



**Velocity Models, First-Arrival Travel Times, and Geometries of
1991 and 1993 USGS Land-Based Controlled-Source Seismic
Investigations in the San Francisco Bay Area, California: In-line
Shots**

by R. D. Catchings, M. R. Goldman, C. E. Steedman, and G. Gandhok

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**U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY**

¹U.S. Geological Survey, 345 Middlefield Rd, MS 977, Menlo Park, CA 94025

Introduction

In May 1991 and 1993, following the 1989 M 7.1 Loma Prieta Earthquake, the U.S. Geological Survey (USGS) acquired four land-based, controlled-source seismic refraction profiles in the San Francisco Bay Area, California (Fig. 1). The seismic profiles were acquired to help calibrate the Northern California Seismic Network (NCSN), to determine the local crustal- and upper-mantle velocity structure in the region, and to determine the effect of crustal and upper-mantle structure on seismic wave propagation from the Loma Prieta epicentral area. However, of the three primary objectives of the 1991 and 1993 land-based seismic surveys, only two of the objectives, calibration of the NCSN network and examination of wave propagation from the epicentral area, were fully realized. The NCSN network accurately located the 1991 and 1993 seismic shot points to within hundreds of meters (unpublished data, 1991, 1993), suggesting that the network was reasonably accurate in locating local earthquakes. The structure of the crust and upper mantle along the San Francisco Peninsula was found to focus seismic energy northward, and likely contributed to the significantly stronger shaking in the San Francisco and Oakland areas during the 1989 Loma Prieta earthquake (Catchings and Kohler, 1996). However, the other three seismic profiles acquired along and across the greater Bay area in 1991 and 1993 were never fully analyzed, and velocity models for the profiles have not been previously published.

The USGS has recently renewed efforts to examine the effect of crustal velocity structure on seismic wave propagation, amplification, and attenuation throughout the San Francisco Bay area. To further accomplish the original goals of the 1991 and 1993 seismic surveys and to aid the current investigations, we developed 2-D tomographic crustal- and upper-mantle velocity models for each of the four seismic profiles. In this report, we present tomographic velocity models and travel time and geometry data for each profile of the 1991 and 1993 seismic profiles. Because of the areal coverage, the volume of data, and the known locations of shots and receivers, travel times from these surveys should be useful in developing more accurate regional 3-D crustal velocity models of the Bay area.

For each of the seismic profiles, first-arrival (P-wave) travel times from inline shots to seismographs along the seismic profiles have been measured, and the travel times between the shot and receiver pairs have been checked against their reciprocal pairs (where possible) to ensure accuracy. Such checks on reciprocity are needed for most of the seismic profiles because the highly urban environment resulted in low signal-to-noise ratios on a number of the 1991 and 1993 shot gathers. Thus, regional velocity models of the San Francisco Bay area that include travel times from the 1991 and 1993 seismic profiles should utilize the travel times presented in this report versus travel times without reciprocity checks.

Regional Geology and Tectonics

In this report, we loosely define the San Francisco Bay area as the series of valleys and mountain ranges extending southeast to northwest from the southernmost Santa Clara Valley to the Mendocino Plateau and west to east from the Pacific Ocean to the Great Valley (Fig. 1). The San Francisco Bay is a low-lying flooded area between the Diablo Ranges to the east and the Santa Cruz Mountains to the west and is among the largest of the valleys. Within the region, the valleys are largely covered by Quaternary alluvium; rocks within the ranges are highly variable but are largely composed of late Paleozoic to Tertiary rocks of the Great Valley and Franciscan complexes, and (Howard, 1979; Graymer, 2000; McLaughlin et al., 2001). Generally, the older rocks are located west of the San Andreas fault, but basement rocks beneath the valleys may be much like those found in the adjacent mountain ranges. Tectonically, the area is highly complex, as it is located along a relatively wide segment of the North American-Pacific tectonic plate boundary consisting of a number of active fault zones, including the San Gregorio, San Andreas, Hayward-Rodgers Creek, Calaveras, and other fault zones (Wallace, 1990). Most of the fault zones consist of a series of right-lateral, strike-slip faults, but a number of reverse faults have components of reverse slip (Graymer, 2000; McLaughlin et al., 2001).

Previous Seismic Studies

Crustal- and upper-mantle velocity structure is not well determined in the San Francisco Bay area because few crustal-scale refraction and reflection surveys have been completed, due in part to its urban setting. Several studies of the Bay area crustal structure were undertaken by utilizing earthquake sources on local networks or a combination of earthquake sources and active sources (Eberhart-Phillips et al., 1990; Catchings and Kohler, 1996; Parsons and Zoback, 1997; Hole et al., 2000; Parsons et al., 2002). Most of these studies provide velocity information to depths less than 18 km, due principally to the uneven distribution of earthquake and active sources in the region. Several active-source crustal studies have also been completed within the region, but those studies focussed on the margins of the San Francisco Bay area, were geographically limited, or utilized unreversed refraction data (Walter and Mooney, 1982; Catchings and Kohler, 1996; Holbrook et al., 1996). In this study, we present active-source refraction data from a much larger segment of the San Francisco Bay area than was available in the previous active-source studies.

Land-Based Seismic Investigations: 1991 and 1993

In May 1991 and 1993, the United States Geological Survey (USGS) acquired a series of seismic refraction and wide-angle reflection profiles along the margins of and across the San Francisco Bay (Fig. 1). The 1993 seismic survey (Kohler and Catchings, 1994) repeated part of the 1991 seismic survey (Murphy et al., 1992) to better resolve one of the profiles, but both surveys included separate imaging targets. From the combined 1991 and 1993 seismic surveys, there were four individual seismic profiles acquired. We refer to these profiles as the (1) Peninsulas profile (A-A'), (2) Loma Prieta profile (B-B'), (3) East Bay profile (C-C'), and (4) Cross Bay profile (D-D') (Fig. 1). For all profiles, seismic sources were generated by explosions of ammonium-nitrate in water wells ranging from about 30 m to 45 m in depth, and the data were recorded on a combination of 3-component Reftek seismographs, vertical-component Seismic Group Recorders (SGR), and 3-component ocean bottom seismometers. At some stations, Reftek and SGR seismographs were co-located for amplitude calibration purposes. We used Global Positioning Systems (GPS) to determine shot and seismic recorder locations, which we estimate to be accurate to within about 20 m.

The Peninsulas profile was a 200-km-long, northwest-southeast-oriented profile that extended from Tres Pinos to Inverness, largely along the San Francisco and Marin Peninsulas (profile A-A' of Fig. 1). The Peninsulas profile was designed to cross the epicenter of the 1989 M. 7.1 Loma Prieta earthquake so that propagation paths from the epicentral region could be examined (Catchings and Kohler, 1996). This profile was first acquired during a 1991 seismic investigation that included seven shot points and 181 seismographs (Murphy et al., 1992). Three of the 1991 shot points were located in the plane of the Peninsulas profile (inline shot points), and an additional four shot points (along the Loma Prieta profile) were recorded on the Peninsulas profile as fan shots. Inline shot points of the 1991 Peninsulas profile were located near the Loma Prieta epicenter (SP 2a), south of the Loma Prieta epicenter (SP 6a), and at the southern tip of the Marin Peninsula (SP 10a) (Fig. 1). Seismic Group Recorders (SGRs) were spaced at ~1 km intervals along the 1991 profile. In 1993, we re-deployed seismographs along the Peninsulas profile and added three in-line shots, shot points 5, 6, and 7 (Fig. 1). We used five of the shots (two from 1991 and 3 from 1993) more accurately constrained the velocity structure along the Peninsulas profile. During the data acquisition phase of the 1993 Peninsulas profile, the Cross Bay profile (see below) was also active, and the inline shots of the Peninsulas profile were recorded on the Cross Bay profile as fan shots.

The Loma Prieta seismic profile was a northeast-southwest-oriented, 25-km-long profile that extended from the Pacific Ocean to the western Santa Clara Valley (profile B-B' of Fig. 1). The profile was also centered on the 1989 M. 7.1 Loma Prieta earthquake epicenter, within the Santa Cruz Mountains. During the 1991 seismic survey, we recorded 5 in-line shots, spaced at average intervals of 5 km, along the Loma Prieta profile,. Additionally, the two in-line shot points from the 1991 Peninsulas profile were recorded as fan shots on the Loma Prieta profile, with shot point 2 serving as an inline shot point for both profiles. Travel times from the off-line shots are not included in this report, but we used four of the five shot points in developing the Loma Prieta velocity model. The Loma Prieta profile utilized 172 seismographs, spaced at approximately 1-km intervals; however, the Loma Prieta profile was not re-deployed during the 1993 seismic investigation.

In addition to the re-deployment of the 1991 Peninsulas profile, two additional seismic profiles were acquired during the 1993 seismic investigation, the East Bay profile (C-C') and the Cross Bay profile (D-D') (Fig. 1). The East Bay seismic profile was 220

km long, oriented northwest to southeast, and extended from Tres Pinos to Santa Rosa on the eastern side of the San Francisco Peninsula (profile C-C', Fig. 1). This East Bay profile was largely within the Diablo Range, but it crossed San Pablo Bay and parts of the southernmost Santa Clara Valley. There were 12 shot points located along the East Bay profile, with shot points spaced at average intervals of ~20 km. In-line shot points included shot points 1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14, and 15. All shots from the Cross Bay profile were also recorded along the East Bay profile as fan shots, however, the travel times for the fan shots are not included in this report. We used all 12 shots in developing the velocity model of the East Bay profile. A total of 214 seismographs (a combination of SGRs and Refteks) were deployed along the East Bay profile, spaced approximately 1 km apart. We used both vertical-component and horizontal-component seismographs along the profile, with a 3-component seismograph located at every third station (3 km). Where the East Bay profile crossed San Pablo Bay, we used ocean-bottom seismometers (OBS) to record the seismic energy, but the data were of poor quality (Kohler and Catchings, 1994).

The Cross Bay profile was a southwest-northeast-oriented, 100-km-long profile that extended from the Pacific Ocean to the town of Byron (profile D-D', Fig. 1). The Cross Bay profile included 4 shot points, spaced an average of ~30 km apart. In-line shot points included SP 7, 17, 3, and 18. Eighty nine seismographs (SGRs and Refteks), spaced at approximately 1-km intervals, were deployed. Every third seismograph deployed along the profile was a 3-component Reftek. In addition to the in-line shots of the Cross Bay profile, we recorded shots from both the Peninsulas and East Bay profiles as fan shots on the Cross Bay profile. Travel times for the fan shots are not included in the report, and all four shot points were used to develop the Cross Bay velocity model.

Data Format

In this report, we present seismograph and shot-point locations and in-line travel times for each of the four seismic profiles (Appendices 1a-4b). Seismograph locations and travel-time information are included in Appendices 1a, 2a, 3a, and 4a. Shot-point information is included in Appendices 1b, 2b, 3b, and 4b. In modeling the seismic refraction data, we used different conventions in naming the shot points than was used in the original field records. Descriptions of column headers for the appendices are described below. Also note that the original field records differentiated between shot

point numbers and shot numbers, whereby shot numbers refer to the chronological order in which the shots were fired, and shot point numbers refer to numbers assigned to geographical locations. To view shot gathers from the seismic profiles, see Murphy et al. (1992) for the 1991 profiles and Kohler and Catchings (1993) for the 1993 profiles.

Chan – The channel number refers to the sequence of seismographs on individual shot gathers; channel number is referenced from the southeasternmost seismograph on profiles A-A' and C-C' and the southwesternmost seismograph for profiles B-B' and D-D'. We refer to channel numbers because they are a convenient reference for purposes of 2-D tomographic velocity modeling and reflection stacking.

Sta #– The station number refers to the field location where each seismograph was deployed during the 1991 and 1993 seismic surveys.

Lat – The latitude of individual stations or shot points in degrees.

Lon – The longitude of individual stations or shot points in degrees.

Elev – The elevation of individuals stations or shot points in meters.

Inst. Type - The type of seismograph used at any particular station. Along most of the profiles, the instrument type was either a vertical-component seismic group recorder (SGR) or a 3-component Reftek seismograph. However, a limited number of ocean bottom seismometers (OBS) were deployed along the East Bay profile, within the San Pablo Bay. The OBS travel time data are not included in the report.

SP#-FAP – The time (in milliseconds) of the first-arrival (refraction) at the listed station for the numbered shot point. For example, in Appendix 1a, Station 3003 (channel 2), SP1-FAP refers to the first-arrival refraction (measured in milliseconds) from shot point 1.

Refraction Images

All models presented here (Figs. 2-5) were developed using first-arrival picks from the refraction profiles (Appendix 1a-4b) and a modified version of the code by Hole (1992). In developing the 2-D models, redundant stations (due to non-linear profiles) were not used. Structures and implications for each of the seismic profiles are discussed in forthcoming reports.

Peninsulas Profile (A-A')

Catchings and Kohler (1996) used forward raytracing methods to model data from shot points 10 and 3 of the Peninsulas profile, and their model utilized both active-source refraction data and aftershocks of the 1989 M. 6.9 Loma Prieta earthquake. Arrivals from the aftershocks provided stronger Moho refractions, which better constrained the structure of the upper mantle. However, the Catchings and Kohler (1996) model did not include data from shot points 5, 6, or 7 of the Peninsulas profile, resulting in less resolution of the upper-crustal velocity structures.

The refraction tomography model presented in this report utilizes all in-line shot points (2a, 6a, 10a, 5, 6, and 7) along the Peninsulas profile, and it provides velocity data from about 1 km to about 25 km depth (Fig. 2). Although the Peninsulas tomographic model and the Catchings and Kohler (1996) forward model were developed with differing methodologies, both models show similar features with respect to crustal thickness, dip of the Moho, depth to Moho, low-velocity zones in the upper crust, and changes in velocity across the San Andreas fault.

Loma Prieta Profile (B-B')

The Loma Prieta profile extends from the Pacific Ocean to the westernmost Santa Clara Valley, within the Santa Cruz Mountains. Because the Loma Prieta profile crosses several of the major faults west of the San Francisco Bay, this profile shows appreciable structural complexity in the upper 5 km of the crust (Fig. 3). The most pronounced feature of this profile is the relative low-velocity zone associated with the San Andreas fault. Generally, velocities west of the San Andreas fault are lower in the upper 2 km, but higher between about 2 to 5 km depth, than those on the east side of the San Andreas fault.

