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A Refined Vs30 Map for Taiwan Based on Ground Motion Attenuation Relationships

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ABSTRACT

Seismic hazard evaluations require an estimate of the expected ground motion at the site of interest usually by using attenuation relationships. The mean shear-wave velocity over the top 30 m (Vs30) is incorporated in the ground motion attenuation relationships in this study. By comparing the standard deviations of the residuals between the observed and predicted values before and after incorporating the site effect term Vs30, the reduction in standard deviation for the peak ground velocity (PGV) is significantly reduced by about 11%. Clearly, the refined attenuation relationships will be more useful for engineering purposes. Analyzing the site effect term using the amplification factor (relative to a site with Vs30 = 760 m s^{-1}), has revealed that the Changhua Plain, Chianan Plain, Pingtung Valley, Ilan Plain, and Taipei Basin have high values, implying large ground motion amplification. Following a disastrous earthquake, quick assessment and timely peak ground acceleration (PGA) and PGV map reporting will be critical for effective emergency response operations. After an earthquake we can combine the simple attenuation relationships, as determined from Model 1, to provide near real-time estimation and reporting of the PGA and PGV values for the Taiwan area. We can also use the relations between the intra-event site residual and the Vs30 to estimate the Vs30 for stations that have recorded strong motions, but do not yet have Vs30 information. Our approach including sites with estimated Vs30 has resulted in a refined Vs30 contour map that can be used for more realistic seismic hazard assessment for Taiwan. This approach is especially applicable to the foothill and mountain areas.

Key words: Attenuation relationship, Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV), Taiwan, Vs30

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1. INTRODUCTION

Local site effects play an important role in modifying seismic motions. This fact is evidenced by the observed damage distribution patterns in numerous earthquakes and is reflected in some seismic codes and ground-motion prediction equations (GMPEs), which prescribe stronger motions for sites located in soft sediments compared to bedrock sites (Borcherdt 1970). Local site conditions at an accelerograph station can dramatically affect the strong motions recorded (Douglas 2003). In particular, soft sediments with low seismic velocities relative to the underlying bedrock can lead to large ground motion amplification at the surface (Pratt et al. 2003). Some studies have found that shallow soil sites have significantly higher ground motions than rock or stiff soil sites (Campbell 1981). Site-effects estimation has been a major issue in engineering seismology for the last 20 years. This is due to the fact that seismic hazard is strongly influenced by site effects because site conditions strongly affect the frequency content and also the amplitude of ground motions. This is also because most populated areas are located in sedimentary basins (Drouet et al. 2008).

The average shear-wave velocity of the upper 30 m of a soil profile (Vs30) is used as a quantitative parameter for most earthquake ground-motion site-effect studies (Boore et al. 1993; Anderson et al. 1996; Bolt and Abrahamson 2003; Huang et al. 2007, 2009; Lee and Tsai 2008). The Vs30 is adopted as an international standard for soil classification since it was proposed by the United States National Earthquake Hazard Reduction Program (NEHRP) (Gallipoli and Mucciarelli 2009). Starting from the work of Borcherdt (1994),

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the Vs30 has become a standard parameter for quantifying response at a site. Accordingly, successive NEHRP regulations (NEHRP 1994, 1997, 2001) included Vs30 to define their respective local site categories (Cadet et al. 2010). For the development of ground-motion models, developers systematically evaluated a list of predictor parameters to consider for predicting earthquake shaking intensity. The most significant decision made by all developers was to use Vs30 as a parameter for characterizing soil-stiffness effects on ground motions (Power et al. 2008). For example, the "Next Generation Attenuation of Ground Motions Project (NGA)" of the Pacific Earthquake Engineering Research Center (PEER) has directly used Vs30 for the ground-motion attenuation models (Power et al. 2008). In Taiwan, Huang et al. (2007, 2009) used the Vs30 data in Central Taiwan and in the Taipei Basin to estimate the high frequency site amplification using the quarter-wavelength method. Lee et al. (2012) developed a new empirical Arias intensity attenuation relationship for shallow crustal earthquakes in Taiwan considering Vs30. Their results show that the incorporation of Vs30 can significantly reduce regression error.

Several studies have been made to evaluate the site effects based on accelerographic recordings. For example, examination of the residuals for sites with different soil categories was shown to be a useful method using sets of records where site information was not complete (Abrahamson and Litehiser 1989). Liu and Tsai (2005) analyzed the residuals of peak ground acceleration (PGA) and peak ground velocity (PGV) with respect to site conditions. They found the contour maps of site residuals for the PGA and PGV data, especially for the PGV, were highly correlated with the regional geology and topography of Taiwan. They further pointed out that almost all major metropolitan areas coincided with high residual areas that would require special attention in structural seismic design. Choi and Stewart (2005) evaluated the ground motion amplification factors from residuals between accelerations from recordings and attenuation relationships for active seismic regions. They also found site amplification to increase with decreasing Vs30.

In this study we first develop refined attenuation relationships by incorporating a site effect term related to Vs30, the average shear-wave velocity in the upper 30 m of sediments, aiming to reduce the standard deviation of the predicted ground motion in large earthquakes. We will also investigate the variation in residuals with Vs30 in order to construct a refined Vs30 map for the entire Taiwan area. The results of this study will provide valuable information for site evaluation of critical facilities in high earthquake hazard regions, as well as for land-use planning.

2. DATA

Beginning in 1991 the Central Weather Bureau Seismology Center (CWBSC) embarked on a six-year seismic strong-motion instrumentation program, known as the Taiwan Strong Motion Instrumentation Program (TSMIP) (Liu et al. 1999). The TSMIP accelerographic network dataset used in this study consists of 617 free-field stations, primarily covering densely populated areas. The locations of these stations are given in Table 1 and shown in Fig. 1. These free-field stations are densely spaced approximately 5 km apart, and only about 3 km apart in urban areas. Concurrently, the Institute of Earth Science, Academia Sinica installed another strong motion network with similar instrumentation in the Central Mountain Strong Motion Array (CMSMA) to provide strong motion data for the mountainous areas (http://www.earth.sinica.edu.tw/~smdmc/cma/cma.htm). The locations of these 10 stations are given in Table 2 and shown in Fig. 1. Strong seismic ground motion data obtained from a total of 627 stations from the TSMIP and CMSMA networks are used in this study to derive new ground motion attenuation relationships.

The Central Weather Bureau (CWB) and National Center for Research on Earthquake Engineering (NCREE) have undertaken a free-field strong-motion station drilling project to construct an engineering geological database for TSMIP (EGDT) since 2000. A total of 468 free-field strong motion stations were surveyed by 2010, with 439 of these stations drilled and their P- and S-wave velocities measured using a suspension PS-logging system (Kuo et al. 2011, 2012). Measured Vs30 records are available at 426 of the 617 TSMIP free-field strong-motion stations. Records from these stations are used to develop the attenuation relationships which incorporate a site effect term, aimed to reduce the standard deviation of the predicted ground motion for engineering applications. The crosses in Fig. 1 represent the TSMIP stations with available Vs30 records. Relevant localities are also indicated.

Over 7900 digital accelerograms were recorded from 51 crustal earthquakes by the TSMIP and CMSMA networks, as shown in Fig. 1, and selected for this study (Liu and Tsai 2005). The M_w magnitudes range from 4.0 - 7.1. These records are analyzed to investigate the attenuation relationship dependence on magnitude, regional earthquake clusters and site effects. Figure 2 shows the data distribution of these events in terms of magnitude and source-to-site distance.

3. METHODOLOGY

The strong-motion attenuation relationships express earthquake ground motion parameters as functions of simple parameters characterizing the earthquake source, the propagation path between the earthquake source and the site, and the geological conditions beneath the site. The following equation form is used in this study (Liu and Tsai 2005):

Model 1: The equation includes only magnitude and distance terms.

$$\ln(\mathrm{PGA},\mathrm{PGV}) = a\ln\left[X + h_1 \exp^{(h_2 M_w)}\right] + bX + cM_w + d \quad (1)$$

Model 2: The equation includes an additional site term (Vs30).

$$\ln(\mathrm{PGA},\mathrm{PGV}) = a\ln\left[X + h_1 \exp^{(h_2 M_w)}\right] + bX + cM_w + d + e\ln(\mathrm{Vs30}/\mathrm{Vref}) \quad (2)$$

or

$$\ln(\mathrm{PGA},\mathrm{PGV}) = a\ln\left[X + h_1 \exp^{(h_2 M_w)}\right] + bX + cM_w + d' + e\ln(\mathrm{Vs30}/760) \quad (3)$$

where PGA and PGV are ground motion parameters, X is the closest distance to the rupture surface or hypo central distance. We characterize the source-to-site distance in terms of the closest distance to the rupture surface, r_{rup}. If the rupture surface is not defined for an event, the hypo central distance is then used as the source-to-site distance, M_w is moment

Table 1. Station code, location, site classifications, ground motion total and intra-event residuals, measured and estimated Vs30 of the TSMIP stations.

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 ($m\ s^{-1}$)	Site‡	Vs30N ($m\ s^{-1}$)
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
1	TAP001	25.04	121.51	0.301	0.789	0.545	0.670	0.397	0.392	0.643	0.230	5	E	160.1	E	160.1
2	TAP002	25.13	121.46	-0.208	0.019	-0.127	0.069	0.063	0.000	0.170	0.014	2	D	374.0	C	374.0
3	TAP003	25.09	121.45	-0.641	0.092	0.025	0.117	-0.371	0.030	0.322	0.039	2	E	209.4	D	209.4
4	TAP004	25.11	121.47	-0.002	0.362	0.395	0.521	0.193	0.102	0.685	0.158	2	E	195.5	D	195.5
5	TAP005	25.11	121.51	0.326	0.000	0.340	0.000	0.465	0.000	0.492	0.000	1	E	177.0	E	177.0
6	TAP006	25.10	121.51	0.004	0.042	0.020	0.056	0.274	0.005	0.316	0.009	2	E	198.4	D	198.4
7	TAP007	25.08	121.51	0.322	0.474	0.455	0.508	0.463	0.193	0.612	0.157	5	E	204.3	D	204.3
8	TAP008	25.08	121.53	-0.465	0.000	-0.006	0.000	-0.062	0.000	0.435	0.000	1	E	191.6	D	191.6
9	TAP009	25.08	121.57	0.115	0.131	0.037	0.038	0.385	0.053	0.333	0.003	2	E	187.6	D	187.6
10	TAP010	25.07	121.47	-0.438	0.207	-0.019	0.135	-0.167	0.104	0.278	0.049	2	E	217.5	D	217.5
11	TAP011	25.06	121.49	-0.182	0.218	-0.107	0.098	0.089	0.112	0.191	0.028	2	D	211.1	D	211.1
12	TAP012	25.06	121.51	-0.232	0.310	-0.050	0.091	0.039	0.180	0.248	0.025	2	E	207.4	D	207.4
13	TAP013	25.06	121.53	0.519	0.310	0.484	0.642	0.514	0.216	0.546	0.383	5	E	207.9	D	207.9
14	TAP014	25.06	121.54	-0.105	0.092	0.259	0.012	0.166	0.029	0.556	0.001	2	E	192.1	D	192.1
15	TAP015	25.05	121.57	0.324	0.288	0.280	0.380	0.374	0.145	0.455	0.264	4	E	208.1	D	208.1
16	TAP016	25.06	121.42	-0.582	0.000	0.166	0.000	-0.444	0.000	0.318	0.000	1	E	326.6	D	326.6
17	TAP017	25.05	121.45	0.157	0.000	0.500	0.000	0.295	0.000	0.652	0.000	1	E	221.4	D	221.4
18	TAP019	25.04	121.49	0.363	0.008	0.230	0.042	0.180	0.169	0.142	0.199	2	E	225.2	D	225.2
19	TAP020	25.04	121.53	-0.264	0.110	0.086	0.089	0.007	0.040	0.383	0.023	2	E	224.2	D	224.2
20	TAP021	25.04	121.54	0.132	0.086	-0.042	0.032	0.403	0.026	0.255	0.001	2	E	165.3	E	165.3
21	TAP022	25.03	121.56	0.514	0.080	0.427	0.081	0.729	0.068	0.693	0.035	3	D	181.0	D	181.0
22	TAP023	25.01	121.46	0.007	0.480	-0.060	0.156	0.278	0.314	0.238	0.063	2	D	*****	*	254.7
23	TAP024	25.02	121.47	0.315	0.000	0.298	0.000	0.453	0.000	0.451	0.000	1	D	187.8	D	187.8
24	TAP025	25.03	121.49	-0.452	0.000	-0.489	0.000	-0.050	0.000	-0.048	0.000	1	E	250.2	D	250.2
25	TAP026	25.02	121.50	0.246	0.000	0.298	0.000	0.384	0.000	0.450	0.000	1	E	200.6	D	200.6
26	TAP028	25.00	121.51	-0.054	0.000	0.053	0.000	0.084	0.000	0.205	0.000	1	D	*****	*	270.1
27	TAP029	25.01	121.53	0.095	0.255	-0.082	0.490	0.095	0.188	-0.039	0.356	6	D	*****	*	419.2
28	TAP030	25.00	121.53	-1.087	0.217	-0.438	0.212	-1.091	0.415	-0.313	0.175	3	D	*****	*	686.7
29	TAP031	25.02	121.54	-0.057	0.000	0.059	0.000	0.081	0.000	0.211	0.000	1	D	222.0	D	222.0

Note: (1) STname = Station Name.
(2) Lat = Station Latitude.
(3) Long = Station Longitude.
(4) TotalRes = Total Residual in ln unit.
(5) IntraRes= Intra-event Residual in ln unit.
(6) PGAh = The mean of residual for horizontal component of peak ground acceleration.
(7) PGVh = The mean of residual for horizontal component of peak ground velocity.
(8) sd = standard deviation.
(9) R = Number of Records.
(10) Vs30 = The average shear-wave velocity in the upper 30 m of sediments in $m\ s^{-1}$.
(11) Vs30N = The estimated Vs30 values from the relation between the intra-event residual and the Vs30 in $m\ s^{-1}$.
†Determined by Lee et al. (2001), on the basis of surface geology and borehole data.
‡Determined according to UBC1997.

