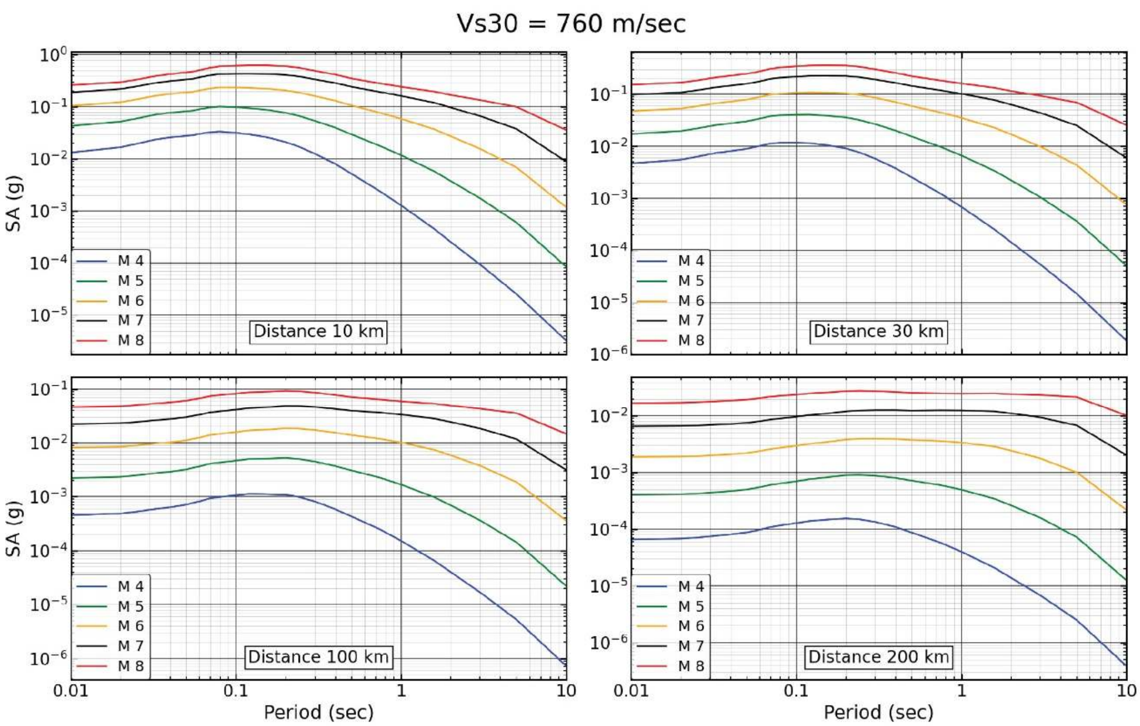

Figure C12. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 760 m/s.

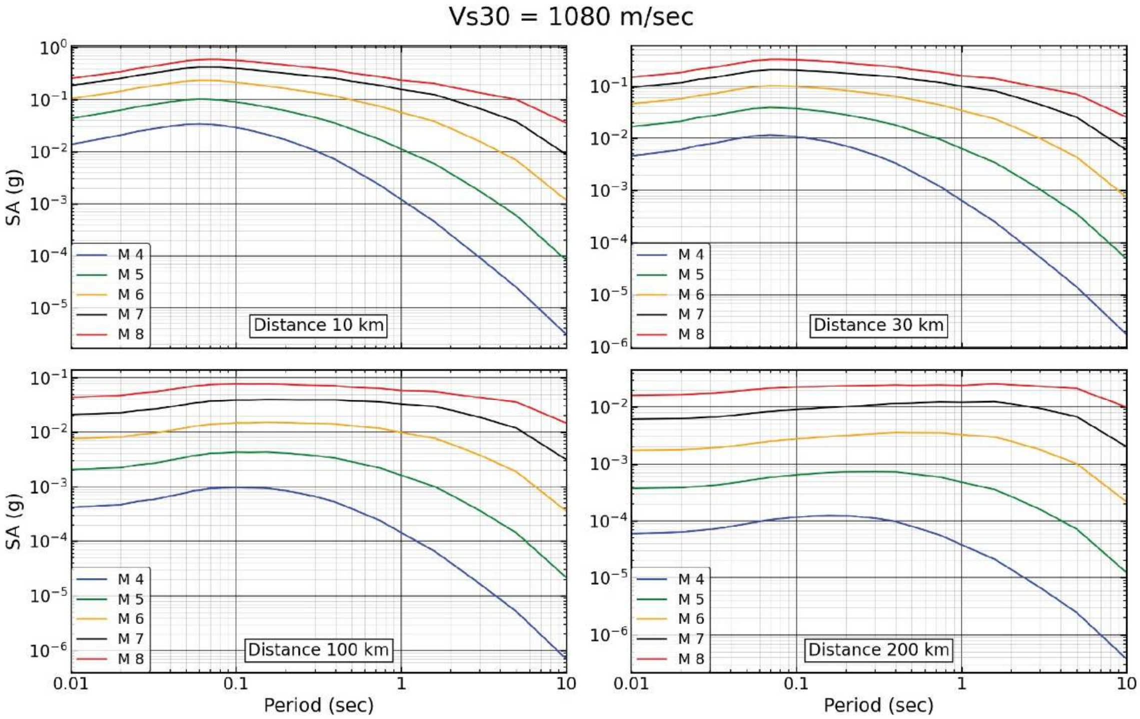

Figure C13. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 1080 m/s.

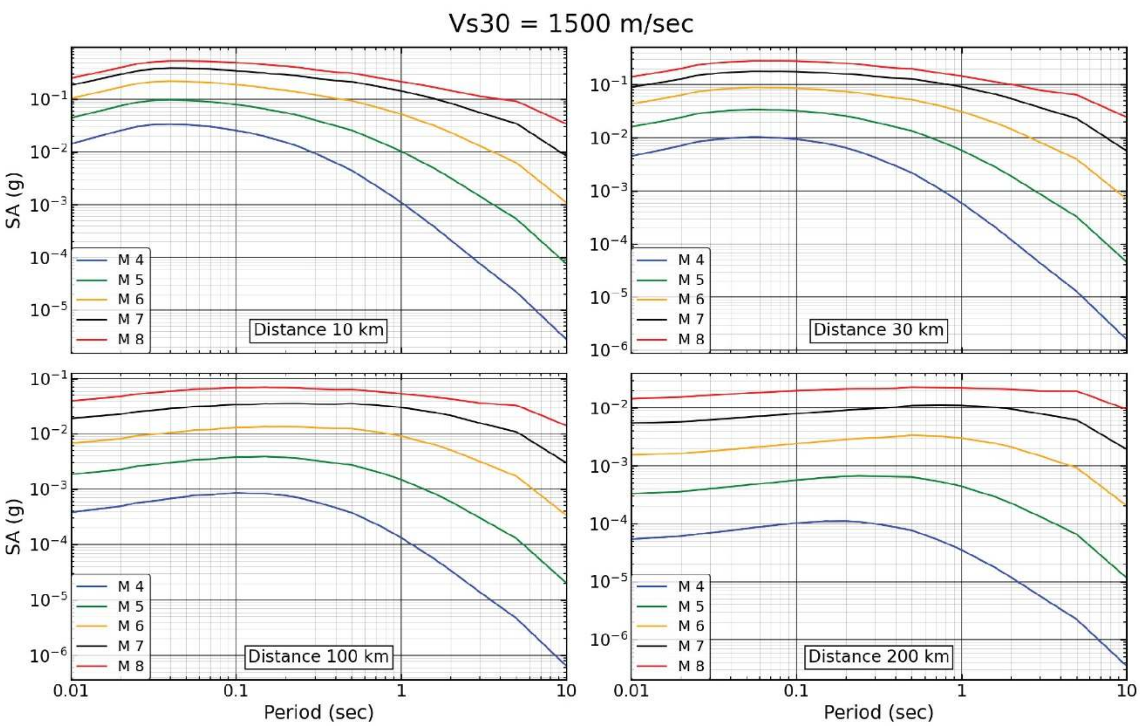

Figure C14. 5%-damped acceleration response spectra for **M** 4, 5, 6, 7, and 8, Rjb distances of 10, 30, 100, and 200 km, and a Vs30 of 1500 m/s.

Appendix D

Comparison of Crustal GMMs with Data

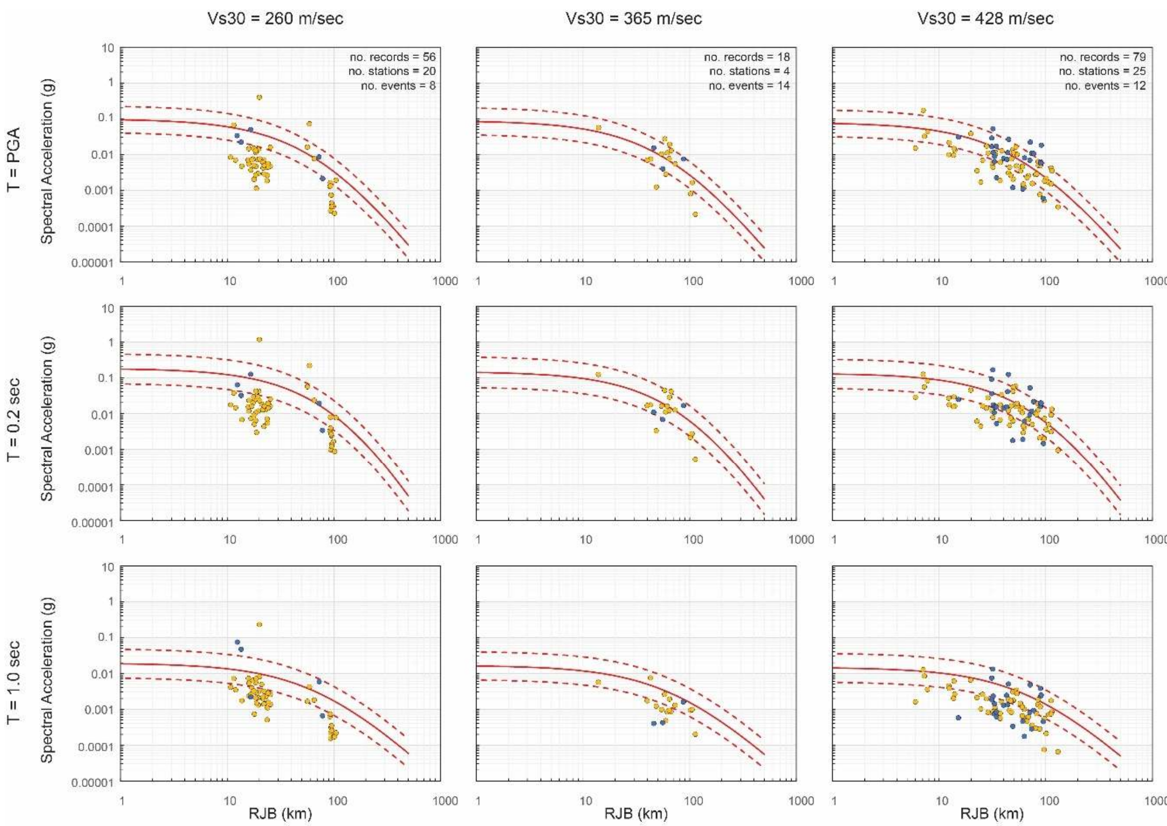

Figure D1. Recorded spectral accelerations for mainshocks **M** 4.5 to 5.0, and ground motion model for **M** 4.75.

