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Title:
Improving Next-Generation Attenuation Models with Shear-Velocity Measurements at All TriNet and Strong-Motion Stations in LA

NEHRP Element(s): I
Keywords: Site effects, Ground motions, Surficial deposits, Seismic zonation, Engineering seismology

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IMPROVING NEXT-GENERATION ATTENUATION MODELS WITH SHEAR-VELOCITY MEASUREMENTS AT ALL TRINET AND STRONG-MOTION STATIONS IN LA

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NON-TECHNICAL ABSTRACT

Traditional methods to test how sturdy the ground is can be costly, and traffic noise can interfere. We use sounds from the streets to determine how a quake will affect a city. A truck hits a crack in the street and waves radiate from it. If the waves travel slowly, the soil is soft. If the waves travel fast, the soil is hard, and will not shake as much during an earthquake. Knowing the true foundation of a city will help us create better hazard maps. Recent tests are allowing researchers to re-calibrate the levels of shaking observed by seismometers in southern California against soil stiffness.

(Modified from Heineman, K. [producer], 2003, Shaking things up: news short on the San Gabriel River transect in the *Discoveries and Breakthroughs Inside Science* series by NewsProNet Productions, subscribed to by 43 stations nationally, August, 1 min 41 sec.)

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TECHNICAL ABSTRACT

The University of Nevada, Reno, and subcontractor Optim Inc. measured shear-velocity profiles near fifty CISN seismic recording stations in southern California, during 2005. Linear arrays 100 to 300 m long of 12 or 20, 4.5-Hz vertical geophones measured seismic microtremor at each site for 20 minutes to one hour. The arrays were placed with their centers an average of 176 m from the CISN station locations (with a geometric mean of 112 m); two arrays had to be placed 600-700 m from their target station and one, STG Santiago in Irvine, was 925 m away. The microtremor used had both natural and cultural sources, largely traffic, and was in the 1.0 to 25 Hz band. Refraction microtremor analysis of the records yielded shear-velocity profiles valid to at least 46 m depths, and to 100 m for most of the stations. The velocity profiles were summarized into vertically slowness-averaged Vs30, Vs50, and Vs100 values to depths of 30, 50, and 100 meters respectively. Despite many of the CISN stations having been established in areas of soft rock, only one, TOV in Thousand Oaks, showed a Vs30 above the NEHRP B-C boundary (Vs30=760 m/s), at 884 m/s in thin alluvium on Mesozoic rock. The lowest measured Vs30 for the fifty CISN stations was 220 m/s, at LLS, Ellis substation in Fountain Valley, in deep alluvium beside the Santa Ana River. Across the broad range of site conditions encountered at the fifty stations, the average Vs30 is 380 m/s by arithmetic averaging and 351 m/s by slowness averaging. We compare our results against prior shear-velocity results at three “rock” sites: PAS Pasadena; GR2 Griffith Observatory; and DJJ Stone Can. Reservoir. Our PAS Vs30 agrees well with a downhole measurement after removing 5 m of ridgetop soil from our profile. At GR2 the Observatory building was inaccessible due to remodeling so our measurement had to be made 660 m away in a small valley. At DJJ we measured in the canyon bottom below the dam, 225 m from the Rosrine LA00 suspension log. Our Vs30 values were lower than the prior measurements at GR2 and DJJ due to distance and the high velocity heterogeneity of rock.

Improving Next-Generation Attenuation Models with Shear-Velocity Measurements at All TriNet and Strong-Motion Stations in LA

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Investigations Undertaken

Objectives: We are assessing shallow conditions at the sites of strong-motion recording within the Los Angeles Basin. We have measured shear velocity as a function of depth, to about 100 meters, using refraction-microtremor arrays placed generally within 200 meters of about 50 ground-motion recording sites. Most of these sites have not been measured for shallow velocities by the USGS, the Rosrine project, or by the 214 site characterizations we conducted along the San Gabriel River in 2003 under USGS-NEHRP sponsorship (Thelen et al., 2006). These 50 new site characterizations are contributing to the efforts to develop a next-generation attenuation model by allowing accurate regressions of Northridge and later ground motions against Vs30, and against other site parameters such as Vs100 and depths to interfaces. This study will contribute as well to microzonation studies of the LA Basin, and to the national hazard mapping effort.

Background: This project will contribute toward the reduction of earthquake losses in the US by providing a more thorough characterization of the near-surface conditions of sites at which earthquake shaking has been measured. The results of this project will allow a more accurate assessment of the role that near-surface shear velocities play in amplifying ground motions. The Next Generation Attenuation effort will have many more ground-motion sites for which they can regress shaking amplifications against shallow velocity data such as Vs30 and Vs100.

Explaining the variations in seismic shaking across the Los Angeles Basin has been an ongoing research topic for nearly 20 years. Tinsley and Fumal (1985) assigned individual shear-wave velocities to each geologic unit in their test area, taking into account age, grain size and depth. In 1994, the Northridge earthquake resulted in unexpected variations of damage and ground motions in and around the Los Angeles area. Immediately, a number of studies were launched to study ground motions in southern California. These variations are reflected in TriNet's ShakeMaps computed for the earthquake (e.g., figure 1), and are surely a combination of source, path, and site effects. Park and Elrick (1998) extracted Vs30 measurements from boreholes to characterize deposits of different ages, to begin evaluating the site effects. Their results show that Vs30 varies with grain size and age, and accordingly grouped the geologic units in southern California into 8 different categories. As part of the Southern California Earthquake Center (SCEC) Phase III Report, Wills et al. (2000) published a site-conditions map for all of

California based on localized field mapping, 1:250,000 scale geologic maps and about 556 Vs30 measurements statewide.

The vertically averaged 30-meter shear velocity (Vs30) is used to define a "NEHRP" soil hazard classification for earthquake shaking as outlined by the NEHRP-UBC provisions (BSSC, 1998). Wald and Mori (2000) regressed 1994 Northridge shaking amplitudes in different frequency bands against the Vs30 measurements for the 50 stations where those data were available (e.g., figure 2). Shallow shear velocities correlated reasonably well against shaking at frequencies above 5 Hz, suggesting that a substantial portion of the "unexpected" variations in Northridge ground motions, and damage, were due to variations in site conditions. The correlation is less apparent for the 1-3 Hz band shown in figure 2. Could these regressions improve if there were more Northridge recordings available from stations having measured Vs30 values? Could there be correlations of shaking amplitudes against other types of site-condition measurements, such as the average shear velocity to 100 meters depth? These are the questions this project sought to answer.