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 ($m s^{-1}$)	Site‡	Vs30N ($m s^{-1}$)
30	TAP032	25.00	121.48	0.414	0.378	0.353	0.249	0.461	0.240	0.430	0.229	15	D	314.9	D	314.9
31	TAP033	24.98	121.53	0.268	0.363	0.199	0.311	0.322	0.207	0.236	0.272	12	D	486.3	C	486.3
32	TAP034	24.95	121.53	0.006	0.268	-0.421	0.233	0.047	0.099	-0.341	0.131	15	B	*****	*	722.7
33	TAP035	24.92	121.54	0.233	0.340	-0.230	0.253	0.238	0.252	-0.207	0.204	21	B	404.7	C	404.7
34	TAP036	24.90	121.54	-0.478	0.309	-0.682	0.297	-0.468	0.185	-0.632	0.124	8	B	*****	*	1219.9
35	TAP037	25.04	121.43	0.101	0.317	0.465	0.381	-0.063	0.180	0.393	0.263	8	D	219.9	D	219.9
36	TAP038	25.02	121.41	0.485	0.460	0.634	0.348	0.464	0.342	0.593	0.189	7	D	209.0	D	209.0
37	TAP039	24.94	121.36	-0.243	0.263	-0.297	0.465	-0.307	0.228	-0.275	0.302	7	D	661.6	C	661.6
38	TAP040	25.18	121.43	0.369	0.347	0.249	0.537	0.306	0.248	0.255	0.414	10	C	432.5	C	432.5
39	TAP041	25.18	121.42	0.289	0.200	0.208	0.333	0.281	0.163	0.273	0.284	14	D	360.5	C	360.5
40	TAP042	25.13	121.45	0.126	0.116	-0.055	0.054	0.074	0.064	-0.064	0.127	12	D	*****	*	438.2
41	TAP043	24.99	121.41	0.184	0.307	-0.003	0.266	0.155	0.247	0.086	0.185	13	D	382.6	C	382.6
42	TAP044	24.98	121.39	-0.222	0.347	-0.101	0.330	-0.215	0.190	0.006	0.182	7	D	473.0	C	473.0
43	TAP045	25.11	121.82	-0.170	0.172	-0.656	0.126	-0.129	0.248	-0.565	0.077	7	B	987.7	B	987.7
44	TAP046	25.10	121.77	0.061	0.126	-0.391	0.097	0.060	0.054	-0.311	0.030	15	D	822.0	B	822.0
45	TAP047	24.95	121.34	-0.280	0.139	-0.445	0.152	-0.331	0.140	-0.402	0.137	11	D	571.2	*	571.2
46	TAP048	24.97	121.43	-0.366	0.370	-0.461	0.162	-0.095	0.227	-0.164	0.067	2	D	*****	*	525.0
47	TAP049	25.15	121.44	0.262	0.237	0.341	0.300	0.258	0.187	0.375	0.240	17	C	*****	*	199.0
48	TAP050	25.15	121.40	0.524	0.509	0.598	0.583	0.494	0.334	0.573	0.356	6	D	280.7	D	280.7
49	TAP051	25.10	121.44	-0.059	0.105	-0.070	0.151	-0.125	0.071	-0.095	0.168	13	B	401.8	C	401.8
50	TAP052	25.08	121.38	0.276	0.165	-0.125	0.245	0.198	0.088	-0.112	0.233	13	C	434.4	C	434.4
51	TAP053	24.96	121.52	0.160	0.353	-0.119	0.171	0.219	0.227	-0.053	0.175	10	D	*****	*	429.6
52	TAP054	25.00	121.43	0.245	0.185	0.501	0.221	0.267	0.233	0.683	0.184	3	D	309.7	D	309.7
53	TAP055	25.17	121.44	0.368	0.271	0.439	0.511	0.336	0.201	0.442	0.335	6	D	*****	*	176.1
54	TAP056	25.19	121.52	0.933	0.000	-0.021	0.000	1.336	0.000	0.421	0.000	1	C	590.1	C	590.1
55	TAP057	25.08	121.64	0.312	0.155	-0.191	0.073	0.426	0.064	0.047	0.045	5	D	366.6	C	366.6
56	TAP058	25.13	121.71	-0.506	0.168	-0.432	0.177	-0.544	0.152	-0.434	0.078	6	B	1056.7		1056.7
57	TAP059	25.16	121.69	-0.212	0.096	-0.552	0.156	-0.223	0.132	-0.496	0.141	15	B	450.6	C	450.6
58	TAP060	25.16	121.72	-0.294	0.133	-0.585	0.178	-0.313	0.134	-0.479	0.108	12	B	*****	*	926.3
59	TAP061	25.13	121.75	0.066	0.041	-0.355	0.119	0.073	0.104	-0.265	0.101	9	B	*****	*	630.3
60	TAP062	25.13	121.78	-0.261	0.037	-0.534	0.050	-0.216	0.055	-0.345	0.016	6	B	*****	*	727.1
61	TAP063	25.10	121.73	0.188	0.024	-0.272	0.174	0.169	0.029	-0.245	0.040	6	B	*****	*	607.3
62	TAP064	25.15	121.77	-0.287	0.020	-0.595	0.020	-0.017	0.000	-0.298	0.000	2	B	*****	*	668.4
63	TAP065	25.15	121.77	-0.697	0.050	-0.617	0.155	-0.742	0.051	-0.510	0.080	8	B	1034.7		1034.7
64	TAP066	25.19	121.52	-0.676	0.200	-0.698	0.143	-0.621	0.103	-0.591	0.073	12	C	658.0	C	658.0
65	TAP067	24.98	121.58	-0.382	0.215	-0.281	0.241	-0.436	0.131	-0.244	0.157	12	B	815.0	B	815.0
66	TAP068	24.88	121.53	-0.356	0.155	-0.692	0.100	-0.086	0.068	-0.395	0.029	2	B	*****	*	796.1
67	TAP069	25.01	121.99	-0.626	0.317	-0.543	0.239	-0.797	0.489	-0.645	0.329	6	B	*****	*	1249.7
68	TAP070	25.12	121.91	-0.534	0.147	-0.876	0.053	-0.458	0.150	-0.702	0.042	5	B	*****	*	1384.1
69	TAP071	25.00	121.61	0.069	0.320	-0.128	0.331	0.103	0.188	-0.086	0.135	9	D	831.4	B	831.4
70	TAP072	24.99	121.65	-0.103	0.229	-0.481	0.323	-0.198	0.143	-0.435	0.192	8	B	*****	*	855.7
71	TAP073	25.01	121.68	-0.119	0.171	-0.546	0.338	-0.002	0.143	-0.299	0.205	4	B	*****	*	669.6
72	TAP074	24.95	121.63	0.118	0.025	-0.017	0.080	0.031	0.156	-0.115	0.084	4	B	*****	*	480.4
73	TAP075	25.03	121.73	0.020	0.164	-0.247	0.216	0.001	0.078	-0.204	0.127	15	B	851.1	B	851.1
74	TAP077	25.06	121.84	-0.266	0.047	-0.267	0.114	-0.315	0.051	-0.250	0.045	9	D	992.4	B	992.4
75	TAP078	25.06	121.87	0.062	0.176	-0.059	0.230	0.017	0.112	-0.022	0.125	8	B	*****	*	406.1
76	TAP079	25.02	121.91	-0.392	0.136	-0.536	0.150	-0.502	0.147	-0.551	0.158	9	B	*****	*	1055.0
77	TAP080	25.02	121.94	0.512	0.155	-0.139	0.239	0.362	0.066	-0.194	0.131	7	D	401.8	C	401.8
78	TAP081	25.02	121.98	-0.723	0.035	-0.712	0.055	-0.847	0.164	-0.665	0.121	6	B	*****	*	1295.6
79	TAP082	25.06	121.92	-0.762	0.162	-0.799	0.228	-0.813	0.072	-0.791	0.116	5	D	*****	*	1624.3
80	TAP083	25.26	121.49	-0.539	0.057	-0.401	0.129	-0.650	0.105	-0.414	0.147	9	D	*****	*	823.5
81	TAP084	25.23	121.63	-0.153	0.125	-0.330	0.211	-0.151	0.159	-0.274	0.192	13	D	204.1	D	204.1
82	TAP085	24.94	121.71	-0.187	0.169	-0.375	0.357	-0.133	0.012	-0.312	0.036	3	B	895.1	B	895.1

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 ($m s^{-1}$)	Site‡	Vs30N ($m s^{-1}$)
83	TAP086	24.95	121.57	-0.182	0.348	-0.408	0.221	-0.127	0.137	-0.339	0.125	13	B	942.8	B	942.8
84	TAP087	25.10	121.42	-0.306	0.347	-0.202	0.447	-0.317	0.257	-0.116	0.306	11	C	*****	*	481.1
85	TAP088	25.04	121.59	-0.040	0.005	-0.187	0.006	0.175	0.067	0.008	0.030	2	D	228.0	D	228.0
86	TAP089	25.03	121.57	-0.869	0.000	-1.149	0.000	-0.466	0.000	-0.707	0.000	1	D	442.1	C	442.1
87	TAP090	25.06	121.60	-0.213	0.000	-0.081	0.000	0.190	0.000	0.361	0.000	1	E	324.6	D	324.6
88	TAP091	25.06	121.59	-0.081	0.000	-0.212	0.000	0.322	0.000	0.230	0.000	1	E	177.3	E	177.3
89	TAP092	25.07	121.56	-0.284	0.000	-0.386	0.000	0.119	0.000	0.056	0.000	1	E	*****	*	353.2
90	TAP093	25.09	121.56	0.685	0.348	0.698	0.422	0.732	0.183	0.817	0.203	5	E	193.6	D	193.6
91	TAP094	25.14	121.48	-0.709	0.000	-0.538	0.000	-0.306	0.000	-0.097	0.000	1	D	409.9	C	409.9
92	TAP095	25.14	121.49	-0.653	0.000	-0.549	0.000	-0.251	0.000	-0.107	0.000	1	E	205.9	D	205.9
93	TAP097	25.02	121.53	0.265	0.262	0.318	0.326	0.269	0.198	0.309	0.203	14	E	*****	*	223.9
94	TAP098	25.10	121.54	-0.265	0.000	-0.445	0.000	0.137	0.000	-0.004	0.000	1	C	*****	*	393.5
95	TAP099	25.04	121.51	-0.465	0.000	-0.347	0.000	-0.063	0.000	0.094	0.000	1	E	*****	*	329.8
96	TAP100	25.03	121.52	0.403	0.499	0.341	0.677	0.479	0.348	0.509	0.438	5	E	*****	*	156.0
97	TAP103	25.07	121.78	0.577	0.197	0.481	0.195	0.596	0.134	0.486	0.168	15	B	444.9	C	444.9
98	TCU001	24.98	121.10	0.246	0.234	0.111	0.086	-0.013	0.181	-0.095	0.085	3	C	570.2	C	570.2
99	TCU002	25.04	121.07	-0.033	0.091	0.349	0.248	-0.091	0.034	0.222	0.178	3	C	502.1	C	502.1
100	TCU003	25.05	121.14	-0.062	0.191	-0.045	0.229	-0.129	0.213	-0.013	0.227	13	D	507.2	C	507.2
101	TCU004	25.06	121.19	0.137	0.241	0.260	0.518	-0.072	0.378	0.186	0.422	2	C	518.8	C	518.8
102	TCU005	25.11	121.24	-0.306	0.185	-0.170	0.244	-0.381	0.120	-0.174	0.229	9	D	491.2	C	491.2
103	TCU006	24.91	121.14	0.016	0.207	-0.028	0.137	-0.047	0.101	-0.086	0.104	13	D	612.1	C	612.1
104	TCU007	25.00	121.31	0.084	0.348	0.024	0.232	0.110	0.243	0.080	0.170	16	D	*****	*	338.3
105	TCU008	25.01	121.21	-0.136	0.139	-0.206	0.064	-0.069	0.066	-0.157	0.140	9	C	*****	*	518.2
106	TCU009	24.97	121.22	-0.169	0.448	0.228	0.488	-0.188	0.272	0.260	0.269	6	C	466.0	C	466.0
107	TCU010	25.00	121.15	-0.166	0.033	-0.098	0.058	-0.223	0.105	-0.068	0.112	8	C	*****	*	441.6
108	TCU011	24.89	121.28	-0.155	0.192	-0.264	0.295	-0.168	0.154	-0.118	0.249	8	D	811.1	B	811.1
109	TCU012	24.94	121.29	-0.061	0.254	0.013	0.280	-0.124	0.180	0.036	0.169	7	C	644.8	C	644.8
110	TCU013	24.87	121.20	0.195	0.228	0.011	0.274	0.131	0.152	0.034	0.163	7	C	*****	*	367.6
111	TCU014	25.05	121.31	0.113	0.333	0.059	0.396	0.163	0.175	0.119	0.276	15	D	523.2	C	523.2
112	TCU015	24.76	120.93	0.001	0.572	-0.009	0.378	0.095	0.306	0.039	0.278	15	C	430.6	C	430.6
113	TCU016	24.82	120.96	0.152	0.333	0.094	0.235	0.211	0.153	0.101	0.071	6	D	485.5	C	485.5
114	TCU017	24.78	121.01	-0.145	0.278	0.069	0.172	-0.135	0.156	0.106	0.112	12	C	548.3	C	548.3
115	TCU018	24.88	121.04	-0.264	0.286	-0.140	0.204	-0.257	0.250	-0.103	0.170	12	C	*****	*	470.6
116	TCU019	24.90	120.98	0.241	0.137	0.306	0.121	0.295	0.076	0.370	0.054	3	C	506.0	C	506.0
117	TCU020	24.84	121.00	0.737	0.000	0.598	0.000	0.649	0.000	0.563	0.000	1	D	489.0	C	489.0
118	TCU021	24.79	121.17	0.273	0.338	-0.062	0.395	0.120	0.342	-0.138	0.398	6	D	446.4	C	446.4
119	TCU022	24.77	120.98	-0.191	0.001	-0.019	0.006	-0.165	0.008	-0.016	0.052	2	D	436.7	C	436.7
120	TCU023	24.72	121.13	-0.156	0.000	-0.219	0.000	-0.018	0.000	-0.067	0.000	1	C	555.2	C	555.2
121	TCU024	24.74	121.08	0.221	0.511	0.044	0.475	0.185	0.414	0.017	0.359	11	C	383.2	C	383.2
122	TCU025	24.71	121.18	-0.556	0.321	-0.892	0.348	-0.582	0.161	-0.792	0.181	9	B	*****	*	1626.9
123	TCU026	24.78	121.08	0.037	0.338	0.060	0.122	0.042	0.208	0.073	0.134	17	D	606.5	C	606.5
124	TCU027	24.83	121.06	-0.137	0.193	-0.038	0.255	-0.209	0.184	-0.043	0.183	7	D	670.4	C	670.4
125	TCU028	24.70	121.04	0.494	0.362	0.207	0.345	0.511	0.306	0.269	0.334	6	D	524.9	C	524.9
126	TCU029	24.56	120.75	0.154	0.392	-0.151	0.078	0.186	0.206	-0.154	0.135	14	C	404.8	C	404.8
127	TCU030	24.59	120.88	-0.089	0.291	-0.163	0.373	-0.109	0.274	-0.173	0.317	9	D	624.7	C	624.7
128	TCU031	24.56	120.70	0.088	0.209	0.150	0.116	0.071	0.179	0.143	0.120	18	C	476.3	C	476.3
129	TCU032	24.52	120.81	-0.221	0.186	-0.029	0.108	-0.206	0.131	-0.074	0.085	11	D	500.3	C	500.3
130	TCU033	24.69	120.86	0.423	0.263	0.154	0.171	0.400	0.167	0.149	0.165	19	D	420.6	C	420.6
131	TCU034	24.64	120.86	0.175	0.426	0.067	0.280	0.207	0.265	0.103	0.209	15	C	391.6	C	391.6
132	TCU035	24.62	120.79	0.028	0.618	0.094	0.451	0.110	0.493	0.147	0.451	13	D	378.1	C	378.1
133	TCU036	24.45	120.70	-0.035	0.402	-0.036	0.195	-0.003	0.200	-0.009	0.139	24	D	483.1	C	483.1
134	TCU037	24.49	120.68	-0.078	0.259	-0.120	0.312	-0.118	0.161	-0.150	0.237	8	D	463.5	C	463.5
135	TCU038	24.49	120.66	0.221	0.350	0.094	0.225	0.242	0.160	0.122	0.188	25	D	*****	*	313.6

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 ($m s^{-1}$)	Site‡	Vs30N ($m s^{-1}$)
136	TCU039	24.49	120.78	0.197	0.387	0.236	0.105	0.218	0.172	0.242	0.115	16	C	549.6	C	549.6
137	TCU040	24.45	120.64	0.212	0.442	0.139	0.173	0.248	0.185	0.178	0.150	23	E	336.2	C	336.2
138	TCU041	24.39	120.69	0.001	0.245	-0.046	0.300	-0.035	0.162	-0.043	0.184	9	D	*****	*	421.9
139	TCU042	24.55	120.81	0.290	0.450	0.100	0.214	0.306	0.257	0.129	0.183	25	D	573.5	C	573.5
140	TCU043	24.69	120.95	0.254	0.233	-0.138	0.344	0.179	0.173	-0.117	0.319	10	C	540.0	C	540.0
141	TCU044	24.40	120.76	0.059	0.376	-0.118	0.073	-0.174	0.229	-0.266	0.080	8	D	508.4	C	508.4
142	TCU045	24.54	120.91	-0.248	0.311	-0.534	0.122	-0.259	0.197	-0.545	0.181	15	C	707.0	C	707.0
143	TCU046	24.47	120.85	-0.489	0.296	-0.510	0.205	-0.422	0.100	-0.443	0.192	17	B	462.6	C	462.6
144	TCU047	24.62	120.94	0.003	0.672	-0.197	0.653	0.070	0.524	-0.153	0.462	13	C	523.0	C	523.0
145	TCU048	24.18	120.59	0.058	0.409	-0.236	0.194	0.012	0.200	-0.248	0.208	22	C	558.4	C	558.4
146	TCU049	24.18	120.69	-0.220	0.269	-0.277	0.227	-0.228	0.113	-0.288	0.234	21	D	469.7	C	469.7
147	TCU050	24.18	120.63	-0.178	0.383	-0.172	0.253	-0.217	0.221	-0.195	0.251	19	D	539.3	C	539.3
148	TCU051	24.16	120.65	0.006	0.376	-0.031	0.181	0.002	0.196	-0.063	0.206	18	D	*****	*	437.9
149	TCU052	24.20	120.74	-0.191	0.478	-0.076	0.225	-0.164	0.306	-0.047	0.225	24	C	589.2	C	589.2
150	TCU053	24.19	120.67	-0.310	0.437	-0.261	0.191	-0.313	0.253	-0.285	0.218	18	D	452.1	C	452.1
151	TCU054	24.16	120.68	-0.387	0.346	-0.228	0.256	-0.263	0.128	-0.157	0.241	11	D	437.0	C	437.0
152	TCU055	24.14	120.66	0.245	0.233	0.066	0.212	0.288	0.052	0.140	0.167	10	D	*****	*	303.9
153	TCU056	24.16	120.62	-0.042	0.343	-0.102	0.266	-0.049	0.174	-0.092	0.277	21	D	401.2	C	401.2
154	TCU057	24.18	120.61	-0.209	0.372	-0.084	0.174	-0.229	0.157	-0.116	0.203	20	C	*****	*	481.5
155	TCU058	24.25	120.70	-0.300	0.218	-0.281	0.034	-0.337	0.169	-0.320	0.011	5	D	*****	*	694.9
156	TCU059	24.27	120.56	0.522	0.302	0.574	0.295	0.542	0.181	0.612	0.226	24	D	232.2	D	232.2
157	TCU060	24.23	120.64	-0.439	0.320	-0.404	0.222	-0.425	0.142	-0.389	0.248	19	D	613.3	C	613.3
158	TCU061	24.14	120.55	0.167	0.424	0.253	0.152	0.204	0.242	0.260	0.140	23	D	365.3	C	365.3
159	TCU062	24.12	120.67	-0.107	0.352	-0.140	0.294	-0.169	0.218	-0.111	0.231	9	D	451.0	C	451.0
160	TCU063	24.11	120.62	-0.063	0.326	-0.044	0.270	-0.011	0.157	-0.002	0.274	17	D	476.2	C	476.2
161	TCU064	24.35	120.61	-0.447	0.499	-0.139	0.179	-0.447	0.165	-0.135	0.171	15	D	647.0	C	647.0
162	TCU065	24.06	120.69	0.483	0.373	0.429	0.435	0.636	0.262	0.573	0.398	19	D	290.1	D	290.1
163	TCU066	24.21	120.70	-0.025	0.302	-0.069	0.085	-0.192	0.187	-0.155	0.049	5	D	582.7	C	582.7
164	TCU067	24.09	120.72	0.077	0.378	0.133	0.359	0.112	0.410	0.169	0.352	16	D	440.3	C	440.3
165	TCU068	24.28	120.77	-0.514	0.398	-0.247	0.205	-0.432	0.232	-0.215	0.148	15	D	490.0	C	490.0
166	TCU069	24.26	120.82	-0.529	0.250	-0.519	0.434	-0.570	0.084	-0.467	0.173	4	D	554.7	C	554.7
167	TCU070	24.20	120.55	0.375	0.560	0.473	0.303	0.411	0.346	0.415	0.330	12	C	396.5	C	396.5
168	TCU071	23.99	120.79	0.008	0.476	-0.161	0.327	0.035	0.799	-0.107	0.515	15	D	614.8	C	614.8
169	TCU072	24.04	120.86	-0.324	0.172	-0.480	0.249	-0.225	0.284	-0.439	0.185	16	D	471.9	C	471.9
170	TCU073	24.01	120.95	-0.580	0.163	-0.832	0.158	-0.502	0.216	-0.670	0.109	10	D	*****	*	1307.5
171	TCU074	23.96	120.96	-0.356	0.201	-0.350	0.267	-0.304	0.278	-0.257	0.263	10	D	558.2	C	558.2
172	TCU075	23.98	120.68	-0.051	0.159	-0.223	0.155	0.080	0.283	-0.091	0.157	14	D	521.2	C	521.2
173	TCU076	23.91	120.68	0.042	0.210	-0.205	0.381	0.107	0.373	-0.154	0.339	18	D	573.2	C	573.2
174	TCU077	23.83	120.78	-0.073	0.243	-0.029	0.379	-0.212	0.236	-0.076	0.270	9	D	507.5	C	507.5
175	TCU078	23.81	120.85	0.003	0.235	-0.035	0.293	0.068	0.523	0.027	0.293	10	D	444.5	C	444.5
176	TCU079	23.84	120.89	-0.130	0.569	-0.305	0.492	-0.017	0.772	-0.254	0.587	13	D	353.9	D	353.9
177	TCU080	23.90	120.93	-0.043	0.415	-0.326	0.220	-0.179	0.309	-0.410	0.186	7	D	*****	*	818.0
178	TCU081	24.80	120.97	-0.017	0.163	0.132	0.117	-0.071	0.070	0.108	0.103	14	D	427.1	C	427.1
179	TCU082	24.15	120.68	-0.265	0.245	-0.146	0.275	-0.285	0.160	-0.178	0.273	20	D	469.4	C	469.4
180	TCU083	24.97	121.19	0.004	0.244	0.050	0.297	-0.015	0.172	0.081	0.236	13	C	370.7	C	370.7
181	TCU084	23.88	120.90	-0.354	0.202	0.102	0.262	-0.318	0.220	0.120	0.257	19	B	*****	*	315.0
182	TCU085	24.68	121.36	-0.573	0.318	-1.020	0.271	-0.547	0.197	-0.964	0.192	16	B	1037.9		1037.9
183	TCU086	23.86	120.28	0.415	0.522	0.224	0.511	0.306	0.327	0.169	0.364	15	E	222.9	D	222.9
184	TCU087	24.35	120.77	-0.385	0.361	-0.386	0.155	-0.363	0.142	-0.349	0.122	20	B	*****	*	733.0
185	TCU088	24.25	121.18	0.038	0.509	-0.929	0.269	0.176	0.694	-0.779	0.207	12	B	*****	*	1590.1
186	TCU089	23.90	120.86	-0.946	0.129	-0.795	0.218	-0.746	0.231	-0.669	0.200	10	B	*****	*	1304.5
187	TCU090	23.65	120.65	-0.166	0.328	-0.461	0.251	-0.139	0.192	-0.414	0.190	13	D	550.9	C	550.9
188	TCU091	24.98	121.26	-0.154	0.269	-0.099	0.243	-0.062	0.140	0.055	0.176	8	C	*****	*	353.8

