IMPLOSION, EARTHQUAKE, AND EXPLOSION RECORDINGS FROM THE 2000 SEATTLE KINGDOME SEISMIC HAZARDS INVESTIGATION OF PUGET SOUND (SHIPS), WASHINGTON

by Thomas M. Brocher[1], Thomas L. Pratt[2], Craig S. Weaver[3], Catherine M. Snelson[4] and Arthur D. Frankel[5]

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[1]U.S. Geological Survey, 345 Middlefield Road, M/S 977, Menlo Park, CA 94025
[2]U.S. Geological Survey, School of Oceanography, Box 357940, Univ. Washington, Seattle, WA 98195
[3]U.S. Geological Survey, Geophysics, Box 351650, Univ. of Washington, Seattle, WA 98195
[4]Dept. of Geoscience, Univ. of Nevada, Las Vegas, 4505 Markland Parkway, Las Vegas, NV 89154-4010; previously at Department of Geological Science, Univ. of Texas, El Paso, TX 79968
[5]U.S. Geological Survey, MS 966, Box 25046, Denver Federal Center, Denver, CO 80225

ABSTRACT

This report describes seismic data obtained in Seattle, Washington, March 24-28, 2000, during a Seismic Hazards Investigation of Puget Sound (SHIPS). The seismic recordings obtained by this SHIPS experiment, nicknamed Kingdome SHIPS, were designed to (1) measure site responses throughout Seattle and to (2) help define the location of the Seattle fault. During Kingdome SHIPS, we recorded the Kingdome implosion, four 150-lb (68-kg) shots, and a M_w = 7.6 teleseism using a dense network of seismographs deployed throughout Seattle. The seismographs were deployed at a nominal spacing of 1 km in a hexagonal grid extending from Green Lake in the north to Boeing Field in the south.

The Seattle Kingdome was a domed sports stadium located in downtown Seattle near the Seattle fault. The Seattle Kingdome was imploded (demolished) at 8:32 AM local time (16:32 UTC) on March 26 (JD 086), 2000. The seismic energy produced by implosion of the Kingdome was equivalent to a local earthquake magnitude of 2.3. Strong impacts produced by the implosion of the Kingdome generated seismic arrivals to frequencies as low as 0.1 Hz. An mpeg movie of the ground motions recorded during the demolition of the Kingdome may be downloaded from the following website: http://groundmotion.cr.usgs.gov/html/movies.shtml. This movie documents longer shaking durations in the Duwamish River valley, as expected for the low shear wave velocities found in these youthful alluvial deposits along the river.

Although the shots varied in their quality, useful seismic refraction data were acquired from all four shot points, located in the corners of our temporary array. Two shots located north of the Seattle fault, where the charges were detonated within the ground water column (Discovery and Magnuson Parks), were much more strongly coupled than were the two shots to the south of the Seattle fault, where the shots were detonated above the water table (Lincoln and Seward Parks).

Thirty-eight RefTek stations, scattered throughout Seattle, recorded the M_w = 7.6 Japan Volcano Islands earthquake (22.4˚N, 143.6˚E, 104 km depth) of 28 March 2000 (JD 088). This teleseism produced useful signals for periods between 4 and 7 seconds. Only a few recordings of small magnitude local earthquakes were made, and these recordings are not presented.

In this report, we describe the acquisition of these data, discuss the processing and merging of the data into common shot gathers, and illustrate the acquired data. We also describe the format and content of the archival tapes containing the SEGY-formatted, common-shot gathers.

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INTRODUCTION

The Seismic Hazard Investigation in Puget Sound (SHIPS) is a series of seismic investigations initiated to better characterize the seismic hazard in western Washington and southwestern British Columbia. Kingdome SHIPS represents the third SHIPS project. The first, nicknamed Wet SHIPS, investigated the regional crustal structure of the Puget Lowland using airgun sources and land recorders during March 1998 [Brocher et al., 1999; Fisher et al., 1999]. Wet SHIPS obtained new, three-dimensional structural control on the seismogenic structures and Cenozoic basins in western Washington and southwestern British Columbia [Brocher et al., 2001; Zelt et al., 2001; Van Wagoner et al., in review]. The second, nicknamed Dry SHIPS, obtained an E-W trending seismic refraction line through Seattle in September 1999 for a study of the Seattle basin [Brocher et al., 2000a]. During Dry SHIPS, more than 1000 receivers and 38 shots were used to obtain a detailed refraction line having traces with a nominal spacing of 100 m and shots at a nominal spacing of 4 km.

This report describes seismic data recorded during Kingdome SHIPS, March 24-28, 2000. The primary goal of Kingdome SHIPS was to measure the spatial variations in site response throughout Seattle using the implosion of the Seattle Kingdome, a concrete domed stadium, as a seismic source (Figure 1). A secondary goal of our work was to refine knowledge of the location of the Seattle fault. During Kingdome SHIPS we deployed 228 temporary seismic stations (land-based Texans, RefTeks, and K2s) on a hexagonal grid with a receiver spacing of 1 km. We used this array to record the seismic waves generated by the implosion of the Kingdome, with the intention of making a movie of the ground motions produced by the demolition in Seattle. The Kingdome was demolished on March 26th (JD 086) to make room for a new professional football stadium. Earlier that morning, we recorded our four 150-lb shots at the corners of the receiver array to offsets up to 20 km. Two days after the Kingdome implosion, 38 RefTeks, deployed throughout Seattle, recorded the M_w = 7.6 Japan Volcano Islands earthquake (22.4˚N, 143.6˚E, 104 km depth) of March 28th (JD 088).

DATA ACQUISITION

Experiment Design

Kingdome SHIPS recorded the implosion of the Seattle Kingdome to provide uniform, fairly dense coverage of seismic site response in Seattle. Seismographs were spaced at 1-km intervals on an hexagonal grid in Seattle from Green Lake in the north to Boeing field in the south (Figure 1). The grid was centered on the Seattle Kingdome, straddled the Seattle fault, and encompassed most of the important transportation, industrial, and commercial areas in Seattle. In addition to this regular grid, we recorded data at 23 sites being investigated in an on-going study of site response (Sites 5001-5023) [Figure 1; Table 1; Frankel et al., 1999].

With the exception of these 23 sites and a few others, station numbers increase in horizontal rows from north to south and from west to east (Figure 1). Stations 1001-1158 were deployed north of the Lake Washington Ship Canal. Stations 2001-2246 were deployed south of the Ship Canal and north of Yesler Way. Stations 3001-3131 were deployed south of Yesler Way to Boeing Field.

Our four small shots were located at the corners of the receiver array in City of Seattle parks: Discovery, Lincoln, Magnuson, and Seward Parks (Figure 1).

A large majority of the receiver sites were located at private residences or businesses. Volunteers for receiver sites were solicited using the local media who advertised our study; 780 volunteers for sites were enlisted using a special web site and a Kingdome SHIPS phone number. Over 101 of the sites we eventually occupied were offered to us by volunteers via the email, web, and telephone. The remaining 102 stations were located by contacting landowners (or property managers) directly.

We sited most (about 80%) of the recorders on Pleistocene deposits; these are mainly stiff soils and include glacial till and outwash deposits [Figure 2; Table 1; Frankel et al., 1999]. The high percentage of sites on Pleistocene deposits reflects the prevalence of this unit in Seattle. Around 18 (9%) of our sites were located on artificial fill in the Harbor Island area and along the Duwamish River. The Kingdome itself was built on artificial fill. A handful of receivers were located at "modified land" sites, where the top soil has been hydraulically removed [Frankel et al., 1999]. The several sites underlain by Holocene alluvium were mainly found along the Duwamish River (Table 1). Finally, several sites near Seward Park were underlain by Tertiary sedimentary rocks (Figure 2).

Seismographs

Three different types of seismographs were used during Kingdome SHIPS (Table 2). The recorders included: Texans (156 units), RefTeks (51 units), and Kinemetrics K2s (21 units). To provide a uniform coverage of the line using a variety of instrumentation, the different land seismographs were interspersed throughout Seattle (Table 1, Figure 1). Because the Texans were completely buried, they were used in more public areas to prevent vandalism or theft of the instruments. The Texans were programmed to record 8 planned shot windows and a 4-hour window to record the Kingdome implosion. Fifty RefTeks, however, were programmed to record continuously during their deployment to obtain records for any local earthquakes and teleseisms occurring during our experiment. These 50 RefTeks were deployed throughout Seattle (Table 1, Figure 1). Three different RefTek models were used, including 06s, 07s, and 07Gs (Table 1). Another RefTek and 21 K2s were deployed by the USGS Earthquake Hazards Team headquartered in Golden, Colorado (Sites 5001-5022). These sites were set to record in trigger mode, and 16 K2s triggered on and recorded the Kingdome Implosion but did not trigger on or record our 4 small shots. Acquisition parameters used by the three types of recorders are given in Table 2. RefTeks and Texans were co-located at five sites so that the responses of the two types of recorders can be compared (these are sites 1058 (and 1158), 2022, 2038 (and 2138), 2047 (and 2147), and 3010, Table 1).

The Texans are single-component, 24-bit, digital seismographs that record the signal produced by a single Mark Products® l-10B vertical component 4.5-Hz geophone. The internal time of the Texans was set at the beginning of their deployment and was checked at the end of their one day deployment, using Global Positioning System (GPS) synchronized timing. The Texans recorded at a sample rate of 250 samples/sec (4 msec sample interval).

The three-component RefTeks we used are described by PASSCAL [1991] and Brocher et al. [1999]. For this experiment, the RefTeks continuously recorded signals produced by Mark Products® L-22 (2 Hz) and L-28 (4.5-Hz) three-component geophones (the geophone type used at each RefTek station is provided in Table 1). The three-component Mark Products® L-28 4.5-Hz geophones were oriented such that the longitudinal (N-S) component was directed to **magnetic north**. [The eastward declination of magnetic north relative to true north in Seattle is about 20°.] The RefTeks were equipped with Global Positioning System (GPS) receivers to synchronize the internal timing on the individual RefTeks to satellite timing. The RefTeks recorded hour-long blocks of data at a sample rate of 250 samples/sec (4 msec sample interval).

The Kinemetrics K2s were equipped with velocity transducers and force-balance accelerometers (FBAs). The velocity sensors have a natural frequency of 2 Hz and were either Mark Products® L-22 or Sprengnether® S-6000 [Hartzell et al., 2000].

Seismograph Deployment

The 50 RefTek recorders were deployed during a two-day period from March 24th to March 25th (Julian Day (JD) 084 to JD 085). The RefTeks were programmed to record continuously as soon as they were deployed. The 156 Texans, programmed to record the four shots and implosion of the Kingdome, were deployed on March 25th (JD 085) and were retrieved the following day. The RefTeks were retrieved on March 28th (JD 088). All instruments were recovered.

Detonation of Shot Points

The shot holes were loaded on March 25th, the day they were detonated. Four shots were detonated at four different shot points, numbered 4001 to 4004 (Figure 1). All shots consisted of 150 lbs (68 kg) of ammonium nitrate emulsion placed at the base of 18-m-deep bore holes. The main charge was detonated using 1-lb boosters ignited by Primacord® detonating cord. The detonating cord was ignited by an electrical blasting cap using shot systems whose clocks were set to a GPS master clock accurate to within a millisecond. The clock drift of each shot system was measured to determine whether correction to the shot time was necessary. Note that shot 1 (Site 4001; Lincoln Park) was fired by hand when the shot system failed. The origin time for this shot was inferred from the shot phone placed at the well head for this shot. Latitudes and longitudes of the shot points are given in UTM eastings and northings (Zone 10). None of these shots triggered the Pacific Northwest Seismic Network and there were no reports by nearby residents that the shots were felt.