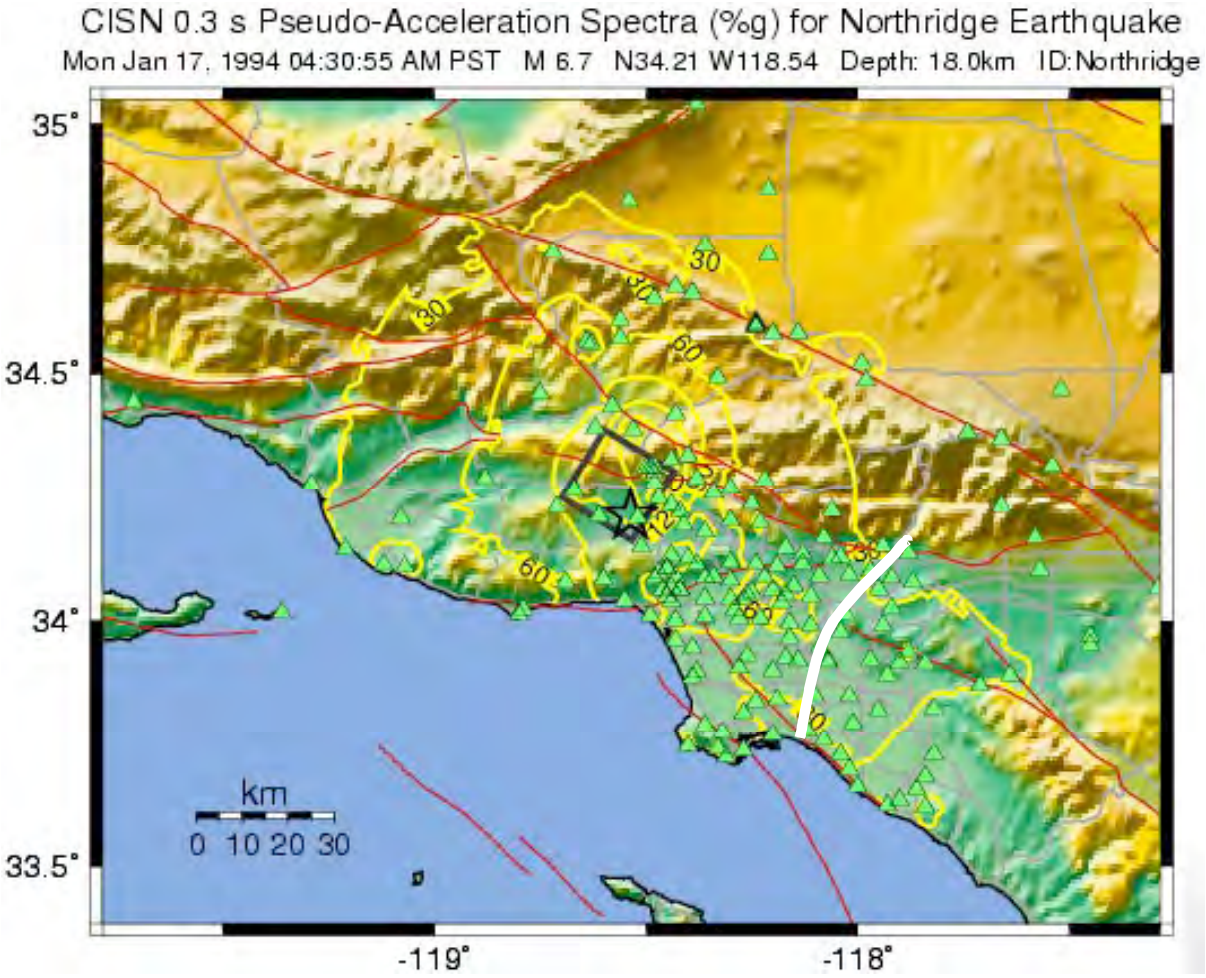

Figure 1. TriNet ShakeMap for the 1994 Northridge earthquake, showing stations recording ground motions as triangles. The white line shows the path of UNR's July 2003 shallow shear-velocity transect.

The most common method for obtaining Vs30 measurements is through borehole soundings. However, the high cost of borehole measurements has driven the search for alternative methods of estimating Vs30 values to meet the NEHRP-UBC code, and for site

condition assessment in general. Louie (2001) developed the *Re*fraction *Mi*crotremor (ReMi) technique as such an alternative. In this method, microtremor noise from sources such as traffic on streets and freeways travels as Rayleigh waves, which are recorded by a linear array of vertical refraction geophones. The records that result are transformed into frequency-slowness space, and a dispersion curve picked for its slowest velocity. Modeling the dispersion curve produces a depth-velocity sounding, which can be vertically averaged to the single Vs30 value required by the NEHRP-UBC code. Louie (2001) reports the accuracy of Vs30 measurements, using the refraction microtremor technique, to be ±20%. The depth-velocity sounding can be evaluated in other ways such as the computation of the average velocity to 100 meters depth ("Vs100"). In blind tests against four deep-borehole suspension logs in Santa Clara Valley, Calif., the refraction microtremor method was able to match Vs30 values as well as Vs50 and Vs100 values to better than 20% in nine out of ten comparisons (Stephenson et al., 2005). The worst match was 27%. The four borehole sites included the Coyote Creek Outdoor Classroom (CCOC), where Asten and Boore (2005) report on the application of 14 various measurement methods. ReMi results compared were very favorably at CCOC.

By improving our understanding of expected ground motions, the results of this research will be directly applied to reducing losses from earthquakes in southern California. By improving our ability to identify and measure key characteristics affecting site response, our contribution to improvement of site response is applicable nationwide.

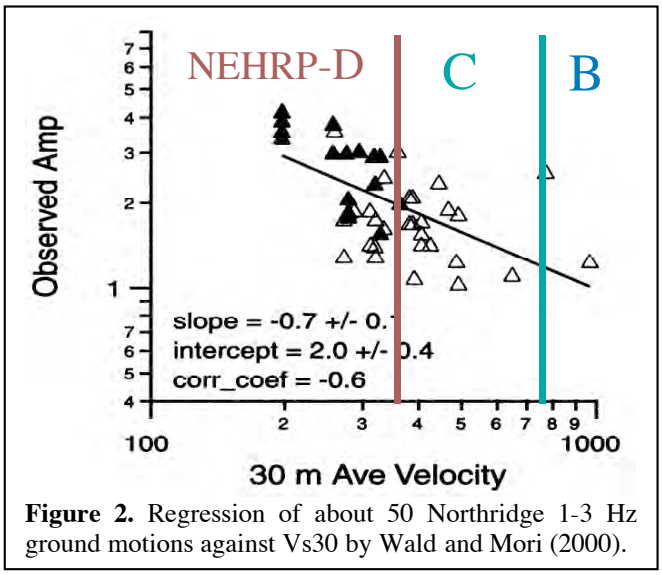

Figure 2. Regression of about 50 Northridge 1-3 Hz ground motions against Vs30 by Wald and Mori (2000).

Methods: This project was funded for one year at a rate that allowed investigation of 50 sites, leaving an additional 50 sites of strong-motion recording in southern California to characterize in future projects (one has recently been funded, to measure 25 sites in the Inland Empire of southern Califronia). With kind advice from from Sue Hough and Alan Yong of the USGS Pasadena office, we identified 51 sites for this project's work, most of them previously un-characterized. Figure 3 shows site locations. Twenty sites (Fig. 3, red triangles) were assessed in January 2005 by UNR students Don Pei and Jeff Hogue. Thirty remaining sites were completed in November. We were unable to obtain permission from the property owner to visit one site.

For the thirty sites completed in November 2005, we engaged subcontractor Satish Pullammanappallil of Optim Inc., UNR's technology partner for refraction microtremor (ReMi) surveying. In June we requested USGS permission for the no-cost budget revision allowing the subcontract, and received that in July. Optim has been donating full stipend support (now $1600/month) for graduate student Don Pei since January, in a related effort to improve the ReMi method. (This effort is nonetheless not formally connected to this project.) Optim completed the measurements and delivered the contracted results before the close of this project on January 31, 2006.

Both Optim Inc. and UNR grad student Don Pei analyzed the ReMi data with commercial SeisOpt®ReMi™ software. The grad student did the analysis under a DOE-Yucca Mountain Project quality assurance procedure, picking Rayleigh dispersion and modeling each site's shear-velocity profile. Student Don Pei has been developing with Satish Pullammanappallil of Optim a new optimization method for modeling shear-velocity profiles from ReMi dispersion data, and they have been presenting their results at national meetings, listed below. Optim also tested the new inversions on the 50 southern California sites.

Figure 3. Map showing 51 CISN and strong-motion stations targeted for characterization by this project. Twenty-one (red triangles) were assessed in January 2005; the remainder were completed in November.

After analysis of the data from each site we computed summary values such as Vs30, Vs50, and Vs100 by arithmetic slowness averaging. These results are given in Table 1 below. In April 2006 we posted both profiles and summary values at www.seismo.unr.edu/hazsurv. These velocity profiles have been dielivered to Magistrale, Shaw, Field, and others updating and using the SCEC CVM and RELM, as well as to workers like Hough and Yong who are conducting PEER/SCEC/USGS NGA analyses.

UNR Seismology grad students Aasha Pancha, Jim B. Scott, Jessie Muehlberg, and Karalyn Heath have all contributed to a number of collaborating papers and presentations on seismic hazard assessment that include ReMi measurements, listed below. The results of this project are being folded into re-analyses of the southern California shear velocity data examined

by Thelen et al. (2006): 214 ReMi measurements; about 300 borehole sites; and microzonation by Wills et al. (2005).

Results

This project was funded to measure the characteristics of fifty ground-motion recording sites in the LA area, calibrating the sources of ground-motion data for prior and future earthquakes. During this project a UNR team measured 21 sties with the refraction microtremor technique in January 2005. The USGS approved a UNR subcontract to Optim Inc. to measure the remaining 29 sites from October to December 2005. Optim, UNR's technology partner for geophysical site assessment, was able to more efficiently prosecute the surveys in Los Angeles than Reno-based UNR students and faculty could. Refraction microtremor data were processed and modeled independently by Dr. Satish Pullammanappallil of Optim and by Don Pei and John Louie of UNR. The fifty velocity profiles are shown in the Appendix.