EXPLANATION
- Data processed using USGS software
- Data used in the inversion
- Ground motion model
- Ground motion model +/- 1 sigma

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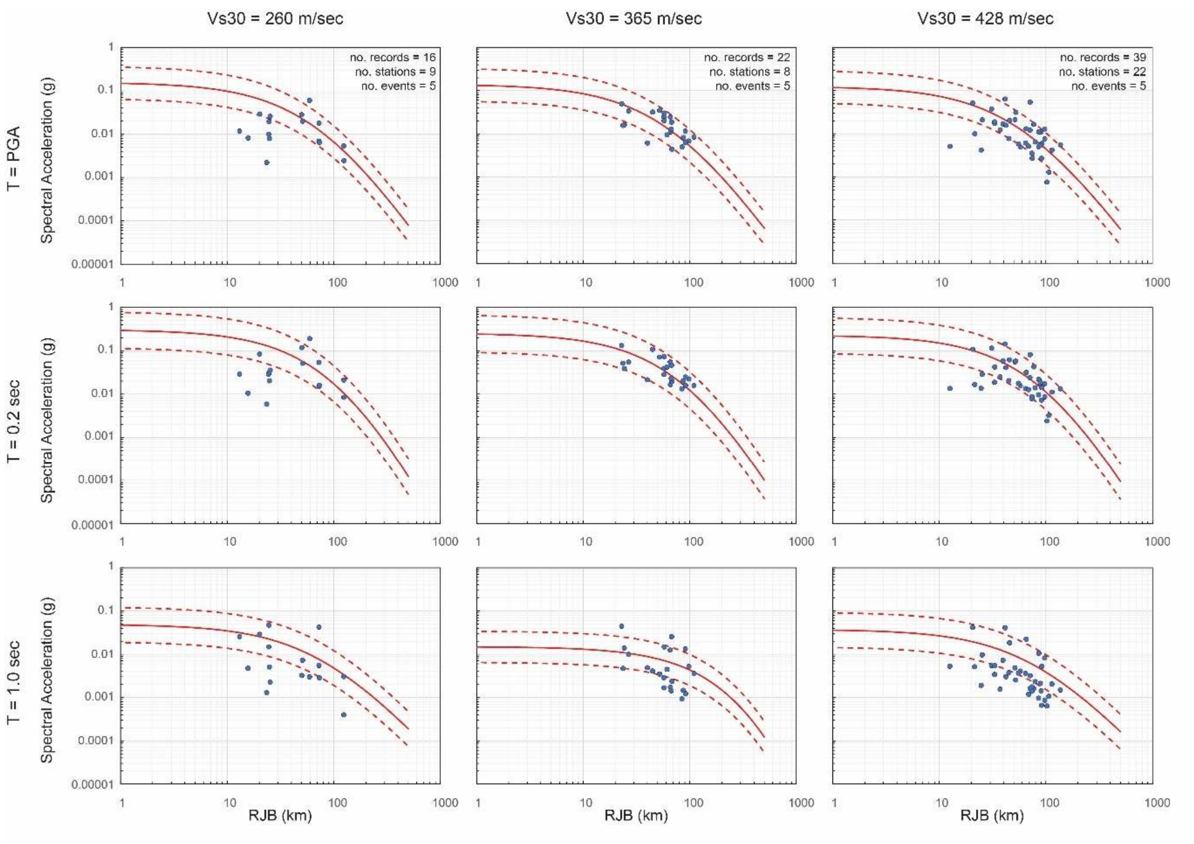

Figure D2. Recorded spectral accelerations for mainshocks **M** 5.0 to 5.5, and ground motion model for **M** 5.25.

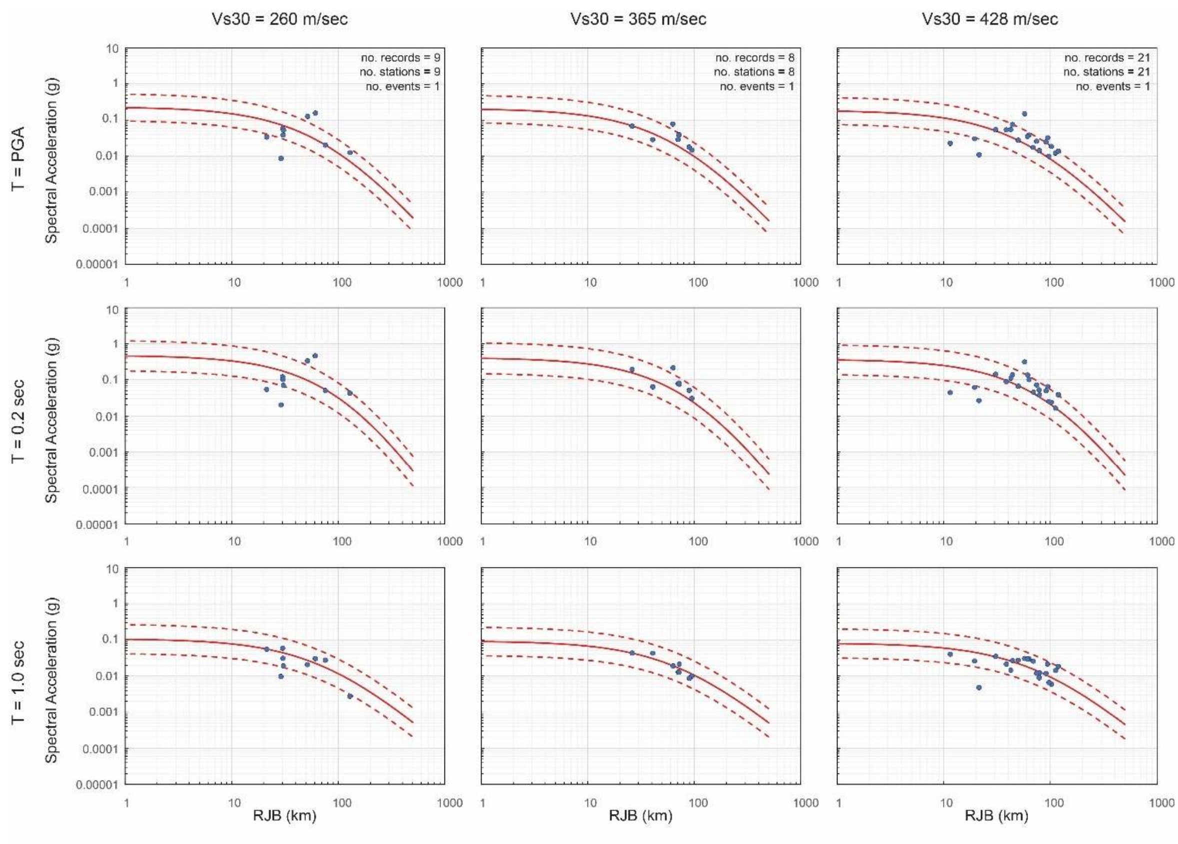

Figure D3. Recorded spectral accelerations for mainshocks **M** 5.5 to 6.0, and ground motion model for **M** 5.75.

303

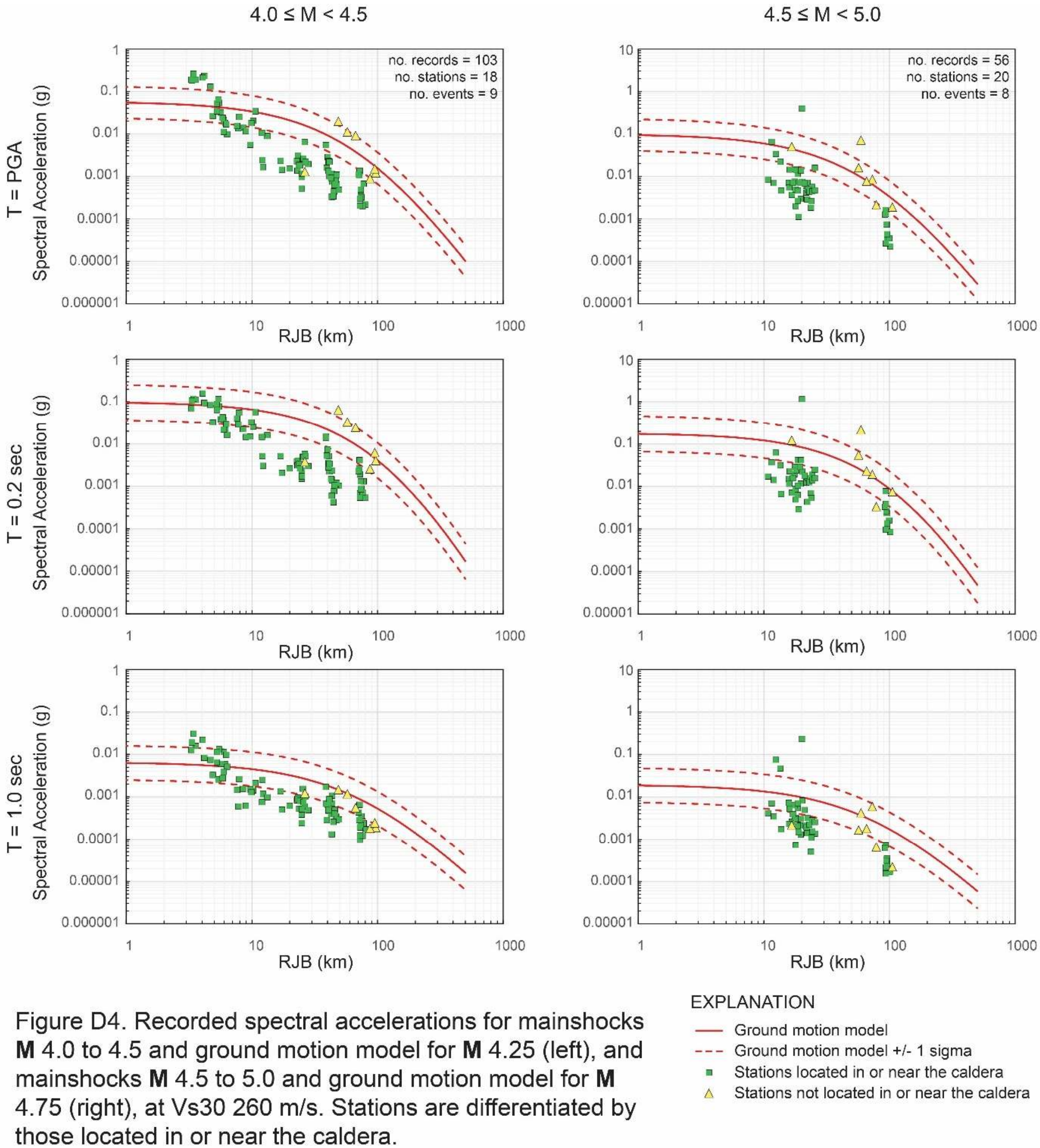

Figure D4. Recorded spectral accelerations for mainshocks **M** 4.0 to 4.5 and ground motion model for **M** 4.25 (left), and mainshocks **M** 4.5 to 5.0 and ground motion model for **M** 4.75 (right), at Vs30 260 m/s. Stations are differentiated by those located in or near the caldera.

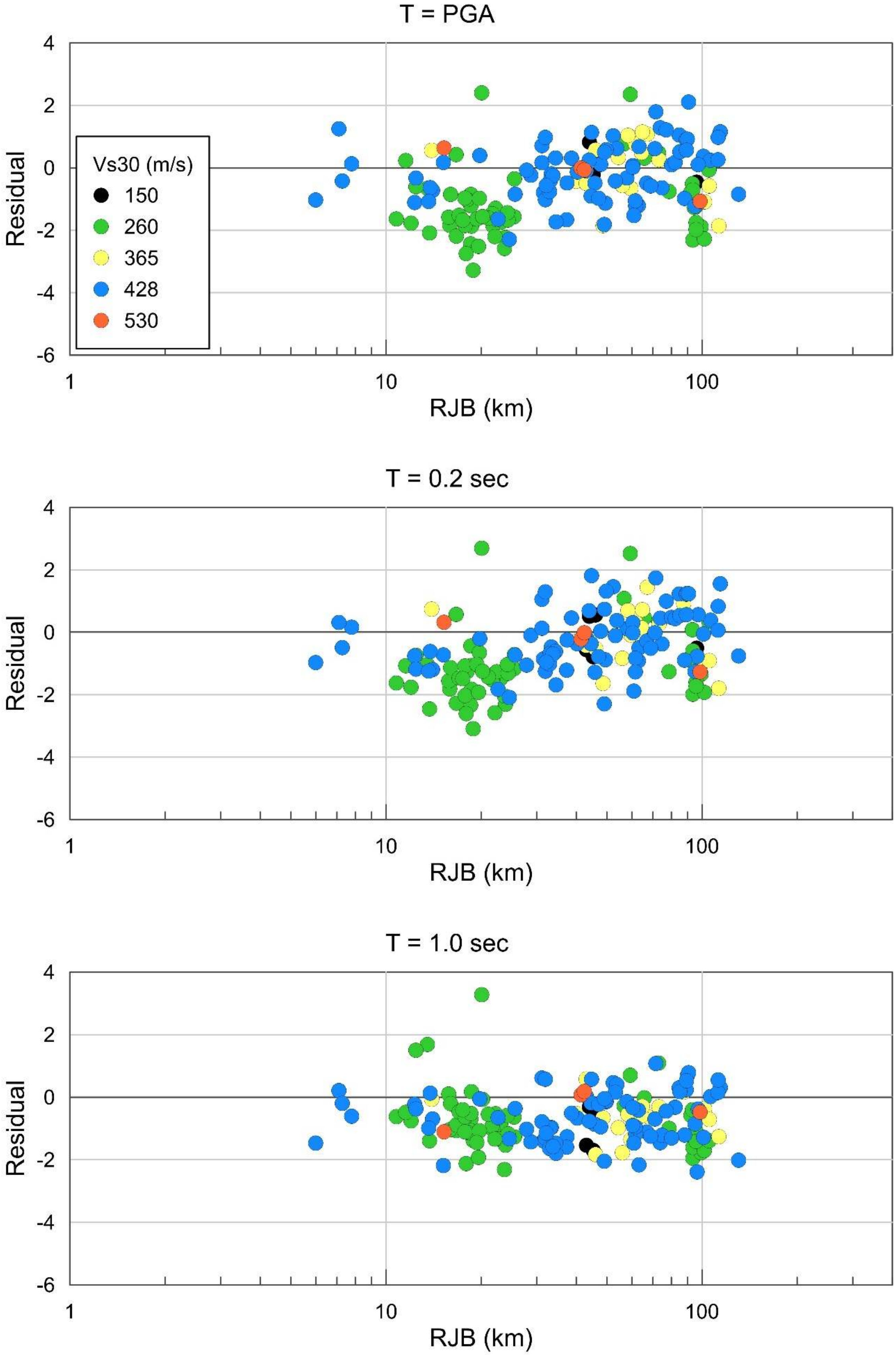

Figure D5. Residuals versus distance for earthquakes 4.5≤**M**<5 and NEHRP site categories, for PGA, 0.2, and 1.0 sec.