Kingdome Implosion

The Seattle Kingdome was a domed, concrete sports stadium approximately 192 m wide, 73 m high, and weighing approximately 100,000 kg. The Kingdome, site 4005 (SP 5) in Tables 1 and 3, was located near the northernmost strand of the Seattle fault in Seattle's downtown area (Figure 1). The Kingdome was imploded at 8:32 AM local time on March 26, 2000. The over 4,000 lbs of demolition charges were detonated in hundreds of small shots over an approximately 15 second interval. These charges weakened the Kingdome's arches and the vertical supporting columns, keeping the central compression ring intact and allowing it to pull the dome structure inward and downward. Although the demolition contractor attempted to minimize the shaking produced by the

implosion by piling concrete debris from the Kingdome beneath the compression ring, the impacts produced by the implosion of the Seattle Kingdome yielded signals equivalent to those of magnitude 2.3 earthquake [Norris, 2000].

Earthquakes

Thirty-eight RefTek stations, scattered throughout Seattle, recorded the M_w = 7.6 Volcano Islands, Japan earthquake (22.407˚N, 143.589˚E, depth 104 km) of 28 March 2000 (Table 4; NEIC). Useful data from the Japanese Volcano Islands earthquake were recorded across the entire array. The distance to the earthquake is about 75˚ (roughly 8300 km) and the azimuth of propagation from the earthquake was about 43˚.

Only small, distant local earthquakes and blasts were recorded during our deployment (Table 5). Events 1 and 2 in Table 5 occurred when less than half of the RefTeks had been deployed. Events 3 to 7 were recorded by most of the RefTeks. Event 4 corresponds to a distant, quarry blast (Table 5). Event 8 is a second quarry blast that occurred after almost all the RefTek stations had been recovered. The first RefTek station was deployed at UTC 16:30 on 3/24/2000 and the last RefTek station was recovered at UTC 23:50 on 3/28/2000. Based on our analysis of local events recorded during Dry SHIPS (Brocher et al., 2000), we did not make SEGY files for the small local events recorded during Kingdome SHIPS.

Data Downloading

Data recorded by the Texans and RefTeks were downloaded in the field at the NOAA Building 8 headquarters at Seattle on the two days of instrument pickup, JD 086 and 088 (March 26th and 28th, 2000).

Station and Shotpoint Locations:

The shotpoint and seismograph locations and elevations provided in Table 1 and 3 were picked from digital USGS 7 1/2 minute topographic maps on a TOPO® CD-Rom. The nominal horizontal accuracy of these locations, marked in the field by the deployers, is thought to be about 30 meters. Coordinates were measured both as decimal degrees and as UTM northings and eastings, in meters, for Zone 10.

SEGY DATA PROCESSING

Initial processing of the RefTek data included using the **ref2segy, refrate**, and **segymerge** programs to reformat the RefTek data to SEGY format, correct the clock drift, and make separate traces for each event. Preprocessing of the Texan data also included clock drift correction. The RefTek and Texan data were then merged. The following describes subsequent processing performed for the recordings of our four shots, the recordings of the implosion of the Kingdome, and the recordings of the Japanese Volcano Island earthquake.

RefTek and Texan data

Clock drift correction: previously made during preprocessing of RefTek and Texan data

Debias by subtracting the mean trace amplitude from every sample

Put UTM geometry (northings and eastings in meters for Zone 10) into SEGY headers

SEGY Trace Format for the Four Shot Gathers

The merged common shot gathers archived to tape were written in SEGY format. The travel times archived to tape have not been reduced. For each shots 60 seconds of data were archived, starting at the origin time, except for shot 4001, which was fired manually 1.084 sec after the programmed shot time (inferred from the uphole geophone at the shotpoint). At a sample rate of 4 msec, there are approximately 15000 samples per trace. Each component was written to a separate file, named shot0n_V.geom.sgy, shot0n_NS.geom.sgy, and shot0n_EW.geom.sgy, where n=1 to 4, corresponding to shotpoints 4001 to 4004. The files for the vertical component (V) contain 199 traces, whereas the files for the two horizontal components each contain either 47 or 46 traces.

SEGY trace header formats described by Barry et al. [1975] were modified slightly, as described in Table 6. Each merged record consists of a 240-byte header. All of the data trace values are written as IEEE, 32 bit, floating-point numbers (non-standard SEGY). All traces have a fixed length. The receiver station numbers are stored as the Channel number. The Source number contains the shot location (4001, 4002, 4003, or 4004).

SEGY Trace Format of Kingdome Recordings

For the Kingdome implosion we archived 119 seconds of the merged data in SEGY format. The traces start approximately 13.5 seconds before the demolition detonations were initiated, providing over 105 seconds of data for the arrivals. The travel times of the archived data have not been reduced. Each component was written to a separate file, named kingdemo_V.sgy, kingdemo_NS.sgy, and kingdemo_EW.sgy. The file for the vertical component (V) gather contains 200 traces, whereas the files for the two horizontal components each contain 45 traces. The SEGY formats for these files are identical to those for the four shots, except that there are 29750 samples per trace (119 seconds). The receiver station numbers are stored as the Channel number (see Table 1). The Source number contains the shot location (4005).

Japanese Volcano Earthquake

We archived files with a length of 256 seconds containing P-wave first arrivals. The sample rate was 8 msec. Data values are 4-byte fixed SEGY format. No source or receiver geometry was put into the headers for this event. Each component was written to a separate file, named japan_eq_V.sgy (Ch. 1), japan_eq_NS.sgy (Ch. 2), and japan_eq_EW.sgy (Ch. 3). Each file contains 38 traces. The traces are identified by FFIDs, ranging from 60 to 97.

DATA QUALITY

In this section we present and describe the data recorded during Kingdome SHIPS using a series of figures (Figures 3 to 11).

The maximum source-receiver ranges for our 150-lb (68-kg) shots varied between 18 to 20 km (Figures 3 to 6). Data quality is variable due to large variations in shotpoint efficiency. Probably due to their location within the water table, shots in northern Seattle (Magnuson and Discovery Parks, SP3 and SP4) carried about twice as far as those in southern Seattle (Lincoln and

Seward Parks, SP 1 and 2), which were located above the water table. None of these shots triggered the Pacific Northwest Seismic Network.

Recordings of the implosion of the Kingdome were made to offsets of 12 km. The record section for the vertical component obtained from the implosion of the Seattle Kingdome shows a series of parallel compressional wave arrivals that Brocher et al. (2000b) interpreted as a series of impacts of pieces of the dome hitting the ground. At least three parallel sets of coherent P-wave arrivals are observed. These arrivals are preceded by less prominent arrivals that may represent the signals produced by the demolition charges themselves. The P-wave arrivals are followed by a series of less coherent but large-amplitude shear-wave and surface wave arrivals (Figure 7). Record sections for the Texan recordings which have been bandpass filtered between 0.1 and 6.4 Hz reveal differences in the frequency content of the P-, S-, and surface-waves (Figure 8). Compressional wave arrivals are prominent at frequencies between 0.1 and 0.8 Hz. Shear wave arrivals are most prominent at higher frequencies between 0.4 and 3.2 Hz. A movie of the ground motions has been made and is available on the web at: http://groundmotion.cr.usgs.gov/html/movies.shtml. The movie shows that shaking produced by the demolition of the Kingdome was prolonged in the Duwamish River valley, presumbably due to the young alluvial deposits there.

Recordings of the M_w = 7.6 Japanese Volcano earthquake (22.4˚N, 143.6˚E, 104 km depth) of 28 March 2000 are shown in Figures 9 to 11. P-wave arrivals are highly coherent in these data, particularly on the vertical component (Figure 9). S-wave arrivals are somewhat less coherent, and are best recorded on the E-W component (Figure 10). Given the azimuth of propagation close to 43˚, the E-W horizontal component is nearly radial whereas the N-S horizontal component is nearly transverse, to the direction of propagation. At Seward Park, large-amplitude compressional, shear, and surface wave arrivals were recorded to periods as low as 4 to 7 seconds (Figure 11).

DATA AVAILABILITY

Tape copies of the SEGY seismic data may be ordered via the World Wide Web from the IRIS/PASSCAL Data Management Center (DMC) in Seattle, Washington. The current Web site address of the Incorporated Research Institutions for Seismology (IRIS) Consortium is www.iris.edu. The current email address for the IRIS DMC is webmaster@iris.washington.edu. In addition to the 18 record sections obtained during Kingdome SHIPS, the archival tape sent to the IRIS DMC contains (1) a copy of mpeg movie of ground motions recorded during the demolition of the Kingdome (kdlog12.mpg), (2) documentation of the movie (KingdomeImplosion.doc), (3) the text for this Open-File Report (in Word), (4) the eleven figures for this Open-File Report (in Adobe Illustrator, version 8), (5) an Open-File Report readme file, and (6) a station location map in pdf format (kd_local_map.pdf). Unprocessed recordings of the Japan Island earthquake were also transmitted to the IRIS DMC on a separate exabyte tape.

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Table 1. Receiver List (coordinates use the WGS 1984 Datum).

Unit No.	Surface Unit	Unit Name	Inst. No.	Geo. Type	UTM Easting (m)	UTM Northing (m)	Latitude (Degrees North)	Longitude (Degrees West)	Elev. (m)	Street Address
1001	Pleistocene deposits	N001	412		545164	5282246	47.692021	122.398120	73	3127 NW 86th St
1002	Pleistocene deposits	N002	409		545660	5282178	47.691374	122.391518	86	2610 NW 86th St
1003	Pleistocene deposits	N003	408		546896	5282272	47.692132	122.375037	103	8560 Mary Ave NW
1004	Pleistocene deposits	N004	406		547684	5282160	47.691066	122.364549	82	618 NW 86th St
1005	Pleistocene deposits	N005	7299	L22	548908	5282158	47.690957	122.348239	94	747 N 86th St
1006	Pleistocene deposits	N006	410		549960	5282128	47.690606	122.334224	80	1916 N 85th St
1007	Pleistocene deposits	N007	435		550682	5282274	47.691864	122.324586	114	8545 4th Ave NE
1008	Pleistocene deposits	N008	433		551797	5282318	47.692171	122.309723	110	8801 17th Ave NE
1009	Pleistocene deposits	N009	7364	L28	553178	5282082	47.689936	122.291349	95	3159 NE 85th St
1010	Pleistocene deposits	N010	434		554104	5282136	47.690345	122.279004	83	4511 NE 86th St
1011	Pleistocene deposits	N011	437		554719	5282438	47.693010	122.270771	12	8760 Sand Point Way NE
1012	Pleistocene deposits	N012	7465	L22	544938	5280906	47.679981	122.401270	69	3415 NW 71st St
1013	Pleistocene deposits	N013	404		545509	5281147	47.682109	122.393638	76	2817 NW 74th St.
1014	Pleistocene deposits	N014	402		546283	5281136	47.681955	122.383327	73	7321 21st Ave NW
1015	Pleistocene deposits	N015	7289	L28	547600	5281046	47.681050	122.365790	75	7319 8th Ave NW
1016	Pleistocene deposits	N016	403		548538	5281159	47.681997	122.353280	88	352 N 73rd St
1017	Pleistocene deposits	N017	411		549494	5281523	47.685199	122.340502	55	1331 N 78th St
1018	Pleistocene deposits	N018	413		550286	5281462	47.684589	122.329957	61	7466 Corliss Ave N
1019	Pleistocene deposits	N019	438		551376	5281340	47.683406	122.315448	95	7511 12th Ave NE
1020	Pleistocene deposits	N020	547		552550	5281334	47.683257	122.299808	76	7501 26th Ave NE
1021	Pleistocene deposits	N021	436		553405	5281236	47.682306	122.288428	84	3707 NE 74th Place
1022	Pleistocene deposits	N022	7324	L28	554561	5281302	47.682803	122.273019	101	7347 51st Ave NE
1023	Pleistocene deposits	N023	427		543565	5279174	47.664491	122.419735	16	Magnuson Park
1024	Pleistocene deposits	N024	407		544826	5280142	47.673114	122.402841	32	6110 36th Ave NW
1025	Pleistocene deposits	N025	401		546085	5280106	47.672702	122.386073	36	2237 NW 61st St
1026	Pleistocene deposits	N026	542		546878	5279917	47.670945	122.375530	33	5816 15th Ave NW
1027	Pleistocene deposits	N027	395		547854	5279950	47.671170	122.362526	40	5806 5th Ave NW
1028	Pleistocene deposits	N028	405		548896	5280103	47.672469	122.348629	73	6107 Woodland Place N
1029	Pleistocene deposits	N029	7610	L28	549792	5280107	47.672436	122.336693	55	6318 E Greenlake Way
1030	Pleistocene deposits	N030	400		550676	5280114	47.672431	122.324917	72	6011 4th Ave NE
1031	Pleistocene deposits	N031	7278	L22	552012	5280300	47.673998	122.307099	63	1900 NE Naomi Place
1032	Pleistocene deposits	N032	428		553249	5280374	47.674563	122.290612	91	6232 34th Ave NE
1033	Pleistocene deposits	N033	432		553950	5280622	47.676736	122.281243	84	6533 44th Ave NE
1034	Pleistocene deposits	N034	430		555052	5280650	47.676895	122.266559	37	6519 58th Ave NE
1035	Pleistocene deposits	N035	544		555841	5280018	47.671141	122.256129	31	6551 NE Windermere Rd
1036	Pleistocene deposits	N036	389		546513	5279131	47.663899	122.380476	10	4763 Ballard Ave NW
1037	Pleistocene deposits	N037	392		547521	5279461	47.666795	122.367015	18	821 NW 53rd St
1038	Pleistocene deposits	N038	398		548285	5279162	47.664048	122.356872	88	4818 1st Ave NW
1039	Pleistocene deposits	N039	396		549481	5279092	47.663328	122.340951	60	1421 N 48th St
1040	Pleistocene deposits	N040	399		550728	5279458	47.666524	122.324301	74	316 NE 52nd St
1041	Pleistocene deposits	N041	416		551734	5279420	47.666103	122.310906	78	5045 16th Ave NE
1042	Artificial fill	N042	415		552282	5279379	47.665690	122.303612	15	5025 Ravenna Ave NE
1043	Pleistocene deposits	N043	419		553448	5279377	47.665577	122.288083	45	5015 37th Ave NE
1044	Pleistocene deposits	N044	7435	L22	554635	5279249	47.664326	122.272290	59	5001 NE 50th St
1045	Pleistocene deposits	N045	390		548174	5278390	47.657111	122.358436	47	4120 Baker Ave NW
1046	Pleistocene deposits	N046	393		549049	5278436	47.657459	122.346778	62	915 N 41st St
1047	Pleistocene deposits	N047	397		550090	5278258	47.655778	122.332936	52	4001 Bagley Ave N
1048	Pleistocene deposits	N048	7443	L22	550948	5278338	47.656430	122.321501	22	4033 7th Ave NE
1049	Pleistocene deposits	N049	391		552073	5278314	47.656125	122.306523	46	Geophysics Bldg., UW Campus