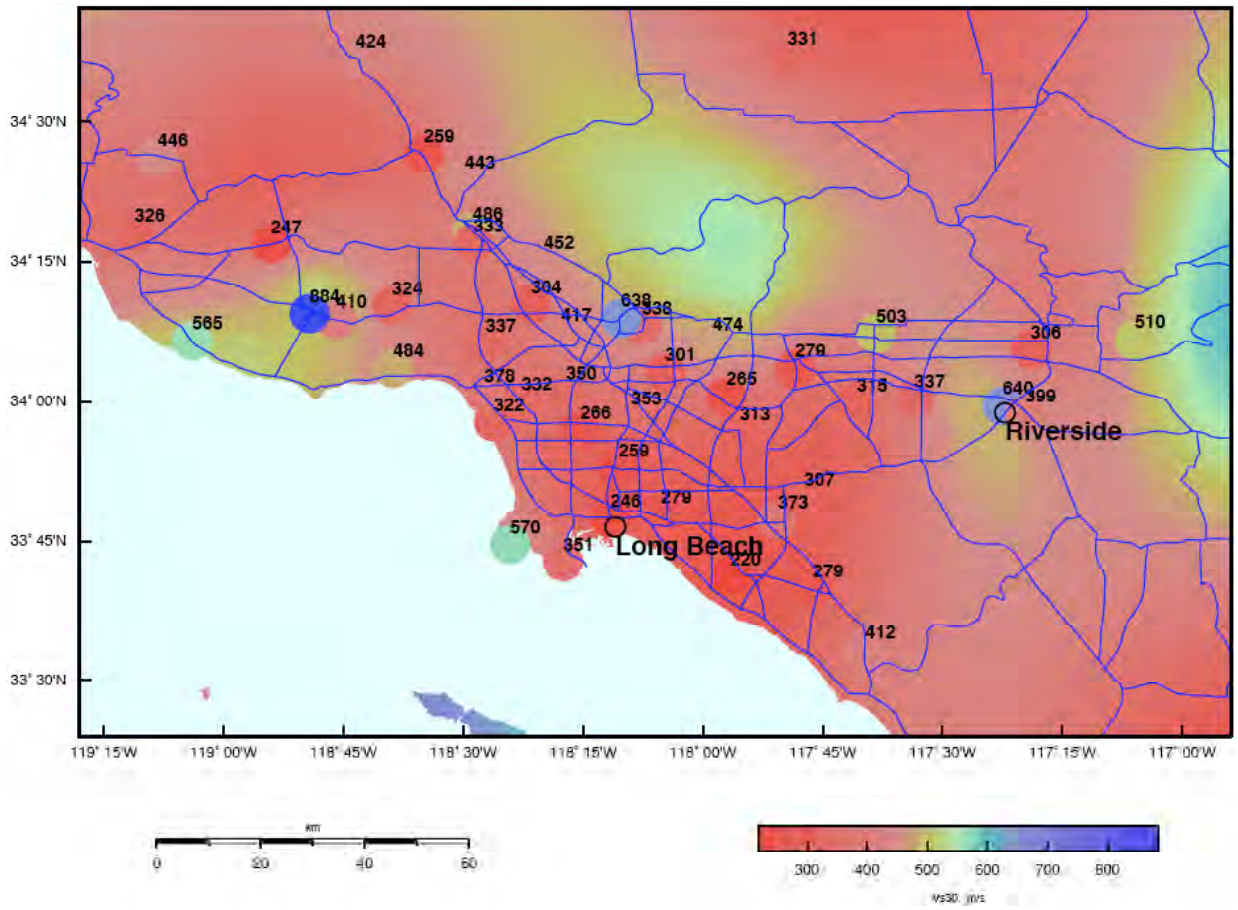

Figure 4. Southern California map showing Vs30 values, in meter/second, determined for 50 CISN and strong-motion instrument sites under USGS contract 05HQGR0078. Site values are imposed as colored circles atop a colored background polynomial fit to all 50 values, shown for pictorial purposes only. Warmer colors indicate lower Vs30 values.

All fifty analyses were completed in January 2006. UNR graduate student Don Pei combined all the Vs30 results into the pictorial Vs30 map of figure 4. PI Louie subsequently posted all velocity profiles and Vs30 results to the on-line archive and interactive mapping facility linked through www.seismo.unr.edu/hazsurv . Figure 5 shows an example of the

archive's point-and-click access to the fifty shear-velocity profiles, and to an additional 385 profiles from around southern California and Nevada.

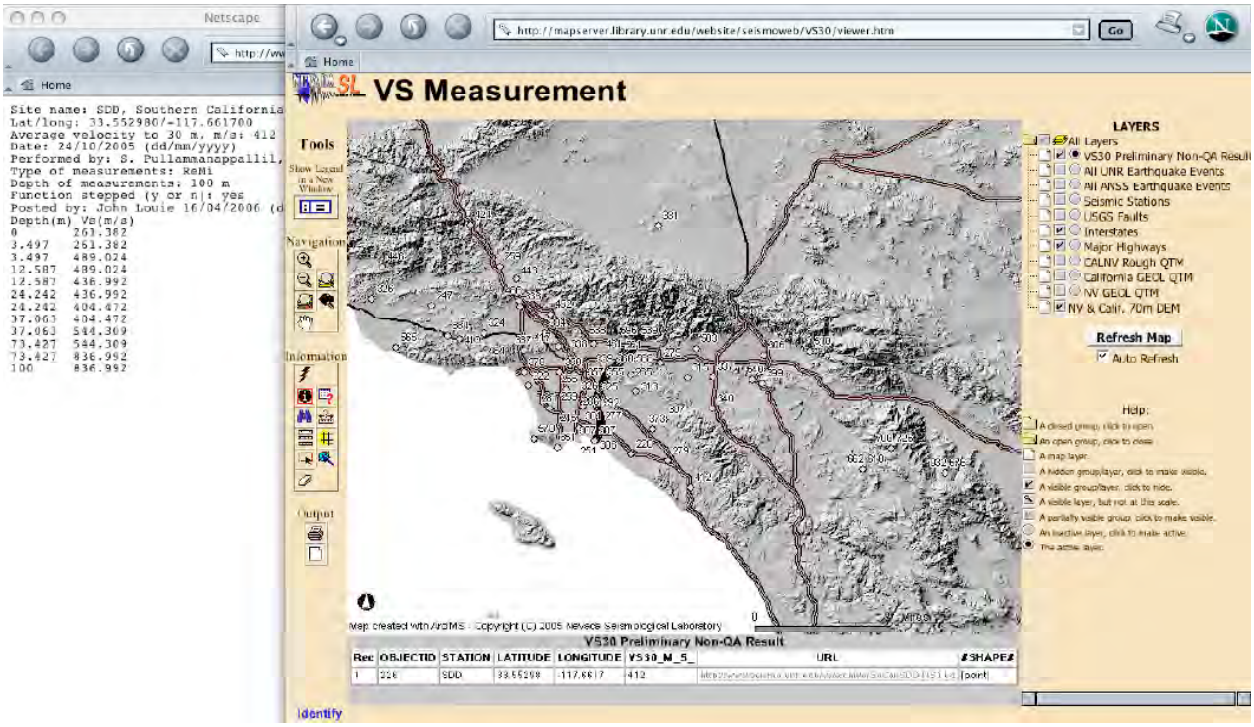

Figure 5. Example of ARCmap web interface allowing interactive mapping and access to shear-velocity profiles and Vs30 values from 250 sites in southern California. The interface is accessed through http://mapserver.library.unr.edu/website/seismoweb/VS30/viewer.htm. With the Identify tool active, click on a site on the map to see a link below the map to the velocity profile, shown here in a separate window to the left. Profiles are archived in a self-explanatory text format, and all are directly accessible from http://www.seismo.unr.edu/vs/archive. Data collection, analyses, and the interface have been partly sponsored by the USGS under contracts 03HQGR0068 and 05HQGR0078. Results from the 200-site San Gabriel River transect and comparisons to borehole data were published in Thelen et al. (2006).

Table 1 summarizes measurement array center locations, distance from the CISN station assessed, and our resulting average velocities to 30-, 50-, and 100-meter depths, denoted Vs30, Vs50, and Vs100, respectively.