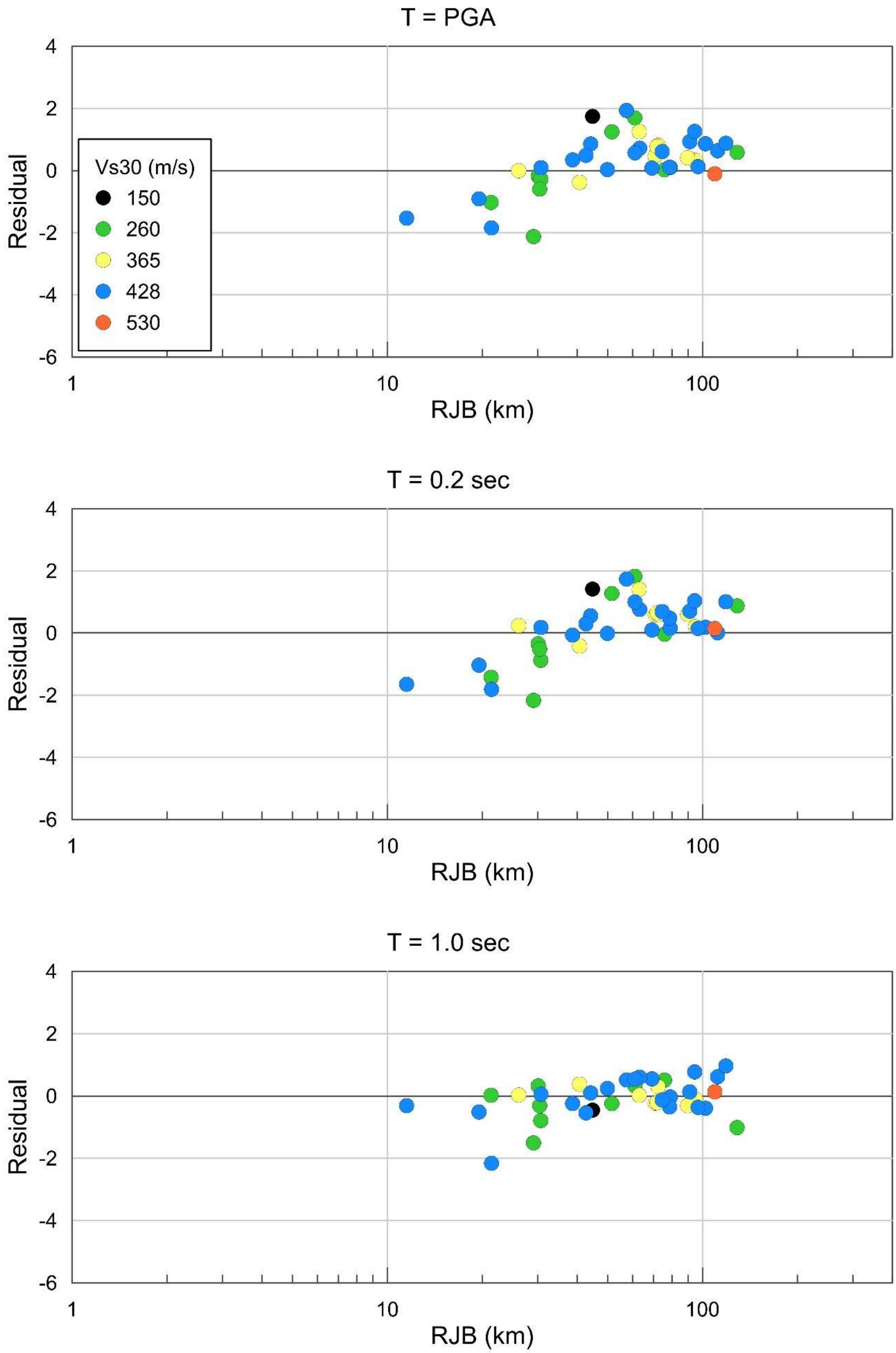

Figure D6. Residuals versus distance for earthquakes 5.5≤**M**<6 and NEHRP site categories, for PGA, 0.2, and 1.0 sec.

Appendix E

Comparison of Crustal GMMs

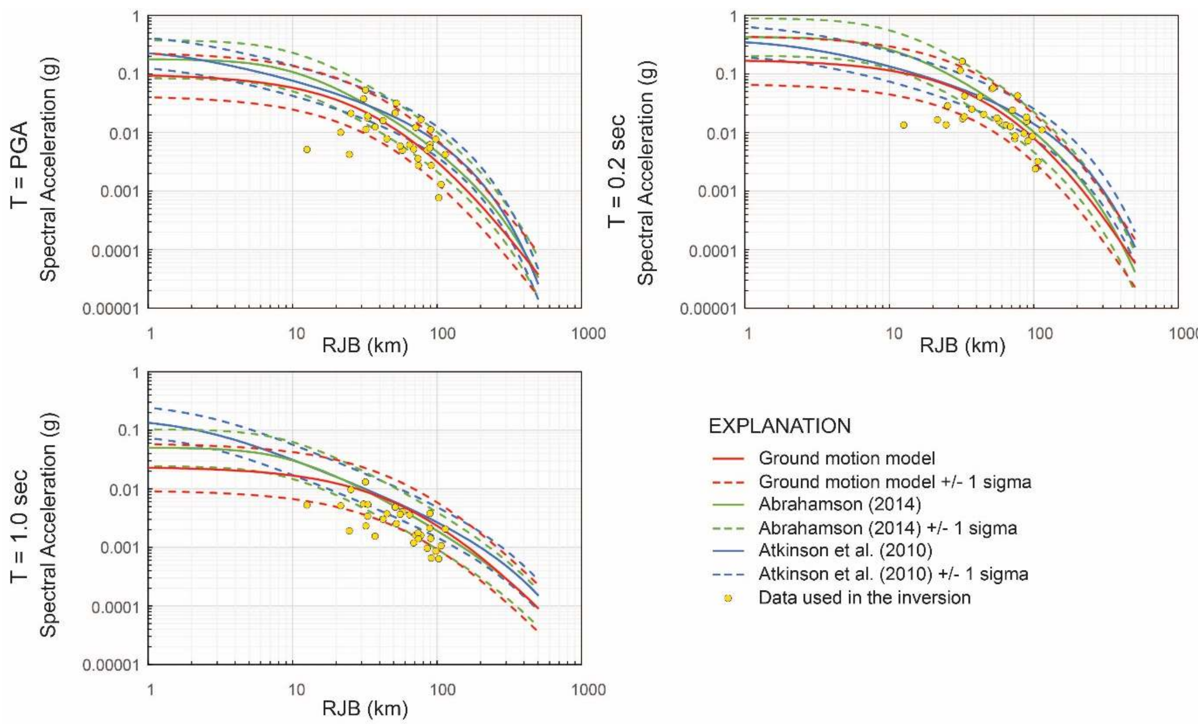

Figure E1. Comparison of crustal ground motion model for PGA and 0.2 and 1.0 s SA for **M** 5.0 with Abrahamson *et al.* (2014) and Atkinson *et al.* (2010), and recorded spectral accelerations for 4.75 ≤ **M** < 5.25, at Vs30 428 m/s.

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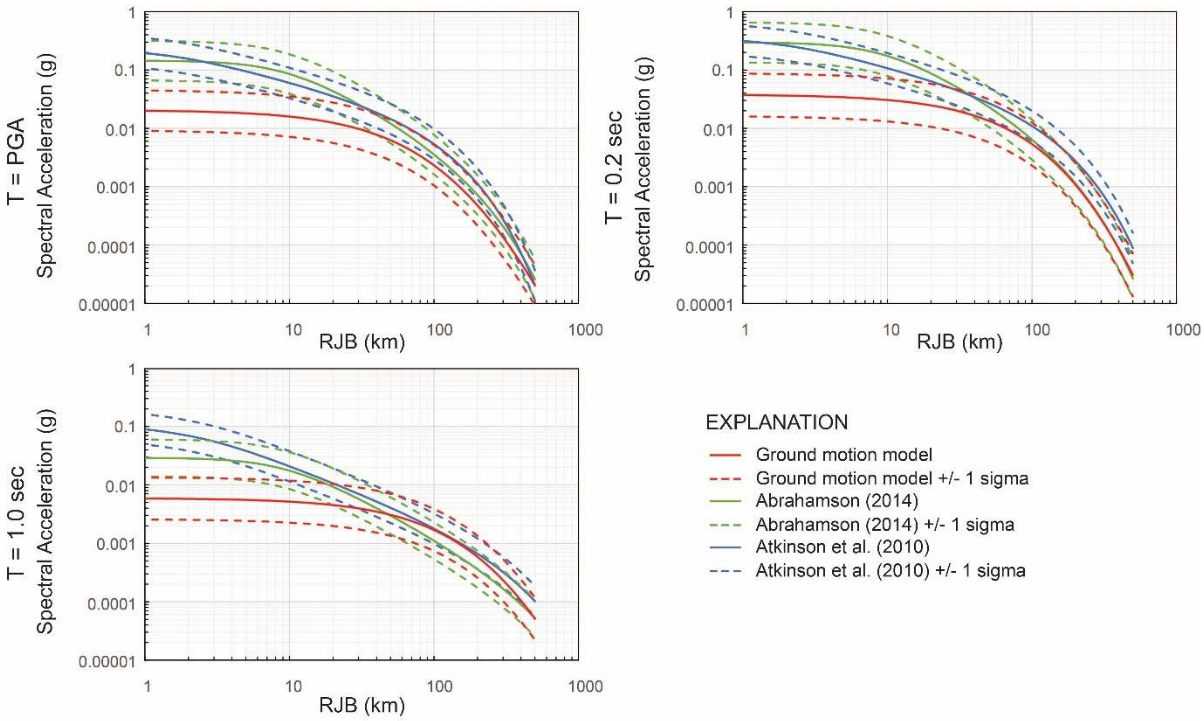

Figure E2. Comparison of ground motion models for PGA and 0.2 and 1.0 s SA for **M** 5.0 with Abrahamson *et al.* (2014) and Atkinson *et al.* (2010) at Vs30 760 m/s.