East Bay Profile (C-C')

The East Bay profile extended from the town of Tres Pinos to Santa Rosa, largely along the crest of the East Bay Hills (Diablo Mountains), directly east of the San Francisco Bay. Because of the long length of the profile (220 km), crustal and upper-mantle velocities were determined from depths of about 1 km to about 25 km (Fig. 4). Velocities range from about 2.5 km/s near the surface to about 6.8 km/s at 25 km depth, with appreciable lateral variation in velocities. Generally, crustal velocities along the

East Bay profile are lower than those along the San Francisco and Marin Peninsulas, but similar southward-dipping, deep-crustal layers are inferred along both profiles.

Cross Bay Profile (D-D')

The Cross Bay profile extends from the Pacific Ocean to the town of Byron, crossing the San Francisco Bay in the vicinity of Palo Alto. The Cross Bay profile, which crosses each of the major faults within the San Francisco Bay area, shows the most complexity of all the seismic profiles (Fig. 5). Within the upper 10 km of the crust, the highest crustal velocities are located between the San Andreas and Hayward faults (bay block), with velocities as high as 6.5 km/s within the upper 6 km. By contrast, velocities west of the San Andreas fault are as low as 5.5 km/s at 6 km depth, and those east of the Hayward fault are as low as 4 km/s at 6 km depth. In general, velocities east of the Hayward fault are significantly lower than velocities observed on any of the seismic profiles at comparable depths.

Data Availability

The seismic data from this report are available as shot gathers in SEG-Y format from the IRIS-PASSCAL data center. For shot gathers with elevation and timing corrections applied, see R. D. Catchings at the address on the front of this report.

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Figures

Figure 1. Map of the San Francisco Bay region showing the locations of the 1991 and 1993 USGS seismic refraction profiles, shot point locations, major faults, and various cities within the San Francisco Bay area.

Figure 2. Profile A-A'. Seismic velocity image along the Peninsulas profile between the towns of Tres Pinos and Inverness. Velocities are in kilometers per second, and the contour interval is 0.2 km/s. Depth and distance are in kilometers.

Figure 3. Profile B-B'. Seismic velocity image along the Loma Prieta profile from the Pacific Ocean to the western Santa Clara Valley. Velocities are in kilometers per second, and the contour interval is 0.2 km/s. Depth and distance are in kilometers.

Figure 4. Profile C-C'. Seismic velocity image along the East Bay profile from Tres Pinos to Santa Rosa. Velocities are in kilometers per second, and the contour interval is 0.2 km/s. Depth and distance are in kilometers.

Figure 5. Profile D-D'. Seismic velocity image along the Cross Bay profile from the Pacific Ocean to the town of Byron. Velocities are in kilometers per second, and the contour interval is 0.2 km/s. Depth and distance are in kilometers.

Appendix 1a. Peninsula profile seismograph locations and travel times.

Chan	Sta #	Lat (deg)	Lon (deg)	Elev (m)	Instr. Type	SP5-FAP	SP2a-FAP	SP7-FAP	SP6-FAP	SP10a-FAP
1	3002	36.79237	-121.29315	292	SGR	0	0	19091.63	23500.3	0
2	3003	36.79552	-121.30078	242	SGR	161.65	0	18965.62	23385.53	0
3	3004	36.79258	-121.31061	174	Reftek	357.56	0	18889.58	23309.9	0
4	3005	36.79103	-121.32197	145	SGR	607.07	0	18771.47	23210.5	0
5	3006	36.79749	-121.33053	150	SGR	809.53	0	18607.32	23045.43	0
6	3008	36.81108	-121.34678	143	SGR	1262.79	0	18282.05	22707.54	0
7	3010	36.81882	-121.3684	134	Reftek	1766.65	0	17948.4	22390.11	0
8	3011	36.82275	-121.3785	107	SGR	2006.7	0	17802.81	22238.79	0
9	3012	36.82367	-121.38691	89	SGR	2170.12	0	17697.09	22133.89	0
10	3013	36.82521	-121.40216	83	Reftek	2464.62	0	17508.22	21927.03	0
11	3014	36.82626	-121.41492	85	SGR	2743.67	0	17354.93	21773.32	0
12	3015	36.82599	-121.42619	88	SGR	2963.93	0	17234.84	21662.48	0
13	3016	36.8316	-121.43435	92	Reftek	3177.61	0	17071.19	21512.39	0
14	3017	36.83602	-121.44491	92	SGR	3401.45	0	16882.92	21351.01	0
15	3018	36.84372	-121.45448	74	SGR	3647.24	0	16701.74	21159.3	0
16	3019	36.84917	-121.46387	71	Reftek	3873.49	0	16539.2	20997.82	0
17	3020	36.84906	-121.47571	59	SGR	4091.87	0	16418.52	20879.87	0
18	3021	36.84893	-121.48642	57	SGR	4295.81	0	16300.8	20765.72	0
19	3022	36.85242	-121.4979	51	Reftek	4547.76	0	16128.11	20607.08	0
20	3023	36.85404	-121.50775	59	SGR	4730.42	0	16000.55	20490.13	0
21	3024	36.85717	-121.51912	52	SGR	4964.66	0	15838.08	20319.05	0
22	3025	36.859	-121.53043	50	SGR	5186.61	0	15688.06	20175.16	0
23	3026	36.86367	-121.54164	41	SGR	5428.03	0	15497.12	19986.44	0
24	3027	36.86984	-121.5482	46	Reftek	5596.99	8497.59	15340.59	19836.92	23235.6
25	3028	36.87624	-121.55313	40	SGR	5749.79	8323.31	15199.78	19701.71	23106.63
26	3029	36.88279	-121.56323	47	SGR	6003.97	8041.78	14998.76	19500.39	22947.16
27	3030	36.88752	-121.57514	143	Reftek	6257.47	7733.44	14795.04	19294.22	22779.22
28	3032	36.89736	-121.59696	109	SGR	6692.73	7156.98	14410.13	18917.36	22475.52
29	3033	36.90218	-121.60201	40	Reftek	6825.24	6969.29	14290.95	18801.29	22378
30	3034	36.90823	-121.61508	35	SGR	7092.09	6664.32	14062.77	18575.64	22190.57
31	3035	36.91079	-121.63016	35	SGR	7336.99	6431.08	13855.04	18375.34	22046.87
32	3036	36.91483	-121.65771	25	Reftek	7780.96	6006.77	13493.13	18028.27	21716.87
33	3037	36.92269	-121.67846	21	SGR	8114.31	5609.84	13156.07	17701.8	21447.67
34	3038	36.93102	-121.66437	442	SGR	7988.33	5618.18	13210.43	17734.25	21444.65
35	3040	36.95097	-121.6538	437	Reftek	8013.91	5423.76	13083.55	17572.87	21279.31
36	3042	36.97201	-121.6606	408	SGR	8288.44	4998.27	12750.88	17219.67	20917.91
37	3043	36.98055	-121.66229	374	Reftek	8392.88	4856.88	12629.08	17092.47	20786.87
38	3044	36.98634	-121.66986	505	SGR	8541.6	4664.36	12470.53	16927.9	20633.5
39	3046	36.99971	-121.69604	486	SGR	8981.09	4123.92	12000	16466.85	20201.23
40	3048	37.01098	-121.71335	567	SGR	9292.31	3737.03	11652.86	16127.94	19908.45
41	3049	37.01762	-121.72305	551	SGR	9476.3	3500.89	11455.63	15929.75	19733.32
42	3050	37.02438	-121.73072	584	Reftek	9636.4	3295.3	11280.77	15761.12	19583.92
43	3051	37.0283	-121.73918	607	SGR	9781.04	3134.46	11133.18	15611.11	19469.67
44	3052	37.03479	-121.74516	652	SGR	9917.66	2932.13	10985.34	15463.98	19339.29
45	3053	37.04505	-121.75209	634	SGR	10108.85	2656.55	10784.15	15258.51	19153.99
46	3054	37.048	-121.76099	698	SGR	10245.15	2463.35	10642.07	15116.09	19050.37
47	3056	37.05672	-121.78033	768	SGR	10569.48	2018.94	10308.35	14788.55	18788.43
48	3057	37.06407	-121.79177	821	Reftek	10782.54	1717.47	10086.96	14572.28	18607.08

49	3060	37.06787	-121.82446	671	SGR	11222.32	1226.75	9652.26	14179.95	18316.83
50	3061	37.07075	-121.83318	545	SGR	11356.39	1091.43	9518.79	14051.66	18227.86
51	3062	37.0766	-121.84043	515	SGR	11500.81	912.84	9346.38	13908.63	18096.71
52	3067	37.09829	-121.88592	578	SGR	12284.6	1219.78	8604.34	13162.9	17463.69
53	3068	37.10113	-121.89479	561	SGR	12433.05	1368.46	8470.65	13025.55	17357.36
54	3069	37.10705	-121.90104	569	Reftek	12569.96	1484.83	8328.97	12891.75	17224.57
55	3070	37.11229	-121.91363	541	SGR	12788.66	1725.59	8124.79	12694.2	17070.5
56	3071	37.11797	-121.92237	473	SGR	12963.68	1898.71	7961.36	12529.38	16921.85
57	3072	37.12304	-121.93195	473	Reftek	13143.11	2095.7	7793	12364.64	16785.73
58	3073	37.12764	-121.94544	462	SGR	13357.25	2357.72	7587.6	12158.63	16626.88
59	3074	37.13127	-121.95674	463	SGR	13543.91	2584.09	7372.2	11988.29	16501.18
60	3075	37.13644	-121.96593	515	Reftek	13719.4	2779.9	7166.94	11826.87	16358.46
61	3076	37.14237	-121.97315	551	SGR	13877.82	2935.46	6976.5	11664.6	16218.88
62	3077	37.14474	-121.99032	613	SGR	14135	3274.46	6716.13	11457.17	16052.23
63	3078	37.15449	-121.99903	652	Reftek	14358.98	3505.13	6429.12	11236.18	15841.02
64	3079	37.15986	-122.00696	654	SGR	14520.71	3689.13	6235.19	11084.71	15705.84
65	3080	37.16556	-122.0148	599	SGR	14694.03	3846.96	6031.72	10929.48	15556.79
66	3081	37.16697	-122.0253	646	Reftek	14848.55	4018.6	5869.12	10810.75	15467.27
67	3082	37.1735	-122.02454	663	SGR	14941.69	4058.18	5776.05	10724.47	15358.02
68	3084	37.18869	-122.03049	698	Reftek	15169.15	4275.44	5440.99	10452.64	15070.24
69	3085	37.19648	-122.03972	726	SGR	15372.08	4484.51	5183.73	10254.47	14868.17
70	3086	37.20639	-122.04854	750	SGR	15601.47	4700.47	4901.87	10030.35	14644.47
71	3087	37.21252	-122.05928	834	Reftek	15805.97	4914.09	4651.63	9841.2	14458.63
72	3088	37.21684	-122.069	864	SGR	15979.2	5087.72	4428.93	9687.75	14300.51
73	3089	37.22178	-122.07665	898	SGR	16133.5	5260.34	4234.46	9545.29	14147.43
74	3091	37.23261	-122.09735	892	SGR	16527.45	5851.95	3759.06	9196.99	13798.69
75	3092	37.23882	-122.10364	875	SGR	16678.3	5973.34	3567.83	9038.84	13635.06
76	3093	37.25016	-122.11247	835	Reftek	16923.36	6169.79	3261.1	8784.01	13360.58
77	3094	37.2572	-122.11907	804	SGR	17087.1	6305.08	3061.23	8615.06	13181.32
78	3095	37.26003	-122.1284	772	SGR	17230.24	6438.9	2885.99	8481.8	13062.65
79	3096	37.26733	-122.13733	768	Reftek	17406.2	6595.94	2641.34	8287.74	12863.99
80	3097	37.27417	-122.14637	759	SGR	17578.7	6759.05	2404.35	8099.48	12672.53
81	3098	37.28219	-122.14864	687	SGR	17682	6863.24	2254.66	7962.11	12515.3
82	3099	37.29258	-122.15735	681	Reftek	17888.81	7052.76	1935.92	7718.9	12267.23
83	3100	37.30056	-122.16122	649	SGR	18011.98	7178.26	1753.17	7561.76	12119.02
84	3101	37.30845	-122.16684	651	SGR	18155.5	7324.12	1552.53	7335.67	11960.86
85	3102	37.31295	-122.17678	639	Reftek	18313.74	7481.53	1318.33	7133.91	11831.12
86	3103	37.31674	-122.18794	695	SGR	18478.88	7654.66	1077.35	6932.13	11715.9
87	3104	37.32196	-122.1983	739	SGR	18649.99	7834.78	819.01	6714.61	11573.45
88	3105	37.32743	-122.20669	685	Reftek	18800.24	7985.24	604.92	6514.68	11439.6
89	3107	37.34119	-122.21926	609	SGR	19081.22	8316.23	337.82	6107.3	11159.93
90	3108	37.34667	-122.22851	621	Reftek	19213.61	8514.44	364.02	5906.41	11031.29
91	3109	37.35114	-122.23829	598	SGR	19369.53	8716.7	485.09	5700.87	10889.36
92	3110	37.35749	-122.24536	568	SGR	19504.27	8899.52	692.47	5496.97	10740.88
93	3111	37.3661	-122.24677	549	Reftek	19606.16	9034.03	906.32	5307.47	10576.45
94	3112	37.37175	-122.25325	536	SGR	19726.42	9183.58	1093.02	5122.11	10443.31
95	3113	37.37843	-122.26158	494	SGR	19880	9385.16	1333.82	4892.73	10244.9
96	3114	37.38869	-122.26614	457	Reftek	20038.41	9586.38	1601.67	4638.97	10015.55
97	3115	37.38921	-122.27686	510	SGR	20179.94	9723.55	1730.73	4507.88	9939.12
98	3116	37.3937	-122.28689	589	SGR	20348.17	9909.46	1924.7	4305.83	9790.3
99	3117	37.39897	-122.29208	685	Reftek	20477.27	10030.43	2086.08	4160.13	9653.56
100	3118	37.40592	-122.3025	670	SGR	20686.76	10211.96	2341.22	3915.34	9452.41