1050	Artificial fill	N050	7294	L28	553101	5278582	47.658452	122.292801	9	3501 Mary Gates Drive NE
1051	Pleistocene deposits	N051	422		554106	5278294	47.655778	122.279453	36	3814 44th Ave NE
1052	Pleistocene deposits	N052	426		554719	5278431	47.656959	122.271273	13	5135 Latimer Place NE
1053	Pleistocene deposits	N053	394		549714	5277442	47.648465	122.338036	20	2101 N 35th St
1054	Pleistocene deposits	N054	421		551641	5277585	47.649601	122.312362	3	Oceanography Bldg., Univ. Washington
1055	Pleistocene deposits	N055	418		552548	5277433	47.648160	122.300303	7	Water Front Activity Center, UW
1057	Pleistocene deposits	N057	425		554377	5277682	47.650249	122.275921	1	3054 E Laurelhurst Drive NE
1058	Modified land	NOAA 8	501		555343	5281752	47.686785	122.262543	10	7600 Sand Point Way NE - NOAA Bldg 8
1148	Pleistocene deposits	N048a	424		551731	5278840	47.660885	122.311015	63	Burke Museum - at NE 45th St and 16 Ave NE
1158	Modified land	NOAA 8	6026	L22	555305	5281764	47.686896	122.263048	9	7600 Sand Point Way NE - NOAA Bldg 8
2001	Pleistocene deposits	C001	462		543904	5279640	47.668661	122.415173	19	4548 W Cramer
2002	Holocene alluvium	C002	459		542416	5278854	47.661689	122.435069	1	West Point Treatment Plant
2003	Pleistocene deposits	C003	456		543576	5279142	47.664203	122.419592	69	Discovery Park
2004	Pleistocene deposits	C004	453		544386	5279351	47.666028	122.408782	17	3775 W Commodore Way
2005	Pleistocene deposits	C005	7591	L28	545065	5279196	47.664586	122.399755	18	3307 W Commodore Way
2006	Pleistocene deposits	C006	7457	L22	544172	5278113	47.654904	122.411758	104	Fort Lawton - 640B
2007	Pleistocene deposits	C007	461		545271	5278138	47.655053	122.397120	82	3843 31st Ave W
2008	Pleistocene deposits	C008	458		546024	5278284	47.656314	122.387078	17	4009 Gilman Ave W
2009	Pleistocene deposits	C009	455		547068	5278229	47.655744	122.373181	8	1220 W Nickerson St
2010	Pleistocene deposits	C010	452		543674	5277804	47.652158	122.418420	38	4715 W Ruffner St
2011	Pleistocene deposits	C011	463		544714	5277202	47.646670	122.404633	87	3705 W Barrett St
2012	Pleistocene deposits	C012	7602	L22	545347	5276992	47.644737	122.396227	72	2800 31st Ave W
2013	Artificial fill	C013	451		546353	5277167	47.646240	122.382815	16	2015 W Barrett St
2014	Pleistocene deposits	C014	450		547444	5277054	47.645144	122.368302	92	817 W Armour St
2015	Pleistocene deposits	C015	7340	L22	548667	5277222	47.646565	122.352000	16	2926 Mayfair Ave N
2016	Pleistocene deposits	C016	414		550742	5277455	47.648502	122.324347	16	2940 Fairview Ave S
2017	Pleistocene deposits	C017	7428	L28	544116	5276609	47.641376	122.412655	68	2510 Magnolia Blvd W
2018	Pleistocene deposits	C018	460		545084	5276331	47.638808	122.399797	44	2140 34th Ave W
2019	Pleistocene deposits	C019	454		545991	5276617	47.641317	122.387693	50	2503 24th Ave W
2020	Pleistocene deposits	C020	7279	L28	547145	5276515	47.640317	122.372341	70	2250 12th Ave W
2021	Pleistocene deposits	C021	6020	L22	548026	5276390	47.639127	122.360626	97	2224 3rd Ave W
2022	Pleistocene deposits	C022	6124	L22	548782	5276413	47.639278	122.350559	110	2308 Nob Hill N
2022	Pleistocene deposits	C022	447		548782	5276413	47.639278	122.350559	110	2308 Nob Hill N
2023	Pleistocene deposits	C023	417		550353	5276588	47.640732	122.329626	1	2362 Fairview Ave E
2024	Pleistocene deposits	C024	423		551210	5276362	47.638631	122.318243	81	2211 11th Ave E
2025	Pleistocene deposits	C025	541		552185	5276646	47.641109	122.305230	31	2002 E Calhoun S
2026	Pleistocene deposits	C026	485		554059	5276578	47.640343	122.280291	11	1660 - 1670 Broadmoor Dr. E
2027	Pleistocene deposits	C027	486		554059	5276587	47.640424	122.280290	11	2344 McGilvra Blvd E
2028	Pleistocene deposits	C028	457		545385	5275746	47.633524	122.395851	51	1563 30th Ave W
2029	Artificial fill	C029	444		546904	5275911	47.634900	122.375614	10	1801 15th Ave W
2030	Pleistocene deposits	C030	441		547470	5275636	47.632384	122.368109	104	1505 8th Ave W
2031	Pleistocene deposits	C031	449		548651	5275463	47.630740	122.352409	126	1400 2nd Ave N Apt 295
2032	Pleistocene deposits	C032	448		549536	5275390	47.630016	122.340638	2	1220 Westlake
2033	Pleistocene deposits	C033	420		550843	5275550	47.631355	122.323223	65	1310 Lakeview Blvd E
2034	Pleistocene deposits	C034	6088	L28	551718	5275503	47.630862	122.311583	118	1203 16th Ave E
2035	Pleistocene deposits	C035	488		552600	5275456	47.630369	122.299849	48	1206 25th Ave E
2036	Pleistocene deposits	C036	487		553783	5275509	47.630748	122.284097	41	1227 38th Ave E
2037	Pleistocene deposits	C037	446		548259	5274443	47.621592	122.357739	29	314 1st Ave W
2038	Modified land	C038	440		549207	5274477	47.621827	122.345119	24	333 Taylor Ave N
2039	Pleistocene deposits	C039	445		550196	5274511	47.622057	122.331954	27	401 Pontius Ave N
2040	Pleistocene deposits	C040	481		551289	5274618	47.622934	122.317396	111	426 11th Ave E
2041	Pleistocene deposits	C041	479		552272	5274385	47.620759	122.304342	107	400 21st Ave E
2042	Pleistocene deposits	C042	6085	L22	553058	5274554	47.622216	122.293862	34	317 Dewey Pl E
2043	Pleistocene deposits	C043	484		553764	5274831	47.624650	122.284433	20	497 McGilvra Blvd E
2044	Modified land	C044	443		548566	5274048	47.618016	122.353697	25	3000 1st Ave