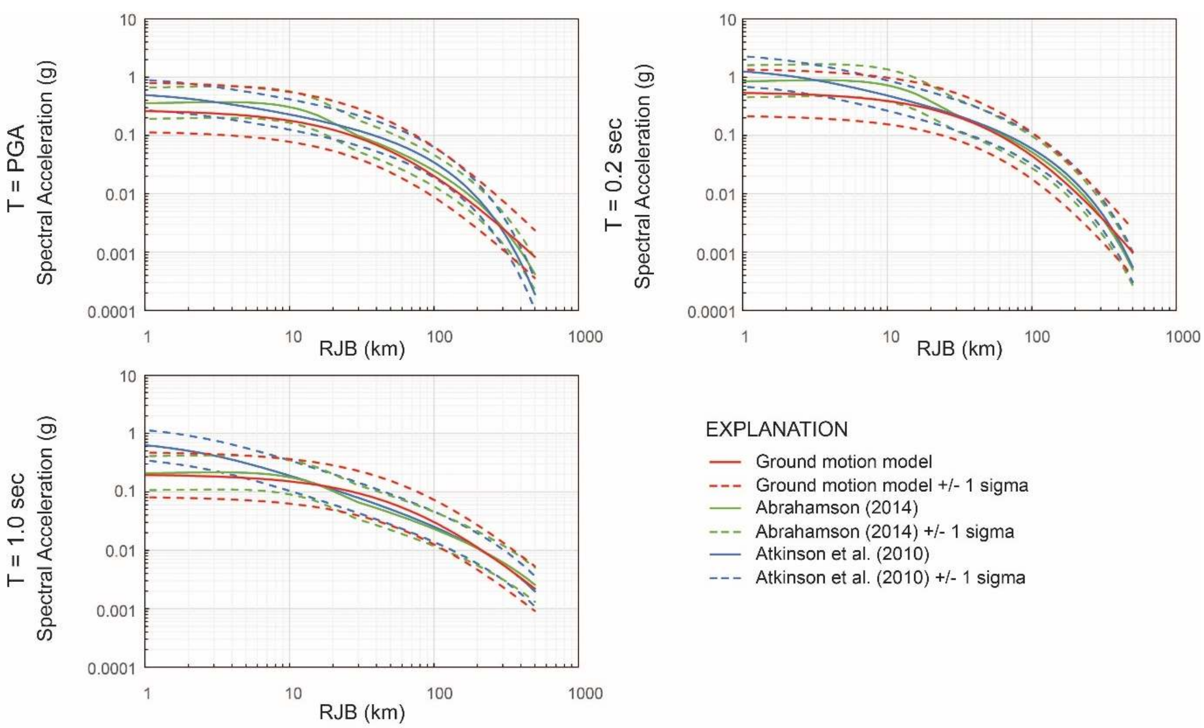

Figure E3. Comparison of ground motion models for PGA and 0.2 and 1.0 s SA for **M** 6.9 with Abrahamson *et al.* (2014) and Atkinson *et al.* (2010) at Vs30 760 m/s.

Appendix F:

Deep GMM Coefficients and Sigma Values

Table F1. GMM Coefficients and Standard Errors for V_S30 150 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	4.37553	.77975	5.80000	.00000	-4.59986	.30767	.00000	-.14658	.2813	1.2756	1.30625
.200	6.55163	1.33405	5.90000	.00000	-4.46379	.19195	.00000	-.22300	.3285	1.1358	1.18235
.331	11.38311	1.68224	6.00000	.00000	-4.85417	.10946	.00000	-.26454	.3719	.9702	1.03904
.501	30.98126	.54258	6.30000	.00000	-7.39710	.25264	.00000	-.30809	.4095	.8636	.95577
.631	49.92847	-1.04082	6.50000	.00000	-9.86362	.46506	.00000	-.33988	.4500	.7680	.89013
1.000	84.68634	-4.87454	6.70000	.00000	-14.29627	.96980	.00000	-.37189	.5312	.6627	.84932
1.349	119.73380	-8.69895	6.90000	.00000	-18.67737	1.45506	.00000	-.35283	.5612	.6566	.86375
1.995	135.07390	-10.27271	6.90000	.00000	-20.71831	1.65558	.00000	-.32696	.6008	.5902	.84220
2.512	153.20490	-12.41574	6.90000	.00000	-23.23709	1.95012	.00000	-.32053	.5926	.5655	.81912
3.311	233.34520	-20.53758	7.20000	.00000	-33.22908	2.97031	.00000	-.28776	.6288	.5581	.84075
4.169	301.79760	-27.35859	7.40000	.00000	-41.47969	3.79423	.00000	-.24674	.6299	.5330	.82514
5.012	284.11340	-26.06946	7.30000	.00000	-39.59374	3.66270	.00000	-.21950	.6197	.5209	.80955

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6.310	221.05410	-20.66703	7.00000	.00000	-32.25760	3.04183	.00000	-.19271	.6396	.5103	.81823
6.607	223.87440	-21.03829	7.00000	.00000	-32.65327	3.09331	.00000	-.18668	.6389	.5113	.81830
8.318	213.04110	-20.43183	6.90000	.00000	-31.52074	3.04296	.00000	-.15920	.6456	.5184	.82797
10.000	220.67960	-21.50187	6.90000	.00000	-32.60587	3.19304	.00000	-.13747	.6484	.4997	.81861
12.589	184.55970	-18.16765	6.70000	.00000	-28.19168	2.78915	.00000	-.11745	.6407	.4866	.80453
14.454	169.09500	-16.73068	6.60000	.00000	-26.28480	2.61423	.00000	-.11189	.6268	.4887	.79480
16.596	153.66470	-15.23057	6.50000	.00000	-24.33881	2.42658	.00000	-.11226	.6204	.4918	.79168
18.197	138.97110	-13.76625	6.40000	.00000	-22.43781	2.23752	.00000	-.11217	.6218	.4852	.78870
19.953	138.46650	-13.70573	6.40000	.00000	-22.37661	2.23038	.00000	-.11380	.6213	.4890	.79065
25.119	112.51850	-11.07698	6.20000	.00000	-18.94926	1.88358	.00000	-.12076	.6174	.4846	.78487
30.903	109.66910	-10.69246	6.20000	.00000	-18.53750	1.82857	.00000	-.13173	.6055	.4793	.77224
39.811	106.44800	-10.25181	6.20000	.00000	-18.06330	1.76436	.00000	-.14413	.5971	.4744	.76262
50.119	104.03920	-9.92014	6.20000	.00000	-17.70504	1.71552	.00000	-.15300	.5876	.4768	.75671
100.000	101.61770	-9.58564	6.20000	.00000	-17.34384	1.66611	.00000	-.16184	.5783	.4774	.74989
PGA	101.44280	-9.55060	6.20000	.00000	-17.31475	1.66075	.00000	-.16232	.5788	.4774	.75028
PGV	52.29073	-3.78249	5.70000	.00000	-10.07493	.90801	.00000	-.18440	.4450		

Table F2. GMM Coefficients and Standard Errors for V_S30 185 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	2.23924	.88904	5.70000	.00000	-4.32670	.29496	.00000	-.14503	.2903	1.2756	1.30822
.200	4.97610	1.26923	5.80000	.00000	-4.27010	.20407	.00000	-.22666	.3373	1.1358	1.18483
.331	10.39555	1.40754	5.90000	.00000	-4.75552	.15144	.00000	-.26862	.3936	.9702	1.04700

.501	17.88831	1.30809	6.00000	.00000	-5.63213	.14066	.00000	-.28729	.4219	.8636	.96115
.631	29.04721	.80828	6.20000	.00000	-7.06492	.20046	.00000	-.30768	.4435	.7680	.88686
1.000	70.86868	-2.72757	6.60000	.00000	-12.54106	.67623	.00000	-.35302	.5067	.6627	.83422
1.349	106.11160	-6.43004	6.80000	.00000	-17.05878	1.16334	.00000	-.35750	.5359	.6566	.84753
1.995	167.80150	-12.39433	7.10000	.00000	-24.73777	1.91219	.00000	-.32696	.5593	.5902	.81311
2.512	162.43070	-12.23821	7.00000	.00000	-24.23815	1.90310	.00000	-.30798	.5820	.5655	.81149
3.311	182.14450	-14.54356	7.00000	.00000	-26.93524	2.21379	.00000	-.28892	.6045	.5581	.82274
4.169	218.53920	-18.39985	7.10000	.00000	-31.56796	2.70736	.00000	-.26152	.6315	.5330	.82637
5.012	229.63580	-19.84729	7.10000	.00000	-33.07245	2.90063	.00000	-.23693	.6548	.5209	.83672
6.310	242.30880	-21.47872	7.10000	.00000	-34.80092	3.11927	.00000	-.20269	.6413	.5103	.81956
6.607	221.03660	-19.64746	7.00000	.00000	-32.25693	2.90152	.00000	-.19915	.6388	.5113	.81823
8.318	191.92920	-17.51850	6.80000	.00000	-28.89044	2.66676	.00000	-.17815	.6303	.5184	.81610
10.000	199.45500	-18.55872	6.80000	.00000	-29.97464	2.81452	.00000	-.15835	.6170	.4997	.79397
12.589	168.47430	-15.93822	6.60000	.00000	-26.18095	2.49940	.00000	-.13857	.6442	.4866	.80732
14.454	170.52630	-16.25515	6.60000	.00000	-26.49816	2.54691	.00000	-.12739	.6432	.4887	.80780
16.596	154.90560	-14.79413	6.50000	.00000	-24.52220	2.36322	.00000	-.12262	.6327	.4918	.80136
18.197	140.91200	-13.47447	6.40000	.00000	-22.72883	2.19519	.00000	-.12298	.6263	.4852	.79226
19.953	127.56000	-12.18776	6.30000	.00000	-20.98351	2.02746	.00000	-.12309	.6253	.4890	.79380
25.119	113.86900	-10.80928	6.20000	.00000	-19.16232	1.84440	.00000	-.12886	.6243	.4846	.79031
30.903	101.24280	-9.51463	6.10000	.00000	-17.44776	1.66844	.00000	-.13768	.6159	.4793	.78042
39.811	97.71396	-9.03698	6.10000	.00000	-16.92421	1.59824	.00000	-.15042	.6056	.4744	.76929
50.119	104.96560	-9.60834	6.20000	.00000	-17.85769	1.66995	.00000	-.15902	.5959	.4768	.76317
100.000	102.08580	-9.21284	6.20000	.00000	-17.42784	1.61145	.00000	-.16875	.5835	.4774	.75391
PGA	101.74880	-9.15899	6.20000	.00000	-17.37388	1.60314	.00000	-.16908	.583000	.4774	.75352
PGV	49.26893	-3.53262	5.60000	.00000	-9.70275	.87669	.00000	-.18271	.4627		

Table F3. GMM Coefficients and Standard Errors for V_S30 260 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-4.06428	1.34282	5.40000	.00000	-3.45320	.23289	.00000	-.14270	.3058	1.2756	1.31174
.200	2.52438	1.35767	5.70000	.00000	-3.94546	.19376	.00000	-.22802	.3468	1.1358	1.18757
.331	11.21896	1.12792	5.90000	.00000	-4.89811	.19535	.00000	-.27638	.3887	.9702	1.04517
.501	16.13302	1.01694	5.90000	.00000	-5.42645	.18666	.00000	-.29415	.4178	.8636	.95935
.631	21.10197	1.01206	6.00000	.00000	-6.00444	.17189	.00000	-.29984	.4435	.7680	.88686
1.000	30.96416	.74999	6.10000	.00000	-7.18627	.18324	.00000	-.30587	.4828	.6627	.81992
1.349	43.71734	-.26484	6.20000	.00000	-8.88793	.31740	.00000	-.30885	.5089	.6566	.83072
1.995	80.53577	-3.34020	6.50000	.00000	-13.82011	.73594	.00000	-.31268	.5498	.5902	.80661
2.512	112.43970	-6.21106	6.70000	.00000	-17.97597	1.11532	.00000	-.29580	.5827	.5655	.81199
3.311	139.22570	-8.85118	6.80000	.00000	-21.49511	1.46421	.00000	-.27930	.6222	.5581	.83583
4.169	168.33290	-11.62806	6.90000	.00000	-25.29347	1.82776	.00000	-.25550	.6441	.5330	.83603
5.012	197.68610	-14.40394	7.00000	.00000	-29.04471	2.18513	.00000	-.23960	.6366	.5209	.82255
6.310	172.95640	-13.05183	6.80000	.00000	-26.20392	2.03980	.00000	-.21531	.6385	.5103	.81737
6.607	175.79600	-13.42590	6.80000	.00000	-26.60735	2.09247	.00000	-.21223	.6442	.5113	.82245
8.318	187.30890	-14.99079	6.80000	.00000	-28.23981	2.31085	.00000	-.18484	.6450	.5184	.82750
10.000	177.03360	-14.59615	6.70000	.00000	-27.09436	2.27932	.00000	-.16581	.6292	.4997	.80349
12.589	136.01090	-11.43608	6.40000	.00000	-21.95613	1.89006	.00000	-.15274	.6616	.4866	.82128
14.454	125.74720	-10.70080	6.30000	.00000	-20.67593	1.80192	.00000	-.14316	.6650	.4887	.82526
16.596	115.39370	-9.89023	6.20000	.00000	-19.34768	1.70006	.00000	-.13524	.6679	.4918	.82943
18.197	115.92360	-9.98450	6.20000	.00000	-19.44174	1.71563	.00000	-.13121	.6574	.4852	.81706
19.953	105.56700	-9.10250	6.10000	.00000	-18.07121	1.59993	.00000	-.12999	.6462	.4890	.81037
25.119	94.88692	-8.14908	6.00000	.00000	-16.63719	1.47287	.00000	-.13059	.6467	.4846	.80812
30.903	91.89919	-7.77002	6.00000	.00000	-16.20113	1.41794	.00000	-.13896	.6383	.4793	.79822