Sta	Meas. Lat	Meas. Lon	Dist to Sta, m	Vs30, m/s	Vs50, m/s	Vs100, m/s
AGO	34.146430	-118.766275	82	410	474	545
CHN	33.999025	-117.679810	18	315	381	474
CLT	34.093060	-117.316360	53	306	377	509
CPP	34.059520	-117.808700	60	279	332	399
CRN	33.876030	-117.560305	64	340	382	421
DEC	34.253410	-118.332795	129	452	548	734
DJJ	34.103990	-118.454270	225	337	380	428
FMP	33.712115	-118.292425	176	351	411	492
GR2	34.123490	-118.296260	660	417	538	715
GSA	34.136590	-118.127810	49	338	386	499
HLL	34.174290	-118.359570	238	304	347	404
LAF	33.869959	-118.333781	247	281	311	339
LBW2	33.798396	-118.088072	52	279	311	368

Sta	Meas. Lat	Meas. Lon	Dist to Sta, m	Vs30, m/s	Vs50, m/s	Vs100, m/s
LCG	33.999925	-118.377360	70	332	366	406
LFP	34.305370	-118.481260	620	486	507	545
LGB	33.974950	-118.149100	40	353	428	553
LGU	34.109200	-119.065480	118	565	642	831
LKL	34.616400	-117.824910	94	331	391	478
LLS	33.686866	-117.942895	267	220	276	392
LTP	33.879131	-118.175901	220	259	291	353
MLS	34.005258	-117.558689	280	337	366	515
MOP	34.281490	-118.900930	372	247	284	352
OGC	33.787950	-117.842940	98	373	389	469
OLI	33.945265	-117.922520	159	313	375	484
OSI	34.612750	-118.724900	233	424	572	860
PAS	34.148295	-118.171140	16	638	777	1098
PDE	34.442500	-118.581260	99	259	342	459
PDR	33.962865	-118.436610	41	322	388	478
PDU	34.121385	-117.637785	47	503	595	697
QUG	34.395765	-118.497830	110	443	480	525
RIN	34.282230	-118.478910	43	333	434	601
RIO	34.105645	-117.980700	96	474	510	554
RPV	33.743835	-118.403465	105	570	647	736
RSS	33.978127	-117.327090	541	399	430	488
RUS	34.051525	-118.079830	170	301	348	438
RVR	33.993415	-117.374285	165	640	847	1132
SDD	33.552980	-117.661700	43	412	438	529
SES	34.437090	-119.137860	38	446	485	583
SMS	34.014810	-118.456285	49	378	429	530
SPF	34.059930	-118.645970	69	484	569	783
SRN	33.827810	-117.789515	52	307	362	425
STC	34.303275	-119.184995	187	326	397	501
STG	33.664100	-117.769992	925	279	307	403
STS	33.791017	-118.193110	529	246	305	420
SVD	34.110251	-117.098956	426	510	670	911
TOV	34.156690	-118.821300	108	884	917	950
USC	34.018595	-118.285730	85	350	390	472
WLT	34.009150	-117.950875	38	265	305	388
WSS	34.170680	-118.648960	133	324	392	593
WTT	33.949020	-118.255640	40	266	330	448

Table 1. Summary results showing the 50 CISN stations measured and average shear velocities obtained.

The depth averaged shear velocities were all obtained by slowness averaging, which preserves the total vertical travel time of seismic waves along the profiles. Some statistics on the fifty measurements are given in Table 2.

Depth Averaging	Minimum, m/s	Maximum, m/s	Arithmetic Average, m/s	Slowness Average, m/s
Vs30	220	884	380	351
Vs50	276	917	443	409
Vs100	339	1132	554	509

Table 2. Statistical summary of VsZ measurements from Table 1 of the fifty CISN stations measured.

Despite many of the CISN stations having been established in areas of soft rock, only one, TOV in Thousand Oaks, showed a Vs30 above the NEHRP B-C boundary (Vs30=760 m/s), at 884 m/s in thin alluvium on Mesozoic rock. The lowest measured Vs30 for the fifty CISN stations was 220 m/s, at LLS, Ellis substation in Fountain Valley, in deep alluvium beside the Santa Ana River. Across the broad range of site conditions encountered at the fifty stations, the average Vs30 is 380 m/s by arithmetic averaging and 351 m/s by slowness averaging.

The on-line archive includes 200 sites along the San Gabriel River transect measured in July 2003 under an earlier project, on contract 03HQGR0068. As mentioned above, that project significantly improved the overall characterization of coarse alluvial geological units. Additionally, it showed that a large number of Vs30 measurements of any geologic unit could continue to exhibit a high degree of spatial variability. The spatial coherence of refraction-microtremor Vs30 values is greater, however, than the spatial coherence of Vs30 values measured with downhole surveys. This might be expected since microtremor-array measurements are 100-meter-scale volume averages while downhole measurements are point samples of conditions within a few meters of the bore. Thelen et al. published these results in *BSSA* (June 2006).

The lateral shear-velocity heterogeneity of rock units is especially prominent in our 2005 results. Note from Table 1 that only five out of the fifty stations measured showed Vs30 values above 550 m/s. The refraction-microtremor technique has shown Vs30 values more than twice as high in hard rock of the Mojave Desert, San Jacinto Mts., and southern Nevada (see the database at http://mapserver.library.unr.edu/website/seismoweb/VS30/viewer.htm). LA's more shattered rock is highly heterogeneous. In taking a volume average of travel time, with surface waves not propagating according to Fermat's principal where heterogeneities are at a smaller scale than wavelengths, Vs30 values reflect the lower side of the spectrum of velocities surrounding a site.

Example Comparisons With Downhole Measurements

PAS: Pasadena– A case illustrating the effects of local heterogeneity is the long-operating station PAS, in a tunnel under a low ridge in the granite hills west of Pasadena (figure 6). The station is in a tunnel into the hillside; the ReMi array was almost directly above along Los Altos Dr., following the top of a low ridge (elevation 311 m). The downhole measurement was likely drilled in just outside the tunnel entrance (elevation 307 m) at the bottom of the hill- where the slope is steepest. Our Vs profile (available from http://www.seismo.unr.edu/vs/archive/SoCal/PAS-RS1.txt), collected along the ridge 5 m above the tunnel, shows 4.8 m of low-velocity fractured rock and soil at the surface, leading to a Vs30 of 638 m/s (figure 7). Removing the upper 4.8 m of low-velocity material from this profile would lead to a Vs30 computation of 905 m/s. A USGS downhole log, likely at the base of the ridge, showed a Vs30 of 969 m/s (C. Will, CGS, pers. comm. 2006).

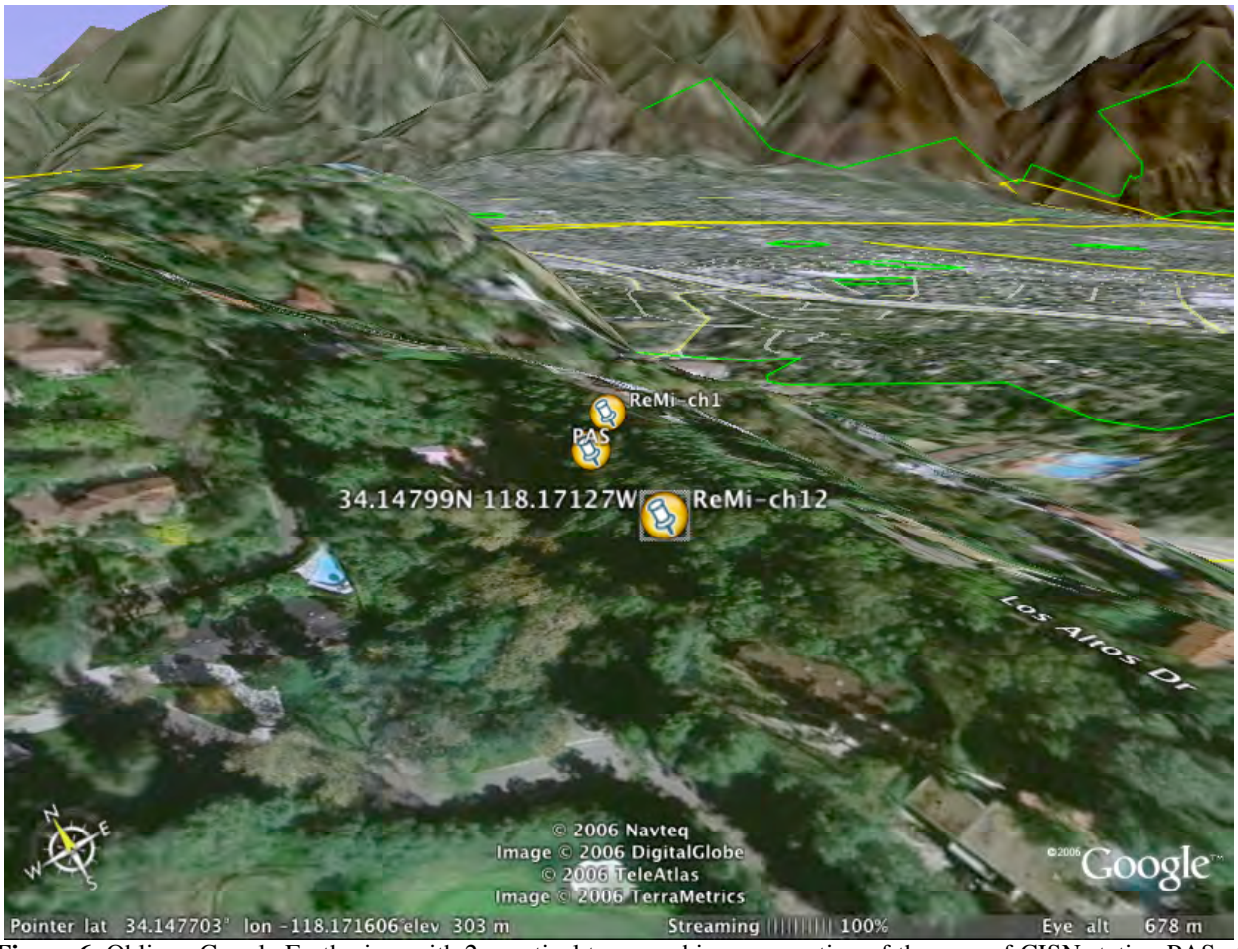

Figure 6. Oblique Google Earth view with 2x vertical topographic exaggeration of the area of CISN station PAS at the former location of the Caltech Seismological Lab, the Kresge facility on the west side of Pasadena. Two pushpin markers locate the ends of our ReMi survey line, along a low ridge above the tunnel containing PAS.