2045	Modified land	C045	442		549689	5273702	47.614817	122.338793	29	6th Avenue Bar & Grill
2046	Pleistocene deposits	C046	477		550671	5273520	47.613104	122.325748	83	1415 Summit Ave
2047	Pleistocene deposits	C047	6049	L28	551680	5273723	47.614851	122.312298	119	1530 15th Ave E
2048	Pleistocene deposits	C048	482		552923	5273726	47.614777	122.295759	59	1524 Martin Luther King Jr Way
2049	Pleistocene deposits	C049	483		553923	5273545	47.613066	122.282475	23	1441 Newport Way
2050	Modified land	C050	439		550366	5272483	47.603798	122.329925	43	500 4th Ave E
2051	Pleistocene deposits	C051	6047	L22	551501	5272439	47.603312	122.314831	66	1229 East Spruce St
2052	Pleistocene deposits	C052	539		552175	5272597	47.604680	122.305846	89	2205 E Terrace St
2053	Pleistocene deposits	C053	475		553273	5272738	47.605859	122.291222	92	416 32nd Ave E
2138	Pleistocene deposits	C038a	6042	L22	549201	5274455	47.621630	122.345202	25	6th and Harrison
2146	Pleistocene deposits	C046a	478		550729	5273121	47.609509	122.325022	101	1004 Boren Ave
2147	Pleistocene deposits	C047	480		551680	5273723	47.614851	122.312298	119	1530 15th Ave E
2246	Pleistocene deposits	C046b	476		551128	5274172	47.618934	122.319591	97	922 E Denny Way
3001	Artificial fill	S001	7611	L22	549891	5271489	47.594891	122.336357	2	401 Alaskan Way S
3002	Modified land	S002	537		550797	5271547	47.595343	122.324300	16	800 Maynard Ave S
3003	Pleistocene deposits	S003	7288	L22	551811	5271730	47.596909	122.310791	46	1632 S Weller St
3004	Pleistocene deposits	S004	474		553071	5271826	47.597671	122.294020	93	705 30th Ave S
3005	Pleistocene deposits	S005	6034	L22	553574	5271991	47.599114	122.287309	19	401 Lakeside Ave S
3006	Artificial fill	S006	510		546046	5270711	47.588176	122.387581	87	4415 SW Massachusetts St
3008	Artificial fill	S008	534		548833	5270666	47.587567	122.350521	2	1102 SW Massachusetts St
3009	Artificial fill	S009	7356	L28	550156	5270644	47.587268	122.332929	4	1750 S Occidental St
3010	Pleistocene deposits	S010	7346	L22	551355	5270887	47.589360	122.316955	92	1512 12th Ave S
3010	Pleistocene deposits	S010	471		551355	5270887	47.589360	122.316955	92	1512 12th Ave S
3011	Pleistocene deposits	S011	470		552395	5270591	47.586614	122.303159	22	1750 22nd Ave S
3012	Pleistocene deposits	S012	473		553101	5270805	47.588482	122.293744	74	1513 30th Ave S
3013	Pleistocene deposits	S013	6058	L22	544912	5269580	47.578079	122.402778	37	5549 SW Campbell Pl
3014	Pleistocene deposits	S014	6038	L28	545361	5269804	47.580063	122.396785	82	2662 51st Ave SW
3015	Pleistocene deposits	S015	511		546707	5269734	47.579338	122.378894	113	2730 37th Ave SW
3016	Pleistocene deposits	S016	502		548075	5268966	47.572328	122.360788	7	
3017	Artificial fill	S017	7323	L28	548743	5269746	47.579296	122.351820	3	2720 13th Ave S
3018	Artificial fill	S018	535		550022	5270092	47.582312	122.334774	4	2265 First Ave S
3019	Artificial fill	S019	536		550933	5270078	47.582115	122.322661	7	800 S Stacy St
3020	Pleistocene deposits	S020	7431	L22	552025	5269919	47.580598	122.308159	59	1900 S Waite St
3021	Pleistocene deposits	S021	472		552712	5270001	47.581280	122.299014	18	2300 26th Ave S
3022	Pleistocene deposits	S022	467		553660	5270082	47.581931	122.286398	12	2334 Shoreland Dr S
3023	Pleistocene deposits	S023	512		545332	5268808	47.571104	122.397274	96	3703 51st Ave SW
3024	Pleistocene deposits	S024	6035	L28	546015	5268687	47.569967	122.388206	117	4417 SW Charlestown St
3025	Artificial fill	S025	506		547287	5268913	47.571909	122.371270	21	3035 Manning Ave SW
3026	Pleistocene deposits	S026	513		548217	5268700	47.569924	122.358929	55	3834 20 Ave SW
3027	Artificial fill	S027	533		548954	5268710	47.569959	122.349130	3	1011 SW Klickitat Way
3028	Artificial fill	S028	7331	L28	550630	5268932	47.571828	122.326823	6	450 S Spokane St
3029	Pleistocene deposits	S029	466		551438	5268694	47.569623	122.316108	94	1223 S Charlestown St
3030	Pleistocene deposits	S030	465		552435	5268965	47.571981	122.302821	78	2308 S Spokane St
3031	Pleistocene deposits	S031	468		553828	5269262	47.574540	122.284265	39	3227 Hunter Blvd S
3032	Pleistocene deposits	S032	469		554358	5268868	47.570950	122.277267	6	3800 Lake Washington Blvd S
3033	Pleistocene deposits	S033	507		545632	5267641	47.560583	122.393406	60	4731 48th Ave SW
3034	Pleistocene deposits	S034	7433	L22	546791	5267625	47.560357	122.378002	93	4722 37th Ave SW
3035	Pleistocene deposits	S035	489		547951	5267711	47.561046	122.362574	45	4700 Delridge Way SW
3036	Artificial fill	S036	7458	L22	548712	5267895	47.562645	122.352438	8	4501 W Marginal Way SW
3037	Artificial fill	S037	7303	L22	549604	5267602	47.559941	122.340614	4	4735 East Marginal Way
3038	Holocene alluvium	S038	532		550780	5267764	47.561307	122.324963	7	636 S Alaska St
3039	Pleistocene deposits	S039	521		551812	5267867	47.562153	122.311234	92	1625 S Columbian Way
3040	Tertiary rock	S040	520		552944	5267695	47.560514	122.296207	50	2801 S Alaska Pl
3041	Pleistocene deposits	S041	519		553907	5267992	47.563107	122.283370	16	4424 39th Ave S
3042	Pleistocene deposits	S042	518		555006	5267705	47.560432	122.268798	36	5103 S Alaska St

3043	Pleistocene deposits	S043	508		545241	5266889	47.553844	122.398681	8	5449 Beach Dr SW
3044	Pleistocene deposits	S044	509		546249	5266896	47.553836	122.385283	108	5412 42nd Ave SW
3045	Pleistocene deposits	S045	504		546945	5266898	47.553804	122.376033	115	5422 35th Ave SW
3046	Pleistocene deposits	S046	490		548035	5267178	47.556244	122.361515	59	5229 23rd Ave SW
3047	Pleistocene deposits	S047	503		549113	5266899	47.553653	122.347219	9	5423 W Marginal Way SW
3048	Holocene alluvium	S048	531		550319	5266892	47.553498	122.331191	9	222 S. Lucile St
3049	Pleistocene deposits	S049	522		551728	5266909	47.553540	122.312463	44	5339 16th Ave S
3050	Tertiary rock	S050	6101	L22	552597	5267234	47.556394	122.300875	101	5016 26th Ave S
3051	Tertiary rock	S051	523		553333	5267080	47.554949	122.291111	48	5206 32nd Ave S
3052	Tertiary rock	S052	6130	L22	554554	5266892	47.553156	122.274907	62	4601 S Brandon
3053	Pleistocene deposits	S053	7339	L22	555501	5267032	47.554335	122.262303	18	5217 57th Ave S
3054	Pleistocene deposits	S054	7596	L22	545543	5265900	47.544925	122.394770	53	6426 49th Ave SW
3055	Pleistocene deposits	S055	505		546850	5266088	47.546523	122.377382	110	6343 36th SW
3056	Pleistocene deposits	S056	491		548006	5265551	47.541607	122.362078	59	2318 SW Willow
3057	Pleistocene deposits	S057	494		548879	5265622	47.542181	122.350471	108	6745 12th Ave SW
3058	Artificial fill	S058	7456	L22	549663	5265658	47.542446	122.340049	6	6700 W Marginal Way SW
3059	Holocene alluvium	S059	530		551120	5265510	47.541001	122.320706	4	6737 Ellis Ave S
3060	Tertiary rock	S060	526		552096	5265883	47.544279	122.307694	7	
3061	Tertiary rock	S061	525		553185	5266244	47.547439	122.293179	78	6014 30th Ave S
3062	Tertiary rock	S062	524		554004	5266196	47.546940	122.282302	44	3928 S Graham St
3063	Tertiary rock	S063	7603	L22	554978	5266184	47.546750	122.269360	92	6202 51st S
3064	Pleistocene deposits	S064	500		545546	5265129	47.537988	122.394810	45	7306 View Lane SW
3065	Pleistocene deposits	S065	499		546472	5264831	47.535241	122.382538	123	3960 SW Austin St
3066	Pleistocene deposits	S066	7464	L22	547359	5264640	47.533458	122.370774	129	3057 SW Holden St
3067	Pleistocene deposits	S067	493		548334	5264656	47.533530	122.357819	103	7706 18th Ave SW
3068	Holocene alluvium	S068	492		549290	5264876	47.535438	122.345093	101	7351 7th Place SW
3069	Pleistocene deposits	S069	497		550559	5265039	47.536807	122.328214	2	Boeing Field
3070	Holocene alluvium	S070	514		551551	5264950	47.535928	122.315045	4	Gate C39 - Flight Test Center
3071	Tertiary rock	S071	527		552567	5265014	47.536423	122.301539	7	King Co. Emerg. OPS 7300 Bldg.
3072	Pleistocene deposits	S072	543		553424	5265052	47.536695	122.290148	74	7307 33rd Ave S
3073	Tertiary rock	S073	516		554634	5265067	47.536729	122.274070	30	4823 S Othello St
3074	Pleistocene deposits	S074	517		555471	5265372	47.539402	122.262911	7	5525 S Frontenac St
3075	Pleistocene deposits	S075	7285	L22	545745	5263911	47.527015	122.392292	25	8440 Fauntleroy Wy SW
3076	Pleistocene deposits	S076	540		546800	5263995	47.527695	122.378269	122	8452 36th Ave SW
3077	Pleistocene deposits	S077	498		548147	5263871	47.526481	122.360389	102	8610 Delridge Way SW
3078	Pleistocene deposits	S078	7624	L22	549288	5264058	47.528078	122.345211	129	8402 8th AVE SW
3079	Holocene alluvium	S079	495		550024	5263916	47.526744	122.335450	18	8425 1st Ave S
3080	Artificial fill	S080	496		550987	5264344	47.530520	122.322609	4	8103 8th Ave S
3081	Artificial fill	S081	529		552376	5264212	47.529222	122.304172	4	8190 E Marginal Way S
3082	Pleistocene deposits	S082	528		553088	5263901	47.526366	122.294751	4	8467 Perimeter Road S
3083	Pleistocene deposits	S083	6046	L28	554078	5264045	47.527580	122.281583	27	3945 S Thistle St
3084	Pleistocene deposits	S084	515		555091	5264106	47.528044	122.268119	11	8345 Wabash Ave S
3101	Artificial fill	S001a	7459	L22	550411	5271857	47.598162	122.329398	6	Amtrak Train Station
3131	Pleistocene deposits	S031a	464		553236	5268968	47.571943	122.292172	13	3011 S Estelle St
4001	Pleistocene deposits	SP 1	546		545260	5264288	47.530441	122.398696	56	Lincoln Park
4002	Pleistocene deposits	SP 2	548		556249	5267894	47.562026	122.252252	8	Seward Park
4003	Modified land	SP 3	549		556382	5281336	47.682952	122.248753	16	Magnuson Park
4004	Pleistocene deposits	SP 4	545		543565	5279196	47.664689	122.419733	73	Discovery Park
4005	Artificial fill	SP 5			550254	5271551	47.595421	122.331522	4	Kingdome
5001	Esperance Sand	WEK	K2		546326	5269212	47.574669	122.384016	119	West Seattle
5002	Artificial fill	KDK	K2		550110	5271519	47.595144	122.333441	4	Kingdome
5003	Tertiary rock	SQ0	RefTek		556360	5266569	47.550095	122.250946	22	Seward Park
5004	Holocene alluvium	ALK	K2		543717	5269316	47.575785	122.418695	20	Alki Point
5005	Modified land	UNK	K2		550052	5273201	47.610282	122.334020	45	Freeway Park
5006	Artificial fill	HAR	K2		548860	5270289	47.584173	122.350204	3	Harbor Island

5007	Pleistocene deposits	BOE	K2	552667	5263623	47.523899	122.300377	4	Boeing Field
5008	Artificial fill	PIE	K2	546587	5275699	47.633015	122.379856	2	Pier - Terminal 91
5009	Pleistocene deposits	LAP	K2	548784	5276444	47.639556	122.350529	109	2308 Nob Hill N
5010	Pleistocene deposits	CRO	K2	548733	5276182	47.637203	122.351237	114	Queen Anne Hill
5011	Pleistocene deposits	GAR	K2	548749	5275774	47.633531	122.351070	131	Queen Anne Hill
5012	Pleistocene deposits	HAL	K2	547943	5276689	47.641824	122.361698	80	Queen Anne Hill
5013	Pleistocene deposits	HIG	K2	547782	5275305	47.629383	122.363993	103	Queen Anne Hill
5014	Pleistocene deposits	EVA	K2	548656	5278255	47.655860	122.352032	56	Fremont
5015	Pleistocene deposits (Till)	BHD	K2	551454	5270542	47.586249	122.315679	94	Beacon Hill School
5016	Modified land	NEW	K2	550177	5272299	47.602157	122.332460	14	Pioneer Square
5017	Modified land	MAR	K2	550089	5272565	47.604557	122.333601	32	2nd Ave
5018	Pleistocene deposits	CRPL	K2	550209	5272993	47.608398	122.331955	62	Crowne Plaza
5019	Modified land	CTR	K2	548720	5274294	47.620217	122.351621	41	Space Needle
5020	Artificial fill	SDN	K2	550267	5270417	47.585217	122.331479	4	Train Yard North
5021	Artificial fill	SDS	K2	550276	5270196	47.583228	122.331384	4	Train Yard South
5022	Artificial fill	SDW	K2	550087	5270315	47.584313	122.333884	4	Train Yard West

Notes:
Unit numbers 389-549 are Texans (vertical component only).
Unit numbers 6000-6200 correspond to 3-component, 16-bit RefTek Model 06 s.
Unit numbers 7200-7624 correspond to 3-component, 24-bit RefTek Model 07 s.
RefTeks and Texans were co-located at five sites (sites 1058 (and 1158), 2022 (and 5009), 2038 (and 2138), 2047 (and 2147), and at site 3010).