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 ($m\ s^{-1}$)	Site‡	Vs30N ($m\ s^{-1}$)
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
189	TCU092	25.10	121.28	0.189	0.377	0.149	0.370	0.129	0.322	0.155	0.249	13	D	*****	*	295.3
190	TCU093	24.85	120.95	0.388	0.163	0.284	0.132	0.338	0.133	0.286	0.108	5	D	*****	*	233.2
191	TCU094	24.77	121.05	-0.150	0.178	-0.025	0.148	-0.184	0.120	-0.020	0.129	15	C	581.5	C	581.5
192	TCU095	24.69	121.01	0.419	0.500	0.070	0.344	0.391	0.371	0.047	0.312	18	C	454.1	C	454.1
193	TCU096	24.79	120.96	0.180	0.371	0.333	0.186	0.111	0.256	0.238	0.187	12	D	456.9	C	456.9
194	TCU097	24.79	120.92	0.173	0.214	0.025	0.153	0.124	0.256	-0.061	0.208	5	D	*****	*	436.4
195	TCU098	24.74	120.90	0.353	0.363	0.154	0.173	0.373	0.204	0.152	0.169	21	D	*****	*	297.2
196	TCU099	24.14	120.69	0.004	0.110	0.165	0.131	-0.093	0.010	0.101	0.095	5	D	*****	*	325.6
197	TCU100	24.19	120.62	-0.390	0.481	-0.137	0.146	-0.266	0.191	-0.162	0.136	11	C	*****	*	522.9
198	TCU101	24.24	120.71	-0.063	0.238	-0.272	0.059	-0.123	0.138	-0.270	0.117	9	D	*****	*	635.3
199	TCU102	24.25	120.72	-0.385	0.392	-0.106	0.160	-0.386	0.172	-0.132	0.147	18	D	706.2	C	706.2
200	TCU103	24.31	120.72	-0.369	0.535	-0.188	0.158	-0.352	0.187	-0.178	0.137	13	C	488.7	C	488.7
201	TCU104	24.21	120.60	-0.235	0.558	-0.155	0.219	-0.233	0.243	-0.172	0.260	17	C	403.5	C	403.5
202	TCU105	24.24	120.56	-0.080	0.496	0.043	0.133	-0.052	0.268	0.018	0.194	15	C	539.1	C	539.1
203	TCU106	24.09	120.55	0.228	0.576	0.228	0.259	0.311	0.261	0.298	0.136	18	D	451.0	C	451.0
204	TCU107	24.07	120.54	0.278	0.388	0.491	0.190	0.316	0.178	0.525	0.113	24	D	*****	*	151.9
205	TCU108	24.09	120.52	0.326	0.489	0.372	0.206	0.349	0.273	0.379	0.157	11	E	*****	*	197.2
206	TCU109	24.08	120.57	0.317	0.439	0.307	0.212	0.384	0.220	0.337	0.196	22	D	*****	*	212.9
207	TCU110	23.96	120.57	0.271	0.161	0.503	0.171	0.299	0.105	0.521	0.151	13	E	199.5	D	199.5
208	TCU111	24.11	120.49	0.171	0.494	0.509	0.150	0.207	0.221	0.532	0.148	17	E	233.5	D	233.5
209	TCU112	24.06	120.42	0.379	0.620	0.447	0.254	0.437	0.283	0.483	0.178	20	E	191.3	D	191.3
210	TCU113	23.89	120.39	0.194	0.519	0.342	0.404	0.238	0.243	0.368	0.314	23	E	231.1	D	231.1
211	TCU114	23.88	120.52	0.292	0.588	0.294	0.666	0.374	0.398	0.390	0.364	6	E	264.6	D	264.6
212	TCU115	23.96	120.47	0.227	0.304	0.457	0.249	0.233	0.136	0.458	0.188	21	E	184.9	D	184.9
213	TCU116	23.86	120.58	0.100	0.521	0.175	0.369	0.208	0.396	0.239	0.331	19	E	463.3	C	463.3
214	TCU117	24.13	120.46	0.362	0.518	0.532	0.275	0.405	0.246	0.574	0.222	24	E	207.2	D	207.2
215	TCU118	24.00	120.42	0.191	0.438	0.426	0.255	0.253	0.208	0.427	0.217	23	E	228.6	D	228.6
216	TCU119	23.92	120.31	0.376	0.521	0.332	0.389	0.364	0.357	0.329	0.316	19	E	*****	*	216.1
217	TCU120	23.98	120.61	0.024	0.348	0.225	0.181	0.082	0.184	0.252	0.273	13	C	458.2	C	458.2
218	TCU121	23.90	120.45	0.428	0.651	0.258	0.465	0.474	0.323	0.407	0.238	10	E	232.4	D	232.4
219	TCU122	23.81	120.61	0.190	0.505	0.056	0.289	0.295	0.346	0.069	0.269	17	D	*****	*	345.2
220	TCU123	24.02	120.54	0.332	0.284	0.555	0.169	0.391	0.091	0.589	0.141	17	D	*****	*	135.2
221	TCU124	23.91	120.68	0.227	0.418	0.044	0.471	0.234	0.313	0.093	0.378	7	D	*****	*	330.6
222	TCU125	23.96	120.68	0.094	0.194	0.115	0.227	0.126	0.165	0.150	0.140	11	D	*****	*	298.5
223	TCU126	23.76	120.68	0.184	0.528	0.346	0.389	0.402	0.272	0.368	0.352	4	D	*****	*	201.2
224	TCU127	24.63	121.00	-0.123	0.360	-0.313	0.299	-0.254	0.369	-0.367	0.339	8	D	807.7	B	807.7
225	TCU128	24.42	120.76	-0.253	0.585	-0.038	0.251	-0.227	0.294	-0.053	0.216	14	C	592.0	C	592.0
226	TCU129	23.88	120.68	0.935	0.734	0.263	0.388	0.949	0.654	0.257	0.367	20	D	506.5	C	506.5
227	TCU130	24.15	121.26	-0.305	0.174	-0.463	0.106	-0.280	0.223	-0.342	0.145	6	B	*****	*	723.2
228	TCU131	24.57	120.82	-0.002	0.280	0.014	0.170	-0.057	0.194	0.005	0.160	16	D	491.4	C	491.4
229	TCU132	24.58	120.82	-0.032	0.221	0.047	0.213	-0.010	0.159	0.229	0.089	3	D	*****	*	258.8
230	TCU133	24.14	120.65	0.462	0.529	0.372	0.260	0.625	0.567	0.517	0.301	6	D	*****	*	154.0
231	TCU134	24.12	120.62	0.302	0.078	0.425	0.011	0.095	0.025	0.391	0.011	2	D	*****	*	193.2
232	TCU135	24.33	120.65	0.061	0.019	0.432	0.215	-0.153	0.029	0.280	0.090	3	C	619.8	C	619.8
233	TCU136	24.26	120.65	-0.215	0.495	-0.129	0.186	-0.199	0.163	-0.133	0.144	13	C	458.0	C	458.0
234	TCU137	24.19	120.92	-0.351	0.592	-0.812	0.478	-0.069	1.236	-0.588	0.609	6	B	*****	*	1126.7
235	TCU138	23.92	120.60	0.330	0.263	0.316	0.111	0.354	0.130	0.331	0.070	9	D	604.2	C	604.2
236	TCU139	23.92	120.54	0.259	0.071	0.866	0.019	0.104	0.037	0.566	0.002	2	E	307.0	D	307.0
237	TCU140	23.96	120.36	0.491	0.585	0.606	0.257	0.469	0.214	0.570	0.151	13	E	221.9	D	221.9
238	TCU141	23.83	120.46	0.343	0.492	0.621	0.238	0.344	0.250	0.545	0.201	13	E	221.2	D	221.2
239	TCU143	23.88	120.76	0.023	0.096	-0.322	0.070	0.044	0.005	-0.140	0.007	3	D	465.9	C	465.9
240	TCU144	24.09	120.44	0.965	0.564	0.984	0.087	0.687	0.493	0.772	0.224	2	E	*****	*	97.2
241	TCU145	23.94	120.34	0.660	0.526	0.586	0.274	0.637	0.179	0.552	0.159	13	E	*****	*	144.6

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 (m s^{-1})	Site‡	Vs30N (m s^{-1})
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
242	TCU146	24.16	120.48	0.726	0.606	0.625	0.358	0.675	0.236	0.708	0.090	4	E	*****	*	109.2
243	CHY001	23.71	120.24	0.713	0.148	0.304	0.174	0.628	0.091	0.302	0.126	10	E	229.9	D	229.9
244	CHY002	23.72	120.41	0.381	0.418	0.522	0.337	0.365	0.207	0.492	0.236	16	E	229.6	D	229.6
245	CHY003	23.72	120.53	0.591	0.205	0.552	0.226	0.437	0.125	0.474	0.156	16	D	177.6	E	177.6
246	CHY004	23.60	120.17	0.468	0.317	0.284	0.155	0.441	0.246	0.273	0.129	26	E	273.0	D	273.0
247	CHY005	23.61	120.41	0.279	0.377	0.346	0.284	0.318	0.248	0.392	0.221	19	E	211.0	D	211.0
248	CHY006	23.58	120.55	0.277	0.277	0.327	0.308	0.312	0.144	0.359	0.197	25	D	422.7	C	422.7
249	CHY007	23.47	120.17	0.350	0.183	0.451	0.136	0.390	0.154	0.525	0.050	11	E	202.1	D	202.1
250	CHY008	23.49	120.27	0.563	0.358	0.478	0.342	0.517	0.192	0.474	0.234	27	E	209.5	D	209.5
251	CHY009	23.47	120.41	0.517	0.300	0.500	0.422	0.506	0.215	0.471	0.333	26	D	226.1	D	226.1
252	CHY010	23.47	120.54	0.260	0.487	0.074	0.367	0.255	0.366	0.056	0.266	24	D	*****	*	353.0
253	CHY011	23.48	120.65	0.278	0.569	0.033	0.763	0.207	0.638	0.001	0.738	8	B	*****	*	390.1
254	CHY012	23.33	120.15	0.394	0.142	0.359	0.253	0.379	0.086	0.369	0.142	21	E	192.2	D	192.2
255	CHY013	23.36	120.27	0.693	0.185	0.622	0.354	0.546	0.113	0.564	0.238	15	E	216.2	D	216.2
256	CHY014	23.30	120.58	0.349	0.346	0.223	0.392	0.319	0.241	0.219	0.268	26	D	341.8	D	341.8
257	CHY015	23.36	120.41	0.640	0.233	0.628	0.293	0.584	0.161	0.568	0.220	28	D	224.7	D	224.7
258	CHY016	23.22	120.15	0.699	0.327	0.715	0.285	0.609	0.175	0.661	0.174	21	E	199.5	D	199.5
259	CHY017	23.21	120.27	0.314	0.340	0.371	0.251	0.244	0.169	0.320	0.168	26	E	196.0	D	196.0
260	CHY018	23.22	120.39	0.798	0.929	0.451	1.132	0.785	0.808	0.486	1.006	12	C	594.7	C	594.7
261	CHY019	23.18	120.48	0.477	0.543	0.049	0.438	0.406	0.376	0.008	0.344	16	D	*****	*	384.8
262	CHY020	23.10	120.15	0.529	0.303	0.435	0.281	0.364	0.256	0.310	0.301	13	E	214.1	D	214.1
263	CHY021	23.08	120.29	0.018	0.322	0.284	0.193	-0.105	0.291	0.223	0.291	14	D	212.3	D	212.3
264	CHY022	23.05	120.46	0.159	0.295	-0.215	0.262	0.105	0.119	-0.234	0.218	19	C	570.0	C	570.0
265	CHY023	22.97	120.28	0.472	0.232	0.405	0.207	0.423	0.154	0.378	0.153	18	D	279.8	D	279.8
266	CHY024	23.76	120.61	0.283	0.386	0.084	0.273	0.319	0.178	0.130	0.164	29	D	408.5	C	408.5
267	CHY025	23.78	120.51	0.296	0.426	0.273	0.246	0.321	0.234	0.295	0.172	28	E	276.5	D	276.5
268	CHY026	23.80	120.41	0.058	0.473	0.143	0.310	0.064	0.199	0.149	0.267	28	E	220.6	D	220.6
269	CHY027	23.75	120.25	0.201	0.536	0.073	0.382	0.243	0.312	0.104	0.398	24	E	209.5	D	209.5
270	CHY028	23.63	120.61	0.498	0.876	0.183	0.713	0.592	0.630	0.248	0.518	24	D	546.9	C	546.9
271	CHY029	23.61	120.53	0.134	0.584	0.173	0.346	0.130	0.362	0.181	0.220	27	C	541.7	C	541.7
272	CHY030	23.64	120.48	0.502	0.387	0.548	0.350	0.476	0.295	0.514	0.307	21	E	207.9	D	207.9
273	CHY031	23.66	120.34	0.273	0.341	0.249	0.184	0.206	0.281	0.232	0.207	19	E	215.7	D	215.7
274	CHY032	23.58	120.29	0.220	0.309	0.373	0.265	0.166	0.174	0.316	0.266	27	E	192.6	D	192.6
275	CHY033	23.54	120.22	0.219	0.274	0.260	0.216	0.223	0.180	0.255	0.209	31	E	193.3	D	193.3
276	CHY034	23.52	120.54	0.360	0.161	0.369	0.322	0.335	0.073	0.346	0.187	19	D	383.1	C	383.1
277	CHY035	23.52	120.58	0.203	0.615	0.196	0.481	0.245	0.383	0.228	0.343	30	D	*****	*	259.1
278	CHY036	23.61	120.48	0.540	0.547	0.499	0.439	0.607	0.335	0.549	0.320	23	D	236.1	D	236.1
279	CHY037	23.56	120.42	0.322	0.293	0.299	0.431	0.255	0.215	0.269	0.324	20	D	208.8	D	208.8
280	CHY038	23.54	120.45	0.811	0.947	0.663	0.905	0.717	0.731	0.639	0.638	8	C	372.9	C	372.9
281	CHY039	23.52	120.34	0.205	0.308	0.359	0.295	0.241	0.168	0.378	0.202	33	E	195.2	D	195.2
282	CHY040	23.43	120.63	-0.347	0.469	-0.441	0.370	-0.386	0.320	-0.438	0.273	15	B	*****	*	859.4
283	CHY041	23.44	120.60	0.295	0.454	0.112	0.381	0.347	0.294	0.159	0.248	25	D	488.1	C	488.1
284	CHY042	23.36	120.58	-0.206	0.420	-0.201	0.372	-0.249	0.316	-0.213	0.296	25	B	*****	*	573.3
285	CHY043	23.41	120.33	0.387	0.516	0.347	0.244	0.341	0.323	0.319	0.195	21	E	225.4	D	225.4
286	CHY044	23.38	120.16	0.301	0.348	0.344	0.320	0.242	0.231	0.315	0.260	29	E	192.7	D	192.7
287	CHY045	23.30	120.66	-0.198	0.378	-0.330	0.249	-0.195	0.282	-0.319	0.239	14	B	627.6	C	627.6
288	CHY046	23.48	120.46	0.253	0.434	0.155	0.370	0.250	0.310	0.142	0.337	36	C	446.5	C	446.5
289	CHY047	23.49	120.45	0.764	0.520	0.623	0.305	0.809	0.252	0.618	0.185	19	D	183.5	E	183.5
290	CHY048	23.47	120.44	0.395	0.431	0.180	0.345	0.476	0.383	0.242	0.287	12	D	248.7	D	248.7
291	CHY049	23.37	120.36	0.450	0.347	0.504	0.316	0.412	0.213	0.478	0.242	33	E	224.8	D	224.8
292	CHY050	23.28	120.41	0.348	0.545	0.047	0.554	0.308	0.386	0.023	0.424	28	C	*****	*	375.0
293	CHY051	23.28	120.46	0.522	0.072	0.335	0.029	0.467	0.079	0.266	0.064	4	D	363.9	C	363.9
294	CHY052	23.29	120.50	0.127	0.287	-0.057	0.403	0.087	0.142	-0.089	0.245	20	B	*****	*	458.9