39.811	88.90305	-7.38200	6.00000	.00000	-15.75632	1.36069	.00000	-.14686	.6268	.4744	.78609
50.119	86.55507	-7.07048	6.00000	.00000	-15.40218	1.31405	.00000	-.15396	.6173	.4768	.78000
100.000	83.82279	-6.70478	6.00000	.00000	-14.98769	1.25899	.00000	-.16222	.6055	.4774	.77106
PGA	83.41772	-6.63195	6.00000	.00000	-14.92092	1.24728	.00000	-.16212	.6060	.4774	.77146
PGV	43.61100	-3.09358	5.40000	.00000	-9.00818	.82445	.00000	-.16302	.4921		

Table F4. GMM Coefficients and Standard Errors for V_S30 365 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-5.89428	1.54704	5.40000	.00000	-3.18565	.20388	.00000	-.14813	.2898	1.2756	1.30811
.200	.82909	1.53292	5.70000	.00000	-3.69799	.16915	.00000	-.23479	.3377	1.1358	1.18494
.331	10.22099	1.15948	5.90000	.00000	-4.76276	.19303	.00000	-.28367	.3661	.9702	1.03698
.501	19.13934	.72139	6.00000	.00000	-5.85525	.23212	.00000	-.30420	.3761	.8636	.94194
.631	25.40152	.53718	6.10000	.00000	-6.61504	.24338	.00000	-.31135	.3848	.7680	.85901
1.000	32.53355	.21408	6.10000	.00000	-7.43641	.26362	.00000	-.31210	.4529	.6627	.80268
1.349	43.69998	-.48336	6.20000	.00000	-8.91529	.34927	.00000	-.30116	.5169	.6566	.83565
1.995	47.13694	-.88354	6.10000	.00000	-9.38070	.39279	.00000	-.27345	.5631	.5902	.81573
2.512	66.01481	-2.09548	6.30000	.00000	-11.92174	.55460	.00000	-.26212	.5865	.5655	.81472
3.311	84.00746	-3.74371	6.40000	.00000	-14.36503	.77954	.00000	-.24890	.6116	.5581	.82797
4.169	92.99872	-4.78684	6.40000	.00000	-15.65712	.92627	.00000	-.23303	.6256	.5330	.82187
5.012	112.00830	-6.51004	6.50000	.00000	-18.24856	1.16354	.00000	-.22159	.6181	.5209	.80832
6.310	136.00000	-8.89998	6.60000	.00000	-21.47893	1.48895	.00000	-.20588	.6414	.5103	.81963
6.607	138.31690	-9.24763	6.60000	.00000	-21.80543	1.53773	.00000	-.20243	.6584	.5113	.83362

8.318	133.30290	-9.43377	6.50000	.00000	-21.32144	1.57964	.00000	-.18015	.6909	.5184	.86376
10.000	115.28580	-8.43449	6.30000	.00000	-19.10105	1.46438	.00000	-.16934	.6836	.4997	.84676
12.589	122.46710	-9.49702	6.30000	.00000	-20.19708	1.62386	.00000	-.15751	.6951	.4866	.84850
14.454	114.50810	-9.10871	6.20000	.00000	-19.22034	1.58278	.00000	-.14825	.6715	.4887	.83051
16.596	105.39700	-8.51048	6.10000	.00000	-18.05312	1.51000	.00000	-.14108	.6770	.4918	.83678
18.197	96.25155	-7.80813	6.00000	.00000	-16.83717	1.41798	.00000	-.13678	.6859	.4852	.84017
19.953	96.17582	-7.83323	6.00000	.00000	-16.84412	1.42371	.00000	-.13404	.6781	.4890	.83602
25.119	86.83934	-7.08907	5.90000	.00000	-15.59138	1.32578	.00000	-.13191	.6578	.4846	.81703
30.903	76.95651	-6.19404	5.80000	.00000	-14.21214	1.20096	.00000	-.13501	.6498	.4793	.80745
39.811	74.29043	-5.87185	5.80000	.00000	-13.81202	1.15290	.00000	-.14086	.6378	.4744	.79489
50.119	72.02564	-5.58468	5.80000	.00000	-13.46659	1.10935	.00000	-.14657	.6224	.4768	.78404
100.000	69.57445	-5.26972	5.80000	.00000	-13.08968	1.06122	.00000	-.15310	.6103	.4774	.77484
PGA	69.33356	-5.22513	5.80000	.00000	-13.04691	1.05354	.00000	-.15287	.6102	.4774	.77476
PGV	44.09953	-3.24840	5.40000	.00000	-9.16765	.85807	.00000	-.15093	.4599		

Table F5. GMM Coefficients and Standard Errors for V_S30 428 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-6.91550	1.66675	5.40000	.00000	-3.03522	.18615	.00000	-.15158	.2945	1.2756	1.3092
.200	-.08881	1.63345	5.70000	.00000	-3.56561	.15429	.00000	-.23807	.3392	1.1358	1.1854
.331	9.41267	1.23611	5.90000	.00000	-4.64883	.18193	.00000	-.28698	.3861	.9702	1.0442
.501	21.84053	.61910	6.10000	.00000	-6.22484	.24654	.00000	-.30737	.3986	.8636	.9512
.631	25.11810	.51244	6.10000	.00000	-6.58828	.24816	.00000	-.31414	.4100	.7680	.8706

1.000	32.93593	.08357	6.10000	.00000	-7.51731	.28394	.00000	-.31387	.4398	.6627	.7954
1.349	43.47321	-.50426	6.20000	.00000	-8.89132	.35245	.00000	-.30295	.4883	.6566	.8183
1.995	46.91267	-.93125	6.10000	.00000	-9.36813	.40094	.00000	-.27491	.5676	.5902	.8188
2.512	58.53881	-1.71001	6.20000	.00000	-10.95674	.50386	.00000	-.25817	.6228	.5655	.8412
3.311	73.99161	-2.90241	6.30000	.00000	-13.06945	.66484	.00000	-.23860	.6400	.5581	.8492
4.169	91.64108	-4.50724	6.40000	.00000	-15.47178	.88528	.00000	-.22629	.6315	.5330	.8264
5.012	98.22293	-5.32783	6.40000	.00000	-16.41981	1.00088	.00000	-.20822	.6565	.5209	.8381
6.310	106.93830	-6.37317	6.40000	.00000	-17.69223	1.15058	.00000	-.19072	.6497	.5103	.8261
6.607	108.81360	-6.61834	6.40000	.00000	-17.96824	1.18618	.00000	-.18760	.6526	.5113	.8290
8.318	106.72080	-7.05038	6.30000	.00000	-17.84235	1.26035	.00000	-.17244	.6654	.5184	.8435
10.000	103.04320	-7.20814	6.20000	.00000	-17.48802	1.29736	.00000	-.16376	.6569	.4997	.8254
12.589	109.74360	-8.23258	6.20000	.00000	-18.51599	1.45171	.00000	-.14918	.6755	.4866	.8325
14.454	102.11800	-7.86625	6.10000	.00000	-17.56159	1.41182	.00000	-.14031	.6823	.4887	.8393
16.596	93.82941	-7.33934	6.00000	.00000	-16.49267	1.34782	.00000	-.13461	.6789	.4918	.8383
18.197	85.58938	-6.72014	5.90000	.00000	-15.38958	1.26654	.00000	-.13275	.6781	.4852	.8338
19.953	85.62312	-6.76578	5.90000	.00000	-15.41352	1.27568	.00000	-.13241	.6740	.4890	.8327
25.119	78.01486	-6.22686	5.80000	.00000	-14.39446	1.20623	.00000	-.12877	.6714	.4846	.8280
30.903	69.46166	-5.48027	5.70000	.00000	-13.19430	1.10188	.00000	-.13149	.6646	.4793	.8194
39.811	67.40193	-5.24299	5.70000	.00000	-12.88585	1.06672	.00000	-.13721	.6520	.4744	.8063
50.119	65.29077	-4.98649	5.70000	.00000	-12.56134	1.02752	.00000	-.14202	.6393	.4768	.7975
100.000	68.77858	-5.13883	5.80000	.00000	-13.00533	1.04366	.00000	-.14918	.6189	.4774	.7816
PGA	68.52187	-5.09631	5.80000	.00000	-12.96010	1.03629	.00000	-.14898	.6172	.4774	.7803
PGV	39.70192	-2.85255	5.30000	.00000	-8.55941	.80414	.00000	-.15077	.4487		

Table F6. GMM Coefficients and Standard Errors for V_S30 530 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-8.03767	1.81000	5.40000	.00000	-2.85976	.16457	.00000	-.15643	.2767	1.2756	1.30527
.200	-1.25751	1.78877	5.70000	.00000	-3.38239	.13112	.00000	-.24196	.3092	1.1358	1.17714
.331	8.15232	1.40183	5.90000	.00000	-4.45366	.15768	.00000	-.28962	.3223	.9702	1.02233
.501	20.94299	.69302	6.10000	.00000	-6.09092	.23685	.00000	-.31168	.3451	.8636	.93000
.631	25.01453	.42709	6.10000	.00000	-6.57384	.26243	.00000	-.31979	.3806	.7680	.85714
1.000	38.35402	-.41740	6.20000	.00000	-8.27339	.35831	.00000	-.31925	.4037	.6627	.77598
1.349	44.88622	-.88836	6.20000	.00000	-9.13036	.41238	.00000	-.30586	.4852	.6566	.81642
1.995	48.98657	-1.46751	6.10000	.00000	-9.70979	.48418	.00000	-.27903	.5800	.5902	.82749
2.512	54.65042	-2.00377	6.10000	.00000	-10.51665	.55588	.00000	-.25843	.6022	.5655	.82610
3.311	61.09278	-2.53809	6.10000	.00000	-11.42838	.62602	.00000	-.23021	.6315	.5581	.84277
4.169	74.60570	-3.59587	6.20000	.00000	-13.28874	.77046	.00000	-.21288	.6833	.5330	.86660
5.012	80.00266	-4.15288	6.20000	.00000	-14.07377	.84958	.00000	-.19862	.7007	.5209	.87311
6.310	87.95488	-5.11364	6.20000	.00000	-15.23049	.98796	.00000	-.18458	.7117	.5103	.87574
6.607	98.80550	-5.92063	6.30000	.00000	-16.69061	1.09728	.00000	-.18137	.7167	.5113	.88039
8.318	97.18981	-6.29408	6.20000	.00000	-16.61059	1.16151	.00000	-.16640	.6930	.5184	.86544
10.000	103.48240	-7.16712	6.20000	.00000	-17.57100	1.29274	.00000	-.15638	.6944	.4997	.85551
12.589	100.12900	-7.40399	6.10000	.00000	-17.25625	1.34181	.00000	-.14196	.6943	.4866	.84784
14.454	93.65316	-7.10737	6.00000	.00000	-16.45844	1.31177	.00000	-.13559	.6817	.4887	.83878
16.596	86.99494	-6.75528	5.90000	.00000	-15.61034	1.27237	.00000	-.13166	.6812	.4918	.84018
18.197	87.73768	-6.92513	5.90000	.00000	-15.74427	1.30060	.00000	-.13039	.6952	.4852	.84777
19.953	80.43280	-6.40826	5.80000	.00000	-14.76011	1.23307	.00000	-.12840	.7043	.4890	.85741
25.119	73.42247	-5.94296	5.70000	.00000	-13.82274	1.17454	.00000	-.12507	.6939	.4846	.84637
30.903	71.87675	-5.81419	5.70000	.00000	-13.60719	1.15756	.00000	-.12684	.6778	.4793	.83015
39.811	63.55502	-5.06540	5.60000	.00000	-12.41712	1.05065	.00000	-.13091	.6674	.4744	.81883

50.119	61.90769	-4.87518	5.60000	.00000	-12.16475	1.02174	.00000	-.13495	.6566	.4768	.81146
100.000	64.88462	-5.00740	5.70000	.00000	-12.54193	1.03547	.00000	-.14146	.6367	.4774	.79580
PGA	64.73113	-4.98090	5.70000	.00000	-12.51300	1.03056	.00000	-.14120	.6370	.4774	.79604
PGV	39.64739	-2.89068	5.30000	.00000	-8.59420	.81631	.00000	-.14725	.4549		