The hill-top is topographically old and could have a Quaternary-age soil developed atop it, having 4.8 m of surface Vs < 600 m/s. Removing the upper two layers from the stack (equal in thickness to the height of the ridge) would make Vs30=905 m/s, closer to the downhole Vs30=969 m/s. The dispersion in the *p-f* shows dispersive energy at velocities above the lowest-velocity envelope picked (figure 7). Under the ¼-wave approximation the dispersion curve from the downhole Vs30 would intersect our picks at the star and cross on the plots of figure 7.

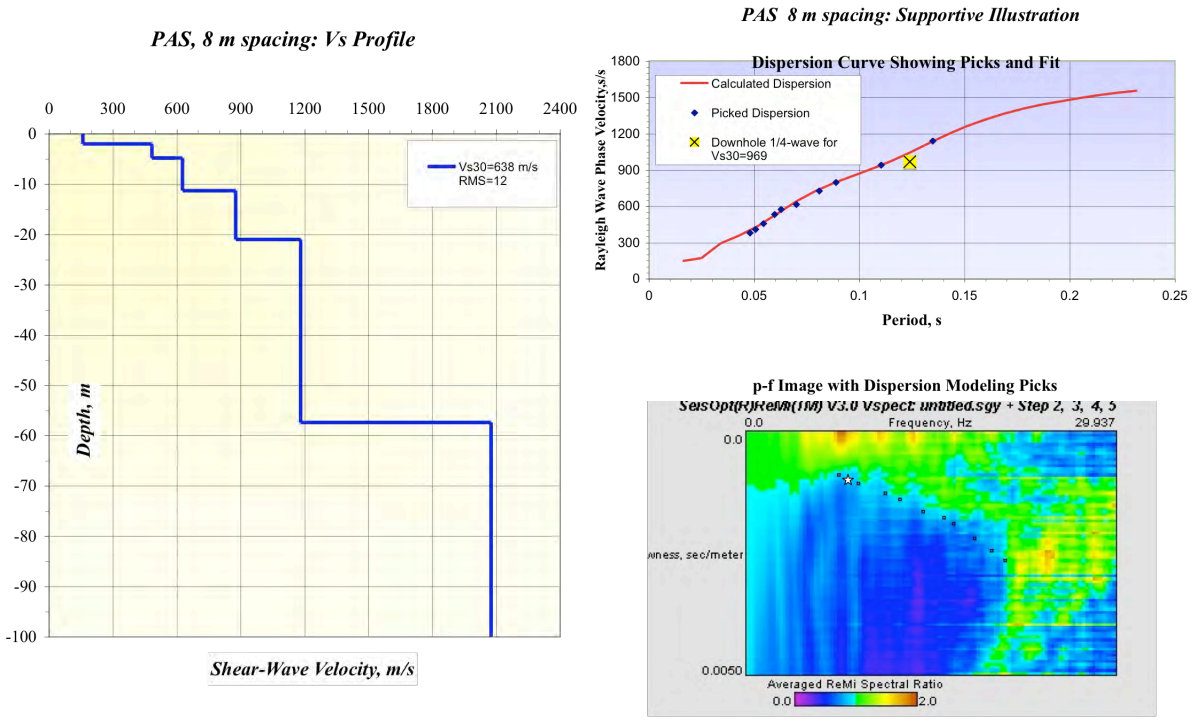

Figure 7. Analysis of ReMi array data collected at CISN station PAS. At lower left is the *p-f* image (as described by Louie, 2001) derived from the array microtremor recordings, with fundamental-mode Rayleigh-wave phase-velocity dispersion picks. The picks are presented on a period versus phase-velocity plot at the upper right as diamonds, with the red line showing the synthetic phase-velocity dispersion curve generated from the 1-d shear-velocity profile at left. This profile, having an average shear velocity to 30 m depth Vs30 = 638 m/s, represents the result of our project work at PAS. The X symbol on the dispersion-curve plot and star on the *p-f* image show the position of the phase velocity computed from a downhole Vs30 measurement of 969 m/s (courtesy of C. Wills, CGS), assuming that 30 m is a quarter of the wavelength. The downhole measurement falls on the ReMi dispersion curve here.

DJJ, Stone Canyon Reservoir– The Rosrine LA00 hole is atop a ridge on the west abutment of the dam (figure 8). (Rosrine data were obtained from gees.usc.edu/ROSRINE/.) This is clearly a resistant ridge within a rapidly eroding canyon. The ridge was competent enough to be selected as a dam abutment, and may have been injected with grout to strengthen it during dam construction. The ReMi array was along the road at the very bottom of the canyon, just before it switchbacks to the base of the dam. Our measurements were centered 160 m from the Rosrine hole and were 30 m lower in elevation.

The ReMi and Rosrine profiles cannot be reconciled (figure 9). They show similar velocities only in their upper few meters. The Rosrine log shows great vertical heterogeneity, as most do, with velocities changing by a factor of almost 2 within a few meters. The *p-f* plot shows a highly heterogeneous wavefield, not the highest-quality data set, but with a fairly obvious lowest-velocity envelope, which has guided our model. The scattering of warm-colored energy peaks in figure 9 could be caused by reverberating low-velocity pockets at a variety of scales. One is near the ¼-wave approximation for Rayleigh phase velocity for the log Vs30=680 m/s.

Figure 8. Oblique Google Earth view with 2x vertical topographic exaggeration of the area of CISN station DJJ at the west abutment of Stone Canyon Reservoir dam. The location of the LA00 Rosrine profile is also shown with a pushpin marker. Two pushpin markers locate the ends of our ReMi survey line, at the bottom of the canyon below the dam.

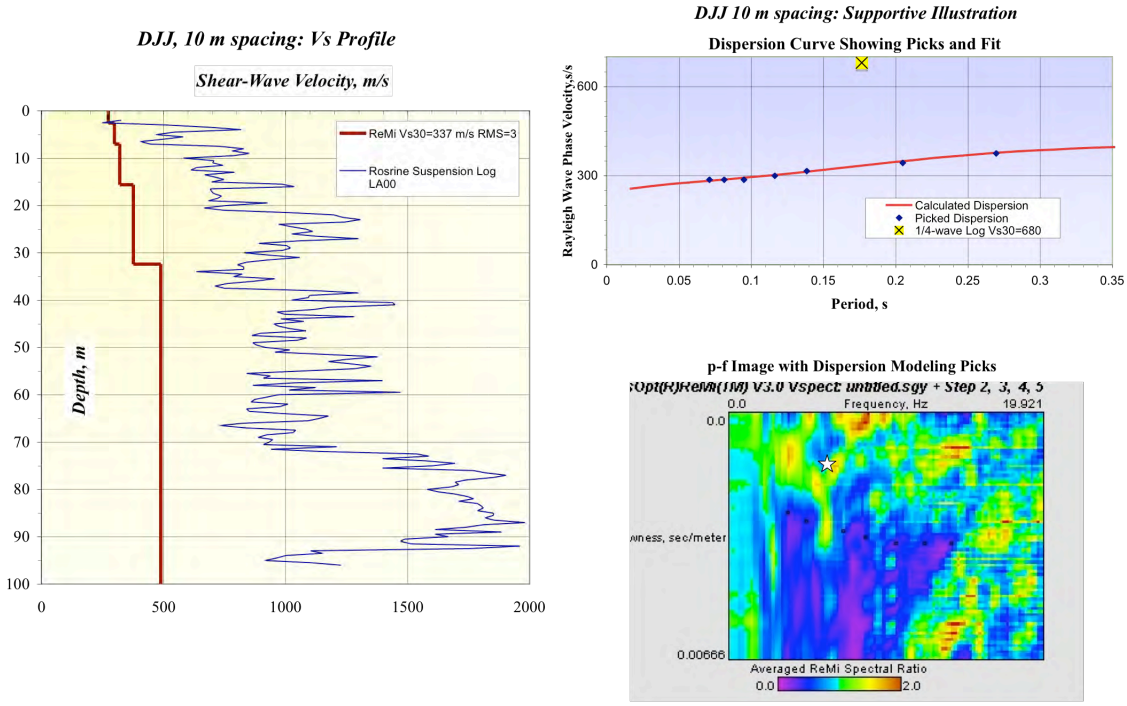

Figure 9. Analysis of ReMi array data collected near CISN station DJJ. The resulting Vs(z) profile, thick line at left, is plotted against the LA00 Rosrine suspension shear-velocity log (from gees.usc.edu/ROSRINE/), the thin line. Our ReMi Vs30 is 337 m/s, much less than the Vs30 = 680 m/s derived from the suspension log. The X symbol on the dispersion-curve plot and star on the *p-f* image show that the quarter-wavelength values derived from the suspension log in the dam abutment are not compatible with the ReMi data obtained from the canyon bottom.