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 ($m s^{-1}$)	Site‡	Vs30N ($m s^{-1}$)
295	CHY053	23.29	120.36	0.875	0.310	0.904	0.487	0.733	0.289	0.791	0.418	12	D	272.7	D	272.7
296	CHY054	23.31	120.31	0.452	0.382	0.577	0.309	0.444	0.223	0.579	0.197	32	E	175.1	E	175.1
297	CHY055	23.27	120.27	0.616	0.490	0.652	0.346	0.568	0.297	0.590	0.249	21	E	221.5	D	221.5
298	CHY056	23.26	120.13	0.362	0.269	0.376	0.319	0.329	0.189	0.342	0.270	21	E	189.0	D	189.0
299	CHY057	23.15	120.41	0.257	0.354	0.022	0.358	0.177	0.239	-0.033	0.312	24	C	*****	*	414.5
300	CHY058	23.17	120.32	0.304	0.285	0.410	0.241	0.322	0.179	0.443	0.211	22	D	271.1	D	271.1
301	CHY059	23.18	120.10	0.191	0.144	0.262	0.288	0.163	0.094	0.248	0.220	20	E	187.0	D	187.0
302	CHY060	23.12	120.24	0.217	0.311	0.286	0.224	0.133	0.257	0.253	0.214	24	E	223.9	D	223.9
303	CHY061	23.08	120.51	-0.180	0.201	-0.435	0.216	-0.252	0.108	-0.457	0.148	21	D	*****	*	890.2
304	CHY062	23.12	120.45	-0.099	0.234	-0.314	0.224	-0.143	0.154	-0.334	0.169	29	D	597.9	C	597.9
305	CHY063	23.03	120.34	0.005	0.162	0.117	0.174	-0.006	0.136	0.107	0.126	25	D	287.7	D	287.7
306	CHY064	23.00	120.23	0.958	0.000	0.529	0.000	0.627	0.000	0.526	0.000	1	D	*****	*	151.4
307	CHY065	22.91	120.34	0.260	0.256	0.436	0.198	0.226	0.210	0.433	0.126	17	D	222.7	D	222.7
308	CHY066	22.92	120.21	0.039	0.127	0.479	0.234	0.007	0.099	0.476	0.171	17	E	211.5	D	211.5
309	CHY067	23.00	120.18	0.528	0.401	0.587	0.388	0.464	0.260	0.522	0.290	14	E	229.0	D	229.0
310	CHY068	22.99	120.20	0.234	0.208	0.209	0.126	0.136	0.092	0.145	0.148	5	D	196.1	D	196.1
311	CHY069	22.97	120.18	0.220	0.231	0.383	0.213	0.189	0.117	0.371	0.095	13	E	220.0	D	220.0
312	CHY070	22.97	120.23	-0.033	0.124	0.144	0.146	-0.062	0.082	0.158	0.086	20	D	228.7	D	228.7
313	CHY071	23.07	120.16	0.294	0.175	0.517	0.215	0.237	0.165	0.456	0.213	21	E	200.5	D	200.5
314	CHY072	23.07	120.12	0.111	0.390	0.105	0.237	0.011	0.404	0.137	0.281	6	E	*****	*	305.1
315	CHY073	23.50	120.42	0.189	0.440	0.285	0.494	0.186	0.340	0.273	0.405	34	D	201.5	D	201.5
316	CHY074	23.51	120.81	-0.214	0.350	-0.103	0.387	-0.123	0.177	-0.059	0.235	19	B	524.6	C	524.6
317	CHY075	23.57	119.56	0.401	0.240	-0.143	0.052	0.502	0.095	-0.131	0.091	11	B	*****	*	494.4
318	CHY076	23.64	120.22	0.481	0.459	0.285	0.275	0.504	0.250	0.297	0.257	33	E	170.9	E	170.9
319	CHY077	23.18	120.19	0.336	0.673	0.310	0.497	0.265	0.510	0.249	0.471	19	E	124.9	E	124.9
320	CHY078	23.04	120.23	0.231	0.241	0.347	0.165	0.199	0.125	0.317	0.112	17	D	162.3	E	162.3
321	CHY079	23.18	120.53	-0.268	0.365	-0.466	0.298	-0.314	0.232	-0.485	0.195	18	C	*****	*	936.2
322	CHY080	23.60	120.68	-0.143	0.444	-0.034	0.476	0.047	0.412	0.072	0.415	15	B	499.2	C	499.2
323	CHY081	23.27	120.49	-0.532	0.351	-0.281	0.438	-0.551	0.255	-0.300	0.324	25	C	*****	*	670.5
324	CHY082	23.72	120.30	0.284	0.456	0.189	0.353	0.333	0.221	0.244	0.282	27	E	194.8	D	194.8
325	CHY083	23.72	120.58	0.218	0.313	0.131	0.210	0.258	0.202	0.195	0.162	14	D	374.0	C	374.0
326	CHY084	23.73	120.46	0.140	0.302	0.171	0.208	0.157	0.179	0.199	0.139	11	E	259.1	D	259.1
327	CHY086	23.35	120.59	0.038	0.447	0.231	0.420	0.035	0.307	0.207	0.293	18	B	*****	*	269.3
328	CHY087	23.38	120.52	0.156	0.436	0.102	0.334	0.143	0.268	0.077	0.269	30	C	508.0	C	508.0
329	CHY088	23.35	120.43	0.588	0.403	0.495	0.310	0.641	0.176	0.545	0.215	30	D	*****	*	146.5
330	CHY089	23.08	120.36	0.066	0.000	0.048	0.000	0.207	0.000	0.330	0.000	1	C	396.2	C	396.2
331	CHY090	23.27	120.22	0.646	0.496	0.695	0.346	0.634	0.296	0.699	0.269	28	E	181.9	D	181.9
332	CHY091	23.08	120.21	0.171	0.220	0.259	0.274	0.123	0.188	0.282	0.274	9	E	*****	*	235.1
333	CHY092	23.79	120.48	0.221	0.265	0.421	0.157	0.193	0.091	0.372	0.127	17	E	252.2	D	252.2
334	CHY093	23.65	120.15	0.395	0.436	0.265	0.189	0.360	0.232	0.231	0.185	18	E	191.4	D	191.4
335	CHY094	23.79	120.32	0.272	0.418	0.391	0.247	0.254	0.172	0.365	0.171	19	E	223.2	D	223.2
336	CHY095	23.45	120.32	0.484	0.253	0.604	0.348	0.478	0.103	0.573	0.212	25	E	216.4	D	216.4
337	CHY096	22.98	120.23	-0.134	0.136	0.261	0.150	-0.098	0.049	0.262	0.070	12	D	*****	*	243.6
338	CHY097	23.01	120.20	0.174	0.202	0.055	0.131	0.014	0.290	0.044	0.137	6	D	*****	*	360.7
339	CHY098	23.00	120.16	0.202	0.148	0.317	0.211	0.104	0.032	0.253	0.240	5	E	*****	*	247.5
340	CHY099	23.14	120.28	0.342	0.224	0.443	0.202	0.253	0.131	0.352	0.188	21	D	217.1	D	217.1
341	CHY100	23.23	120.34	0.542	0.352	0.490	0.365	0.469	0.243	0.419	0.313	23	D	*****	*	183.8
342	CHY101	23.69	120.56	0.289	0.485	0.410	0.411	0.419	0.230	0.469	0.234	21	D	252.4	D	252.4
343	CHY102	23.25	120.61	-0.148	0.369	-0.611	0.282	-0.187	0.178	-0.652	0.153	22	B	836.1	B	836.1
344	CHY103	23.70	120.53	0.149	0.508	0.505	0.105	0.279	0.312	0.478	0.143	4	D	223.7	D	223.7
345	CHY104	23.67	120.47	0.533	0.314	0.669	0.297	0.497	0.144	0.681	0.174	16	E	218.8	D	218.8
346	CHY105	23.56	120.34	0.187	0.375	0.356	0.313	0.123	0.174	0.267	0.227	15	E	204.4	D	204.4
347	CHY106	23.44	120.41	0.503	0.355	0.573	0.446	0.470	0.232	0.544	0.327	22	D	227.6	D	227.6

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 (m s^{-1})	Site‡	Vs30N (m s^{-1})
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
348	CHY107	23.30	120.29	0.554	0.265	0.549	0.368	0.489	0.188	0.494	0.278	20	E	181.1	D	181.1
349	CHY108	23.19	120.25	0.998	0.721	1.030	0.117	0.932	0.250	1.012	0.116	3	E	249.7	D	249.7
350	CHY109	23.25	120.53	-0.797	0.000	-0.557	0.000	-0.884	0.000	-0.592	0.000	1	B	*****	*	1135.3
351	CHY111	23.79	120.23	0.719	0.549	0.291	0.554	0.622	0.280	0.249	0.423	13	E	269.6	D	269.6
352	CHY112	23.70	120.18	0.695	0.774	0.249	0.348	0.608	0.398	0.207	0.292	7	E	239.7	D	239.7
353	CHY113	23.42	120.21	0.494	0.465	0.546	0.276	0.391	0.207	0.450	0.249	5	E	240.6	D	240.6
354	CHY114	23.04	120.12	0.363	0.111	0.488	0.225	0.336	0.109	0.454	0.169	14	E	215.1	D	215.1
355	CHY115	23.15	120.10	0.468	0.192	0.449	0.139	0.419	0.072	0.436	0.075	12	E	*****	*	178.0
356	CHY116	23.08	120.11	0.624	0.237	0.635	0.156	0.580	0.119	0.601	0.096	14	E	194.3	D	194.3
357	CHY117	23.80	120.22	0.280	0.643	0.106	0.320	0.233	0.275	-0.005	0.318	4	E	*****	*	394.5
358	CHY123	23.48	120.24	0.415	0.000	0.380	0.000	0.088	0.000	0.347	0.000	1	E	212.5	D	212.5
359	KAU001	23.16	120.64	-0.733	0.253	-0.799	0.311	-0.739	0.113	-0.791	0.197	11	D	*****	*	1624.6
360	KAU002	22.62	120.31	-0.230	0.029	-0.303	0.005	-0.299	0.008	-0.269	0.009	2	E	*****	*	633.8
361	KAU003	22.63	120.26	-0.220	0.227	-0.212	0.141	-0.244	0.124	-0.242	0.122	14	D	887.7	B	887.7
362	KAU004	22.63	120.34	-0.257	0.089	-0.110	0.399	-0.352	0.004	0.030	0.239	2	E	221.9	D	221.9
363	KAU005	22.62	120.34	-0.164	0.020	-0.076	0.017	-0.240	0.112	-0.066	0.043	3	E	253.5	D	253.5
364	KAU006	22.59	120.32	-0.225	0.138	0.213	0.266	-0.335	0.101	0.188	0.181	9	E	219.0	D	219.0
365	KAU007	22.65	120.36	-0.151	0.091	0.096	0.130	-0.170	0.048	0.097	0.100	16	D	*****	*	327.8
366	KAU008	22.63	120.37	-0.105	0.158	0.194	0.187	-0.099	0.092	0.200	0.142	13	D	287.5	D	287.5
367	KAU009	22.87	120.26	-0.230	0.163	-0.339	0.217	-0.378	0.063	-0.373	0.109	7	D	270.5	D	270.5
368	KAU010	22.79	120.28	-0.371	0.056	0.121	0.182	-0.314	0.049	0.167	0.142	10	E	*****	*	289.2
369	KAU011	22.76	120.26	0.078	0.435	0.129	0.510	0.008	0.290	0.119	0.395	10	E	145.4	E	145.4
370	KAU012	22.88	120.37	-0.053	0.223	0.053	0.207	-0.090	0.135	0.057	0.137	22	D	304.7	D	304.7
371	KAU013	22.80	120.36	-0.027	0.162	-0.040	0.276	-0.162	0.071	-0.051	0.177	7	D	261.6	D	261.6
372	KAU014	22.70	120.34	-0.102	0.301	0.045	0.196	-0.175	0.166	0.013	0.078	7	E	243.1	D	243.1
373	KAU015	22.66	120.33	-0.121	0.099	0.206	0.164	-0.127	0.073	0.211	0.100	10	D	227.1	D	227.1
374	KAU016	22.61	120.39	-0.485	0.000	-0.271	0.000	-0.817	0.000	-0.398	0.000	1	D	*****	*	800.4
375	KAU017	22.51	120.39	-0.034	0.061	0.279	0.100	-0.227	0.094	0.200	0.073	7	E	252.6	D	252.6
376	KAU018	22.89	120.47	-0.605	0.251	-0.332	0.213	-0.666	0.141	-0.357	0.125	13	D	*****	*	743.0
377	KAU019	22.89	120.45	-0.649	0.048	-0.509	0.055	-0.651	0.023	-0.380	0.029	4	C	*****	*	774.1
378	KAU020	22.90	120.52	0.126	0.314	0.373	0.273	0.139	0.216	0.413	0.183	20	D	344.2	D	344.2
379	KAU021	22.75	120.44	-1.378	0.000	-1.023	0.000	-1.185	0.000	-0.829	0.000	1	C	*****	*	1740.0
380	KAU022	22.67	120.49	-0.273	0.305	0.051	0.361	-0.148	0.239	0.138	0.187	12	E	*****	*	304.8
381	KAU023	22.68	120.49	-0.578	0.001	-0.247	0.098	-0.595	0.010	-0.374	0.049	2	D	218.2	D	218.2
382	KAU024	22.66	120.47	-0.353	0.213	-0.504	0.244	-0.444	0.074	-0.433	0.140	3	E	220.6	D	220.6
383	KAU025	22.68	120.48	-0.437	0.131	-0.109	0.208	-0.482	0.030	-0.154	0.082	7	D	*****	*	515.9
384	KAU026	22.70	120.50	-0.131	0.045	0.193	0.113	-0.408	0.045	0.069	0.076	5	D	275.2	D	275.2
385	KAU027	22.65	120.50	-0.352	0.076	-0.337	0.181	-0.445	0.020	-0.256	0.152	3	E	*****	*	620.0
386	KAU028	22.83	120.59	-0.746	0.236	-0.645	0.267	-0.694	0.040	-0.661	0.084	5	D	547.8	C	547.8
387	KAU029	22.76	120.57	-0.204	0.031	-0.056	0.005	-0.536	0.031	-0.121	0.017	2	D	351.9	D	351.9
388	KAU030	22.61	120.56	-0.209	0.181	0.115	0.218	-0.316	0.125	0.050	0.126	12	E	265.2	D	265.2
389	KAU031	22.61	120.48	-0.489	0.051	-0.010	0.135	-0.585	0.043	-0.132	0.050	5	E	219.6	D	219.6
390	KAU032	22.55	120.45	0.025	0.131	0.360	0.164	0.049	0.127	0.382	0.105	12	E	190.7	D	190.7
391	KAU033	22.47	120.45	-0.134	0.127	0.258	0.170	-0.291	0.098	0.181	0.122	9	E	186.6	D	186.6
392	KAU034	22.53	120.62	-0.768	0.143	-0.610	0.051	-0.758	0.002	-0.750	0.032	3	B	999.2	B	999.2
393	KAU035	22.55	120.53	0.112	0.129	0.456	0.211	-0.045	0.109	0.342	0.111	8	E	282.0	D	282.0
394	KAU036	22.47	120.54	0.058	0.272	0.323	0.256	-0.063	0.121	0.248	0.147	12	E	234.6	D	234.6
395	KAU037	22.30	120.63	-0.130	0.213	-0.134	0.154	-0.181	0.138	-0.177	0.096	12	D	277.3	D	277.3
396	KAU038	22.19	120.69	-0.549	0.193	-0.664	0.403	-0.678	0.165	-0.807	0.336	6	B	660.4	C	660.4
397	KAU039	22.10	120.74	-0.120	0.067	0.013	0.010	-0.307	0.000	-0.195	0.013	2	D	459.5	C	459.5
398	KAU040	22.19	120.87	0.014	0.021	0.119	0.051	-0.174	0.148	-0.090	0.046	2	D	*****	*	459.5
399	KAU042	22.02	120.83	0.023	0.000	-0.028	0.000	-0.405	0.000	-0.225	0.000	1	D	815.6	B	815.6
400	KAU043	21.91	120.84	0.093	0.078	0.524	0.000	0.081	0.019	0.423	0.008	2	D	*****	*	182.5
401	KAU044	22.44	120.50	0.165	0.189	0.537	0.166	0.077	0.144	0.474	0.146	11	E	215.9	D	215.9