101	3119	37.4136	-122.30744	687	SGR	20839.83	10349.21	2549.68	3711.58	9266.06
102	3120	37.41668	-122.31548	718	Reftek	20940.54	10467.42	2705.26	3572.95	9164.28
103	3121	37.42738	-122.30958	617	SGR	21029.02	10519.43	2845.78	3416.91	8977.64
104	3122	37.4339	-122.31568	603	SGR	21173.93	10657.01	3043.32	3222	8805.73
105	3123	37.44145	-122.32338	656	Reftek	21358.64	10815.57	3280.05	2994.99	8617.82
106	3124	37.4481	-122.33431	632	SGR	21570.74	10980.15	3541.02	2756.56	8440.77
107	3125	37.45707	-122.33783	585	SGR	21723.19	11110.04	3746.82	2521.81	8257.58
108	3127	37.47142	-122.35483	450	SGR	0	11417.24	4223.01	2042.89	7910.63
109	3128	37.48201	-122.35845	377	SGR	0	11569.47	4447.55	1778.22	7698.34
110	3129	37.48731	-122.36266	335	Reftek	0	11662.65	4600.59	1623.99	7586.67
111	3130	37.49685	-122.36871	274	SGR	0	11819.74	4857.32	1376.78	7382.88
112	3131	37.50485	-122.37235	333	SGR	0	11950.73	5057.36	1158.42	7235.28
113	3132	37.51269	-122.37505	331	Reftek	0	12051.32	5247.74	986.1	7084.97
114	3133	37.52123	-122.37866	327	SGR	0	12180.48	5436.5	776.52	6918.5
115	3134	37.52688	-122.38632	328	SGR	0	12315.37	5632.51	552.71	6778.02
116	3135	37.53228	-122.39383	337	Reftek	0	12426.62	5806.91	336.87	6653.11
117	3136	37.53863	-122.40148	329	SGR	0	12570.43	6000.75	111.14	6502.43
118	3137	37.54452	-122.41077	344	SGR	0	12725.61	6201.31	156.38	6365.38
119	3138	37.55073	-122.41596	343	Reftek	0	12851.01	6366.25	372.67	6236.96
120	3139	37.55785	-122.42111	255	SGR	0	12978.44	6551.5	569.32	6083.25
121	3140	37.56393	-122.42723	327	SGR	0	13102.68	6735.66	763.28	5955.62
122	3142	37.5772	-122.44128	417	SGR	0	13412.8	7102.84	1210.2	5669.37
123	3143	37.58483	-122.44557	382	SGR	0	13547.58	7273.69	1404.39	5511.08
124	3144	37.59542	-122.44484	359	Reftek	0	13669.65	7458.7	1614.74	5309.59
125	3145	37.59961	-122.45229	330	SGR	0	13801.73	7611.99	1777.82	5207.99
126	3146	37.60944	-122.45678	381	SGR	0	13977.88	7828.28	2027.4	5009.98
127	3148	37.62999	-122.46074	189	SGR	0	14292.83	8245.89	2483.58	4616.34
128	3149	37.64254	-122.44785	99	SGR	0	14335.45	8377.56	2716.72	4358.14
129	3150	37.65624	-122.45325	76	Reftek	0	14577.41	8675.19	3073.03	4076.08
130	3151	37.67063	-122.45038	29	SGR	0	14750.41	8908.66	3352	3793.84
131	3152	37.68171	-122.45399	58	SGR	0	14950.22	9105.65	3601.88	3563.72
132	3153	37.69616	-122.45077	85	Reftek	0	15125.22	9323.72	3895.19	3284.24
133	3154	37.70035	-122.45408	225	SGR	0	15197.16	9405.25	4003.23	3197.83
134	3155	37.70796	-122.48505	7	SGR	0	15596.78	9738.53	4338.29	2990.57
135	3156	37.7156	-122.48441	18	Reftek	0	15698.65	9849.16	4501.22	2840.32
136	3157	37.73621	-122.48159	27	SGR	0	16023.03	10159.81	4953.05	2452.68
137	3158	37.73725	-122.45358	229	SGR	0	15773.9	10012.03	4852.4	2512.23
138	3160	37.75736	-122.47094	156	SGR	0	16242.88	10408.46	5368.96	2020.92
139	3163	37.78354	-122.4923	54	SGR	0	16836.69	10950.94	6042.33	1394.8
140	3164	37.79064	-122.48134	0	SGR	0	16844.75	10995.14	6148.67	1227.47
141	3165	37.79883	-122.47732	69	Reftek	0	16931.72	11110.95	6329.43	1039.28
142	3167	37.80932	-122.47513	-1	SGR	0	17079.5	11268.28	6572.13	811.66
143	3169	37.83592	-122.49657	980	Reftek	0	17681.36	11918.52	7306.36	327.47
144	3170	37.8443	-122.50572	85	SGR	0	17885.46	12132.51	7502.7	559.76
145	3171	37.85523	-122.51037	241	SGR	0	18099.03	12373.37	7732.05	822.4
146	3173	37.86834	-122.52857	11	SGR	0	18423.14	12758.73	8064.07	1267
147	3174	37.87273	-122.54126	177	SGR	0	18588.42	12899.94	8210.02	1523.65
148	3175	37.88497	-122.55359	195	Reftek	0	18849.53	13162.49	8495.06	1850.49
149	3176	37.8936	-122.55595	207	SGR	0	18989.62	13302.93	8667.23	2023.27
150	3177	37.90256	-122.56846	304	SGR	0	19212.53	13511.95	8893.85	2314.58
151	3178	37.90852	-122.575	281	Reftek	0	19320.37	13624.41	9036.68	2488.82
152	3180	37.91276	-122.59619	377	SGR	0	19558.21	13822.25	9231.55	2756.14

153	3182	37.91561	-122.62587	606	SGR	0	19834.79	14061.14	9463.72	3086.06
154	3183	37.92278	-122.6339	542	SGR	0	20052.38	14224.44	9640.39	3251.71
155	3185	37.93957	-122.65751	476	SGR	0	20450.16	14644.91	10044.63	3697.33
156	3186	37.94399	-122.66616	358	SGR	0	20583.19	14778.47	10168.23	3837.54
157	3187	37.94053	-122.6826	301	Reftek	0	20682.86	14835.01	10221.48	3959.57
158	3188	37.93512	-122.69761	-12	SGR	0	20744.06	14891.98	10239.99	4083.4
159	3189	37.94768	-122.70964	53	SGR	0	21054.16	15182.26	10509.71	4349.53
160	3190	37.95587	-122.71314	71	Reftek	0	21156.67	15337.93	10690.37	4478.64
161	3191	37.9643	-122.72166	136	SGR	0	21318.67	15536.18	10888.04	4680.78
162	3192	37.97283	-122.72935	122	SGR	0	21483.81	15720.18	11090.58	4903.2
163	3193	37.9809	-122.73734	118	Reftek	0	21645.12	15908.71	11288.08	5133.99
164	3194	37.99049	-122.74753	94	SGR	0	21839.17	16138.2	11526.33	5436.14
165	3195	37.9997	-122.75498	59	SGR	0	22002.39	16349.83	11719.08	5637.31
166	3196	38.01108	-122.76407	48	Reftek	0	22211.89	16579.96	11939.75	5892.82
167	3197	38.01802	-122.76967	37	SGR	0	22316.09	16713.38	12073.14	6047.73
168	3198	38.02779	-122.77751	46	SGR	0	22481.58	16917.97	12258.85	6262.1
169	3199	38.03556	-122.78186	24	Reftek	0	22595.64	17064.05	12395.89	6414.4
170	3200	38.04898	-122.7919	11	SGR	0	22852.75	17324.06	12646.57	6671.14
171	3201	38.05615	-122.79763	6	SGR	0	22933.29	17471.49	12784.57	6803.92
172	3203	38.0682	-122.82186	3	SGR	0	23235.23	17821.4	13113.11	7168.34
173	3204	38.0773	-122.83021	3	SGR	0	23386.32	18019.55	13301.72	7343.8
174	3205	38.08773	-122.84017	3	Reftek	0	23571.35	18241.74	13504.88	7553.48
175	3206	38.09461	-122.84791	3	SGR	0	23703.77	18400.61	13654.08	7713.6
176	3207	38.10928	-122.8639	3	SGR	0	23976.97	18708.39	13961.42	8032.05

Appendix 1b. Peninsula profile shot point locations and numbers.

Field SP#	Field Shot#	Model SP#	Lat (deg)	Long (deg)	Elev. (m)	Depth (m)
SP 5	Shot 1	SP1	36.79268	-121.29377	299	
SP 2a	Shot 8	SP2	37.105612	-121.847205	1034	27
SP 7	Shot 2	SP3	37.33563	-122.23213	536	
SP 6	Shot 5	SP4	37.5402	-122.40602	340	
SP 10a	Shot 10	SP5	37.827884	-122.490028	15	57

Appendix 2a. Loma Prieta profile seismograph locations and travel times.

Chan	Sta	Lat (deg)	Lon (deg)	Elev. (m)	Instr. Type	SP1-FAP	SP8-FAP	SP2-FAP	SP3-FAP
1	1016	36.98323	-121.90266	37	SGR	1299.69	2132.49	3388.24	5068.24
2	1017	36.98466	-121.90284	44	SGR	1262.56	2114.75	3367.06	5047.06
3	1018	36.98573	-121.90357	46	SGR	1236.85	2100.56	3360	5025.88
4	1019	36.98679	-121.90419	46	SGR	1214	2093.46	3345.88	5011.76
5	1020	36.98813	-121.90433	50	SGR	1185.44	2057.98	3331.76	4983.53
6	1021	36.98957	-121.90529	50	SGR	1156.87	2033.14	3317.65	4955.29
7	1022	36.99104	-121.90554	55	SGR	1119.74	2001.2	3296.47	4920
8	1023	36.99271	-121.90545	55	SGR	1085.46	1965.72	3282.35	4863.53
9	1024	36.99373	-121.90553	52	SGR	1062.61	1940.88	3261.18	4842.35
10	1025	36.99486	-121.90451	61	SGR	1036.9	1905.4	3229.53	4800
11	1026	36.99585	-121.90497	56	SGR	1016.9	1884.11	3210.19	4771.76

12	1027	36.99714	-121.90545	55	SGR	988.34	1852.18	3184.4	4736.47
13	1028	36.99846	-121.90521	56	SGR	959.77	1816.7	3155.39	4701.18
14	1029	36.99969	-121.90456	59	SGR	931.21	1788.31	3123.15	4665.88
15	1030	37.00123	-121.90523	49	SGR	879.79	1759.92	3097.36	4644.71
16	1031	37.00259	-121.90568	64	SGR	848.37	1735.09	3065.13	4616.47
17	1032	37.00411	-121.90543	64	SGR	808.38	1706.7	3036.12	4588.24
18	1033	37.00539	-121.90558	64	SGR	782.67	1664.12	3010.33	4567.06
19	1034	37.00662	-121.90659	58	SGR	765.53	1635.74	2994.21	4552.94
20	1035	37.00771	-121.90604	67	SGR	714.12	1596.71	2971.65	4524.71
21	1036	37.00899	-121.90554	67	SGR	665.56	1557.68	2945.86	4496.47
22	1037	37.01031	-121.90567	67	SGR	617	1536.39	2923.29	4475.29
23	1038	37.01159	-121.90533	73	SGR	562.72	1511.55	2894.28	4447.06
24	1039	37.01261	-121.90548	79	SGR	508.45	1493.81	2874.94	4432.94
25	1040	37.01372	-121.9053	79	SGR	451.32	1472.52	2852.38	4411.76
26	1041	37.01501	-121.90456	79	SGR	379.91	1444.13	2829.81	4376.47
27	1042	37.01659	-121.90504	79	SGR	311.36	1422.84	2810.47	4341.18
28	1043	37.01791	-121.90452	73	SGR	234.23	1387.26	2787.91	4334.12
29	1044	37.01924	-121.90413	70	SGR	174.24	1365.87	2768.56	4320
30	1045	37.02074	-121.90355	70	SGR	105.69	1339.14	2752.45	4291.76
31	1046	37.02207	-121.90323	79	SGR	34.277649	1317.76	2729.88	4277.65
32	1047	37.0232	-121.90302	79	SGR	108.55	1301.72	2713.76	4263.53
33	1048	37.02422	-121.9023	82	SGR	197.1	1266.97	2697.65	4249.41
34	1049	37.0252	-121.90151	91	SGR	291.36	1250.94	2681.53	4235.29
35	1050	37.02601	-121.90027	98	SGR	357.06	1234.9	2671.86	4221.18
36	1052	37.02864	-121.89909	113	SGR	485.6	1192.13	2620.28	4185.88
37	1053	37.02905	-121.89713	110	SGR	531.3	1160.06	2600.94	4171.76
38	1054	37.02969	-121.89454	113	SGR	605.57	1103.92	2575.15	4143.53
39	1055	37.03153	-121.89491	134	SGR	671.27	1071.85	2565.48	4150.59
40	1057	37.03389	-121.89313	201	SGR	816.95	962.26	2542.92	4108.24
41	1058	37.03534	-121.8931	213	SGR	894.08	858.01	2528.38	4087.06
42	1059	37.03654	-121.89225	226	SGR	934.07	831.28	2514.6	4065.88
43	1060	37.03899	-121.89489	323	SGR	974.06	817.92	2504.26	4051.76
44	1061	37.04111	-121.89545	329	SGR	1031.19	783.17	2459.48	4030.59
45	1062	37.04238	-121.89466	341	SGR	1074.03	745.75	2428.48	4009.41
46	1063	37.04295	-121.8928	347	SGR	1101.55	689.62	2400.92	3995.29
47	1064	37.04426	-121.89225	347	SGR	1136.96	633.49	2373.36	3981.18
48	1065	37.04369	-121.88758	384	SGR	1168.43	531.92	2352.7	3967.06
49	1066	37.04539	-121.88846	396	SGR	1231.38	505.19	2301.03	3952.94
50	1067	37.04721	-121.88891	396	SGR	1239.25	483.8	2263.13	3945.88
51	1068	37.04873	-121.88842	408	SGR	1247.12	443.71	2225.24	3882.35
52	1069	37.04839	-121.88423	433	SGR	1274.65	219.18	0	3825.88
53	1070	37.04929	-121.88265	433	SGR	1306.13	144.34	2111.57	3776.47
54	1071	37.05083	-121.88315	445	SGR	1345.47	224.53	2056.45	3734.12
55	1072	37.0522	-121.88257	463	SGR	1388.74	291.35	1994.45	3677.65
56	1073	37.05372	-121.88267	469	SGR	1443.82	358.17	1949.67	3635.29
57	1075	37.05695	-121.88255	518	SGR	1534.31	526.57	1880.77	3559.11
58	1076	37.05832	-121.88173	512	SGR	1581.52	628.14	1863.55	3544.26
59	1077	37.05742	-121.87678	555	SGR	1616.92	638.83	1832.55	3518.27
60	1078	37.05871	-121.87623	567	SGR	1668.07	684.27	1794.65	3495.99
61	1079	37.05969	-121.87529	585	SGR	1699.54	724.37	1760.21	3470
62	1080	37.06095	-121.87528	597	SGR	1727.08	761.79	1732.65	3432.87
63	1082	37.06395	-121.87443	640	SGR	1797.89	868.71	1622.42	0