Table 2. Recording Parameters Used by the Different Types of Seismographs

Instrument Type	Number of Units	Record Length (seconds)	Recording Start Time (seconds before shottime)	Sample Rate (Hz)	No. of Geophone Components	Natural Frequency Geophone (Hz)	Timing
K2	21	Triggered	N/A	??	3	2	GPS
RefTek	50	Continuous	N/A	250	3	2, 4.5	GPS
Texan	156	60	0	250	1 (Vertical)	4.5	Pulsed

Channel 1 recorded the vertical component, channel 2 recorded the N-S oriented horizontal component, and channel 3 recorded the E-W oriented horizontal component.

Internal timing of the seismographs was synchronized to Universal Time either by using an internal GPS receiver to continuously record UTC (for the RefTeks) or by setting the internal time from a master clock at the time of deployment and using this master clock to note the clock drift at the time that the receiver was retrieved (pulsed).

Table 3. Kingdome SHIPS Shot list.

Site No.	Shot No.	Shot Point No.	Shot Time (JD:Hr:Mn:S) UTC	Shot Point Latitude	Shot Point Longitude	UTM Easting (m)	UTM Northing (m)	Shot Elev. (m)	Shot Depth (m)	Trace Header Stat.	Shot Size (lbs)	Shot Size (kgs)
4001	1	SP01	086:11:44:01	47.530441	122.398696	545260	5264288	56	18	20	150	68
4002	2	SP02	086:11:46:00	47.562026	122.252252	556249	5267894	8	18	60	150	68
4003	3	SP03	086:11:48:00	47.682952	122.248753	556382	5281336	16	18	300	150	68
4004	4	SP04	086:11:50:00	47.664689	122.419733	543565	5279196	73	18	310	150	68
4005		SP05	086:16:32:14.8	47.595421	122.331522	550254	5271551	4	-73	--	--	--

Note: Site 4005 was at the location of the Kingdome.

TABLE 4. Teleseism Recorded on March 28, 2000*.

Event Number	Event Window	Origin Time (UTC) Yr:JD:Hr:Min:Sec	Latitude	Longitude	Depth (km)	Mag.	Window start Yr:JD:Hr:Min	Window stop Yr:JD:Hr:Min
1	1	2000:088:11:00:20.9	22.407	143.589	100	7.6	00:088:11:00	00:088:13:00

*National Earthquake Information Center, UGSG, Golden, web site.

TABLE 5. Earthquake and Blasts in Western Washington, March 24-28, 2000[1]

Event Number	Origin Time (UTC) Yr:JD:Hr:Min:Sec	Latitude Deg. (N)	Longitude Deg. (W)	Depth (km)	Mag.
1	2000:084:22:55:35	46.130	122.830	0	1.3
2	2000:085:10:58:47	47.400	121.810	26.1	0.7
3	2000:086:22:24:45	47.170	121.900	4.3	1.3
4	2000:087:23:05:24	46.700	122.780	8.2	2.4
5	2000:088:00:30:10	46.850	120.360	5.4	1.6
6	2000:088:04:51:15	47.760	121.880	1.4	0.3
7	2000:088:20:12:42	46.530	122.000	0	1.6
8	2000:088:23:04:52	46.700	122.790	6.8	2.4

[1]http://www.geophys.washington.edu/SEIS/PNSN/CATALOG_SEARCH/cat.search.html

Table 6. SEGY trace header values used for Kingdome SHIPS SEGY Tapes.

Bytes	Format	SEGY name	SHIPS header
9-12	integer	field file number (FFID)	shot sequence number (1-5)
13-16	integer	trace within field record	receiver station number
17-20	integer	source point number	shot station number
31-32	integer	vertical traces summed	instrument type: 1,2,3 - RefTek vertical, N-S, E-W 4 - Texan vertical
37-40	integer	offset	source-receiver distance (m) (negative = west of shot)
41-44	integer	receiver elevation	receiver elevation (m)
45-48	integer	source elevation	elevation at top of shot hole (m)
49-52	integer	shot depth	depth of charge below surface (m)
73-76	integer	source – x	x coordinate at source (m, UTM Zone 10)
77-80	integer	source – y	y coordinate at source (m, UTM Zone 10)
81-84	integer	receiver – x	x coordinate at receiver (m, UTM Zone 10)
85-88	integer	receiver – y	y coordinate at receiver (m, UTM Zone 10)
103-104	int*2	total static correction	RefTek, Texan: 2000 msec time shift
105-106	int*2	lag time A to time break	
115-116	int*2	samples per trace	samples per trace
117-118	int*2	sample rate (microsec)	sample rate (microsec)
157-158	int*2	year	year
159-160	int*2	day	day
161-162	int*2	hour	hour at start of trace
163-164	int*2	minute	minute at start of trace
165-166	int*2	second	second at start of trace
167-168	int*2	time basis	time basis (2=GMT)
173-174	int*2	Instrument number	From Table 1
181-184	Float	Shot latitude	Decimal Degree
185-188	float	Shot Longitude	Decimal Degree
189-192	float	Receiver latitude	Decimal Degree
193-196	float	Receiver longitude	Decimal Degree

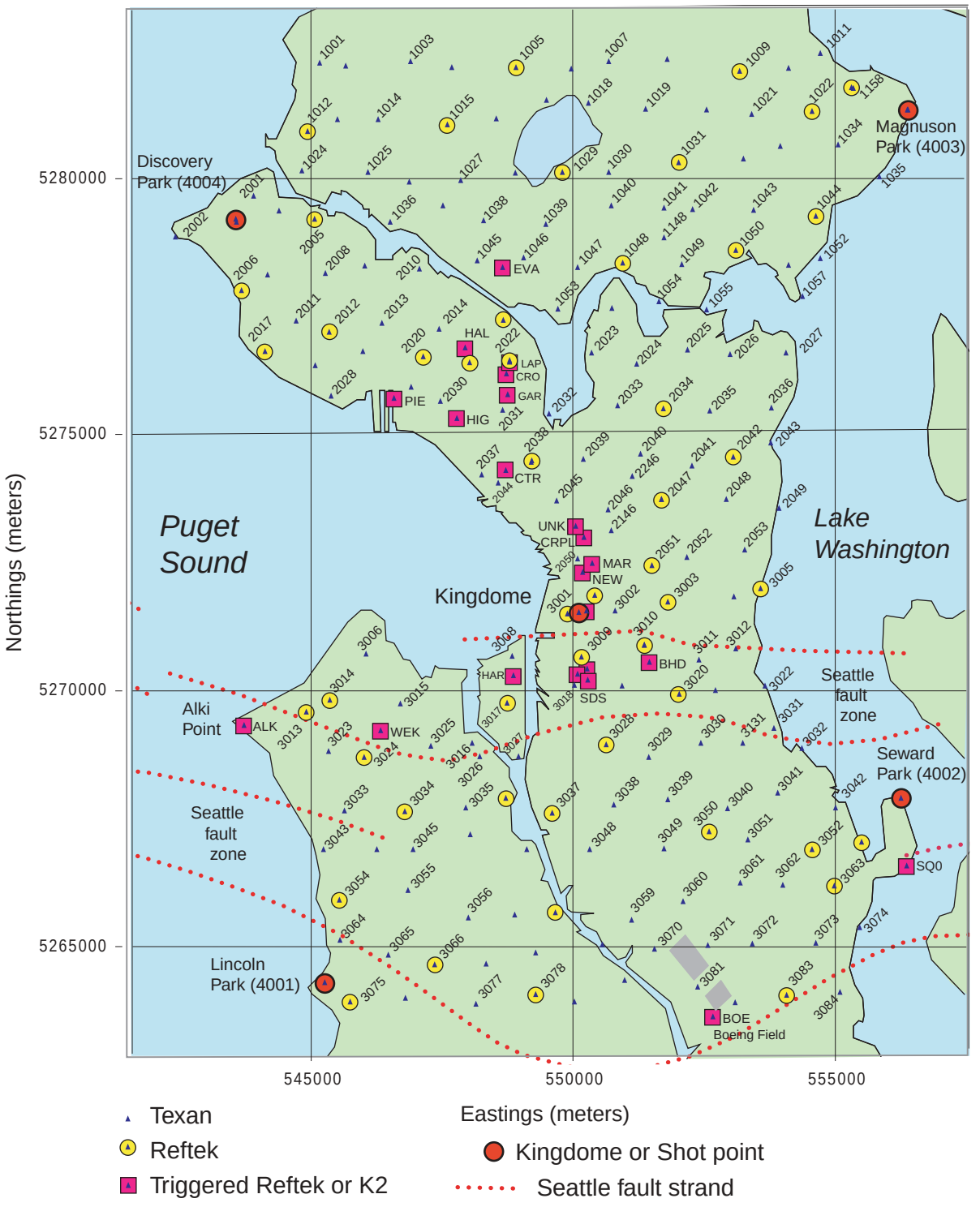

Figure 1. Map showing locations of Kingdome SHIPS seismic shots and recorders in Seattle. Stations having alphabetical labels correspond to sites 5001-5023 in Table 1. Seattle fault zone strands are from Blakely et al. (2002).

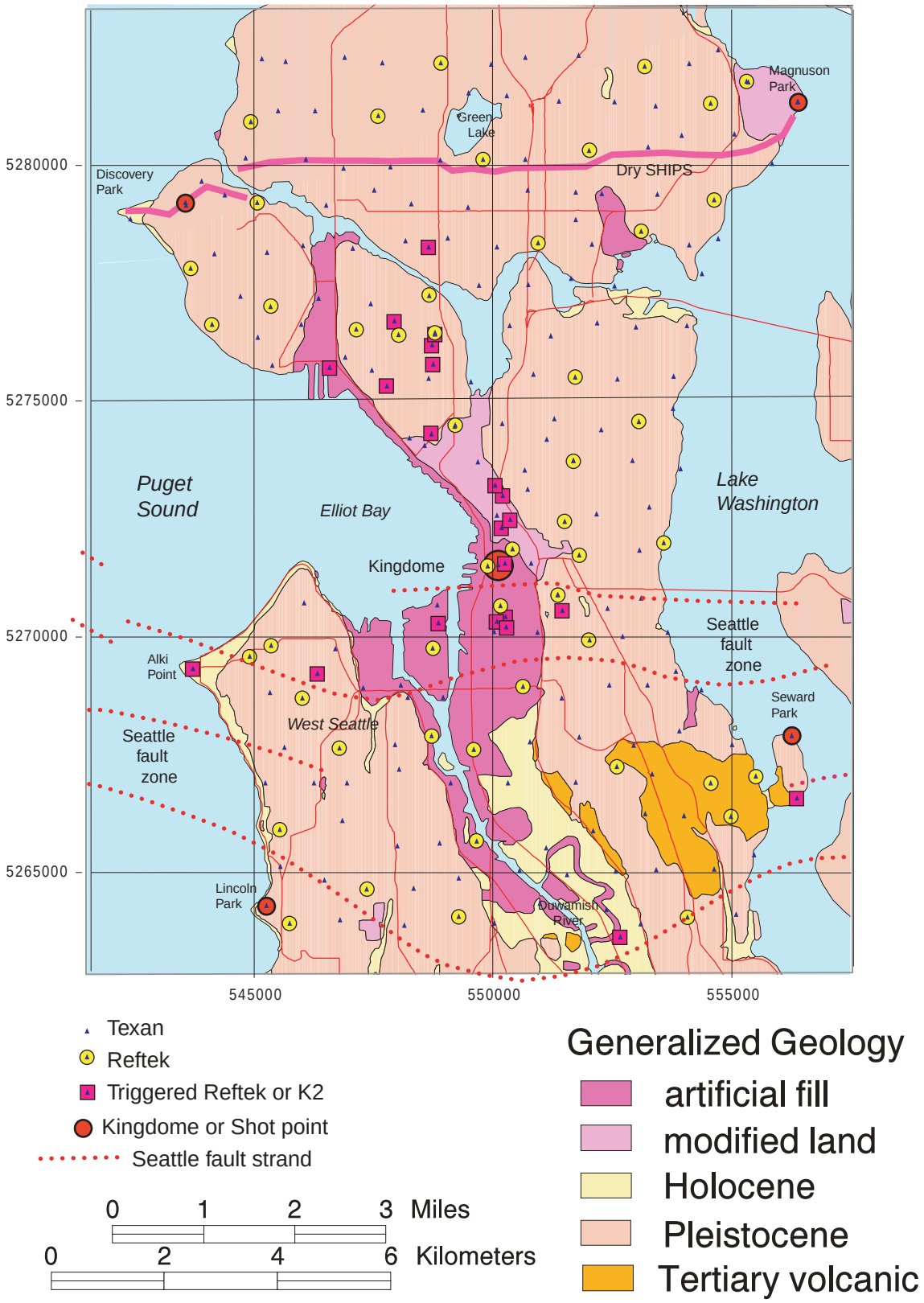

Figure 2. Locations of Kingdome SHIPS seismic shots and recorders superimposed on a generalized geological map for Seattle (modified from Frankel et al., 1999). Seattle fault zone strands from Blakely et al. (2002).