Table F7. GMM Coefficients and Standard Errors for V_S30 760 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-9.22402	1.94021	5.40000	.00000	-2.69597	.14582	.00000	-.15966	.2835	1.2756	1.3067
.200	-2.19341	1.87567	5.70000	.00000	-3.25694	.11873	.00000	-.24647	.3272	1.1358	1.1820
.331	10.20900	1.28757	6.00000	.00000	-4.75429	.17465	.00000	-.29404	.3752	.9702	1.0402
.501	20.33703	.67544	6.10000	.00000	-6.02319	.24061	.00000	-.31542	.3731	.8636	.94075
.631	28.17415	.28135	6.20000	.00000	-7.01483	.28296	.00000	-.32196	.3683	.7680	.85174
1.000	37.99058	-.39601	6.20000	.00000	-8.27053	.35640	.00000	-.31746	.4298	.6627	.78987
1.349	44.55770	-.86527	6.20000	.00000	-9.13144	.40982	.00000	-.30304	.4817	.6566	.81435
1.995	47.53404	-1.20048	6.10000	.00000	-9.52729	.44397	.00000	-.27306	.5276	.5902	.79164
2.512	52.11226	-1.49083	6.10000	.00000	-10.14325	.47670	.00000	-.25038	.5565	.5655	.79340
3.311	57.95681	-1.92831	6.10000	.00000	-10.95883	.53184	.00000	-.22169	.5979	.5581	.81790
4.169	63.14175	-2.35722	6.10000	.00000	-11.69920	.58910	.00000	-.19799	.6183	.5330	.81632
5.012	67.73399	-2.80825	6.10000	.00000	-12.37446	.65295	.00000	-.18027	.6400	.5209	.82519
6.310	66.85735	-3.08451	6.00000	.00000	-12.34889	.69779	.00000	-.15953	.6706	.5103	.84268
6.607	67.98064	-3.20709	6.00000	.00000	-12.52122	.71605	.00000	-.15554	.6724	.5113	.84472
8.318	73.97302	-3.92204	6.00000	.00000	-13.44834	.82423	.00000	-.13877	.6812	.5184	.85602

10.000	71.43771	-4.06123	5.90000	.00000	-13.19303	.85325	.00000	-.12811	.6812	.4997	.84483
12.589	76.61803	-4.77255	5.90000	.00000	-14.02002	.96470	.00000	-.11795	.6890	.4866	.84351
14.454	71.88163	-4.64213	5.80000	.00000	-13.42685	.95465	.00000	-.11275	.7025	.4887	.85577
16.596	66.97212	-4.46293	5.70000	.00000	-12.79742	.93716	.00000	-.10889	.7031	.4918	.85803
18.197	67.62684	-4.59324	5.70000	.00000	-12.92078	.95962	.00000	-.10653	.7067	.4852	.85723
19.953	62.08216	-4.23285	5.60000	.00000	-12.16202	.91183	.00000	-.10505	.7180	.4890	.86870
25.119	57.73029	-4.06066	5.50000	.00000	-11.58973	.89450	.00000	-.10552	.7204	.4846	.86822
30.903	57.97868	-4.17019	5.50000	.00000	-11.65156	.91463	.00000	-.10812	.7200	.4793	.86494
39.811	51.75620	-3.71567	5.40000	.00000	-10.76019	.85118	.00000	-.11264	.6975	.4744	.84354
50.119	50.09983	-3.58159	5.40000	.00000	-10.50493	.83123	.00000	-.11897	.6786	.4768	.82936
100.000	51.52443	-3.61327	5.50000	.00000	-10.66384	.83166	.00000	-.12816	.6373	.4774	.79628
PGA	51.14649	-3.57103	5.50000	.00000	-10.59901	.82422	.00000	-.12837	.6336	.4774	.79332
PGV	38.93484	-2.83525	5.30000	.00000	-8.54137	.81287	.00000	-.14409	.4554		

Table F8. GMM Coefficients and Standard Errors for V_S30 1080 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-9.94467	2.03274	5.40000	.00000	-2.58611	.13184	.00000	-.16348	.2739	1.2756	1.30468
.200	-2.85757	1.96038	5.70000	.00000	-3.15687	.10616	.00000	-.24948	.3110	1.1358	1.17761
.331	9.50447	1.37435	6.00000	.00000	-4.65042	.16201	.00000	-.29654	.3350	.9702	1.02641
.501	19.42515	.78887	6.10000	.00000	-5.88408	.22405	.00000	-.31785	.3511	.8636	.932243
.631	27.22984	.39421	6.20000	.00000	-6.87085	.26668	.00000	-.32407	.3734	.7680	.853962
1.000	37.72668	-.41228	6.20000	.00000	-8.24274	.36012	.00000	-.31850	.4143	.6627	.781547

1.349	44.39633	-.89301	6.20000	.00000	-9.11520	.41483	.00000	-.30422	.4455	.6566	.793470
1.995	48.02106	-1.37182	6.10000	.00000	-9.61985	.47167	.00000	-.27523	.4975	.5902	.771908
2.512	53.04999	-1.76242	6.10000	.00000	-10.31090	.51995	.00000	-.25320	.5282	.5655	.773812
3.311	59.63075	-2.36002	6.10000	.00000	-11.25182	.60028	.00000	-.22461	.5586	.5581	.789626
4.169	58.88488	-2.54016	6.00000	.00000	-11.20858	.62655	.00000	-.20009	.5930	.5330	.797332
5.012	63.04949	-2.93622	6.00000	.00000	-11.82560	.68261	.00000	-.18061	.6078	.5209	.800473
6.310	68.38110	-3.46609	6.00000	.00000	-12.62900	.75970	.00000	-.15764	.6285	.5103	.809579
6.607	69.46798	-3.57603	6.00000	.00000	-12.79463	.77593	.00000	-.15330	.6274	.5113	.809357
8.318	67.81388	-3.68465	5.90000	.00000	-12.65502	.79768	.00000	-.13347	.6533	.5184	.833990
10.000	71.67037	-4.09398	5.90000	.00000	-13.25869	.86044	.00000	-.12008	.6724	.4997	.837748
12.589	69.37630	-4.14677	5.80000	.00000	-13.03577	.87696	.00000	-.10694	.6944	.4866	.847922
14.454	65.34000	-3.99283	5.70000	.00000	-12.52696	.86127	.00000	-.10106	.7044	.4887	.857326
16.596	67.42964	-4.27086	5.70000	.00000	-12.87548	.90671	.00000	-.09675	.7128	.4918	.865997
18.197	62.56392	-4.01021	5.60000	.00000	-12.22293	.87403	.00000	-.09471	.7176	.4852	.866238
19.953	63.57597	-4.17060	5.60000	.00000	-12.39880	.90097	.00000	-.09330	.7216	.4890	.871681
25.119	59.57322	-4.06961	5.50000	.00000	-11.89416	.89577	.00000	-.09197	.7281	.4846	.874624
30.903	54.89888	-3.83474	5.40000	.00000	-11.25994	.86786	.00000	-.09258	.7281	.4793	.871698
39.811	50.08947	-3.54479	5.30000	.00000	-10.58589	.83003	.00000	-.09554	.7265	.4744	.867674
50.119	49.10114	-3.52464	5.30000	.00000	-10.44304	.82905	.00000	-.10110	.7273	.4768	.869657
100.000	49.50914	-3.58029	5.40000	.00000	-10.45222	.83490	.00000	-.11428	.6471	.4774	.804145
PGA	49.01306	-3.53963	5.40000	.00000	-10.36996	.82790	.00000	-.11490	.6388	.4774	.797481
PGV	35.32381	-2.50490	5.20000	.00000	-8.04105	.76843	.00000	-.14424	.4401		

Table F9. GMM Coefficients and Standard Errors for V_S30 1500 m/s

Freq. (Hz)	C1	C2	C4	C5	C6	C7	C8	C10	Total Parametric Sigma	Model Sigma	Total Sigma
.100	-10.49826	2.09582	5.40000	.00000	-2.51426	.12288	.00000	-.16307	.2731	1.2756	1.30451
.200	-3.07494	1.97375	5.70000	.00000	-3.14119	.10461	.00000	-.24902	.3084	1.1358	1.17692
.331	9.83182	1.28979	6.00000	.00000	-4.73407	.17553	.00000	-.29387	.3216	.9702	1.02211
.501	19.75484	.70839	6.10000	.00000	-5.96460	.23664	.00000	-.31617	.3406	.8636	.92834
.631	27.73978	.29543	6.20000	.00000	-6.97664	.28134	.00000	-.32269	.3595	.7680	.84798
1.000	37.47560	-.37858	6.20000	.00000	-8.21498	.35451	.00000	-.31819	.4115	.6627	.78007
1.349	44.11293	-.87037	6.20000	.00000	-9.08773	.41153	.00000	-.30435	.4509	.6566	.79651
1.995	47.47013	-1.27662	6.10000	.00000	-9.53965	.45639	.00000	-.27493	.5044	.5902	.77637
2.512	53.04236	-1.78513	6.10000	.00000	-10.32908	.52354	.00000	-.25306	.5327	.5655	.77689
3.311	59.67915	-2.38283	6.10000	.00000	-11.27705	.60363	.00000	-.22401	.5644	.5581	.79374
4.169	58.74831	-2.51538	6.00000	.00000	-11.19996	.62220	.00000	-.19957	.5889	.5330	.79429
5.012	63.04345	-2.93681	6.00000	.00000	-11.83945	.68231	.00000	-.18005	.6063	.5209	.79934
6.310	68.54849	-3.51136	6.00000	.00000	-12.67392	.76662	.00000	-.15731	.6261	.5103	.80772
6.607	69.59005	-3.60960	6.00000	.00000	-12.83070	.78093	.00000	-.15297	.6305	.5113	.81176
8.318	68.04929	-3.74767	5.90000	.00000	-12.71170	.80748	.00000	-.13335	.6490	.5184	.83063
10.000	72.01244	-4.18625	5.90000	.00000	-13.33419	.87497	.00000	-.12009	.6626	.4997	.82990
12.589	69.74603	-4.24538	5.80000	.00000	-13.11702	.89264	.00000	-.10685	.6775	.4866	.83414
14.454	65.68249	-4.07579	5.70000	.00000	-12.60331	.87448	.00000	-.10067	.6853	.4887	.84170
16.596	67.79343	-4.32930	5.70000	.00000	-12.95181	.91570	.00000	-.09573	.6919	.4918	.84888
18.197	62.94144	-4.04373	5.60000	.00000	-12.29884	.87880	.00000	-.09307	.6957	.4852	.84819
19.953	64.05569	-4.18264	5.60000	.00000	-12.48718	.90190	.00000	-.09087	.6991	.4890	.85315
25.119	60.57238	-4.05466	5.50000	.00000	-12.05671	.89126	.00000	-.08726	.7054	.4846	.85582
30.903	51.68260	-3.48432	5.30000	.00000	-10.81647	.81431	.00000	-.08616	.7077	.4793	.85473

39.811	47.77340	-3.29534	5.20000	.00000	-10.28098	.79220	.00000	-.08751	.7071	.4744	.85150
50.119	47.17186	-3.34137	5.20000	.00000	-10.20652	.80257	.00000	-.09145	.7024	.4768	.84894
100.000	51.14855	-3.75480	5.40000	.00000	-10.73373	.86222	.00000	-.10771	.6371	.4774	.79612
PGA	50.38409	-3.69514	5.40000	.00000	-10.60943	.85235	.00000	-.10911	.6287	.4774	.78941
PGV	35.63970	-2.57346	5.20000	.00000	-8.12670	.78163	.00000	-.13717	.4352		