64	1083	37.06508	-121.87416	658	SGR	1821.5	919.49	1577.64	3273.21
65	1084	37.06596	-121.87224	664	SGR	1864.77	972.95	1529.41	3254.65
66	1085	37.06763	-121.87242	658	SGR	1896.24	1026.41	1481.19	3232.37
67	1086	37.0691	-121.8719	673	SGR	1939.52	1079.87	1438.49	3206.38
68	1087	37.07003	-121.87085	683	SGR	1970.99	1119.96	1414.06	3180.39
69	1088	37.07135	-121.8703	713	SGR	2010.33	1192.13	1386.57	3161.83
70	1089	37.07252	-121.86922	732	SGR	2061.48	1226.88	1356.03	3117.27
71	1091	37.07487	-121.86727	774	SGR	2112.62	1328.45	1249.13	3046.72
72	1092	37.07654	-121.86759	762	SGR	2136.23	1379.24	1215.54	3002.17
73	1093	37.07668	-121.86468	768	SGR	2159.83	1422	1148.35	2972.47
74	1094	37.07796	-121.86411	771	SGR	2187.37	1496.85	1075.05	2890.78
75	1096	37.08013	-121.86226	668	SGR	2238.51	1574.36	928.45	2738.55
76	1097	37.0813	-121.86164	597	SGR	2258.18	1587.73	894.86	2671.72
77	1098	37.08251	-121.86043	549	SGR	2289.66	1603.76	839.88	2630.88
78	1099	37.08373	-121.8597	524	SGR	2305.39	1617.13	830.72	2608.6
79	1100	37.08496	-121.85861	488	SGR	2329	1633.17	775.75	2567.76
80	1101	37.08613	-121.85801	524	SGR	2356.54	1662.94	717.72	2545.48
81	1102	37.08745	-121.85755	604	SGR	2384.08	1725.86	708.56	2541.76
82	1171	37.09088	-121.85742	783	SGR	2462.76	1815.74	595.55	0
83	1172	37.09116	-121.85673	786	SGR	2466.69	1824.73	574.17	2448.24
84	1173	37.09214	-121.85587	793	SGR	2482.43	1851.69	534.47	2427.13
85	1174	37.09333	-121.85601	802	SGR	2502.1	1874.16	497.82	2409.03
86	1175	37.09444	-121.85678	821	SGR	2509.97	1887.65	482.55	2399.98
87	1176	37.09554	-121.85756	840	SGR	2521.77	1905.62	464.23	2390.93
88	1177	37.09657	-121.8577	849	SGR	2537.51	1923.6	448.96	2372.83
89	1178	37.09762	-121.85866	883	SGR	2545.37	1937.08	439.79	2363.78
90	1179	37.09833	-121.85768	895	SGR	2561.11	1959.55	406.2	2339.65
91	1180	37.09904	-121.8567	907	SGR	2576.85	1982.02	384.82	2300.44
92	1181	37.09866	-121.85259	886	SGR	2600.45	2000	335.95	2252.17
93	1182	37.09868	-121.84953	916	SGR	2620.12	2026.96	323.74	2215.98
94	1183	37.09725	-121.84526	927	SGR	2631.92	2035.95	348.17	2206.93
95	1184	37.09761	-121.84346	956	SGR	2651.6	2058.42	339.01	2188.83
96	1185	37.09825	-121.84295	971	SGR	2667.33	2058.42	332.9	2173.75
97	1186	37.09989	-121.84263	1002	SGR	2701.12	2094.38	314.57	2149.61
98	1187	37.10104	-121.84211	1024	SGR	2711.36	2125.84	290.14	2125.48
99	1188	37.10195	-121.8428	1045	SGR	2721.6	2134.82	280.98	2119.45
100	1189	37.10303	-121.8436	1033	SGR	2731.84	2148.31	238.22	2110.4
101	1190	37.10401	-121.84491	1040	SGR	2736.96	2157.29	192.41	2104.37
102	1191	37.10481	-121.84607	1015	SGR	2742.08	2161.79	134.38	2101.35
103	1192	37.10577	-121.84699	1025	SGR	2752.32	2175.27	79.407059	2095.32
104	1194	37.10651	-121.844	1042	SGR	2788.16	2220.21	216.84	2028.96
105	1195	37.10731	-121.84329	1061	SGR	2803.52	2242.68	235.17	2016.89
106	1196	37.10811	-121.84246	1067	SGR	2824	2265.15	268.76	2007.84
107	1197	37.10906	-121.84157	1073	SGR	2854.55	2305.6	317.63	1992.76
108	1199	37.11153	-121.84105	1109	SGR	2898.04	2350.54	357.33	1941.48
109	1201	37.11307	-121.83886	1076	SGR	2937.92	2395.48	421.47	1860.03
110	1202	37.11331	-121.83702	1083	SGR	2956.04	2413.46	452.01	1835.9
111	1203	37.11427	-121.83571	1078	SGR	2977.79	2440.42	488.66	1799.7
112	1204	37.1153	-121.83476	1038	SGR	2999.54	2467.39	522.25	1769.54
113	1205	37.11668	-121.83373	1064	SGR	3028.53	2507.84	561.96	1733.34
114	1206	37.11822	-121.83339	1046	SGR	3053.91	2525.81	598.61	1715.24
115	1207	37.1192	-121.83227	1046	SGR	3075.66	2552.78	638.31	1697.14

116	1208	37.12018	-121.83116	1046	SGR	3097.4	2597.72	674.96	1679.04
117	1209	37.12129	-121.83022	1013	SGR	3122.78	2620.19	729.93	1630.78
118	1210	37.12206	-121.82919	994	SGR	3140.9	2642.66	757.42	1603.63
119	1211	37.12358	-121.82911	966	SGR	3166.27	2674.12	815.45	1558.39
120	1212	37.12547	-121.82903	920	SGR	3191.65	2696.59	842.94	1531.24
121	1213	37.12645	-121.82789	878	SGR	3220.64	2750.52	870.42	1513.14
122	1215	37.12807	-121.82511	774	SGR	3278.64	2786.47	928.45	1458.84
123	1216	37.12952	-121.82491	774	SGR	3300.16	2813.44	949.83	1437.73
124	1217	37.13119	-121.82504	719	SGR	3325.76	2840.4	971.21	1401.53
125	1218	37.13264	-121.82439	674	SGR	3351.36	2871.86	998.7	1347.23
126	1219	37.13405	-121.82377	634	SGR	3382.08	2903.32	1044.51	1298.97
127	1220	37.13534	-121.82279	598	SGR	3402.56	2930.28	1062.83	1259.76
128	1221	37.13698	-121.82291	609	SGR	3433.28	2943.76	1090.32	1229.59
129	1222	37.13862	-121.82281	638	SGR	3464	2957.25	1120.86	1196.41
130	1223	37.13965	-121.82198	633	SGR	3489.6	2970.73	1145.29	1169.26
131	1224	37.14077	-121.82123	633	SGR	3510.08	2988.71	1172.78	1142.11
132	1225	37.14151	-121.81903	625	SGR	3540.8	3029.15	1203.32	1099.88
133	1226	37.14237	-121.81743	611	SGR	3576.64	3060.61	1239.97	1036.64
134	1227	37.14292	-121.81615	625	SGR	3597.12	3110.05	1279.68	1038.61
135	1228	37.14459	-121.81585	556	SGR	3638.08	3128.02	1304.11	979.6
136	1229	37.14563	-121.81485	523	SGR	3663.68	3150.49	1331.6	957.96
137	1230	37.14722	-121.81451	491	SGR	3704.64	3177.46	1365.19	924.52
138	1231	37.14878	-121.81488	478	SGR	3735.36	3213.41	1401.84	900.91
139	1232	37.15009	-121.8143	482	SGR	3766.08	3244.87	1435.44	873.37
140	1233	37.1514	-121.81372	487	SGR	3801.92	3289.81	1481.25	863.54
141	1234	37.15244	-121.81245	524	SGR	3832.64	3343.74	1530.11	836
142	1235	37.15378	-121.81217	503	SGR	3827.52	3370.71	1578.98	806.49
143	1236	37.15605	-121.81375	479	SGR	3873.6	3411.15	1618.68	792.72
144	1237	37.15818	-121.81541	471	SGR	3904.32	3456.09	1658.39	784.86
145	1238	37.15968	-121.81576	488	SGR	3935.04	3485.68	1701.14	775.02
146	1239	37.16116	-121.81573	506	SGR	3965.76	3513.09	1743.9	759.28
147	1240	37.1626	-121.81512	496	SGR	4022.08	3547.35	1792.77	739.61
148	1300	37.16573	-121.80257	232	SGR	4119.36	3667.26	1913.59	373.74
149	1301	37.16627	-121.80106	232	SGR	4129.6	3684.39	1943.84	352.1
150	1302	37.16699	-121.79951	207	SGR	4144.96	3708.37	1974.1	324.56
151	1304	37.16852	-121.79721	189	SGR	4185.92	3752.9	2028.57	230.15
152	1305	37.17052	-121.79697	168	SGR	4216.64	3790.59	2058.83	192.77
153	1306	37.17147	-121.79561	165	SGR	4237.12	3845.4	2083.04	155.4
154	1307	37.1721	-121.794	182	SGR	4257.6	3859.11	2107.24	116.06
155	1308	37.17277	-121.79222	190	SGR	4283.2	3872.81	2125.4	39.341175
156	1309	37.17298	-121.7904	176	SGR	4293.44	3883.09	2140.53	43.275295
157	1310	37.17264	-121.78811	161	SGR	4308.8	3893.36	2164.73	137.69
158	1311	37.17365	-121.78692	162	SGR	4329.28	3927.62	2207.1	180.97
159	1312	37.17482	-121.78566	152	SGR	4354.88	3968.73	2252.48	216.38
160	1313	37.17653	-121.78561	152	SGR	4375.36	4016.7	2297.87	247.85
161	1314	37.17958	-121.78783	156	SGR	4406.08	4044.1	2346.29	279.32

Appendix 2b. Loma Prieta profile shot point locations and numbers.

Field SP#	Field Shot#	Model SP#	Lat (deg)	Lon (deg)	Elev. (m)	Depth (m)
SP 1	Shot 1	SP 1	37.021353	-121.902786	79	38
SP 8	Shot 5	SP 2	37.048383	-121.882774	433	3
SP 2	Shot 2	SP 3	37.105612	-121.847205	1034	33
SP 3	Shot 3	SP 4	37.172819	-121.791568	175	33

Appendix 3a-1. East Bay profile seismograph locations and travel times (Southern Shots).

Chan	Sta	Lat (deg)	Lon (deg)	Elev. (m)	Instr. Type	SP5-FAP	SP15-FAP	SP14-FAP	SP4-FAP	SP13-FAP	SP12-FAP
1	5004	36.79237	-121.29315	292	Reftek	0	5636.94	8390.03	10932.67	0	0
2	5005	36.80187	-121.29205	249	SGR	412.87	5568.53	8302.41	10735.33	0	16918.52
3	5006	36.80464	-121.29888	236	SGR	523.88	5453.03	8190.96	10660.32	0	0
4	5007	36.8199	-121.30215	191	Reftek	0	5115.22	7881.8	10524.26	0	0
5	5008	36.82409	-121.31299	220	SGR	1355.39	4979.01	7799.47	10269.17	0	0
6	5009	36.82934	-121.33221	192	SGR	1766.78	4718.88	7549.33	10090.17	0	0
7	5010	36.83611	-121.33594	136	Reftek	0	4584.64	7339.96	10065.24	0	0
8	5011	36.84577	-121.33507	157	SGR	2100.04	4412.01	7259.55	9838.69	0	0
9	5012	36.85619	-121.33593	140	SGR	2297.31	4229.09	7068.08	9735.35	0	0
10	5015	36.87571	-121.35904	86	SGR	3016.38	3657.97	6515.29	9291.67	0	0
11	5018	36.90067	-121.37376	61	SGR	3671.2	2994.86	5985.86	8788.25	0	0
12	5019	36.9091	-121.37832	62	Reftek	0	2824.28	5831.37	8671.05	0	0
13	5020	36.9177	-121.3793	59	SGR	4059.42	2571.56	5706.99	8484.95	0	0
14	5021	36.92416	-121.38965	59	SGR	4313.24	0	5494.94	8285.77	0	0
15	5022	36.92791	-121.40582	45	Reftek	0	2043.74	5301.71	8114.5	0	0
16	5023	36.93772	-121.4088	48	SGR	4749.61	1900.05	5126.39	0	0	0
17	5024	36.9459	-121.41147	57	SGR	4947.8	1691.04	4979.54	7770.17	0	0
18	5025	36.9553	-121.41452	64	Reftek	0	1386.94	4800.04	7589.99	0	0
19	5026	36.95689	-121.43537	47	SGR	5361.34	0	4601.72	7387.59	0	0
20	5027	36.968	-121.43193	32	SGR	5516.35	645.62	4433.55	7236.08	0	0
21	5028	36.96749	-121.45181	44	Reftek	0	0	4271.06	7040.47	0	0
22	5029	36.97863	-121.45308	57	SGR	5878.49	551.92	4084.53	6895.33	0	0
23	5030	36.98978	-121.45435	70	SGR	6048.14	991.84	3729.17	6715.02	0	0
24	5033	37.01032	-121.46601	329	SGR	6461.05	1616.58	3220.78	6293.71	0	0
25	5035	37.0286	-121.48328	341	SGR	6895.87	2277.17	2710.78	5844.66	0	0
26	5036	37.03723	-121.48387	387	SGR	0	0	2504.69	0	0	0
27	5037	37.04507	-121.48733	448	Reftek	0	3000.26	2297.92	5344.67	0	0
28	5038	37.05102	-121.48953	472	SGR	7308.31	2881.85	2146.84	5435.27	0	0
29	5039	37.05878	-121.50423	424	SGR	7545.34	3243.59	1845.26	5125.75	0	0
30	5042	37.07846	-121.52726	248	SGR	8048.31	3783.49	1114.7	4580.64	0	0
31	5043	37.08485	-121.53485	257	Reftek	0	4273.25	645.27	4246.8	0	0
32	5044	37.0937	-121.54246	243	SGR	8383.61	4188.22	176.73	4146.15	0	0
33	5045	37.1027	-121.545	240	SGR	0	4388.86	237.75	3966.7	0	0
34	5047	37.12112	-121.55275	226	SGR	0	4866.37	1047.31	3531.89	0	0
35	5051	37.14905	-121.58095	262	SGR	9552.09	5605.76	1981.86	2586.51	0	0
36	5053	37.16127	-121.59822	226	SGR	9881.31	5941.9	2713.15	1939.93	0	0
37	5058	37.19427	-121.63508	241	Reftek	0	6846.46	3686.47	569.53	0	0