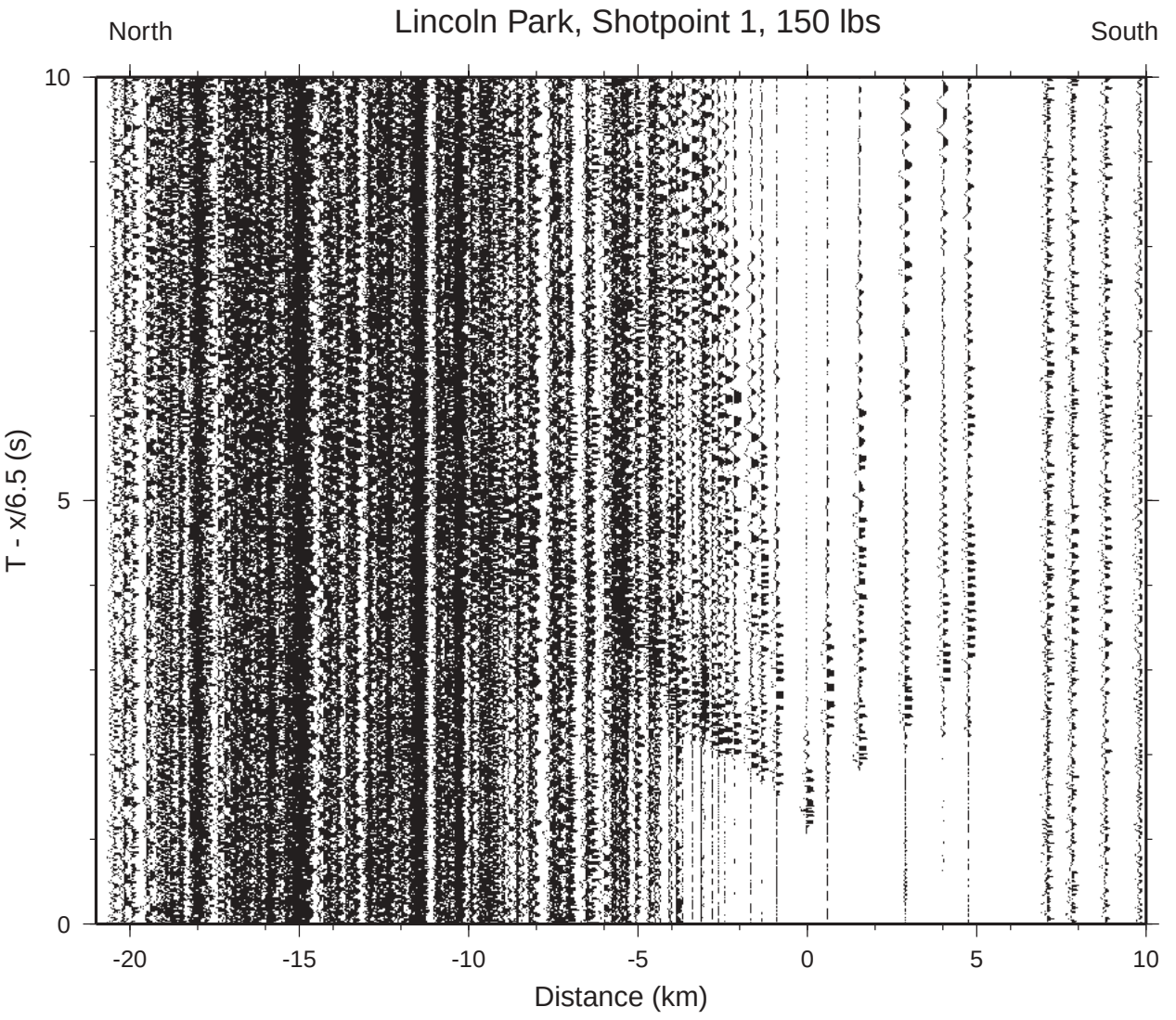

Figure 3. Record section for SP1 in Lincoln Park, filtered between 2 and 15 Hz.

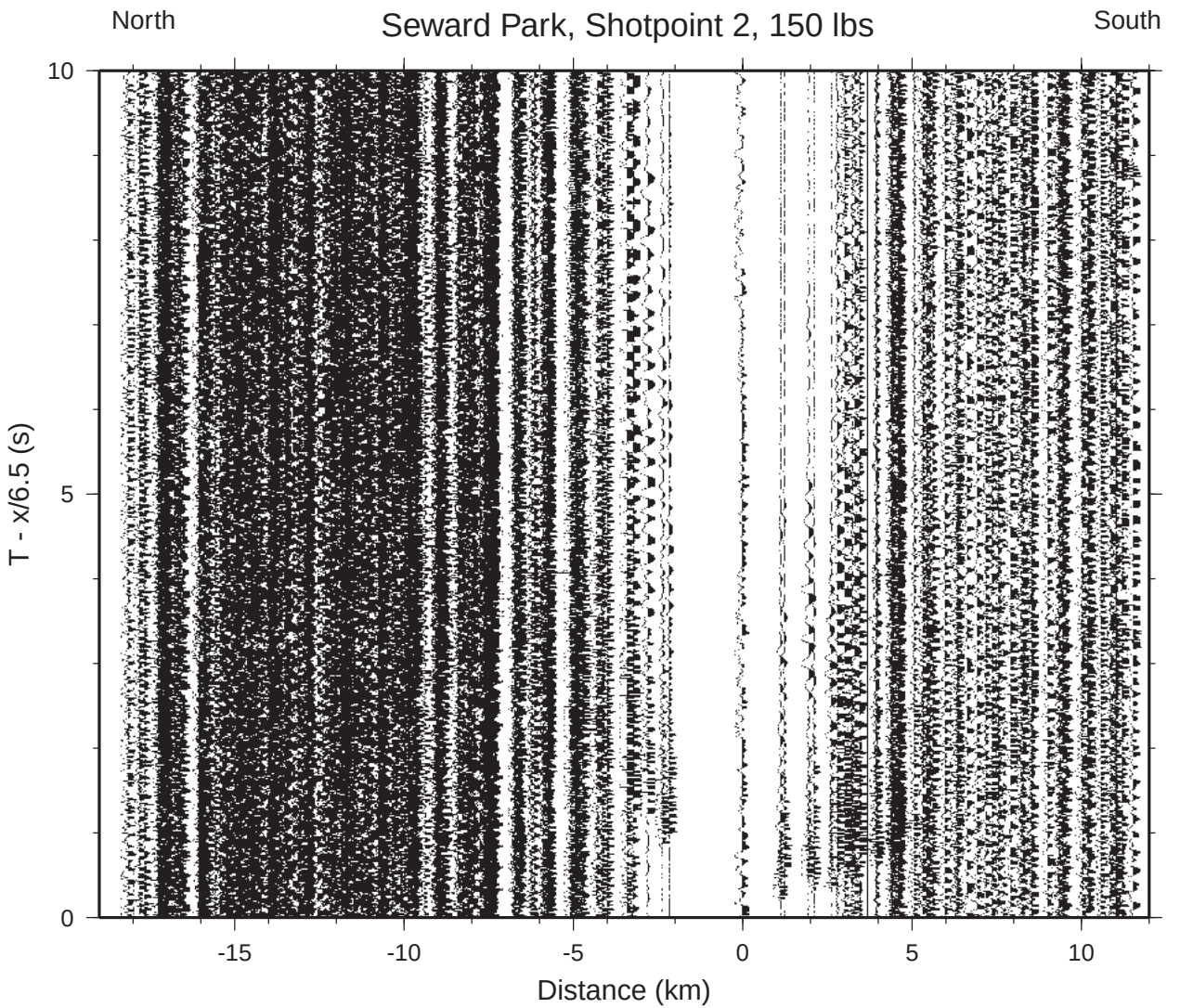

Figure 4. Record section for SP2 in Seward Park, filtered between 2 and 15 Hz.

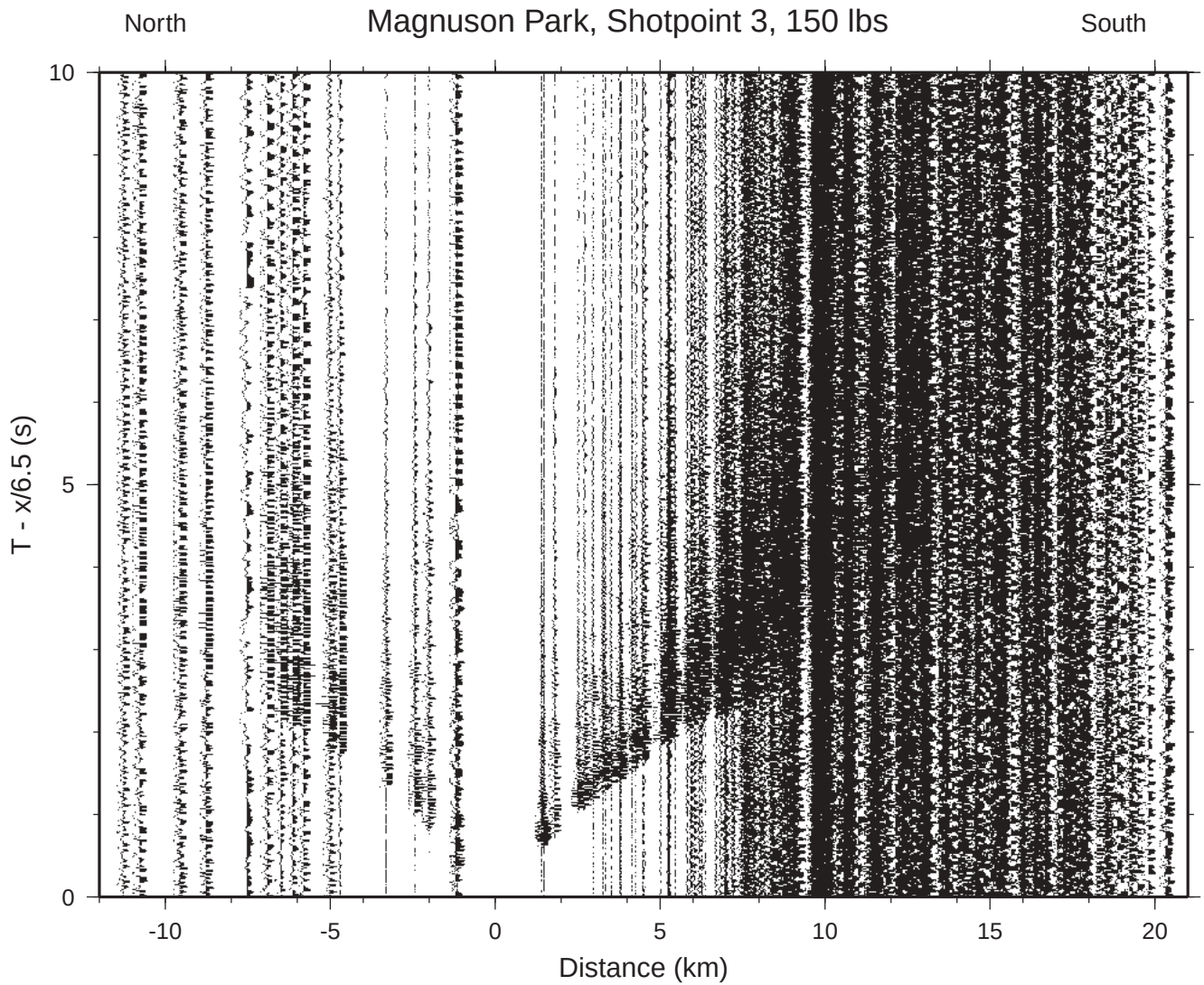

Figure 5. Record section for SP3 in Magnuson Park, filtered between 2 and 15 Hz.