GR2: Griffith Observatory– The GR2 station is likely to be in the Observatory building, with the downhole logs beside the building. Our ReMi measurement was over 640 m away along Vermont Ave., in a grassy canyon-bottom park instead of the Observatory's rocky knoll (figure 10). Construction activity remodeling the Observatory building in January 2005 prevented our crew from any closer approach to the GR2 station.

Our Vs profile shows 19 m of surface materials near 300 m/s (figure 11); velocities we associate with young, fine-grained alluvium. The underlying velocities are similar to those under the Observatory. Having 19 m of alluvium below the canyon bottom, in a thin tongue only 50-60 m wide, may be reasonable considering that the there is over 50 m of relief on the surrounding ridges (figure 10).

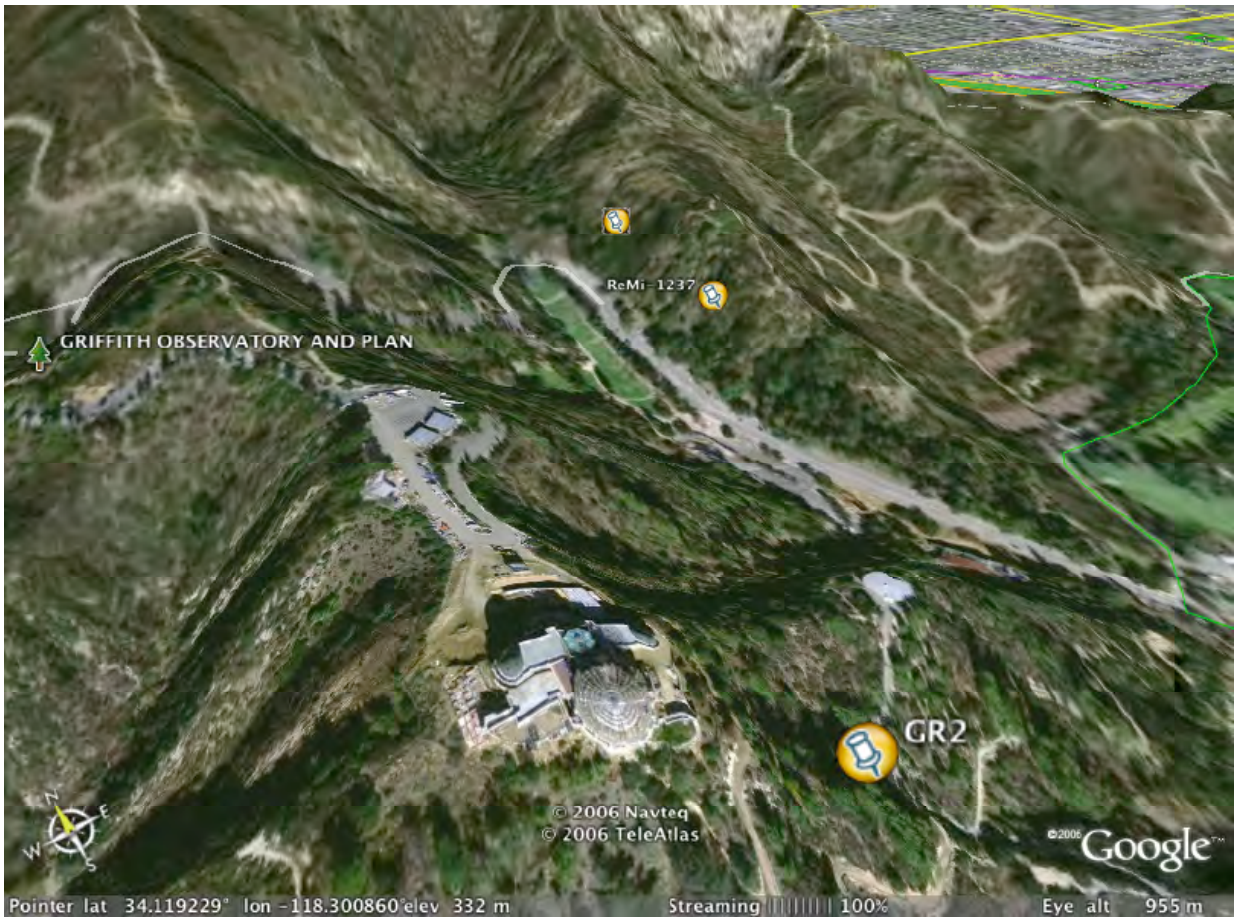

Figure 10. Oblique Google Earth view with 2x vertical topographic exaggeration of the area of CISN station GR2 at Griffith Observatory. Two pushpin markers locate the ends of our ReMi survey line, in a park along the bottom of a small valley.

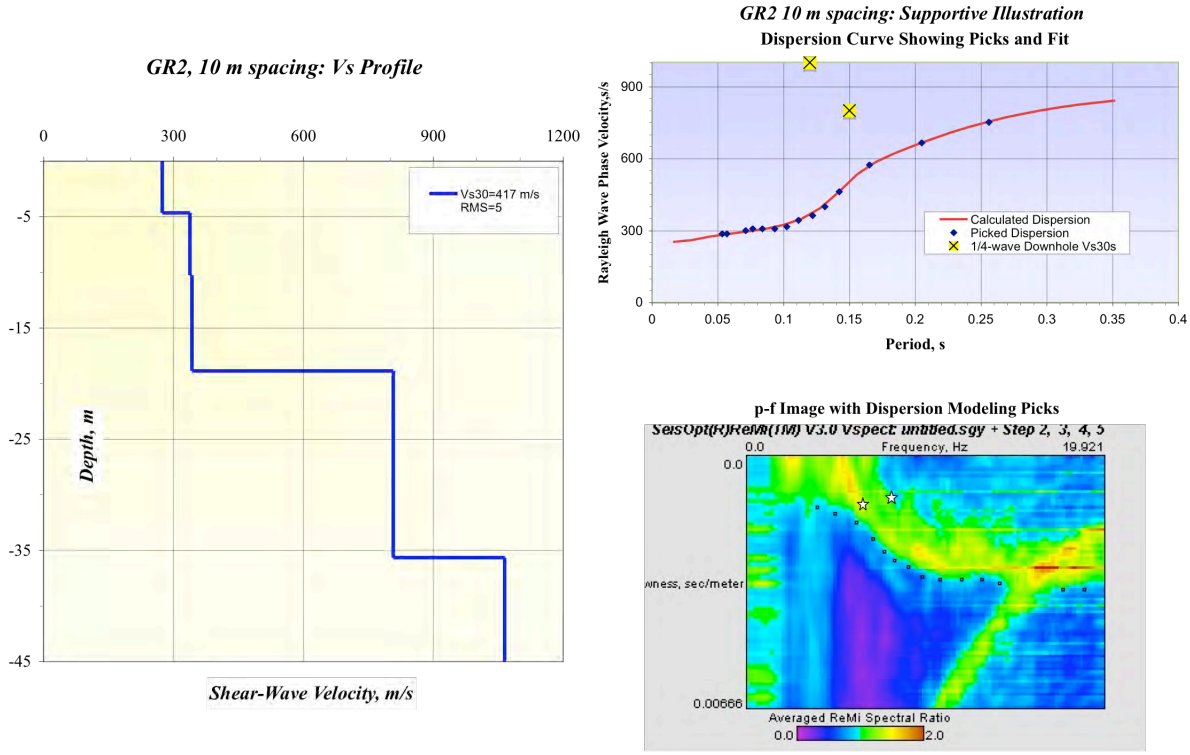

Figure 11. Analysis of ReMi array data collected near CISN station GR2. The resulting Vs(z) profile, thick line at left, shows Vs30 = 417 m/s. The X symbol on the dispersion-curve plot and star on the *p-f* image show that the quarter-wavelength values derived from downhole measurements nearer to DJJ (courtesy of C. Wills, CGS) are not compatible with the ReMi data obtained from the small valley 600 m away on Vermont Ave.