38	5059	37.20439	-121.64498	195	SGR	10904.43	6985.17	3900.04	93.248337	0	0
39	5060	37.20869	-121.65145	207	SGR	11049.23	7129.16	4168.21	363.52	0	0
40	5062	37.22453	-121.65961	219	SGR	11347	7464.38	4647.31	1096.81	0	0
41	5063	37.23374	-121.66663	244	SGR	11546.2	7688.77	4957.2	1590.27	0	0
42	5064	37.24148	-121.66826	262	Refttek	0	7920.4	5039.31	1800.91	0	0
43	5065	37.25207	-121.67635	307	SGR	11907.53	8088.85	5452.48	0	0	0
44	5066	37.26116	-121.67428	341	SGR	0	8239.74	5600.29	0	0	0
45	5067	37.2697	-121.67435	326	Refttek	0	8449.87	5637.27	2745.84	0	0
46	5068	37.28065	-121.67729	335	SGR	12357.99	8572.72	5956.79	0	0	0
47	5070	37.29681	-121.68763	433	Refttek	0	8993.96	6255.01	0	0	0
48	5071	37.30314	-121.69543	506	SGR	12852.75	9091.93	6463.06	0	0	0
49	5072	37.31228	-121.70139	518	SGR	13054.66	9306.32	6690.42	0	0	0
50	5078	37.35594	-121.74291	567	SGR	14089.03	10313.23	7747.08	0	0	0
51	5081	37.37217	-121.76855	448	SGR	14560.05	10791.96	8240.07	0	0	0
52	5084	37.39683	-121.79591	183	SGR	15163.33	11430.32	8856.19	0	0	0
53	5085	37.40902	-121.80021	616	Refttek	0	11654.53	8980.08	0	0	0
54	5086	37.4194	-121.78991	671	Refttek	0	11750.36	9061.09	0	0	0
55	5087	37.42761	-121.79584	518	SGR	15651.38	11913.55	9335.26	0	0	0
56	5088	37.43195	-121.80632	500	Refttek	0	12086.24	9410.73	0	0	0
57	5089	37.43529	-121.81898	415	Refttek	0	12237.12	9575.21	0	0	0
58	5090	37.43955	-121.82853	329	SGR	16111.52	12367.07	9792.37	0	0	0
59	5092	37.45462	-121.83957	390	Refttek	0	12751.55	10052.6	0	0	0
60	5093	37.46364	-121.8438	488	SGR	16632.21	12912.78	10288.23	0	0	0
61	5094	37.47308	-121.84762	543	Refttek	0	13090.49	10428.3	0	0	0
62	5095	37.48003	-121.85073	585	SGR	16966.64	13260.76	10598.19	0	0	0
63	5096	37.48762	-121.85777	634	SGR	17140.88	13385.76	0	0	0	0
64	5097	37.4981	-121.86195	683	SGR	17336.9	13656.84	0	0	0	0
65	5098	37.50301	-121.86968	707	SGR	0	13806.11	0	0	0	0
66	5099	37.51087	-121.87536	658	SGR	17654.58	13936.72	0	0	0	0
67	5100	37.51744	-121.88343	628	Refttek	0	0	0	0	0	0
68	5102	37.52786	-121.8951	347	SGR	18076.77	0	11707.88	0	0	0
69	5103	37.54223	-121.9056	219	Refttek	0	14750.75	12002.95	0	0	0
70	5104	37.54817	-121.91256	235	SGR	18543.86	14874.41	12162.93	0	0	0
71	5105	37.5564	-121.91716	140	SGR	18733.21	15063.2	0	0	0	0
72	5106	37.56214	-121.92634	183	Refttek	0	15250.33	12466.22	0	0	0
73	5108	37.57842	-121.92915	305	SGR	19182.58	15514.81	12790.28	0	0	0
74	5110	37.59354	-121.95006	61	SGR	19597.16	15927.61	13204.23	0	0	0
75	5111	37.60467	-121.95495	414	SGR	19821.64	16127.9	13452.97	10952.02	8319.54	3876.72
76	5114	37.62419	-121.97103	451	SGR	20191.22	16571.43	0	0	0	0
77	5115	37.63345	-121.97456	482	Refttek	0	16755.93	13994.57	0	0	0
78	5118	37.64443	-121.99693	442	Refttek	0	17116.03	14357.4	0	0	0
79	5121	37.66165	-122.02272	320	Refttek	0	17565.99	14833.1	0	0	0
80	5123	37.67925	-122.04195	203	SGR	21396.22	17956.45	15236.26	0	0	0
81	5124	37.68515	-122.04297	113	Refttek	0	18080.66	15346.83	0	0	0
82	5125	37.69734	-122.04473	55	SGR	21598.38	18233.29	15499.23	0	0	0
83	5126	37.70448	-122.04952	104	SGR	0	18395.34	15636.12	0	0	0
84	5128	37.72226	-122.06029	205	SGR	22058.61	18757.29	15985.56	0	0	0
85	5129	37.72953	-122.06756	251	SGR	22217.7	18915.18	16131.61	0	0	0
86	5130	37.73606	-122.07596	75	Refttek	0	19059.67	16362.48	0	0	0
87	5131	37.74199	-122.08485	139	SGR	22513.4	19246.9	16439.24	0	0	0
88	5132	37.74902	-122.09235	201	SGR	22658.74	19404.03	16596.58	0	0	0
89	5134	37.76368	-122.10714	258	SGR	0	19724.9	16918.79	0	0	0

90	5135	37.77025	-122.11342	240	SGR	23120.2	19865.09	17083.08	0	0	0
91	5137	37.78619	-122.12747	138	SGR	23417.91	20224.72	17442.79	15098.09	12708.5	8645.94
92	5138	37.79542	-122.12998	205	SGR	23580.01	20363.47	17579.85	0	0	0
93	5139	37.80281	-122.13575	235	Refttek	0	20536.17	17789.5	0	0	0
94	5140	37.81107	-122.14091	194	SGR	23897.68	20680.41	17860.53	0	0	0
95	5141	37.81854	-122.14541	150	SGR	24037.19	20783.14	18000.05	0	0	0
96	5142	37.82342	-122.15577	152	Refttek	0	20930.03	18159.7	0	0	0
97	5143	37.83107	-122.16578	208	SGR	24383.28	21092.05	18322.16	0	0	0
98	5145	37.84795	-122.17538	376	Refttek	0	21405.06	18561.6	0	0	0
99	5147	37.86238	-122.18613	265	SGR	25006.15	21641.61	18894.98	16427.9	0	10341.7
100	5148	37.86875	-122.18804	318	Refttek	0	21706.42	0	0	0	0
101	5149	37.88103	-122.18688	149	SGR	25262.13	21887.44	19127.27	0	0	0
102	5150	37.88266	-122.20197	269	SGR	0	22008.53	19274.78	0	0	0
103	5152	37.89807	-122.21797	208	SGR	25679.28	22338.53	19580.12	0	0	0
104	5153	37.90619	-122.22143	105	SGR	0	22479.79	19696	0	0	0
105	5154	37.91061	-122.23082	105	Refttek	0	22660.85	19939.69	0	0	0
106	5155	37.91812	-122.23814	122	SGR	26102.96	22810.87	19991.81	0	0	0
107	5156	37.92454	-122.24643	80	SGR	0	22965	0	0	0	0
108	5158	37.93846	-122.25779	115	SGR	26538.81	23234.48	20439.69	0	0	0
109	5159	37.94709	-122.26687	56	SGR	26708.55	23416.05	20646.45	0	0	0
110	5160	37.95369	-122.27245	58	Refttek	0	23513.93	20818.33	0	0	0
111	5161	37.95999	-122.27986	51	SGR	26999.79	23708.1	20926.72	0	0	0
112	5162	37.96376	-122.29104	40	SGR	27125.77	23820.38	21051.92	0	0	0
113	5163	37.96779	-122.29871	34	Refttek	0	23884.11	21214.15	0	0	0
114	5164	37.97593	-122.30801	82	SGR	0	24122.17	21378.48	0	0	0
115	5165	37.97857	-122.32002	85	SGR	27543.5	24236.9	21519.44	0	0	0
116	5166	37.98736	-122.32703	21	Refttek	0	24379.97	0	0	0	0
117	5167	37.99383	-122.33343	24	SGR	0	24519.65	21863.18	0	0	0
118	5168	37.99564	-122.34661	24	SGR	28037.51	24644.22	22002.28	0	0	0
119	5169	38.00197	-122.3538	11	Refttek	0	24788.47	22134.73	19799.5	0	0
120	5173	38.12185	-122.43283	-1	SGR	30217.75	26912.99	24513.03	0	0	0
121	5174	38.13281	-122.43685	-1	SGR	30405.91	27113.54	24701.02	0	0	0
122	5175	38.14322	-122.42877	-2	Refttek	0	27182.22	24805.1	0	0	0
123	5176	38.15027	-122.44191	-6	SGR	30689	27385.39	25020.9	0	0	0
124	5177	38.1578	-122.44872	-3	SGR	30848.08	27507.44	25179.99	0	0	0
125	5179	38.17401	-122.44866	16	SGR	31083.6	27756.11	25427.45	23181.42	21057.53	0
126	5180	38.1836	-122.44152	29	SGR	0	27821.78	25491.95	0	0	0
127	5181	38.19152	-122.44228	-3	Refttek	0	27938.51	0	0	0	0
128	5182	38.20106	-122.4466	2	SGR	31420.9	28070.8	25704.31	0	0	0
129	5183	38.20871	-122.4522	13	SGR	31522.98	28172.96	25806.42	0	0	0
130	5184	38.21756	-122.45373	-3	Refttek	0	28359.53	26053.63	0	0	0
131	5185	38.22726	-122.4569	-13	SGR	31798.3	28437.43	26106.24	0	0	0
132	5186	38.2364	-122.46031	-6	SGR	31942.01	28581.6	26226.18	0	0	0
133	5187	38.24531	-122.46676	0	Refttek	0	28820.1	26366.64	0	0	0
134	5188	38.24969	-122.47354	4	SGR	32216.3	28806.62	26500.34	0	0	0
135	5189	38.25787	-122.48015	7	SGR	0	28936.99	26654.71	0	0	0
136	5191	38.27286	-122.49485	20	SGR	32720.99	29237.06	26930.91	0	0	0
137	5192	38.27849	-122.50133	37	SGR	32834.86	29338.73	27044.69	0	0	0
138	5193	38.28591	-122.50468	55	Refttek	0	29627.56	27075.36	0	0	0
139	5194	38.29678	-122.50746	58	SGR	33154.86	29597.69	27328.17	0	0	0
140	5195	38.30612	-122.51245	62	SGR	33327.29	29757.42	27450.76	0	0	0
141	5198	38.32776	-122.53284	293	SGR	33713.76	30230.6	27789.08	0	0	0

142	5199	38.33004	-122.53387	298	Reftek	0	30348.2	27905.65	0	0	0
143	5200	38.33996	-122.54531	320	SGR	33964.97	30493.55	28003.16	0	0	0
144	5201	38.35061	-122.55027	298	SGR	34120.41	30661.38	28182.8	0	0	0
145	5202	38.35935	-122.55577	241	Reftek	0	30926.71	28461.06	0	0	0
146	5203	38.3671	-122.56107	203	SGR	34436.79	30991.05	0	0	0	0
147	5204	38.3761	-122.56417	178	SGR	34563.98	31106.7	28553.8	0	0	0
148	5205	38.38328	-122.57288	168	Reftek	0	31323.79	28857.03	0	0	0
149	5206	38.38859	-122.58175	210	SGR	34873.11	31390.04	28825.49	0	0	0
150	5207	38.40399	-122.58161	239	SGR	35073.94	31580.23	29027.12	0	0	0
151	5208	38.40547	-122.59495	359	Reftek	0	0	29191.95	0	0	0
152	5209	38.40729	-122.6095	390	SGR	35297.68	31813.39	29273.46	0	0	0
153	5210	38.41945	-122.60993	368	SGR	35477.16	31980.81	29404.4	0	0	0
154	5212	38.42225	-122.62555	303	SGR	35620.2	32110.58	29546.84	27402.17	25368.8	0
155	5213	38.42583	-122.64055	220	SGR	35770.99	32261.29	29698.22	0	0	0
156	5214	38.43001	-122.64508	171	Reftek	0	32399.08	29836.07	0	0	0

Appendix 3a-2. East Bay profile seismograph locations and travel times (Northern Shots).