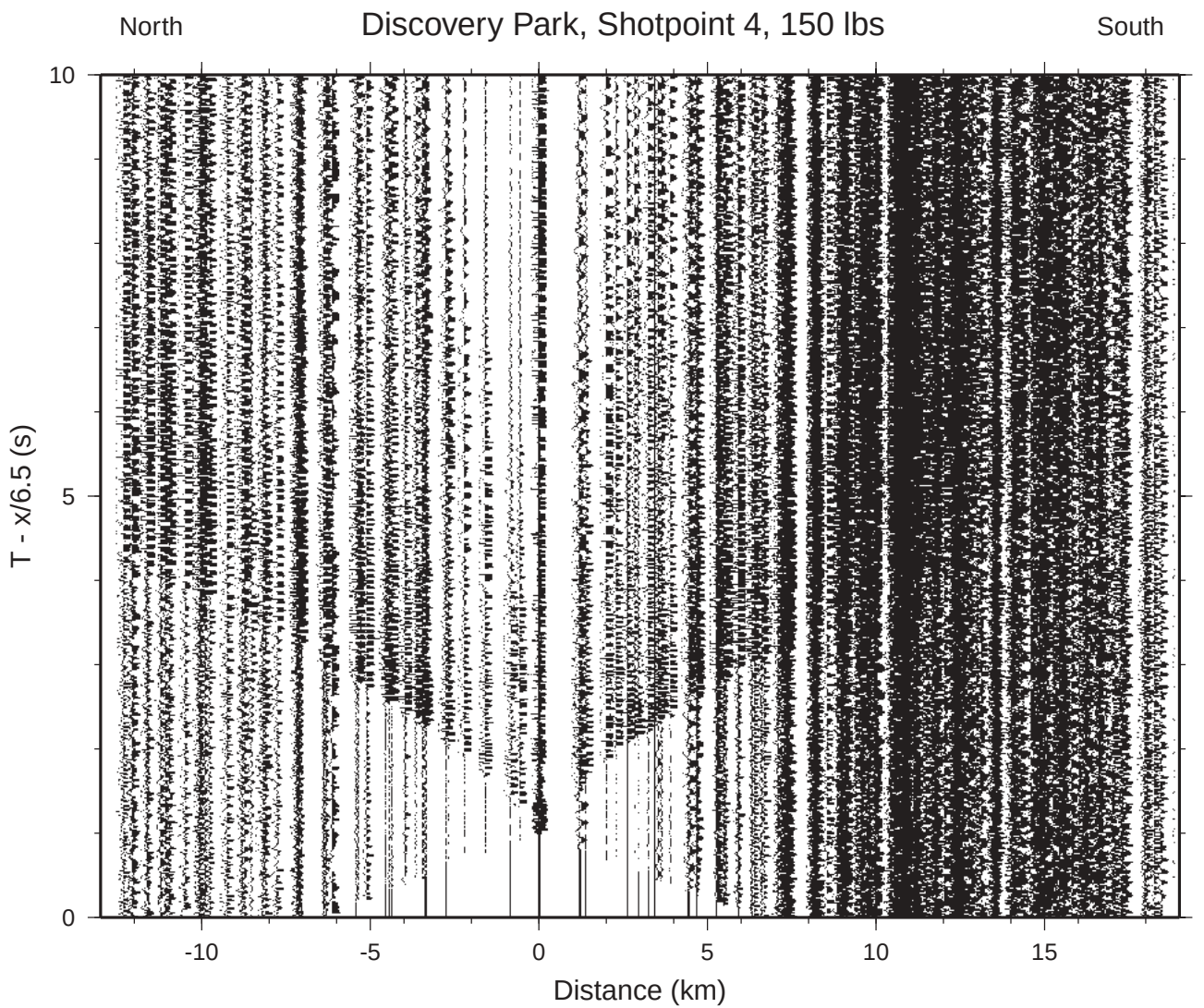

Figure 6. Record section for SP4 in Discovery Park, filtered between 2 and 15 Hz.

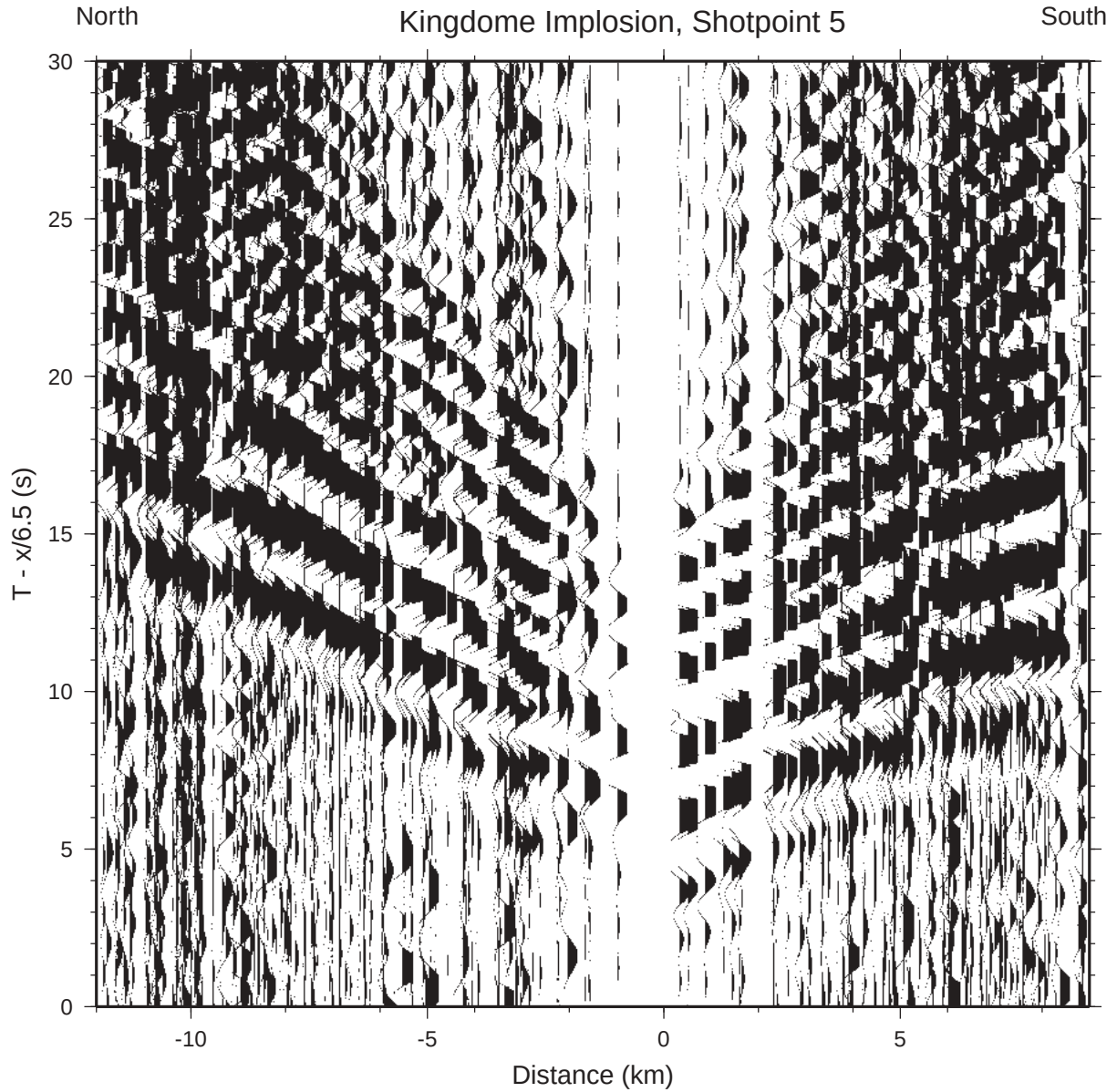

Figure 7. Record section for the implosion of the Kingdome (SP5) , filtered between 0.2 and 0.4 Hz.

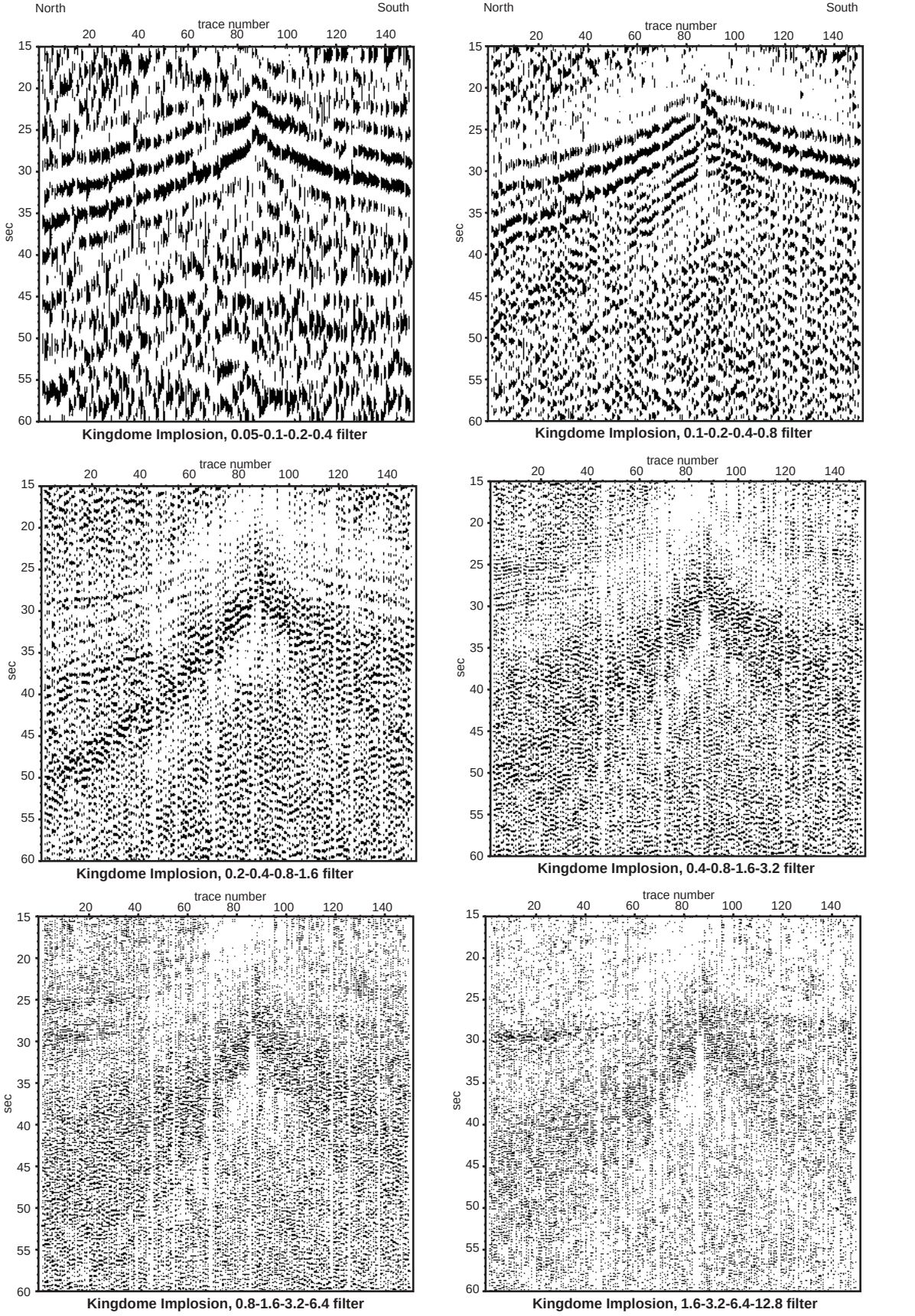

Figure 8. Record sections for the implosion of the Kingdome (SP5) , filtered between various bands.