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 (m s-1)	Site‡	Vs30N (m s-1)
402	KAU045	22.57	120.31	-0.120	0.118	0.384	0.202	-0.247	0.138	0.339	0.155	10	E	145.2	E	145.2
403	KAU046	22.01	120.74	0.363	0.109	0.539	0.070	0.286	0.075	0.412	0.030	5	D	198.4	D	198.4
404	KAU047	23.08	120.58	-0.346	0.333	-0.356	0.165	-0.395	0.138	-0.397	0.086	19	B	*****	*	799.5
405	KAU048	22.73	120.49	-0.297	0.198	0.205	0.131	-0.306	0.108	0.160	0.074	14	D	139.5	E	139.5
406	KAU049	22.75	120.63	-0.006	0.128	-0.336	0.233	-0.131	0.413	-0.420	0.326	6	C	*****	*	833.2
407	KAU050	23.16	120.76	-0.352	0.366	-0.709	0.332	-0.338	0.247	-0.671	0.183	17	B	*****	*	1308.7
408	KAU051	22.37	120.62	-0.763	0.202	-0.926	0.289	-0.813	0.095	-0.929	0.222	6	B	1019.5	B	1019.5
409	KAU053	22.82	120.42	-0.470	0.252	-0.160	0.107	-0.609	0.121	-0.237	0.055	7	B	*****	*	599.2
410	KAU054	23.28	120.71	-0.484	0.253	-0.733	0.214	-0.488	0.206	-0.724	0.131	26	D	502.8	C	502.8
411	KAU055	22.57	120.34	-0.244	0.107	0.186	0.155	-0.252	0.091	0.139	0.120	10	E	*****	*	304.0
412	KAU056	22.55	120.34	-0.269	0.093	0.078	0.150	-0.424	0.060	-0.002	0.123	9	E	*****	*	392.2
413	KAU057	22.63	120.26	-0.352	0.087	-0.362	0.177	-0.426	0.039	-0.417	0.104	9	C	*****	*	828.1
414	KAU058	22.64	120.32	-0.163	0.129	0.151	0.130	-0.151	0.076	0.115	0.103	11	E	*****	*	317.6
415	KAU059	22.73	120.31	-0.666	0.075	-0.416	0.166	-0.577	0.014	-0.329	0.073	3	E	229.6	D	229.6
416	KAU060	22.67	120.31	-0.020	0.000	-0.036	0.000	-0.352	0.000	-0.039	0.000	1	E	246.0	D	246.0
417	KAU061	22.64	120.29	0.149	0.106	0.088	0.018	0.054	0.008	0.228	0.000	2	E	214.4	D	214.4
418	KAU062	22.62	120.28	0.048	0.136	0.063	0.227	0.083	0.079	0.105	0.143	10	E	195.6	D	195.6
419	KAU063	22.91	120.17	-0.167	0.103	0.387	0.240	-0.106	0.105	0.417	0.164	12	E	211.6	D	211.6
420	KAU064	22.79	120.24	0.090	0.116	0.139	0.162	0.053	0.083	0.147	0.107	13	E	242.5	D	242.5
421	KAU065	22.75	120.30	-0.291	0.003	-0.313	0.000	-0.044	0.003	0.021	0.002	2	E	244.9	D	244.9
422	KAU066	22.73	120.34	0.092	0.139	0.189	0.161	0.045	0.102	0.155	0.104	15	E	228.6	D	228.6
423	KAU067	22.66	120.42	-0.409	0.000	-0.101	0.000	-0.741	0.000	-0.104	0.000	1	D	463.6	C	463.6
424	KAU068	22.98	120.54	0.101	0.001	-0.033	0.004	-0.228	0.001	-0.051	0.003	2	D	813.2	B	813.2
425	KAU069	22.89	120.66	-0.062	0.376	-0.643	0.299	-0.081	0.109	-0.625	0.123	14	B	512.7	C	512.7
426	KAU070	22.78	120.49	-0.243	0.166	0.019	0.190	-0.383	0.064	-0.028	0.076	5	D	289.4	D	289.4
427	KAU071	22.66	120.51	-0.154	0.020	0.210	0.033	-0.477	0.027	0.025	0.035	3	E	238.7	D	238.7
428	KAU072	22.67	120.59	-0.194	0.087	-0.244	0.200	-0.278	0.299	-0.345	0.324	5	D	487.1	C	487.1
429	KAU073	22.53	120.53	-0.384	0.477	0.053	0.406	-0.393	0.314	0.057	0.319	15	E	*****	*	352.4
430	KAU074	22.57	120.57	-0.101	0.170	0.196	0.194	-0.116	0.110	0.194	0.093	17	E	224.9	D	224.9
431	KAU075	22.49	120.50	0.108	0.106	0.513	0.134	0.119	0.072	0.498	0.075	14	E	196.8	D	196.8
432	KAU076	22.43	120.56	0.023	0.002	0.278	0.009	-0.116	0.020	0.166	0.000	2	D	280.2	D	280.2
433	KAU077	22.75	120.72	-0.349	0.269	-0.672	0.386	-0.334	0.242	-0.667	0.284	16	B	*****	*	1299.1
434	KAU078	22.71	120.64	-0.064	0.514	-0.723	0.556	-0.020	0.405	-0.704	0.441	17	B	553.1	C	553.1
435	KAU079	22.59	120.62	-0.297	0.083	-0.801	0.165	-0.422	0.144	-0.885	0.180	6	B	593.8	C	593.8
436	KAU081	22.01	120.74	0.138	0.113	0.282	0.236	0.176	0.146	0.226	0.157	7	D	*****	*	260.1
437	KAU082	21.94	120.73	0.386	0.028	0.650	0.019	0.132	0.000	0.447	0.021	2	C	*****	*	174.8
438	KAU083	22.57	120.45	-0.208	0.164	0.357	0.137	-0.140	0.112	0.341	0.062	9	E	*****	*	211.3
439	KAU084	22.35	120.36	-0.121	0.000	0.527	0.000	-0.548	0.000	0.330	0.000	1	B	*****	*	215.6
440	KAU085	22.89	120.32	0.032	0.211	0.450	0.241	0.046	0.134	0.465	0.129	15	D	255.8	D	255.8
441	KAU086	22.79	120.30	0.082	0.058	0.330	0.212	0.028	0.068	0.334	0.181	8	E	*****	*	214.1
442	KAU087	22.61	120.31	-0.090	0.155	0.220	0.372	-0.077	0.086	0.239	0.268	11	E	247.4	D	247.4
443	KAU088	22.65	120.31	-0.089	0.113	0.145	0.214	-0.091	0.043	0.126	0.171	12	E	228.7	D	228.7
444	KAU089	22.48	120.39	-0.209	0.130	0.405	0.261	-0.198	0.119	0.396	0.198	12	E	191.5	D	191.5
445	ILA001	24.88	121.84	-0.630	0.223	-0.535	0.175	-0.671	0.111	-0.487	0.100	9	D	939.1	B	939.1
446	ILA002	24.84	121.80	0.138	0.189	0.142	0.140	0.124	0.107	0.170	0.120	16	D	220.7	D	220.7
447	ILA003	24.80	121.78	0.232	0.159	0.267	0.090	0.253	0.083	0.270	0.063	14	E	265.6	D	265.6
448	ILA004	24.75	121.78	0.187	0.110	0.563	0.094	0.223	0.072	0.608	0.080	13	E	121.5	E	121.5
449	ILA005	24.70	121.80	0.268	0.212	0.311	0.194	0.275	0.106	0.296	0.153	20	E	237.2	D	237.2
450	ILA006	24.64	121.82	0.303	0.171	0.327	0.229	0.274	0.116	0.304	0.220	21	E	276.4	D	276.4
451	ILA007	24.59	121.85	0.320	0.300	0.029	0.267	0.309	0.228	0.013	0.279	23	D	*****	*	381.7
452	ILA008	24.71	121.76	0.176	0.130	0.227	0.170	0.147	0.092	0.205	0.152	21	E	290.7	D	290.7
453	ILA010	24.63	121.78	0.025	0.294	-0.348	0.328	-0.047	0.158	-0.382	0.284	13	D	*****	*	777.9
454	ILA011	24.83	121.75	-0.559	0.000	-0.952	0.000	-0.421	0.000	-0.800	0.000	1	B	*****	*	1651.4
455	ILA012	24.78	121.73	0.165	0.112	0.298	0.126	0.141	0.070	0.273	0.112	16	D	255.5	D	255.5

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 (m s^{-1})	Site‡	Vs30N (m s^{-1})
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
456	ILA013	24.73	121.73	0.591	0.344	0.648	0.207	0.626	0.137	0.673	0.140	16	D	194.5	D	194.5
457	ILA014	24.69	121.72	0.132	0.269	0.140	0.294	0.103	0.157	0.114	0.236	14	D	307.5	D	307.5
458	ILA015	24.78	121.69	-0.322	0.107	-0.512	0.114	-0.385	0.062	-0.515	0.079	16	B	776.8	B	776.8
459	ILA016	24.75	121.68	0.004	0.239	0.116	0.200	0.017	0.120	0.130	0.153	20	D	269.7	D	269.7
460	ILA017	24.72	121.68	-0.560	0.300	-0.169	0.469	-0.482	0.244	-0.035	0.398	7	D	627.4	C	627.4
461	ILA018	24.68	121.68	-0.520	0.066	-0.477	0.215	-0.524	0.086	-0.433	0.103	4	D	497.5	C	497.5
462	ILA019	24.64	121.69	-0.049	0.052	-0.158	0.126	-0.179	0.077	-0.324	0.114	5	B	*****	*	700.0
463	ILA020	24.76	121.63	0.264	0.000	0.193	0.000	0.036	0.000	-0.196	0.000	1	B	453.6	C	453.6
464	ILA021	24.71	121.64	-0.335	0.274	-0.360	0.214	-0.330	0.140	-0.338	0.157	15	D	*****	*	718.0
465	ILA022	24.67	121.64	-0.498	0.242	-0.465	0.488	-0.534	0.200	-0.373	0.330	6	D	*****	*	765.5
466	ILA023	24.68	121.60	-0.164	0.230	-0.453	0.327	-0.196	0.185	-0.429	0.172	9	D	*****	*	845.9
467	ILA024	24.64	121.59	-0.619	0.237	-0.859	0.346	-0.671	0.217	-0.787	0.240	14	B	*****	*	1612.6
468	ILA025	24.64	121.57	0.494	0.283	-0.158	0.311	0.460	0.400	-0.145	0.325	9	B	*****	*	507.0
469	ILA026	24.67	121.76	0.137	0.297	0.401	0.127	0.177	0.065	0.451	0.063	4	D	237.5	D	237.5
470	ILA027	24.69	121.76	0.281	0.080	0.297	0.144	0.302	0.044	0.479	0.156	3	D	212.7	D	212.7
471	ILA028	24.76	121.75	0.635	0.170	0.794	0.186	0.771	0.079	0.835	0.207	5	D	218.4	D	218.4
472	ILA029	24.77	121.75	-0.312	0.317	-0.005	0.267	-0.289	0.230	0.118	0.288	4	D	187.0	D	187.0
473	ILA030	24.73	121.76	0.374	0.253	0.499	0.194	0.410	0.130	0.534	0.145	14	E	198.5	D	198.5
474	ILA031	24.60	121.83	0.387	0.211	-0.122	0.248	0.368	0.159	-0.083	0.231	16	B	657.4	C	657.4
475	ILA032	24.62	121.83	0.092	0.160	-0.027	0.118	0.114	0.133	0.155	0.067	3	D	296.5	D	296.5
476	ILA033	24.86	121.82	0.265	0.118	0.083	0.134	0.166	0.053	0.114	0.092	5	D	253.6	D	253.6
477	ILA034	24.80	121.81	-0.303	0.253	0.401	0.239	-0.199	0.061	0.470	0.028	3	E	217.7	D	217.7
478	ILA035	24.82	121.76	-0.274	0.353	-0.109	0.161	-0.252	0.338	0.073	0.151	3	D	293.1	D	293.1
479	ILA036	24.79	121.75	-0.071	0.173	0.187	0.138	-0.088	0.085	0.198	0.092	18	D	179.0	E	179.0
480	ILA037	24.75	121.71	0.272	0.184	0.357	0.190	0.319	0.068	0.402	0.128	19	D	212.9	D	212.9
481	ILA038	24.72	121.73	0.061	0.081	0.157	0.171	0.082	0.082	0.339	0.141	3	D	243.9	D	243.9
482	ILA039	24.76	121.72	-0.118	0.194	0.086	0.293	-0.097	0.208	0.268	0.367	3	D	222.8	D	222.8
483	ILA040	24.77	121.79	0.182	0.340	0.360	0.190	0.223	0.113	0.411	0.182	4	E	188.4	D	188.4
484	ILA041	24.72	121.79	0.370	0.132	0.516	0.138	0.364	0.043	0.478	0.090	14	E	194.2	D	194.2
485	ILA042	24.69	121.79	0.176	0.232	0.271	0.260	0.188	0.102	0.298	0.187	12	E	213.2	D	213.2
486	ILA044	24.66	121.76	0.192	0.258	0.447	0.164	0.227	0.159	0.452	0.150	11	D	159.0	E	159.0
487	ILA046	24.67	121.73	-0.004	0.281	-0.060	0.264	-0.001	0.161	-0.025	0.184	18	D	397.6	C	397.6
488	ILA047	24.64	121.79	0.056	0.003	0.281	0.044	0.091	0.134	0.398	0.154	4	D	*****	*	190.7
489	ILA048	24.77	121.76	0.474	0.292	0.616	0.157	0.553	0.109	0.636	0.120	15	E	192.1	D	192.1
490	ILA049	24.77	121.75	-0.020	0.264	0.257	0.258	-0.059	0.200	0.256	0.219	16	D	187.1	D	187.1
491	ILA050	24.43	121.74	0.280	0.565	-0.521	0.437	0.345	0.495	-0.456	0.461	17	B	626.6	C	626.6
492	ILA051	24.72	121.67	-0.222	0.265	-0.358	0.244	-0.234	0.175	-0.307	0.227	17	B	535.2	C	535.2
493	ILA052	24.61	121.85	-0.290	0.225	-0.668	0.283	-0.387	0.272	-0.666	0.323	15	B	*****	*	1297.4
494	ILA053	24.33	121.73	0.197	0.106	-0.131	0.113	0.083	0.096	-0.200	0.150	11	D	534.7	C	534.7
495	ILA054	24.97	121.92	-0.501	0.116	-0.721	0.158	-0.553	0.109	-0.670	0.125	10	B	783.1	B	783.1
496	ILA055	24.74	121.81	0.343	0.273	0.371	0.192	0.368	0.155	0.402	0.170	21	E	266.0	D	266.0
497	ILA056	24.76	121.81	0.110	0.176	0.437	0.176	0.108	0.096	0.445	0.141	15	E	221.3	D	221.3
498	ILA057	24.81	121.74	-0.343	0.283	-0.897	0.156	-0.347	0.082	-0.773	0.081	3	B	*****	*	1572.2
499	ILA058	24.68	121.75	0.314	0.162	0.406	0.107	0.292	0.155	0.353	0.083	11	D	*****	*	206.8
500	ILA059	24.67	121.82	0.211	0.191	0.243	0.150	0.193	0.145	0.213	0.164	18	E	232.2	D	232.2
501	ILA060	24.58	121.84	0.052	0.194	-0.436	0.211	0.003	0.196	-0.438	0.252	10	D	*****	*	860.7
502	ILA061	24.52	121.83	-0.342	0.166	-0.570	0.124	-0.372	0.115	-0.540	0.137	15	D	502.1	C	502.1
503	ILA062	24.47	121.79	0.183	0.295	-0.167	0.213	0.172	0.137	-0.184	0.140	20	D	*****	*	543.8
504	ILA063	24.61	121.52	-0.341	0.183	-0.783	0.104	-0.437	0.151	-0.816	0.090	14	B	1002.7		1002.7
505	ILA064	24.48	121.78	-0.102	0.253	-0.533	0.190	-0.074	0.164	-0.531	0.165	14	D	*****	*	1017.8
506	ILA065	24.47	121.77	0.703	0.470	0.000	0.295	0.703	0.416	0.055	0.198	11	D	*****	*	354.2
507	ILA066	24.45	121.77	0.311	0.258	-0.089	0.215	0.319	0.119	-0.083	0.147	21	D	477.6	C	477.6
508	ILA067	24.44	121.37	-0.121	0.334	-0.497	0.325	0.126	0.134	-0.363	0.274	9	B	*****	*	751.1
509	HWA001	23.79	121.56	-0.149	0.320	-0.262	0.343	-0.184	0.273	-0.180	0.270	9	D	565.2	C	565.2