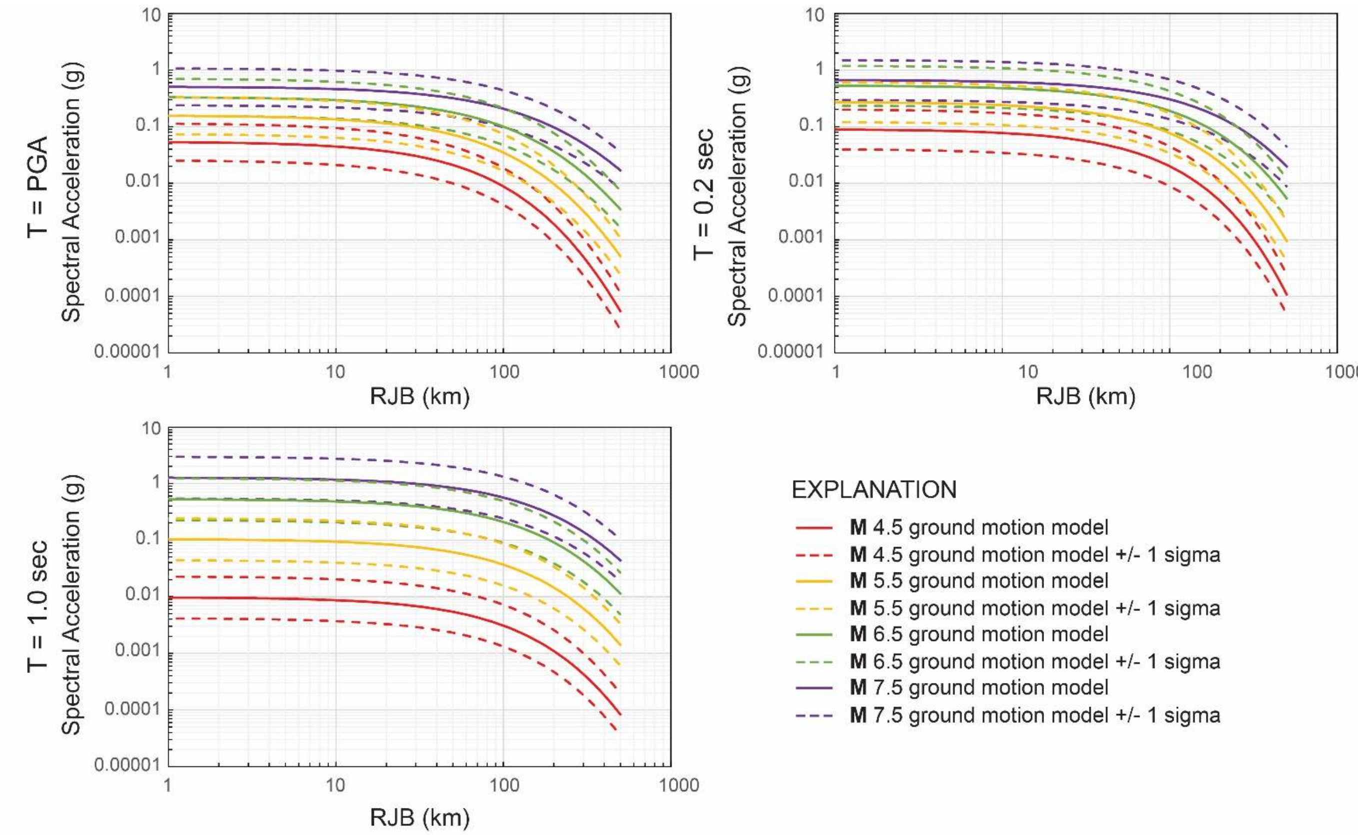

Figure F1. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 150 m/s.

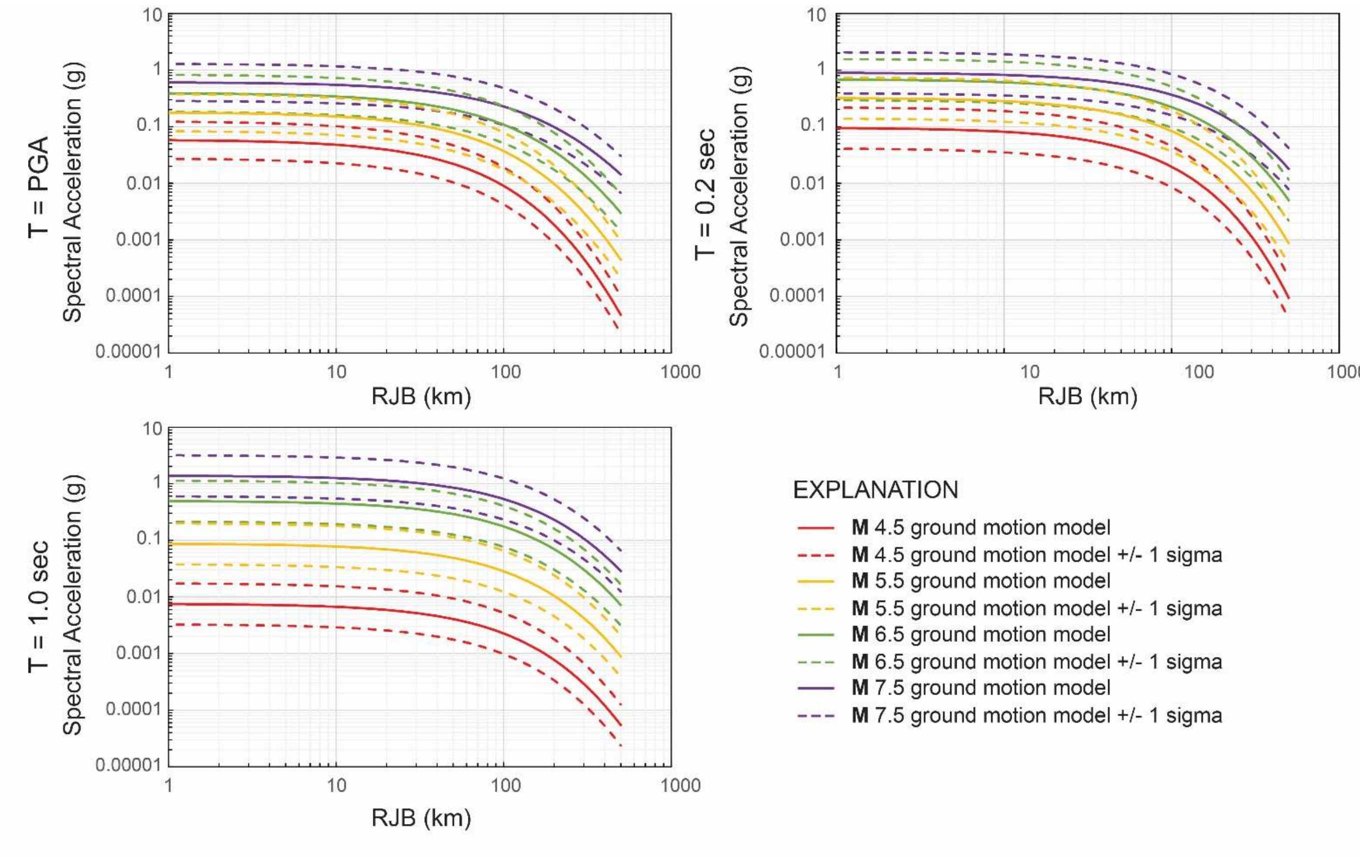

Figure F2. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 185 m/s.

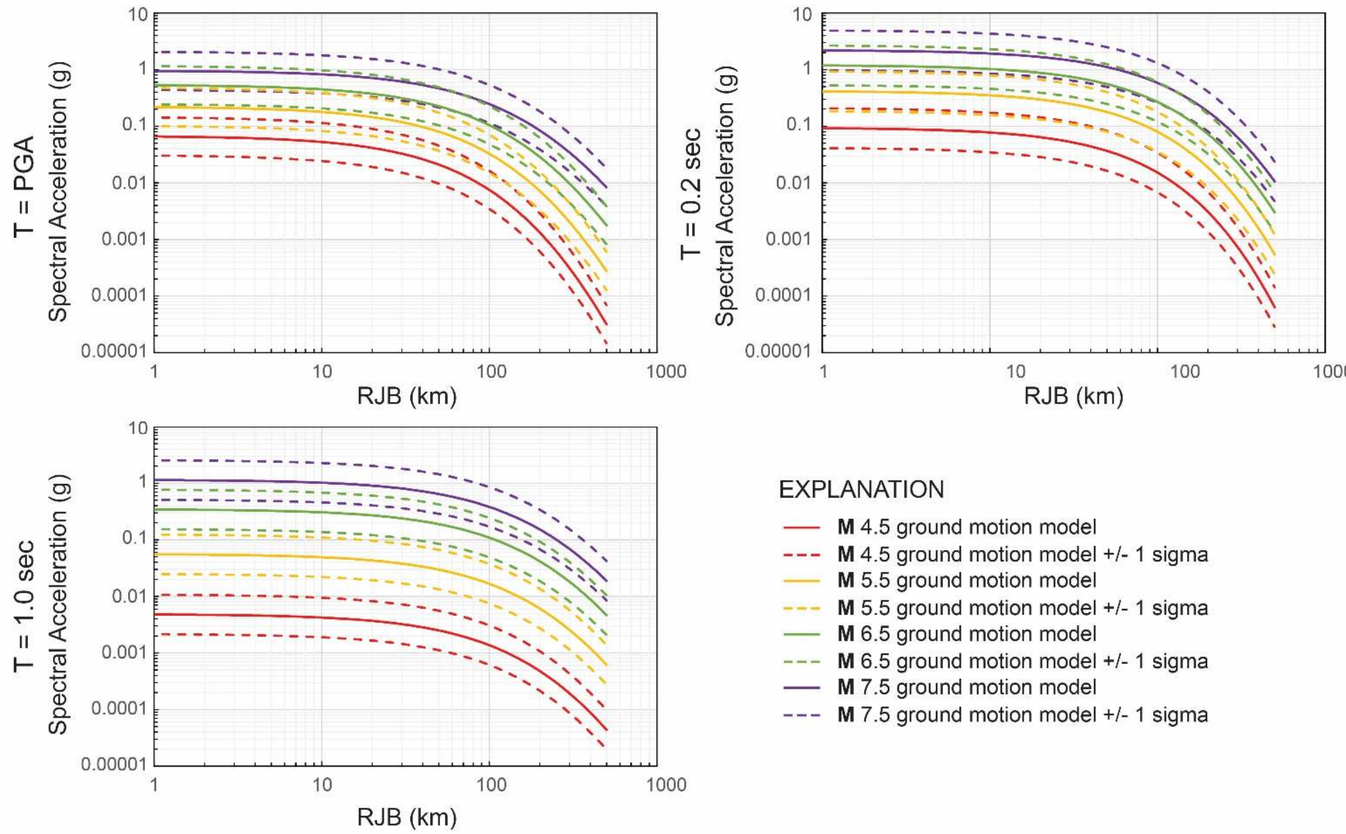

Figure F3. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 365 m/s.

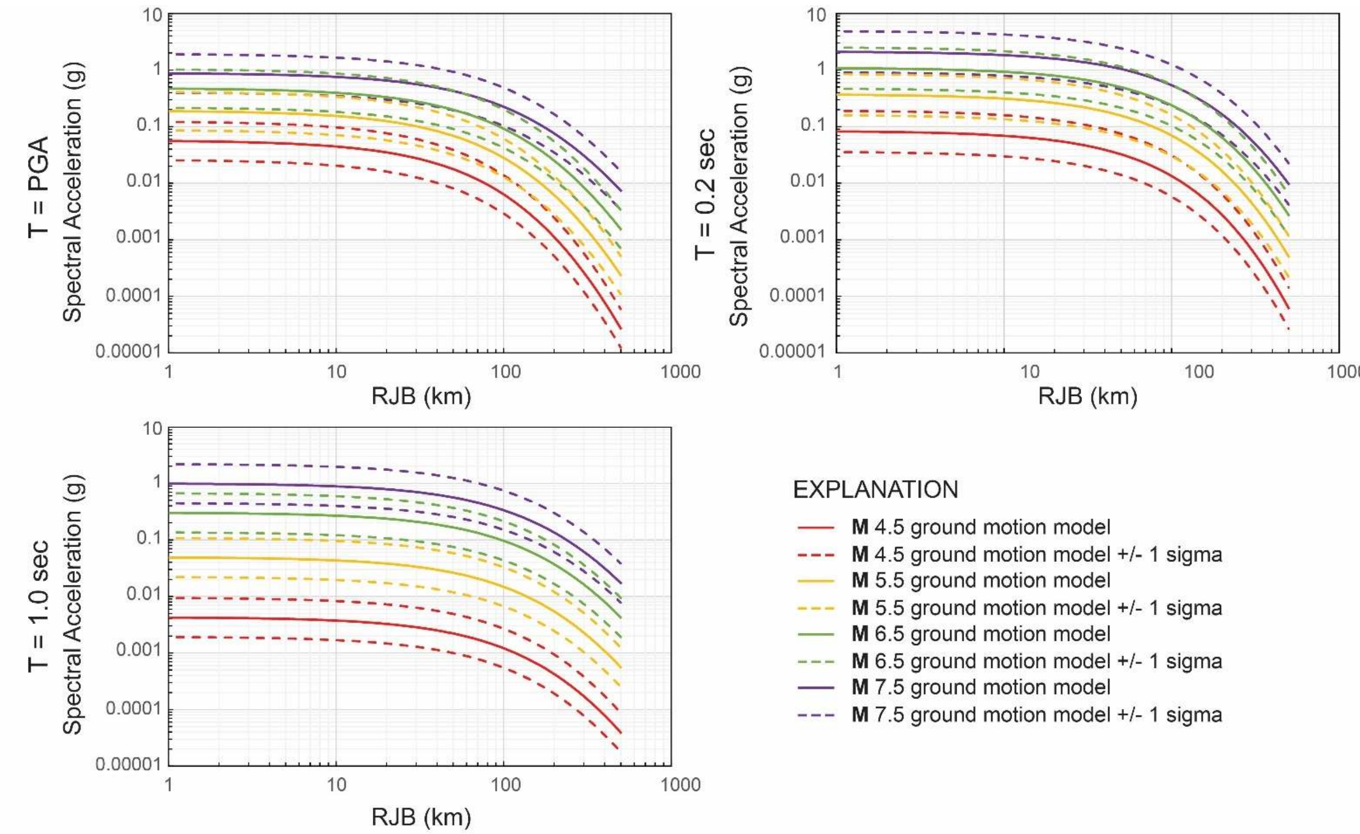

Figure F4. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 428 m/s.