Chan	Sta	Lat (deg)	Lon (deg)	Elev. (m)	Instr. Type	SP3-FAP	SP10-FAP	SP2-FAP	SP9-FAP	SP8-FAP	SP1-FAP
1	5004	36.79237	-121.29315	292	Reftek	0	0	24985.49	28296.08	31022.12	35590.39
2	5005	36.80187	-121.29205	249	SGR	19845.28	23114.36	24934.12	28174.57	30896.91	35463.54
3	5006	36.80464	-121.29888	236	SGR	19746.54	23039.44	24872.22	28098.28	30809.94	35378.43
4	5007	36.8199	-121.30215	191	Reftek	0	0	24561.46	27901.54	30585.28	35201.02
5	5008	36.82409	-121.31299	220	SGR	19342.75	22672.73	24443.51	27732.33	30419.26	34998.43
6	5009	36.82934	-121.33221	192	SGR	19155.2	22459.39	24341.16	27514.15	30205.51	34775.44
7	5010	36.83611	-121.33594	136	Reftek	0	0	24181.04	27379.68	30156.45	34750.07
8	5011	36.84577	-121.33507	157	SGR	18938.37	22219.17	24112.96	27277.59	29964.62	34545.63
9	5012	36.85619	-121.33593	140	SGR	18807.54	22063.67	24019.43	27149.66	29859.22	34425.75
10	5015	36.87571	-121.35904	86	SGR	18354.03	21756.86	23577.64	26717.75	29442.33	34010.25
11	5018	36.90067	-121.37376	61	SGR	17872.37	21313.46	23133.22	26263.53	29023.01	33601.82
12	5019	36.9091	-121.37832	62	Reftek	0	0	22855.99	26233.2	28867.8	33459.13
13	5020	36.9177	-121.3793	59	SGR	17601.87	21153.22	22862.91	0	28727.73	33341.8
14	5021	36.92416	-121.38965	59	SGR	17442.02	20993.23	22738.97	25895.73	28603.79	33170.91
15	5022	36.92791	-121.40582	45	Reftek	0	0	22450.18	25762.45	28412.77	0
16	5023	36.93772	-121.4088	48	SGR	17050.84	20663.73	0	25575.68	0	32867
17	5024	36.9459	-121.41147	57	SGR	16927.82	20539.9	22274.66	25442.34	28163.45	32743.39
18	5025	36.9553	-121.41452	64	Reftek	0	0	22031.08	25335.51	28005.9	32596.86
19	5026	36.95689	-121.43537	47	SGR	16551.38	0	0	25157.79	27846.74	0
20	5027	36.968	-121.43193	32	SGR	16431.39	20031.37	21790.15	25043.3	27765.9	32321.33
21	5028	36.96749	-121.45181	44	Reftek	0	0	21635.85	25017.44	27622.87	32206.35
22	5029	36.97863	-121.45308	57	SGR	16095.07	19731.26	21478.03	24738.73	27477.43	32010.41
23	5030	36.98978	-121.45435	70	SGR	15924.02	0	21295.55	24572.33	27307.21	31838.61
24	5033	37.01032	-121.46601	329	SGR	15536.72	19185.76	20883.53	24174.52	26957.3	31475.6
25	5035	37.0286	-121.48328	341	SGR	15125.47	18836.39	20497.17	23774.59	26582.91	31101.71
26	5036	37.03723	-121.48387	387	SGR	0	0	0	0	0	0
27	5037	37.04507	-121.48733	448	Reftek	0	0	20173.85	23603.1	26382.67	30899.35
28	5038	37.05102	-121.48953	472	SGR	14742.4	18465.81	20088.47	23408.83	26248.28	30752.33
29	5039	37.05878	-121.50423	424	SGR	14525.71	18224.85	19860.6	23176.98	26056.41	30550.36
30	5042	37.07846	-121.52726	248	SGR	14033.84	17756.6	19380.39	22682.38	25614.07	30108.57

31	5043	37.08485	-121.53485	257	Reftek	0	0	19194.73	0	25539.35	30009.38
32	5044	37.0937	-121.54246	243	SGR	13674.68	17422.24	19009.03	22347.16	25340.64	29810.75
33	5045	37.1027	-121.545	240	SGR	13502.92	17250.83	18861.61	0	25316.35	29675.38
34	5047	37.12112	-121.55275	226	SGR	13155.84	16953.14	18514.85	21883.5	24944.68	29338.96
35	5051	37.14905	-121.58095	262	SGR	12482.37	16315.44	17865.2	21257.26	24405.99	28740.51
36	5053	37.16127	-121.59822	226	SGR	12139.99	15985.53	17511.32	20960.47	24149.94	28449.19
37	5058	37.19427	-121.63508	241	Reftek	0	0	16738.68	20196.83	23179.81	27653.38
38	5059	37.20439	-121.64498	195	SGR	11083.17	14915.23	16488.92	19922.44	23114.95	27453.91
39	5060	37.20869	-121.65145	207	SGR	10939.93	14796.48	16383.11	19802.22	23007.9	0
40	5062	37.22453	-121.65961	219	SGR	10603.73	14448.04	16071.75	19505.55	22696.92	27047.49
41	5063	37.23374	-121.66663	244	SGR	10404.3	14211.67	15884.4	19318.62	22510.6	26885.07
42	5064	37.24148	-121.66826	262	Reftek	0	0	15775.55	19238.31	22255.02	26727.37
43	5065	37.25207	-121.67635	307	SGR	9967.31	13849.44	15534.22	18984.51	22135.73	26558.94
44	5066	37.26116	-121.67428	341	SGR	9782.54	13701.64	15423.39	0	0	26470.95
45	5067	37.2697	-121.67435	326	Reftek	0	0	15317.14	18763.94	21820.93	26263.78
46	5068	37.28065	-121.67729	335	SGR	9397.79	13343.25	15100.67	18575.65	21715.29	0
47	5070	37.29681	-121.68763	433	Reftek	0	0	14768.08	18281.02	21321.53	25773.67
48	5071	37.30314	-121.69543	506	SGR	8805.39	12811.81	14631.17	18106.16	0	25661.62
49	5072	37.31228	-121.70139	518	SGR	8518.54	12585.87	14442.15	17930.23	21056.62	25484.97
50	5078	37.35594	-121.74291	567	SGR	7283.36	11535.82	13441.24	17002.43	20080.89	24546.72
51	5081	37.37217	-121.76855	448	SGR	6761.11	11025.12	12955.88	16523.14	19631.68	24138.15
52	5084	37.39683	-121.79591	183	SGR	6096.67	10396.56	12315.34	15941.33	19039.91	23572.44
53	5085	37.40902	-121.80021	616	Reftek	0	0	12018.7	15673.62	18817.49	23348.33
54	5086	37.4194	-121.78991	671	Reftek	0	0	11947.13	15625.12	18770.22	23283.95
55	5087	37.42761	-121.79584	518	SGR	5518.64	9879.9	11834.69	15500.59	18570.66	23109.03
56	5088	37.43195	-121.80632	500	Reftek	0	0	11606.06	15305.47	18453.58	22994.27
57	5089	37.43529	-121.81898	415	Reftek	0	0	11437.23	15143.03	18309.05	22864.97
58	5090	37.43955	-121.82853	329	SGR	4962.93	9386.35	11342.13	15020.35	18115.85	22685.65
59	5092	37.45462	-121.83957	390	Reftek	0	0	10958.03	14674.8	17830.8	22437.17
60	5093	37.46364	-121.8438	488	SGR	4405.99	8854.21	10821.92	14541.2	17620.75	22214.08
61	5094	37.47308	-121.84762	543	Reftek	0	0	10585.05	14343.34	17493.82	22122.82
62	5095	37.48003	-121.85073	585	SGR	4086.5	8534.88	10477.27	14238.6	17324.93	21941
63	5096	37.48762	-121.85777	634	SGR	3849.99	8323.39	10278.81	14064.1	17150.49	21790.8
64	5097	37.4981	-121.86195	683	SGR	3633.08	8092.64	0	13885.41	16969.04	21619.69
65	5098	37.50301	-121.86968	707	SGR	3504.44	7952.65	9944.96	13743.71	16829.56	0
66	5099	37.51087	-121.87536	658	SGR	3251.71	7773.66	9764.88	13577.67	16662.41	21326.04
67	5100	37.51744	-121.88343	628	Reftek	0	0	9499.22	0	0	0
68	5102	37.52786	-121.8951	347	SGR	2752.92	7337.41	9303.96	13139.07	16238.74	20916.35
69	5103	37.54223	-121.9056	219	Reftek	0	0	8924.44	12809.49	15969.14	20659.21
70	5104	37.54817	-121.91256	235	SGR	2236.78	6808.27	8861.8	12684.81	15807.58	20486.38
71	5105	37.5564	-121.91716	140	SGR	1987.71	6644.78	8698.13	0	15643.79	20321.75
72	5106	37.56214	-121.92634	183	Reftek	0	0	8422.98	12307.32	15479.8	20245.39
73	5108	37.57842	-121.92915	305	SGR	1340.32	6162.25	8263.68	12070.01	15208.61	19909.01
74	5110	37.59354	-121.95006	61	SGR	0	5706.42	7844.78	11659.31	14816.48	19556.14
75	5111	37.60467	-121.95495	414	SGR	349.72	5472.28	7648.02	11453.83	14606.28	19368.15
76	5114	37.62419	-121.97103	451	SGR	572.33	5004.32	7167.77	11012.57	14174.87	18949.58
77	5115	37.63345	-121.97456	482	Reftek	0	0	6936.58	10847.45	14004.83	18826.66
78	5118	37.64443	-121.99693	442	Reftek	0	0	6482.59	0	13662.41	18489.84
79	5121	37.66165	-122.02272	320	Reftek	0	0	5872.27	0	13186.16	18030.16
80	5123	37.67925	-122.04195	203	SGR	2695.66	3283.09	5506.98	9516.78	12819.63	17543.47
81	5124	37.68515	-122.04297	113	Reftek	0	0	5369.75	9433.92	12671.46	17528.89
82	5125	37.69734	-122.04473	55	SGR	3059	2794.59	5155.32	9205.53	12532.13	17238.22

83	5126	37.70448	-122.04952	104	SGR	3244.51	2620.99	0	0	12383.41	0
84	5128	37.72226	-122.06029	205	SGR	3666.47	2225.27	4584.4	8705.55	12022.86	16750.62
85	5129	37.72953	-122.06756	251	SGR	3923.56	2029.6	4412.97	8509.97	11851.54	16592.88
86	5130	37.73606	-122.07596	75	Reftek	0	0	3961.31	8338.03	11571.12	16485.83
87	5131	37.74199	-122.08485	139	SGR	4319.44	1546.49	4006.25	8157.95	11517.93	16274.47
88	5132	37.74902	-122.09235	201	SGR	4538.24	1267.69	3763.05	8011.57	11335.52	0
89	5134	37.76368	-122.10714	258	SGR	4996.14	716.94	3356.5	7664.35	0	15760.9
90	5135	37.77025	-122.11342	240	SGR	5160.62	411.88	3142.55	7512.06	10825.08	15634.05
91	5137	37.78619	-122.12747	138	SGR	5508.32	406.32	2660.35	7154	10428.4	15286.86
92	5138	37.79542	-122.12998	205	SGR	5729.74	703.25	2484.64	6989.3	10278.34	15159.44
93	5139	37.80281	-122.13575	235	Reftek	0	0	2274.97	0	10031.74	14986.68
94	5140	37.81107	-122.14091	194	SGR	6058.94	1180.14	2130.15	0	9936.93	14841.03
95	5141	37.81854	-122.14541	150	SGR	6235.23	1394.41	1955.37	6508.81	9785.73	14700.92
96	5142	37.82342	-122.15577	152	Reftek	0	0	1487.38	6228.36	9539.4	14580.91
97	5143	37.83107	-122.16578	208	SGR	6608.29	1877.72	1255.49	6135.9	9426.04	14396.41
98	5145	37.84795	-122.17538	376	Reftek	0	0	766.31	5688.65	8978.56	14080.82
99	5147	37.86238	-122.18613	265	SGR	7376.59	2792.31	149.49	5497.66	8755.31	13832.96
100	5148	37.86875	-122.18804	318	Reftek	0	0	0	0	8568.47	13705.16
101	5149	37.88103	-122.18688	149	SGR	7742.46	3252.45	626.71	5241.75	8430.31	13559.34
102	5150	37.88266	-122.20197	269	SGR	7927.16	3430.14	762.67	5045.69	8277.73	13415.87
103	5152	37.89807	-122.21797	208	SGR	8344.89	3821.5	1374.86	4654.97	7910.06	13050.18
104	5153	37.90619	-122.22143	105	SGR	8509.31	4048.4	1650.82	4505.37	7720.64	12895.77
105	5154	37.91061	-122.23082	105	Reftek	0	0	1919.13	4150.96	7550.41	12754.08
106	5155	37.91812	-122.23814	122	SGR	8842.06	4430.57	0	4089.9	0	12579.68
107	5156	37.92454	-122.24643	80	SGR	9009.05	4633.63	0	3834.46	7234.05	12427.23
108	5158	37.93846	-122.25779	115	SGR	9352.3	5050.84	0	3444.02	6915.57	12133.87
109	5159	37.94709	-122.26687	56	SGR	9608.38	5319.98	0	3192.75	6672.06	11928.61
110	5160	37.95369	-122.27245	58	Reftek	0	0	0	2760.42	6549.18	11768.92
111	5161	37.95999	-122.27986	51	SGR	9938.01	5697.7	0	2851.4	6343.24	11589.33
112	5162	37.96376	-122.29104	40	SGR	10151.27	5900.03	0	2590.62	6171.5	11446.49
113	5163	37.96779	-122.29871	34	Reftek	0	0	0	0	5976.29	11349.95
114	5164	37.97593	-122.30801	82	SGR	10479.77	6266.77	0	2259.39	5826.24	11115.85
115	5165	37.97857	-122.32002	85	SGR	10636.47	6476.46	0	1705.02	5671.76	10987.84
116	5166	37.98736	-122.32703	21	Reftek	0	0	4649.67	1531.16	5418.91	10808
117	5167	37.99383	-122.33343	24	SGR	11029.9	6868.27	0	1308.88	5306.1	10646.16
118	5168	37.99564	-122.34661	24	SGR	11186.25	7042.03	0	862.33	5139.75	10526.24
119	5169	38.00197	-122.3538	11	Reftek	0	0	5249.25	511.56	4926.91	10360.96
120	5173	38.12185	-122.43283	-1	SGR	13698.32	9668.41	0	3736.84	1858.14	7849.02
121	5174	38.13281	-122.43685	-1	SGR	13885.09	9854.79	0	4007.75	1525.25	7629.98
122	5175	38.14322	-122.42877	-2	Reftek	0	0	8136.71	4326.15	1640.42	7540.81
123	5176	38.15027	-122.44191	-6	SGR	14179.31	10123.84	0	4406.54	1098.11	7273.04
124	5177	38.1578	-122.44872	-3	SGR	14325.42	0	0	4684.62	614.8	7091.32
125	5179	38.17401	-122.44866	16	SGR	14559.6	10528.82	0	5010.51	390	0
126	5180	38.1836	-122.44152	29	SGR	14636.94	0	8875.06	5141.41	815.6	6704.65
127	5181	38.19152	-122.44228	-3	Reftek	0	0	0	0	517.63	6599.53
128	5182	38.20106	-122.4466	2	SGR	14836.84	10920.64	0	5471.15	1304.62	6379.93
129	5183	38.20871	-122.4522	13	SGR	14914.02	11083.93	0	5656.23	1601.7	6228.75
130	5184	38.21756	-122.45373	-3	Reftek	0	0	9503.58	5781.52	1986.82	6030.8
131	5185	38.22726	-122.4569	-13	SGR	15203	11400.17	0	6027.38	2168.35	5868.46
132	5186	38.2364	-122.46031	-6	SGR	15347.52	11557.65	0	6216.5	2401.98	0
133	5187	38.24531	-122.46676	0	Reftek	0	0	9993.24	6377.48	2614.32	5463.67
134	5188	38.24969	-122.47354	4	SGR	15622.31	11843.72	10186.07	6449.18	2773.75	5389.37