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 (m s-1)	Site‡	Vs30N (m s-1)
510	HWA002	23.60	121.51	-0.756	0.210	-0.660	0.235	-0.762	0.115	-0.649	0.214	16	C	789.4	B	789.4
511	HWA003	23.48	121.50	-0.664	0.258	-0.235	0.227	-0.782	0.113	-0.276	0.183	7	D	1538.0		1538.0
512	HWA004	23.17	121.24	-0.365	0.232	-0.491	0.217	-0.484	0.136	-0.584	0.195	9	C	319.6	D	319.6
513	HWA005	23.66	121.41	-0.033	0.352	-0.103	0.209	-0.059	0.199	-0.095	0.139	25	D	*****	*	463.4
514	HWA006	23.67	121.42	-0.546	0.265	-0.752	0.245	-0.439	0.169	-0.660	0.207	9	D	557.1	C	557.1
515	HWA007	23.99	121.62	-0.462	0.399	-0.161	0.294	-0.492	0.241	-0.136	0.198	20	D	*****	*	499.4
516	HWA008	23.99	121.60	0.004	0.435	0.264	0.308	-0.035	0.241	0.281	0.177	15	D	297.0	D	297.0
517	HWA009	23.99	121.62	-0.332	0.374	-0.223	0.289	-0.336	0.227	-0.204	0.248	25	D	*****	*	564.0
518	HWA010	23.98	121.60	-0.040	0.722	0.148	0.414	-0.072	0.475	0.159	0.253	12	D	249.7	D	249.7
519	HWA011	24.00	121.59	0.016	0.450	0.123	0.354	0.054	0.183	0.150	0.232	21	D	360.8	C	360.8
520	HWA012	23.99	121.62	-0.492	0.469	-0.220	0.354	-0.512	0.248	-0.195	0.246	23	D	409.8	C	409.8
521	HWA013	23.98	121.59	-0.042	0.437	0.151	0.302	-0.020	0.208	0.183	0.195	26	D	336.8	D	336.8
522	HWA014	23.97	121.60	-0.187	0.412	0.121	0.297	-0.195	0.220	0.126	0.209	25	D	*****	*	311.2
523	HWA015	23.97	121.56	-0.390	0.561	-0.359	0.439	-0.367	0.289	-0.325	0.300	25	D	445.6	C	445.6
524	HWA016	23.97	121.56	-0.557	0.606	-0.473	0.491	-0.536	0.330	-0.424	0.309	24	D	579.6	C	579.6
525	HWA017	23.95	121.55	-0.344	0.740	-0.534	0.559	-0.376	0.424	-0.487	0.369	20	D	584.7	C	584.7
526	HWA018	23.91	121.52	-0.518	0.333	-0.542	0.185	-0.557	0.180	-0.541	0.135	17	D	462.6	C	462.6
527	HWA019	23.98	121.61	-0.006	0.536	0.074	0.437	0.012	0.280	0.096	0.294	27	D	503.5	C	503.5
528	HWA020	23.81	121.43	-0.709	0.728	-1.016	0.346	-0.698	0.462	-1.003	0.289	25	D	629.6	C	629.6
529	HWA021	23.51	121.32	-0.610	0.334	-1.114	0.199	-0.647	0.248	-1.096	0.203	11	B	*****	*	2813.5
530	HWA022	24.27	121.73	0.207	0.208	-0.037	0.297	0.283	0.173	0.032	0.352	17	B	*****	*	369.0
531	HWA023	24.08	121.60	-0.812	0.513	-1.011	0.429	-0.825	0.332	-0.952	0.286	18	B	*****	*	2171.0
532	HWA024	23.35	121.30	-1.044	0.199	-0.996	0.169	-1.059	0.040	-1.005	0.096	14	B	*****	*	2390.2
533	HWA025	24.16	121.64	-0.445	0.275	-0.594	0.255	-0.412	0.245	-0.545	0.297	22	D	483.1	C	483.1
534	HWA026	24.13	121.62	-0.279	0.539	-0.588	0.404	-0.260	0.290	-0.543	0.325	24	B	460.9	C	460.9
535	HWA027	24.06	121.59	-0.197	0.541	-0.392	0.478	-0.178	0.293	-0.347	0.354	24	D	434.6	C	434.6
536	HWA028	24.02	121.60	-0.103	0.448	-0.034	0.389	-0.082	0.231	-0.001	0.311	25	D	404.9	C	404.9
537	HWA029	23.94	121.57	-0.478	0.499	-0.383	0.327	-0.474	0.242	-0.348	0.182	22	D	597.1	C	597.1
538	HWA030	23.78	121.45	-0.651	0.739	-0.668	0.271	-0.731	0.526	-0.701	0.256	21	D	594.1	C	594.1
539	HWA031	23.77	121.49	-0.489	0.467	-0.416	0.215	-0.472	0.242	-0.392	0.162	25	D	593.8	C	593.8
540	HWA032	23.71	121.41	-0.278	0.566	-0.687	0.313	-0.302	0.252	-0.697	0.216	20	D	*****	*	1372.7
541	HWA033	23.69	121.47	-0.315	0.308	-0.217	0.233	-0.285	0.148	-0.179	0.182	26	C	392.8	C	392.8
542	HWA034	23.59	121.38	-0.454	0.432	-0.446	0.301	-0.407	0.230	-0.404	0.196	23	D	381.8	C	381.8
543	HWA035	23.73	121.44	-0.552	0.405	-0.742	0.390	-0.565	0.283	-0.726	0.389	23	D	686.1	C	686.1
544	HWA036	23.50	121.37	-0.684	0.216	-0.414	0.164	-0.723	0.089	-0.423	0.115	17	D	520.6	C	520.6
545	HWA037	23.45	121.38	-0.228	0.198	0.084	0.176	-0.235	0.075	0.097	0.150	20	D	466.5	C	466.5
546	HWA038	23.46	121.34	-0.957	0.258	-0.791	0.217	-1.007	0.135	-0.837	0.191	18	C	661.5	C	661.5
547	HWA039	23.38	121.35	-0.443	0.219	-0.232	0.138	-0.468	0.084	-0.249	0.103	18	D	*****	*	612.4
548	HWA040	23.34	121.31	-0.373	0.138	-0.116	0.190	-0.298	0.208	-0.082	0.285	5	D	438.6	C	438.6
549	HWA041	23.27	121.29	-0.081	0.251	-0.076	0.261	-0.152	0.242	-0.106	0.238	15	D	481.9	C	481.9
550	HWA042	23.22	121.26	-0.398	0.357	-0.362	0.261	-0.370	0.438	-0.306	0.348	6	D	*****	*	677.5
551	HWA043	23.71	121.54	-0.647	0.386	-0.678	0.201	-0.646	0.234	-0.665	0.178	23	D	544.5	C	544.5
552	HWA044	23.65	121.53	-0.793	0.362	-0.706	0.222	-0.777	0.208	-0.674	0.193	18	D	533.1	C	533.1
553	HWA045	24.31	121.74	0.194	0.245	-0.080	0.276	0.205	0.100	-0.067	0.226	17	D	472.8	C	472.8
554	HWA046	24.15	121.62	-0.520	0.271	-0.705	0.108	-0.462	0.100	-0.668	0.133	8	B	643.7	C	643.7
555	HWA047	24.13	121.65	0.430	0.477	0.278	0.328	0.223	0.538	0.224	0.275	4	D	543.7	C	543.7
556	HWA048	24.01	121.57	-0.035	0.441	-0.020	0.273	0.021	0.128	-0.003	0.195	13	D	349.8	D	349.8
557	HWA049	24.00	121.56	-0.217	0.302	-0.017	0.268	-0.196	0.135	-0.015	0.193	19	D	509.3	C	509.3
558	HWA050	23.99	121.58	-0.401	0.413	-0.517	0.352	-0.405	0.164	-0.510	0.232	16	D	*****	*	978.5
559	HWA051	23.87	121.55	-0.169	0.273	-0.270	0.157	-0.199	0.134	-0.293	0.106	18	D	449.7	C	449.7
560	HWA052	23.82	121.47	-0.730	0.361	-0.926	0.288	-0.735	0.168	-0.826	0.111	4	D	576.5	C	576.5
561	HWA055	23.32	121.33	-0.187	0.252	0.027	0.301	-0.225	0.049	-0.011	0.179	11	D	*****	*	398.7
562	HWA056	24.18	121.51	-0.077	0.363	-0.557	0.271	-0.064	0.230	-0.516	0.287	22	B	516.4	C	990.0
563	HWA057	24.16	121.61	-0.146	0.386	-0.874	0.155	-0.150	0.271	-0.872	0.185	18	B	*****	*	1878.9

Table 1. (Continued)

No.	Stname	Lat (°N)	Long (°E)	TotalRes PGAh ± sd		TotalRes PGVh ± sd		IntraRes PGAh ± sd		IntraRes PGVh ± sd		R	Site†	Vs30 (m s-1)	Site‡	Vs30N (m s-1)
564	HWA058	23.97	121.49	-0.481	0.278	-0.801	0.210	-0.441	0.192	-0.798	0.161	18	B	525.7	C	525.7
565	HWA059	23.87	121.51	-0.282	0.281	-0.496	0.225	-0.262	0.100	-0.494	0.171	19	D	209.7	D	209.7
566	HWA060	23.87	121.60	-1.141	0.163	-1.166	0.125	-1.234	0.081	-1.145	0.064	12	C	*****	*	3072.1
567	HWA061	24.02	121.60	-0.108	0.094	-0.098	0.126	-0.125	0.087	-0.099	0.103	7	D	*****	*	466.7
568	TTN001	23.32	121.44	-0.443	0.305	-0.272	0.131	-0.481	0.190	-0.286	0.066	16	D	484.5	C	484.5
569	TTN002	22.97	121.30	-0.276	0.534	-0.448	0.266	-0.339	0.550	-0.426	0.309	10	D	663.9	C	663.9
570	TTN003	22.61	121.00	-0.388	0.158	-0.594	0.221	-0.468	0.061	-0.661	0.134	10	D	508.5	C	508.5
571	TTN004	22.91	121.13	-0.066	0.238	0.033	0.176	-0.064	0.113	0.012	0.132	17	D	*****	*	382.2
572	TTN005	22.76	121.14	-0.603	0.122	-0.196	0.126	-0.617	0.108	-0.131	0.084	10	D	*****	*	494.5
573	TTN006	22.77	121.14	-0.429	0.252	0.033	0.154	-0.405	0.267	0.050	0.129	11	D	*****	*	357.0
574	TTN007	22.76	121.14	-0.417	0.227	-0.004	0.167	-0.376	0.197	0.030	0.095	9	D	*****	*	369.9
575	TTN008	22.76	121.15	-0.499	0.091	0.073	0.122	-0.520	0.144	0.069	0.084	11	D	*****	*	345.0
576	TTN009	22.75	121.13	-0.529	0.125	-0.118	0.224	-0.584	0.123	-0.140	0.220	14	D	*****	*	502.9
577	TTN010	22.74	121.11	-0.498	0.142	-0.165	0.118	-0.576	0.086	-0.201	0.098	11	D	*****	*	560.8
578	TTN011	22.78	121.11	-0.535	0.039	-0.606	0.029	-0.757	0.054	-0.637	0.045	4	D	445.4	C	445.4
579	TTN012	22.77	121.13	-0.545	0.188	-0.179	0.092	-0.445	0.119	-0.124	0.057	11	D	*****	*	488.9
580	TTN013	22.77	121.13	-0.805	0.114	-0.332	0.073	-0.805	0.129	-0.317	0.024	6	D	*****	*	691.3
581	TTN014	23.10	121.37	-0.370	0.154	-0.440	0.153	-0.393	0.158	-0.454	0.127	16	D	539.6	C	539.6
582	TTN015	22.75	121.15	-0.539	0.123	-0.084	0.155	-0.579	0.115	-0.082	0.114	15	D	491.7	C	491.7
583	TTN016	22.36	120.90	0.154	0.056	0.285	0.036	-0.034	0.227	0.077	0.031	2	B	842.8	B	842.8
584	TTN017	22.04	121.55	0.872	0.000	0.202	0.000	0.545	0.000	0.169	0.000	1	C	*****	*	288.1
585	TTN018	22.82	121.07	-0.492	0.200	-0.499	0.144	-0.485	0.117	-0.506	0.116	14	B	*****	*	971.4
586	TTN020	23.13	121.21	-0.694	0.290	-0.454	0.263	-0.709	0.249	-0.459	0.260	17	D	*****	*	893.2
587	TTN021	23.10	121.17	0.042	0.127	-0.528	0.402	0.093	0.331	-0.454	0.526	5	B	*****	*	885.0
588	TTN022	23.10	121.21	-0.218	0.386	-0.089	0.403	-0.171	0.316	-0.069	0.399	18	D	*****	*	442.6
589	TTN023	23.05	121.16	-0.038	0.362	0.136	0.240	-0.015	0.263	0.128	0.207	13	D	542.2	C	542.2
590	TTN024	22.97	121.11	-0.356	0.274	-0.748	0.266	-0.329	0.199	-0.731	0.238	19	B	*****	*	1458.4
591	TTN025	22.90	121.07	-0.329	0.292	-0.683	0.311	-0.289	0.161	-0.668	0.253	19	D	701.1	C	701.1
592	TTN026	22.86	121.08	-0.441	0.247	-0.524	0.191	-0.400	0.094	-0.520	0.115	17	B	*****	*	996.6
593	TTN027	22.81	121.09	-0.258	0.270	-0.283	0.244	-0.243	0.198	-0.283	0.260	19	C	*****	*	650.7
594	TTN028	22.78	121.06	-0.627	0.264	-0.646	0.219	-0.613	0.248	-0.657	0.207	14	B	619.8	C	619.8
595	TTN029	22.72	121.04	0.025	0.581	0.056	1.100	-0.028	1.049	-0.021	1.252	6	D	*****	*	405.6
596	TTN030	22.70	121.02	0.050	0.186	-0.030	0.780	0.052	0.419	-0.116	0.884	5	B	688.9	C	688.9
597	TTN031	23.36	121.46	-0.460	0.183	-0.586	0.169	-0.432	0.144	-0.546	0.133	15	D	512.7	C	512.7
598	TTN032	23.25	121.41	-0.544	0.480	-0.509	0.207	-0.559	0.414	-0.514	0.206	17	D	736.1	C	736.1
599	TTN033	23.19	121.39	-0.605	0.728	-0.636	0.400	-0.615	0.655	-0.617	0.364	14	D	660.2	C	660.2
600	TTN034	22.93	121.26	0.209	0.601	0.048	0.198	0.513	0.465	0.184	0.351	3	D	457.5	C	457.5
601	TTN035	22.88	121.22	-0.275	0.713	-0.376	0.386	-0.187	0.604	-0.322	0.510	7	D	*****	*	697.6
602	TTN036	22.80	121.19	-0.928	0.222	-0.443	0.207	-0.889	0.151	-0.435	0.222	15	C	*****	*	855.1
603	TTN037	22.53	120.84	-0.122	1.225	-0.219	1.453	0.005	1.356	-0.158	1.182	4	B	738.2	C	738.2
604	TTN038	22.46	120.93	-0.462	0.000	-1.021	0.000	-0.794	0.000	-1.024	0.000	1	D	*****	*	2472.6
605	TTN040	23.15	121.20	-0.781	0.330	-0.936	0.229	-0.809	0.165	-0.947	0.155	13	B	726.6	C	726.6
606	TTN041	23.13	121.12	0.464	0.310	-0.124	0.481	0.417	0.217	-0.158	0.424	15	B	431.6	C	431.6
607	TTN042	23.00	121.28	-0.147	0.314	-0.518	0.165	-0.145	0.149	-0.512	0.079	12	D	824.5	B	824.5
608	TTN043	23.03	121.32	-0.503	0.329	-0.711	0.047	-0.440	0.032	-0.721	0.051	2	D	490.6	C	490.6
609	TTN044	23.01	121.17	-0.179	0.230	0.033	0.167	-0.223	0.166	0.000	0.101	14	C	*****	*	391.0
610	TTN045	22.98	121.15	-0.766	0.245	-0.410	0.207	-0.742	0.101	-0.395	0.164	9	D	539.5	C	539.5
611	TTN046	22.96	121.23	-0.129	0.233	-0.346	0.173	-0.173	0.128	-0.379	0.117	14	C	529.1	C	529.1
612	TTN047	22.84	121.13	-0.788	0.189	-0.998	0.126	-0.995	0.099	-1.032	0.127	2	C	*****	*	2508.5
613	TTN048	22.79	121.08	-0.502	0.164	-0.204	0.146	-0.547	0.065	-0.238	0.118	9	D	*****	*	599.7
614	TTN049	22.73	121.10	-0.767	0.219	-0.290	0.016	-0.833	0.012	-0.308	0.018	3	D	*****	*	680.9
615	TTN050	22.67	121.03	-0.296	0.229	-0.590	0.192	-0.342	0.134	-0.613	0.085	11	D	*****	*	1179.1
616	TTN051	23.19	121.02	-0.376	0.377	-0.797	0.391	-0.420	0.337	-0.818	0.324	14	B	*****	*	1704.7
617	TTN052	22.60	120.95	-0.534	0.079	-0.698	0.199	-0.857	0.109	-0.883	0.112	3	B	*****	*	1916.8

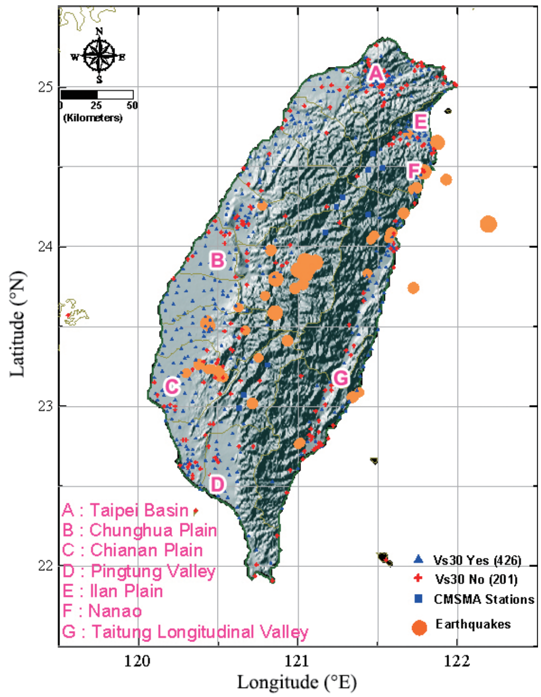

Fig. 1. Distribution of the earthquakes, Taiwan Strong Motion Instrumentation Program (TSMIP) and Central Mountain Strong Motion Array (CMSMA) free-field stations used in this study. Relevant localities and topography are also indicated.