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Appendix

Printouts of shear-velocity profiles measured by UNR for 50 sites in southern California, sponsored by the USGS External Research Program under contract 05HQGR0078. The format is the same used in the on-line archive, and was inspired by Prof. B. Luke of UNLV. Data fields are delimited by return and whitespace characters. The raw data values output by SeisOpt® ReMi™ are given but do not represent true precision, which is limited to one meter and one meter per second at best. Open-source software reading this format is at www.seismo.unr.edu/vs/archive/getv30/ .

```
Site name: AGO, Southern California
Lat/long: 34.146430/-118.766275
Average velocity to 30 m, m/s: 410
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 45 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0    276.829
6.993     276.829
6.993     374.39
11.655    374.39
11.655    459.756
20.512    459.756
20.512    576.829
35.198    576.829
35.198    640.244
45.198    640.244

Site name: CHN, Southern California
Lat/long: 33.999025/-117.679810
Average velocity to 30 m, m/s: 315
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 50 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0    193.902
7.459     193.902
7.459     348.103
17.715    348.103
17.715    409.079
26.34     409.079
26.34     525.61
40.326    525.61
40.326    625.61
50.326    625.61
```

Site name: CLT, Southern California
Lat/long: 34.093060/-117.316360
Average velocity to 30 m, m/s: 306
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 196.341
6.061 196.341
6.061 239.702
14.453 239.702
14.453 434.824
23.776 434.824
23.776 543.225
43.822 543.225
43.822 735.637
80.186 735.637
80.186 873.848
90.186 873.848

Site name: CPP, Southern California
Lat/long: 34.059520/-117.808700
Average velocity to 30 m, m/s: 279
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 174.39
3.963 174.39
3.963 237.805
9.557 237.805
9.557 318.293
16.317 318.293
16.317 340.244
33.1 340.244
33.1 498.78
100 498.78

Site name: CRN, Southern California
Lat/long: 33.876030/-117.560305
Average velocity to 30 m, m/s: 340
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 70 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	311.333
21.54	311.333
21.54	405.556
24.777	405.556
24.777	468.667
70.536	468.667

Site name: DEC, Southern California
Lat/long: 34.253410/-118.332795
Average velocity to 30 m, m/s: 452
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 52 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	391.463
12.354	391.463
12.354	440.244
17.949	440.244
17.949	460.569
24.709	460.569
24.709	680.081
41.492	680.081
41.492	1110.976
51.492	1110.976

Site name: DJJ, Southern California
Lat/long: 34.103990/-118.454270
Average velocity to 30 m, m/s: 337
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	274.39
2.564	274.39
2.564	298.78
6.993	298.78
6.993	320.732
15.618	320.732
15.618	376.829
32.401	376.829
32.401	489.024
100	489.024

Site name: FMP, Southern California
Lat/long: 33.712115/-118.292425
Average velocity to 30 m, m/s: 351
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 52 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	235.366
4.662	235.366
4.662	337.805
10.256	337.805
10.256	397.967
17.016	397.967
17.016	401.22
33.8	401.22
33.8	613.415
100	613.415

Site name: GR2, Southern California
Lat/long: 34.123490/-118.296260
Average velocity to 30 m, m/s: 417
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 46 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 274.39
4.662 274.39
4.662 337.805
10.256 337.805
10.256 342.683
18.881 342.683
18.881 807.724
35.664 807.724
35.664 1064.634
45.664 1064.634

Site name: GSA, Southern California
Lat/long: 34.136590/-118.127810
Average velocity to 30 m, m/s: 338
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 75 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 258.672
3.263 258.672
3.263 288.482
9.79 288.482
9.79 339.973
16.317 339.973
16.317 383.333
28.205 383.333
28.205 494.444
64.569 494.444
64.569 857.588
74.569 857.588

Site name: HLL, Southern California
Lat/long: 34.174290/-118.359570
Average velocity to 30 m, m/s: 304
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 62 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	198.78
4.662	198.78
4.662	264.634
11.888	264.634
11.888	367.073
28.205	367.073
28.205	445.122
53.613	445.122
53.613	486.585
100	486.585

Site name: LAF, Southern California
Lat/long: 33.869959/-118.333781
Average velocity to 30 m, m/s: 281
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	165.556
6.696	165.556
6.696	447.778
20.696	447.778
20.696	230
26.786	230
26.786	372.222
126.786	372.222

Site name: LBW2, Southern California
Lat/long: 33.798396/-118.088072
Average velocity to 30 m, m/s: 279
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 71 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	112.873
3.263	112.873
3.263	292.818
8.275	292.818
8.275	338.347
14.802	338.347
14.802	344.851
24.476	344.851
24.476	379.539
60.84	379.539
60.84	472.764
70.84	472.764

Site name: LCG, Southern California
Lat/long: 33.999925/-118.377360
Average velocity to 30 m, m/s: 332
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	208.266
3.03	208.266
3.03	251.626
10.023	251.626
10.023	403.388
16.783	403.388
16.783	416.396
29.604	416.396
29.604	438.076
65.968	438.076
65.968	461.924
100	461.924

Site name: LFP, Southern California
Lat/long: 34.305370/-118.481260
Average velocity to 30 m, m/s: 486
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	306.098
4.662	306.098
4.662	432.927
10.256	432.927
10.256	523.171
18.881	523.171
18.881	564.634
35.664	564.634
35.664	589.024
100	589.024

Site name: LGB, Southern California
Lat/long: 33.974950/-118.149100
Average velocity to 30 m, m/s: 353
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	236.992
3.497	236.992
3.497	304.743
6.993	304.743
6.993	350.813
14.452	350.813
14.452	377.913
27.273	377.913
27.273	643.496
63.637	643.496
63.637	849.458
100	849.458

Site name: LGU, Southern California
Lat/long: 34.109200/-119.065480
Average velocity to 30 m, m/s: 565
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	371.951
3.963	371.951
3.963	466.26
10.723	466.26
10.723	638.618
19.114	638.618
19.114	726.423
44.522	726.423
44.522	1178.455
100	1178.455

Site name: LKL, Southern California
Lat/long: 34.616400/-117.824910
Average velocity to 30 m, m/s: 331
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 46 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	213.415
4.662	213.415
4.662	281.707
10.256	281.707
10.256	391.463
18.881	391.463
18.881	410.976
35.664	410.976
35.664	615.854
45.664	615.854

Site name: LLS, Southern California
Lat/long: 33.686866/-117.942895
Average velocity to 30 m, m/s: 220
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	123.713
3.263	123.713
3.263	151.897
8.275	151.897
8.275	208.266
14.802	208.266
14.802	275.474
24.476	275.474
24.476	461.924
60.84	461.924
60.84	778.455
100	778.455

Site name: LTP, Southern California
Lat/long: 33.879131/-118.175901
Average velocity to 30 m, m/s: 259
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 68 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	134.553
1.981	134.553
1.981	162.195
4.779	162.195
4.779	267.886
11.305	267.886
11.305	274.39
20.979	274.39
20.979	362.195
57.343	362.195
57.343	467.886
67.343	467.886

Site name: MLS, Southern California
Lat/long: 34.005258/-117.558689
Average velocity to 30 m, m/s: 337
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	230.488
2.331	230.488
2.331	262.195
6.527	262.195
6.527	342.683
11.422	342.683
11.422	365.447
21.096	365.447
21.096	396.341
47.786	396.341
47.786	869.512
100	869.512

Site name: MOP, Southern California
Lat/long: 34.281490/-118.900930
Average velocity to 30 m, m/s: 247
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	184.959
4.662	184.959
4.662	228.862
10.023	228.862
10.023	248.374
24.709	248.374
24.709	370.325
50.117	370.325
50.117	464.634
60.117	464.634

Site name: OGC, Southern California
Lat/long: 33.787950,-117.842940
Average velocity to 30 m, m/s: 373
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 67 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	352.439
10.256	352.439
10.256	371.951
21.678	371.951
21.678	401.22
40.326	401.22
40.326	432.927
57.11	432.927
57.11	628.049
67.11	628.049

Site name: OLI, Southern California
Lat/long: 33.945265/-117.922520
Average velocity to 30 m, m/s: 313
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 62 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	164.634
4.196	164.634
4.196	284.146
10.023	284.146
10.023	376.829
23.31	376.829
23.31	445.122
40.093	445.122
40.093	684.146
100	684.146

Site name: OSI, Southern California
Lat/long: 34.612750/-118.724900
Average velocity to 30 m, m/s: 424
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 63 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	232.927
7.226	232.927
7.226	334.553
12.587	334.553
12.587	659.756
27.273	659.756
27.273	1255.962
52.681	1255.962
52.681	1770.867
62.681	1770.867

Site name: PAS, Southern California
Lat/long: 34.148295/-118.171140
Average velocity to 30 m, m/s: 638
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 75 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	158.401
1.981	158.401
1.981	483.604
4.779	483.604
4.779	625.881
11.305	625.881
11.305	876.558
20.979	876.558
20.979	1181.436
57.343	1181.436
57.343	2075.745
100	2075.745