135	5189	38.25787	-122.48015	7	SGR	15764.69	11986.04	10365.34	6649.01	2991.81	5198.2
136	5191	38.27286	-122.49485	20	SGR	16088.55	12334.25	10713.09	7044.55	3403.53	4848.13
137	5192	38.27849	-122.50133	37	SGR	16215.1	12435.37	10838.95	7138.83	3544.48	4696.7
138	5193	38.28591	-122.50468	55	Reftek	0	0	10895.77	7297.4	3641.13	4531.34
139	5194	38.29678	-122.50746	58	SGR	16536.75	12746.84	11187.43	7474.41	3979.31	4345.26
140	5195	38.30612	-122.51245	62	SGR	16696.75	12919.37	11361.24	7661.74	4203.3	4114.99
141	5198	38.32776	-122.53284	293	SGR	17168.61	13452.43	11807.76	8143.6	4743.27	3579.77
142	5199	38.33004	-122.53387	298	Reftek	0	0	11802.7	8213.3	4579	3402.45
143	5200	38.33996	-122.54531	320	SGR	17395.33	13702.55	12082.49	8396.86	5009.3	3228.13
144	5201	38.35061	-122.55027	298	SGR	17600.49	13884.41	12251.72	8582.38	5218.79	2957.01
145	5202	38.35935	-122.55577	241	Reftek	0	0	12357.62	8811.46	5214.9	2634.63
146	5203	38.3671	-122.56107	203	SGR	0	14177.76	12520.28	8887.58	0	2477.01
147	5204	38.3761	-122.56417	178	SGR	18058.52	14343.72	12686.69	9058.38	5707.8	2327.89
148	5205	38.38328	-122.57288	168	Reftek	0	0	12804.37	9267.44	5720.16	1849.69
149	5206	38.38859	-122.58175	210	SGR	18341.06	14660.64	12990.67	9372.38	6034.99	1787.19
150	5207	38.40399	-122.58161	239	SGR	18581.68	14891.78	13186.18	9644.42	6281.93	1523.94
151	5208	38.40547	-122.59495	359	Reftek	0	0	13259.18	9735.91	6313.25	1195.61
152	5209	38.40729	-122.6095	390	SGR	18812.62	15117.96	13385.79	9868.06	6498.78	1010.62
153	5210	38.41945	-122.60993	368	SGR	18992.57	15288.44	13569.04	10073.95	6702.09	640.59
154	5212	38.42225	-122.62555	303	SGR	19158.68	15427.44	13731.97	10207.07	6852.6	52.125
155	5213	38.42583	-122.64055	220	SGR	19260.37	15526.62	13891.47	10352.66	7016.85	0
156	5214	38.43001	-122.64508	171	Reftek	0	0	13968.11	10451.64	7141.79	0

Appendix 3b. East Bay profile shot point locations and numbers.

Field SP#	Field Shot#	Model SP#	Lat (deg)	Lon (deg)	Elev. (m)
SP 5	Shot 10	SP 1	36.79268	-121.29377	299
SP 15	Shot 7	SP 2	36.96718	-121.4525	44
SP 14	Shot 14	SP 3	37.09758	-121.54524	253
SP 4	Shot 6	SP 4	37.20493	-121.64463	201
SP 13	Shot 13	SP 5	37.31633	-121.70225	463
SP 12	Shot 15	SP 6	37.48407	-121.85296	622
SP 3	Shot 8	SP 7	37.60766	-121.96499	411
SP 10	Shot 16	SP 8	37.77989	-122.1162	198
SP 2	Shot 12	SP 9	37.86486	-122.18826	244
SP 9	Shot 17	SP 10	38.00375	-122.36447	21
SP 8	Shot 9	SP 11	38.16774	-122.45167	2
SP 1	Shot 11	SP 12	38.4234	-122.62912	280

Appendix 4a. Cross Bay profile seismograph locations and travel times.

Chan	Sta #	Lat (deg)	Lon (deg)	Elev. (m)	Instr. Type	SP7-FAP	SP17-FAP	SP3-FAP	SP18-FAP
1	4004	37.23389	-122.40403	61	SGR/No_data	4250.59	8523.06	0	14849.15
2	4005	37.24253	-122.39699	55	No_data/SGR	0	0	10794.99	0
3	4006	37.25113	-122.38802	7	Reftek/Missing	3963.95	8130.37	0	14543.05
4	4007	37.24686	-122.36692	18	SGR/No_data	3887.6	8042.18	0	14450.45
5	4008	37.25064	-122.3534	21	SGR	3701.11	7862.93	10336.18	14318.54
6	4009	37.25462	-122.34531	37	Reftek	3488.82	7699.41	10216.42	14070.18

7	4010	37.26082	-122.33014	24	SGR	3098.4	7448.54	10026.1	13948.89
8	4011	37.26252	-122.32148	37	SGR	2922.33	7375.38	9920.25	13949.5
9	4012	37.26974	-122.31467	37	Reftek	2830.62	7169.23	9725.21	13609.99
10	4013	37.27393	-122.30085	67	SGR	2571.06	7012.88	9578.42	13531.83
11	4014	37.27723	-122.2856	67	SGR	2423.85	6836.23	9405.27	13535.05
12	4015	37.2853	-122.28131	146	Reftek/Missing	2214.56	6679.77	0	13225.03
13	4016	37.29196	-122.27788	195	SGR	1896.9	6560.2	9120.3	13152.18
14	4017	37.29745	-122.27528	308	SGR	1826.06	6426.55	9016.86	13050.81
15	4018	37.3081	-122.27172	140	Reftek	1450.21	6223.45	8914.44	0
16	4019	37.31543	-122.27163	128	SGR	1167.63	6137.06	8710.96	12768.51
17	4020	37.32319	-122.26194	241	SGR	842.65	5951.12	8439.14	12524.01
18	4021	37.33815	-122.26889	177	Reftek	871.74	5759.28	8240.59	12538.86
19	4022	37.33644	-122.24625	488	SGR	452.01	5617.48	8074.69	12186.84
20	4023	37.33784	-122.23394	506	SGR	112.83	5494.66	7940.33	12076.2
21	4024	37.34667	-122.22851	621	Reftek	570.02	5289.12	7706.69	11859.39
22	4025	37.35838	-122.21782	226	SGR/No_data	1050.73	5028.53	0	11667.11
23	4026	37.36477	-122.21737	195	SGR	1277.21	5001.39	7399.3	11607.85
24	4027	37.3696	-122.20991	189	Reftek/Missing	1461.62	4791.01	0	11424.47
25	4028	37.37528	-122.20195	149	SGR	1595.9	4642.92	7062.79	11360.58
26	4029	37.38126	-122.19408	122	SGR	1814.58	4431.34	6860.8	11139.55
27	4030	37.39088	-122.1895	98	Reftek	2011.84	4219.93	6638.16	10963.32
28	4031	37.40257	-122.1915	73	SGR/Reftek+SGR	2450.39	4026.4	6492.55	10873.65
29	4032	37.4111	-122.18935	82	SGR	2691.69	3880.26	6311.74	10735.15
30	4033	37.42022	-122.18171	70	Reftek	2881.11	3635.74	6125.22	10441.28
31	4034	37.42807	-122.17897	37	SGR/No_data	2872.72	3456.08	0	10405.72
32	4035	37.43477	-122.16979	23	SGR	3032.04	3188.17	5836.49	10191.3
33	4036	37.44227	-122.16554	20	Reftek/No_data	3251.11	2952.28	0	9996.83
34	4037	37.45182	-122.1643	18	No_data/SGR	0	0	5431.45	0
35	4038	37.45647	-122.15261	14	SGR	3746.73	2520.16	5287.76	9719.68
36	4039	37.46325	-122.1416	6	Missing/Reftek	0	0	4944.63	0
37	4040	37.47285	-122.14019	5	SGR	4110.1	2114.21	4804.5	9295.2
38	4041	37.48325	-122.13419	2	SGR	4311.4	1799.02	4481.08	9058.4
39	4042	37.49	-122.12531	2	Reftek/Missing	4420.47	1509.5	0	8813.65
40	4044	37.5015	-122.10611	2	Reftek	4714.37	1057.89	3920.38	8712.13
41	4045	37.5071	-122.10009	2	SGR	4880.97	823.7	3700.83	8504.92
42	4046	37.51379	-122.09429	2	Reftek	4999.12	680.61	3624.1	8359.76
43	4047	37.5209	-122.08326	2	Reftek/SGR	5185.96	409.99	3457.51	8136.99
44	4048	37.5295	-122.07741	2	SGR/Reftek	5419.36	198.26	3147.12	7896.17
45	4050	37.5392	-122.06232	3	SGR/No_data	5680.99	469.23	0	7642.81
46	4051	37.54557	-122.0527	5	Reftek	5787.87	0	2621.66	7525.64
47	4052	37.54855	-122.0427	6	Reftek	5944.26	845.52	2419.06	7321.92
48	4054	37.56187	-122.03309	9	Reftek/No_data	6333.07	1187.24	0	7137.97
49	4055	37.5648	-122.01834	12	No_data/Reftek	0	0	1868.61	0
50	4057	37.57963	-122.00224	15	Reftek/Missing	6928.88	1886.75	0	6523.91
51	4058	37.58458	-121.9936	24	Reftek/Missing	7067.68	2060.28	0	6308.04
52	4060	37.5969	-121.98026	290	Reftek	7378.94	2452.25	632.11	6098.15
53	4061	37.60298	-121.97204	396	SGR/Reftek	7458.88	2701.18	382.09	5782.11
54	4063	37.6168	-121.95844	512	Reftek	7887.45	3089.89	315.56	5320.08
55	4064	37.61689	-121.94376	219	Reftek	8034.53	3280.08	616.92	4974.28
56	4065	37.62629	-121.94308	256	SGR/Reftek	8228.07	3403.36	789.78	4630.18
57	4066	37.63477	-121.93255	579	Reftek	8521.25	3722.27	1136.12	4140.8
58	4067	37.63585	-121.91935	280	SGR/Reftek	8754.53	3882.75	1518.97	3902.78

59	4068	37.64776	-121.90896	183	No_data/SGR	0	0	1889.63	0
60	4069	37.65496	-121.90427	98	No_data/SGR	0	0	2200.05	0
61	4070	37.65925	-121.89586	101	Missing/Refttek	0	0	2456.23	0
62	4071	37.66577	-121.89052	101	No_data/SGR	0	0	2891.35	0
63	4072	37.66955	-121.88339	101	No_data/SGR	0	0	3170.31	0
64	4073	37.67638	-121.87071	107	Refttek	10336.45	5175.15	3546.74	2584.8
65	4074	37.68214	-121.86144	110	No_data/SGR	0	0	3845.21	0
66	4075	37.68841	-121.85756	110	No_data/SGR	0	0	4120.79	0
67	4076	37.6945	-121.84747	107	Refttek	11087.05	5849.96	4280.01	2053.33
68	4077	37.70061	-121.84043	110	No_data/SGR	0	0	4528.73	0
69	4078	37.70538	-121.8343	128	No_data/SGR	0	0	4781.77	0
70	4079	37.71209	-121.82273	134	Refttek	11570.86	6440.77	4951.76	1583.02
71	4080	37.72271	-121.82326	155	No_data/SGR	0	0	5177.92	0
72	4081	37.72473	-121.80758	158	No_data/SGR	0	0	5410.91	0
73	4083	37.73012	-121.78826	235	Refttek	12229.18	7125.55	5660.48	59.53072
74	4085	37.74514	-121.76871	177	No_data/SGR	0	0	6396.48	0
75	4087	37.75247	-121.7459	196	No_data/SGR	0	0	6655.25	0
76	4089	37.77235	-121.73797	238	Missing/Refttek	0	0	6970.42	0
77	4092	37.80998	-121.73627	119	No_data/SGR	0	0	7622.12	0
78	4094	37.83195	-121.72811	101	Refttek	14582.78	9434.96	8049.27	3625.49
79	4096	37.84722	-121.71299	70	No_data/SGR	0	0	8478.15	0
80	4098	37.85503	-121.69526	55	No_data/SGR	0	0	8785.8	0
81	4100	37.86216	-121.67232	55	Refttek	15661.61	0	9234.16	4899.66

Appendix 4b. Cross Bay profile shot point locations and numbers.