Table 2. Station code, location, site classifications, ground motion total and intra-event residuals, measured and estimated Vs30 of the CMSMA stations.

No.	Stname	Lat (°N)	Long (°E)	TotalRes				IntraRes				R	Site†	Vs30 ($m\ s^{-1}$)	Site‡	Vs30N ($m\ s^{-1}$)
				PGAh ± sd		PGVh ± sd		PGAh ± sd		PGVh ± sd						
1	CMA001	22.99	120.63	-0.336	0.214	-0.466	0.116	-0.316	0.131	-0.500	0.046	11	D	*****	*	961.3
2	CMA002	23.07	120.66	-0.481	0.170	-0.653	0.257	-0.461	0.056	-0.687	0.137	11	D	*****	*	1346.3
3	CMA004	23.26	120.81	0.035	0.239	-0.792	0.156	0.412	0.230	-0.599	0.096	5	B	*****	*	1149.7
4	CMA008	24.20	121.44	-0.617	0.241	-0.991	0.225	-0.541	0.342	-0.934	0.289	7	D	*****	*	2103.9
5	CMA012	24.09	121.17	-0.193	0.658	0.041	0.708	-0.062	0.741	0.134	0.792	6	B	*****	*	307.2
6	CMA014	24.58	121.47	-0.324	0.345	-0.763	0.264	-0.285	0.389	-0.747	0.341	8	B	*****	*	1500.2
7	CMA015	24.49	121.53	-0.360	0.309	-0.645	0.192	-0.280	0.379	-0.632	0.283	9	B	*****	*	1219.2
8	CMA016	24.48	121.44	-0.696	0.255	-0.898	0.291	-0.623	0.603	-0.857	0.523	7	B	*****	*	1829.1
9	CMA018	24.31	121.28	-0.262	0.258	-1.409	0.060	-0.081	0.035	-1.238	0.104	3	B	*****	*	3637.8
10	CMA019	24.25	121.24	0.549	0.000	-0.262	0.000	0.687	0.000	-0.017	0.000	1	B	*****	*	402.9

Note: (1) STname = Station Name.
(2) Lat = Station Latitude.
(3) Long = Station Longitude.
(4) TotalRes = Total Residual in ln unit.
(5) IntraRes= Intra-event Residual in ln unit.
(6) PGAh = The mean of residual for horizontal component of peak ground acceleration.
(7) PGVh = The mean of residual for horizontal component of peak ground velocity.
(8) sd = standard deviation.
(9) R = Number of Records.
(10) Vs30 = The average shear-wave velocity in the upper 30 m of sediments in $m\ s^{-1}$.
(11) Vs30N = The estimated Vs30 values from the relation between the intra-event residual and the Vs30 in $m\ s^{-1}$.
†Determined by Lee et al. (2001), on the basis of surface geology and borehole data.
‡Determined according to UBC1997.

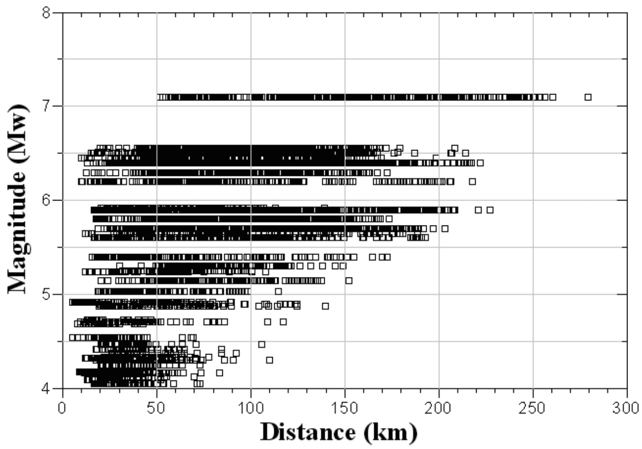

Fig. 2. Magnitude-distance distribution of the earthquakes used in this study.

magnitude, a is the geometric spreading coefficient, b is the inelastic attenuation coefficient, c is magnitude coefficient, d is a constant, h_1 and h_2 are close-in distance saturation coefficients. Vref is the reference shear-wave velocity. The coefficients a, b, c, d, d′, e, h_1, h_2, and Vref are to be determined by regression from the data. In Eq. (2) the constant changed from d to d′ while we specify Vref, the reference velocity to be 760 m s^{-1}. In this case the soil amplifications are specified relative to motions that would be recorded on a NEHRP B/C boundary site condition.

The coefficients in the equation for predicting ground motion were determined using a two-stage regression procedure. The least square method was used in the regression. A similar approach was used previously by Joyner and Boore (1993) and Liu and Tsai (2005).

The two models are adopted to account for different situations. Model 1, uses recordings from all 627 strong-motion sites, is especially useful for early warning systems to make quick assessment and timely reporting of the PGA and PGV maps. Their results will be critical for effective emergency response operations. Model 2, using 426 strong-motion sites to incorporate a site effect term with available Vs30, is aimed to reduce the standard deviation of the predicted ground motion. This approach emphasizes direct use of strong ground motion recordings for seismic ground shaking estimation for engineering applications.

The residual value, i.e., site response factor, is defined as the difference between logarithms of the observed and the predicted ground motion, and is expressed by the following equation:

$$r = \ln Y_s - \ln Y_r = \eta + \varepsilon \tag{4}$$

where Y_s is the observed value, Y_r is the predicted value from Eq. (1), η is the earthquake inter-event errors with standard deviation equal to τ, and ε is intra-event errors with standard deviation equal to σ. The η and ε are assumed to be normally distributed independent variants with variances τ^2 and σ^2. The amplification factors of site effect can be calculated from exponent of (r). The standard deviation of total residual σ_T is given by the equation:

$$\sigma_T = \sqrt{\sigma^2 + \tau^2} \tag{5}$$

The residuals due to regression were decomposed into inter-event (earthquake-to-earthquake) and intra-event residuals. The inter-event and intra-event residuals are calculated using Eqs. (3.15) and (3.16) in Campbell and Bozorgnia (2007).

We analyzed the relations between the intra-event residuals ε and the average shear-wave velocity in the upper 30 m of sediments, Vs30 using the following equation (Boore et al. 1997; Choi and Stewart 2005; Liu et al. 2013):

$$\varepsilon = f \ln(Vs30/Vref) \tag{6}$$

where the coefficient f and Vref are to be determined by regression from the data.

4. RESULTS AND DISCUSSION

4.1 Attenuation Relationships for Vertical and Horizontal PGA and PGV

Ground motion characteristic studies in Taiwan require ground-motion attenuation models. Attenuation relationships, or "GMPEs", provide an efficient means for predicting the level of ground shaking and its associated uncertainty at any given site or location, as well as for use in seismic hazard analyses (Bolt and Abrahamson 2003). An attenuation relationship is a mathematical equation that relates a specific strong-motion ground shaking parameter to a number of earthquake seismological parameters and the recording site. The seismological parameters quantitatively characterize the earthquake source, the wave propagation path between the source and the site, and the soil and geological profile beneath the site (Campbell 2003).

Regressions on the dataset for Model 1 without differentiating site conditions and Model 2 with site conditions have resulted in the coefficients of the attenuation relationships, as given in Tables 3 and 4, respectively, for the vertical and horizontal components of PGA and PGV in Taiwan area. In Tables 3 and 4, σ_1 and σ_2 are standard deviations on ln(PGA, PGV).

4.2 Analyses of Site Total Residuals for PGA and PGV

Residual examination for sites with qualitative soil categories is a useful method for sets of records where site information is not complete, and hence cannot be included explicitly within the equation (Abrahamson and Litehiser 1989). In this study we analyze the residuals to investigate variations in PGA and PGV with respect to site conditions.

The mean and standard deviation of total and intra-event residuals for 627 stations for the vertical and horizontal PGA and PGV are given in columns 5 - 8 of Tables 1 and 2. The corresponding contour maps of mean of total residuals for the horizontal PGA and PGV are shown in the Figs. 3 and 4, respectively. The total residual patterns, especially those for PGV, agree reasonably well with the regional geology and topography patterns. Notably, the PGV residual is more

Table 3. Coefficients for the vertical and horizontal components of PGA and PGV from Eq. (1).

PGA	**a**	**b**	**c**	**d**	**h_1**	**h_2**	**e**	**Vref**	**σ_1**
V-Comp.	-1.340	-0.0036	1.101	1.824	1.62	0.0			0.640
H-Comp.	-0.852	-0.0071	1.027	1.164	1.24	0.0			0.683
PGV	**a**	**b**	**c**	**d**	**h_1**	**h_2**	**e**	**Vref**	**σ_1**
V-Comp.	-0.953	-0.0012	1.534	-5.184	1.19	0.0			0.566
H-Comp.	-0.857	-0.0023	1.486	-4.371	1.34	0.0			0.663

Table 4. Coefficients for the vertical and horizontal components of PGA and PGV from Eqs. (2) and (3).

PGA	**a**	**b**	**c**	**d**	**h_1**	**h_2**	**d′**	**e**	**Vref**	**σ_2**
V-Comp.	-1.340	-0.0036	1.101	1.824	1.62	0.0	1.635	-0.263	370	0.621
H-Comp.	-0.852	-0.0071	1.027	1.164	1.24	0.0	0.886	-0.375	362	0.647
PGV	**a**	**b**	**c**	**d**	**h_1**	**h_2**	**d′**	**e**	**Vref**	**σ_2**
V-Comp.	-0.953	-0.0012	1.534	-5.184	1.19	0.0	-5.351	-0.230	368	0.549
H-Comp.	-0.857	-0.0023	1.486	-4.371	1.34	0.0	-4.760	-0.549	374	0.587

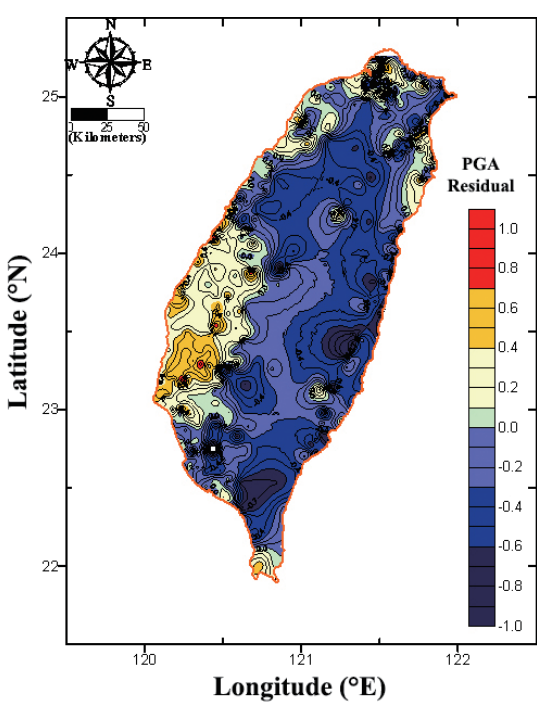

Fig. 3. The total residual contour map (in ln unit) for horizontal PGA.

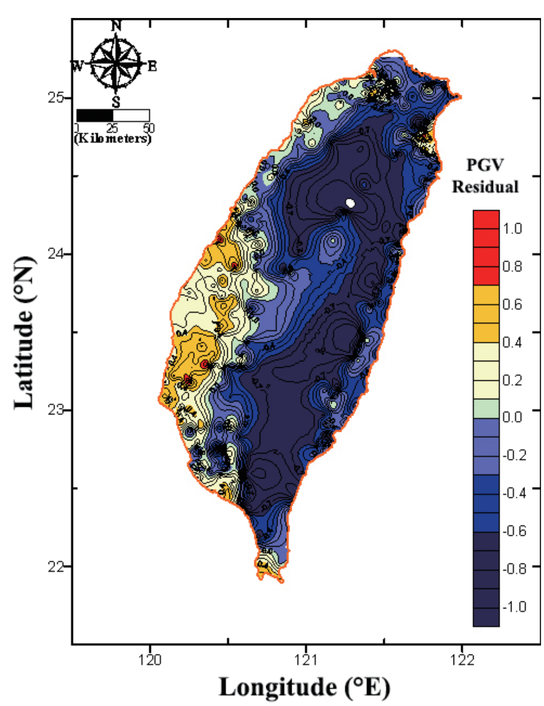

Fig. 4. The total residual contour map (in ln unit) for horizontal PGV.

sensitive to the site class than the PGA residual, because the PGA is a high-frequency parameter which is less affected by local site conditions. Local site conditions can dramatically affect the strong motions recorded (Douglas 2003). Furthermore, in order to understand the relation between the ground motion parameter site residuals and Vs30, we plot the Vs30 contour map based on 426 measured data as shown in Fig. 5. We also found that the PGV residual contour patterns in major plain areas are similar to the Vs30 contour patterns.

The purpose of Model 1 is early warning systems to make quick assessment and timely reporting of the PGA and PGV maps. Hence, the equation form is so simple that is does not include the fault type (focal mechanism), intra- or inter-event term and site effect term such as Vs30. Their results will be critical for effective emergency response operations. Accordingly, following a disastrous earthquake, quick assessment and timely reporting of PGA and PGV maps will be critical for effective emergency response operations. Thus, after an earthquake we can combine the simple attenuation relationships, as determined from Eq. (1), and the total residuals, as determined from Table 1, to provide near real-time estimation and reporting of the PGA and PGV values for the Taiwan area.

4.3 Comparisons of Model Predictions Including Vs30

In early times most attenuation relationships used broad site categories such as “rock”, “stiff-soil”, and “soft-soil”. There has recently been a move toward using quantitative site classifications based on the shear-wave velocity measured at the strong-motion site. The most commonly used parameter is the average shear-wave velocity over the top 30 m (Vs30) (Boore et al. 1997; Bolt and Abrahamson 2003). For ground-motion model development, developers systematically evaluated a list of predictor parameters to consider for predicting earthquake shakings. One of the most significant decisions made by all developers was to use the average shear-wave velocity in the upper 30 m of sediments, Vs30, as the parameter for characterizing soil-stiffness effects on ground motions (Power et al. 2008).

A major limitation in using quantitative site descriptions is that the Vs30 information is not available for most strong-motion recording sites. This situation has been greatly improved for our study because measured shear-wave velocity profiles are available at 439 strong-motion recording sites in the Taiwan area. Of these, 426 stations were used in this study as given in Table 1. To incorporate a site effect term based on the average shear-wave velocity over the top 30 m (Vs30) into the attenuation relationship, the analytical form used in this study is given in Eq. (2).

As our understanding and modeling of attenuation relationships improve, there will be a trend toward reducing the modeling variability. In empirical attenuation models the modeling variability given for the model is the standard deviation (Bolt and Abrahamson 2003). In addition to the median ground motion, the standard deviation of the ground motion is also important for seismic hazard analyses. After incorporating a site effect term, Vs30 in the attenuation relationships, the standard deviations between the observed and predicted values are reduced from 0.683 - 0.647 for horizontal PGA, and from 0.663 - 0.587 for horizontal PGV, respectively. We found only minor reduction in standard deviation for PGA. In contrast, the PGV standard deviation is significantly reduced by about 11%.

We analyzed the site effect term using the amplification factor (relative to a site with Vs30 = 760 m s^{-1}): exp[-e ln(760/Vref) + Res_av], where Res_av is the average intra-event residual from Eq. (1) for each site and the e and Vref of horizontal PGA and PGV are given in Table 4. The corrected site amplification factor contour maps relative to a NEHRP B/C boundary site condition (Vs30 = 760 m s^{-1}) are plotted in Fig. 6 for horizontal PGA and in Fig. 7 for horizontal PGV, respectively. The amplification factors are contoured at 0.2 intervals. They range from 3.4 - 0.4 for horizontal PGA and from 4.0 - 0.4 for horizontal PGV, respectively. Both total residual and amplification factor contour maps of horizontal PGV have similar patterns, revealing that the Changhua Plain, Chianan Plain, Pingtung Valley, Ilan Plain, and Taipei Basin have high values, implying large amplification of ground motions.