Site name: PDE, Southern California
Lat/long: 34.442500/-118.581260
Average velocity to 30 m, m/s: 259
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	183.333
4.895	183.333
4.895	189.837
11.888	189.837
11.888	267.886
21.212	267.886
21.212	476.016
31.002	476.016
31.002	697.154
100	697.154

Site name: PDR, Southern California
Lat/long: 33.962865,-118.436610
Average velocity to 30 m, m/s: 322
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	258.672
3.497	258.672
3.497	283.062
10.723	283.062
10.723	312.873
20.746	312.873
20.746	412.06
33.567	412.06
33.567	613.686
69.931	613.686
69.931	628.862
100	628.862

Site name: PDU, Southern California
Lat/long: 34.121385/-117.637785
Average velocity to 30 m, m/s: 503
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 58 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	467.073
3.73	467.073
3.73	471.951
13.52	471.951
13.52	532.927
30.769	532.927
30.769	835.366
47.552	835.366
47.552	842.683
57.552	842.683

Site name: QUG, Southern California
Lat/long: 34.395765/-118.497830
Average velocity to 30 m, m/s: 443
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	384.146
8.625	384.146
8.625	406.098
18.415	406.098
18.415	542.683
35.664	542.683
35.664	557.317
52.448	557.317
52.448	579.268
100	579.268

Site name: RIN, Southern California
Lat/long: 34.282230/-118.478910
Average velocity to 30 m, m/s: 333
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 47 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 192.276
3.03 192.276
3.03 246.477
8.392 246.477
8.392 375.203
23.077 375.203
23.077 497.154
34.266 497.154
34.266 978.184
44.266 978.184

Site name: RIO, Southern California
Lat/long: 34.105645/-117.980700
Average velocity to 30 m, m/s: 474
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 250
3.963 250
3.963 489.024
7.459 489.024
7.459 557.317
24.709 557.317
24.709 559.756
41.492 559.756
41.492 606.098
100 606.098

Site name: RPV, Southern California
Lat/long: 33.743835/-118.403465
Average velocity to 30 m, m/s: 570
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	472.764
8.858	472.764
8.858	517.48
18.415	517.48
18.415	732.927
29.138	732.927
29.138	810.163
45.921	810.163
45.921	854.878
100	854.878

Site name: RSS, Southern California
Lat/long: 33.978127/-117.327090
Average velocity to 30 m, m/s: 399
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	272.222
3.963	272.222
3.963	342.683
9.79	342.683
9.79	383.333
16.317	383.333
16.317	456.504
25.991	456.504
25.991	516.125
62.355	516.125
62.355	581.165
72.355	581.165

Site name: RUS, Southern California
Lat/long: 34.051525/-118.079830
Average velocity to 30 m, m/s: 301
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 57 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	198.78
7.925	198.78
7.925	310.976
13.287	310.976
13.287	389.024
30.536	389.024
30.536	442.683
47.319	442.683
47.319	593.902
57.319	593.902

Site name: RVR, Southern California
Lat/long: 33.993415/-117.374285
Average velocity to 30 m, m/s: 640
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	141.057
2.564	141.057
2.564	419.919
6.993	419.919
6.993	863.821
15.618	863.821
15.618	1671.951
32.401	1671.951
32.401	1706.098
100	1706.098

Site name: SDD, Southern California
Lat/long: 33.552980/-117.661700
Average velocity to 30 m, m/s: 412
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 261.382
3.497 261.382
3.497 489.024
12.587 489.024
12.587 436.992
24.242 436.992
24.242 404.472
37.063 404.472
37.063 544.309
73.427 544.309
73.427 836.992
100 836.992

Site name: SES, Southern California
Lat/long: 34.437090/-119.137860
Average velocity to 30 m, m/s: 446
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 80 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)
Depth(m) Vs(m/s)
0 334.553
3.497 334.553
3.497 461.924
10.256 461.924
10.256 502.575
20.979 502.575
20.979 434.824
33.8 434.824
33.8 597.425
70.163 597.425
70.163 857.588
80.163 857.588

Site name: SMS, Southern California
Lat/long: 34.014810/-118.456285
Average velocity to 30 m, m/s: 378
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 78 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	255.962
2.331	255.962
2.331	296.612
5.827	296.612
5.827	369.783
15.851	369.783
15.851	437.534
28.672	437.534
28.672	543.225
65.036	543.225
65.036	784.417
75.036	784.417

Site name: SPF, Southern California
Lat/long: 34.059930/-118.645970
Average velocity to 30 m, m/s: 484
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	328.049
3.497	328.049
3.497	415.854
8.625	415.854
8.625	498.78
20.28	498.78
20.28	615.854
33.1	615.854
33.1	815.854
69.464	815.854
69.464	1909.079
100	1909.079

Site name: SRN, Southern California
Lat/long: 33.827810/-117.789515
Average velocity to 30 m, m/s: 307
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 46 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	213.415
3.73	213.415
3.73	240.244
10.956	240.244
10.956	296.341
19.58	296.341
19.58	479.268
36.364	479.268
36.364	515.854
46.364	515.854

Site name: STC, Southern California
Lat/long: 34.303275/-119.184995
Average velocity to 30 m, m/s: 326
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	208.537
4.196	208.537
4.196	301.22
8.625	301.22
8.625	337.805
17.249	337.805
17.249	398.78
34.033	398.78
34.033	679.268
100	679.268

Site name: STG, Southern California
Lat/long: 33.664100/-117.769992
Average velocity to 30 m, m/s: 279
Date: 11/01/2005 (dd/mm/yyyy)
Performed by: Don Pei, Jeff Hogue, Nevada Seismological Lab.
Type of measurements: ReMi
Depth of measurements: 52 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	267.073
8.625	267.073
8.625	276.829
17.016	276.829
17.016	286.585
25.641	286.585
25.641	293.902
42.424	293.902
42.424	584.146
52.424	584.146

Site name: STS, Southern California
Lat/long: 33.791017/-118.193110
Average velocity to 30 m, m/s: 246
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	162.737
3.03	162.737
3.03	169.241
8.042	169.241
8.042	223.171
14.569	223.171
14.569	286.314
24.242	286.314
24.242	490.108
60.606	490.108
60.606	745.935
100	745.935

Site name: SVD, Southern California
Lat/long: 34.110251/-117.098956
Average velocity to 30 m, m/s: 510
Date: 27/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 74 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	367.073
6.294	367.073
6.294	383.333
11.305	383.333
11.305	525.61
17.832	525.61
17.832	651.626
27.506	651.626
27.506	1310.163
63.87	1310.163
63.87	1472.764
73.87	1472.764

Site name: TOV, Southern California
Lat/long: 34.156690/-118.821300
Average velocity to 30 m, m/s: 884
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	619.106
3.497	619.106
3.497	903.659
8.625	903.659
8.625	923.984
17.949	923.984
17.949	957.859
36.83	957.859
36.83	984.959
46.83	984.959

Site name: USC, Southern California
Lat/long: 34.018595/-118.285730
Average velocity to 30 m, m/s: 350
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	204.472
3.263	204.472
3.263	321.003
6.527	321.003
6.527	369.783
13.054	369.783
13.054	380.623
25.875	380.623
25.875	475.474
62.239	475.474
62.239	654.336
100	654.336

Site name: WLT, Southern California
Lat/long: 34.009150/-117.950875
Average velocity to 30 m, m/s: 265
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 80 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	249.187
3.497	249.187
3.497	258.672
6.993	258.672
6.993	264.363
18.648	264.363
18.648	273.848
31.469	273.848
31.469	406.64
67.833	406.64
67.833	647.561
77.833	647.561

Site name: WSS, Southern California
Lat/long: 34.170680/-118.648960
Average velocity to 30 m, m/s: 324
Date: 12/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 100 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	131.301
3.03	131.301
3.03	239.702
8.392	239.702
8.392	415.854
23.077	415.854
23.077	558.13
48.485	558.13
48.485	1215.312
100	1215.312

Site name: WTT, Southern California
Lat/long: 33.949020/-118.255640
Average velocity to 30 m, m/s: 266
Date: 24/10/2005 (dd/mm/yyyy)
Performed by: S. Pullammanappallil, Don Pei, Optim Inc.
Type of measurements: ReMi
Depth of measurements: 72 m
Function stepped (y or n): yes
Posted by: John Louie 16/04/2006 (dd/mm/yyyy)

Depth(m)	Vs(m/s)
0	161.111
3.263	161.111
3.263	188.211
10.256	188.211
10.256	266.802
17.016	266.802
17.016	416.396
29.837	416.396
29.837	532.385
66.201	532.385
66.201	814.228
76.201	814.228