Field SP#	Field Shot#	Model SP#	Lat (deg)	Lon (deg)	Elev. (m)
SP 7	Shot 2	SP 1	37.33563	-122.23213	536
SP 17	Shot 3	SP 2	37.53497	-122.07312	21
SP 3	Shot 8	SP 3	37.60766	-121.96499	411
SP 18	Shot 4	SP 4	37.7297	-121.78802	235

Bay Area Refraction Profiles

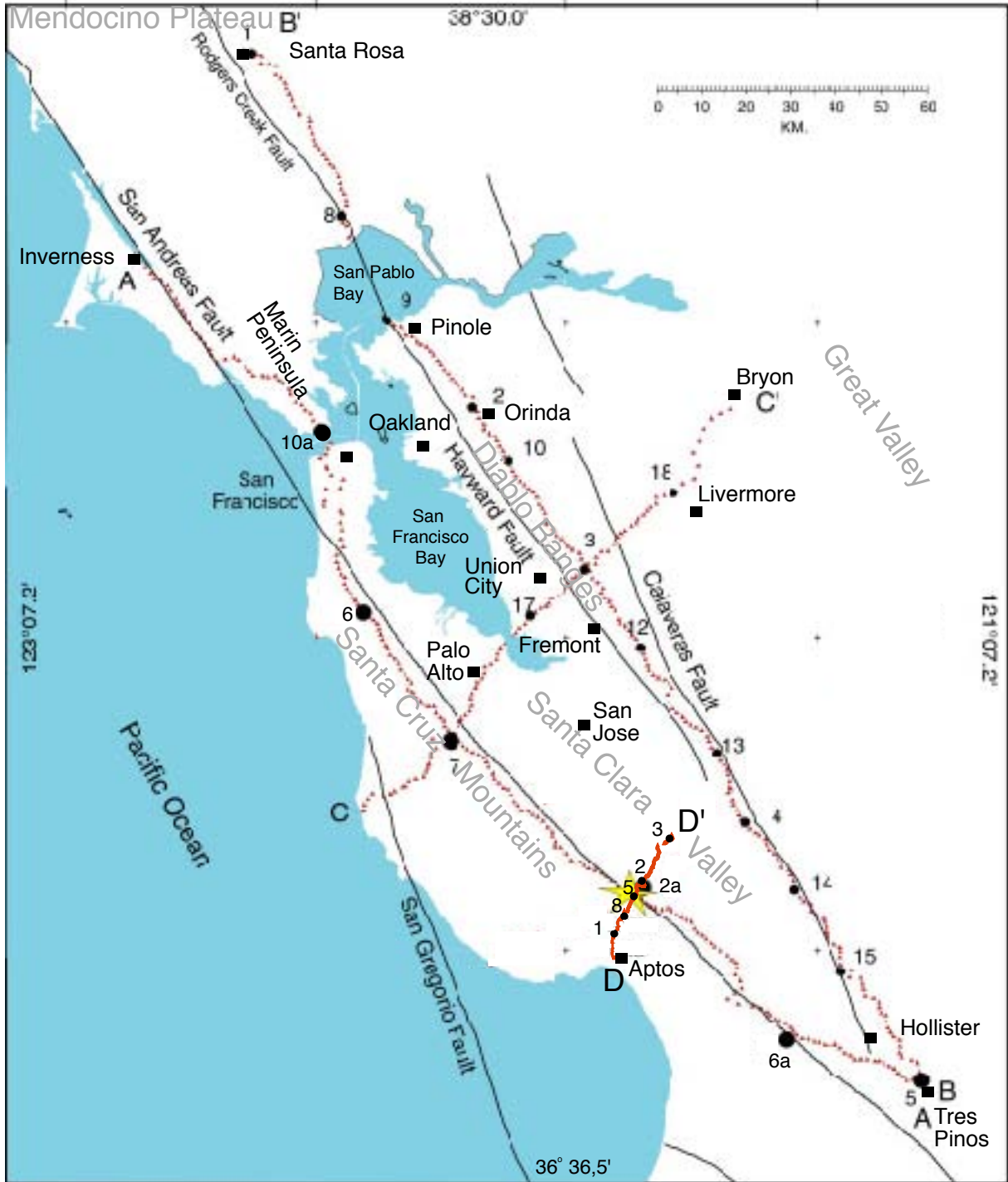


Fig. 1

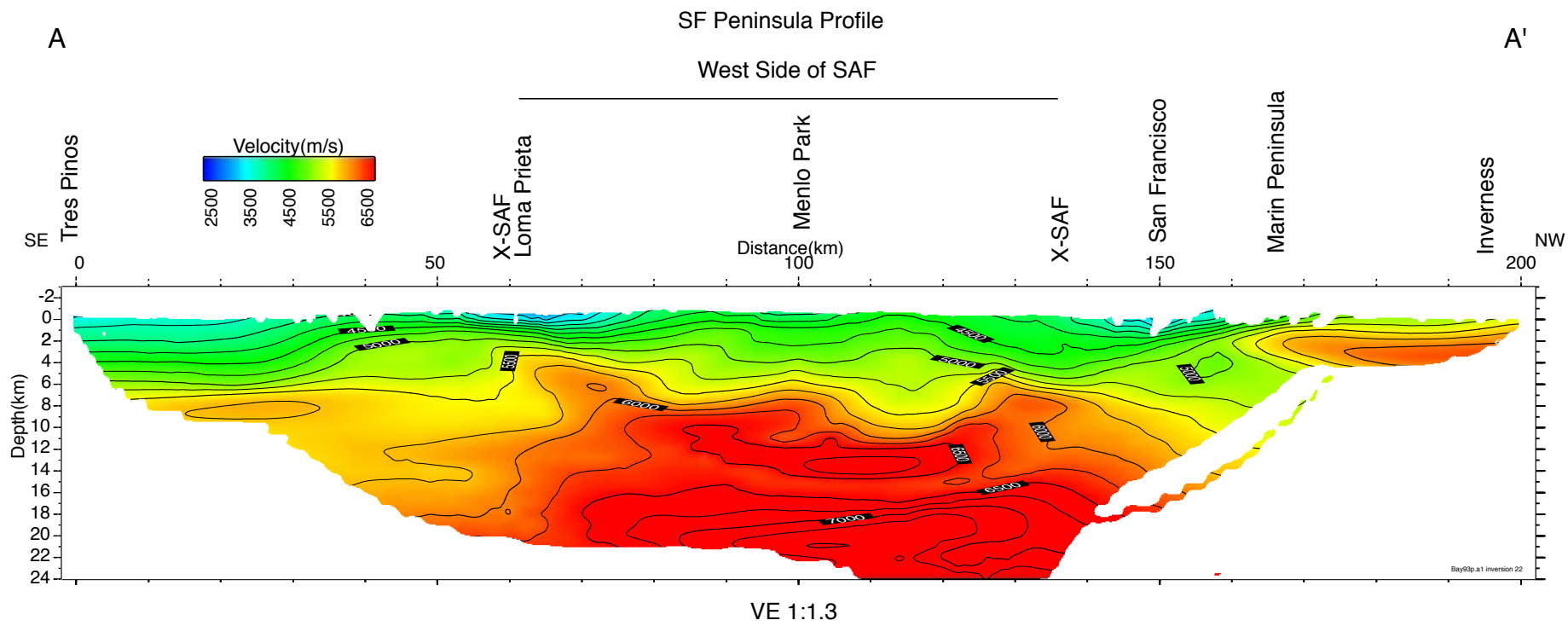


Fig. 2

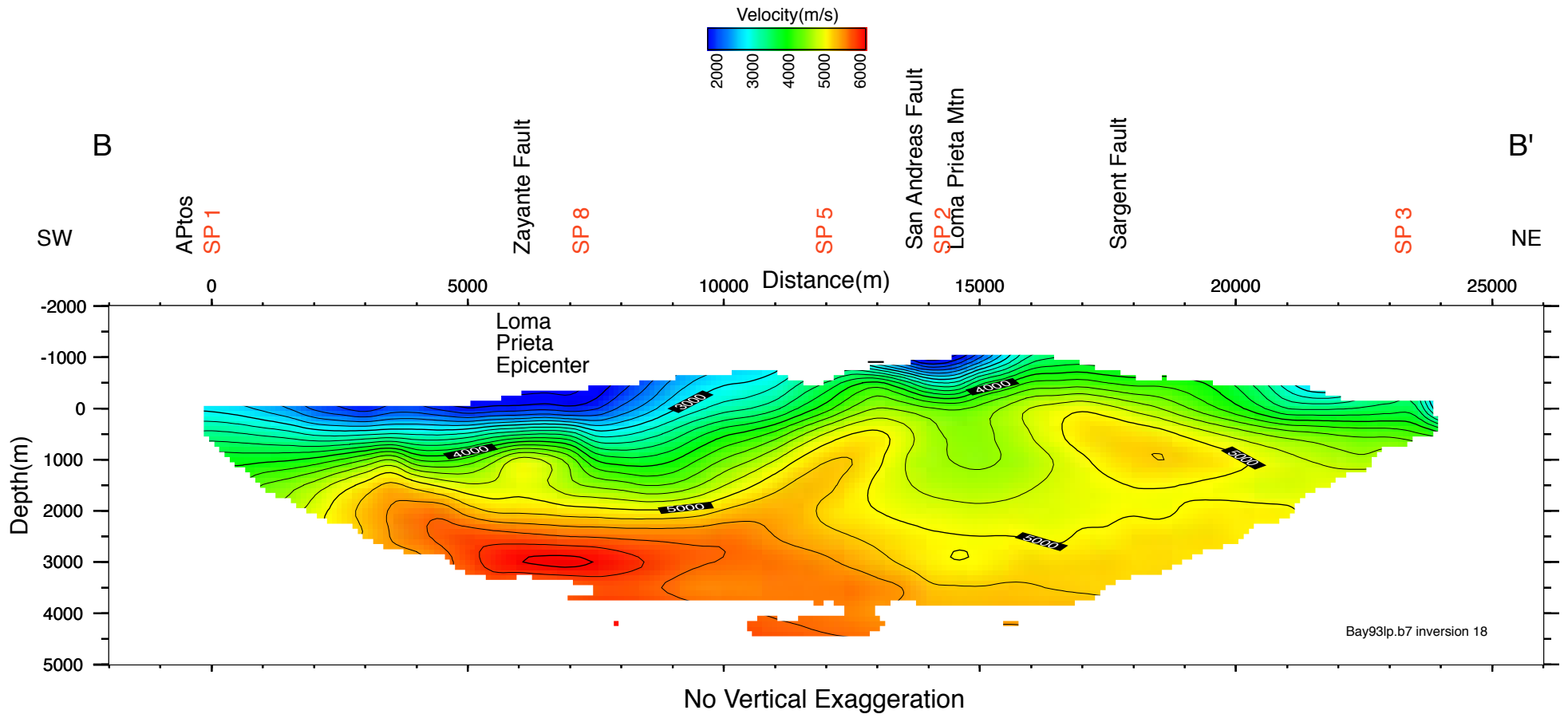


Fig. 3

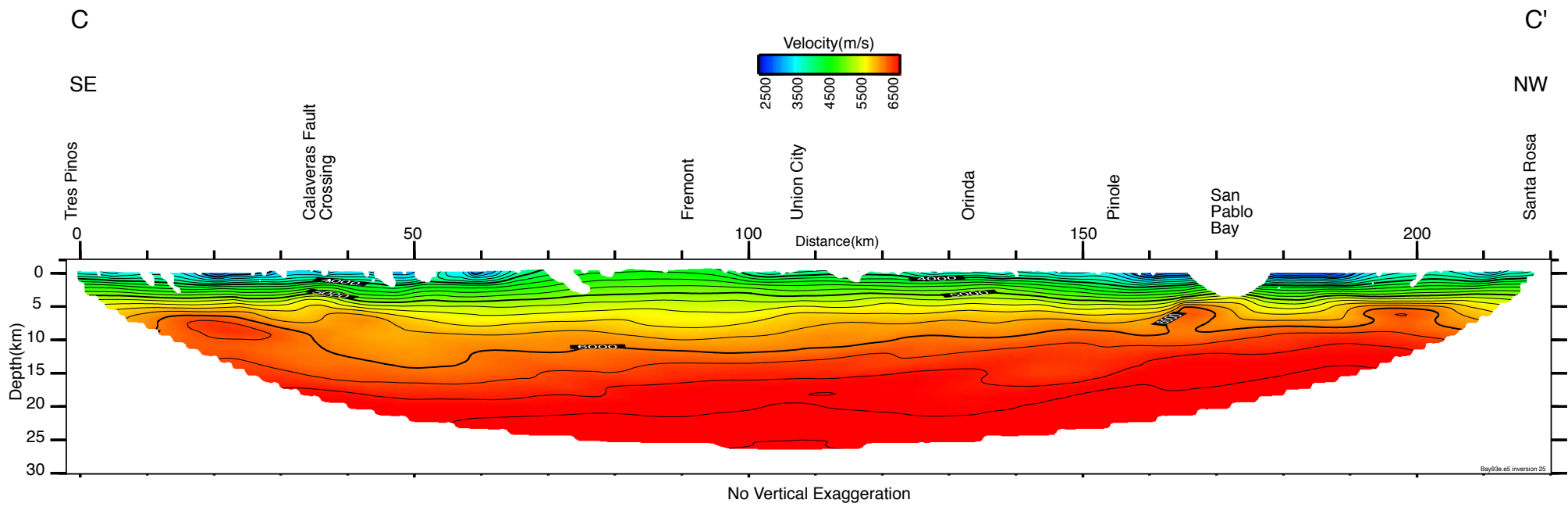


Fig. 4

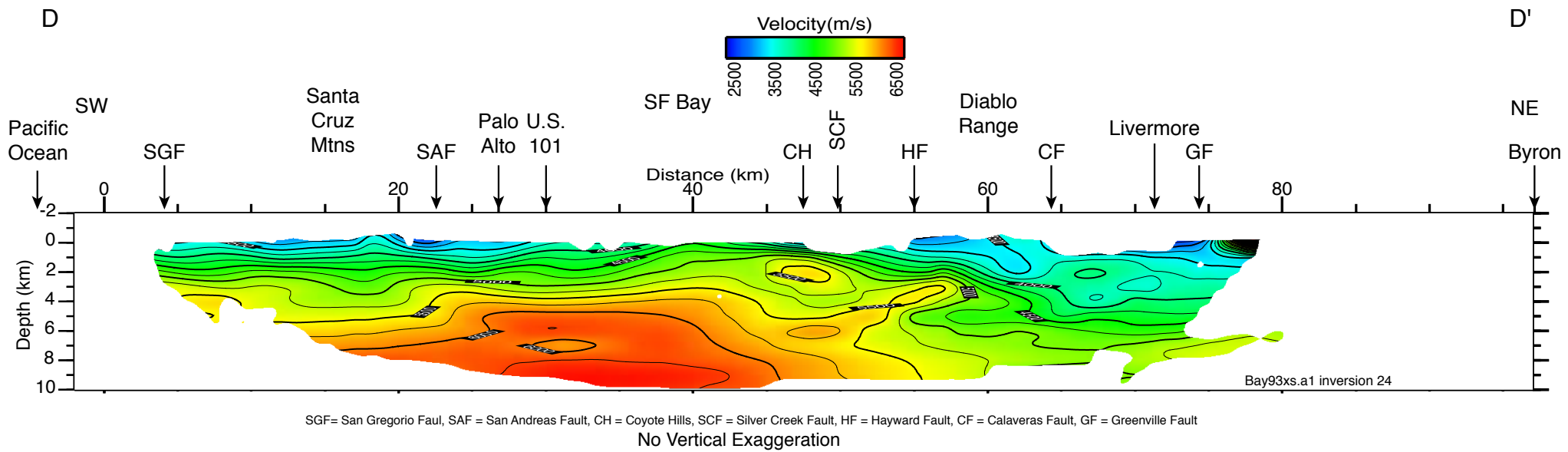


Fig. 5