4.4 Construction of a Refined Vs30 Map

Correlations between the intra-event residual and

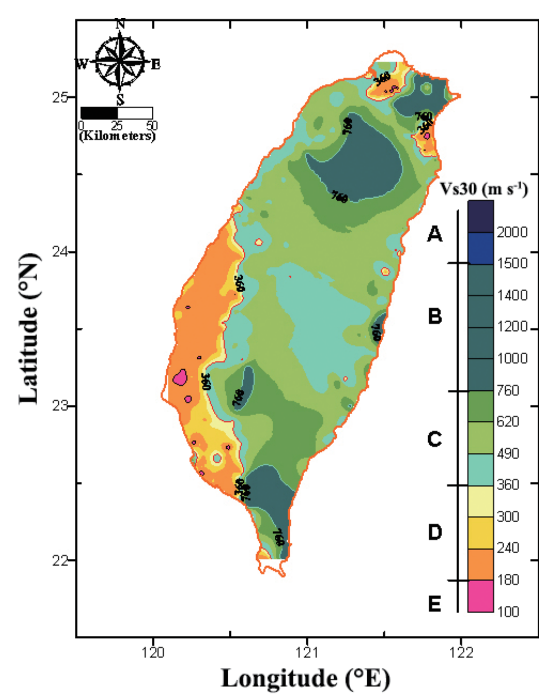

Fig. 5. The Vs30 contour map based on measured data.

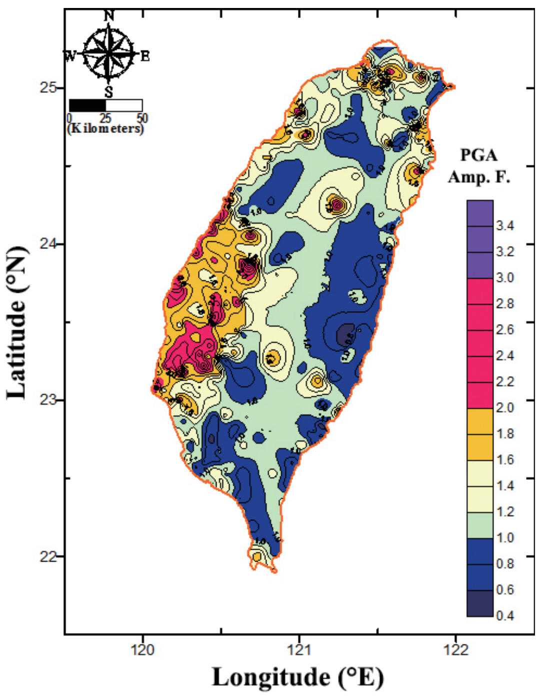

Fig. 6.The corrected site amplification factor contour map relative to a NEHRP B/C boundary site condition (Vs30 = 760 m s^{-1}) for horizontal PGA.

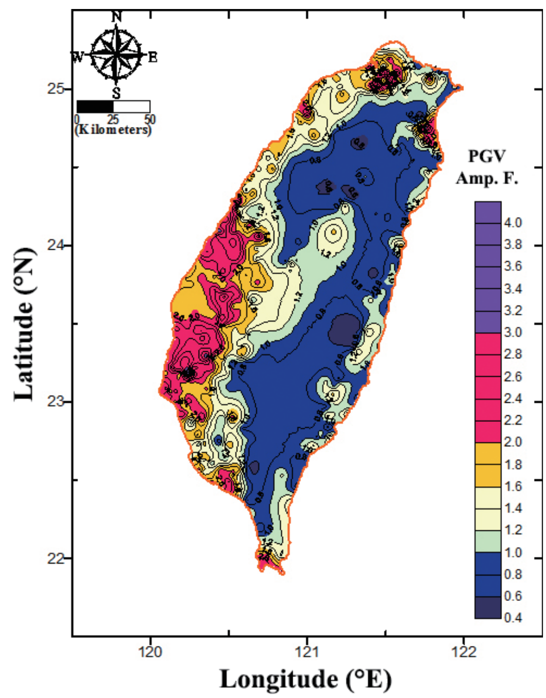

Fig. 7. The corrected site amplification factor contour map relative to a NEHRP B/C boundary site condition (Vs30 = 760 m s^{-1}) for horizontal PGV.

average shear-wave velocity in the upper 30 m of sediments Vs30 are plotted in Figs. 8 and 9 for vertical and horizontal PGA and Figs. 10 and 11 for vertical and horizontal PGV, respectively. The regression equations and the coefficient of determination R^2 are also shown in the figures. R is the correlation coefficient used to measure how well the linear relationship exists between the values for the two variables. The corresponding coefficients (f and Vref) are given in Table 5. Reading from Fig. 11 the value of R was 0.712 ($R^2 = 0.5070$) indicating that the horizontal PGV residuals are much more dependent on Vs30 than the residuals for the other three ground motion parameters, probably due to their frequency content which is less affected by local site conditions.

Since the Vs30 information is not available for a significant number of TSMIP and CMSMA stations, especially for those having a NEHRP B and C site conditions, here we use the relations between the intra-event site residual and the Vs30 for horizontal PGV, as given by Eq. (6), to estimate the Vs30 for these stations that have recorded strong motions. The estimated Vs30 values, denoted as Vs30N, are given in the last column of Tables 1 and 2. A refined Vs30 contour map that includes the 201 Vs30N sites and 426 Vs30 sites is shown in Fig. 12. By comparing the Vs30 contour maps, as shown in Fig. 5 based on 426 Vs30 sites with Fig. 12, we can find the following results: (1) Fig. 12 offers a more detailed Vs30 contour map for using data from more Vs30 sites. (2) The class D contour pattern is similar. (3) The class E area appears in the Changhua Plain in Fig. 12 needed to pay more attention. (4) The rocky areas of classes B and A coincide with the foothill and mountain areas distribution in Fig. 12.

We compared our refined Vs30 results with studies by the United States Geological Survey (USGS) (http://earthquake.usgs.gov/hazards/apps/vs30/predefined.php) and Lee and Tsai (2008). The refined Vs30 pattern in this study is similar to that in USGS. Previously, Lee and Tsai (2008) mapped the Vs30 distribution in Taiwan using 230 P and S wave velocity (PS) logging at soil and soft rock strong-motion station sites and 4885 engineering boreholes. The Vs30 map supplied important knowledge for each strong-motion station, and for sites between stations in Taiwan. However, the accuracy of such mapping is inevitably dependent on the amount and quality of data. In eastern Taiwan and the southern tip of Taiwan, where boreholes are few and scattered, the map accuracy is relatively poor. The mapping results use the 2000 - 2005 Vs measurements and may be further refined based on new data. Kuo et al. (2012) reclassified the 439 drilled free-field TSMIP stations and compared the results with that of Lee and Tsai (2008). It was found that 80 of the 436 stations in common were misclassified by Lee and Tsai (2008). It is probably that Lee and Tsai (2008) focused on mapping the soil sites, and thus tentatively assigned all of the unmeasured rock site stations a value of 760 m s^{-1}.

We compared the Vs30 estimations from Lee and Tsai (2008) with the Vs30N from this study. The above relation is plotted in Fig. 13. The regression equations and the coefficient of determination R^2 are also shown in the figures. R is

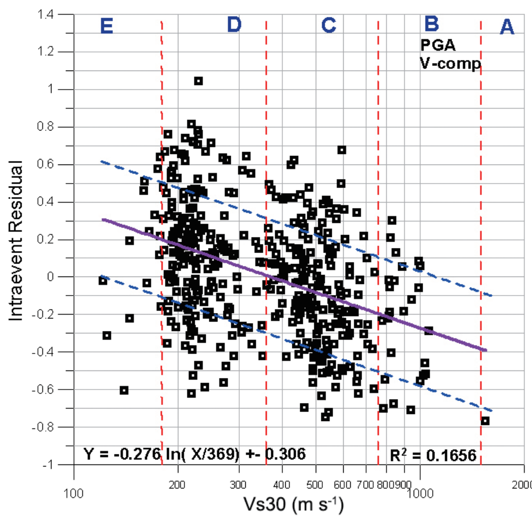

Fig. 8. The relation between the intra-event residual of vertical PGA and the average shear-wave velocity in the upper 30 m of sediments Vs30.

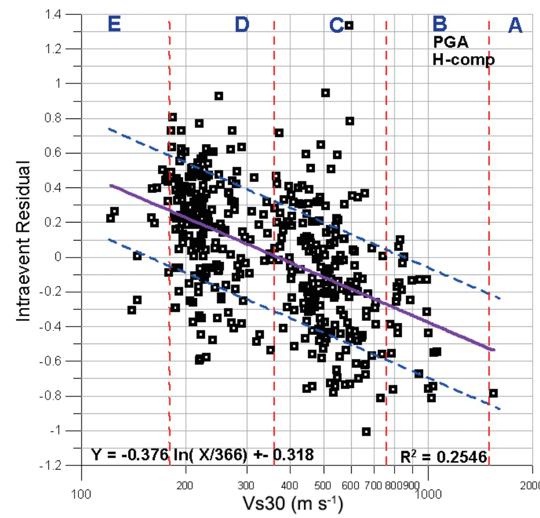

Fig. 9. The relation between the intra-event residual of horizontal PGA and the average shear-wave velocity in the upper 30 m of sediments Vs30.

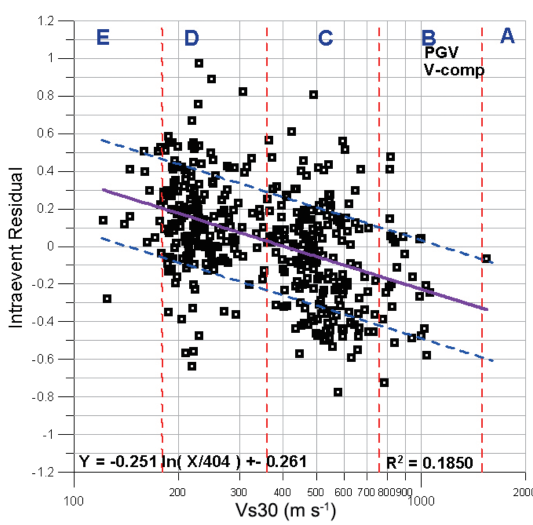

Fig. 10. The relations between the intra-event residual of vertical PGV and the average shear-wave velocity in the upper 30 m of sediments Vs30.

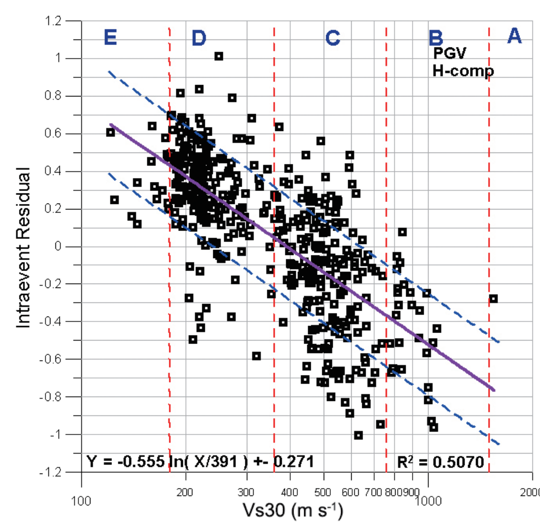

Fig. 11. The relations between the intra-event residual of horizontal PGV and the average shear-wave velocity in the upper 30 m of sediments Vs30.

Table 5. Coefficients for the vertical and horizontal components of PGA and PGV from Eq. (6).

PGA	f	Vref	σ	R^2
V-Comp.	-0.276	369	0.306	0.1656
H-Comp.	-0.376	366	0.318	0.2546
PGV	**f**	**Vref**	σ	R^2
V-Comp.	-0.251	404	0.261	0.1850
H-Comp.	-0.555	391	0.271	0.5470

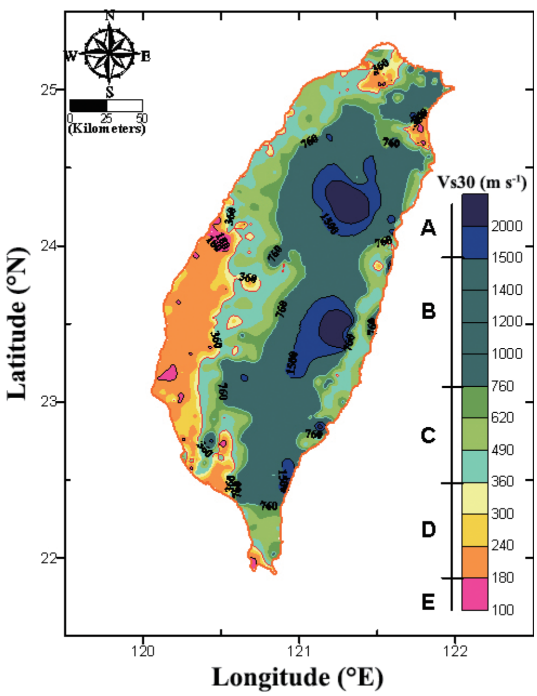

Fig. 12. The refined Vs30 contour map based on combined measured and estimated data.

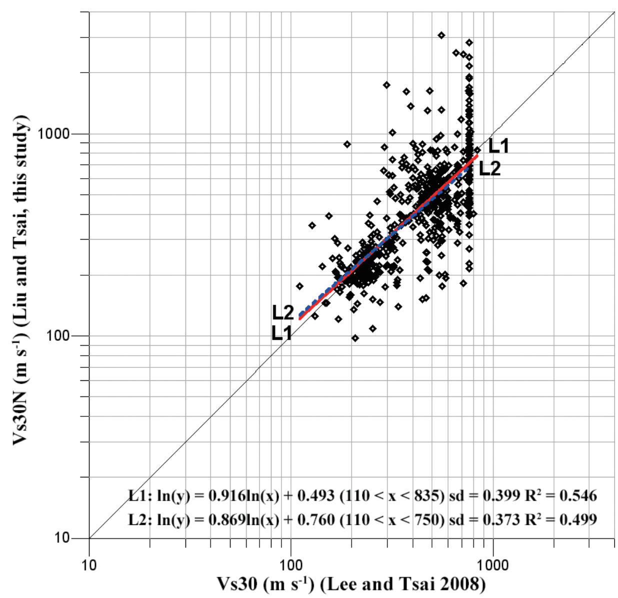

Fig. 13. The relation between the Vs30 estimated from Lee and Tsai (2008) and the Vs30N from this study.

the correlation coefficient used to measure how good a linear relationship exists between the values for the two variables. The L1 and L2 were conducted for Vs30 estimated from Lee and Tsai (2008) ranging from 110 - 835 and 750 m s^{-1}, respectively. Reading from Fig. 13, the values of R are 0.739 ($R^2 = 0.549$) and 0.706 ($R^2 = 0.499$) indicating that a highly dependent relation exists between the two estimated Vs30 models. One model is adopted between the Standard penetration test N value (SPT-N) and the Vs from Lee and Tsai (2008) while the other model is conducted between the horizontal PGV intra-event residuals and Vs30 from this study. The result also shows that residual examination for sites based on accelerographic recordings is a useful method to evaluate the site effects.

Site classifications for 426 of the 439 drilled free-field TSMIP stations were used in this study. There is one Class A site, 26 Class B sites, 194 Class C sites, 189 Class D sites, and 16 Class E sites. Evidently, most drilled stations belong to Classes C and D (89.9%). This means that most of the drilled stations were installed in metropolitan districts, which are usually located on sediments or soft rocks. The number of surveyed stations in the EGDT reached a total of 469 by 2010. Of these, 439 stations were drilled and the other 30 stations, to which the equipment could not be transported or where the landowner declined the request for drilling (Kuo et al. 2012). A major objective of this study is to estimate the Vs30 values for the 201 stations which were not drilled. Note that 426 drilled Vs30 stations and 7833 high quality strong motion recording were used to estimate Vs30 by intra-event residual technique. Of the 201 stations, 21 Class A sites, 43 Class B sites, 75 Class C sites, 50 Class D sites, and 12 Class E sites. A large number of undrilled stations belong to Classes A and B (64/201), usually located in foothill and mountain areas. Hence, the refined Vs30 map would be helpful for engineering and other research purposes, and especially applicable to the foothill and mountain areas.

5. CONCLUSIONS

From above results and discussion, we can summarize our findings as follows:

(1) The PGV residual contour pattern is highly similar to the Vs30 contour pattern. The horizontal PGV residual as found more dependent on Vs30 than the vertical and horizontal PGA, as well as vertical PGV, probably due to their high-frequency content which is less affected by local site conditions.

(2) By comparing the standard deviations between the observed and predicted ground motion values before and after incorporating the site effect term Vs30, the reduction in standard deviation for PGA is only moderate. In contrast, the PGV standard deviation is significantly reduced by about 11%. Evidently, the refined attenuation relationships will be more appropriate for engineering applications.

(3) After analyzing the local site effect in terms of the amplification factor (relative to a site with Vs30 = 760 m s^{-1}), the Changhua Plain, Chianan Plain, Pingtung Valley,

Ilan Plain, and Taipei Basin were revealed to high values, implying large ground motion amplification. Large parts of the Central Mountain Range have low values, implying potential ground motion de-amplification.

(4) Following a disastrous earthquake, quick assessment and timely reporting of PGA and PGV maps will be critical for effective emergency response operations. Thus, after an earthquake, we can combine the simple attenuation relationships, as determined from Eq. (1), and the site residuals, as given in Tables 1 and 2, to provide near real-time estimation and reporting of the PGA and PGV values for the Taiwan area.

(5) Finally, using the correlations between the intra-event residual and Vs30 according to Eq. (6), we can estimate Vs30 for stations that recorded strong motions, but whose Vs30 information is not available. Our approach including sites with estimated Vs30 has resulted in a detailed Vs30 contour map to facilitate more realistic seismic hazard assessment for Taiwan, especially applicable to the foothill and mountain areas.

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