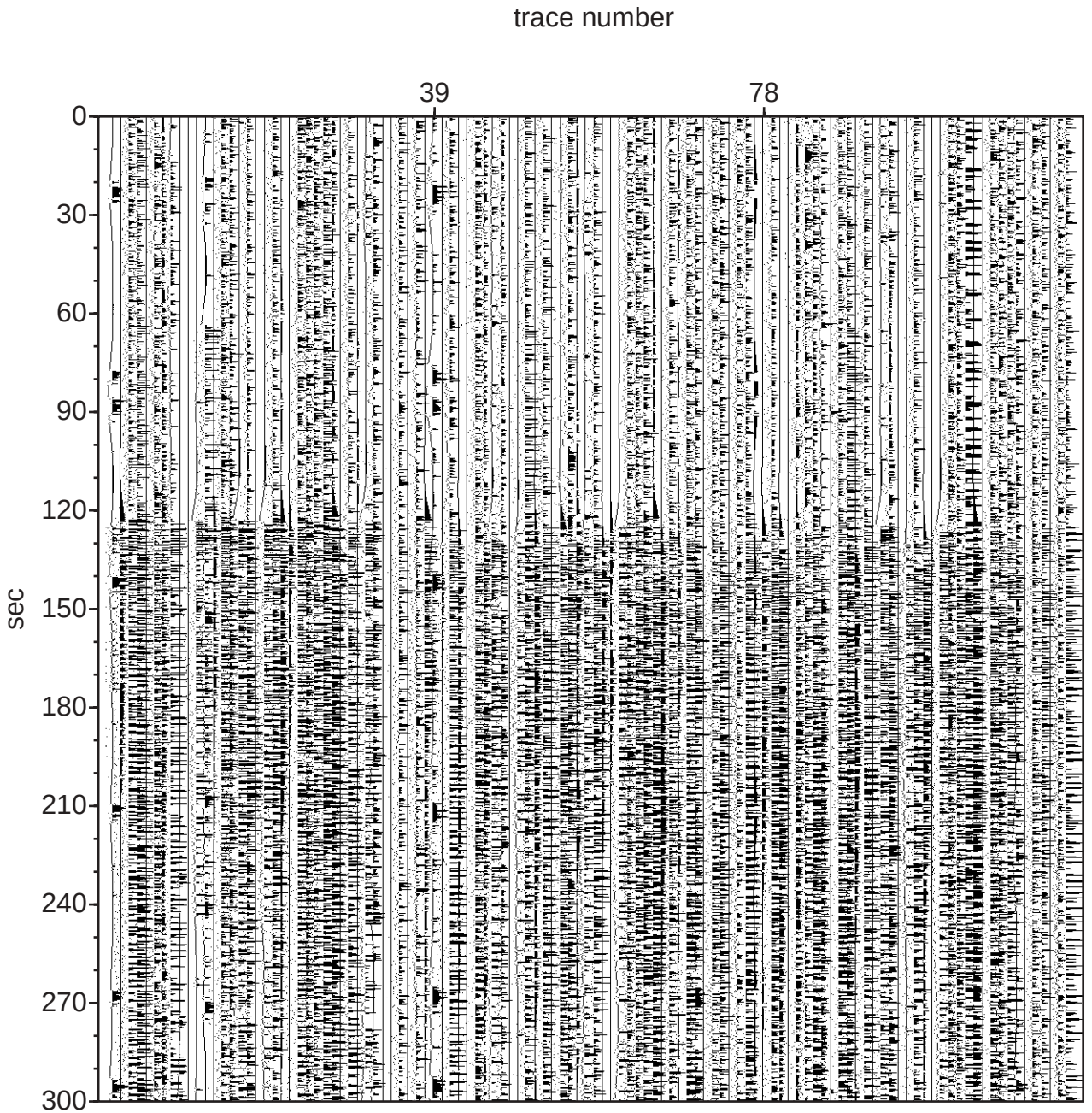

Figure 9. Recordings of the P-wave arrival from the Japan Volcano Islands earthquake.

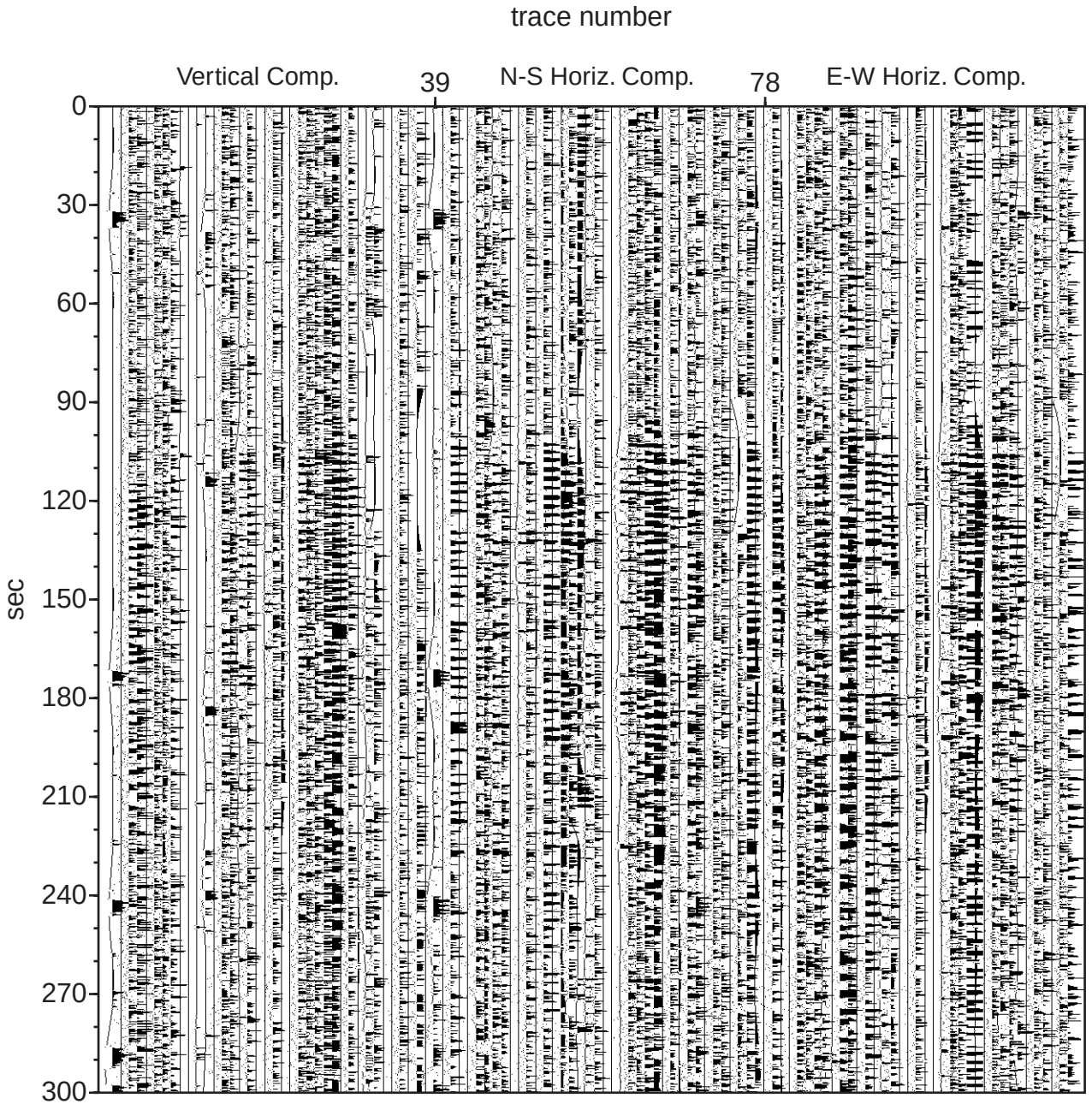

Figure 10. Recordings of the S-wave arrival from the Japan Volcano Islands earthquake.

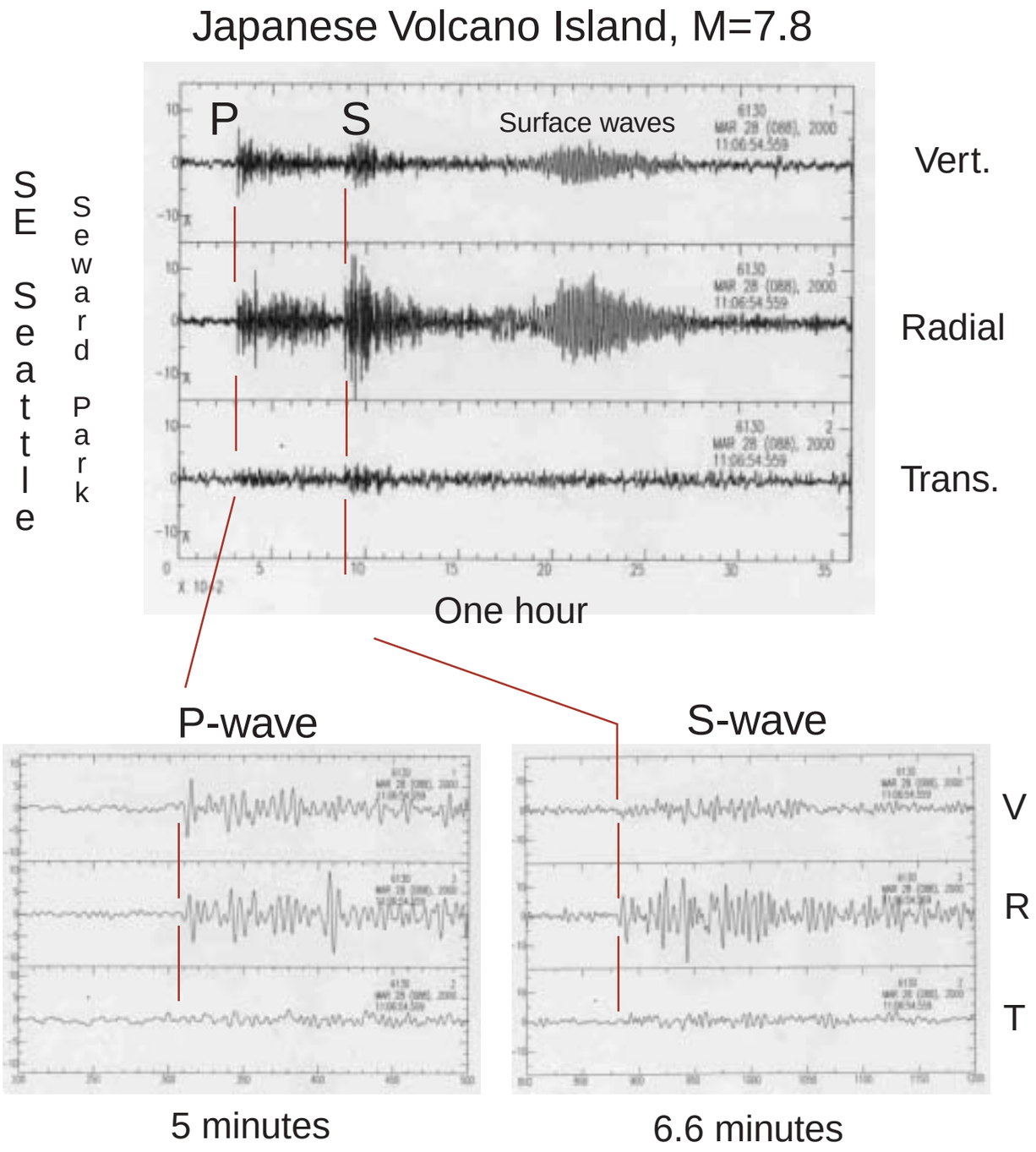

Figure 11. Record at Seward Park for the Japan Volcano Islands earthquake for periods between 4 and 7 seconds. Vertical, radial, and transverse components of motion are displayed.