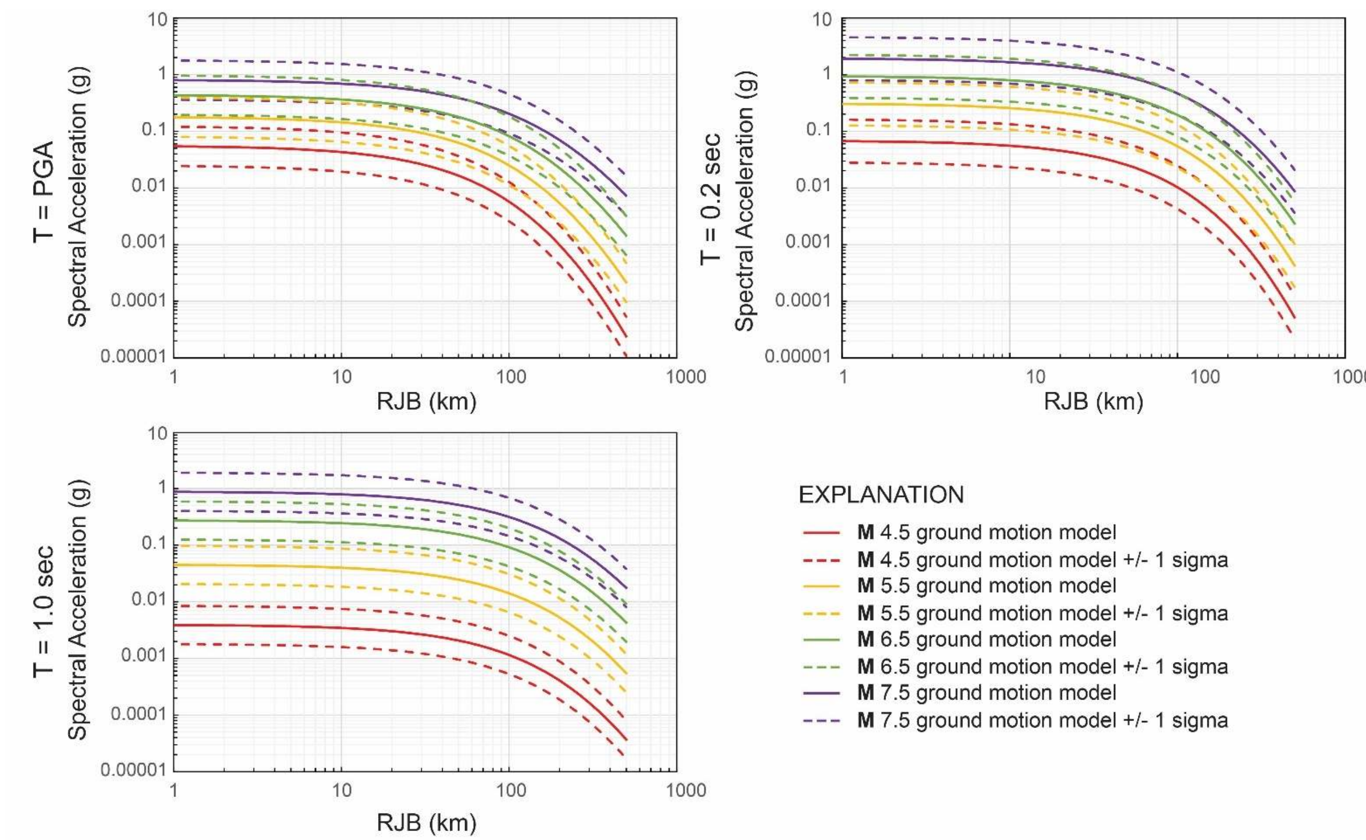

Figure F5. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 530 m/s.

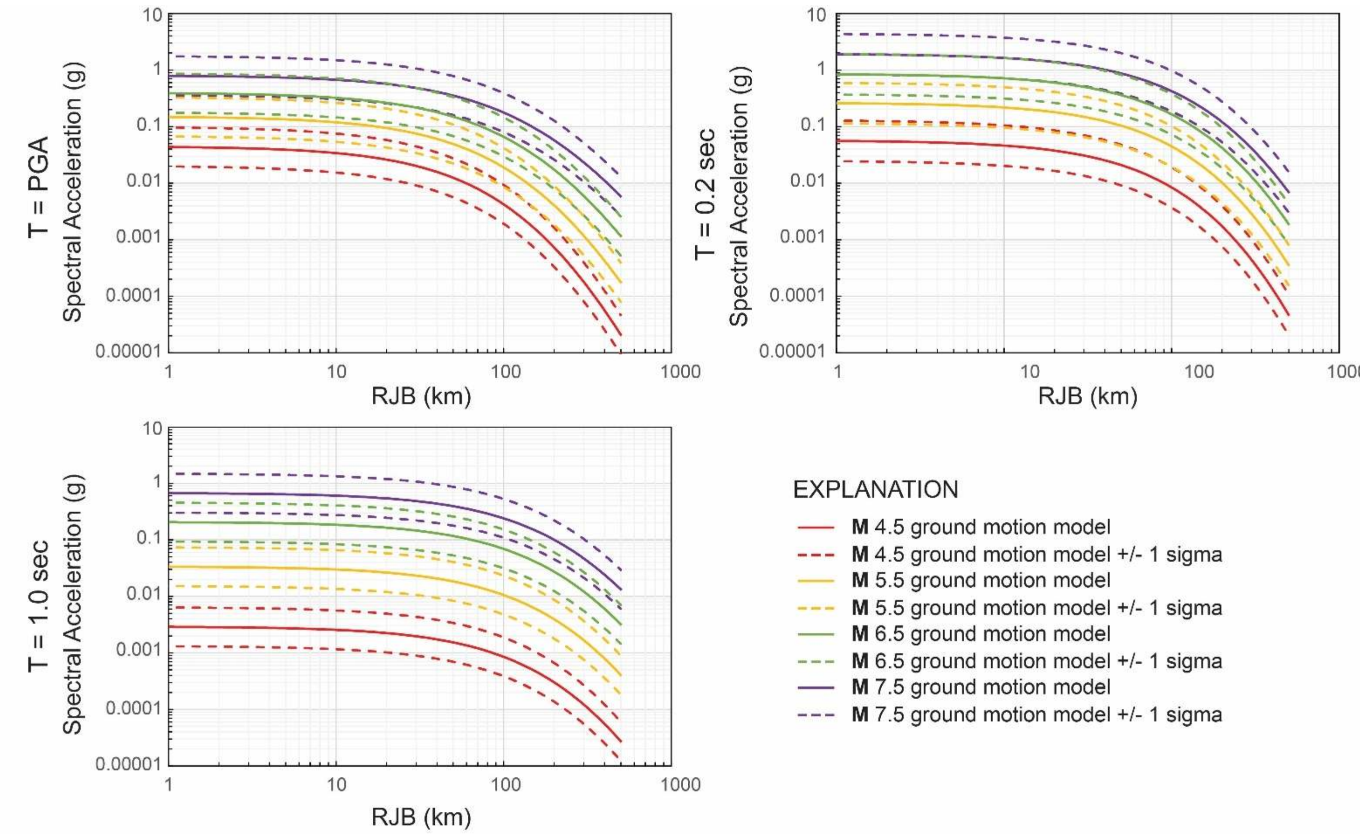

Figure F6. Ground motion models for PGA and 0.2 and 1.0 s SA from this study for **M** 4.5, 5.5, 6.5, and 7.5 at Vs30 760 m/s.

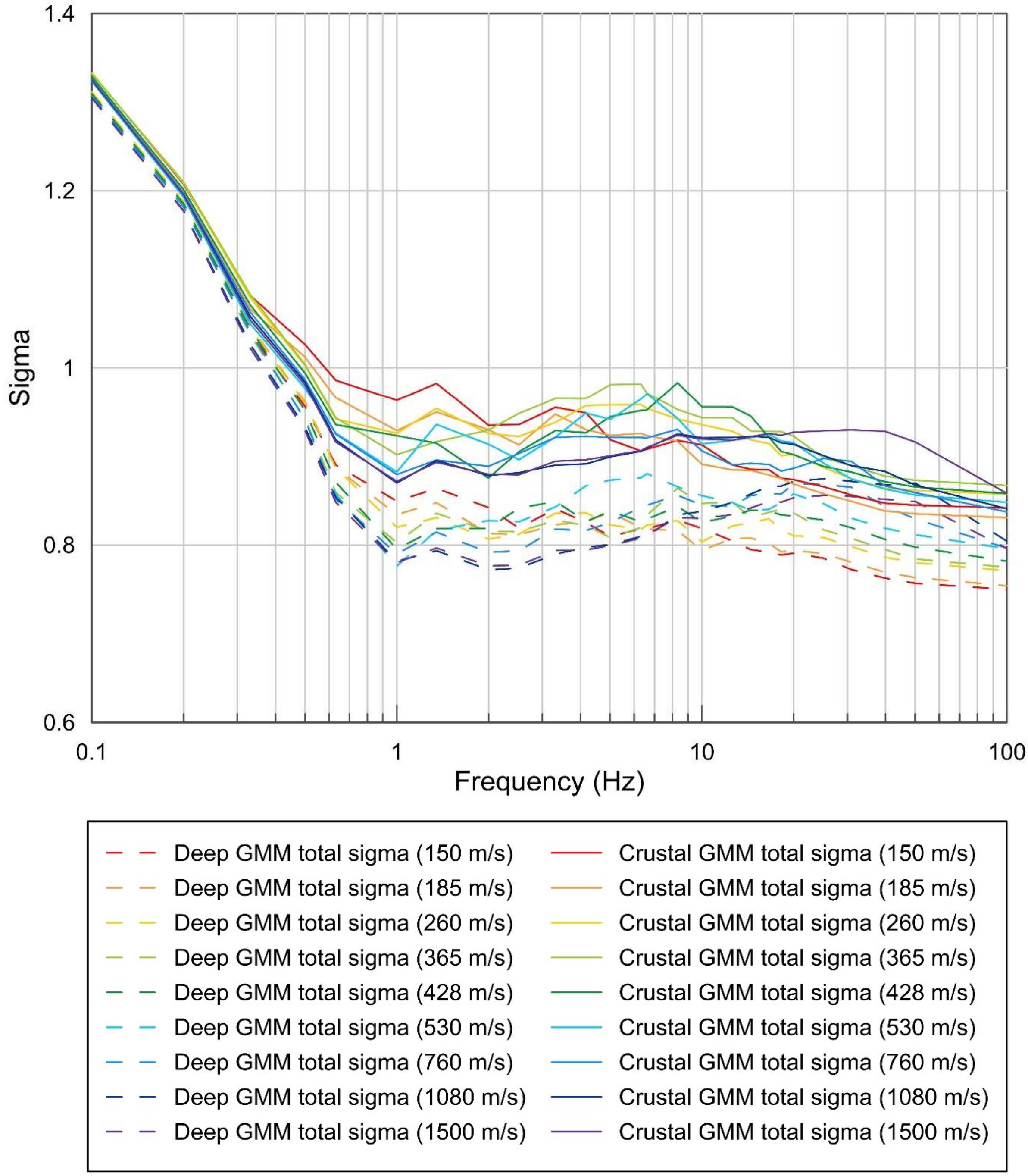

Figure F7. Comparison of total sigma for crustal and deep ground motion models with Vs30 150, 185, 260, 365, 428, 530, 760, 1,080, and 1,500 m/s.